Final Report
Site OK3A
Pork Production Facility

for the

NATIONAL AIR EMISSIONS MONITORING STUDY

to

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1 Overview

1.1 Introduction

The primary goals of the National Air Emissions Monitoring Study (NAEMS) were to: 1) quantify aerial pollutant emissions from dairy, pork, egg, and broiler production facilities, 2) provide reliable data for developing and validating emissions models for livestock and poultry production and for comparison with government regulatory thresholds, and 3) promote a national consensus on methods and procedures for measuring emissions from livestock operations. NAEMS consists of two components: a barn component and an open source component. Open source emissions measurements were conducted at a total of 10 different farms in the continental US. Farms chosen for monitoring were selected based on location (relative to climate and typical practice), method of manure collection, method of manure storage, and physical configuration of the buildings and lagoons/ basins relative to the surrounding terrain.

The NAEMS was managed by Purdue University, in its role as Independent Research Contractor (IRC) to the Agricultural Air Research Council (AARC). The Purdue Applied Meteorology Laboratory (PAML) maintained and calibrated equipment, collected samples, conducted all other on-site activities, and analyzed the data for all open sources.

The objective of this report is to present the quality-assured measurements of ammonia (NH_3) and hydrogen sulfide (H_2S) emissions from the waste lagoon open source at the western hog finisher facility. Within that objective, this report will:

- Describe the farm and the lagoon/basin monitored for the NAEMS
- Describe the monitoring methods and quality assurance
- Present tabulated daily averages of emissions

1.2 Procedures

To meet these objectives, gaseous emissions of NH_3 and H_2S from open sources were measured at a number of farm operations with a range of characteristics. Emissions were measured at a total of 10 farms over the course of two and one-half years.

The emissions from the lagoon were measured to determine the variation in emissions with time of year, stability of the atmosphere, and facility operation. Emissions were measured using models that rely on concentration and wind flow measurements. Lagoon emissions were measured for up to 21 days (d) each season over two years. The duration of measurement periods designated ‘up to 21 d’ depends on the weather conditions during the 21-d interval for measurement. The DQO for completeness stipulates a 75% completeness of 10 d per quarter. Setting aside 21 d per quarter to acquire at least 7.5 d of valid data (75% of 10 d) minimized the risk of not meeting this completeness DQO due to instrumentation problems associated with unfavorable weather conditions.

Atmospheric concentrations of NH_3 around the lagoon were measured using narrow-bandwidth open path tunable-diode laser absorption spectroscopy (TDLAS). Atmospheric measurements of H_2S concentrations were made using pulsed fluorescence (PF) technology from air collected from 50 m synthetic open path systems (S-OPS) and sampled from a gas sampling system (GSS) that drew the air through the S-OPS. Emissions of NH_3 were determined from the difference in upwind and downwind concentration measurements from the TDLAS open path systems using two emissions models: a Gaussian plume fit model (Radial Plume Mapping: *RPM*; Arcadis Inc, Denver, CO) and a backward Lagrangian Stochastic (bLS) model (*Windtrax*; Thunder Beach Scientific, http://www.thunderbeachscientific.com). Emissions of H_2S were determined using the concentration measurements from the PF analyzer from air sampled by the air inlets of the S-OPS using two emissions models: a Ratiometric model using the ratio of these concentrations to NH_3 concentrations along the same path with the corresponding *RPM* NH_3 emissions measurement, and the bLS model. The critical measurements needed to make the emissions measurements are described in Table 1-1.

Measurements of the lagoon pH, oxidation-reduction potential, and temperature at 0.3 m depth were also measured from a float located at least 30 m from the lagoon inlet (Table 1-2). Measurements of the atmospheric temperature, relative humidity, barometric pressure, solar radiation and wetness were measured and recorded at an automated weather station established on the lagoon berm (Table 1-2).

Table 1-1: Critical measurements.

Measurement	Method/ Instrument	Required operating range	MDL	Minimum sample frequency	Final data-aggregation
NH_3	TDLAS/ Boreal Laser, Inc. GasFinder2™	1-800 ppb	5 ppm-m	1.2 s dwell	30 min & 24 h
H_2S	PF/Thermo Environmental 450i analyzer	1-800 ppb	2 ppb	60 s averaging	30 min & 24 h
Wind speed	3D Sonic anemometer/ RM Young 81000	0-60 ms^{-1}	0.01 ms^{-1}	160 Hz sampling/16 Hz averaging	30 min & 24 h
Wind direction	3D Sonic anemometer/ RM Young 81000	0^{o} -360^{o}	0.1^{o}	160 Hz sampling/16 Hz averaging	30 min & 24 h
3D turbulence wind components	3D Sonic anemometer/ RM Young 81000	0-40 ms^{-1}	0.01 ms^{-1}	160 Hz sampling/16 Hz averaging	30 min
Temperature variability	3D Sonic anemometer/ RM Young 81000	-50 to +50°C	0.01°C	160 Hz sampling/16 Hz averaging	30 min
GSS sample flow rate	GSS/S-OS	10 L min^{-1}	0.1 L min^{-1}	30 s	30 min
GSS sampling manifold pressure	GSS/SOP-S	±60,000 Pa	±500 Pa	30 s	30 min
NH_3 emissions	Radial Plume Mapping Model	N/A	N/A	30 min	30 min, 24 h
H_2S emissions	Backward Lagrangian Stochastic Model	N/A	N/A	30 min	30 min, 24 h
NH_3 emissions	Backward Lagrangian Stochastic Model	N/A	N/A	30 min	30 min, 24 h
H_2S emissions	Ratiometric to RPM Model	N/A	N/A	30 min	30 min, 24 h

All measurements from around the lagoon (TDLAS, barometric pressure, air temperature and relative humidity, wetness, solar radiation, lagoon pH, lagoon oxidation-reduction potential, lagoon temperature, and wind) were telemetered to an instrumentation trailer on site via radio communications. The instrumentation trailer also housed the GSS (with associated pressure, flow, temperature, and humidity measurements) and PF analyzer for the measurement of H_2S in the S-OPS collected air and two computers that controlled the two TDLAS scanners and collected measurements made by the two TDLAS units. All measurements were then stored on a computer in the trailer and downloaded daily by file transfer protocol (FTP) via the internet to a computer located at the PAML.

Additional information concerning farm operations and the United States Department of Agriculture National Resource Conservation Service (USDA NRCS)-required analysis of wastewater used to irrigate nearby fields were routinely collected from the producers.

Table 1-2: Non-critical measurements.

Measurement	Method/Instrument	Required operating range	MDL	Minimum sample frequency	Final data-aggregation
Ambient temperature	Thermistor/ Campbell Scientific Inc HMP45C (Vaisala)	-40 to 50°C	0.1°C	5 min	30 min, 24 h
Relative humidity	Hygrometer/ Campbell Scientific Inc HMP45C (Vaisala)	0-100%	5%	5 min	30 min, 24 h
Barometric pressure	Aneroid barometer/ Setra 278	600 to 1100 hPa	600 hPa	5 min	30 min, 24 h
Surface wetness	VAC resistance grid/ Campbell Scientific Inc.	(binary)	(binary)	5 min	30 min & 24 h
Solar radiation	Silicon pyranometer/ LiCOR 190SB	0- 1200 Wm^{-2}	10 Wm^{-2}	5 min	30 min & 24 h
Lagoon solids depth	Sludge level detector/ SludgeGun 10HD, Markland Specialty Eng.	0-10 m	0.05 m	1/ measurement period	1 time
Lagoon/ basin pH	Campbell Scientific Inc CSIM11 (Innovative Sensors, Inc)	0-14 units	0.2 unit	5 min	30 min & 24 h
Lagoon/ basin oxidation-reduction potential	Campbell Scientific Inc CSIM11-ORP (Innovative Sensors, Inc)	-800 - +1100 mV	20 mV	5 min	30 min & 24 h
Lagoon/ basin temperature	Thermistor/ Campbell Scientific Inc 107-L	-35 - +50°C	0.5°C	5 min	30 min & 24 h

1.3 Farm description and operation

The western finisher facility was located in Oklahoma. The elevation at the farm was 927 m. The farm consisted of three barns (Fig. 1-1). The facility had a maximum capacity of 3,024 finishing pigs. Construction was completed in 1997.

Manure from the barns was transferred three times a week to the lagoon by a pull plug system with lagoon water recharge. Waste water from all three units combined into one inlet. The waste lagoon was rectangular and was located to the west of the barns (separated by a drainage swale). The clay-lined lagoon was 59 m wide and 210 m long, and was oriented north-south. The lagoon bank was clay, with a berm slope of 3.8:1. At maximum capacity, the liquid depth 6 m with a surface area of 22,500 m^2 and a volume of 28,700 m^3. Liquid was removed approximately every six months. Sludge from the lagoon had not been removed since construction (20-yr sludge removal cycle). Since the gaseous lagoon emissions emanate from manure and effluent residing in the lagoon for multiple months, it was assumed that the number of animals contributing to the lagoon was the maximum capacity of the farm.

Figure 1-1: Configuration of the OK3A farm.

1.4 Operational events and changes

A number of feed changes occurred at this location during the study period (Table 1-3).

Table 1-3: Operational changes during the study.

Period	Events during period
2: 8/29 - 9/19/2007	8/30/2007 feed change: Paylean 4.5g 9/13/2007 feed change: Paylean 6.5g
4: 5/7 - 5/29/2008	5/7/2008 feed change: Paylean 4.5g all 3 barns. 5/20/2008 feed change: Paylean 6.5g north barn 5/22/2008 feed change: Paylean 6.5g middle and south barns.

1.5 Measurement layout

The NH_3 emissions from the basin were monitored for 8 to 20 d each quarter of the year for two years using scanning Tunable Diode Laser Absorption Spectrometer (TDLAS) open-path instruments and 3-dimensional (3D) sonic anemometers, in conjunction with meteorological measurements and the radial plume mapping (*RPM*) and backward Lagrangian Stochastic (bLS) emissions models. The H_2S emissions from the lagoon were monitored using pulsed-florescence (PF) of air sampled through a Synthetic Open Path System (S-OPS) and 3-dimensional (3D) sonic anemometers, in conjunction with meteorological measurements and both the bLS emissions model and the *RPM* emissions model in combination with the ratiometric relationships of measured NH_3 and H_2S concentrations.

The path-integrated concentrations (PICs) of NH_3 were measured by TDLAS along optical paths defined by TDLAS/scanner systems and retro-reflectors. The scanning TDLAS instruments (TDLAS/scanner) were mounted at 1-m height above the lagoon berm (abl) at the northwest and southeast corners (Figure 1-2). Towers for mounting retro-reflectors were located off the northeast and southwest corners of the lagoon (Figure 1-2). A description of the position and path length of the optical paths along each side of the lagoon follows:

- <u>North side</u>: Retro-reflectors were located on anchored tripods at 1 m abl at distances of 21 m and 42 m from the northwest TDLAS/scanner. Three retro-reflectors were mounted on the northeast tower 63 m from the TDLAS/scanner at heights of 0.85 m, 6.65 m, and 14.1 m abl.
- <u>East side</u>: Retro-reflectors were located on anchored tripods at 1 m abl at distances of 69 m and 138 m from the southeast TDLAS/scanner. Three retro-reflectors were mounted on the northeast tower 215.5 m from the TDLAS/scanner at heights of 0.85 m, 6.65 m, and 14.1 m abl.
- <u>South side</u>: Retro-reflectors were located on anchored tripods at 1 m abl at distances of 20 m and 40 m from the southeast TDLAS/scanner. Three retro-reflectors were mounted on the southwest tower 68 m from the TDLAS/scanner at heights of 1.1 m, 6.8 m, and 14.2 m abl.
- <u>West side</u>: Retro-reflectors were located on anchored tripods at 1 m abl at distances of 70 m and 144 m from the northwest TDLAS/scanner. Three retro-reflectors were mounted on the southwest tower 219.5 m from the TDLAS/scanner at heights of 1.1 m, 6.8 m, and 14.2 m abl.

Two synthetic PICs of H_2S were measured by PF from air sampled from linear S-OPS positioned at 1-m abl. A 50-m long S-OPS path was parallel to and 5 m north of the north berm and began at the northwest berm corner and extended east (Figure 1-2). The second 50-m long S-OPS was parallel to and 5 m south of the south lagoon berm and began at the southeast corner of south berm and extended west (Figure 1-2). The flow through the S-OPS was maintained and sampled by a gas sampling system (GSS) located in the on-site instrumentation trailer. The temperature and humidity of the air flowing through the GSS, as well as the flow rate through and the suction in the negative-pressure portion of the GSS were measured and recorded on a data logger (Model CR800, Campbell Scientific, Logan, Utah).

Meteorological measurements (barometric pressure, air temperature and relative humidity, solar radiation, and surface wetness) were made 10 m south of the northwest berm corner (Fig. 1-2). The 3D sonic anemometers were located on the meteorological tower at 2.5 m abl and on the southwest corner tower (Fig. 1-2) at 4.6 m and 16.3 m abl.

The barns located 10 m to the west of the lagoon berm have an approximate ridge height of 5.8 m agl, which resulted in a fetch ratio of 6:10 to the east side of the lagoon. Fetch in all other directions was better than 1:100, with upwind interference from center-pivot irrigated crops (Fig. 1-1). Due to the proximity of the barns, emissions from wind directions of 90 ^{o} to 135^{o} were excluded from analysis. The aerodynamic roughness of the barns (5.8 m high) contributed to non-homogeneous surface roughness. All fans exhausted on the East side of the barns and therefore did not influence the lagoon PIC measurements except under easterly winds (which were not the prevailing winds at any time of the year).

Lagoon measurements (pH, oxidation-reduction potential, and temperature) were made from a float located in the northwest corner of the lagoon.

Figure 1-2: Locations of instrumentation around the lagoon under measurement. Retro-reflectors are indicated according to side (north, south, east, and west) with 345 indicating the location of a tower. TDLAS/scanner locations are indicated by TS. The locations of the two S-OPS are indicated by the solid yellow lines. The instrumentation trailer was located on the east side of the lagoon.

2 Monitoring activities

2.1 Measurement periods

This location was measured for approximately 20 d each season in rotation with three other farms. The equipment was on site a total of 161 d over eight measurement periods (Table 2.1-1). Setup calibrations and site takedowns reduced the number of measurement days from the total number of days on site. NH_3 emissions were measured 155 d and H_2S emissions were measured 120 d.

Table 2.1-1: Days on site

Measurement period	Start date	End date	# days
2	8/30/2007	9/18/2007	19
3	1/24/2008	2/19/2008	26
4	5/7/2008	5/29/2008	22
5	5/29/2008	6/10/2008	12
6	11/5/2008	12/2/2008	27
7	12/2/2008	12/16/2008	14
8	4/23/2009	5/14/2009	21
9	7/15/2009	8/4/2009	20

2.2 Site visits

The field operation team visited this farm 33 d (Table 2.2.1). Visits to set up the site instrumentation and conduct calibration verification checks of instruments typically lasted 3 d, while visits for calibration verifications and take-down of the equipment on site typically lasted 2 d.

Table2.2-1 Dates of site visits

Year	Spring	Summer	Fall	Winter
2007		Aug 30,31	Sep 18,19	Jan 24,25 Feb 5,6,19
2008	May 6,7,8 19,28,29	Jun 10,	Nov 5,6,7,17	Dec 2,3,16,17
2009	Apr 21,22,23 May 6,14	Jul 14,15,16 Aug 4		

2.3 Instrumentation QA/QC

Calibration verification checks of the instruments making the critical measurements and some of the non-critical measurements most susceptible to deterioration were generally conducted within 21 d intervals on site. Instruments checked during these visits (with indication of Section documenting the instrument performance and calibration verification check results) included:

- GasFinder2™ NH_3 TDLAS serial number (s/n) 1026, 1027, 1028, 1029, 1031 and 1032 (Section 6.1)
- TEC 450i H_2S Analyzer s/n 0733825128 (Section 6.2)
- RM Young 81000 3D sonic anemometers s/n 1920, 1921, 1927, 1928, 1932, 1936 and 1938 (Section 6.3)
- lagoon pH probes s/n 002, 0008, and 009 (Section 6.4)
- lagoon ORP probe s/n 020, 030 and 050 (Section 6.5)
- GSS/ S-OPS s/n 4-0017 (Section 6.6)

In addition, the instruments making the critical measurements were calibrated at least semi-annually. During the semi-annual calibrations, multi-point calibrations were conducted on the TDLAS (Section 6.1) and TEC 450i (Section 6.2) instruments and an inter-comparison conducted on the sonic anemometers (Section 6.3) with three unused 'standard' anemometers. A further QA check was made by inter-comparing TDLAS units: on May 28, 2009 two TDLAS units were inter-compared on site (s/n 1026 and 1032).

2.4 Audits

Three internal audits were conducted at this location: 1) on May 28, 2008, with particular attention to the TDLAS calibration verification and the lagoon probe calibrations, 2) on December 2, 2008, with particular attention to the H_2S Analyzer and TDLAS calibration verification and the checks on the meteorological sensors, and 3) on April 23, 2009, with particular attention to the sonic anemometer inter-comparison and the lagoon probe calibrations. The TDLAS units on location (s/n 1026 and 1032) were inter-compared on May 28, 2008.

2.5 Repair trips

Four repair trips were made to this location: February 5-6, 2008, May 19, 2008, November 17, 2008, and May 6, 2009.

2.6 Remote site checks

Over the course of measurements, there were 55 remote checks made from PAML through the computer for instruments operating at this location.

2.7 Measurement data acquisition

Data from the TDLAS units (Model GasFinder2™ NH3-OP, Boreal Laser Inc., Spruce Grove, Alberta, Canada) were acquired using the Boreal Laser *GasView MP* software (Boreal Laser Inc., Spruce Grove, Alberta, Canada) program running on laptops dedicated to this purpose (one laptop per TDLAS unit). The TDLAS units sent back data through 2.4 GHz wireless modems about every 1.2 s. This software also controlled the movements of the scanner (Model PTU-D300, Directed Perception Inc., Burlingame, CA) that aimed the TDLAS units.

Weather and lagoon data were saved to the internal memory of the data logger (Model CR1000, Campbell Scientific Inc, Logan, UT) at 5-min intervals. Optimally, these data were transferred to the trailer through 2.4 GHz wireless modem at intervals of 10 min using *LoggerNet* software (Campbell Scientific Inc, Logan, UT). However, communications interference at a number of sites significantly impeded this regular data transfer. Thus, it was sometimes necessary to download data directly to a laptop during site visits. The data were then transferred from the laptop to the trailer computer using a USB thumb-drive. As a backup, all data were also stored on a compact flash memory card that was brought back to Purdue and downloaded after each period.

Data from the gas sampling system (GSS) were saved to a data logger (Model CR800, Campbell Scientific Inc, Logan, UT) located in the trailer at intervals of 30 s. These data included the line currently being sampled and the mass flow rate. The data were transferred through a serial cable to the trailer computer every 10 min using *LoggerNet*.

Data from the H_2S analyzer (Model 450i, Thermo Fisher Scientific, Franklin, MA) were downloaded in real-time through a serial cable to the trailer computer using the *iPort* (Thermo Fisher Scientific, Franklin, MA) software program. The *iPort* software frequently disconnected from the analyzer, so that during our daily status checks from PAML it was frequently necessary to reconnect *iPort* to the analyzer, download data back to the time when *iPort* had crashed and stopped collecting data, and restart real-time data collection

Data from the 3D sonic anemometers (Model 81000, RM Young Inc., Traverse City, MI) were downloaded to the data acquisition computer in the trailer using custom built *Visual Basic* software. Binary data from up to four anemometers were transferred at 16 Hz through 900 MHz wireless modems to a single polling modem connected to the data acquisition computer in the trailer. The software time stamped and stored each 16 Hz data point and calculated 100-s and 300-s averages, variances, and covariances for each component of the wind and the sonic temperature.

Files were transferred from the instrument trailers to the PAML FTP server using the program *rsync* in the *cygwin* environment (open source programs). This transfer took place every 6 h, as long as the internet connection was available. The program was set up so that only new or modified files were transferred each time, so that only the updated data were transferred. A log of each file transferred was produced by the *rsync* program. The *rsync* program was used to transfer data daily from the PAML FTP server to the PAML data computer. This transfer was performed early each morning before the automated quality control software runs. Two copies of the data were stored on the Data computer. One copy was placed in the directory “FTP” and was never modified. This copy represents the original data as transferred from the trailers. The other copy of the data was placed in the directory “Data”. The data processing and quality control programs used this copy of the data, and modifications and corrections were made to this copy of the data as needed to allow the data to be processed. These modifications will be described below. It is important to note that no actual data numbers were changed during these modifications.

In addition to the copies of the data transferred over the internet, a copy of the data for each period was produced on a CD and DVD. To ensure complete and accurate data transfer, a data comparison program was used to compare the data on the CD/DVDs with the data in the “FTP” directory.

3 Data Processing and analysis

Before final data processing, the data files were examined to ensure that they were ready to be processed. Modifications to the files were required due to human error, issues related to changing from one site or period to another, and bugs in the data collection software. None of the actual data were modified in this file preparation, only filenames and/or the file in which the data appeared were changed. A detailed log was kept of each modification.

Deleting empty files: Data files created but not filled with data occurred as a byproduct of the data collection systems. The sonic anemometer data collection program was set up to start automatically when the trailer LAN server computer (hereafter termed LAN) was started. As a result, when the LAN was started at a new location empty files were often created because the sonic anemometers were not yet in place. If the location and/or period were not adjusted in the sonic parameter input file before the computer was shut down at the previous site, these empty files would be present in the directory from this previous location or period. These empty files contain no data and were deleted. Empty files also sometimes occurred for the TDLAS units if the TDLAS laptop was still logging but no data were being transferred from the TDL. These empty files were generally deleted, although they were sometimes retained since empty files can be handled by the data analysis and QC software. Even if deleted from the “data” directory, these empty files were still present in the “FTP” directory, and in some cases these empty files were useful in determining whether missing TDLAS data are due to problems with the TDLAS unit itself or with the TDLAS data collection laptop computer. Empty files in other data sets were also deleted.

Moving/deleting data from surrounding periods: When moving from one site to another or switching periods during a “back-to-back” site visit, several changes needed to be made for the data to be saved in the directories for the new site or period. If these changes were not made when the LAN was first started or before the computer was shut down at the preceding site, data for the new site was often saved in the directory for the preceding site. Data were moved from the file for one site to the file for the correct site. Data to be moved were identified by breaks in the data timestamps corresponding to the period when the equipment was shut down and in transit from one site to the next. Data were most often moved in the files for the CR1000 data logger and GSS (CR800 data logger), as these data files started adding new data immediately when the LAN was turned on, and it was easy to forget to immediately make the directory and file name change in *Loggernet*.

Combining data files: The *iPort* software used to collect data from the H_2S analyzer occasionally lost its connection with the analyzer causing the data collection to stop. These events were noticed during the daily site checks from PAML at which time the missing data were filled from the internal memory on the analyzer and a new data file was started to collect the data in real-time. To allow the quality control software to run most efficiently, these multiple data files were combined into a single file at the conclusion of the period. The files that were included in this single file were placed in a subdirectory of the H_2S data folder named “Pieces”. On isolated occasions, the CR1000-logged or CR800-logged data for a period were split into more than one file, and these data files were generally combined into a single file for the period, unless a change was made to the data stream in between the files (e.g. adding temperature and relative humidity probe to the gas sampling system output).

Renaming files: On some occasions, files had to be renamed due to human error in naming the files or, in the early days of the project, because of the lack of a finalized file structure in which the field operations staff had been trained. These changes were primarily to the TDLAS data files, when the files on the TDLAS laptops were not named appropriately or else TDLAS1 and TDLAS2 were reversed. Various files for other instruments also had to be renamed for a variety of reasons.

Data Processing and Quality Control Input Files: The data processing and quality control software programs require inputs that describe the data to be analyzed. The input parameters for a given site and period are in a single *Excel* workbook consisting of a separate worksheet for each component of the data processing software. These parameter files were produced and then independently double-checked for errors.

3.1 QA/QC software procedures

The valid data times were produced by examining the data in a preliminary run through the data and finding in the records the times when the instrument was calibrated and times when the instrument was known to be malfunctioning. The data excluded as being from a calibration or period of instrument malfunction were placed in separate columns in the output files and plotted in a different color on the output graphs.

Because measurements were acquired on various data acquisition systems, time synchronization of the various systems was critical. The time synchronization data were obtained from the remote site visits conducted as part of the daily status checks. Time corrections were only included if the instrument time was more than one minute off from the LAN. In the end, corrections were made only to the TEC 450i H_2S analyzer as this instrument would infrequently be out of sync by several minutes due to issues with its automatic time updates. The time synchronization is especially important for the TEC 450i because it samples from lines located on both sides of the lagoon and the time difference could lead to H_2S concentrations being recorded for the wrong S-OPS line (side of source).

One worksheet in the *Excel* parameter workbook for each site contains a list of the times of valid data for each data stream and one worksheet indicates when an instrument was out of time synchronization with the LAN as well as the time correction required to bring the data stream into time synchronization with the LAN.

Once the data files were prepared for final processing and the input parameter files were produced for each site and period, the data were processed through the custom designed software for this purpose. Through the duration of the project, each data stream was processed through a separate program, but in preparation for the final data processing these individual programs were combined into a single program to allow for more efficient data processing and easier debugging, as processes that were previously done multiple times in the earlier software versions are now done only once.

The order in which the various data streams were processed was determined by the dependencies in the data processing and quality control between the various instruments: a given data stream may depend on one or more of the preceding streams, but not on following data streams. For each data stream, the data were first loaded into arrays and any corrections for time synchronization applied. The flags were then assigned based on the QAPP. After this, the data exclusion times were applied and the data appropriately broken up into columns. Finally, the data were loaded into *Excel*, plots were produced, and the final data files were saved.

3.2 Data exclusions

Data were excluded from processing due to equipment failures, calibration failures, and calibration checks in progress. Periods of invalidated measurements associated with the calibration check failures are documented in the calibration reports in Section 6. Significant data exclusions of greater than one-day duration are indicated below by instrument with all time references in Coordinated Universal Time (UTC:

TDLAS measurement exclusions: Excluded measurements are summarized in Table 3.2-1.

Table 3.2-1: TDLAS measurement exclusions

Begin		End		Reason
9/9/2007	15:00	9/11/2007	18:53	TDLAS 1 Has no data, unknown cause
9/10/2007	20:02	9/18/2007	13:00	TDLAS 2 Shutter failed
2/7/2008	06:30	2/19/2008	00:00	TDLAS 1 Scanner failed
5/9/2008	00:40	5/28/2008	12:00	TDLAS 1 Scanner failed
11/7/2008	14:41	11/17/2008	15:55	TDLAS 2 Power supply unstable
11/27/2008	05:20	12/2/2008	22:00	TDLAS 2 Laptop Locked up
4/22/2009	23:58	5/2/2009	09:30	TDLAS 1 Centerline Duty Cycle failure
4/23/2009	22:27	5/6/2009	23:30	TDLAS 2 Missing Data (TDLAS Failure)
5/8/2009	15:00	5/14/2009	15:00	TDLAS 1 Scanner failed: Pan-tilt error
7/27/2009	05:10	7/30/2009	19:32	TDLAS 1 Power failed from storm
8/1/2009	02:00	8/3/2009	15:25	TDLAS 1 Power failed from storm

TEC 450i measurement exclusions: Excluded measurements are summarized in Table 3.2-2.

Table 3.2-2: TEC 450i measurement exclusions

Begin		End		Reason
2/2/2008	07:00	2/4/2008	15:30	Data not retrieved on time
2/7/2008	06:30	2/7/2008	21:30	Data not retrieved on time

Air temperature and relative humidity measurement exclusions: There was often no communications between meteorological data logger and trailer. However measurements were stored on the internal data storage module. Excluded measurements are summarized in Table 3.2-3.

Table 3.2-3: Air temperature and relative humidity measurement exclusions

Begin		End		Reason
9/9/2007	08:10	9/10/2007	17:30	Power failed at farm
5/6/2008	22:15	5/8/2008	14:45	FOS on site; data logger unplugged
5/15/2008	02:45	5/19/2008	21:30	Power failure at meteorological station
7/27/2009	05:10	7/30/2009	19:32	Power failure at meteorological station
8/1/2009	02:00	8/3/2009	15:25	Power failure at meteorological station

Solar radiation measurement exclusions: There was often no communications between meteorological data logger and trailer. However measurements were stored on the internal data storage module. Excluded measurements are summarized in Table 3.2-4.

Table 3.2-4: Solar radiation measurement exclusions

Begin		End		Reason
9/9/2007	08:10	9/10/2007	17:30	Power failed at farm
5/6/2008	22:15	5/8/2008	14:45	FOS on site; data logger unplugged
5/15/2008	02:45	5/19/2008	21:30	Power failure at meteorological station
7/27/2009	05:10	7/30/2009	19:32	Power failure at meteorological station
8/1/2009	02:00	8/3/2009	15:25	Power failure at meteorological station

Wetness measurement exclusions: There was often no communications between meteorological data logger and trailer. However measurements were stored on the internal data storage module. Excluded measurements are summarized in Table 3.2-5.

Table 3.2-5: Wetness measurement exclusions

Begin		End		Reason
9/9/2007	08:10	9/10/2007	17:30	Power failed at farm
5/6/2008	22:15	5/8/2008	14:45	FOS on site; data logger unplugged
7/27/2009	05:10	7/30/2009	19:32	Power failure at meteorological station
8/1/2009	02:00	8/3/2009	15:25	Power failure at meteorological station

Barometric Pressure measurement exclusions: There was often no communications between meteorological data logger and trailer. However measurements were stored on the internal data storage module. Excluded measurements are summarized in Table 3.2-6.

Table 3.2-6: Barometric Pressure measurement exclusions

Begin		End		Reason
9/9/2007	08:10	9/10/2007	17:30	Power failed at farm
5/6/2008	22:15	5/8/2008	14:45	FOS on site; data logger unplugged
5/15/2008	02:45	5/19/2008	21:30	Power failure at meteorological station
7/27/2009	05:10	7/30/2009	19:32	Power failure at meteorological station
8/1/2009	02:00	8/3/2009	15:25	Power failure at meteorological station

Sonic anemometer measurement exclusions: Sonic anemometers experienced communications interference throughout the study. Excluded measurements are summarized in Table 3.2-7.

Table 3.2-7: Sonic anemometer measurement exclusions

Begin		End		Reason
9/9/2007	08:10	9/10/2007	17:30	Sonic 1 Power failed
9/5/2007	20:30	9/6/2007	18:25	Sonic 2 No Data Sent
1/28/2008	18:50	1/31/2008	15:30	All Sonic anemometers fail, Program Failure?
2/5/2008	07:50	2/6/2008	18:25	All Sonic anemometers fail due to ice storm
2/10/2008	15:50	2/11/2008	16:09	All Sonic anemometers fail due to ice on sonic anemometers
5/15/2008	02:45	5/19/2008	21:30	Sonic 1 Power failure at met station
12/8/2008	18:10	12/10/2008	19:15	All Sonic anemometers program error
12/12/2008	15:15	12/16/2008	16:30	All Sonic anemometers program error
7/27/2009	05:10	7/30/2009	19:32	Sonic 1 Power failed from storm
8/1/2009	02:00	8/3/2009	15:25	Sonic 1 Power failed from storm

Lagoon temperature, pH, and ORP measurement exclusions: There was often no communications between meteorological data logger and trailer. However measurements were stored on the internal data storage module. Lagoon measurements stopped during winter due to expected lagoon freezing before next 20 day visit. Excluded measurements are summarized in Table 3.2-8.

Table 3.2-8: Lagoon temperature, pH, and ORP measurement exclusions

Begin		End		Reason
Lagoon temperature exclusion times				
1/24/2008	21:00	2/19/2008	21:15	No probes for this period, lagoon frozen
5/6/2008	22:15	5/8/2008	14:45	FOS on site; data logger unplugged
5/15/2008	02:45	5/19/2008	21:30	Power failure at meteorological station
7/27/2009	05:10	7/30/2009	19:32	Power failure at meteorological station

8/1/2009	02:00	8/3/2009	15:25	Power failure at meteorological station
Begin		**End**		**Reason**
Lagoon pH exclusion times				
7/15/2009	16:20	8/4/2009	18:30	Probe did not pass calibration at beginning or end of period
1/24/2008	21:00	2/19/2008	21:15	No probes for this period, lagoon frozen
5/6/2008	22:15	5/8/2008	14:45	FOS on site; data logger unplugged
5/15/2008	02:45	5/19/2008	21:30	Power failure at meteorological station
7/27/2009	05:10	7/30/2009	19:32	Power failure at meteorological station
8/1/2009	02:00	8/3/2009	15:25	Power failure at meteorological station
Begin		**End**		**Reason**
Lagoon ORP exclusion times				
1/24/2008	21:00	2/19/2008	21:15	No probes for this period, lagoon frozen
5/6/2008	22:15	5/8/2008	14:45	FOS on site; data logger unplugged
5/15/2008	02:45	5/19/2008	21:30	Power failure at meteorological station
7/27/2009	05:10	7/30/2009	19:32	Power failure at meteorological station
8/1/2009	02:00	8/3/2009	15:25	Power failure at meteorological station

GSS/S-OPS measurement exclusions: Rodents chewed through south S-OPS; measurements excluded from 6/8/2008 06:00 through 6/10/2008 21:30.

3.3 Data correction procedures

Calibration adjustments based on the multipoint calibrations and calibration verifications were made to the NH_3 and H_2S gas concentration measurements. All concentration measurements were normalized to 101.325 kPa and 20^{o}C (STP) within the instruments. The measured system response corrections used the entire record of calibration verifications and adjusted for a bias associated with the sampling system defined by the EPA Method 301 S-OPS validation by using a correction factor of 0.98. No corrections were required for the sonic anemometer measurements.

3.4 Data validation procedures

3.4.1 NH_3 concentration measurements

Because of the nature of the TDLAS data, the TDLAS routine is the most complicated portion of the data processing and quality control software. It is broken into several subroutines. The first subroutine flags pan/tilt locations that are likely to be in super-saturated “holes” in the retro-reflector array. The TDLAS instrument contains a sensor that detects the intensity of the energy returned from the retro-reflector in arbitrary units. Light levels of between 500 and 12000 are required for data to be considered valid. The light level sensor in the TDLAS instrument has a maximum value of 16368 (arbitrary units). Additional returned energy causes the light level to decrease. This creates a super-saturated condition in which the light levels appear valid, but in reality the returned energy is much greater than the allowable threshold for a valid reading. This leads to erroneous instrument readings, frequently indicated by low r^2 values that are associated with large path integrated concentrations (PICs). The term “hole” refers to a region of light levels that appear valid surrounded by maximized light levels. A hole is a region where the instrument will give faulty data, even though the light levels appear valid. The hole-finding algorithm goes through all the data points defined in “optimize” strings output by the instrument each time the scanner moves to a new location and determines data points that either have maximized light levels (16368) on the current day or else are surrounded above and below or to the left and to the right by points that have maximized light levels on the current day. The routine produces a list of locations (pan and tilt) and days that are probably super-saturated.

The next subroutine inputs all the concentration data and calculates averages over each dwell on a retro-reflector array. A scanner moved the TDLAS from one retro-reflector to another, dwelling for about 15 s on each retro-reflector array. The *GasView MP* program produced a flag that indicated when the scanner was moving. Once this flag indicated that the scanner had stopped its movement, one additional 1-second value was ignored, and then the remaining points were averaged to produce the dwell averages. The additional ignored value helped reduce the occurrence of data from the preceding path leaking into the current path because of communications delays.

On the next pass, concentration data from pan/tilt locations and days that were determined to be super-saturated were flagged as super-saturated. However, it was found that simply using the light levels as the super-saturation criteria resulted in the removal of much data that was clearly not super-saturated. To determine which points truly were super-saturated and which were not, a threshold curve of PIC as a function of r^2 was produced (for valid data, r^2 generally increases as PIC increases). As part of the determination of this PIC vs. r^2 threshold, a record was kept for each retro-reflector array of the ten largest path integrated concentrations corresponding to each r^2 value from pan/tilt locations that were not determined from the initial hole-finding routine to be super-saturated. Based on this top-ten record, the PIC vs. r^2 threshold was determined by searching for outlying values that might indicate a PIC value that should have been indicated as super-saturated but were not.

Once the PIC vs. r^2 threshold curve was determined, a final pass was made through the data, this time comparing the PIC value for each data point with the threshold value at the corresponding r^2. Data points with PIC values greater than the threshold were considered to be supersaturated and excluded.

In a final pass through the data, data from the individual dwells was averaged up to the 30-min time intervals required by the *WindTrax* and *RPM* emissions models.

3.4.2 H_2S concentration measurements

The H_2S data processing routine first loaded all the H_2S data into an array. Based on the GSS data array, the data were then sorted by source side and a determination was made whether the GSS had been sampling that side long enough and whether enough time remained until the end of sampling that side for the H_2S data to be considered valid. The data were then sorted and averaged into 30-minute intervals for placement into the *WindTrax* input file.

3.4.3 S-OPS sampling

The GSS software routine imported the CR800 data and produced two separate arrays of the data. The time grid for one array was based on when the S-OPS changed from one line to the other line. This array was later used when separating the H_2S data according to which SOPS line was being measured and determining whether enough time had elapsed since the previous line-switch and enough time remained before the next line switch to consider the data valid. The other array was based on a regular 30-min grid. This array was used to produce output over the intervals required as input to *WindTrax*. Output from the GSS were also used to ensure that adequate flow was present for the instruments, that condensation was not a problem inside the GSS, and that there were no major issues with the S-OPS lines (leaks, etc.).

3.4.4 Wind component measurements

The sonic anemometer software imported the 300-s sonic anemometer data files and produced the final sonic anemometer QC output file and also arrays of data at 30-min intervals for use by the *WindTrax* and *RPM* emissions models. The *WindTrax* arrays contain the turbulence statistics required as inputs to *WindTrax* and also flags used for characterizing the output from *WindTrax* or else the reason that sonic anemometer data were not suitable for use by *WindTrax* during a particular data interval. The *RPM* arrays contained the wind direction and wind speed averaged over a 30-min interval and interpolated to 10 levels from the surface to 20 m above the surface.

At some sites and during some periods one or more sonic anemometers experienced intermittent communications interference. This interference reduced the number of 16-Hz data points recorded in the trailer and also led to some spurious data points that resulted in some outlying, unphysical data points. These spurious data had little impact on the mean wind speeds, but did impact the variances, sometimes significantly. It was found that the spurious variances were nearly always associated with sonic temperature variance of greater than 2.5 K^2, while realistic variances never exceeded this same value. To be considered a valid 300-s period, at least 90% (4320) of the possible 4800 16-Hz values had to be present and the sonic temperature variance had to be less than 2.5 K^2. To be considered a valid 30-min interval, at least 3 of the 6 possible 300-s intervals were required to be valid. This acceptance scheme caught most of the unacceptable variances.

3.5 Emission calculations

3.5.1 NH3 emissions by RPM

The *RPM* model was used to estimate the NH_3 emission rates based on the TDLAS and sonic anemometer data. Running the supplied version of *RPM* was very time consuming and inefficient and produced data at short intervals on the order of several minutes (time for a scan through all the paths). To make *RPM* processing much quicker and more efficient, the sonic anemometer and TDLAS data processing programs were used to skip the first two stages of *RPM* data processing by producing data in the proper format and with the proper filenames for level 3 processing by the *RPM*. These files were produced at an interval of 30 min with all the data for a site and period contained in a single *RPM* input file. This allowed an entire period of data to be *RPM* processed with just a few clicks of the mouse, instead of with many clicks just for each individual day. The 30-min time interval was appropriate because the focus of the NAEMS study is on the long-term emissions over the course of the day rather than on the minute-by-minute emissions. In addition, the 30-min interval also allowed for a higher percentage of data capture since not all paths were necessarily required to be present for the entire 30-min interval.

3.5.2 NH3 emissions by bLS

Data input into the *WindTrax* model were produced by combining output from the sonic anemometer and TDLAS portions of the data processing software. The *WindTrax* program was run by a portion of the data processing software that assigns values to the concentrations and wind statistics required by the model and told the model to run depending on whether or not the u_* and L values were acceptable.

GoogleEarth® was used extensively in producing the site maps required by *WindTrax*. By the end of the project, each site had a high-resolution image on *GoogleEarth*® sufficient to see the outline of the source area. A GPS was used to obtain precise latitudes and longitudes for the TDLAS units and each of the retro reflectors. Labeled location markers were then placed at these coordinate locations. When the locations were obviously wrong (the accuracy indicated by the GPS was generally on the order of 4 m or so), either because the path crossed the lagoon or because it was not correctly placed relative to the corner, the markers were moved slightly to the approximate proper location. The image was then saved and loaded into *WindTrax*, where it was used to define the source areas and measurement paths.

All data required for post-processing the *WindTrax* output were placed into the *WindTrax* output file.

3.5.3 Validation of bLS emissions model

All ½ hourly emissions calculated using the *Windtrax* bLS emissions model in which there was a corresponding *RPM* emissions measurement were compared by pairs using EPA Method 301. The precision of the bLS method for each pair of bLS and *RPM* measurements of emissions was assessed assuming the *RPM* method was the reference. The F-test was used to determine if the precision of the bLS method was significantly different from that of the *RPM* method under a range of meteorological conditions. The experimental *F*-value was calculated according to

$$F = \frac{S_{bLS}^2}{S_{RPM}^2}$$

where S^2_{bLS} is the variance of the bLS measurement method determined from all PICs, and S^2_{RPM} is the variance of the *RPM* measurement method determined from five to ten PICs (depending on the incidence angle) on a given downwind side (and possibly an upwind side) for the paired 30-min measurement periods. The experimental *F*-value was compared to the critical range of *F* at a 95% confidence level for the appropriate degrees of freedom associated with the number of measurements used in the variance calculations in both the numerator and denominator. If the experimental *F* was above the critical range, the precision of the bLS method was significantly greater than the *RPM* method. If the experimental *F* was below the critical range, the precision of the bLS method was accepted as equivalent to the *RPM* method.

The bias of the bLS method was determined from the measurement periods and beamlines used in the precision determination. Bias was determined by t-test of the mean differences in emissions calculations for each meteorological condition evaluated for precision. An 80% confidence interval was used (t=1.397). The correction factor was calculated if the difference was significant. If the correction factor was more than 1.10 or less than 0.90, then the bLS method was considered biased accordingly relative to the *RPM* emissions measurements for the location but not invalidated.

3.5.4 H2S emissions by Ratiometric

Ratiometric H_2S emissions were determined by first finding 30-minute intervals for which all the following conditions were satisfied: the *RPM* calculated a valid emission, one of the S-OPS lines was downwind (angle < 60 degrees) and both S-OPS lines had valid H_2S readings, and the TDLAS path corresponding to the downwind H_2S path had a valid concentration. An upwind TDLAS concentration was not used in the calculations. If the preceding conditions were met, then the H_2S emission was estimated as:

$$Flux_{H2S} = Flux_{RPM-NH3} \frac{34.0818\left([H_2S]_{downwind} - [H_2S]_{upwind}\right)}{17030.4[NH_3]_{downwind}}$$

The yield for the Ratiometric method for determining H_2S emissions was limited significantly by the generally poor yield for the *RPM* emissions method for NH_3.

3.5.5 H2S emissions by bLS

Data input into the *WindTrax* model were produced by combining output from the sonic anemometer, GSS, and H_2S portions of the data processing software. The *WindTrax* program was run by a portion of the data processing software that assigns values to the concentrations and wind statistics required by the model and tells the model to run depending on whether or not the u_* and L values are acceptable.

GoogleEarth® was used extensively in producing the site maps required by *WindTrax*. By the end of the project, each site had a high-resolution image on *GoogleEarth®* sufficient to see the outline of the source area. A GPS was used to obtain precise latitudes and longitudes for the ends of the S-OPS lines. Labeled location markers were then placed at these coordinate locations. When the locations were obviously wrong (the accuracy indicated by the GPS was generally on the order of 4 m or so), either because the path crossed the lagoon or because it was not correctly placed relative to the corner, the markers were moved slightly to the approximate proper location. The image was then saved and loaded into *WindTrax*, where it was used to define the source areas and measurement paths. All data required for post-processing the *WindTrax* output were placed into the *WindTrax* output file.

4 Results

4.1 Farm activity

Pertinent activities affecting the lagoon include transfer of waste from barns into the lagoon (Table 4.1-1) and lagoon pump-outs for irrigation. Lagoon was pumped-down in June 2009. No other pump-outs occurred during the study. Animal inventories for the calculation of lagoon loading rates are indicated in Table 4.1-1.

Table 4.1-1: Producer activities

Period	Activity	Animal inventory
2: 8/30 – 9/18/2007	No events	2267
9/25/2007	All 3 Barns Emptied	
9/27 and 10/4/2007	New Group of Pigs Restocked	
3: 1/24 - 2/19/2008	1/29/2008 North Barn emptied 1/30/2008 Middle Barn emptied 1/31/2008 South Barn emptied 2/11/2008 North & Middle restocked 2/14/2008 South Barn restocked	2660
4: 5/7 - 5/29/2008	No events	2747
5: 5/29 - 6/10/2008	5/28-6-11/2008 Pig Shipments: Total of 2079 was shipped out during this period.	2747
6: 11/4 -12/3/2008	No events	2909
7: 12/3 - 12/16/2008	No events	2880
8: 4/21 - 5/14/2009	No events	2882
9: 7/14 - 8/4/2009	No events	2845

4.2 Weather conditions

4.2.1 Synoptic weather events

Weather conditions during the measurement periods varied widely as expected for midlatitude climates (Table 4.2-1). Twenty-nine percent of the days had extra-tropical frontal systems overhead while 71% of the days were under the general influence of extra-tropical high pressure. The Daily Weather Maps for the measurement days are found in Section 6.9.

Table 4.2-1: Synoptic weather events during measurements

Measurement period	# days	# Warm front passages	# Cold front passages	# days stationary front	# days tropical storm
2	19	0	2	1	0
3	26	0	7	0	0
4	22	2	4	2	0
5	12	0	3	1	0
6	27	0	6	1	0
7	14	0	3	0	0
8	21	2	4	2	0
9	20	0	3	3	0

4.2.2 Variation in barometric pressure, solar radiation, air temperature and wetness

Over the course of the measurement periods, the mean daily air temperature varied from -13.4^{o} C to 34.5^{o} C, while the barometric pressure varied from 88.78 kPa to 92.27 kPa (Section 6.10). Sky conditions ranged from clear skies with maximum ½ hr solar irradiance of 1170Wm^{-2} to overcast conditions with maximum ½ hr solar irradiance of 62 Wm^{-2} (Section 6.10).

4.2.3 Variation in air temperature and relative humidity

The relationship between the daily mean air temperature and humidity compared to the monthly climatology is indicated in Figure 4.2-1. Temperatures were generally within the climatological normal conditions throughout the study measurement periods at this location.

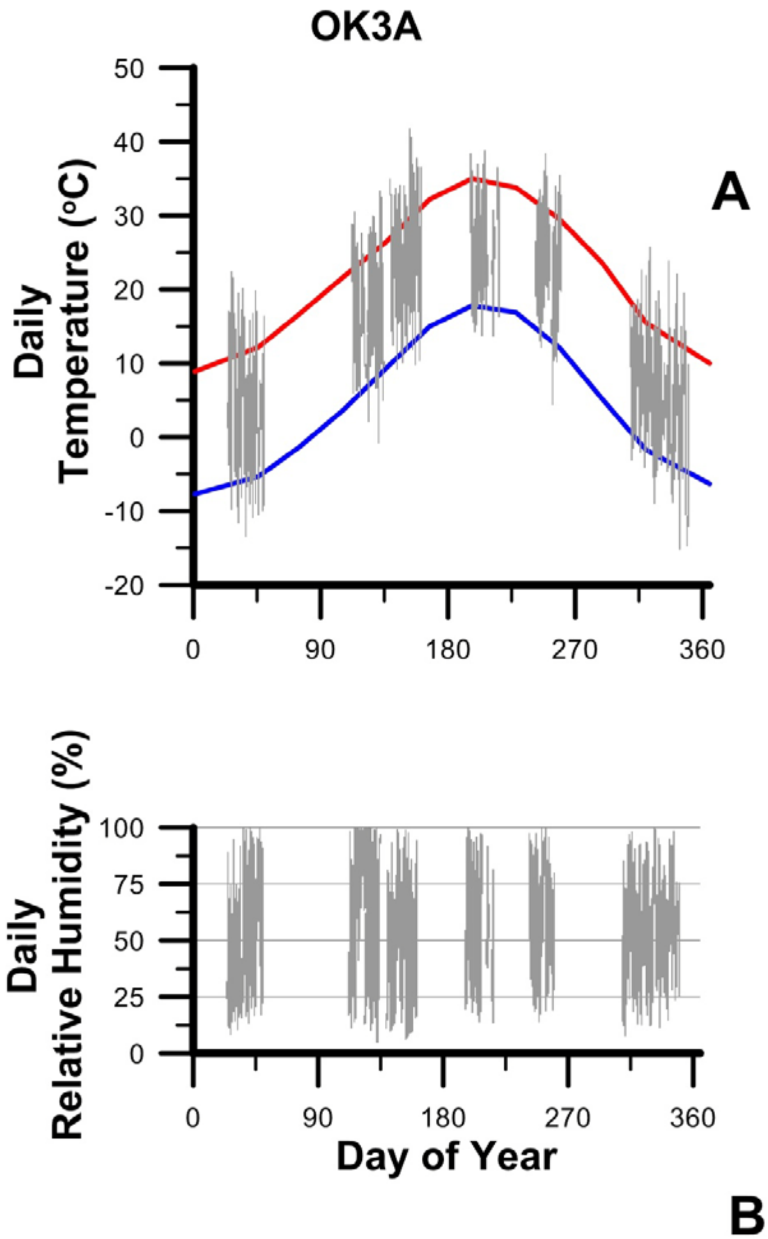

Figure 4.2-1: Variation in daily temperatures and relative humidity during measurements. The mean monthly climatological maximum (red solid line) and minimum (blue solid line) temperature are compared against the daily maximum and minimum temperatures for measurement days (grey bars) in panel A. The maximum and minimum relative humidity for measurement days is indicated by the grey bars in panel B.

4.2.4 Wind conditions

Wind conditions for each measurement period are illustrated in Figure 4.2-2 through 4.2-5. Emission calculation exclusion regions due to surrounding sources (wind directions of 90^{o} through 135^{o}) are indicated as a grayed region in the figure. Winds were generally from the north during periods 3 (Winter), 4 (Spring), and 6 (Fall) and from the south or southwest during periods 2 (Fall), 5 (Summer), 9 (Summer). Wind directions were highly variable during periods 6 (Fall), 7 (Winter), and 8 (Spring). Winds speeds were commonly greater than 5 ms^{-1}.

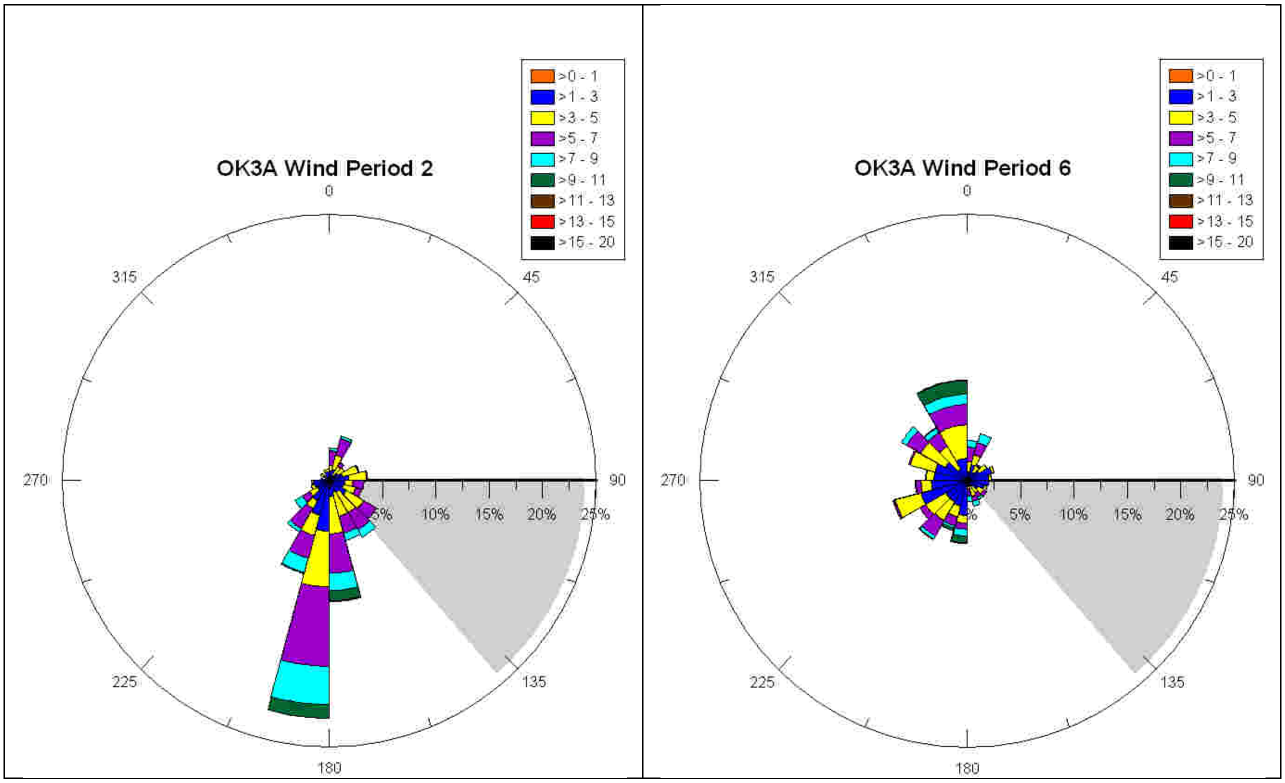

Figure 4.2-2: Wind roses for ½ hourly wind measurements during the Fall measurement periods. The periods in which measurements were made are indicated. The relative portion of time in which the wind is from a given direction is indicated by the length of the triangle pointing in that direction. The fraction of time in which the winds were in the binned speed ranges (units of m/s) is indicated by colors within each triangle. The shaded region defines the wind directions excluded due to upwind influence of the barns.

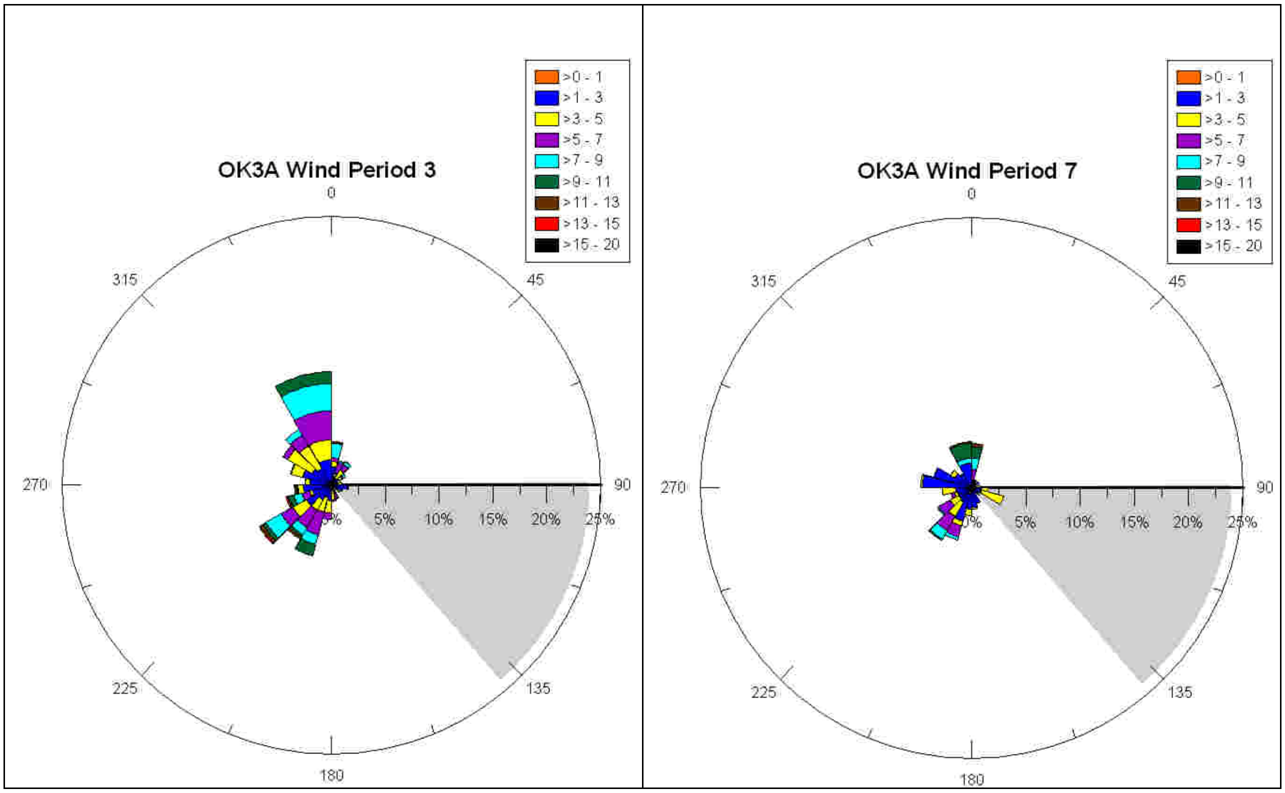

Figure 4.2-3: Wind roses for ½ hourly wind measurements during the Winter measurement periods. The periods in which measurements were made are indicated. The relative portion of time in which the wind is from a given direction is indicated by the length of the triangle pointing in that direction. The fraction of time in which the winds were in the binned speed ranges (units of m/s) is indicated by colors within each triangle. The shaded region defines the wind directions excluded due to upwind influence of the barns.

