Final Report
Site IA3A
Pork Production Facility

for the

NATIONAL AIR EMISSIONS MONITORING STUDY

to

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July 2, 2010

Citation

R.H. Grant and M.T. Boehm. 2010. National Air Emissions Monitoring Study: Data from the midwestern US pork production facility IA3A. Final Report to the Agricultural Air Research Council. Purdue University, West Lafayette, IN, July 2.

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Acknowledgments

This project was supported by the National Pork Board and the Agricultural Air Research Council.

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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 wastewater basin open source at the Midwestern hog finisher facility. Within that objective, this report will:

- Describe the farm and the 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 basin 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. Basin emissions were measured up to 21 d each season over two years. The duration of measurement periods designated 'up to 21 d' depended 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 basin 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, which uses 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 atmospheric temperature, relative humidity, barometric pressure, solar radiation and wetness were measured and recorded at an automated weather station established on the basin rim (Table 1-2).

Table 1-1: Critical measurements

Measurement	Method/ Instrument	Required operating range	MDL	Minimum sample frequency	Final data-aggregation
NH_3	TDLAS/ Boreal Laser, Inc. GasFinder 2.0™	1-800 ppb	5 ppm-m	1.2 s dwell	30 min & 24 h
H_2S	PF/Thermo Environmental 450i analyzer	1-800 ppb	2 ppb	60 s averaging	30 min & 24 h
Wind speed	3D Sonic anemometer/ RM Young 81000	0-60 ms^{-1}	0.01 ms^{-1}	160 Hz sampling/ 16 Hz averaging	30 min & 24 h
Wind direction	3D Sonic anemometer/ RM Young 81000	0^{o} -360^{o}	0.1^{o}	160 Hz sampling/ 16 Hz averaging	30 min & 24 h
3D Turbulence wind components	3D Sonic anemometer/ RM Young 81000	0-40 ms^{-1}	0.01 ms^{-1}	160 Hz sampling/ 16 Hz averaging	30 min
Temperature variability	3D Sonic anemometer/ RM Young 81000	-50 to +50^{o}C	0.01^{o}C	160 Hz sampling/ 16 Hz averaging	30 min
GSS sample flow rate	GSS/SOP-S	10 L min^{-1}	0.1 L min^{-1}	30 s	30 min
GSS sampling manifold pressure	GSS/SOP-S	±60,000 Pa	±500 Pa	30 s	30 min
NH_3 emissions	Radial Plume Mapping Model	N/A	N/A	30 min	30 min, 24 h
H_2S emissions	Backward Lagrangian Stochastic Model	N/A	N/A	30 min	30 min, 24 h
NH_3 emissions	Backward Lagrangian Stochastic Model	N/A	N/A	30 min	30 min, 24 h
H_2S emissions	Ratiometric to RPM Model	N/A	N/A	30 min	30 min, 24 h

All measurements from around the basin (TDLAS, barometric pressure, air temperature and relative humidity, wetness, solar radiation, 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 was routinely collected from the producers. In addition, samples of the basin manure were collected during approximately each measurement period at the basin and analyzed for pH, total and ammoniacal nitrogen, sulfur and total solids by a commercial laboratory (Table 1-2).

Table 1-2: Non-critical measurements.

Measurement	Method/ Instrument	Required operating range	MDL	Minimum sample frequency	Final data-aggregation
Ambient temperature	Thermistor/ Campbell Scientific Inc HMP45C (Vaisala)	-40 to 50 ^{o} C	0.1 ^{o} C	5 min	30 min, 24 h
Relative humidity	Hygrometer/ Campbell Scientific Inc HMP45C (Vaisala)	0-100%	5%	5 min	30 min, 24 h
Barometric pressure	Aneroid barometer/ Setra 278	600 to 1100 hPa	600 hPa	5 min	30 min, 24 h
Surface wetness	VAC resistance grid/ Campbell Scientific Inc.	(binary)	(binary)	5 min	30 min & 24 h
Solar radiation	Silicon pyranometer/ LiCOR 190SB	0- 1200 Wm^{-2}	10 Wm^{-2}	5 min	30 min & 24 h
Manure NH_4	Micro Kjeldahl+ titrometric	0.5-10 mg L^{-1} (diluted)	0.05 mg L^{-1}	1/ meas. period	1/ meas. period
Manure total Kjeldahl nitrogen	Micro Kjeldahl+ titrometric	0.5-10 mg L^{-1} (diluted)	0.05 mg L^{-1}	1/ meas. period	1/ meas. period
Manure pH	KCl pH electrode	0-14 units	0.02	1/ meas. period	1/ meas. period
Manure total solids content	Dry at 103-105 ^{o}C	0-50 g sample	3 mg L^{-1}	1/ meas. period	1/ meas. period

1.3 Farm description and operation

The Midwestern finisher basin facility was located in Iowa. The elevation at the farm was 351 m (1151 ft). The farm consisted of four barns and a manure basin (Figure 1-1). The facility had a capacity of 3840 finishers in the four units. The construction of the facility was completed in 1998.

Manure from the 2-ft deep pits in each of the four barns was transferred to the basin, which was W of the barns (Figure 1-1), approximately once every ten weeks through two inlets (Figure 1-1). The concrete, circular basin had a diameter of 55-m (180-ft) with its sides approximately 1.5 ft above (agl) and 6.5 ft below ground level. While the basin was circular, the measurements are described below in terms of the north, east, south and west "sides" and "corners" of the basin, which refers to measurements made to the north, east, south and west. Manure was surface-applied yearly, alternating between the adjacent fields and the remote fields (those located up to 2 mi from the basin).

Figure 1-1: Configuration of the IA3A farm.

1.4 Measurement layout

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

The path-integrated concentrations (PICs) of NH_3 were measured by TDLAS along optical paths defined by TDLAS/scanner systems and retro-reflectors. The scanning TDLAS instruments

(TDLAS/scanner) were mounted at 1-m height above the basin rim (abl) at the northeast and southwest ‘corners’ (Figure 1-2). The northeast TDLAS/scanner was located 12 m northwest of northwest corner of northernmost barn. Towers for mounting retro-reflectors were located off the northwest and southeast ‘corners’ of the basin (Figure 1-2). The southeast tower was located 12 m west of the barns. A description of the position and path length of the optical paths along each side of the basin follows:

- North side of basin: Retro-reflectors were located on anchored tripods at 1 m abl at distances of 25 m and 45.5 m from the northeast TDLAS/scanner. Three retro-reflectors were mounted on the northwest tower 75 m from the TDLAS/scanner at heights of 1.5 m, 8 m, and 13.6 m abl. The optical paths were approximately 3 m from the basin at their closest point.
- East side of basin: Retro-reflectors were located on anchored tripods at 1 m abl at distances of 27 and 48 m from the northeast TDLAS/ scanner. Retro-reflectors were located halfway between barns 2 and 3, and 3 and 4. Three retro-reflectors were mounted on the southeast tower 80.5 m from the TDLAS/scanner at heights of 1.2 m, 8.2 m, and 14.3 m abl. The optical paths were approximately 1 m from the basin at their closest point.
- South side of basin: Retro-reflectors were located on anchored tripods at 1 m abl at distances of 22 m and 44 m from the southwest TDLAS/scanner. Three retro-reflectors were mounted on the southeast tower 71 m from the TDLAS/scanner at heights of 1.2 m, 8.2 m, and 14.3 m. The optical paths were approximately 9 m from the basin at their closest point.
- West side of basin: Retro-reflectors were located on anchored tripods at 1 m abl at distances of 18 m and 36 m from the southwest TDLAS/scanner. Three retro-reflectors were mounted on the northwest tower 60.5 m from the southwest TDLAS/scanner at heights of 1.5 m, 8 m, and 13.6 m abl. The optical paths were approximately 12 m west of the basin rim at their closest point.

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 length S-OPS path began at the northeast TDLAS/scanner and ended 19 m south of the fence and 59 m west of the northernmost barn (Figure 1-2). The nearest point from S-OPS path to basin was 3 m. The second 50-m S-OPS path ran east-west along the TDLAS path lines with closest point at 9 m south of the basin. S-OPS path began 11 m west of barns, 1 m above basin rim height, and ended along the TDLAS path lines, 62 m west of the barns (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 measurement sensors, including barometric pressure, air temperature, relative humidity, solar radiation, and surface wetness, were located 10 m to the southwest of the basin and 66 m west of the barns (Figure 1-2). The meteorological measurement data were collected on the data logger. The 3D sonic anemometers were located on the meteorological tower at 2.3-m heights, and on the northwest corner tower (Figure 1-2) at 4-m and 15.4-m heights agl (Figure 1-2).

Figure 1-2: Locations of instrumentation around the basin under measurement.

Retro-reflectors are indicated according to side (north-N, south-S, east-E, west-W) with 345 indicating the location of a tower. TDLAS/scanner locations are indicated by TS. The locations of the two S-OPS are indicated by the solid yellow lines. The instrumentation trailer was located between the middle barns.

The farm was located in rolling terrain. The barns, 12 m to the east of the basin, had an approximate ridge height of 5 m agl, which resulted in a fetch ratio (rise: run) of 1:3 or better for the nearest TDLAS beam line. Crops were grown to the north, south and west of the basin. The area to the north alternated between corn and soybeans, while the west and south varied between wheat, soybean, and corn. Crops approximately 10 m to the north, south, and west of the basin had a height ranging from 1 m (soybeans, wheat) to 3 m (corn). Since measurements were at 1.5 m agl or higher, the soybean and wheat crops did not affect the air flow at beam line or anemometer measurement heights. The fetch for the TDLAS and S-OPS paths to the south of the basin was 1:17 or better when cropped with corn. The fetch for TDLAS paths to the west of the basin was 1:6 or better when cropped with corn. The fetch for the S-OPS and TDLAS to the north of the basin was 1:3 or better when cropped with corn. The 2-m anemometer had a prevailing wind upwind fetch of 1:36 for the northwest, 1:33 for south winds, and 1:22 for the east winds coming from the barns. The 4-m anemometer fetch in all directions except east winds was greater than 1:100; for the east wind, fetch was 1:78. All wind measurements were relatively unaffected by upwind conditions, however the concentration measurements and wind profile along the east side of the basin was affected by the barn exhausts. Consequently, emissions calculated when the winds were from between 10^o and 170^o were excluded from analysis.

Three samples of the basin liquid/ manure were collected during most measurement periods at random locations around the basin edge and analyzed for pH, total and ammoniacal nitrogen, sulfur and total solids. No samples were collected during the winter when the basin was frozen.

2 Monitoring activities

2.1 Measurement periods

This location was measured as part of an approximate 20-d rotation between three other farms. The equipment was on site a total of 164 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 153 d and H_2S emissions were measured 96 d.

Table 2.1-1: Days on site

Measurement Period	Start date	End date	# days
2	8/30/2007	9/26/2007	27
3	12/19/2007	1/15/2008	27
4	5/14/2008	6/4/2008	21
5	6/4/2008	6/25/2008	21
6	11/13/2008	11/25/2008	12
7	11/25/2008	12/16/2008	21
8	4/8/2009	4/23/2009	15
9	7/28/2009	8/17/2009	20

2.2 Site visits

The Field operation team visited this farm 31 d (Table 2.2-1). Visits to set up the site instrumentation and conduct calibration verification checks of instruments typically lasted 3 d while visits for calibration verifications and take-down of the equipment on site typically needed 2 d.

Table 2.2-1: Dates of site visits

Year	Spring	Summer	Fall	Winter
2007			Aug 30,31 Sep 17,18,26	Dec,19,20 Jan 14,15
2008	May 14,15	Jun 4,5,12,23,24	Nov 12,13,14,25	Dec 15,16
2009	Apr 8,9,22,23	Jul 27,28,29 Aug 17,18		

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:

- GasFinder 2.0™ NH_3 TDLAS serial number (s/n) 1026, 1027, 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)
- 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 'standard' anemometers. The TDLAS units on location (s/n 1031 and 1028) were inter-compared on 6/5/2008.

2.4 Audits

Two internal audits were conducted at this location: 1) on 6/5/2008 with particular attention to the H_2S Analyzer and TDLAS calibration verification, and 2) on 7/28/2009 with particular attention to the sonic anemometer inter-comparison and H_2S Analyzer and TDLAS calibration verification.

2.5 Repair trips

Two repair trips were made to this location: 7/18/2007 and 6/12/2008.

2.6 Remote site checks

Over the course of measurements, there were 63 remote checks made through the computer for instruments operating at this location.

2.7 Measurement data acquisition

Data from the TDLAS units (Model GasFinder 2.0™ NH3-OP, Boreal Laser Inc., Spruce Grove, Alberta, Canada) were acquired using the Boreal Laser *GasView MP* software (Boreal Laser Inc., Spruce Grove, Alberta, Canada) program running on laptops dedicated to this purpose (one laptop per TDLAS unit). The TDLAS units sent back data through 2.4 GHz wireless modems about every 1.2 s. This software also controlled the movements of the scanner (Model PTU-D300, Directed Perception Inc., Burlingame, CA) that aimed the TDLAS units.

Weather 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 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 basin and the time difference could lead to H_2S concentrations being recorded for the wrong S-OPS line (side of source).

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

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

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

3.2 Data exclusions

Data were excluded from processing due to equipment failures, calibration failures, and calibration checks were in progress. Periods of invalidated measurements associated with the calibration check failures is documented in the calibration reports in Section 6. Significant data exclusions of greater than 1-d duration are indicated below by instrument. All time references are in Coordinated Universal Time (UTC):

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

Table 3.2-1: TDLAS measurement exclusions

Begin		End		Reason
9/1/2007	00:30	9/18/2007	16:35	TDLAS 1 could not maintain communication with laptop
6/8/2008	09:45	6/9/2008	18:41	TDLAS 1 unknown failure
6/5/2008	22:33	6/11/2008	23:20	TDLAS 2 scanner / power supply issue

Wetness measurement exclusions: Excluded measurements are summarized in Table 3.2-2.

Table 3.2-2: Wetness measurement exclusions

Begin		End		Reason
8/30/2007	22:15	9/26/2007	19:10	Sensor not functioning; reads continuously wet
12/19/2007	21:40	1/15/2008	15:10	Sensor not functioning; reads continuously wet

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
6/8/2008	09:45	6/9/2008	12:15	Sonic program failure
11/29/2008	23:30	11/30/2008	19:45	All 3 sonic anemometers inoperable due to icing
12/9/2008	02:15	12/10/2008	01:30	All 3 sonic anemometers inoperable due to icing

GSS/S-OPS measurement exclusions: Excluded measurements are summarized in Table 3.2-4.

Table 3.2-4: GSS/S-OPS measurement exclusions

Begin		End		Reason
8/7/2009	22:45	8/8/2009	09:45	Condensation inside GSS

3.3 Data correction procedures

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

3.4 Data validation procedures

3.4.1 NH_3 concentration measurements

Because of the nature of the TDLAS data, the TDLAS routine is the most complicated portion of the data processing and quality control software. It is broken into several subroutines. The first subroutine flags pan/tilt locations that are likely to be in supersaturated "holes" in the retro-reflector array. The TDLAS instrument contains a sensor that detects the intensity of the energy returned from the retro-reflector in arbitrary units. Light levels of between 500 and 12000 are required for data to be considered valid. The light level sensor in the TDLAS instrument has a maximum value of 16368 (arbitrary units). Additional returned energy causes the light level to decrease. This creates a supersaturated condition in which the light levels appear valid, but in reality the returned energy is much greater than the allowable threshold for a valid reading. This leads to erroneous instrument readings, frequently indicated by low r^2 values that are associated with large path integrated concentrations (PICs). The term "hole" refers to a region of light levels that appear valid surrounded by 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 supersaturated.

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

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

Once the PIC vs. r^2 threshold curve was determined, a final pass was made through the data, this time comparing the PIC value for each data point with the threshold value at the current r^2. This resulted in four categories of points depending on whether or not super-saturation was indicated by the hole-finding algorithm and whether or not super-saturation was indicated by the hole-finding routine.

In a final pass through the data, data from the individual dwells 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 S-OPS changed from one line to the other line. This array was later used when separating the H_2S data according to which S-OPS 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 anemometer data files and produced the final sonic anemometer QC output file and also arrays of data at 30-min intervals for use by the *WindTrax* and *RPM* emissions models. The *WindTrax* arrays contain the turbulence statistics required as inputs to *WindTrax* and also flags used for characterizing the output from the *WindTrax* or else the reason that sonic anemometer data were not suitable for use by *WindTrax* during a particular data interval. The *RPM* arrays contained the wind direction and wind speed averaged over a 30-min interval and interpolated to 10 levels from the surface to 20 m above the surface.

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

3.5 Emission calculations

3.5.1 NH_3 emissions by RPM

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

3.5.2 NH_3 emissions by bLS

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

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

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

3.5.3 Validation of bLS emissions model

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

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

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

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

3.5.4 H_2S emissions by Ratiometric

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

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

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

3.5.5 H_2S emissions by bLS

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

GoogleEarth® was used extensively in producing the site maps required by *WindTrax*. By the end of the project, each site had a high-resolution image on *GoogleEarth*® sufficient to see the outline of the source area. A GPS was used to obtain precise latitudes and longitudes for the ends of the S-OPS lines. Labeled location markers were then placed at these coordinate locations. When the locations were obviously wrong (the accuracy indicated by the GPS was generally on the order of 4 m or so), either because the path crossed the basin 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 basin include transfer of waste from barns into the basin (Table 4.1-1) and basin pump-outs for irrigation. Animal inventories for the calculation of basin loading rates are indicated in Table 4.1-1.

Table 4.1-1: Producer activities

Period	Activity	Animal inventory
2: 8/30/2007 - 9/26/2007	Pit agitation and pump out 9/21/07	3592
3: 12/19/2007 -1/15/2008	No events	3564
4: 5/14/2008 - 6/4/2008	No events	3547
5: 6/4/2008-6/25/2008	Pulled plugs in building to drain manure into pits 6/18/08 and 6/25/08	3111
6: 11/13/2008-11/25/2008	No events	3873
7: 11/25/2008 - 12/16/2008	Drained manure from 2 north barns 12/6/08 and the 2 south barns 12/8/08	3800
8: 4/8/2009-4/23/2009	No events	3201
9: 7/28/2009 - 8/17/2009	Pit agitation and pump out. 8/12/09 12pm-6pm 8/13 - 8/14/09 8am-6pm 8/17/09 8am-12pm	3374

4.2 Weather conditions

4.2.1 Synoptic weather events

Weather conditions during the measurement periods varied widely as expected for midlatitude climates (Table 4.2-1). Twenty-five percent of the days had extra-tropical frontal systems overhead while 75% 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
2	27	0	7	0	0
3	27	0	4	2	0
4	21	1	5	1	0
5	21	0	3	1	0
6	12	0	2	0	0
7	21	2	4	0	0
8	15	1	1	0	0
9	20	1	6	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 -19.1 ^{o}C to 28 ^{o}C while the barometric pressure varied from 95.85 kPa to 99.88 kPa (Section 6.10). Sky conditions ranged from clear skies with maximum ½ hr solar irradiance of 1194 Wm^{-2} to overcast conditions with maximum ½ hr solar irradiance of 92 Wm^{-2} (Section 6.10). The wetness sensor failed frequently due to corrosion issues.

4.2.3 Variation in air temperature and relative humidity

The relationship between the daily mean air temperature and humidity compared to the monthly climatology is indicated in Figure 4-1. Temperatures were generally within the climatological normal conditions throughout the study measurement periods at this location.

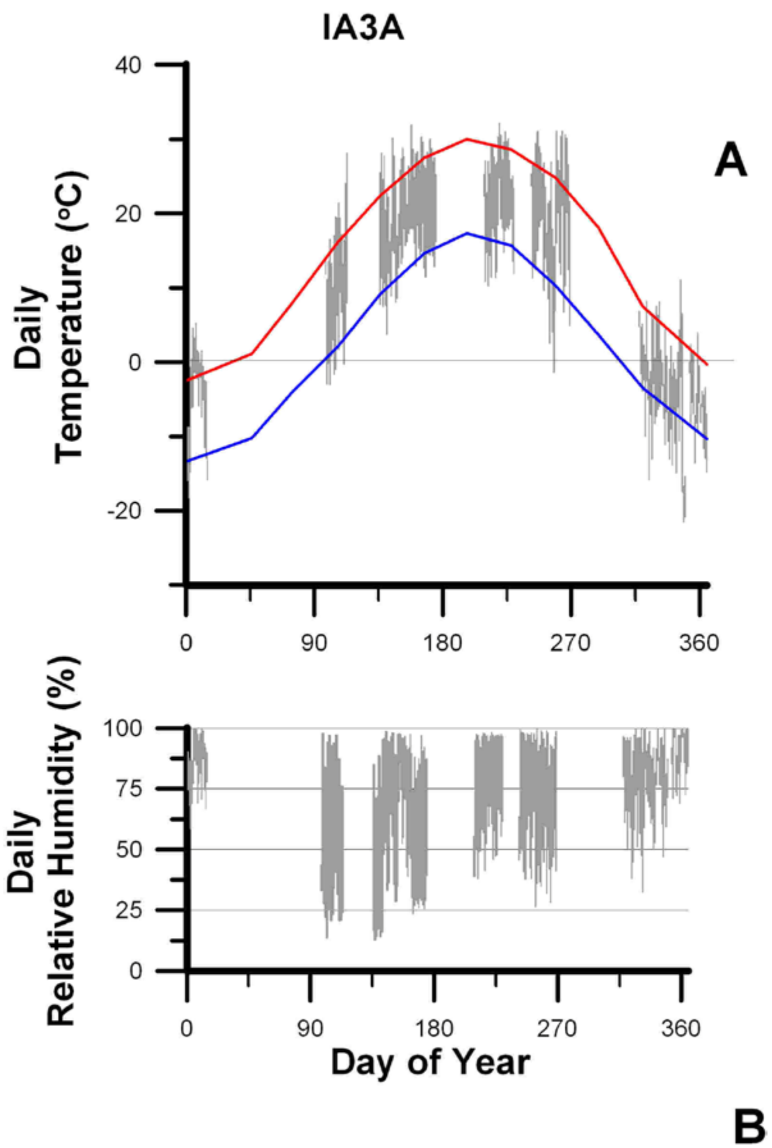

Figure 4-1: Variation in daily temperatures and relative humidity during measurements. The mean monthly climatological maximum (red solid line) and minimum (blue solid line)

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

4.2.4 Wind conditions

Wind conditions for each measurement period are illustrated in Figure 4.2-1 through 4.2-4. Emission calculation exclusion regions due to surrounding sources (wind directions of 10^o through 170^o) are indicated as a grayed region in the figures.

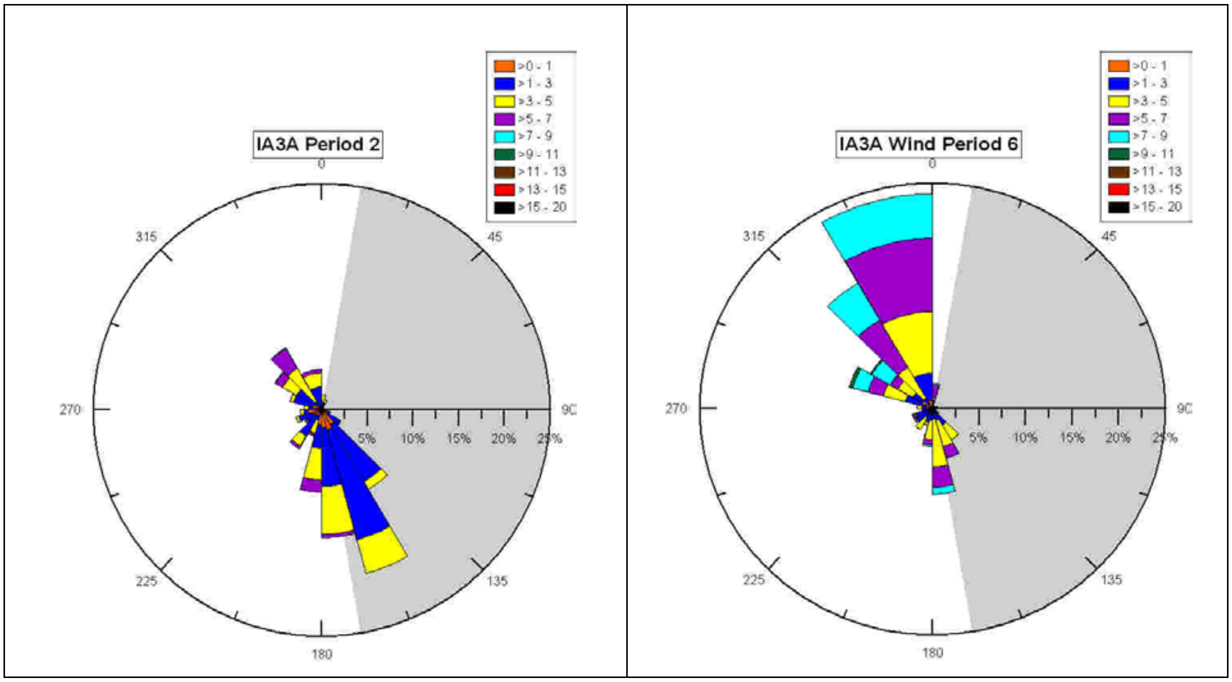

Figure 4.2-1: Wind roses for ½ hourly wind measurements during the Fall Measurement Periods. The periods in which measurements were made are indicated. The relative portion of time in which the wind is from a given direction is indicated by the length of the triangle pointing in that direction. The fraction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

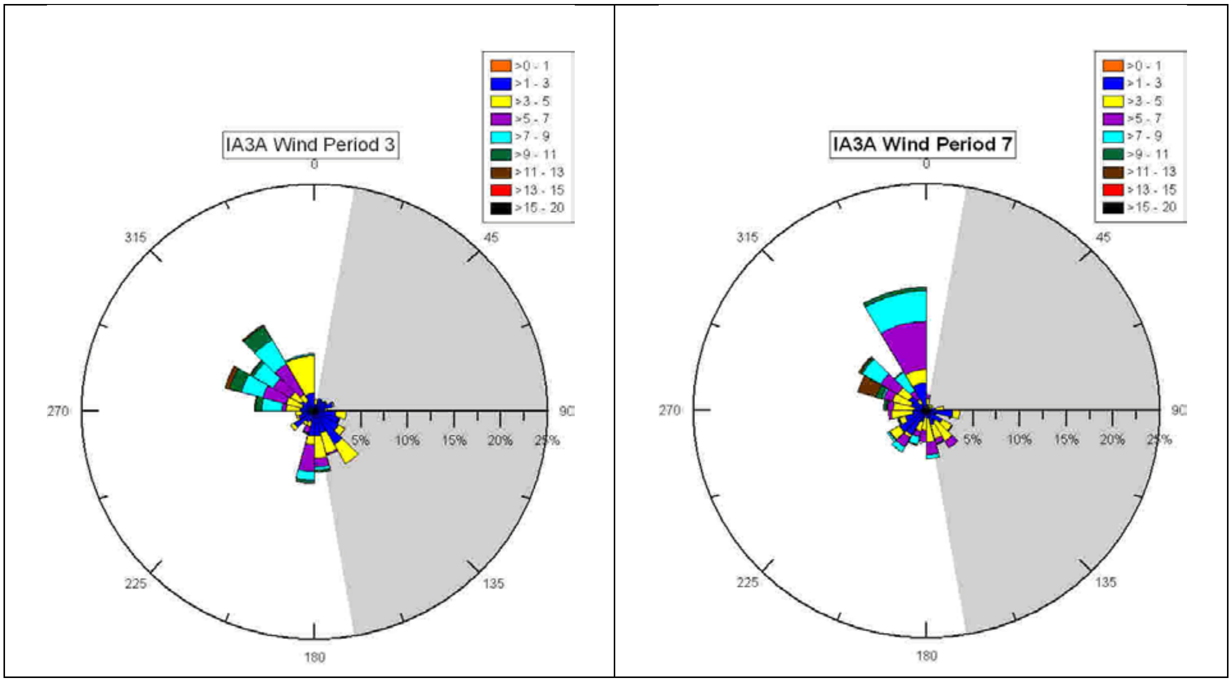

Figure 4.2-2: Wind roses for ½ hourly wind measurements during the Winter Measurement Periods. The periods in which measurements were made are indicated. The relative portion of time in which the wind is from a given direction is indicated by the length of the triangle pointing in that direction. The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

