Final Report
Site NC4A
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 the location (relative to climate and typical practice), method of manure collection, 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 wastewater lagoon open source at the southeastern sow 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 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. GasFinder 2.0	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^{o}C	0.01^{o}C	160 Hz sampling/ 16 Hz averaging	30 min
GSS sample flow rate	GSS/SOP-S	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 that was 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 was 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 ^{o} C	0.1 ^{o} 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 ^{o}C	0.5 ^{o}C	5 min	30 min & 24 h

1.3 Farm description and operation

The southeastern sow facility was located in North Carolina. The elevation at the farm was 59 m. The farm consisted of three barns, one each of gestation, breeding, and farrowing, and an office (Fig. 1-1). The facility had a capacity of 2000 sows in three units. Construction of the farm was completed in 1994.

Manure from the barns was transferred once a week from the gestation, farrowing, and breeding barns to the lagoon by pull plug with lagoon water recharge of the pits. Waste water from all three buildings combined into one inlet (SW corner of lagoon- Fig. 1-1). The waste lagoon was located to the north of the barns. The clay-lined, trapezoidal-shaped lagoon was 123 m wide and 187 m long, and was oriented east-west. The lagoon bank was clay, with a berm slope of 3:1. The lagoon had a surface area of 23,195 m^2 and a volume of 56,851 m^3. At the beginning of the study the sludge depth was approximately 0.7 m. Liquid was removed as weather permitted. Sludge from the lagoon had not been removed since construction (15-yr sludge removal cycle).

Figure 1-1: Configuration of the NC4A farm.

1.4 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 northeast and southwest corners (Figure 1-2). Towers for mounting retro-reflectors were located off the northwest and southeast 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:

- North side: Retro-reflectors were located on anchored tripods at 1 m abl at distances of 58.5 m and 116 m from the northeast TDLAS/scanner. Three retro-reflectors were mounted on the northwest tower 184 m from the TDLAS/scanner at heights of 1.1 m, 7.2 m, and 15.6 m abl.
- East side: Retro-reflectors were located on anchored tripods at 1 m abl at distances of 43.5 m and 83 m south of the northeast TDLAS/scanner. Three retro-reflectors were mounted on the southeast tower 134.5 m from the TDLAS/scanner at heights of 1.4 m, 7 m, and 15.4 m abl.
- South side: Retro-reflectors were located on anchored tripods at 1 m abl at distances of 61.5 m and 126 m from the southwest TDLAS/scanner. Three retro-reflectors were mounted on the southeast tower 218.5 m from the TDLAS/scanner at heights of 1.4 m, 7 m, and 15.4 m abl.
- West side: Retro-reflectors were located on anchored tripods at 1 m abl at distances of 46 m and 90.5 m north from the southwest TDLAS/scanner. Three retro-reflectors were mounted on the northwest tower 163.5 m from the TDLAS/scanner at heights of 1.1 m, 7.2 m, and 15.6 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 northeast berm corner and extended west (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 retro-reflector S2 and extended west 50 m towards retro-reflector S1 (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 northeast berm corner (Figure 1-2). The 3D sonic anemometers were located on the meteorological tower at 2.8 m abl and on the southwest corner tower (Figure 1-2) at 4.5 m and 16.3 m abl.

The barns located 20 m south of the lagoon berm had an approximate ridge height of 6 m agl, resulting in a fetch ratio to the south of 10:3 to the surface of the lagoon. Fetch for wind measurements from the east (cropland) was 100:1 for the all measurement heights. Fetch for the wind measurements to the west was limited by a 23-m deciduous tree line. The fetch to the west for the 2-m wind measurement was 100:1. Fetch to the west for the 4-m wind measurement (influenced by the 5.5-m high breeding building) was 100:2.4. Fetch to the west for the 16-m height wind measurement (influenced by the 23-m high tree line at a 287-mdistance) was 100:2. Consequently, all wind measurements were relatively unaffected by upwind conditions. The fan exhaust from the northernmost barn was to both the east and west. The fan exhaust from the middle barn was to the west. As a result of the proximity of the barns, winds from 225^o through 315^o were excluded from analysis.

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

Figure 1-2: Locations of instrumentation around the lagoon under measurement. Retro-reflectors are indicated according to side (N,S,E,W) with 345 indicating the location of a tower. TDLAS/scanner locations are indicated by TS. The location of the two S-OPS are indicated by the solid yellow lines. The instrumentation trailer was located near the SW corner of the lagoon.

2 Monitoring activities

2.1 Measurement periods

This location was measured as part of an approximate 20-d rotation between three other farms. The equipment was on site a total of 138 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 131 d and H_2S emissions were measured 108 d.

Table 2-1: Dates on site

Period	Start date	End date	# d
2	10/04/2007	10/22/2007	18
3	01/29/2008	02/11/2008	13
4	03/31/2008	04/16/2008	16
5	08/13/2008	09/02/2008	20
6	09/04/2008	09/23/2008	19
7	01/14/2009	02/02/2009	19
8	04/28/2009	05/11/2009	13
9	07/01/2009	07/21/2009	20

2.2 Site visits

The Field operation team visited this farm 40 d (Table 2.2). 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.

Table 2-2: Dates of site visits

Year	Spring	Summer	Fall	Winter
2007			Oct 2,3,4,5,22	Jan 29,30,31 Feb 1,11,12
2008	Mar 31, Apr 1,2,14,15,16,17	Aug 12,13,14,26	Sep 2,3,4,22,23	Jan 14,15,16,21 Feb 2,3
2009	Apr 28,29 May 11,12	Jun 30 Jul 1,21,22		

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 day intervals on site. Instruments checked during these visits (with indication of Section documenting the instrument performance and calibration verification check results) included:

- GasFinder 2.0™ NH3 TDLAS serial number (s/n) 1026, 1027, 1028 and 1030 (Section 6.1)

- TEC 450i H2S Analyzer s/n 0733825129 (Section 6.2)
- RM Young 81000 3D sonic anemometers s/n 1920, 1926, 1927, 1928, 1932, 1933 and 1945 (Section 6.3)
- lagoon pH probes s/n 001, 004 and 007 (Section 6.4)
- lagoon ORP probe s/n 020 and 050 (Section 6.5)
- GSS/ S-OPS s/n 4-0018 (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 ‘reference’ anemometers.

2.4 Audits

Two internal audits were conducted at this location: 1) on 1/15/2009 with particular attention to the H_2S and TDLAS calibration verification and the checks on the meteorological sensors, and 2) on 5/13/2009 with particular attention to the documentation and lagoon probe calibrations.

2.5 Repair trips

Three repair trips were made to this location: 10/16/2007, 1/29/2008 and 8/26/2008.

2.6 Remote site checks

Over the course of measurements, there were 58 remote checks made through the computer for instruments operating at this location.

2.7 Measurement data acquisition

Data from the TDLAS units (Model GasFinder 2.0™ 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 six 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 anemometer 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 TDLAS. 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 will still be present in the "FTP" directory, and in some cases these empty files will be 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 need 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 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 is documented in the calibration reports in Section 6. Significant data exclusions of greater than one-day duration are indicated below by instrument. All time references are in Coordinated Universal Time (UTC):

TDLAS measurement exclusions: Excluded measurements due to either the TDLAS or scanner are summarized in Table 3.2-1.

Table 3.2-1: Air temperature and relative humidity measurement exclusions

Begin		End		Reason
10/5/2007	20:00	10/22/2007	16:00	TDLAS 2 did not calibrate; all paths lost nearly entire period. Equipment returned to PAML for replacement and repair by manufacturer
10/17/2007	17:00	10/22/2007	16:00	Communications failure with controller computer
2/1/2008	06:00	2/11/2008	17:22	TDLAS 2 centerline duty cycle maxed out nearly entire period. Equipment returned to PAML for replacement and repair by manufacturer
8/15/2008	17:00	8/27/2008	1:45	TDLAS 1 centerline duty cycle maxed out; scanner found pointing straight down with water inside TDLAS. Equipment returned to PAML for replacement and repair by manufacturer
1/26/2009	17:00	2/2/2009	18:00	TDLAS 2 scanner found pointing down; TDLAS vital signs continued to look good, though data were missing intermittently. Scanner returned to PAML for replacement and repair by manufacturer
7/11/2009	02:00	7/20/2009	23:00	TDLAS 1 scanner found pointing down; TDLAS 1026 wet inside and stopped working from 7/14 until end of period. . Equipment returned to PAML for replacement and repair by manufacturer

In addition, very wet weather and some deflective seals caused several retro-reflector boxes to become moist or wet inside resulting in loss of TDLAS signal from those retro-reflectors. This retro-reflector moisture did not dry out since the heaters designed to dry out the retro-reflector only heat up to 20 °C and the weather in NC at the time was well above 20°C. One TDLAS path was often blocked by equipment involved in the pumping out of the lagoon.

Air temperature and relative humidity measurement exclusions: Excluded measurements are summarized in Table 3.2-2.

Table 3.2-2: Air temperature and relative humidity measurement exclusions

Begin		End		Reason
4/2/2008	15:35	4/2/2008	17:00	Wires were switched

Sonic anemometer measurement exclusions: Sonic anemometers experienced communications interference throughout the study. Excluded measurements are summarized in Table 3.2-3.

Table 3.2-3: Sonic anemometer measurement exclusions

Begin		End		Reason
9/8/2008	23:00	9/23/2008	23:55	Sonic anemometer 2 stopped functioning
7/18/2009	00:15	7/21/2009	18:20	Sonic anemometer 3 stopped functioning

Lagoon temperature, pH, and ORP measurement exclusions: Excluded measurements are summarized in Table 3.2-4.

Table 3.2-4: Lagoon temperature, pH, and ORP measurement exclusions

Lagoon temperature exclusion times				
Begin		**End**		**Reason**
9/3/2008	13:55	9/3/2008	16:35	Calibration check
Lagoon pH exclusion times				
9/3/2008	13:55	9/3/2008	16:35	Calibration check
1/15/2009	15:55	2/2/2009	22:10	pH sensor failed at end of calibration, data cannot be validated
Lagoon ORP exclusion times				
9/3/2008	13:55	9/3/2008	16:35	Calibration check

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°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 supersaturated “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 supersaturated 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 supersaturated.

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-s 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 supersaturated were flagged as supersaturated. 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 supersaturated. To determine which points truly were supersaturated 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 supersaturated. 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 supersaturated 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 current r^2. This resulted in four categories of points depending on whether or not super-saturation was indicated by the hole-finding algorithm and whether or not super-saturation was indicated by the hole-finding routine.

In a final pass through the data, data from the individual dwells were 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-min 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 SOPs 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 the *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 $m^2 s^{-2}$, 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 $m^2 s^{-2}$ 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 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 NH_3 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 beam lines 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 H_2S emissions by Ratiometric

Ratiometric H_2S emissions were determined by first finding 30-min 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 H_2S 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 and lagoon pump-outs for irrigation (Table 4.1-1).

Table 4.1-1: Producer activities

Period	Events during period
2: 10/2 - 10/22/2007	Lagoon below stop pump level entire period
3: 1/29 - 2/12/2008	Lagoon below stop pump level entire period
4: 3/31 - 4/17/2008	4/16/2008 9:25 AM-2:40 PM pump out
5: 8/12 - 9/3/2008	8/23/2008 9:55 AM-2:00 PM pump out.
6: 9/3 - 9/23/2008	9/22/2008 9:30 AM-12:15 PM pump out 9/23/2008 8 AM-9:45 AM pump out 9/2420/08 6:30 AM-7:45 AM pump out
7: 1/14 - 2/3/2009	2/7/2009 9:30 AM-5:30 PM pump out.
8: 4/27 - 5/11/2009	no events
9: 6/30 - 7/22/2009	no events

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 seven percent of the days had extra-tropical frontal systems overhead while 73% of the days were under the general influence of extra-tropical high pressure. One tropical cyclone influenced the weather at this location. The Daily Weather Maps for the measurement days are found in Section 6.9.

Table 4.2-1: Synoptic weather events during measurements

Period	# days	# Warm front passages	# Cold front passages	# days stationary front	# days tropical storms
2	18	0	2	0	0
3	13	2	4	0	0
4	16	0	3	0	0
5	20	0	3	2	0
6	19	0	2	2	1
7	19	1	5	1	0
8	13	0	3	3	0
9	20	0	4	0	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 -5.1 ^{o}C to 32.4 ^{o}C while the barometric pressure varied from 99.74 kPa to 102.85 kPa (Section 6.10). Sky conditions ranged from clear skies with maximum ½ h solar irradiance of 1186 Wm^{-2} to overcast conditions with maximum ½ h solar irradiance of 117 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 except for the measurements made during the beginning of the year (Period 7) when temperatures were below normal.

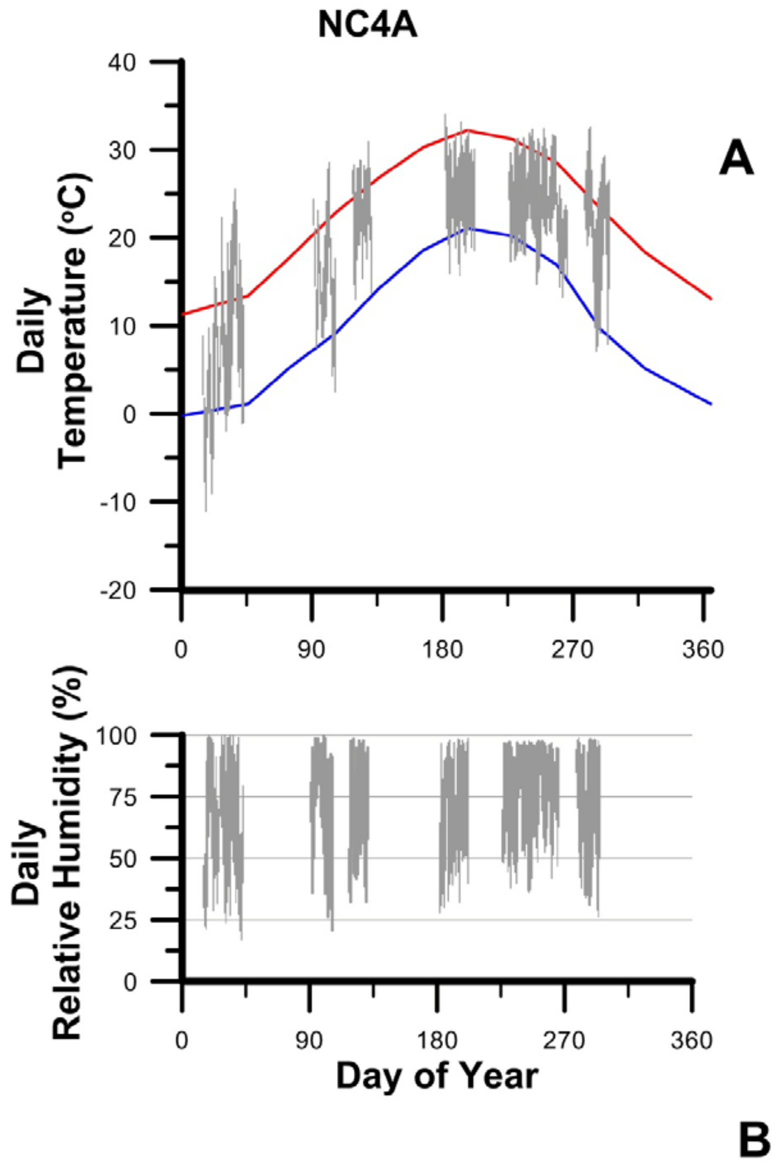

Figure 4.2-1: Variation in daily temperatures and relative humidity during measurements. The mean monthly climatological maximum (red solid line) and minimum (blue solid line) temperature are compared against the daily maximum and minimum temperatures for measurement days (grey bars) in panel A. The 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 135° through 225°) are indicated as a grayed region in the figures. Winds were generally from the southwest during measurement periods 3, 8 and 9 and from the north-northeast during measurement periods 4, 5, and 6 (Figure 4.2-2 through 4.2-5).

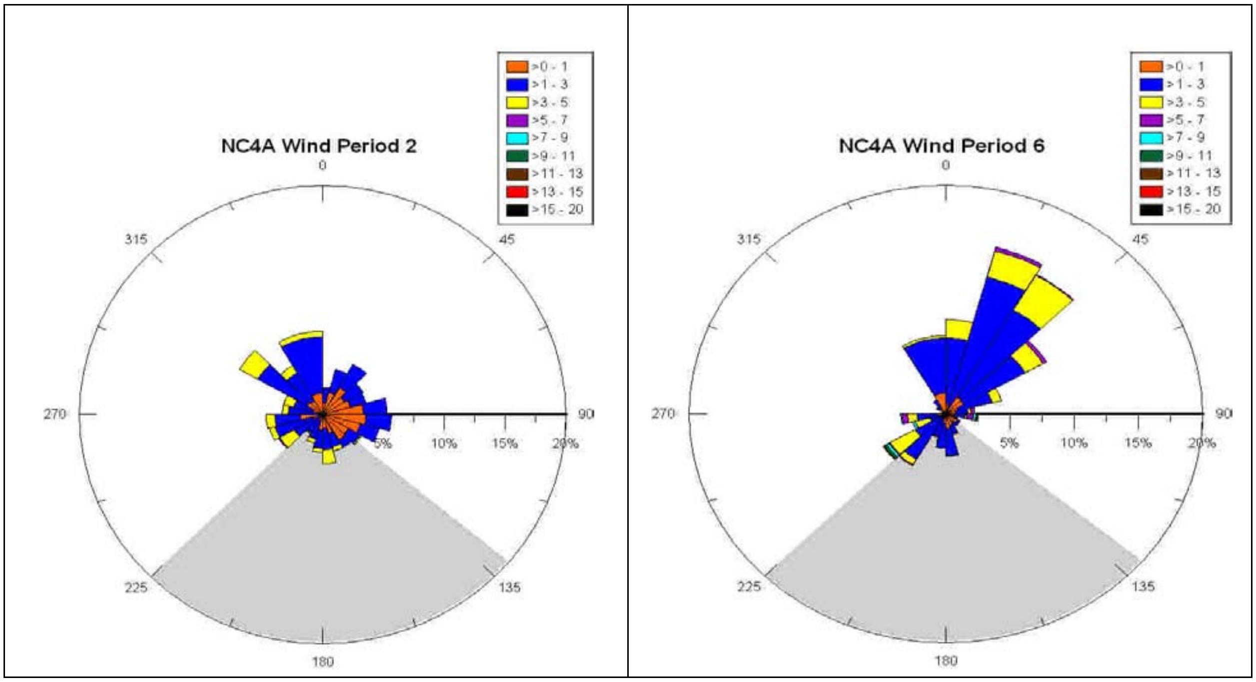

Figure 4.2-2: Wind roses for ½ hourly wind measurements during the Fall Measurement Periods. The periods in which measurements were made are indicated. The relative portion of time in which the wind is from a given direction is indicated by the length of the triangle pointing in that direction. The fraction of time in which the winds were in the binned speed ranges (units of ms^{-1}) is indicated by colors within each triangle. The shaded region defines the wind directions excluded due to upwind influence of the barns.

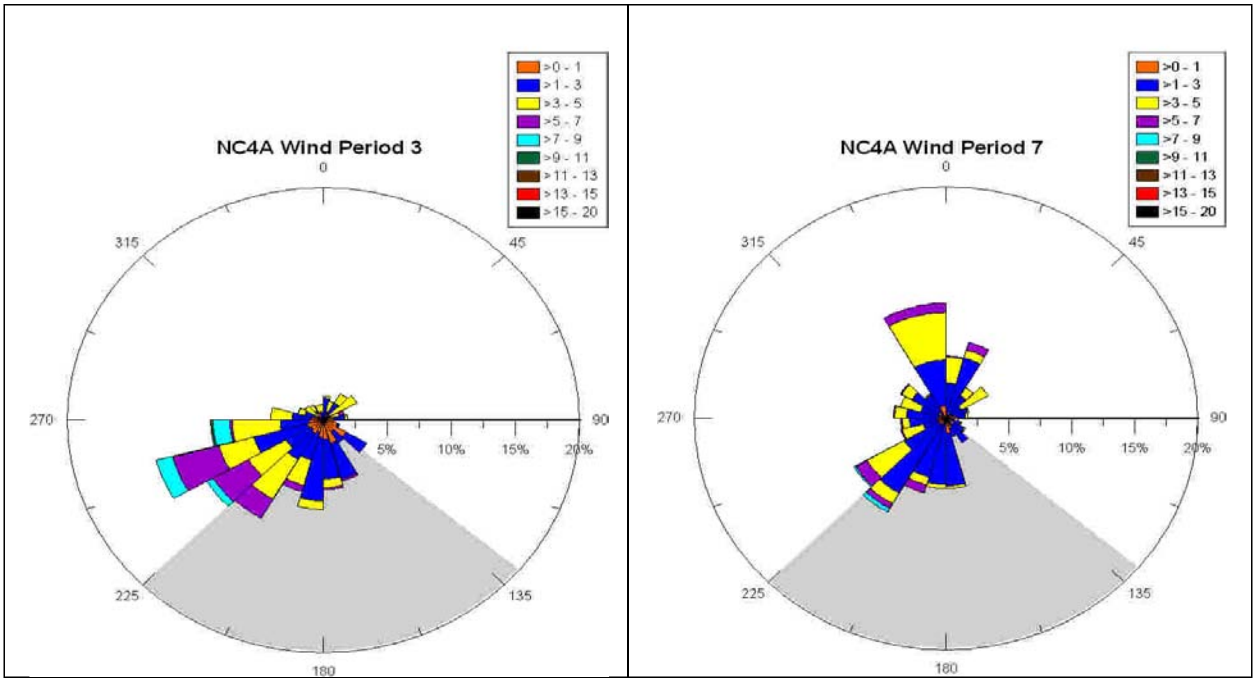

Figure 4.2-3: Wind roses for ½ hourly wind measurements during the Winter Measurement Periods. The periods in which measurements were made are indicated. The relative portion of time in which the wind is from a given direction is indicated by the length of the triangle pointing in that direction. The fraction of time in which the winds were in the binned speed ranges (units of ms^{-1}) is indicated by colors within each triangle. The shaded region defines the wind directions excluded due to upwind influence of the barns.

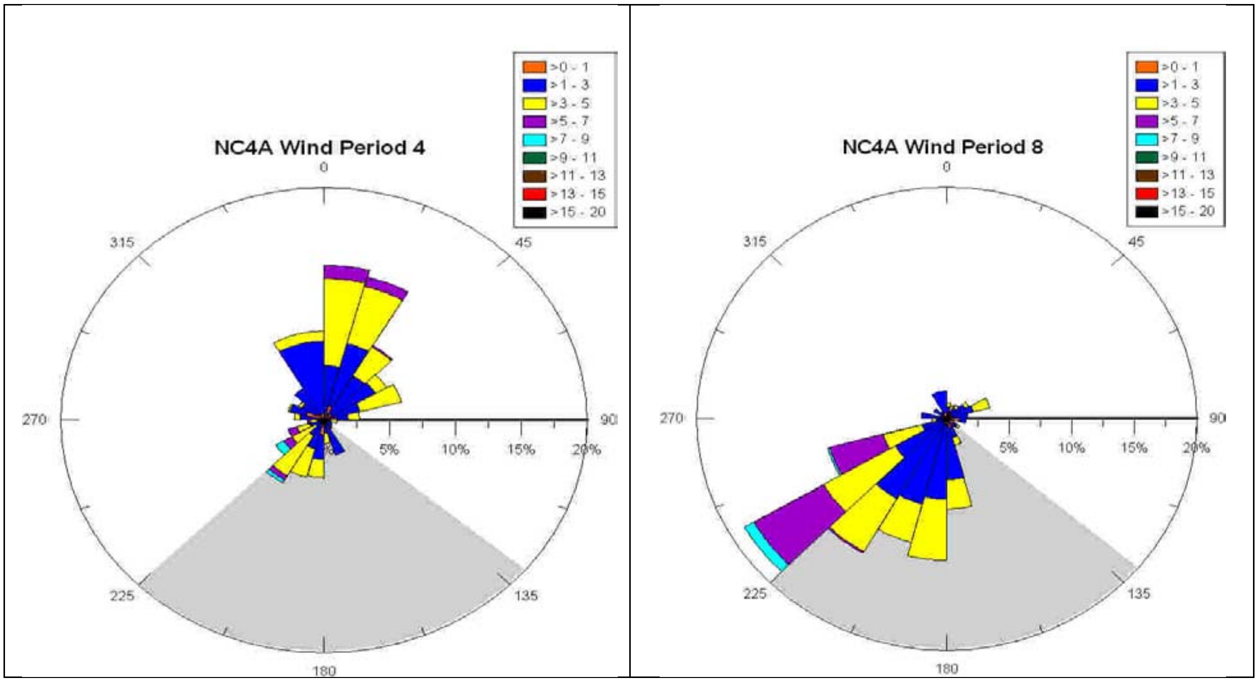

Figure 4.2-4: Wind roses for ½ hourly wind measurements during the Spring Measurement Periods. The periods in which measurements were made are indicated. The relative portion of time in which the wind is from a given direction is indicated by the length of the triangle pointing in that direction. The fraction of time in which the winds were in the binned speed ranges (units of ms^{-1}) is indicated by colors within each triangle. The shaded region defines the wind directions excluded due to upwind influence of the barns.

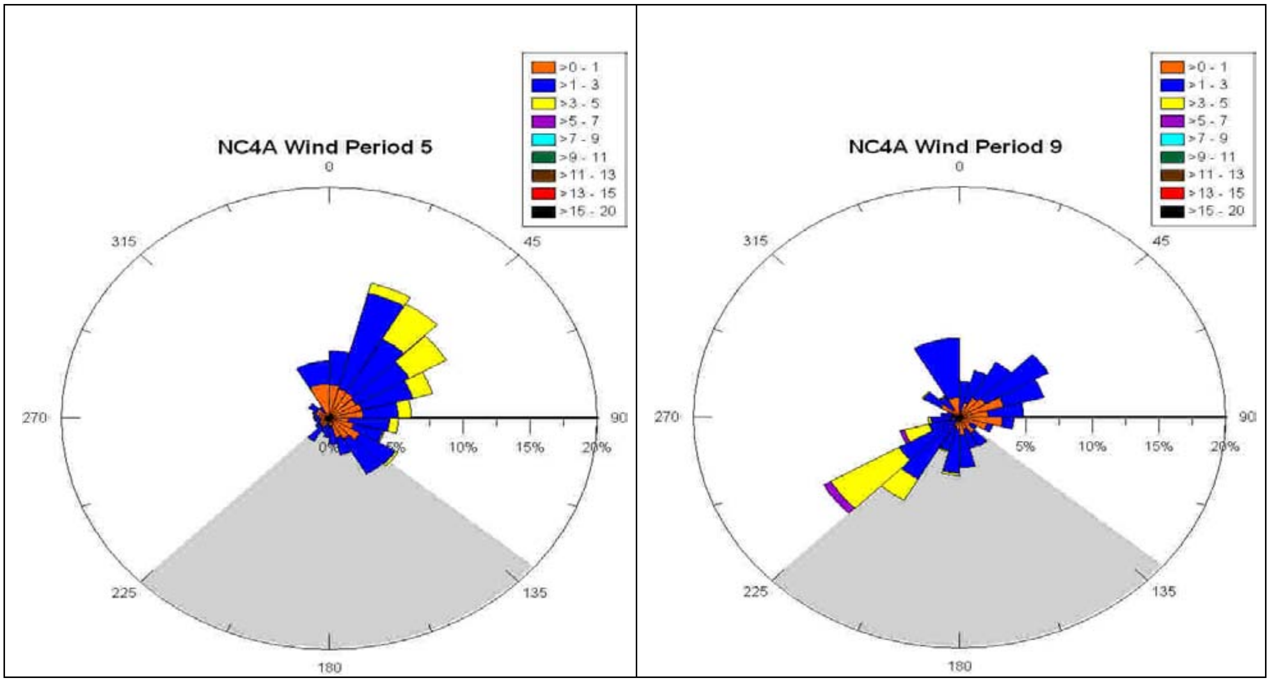

Figure 4.2-5: Wind roses for ½ hourly wind measurements during the Summer Measurement Periods. The periods in which measurements were made are indicated. The relative portion of time in which the wind is from a given direction is indicated by the length of the triangle pointing in that direction. The fraction of time in which the winds were in the binned speed ranges (units of ms^{-1}) 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 red with no crust or scum. Scum was evident at times during the spring and summer.

Table 4.3-1: Lagoon physical characteristics

Period	Appearance	Liquid depth	Sludge depth	Source of meas.
	Color/crust	(m)	(m)	
2; 10/02 - 10/22/2007	10/2/07 light red/no crust or scum 10/3/07 light red/no crust or scum 10/4/07 light red/no crust or scum 10/5/07 light red/no crust or scum 10/22/07 light red/15% scum	2.35		Producer
3: 01/29 - 02/12/2008	1/29/08 red/no crust or scum 1/30/08 red/no crust or scum 1/31/08 red/no crust or scum 2/1/08 red/no crust or scum 2/11/08 red/no crust or scum 2/12/08 red/no crust or scum	2.05		Producer
4: 03/31 - 04/17/2008	3/31/08 red/no crust or scum 4/1/08 red/no crust or scum 4/2/08 red/no crust or scum 4/14/08 red/no crust or scum 4/15/08 red/no crust or scum 4/16/08 red/5% scum 4/17/08 red/8% scum	2.27 1.76 (4/16/08)	0.2	Producer Sludge Gun
5: 08/12 - 09/03/2008	8/12/08 red/no crust or scum 8/13/08 red/no crust or scum 8/14/08 red/5% scum 8/26/08 red/no crust or scum 9/2/08 pink/no crust or scum	2.87		Producer
6: 09/03 - 09/23/2008	9/3/08 red/no crust or scum 9/4/08 red/no crust or scum 9/22/08 red/no crust or scum 9/23/08 red/no crust or scum	1.42 (9/3/08)	0.61	Sludge Gun
7: 01/14 - 02/03/2009	1/14/09 red/no crust or scum 1/15/09 red/no crust or scum 1/16/09 red/no crust or scum 2/2/09 pink/no crust or scum 2/3/09 pink/no crust or scum	2.22 1.69 (2/2/09)	0.16	Producer Sludge Gun
8: 04/27 - 05/11/2009	4/28/09 pink/no crust or scum 4/29/09 pink/no crust or scum 5/11/09 pink/no crust or scum 5/12/09 pink/5% scum	2.06		Producer
9: 06/30 - 07/22/2009	6/30/09 pink/no crust or scum 7/1/09 dark pink/15% crust 7/21/09 red/2% scum 7/22/09 red/1% scum	1.87 1.33 (7/1/09)	0.885	Producer Sludge Gun

4.3.2 Temperature, pH and oxidation-reduction potential

The measured lagoon liquid temperature varied from 3.2^{o} C to 32.4^{o} C (Section 6.11). The measured lagoon pH varied from 7.6 to 8.1 (Section 6.11) while the oxidation-reduction potentials varied from -245 mV to -553 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 was available for applications during the overall project period. Due to the drought conditions present at the site, water was only removed once (Table 4.3-3).

Table 4.3-3: Record of lagoon chemistry

				Percent (wet weight basis)		
Date	**n**	**pH (SU)**	**Nitrogen**	**Solids**	**Ammonia**	**Sulfur**
8/31/2009	1	7.40	0.20	N/A	N/A	0.08
7/17/2009	1	7.66	0.30	N/A	N/A	0.08
5/26/2009	1	7.46	0.36	N/A	N/A	0.01
4/3/2009	1	7.30	0.30	N/A	N/A	0.07
4/3/2009	1	7.30	0.30	N/A	N/A	0.07
2/18/2009	1	7.31	0.32	N/A	N/A	0.07
12/16/2009	1	7.63	0.24	N/A	N/A	0.07
10/15/2008	1	7.56	0.24	N/A	N/A	0.07
8/26/2008	1	7.68	0.26	N/A	N/A	0.08
7/9/2008	1	7.42	0.30	N/A	N/A	0.09
7/9/2008	1	7.42	0.30	N/A	N/A	0.09
5/16/2008	1	7.79	0.33	N/A	N/A	0.07
5/25/2009	1	7.49	0.38	N/A	N/A	0.08
1/24/2008	1	7.51	0.29	N/A	N/A	0.08
11/20/2007	1	7.41	0.29	N/A	N/A	0.08
9/25/2007	1	7.68	0.26	N/A	N/A	0.08
8/1/2007	1	7.68	0.27	N/A	N/A	0.07
6/15/2007	1	7.22	0.28	N/A	N/A	0.07
4/19/2007	1	7.50	0.39	N/A	N/A	0.07
3/22/2007	1	7.54	0.31	N/A	N/A	0.06
1/24/2007	1	7.59	0.23	N/A	N/A	0.04
12/1/2006	1	7.41	0.20	N/A	N/A	0.05

4.4 Emissions measurements

Emissions data were calculated on a ½ h 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. Emissions reported on a head basis were scaled by the design animal population and not the animal population at the time of measurements to account for the longer term manure storage of the lagoon or basin. Emissions reported on an animal unit (1 AU = 500 lb) basis assumed the typical animal weight values reported by the producer. Piglets were not included in the populations or AU determinations. Emissions reported on an area basis are based on the surface area of the lagoon.

Validation of bLS

The Method 301 validation method for the bLS emissions measurement was based on 829 ½ h measurement periods over the entire measurement time at this location. Results show that the bLS emissions had a significantly difference precision (F=3.14, critical F 1.0) and a significant bias over the *RPM* emissions (t=21.59, $t_{0.2}$=1.29) with a corresponding correction factor for the bLS of 1.55 (Table 4.4.1-1). Consequently the ½ h bLS emissions measurements are biased high by 64% 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 (gs^{-1})	0.793	1.227	0.434
Standard Deviation (gs^{-1})	0.443	0.785	
Variance of the mean (gs^{-1})	0.196	0.617	

4.4.1 NH_3 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 a highly variable summer emission of between approximately 20 g and 80 g $NH_3d^{-1}hd^{-1}$. The daily emissions during the winter decreased to approximately 5 g to 20g $NH_3d^{-1}hd^{-1}$; however most of the winter emissions measurements may be overestimated by 64% due to the interference of atmospheric moisture. There are only a small number of daily emissions measurements estimated with more than 75% of the day's emissions. Considering only those emission values reduces the summer emission maximum to between approximately 30 and 60 g $NH_3d^{-1}hd^{-1}$. 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.

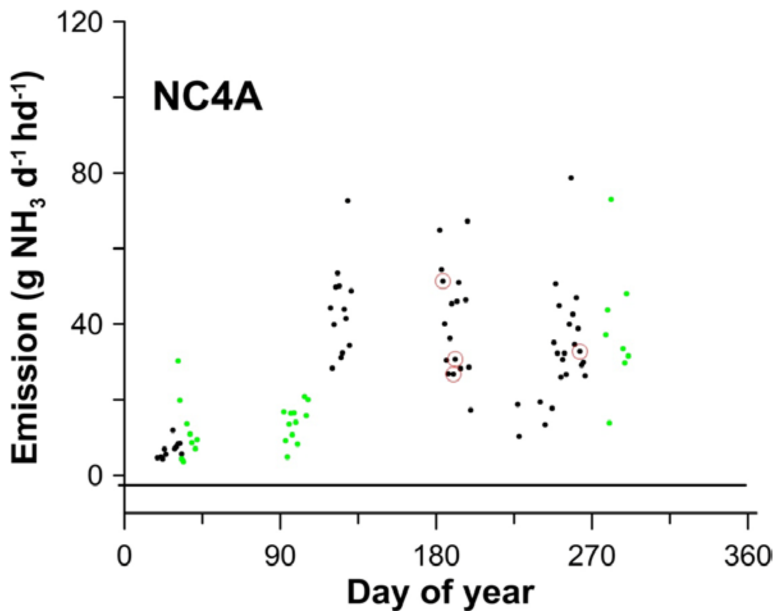

Figure 4.4.1-1: Annual variation in RPM-computed daily NH_3 emissions. Days with a red circle indicate there are measurements for greater than 75% of the continuous day. The green solid circles indicate moisture interference with the NH_3 concentration measurement.

An annual trend in the daily NH_3 emissions based on the bLS model was indicated (Figure 4.4.1-2) with a highly variable summer emission of between approximately -20 and 200 g NH_3 $d^{-1}hd^{-1}$.

The daily emissions during the winter decreased to approximately 10 g to 20 g NH_3 $d^{-1}hd^{-1}$; however most of the winter emissions measurements may be overestimated by 64% due to the interference of atmospheric moisture. There were more daily measurements estimated with more than 75% of the day's emissions than using the *RPM* emissions model. Considering only those emission values reduces the summer emission maximum to between approximately 40 and 75 g NH_3 $d^{-1}hd^{-1}$. 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.

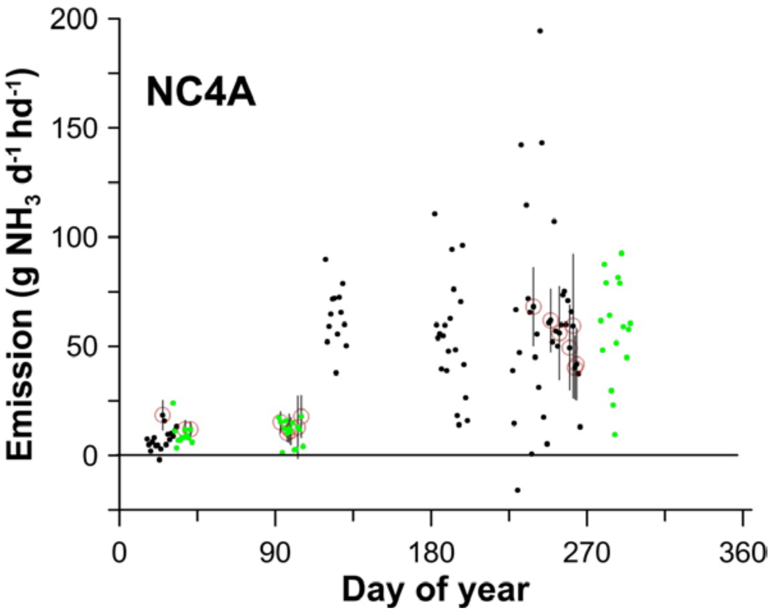

Figure 4.4.1-2: Annual variation in bLS-computed daily NH_3 emissions. Days with a red circle indicate there are measurements for greater than 75% of the continuous day. The bars represent the standard deviation of emissions based on individual ½ hr values when at least 75% of the day had valid measurements. 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 0.1 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 0.1 ppm, this corresponds to a background PIC of less than 10 ppm-m. This is approximately five times the MDL for the TDLAS instruments of 2 ppm-m (Section 8.1) and therefore represents a real background for this location. Negative background concentrations occur when the winds are variable resulting in no distinct upwind or downwind measurements.

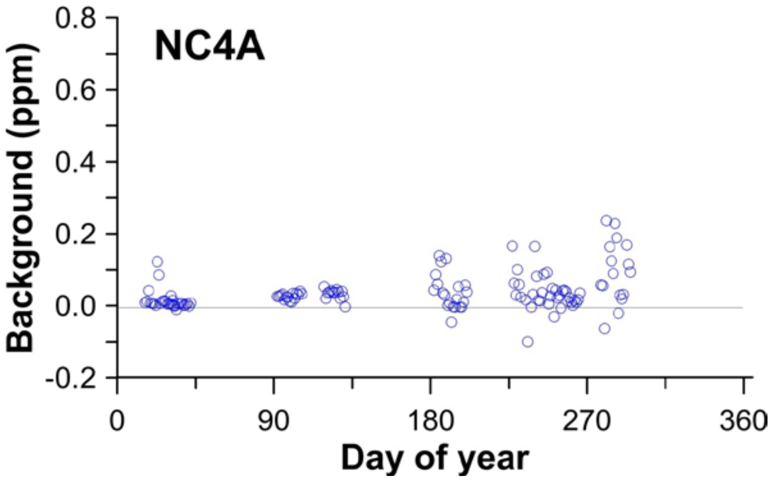

Figure 4.4.1-3: Annual variation in bLS-computed mean daily background concentration of NH_3.

4.4.1.2 Diurnal variation in NH_3 emissions

In general, there was a strong diurnal pattern to the NH_3 emissions during all but the winter and early spring measurement periods (Figure 4.4.1-4).

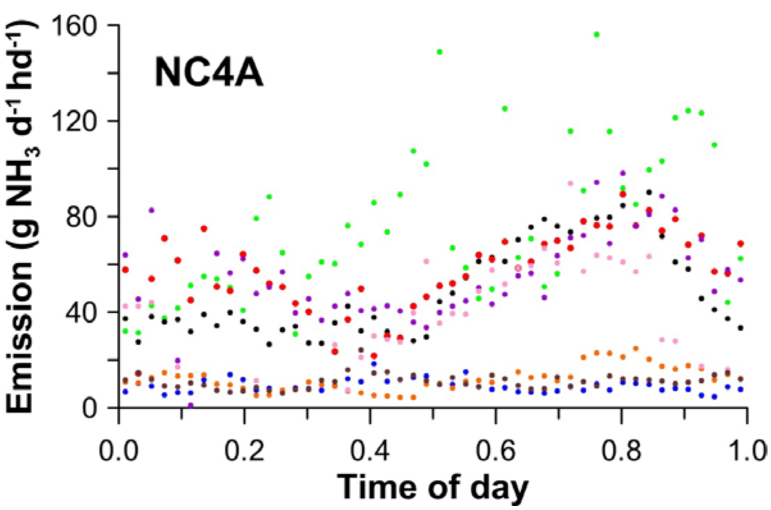

Figure 4.4.1-4: Diurnal variation in bLS-computed NH_3 emissions. Time based on Universal Time Coordinates. The mean emission for each half-hour of the day within a given measurement period (Period 2-Fall (pink), Period3-Winter (brown), Period 4-Spring (orange), Period 5-Summer (green), Period 6-Fall (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 h 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 h 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 h 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 are summarized in Table 4.4.1-2.

Table 4.4.1-2: Completeness statistics for NH_3 emissions measurements

	Measurement Period								
	2	**3**	**4**	**6**	**7**	**8**	**9**	**10**	**Total**
NH_3 RPM model									
Valid 1/2 h measurements (d)	1.3	1.5	1.5	0.3	6.9	1.9	4.4	7.0	**24.7**
Measurements excluded due to wind direction (d)	0.0	1.5	0.0	0.9	0.5	1.0	5.3	3.0	**12.0**
Measurements excluded because at least one downwind path is missing or invalid (d)	13.9	6.8	12.1	17.0	11.2	10.1	2.0	7.6	**80.8**
Number of d with≥36 valid 1/2 h periods (d)	0	0	0	0	1	0	0	3	**4**
NH_3 bLS model									
Valid 1/2 h measurements (d)	4.3	3.9	8.9	4.1	10.6	6.1	4.5	6.3	**48.7**
Measurements excluded due to wind direction (d)	0.7	2.0	2.6	1.8	1.6	2.8	5.1	3.0	**19.6**
Measurements excluded because touchdown fraction < 0.1 (d)	1.1	0.3	0.1	3.8	0.1	1.3	0.0	2.0	**8.6**
Measurements excluded because $u_* < 0.15$ ms^{-1} or $\|L\| < 2$ m (d)	8.5	4.1	2.7	8.0	6.0	6.8	2.1	7.4	**45.5**
Number of d with ≥36 valid 1/2 h periods (d)	0	2	6	1	6	1	0	0	**16**

In total, 24 d of valid NH_3 emissions were determined from the 138 measurement d using the *RPM* model, with only 4 d having at least 36 valid ½ h NH_3 emissions. The absence or invalidation of at least one downwind path led to 81 d for which emissions could not be calculated.

Forty eight d of valid NH_3 emissions were determined from the 138 measurement d using the bLS model, with 16 d having at least 36 valid ½ h NH_3 emissions. The exclusion wind directions due to the location of the barns relative to the lagoon resulted in the loss of 20 d of measurements. Invalid turbulence statistics ($u_* < 0.15$ ms^{-1} or $|L| < 2$ m) led to 46 d for which emissions could not be calculated. A touchdown fraction of less than 0.1 led to the exclusion of 8 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 h 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 h 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 while 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 H_2S Emissions

4.4.2.1 Mean daily H_2S emissions

The average concentrations of air measured from the two S-OPS were nearly always at the MDL for the 450i H_2S analyzer. Consequently the Ratiometric model emissions measurements reported are essentially the MDL of the emissions method under the wind conditions at this location. There was no distinct annual pattern to the Ratiometric H_2S emissions measurements at this location based on the Ratiometric emissions model. One value is not plotted (48.6 g H_2S d^{-1} hd^{-1} on DOY 125). This extremely high value is a result of highly variable winds. The negative emissions correspond to light and variable winds making an indistinct upwind and downwind S-OPS path. 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.

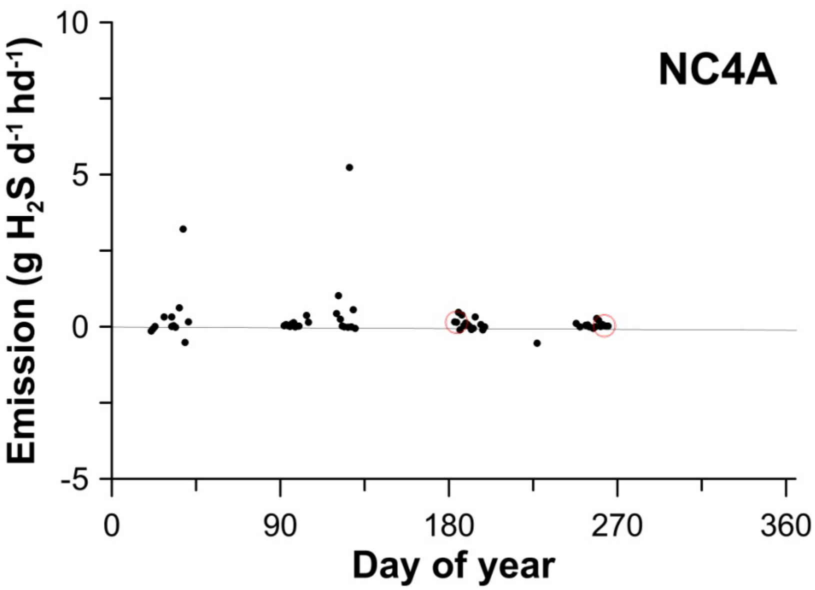

Figure 4.4.2-1: Annual variation in Ratiometric-computed daily H_2S emissions. Days with a red circle indicate there are measurements for greater than 75% of the continuous day. The green solid circles indicate moisture interference with the NH_3 concentration measurement.