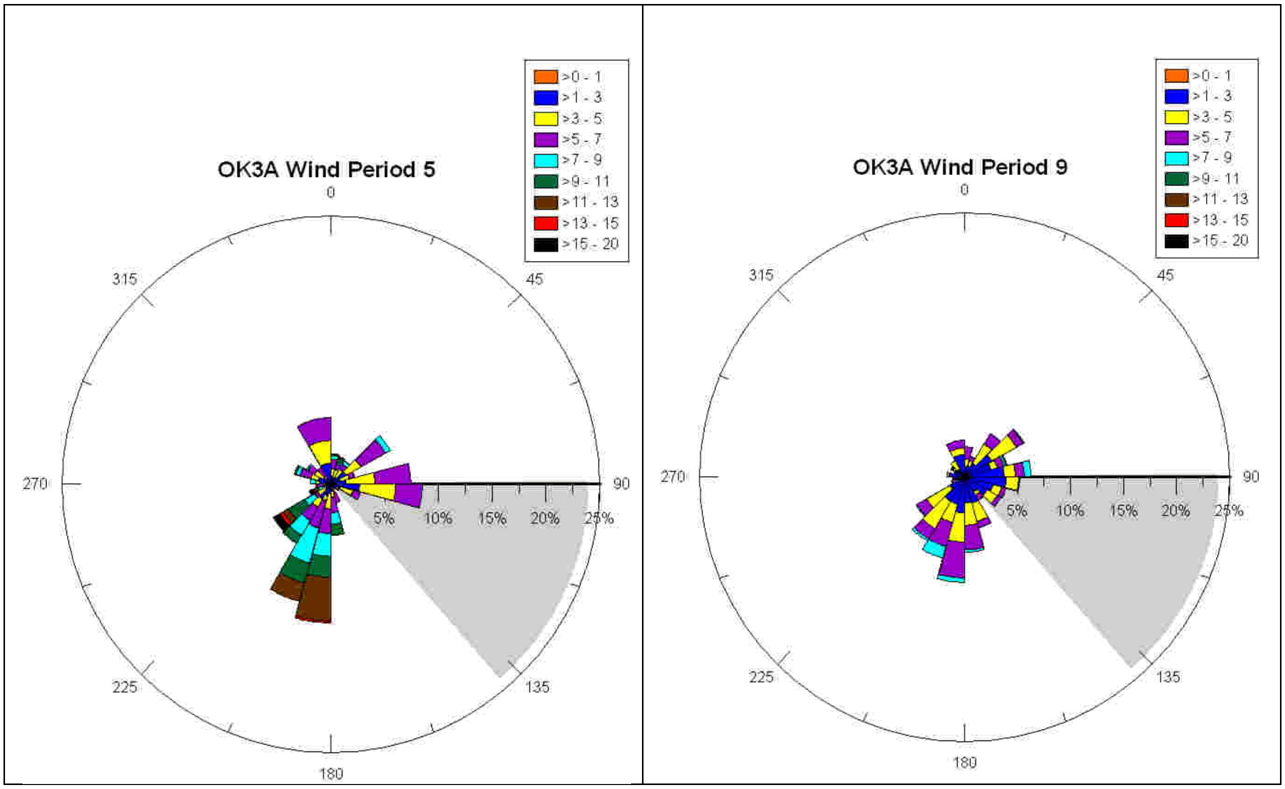

Figure 4.2-4: Wind roses for ½ hourly wind measurements during the Summer measurement periods. The periods in which measurements were made are indicated. The relative portion of time in which the wind is from a given direction is indicated by the length of the triangle pointing in that direction. The fraction of time in which the winds were in the binned speed ranges (units of m/s) is indicated by colors within each triangle. The shaded region defines the wind directions excluded due to upwind influence of the barns.

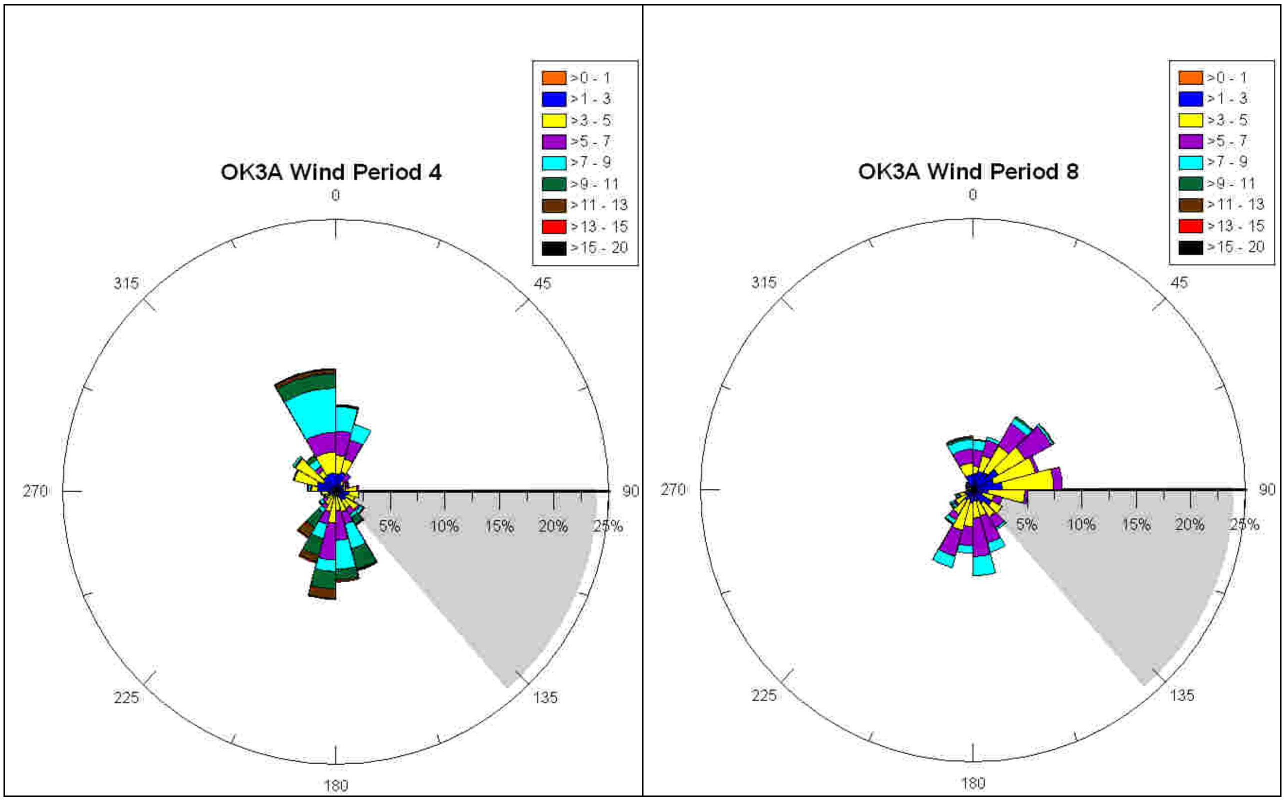

Figure 4.2-5: Wind roses for ½ hourly wind measurements during the Spring measurement periods. The periods in which measurements were made are indicated. The relative portion of time in which the wind is from a given direction is indicated by the length of the triangle pointing in that direction. The fraction of time in which the winds were in the binned speed ranges (units of m/s) is indicated by colors within each triangle. The shaded region defines the wind directions excluded due to upwind influence of the barns.

4.3 Lagoon conditions

4.3.1 Lagoon appearance, liquid depth and sludge depth

The appearance of the lagoon was recorded on almost every site visit (Table 4.3-1). The lagoon generally appeared brown with surface characteristics ranging from frozen during the winter to free of crust during the remainder of the year.

Table 4.3-1: Lagoon physical characteristics

OK3A	Date, appearance (color/crust)	Liquid depth	Sludge depth	Source of meas.
Period		**(m)**	**(m)**	
2: 8/29 - 9/19/2007	8/30/2007 brown/red/foamy 8/31/2007 brown/red/ no crust 9/18/2007 brown/red/ no crust 9/19/2007 brown/red/ 20% crust	5.26	N/A	Producer
3: 1/24 - 2/19/2008	1/24/2008 brown/ 100% frozen 1/25/2008 brown/ 100% frozen 2/5/2008 brown/ no crust 2/6/2008 brown/ no crust 2/19/2008 brown/red/ 5% crust	5.54	N/A	Producer
4: 5/07 - 5/29/2008	5/6/2008 brown/ no crust 5/7/2008 brown/ no crust 5/8/2008 brown/ no crust/100% film 5/19/2008 brown/ 15% scum 5/28/2008 brown/ 15% crust 5/29 /2008 brown/ no crust	5.69	N/A	Producer
5: 5/29 - 6/10/2008	5/29/2008 brown/ no crust 6/10/2008 brown/ no crust	5.71	N/A	Producer
6: 11/04 - 12/3/2008	11/5/2008 brown/ no crust 11/6/2008 brown/red/ 5% scum 11/7/2008 brown/red/ no crust 11/17/2008 brown/ no crust 12/2/2008 brown/red/ no crust 12/3/2008 brown/ no crust	5.41	N/A	Producer
7: 12/03 - 12/16/2008	12/3/2008 brown/ no crust 12/16/2008 brown/red/ 50% frozen	1/5/2009 5.56	N/A	Producer
8: 4/21 - 5/14/2009	4/21/2009 Black/ 40% scum 4/22/2009 brown/ 30% scum 4/23/2009 brown/ 50% scum 5/6/2009 brown/ 20% scum 5/14/2009 brown/ 10% scum	4/14/2009 5.49	N/A	Producer
9: 7/14 - 8/4/2009	7/14/2009 brown/ no crust 7/15/2009 brown/ no crust 7/16/2009 brown/black/ no crust 8/4/2009 Black/ no crust	N/A	N/A	

4.3.2 Temperature, pH and oxidation-reduction potential

The measured lagoon liquid temperature varied from 0.9^{o}C to 27.9^{o}C with the lowest temperatures just prior to when the sensors were removed in anticipation of the lagoon freezing during the winter (Section 6.11). The measured lagoon pH varied from 7.4 to 8.2 (Section 6.11) while the oxidation-reduction potentials varied from -201 mV to -591 mV over the entire study period (Section 6.11).

4.3.3 Lagoon Chemistry

Lagoon water chemical analyses were not conducted by the project but analyses required by the NRCS at the time of water removal for field application were available for applications during the overall project period (Table 4.3-3).

Table 4.3-3: Record of lagoon chemistry

			Percent (wet weight basis)			
Date	**n**	**pH (SU)**	**Nitrogen**	**Solids**	**Ammonia**	**Sulfur**
11/28/2007	1	8.36	0.68	0.55	0.55	0.03
11/19/2008	1	8.26	0.46	0.43	0.45	0.03
7/17/2009	1	7.90	0.57	0.40	0.49	0.02

4.4 Emissions measurements

Emissions data were calculated on a ½ hour basis since this was the interval over which the S-OPS system sampled both sides of the lagoon and since this interval is in the range over which turbulence statistics are often calculated. To account for the longer term manure storage of the lagoon, emissions reported on a head basis were scaled by the animal population for which the facility was designed and not the animal population at the time of measurements. Emissions reported on an animal unit (AU) basis (1 AU = 500 kg) assumed the typical animal weight values reported by the producer. Emissions reported on an area basis are based on the surface area of the lagoon.

Comparison of RPM and bLS emissions models

The comparison between the RPM and bLS emissions models was conducted according to the USEPA Method 301 'Field Validation of Pollutant Measurement Method' using NH_3 emissions measurements. The comparison was based on 1414 half-hour measurement periods over the entire measurement time at this location. Results show that the bLS emissions did not have a significantly difference precision (F=0.68, critical F 1.0) but had a significant bias over the *RPM* emissions (t=-9.92, $t_{0.2}$=1.29) with a corresponding correction factor for the bLS of 1.06 (Table 4.4.1-1). Consequently the ½ hour bLS emissions measurements are biased low by 17% compared to the *RPM* measurements.

Table 4.4.1-1: Comparison of the bLS and RPM NH_3 emissions

	RPM	**bLS**	**bLS-RPM**
Mean emission (g/s)	0.94	0.80	-0.013
Standard Deviation (g/s)	0.747	0.614	
Variance of the mean (g/s)	0.558	0.377	

4.4.1 NH3 Emissions

4.4.1.1 Mean daily NH_3 emissions

An annual trend in the daily NH_3 emissions based on the *RPM* model was indicated (Figure 4.4.1-1) with an early fall maximum emission of approximately 60 g $NH_3 d^{-1} hd^{-1}$. The spring and summer lagoon emissions were similar at between 20 g $NH_3d^{-1}hd^{-1}$ and 40 g $NH_3d^{-1}hd^{-1}$. The daily emissions during the winter decreased to approximately 5 g $NH_3d^{-1}hd^{-1}$. The measurements with potential for atmospheric moisture interference could be low by 40% (Figure 4.4.1-1: green circles). There were only a small number of measurements with more than 75% of the day's emissions measured. The wide variability during the spring and fall in combination with the few 'complete' days of measurements limits confidence in the magnitude of the emissions. The daily NH_3 emissions and the number of valid measurements used in the mean daily emissions estimate calculated using the *RPM* model are listed in Section 6.12.1.

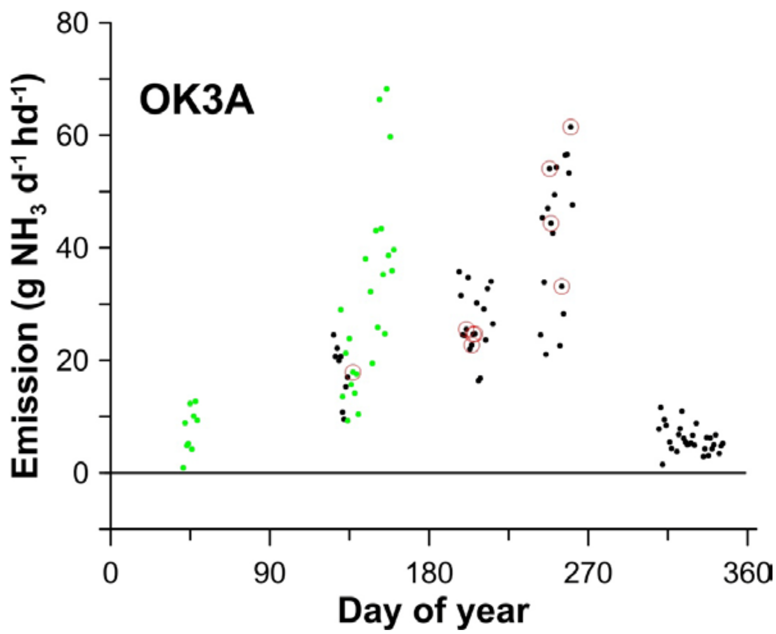

Figure 4.4.1-1: Annual variation in RPM-computed daily NH_3 emissions. The green solid circles indicate moisture interference with the NH_3 concentration measurement. Days with a red circle indicate there are measurements for greater than 75% of the continuous day.

An annual trend in the daily NH_3 emissions based on the bLS model was indicated (Figure 4.4.1-2); again with an early fall maximum emission of approximately 60 g $NH_3d^{-1}hd^{-1}$. The spring and summer lagoon emissions were similar at between 15 g $NH_3d^{-1}hd^{-1}$ and 35 g $NH_3d^{-1}hd^{-1}$. The measurements with potential for atmospheric moisture interference could be low by 40% although comparisons between these measurements and those without interference suggest negligible effect of moisture on the NH_3 emissions at this relatively dry location (Figure 4.4.1-2: green circles). Measurements with more than 75% of the day's emissions measured include days in summer, fall, and winter providing a good confidence that the emission measurements are representative. There was however still a relatively wide range in emissions from day to day. The daily NH_3 emissions and the number of valid measurements used in the mean daily emissions estimate calculated using the bLS model are listed in Section 6.12.2.

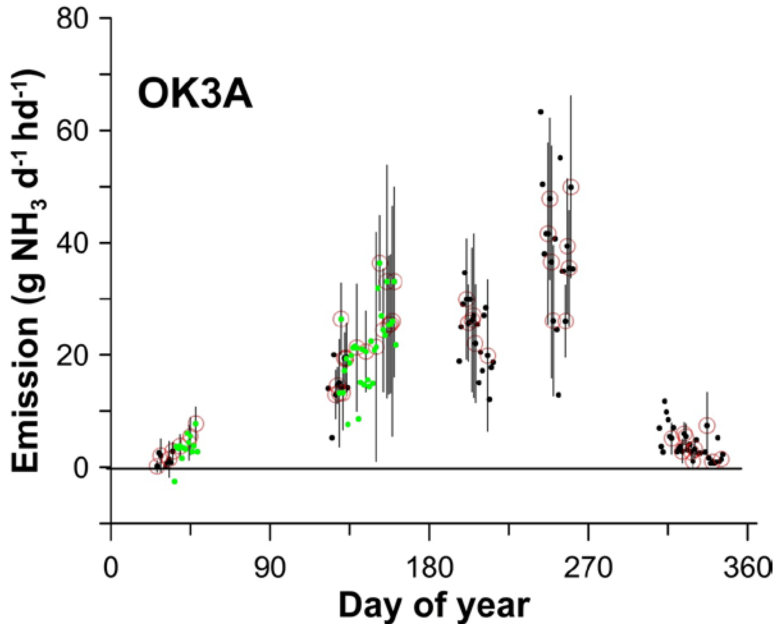

Figure 4.4.1-2: Annual variation in bLS-computed daily NH_3 emissions. Days with a red circle indicate there are measurements for greater than 75% of the continuous day. The bars represent the standard deviation of emissions based on individual ½ hr values when at least 75% of the day had valid measurements. The green solid circles indicate moisture interference with the NH_3 concentration measurement.

The bLS model is influenced by the calculated background concentrations. Results indicate that the background concentration of NH_3 was generally less than 0.2 ppm (Figure 4.4.1-3). Given that the typical path length around the lagoon was 100 m and the typical background concentration is less than 0.2 ppm, this corresponds to a background concentration for a given PIC of less than 20 ppm-m. This is approximately ten times the MDL for the TDLAS instruments of 2 ppm-m (Section 8.1) and therefore represents a real background for this location. This may be expected given the relatively high density of swine production units in the vicinity of this farm.

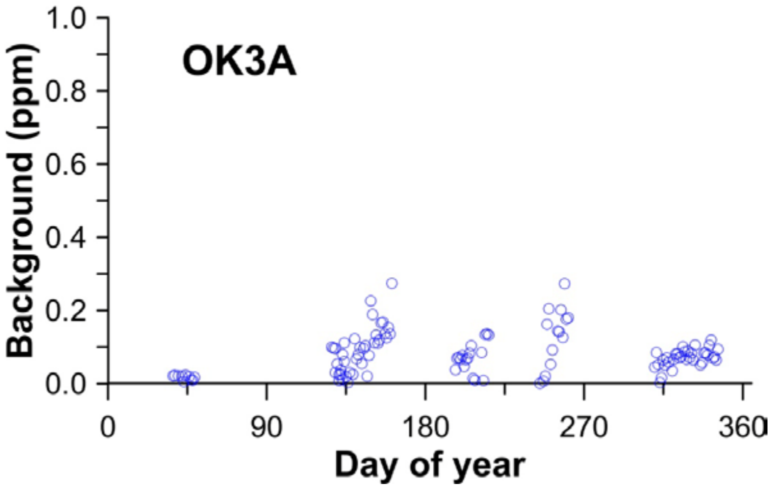

Figure 4.4.1-3: Annual variation in bLS-computed mean daily background concentration of NH_3.

4.4.1.2 Diurnal variation in NH_3 emissions

In general, there was not a strong diurnal pattern to the NH_3 emissions. A diurnal pattern in the emissions was evident during only three of the eight measurement periods (Figure 4.4.1-4). This lack of diurnal pattern was likely due to the generally high winds at the location.

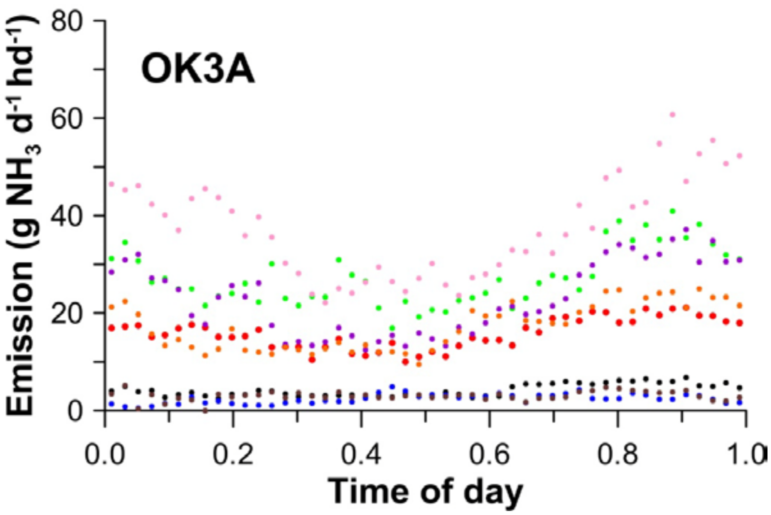

Figure 4.4.1-4: Diurnal variation in bLS-computed NH_3 emissions. Time based on Universal Time Coordinates. The mean emission for each half-hour of the day within a given measurement period (Period 2-Fall (pink), Period 3- Winter (brown), Period 4- Spring (orange), Period 5-Summer (green), Period 6-Fall (black), Period 7-Winter (blue), Period 8-Spring (red), and Period 9-Summer (purple)) are indicated.

4.4.1.3 NH_3 emissions data completeness

Unless otherwise indicated, emissions completeness and failure totals are given in number of days corresponding to the total number of ½ hour intervals for which the indicated condition was true. This number of days does not indicate the data completeness for any individual day. Therefore, an additional value giving the total number of days with at least 36 valid ½ hour periods (corresponding to 75% completeness on a daily basis) is given. Because of the requirement of 5 to 10 valid TDLAS measurements before an *RPM* emission measurement is possible, the number of valid ½ hour periods with *RPM* emissions was greatly limited. The wind conditions and wind direction exclusion region did not greatly reduce the yield of valid bLS emission measurements. The completeness statistics by measurement period are summarized in Table 4.4.1-2.

Table 4.4.1-2: Completeness statistics for NH3 emissions measurements

	Measurement period								
	2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Total**
NH3 RPM model									
Valid 1/2 hour measurements (d)	8.2	0.9	4.5	2.8	7.0	3.0	3.1	8.0	**37.5**
Measurements excluded due to wind direction (d)	0.7	0.0	0.0	0.5	0.5	0.4	0.9	1.0	**4.0**
Measurements excluded because at least one downwind path is missing or invalid (d)	6.8	15.7	13.4	6.4	11.4	1.3	16.0	8.9	**79.8**
Number of days with ≥ 36 valid 1/2 hour periods	4	0	1	0	0	0	0	4	**9**
NH3 bLS model									
Valid 1/2 hour measurements (d)	11.6	13.0	11.9	9.5	12.1	4.8	6.1	11.3	**80.5**
Measurements excluded due to wind direction (d)	1.4	0.2	0.2	1.3	1.0	0.6	0.9	1.3	**7.0**
Measurements excluded because touchdown fraction < 0.1 (d)	0.4	0.5	2.2	0.0	4.2	0.0	3.1	1.3	**11.7**
Measurements excluded because u* < 0.15 m/s or |L| < 2 m (d)	3.4	4.6	2.4	0.8	4.3	2.0	1.8	4.5	**23.6**
Number of days with ≥ 36 valid 1/2 hour periods	8	8	6	8	7	3	4	6	**50**

In total, 37 d of valid NH_3 emissions were determined from the 161 measurement days using the *RPM* model, with 30 d having at least 36 valid ½ hour NH_3 emissions. The absence or invalidation of at least one downwind path led to 80 d for which emissions could not be calculated.

Eighty days of valid NH_3 emissions were determined from the 161 measurement days using the bLS model, with 50 d having at least 36 valid ½ hour NH_3 emissions. The exclusion wind directions due to the location of the barns relative to the lagoon resulted in the loss of only 7 d of measurements. Invalid turbulence statistics ($u_* < 0.15$ m/s or $|L| < 2$ m) led to 23 d for which emissions could not be calculated. A touchdown fraction of less than 0.1 led to the exclusion of

11.7 d of data. Low touchdown fractions indicated that little, if any, downwind data was available. This corresponded to either when the downwind TDLAS was not present or else the downwind paths were lost because of invalid light levels.

The *RPM* model requires all 5 or 10 (depending on the wind direction) downwind paths to have valid concentration readings for at least a portion of the ½ hour interval. This contrasts with the bLS model which requires only 1 downwind surface path to have valid concentration readings. This difference is largely responsible for the much greater completeness for the bLS model than the *RPM* model. The *RPM* model uses ½ hour mean wind speed and direction, in contrast to the bLS model that requires extensive turbulence statistics over this same period. As a result, there are times that the *RPM* model produces a valid emission that the bLS model does not. However, these times are overwhelmed by the times that the *RPM* model is missing concentration data for one or more paths, while the bLS model is able to run.

4.4.2 H2S Emissions

4.4.2.1 Mean daily H_2S emissions

Emissions of H_2S calculated using the Ratiometric model were highest in the spring and decreased throughout the rest of the year (Figure 4.4.2-1). Peak emissions were approximately 10 g H_2S d^{-1} hd^{-1}. There was however wide variability in H_2S emissions from day to day during the spring and summer (Figure 4.4.2-1). Since only one day had more the 75% of the ½ periods with valid emissions measurements, there is no confidence that the emissions pattern illustrated is representative of conditions on the farm. The daily H_2S emissions and the number of valid measurements used in the mean daily emissions estimate calculated using the Ratiometric model are listed in Section 6.12.3.

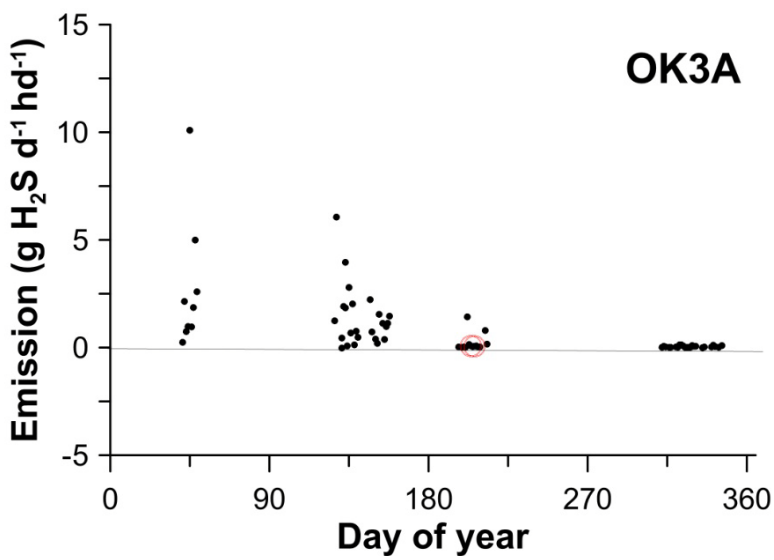

Figure 4.4.2-1: Annual variation in Radiometric-computed daily H_2S emissions. The green solid circles indicate moisture interference with the NH_3 concentration measurement. Days with a red circle indicate there are measurements for greater than 75% of the continuous day.

Emissions of H_2S determined using the bLS model suggested that emissions during the winter and spring are highest at approximately 5 g H_2S d^{-1} hd^{-1} with the emissions decreasing throughout the rest of the year (Figure 4.4.2-2). Peak emissions were approximately 10 g H_2S d^{-1} hd^{-1} with wide variability in H_2S emissions from day to day during the winter and spring (Figure 4.4.2-2). A near-zero emission during the summer, fall and early winter is strongly indicated. The relatively large number of days with at least 75% of the ½ hour emissions measurements valid confirms the emission tendencies for this location. The daily H_2S emissions and the number of valid measurements used in the mean daily emissions estimate calculated using the bLS model are listed in Section 6.12.4.

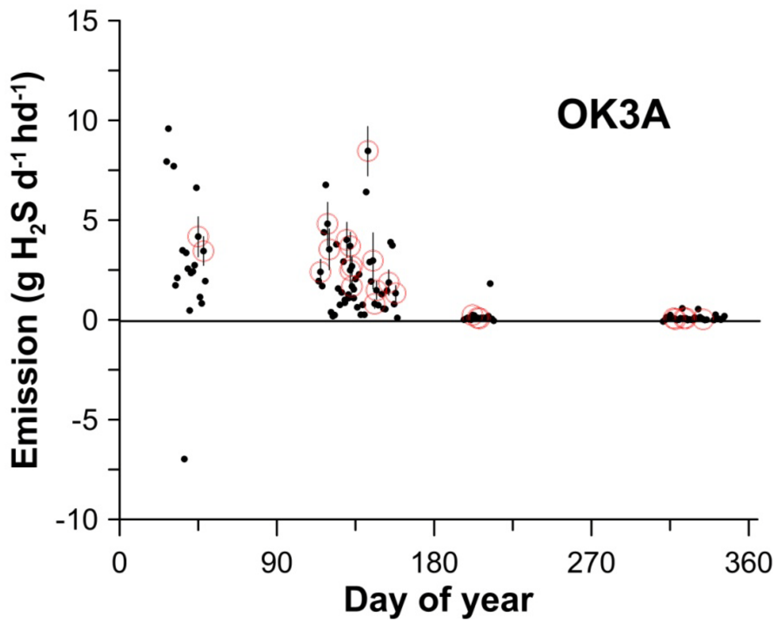

Figure 4.4.2-2: Annual variation in bLS-computed daily H_2S emissions. Days with a red circle indicate there are measurements for greater than 75% of the continuous day. The bars represent the standard deviation of emissions based on individual ½ hr values when at least 75% of the day had valid measurements.

The bLS emission model depends on a good estimate of the background H_2S concentration. Results indicate that the background concentration was generally less than ± 2.5 ppb (Figure 4.4.2-3).

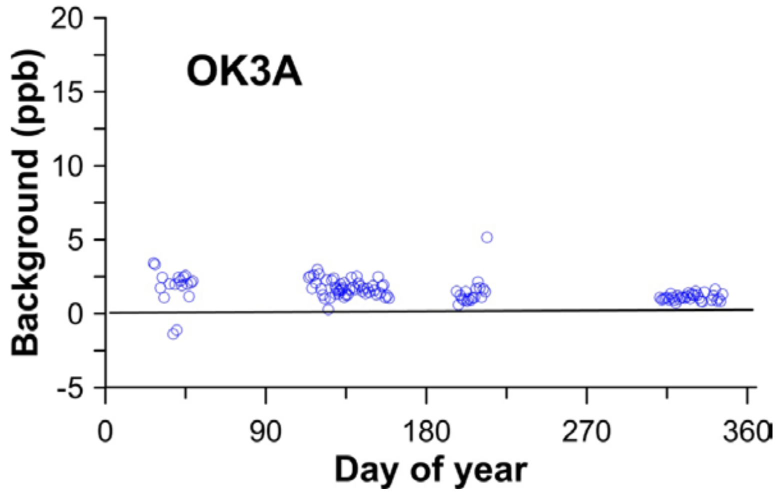

Figure 4.4.3-3: Annual variation in mean bLS-computed daily background concentration of H_2S.

4.4.2.2 Diurnal variation in H_2S emissions

The H_2S emissions calculated using the bLS model generally showed a diurnal trend when emissions were greater than approximately 0.5 g H_2S d^{-1} hd^{-1} (Figure 4.4.2-4). Highest emissions occurred during the day.

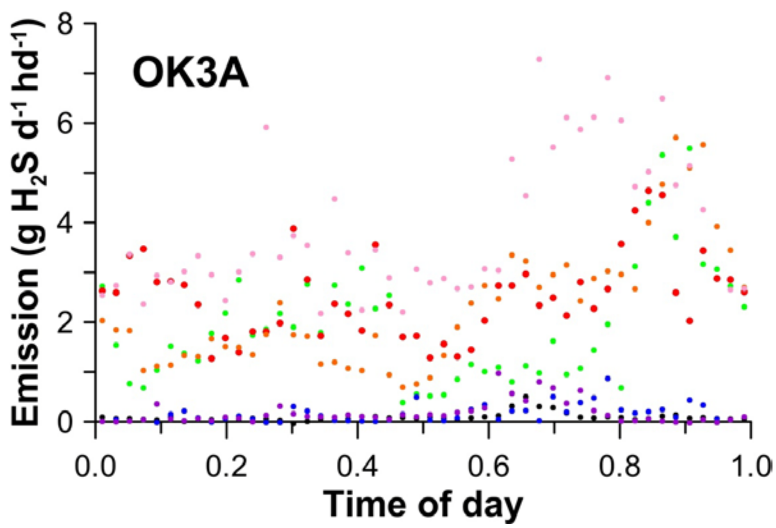

Figure 4.4.2-4: Diurnal variation in bLS-computed H_2S emissions. Time based on Universal Time Coordinates. The mean emission for each half-hour of the day within a given measurement period (Period 3- Winter (pink), Period 4- Spring (orange), Period 5- Summer (green), Period 6-Fall (black), Period 7-Winter (blue), Period 8-Spring (red), and Period 9-Summer (purple)) are indicated.

4.4.2.3 H_2S emissions data completeness

H_2S Measurements were begun in Period 3. Consequently there were no measurements possible for fall 2007. As described for the NH_3 emissions, emissions completeness and failure totals are given in number of days corresponding to the total number of ½ hour intervals for which the indicated condition was true. This number of days does not indicate the data completeness for any individual day. The completeness statistics by measurement period are summarized in Table 4.4.2-1.

Because there were few valid ½ measurements of the NH_3 emissions based on the *RPM* model (Table 4.4.1-2), the number of valid ½ periods of valid Ratiometric emissions measurements of H_2S is small. The majority of bLS emissions measurements were invalidated due to wind conditions. In total, 27 d of valid H_2S emissions were determined using the Ratiometric emission method, with 17 d having at least 36 valid ½ hour H_2S emissions. Forty-five days of valid H_2S emissions were determined using the bLS model, with 24 d having at least 36 valid ½ hour H_2S emissions. Invalid turbulence statistics ($u_* < 0.15$ m/s or $|L| < 2$ m) and excluded wind directions contributed equally to the invalidation of measurements.

Table 4.4.2-1: Completeness statistics for H2S emissions measurements

	Measurement period								
	2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Total**
H2S Ratiometric model									
Valid 1/2 hour measurements (d)		0.5	3.2	0.7	4.8	1.1	1.6	5.6	**17.6**
Number of days (d) with ≥ 36 valid 1/2 hour periods		0	0	0	0	0	0	2	**2**
H2S bLS model									
Valid 1/2 hour measurements (d)		8.3	13.8	5.0	13.5	1.6	12.5	8.3	**62.9**
Measurements excluded due to wind direction (d)		0.2	1.1	1.1	1.0	0.0	2.0	1.8	**7.2**
Measurements excluded because angle of attack < 60° (d)		2.0	1.6	2.3	5.1	0.8	3.8	2.0	**17.5**
Measurements excluded because u* < 0.15 m/s or |L| < 2 m (d)		3.5	2.5	0.6	4.3	1.3	1.7	4.3	**18.2**
Number of days (d) with ≥ 36 valid 1/2 hour periods		2	7	2	5	0	5	3	**24**

4.4.3 Estimation of emission measurement errors

Errors in the response of the TDLAS due to atmospheric moisture limited the accuracy of TDLAS serial numbers 1026, 1027, and 1028 prior to July 21, 2008. TDLAS 1026 was used at OK3A from 1/24/2008 to 2/19/2008 (Measurement period 3), 5/7/2008 to 5/29/2008 (Measurement period 4), and 5/29/2008 to 6/10/2008 (Measurement period 5). Under the calibration verification checks, the allowed TDLAS error of all units was 10% accuracy. Howe ver due to the short path length of the calibration verification, these checks did not assess water vapor interferences experienced in the long path lengths around the area sources. Inter-comparisons between various TDLAS units experiencing atmospheric moisture interference and units without apparent interference revealed reduced responses with the moisture-affected units of 28%, 68%, 36% and 31% for atmospheric moisture varying from dewpoint temperatures of -2^{o}C to 20^{o}C. A conservative estimate of the bias of all of the above TDLAS units with evident moisture interference was -40%.

4.4.3.1 Error in RPM-measured NH_3 emissions

Tracer releases studies indicated that the RPM emissions measurement has an error in accuracy of approximately ±15% (Hashmonay et al., 2001; Verma et al., 2005; USEPA, 2007). The TDLAS measurement error was 10% (Section 6.1). Combining errors results in an expected error in the RPM-measurement of NH_3 emissions of ± 18%. In addition, the NH_3 measurements made using the TDLAS units with moisture interference had a bias of -40%.

4.4.3.2 Error in bLS-measured NH_3 and H_2S emission

Tracer studies using TDLAS concentration measurements in combination with the bLS emissions model averaged over roughly two hour periods indicated the bLS method error for a given 15-min period varied with stability: overestimated by 12% under near neutral conditions, underestimated by 13% under unstable conditions, and overestimated by 38% under stable conditions (Flesch et al., 2004). Under conditions when Monin Obukhov similarity theory was valid, the bLS-calculated emission rate was biased 6% high with a standard deviation of 16%. Laubach and Kelliher (2005) evaluated the theoretical errors of the bLS model. The breakdown of their 22% model error included a 12% error for the estimate of the Monin-Obukov Length (L) derived from measurements, a 5% error in turbulence statistics (10% error for the normalized variability statistics in the x and y directions and 5% in the z direction), a 15% error associated with the roughness length (z_o) estimate, and a 10% error due to the stochastic methodology. This was consistent with tracer-estimated errors of the bLS emission calculation method, when constrained by the data quality indicators of the bLS method, of between 5% and 36%.

For this study, we assumed the above theoretical random error of 22% for the bLS emissions measurements. The TDLAS measurement error was 10% (Section 6.1). At this location the daily mean bLS emissions bias from the RPM emissions measurement was -14% (from the RPM/bLS method comparison in Section 4.4). As previously stated, the TDLAS units with moisture interference had a bias of -40%. Combining errors resulted in an expected error in the RPM-measurement of NH_3 emissions of ± 24% with a bias of -54% for TDLAS NH_3 measurements made by units with moisture interference and a bias of-14% for TDLAS NH_3 measurements made by units without moisture interference.

The H_2S PF instrument measurement error was 10% (Section 6.2). Given the expected error in the bLS measurement of emissions of 22%, the H_2S emissions error was estimated as ± 24%

4.4.3.3 Error in Ratiometric-measured H_2S emission

The Ratiometric method of H_2S emissions measurement depends on the RPM measurement of NH_3 emissions. The RPM emissions measurement had an error of approximately ±15%. Since the Ratiometric method ratios the emissions and concentrations of NH_3, there was no affect of the moisture interference in the TDLAS measurement on the H_2S emissions calculation. Given the H_2S PF instrument measurement error of 10% (Section 6.2), the combined error for the Ratiometric measurement of H_2S emissions was ± 18%.

5 References

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6 Appendices

6.1 TDLAS NH3 calibrations

Six TDLAS units (Model GasFinder2™ NH3OP, Boreal Laser Inc., Spruce Grove, Alberta, Canada) were used for measurements at this location: TDLAS 1026, TDLAS 1027, TDLAS 1028, TDLAS 1029, TDLAS 1031 and TDLAS 1032.

TDLAS 1026 was multipoint calibrated seven times during the study (Figure 6.1-1). The response was non-linear and consequently a third-order polynomial was used to correct the instrument measurements for the instrument response. The multi-point calibration on 1/17/2007 was used for the entire study period. The offset of the equation was determined from a least squares fit of the entire record of calibration verifications made at 50 ppm-m applied to the first, second, and third order terms derived from the multipoint calibration. The regression equation was:

$$\text{ppm-m} = -0.97 + 1.0197 * X - 4.410E\text{-}5 * X^2 + 1.591E\text{-}8 * X^3,$$

where X was the instrument response. The response of the sensor was influenced by humidity until July, 21 2008 due to an error in the factory settings for the spectral waveband analysis window. At that time, factory personnel corrected the spectral waveband used for analysis. The effect of this error was to 1) reduce the maximum possible linear correlation with the internal reference cell resulting in unusually low r2 values under conditions in which the concentration of NH_3 was more than three times of the MDL, and 2) reduce the reported concentration. Adjustments made on the instrument at this time did not appear to affect the calibration (conducted before and after adjustments) but did change the maximum r2 reached by the instrument when in the field for long path lengths and high humidity.

A zero concentration was not reportable by this instrument because the concentration was based on the correlation of the measured NH_3 absorption to a reference gas. No measured absorption at zero concentration resulted in no correlation and consequently no reportable measurement. The MDL of the instrument was determined from the mean of the variability (3 times the standard deviation) experienced at the verification concentration during each calibration verification. Since the calibration verifications were conducted in a very short path length, the water vapor effect on the instrument response was generally not detectable. The MDL was calculated to be 2.04 ppm-m prior to the July 2008 modification and 1.77 ppm-m after the modification. The instrument performance was within the MDL DQI that required the MDL to be less than 10 ppm-m. The calibration equation offset was less than the requisite DQI MDL.

Instrument performance calibration checks (Figure 6.1-2) were made at the beginning and end of each measurement period. The majority of calibration checks were made within 21 d (Figure 6.1-3). The large fraction of checks made within 7 d was the result of calibration checks made at the end and beginning of sequential measurement periods. The standard deviation of the verifications about that predicted by the calibration equation was 8.27 ppm-m. The precision DQI was ±10% RSD at 100 ppm-m. All verifications resulted in less than 10% RSD for 50 ppm-m (Figure 6.1-2) and were well within the precision DQI. The accuracy DQI was ± 10% of the 1000 ppm-m range of the measurements. A positive bias in the calibration verification exceeding the DQI occurred on 4/28/2009 and 11/10/2009 while negative biases exceeding the DQI occurred over the period 4/2/2008 through 7/1/2008 (Figure 6.1-2). The 4/28/2009 and 11/10/2009 exceeding biases were followed the same or next day with a passing verification and were deemed to be a result of operator error. The negative bias over the period 4/2/2008 through 7/1/2008 was not a result of calibration cylinder certification error (three different cylinders were used) and was only intermittently evident during operations because two different multipoint calibration were applied to the calibration verification measurements. Repeated calibrations within 24 h often showed biases differing by more than 10 ppm-m, suggesting operator errors. Although this instrument had a bias associated with water vapor interference, the instrument was in use in dry climates during this time. The measurements made during this period are considered valid and the error is assumed to be due to the calibration verification operator.

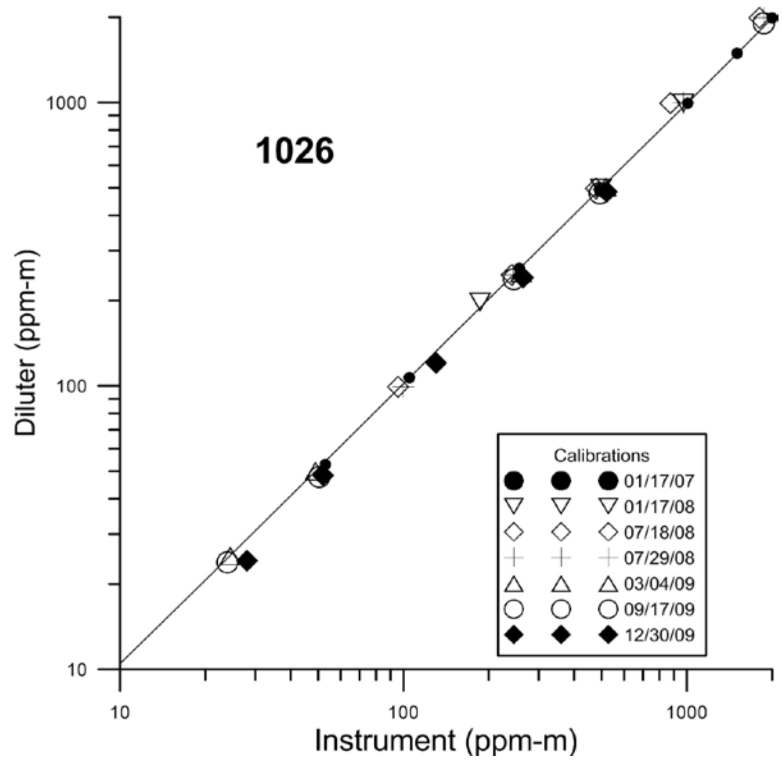


Figure 6.1-1: Multipoint calibrations of the GasFinder2 ™ s/n NH3OP-1026. The solid line is the 3rd order polynomial regression for the chosen multipoint calibration.

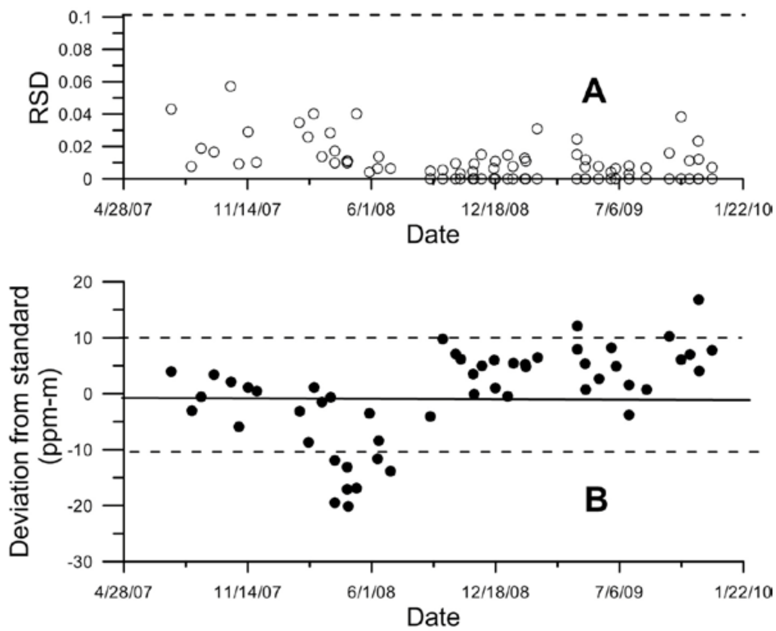


Figure 6.1-2: Control charts of the GasFinder2 ™ s/n NH3OP-1026

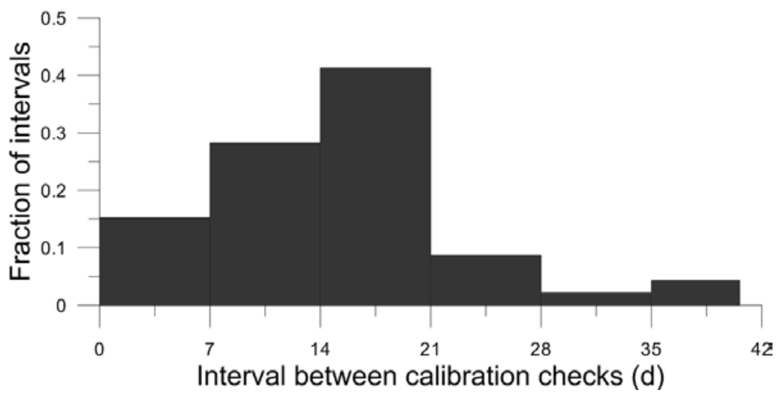


Figure 6.1-3: Calibration check intervals of the GasFinder2 ™ s/n NH3OP-1026

TDLAS 1027 was multipoint calibrated eight times during the study (Figure 6.1-4). The response was non-linear and consequently a third-order polynomial was used to correct the instrument measurements for the instrument response. The multi-point calibration on 6/18/2008 was used for the entire study period. The offset of the equation was determined from a least squares fit of the entire record of calibration verifications made at 50 ppm-m applied to the first, second, and third order terms derived from the multipoint calibration. The regression equation was:

$$\text{ppm-m} = 2.24 + 0.9936 * X - 3.59E\text{-}5 * X^2 + 6.230E\text{-}8 * X^3,$$

where X was the instrument response. The response of the sensor was influenced by humidity until July, 21 2008 due to an error in the factory settings for the spectral waveband analysis window. At that time, factory personnel corrected the spectral waveband used for analysis. The effect of this error was to 1) reduce the maximum possible linear correlation with the internal reference cell resulting in unusually low r2 values under conditions in which the concentration of NH_3 was more than three times of the MDL, and 2) reduce the reported concentration. Adjustments made on the instrument at this time did not appear to affect the calibration (conducted before and after adjustments) but did change the maximum r2 reached by the instrument when in the field for long path lengths and high humidity.

A zero concentration was not reportable by this instrument because the concentration was based on the correlation of the measured NH_3 absorption to a reference gas. No measured absorption at zero concentration resulted in no correlation and consequently no reportable measurement. The MDL of the instrument was determined from the mean of the variability (3 times the standard deviation) experienced at the verification concentration during each calibration verification. Since the calibration verifications were conducted in a very short path length, the water vapor effect on the instrument response was generally not detectable. The MDL was calculated to be 2.13 ppm-m prior to the July 2008 modification and 1.83 ppm-m after the modification. The instrument performance was within the MDL DQI that required the MDL to be less than 10 ppm-m. The calibration equation offset was less than the requisite DQI MDL.

Instrument performance calibration checks (Figure 6.1-5) were made at the beginning and end of each measurement period. The majority of calibration checks were made within 21 d (Figure 6.1-6). The large fraction of checks made within 7 d was the result of calibration checks made at the end and beginning of sequential measurement periods. The standard deviation of the verifications about that predicted by the calibration equation was 5.36 ppm-m. The precision DQI was ±10% RSD at 100 ppm-m. All verifications resulted in less than 10% RSD for 50 ppm-m (Figure 6.1-5) and were well within the precision DQI. The accuracy DQI was ± 10% of the 1000 ppm-m range of the measurements. A positive bias in the calibration verification exceeding the DQI occurred on 9/26/2008 and 9/24/2009 (Figure 6.1-5). No negative biases exceeding the DQI occurred. Since both positive exceeding biases were followed by a DQI compliant verification on the subsequent calibration verification without intervention, it is assumed that operator error was the cause for the non-compliance.

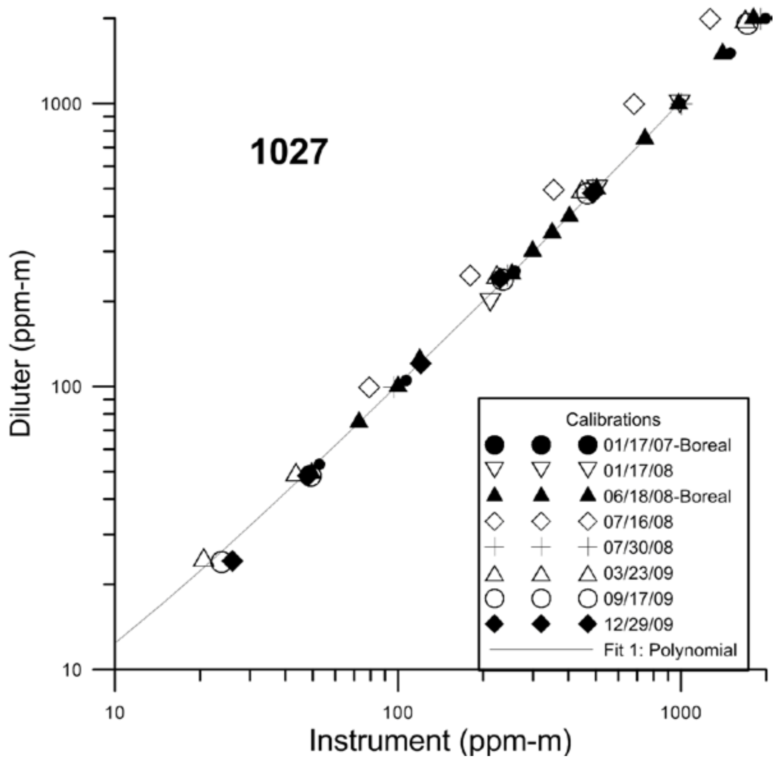


Figure 6.1-4: Multipoint calibrations of the GasFinder2 TM s/n NH3OP-1027. The solid line is the 3rd order polynomial regression for the chosen multipoint calibration.

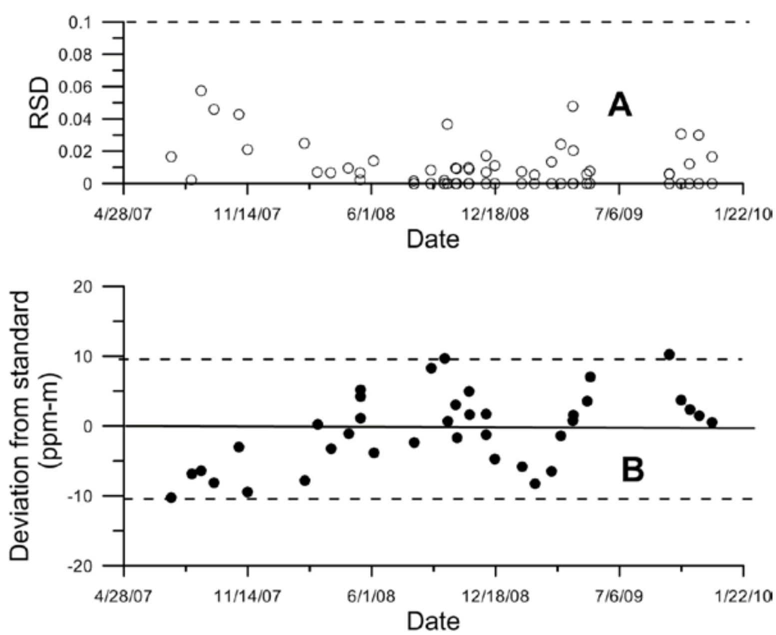


Figure 6.1-5: Control charts of the GasFinder2 TM s/n NH3OP-1027

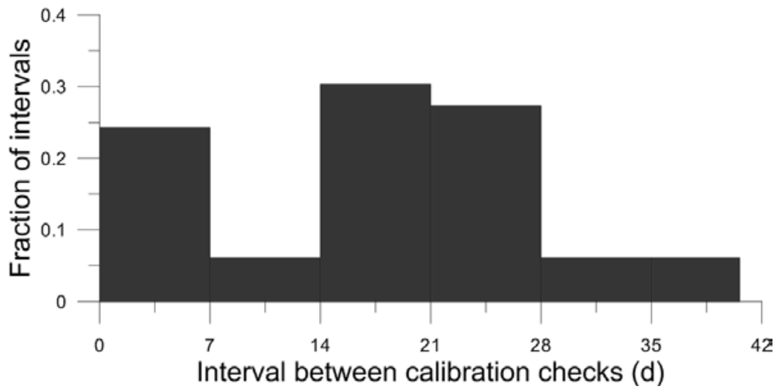


Figure 6.1-6: Calibration check intervals of the GasFinder2 TM s/n NH3OP-1027

TDLAS 1028 was multipoint calibrated six times during the study (Figure 6.1-7). The response was non-linear and consequently a third-order polynomial was used to correct the instrument measurements for the instrument response. The multi-point calibration on 5/23/2007 was used for the entire study period. The offset of the equation was determined from a least squares fit of the entire record of calibration verifications made at 50 ppm-m applied to the first, second, and third order terms derived from the multipoint calibration. The regression equation was:

$$\text{ppm-m} = 1.46 + 0.985 * X + 8.465E\text{-}6 * X^2 + 3.879E\text{-}8 * X^3,$$

where X was the instrument response. The response of the sensor was influenced by humidity until July, 21 2008 due to an error in the factory settings for the spectral waveband analysis window. At that time, factory personnel corrected the spectral waveband used for analysis. The effect of this error was to 1) reduce the maximum possible linear correlation with the internal reference cell resulting in unusually low r2 values under conditions in which the concentration of NH_3 was more than three times of the MDL, and 2) reduce the reported concentration. Adjustments made on the instrument at this time did not appear to affect the calibration (conducted before and after adjustments) but did change the maximum r2 reached by the instrument when in the field for long path lengths and high humidity.
A zero concentration was not reportable by this instrument because the concentration was based on the correlation of the measured NH_3 absorption to a reference gas. No measured absorption at zero concentration results in no correlation and consequently no reportable measurement. The MDL of the instrument was determined from the mean of the variability (3 times the standard deviation) experienced at the verification concentration during each calibration verification. Since the calibration verifications were conducted in a very short path length, the water vapor effect on the instrument response was generally not detectable. The MDL was calculated to be 2.48 ppm-m prior to the July 2008 modification and 1.91 ppm-m after the modification. The instrument performance was within the MDL DQI that required the MDL to be less than 10 ppm-m. The calibration equation offset was less than the requisite DQI MDL.

Instrument performance calibration checks (Figure 6.1-8) were made at the beginning and end of each measurement period. The majority of calibration checks were made within 21 d (Figure 6.1-9). The large fraction of checks made within 7 d was the result of calibration checks made at the end and beginning of sequential measurement periods. The standard deviation of the verifications about that predicted by the calibration equation was 6.46 ppm-m. The precision DQI was ±10% RSD at 100 ppm-m. All verifications resulted in less than 10% RSD for 50 ppm-m (Figure 6.1-8) and were well within the precision DQI. The accuracy DQI was ± 10% of the 1000 ppm-m range of the measurements. A positive bias in the calibration verification exceeding the DQI occurred on three dates (9/26/2008, 10/1/20008 and 9/24/2009) while negative biases exceeding the DQI occurred on 12/16/2008 (Figure 6.1-8). In all cases except the short 9/24/2008 through 10/1/2008 period, subsequent calibration verifications did not indicate the same exceeding biases and it is concluded that operator error resulted in the exceeding biases rather than instrument failure.

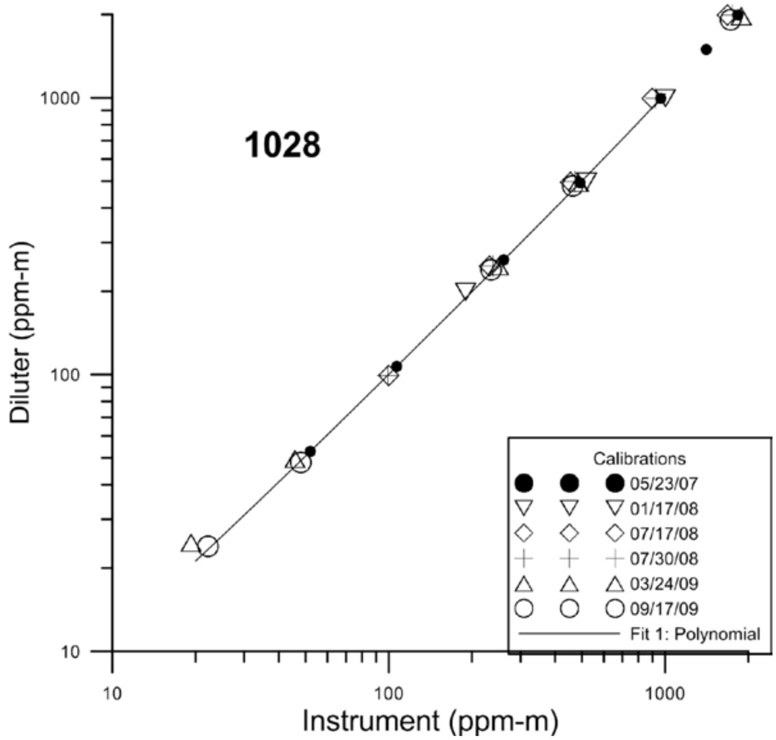


Figure 6.1-7: Multipoint calibrations of the GasFinder2 ™ s/n NH3OP-1028. The solid line is the 3rd order polynomial regression for the chosen multipoint calibration.

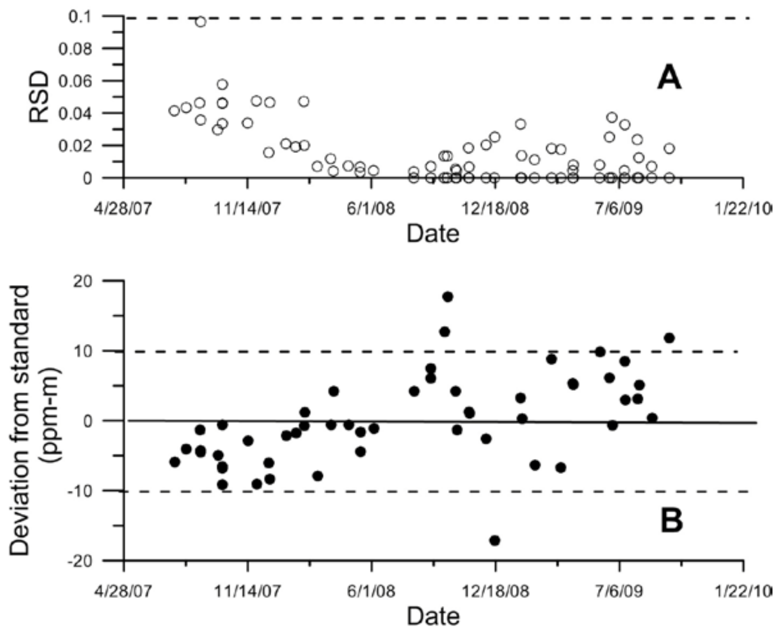


Figure 6.1-8: Control charts of the GasFinder2 TM s/n NH3OP-1028

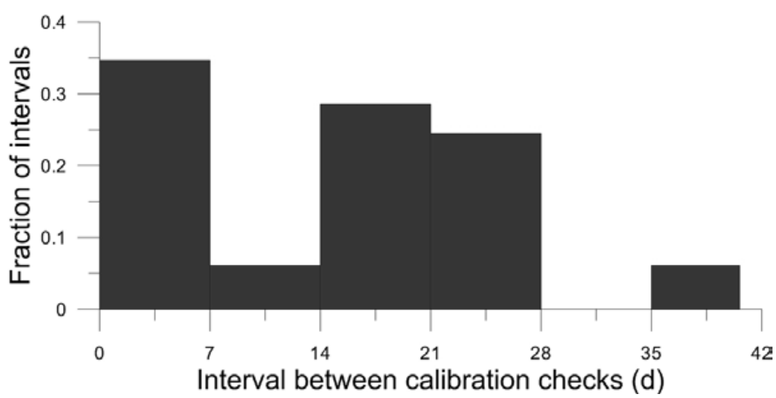


Figure 6.1-9: Calibration check intervals of the GasFinder2 TM s/n NH3OP-1028

TDLAS 1029 was multipoint calibrated seven times during the study (Figure 6.1-10). The response was non-linear and consequently a third-order polynomial was used to correct the instrument measurements for the instrument response. Table 6.1-1 indicated the multi-point calibrations used during different periods in the study.