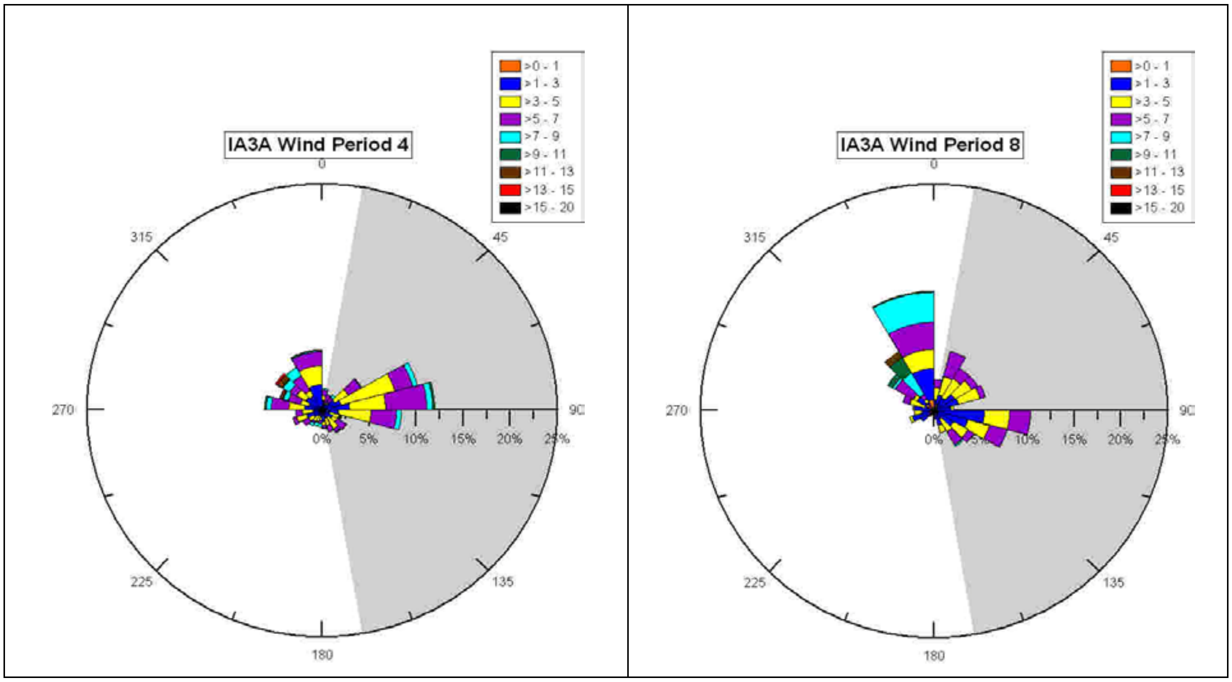

Figure 4.2-3: Wind roses for ½ hourly wind measurements during the Spring Measurement Periods. The periods in which measurements were made are indicated. The relative portion of time in which the wind is from a given direction is indicated by the length of the triangle pointing in that direction. The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

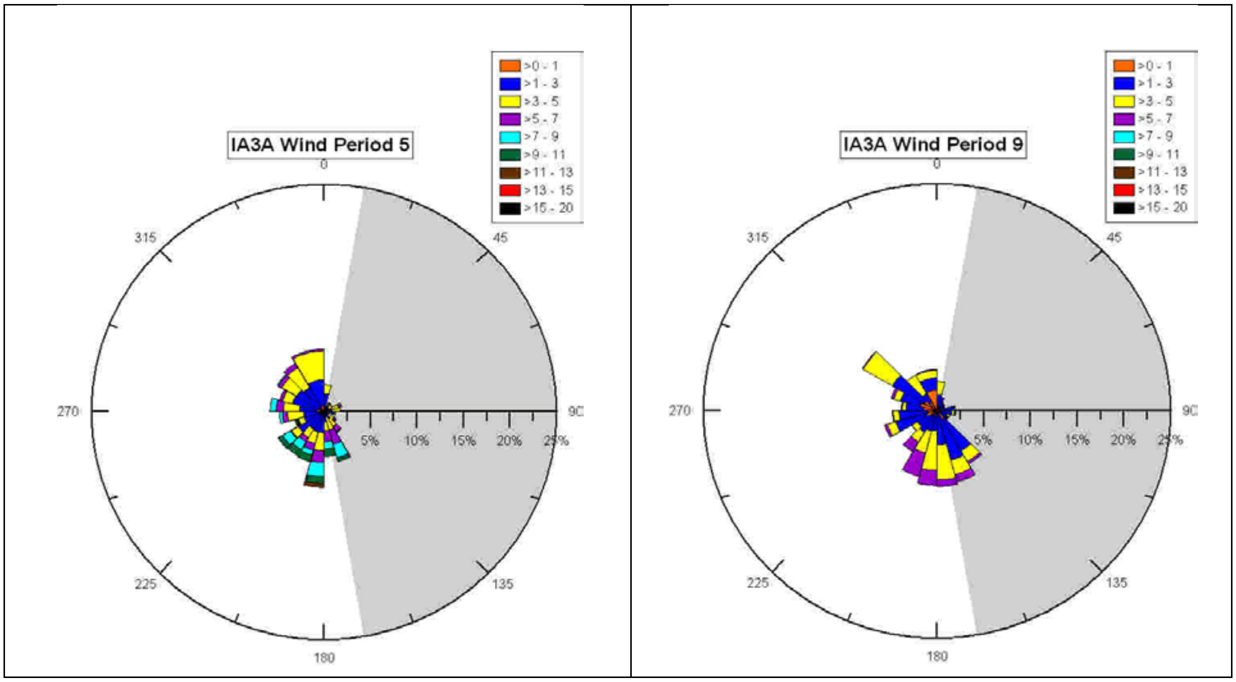

Figure 4.2-4: Wind roses for ½ hourly wind measurements during the spring measurement periods. The periods in which measurements were made are indicated. The relative portion of time in which the wind is from a given direction is indicated by the length of the triangle pointing in that direction. The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

4.3 Basin conditions

4.3.1 Basin appearance

The appearance of the basin was recorded on almost every site visit (Table 4.3-1). The basin generally appeared brown or black with surface characteristics ranging from frozen during the winter to free of crust during the remainder of the year. Crusting was evident in many of the measurement periods.

Table 4.3-1: Basin description

Period	Date, appearance (color/crust)
2: 8/30/2007 - 9/26/2007	8/30/2007 - 100% crusted 8/31/2007 - 100% crusted 9/17/2007 - brown/100% crust 9/18/2007 - brown 9/26/2007 - black/ 40% crust

Period	Date, appearance (color/crust)
3: 12/19/2007 - 1/15/2008	12/19/2007 - black/90% crust 12/20/2007 - black/90% crust 1/14/2008 - brown/100% crust 1/15/2008 - brown/100% crust
4: 5/14/2008 - 6/4/2008	5/14/2008 - black/no crust 5/15/2008 - black/no crust 6/4/2008 - black/no crust
5: 6/4-25/2008	6/4/2008 - black/no crust 6/5/2008 - black/no crust 6/12/2008 - black/no crust 6/23/2008 - black/no crust 6/24/2008 - black/no crust
6: 11/13-25/2008	11/12/2008 - black/no crust 11/13/2008 - dark/no rust 11/14/2008 - black/no crust 11/25/2008 - dark/100% frozen
7: 11/25/2008 - 12/16/2008	11/25/2008 - dark/100% frozen 12/15/2008 - white - 100% frozen 12/16/2008 - white - 100% frozen
8: 4/8-23/2009	4/8/2009 - black/no crust 4/9/2009 - black/no crust 4/22/2009 - brown/light scum 4/23/2009 - brown/light scum
9: 7/28/2009 - 8/17/2009	7/27/2009 - brown/100% crust 7/28/2009 - brown/100% crust 7/29/2009 - brown/100% crust 8/18/2009 - brown/100% crust

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4.3.2 Basin Chemistry

The composition of waste in the basin is documented in Table 4.3-2.

Table 4.3-2: Characteristics of liquid manure samples from the basin

			Percent (wet weight basis)				
Date	**n**	**pH (SU)** (Mean ± standard deviation)	**Nitrogen** (Mean ± standard deviation)	**Solids** (Mean ± standard deviation)	**Ammonia** (Mean ± standard deviation)	**Sulfur** (Mean ± standard deviation)
6/4/2008	3	7.54 ± 0.02	N/A	1.33 ± 0.05	0.24 ± 0.01	N/A
4/9/2009	3	7.62 ± 0.03	0.37 ± 0.02	1.81 ± 0.04	0.30 ± 0.01	N/A
(est 4/15/2009)	3	7.44 ± 0.08	0.40 ± 0.02	1.82 ± 0.12	0.30 ± 0.03	N/A
7/29/2009	3	6.91 ± 0.02	0.47 ± 0.02	4.20 ± 0.13	0.36 ± 0.02	0.03 ± 0.00
8/18/2009	3	7.11 ± 0.10	0.48 ± 0.02	4.37 ± 0.07	0.33 ± 0.00	0.03 ± 0.00

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 basin 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 basin or basin. Emissions reported on an animal unit (AU) basis assumed an animal weight of 500 kg equals 1 AU and the typical animal weight values reported by the producer. Emissions reported on an area basis are based on the surface area of the basin.

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 624 ½ h half-hour measurement periods over the entire measurement time at this location. Results show that the bLS emissions did not have a significantly difference precision (F=0.70, critical F 1.0) but had a significant bias over the *RPM* emissions (t=-20.5, $t_{0.2}$=1.29) with a corresponding correction factor for the bLS of 0.63 (Table 4.4.1-1). Consequently the ½ hour bLS emissions measurements are biased low by 36% compared to the *RPM* measurements.

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

	RPM	bLS	bLS-RPM
Mean emission (gs^{-1})	0.662	0.432	-0.240
Standard deviation (gs^{-1})	0.458	0.384	
Variance of the mean (gs^{-1})	0.210	0.148	

4.4.1 NH_3 Emissions

4.4.1.1 Mean daily NH_3 emissions

An annual trend in the daily NH_3 emissions based on the *RPM* model was indicated (Figure 4.4.1-1) with a summer maximum emission of approximately 30 g $NH_3 d^{-1} hd^{-1}$. The daily emissions during the winter decreased to approximately 5 g $NH_3 d^{-1} hd^{-1}$. The measurements with potential for atmospheric moisture interference could be low by 40% (Figure 4.4.1-1: green circles). There were only a small number of measurements with more than 75% of the day's emissions measured. The wide variability during the summer in combination with the few 'complete' days of measurements limits confidence in the magnitude of the emissions. The daily NH_3 emissions and the number of valid measurements used in the mean daily emissions estimate calculated using the *RPM* model are listed in Section 6.12.1.

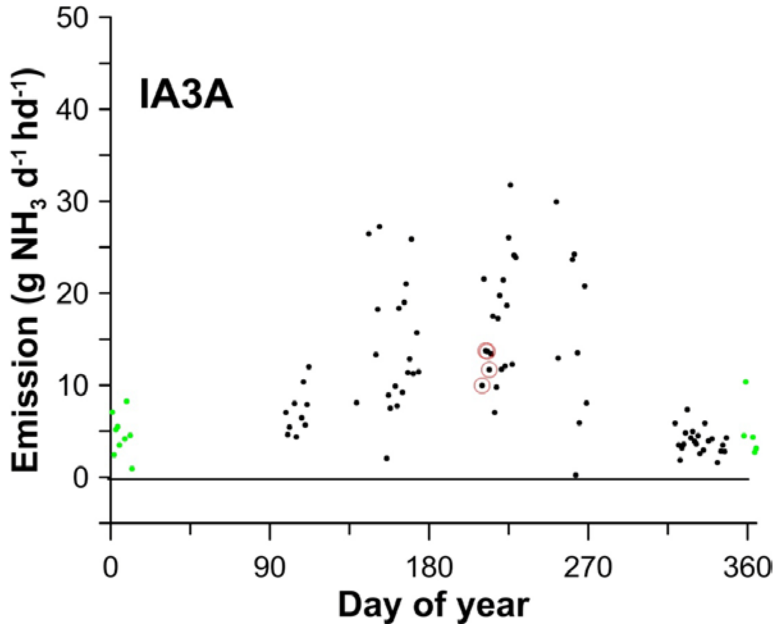

Figure 4.4.1-1: Annual variation in daily RPM-computed NH_3 emissions. Days with a red circle indicate there are measurements for greater than 75% of the continuous day. The green solid circles indicate moisture interference with the NH_3 concentration measurement.

An annual trend in the daily NH_3 emissions based on the bls model was indicated (Figure 4.4.1-2) with a fall maximum emission of approximately 30 g $NH_3d^{-1}hd^{-1}$. The daily emissions during the winter decreased to negligible levels. The measurements with potential for atmospheric moisture interference could be low by 40% (Figure 4.4.1-2: green circles). The number of daily emissions measurements based on more than 75% of the day's emissions measured during the summer suggest a summer emissions of 5 g $NH_3d^{-1}hd^{-1}$ and a fall emissions of approximately 20 g $NH_3d^{-1}hd^{-1}$. The wide variability during the summer in combination with the few 'complete' days of measurements limits confidence in the magnitude of the emissions. The daily NH_3 emissions and the number of valid measurements used in the mean daily emissions estimate calculated using the bLS model are listed in Section 6.12.2.

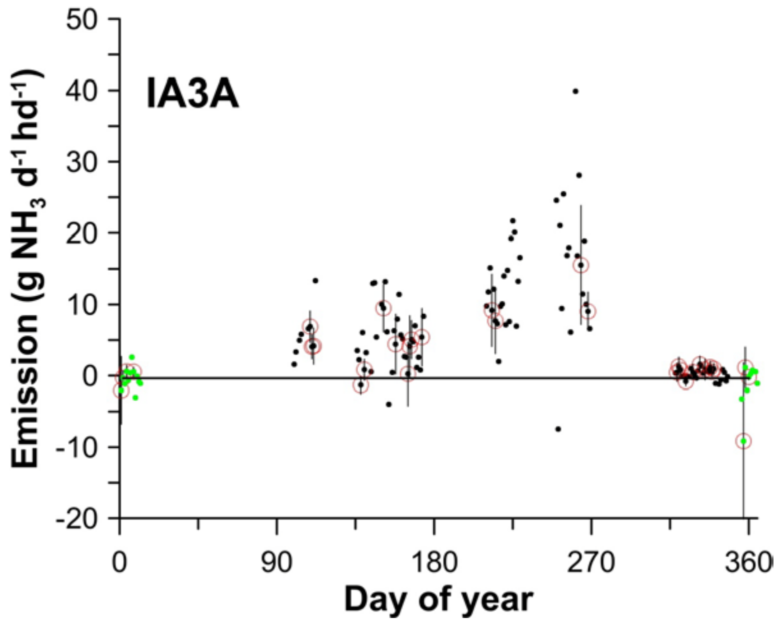

Figure 4.4.1-2: Annual variation in daily bLS-computed NH_3 emissions. Days with a red circle indicate there are measurements for greater than 75% of the continuous day. The green solid circles indicate moisture interference with the NH_3 concentration measurement. The bars represent the standard deviation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

The bLS model is influenced by the calculated background concentrations. Results indicate that the background concentration of NH_3 was generally less than 0.3 ppm (Figure 4.4.1-3). Given that the typical path length around the basin was 50 m and the typical background concentration is less than 0.3 ppm, this corresponds to a background concentration for a given PIC of aproximately 15 ppm-m. This is approximately seven times the MDL for the TDLAS instruments of 2 ppm-m (Section 8.1) and therefore represents a real background for this location. This may be expected given the close proximity of the barns on this farm.

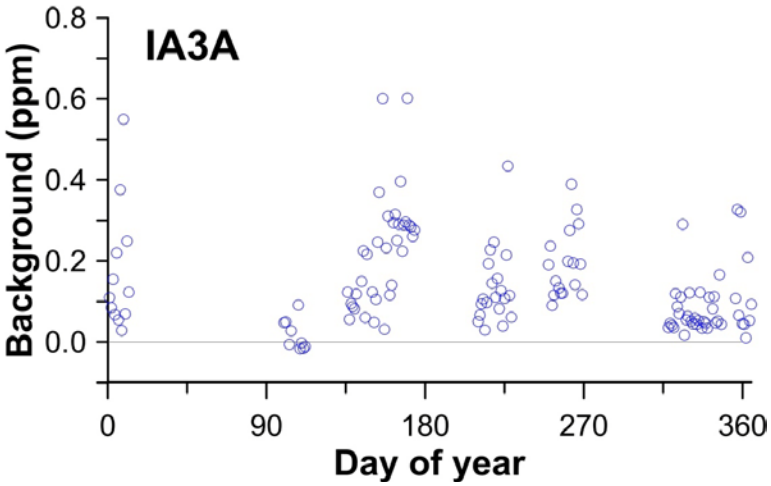

Figure 4.4.1-3: Annual variation in mean daily bLS-computed background concentration of NH_3.

4.4.1.2 Diurnal variation in NH_3 emissions

There was a distinct diurnal pattern in the daily NH_3 emissions during most of the measurement periods except during the winter with emissions higher during the daytime (Figure 4.4.1-4).

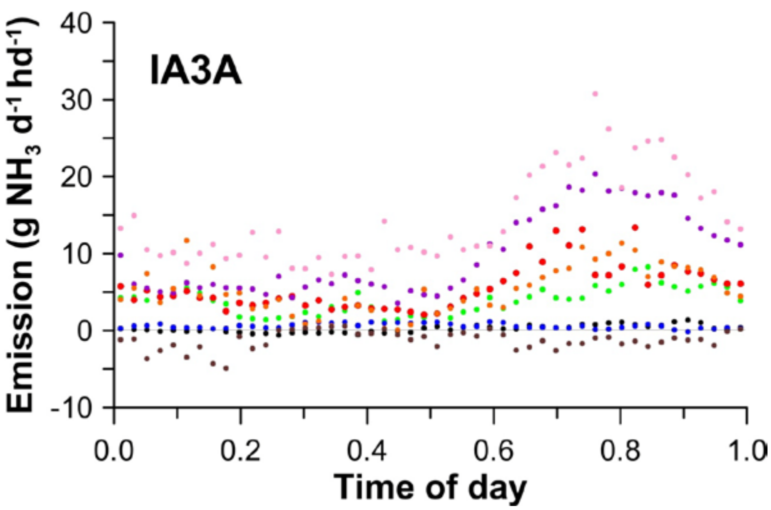

Figure 4.4.1-4: Diurnal variation in bLS-computed NH_3 emissions. Time based on Universal Time Coordinates. The mean emission for each half-hour of the day within a given measurement period (Period 2-Fall (pink), Period3-Winter (brown), Period 4-Spring (orange), Period 5 (green), Period 6-Fall (black), Period 7-Winter (blue), Period 8-Spring (red), and Period 9-Summer (purple)) are indicated.

4.4.1.3 NH_3 emissions data completeness

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

Table 4.4.1-2: Completeness statistics for NH_3 emissions measurements

	Measurement periods								
	2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Total**
NH_3 RPM model									
Valid 1/2 h measurements (d)	1.8	1.5	1.1	2.9	0.9	1.9	2.6	9.5	**22.1**
Measurements excluded due to wind direction (d)	0.5	0.1	0.1	0.9	0.0	1.0	5.3	1.5	**9.3**
Measurements excluded because at least one downwind path is missing or invalid (d)	22.6	17.5	18.1	12.4	5.6	4.2	2.0	5.9	**88.3**
Number of days with ≥ 36 valid 1/2 h periods	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	**4.0**
NH_3 bLS model									
Valid 1/2 h measurements (d)	6.0	11.4	6.7	10.1	7.0	10.2	3.9	8.9	**64.1**
Measurements excluded due to wind direction (d)	3.9	5.7	9.8	3.3	1.5	3.8	7.0	3.6	**38.5**
Measurements excluded because touchdown fraction < 0.1 (d)	3.6	0.4	0.0	0.1	0.0	0.2	0.0	0.0	**4.3**
Measurements excluded because $u_* < 0.15$ ms^{-1} or $\|L\| < 2$ m (d)	6.1	5.2	2.8	3.4	1.8	3.2	2.6	6.6	**31.6**
Number of days with ≥ 36 valid 1/2 h periods	2.0	7.0	3.0	5.0	5.0	5.0	3.0	2.0	**32.0**

In total, 22 d of valid NH_3 emissions were determined from the 153 measurement days using the *RPM* model, with only 4 d having at least 36 valid ½ hour NH_3 emissions. The absence or invalidation of at least one downwind path led to 88 d for which emissions could not be calculated.

Sixty four days of valid NH_3 emissions were determined from the 153 measurement days using the bLS model, with 32 d having at least 36 valid ½ hour NH_3 emissions. The exclusion wind directions due to the location of the barns relative to the basin resulted in the loss of 39 d of measurements. Invalid turbulence statistics ($u_* < 0.15$ m/s or $|L| < 2$ m) led to 23 d for which emissions could not be calculated. A touchdown fraction of less than 0.1 led to the exclusion of

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

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

4.4.2 H_2S emissions

4.4.2.1 Mean daily H_2S emissions

Emissions of H_2S calculated using the Ratiometric model were highest in the late summer (Figure 4.4.2-1). Peak emissions were approximately 6 g H_2S d^{-1} hd^{-1}. There was however wide variability in H_2S emissions from day to day (Figure 4.4.2-1). Since only one day had more the 75% of the ½ periods with valid emissions measurements, there is no confidence that the emissions pattern illustrated is representative of conditions on the farm. One value (45.4 g H_2S d^{-1} hd^{-1}) is not plotted. 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.

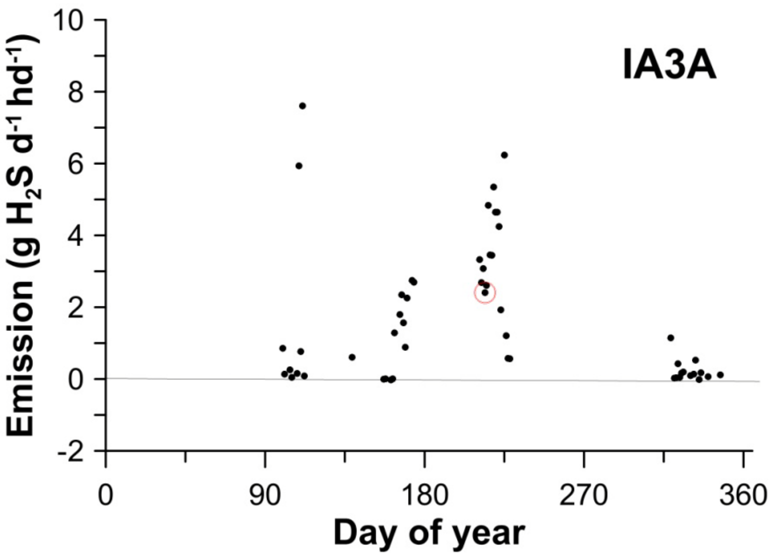

Figure 4.4.2-1: Annual variation in daily H_2S emissions. Days with a red circle indicate there are measurements for greater than 75% of the continuous day.

Emissions of H_2S calculated using the bLS model were highest in the summer (Figure 4.4.2-1). Peak emissions were approximately 20 g H_2S d^{-1} hd^{-1}. There was however wide variability in

H_2S emissions from day to day (Figure 4.4.2-2). Since only a few days had more the 75% of the ½ periods with valid emissions measurements, there is no confidence that the emissions pattern illustrated is representative of conditions on the farm. The daily H_2S emissions and the number of valid measurements used in the mean daily emissions estimate calculated using the bLS model are listed in Section 6.12.4

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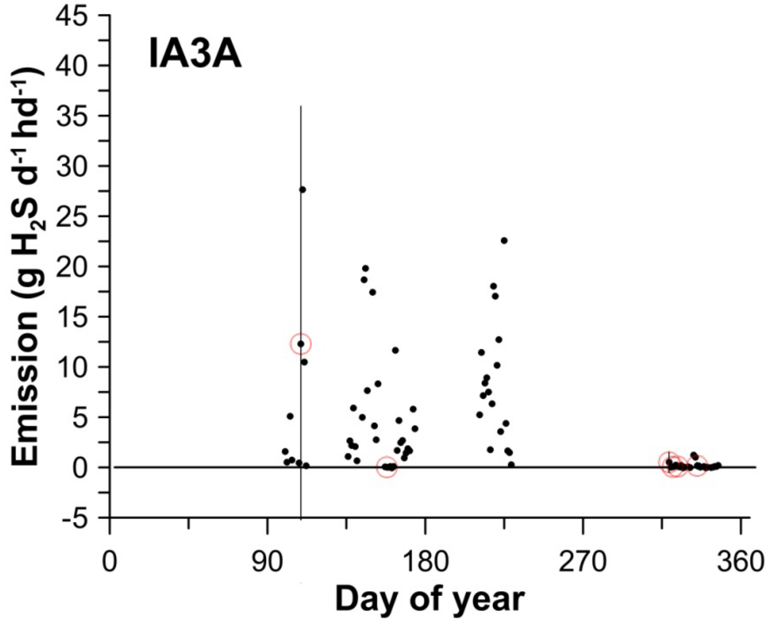

Figure 4.4.2-2: Annual variation in daily H_2S emissions. Days with a red circle indicate there are measurements for greater than 75% of the continuous day. The bars represent the standard deviation of emissions based on individual ½ hr values when at least 75% of the day had valid measurements. The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

The bLS model is influenced by the calculated background concentrations. Results indicate that the background concentration of H_2S was generally less than 5 ppb (Figure 4.4.3-3). This is approximately two times the MDL for the instrument (Section 6.2) and therefore may represent a real background for this location. This may be expected given the close proximity of the barns on this farm.

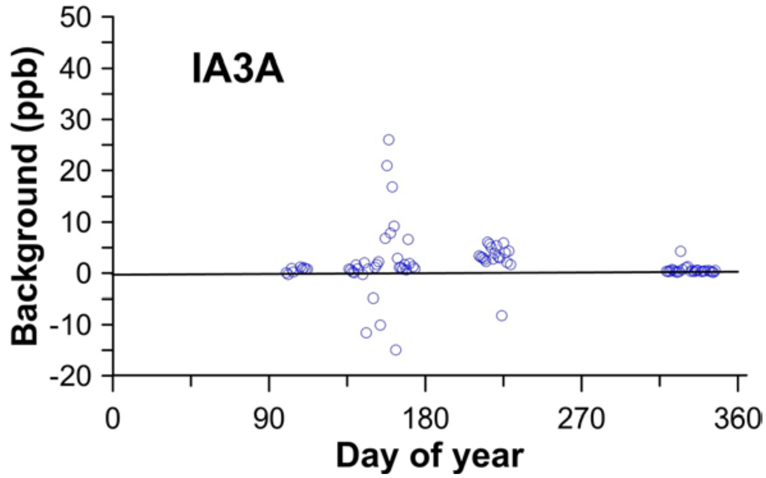

Figure 4.4.3-3: Annual variation in mean daily background concentration of H_2S.