As stated above, the average concentrations of air measured from the two S-OPS were nearly always at the MDL for the 450i H_2S analyzer and consequently the emissions measurements reported are essentially the MDL of the bLS emissions method under the wind conditions at this location. There is no distinct annual pattern to the H_2S emissions measurements at this location based on the bLS emissions model. One value (the same one as in the Ratiometric emissions estimate) is not plotted (26.1 g H_2S d^{-1} hd^{-1} on DOY 125). This extremely high value is a result of highly variable winds. The negative emissions correspond to light and variable winds making an indistinct upwind and downwind S-OPS path. 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.

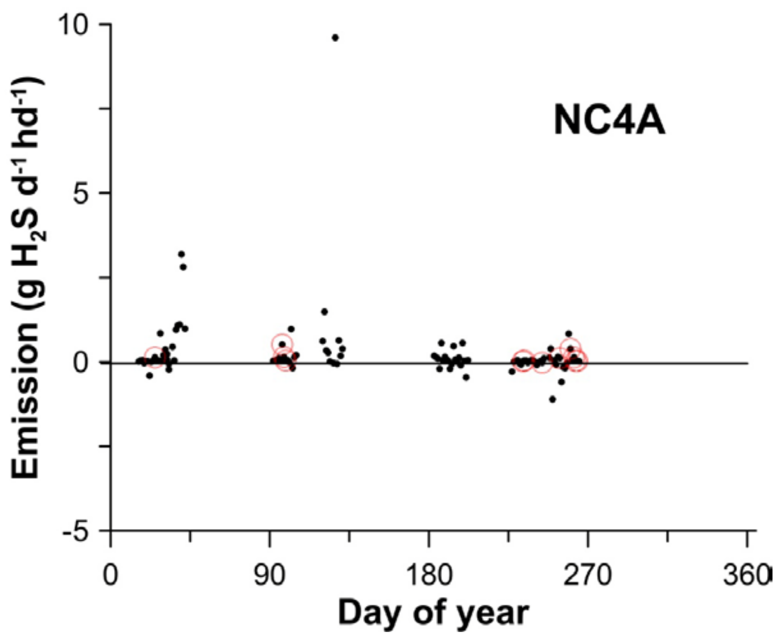

Figure 4.4.2-2: Annual variation in bLS-Computed daily H_2S emissions. Days with a red circle indicate there are measurements for greater than 75% of the continuous day. The bars represent the standard deviation of emissions based on individual ½ hr values when at least 75% of the day had valid measurements.

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 4.4.3-3). This background is consistent with an equivalent zero value where the instrument MDL was 3.4 ppb (Section 6.2).

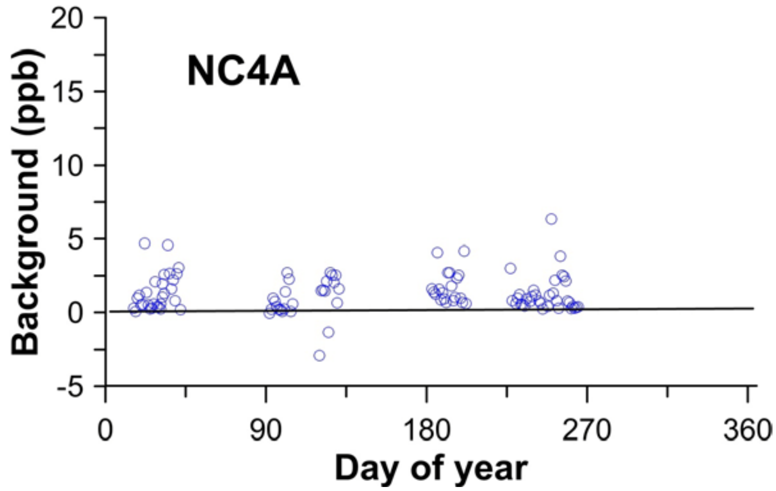

Figure 4.4.3-3: Annual variation in bLS-computed mean daily background concentration of H_2S.

4.4.2.2 Diurnal variation in H_2S emissions

There was no distinct diurnal periodicity in the H_2S emissions measurements (Figure 4.4.2-4).

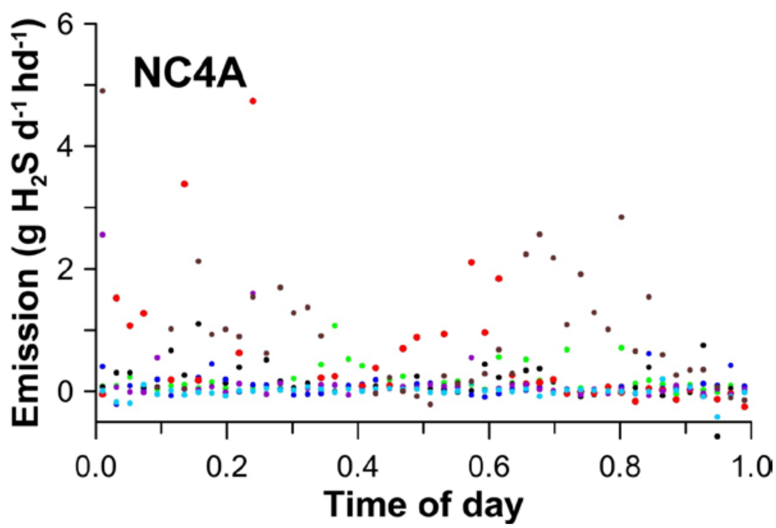

Figure 4.4.2-4: Diurnal variation in bLS-computed H_2S emissions. Time based on Universal Time Coordinates. The mean emission for each half-hour of the day within a given measurement period (Period 3-Winter (brown), Period 4-Spring (green), Period 5-Summer (light blue), Period 6-Fall (black), Period 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 h 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 are summarized in Table 4.4.2-1.

Table 4.4.2-1: Completeness statistics for H_2S emissions measurements

	Measurement Period								
	2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Total**
H_2S Ratiometric model									
Valid 1/2 h measurements (d)		0.6	1.1	0.0	5.1	0.5	2.7	4.7	**14.7**
Number of d with ≥36 valid 1/2 h periods (d)		0	0	0	1	0	0	1	**2**
H_2S bLS model									
Valid 1/2 h measurements (d)		2.6	5.9	5.4	8.3	5.0	3.0	6.4	**36.6**
Measurements excluded due to wind direction (d)		2.0	2.3	1.8	1.6	3.0	5.2	3.0	**18.7**
Measurements excluded because angle of attack > 60 degrees (d)		1.5	1.8	2.6	1.7	2.0	1.1	2.2	**12.9**
Measurements excluded because $u_* < 0.15$ ms^{-1} or $\|L\| < 2$ m (d)		5.0	2.5	8.8	6.0	7.1	2.0	7.9	**39.4**
Number of d with ≥36 valid 1/2 h periods (d)		0	3	3	5	1	0	0	**12**

The H_2S emissions were measured a total of 108.8 d at this location. The majority of measurements were invalidated as a result of inconsistent turbulence statistics- probably a result of the proximity of the wooded areas to the lagoon (Figure 1-2). 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, 14 d of valid H_2S emissions were determined using the Ratiometric emission method, with only 2 d having at least 36 valid ½ h H2S emissions. Thirty six d of valid H_2S emissions were determined using the bLS model, with 12 d having at least 36 valid ½ h H_2S emissions. Invalid turbulence statistics ($u_* < 0.15$ ms^{-1} or $|L| < 2$ m) excluded 39 d, largely due to low winds speeds. Wind direction exclusions invalidated 19 d of measurements.

4.4.3 Estimation of emission measurement errors

Errors in the response of the TDLAS due to atmospheric moisture limited the accuracy of the TDLAS serial numbers 1026, 1027, and 1028 prior to July 21, 2008. TDLAS 1027 was used at NC4A from 3/31/2008 to 4/16/2008 (Measurement period 4). TDLAS 1028 was used at NC4A from 10/4/2007 to 10/22/2007, 1/29/2008 to 2/11/2008, 3/31/2008 to 4/16/2008 (Measurement periods 2, 3 and 4). Under the calibration verification checks, the TDLAS error of all units was 10% accuracy. However 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°C to 20°C. A conservative estimate of the bias of all of the above TDLAS units with evident moisture interference was estimated at -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 +55% (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 +15% for TDLAS NH_3 measurements made by units with moisture interference and a bias of +55% 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%.

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6 Appendices

6.1 TDLAS NH_3 calibrations

Six TDLAS units Model GasFinder 2.0™ NH3OP (Boreal Laser Inc., Spruce Grove, Alberta, Canada) were used at this location: serial numbers 1026, 1027, 1028, 1030, 1031, and 1032

TDLAS 1026 was multipoint calibrated seven times (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 7/21/2008 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 r^2 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 r^2 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 2.04 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 bias exceedances 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). During operations the bias was only intermittently evident because two different multipoint calibrations were applied to the calibration verification measurements during the progress of the study. Repeated calibrations within 24 hours often showed biases differing by more than 10 ppm-m, which suggested 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 assumed to be due to the calibration verification operator.

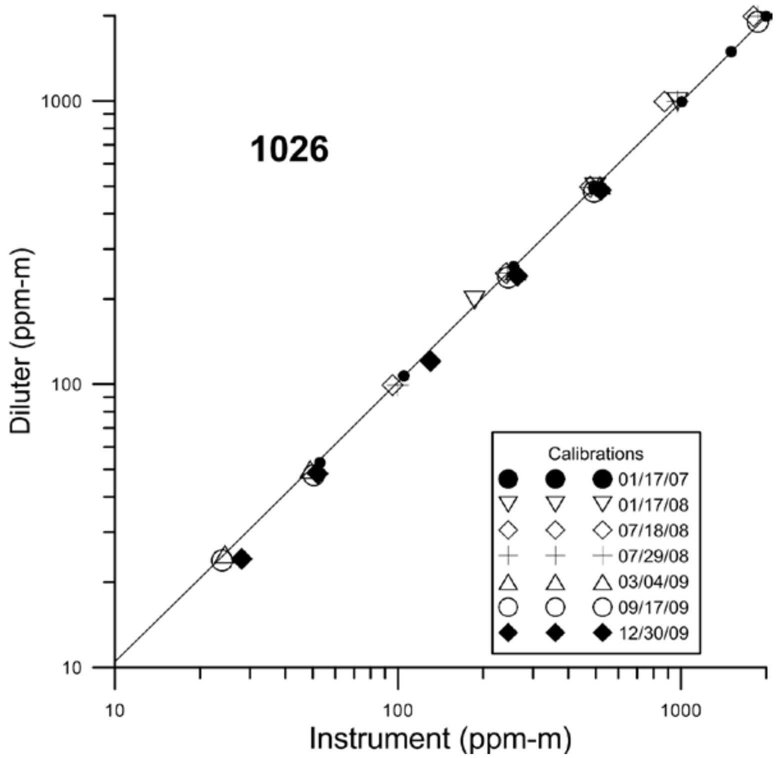


Figure 6.1-1: Multipoint calibrations of the GasFinder 2.0 TM s/n NH3OP-1026. The solid line is the 3rd order polynomial regression for the chosen multipoint calibration.

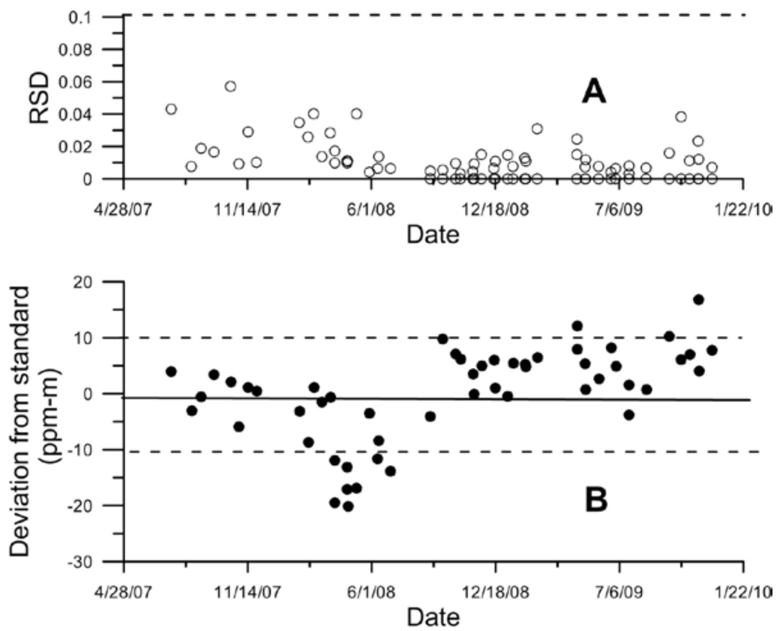


Figure 6.1-2: Control charts of the GasFinder 2.0 TM s/n NH3OP-1026

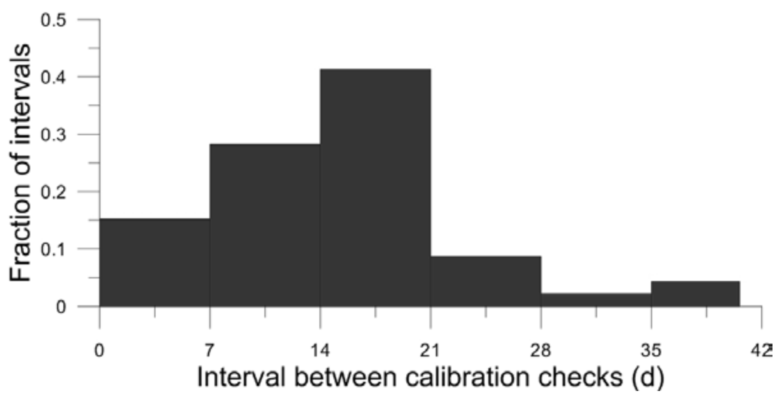


Figure 6.1-3: Calibration check intervals of the GasFinder 2.0 TM s/n NH3OP-1026

TDLAS 1027 was multipoint calibrated eight times (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 6/18/08 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 7/21/2008 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 r^2 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 r^2 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 is 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 2.13 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 were 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 6.1-4). No negative biases exceeding the DQI occurred. Since both positive bias exceedances 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.

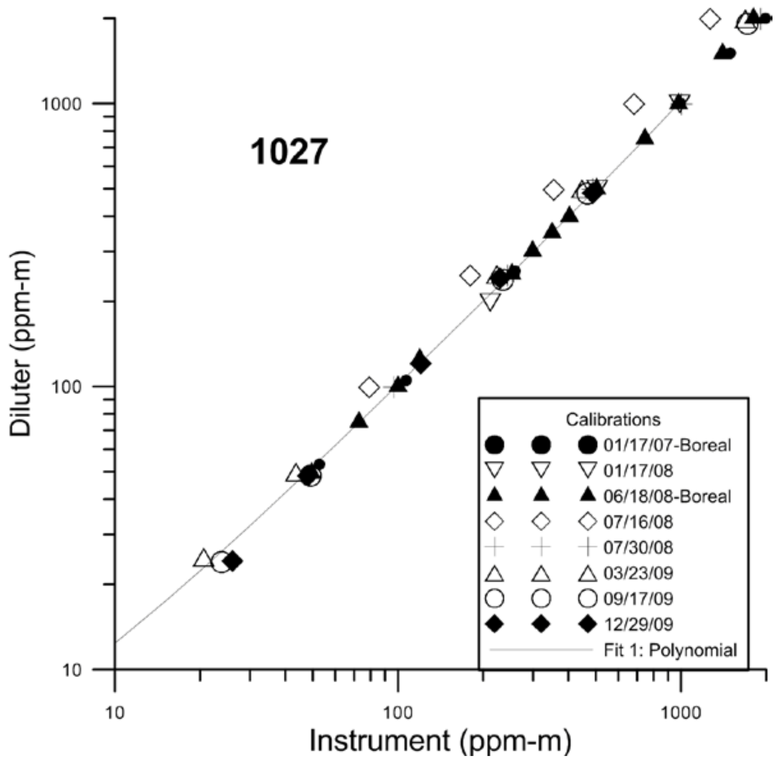


Figure 6.1-4: Multipoint calibrations of the GasFinder 2.0 ™ s/n NH3OP-1027. The solid line is the 3rd order polynomial regression for the chosen multipoint calibration.

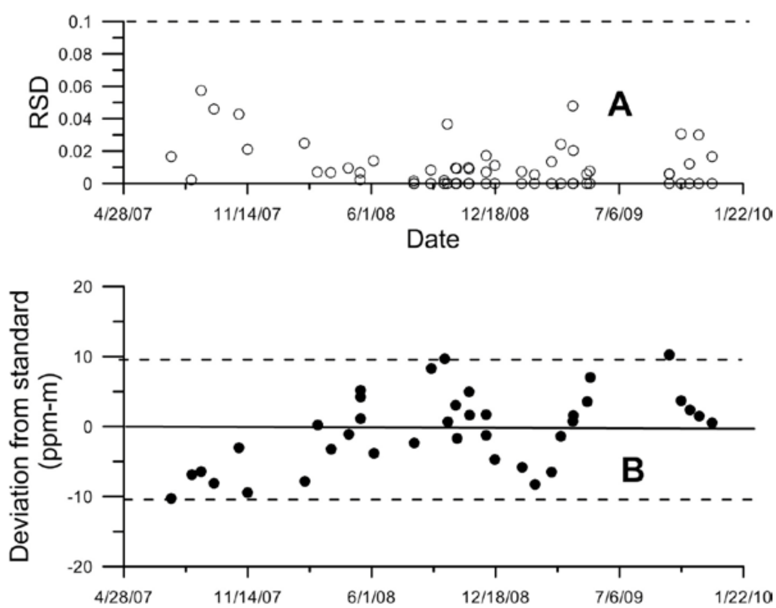


Figure 6.1-5: Control charts of the GasFinder 2.0 ™ s/n NH3OP-1027

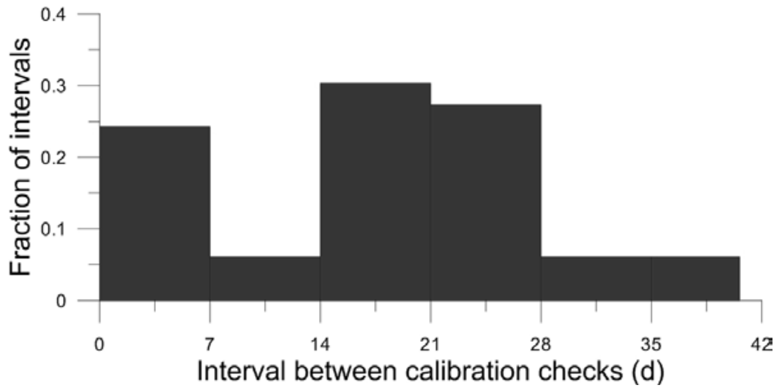


Figure 6.1-6: Calibration check intervals of the GasFinder 2.0 ™ s/n NH3OP-1027

TDLAS 1028 was multipoint calibrated six times (Figure 6.1-7). The response is non-linear and consequently a third-order polynomial was used to correct the instrument measurements for the instrument response. The multi-point calibration on 5/23/07 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:

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

where X was the instrument response. The response of the sensor was influenced by humidity until 7/21/2008 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 r^2 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 r^2 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 is 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 were 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 exceedance bias and it is concluded that operator error resulted in the exceedances rather than instrument failure.

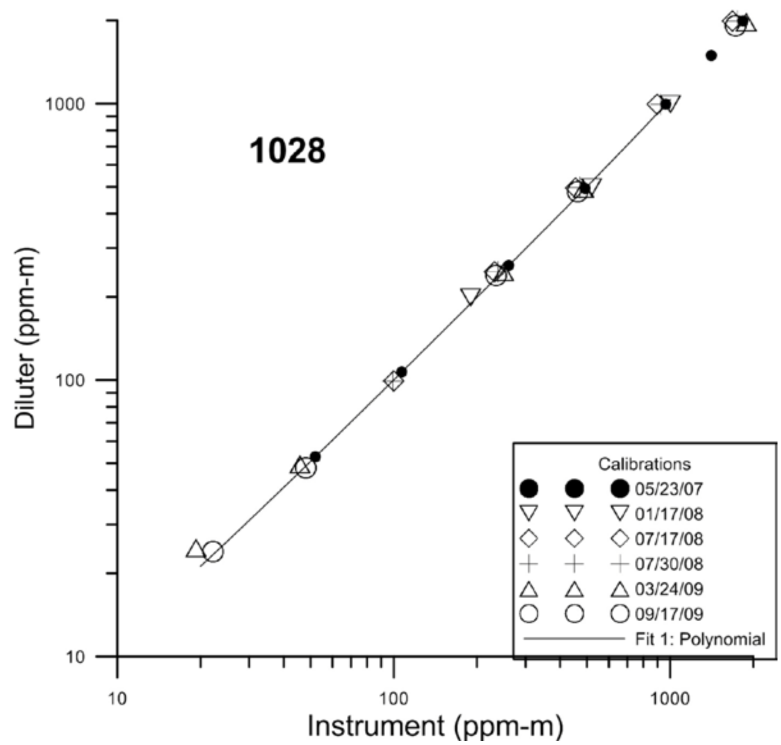


Figure 6.1-7: Multipoint calibrations of the GasFinder 2.0 ™ s/n NH3OP-1028. The solid line is the 3rd order polynomial regression for the chosen multipoint calibration.

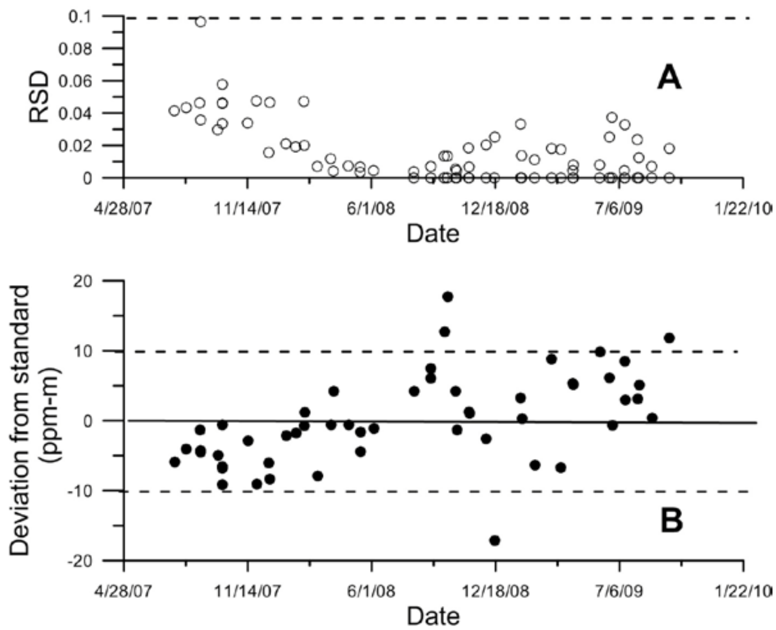


Figure 6.1-8: Control charts of the GasFinder 2.0 TM s/n NH3OP-1028

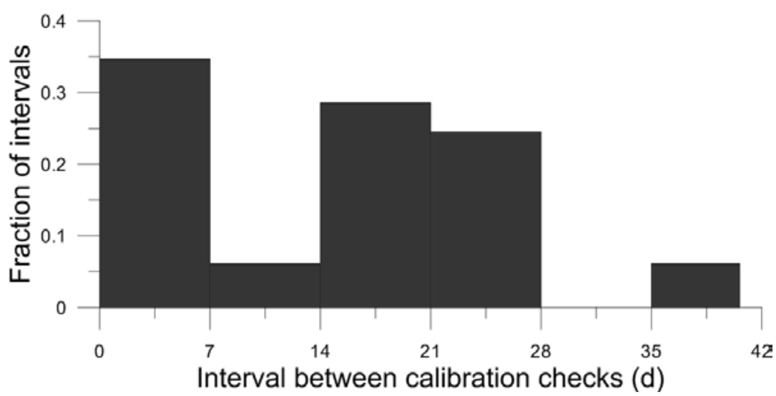


Figure 6.1-9: Calibration check intervals of the GasFinder 2.0 TM s/n NH3OP-1028

TDLAS 1030 was multipoint calibrated eight times (Figure 6.1-10). The response is non-linear and consequently a third-order polynomial was used to correct the instrument measurements for the instrument response. The multi-point calibration on 3/26/08 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:

ppm-m = $0.13 + 0.9974 * X - 2.1056E\text{-}005 * X^2 + 3.050E\text{-}008 * X^3$, where X was the instrument response. The response of the sensor was influenced by humidity until 7/21/2008 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 r^2 values under conditions in which the concentration of NH_3 was more than three times of the MDL, and 2) reduce the reported concentration. The 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 r^2 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 3.05 ppm-m prior to the July 2008 modification and 0.685 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 6.1-11) 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 were 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 7.27 ppm-m. The precision DQI was ±10% RSD at 100 ppm-m. All verifications resulted in less than 10% RSD for 50 ppm-m except on 8/30/2007 (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 positive bias in the calibration verification exceeding the DQI occurred on 8/14/2008 and 9/23/2008 while negative biases exceeding the DQI occurred on 10/4/2007, 9/23/2008, and 4/28/2009 (Figure 6.1-11). In all cases, subsequent calibration verifications did not indicate the same exceedance bias and it is concluded that operator error resulted in the exceedances rather than instrument failure.

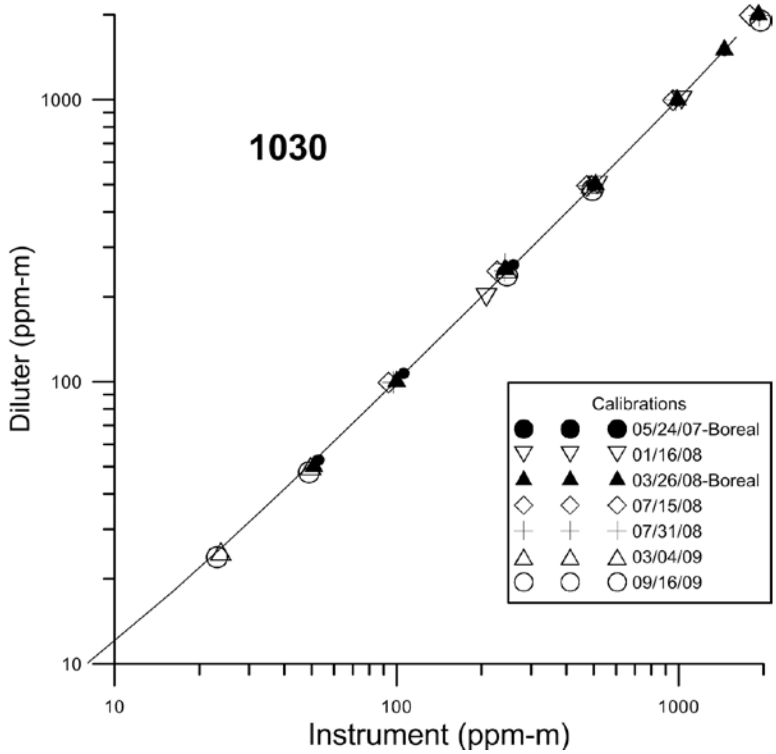


Figure 6.1-10: Multipoint calibrations of the GasFinder 2.0 ™ s/n NH3OP-1030. The solid line is the 3rd order polynomial regression for the chosen multipoint calibration.

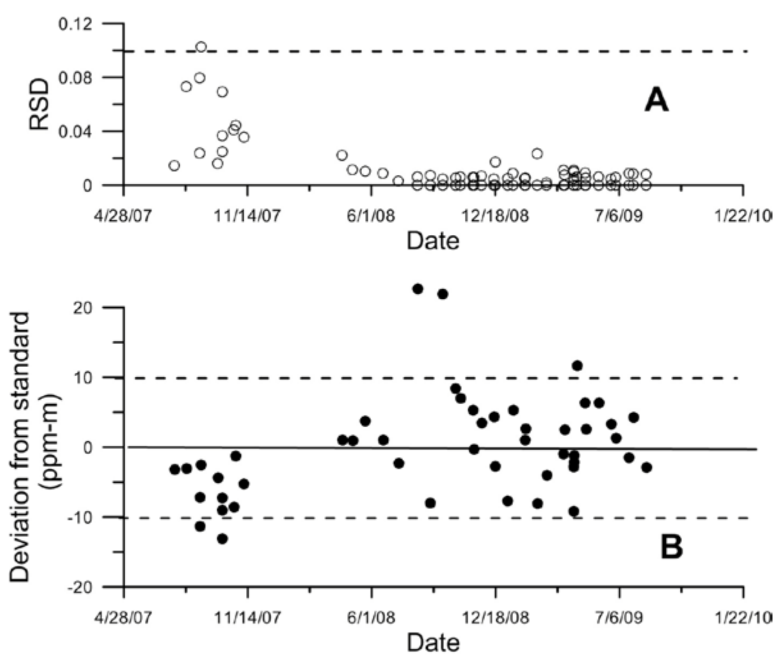


Figure 6.1-11: Control charts of the GasFinder 2.0 ™ s/n NH3OP-1030

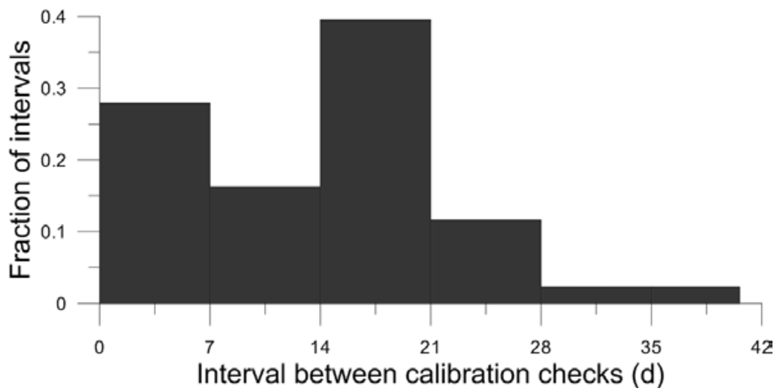


Figure 6.1-12: Calibration check intervals of the GasFinder 2.0 TM s/n NH3OP-1030

TDLAS 1031 was multipoint calibrated six times (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 5/30/07 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 bias exceedances 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 exceedance was preceeded and followed by DQI-compliant verifications and the 8/12/2009 verification was preceeded 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 due to damage from moisture in the instrument.

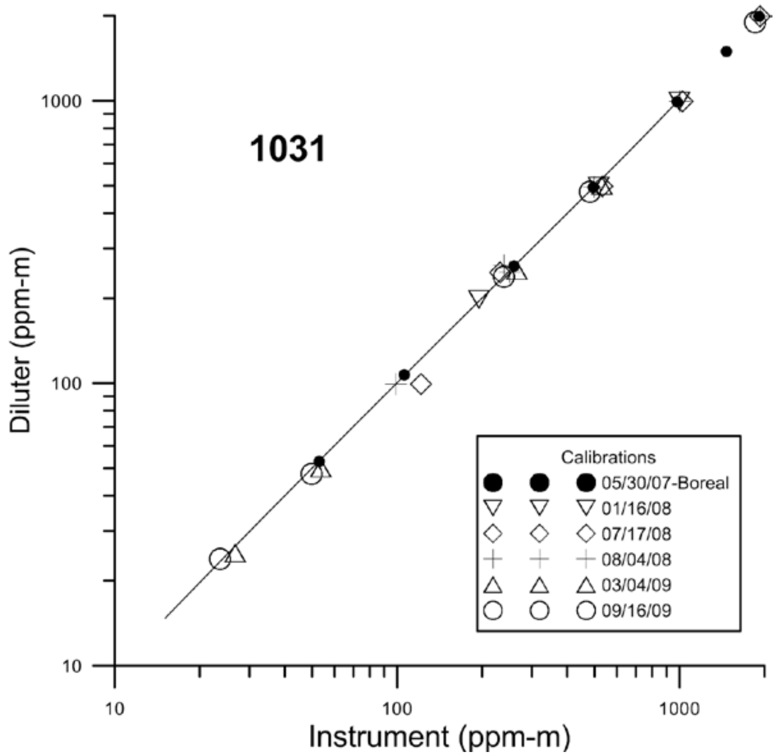


Figure 6.1-13: Multipoint calibrations of the GasFinder 2.0 ™ s/n NH3OP-1031. The solid line is the 3rd order polynomial regression for the chosen multipoint calibration.

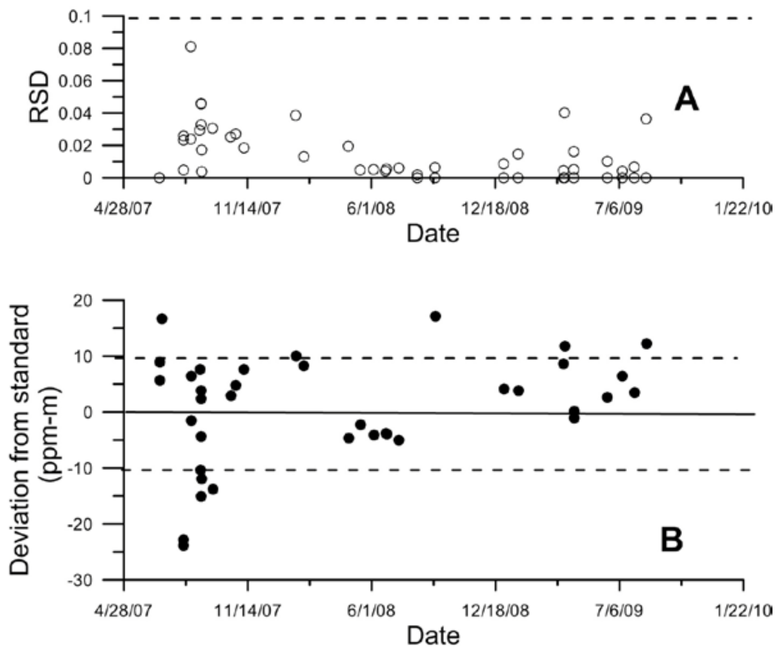


Figure 6.1-14: Control charts of the GasFinder 2.0 ™ s/n NH3OP-1031

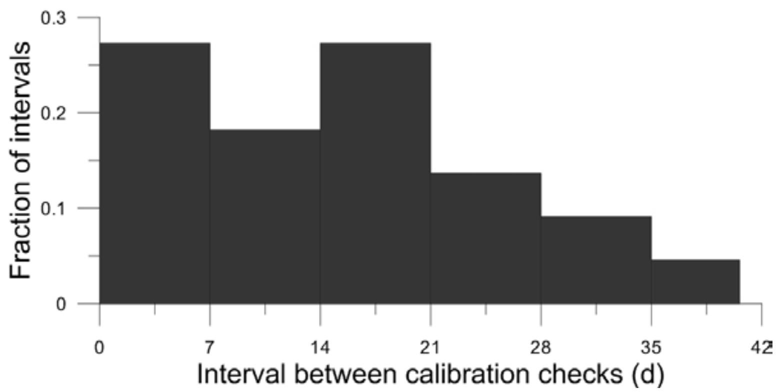


Figure 6.1-15: Calibration check intervals of the GasFinder 2.0 ™ s/n NH3OP-1031

The Boreal GasFinder 2.0 TM, serial number NH3OP-1032, was multipoint calibrated six times (Figure 6.1-16). The response is 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 6.1-1: 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 6.1-1) 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:

9/12/07: $\text{ppm-m} = -4.35 + 1.005 * X + 3.563\text{ E-005} * X^2 - 2.618\text{ E-008} * X^3$

3/4/09: $\text{ppm-m} = -0.69 + 0.995 * X - 2.3298\text{ E-004} * X^2 + 2.891\text{ E-007} * X^3$

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 reportable instrument response was above the minimum light level threshold considered for a valid instrument measurement.

A zero concentration was not reportable by this instrument because the concentration is 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 exceedances were preceeded and followed by valid calibration verifications and it is assumed that since no modifications of the instrument were made that the exceedances are 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 exceedance was followed by compliant verifications (although low) without correction of the grounding problem it is assumed that the measurements are valid throughout the period of the grounding problem.

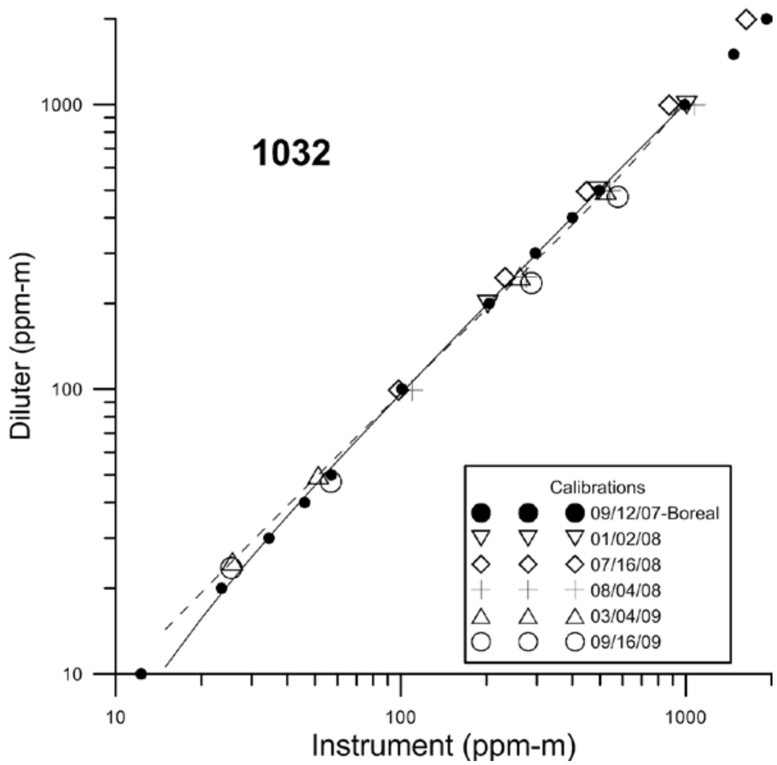


Figure 6.1-16: Multipoint calibrations of the GasFinder 2.0 ™ s/n NH3OP-1032. The solid (9/12/07) and dashed (3/4/09) lines are the 3rd order polynomial regressions for the chosen multipoint calibration.

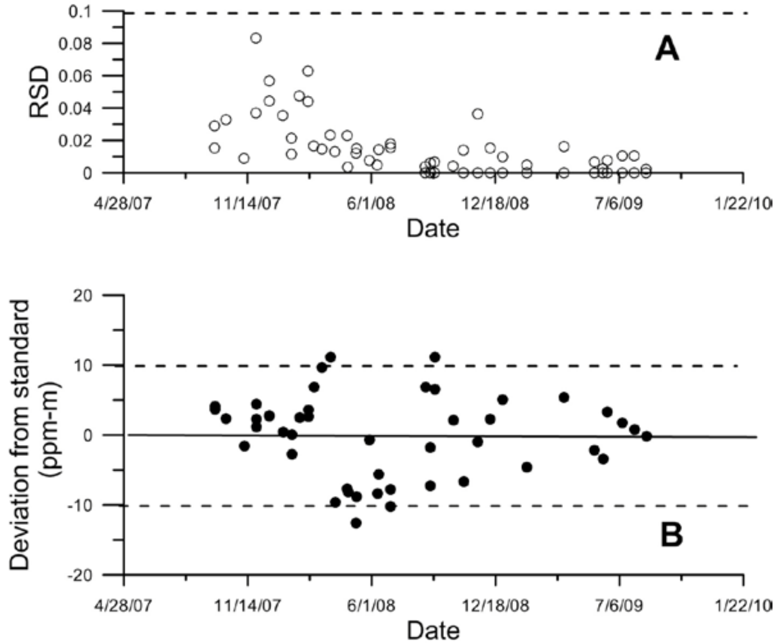


Figure 6.1-17: Control charts of the GasFinder 2.0 ™ s/n NH3OP-1032

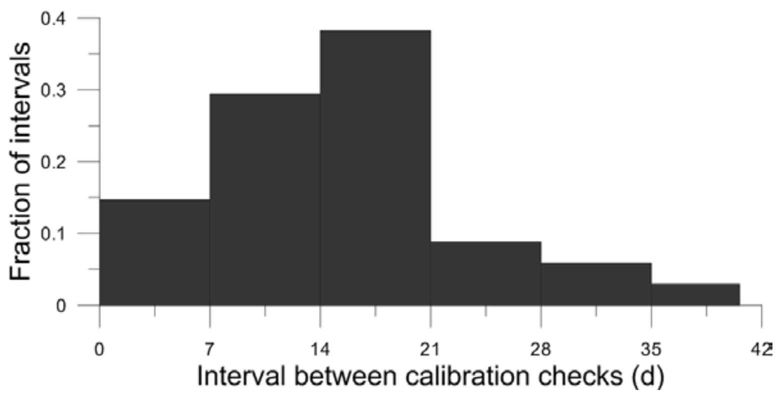


Figure 6.1-18: Calibration check intervals of the GasFinder 2.0 ™ s/n NH3OP-1032

6.2 TEC 450i analyzer H_2S calibrations

The SO_2/H_2S Analyzer (Model TEC 450i, Thermo Fisher Scientific, Franklin, MA) (serial number 0733825130) (serial number 0733825129) was multipoint calibrated seven times (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 0.67 to 0.94 (Table 6.2-1). The initial 12/30/2007 multipoint calibration records were lost.

Table 6.2-1: Multipoint H_2S calibrations

Date	Slope (ppb/response)	Intercept (ppb)	r^2
07/21/2008	0.67	0.0100	0.999
11/25/2008	0.81	0.0070	0.999
03/05/2009	0.94	0.0165	0.999
04/23/2009	0.73	0.0263	0.999
04/29/2009	0.78	0.0206	0.999
09/01/2009	0.75	0.0054	0.999
12/29/2009	0.81	0.0083	0.999

The standard deviation of instrument response with CEM zero air measured over a one hour period was 0.81 ppb (12/29/2009). The instrument MDL, defined as 3σ was 2.4 ppb and is indicated in Figure 6.2-2A with dashed lines. This is much less than the mean absolute value of the multipoint calibration intercept of 13.4 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 25 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 to instrument reading. The long-term mean ratio for this instrument was 0.800. The mean zero concentration was +0.3 ppb, less than the MDL.

The instrument measurement accuracy DQI was 10% of full scale (FS; 1 ppm). The initial calibration check (1/15/2008) was conducted prior to the complete burn-in of the converter and consequently differs from the other calibrations and indicated a failed check in the post-study response check (Figure 6.2-2B). Post-study response checks in August and September 2008 also indicated check failures (Figure 6.2-2B), although all of these failures are associated with a non-diluted calibration cylinder where the balance gas was N_2 and consequently, the 450i converter was unable to function properly.

The instrument measurement precision DQI was 10% of FS. Precision DQI exceedances (Figure 6.2-3) occurred on 2/12/2008 and 3/5/2009. The 2/2/2008 failure was likely due to the burn-in of the converter and signal changes in the instrument response as the instrument is conditioned. The failure on 3/5/2009 was likely a result of the use of an out-of-certification range calibration cylinder (although within certification period; FF44447). This cylinder was 38% below the mean concentration of nine cylinders inter-compared on 8/28,31/2009. Calibration certifications before and after this date were valid.

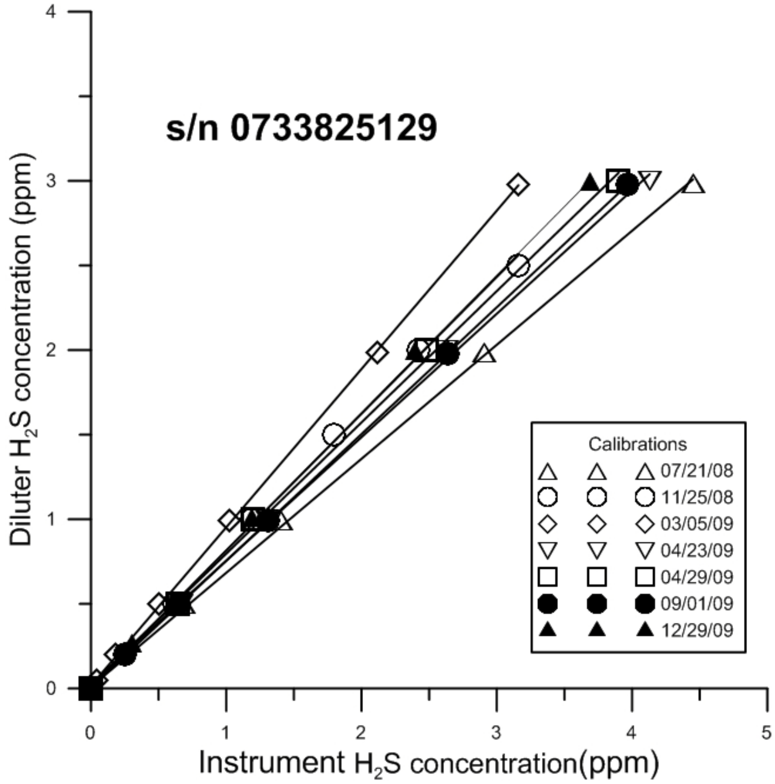


Figure 6.2-1: Multipoint calibrations of the 450i SO_2/H_2S Analyzer

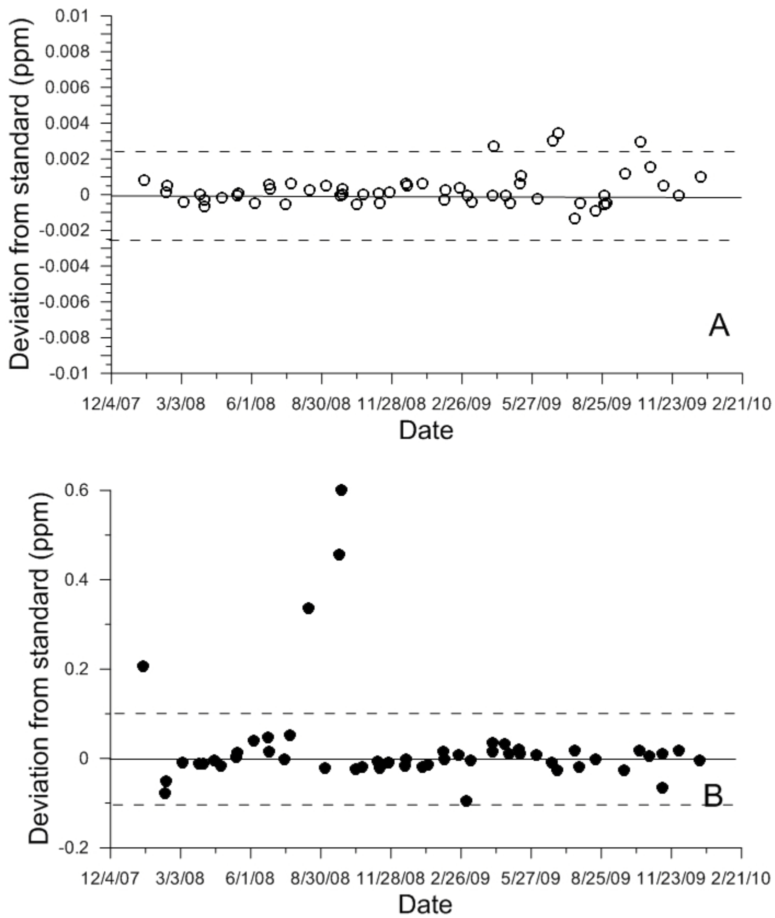


Figure 6.2-2: Instrument Control Charts

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).

