Final Report
Site WI5A
Milk 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), hydrogen sulfide (H_2S) emissions from two lagoon open sources at the mid-western dairy 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 two lagoons 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 lagoons were measured using narrow-bandwidth open path tunable-diode laser absorption spectroscopy (TDLAS). Atmospheric measurements of H_2S concentrations were made using pulsed fluorescence (PF) technology from air collected from 50 m synthetic open path systems (S-OPS) and sampled from a gas sampling system (GSS) that drew the air through the S-OPS. Emissions of NH_3 were determined from the difference in upwind and downwind concentration measurements from the TDLAS open path systems using two emissions models: a Gaussian plume fit model (Radial Plume Mapping: *RPM*; Arcadis Inc,, Denver, CO) and a backward Lagrangian Stochastic (bLS) model (*WindTrax*; Thunder Beach Scientific, http://www.thunderbeachscientific.com). Emissions of H_2S were determined using the concentration measurements from the PF analyzer from air sampled by the air inlets of the S-OPS using two emissions models: a Ratiometric model using the ratio of these concentrations to NH_3 concentrations along the same path with the corresponding *RPM* NH_3 emissions measurement, and the bLS model. The critical measurements needed to make the emissions measurements are described in Table 1-1.

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

Table 1-1: Critical measurements

Measurement	Method/ Instrument	Required operating range	MDL	Minimum sample frequency	Final data-aggregation
NH_3	TDLAS/ Boreal Laser, Inc. GasFinder2	1-800 ppb	5 ppm-m	1.2 s dwell	30 min & 24 h
H_2S	PF/Thermo Environmental 450i analyzer	1-800 ppb	2 ppb	60 s averaging	30 min & 24 h
Wind speed	3D Sonic anemometer/ RM Young 81000	0-60 ms^{-1}	0.01 ms^{-1}	160 Hz sampling/ 16 Hz averaging	30 min & 24 h
Wind direction	3D Sonic anemometer/ RM Young 81000	0^o -360^o	0.1^o	160 Hz sampling/ 16 Hz averaging	30 min & 24 h
3D turbulence wind components	3D Sonic anemometer/ RM Young 81000	0-40 ms^{-1}	0.01 ms^{-1}	160 Hz sampling/ 16 Hz averaging	30 min
Temperature variability	3D Sonic anemometer/ RM Young 81000	-50 to +50°C	0.01°C	160 Hz sampling/ 16 Hz averaging	30 min
GSS sample flow rate	GSS/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 °C	0.1 ° C	5 min	30 min, 24 h
Relative humidity	Hygrometer/ Campbell Scientific Inc HMP45C (Vaisala)	0-100%	5%	5 min	30 min, 24 h
Barometric pressure	Aneroid barometer/ Setra 278	600 to 1100 hPa	600 hPa	5 min	30 min, 24 h
Surface wetness	VAC resistance grid/ Campbell Scientific Inc.	(binary)	(binary)	5 min	30 min, 24 h
Solar radiation	Silicon pyranometer/ LiCOR 190SB	0- 1200 W/m^2	10 W/m^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 potential	Campbell Scientific Inc CSIM11-ORP (Innovative Sensors, Inc)	-800 - +1100 mV	20 mV	5 min	30 min, 24 h
Lagoon/ basin Temperature	Thermistor/ Campbell Scientific Inc 107-L	-35 - +50 °C	0.5 °C	5 min	30 min, 24 h

1.3 Farm description and operation

The Midwest freestall dairy facility was located in WI. The elevation at the farm was approximately 332 m. The farm had a total of 6 barns, a milking parlor with holding pen, and a special needs area. The farm had a capacity of 1,700 Holstein cows.

Manure from the freestall barns and the milking parlor complex was removed by flushing three times daily. The manure flushed from the parlor, holding pen, and freestall barns flowed to a solids separator, from which the solids are removed and stacked on a pad until they are spread on fields (the nearest of which is approximately 100 m from the barns) (Figure 1-1). The liquid effluent from the solids separator was pumped back into vertical tanks for reuse to flush the barns. Once a week, enough water was removed from the third stage of the three-stage lagoon and added to the flush tanks to compensate for water lost in the recycled flush system. The lagoons were pumped out into trucks twice yearly. The first and second stages of the three-stage lagoon system were monitored (Figure 1-1). These lagoons had an outer berm height of 6 m to the west, and between 1 and 6 m to the north. The 1st lagoon at maximum capacity had a surface area of 4,264 m^2 and a volume of 10,563 m^3. The second lagoon at maximum capacity had a surface area of 2,898 m^2 and a volume of 6,420 m^3.

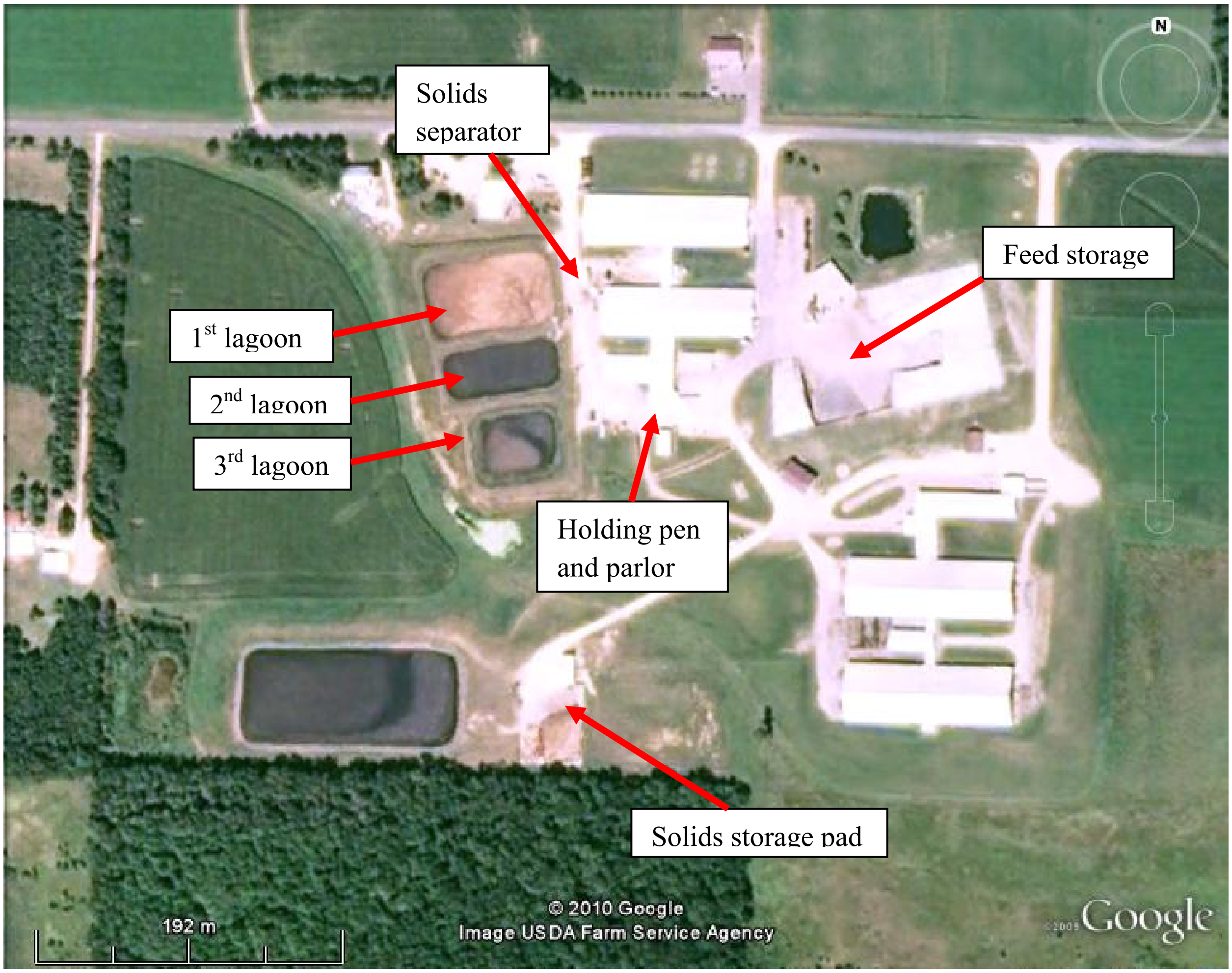

Figure 1-1: Configuration of the WI5A farm.

1.4 Changes in farm operation

The producer modified the bedding and routing of the wastewater several times during the study (Table 1-3).

Table 1-3: Operational changes during the study.

Period	Events during period
1: 7/17-8/28/2007	No events
2: 11/12-11/29/2007	No events
3: 11/29-12/18/2007	No events
4: 4/22-5/13/2008	No events
5: 6/24-7/15/2008	7/15/2008: Modification of wastewater routing: Pumped water from solids separator system to sand separator with excess water from solids separator pumped to lagoon 1
6: 10/20-11/11/2008	10/28/2008: Changed Bedding from Shavings to Recycled Sand 10/30 7:50am (CDT) -10/31/2008 1:00pm: Lagoon 1wastwater emptied into trucks. 11/25/2008: Changed Bedding to Sand
7: 12/17/2008-1/7/2009	Modification of wastewater routing: For entire duration of period water was sucked from parlor flush system and unloaded on top of ice in lagoon 1 (this action required because buried pipe plugged and will continue until permanent fix installed in spring).
8: 3/09-4/7/2009	3/9-3/15/2009: Modification of wastewater routing: Water was sucked from parlor flush system and unloaded on top of ice in lagoon 1. 4/6/2009: Started emptying wastewater from lagoons 1 and 2 into trucks. 3/16/2009: Bedding switched to a mix of sand and recycled sand 3/23/2009: Bedding switched to recycled sand

1.5 Measurement layout

The NH_3 emissions from the basin were monitored for 8 to 20 days 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 were mounted at 1-m heights above berm level (abl) on anchored tripods at the northeast berm corner of the 1st stage lagoon and off the southwest berm corner of the 2nd stage lagoon. Towers for mounting retro-reflectors were located at the southeast corner of the 2nd stage lagoon and at the northwest corners of the 1st stage lagoon (Figure 1-2). A description of the position and path length of the optical paths along each side of the lagoon follows:

- <u>North side of 1st stage lagoon</u>: Retro-reflectors were located on anchored tripods at 1 m abl at distances of 30.5 m and 60 m from the northeast TDLAS/scanner. Three retro-reflectors were mounted on the northwest tower 111 m from the TDLAS/scanner at heights of 1.1 m, 7.2 m, and 13.3 m abl.
- <u>East side of lagoons</u>: Retro-reflectors were located on anchored tripods at 1 m abl at distances of 34 m and 73 m from the northeast TDLAS/ scanner. Three retro-reflectors

were mounted on the southeast tower 102 m from the TDLAS/scanner at heights of 1.2 m, 6.3 m, and 13.8 m abl.

- South side of 2nd stage lagoon: Retro-reflectors were located on anchored tripods at 1 m abl at distances of 24.5 m and 54 m from the southwest TDLAS/scanner. Three retro-reflectors were mounted on the southeast tower 83 m from the TDLAS/scanner at heights of 1.2 m, 6.3 m, and 13.8 m abl.
- West side of lagoons: Retro-reflectors were were located on anchored tripods at 1 m abl at distances of 30 m and 60 m from the southwest TDLAS/scanner. Three retro-reflectors were mounted on the northwest tower 108 m from the TDLAS/scanner at heights of 1.1 m, 7.2 m abl, and 13.3 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 the north berm and began at the northwest berm corner of the 1st lagoon and 2.5 m from the north berm and ran west, parallel to the berm (Figure 1-2). The second 50-m long S-OPS was parallel to the south lagoon berm and began at the southwest berm corner of the 2nd stage lagoon and extended east between the 2nd and 3rd stage lagoons (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 instruments (barometric pressure, air temperature, relative humidity, solar radiation, and surface wetness) were mounted on the meteorological tower located on the berm between the 1st and 2nd stage lagoons, 20 m to the east of the 2nd lagoon northwest corner (Fig. 1-2). The 3D sonic anemometers were located on the meteorological tower at 2.5 m heights, between the 1st and 2nd stage lagoons (Fig. 1-2), and at 4.1 m and 16.7 m heights above berm level (abl) on the southeast corner tower.

Fetch from the TDLAS beam line along the north berm of the 1st stage lagoon was 1:2.5 (42 m distance, 16 m tree height) (Fig. 1-2). Fetch from the TDLAS beam line south of the south berm of the 2nd stage lagoon was greater than 1:100 while that to the north was 1:8.6. Fetch to east from the TDLAS beam line along the east of the three lagoons is 1:4.6 (7 m high at a distance of 31 m) with the 2nd barn, 1:3.1 (6 m high at a distance of 20 m) with the 1st barn and 1:3.5 (4 m high at a distance of 14 m) with the 3rd barn. Fetch from the S-OPS path along the north berm of the 1st stage lagoon was 1:3 (42 m distance, 16 m tree height) (Fig. 1-2). Fetch from the S-OPS path south of the south berm of the 2nd stage lagoon was greater than 1:100, while that to the north is 1:8.6. Due to poor fetch to the east of the beam lines, measurements were excluded from analysis when winds are from 0^o through 180^o.

Lagoon measurements (pH, oxidation-reduction potential, and temperature) were made from a float located in the SE corner of the 1st lagoon and when possible the NE corner of 2nd 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 in the northeast 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 185 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 176.7 d and H_2S emissions were measured 100 d.

Table 2.1-1: Days on Site

Period	Start date	End date	# days
1	7/18/2007	8/28/2007	41
2	11/13/2007	11/28/2007	15
3	11/28/2007	12/18/2007	20
4	4/23/2008	5/13/2008	20
5	6/25/2008	7/14/2008	19
6	10/21/2008	11/11/2008	21
7	12/17/2008	1/7/2009	21
8	3/10/2009	4/7/2009	28

2.2 Site visits

The field operation team involved in the on-site calibration checks, set-up, and take-down visited this farm 32 d (Table 2.2-1).

Table 2.2-1: Dates of site visits

WI5A	Spring	Summer	Fall	Winter
2007		Jul 17,18,19 Aug 6,7,9,28	Nov 13,14,27,28,29	Dec 17,18
2008	Apr 24, May 12,13,	Jun 24,25 Jul 14,15	Oct 21,22 Nov 11	Dec 17,18 Jan 6,7
2009	Mar 9,10 Apr 6,7			

2.3 Instrumentation QA/QC

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

- GasFinder2 NH3 TDLAS serial number (s/n) 1026, 1028, 1030 and 1031 (Section 6.1)
- TEC 450i H_2S Analyzer s/n 0733825129 (Section 6.2)
- RM Young 81000 3D sonic anemometers s/n 1920, 1926, 1928, 1932, 1933 and 1945 (Section 6.3)
- lagoon pH probes s/n 001 and 004 (Section 6.4)

- lagoon ORP probe s/n 020 and 040 (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, multipoint 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. An inter-comparison of three TDLAS units (s/n 1027, 1028 and 1031) was conducted at this location on April 23, 2008.

2.4 Audits

Two internal audits were conducted at this location: 1) on 23 April 2008 with particular attention to the sonic anemometer inter-comparison and TDLAS calibration verification, and 2) on 28 November 2008 with particular attention to the operation documentation.

2.5 Remote site checks

Over the course of measurements, there were 61 remote checks made through the computer for instruments operating at this location.

2.6 Measurement data acquisition

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

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

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

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

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

Files were transferred from the instrument trailers to the PAML FTP server using the program *rsync* in the *cygwin* environment (open source programs). This transfer took place every 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 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 the data collection to stop. These events were noticed during the daily site checks from PAML at which time the missing data were filled from the internal memory on the analyzer and a new data file was started to collect the data in real-time. To allow the quality control software to run most efficiently, these multiple data files were combined into a single file at the conclusion of the period. The files that were included in this single file were placed in a subdirectory of the H_2S data folder named "Pieces". On isolated occasions, the CR1000-logged or CR800-logged data for a period were split into more than one file, and these data files were generally combined into a single file for the period, unless a change was made to the data stream in between the files (e.g. adding temperature and relative humidity probe to the gas sampling system output).

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

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

3.1 QA/QC software procedures

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

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

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

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

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

3.2 Data exclusions

Data were excluded from processing due to equipment failures, calibration failures, and because calibration checks were in progress. Periods of invalidated measurements associated with the calibration check failures are documented in the calibration reports in Section 8. 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: Examples of events resulting in measurement exclusions include the following issues. Specific events are described in Table 3.2-1

Table 3.2-1: TDLAS exclusion events

Begin		End		Reason
8/20/2007	03:40	8/23/2007	15:50	TDLAS 2 Unknown failure
11/14/2007	19:00	12/5/2007	22:30	West side of the lagoon will have no RPM due to TDLAS 2 path 6 being aimed at retro-reflector7
12/6/2007	07:45	12/11/2007	22:45	TDLAS 1 Scanner failure
12/12/2007	07:00	12/17/2007	22:00	TDLAS 1 Scanner failure
12/1/2007	23:45	12/5/2007	20:50	TDLAS 2 Snow/ice storm
3/13/2009	variable	3/16/2009	variable	TDLAS 1 shifted due to snow/icemelt
3/14/2009	variable	3/16/2009	variable	TDLAS 2 shifted due to snow/icemelt
4/28/2008	03:10	5/12/2008	22:00	TDLAS 1 Centerline duty cycle maxed out
3/30/2009	12:00	4/3/2009	18:30	Both TDLAS laptops locked up

Wetness measurement exclusions: Wetness sensor measurements were excluded from 8/4/2007 through 8/28/2001, from 11/14/2007 through 11/27/2007, and from 11/28/2007 through 12/18/2007. These events are described in Table 3.2-2.

Table 3.2-2: Wetness sensor exclusion events

Begin		End		Reason
8/4/2007	00:00:00	8/28/2007	14:20:00	Wetness sensor started showing wetness for entire period after 8/4
11/14/2007	22:30:00	11/27/2007	22:55:00	Sensor malfunction
11/28/2007	20:45:00	12/18/2007	14:15:00	Sensor malfunction

Pressure measurement exclusions: Due to a large spike in the pressure reading, pressure sensor measurements were excluded from 12:55 to 15:15 on 10/28/2008.

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
8/7/2007	13:45	8/7/2007	19:00	Calibration check
12/1/2007	23:50	12/5/2007	17:10	All sonic anemometers Icing
12/7/2007	00:35	12/7/2007	17:20	All sonic anemometers Icing
7/8/2008	02:35	7/10/2008	19:55	Sonic anemometer 1 no data transferred (unknown reason)
10/24/2008	07:35	10/27/2008	03:45	Sonic anemometer 3 extensive flagging
12/26/2008	15:24	12/30/2008	19:35	Sonic anemometer 3 extensive flagging
1/3/2009	22:10	1/5/2009	16:00	Sonic anemometer 3 icing
1/3/2009	22:20	1/4/2009	19:25	Sonic anemometers 1 and 2 icing
4/4/2009	13:30	4/6/2009	12:45	All sonic anemometers have no data; program failure?

Lagoon temperature, pH, and ORP measurement exclusions: When possible, lagoon measurements were made on both lagoons. Excluded measurements are summarized in Table 3.2-4.

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

Begin		End		Reason
Lagoon 1 temperature probe				
7/20/2007	13:55:00	7/20/2007	14:10:00	Removing other probes
8/7/2007	21:25:00	8/7/2007	21:35:00	Adding other probes
8/9/2007	14:50:00	8/9/2007	15:30:00	Removing other probes
11/28/2007	20:45:00	12/18/2007	14:15:00	Probe not in lagoon (frozen)
4/23/2008	15:35:00	5/13/2007	19:10:00	Probe not in lagoon (crusted)
6/26/2008	15:40:00	7/14/2007	20:20:00	Probe not in lagoon (crusted)
10/21/2008	18:25:00	11/11/2008	23:35:00	Probe not in lagoon (empty/dry)
12/18/2008	07:35:00	1/7/2009	18:50:00	Probe not in lagoon (frozen)
3/10/2009	01:40:00	4/7/2009	13:00:00	Probe not in lagoon (frozen)
Lagoon 2 temperature probe				
7/20/2007	13:25:00	7/20/2007	13:55:00	Removing other probes
8/7/2007	21:35:00	8/7/2007	21:50:00	Adding other probes
8/9/2007	14:55:00	8/9/2007	15:05:00	Removing other probes
11/28/2007	20:45:00	12/18/2007	14:15:00	Probe not in lagoon (frozen)
4/23/2008	15:35:00	5/13/2008	19:10:00	Probe not in lagoon (crusted)
6/26/2008	15:40:00	7/14/2008	20:20:00	Probe not in lagoon (crusted)
10/21/2008	18:25:00	11/11/2008	23:35:00	Probe not in lagoon (empty/dry)
12/18/2008	07:35:00	1/7/2009	18:50:00	Probe not in lagoon (frozen)
3/10/2009	01:40:00	4/7/2009	13:00:00	Probe not in lagoon (frozen)
Lagoon 1 pH probe				
7/20/2007	13:25:00	8/7/2007	21:45:00	Only placed in for 1 d
8/9/2007	14:50:00	8/28/2007	14:20:00	Only placed in for 1 d
11/28/2007	20:45:00	12/18/2007	14:15:00	Probe not in lagoon (frozen)
4/23/2008	15:35:00	5/13/2008	19:10:00	Probe not in lagoon (crusted)

Begin		End		Reason
6/26/2008	15:40:00	7/14/2008	20:20:00	Probe not in lagoon (crusted)
10/21/2008	18:25:00	11/11/2008	23:35:00	Probe not in lagoon (empty/dry)
12/18/2008	07:35:00	1/7/2009	18:50:00	Probe not in lagoon (frozen)
3/10/2009	01:40:00	4/7/2009	13:00:00	Probe not in lagoon (frozen)
Lagoon 2 pH probe				
7/20/2007	13:25:00	8/7/2007	21:45:00	Only placed in for 1 d
8/9/2007	14:50:00	8/28/2007	14:20:00	Only placed in for 1 d
11/28/2007	20:45:00	12/18/2007	14:15:00	Probe not in lagoon (frozen)
4/23/2008	15:35:00	5/13/2008	19:10:00	Probe not in lagoon (crusted)
6/26/2008	15:40:00	7/14/2008	20:20:00	Probe not in lagoon (crusted)
10/21/2008	18:25:00	11/11/2008	23:35:00	Probe not in lagoon (empty/dry)
12/18/2008	07:35:00	1/7/2009	18:50:00	Probe not in lagoon (frozen)
3/10/2009	01:40:00	4/7/2009	13:00:00	Probe not in lagoon (frozen)
Lagoon 1 ORP probe				
7/20/2007	13:25:00	8/7/2007	21:45:00	Only placed in for 1 d
8/9/2007	14:50:00	8/28/2007	14:20:00	Only placed in for 1 d
11/28/2007	20:45:00	12/18/2007	14:15:00	Probe not in lagoon (frozen)
4/23/2008	15:35:00	5/13/2008	19:10:00	Probe not in lagoon (crusted)
6/26/2008	15:40:00	7/14/2008	20:20:00	Probe not in lagoon (crusted)
10/21/2008	18:25:00	11/11/2008	23:35:00	Probe not in lagoon (empty/dry)
12/18/2008	07:35:00	1/7/2009	18:50:00	Probe not in lagoon (frozen)
3/10/2009	01:40:00	4/7/2009	13:00:00	Probe not in lagoon (frozen)
Lagoon 2 ORP probe				
7/20/2007	13:20:00	8/7/2007	21:45:00	Only placed in for 1 d
8/9/2007	14:50:00	8/28/2007	14:20:00	Only placed in for 1 d
11/28/2007	20:45:00	12/18/2007	14:15:00	Probe not in lagoon (frozen)
4/23/2008	15:35:00	5/13/2008	19:10:00	Probe not in lagoon (crusted)
6/26/2008	15:40:00	7/14/2008	20:20:00	Probe not in lagoon (crusted)
10/21/2008	18:25:00	11/11/2008	23:35:00	Probe not in lagoon (empty/dry)
12/18/2008	07:35:00	1/7/2009	18:50:00	Probe not in lagoon (frozen)
3/10/2009	01:40:00	4/7/2009	13:00:00	Probe not in lagoon (frozen)

3.3 Data correction procedures

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

3.4 Data validation procedures

3.4.1 NH_3 concentration measurements

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

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

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

Once the PIC vs. r^2 threshold curve was determined, a final pass was made through the data, this time comparing the PIC value for each data point with the threshold value at the 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 was averaged up to the 30-min time intervals required by the *WindTrax* and *RPM* emissions models.

3.4.2 H_2S concentration measurements

The H_2S data processing routine first loaded all the H_2S data into an array. Based on the GSS data array, the data were then sorted by source side and a determination was made whether the GSS had been sampling that side long enough and whether enough time remained until the end of sampling that side for the H_2S data to be considered valid. The data were then sorted and averaged into 30-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 software imported the 300-s sonic data files and produced the final sonic 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 data were not suitable for use by *WindTrax* during a particular data interval. The *RPM* arrays contained the wind direction and wind speed averaged over a 30-min interval and interpolated to 10 levels from the surface to 20 m above the surface.

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

3.5 Emission calculations

3.5.1 NH3 emissions by RPM

The *RPM* model was used to estimate the NH3 emission rates based on the TDLAS and sonic 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 and TDLAS data processing programs were used to skip the first two stages of *RPM* data processing by producing data in the proper format and with the proper filenames for level 3 processing by the *RPM*. These files were produced at an interval of 30 min with all the data for a site and period contained in a single *RPM* input file. This allowed an entire period of data to be *RPM* processed with just a few clicks of the mouse, instead of with many clicks just for each individual day. The 30-min time interval was appropriate because the focus of the NAEMS study is on the long-term emissions over the course of the day rather than on the minute-by-minute emissions. In addition, the 30-min interval also allowed for a higher percentage of data capture since not all paths were necessarily required to be present for the entire 30-min interval.

3.5.2 NH3 emissions by bLS

Data input into the *WindTrax* model were produced by combining output from the sonic 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

$$F = \frac{S^2_{bLS}}{S^2_{RPM}}$$

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, GSS, and H_2S portions of the data processing software. The *WindTrax* program was run by a portion of the data processing software that assigns values to the concentrations and wind statistics required by the model and tells the model to run depending on whether or not the u_* and L values are acceptable.

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

4 Results

4.1 Farm activity

Pertinent activities affecting the lagoon include transfer of waste from barns into the lagoon (Table 4.1-1) and lagoon pump-outs for irrigation. Animal inventories for the calculation of lagoon loading rates are indicated in Table 4.1-1.

Table 4.1-1 Producer activities

Period	Activity	Animal Inventory
1: 7/17-8/28/2007	No events	500
11/5/2007	Lagoon 1 emptied	
2: 11/12-11/29/2007	11/22: Stage 1 lowline closed	500
3: 11/29-12/18/2007	12/16: Flow started into stage 3	500
4: 4/22-5/13/2008	No events	500
5: 6/24-7/15/2008	7/15: Pumped water from ISS system to sand separator. Excess water from ISS pumped to lagoon 1	500
6: 10/20-11/11/2008	10/30: Lagoon 1 emptied	556
7: 12/17/2008-1/7/2009	Duration of period: sucked parlor water out of flush system and unloaded on top of ice in lagoon 1.	554
8: 3/09-4/7/2009	3/9-3/15: Sucked parlor water out of flush system and unloaded on top of ice in lagoon 1.	554

4.2 Weather conditions

4.2.1 Synoptic weather events

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

Table 4.2-1: Synoptic weather events during measurements

Measurement Period	# days	# Warm front passages	# Cold front passages	# days stationary front	# days Tropical storms
1	41	1	9	8	0
2	15	0	2	1	0
3	20	0	3	0	0
4	20	1	3	1	0
5	19	3	6	0	0
6	21	1	3	0	0
7	21	1	3	2	0
8	28	1	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 -21.5°C to 26.2°C while the barometric pressure varied from 93.53 kPa to 99.73 kPa (Section 6.10). Sky conditions ranged from clear skies with maximum ½ h solar irradiance of 1287 Wm^{-2} to overcast conditions with maximum ½ h solar irradiance of 85 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 with the monthly climatology is indicated in Figure 4-1. Temperatures were generally within the climatological normal conditions throughout the study measurement periods at this location.

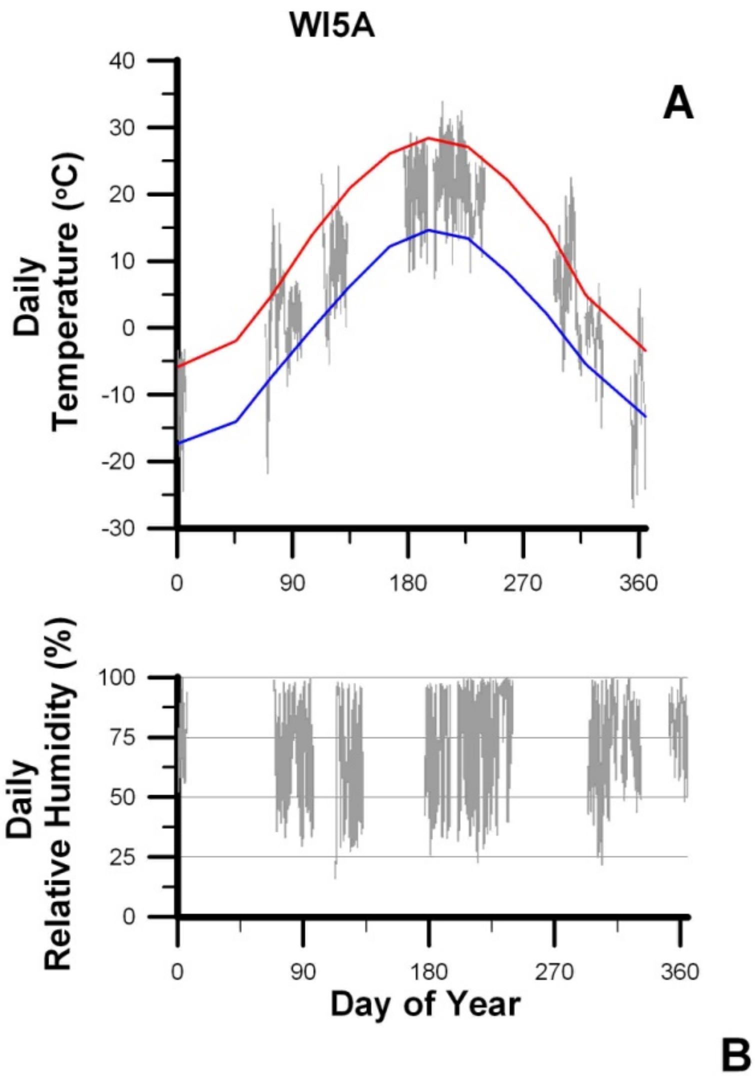

Figure 4-1: Variation in daily temperatures and relative humidity during measurements. The mean monthly climatological maximum (red solid line) and minimum (blue solid line)

temperature are compared against the daily maximum and minimum temperatures for measurement days (grey bars) in panel A. The maximum and minimum relative humidities for measurement days are indicated by the grey bars in panel B.

4.2.4 Wind conditions

Wind conditions for each measurement period are illustrated in Figures 4.2-1 through 4.2-4. Emission calculation exclusion regions due to surrounding sources (wind directions of 0° through 180°) are indicated as a grayed region in the figures.

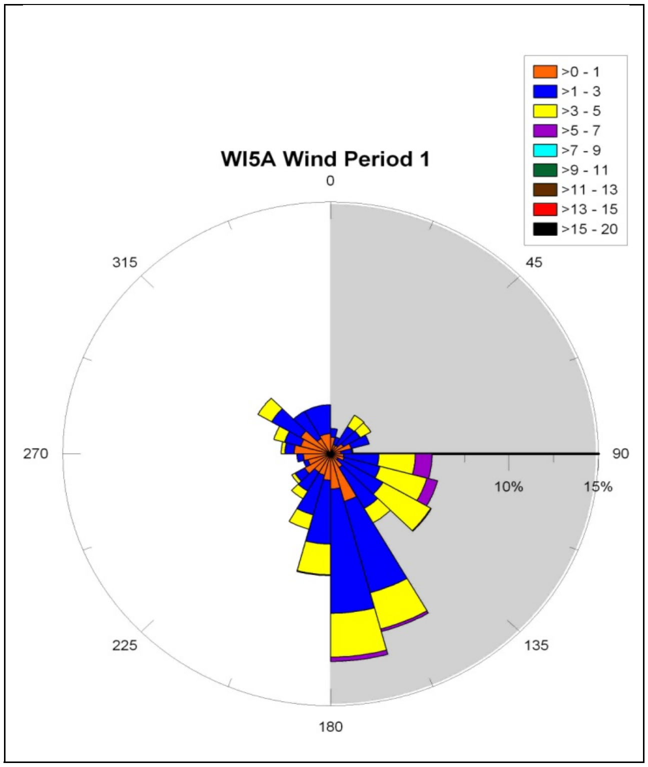

Figure 4.2-1: Wind rose for ½ hourly wind measurements during the Summer Measurement Period. The period in which measurements were made are indicated. The relative portion of time in which the wind was from a given direction is indicated by the length of the triangle pointing in that direction. The fraction 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 excluded wind directions.

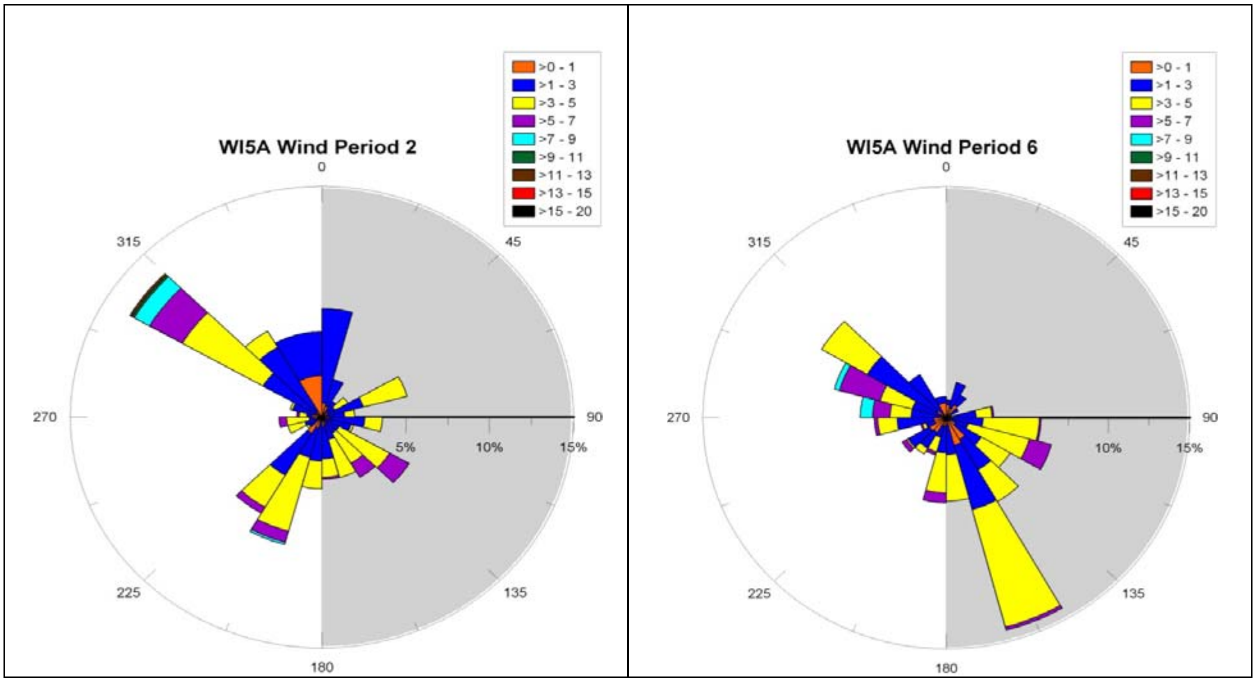

Figure 4.2-2: Wind rose for ½ hourly wind measurements during the Fall Measurement Periods. The periods in which measurements were made are indicated. The relative portion of time in which the wind was from a given direction is indicated by the length of the triangle pointing in that direction. The fraction 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 excluded wind directions.

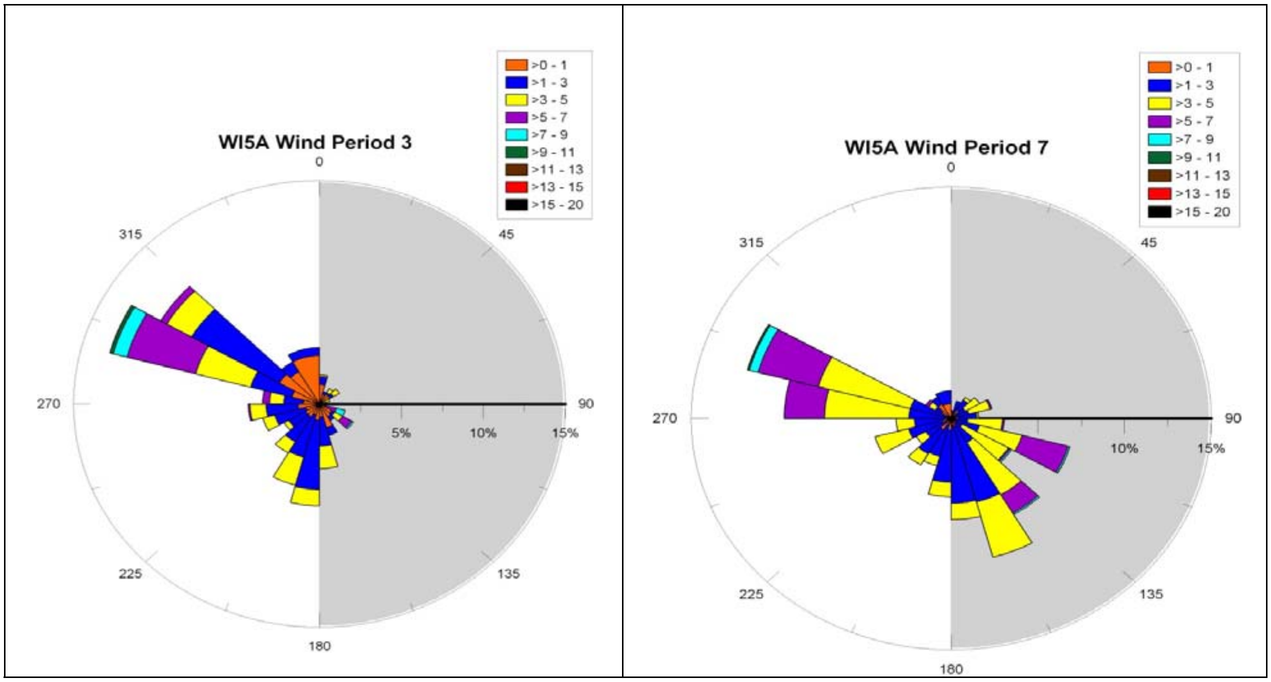

Figure 4.2-3: Wind rose for ½ hourly wind measurements during the Winter Measurement Periods. The periods in which measurements were made are indicated. The relative portion of time in which the wind was from a given direction is indicated by the length of the triangle pointing in that direction. The 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 excluded wind directions.

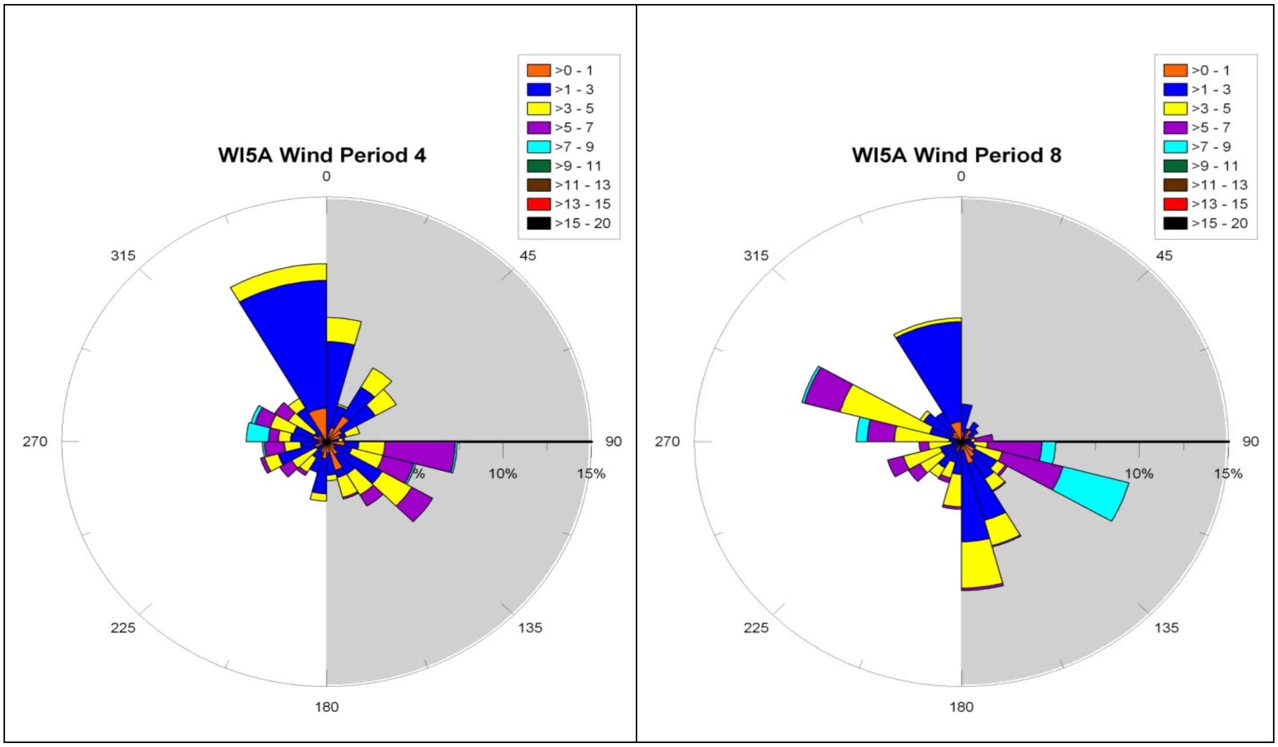

Figure 4.2-4: Wind rose for ½ hourly wind measurements during the Spring Measurement Periods. The periods in which measurements were made are indicated. The relative portion of time in which the wind was from a given direction is indicated by the length of the triangle pointing in that direction. The 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 excluded wind directions.

4.3 Lagoon conditions

4.3.1 Lagoon appearance, liquid depth and sludge depth

The appearance of the two measurement lagoons was recorded on almost every site visit (Table 4.3-1). The lagoons generally appeared brown/black and crusted.

Table 4.3-1: Lagoon physical characteristics

Period	Date, appearance (Color/Crust)
1: 7/17-8/28/2007	7/17/2007 - Brown/Black/ 75% Crust 7/18/2007 - Brown/Black/ 75% Crust 7/19/2007 - Brown/ 75% Crust 8/6/2007 - Brown/ 90% Crust 8/7/2007 - Brown/Black/ 95% Crust 8/9/2007 - Brown/Black/ 95% Crust 8/28/2007 - Brown/Black/ 100% Crust
2: 11/12-11/29/07	11/13/2007 - Brown/ No crust 11/14/2007 - Brown/ No crust 11/27/2007 - Brown/ Frozen/ 4" Liquid Foam 11/28/2007 - Black/ Frozen
3: 11/29-12/18/07	11/29/2007 - Black/ Frozen 12/17/2007 - Brown/ Frozen 12/18/2007 - White(snow)/ Frozen
4: 4/22-5/13/08	4/24/2008 - Black/ No crust 5/12/2008 - Black/ 85% Crust 5/13/2008 - Black/ 80% Crust
5: 6/24-7/15/08	6/24/2008 - Light brown/ 100% Crust 6/25/2008 - Brown/ 100% Crust 7/14/2008 - Brown/ 100% Crust 7/15/2008 - Brown/ 100% Crust
6: 10/20-11/11/08	10/21/2008 - Black/ Empty 10/22/2008 - Brown/ Empty 11/11/2008 - Black/White/ Frozen
7: 12/17/08-1/7/09	12/17/2008 - White(snow)/ Frozen 12/18/2008 - White(snow)/ Frozen 1/6/2009 - White(snow)/ Frozen 1/7/2009 - White(snow)/ Frozen
8: 3/9-4/7/09	3/9/2009 - White/Brown/ 90% Frozen 3/10/2009 - White/Brown/ 95% Frozen 4/6/2009 - Black/ No crust 4/7/2009 - Black/ No crust

4.3.2 Temperature, pH and Oxidation-Reduction Potential

The conditions of the first two lagoons were measured. The first measured lagoon liquid temperature varied from 4.6°C to 24.7°C with the lowest temperatures just prior to when the sensors were removed in anticipation of the lagoon freezing during the winter (Section 6.11.1). The lagoon pH varied from 6.6 to 7.1 (Section 6.11.1) while the oxidation-reduction potentials varied from -338 mV to -507 mV over the entire study period (Section 6.11.1). The second measured lagoon liquid temperature varied from 1.7°C to 25.0°C with the lowest temperatures just prior to when the sensors were removed in anticipation of the lagoon freezing during the winter (Section 6.11.2). The lagoon pH varied from 6.5 to 7.2 (Section 6.11.2) while the oxidation-reduction potentials varied from -336 mV to -467 mV over the entire study period (Section 6.11.2).

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 (AU) basis assumed an animal weight of 500 lb equals 1 AU and the typical animal weight values reported by the producer. Piglets and calves were not included in the populations or AU determinations. Emissions reported on an area basis are based on the surface area of the lagoon.

Comparison of RPM and bLS emissions models

The comparison between the RPM and bLS emissions models was conducted according to the USEPA Method 301 'Field Validation of Pollutant Measurement Method' using NH_3 emissions measurements. The comparison was based on 274 ½ h measurement periods over the entire measurement time at this location. Results showed that the bLS emissions did not have significantly different precision (F=0.47, critical F=1.0) but had a significant bias over the *RPM* emissions ($t=-4.39$, $t_{0.2}=1.29$) with a corresponding correction factor for the bLS of 0.78 (Table 4.4.1-1). Consequently, the ½ h bLS emissions measurements were biased low by 22% compared with 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})	0.427	0.334	-0.094
Standard deviation (gs^{-1})	0.458	0.313	
Variance of the mean (gs^{-1})	0.210	0.098	

4.4.1 NH_3 Emissions

4.4.1.1 Mean daily NH_3 emissions

There was a distinct annual trend in NH_3 emissions based on the *RPM* model (Figure 4.4.1-1). Maximum summertime daily emissions were highly variable, ranging from 20 g to 280 g NH_3 d^{-1} hd^{-1}. These summertime measurements were influenced by the atmospheric moisture interference which the TDLAS instruments had at the time and consequently these emissions may be underestimated by as much as 40%. There were, however, no days in which the daily emission estimate was based on more than 75% of the day's emissions. Consequently there is no confidence that the estimated emission is representative of a daily emission rate. 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.

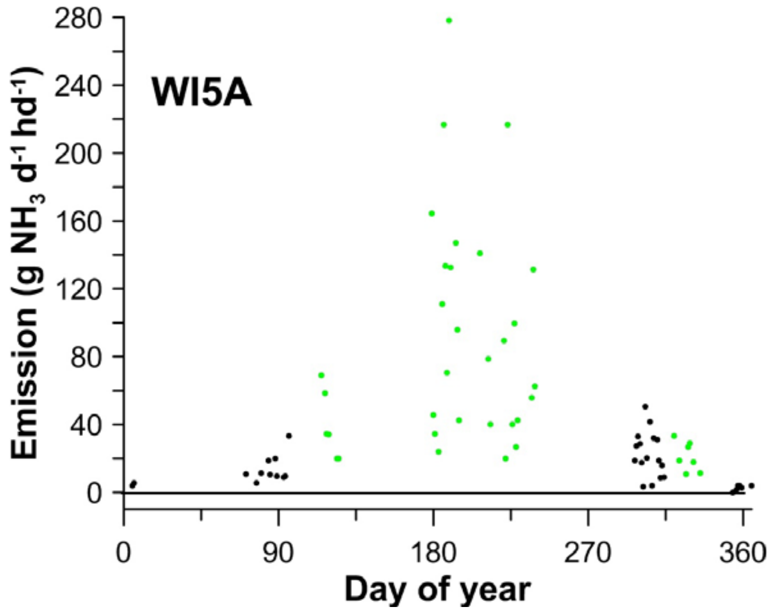

Figure 4.4.1-1: Annual variation in RPM-computed daily NH_3 emissions. Days with a red circle indicate there are measurements for greater than 75% of the continuous day. The green solid circles indicate moisture interference with the NH^3 concentration measurement.

There was a distinct annual trend in NH_3 emissions based on the bLS model (Figure 4.4.1-2). Maximum summertime daily emissions were highly variable, ranging from 0 to 180 g NH_3 d^{-1} hd^{-1}. There were however many days in which the daily emission estimate was based on more than 75% of the day's emissions. Considering only those days, the maximum summertime daily emission was approximately 60 g NH_3 d^{-1} hd^{-1}. These summertime measurements were influenced by the atmospheric moisture interference which the TDLAS instruments had at the time and consequently these emissions may be underestimated by as much as 40%. 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.