4.4.2.2 Diurnal variation in H_2S emissions

No distinct diurnal pattern was evident in the measurements although higher emissions didi occur during the daytime (Figure 4.4.2-4).

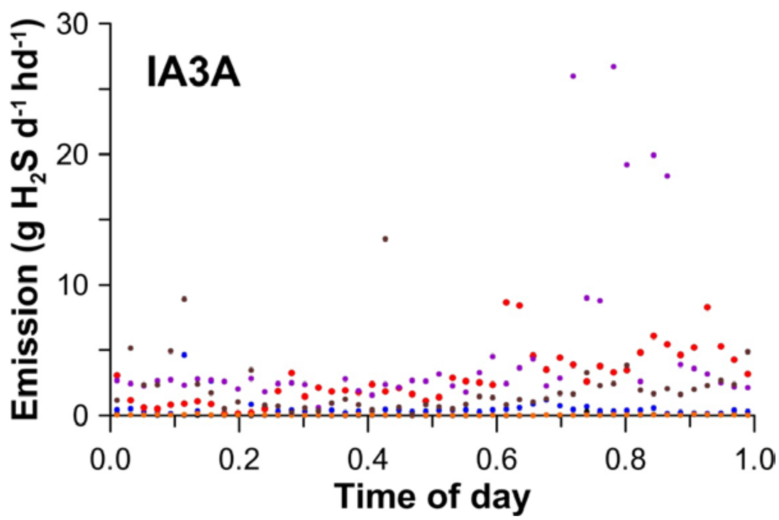

Figure 4.4.2-4: Diurnal variation in bLS-computed H_2S emissions. Time based on Universal Time Coordinates. The mean emission for each half-hour of the day within a given measurement period (Period 4-Spring (brown)), Period 5-Summer (blue), Period 6-Fall (orange), Period 7-Winter (black), Period 8-Spring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

4.4.2.3 H_2S emissions data completeness

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

Table 4.4.2-1: Completeness statistics for H_2S emissions measurements

	Measurement periods								
	2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Total**
H_2S Ratiometric model									
Valid 1/2 h measurements (d)	0.0	0.0	0.0	1.7	0.4	0.4	1.3	4.7	8.5
Number of days with ≥ 36 valid 1/2 h periods	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0
H_2S bLS model									
Valid 1/2 h measurements (d)	0.0	0.0	3.1	6.3	5.0	5.8	2.1	5.6	**28.0**
Measurements excluded due to wind direction (d)	0.0	0.0	9.6	2.3	1.5	3.8	6.4	3.4	**26.9**
Measurements excluded because angle of attack > 60 degrees (d)	0.0	0.0	2.8	3.4	1.1	3.3	1.1	2.6	**14.4**
Measurements excluded because $u_* < 0.15\ ms^{-1}$ or $\|L\| < 2$ m (d)	0.0	0.0	2.9	3.7	1.6	2.9	2.5	6.2	**19.8**
Number of days with ≥ 36 valid 1/2 h periods	0.0	0.0	0.0	1.0	3.0	1.0	1.0	0.0	**6.0**

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, 8 d of valid H_2S emissions were determined using the Ratiometric emission method, with only one day having at least 36 valid ½ hour H_2S emissions. Twenty eight days of valid H_2S emissions were determined using the bLS model, with 6 d having at least 36 valid ½ hour H_2S emissions. Measurements excluded due to wind direction was the dominant source of invalidate measurements. Invalidation of measurements due to turbulence statistics ($u_* < 0.15$ m/s or $|L| < 2$ m) was also a significantly factor in the number of days with valid measurements.

4.4.3 Estimation of emission measurement errors

Errors in the response of the TDLAS due to atmospheric moisture limited the accuracy of the TDLAS serial numbers 1026, 1027, and 1028 prior to July 21, 2008. TDLAS 1026 was used at IA3A from 8/30/2007 to 9/26/2007 (Measurement period 2) and 12/19/2007 to 1/15/2008 (Measurement period 3). TDLAS 1027 was used at IA3A from 5/14/2008 to 6/4/2008 (Measurement period 4). TDLAS 1028 was used at IA3A from 8/30/2007 to 9/26/2007 (Measurement period 2), 12/19/2007 to 1/15/2008 (Measurement period 3) and 5/14/2008 to 6/4/2008 (Measurement period 4), and 6/4/2008 to 6/25/2008 (Measurement period 5). Under the calibration verification checks, the TDLAS error of all units was 10% accuracy. However due to the short path length of the calibration verification, these checks did not assess water vapor interferences experienced in the long path lengths around the area sources. Inter-comparisons between various TDLAS units experiencing atmospheric moisture interference and units without apparent interference revealed reduced responses with the moisture-affected units of 28%, 68%, 36% and 31% for atmospheric moisture varying from dewpoint temperatures of -2^{o}C to 20^{o}C. A conservative estimate of the accuracy 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 -36% (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 -76% for TDLAS NH_3 measurements made by units with moisture interference and a bias of -36% 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

Five TDLAS units (Model GasFinder 2.0™ NH3OP, Boreal Laser Inc., Spruce Grove, Alberta, Canada) were used at this location: TDLAS 1026, TDALS 1027, TDLAS 1028, TDLAS 1030, and TDLAS 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 1/17/2007 was used for the entire study period. The offset of the equation was determined from a least squares fit of the entire record of calibration verifications made at 50 ppm-m applied to the first, second, and third order terms derived from the multipoint calibration. The regression equation was:

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

where X was the instrument response. The response of the sensor was influenced by humidity until 7/21/2008 due to an error in the factory settings for the spectral waveband analysis window. At that time, factory personnel corrected the spectral waveband used for analysis. The effect of this error was to 1) reduce the maximum possible linear correlation with the internal reference cell resulting in unusually low r^2 values under conditions in which the concentration of NH_3 was more than three times of the MDL, and 2) reduce the reported concentration. Adjustments made on the instrument at this time did not appear to affect the calibration (conducted before and after adjustments) but did change the maximum r^2 reached by the instrument when in the field for long path lengths and high humidity.

A zero concentration 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 2.04 ppm-m prior to the July 2008 modification and 1.77 ppm-m after the modification. The instrument performance was within the MDL DQI that required the MDL to be less than 10 ppm-m. The calibration equation offset was less than the requisite DQI MDL.

Instrument performance calibration checks (Figure 6.1-2) were made at the beginning and end of each measurement period. The majority of calibration checks were made within 21 d (Figure 6.1-3). The large fraction of checks made within 7 d was the result of calibration checks made at the end and beginning of sequential measurement periods. The standard deviation of the verifications about that predicted by the calibration equation was 8.27 ppm-m. The precision DQI was ± 10% RSD at 100 ppm-m. All verifications resulted in less than 10% RSD for 50 ppm-m (Figure 6.1-2) and were well within the precision DQI. The accuracy DQI was ± 10% of the 1000 ppm-m range of the measurements. A positive bias in the calibration verification exceeding the DQI occurred on 4/28/2009 and 11/10/2009 while negative biases exceeding the DQI occurred over the period 4/2/2008 through 7/1/2008 (Figure 6.1-2). The 4/28/2009 and

11/10/2009 bias exceedances were followed the same or next day with a passing verification and was 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 h often showed biases differing by more than 10 ppm-m suggesting operator errors. Although this instrument had a bias associated with water vapor interference, the instrument was in use in dry climates during this time. The measurements made during this period are considered valid and the error assumed to be due to the calibration verification operator.

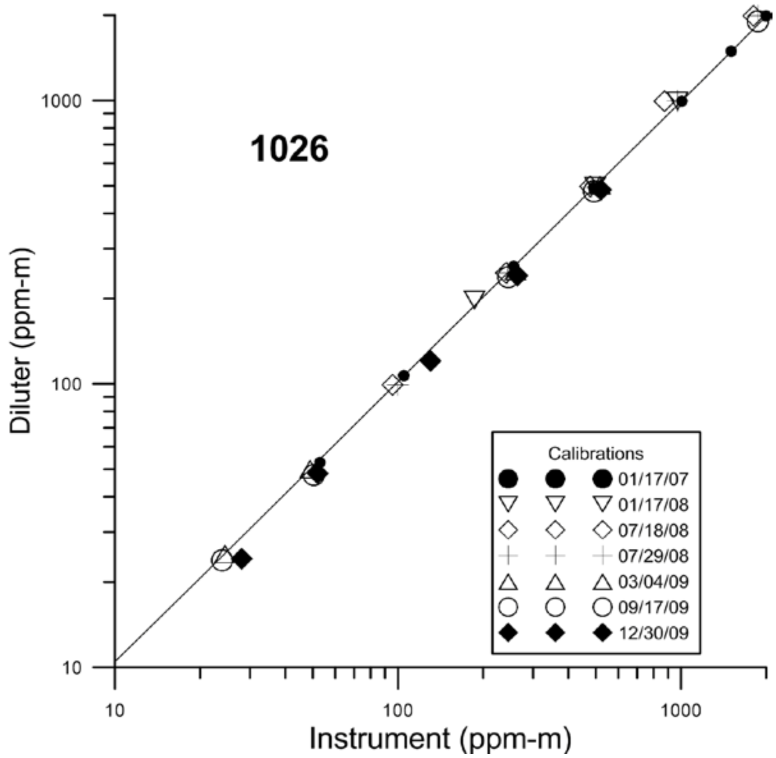

Figure 6.1-1: Multipoint calibrations of the GasFinder 2.0 ™ s/n NH3OP-1026. The solid line is the 3rd order polynomial regression for the chosen multipoint calibration.

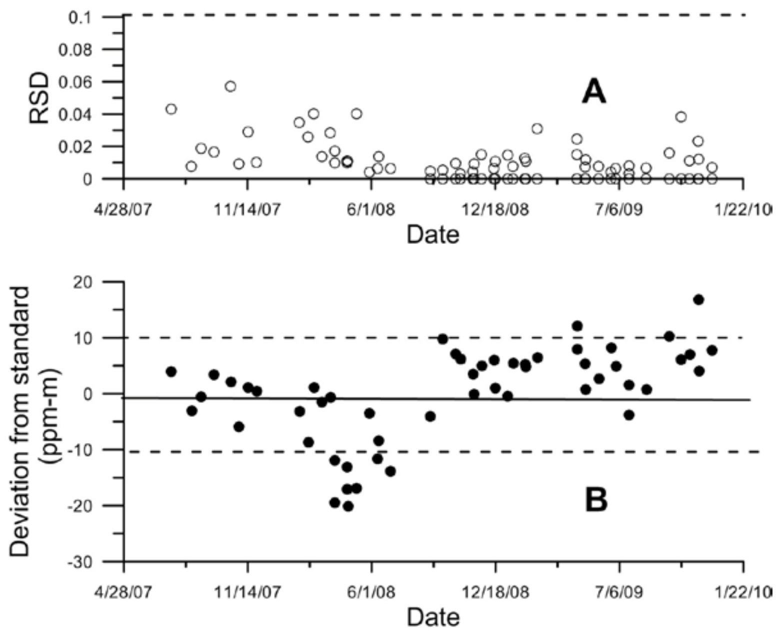

Figure 6.1-2: Control charts of the GasFinder 2.0 ™ s/n NH3OP-1026

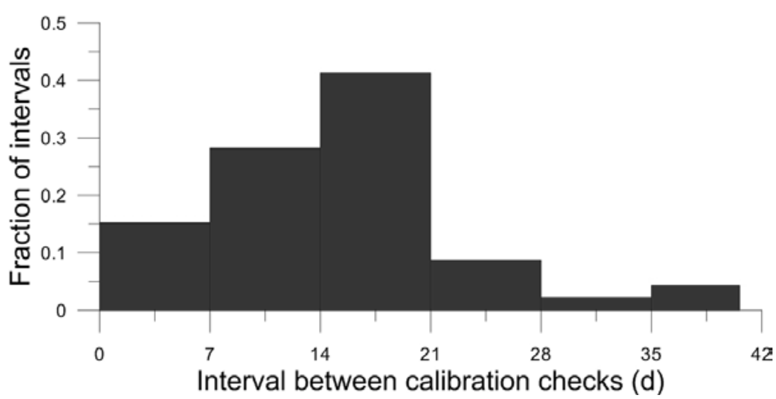

Figure 6.1-3: Calibration check intervals of the GasFinder 2.0 ™ s/n NH3OP-1026

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

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

where X was the instrument response. The response of the sensor was influenced by humidity until 7/21/2008 due to an error in the factory settings for the spectral waveband analysis window. At that time, factory personnel corrected the spectral waveband used for analysis. The effect of this error was to 1) reduce the maximum possible linear correlation with the internal reference cell resulting in unusually low r^2 values under conditions in which the concentration of NH_3 was more than three times of the MDL, and 2) reduce the reported concentration. Adjustments made on the instrument at this time did not appear to affect the calibration (conducted before and after adjustments) but did change the maximum r^2 reached by the instrument when in the field for long path lengths and high humidity.

A zero concentration 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 2.13 ppm-m prior to the July 2008 modification and 1.83 ppm-m after the modification. The instrument performance was within the MDL DQI that required the MDL to be less than 10 ppm-m. The calibration equation offset was less than the requisite DQI MDL.

Instrument performance calibration checks (Figure 6.1-5) were made at the beginning and end of each measurement period. The majority of calibration checks were made within 21 d (Figure 6.1-6). The large fraction of checks made within 7 d was the result of calibration checks made at the end and beginning of sequential measurement periods. The standard deviation of the verifications about that predicted by the calibration equation was 5.36 ppm-m. The precision DQI was ± 10% RSD at 100 ppm-m. All verifications resulted in less than 10% RSD for 50 ppm-m (Figure 6.1-5) and were well within the precision DQI. The accuracy DQI was ± 10% of the 1000 ppm-m range of the measurements. A positive bias in the calibration verification exceeding the DQI occurred on 9/26/2008 and 9/24/2009 (Figure 6.1-4). No negative biases exceeding the DQI occurred. Since both positive bias exceedances were followed by a DQI compliant verification on the subsequent calibration verification without intervention, it is assumed that operator error was the cause for the non-compliance.

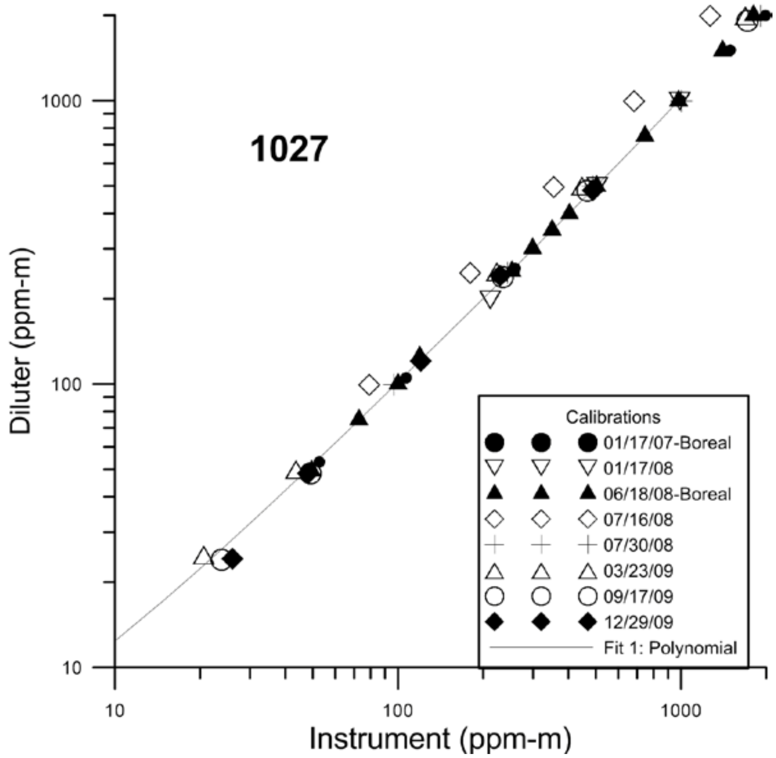

Figure 6.1-4: Multipoint calibrations of the GasFinder 2.0 TM s/n NH3OP-1027. The solid line is the 3rd order polynomial regression for the chosen multipoint calibration.

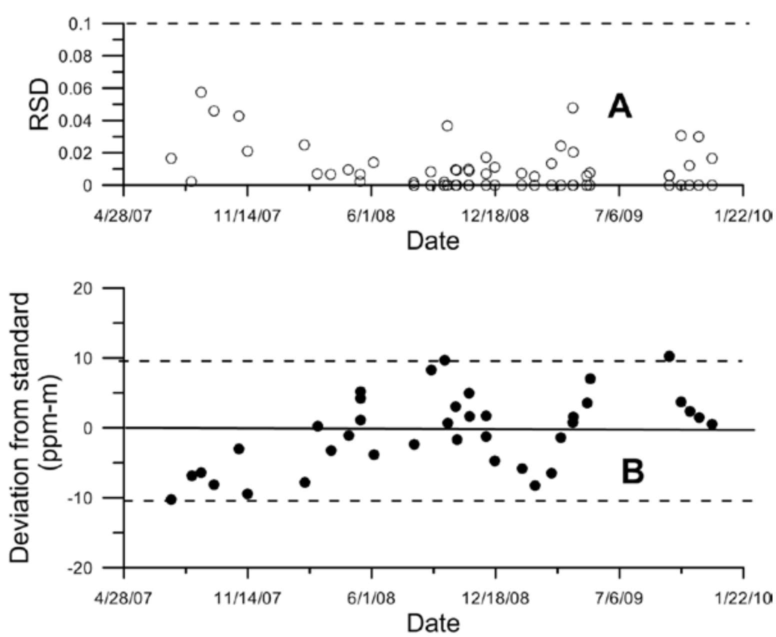

Figure 6.1-5: Control charts of the GasFinder 2.0 TM s/n NH3OP-1027

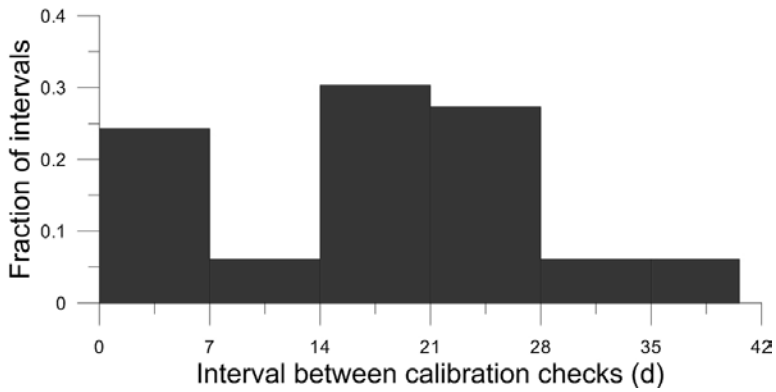

Figure 6.1-6: Calibration check intervals of the GasFinder 2.0 TM s/n NH3OP-1027

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

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

where X was the instrument response. The response of the sensor was influenced by humidity until 7/21/2008 due to an error in the factory settings for the spectral waveband analysis window. At that time, factory personnel corrected the spectral waveband used for analysis. The effect of this error was to 1) reduce the maximum possible linear correlation with the internal reference cell resulting in unusually low r^2 values under conditions in which the concentration of NH_3 was more than three times of the MDL, and 2) reduce the reported concentration. Adjustments made on the instrument at this time did not appear to affect the calibration (conducted before and after adjustments) but did change the maximum r^2 reached by the instrument when in the field for long path lengths and high humidity.

A zero concentration 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 6.1-8) were made at the beginning and end of each measurement period. The majority of calibration checks were made within 21 d (Figure 6.1-9). The large fraction of checks made within 7 d was the result of calibration checks made at the end and beginning of sequential measurement periods. The standard deviation of the verifications about that predicted by the calibration equation was 6.46 ppm-m. The precision

DQI was ± 10% RSD at 100 ppm-m. All verifications resulted in less than 10% RSD for 50 ppm-m (Figure 6.1-8) and were well within the precision DQI. The accuracy DQI was ± 10% of the 1000 ppm-m range of the measurements. A positive bias in the calibration verification exceeding the DQI occurred on three dates (9/26/2008, 10/1/20008 and 9/24/2009) while negative biases exceeding the DQI occurred on 12/16/2008 (Figure 6.1-8). In all cases except the short 9/24/2008 through 10/1/2008 period, subsequent calibration verifications did not indicate the same exceedance bias and it is concluded that operator error resulted in the exceedances rather than instrument failure.

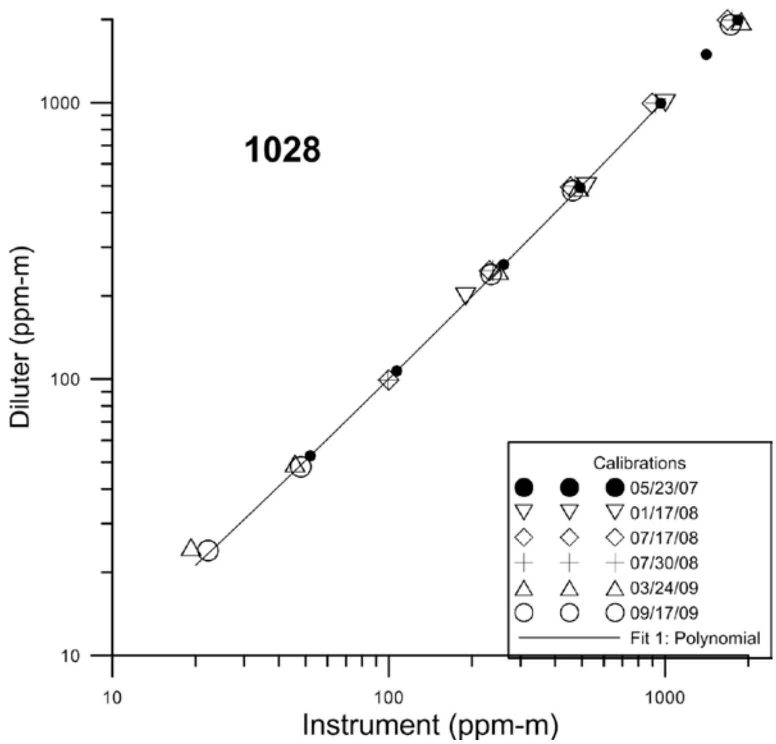

Figure 6.1-7: Multipoint calibrations of the GasFinder 2.0 ™ s/n NH3OP-1028. The solid line is the 3rd order polynomial regression for the chosen multipoint calibration.

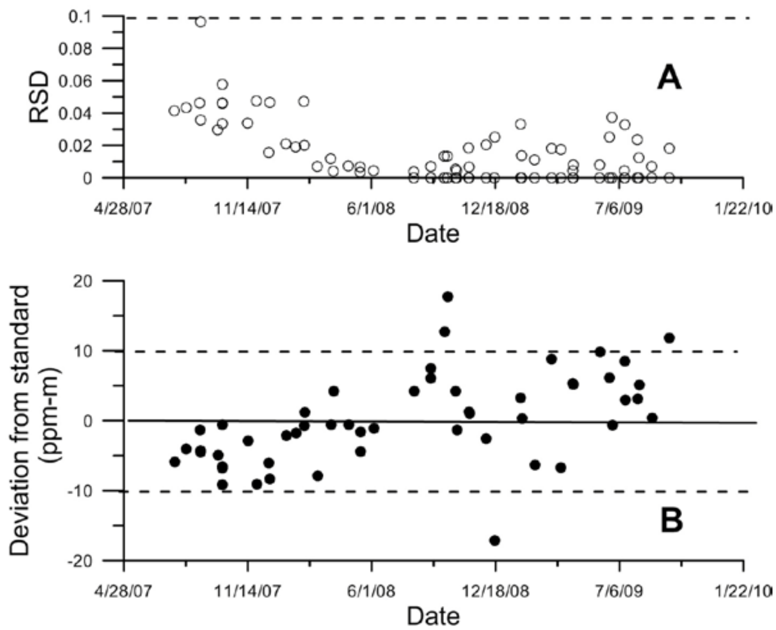

Figure 6.1-8: Control charts of the GasFinder 2.0 TM s/n NH3OP-1028

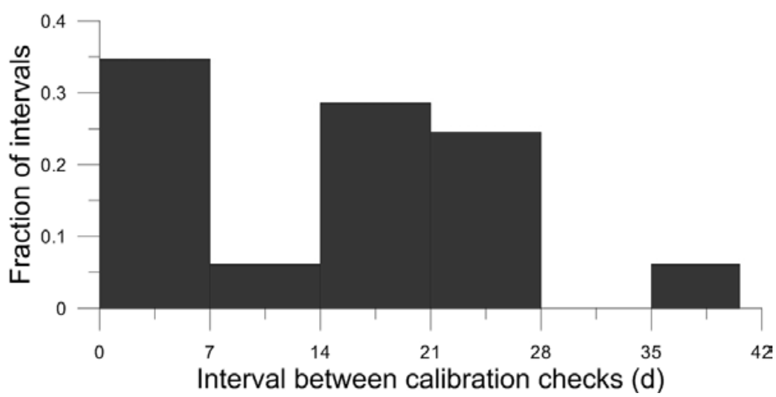

Figure 6.1-9: Calibration check intervals of the GasFinder 2.0 TM s/n NH3OP-1028

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

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

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 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 3.05 ppm-m prior to the July 2008 modification and 0.685 ppm-m after the modification. The instrument performance was within the MDL DQI that required the MDL to be less than 10 ppm-m. The calibration equation offset was less than the requisite DQI MDL.

Instrument performance calibration checks (Figure 6.1-11) were made at the beginning and end of each measurement period. The majority of calibration checks were made within 21 d (Figure 6.1-12). The large fraction of checks made within 7 d 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 7.27 ppm-m. The precision DQI was ± 10% RSD at 100 ppm-m. All verifications resulted in less than 10% RSD for 50 ppm-m except on 8/30/2007 (Figure 6.1-11) and 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 6.1-11). In all cases, subsequent calibration verifications did not indicate the same exceedance bias and it is concluded that operator error resulted in the exceedances rather than instrument failure.

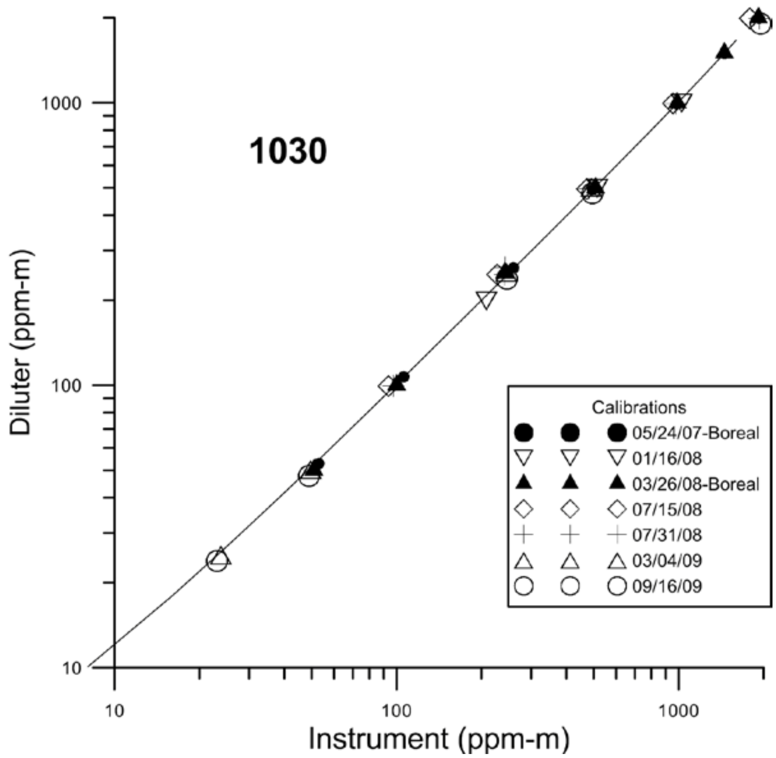

Figure 6.1-10: Multipoint calibrations of the GasFinder 2.0 ™ s/n NH3OP-1030. The solid line is the 3rd order polynomial regression for the chosen multipoint calibration.