Table 1- Multi-point calibration application

Period of applicability (MM/DD/YYYY)		
Begin	**End**	**Multipoint calibration**
6/24/2007	3/1/2008	5/24/2007
3/24/2008	7/15/2008	3/24/2008
7/31/2008	8/3/2009	3/4/2009
8/4/2009	12/2/2009	12/29/2009

The offsets of the calibration equations were determined from a least squares fit of the appropriate period (Table 1) of calibration verifications made at 50 ppm-m applied to the first, second, and third order terms derived from the multipoint calibrations. The regression equations were:

5/24/2007: ppm-m = -1.48 + 0.967 * X + 4.842E-005 * X^2 - 7.312-009 * X^3

3/24/2008: ppm-m = -2.58 + 0.998 * X - 1.611E-004 * X^2 + 7.449E-008 * X^3

3/4/2009: ppm-m = 4.36 + 1.069 * X + 1.128-004 * X^2 - 1.206E-007 * X^3

12/29/2009: ppm-m = 5.48+ 1.268 * X - 6.072E-005 * X^2

where X was the instrument response. In July 2008 factory representatives adjusted the response of this unit. Adjustments made on the instrument at this time did not appear to affect the calibration (conducted before and after adjustments).

A zero concentration was not reportable by this instrument because the concentration was based on the correlation of the measured NH_3 absorption to a reference gas. No measured absorption at zero concentration results in no correlation and consequently no reportable measurement. The MDL of the instrument was determined from the mean of the variability (3 times the standard deviation) experienced at the verification concentration during each calibration verification. Since the calibration verifications were conducted in a very short path length, the water vapor effect on the instrument response was generally not detectable. The MDL was calculated to be 2.74 ppm-m prior to the July 2008 modification and 1.66 ppm-m after the modification. The instrument performance was within the MDL DQI that required the MDL to be less than 10 ppm-m. The MDL prior to the July 2008 modification was greater than the offset in the calibration regression equations but less than the offset in the calibration equations after the modification. The calibration equation offset was less than the requisite DQI MDL.

Instrument performance calibration checks (Figure 6.1-11) were made at the beginning and end of each measurement period. The majority of calibration checks were made within 21 d (Figure 6.1-12). The large fraction of checks made within 7 d was the result of calibration checks made at the end and beginning of sequential measurement periods. The standard deviation of the verifications about that predicted by the calibration equations was 4.65, 4.15, 5.23, and 4.27 ppm-m respectively. The precision DQI was ±10% RSD at 100 ppm-m. All verifications resulted in less than 10% RSD for 50 ppm-m (Figure 6.1-11) and well within the precision DQI.

The accuracy DQI was ± 10% of the 1000 ppm-m range of the measurements. A negative bias exceeding the DQI threshold occurred on two dates (Figure 6.1-11). No positive bias exceeding the DQI threshold occurred. In all cases subsequent calibration verifications did not indicate the same exceeding bias and it is concluded that operator error resulted in the exceeding biases rather than instrument failure.

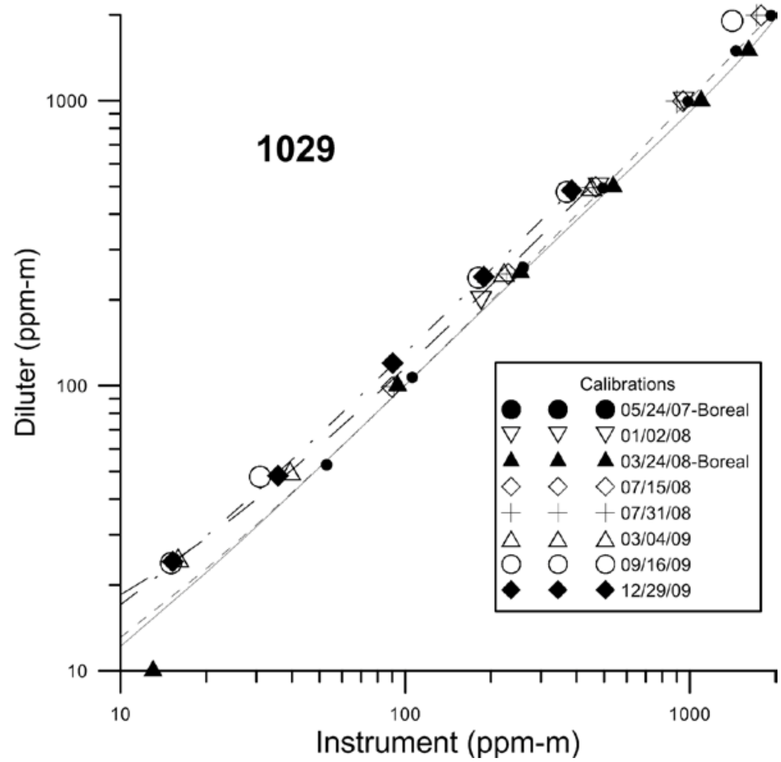


Figure 6.1-10: Multipoint calibrations of the GasFinder2 ™ s/n NH3OP-1029. The solid (5/24/2007), dotted (3/24/2008), dashed (3/4/2009) and dash-dot (12/29/2009) lines are the 3rd order polynomial regression for the chosen multipoint calibration.

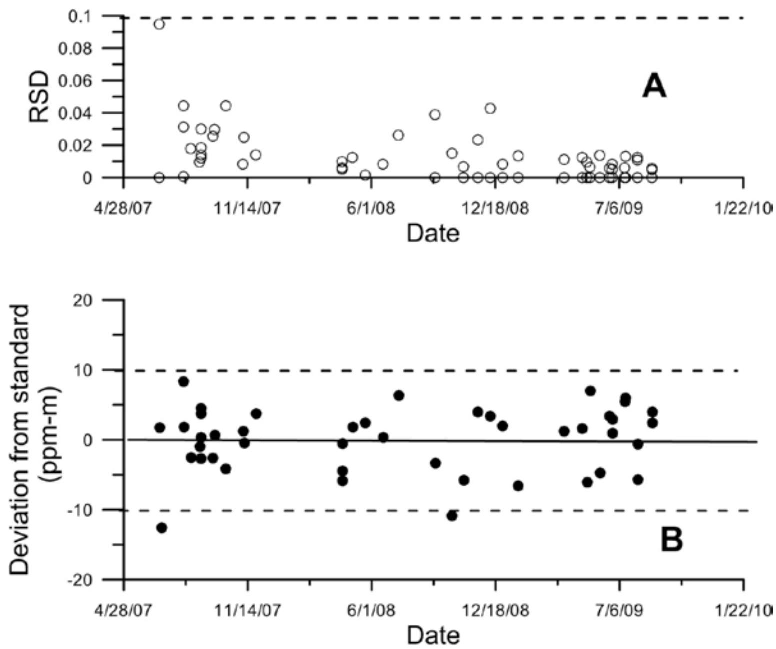


Figure 6.1-11: Control charts of the GasFinder2 ™ s/n NH3OP-1029

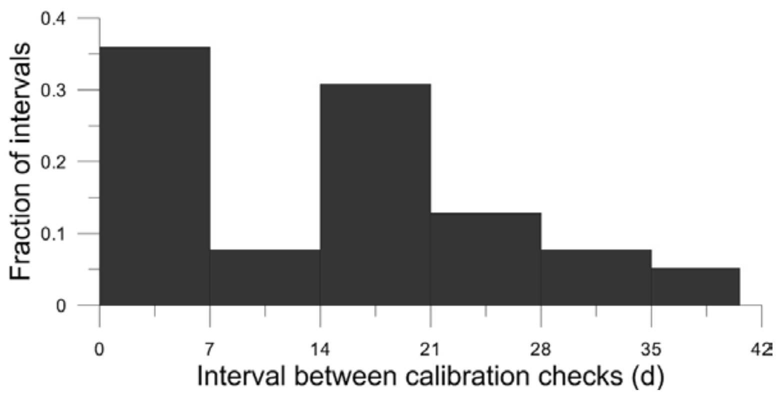


Figure 6.1-12: Calibration check intervals of the GasFinder2 ™ s/n NH3OP-1029

TDLAS 1031 was multipoint calibrated six times during the study (Figure 6.1-13). The response was non-linear and consequently a third-order polynomial was used to correct the instrument measurements for the instrument response. The multi-point calibration on 5/30/2007 was used for the entire study period. The offset of the equation was determined from a least squares fit of the entire record of calibration verifications made at 50 ppm-m applied to the first, second, and third order terms derived from the multipoint calibration. The regression equation was:

$$\text{ppm-m} = -4.43 + 1.0120 * X - 5.7496E\text{-}005 * X^2 + 6.0196E\text{-}008 * X^3,$$

where X was the instrument response. In July 2008 factory representatives adjusted the response of this unit. Adjustments made on the instrument at this time did not appear to affect the calibration (conducted before and after adjustments).

A zero concentration was not reportable by this instrument because the concentration was based on the correlation of the measured NH_3 absorption to a reference gas. No measured absorption at zero concentration results in no correlation and consequently no reportable measurement. The MDL of the instrument was determined from the mean of the variability (3 times the standard deviation) experienced at the verification concentration during each calibration verification. Since the calibration verifications were conducted in a very short path length, the water vapor effect on the instrument response was generally not detectable. The MDL was calculated to be 5.70 ppm-m prior to the July 2008 modification and 1.92 ppm-m after the modification. The instrument performance was within the MDL DQI that required the MDL to be less than 10 ppm-m. The average MDL was approximately equal to the offset indicated in the calibration regression. The calibration equation offset was less than the requisite DQI MDL.

Instrument performance calibration checks (Figure 6.1-14) were made at the beginning and end of each measurement period. The majority of calibration checks were made within 21 d (Figure 6.1-15). The large fraction of checks made within 7 d was the result of calibration checks made at the end and beginning of sequential measurement periods. The standard deviation of the verifications about that predicted by the calibration equation was 15.60 ppm-m. The precision DQI was ±10% RSD at 100 ppm-m. All verifications resulted in less than 10% RSD for 50 ppm-m (Figure 6.1-14) and were well within the precision DQI. The accuracy DQI was ± 10% of the 1000 ppm-m range of the measurements. A negative bias exceeding the DQI occurred in the calibration verifications between 8/2/2007 and 9/18/2007 (Figure 6.1-14). Positive DQI exceeding biases occurred on 6/28/2007, 9/11/2008, 4/8/2009 and 8/12/2009. Verification failures in the 6/28/2007 to 9/18/2007 interval were a result of un-anticipated optical noise in the calibration procedure which was later corrected. The 4/8/2009 exceeding bias was preceded and followed by DQI-compliant verifications and the 8/12/2009 verification was preceded by a compliant verification and followed by a multi-point indicating no problem with instrument performance. The instrument was taken out of service between 9/11/2008 and 12/31/2008.

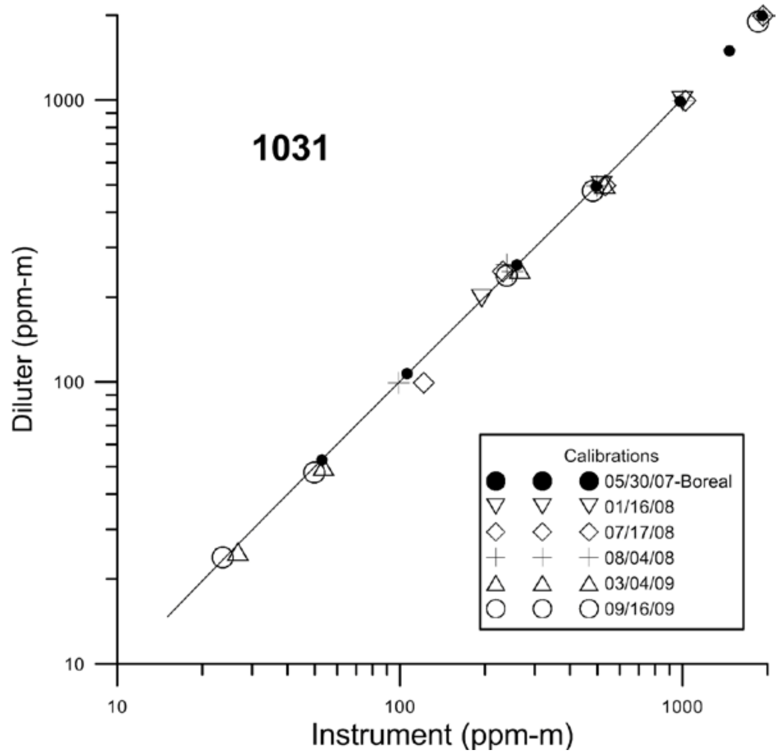


Figure 6.1-13: Multipoint calibrations of the GasFinder2 TM s/n NH3OP-1031. The solid line is the 3rd order polynomial regression for the chosen multipoint calibration.

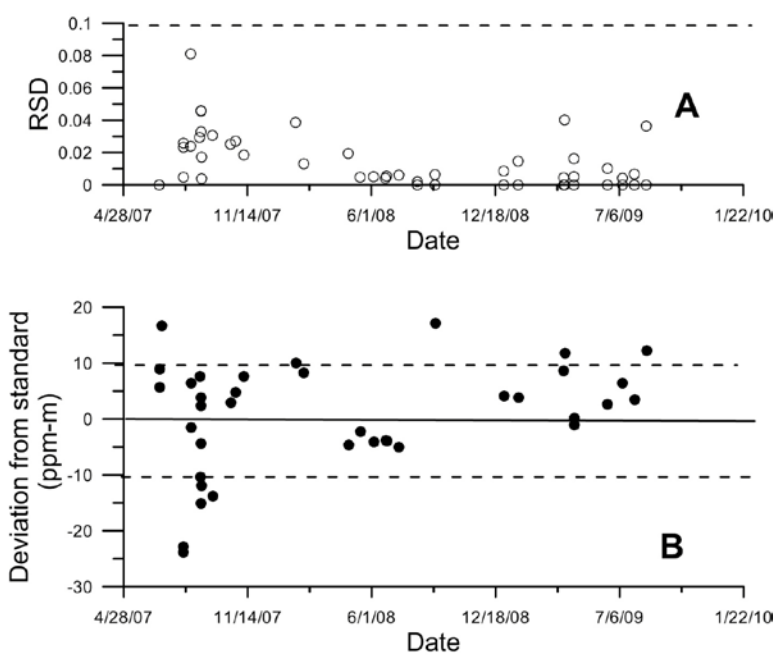


Figure 6.1-14: Control charts of the GasFinder2 TM s/n NH3OP-1031

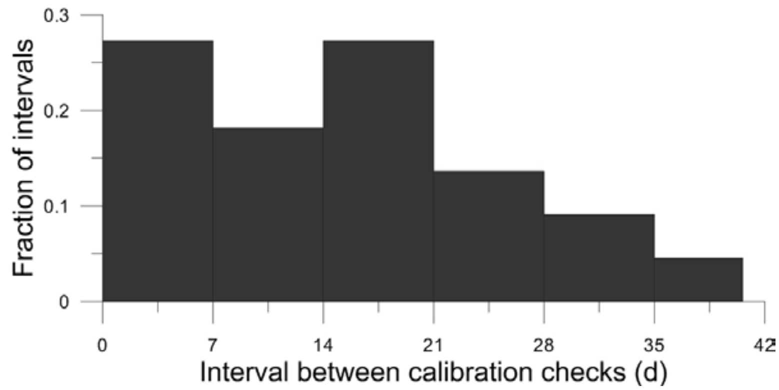


Figure 6.1-15: Calibration check intervals of the GasFinder2 ™ s/n NH3OP-1031

TDLAS 1032 was multipoint calibrated six times during the study (Figure 6.1-16). The response was non-linear and consequently a third-order polynomial was used to correct the instrument measurements for the instrument response. Table 6.1-2 indicated the multi-point calibrations used during different periods in the study.

Table 6.1-2: Multi-point calibration application

Period of applicability (MM/DD/YYYY)		
Begin	**End**	**Multipoint calibration**
9/21/2007	8/1/2008	9/12/2007
8/27/2008	8/18/2009	3/4/2009

The offset of the calibration equation was determined from a least squares fit of the appropriate period (Table 6.1-2) of calibration verifications made at 50 ppm-m applied to the first, second, and third order terms derived from the multipoint calibrations. The regression equations were:

9/12/2007: ppm-m = -4.35 + 1.005 * X + 3.563 E-005 * X^2 - 2.618 E-008 * X^3

3/4/2009: ppm-m = -0.69 + 0.995 * X - 2.3298 E-004 * X^2 + 2.891 E-007 * X^3

where X was the instrument response. In July 2008 factory representatives adjusted the response of this unit. Adjustments made on the instrument at this time did not appear to affect the calibration (conducted before and after adjustments). The laser was found on 7/21/2008 to not be internally grounded properly, resulting is the inclusion of responses at very low light levels. The no-return light levels were above the minimum light level threshold considered for a valid instrument measurement.

A zero concentration was not reportable by this instrument because the concentration was based on the correlation of the measured NH_3 absorption to a reference gas. No measured absorption at zero concentration results in no correlation and consequently no reportable measurement. The

MDL of the instrument was determined from the mean of the variability (3 times the standard deviation) experienced at the verification concentration during each calibration verification. Since the calibration verifications were conducted in a very short path length, the water vapor effect on the instrument response was generally not detectable. The MDL was calculated to be 2.60 ppm-m prior to the July 2008 modification and 1.36 ppm-m after the modification. The instrument performance was within the MDL DQI that required the MDL to be less than 10 ppm-m. The MDL was greater than the offset in the calibration equation for measurements prior to July 2008 and less than that after July 2008. The calibration equation offset was less than the requisite DQI MDL.

Instrument performance calibration checks (Figure 6.1-17) were made at the beginning and end of each measurement period. The majority of calibration checks were made within 21 d (Figure 6.1-18). The large fraction of checks made within 7 d was the result of calibration checks made at the end and beginning of sequential measurement periods. The standard deviation of the verifications about that predicted by the calibration equation was 6.13 and 5.61 ppm-m respectively. The precision DQI was ±10% RSD at 100 ppm-m. All verifications resulted in less than 10% RSD for 50 ppm-m (Figure 6.1-17) and were well within the precision DQI. The accuracy DQI was ± 10% of the 1000 ppm-m range of the measurements. A positive bias exceeding the DQI occurred on 3/26/2008 and 9/10/2008 (Figure 6.1-17). These exceeding biases were preceded and followed by valid calibration verifications and it was assumed that since no modifications of the instrument were made that the exceeding biases were due to operator error. A negative bias exceeding the DQI was indicated in the calibration verifications on 5/6/2008 (Figure 6.1-17). The grounding problem found on 7/21/2008 (described above) may have been the cause for the period of consistently negative verifications after 4/21/2008 when the background light levels exceeded the minimum acceptable light level. However since the 5/6/2008 exceeding bias was followed by compliant verifications (although low) without correction of the grounding problem it is assumed that the measurements were valid throughout the period of the grounding problem.

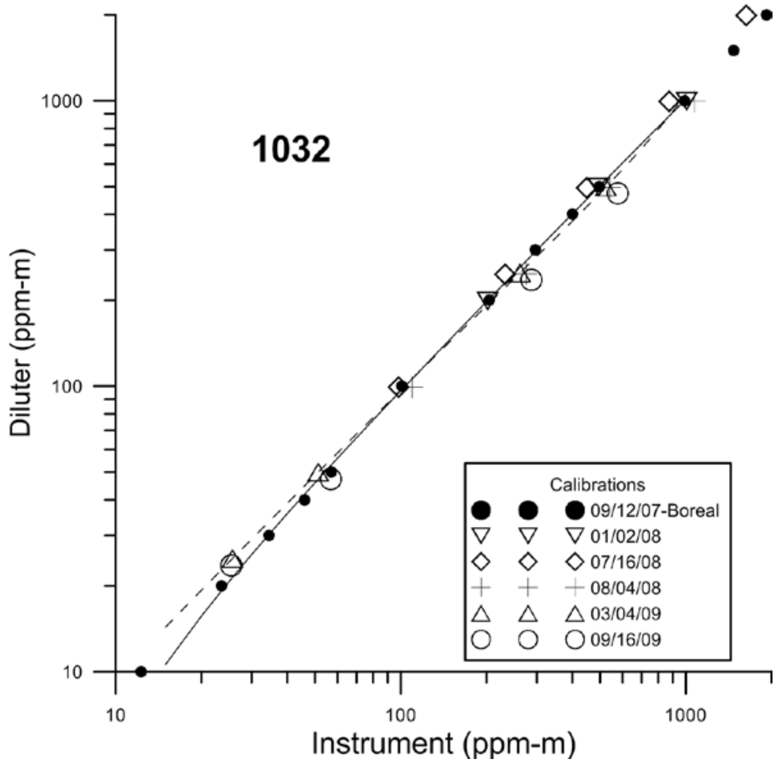


Figure 6.1-16: Multipoint calibrations of the GasFinder2 ™ s/n NH3OP-1032. The solid (9/12/2007) and dashed (3/4/2009) lines are the 3rd order polynomial regressions for the chosen multipoint calibration.

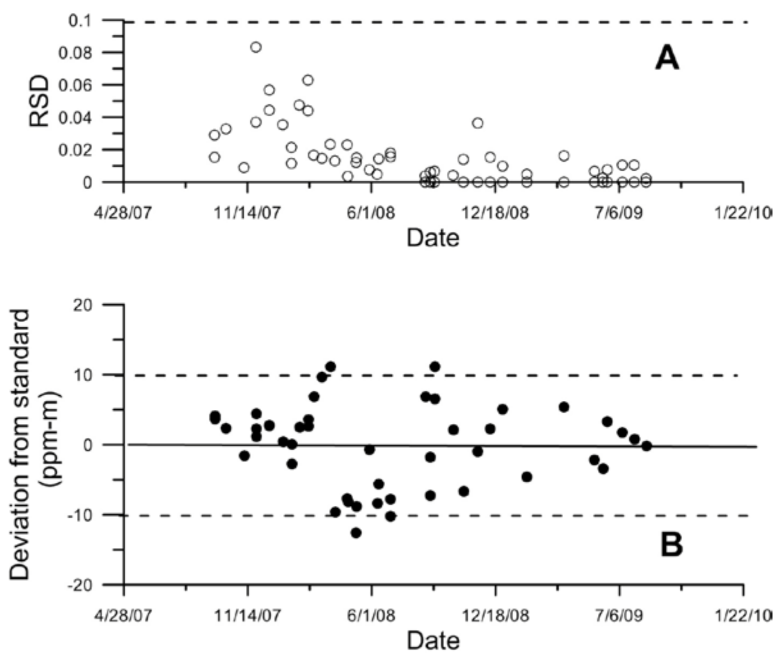


Figure 6.1-17: Control charts of the GasFinder2 ™ s/n NH3OP-1032

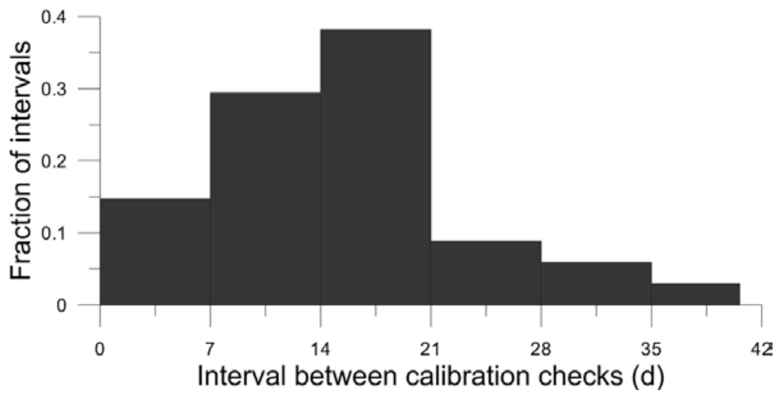


Figure 6.1-18: Calibration check intervals of the GasFinder2 ™ s/n NH3OP-1032

6.2 TEC 450i analyzer H_2S calibrations

The H_2S Analyzer (Model TEC 450i, Thermo Fisher Scientific, Franklin, MA) with serial number 0733825128 was multipoint calibrated eight times during the study (Figure 6.2-1). The coefficient of determination (r^2) for linear fits to the calibration values were never less than 0.999 although the slope of the linear regression equation varied from 0.73 to 1.38 (Table 6.2-1). Part of the variation in slope was a result of the H_2S calibration cylinders used. The initial multipoint calibration was conducted prior to the complete burn-in of the converter and consequently differs greatly from the other calibrations.

Table 1- Multipoint H_2S calibrations

Date	Slope (ppb/response)	Intercept (ppb)	r2
12/12/2007	1.38	-0.0220	0.999
7/11/2008	0.99	0.0034	0.999
8/13/2008	1.18	-0.0045	0.999
9/4/2008	1.22	0.0065	0.999
3/25/2009	0.73	0.0068	0.999
6/19/2009	1.14	-0.0037	0.999
6/24/2009	0.75	0.0075	0.999
9/9/2009	1.14	-0.0052	0.999

The standard deviation of instrument response with CEM zero air measured over a one hour period was 0.83 ppb (10/19/2009). The instrument MDL, defined as 3σ, was 2.5 ppb and is indicated in Figure 6.2-2A with dashed lines. This value was much less than the mean absolute multipoint calibration intercept concentration of 7.5 ppb.

Instrument performance calibration checks (Figure 6.2-2, 6.2-3) were made at the beginning and end of each measurement period. The majority of calibration checks were made within 21 d (Figure 6.2-4). The large fraction of checks made within 7 d were the result of calibration checks made at the end and beginning of sequential measurement periods. Instrument response was converted into measured concentrations by multiplying the instrument response by the long-term mean ratio of diluted calibration gas by instrument reading. The long-term mean ratio for this instrument was 0.788. The mean zero concentration was +1.7 ppb, less than the MDL.

The instrument measurement accuracy DQI was 10% of full scale (FS; 1 ppm). Three major periods of instrument bias that exceeded the ± 10% of FS are evident (Figure 6.2-2). The first period extended from the beginning of the measurements until 9/5/2008. Based on the correlation of instrument performance and the calibration cylinder used, it was determined that the concentration of H_2S in the SGAL053 cylinder, which could not be independently verified, was significantly below the indicated specification. This resulted in unusually high ratios of diluter concentration versus instrument response (1.01 to 1.18) up until the cylinder was replaced. The second period was from 11/4/2008 to 12/16/2008 when the calibration checks were inconsistent. Checks conducted on 11/04 and 12/16 at the end of measurement periods failed while checks made two days later at the set up of the next site passed. Since no modifications/repairs of the instruments were done in the interim between these calibrations, it was assumed that the FOS must have erred in his or her procedures.

The third period of calibration check failures occurred after April 2009. High zero checks (Figure 6.2-2A) and low reference checks (Figure 6.2-2B) occurred throughout this time. The instrument response time was found to be unusually long (11 min versus typical 5 min) when specifically checked in July 2009. After the prescribed 10 minute interval, as was specified in the SOP, the response was only 59% of the span value when the long time constant was discovered. Given the SOP reference value of 0.5 ppm, the 59% response after 10 min corresponds to approximately 0.2 ppm less than the stabilized reference value. The control chart of the calibration checks (Figure 6.2-2) showed a shift in response of approximately -0.2 ppm, which occurred in May 2009 and continued through July 2009 but appeared to return to normal operation in August 2009. This change in time response occurred during dusty conditions when the equipment was at WA5A. The change in response resulted in two multipoint calibrations in the field (Table 6.1-1).

The instrument measurement precision DQI was 10% of FS. Precision DQI exceeding biases (Figure 6.2-3) occurred on 9/5/2008, 6/4/2009 and 8/4/2009. The failure on 9/5/2008 was associated with a change in calibration cylinder (from SGAL053 to FF27944). As previously discussed, it is believed that the certified concentration in SGAL053 was low, resulting in a significant shift in the measured diluter concentration when the new cylinder began use. The failures on 6/4/2009 and 8/4/2009 were probably associated with the variable response of the instrument during the period that the shift in response time of the instrument occurred.

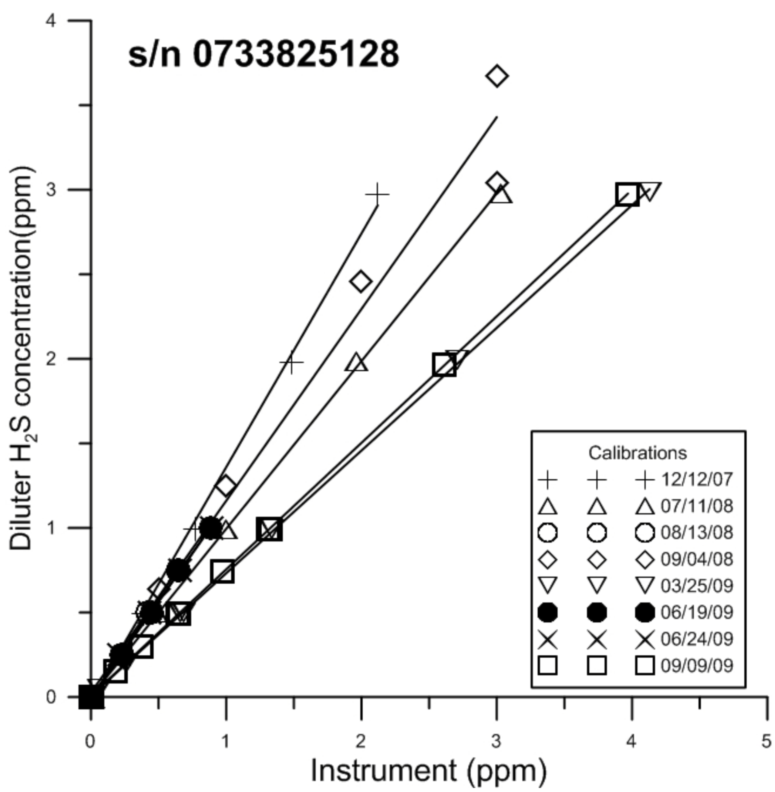


Figure 6.2-1: Multipoint calibrations of the 450i SO2/H2S Analyzer

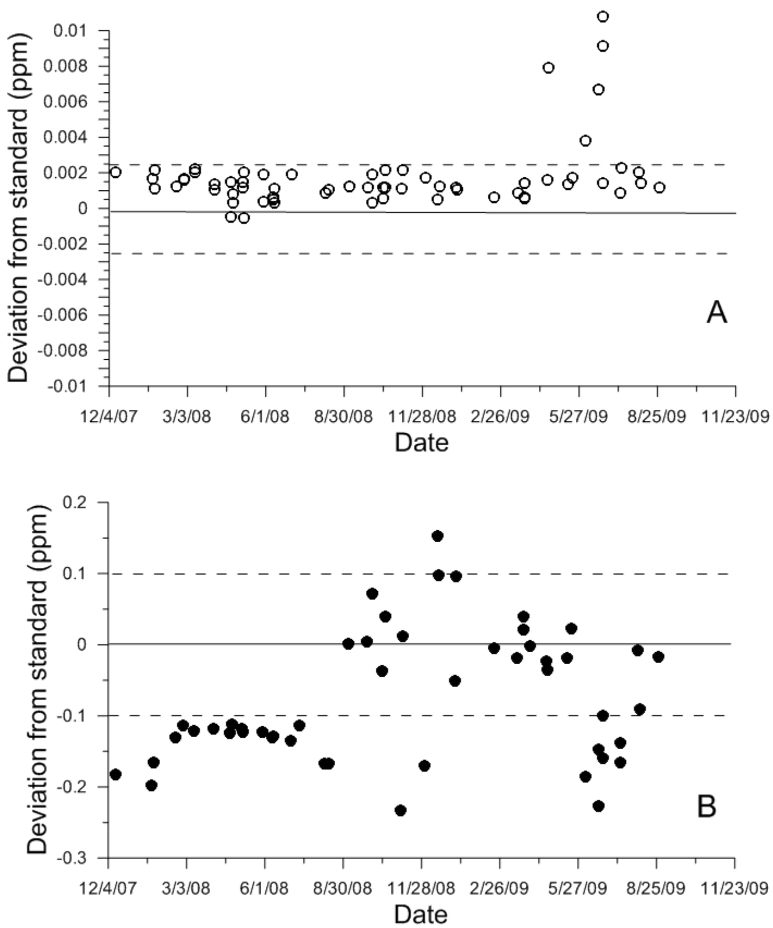


Figure 6.2-2: Instrument Control Charts.
The zero check (panel A) and span check (panel B) are indicated. The dashed lines in panel A represent the MDL. The dashed lines in panel B represent 10% of the Full Scale value (1 ppm).

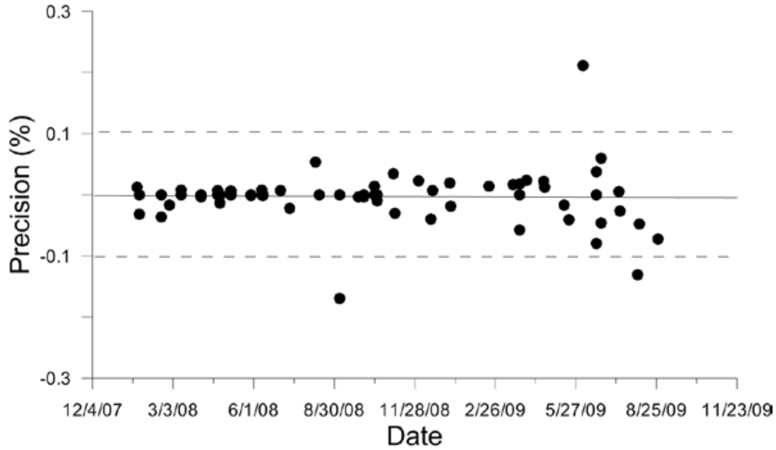


Figure 6.2-3: Instrument Precision
The precision of span checks are indicated. The dashed lines in panel A represent the MDL. The dashed lines represent 10% of the Full Scale value (1 ppm).

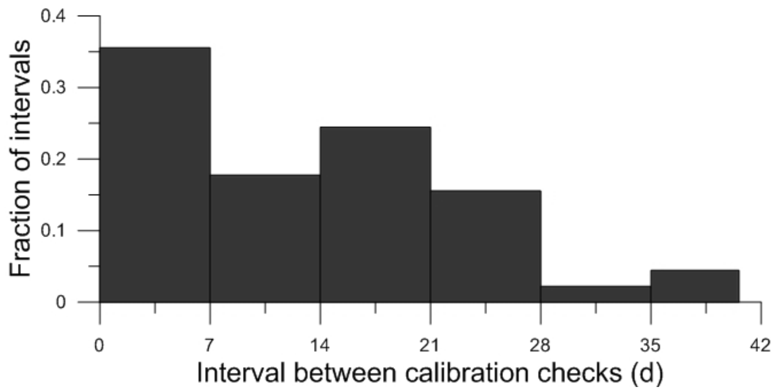


Figure 6.2-4: Calibration check intervals

6.3 Sonic anemometer calibrations

Six sonic anemometers (Model 81000, RM Young Inc, Traverse City, MI) were used at this location: serial numbers 1920, 1921, 1927, 1928, 1932, and 1936.

Sonic anemometer 1927 was inter-compared with three standard anemometers of identical design, five times (Table 6.3-1). No absolute turbulence calibration was possible with this instrument. To assure proper performance and comparability in the wind measurements, the anemometer was inter-compared on-site with those used during a given measurement period at the beginning and end of a measurement period. This instrument was inter-compared with the co-located anemometer sensors on site 35 times (Figure 6.3-1). The majority of calibration checks were made within 21 d (Figure 6.3-2). The large fraction of checks made within 7 d were the result of calibration checks made at the end and beginning of sequential measurement periods.

The accuracy DQI for the on-site inter-comparisons required the individual instruments to have the mean wind speed within 0.2 ms^{-1} of the grand mean value of the three (or four) on-site instruments (Figure 6.3-1B). This instrument passed this check on all checks except 9/23-25/2008 when it was taken out of service. Laboratory testing indicated wetness in the sensor. The sensor was dried, tested, and put back to use.

The precision DQI for the on-site inter-comparisons required each wind component (x, y, and z) of the individual instruments to be within 0.3 ms^{-1} of zero (Figure 6.3-1A). Records of the zero checks made before 12/2007 were recorded as pass/fail such that the actual measurements were not indicated. The instrument always passed this DQI.

Table 6.3-1: Standards inter-comparisons

Calibration date		Mean difference from reference anemometers (ms^{-1})	
Alignment 1	**Alignment 2**	**Alignment 1**	**Alignment 2**
6/8-12/2007	6/12-14/2007	-0.025	-0.043
1/21/2008	1/23/2008	-0.051	-0.033
7/16-17/2008	7/17-18/2008	+0.042	+0.029
3/23-25/2009	3/25-27/2009	-0.050	-0.028
9/1-2/2009	9/2-3/2009	-0.035	-0.023

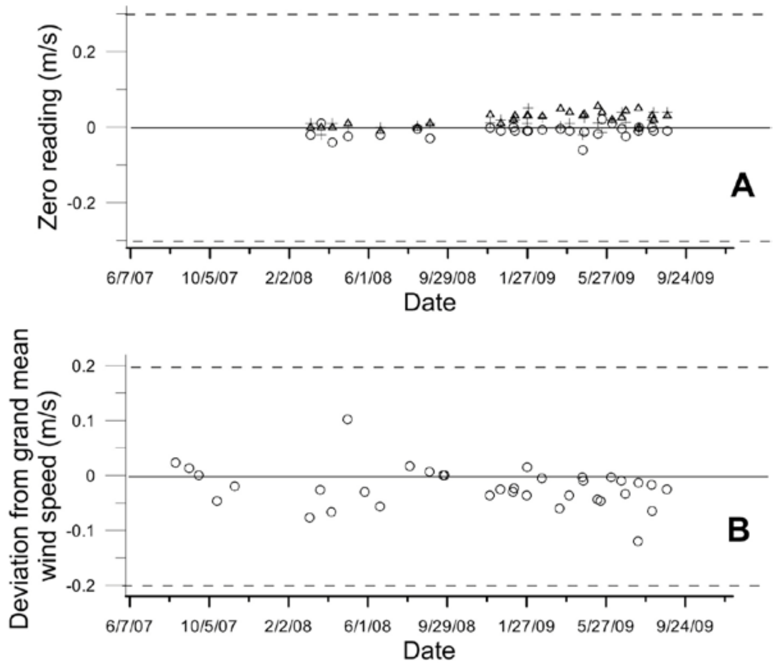


Figure 6.3-1: On-site quality assurance of s/n 1927. The DQI for the zero and inter-comparisons are indicated by the dashed lines. The zero check in the x (open circle), y (open triangle) and z (cross) components are indicated in panel A.

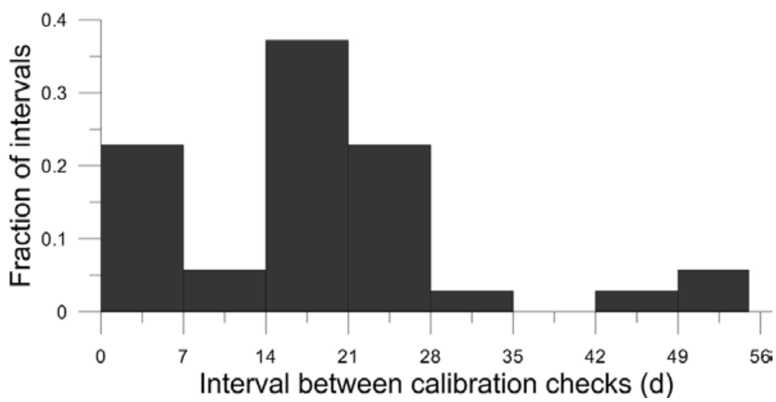


Figure 6.3-2: Inter-comparison check intervals for s/n 1927.

Sonic anemometer 1920 was inter-compared with three standard anemometers of identical design five times during the study (Table 6.3-2). No absolute turbulence calibration was possible with this instrument. To assure proper performance and comparability in the wind measurements, the anemometer was inter-compared on-site with those used during a given measurement period at the beginning and end of a measurement period. This instrument was inter-compared with the co-located anemometer sensors on site 51 times (Figure 6.3-3). The majority of calibration checks were made within 21 d (Figure 6.3-4). The large fraction of checks made within 7 d is the result of calibration checks made at the end and beginning of sequential measurement periods.

The accuracy DQI for the on-site inter-comparisons required the individual instruments to have the mean wind speed within 0.2 ms^{-1} of the grand mean value of the three (or four) on-site instruments (Figure 6.3-3B). This instrument passed this check at all times. However this instrument developed intermittent problems during operation and was sent to the factory for repair on 10/10/2008.

The precision DQI for the on-site inter-comparisons required each wind component (x, y, and z) of the individual instruments to be within 0.3 ms^{-1} of zero (Figure 6.3-3A). Records of the zero checks made before 12/2007 were recorded as pass/fail such that the actual measurements were not indicated. The instrument always passed this DQI.

Table 6.3-2: Standards inter-comparisons

Calibration date		Mean difference from reference anemometers (ms^{-1})	
Alignment 1	**Alignment 2**	**Alignment 1**	**Alignment 2**
6/19-22/2007	6/29/2007-7/2/2007	+0.001	+0.002
1/17-19/2008	1/20-21/2008	+0.045	+0.003
7/18-21/2008	7/21-22/2008	+0.017	-0.006
3/23-25/2009	3/25-27/2009	-0.036	-0.033
9/1-2/2009	9/2-3/2009	-0.046	-0.025

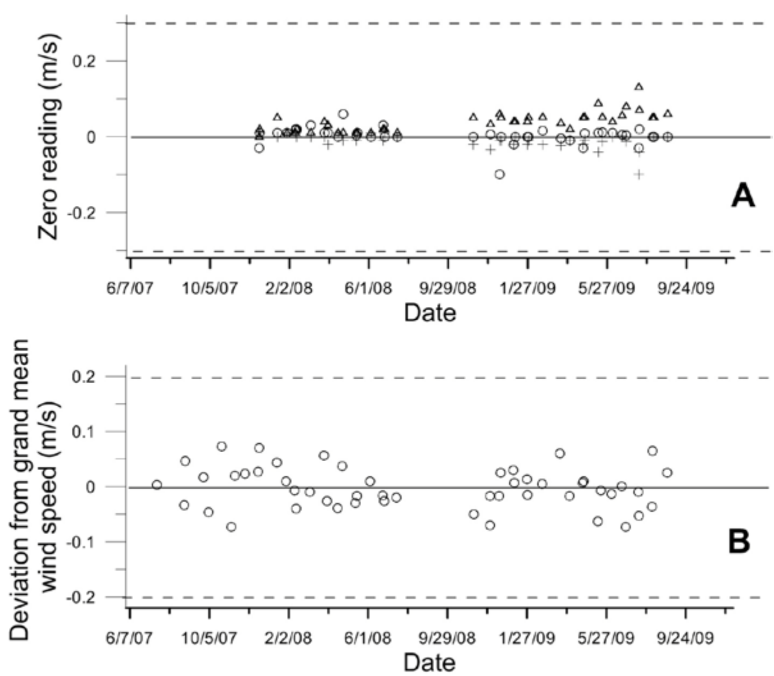


Figure 6.3-3: On-site quality assurance of s/n 1920. The DQI for the zero and inter-comparisons are indicated by the dashed lines. The zero check in the x (open circle), y (open triangle) and z (cross) components are indicated in panel A.

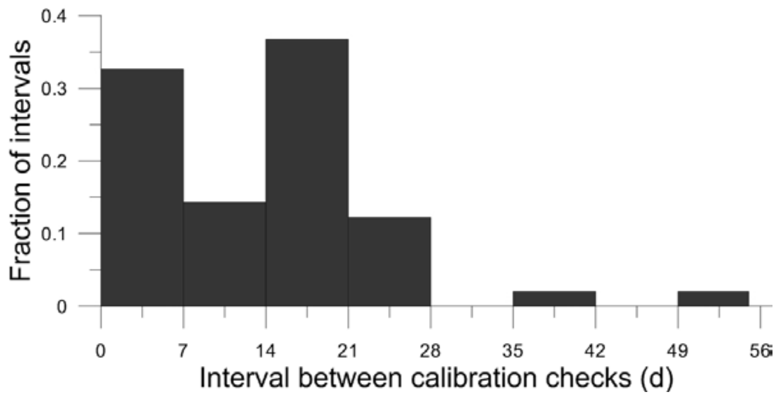


Figure 6.3-4: Inter-comparison check intervals for s/n 1920.

Sonic anemometer 1928 was inter-compared with three standard sonic anemometers of identical design six times (Table 6.3-3). No absolute turbulence calibration was possible with this instrument. To assure proper performance and comparability in the wind measurements, the anemometer was inter-compared on-site with those used during a given measurement period at the beginning and end of a measurement period. This instrument was inter-compared with the co-located anemometer sensors on site 48 times (Figure 6.3-5). The majority of calibration checks were made within 21 d (Figure 6.3-6). The large fraction of checks made within 7 d was the result of calibration checks made at the end and beginning of sequential measurement periods.

The accuracy DQI for the on-site inter-comparisons required the individual instruments to have the mean wind speed within 0.2 ms^{-1} of the grand mean value of the three (or four) on-site instruments (Figure 6.3-5B). This instrument passed this check all but one time. On this one date, the inter-comparison was rerun and the instrument passed the check.

The precision DQI for the on-site inter-comparisons required each wind component (x, y, and z) of the individual instruments to be within 0.3 ms^{-1} of zero (Figure 6.3-5A). Records of the zero checks made before 12/2007 were recorded as pass/fail such that the actual measurements were not indicated. The instrument always passed this DQI.

Table 6.3-3: Standards inter-comparisons

Calibration date		Mean difference from reference anemometers (ms^{-1})	
Alignment 1	**Alignment 2**	**Alignment 1**	**Alignment 2**
6/15-18/2007	6/18-19/2007	+0.004	+0.019
12/27-28/2007	12/29-31/2007	+0.003	-0.005
7/10-11/2008	7/11-14/2008	+0.022	+0.007
3/3-4/2009	3/5-6/2009	+0.070	-0.027
9/16-17/2009	9/17-18/2009	+0.056	+0.022
12/18-19/2009	12/21-23/2009	+0.094	-0.077

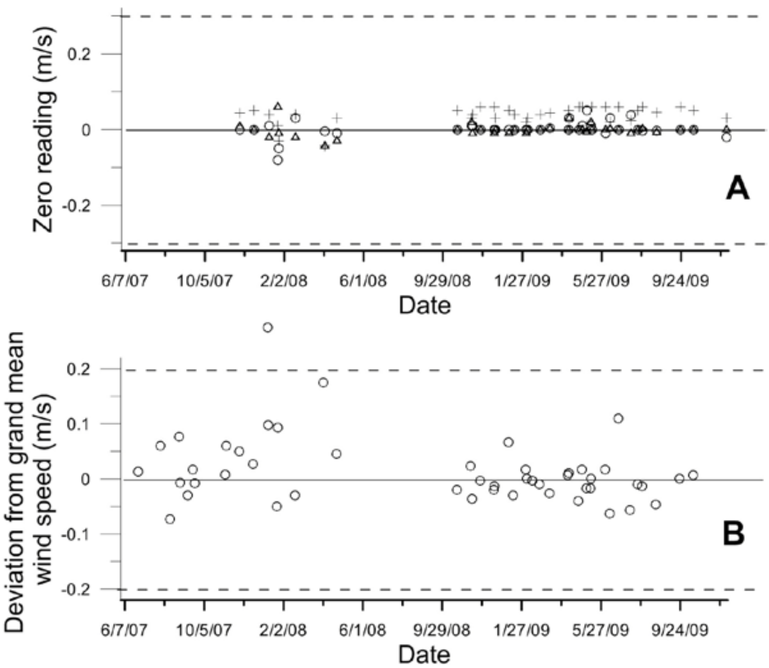


Figure 6.3-5: On-site quality assurance of s/n 1928. The DQI for the zero and inter-comparisons are indicated by the dashed lines. The zero check in the x (open circle), y (open triangle) and z (cross) components are indicated in panel A.

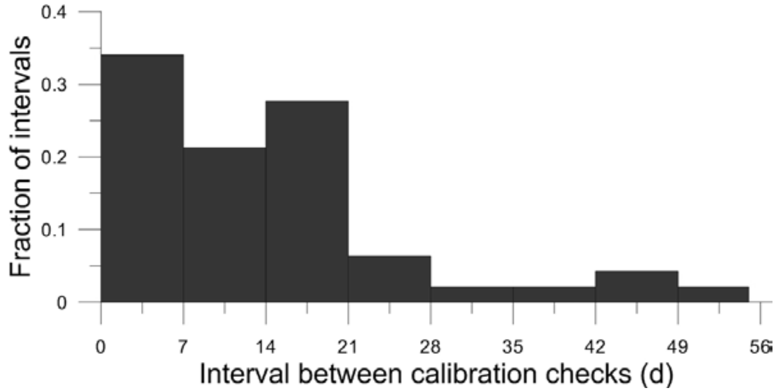


Figure 6.3-6: Inter-comparison check intervals for s/n 1928.

Sonic anemometer 1921 was inter-compared with three standard anemometers of identical design six times during the study (Table 6.3-4). No absolute turbulence calibration was possible with this instrument. To assure proper performance and comparability in the wind measurements, the anemometer was inter-compared on-site with those used during a given measurement period at the beginning and end of a measurement period. This instrument was inter-compared with the co-located anemometer sensors on site 43 times (Figure 6.3-7). The majority of calibration checks were made within 21 d (Figure 6.3-8). The large fraction of checks made within 7 d were the result of calibration checks made at the end and beginning of sequential measurement periods.

The accuracy DQI for the on-site inter-comparisons required the individual instruments to have the mean wind speed within 0.2 ms^{-1} of the grand mean value of the three (or four) on-site instruments (Figure 6.3-7B). This instrument passed this check at all times. However, this instrument developed intermittent problems during operation and was sent to the factory for repair on 12/9/2008.

The precision DQI for the on-site inter-comparisons required each wind component (x, y, and z) of the individual instruments to be within 0.3 ms^{-1} of zero (Figure 6.3-7A). Records of the zero checks made before 12/2007 were recorded as pass/fail such that the actual measurements were not indicated. The instrument always passed this DQI.

Table 6.3-4: Standards inter-comparisons

Calibration date		**Mean difference from reference anemometers (ms^{-1})**	
Alignment 1	**Alignment 2**	**Alignment 1**	**Alignment 2**
6/15-18/2007	6/18-19/2007	+0.008	-0.003
12/27-28/2007	12/29-31/2007	-0.034	+0.001
7/10-11/2008	7/11-14/2008	+0.029	-0.022
3/23-25/2009	3/25-27/2009	-0.021	-0.040
9/8-14/2009	9/15-16/2009	+0.028	+0.038
12/18-19/2009	12/21-23/2009	+0.078	+0.002

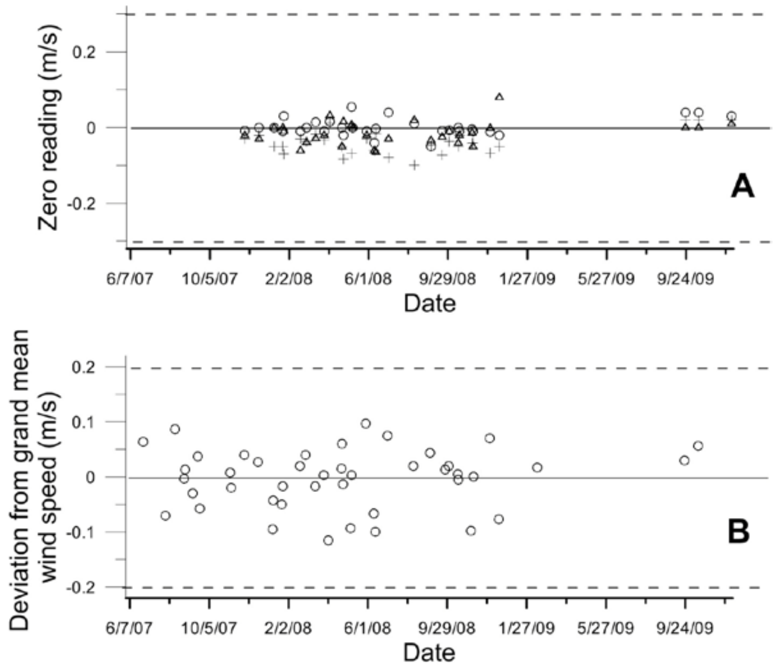


Figure 6.3-7: On-site quality assurance of s/n 1921. The DQI for the zero and inter-comparisons are indicated by the dashed lines. The zero check in the x (open circle), y (open triangle) and z (cross) components are indicated in panel A.

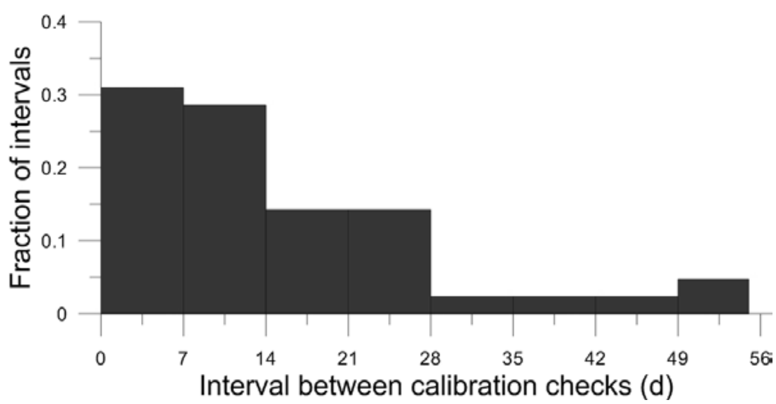


Figure 6.3-8: Inter-comparison check intervals for s/n 1921.

Sonic anemometer 1932 was inter-compared with three standard sonic anemometers of identical design six times during the study (Table 6.3-5). No absolute turbulence calibration was possible with this instrument. To assure proper performance and comparability in the wind measurements, the anemometer was inter-compared on-site with those used during a given measurement period at the beginning and end of a measurement period. This instrument was inter-compared with the co-located anemometer sensors on site 55 times (Figure 6.3-9). The majority of calibration checks were made within 21 d (Figure 6.3-10). The large fraction of checks made within 7 d was the result of calibration checks made at the end and beginning of sequential measurement periods.

The accuracy DQI for the on-site inter-comparisons required the individual instruments to have the mean wind speed within 0.2 ms^{-1} of the grand mean value of the three (or four) on-site instruments (Figure 6.3-9B). This instrument passed this check on all checks except 10/15-16/2008 when it was taken out of service. Laboratory testing indicated wetness in the sensor. The sensor was dried, tested, and put back to use.

The precision DQI for the on-site inter-comparisons required each wind component (x, y, and z) of the individual instruments to be within 0.3 ms^{-1} of zero (Figure 6.3-9B). Records of the zero checks made before 12/2007 were recorded as pass/fail such that the actual measurements were not indicated. The instrument always passed this DQI.

Table 6.3-5: Standards inter-comparisons

Calibration date		Mean difference from reference anemometers (ms^{-1})	
Alignment 1	**Alignment 2**	**Alignment 1**	**Alignment 2**
6/15-17/2007	6/18-19/2007	+0.004	+0.160
12/27-28/2007	12/29-31/2007	+0.014	-0.009
7/10-11/2008	7/11-14/2008	+0.008	+0.031
3/3-5/2009	3/5-6/2009	-0.024	-0.005
9/8-14/2009	9/15-16/2009	-0.025	-0.044
1/7-9/2010	1/23-24/2010	+0.020	-0.016

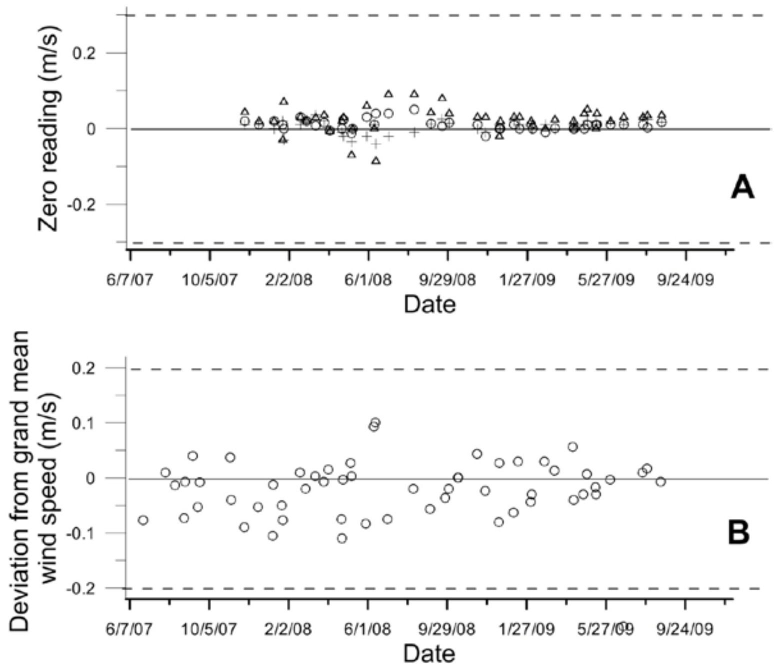


Figure 6.3-9: On-site quality assurance of s/n 1932. The DQI for the zero and inter-comparisons are indicated by the dashed lines. The zero check in the x (open circle), y (open triangle) and z (cross) components are indicated in panel A.

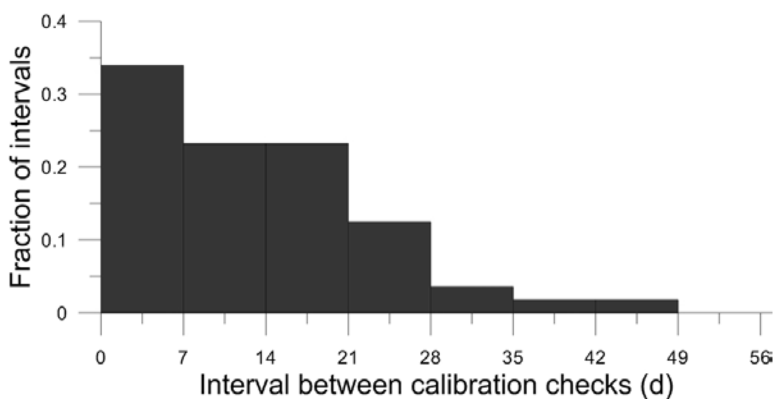


Figure 6.3-10 Inter-comparison check intervals for s/n 1932.