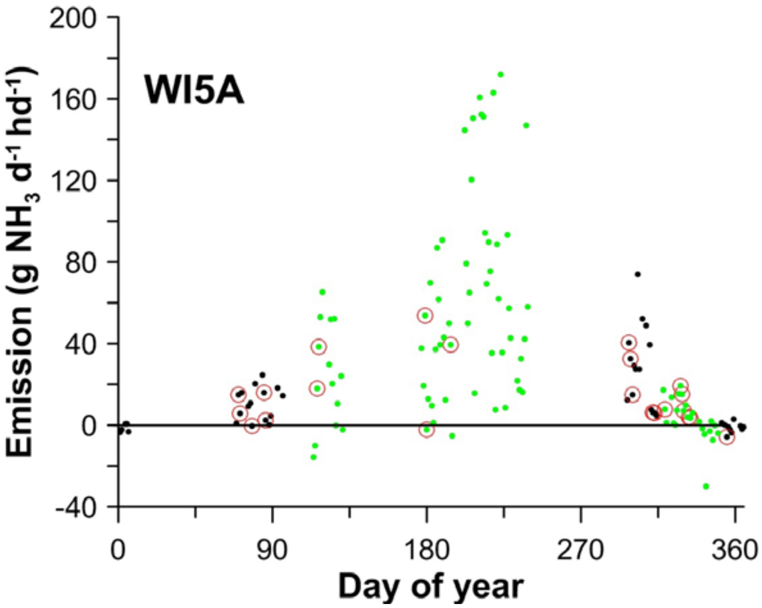

Figure 4.4.1-2: Annual variation in bLS-computed daily NH_3 emissions. Days with a red circle indicate there are measurements for greater than 75% of the continuous day. The green solid circles indicate moisture interference with the NH^3 concentration measurement. The bars represent the standard deviation of emissions based on individual ½ h values when at least 75% of the day had valid measurements.

The bLS model was influenced by the calculated background concentrations. Results indicated that the background concentration of NH_3 was generally less than 0.1 ppm except in mid-year (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 corresponded to a background concentration for a given PIC of less than 10 ppm-m. This was approximately five times the MDL for the TDLAS instruments of 2 ppm-m (Section 8.1) and therefore represented a real background for this location. Negative background concentrations occurred when the winds were variable resulting in no distinct upwind or downwind S-OPS.

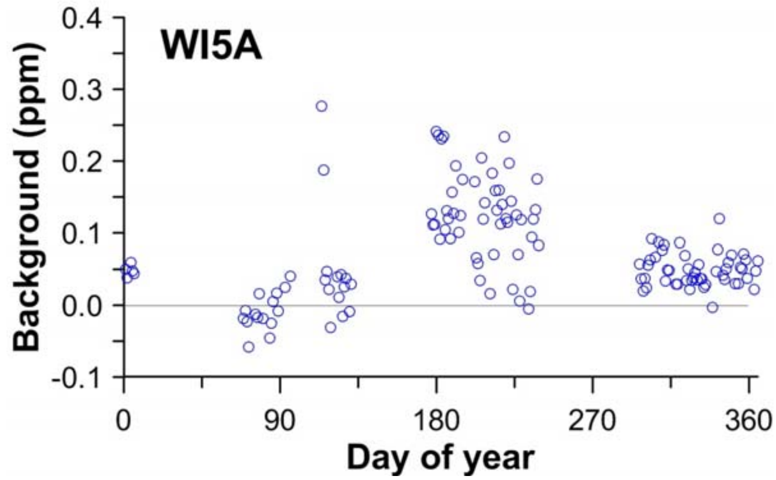

Figure 4.4.1-3: Annual variation in bLS-computed daily background concentration of NH_3.

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). Negative emission rates are a result of upwind (background) concentrations exceeding the downwind concentrations under variable winds.

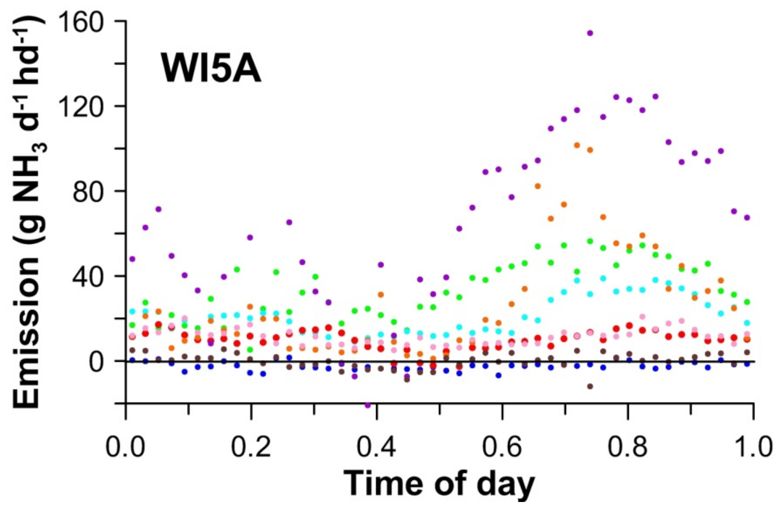

Figure 4.4.1-4: Diurnal variation in bLS-computed NH_3 emissions. Time based on Universal Time Coordinates. The mean emission for each half-hour of the day within a given measurement period (Period 1-Summer (purple), Period 2-Fall (pink), Period 3-Winter (brown), Period 4-Spring (orange), Period 5-Summer (green), Period 6-Fall (light blue), Period 7-Winter (blue), and Period 8-Spring (red)) 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								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Total**
NH_3 RPM model									
Valid 1/2 h measurements (d)	1.0	0.5	0.0	0.4	1.1	3.1	0.3	1.0	**7.4**
Measurements excluded due to wind direction (d)	2.8	0.8	0.1	0.5	1.4	6.9	0.6	0.9	**13.9**
Measurements excluded because at least one downwind path is missing or invalid (d)	31.7	9.3	14.5	16.5	10.3	2.3	9.2	14.0	**107.9**
Number of days with >=36 valid 1/2 h periods (d)	0	0	0	0	0	0	0	0	**0**
NH_3 bLS model									
Valid 1/2 h measurements (d)	7.1	6.5	4.3	5.6	7.8	7.3	5.2	8.0	**51.8**
Measurements excluded due to wind direction (d)	11.6	4.8	1.4	4.2	4.7	8.0	7.1	5.3	**47.1**
Measurements excluded because touchdown fraction < 0.1 (d)	2.4	0.0	1.8	1.9	0.1	0.0	0.6	3.5	**10.4**
Measurements excluded because $u_* < 0.15$ ms^{-1} or $\|L\| <$ 2 m (d)	12.7	1.5	5.1	3.6	4.1	2.6	2.7	3.9	**36.2**
Number of days with >=36 valid 1/2 h periods (d)	0	4	2	2	3	5	1	5	**22**

In total, 7 d of valid NH_3 emissions were determined from the 176.7 measurement days using the *RPM* model, with no days having at least 36 valid ½ h NH_3 emissions. The absence or invalidation of at least one downwind path led to 108 d for which emissions could not be calculated.

Valid NH_3 emissions for 52 d were determined from the 176.7 measurement days using the bLS model, with 22 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 47 d of measurements. Invalid turbulence statistics ($u_* < 0.15$ ms^{-1}or $|L| < 2$ m) led to 36 d for which emissions could not be calculated. A touchdown fraction of less than 0.1 led to the exclusion of 10 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 when 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

There was some evidence for an annual pattern of emissions based on the Ratiometric model (Figure 4.4.2-1). Emissions were highest during the summer at approximately 8 g H_2S $d^{-1}hd^{-1}$ or less and decreased to zero during the winter. The summer emissions were however influenced by the moisture interference of the TDLAS instruments and consequently may be 40% low. However since there were no days in which more than 75% of the day's emissions were available for calculating the daily emission rate, the confidence in the daily emission rates using this emissions model is poor. 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.

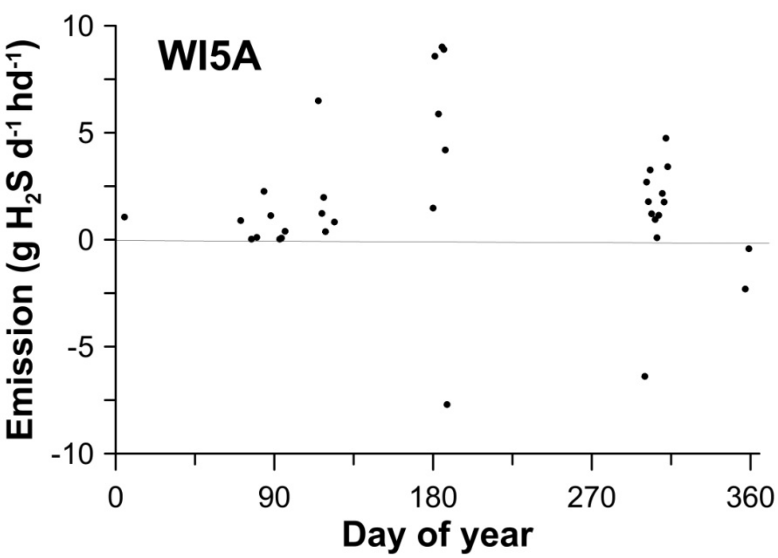

Figure 4.4.2-1: Annual variation in Ratiometric-computed daily H_2S emissions. Days with a red circle indicate there are measurements for greater than 75% of the continuous day.

There was some evidence for an annual pattern of emissions based on the bLS model (Figure 4.4.2-2). Emissions were highest during the summer at between 2 g and 12 g H_2S $d^{-1}hd^{-1}$ with emissions decreased to zero during the winter. Considering only days in which more than 75% of the day's emissions were available for calculating the daily emission rate, the maximum daily emissions during the summer was 3 g H_2S $d^{-1}hd^{-1}$. 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.

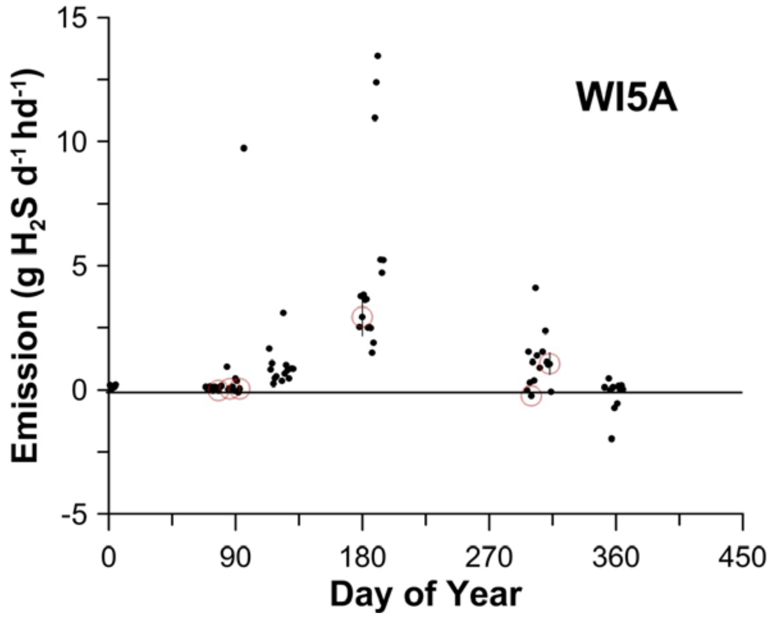

Figure 4.4.2-2: Annual variation in bLS-computed daily H_2S emissions. Days with a red circle indicate there are measurements for greater than 75% of the continuous day. The bars represent the standard deviation of emissions based on individual ½ h values when at least 75% of the day had valid measurements.

The bLS emission model depends on good estimates of the background H_2S concentration. Results indicated that the background concentration was generally less than ± 5 ppb (Figure 4.4.3-3). This background was consistent with an equivalent zero value where the instrument MDL was 3.4 ppb (Section 6.2).

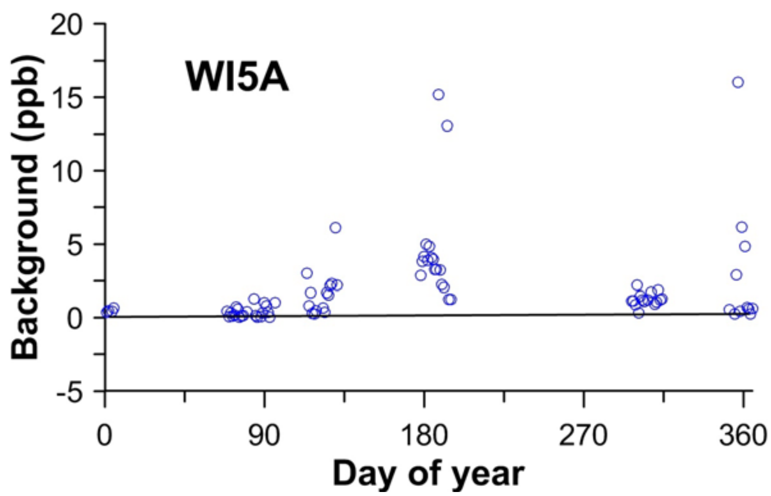

Figure 4.4.3-3: Annual variation in bLS-computed daily background concentration of H_2S.

4.4.2.2 Diurnal variation in H_2S emissions

In general, there was a weak diurnal pattern to the H_2S emissions (Figure 4.4.2-4). Negative emission rates are a result of upwind (background) concentrations exceeding the downwind concentrations under variable winds.

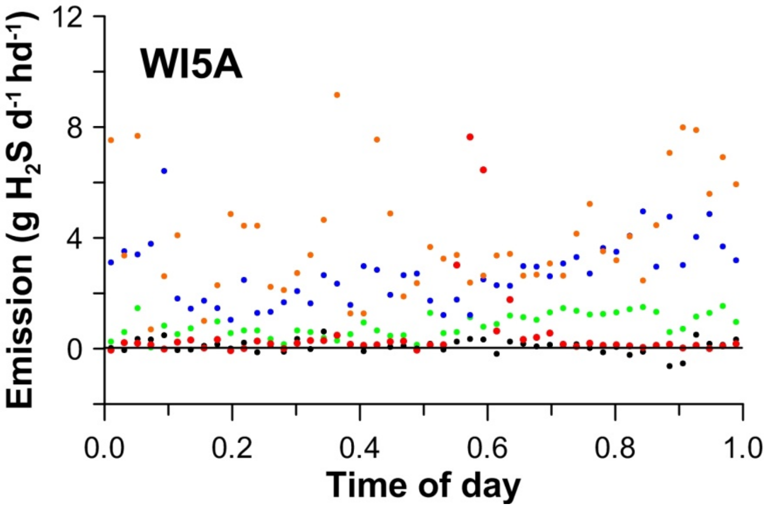

Figure 4.4.2-4: Diurnal variation in bLS-computed H_2S emissions. Time based on Universal Time Coordinates. The mean emission for each half-hour of the day within a given measurement period (Period 6-Fall (red), Period 7-Winter (blue), Period 8-Spring (black), and Period 9-Summer (green)) are indicated.

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.

The H_2S emissions were measured a total of 100 d at this location. The majority of measurements were invalidated as a result of wind direction exclusions associated with the proximity of the lagoons to the barns (Figure 1-2). Wind direction exclusions invalidated 36 d of measurements. 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, only two days of valid H_2S emissions were determined using the Ratiometric emission method, with none having at least 36 valid ½ h H_2S emissions. Valid H_2S emissions for 27 d were determined using the bLS model, with 6 d having at least 36 valid ½ h H_2S emissions. Invalid turbulence statistics ($u_* < 0.15$ ms^{-1} or $|L| < 2$ m) excluded 20 d, due to low wind speeds and turbulence from the local barns and trees.

Table 4.4.2-1: Completeness statistics for H_2S emissions measurements

	Measurement Period								
	1	2	3	4	5	6	7	8	Total
H_2S Ratiometric model									
Valid 1/2 h measurements (d)	[redacted]	[redacted]	[redacted]	0.3	0.3	1.3	0.1	0.6	**2.6**
Number of days with >=36 valid 1/2 h periods (d)	[redacted]	[redacted]	[redacted]	0	0	0	0	0	**0**
H_2S bLS model									
Valid 1/2 h measurements (d)	[redacted]	[redacted]	[redacted]	4.4	5.0	5.6	4.5	7.6	**27.2**
Measurements excluded due to wind direction (d)	[redacted]	[redacted]	[redacted]	6.5	4.5	7.9	7.8	9.5	**36.3**
Measurements excluded because angle of attack > 60 degrees (d)	[redacted]	[redacted]	[redacted]	2.1	2.7	1.7	2.7	3.7	**12.9**
Measurements excluded because $u_* < 0.15$ ms^{-1} or $\|L\| <$ 2 m (d)	[redacted]	[redacted]	[redacted]	3.9	5.0	3.5	3.4	4.4	**20.2**
Number of days with >=36 valid 1/2 h periods (d)	[redacted]	[redacted]	[redacted]	0	1	2	0	3	**6**

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, 1028, and 1030 prior to July 21, 2008. TDLAS 1026 was used at WI5A from 11/13/2007 to 12/18/2007 (Measurement period 2 and 3). TDLAS 1028 was used at WI5A from 7/18/2007 to 8/28/2007, 11/13/2007 to 12/18/2007, 4/23/2008 to 5/13/2008, 6/25/2008 to 7/14/2008 (Measurement periods 1, 2, 3, 4 and 5). TDLAS 1030 was used at WI5A from 7/18/2007 to 8/28/2007 (Period 1). 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 dew point temperatures of -2^{o}C to 20^{o}C. A conservative estimate of the bias of all of the above TDLAS units with evident moisture interference was 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 -22% (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 -62% for TDLAS NH_3 measurements made by units with moisture interference and a bias of -22% 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

Four TDLAS units (Model GasFinder2™ NH3OP, Boreal Laser Inc., Spruce Grove, Alberta, Canada) were used at this location: serial numbers 1026, 1028, 1030, and 1031.

TDLAS 1026 was multipoint calibrated seven times during the study (Figure 6.1-1). The response was non-linear and consequently a third-order polynomial was used to correct the instrument measurements for the instrument response. The multipoint calibration on 1/17/07 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:

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

where X was the instrument response. The response of the sensor was influenced by humidity until July, 21 2008 due to an error in the factory settings for the spectral waveband analysis window. At that time, factory personnel corrected the spectral waveband used for analysis. The effect of this error was to 1) reduce the maximum possible linear correlation with the internal reference cell resulting in unusually low 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 resulted in no correlation and consequently no reportable measurement. The MDL of the instrument was determined from the mean of the variability (3σ) 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 days (Figure 6.1-3). The large fraction of checks made within 7 days 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 to different multipoint calibration was applied to the calibration verification measurements during the progress of the study than finally applied during the analysis. Repeated calibrations within 24 hours often showed biases differing by more than 10 ppm-m suggesting operator errors. Although this instrument had a bias associated with water vapor interference, the instrument was in use in dry climates during this time. The measurements made during this period were considered valid and the error assumed to be due to the calibration verification operator.

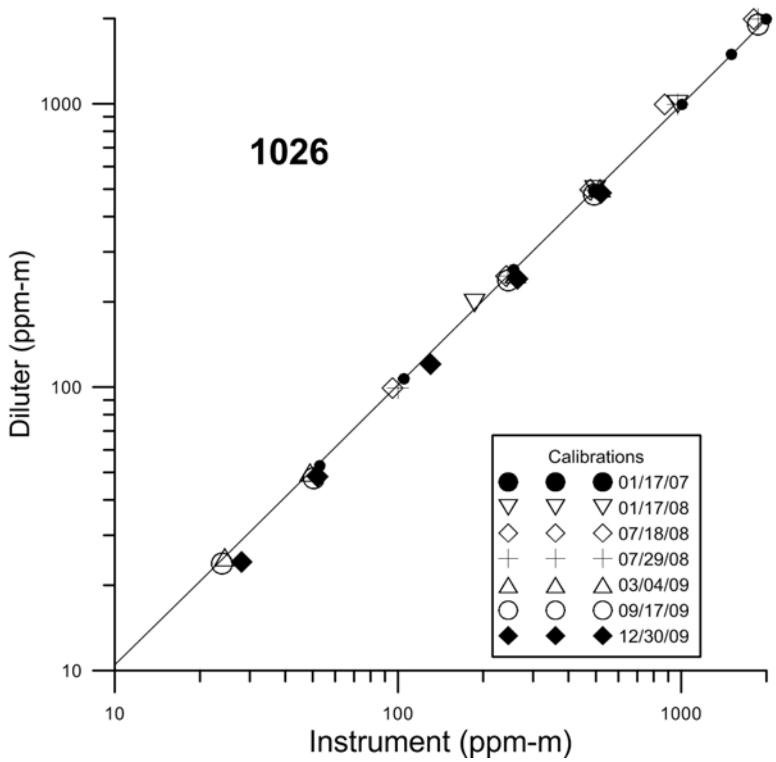


Figure 6.1-1: Multipoint calibrations of the GasFinder2 ™ s/n NH3OP-1026. The solid line is the 3rd order polynomial regressions for the chosen multipoint calibration.

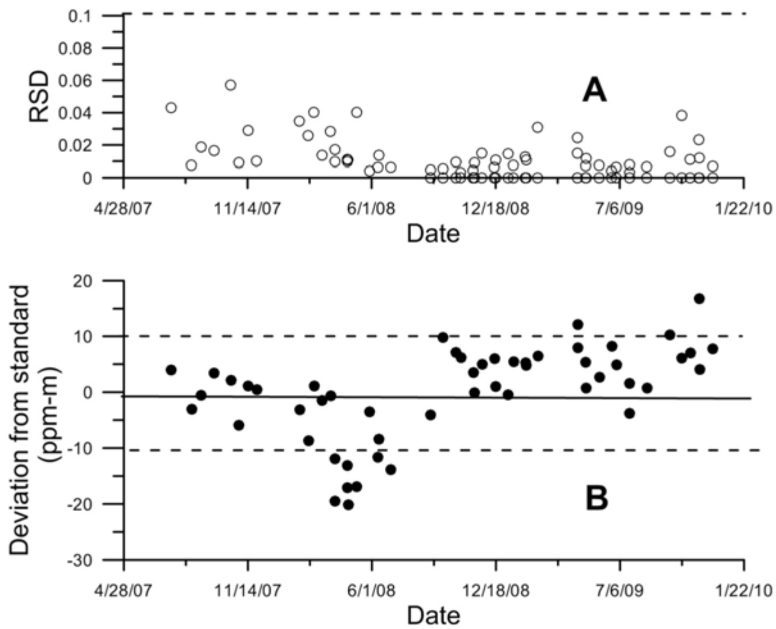


Figure 6.1-2: Control charts of the GasFinder2 ™ s/n NH3OP-1026

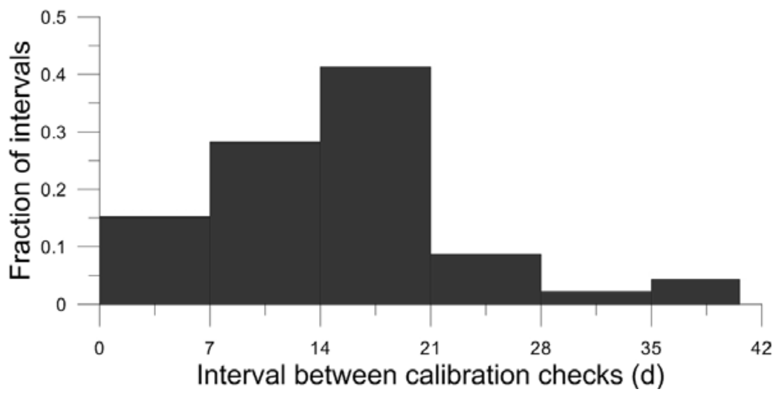


Figure 6.1-3: Calibration check intervals of the GasFinder2 ™ s/n NH3OP-1026

TDLAS 1028 was multipoint calibrated six times during the study (Figure 6.1-4). The response was non-linear and consequently a third-order polynomial was used to correct the instrument measurements for the instrument response. The multipoint 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:

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

where X was the instrument response. The response of the sensor was influenced by humidity until July, 21 2008 due to an error in the factory settings for the spectral waveband analysis window. At that time, factory personnel corrected the spectral waveband used for analysis. The effect of this error was to 1) reduce the maximum possible linear correlation with the internal reference cell resulting in unusually low 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 is 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 (3σ) 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 6.1-5) were made at the beginning and end of each measurement period. The majority of calibration checks were made within 21 days (Figure 6.1-6). The large fraction of checks made within 7 days was the result of calibration checks made at the end and beginning of sequential measurement periods. The standard deviation of the verifications about that predicted by the calibration equation was 6.46 ppm-m. The precision DQI was ±10% RSD at 100 ppm-m. All verifications resulted in less than 10% RSD for 50 ppm-m (Figure 6.1-5) 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 three dates (9/26/2008, 10/1/20008 and 9/24/2009) while negative biases exceeding the DQI occurred on 12/16/2008 (Figure 6.1-5). 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.

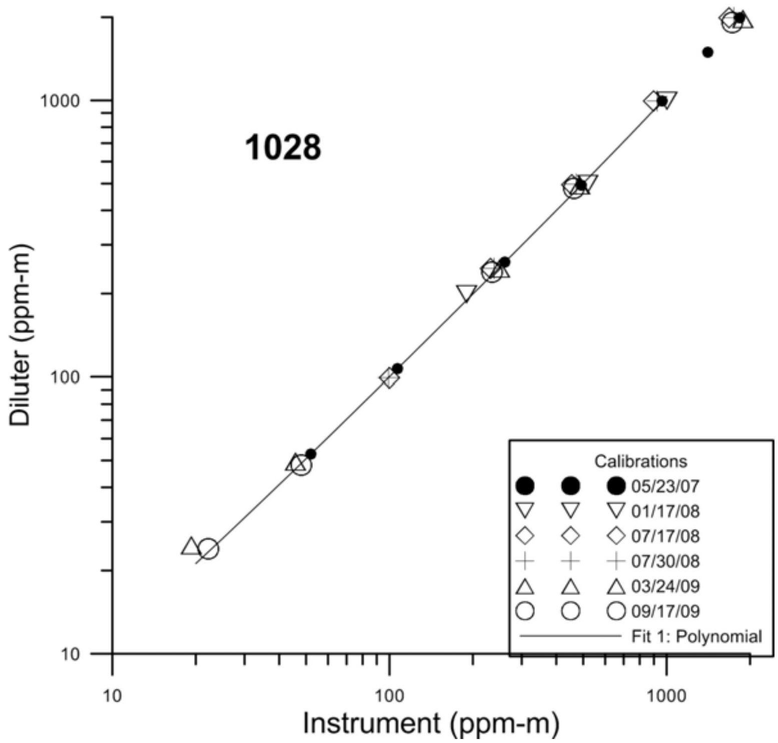


Figure 6.1-4: Multipoint calibrations of the GasFinder2 ™ s/n NH3OP-1028. The solid line is the 3rd order polynomial regression for the chosen multipoint calibration.

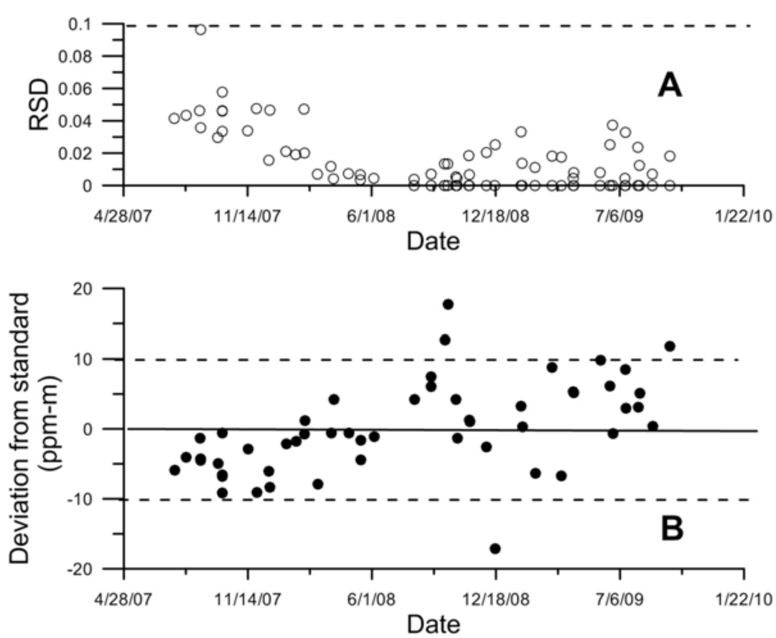


Figure 6.1-5: Control charts of the GasFinder2 ™ s/n NH3OP-1028

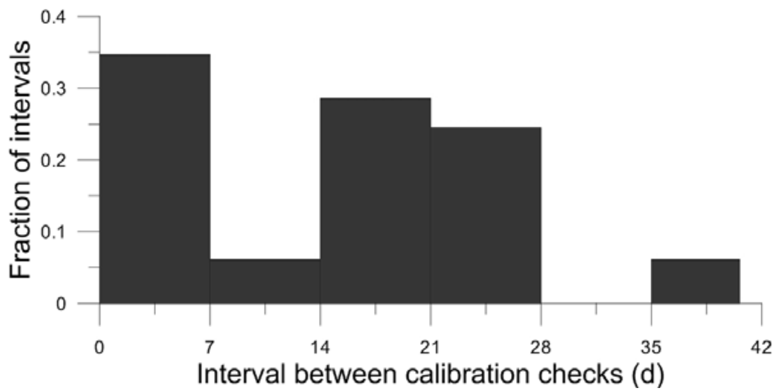


Figure 6.1-6: Calibration check intervals of the GasFinder2 ™ s/n NH3OP-1028

TDLAS 1030 was multipoint calibrated eight times during the study (Figure 6.1-7). The response was non-linear and consequently a third-order polynomial was used to correct the instrument measurements for the instrument response. The multipoint calibration on 3/26/2008 was used for the entire study period. The offset of the equation was determined from a least squares fit of the entire record of calibration verifications made at 50 ppm-m applied to the first, second, and third order terms derived from the multipoint calibration. The regression equation was

$$\text{ppm-m} = 0.13 + 0.9974 * X - 2.1056E\text{-}005 * X^2 + 3.050E\text{-}008 * X^3$$

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 (3σ) 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 6.1-8) were made at the beginning and end of each measurement period. The majority of calibration checks were made within 21 days (Figure 6.1-9). The large fraction of checks made within 7 days is 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 6.1-8) 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 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 6.1-8). 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.

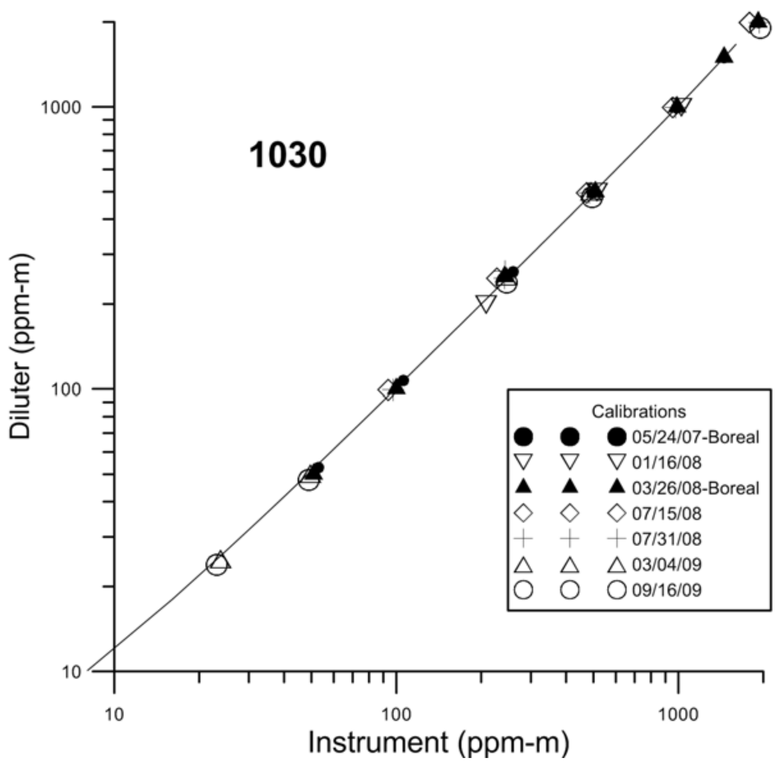


Figure 6.1-7: Multipoint calibrations of the GasFinder2 TM s/n NH3OP-1030. The solid line is the 3rd order polynomial regression for the chosen multipoint calibration.

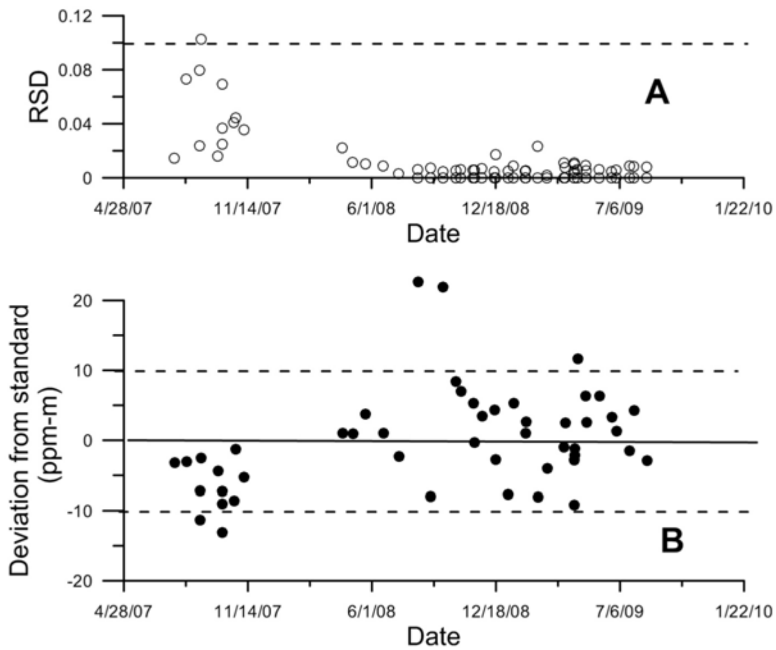


Figure 6.1-8: Control charts of the GasFinder2 ™ s/n NH3OP-1030

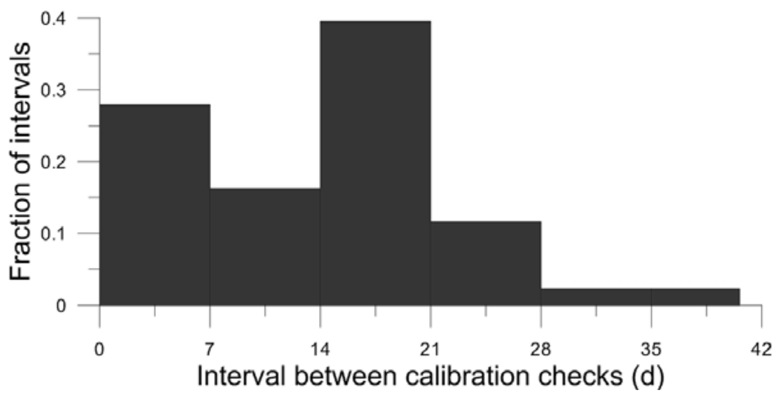


Figure 6.1-9: Calibration check intervals of the GasFinder2 ™ s/n NH3OP-1030

TDLAS 1031, was multipoint calibrated six times during the study (Figure 6.1-10). The response was non-linear and consequently a third-order polynomial was used to correct the instrument measurements for the instrument response. The multipoint 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 is 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 (3σ) 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 6.1-11) were made at the beginning and end of each measurement period. The majority of calibration checks were made within 21 days (Figure 6.1-12). The large fraction of checks made within 7 days 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 6.1-11) 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 6.1-11). Positive DQI bias exceedances occurred on 6/28/2007, 9/11/2008, 4/8/2009 and 8/12/2009. Verification failures in the 6/28/07 to 9/18/07 interval were a result of un-anticipated optical noise in the calibration procedure which was later corrected. The 4/8/2009 exceedance was preceded and followed by DQI-compliant verifications and the 8/12/2009 verification was preceded by a compliant verification and followed by a multipoint indicating no problem with instrument performance. The instrument was taken out of service between 9/11/2008 and 12/31/2008.

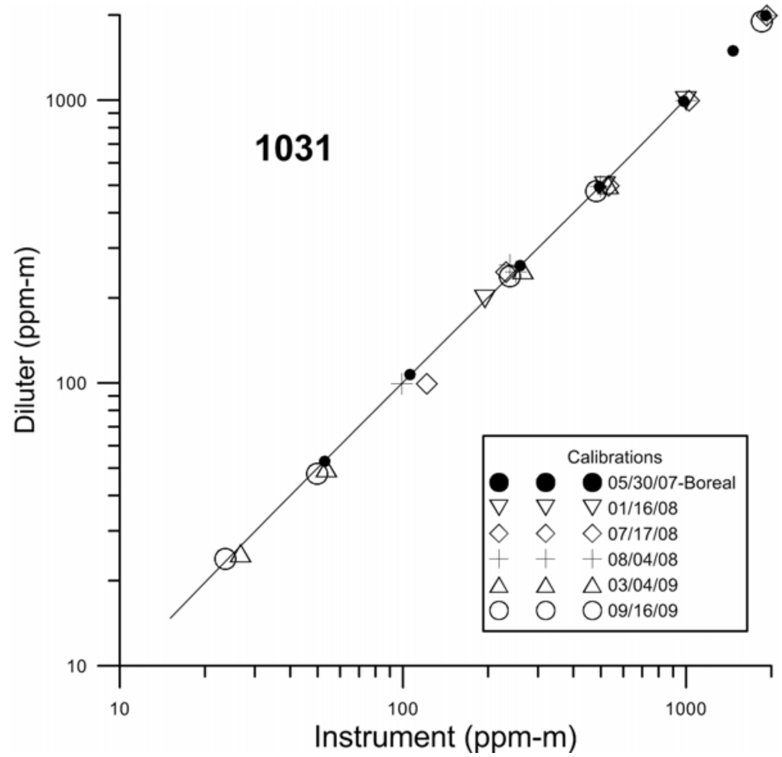


Figure 6.1-10: Multipoint calibrations of the GasFinder2™ s/n NH3OP-1031. The solid line is the 3rd order polynomial regression for the chosen multipoint calibration.

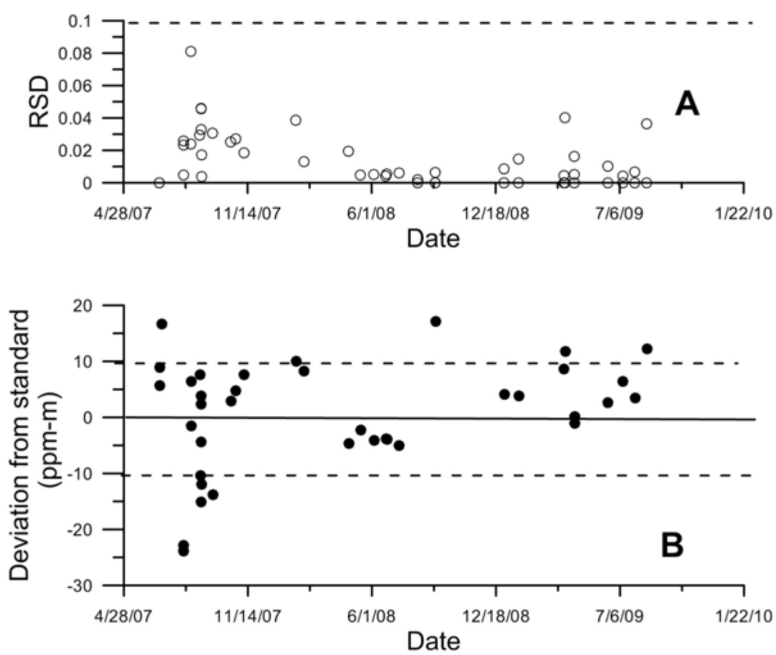


Figure 6.1-11: Control charts of the GasFinder2™ s/n NH3OP-1031

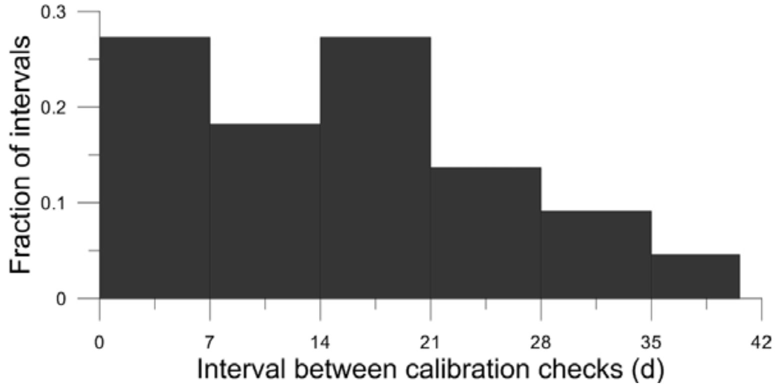


Figure 6.1-12: Calibration check intervals of the GasFinder2 ™ s/n NH3OP-1031

6.2 TEC 450i analyzer H_2S calibrations

The H_2S Analyzer (Model TEC 450i, Thermo Fisher Scientific, Franklin, MA) with serial number 0733825129 was multipoint calibrated seven times during the study (Figure 6.2-1). The coefficient of determination (r^2) for linear fits to the calibration values were never less than 0.999 although the slope of the linear regression equation varied from 0.67 to 0.94 (Table 6.2-1). The initial 12/30/07 multipoint calibration records were lost.

Table 6.2-1: Multipoint H_2S calibrations

Date	Slope (ppb/response)	Intercept (ppb)	r^2
7/21/08	0.67	0.0100	0.999
11/25/08	0.81	0.0070	0.999
3/5/09	0.94	0.0165	0.999
4/23/09	0.73	0.0263	0.999
4/29/09	0.78	0.0206	0.999
9/1/09	0.75	0.0054	0.999
12/29/09	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 (Figures 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 days was the result of calibration checks made at the end and beginning of sequential measurement periods. Instrument response was converted into measured concentrations by multiplying the instrument response by the long-term mean ratio of diluted calibration gas by instrument reading. The long-term mean ratio for this instrument was 0.800. 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 the 450i converter was consequently 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 signals 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 8/28/2009 through 8/31/2009. Calibration certification before and after this date were valid.

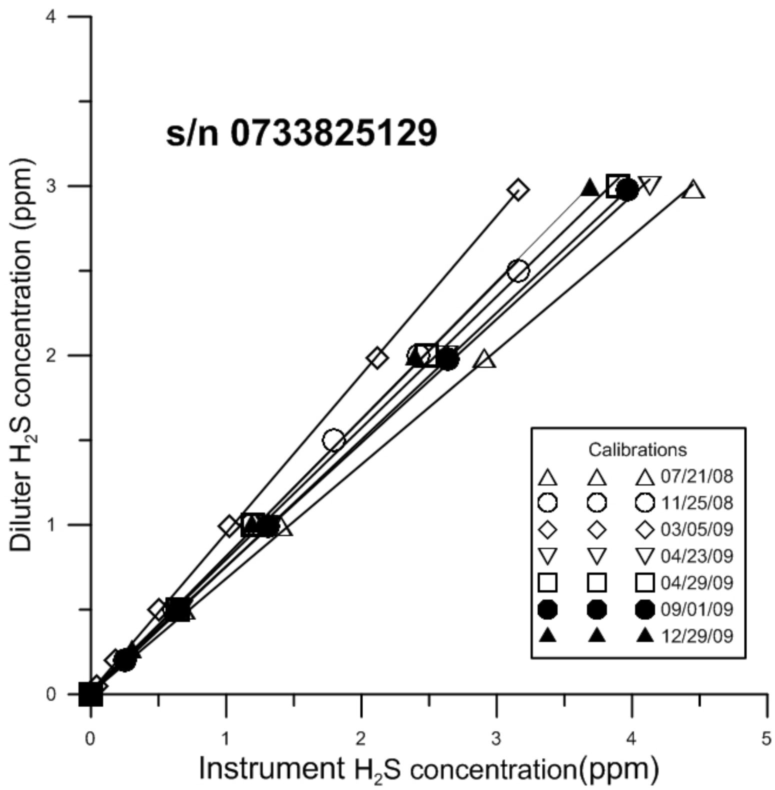


Figure 6.2-1: Multipoint calibrations of the 450i SO_2/H_2S Analyzer

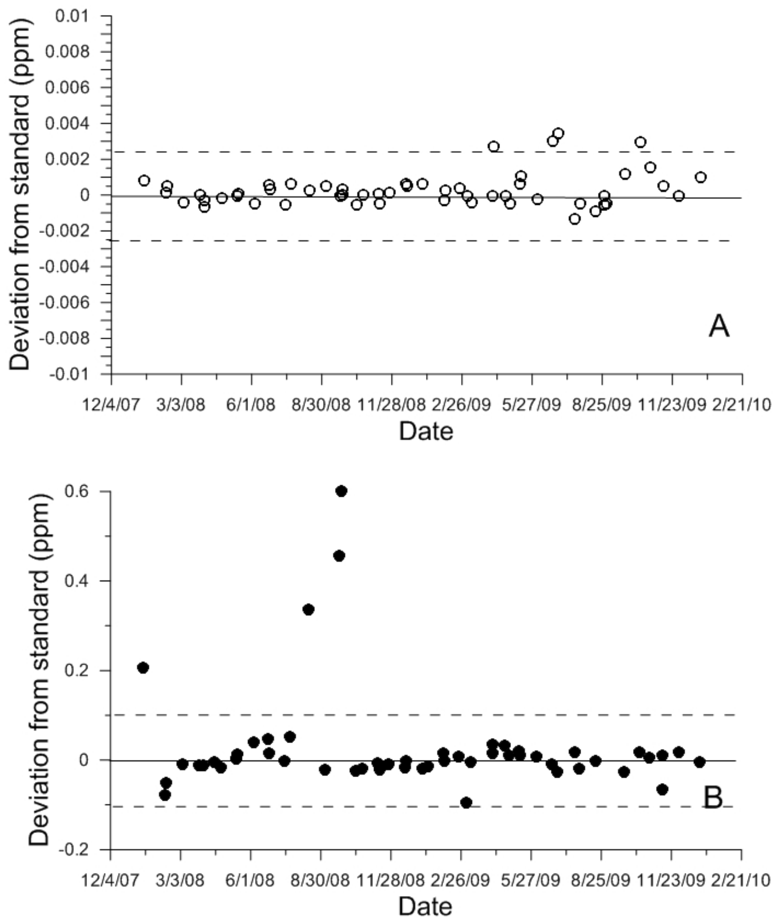


Figure 6.2-2: Instrument Control Charts

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).

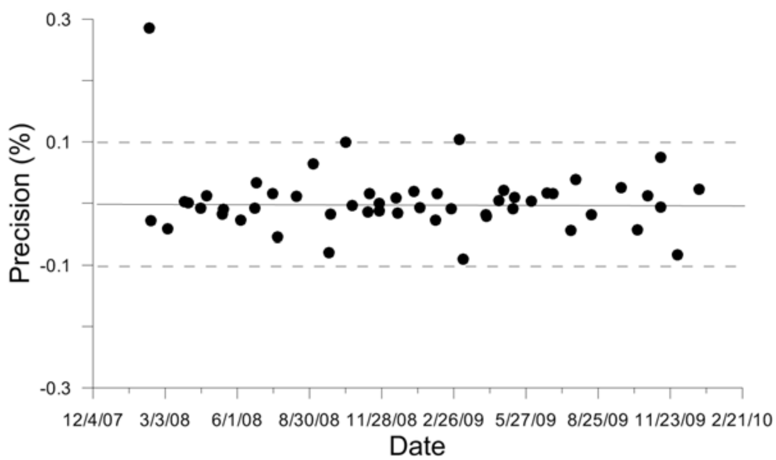


Figure 6.2-3: Instrument Precision

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).

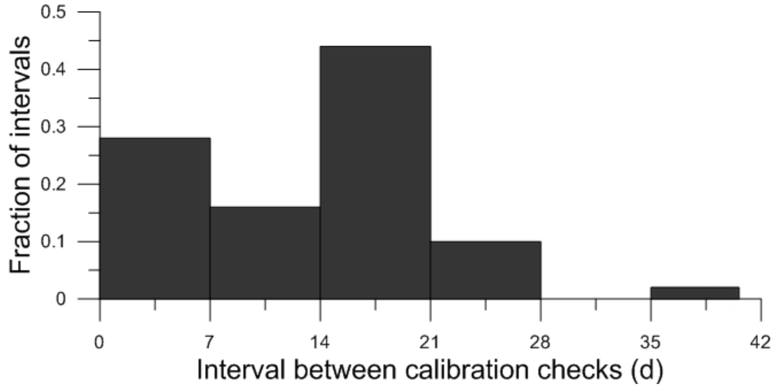


Figure 6.2-4: Calibration check intervals

6.3 Sonic anemometer calibrations

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

The sonic 1926 was inter-compared with three reference anemometers of identical design five times during the study (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 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 days (Figure 6.1-2). The large fraction of checks made within 7 days 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 6.3-1B). 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 6.3-1A). Records of the zero checks made before 12/2007 were recorded as pass/fail such that the actual measurements were not indicated. The instrument always passed this DQI.