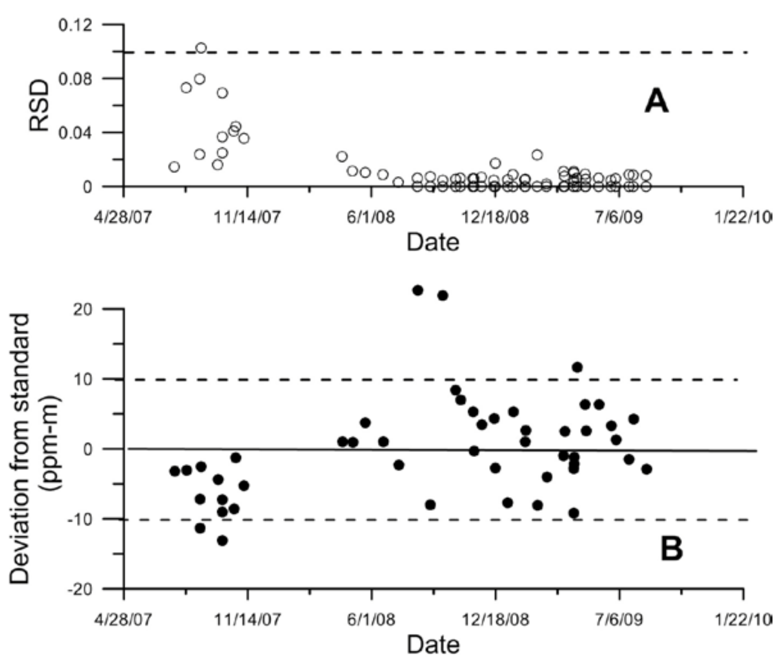

Figure 6.1-11: Control charts of the GasFinder 2.0 ™ s/n NH3OP-1030

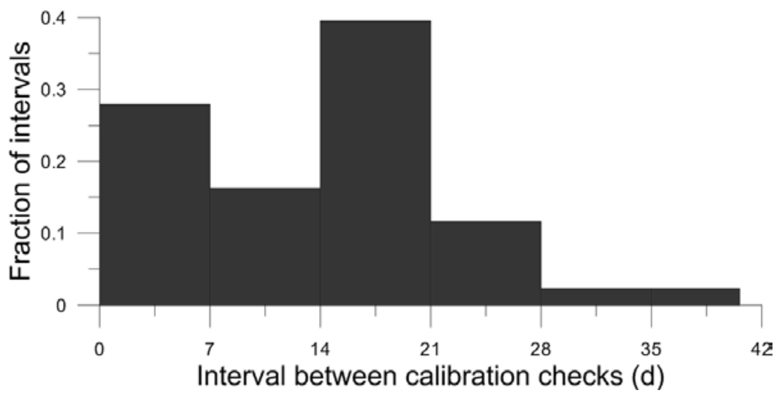

Figure 6.1-13: Calibration check intervals of the GasFinder 2.0 TM s/n NH3OP-1030

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

ppm-m = -4.43 + 1.0120 * X - 5.7496E-005 * X^2 + 6.0196E-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 6.1-14) were made at the beginning and end of each measurement period. The majority of calibration checks were made within 21 d (Figure 6.1-15). The large fraction of checks made within 7 d was the result of calibration checks made at the end and beginning of sequential measurement periods. The standard deviation of the verifications about that predicted by the calibration equation was 15.60 ppm-m. The precision DQI was ± 10% RSD at 100 ppm-m. All verifications resulted in less than 10% RSD for 50 ppm-m (Figure 6.1-14) and were well within the precision DQI. The accuracy DQI was ± 10% of the 1000 ppm-m range of the measurements. A negative bias exceeding the DQI occurred in the calibration verifications between 8/2/2007 and 9/18/2007 (Figure 6.1-14). Positive DQI bias exceedances occurred on 6/28/2007, 9/11/2008, 4/8/2009 and 8/12/2009. Verification failures in the 6/28/2007 to 9/18/2007 interval were a result of un-anticipated optical noise in the calibration procedure which was later corrected. The 4/8/2009 exceedance was 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.

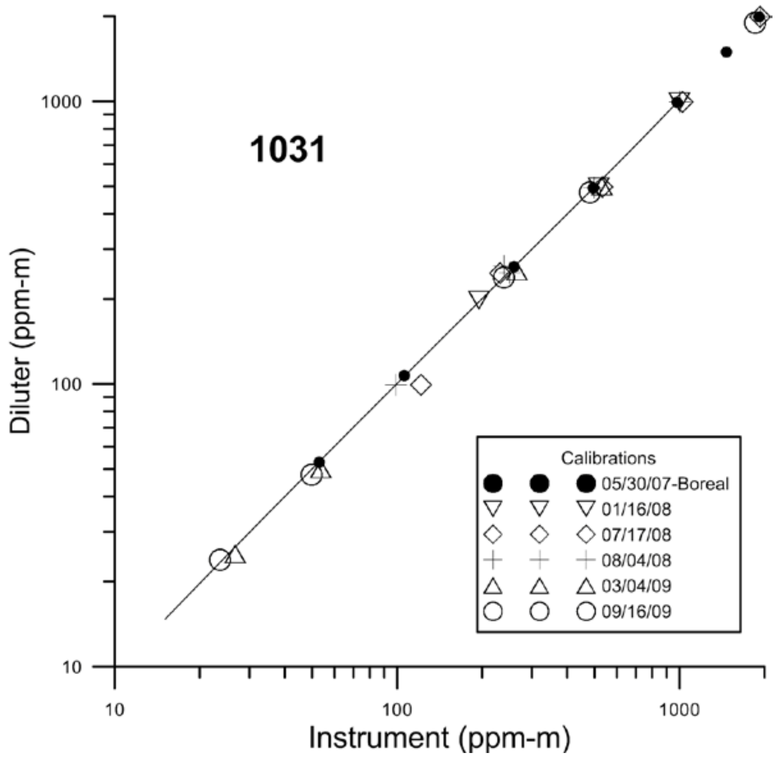

Figure 6.1-13: Multipoint calibrations of the GasFinder 2.0 ™ s/n NH3OP-1031. The solid line is the 3rd order polynomial regression for the chosen multipoint calibration.

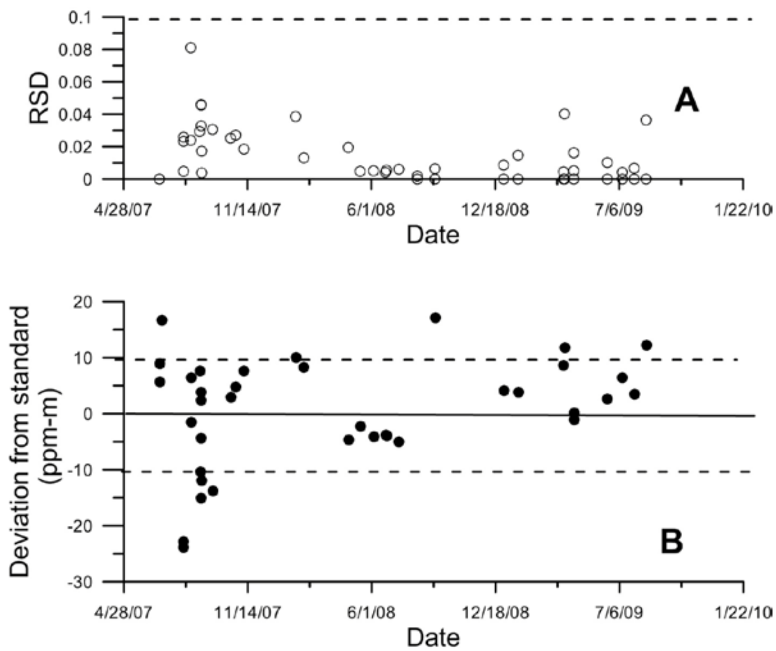

Figure 6.1-14: Control charts of the GasFinder 2.0 ™ s/n NH3OP-1031

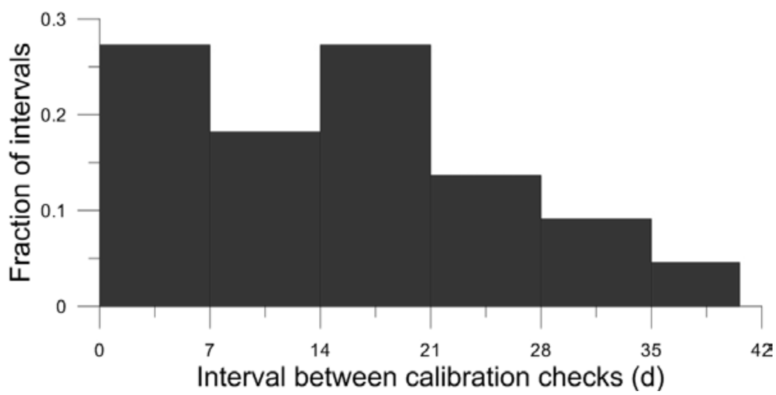

Figure 6.1-15: Calibration check intervals of the GasFinder 2.0 ™ s/n NH3OP-1031

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
7/21/2008	0.67	0.0100	0.999
11/25/2008	0.81	0.0070	0.999
3/5/2009	0.94	0.0165	0.999
4/23/2009	0.73	0.0263	0.999
4/29/2009	0.78	0.0206	0.999
9/1/2009	0.75	0.0054	0.999
12/29/2009	0.81	0.0083	0.999

The standard deviation of instrument response with CEM zero air measured over a one h period was 0.81 ppb (12/29/2009). The instrument MDL, defined as 3σ was 2.4 ppb and is indicated in Figure 6.1-2A with dashed lines. This is much less than the mean absolute value of the multipoint calibration intercept of 13.4 ppb.

Instrument performance calibration checks (Figure 6.1-2, 6.1-3) were made at the beginning and end of each measurement period. The majority of calibration checks were made within 25 d (Figure 6.1-4). The large fraction of checks made within 7 d was the result of calibration checks made at the end and beginning of sequential measurement periods. 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 6.1-2B). Post-study response checks in August and September 2008 also indicated check failures (Figure 6.1-2B), although all of these failures are associated with a non-diluted calibration cylinder where the balance gas was N_2 and consequently the 450i converter was unable to function properly.

The instrument measurement precision DQI was 10% of FS. Precision DQI exceedances (Figure 6.1-3) 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 cylinder inter-compared on 8/28, 31/2009. Calibration certification before and after this date were valid.

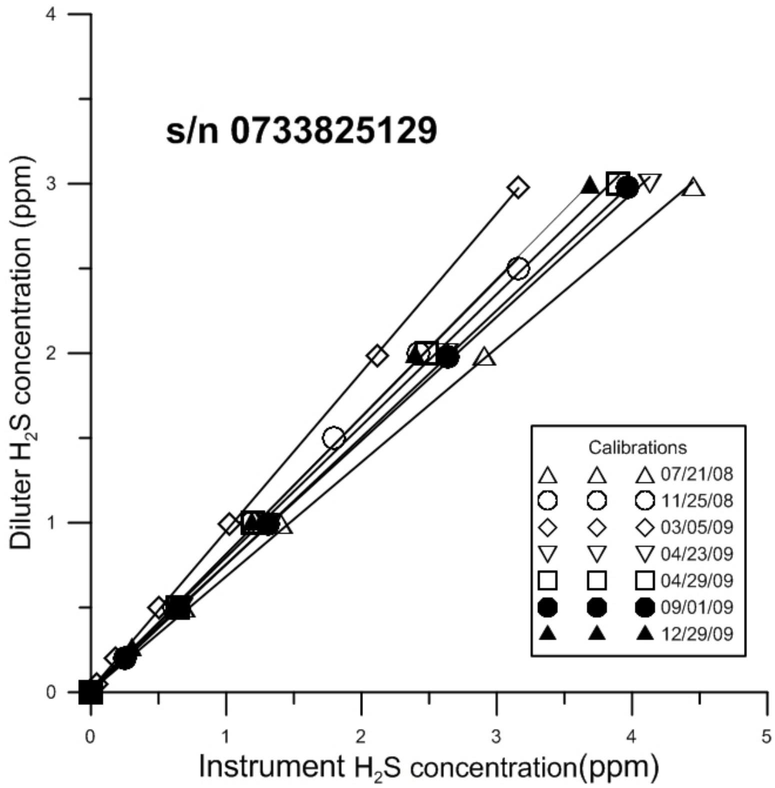

Figure 6.2-1: Multipoint calibrations of the 450i SO_2/H_2S Analyzer

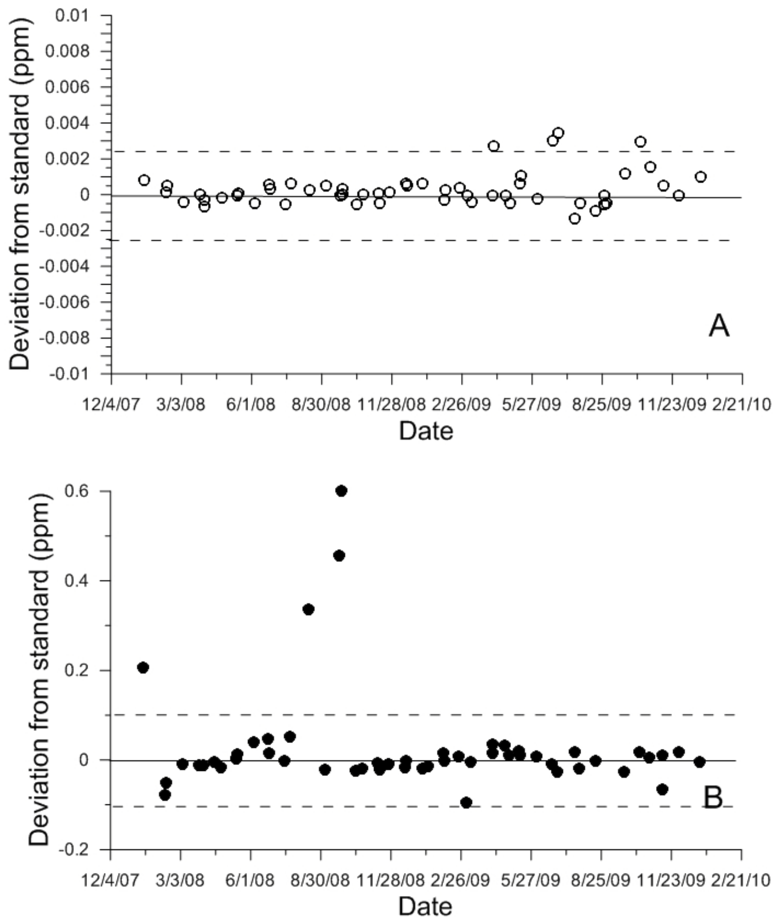

Figure 6.1-2: Instrument Control Charts

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).

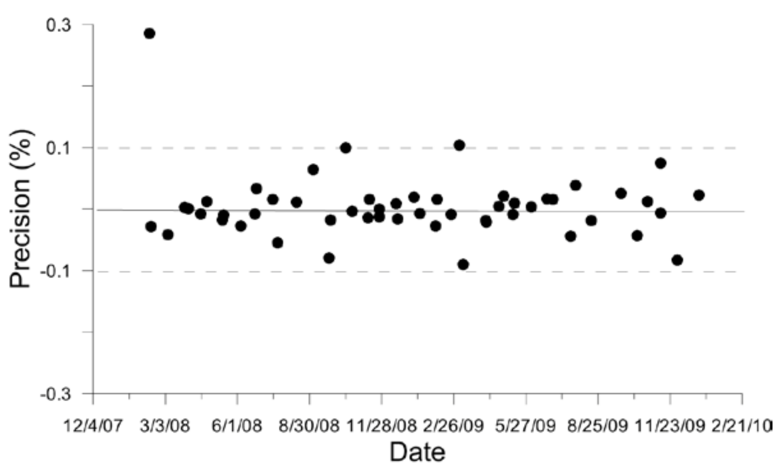

Figure 6.1-3: Instrument Precision

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).

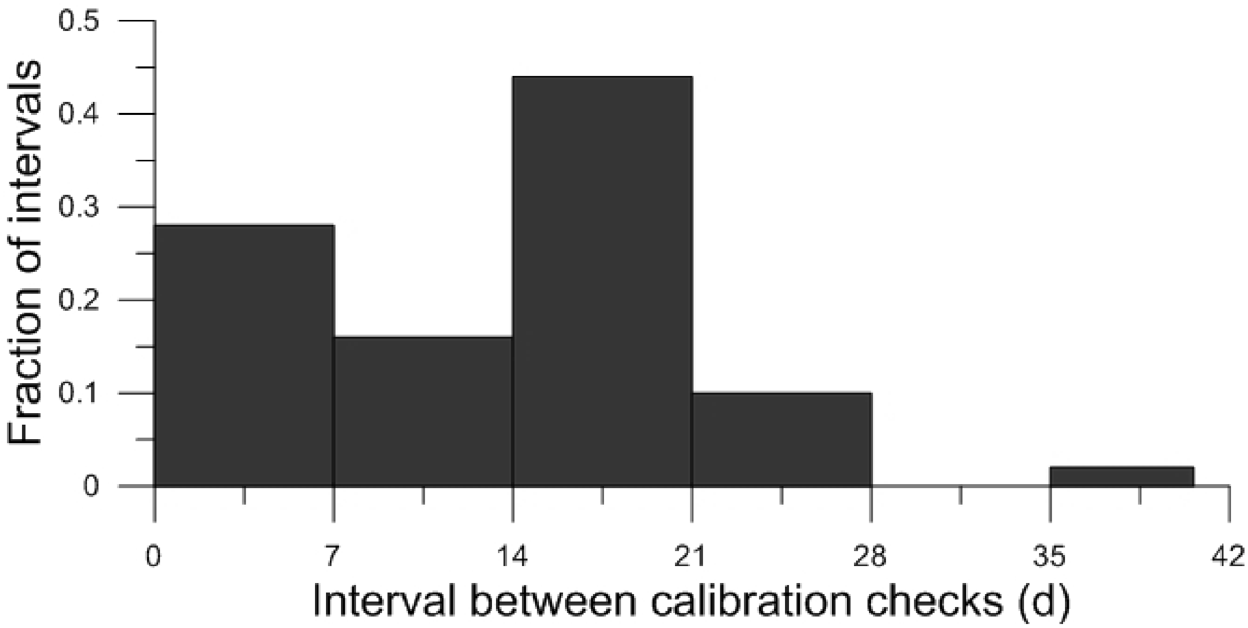

Figure 6.1-4: Calibration check intervals

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.

Sonic anemometer 1926 was inter-compared with three standard 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 measurement period at the beginning and end of a measurement period. This instrument was inter-compared with the co-located anemometer sensors on site 35 times (Figure 6.3-1). The majority of calibration checks were made within 21 d (Figure 6.3-2). The large fraction of checks made within 7 d 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 the actual measurements were not indicated. The instrument always passed this DQI.

Table 6.3-1: Standards inter-comparisons

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

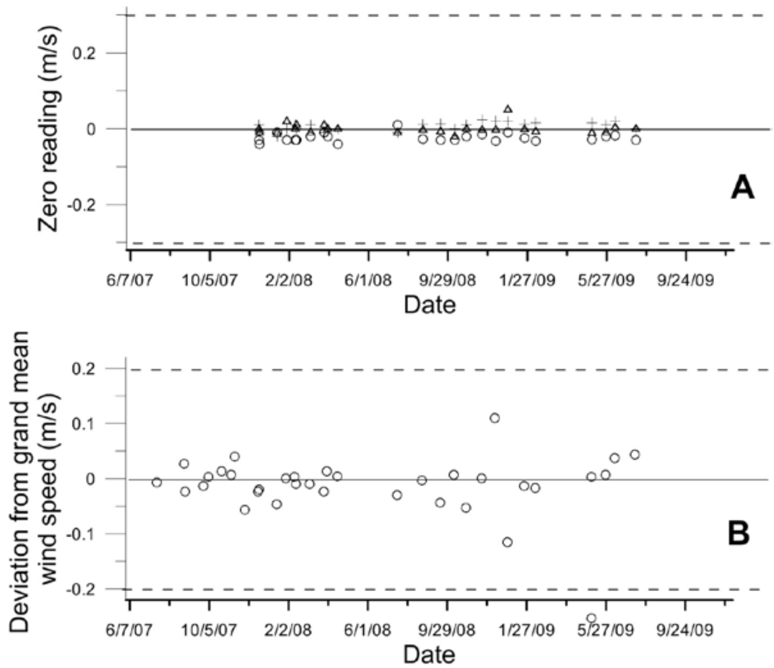

Figure 6.3-1: On-site quality assurance of s/n 1926. The DQI for the zero and inter-comparisons are indicated by the dashed lines. The zero check in the x (open circle), y (open triangle) and z (cross) components are indicated in panel A.

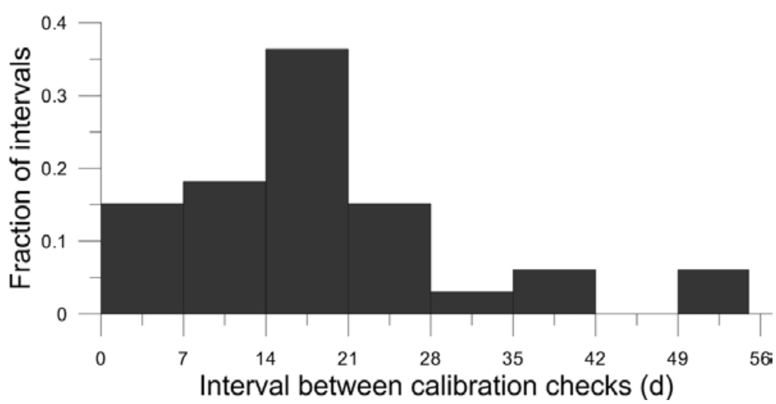

Figure 6.3-2: Inter-comparison check intervals for s/n 1926

Sonic anemometer 1933 was inter-compared with three standard anemometers of identical design three times during the study (Table 6.3-2). This instrument was used as a standard prior to use in the on-site measurements beginning 4/23/2008. No absolute turbulence calibration was possible with this instrument. To assure proper performance and comparability in the wind measurements, the anemometer was inter-compared on-site with those used during a given measurement period at the beginning and end of a measurement period. This instrument was inter-compared with the co-located anemometer sensors on site 23 times (Figure 6.3-3). The majority of calibration checks were made within 21 d (Figure 6.3-4). The large fraction of checks made within 7 d was the result of calibration checks made at the end and beginning of sequential measurement periods.

The accuracy DQI for the on-site inter-comparisons required the individual instruments to have the mean wind speed within 0.2 ms^{-1} of the grand mean value of the three (or four) on-site instruments (Figure 6.3-3B). This instrument passed this check 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 date		Mean difference from reference anemometers (ms^{-1})	
Alignment 1	Alignment 2	Alignment 1	Alignment 2
7/18-19/2008	7/21-22/2008	+0.012	+0.014
3/3-5/2009	3/5-6/2009	-0.016	-0.004
1/7-9/2010	1/23-25/2010	-3.733	-3.930

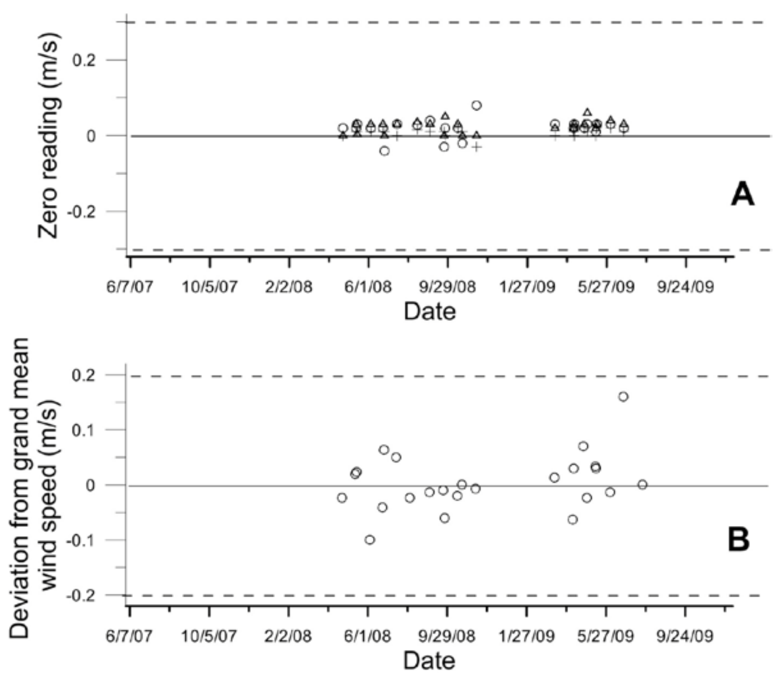

Figure 6.3-3: On-site quality assurance of s/n 1933. The DQI for the zero and inter-comparisons are indicated by the dashed lines. The zero check in the x (open circle), y (open triangle) and z (cross) components are indicated in panel A.

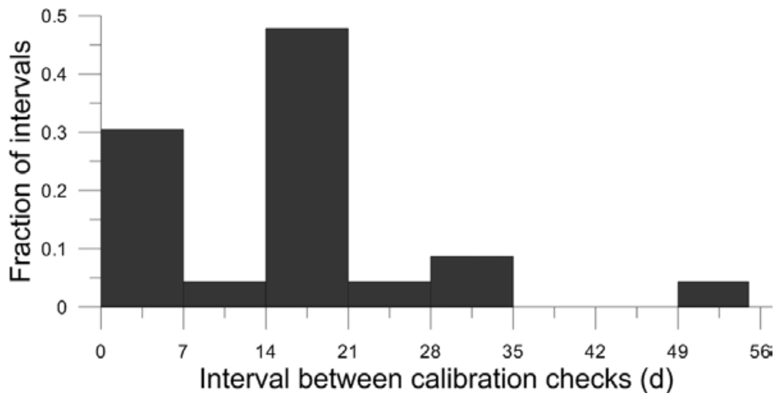

Figure 6.3-4: Inter-comparison check intervals for s/n 1933.

Sonic anemometer 1920 was inter-compared with three standard 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 d (Figure 6.3-6). The large fraction of checks made within 7 d was the result of calibration checks made at the end and beginning of sequential measurement periods.