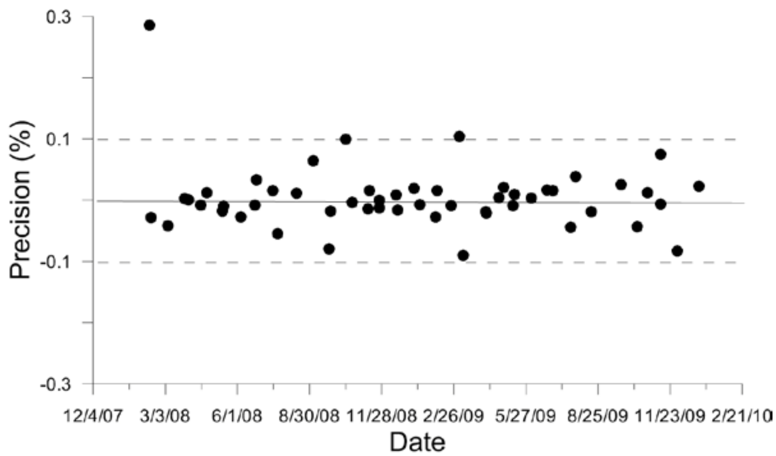


Figure 6.2-3: Instrument Precision

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).

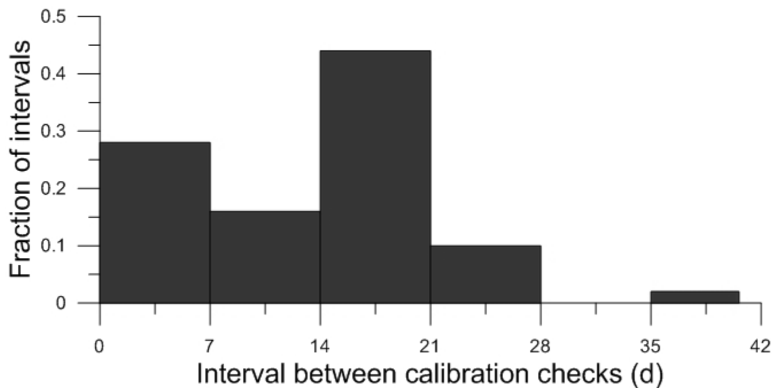


Figure 6.2-4: Calibration check intervals

6.3 Sonic anemometer calibrations

Seven sonic anemometers (Model 81000, RM Young Inc, Traverse City, MI) were used at this location: serial numbers 1927, 1926, 1933, 1920, 1928, 1945, and 1932.

The sonic anemometer 1927 was inter-compared with three reference 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 and 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: Reference inter-comparisons

Calibration dates		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	03/25-27/2009	-0.050	-0.028
9/1-2/2009	9/2-03/2009	-0.035	-0.023

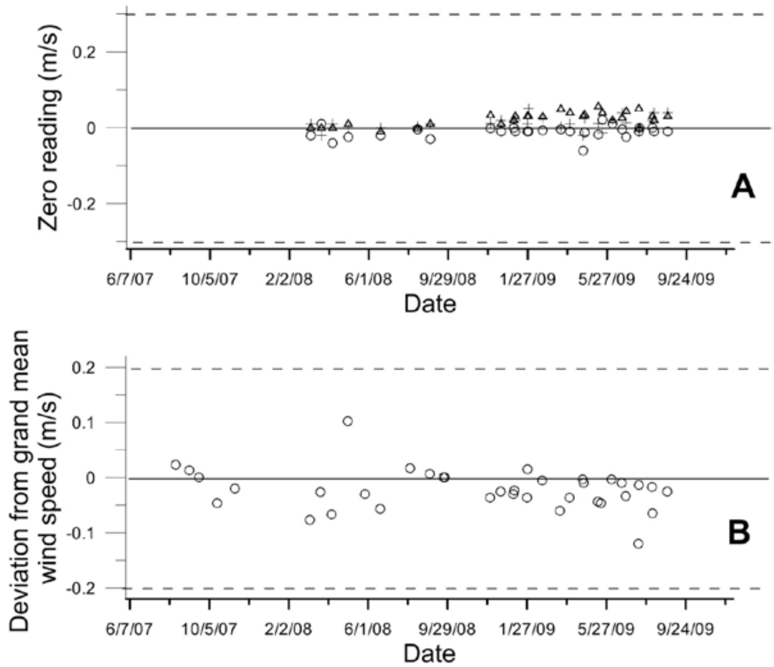


Figure 6.3-1: On-site quality assurance of s/n 1927. The DQI for the zero and inter-comparisons are indicated by the dashed lines. The zero check in the x (open circle), y (open triangle) and z (cross) components are indicated in panel A.

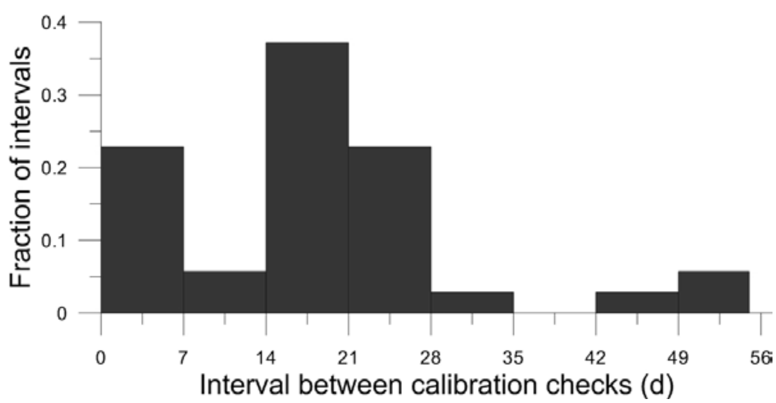


Figure 6.3-2: Inter-comparison check intervals for s/n 1927.

The sonic anemometer 1926 was inter-compared with three reference anemometers of identical design five times (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 35 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 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 6.3-3B). 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 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 6.3-2: Reference inter-comparisons

Calibration dates		Mean difference from reference anemometers (ms^{-1})	
Alignment 1	**Alignment 2**	**Alignment 1**	**Alignment 2**
6/19-22/2007	6/29-7/2/2007	-0.005	-0.033
1/17-18/2008	1/20-21/2008	-0.013	-0.032
7/16-17/2008	7/17-18/2008	+0.037	+0.059
3/6-7/2009	3/7-9/2009	+0.004	+0.048
9/16-17/2009	9/17-18/2009	+0.059	+0.001

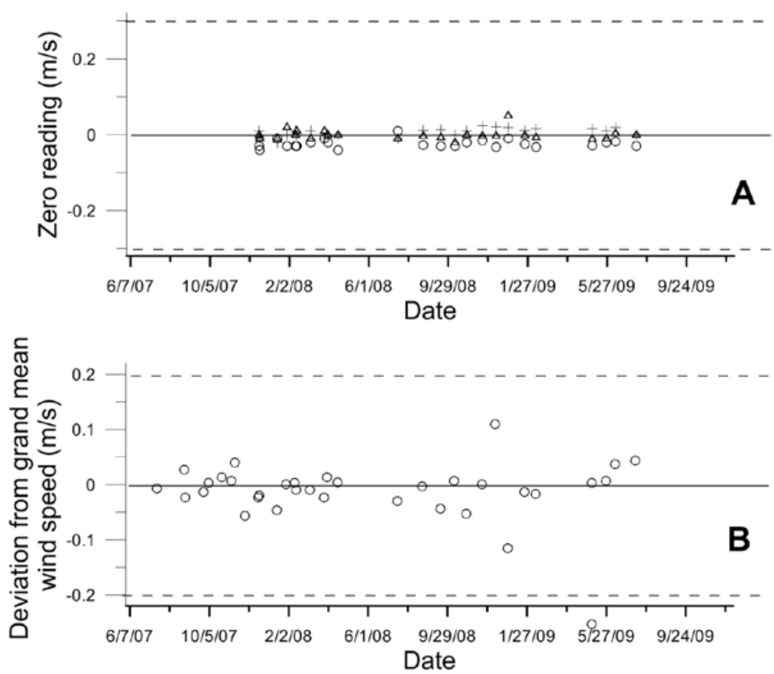


Figure 6.3-3: On-site quality assurance of s/n 1926. The DQI for the zero and inter-comparisons are indicated by the dashed lines. The zero check in the x (open circle), y (open triangle) and z (cross) components are indicated in panel A.

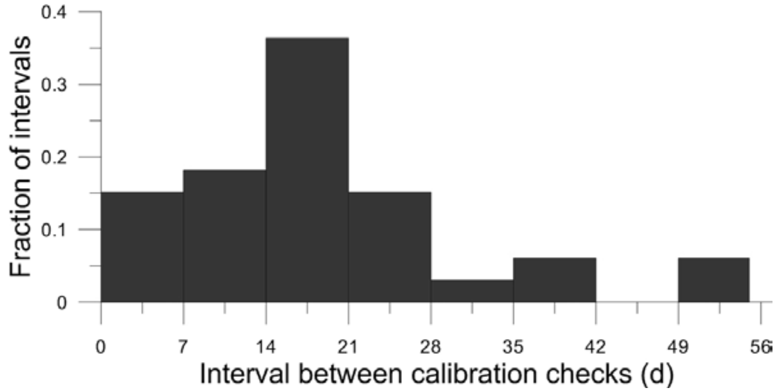


Figure 6.3-4: Inter-comparison check intervals for s/n 1926.

The sonic anemometer 1933 was inter-compared with three reference anemometers of identical design three times (Table 6.3-3). This instrument was used as a reference prior to use in the on-site measurements beginning 4/23/2008. 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 23 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 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 6.3-5B). This instrument passed this check on all checks except 7/21/2009 and was taken out of service. The last reference inter-comparison (1/2010) failed due to loss of communications.

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: Reference inter-comparisons

Calibration dates		Mean difference from reference anemometers (ms^{-1})	
Alignment 1	Alignment 2	Alignment 1	Alignment 2
7/18-19/2008	7/21-22/2008	+0.012	+0.014
3/3-5/2009	3/5-6/2009	-0.016	-0.004
1/7-9/2010	1/23-25/2010	-3.733	-3.93

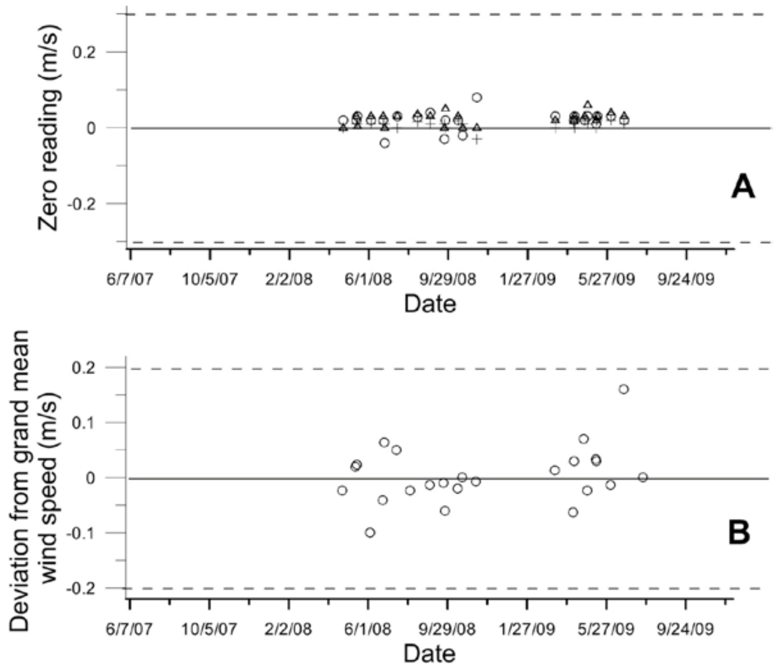


Figure 6.3-5: On-site quality assurance of s/n 1933. The DQI for the zero and inter-comparisons are indicated by the dashed lines. The zero check in the x (open circle), y (open triangle) and z (cross) components are indicated in panel A.

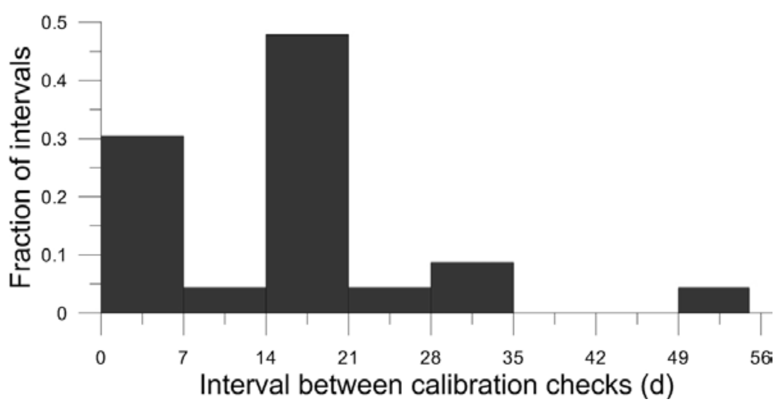


Figure 6.3-6: Inter-comparison check intervals for s/n 1933.

The sonic anemometer 1920 was inter-compared with three reference anemometers of identical design five times (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 51 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 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 6.3-7B). This instrument passed this check at all times. However this instrument developed intermittent problems during operation and was sent to the factory for repair 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 6.3-7A). 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: Reference inter-comparisons

Calibration dates		Mean difference from reference anemometers (ms^{-1})	
Alignment 1	**Alignment 2**	**Alignment 1**	**Alignment 2**
6/19-22/2007	6/29-7/2/2007	+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

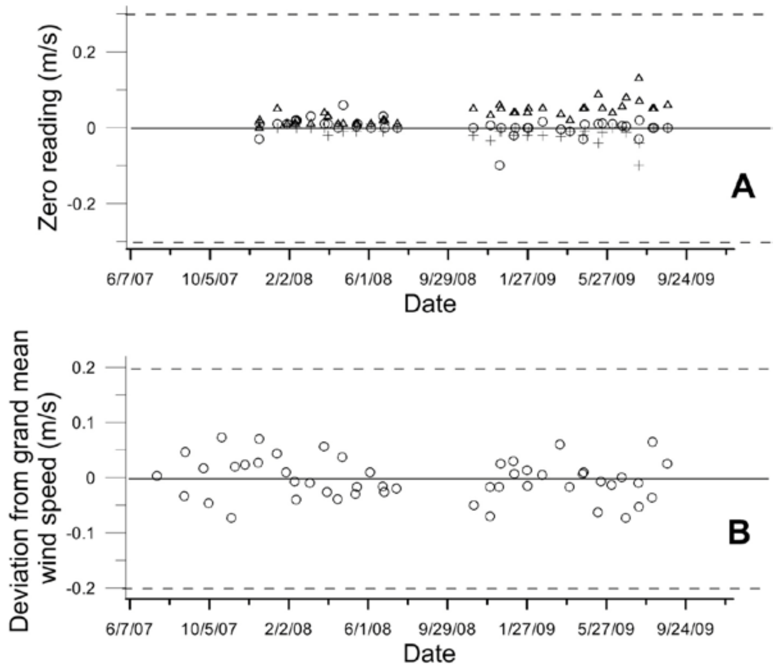


Figure 6.3-7: On-site quality assurance of s/n 1920. The DQI for the zero and inter-comparisons are indicated by the dashed lines. The zero check in the x (open circle), y (open triangle) and z (cross) components are indicated in panel A.

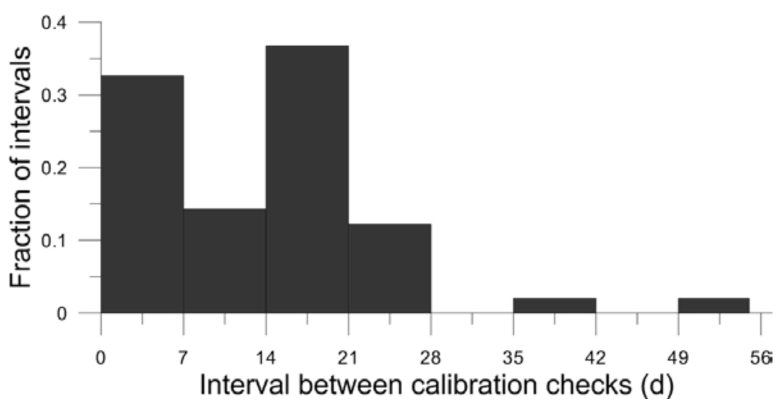


Figure 6.3-8: Inter-comparison check intervals for s/n 1920.

The sonic anemometer 1928 was inter-compared with three reference anemometers of identical design six times (Table 6.3-5). No absolute turbulence calibration is 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 6.3-9). 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 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 6.3-9A). 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: Reference inter-comparisons

Calibration dates		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

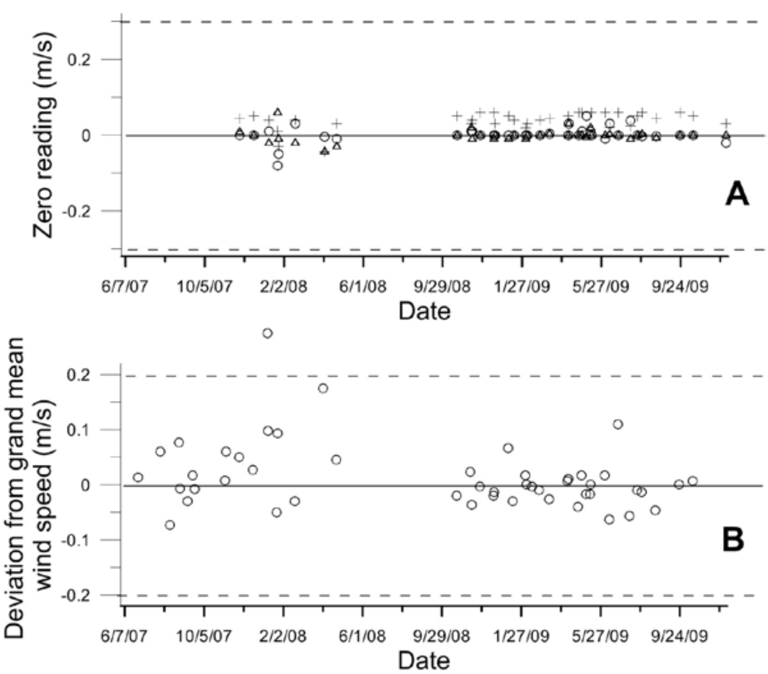


Figure 6.3-9: On-site quality assurance of s/n 1928. The DQI for the zero and inter-comparisons are indicated by the dashed lines. The zero check in the x (open circle), y (open triangle) and z (cross) components are indicated in panel A.

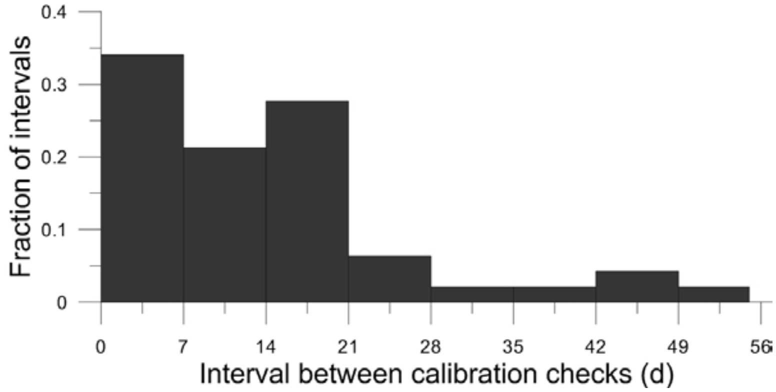


Figure 6.3-10: Inter-comparison check intervals for s/n 1928.

The sonic anemometer 1945 was inter-compared with three reference anemometers of identical design five times (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 45 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 6.3-6: Standards inter-comparisons

Calibration dates		**Mean difference from reference anemometers (ms^{-1})**	
Alignment 1	**Alignment 2**	**Alignment 1**	**Alignment 2**
6/19-22/2007	6/27-7/2/2007	+0.001	-0.051
1/17-19/2008	1/20-21/2008	-0.023	-0.037
7/18-21/2008	7/21-22/2008	+0.023	+0.026
3/3-4/2009	3/5-6/2009	+0.014	+0.171
9/16-17/2009	9/17-18/2009	+0.028	-0.012

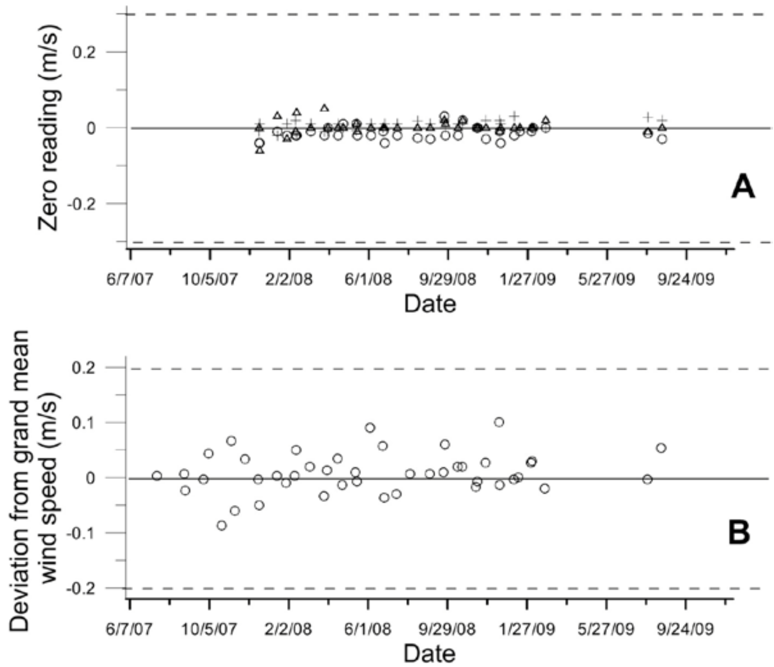


Figure 6.3-11: On-site quality assurance of s/n 1945. The DQI for the zero and inter-comparisons are indicated by the dashed lines. The zero check in the x (open circle), y (open triangle) and z (cross) components are indicated in panel A.

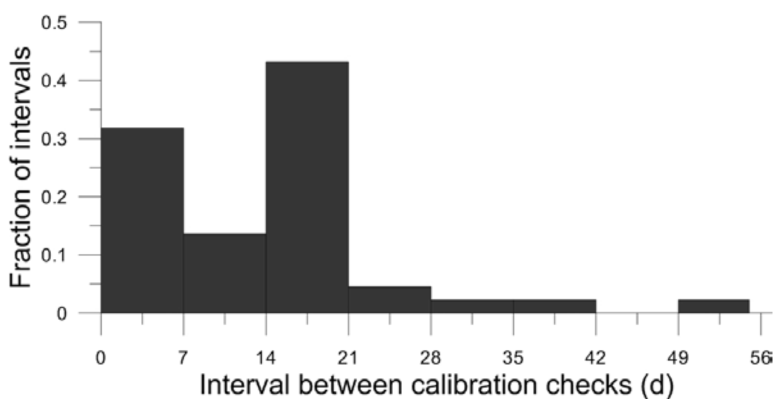


Figure 6.3-12: Inter-comparison check intervals for s/n 1945.

The sonic anemometer 1932 was inter-compared with three reference anemometers of identical design six times (Table 6.3-7). 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 6.3-13). The majority of calibration checks were made within 21 d (Figure 6.3-14). 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 6.3-13B). This instrument passed this check on all checks except 10/15-16/2008 and 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 6.3-13B). 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 6.3-7: Standards inter-comparisons

Calibration dates		**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

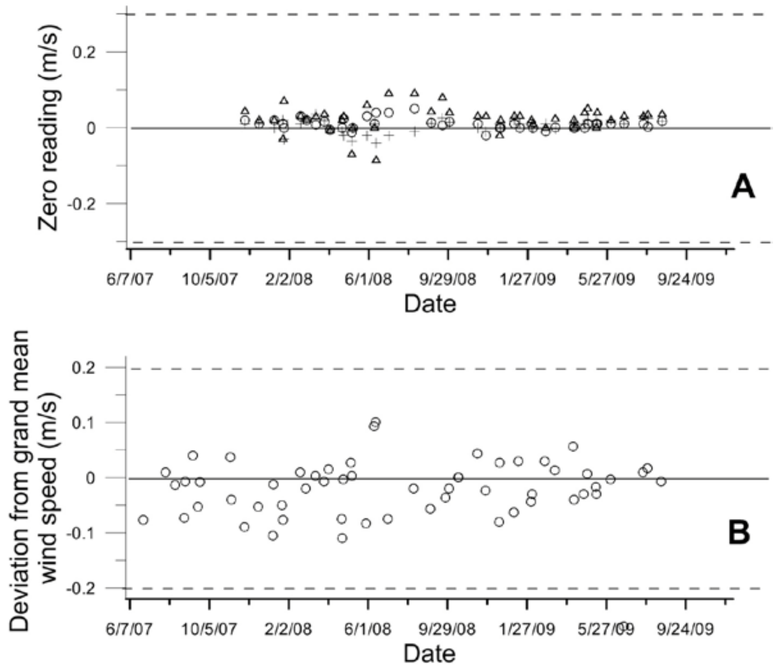


Figure 6.3-13: On-site quality assurance of s/n 1932. The DQI for the zero and inter-comparisons are indicated by the dashed lines. The zero check in the x (open circle), y (open triangle) and z (cross) components are indicated in panel A.

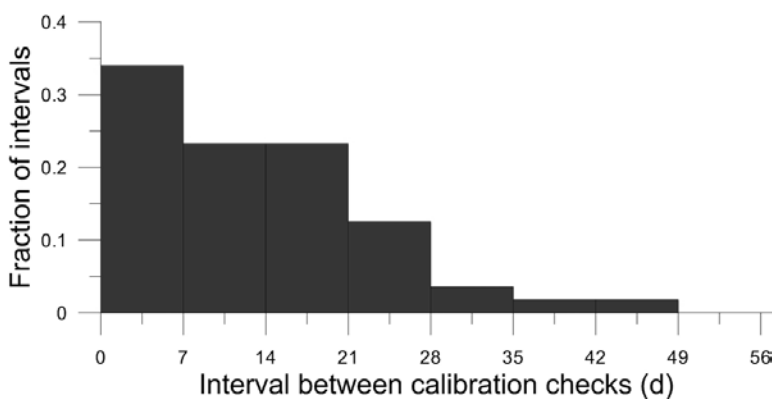


Figure 6.3-14: Inter-comparison check intervals for s/n 1932.

6.4 pH probe calibrations

Three probes (Model CSIMM-ph, Innovative Sensors Inc., Anaheim, California) were used at this location with serial numbers 001, 004, and 007.

Probe 001, was used between 7/18/2007 and 4/30/2008. The probe was calibrated 17 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 probe always passed both the accuracy DQI and the stability checks.

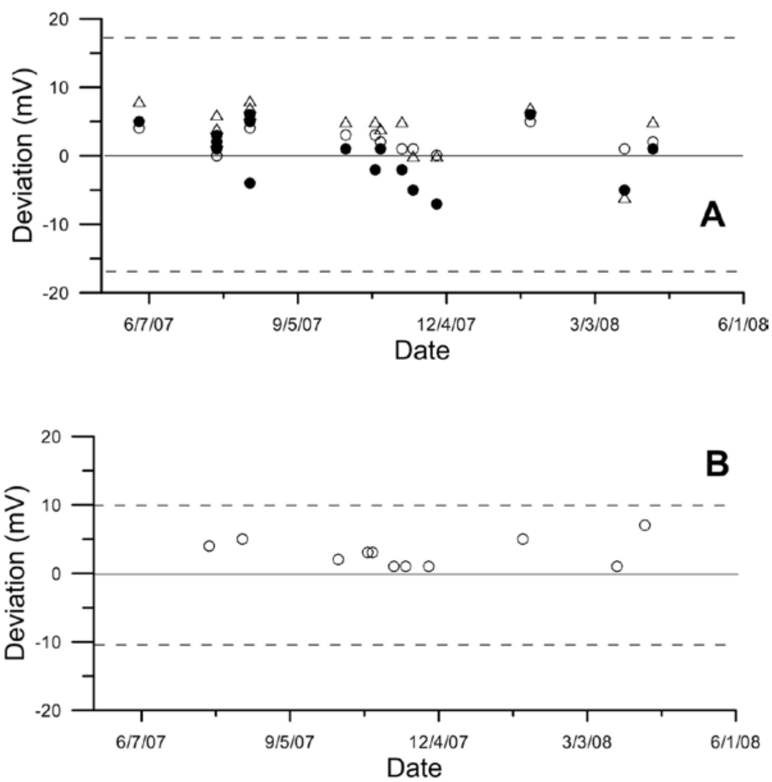


Figure 6.4-1: Accuracy and stability calibration checks of CSIM11 pH probe s/n 001. The absolute deviation in mV of the pH 4 (closed circle), pH 7 (open circle), and ph 10 (solid triangle) are indicated in panel A. The dashed lines define the DQI limits. The time history of the absolute stability is indicated in panel B where the dashed lines indicate the desired bounds on the stability.

Probe 004, was used between 7/8/2007 and 2/3/2009. The probe was calibrated 27 times. Since freezing conditions damage the probe, the probes were not used during the winter at many locations. 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 probe passed the accuracy DQI on all checks but 2/3/2009 but failed the stability checks 9/23/2008, 9/25/2008, and 2/3/2009. Since the sensor passed checks subsequent to the 9/2008 checks, these failures were likely due to operator error. The last check on 2/3/2009 indicated a faulty sensor.

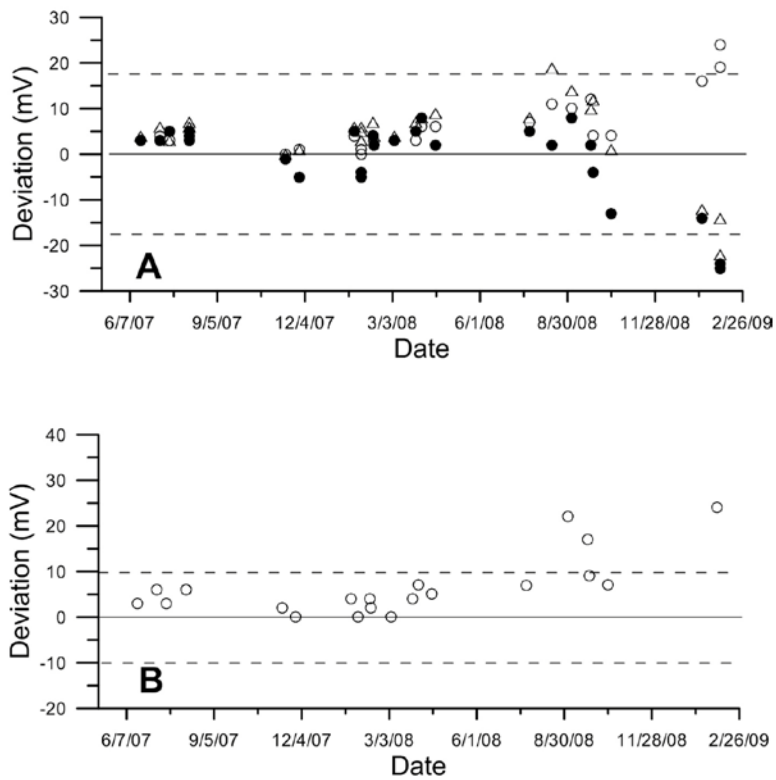


Figure 6.4-2: Accuracy and stability calibration checks of CSIM11 pH probe s/n 004. The absolute deviation in mV of the pH 4 (closed circle), pH 7 (open circle), and ph 10 (solid triangle) are indicated in panel A. The dashed lines define the DQI limits. The time history of the absolute stability is indicated in panel B where the dashed lines indicate the desired bounds on the stability.

Probe 007, was used between 2/5/2009 and 12/2/2009. The probe was calibrated 14 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 both the accuracy DQI and the stability checks.

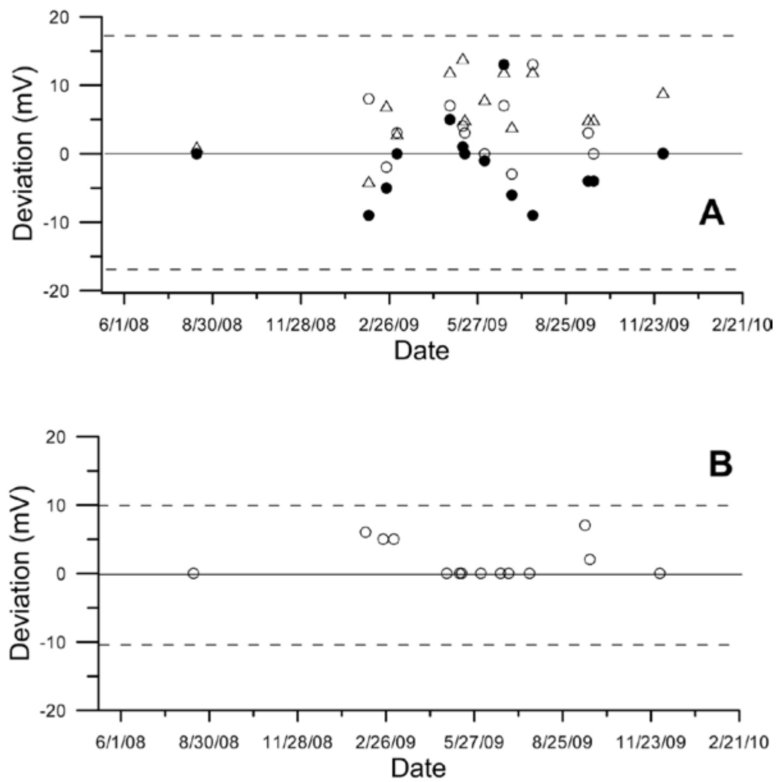


Figure 6.4-3: Accuracy and stability calibration checks of CSIM11 pH probe s/n 007. The absolute deviation in mV of the pH 4 (closed circle), pH 7 (open circle), and ph 10 (solid triangle) are indicated in panel A. The dashed lines define the DQI limits. The time history of the absolute stability is indicated in panel B where the dashed lines indicate the desired bounds on the stability.

In general, the probe calibrations were conducted at the beginning and end of each measurement period. Since freezing conditions damaged the probes, the probes were not used during the winter at many locations. 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.

6.5 ORP probe calibrations

Two oxidation-reduction potential (ORP) probes (Model CSIM11-ORP, Innovative Sensors Inc., Anaheim, California) were used at this location with serial numbers 020 and 050

ORP probe s/n 020 was used between 7/18/2007 and 9/3/2008. The probe was calibrated 16 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 probe passed the accuracy check DQI on all but 3/27/2008, 4/2/2008, and 8/14/2008. Subsequent accuracy check however met the accuracy DQI without probe modification so the prior failures were assumed to be due to operator error. The stability deviated significantly from the normal range on 4/2/2008 and 8/14/2008 indicating a possible partially-plugged probe.

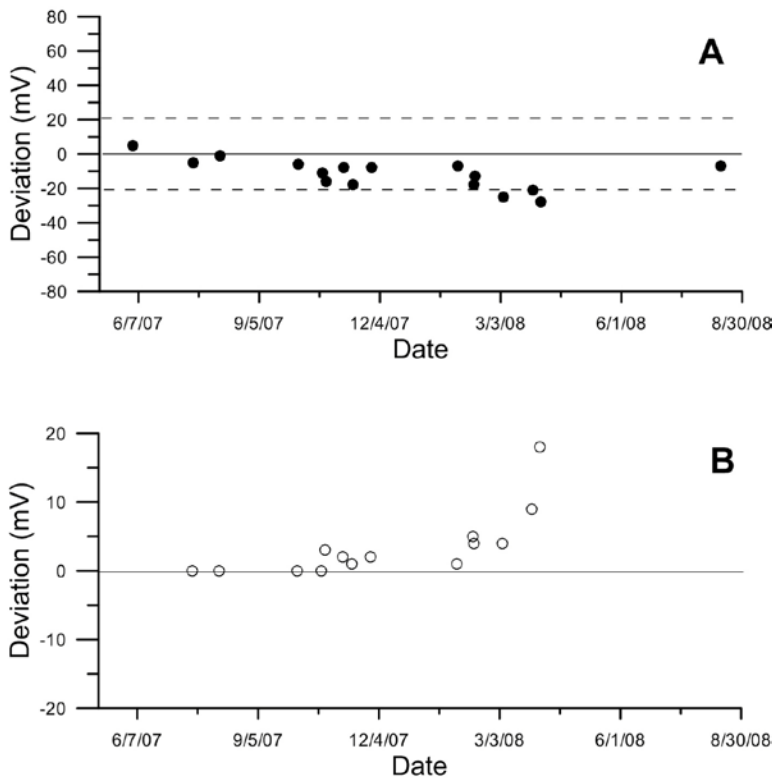


Figure 6.5-1: Accuracy and stability calibration checks of CSIM11 ORP probe s/n 020. The stability check of the probe (Panel B) and the absolute deviation in mV of the probe (panel A) are indicated. The dashed lines define the DQI limits in panel A.

ORP probe s/n 020 was used between 4/24/2008 and 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.

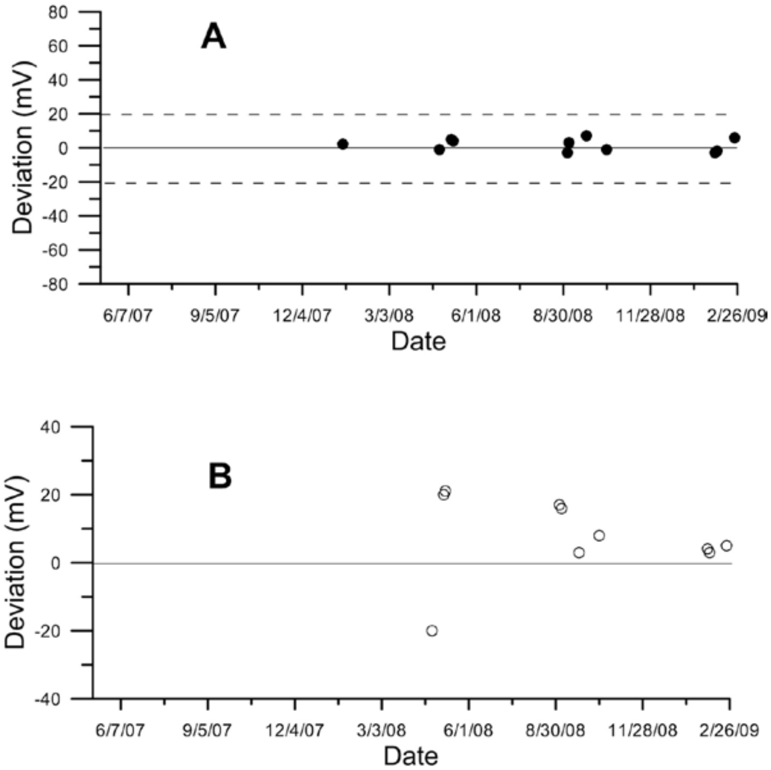


Figure 6.5-2: Accuracy and stability calibration checks of CSIM11 ORP probe s/n 050. The stability check of the probe (Panel B) and the absolute deviation in mV of the probe (panel A) are indicated. The dashed lines define the DQI limits in panel A.

In general, the probe calibrations were conducted at the beginning and end of each measurement period. Since freezing conditions damaged the probes, the probes were not used during the winter at many locations. 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.