Table 6.3-1 Standards inter-comparisons

Calibration dates		Mean difference from reference anemometers (ms^{-1})	
Alignment 1	**Alignment 2**	**Alignment 1**	**Alignment 2**
6/19-22/07	6/29-7/2/07	-0.005	-0.033
1/17-18/08	1/20-21/08	-0.013	-0.032
7/16-17/08	7/17-18/08	+0.037	+0.059
3/6-7/09	3/7-9/09	+0.004	+0.048
9/16-17/09	9/17-18/09	+0.059	+0.001

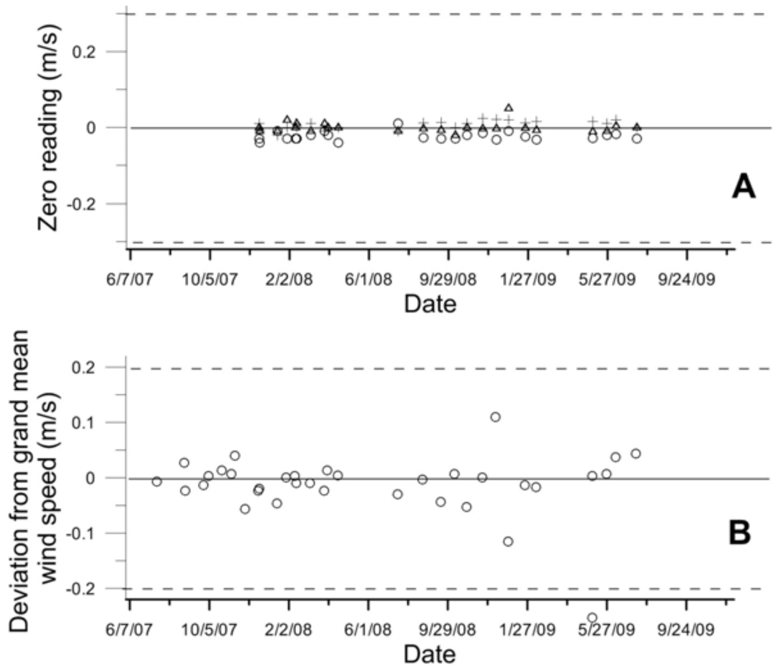


Figure 6.3-1: On-site quality assurance of the 1926 sonic. The DQI for the zero and inter-comparisons are indicated by the dashed lines. The zero check in the x (open circle), y (open triangle) and z (cross) components are indicated in panel A.

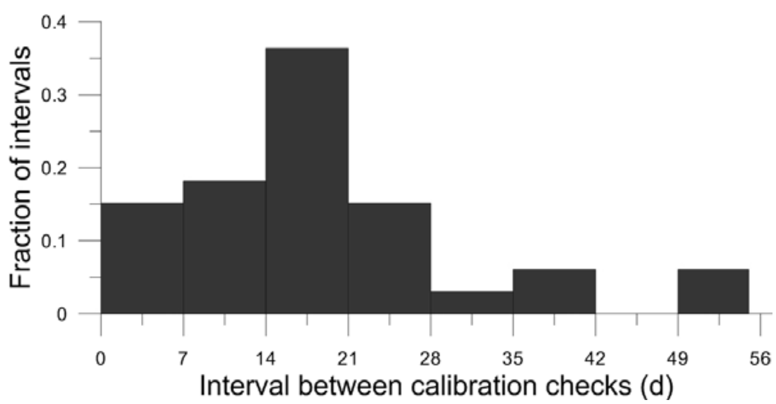


Figure 6.3-2: Inter-comparison check intervals the 1926 sonic.

The sonic 1933 was inter-compared with three reference anemometers of identical design three times during the study (Table 6.3-2). This instrument was used as a reference prior to use in the on-site measurements beginning 4/23/08. 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 6.3-3). The majority of calibration

checks were made within 21 days (Figure 6.3-4). The large fraction of checks made within 7 days 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 6.3-1B). This instrument passed this check on all checks except 7/21/2009 and was taken out of service. The last standard 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 6.3-3A). Records of the zero checks made before 12/2007 were recorded as pass/fail such that the actual measurements were not indicated. The instrument always passed this DQI.

Table 6.3-2: Standards inter-comparisons

Calibration dates		Mean difference from reference anemometers (ms^{-1})	
Alignment 1	**Alignment 2**	**Alignment 1**	**Alignment 2**
7/18-19/08	7/21-22/08	+0.012	+0.014
3/3-5/09	3/5-6/09	-0.016	-0.004
1/7-9/10	1/23-25/10	-3.733	-3.93

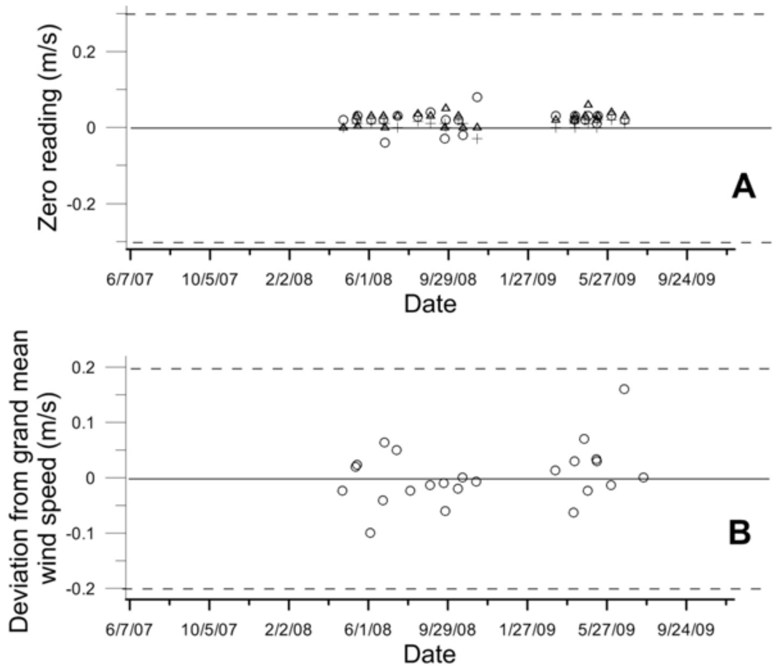


Figure 6.3-3: On-site quality assurance of the 1933 sonic. The DQI for the zero and inter-comparisons are indicated by the dashed lines. The zero check in the x (open circle), y (open triangle) and z (cross) components are indicated in panel A.

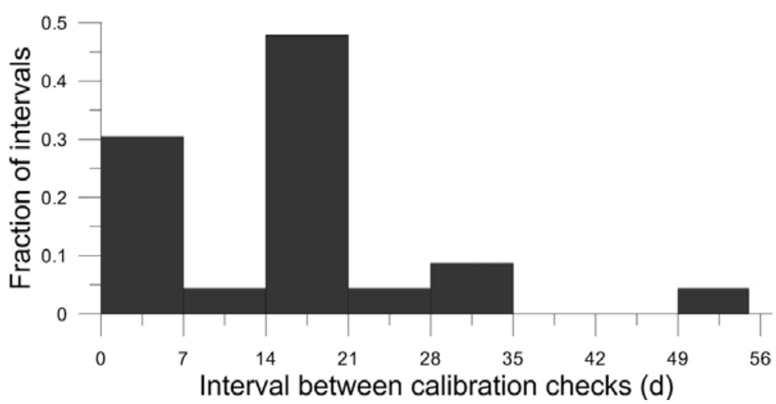


Figure 6.3-4: Inter-comparison check intervals for the 1933 sonic.

The sonic 1920 was inter-compared with three reference anemometers of identical design five times during the study (Table 6.3-3). No absolute turbulence calibration was possible with this instrument. To assure proper performance and comparability in the wind measurements, the anemometer was inter-compared on-site with those used during a given measurement period at the beginning and end of a measurement period. This instrument was inter-compared with the co-located anemometer sensors on site 51 times (Figure 6.3-5). The majority of calibration

checks were made within 21 days (Figure 6.3-6). The large fraction of checks made within 7 days was the result of calibration checks made at the end and beginning of sequential measurement periods.

The accuracy DQI for the on-site inter-comparisons required the individual instruments to have the mean wind speed within 0.2 ms^{-1} of the grand mean value of the three (or four) on-site instruments (Figure 6.3-5B). This instrument passed this check 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 6.3-5A). Records of the zero checks made before 12/2007 were recorded as pass/fail such that the actual measurements were not indicated. The instrument always passed this DQI.

Table 6.3-3: Standards inter-comparisons

Calibration dates		**Mean difference from reference anemometers (ms^{-1})**	
Alignment 1	**Alignment 2**	**Alignment 1**	**Alignment 2**
6/19-22/07	6/29-7/2/07	+0.001	+0.002
1/17-19/08	1/20-21/08	+0.045	+0.003
7/18-21/08	7/21-22/08	+0.017	-0.006
3/23-25/09	3/25-27/09	-0.036	-0.033
9/1-2/09	9/2-3/09	-0.046	-0.025

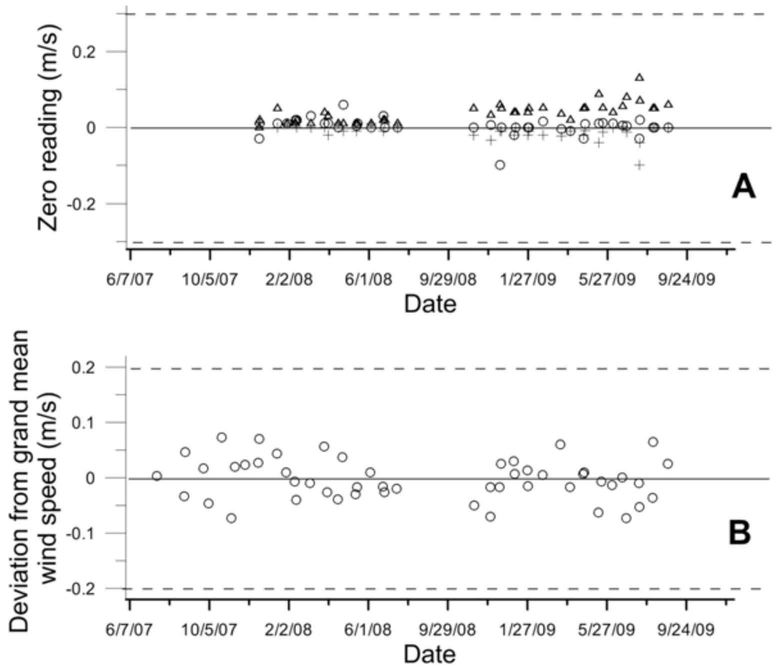


Figure 6.3-5: On-site quality assurance of the 1920 sonic. The DQI for the zero and inter-comparisons are indicated by the dashed lines. The zero check in the x (open circle), y (open triangle) and z (cross) components are indicated in panel A.

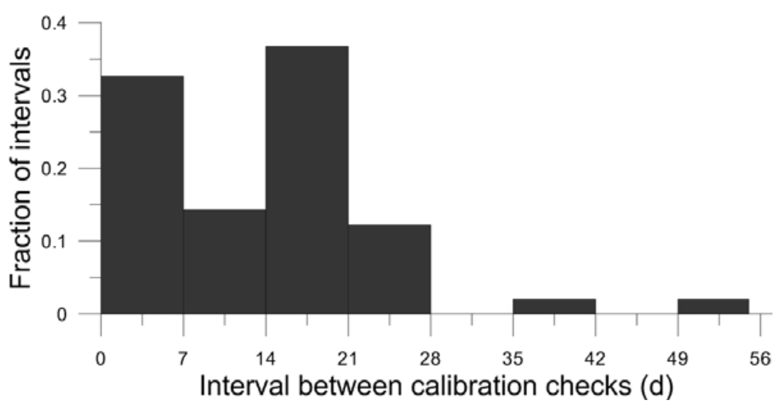


Figure 6.3-6: Inter-comparison check intervals for the 1920 sonic.

The 1928 sonic was inter-compared with three reference anemometers of identical design six times during the study (Table 6.3-4). No absolute turbulence calibration was possible with this instrument. To assure proper performance and comparability in the wind measurements, the anemometer was inter-compared on-site with those used during a given measurement period at the beginning and end of a measurement period. This instrument was inter-compared with the co-located anemometer sensors on site 48 times (Figure 6.3-7). The majority of calibration

checks were made within 21 days (Figure 6.3-8). The large fraction of checks made within 7 days 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 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 6.3-7A). Records of the zero checks made before 12/2007 were recorded as pass/fail such that the actual measurements were not indicated. The instrument always passed this DQI.

Table 6.3-4: Standards inter-comparisons

Calibration dates		Mean difference from reference anemometers (ms^{-1})	
Alignment 1	**Alignment 2**	**Alignment 1**	**Alignment 2**
6/15-18//07	6/18-19/07	+0.004	+0.019
12/27-28/07	12/29-31/07	+0.003	-0.005
7/10-11/08	7/11-14/08	+0.022	+0.007
3/3-4/09	3/5-6/09	+0.070	-0.027
9/16-17/09	9/17-18/09	+0.056	+0.022
12/18-19/09	12/21-23/09	+0.094	-0.077

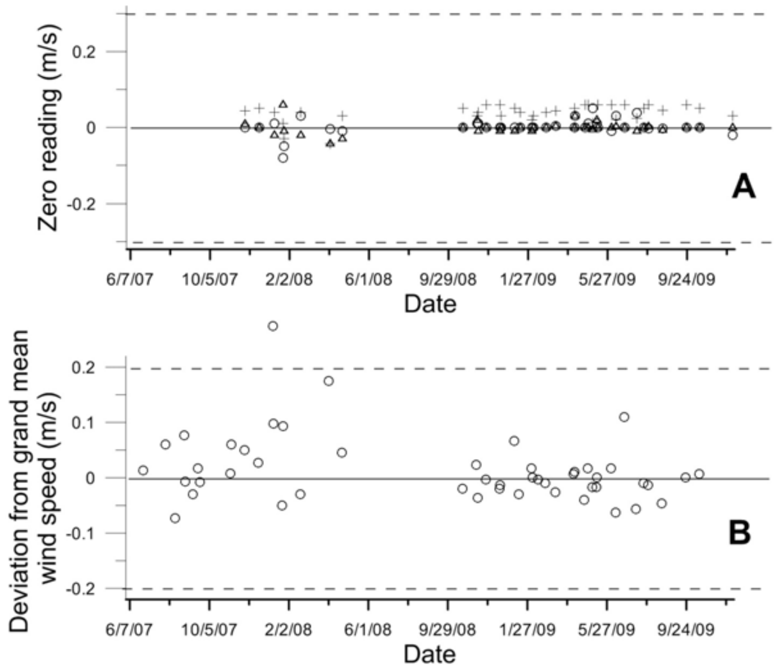


Figure 6.3-7: On-site quality assurance of the 1928 sonic. The DQI for the zero and inter-comparisons are indicated by the dashed lines. The zero check in the x (open circle), y (open triangle) and z (cross) components are indicated in panel A.

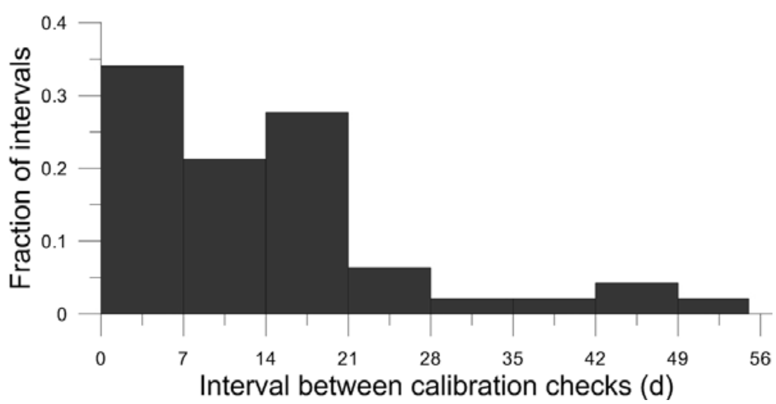


Figure 6.3-8: Inter-comparison check intervals for the 1928 sonic.

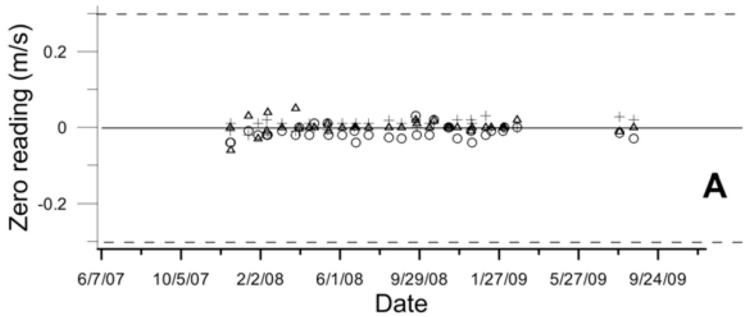
The sonic 1945 was inter-compared with three reference anemometers of identical design five times during the study (Table 6.3-5). No absolute turbulence calibration was possible with this instrument. To assure proper performance and comparability in the wind measurements, the anemometer was inter-compared on-site with those used during a given measurement period at the beginning and end of a measurement period. This instrument was inter-compared with the co-located anemometer sensors on site 45 times (Figure 6.3-9). The majority of calibration checks were made within 21 days (Figure 6.3-10). The large fraction of checks made within 7 days is the result of calibration checks made at the end and beginning of sequential measurement periods.

The accuracy DQI for the on-site inter-comparisons required the individual instruments to have the mean wind speed within 0.2 ms^{-1} of the grand mean value of the three (or four) on-site instruments (Figure 6.3-9B). 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 6.3-9A). 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: Standards inter-comparisons

Calibration dates		Mean difference from reference anemometers (ms^{-1})	
Alignment 1	**Alignment 2**	**Alignment 1**	**Alignment 2**
6/19-22/07	6/27-7/2/07	+0.001	-0.051
1/17-19/08	1/20-21/08	-0.023	-0.037
7/18-21/08	7/21-22/08	+0.023	+0.026
3/3-4/09	3/5-6/09	+0.014	+0.171
9/16-17/09	9/17-18/09	+0.028	-0.012



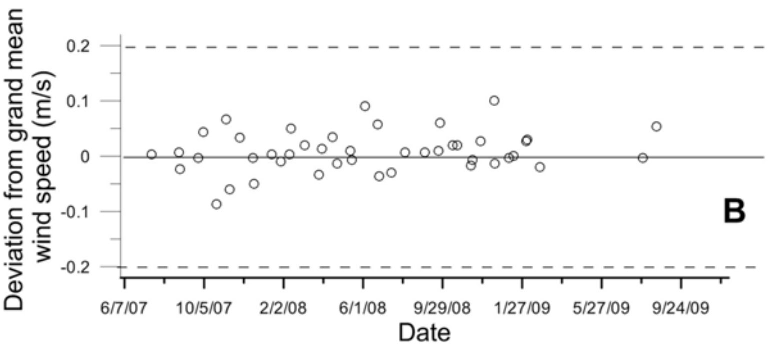


Figure 6.3-9: On-site quality assurance of the 1945 sonic. The DQI for the zero and inter-comparisons are indicated by the dashed lines. The zero check in the x (open circle), y (open triangle) and z (cross) components are indicated in panel A.

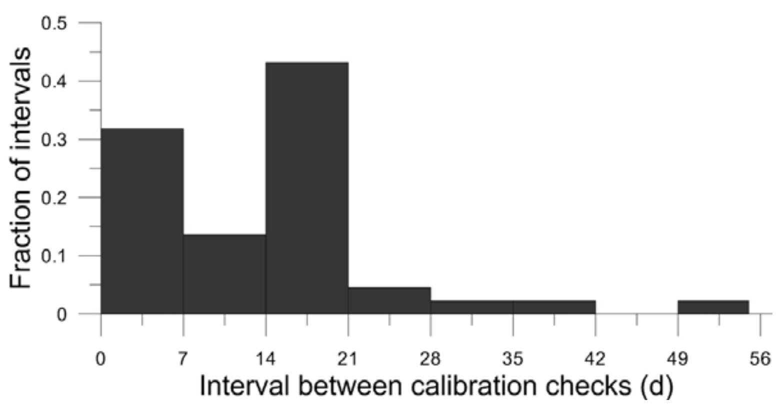


Figure 6.3-10: Inter-comparison check intervals for the 1945 sonic.

The sonic 1932 was inter-compared with three reference anemometers of identical design six times during the study (Table 6.3-6). No absolute turbulence calibration was possible with this instrument. To assure proper performance and comparability in the wind measurements, the anemometer was inter-compared on-site with those used during a given measurement period at the beginning and end of a measurement period. This instrument was inter-compared with the co-located anemometer sensors on site 55 times (Figure 6.3-11). The majority of calibration

checks were made within 21 days (Figure 6.3-12). The large fraction of checks made within 7 days 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 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 6.3-11B). 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**
6/15-17/07	6/18-19/07	+0.004	+0.160
12/27-28/07	12/29-31/07	+0.014	-0.009
7/10-11/08	7/11-14/08	+0.008	+0.031
3/3-5/09	3/5-6/09	-0.024	-0.005
9/8-14/09	9/15-16/09	-0.025	-0.044
1/7-9/10	1/23-24/10	+0.020	-0.016

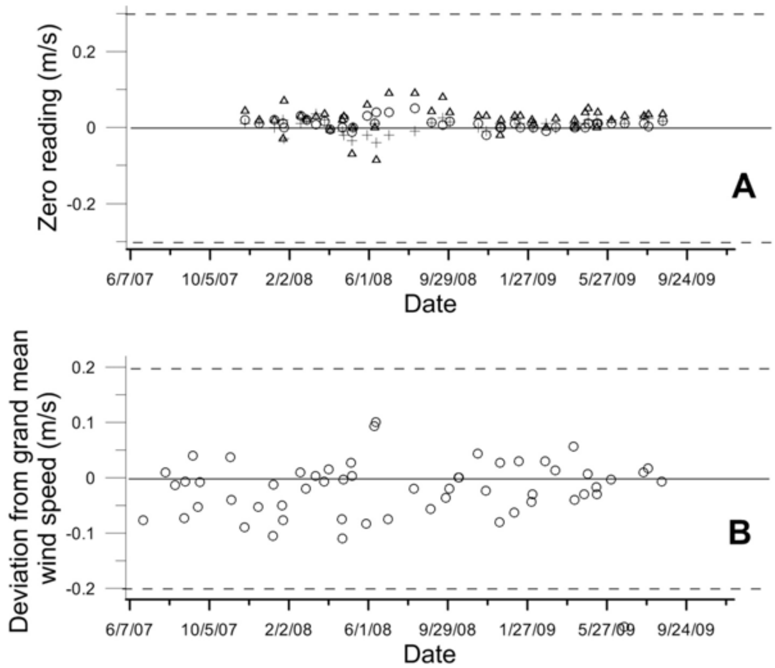


Figure 6.3-11: On-site quality assurance of the 1932 sonic. The DQI for the zero and inter-comparisons are indicated by the dashed lines. The zero check in the x (open circle), y (open triangle) and z (cross) components are indicated in panel A.

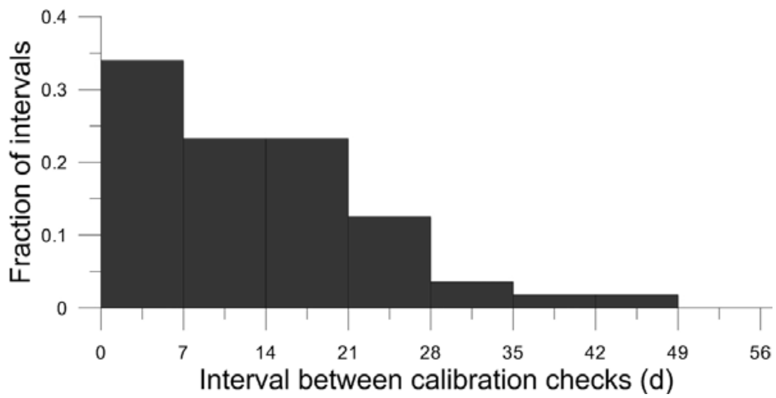


Figure 6.3-12: Inter-comparison check intervals for the 1932 sonic.

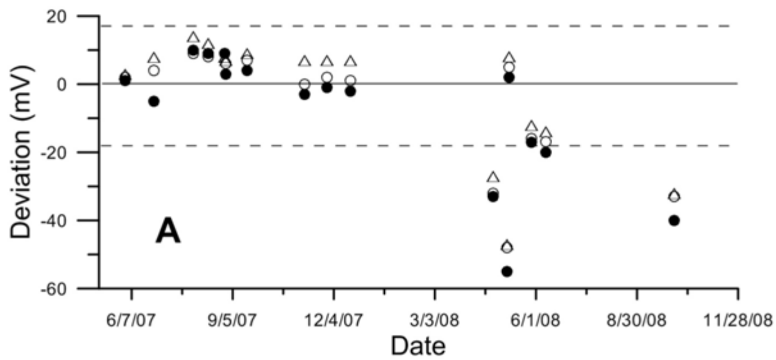
6.4 pH probe calibrations

Two pH probes (Model CSIMM-ph, Innovative Sensors Inc., Anaheim, California) were used at this location: serial numbers 002 and 004.

Probe 002, was used between 6/27/2007 and 10/2/2008. The probe was calibrated 16 times. The pH probe DQI specified an accuracy of ± 0.3 pH units, corresponding to a difference between the calculated and measured pH of 17.7 mV of signal. Figure 6.4-1A illustrates the control chart for the three pH standards used (pH 4, 7, and 10) relative to the mV error. Each sensor was also checked for stability using QCCS solution, with the requirement that the sensor be within 0.05 pH units, or 3 mV. The history of the probe stability check is illustrated in Figure 6.4-1B. Problems with freezing of the electrolyte in the reference electrode during the winter reduced the frequency of these checks. The accuracy check exceeded the DQI on 4/24/2008, 5/6/2008, and 10/2/2008. The DQI exceedances on 4/24/2008 and 5/6/08 were followed with a valid accuracy check without sensor modification or repair so it is assumed that the checks failed due to inadequate probe cleaning. The accuracy check failure on 10/2/2008 was a result of probe failure. The stability check failed on 11/28/2007, 12/19/2007, 6/10/2008, and 10/2/2008. The failed stability checks on 11/28/2007 and 12/19/2007 did not correspond with accuracy check failures and were assumed to be operator error. The stability check on 6/10/2008 was indicative of the probe failure noted in the following accuracy check.

Probe 004, was used between 7/8/2007 and 2/3/2009. The probe was calibrated 27 times. The pH probe DQI specified an accuracy of ± 0.3 pH units, corresponding to a difference between the calculated and measured pH of 17.7 mV of signal. Figure 6.4-2A illustrates the control chart for the three pH standards used (pH 4, 7, and 10) relative to the mV error. Each sensor was also checked for stability using QCCS solution, with the requirement that the sensor be within 0.05 pH units, or 3 mV. The history of the probe stability check is illustrated in Figure 6.4-2B. Problems with freezing of the electrolyte in the reference electrode during the winter reduced the frequency of these checks. The 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.

In general, the probe calibrations were conducted at the beginning and end of each measurement period. Since freezing conditions damage the probe, 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 such that locations that did not have lagoon pH measurements were visited between locations where the measurements were made.



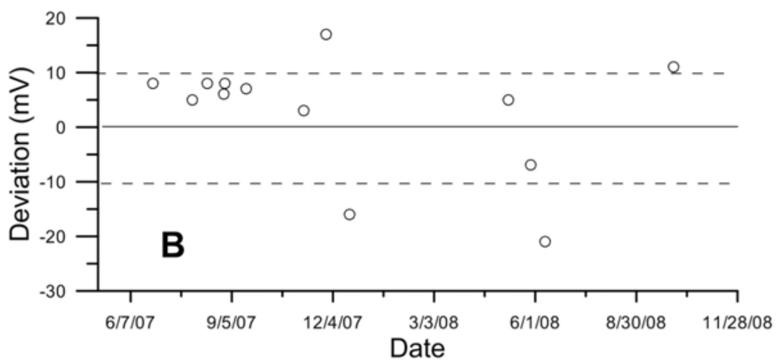
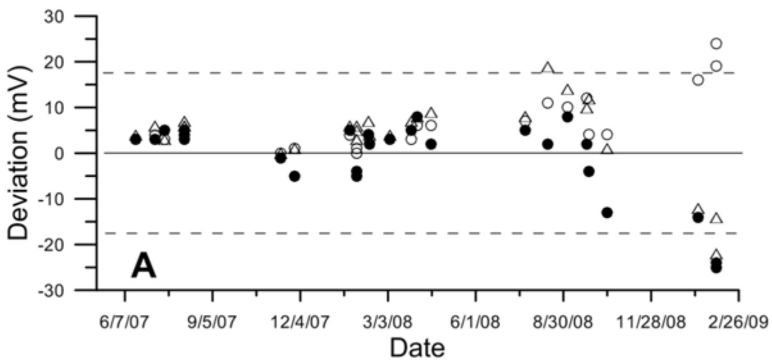


Figure 6.4-1: Accuracy and stability calibration checks of pH probe 002. The absolute deviation in mV of the pH 4 (closed circle), pH 7 (open circle), and pH 10 (solid triangle) tests are indicated in panel A. The dashed lines define the DQI limits. The time history of the absolute stability is indicated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



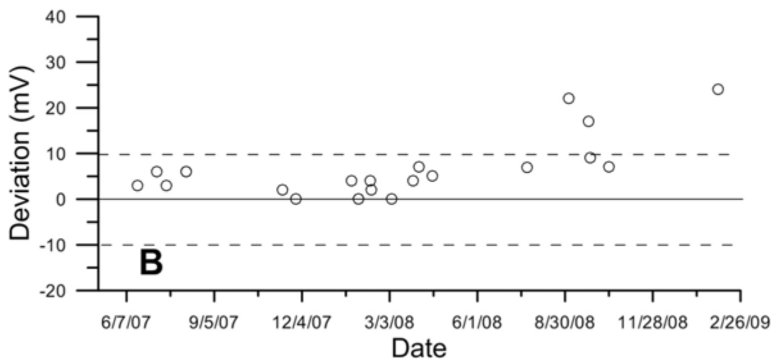


Figure 6.4-2: Accuracy and stability calibration checks of pH probe 004. The absolute deviation in mV of the pH 4 (closed circle), pH 7 (open circle), and pH 10 (solid triangle) tests are indicated in panel A. The dashed lines define the DQI limits. The time history of the absolute stability is indicated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

6.5 ORP probe calibrations

Two oxidation-reduction potential (ORP) probes (Model CSIM11-ORP, Innovative Sensors Inc., Anaheim, California) were used at this location: serial numbers 020 and 040.

Probe 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.

Probe 040 was used between 7/18/2007 and 4/7/2008. The probe was calibrated six 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 check DQI and the stability check indicated excellent probe stability.

In general, the probe calibrations were conducted at the beginning and end of each measurement period. Since freezing conditions damage the probe, 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.

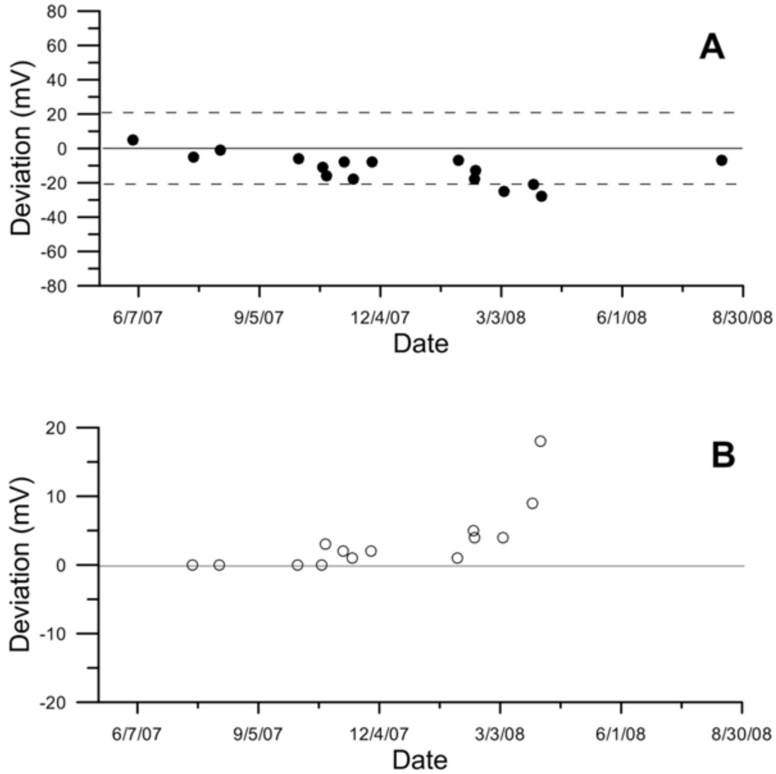


Figure 6.5-1: Accuracy and stability calibration checks of ORP probe 020. The stability check of the probe (Panel B) and the absolute deviation in mV of the probe (panel A) are indicated. The dashed lines define the DQI limits in panel A.

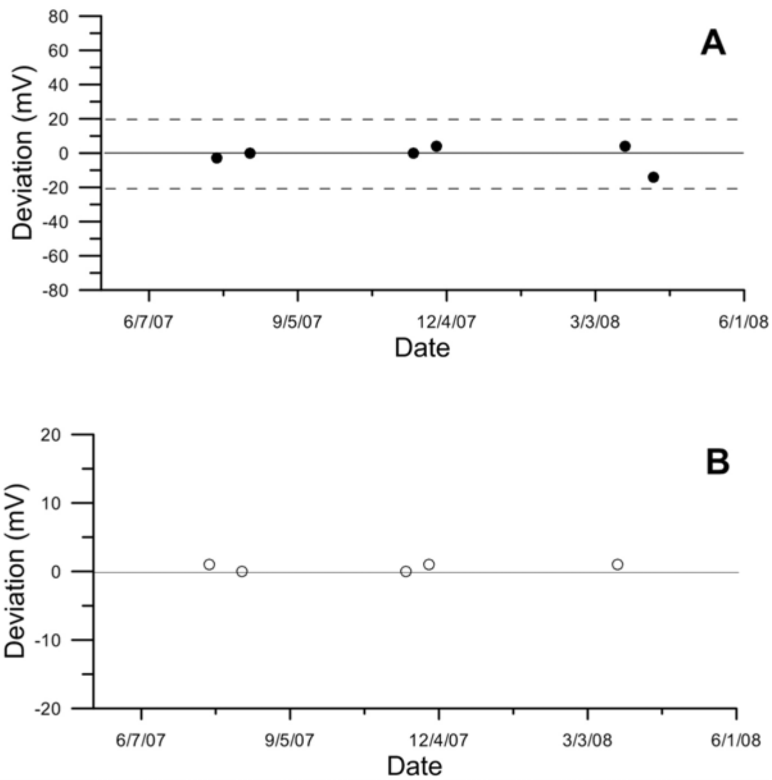


Figure 6.5-2: Accuracy and stability calibration checks of ORP probe 040. The stability check of the probe (Panel B) and the absolute deviation in mV of the probe (panel A) are indicated. The dashed lines define the DQI limits in panel A.

6.6 S-OPS operational checks

The Synthetic Open Path Systems (S-OPS; s/n 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 of 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 H_2S analyzer. In all cases flow available to the analyzer greatly exceeded that used by the analyzer (1.5 L min^{-1}) (Table 6.6-1).

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

Date	Site	GSS solenoid	GSS mass Flow (L min^{-1})	GSS pressure (kPa)	GSS check result	S-OPS max flow (L min^{-1})	S-OPS mass flow (L min^{-1})	S-OPS pressure (kPa)	S-OPS check result
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
4/24/08	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
5/13/08	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
5/15/08	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
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

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
6/25/2008	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
		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

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
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**
3/26/08	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**
3/26/08	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

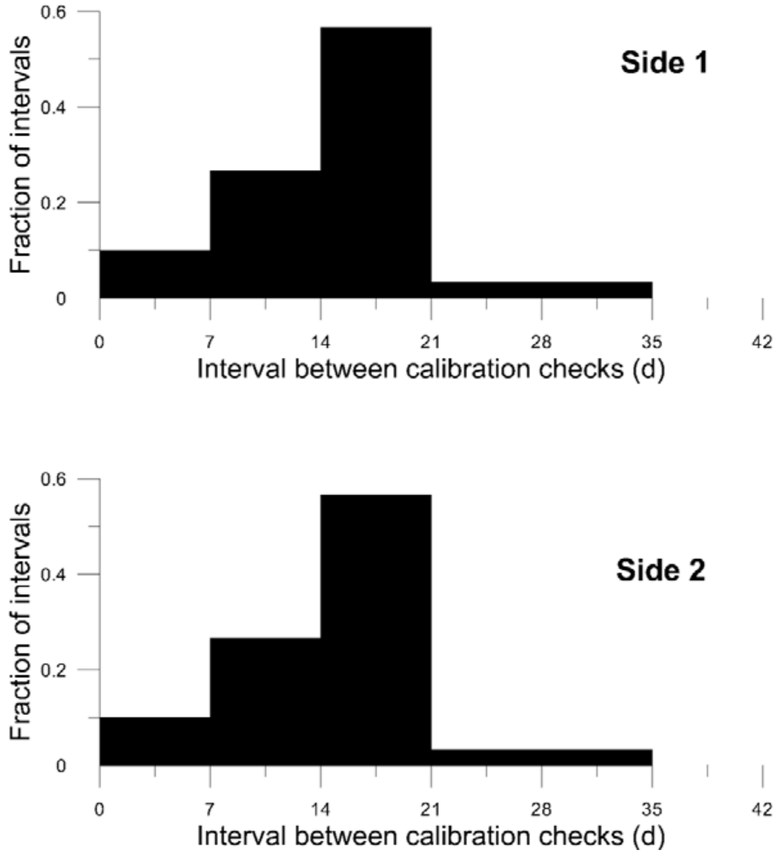


Figure 6.6-1: Intervals between checks

6.7 Miscellaneous meteorological and lagoon calibrations

6.7.1 Air temperature/humidity

The Vaisala HMP45C 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 checks are documented in Table 6.7-1.

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

Relative Humidity (RH)					
Calibration Dates	**Temperature (°C)**	**Expected RH (%)**	**Deviation from expected RH (%)**	**Average deviation RH (%)**	**Action**
3/8/2010	24.7	25	1.9		Accept
3/8/2010	24.7	50	1.4		Accept
3/8/2010	24.7	95	2.3		Accept
3/8/2010				1.9	Accept
3/6/2010	N/A	40	1.2	1.2	Accept
8/1/2008	27.8	11	-0.7		Accept
8/1/2008	27.5	51	2.5		Accept
8/1/2008	27.8	96	8.6		Accept
8/1/2008				3.1	Accept
Temperature (T)					
Calibration Dates	**Expected T (°C)**	**Measured T (°C)**	**Deviation 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.) with serial number 3033740 was used to measure barometric pressure. Calibration of this sensor was conducted at least annually. Initial calibrations were conducted by the factory. The record of calibration checks are documented in Table 6.7-2.

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

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

6.7.3 Solar radiation

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

Table 6.7-3: Calibration record of LiCOR 200SB Pyranometer s/n PY554448

Calibration Dates	Mean difference from reference (Wm^{-2})	Mean difference from reference (%)	Action
3/5-3/8 2010	-3.8	0.71	Pass
8/30/2006	—	—	Pass (factory calibration)

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. Three thermistor probes were used at this location: serial numbers 0030, 005, and 006. The record of calibration checks are documented in Table 6.7-4 and Table 6.7-5.

Table 6.7-4: Calibration record of Thermistor CSI 107-L s/n III

Calibration Date	Expected value (°C)	Difference from expected (°C)	Action
2/15/2010	1.0	18	Replace
9/14/2009	0.0	0.0	Accept
3/6/2009	0.0	0.0	Accept

Table 6.7-5: Calibration record of Thermistor CSI 107-L s/n 0010 (9999)

Calibration Date	Expected value (°C)	Difference from expected (°C)	Action
1/25/2008	0	-0.1	Accept
6/18/2007	25	0.1	Accept
6/18/2007	25	0.2	Accept
6/18/2007	24	0.4	Accept

6.7.5 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 6.7-6 and Table 6.7-7.

Table 6.7-6: Calibration record of Campbell Scientific CR1000 data logger, s/n 7886 (7675)

SE Channel	Input (mV)	Tolerance SE|DE (mV)	Measured mV mean value	Error (mV)	Measured (mV)	Error (mV)
Factory calibration						
Calibration date: 1/18/2007			**Single-ended**		**Differential**	
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**	
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	—	—

SE Channel	Input (mV)	Tolerance SE|DE (mV)	Measured mV mean value	Error (mV)	Measured (mV)	Error (mV)
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**	
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**	
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 6.7-7: 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)	Tolerance SE | DE (mV)	Measured (mV)	Error (mV)	Measured (mV)	Error (mV)
1	0	± 2.06 | 1.06	0	0		
2	0	± 2.06 | 1.06	0	0	0	0
3	0	± 2.06 | 1.06	0	0		
4	0	± 2.06 | 1.06	0	0		
5	0	± 2.06 | 1.06	0	0	0	0
6	0	± 2.06 | 1.06	0	0	0	0
7	0	± 2.06 | 1.06	0	0	0	0
8	0	± 2.06 | 1.06	0	0	0	0
9	0	± 2.06 | 1.06	0	0		
10	0	± 2.06 | 1.06	0	0		
11	0	± 2.06 | 1.06	0	0		
12	0	± 2.06 | 1.06	0	0		
13	0	± 2.06 | 1.06	0	0		
14	0	± 2.06 | 1.06	0	0		
15	0	± 2.06 | 1.06	0	0		
16	0	± 2.06 | 1.06	0	0		

6.7.6 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 checks of this unit were conducted only at end of the study. Initial calibrations were conducted by the factory. The record of calibration checks are documented in Table 6.7-8.

Table 6.7-8: Calibration record of Campbell Scientific CR800 data logger, s/n 3697

Calibration Date: 3/8/2010			**Single-Ended**	
Channel	**Input (mV)**	**Tolerance SE (mV)**	**Measured (mV)**	**Error (mV)**
1	100	± 2.061	99.3	0.7
2	100	± 2.061	99.3	0.7
3	100	± 2.061	99.3	0.7
4	100	± 2.061	99.3	0.7
5	100	± 2.061	99.3	0.7
6	100	± 2.061	99.3	0.7
Calibration Date: 3/8/2010			**Single-Ended**	
Channel	**Input (mV)**	**Tolerance SE (mV)**	**Measured (mV)**	**Error (mV)**
1	0	± 2.061	0.0	0
2	0	± 2.061	0.0	0
3	0	± 2.061	0.0	0
4	0	± 2.061	0.0	0
5	0	± 2.061	0.0	0
6	0	± 2.06	0.0	0

6.8 Site activity

Time HHMM UTC	Date MM/DD/YYYY	Activity (Setup, Takedown, Calibration, Repair, Remote)	Event
23:00-23:10	6/27/2007	Calibration	Zero Calibration on sonic anemometers; all pass.
	7/17/2007	Setup	Tower height measurements taken
22:20-23:20	7/17/2007	Setup	Sonic inter-comparison: Sensor 1: 1.32 ms^{-1} Sensor 2: 1.35 ms^{-1} Sensor 3: 1.36 ms^{-1}. Sensors 1 and 3 were reversed from their positions on the tower. They were simply plugged into each others' modem/ power supply box.
	7/18/2007	Setup	pH sensor 001: Calibration and Acceptance done; QA good
	7/18/2007	Setup	pH sensor 004: Calibration and Acceptance done; QA good
	7/18/2007	Setup	ORP sensor 020: Calibration and Acceptance done
	7/18/2007	Setup	ORP sensor 040: Calibration and Acceptance done
13:45-14:21	7/18/2007	Setup	Zero Calibration on sonic anemometers; all pass. Black box used for sensor 1. Plastic bags used for sensors 2 and 3 (on tower). Different time used for sensor 2 since path obstruction was experienced due to the plastic bag of the earlier time.
20:29-21:04	7/18/2007	Setup	Calibrated TDLAS (1028 and 1030); no measurements noted
	7/19/2007	Setup	As 75% of lagoon is crusted we will be doing pH and ORP for 2 days (till we are here), and then we will leave temp probe only for rest of period.
21:04	7/19/2007	Setup	Barometer audit: Accepted
	8/6/2007	Calibration	Rain caused retro-reflectors to fill with water
20:15	8/6/2007	Calibration	CR1000 data collected-all instrument present looks good
20:40	8/6/2007	Calibration	TDLAS 1 (1028) turned off and brought to trailer for calibration (comm. problems). Installed updates on TDLAS 1 PC.
21:45-21:50	8/6/2007	Calibration	Calibrated TDLAS 1028: Mean 48.85 SD: 3.61…all measurements valid
23:01-23:06	8/6/2007	Calibration	Calibrated TDLAS 1030: Mean 49.84 SD: 4.18
	8/7/2007	Calibration	Removed sonic anemometers from tower; tried to put up top sonic, but due to wind, unable to do so. The other two sonic anemometers are working well. Cleaned bird droppings off of wetness sensors with water. Sealed tower retro-reflectors with tube silicon.
	8/7/2007	Calibration	pH sensor 001: Calibration and Acceptance done; QA good
	8/7/2007	Calibration	pH sensor 004: Acceptance and Calibration done; QA good
	8/7/2007	Calibration	ORP sensor 020: Calibration and Acceptance done
	8/7/2007	Calibration	ORP sensor 040: Calibration and Acceptance done
15:15-16:15	8/7/2007	Calibration	Sonic anemometer inter-comparison: Sensor 1: 2.32 Sensor 2: 2.36 Sensor 3: 2.33
16:48	8/7/2007	Calibration	Zero Calibration on sonic anemometers; all pass.
	8/8/2007	Calibration	Wetness sensor not giving valid reading due to bird droppings. Cleaned with distilled water/soap. Still won't give valid reading.
16:22	8/8/2007	Calibration	Barometer audit: Accepted
	8/9/2007	Calibration	Used Emory cloth for cleaning wetness sensor, and then it worked well.