The accuracy DQI for the on-site inter-comparisons required the individual instruments to have the mean wind speed within 0.2 ms^{-1} of the grand mean value of the three (or four) on-site instruments (Figure 6.3-5B). This instrument passed this check 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 date		Mean difference from reference anemometers (ms^{-1})	
Alignment 1	**Alignment 2**	**Alignment 1**	**Alignment 2**
6/19-22/2007	6/29 - 7/2/2007	+0.001	+0.002
1/17-19/2008	1/20-21/2008	+0.045	+0.003
7/18-21/2008	7/21-22/2008	+0.017	-0.006
3/23-25/2009	3/25-27/2009	-0.036	-0.033
9/1-2/2009	9/2-3/2009	-0.046	-0.025

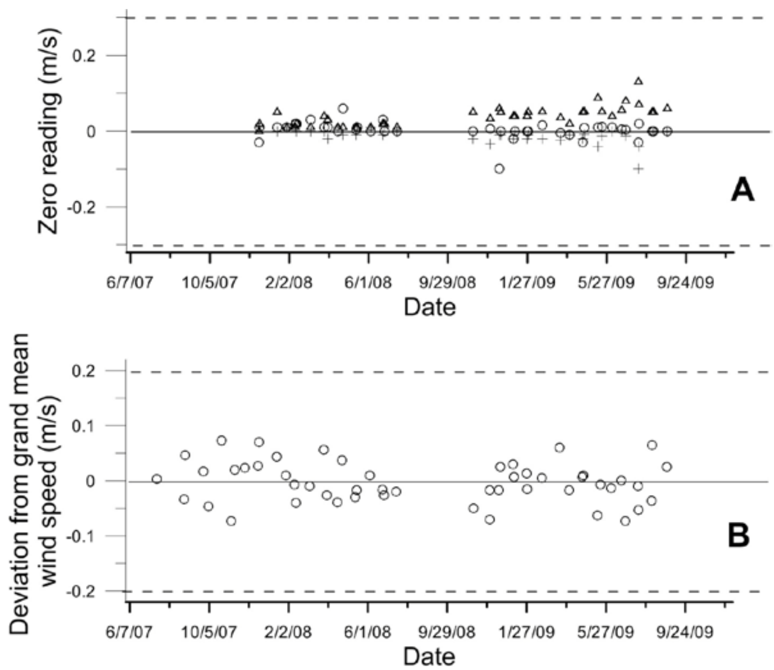

Figure 6.3-5: On-site quality assurance of s/n 1920. The DQI for the zero and inter-comparisons are indicated by the dashed lines. The zero check in the x (open circle), y (open triangle) and z (cross) components are indicated in panel A.

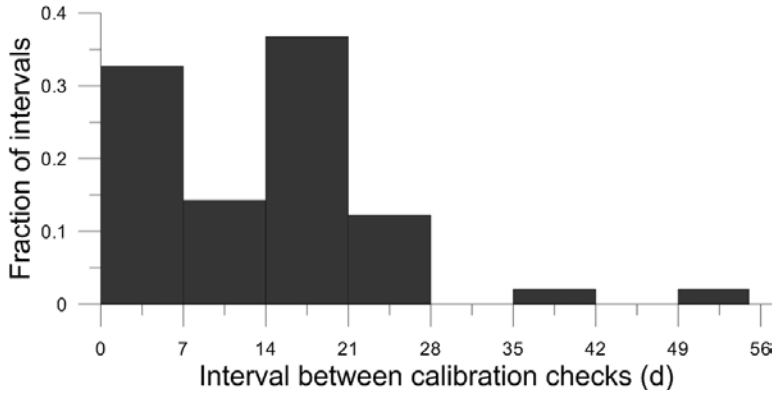

Figure 6.3-6: Inter-comparison check intervals for s/n 1920

Sonic anemometer 1928 was inter-compared with three standard anemometers of identical design six times during the study (Table 6.3-4). No absolute turbulence calibration was possible with this instrument. To assure proper performance and comparability in the wind measurements, the anemometer was inter-compared on-site with those used during a given measurement period at the beginning and end of a measurement period. This instrument was inter-compared with the co-located anemometer sensors on site 48 times (Figure 6.3-7). The majority of calibration checks were made within 21 d (Figure 6.3-8). The large fraction of checks made within 7 d was the result of calibration checks made at the end and beginning of sequential measurement periods.

The accuracy DQI for the on-site inter-comparisons required the individual instruments to have the mean wind speed within 0.2 ms^{-1} of the grand mean value of the three (or four) on-site instruments(Figure 6.3-7B). This instrument passed this check 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 date		**Mean difference from reference anemometers (ms^{-1})**	
Alignment 1	**Alignment 2**	**Alignment 1**	**Alignment 2**
6/15-18/2007	6/18-19/2007	+0.004	+0.019
12/27-28/2007	12/29-31/2007	+0.003	-0.005
7/10-11/2008	7/11-14/2008	+0.022	+0.007
3/3-4/2009	3/5-6/2009	+0.070	-0.027
9/16-17/2009	9/17-18/2009	+0.056	+0.022
12/18-19/2009	12/21-23/2009	+0.094	-0.077

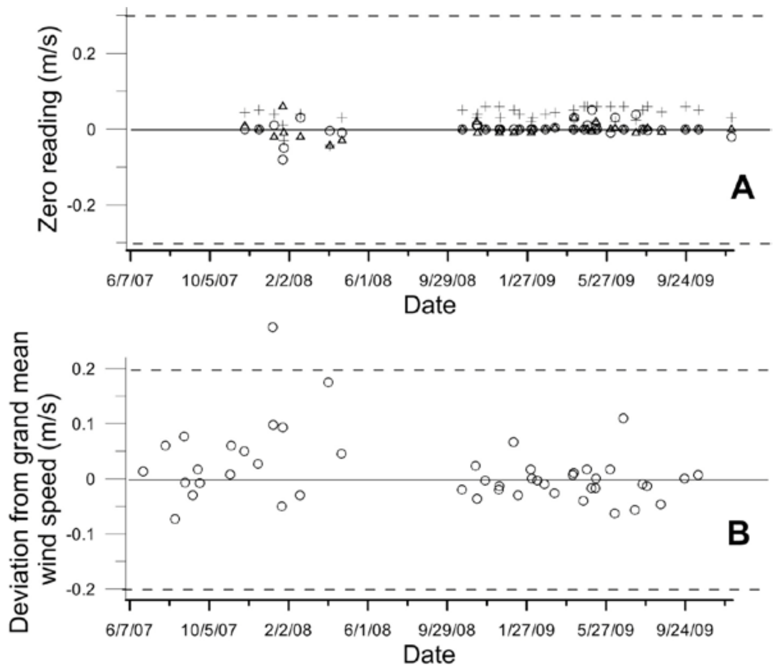

Figure 6.3-7: On-site quality assurance of s/n 1928. The DQI for the zero and inter-comparisons are indicated by the dashed lines. The zero check in the x (open circle), y (open triangle) and z (cross) components are indicated in panel A.

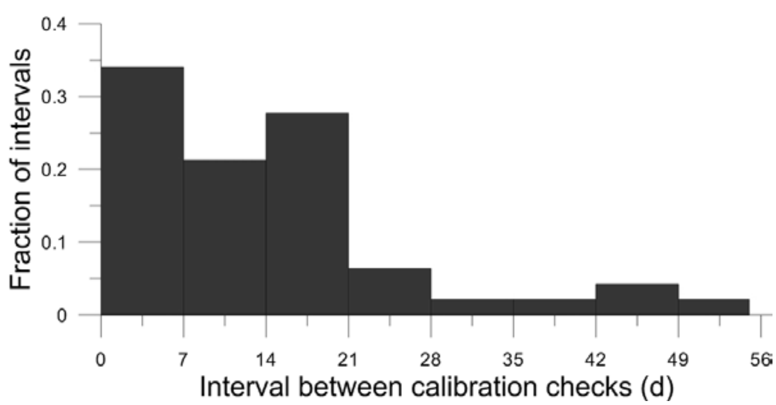

Figure 6.3-8: Inter-comparison check intervals for s/n 1928

Sonic anemometer 1945 was inter-compared with three standard 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 d (Figure 6.3-10). The large fraction of checks made within 7 d was the result of calibration checks made at the end and beginning of sequential measurement periods.

The accuracy DQI for the on-site inter-comparisons required the individual instruments to have the mean wind speed within 0.2 ms^{-1} of the grand mean value of the three (or four) on-site instruments (Figure 6.3-9B). This instrument passed this check 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 date		Mean difference from reference anemometers (ms^{-1})	
Alignment 1	**Alignment 2**	**Alignment 1**	**Alignment 2**
6/19-22/2007	6/27 - 7/2/2007	+0.001	-0.051
1/17-19/2008	1/20-21/2008	-0.023	-0.037
7/18-21/2008	7/21-22/2008	+0.023	+0.026
3/3-4/2009	3/5-6/2009	+0.014	+0.171
9/16-17/2009	9/17-18/2009	+0.028	-0.012

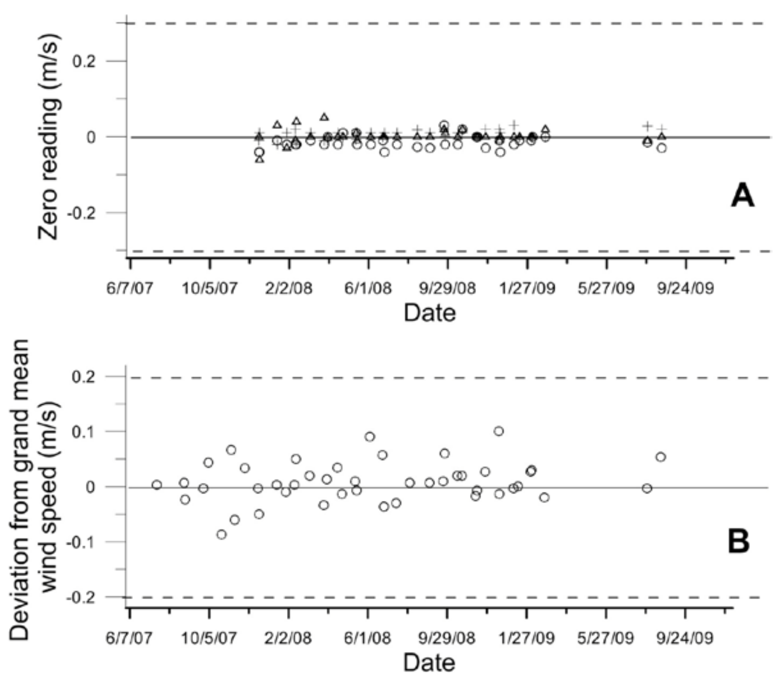

Figure 6.3-9: On-site quality assurance of s/n 1945. The DQI for the zero and inter-comparisons are indicated by the dashed lines. The zero check in the x (open circle), y (open triangle) and z (cross) components are indicated in panel A.

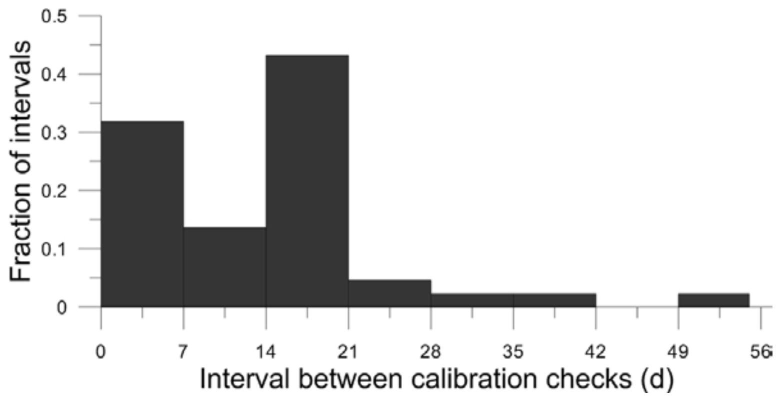

Figure 6.3-10: Inter-comparison check intervals for s/n 1945.

Sonic anemometer 1932 was inter-compared with three standard 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 d (Figure 6.3-12). The large fraction of checks made within 7 d was the result of calibration checks made at the end and beginning of sequential measurement periods.

The accuracy DQI for the on-site inter-comparisons required the individual instruments to have the mean wind speed within 0.2 ms^{-1} of the grand mean value of the three (or four) on-site instruments (Figure 6.3-11B). This instrument passed this check 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 in 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 date		**Mean difference from reference anemometers (ms^{-1})**	
Alignment 1	**Alignment 2**	**Alignment 1**	**Alignment 2**

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

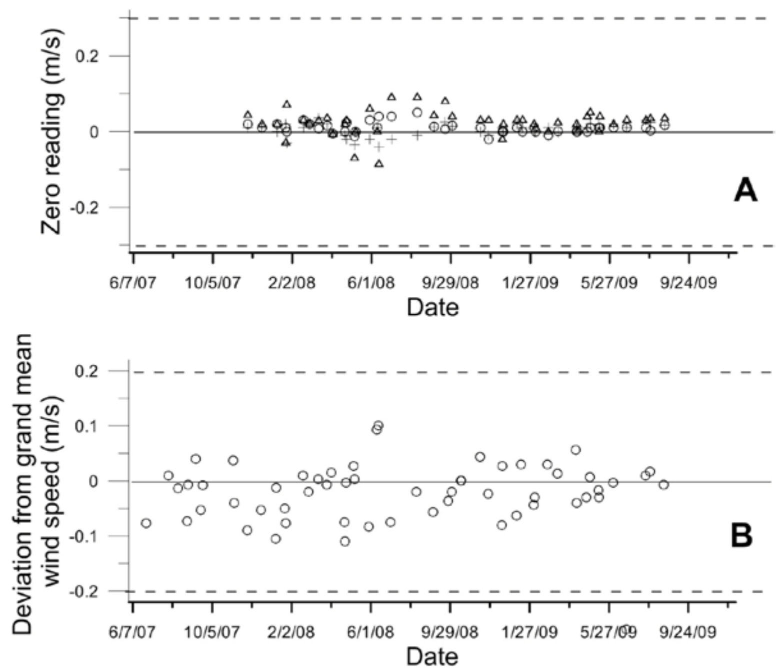

Figure 6.3-11: On-site quality assurance of s/n 1932. The DQI for the zero and inter-comparisons are indicated by the dashed lines. The zero check in the x (open circle), y (open triangle) and z (cross) components are indicated in panel A.

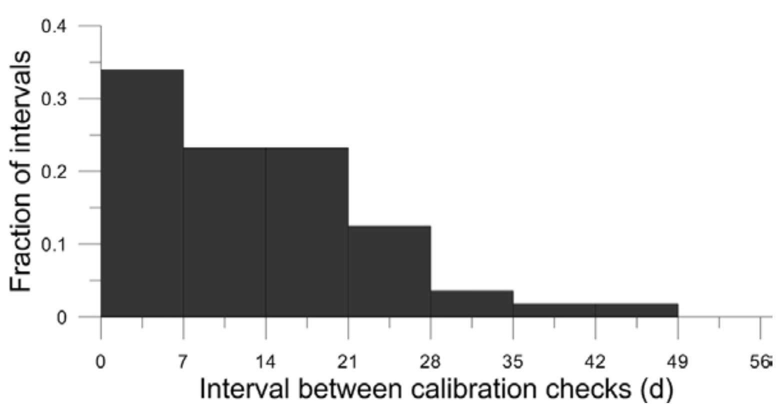

Figure 6.3-12: Inter-comparison check intervals for s/n 1932.

6.4 S-OPS operational checks

The Synthetic Open Path Systems (S-OPS; s/n D and F) and the Gas Sampling System (GSS s/n 4-0018) were checked at the beginning and end of every measurement period. A leak check and maximum flow check were made for both the S-OPS in combination with the GSS and for the GSS alone. In addition, the balance of flow into each inlet in the S-OPS was checked before and after each measurement period.

Results for the leak tests for both the GSS and the Combined GSS/S-OPS are indicated in sequence in Table 6.6-1. Consequently records of the checks at a given measurement site are interspersed according to the sequence of measurements for this trailer. Often GSS leak check failures corresponded to successful S-OPS leak checks that included the GSS within the system check (Table 6.6-1). Leaks in the GSS generally were a result of pump problems or incorrect zero offset determinations. Leaks in the S-OPS occurred several times in the study. These leaks were apparently a result of vibration within the GSS. The permissible leak in the S-OPS/GSS or GSS alone was 10% of the maximum flow. Details of the leak check failure follow:

- S-OPS leak check failure of single lines on 6/26/2008, 7/15/2008, 12/17/2008, 1/15/2009, 2/3/2009, 2/6/2009, and both lines on 10/22/2008 were not resolved during the site visit due to time constraints. Repairs to the S-OPS were made on subsequent visits.
- GSS leak check failures that paired with S-OPS leak check passes indicated that the GSS leak check test may have been in error.
- GSS leak check failure on 10/14/2008 was a result of pump diaphragm failure.

The impact of leak check failures in the S-OPS lines (with the exception of those at the GSS inlet filters) was minimal as the leaks were at junctions of tubing and tubing/inlet filters and would allow air into the lines that differ only from height above the berm from the air sampled along the inlets themselves. The impact of GSS leak check failures associated with pump diaphragm failures would only influence the volume of flow available to the 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
6/25/2008	WI5A	2	0.05	-35.75	Pass	10	0.31	-34.95	Pass

Date	Site	GSS solenoid	GSS mass flow (L min^{-1})	GSS pressure (kPa)	GSS check result	S-OPS max flow (L min^{-1})	S-OPS mass flow (L min^{-1})	S-OPS pressure (kPa)	S-OPS check result
		3	-0.01	-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	10.1	0.16	-34.9	Pass
		3	0.03	-36.36	Pass	10.1	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 result**
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 result**
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**

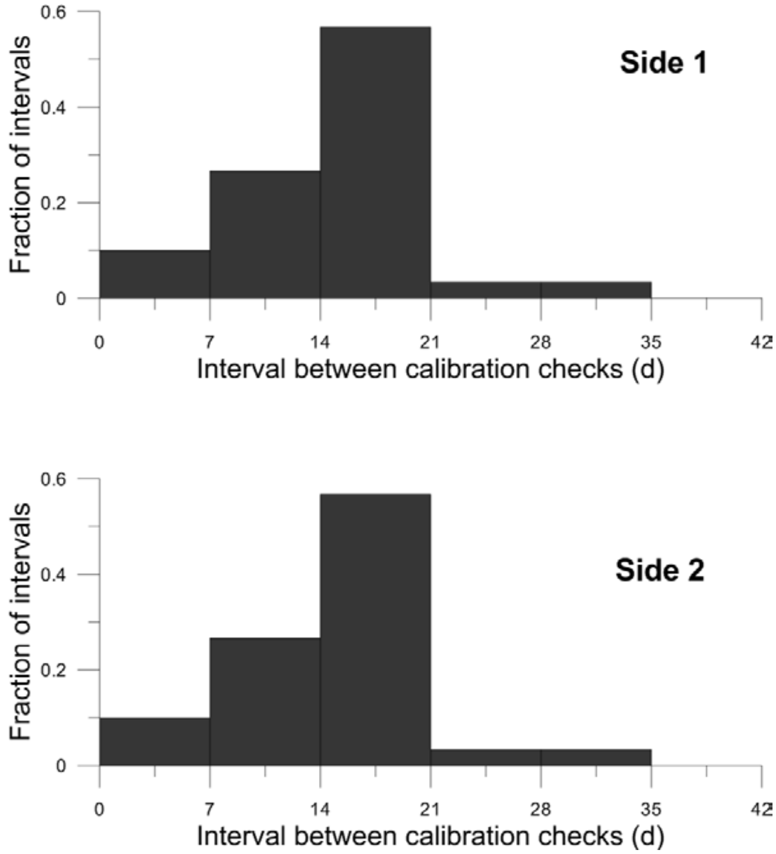

Figure 6.6-1 – Intervals between checks

6.5 Miscellaneous meteorological calibrations

6.5.1 Air temperature/humidity

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

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

Relative humidity (RH)					
Calibration date	**Temperature (°C)**	**Expected RH (%)**	**Difference from expected RH (%)**	**Mean difference RH (%)**	**Action**
3/8/2010	24.7	25.0	1.86		Accept
	24.7	50.0	1.41		Accept
	24.7	95.0	2.28		Accept
				1.85	Accept
3/6/2010	N/A	39.6	1.19	1.19	Accept
8/1/2008	27.8	10.9	-0.72		Accept
	27.5	50.8	2.48		Accept
	27.8	96.4	7.63		Accept
				3.13	Accept
Temperature (T)					
Calibration date	**Expected T (°C)**	**Measured T (°C)**	**Difference from expected T (°C)**		**Action**
3/8/2010	25.6	24.7	0.9		Pass
3/6/2009	25.3	25.2	0.2		Pass
8/1/2008	27.5	27.3	0.2		Accept

6.5.2 Barometric pressure

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

Table 6.7-2: Calibration record of Setra 278 s/n 30351828

Calibration date	Expected value range (hPa)	Number of comparisons	Mean difference from reference (hPa)	Action
3/4-8/2010	997-1004	4	0.1	Pass
2/27 - 3/2/2009	990.9-1007.1	6	1.6	Pass
7/23-27/2008	995.3-996.5	6	0.9	Pass
1/17-18/2008	984.9-996.9	6	0.8	Pass

6.5.3 Solar radiation

The LiCOR 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 date	Mean difference from reference (Wm^{-2})	Mean deviation from standard (%)	Action
3/5-3/8/2010	-3.81	0.71	Pass
8/30/2006			Pass, Factory Calibration

6.5.4 CR1000 data logger

The CR1000 data logger (Campbell Scientific Inc., Lagan, UT) was used to log 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 6.7-4 and Table 6.7-5.

Table 6.7-4: Calibration record of Campbell Scientific CR1000 data logger, s/n 7886 (7675)

Factory calibration						
Calibration date: 1/18/2007			**Single-ended**		**Differential**	
Channel	**Input (mV)**	**Tolerance (mV)**	**Measured mV**	**Error (mV)**	**Measured (mV)**	**Error (mV)**
11	5000	± 3	5001.25	-1.25	5001.35000	-1.35000
11	-5000	± 3	-5001.48	-1.48	-5001.69000	-1.69000
11	2500	± 1.5	—	—	2500.30000	-0.30000
11	250	± 0.15	—	—	249.99900	0.00100
11	25	± 0.015	—	—	25.00320	-0.00320
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	4999.32000	0.32000
11	5000	± 6	5001.96	-1.96	5001.69000	-1.69000
11	5000	± 6	—	—	—	—
11	5000	± 6	—	—	—	—

PAML calibration						
SE channel	**Input (mV)**	**Tolerance SE | DE (mV)**	**Measured mV (mean value)**	**Error (mV)**	**Measured (mV)**	**Error (mV)**
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	—	—
15	4950	± 6.96 | 4.97	4950.5	-0.5	—	—

PAML calibration						
SE channel	**Input (mV)**	**Tolerance SE | DE (mV)**	**Measured mV (mean value)**	**Error (mV)**	**Measured (mV)**	**Error (mV)**
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 6.7-5: Calibration record of Campbell Scientific CR1000 data logger, s/n 7752

PAML calibration						
Channel	**Input (mV)**	**Tolerance SE | DE (mV)**	**Measured (mV)**	**Error (mV)**	**Measured (mV)**	**Error (mV)**
Calibration date: 3/1/2010			**Single-ended**		**Differential**	
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**	
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	—	—

6.5.5 CR800 data logger

The CR800 data logger (Campbell Scientific Inc., Logan, UT) was used to log all GSS measurements (air temperature and relative humidity, flow rate, and pressure). Calibration check was conducted only at end of the study. Initial calibrations were conducted by the factory. The record of calibration checks are documented in Table 6.7-6.

Table 6.7-6: Calibration record of Campbell Scientific CR800 data logger, s/n 3697

Channel	Input (mV)	Tolerance SE (mV)	Measured (mV)	Error (mV)
Calibration date: 3/8/2010			**Single-ended**	
1	100	± 2.061	99.29	0.71
2	100	± 2.061	99.29	0.71
3	100	± 2.061	99.29	0.71
4	100	± 2.061	99.29	0.71
5	100	± 2.061	99.29	0.71
6	100	± 2.061	99.29	0.71
Calibration date: 3/8/2010			**Single-ended**	
1	0	± 2.061	0	0
2	0	± 2.061	0	0
3	0	± 2.061	0	0
4	0	± 2.061	0	0
5	0	± 2.061	0	0
6	0	± 2.061	0	0

6.6 Site activity

Time (UTC)	**Date (mm/dd/yyyy)**	**Activity (Setup, Takedown, Calibration, Repair, Remote)**	**Event**
	8/30/2007	Setup	Anemometer heights taken.
21:35-22:35	8/30/2007	Setup	Sonic inter-comparison: Sonic 1: 0.85 Sonic 2: 0.78 Sonic 3: 0.85
22:55	8/30/2007	Setup	Zero calibration performed on sonic anemometers; all pass.
23:31-23:36	8/30/2007	Setup	Calibrated TDLAS 1030: Mean:49.95 SD: 5.71
00:54-00:59	8/30/2007	Setup	Calibrated TDLAS 1028: Mean 50.17 SD: 3.49 Note: two calibrations done but no explanation given.
	8/31/2007	Setup	Retro-reflectors are on both towers and on the ground. Retro reflector heights are recorded. Sensors are calibrated and installed.
	8/31/2007	Setup	Wetness sensor doesn't seem to be working.
	8/31/2007	Setup	TDLAS system on NE corner NOT operating. Part of system taken back to Purdue for repair. No communication from GasFinder 2.0™ to trailer.
	8/31/2007	Setup	Barometer audit: accepted
	9/17/2007	Repair	TDLAS 1 loses comm. Thru *GasView MP* v17, v19 when signal strength goes to zero (cable could be problem).
	9/17/2007	Repair	No internet connection.
	9/17/2007	Repair	Optimization problems with TDLAS 1028. See notes for detailed explanation.
16:00	9/17/2007	Repair	Changed observation to zero, still have problem. Swapped info 1030 on TDLAS 2 paths with 1028-problem occurred on TDLAS 2 paths with 1028.
	9/17/2007	Repair	Still no internet connection.
	9/17/2007	Repair	Reestablished TDLAS 1 laptop in trailer. Communications ok except when signal separation and pumping hamper connectivity.
	9/18/2007	Repair	Reset clock on TDLAS 1/1028 from 00:54 1/15/2006 to 16:15 9/18/2007. Synched with TDLAS 2.
	9/19/2007	Remote	Purpose was to realign TDLAS systems.
	9/24/2007	Remote	Checking instruments from Purdue. Sonic program error: "Subscript out of range." Occurred near top of Initial Summing subroutine in line son_1005_time=timeGetTime. Program restarted at 1815 UTC. It had stopped at 1733 UTC. Program still crashes.
	9/26/2007	Takedown	In this period, for 3 d trucks were put in way near the barns, emptied the basin.
	9/26/2007	Takedown	Barometer audit: accepted
15:15-16:15	9/26/2007	Takedown	Sonic inter-comparison: Sonic 1: 2.17 Sonic 2: 2.14 Sonic 3: 2.16
18:47	9/26/2007	Takedown	Zero calibration performed on sonic anemometers; all pass.
20:17-20:22	9/26/2007	Takedown	Calibrated TDLAs 1028– Mean: 50.06 SD: 3.17
20:48-20:53	9/26/2007	Takedown	Calibrated TDLAS 1030– Mean: 51.64 SD: 1.17
	9/26/2007	Remote	Check times on computers.
	12/19/2007	Setup	During transportation of trailer, trailer breaks were not working smoothly. Cover of one light fell down and got broken.