6.6 S-OPS operational checks

The Synthetic Open Path Systems (S-OPS; s/n D and F) and the Gas Sampling System (GSS s/n 4-0018) 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. Often GSS leak check failures corresponded to successful S-OPS leak checks that included the GSS within the system check (Table 6.6-1). Leaks in the GSS generally were a result of pump problems or incorrect zero offset determinations. 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 6/26/2008, 7/15/2008, 12/17/2008, 1/15/2009, 2/3/2009, 2/6/2009, and both lines on 10/22/2008 were not resolved during the site visit due to time constraints. Repairs to the S-OPS were made on subsequent visits.
- GSS leak check failures that paired with S-OPS leak check passes indicated that the GSS leak check test may have been in error.
- GSS leak check failure on 10/14/2008 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 from 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 H2S 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 s/n 4-0018 and GSS/S-OPS s/n D and F

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
4/1/2008	NC4A	2	0.04	-38.42	Pass	9.7	0.49	-35.63	Pass
		3	0.07	-38.12	Pass	9.8	0.62	-37.59	Pass
4/15/2008	NC4A	2	0.04	-36.59	Pass	6.5	0.54	-38.45	Pass
		3	0.04	-36.36	Pass	9.6	0.68	-36.38	Pass
4/24/2008	WI5A	2	0.07	-35.13	Pass	8.3	0.62	-35.39	Pass
		3	0.09	-37.54	Pass	8	0.61	-35.54	Pass
5/13/2008	WI5A	2	0.08	-34.5	Pass	7.7	0.69	-36.06	Pass
		3	0.07	-37.35	Pass	10	0.65	-37	Pass
5/15/2008	IA3A	2	0.01	-37.16	Pass	8.2	0.51	-36.29	Pass
		3	0.04	-36.72	Pass	10	0.65	-35.9	Pass
6/4/2008	IA3A	2	0.08	-38.67	Pass	9.9	0.32	-37.49	Pass
		3	0.07	-23.71	Pass	10	0.47	-20.66	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
6/23/2008	IA3A	2	0.01	-35.74	Pass	10	0.38	-36.45	Pass
		3	0.05	-34.5	Pass	10	1.00	-37.66	Pass
6/25/2008	WI5A	2	0.05	-35.75	Pass	10	0.31	-34.95	Pass
		3	-0.01	-35.63	Pass	10	1.07	-36.71	Fail
7/15/2008	WI5A	2	0.05	-37.52	Pass	10	0.39	-36.92	Pass
		3	0.08	-34.45	Pass	8	0.90	-34.97	Fail
8/13/2008	NC4A	2	0.11	-36.28	Pass	10.1	0.38	-36.27	Pass
		3	0.08	-35.29	Pass	10	1.03	-36.16	Fail
9/3/2008	NC4A	2	-0.01	-35.49	Pass	9.8	0.46	-35.83	Pass
		3	-0.01	-37.07	Pass	9.5	0.62	-35.51	Pass
9/22/2008	NC4A	2	0.07	-37.58	Pass	10	0.61	-35.03	Pass
		3	0.04	-36.9	Pass	9.8	0.89	-35.95	Pass
9/25/2008	NC3A	2	0.08	-38.32	Pass	10	0.59	-35.9	Pass
		3	0.12	-37.84	Pass	10	0.96	-35.15	Pass
10/14/2008	NC3A	2	0.23	2.01	Fail	9.9	0.85	2.24	Pass
		3	0.24	2.76	Fail	9.8	0.82	3.74	Pass
10/22/2008	WI5A	2	0.03	-37.7	Pass	9.1	1.01	-37.55	Fail
		3	0.05	-36.53	Pass	8.3	0.93	-35.01	Fail
11/11/2008	WI5A	2	0.23	-38.84	Fail	9	0.32	-36.7	Pass
		3	0.09	-40.18	Pass	10	0.18	-39.43	Pass
11/13/2008	IA3A	2	0.14	-35.89	Pass	10	0.31	-33.84	Pass
		3	0.15	-36	Fail	10	0.32	-37.98	Pass
11/25/2008	IA3A	2	0.09	-32.04	Pass	9.9	0.63	-32.86	Pass
		3	0.09	-32.17	Pass	9.8	0.81	-32.56	Pass
12/16/2008	IA3A	2	0.18	-34.49	Fail	10	0.84	-35.46	Pass
		3	0.16	-32.41	Fail	10	0.51	-31.94	Pass
12/17/2009	WI5A	2	0.15	-36.18	Fail	8	0.82	-35.46	Fail
		3	0.18	-37.68	Fail	9.2	0.69	-35.44	Pass
1/6/2009	WI5A	2	0.20	-35.97	Fail	7	0.65	-35.46	Pass
		3	0.24	-23.82	Fail	9.1	0.68	-36.42	Pass
1/15/2009	NC4A	2	-0.05	-44.56	Pass	9.2	0.63	-43.36	Pass
		3	0.12	-43.57	Pass	8.5	1.03	-42.33	Fail
2/3/2009	NC4A	2	-0.03	-32.52	Pass	9	0.66	-31.73	Pass
		3	0.16	-32.07	Fail	8.5	1.07	-30.71	Fail
2/6/2009	NC3A	2	-0.28	-46.68	Pass	9.9	1.43	-33.54	Fail
		3	-0.01	-34.92	Pass	9.7	0.78	-33.01	Pass
2/23/2009	NC3A	2	0.05	-35.36	Pass	9.9	0.85	-35.24	Pass
		3	0.05	-35.51	Pass	9.7	0.43	-36.15	Pass
3/10/2009	WI5A	2	0.00	-36.55	Pass	8.2	0.39	-36.06	Pass
		3	0.03	-34.443	Pass	9.2	0.34	-36.32	Pass
4/7/2009	WI5A	2	0.12	-34.35	Pass	8.3	0.20	-32.15	Pass
		3	0.12	-32.31	Pass	9.4	0.24	-32.25	Pass
4/9/2009	IA3A	2	0.03	-33.32	Pass	10	0.23	-34.89	Pass
		3	0.11	-34.66	Pass	10	0.22	-36.33	Pass
4/23/2009	IA3A	2	0.01	-34.49	Pass	10.01	0.16	-34.9	Pass
		3	0.03	-36.36	Pass	10.01	0.15	-36.06	Pass
4/29/2009	NC4A	2	0.04	-33.83	Pass	9.8	0.14	-33.81	Pass
		3	0.00	-34.77	Pass	9.7	0.15	-34.79	Pass
5/11/2009	NC4A	2	0.03	-34.5	Pass	9.7	0.20	-34.34	Pass
		3	0.04	-32.88	Pass	9.7	0.20	-35.06	Pass
5/13/2009	NC3A	2	0.04	-34.4	Pass	9.3	0.30	-34.94	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	0.03	-35.18	Pass	9.7	0.23	-34.04	Pass
6/2/2009	NC3A	2	0.04	-37.94	Pass	9.6	0.14	-37.45	Pass
		3	0.04	-35.54	Pass	9.5	0.22	-35.11	Pass
6/22/2009	NC3A	2	0.01	-35.46	Pass	9.8	0.20	-37.18	Pass
		3	0.03	-35.24	Pass	9.7	0.22	-37.89	Pass
7/1/2009	NC4A	2	0.03	-35.48	Pass	9.7	0.14	-36.58	Pass
		3	0.01	-34.46	Pass	9.5	0.14	-34.58	Pass
7/21/2009	NC4A	2	0.01	-35.69	Pass	9.8	0.11	-36.99	Pass
		3	0.03	-35.72	Pass	9.6	0.15	-35.37	Pass
7/28/2009	IA3A	2	0.01	-34.9	Pass	10	0.20	-33.94	Pass
		3	0.04	-34.55	Pass	10	0.31	-34.19	Pass
8/17/2009	IA3A	2	0.07	-42.67	Pass	10.05	0.14	-42.19	Pass
		3	0.07	-42.05	Pass	10.05	0.18	-41.85	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 D)

			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**
3/26/2008	4/1/2008	NC3A	0.00	0.02	0.00	-0.01	0.19	-0.03	-0.01	-0.03	-0.07	-0.09	**Fail**
4/1/2008	4/15/2008	NC4A	0.03	0.01	0.02	0.09	0.03	0.04	-0.07	0.20	0.28	-0.06	**Fail**
4/15/2008	4/24/2008	NC4A	-0.13	-0.14	-0.15	-0.12	-0.21	-0.26	-0.32	-0.31	-0.33	-0.36	**Fail**
4/24/2008	5/13/2008	WI5A	-0.04	-0.03	-0.03	-0.06	-0.03	-0.02	-0.02	-0.02	-0.03	-0.03	**Pass**
5/15/2008	6/4/2008	IA3A	0.00	-0.05	-0.02	-0.03	-0.01	-0.07	-0.02	-0.03	0.01	0.02	**Pass**
6/4/2008	6/23/2008	IA3A	0.05	0.02	0.00	0.05	0.00	0.08	0.01	0.01	-0.01	-0.03	**Pass**
6/25/2008	7/15/2008	WI5A	0.05	0.02	0.07	-0.03	-0.01	-0.05	0.02	-0.03	-0.02	-0.01	**Pass**
7/15/2008	8/13/2008	WI5A	-0.05	0.10	-0.02	0.03	0.08	-0.09	0.00	0.06	-0.01	0.04	**Pass**
8/13/2008	9/3/2008	NC4A	-0.27	-0.12	-0.17	-0.13	-0.14	-0.29	-0.20	-0.21	-0.25	-0.22	**Pass**
9/3/2008	9/22/2008	NC4A	-0.12	-0.13	-0.11	-0.10	-0.15	-0.09	-0.10	-0.06	-0.10	-0.11	**Pass**
9/25/2008	10/14/2008	NC3A	-0.12	-0.09	-0.11	-0.12	-0.17	-0.16	-0.17	-0.22	-0.17	-0.23	**Pass**
10/14/2008	10/22/2008	NC3A	-0.32	-0.18	-0.23	-0.31	-0.19	-0.31	-0.29	-0.24	-0.22	-0.13	**Pass**
10/22/2008	11/11/2008	WI5A	-0.07	-0.10	-0.10	-0.13	-0.10	-0.10	-0.09	-0.13	-0.12	-0.15	**Pass**
11/13/2008	11/25/2008	IA3A	-0.10	-0.17	-0.18	-0.17	-0.13	-0.06	-0.15	-0.13	-0.15	-0.17	**Pass**
11/25/2008	12/16/2008	IA3A	-0.22	-0.18	-0.17	-0.18	-0.17	-0.20	-0.20	-0.16	-0.19	-0.16	**Pass**
12/17/2008	1/6/2009	WI5A	-0.30	-0.41	-0.27	-0.62	-0.15	-0.22	-0.29	-0.15	-0.23	-0.05	**Fail**
1/6/2009	1/15/2009	WI5A	-0.10	0.17	-0.17	0.34	-0.20	-0.12	-0.02	-0.18	-0.11	-0.17	**Fail**
1/15/2009	2/3/2009	NC4A	-0.27	-0.32	0.14	-0.07	-0.25	-0.32	-0.13	0.04	-0.40	-0.29	**Fail**
2/5/2009	2/23/2009	NC3A	-0.11	-0.13	-0.12	-0.12	-0.13	-0.11	-0.13	-0.16	-0.16	-0.09	**Pass**
2/23/2009	3/10/2009	NC3A	-0.11	-0.07	-0.12	-0.17	-0.15	-0.18	-0.19	-0.03	-0.19	-0.21	**Pass**
3/10/2009	4/7/2009	WI5A	-0.17	-0.17	-0.16	-0.19	-0.11	-0.08	-0.06	-0.22	-0.07	-0.11	**Pass**
4/9/2009	4/23/2009	IA3A	-0.15	-0.13	-0.11	-0.14	-0.15	-0.13	-0.13	-0.09	-0.11	-0.10	**Pass**
4/23/2009	4/29/2009	IA3A	-0.13	-0.11	-0.14	-0.14	-0.14	-0.16	-0.15	-0.20	-0.22	-0.20	**Pass**
4/29/2009	5/11/2009	NC4A	-0.26	-0.19	-0.16	-0.14	-0.15	-0.13	-0.14	-0.14	-0.11	-0.10	**Fail**
5/13/2009	6/2/2009	NC3A	-0.14	-0.12	-0.13	-0.12	-0.14	-0.14	-0.14	-0.15	-0.15	-0.14	**Pass**
6/2/2009	6/22/2009	NC3A	-0.12	-0.10	-0.11	-0.11	-0.11	-0.13	-0.09	-0.14	-0.13	-0.14	**Pass**
6/22/2009	6/30/2009	NC3A	-0.15	-0.13	-0.13	-0.13	-0.13	-0.11	-0.13	-0.13	-0.12	-0.12	**Pass**
6/30/2009	7/21/2009	NC4A	-0.09	-0.13	-0.10	-0.11	-0.09	-0.11	-0.11	-0.08	-0.10	-0.10	**Pass**
7/21/2009	7/28/2009	NC4A	-0.08	-0.06	-0.08	-0.07	-0.06	-0.06	-0.05	-0.06	-0.06	-0.02	**Pass**
7/28/2009	8/17/2009	IA3A	-0.14	-0.14	-0.15	-0.13	-0.14	-0.15	-0.13	-0.12	-0.11	-0.15	**Pass**

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

			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**
3/26/2008	4/1/2008	NC3A	0.09	0.03	0.02	0.04	0.00	0.06	0.06	0.05	0.04	0.02	**Pass**
4/1/2008	4/15/2008	NC4A	0.05	0.21	0.05	0.04	0.10	0.03	0.27	0.00	0.08	0.13	**Fail**
4/15/2008	4/24/2008	NC4A	0.09	0.24	0.26	0.26	0.21	0.29	0.22	0.25	0.30	0.22	**Fail**
4/24/2008	5/13/2008	WI5A	-0.04	-0.03	-0.02	-0.02	0.12	-0.02	-0.04	-0.04	-0.07	0.03	**Fail**
5/15/2008	6/4/2008	IA3A	-0.09	-0.12	-0.08	-0.10	0.34	-0.02	-0.05	0.88	-0.06	-0.08	**Fail**
6/4/2008	6/23/2008	IA3A	0.05	0.06	0.04	0.02	0.03	-0.01	0.00	-0.01	0.07	-0.01	**Pass**
6/26/2008	7/15/2008	WI5A	0.03	0.03	0.02	0.02	-0.02	0.05	0.06	-0.01	0.00	0.01	**Pass**
7/15/2008	8/13/2008	WI5A	-0.27	-0.25	-0.30	-0.29	-0.23	-0.34	-0.36	-0.17	-0.27	-0.26	**Pass**
8/13/2008	9/3/2008	NC4A	0.02	0.02	0.06	0.05	0.00	0.09	0.06	-0.07	0.03	0.08	**Pass**
9/3/2008	9/22/2008	NC4A	0.00	0.02	0.00	-0.01	-0.02	-0.06	-0.02	-0.01	-0.06	-0.03	**Pass**
9/25/2008	10/14/2008	NC3A	0.00	0.02	0.02	0.00	0.02	-0.01	-0.06	0.03	0.04	0.08	**Fail**
10/14/2008	10/22/2008	NC3A	0.22	0.16	0.17	0.20	0.23	0.24	0.20	0.19	0.23	0.14	**Fail**
10/22/2008	11/11/2008	WI5A	-0.02	0.03	0.02	-0.01	0.00	-0.07	-0.09	-0.01	-0.02	0.00	**Fail**
11/13/2008	11/25/2008	IA3A	-0.23	-0.06	-0.11	-0.09	-0.06	-0.17	-0.16	-0.21	-0.12	-0.10	**Pass**
11/25/2008	12/16/2008	IA3A	-0.14	-0.23	-0.19	-0.18	-0.21	-0.17	-0.10	-0.07	-0.11	-0.13	**Fail**
12/17/2008	1/6/2009	WI5A	-0.26	-0.36	-0.28	-0.31	-0.31	-0.33	-0.35	-0.11	-0.26	-0.36	**Fail**
1/6/2009	1/15/2009	WI5A	0.02	-0.28	0.09	0.12	0.08	0.21	0.24	-0.97	0.20	0.20	**Fail**
1/16/2009	2/3/2009	NC4A	-0.29	-0.32	-0.20	0.34	-0.42	0.63	0.50	-0.51	0.23	0.23	**Fail**
2/5/2009	2/23/2009	NC3A	-0.11	-0.11	-0.13	-0.13	-0.15	-0.14	-0.17	-0.16	-0.16	-0.11	**Pass**
2/23/2009	3/10/2009	NC3A	-0.16	-0.16	-0.18	-0.19	-0.15	-0.19	-0.22	-0.15	-0.17	-0.12	**Pass**
3/10/2009	4/7/2009	WI5A	-0.21	-0.24	-0.21	-0.21	-0.24	-0.22	-0.23	-0.23	-0.20	-0.32	**Pass**
4/9/2009	4/23/2009	IA3A	0.00	0.00	0.00	-0.01	-0.03	-0.02	0.00	-0.04	-0.03	-0.05	**Pass**
4/23/2009	4/29/2009	IA3A	-0.15	-0.16	-0.15	-0.16	-0.16	-0.17	-0.18	-0.18	-0.20	-0.17	**Pass**
4/29/2009	5/11/2009	NC4A	-0.14	-0.10	-0.14	-0.13	-0.16	-0.11	-0.14	-0.11	-0.09	-0.11	**Pass**
5/13/2009	6/2/2009	NC3A	-0.12	-0.14	-0.14	-0.14	-0.19	-0.14	-0.22	-0.11	-0.15	-0.21	**Pass**
6/2/2009	6/22/2009	NC3A	-0.10	-0.77	-0.09	-0.10	-0.04	-0.05	-0.03	-0.04	-0.05	-0.03	**Fail**
6/22/2009	6/30/2009	NC3A	-0.14	0.53	-0.16	-0.15	-0.22	-0.18	-0.25	-0.20	-0.19	-0.22	**Fail**
6/30/2009	7/21/2009	NC4A	-0.14	-0.12	-0.11	-0.12	-0.14	-0.10	-0.06	-0.09	-0.10	-0.09	**Pass**
7/21/2009	7/28/2009	NC4A	-0.08	-0.08	-0.08	-0.10	-0.03	-0.06	-0.06	-0.05	-0.03	-0.03	**Fail**
7/28/2009	8/17/2009	IA3A	-0.04	-1.01	-0.07	-0.05	-0.04	-0.07	0.01	-0.09	-0.06	-0.05	**Fail**

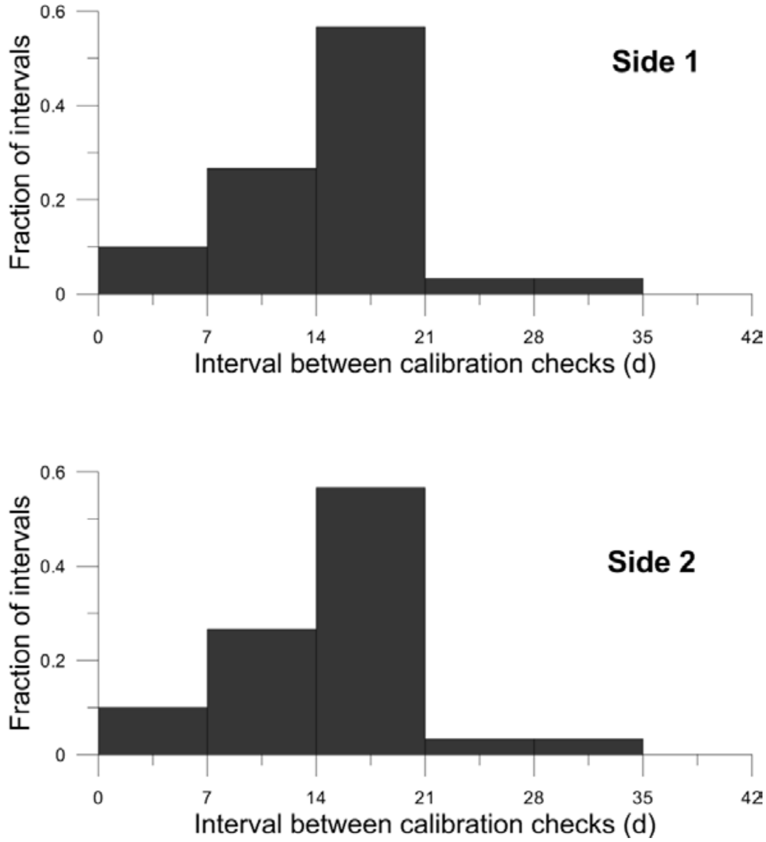


Figure 6.6-1 – Intervals between checks for GSS s/n 4-0018 and GSS/S-OPS s/n D and F

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 calibration check is documented in Table 6.7-1.

Table 6.7-1: Calibration record of Vaisala HMP45C, s/n: 4410027

Relative Humidity (RH)					
Calibration Date (mm/dd/yyyy)	**Temperature (°C)**	**Expected RH (%)**	**Difference from expected RH (%)**	**Average Difference RH (%)**	**Action**
3/8/2010	24.7	25	2		Accept
	24.7	50	1		Accept
	24.7	95	2		Accept
				2	Accept
3/6/2010	N/A	40	1	1	Accept
8/1/2008	27.8	11	-1		Accept
	27.5	51	2		Accept
	27.8	96	8		Accept
				3	Accept

Temperature (T)				
Calibration Date (mm/dd/yyyy)	**Expected T (°C)**	**Measured T (°C)**	**Difference from expected T (°C)**	**Action**
3/8/2010	25.6	24.7	0.9	Accept
3/6/2009	25.3	25.2	0.2	Accept
8/1/2008	27.5	27.3	0.2	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 3051828

Calibration date	Expected value range (hPa)	Number of comparisons	Mean difference from reference (hPa)	Action
3/4-8/2010	997-1004	4	0.10	Pass
2/27 - 3/2/2009	990.9-1007.1	6	1.60	Pass
7/23-27/2008	995.3-996.5	6	0.90	Pass
1/17-18/2008	984.9-996.9	6	0.80	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 is documented in Table 6.7-3.

Table 6.7-3: Calibration record of LiCOR 200SB Pyranometer s/n PY55448

Calibration Date (mm/dd/yyyy)	Mean Difference from standard (W/m^2)	Mean Difference from standard (%)	Action
3/5-8/2010	-3.8	0.7	Pass
8/30/2006	N/A	N/A	Pass (factory calibr.)

6.7.4 Lagoon water temperature

A thermistor (Model 107-L, Campbell Scientific Inc, Logan, Utah) was used to measure lagoon temperature. Calibration of this sensor was conducted at least annually. Initial calibrations were conducted by the factory. The record of calibration checks is documented in Tables 6.7-4 through Table 6.7-6.

Table 6.7-4: Calibration record of Thermistor CSI 107-L (0010)

Calibration Dates	Expected value (°C)	Deviation from expected (°C)	Action
1/25/2008	0.0	0.0	Accept
6/18/2007	25.0	0.1	Accept
	24.5	0.2	Accept
	24.0	0.4	Accept

Table 6.7-5: Calibration record of Thermistor CSI 107-L (III)

Calibration Date	Expected value (°C)	Difference from expected (°C)	Action
2/15/2010	1.1	18.4	Replace
9/14/2009	0.0	-0.1	Accept
3/6/2009	0.0	0.0	Accept

Table 6.7-6: Calibration record of Thermistor CSI 107-L (V)

Calibration Date	Expected value (°C)	Difference from expected (°C)	Action
2/15/2010	1.1	1.2	Accept
2/15/2010	35.7	2.9	Accept
9/14/2009	0.1	-0.1	Accept
3/6/2009	0.0	0.1	Accept

6.7.5 Sludge Gun

A sludge gun (Model 10, Marklin Specialty Engineering, Toronto, Ontario, Canada) with serial number 20176A 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 is documented in Table 6.7-7.

Table 6.7-7: Calibration record of Marklin Sludge Gun s/n 20176B

Calibration Date	Mean	Standard deviation	Accuracy	Action
2/26/2010	69.0	0.75	1	Accept
3/6/2009	71.8	0.75	0.937	Accept
7/23/2008	73.3	0.35	1.11	Accept
7/27/2008	79.9	0.78	0.88	Accept
2/23/2007	81.2	0.97	1.22	Accept

6.7.6 CR1000 Data logger

The CR1000 data logger (Campbell Scientific Inc., Lagan, 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. Two different loggers were used. The record of calibration checks are documented in Table 6.7-8 and Table 6.7-9.

Table 6.7-8: Calibration record of Campbell Scientific CR1000 data logger, s/n 7886 (7675)

Factory Calibration						
Calibration Date: 1/18/2007			Single-Ended		Differential	
Channel	**Input (mV)**	**Tolerance (mV)**	**Measured mV**	**Error (mV)**	**Measured (mV)**	**Error (mV)**
11	5000	± 3	5001.25	-1.25	5001.35	-1.35
11	-5000	± 3	-5001.48	-1.48	-5001.69	-1.69
11	2500	± 1.5			2500.3	-0.3
11	250	± 0.15			249.999	0.001
11	25	± 0.015			25.0032	-0.0032
11	7.5	± 0.0045			7.49571	0.00429
11	2.5	± 0.0015			2.50062	-0.00062
11	-2.5	± 0.0015			-2.49924	0.00024
11	5000	± 6	4999.45	0.45	4999.32	0.32
11	5000	± 6	5001.96	-1.96	5001.69	-1.69
11	5000	± 6				
11	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	4950.5	-0.5		
2	4950	± 6.96| 4.97	4950.5	-0.5		
3	4950	± 6.96| 4.97	4950.5	-0.5		
4	4950	± 6.96| 4.97	4950.5	-0.5		
5	4950	± 6.96| 4.97	4950.5	-0.5		
6	4950	± 6.96| 4.97	4950.5	-0.5		
7	4950	± 6.96| 4.97	4950.5	-0.5		
8	4950	± 6.96| 4.97	4950.5	-0.5		
9	4950	± 6.96| 4.97	4950.5	-0.5		
10	4950	± 6.96| 4.97	4950.5	-0.5		
12	4950	± 6.96| 4.97	4950.5	-0.5		

13	4950	± 6.96| 4.97	4950.5	-0.5		
14	4950	± 6.96| 4.97	4950.5	-0.5		
15	4950	± 6.96| 4.97	4950.5	-0.5		
16	4950	± 6.96| 4.97	4950.5	-0.5		

Calibration Date: 5/28/2010			Single-Ended		Differential	
Channel	**Input (mV)**	**Tolerance SE | DE (mV)**	**Measured (mV)**	**Error (mV)**	**Measured (mV)**	**Error (mV)**
1	100	± 2.06 | 1.06	99.49	0.51		
2	100	± 2.06 | 1.06	99.49	0.51	99.83	0.17
3	100	± 2.06 | 1.06	99.49	0.51		
4	100	± 2.06 | 1.06	99.49	0.51		
5	100	± 2.06 | 1.06	99.49	0.51	99.83	0.17
6	100	± 2.06 | 1.06	99.49	0.51	99.83	0.17
7	100	± 2.06 | 1.06	99.49	0.51	99.83	0.17
8	100	± 2.06 | 1.06	99.49	0.51	99.83	0.17
9	100	± 2.06 | 1.06	99.49	0.51		
10	100	± 2.06 | 1.06	99.49	0.51		
11	100	± 2.06 | 1.06	99.49	0.51		
12	100	± 2.06 | 1.06	99.49	0.51		
13	100	± 2.06 | 1.06	99.49	0.51		
14	100	± 2.06 | 1.06	99.49	0.51		
15	100	± 2.06 | 1.06	99.49	0.51		
16	100	± 2.06 | 1.06	99.49	0.51		

Calibration Date: 5/28/2010			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		

Table 6.7-9: Calibration record of Campbell Scientific CR1000 data logger, s/n 7752

Calibration Date: 3/1/2010			Single-Ended		Differential	
Channel	Input (mV)	Tolerance SE | DE (mV)	Measured (mV)	Error (mV)	Measured (mV)	Error (mV)
1	100	± 2.06 | 1.06	99.23	0.77		
2	100	± 2.06 | 1.06	99.23	0.77	99.57	0.43
3	100	± 2.06 | 1.06	99.23	0.77		
4	100	± 2.06 | 1.06	99.23	0.77		
5	100	± 2.06 | 1.06	99.23	0.77	99.57	0.43
6	100	± 2.06 | 1.06	99.23	0.77	99.57	0.43
7	100	± 2.06 | 1.06	99.23	0.77	99.57	0.43
8	100	± 2.06 | 1.06	99.23	0.77	99.57	0.43
9	100	± 2.06 | 1.06	99.23	0.77		
10	100	± 2.06 | 1.06	99.23	0.77		
11	100	± 2.06 | 1.06	99.23	0.77		
12	100	± 2.06 | 1.06	99.23	0.77		
13	100	± 2.06 | 1.06	99.23	0.77		
14	100	± 2.06 | 1.06	99.23	0.77		
15	100	± 2.06 | 1.06	99.23	0.77		
16	100	± 2.06 | 1.06	99.23	0.77		
Calibration Date: 3/1/2010			**Single-Ended**		**Differential**	
Channel	**Input (mV)**	**Tolerence 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, Utah) 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 is documented in Table 6.7-10.

Table 6.7-10: Calibration record of Campbell Scientific CR800 data logger s/n 3697

Calibration Date: **3/8/2010**			**Single-Ended**		**Differential**	
Channel	**Input (mV)**	**Tolerence SE (mV)**	**Measured (mV)**	**Error (mV)**	**Measured (mV)**	**Error (mV)**
1	100	+ / - 2.061	99.29	0.71		
2	100	+ / - 2.061	99.29	0.71		
3	100	+ / - 2.061	99.29	0.71		
4	100	+ / - 2.061	99.29	0.71		
5	100	+ / - 2.061	99.29	0.71		
6	100	+ / - 2.061	99.29	0.71		

Calibration Date: **3/8/2010**			**Single-Ended**		**Differential**	
Channel	**Input (mV)**	**Tolerence SE | DE (mV)**	**Measured (mV)**	**Error (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	Date MM-DD-YYYY	Activity (Setup, Takedown, Calibration, Repair, Remote)	Event
	10/2/2007	Setup	Reached site by afternoon, messed up with electricity. Called the electrician (He didn't respond the same day).
	10/2/2007	Setup	Carried all retro-reflectors and placed up on their respective sites. Tried to do tower but could not complete. Purchased extension cords for 6 retro-reflectors.
	10/3/2007	Setup	Did anchoring for trailer. Got trailer steady.
	10/3/2007	Setup	Spent hours on TDLAS calibrations as we were getting high values with too much fluctuation.
	10/3/2007	Setup	It was raining heavily, so could not do additional stuff, but still got retro work done.
23:55-00:00	10/3/2007	Setup	Calibrated TDLAS 1030: Mean: 57.98 SD: 4.77
	10/4/2007	Setup	Tried to calibrate TDLAS 1030 but could not do so as it was giving very high values with high SD.
	10/4/2007	Setup	Did the towers and electricity on towers.
14:00-15:00	10/4/2007	Setup	Sonic anemometer inter-comparison: all pass.
14:12	10/4/2007	Setup	ORP sensor: calibration and acceptance accepted
15:28	10/4/2007	Setup	pH sensor: calibration, acceptance, QA accepted
16:13-16:16	10/4/2007	Setup	Zero calibration on sonic anemometers; all pass.
01:29-01:34	10/5/2007	Setup	Calibrated TDLAS 1028: Mean: 47.38 SD: 1.58 RSD: 3.2%
01:57-02:02	10/5/2007	Setup	Calibrated TDLAS 1030: Mean: 62.05 SD: 1.55
	10/5/2007	Setup	Did time check on PC's.
	10/5/2007	Setup	Took retro and sonic anemometer heights.
	10/10/2007	Remote	Check status of PC's and instruments after set up last week.
	10/10/2007	Remote	Check site status.
	10/11/2007	Remote	Install new version of sonic anemometer program (V3).
	10/12/2007	Remote	Check out site operations.
	10/22/2007	Takedown	Arrived at 11:15 a.m. Took down all instruments and did all calibrations by 8:30 p.m.
	10/22/2007	Takedown	Dropped retro from top of tower. Minimal damage.
	10/22/2007	Takedown	Recorded locations of retro-reflectors relative to electric posts. See notes.
	10/22/2007	Takedown	500 ppm NH_3 cylinder has expired; according to Praxair it was delivered on 10/8/2007, but Murphy Brown does not know where it is. It is missing.
	10/22/2007	Takedown	Barometer audit: accepted.
15:00	10/22/2007	Takedown	Wetness Sensor calibration: accepted.
18:56	10/22/2007	Takedown	Zero calibration on sonic anemometers; all pass.
23:16-23:21	10/22/2007	Takedown	Calibrated TDLAS 1030: Mean: 57.54 SD: 2.32 notes: Continued passing NH_3 from 2321 UTC-2327 UTC during the calculations. During initial background, the program was set in scanning mode with varying distances in the log file.

23:52	10/22/2007	Takedown	pH sensor: calibration, acceptance, QA accepted
00:20	10/23/2007	Takedown	ORP sensor: calibration and acceptance accepted
	1/29/2008	Setup	Dried tower retro-reflectors; calibrated sonic anemometers; started S-OPS.
17:45-18:45	1/29/2008	Setup	Sonic anemometer inter-comparison: all pass.
19:30	1/29/2008	Setup	Zero calibration on sonic anemometers; all pass.
	1/30/2008	Setup	Started S-OPS. Found some leakage in 2nd and 9th inlets of north side S-OPS. Corrected it and started.
	1/30/2008	Setup	GSS acceptance
22:30	1/30/2008	Setup	Barometer audit: accepted.
22:30-23:45	1/30/2008	Setup	Wetness Sensor calibration: accepted.
22:35-22:40	1/30/2008	Setup	Calibrated TDLAS 1028: Mean: 49.15 SD: 0.94 RSD: 1.9% Bias: -1.9%
23:32	1/30/2008	Setup	Calibrated TDLAS 1031 Mean: 48.35 SD: 1.86 RSD: 3.9% Bias: -3.5%
	1/30/2008	Setup	Did not have 590 gas regulator, so H2S single check calibration was not done.
	1/31/2008	Setup	Having some communication problems with TDLAS 1028. Checked cable, pin 4 and 12 are already connected. System is still functioning even with the error. Moved the modem/power supply box to different leg of tripod higher up.
	1/31/2008	Setup	pH sensor: calibration, acceptance, QA accepted
	1/31/2008	Setup	Sludge Depth measurements taken.
	1/31/2008	Setup	S-OPS installation report made
13:55	1/31/2008	Setup	ORP sensor: calibration and acceptance accepted
	2/1/2008	Setup	At 0733 UTC, found out that TDLAS 2 (1031) stopped sending data. Found that back of GasFinder 2.0™ said "centering" and that centerline data cycle was increasing above 200 and r^2 was decreasing. Problem was "fixed" by powering off and powering on the GasFinder 2.0™. Initially, the CDC and reference r^2 were bad, but in a few moments the values looked good. System appears to be working.
	2/4/2008	Remote	Fix problems with TDLAS system 2
	2/8/2008	Remote	Fix corrupt paths on TDLAS 2 (1031).
	2/11/2008	Takedown	Need black printer cartridge.
	2/11/2008	Takedown	S-OPS acceptance
	2/11/2008	Takedown	S-OPS Inlet Flow Verification
18:30-19:30	2/11/2008	Takedown	Sonic anemometer inter-comparison: all pass.
20:10	2/11/2008	Takedown	Barometer audit: accepted.
20:10	2/11/2008	Takedown	Wetness Sensor calibration: accepted.
20:25	2/11/2008	Takedown	Zero calibration on sonic anemometers; all pass.
	2/12/2008	Takedown	TDLAS 1031 is not working well. Replaced with different unit.
	2/12/2008	Takedown	pH sensor: calibration, acceptance, QA accepted
17:52-17:57	2/12/2008	Takedown	Calibrated TDLAS 1028: Mean: 49.85 SD: 3.35 RSD: 4.77% Bias: -0.8%
16:38-16:51	2/12/2008	Takedown	Calibrated TDLAS 1031: Mean: 50.22 SD: 0.65 RSD: 1.3% Bias: -0.2% notes: During the measurement period, the TDLAS was giving 401(calibration) errors most of the time. At start of calibration, the background test gave some wild numbers (ex. 170 ppm with r^2 of 0.65). This settled down. After NH3 was passed into cell, got values

			of 0, 0.000 for 10+ min. Powered off and back on again and got better values (~22 ppm, 0.95) Also error code of 5. Moved cell slightly and got great results even with error code.
	3/31/2008	Setup	Threads were damaged on new NH3 cylinder and on associated gas regulator.
20:00-21:00	3/31/2008	Setup	Sonic anemometer inter-comparison: all pass.
20:20-20:25	3/31/2008	Setup	Calibrated TDLAS 1028: Mean: 46.15 SD: 0.18 RSD: 0.4% Bias: -3.0%
22:18	3/31/2008	Setup	Zero calibration on sonic anemometers; all pass.
	4/1/2008	Setup	Replaced filter on SOP inlet D5.
	4/1/2008	Setup	Replaced one rivet on SE tower.
	4/1/2008	Setup	S-OPS Max Flow test
	4/1/2008	Setup	S-OPS Inlet flow Verification: Pass (second attempt)
	4/1/2008	Setup	S-OPS/GSS Leak Test: Pass
	4/1/2008	Setup	GSS Leak Test: Pass
	4/1/2008	Setup	GSS no Flow Test
18:16	4/1/2008	Setup	TFC 450i calibration check
21:15	4/1/2008	Setup	Wetness Sensor calibration: accepted.
21:15	4/1/2008	Setup	Barometer audit: accepted.
21:58	4/1/2008	Setup	TFC 450i calibration check
22:16	4/1/2008	Setup	TFC 450i Reference precision check
	4/2/2008	Setup	Talked to Thermo about 450i motherboard error. When booting, unable to find motherboard. No answers. Decided to leave here.
	4/2/2008	Setup	Connecting/disconnecting ground for temp. probe and RH probe changes values measured by pH and ORP probes by about 0.3 pH and 200 ORP (i.e., if Air Temp/RH is unhooked we get lower values for ORP and higher values for pH).
	4/2/2008	Setup	pH sensor: calibration, acceptance, QA accepted
13:50	4/2/2008	Setup	ORP sensor: calibration and acceptance accepted
14:30	4/4/2008	Remote	Daily Status Check from PAML notes: Sonic anemometer 2 has 6 five-min intervals with >1000 flagged points.
12:00	4/7/2008	Remote	Daily Status Check from PAML notes: Spikes >160 in sonic anemometer 1 are related to sonic anemometer flagged data due to rain.
12:31	4/8/2008	Remote	Daily Status Check from PAML notes: TDLAS 1 reference r^2 varies from 96-99. Reference status 10 for a period on day 462. TDLAS 2 reference status is sometimes 10 or 30.
12:00	4/9/2008	Remote	Daily Status Check from PAML notes: Wetness sensor does not appear to be responding normally to dry condition.
	4/10/2008	Remote	Fix corrupt path on TDLAS 2
12:30	4/10/2008	Remote	Daily Status Check from PAML notes: Dense fog causing TDLAS 2 to optimize.
	4/11/2008	Remote	Fix corrupt path on TDLAS 2
12:20	4/11/2008	Remote	Daily Status Check from PAML notes: Most 5 min periods have 10-40 flagged points for sonic anemometer 1. Also, for last day or so we are often losing several hundred points for sonic anemometer 1 per five min. Lagoon temperature jumped from 16c to 22C yesterday. More variable since at about 19C. TDLAS 2 has corrupt path and pan/tilt errors.
	4/12/2008	Remote	Check operation
	4/13/2008	Remote	Check operation
	4/14/2008	Takedown	Zoebell's solution stored in refrigerator has turned blue. This is due

			to reaction with metal rod used during mixing; we have to use glass rod.
	4/14/2008	Takedown	Path 6 on TDLAS 2 (1028) had corrupt pan/tilt values upon arrival. Reaimed at about 21 UTC.
	4/14/2008	Takedown	Tubing added to barometer.
	4/15/2008	Takedown	S-OPS Max Flow test
	4/15/2008	Takedown	S-OPS Inlet flow Verification: Fail (several attempts) note: Tried several times to balance the air but could not do so; spent almost one day.
	4/15/2008	Takedown	S-OPS/GSS Leak Test: Pass
	4/15/2008	Takedown	GSS Leak Test: Pass
	4/15/2008	Takedown	GSS no Flow Test
	4/15/2008	Takedown	While doing S-OPS inlet verification for #F we found water droplets in new orifices connecting tubes (orifices #1, 2, 4, 8, and 9 and nos. 1 and 9 also had spider webs). When reading flow rate on orifice 2, the values were fluctuating from 6.3 to 8 L min^{-1}.
	4/16/2008	Takedown	Spent almost 8+ hours in balancing air flow on S-OPS "D." Was able to get rid of leaks but not able to balance.
	4/16/2008	Takedown	Pumping out lagoon and spraying to nearby field from 8:40 am to 3:00 pm
	4/16/2008	Takedown	Dipped ORP probe in Zoebell's solution. It was supposed to read 224 ± 30, but instead it gave 160 ± 50.
	4/16/2008	Takedown	Barometer audit: accepted.
14:05	4/16/2008	Takedown	Wetness Sensor calibration: accepted.
14:30-15:30	4/16/2008	Takedown	Sonic anemometer inter-comparison: all pass.
16:11	4/16/2008	Takedown	Zero calibration on sonic anemometers; all pass.
18:35	4/16/2008	Takedown	TFC 450i Reference precision check
22:10	4/16/2008	Takedown	ORP sensor: calibration and acceptance accepted
22:30	4/16/2008	Takedown	pH sensor: calibration, acceptance, QA accepted
23:30	4/16/2008	Takedown	Sludge Depth measurements taken. Avg. Depth to sludge layer: 1.56 m.
	4/17/2008	Takedown	Lagoon 8% crusted.
18:08-18:13	4/18/2008	Takedown	Calibrated TDLAS 1027: Mean: 90.94 SD: 1.34 RSD: 1.3% Bias: -0.9%
19:03-19:08	4/18/2008	Takedown	Calibrated TDLAS 1028: Mean: 109.74 SD: 5.46 RSD: 4.98% Bias: 11.0% After offset bias of 15.4: -4.6% note: During second background, many large concentrations were obtained but no r^2 >0.85
	8/12/2008	Setup	Tied down trailer and hooked up power.
	8/13/2008	Setup	Had problems connecting to internet--had to reinstall software on LAN (needed because new radio is being used).
	8/13/2008	Setup	146i diluter not working properly. Call Thermo--said flow controller must have recently been calibrated and perhaps rushed or connection is loose. Called Juan Carlos from barn source and sent diagram of diluter that displayed connections they may have disconnected. Will check in morning.
	8/13/2008	Setup	Current IP address is 75.203.33.222 (Sierra Wireless Program) Dyn DNS Current IP: 75.203.33.222 (same as yesterday).
	8/13/2008	Setup	GSS Leak Test: Pass
	8/13/2008	Setup	GSS Max Flow Test
	8/13/2008	Setup	GSS no Flow Test
	8/13/2008	Setup	S-OPS Balance: D

	8/13/2008	Setup	S-OPS Balance: F
	8/13/2008	Setup	S-OPS/GSS Leak Test
	8/13/2008	Setup	S-OPS Max Flow Test
19:55-20:55	8/13/2008	Setup	Sonic anemometer inter-comparison: all pass.
	8/14/2008	Setup	Diluter connections appear secure--will ship back to PAML to assess problems.
	8/14/2008	Setup	Yesterday's S-OPS calibration was on a file from WI5A.
	8/14/2008	Setup	Made KCl, QCCS, and Zobells solutions.
	8/14/2008	Setup	Could not perform pH/ORP stability/reference check because of broken reference electrode during ORP calibration. Both probes passed calibration.
	8/14/2008	Setup	Mounted TDLAS 1030/PTU 4 power/communication box on pole so communication Signal can be above pump (lagoon pump metal).
	8/14/2008	Setup	Used extension cords to some retro-reflectors when power cords could not reach outlets,
	8/14/2008	Setup	Could not find lagoon calibration control charts.
	8/14/2008	Setup	Changed the following inlet filters: D--1, 2, 4, and 5 F--1, 2, 5, 6, and 10.
	8/14/2008	Setup	Lagoon site layout made
	8/14/2008	Setup	Maintenance list made
1313	8/14/2008	Setup	Zero calibration on sonic anemometers; all pass.
15:34	8/14/2008	Setup	Wetness Sensor calibration: accepted.
15:45	8/14/2008	Setup	Barometer audit: accepted.
15:20	8/14/2008	Setup	TEC 450i Calibration Verification Check
15:34	8/14/2008	Setup	TEC 450i Instrument Operating Parameters
15:34	8/14/2008	Setup	TEC 450i Reference Precision Check
22:00	8/14/2008	Setup	ORP sensor 020: calibration. Could not perform acceptance because of broken reference electrode.
22:05	8/14/2008	Setup	pH sensor: calibration, and QA accepted Could not do QA because of broken reference electrode.
12:41	8/20/2008	Remote	Daily Status Check from PAML notes: Stopped sonic anemometer program to try and update H2S data. Connected to H2S analyzer successfully. H2S analyzer not staying connected--no data to process in QC check. Filled 1000 records back--only from 8/19/2008. Filled again from 8/14/2008 at 12:00 UTC. Sonic anemometer 1 mostly below 160 in flagging data...some greater than 160. On TDLAS's centerline duty cycle jumped from approximately. 150 to 250 at NAEMS day 494.7. TDLAS 1 paths are not all aimed correctly. Paths on optimize sheet seem to be in the correct spot relative to each other.
14:45	8/21/2008	Remote	Daily Status Check from PAML notes: no data received during this time.
	8/26/2008	Repair	no internet upon arrival. Updated DynDNS--green checkmark temporarily. Power-cycled radio and router--internet slow and intermittent.
	8/14/2008	Repair	Scanner on SW corner pointing straight down--still no communication with TDLAS 1031.
	8/14/2008	Repair	Calibrated TDLAS 1032 with oscilloscope--seemed to work successfully.
	8/14/2008	Repair	New diluter seems to work well PU# 1040240 SN# 079220664
	8/14/2008	Repair	TDLAS 1032: when using new control charts to account for temperature and pressure--cal curve, unable to pass (100 ppm, 200

			ppm, 50 ppm-m, 100 ppm-m, 125 ppm-m, 25 ppm-m respectively).
	8/14/2008	Repair	TDLAS 1031 had water inside window plastic. Serial controller rusted and wet when disconnected in field.
	8/14/2008	Repair	SW scanner grinding briefly during first initialization; new commands seem to make resets and initializations go very slowly (~20-25 min), but "home" is in same spot and paths stay aligned. Giving pan/tilt errors after every move, but still moving to each path successfully.
18:34-21:06	8/14/2008	Repair	Calibrated TDLAS 1032 See calibration sheet for full details.
	9/2/2008	Calibration	When arrived LAN said M drive was not accessible.
	9/2/2008	Calibration	TDLAS 1 only had paths 8 and 9--lost all other paths. TDLAS 2 lost path 8 and was optimizing until time-out on path 8 because obstruction level was set to 100; changed obstruction level to 300.
	9/2/2008	Calibration	H2S program stopped on 8/29/2008 at 2:26 UTC. Will make a fill file.
	9/2/2008	Calibration	TDLAS 1 kept getting a pan/tilt error on *GasView MP*. Tried restarting computer but it did not help.
	9/2/2008	Calibration	Switched out internet radio from 0724312186 to 0721320042. Internet is now working very well.
	9/2/2008	Calibration	Reaimed all paths on TDLAS 1 except path 7 and all paths on TDLAS 2 except path 8 from inside. We will see if anything is blocking these paths and aim them from the outside.
	9/2/2008	Calibration	Retro-reflector 8 on TDLAS 2 had quite a lot of water in it. Drained water out, and it is fine now. Will re-silicone it tomorrow.
	9/2/2008	Calibration	Retro-reflector 7 on TDLAS 1 was very low and grass was blocking the path. Raised up the retro-reflector, and it is fine now. Also raised retro-reflector 2 and TDLAS 1 since grass was starting to block the path as well.
21:23	9/2/2008	Calibration	Zero calibration on sonic anemometers; all pass.
21:35-22:35	9/2/2008	Calibration	Sonic anemometer inter-comparison: all pass.
	9/3/2008	Calibration	When conducting the S-OPS leak test, there was a leak of 1.66 L min^{-1}. Fixed the leak and balanced the inlets.
	9/3/2008	Calibration	Raised scanner/TDLAS 1 because it was low and the grass was getting in the way. Reaimed the paths.
	9/3/2008	Calibration	The ORP probe would not calibrate properly (S/N: 020). Replaced it with new ORP probe (S/N: 050).
	9/3/2008	Calibration	Initially the diluter was flowing very slowly. Open case and rejected the cable, and it works fine now.
	9/3/2008	Calibration	Remainder of zero air was lost due to high flow rate for TDLAS calibration and a leak in the T used to split the zero air stream going into the diluter. Zero air was used instead of N2 because N2 tank is empty.
	9/3/2008	Calibration	Replaced broken retro-reflector box.
	9/3/2008	Calibration	Added silicone sealing to bottom retro-reflector on N side of SE tower. It was wet yesterday upon arrival.
	9/3/2008	Calibration	pH sensor: calibration, acceptance, QA accepted
	9/3/2008	Calibration	ORP sensor 020: calibration and acceptance. Acceptance fails. Will replace probe.
	9/3/2008	Calibration	ORP sensor 050: calibration and acceptance accepted.
	9/3/2008	Calibration	Sludge Depth measurements taken. Avg. Depth to sludge layer: 0.86 m.

	9/3/2008	Calibration	Wetness Sensor calibration: accepted.
	9/3/2008	Calibration	Barometer audit: accepted.
	9/3/2008	Calibration	GSS Leak Test: Pass
	9/3/2008	Calibration	GSS Max Flow Test
	9/3/2008	Calibration	GSS no Flow Test
	9/3/2008	Calibration	S-OPS Balance: D
	9/3/2008	Calibration	S-OPS Balance: F
	9/3/2008	Calibration	S-OPS/GSS Leak Test
	9/3/2008	Calibration	S-OPS Max Flow Test
23:12	9/3/2008	Calibration	Calibrated TDLAS 1030 Mean: 51.42 SD: 0.38 RSD: 0.7% Bias: 3.6% notes: There were scratches in the front window of the TDLAS. Had to restart calibration because of trouble with diluter.
23:58	9/3/2008	Calibration	Calibrated TDLAS 1026 Mean: 49.71 SD: 0.76 RSD: 1.5% Bias: 0.16%
	9/4/2008	Calibration	TDLAS 1 retro-reflector 6: removed 1/8 plastic; now just 1/4 plastic.
	9/4/2008	Calibration	Maintenance list made
	9/4/2008	Calibration	Electronic Data Chain of Custody form made.
00:41	9/4/2008	Calibration	Calibrated TDLAS 1032 Mean: 46.58 SD: 0.27 RSD: 0.6% Bias: -6.1% notes: Could not get a smooth reading on the oscilloscope. It always had a very deep wave. Will bring it back to PAML to investigate. Later, recheck oscilloscope; got a smooth waveform but not ideal.
03:34	9/4/2008	Calibration	TEC 450i Calibration Verification Check
03:54	9/4/2008	Calibration	TEC 450i Instrument Operating Parameters
03:54	9/4/2008	Calibration	TEC 450i Reference Precision Check
04:18	9/4/2008	Calibration	SO2 calibration
13:10	9/5/2008	Remote	Daily Status Check from PAML notes: Last evening around 10pm EDT, I (MJB) logged in from home and found that sonic anemometer program was not running. It had been shut down during the final on-site check to allow *iPort* to run. Sonic anemometer data missing from 613.56-614.11. Sonic anemometer 1 has a quite a few 5-min periods with 1-20 sonic anemometer flagged points. Sonic anemometers 1 and 2 have a few periods with over 160 spike counts. Period 6 started yesterday. Many TDLAS paths are losing some data probably because of dew.
12:30	9/8/2008	Remote	Daily Status from PAML notes: Tropical Storm Hanna impacted site on Saturday morning (9/6/2008). Very few paths getting valid light levels at this time. Valid paths on TDLAS 1: 3, 4, 8, and 10. Valid paths on TDLAS 2: 1, 2, and 4. Possibly caused by a combination of dew/fog and possibly wet plastic inside retro-reflectors. CR 1000 RH is 90% and T=24.4 C.
11:50	9/9/2008	Remote	Daily Status Check from PAML notes: At 13:00 EDT reaimed TDLAS paths: TDLAS 1 R5 and TDLAS 2 R9. See form for details. Unable to find TDLAS 2 R10 yet. May be caused by fog or mist. FTP server was off (unknown cause), so no data were received this morning. Turned on FTP server and reset data. Flagged data in sonic anemometers 2 and 3 around 617.95-618. Sonic anemometer 2 stopped sending data around 618.0. Since about 618.0 both side on GSS mass flow data have similar readings. Will keep checking. Change (step) in H2S sample flow from 0.77 to 0.66 at 618.1.
12:00	9/10/2008	Remote	Daily Status Check from PAML notes: Very humid conditions for long periods; none of the paths valid. Sonic anemometer 2 not functioning. H2S sample flow had a step drop around day 618. SO2 has been around 10 ppb entire period. H2S has rarely reached 5 ppb.