Sonic anemometer 1936 was inter-compared with three standard sonic anemometers of identical design five times during the study (Table 6.3-6). No absolute turbulence calibration was possible with this instrument. To assure proper performance and comparability in the wind measurements, the anemometer was inter-compared on-site with those used during a given measurement period at the beginning and end of a measurement period. This instrument was inter-compared with the co-located anemometer sensors on site 41 times (Figure 6.3-11). The majority of calibration checks were made within 21 d (Figure 6.3-12). The large fraction of checks made within 7 d was the result of calibration checks made at the end and beginning of sequential measurement periods.

The accuracy DQI for the on-site inter-comparisons required the individual instruments to have the mean wind speed within 0.2 ms^{-1} of the grand mean value of the three (or four) on-site instruments (Figure 6.3-11B). This instrument passed this check at all times.

The precision DQI for the on-site inter-comparisons required each wind component (x, y, and z) of the individual instruments to be within 0.3 ms^{-1} of zero (Figure 6.3-11A). Records of the zero checks made before 12/2007 were recorded as pass/fail such that the actual measurements were not indicated. The instrument always passed this DQI.

Table 6.3-5: Standards inter-comparisons

Calibration date		**Mean difference from reference anemometers (ms^{-1})**	
Alignment 1	**Alignment 2**	**Alignment 1**	**Alignment 2**
6/15-18/2007	6/18-19/2007	+0.011	-0.036
12/27-28/2007	12/29-31/2007	-0.022	-0.009
7/10-11/2008	7/11-14/2008	+0.021	-0.019
3/23-25/2009	3/25-27/2009	+0.018	+0.047
9/1-2/2009	9/2-3/2009	-0.029	-0.016

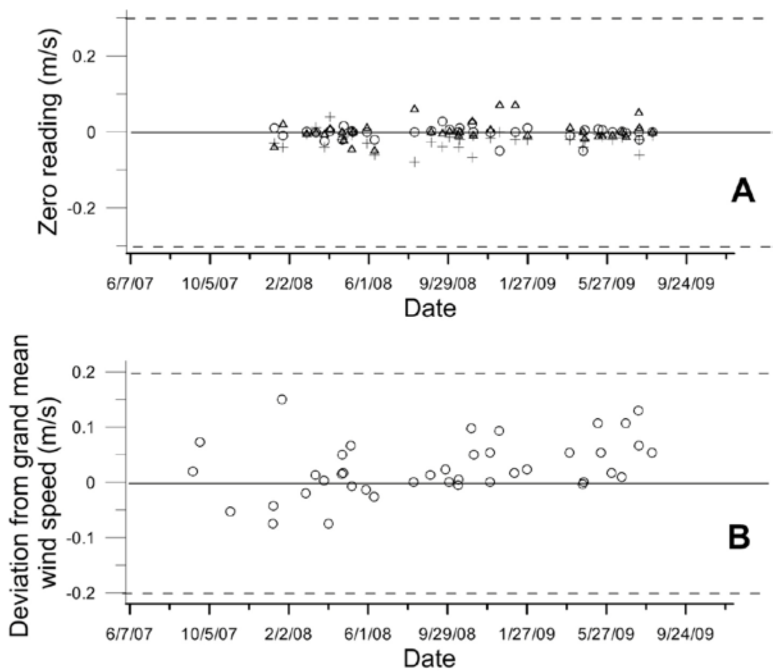


Figure 6.3-11: On-site quality assurance of s/n 1936. The DQI for the zero and inter-comparisons are indicated by the dashed lines. The zero check in the x (open circle), y (open triangle) and z (cross) components are indicated in panel A.

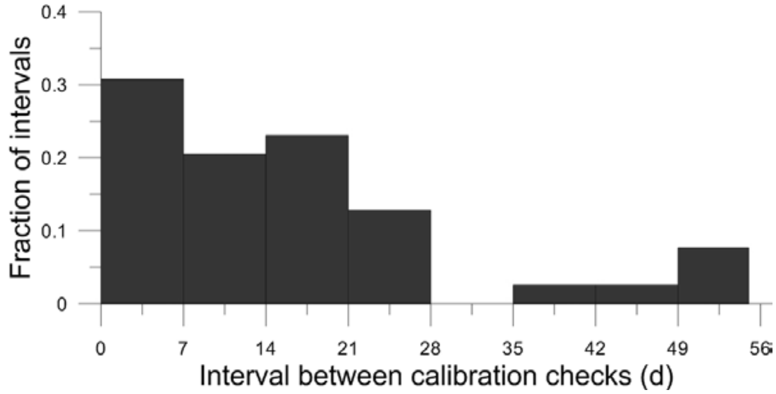


Figure 6.3-12: Inter-comparison check intervals for s/n 1936.

6.4 pH probe calibrations

Three pH probes (Model CSIMM-ph, Innovative Sensors Inc., Anaheim, California) were used at this location: serial numbers 002, 008, and 009.

Probe 002 was first used 6/27/2007 and last used 10/2/2008. The probe was calibrated 16 times. The pH probe DQI specified an accuracy of ± 0.3 pH units, corresponding to a difference between the calculated and measured pH of 17.7 mV of signal. Figure 6.4-1A illustrates the control chart for the three pH standards used (pH 4, 7, and 10) relative to the mV error. Each sensor was also checked for stability using QCCS solution, with the requirement that the sensor be within 0.05 pH units, or 3 mV. The history of the probe stability check is illustrated in Figure 6.4-1B. Problems with freezing of the electrolyte in the reference electrode during the winter reduced the frequency of these checks. The accuracy check exceeded the DQI on 4/24/2008, 5/6/2008, and 10/2/2008. The DQI exceedances on 4/24/2008 and 5/6/2008 were followed with a valid accuracy check without sensor modification or repair so it is assumed that the checks failed due to inadequate probe cleaning. The accuracy check failure on 10/2/2008 was a result of probe failure. The stability check failed on 11/28/2007, 12/19/2007, 6/10/2008, and 10/2/2008. The failed stability checks on 11/28/2007 and 12/19/2007 did not correspond with accuracy check failures and were assumed to be operator error. The stability check on 6/10/2008 was indicative of the probe failure noted in the following accuracy check.

Probe 008 was first used 9/4/2008 and last used 4/21/2009. The probe was calibrated eight times. The pH probe DQI specified an accuracy of ± 0.3 pH units, corresponding to a difference between the calculated and measured pH of 17.7 mV of signal. Figure 6.4-2A illustrates the control chart for the three pH standards used (pH 4, 7, and 10) relative to the mV error. Each sensor was also checked for stability using QCCS solution, with the requirement that the sensor be within 0.05 pH units, or 3 mV. The history of the probe stability check is illustrated in Figure 6.4-2B. Problems with freezing of the electrolyte in the reference electrode during the winter reduced the frequency of these checks. The accuracy check did not meet the DQI on 4/21/2009 and 9/17/2009. The stability check did not meet requirements 11/15/2008, 12/3/2008, 12/16/2008 and 9/17/2009.

Probe 009 was first used 4/23/2009 and last used 8/4/2009. The probe was calibrated seven times. The pH probe DQI specified an accuracy of ± 0.3 pH units, corresponding to a difference between the calculated and measured pH of 17.7 mV of signal. Figure 6.4-3A illustrates the control chart for the three pH standards used (pH 4, 7, and 10) relative to the mV error. Each sensor was also checked for stability using QCCS solution, with the requirement that the sensor be within 0.05 pH units, or 3 mV. The history of the probe stability check is illustrated in Figure 6.4-3B. Problems with freezing of the electrolyte in the reference electrode during the winter reduced the frequency of these checks. The probe always passed the stability check but failed the accuracy DQI for pH 7 and pH 10 four times: 7/14/2009, 7/15/2009, 8/4/2009 and 9/17/2009. These accuracy failures were likely due to operator error.

In general, the probe calibrations were conducted at the beginning and end of each measurement period. Since lagoon pH measurements were not made at several locations the interval between calibrations can be large when locations that did not have lagoon pH measurements were visited between locations where the measurements were made. Since freezing conditions damage the probe, the probes were not used during the winter at many locations.

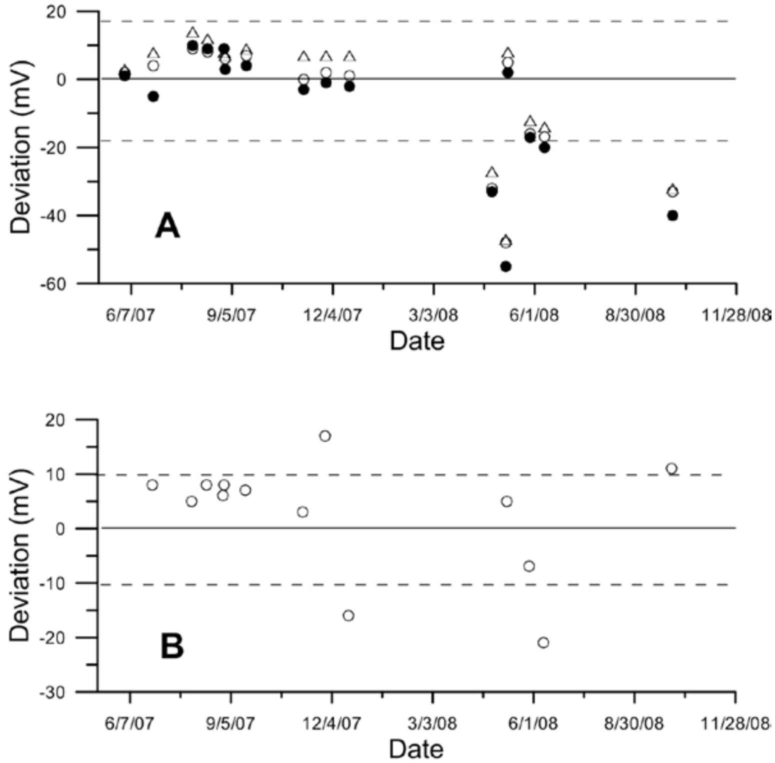


Figure 6.4-1: Accuracy and stability calibration checks of CSIM11 pH probe, s/n 002. The absolute deviation in mV of the pH 4 (closed circle), pH 7 (open circle), and ph 10 (solid triangle) are indicated in panel A. The dashed lines define the DQI limits. The time history of the absolute stability is indicated in panel B where the dashed lines indicate the desired bounds on the stability.

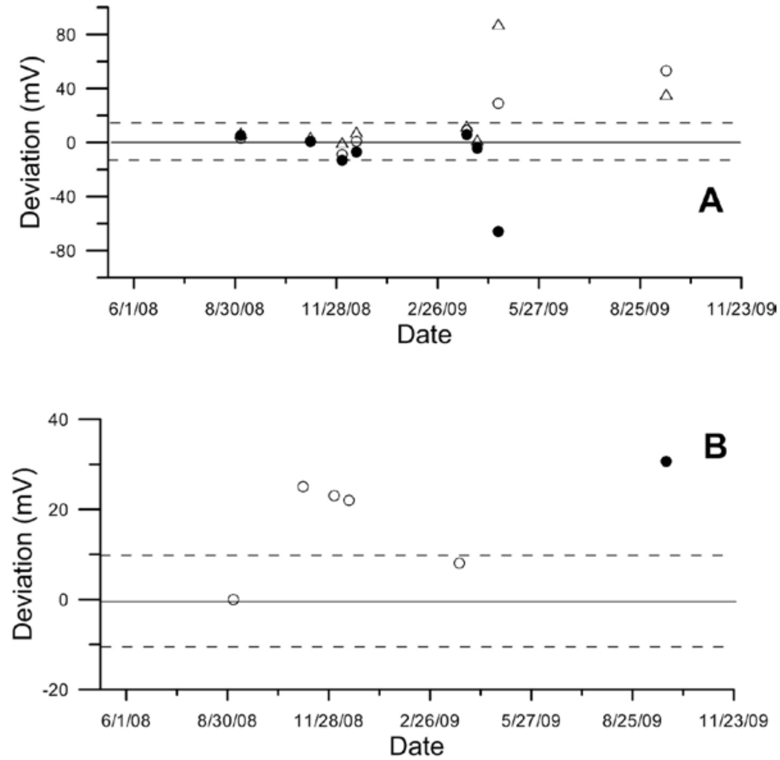


Figure 6.4-2: Accuracy and stability calibration checks of CSIM11 pH probe, s/n 008. The absolute deviation in mV of the pH 4 (closed circle), pH 7 (open circle), and ph 10 (solid triangle) are indicated in panel A. The dashed lines define the DQI limits. The time history of the absolute stability is indicated in panel B where the dashed lines indicate the desired bounds on the stability.

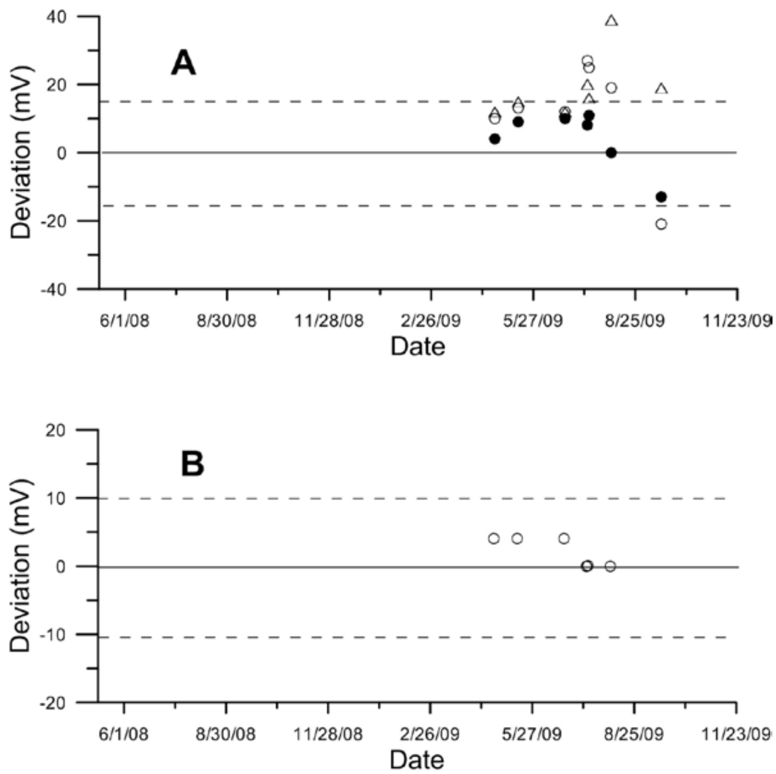


Figure 6.4-3: Accuracy and stability calibration checks of CSIM11 pH probe, s/n 009. The absolute deviation in mV of the pH 4 (closed circle), pH 7 (open circle), and ph 10 (solid triangle) are indicated in panel A. The dashed lines define the DQI limits. The time history of the absolute stability is indicated in panel B where the dashed lines indicate the desired bounds on the stability.

6.5 ORP probe calibrations

Two oxidation-reduction potential (ORP) probes (Model CSIM11-ORP, Innovative Sensors Inc., Anaheim, California) were used at this location: serial numbers 030 and 050.

Probe 030 was first used 6/27/2007 and last used 6/24/2009. The probe was calibrated 19 times. The ORP probe DQI specified an accuracy of ± 20 mV (Figure 6.5-1A). Each sensor was also checked for stability using a KCl solution, with the requirement that the sensor be within 1 mV of the reference solution. The history of the probe stability check is illustrated in Figure 6.5-1B. Problems with freezing of the electrolyte in the reference electrode during the winter reduced the frequency of these checks. The stability checks indicated variability in the response but the accuracy check passed the DQI except for the first check (6/27/2007) which was assumed to fail due to operator error since the probe passed the subsequent accuracy check without modification.

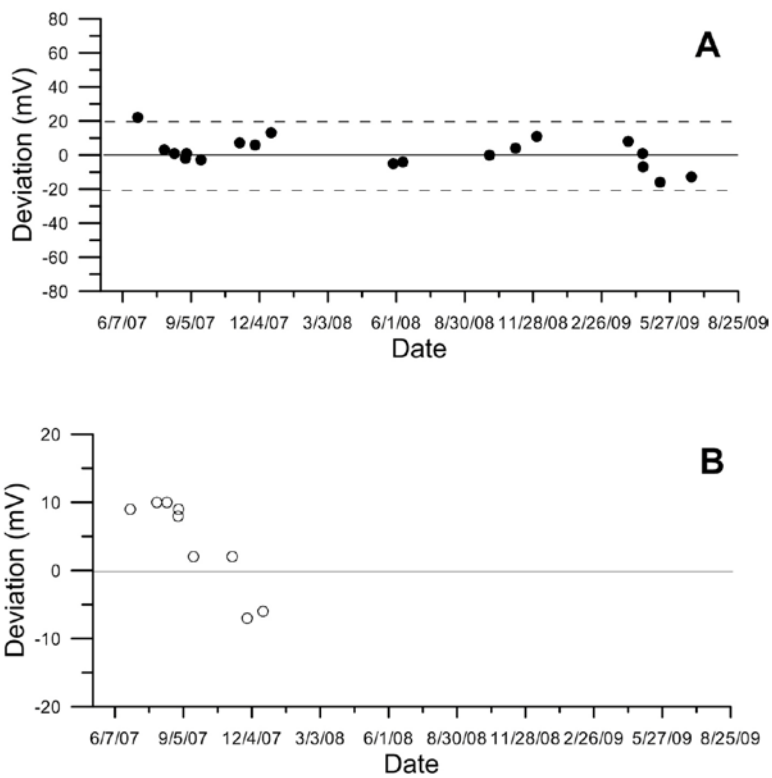


Figure 6.5-1: Accuracy and stability calibration checks of CSIM11 ORP probe, s/n 030. The stability check of the probe (Panel B) and the absolute deviation in mV of the probe (panel A) are indicated. The dashed lines define the DQI limits in panel A.

Probe 050 was first used 4/24/2008 and last used 2/23/2009. The probe was calibrated 11 times. The ORP probe DQI specified an accuracy of ± 20 mV (Figure 6.5-2A). Each sensor was also checked for stability using a KCl solution, with the requirement that the sensor be within 1 mV of the reference solution. The history of the probe stability check is illustrated in Figure 6.5-2B. Problems with freezing of the electrolyte in the reference electrode during the winter reduced the frequency of these checks. The probe always passed the accuracy DQI although showed wide response variation to the stability check. The cause of this instability is unknown.

In general, the probe calibrations were conducted at the beginning and end of each measurement period. Since lagoon ORP measurements were not made at several locations the interval between calibrations can be large when locations that did not have lagoon ORP measurements were visited between locations where the measurements were made. Since freezing conditions damage the probe, the probes were not used during the winter at many locations.

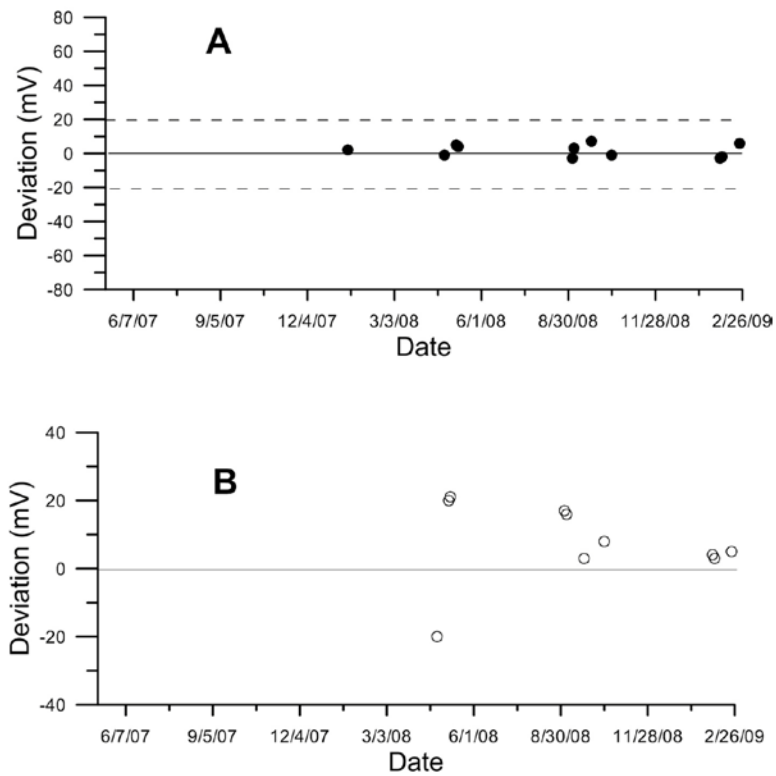


Figure 6.5-2: Accuracy and stability calibration checks of CSIM11 ORP probe, s/n 050. The stability check of the probe (Panel B) and the absolute deviation in mV of the probe (panel A) are indicated. The dashed lines define the DQI limits in panel A.

6.6 S-OPS operational checks

The Synthetic Open Path Systems (S-OPS; s/n B and E) and the Gas Sampling System (GSS s/n 4-0017) used at this location were checked at the beginning and end of every measurement period. A leak check and maximum flow check were made for both the S-OPS in combination with the GSS and for the GSS alone. In addition, the balance of flow into each inlet in the S-OPS was checked before and after each measurement period.

Results for the leak tests for both the GSS and the Combined GSS/S-OPS are indicated in sequence in Table 6.6-1. Consequently records of the checks at a given measurement site are interspersed according to the sequence of measurements for this trailer. Leaks in the GSS rarely occurred, however leaks in the S-OPS occurred several times in the study. These leaks were apparently a result of vibration within the GSS. The permissible leak in the S-OPS/GSS or GSS alone was 10% of the maximum flow. Details of the leak check failure follow:

- S-OPS leak check failure of single lines on 9/3/2008, 10/2/2008, 12/6/2008, 5/14/2009, 8/4/2009, 10/29/2009 were not resolved during the site visit due to time constraints. Repairs to the S-OPS were made on the subsequent visit.
- GSS leak check failure on 1/6/2009 was a result of pump diaphragm failure.

The impact of leak check failures in the S-OPS lines (with the exception of those at the GSS inlet filters) was minimal as the leaks were at junctions of tubing and tubing/inlet filters and would allow air into the lines that differ only in height above the berm from the air sampled along the inlets themselves. The impact of GSS leak check failures associated with pump diaphragm failures would only influence the volume of flow available to the H_2S analyzer. In all cases flow available to the analyzer greatly exceeded that used by the analyzer (1.5 L min^{-1}) (Table 6.6-1).

Table 6.6-1 - Record of leak checks for GSS and GSS/S-OPS

Date	Site	GSS solenoid	GSS mass flow (L min^{-1})	GSS pressure (kPa)	GSS check result	S-OPS max flow (L min^{-1})	S-OPS mass flow (L min^{-1})	S-OPS pressure (kPa)	S-OPS check result
3/13/2008	WA5A	2	0.08	-41.29	Pass	8	0.56	-41.19	Pass
		3	0.01	-41.46	Pass	10.1	0.43	-39.25	Pass
4/3/2008	TX5A	2	0.00	-37.94	Pass	9.3	0.46	-40.07	Pass
		3	-0.01	-40.41	Pass	9.7	0.34	-40.19	Pass
4/22/2008	TX5A	2	0.09	-31.84	Pass	9.2	0.50	-32.48	Pass
		3	0.04	-40.85	Pass	9.6	0.36	-39.59	Pass
4/24/2008	OK4A	2	0.07	-30.69	Pass	8.4	0.44	-31.03	Pass
		3	0.01	-28.52	Pass	9.7	0.63	-28.7	Pass
5/6/2008	OK4A	2	0.14	-24.42	Pass	8.5	0.65	-26.2	Pass
		3	0.17	-24.74	Fail	9.8	0.66	-23.07	Pass
5/8/2008	OK3A	2	-0.14	-32.28	Pass	9.7	0.11	-30.99	Pass
		3	-0.14	-31.16	Pass	9.2	0.51	-30.83	Pass
5/29/2008	OK3A	2	0.15	-30.98	Fail	9.8	0.31	-32.07	Pass
		3	0.27	-30.89	Fail	9.2	0.58	-32.37	Pass
6/10/2008	OK3A	2	0.07	-39.64	Pass	9.7	0.37	-38.89	Pass

Date	Site	GSS solenoid	GSS mass flow (L min^{-1})	GSS pressure (kPa)	GSS check result	S-OPS max flow (L min^{-1})	S-OPS mass flow (L min^{-1})	S-OPS pressure (kPa)	S-OPS check result
		3	0.06	-40.66	Pass	N/A	N/A	N/A	N/A
6/11/2008	TX5A	2	0.19	-39.52	Fail	9.4	0.19	-38.31	Pass
		3	0.00	-38.50	Pass	9.5	0.77	-38.43	Pass
7/1/2008	TX5A	2	0.15	-31.62	Fail	9.3	0.28	-31.17	Pass
		3	0.15	-31.69	Fail	9.3	1.00	-32.02	Pass
8/10/2008	WA5A	2	0.09	-40.90	Pass	7.5	0.44	-40.5	Pass
		3	0.07	-40.35	Pass	10.5	0.75	-38.31	Pass
9/3/2008	WA5A	2	0.27	-32.88	Fail	8	6.86	-23.56	Fail
		3	0.30	-32.92	Fail	10.5	0.53	-34.62	Pass
9/3/2008	WA5A	2	0.20	-32.22	Fail	8	0.43	-32.51	Pass
		3	0.30	-32.36	Fail	10.5	0.52	-32.73	Pass
9/26/2008	WA5A	2	0.53	-38.99	Fail	8.1	0.33	-40.01	Pass
		3	0.19	-37.03	Fail	10.5	0.41	-39.44	Pass
10/2/2008	OK4A	2	0.23	-40.69	Fail	9.6	0.95	-0.43	Pass
		3	0.23	-39.56	Fail	8.6	0.87	-0.04	Fail
10/15/2008	OK4A	2	0.17	-41.03	Fail	9.8	0.32	-38.14	Pass
		3	0.18	-38.71	Fail	8.5	0.32	-38.9	Pass
10/16/2008	TX5A	2	0.20	-39.65	Fail	9.7	0.28	-39.72	Pass
		3	0.23	-40.98	Fail	9.5	0.59	-39.55	Pass
11/4/2008	TX5A	2	0.33	-41.59	Fail	9.4	0.31	-39.62	Pass
		3	0.32	-41.56	Fail	9.3	0.50	-40.62	Pass
11/6/2008	OK3A	2	0.33	-39.79	Fail	8.7	0.73	-42.34	Pass
		3	0.32	-38.77	Fail	9.3	0.47	-39.46	Pass
12/3/2008	OK3A	2	0.79	-40.32	Fail	8.4	0.65	-39.24	Pass
		3	0.83	-39.05	Fail	9.2	0.43	-40.53	Pass
12/16/2008	OK3A	2	0.72	-37.70	Fail	8.6	1.05	-40.13	Fail
		3	0.79	-36.81	Fail	9.5	0.91	-40.65	Pass
12/18/2008	TX5A	2	1.98	-38.41	Fail	9.4	0.92	-37.74	Pass
		3	2.09	-38.03	Fail	9.4	0.90	-37.46	Pass
1/6/2009	TX5A	2	0.12	-40.60	Pass	9.1	2.09	-37.63	Fail
		3	0.13	-40.35	Pass	8.9	2.12	-37.72	Fail
1/8/2009	OK4A	2	0.11	-38.95	Pass	9.8	0.41	-39.67	Pass
		3	0.11	-37.59	Pass	7.2	0.30	-41.91	Pass
1/27/2009	OK4A	2	0.09	-38.64	Pass	9.4	0.36	-40.34	Pass
		3	0.09	-38.15	Pass	8.3	0.20	-41.46	Pass
1/29/2009	TX5A	2	0.05	-37.73	Pass	9.8	0.37	-38.37	Pass
		3	0.17	-38.46	Fail	9.6	0.24	-37.24	Pass
2/19/2009	TX5A	2	0.19	-36.64	Fail	9.9	0.92	-39.35	Pass
		3	0.04	-36.77	Pass	9.7	0.64	-38.72	Pass
3/18/2009	TX5A	2	0.15	-38.19	Fail	9.3	0.65	-37.14	Pass
		3	0.07	-39.28	Pass	9.8	0.45	-37.54	Pass
4/21/2009	OK4A	2	0.15	0.06	Fail	10.2	0.55	-40.07	Pass
		3	0.01	-39.72	Pass	9	0.24	-37.98	Pass
4/22/2009	OK3A	2	0.14	-40.11	Pass	9.7	0.30	-38.44	Pass
		3	0.05	-38.69	Pass	8.8	0.77	-27.92	Pass
5/14/2009	OK3A	2	0.20	-39.22	Fail	9.7	0.26	-38.46	Pass
		3	0.09	-39.13	Pass	8.6	0.88	-38.07	Fail
5/21/2009	WA5A	2	0.17	-37.70	Fail	7.9	0.18	-39.69	Pass
		3	0.02	-39.60	Pass	10.5	0.96	-39.37	Pass
6/4/2009	WA5A	2	0.18	-40.86	Fail	8.6	0.24	-40.49	Pass
		3	0.04	-38.48	Pass	10.5	0.97	-38.07	Pass

Date	Site	GSS solenoid	GSS mass flow (L min^{-1})	GSS pressure (kPa)	GSS check result	S-OPS max flow (L min^{-1})	S-OPS mass flow (L min^{-1})	S-OPS pressure (kPa)	S-OPS check result
6/19/2009	WA5A	2	0.33	-39.50	Fail	8.7	0.25	-38.74	Pass
		3	0.14	-39.60	Pass	10.5	0.95	-37.89	Pass
6/23/2009	OK4A	2	0.07	-39.89	Pass	9.7	0.37	-39.37	Pass
		3	0.04	-38.56	Pass	8.8	0.60	-40.96	Pass
7/14/2009	OK4A	2	0.25	-39.85	Fail	8.5	0.14	-40.79	Pass
		3	0.08	-38.49	Pass	9.7	0.13	-39.51	Pass
7/15/2009	OK3A	2	0.02	-38.14	Pass	8.7	0.63	-38.59	Pass
		3	0.04	-36.71	Pass	9.9	0.08	-39.75	Pass
8/4/2009	OK3A	2	0.06	-38.09	Pass	8.5	2.25	-37.22	Fail
		3	0.11	-34.41	Pass	9.7	0.09	-39.78	Pass
8/6/2009	TX5A	2	0.05	-38.30	Pass	9.8	0.75	-39.4	Pass
		3	0.00	-40.36	Pass	9.9	0.14	-38.93	Pass
8/27/2009	TX5A	2	0.02	-39.89	Pass	9.7	0.65	-37.52	Pass
		3	0.05	-40.26	Pass	9.5	0.11	-38.95	Pass
9/23/2009	NC3A	2	0.06	-40.15	Pass	10.1	0.34	-39.61	Pass
		3	0.07	-38.33	Pass	0	-0.60	-0.05	Pass
10/13/2009	NC3A	2	0.17	-39.38	Fail	9.6	0.41	-39.03	Pass
		3	0.04	-37.77	Pass	10	0.20	-41.33	Pass
10/27/2009	NC3A	2	0.08	-41.29	Pass	10	0.26	-39.3	Pass
		3	0.01	-41.46	Pass	9.3	1.45	0.11	Fail
10/27/2009	NC3A	2	0.00	-37.94	Pass	10	0.26	-39.3	Pass
		3	-0.01	-40.41	Pass	9.3	0.51	-40.26	Pass
11/11/2009	NC3A	2	0.04	-39.92	Pass	10	0.79	-40.71	Pass
		3	0.04	-39.74	Pass	9.6	0.27	-40.26	Pass

The inlet flow balance checks are summarized in sequence in Tables 6.6-2A and 6.6-2B. Consequently records of the checks at a given measurement site are interspersed according to the sequence of measurements for this trailer. While the inlet flow balance was measured at the beginning and end of each measurement period, results showed that the balance throughout the period was not assured if the balance test indicated an adequate balance. Balance across the inlets at any time during a period or at the beginning or end of a period was limited due to wetness of the inlet filters associated with fog, ice, snow, or rain. In addition dust on the inlet filters contributed to an undetermined rate of flow degradation of individual inlets over a period. Spider webs would also restrict flow across the inlet filters. The allowable tolerance in the inlet balance was that the flow through any inlet was within 10% of the expected flow for the inlet.

Condensation or liquid water intrusion into the Teflon tubing of the S-OPS occurred often in the tubing around the area sources. Analysis of the problem revealed that condensation occurred as the air cooled in transit from the inlet to the trailer through tubing under a negative net radiation balance (particularly at night). In addition, water intrusion occurred during the leak testing if any water had accumulated along the junction between the filter/inlet and the S-OPS tubing. The impact of the liquid water in the S-OPS tubing on the measured concentration of H_2S was minimal due to the low solubility of H_2S.

Table 6.6-2A: Record of flow balancing-Side 1 (s/n B)

			Delta inlet flow (beginning-end) (L min^{-1})										
Start date	End date	Site	1	2	3	4	5	6	7	8	9	10	Check results
3/13/2008	4/3/2008	WA5A	-0.20	-0.21	-0.06	-0.14	-0.20	-0.24	-0.21	-0.04	-0.20	-0.23	**Fail**
4/3/2008	4/22/2008	TX5A	-0.08	-0.07	-0.08	-0.09	-0.07	-0.09	-0.13	-0.09	-0.12	-0.14	**Pass**
4/24/2008	5/6/2008	OK4A	-0.02	-0.04	-0.01	-0.14	-0.02	-0.03	-0.09	-0.10	-0.07	-0.12	**Fail**
5/8/2008	5/29/2008	OK3A	0.01	0.02	0.02	0.02	0.02	0.03	0.01	0.03	0.01	0.04	**Pass**
5/29/2008	6/10/2008	OK3A	M	M	M	M	M	M	M	M	M	M	**M**
6/11/2008	7/1/2008	TX5A	-0.01	-0.01	-0.02	-0.01	-0.02	-0.02	-0.01	-0.01	-0.02	-0.02	**Pass**
7/1/2008	8/10/2008	TX5A	0.35	0.38	0.11	0.39	0.27	0.31	0.30	0.18	0.34	0.31	**Pass**
8/10/2008	9/3/2008	WA5A	0.00	-0.10	0.11	-0.20	0.00	0.00	-0.10	0.00	-0.10	0.00	**Fail**
9/3/2008	9/26/2008	WA5A	0.00	-0.10	-0.10	0.10	0.00	-0.20	-0.10	0.10	0.00	0.00	**Fail**
10/2/2008	10/15/2008	OK4A	0.02	-0.02	0.01	0.01	-0.03	0.06	0.06	0.05	0.04	0.02	**Fail**
10/16/2008	11/4/2008	TX5A	0.02	0.00	0.00	-0.01	-0.02	-0.05	-0.05	0.00	0.01	0.03	**Pass**
11/6/2008	12/3/2008	OK3A	0.03	0.00	0.00	0.01	-0.02	0.03	0.04	0.05	0.05	0.05	**Pass**
12/3/2008	12/16/2008	OK3A	-0.02	-0.01	-0.01	0.00	0.04	-0.06	0.04	-0.04	-0.03	-0.03	**Pass**
12/18/2008	1/6/2009	TX5A	-0.02	-0.06	-0.03	0.00	-0.04	-0.02	-0.02	0.00	0.01	-0.01	**Fail**
1/8/2009	1/27/2009	OK4A	-0.02	-0.04	-0.04	0.00	-0.05	-0.01	0.00	0.00	0.00	0.01	**Pass**
1/29/2009	2/19/2009	TX5A	-0.04	-0.02	0.00	0.06	0.00	-0.06	0.00	-0.02	-0.02	0.00	**Pass**
2/19/2009	3/18/2009	TX5A	0.01	-0.02	0.01	0.01	0.01	-0.02	0.00	0.00	0.00	-0.01	**Fail**
3/18/2009	4/2/2009	TX5A	0.06	0.06	0.05	0.06	0.04	0.08	0.06	0.10	0.05	0.11	**Pass**
4/2/2009	4/21/2009	OK4A	0.02	0.05	0.04	0.04	-0.03	0.01	0.02	0.01	-0.01	-0.01	**Pass**
4/22/2009	5/14/2009	OK4A	-0.03	-0.04	-0.02	-0.03	-0.02	-0.14	-0.02	-0.01	-0.02	-0.03	**Pass**
5/14/2009	5/21/2009	OK4A	0.23	0.24	0.27	0.28	0.17	0.28	0.23	0.26	0.17	0.29	**Pass**
5/21/2009	6/4/2009	WA5A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**Pass**
6/4/2009	6/19/2009	WA5A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**Pass**
6/23/2009	7/14/2009	OK4A	0.00	-0.02	-0.03	-0.01	-0.04	0.01	0.01	0.00	-0.01	-0.04	**Pass**
7/15/2009	8/4/2009	OK3A	0.05	0.04	0.13	0.09	0.13	0.20	0.16	0.14	0.14	0.18	**Pass**
8/6/2009	8/27/2009	TX5A	0.05	0.05	0.01	0.00	0.01	0.03	0.02	0.03	0.06	0.04	**Pass**
8/27/2009	9/24/2009	TX5A	-0.10	-0.06	-0.05	-0.06	-0.08	-0.01	-0.04	-0.05	-0.14	-0.01	**Pass**
9/24/2009	10/13/2009	NC3A	0.00	-0.03	0.00	-0.05	-0.03	-0.08	87.39	-0.11	-0.12	0.06	**Pass**
10/13/2009	10/27/2009	NC3A	-0.02	-0.05	-0.04	-0.03	-0.04	-0.04	-0.03	-0.03	-0.05	0.00	**Pass**
10/27/2009	11/11/2009	NC3A	0.00	-0.02	-0.01	-0.01	-0.01	0.00	-0.02	0.00	-0.04	0.02	**Pass**
11/11/2009	12/2/2009	NC3A	0.02	0.04	-0.11	-0.01	0.01	0.00	-0.03	-0.08	0.37	0.03	**Fail**

M: missing measurements.

Table 6.6-2B: Record of flow balancing- Side 2 (s/n E)

			Delta inlet flow (beginning-end) (L min^{-1})										
Start date	**End date**	**Site**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Check results**
3/13/2008	4/3/2008	WA5A	0.19	0.18	0.11	0.19	0.14	0.14	0.15	0.17	0.15	0.21	**Fail**
4/3/2008	4/22/2008	TX5A	-0.03	-0.03	0.01	-0.04	-0.09	-0.06	0.00	0.01	0.00	0.00	**Pass**
4/24/2008	5/6/2008	OK4A	0.00	0.00	0.00	-0.03	-0.02	-0.05	0.06	-0.01	-0.03	0.06	**Fail**
5/8/2008	5/29/2008	OK3A	0.02	0.01	0.04	0.00	0.05	0.02	0.01	0.04	0.02	0.02	**Pass**
5/29/2008	6/10/2008	OK3A	-0.01	-0.01	-0.02	0.00	0.00	-0.02	0.01	-0.04	-0.02	0.00	**Pass**
6/11/2008	7/1/2008	TX5A	0.01	0.00	0.00	0.01	-0.01	-0.02	-0.02	-0.02	-0.01	-0.03	**Pass**
7/1/2008	7/29/2008	TX5A	-0.03	-0.09	0.00	-0.05	-0.03	-0.06	0.02	-0.03	-0.02	0.00	**Pass**
8/10/2008	9/3/2008	WA5A	0.05	0.14	0.09	0.10	0.16	0.14	0.12	0.15	0.18	0.15	**Pass**
9/3/2008	9/26/2008	WA5A	-0.04	-0.06	-0.02	-0.01	0.00	0.00	0.02	-0.04	0.02	0.00	**Pass**
10/2/2008	10/15/2008	OK4A	0.00	0.01	-0.02	0.00	-0.01	0.01	0.03	0.03	0.11	0.00	**Pass**
10/16/2008	11/4/2008	TX5A	-0.02	-0.05	-0.03	-0.04	0.00	0.00	-0.04	-0.04	-0.01	-0.02	**Pass**
11/6/2008	12/3/2008	OK3A	-0.01	0.01	0.00	-0.02	0.14	-0.07	0.01	0.02	0.02	0.02	**Fail**
12/3/2008	12/16/2008	OK3A	0.01	-0.02	-0.01	-0.02	-0.01	0.02	0.00	0.00	-0.02	-0.01	**Pass**
12/18/2008	1/6/2009	TX5A	-0.03	-0.08	-0.05	-0.05	-0.06	-0.05	-0.06	-0.04	-0.07	-0.02	**Pass**
1/8/2009	1/27/2009	OK4A	-0.04	-0.03	-0.03	-0.04	-0.04	-0.02	-0.03	-0.02	-0.02	-0.01	**Pass**
1/29/2009	2/19/2009	TX5A	0.00	-0.05	0.00	0.01	-0.02	-0.05	0.02	0.02	0.12	-0.01	**Pass**
2/19/2009	3/18/2009	TX5A	0.03	0.03	0.04	0.03	0.02	0.04	0.01	0.02	0.03	0.01	**Fail**
3/18/2009	4/2/2009	TX5A	-0.14	-0.12	-0.13	-0.12	-0.14	-0.16	-0.14	-0.12	-0.15	-0.14	**Pass**
4/2/2009	4/21/2009	OK4A	0.00	0.05	0.05	0.04	0.04	0.07	0.05	0.03	0.01	0.02	**Pass**
4/22/2009	5/14/2009	OK3A	-0.06	0.00	0.00	-0.01	0.01	0.02	0.01	0.03	0.03	0.00	**Pass**
5/14/2009	5/21/2009	OK3A	-0.07	-0.11	-0.13	-0.11	-0.21	-0.10	-0.19	-0.16	-0.17	-0.18	**Pass**
5/21/2009	6/4/2009	WA5A	0.01	0.00	0.00	0.01	0.07	-0.03	0.05	0.02	0.00	0.00	**Pass**
6/4/2009	6/19/2009	WA5A	0.01	0.01	-0.04	-0.03	-0.03	-0.03	-0.02	-0.01	-0.02	0.00	**Pass**
6/23/2009	7/14/2009	OK3A	-0.02	-0.02	0.00	-0.02	-0.02	0.03	-0.03	-0.02	-0.02	0.01	**Pass**
7/15/2009	8/4/2009	OK3A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**Pass**
8/4/2009	8/6/2009	OK3A	0.00	-0.01	0.01	0.01	-0.01	0.01	-0.01	0.02	0.01	0.00	**Pass**
8/6/2009	8/27/2009	TX5A	0.00	-0.03	-0.05	-0.04	-0.02	-0.02	-0.01	0.01	0.01	0.03	**Pass**
8/27/2009	9/23/2009	TX5A	0.05	0.05	0.08	0.11	0.22	0.22	0.21	0.25	0.22	0.21	**Fail**
9/24/2009	10/13/2009	NC3A	0.02	0.03	0.00	0.02	0.00	0.00	0.00	-0.03	0.00	0.16	**Fail**
10/13/2009	10/27/2009	NC3A	0.00	-0.01	0.12	-0.05	-0.02	-0.12	-0.04	-0.05	-0.06	0.00	**Pass**
10/27/2009	11/11/2009	NC3A	0.15	0.06	0.18	0.10	-0.05	0.25	0.25	0.05	0.21	-0.60	**Fail**

The nominal planned interval between S-OPS checks was 20 d (three weeks). S-OPS checks were conducted at this long-term measurement location a relatively few times with the period of time between checks varying from one to three weeks (Figure 6.6-1). Shorter intervals between checks occurred due to work on the systems.

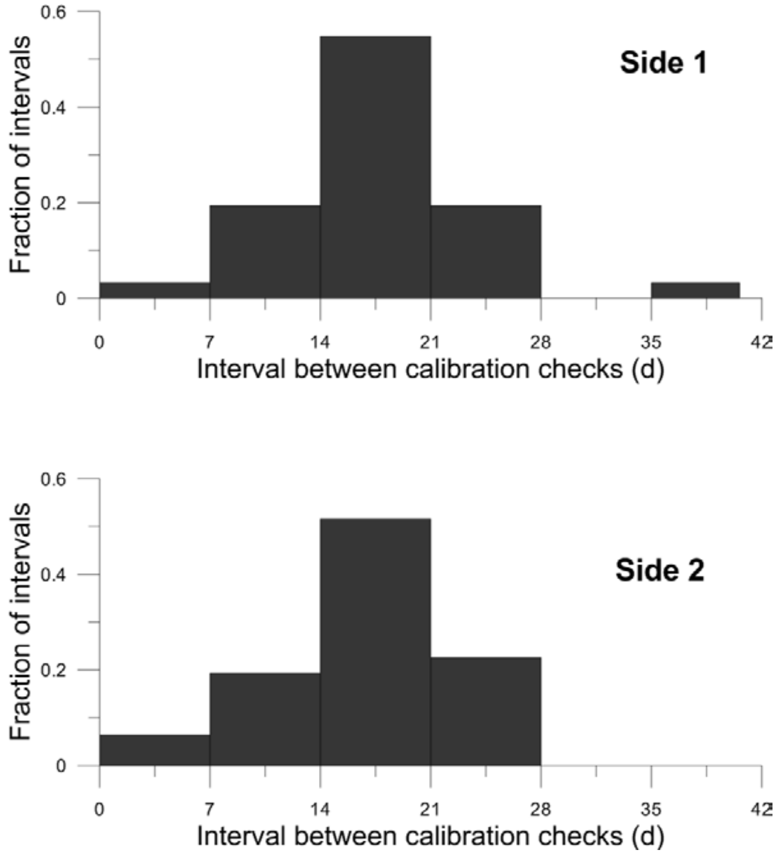


Figure 6.6-1 – Intervals between checks

6.7 Miscellaneous meteorological and lagoon calibrations

6.7.1 Air temperature/ humidity

A hygrothermometer (Model HMP45C, Vaisala Inc., Helsinki, Finland) measured both air temperature and relative humidity. Calibration of this sensor was conducted at least annually. Initial calibrations were conducted by the factory. The record of calibration checks are documented in Table 6.7-1.

Table 6.7-1: Calibration record of Vaisala HMP45C, s/n: 4410015

Relative humidity (RH)					
Calibration date	**Expected RH (%)**	**Measured RH (%)**	**Difference from expected RH (%)**	**Average difference RH (%)**	**Action**
2/17/2010	21	19	2		
	50	48	2		
	98	94	4		
				2.7	Accept
9/18/2009	11	20	-9		
	50	50	0		
	98	85	13		
				7.3	Adjust
	11	11	0		
	98	95	3		
	50	37	13		
	11	11	0		
	50	42	8		
				4.8	Accept
3/26/2009	23	20	3	3	Accept

Temperature (T)				
Calibration date	**Expected T (°C)**	**Measured T (°C)**	**Difference from expected T (°C)**	**Action**
2/17/2010	24.3	24.5	-0.2	Accept
9/18/2009	26.5	26.9	-0.4	Accept
3/26/2009	24.9	24.9	0.0	Accept

6.7.2 Barometric Pressure

An aneroid barometer (Model 278, Setra Inc., Boxborough, MA) was used to measure barometric pressure. Calibration of this sensor was conducted at least annually. Initial calibrations were conducted by the factory. The record of calibration checks are documented in Table 6.7-2.

Table 6.7-2: Calibration record of Setra 278, s/n: 3033740

Calibration date	Expected value range (hPa)	Number of comparisons	Mean difference from reference (hPa)	Action
2/11-12/2010	998.6-992.5	5	1.5	Pass
9/16-17/2009	997.5-1000.1	6	0.9	Pass
3/24-25/2009	986.0-992.0	6	1.4	Pass
7/9-11/2008	993.1-996.8	6	1.5	Pass
1/3-4/2008	1018.4-1001.7	6	2.5	Pass

6.7.3 Solar radiation

A pyranometer (Model 200SB, LiCOR Inc., Lincoln, NE) was used to measure solar radiation. Calibration of this sensor was conducted at least annually. Initial calibrations were conducted by the factory. The record of calibration checks are documented in Table 6.7-3.

Table 6.7-3: Calibration record of LiCOR Pyranometer, s/n: PY55449

Calibration date	Mean difference from reference (Wm^{-2})	Mean difference from reference (%)	Action
3/5/2010	4.84	0.91	Retry
3/6/2010	1.4	0.37	Pass
8/30/2006			Pass - Factory Cal.

6.7.4 Lagoon water temperature

A thermistor (Model 107-L, Campbell Scientific Inc., Logan, UT) was used to measure lagoon temperature. Calibration of this sensor was conducted at least annually. Initial calibrations were conducted by the factory. Three thermistor probes (s/n 0020, 0040, and I) were used at this location. The record of calibration checks are documented in Table 6.7-4.

Table 6.7-4: Calibration record of Thermistor CSI 107-L

Calibration date	Expected value (°C)	Difference from expected (°C)	Action
Thermistor CSI 107-L, s/n 0020 (8888)			
6/18/2007	25	0.3	Accept
6/18/2007	24.5	0.4	Accept
6/18/2007	24	0.6	Accept
Thermistor CSI 107-L, s/n 0040			
6/18/2007	25	0.5	Accept
6/18/2007	24.5	0.7	Accept
6/18/2007	24	0.6	Accept
Thermistor CSI 107-L, s/n I			
2/15/2010	1.1	1.2	Accept
2/15/2010	35.7	2.9	Accept
9/14/2009	0.1	0.0	Accept
3/27/2009	- 0.1	-0.0	Accept

6.7.5 Sludge Gun

A sludge gun (Model 10, Marklin Specialty Engineering, Toronto, Ontario, Canada) with serial number 20176 was used to measure sludge depth in the lagoon. Calibration of this sensor was conducted at least annually. Initial calibrations were conducted by the factory. The record of calibration checks are documented in Table 6.7-5.

Table 6.7-5: Calibration record of Marklin Sludge Gun, s/n 20176C

Calibration date	Mean (mm)	Standard Deviation (mm)	Accuracy (mm)	Action
2/26/2010	69.7	0.51	1.7	Accept
3/24/2009	78.11	1.05	-0.11	Accept
7/23/2008	75.38	0.51	1.1	Accept
1/4/2008	39.67	2.06	0.67	Accept
3/23/2007	81.56	0.73	1.56	Accept

6.7.6 CR1000 Data logger

The CR1000 data logger (Campbell Scientific Inc., Logan, UT) was used to log all lagoon measurements (pH, oxidation-reduction potential, and temperature) and air temperature, relative humidity, barometric pressure, and wetness. Calibration checks of this unit were conducted at the beginning and end of the study. Initial calibrations were conducted by the factory. The record of calibration checks are documented in Table 6.7-6.

Table 6.7-6: Calibration record of Campbell Scientific CR1000 data logger, s/n 7677

Factory calibration						
Calibration date: 1/18/2007			Single-ended		Differential	
Channel	**Input (mV)**	**Tolerance (mV)**	**Measured mV**	**Error (mV)**	**Measured (mV)**	**Error (mV)**
13	5000	± 3	5000.48	-0.48	5001.02	-1.02
13	-5000	± 3	-5001.56	-1.56	-5001.02	-1.02
13	2500	± 1.5			2500.34	-0.34
13	250	± 0.15			250.042	-0.042
13	25	± 0.015			25.004	-0.004
13	7.5	± 0.0045			7.49724	0.00276
13	2.5	± 0.0015			2.49923	0.00077
13	-2.5	± 0.0015			-2.49906	0.00094
13	5000	± 6	4999.31	1.31	4998.64	2.64
13	5000	± 6	5000.58	-0.58	5001.02	-1.02
13	5000	± 6				
13	5000	± 6				

PAML calibration						
Calibration date: 2/5/2007			Single ended		Differential	
SE Channel	**Input (mV)**	**Tolerance SE|DE (mV)**	**Measured mV Mean Value**	**Error (mV)**	**Measured (mV)**	**Error (mV)**
1	4950	± 6.96| 4.97	4951.7	-1.7		
2	4950	± 6.96| 4.97	4951.7	-1.7		
3	4950	± 6.96| 4.97	4951.7	-1.7		
4	4950	± 6.96| 4.97	4951.7	-1.7		
5	4950	± 6.96| 4.97	4951.7	-1.7		
6	4950	± 6.96| 4.97	4951.7	-1.7		
7	4950	± 6.96| 4.97	4951.7	-1.7		
8	4950	± 6.96| 4.97	4951.7	-1.7		
9	4950	± 6.96| 4.97	4951.7	-1.7		
10	4950	±6.96| 4.97	4951.7	-1.7		
12	4950	± 6.96| 4.97	4951.7	-1.7		
13	4950	± 6.96| 4.97	4951.7	-1.7		
14	4950	± 6.96| 4.97	4951.7	-1.7		
15	4950	± 6.96| 4.97	4951.7	-1.7		
16	4950	± 6.96| 4.97	4951.7	-1.7		
Calibration date: 3/10/2010			Single-ended		Differential	

PAML calibration						
Calibration date: 2/5/2007			Single ended		Differential	
SE	**Input**	**Tolerance**	**Measured**	**Error**	**Measured**	**Error**
Channel	**Input (mV)**	**Tolerance SE | DE (mV)**	**Measured (mV)**	**Error (mV)**	**Measured (mV)**	**Error (mV)**
1	100	± 2.06 | 1.06	99.37	0.63		
2	100	± 2.06 | 1.06	99.37	0.63	99.71	0.29
3	100	±2.06 | 1.06	99.37	0.63		
4	100	± 2.06 | 1.06	99.37	0.63		
5	100	± 2.06 | 1.06	99.37	0.63	99.71	0.29
6	100	± 2.06 | 1.06	99.37	0.63	99.71	0.29
7	100	± 2.06 | 1.06	99.37	0.63	99.71	0.29
8	100	± 2.06 | 1.06	99.37	0.63	99.71	0.29
9	100	± 2.06 | 1.06	99.37	0.63		
10	100	± 2.06 | 1.06	99.37	0.63		
11	100	± 2.06 | 1.06	99.37	0.63		
12	100	± 2.06 | 1.06	99.37	0.63		
13	100	± 2.06 | 1.06	99.37	0.63		
14	100	± 2.06 | 1.06	99.37	0.63		
15	100	± 2.06 | 1.06	99.37	0.63		
16	100	± 2.06 | 1.06	99.37	0.63		
Calibration date: 3/10/2010			**Single-ended**		**Differential**	
Channel	**Input (mV)**	**Tolerance SE | DE (mV)**	**Measured (mV)**	**Error (mV)**	**Measured (mV)**	**Error (mV)**
1	0	± 2.06 | 1.06	0	0		
2	0	± 2.06 | 1.06	0	0	0	0
3	0	± 2.06 | 1.06	0	0		
4	0	± 2.06 | 1.06	0	0		
5	0	± 2.06 | 1.06	0	0	0	0
6	0	± 2.06 | 1.06	0	0	0	0
7	0	± 2.06 | 1.06	0	0	0	0
8	0	± 2.06 | 1.06	0	0	0	0
9	0	± 2.06 | 1.06	0	0		
10	0	± 2.06 | 1.06	0	0		
11	0	± 2.06 | 1.06	0	0		
12	0	± 2.06 | 1.06	0	0		
13	0	± 2.06 | 1.06	0	0		
14	0	± 2.06 | 1.06	0	0		
15	0	± 2.06 | 1.06	0	0		
16	0	± 2.06 | 1.06	0	0		

6.7.7 CR800 Data logger

The CR800 data logger (Campbell Scientific Inc., Logan UT) was used to log all GSS measurements (air temperature and relative humidity, flow rate, and pressure). Calibration check of this unit was conducted only at end of the study. Initial calibrations were conducted by the factory. The record of calibration checks are documented in Table 6.7-7.

Table 6.7-7: Calibration record of Campbell Scientific CR800 data logger, s/n 3698

Calibration date: 3/10/2010			**Single-ended**	
Channel	**Input (mV)**	**Tolerance SE (mV)**	**Measured (mV)**	**Error (mV)**
1	0	2.061	99.23	0.77
2	0	2.061	99.23	0.77
3	0	2.061	99.23	0.77
4	0	2.061	99.23	0.77
5	0	2.061	99.23	0.77
6	0	2.061	99.23	0.77
Calibration date: 3/10/2010			**Single-ended**	
Channel	**Input (mV)**	**Tolerance SE | DE (mV)**	**Measured (mV)**	**Error (mV)**
1	0	2.061	0	0
2	0	2.061	0	0
3	0	2.061	0	0
4	0	2.061	0	0
5	0	2.061	0	0
6	0	2.061	0	0

6.8 Site Activity

Time (GMT)	**Date** (MM/DD/YYYY)	**Activity** (setup, takedown, calibration, repair, remote)	**Event**
	8/30/2007	Setup	When setting up retro-reflectors, noticed that a tripod was broken when extending the legs. Another tripod was bent at the leg.
	8/30/2007	Setup	TDLAS 1031 has lower light values than 1029 when placed in exactly same position. Changed to Port B.
	8/30/2007	Setup	Noticed C must have a leak in diluter because flow of air is so high relative to A and B.
	8/30/2007	Setup	TDLAS 1031 was not giving steady values during calibration while TDLAS 1029 was giving accurate and stable values when using Port B.
	8/30/2007	Setup	During sonic anemometer inter-comparison, there was a trip in power outlet, so data stopped temporarily in calibration data file.
	8/30/2007	Setup	pH sensor: calibration done; acceptance and QA accepted.
	8/30/2007	Setup	ORP sensor: acceptance and calibration done.
15:40-16:40	8/30/2007	Setup	Sonic inter-comparison: Sonic 1: 1.89 Sonic 2: 1.91 Sonic 3: 1.91
18:11	8/30/2007	Setup	Zero calibration performed on sonic anemometers; all pass.
21:26-00:15	8/30/2007	Setup	TDLAS 1031 calibration failed. Notes: R-squared values were above 0.84 for 4 times during first background calibration; values varied significantly and were too high. Values also too high during second calibration. Switched from Port A to Port C. Lots of pressure released when removed from Port A when using Port C, use of gas is ~2-3 times the amount using Port A. Values still jumpy so restarted TDLAS power. Wiped off lenses. Changed to Port B.
23:47-23:53	8/30/2007	Setup	Calibrated TDLAS 1029: Mean: 25.8 - SD: 2.3 - Accuracy: 3.6 - Notes: Accuracy was too low but very stable on first calibration. Calibration chamber was bumped on second calibration, so values decreased significantly (R^2 was too low during end of period). Used port B.
	8/31/2007	Setup	Wetness sensor giving values (not INF), but sunny day; had bird droppings on it. Used Port B.
	8/31/2007	Setup	Tried sludge gun measurements (have pictures), but wind was too strong, would give inaccurate readings, so it was put on hold.
	8/31/2007	Setup	After aligning scanner 1 (TDLAS 1031), gave back values of 0.28 for R^2 for every path. Then gave R^2 reading of 0.60 for every path. This was a result of forgetting to turn on scanning, not aligning made. Power-cycled.
	8/31/2007	Setup	Retro and berm heights taken.