Time (UTC)	**Date** (mm/dd/yyyy)	**Activity** (Setup, Takedown, Calibration, Repair, Remote)	**Event**
	12/19/2007	Setup	While starting TDLAS scanner, initially there was no power in both scanners. For TDLAS 1026, hooked and unhooked power cables, and after that it started functioning. For TDLAS 1028, tried hooking and unhooking power cables and warming and drying the power cables with heat gun. Helped it working.
	12/19/2007	Setup	Wetness sensor calibration: accepted
19:30-20:30	12/19/2007	Setup	Sonic inter-comparison: Sonic 1: 1.84 - Sonic 2: 1.75 - Sonic 3: 1.87 -Action: pass
20:13-20:18	12/19/2007	Setup	Calibrated TDLAS 1026 – Mean: 24.73 - SD: 0.52 - RSD: 2.1% - Bias: -1.1%
20:42	12/19/2007	Setup	Calibrated TDLAS 1028– Mean: 26.67 - SD: 1.24 - RSD: 4.7% - Bias: 6.7%
21:08	12/19/2007	Setup	Zero calibration performed on sonic anemometers
21:40	12/19/2007	Setup	Barometer audit: accepted
	12/20/2007	Setup	Checked CR1000 and collected data.
	12/20/2007	Setup	Taped all power supply boxes.
	12/20/2007	Setup	Orange light on CR1000 card reader; blinking, red light when card first put in.
	1/14/2008	Remote	Realign path on TDLAS 1 (1026)/
	1/14/2008	Takedown	Upon arrival found TDLAS laptops malfunctioning. Unable to log in to check out. Turned off and on again and went through hard disk check.
	1/14/2008	Takedown	Found that TDLAS data collection stopped on 1/12/2008 at 1800 UTC (scanner 1) and on 1/13/2008 at 0 UTC (scanner 2). It looks like it simply stopped creating log files. When checked at Purdue this morning, the screens looked fine.
	1/14/2008	Takedown	Sonic collection error at 1310 UTC. Had restarted program at 12:53Z.
	1/14/2008	Takedown	Evidence of power failures on 12/3/2007 at 1018 UTC, on 1/7/2008 at 2053 UTC, and on 1/10/2008 at 2002 UTC.
	1/15/2008	Takedown	Wetness sensor dirty/gritty.
	1/15/2008	Takedown	Rubber feet on tripods buried/frozen in ground. Some difficulty removing due to thawing/freezing since last setup. Some feet sunk 6-10 inches into frozen mud.
	1/15/2008	Takedown	Several tripods on W and N sides were loose.
15:20	1/15/2008	Takedown	Barometer audit: accepted
15:20	1/15/2008	Takedown	Wetness sensor calibration: returned to Purdue for cleaning.
15:30-16:30	1/15/2008	Takedown	Sonic inter-comparison: Sonic 1: 4.88 - Sonic 2 :4.79 - Sonic 3: 4.83 - Action: pass
16:46	1/15/2008	Takedown	Zero calibration performed on sonic anemometers
01:35-01:40	1/16/2008	Takedown	Calibrated TDLAS 1026 – Mean: 23.56 - SD: 0.61 - RSD: 2.6% - Bias: -6.2%
02:19-02:24	1/16/2008	Takedown	Calibrated TDLAS 1028 – Mean: 23.98 - SD: 0.51 - RSD: 2.1% - Bias: -4.6%
	5/14/2008	Setup	While doing TDLAS calibration, 1028 passed, but 1027 failed, giving concentration of 87.56 ppm, so it passed 200 ppm, giving 182.94. After waiting five min, 1027 passed calibration, giving 90.30 (it just passed).

Time (UTC)	**Date** (mm/dd/yyyy)	**Activity** (Setup, Takedown, Calibration, Repair, Remote)	**Event**
22:23	5/14/2008	Setup	Calibrated TDLAS 1028 – Mean: 48.97 - SD:0.20 - RSD: 0.4% - Bias: -2.7%
23:47	5/14/2008	Setup	Calibrated TDLAS 1027– Mean: 45.15 - SD: 0.29 - RSD: 0.7% - Bias: -9.8% Note: Passed on third attempt
	5/15/2008	Setup	TDLAS 1027 (power box 3) at SW. TDLAS 1028 (power box 4) at NE.
	5/15/2008	Setup	GSS no flow test
	5/15/2008	Setup	S-OPS/GSS leak test: Pass
	5/15/2008	Setup	GSS leak test: Pass
	5/15/2008	Setup	S-OPS inlet flow verification: Pass
	5/15/2008	Setup	S-OPS max flow test: Pass
19:05	5/15/2008	Setup	Wetness sensor calibration.
19:05	5/15/2008	Setup	Barometer audit: accepted
23:32	5/15/2008	Setup	TFC 450i calibration.
15:15	5/19/2008	Remote	Daily Status Check from PAML Notes: *iPort* fill data from 5/17/2008 1800 UTC. While downloading Fill data, received error message: "error: Bad command: "iscreen."' Reconnected and resumed fill from 5/18/2008 0021 UTC. Communication error required another restart from 5/19/2008 521 UTC. Got connection error multiple times; finally worked when starting load from 5/19/2008 0 UTC. Unable to get fill data after 5/19/2008 1220 UTC. Successfully filled gap by "loading last xx records."
12:15	5/20/2008	Remote	Daily Status Check from PAML
12:30	5/21/2008	Remote	Daily Status Check from PAML
12:10	5/22/2008	Remote	Daily Status Check from PAML – Notes: Graph for w graph looks different. r^2 on TDLAS 2 is between 0.96 and 0.99.
12:20	5/27/2008	Remote	Daily Status Check from PAML Notes: All 3 sonic anemometers had sonic anemometer flags over the extended weekend. Finding strong "spikes" in the wind data. Maybe due to strong thunderstorms? Stopped and restarted sonic anemometer program. *iPort* data collection ended on day 511. *iPort* locked up; last date collected 5/25/2008 at 0357 UTC. Collected H_2S data through *iPort* (required multiple tries). Restarted real-time data download. Unable to realign retro-reflectors 1 and 2 on TDLAS 1. Likely caused by thunderstorms in the area (winds >20 ms^{-1}) at time paths lost on 5/24/2008 around 12 UTC.
14:30	5/28/2008	Remote	Daily Status Check from PAML – Notes: About half day flagged yesterday on sonic anemometer 1. Back giving good values now. Unusual values showing up during this time. Retros 1 and 2 were knocked down by high winds on 5/24/2008and straightened yesterday.
12:15	5/29/2008	Remote	Daily Status Check from PAML – Notes: TDLAS reference r^2 values fluctuating from 0.96 to 0.99. Error messages related to sonic/*iPort*/Innova programs: Connect screen "communication with the station failed."
13:54	6/3/2008	Remote	Daily Status Check from PAML – Notes: Supply voltage has dropped from 1345 on day 515 to 1320 on day 520.

Time (UTC)	**Date (mm/dd/yyyy)**	**Activity (Setup, Takedown, Calibration, Repair, Remote)**	**Event**
	6/4/2008	Calibration	TDLAS 1031 replaces TDLAS 1027. Changed filter papers (nos. 2, 3, 4, 5, 6 and 9) for north side of S-OPS. Added plastic on all ground retro-reflectors; cleaned all ground retro-reflectors and took pictures of the cubes. UPS switched to battery power on 5/30/2008 at 02:39:49--02:39:54 and 6/3/2008 at 10:13:34.
	6/4/2008	Calibration	Basin site layout recorded. See open site notes for details.
	6/4/2008	Calibration	S-OPS inlet flow verification: Pass
	6/4/2008	Calibration	S-OPS max flow test: Pass
	6/4/2008	Calibration	GSS leak test: Pass
	6/4/2008	Calibration	GSS no flow test
	6/4/2008	Calibration	S-OPS/GSS leak test: Pass
	6/4/2008	Calibration	Barometer audit: accepted
	6/4/2008	Calibration	Wetness sensor calibration: accepted
14:00-15:00	6/4/2008	Calibration	Sonic inter-comparison: Pass
14:55	6/4/2008	Calibration	TFC 450i calibration.
15:12	6/4/2008	Calibration	TFC 450i reference precision check
15:28	6/4/2008	Calibration	Sonic zero calibration: Pass
18:15	6/4/2008	Calibration	Calibrated TDLAS 1028– Mean: 47.01 - SD: 0.2 - RSD: 0.4% - Bias: -6.4%
18:56	6/4/2008	Calibration	Calibrated TDLAS 1027 – Mean: 95.21 - SD: 1.33 - RSD: 1.4% - Bias: -5.3% - Notes: Pass 100 ppm of NH_3. Got max conc of 43.10 ppm and max r^2 of 0.91; therefore, passed 200 ppm.
19:29	6/4/2008	Calibration	Calibrated TDLAS 1031 – Mean: 53.35 - SD: 0.27 - RSD: 0.5% - Bias: 6.4%
	6/5/2008	Calibration	Prof. Grant did QA and inter-comparison of TDLAS (1031 and 1028). Yesterday, water was seen (half-filled) inside UPS box (SW). Drained water and dried UPS with heat gun. Saw much water inside retro-reflector boxes. Flagged all the extension tubing; used duct tape to seal retro-reflector box (#6 SW). Power box of retro-reflector #2 (NE) was sealed with plastic bag, for it was missing its lid. Capped both UPS boxes and kept wood and a small rock.
	6/9/2008	Remote	Daily Status Check from PAML – Notes: Sonic, GSS, H_2S QC files stopped updating on 6/8/2008 13:45 UTC. TDLAS QC files stopped updating at 13:07 UTC on 6/8/2008. Only one TDLAS is working as the power supply to the other TDLAS got corroded. CR1000 data stopped updating on 6/8/2008. Cannot remotely connect to TDLAS laptops.
12:15	6/10/2008	Remote	Daily Status Check from PAML – Notes: Sonic 1 graph looks different slightly. TDLAS QC data was incrementing and was up to date. However, scanner 1 data had only incremented to 6/8/2008. Started transferring .bat file, and it started working; data is up to date. No pH probe need for a basin. Scanner for TDLAS 2 has corroded power supply; therefore, there is only one TDLAS working.
12:55	6/11/2008	Remote	Daily Status Check from PAML – Notes: TDLAS 2 scanner is broken. No pH probe needed for this site.
	6/12/2008	Repair	Changed scanner and reaimed all the paths for SW TDLAS (1031). Changed #6 retro-reflector plastic from dense to light plastic.

Time (UTC)	**Date** (mm/dd/yyyy)	**Activity** (Setup, Takedown, Calibration, Repair, Remote)	**Event**
	6/12/2008	Repair	Checked all the power supply outlets and tapped them properly. Checked antennas. Checked to make sure all data was incrementing.
12:10	6/13/2008	Remote	Daily Status Check from PAML – Notes: Re-aimed paths 2, 3, and 7 on TDLAS 2. Will check again because path 2 is not behaving well (low light values). Spent at least one hour working to align path 2 but could not. At 20:50 UTC, called farm owner (Scott) and asked him to remove plastics from retro-reflectors 2 and 7. All the paths are giving valid light values now.
12:00	6/16/2008	Remote	Daily Status Check from PAML – Notes: Graph w for sonic anemometer 1 looks slightly different (as compared to sonic anemometers 2 and 3). Higher concentrations of H_2S are seen after 6/12/2008. Cannot explain. No pH probe necessary at this site.
12:10	6/17/2008	Remote	Daily Status Check from PAML – Notes: 2-3 values for sonic anemometer 1 are more than 160 in spike count.
12:10	6/18/2008	Remote	Daily Status Check from PAML – Notes: Graph for sonic anemometer 1 for average w values looks slightly different from sonic anemometers 2 and 3. On TDLAS 2, fraction will all 10 paths aligned is only 0.04, and values for reference cell quality are more than 12800.
17:00	6/18/2008	Remote	Remote login to change power settings on IA3A scanners. Changed power settings on both scanners to "PMR TMR PHL THL"
12:10	6/19/2008	Remote	Daily Status Check from PAML
12:40	6/20/2008	Remote	Daily Status Check from PAML
	6/23/2008	Takedown	Found water in retro-reflector 6 on TDLAS 1031 (SW corner). Tape around retro-reflector box appears to be worn off, allowing water inside.
	6/23/2008	Takedown	Barometer audit: accepted
	6/23/2008	Takedown	S-OPS max flow test conducted
	6/23/2008	Takedown	S-OPS/GSS leak test: Pass
	6/23/2008	Takedown	GSS no flow test
	6/23/2008	Takedown	GSS leak test: Pass
13:00	6/23/2008	Remote	Daily Status Check from PAML Notes: TDLAS 1 is finding all paths but optimizing frequently. Sonic 3 had flagging briefly at one time but is currently not flagging.
14:11	6/23/2008	Takedown	TEC 450i calibration verification check
14:34	6/23/2008	Takedown	TEC 450i reference precision check
20:55	6/23/2008	Takedown	Wetness sensor calibration: accepted
21:45	6/23/2008	Takedown	Calibrated TDLAS 1028 – Mean: 46.71 - SD: 0.31 - RSD: 0.7% - Bias: -6.7%
22:27	6/23/2008	Takedown	Calibrated TDLAS 1031 – Mean: 54.54 - SD: 0.21 - RSD: 0.4% - Bias: 8.3%
0:05-0:59	6/24/2008	Takedown	Sonic inter-comparison: Pass
01:20	6/24/2008	Takedown	Sonic zero calibration: Pass
00:00	6/24/2008	Takedown	Front left jack of the trailer is not working well.
	6/24/2008	Takedown	TEC 450i instrument operating parameters calculated

Time (UTC)	Date (mm/dd/yyyy)	Activity (Setup, Takedown, Calibration, Repair, Remote)	Event
12:30	6/24/2008	Remote	Daily Status Check from PAML Notes: Sonic 1 w values are slightly above zero. Flag "64" in H_2S analyzer data--could be caused by FOS on site yesterday. GSS pressure drops off dramatically in late afternoon; FOS arrived on site yesterday. Not a full day of data yesterday for TDLAS QC; FOS on site.
	11/12/2008	Setup	Reached site at 3:00 P.M. local time. Ground is muddy.
	11/12/2008	Setup	Saw three fenceposts missing from S-OPS (south side).
	11/12/2008	Setup	Two power poles (with sockets) were missing upon arrival, so there was no electricity around the basin; only electric power was around the towers.
	11/12/2008	Setup	While setting up tralier, the trailer slipped resulting in breaking of one scissor jack (which has been temporarily repaired).
00:02	11/13/2008	Setup	TEC 450i instrument operating parameters calculated
00:02	11/13/2008	Setup	TEC 450i calibration verification check
00:24	11/13/2008	Setup	TEC 450i reference precision check
00:35	11/13/2008	Setup	SO_2 calibration
	11/13/2008	Setup	Checked leak test for TEC 450i (H_2S analyzer). Flow showing is 0.00 but pressure showing 547.8 mmHg (i.e., pump needs to be replaced).
	11/13/2008	Setup	Changed filters for nozzles #1, 2, 3, and 8 of "F" S-OPS. Changed filters for nozzle #4 for "D" S-OPS.
	11/13/2008	Setup	Fixed electric wires at retro-reflector #1 of SW TDLAS and retro-reflector #6 of NE TDLAX
	11/13/2008	Setup	Basin site layout recorded. See open site notes for details.
	11/13/2008	Setup	GSS no flow test
	11/13/2008	Setup	GSS leak test: Pass
	11/13/2008	Setup	GSS max flow test
	11/13/2008	Setup	S-OPS max flow test conducted
	11/13/2008	Setup	S-OPS/GSS leak test: Pass
	11/13/2008	Setup	S-OPS balance: F
	11/13/2008	Setup	S-OPS balance: D
12:35	11/13/2008	Setup	Wetness sensor calibration: pass.
16:55	11/13/2008	Setup	Calibrated TDLAS 1030
17:00-17:54	11/13/2008	Setup	Sonic inter-comparison; all pass.
17:34	11/13/2008	Setup	Calibrated TDLAS 1026
18:10	11/13/2008	Setup	Zero sonic anemometer calibration; all pass.
	11/14/2008	Setup	Set up all ground retros. Set up TDLAS, aimed both; rain made obtaining good light values difficult. Initially found little problem with scanner at SW (s/n: 1122), but after a while it worked well.
	11/14/2008	Setup	Barometer audit: accepted
	11/14/2008	Setup	Maintenance list completed.
17:50	11/17/2008	Remote	Daily Status Check from PAML Notes: On TDLAS 1, found 5 paths had dwell times set to zero s. Changed to 15 s. Paths 2, 4, 6, 7, and 10 are now good. Sonic 3 w goes up to 1 ms^{-1}. Sonic 1 w goes to up to 0.5 ms^{-1}. No communication with CR 1000.
13:35	11/18/2008	Remote	Daily Status Check from PAML Notes: Graphs for u, v, and w look different for sonic anemometers 1 and 3. No communication with CR 1000.

Time (UTC)	**Date** (mm/dd/yyyy)	**Activity** (Setup, Takedown, Calibration, Repair, Remote)	**Event**
14:42	11/19/2008	Remote	Daily Status Check from PAML Notes: No QC file for 11/19/2008. No communication with CR 1000.
14:15	11/20/2008	Remote	Daily Status Check from PAML Notes: Sonic 3 has quite a few periods with 10-50 sonic anemometer flagged points and less than 4000 data points. No communication with CR 1000.
13:36	11/21/2008	Remote	Daily Status Check from PAML Notes: Path 7 on TDLAS 1 and path 8 on TDLAS 2 did not have good light levels; re-aimed them, and they are now working well. Graphs for u, v, and w look different for sonic anemometers 1 and 2. No communication with CR 1000.
13:00	11/24/2008	Remote	Daily Status Check from PAML Notes: All 3 sonic anemometers had major flagging from 693.2-693.8 (dense freezing fog). No communication with CR 1000.
	11/25/2008	Calibration	Scott fixed the missing power outlets.
	11/25/2008	Calibration	Could not do manure sampling as it was frozen.
	11/25/2008	Calibration	Changed (fixed) diaphragm of TEC 450i pump; now it is working well, giving 1.08 LPM. Last time 450i failed, we have done multipoint calibration.
	11/25/2008	Calibration	Maintenance list completed.
	11/25/2008	Calibration	GSS no flow test
	11/25/2008	Calibration	GSS max flow test
	11/25/2008	Calibration	S-OPS max flow test conducted
	11/25/2008	Calibration	S-OPS/GSS leak test: Pass
	11/25/2008	Calibration	GSS leak test: Pass
	11/25/2008	Calibration	S-OPS balance: D
	11/25/2008	Calibration	S-OPS balance: F
16:25	11/25/2008	Calibration	Calibrated TDLAS 1026
16:58	11/25/2008	Calibration	Calibrated TDLAS 1030
17:10	11/25/2008	Calibration	Barometer audit: accepted
17:13	11/25/2008	Calibration	Wetness sensor calibration: pass.
17:10-18:05	11/25/2008	Calibration	Sonic inter-comparison; all pass.
20:05	11/25/2008	Calibration	Zero sonic anemometer calibration; all pass.
20:48	11/25/2008	Calibration	TEC 450i calibration verification check
20:48	11/25/2008	Calibration	TEC 450i instrument operating parameters calculated
21:01	11/25/2008	Calibration	TEC 450i reference precision check
22:54	11/25/2008	Calibration	SO_2 calibration
14:15	11/26/2008	Calibration	Daily Status Check from PAML
13:10	12/1/2008	Calibration	Daily Status Check from PAML Notes: Sonic measurement stopped on 11/29/2008 from 23:00 to 11/30/2008 at 20:14:57.
13:05	12/2/2008	Calibration	Daily Status Check from PAML
14:00	12/3/2008	Calibration	Daily Status Check from PAML
12:50	12/4/2008	Calibration	Daily Status Check from PAML Notes: Sonic 1 w may be slightly different than other graphs.
13:10	12/5/2008	Calibration	Daily Status Check from PAML Notes: On TDLAS 1, found paths 1 and 4 with low light levels. Re-aimed the paths, and they are now working well.
13:40	12/11/2008	Remote	Daily Status Check from PAML
14:15	12/12/2008	Remote	Daily Status Check from PAML – Notes: GSS/H_2S data stops at about 712.239

Time (UTC)	**Date** (mm/dd/yyyy)	**Activity** (Setup, Takedown, Calibration, Repair, Remote)	**Event**
	12/15/2008	Takedown	Arrived on site at 5:00 pm CST.
	12/15/2008	Takedown	TDLAS PC error message upon arrival. TDLAS 2: "Valve creation failed at line 599." (parser message) (locked up). TDLAS 1: Error connecting to existing session for registration. A device attached to the system is not functioning. A new session were created. (unable to log in).
00:52	12/15/2008	Takedown	Calibrated TDLAS 1026
01:13	12/15/2008	Takedown	Calibrated TDLAS 1030
	12/16/2008	Takedown	Temp -17C. Basin frozen.
	12/16/2008	Takedown	Maintenance list completed.
16:50-17:50	12/16/2008	Takedown	Sonic inter-comparison; all pass.
18:30	12/16/2008	Takedown	Barometer audit: accepted
18:30	12/16/2008	Takedown	Sonic zero calibration: Pass
18:31	12/16/2008	Takedown	Wetness sensor calibration: pass.
	4/8/2009	Setup	Reached site at 9:30 A.M. local time. Saw many dead animals near the basin towards the basin.
	4/8/2009	Setup	Maintenance list completed.
17:49-18:54	4/8/2009	Setup	Sonic inter-comparison; all pass.
19:18	4/8/2009	Setup	Zero sonic calibration; all pass.
20:00	4/8/2009	Setup	Calibrated TDLAS 1030
20:42	4/8/2009	Setup	Calibrated TDLAS 1031
21:27-21:55	4/8/2009	Setup	TEC 450i Single Point calibration
	4/9/2009	Setup	Did manure sampling today.
	4/9/2009	Setup	Basin site layout recorded.
12:15-13:50	4/9/2009	Setup	S-OPS/GSS calibrations
13:00	4/9/2009	Setup	Barometer audit: accepted
13:01	4/9/2009	Setup	Wetness sensor calibration: accepted
14:00	4/9/2009	Setup	Started sonic anemometer 1
14:55	4/9/2009	Setup	Started TEC 450i sampling
15:50	4/10/2009	Remote	Daily Status Check from PAML – Notes: Check out paths that QC indicates might be in a "hole." TDLAS 2 R1 current position of 12724, -246 is surrounded by 16368 in optimization plots. However this location is not in a hole now as indicated by manual searching to left and right of this position. Believe that the indicated holes are base on the data collected before additional plastics were added around 8:00 P.M. CDT on 4/8/2009. Sonic 1 w reaches 1 ms^{-1}; direction is across the basin at that time (excluded due to barns).

Time (UTC)	**Date** (mm/dd/yyyy)	**Activity** (Setup, Takedown, Calibration, Repair, Remote)	**Event**
13:30	4/13/2009	Remote	Daily Status Check from PAML – Notes: *iPort* encountered an error and had to be restarted. Stopped sonic anemometers at 15:50, filled missing data, restarted data collection, and restarted sonic anemometers s. Sonics showing wind from the east most of the time. H_2S chamber pressure dropped by 20 (643 to 623) at NAEMS day 832.65 and has steadily dropped to about 600 since. TDLAS 2 reference cell quality fluctuates between ~1000 and ~6000. When it is ~6000, the reference r^2 is about 50%. Also, at these times, the measured r^2 at about 50.
12:10	4/14/2009	Remote	Daily Status Check from PAML Notes: Sonic 3 has no data on 4/13/2009 between about 15:30 and 16:30. H_2S chamber pressure has stabilized around 600.
12:00	4/15/2009	Remote	Daily Status Check from PAML Notes: *iPort* encountered an error and had to be restarted. Stopped sonic anemometers, filled missing data, restarted data collection, and restarted sonic anemometers. According to Scott Shriver the dead animals (where were lying beside the barns towards the basin) were removed on Sunday (4/12/2009). TDLAS 2 reference cell quality and reference r^2 both alternating.
12:00	4/16/2009	Remote	Daily Status Check from PAML – Notes: Max r^2 on TDLAS 2 around 0.6.
12:10	4/20/2009	Remote	Daily Status Check from PAML
13:15	4/21/2009	Remote	Daily Status Check from PAML – Notes: Average w for sonic anemometer 1 is 0.4 ms^{-1}; for sonic anemometer 3 the average is 0.4 ms^{-1}.
	4/22/2009	Takedown	Stopped TDLAS's, sonic anemometer anemometers, H_2S, and GSS log files at around 4:00 CDT.
	4/22/2009	Takedown	Took down all tower equipment and ground equipment except the met tower station.
	4/22/2009	Takedown	Started sonic anemometer calibration at 22:46 UTC; will let the sonic anemometers run overnight.
	4/23/2009	Takedown	TDLAS calibration took about 3 h. Did tie-tin of old NH_3 cylinder with new using TDLAS 1030. Conducted two trials of each calibration because of large difference between tanks on trial 1. Got good agreement on trial 2. Calibration cell was bumped while changing cylinders during trial 1. TDLAS 1030 failed trial 1, but passed trial 2. TDLAS 1031 was very erratic in oscilloscope; failed trial 1 and barely passed trial 2.
	4/23/2009	Takedown	Conducted multipoint calibration of 450i. Read about 30% higher than the last multipoint. Value at 0.5 ppm consistent with last several calibration checks.
	4/23/2009	Takedown	Took manure sample at end of day while packing trailer. Will ship tomorrow morning.
	4/23/2009	Takedown	Maintenance list completed.
	4/23/2009	Takedown	Basin site layout made.
12:04-15:00	4/23/2009	Takedown	Sonic inter-comparison; all pass.
15:10	4/23/2009	Takedown	Wetness sensor calibration: pass.
15:10	4/23/2009	Takedown	Barometer audit: accepted
15:28	4/23/2009	Takedown	Zero sonic anemometer calibration; all pass.

Time (UTC)	Date (mm/dd/yyyy)	Activity (Setup, Takedown, Calibration, Repair, Remote)	Event
15:45	4/23/2009	Takedown	S-OPS/GSS calibrations
17:10-19:31	4/23/2009	Takedown	Calibrated TDLAS 1030 (see open site notes for details)
17:32-19:01	4/23/2009	Takedown	Calibrated TDLAS 1030 (see open site notes for details)
17:57-19:54	4/23/2009	Takedown	Calibrated TDLAS 1031 (see open site notes for details)
20:29-21:17	4/23/2009	Takedown	TEC 450i multipoint calibration.
	7/27/2009	Setup	Connected trailer
	7/27/2009	Setup	Distributed retros and scanners
	7/27/2009	Setup	Mounted S-OPS
	7/28/2009	Setup	Open site notes completed
15:45-16:45	7/28/2009	Setup	Sonic inter-comparison; all pass.
17:51	7/28/2009	Setup	Zero sonic anemometer calibration; all pass.
18:00	7/28/2009	Setup	S-OPS/GSS calibrations Notes: S-OPS F line failed inlet flow on the first try. Changed filters 3 and 4.
18:15-19:00	7/28/2009	Setup	Calibrated TDLAS 1030 Notes: A second background test was needed because tripod was bumped during testing.
18:48	7/28/2009	Setup	Barometer audit: accepted
18:50	7/28/2009	Setup	Wetness sensor calibration: accepted
19:44-20:01	7/28/2009	Setup	Calibrated TDLAS 1026
23:47-00:29	7/28/2009	Setup	TEC 450i Single Point calibration
	7/29/2009	Setup	H_2S analyzer hooked up to sample line at about 13:30 UTC on 7/29/2009.
	7/29/2009	Setup	Maintenance list completed.
15:30	7/30/2009	Remote	Daily Status Check from PAML Notes: No communication with CR 1000. Reaimed TDLAS 1 path 8.
12:20	7/31/2009	Remote	Daily Status Check from PAML Notes: Reaimed TDLAS 1 path 8 (xxxx appeared briefly while aiming). Having a difficult time keeping path 8 with good light levels. It get great light levels when aiming, but then has low light levels of the same pan/tilt on the next path. Changed obstruction level from 200 to 2 to try to correct TDLAS 1. No communication with CR 1000.
12:40	8/3/2009	Remote	Daily Status Check from PAML Notes: CDC brief fell to 133 on both TDLAS's. No communication with CR 1000.
12:20	8/4/2009	Remote	Daily Status Check from PAML Notes: Small amount of sonic anemometer flagging sonic anemometer anemometers 2 and 3. No communication with CR 1000. TDLAS paths have low light levels, probably due to fog/mist in area.
12:10	8/5/2009	Remote	Daily Status Check from PAML Notes: No communication with CR 1000. Low light levels on TDLAS's (alarm 50 on TDLAS 1), probably caused by fog/moisture.
12:10	8/6/2009	Remote	Daily Status Check from PAML Notes: Re-aimed TDLAS 1 path 1 and TDLAS 2 path 7; having trouble with TDLAS 2 path 7. Will see if they recover by themselves.