12:30	9/11/2008	Remote	Daily Status Check from PAML notes: AT 18:20, moved TDLAS 2 R10. Still have not realigned path, but new location is closer to where it should be. Sonic anemometer 2 is still not working. H2S chamber pressure jumped from 698 to 710 about 2 d ago (618.1) (at that same time that sample flow decreased).
12:15	9/12/2008	Remote	Daily Status Check from PAML notes: Last 450I data point was on 9/12/2008 at 07:37 UTC. Stopped sonic anemometer program; created data fill file; restarted real-time file; restarted sonic anemometer program. Only one TDLAS path getting valid light levels out of 20. Continued fog/mist/dew. Sonic anemometer 2 still not working. H2S sample flow is still low at 0.66 L min^{-1}.
12:00	9/15/2008	Remote	Daily Status Check from PAML notes: Tried to reaim path 5 on TDLAS 2. See form for details. Paths 5 and 10 on TDLAS 2 are lost. Sonic anemometer 2 still not working. H2S sample flow has been steady at 0.66 L min^{-1} for past few days.
11:50	9/16/2008	Remote	Daily Status Check from PAML notes: Still very humid. Path TDLAS paths with relatively low light levels on TDLAS 1. Path 10 on TDLAS 2 is completely lost. Sonic anemometer 2 still not working. Sonic anemometer 3 has four 5-min periods with over 1500 flags. H2S sample flow is still not normal with a reading of 0.66 L min^{-1}.
12:30	9/17/2008	Remote	Daily Status Check from PAML notes: Reaimed TDLAS 2 paths 5 and 10. Paths are still wet probably as light levels are still low. See forms for details. Sonic anemometer 2 still not working. H2S sample flow is still low at 0.66 L min^{-1}.
12:00	9/18/2008	Remote	Daily Status Check from PAML notes: Fog/mist still causing low light levels on some paths. Paths 5 and 10 on TDLAS 2 still have low light levels most of the time. Sonic anemometer 2 still not functioning. Sample flow on H2S analyzer still low at 0.66 L min^{-1}.
	9/22/2008	Takedown	Arrived at site around 20:00 UTC. Opened up retro-reflector door on TDLAS 2 retro-reflector 10 since the plastic was wet. Retro-reflector seal appears bad. Path 10 was saturated, so moved to a good location and restarted.
	9/22/2008	Takedown	At orifice 3 on F-S-OPS, lower "T" was covered by a fire ant nest. When the "T" was removed the ants came out of the nest. Saw a lot of tape attached to the "T" also; must have leaked the last time as well.
	9/22/2008	Takedown	Plastic in TDLAS 2 retro-reflector 10 still slightly damp at 23:00 UTC. Took out and dried in the breeze, and placed back in retro-reflector box.
	9/22/2008	Takedown	GSS Leak Test: Pass
	9/22/2008	Takedown	GSS Max Flow Test
	9/22/2008	Takedown	GSS no Flow Test
	9/22/2008	Takedown	S-OPS Max Flow test
	9/22/2008	Takedown	S-OPS/GSS Leak Test: Pass
	9/22/2008	Takedown	S-OPS Balance: D
20:35	9/22/2008	Takedown	Barometer audit: accepted.
	9/22/2008	Takedown	S-OPS Balance: F
	9/23/2008	Takedown	Received nitrogen and zero air cylinders.
	9/23/2008	Takedown	Retro-reflector plastic information taken. See site notes for details.
	9/23/2008	Takedown	Maintenance list made
	9/23/2008	Takedown	pH sensor: Calibration, Acceptance, Stability, and QA accepted.
	9/23/2008	Takedown	ORP sensor: calibration and acceptance accepted
16:10-	9/23/2008	Takedown	Sonic anemometer inter-comparison: Sonic anemometer 2 fails

17:10			
17:28	9/23/2008	Takedown	Zero calibration on sonic anemometers. Notes: Sonic anemometer 2 is not working. All values are zero with a flag 2.
20:03-20:17	9/23/2008	Takedown	TEC 450i Calibration Verification Check
20:19	9/23/2008	Takedown	TEC 450i Instrument Operating Parameters
20:19	9/23/2008	Takedown	TEC 450i Reference Precision Check
22:30	9/23/2008	Takedown	Calibrated TDLAS 1030 notes: Diluter only being used to control flow.
23:09	9/23/2008	Takedown	Calibrated TDLAS 1026 notes: Diluter only being used to control flow.
	1/14/2009	Setup	Reached site at 2:30 pm local time.
	1/14/2009	Setup	Hooked up trailer and power supply.
	1/14/2009	Setup	Set up all ground retro-reflectors and scanners.
	1/14/2009	Setup	Scissor jack at right side of the trailer got damaged while driving from PAML to NC4A. Have to use blocks to give support.
	1/14/2009	Setup	Glass reference electrode got broken (it may have broke while traveling). Could not perform acceptance or pH and ORP probes. Will only do calibration.
	1/14/2009	Setup	Truck got stuck in evening hours.
21:55-22:50	1/14/2009	Setup	Sonic anemometer inter-comparison; all pass.
23:25	1/14/2009	Setup	Zero sonic anemometer calibration; all pass.
	1/15/2009	Setup	One scanner is completely dead. Power supply is outputting 24.6 V as verified by "test box," but scanner fails to do "initialization dance" or any sort of measures in start up. Will return to DP tomorrow.
	1/15/2009	Setup	During Innova calibration, NH3 looks good and passes. Methane, however, had values ten times higher than NH3. Found an error in calculation (calculating using C3H8 instead of CH4). CH4 still not passing with accuracy of -36.4%.
	1/15/2009	Setup	While balance S-OPS side F filter paper on orifices #2 and #8 had to be changed. There is a leak somewhere in the F side. Will try to fix leak tomorrow.
	1/15/2009	Setup	Maintenance list made
14:18	1/15/2009	Setup	pH sensor: QA and inspection/maintenance completed. Note: Glass reference electrode got broken (it may have broke while traveling). Could not perform acceptance or pH and ORP probes.
14:28	1/15/2009	Setup	ORP calibration note: Glass reference electrode got broken (it may have broke while traveling). Could not perform acceptance or pH and ORP probes.
15:50	1/15/2009	Setup	Installed lagoon probes.
17:14	1/15/2009	Setup	TEC 450i calibration
17:28	1/15/2009	Setup	Wetness Sensor calibration: accepted.
17:31	1/15/2009	Setup	Wetness Sensor calibration: accepted.
19:05	1/15/2009	Setup	Calibrated TDLAS 1026
20:21	1/15/2009	Setup	Calibrated TDLAS 1030
	1/16/2009	Setup	Since SW scanner was not working, TDLAS 1026 was fixed on a single path.
	1/16/2009	Setup	Took about one h to balance S-OPS "D" side. Changed nozzle for orifice number 2.
	1/16/2009	Setup	Spent about two hours to find leaks in S-OPS. Found orifices 2 and 8 leaking. Managed to drop leak by 0.3 L min^{-1}. Still not good enough to pass; failing by 0.04 L min^{-1}. Will keep like that.

	1/16/2009	Setup	Lagoon site layout made
14:00	1/20/2009	Remote	Daily Status Check from PAML notes: Unable to find paths on TDLAS 1 due to snow. Extensive communication problems with TDLAS 1. Innova present, but QC not working at PAML. GSS mass flow and pressure on one line dropped for a while yesterday. Single path on TDLAS 2.
	1/21/2009	Repair	Flight to site was delayed, so did not arrive on site until 6:00 P.M. local time. Gate was locked upon arrive so had to walk the scanner to the trailer.
	1/21/2009	Repair	Set up the scanner and aimed the paths using the halogen work lights. When the laptop was brought back into the trailer, the *GasView MP* program kept showing pan/tilt errors. Tried moving antennas on the trailer roof and also took a spare tripod over the scanner and mounted the modem box as high as possible. Restarted program the scanner and TDLAS modems, and it seems to be running better. However, some pan/tilt errors occur sporadically.
	1/21/2009	Repair	Performed CH4 span check on Innova. Recorded the results in the Innova control chart. With the Humidifier canister in the line, got similar results to the calibration on 1/15/2009 (6.55 ppm CH_4). Then ran calibration span without the Humidifier in the line and got very different results (11.88 ppm CH4). Hooked the sampling tube from the GSS back to the Innova at 1:38 UTC on 1/22/2009.
13:15	1/21/2009	Remote	Daily Status Check from PAML notes: Restarted GasViewMP program and reloaded setup files for TDLAS 1. System is attempting to reaim/optimize paths. Some light values at 16,368 to start out. GSS mass flow has been gradually decreasing. Flag 4 (valve constant) in H2S data. Innova QC not working. TDLAS 2 is on a single path.
13:10	1/22/2009	Remote	Daily Status Check from PAML notes: On TDLAS 2, paths 4, 9, and 10 have red box errors. Placed correct values in repair file. When in Aim screen, all ten paths have good light level values. However, when running, the indicator goes to "moving" for long periods of time and then "pan-tilt error." Some paths go to correct spots and others do not. Pan-tilt unit seems to struggle to send data back to trailer. Innova QC not working. TDLAS 2 is on a single path.
15:07	1/23/2009	Remote	Daily Status Check from PAML notes: TDLAS 2 is not working properly. Scanner keeps giving pan-tilt errors.
14:10	1/26/2009	Remote	Daily Status Check from PAML notes: Scanner 2 is not working (pan-tilt errors). Found that path 8 on TDLAS 2 had a dwell time of zero sec since set up occurred. Set this path up as a "single path" by changing dwell to 600s and all other paths' dwell to zero sec. Left system aimed at path 9 by not pressing run button. This is tower path on west side of lagoon since winds should be from the east for the next day or so.
13:00	1/27/2009	Remote	Daily Status Check from PAML notes: TDLAS 2 is set to a single path on path 8. QC program cannot handle this. GSS mass flow still fluctuating. No Innova QC.
14:50	1/28/2009	Remote	Daily Status Check from PAML notes: Moved TDLAS 2 from pointing at retro-reflector 8 (west side) to retro-reflector 3 (south side) at 16:08 since winds have shifted to the south. No Innova QC. GSS mass flow fluctuating.
13:05	1/29/2009	Remote	Daily Status Check from PAML notes: TDLAS 2 is on a fixed path (path 3). TDLAS 2 path 3 has low light values (~832). TDLAS 2 has extensive "xxxx" error values. No QC file for GSS/H2S/Innova. GSS mass flow pink line still variable. No Innova QC available.

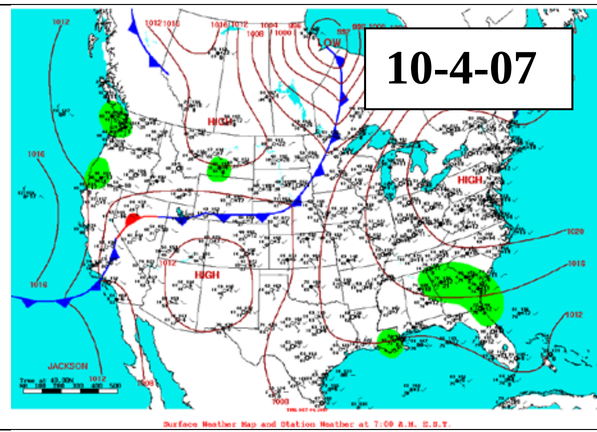
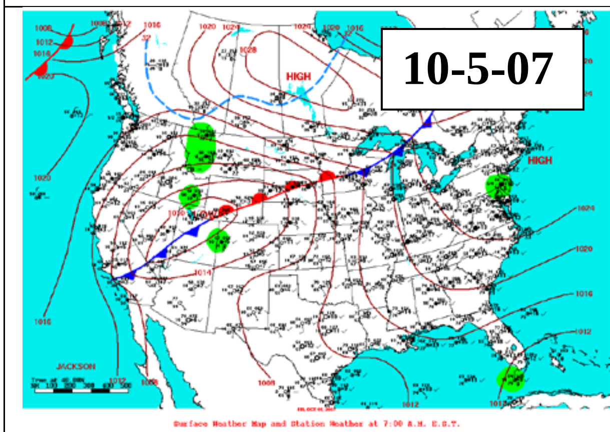
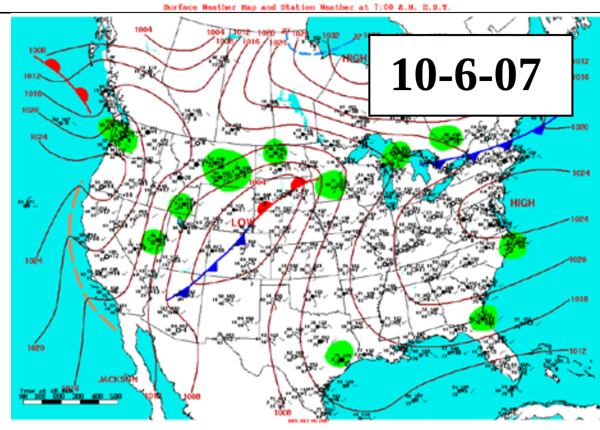
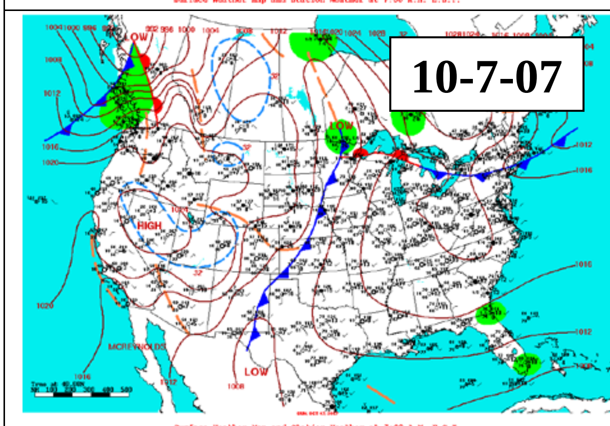
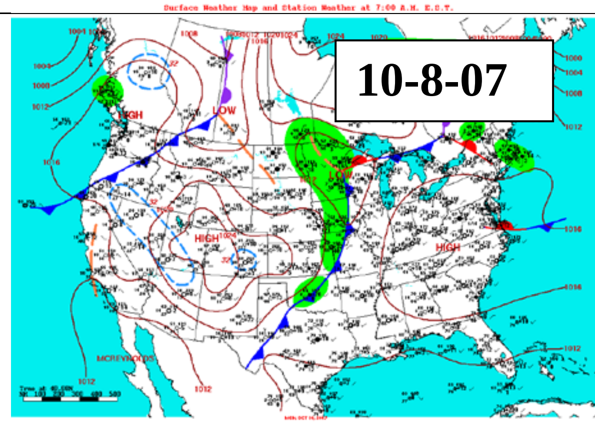
16:30	1/30/2009	Remote	Daily Status Check from PAML notes: TDLAS 2 is on a fixed path (path 3). TDLAS 2 also has continuous communication problems ("xxxx" displayed as values). No TDLAS 2 QC because of single path; values look good. GSS mass flow/pressure still varying. No Innova QC.
	2/2/2009	Takedown	Reached site at 2:15 pm local time.
	2/2/2009	Takedown	Everything was working well; even TDLAS 2 (1026) was working. It was not showing communication (xxxx) error.
	2/2/2009	Takedown	Scanner seems to be not working. TDLAS is stuck in one direction that is opposite to the lagoon facing downwards.
20:35-21:29	2/2/2009	Takedown	Sonic anemometer inter-comparison; all pass.
21:30-22:00	2/2/2009	Takedown	Sludge Depth measurements taken. Notes: Did measurements in two different ways. The first was recording the depth when the gun begins to squeal when lowering. The second was recording the depth when the sludge gun stops squealing when raised. The two depths were very different, varying by more than one meter. See worksheet for details.
22:02	2/2/2009	Takedown	Removed probe float from lagoon.
22:51	2/2/2009	Takedown	Zero sonic anemometer calibration; all pass.
23:08	2/2/2009	Takedown	Barometer audit: accepted.
	2/3/2009	Takedown	CH4 calibration fails for Innova; it initially gave a good reading, but after one minute it started giving lower values. The cylinder may be bad.
	2/3/2009	Takedown	S-OPS "F" balancing failed. Had to change filter paper for orifices 1 and 8 (before changing filter paper leak test was failing but after change it passed).
	2/3/2009	Takedown	S-OPS "D" balanced failed too. Will check at NC3A. Filter holder for #1 is leaking, but do not have replacement available. Water is in the liner of the inlets with leaking filer paper holders.
	2/3/2009	Takedown	pH sensor failed during calibration. It was giving more basic values than reference solution. Changed reference solution and cleaned probe with soap. Readings improved slightly, but still failing. Will replace with a new sensor.
	2/3/2009	Takedown	Maintenance list made
14:32-16:34	2/3/2009	Takedown	S-OPS/GSS calibrations: See Open Site notes for details on S-OPS balancing.
15:34-16:44	2/3/2009	Takedown	Innova single point calibration notes: It initially gave a good reading, but after 2-3 min it started giving lower values. Did CH4 calibration again with Teflon tubing, but got same result.
17:42	2/3/2009	Takedown	Calibrated TDLAS 1026
18:10	2/3/2009	Takedown	Calibrated TDLAS 1030
19:28	2/3/2009	Takedown	Wetness Sensor calibration: accepted.
22:00	2/3/2009	Takedown	ORP sensor: calibration and acceptance accepted
22:28	2/3/2009	Takedown	pH sensor: QA and inspection/maintenance completed.
	4/28/2009	Setup	TDLAS 1026 failed calibration (bias -15.34%). Tried calibrating the TDLAS a second time, but it failed again (bias -11.43%).
17:20	4/28/2009	Setup	Zero sonic anemometer calibration; all pass.
17:40	4/28/2009	Setup	Sonic anemometer inter-comparison; all pass.
21:32-23:21	4/28/2009	Setup	Calibrated TDLAS 1026 notes: TDLAS 1026 failed calibration (bias -15.34%). Tried calibrating the TDLAS a second time, but it failed again (bias -11.43%).
22:05	4/28/2009	Setup	Calibrated TDLAS 1030

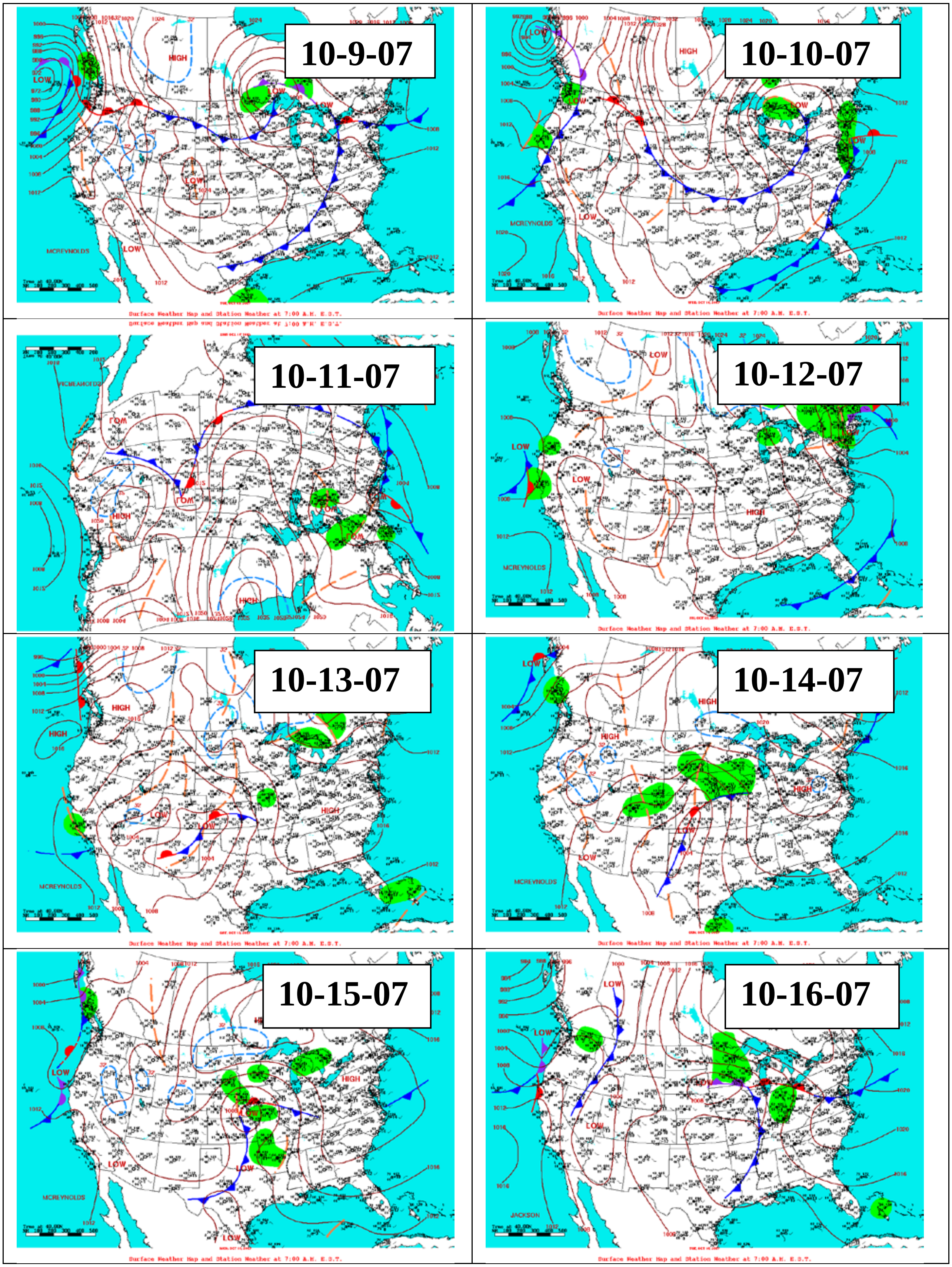
	4/29/2009	Setup	While aiming TDLAS 1030 (SW corner), the machine displayed communication errors (“xxxx”) most of the time. Some improvement when we started running. Placed grad modem/power supply box on top of the tall tripod and communication errors went away.
	4/29/2009	Setup	Maintenance list made
	4/29/2009	Setup	Lagoon site layout made
	4/29/2009	Setup	S-OPS/GSS calibrations
	4/29/2009	Setup	ORP sensor: calibration and acceptance accepted
15:32	4/29/2009	Setup	Wetness Sensor calibration: accepted.
15:34	4/29/2009	Setup	Barometer audit: accepted.
15:46-16:55	4/29/2009	Setup	TEC 450i multipoint calibration
16:40	4/29/2009	Setup	pH sensor: QA, calibration, and inspection and maintenance completed
14:15	4/30/2009	Remote	Daily Status Check from PAML notes: no QC data.
14:10	5/1/2009	Remote	Daily Status Check from PAML notes: no Innova at site.
13:10	5/4/2009	Remote	Daily Status Check from PAML notes: *iPort* error; had to stop sonic anemometers to restart *iPort*. Filled missing data from 5/2/2009 00:11 to 5/4/2009 02:29 and from 5/4/2009 2:40 to 5/4/2009 13:01. Sonic anemometer 1 average w is slightly higher than zero. Sonic anemometer u, v, and w graphs look different.
12:05	5/5/2009	Remote	Daily Status Check from PAML notes: On TDLAS 2, paths 2, 3, and 8 were off. Weather is bad; will check again later. Not able to connect to CR 800. Later, restarted *Loggernet* and was able to connect. Sonic anemometer 1 w looks different from the other sonic anemometers' graphs.
13:00	5/6/2009	Remote	Daily Status Check from PAML notes: Unable to connect to CR 800; restarted *Loggernet* to be able to connect to CR 800. Checked GSS (CR 800) data collection and TDLAS 2 alignment later in the day. Found that date was set one day behind on "Date and Time Properties." Corrected from 5/5/2009 to 5/6/2009, and *Loggernet* appears to be downloading data again. Does not appear to have affected any data streams. At least two paths on TDLAS 2 have low light levels (path 8 optimizing the most). Handful of five-min intervals for sonic anemometer 3 has flagging (only two are greater than 500).
12:50	5/7/2009	Remote	Daily Status Check from PAML notes: Around day 856.6 there is some period of time that is repeated, probably due to the date error noticed yesterday. The data with the incorrect time stamps is from 5/6 13:39 to 5/6 15:00.
13:00	5/8/2009	Remote	Daily Status Check from PAML notes: *iPort* error; had to stop sonic anemometers to restart *iPort*. Filled missing data from 5/7/2009 22:29 to 5/8/2009 05:38. Data is now complete. Tried to reaim TDLAS 2 path 5 but was not successful. Spent about 30 min trying to re-aim; will try again later.
	5/11/2009	Takedown	Fifth paths on SW TDLAS (the path that which was unable to be found in Daily Status Check for 5/8/2009) was found to be filled with water, and the plastic was found to be stuck to the window due to water. Resealed the window with putty.
17:51-18:19	5/11/2009	Takedown	TEC 450i single point calibration
18:45-19:02	5/11/2009	Takedown	Calibrated TDLAS 1030
19:00-	5/11/2009	Takedown	Sonic anemometer inter-comparison; all pass.

19:54			
19:21-19:35	5/11/2009	Takedown	Calibrated TDLAS 1026
20:13	5/11/2009	Takedown	Zero sonic anemometer calibration; all pass.
20:30	5/11/2009	Takedown	S-OPS/GSS calibrations notes: Inlet balance failed; will check "D" side at NC3A.
21:45	5/11/2009	Takedown	Barometer audit: accepted.
22:00	5/11/2009	Takedown	Wetness Sensor calibration: accepted.
	5/12/2009	Takedown	no lagoon boating for sludge depth due to breezy conditions and injured boater (MTB pulled chest muscle while removing probe float).
	5/12/2009	Takedown	Maintenance list made
	5/12/2009	Takedown	ORP sensor: calibration and acceptance accepted
13:15	5/12/2009	Takedown	pH sensor: QA, calibration, and inspection and maintenance completed
	6/30/2009	Setup	Replaced broken retro-reflector box with a new one.
	6/30/2009	Setup	New QCCS and Zobell's solution made.
	6/30/2009	Setup	New wetness sensor installed.
18:37	6/30/2009	Setup	Calibrated wetness sensor: accepted. Notes: New wetness sensor (s/n: 6)
18:48	6/30/2009	Setup	Barometer audit: accepted.
	7/1/2009	Setup	Sludge depth measurements taken
	7/1/2009	Setup	ORP sensor: calibration and acceptance accepted
	7/1/2009	Setup	Lagoon site layout made
	7/1/2009	Setup	Maintenance list made
15:55-17:25	7/1/2009	Setup	S-OPS/GSS calibrations
17:15	7/1/2009	Setup	pH sensor: QA, calibration, and inspection and maintenance completed
18:08	7/1/2009	Setup	Started H2S measurement
19:55	7/1/2009	Setup	Installed lagoon probes.
13:20	7/6/2009	Remote	Daily Status Check from PAML
13:20	7/7/2009	Remote	Daily Status Check from PAML notes: When connecting to the TDLAS 1 laptop, found that the aiming screen was still there from yesterday. It was aimed at path 6. Clicked OK, and it started scanning again as it was already in run mode. Stopped scanning at 13:29 UTC 7/6/2009. Started scanning at 13:49 UTC 7/7/2009.
12:55	7/8/2009	Remote	Daily Status Check from PAML notes: Paths on both TDLs have low light levels, probably caused by fog in the area.
16:12	7/9/2009	Remote	Daily Status Check from PAML
12:00	7/10/2009	Remote	Daily Status Check from PAML
12:20	7/13/2009	Remote	Daily Status Check from PAML notes: Sonic anemometers' 2 and 3 w values are on either side of the zero line. TDLAS 1 had a fraction of all ten paths aligned as zero for the previous day and is continuing today. Unable to aim any TDLAS 1 paths.
12:20	7/14/2009	Remote	Daily Status Check from PAML notes: Sonic anemometer 1 w is on the positive side of the zero line. CDC for TDLAS 1 went to 255 and quit; unable to connect to TDLAS 1.
12:20	7/15/2009	Remote	Daily Status Check from PAML notes: Sonic anemometer 1 average w is biased to the positive. TDLAS 1 is no longer work or collecting data. Many paths with low light levels on TDLAS 2 probably caused by dense fog at site.
	7/16/2009	Remote	Daily Status Check from PAML notes: TDLAS 1 is offline.

	7/17/2009	Remote	Daily Status Check from PAML notes: Sonic anemometer 1 is biased to the positive. TDLAS 1 is not working. Morning fog/dew in area probably cause low light levels on TDLAS 2.
	7/20/2009	Remote	Daily Status Check from PAML notes: TDLAS 1 is offline. Sonic anemometer 3 has stopped sending data for unflagged data points and for number of spike data points. Checked 300 sec data, and it was all zeros. Sonic anemometer 3 has not sent any w data since day 930.
	7/21/2009	Remote	Daily Status Check from PAML notes: N:\ is not accessible. Associated error message upon remote login: "not enough server space to process this command." no data for sonic anemometer 3. TDLAS 2 stopped at 13:07:01 UTC on 7/20/2009. Cannot connect to TDLAS laptops. FOS on site.
	7/21/2009	Takedown	Value 10 Error at line 422; computers messed up. Scanner 1202 failed, pointing down. TDLAS 1026 was wet inside, pointing down as well. Let TDLAS dry in the sun. Its connector was badly corroded.
	7/21/2009	Takedown	Sonic anemometer 3 (1933) stopped working on 7/18 at about 00:15 UTC.
13:27-14:21	7/21/2009	Takedown	Calibrated TEC 450i notes: fail precision; 8.47%
19:55-20:55	7/21/2009	Takedown	Sonic anemometer inter-comparison note: Sonic anemometer 3 (1933) stopped working on 7/18/2009 at about 00:15 UTC.
20:08-20:32	7/21/2009	Takedown	Calibrated TDLAS 1030
21:11	7/21/2009	Takedown	Zero sonic anemometer calibration note: Sonic anemometer 3 (1933) stopped working on 7/18 at about 00:15 UTC.
21:30	7/21/2009	Takedown	S-OPS/GSS calibrations
21:42-22:02	7/21/2009	Takedown	Calibrated TDLAS 1026
	7/22/2009	Takedown	Open site notes completed.
	7/22/2009	Takedown	Maintenance list made
	7/22/2009	Takedown	ORP sensor: calibration accepted
14:12	7/22/2009	Takedown	Barometer audit: accepted.
14:16	7/22/2009	Takedown	Wetness Sensor calibration: accepted.
15:05	7/22/2009	Takedown	pH sensor: QA accepted

6.9 Site Weather

Period 2	
	
	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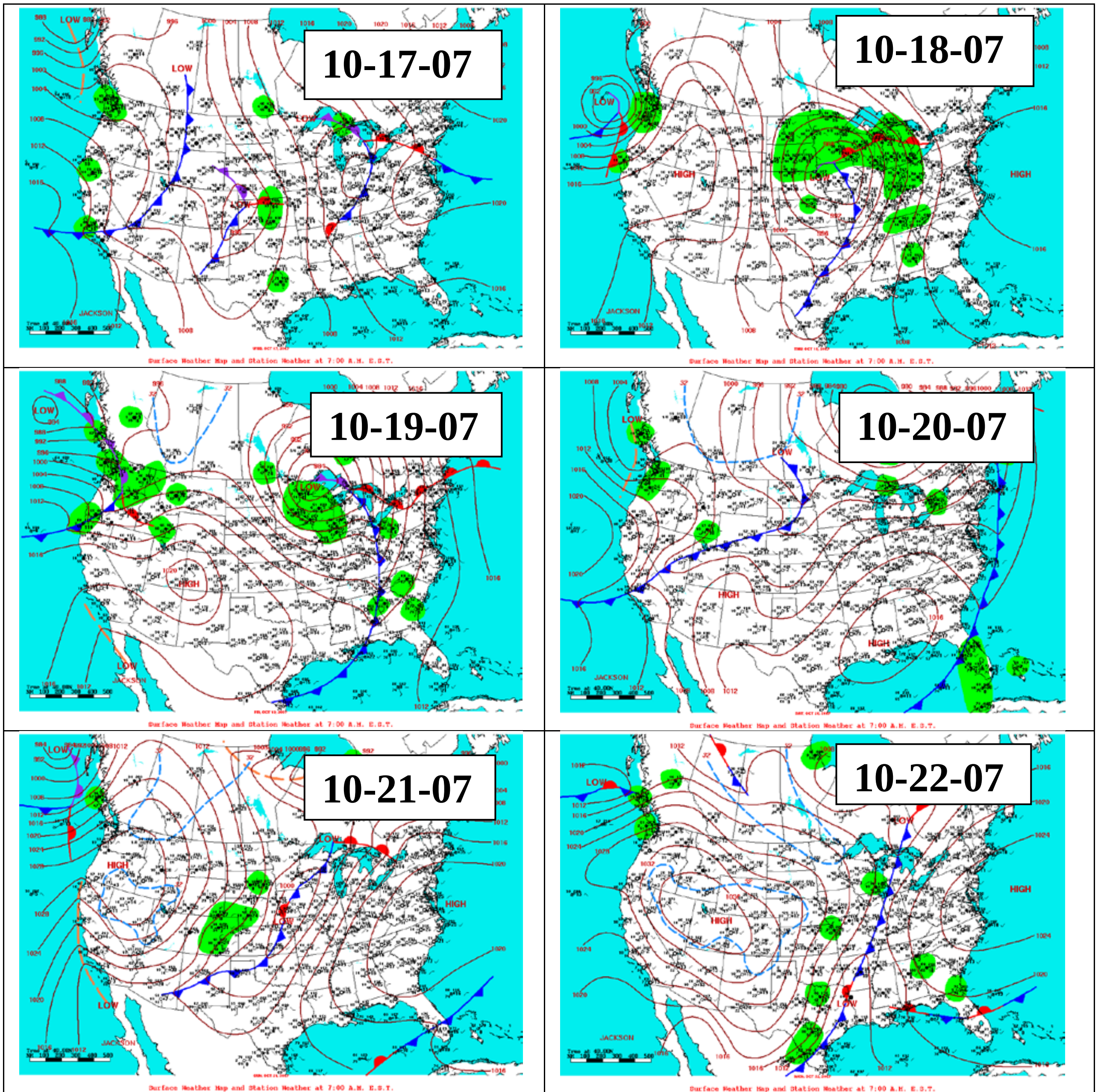

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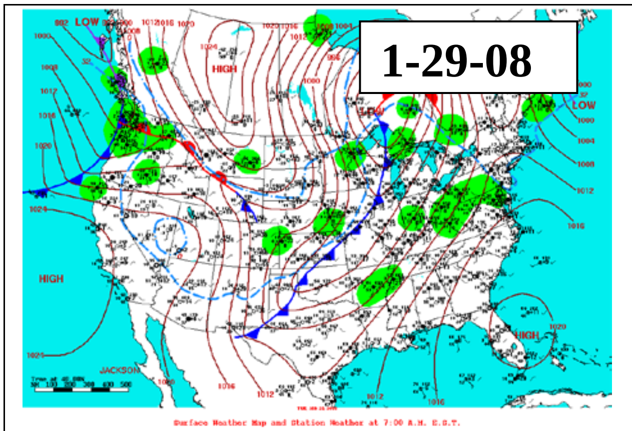
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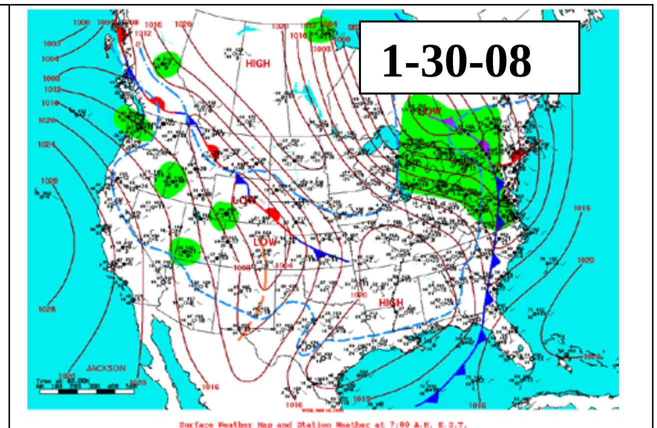
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.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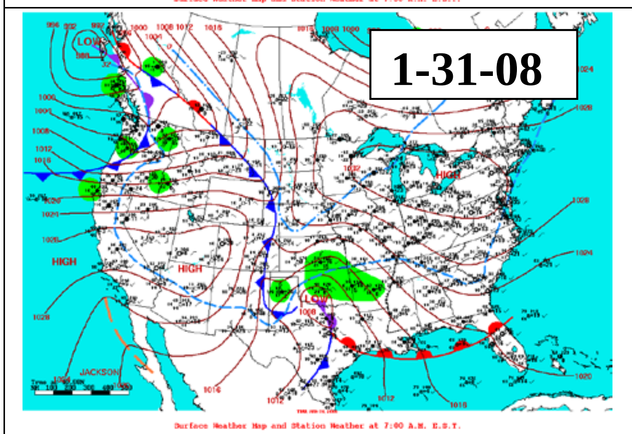
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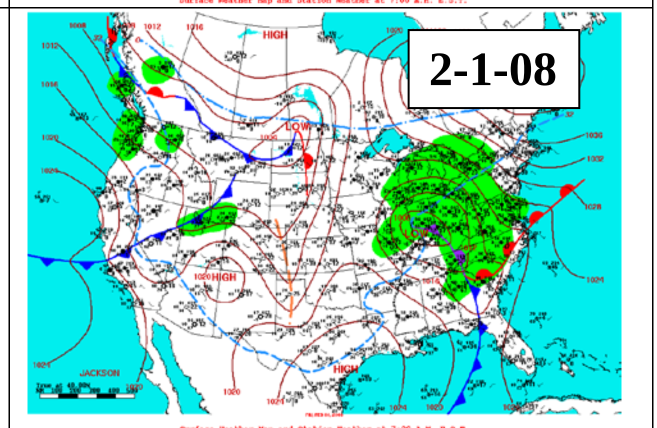
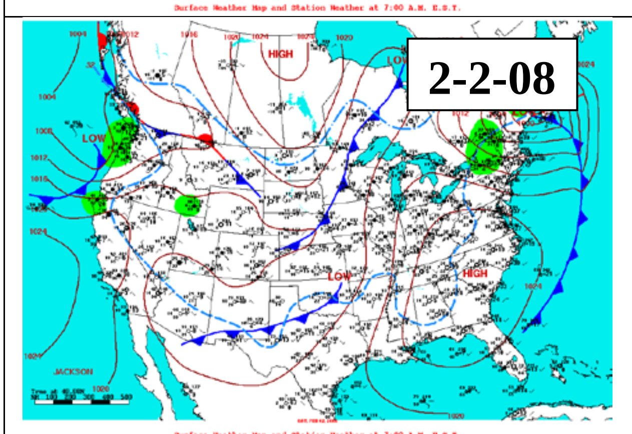