Time HHMM UTC	Date MM/DD/YYYY	Activity (Setup, Takedown, Calibration, Repair, Remote)	Event
	8/9/2007	Calibration	Also checked TDLAS, electrical connections and tape, pyronometer level, cables at the towers, scanners, and the UPS. All looked good.
	8/28/2007	Takedown	Took down all sensors from weather station. Took down every ground retro-reflector. Wetness sensor doesn't seem ok; it's in bad condition. Data stored in DVD, CD, thumb drive.
15:40-16:40	8/28/2008	Takedown	Sonic anemometer inter-comparison; all pass.
16:55-17:00	8/28/2007	Takedown	Calibrated TDLAS 1028: Mean 46.85 SD: 2.29
17:16	8/28/2007	Takedown	Zero sonic anemometer calibration; all pass.
18:35-18:40	8/28/2007	Takedown	Calibrated TDLAS 1030: mean 53.72 SD: 5.00. First test failed. Not sure of reason. Door to trailer was opened several times perhaps letting in NH_3 from outside. Perhaps manure from boots in trailer caused problems. Good results for second test came when Alfred held the outlet tubing further out the door.
	10/4/2007	Calibration	pH sensor 001: Calibration and Acceptance done
	10/22/2007	Calibration	pH sensor 001: Calibration and Acceptance done
	10/25/2007	Calibration	pH sensor 001: Calibration and Acceptance done
	11/13/2007	Setup	Installed sonic anemometers and retro-reflectors on towers. Installed ground retro-reflectors and met tower.
	11/13/2007	Setup	No pipe to mount middle sonic anemometer. Will have to purchase it. Also, internet is not working (tried several times).
	11/13/2007	Setup	Sonic anemometer inter-comparison: Sensor 1: 4.42 Sensor 2: 4.44 Sensor 3: 4.52
	11/13/2007	Setup	Zero Calibration on sonic anemometers; all pass.
	11/14/2007	Setup	Launched lagoon probe.
	11/14/2007	Setup	Trailer heater still not working. Will notify manufacturer. Got internet to start working.
	11/14/2007	Setup	pH sensor 001: Calibration and Acceptance done; QA good
	11/14/2007	Setup	pH sensor 004: Calibration and Acceptance done; QA good
	11/14/2007	Setup	ORP sensor 020: Calibration and Acceptance done
	11/14/2007	Setup	ORP sensor 040: Calibration and Acceptance done
	11/14/2007	Setup	Barometer audit: Accepted
	11/14/2007	Setup	Wetness sensor calibration: Accepted
13:52-13:57	11/14/2007	Setup	Calibrated TDLAS 1028: Mean: 24.3 SD: 3.4%
14:36-14:41	11/14/2007	Setup	Calibrated TDLAS 1026: Mean: 24.0 SD: 2.9%
	11/27/2007	Calibration	Top (film) of lagoon was frozen, but electrodes (pH and ORP) and temp probe were immersed inside liquid.
	11/28/2007	Calibration	Internal audit was taken (audited) by Prof. Richard Grant.
	11/28/2007	Calibration	pH sensor 001: Calibration and Acceptance done; QA good
	11/28/2007	Calibration	pH sensor 004: Calibration and Acceptance done; QA good
	11/28/2007	Calibration	ORP sensor 020: Calibration and Acceptance done
	11/28/2007	Calibration	ORP sensor 040: Calibration and Acceptance done
	11/28/2007	Calibration	Barometer audit: Accepted
	11/28/2007	Calibration	Wetness sensor calibration: Accepted
15:45-	11/28/2007	Calibration	Sonic anemometer inter-comparison: Sensor 1: 4.07 Sensor 2:

Time HHMM UTC	Date MM/DD/YYYY	Activity (Setup, Takedown, Calibration, Repair, Remote)	Event
16:-45			3.99 Sensor 3: 3.98
16:40-16:45	11/28/2007	Calibration	Calibrated TDLAS 1028: Mean: 54.06 SD: 2.57/4.7%
17:08	11/28/2007	Calibration	Zero Calibration on sonic anemometers; all pass.
17:24-17:29	11/28/2007	Calibration	Calibrated TDLAS 1026: Mean:47.74 SD: 0.49 RSD: 1.0%
	11/29/2007	Calibration	Evidence of power failure on 11/15/2007
15:30	11/29/2007	Calibration	Reoriented tower sonic anemometers. Middle (4m): was 20 degrees west of north before reorienting. Top was 10 degrees east of north before reorienting.
	12/5/2007	Remote	Get things back on track after snowstorm/ice storm on 12/1/2007. Logged onto LAN, TDLAS 1, TDLAS 2
	12/17/2007	Takedown	Scanner 1 (labeled scanner 4) on NE corner pointing at scanner on SW corner for paths 1-5 and toward barns for paths 6-10.
	12/17/2007	Takedown	Scanner 2 (SW corner) was pointing at retro-reflector7 for both paths 7 and 8. Taken back to Purdue.
23:47-23:52	12/17/2007	Takedown	Calibrated TDLAS 1026: Mean: 50.42 SD: 0.61 RSD: 1.2% Bias: 0.0%
	12/18/2007	Takedown	UPS lost power : 12/1/2007; switched to battery power on 12/5/2007
	12/18/2007	Takedown	Barometer audit: Accepted
	12/18/2007	Takedown	Wetness sensor calibration: Accepted
14:45-15:45	12/18/2007	Takedown	Sonic anemometer inter-comparison: Sensor 1: 1.66 Sensor 2: 1.61 Sensor 3: 1.64…all pass.
16:30	12/18/2007	Takedown	Zero Calibration on sonic anemometers; all pass.
00:37-00:42	12/19/2007	Takedown	Calibrated TDLAS 1028: Mean: 51.53 SD: 0.80 RSD: 1.6% Bias: 2.2%
	4/22/2008	Setup	During morning hours until afternoon, drainage was in progress. At 3:30 pm, loading was started in first sludge lagoon and was then stopped after one hour.
21:05-21:10	4/22/2008	Setup	Calibrated TDLAS 1027: Mean: 46.35 SD: 0.44 RSD: 1.0% Bias: -7.7%
21:48-21:53	4/22/2008	Setup	Calibrated TDLAS 1028: Mean: 47.07 SD: 0.34 RSD: 0.7% Bias: -6.1%
	4/23/2008	Setup	Did inter-comparison of TDLAS. TDLAS 1028 was working well, but TDLAS 1027 was working poorly (very low r^2 values as compared to 1028). Changed to TDLAS TDLAS 1031; have to calibrate 1031.
	4/23/2008	Setup	Still lagoon loading and drainage in process.
	4/23/2008	Setup	Balanced S-OPS "D"
	4/23/2008	Setup	Changed old data logger (CR1000) of weather station to a new one.
14:10-15:05	4/23/2008	Setup	Sonic anemometer inter-comparison; all pass.
15:36	4/23/2008	Setup	Sonic anemometer zero calibration; all pass.
	4/24/2008	Setup	Water leakage from back door of trailer.
	4/24/2008	Setup	Drainage and loading stopped at 10:30 am.
	4/24/2008	Setup	Flagged the tubings properly, leveled the sensors.
	4/24/2008	Setup	GSS max flow test: Fail (solenoids 2 and 3).

Time HHMM UTC	Date MM/DD/YYYY	Activity (Setup, Takedown, Calibration, Repair, Remote)	Event
	4/24/2008	Setup	S-OPS/GSS leak test: Pass (solenoids 2 and 3).
	4/24/2008	Setup	GSS No Flow Test conducted (solenoids 2 and 3).
	4/24/2008	Setup	S-OPS Inlet Flow Verification: Pass on second attempt
	4/24/2008	Setup	S-OPS Max Flow Test conducted (solenoids 2 and 3).
14:08-14:13	4/24/2008	Setup	Calibrated TDLAS 1031: Mean: 53.87 SD: 1.05 RSD: 7.4% Bias: 2.0%
18:30	4/24/2008	Setup	TFC 450i Reference Precision Check
20:35	4/24/2008	Setup	Barometer audit: Accepted
20:36	4/24/2008	Setup	Wetness sensor calibration: Accepted
13:00	4/25/2008	Remote	Daily Status Check from PAML Notes: Many periods for sonic anemometer 3 had a few up to 70 sonic anemometer flagged points yesterday. Rainy. A few periods (most is sonic anemometer 3) has >160 spike points.
12:00	4/28/2008	Remote	Daily Status Check from PAML Notes: Sonic anemometer flagging data for 2,3 around day 482.3. *iPort* shut down; restarted this morning. Looked at *iPort* screen to check. Stopped sonic anemometer program. Downloaded missing *iPort* data.
13:17	4/28/2008	Remote	Correct dwell time on TDL2, path 2. Dwell time currently set to 1 s. Change to 15 s.
12:00	4/29/2008	Remote	Daily Status Check from PAML Notes: Lagoon float not present.
12:00	4/29/2008	Remote	Daily Status Check from PAML Notes: Sonic anemometer flagging >160 (sonic anemometer 1--1 point; sonic anemometer 3--3 points)
	4/30/2008	Remote	Correct path lengths in retro-reflector aiming *Excel* workbook for WI5A.
11:40	5/1/2008	Remote	Daily Status Check from PAML Note: Sonic anemometer 3 appears to be having communication issues. Especially during first day and the past 2 days. Total data points have dropped, variance increased, and number of spike data points has increased. Lagoon probe not present.
12:30	5/2/2008	Remote	Daily Status Check from PAML Note: lagoon probe not present
12:15	5/5/2008	Remote	Daily Status Check from PAML Notes: Lagoon probe not present.
12:45	5/6/2008	Remote	Daily Status Check from PAML. Notes: Only one point lost due to sonic anemometer flagging. Lagoon probe not present.
12:50	5/7/2008	Remote	Daily Status Check from PAML Notes: Lagoon probe not present. Innova not present. "XXXX" on TDLAS 2 when first looked at and when looking at paths.
12:00	5/8/2008	Remote	Daily Status Check from PAML. Notes: TDLAS 2 paths 1 and 2 have 0%. Both lost around 2230 UTC on 2008-5-7. Lagoon probes not present. Occasional "xxxx" and red boxes on path 10. Paths 1 and 2 have low light values. Created new .gmp file file and replaced corrupt path 10 values with last good values from mpo string in data file. Uncertain which path values saved for path 10 actually correspond to (likely path 9). Loaded this new setup file. All 10 paths back on.
12:35	5/9/2008	Remote	Daily Status Check from PAML Notes: No lagoon probe. Pan-tilt problems with TDLAS 1 (1028). *iPort* not working;

Time HHMM UTC	Date MM/DD/YYYY	Activity (Setup, Takedown, Calibration, Repair, Remote)	Event
			data was not stored for H_2S since 2008-5-8. Stored data since yester day as a FillWI5A file; checked all the files and saw data was missing from 1220 UTC to 1306 UTC (2008-5-8), so again stored in FillWI5A. Started a new file to save real-time data.
	5/12/2008	Takedown	Reached site at 21:30 UTC. Took down all ground and tower retro-reflectors, and took down sonic anemometers.
	5/12/2008	Remote	Fixed red boxes on TDLAS 2. Red box on path 5.
14:23	5/12/2008	Remote	Daily Status Check from PAML. Notes: Sonic anemometer 1 temp had w values ~0.5 ms^{-1}, but back to normal. No lagoon instruments installed. Path 7 on TDLAS 2 off; moved 10 down for correction.
	5/12/2008	Takedown	80% lagoon crusted
	5/13/2008	Takedown	S-OPS Inlet Flow Verification: Pass on second attempt
	5/13/2008	Takedown	GSS max flow test: Fail (solenoids 2 and 3).
	5/13/2008	Takedown	S-OPS Max Flow Test conducted (solenoids 2 and 3).
	5/13/2008	Takedown	S-OPS/GSS leak test: Pass (solenoids 2 and 3).
	5/13/2008	Takedown	GSS No Flow Test conducted (solenoids 2 and 3).
15:00-16:00	5/13/2008	Takedown	Sonic anemometer inter-comparison: all pass
16:48	5/13/2008	Takedown	Sonic anemometer zero calibration; all pass.
16:53	5/13/2008	Takedown	Calibrated TDLAS 1027 Mean: 53.14 SD: 0.24 RSD: 0.5% Bias: 5.7%
17:27	5/13/2008	Takedown	Calibrated TDLAS 1028 Mean: 47.89 SD: 0.16 RSD: 0.3% Bias: -5.0%
19:53	5/13/2008	Takedown	TFC 450i Reference Precision Check
20:07	5/13/2008	Takedown	TFC 450i Calibration Verification Check
20:08	5/13/2008	Takedown	Barometer audit: Accepted
20:11	5/13/2008	Takedown	Wetness sensor calibration: Accepted
23:30-00:30	5/14/2008	Takedown	Sonic anemometer inter-comparison: Pass Note: Passed on second attempted because sonic anemometers turned perpendicular to the wind before second attempt.
00:48	5/15/2008	Takedown	Sonic anemometer zero calibration; all pass.
	6/24/2008	Setup	Reached WI5A at 5pm local time. Leveled the trailer and made it fixed. Front left jack of the trailer is not working so used wooden blocks.
	6/25/2008	Setup	Lagoon 100% crusted.
	6/25/2008	Setup	S-OPS Inlet Flow Verification: Pass
	6/25/2008	Setup	S-OPS/GSS leak test: Pass (solenoids 2 and 3).
	6/25/2008	Setup	GSS No Flow Test conducted (solenoids 2 and 3).
	6/25/2008	Setup	GSS Leak Test: Pass
15:00-15:55	6/25/2008	Setup	Sonic anemometer inter-comparison: all pass
15:50	6/25/2008	Setup	Calibrated TDLAS 1028 Mean: 48.2 SD: 0.34 RSD: 0.7% Bias: -3.8%
16:39	6/25/2008	Setup	Calibrated TDLAS 1031 Mean: 54.23 SD: 0.29 RSD: 0.5% Bias: 8.2%
16:43	6/25/2008	Setup	Sonic anemometer zero calibration: all pass.
21:24	6/25/2008	Setup	TEC 450i instrument operating parameters calculated
21:24	6/25/2008	Setup	TEC 450i calibration verification check

Time HHMM UTC	Date MM/DD/YYYY	Activity (Setup, Takedown, Calibration, Repair, Remote)	Event
21:45	6/25/2008	Setup	TEC 450i reference precision check
	6/26/2008	Setup	Lagoon site layout completed
	6/26/2008	Setup	While doing S-OPS/GSS leak test, found leak at F-3 (T-section). Used Teflon tape to fix the leak. Changed filter papers of F-7 and F-9, and changed orifices of F-5 and F-9. The leak was about 0.8 LPM, but max flow was 10 LPM, so it passed. Added plastic on all ground retro-reflectors.
	6/26/2008	Setup	S-OPS max flow test: Pass
15:30	6/26/2008	Setup	Barometer audit: Accepted
15:33	6/26/2008	Setup	Wetness sensor calibration: Accepted
15:30	6/27/2008	Setup	Daily Status Check from PAML Notes: QC programs not working. No communication with CR 1000.
12:30	6/30/2008	Remote	Daily Status Check from PAML Notes: Sonic anemometer 2 consistently has non-zero flags, often up to 20 and sometimes 60. TDLAS 2 reference cell quality is usually greater than 12,000. No connection with CR1000.
12:50	7/1/2008	Remote	Daily Status Check from PAML Notes: No connection with CR 1000. No lagoon probe (lagoon is 100% crusted).
11:55	7/2/2008	Remote	Daily Status Check from PAML Notes: No connection with CR 1000. No lagoon probe (lagoon is 100% crusted).
12:10	7/3/2008	Remote	Daily Status Check from PAML Notes: Few excessive periods with over 160 spike counts for sonic anemometer 1. CR 1000 not connected with LAN. No lagoon probe (lagoon is 100% crusted).
12:00	7/7/2008	Remote	Daily Status Check from PAML Notes: Few excessive periods with over 160 spike counts for sonic anemometer anemometers 1 and 2. TDLAS 1 (1028) and TDLAS 2 (1031) were not aimed at all paths. Cause may be due to fog or heavy rain. Checked again at 15:55 UTC, and both TDLAS's were properly aligned with a status code of 1. CR 1000 is not connected with LAN.
15:05	7/8/2008	Remote	Daily Status Check from PAML Notes: TDLAS 1 (1028) is taking too much time for optimizing on path 5. Tried to adjust by to lower light values. TDLAS 1028 path 3 had very low light values (38-52); reaim path for 0.5 hours before finding good light values. Sonic anemometer 1 stop incrementing data at 2:30 UTC. Sonic anemometer 1 had the following error codes: 106, 2, 74, 66, 170, 42, 98, 106, 34, 10, and 6. CR 1000 is not connected to LAN.
12:05	7/9/2008	Remote	Daily Status Check from PAML Notes: Sonic anemometer 1 is not incrementing data. No communication with CR1000.
12:10	7/10/2008	Remote	Daily Status Check from PAML Notes: Sonic anemometer 1 is not incrementing data. Data stopped incrementing on 7/8/2008. Will check today if there is electric problem or not. No communication with CR1000.
16:00	7/11/2008	Remote	Daily Status Check from PAML Notes: Communication problems with CR1000.
12:15	7/14/2008	Remote	Daily Status Check from PAML Notes: No communication with CR1000.
	7/14/2008	Takedown	Reached site at 21:10 UTC. Saw sonic anemometers had stopped incrementing data at 12:36 UTC; probably caused by

Time HHMM UTC	Date MM/DD/YYYY	Activity (Setup, Takedown, Calibration, Repair, Remote)	Event
			someone at PAML starting H_2S analyzer and not restarting sonic anemometer program.
	7/14/2008	Takedown	Evidence of power failure on 7/2/2008 at 14:42:08, on 7/9/2008 at 14:42:36, and on 7/10/2008 at 18:28:11.
21:55-22:49:36	7/14/2008	Takedown	Sonic anemometer inter-comparison: Pass
23:24	7/14/2008	Takedown	Calibrated TDLAS 1028 Mean:46.96 SD: 0.79 RSD: 1.7% Bias: -6.2%
23:26	7/14/2008	Takedown	Calibrated TDLAS 1031 Mean: 54.31 SD: 0.33 RSD: 0.6% Bias: 8.3%
23:26	7/14/2008	Takedown	Wetness sensor calibration: Accepted
23:26	7/14/2008	Takedown	Barometer audit: Accepted
23:28	7/14/2008	Takedown	Zero Calibration on sonic anemometers; all pass.
	7/15/2008	Takedown	UPS boxes contained water and were broken. Saw a lot of bird dropping, especially on met tower.
	7/15/2008	Takedown	GSS Leak Test: Pass
	7/15/2008	Takedown	GSS No Flow Test conducted (solenoids 2 and 3).
	7/15/2008	Takedown	S-OPS Max Flow Test conducted (solenoids 2 and 3).
	7/15/2008	Takedown	S-OPS/GSS leak test: Pass (solenoids 2 and 3).
	7/15/2008	Takedown	S-OPS inlet flow verification: Pass
14:18	7/15/2008	Takedown	TEC 450i instrument operating parameters calculated
14:18	7/15/2008	Takedown	TEC 450i calibration verification check
14:38	7/15/2008	Takedown	TEC 450i reference precision check
	10/21/2008	Setup	Trailer light not working. Tried to fix it but could not.
	10/21/2008	Setup	Lagoons are dried.
	10/21/2008	Setup	Calibrated sonic anemometers and did all ground and tower work.
	10/21/2008	Setup	GFCI outlet at met tower tripped; running extension cord for met tower and sonic anemometer 1 to nearby retro-reflector outlet (SW of met tower).
	10/21/2008	Setup	Using 1/8 plastics in tower retro-reflectors to minimize effects of rain/frost/dew on decreasing light levels.
16:50-17:49:32	10/21/2008	Setup	Sonic anemometer inter-comparison; all pass.
18:17	10/21/2008	Setup	Zero Calibration on sonic anemometers; all pass.
	10/22/2008	Setup	Leak in S-OPS F inlets; tightened connections, T's, and sealed with more Teflon tape. Cleaned inlets and replaced inlet filters.
	10/22/20008	Setup	Ground rod at met tower without a football clamp; secured by twisting/tying ground wire around ground rod.
	10/22/2008	Setup	Lagoon site layout made
	10/22/2008	Setup	Maintenance list completed.
	10/22/2008	Setup	GSS Max Flow test
	10/22/2008	Setup	GSS No Flow Test conducted (solenoids 2 and 3).
	10/22/2008	Setup	GSS Leak Test: Pass
13:15	10/22/2008	Setup	Wetness sensor calibration: Accepted
13:18	10/22/2008	Setup	Barometer audit: Accepted
14:35	10/22/2008	Setup	Calibrated TDLAS 1030
15:36	10/22/2008	Setup	Calibrated TDLAS 1026
16:30	10/22/2008	Setup	TEC 450i instrument operating parameters calculated

Time HHMM UTC	Date MM/DD/YYYY	Activity (Setup, Takedown, Calibration, Repair, Remote)	Event
16:30	10/22/2008	Setup	TEC 450i calibration verification check
16:46	10/22/2008	Setup	TEC 450i reference precision check
17:08	10/22/2008	Setup	SO_2 calibration
12:09	10/23/2008	Remote	Daily Status Check from PAML Notes: Reaimed path 1 on TDLAS 2. Changed pan/tilt settings on TDLAS's; changed minimum light level to 1000 and the optimum light level to 3000. Some flagged data on sonic anemometer 2. Average w value for sonic anemometer 1 is about 0.1 ms^{-1}. Low sample flow on H_2S analyzer. No communication with CR 1000.
14:00	10/24/2008	Remote	Daily Status Check from PAML Notes: Ran time sync on both Panasonics and LAN. Realigned path 1 on TDLAS 2. Sonic anemometer 1 w values are constantly above zero. Sonic anemometer 2 spike counts exceed 160 throughout period, maxing at 250; majority below 160. Sonic anemometer 3 has flagging starting at approx. 663.37. Low flow in H_2S sample flow (0.66 LPM). No communications with CR 1000.
12:50	10/27/2008	Remote	Daily Status Check from PAML Notes: Sonic anemometer 3 appears to be failing. Lots of flagged data and outliers in u, v, w, and T data. Low flow on H_2S sample flow (0.66 LPM). Path 1 on TDLAS 2 is having trouble staying aligned. No communication with CR 1000.
12:00	10/28/2008	Remote	Daily Status Check from PAML Notes: TDLAS 1 path 1 and TDLAS 2 path 6 have low light levels. Tried to reaim paths but could not improve light levels, may be caused by frost as temperature is 28F with dew point of 28F. Later, found TDLAS 1 path 1 with too high light levels. Optimization unable to drop levels below 16368. It appears that super-saturation has been reached. Reaimed path. Sonic anemometer 2 has quite a bit of 5-min periods with up to 20 sonic anemometer flagged points. No communication with CR 1000.
12:35	10/29/2008	Remote	Daily Status Check from PAML Notes: Sonic anemometer 3 has flagging; no flagging on yesterday's status check. Sonic anemometer 3 u, v, w, and T graphs look normal as of yesterday's status check. No communication with CR 1000. No lagoon measurements.
13:00	10/30/2008	Remote	Daily Status Check from PAML Notes: Average w values are greater than zero on sonic anemometer 2. No communications with CR1000. No lagoon measurements.
12:50	10/31/2008	Remote	Daily Status Check from PAML Notes: No communication with CR1000 and LAN. No lagoon measurements.
14:00	11/3/2008	Remote	Daily Status Check from PAML Notes: Reaimed TDLAS 1 path 1 to off of 16368. Fixed invalid data value (red box) in path 3 of TDLAS 2; appeared to have started on 10/31/2008 at 22:53x. No communication with CR 1000. See notes for more details.
13:00	11/4/2008	Remote	Daily Status Check from PAML Notes: TDLAS 1 path 1 has low light level. TDLAS 2 path 6 has low light level. Unable to find valid LL values (dew?). No communication with CR 1000.

Time HHMM UTC	Date MM/DD/YYYY	Activity (Setup, Takedown, Calibration, Repair, Remote)	Event
13:45	11/5/2008	Remote	Daily Status Check from PAML Notes: No communication with CR 1000.
13:30	11/5/20008	Remote	Daily Status Check from PAML Notes: Sonic anemometer 3 started to get significant flags around 676.27 (heavy rain in area). No communication with CR 1000.
13:30	11/7/2008	Remote	Daily Status Check from PAML Notes: All TDLAS paths good until a few minutes ago. Might be snowing or raining at site. H_2S sample flow at 0.66 LPM. No communication with CR1000.
18:52	11/10/2008	Remote	Daily Status Check from PAML Notes: No communication with CR 1000.
	11/11/2008	Takedown	Arrived on site late on 11/10/2008 and took down sonic anemometers and ground/tower retro-reflectors. Electricity was working well (no evidence of power failure).
	11/11/2008	Takedown	Upon arrival the next morning, found power not to be working in the trailer or on the towers. Could not solve problem; called farm owner but he could not figure out problem either. Called electrician (Richardson), and they will come out to site before Christmas to solve problem. Ran extension cords from barn to trailer for power.
	11/11/20008	Takedown	Unhooked power. Found connecting block. Wiring scheme: white tape--white; red tape--red; yellow tape--black; green tape--ground.
	11/11/2008	Takedown	Lagoon site layout made; see open site notes.
	11/11/2008	Takedown	Maintenance list completed.
	11/11/2008	Takedown	GSS Max flow test
	11/11/2008	Takedown	GSS No Flow Test conducted (solenoids 2 and 3).
	11/11/2008	Takedown	GSS Leak Test: Pass
15:45-16:40	11/11/2008	Takedown	Sonic anemometer inter-comparison; all pass.
15:49	11/11/2008	Takedown	Calibrated TDLAS 1030
17:02	11/11/2008	Takedown	Calibrated TDLAS 1026
17:05	11/11/2008	Takedown	Zero Calibration on sonic anemometers; all pass.
19:13	11/11/2008	Takedown	Wetness sensor calibration: Accepted
19:15	11/11/2008	Takedown	Barometer audit: Accepted
22:51	11/11/2008	Takedown	TEC 450i calibration verification check
22:51	11/11/2008	Takedown	TEC 450i instrument operating parameters calculated
23:06	11/11/2008	Takedown	TEC 450i reference precision check
23:30	11/11/2008	Takedown	SO_2 calibration
	12/17/2008	Setup	We did not do a wetness sensor calibration because it was so cold it would freeze.
	12/17/2008	Setup	Power issue on arrival. Found breakers were loose in farm power supply box.
	12/17/2008	Setup	Lagoon site layout completed
21:00-22:15	12/17/2008	Setup	Sonic anemometer inter-comparison; all pass.
22:30	12/17/2008	Setup	Zero Calibration on sonic anemometers; all pass.
00:58	12/18/2008	Setup	Calibrated TDLAS 1030
01:26	12/18/2008	Setup	Calibrated TDLAS 1026
	12/18/2008	Setup	Lost F5 inlet on S-OPS; replaced.

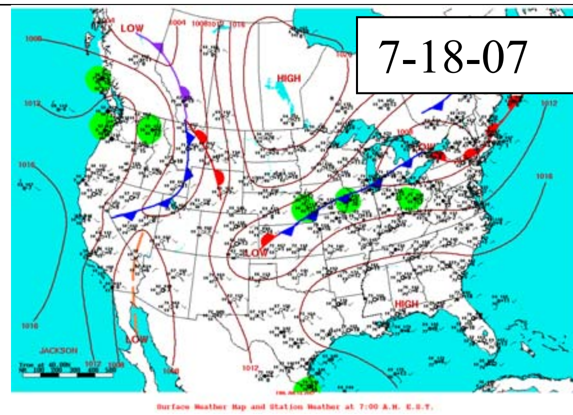
Time HHMM UTC	Date MM/DD/YYYY	Activity (Setup, Takedown, Calibration, Repair, Remote)	Event
	12/18/2008	Setup	Too cold to use electrical tape (it just ripped apart). Also, when using zip ties, had to be very careful or else they would break because of the cold.
	12/18/2008	Setup	Outlet for weather station not working.
	12/18/2008	Setup	Trailer heater not putting out much heat. Can only get temperature in trailer to about 55F.
	12/18/2008	Setup	Maintenance list completed.
19:45	12/18/2008	Setup	Barometer audit: Accepted
16:30	12/22/2008	Remote	Daily Status Check from PAML Notes: Paths 1-5 on TDLAS 2 had low light levels. Successfully reaimed at 21:50 UTC. Sonic anemometer 1 has up to 80 flagged data points. H_2S internal temperature dipped as low as 25C due to chilly trailer. No lagoon probes.
13:15	12/23/2008	Remote	Daily Status Check from PAML Notes: *iPort* had an error and needed to be restarted. Had to stop sonic anemometers to restart *iPort*. Created fill file starting at 12/23/08 at 12:53 (actually had to start 60 records ago). Restarted sonic anemometer program. No lagoon probes.
13:30	12/24/2008	Remote	Daily Status Check from PAML Notes: Flag 1 in H_2S data from 723.53-727.55 (correspond to a fill file). No lagoon probe.
13:29	12/29/2008	Remote	Daily Status Check from PAML Notes: All TDLAS paths out of alignment (Light levels less than 40). Conditions were foggy/drizzly when paths were lost on evening on 12/26. Took about four hours to reaim all the paths. See aiming sheet for new paths. Extensive, but not complete flagging on sonic anemometer three since 726.68. Values for u, v, w, and T have gone crazy for sonic anemometer 3.
13:00	12/30/2008	Remote	Daily Status Check from PAML
14:10	1/5/2009	Remote	Daily Status Check from PAML Notes; Paths 2 and 5 on TDLAS 1 had low light levels. See notes for new paths values. Sonic anemometer 3 flagging all points (malfunctioning). Sonic anemometers 1 and 2 have recovered after flagging yesterday. No lagoon probes.
	1/6/2009	Takedown	All TDLAS paths were aligned upon arrival.
23:42	1/6/2009	Takedown	Calibrated TDLAS 1026
00:03	1/7/2009	Takedown	Calibrated TDLAS 1030
	1/7/2009	Takedown	Performed diluter test with 450i and cylinder from ABE (4.46 ppm H_2S in air). Also diluted our 29.6 ppm H_2S tank in air to 4.46 pmm to compare with direct from ABE tank.
	1/7/2009	Takedown	Maintenance list completed.
15:40-16:40	1/7/2009	Takedown	Sonic anemometer inter-comparison; all pass.
16:55	1/7/2009	Takedown	Zero Calibration on sonic anemometers; all pass.
17:08	1/7/2009	Takedown	Wetness sensor calibration: Accepted
17:11	1/7/2009	Takedown	Barometer audit: Accepted
	3/9/2009	Setup	Performed sonic anemometer calibrations and set up all outside equipment, because it is forecasted to rain/snow tomorrow.
	3/10/2009	Setup	Set up and aligned TDLAS/scanner units.
	3/10/2009	Setup	CR 1000 not connecting to LAN.

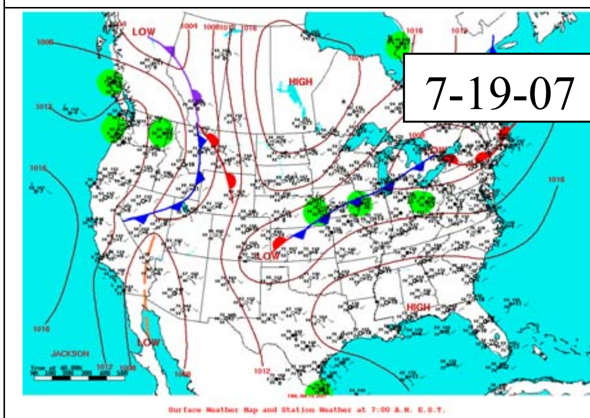
Time HHMM UTC	Date MM/DD/YYYY	Activity (Setup, Takedown, Calibration, Repair, Remote)	Event
	3/10/2009	Setup	No wetness sensor calibration because of rain.
	3/10/2009	Setup	Maintenance list completed.
	3/10/2009	Setup	Lagoon site layout completed
00:10-01:10	3/10/2009	Setup	Sonic anemometer inter-comparison; all pass.
01:26	3/10/2009	Setup	Zero sonic anemometer calibration; all pass.
14:00-16:00	3/10/2009	Setup	S-OPS/GSS calibrations
16:45	3/10/2009	Setup	Barometer audit: Accepted
17:23	3/10/2009	Setup	Calibrated TDLAS 1031
17:51	3/10/2009	Setup	Calibrated TDLAS 1030
19:45-20:27	3/10/2009	Setup	TEC 450i Single Point calibration
15:40	3/12/2009	Remote	Daily Status Check from PAML Notes: Two points with flag 4 are recurrent in H_2S data. No communication with CR 1000. Lagoon is frozen, so there are no lagoon probes.
12:20	3/13/2009	Remote	Daily Status Check from PAML Notes: TDLAS 1 paths 1-5, and 7-8 currently have low light levels. Likely caused by ice or frost. Will check later after temperatures have warmed to see if they return. At the beginning of day 801, sonic anemometer 3 appears to have no data for several hours.
16:00	3/16/2009	Remote	Daily Status Check from PAML Notes: *iPort* had an error and needed to be restarted. Data stopped collecting at 3/16/2009 at 3:00 UTC. Had to stop sonic anemometers to restart *iPort*. Created fill file starting at 3/16/09 at 2:55. Restarted sonic anemometer program. All paths on TDLAS 1 No lagoon probes.
	3/17/2009	Remote	Daily Status Check from PAML Notes: Reaimed TDLAS 1 (NE corner) with Brian Hetchler's assistance. Scanner tripod had been shifted due to thawing of ground. Paths were off 300+ steps vertically and horizontally. Reaimed paths, and a chart with new coordinates is attached to QC check. Sonic anemometer 3 has a few flagged five-min intervals around 865. Flag 1 on H_2S data from 806.13 to 806.98; missed missing data. No communication with CR 1000.
12:55	3/18/2009	Remote	Daily Status Check from PAML Notes: TDLAS 1 paths 6-10 are lost. Had to reaim twice; see report for details. No lagoon probes.
12:15	3/19/2009	Remote	Daily Status Check from PAML Notes: Changed optimization settings on TDLAS 1. See notes for details. Reaimed paths 7 and 8 on TDLAS 1. No connection with CR 1000.
13:15	3/23/2009	Remote	Daily Status Check from PAML Notes: Average w values for sonic anemometer 1=0.1 ms^{-1}; -0.1 ms^{-1} for sonic anemometer 2; and -0.3 ms^{-1} for sonic anemometer 3. No communication with CR 1000.
13:35	3/24/2009	Remote	Daily Status Check from PAML Notes: Average w values for sonic anemometer 1=0.1 ms^{-1}; -0.1 ms^{-1} for sonic anemometer 2; and -0.3 ms^{-1} for sonic anemometer 3. No communication with CR 1000.
14:30	3/25/2009	Remote	Daily Status Check from PAML Notes: Sonic anemometer 3

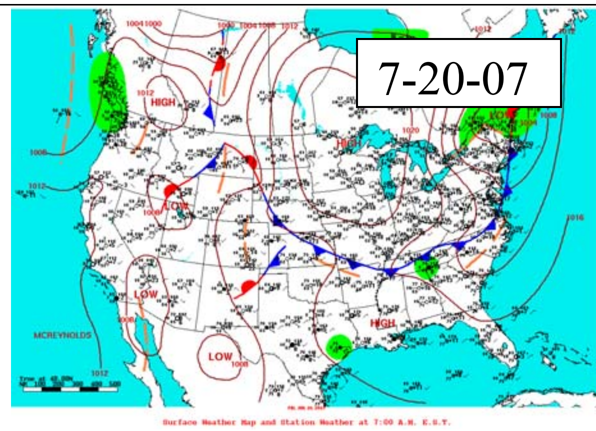
Time HHMM UTC	Date MM/DD/YYYY	Activity (Setup, Takedown, Calibration, Repair, Remote)	Event
			has not sent any data since 11:20 UTC on 3/25/2009. There was also a period from 22:40 UTC on 3/24/2009 to 4:25 UTC on 3/25/2009 where sonic anemometer 3 did not send back any data. Sonic anemometer 1 w is 0.1 ms^{-1}. Sonic anemometer 2 w is 0.15 ms^{-1}. No CR 1000 communication.
15:45	3/26/2009	Remote	Daily Status Check from PAML Notes: There were a few times yesterday that sonic anemometer 3 was sending back no data, but it is working fine now. No CR 1000 connection.
13:20	3/27/2009	Remote	Daily Status Check from PAML Notes: No communication with CR 1000.
15:30	4/2/2009	Remote	Daily Status Check from PAML Notes: TDLAS 1 and 2 appear to have lost connection on 3/30/2009. TDLAS laptop screens are stuck on 3/27/2009. *iPort* program encountered an error. Stopped sonic anemometer program at 16:00 UTC and restarted. Reconnected to TEC 450i and checked time-sync. Filled data starting at 4/2/2009 10:42 UTC. Restarted real-time data collection (0402091605) Restarted sonic anemometers at 16:07 UTC. Sonic anemometer 3 has no data from 821.64 to 821.99.
16:30	4/2/2009	Remote	Daily Status Check from PAML Notes: Called Todd Doornick about resetting the TDLAS laptops. John then helped reset the TDLAS laptops and was able to get everything realigned without too much difficulty. No lagoon probes.
	4/6/2009	Takedown	Used expired NH_3 tank for TDLAS calibrations. Will do inter-comparison with a valid cylinder next time.
	4/6/2009	Takedown	Lagoon is being filled by force (pressurized).
	4/6/2009	Takedown	Lots of work (heavy trucks) is in progress around the lagoon. TDLAS path near the trailer has been blocked by the trucks. Took many photos.
15:14	4/6/2009	Takedown	Barometer audit: Accepted
23:28	4/6/2009	Takedown	Calibrated TDLAS 1030
23:50	4/6/2009	Takedown	Calibrated TDLAS 1031
	4/7/2009	Takedown	S-OPS tubing lengths North: 250 m South: 160 m
	4/7/2009	Takedown	Maintenance list completed.
12:20-13:30	4/7/2009	Takedown	S-OPS/GSS calibrations
13:15-14:10	4/7/2009	Takedown	Sonic anemometer inter-comparison; all pass.
14:53-15:22	4/7/2009	Takedown	TEC 450i Single Point calibration
15:15	4/7/2009	Takedown	Wetness sensor calibration: Accepted
15:16	4/7/2009	Takedown	Zero sonic anemometer calibration; all pass.