Time (UTC)	**Date** (mm/dd/yyyy)	**Activity** (Setup, Takedown, Calibration, Repair, Remote)	**Event**
12:15	8/7/2009	Remote	Daily Status Check from PAML Notes: Many TDLAS paths have low light levels, probably caused by rain at the site. No communication with CR 1000.
12:45	8/10/2009	Remote	Daily Status Check from PAML Notes: Nearly all TDLAS paths have low light levels, caused by dew/fog. MFC dropped to less than zero for about 12 h (950.9-951.4). RH jumped over 100% for some periods of time. H_2S data was not updated. Filled missing data. Period of flag 64 in H_2S data. No communication with CR 1000.
12:15	8/11/2009	Remote	Daily Status Check from PAML Notes: TDLAS paths recovering from dew. No communication with CR 1000.
13:15	8/12/2009	Remote	Daily Status Check from PAML Notes: No communication with CR 1000. TDLAS 2 paths are likely recovering from dew. T/RH sensor in GSS appears to have failed due to high humidity/condensation. H_2S concentration spiked to >20000 ppb.
12:45	8/13/2009	Remote	Daily Status Check from PAML Notes: TDLAS 2 is optimizing a lot. Will check later.
12:20	8/14/2009	Remote	Daily Status Check from PAML Notes: No communication with CR 1000. T/RH sensor in GSS appears to have failed due to high humidity/condensation. H_2S concentration spiked to >20000 ppb.
	8/17/2009	Takedown	Relabeled S-OPS D line.
	8/17/2009	Takedown	Maintenance list completed.
	8/17/2009	Takedown	Basin site layout completed.
12:16	8/17/2009	Remote	Daily Status Check from PAML Notes: Paths are off on both TDLAS units, probably caused by fog/moisture. Humidity is 100% currently.
22:00-22:37	8/17/2009	Takedown	S-OPS/GSS calibrations performed
22:45-23:12	8/17/2009	Takedown	TEC 450i Single Point calibration
	8/18/2009	Takedown	NAEMS Open site notes completed.
13:25-14:25	8/18/2009	Takedown	Sonic inter-comparison; all pass.
15:00	8/18/2009	Takedown	Wetness sensor calibration: pass.
15:03	8/18/2009	Takedown	Barometer audit: accepted
15:08	8/18/2009	Takedown	Zero/Bias sonic anemometer check: pass
15:10-15:33	8/18/2009	Takedown	Calibrated TDLAS 1026 Notes: Having the air conditioner results in significant background values; turned air conditioner off.
16:04-16:25	8/18/2009	Takedown	Calibrated TDLAS 1030 Notes: Cleaned TDLAS window. TDLAS would go into Menu mode. ESC and ENT keys are not functioning.

6.7 Site Weather

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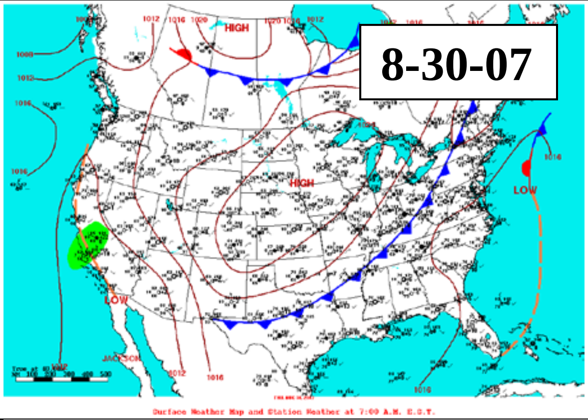
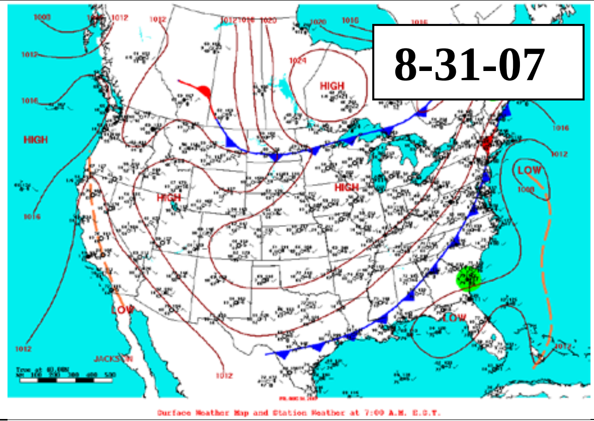
<tr><td>
</td><td>
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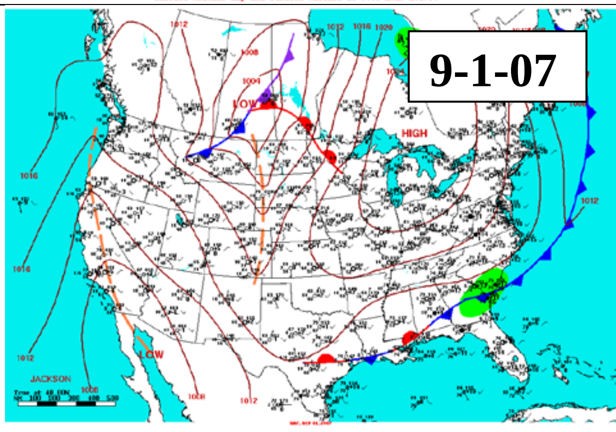
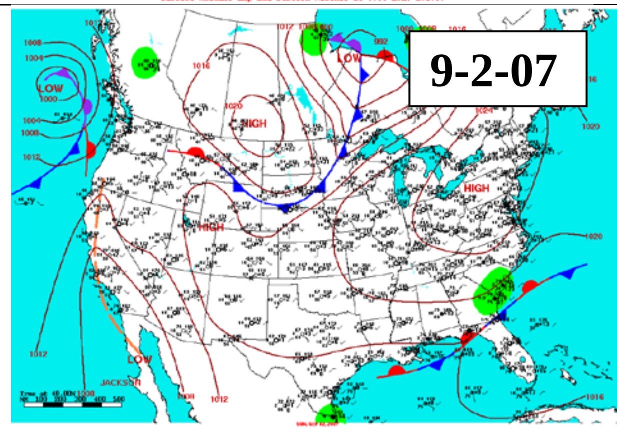
<tr><td>
</td><td>
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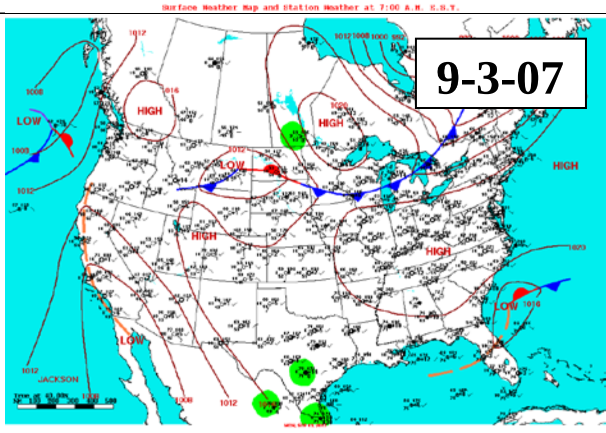
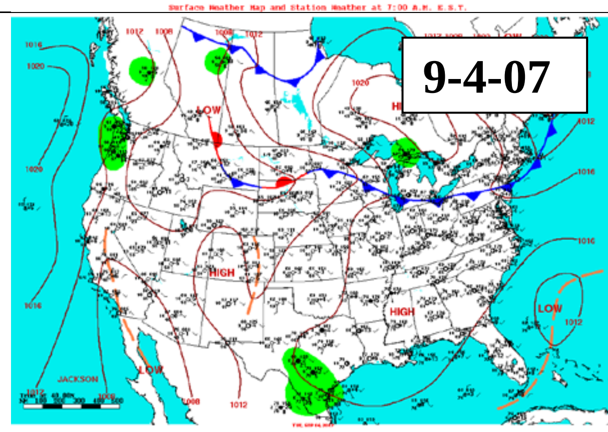
<tr><td>
</td><td>
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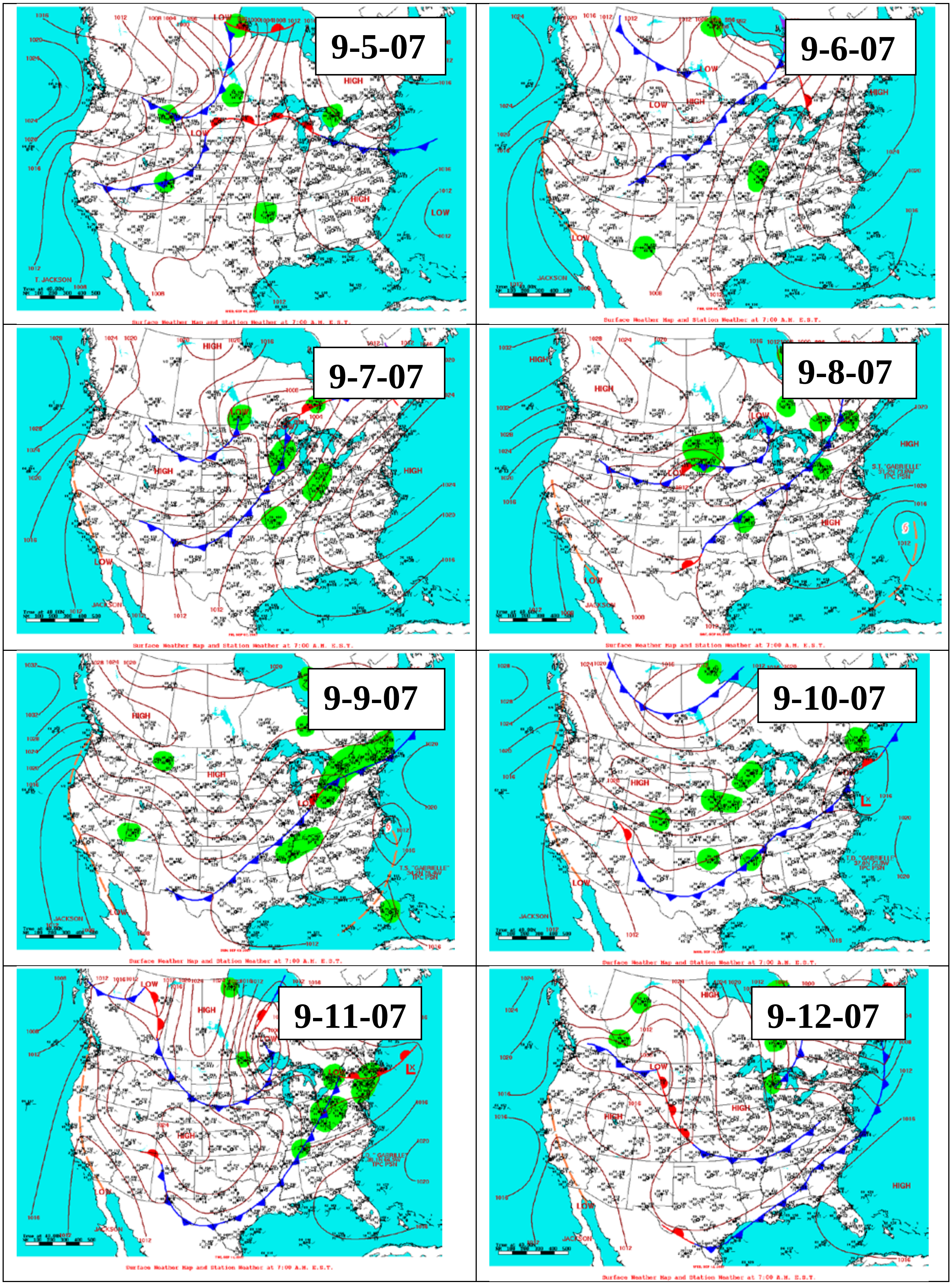
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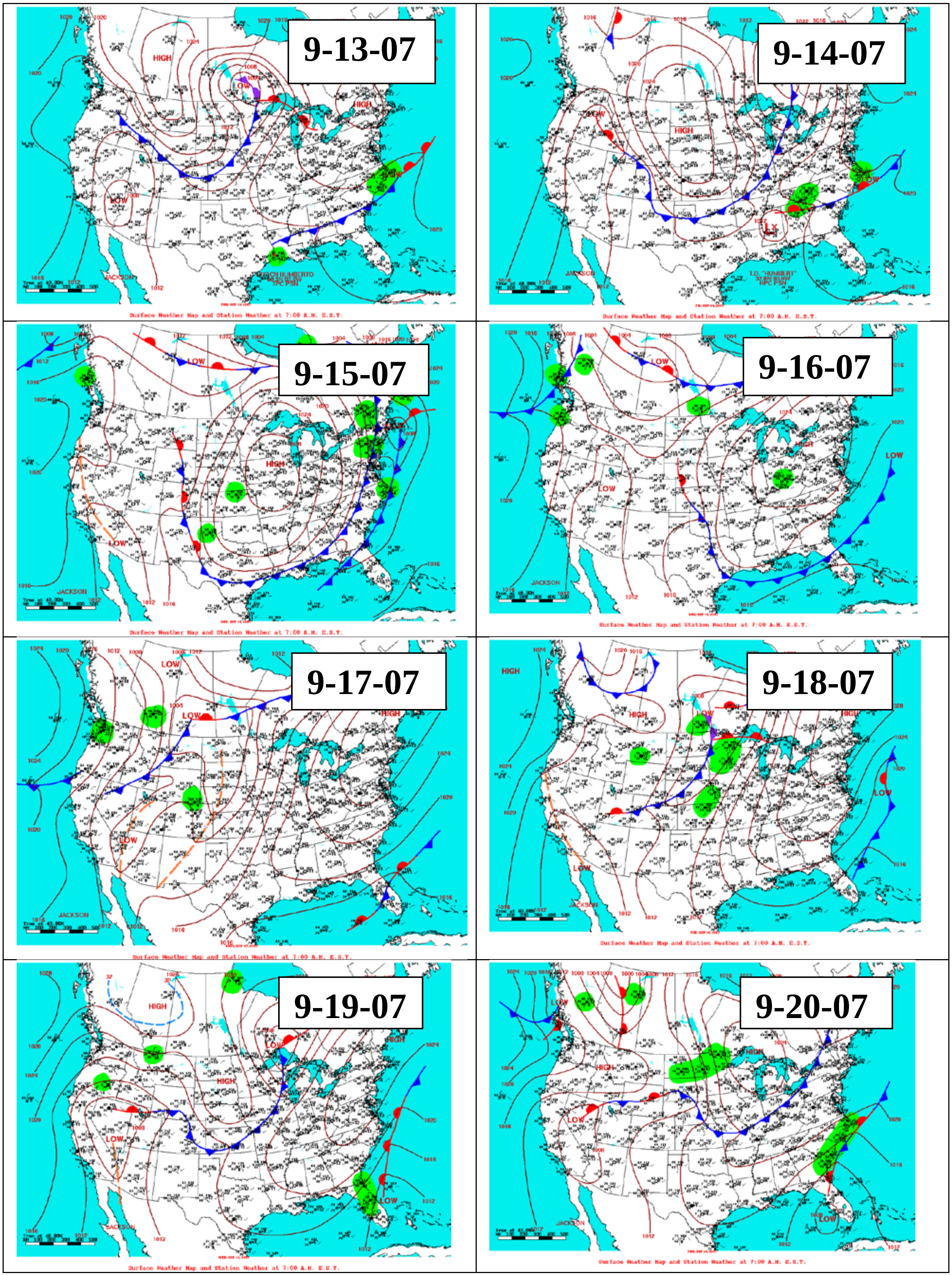
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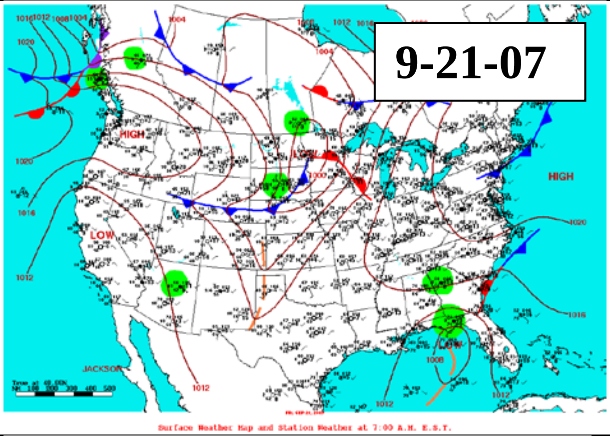

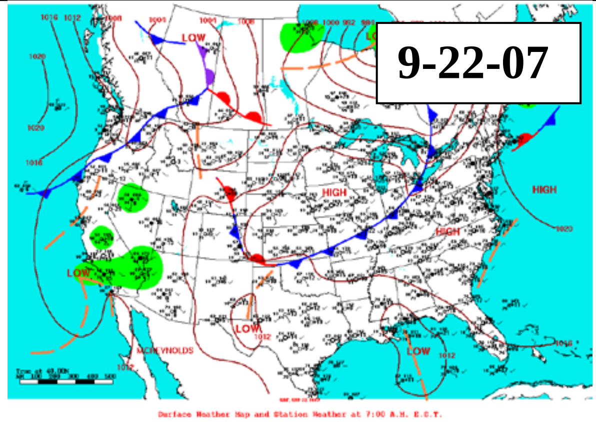

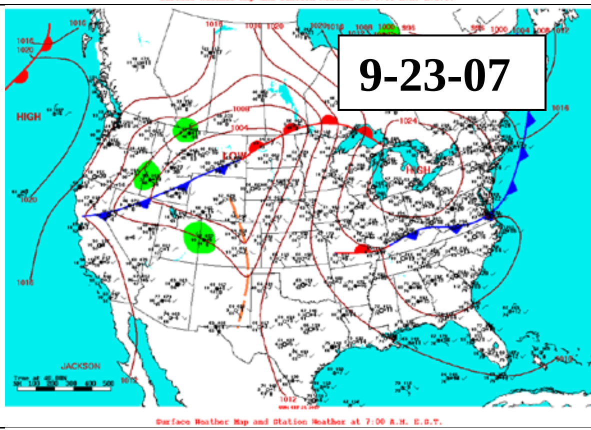

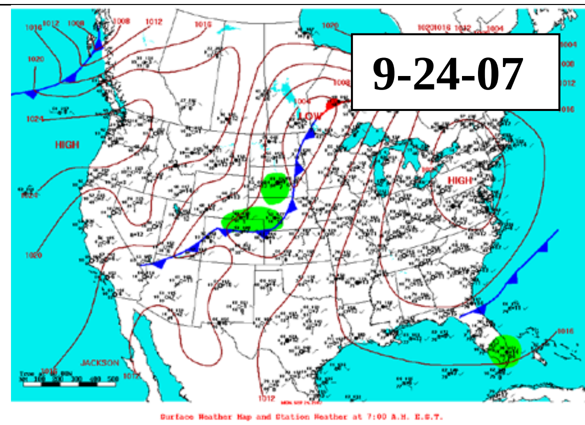

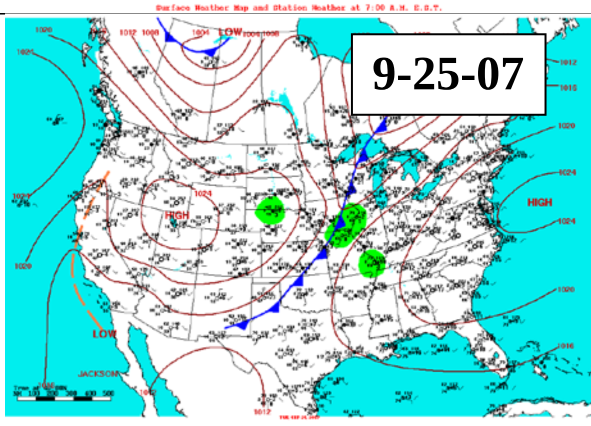

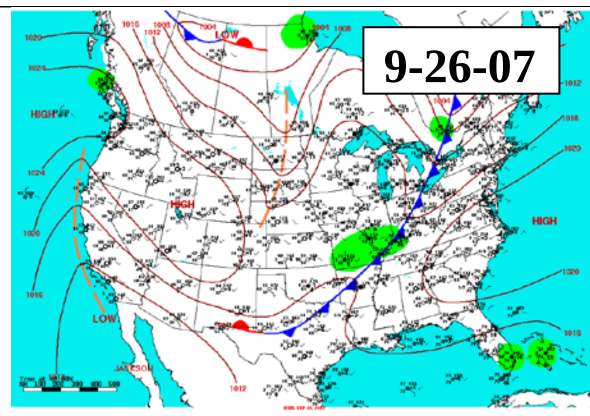

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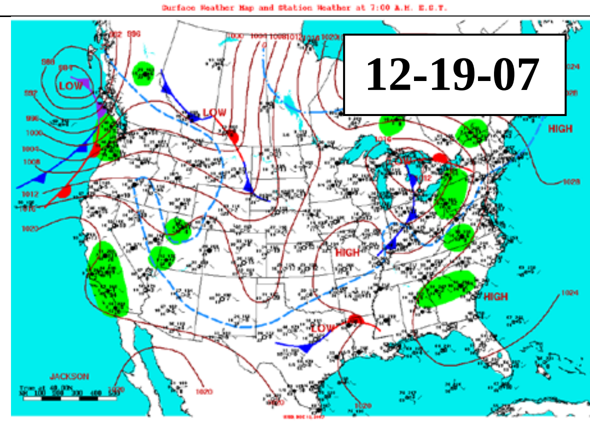

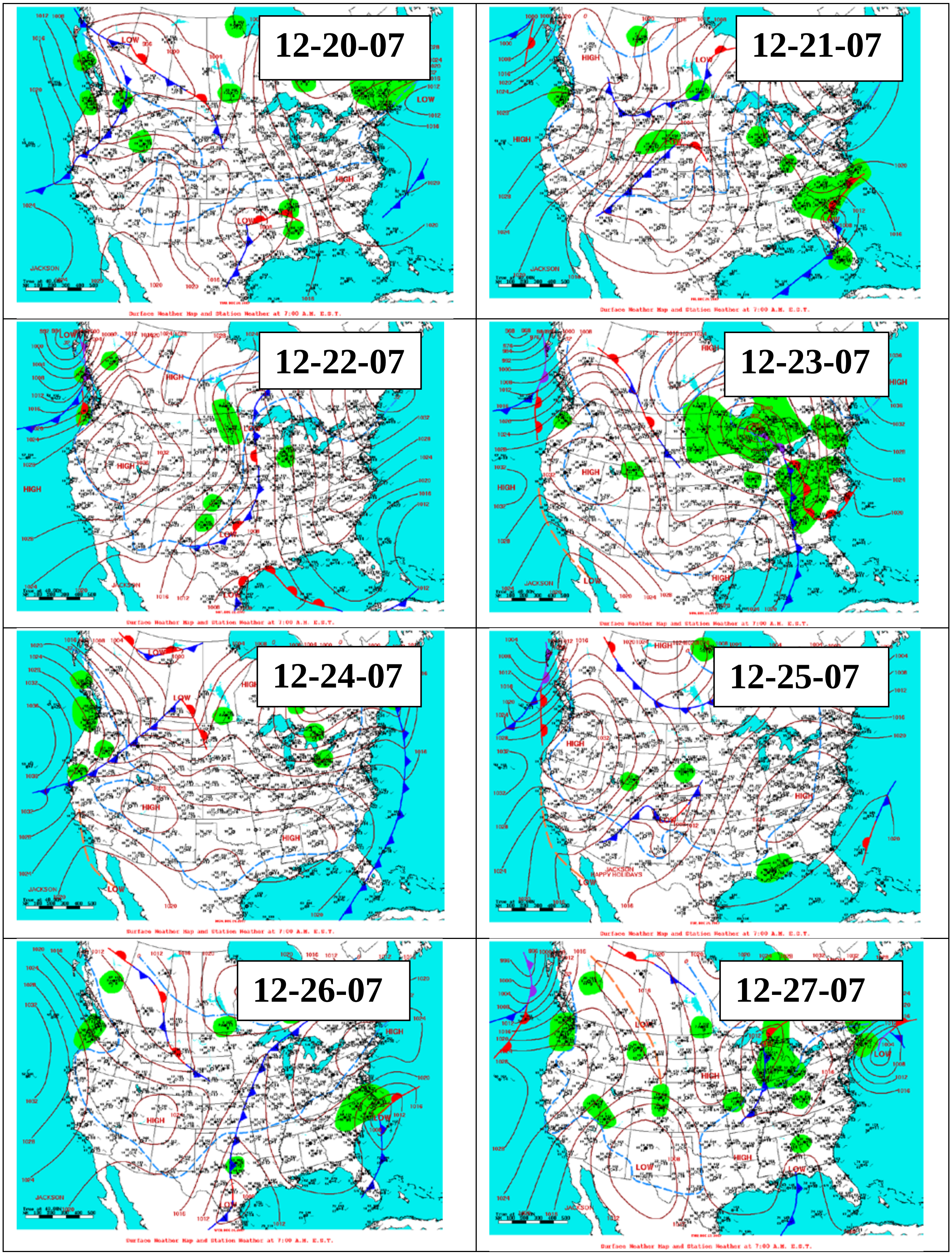
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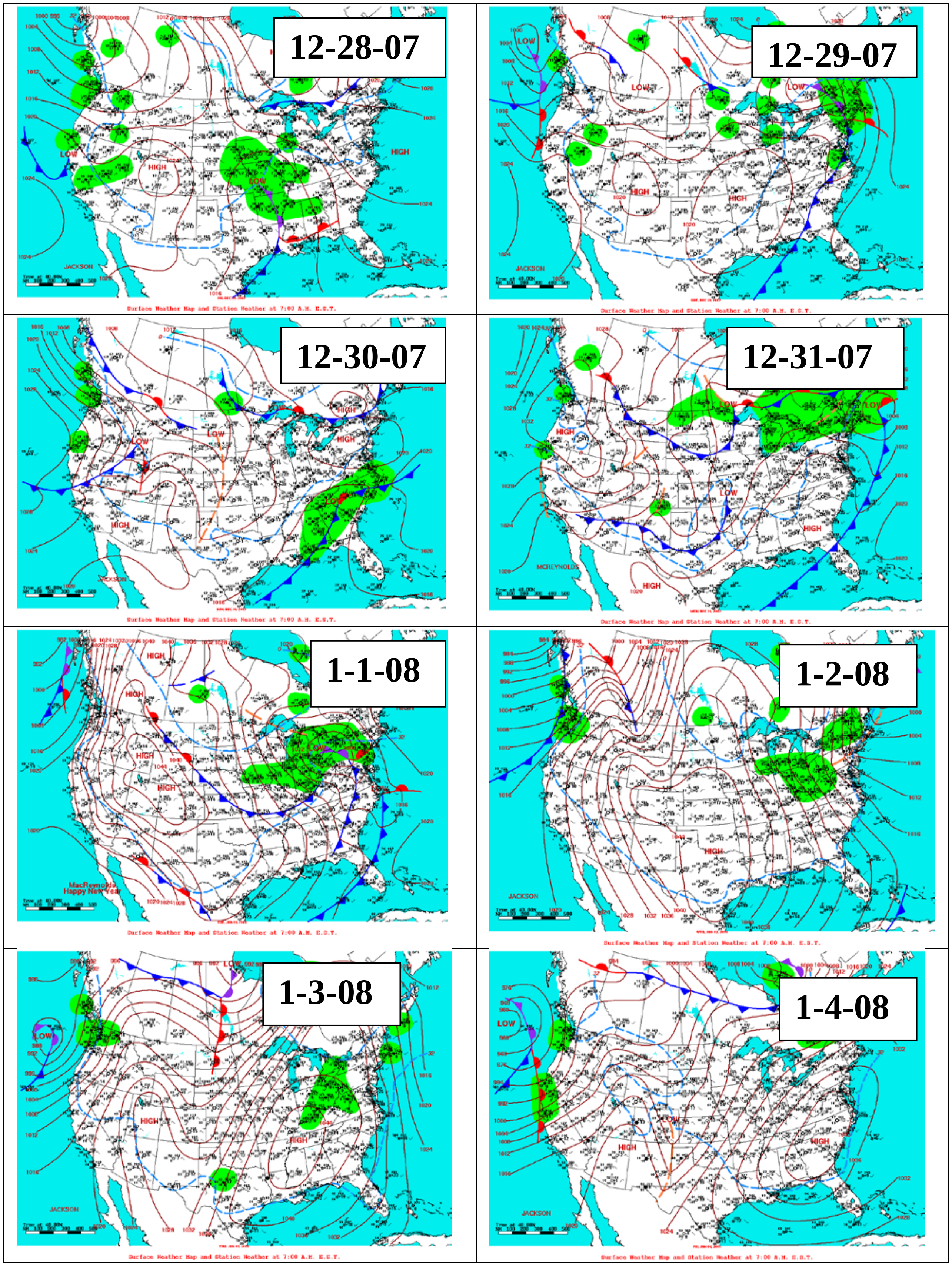
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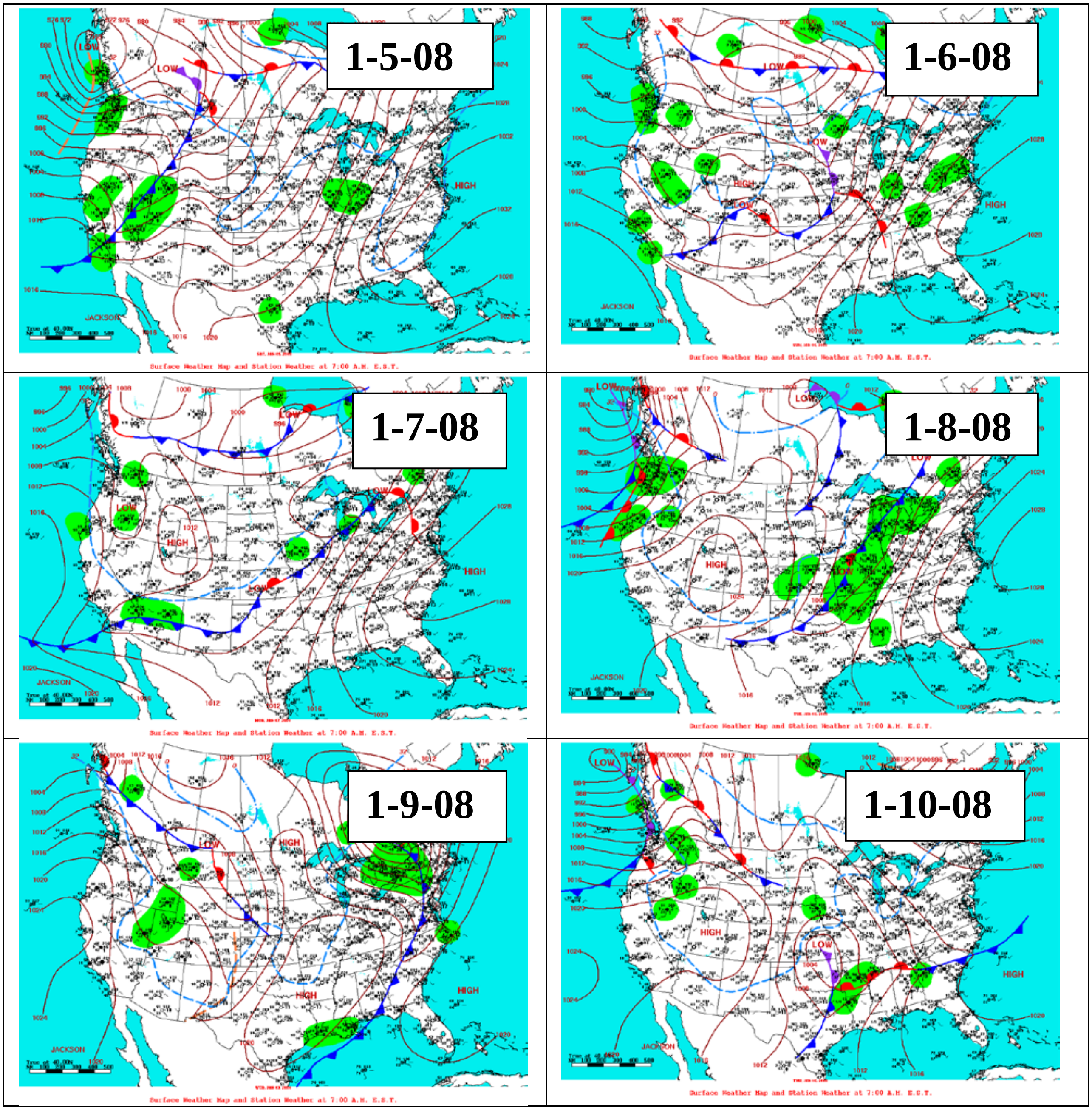
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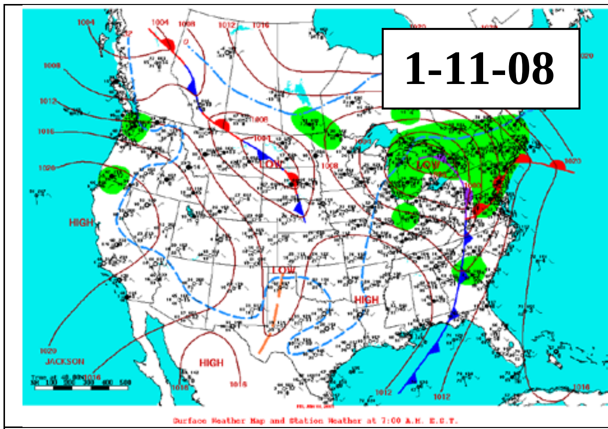