2-1-08
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.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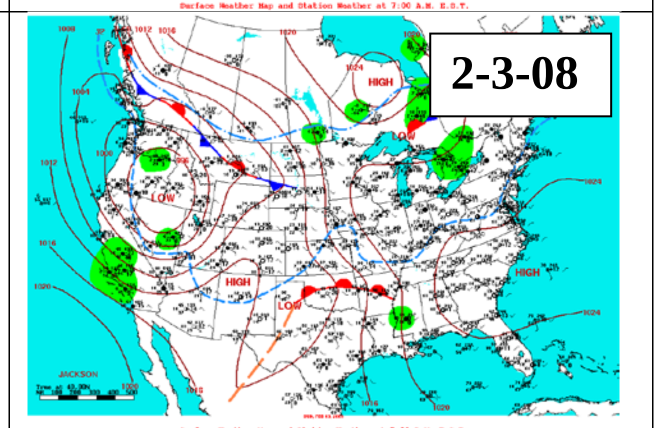
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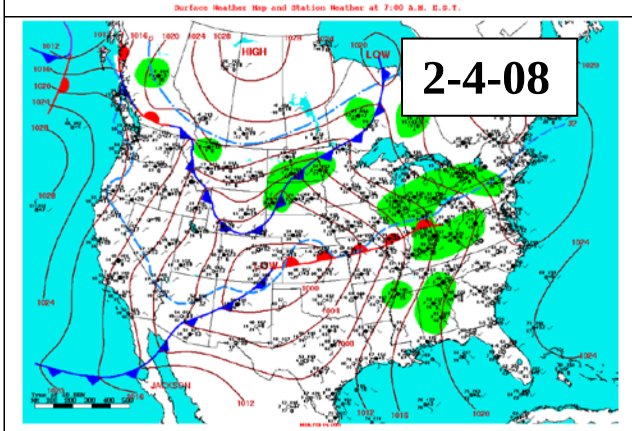
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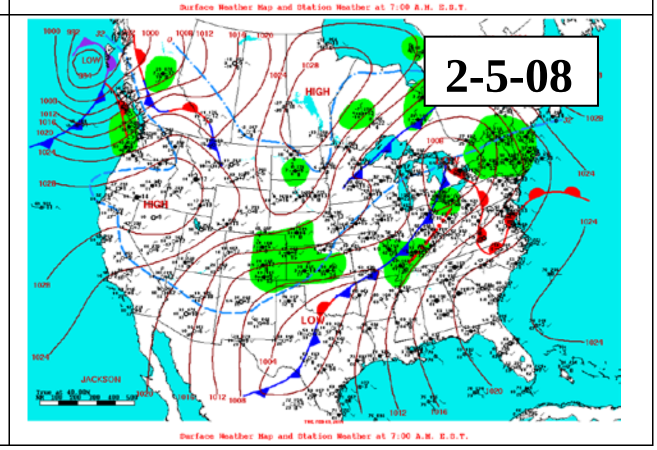
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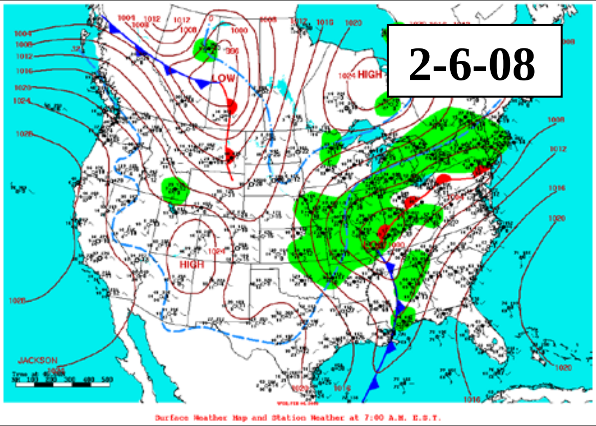
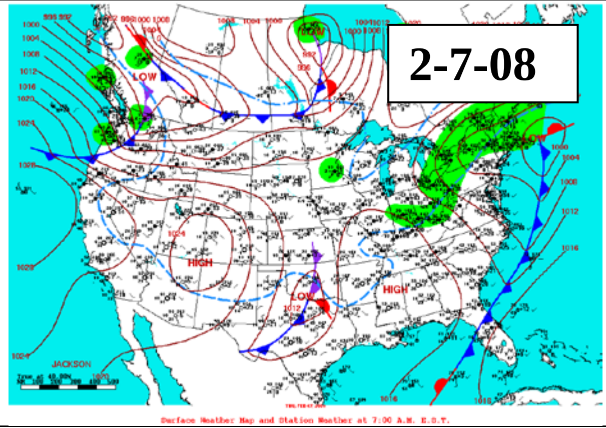
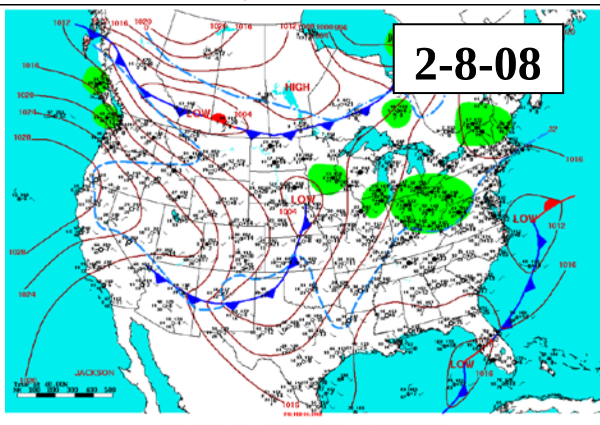
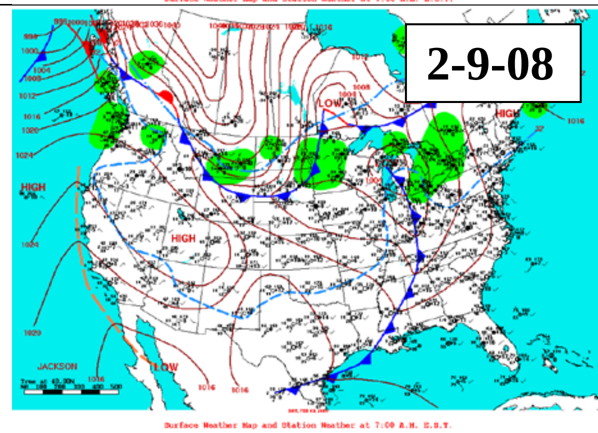
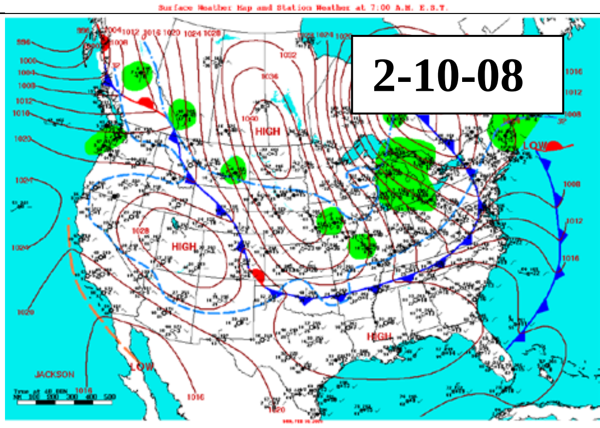
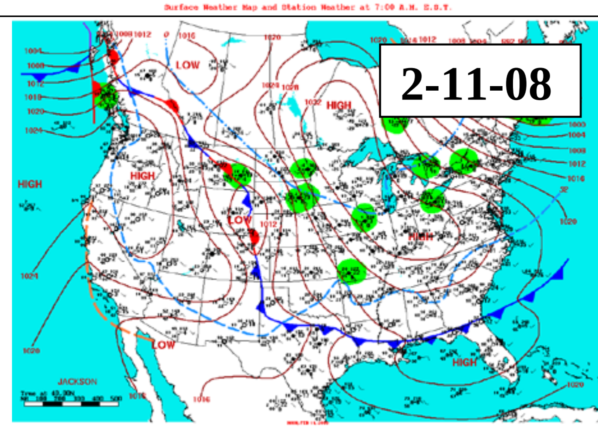
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.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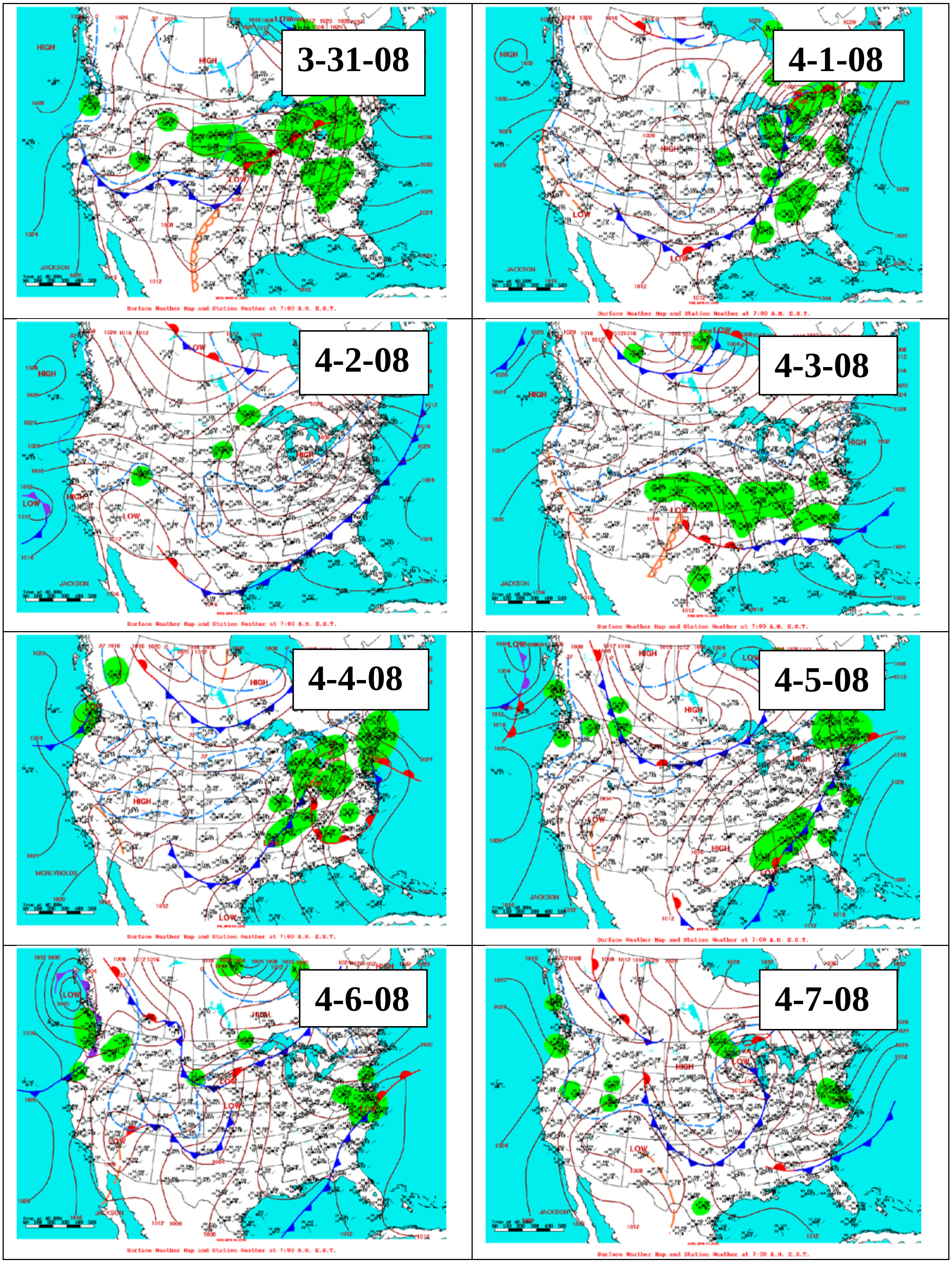
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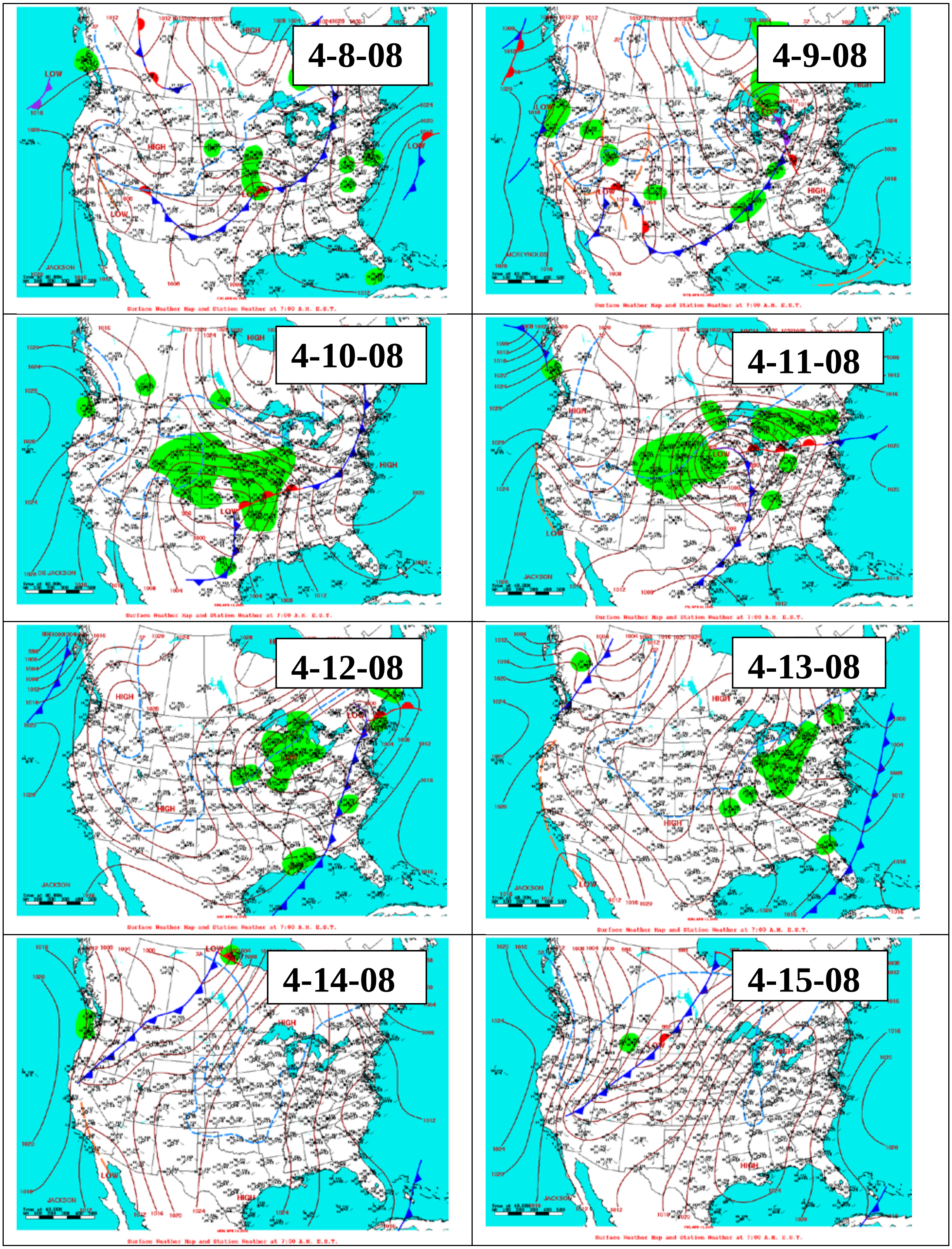
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.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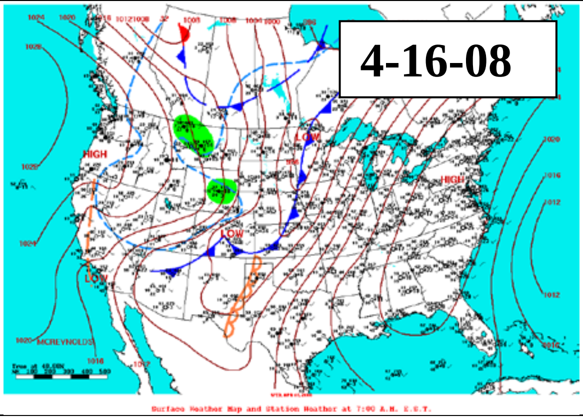

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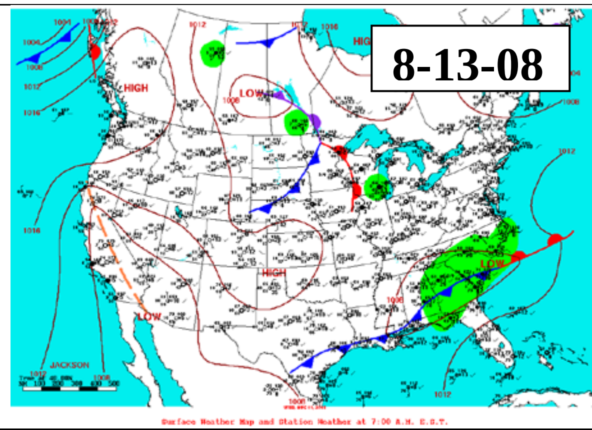

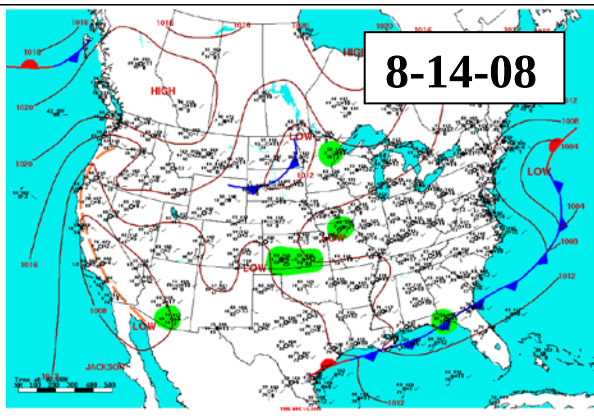

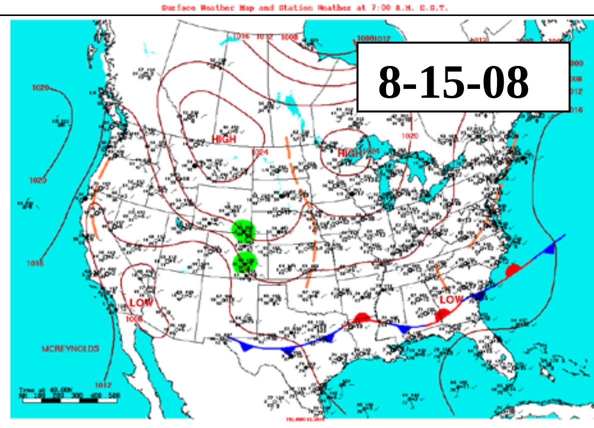

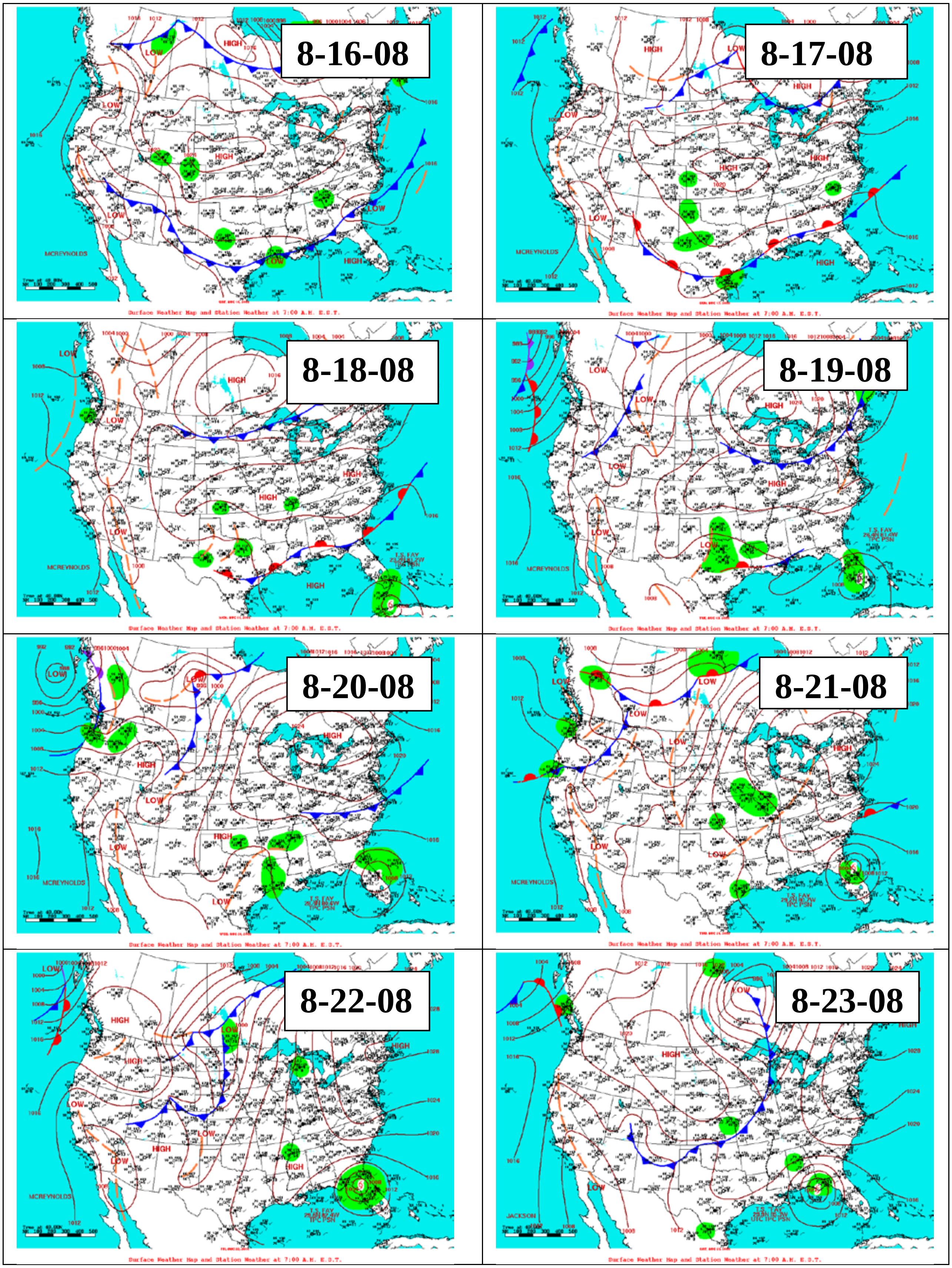
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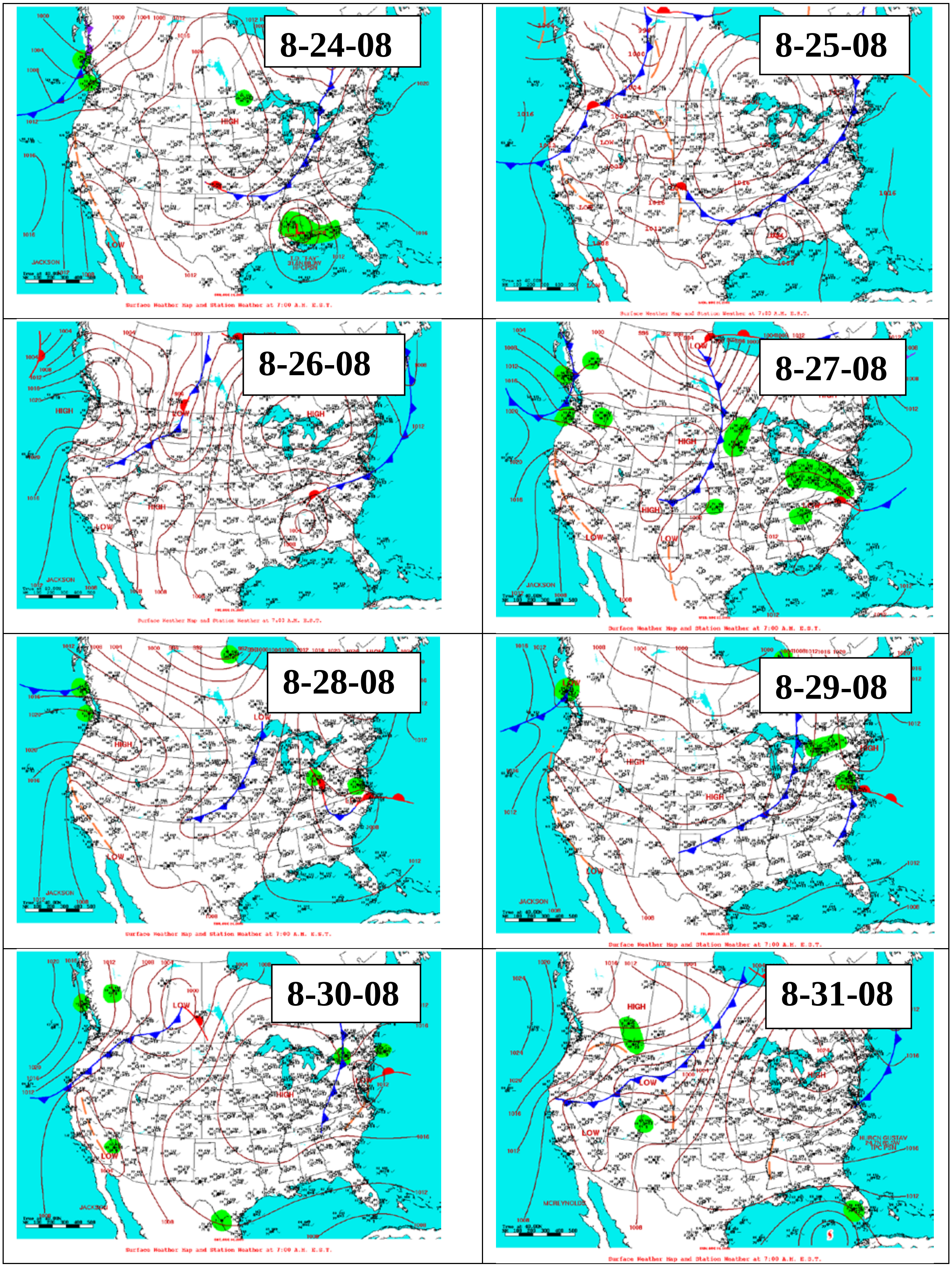
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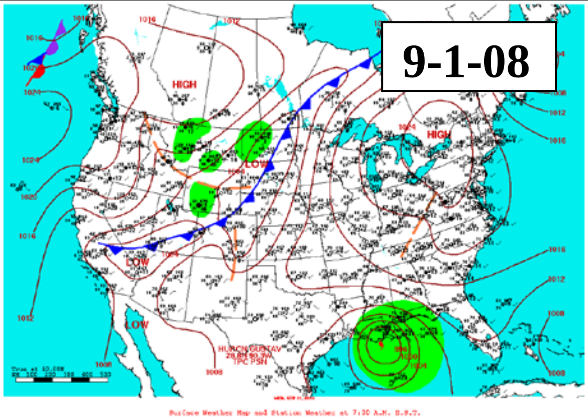

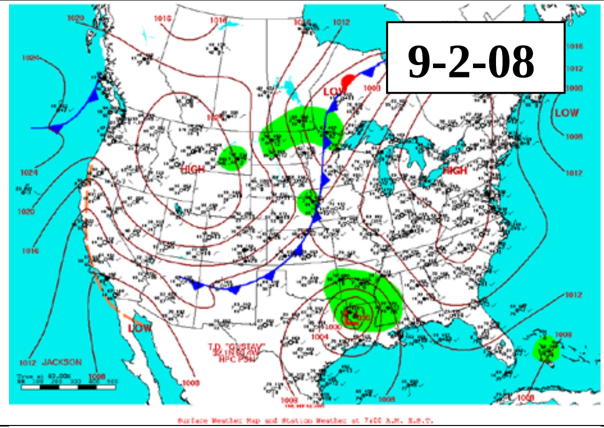

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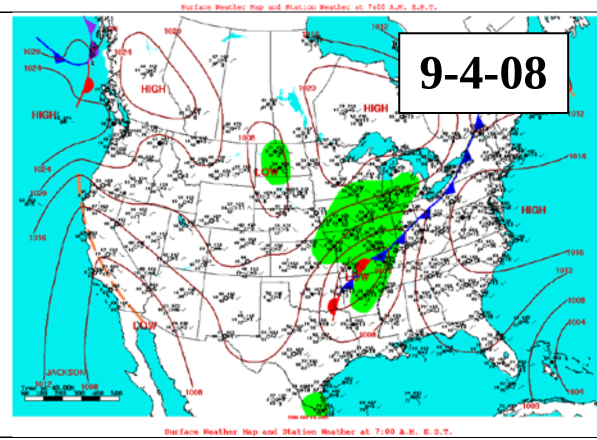

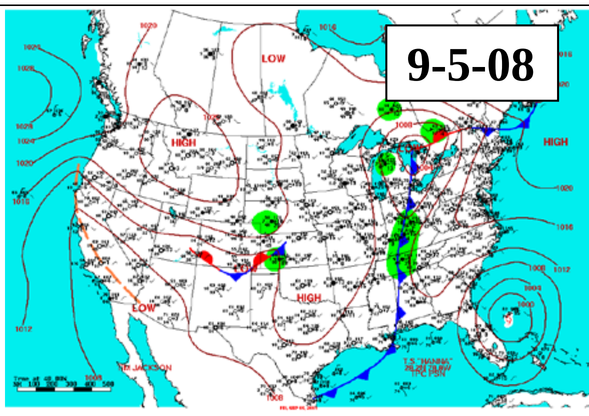

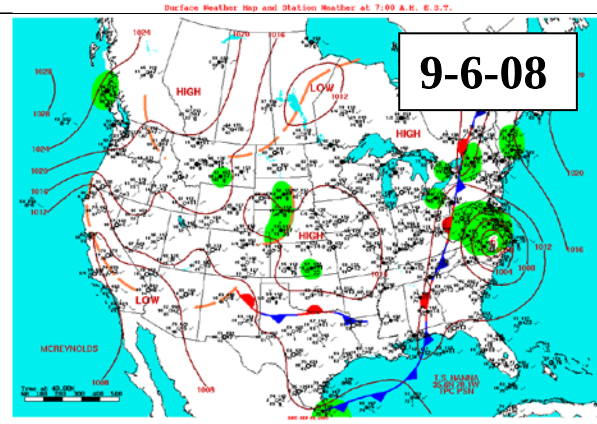

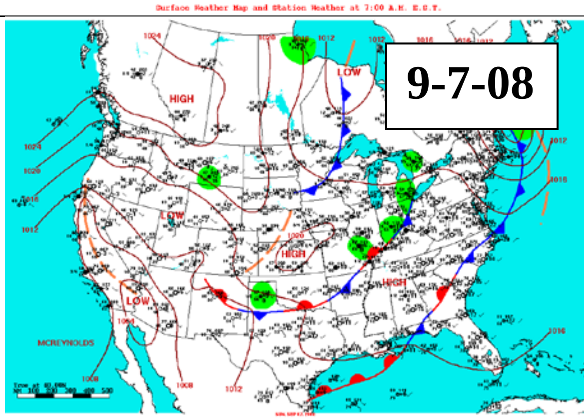

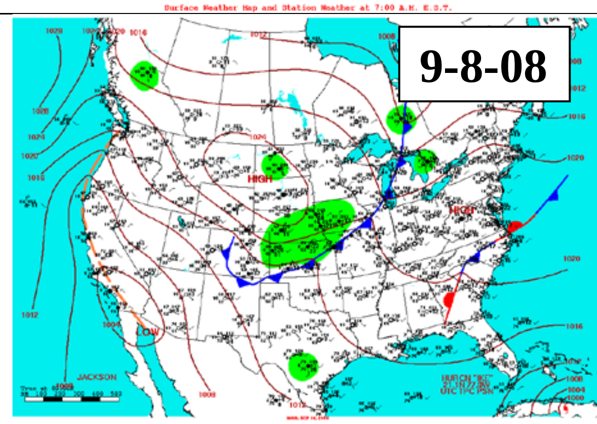

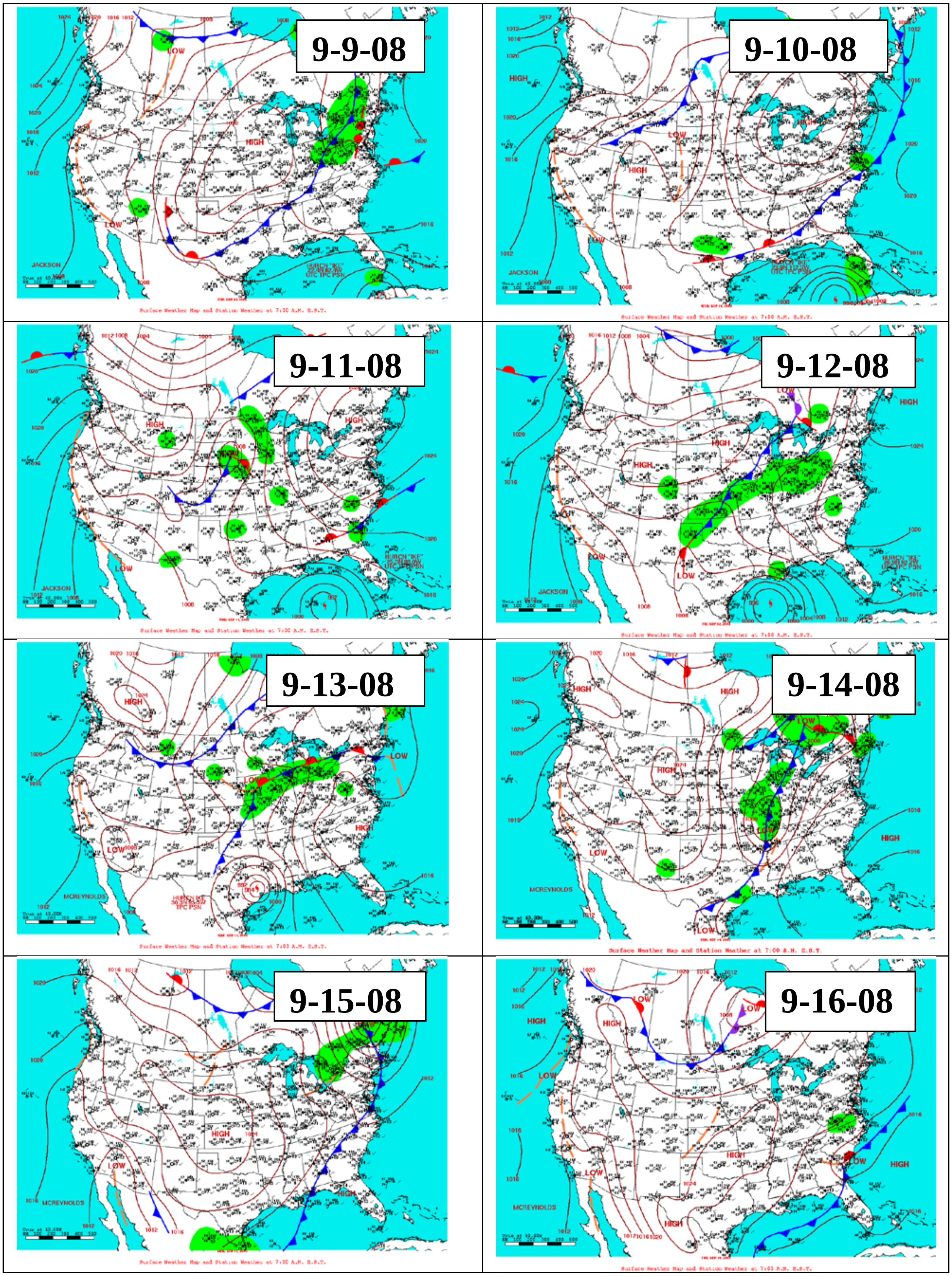
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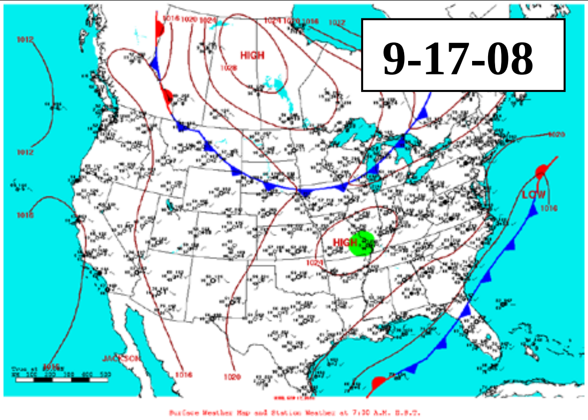
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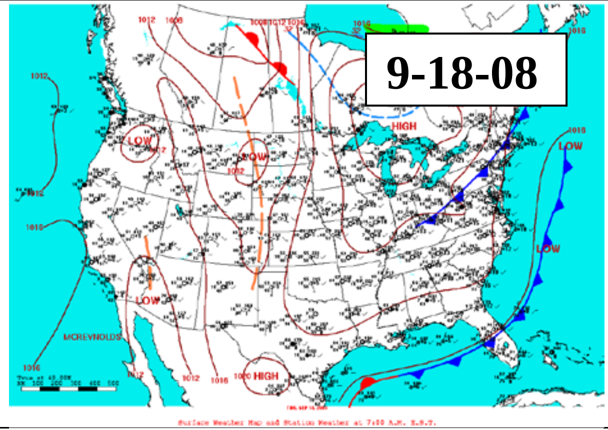
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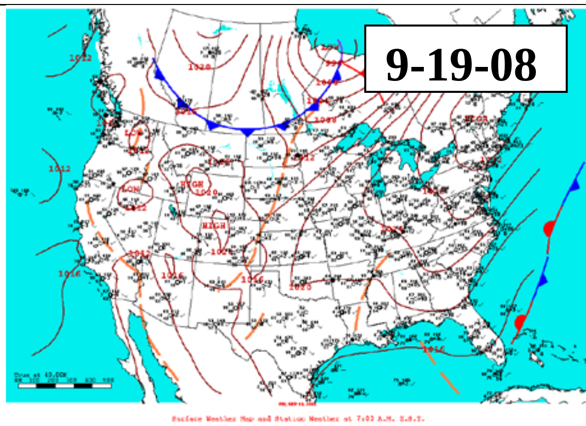
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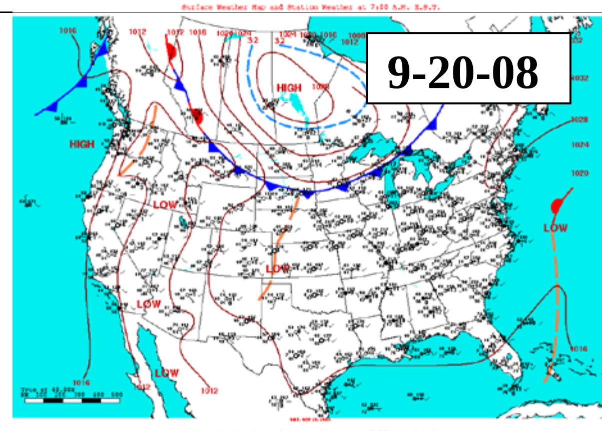
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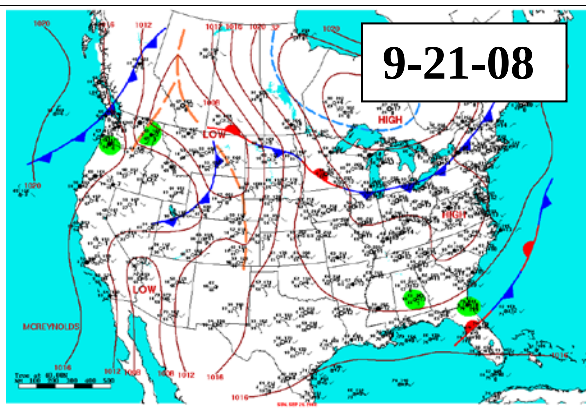
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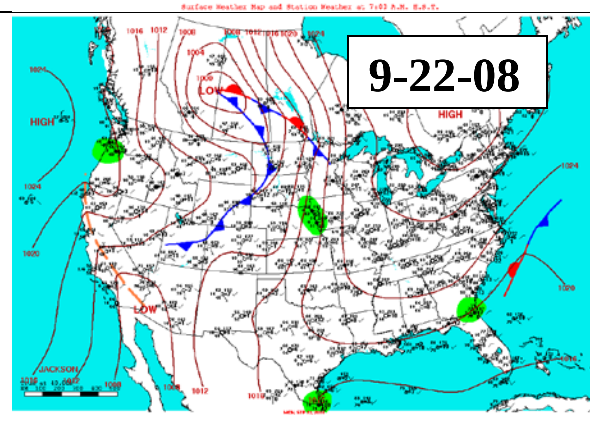
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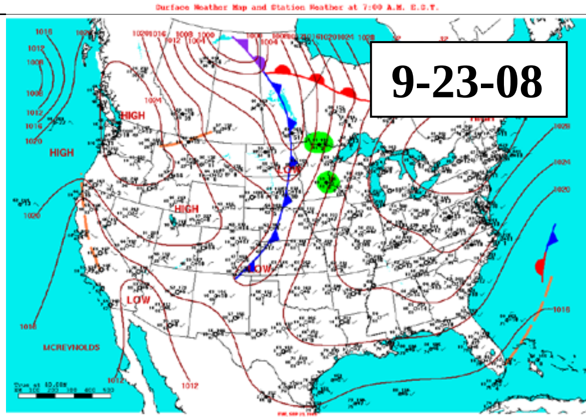
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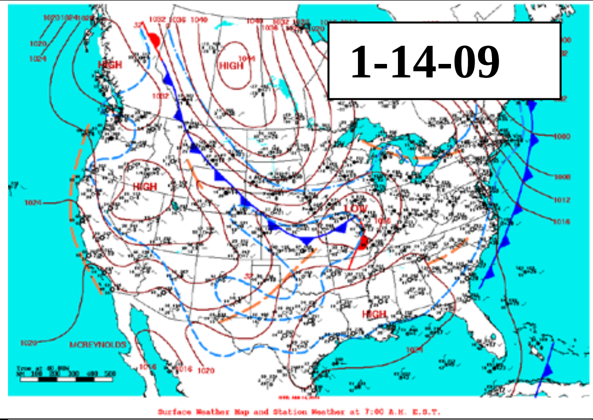
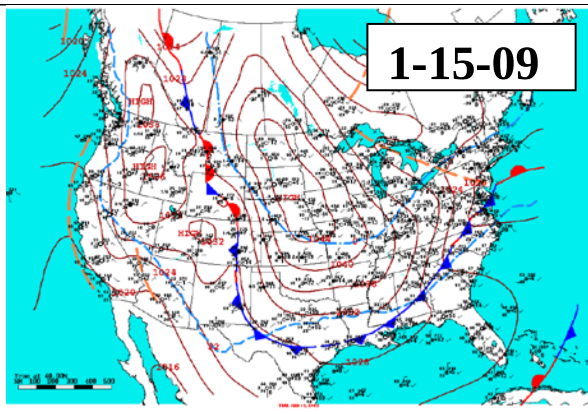
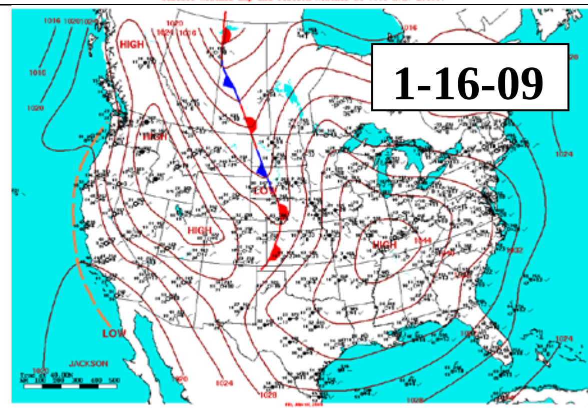
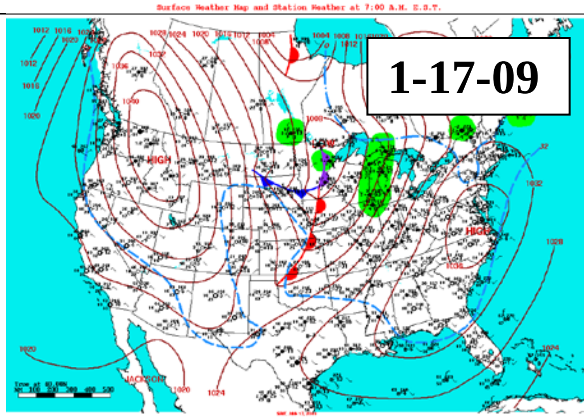
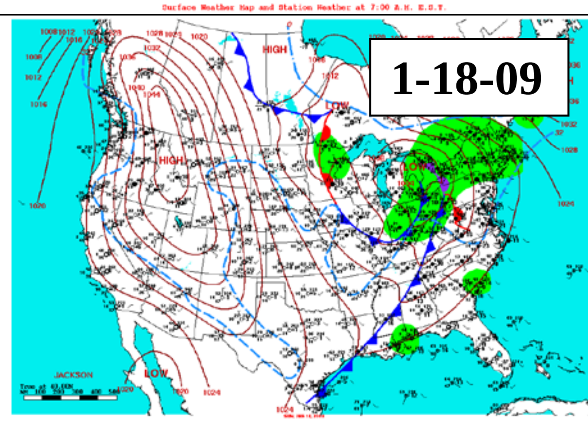
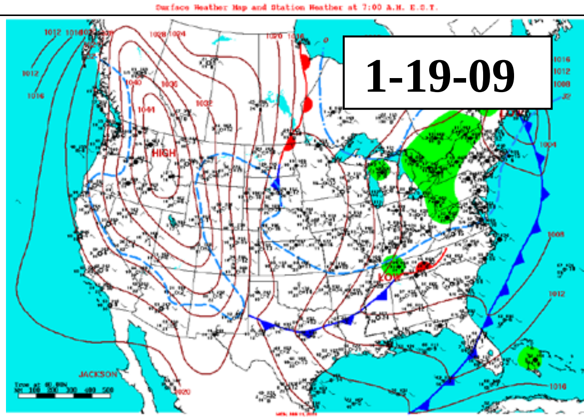
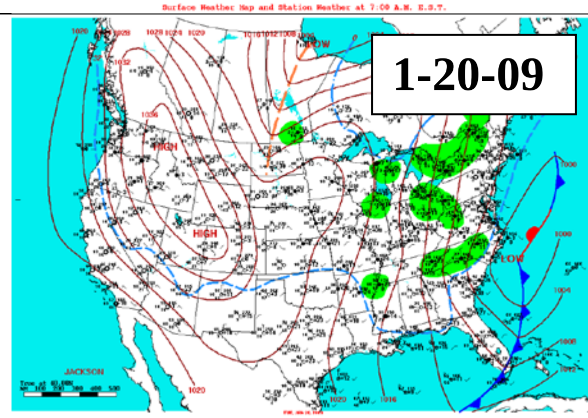
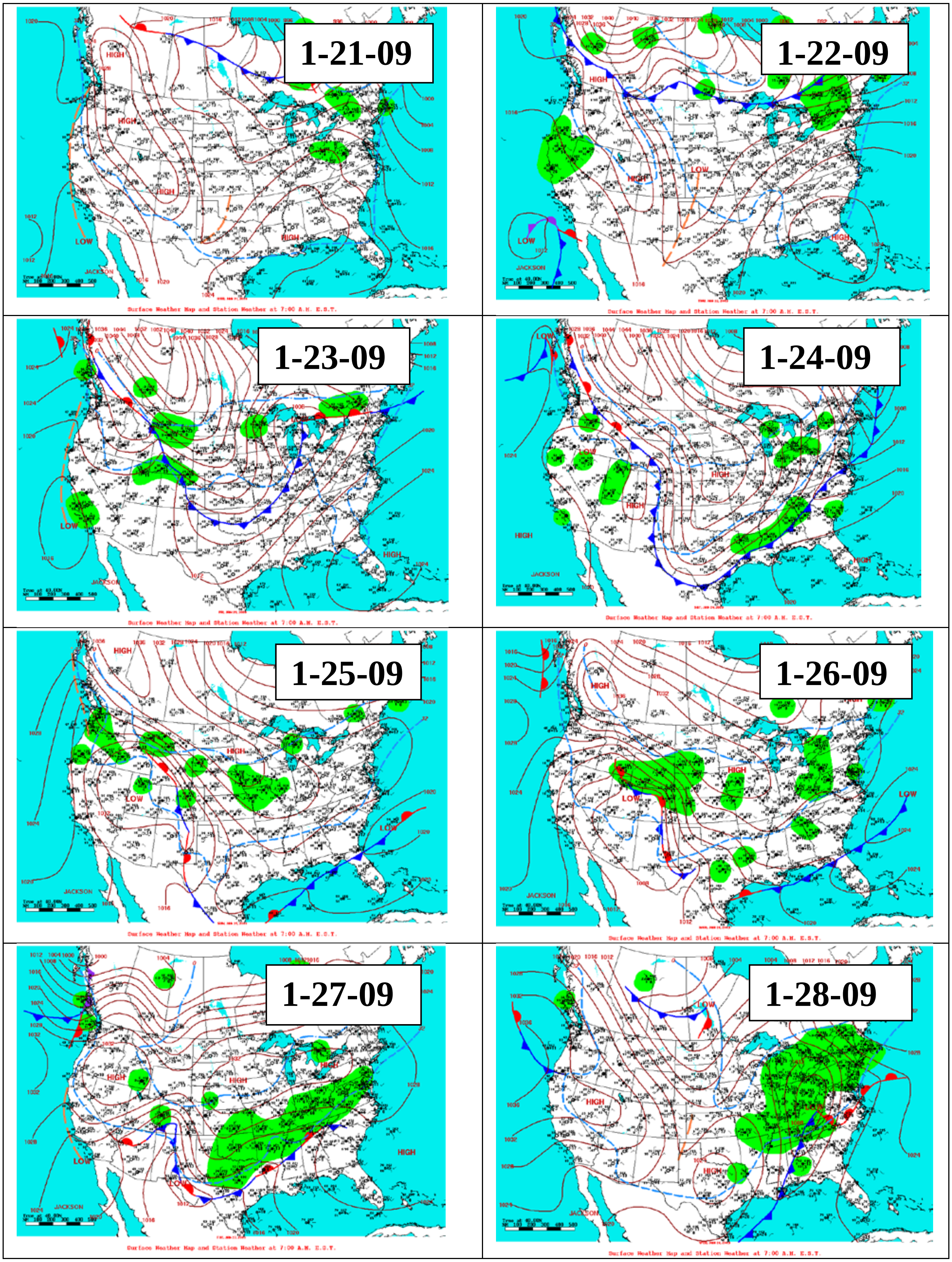
Period 7	
	
	
	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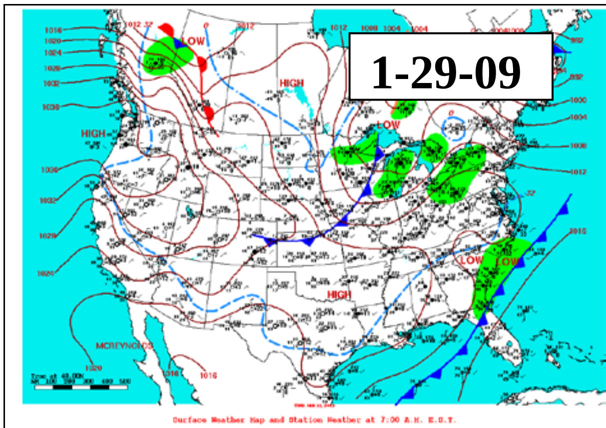
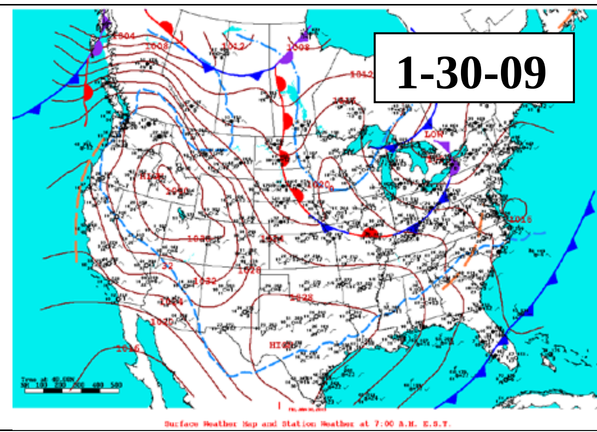

1-29-09
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.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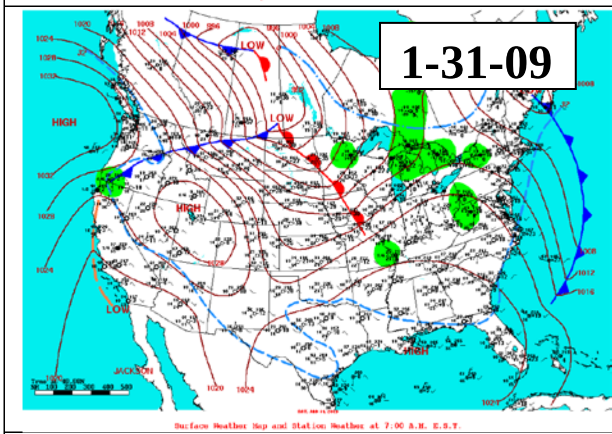
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.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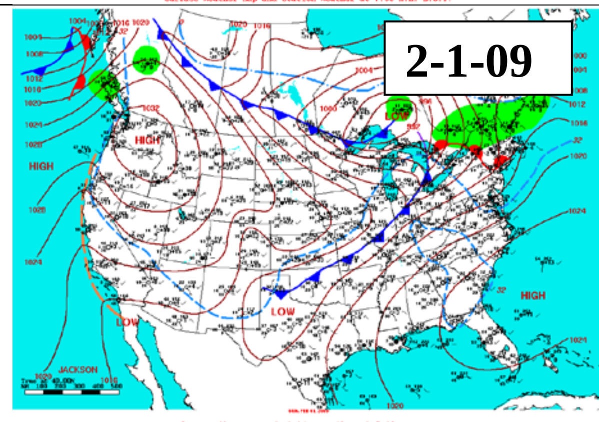
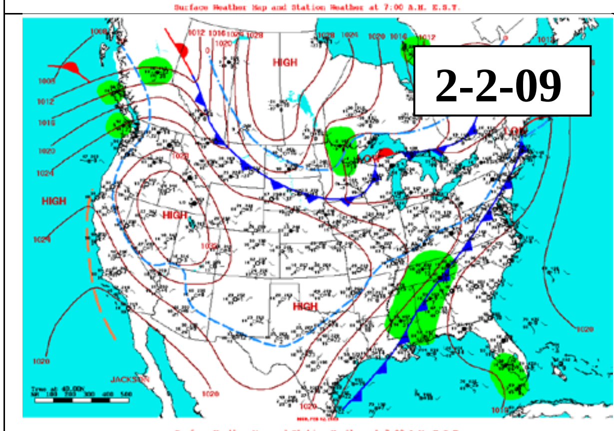
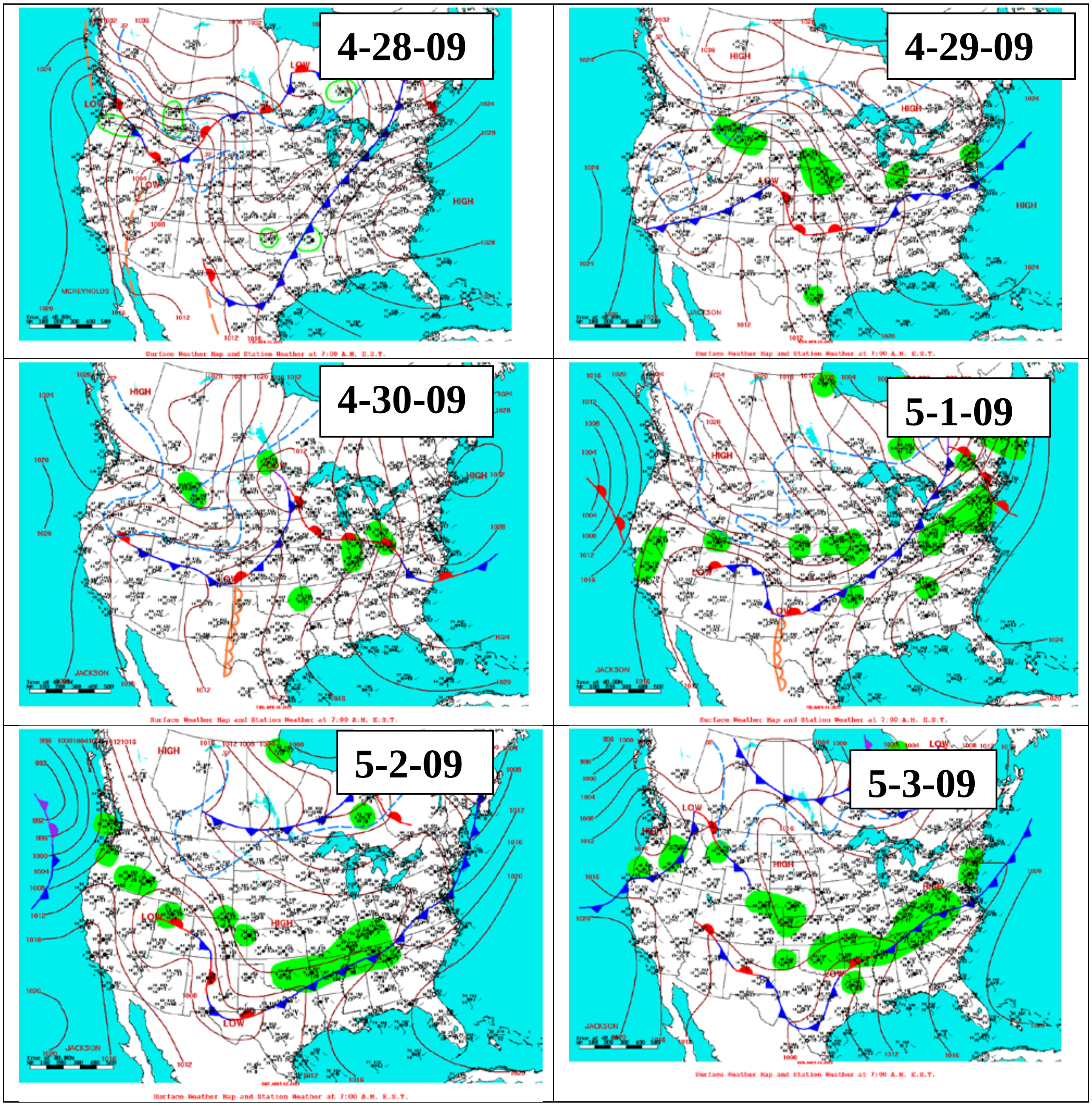
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.