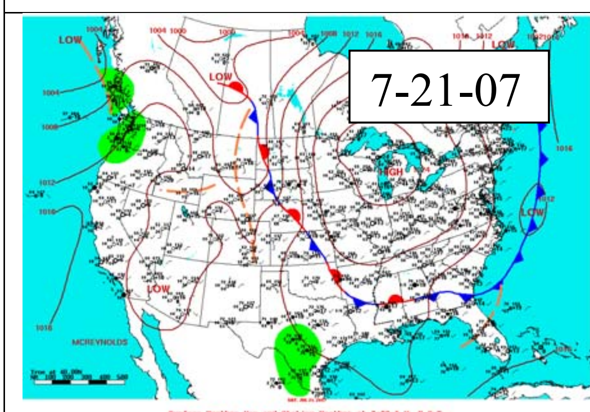
6.9 Site weather

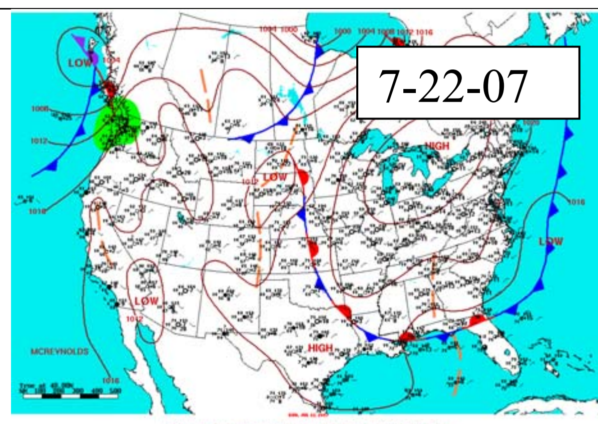
Period 1

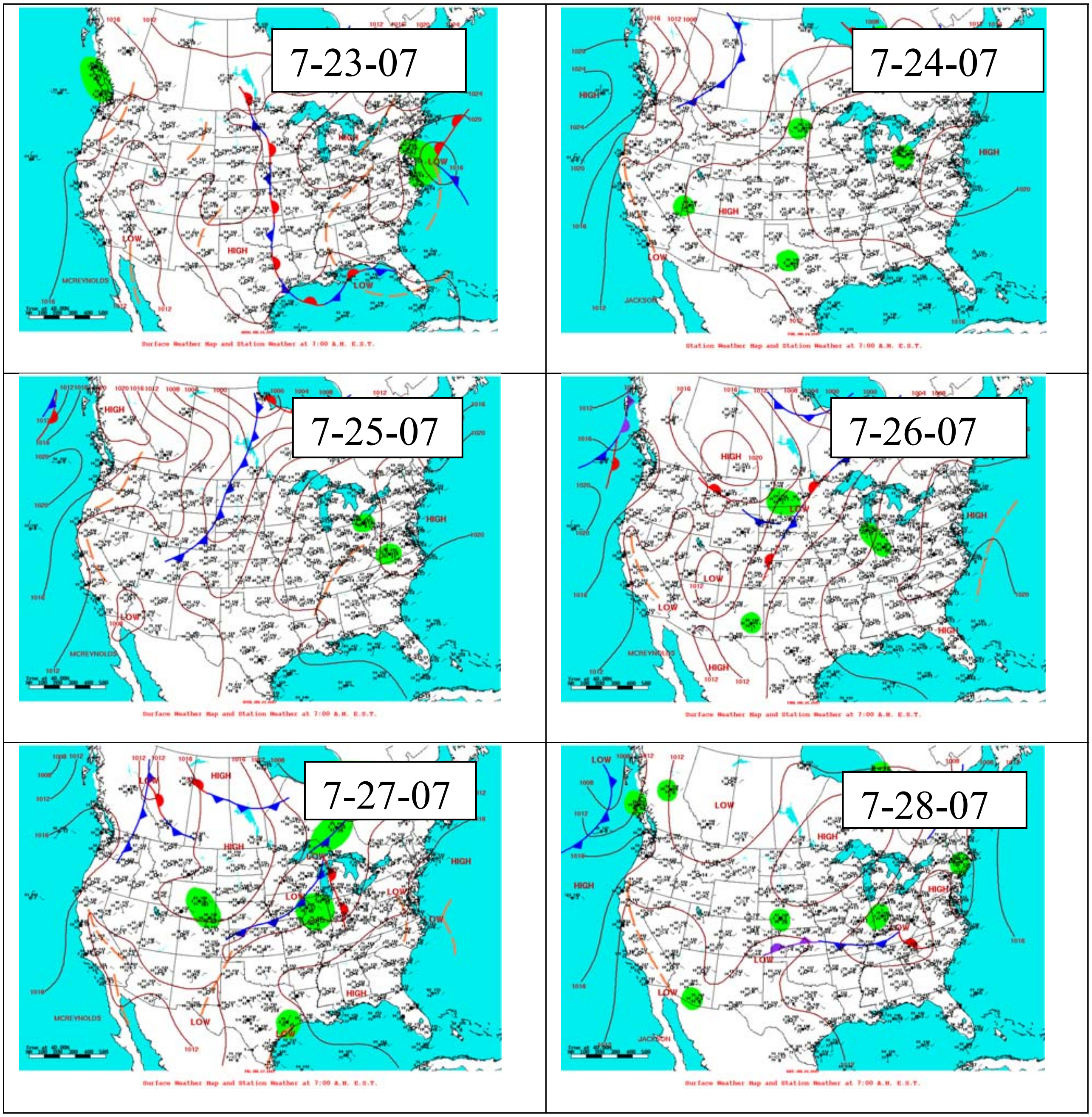








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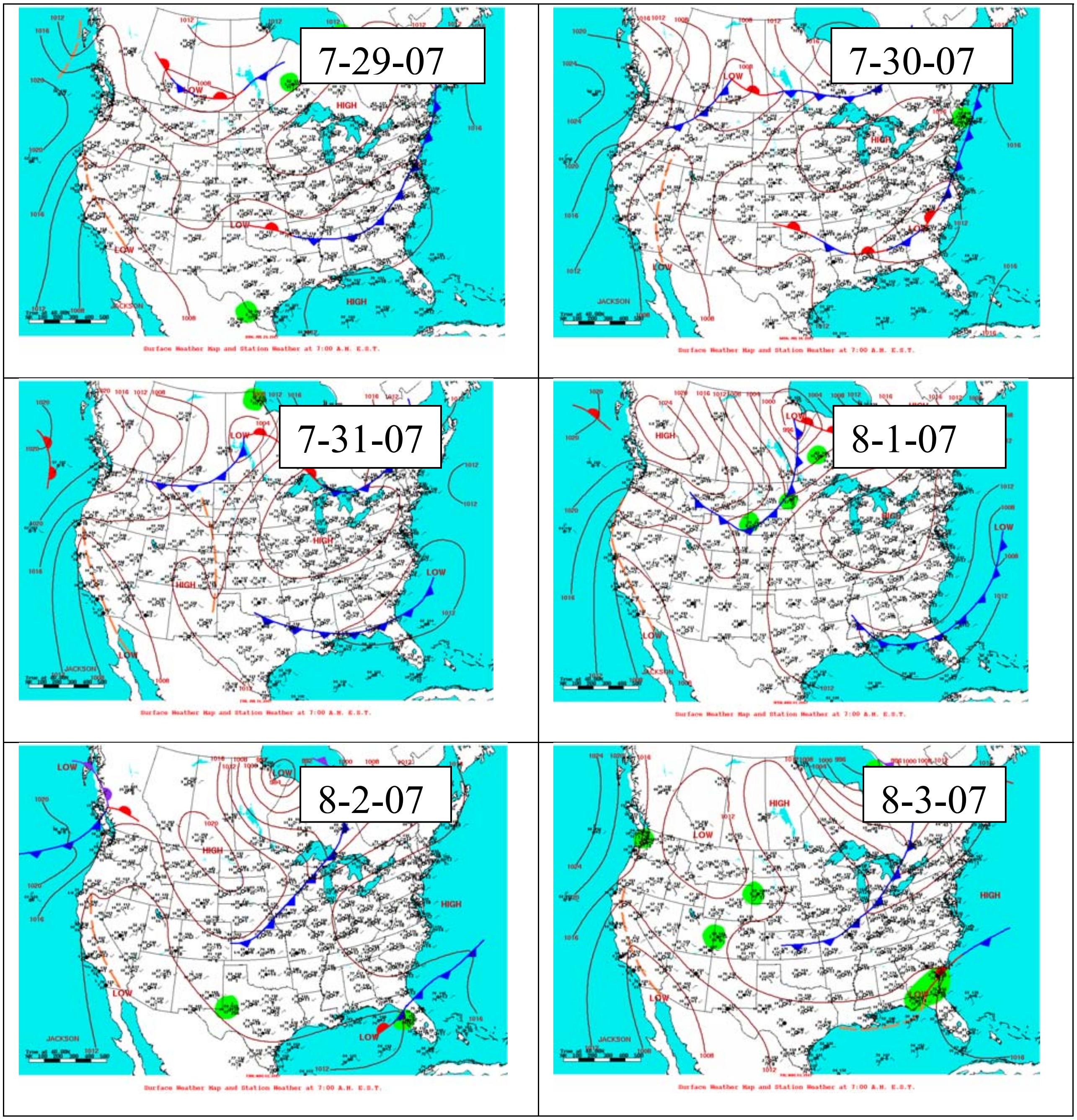
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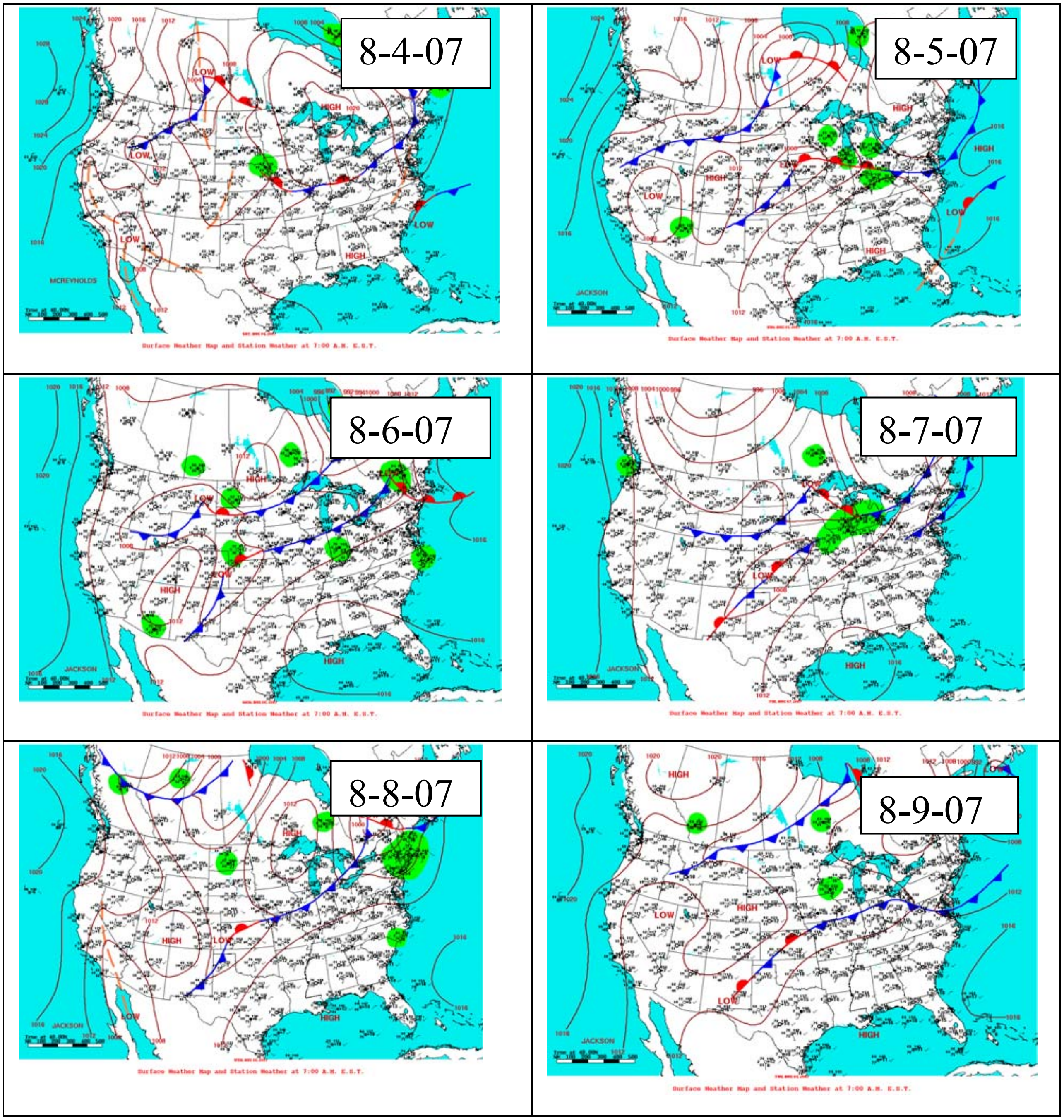
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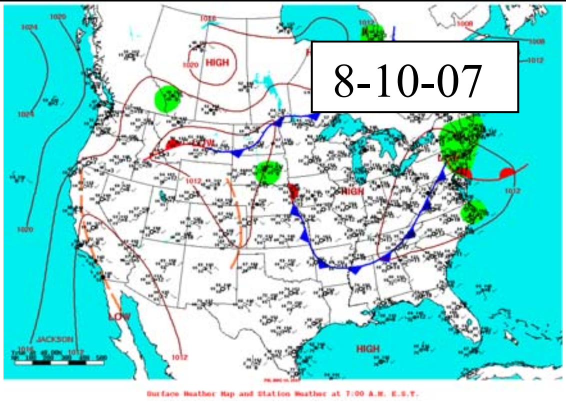
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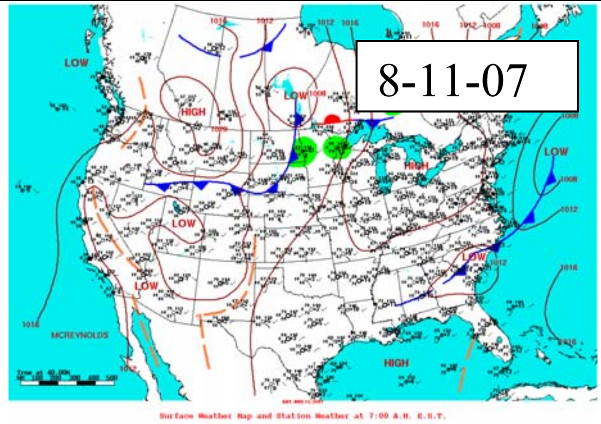
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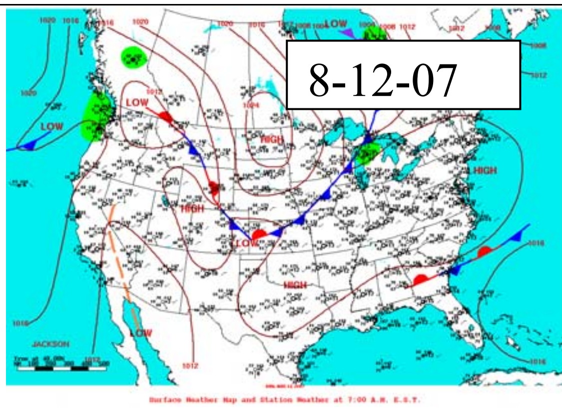
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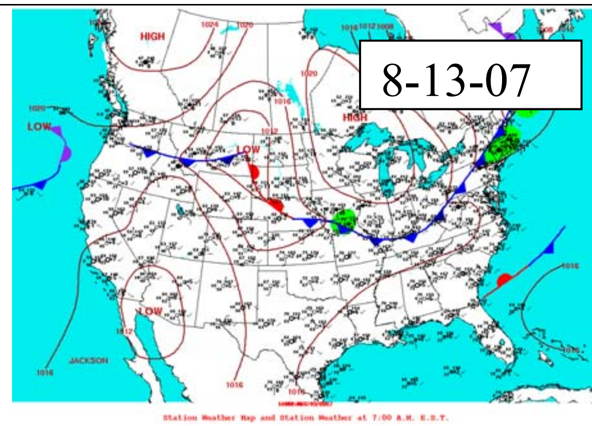
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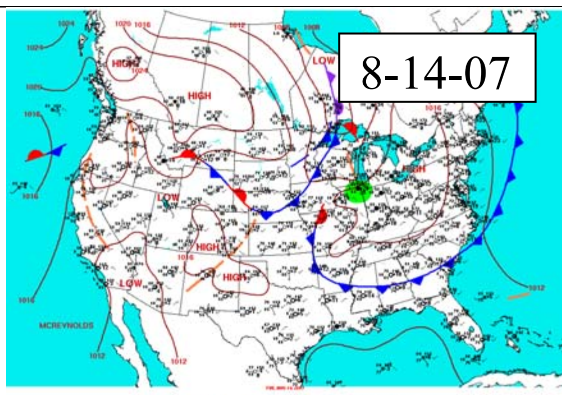
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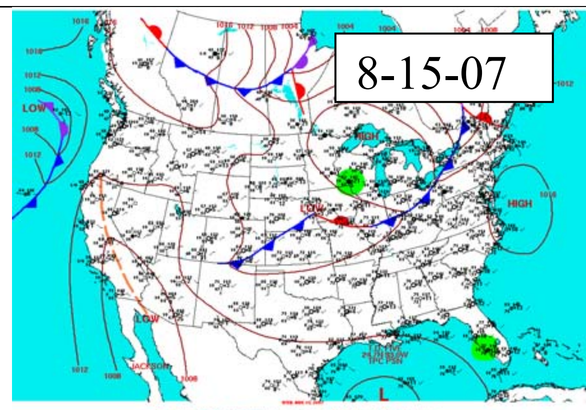
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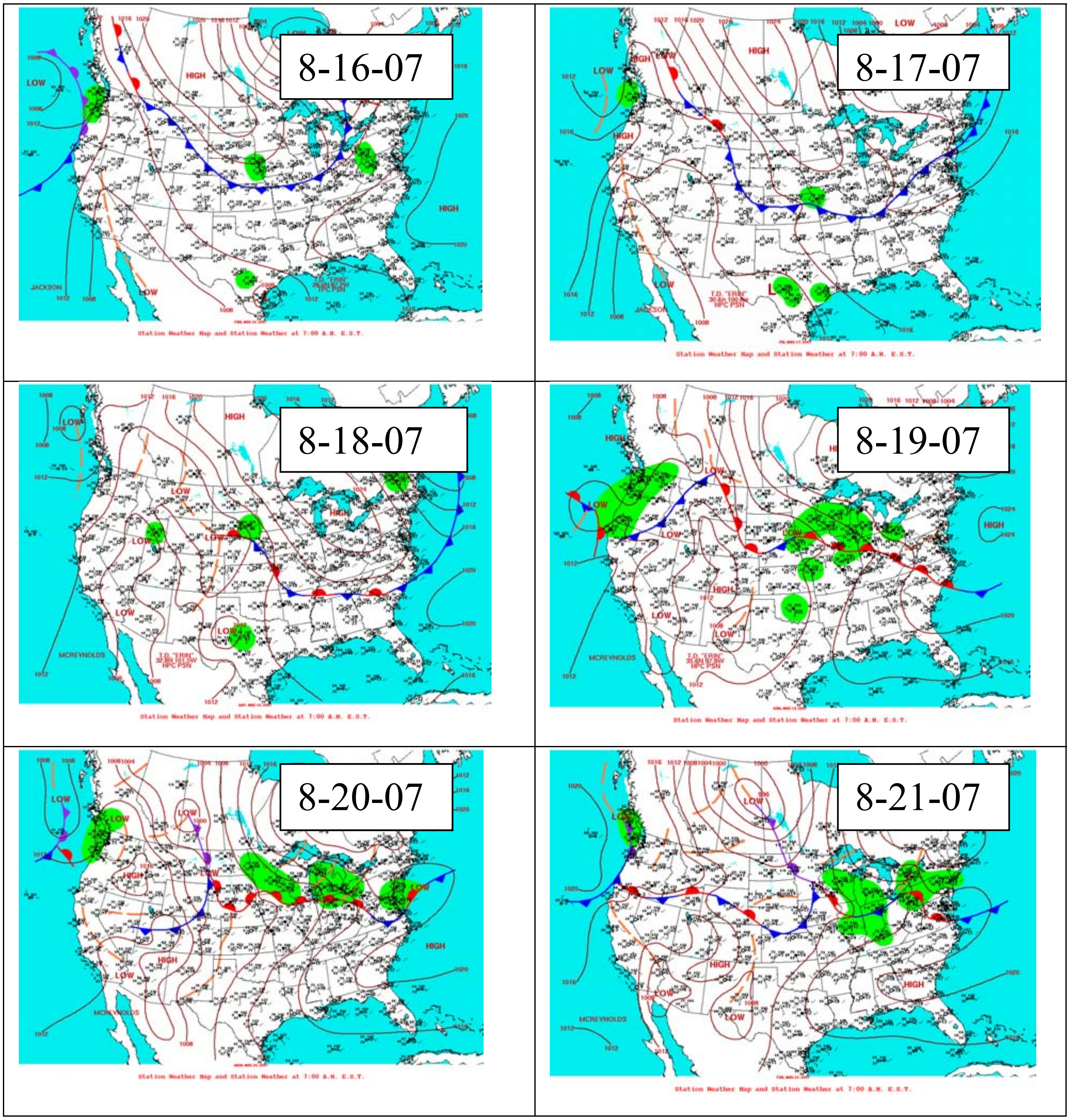
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8-19-07
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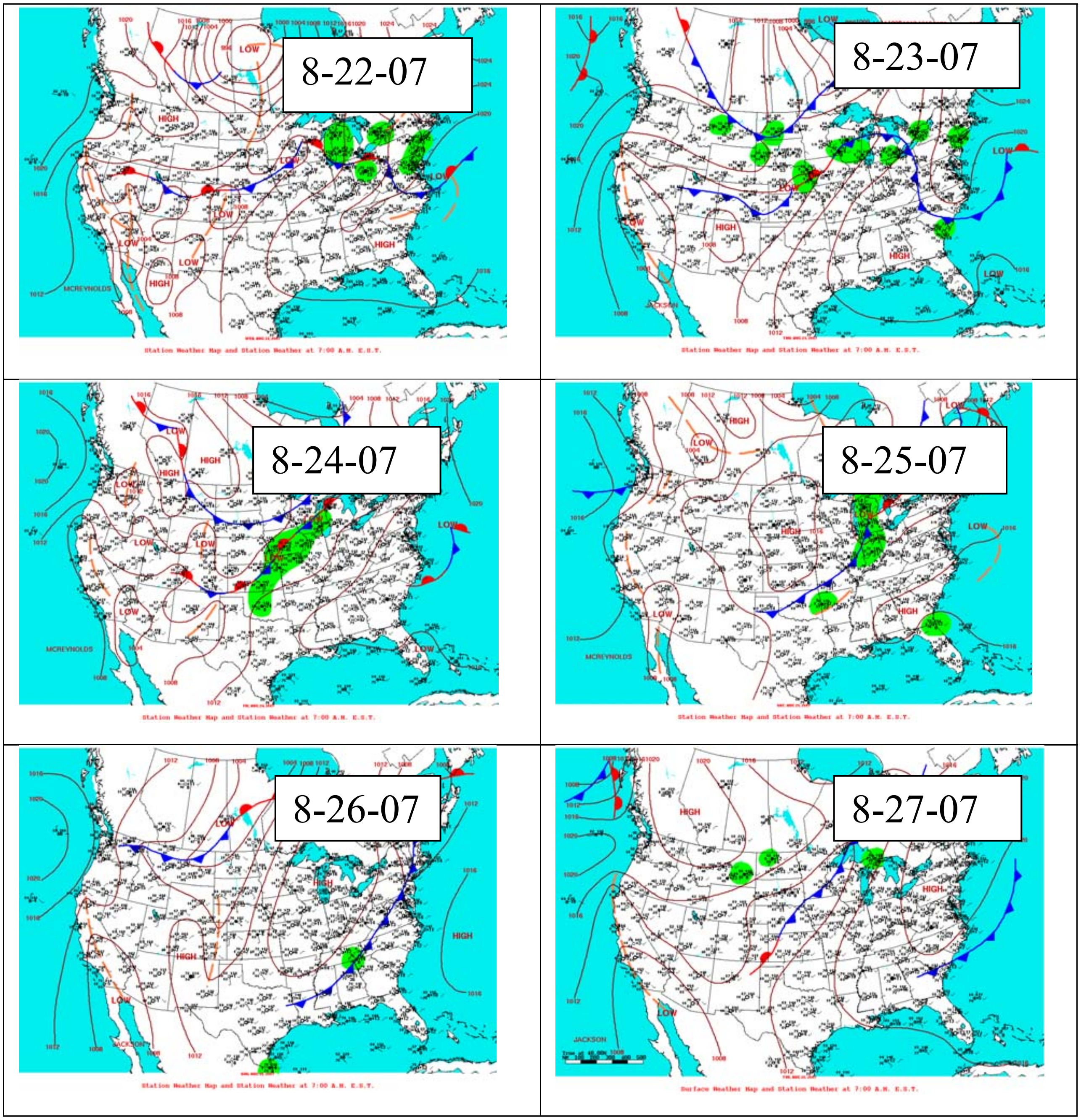
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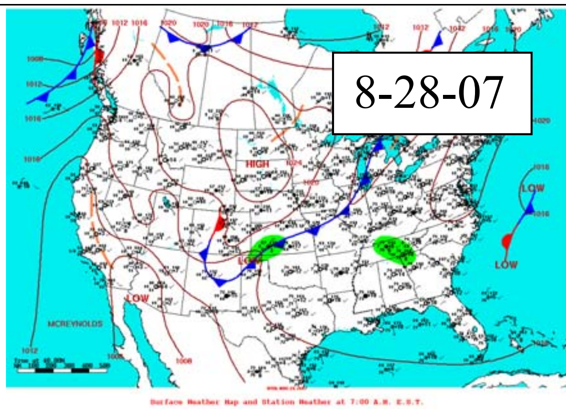
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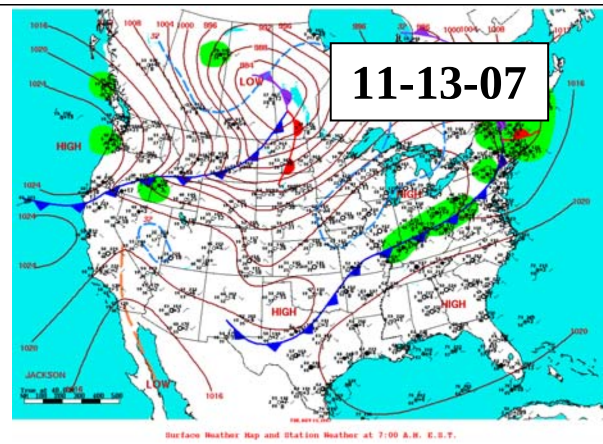
Period 2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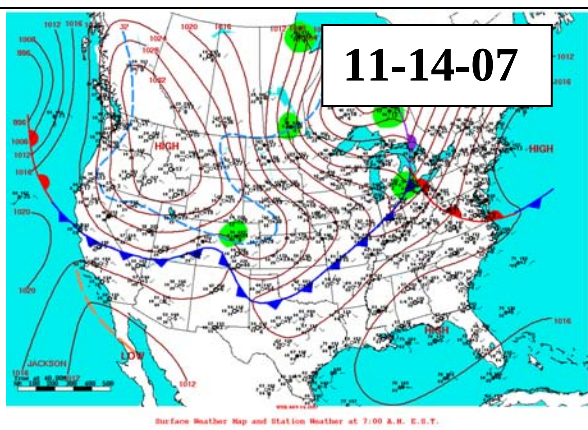
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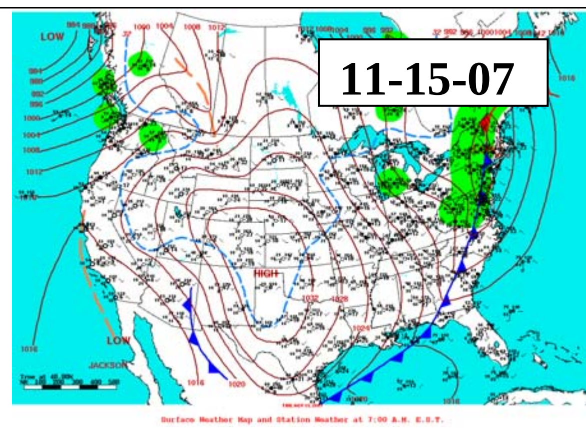
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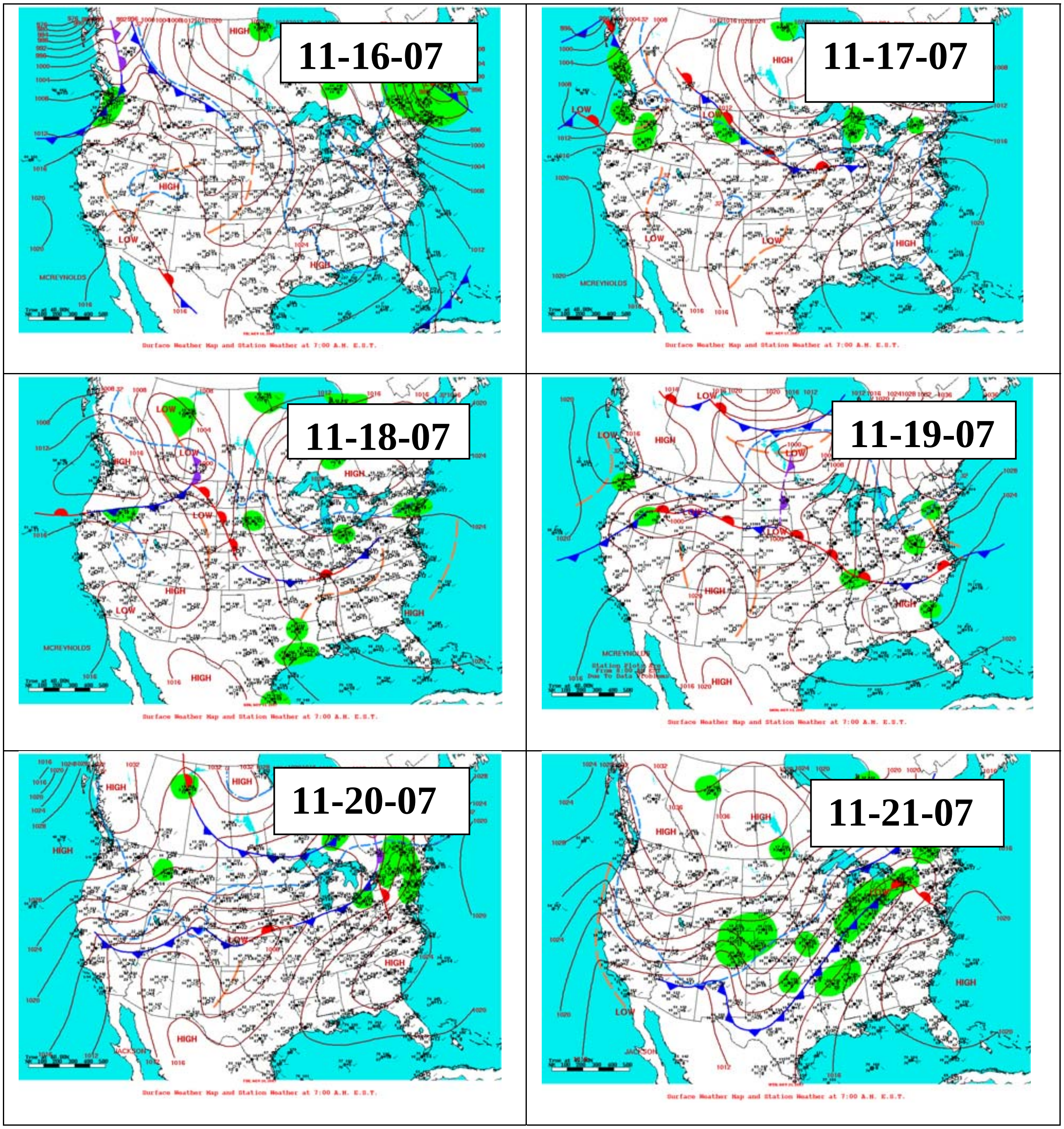
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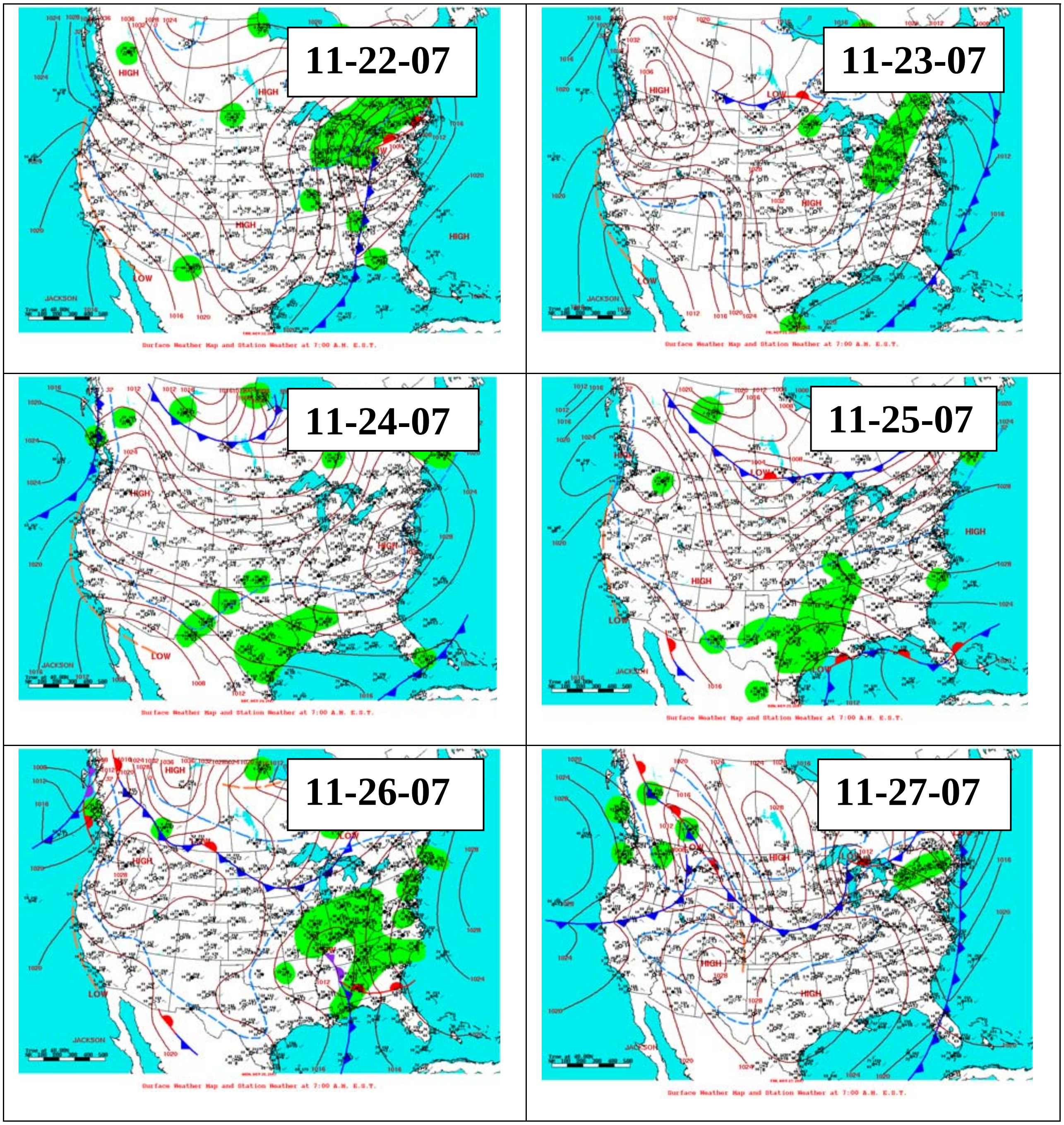
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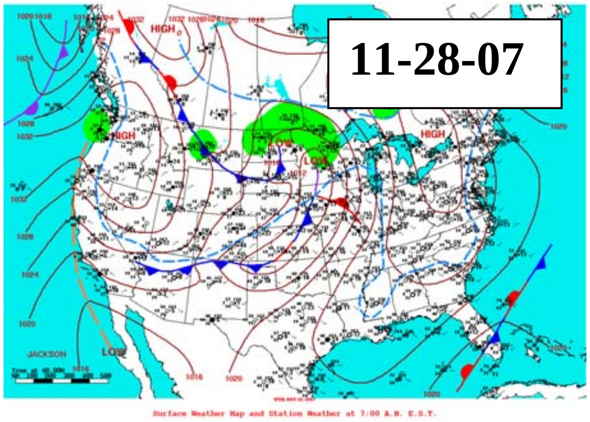
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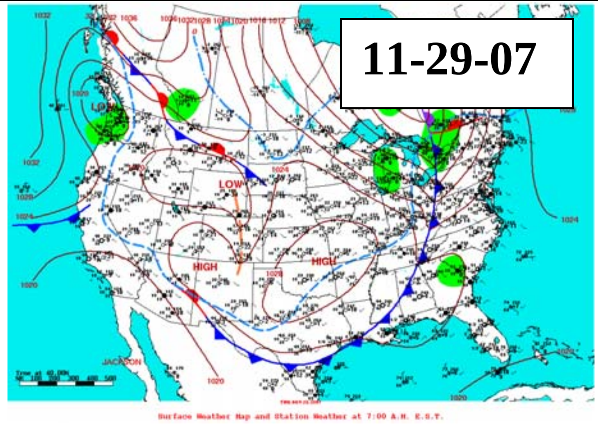
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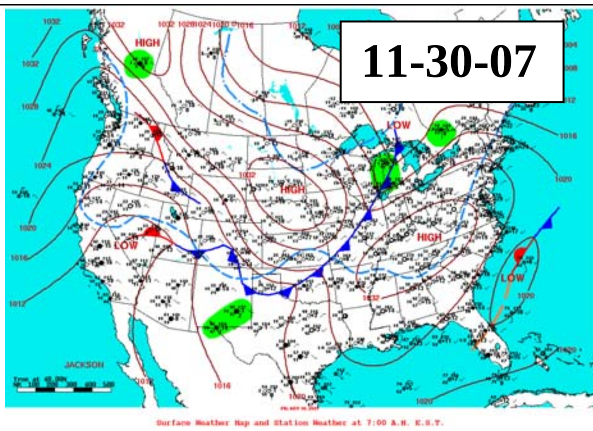
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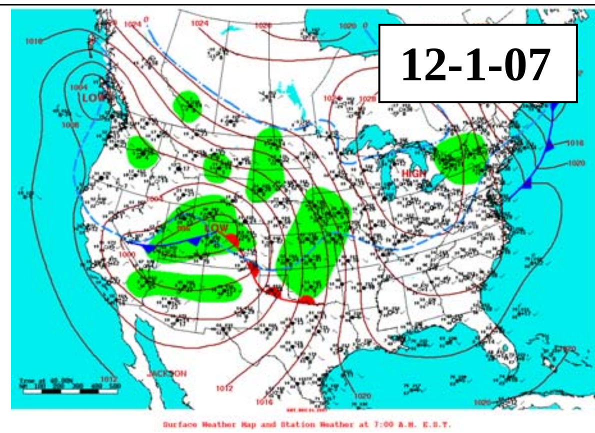
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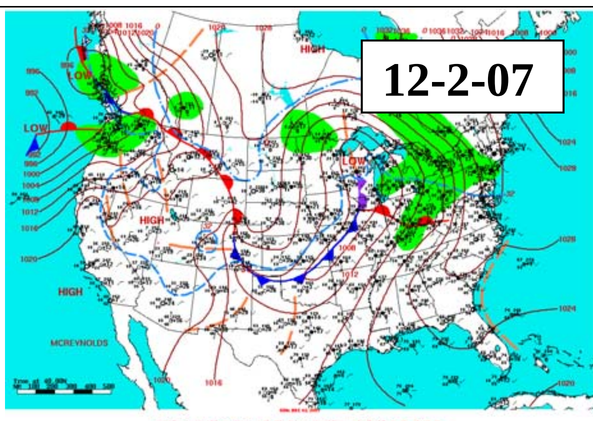
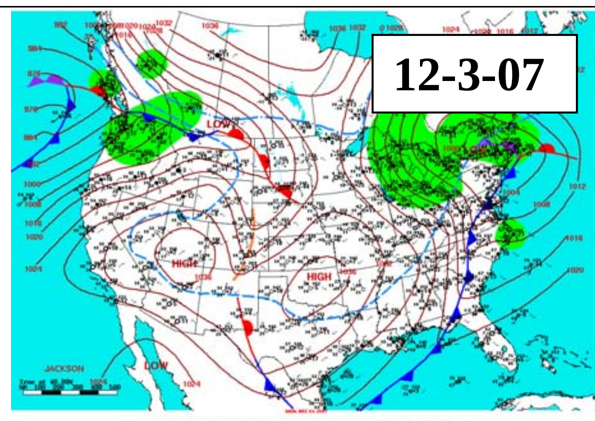
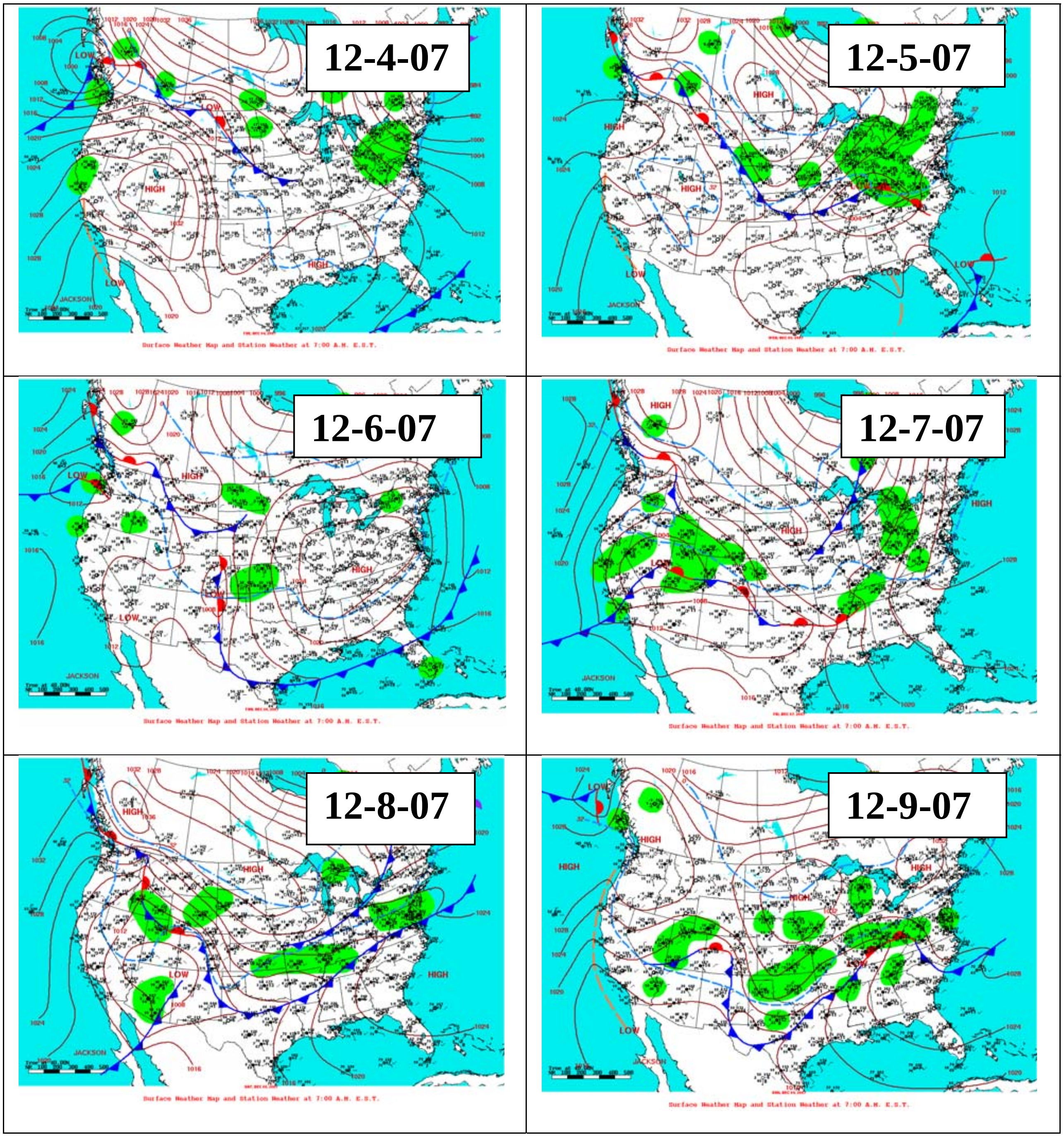
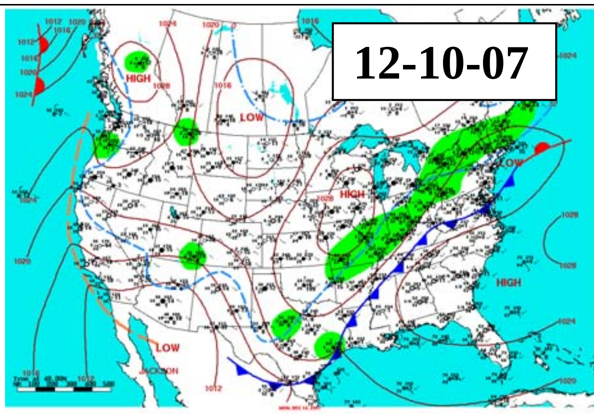
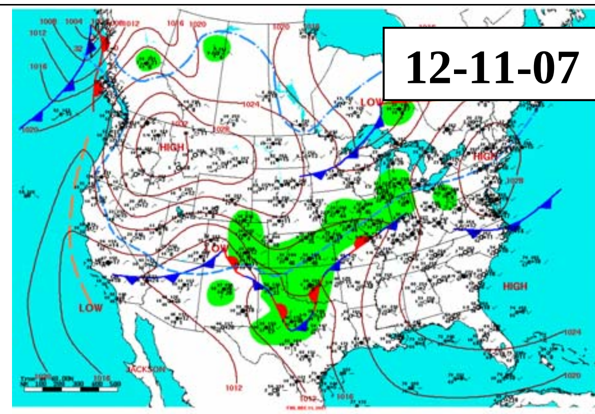

12-2-07
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.


12-3-07
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.

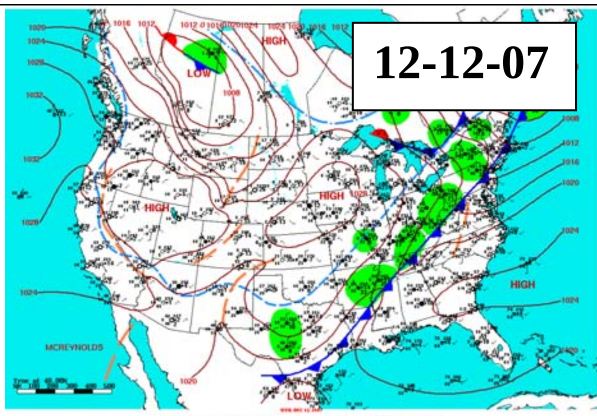

12-4-07
12-5-07
12-6-07
12-7-07
12-8-07
12-9-07
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.



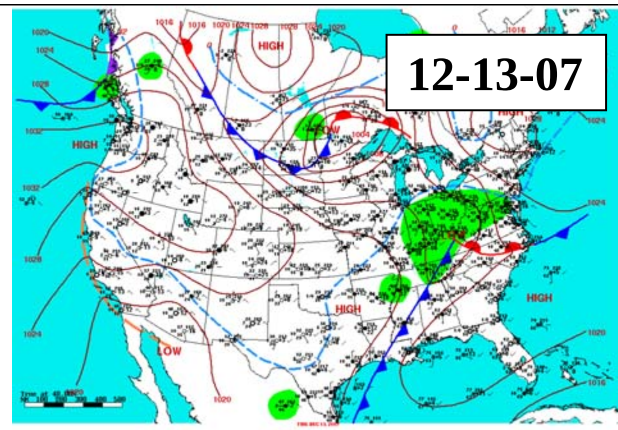
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.



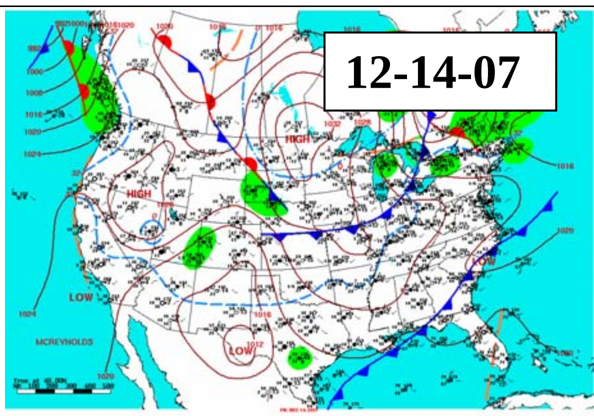
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.



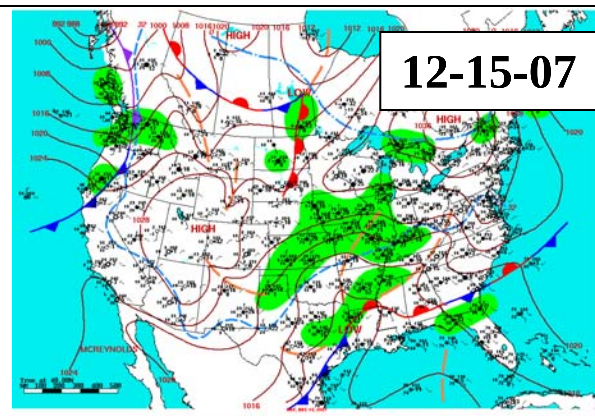
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.



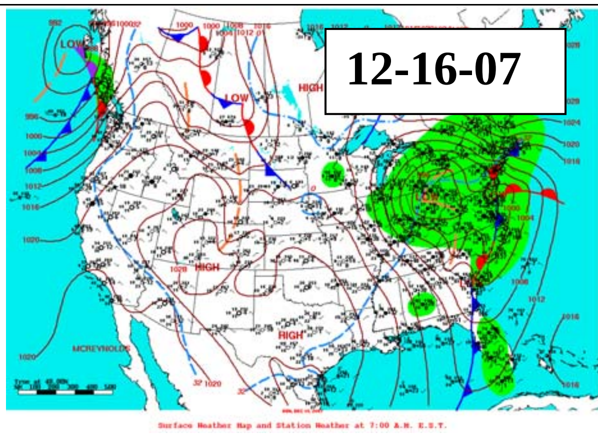
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.

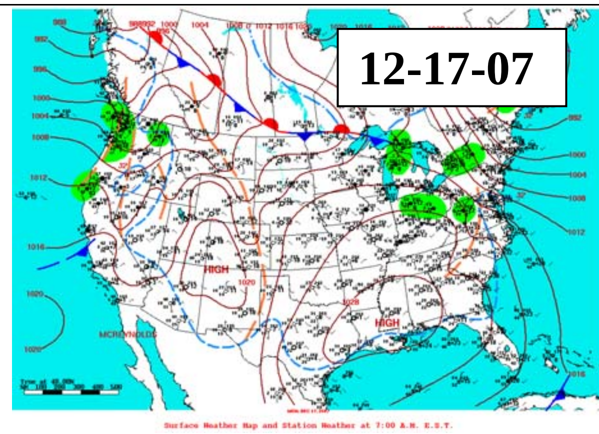


Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.

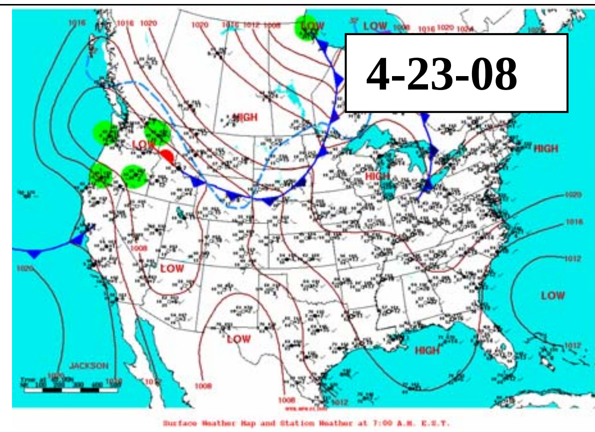


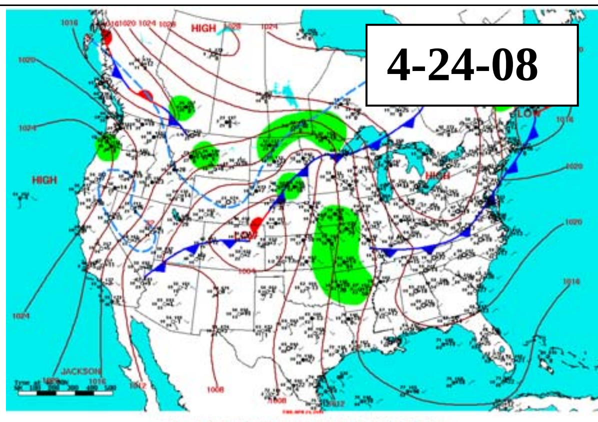
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.

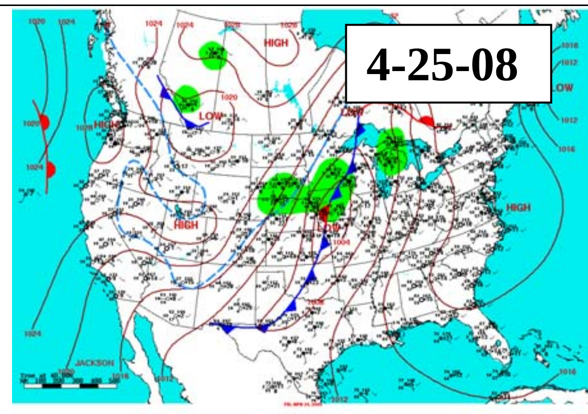

12-16-07
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.

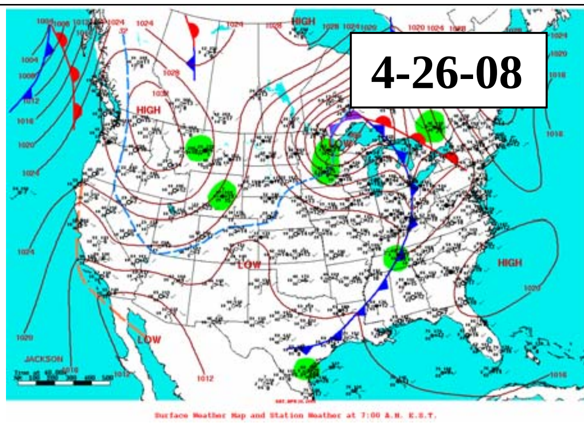

12-17-07
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.

Period 4


4-23-08
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.


4-24-08
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.