Time (GMT)	Date (MM/DD/YYYY)	Activity (setup, takedown, calibration, repair, remote)	Event
14:19-14:24	8/31/2007	Setup	Calibrated TDLAS 1031: Mean: 97.9 - SD: 2.3 - Notes: Left TDLAS 1031 running overnight while emptying chamber and TDL was reading ~60-80 ppm in the morning. Tank may not have been shut off completely. Redid background. Retested from tank directly (496 ppm) for calibration test 1. Standard deviation is very low. For actual test, ran 200 ppm thru diluter.
	9/18/2007	Takedown	Too windy for sludge depth measurements today (~15 mph winds with gusts to 25 mph)
	9/18/2007	Takedown	Wetness sensor had bird droppings on it, but it did not affect measurements. Cleaned wetness sensor off between metal grid.
	9/18/2007	Takedown	Calibrated TDLAS measurements at 100 ppm since that is what we were measuring in the field.
	9/18/2007	Takedown	Could not find pen to use during TDLAS calibrations, so wrote with pencil at beginning of TDLAS 1029 calibrations and traced over with pen.
	9/18/2007	Takedown	Repaired TDLAS 1029. Disassemble, inspect, replace shutter mechanism with new part (OEM). Reassemble, verify, calibration.
	9/18/2007	Takedown	pH sensor: calibration done; acceptance and QA accepted.
	9/18/2007	Takedown	ORP sensor: acceptance and calibration done.
18:40-19:40	9/18/2007	Takedown	Sonic Inter-comparison: Sonic 1: 4.20 - Sonic 2: 4.29 - Sonic: 4.22
20:18-20:33	9/18/2007	Takedown	Zero calibration performed on sonic anemometers; all pass.
21:28-21:33	9/18/2007	Takedown	Calibration TDLAS 1031– Mean: 98.36 - SD: 4.1% - Notes: Saved log file in wrong location. Had to close log file after trial 1 and move to correct directory. Reopened correct data file in correct directory for rest of calibrations. Appended log file.
22:47-22:52	9/18/2007	Takedown	Calibrated TDLAS 1029– Mean: 92.67 - SD: 2.4% - Notes: Calibrated at 100 ppm because these were/are values that were seen in the field.
	9/19/2007	Takedown	Collected data and packed trailer to move to TX5A. See inspection checklist.
	9/19/2007	Takedown	Data for this period (weather data) ended at 9:30 a.m. EST, even though data extends beyond this on data CD's and memory card.
	9/19/2007	Takedown	Still too windy to take sludge depth measurements.
	9/19/2007	Takedown	When switching out memory card for data logger, plug was unplugged from outlet; plugged met station back into charge memory card; waited 2 min for light to turn green, but stayed orange-red color; switched out memory card (light turned yellow-orange)-may have lost data on memory card but have it recorded on CD.
	1/24/2008	Setup	Frozen lagoon so no pH, ORP, or temp. probes

Time (GMT)	**Date** (MM/DD/YYYY)	**Activity** (setup, takedown, calibration, repair, remote)	**Event**
	1/24/2008	Setup	Could not calibration TDLAS 1029 at 50 ppm (25 ppm), but it would not stabilize for 50 min. Tried again straight from calibration gas (NH3) cylinder at 502 ppm. Stabilized well at 502 ppm--tried again at 25 ppm/50 ppm. Would not stabilize at 25 ppm/50 ppm. Tried again at 502 ppm.
	1/25/2008	Setup	Lagoon is frozen; no pH, ORP, or temp. probes TDLAS aimed.
	1/25/2008	Setup	S-OPS acceptance; S-OPS placement form made.
	2/5/2008	Calibration	Everything was covered in 0.25-inch of ice upon arrival (TDLAS, retro-reflectors, sonic anemometers, etc.). Both TDLs were getting zero light values because of ice.
	2/5/2008	Calibration	Calibrated TDL's 1026, 1029, and 1032. 1029 would not calibrate at 50 ppm so had to calibrate at 500 ppm. Will take 1029 back to PAML and replace with 1026.
	2/5/2008	Calibration	Scanner in NW corner was way off target (by about 45 degrees), and scanner in SW corner was off by about 100-200 steps. Unable to realign because of 0.25-inch of ice on retro-reflectors. Will warm up tomorrow, so will come back out to align scanners.
	2/5/2008	Calibration	Cleared ice off retro-reflectors and aimed scanners. NW scanner was off by about 45 degrees to the right. SE scanner was off by about 500 steps to the right. Changed optimization settings on NW scanner because it was optimizing too much.
	2/6/2008	Calibration	H_2S analyzer had motherboard failure. Looked inside 450i and could not find anything wrong. Performed H_2S calibration on 450i by running gas straight from H_2S tank. Calibration results in open site notes.
	2/7/2008	Remote	Checked site status. NW scanner was not aligned. Forced data to send to office. H_2S analyzer stopped at same time as scanner (~midnight 2/6-7/2008). Had to stop sonic anemometers and start *iPort*.
	2/11/2008	Remote	Checked sonic anemometer status. Inhomogeneous turbulence (w) flagged (starting at 406.67; 2/10/2008 1605 UTC). At beginning of flagged data, noticed wetness and RH values showed some type of precipitation. Also saw freezing fog observations in Guymon on NWS website starting at 9am (CST) on 2/10/2008. Vertical wind speeds increased dramatically during this time too, and temps have not reached above freezing since time of flagged values.
	2/19/2008	Takedown	Scanner 6 (NW corner) off by 180 degrees. Will let run overnight on 2 retro-reflectors on ground after sending high power command.
	2/19/2008	Takedown	S-OPS acceptance
	2/19/2008	Takedown	TFC 450i Reference Precision Check/Calibration check.
	2/19/2008	Takedown	S-OPS Inlet flow verification: pass (Solenoids 2 and 3)

Time (GMT)	**Date** (MM/DD/YYYY)	**Activity** (setup, takedown, calibration, repair, remote)	**Event**
17:35-18:35	2/19/2008	Takedown	Sonic Inter-comparison: Sonic 1: 3.13 Sonic 2: 3.14 Sonic 3: 3.18. All pass.
20:22	2/19/2008	Takedown	Zero calibration performed on sonic anemometers; all pass.
21:10	2/19/2008	Takedown	Barometer audit: pass
21:10-21:12	2/19/2008	Takedown	Wetness sensor calibration: accepted
22:23-22:28	2/19/2008	Takedown	Calibrated TDLAS 1026: Mean: 26.6 - SD: 0.69 - RSD: 0 Bias: 0
23:22-23:23	2/19/2008	Takedown	Calibrated TDLAS 1032: Mean: 24.9 - SD: 1.1 - RSD:4.4 Bias: 0
	5/6/2008	Setup	Chance of rain tonight. Could be difficult to pull on muddy road. Pulled in trailer; leveled and tied down.
	5/7/2008	Setup	Hooked up power to trailer, so calibrations could be performed inside of trailer (raining outside).
	5/7/2008	Setup	Changed all S-OPS filters and put Teflon tape on filter holder threads.
	5/7/2008	Setup	Changed settings on TDL's 1032 and 1026 to 200 sample/Ref scans (had been 20).
	5/7/2008	Setup	Too windy to perform sludge depth measurements.
	5/7/2008	Setup	Burned new TX5A period 4 data disc. Checked on computer and both discs 1-2 work properly. Burned discs for OK4A period 4. Both work properly on LAN.
17:15	5/7/2008	Setup	Calibrated TDLAS 1026: Mean: 51.4 - SD: 2.1 - RSD: 4.0% - Bias: 3.1%
17:50	5/7/2008	Setup	Calibrated TDLAS 1032: Mean: 51.2 - SD: 0.77 - RSD: 1.5% - Bias: 2.8% - Notes: Lost communication even though directly connected to Panasonic. Did not zero but R-squared values low enough (< 84).
18:27	5/7/2008	Setup	TEC 450i reference precision check.
18:35	5/7/2008	Setup	TEC 450i instrument operating parameters.
18:37	5/7/2008	Setup	TEC 450i calibration verification check.
19:40-20:40	5/7/2008	Setup	Sonic inter-comparison: pass.
	5/7/2008	Setup	Sonic inter-comparison performed (no bias)-pass.
	5/8/2008	Setup	Could not perform sonic anemometer bias. Sonic anemometers were giving all zeros for readings. May have water leakage.
	5/8/2008	Setup	Changed pH reference solution. Calibration passed.
	5/8/2008	Setup	Troubleshot NW scanner. See notes for details.
	5/8/2008	Setup	Changed filters in S-OPS inlets.
	5/8/2008	Setup	Power box #5 had burning smell and was very hot.
	5/8/2008	Setup	TDL 1026 had centerline duty problems at OK4A.
	5/8/2008	Setup	Lagoon site layout made.
	5/8/2008	Setup	Getting motherboard failure on H2S analyzer, but still seems to be working properly.
	5/8/2008	Setup	GSS leak test: pass
	5/8/2008	Setup	GSS no flow test
	5/8/2008	Setup	GSS max flow test

Time (GMT)	**Date** (MM/DD/YYYY)	**Activity** (setup, takedown, calibration, repair, remote)	**Event**
	5/8/2008	Setup	S-OPS/GSS leak test: Pass
	5/8/2008	Setup	pH calibration: pass
13:48	5/8/2008	Setup	Could not perform sonic anemometer bias. Sonic anemometers were giving all zeros for readings. May have water leakage. Will set up sonic anemometers and run for measurement period. Will redo bias test at takedown.
14:24	5/8/2008	Setup	Barometer audit: pass
18:26	5/8/2008	Setup	Wetness sensor calibration: accepted
14:32	5/9/2008	Remote	Daily Status Check from PAML. Notes: Most periods over past day have >160 spike counts for sonic anemometer 3. TDL 1 not present due to poor power supply failure failures. Communication with CR1000 not working. TDL 2 paths 2 and 9 have low light levels—re-aim successfully.
12:33	5/12/2008	Remote	Daily Status Check from PAML. Notes: Sonic 1 flagged briefly at 715 UTC. As of 2015 UTC (497) H2S values no longer normal. H2S analyzer lost connection; last update on 1916 UTC on 5/11/2008. Filled starting at 1915 UTC 5/11/2008. CR1000 communication problems with LAN. Motherboard status – fail on 450i.
13:00	5/13/2008	Remote	Daily Status Check from PAML. Notes: A flags on GSS/H2S/Innova QC yesterday but occurred before correction yesterday; currently working properly.
13:14	5/14/2008	Remote	Daily Status Check from PAML. Notes: H2S Motherboard status – fail. Can only temporarily connect to CR1000 to check time synch.
14:32	5/15/2008	Remote	Daily Status Check from PAML. Notes: Zero unflagged on sonic anemometer 1 during previous day; zero flagged (seems odd); will monitor. Limited communication with CR1000. No data sent from sonic anemometer 1 as of 0241 UTC on 5/15/2008. Will keep eye on data and see if it updates. Also no communications with CR1000 (same power outlet), but have been having problems with communications throughout period.
18:02	5/16/2008	Remote	Daily Status Check from PAML – Notes: Sonic 1 has not received valid data since 0250 Z on 5/15/2008. All data is coming in as zero values for sonic anemometer 1. Sonic 1 data is not incrementing.
	5/19/2008	Repair	Sonic 1, met tower without power. GFCI tripped and could not be reset. No tripped breakers in power box. Shut off all power to rewire new GFCI outlet (new outlet works fine). Found large spiders/dead bugs inside power outlet.
	5/19/2008	Repair	Pumping lagoon.
	5/19/2008	Repair	Tried aligning paths with new power supply box (NW corner-TDL 1 (1032)) using scanner test box. Powered scanner and TDLAS successfully, but could not

Time (GMT)	**Date** (MM/DD/YYYY)	**Activity** (setup, takedown, calibration, repair, remote)	**Event**
			communicate with either instrument. Aligned NW scanner/TDLAS with modem from wall.
	5/19/2008	Repair	Sonic 1 now running, incrementing same amount of data as sonic anemometers 2 and 3. CR1000 now capable to communicate with LAN (even though temporarily).
	5/19/2008	Repair	Took out cubes in retro-reflectors 1, 2, 6, and 7 NW scanner (TDL 1). #1--1 cube remaining; #2--3 cubes; #6--1 cube; #7--3 cubes.
	5/19/2008	Repair	Put 1/4-inch plastic in 1, 6 paths on SE scanner (TDL 2). Put 1/8-inch in 2, 7 paths on SE corner (TDL 2)
	5/19/2008	Repair	Communication with TDL 1032 (1--NW) is in and out but still working majority of time.
	5/19/2008	Repair	Having same voltage issues with power supply box-works temporarily then only uses 6 VOC. Tried new and old cables but still have issues. Removing box and bringing back to PAML. Leaving rest of instrumentation setup.
12:59	5/19/2008	Remote	Daily Status Check from PAML – Notes: Sonic 1 seems to be not working since 5/15/2008 as last data received was at 250 UTC on 5/15/2008 CR1000 seems not to be connected.
19:20	5/21/2008	Remote	Daily Status Check from PAML – Notes: TDL1 not present (bad scanner); no connection to TDL laptops. Poor communication with CR1000. Values look ok on numeric display for CR1000. Back-up error related to sonic anemometer program/*iPort*/Innova program.
12:35	5/22/2008	Remote	Daily Status Check from PAML – Notes: Graphs of u,v, and w look different for sonic anemometer 1. Data not incrementing for TDLAS since 5/20/2008. Communication problems with CR1000; can only connect for 1-2 min, and hence data cannot be transferred. Back-up error related to sonic anemometer/*iPort*/Innova programs. Not able to connect to TDLAS laptops.
14:45	5/27/2008	Remote	Daily Status Check from PAML – Notes: Lamp voltage has dropped from about 950 at start of period to about 935 now. No TDLAS data since 5/19/2008. Poor communication with CR1000 prevents download. Looked at data directly, and they seem reasonable. Unable to access TDL laptops.
	5/28/2008	Calibration	TDLAS 1032 zero calibration went smoothly. Could not get span gas to reach 50 ppm (100 ppmm). Tried spanning 200 ppmm (100 ppm) but could not get values above 89 ppm. Removed TDLAS from calibration and started calibration 1026.
	5/28/2008	Calibration	UPS output power has been stored to Load Segment 2 (probably when shut power down when changing GFCI outlet)…5/19/2008 21:33:10. UPS switched to battery power…5/25/2008 21:54:08. AC restored message sent to registered clients connected to Load Segment

Time (GMT)	Date (MM/DD/YYYY)	Activity (setup, takedown, calibration, repair, remote)	Event
			2...5/25/2008 21:54:12.
	5/28/2008	Calibration	Performed pH/ORP calibrations. pH gave values about -17 mV to -12 mV deviated from expected. Will launch lagoon and perform calibration after measurement period.
	5/28/2008	Calibration	Performed TDLAS inter-comparison (1026/1032). 1026 gave lower concentrations than 1032 and did not have good R^2 values (0.20). Installed new power supply with new scanner on NW corner.
	5/28/2008	Calibration	pH calibration: pH gave values about -17 mV to -12 mV deviated from expected. Will launch lagoon and perform calibration after measurement period.
	5/28/2008	Calibration	ORP calibration: pass
14:42	5/28/2008	Calibration	Calibrated TDLAS 1026 – Mean: 45.3 - SD: 0.18 - RSD: 0.4% - Bias: -9.0%
15:08	5/28/2008	Calibration	Calibrated TDLAS 1032 – Mean: 47.76 - SD: 0.37 - RSD: 0.8% - Bias: -3.9% - Notes: Could not get span gas to reach 50 ppm (100 ppmm). Tried spanning 200 ppmm (100 ppm) but could not get values above 89 ppm. Removed TDLAS from calibration and started calibration 1026. During first background, got values of 0.0 R-squared and 0.0 ppm. Second background gave values of 40-50 R^2 and 5-6 ppm.
	5/29/2008	Calibration	Too windy today and yesterday to perform sludge depth measurements. No film on lagoon today because of such windy conditions (lagoon producing waves).
	5/29/2008	Calibration	Painted scanners white and put Vaseline/petroleum jelly on screws to prevent streaking.
	5/29/2008	Calibration	Used new zero gas cylinder for 450i calibration.
	5/29/2008	Calibration	*iPort* was not logging any H2S data since yesterday 17:19 UTC. Was giving an error due to data collection and has logged any data since error. Closed *iPort* and reopened a few times, loading data from 17:19 UTC yesterday in fillOK3A450I0529081727.dat. Calibrations from today were in this "fill" file; calibration times are entered on control chart. 450i motherboard still failing, but parameters/measurements seem valid.
	5/29/2008	Calibration	Sonic anemometers did not pass during first inter-comparison--very high winds. Sonic anemometers 1 and 3 barely out of spec.
	5/29/2008	Calibration	Updated *rsync* program and restarted all computers.
	5/29/2008	Calibration	Removed plastics and cubes from TDL 2 (1026-SE) paths 1, 2, 6, and 7. 1 and 6 have one cube remaining. 2 and 7 have three cubes computers.
	5/29/2008	Calibration	Yesterday, switched scanners to low hold and reg move.
	5/29/2008	Calibration	Could not connect to CR1000 long enough to download data. Used laptop and downloaded from 5/1/2008--present and transferred to LAN. C:\NAEMS\Data\OK3A\Period4\CR1000 …and

Time (GMT)	**Date** (MM/DD/YYYY)	**Activity** (setup, takedown, calibration, repair, remote)	**Event**
			Period5\CR1000.
	5/29/2008	Calibration	Lagoon site layout made.
	5/29/2008	Calibration	GSS leak test: pass
	5/29/2008	Calibration	GSS no flow test
	5/29/2008	Calibration	GSS max flow test
	5/29/2008	Calibration	S-OPS/GSS leak test: Pass
15:50-16:50	5/29/2008	Calibration	Sonic inter-comparison: pass. Notes: Did not pass during first inter-comparison, very high winds. Sonic anemometers 1 and 3 barely out of spec.
16:20	5/29/2008	Calibration	TEC 450i reference precision check.
16:57	5/29/2008	Calibration	Barometer audit: pass
16:54	5/29/2008	Calibration	TEC 450i calibration verification check.
17:05	5/29/2008	Calibration	TEC 450i instrument operating parameters.
18:21	5/29/2008	Calibration	Sonic zero calibration: pass.
21:58	5/29/2008	Calibration	Wetness sensor calibration: accepted
12:54	6/2/2008	Remote	Daily Status Check from PAML – Notes: CR1000 data was downloaded and stored on laptop then LAN on 5/29/2008 (day 515). Communications with CR1000 are limited which is why data has not been updated since manual data upload. Could not perform back up because there was not enough space. Changed settings to only keep last backup (not last 3). Deleted 2 previous backups and kept/saved last backup. Now Directory (NAEMS_West) has 28.8GB. Paths 1 and 2 were off on TDL 1. Realigned and now running properly. Could temporarily connect to CR1000-checked current values and all parameters looked valid.
12:15	6/3/2008	Remote	Daily Status Check from PAML Notes: Limited communication with CR 1000. Was able to temporarily connect to CR1000 but could not collect data. Values seem to be valid.
12:15	6/4/2008	Remote	Daily Status Check from PAML – Notes: Flagging on each sonic anemometer at approx. the same time (~520.9); currently none are flagging. Paths on TDL 2 that seemed to be not aligned were actually aligned--after entering aim menu, left scanner stationary on unaligned path and light level gradually increased to valid levels.
12:30	6/5/2008	Remote	Daily Status Check from PAML– Notes: Not sure how to sync times; will check later. Internet connect is very slow; TDL time sync check may not be correct.
12:30	6/6/2008	Remote	Daily Status Check from PAML – Notes: Not enough space to perform backup. CR1000 has not updated since day 515.
	6/10/2008	Takedown	Too windy to perform sludge depth measurements.
	6/10/2008	Takedown	pH probe gave values that were too low for each solution; will return to PAML for more analysis.
	6/10/2008	Takedown	Sonic anemometers did not pass during first inter-

Time (GMT)	**Date** (MM/DD/YYYY)	**Activity** (setup, takedown, calibration, repair, remote)	**Event**
			comparison. Sonic 1, deviations were greater than 0.3 m/s. Noticed bird droppings on sonic anemometer 1.
	6/10/2008	Takedown	TDLAS 1032 second background did not give zero. Gave one with R^2 over 0.84. Power-cycled and redid background--passed.
	6/10/2008	Takedown	Tubing for S-3 on south end had holes where rodent chewed through. Could not perform max-flow/leak/inlet tests for S-OPS. Repaired and will perform leak test when setting up at TX5A.
	6/10/2008	Takedown	Farm manager said lagoon overturned about two weeks ago, and place had strong odor.
	6/10/2008	Takedown	pH sensor: calibration, acceptance, QA done. Probe did not pass acceptance, but probe is finished for 6-month calibration. Will inspect at PAML.
	6/10/2008	Takedown	ORP sensor: calibration done. Acceptance passes.
	6/10/2008	Takedown	GSS leak test: pass
	6/10/2008	Takedown	GSS no flow test
	6/10/2008	Takedown	GSS max flow test
	6/10/2008	Takedown	S-OPS/GSS leak test: Pass
16:59	6/10/2008	Takedown	TEC 450i reference precision check.
17:05	6/10/2008	Takedown	TEC 450i calibration verification check.
17:05	6/10/2008	Takedown	TEC 450i instrument operating parameters.
17:40	6/10/2008	Takedown	Calibrated TDLAS 1032 – Mean: 50.82 - SD: 0.23 - RSD: 0.5% - Bias: 2.5% - Note: Second background test did not pass; had one value ~1 R^2 >84. Power-cycled and redid background.
18:33	6/10/2008	Takedown	Calibrated TDLAS 1026 – Mean: 47.12 - SD: 0.30 - RSD: 0.6% - Bias: -4.2%
19:55-20:55	6/10/2008	Takedown	Sonic inter-comparison: pass
21:25	6/10/2008	Takedown	Sonic zero calibration: pass.
22:02	6/10/2008	Takedown	Wetness sensor calibration: accepted
22:58	6/10/2008	Takedown	Barometer audit: pass
	11/5/2008	Setup	Tied down trailer and hooked up power
	11/5/2008	Setup	Calibrated all instruments except weather station and S-OPS/GSS (sonic anemometer bias were done tomorrow)
	11/5/2008	Setup	Fixed lagoon probe wire
	11/5/2008	Setup	pH sensor: calibration done; acceptance and QA accepted.
	11/5/2008	Setup	ORP sensor: calibration done. Acceptance passes.
21:15-22:15	11/5/2008	Setup	Sonic inter-comparison: all pass
22:26	11/5/2008	Setup	Calibrated TDLAS 1028
22:56	11/5/2008	Setup	Calibrated TDLAS 1027
00:03	11/6/2008	Setup	Barometer audit: pass
00:03	11/6/2008	Setup	Wetness sensor calibration: accepted
	11/6/2008	Setup	Used N2 cylinder #CC8383; used zero air cylinder #CC183079 (changed on H_2S control chart)
	11/6/2008	Setup	Outlets in SE corner (scanner outlet/TDL 2) and retro 6/TDL 2 without power. Ran extension cords from retro

Time (GMT)	**Date** (MM/DD/YYYY)	**Activity** (setup, takedown, calibration, repair, remote)	**Event**
			7 outlet to scanner and retro 6.
	11/6/2008	Setup	Towers have 1/8 plastics; short sides have 1 and 3 cubes with 1/4 plastics; long sides have 1 and 3 cubes with 1/8 plastics.
	11/6/2008	Setup	New scanner/power supply SE corner (24 V)
	11/6/2008	Setup	Lagoon site layout made.
	11/6/2008	Setup	Maintenance list completed.
16:25	11/6/2008	Setup	Zero calibration performed on sonic anemometers; all pass.
20:52	11/6/2008	Setup	Launched lagoon float
16:00	11/7/2008	Remote	Daily Status Check from PAML – Notes: It appears that TDL 2/scanner 2 has lost power. Last TDL record at 14:44 GMT on 11/7/2008. West team mentioned power issues in open site notes. Sonic 3 has a lot of spikes (up to 400). Pump diaphragm changed on H_2S analyzer.
16:56-16:58	11/7/2008	Setup	TEC 450i leak test. Flow went to ~0 LPM; pressure ~317.1 mmHg (above 250 mmHg). According to manual, pump may need to be rebuilt. Changed inlet filter (was clean previously but still changed). No obstruction in capillary but blew dust remover air through just in case. Tightened all metal fittings inside 450i. Checked capillary to see if loose on 11/5/2008 but was tight; tightened again and reapplied tape to secure. Flow ~0.77 LPM.
16:00	11/10/2008	Remote	Daily Status Check from PAML – Notes: Currently no power to TDL 2 (SE corner). Bad GFCI outlet was replaced by Hitch but extension cord may not have been plugged back in. Call Ken Smith and left voicemail to check to see if cord was plugged in. Sonic QC did not run today. Poor communications between CR 1000 and LAN. Last CR 1000 data point around 21:00 GMT on 10/30/2008).
13:30	11/11/2008	Remote	Daily Status Check from PAML – Notes: The following happened yesterday: Had Ken Smith from Hitch go to site to check power at outlets on south side of lagoon (TDL 2); all outlets have power. Ken opened power supply box to check if modem lights were on--they were not. Checked power from pins from cord running from outlets to power box--has power. Plugged back in and checked voltage to modems and spontaneously started working; went back to align paths ~5-10 min later and system had no power. The following today: sonic anemometer 1 is 7-8C greater than sonic anemometers 2 and 3. Ken Smith checked if metal post mounting power supply was touching and heat sink black where they made contact; no power/voltage from power supply to modems; power coming from outlet to 3-pin cord; power supply most likely shorted out (burned up) and needs to be

Time (GMT)	**Date** (MM/DD/YYYY)	**Activity** (setup, takedown, calibration, repair, remote)	**Event**
			replaced...repair trip. Sonic program QC not running daily. H_2S chamber pressure gradually decreasing but may be due to weather. Cannot see CR 1000 data to test hypothesis due to poor communication with CR 1000. Will continue to monitor.
13:45	11/12/2008	Remote	Daily Status Check from PAML– Notes: TDL 2/scanner not working. Repair trip next week. Runtime error in QC program. H_2S conc. Range ~0-12.5 ppb with outlier 22.8 ppb. Limited communications between LAN-CR1000; no QC files.
13:30	11/13/2008	Remote	Daily Status Check from PAML – Notes: Bad power supply for TDL 2/SE scanner. Repair trip next week. Runtime errors in QC program. Limited LAN-CR 1000 communications.
14:00	11/14/2008	Remote	Daily Status Check from PAML – Notes: Bad power supply for TDL 2/SE scanner. Repair trip next week. Runtime errors in QC program. Limited LAN-CR 1000 communications.
	11/17/2008	Repair	Changed 24V power supply on the modem/power box for TDL 2. TDLAS and scanner are working fine now. Re-aimed few paths and saved new settings in the Gas View setup file.
13:30	11/17/2008	Remote	Daily Status Check from PAML – Notes: Last H2S modification occurrence at 23:04 11/16/2008 (yesterday evening). Filled data: FillOK3A450I1117081330.dat. Restarted sonic anemometer program. QC program runtime error. Limited LAN-CR 1000 communications.
13:30	11/18/2008	Remote	Daily Status Check from PAML – Notes: H_2S analyzer running properly and collecting data. QC program may only be accepting data for data file referenced in QC parameter files; new files started yesterday when program failed (fill and current real-time files). Will check then change to first file/last file if needed (was needed and changed). Flagging on all sonic anemometers. See notes for details. H_2S values are zero due to *iPort* failure. New power supply for TDL 2/SE scanner during repair trip yesterday. Not much data collected since then. Limited LAN-CR 1000 communications.
15:40	11/19/2008	Remote	Daily Status Check from PAML – Notes: No CR 1000 data in QC file due to communication problems.
14:15	11/20/2008	Remote	Daily Status Check from PAML – Notes: All 3 sonic anemometers have irregular number of total data points (occasionally). Sonic 1 about 8C higher than the other two sonic anemometers. Flag 4 is frequent in H_2S data (value does not vary more than 2 ppb over 1 hour). No communication with CR 1000.
13:30	11/21/2008	Remote	Daily Status Check from PAML – Notes: Sonic 1 had some flagging but majority not flagged. Sonic 1 temp is

Time (GMT)	**Date** (MM/DD/YYYY)	**Activity** (setup, takedown, calibration, repair, remote)	**Event**
			7-8C greater than sonic anemometers 2 and 3. Sonic 2 w is less than zero (0.1-0.2 m/s). Sonic 3 has had spike counts greater than 160 in the past but not during previous day. No communication with CR 1000.
13:30	11/24/2008	Remote	Daily Status Check from PAML – Notes: Sonic 1 had some flagging but majority not flagged. Sonic 1 temp is 7-8C greater than sonic anemometers 2 and 3. Sonic 2 w is less than zero (0.1-0.2 m/s). Sonic 3 has had spike counts greater than 160 but majority is less than 160. No communication with CR 1000.
13:56	11/25/2008	Remote	Daily Status Check from PAML – Notes: Sonic 1 had some flagging but majority not flagged. Sonic 1 temp is 7-8C greater than sonic anemometers 2 and 3. Sonic anemometers 1 and 2, average w as less than zero (0.2-0.5 m/s). Sonic 3 has had spike counts greater than 160 but majority is less than 160. No communication with CR 1000.
13:15	11/26/2008	Remote	Daily Status Check from PAML – Notes: Sonic 1 had some flagging but majority not flagged. Sonic 1 temp is 7-8C greater than sonic anemometers 2 and 3. Sonic anemometers 1 and 2, average w is less than zero (0.2-0.5 m/s). Sonic 3 has excessive spike counts greater than 160; occur daily around 23:30 GMT. No communication with CR 1000.
14:15	12/1/2008	Remote	Daily Status Check from PAML – Notes: Sonic program crashed. Restarted sonic anemometer program at 15:53. See notes for details. TDL 2 laptop appears to have frozen up on 11/26 at 13:17. Last data in file on 11/26/2008 at 15:10. Still able to connect but no response on screen. TDL 1 path 1 has low LL. Re-aimed and LL are now good. Sonic 3 has a lot of spikes on days 698 and 699. No communication with CR 1000.
	12/2/2008	Calibration	Tied in old NH3 cylinder (FF15402--500 ppm) with new cylinder (FF57856--469 ppm) using TDLAS 1027.
	12/2/2008	Calibration	Parser message; value creation failed at line 599.
	12/2/2008	Calibration	New NH3 cylinder started at 1750 psi.
	12/2/2008	Calibration	Power failures recorded on 11/20/2008 and 11/29/2008. See open site notes for details.
	12/2/2008	Calibration	Performed two sonic anemometer inter-comparisons; one with old sonic anemometer (1921) and one with new (1927).
	12/2/2008	Calibration	TEC 450i flow less than 0.9 LPM; performed leak test after calibration (0.017 LPM).
	12/2/2008	Calibration	New steel gear scanner in NW corner; shipping old scanner in that corner back to DP. Old brass scanner: PTU #5, s/n: 50705255001207, Purdue #: 1043282; New steel scanner: PTU #4, s/n: ...1206, Purdue #: 1043284.
	12/2/2008	Calibration	Too windy to perform sludge depth measurements.

Time (GMT)	**Date** (MM/DD/YYYY)	**Activity** (setup, takedown, calibration, repair, remote)	**Event**
	12/2/2008	Calibration	Restarted all computers and installed updates.
	12/2/2008	Calibration	S-OPS installation report completed.
17:51	12/2/2008	Calibration	Barometer audit: pass
17:51	12/2/2008	Calibration	Wetness sensor calibration: accepted
18:09-19:09	12/2/2008	Calibration	Sonic inter-comparison: all pass
18:43	12/2/2008	Calibration	Calibrated TDLAS 1028
19:14	12/2/2008	Calibration	Calibrated TDLAS 1027
20:08	12/2/2008	Calibration	Sonic zero/bias check. Notes: sensor 4 was sensor 1 in program. Replaced old sensor 1 (1921) with new sensor 1 (1927) and performed bias at different times.
20:27	12/2/2008	Calibration	SO2 calibration
20:35	12/2/2008	Calibration	TEC 450i calibration verification check.
20:35	12/2/2008	Calibration	TEC 450i instrument operating parameters.
20:43	12/2/2008	Calibration	H2S check
21:20-22:20	12/2/2008	Calibration	Sonic inter-comparison: all pass
	12/3/2008	Calibration	Very windy today; foam from lagoon blowing off top layer towards south retro-reflectors and S-OPS path. Too windy to perform sludge depth measurements.
	12/3/2008	Calibration	Restarted LAN (sonic anemometer program error? C++ runtime error with visual basic program). Sonic anemometers were still running after error.
	12/3/2008	Calibration	Tubing length for S-OPS: North--124 m; South--231 m
	12/3/2008	Calibration	Distances not entered into TDL 1--NW--1028
	12/3/2008	Calibration	*rsync* took a few hours to ship previous data and could not wait for completion. Had to go to Praxair and UPS before they closed. Will check back later remotely to complete *rsync* process.
	12/3/2008	Calibration	Lagoon site layout made.
	12/3/2008	Calibration	Maintenance list completed.
	12/3/2008	Calibration	ORP sensor: calibration done. Acceptance passes.
	12/3/2008	Calibration	S-OPS balance: South
	12/3/2008	Calibration	S-OPS balance: North
	12/3/2008	Calibration	S-OPS/GSS leak test: Pass
	12/3/2008	Calibration	S-OPS max flow test
	12/3/2008	Calibration	GSS max flow test
	12/3/2008	Calibration	GSS no flow test
	12/3/2008	Calibration	GSS leak test: pass
18:40	12/3/2008	Calibration	Removed lagoon float.
19:00	12/3/2008	Calibration	pH sensor: QA completed; acceptance done; inspection done.
19:35	12/3/2008	Calibration	Rewired lagoon float.
19:00	12/10/2008	Remote	Daily Status Check from PAML – Notes: Sonic error at son_100s_time. Increased 2nd dimension of son_100s_time (and _u, _v, _w, _T) from 4000 to 8000. Restarted sonic anemometer program and it works fine. There are about 20 sonic anemometer flags continuously

Time (GMT)	**Date** (MM/DD/YYYY)	**Activity** (setup, takedown, calibration, repair, remote)	**Event**
			for all three sonic anemometers. In H2S data, there are two 30-minute periods with flag 1. No communication with CR 1000.
13:15	12/11/2008	Remote	Daily Status Check from PAML – Notes: No CR 1000 data in QC file due to communication problems.
14:00	12/12/2008	Remote	Daily Status Check from PAML – Notes: No CR 1000 data in QC file due to communication problems. Some data lost due to sonic anemometer flagging on sonic anemometer 3, but not significant. TDL 1 path 8 not aligned; re-aimed successfully.
	12/16/2008	Takedown	Started GSS/SOPS calibration at 18:45 GMT (end H2S/GSS data collection).
	12/16/2008	Takedown	Lagoon frozen where probes/float is inserted. Cut ropes when trying to pull out probes. Had to throw rocks at float to break loose.
	12/16/2008	Takedown	12/8/2008 02:33:51: AC restored message sent to registered clients connected to load segment 2. 12/14/2008 13:23:32: UPS switched to battery power; UPS bypass unavailable. 12/14/2008 13:23:37: AC restored message sent to registered clients connected to load segment 2.
	12/16/2008	Takedown	Too windy to perform sludge depth measurements.
	12/16/2008	Takedown	Pumping into lagoon producing strong odor.
	12/16/2008	Takedown	NH3 tank/regulator threads stripped after calibration. Turned a few times then stopped moving and could not move without using a sledge hammer. Will return NH3 cylinder tomorrow and bring regulator to PAML. Cannot perform TDL calibrations in TX5A--TDL's passed today. Will perform calibration at end of the period in TX (assuming new NH3 tank will arrives on time).
	12/16/2008	Takedown	Maintenance list completed.
	12/16/2008	Takedown	pH sensor: QA completed; acceptance done; inspection done.
	12/16/2008	Takedown	ORP sensor: calibration done. Acceptance passes.
17:45	12/16/2008	Takedown	Barometer audit: pass
17:48	12/16/2008	Takedown	Wetness sensor calibration: accepted
18:15-19:10	12/16/2008	Takedown	Sonic inter-comparison; all pass.
20:10	12/16/2008	Takedown	Zero calibration performed on sonic anemometers; all pass.
22:31	12/16/2008	Takedown	Calibrated TDLAS 1027 – See site notes for details.
	12/17/2008	Takedown	Unhooked the trailer, weather station, and power and will move to TX5A.
	4/21/2009	Setup	Reached site at 6:30 PM local time. Found a flat tire on trailer; replaced tire with new one.
	4/22/2009	Setup	Lagoon 20-30% crusted.
18:24	4/22/2009	Setup	Calibrated TDLAS 1027
18:50	4/22/2009	Setup	Calibrated TDLAS 1028

Time (GMT)	**Date** (MM/DD/YYYY)	**Activity** (setup, takedown, calibration, repair, remote)	**Event**
16:40-17:17	4/22/2009	Setup	TEC 450i Single Point calibration
17:00	4/22/2009	Setup	GSS/S-OPS calibrations
	4/23/2009	Setup	UPS history: 4/22/2009: 15:15:49: Communication with UPS restored. 4/22/2009 15:13:17: UPS output power has been restored to Load Segment 1. 4/22/2009 15:13:17: UPS output power has been restored to Load Segment 2. Most likely happened when power was hooked up.
	4/23/2009	Setup	Apparent problem with TDL 1028 shutter; disassembled device, it appeared ok, so it was put back into service.
	4/23/2009	Setup	Failed pH probe (008) replaced with new one (009); will take broken probe to PAML for analysis.
	4/23/2009	Setup	Maintenance list completed.
	4/23/2009	Setup	Lagoon site layout made.
	4/23/2009	Setup	ORP sensor: calibration done.
14:50-15:50	4/23/2009	Setup	Sonic inter-comparison; all pass.
15:00	4/23/2009	Setup	pH sensor (009): QA, calibration, and maintenance and inspection completed. Note: Think pH buffer is bad; will replace on next trip.
16:08	4/23/2009	Setup	Zero calibration performed on sonic anemometers; all pass.
20:12	4/23/2009	Setup	Wetness sensor calibration: accepted
20:12	4/23/2009	Setup	Barometer audit: pass
13:30	4/27/2009	Remote	Daily Status Check from PAML – Notes: Not enough space to perform backup. Deleted previous backups to make room for new backups. TDL 1 only aligned on path 9. Optimization was not enrolled; enabled optimization after finding the lost paths. Saved new backup running setup files. TDL 1 path 8 was very difficult to find with high enough light levels; running optimization on path to see if program can find path. Will check later. Sonic 3 always has excessive spike counts at OK3A. Poor communication with CR 1000; files have not updated since yesterday.
12:30	4/28/2009	Remote	Daily Status Check from PAML – Notes: Unable to access site remotely. QC files not up to date. No data beyond 848.9. Cannot force shipment of data. Sonic 3 always has excessive spike counts at OK3A.
12:30	5/4/2009	Remote	Daily Status Check from PAML – Notes: Not able to remotely access site. Sonic 3 always has excessive spike counts at OK3A. Centerline duty cycle up to 255 when no paths were aligned. CDC is 156 currently when there are two paths aligned. QC files are update through yesterday.
	5/6/2009	Repair	Found red checkmark on DnyDNS. Forced update and powercycled modem and routers but no change. Internet is working but still red checkmark. Forced another

Time (GMT)	**Date** (MM/DD/YYYY)	**Activity** (setup, takedown, calibration, repair, remote)	**Event**
			update and green checkmark appeared.
	5/6/2009	Repair	TDL 1 only had two paths aligned upon arrival. All paths needed to be moved ten steps up and five steps left. Retro seven was knocked out of place due to soft ground; secured in a more solid area. Used modem from wall to align TDL 2 (1029/NW corner/scanner 1205).
	5/6/2009	Repair	Restarted LAN and Panasonic anemometers.
	5/6/2009	Repair	Deleted previous backups to make room for new backups.
	5/6/2009	Repair	Forced data shipment.
	5/6/2009	Repair	UPS history: 5/2/2009 9:20:11: AC Restored Message sent to registered clients connected to Load Segment 2 5/4/2009 16:02:51: UPS switched to battery power. 5/4/2009 16:02:52: AC Restored Message sent to registered clients connected to Load Segment 2
22:00	5/6/2009	Repair	Calibrated TDLAS 1029
14:30	5/8/2009	Remote	Daily Status Check from PAML – Notes: No QC update. Microsoft Visual C++ runtime error. No CR 1000 update since 5/6/2009. TDL 1 paths 2, 3, 7, and 8 were off. Could not re-aim path 3 due to slow internet. Started showing pan/tilt errors for all paths; unsuccessfully tried to fix but could not. Will talk to Dr. Grant.
	5/14/2009	Takedown	Found pan/tilt error on SE scanner. Power supply/modem box was not mounted on tripod correctly (wind may have moved it) and antenna was not vertical (wind?). Power-cycled scanner and it now works properly.
	5/14/2009	Takedown	Yellow wire pulled out of CR 1000 when disconnecting lagoon sensors; reattached for calibration (from barometer); also, the wetness sensor wires were disconnected but reattached for calibration.
	5/14/2009	Takedown	Maintenance list completed.
	5/14/2009	Takedown	ORP sensor: calibration and acceptance performed; all pass.
16:00-18:00	5/14/2009	Takedown	S-OPS/GSS calibrations Note: S3 failed GSS leak test; will check again at WA5A.
16:55-17:55	5/14/2009	Takedown	Sonic inter-comparison; all pass.
18:09	5/14/2009	Takedown	Zero calibration performed on sonic anemometers; all pass.
19:15	5/14/2009	Takedown	Pulled out lagoon float.
19:30	5/14/2009	Takedown	pH sensor: QA and inspection completed.
20:25-21:04	5/14/2009	Takedown	TEC 450i single point calibration Note: Had to redo H2S calibration because initial calibration was performed at about 1 ppm and not at 0.5 ppm.
20:48	5/14/2009	Takedown	Wetness sensor calibration: accepted
20:52	5/14/2009	Takedown	Barometer audit: pass
22:35-22:52	5/14/2009	Takedown	Calibrated TDLAS 1027
23:02-23:22	5/14/2009	Takedown	Calibrated TDLAS 1029

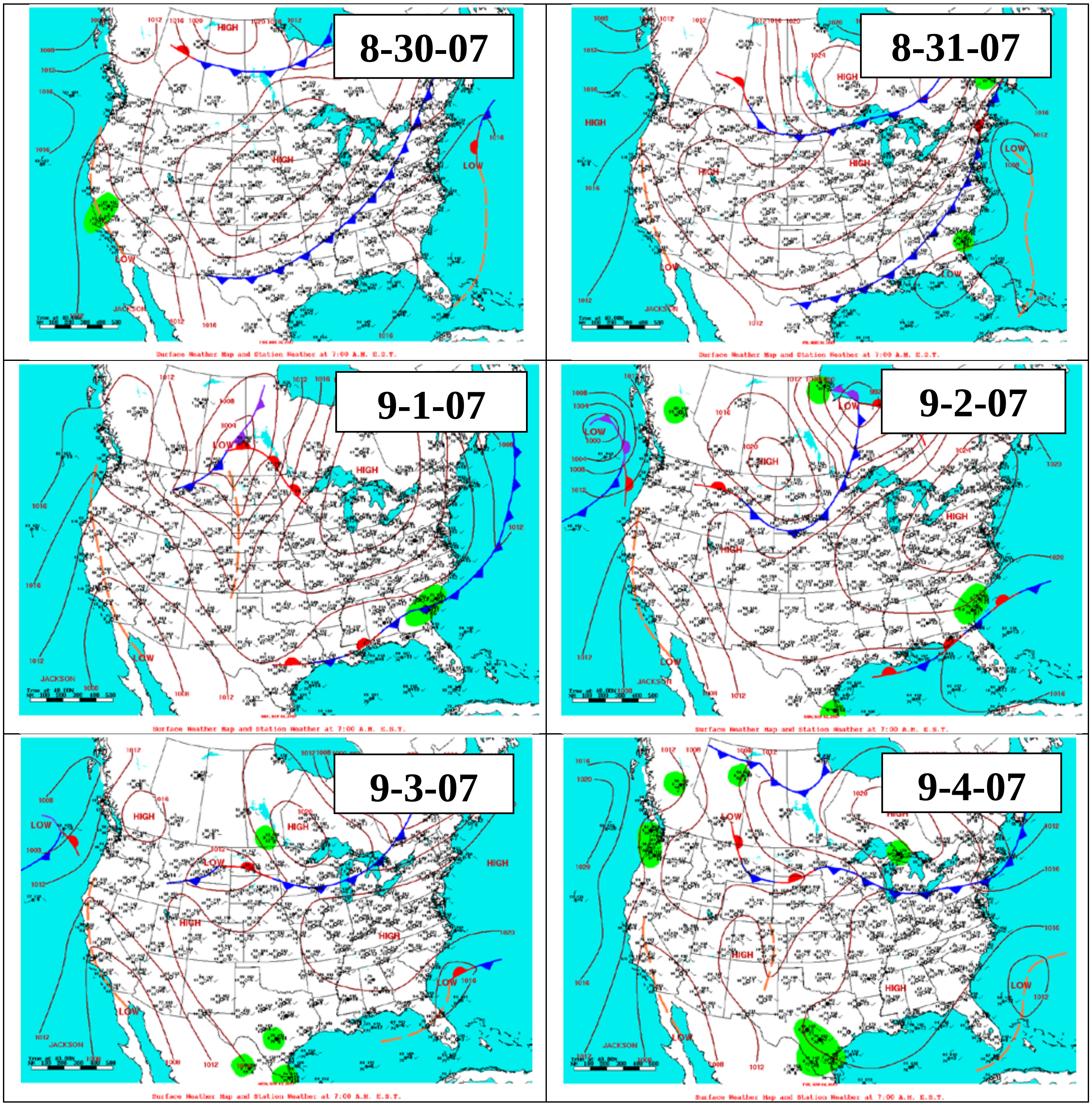
Time (GMT)	**Date** (MM/DD/YYYY)	**Activity** (setup, takedown, calibration, repair, remote)	**Event**
	7/14/2009	Setup	Leveled trailer and started to tie down and hook up power to the trailer. However, a storm arrived with heavy rain and lightning forced us to leave for the day. Will continue tomorrow.
	7/15/2009	Setup	Too windy to perform sludge depth measurements.
	7/15/2009	Setup	TDLAS 1029 failed calibration at low light levels. Managed to increase the light levels, and it passed barely with a bias of -9.53%.
	7/15/2009	Setup	Sonic anemometers failed calibration (sonic anemometer 3 specifically; it was giving high values). Sonic anemometers passed on the second calibration.
	7/15/2009	Setup	SO2 and zero gas PSI values have decreased by a lot; checked for leaks but couldn't find any.
	7/15/2009	Setup	pH probe failed calibration again. Will use it anyway as it is passing at buffer 4 and 10. Will discuss, and if needed will disregard data collected during this period (OK3A Period 9).
	7/15/2009	Setup	UPS history: 7/15/2009: 15:39:50: Load Segment 2 has been turned off. 7/15/2009 15:43:19: UPS output power has been restored to Load Segment 1. 7/15/2009 15:43:19: UPS output power has been restored to Load Segment 2.
	7/15/2009	Setup	Maintenance list completed.
	7/15/2009	Setup	Lagoon site layout made.
	7/15/2009	Setup	ORP sensor: calibration and acceptance performed; all pass.
16:40	7/15/2009	Setup	Sonic inter-comparison; all pass.
17:40-18:00	7/15/2009	Setup	Calibrated TDLAS 1028
18:43-19:03	7/15/2009	Setup	Calibrated TDLAS 1029
19:30-20:33	7/15/2009	Setup	S-OPS/GSS calibrations
19:32-20:04	7/15/2009	Setup	TEC 450i single point calibration
20:21	7/15/2009	Setup	Zero calibration performed on sonic anemometers; all pass.
22:15	7/15/2009	Setup	pH sensor: QA, inspection, and maintenance done. Notes: pH probe failed calibration again. Will use it anyway as it is passing at buffer 4 and 10. Will discuss, and if needed will disregard data collected during this period (OK3A Period 9).
	7/16/2009	Setup	Had many aiming problems with TDL 1028. Telescope is not aimed properly. Could not get good light level values for path 9 without removing plastic.
	7/16/2009	Setup	Took out plastic in retro 4 of TDL 1 because of insufficient light not achieved.
14:58	7/16/2009	Setup	Wetness sensor calibration: accepted
14:58	7/16/2009	Setup	Barometer audit: pass

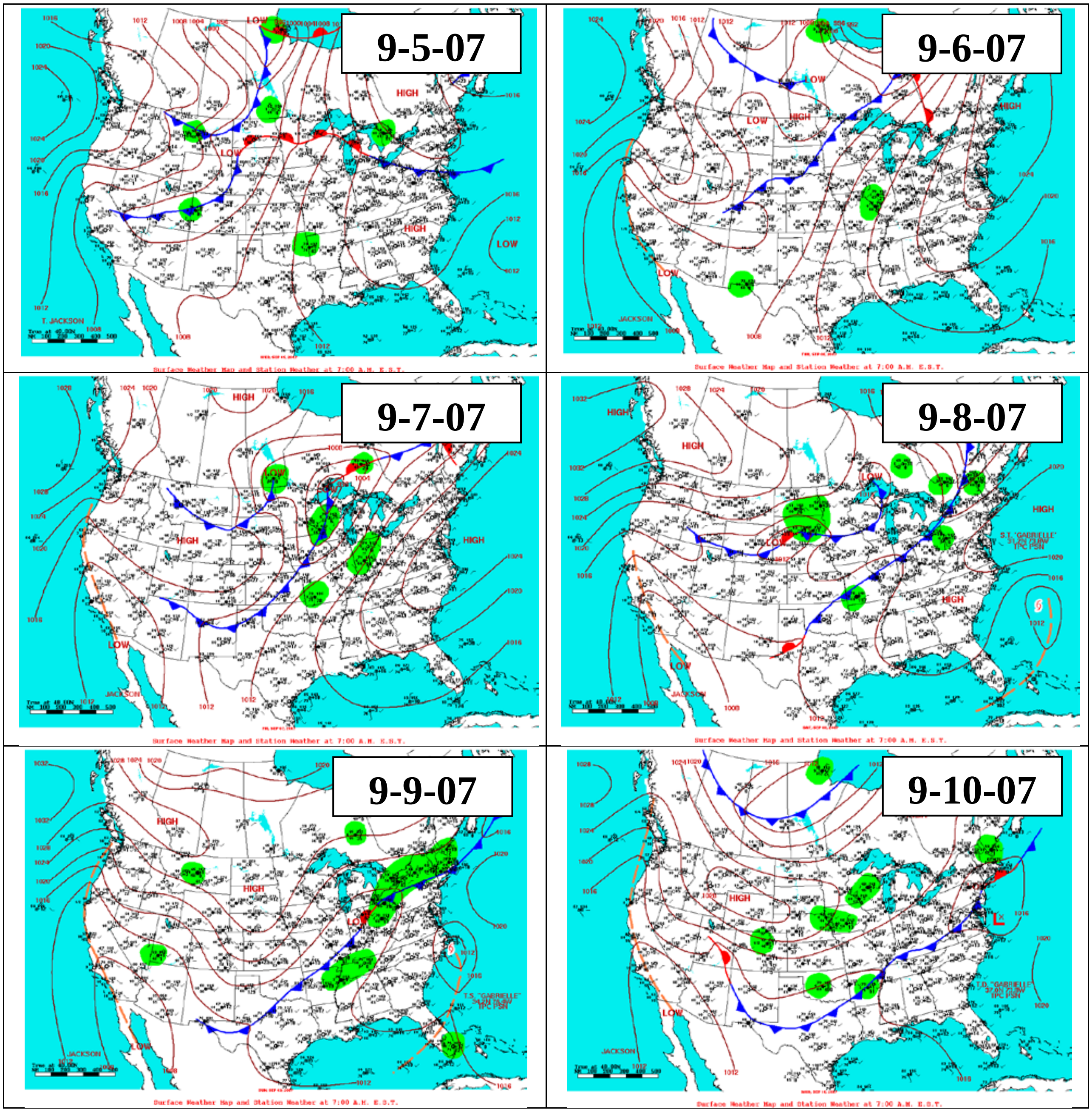
Time (GMT)	**Date** (MM/DD/YYYY)	**Activity** (setup, takedown, calibration, repair, remote)	**Event**
16:45	7/16/2009	Setup	Launched lagoon float
12:30	7/17/2009	Remote	Daily Status Check from PAML – Notes: Sonic anemometers had some flagging during big storm (especially sonic anemometer 2). Sonic 3 has up to 350 spikes. Many TDL paths were not aligned. TDL 1 path 1 was being skipped; changed dwell time from 0 s to 15 s. Changed dist on TDL 1 path 1 from 15 s to one minute. CR 1000 data file contained a bunch of old data, and no data from current site. Did a custom collection to download data for current site and then placed this data in the appropriate file. Data are now collected.
12:15	7/20/2009	Remote	Daily Status Check from PAML – Notes: Not enough space to perform backup. Deleted previous backups to make room for new backups. TDL 1 paths 4 and 5 are way off their saved setup values. Saved setup to get original paths back to normal; paths had been changed without setup being saved.
13:00	7/21/2009	Remote	Daily Status Check from PAML – Notes: Sonic 3 always has periods of excessive flagging at OK3A. Strong storms in area last night; they may have knocked TDL 2 path 9 out of alignment. On both TDL's CDC temperature dropped to 133, now back to normal.
12:15	7/22/2009	Remote	Daily Status Check from PAML – Notes: Sonic 3 always has periods of excessive flagging at OK3A.
13:06	7/24/2009	Remote	Daily Status Check from PAML
12:30	7/27/2009	Remote	Daily Status Check from PAML – Notes: Upon login, found runtime error: "Program: C:\Program Files\Genie-Soft\GBMPro7\GBM7.exe has requisitioned the runtime to terminate it in an unusual way. Please contact the applications support team for more info." Click ok. TDL 1 lost connection during optimization. Could not aim TDL 2 path 7. Overall, sonic anemometer 3 w is not that far off the line, but it has four recent points that are way above zero. Sonic 2 w has three negative points and one positive point. H2S graphs showed that chamber pressure, sample flow, voltage, and lamp intensity briefly went to zero. Remote check showed H2S analyzer was working fine thought. No communication with CR 1000.
12:30	7/29/2009	Remote	Daily Status Check from PAML – Notes: *iPort* encountered a problem and needed to close. TEC 450i is sending back zeros for H2S data. Sonic 1 not recording data since 7/27/2009. No CR 1000 data since 7/27/2009. No TDL 1 info since 7/27/2009. TDL 1 had pan/tilt error. Unable to aim TDL 1 paths 1 and 7.
13:00	7/30/2009	Remote	Daily Status Check from PAML – Notes: TEC 450i is sending back zeros for H2S data. Sonic 1 not recording data since 7/27/2009. No CR 1000 data since 7/27/2009. No TDL 1 info since 7/27/2009. Unable to aim TDL 1

Time (GMT)	**Date** (MM/DD/YYYY)	**Activity** (setup, takedown, calibration, repair, remote)	**Event**
			path 1. MJB talked to Thomas Sowell at site. Found two tripped GFCI outlets on NW corner area. Found one plug unplugged on SW tower. Found TDL 2 path 1 knocked over and unplugged. Found TDL 1 path 7 leaning. Sonic anemometers are now working. After talking to Thomas, site was running except for low light levels on TDL 2 path 2.
13:00	7/31/2009	Remote	Daily Status Check from PAML – Notes: Unsuccessfully tried to re-aim TDL 2 path 7. Could only get light levels around 200. A couple of outlying values for v, w for sonic anemometer 2. Several points with very large w and low temperature for sonic anemometer 3.
13:00	8/3/2009	Remote	Daily Status Check from PAML – Notes: No data from sonic anemometer 1; data stop at 1:55 UTC. No connection to CR 1000. Appears like power has been lost again to NW corner. Appears that a thunderstorm passed through the site around 02:00 UTC on 8/1/2009. Thomas Sowell fixed outlets again.
	8/4/2009	Takedown	TEC 450i failed calibration. Will take to next site (TX5A), and if it fails again will perform multipoint calibration.
	8/4/2009	Takedown	SO2 cylinder only has 75 PSI left. It is still leaking but cannot locate leak.
	8/4/2009	Takedown	S-OPS side B (south side) failed leak test. Will check again at TX5A.
	8/4/2009	Takedown	TDLAS 1029 failed calibration with a bias of -13.5%.
	8/4/2009	Takedown	Too windy to perform sludge depth measurements.
	8/4/2009	Takedown	See open site notes for UPS history.
	8/4/2009	Takedown	Maintenance list completed.
	8/4/2009	Takedown	ORP probe: calibration and acceptance pass.
	8/4/2009	Takedown	pH sensor: QA fails.
15:00	8/4/2009	Takedown	Barometer audit: pass
15:04	8/4/2009	Takedown	Wetness sensor calibration: accepted
16:25-17:24	8/4/2009	Takedown	Sonic inter-comparison; all pass.
16:38-17:03	8/4/2009	Takedown	Calibrated TDLAS 1028
17:17-17:38	8/4/2009	Takedown	Calibrated TDLAS 1029 – Notes: Failed calibration with a bias of -13.5%.
18:03	8/4/2009	Takedown	Zero calibration performed on sonic anemometers; all pass.
19:45-21:00	8/4/2009	Takedown	S-OPS/GSS calibrations Notes: Side B (south side) failed leak test. Will check again at TX5A.
20:15-20:49	8/4/2009	Takedown	TEC 450i single point calibration: failed. Notes: Will take to next site (TX5A), and if it fails again will perform multipoint calibration.