2-1-09
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.


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

Period 8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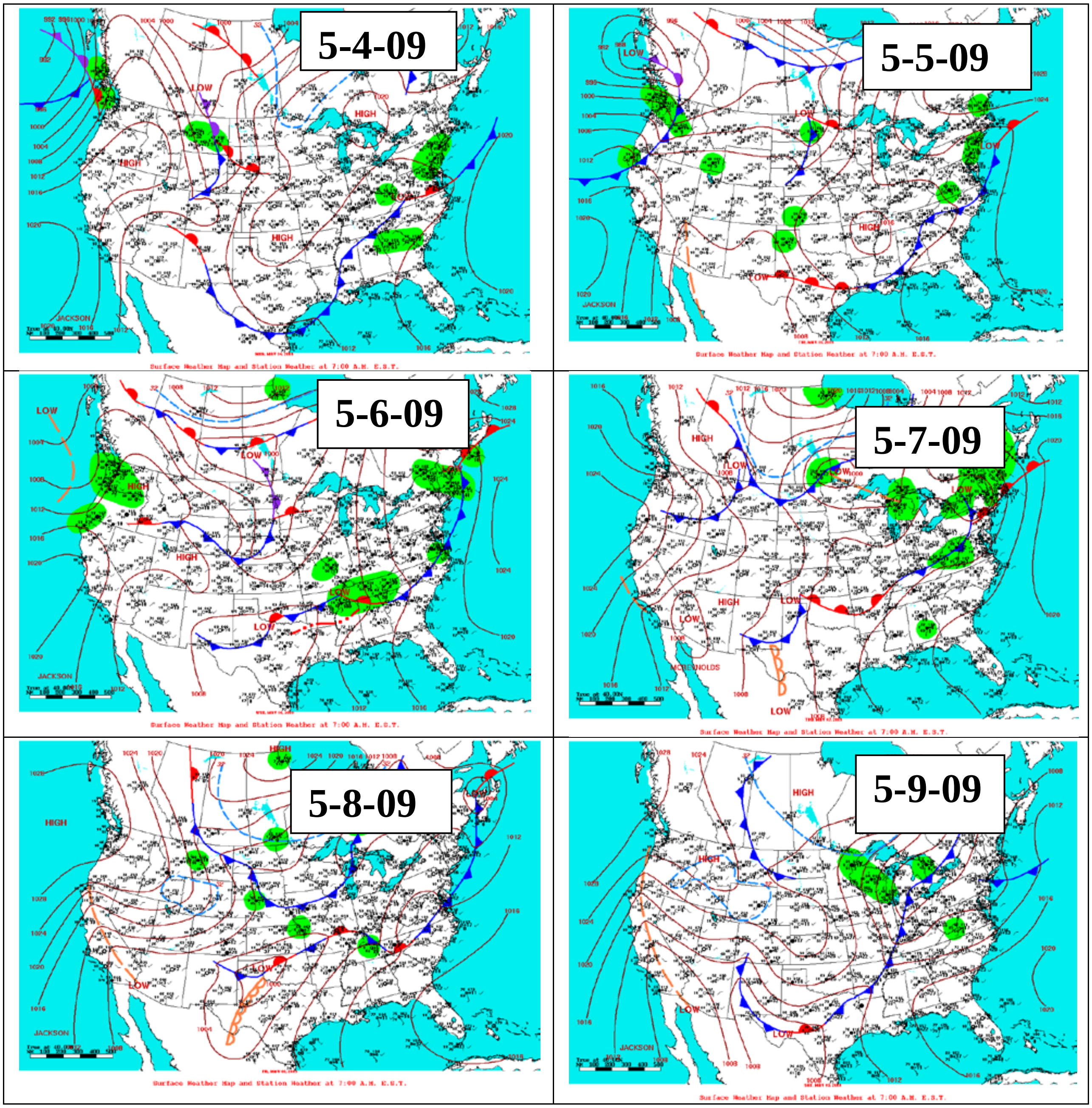
5-2-09
5-3-09


5-4-09
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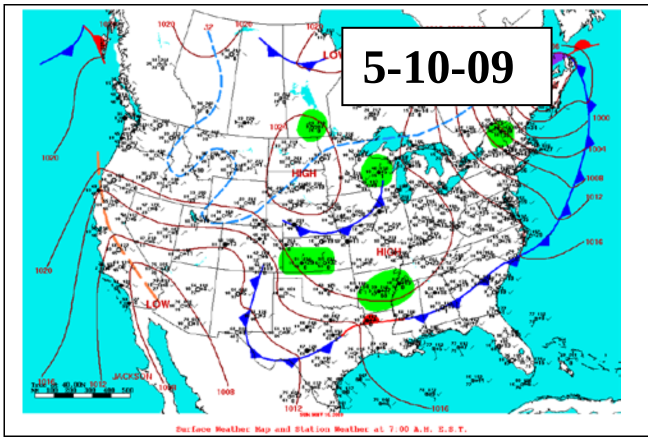
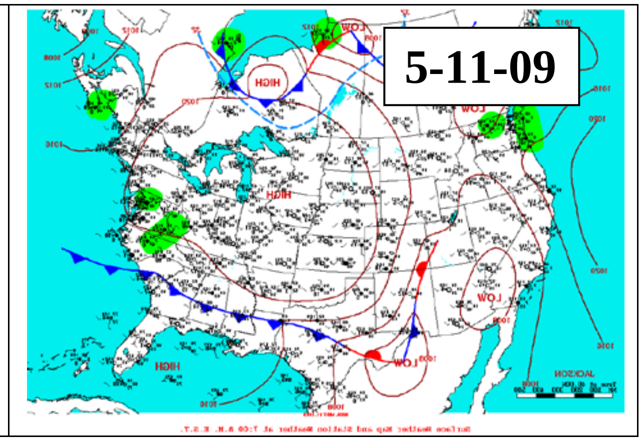
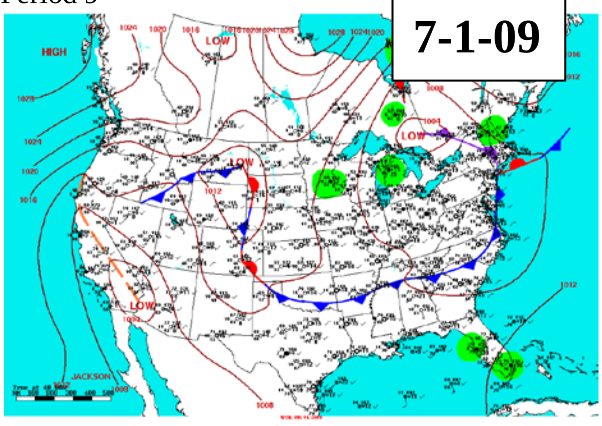
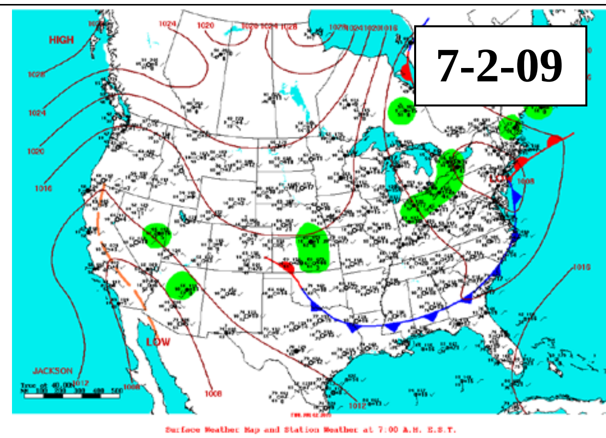
5-6-09
5-7-09
5-8-09
5-9-09
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.

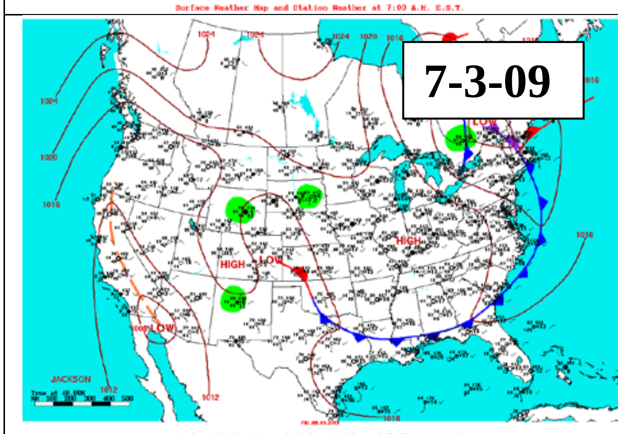


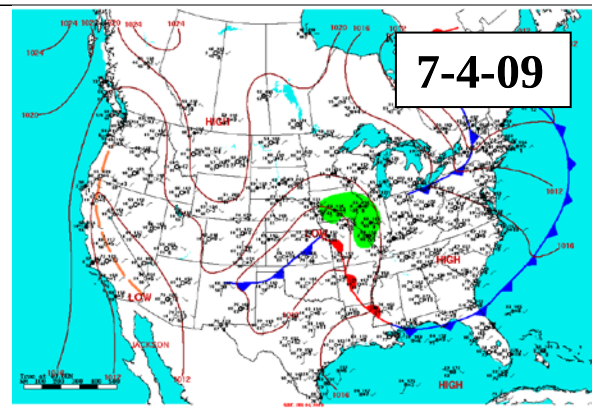


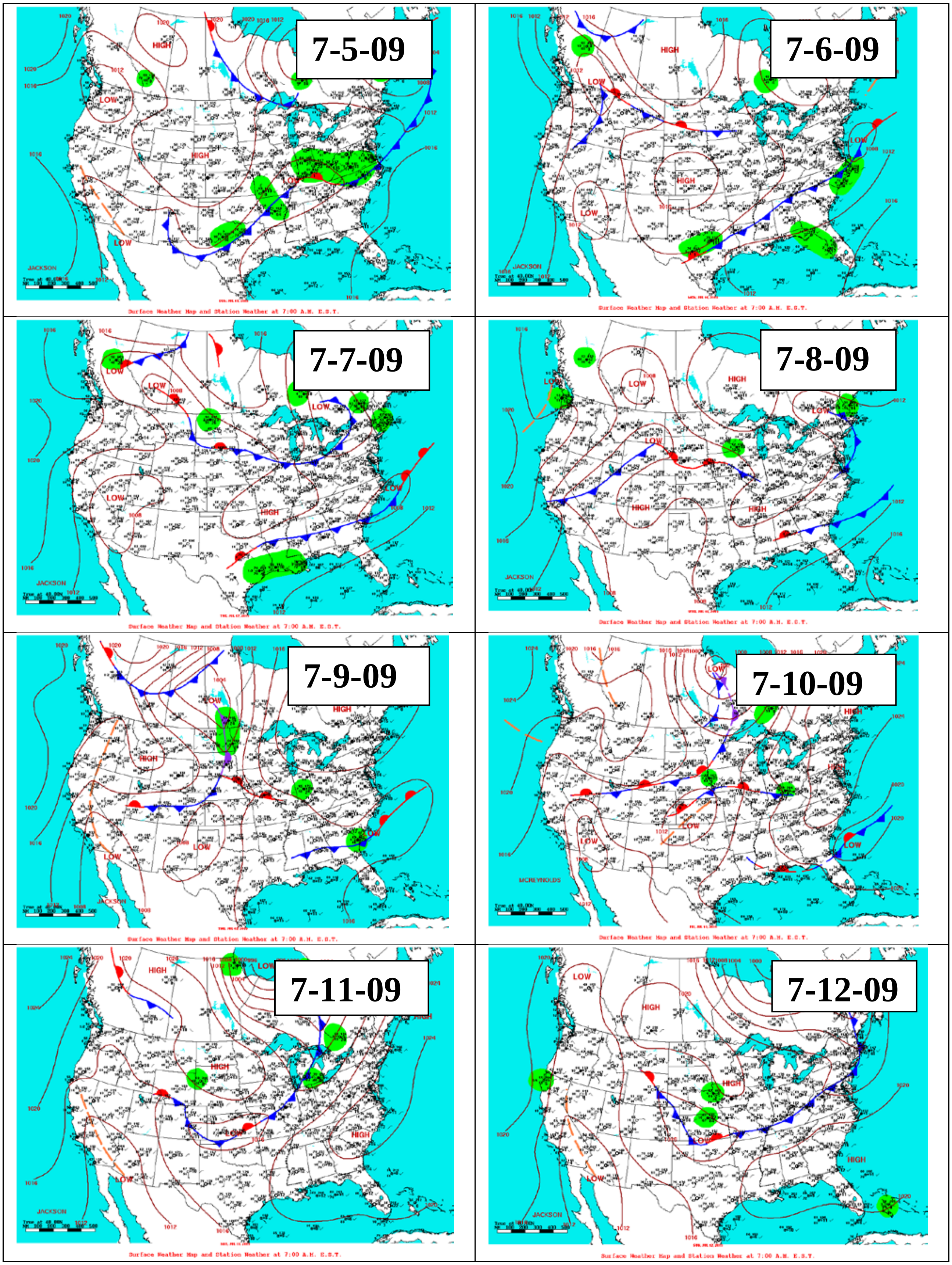
Period 9







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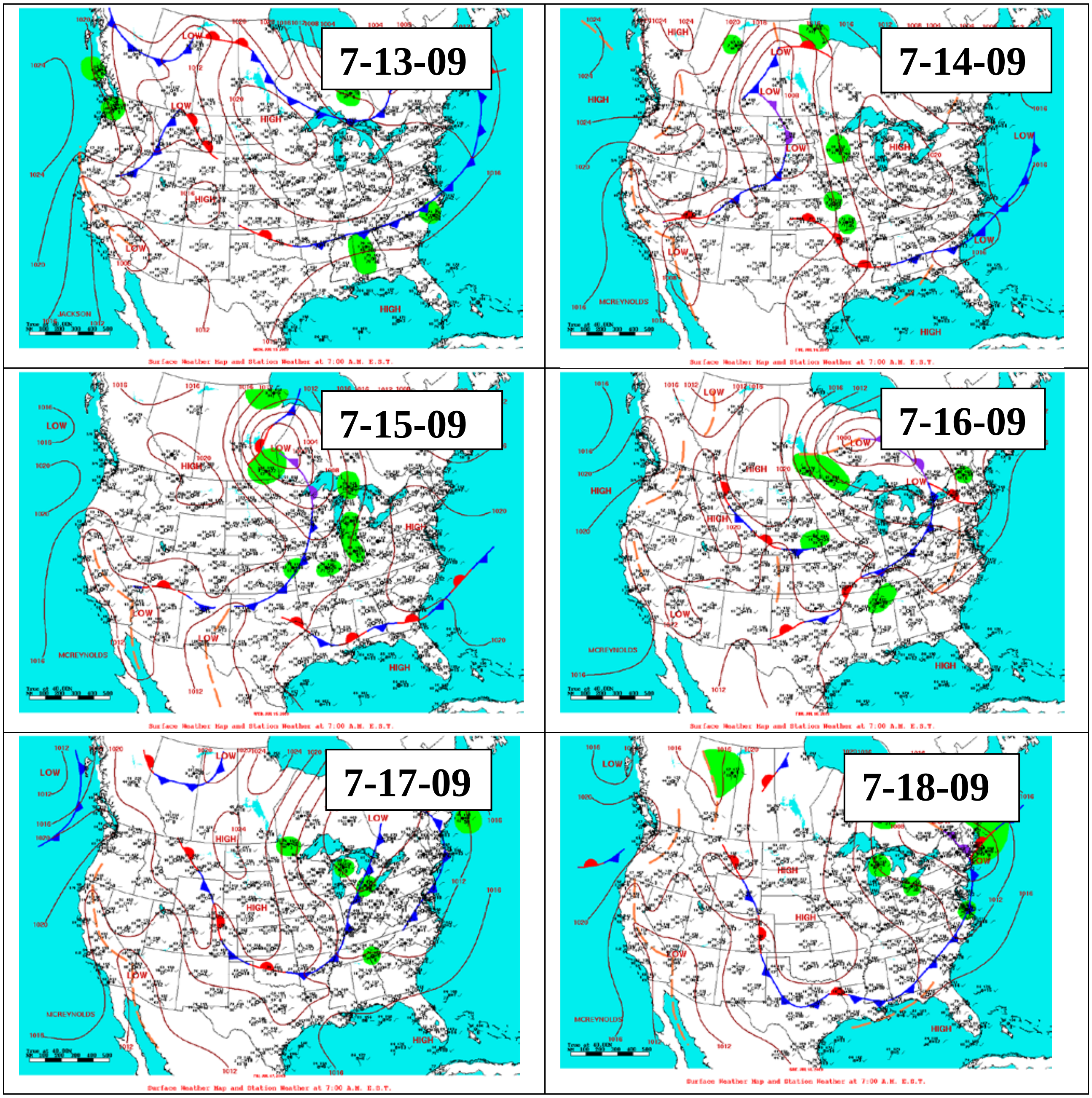
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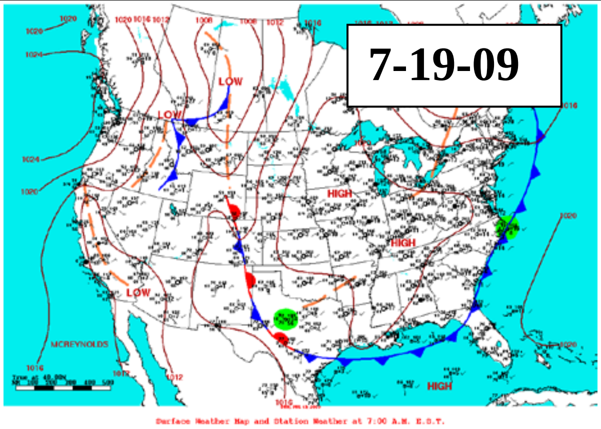
7-18-09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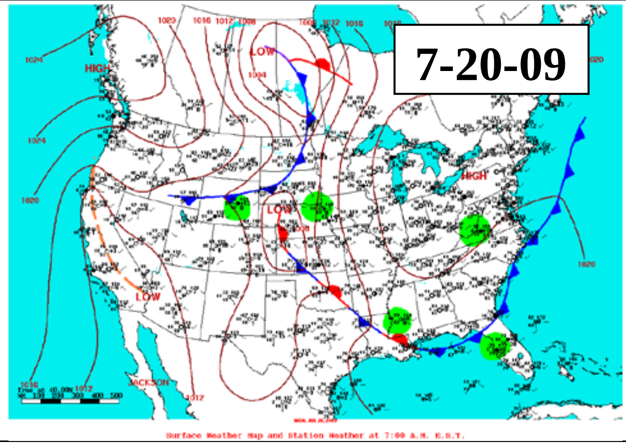
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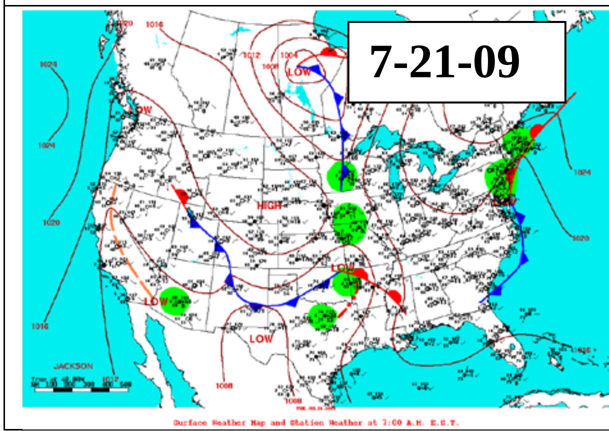
7-21-09

6.10 Daily Weather conditions

Date (MM/DD/YYYY)	Barometric pressure (kPA)	Max Solar radiation (Wm^{-2})	Wetness (%)	Air temperature (°C)
Period 2				
10/5/2007	101.65	259	N/A	24.4
10/6/2007	101.55	722	N/A	22.7
10/7/2007	101.30	878	N/A	23.4
10/8/2007	101.10	756	N/A	25.0
10/9/2007	100.73	728	N/A	25.8
10/10/2007	100.28	829	N/A	24.0
10/11/2007	99.98	763	N/A	19.2
10/12/2007	100.53	768	N/A	14.7
10/13/2007	101.02	745	N/A	14.8
10/14/2007	101.28	723	N/A	15.4
10/15/2007	101.57	724	N/A	17.1
10/16/2007	101.48	713	N/A	17.6
10/17/2007	101.36	844	N/A	20.4
10/18/2007	100.94	782	N/A	22.4
10/19/2007	100.31	695	N/A	24.6
10/20/2007	100.50	766	N/A	22.4
10/21/2007	101.63	794	N/A	16.2
10/22/2007	101.91	774	N/A	17.5
Period 3				
1/30/2008	101.25	N/A	N/A	8.9
1/31/2008	102.09	695	N/A	4.2
2/1/2008	101.31	399	N/A	10.1
2/2/2008	101.70	692	N/A	8.7
2/3/2008	101.76	642	N/A	9.5
2/4/2008	101.70	668	N/A	13.3
2/5/2008	101.50	674	N/A	16.8
2/6/2008	100.74	718	N/A	20.1
2/7/2008	100.37	682	N/A	16.1
2/8/2008	100.72	671	N/A	8.8
2/9/2008	100.92	681	N/A	9.9
2/10/2008	101.01	701	N/A	12.4
2/11/2008	101.89	698	N/A	5.4
2/12/2008	102.02	330	N/A	1.9
Period 4				
4/1/2008	101.13	407	100%	23.0
4/2/2008	101.60	997	62%	18.1
4/3/2008	102.18	285	52%	10.5
4/4/2008	101.19	945	73%	14.1
4/5/2008	100.77	276	96%	18.2
4/6/2008	100.88	307	93%	15.2
4/7/2008	101.46	782	92%	10.6

Date (MM/DD/YYYY)	Barometric pressure (kPA)	Max Solar radiation (Wm^{-2})	Wetness (%)	Air temperature (°C)
4/8/2008	101.65	1085	92%	11.5
4/9/2008	101.63	561	65%	14.4
4/10/2008	101.46	1054	66%	16.3
4/11/2008	101.03	998	60%	20.1
4/12/2008	100.25	998	13%	21.7
4/13/2008	100.20	1014	1%	17.1
4/14/2008	100.79	1145	34%	10.4
4/15/2008	101.23	1101	31%	10.3
4/16/2008	101.77	977	37%	8.6
Period 5				
8/14/2008	100.64	414	0%	26.8
8/15/2008	100.88	1103	52%	23.6
8/16/2008	101.07	960	54%	22.7
8/17/2008	101.10	582	63%	23.0
8/18/2008	101.03	1058	55%	22.9
8/19/2008	101.04	1034	55%	24.5
8/20/2008	101.22	1080	51%	25.0
8/21/2008	101.49	1084	49%	24.5
8/22/2008	101.65	1109	34%	23.6
8/23/2008	101.61	1059	38%	24.0
8/24/2008	101.23	1133	66%	24.1
8/25/2008	100.90	1050	65%	24.6
8/26/2008	100.87	648	95%	24.0
8/27/2008	100.75	588	84%	24.0
8/28/2008	100.53	1043	57%	26.5
8/29/2008	100.66	996	62%	25.2
8/30/2008	101.02	1009	59%	25.3
8/31/2008	101.27	944	46%	25.7
9/1/2008	101.47	886	45%	24.4
9/2/2008	101.32	895	43%	22.3
9/3/2008	100.99	881	49%	23.3
9/4/2008	100.88	0	71%	21.6
Period 6				
9/5/2008	100.77	531	76%	22.0
9/6/2008	99.75	877	63%	25.5
9/7/2008	101.00	991	51%	26.3
9/8/2008	101.38	852	62%	25.0
9/9/2008	101.27	1084	67%	23.7
9/10/2008	101.38	413	74%	23.1
9/11/2008	101.73	703	74%	23.0
9/12/2008	101.60	935	64%	24.4
9/13/2008	101.15	858	62%	26.2
9/14/2008	100.86	793	60%	27.1
9/15/2008	100.67	834	57%	26.7
9/16/2008	101.08	528	84%	22.0

Date (MM/DD/YYYY)	Barometric pressure (kPA)	Max Solar radiation (Wm^{-2})	Wetness (%)	Air temperature (°C)
9/17/2008	101.42	914	53%	19.8
9/18/2008	101.46	792	47%	19.9
9/19/2008	101.76	823	N/A	19.6
9/20/2008	101.70	734	N/A	17.5
9/21/2008	101.71	819	N/A	19.4
9/22/2008	101.79	618	N/A	20.1
9/23/2008	101.90	671	N/A	18.0
Period 7				
1/15/2009	101.81	570	3%	7.0
1/16/2009	102.84	592	0%	-4.2
1/17/2009	102.85	588	32%	-5.1
1/18/2009	101.28	117	61%	1.7
1/19/2009	100.06	567	69%	4.0
1/20/2009	99.74	233	93%	0.5
1/21/2009	101.15	607	63%	-4.4
1/22/2009	101.54	599	54%	0.4
1/23/2009	101.37	679	57%	6.7
1/24/2009	101.08	266	73%	10.5
1/25/2009	101.85	487	0%	3.1
1/26/2009	102.12	377	0%	2.3
1/27/2009	102.20	538	81%	5.8
1/28/2009	101.11	507	74%	13.7
1/29/2009	100.84	684	28%	8.9
1/30/2009	100.93	662	64%	4.5
1/31/2009	101.41	645	0%	2.7
2/1/2009	101.66	636	17%	6.4
2/2/2009	101.12	558	41%	8.9
2/3/2009	100.46	762	59%	5.5
Period 8				
4/28/2009	102.11	953	0%	26.6
4/29/2009	102.01	1026	37%	20.9
4/30/2009	102.07	1186	42%	17.7
5/1/2009	101.56	1061	50%	21.5
5/2/2009	100.97	993	39%	22.7
5/3/2009	100.84	1058	34%	23.7
5/4/2009	100.84	1026	31%	23.9
5/5/2009	101.07	950	81%	19.5
5/6/2009	101.09	955	64%	23.1
5/7/2009	100.78	955	54%	22.6
5/8/2009	100.68	984	42%	22.5
5/9/2009	100.59	949	41%	25.7
5/10/2009	100.94	1077	26%	22.8
5/12/2009	101.17	622	64%	16.7
Period 9				
7/1/2009	99.97	1044	9%	32.4

Date (MM/DD/YYYY)	Barometric pressure (kPA)	Max Solar radiation (Wm^{-2})	Wetness (%)	Air temperature (°C)
7/2/2009	100.35	1061	45%	26.5
7/3/2009	100.81	1147	39%	24.4
7/4/2009	101.07	982	31%	23.9
7/5/2009	100.73	924	66%	24.7
7/6/2009	100.27	822	77%	24.5
7/7/2009	100.29	1072	50%	25.0
7/8/2009	100.51	1118	48%	24.9
7/9/2009	101.06	1088	55%	23.5
7/10/2009	101.73	993	34%	22.7
7/11/2009	101.75	1059	38%	22.9
7/12/2009	101.21	935	0%	26.6
7/13/2009	100.82	300	63%	23.9
7/14/2009	101.08	1006	52%	23.3
7/15/2009	101.47	978	49%	24.3
7/16/2009	101.02	999	53%	24.7
7/17/2009	100.51	965	57%	25.6
7/18/2009	100.58	1025	55%	24.7
7/19/2009	101.13	1077	42%	24.3
7/20/2009	101.12	1009	62%	24.2
7/21/2009	101.25	968	63%	22.5

6.11 Daily lagoon conditions

Lagoon temperature, pH and oxidation-reduction potential

Date (MM/DD/YYYY)	Air temperature (°C)	Lagoon temperature (°C)	Lagoon (pH)	Lagoon ORP (mV)
Period 2				
10/5/2007	24.4	25.72	7.87	-394
10/6/2007	22.7	25.63	7.84	-435
10/7/2007	23.4	26.27	7.90	-405
10/8/2007	25.0	26.98	7.87	-455
10/9/2007	25.8	28.08	7.90	-425
10/10/2007	24.0	27.76	7.86	-433
10/11/2007	19.2	25.72	7.85	-465
10/12/2007	14.7	23.07	7.85	-460
10/13/2007	14.8	21.33	7.89	-457
10/14/2007	15.4	20.14	7.90	-481
10/15/2007	17.1	19.53	7.93	-489
10/16/2007	17.6	19.55	7.91	-503
10/17/2007	20.4	20.07	7.92	-502
10/18/2007	22.4	21.88	7.90	-457
10/19/2007	24.6	24.50	7.94	-415
10/20/2007	22.4	24.53	7.90	-455
10/21/2007	16.2	21.82	7.87	-512
10/22/2007	17.5	20.87	7.89	-520
Period 3				
1/30/2008	8.9	N/A	N/A	N/A
1/31/2008	4.2	8.23	7.94	-395
2/1/2008	10.1	8.41	8.00	-370
2/2/2008	8.7	9.00	8.05	-411
2/3/2008	9.5	9.75	8.08	-454
2/4/2008	13.3	10.84	8.06	-479
2/5/2008	16.8	13.36	8.07	-466
2/6/2008	20.1	14.63	7.99	-495
2/7/2008	16.1	15.51	7.91	-507
2/8/2008	8.8	14.75	7.90	-517
2/9/2008	9.9	13.98	7.90	-510
2/10/2008	12.4	13.19	7.89	-502
2/11/2008	5.4	12.01	7.88	-514
2/12/2008	1.9	10.73	7.83	-514
Period 4				
4/1/2008	23.0	N/A	N/A	N/A
4/2/2008	18.1	18.08	7.73	-403
4/3/2008	10.5	16.23	7.72	-470
4/4/2008	14.1	15.95	7.74	-458
4/5/2008	18.2	17.17	7.75	-473
4/6/2008	15.2	17.09	7.73	-544
4/7/2008	10.6	16.06	7.67	-545

Date (MM/DD/YYYY)	Air temperature (°C)	Lagoon temperature (°C)	Lagoon (pH)	Lagoon ORP (mV)
4/8/2008	11.5	15.45	7.71	-549
4/9/2008	14.4	16.05	7.72	-553
4/10/2008	16.3	17.25	7.73	-543
4/11/2008	20.1	20.80	7.77	-521
4/12/2008	21.7	21.16	7.72	-511
4/13/2008	17.1	20.94	7.72	-514
4/14/2008	10.4	18.72	7.71	-529
4/15/2008	10.3	17.02	7.63	-522
4/16/2008	8.6	16.19	7.65	-521
Period 5				
8/14/2008	26.8	23.91	7.58	-428
8/15/2008	23.6	24.18	7.62	-456
8/16/2008	22.7	24.59	7.69	-415
8/17/2008	23.0	25.17	7.67	-428
8/18/2008	22.9	24.64	7.67	-461
8/19/2008	24.5	25.65	7.65	-442
8/20/2008	25.0	26.11	7.66	-428
8/21/2008	24.5	26.66	7.64	-441
8/22/2008	23.6	25.80	7.65	-422
8/23/2008	24.0	26.31	7.66	-390
8/24/2008	24.1	26.47	7.64	-337
8/25/2008	24.6	26.44	7.64	-281
8/26/2008	24.0	26.26	7.65	-245
8/27/2008	24.0	25.33	7.63	-281
8/28/2008	26.5	25.64	7.69	-339
8/29/2008	25.2	26.78	7.65	-371
8/30/2008	25.3	26.26	7.61	-398
8/31/2008	25.7	26.51	7.62	-399
9/1/2008	24.4	27.33	7.64	-397
9/2/2008	22.3	26.61	7.65	-394
9/3/2008	23.3	25.93	7.62	-405
9/4/2008	21.6	26.26	7.59	-443
Period 6				
9/5/2008	22.0	25.19	7.65	-459
9/6/2008	25.5	25.73	7.74	-304
9/7/2008	26.3	26.59	7.69	-447
9/8/2008	25.0	27.05	7.68	-489
9/9/2008	23.7	27.65	7.73	-485
9/10/2008	23.1	26.78	7.71	-542
9/11/2008	23.0	25.85	7.68	-548
9/12/2008	24.4	25.86	7.71	-548
9/13/2008	26.2	27.23	7.75	-505
9/14/2008	27.1	28.79	7.76	-451
9/15/2008	26.7	27.92	7.73	-512
9/16/2008	22.0	26.52	7.67	-543

Date (MM/DD/YYYY)	**Air temperature** (°C)	**Lagoon temperature** (°C)	**Lagoon (pH)**	**Lagoon ORP** (mV)
9/17/2008	19.8	24.54	7.75	-537
9/18/2008	19.9	23.89	7.77	-540
9/19/2008	19.6	23.52	7.77	-515
9/20/2008	17.5	22.39	7.79	-508
9/21/2008	19.4	21.83	7.77	-521
9/22/2008	20.1	22.01	7.77	-521
9/23/2008	18.0	N/A	N/A	N/A
Period 7				
1/15/2009	7.0	7.67	N/A	-355
1/16/2009	-4.2	6.13	N/A	-390
1/17/2009	-5.1	4.53	N/A	-410
1/18/2009	1.7	3.84	N/A	-349
1/19/2009	4.0	4.42	N/A	-319
1/20/2009	0.5	4.54	N/A	-390
1/21/2009	-4.4	3.15	N/A	-378
1/22/2009	0.4	3.52	N/A	-414
1/23/2009	6.7	3.96	N/A	-377
1/24/2009	10.5	5.31	N/A	-418
1/25/2009	3.1	5.28	N/A	-450
1/26/2009	2.3	4.97	N/A	-468
1/27/2009	5.8	5.21	N/A	-473
1/28/2009	13.7	7.05	N/A	-452
1/29/2009	8.9	9.37	N/A	-474
1/30/2009	4.5	9.15	N/A	-492
1/31/2009	2.7	8.37	N/A	-485
2/1/2009	6.4	7.83	N/A	-469
2/2/2009	8.9	8.24	N/A	-476
2/3/2009	5.5	N/A	N/A	N/A
Period 8				
4/28/2009	26.6	N/A	N/A	N/A
4/29/2009	20.9	24.24	7.60	-455
4/30/2009	17.7	21.63	7.62	-507
5/1/2009	21.5	22.74	7.81	-519
5/2/2009	22.7	23.38	7.78	-523
5/3/2009	23.7	24.40	7.76	-527
5/4/2009	23.9	24.59	7.78	-531
5/5/2009	19.5	23.69	7.76	-532
5/6/2009	23.1	24.06	7.84	-523
5/7/2009	22.6	24.64	7.84	-534
5/8/2009	22.5	25.65	7.81	-538
5/9/2009	25.7	26.06	7.82	-539
5/10/2009	22.8	25.81	7.69	-538
5/11/2009	16.7	24.32	7.66	-531
Period 9				
7/1/2009	32.4	31.36	7.75	-317

Date (MM/DD/YYYY)	Air temperature (°C)	Lagoon temperature (°C)	Lagoon (pH)	Lagoon ORP (mV)
7/2/2009	26.5	27.23	7.77	-442
7/3/2009	24.4	26.66	7.79	-490
7/4/2009	23.9	25.99	7.80	-464
7/5/2009	24.7	26.82	7.86	-432
7/6/2009	24.5	26.14	7.85	-509
7/7/2009	25.0	25.78	7.80	-524
7/8/2009	24.9	26.62	7.80	-524
7/9/2009	23.5	25.87	7.75	-525
7/10/2009	22.7	25.57	7.83	-528
7/11/2009	22.9	26.07	7.79	-504
7/12/2009	26.6	27.41	7.84	-435
7/13/2009	23.9	26.47	7.84	-479
7/14/2009	23.3	25.27	7.82	-531
7/15/2009	24.3	26.63	7.77	-529
7/16/2009	24.7	27.40	7.82	-474
7/17/2009	25.6	28.27	7.84	-448
7/18/2009	24.7	26.98	7.81	-476
7/19/2009	24.3	26.95	7.76	-535
7/20/2009	24.2	27.31	7.76	-536
7/21/2009	22.5	26.28	7.77	-536

6.12 Daily Site Emissions and Data completeness

6.12.1 Daily NH_3 emission using RPM emissions model

Date: Month/Day/Year

Valid values: Number of ½ h periods with valid emissions data

Direction limited: Number of ½ h periods invalidated because wind was from an excluded wind direction

Missing downwind NH_3: Number of ½ h periods invalidated because at least 1 TDLAS path was either missing or else had invalid concentration values

Emission average ($\mu g m^{-2} s^{-1}$): Daily average emission calculated from the valid ½ h periods

Emissions SD ($\mu g m^{-2} s^{-1}$): Daily emission standard deviation of the valid ½ h periods

Emission minimum ($\mu g m^{-2} s^{-1}$): Daily minimum emission of the valid ½ h periods

Emission maximum ($\mu g m^{-2} s^{-1}$): Daily maximum emission of the valid ½ h periods

Emission average ($kg d^{-1}$): Daily average emission calculated from the valid ½ h periods; totaled over the source area

Emission average ($g d^{-1} hd^{-1}$): Daily average emission calculated from the valid ½ h 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 h periods; totaled over the source area on a per animal unit basis

	Valid values	Cause for invalid values		Emission						
Date		Direction limited	Missing downwind NH_3	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 ($g\ d^{-1}\ AU^{-1}$)
Period 2										
10/5/2007	4	0	6	36.6	5.5	28.5	40.0	74.3	37.2	95.3
10/6/2007	9	0	38	43.0	10.9	26.4	54.0	87.4	43.7	112.1
10/7/2007	1	0	45	13.6	N/A	13.6	13.6	27.6	13.8	35.5
10/8/2007	2	0	46	71.9	16.2	60.4	83.4	146.0	73.0	187.3
10/9/2007	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10/10/2007	0	0	29	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10/11/2007	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10/12/2007	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10/13/2007	0	0	47	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10/14/2007	0	0	47	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10/15/2007	20	0	22	33.0	11.2	16.6	54.9	67.0	33.5	85.9
10/16/2007	13	0	16	29.3	9.8	13.2	49.4	59.4	29.7	76.2
10/17/2007	11	0	21	47.4	16.2	17.0	68.5	96.1	48.1	123.4
10/18/2007	2	0	42	31.1	2.4	29.4	32.8	63.1	31.5	80.9
10/19/2007	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10/20/2007	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10/21/2007	0	0	43	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10/22/2007	0	0	26	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period 3										
1/31/2008	1	0	17	29.8	N/A	29.8	29.8	60.5	30.2	77.6
2/1/2008	5	2	37	19.5	7.5	6.8	26.0	39.6	19.8	50.8
2/2/2008	2	5	37	4.3	0.6	3.8	4.7	8.6	4.3	11.1