4-25-08
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.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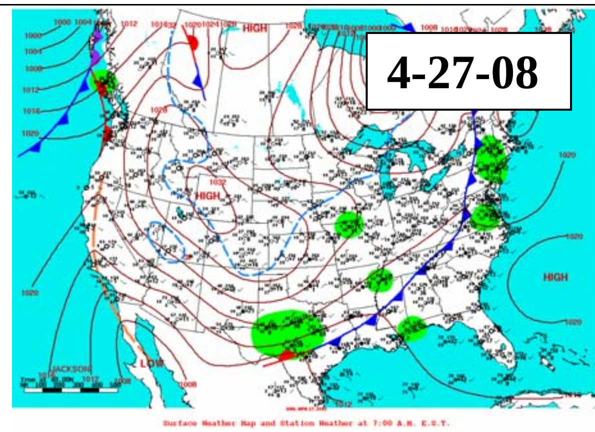
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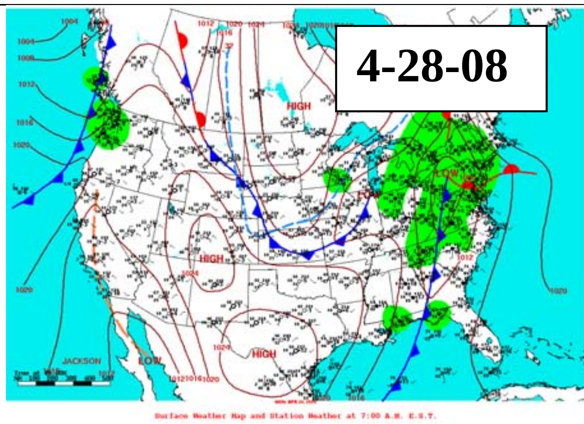
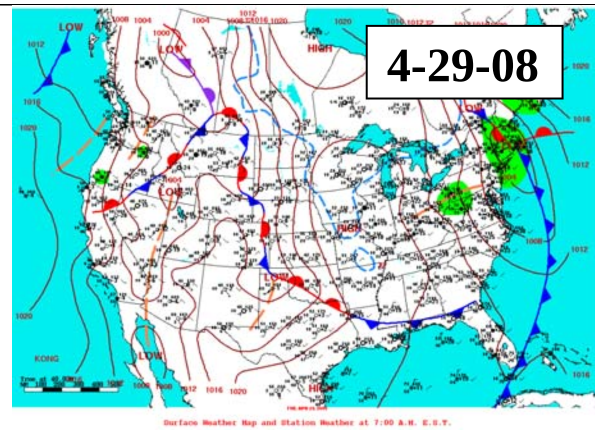
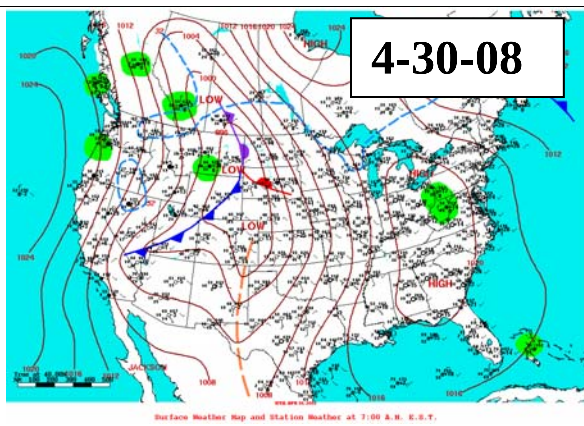

4-28-08


4-29-08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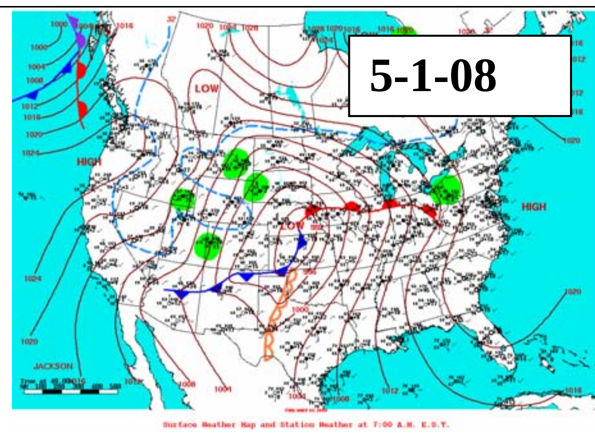
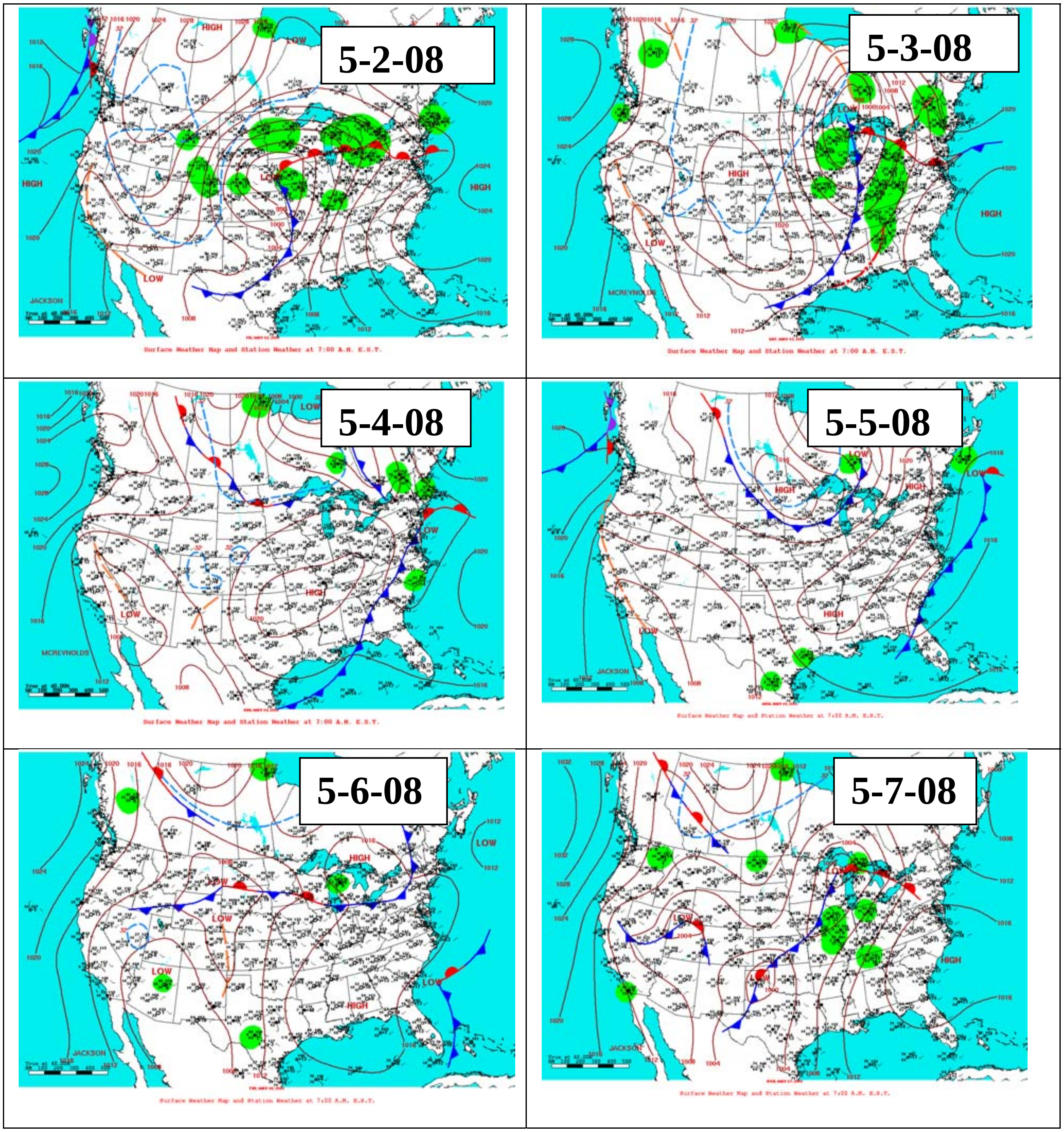

5-1-08


5-2-08
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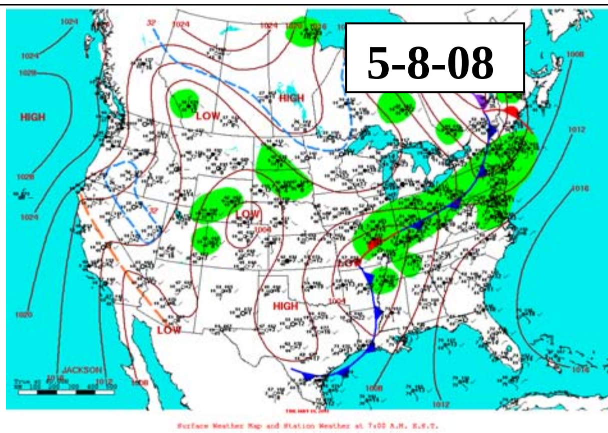
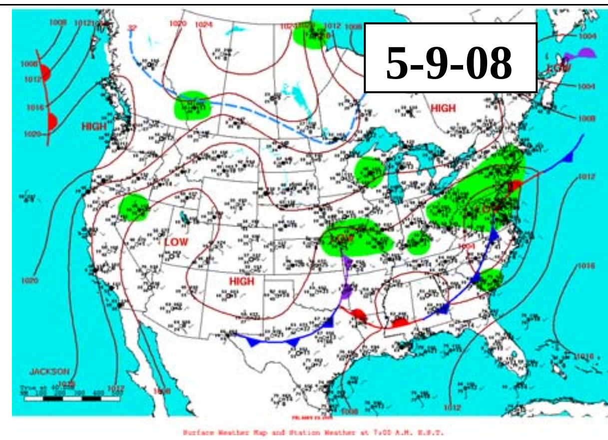
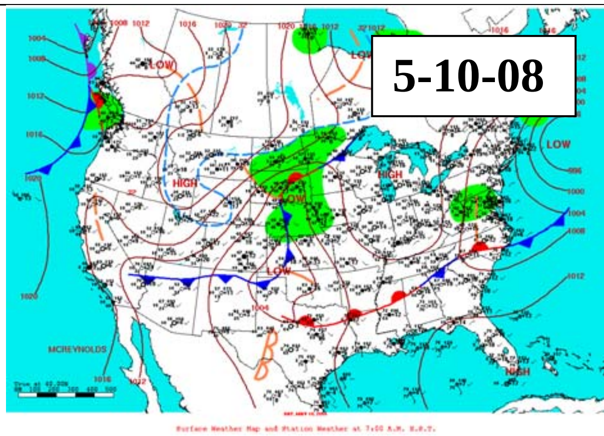
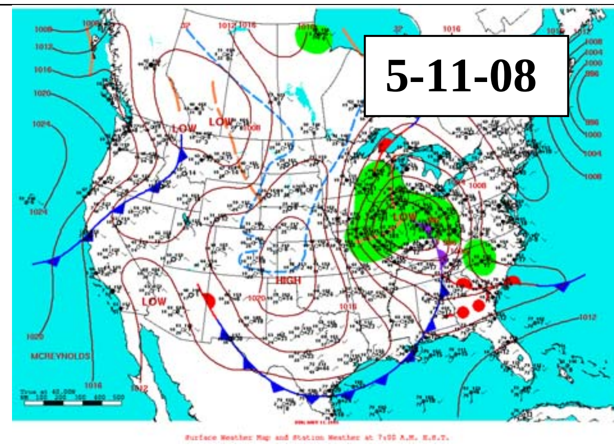
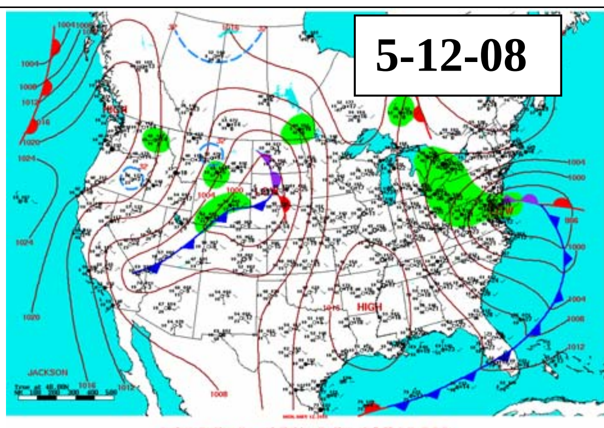
5-5-08
5-6-08
5-7-08

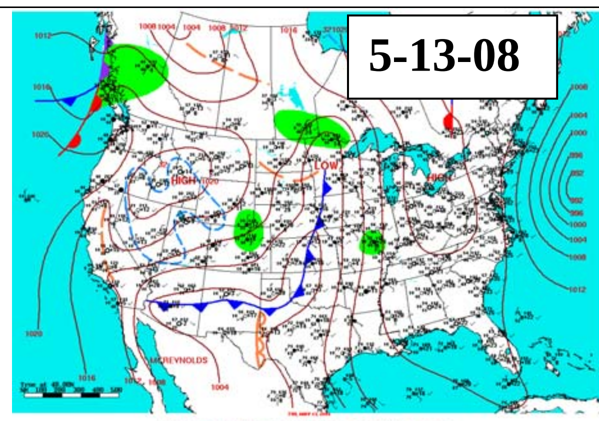




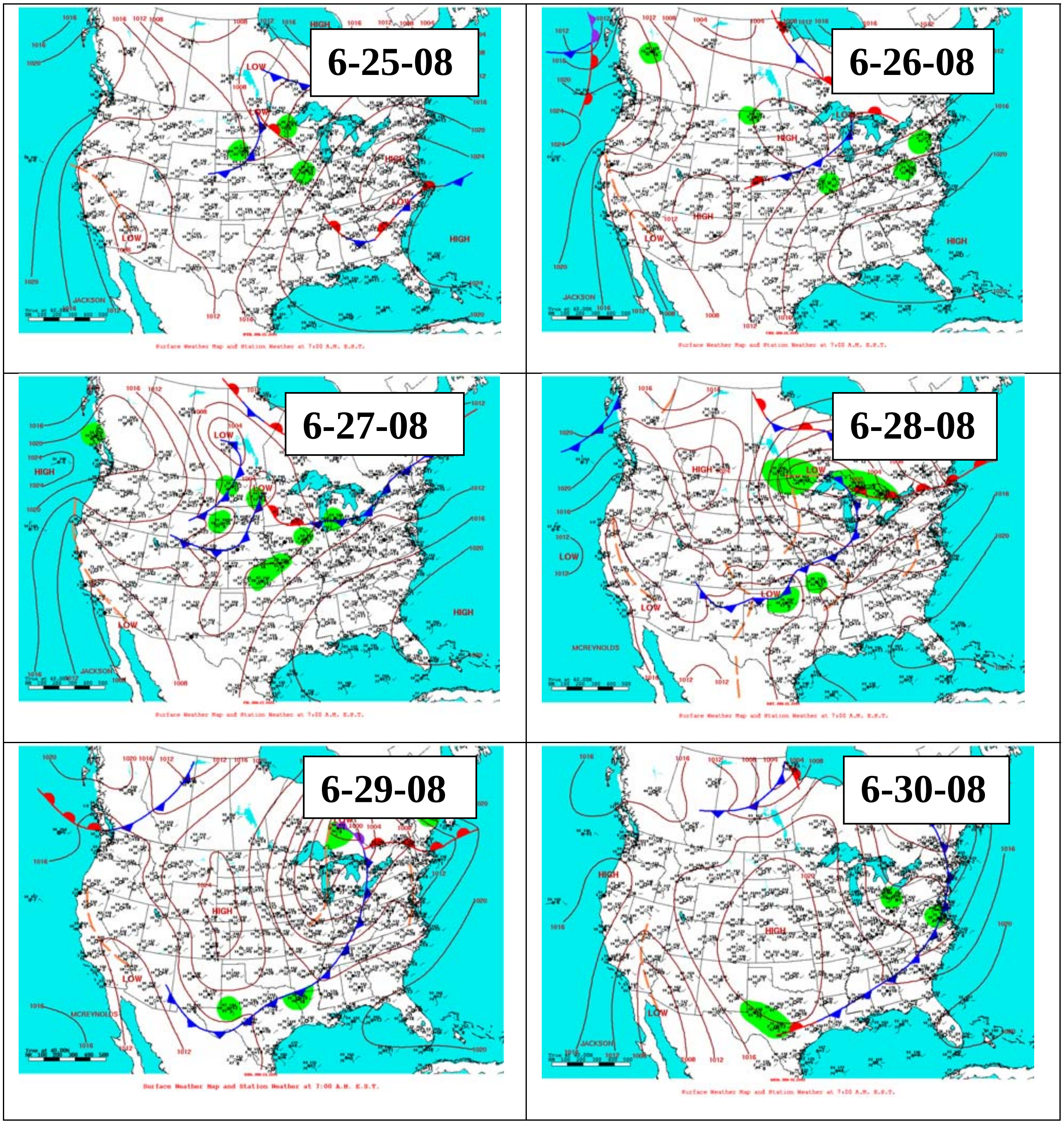


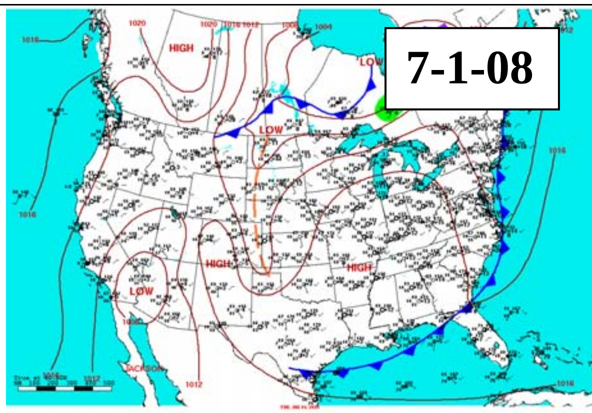


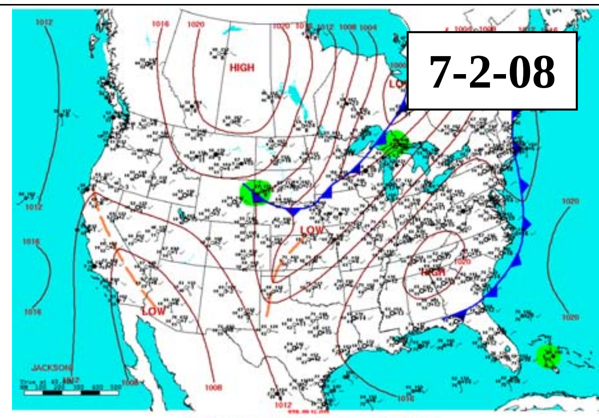


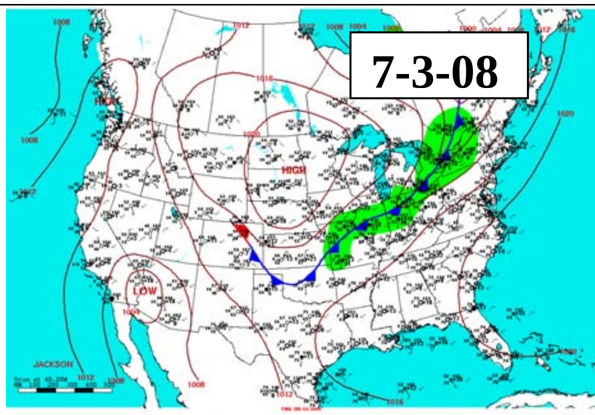


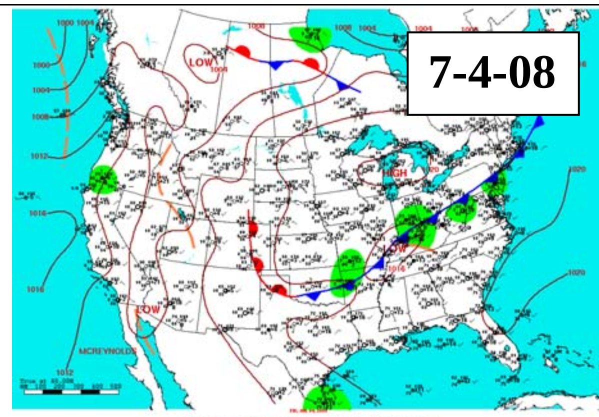
Period 5

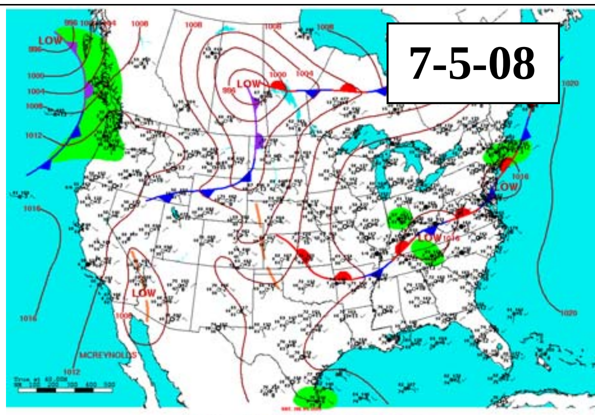

6-25-08
6-26-08
6-27-08
6-28-08
6-29-08
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.
6-30-08

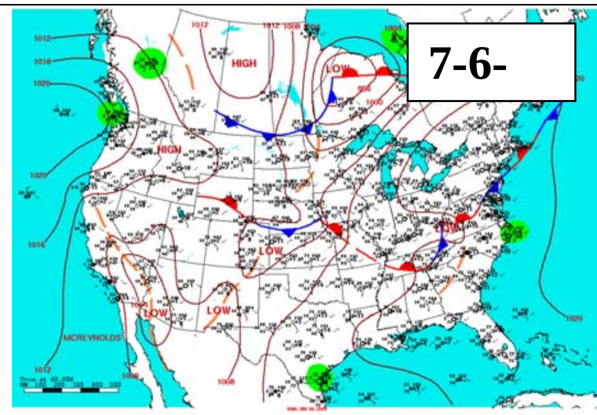

7-1-08

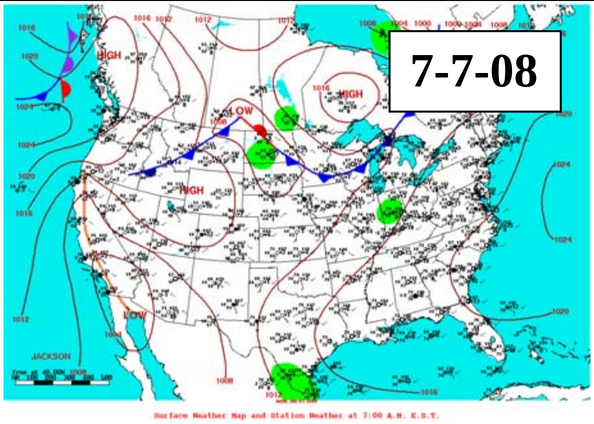

7-2-08

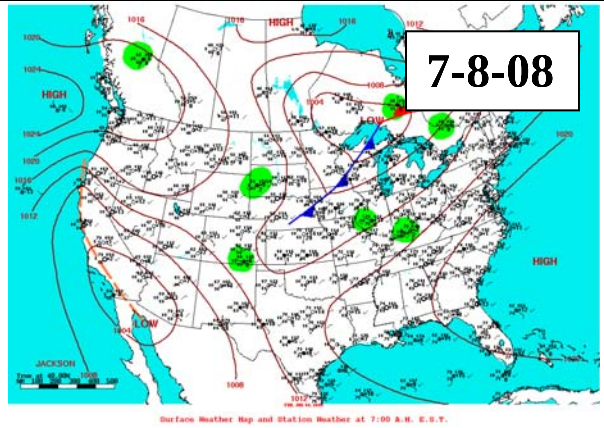

7-3-08

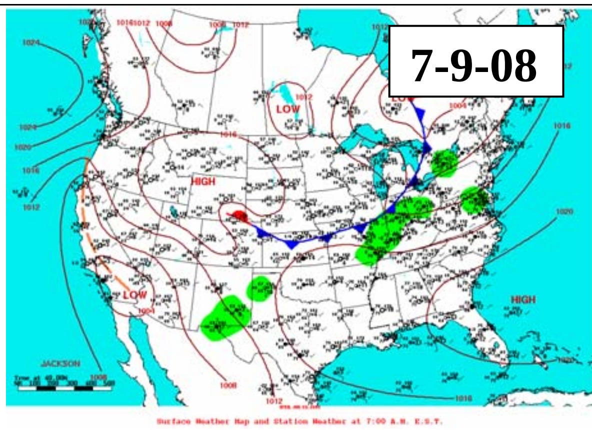

7-4-08

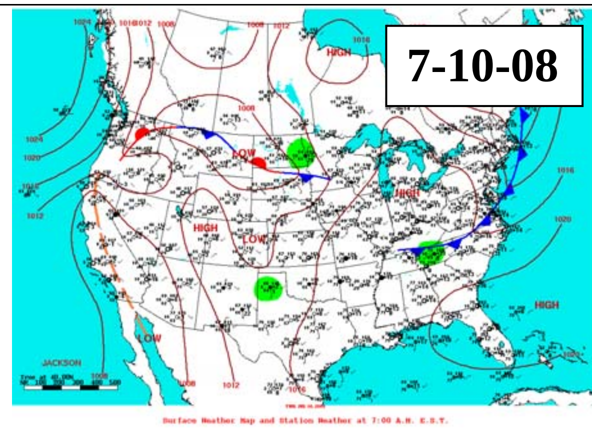

7-5-08

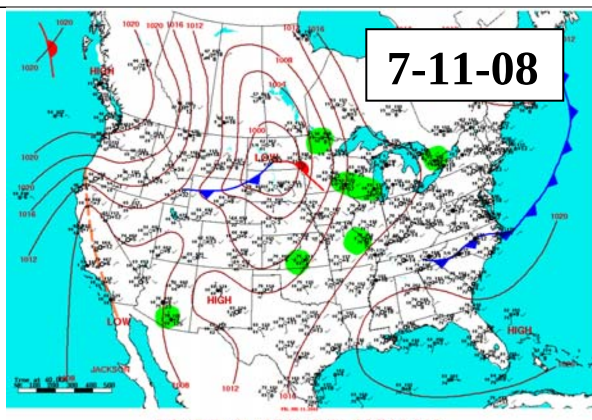

7-6-

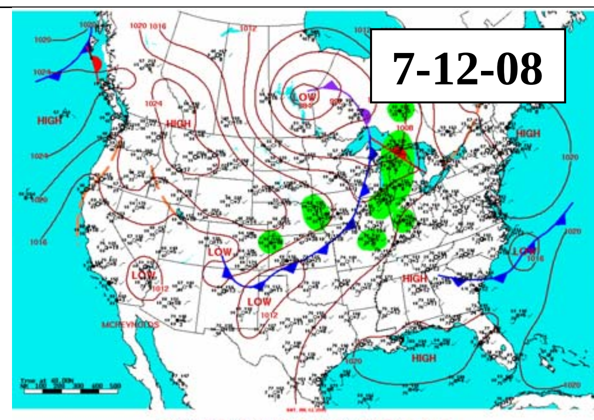

7-7-08
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.

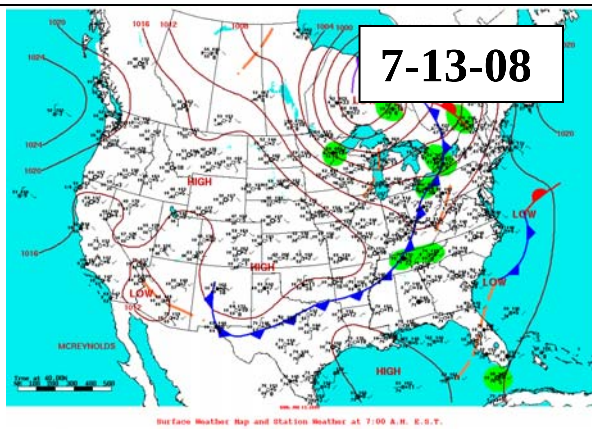
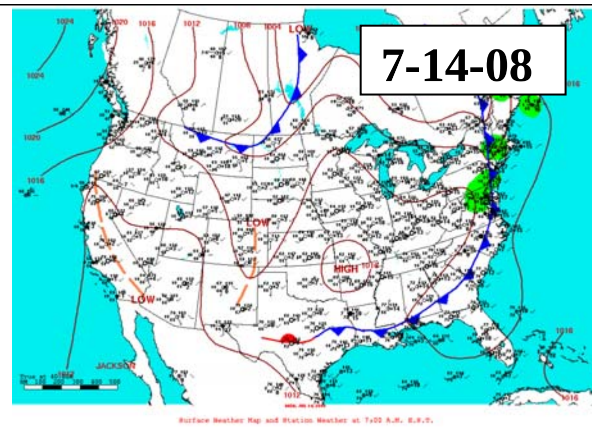

7-8-08
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.

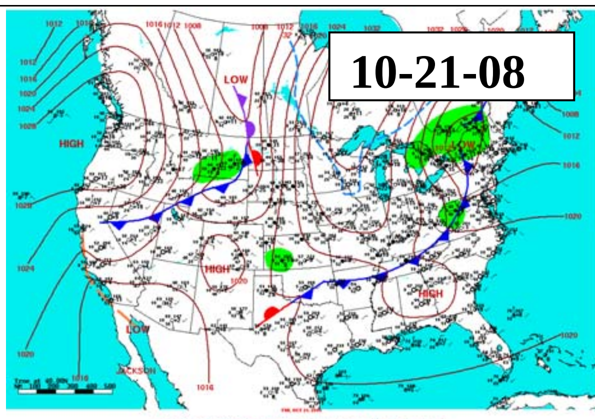
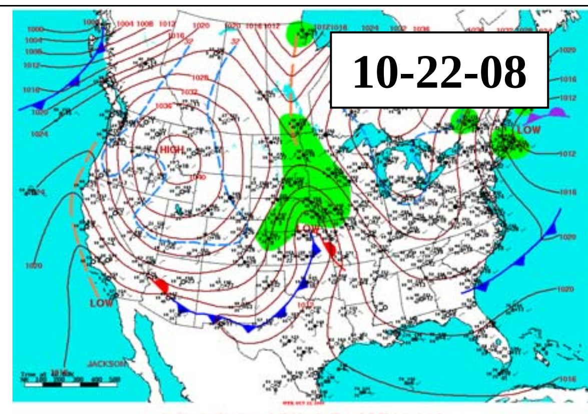
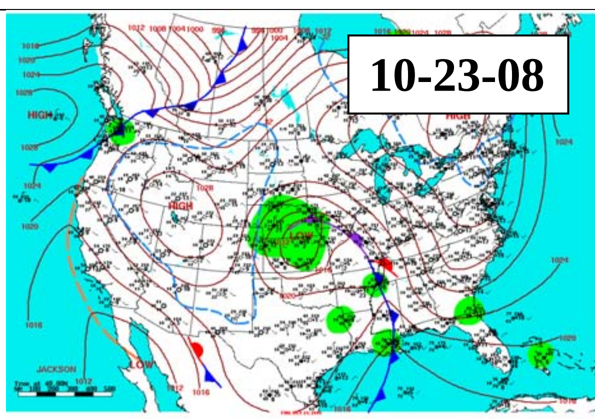
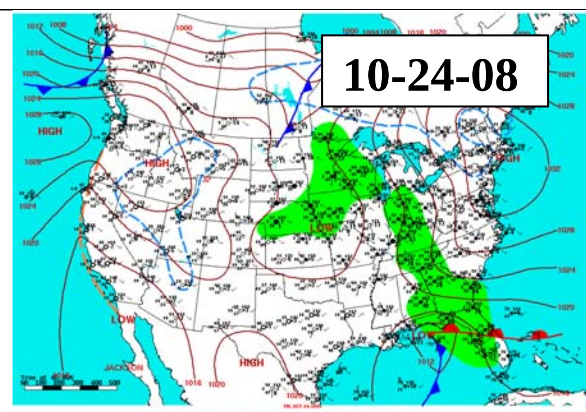

7-9-08
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.

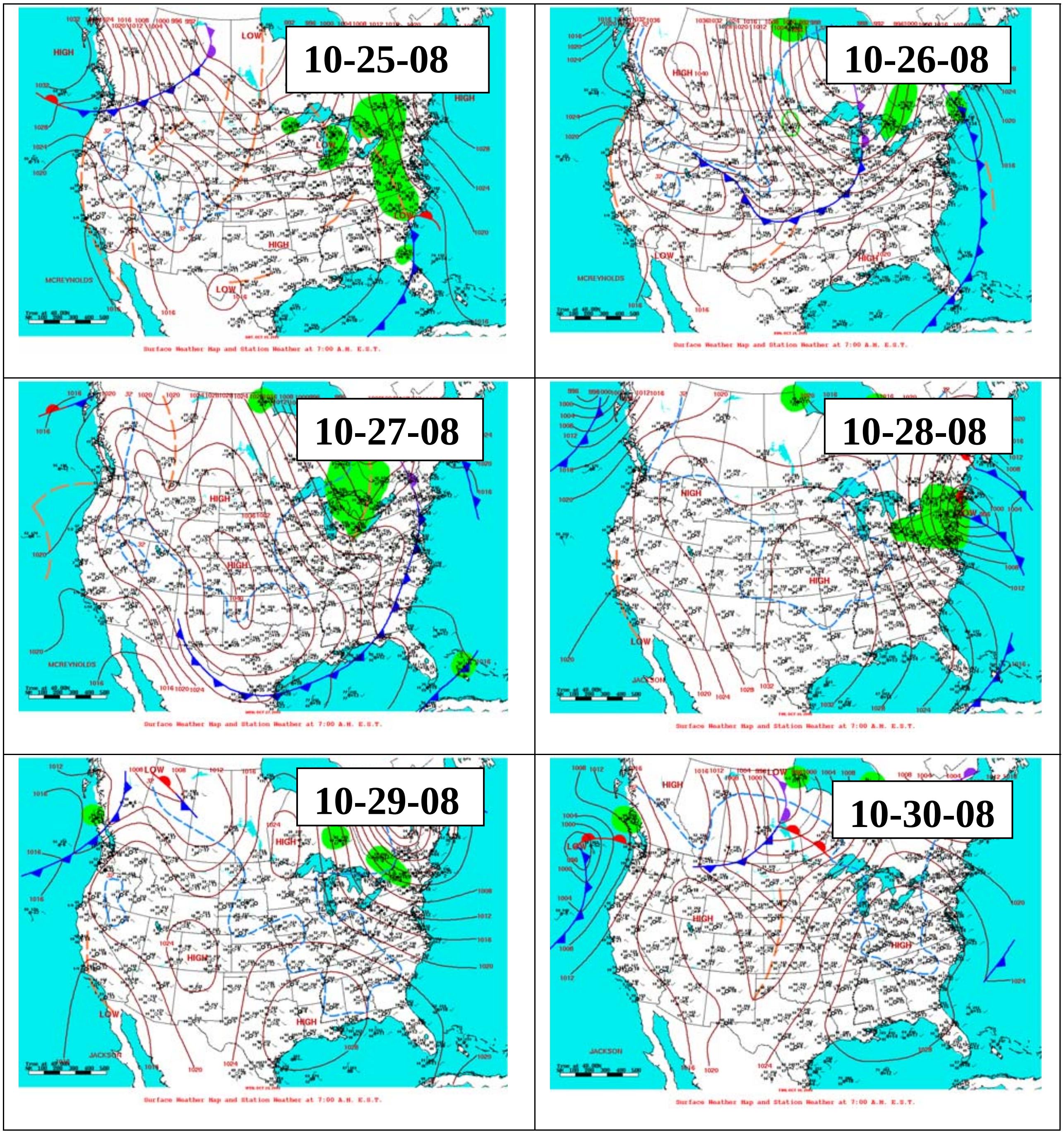

7-10-08
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.


7-11-08
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.


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

Period 6	
	
	


10-25-08
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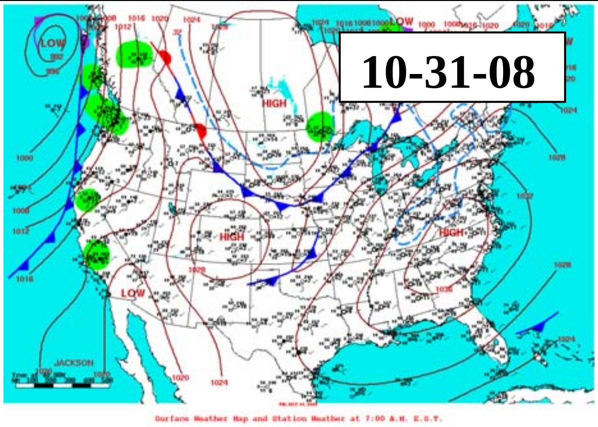
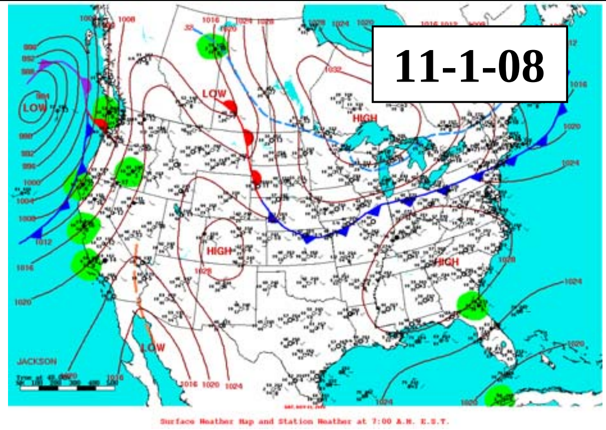
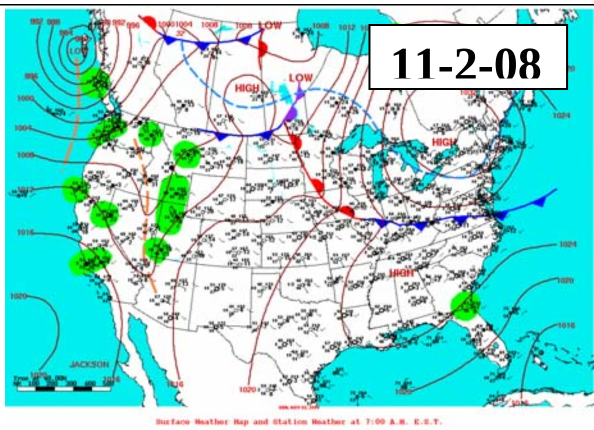
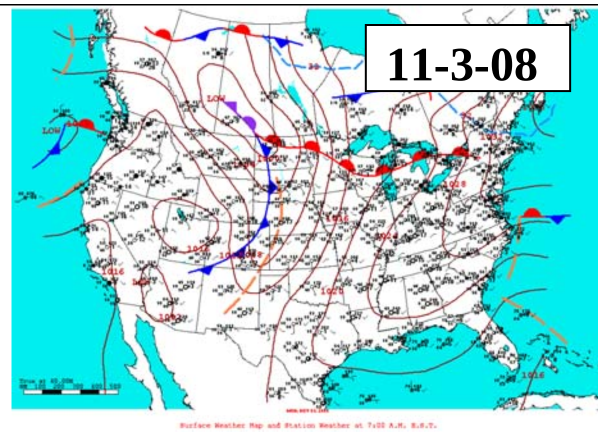
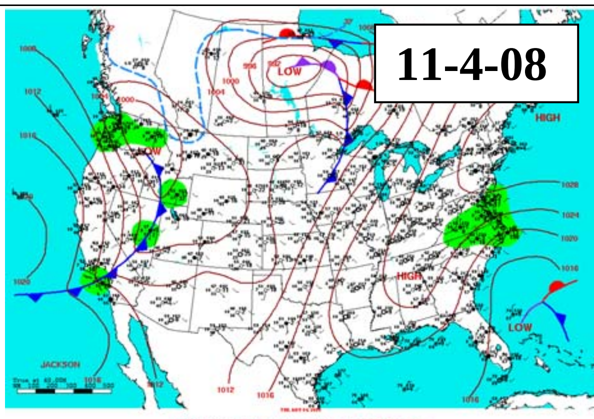
10-29-08
10-30-08

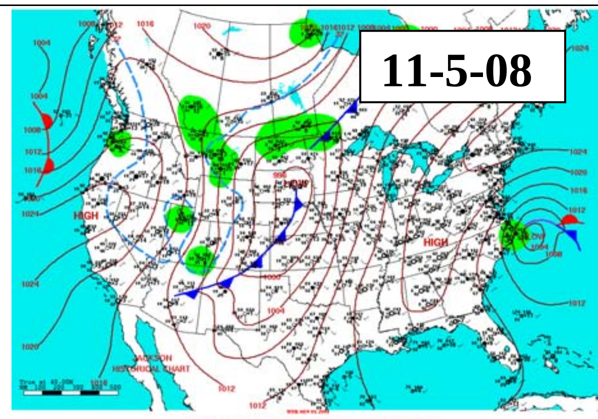

10-31-08

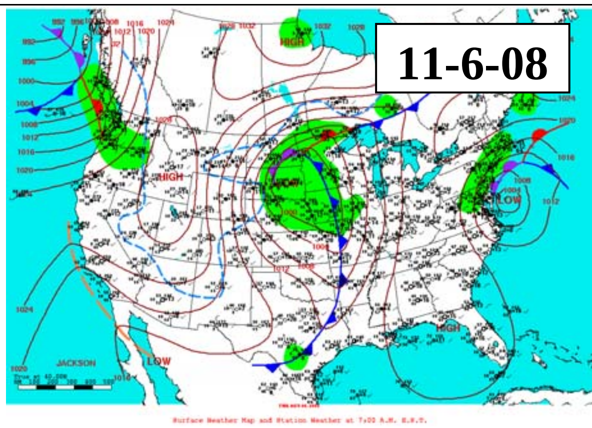

11-1-08

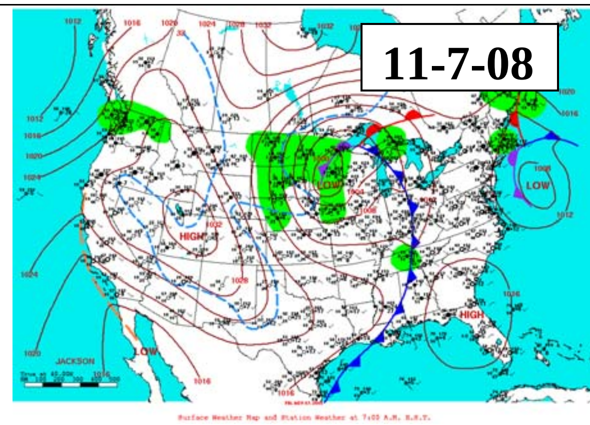

11-2-08

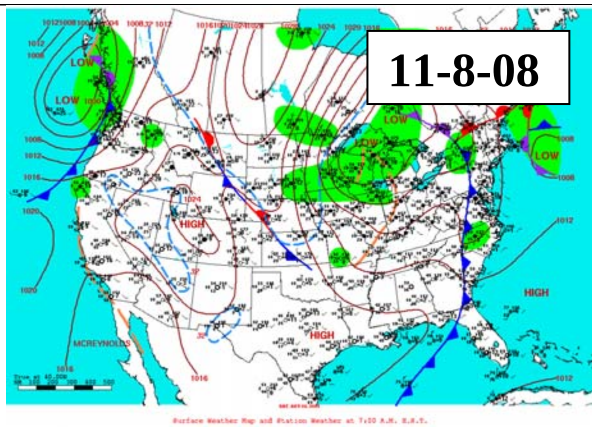

11-3-08

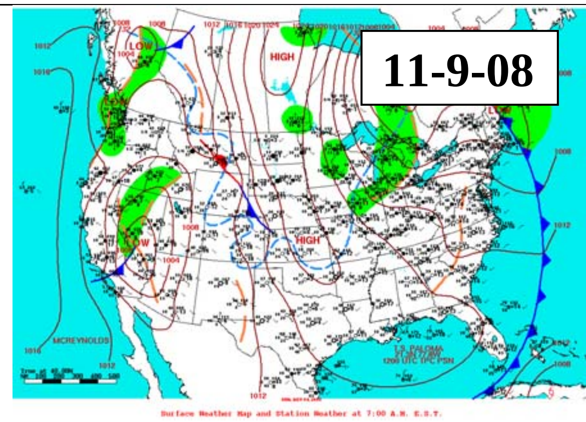

11-4-08

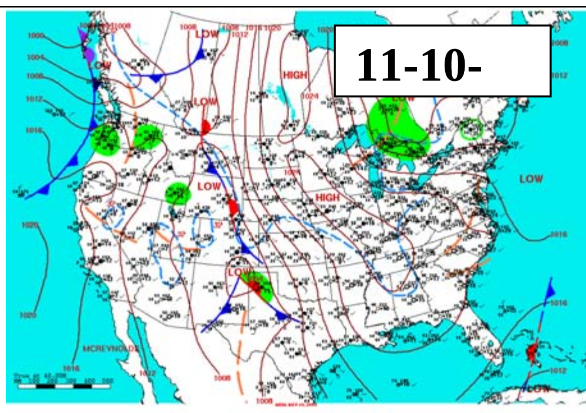

11-5-08

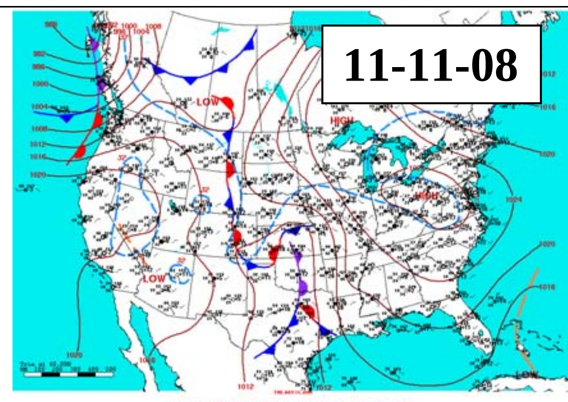

11-6-08


11-7-08


11-8-08


11-9-08


11-10-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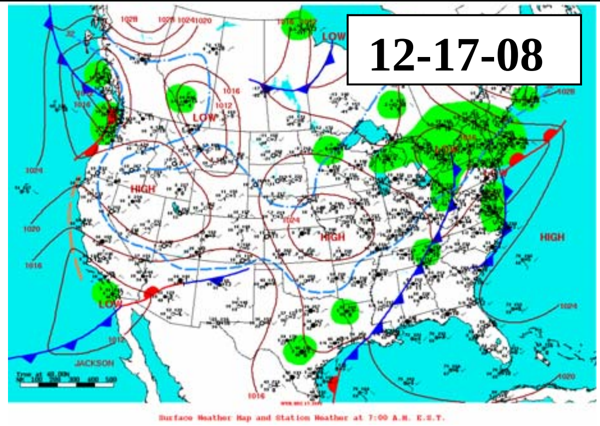
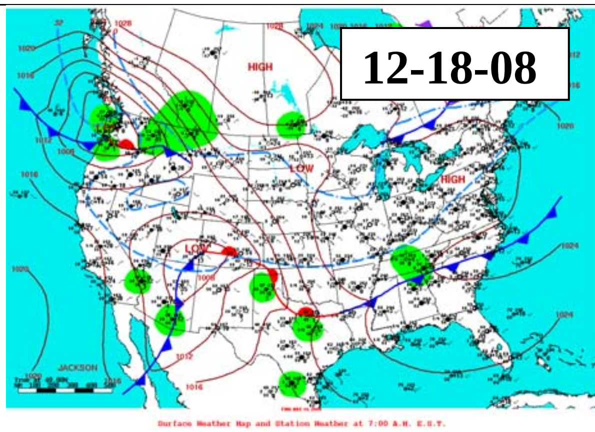
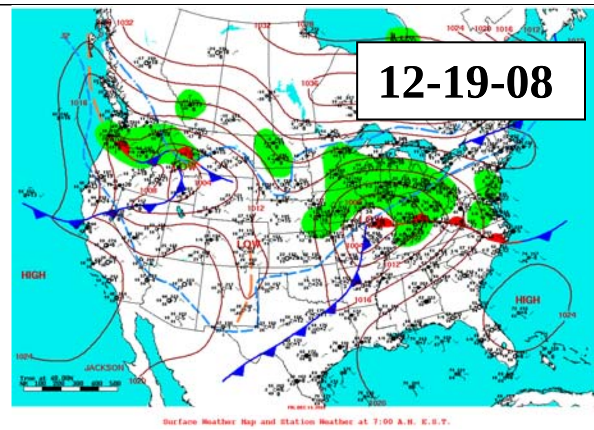
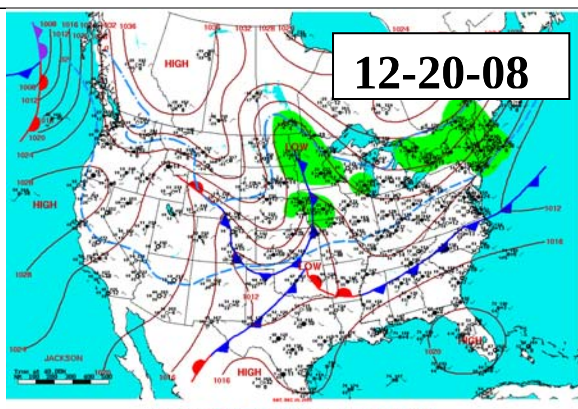
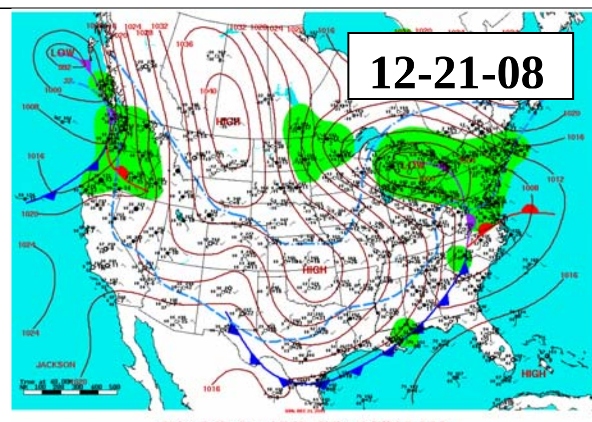
Period 7

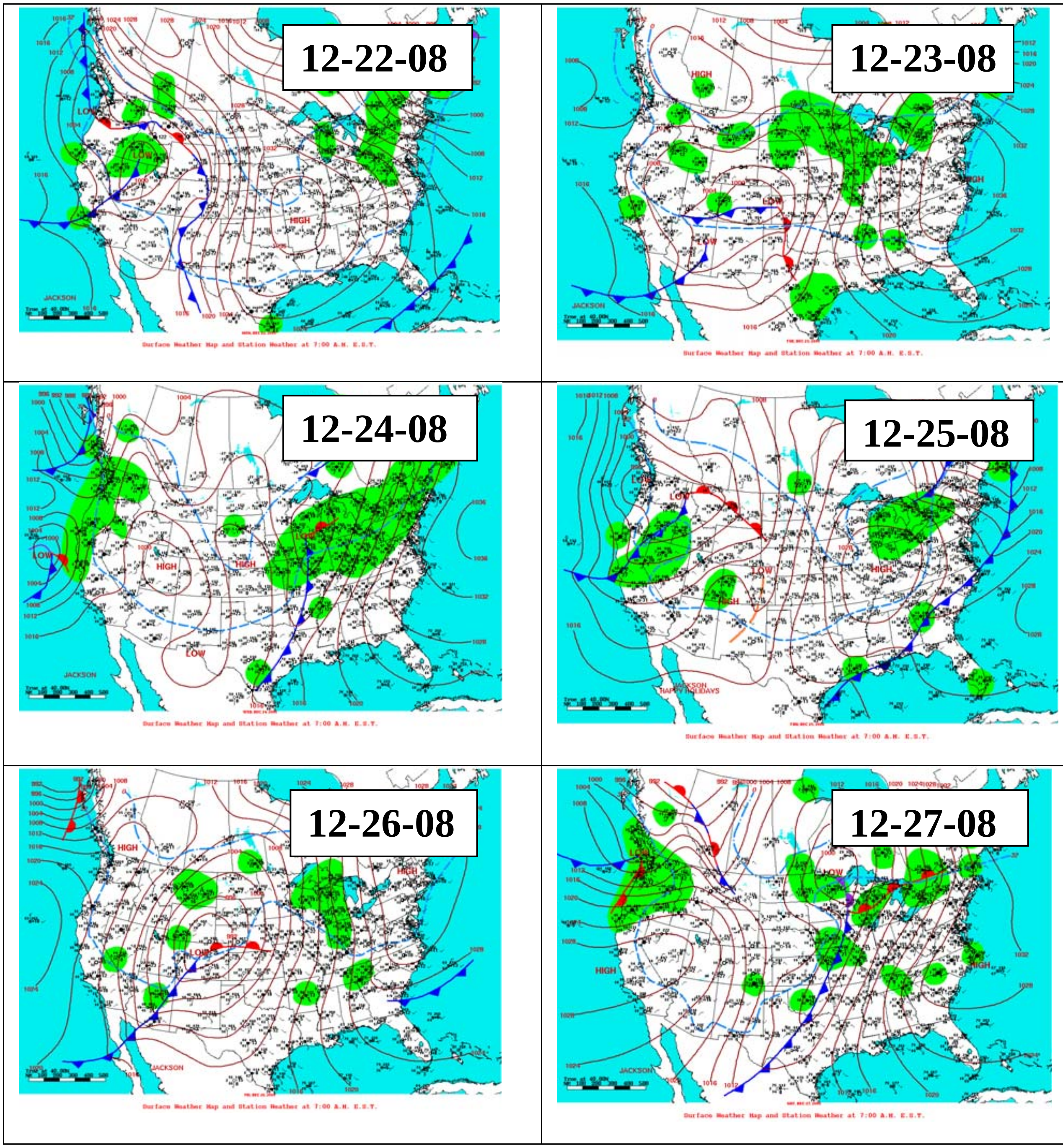

12-17-08
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.


12-18-08
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.


12-19-08
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.


12-20-08
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.