6.9 Site Weather

Period 2

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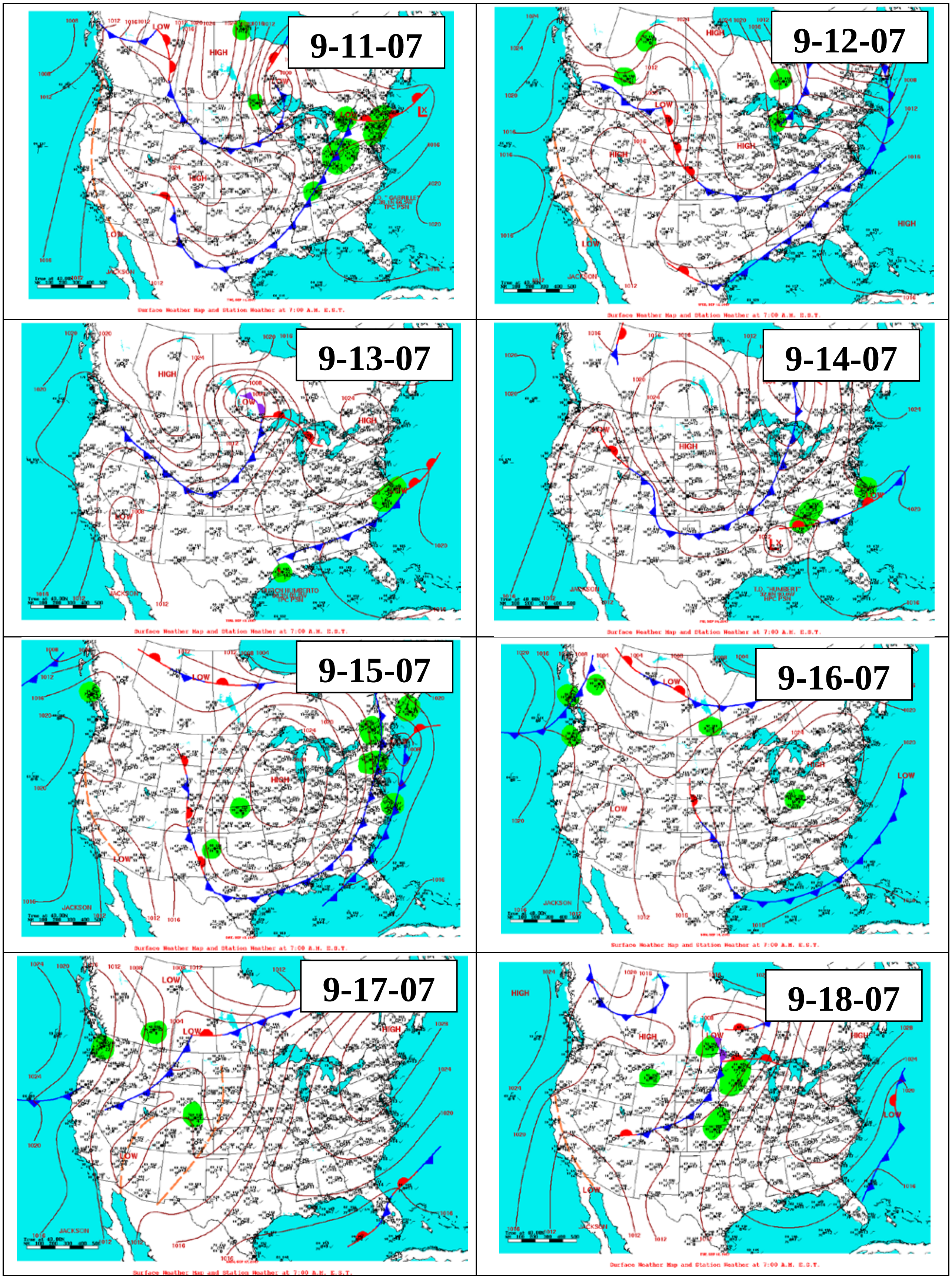
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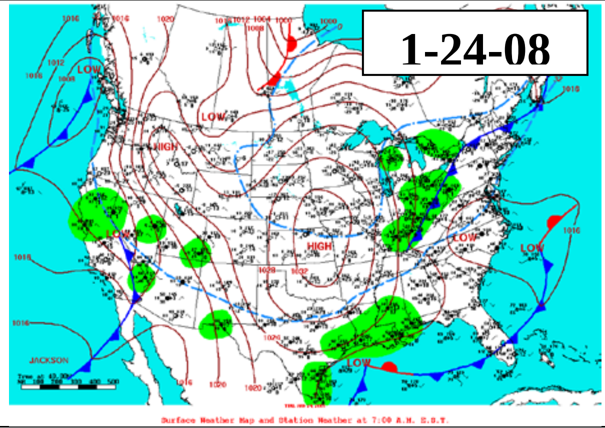
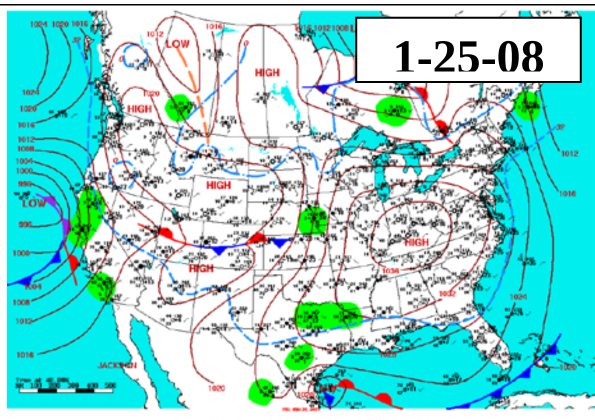
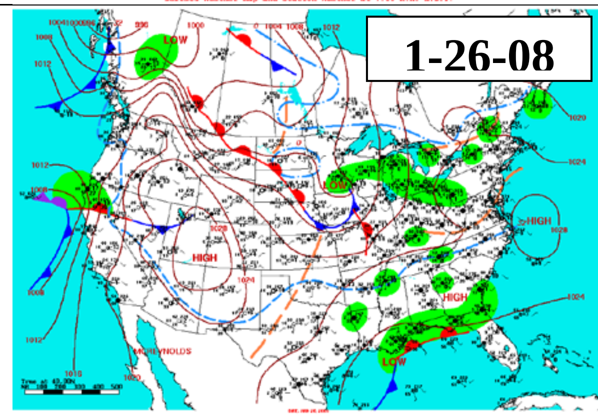
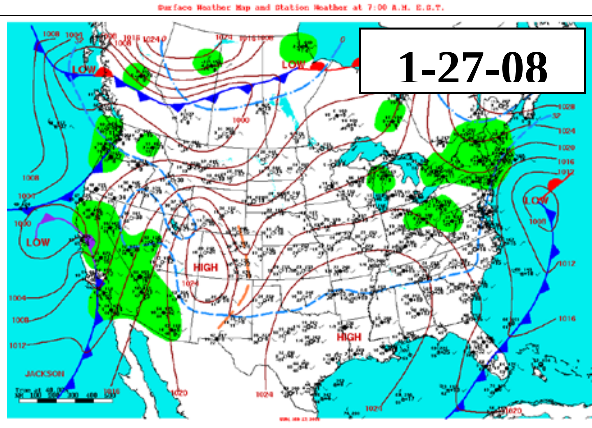
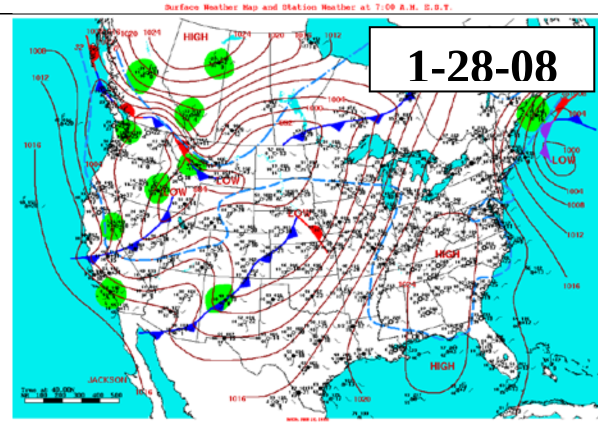
Period 3

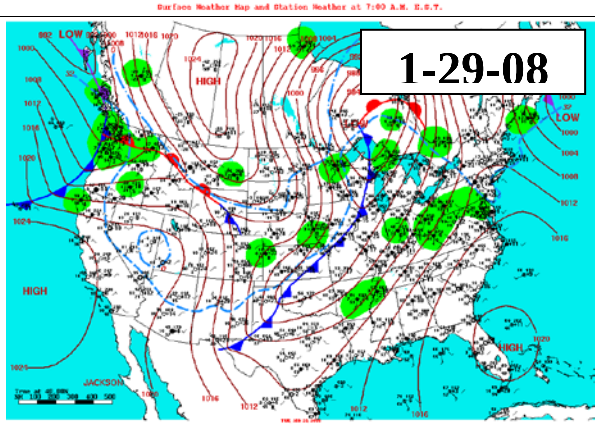


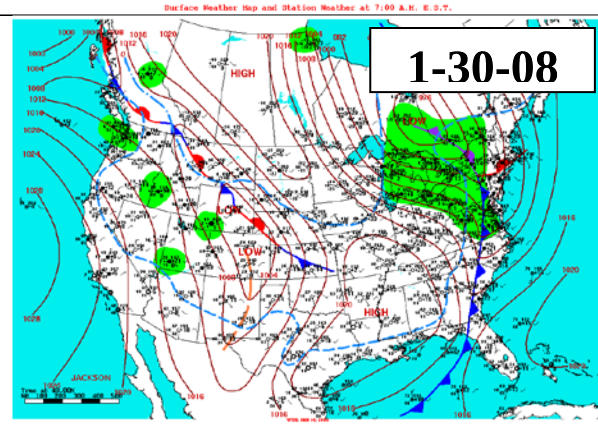


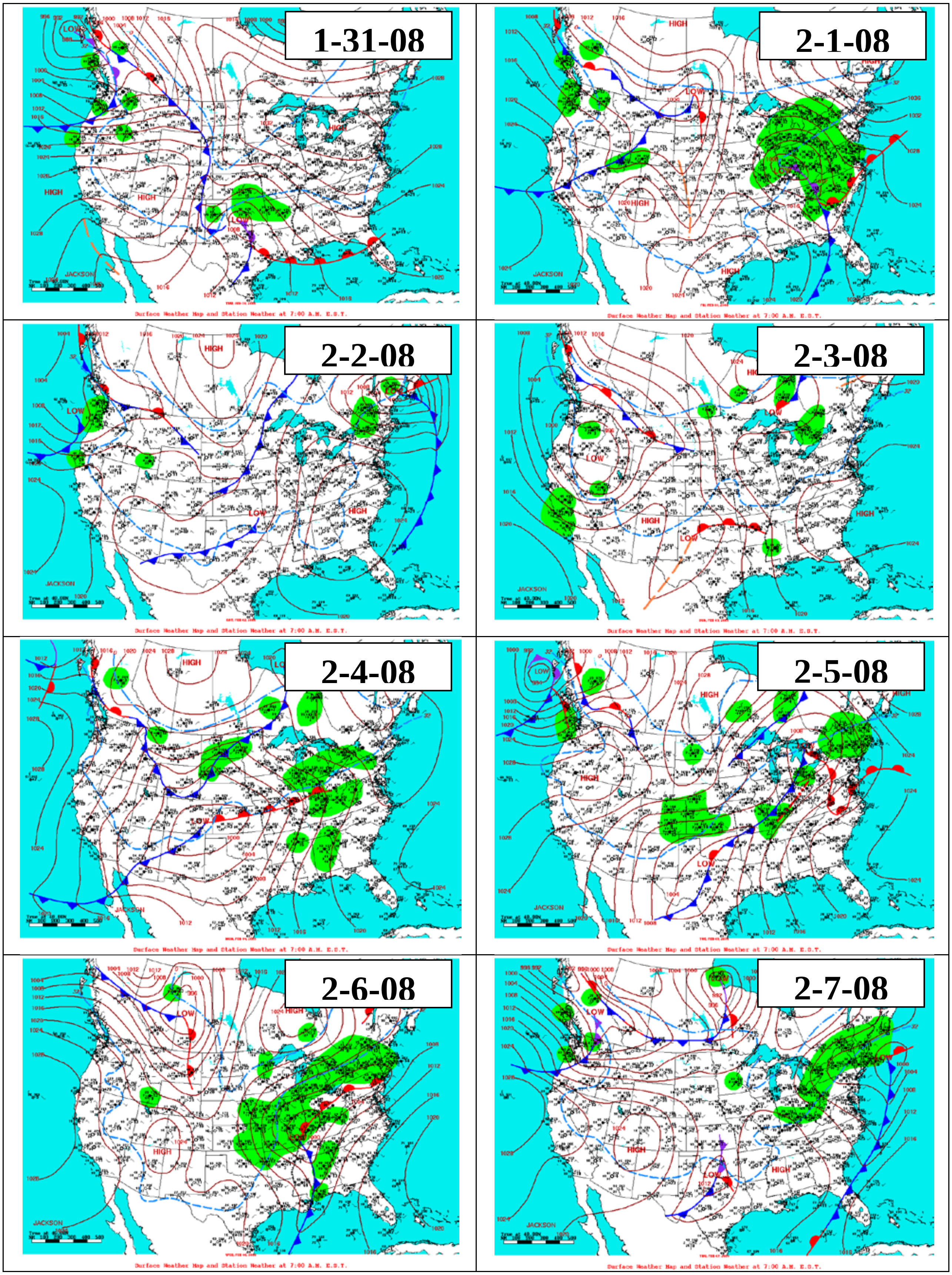








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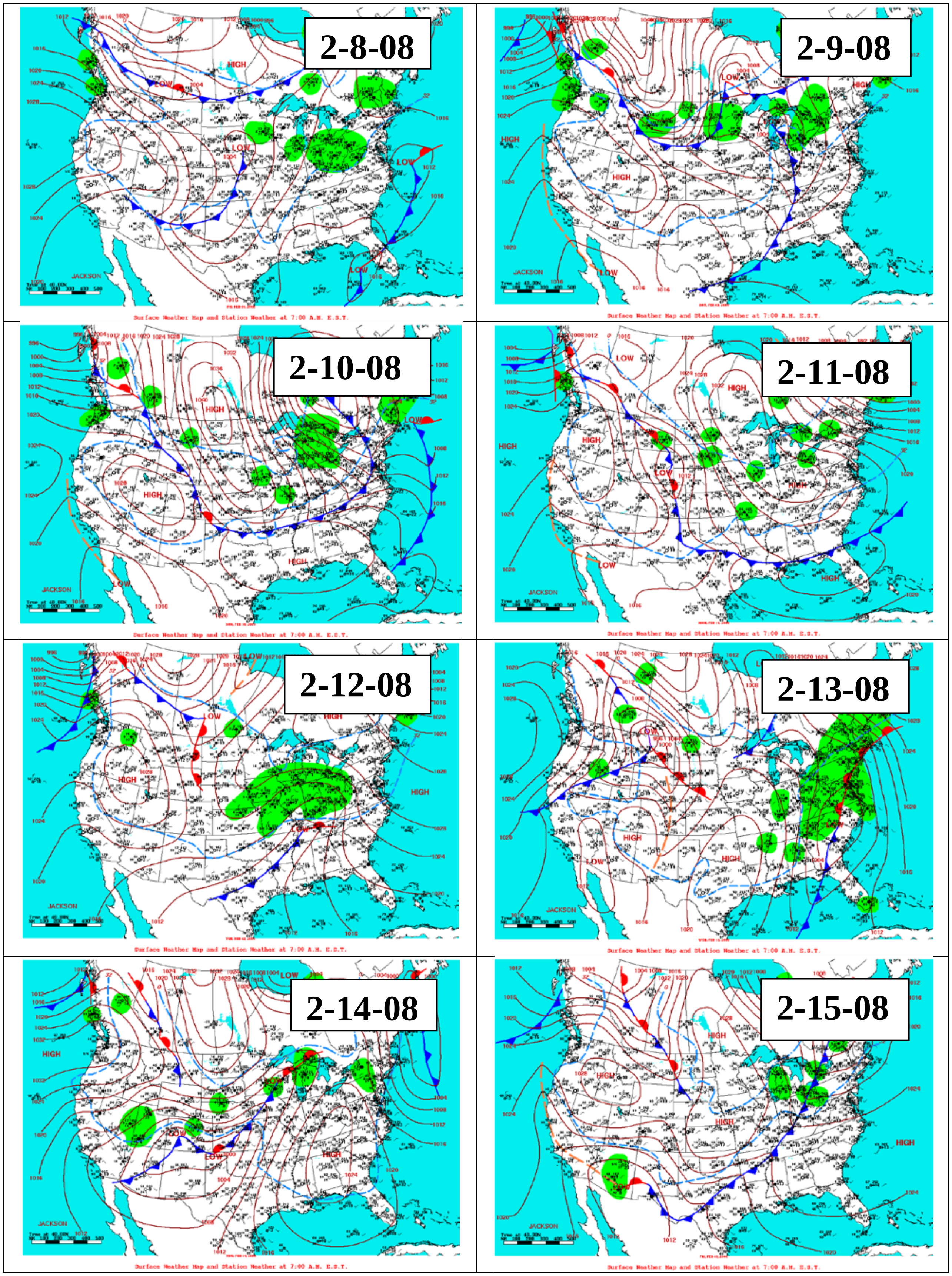
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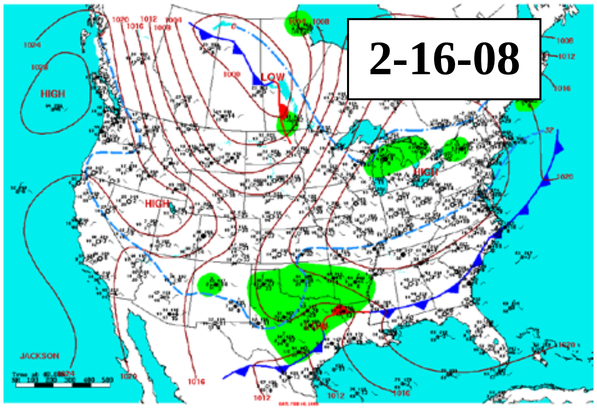
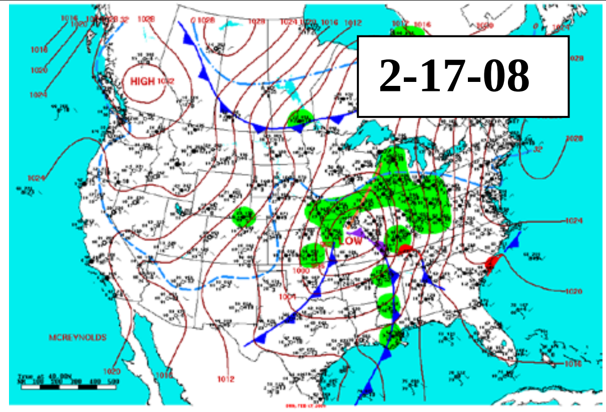


Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.



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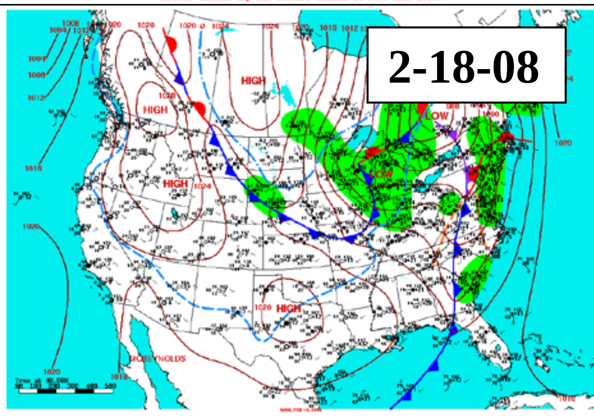

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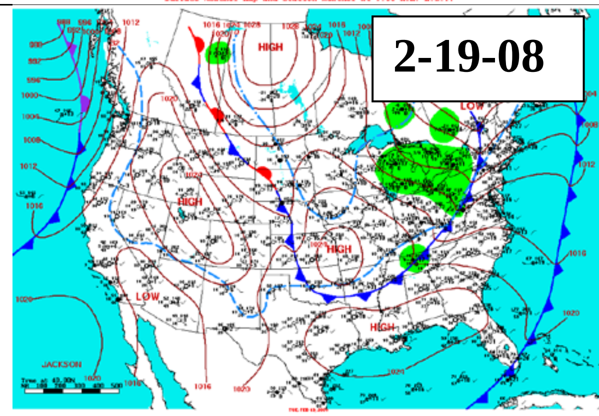
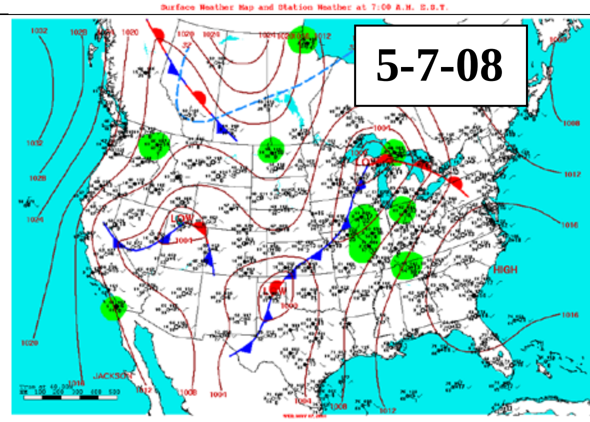


Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.

Period 4



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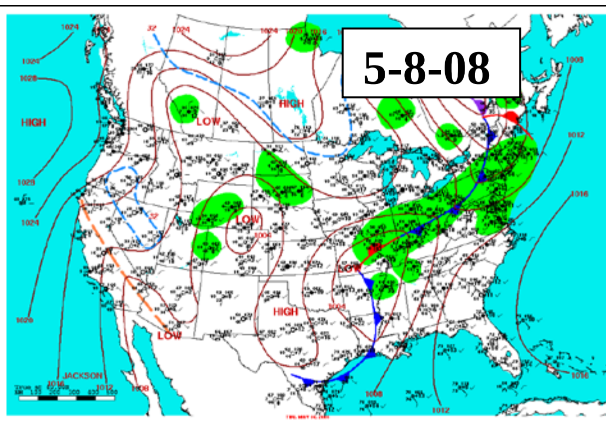

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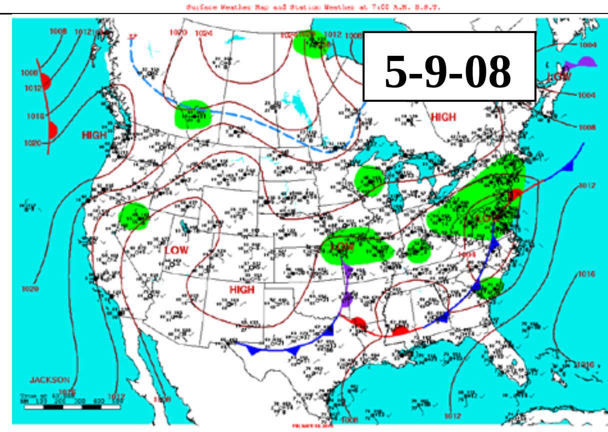

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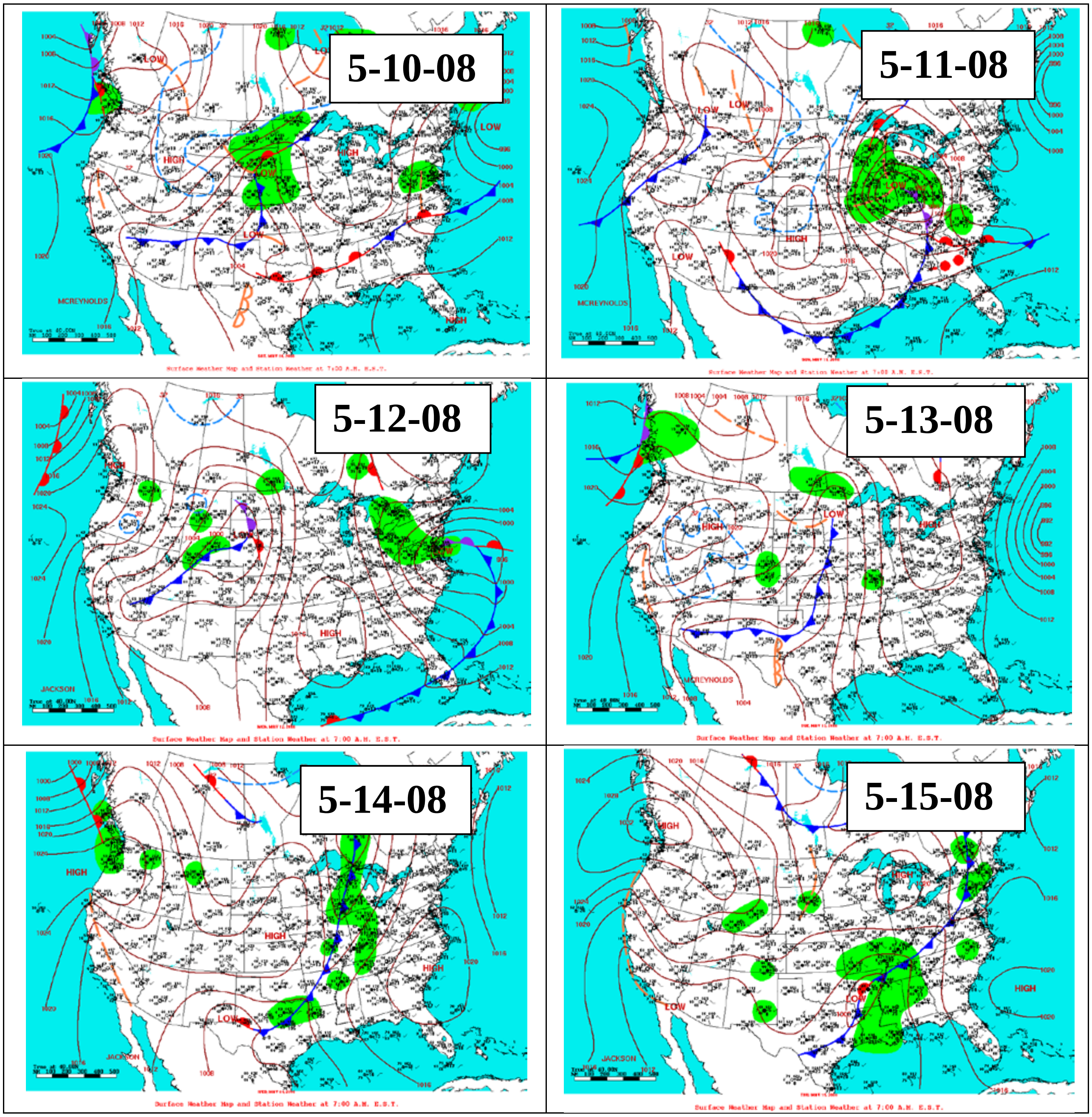
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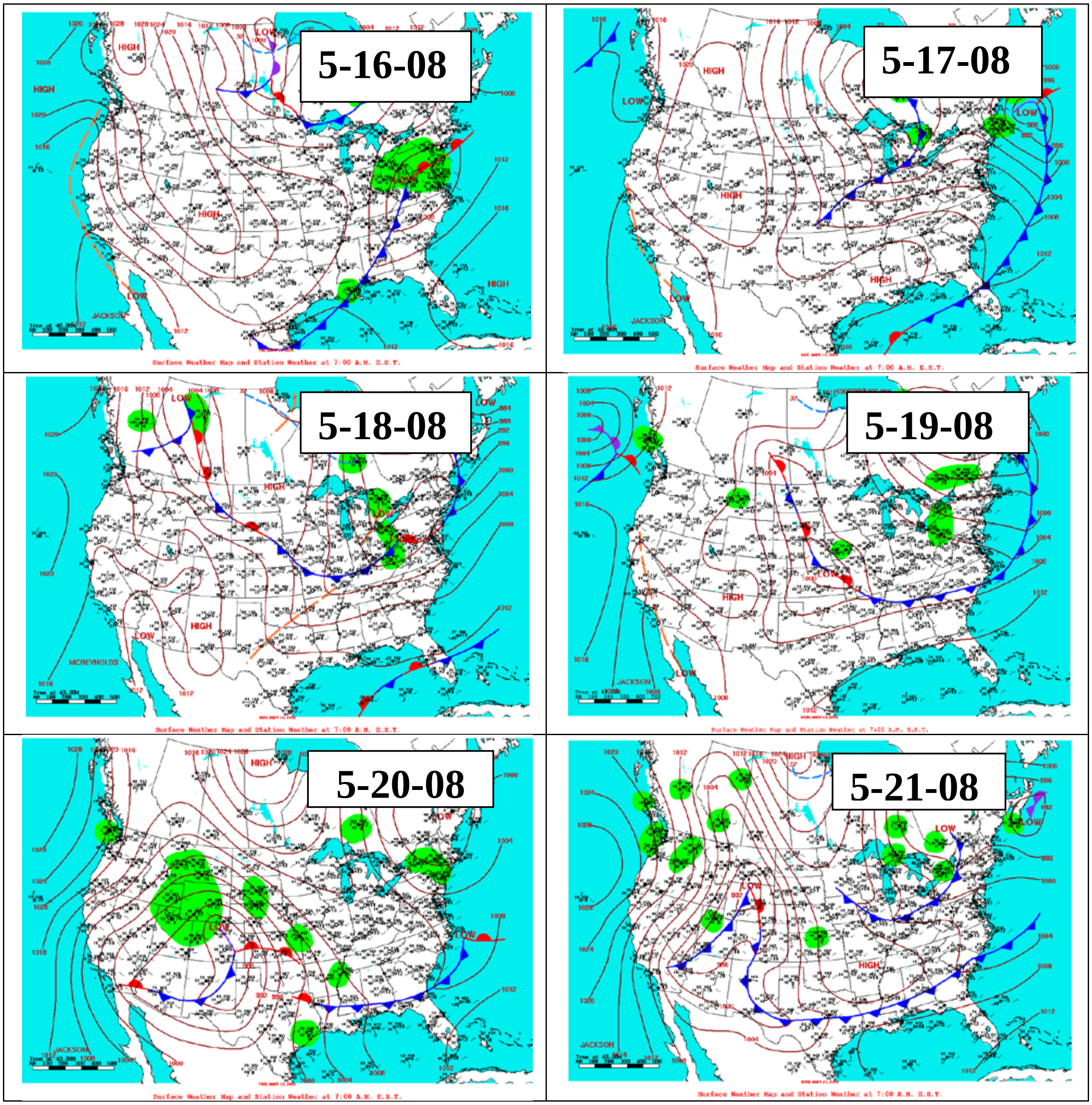

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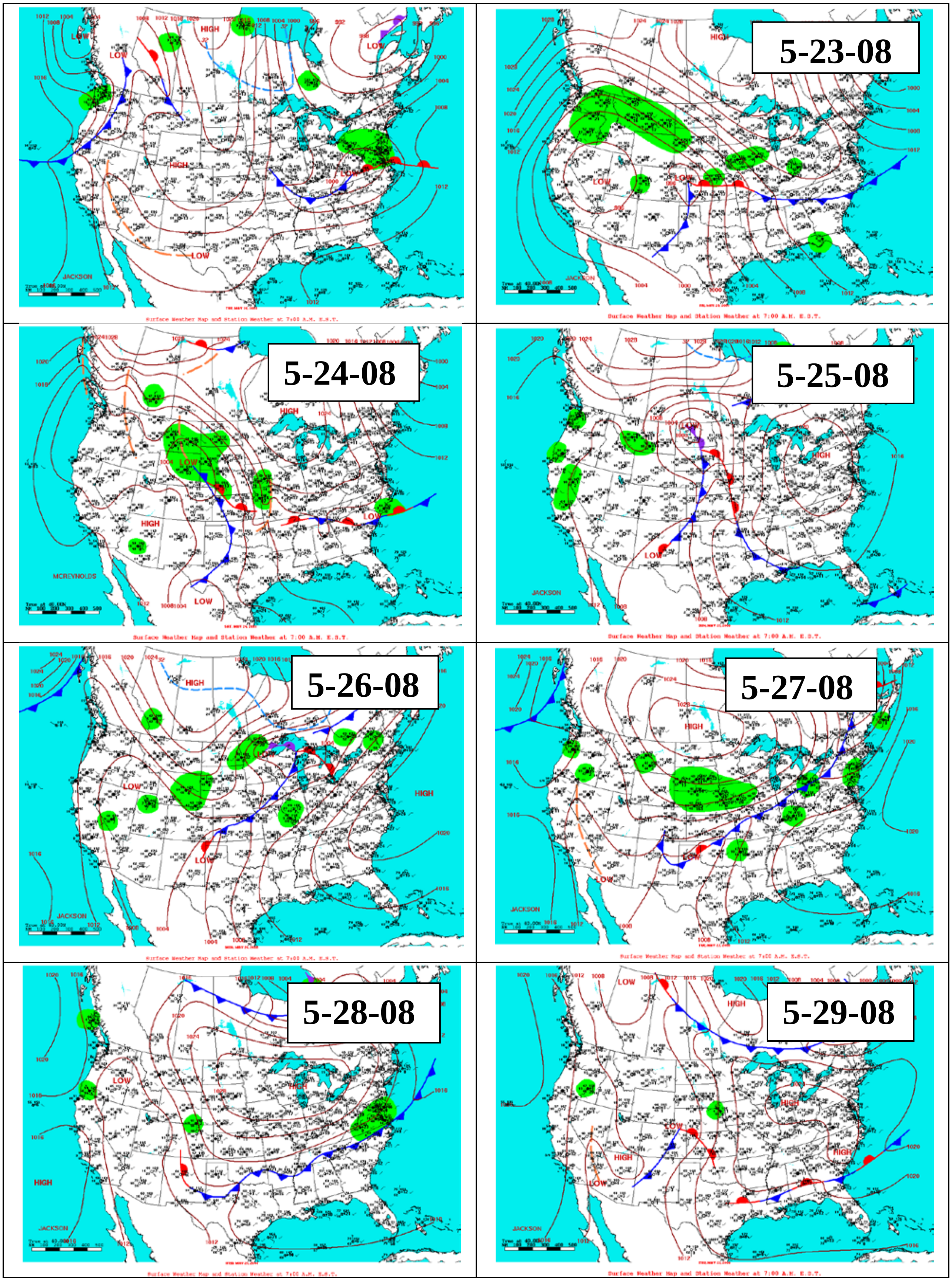
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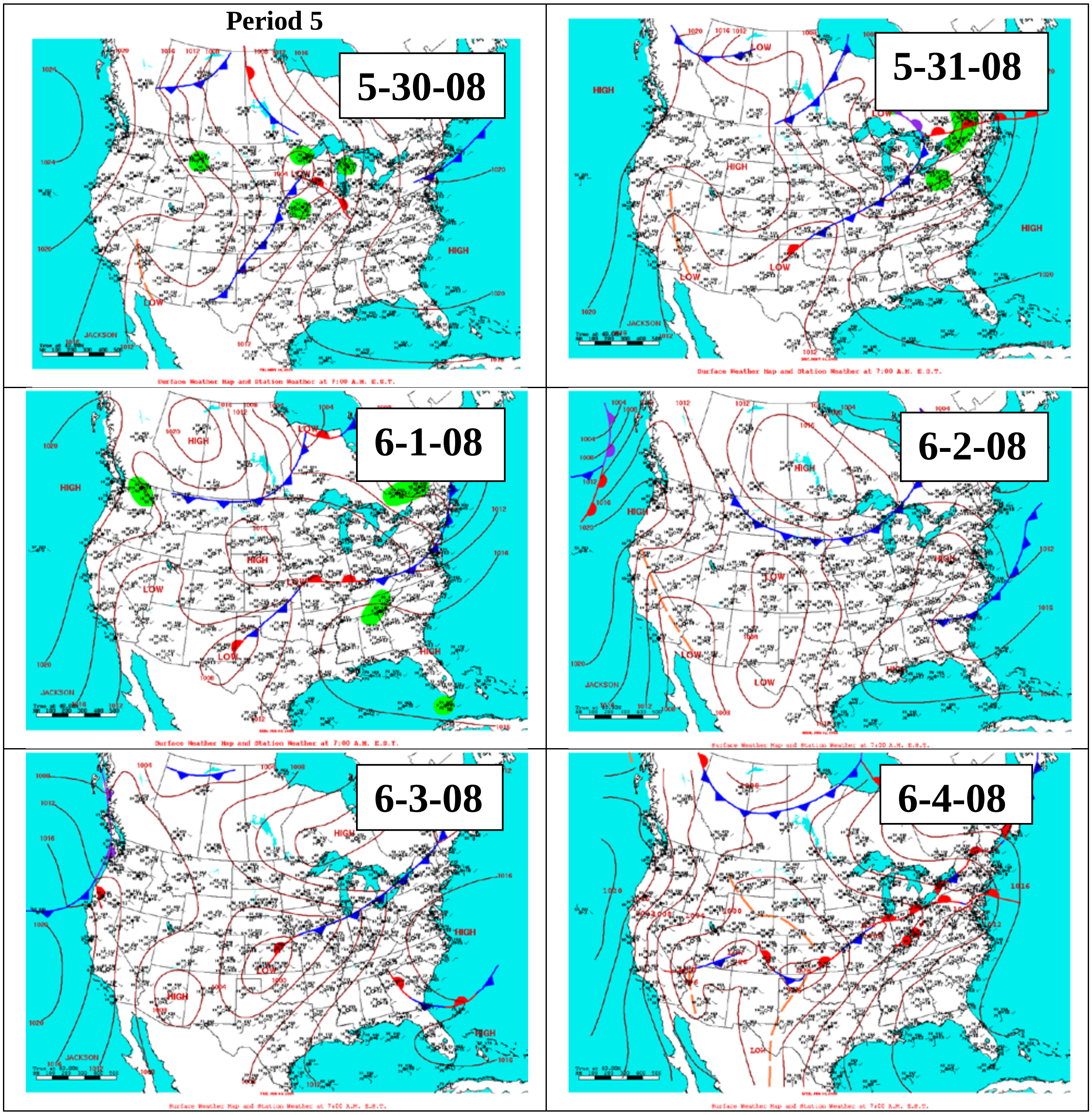
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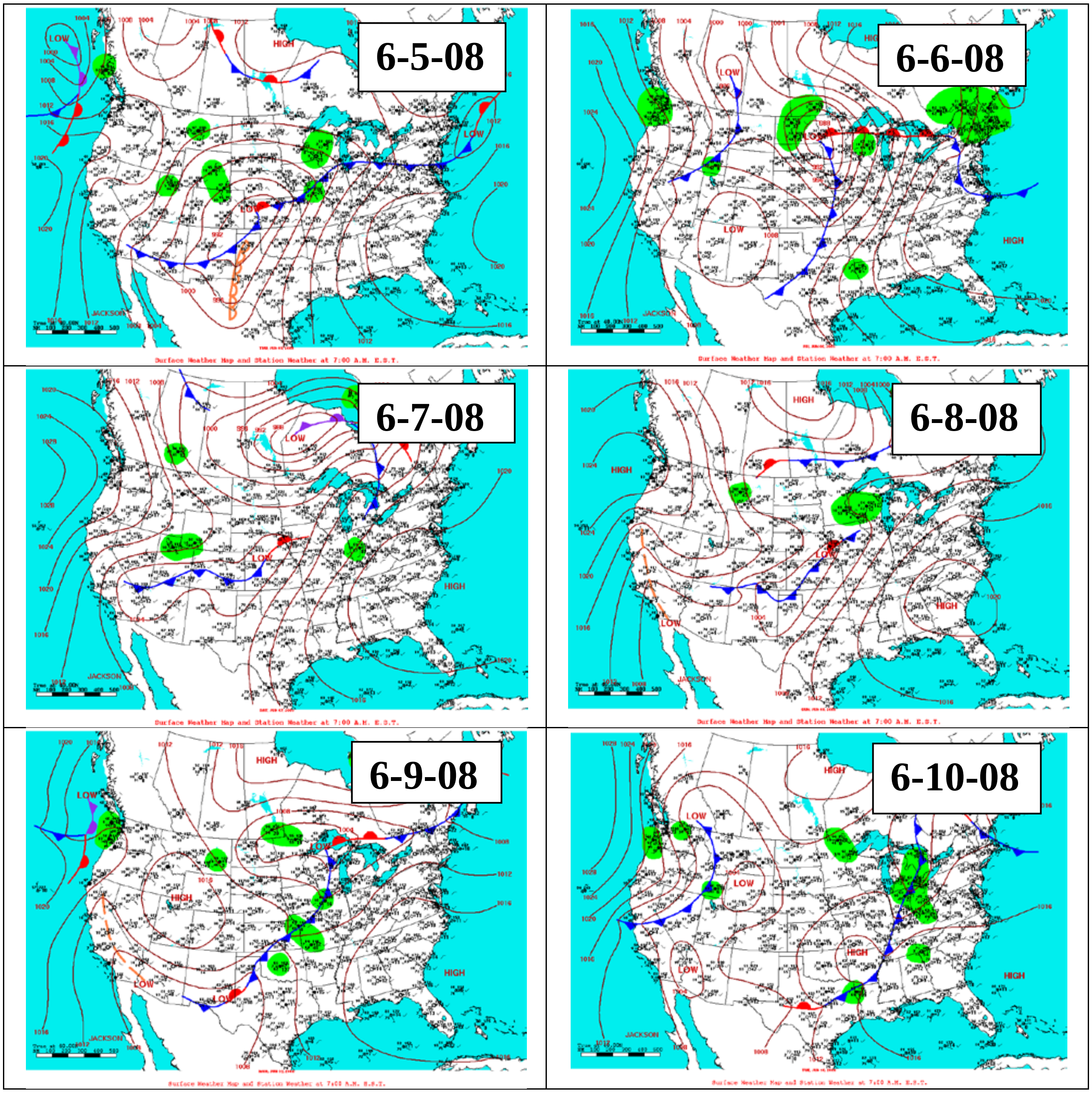
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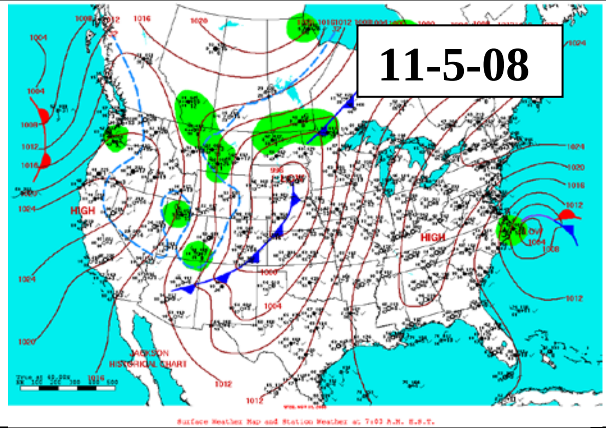

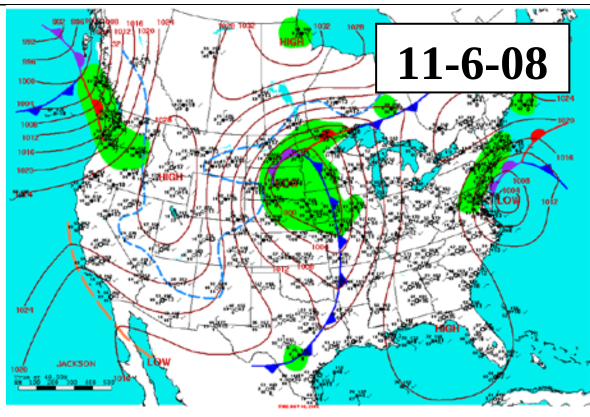

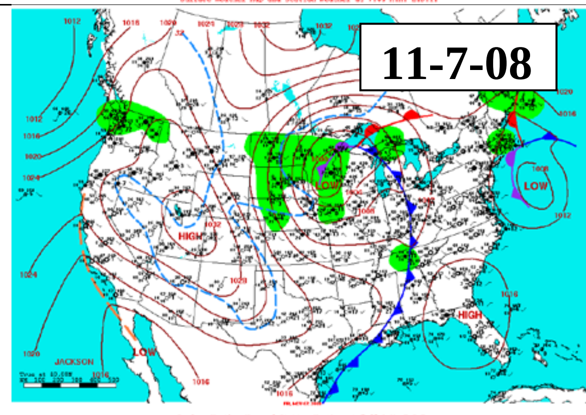

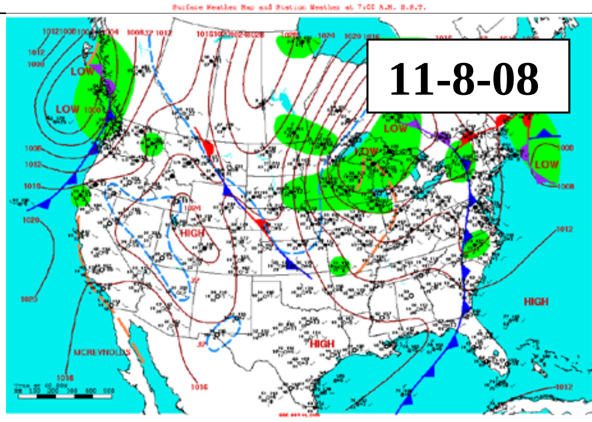

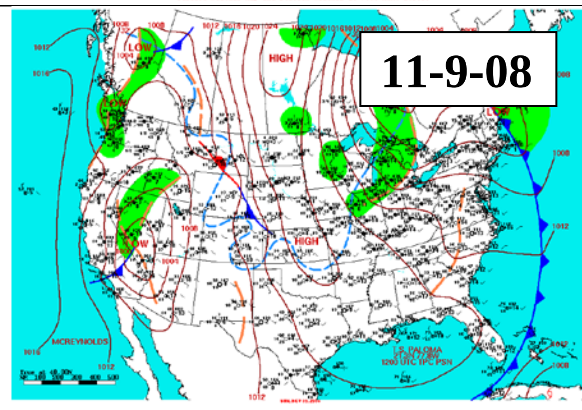

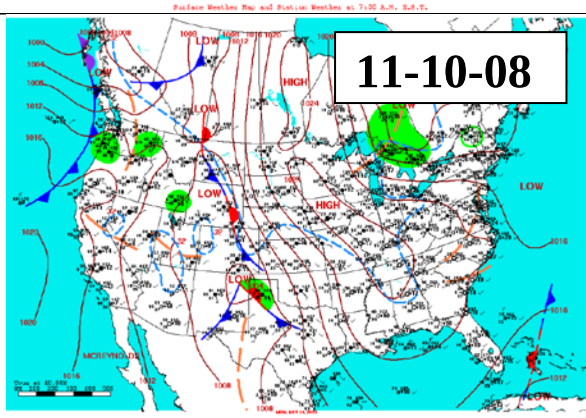

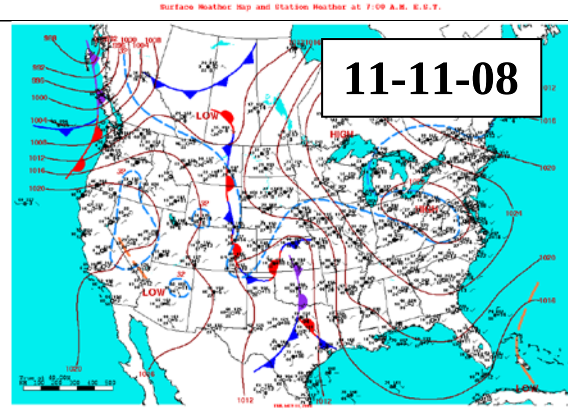

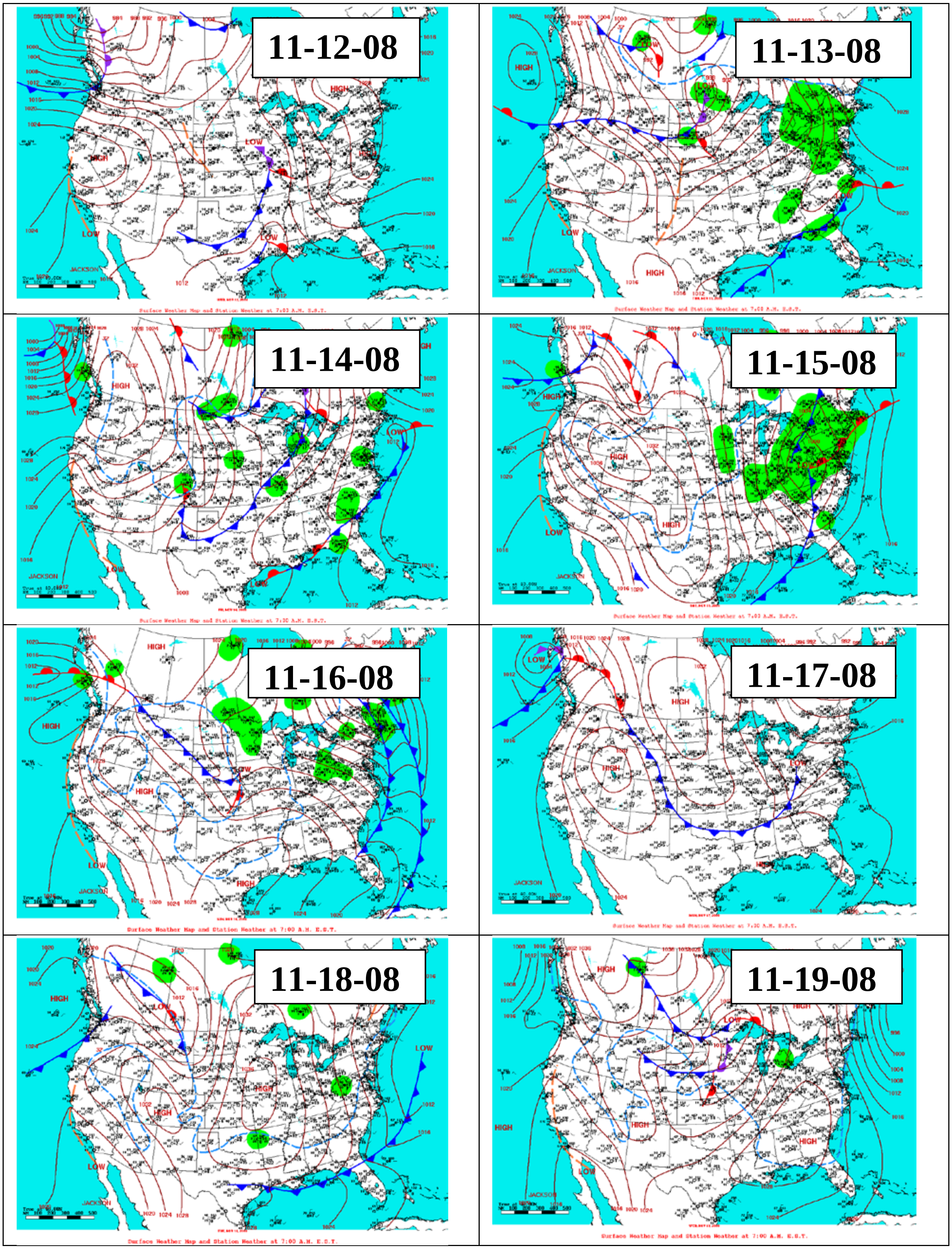
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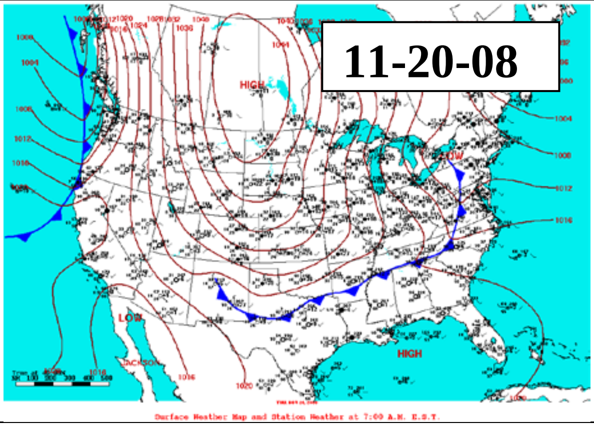
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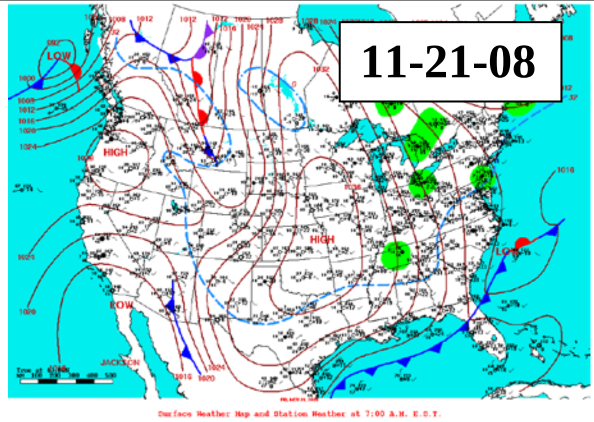
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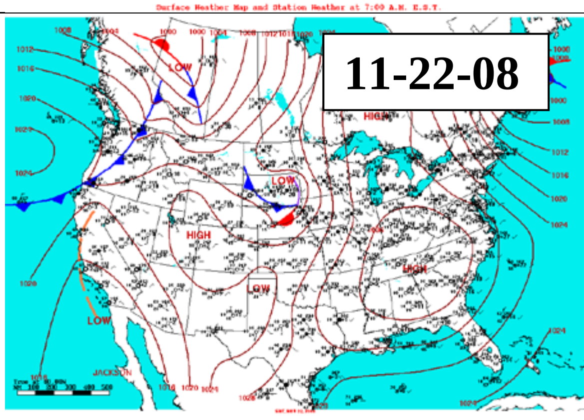
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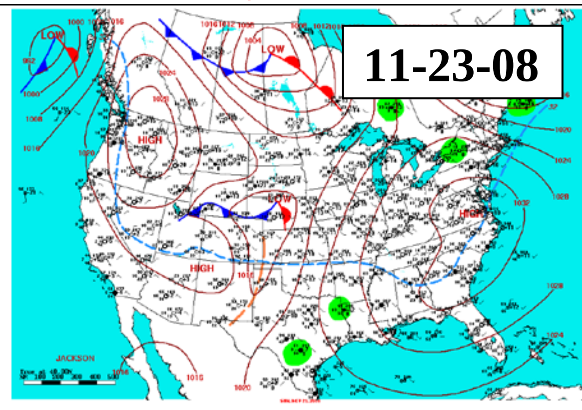
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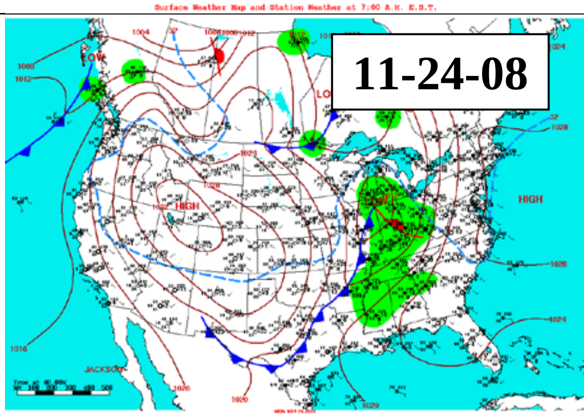
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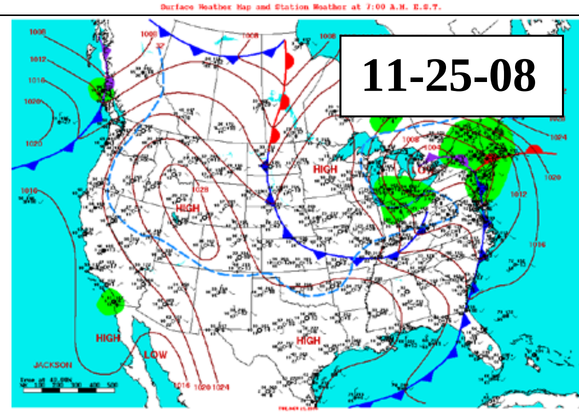
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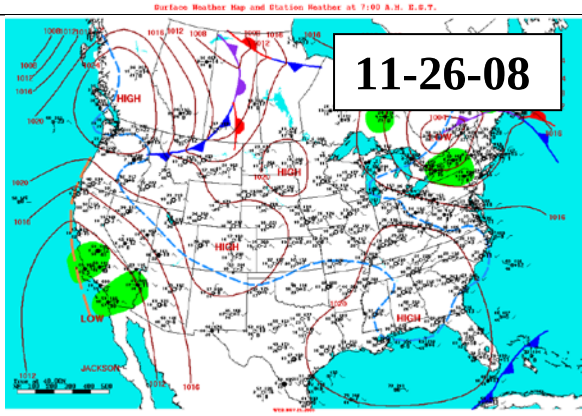
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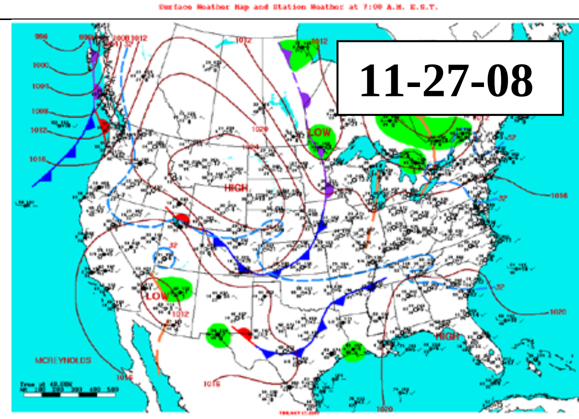
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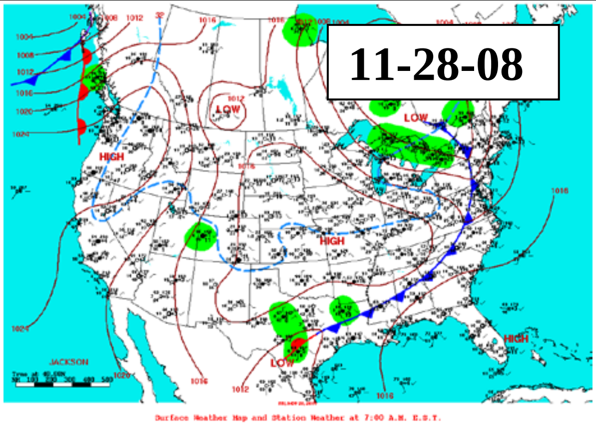
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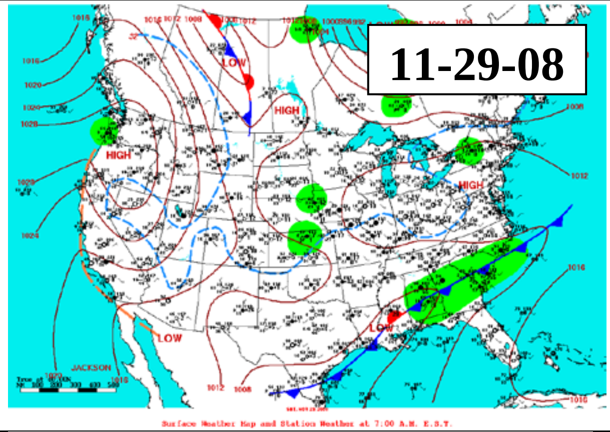
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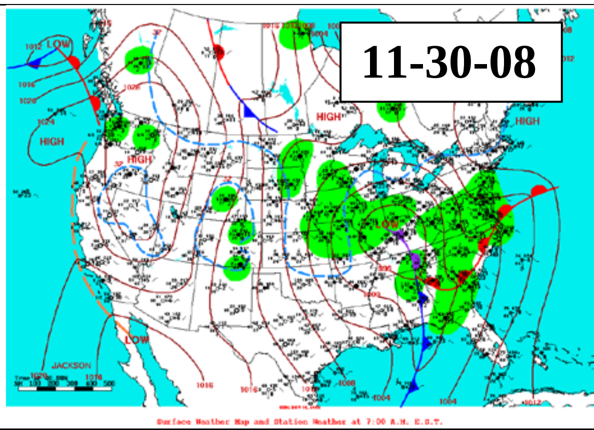
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.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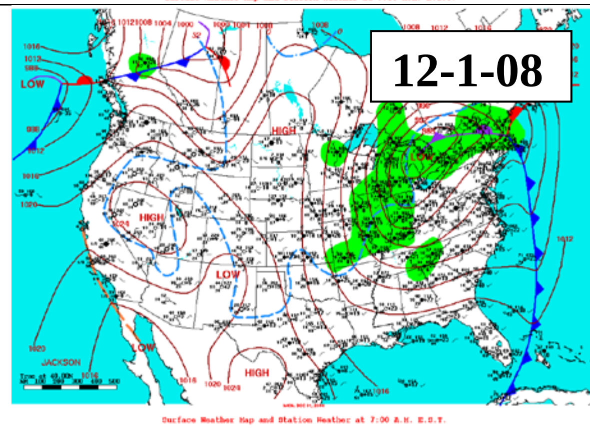
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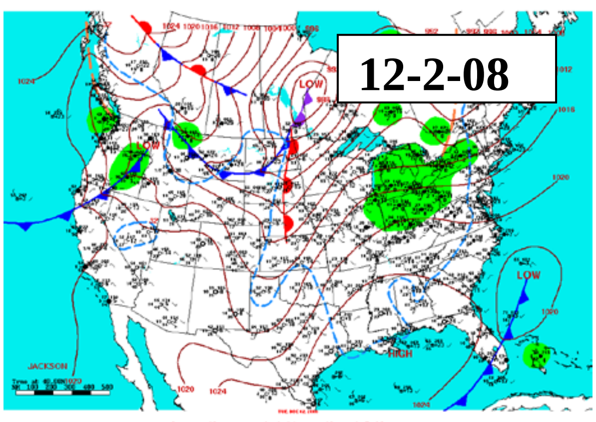
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.