Date	Valid values	Cause for invalid values		Emission						
		Direction limited	Missing downwind NH_3	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 (kg d^{-1})	Emission average (g d^{-1} hd^{-1})	Emission average (g d^{-1} AU^{-1})
2/3/2008	5	6	27	3.6	1.2	1.7	5.1	7.3	3.6	9.3
2/4/2008	0	0	47	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2/5/2008	4	12	26	13.4	4.7	9.8	20.0	27.2	13.6	34.9
2/6/2008	0	33	14	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2/7/2008	22	8	6	10.7	4.8	5.1	21.3	21.8	10.9	28.0
2/8/2008	10	3	19	8.5	3.1	3.4	12.8	17.2	8.6	22.1
2/9/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2/10/2008	15	2	22	6.9	2.4	3.4	11.1	13.9	7.0	17.9
2/11/2008	7	0	28	9.2	3.1	6.0	14.0	18.8	9.4	24.1
Period 4										
4/1/2008	0	0	3	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/2/2008	6	0	40	16.5	6.4	8.5	26.8	33.6	16.8	43.0
4/3/2008	5	0	26	9.0	3.9	3.4	12.3	18.3	9.2	23.5
4/4/2008	3	0	45	4.7	2.0	2.6	6.4	9.5	4.8	12.2
4/5/2008	6	0	38	13.3	3.6	6.0	15.3	27.1	13.5	34.7
4/6/2008	11	0	28	16.1	4.4	6.0	22.6	32.8	16.4	42.0
4/7/2008	3	0	39	10.5	3.0	7.2	13.2	21.3	10.7	27.3
4/8/2008	4	0	43	16.3	3.7	13.2	21.7	33.0	16.5	42.4
4/9/2008	10	0	36	13.8	3.2	9.4	18.3	28.1	14.0	36.0
4/10/2008	2	0	45	8.1	2.4	6.4	9.8	16.4	8.2	21.1
4/11/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/12/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/13/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/14/2008	3	0	45	20.6	15.2	9.4	37.9	41.8	20.9	53.6
4/15/2008	15	0	30	15.5	4.9	8.5	28.9	31.5	15.8	40.4
4/16/2008	3	0	20	19.7	5.0	14.0	23.4	40.0	20.0	51.4
Period 5										
8/14/2008	0	0	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/15/2008	8	4	27	18.5	4.4	10.2	23.8	37.5	18.7	48.1
8/16/2008	1	0	47	10.2	N/A	10.2	10.2	20.7	10.4	26.6
8/17/2008	0	0	46	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/18/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/19/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/20/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/21/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/22/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/23/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/24/2008	0	5	42	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/25/2008	0	15	31	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/26/2008	0	0	38	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/27/2008	0	1	47	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/28/2008	4	3	39	19.0	6.5	13.2	27.2	38.7	19.3	49.6
8/29/2008	0	7	37	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Date	Valid values	Cause for invalid values		Emission						
		Direction limited	Missing downwind NH_3	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 ($g\ d^{-1}\ AU^{-1}$)
8/30/2008	0	4	41	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/31/2008	1	3	44	13.2	N/A	13.2	13.2	26.8	13.4	34.4
9/1/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9/2/2008	0	0	40	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9/3/2008	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period 6										
9/4/2008	3	7	12	17.4	0.4	17.0	17.9	35.4	17.7	45.5
9/5/2008	17	0	22	34.6	11.2	2.6	48.9	70.2	35.1	90.1
9/6/2008	10	0	38	49.8	15.2	33.6	71.5	101.2	50.6	129.8
9/7/2008	5	3	36	31.7	7.5	20.0	38.7	64.5	32.2	82.7
9/8/2008	13	0	34	44.2	15.4	13.6	72.3	89.7	44.9	115.1
9/9/2008	8	6	33	25.5	13.0	5.1	43.0	51.7	25.9	66.4
9/10/2008	21	0	27	30.2	7.4	17.0	39.6	61.2	30.6	78.5
9/11/2008	34	0	14	31.8	6.8	13.2	44.7	64.5	32.2	82.7
9/12/2008	14	6	26	26.3	9.3	13.6	40.9	53.3	26.7	68.4
9/13/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9/14/2008	2	1	45	39.4	1.5	38.3	40.4	79.9	40.0	102.5
9/15/2008	3	0	45	77.4	11.4	68.1	90.2	157.2	78.6	201.8
9/16/2008	13	0	35	41.9	11.2	14.0	57.9	85.1	42.6	109.2
9/17/2008	27	0	21	34.2	9.6	16.6	54.0	69.3	34.7	89.0
9/18/2008	24	0	23	46.2	10.4	29.4	70.2	93.8	46.9	120.4
9/19/2008	30	0	18	38.2	8.5	22.1	59.1	77.6	38.8	99.6
9/20/2008	39	0	9	32.2	5.2	20.0	41.3	65.4	32.7	84.0
9/21/2008	32	0	16	28.7	4.6	19.6	37.4	58.2	29.1	74.7
9/22/2008	27	0	16	29.4	5.6	18.3	39.6	59.7	29.9	76.7
9/23/2008	8	0	18	25.9	4.0	19.1	29.8	52.6	26.3	67.5
Period 7										
1/16/2009	0	0	42	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/17/2009	0	0	47	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/18/2009	0	6	7	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/19/2009	7	1	36	4.6	1.5	2.6	6.8	9.3	4.6	11.9
1/20/2009	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/21/2009	9	0	32	4.7	1.0	3.0	6.4	9.5	4.8	12.2
1/22/2009	6	6	0	4.3	2.2	1.7	7.7	8.6	4.3	11.1
1/23/2009	5	2	0	6.8	3.1	3.4	10.2	13.8	6.9	17.7
1/24/2009	8	0	13	5.5	1.0	3.4	6.8	11.1	5.6	14.3
1/25/2009	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/26/2009	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/27/2009	0	0	44	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/28/2009	2	9	27	11.7	8.1	6.0	17.4	23.8	11.9	30.5
1/29/2009	4	2	38	6.9	5.4	2.6	14.0	14.0	7.0	18.0
1/30/2009	7	0	35	7.5	0.9	6.4	8.9	15.2	7.6	19.5
1/31/2009	35	0	12	8.2	1.7	4.3	12.3	16.6	8.3	21.3

Date	Valid values	Cause for invalid values: Direction limited	Cause for invalid values: Missing downwind NH_3	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 (kg d^{-1})	Emission average (g d^{-1} hd^{-1})	Emission average (g d^{-1} AU^{-1})
2/1/2009	5	13	2	8.3	2.3	5.5	11.1	16.8	8.4	21.5
2/2/2009	1	7	7	5.5	N/A	5.5	5.5	11.2	5.6	14.4
Period 8										
4/29/2009	14	1	5	43.6	11.5	26.0	58.3	88.6	44.3	113.6
4/30/2009	32	11	0	27.8	15.3	9.8	79.1	56.5	28.3	72.5
5/1/2009	19	15	14	39.3	10.9	23.4	54.5	79.7	39.9	102.3
5/2/2009	21	27	0	49.0	10.5	28.1	68.1	99.5	49.8	127.7
5/3/2009	20	24	4	52.7	16.7	24.3	78.7	107.0	53.5	137.3
5/4/2009	20	28	0	49.3	13.0	27.2	67.7	100.1	50.0	128.4
5/5/2009	7	21	16	30.7	8.3	22.6	42.6	62.3	31.2	80.0
5/6/2009	1	45	0	31.9	N/A	31.9	31.9	64.8	32.4	83.1
5/7/2009	11	37	0	43.2	16.1	26.4	65.1	87.8	43.9	112.7
5/8/2009	18	17	9	40.9	17.1	8.5	69.8	83.0	41.5	106.5
5/9/2009	24	23	0	71.6	12.8	47.2	90.2	145.4	72.7	186.5
5/10/2009	24	0	24	33.9	9.0	17.4	56.6	68.9	34.4	88.4
5/11/2009	1	3	22	48.1	N/A	48.1	48.1	97.6	48.8	125.3
Period 9										
7/1/2009	13	5	2	63.9	17.4	36.2	99.1	129.7	64.8	166.4
7/2/2009	23	10	7	53.6	22.9	17.4	103.0	108.8	54.4	139.5
7/3/2009	37	1	0	50.6	11.3	32.3	79.1	102.8	51.4	131.9
7/4/2009	27	2	1	39.4	15.5	7.7	65.1	80.0	40.0	102.6
7/5/2009	9	22	0	29.9	13.0	6.8	51.1	60.8	30.4	78.0
7/6/2009	17	11	18	26.4	12.0	11.5	48.5	53.7	26.8	68.9
7/7/2009	18	0	28	35.7	10.6	20.0	52.3	72.4	36.2	92.9
7/8/2009	12	16	14	44.7	17.1	17.4	73.6	90.7	45.4	116.4
7/9/2009	38	4	0	26.3	8.7	13.2	44.7	53.4	26.7	68.5
7/10/2009	44	0	0	30.3	9.1	17.4	50.6	61.5	30.7	78.9
7/11/2009	14	11	21	45.3	14.8	23.8	69.8	92.0	46.0	118.1
7/12/2009	34	14	0	50.3	19.0	20.0	84.7	102.1	51.0	130.9
7/13/2009	15	13	17	27.8	10.0	7.7	46.0	56.4	28.2	72.4
7/14/2009	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7/15/2009	0	0	44	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7/16/2009	15	14	16	45.7	15.9	14.5	65.1	92.8	46.4	119.1
7/17/2009	11	14	22	66.2	23.3	32.3	91.9	134.5	67.2	172.5
7/18/2009	7	6	33	28.1	6.6	18.7	36.2	57.1	28.6	73.3
7/19/2009	1	0	47	17.0	N/A	17.0	17.0	34.6	17.3	44.3
7/20/2009	0	0	47	N/A	N/A	N/A	N/A	N/A	N/A	N/A

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 h periods with valid emissions data

Direction limited: Number of ½ h periods invalidated because wind was from an excluded wind direction
Touchdown limited: Number of ½ h periods invalidated because fraction of source area surface covered by particle touchdowns was less than 0.1
Turbulence limited: Number of ½ h periods that the bLS model was not run because either u_* < 0.15 ms^{-1} or |L| < 2 m
Background (ppm): bLS model calculated daily average background concentration (ppm); average is over the ½ h periods included in the valid column
Emission average ($\mu gm^{-2}s^{-1}$): Daily average emission calculated from the valid ½ h periods
Emissions SD ($\mu gm^{-2}s^{-1}$): Daily emission standard deviation of the valid ½ h periods
Emission minimum ($\mu gm^{-2}s^{-1}$): Daily minimum emission of the valid ½ h periods
Emission maximum ($\mu gm^{-2}s^{-1}$): Daily maximum emission of the valid ½ h periods
Emission average (kgd^{-1}): Daily average emission calculated from the valid ½ h periods; totaled over the source area
Emission average ($gd^{-1}hd^{-1}$): Daily average emission calculated from the valid ½ h periods; totaled over the source area on a per head basis
Emission average ($gd^{-1}AU^{-1}$): Daily average emission calculated from the valid ½ h periods; totaled over the source area on a per animal unit basis

Date	Valid	Direction Limited	Touchdown Limited	Turbulence Limited	Background (ppm)	Emission Average ($\mu gm^{-2}s^{-1}$)	Emission SD (μgm^{-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 2												
10/5/2007	3	0	0	3	0.06	61.1	14.9	48.2	77.5	123.5	61.7	158.4
10/6/2007	27	0	0	21	0.06	47.7	18.0	-2.1	88.6	96.3	48.2	123.6
10/7/2007	10	0	0	30	-0.06	86.5	46.4	12.1	176.5	174.9	87.4	224.3
10/8/2007	9	0	1	37	0.24	78.2	31.8	8.7	107.9	158.0	79.0	202.8
10/9/2007	0	0	12	27	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10/10/2007	5	0	9	13	0.16	63.5	58.7	2.4	155.3	128.2	64.1	164.5
10/11/2007	28	1	6	8	0.12	29.3	27.1	-34.0	75.7	59.2	29.6	76.0
10/12/2007	24	0	1	21	0.09	22.8	43.8	-44.6	201.8	46.0	23.0	59.0
10/13/2007	15	0	0	28	0.23	9.4	41.2	-75.8	93.6	19.0	9.5	24.4
10/14/2007	15	0	1	28	0.19	51.0	52.1	4.2	199.8	103.1	51.5	132.3
10/15/2007	13	0	0	28	-0.02	80.7	32.4	32.2	130.7	163.1	81.6	209.3
10/16/2007	14	1	0	28	0.03	77.9	30.6	0.4	115.7	157.5	78.7	202.0
10/17/2007	9	4	0	29	0.02	91.6	23.0	56.4	128.6	185.0	92.5	237.3
10/18/2007	2	16	2	20	0.03	58.4	11.9	50.0	66.8	118.0	59.0	151.3
10/19/2007	0	6	13	15	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10/20/2007	18	0	9	15	0.17	44.3	30.0	-11.0	114.3	89.5	44.7	114.8
10/21/2007	6	4	0	33	0.12	57.2	22.9	33.3	94.1	115.6	57.8	148.3
10/22/2007	6	0	0	23	0.09	59.8	15.9	37.3	80.3	120.9	60.4	155.1
Period 3												
1/31/2008	11	0	0	0	0.03	23.7	6.5	18.6	41.4	47.8	23.9	61.4
2/1/2008	22	8	2	11	0.02	11.1	7.9	0.1	30.6	22.3	11.2	28.7
2/2/2008	11	11	0	25	0.00	3.5	1.1	1.8	5.0	7.0	3.5	9.0
2/3/2008	8	4	0	33	-0.01	6.7	3.7	2.2	11.1	13.6	6.8	17.4
2/4/2008	4	6	0	28	0.01	6.8	2.9	3.3	10.0	13.7	6.8	17.6
2/5/2008	12	14	1	19	0.01	8.1	1.5	5.8	10.2	16.3	8.2	20.9

Date	Valid	Direction Limited	Touchdown Limited	Turbulence Limited	Background (ppm)	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 ($gd^{-1}AU^{-1}$)
2/6/2008	4	39	0	4	0.01	8.0	1.9	6.3	10.5	16.3	8.1	20.9
2/7/2008	36	8	0	4	0.00	11.8	4.1	5.3	23.9	23.9	12.0	30.7
2/8/2008	17	0	0	29	0.00	9.1	2.4	4.6	12.5	18.5	9.2	23.7
2/9/2008	13	7	0	24	0.01	7.8	1.4	5.2	9.8	15.8	7.9	20.3
2/10/2008	36	1	0	11	0.00	11.8	3.2	6.1	19.6	23.9	12.0	30.7
2/11/2008	15	0	12	7	0.01	5.9	5.2	0.9	17.7	12.0	6.0	15.3
Period 4												
4/1/2008	0	1	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/2/2008	31	14	0	2	0.03	17.2	12.2	0.3	43.0	34.7	17.3	44.5
4/3/2008	47	0	0	1	0.03	15.1	4.9	5.4	25.9	30.5	15.2	39.1
4/4/2008	13	20	0	15	0.03	1.3	1.1	0.3	3.7	2.6	1.3	3.3
4/5/2008	20	20	0	7	0.03	12.2	9.5	0.1	43.5	24.7	12.3	31.7
4/6/2008	30	0	1	17	0.02	15.6	5.2	4.6	27.0	31.5	15.7	40.4
4/7/2008	48	0	0	0	0.02	10.0	4.0	2.4	18.9	20.3	10.2	26.0
4/8/2008	48	0	0	0	0.02	12.2	6.7	1.2	33.5	24.7	12.4	31.7
4/9/2008	45	0	0	3	0.01	11.1	6.2	2.3	29.8	22.4	11.2	28.7
4/10/2008	14	7	0	21	0.01	14.6	13.6	-1.5	44.4	29.6	14.8	37.9
4/11/2008	1	25	0	21	0.03	2.6	N/A	2.6	2.6	5.2	2.6	6.7
4/12/2008	13	34	0	0	0.02	2.8	3.0	-2.0	8.6	5.6	2.8	7.2
4/13/2008	42	2	0	4	0.03	12.8	14.3	-30.3	46.8	25.8	12.9	33.1
4/14/2008	31	0	1	16	0.03	11.9	10.9	-1.8	36.0	24.0	12.0	30.8
4/15/2008	39	0	0	9	0.04	17.7	9.7	2.4	44.1	35.7	17.8	45.8
4/16/2008	5	0	1	13	0.03	4.1	7.1	-2.7	16.3	8.4	4.2	10.8
Period 5												
8/14/2008	0	0	0	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/15/2008	8	11	1	24	0.16	38.3	58.5	-64.6	121.9	77.5	38.7	99.4
8/16/2008	8	1	15	21	0.06	14.5	21.7	-22.4	51.3	29.3	14.7	37.7
8/17/2008	4	0	9	34	0.03	66.2	26.3	36.6	98.0	133.7	66.9	171.5
8/18/2008	5	0	15	21	0.10	-15.8	76.6	-127.3	82.0	-31.9	-15.9	-40.9
8/19/2008	10	2	3	28	0.06	46.6	56.3	-15.4	141.1	94.2	47.1	120.8
8/20/2008	3	1	16	24	0.02	140.7	24.4	114.7	163.2	284.4	142.2	364.9
8/21/2008	0	0	32	11	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/22/2008	0	0	38	6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/23/2008	4	0	27	17	0.02	113.5	32.7	77.7	151.6	229.4	114.7	294.3
8/24/2008	8	6	6	23	-0.10	71.1	50.8	11.0	135.9	143.7	71.8	184.3
8/25/2008	1	26	0	17	-0.22	64.9	N/A	64.9	64.9	131.2	65.6	168.3
8/26/2008	1	1	9	34	0.00	0.7	N/A	0.7	0.7	1.4	0.7	1.8
8/27/2008	40	1	1	6	0.03	67.4	17.7	26.9	106.3	136.2	68.1	174.8
8/28/2008	21	13	0	14	0.16	44.5	37.4	-67.8	114.3	89.9	44.9	115.3
8/29/2008	10	11	0	26	0.08	54.9	82.2	0.4	271.2	110.9	55.4	142.3
8/30/2008	9	7	0	28	0.02	30.7	28.6	5.5	83.2	62.1	31.0	79.7
8/31/2008	21	4	2	17	0.01	192.5	129.2	4.5	529.1	389.0	194.5	499.1
9/1/2008	30	0	6	12	0.04	141.6	80.4	36.8	295.7	286.1	143.0	367.0
9/2/2008	14	0	0	18	0.09	17.4	37.8	-19.5	116.3	35.1	17.6	45.0
9/3/2008	0	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period 6												

Date	Valid	Direction Limited	Touchdown 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})
9/4/2008	1	1	0	16	0.09	5.1	N/A	5.1	5.1	10.4	5.2	13.3
9/5/2008	25	0	0	15	0.00	60.2	24.1	18.7	103.8	121.6	60.8	156.0
9/6/2008	37	3	3	4	0.03	61.2	14.4	41.8	114.1	123.7	61.9	158.7
9/7/2008	12	9	0	24	0.05	51.5	28.2	8.3	107.1	104.1	52.1	133.6
9/8/2008	19	2	0	26	-0.03	106.2	42.2	22.6	186.7	214.6	107.3	275.3
9/9/2008	10	11	0	22	0.04	56.3	17.3	30.1	98.0	113.8	56.9	146.0
9/10/2008	20	6	0	21	0.02	49.6	21.1	1.9	74.0	100.2	50.1	128.6
9/11/2008	41	0	0	7	0.03	55.4	21.1	3.1	108.9	112.0	56.0	143.7
9/12/2008	3	10	2	28	-0.01	59.2	68.3	3.5	135.4	119.6	59.8	153.5
9/13/2008	21	0	0	27	0.04	72.8	24.8	33.2	128.9	147.0	73.5	188.6
9/14/2008	17	14	0	17	0.04	74.6	18.9	47.8	114.9	150.6	75.3	193.3
9/15/2008	23	21	0	4	0.04	59.4	16.4	34.8	100.5	120.0	60.0	154.0
9/16/2008	34	2	0	12	0.01	70.1	60.7	-5.9	373.7	141.7	70.8	181.8
9/17/2008	47	0	0	1	0.02	48.8	19.3	16.7	97.4	98.7	49.3	126.6
9/18/2008	24	0	0	23	0.01	65.3	29.7	16.3	123.1	131.9	65.9	169.2
9/19/2008	37	0	0	11	0.00	58.7	32.7	14.6	119.6	118.7	59.3	152.3
9/20/2008	46	0	0	2	0.01	39.8	14.3	8.8	78.8	80.5	40.2	103.2
9/21/2008	36	0	0	12	0.01	41.4	16.3	9.7	75.8	83.7	41.8	107.3
9/22/2008	32	0	0	15	0.02	37.1	18.7	7.1	72.0	74.9	37.5	96.2
9/23/2008	23	0	0	0	0.04	12.9	5.1	2.4	24.0	26.1	13.1	33.5
Period 7												
1/16/2009	32	0	8	2	0.01	7.5	2.7	2.2	13.8	15.1	7.5	19.3
1/17/2009	13	3	3	28	0.01	4.9	1.6	2.6	9.1	9.9	4.9	12.7
1/18/2009	1	39	0	8	0.04	2.1	N/A	2.1	2.1	4.2	2.1	5.4
1/19/2009	18	1	3	24	0.01	6.2	1.3	3.9	9.0	12.5	6.3	16.1
1/20/2009	31	0	0	12	0.01	8.0	2.7	1.3	11.5	16.1	8.0	20.6
1/21/2009	23	0	0	24	0.01	4.3	1.7	0.5	8.5	8.8	4.4	11.3
1/22/2009	13	7	0	27	0.00	4.5	3.0	0.7	8.7	9.1	4.6	11.7
1/23/2009	17	11	0	20	0.12	-1.9	4.9	-12.3	6.4	-3.8	-1.9	-4.9
1/24/2009	6	15	8	19	0.09	2.9	1.7	1.6	5.5	5.9	3.0	7.6
1/25/2009	36	0	8	4	0.01	18.3	6.7	11.6	44.8	36.9	18.5	47.4
1/26/2009	17	0	7	23	0.01	15.7	12.3	0.1	40.3	31.7	15.8	40.7
1/27/2009	7	0	9	30	0.01	4.9	1.9	1.6	6.9	9.9	4.9	12.7
1/28/2009	6	25	0	13	0.01	9.6	5.5	5.6	19.8	19.4	9.7	24.9
1/29/2009	11	0	16	20	0.00	7.1	1.7	3.9	10.6	14.4	7.2	18.4
1/30/2009	17	0	0	25	0.00	10.1	1.4	6.8	11.9	20.4	10.2	26.1
1/31/2009	33	0	0	15	0.00	8.7	2.1	5.2	13.8	17.5	8.7	22.4
2/1/2009	10	22	0	16	0.00	11.4	1.3	9.5	13.8	22.9	11.5	29.4
2/2/2009	4	12	0	18	0.00	13.0	3.5	8.2	16.7	26.3	13.2	33.8
Period 8												
4/29/2009	9	0	0	8	0.05	89.0	19.8	50.1	120.4	179.8	89.9	230.6
4/30/2009	28	12	0	8	0.02	51.5	22.2	14.2	98.9	104.1	52.0	133.5
5/1/2009	18	21	0	2	0.04	58.6	7.6	34.0	66.8	118.5	59.2	152.0
5/2/2009	21	26	0	1	0.04	64.1	11.2	38.4	83.0	129.4	64.7	166.1
5/3/2009	18	21	0	7	0.04	70.8	11.1	46.4	86.3	143.1	71.6	183.6
5/4/2009	19	27	0	1	0.04	71.2	10.6	51.4	87.9	143.8	71.9	184.5

Date	Valid	Direction Limited	Touchdown Limited	Turbulence Limited	Background (ppm)	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 ($gd^{-1}AU^{-1}$)
5/5/2009	8	22	0	18	0.04	37.4	12.4	13.6	49.9	75.5	37.7	96.9
5/6/2009	2	40	0	3	0.05	54.9	3.2	52.7	57.2	111.0	55.5	142.4
5/7/2009	11	37	0	0	0.04	71.6	19.6	40.7	100.3	144.7	72.4	185.7
5/8/2009	13	17	0	16	0.02	64.9	24.7	23.7	96.8	131.1	65.5	168.2
5/9/2009	24	21	0	3	0.04	77.9	11.6	60.6	98.8	157.4	78.7	202.0
5/10/2009	30	0	0	18	0.02	59.3	19.8	28.9	99.7	119.9	60.0	153.8
5/11/2009	15	0	0	18	0.00	49.7	22.4	0.5	85.0	100.3	50.2	128.7
Period 9												
7/1/2009	10	5	0	5	0.04	109.4	24.3	49.5	132.9	221.0	110.5	283.6
7/2/2009	20	12	0	14	0.09	59.3	34.5	4.2	128.1	119.8	59.9	153.7
7/3/2009	33	0	0	10	0.06	53.2	21.8	17.9	110.9	107.5	53.7	137.9
7/4/2009	17	1	0	27	0.14	55.0	38.0	0.2	126.9	111.2	55.6	142.6
7/5/2009	7	11	0	30	0.12	39.2	32.9	1.0	77.1	79.1	39.6	101.5
7/6/2009	8	11	13	15	0.04	54.1	11.0	32.7	69.8	109.4	54.7	140.3
7/7/2009	18	0	13	13	0.03	59.1	30.1	12.0	105.8	119.4	59.7	153.2
7/8/2009	12	10	0	25	0.13	38.3	24.9	1.0	79.9	77.4	38.7	99.3
7/9/2009	33	2	0	12	0.00	47.2	26.3	16.3	121.0	95.4	47.7	122.4
7/10/2009	26	0	0	21	0.01	62.1	23.4	17.9	118.0	125.4	62.7	161.0
7/11/2009	13	11	0	21	-0.05	93.4	38.7	10.2	147.8	188.6	94.3	242.0
7/12/2009	29	12	0	6	0.00	75.3	30.5	45.3	145.9	152.1	76.1	195.2
7/13/2009	18	18	2	10	0.00	47.8	26.8	-0.5	96.3	96.5	48.3	123.8
7/14/2009	1	0	22	23	0.02	18.1	N/A	18.1	18.1	36.6	18.3	47.0
7/15/2009	7	4	8	23	0.05	13.8	8.8	3.1	23.5	28.0	14.0	35.9
7/16/2009	11	15	2	19	0.00	69.7	22.6	13.8	95.7	140.8	70.4	180.6
7/17/2009	12	12	0	22	0.00	95.2	28.5	51.9	129.2	192.3	96.1	246.7
7/18/2009	20	6	4	17	0.01	41.2	17.0	12.6	81.7	83.2	41.6	106.7
7/19/2009	1	0	28	18	0.06	26.1	N/A	26.1	26.1	52.8	26.4	67.8
7/20/2009	4	15	2	23	0.04	15.8	7.7	9.3	25.6	31.9	16.0	41.0

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 h periods with valid emissions data
Emission average ($\mu gm^{-2}s^{-1}$): Daily average emission calculated from the valid ½ h periods
Emissions SD ($\mu gm^{-2}s^{-1}$): Daily emission standard deviation of the valid ½ h periods
Emission minimum ($\mu gm^{-2}s^{-1}$): Daily minimum emission of the valid ½ h periods
Emission maximum ($\mu gm^{-2}s^{-1}$): Daily maximum emission of the valid ½ h periods
Emission average (kgd^{-1}): Daily average emission calculated from the valid ½ h periods; totaled over the source area
Emission average ($gd^{-1}hd^{-1}$): Daily average emission calculated from the valid ½ h periods; totaled over the source area on a per head basis
Emission average ($gd^{-1}AU^{-1}$): Daily average emission calculated from the valid ½ h periods; totaled over the source area on a per animal unit basis

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 ($gd^{-1}AU^{-1}$)
Period 3								
1/31/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2/1/2008	4	0.0	0.5	-0.1	0.0	0.0	0.0	0.0
2/2/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2/3/2008	1	0.0	0.0	0.0	0.0	0.0	0.0	-0.1
2/4/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2/5/2008	4	0.6	5.9	0.1	1.4	1.2	0.6	1.6
2/6/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2/7/2008	11	3.2	11.7	-2.3	18.5	6.4	3.2	8.2
2/8/2008	6	-0.5	0.0	-3.9	1.2	-1.0	-0.5	-1.3
2/9/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2/10/2008	2	0.2	3.7	-0.2	0.6	0.3	0.2	0.4
2/11/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period 4								
4/1/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/2/2008	1	0.0	0.0	0.0	0.0	0.1	0.0	0.1
4/3/2008	1	0.1	0.0	0.1	0.1	0.1	0.1	0.2
4/4/2008	3	0.0	1.3	0.0	0.0	0.1	0.0	0.1
4/5/2008	5	0.0	0.8	0.0	0.1	0.0	0.0	0.0
4/6/2008	9	0.1	2.1	0.0	0.2	0.2	0.1	0.2
4/7/2008	3	0.1	2.9	0.0	0.3	0.3	0.1	0.3
4/8/2008	4	0.0	0.0	-0.1	0.0	0.0	0.0	0.0
4/9/2008	10	0.0	1.1	-0.1	0.1	0.0	0.0	0.1
4/10/2008	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4/11/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/12/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/13/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/14/2008	3	0.4	4.8	0.0	0.9	0.7	0.4	0.9
4/15/2008	12	0.1	2.6	0.1	0.2	0.3	0.1	0.4

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})
4/16/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period 5								
8/14/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/15/2008	1	-0.5	0.0	-0.5	-0.5	-1.1	-0.5	-1.4
8/16/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/17/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/18/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/19/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/20/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/21/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/22/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/23/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/24/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/25/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/26/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/27/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/28/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/29/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/30/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/31/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9/1/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9/2/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9/3/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9/4/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period 6								
9/5/2008	11	0.1	2.3	-0.1	0.3	0.2	0.1	0.3
9/6/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9/7/2008	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9/8/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9/9/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9/10/2008	13	0.0	1.4	-0.1	0.4	0.1	0.0	0.1
9/11/2008	32	0.1	1.6	-0.1	0.2	0.1	0.1	0.2
9/12/2008	6	0.0	0.0	-0.1	0.0	0.0	0.0	0.0
9/13/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9/14/2008	2	-0.1	0.0	-0.1	0.0	-0.1	-0.1	-0.1
9/15/2008	3	0.0	0.0	-0.1	0.0	0.0	0.0	0.0
9/16/2008	12	0.3	3.5	0.0	1.2	0.5	0.3	0.7
9/17/2008	27	0.2	3.0	0.0	1.7	0.4	0.2	0.5
9/18/2008	24	0.0	0.7	-0.2	0.2	0.0	0.0	0.0
9/19/2008	30	0.1	1.7	-0.4	1.1	0.1	0.1	0.2
9/20/2008	39	0.0	1.1	-0.2	0.2	0.1	0.0	0.1
9/21/2008	32	0.0	1.0	-0.1	0.1	0.0	0.0	0.1
9/22/2008	14	0.0	0.8	-0.1	0.3	0.0	0.0	0.0
9/23/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period 7								

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})
1/16/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/17/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/18/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/19/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/20/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/21/2009	3	-0.1	0.0	-0.3	0.0	-0.3	-0.1	-0.4
1/22/2009	6	-0.1	0.0	-0.2	0.1	-0.1	-0.1	-0.2
1/23/2009	5	0.0	0.7	-0.1	0.2	0.0	0.0	0.0
1/24/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/25/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/26/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/27/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/28/2009	2	0.3	5.2	0.2	0.4	0.6	0.3	0.8
1/29/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/30/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/31/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2/1/2009	5	0.3	4.1	-0.2	1.2	0.6	0.3	0.8
2/2/2009	1	0.0	0.0	0.0	0.0	0.1	0.0	0.1
Period 8								
4/29/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/30/2009	8	0.4	4.5	0.0	1.0	0.9	0.4	1.1
5/1/2009	17	1.0	6.7	0.0	7.3	2.0	1.0	2.6
5/2/2009	18	0.2	3.3	-0.3	1.7	0.5	0.2	0.6
5/3/2009	18	0.0	0.8	-0.2	0.5	0.0	0.0	0.0
5/4/2009	14	0.0	0.0	-0.3	0.1	0.0	0.0	0.0
5/5/2009	5	47.9	117.7	0.0	238.1	97.3	48.7	124.9
5/6/2009	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5/7/2009	11	5.2	14.6	-0.2	50.0	10.5	5.2	13.4
5/8/2009	11	0.0	0.0	-0.2	0.2	0.0	0.0	0.0
5/9/2009	24	0.6	4.9	-0.7	5.3	1.1	0.6	1.4
5/10/2009	3	-0.1	0.0	-0.1	0.0	-0.1	-0.1	-0.1
5/11/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period 9								
7/1/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7/2/2009	18	0.2	2.7	-0.2	1.1	0.3	0.2	0.4
7/3/2009	37	0.1	2.5	-0.1	0.5	0.3	0.1	0.4
7/4/2009	18	0.5	4.5	-0.1	3.9	0.9	0.5	1.2
7/5/2009	5	-0.1	0.0	-0.2	0.0	-0.2	-0.1	-0.3
7/6/2009	10	0.4	4.2	-0.3	3.9	0.8	0.4	1.0
7/7/2009	13	0.0	1.1	-0.1	0.2	0.1	0.0	0.1
7/8/2009	4	0.1	2.5	0.1	0.2	0.2	0.1	0.3
7/9/2009	15	0.1	1.7	0.0	0.3	0.1	0.1	0.2
7/10/2009	26	0.0	0.5	-0.1	0.2	0.0	0.0	0.0
7/11/2009	10	-0.1	0.0	-0.2	0.0	-0.2	-0.1	-0.2
7/12/2009	32	-0.1	0.0	-0.4	0.2	-0.1	-0.1	-0.2

Date	Valid	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 ($g d^{-1} AU^{-1}$)
7/13/2009	13	0.3	4.0	-0.1	3.7	0.6	0.3	0.8
7/14/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7/15/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7/16/2009	13	0.1	1.8	-0.1	0.4	0.1	0.1	0.2
7/17/2009	11	-0.1	0.0	-0.6	0.1	-0.2	-0.1	-0.3
7/18/2009	2	0.0	0.0	-0.2	0.1	0.0	0.0	0.0
7/19/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7/20/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7/21/2009	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 h periods with valid emissions data
Direction limited: Number of ½ h periods invalidated because wind was from an excluded wind direction
Angle limited: Number of ½ h periods invalidated because angle of attack to the downwind side was greater than 60 degrees
Turbulence limited: Number of ½ h periods that the bLS model was not run because either u_* < 0.15 ms^{-1} or |L| < 2 m
Background (ppb): bLS model calculated daily average background concentration (ppb); average is over the ½ h periods included in the valid column
Emission average ($\mu gm^{-2}s^{-1}$): Daily average emission calculated from the valid ½ h periods
Emissions SD ($\mu gm^{-2}s^{-1}$): Daily emission standard deviation of the valid ½ h periods
Emission minimum ($\mu gm^{-2}s^{-1}$): Daily minimum emission of the valid ½ h periods
Emission maximum ($\mu gm^{-2}s^{-1}$): Daily maximum emission of the valid ½ h periods
Emission average (kgd^{-1}): Daily average emission calculated from the valid ½ h periods; totaled over the source area
Emission average ($gd^{-1}hd^{-1}$): Daily average emission calculated from the valid ½ h periods; totaled over the source area on a per head basis
Emission average ($gd^{-1}AU^{-1}$): Daily average emission calculated from the valid ½ h 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												
1/31/2008	19	0	0	25	0.6	0.4	0.4	-0.1	1.1	0.7	0.4	0.9
2/1/2008	20	6	7	12	1.0	0.1	0.2	-0.2	1.0	0.1	0.1	0.2
2/2/2008	1	10	10	26	1.3	-0.2	N/A	-0.2	-0.2	-0.5	-0.2	-0.6
2/3/2008	0	3	8	36	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2/4/2008	3	6	0	38	4.6	0.4	0.4	0.1	0.9	0.9	0.4	1.1
2/5/2008	12	16	0	19	2.7	0.0	0.4	-0.8	0.5	0.1	0.0	0.1
2/6/2008	4	37	0	5	1.6	0.9	0.5	0.2	1.4	1.9	0.9	2.4
2/7/2008	17	8	17	4	2.2	1.1	1.5	-1.5	4.8	2.2	1.1	2.8
2/8/2008	8	0	8	31	0.8	1.1	1.1	-0.2	2.9	2.2	1.1	2.8
2/9/2008	13	7	0	28	2.6	3.1	3.0	0.6	10.0	6.4	3.2	8.2
2/10/2008	8	1	21	11	3.0	2.7	3.6	-0.1	8.0	5.6	2.8	7.2
2/11/2008	18	0	0	4	0.2	1.0	1.1	0.0	4.1	2.0	1.0	2.5
Period 4												
4/2/2008	2	0	2	0	-0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.1
4/3/2008	7	0	40	1	0.2	0.0	0.1	-0.1	0.1	0.1	0.0	0.1
4/4/2008	9	20	4	15	1.0	0.1	0.1	-0.1	0.2	0.1	0.1	0.1
4/5/2008	14	20	6	8	0.8	0.1	0.2	-0.1	0.8	0.2	0.1	0.3
4/6/2008	26	0	5	17	0.4	0.0	0.1	-0.1	0.2	0.1	0.0	0.1
4/7/2008	48	0	0	0	0.2	0.5	0.7	-0.1	3.8	1.0	0.5	1.3

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 ($gd^{-1}AU^{-1}$)
4/8/2008	48	0	0	0	0.2	0.1	0.1	-0.1	0.4	0.3	0.1	0.4
4/9/2008	45	0	0	3	0.1	0.0	0.1	-0.1	0.2	0.1	0.0	0.1
4/10/2008	6	7	8	27	0.2	0.0	0.0	0.0	0.1	0.1	0.0	0.1
4/11/2008	1	25	0	21	1.4	0.0	N/A	0.0	0.0	0.0	0.0	0.0
4/12/2008	12	34	1	0	2.7	1.0	1.7	-0.4	3.7	2.0	1.0	2.5
4/13/2008	25	2	17	4	2.3	-0.2	0.3	-0.7	0.4	-0.4	-0.2	-0.5
4/14/2008	29	0	2	16	0.1	0.1	0.2	-0.2	0.6	0.3	0.1	0.3
4/15/2008	13	0	0	9	0.6	0.2	0.1	0.0	0.3	0.4	0.2	0.5
Period 5												
8/15/2008	6	11	3	28	3.0	-0.3	0.3	-0.8	0.0	-0.6	-0.3	-0.7
8/16/2008	19	2	4	22	0.8	0.0	0.1	-0.4	0.2	0.0	0.0	0.0
8/17/2008	0	0	13	35	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/18/2008	11	0	9	28	0.6	0.1	0.1	-0.1	0.2	0.1	0.1	0.1
8/19/2008	11	2	2	31	1.0	0.0	0.1	-0.2	0.3	-0.1	0.0	-0.1
8/20/2008	7	1	12	26	1.2	-0.1	0.2	-0.5	0.2	-0.2	-0.1	-0.2
8/21/2008	37	0	0	11	0.5	0.0	0.1	-0.2	0.4	0.0	0.0	0.0
8/22/2008	36	0	6	6	0.5	0.0	0.2	-0.3	0.5	0.1	0.0	0.1
8/23/2008	22	0	9	17	0.4	0.0	0.1	-0.1	0.3	0.1	0.0	0.1
8/24/2008	6	6	8	28	0.9	0.0	0.1	-0.1	0.1	-0.1	0.0	-0.1
8/25/2008	0	26	1	21	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/26/2008	11	1	1	35	0.8	0.0	0.1	-0.1	0.3	0.1	0.0	0.1
8/27/2008	18	1	23	6	1.1	0.0	0.1	-0.3	0.3	0.1	0.0	0.1
8/28/2008	2	13	19	14	1.5	0.0	0.2	-0.2	0.2	0.0	0.0	0.0
8/29/2008	6	11	4	26	1.2	-0.1	0.6	-1.3	0.6	-0.2	-0.1	-0.2
8/30/2008	0	7	9	31	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/31/2008	21	4	2	20	0.8	0.0	0.2	-0.2	0.3	0.0	0.0	0.0
9/1/2008	36	0	0	12	0.6	0.0	0.1	-0.3	0.2	-0.1	0.0	-0.1
9/2/2008	12	0	0	26	0.2	0.1	0.1	0.0	0.4	0.2	0.1	0.3
Period 6												
9/4/2008	0	0	0	3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9/5/2008	19	0	6	18	0.4	0.1	0.2	-0.2	0.6	0.3	0.1	0.3
9/6/2008	17	3	24	4	1.2	0.4	1.5	-0.9	5.5	0.8	0.4	1.0
9/7/2008	6	9	6	27	6.3	-1.1	2.4	-5.9	0.1	-2.2	-1.1	-2.8
9/8/2008	7	2	12	27	1.3	0.0	0.2	-0.2	0.3	0.1	0.0	0.1
9/9/2008	8	11	2	27	2.2	-0.1	0.2	-0.3	0.2	-0.2	-0.1	-0.2
9/10/2008	15	6	5	22	0.8	0.1	0.4	-0.1	1.6	0.3	0.1	0.4
9/11/2008	39	0	2	7	0.3	0.1	0.2	-0.2	0.5	0.2	0.1	0.3
9/12/2008	2	10	6	30	3.8	-0.6	0.8	-1.2	0.0	-1.2	-0.6	-1.5
9/13/2008	10	0	11	27	2.5	-0.2	0.1	-0.4	0.0	-0.3	-0.2	-0.4
9/14/2008	17	14	0	17	2.4	-0.2	0.2	-0.8	0.1	-0.4	-0.2	-0.5
9/15/2008	18	21	5	4	2.2	0.0	0.5	-1.5	1.3	-0.1	0.0	-0.1
9/16/2008	31	2	3	12	0.8	0.8	1.8	-0.1	9.1	1.7	0.8	2.1
9/17/2008	47	0	0	1	0.7	0.4	0.6	-0.2	3.3	0.8	0.4	1.0
9/18/2008	24	0	0	24	0.3	0.1	0.2	-0.2	0.8	0.1	0.1	0.2
9/19/2008	36	0	1	11	0.4	0.1	0.4	-0.7	2.0	0.3	0.1	0.3

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 ($gd^{-1}AU^{-1}$)
9/20/2008	46	0	0	2	0.3	0.0	0.1	-0.2	0.3	0.1	0.0	0.1
9/21/2008	36	0	0	12	0.3	0.0	0.1	-0.2	0.2	0.1	0.0	0.1
9/22/2008	19	0	0	15	0.4	0.0	0.1	-0.2	0.3	0.0	0.0	0.0
Period 7												
1/16/2009	10	0	0	2	0.3	0.0	0.2	-0.2	0.3	0.0	0.0	0.0
1/17/2009	8	3	8	29	0.1	0.0	0.1	-0.1	0.2	0.1	0.0	0.1
1/18/2009	1	39	0	8	1.0	0.0	N/A	0.0	0.0	0.1	0.0	0.1
1/19/2009	5	5	13	25	1.2	0.0	0.0	-0.1	0.0	-0.1	0.0	-0.1
1/20/2009	29	0	5	14	0.5	0.0	0.2	-0.3	0.3	0.0	0.0	0.0
1/21/2009	13	0	10	25	0.6	0.0	0.1	-0.1	0.2	0.0	0.0	0.0
1/22/2009	13	7	0	28	4.7	-0.4	0.4	-1.4	0.1	-0.8	-0.4	-1.1
1/23/2009	17	11	0	20	1.4	0.0	0.1	-0.2	0.3	0.0	0.0	0.0
1/24/2009	8	15	6	19	0.5	0.0	0.1	-0.1	0.2	0.1	0.0	0.1
1/25/2009	43	0	1	4	0.2	0.1	0.2	-0.2	0.8	0.3	0.1	0.4
1/26/2009	23	0	2	23	0.3	0.0	0.1	-0.1	0.2	0.1	0.0	0.1
1/27/2009	6	0	12	30	0.6	0.0	0.1	-0.1	0.2	0.1	0.0	0.1
1/28/2009	5	28	2	13	2.1	0.8	2.1	-1.4	4.3	1.7	0.8	2.2
1/29/2009	22	0	6	20	0.4	0.0	0.1	-0.3	0.2	0.1	0.0	0.1
1/30/2009	12	0	5	31	0.3	0.2	0.2	0.0	0.5	0.4	0.2	0.5
1/31/2009	9	0	24	15	0.2	0.2	0.1	0.1	0.4	0.5	0.2	0.6
2/1/2009	10	22	0	16	2.0	0.2	0.5	-0.4	1.1	0.5	0.2	0.6
2/2/2009	4	13	0	19	2.6	-0.1	0.2	-0.4	0.2	-0.1	-0.1	-0.2
Period 8												
4/30/2009	7	12	21	8	-2.9	0.6	0.7	-0.4	1.5	1.2	0.6	1.6
5/1/2009	18	26	2	2	1.5	1.4	2.3	0.1	7.9	3.0	1.5	3.8
5/2/2009	18	26	3	1	1.5	0.3	0.7	-0.3	2.3	0.7	0.3	0.9
5/3/2009	17	21	2	8	1.5	0.3	1.1	-0.3	4.6	0.5	0.3	0.7
5/4/2009	13	27	6	1	2.1	0.0	0.2	-0.3	0.3	0.0	0.0	0.0
5/5/2009	5	22	3	18	-1.4	25.4	56.2	-4.5	125.8	52.2	26.1	67.0
5/6/2009	1	40	0	3	2.7	0.0	N/A	0.0	0.0	-0.1	0.0	-0.1
5/7/2009	11	37	0	0	2.5	9.4	25.7	-0.3	85.2	19.2	9.6	24.6
5/8/2009	8	17	5	16	2.0	-0.1	0.2	-0.4	0.2	-0.1	-0.1	-0.1
5/9/2009	24	21	0	3	2.5	0.6	1.2	-0.7	4.8	1.3	0.6	1.6
5/10/2009	19	0	11	18	0.7	0.2	0.3	-0.2	0.8	0.3	0.2	0.4
5/11/2009	4	0	0	19	1.6	0.4	0.5	0.0	1.1	0.8	0.4	1.0
Period 9												
7/2/2009	15	12	5	15	1.6	0.2	0.3	-0.3	1.1	0.4	0.2	0.5
7/3/2009	33	0	0	14	1.4	0.1	0.2	-0.5	0.5	0.3	0.1	0.3
7/4/2009	9	1	8	29	1.2	0.1	0.2	-0.3	0.3	0.2	0.1	0.3
7/5/2009	4	11	3	30	4.1	-0.2	0.2	-0.4	0.1	-0.4	-0.2	-0.5
7/6/2009	19	11	3	15	1.6	0.5	2.1	-0.1	9.2	1.1	0.6	1.4
7/7/2009	24	0	9	13	0.9	0.0	0.1	-0.1	0.3	0.1	0.0	0.1
7/8/2009	7	10	5	26	1.3	0.1	0.2	0.0	0.5	0.3	0.1	0.4
7/9/2009	14	2	19	12	0.9	0.1	0.1	-0.1	0.3	0.2	0.1	0.2
7/10/2009	21	0	5	22	0.7	0.0	0.1	-0.1	0.3	0.1	0.0	0.1

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 ($gd^{-1}AU^{-1}$)
7/11/2009	11	11	2	23	2.7	-0.2	0.2	-0.5	0.1	-0.4	-0.2	-0.5
7/12/2009	28	12	1	7	2.7	-0.1	0.2	-0.6	0.3	-0.1	-0.1	-0.2
7/13/2009	15	18	5	10	1.8	0.4	1.5	-0.1	5.8	0.9	0.5	1.2
7/14/2009	22	0	1	25	0.8	0.1	0.1	-0.1	0.2	0.1	0.1	0.2
7/15/2009	2	4	15	26	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7/16/2009	10	15	3	20	2.3	0.1	0.2	-0.2	0.6	0.2	0.1	0.3
7/17/2009	12	14	0	22	2.5	-0.1	0.3	-0.7	0.2	-0.2	-0.1	-0.3
7/18/2009	21	6	3	17	1.0	0.5	2.1	-0.2	9.6	1.1	0.6	1.4
7/19/2009	23	0	7	18	0.7	0.0	0.1	-0.1	0.2	0.1	0.0	0.1
7/20/2009	2	15	6	24	4.2	-0.5	0.1	-0.5	-0.4	-0.9	-0.5	-1.2
7/21/2009	16	0	6	11	0.6	0.0	0.1	0.0	0.1	0.1	0.0	0.1