12-21-08
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.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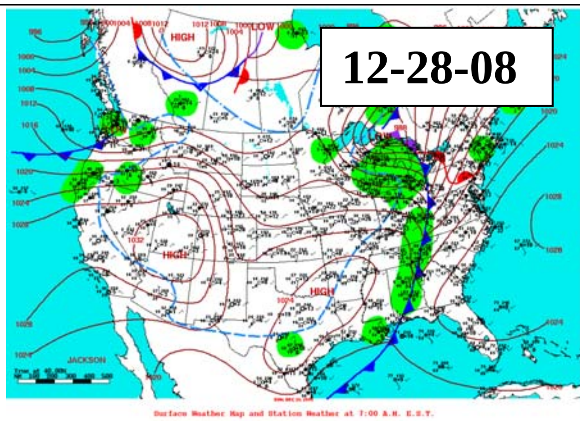
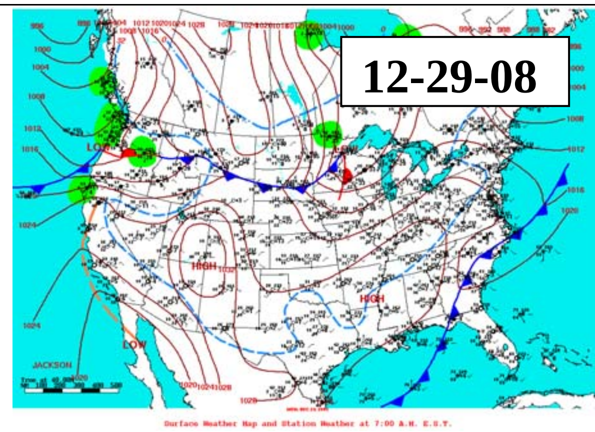
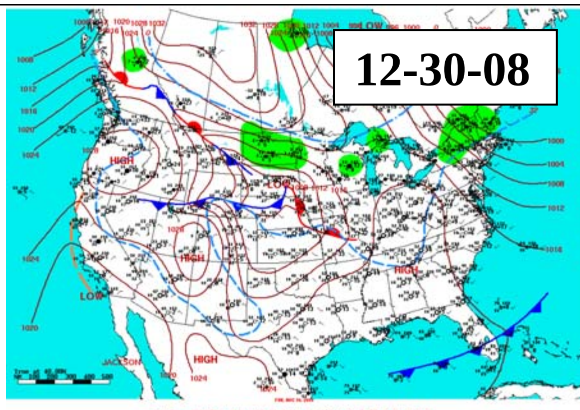
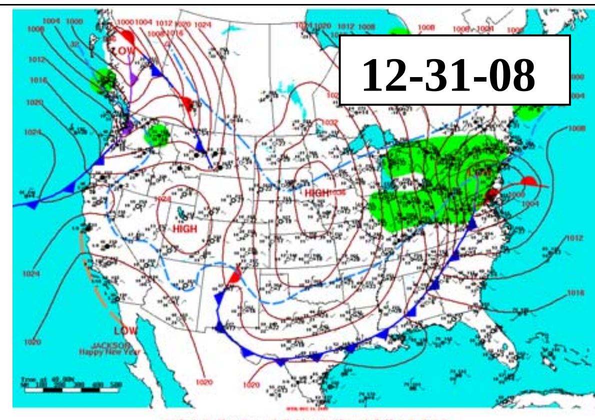
12-26-08
12-27-08


12-28-08


12-29-08


12-30-08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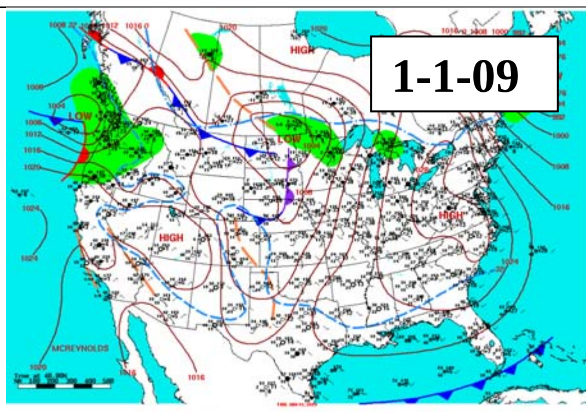
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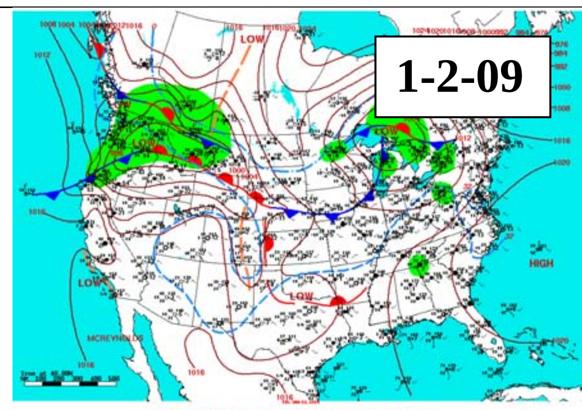
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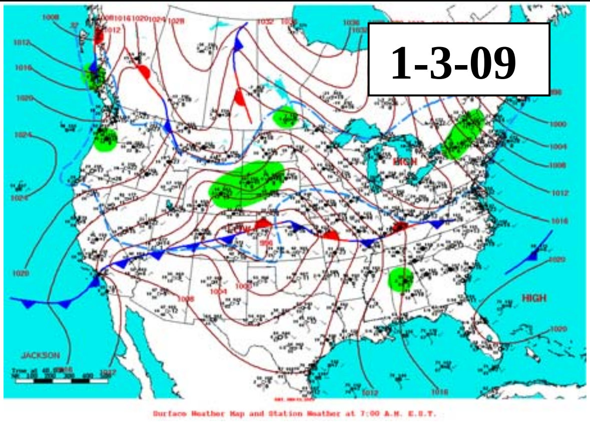	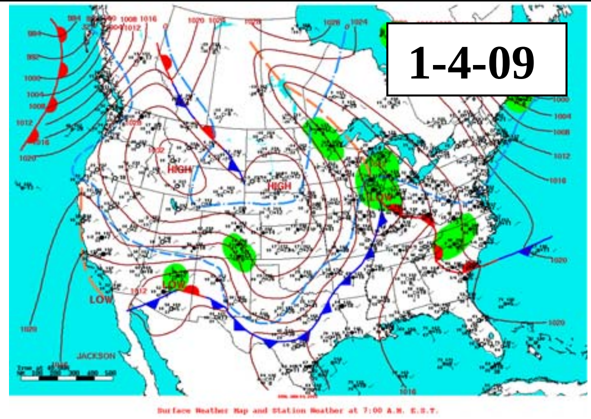
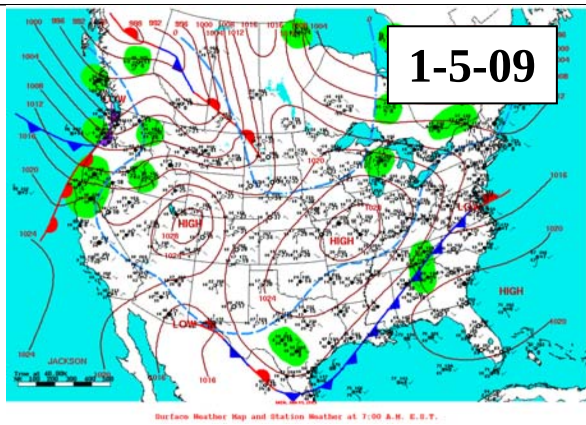	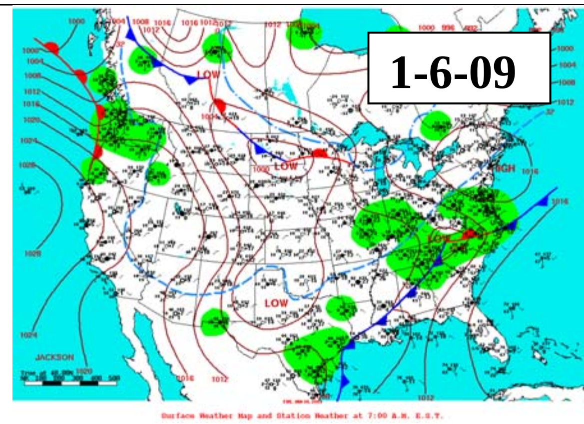
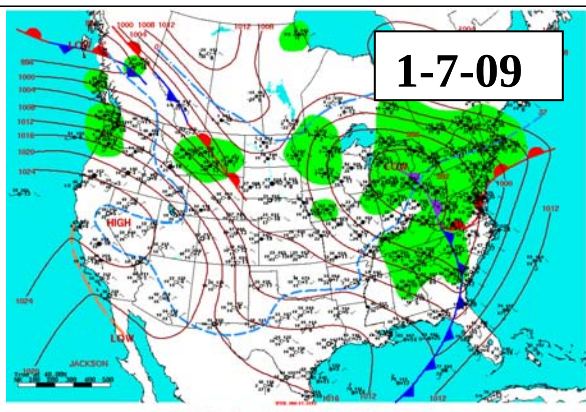	
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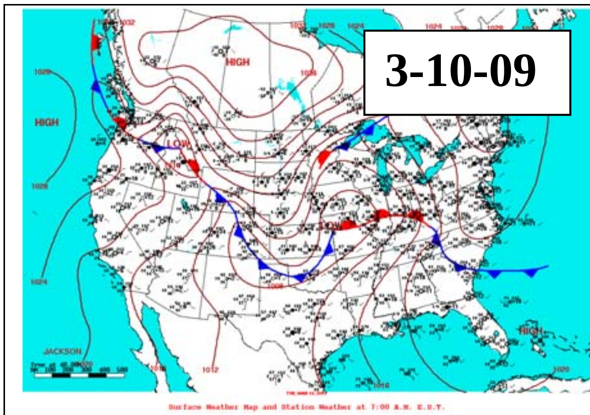
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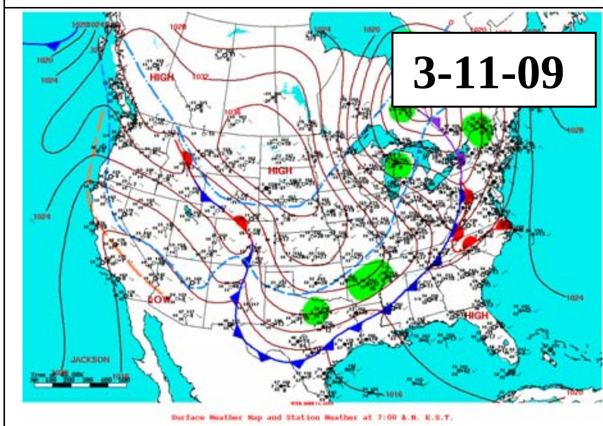
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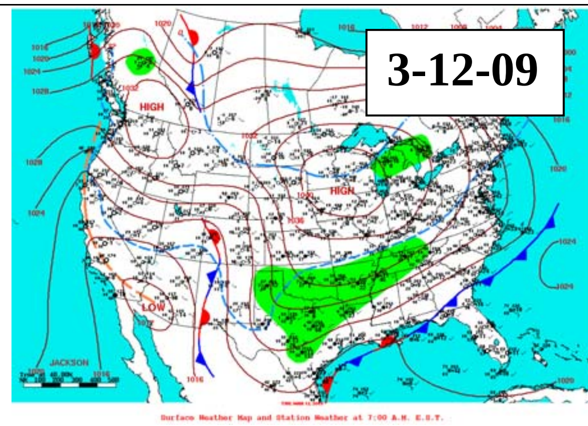
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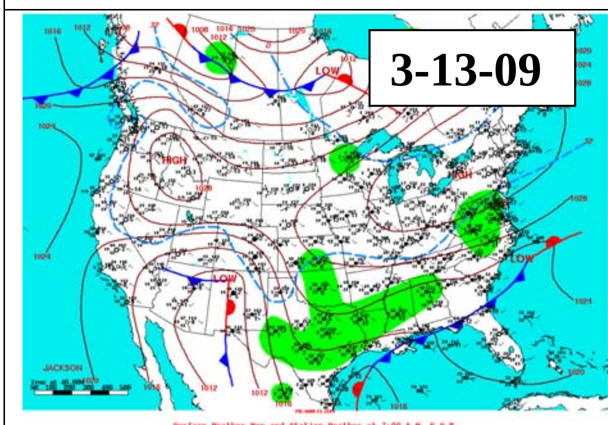
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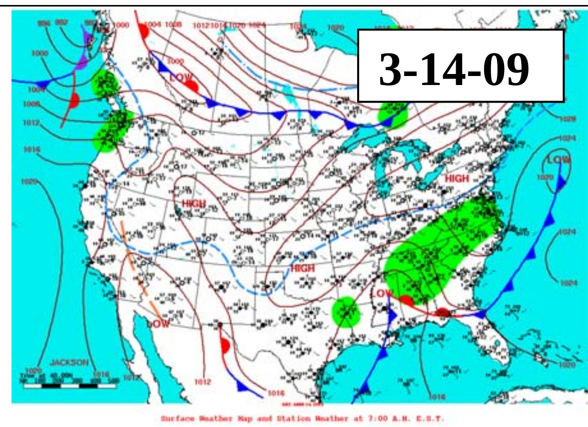
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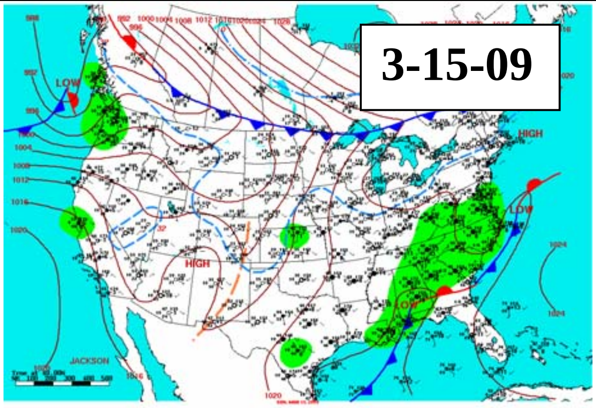
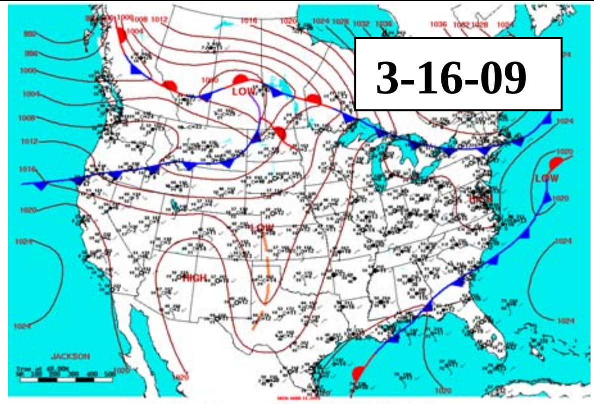
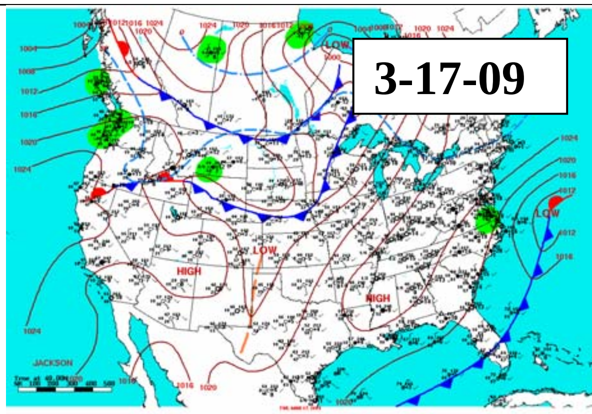


Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.



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



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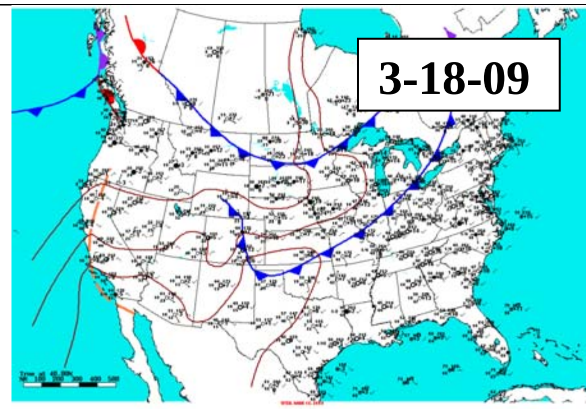

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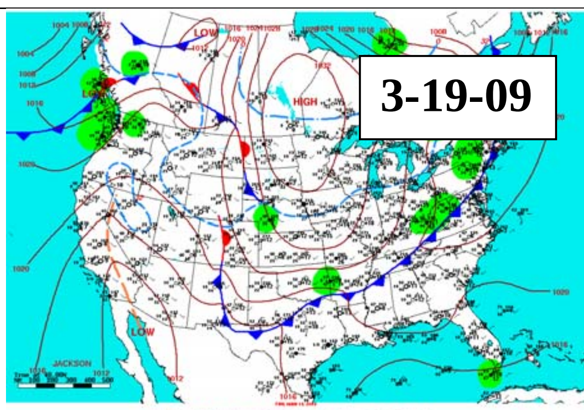

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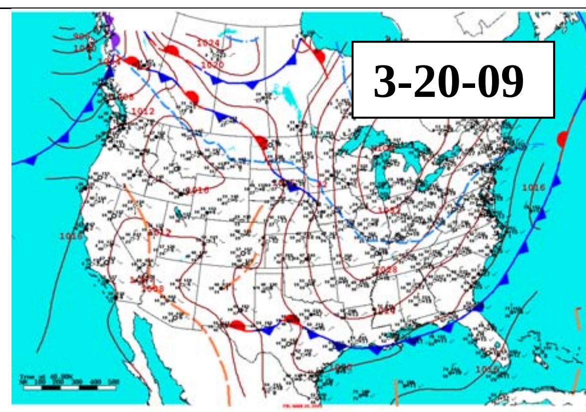

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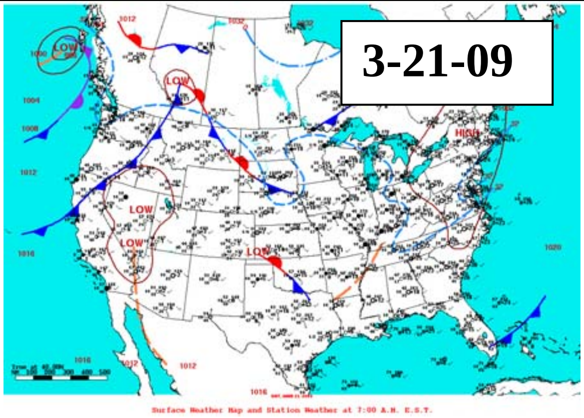
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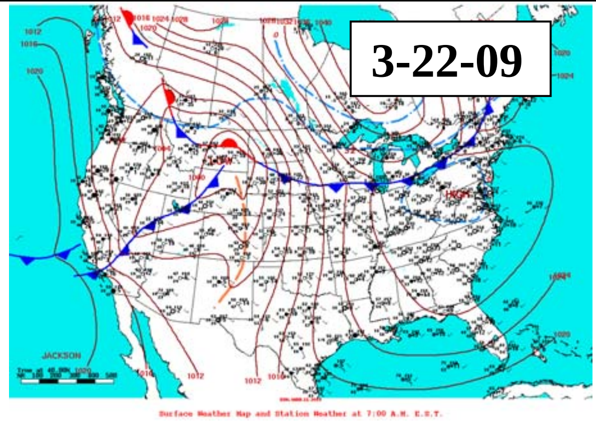
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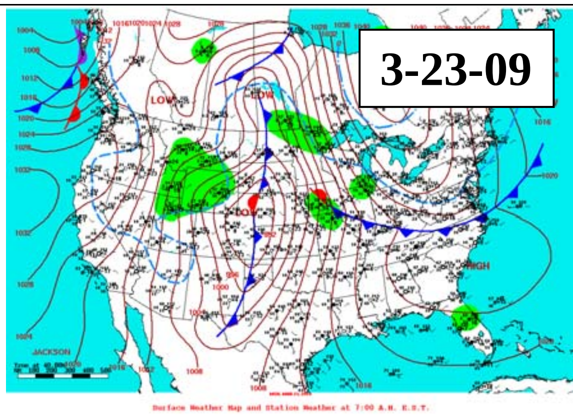
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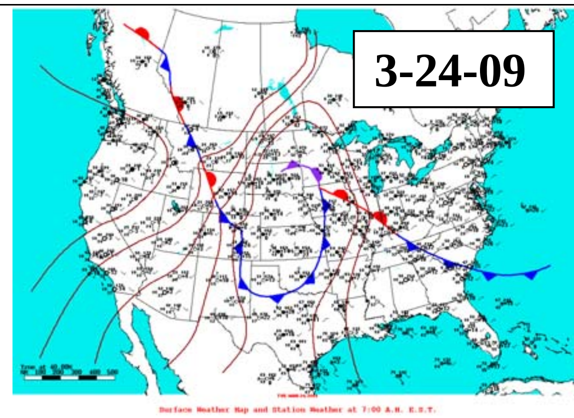
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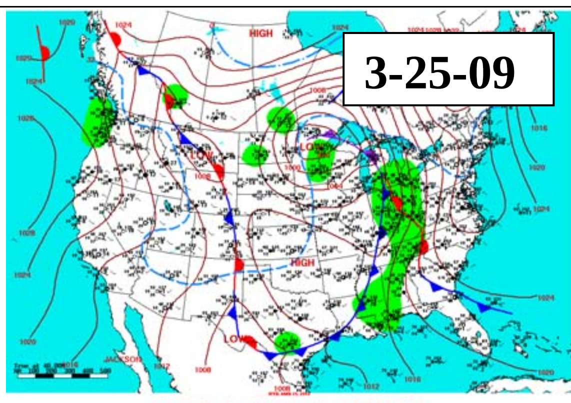
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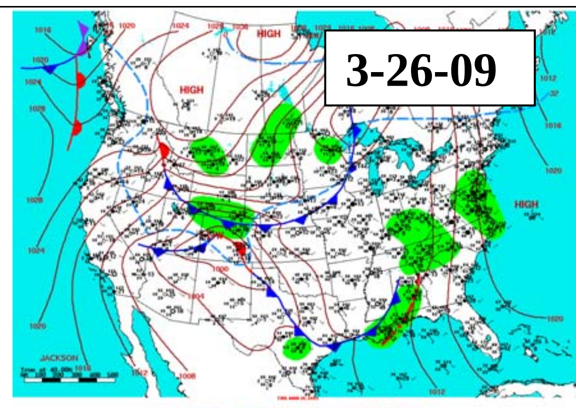
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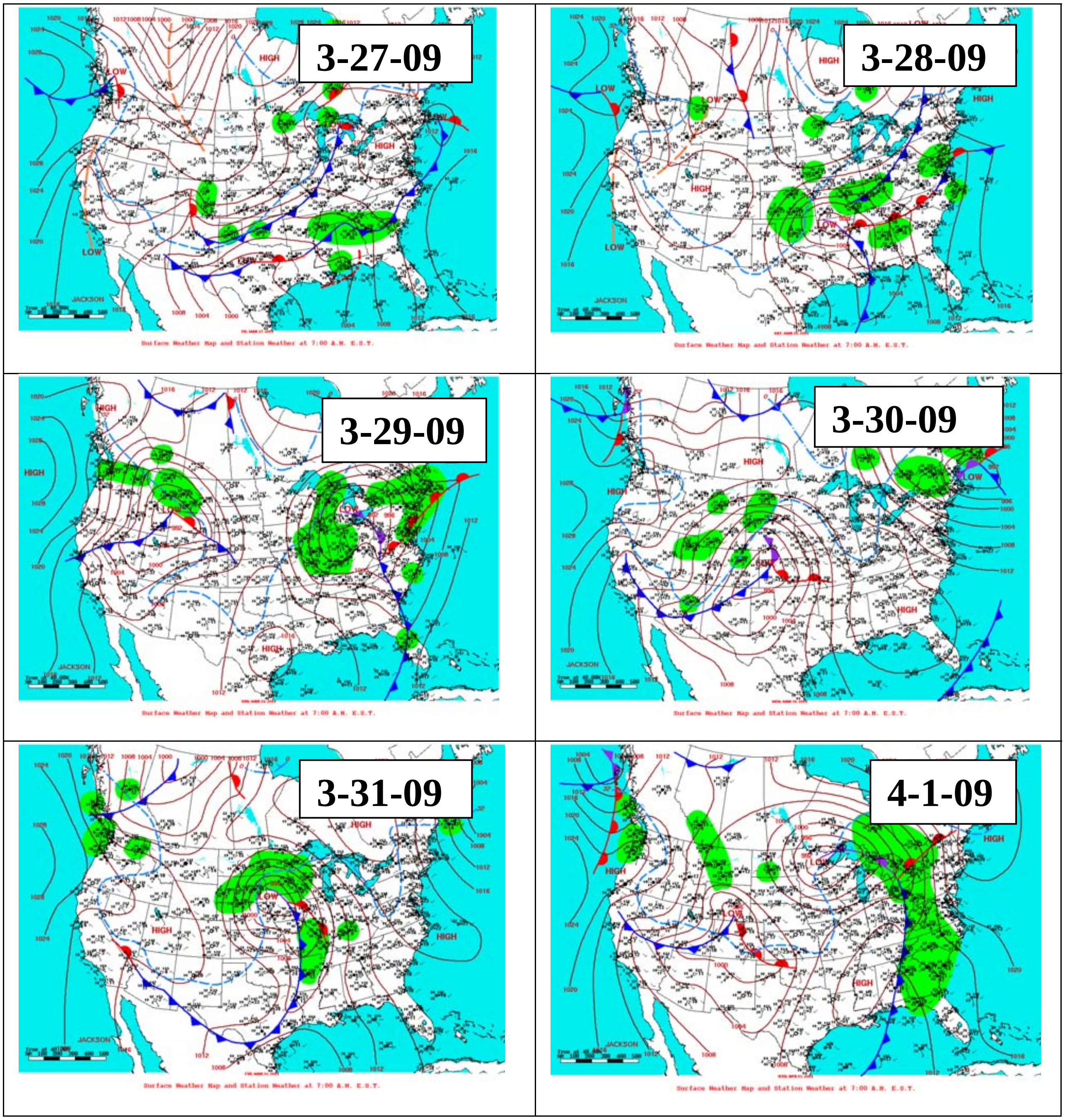
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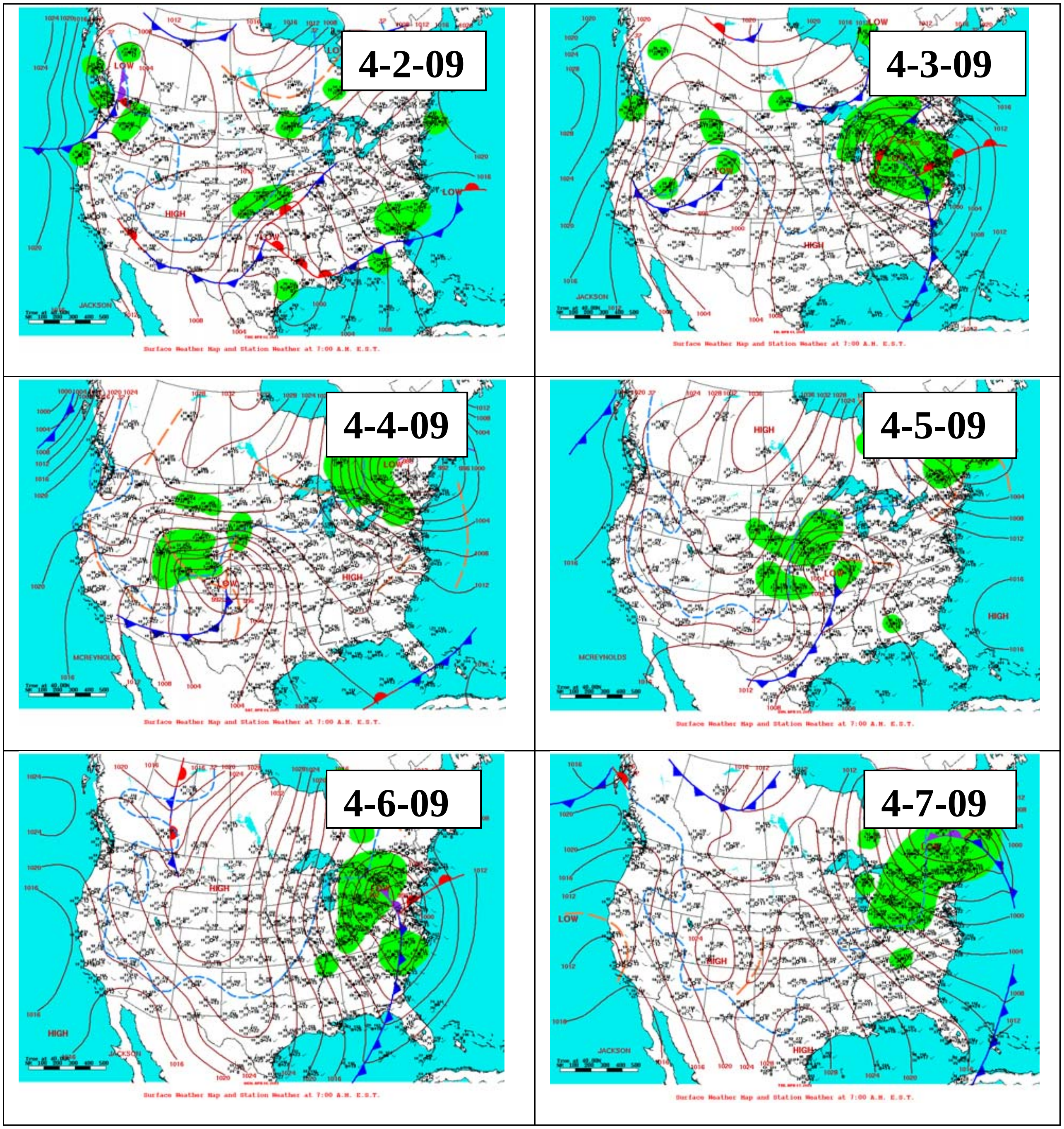
4-1-09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4-3-09
4-4-09
4-5-09
4-6-09
4-7-09

6.10 Daily weather conditions

Date	Barometric pressure (kPA)	Max solar radiation (Wm^{-2})	Wetness (%)	Air temperature (°C)
Period 1				
7/19/2007	97.40	952	4%	24.5
7/20/2007	98.28	944	42%	17.2
7/21/2007	98.32	931	71%	18.2
7/22/2007	98.15	548	92%	19.7
7/23/2007	97.91	643	70%	21.2
7/24/2007	97.73	853	100%	24.0
7/25/2007	97.61	961	83%	25.2
7/26/2007	97.25	941	94%	26.1
7/27/2007	97.28	952	60%	23.8
7/28/2007	97.74	937	23%	22.0
7/29/2007	97.78	939	41%	21.5
7/30/2007	97.86	994	45%	22.2
7/31/2007	97.91	875	42%	24.2
8/1/2007	97.63	986	38%	25.1
8/2/2007	97.63	895	38%	24.3
8/3/2007	97.91	975	34%	20.8
8/4/2007	97.80	457	87%	17.9
8/5/2007	97.13	787	100%	17.6
8/6/2007	97.18	940	100%	20.2
8/7/2007	96.87	878	100%	24.7
8/8/2007	97.20	925	99%	22.1
8/9/2007	97.11	1036	69%	24.9
8/10/2007	97.63	917	36%	23.6
8/11/2007	97.46	926	64%	24.6
8/12/2007	97.95	934	100%	22.3
8/13/2007	98.11	831	100%	21.5
8/14/2007	97.39	768	100%	22.4
8/15/2007	97.39	744	100%	20.0
8/16/2007	97.63	840	100%	20.2
8/17/2007	98.14	879	100%	16.2
8/18/2007	98.15	221	100%	14.3
8/19/2007	97.55	410	100%	14.5
8/20/2007	97.27	261	100%	15.7
8/21/2007	97.21	887	100%	19.0
8/22/2007	97.35	299	100%	20.8
8/23/2007	97.18	257	100%	18.6
8/24/2007	97.22	949	100%	18.6
8/25/2007	97.58	1020	100%	17.6
8/26/2007	97.73	881	100%	17.9
8/27/2007	97.39	782	100%	20.8

Date	Barometric pressure (kPA)	Max solar radiation (Wm^{-2})	Wetness (%)	Air temperature (°C)
8/28/2007	97.11	439	100%	21.7
Period 2				
11/14/2007	97.15	N/A	0%	1.7
11/15/2007	97.82	343	0%	2.2
11/16/2007	97.38	392	23%	5.2
11/17/2007	97.46	481	82%	2.4
11/18/2007	98.26	299	100%	3.3
11/19/2007	97.35	86	100%	4.6
11/20/2007	97.61	151	99%	4.3
11/21/2007	98.21	168	97%	1.5
11/22/2007	98.75	207	98%	-1.6
11/23/2007	98.60	425	98%	0.1
11/24/2007	97.79	333	98%	2.3
11/25/2007	97.25	458	98%	6.7
11/26/2007	97.56	454	98%	4.7
11/27/2007	98.22	427	98%	0.5
11/28/2007	97.61	378	98%	-1.8
Period 3				
11/29/2007	N/A	N/A	N/A	N/A
11/30/2007	N/A	N/A	N/A	N/A
12/1/2007	N/A	N/A	N/A	N/A
12/2/2007	N/A	N/A	N/A	N/A
12/3/2007	N/A	N/A	N/A	N/A
12/4/2007	N/A	N/A	N/A	N/A
12/5/2007	N/A	N/A	N/A	N/A
12/6/2007	N/A	N/A	N/A	N/A
12/7/2007	N/A	N/A	N/A	N/A
12/8/2007	N/A	N/A	N/A	N/A
12/9/2007	N/A	N/A	N/A	N/A
12/10/2007	N/A	N/A	N/A	N/A
12/11/2007	N/A	N/A	N/A	N/A
12/12/2007	N/A	N/A	N/A	N/A
12/13/2007	N/A	N/A	N/A	N/A
12/14/2007	N/A	N/A	N/A	N/A
12/15/2007	N/A	N/A	N/A	N/A
12/16/2007	N/A	N/A	N/A	N/A
12/17/2007	N/A	N/A	N/A	N/A
12/18/2007	N/A	N/A	N/A	N/A
Period 4				
4/23/2008	97.92	789	50%	22.5
4/24/2008	97.42	261	100%	14.5
4/25/2008	96.43	208	56%	10.9

Date	Barometric pressure (kPA)	Max solar radiation (Wm^{-2})	Wetness (%)	Air temperature (°C)
4/26/2008	96.43	696	4%	0.8
4/27/2008	97.91	1023	57%	1.9
4/28/2008	97.90	532	47%	0.5
4/29/2008	98.03	990	28%	1.4
4/30/2008	97.31	965	68%	7.8
5/1/2008	96.52	948	100%	12.4
5/2/2008	95.91	163	54%	10.2
5/3/2008	96.30	994	0%	5.9
5/4/2008	97.30	1025	11%	10.1
5/5/2008	97.50	970	11%	10.8
5/6/2008	97.18	935	54%	14.8
5/7/2008	96.57	1033	33%	12.7
5/8/2008	97.08	971	13%	10.5
5/9/2008	97.25	1018	45%	11.3
5/10/2008	97.20	753	56%	10.5
5/11/2008	96.94	1178	33%	7.7
5/12/2008	97.30	1027	0%	8.2
5/13/2008	96.96	370	100%	12.7
Period 5				
6/26/2008	97.26	1001	1%	25.0
6/27/2008	96.79	1131	82%	19.5
6/28/2008	96.48	1046	54%	16.7
6/29/2008	97.03	1047	41%	18.4
6/30/2008	97.84	984	44%	18.5
7/1/2008	97.45	1015	80%	20.4
7/2/2008	96.84	989	64%	23.3
7/3/2008	97.88	1287	55%	17.4
7/4/2008	97.93	1086	98%	17.7
7/5/2008	97.52	912	100%	22.0
7/6/2008	97.07	919	100%	23.4
7/7/2008	97.07	621	100%	22.6
7/8/2008	96.92	947	60%	21.4
7/9/2008	97.50	1111	62%	19.1
7/10/2008	97.37	808	93%	18.7
7/12/2008	97.00	733	100%	20.9
7/13/2008	97.05	933	57%	20.0
7/14/2008	96.99	1019	0%	19.4
7/15/2008	97.27	924	44%	18.1
Period 6				
10/21/2008	98.68	525	0%	9.1
10/22/2008	98.60	137	18%	5.6
10/23/2008	98.42	540	0%	7.4

Date	Barometric pressure (kPA)	Max solar radiation (Wm^{-2})	Wetness (%)	Air temperature (°C)
10/24/2008	97.59	268	54%	7.7
10/25/2008	96.53	483	54%	7.5
10/26/2008	96.50	253	27%	5.6
10/27/2008	98.32	592	7%	1.9
10/28/2008	98.90	477	41%	-0.7
10/29/2008	98.19	476	4%	2.9
10/30/2008	97.91	468	0%	9.9
10/31/2008	98.35	472	27%	11.5
11/1/2008	98.88	426	0%	6.8
11/2/2008	97.96	488	4%	10.2
11/3/2008	97.46	431	63%	12.6
11/4/2008	97.28	549	19%	17.4
11/5/2008	96.66	318	3%	15.9
11/6/2008	96.23	391	65%	13.2
11/7/2008	96.20	147	70%	2.9
11/8/2008	96.38	98	68%	0.6
11/9/2008	96.41	203	0%	-3.1
11/10/2008	96.33	535	5%	-4.1
11/11/2008	98.24	99	99%	-3.9
Period 7				
12/18/2008	98.21	371	9%	-16.3
12/19/2008	97.88	398	9%	-8.9
12/20/2008	97.66	149	77%	-9.0
12/21/2008	97.48	456	5%	-21.2
12/22/2008	98.60	376	0%	-21.5
12/23/2008	97.39	281	31%	-13.4
12/24/2008	96.84	279	74%	-13.5
12/25/2008	98.01	370	15%	-16.2
12/26/2008	96.70	113	81%	-2.1
12/27/2008	96.16	118	100%	-0.5
12/28/2008	95.62	368	68%	-8.8
12/29/2008	97.27	381	66%	-3.3
12/30/2008	96.73	141	31%	-9.7
12/31/2008	93.53	393	6%	-19.0
1/1/2009	96.65	344	3%	-9.0
1/2/2009	96.96	389	8%	-13.8
1/3/2009	97.29	159	10%	-9.5
1/4/2009	97.72	405	100%	-10.9
1/5/2009	97.80	402	86%	-15.8
1/6/2009	96.34	423	31%	-7.0
1/7/2009	95.63	352	99%	-10.5
Period 8				

Date	Barometric pressure (kPA)	Max solar radiation (Wm^{-2})	Wetness (%)	Air temperature (°C)
3/10/2009	96.22	85	100%	-0.4
3/11/2009	98.18	720	39%	-14.8
3/12/2009	99.73	719	0%	-16.2
3/13/2009	98.74	690	20%	-6.3
3/14/2009	97.83	675	45%	1.6
3/15/2009	97.50	672	0%	5.7
3/16/2009	97.56	667	4%	9.7
3/17/2009	97.31	646	42%	9.3
3/18/2009	98.12	801	20%	3.5
3/19/2009	98.89	727	15%	-2.1
3/20/2009	98.69	616	19%	-1.0
3/21/2009	98.25	711	55%	6.1
3/22/2009	98.37	716	0%	7.6
3/23/2009	97.45	684	38%	5.0
3/24/2009	96.41	380	47%	7.0
3/25/2009	96.03	266	59%	1.7
3/26/2009	97.00	386	0%	-2.0
3/27/2009	97.81	962	7%	-5.2
3/28/2009	97.53	922	35%	-1.9
3/29/2009	96.83	780	31%	-1.6
3/30/2009	97.33	734	28%	0.8
3/31/2009	96.15	349	57%	2.9
4/1/2009	95.59	364	55%	0.7
4/2/2009	96.76	982	19%	1.5
4/3/2009	96.86	865	3%	2.1
4/4/2009	97.65	760	48%	1.1
4/5/2009	97.70	841	70%	1.4
4/6/2009	97.83	819	0%	0.8
4/7/2009	97.62	183	0%	-1.6

6.11 Daily lagoon conditions

6.11.1 Conditions of lagoon 1

Date	Air temperature (°C)	Lagoon temp(°C)	Lagoon pH	Lagoon ORP (mV)
Period 1				
7/19/2007	24.5	24.7	6.58	-407
7/20/2007	17.2	22.8	6.60	-422
7/21/2007	18.2	21.9	N/A	N/A
7/22/2007	19.7	21.5	N/A	N/A
7/23/2007	21.2	21.4	N/A	N/A
7/24/2007	24.0	21.5	N/A	N/A
7/25/2007	25.2	21.8	N/A	N/A
7/26/2007	26.1	22.4	N/A	N/A
7/27/2007	23.8	22.6	N/A	N/A
7/28/2007	22.0	22.6	N/A	N/A
7/29/2007	21.5	22.7	N/A	N/A
7/30/2007	22.2	22.8	N/A	N/A
7/31/2007	24.2	23.2	N/A	N/A
8/1/2007	25.1	23.6	N/A	N/A
8/2/2007	24.3	24.1	N/A	N/A
8/3/2007	20.8	23.8	N/A	N/A
8/4/2007	17.9	23.2	N/A	N/A
8/5/2007	17.6	22.6	N/A	N/A
8/6/2007	20.2	22.3	N/A	N/A
8/7/2007	24.7	22.7	N/A	N/A
8/8/2007	22.1	23.1	N/A	N/A
8/9/2007	24.9	23.3	N/A	N/A
8/10/2007	23.6	23.6	N/A	N/A
8/11/2007	24.6	23.9	N/A	N/A
8/12/2007	22.3	23.9	N/A	N/A
8/13/2007	21.5	23.3	N/A	N/A
8/14/2007	22.4	23.1	N/A	N/A
8/15/2007	20.0	22.6	N/A	N/A
8/16/2007	20.2	22.1	N/A	N/A
8/17/2007	16.2	21.6	N/A	N/A
8/18/2007	14.3	21.1	N/A	N/A
8/19/2007	14.5	20.3	N/A	N/A
8/20/2007	15.7	19.6	N/A	N/A
8/21/2007	19.0	19.8	N/A	N/A
8/22/2007	20.8	20.1	N/A	N/A
8/23/2007	18.6	21.0	N/A	N/A
8/24/2007	18.6	21.7	N/A	N/A
8/25/2007	17.6	22.4	N/A	N/A
8/26/2007	17.9	23.9	N/A	N/A
8/27/2007	20.8	23.4	N/A	N/A

Date	Air temperature (°C)	Lagoon temp(°C)	Lagoon pH	Lagoon ORP (mV)
8/28/2007	21.7	23.8	N/A	N/A
Period 2				
11/14/2007	N/A	N/A	N/A	N/A
11/15/2007	2.2	7.8	7.09	-478
11/16/2007	5.2	7.4	7.05	-505
11/17/2007	2.4	7.1	7.05	-503
11/18/2007	3.3	5.5	7.07	-506
11/19/2007	4.6	5.7	7.04	-503
11/20/2007	4.3	5.5	7.04	-507
11/21/2007	1.5	5.5	7.05	-506
11/22/2007	-1.6	5.3	7.04	-505
11/23/2007	0.1	4.6	7.05	-505
11/24/2007	2.3	4.8	7.03	-506
11/25/2007	6.7	4.7	7.00	-506
11/26/2007	4.7	4.6	7.00	-505
11/27/2007	0.5	4.8	6.98	-506
11/28/2007	-1.8	N/A	N/A	N/A
Period 3				
11/29/2007	N/A	N/A	N/A	N/A
11/30/2007	N/A	N/A	N/A	N/A
12/1/2007	N/A	N/A	N/A	N/A
12/2/2007	N/A	N/A	N/A	N/A
12/3/2007	N/A	N/A	N/A	N/A
12/4/2007	N/A	N/A	N/A	N/A
12/5/2007	N/A	N/A	N/A	N/A
12/6/2007	N/A	N/A	N/A	N/A
12/7/2007	N/A	N/A	N/A	N/A
12/8/2007	N/A	N/A	N/A	N/A
12/9/2007	N/A	N/A	N/A	N/A
12/10/2007	N/A	N/A	N/A	N/A
12/11/2007	N/A	N/A	N/A	N/A
12/12/2007	N/A	N/A	N/A	N/A
12/13/2007	N/A	N/A	N/A	N/A
12/14/2007	N/A	N/A	N/A	N/A
12/15/2007	N/A	N/A	N/A	N/A
12/16/2007	N/A	N/A	N/A	N/A
12/17/2007	N/A	N/A	N/A	N/A
12/18/2007	N/A	N/A	N/A	N/A
Period 4				
4/23/2008	22.5	N/A	N/A	N/A
4/24/2008	14.5	N/A	N/A	N/A
4/25/2008	10.9	N/A	N/A	N/A
4/26/2008	0.8	N/A	N/A	N/A

Date	Air temperature (°C)	Lagoon temp(°C)	Lagoon pH	Lagoon ORP (mV)
4/27/2008	1.9	N/A	N/A	N/A
4/28/2008	0.5	N/A	N/A	N/A
4/29/2008	1.4	N/A	N/A	N/A
4/30/2008	7.8	N/A	N/A	N/A
5/1/2008	12.4	N/A	N/A	N/A
5/2/2008	10.2	N/A	N/A	N/A
5/3/2008	5.9	N/A	N/A	N/A
5/4/2008	10.1	N/A	N/A	N/A
5/5/2008	10.8	N/A	N/A	N/A
5/6/2008	14.8	N/A	N/A	N/A
5/7/2008	12.7	N/A	N/A	N/A
5/8/2008	10.5	N/A	N/A	N/A
5/9/2008	11.3	N/A	N/A	N/A
5/10/2008	10.5	N/A	N/A	N/A
5/11/2008	7.7	N/A	N/A	N/A
5/12/2008	8.2	N/A	N/A	N/A
5/13/2008	12.7	N/A	N/A	N/A
Period 5				
6/26/2008	25.0	N/A	N/A	N/A
6/27/2008	19.5	N/A	N/A	N/A
6/28/2008	16.7	N/A	N/A	N/A
6/29/2008	18.4	N/A	N/A	N/A
6/30/2008	18.5	N/A	N/A	N/A
7/1/2008	20.4	N/A	N/A	N/A
7/2/2008	23.3	N/A	N/A	N/A
7/3/2008	17.4	N/A	N/A	N/A
7/4/2008	17.7	N/A	N/A	N/A
7/5/2008	22.0	N/A	N/A	N/A
7/6/2008	23.4	N/A	N/A	N/A
7/7/2008	22.6	N/A	N/A	N/A
7/8/2008	21.4	N/A	N/A	N/A
7/9/2008	19.1	N/A	N/A	N/A
7/10/2008	18.7	N/A	N/A	N/A
7/12/2008	20.9	N/A	N/A	N/A
7/13/2008	20.0	N/A	N/A	N/A
7/14/2008	19.4	N/A	N/A	N/A
7/15/2008	18.1	N/A	N/A	N/A
Period 6				
10/21/2008	9.1	N/A	N/A	N/A
10/22/2008	5.6	N/A	N/A	N/A
10/23/2008	7.4	N/A	N/A	N/A
10/24/2008	7.7	N/A	N/A	N/A
10/25/2008	7.5	N/A	N/A	N/A

Date	Air temperature (°C)	Lagoon temp(°C)	Lagoon pH	Lagoon ORP (mV)
10/26/2008	5.6	N/A	N/A	N/A
10/27/2008	1.9	N/A	N/A	N/A
10/28/2008	-0.7	N/A	N/A	N/A
10/29/2008	2.9	N/A	N/A	N/A
10/30/2008	9.9	N/A	N/A	N/A
10/31/2008	11.5	N/A	N/A	N/A
11/1/2008	6.8	N/A	N/A	N/A
11/2/2008	10.2	N/A	N/A	N/A
11/3/2008	12.6	N/A	N/A	N/A
11/4/2008	17.4	N/A	N/A	N/A
11/5/2008	15.9	N/A	N/A	N/A
11/6/2008	13.2	N/A	N/A	N/A
11/7/2008	2.9	N/A	N/A	N/A
11/8/2008	0.6	N/A	N/A	N/A
11/9/2008	-3.1	N/A	N/A	N/A
11/10/2008	-4.1	N/A	N/A	N/A
11/11/2008	-3.9	N/A	N/A	N/A
Period 7				
12/18/2008	-16.3	N/A	N/A	N/A
12/19/2008	-8.9	N/A	N/A	N/A
12/20/2008	-9.0	N/A	N/A	N/A
12/21/2008	-21.2	N/A	N/A	N/A
12/22/2008	-21.5	N/A	N/A	N/A
12/23/2008	-13.4	N/A	N/A	N/A
12/24/2008	-13.5	N/A	N/A	N/A
12/25/2008	-16.2	N/A	N/A	N/A
12/26/2008	-2.1	N/A	N/A	N/A
12/27/2008	-0.5	N/A	N/A	N/A
12/28/2008	-8.8	N/A	N/A	N/A
12/29/2008	-3.3	N/A	N/A	N/A
12/30/2008	-9.7	N/A	N/A	N/A
12/31/2008	-19.0	N/A	N/A	N/A
1/1/2009	-9.0	N/A	N/A	N/A
1/2/2009	-13.8	N/A	N/A	N/A
1/3/2009	-9.5	N/A	N/A	N/A
1/4/2009	-10.9	N/A	N/A	N/A
1/5/2009	-15.8	N/A	N/A	N/A
1/6/2009	-7.0	N/A	N/A	N/A
1/7/2009	-10.5	N/A	N/A	N/A
Period 8				
3/10/2009	-0.4	N/A	N/A	N/A
3/11/2009	-14.8	N/A	N/A	N/A
3/12/2009	-16.2	N/A	N/A	N/A

Date	Air temperature (°C)	Lagoon temp(°C)	Lagoon pH	Lagoon ORP (mV)
3/13/2009	-6.3	N/A	N/A	N/A
3/14/2009	1.6	N/A	N/A	N/A
3/15/2009	5.7	N/A	N/A	N/A
3/16/2009	9.7	N/A	N/A	N/A
3/17/2009	9.3	N/A	N/A	N/A
3/18/2009	3.5	N/A	N/A	N/A
3/19/2009	-2.1	N/A	N/A	N/A
3/20/2009	-1.0	N/A	N/A	N/A
3/21/2009	6.1	N/A	N/A	N/A
3/22/2009	7.6	N/A	N/A	N/A
3/23/2009	5.0	N/A	N/A	N/A
3/24/2009	7.0	N/A	N/A	N/A
3/25/2009	1.7	N/A	N/A	N/A
3/26/2009	-2.0	N/A	N/A	N/A
3/27/2009	-5.2	N/A	N/A	N/A
3/28/2009	-1.9	N/A	N/A	N/A
3/29/2009	-1.6	N/A	N/A	N/A
3/30/2009	0.8	N/A	N/A	N/A
3/31/2009	2.9	N/A	N/A	N/A
4/1/2009	0.7	N/A	N/A	N/A
4/2/2009	1.5	N/A	N/A	N/A
4/3/2009	2.1	N/A	N/A	N/A
4/4/2009	1.1	N/A	N/A	N/A
4/5/2009	1.4	N/A	N/A	N/A
4/6/2009	0.8	N/A	N/A	N/A
4/7/2009	-1.6	N/A	N/A	N/A