Period 7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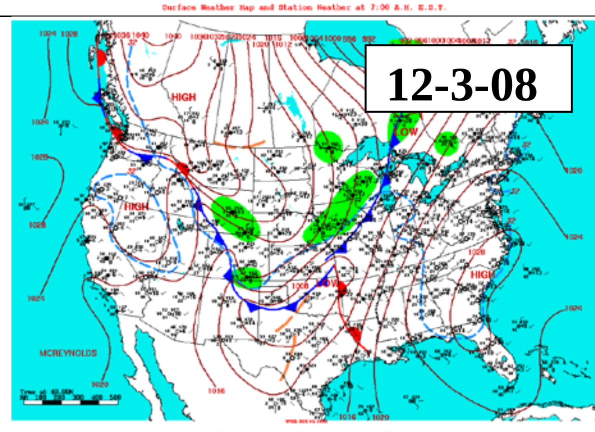
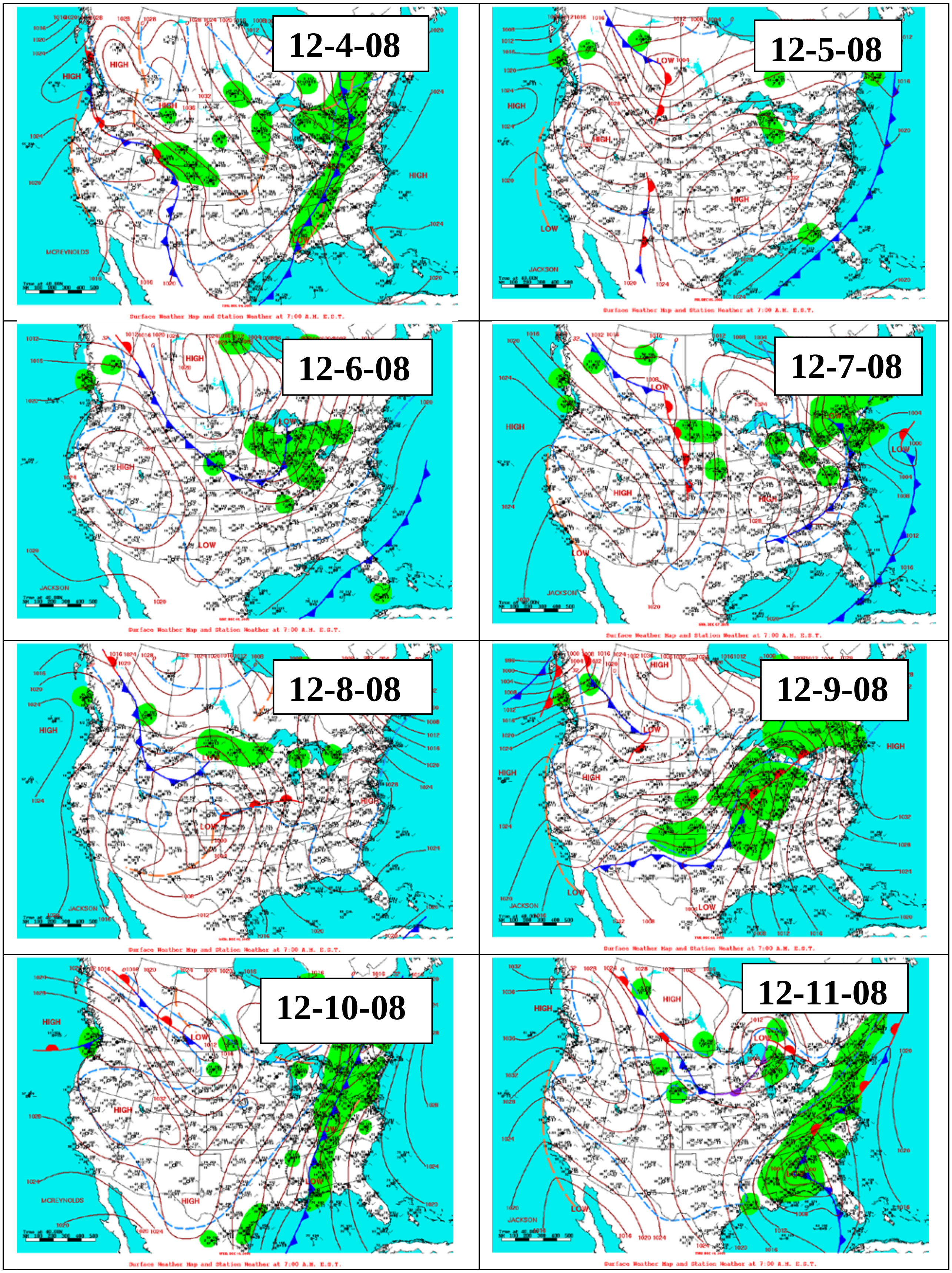
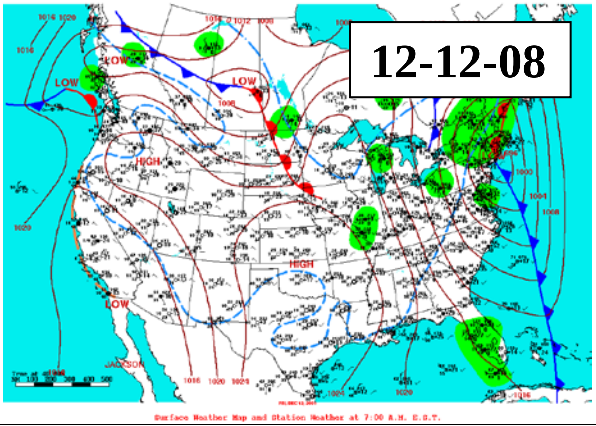
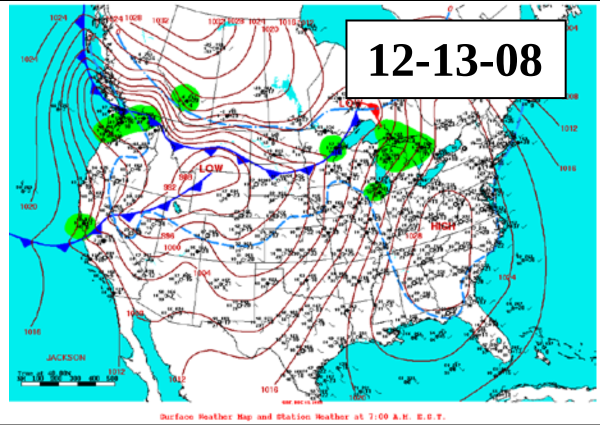
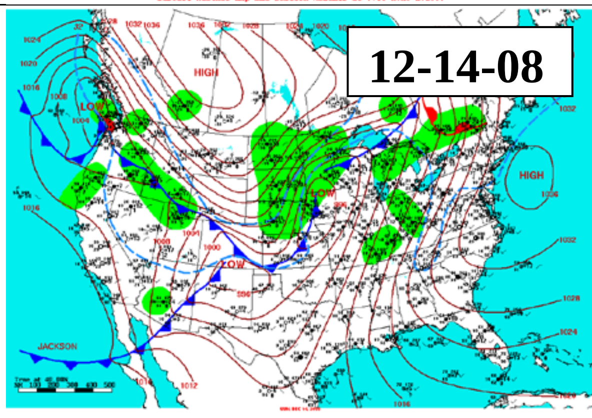
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.

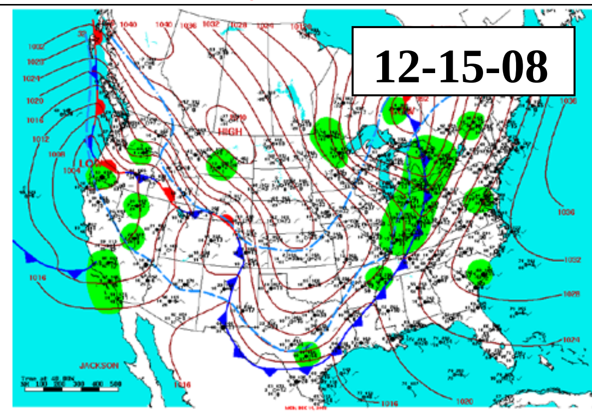

12-3-08
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.

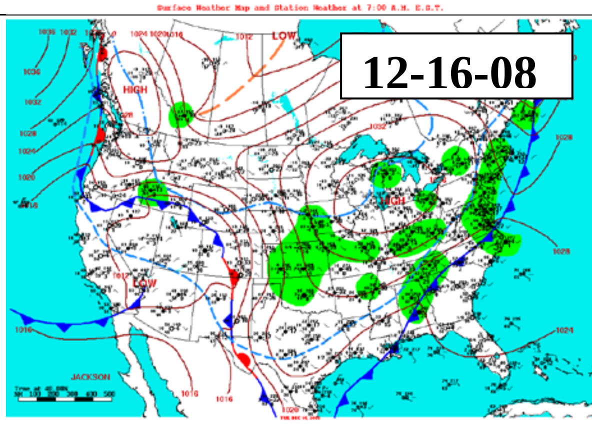

12-4-08
12-5-08
12-6-08
12-7-08
12-8-08
12-9-08
12-10-08
12-11-08



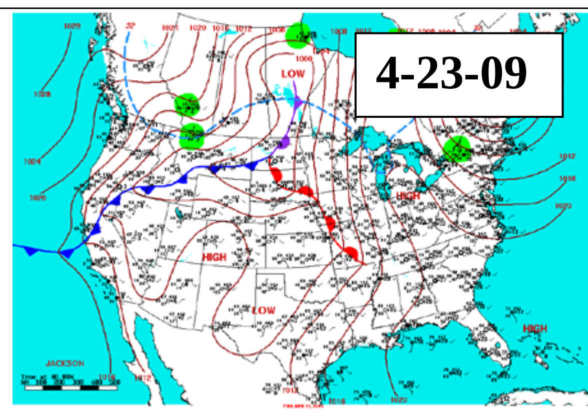


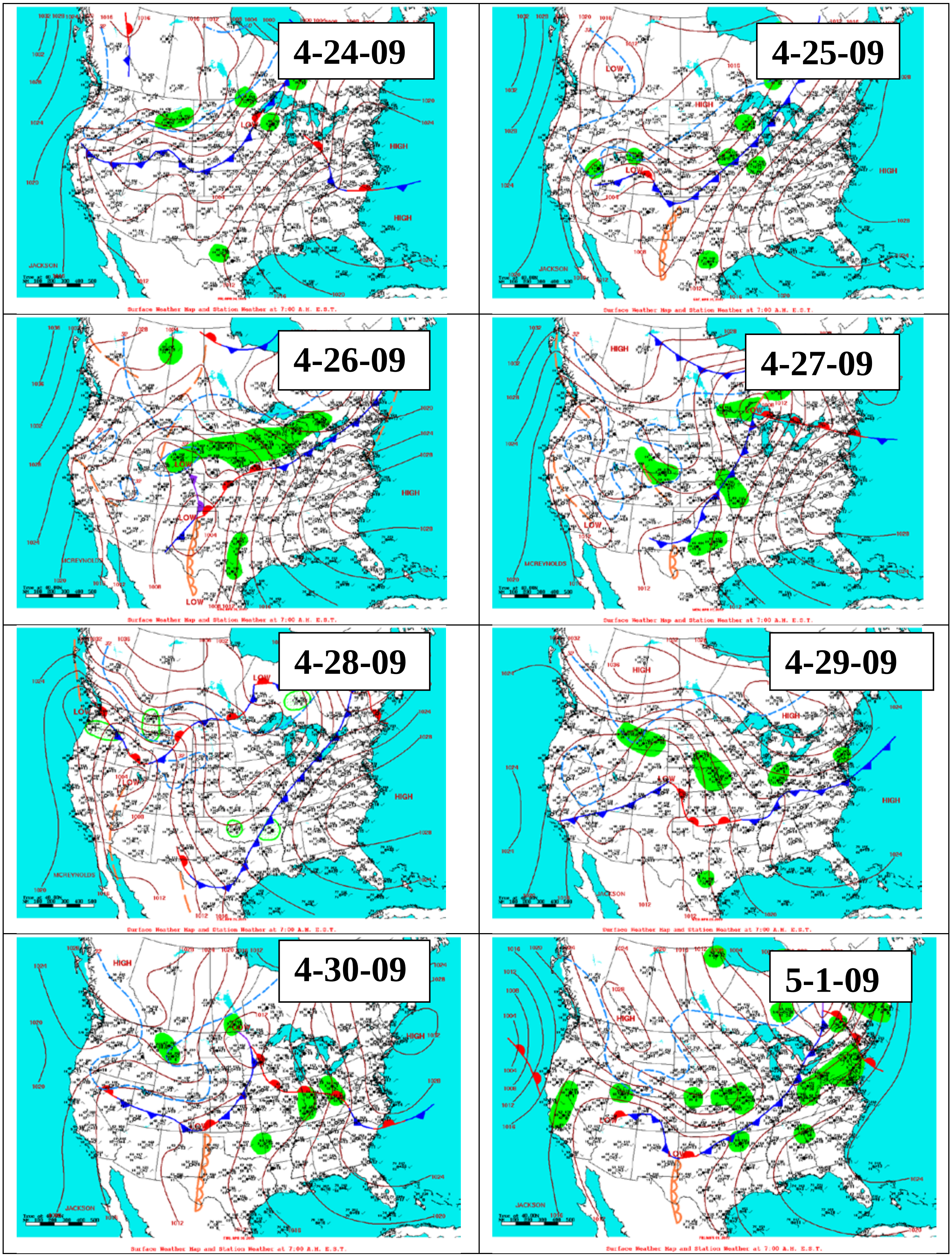


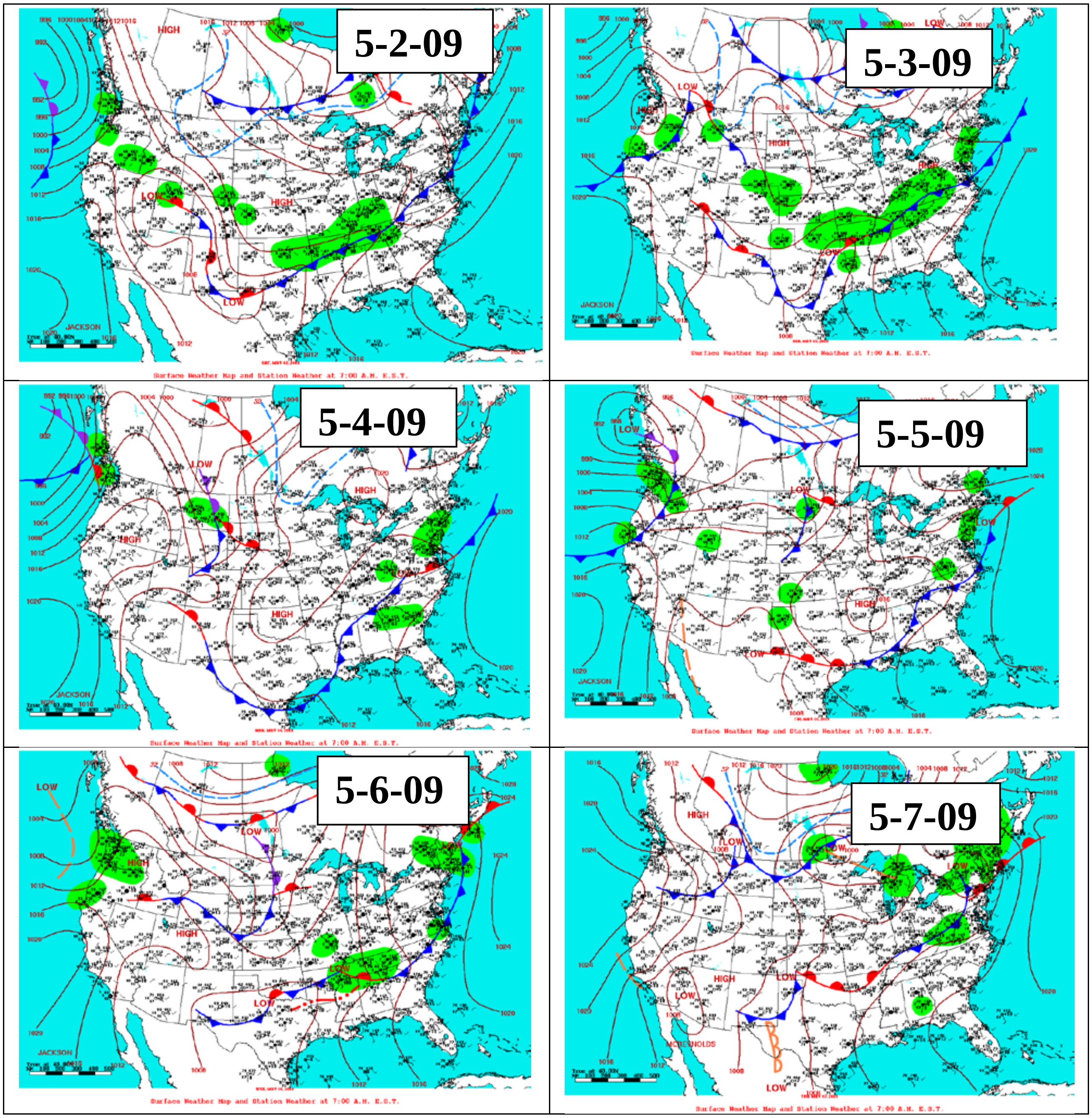


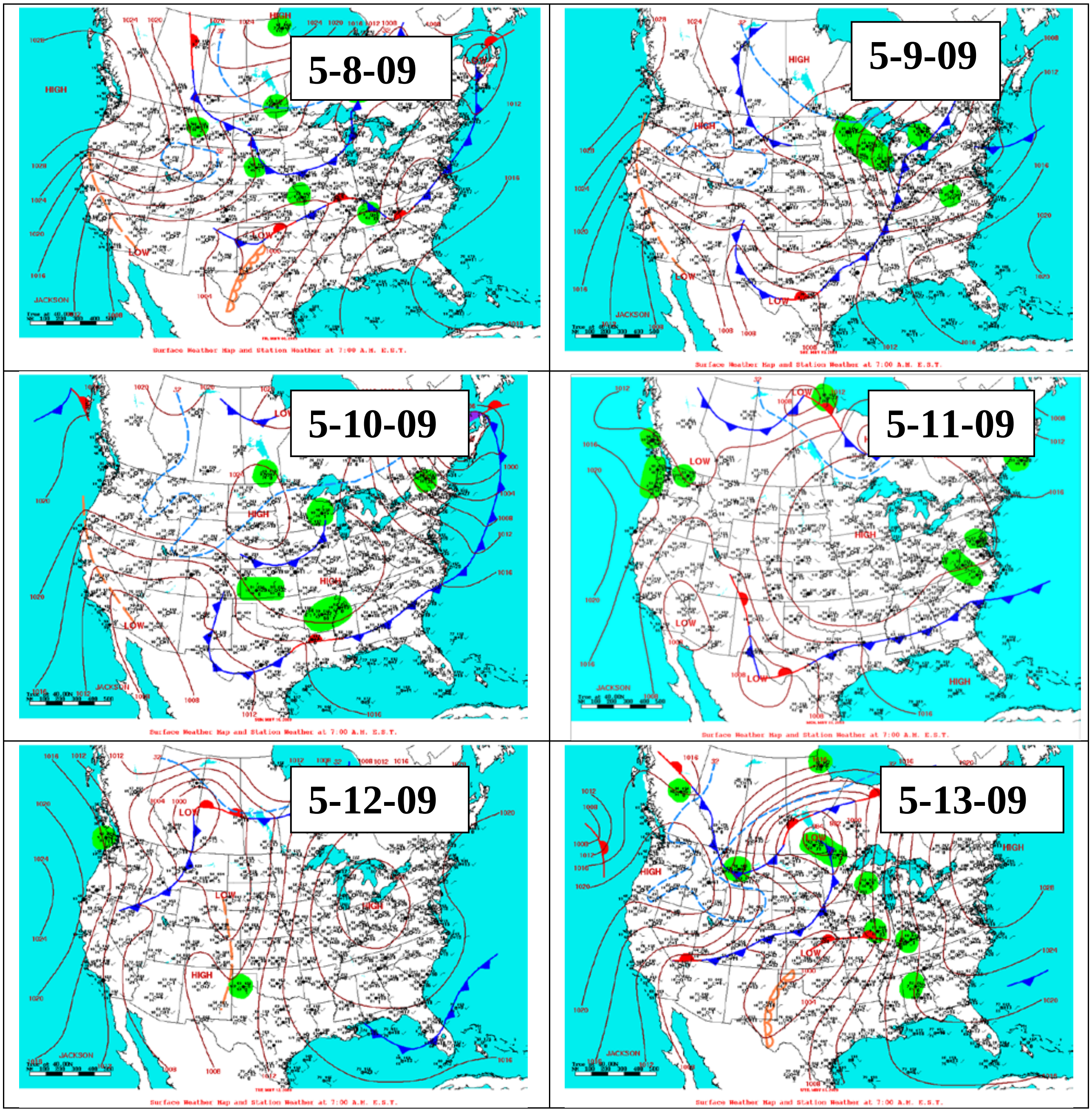


Period 8




4-24-09
4-25-09
4-26-09
4-27-09
4-28-09
4-29-09
4-30-09
5-1-09
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.


5-2-09
5-3-09
5-4-09
5-5-09
5-6-09
5-7-09


5-8-09
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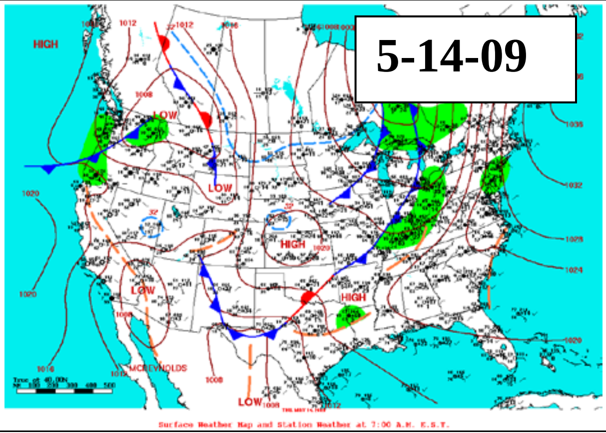
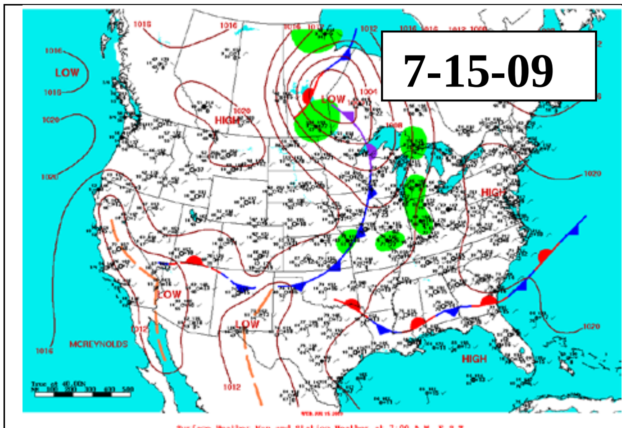
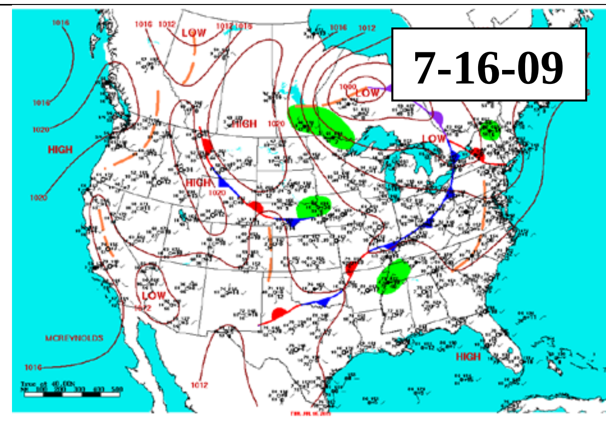
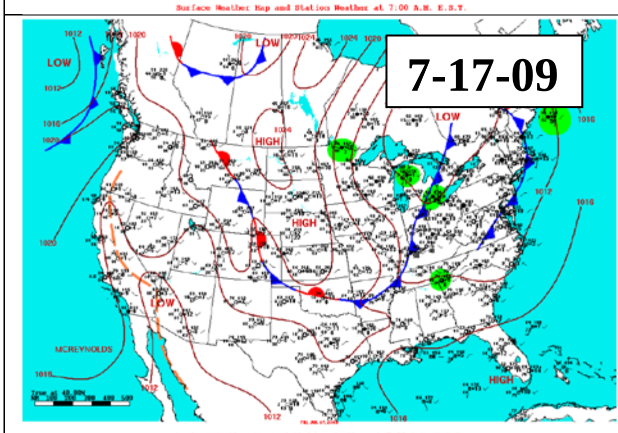
5-10-09
5-11-09
5-12-09
5-13-09

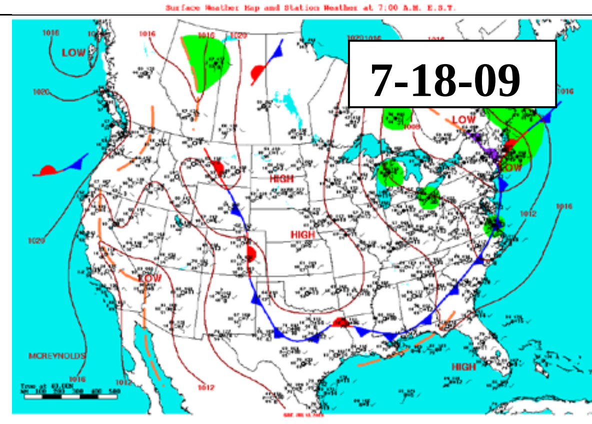


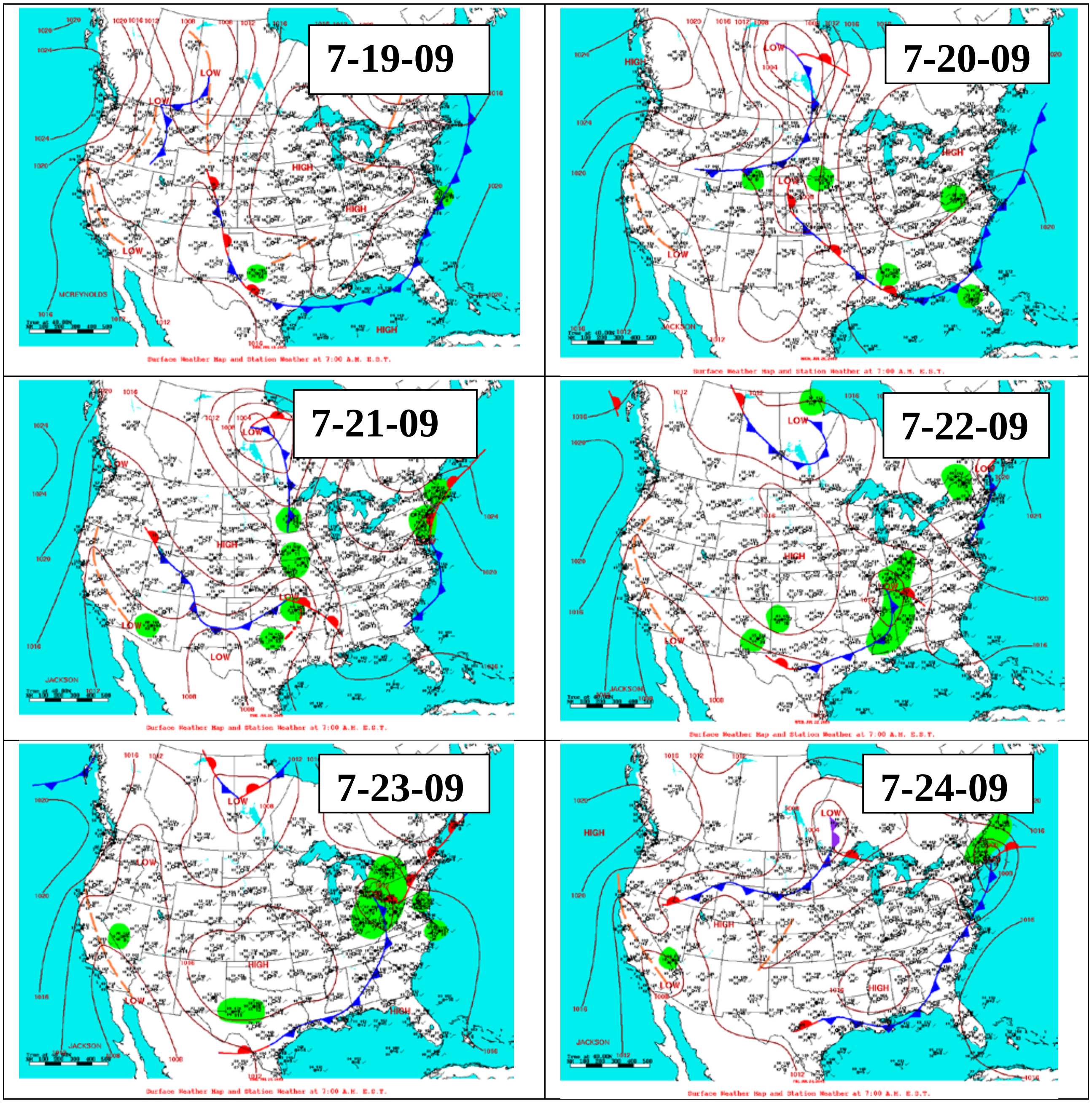
Period 9

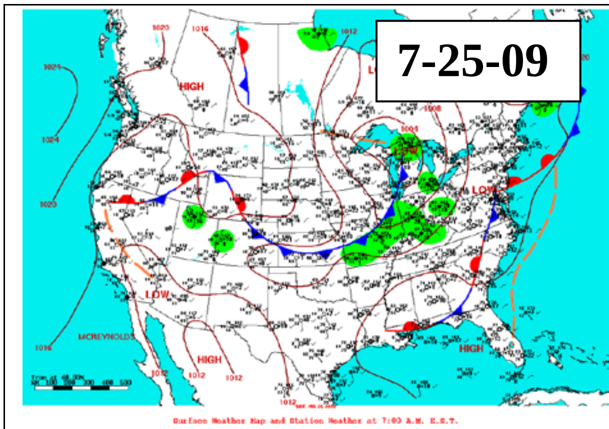


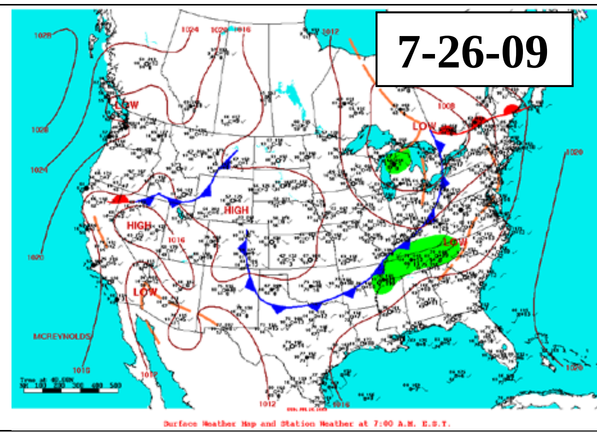


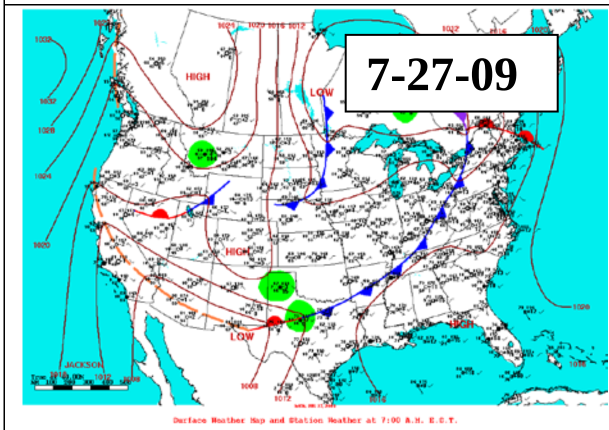


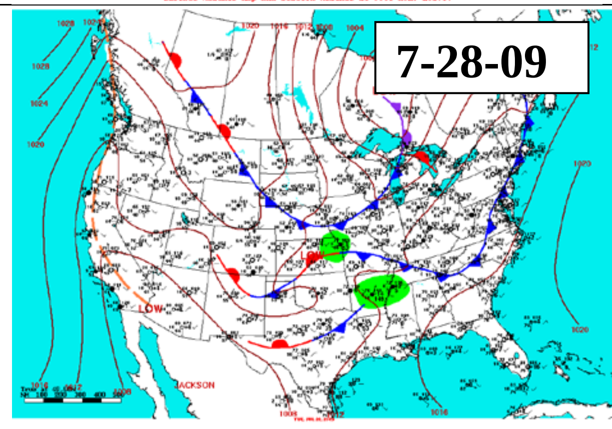


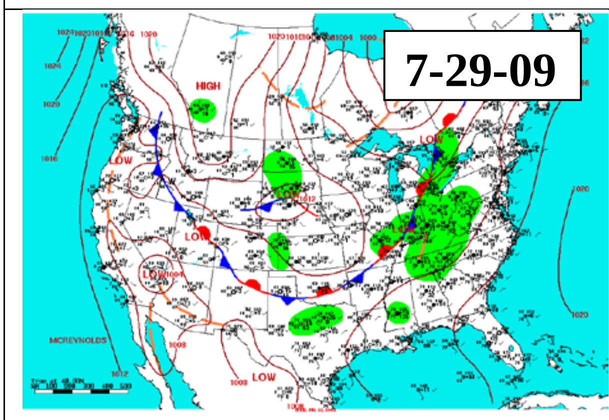

7-19-09
7-20-09
7-21-09
7-22-09
7-23-09
7-24-09

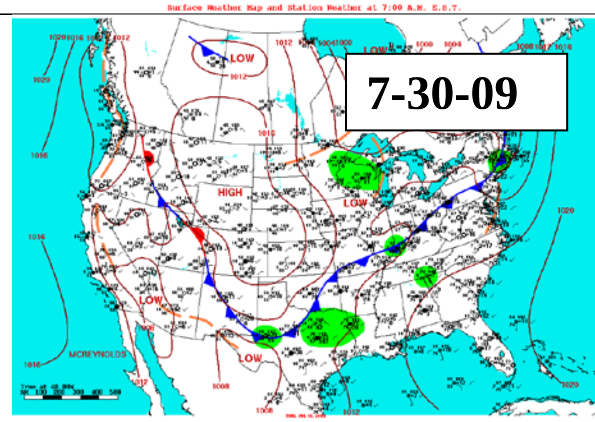

7-25-09
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.

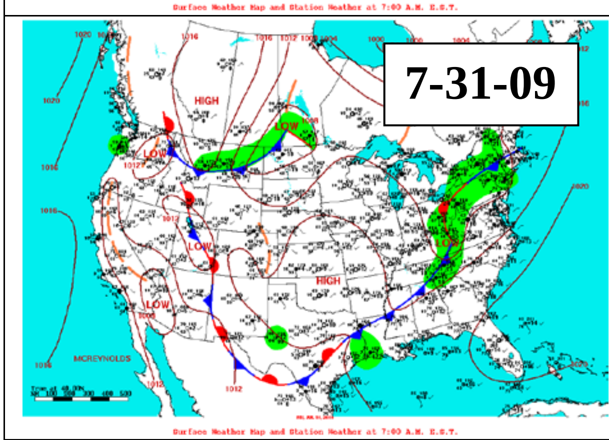

7-26-09
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.

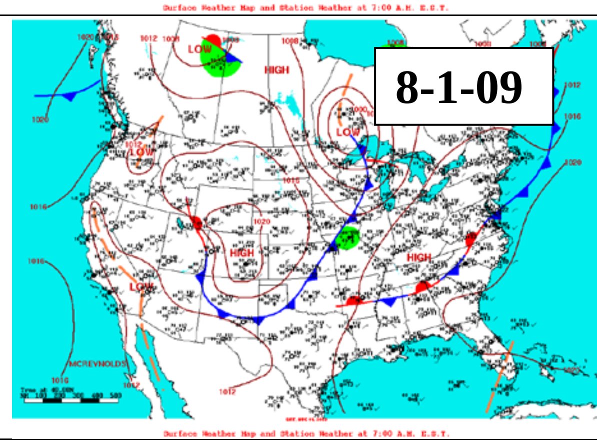

7-27-09
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.

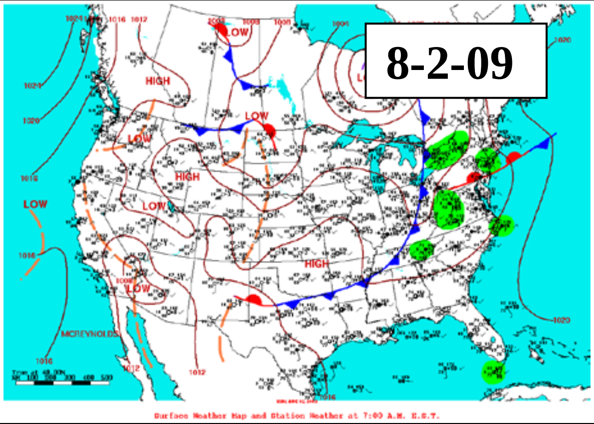

7-28-09
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.

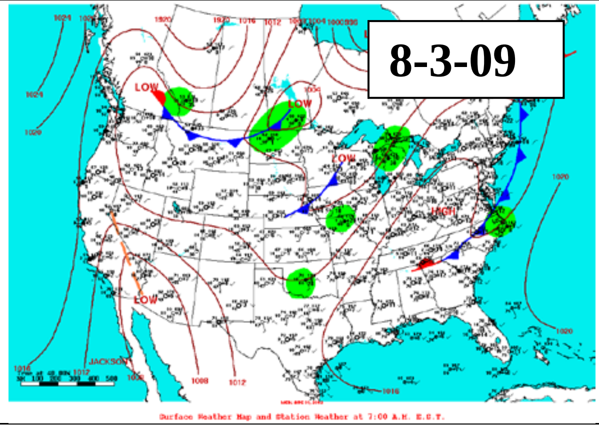

7-29-09
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.

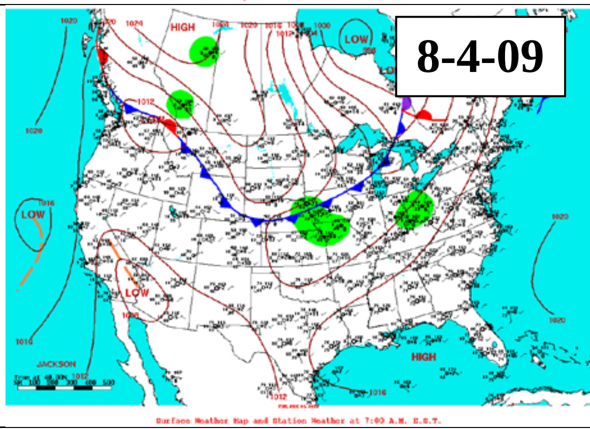

7-30-09
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.


7-31-09
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.


8-1-09
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.


8-2-09
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.


8-3-09
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.


8-4-09
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.

6.10 Daily Weather conditions

Date	Barometric pressure (kPA)	Max solar radiation (Wm^{-2})	Wetness (%)	Air temperature (°C)
Period 2				
8/30/2007	91.80	958	0%	23.1
8/31/2007	91.57	973	9%	23.0
9/1/2007	91.40	977	42%	23.5
9/2/2007	91.37	898	71%	24.0
9/3/2007	91.40	897	64%	23.2
9/4/2007	90.99	951	61%	24.3
9/5/2007	90.46	855	74%	25.6
9/6/2007	90.30	1010	61%	28.6
9/7/2007	90.82	446	69%	25.7
9/8/2007	91.04	1020	64%	23.4
9/9/2007	91.13	76	43%	23.7
9/10/2007	91.78	285	40%	14.9
9/11/2007	91.75	843	43%	15.2
9/12/2007	91.21	832	0%	18.9
9/13/2007	90.85	822	15%	22.1
9/14/2007	91.46	672	0%	17.1
9/15/2007	91.57	808	0%	20.0
9/16/2007	91.00	844	0%	27.0
9/17/2007	90.66	851	0%	25.2
Period 3				
1/24/2008	91.30	242	0%	2.9
1/25/2008	91.07	607	33%	3.6
1/26/2008	91.35	613	1%	3.5
1/27/2008	91.12	610	6%	4.4
1/28/2008	89.69	609	4%	16.3
1/29/2008	89.88	630	14%	4.1
1/30/2008	89.95	755	0%	3.1
1/31/2008	90.68	633	6%	-2.4
2/1/2008	90.43	710	0%	0.9
2/2/2008	90.65	642	16%	2.7
2/3/2008	90.26	686	40%	3.2
2/4/2008	89.52	646	0%	12.2
2/5/2008	90.39	256	92%	-1.1
2/6/2008	90.75	658	87%	-4.1
2/7/2008	90.67	674	17%	0.8
2/8/2008	90.28	673	6%	3.0
2/9/2008	91.02	694	24%	1.6
2/10/2008	91.67	186	46%	-1.9
2/11/2008	90.89	837	68%	-1.5
2/12/2008	91.06	807	43%	3.4
2/13/2008	90.74	685	28%	3.1
2/14/2008	90.00	454	0%	6.9
2/15/2008	91.62	472	40%	-4.3

2/16/2008	90.85	312	52%	0.4
2/17/2008	90.12	868	53%	4.1
2/18/2008	91.13	768	15%	-0.6
2/19/2008	91.18	610	12%	0.5
Period 4				
5/3/2008	91.45	972	0%	16.0
5/4/2008	91.27	978	0%	12.8
5/5/2008	91.15	1035	3%	19.1
5/6/2008	90.77	1009	48%	18.6
5/7/2008	N/A	N/A	100%	N/A
5/8/2008	89.77	979	13%	23.9
5/9/2008	90.38	1073	56%	15.5
5/10/2008	90.12	1077	7%	18.0
5/11/2008	91.26	991	30%	10.7
5/12/2008	90.03	1063	0%	19.9
5/13/2008	90.10	970	9%	17.7
5/14/2008	91.04	971	66%	10.8
5/15/2008	91.00	62	100%	10.0
5/16/2008	N/A	N/A	100%	N/A
5/17/2008	N/A	N/A	100%	N/A
5/18/2008	N/A	N/A	100%	N/A
5/19/2008	90.09	763	0%	33.8
5/20/2008	90.67	972	4%	21.9
5/21/2008	89.96	1074	0%	21.0
5/22/2008	88.78	1018	0%	26.0
5/23/2008	89.39	1071	37%	24.4
5/24/2008	90.28	1001	0%	19.9
5/25/2008	90.41	1018	0%	23.8
5/26/2008	90.15	942	3%	23.5
5/27/2008	90.62	953	46%	17.2
5/28/2008	91.49	949	54%	14.2
5/29/2008	90.98	944	18%	23.1
Period 5				
5/30/2008	90.48	997	0%	25.3
5/31/2008	90.71	1117	18%	22.8
6/1/2008	90.80	1158	35%	23.4
6/2/2008	90.32	1073	39%	26.9
6/3/2008	89.80	996	5%	27.6
6/4/2008	89.34	1010	39%	21.8
6/5/2008	88.95	1135	1%	25.9
6/6/2008	90.11	988	6%	21.1
6/7/2008	90.04	977	0%	28.7
6/8/2008	90.11	1012	0%	26.4
6/9/2008	90.75	986	5%	20.4
6/10/2008	90.61	964	24%	22.6
Period 6				
11/5/2008	89.93	106	0%	12.7
11/6/2008	90.69	635	0%	6.5

11/7/2008	91.23	644	0%	6.5
11/8/2008	91.16	613	0%	7.9
11/9/2008	90.79	603	49%	6.3
11/10/2008	90.16	634	23%	10.5
11/11/2008	90.49	545	45%	6.1
11/12/2008	90.80	696	57%	5.8
11/13/2008	90.26	543	11%	9.9
11/14/2008	90.68	581	25%	7.6
11/15/2008	92.15	556	0%	2.1
11/16/2008	91.63	545	0%	7.0
11/17/2008	91.81	534	10%	6.1
11/18/2008	92.10	531	50%	7.4
11/19/2008	91.27	536	0%	13.6
11/20/2008	92.23	297	1%	3.8
11/21/2008	92.27	515	4%	-0.4
11/22/2008	91.45	526	26%	2.4
11/23/2008	90.99	555	24%	5.4
11/24/2008	91.91	528	16%	5.1
11/25/2008	91.35	544	0%	6.6
11/26/2008	91.15	553	0%	5.9
11/27/2008	91.15	494	9%	2.7
11/28/2008	91.02	159	100%	1.7
11/29/2008	90.56	625	42%	3.8
11/30/2008	90.50	468	0%	5.5
12/1/2008	91.10	518	11%	2.1
12/2/2008	90.49	537	21%	6.3
12/3/2008	90.32	519	0%	7.1
Period 7				
12/4/2008	92.06	193	0%	-2.9
12/5/2008	91.89	502	0%	-1.6
12/6/2008	91.22	504	0%	1.8
12/7/2008	90.98	489	0%	6.8
12/8/2008	89.56	525	0%	10.1
12/9/2008	90.60	483	58%	0.3
12/10/2008	91.74	516	55%	-6.3
12/11/2008	91.42	497	61%	3.6
12/12/2008	91.47	505	63%	1.9
12/13/2008	89.53	541	0%	10.7
12/14/2008	89.57	431	0%	2.8
12/15/2008	91.89	349	0%	-13.4
12/16/2008	91.22	505	23%	-8.3
Period 8				
4/22/2009	90.42	543	0%	25.6
4/23/2009	90.31	1077	34%	17.6
4/24/2009	90.06	1036	4%	19.8
4/25/2009	90.33	1020	25%	14.0
4/26/2009	90.04	1028	75%	14.0
4/27/2009	90.75	1000	69%	11.4

4/28/2009	91.53	515	100%	8.6
4/29/2009	90.77	1022	73%	18.2
4/30/2009	90.54	1076	68%	18.3
5/1/2009	90.97	420	86%	12.8
5/2/2009	91.08	556	98%	9.0
5/3/2009	90.83	1097	76%	9.4
5/4/2009	90.88	1107	72%	10.2
5/5/2009	90.59	940	70%	12.9
5/6/2009	90.52	934	56%	17.6
5/7/2009	90.35	949	34%	20.9
5/8/2009	90.16	942	67%	20.6
5/9/2009	91.27	1068	69%	14.2
5/10/2009	91.34	252	96%	10.4
5/11/2009	91.49	953	100%	10.1
5/12/2009	90.46	985	84%	17.9
5/13/2009	89.85	973	71%	22.1
5/14/2009	91.11	1018	21%	15.6
Period 9				
7/15/2009	91.04	957	0%	34.5
7/16/2009	91.10	1002	55%	24.4
7/17/2009	91.47	1038	53%	21.2
7/18/2009	91.62	1170	56%	20.6
7/19/2009	91.43	948	43%	24.1
7/20/2009	90.70	942	13%	27.7
7/21/2009	90.97	1048	36%	24.6
7/22/2009	91.29	1091	12%	23.7
7/23/2009	91.18	948	31%	24.0
7/24/2009	90.93	950	57%	27.4
7/25/2009	90.84	958	38%	29.0
7/26/2009	91.25	1077	62%	25.0
7/27/2009	91.07	73	99%	23.1
7/28/2009	N/A	N/A	N/A	N/A
7/29/2009	N/A	N/A	N/A	N/A
7/30/2009	91.23	892	0%	23.3
7/31/2009	91.19	1049	40%	21.1
8/1/2009	90.76	128	0%	27.1
8/2/2009	N/A	N/A	N/A	N/A
8/3/2009	90.71	934	0%	34.4
8/4/2009	90.87	921	1%	24.9

6.11 Daily lagoon conditions

Lagoon temperature, pH, and oxidation-reduction potential

Date	Lagoon temp (°C)	Lagoon pH	Lagoon ORP (mV)
Period 2			

Date	Lagoon temp (°C)	Lagoon pH	Lagoon ORP (mV)
8/30/2007	N/A	N/A	N/A
8/31/2007	27.9	7.71	-353
9/1/2007	25.6	7.71	-445
9/2/2007	25.5	7.72	-440
9/3/2007	24.8	7.74	-446
9/4/2007	24.5	7.75	-449
9/5/2007	24.2	7.76	-439
9/6/2007	24.7	7.77	-445
9/7/2007	24.1	7.76	-495
9/8/2007	23.4	7.70	-530
9/9/2007	23.9	7.71	-521
9/10/2007	22.1	7.68	-532
9/11/2007	21.2	7.71	-521
9/12/2007	21.1	7.71	-514
9/13/2007	21.5	7.72	-523
9/14/2007	21.1	7.69	-539
9/15/2007	20.0	7.72	-496
9/16/2007	20.9	7.73	-514
9/17/2007	21.0	7.73	-453
Period 3			
1/24/2008	N/A	N/A	N/A
1/25/2008	N/A	N/A	N/A
1/26/2008	N/A	N/A	N/A
1/27/2008	N/A	N/A	N/A
1/28/2008	N/A	N/A	N/A
1/29/2008	N/A	N/A	N/A
1/30/2008	N/A	N/A	N/A
1/31/2008	N/A	N/A	N/A
2/1/2008	N/A	N/A	N/A
2/2/2008	N/A	N/A	N/A
2/3/2008	N/A	N/A	N/A
2/4/2008	N/A	N/A	N/A
2/5/2008	N/A	N/A	N/A
2/6/2008	N/A	N/A	N/A
2/7/2008	N/A	N/A	N/A
2/8/2008	N/A	N/A	N/A
2/9/2008	N/A	N/A	N/A
2/10/2008	N/A	N/A	N/A
2/11/2008	N/A	N/A	N/A
2/12/2008	N/A	N/A	N/A
2/13/2008	N/A	N/A	N/A
2/14/2008	N/A	N/A	N/A
2/15/2008	N/A	N/A	N/A
2/16/2008	N/A	N/A	N/A
2/17/2008	N/A	N/A	N/A

Date	Lagoon temp (°C)	Lagoon pH	Lagoon ORP (mV)
2/18/2008	N/A	N/A	N/A
2/19/2008	N/A	N/A	N/A
Period 4			
5/3/2008	N/A	N/A	N/A
5/4/2008	N/A	N/A	N/A
5/5/2008	N/A	N/A	N/A
5/6/2008	N/A	N/A	N/A
5/7/2008	N/A	N/A	N/A
5/8/2008	18.7	7.57	-391
5/9/2008	18.0	7.66	-485
5/10/2008	17.9	7.71	-491
5/11/2008	17.4	7.78	-516
5/12/2008	17.1	7.82	-481
5/13/2008	17.0	7.86	-503
5/14/2008	17.3	7.88	-504
5/15/2008	17.3	7.88	-509
5/16/2008	N/A	N/A	N/A
5/17/2008	N/A	N/A	N/A
5/18/2008	N/A	N/A	N/A
5/19/2008	20.1	7.79	-540
5/20/2008	20.5	7.81	-506
5/21/2008	20.8	7.81	-522
5/22/2008	21.0	7.87	-460
5/23/2008	21.0	7.90	-492
5/24/2008	21.1	7.89	-514
5/25/2008	21.2	7.90	-472
5/26/2008	21.0	7.97	-460
5/27/2008	21.0	7.96	-501
5/28/2008	20.2	7.96	-460
5/29/2008	20.4	7.92	-444
Period 5			
5/30/2008	21.6	7.97	-444
5/31/2008	22.3	7.96	-498
6/1/2008	23.7	7.95	-475
6/2/2008	23.9	7.95	-534
6/3/2008	23.2	7.99	-514
6/4/2008	23.5	8.00	-514
6/5/2008	22.9	8.04	-504
6/6/2008	21.8	8.10	-495
6/7/2008	22.1	8.12	-409
6/8/2008	22.5	8.17	-427
6/9/2008	22.6	8.17	-540
6/10/2008	22.7	8.19	-525
Period 6			
11/5/2008	N/A	N/A	N/A

Date	Lagoon temp (°C)	Lagoon pH	Lagoon ORP (mV)
11/6/2008	12.1	7.74	-201
11/7/2008	11.3	7.97	-246
11/8/2008	11.1	8.00	-279
11/9/2008	10.9	8.01	-288
11/10/2008	10.4	8.04	-263
11/11/2008	10.3	8.04	-513
11/12/2008	10.4	8.02	-529
11/13/2008	10.1	8.03	-531
11/14/2008	9.8	8.03	-472
11/15/2008	8.2	8.08	-507
11/16/2008	8.0	8.09	-530
11/17/2008	8.1	8.09	-523
11/18/2008	8.0	8.08	-478
11/19/2008	8.3	8.05	-543
11/20/2008	8.1	8.06	-541
11/21/2008	6.6	8.09	-323
11/22/2008	6.1	8.10	-418
11/23/2008	6.0	8.11	-530
11/24/2008	6.0	8.10	-531
11/25/2008	6.0	8.06	-525
11/26/2008	5.6	8.06	-539
11/27/2008	5.8	8.06	-539
11/28/2008	5.3	8.07	-519
11/29/2008	5.0	8.07	-537
11/30/2008	4.9	8.09	-456
12/1/2008	4.1	8.11	-481
12/2/2008	4.5	8.06	-480
12/3/2008	5.2	8.02	-448
Period 7			
12/4/2008	4.1	8.10	-411
12/5/2008	3.3	8.12	-336
12/6/2008	3.5	8.11	-494
12/7/2008	3.8	8.11	-459
12/8/2008	4.0	8.09	-517
12/9/2008	4.3	8.10	-393
12/10/2008	3.4	8.09	-501
12/11/2008	3.2	8.08	-538
12/12/2008	3.5	8.08	-470
12/13/2008	4.1	8.10	-315
12/14/2008	4.8	8.11	-489
12/15/2008	2.7	8.14	-481
12/16/2008	0.9	8.14	-449
Period 8			
4/22/2009	N/A	N/A	N/A
4/23/2009	18.1	7.47	-431

Date	Lagoon temp (°C)	Lagoon pH	Lagoon ORP (mV)
4/24/2009	17.7	7.48	-451
4/25/2009	17.8	7.48	-455
4/26/2009	17.5	7.48	-466
4/27/2009	17.2	7.49	-510
4/28/2009	16.2	7.51	-528
4/29/2009	16.1	7.47	-530
4/30/2009	17.1	7.42	-533
5/1/2009	17.9	7.47	-540
5/2/2009	16.7	7.49	-546
5/3/2009	16.3	7.47	-547
5/4/2009	15.9	7.48	-542
5/5/2009	16.1	7.47	-549
5/6/2009	17.2	7.44	-550
5/7/2009	18.6	7.44	-547
5/8/2009	19.4	7.45	-538
5/9/2009	19.3	7.46	-540
5/10/2009	18.8	7.45	-543
5/11/2009	18.0	7.45	-553
5/12/2009	18.0	7.47	-537
5/13/2009	18.8	7.48	-539
5/14/2009	18.9	7.47	-539
Period 9			
7/15/2009	N/A	N/A	N/A
7/16/2009	27.4	N/A	-390
7/17/2009	26.0	N/A	-384
7/18/2009	25.6	N/A	-416
7/19/2009	25.7	N/A	-410
7/20/2009	26.0	N/A	-482
7/21/2009	25.9	N/A	-531
7/22/2009	26.2	N/A	-534
7/23/2009	26.0	N/A	-527
7/24/2009	26.7	N/A	-541
7/25/2009	27.2	N/A	-551
7/26/2009	25.8	N/A	-556
7/27/2009	26.7	N/A	-591
7/28/2009	N/A	N/A	N/A
7/29/2009	N/A	N/A	N/A
7/30/2009	23.9	N/A	-559
7/31/2009	23.8	N/A	-560
8/1/2009	24.3	N/A	-549
8/2/2009	N/A	N/A	N/A
8/3/2009	27.3	N/A	-543
8/4/2009	25.7	N/A	-563

6.12 Daily Site Emissions and Data completeness

6.12.1 Daily NH_3 emission using RPM emissions model

Column headings for the following table are:

Date: Month/Day/Year
Valid values: Number of ½ hour periods with valid emissions data
Direction Limited: Number of ½ hour periods invalidated because wind was from an excluded wind direction
Missing Downwind NH3: Number of ½ hour periods invalidated because at least 1 TDL path was either missing or else had invalid concentration values
Emission Average (µg m^{-2} s^{-1}): Daily average emission calculated from the valid ½ hour periods
Emissions SD (µg m^{-2} s^{-1}): Daily emission standard deviation of the valid ½ hour periods
Emission Minimum (µg m^{-2} s^{-1}): Daily minimum emission of the valid ½ hour periods
Emission Maximum (µg m^{-2} s^{-1}): Daily maximum emission of the valid ½ hour periods
Emission Average (kg d^{-1}): Daily average emission calculated from the valid ½ hour periods; totaled over the source area
Emission Average (g d^{-1} hd^{-1}): Daily average emission calculated from the valid ½ hour periods; totaled over the source area on a per head basis
Emission Average (g d^{-1} AU^{-1}): Daily average emission calculated from the valid ½ hour periods; totaled over the source area on a per animal unit basis

	Valid values	Cause for invalid values		Emission						
Date		Direction limited	Missing Down-wind NH3	Average ($\mu gm^{-2}s^{-1}$)	SD ($\mu gm^{-2}s^{-1}$)	Minimum ($\mu gm^{-2}s^{-1}$)	Maximum ($\mu gm^{-2}s^{-1}$)	Average (kgd^{-1})	Average ($gd^{-1}hd^{-1}$)	Average ($gd^{-1}AU^{-1}$)
Period 2										
8/31/2007	2	3	6	85.0	11.3	77.0	93.0	73.4	24.5	160.0
9/1/2007	22	2	15	157.3	39.7	78.0	238.0	135.9	45.3	296.1
9/2/2007	12	0	36	117.6	36.8	59.0	191.0	101.6	33.9	221.3
9/3/2007	2	0	46	73.0	17.0	61.0	85.0	63.1	21.0	137.4
9/4/2007	21	0	27	163.3	26.0	114.0	214.0	141.1	47.0	307.4
9/5/2007	37	0	8	187.6	63.3	109.0	444.0	162.1	54.0	353.1
9/6/2007	39	0	0	154.0	99.5	49.0	487.0	133.1	44.4	289.9
9/7/2007	26	1	0	148.1	83.4	27.0	348.0	128.0	42.7	278.8
9/8/2007	13	12	13	171.6	74.5	26.0	301.0	148.3	49.4	323.0
9/9/2007	14	6	13	188.5	148.1	-74.0	373.0	162.9	54.3	354.8
9/10/2007	0	0	45	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9/11/2007	3	3	39	78.3	50.0	33.0	132.0	67.7	22.6	147.5
9/12/2007	39	3	1	115.1	48.2	43.0	296.0	99.4	33.1	216.6
9/13/2007	32	0	12	98.2	37.8	42.0	221.0	84.8	28.3	184.8
9/14/2007	10	1	25	196.2	73.0	68.0	261.0	169.5	56.5	369.3
9/15/2007	33	3	0	196.5	75.6	71.0	319.0	169.8	56.6	369.9

	Valid values	Cause for invalid values		Emission						
Date		**Direction limited**	**Missing Down-wind NH3**	**Average ($\mu gm^{-2}s^{-1}$)**	**SD ($\mu gm^{-2}s^{-1}$)**	**Minimum ($\mu gm^{-2}s^{-1}$)**	**Maximum ($\mu gm^{-2}s^{-1}$)**	**Average (kgd^{-1})**	**Average ($gd^{-1}hd^{-1}$)**	**Average ($gd^{-1}AU^{-1}$)**
9/16/2007	24	0	24	185.0	35.8	125.0	254.0	159.8	53.3	348.2
9/17/2007	48	0	0	213.5	79.3	109.0	395.0	184.4	61.5	401.8
9/18/2007	15	0	14	165.4	68.4	82.0	321.0	142.9	47.6	311.3
Period 3										
1/25/2008	0	0	5	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/26/2008	0	0	47	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/27/2008	0	0	47	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/28/2008	0	0	38	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/29/2008	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/30/2008	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/31/2008	0	0	17	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2/1/2008	0	0	47	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2/2/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2/3/2008	0	0	47	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2/4/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2/5/2008	0	0	20	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2/6/2008	0	0	13	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2/7/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2/8/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2/9/2008	0	0	46	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2/10/2008	1	0	35	3.0	N/A	3.0	3.0	2.6	0.9	5.6
2/11/2008	3	0	7	30.7	16.9	19.0	50.0	26.5	8.8	57.7
2/12/2008	5	0	9	16.8	6.1	8.0	24.0	14.5	4.8	31.6
2/13/2008	2	0	28	18.0	7.1	13.0	23.0	15.6	5.2	33.9
2/14/2008	4	0	40	42.8	9.6	36.0	57.0	36.9	12.3	80.5
2/15/2008	2	0	23	14.5	0.7	14.0	15.0	12.5	4.2	27.3
2/16/2008	6	0	28	35.0	13.3	16.0	53.0	30.2	10.1	65.9
2/17/2008	11	0	15	44.0	15.6	17.0	59.0	38.0	12.7	82.8
2/18/2008	10	0	17	32.4	15.4	15.0	60.0	28.0	9.3	61.0
2/19/2008	0	0	31	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period 4										
5/8/2008	0	0	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/9/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/10/2008	2	0	42	100.5	4.9	97.0	104.0	86.8	28.9	189.2
5/11/2008	13	0	30	46.8	14.7	26.0	67.0	40.5	13.5	88.2
5/12/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/13/2008	15	0	17	73.8	28.1	30.0	135.0	63.8	21.3	138.9
5/14/2008	10	0	26	32.1	12.0	14.0	50.0	27.7	9.2	60.4
5/15/2008	23	0	21	82.9	22.4	35.0	109.0	71.6	23.9	156.0
5/16/2008	24	0	14	54.5	23.2	18.0	101.0	47.1	15.7	102.7
5/17/2008	39	0	2	62.1	23.4	13.0	119.0	53.6	17.9	116.9
5/18/2008	28	0	9	49.1	22.6	6.0	101.0	42.4	14.1	92.4
5/19/2008	24	0	20	60.9	23.4	25.0	119.0	52.6	17.5	114.7

	Valid values	Cause for invalid values		Emission						
Date		**Direction limited**	**Missing Down-wind NH3**	**Average ($\mu gm^{-2}s^{-1}$)**	**SD ($\mu gm^{-2}s^{-1}$)**	**Minimum ($\mu gm^{-2}s^{-1}$)**	**Maximum ($\mu gm^{-2}s^{-1}$)**	**Average (kgd^{-1})**	**Average ($gd^{-1}hd^{-1}$)**	**Average ($gd^{-1}AU^{-1}$)**
5/20/2008	4	0	41	36.0	3.7	31.0	40.0	31.1	10.4	67.8
5/21/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/22/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/23/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/24/2008	10	0	37	132.1	52.1	53.0	204.0	114.1	38.0	248.7
5/25/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/26/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/27/2008	19	0	26	111.6	26.6	23.0	138.0	96.4	32.1	210.1
5/28/2008	6	0	19	67.5	8.4	56.0	76.0	58.3	19.4	127.1
Period 5										
5/29/2008	0	0	8	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/30/2008	3	3	31	149.3	74.3	88.0	232.0	129.0	43.0	281.1
5/31/2008	10	2	11	89.8	63.3	37.0	238.0	77.6	25.9	169.0
6/1/2008	8	7	13	230.4	72.6	128.0	358.0	199.0	66.3	433.6
6/2/2008	9	3	31	150.7	39.1	122.0	251.0	130.2	43.4	283.6
6/3/2008	18	1	22	122.3	37.2	67.0	200.0	105.7	35.2	230.3
6/4/2008	12	2	24	85.7	51.0	13.0	174.0	74.0	24.7	161.3
6/5/2008	16	0	30	236.9	105.4	79.0	404.0	204.7	68.2	445.9
6/6/2008	17	0	24	134.1	43.3	88.0	234.0	115.9	38.6	252.5
6/7/2008	2	0	45	207.5	43.1	177.0	238.0	179.3	59.8	390.6
6/8/2008	18	0	22	124.7	59.3	43.0	279.0	107.7	35.9	234.7
6/9/2008	21	4	17	137.6	93.7	26.0	345.0	118.9	39.6	259.0
6/10/2008	0	0	28	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period 6										
11/6/2008	2	0	3	27.0	1.4	26.0	28.0	23.3	7.8	50.8
11/7/2008	24	0	19	40.4	7.8	16.0	54.0	34.9	11.6	76.0
11/8/2008	1	2	40	5.0	N/A	5.0	5.0	4.3	1.4	9.4
11/9/2008	23	15	0	32.8	13.1	13.0	61.0	28.4	9.5	61.8
11/10/2008	6	0	8	29.2	10.0	12.0	39.0	25.2	8.4	54.9
11/11/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11/12/2008	9	1	31	19.0	9.9	5.0	32.0	16.4	5.5	35.8
11/13/2008	2	0	42	15.0	2.8	13.0	17.0	13.0	4.3	28.2
11/14/2008	0	0	46	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11/15/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11/16/2008	2	0	42	13.0	5.7	9.0	17.0	11.2	3.7	24.5
11/17/2008	4	0	35	23.8	12.3	14.0	41.0	20.5	6.8	44.7
11/18/2008	33	1	3	27.1	16.7	9.0	66.0	23.4	7.8	51.1
11/19/2008	19	0	1	38.2	18.1	10.0	71.0	33.0	11.0	71.8
11/20/2008	31	0	3	21.3	7.7	9.0	41.0	18.4	6.1	40.1
11/21/2008	31	1	2	18.9	7.5	6.0	33.0	16.4	5.5	35.6
11/22/2008	20	3	1	17.3	7.2	5.0	28.0	14.9	5.0	32.6
11/23/2008	35	0	1	17.7	7.8	4.0	31.0	15.3	5.1	33.2
11/24/2008	19	0	3	18.4	7.4	7.0	34.0	15.9	5.3	34.6

	Valid values	Cause for invalid values		Emission						
Date		**Direction limited**	**Missing Down-wind NH3**	**Average ($\mu gm^{-2}s^{-1}$)**	**SD ($\mu gm^{-2}s^{-1}$)**	**Minimum ($\mu gm^{-2}s^{-1}$)**	**Maximum ($\mu gm^{-2}s^{-1}$)**	**Average (kgd^{-1})**	**Average ($gd^{-1}hd^{-1}$)**	**Average ($gd^{-1}AU^{-1}$)**
11/25/2008	27	0	0	23.1	13.0	5.0	50.0	20.0	6.7	43.6
11/26/2008	23	0	0	17.0	8.7	3.0	39.0	14.7	4.9	32.1
11/27/2008	8	3	36	30.5	11.6	9.0	44.0	26.4	8.8	57.4
11/28/2008	0	0	18	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11/29/2008	0	0	42	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11/30/2008	0	0	41	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/1/2008	1	0	16	10.0	N/A	10.0	10.0	8.6	2.9	18.8
12/2/2008	15	0	19	14.8	11.9	7.0	52.0	12.8	4.3	27.9
Period 7										
12/3/2008	18	0	15	21.7	5.4	11.0	30.0	18.7	6.2	40.8
12/4/2008	16	18	0	10.6	5.5	4.0	19.0	9.2	3.1	20.0
12/5/2008	6	2	12	21.5	15.0	11.0	51.0	18.6	6.2	40.5
12/6/2008	19	0	12	14.9	10.1	2.0	43.0	12.9	4.3	28.0
12/7/2008	19	1	9	17.3	16.2	-6.0	59.0	14.9	5.0	32.5
12/8/2008	15	0	7	23.5	18.1	-7.0	63.0	20.3	6.8	44.3
12/9/2008	0	0	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/10/2008	7	0	1	12.0	6.0	4.0	18.0	10.4	3.5	22.6
12/11/2008	23	0	1	16.6	4.8	8.0	27.0	14.3	4.8	31.3
12/12/2008	19	0	3	18.1	7.4	5.0	34.0	15.6	5.2	34.1
12/13/2008	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/14/2008	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/15/2008	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/16/2008	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period 8										
4/22/2009	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/23/2009	0	0	8	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/24/2009	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/25/2009	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/26/2009	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/27/2009	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/28/2009	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/29/2009	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/30/2009	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/1/2009	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/2/2009	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/3/2009	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/4/2009	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/5/2009	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/6/2009	1	0	47	85.0	N/A	85.0	85.0	73.4	24.5	160.0
5/7/2009	22	5	9	71.9	29.6	26.0	110.0	62.1	20.7	135.3
5/8/2009	25	4	18	76.8	28.9	25.0	145.0	66.3	22.1	144.5
5/9/2009	10	10	28	69.2	6.9	59.0	82.0	59.8	19.9	130.3
5/10/2009	25	16	5	71.8	10.4	46.0	86.0	62.0	20.7	135.1

	Valid values	Cause for invalid values		Emission						
Date		**Direction limited**	**Missing Down-wind NH3**	**Average ($\mu g m^{-2} s^{-1}$)**	**SD ($\mu g m^{-2} s^{-1}$)**	**Minimum ($\mu g m^{-2} s^{-1}$)**	**Maximum ($\mu g m^{-2} s^{-1}$)**	**Average ($kg d^{-1}$)**	**Average ($g d^{-1} hd^{-1}$)**	**Average ($g d^{-1} AU^{-1}$)**
5/11/2009	25	4	10	37.5	15.2	19.0	77.0	32.4	10.8	70.6
5/12/2009	26	0	10	33.1	8.4	22.0	60.0	28.6	9.5	62.3
5/13/2009	15	0	30	53.1	17.2	34.0	93.0	45.8	15.3	99.9
5/14/2009	2	2	28	59.0	17.0	47.0	71.0	51.0	17.0	111.1
Period 9										
7/15/2009	0	0	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7/16/2009	2	0	46	124.0	49.5	89.0	159.0	107.1	35.7	233.4
7/17/2009	2	1	45	109.5	26.2	91.0	128.0	94.6	31.5	206.1
7/18/2009	20	6	12	85.0	39.9	48.0	179.0	73.4	24.5	160.0
7/19/2009	32	3	6	84.7	26.1	37.0	151.0	73.2	24.4	159.5
7/20/2009	40	0	6	88.6	37.2	42.0	172.0	76.6	25.5	166.8
7/21/2009	11	2	34	120.5	22.7	76.0	164.0	104.2	34.7	226.9
7/22/2009	28	8	5	76.3	26.5	26.0	118.0	65.9	22.0	143.7
7/23/2009	43	0	2	78.8	27.5	23.0	126.0	68.1	22.7	148.4
7/24/2009	41	0	0	85.4	31.0	33.0	147.0	73.8	24.6	160.8
7/25/2009	39	6	1	85.8	36.5	29.0	169.0	74.1	24.7	161.4
7/26/2009	27	12	5	104.8	52.6	8.0	204.0	90.5	30.2	197.2
7/27/2009	8	6	31	57.0	32.2	33.0	131.0	49.2	16.4	107.3
7/28/2009	4	0	44	58.3	9.4	45.0	67.0	50.3	16.8	109.6
7/29/2009	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7/30/2009	1	0	14	101.0	N/A	101.0	101.0	87.3	29.1	190.1
7/31/2009	32	5	5	82.0	31.5	37.0	168.0	70.8	23.6	154.3
8/1/2009	14	0	33	113.7	36.2	61.0	203.0	98.2	32.7	214.1
8/2/2009	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/3/2009	18	0	30	118.1	38.4	57.0	183.0	102.0	34.0	222.3
8/4/2009	21	0	9	91.9	35.3	40.0	183.0	79.4	26.5	173.0

6.12.2 Daily NH_3 emission using bLS emissions model

Column headings for the following table are:

Date: Month/Day/Year
Valid: Number of ½ hour periods with valid emissions data
Direction Limited: Number of ½ hour periods invalidated because wind was from an excluded wind direction
Touchdown Limited: Number of ½ hour periods invalidated because fraction of source area surface covered by particle touchdowns was less than 0.1
Turbulence Limited: Number of ½ hour periods that the bLS model was not run because either u* < 0.15 m/s or |L| < 2 m
Background (ppm): bLS model calculated daily average background concentration (ppm); average is over the ½ hour periods included in the valid column
Emission Average (µg m^{-2} s^{-1}): Daily average emission calculated from the valid ½ hour periods
Emissions SD (µg m^{-2} s^{-1}): Daily emission standard deviation of the valid ½ hour periods
Emission Minimum (µg m^{-2} s^{-1}): Daily minimum emission of the valid ½ hour periods
Emission Maximum (µg m^{-2} s^{-1}): Daily maximum emission of the valid ½ hour periods
Emission Average (kg d^{-1}): Daily average emission calculated from the valid ½ hour periods; totaled over the source area
Emission Average (g d^{-1} hd^{-1}): Daily average emission calculated from the valid ½ hour periods; totaled over the source area on a per head basis
Emission Average (g d^{-1} AU^{-1}): Daily average emission calculated from the valid ½ hour periods; totaled over the source area on a per animal unit basis

Date	Valid	Direction limited	Touch-down limited	Turbulence limited	Background (ppm)	Emission Average (µg$m^{-2}s^{-1}$)	Emission SD (µg$m^{-2}s^{-1}$)	Emission Minimum (µg$m^{-2}s^{-1}$)	Emission Maximum (µg$m^{-2}s^{-1}$)	Emission Average (kgd^{-1})	Emission Average (g$d^{-1}hd^{-1}$)	Emission Average (g$d^{-1}AU^{-1}$)
Period 2												
8/31/2007	4	7	1	0	-0.10	209.1	18.5	181.8	222.0	189.8	63.3	413.4
9/1/2007	28	9	0	10	-0.03	166.6	52.5	63.4	277.5	151.2	50.4	329.4
9/2/2007	28	9	0	10	0.00	125.6	54.3	32.2	243.0	113.9	38.0	248.2
9/3/2007	34	2	0	11	-0.01	137.6	38.1	46.2	243.6	124.9	41.6	272.1
9/4/2007	37	0	0	11	0.01	137.6	53.3	40.5	247.7	124.9	41.6	272.1
9/5/2007	48	0	0	0	0.02	158.0	47.5	79.1	265.2	143.3	47.8	312.3
9/6/2007	41	0	0	7	0.16	121.0	68.2	11.3	260.9	109.7	36.6	239.1
9/7/2007	36	9	0	3	0.20	86.2	44.2	20.5	183.6	78.3	26.1	170.5
9/8/2007	12	7	0	28	0.05	134.6	61.5	43.4	224.0	122.1	40.7	266.1
9/9/2007	28	6	7	3	0.09	81.0	39.7	23.5	180.9	73.5	24.5	160.2
9/10/2007	6	0	3	17	-0.02	42.6	25.3	3.7	65.8	38.6	12.9	84.2
9/11/2007	4	5	7	20	-0.30	182.4	195.4	25.6	448.5	165.5	55.2	360.6
9/12/2007	27	3	0	16	0.14	115.4	46.5	37.7	212.2	104.7	34.9	228.2
9/13/2007	35	0	0	13	0.14	115.4	39.9	21.3	209.0	104.7	34.9	228.0

Date	Valid	Direction limited	Touch-down limited	Turbulence limited	Background (ppm)	Emission Average ($\mu g m^{-2} s^{-1}$)	Emission SD ($\mu g m^{-2} s^{-1}$)	Emission Minimum ($\mu g m^{-2} s^{-1}$)	Emission Maximum ($\mu g m^{-2} s^{-1}$)	Emission Average ($kg d^{-1}$)	Emission Average ($g d^{-1} hd^{-1}$)	Emission Average ($g d^{-1} AU^{-1}$)
9/14/2007	38	1	1	8	0.20	86.1	21.3	19.4	139.4	78.1	26.0	170.2
9/15/2007	38	10	0	0	0.13	130.1	39.8	80.2	237.2	118.1	39.4	257.2
9/16/2007	48	0	0	0	0.27	117.3	34.1	76.3	185.7	106.4	35.5	231.8
9/17/2007	48	0	0	0	0.18	165.1	53.7	110.6	276.4	149.8	49.9	326.3
9/18/2007	18	1	1	6	0.18	117.0	49.2	25.0	249.2	106.1	35.4	231.2
Period 3												
1/25/2008	0	0	0	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/26/2008	36	0	0	12	-0.02	0.6	3.5	-5.2	8.2	0.6	0.2	1.2
1/27/2008	27	0	0	20	-0.04	8.7	8.2	0.4	31.4	7.9	2.6	17.2
1/28/2008	38	0	0	0	-0.02	6.9	9.8	-27.8	27.2	6.3	2.1	13.6
1/29/2008	0	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/30/2008	0	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/31/2008	16	0	0	1	-0.01	0.3	3.7	-4.7	10.5	0.3	0.1	0.6
2/1/2008	28	0	0	18	-0.01	3.0	4.0	-8.9	11.1	2.7	0.9	5.9
2/2/2008	41	4	0	2	-0.04	4.7	10.5	-25.0	46.0	4.3	1.4	9.3
2/3/2008	23	1	4	16	-0.03	2.7	6.5	-9.2	13.8	2.4	0.8	5.3
2/4/2008	47	0	0	1	-0.04	9.4	5.2	-0.3	18.2	8.6	2.9	18.7
2/5/2008	16	0	0	0	-0.02	-8.2	33.2	-116.0	30.3	-7.4	-2.5	-16.2
2/6/2008	8	0	1	1	0.02	12.3	8.7	-4.9	21.1	11.1	3.7	24.3
2/7/2008	20	2	0	5	0.02	11.1	7.1	2.3	33.9	10.0	3.3	21.9
2/8/2008	36	0	3	9	0.00	12.4	7.0	4.2	31.9	11.3	3.8	24.6
2/9/2008	21	0	0	21	0.02	5.5	4.5	0.3	18.1	5.0	1.7	10.9
2/10/2008	9	1	8	11	-0.01	11.3	2.7	6.0	15.0	10.2	3.4	22.3
2/11/2008	17	0	1	0	0.02	10.8	11.3	-13.8	26.6	9.8	3.3	21.3
2/12/2008	33	0	1	14	0.01	20.0	6.3	0.7	30.0	18.1	6.0	39.5
2/13/2008	42	0	0	6	0.02	14.6	10.2	-3.6	34.1	13.2	4.4	28.8
2/14/2008	48	0	0	0	0.00	18.4	10.9	-7.5	36.2	16.7	5.6	36.4
2/15/2008	28	0	4	15	0.02	9.2	13.4	-14.5	55.2	8.4	2.8	18.3
2/16/2008	22	1	0	20	0.01	12.7	5.2	0.4	21.5	11.5	3.8	25.1
2/17/2008	38	0	0	7	0.01	25.8	10.0	7.6	48.1	23.4	7.8	51.0
2/18/2008	32	0	1	14	0.02	9.2	6.2	-14.0	19.3	8.4	2.8	18.2
2/19/2008	0	0	0	26	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period 4												
5/8/2008	0	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/9/2008	37	4	2	0	0.03	43.7	31.7	-28.8	142.1	39.6	13.2	86.3
5/10/2008	37	0	3	0	-0.02	87.3	21.2	52.9	136.4	79.2	26.4	172.6
5/11/2008	39	0	2	7	0.01	44.0	21.8	4.4	97.0	39.9	13.3	86.9
5/12/2008	30	0	12	0	0.02	56.9	26.2	8.0	97.7	51.6	17.2	112.5
5/13/2008	40	0	7	0	0.01	63.9	19.5	4.6	106.1	58.0	19.3	126.3
5/14/2008	17	1	10	17	0.06	25.4	18.8	-14.7	53.6	23.0	7.7	50.2
5/15/2008	25	0	2	18	0.02	61.3	21.8	12.8	97.4	55.6	18.5	121.2
5/16/2008	33	0	0	15	0.00	65.8	27.6	16.2	116.0	59.7	19.9	130.0
5/17/2008	31	0	0	14	0.03	70.4	24.0	28.0	104.1	63.9	21.3	139.2
5/18/2008	24	2	2	16	-0.04	71.4	53.9	24.3	253.4	64.8	21.6	141.1

Date	Valid	Direction limited	Touch-down limited	Turbulence limited	Background (ppm)	Emission Average ($\mu g m^{-2} s^{-1}$)	Emission SD ($\mu g m^{-2} s^{-1}$)	Emission Minimum ($\mu g m^{-2} s^{-1}$)	Emission Maximum ($\mu g m^{-2} s^{-1}$)	Emission Average ($kg d^{-1}$)	Emission Average ($g d^{-1} hd^{-1}$)	Emission Average ($g d^{-1} AU^{-1}$)
5/19/2008	38	0	0	8	0.02	70.4	37.5	17.6	154.7	63.9	21.3	139.1
5/20/2008	10	0	20	11	0.12	28.5	5.8	19.3	36.5	25.8	8.6	56.3
5/21/2008	14	0	10	2	0.07	50.0	18.7	17.8	82.3	45.4	15.1	98.9
5/22/2008	19	0	4	0	0.08	69.6	26.3	19.5	109.0	63.2	21.1	137.6
5/23/2008	25	1	7	2	0.10	48.5	26.2	-9.4	90.5	44.0	14.7	95.8
5/24/2008	39	1	2	2	0.05	68.2	23.8	-1.1	97.8	61.9	20.6	134.8
5/25/2008	33	0	8	1	0.10	51.4	21.5	-0.4	81.5	46.6	15.5	101.5
5/26/2008	35	0	6	0	0.10	47.4	23.1	-27.6	79.1	43.0	14.3	93.6
5/27/2008	28	1	5	0	0.02	74.3	36.0	-6.3	146.0	67.5	22.5	147.0
5/28/2008	19	0	2	0	0.08	49.3	17.4	13.3	84.2	44.7	14.9	97.4
Period 5												
5/29/2008	8	0	0	0	0.23	69.0	66.8	-40.7	137.4	62.6	20.9	136.3
5/30/2008	40	6	0	0	0.19	70.8	67.5	-59.2	255.6	64.3	21.4	140.0
5/31/2008	26	15	0	7	0.11	105.5	43.8	30.0	165.2	95.7	31.9	208.6
6/1/2008	36	12	0	0	0.13	120.3	28.2	71.6	182.1	109.1	36.4	237.8
6/2/2008	25	12	2	9	0.11	89.2	22.8	26.8	122.8	80.9	27.0	176.3
6/3/2008	46	2	0	0	0.12	80.7	36.4	27.0	219.1	73.3	24.4	159.6
6/4/2008	32	8	0	6	0.17	77.6	51.0	4.1	172.6	70.4	23.5	153.5
6/5/2008	46	0	0	2	0.17	109.3	68.4	-17.2	272.1	99.2	33.1	216.1
6/6/2008	44	0	0	4	0.14	83.8	40.6	8.5	188.0	76.0	25.3	165.6
6/7/2008	48	0	0	0	0.12	84.4	40.7	-22.8	145.9	76.6	25.5	166.9
6/8/2008	48	0	0	0	0.15	86.0	67.8	-35.7	271.5	78.0	26.0	169.9
6/9/2008	37	4	0	6	0.14	109.2	55.9	10.9	204.7	99.1	33.0	215.9
6/10/2008	22	1	0	3	0.27	72.2	36.3	8.6	149.9	65.5	21.8	142.8
Period 6												
11/6/2008	3	0	2	0	0.04	23.2	6.2	16.9	29.4	21.0	7.0	45.8
11/7/2008	24	0	14	5	0.08	12.2	7.0	7.1	33.5	11.1	3.7	24.2
11/8/2008	11	4	21	9	0.05	9.1	9.0	0.9	29.1	8.3	2.8	18.0
11/9/2008	24	16	0	8	0.00	39.1	11.3	18.8	55.0	35.5	11.8	77.3
11/10/2008	30	16	1	1	0.02	32.4	11.2	5.6	51.4	29.4	9.8	64.0
11/11/2008	1	0	27	2	0.06	28.1	N/A	28.1	28.1	25.5	8.5	55.6
11/12/2008	20	0	3	22	0.05	18.2	6.9	4.2	31.4	16.5	5.5	36.0
11/13/2008	36	0	3	8	0.07	17.0	9.1	3.8	42.3	15.4	5.1	33.6
11/14/2008	5	0	3	2	0.06	23.3	10.0	8.5	32.7	21.1	7.0	46.0
11/15/2008	0	0	21	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11/16/2008	11	0	27	8	0.04	9.2	6.4	0.4	18.6	8.3	2.8	18.2
11/17/2008	22	0	12	9	0.07	10.9	8.3	-18.8	23.5	9.9	3.3	21.5
11/18/2008	30	0	0	17	0.08	12.4	3.5	7.0	22.6	11.3	3.8	24.6
11/19/2008	46	0	0	2	0.08	9.4	7.0	0.1	25.9	8.5	2.8	18.6
11/20/2008	45	0	0	3	0.07	19.8	6.6	8.6	34.9	18.0	6.0	39.2
11/21/2008	36	3	0	9	0.07	18.0	7.6	3.8	34.2	16.4	5.5	35.7
11/22/2008	27	7	0	12	0.10	10.4	6.3	0.1	23.4	9.4	3.1	20.6
11/23/2008	33	0	0	13	0.09	13.4	10.8	2.0	34.8	12.2	4.1	26.6
11/24/2008	46	0	0	2	0.07	9.0	5.5	0.6	18.6	8.2	2.7	17.8

Date	Valid	Direction limited	Touch-down limited	Turbulence limited	Background (ppm)	Emission Average (μgm^{-2}s^{-1})	Emission SD (μgm^{-2}s^{-1})	Emission Minimum (μgm^{-2}s^{-1})	Emission Maximum (μgm^{-2}s^{-1})	Emission Average (kgd^{-1})	Emission Average (gd^{-1}hd^{-1})	Emission Average (gd^{-1}AU^{-1})
11/25/2008	40	0	0	6	0.09	3.5	4.5	-2.1	22.7	3.1	1.0	6.8
11/26/2008	38	0	0	10	0.07	10.7	5.2	2.2	30.3	9.7	3.2	21.1
11/27/2008	15	0	12	15	0.08	16.0	8.3	0.4	27.5	14.5	4.8	31.6
11/28/2008	29	3	1	15	0.06	8.3	4.0	1.8	20.2	7.5	2.5	16.4
11/29/2008	1	1	18	13	0.11	8.3	N/A	8.3	8.3	7.6	2.5	16.5
11/30/2008	0	0	12	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/1/2008	0	0	11	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/2/2008	8	0	14	12	0.05	9.0	1.8	5.4	11.4	8.2	2.7	17.9
Period 7												
12/3/2008	47	0	0	0	0.06	24.7	19.5	-1.3	68.7	22.4	7.5	48.7
12/4/2008	6	19	0	23	0.08	5.7	1.1	3.9	7.3	5.1	1.7	11.2
12/5/2008	31	12	0	3	0.08	2.2	4.6	-6.2	9.6	2.0	0.7	4.4
12/6/2008	36	0	0	11	0.08	3.2	2.2	0.0	9.4	2.9	1.0	6.4
12/7/2008	35	0	0	13	0.10	2.3	3.3	-3.1	10.2	2.1	0.7	4.6
12/8/2008	15	0	0	11	0.12	3.2	1.3	1.5	6.0	2.9	1.0	6.2
12/9/2008	7	0	0	0	0.07	17.2	2.8	13.3	21.6	15.6	5.2	34.1
12/10/2008	4	0	0	5	0.07	3.2	1.5	2.1	5.5	2.9	1.0	6.4
12/11/2008	40	0	0	8	0.06	4.8	2.2	0.9	8.9	4.3	1.4	9.4
12/12/2008	9	0	0	20	0.09	7.8	6.0	1.7	20.7	7.1	2.4	15.4
12/13/2008	0	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/14/2008	0	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/15/2008	0	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/16/2008	0	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period 8												
4/22/2009	0	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/23/2009	0	0	6	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/24/2009	0	0	1	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/25/2009	0	0	6	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/26/2009	0	0	12	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/27/2009	0	0	12	3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/28/2009	0	0	5	3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/29/2009	0	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/30/2009	0	0	8	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/1/2009	0	0	20	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/2/2009	0	0	28	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/3/2009	13	0	27	3	-0.02	46.5	25.3	17.7	100.0	42.2	14.1	91.8
5/4/2009	0	0	4	14	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/5/2009	1	0	0	5	-0.02	17.2	N/A	17.2	17.2	15.6	5.2	34.1
5/6/2009	14	1	11	2	-0.01	66.2	26.6	40.9	148.7	60.0	20.0	130.8
5/7/2009	39	7	0	2	0.10	42.9	14.4	16.7	74.3	38.9	13.0	84.8
5/8/2009	44	4	0	0	0.10	48.3	10.6	26.2	72.5	43.8	14.6	95.5
5/9/2009	29	10	1	8	0.10	49.8	10.5	26.7	70.0	45.2	15.1	98.4
5/10/2009	23	16	0	9	0.05	46.9	8.3	31.8	65.1	42.6	14.2	92.8
5/11/2009	29	4	0	14	0.02	47.2	24.9	7.0	87.3	42.8	14.3	93.2

Date	Valid	Direction limited	Touch-down limited	Turbulence limited	Background (ppm)	Emission Average (μgm^{-2}s^{-1})	Emission SD (μgm^{-2}s^{-1})	Emission Minimum (μgm^{-2}s^{-1})	Emission Maximum (μgm^{-2}s^{-1})	Emission Average (kgd^{-1})	Emission Average (gd^{-1}hd^{-1})	Emission Average (gd^{-1}AU^{-1})
5/12/2009	46	0	0	0	0.04	64.0	15.1	38.6	98.1	58.1	19.4	126.6
5/13/2009	42	0	5	0	0.08	64.7	20.4	10.9	108.1	58.7	19.6	127.9
5/14/2009	15	2	2	10	0.11	46.8	9.6	33.6	69.4	42.5	14.2	92.5
Period 9												
7/15/2009	0	0	1	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7/16/2009	19	0	6	14	0.04	62.5	39.2	5.9	145.2	56.7	18.9	123.5
7/17/2009	7	16	5	19	0.07	82.7	38.0	6.4	117.1	75.0	25.0	163.4
7/18/2009	25	6	0	17	0.07	95.9	29.5	17.8	140.7	87.0	29.0	189.6
7/19/2009	27	1	0	19	0.07	114.5	33.8	29.1	174.3	103.9	34.6	226.3
7/20/2009	38	0	0	10	0.08	99.0	35.6	35.4	190.4	89.9	30.0	195.8
7/21/2009	42	0	0	5	0.05	85.0	22.6	38.3	140.2	77.1	25.7	167.9
7/22/2009	28	9	0	11	0.07	98.9	38.5	42.4	179.5	89.7	29.9	195.5
7/23/2009	37	0	0	11	0.07	86.7	42.3	21.3	163.0	78.7	26.2	171.4
7/24/2009	45	0	0	3	0.08	89.3	48.2	39.4	207.7	81.0	27.0	176.6
7/25/2009	38	6	0	4	0.10	72.9	34.7	36.0	180.8	66.2	22.1	144.2
7/26/2009	26	11	0	10	0.01	84.2	51.7	5.3	215.8	76.4	25.5	166.3
7/27/2009	21	10	5	10	0.01	49.9	32.2	-12.0	109.3	45.2	15.1	98.6
7/28/2009	31	1	6	8	-0.03	67.8	39.5	11.7	166.7	61.5	20.5	134.0
7/29/2009	8	0	28	10	-0.11	56.8	23.2	3.1	74.5	51.6	17.2	112.4
7/30/2009	13	0	1	0	0.00	89.3	26.2	37.3	136.0	81.1	27.0	176.6
7/31/2009	25	1	0	22	0.08	93.8	37.7	34.8	172.9	85.1	28.4	185.5
8/1/2009	39	0	2	5	0.01	65.9	44.5	-21.1	210.2	59.8	19.9	130.3
8/2/2009	24	0	1	21	0.13	40.1	23.1	-3.0	70.6	36.4	12.1	79.2
8/3/2009	35	0	9	3	0.14	58.9	40.2	-2.8	178.3	53.4	17.8	116.4
8/4/2009	13	0	0	14	0.13	61.7	30.3	19.8	119.4	56.0	18.7	122.0

6.12.3 Daily H_2S emission using Ratiometric emissions model

Column headings for the following table are:

Date: Month/Day/Year
Valid: Number of ½ hour periods with valid emissions data
Emission Average (μg m^{-2} s^{-1}): Daily average emission calculated from the valid ½ hour periods
Emissions SD (μg m^{-2} s^{-1}): Daily emission standard deviation of the valid ½ hour periods
Emission Minimum (μg m^{-2} s^{-1}): Daily minimum emission of the valid ½ hour periods
Emission Maximum (μg m^{-2} s^{-1}): Daily maximum emission of the valid ½ hour periods
Emission Average (kg d^{-1}): Daily average emission calculated from the valid ½ hour periods; totaled over the source area
Emission Average (g d^{-1} hd^{-1}): Daily average emission calculated from the valid ½ hour periods; totaled over the source area on a per head basis
Emission Average (g d^{-1} AU^{-1}): Daily average emission calculated from the valid ½ hour periods; totaled over the source area on a per animal unit basis

Date	Valid	Emission average (μgm^{-2}s^{-1})	Emission SD (μgm^{-2}s^{-1})	Emission minimum (μgm^{-2}s^{-1})	Emission maximum (μgm^{-2}s^{-1})	Emission average (kgd^{-1})	Emission average (gd^{-1}hd^{-1})	Emission average (gd^{-1}AU^{-1})
Period 3								
1/25/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/26/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/27/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/28/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/29/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/30/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/31/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2/1/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2/2/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2/3/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2/4/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2/5/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2/6/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2/7/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2/8/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2/9/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2/10/2008	1	0.8	0.0	0.8	0.8	0.7	0.2	1.6
2/11/2008	1	7.4	0.0	7.4	7.4	6.4	2.1	14.0
2/12/2008	2	2.6	22.8	1.3	3.9	2.2	0.7	4.9
2/13/2008	1	3.4	0.0	3.4	3.4	2.9	1.0	6.3
2/14/2008	4	35.0	69.0	0.0	71.9	30.3	10.1	65.9
2/15/2008	2	3.3	25.7	3.1	3.6	2.9	1.0	6.3
2/16/2008	1	6.4	0.0	6.4	6.4	5.6	1.9	12.1
2/17/2008	9	17.3	40.3	8.9	32.5	15.0	5.0	32.6
2/18/2008	3	9.0	35.2	5.8	14.9	7.8	2.6	16.9
2/19/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period 4								

Date	Valid	Emission average ($\mu gm^{-2}s^{-1}$)	Emission SD ($\mu gm^{-2}s^{-1}$)	Emission minimum ($\mu gm^{-2}s^{-1}$)	Emission maximum ($\mu gm^{-2}s^{-1}$)	Emission average (kgd^{-1})	Emission average ($gd^{-1}hd^{-1}$)	Emission average ($gd^{-1}AU^{-1}$)
5/8/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/9/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/10/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/11/2008	2	-0.1	0.0	-0.2	0.0	-0.1	0.0	-0.1
5/12/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/13/2008	14	6.4	25.4	1.6	12.1	5.5	1.8	12.1
5/14/2008	7	0.3	5.4	-0.3	0.5	0.2	0.1	0.5
5/15/2008	18	9.7	30.5	4.0	17.5	8.4	2.8	18.2
5/16/2008	23	2.4	15.6	-0.5	11.8	2.0	0.7	4.4
5/17/2008	27	7.0	26.1	-0.5	14.4	6.1	2.0	13.2
5/18/2008	20	0.4	6.7	-0.2	3.3	0.4	0.1	0.8
5/19/2008	15	2.6	16.6	0.3	9.6	2.3	0.8	5.0
5/20/2008	4	1.6	14.7	1.0	2.6	1.4	0.5	3.1
5/21/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/22/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/23/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/24/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/25/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/26/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/27/2008	18	7.7	27.5	1.9	21.9	6.7	2.2	14.5
5/28/2008	6	2.5	17.2	1.2	3.9	2.2	0.7	4.8
Period 5								
5/29/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/30/2008	1	1.3	0.0	1.3	1.3	1.2	0.4	2.5
5/31/2008	7	0.7	8.9	0.1	1.5	0.6	0.2	1.3
6/1/2008	1	5.3	0.0	5.3	5.3	4.6	1.5	10.0
6/2/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6/3/2008	10	3.9	20.4	0.3	9.7	3.4	1.1	7.3
6/4/2008	6	1.3	12.4	-0.1	3.9	1.1	0.4	2.4
6/5/2008	4	3.4	21.0	1.8	5.0	2.9	1.0	6.4
6/6/2008	2	3.9	28.1	1.4	6.3	3.4	1.1	7.3
6/7/2008	2	5.1	31.4	5.0	5.1	4.4	1.5	9.5
6/8/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6/9/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6/10/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period 6								
11/6/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11/7/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11/8/2008	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11/9/2008	16	0.2	4.7	-0.2	1.0	0.2	0.1	0.4
11/10/2008	6	0.1	3.2	-0.2	0.3	0.1	0.0	0.2
11/11/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11/12/2008	6	0.0	2.1	-0.1	0.2	0.0	0.0	0.1
11/13/2008	2	0.1	3.2	0.0	0.1	0.0	0.0	0.1
11/14/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Date	Valid	Emission average ($\mu gm^{-2}s^{-1}$)	Emission SD ($\mu gm^{-2}s^{-1}$)	Emission minimum ($\mu gm^{-2}s^{-1}$)	Emission maximum ($\mu gm^{-2}s^{-1}$)	Emission average (kgd^{-1})	Emission average ($gd^{-1}hd^{-1}$)	Emission average ($gd^{-1}AU^{-1}$)
11/15/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11/16/2008	2	0.1	4.0	0.0	0.1	0.1	0.0	0.1
11/17/2008	2	0.0	1.5	0.0	0.1	0.0	0.0	0.0
11/18/2008	32	0.5	6.9	-0.2	4.7	0.4	0.1	0.9
11/19/2008	11	0.5	7.1	0.1	1.3	0.4	0.1	0.9
11/20/2008	29	0.3	5.1	-0.3	0.9	0.2	0.1	0.5
11/21/2008	29	0.0	2.2	-0.2	0.6	0.0	0.0	0.1
11/22/2008	11	0.0	0.5	-0.2	0.3	0.0	0.0	0.0
11/23/2008	28	0.0	1.4	-0.6	0.5	0.0	0.0	0.0
11/24/2008	6	0.0	2.4	-0.3	0.5	0.0	0.0	0.1
11/25/2008	15	0.3	5.9	-0.2	1.2	0.3	0.1	0.6
11/26/2008	10	0.2	4.5	-1.0	0.7	0.2	0.1	0.3
11/27/2008	7	0.2	5.0	0.0	0.4	0.2	0.1	0.4
11/28/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11/29/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11/30/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/1/2008	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12/2/2008	15	0.1	2.6	0.0	0.2	0.1	0.0	0.1
Period 7								
12/3/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/4/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/5/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/6/2008	6	0.1	3.1	0.0	0.2	0.1	0.0	0.1
12/7/2008	19	0.3	6.0	-0.1	1.8	0.3	0.1	0.7
12/8/2008	11	0.1	3.9	-0.1	0.6	0.1	0.0	0.3
12/9/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/10/2008	6	0.0	2.2	-0.1	0.1	0.0	0.0	0.1
12/11/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/12/2008	11	0.3	6.0	-0.1	1.7	0.3	0.1	0.6
12/13/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/14/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/15/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/16/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period 8								
4/22/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/23/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/24/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/25/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/26/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/27/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/28/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/29/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/30/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/1/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/2/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Date	Valid	Emission average (μgm^{-2}s^{-1})	Emission SD (μgm^{-2}s^{-1})	Emission minimum (μgm^{-2}s^{-1})	Emission maximum (μgm^{-2}s^{-1})	Emission average (kgd^{-1})	Emission average (gd^{-1}hd^{-1})	Emission average (gd^{-1}AU^{-1})
5/3/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/4/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/5/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/6/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/7/2009	14	4.3	21.1	1.6	9.2	3.7	1.2	8.1
5/8/2009	16	21.0	43.5	3.5	73.0	18.2	6.1	39.6
5/9/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/10/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/11/2009	8	1.6	13.5	-0.1	6.4	1.3	0.4	2.9
5/12/2009	26	6.6	25.4	1.9	14.3	5.7	1.9	12.5
5/13/2009	15	13.7	35.7	3.0	30.3	11.9	4.0	25.8
5/14/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period 9								
7/15/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7/16/2009	1	0.1	0.0	0.1	0.1	0.1	0.0	0.1
7/17/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7/18/2009	10	0.0	1.7	-0.1	0.3	0.0	0.0	0.1
7/19/2009	23	0.1	2.8	-0.3	0.3	0.1	0.0	0.1
7/20/2009	35	0.0	1.4	-0.5	0.6	0.0	0.0	0.0
7/21/2009	5	5.0	24.3	-0.2	23.0	4.3	1.4	9.4
7/22/2009	22	0.5	7.3	-0.2	2.8	0.4	0.1	1.0
7/23/2009	36	0.2	4.9	-0.2	1.3	0.2	0.1	0.4
7/24/2009	34	0.2	4.1	-0.4	1.4	0.1	0.0	0.3
7/25/2009	37	0.2	4.3	-0.9	1.3	0.2	0.1	0.3
7/26/2009	17	0.3	5.4	-0.6	1.5	0.2	0.1	0.5
7/27/2009	6	0.1	2.7	0.0	0.2	0.1	0.0	0.1
7/28/2009	3	0.1	3.4	-0.1	0.4	0.1	0.0	0.1
7/29/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7/30/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7/31/2009	30	2.8	16.7	-0.2	16.3	2.4	0.8	5.2
8/1/2009	12	0.5	7.7	-0.4	2.3	0.5	0.2	1.0
8/2/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/3/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/4/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A

6.12.4 Daily H_2S emission using bLS emissions model

Column headings for the following table are:

Date: Month/Day/Year
Valid: Number of ½ hour periods with valid emissions data
Direction Limited: Number of ½ hour periods invalidated because wind was from an excluded wind direction
Angle Limited: Number of ½ hour periods invalidated because angle of attack to the downwind side was greater than 60 degrees
Turbulence Limited: Number of ½ hour periods that the bLS model was not run because either u* < 0.15 m/s or |L| < 2 m
Background (ppb): bLS model calculated daily average background concentration (ppb); average is over the ½ hour periods included in the valid column
Emission Average (µg m^{-2} s^{-1}): Daily average emission calculated from the valid ½ hour periods
Emissions SD (µg m^{-2} s^{-1}): Daily emission standard deviation of the valid ½ hour periods
Emission Minimum (µg m^{-2} s^{-1}): Daily minimum emission of the valid ½ hour periods
Emission Maximum (µg m^{-2} s^{-1}): Daily maximum emission of the valid ½ hour periods
Emission Average (kg d^{-1}): Daily average emission calculated from the valid ½ hour periods; totaled over the source area
Emission Average (g d^{-1} hd^{-1}): Daily average emission calculated from the valid ½ hour periods; totaled over the source area on a per head basis
Emission Average (g d^{-1} AU^{-1}): Daily average emission calculated from the valid ½ hour periods; totaled over the source area on a per animal unit basis

Date	Valid	Direction limited	Angle limited	Turbulence limited	Background (ppb)	Emission average ($\mu gm^{-2}s^{-1}$)	Emission SD ($\mu gm^{-2}s^{-1}$)	Emission minimum ($\mu gm^{-2}s^{-1}$)	Emission maximum ($\mu gm^{-2}s^{-1}$)	Emission average (kgd^{-1})	Emission average ($gd^{-1}hd^{-1}$)	Emission average ($gd^{-1}AU^{-1}$)
Period 3												
1/27/2008	26	0	1	17	3.4	28.2	33.3	-0.6	84.1	23.8	7.9	51.8
1/28/2008	33	0	5	0	3.3	34.1	23.7	13.5	123.1	28.7	9.6	62.6
1/29/2008	0	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/30/2008	0	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/31/2008	14	0	0	1	1.7	27.4	21.0	5.1	69.1	23.1	7.7	50.4
2/1/2008	14	0	12	20	2.4	6.1	7.7	0.5	24.4	5.2	1.7	11.3
2/2/2008	11	0	0	1	1.1	7.5	2.7	2.2	12.3	6.3	2.1	13.7
2/3/2008	0	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2/4/2008	0	0	16	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2/5/2008	15	0	0	0	2.0	12.4	4.5	6.6	23.9	10.4	3.5	22.8
2/6/2008	11	0	0	1	245.4	-24.8	122.6	-394.2	16.7	-20.9	-7.0	-45.6
2/7/2008	10	2	0	5	-1.4	11.9	12.1	4.2	45.3	10.1	3.4	22.0
2/8/2008	33	0	4	9	2.0	9.1	5.6	1.7	23.7	7.7	2.6	16.7
2/9/2008	10	0	11	23	-1.1	1.6	0.9	0.4	2.9	1.4	0.5	3.0
2/10/2008	7	2	8	12	2.4	8.4	3.9	3.2	13.9	7.1	2.4	15.4
2/11/2008	12	0	4	0	2.2	8.6	4.0	-0.1	16.3	7.3	2.4	15.8
2/12/2008	29	0	3	14	1.9	9.8	3.6	3.0	17.6	8.2	2.7	17.9
2/13/2008	29	0	11	6	2.5	23.5	20.1	3.8	68.0	19.9	6.6	43.2
2/14/2008	47	0	1	0	2.5	14.8	7.9	0.0	52.3	12.5	4.2	27.2

Date	Valid	Direction limited	Angle limited	Turbulence limited	Background (ppb)	Emission average (µgm^{-2}s^{-1})	Emission SD (µgm^{-2}s^{-1})	Emission minimum (µgm^{-2}s^{-1})	Emission maximum (µgm^{-2}s^{-1})	Emission average (kgd^{-1})	Emission average (gd^{-1}hd^{-1})	Emission average (gd^{-1}AU^{-1})
2/15/2008	26	3	2	15	2.0	4.1	2.0	0.0	8.2	3.4	1.1	7.5
2/16/2008	16	1	5	20	1.2	3.0	2.2	0.0	7.2	2.5	0.8	5.4
2/17/2008	36	2	0	7	2.1	12.3	6.8	2.9	30.2	10.4	3.5	22.6
2/18/2008	21	0	12	14	2.2	6.9	3.5	2.2	14.5	5.8	1.9	12.7
Period 4												
5/9/2008	26	4	6	0	1.8	3.1	4.1	-1.6	11.3	2.6	0.9	5.7
5/10/2008	46	0	2	0	1.7	14.3	11.1	4.1	50.8	12.1	4.0	26.3
5/11/2008	29	0	12	7	1.3	3.9	3.2	-0.1	11.8	3.3	1.1	7.1
5/12/2008	48	0	0	0	1.6	8.9	7.5	2.0	37.0	7.5	2.5	16.3
5/13/2008	47	0	1	0	1.6	6.0	3.0	1.5	13.9	5.1	1.7	11.0
5/14/2008	20	3	7	17	2.1	5.5	8.6	-0.9	27.9	4.6	1.5	10.0
5/15/2008	21	4	5	18	1.3	7.3	3.4	1.0	13.5	6.2	2.1	13.4
5/16/2008	31	0	0	15	1.3	2.3	2.3	-0.3	8.1	1.9	0.6	4.1
5/17/2008	27	0	4	17	1.6	8.1	4.6	0.2	16.5	6.8	2.3	14.9
5/18/2008	24	3	2	19	2.4	0.9	1.8	-3.2	5.0	0.8	0.3	1.7
5/19/2008	30	0	3	7	1.8	2.7	2.5	-1.5	9.7	2.2	0.7	4.9
5/20/2008	7	10	17	12	1.7	0.9	0.2	0.5	1.1	0.8	0.3	1.7
5/21/2008	34	10	0	2	2.5	22.8	15.9	2.1	64.0	19.2	6.4	41.8
5/22/2008	42	5	0	0	2.0	30.1	16.7	8.1	75.5	25.4	8.5	55.3
5/23/2008	35	9	0	2	1.9	10.3	11.8	0.1	49.8	8.7	2.9	19.0
5/24/2008	29	1	12	2	1.5	6.9	8.6	-1.2	29.2	5.8	1.9	12.6
5/25/2008	45	0	0	2	1.7	10.5	11.7	0.7	60.3	8.9	3.0	19.4
5/26/2008	47	0	0	0	1.4	2.8	2.0	0.4	8.7	2.4	0.8	5.2
5/27/2008	43	1	3	0	1.7	5.3	4.2	-0.3	18.4	4.5	1.5	9.7
5/28/2008	30	2	3	0	1.5	2.6	1.3	0.2	5.6	2.2	0.7	4.9
Period 5												
5/30/2008	35	6	5	0	1.9	4.6	4.2	-3.2	19.3	3.9	1.3	8.4
5/31/2008	13	13	13	7	1.6	2.0	1.5	0.2	4.3	1.7	0.6	3.6
6/1/2008	7	10	29	0	1.3	1.9	1.2	0.4	3.7	1.6	0.5	3.5
6/2/2008	5	13	19	9	2.5	5.2	4.9	0.0	10.7	4.4	1.5	9.5
6/3/2008	36	2	10	0	1.4	6.7	5.8	0.1	26.1	5.6	1.9	12.3
6/4/2008	21	8	11	6	1.9	13.9	18.2	-0.1	71.8	11.7	3.9	25.5
6/5/2008	34	0	12	2	1.9	13.3	14.1	0.2	56.8	11.2	3.7	24.4
6/6/2008	31	0	13	4	1.1	2.8	2.7	-0.4	9.8	2.4	0.8	5.1
6/7/2008	48	0	0	0	1.2	4.8	3.2	0.4	16.3	4.0	1.3	8.8
6/8/2008	11	0	0	0	1.0	0.3	0.3	-0.2	0.7	0.3	0.1	0.6
Period 6												
11/7/2008	5	0	27	1	1.1	-0.3	0.4	-0.7	0.2	-0.2	-0.1	-0.5
11/8/2008	11	4	22	9	0.9	0.0	0.1	-0.3	0.1	0.0	0.0	0.0
11/9/2008	19	16	5	8	1.0	0.5	0.6	-0.2	2.0	0.4	0.1	0.9
11/10/2008	30	16	1	1	1.1	0.6	0.7	-0.6	2.2	0.5	0.2	1.0
11/11/2008	27	0	16	3	1.1	0.9	2.9	-0.7	14.6	0.7	0.2	1.6
11/12/2008	19	0	3	23	0.9	0.3	0.4	-0.5	1.3	0.3	0.1	0.6
11/13/2008	36	0	3	8	1.3	0.3	0.6	-1.4	1.3	0.2	0.1	0.5
11/14/2008	43	0	1	2	1.1	0.2	0.4	-0.7	1.3	0.2	0.1	0.3
11/15/2008	31	0	14	1	0.9	0.0	0.3	-0.6	0.6	0.0	0.0	0.0

Date	Valid	Direction limited	Angle limited	Turbulence limited	Background (ppb)	Emission average ($\mu gm^{-2}s^{-1}$)	Emission SD ($\mu gm^{-2}s^{-1}$)	Emission minimum ($\mu gm^{-2}s^{-1}$)	Emission maximum ($\mu gm^{-2}s^{-1}$)	Emission average (kgd^{-1})	Emission average ($gd^{-1}hd^{-1}$)	Emission average ($gd^{-1}AU^{-1}$)
11/16/2008	5	0	31	10	0.7	0.1	0.2	-0.3	0.3	0.0	0.0	0.1
11/17/2008	23	0	16	9	1.2	0.3	0.4	-1.1	0.8	0.3	0.1	0.6
11/18/2008	29	0	0	17	1.0	2.1	3.0	-0.1	10.3	1.7	0.6	3.8
11/19/2008	36	0	8	2	1.1	0.3	0.4	-0.8	1.4	0.2	0.1	0.5
11/20/2008	43	0	2	3	1.1	0.3	0.3	-0.3	1.1	0.2	0.1	0.5
11/21/2008	34	3	2	9	1.0	0.0	0.2	-0.6	0.4	0.0	0.0	-0.1
11/22/2008	18	6	9	12	1.2	0.1	0.2	-0.2	0.7	0.1	0.0	0.1
11/23/2008	28	0	4	13	1.4	0.0	0.3	-0.6	0.7	0.0	0.0	0.1
11/24/2008	27	0	17	2	1.0	0.0	0.2	-0.4	0.4	0.0	0.0	0.0
11/25/2008	27	0	13	6	1.3	0.4	0.7	-0.7	2.3	0.4	0.1	0.8
11/26/2008	27	0	11	10	1.2	0.3	0.4	-0.8	1.1	0.2	0.1	0.5
11/27/2008	24	0	6	17	1.5	1.9	1.2	0.0	4.5	1.6	0.5	3.6
11/28/2008	17	3	13	15	1.3	0.5	0.4	0.0	1.2	0.4	0.1	0.8
11/29/2008	30	1	4	13	1.0	0.3	0.4	-0.5	1.0	0.2	0.1	0.5
11/30/2008	38	0	2	0	0.8	0.1	0.4	-0.9	0.8	0.1	0.0	0.2
12/1/2008	12	0	2	2	0.8	0.0	0.3	-0.5	0.4	0.0	0.0	-0.1
12/2/2008	8	0	13	12	1.5	0.1	0.1	0.0	0.2	0.0	0.0	0.1
Period 7												
12/6/2008	2	0	2	5	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12/7/2008	33	0	2	13	1.2	0.9	1.0	-0.8	3.4	0.8	0.3	1.6
12/8/2008	9	0	5	12	1.6	0.1	0.2	-0.2	0.3	0.1	0.0	0.3
12/9/2008	7	0	0	0	0.9	0.2	0.4	-0.4	0.7	0.2	0.1	0.3
12/10/2008	4	0	0	5	1.0	0.0	0.2	-0.1	0.3	0.0	0.0	0.0
12/11/2008	15	0	25	8	0.8	0.2	0.3	-0.2	0.8	0.2	0.1	0.4
12/12/2008	7	0	2	21	1.3	0.7	0.5	0.1	1.4	0.6	0.2	1.2
Period 8												
4/24/2009	31	0	2	4	2.4	6.9	10.2	-4.6	44.1	5.8	1.9	12.7
4/25/2009	43	0	5	0	2.5	8.5	6.5	1.3	27.8	7.2	2.4	15.7
4/26/2009	29	0	17	2	1.7	6.0	9.9	-0.2	46.7	5.1	1.7	11.0
4/27/2009	34	0	5	6	2.6	15.6	23.2	-3.5	112.1	13.2	4.4	28.7
4/28/2009	11	16	18	3	2.1	24.0	33.3	3.0	107.7	20.3	6.8	44.2
4/29/2009	48	0	0	0	3.0	17.1	9.0	1.3	39.5	14.4	4.8	31.5
4/30/2009	43	1	4	0	2.6	12.6	9.3	0.6	35.6	10.6	3.5	23.1
5/1/2009	34	2	10	0	1.7	1.4	1.0	-0.3	3.6	1.2	0.4	2.5
5/2/2009	20	11	15	0	1.3	0.7	0.6	-0.5	1.7	0.6	0.2	1.3
5/3/2009	19	2	22	3	1.0	0.8	0.9	0.1	2.7	0.7	0.2	1.5
5/4/2009	27	4	3	14	2.3	13.5	10.7	0.0	44.5	11.4	3.8	24.8
5/5/2009	31	11	1	5	0.3	5.6	12.6	0.1	71.6	4.7	1.6	10.3
5/6/2009	24	9	12	2	1.1	2.7	2.9	-0.1	12.2	2.2	0.7	4.9
5/7/2009	28	7	10	2	2.3	4.9	4.0	-1.4	15.8	4.1	1.4	8.9
5/8/2009	34	4	9	0	2.4	10.4	11.9	1.1	63.6	8.7	2.9	19.0
5/9/2009	20	10	10	8	1.3	3.5	2.7	0.2	7.3	3.0	1.0	6.5
5/10/2009	0	15	23	9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/11/2009	17	4	12	15	1.5	4.5	4.5	0.0	12.5	3.8	1.3	8.3
5/12/2009	46	0	0	0	2.0	13.1	10.1	1.5	53.6	11.1	3.7	24.1
5/13/2009	43	0	5	0	1.7	9.6	7.1	0.2	27.9	8.1	2.7	17.6

Date	Valid	Direction limited	Angle limited	Turbulence limited	Background (ppb)	Emission average ($\mu gm^{-2}s^{-1}$)	Emission SD ($\mu gm^{-2}s^{-1}$)	Emission minimum ($\mu gm^{-2}s^{-1}$)	Emission maximum ($\mu gm^{-2}s^{-1}$)	Emission average (kgd^{-1})	Emission average ($gd^{-1}hd^{-1}$)	Emission average ($gd^{-1}AU^{-1}$)
5/14/2009	16	0	0	8	1.1	3.9	2.8	0.3	9.6	3.3	1.1	7.2
Period 9												
7/16/2009	26	2	4	16	1.5	0.0	0.4	-1.0	0.8	0.0	0.0	0.1
7/17/2009	3	17	8	19	0.6	0.1	0.3	-0.1	0.4	0.1	0.0	0.2
7/18/2009	8	6	15	17	1.2	0.4	0.7	-0.2	2.1	0.3	0.1	0.7
7/19/2009	20	1	4	20	1.0	0.1	0.2	-0.5	0.5	0.1	0.0	0.2
7/20/2009	33	0	4	10	0.9	0.1	0.2	-0.3	0.7	0.0	0.0	0.1
7/21/2009	37	0	5	6	1.5	0.8	3.2	-0.6	19.2	0.7	0.2	1.5
7/22/2009	26	9	2	11	0.9	0.8	1.2	-0.3	4.2	0.6	0.2	1.4
7/23/2009	32	0	4	11	1.0	0.3	0.6	-0.5	1.8	0.2	0.1	0.5
7/24/2009	39	0	3	3	0.9	0.3	0.5	-0.6	1.8	0.3	0.1	0.6
7/25/2009	37	6	0	4	1.1	0.3	0.5	-1.3	1.8	0.2	0.1	0.5
7/26/2009	15	11	11	11	1.1	0.4	0.7	-0.4	2.5	0.3	0.1	0.7
7/27/2009	16	13	5	10	1.7	0.4	1.0	-0.1	3.9	0.3	0.1	0.7
7/28/2009	25	3	10	8	2.1	0.3	0.4	-0.1	1.7	0.3	0.1	0.6
7/29/2009	10	17	11	10	1.7	0.2	0.4	-0.3	0.9	0.2	0.1	0.4
7/30/2009	12	0	2	0	1.1	0.7	1.9	-0.2	6.6	0.5	0.2	1.2
7/31/2009	25	1	0	22	1.7	6.5	10.1	-0.2	37.2	5.5	1.8	11.9
8/1/2009	31	2	6	6	1.5	0.2	0.5	-0.6	1.2	0.1	0.0	0.3
8/2/2009	1	0	0	23	5.2	-0.2	N/A	-0.2	-0.2	-0.2	-0.1	-0.3