6.11.2 Conditions of lagoon 2

Date	Air temperature (°C)	Lagoon temp(°C)	Lagoon pH	Lagoon ORP (mV)
Period 1				
7/19/2007	24.5	21.3	6.56	-425
7/20/2007	17.2	20.8	6.61	-457
7/21/2007	18.2	20.3	N/A	N/A
7/22/2007	19.7	20.6	N/A	N/A
7/23/2007	21.2	20.7	N/A	N/A
7/24/2007	24.0	20.7	N/A	N/A
7/25/2007	25.2	21.1	N/A	N/A
7/26/2007	26.1	22.0	N/A	N/A
7/27/2007	23.8	23.8	N/A	N/A
7/28/2007	22.0	23.1	N/A	N/A
7/29/2007	21.5	22.9	N/A	N/A
7/30/2007	22.2	22.7	N/A	N/A
7/31/2007	24.2	22.8	N/A	N/A
8/1/2007	25.1	23.0	N/A	N/A
8/2/2007	24.3	23.4	N/A	N/A
8/3/2007	20.8	22.9	N/A	N/A
8/4/2007	17.9	22.7	N/A	N/A
8/5/2007	17.6	21.5	N/A	N/A
8/6/2007	20.2	21.6	N/A	N/A
8/7/2007	24.7	22.0	6.67	-389
8/8/2007	22.1	21.9	6.80	-428
8/9/2007	24.9	22.1	6.82	-446
8/10/2007	23.6	22.4	N/A	N/A
8/11/2007	24.6	22.3	N/A	N/A
8/12/2007	22.3	22.7	N/A	N/A
8/13/2007	21.5	22.6	N/A	N/A
8/14/2007	22.4	22.2	N/A	N/A
8/15/2007	20.0	22.2	N/A	N/A
8/16/2007	20.2	21.9	N/A	N/A
8/17/2007	16.2	21.8	N/A	N/A
8/18/2007	14.3	20.8	N/A	N/A
8/19/2007	14.5	19.8	N/A	N/A
8/20/2007	15.7	19.0	N/A	N/A
8/21/2007	19.0	18.5	N/A	N/A
8/22/2007	20.8	18.5	N/A	N/A
8/23/2007	18.6	18.9	N/A	N/A
8/24/2007	18.6	19.3	N/A	N/A
8/25/2007	17.6	19.5	N/A	N/A
8/26/2007	17.9	19.7	N/A	N/A
8/27/2007	20.8	19.4	N/A	N/A

Date	Air temperature (°C)	Lagoon temp(°C)	Lagoon pH	Lagoon ORP (mV)
8/28/2007	21.7	19.8	N/A	N/A
Period 2				
11/14/2007	1.5	9.3	7.0	-378
11/15/2007	0.0	8.5	7.1	-429
11/16/2007	-0.2	8.5	7.1	-442
11/17/2007	0.0	5.8	7.1	-438
11/18/2007	-0.6	2.4	7.2	-439
11/19/2007	3.0	4.8	7.2	-435
11/20/2007	1.3	6.0	7.2	-446
11/21/2007	-1.3	6.3	7.1	-449
11/22/2007	-4.0	6.4	7.1	-451
11/23/2007	-6.1	6.3	7.1	-450
11/24/2007	-0.6	6.1	7.0	-445
11/25/2007	0.8	6.1	7.0	-441
11/26/2007	0.1	6.5	7.0	-441
11/27/2007	-8.9	6.9	6.9	-439
11/28/2007	-6.2	N/A	N/A	N/A

6.12 Daily Site Emissions and Data completeness

6.12.1 Daily NH_3 emission using RPM emissions model

Column headings for the following table are:

Date: Month/Day/Year
Valid values: Number of ½ 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 TDL path was either missing or else had invalid concentration values
Emission average (μgm^{-2}s^{-1}): Daily average emission calculated from the valid ½ h periods
Emissions SD (μgm^{-2}s^{-1}): Daily emission standard deviation of the valid ½ h periods
Emission minimum (μgm^{-2}s^{-1}): Daily minimum emission of the valid ½ h periods
Emission maximum (μgm^{-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	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})
Period 1										
7/19/2007	0	0	46	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7/20/2007	0	0	47	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7/21/2007	0	1	47	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7/22/2007	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7/23/2007	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7/24/2007	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7/25/2007	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7/26/2007	1	0	47	189.3	N/A	189.3	189.3	91.6	140.9	111.8
7/27/2007	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7/28/2007	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7/29/2007	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7/30/2007	0	0	46	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7/31/2007	1	2	43	105.4	N/A	105.4	105.4	51.0	78.4	62.2
8/1/2007	1	2	43	53.6	N/A	53.6	53.6	25.9	39.9	31.6
8/2/2007	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/3/2007	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/4/2007	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/5/2007	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/6/2007	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/7/2007	0	0	37	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/8/2007	0	24	7	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/9/2007	11	19	17	120.0	58.1	19.6	192.9	58.0	89.3	70.9
8/10/2007	1	2	21	26.8	N/A	26.8	26.8	13.0	19.9	15.8

Date	Valid	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})
8/11/2007	1	8	38	291.1	N/A	291.1	291.1	140.8	216.7	172.0
8/12/2007	0	6	42	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/13/2007	0	10	35	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/14/2007	1	0	46	53.6	N/A	53.6	53.6	25.9	39.9	31.6
8/15/2007	12	6	23	133.8	54.0	76.8	241.1	64.7	99.6	79.0
8/16/2007	2	0	3	35.7	30.3	14.3	57.1	17.3	26.6	21.1
8/17/2007	4	0	9	57.1	28.8	32.1	98.2	27.6	42.5	33.8
8/18/2007	0	8	32	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/19/2007	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/20/2007	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/21/2007	0	1	45	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/22/2007	0	3	41	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/23/2007	0	3	44	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/24/2007	0	0	47	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/25/2007	3	4	26	75.0	26.4	57.1	105.4	36.3	55.8	44.3
8/26/2007	11	16	8	176.5	73.9	5.4	282.1	85.4	131.4	104.2
8/27/2007	1	21	11	83.9	N/A	83.9	83.9	40.6	62.5	49.6
Period 2										
11/14/2007	0	0	6	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11/15/2007	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11/16/2007	1	13	23	44.6	N/A	44.6	44.6	21.6	33.2	26.4
11/17/2007	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11/18/2007	0	2	33	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11/19/2007	1	10	18	25.0	N/A	25.0	25.0	12.1	18.6	14.8
11/20/2007	0	0	46	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11/21/2007	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11/22/2007	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11/23/2007	3	0	26	14.3	3.6	10.7	17.9	6.9	10.6	8.4
11/24/2007	8	0	2	35.7	11.2	23.2	55.4	17.3	26.6	21.1
11/25/2007	8	0	10	38.6	15.1	19.6	67.9	18.7	28.7	22.8
11/26/2007	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11/27/2007	3	3	34	23.8	9.8	12.5	30.4	11.5	17.7	14.1
11/28/2007	0	8	9	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period 3										
11/29/2007	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11/30/2007	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/1/2007	2	3	37	15.2	3.8	12.5	17.9	7.3	11.3	9.0
12/2/2007	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/3/2007	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/4/2007	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/5/2007	0	0	45	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/6/2007	0	0	37	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/7/2007	0	0	15	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/8/2007	0	0	47	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/9/2007	0	0	45	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/10/2007	0	0	47	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Date	Valid	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})
12/11/2007	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/12/2007	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/13/2007	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/14/2007	0	0	42	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/15/2007	0	0	44	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/16/2007	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/17/2007	0	0	47	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period 4										
4/24/2008	0	0	19	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/25/2008	4	11	28	92.9	61.5	3.6	139.3	44.9	69.1	54.9
4/26/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/27/2008	1	1	45	78.6	N/A	78.6	78.6	38.0	58.5	46.4
4/28/2008	1	3	42	46.4	N/A	46.4	46.4	22.5	34.6	27.4
4/29/2008	7	0	29	45.7	20.3	23.2	83.9	22.1	34.0	27.0
4/30/2008	0	7	38	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/1/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/2/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/3/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/4/2008	7	0	39	26.8	26.7	5.4	78.6	13.0	19.9	15.8
5/5/2008	1	0	47	26.8	N/A	26.8	26.8	13.0	19.9	15.8
5/6/2008	0	2	44	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/7/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/8/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/9/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/10/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/11/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/12/2008	0	0	28	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period 5										
6/25/2008	0	0	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6/26/2008	0	1	34	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6/27/2008	0	8	28	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6/28/2008	18	0	22	220.8	57.7	141.1	308.9	106.8	164.4	130.5
6/29/2008	6	0	39	61.3	84.0	5.4	176.8	29.7	45.6	36.2
6/30/2008	3	3	29	46.4	57.3	10.7	112.5	22.5	34.6	27.4
7/1/2008	0	1	20	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7/2/2008	4	4	29	32.1	39.4	10.7	91.1	15.6	23.9	19.0
7/3/2008	0	0	43	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7/4/2008	2	4	11	149.1	46.7	116.1	182.1	72.1	111.0	88.1
7/5/2008	2	20	3	291.1	5.1	287.5	294.6	140.8	216.7	172.0
7/6/2008	2	5	13	179.5	59.3	137.5	221.4	86.8	133.6	106.0
7/7/2008	1	1	28	94.6	N/A	94.6	94.6	45.8	70.4	55.9
7/8/2008	3	3	35	373.8	8.4	364.3	380.4	180.9	278.3	220.8
7/9/2008	3	1	34	178.0	64.8	108.9	237.5	86.1	132.5	105.1
7/10/2008	0	2	19	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7/11/2008	0	12	12	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7/12/2008	7	2	29	197.4	92.1	91.1	335.7	95.5	147.0	116.6

Date	Valid	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})
7/13/2008	1	0	44	128.6	N/A	128.6	128.6	62.2	95.7	76.0
7/14/2008	1	0	21	57.1	N/A	57.1	57.1	27.6	42.5	33.8
Period 6										
10/22/2008	0	3	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10/23/2008	0	46	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10/24/2008	2	23	4	25.0	5.1	21.4	28.6	12.1	18.6	14.8
10/25/2008	11	0	36	36.7	19.2	16.1	71.4	17.8	27.3	21.7
10/26/2008	32	0	3	44.3	16.3	21.4	75.0	21.4	32.9	26.1
10/27/2008	2	0	2	38.4	49.2	3.6	73.2	18.6	28.6	22.7
10/28/2008	23	0	4	23.3	18.2	-8.9	60.7	11.3	17.3	13.8
10/29/2008	7	12	4	4.3	9.2	-7.1	16.1	2.1	3.2	2.6
10/30/2008	14	28	0	67.6	21.9	26.8	98.2	32.7	50.3	39.9
10/31/2008	11	9	4	27.3	12.6	10.7	48.2	13.2	20.3	16.1
11/1/2008	0	25	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11/2/2008	9	29	0	55.8	21.3	21.4	80.4	27.0	41.5	32.9
11/3/2008	1	21	17	5.4	N/A	5.4	5.4	2.6	4.0	3.2
11/4/2008	8	30	0	42.9	21.7	23.2	89.3	20.7	31.9	25.3
11/5/2008	0	40	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11/6/2008	4	35	2	41.5	6.9	32.1	48.2	20.1	30.9	24.5
11/7/2008	2	31	1	25.0	7.6	19.6	30.4	12.1	18.6	14.8
11/8/2008	10	0	3	11.6	4.1	5.4	19.6	5.6	8.6	6.9
11/9/2008	2	0	14	21.4	5.1	17.9	25.0	10.4	16.0	12.7
11/10/2008	10	0	15	11.8	1.2	10.7	14.3	5.7	8.8	7.0
11/11/2008	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period 7										
12/18/2008	0	0	9	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/19/2008	0	1	20	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/20/2008	1	0	12	0.0	N/A	0.0	0.0	0.0	0.0	0.0
12/21/2008	0	0	34	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/22/2008	1	2	24	1.8	N/A	1.8	1.8	0.9	1.3	1.1
12/23/2008	1	8	7	5.4	N/A	5.4	5.4	2.6	4.0	3.2
12/24/2008	4	1	12	5.4	4.6	0.0	10.7	2.6	4.0	3.2
12/25/2008	2	3	4	3.6	2.5	1.8	5.4	1.7	2.7	2.1
12/26/2008	0	1	24	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/27/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/28/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/29/2008	0	0	43	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/30/2008	0	0	25	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/31/2008	1	1	16	5.4	N/A	5.4	5.4	2.6	4.0	3.2
1/1/2009	0	3	18	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/2/2009	0	0	30	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/3/2009	0	1	9	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/4/2009	0	0	17	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/5/2009	2	1	31	5.4	5.1	1.8	8.9	2.6	4.0	3.2
1/6/2009	1	5	12	7.1	N/A	7.1	7.1	3.5	5.3	4.2
Period 8										

Date	Valid	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})
3/10/2009	0	0	6	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3/11/2009	0	0	41	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3/12/2009	1	0	34	14.3	N/A	14.3	14.3	6.9	10.6	8.4
3/13/2009	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3/14/2009	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3/15/2009	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3/16/2009	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3/17/2009	0	0	45	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3/18/2009	2	5	27	7.1	5.1	3.6	10.7	3.5	5.3	4.2
3/19/2009	0	0	30	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3/20/2009	0	11	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3/21/2009	7	10	7	15.3	6.0	7.1	25.0	7.4	11.4	9.0
3/22/2009	0	2	6	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3/23/2009	0	0	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3/24/2009	0	0	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3/25/2009	6	6	6	25.0	12.7	12.5	39.3	12.1	18.6	14.8
3/26/2009	16	0	15	13.7	3.4	7.1	17.9	6.6	10.2	8.1
3/27/2009	0	0	33	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3/28/2009	0	1	5	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3/29/2009	1	0	13	26.8	N/A	26.8	26.8	13.0	19.9	15.8
3/30/2009	1	2	24	12.5	N/A	12.5	12.5	6.0	9.3	7.4
3/31/2009	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/1/2009	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/2/2009	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/3/2009	3	0	38	11.9	1.0	10.7	12.5	5.8	8.9	7.0
4/4/2009	1	5	0	12.5	N/A	12.5	12.5	6.0	9.3	7.4
4/5/2009	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/6/2009	8	0	3	44.6	9.0	33.9	58.9	21.6	33.2	26.4

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 ($\mu gm^{-2}s^{-1}$)	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 1												
7/19/2007	0	7	13	12	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7/20/2007	0	29	1	9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7/21/2007	9	14	1	20	0.17	194.3	112.5	110.9	476.7	94.0	144.6	114.8
7/22/2007	4	34	1	7	0.07	106.5	17.6	87.6	129.8	51.5	79.2	62.9
7/23/2007	4	18	10	13	0.06	67.1	13.7	53.3	85.7	32.5	50.0	39.7
7/24/2007	2	4	7	27	0.03	87.3	49.0	52.6	121.9	42.2	64.9	51.5
7/25/2007	9	10	6	22	0.20	161.7	49.5	94.8	262.2	78.2	120.3	95.5
7/26/2007	15	10	5	10	0.12	202.2	93.4	60.8	371.5	97.8	150.5	119.4
7/27/2007	3	2	16	12	0.14	21.2	55.5	-42.8	56.9	10.2	15.8	12.5
7/28/2007	0	1	12	17	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7/29/2007	0	1	12	29	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7/30/2007	17	2	0	23	0.02	215.8	74.8	106.1	373.0	104.4	160.6	127.5
7/31/2007	17	4	0	21	0.18	204.5	60.5	127.1	313.8	98.9	152.2	120.8
8/1/2007	28	4	0	15	0.07	203.4	81.0	87.8	382.7	98.4	151.3	120.1
8/2/2007	32	0	0	11	0.16	126.7	81.4	-9.9	266.6	61.3	94.3	74.9
8/3/2007	22	0	0	17	0.13	93.2	30.9	36.0	155.4	45.1	69.3	55.0
8/4/2007	2	20	0	20	0.16	120.4	22.2	104.7	136.1	58.2	89.6	71.1
8/5/2007	10	23	0	15	0.11	101.3	44.7	22.7	178.6	49.0	75.4	59.9
8/6/2007	1	11	1	31	0.14	47.5	N/A	47.5	47.5	23.0	35.3	28.1

Date	Valid	Direction limited	Touchdown limited	Turbulence limited	Background (ppm)	Emission average ($\mu g m^{-2} s^{-1}$)	Emission SD ($\mu g m^{-2} s^{-1}$)	Emission minimum ($\mu g m^{-2} s^{-1}$)	Emission maximum ($\mu g m^{-2} s^{-1}$)	Emission average ($kg d^{-1}$)	Emission average ($g d^{-1} hd^{-1}$)	Emission average ($g d^{-1} AU^{-1}$)
8/7/2007	10	0	1	21	0.23	219.1	71.9	48.6	301.5	106.0	163.0	129.4
8/8/2007	1	22	0	21	0.12	10.1	N/A	10.1	10.1	4.9	7.5	6.0
8/9/2007	23	2	0	21	0.12	119.1	69.5	4.9	227.4	57.6	88.6	70.3
8/10/2007	5	16	1	17	0.20	83.1	78.4	0.0	158.7	40.2	61.9	49.1
8/11/2007	13	25	3	3	0.14	231.0	108.1	-53.0	368.4	111.7	171.9	136.4
8/12/2007	11	18	0	11	0.02	47.7	52.1	11.2	189.6	23.0	35.5	28.1
8/13/2007	0	25	4	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/14/2007	26	7	5	3	0.12	11.5	19.8	-41.2	48.3	5.5	8.5	6.8
8/15/2007	13	11	1	19	0.07	125.4	53.3	1.8	206.0	60.7	93.3	74.1
8/16/2007	1	0	0	3	0.01	76.9	N/A	76.9	76.9	37.2	57.2	45.4
8/17/2007	8	0	0	4	0.12	57.4	23.1	30.3	102.8	27.8	42.7	33.9
8/18/2007	0	35	0	11	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/19/2007	0	48	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/20/2007	0	47	1	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8/21/2007	5	25	6	11	-0.01	29.1	12.2	12.4	44.5	14.1	21.7	17.2
8/22/2007	4	13	4	25	0.02	23.3	10.0	16.5	37.8	11.3	17.3	13.7
8/23/2007	1	6	3	36	0.09	43.6	N/A	43.6	43.6	21.1	32.5	25.8
8/24/2007	15	6	1	19	0.12	21.8	36.2	-45.3	65.7	10.5	16.2	12.9
8/25/2007	19	1	0	24	0.13	56.7	46.2	2.9	210.9	27.4	42.2	33.5
8/26/2007	11	14	0	19	0.18	197.5	48.0	148.8	289.5	95.6	147.0	116.7
8/27/2007	1	42	2	0	0.08	78.0	N/A	78.0	78.0	37.7	58.0	46.1
Period 2												
11/14/2007	6	0	0	0	0.03	23.1	6.0	12.8	28.8	11.2	17.2	13.7
11/15/2007	44	0	0	2	0.03	10.3	6.3	-1.3	24.9	5.0	7.6	6.1
11/16/2007	2	32	0	9	0.09	1.4	2.0	0.0	2.9	0.7	1.1	0.9
11/17/2007	0	47	0	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11/18/2007	0	47	0	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11/19/2007	18	26	0	4	0.07	18.2	14.6	-12.7	40.9	8.8	13.5	10.7
11/20/2007	3	18	0	21	0.03	1.0	1.6	-0.6	2.7	0.5	0.8	0.6
11/21/2007	20	26	0	2	0.05	0.1	1.2	-2.4	2.5	0.0	0.1	0.0
11/22/2007	19	27	0	2	0.02	9.8	8.5	-0.6	23.1	4.8	7.3	5.8
11/23/2007	30	0	0	16	0.03	20.8	8.8	2.2	35.9	10.1	15.5	12.3
11/24/2007	48	0	0	0	0.04	25.8	10.6	6.7	64.6	12.5	19.2	15.3
11/25/2007	48	0	0	0	0.05	20.2	17.7	-13.1	60.9	9.8	15.0	11.9
11/26/2007	40	0	0	7	0.03	9.3	6.5	-0.3	29.8	4.5	6.9	5.5
11/27/2007	35	8	0	5	0.06	13.0	9.5	-6.7	33.5	6.3	9.7	7.7
Period 3												
11/28/2007	9	27	0	1	0.04	5.1	8.3	-5.9	16.2	2.5	3.8	3.0
11/29/2007	47	0	0	1	0.04	5.2	13.7	-21.1	38.9	2.5	3.9	3.1
11/30/2007	47	0	0	1	0.02	4.4	6.6	-7.2	24.4	2.1	3.3	2.6
12/1/2007	10	33	0	4	0.03	8.2	3.1	2.6	13.5	3.9	6.1	4.8
12/2/2007	0	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/3/2007	0	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/4/2007	0	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/5/2007	5	0	3	9	0.00	2.3	2.8	-0.2	6.6	1.1	1.7	1.4
12/6/2007	0	0	8	12	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

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})
12/7/2007	9	0	0	3	0.05	-2.2	4.9	-12.5	4.8	-1.1	-1.6	-1.3
12/8/2007	8	3	1	30	0.08	-6.0	4.9	-12.3	1.6	-2.9	-4.5	-3.5
12/9/2007	3	0	0	43	0.12	-40.3	68.6	-119.5	-0.3	-19.5	-30.0	-23.8
12/10/2007	0	1	13	17	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/11/2007	21	0	7	7	0.04	-4.0	8.2	-23.8	5.7	-1.9	-2.9	-2.3
12/12/2007	4	1	5	33	0.04	2.4	1.2	1.3	3.7	1.2	1.8	1.4
12/13/2007	11	2	25	1	0.05	-9.9	11.5	-35.8	4.0	-4.8	-7.3	-5.8
12/14/2007	17	0	0	27	0.06	-0.4	6.3	-10.7	10.6	-0.2	-0.3	-0.2
12/15/2007	0	0	1	32	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/16/2007	16	2	1	24	0.07	-5.5	4.3	-18.6	0.4	-2.7	-4.1	-3.3
12/17/2007	0	0	22	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period 4												
4/24/2008	1	13	0	0	0.28	-21.3	N/A	-21.3	-21.3	-10.3	-15.8	-12.6
4/25/2008	7	23	0	16	0.19	-13.5	12.6	-28.1	1.6	-6.5	-10.0	-8.0
4/26/2008	43	0	4	0	0.04	24.1	24.2	-19.8	77.1	11.7	17.9	14.2
4/27/2008	47	0	0	1	0.05	51.6	54.7	-4.1	223.8	25.0	38.4	30.5
4/28/2008	3	5	22	14	0.02	71.1	46.3	25.1	117.7	34.4	52.9	42.0
4/29/2008	21	1	0	21	-0.03	87.7	50.3	14.5	241.0	42.4	65.3	51.8
4/30/2008	0	39	1	5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/1/2008	0	34	12	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/2/2008	0	22	13	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/3/2008	26	0	9	4	0.04	39.8	60.1	-49.6	179.2	19.2	29.6	23.5
5/4/2008	34	6	0	8	0.01	69.7	53.0	-0.3	156.4	33.7	51.9	41.2
5/5/2008	26	3	2	16	0.04	27.4	33.7	-34.3	120.3	13.2	20.4	16.2
5/6/2008	21	11	2	12	-0.02	70.1	48.8	2.1	160.7	33.9	52.2	41.4
5/7/2008	12	11	0	7	0.03	-0.2	8.3	-13.6	17.4	-0.1	-0.1	-0.1
5/8/2008	4	1	6	20	0.04	14.2	32.1	-3.7	62.2	6.8	10.5	8.4
5/9/2008	0	2	11	21	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/10/2008	8	24	0	7	-0.01	32.3	18.2	8.8	64.1	15.6	24.0	19.1
5/11/2008	14	0	10	8	0.03	-3.0	9.5	-16.3	21.5	-1.5	-2.3	-1.8
5/12/2008	0	6	1	12	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period 5												
6/25/2008	0	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6/26/2008	12	5	0	17	0.13	50.5	22.6	21.4	90.8	24.4	37.6	29.8
6/27/2008	7	14	0	21	0.11	25.9	21.5	3.6	59.5	12.5	19.3	15.3
6/28/2008	38	0	1	8	0.11	72.2	34.3	10.3	149.1	34.9	53.7	42.6
6/29/2008	41	0	0	6	0.24	-3.1	13.5	-20.4	54.5	-1.5	-2.3	-1.8
6/30/2008	24	0	0	13	0.24	17.3	15.8	-16.5	59.3	8.3	12.8	10.2
7/1/2008	25	0	0	15	0.09	93.8	25.3	10.3	126.4	45.4	69.8	55.4
7/2/2008	33	12	0	1	0.23	12.7	32.4	-18.4	89.2	6.2	9.5	7.5
7/3/2008	10	19	0	14	0.23	1.4	6.8	-4.8	15.0	0.7	1.0	0.8
7/4/2008	13	9	0	21	0.10	50.0	28.6	11.0	106.8	24.2	37.2	29.5
7/5/2008	10	34	0	3	0.13	116.9	40.3	50.0	171.2	56.6	87.0	69.0
7/6/2008	17	28	0	3	0.12	82.7	28.3	38.1	139.5	40.0	61.5	48.8
7/7/2008	4	24	1	18	0.09	53.0	58.6	5.0	129.2	25.6	39.4	31.3
7/8/2008	24	6	1	10	0.16	121.9	46.8	34.5	233.0	58.9	90.7	72.0

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})
7/9/2008	28	0	0	10	0.13	57.8	47.7	2.1	237.2	27.9	43.0	34.1
7/10/2008	1	29	0	9	0.19	16.6	N/A	16.6	16.6	8.0	12.3	9.8
7/11/2008	0	38	0	7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7/12/2008	35	6	0	5	0.10	67.0	40.3	12.3	171.8	32.4	49.8	39.6
7/13/2008	48	0	0	0	0.12	52.8	24.1	-9.6	95.8	25.6	39.3	31.2
7/14/2008	5	0	0	16	0.17	-6.9	10.4	-22.1	2.3	-3.3	-5.2	-4.1
Period 6												
10/22/2008	0	4	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10/23/2008	0	48	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10/24/2008	14	25	0	8	0.06	16.6	9.6	1.2	36.1	8.0	12.4	9.8
10/25/2008	37	0	0	10	0.04	54.4	38.0	8.2	130.6	26.3	40.5	32.1
10/26/2008	47	0	0	1	0.02	43.5	10.9	24.1	64.2	21.1	32.4	25.7
10/27/2008	47	0	0	1	0.04	20.2	10.2	1.9	41.1	9.8	15.0	11.9
10/28/2008	18	0	0	20	0.02	39.2	20.3	10.7	67.6	19.0	29.2	23.2
10/29/2008	1	11	0	25	0.06	36.7	N/A	36.7	36.7	17.7	27.3	21.7
10/30/2008	16	26	0	2	0.06	99.1	27.3	46.2	137.0	47.9	73.8	58.5
10/31/2008	8	21	0	12	0.09	36.7	12.9	15.8	49.3	17.8	27.3	21.7
11/1/2008	0	36	0	11	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11/2/2008	11	30	0	6	0.07	70.0	26.6	14.5	111.1	33.8	52.1	41.3
11/3/2008	0	28	0	7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11/4/2008	14	33	0	1	0.09	65.7	23.9	33.5	115.5	31.8	48.9	38.8
11/5/2008	0	48	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11/6/2008	4	43	0	1	0.08	53.0	9.7	45.3	67.3	25.7	39.5	31.3
11/7/2008	5	29	0	9	0.08	10.2	6.0	3.9	20.2	4.9	7.6	6.0
11/8/2008	44	0	0	2	0.03	8.5	4.3	1.4	20.6	4.1	6.3	5.0
11/9/2008	48	0	0	0	0.05	8.0	7.1	-1.1	27.2	3.9	6.0	4.7
11/10/2008	34	2	0	10	0.05	6.3	6.3	-2.2	27.5	3.1	4.7	3.7
11/11/2008	0	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period 7												
12/18/2008	8	2	0	8	0.03	1.7	2.8	-2.6	6.1	0.8	1.2	1.0
12/19/2008	0	34	0	14	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/20/2008	1	35	0	7	0.03	0.3	N/A	0.3	0.3	0.1	0.2	0.2
12/21/2008	47	0	0	0	0.05	-7.6	6.9	-29.7	7.2	-3.7	-5.7	-4.5
12/22/2008	29	2	0	17	0.05	-1.3	3.4	-11.5	5.6	-0.7	-1.0	-0.8
12/23/2008	2	44	0	1	0.07	-3.0	1.1	-3.8	-2.3	-1.5	-2.2	-1.8
12/24/2008	21	1	0	14	0.06	-4.9	5.0	-13.9	5.8	-2.4	-3.6	-2.9
12/25/2008	7	26	0	8	0.04	3.8	2.1	1.8	7.9	1.9	2.9	2.3
12/26/2008	0	45	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/27/2008	0	5	5	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/28/2008	0	0	13	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/29/2008	15	0	4	0	0.02	-0.7	4.5	-9.4	7.0	-0.3	-0.5	-0.4
12/30/2008	6	20	6	13	0.05	-2.5	1.8	-5.4	0.0	-1.2	-1.8	-1.5
12/31/2008	23	5	0	19	0.06	-1.1	4.0	-11.2	9.0	-0.6	-0.9	-0.7
1/1/2009	23	24	0	1	0.05	-4.6	4.6	-11.2	4.2	-2.2	-3.4	-2.7
1/2/2009	33	1	0	14	0.04	-2.9	6.3	-17.6	13.8	-1.4	-2.2	-1.7
1/3/2009	0	44	2	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

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 ($gd^{-1}AU^{-1}$)
1/4/2009	16	0	0	3	0.06	0.8	7.7	-9.9	15.8	0.4	0.6	0.5
1/5/2009	17	10	0	11	0.05	0.7	5.0	-7.6	9.0	0.3	0.5	0.4
1/6/2009	2	43	0	0	0.04	-4.3	0.8	-4.9	-3.8	-2.1	-3.2	-2.6
Period 8												
3/10/2009	6	0	0	1	-0.02	1.0	5.7	-6.7	6.9	0.5	0.8	0.6
3/11/2009	48	0	0	0	-0.01	19.8	16.4	-11.4	48.0	9.6	14.8	11.7
3/12/2009	39	0	0	9	-0.02	7.7	8.3	-6.1	24.1	3.7	5.7	4.5
3/13/2009	10	1	15	15	-0.06	21.3	8.8	11.0	42.0	10.3	15.8	12.6
3/14/2009	0	0	22	11	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3/15/2009	0	0	45	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3/16/2009	0	9	35	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3/17/2009	16	2	19	5	-0.01	12.5	16.1	-7.6	40.9	6.1	9.3	7.4
3/18/2009	21	0	0	22	-0.02	14.4	15.9	-16.5	41.1	7.0	10.7	8.5
3/19/2009	38	8	0	2	0.02	-0.6	11.6	-24.0	18.0	-0.3	-0.4	-0.3
3/20/2009	0	32	0	13	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3/21/2009	14	24	0	9	-0.02	27.1	15.8	6.5	62.6	13.1	20.2	16.0
3/22/2009	0	44	0	4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3/23/2009	0	48	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3/24/2009	0	48	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3/25/2009	35	9	0	0	-0.05	33.1	7.7	18.0	49.4	16.0	24.6	19.5
3/26/2009	48	0	0	0	-0.03	21.3	8.6	5.6	37.6	10.3	15.8	12.6
3/27/2009	45	1	0	2	0.00	3.1	7.0	-12.4	15.5	1.5	2.3	1.8
3/28/2009	0	19	0	28	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3/29/2009	30	10	0	8	0.02	0.0	14.0	-25.5	26.9	0.0	0.0	0.0
3/30/2009	1	0	4	21	-0.01	5.9	N/A	5.9	5.9	2.9	4.4	3.5
3/31/2009	0	0	11	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/1/2009	0	0	14	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/2/2009	0	0	0	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/3/2009	12	0	3	8	0.03	24.6	22.5	-24.5	55.0	11.9	18.3	14.5
4/4/2009	0	0	0	25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/5/2009	0	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/6/2009	19	0	0	0	0.04	19.2	14.7	-5.4	45.2	9.3	14.3	11.3

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 (μgm^{-2}s^{-1}): Daily average emission calculated from the valid ½ h periods
Emissions SD (μgm^{-2}s^{-1}): Daily emission standard deviation of the valid ½ h periods
Emission minimum (μgm^{-2}s^{-1}): Daily minimum emission of the valid ½ h periods
Emission maximum (μgm^{-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 (μgm^{-2}s^{-1})	Emission SD (μgm^{-2}s^{-1})	Emission minimum (μgm^{-2}s^{-1})	Emission maximum (μgm^{-2}s^{-1})	Emission average (kgd^{-1})	Emission average (gd^{-1}hd^{-1})	Emission average (gd^{-1}AU^{-1})
Period 4								
4/24/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/25/2008	3	8.7	47.4	6.9	12.1	4.2	6.5	5.1
4/26/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/27/2008	1	1.6	0.0	1.6	1.6	0.8	1.2	1.0
4/28/2008	1	2.7	0.0	2.7	2.7	1.3	2.0	1.6
4/29/2008	4	0.5	10.9	0.2	0.8	0.2	0.4	0.3
4/30/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/1/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/2/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/3/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/4/2008	5	1.1	15.8	0.4	3.8	0.5	0.8	0.7
5/5/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/6/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/7/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/8/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/9/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/10/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/11/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/12/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period 5								
6/25/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6/26/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6/27/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6/28/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6/29/2008	4	2.0	21.6	1.0	3.0	1.0	1.5	1.2
6/30/2008	3	11.5	57.2	1.3	28.0	5.6	8.6	6.8
7/1/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Date	Valid	Emission average (μgm^{-2}s^{-1})	Emission SD (μgm^{-2}s^{-1})	Emission minimum (μgm^{-2}s^{-1})	Emission maximum (μgm^{-2}s^{-1})	Emission average (kgd^{-1})	Emission average (gd^{-1}hd^{-1})	Emission average (gd^{-1}AU^{-1})
7/2/2008	4	7.9	43.6	2.6	17.7	3.8	5.9	4.7
7/3/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7/4/2008	1	12.1	0.0	12.1	12.1	5.9	9.0	7.1
7/5/2008	2	11.9	63.6	8.3	15.6	5.8	8.9	7.1
7/6/2008	1	5.6	0.0	5.6	5.6	2.7	4.2	3.3
7/7/2008	1	-10.4	0.0	-10.4	-10.4	-5.0	-7.7	-6.1
7/8/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7/9/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7/10/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7/11/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7/12/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7/13/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7/14/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period 6								
10/22/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10/23/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10/24/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10/25/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10/26/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10/27/2008	2	-8.6	0.0	-16.4	-0.7	-4.2	-6.4	-5.1
10/28/2008	2	3.6	35.9	2.8	4.4	1.8	2.7	2.1
10/29/2008	6	2.4	22.5	-1.6	8.9	1.2	1.8	1.4
10/30/2008	14	4.4	28.7	2.4	7.7	2.1	3.3	2.6
10/31/2008	11	1.6	17.7	0.6	2.8	0.8	1.2	1.0
11/1/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11/2/2008	9	1.3	15.9	0.5	1.7	0.6	0.9	0.7
11/3/2008	1	0.1	0.0	0.1	0.1	0.1	0.1	0.1
11/4/2008	8	1.5	17.7	0.7	2.3	0.7	1.1	0.9
11/5/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11/6/2008	4	2.9	26.1	2.2	4.5	1.4	2.2	1.7
11/7/2008	2	2.4	28.9	2.2	2.6	1.1	1.8	1.4
11/8/2008	1	6.4	0.0	6.4	6.4	3.1	4.7	3.8
11/9/2008	2	4.6	39.9	1.8	7.3	2.2	3.4	2.7
11/10/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11/11/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period 7								
12/18/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/19/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/20/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/21/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/22/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/23/2008	1	-3.1	0.0	-3.1	-3.1	-1.5	-2.3	-1.8
12/24/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/25/2008	1	-0.6	0.0	-0.6	-0.6	-0.3	-0.4	-0.3
12/26/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/27/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Date	Valid	Emission average (μgm^{-2}s^{-1})	Emission SD (μgm^{-2}s^{-1})	Emission minimum (μgm^{-2}s^{-1})	Emission maximum (μgm^{-2}s^{-1})	Emission average (kgd^{-1})	Emission average (gd^{-1}hd^{-1})	Emission average (gd^{-1}AU^{-1})
12/28/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/29/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/30/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/31/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/1/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/2/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/3/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/4/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/5/2009	2	1.4	22.5	0.1	2.8	0.7	1.1	0.8
1/6/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period 8								
3/10/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3/11/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3/12/2009	1	1.2	0.0	1.2	1.2	0.6	0.9	0.7
3/13/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3/14/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3/15/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3/16/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3/17/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3/18/2009	2	0.0	3.9	0.0	0.1	0.0	0.0	0.0
3/19/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3/20/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3/21/2009	7	0.2	5.6	-0.2	0.6	0.1	0.1	0.1
3/22/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3/23/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3/24/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3/25/2009	4	3.0	26.9	0.5	6.2	1.5	2.3	1.8
3/26/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3/27/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3/28/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3/29/2009	1	1.5	0.0	1.5	1.5	0.7	1.1	0.9
3/30/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3/31/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/1/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/2/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/3/2009	3	0.0	2.9	0.0	0.1	0.0	0.0	0.0
4/4/2009	1	0.1	0.0	0.1	0.1	0.0	0.1	0.1
4/5/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/6/2009	8	0.5	10.4	0.1	1.7	0.3	0.4	0.3
4/7/2009	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 (µgm^{-2}s^{-1}): Daily average emission calculated from the valid ½ h periods
Emissions SD (µgm^{-2}s^{-1}): Daily emission standard deviation of the valid ½ h periods
Emission minimum (µgm^{-2}s^{-1}): Daily minimum emission of the valid ½ h periods
Emission maximum (µgm^{-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 (µgm^{-2}s^{-1})	Emission SD (µgm^{-2}s^{-1})	Emission minimum (µgm^{-2}s^{-1})	Emission maximum (µgm^{-2}s^{-1})	Emission average (kgd^{-1})	Emission average (gd^{-1}hd^{-1})	Emission average (gd^{-1}AU^{-1})
Period 4												
4/24/2008	1	9	0	0	3.0	2.2	N/A	2.2	2.2	1.1	1.7	1.3
4/25/2008	3	24	4	17	0.8	1.1	1.3	0.1	2.6	0.5	0.8	0.6
4/26/2008	19	0	29	0	1.7	1.4	1.0	-0.3	3.6	0.7	1.1	0.9
4/27/2008	29	0	18	1	0.3	0.3	0.5	-1.0	1.1	0.2	0.2	0.2
4/28/2008	6	26	0	15	0.3	0.6	0.4	0.0	1.2	0.3	0.5	0.4
4/29/2008	10	1	11	26	0.5	0.7	0.3	0.3	1.2	0.3	0.5	0.4
4/30/2008	0	40	0	8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/1/2008	0	48	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/2/2008	0	48	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/3/2008	34	8	0	6	0.7	0.5	0.4	-0.3	1.2	0.2	0.4	0.3
5/4/2008	13	6	21	8	0.4	4.1	5.4	0.1	16.6	2.0	3.1	2.5
5/5/2008	18	3	10	17	1.7	0.9	0.8	-0.2	2.4	0.4	0.7	0.5
5/6/2008	12	13	9	14	1.6	1.3	1.3	-0.3	4.0	0.7	1.0	0.8
5/7/2008	17	21	0	9	2.2	1.1	0.7	0.2	2.7	0.5	0.8	0.6
5/8/2008	11	9	0	27	2.3	0.6	0.6	-0.1	1.7	0.3	0.5	0.4
5/9/2008	0	24	0	22	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/10/2008	8	25	0	11	6.1	1.2	1.2	-0.3	3.4	0.6	0.9	0.7
5/11/2008	32	7	0	8	2.2	1.1	0.7	-0.1	3.2	0.6	0.8	0.7
5/12/2008												

Date	Valid	Direction limited	Angle limited	Turbulence limited	Background (ppb)	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 5	5	12	2	25	2.9	3.4	5.7	0.2	13.5	1.6	2.5	2.0
6/25/2008	8	0	32	8	3.8	5.0	2.8	1.1	9.1	2.4	3.8	3.0
6/26/2008	38	0	3	7	4.1	3.9	2.1	1.2	10.4	1.9	2.9	2.3
6/27/2008	24	0	0	23	5.0	5.1	2.3	1.1	10.2	2.5	3.8	3.0
6/28/2008	24	0	1	23	3.9	4.8	3.0	1.7	16.2	2.4	3.6	2.9
6/29/2008	30	12	3	3	4.8	4.9	2.9	0.0	13.7	2.4	3.7	2.9
6/30/2008	10	19	0	16	4.1	3.3	3.5	0.3	9.3	1.6	2.5	2.0
7/1/2008	11	9	2	24	4.0	3.4	3.3	0.0	10.8	1.6	2.5	2.0
7/2/2008	10	34	0	4	3.3	3.3	1.3	1.7	5.5	1.6	2.5	2.0
7/3/2008	16	28	1	3	3.3	2.0	1.0	0.4	4.5	1.0	1.5	1.2
7/4/2008	5	24	0	19	15.2	2.5	2.2	-0.4	5.4	1.2	1.9	1.5
7/5/2008	8	6	18	15	3.2	14.6	5.8	3.3	22.4	7.1	11.0	8.7
7/6/2008	15	0	13	18	2.2	16.5	14.5	-2.4	44.8	8.0	12.4	9.8
7/7/2008	1	29	0	18	2.1	17.9	N/A	17.9	17.9	8.7	13.4	10.7
7/8/2008	0	38	0	7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7/9/2008	8	6	29	5	13.1	7.0	7.7	-2.0	21.5	3.4	5.3	4.2
7/10/2008	26	0	22	0	1.3	6.3	2.4	2.6	10.7	3.1	4.7	3.7
7/11/2008	3	0	2	20	1.3	7.0	3.0	3.5	9.1	3.4	5.2	4.1
7/12/2008												
7/13/2008	0	48	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7/14/2008	10	25	4	9	1.1	0.0	0.2	-0.3	0.3	0.0	0.0	0.0
Period 6	29	0	8	11	1.1	2.0	1.1	0.5	5.1	1.0	1.5	1.2
10/22/2008	11	0	36	1	0.9	0.4	0.8	-0.5	2.0	0.2	0.3	0.2
10/23/2008	47	0	0	1	2.2	-0.3	0.9	-2.6	1.3	-0.2	-0.2	-0.2
10/24/2008	2	0	16	29	0.3	1.5	1.9	0.2	2.8	0.7	1.1	0.9
10/25/2008	1	11	0	32	1.5	0.5	N/A	0.5	0.5	0.2	0.4	0.3
10/26/2008	16	26	0	6	1.2	5.5	1.9	2.7	8.2	2.7	4.1	3.3
10/27/2008	8	21	0	16	1.1	1.8	1.0	0.5	3.6	0.9	1.4	1.1
10/28/2008	0	36	0	12	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10/29/2008	11	30	0	7	1.2	1.2	0.4	0.8	2.1	0.6	0.9	0.7
10/30/2008	0	28	0	20	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10/31/2008	14	33	0	1	1.7	2.0	0.7	1.2	3.7	1.0	1.5	1.2
11/1/2008	0	48	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11/2/2008	4	43	0	1	0.9	3.2	1.1	2.3	4.6	1.5	2.4	1.9
11/3/2008	5	29	0	9	1.1	1.5	0.6	0.4	2.1	0.7	1.1	0.9
11/4/2008	34	0	10	2	1.9	1.4	0.6	0.4	3.4	0.7	1.0	0.8
11/5/2008	48	0	0	0	1.2	1.4	1.0	0.3	4.1	0.7	1.1	0.8
11/6/2008	28	2	6	9	1.3	-0.1	0.3	-0.9	0.2	0.0	-0.1	-0.1
11/7/2008												
11/8/2008	8	2	0	8	0.6	0.1	0.1	0.0	0.4	0.1	0.1	0.1
11/9/2008	0	34	0	14	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11/10/2008	0	35	2	10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11/11/2008	21	0	27	0	0.3	0.6	1.1	-0.8	3.2	0.3	0.5	0.4
Period 7	21	2	8	17	2.9	0.0	1.0	-1.7	2.1	0.0	0.0	0.0
12/18/2008	2	44	0	1	16.0	-2.6	0.3	-2.9	-2.4	-1.3	-2.0	-1.6
12/19/2008	14	1	7	26	0.4	0.1	0.3	-0.5	0.5	0.1	0.1	0.1

Date	Valid	Direction limited	Angle limited	Turbulence limited	Background (ppb)	Emission average (μgm⁻²s⁻¹)	Emission SD (μgm⁻²s⁻¹)	Emission minimum (μgm⁻²s⁻¹)	Emission maximum (μgm⁻²s⁻¹)	Emission average (kgd⁻¹)	Emission average (gd⁻¹hd⁻¹)	Emission average (gd⁻¹AU⁻¹)
12/20/2008	2	26	5	15	6.2	-1.0	1.0	-1.7	-0.3	-0.5	-0.7	-0.6
12/21/2008	0	47	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/22/2008	6	10	32	0	4.9	-0.7	0.3	-1.2	-0.4	-0.4	-0.6	-0.4
12/23/2008	22	10	15	1	0.7	0.2	0.5	-0.4	1.4	0.1	0.2	0.1
12/24/2008	29	15	4	0	0.6	0.0	0.5	-1.0	0.9	0.0	0.0	0.0
12/25/2008	6	26	2	14	0.2	0.2	0.3	-0.1	0.7	0.1	0.2	0.1
12/26/2008	22	5	1	19	0.6	0.0	0.1	-0.2	0.3	0.0	0.0	0.0
12/27/2008	20	24	3	1	0.4	0.2	0.3	-0.6	0.7	0.1	0.2	0.1
12/28/2008	25	1	8	14	0.5	0.0	0.4	-0.9	0.7	0.0	0.0	0.0
12/29/2008	0	48	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/30/2008	4	1	12	3	0.5	0.1	0.2	-0.2	0.4	0.1	0.1	0.1
12/31/2008	15	10	2	21	0.7	0.3	0.3	-0.1	0.8	0.1	0.2	0.2
1/1/2009	0	35	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/2/2009												
1/3/2009	3	0	3	0	0.4	0.2	0.4	-0.1	0.6	0.1	0.1	0.1
1/4/2009	15	0	33	0	0.1	0.1	0.6	-1.0	1.4	0.0	0.1	0.0
1/5/2009	26	0	13	9	0.3	0.1	0.3	-0.3	1.0	0.1	0.1	0.1
1/6/2009	10	7	11	20	0.1	0.2	0.3	-0.4	0.7	0.1	0.1	0.1
Period 8	19	13	2	14	0.2	0.1	0.2	-0.4	0.5	0.1	0.1	0.1
3/10/2009	3	45	0	0	0.8	0.0	0.2	-0.3	0.1	0.0	0.0	0.0
3/11/2009	5	39	0	0	0.6	0.2	0.2	0.0	0.3	0.1	0.1	0.1
3/12/2009	18	19	3	8	0.0	0.1	0.4	-0.4	1.0	0.1	0.1	0.1
3/13/2009	19	0	2	27	0.1	0.1	0.4	-0.7	1.0	0.0	0.1	0.1
3/14/2009	38	8	0	2	0.1	0.0	0.3	-1.0	0.4	0.0	0.0	0.0
3/15/2009	0	32	0	16	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3/16/2009	13	24	0	10	0.4	0.2	0.2	0.0	0.5	0.1	0.2	0.1
3/17/2009	0	44	0	4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3/18/2009	0	48	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3/19/2009	0	48	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3/20/2009	24	9	15	0	1.3	1.2	0.5	0.3	2.4	0.6	0.9	0.7
3/21/2009	10	0	38	0	0.2	0.0	0.5	-1.2	0.8	0.0	0.0	0.0
3/22/2009	45	1	0	2	0.0	0.1	0.3	-0.9	0.7	0.0	0.0	0.0
3/23/2009	0	19	0	29	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3/24/2009	30	10	0	8	0.1	0.1	0.3	-0.2	1.0	0.1	0.1	0.1
3/25/2009	1	23	0	24	0.3	0.0	N/A	0.0	0.0	0.0	0.0	0.0
3/26/2009	2	45	0	1	1.0	0.6	0.1	0.6	0.7	0.3	0.5	0.4
3/27/2009	14	12	22	0	0.8	0.5	0.5	-0.2	1.7	0.2	0.4	0.3
3/28/2009	10	0	37	1	0.4	-0.1	0.4	-1.2	0.3	-0.1	-0.1	-0.1
3/29/2009	39	0	0	9	0.0	0.1	0.2	-0.2	0.5	0.0	0.0	0.0
3/30/2009	0	0	0	27	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3/31/2009	0	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/1/2009	21	0	0	0	1.0	13.0	27.7	0.0	99.2	6.3	9.7	7.7
4/2/2009	0	11	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A