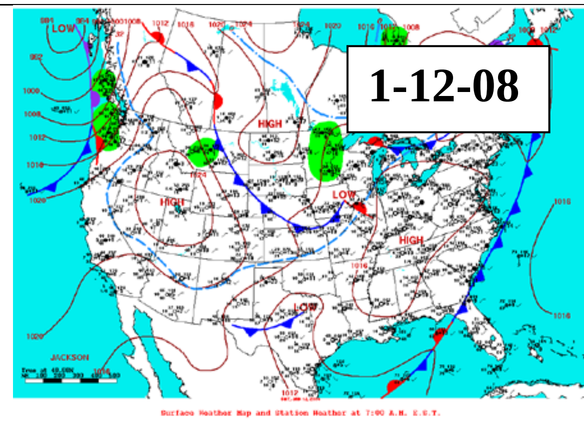

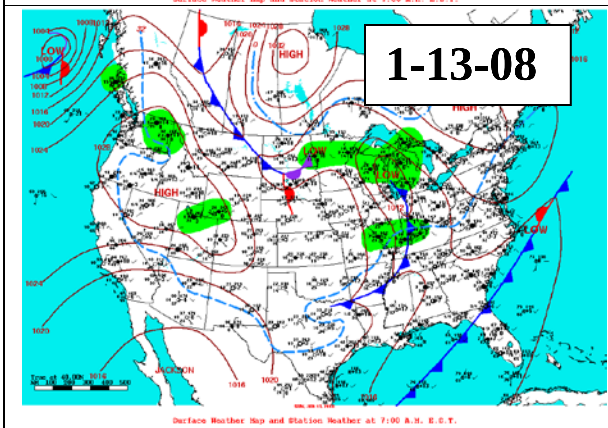

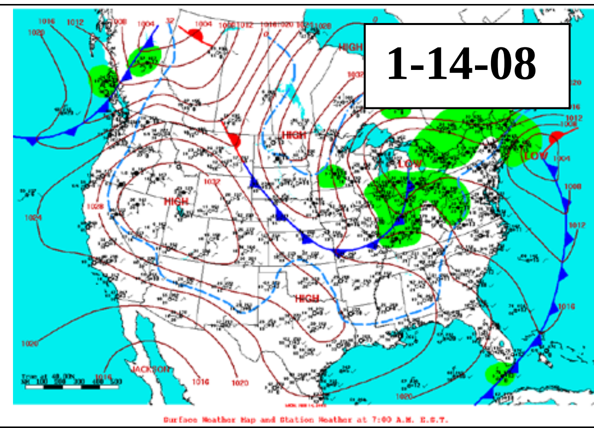

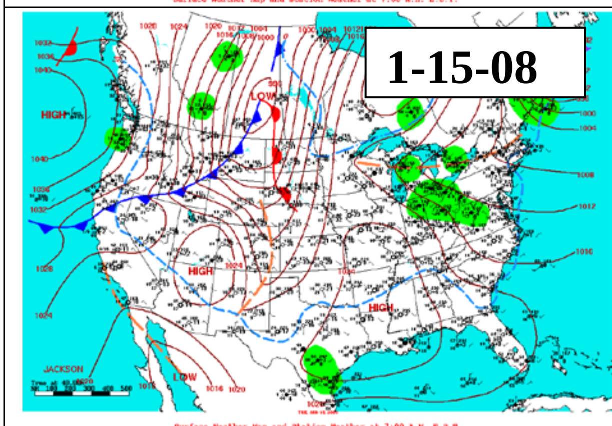

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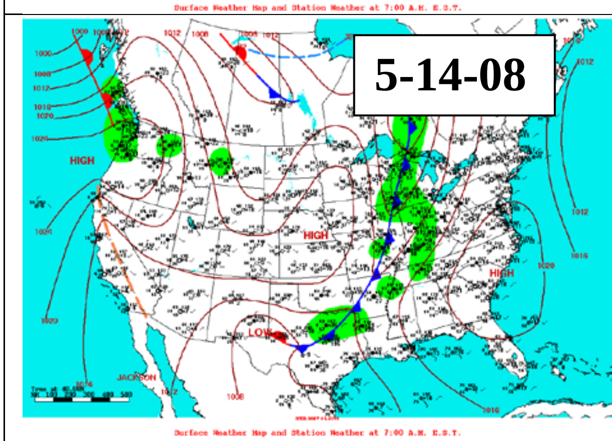

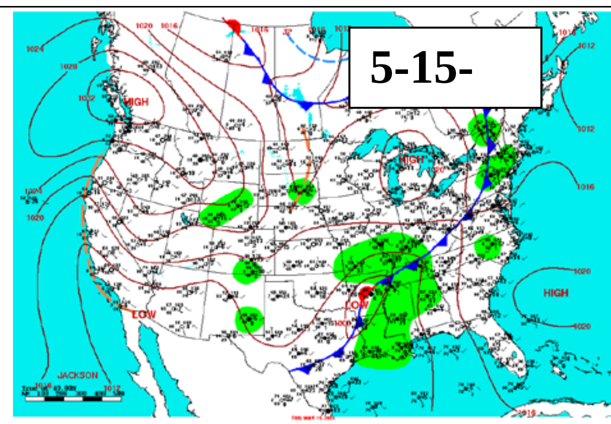

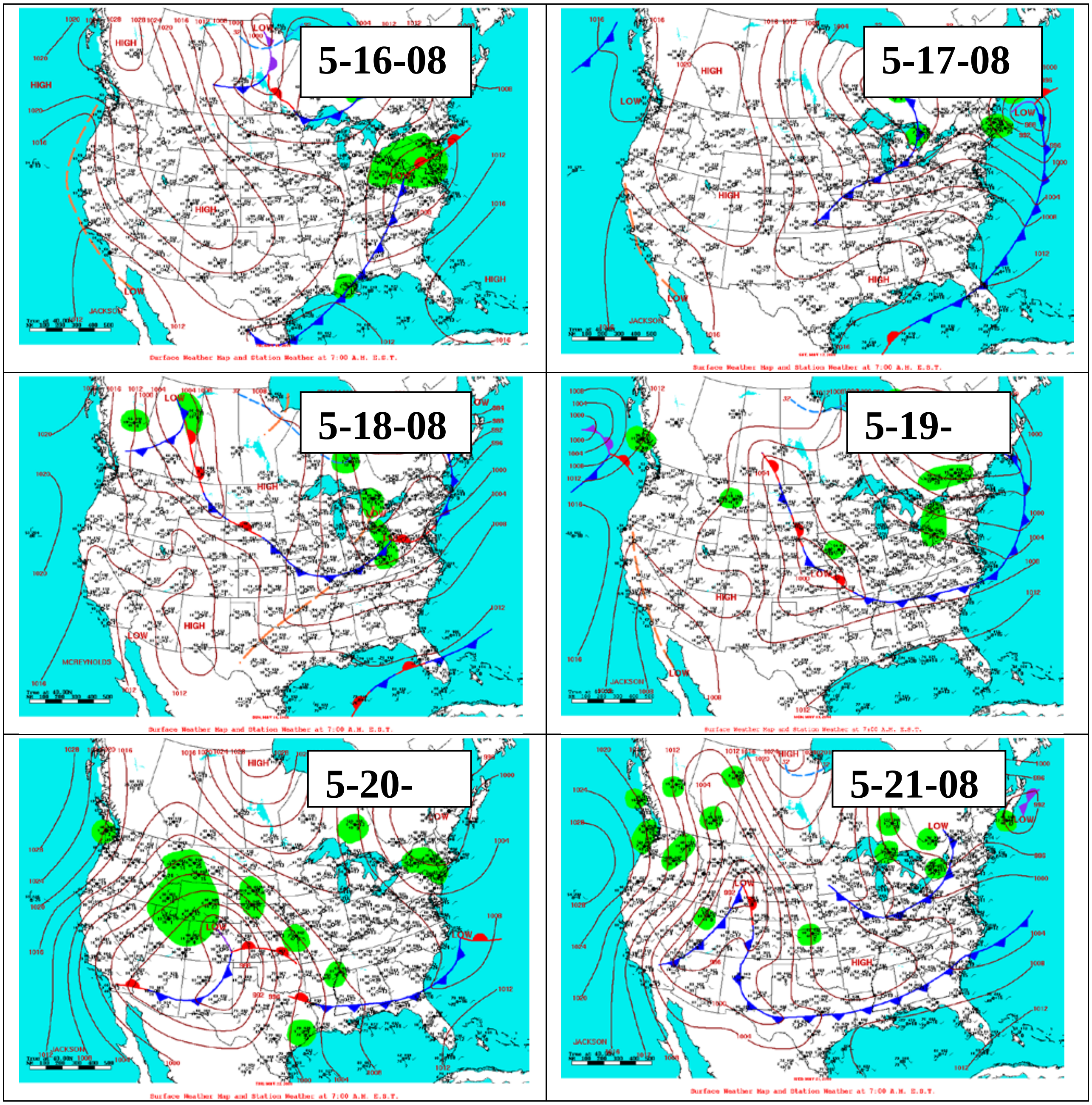

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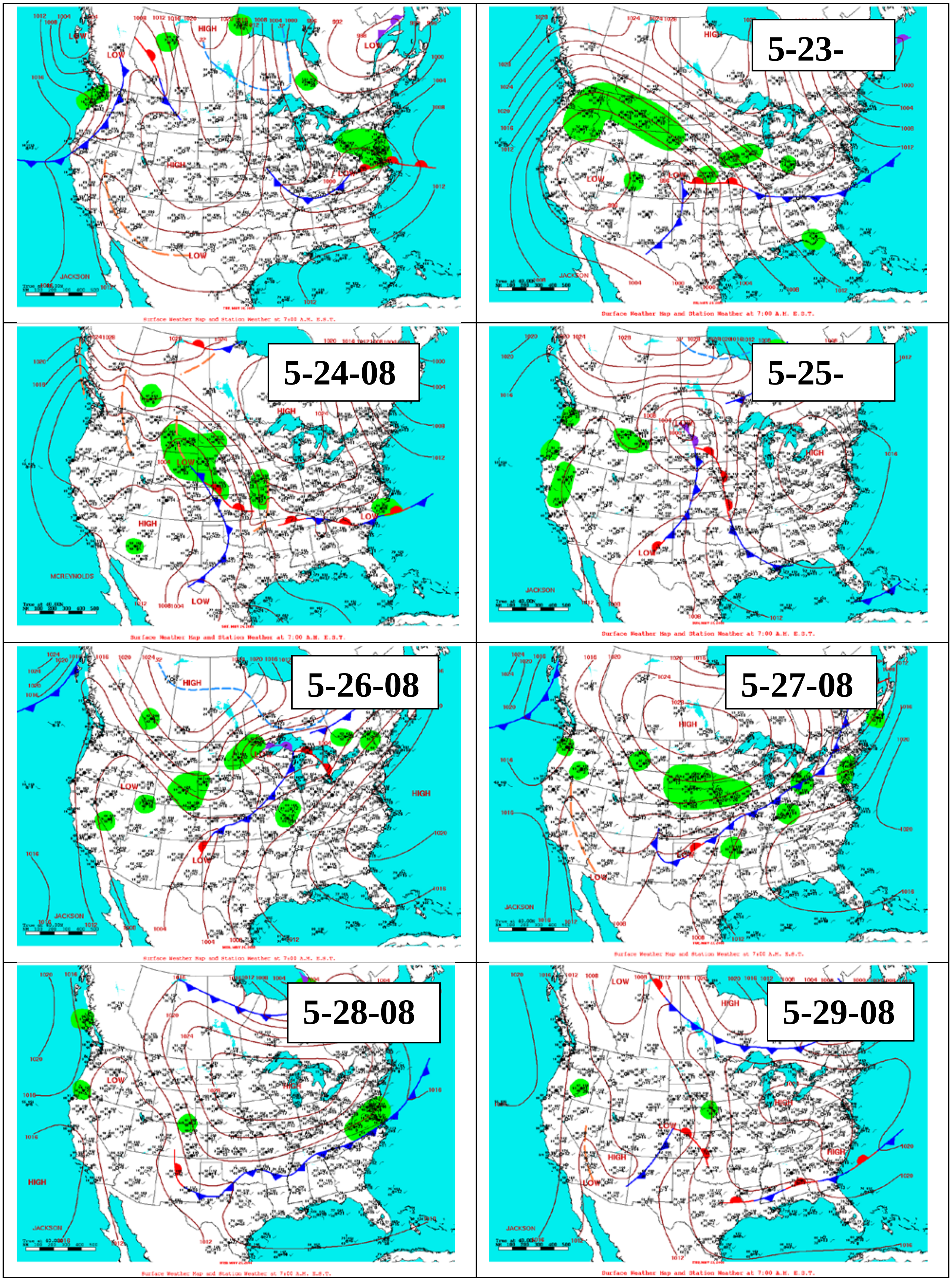
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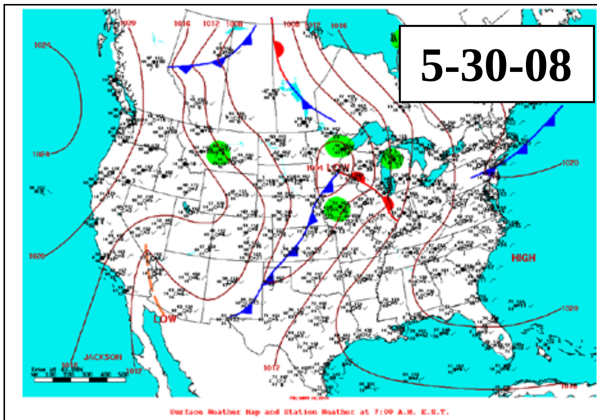
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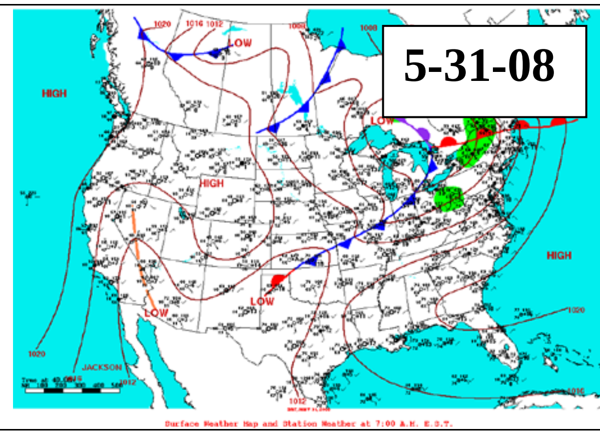
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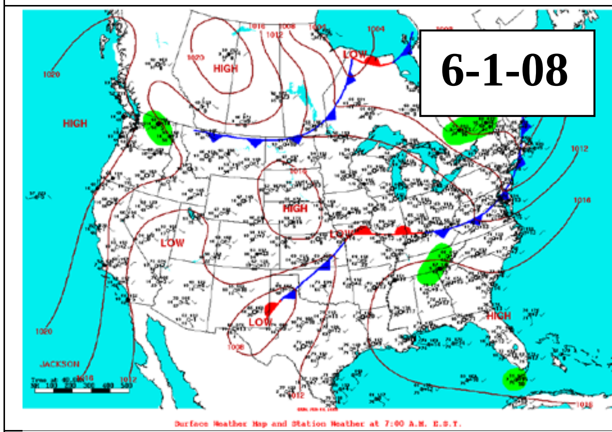
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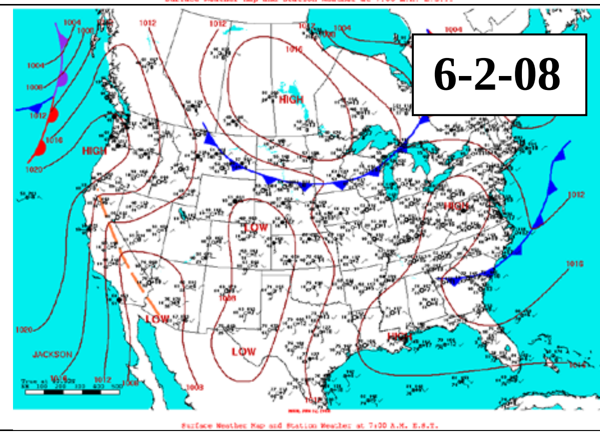
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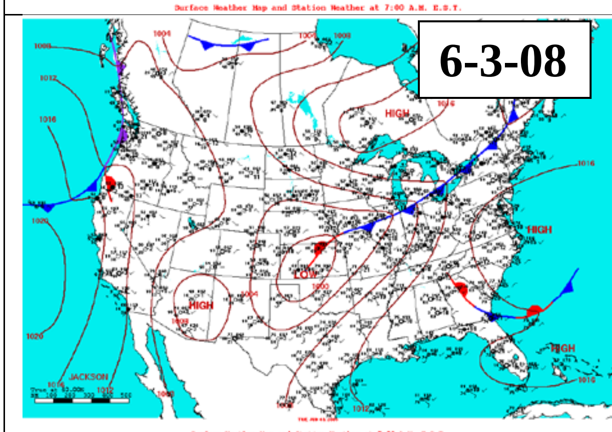
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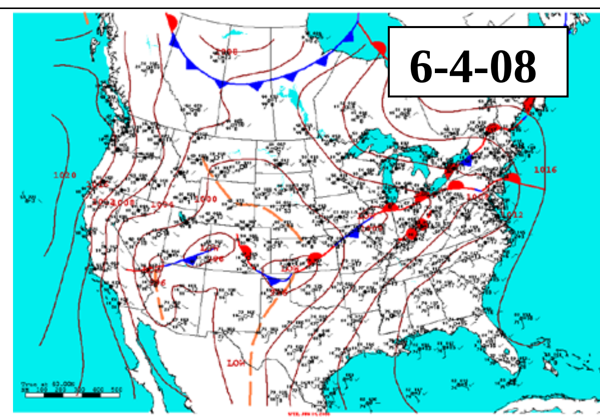
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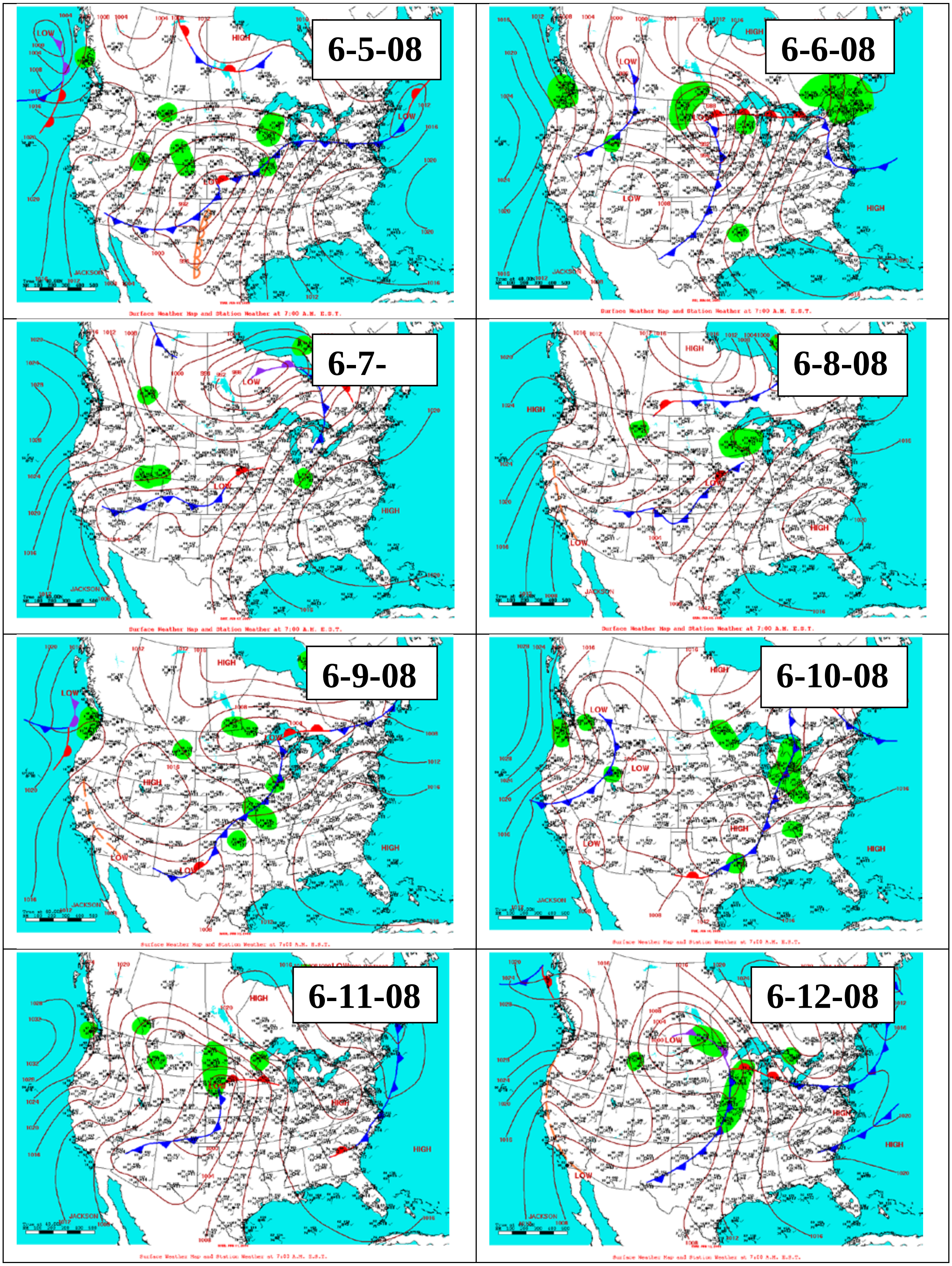
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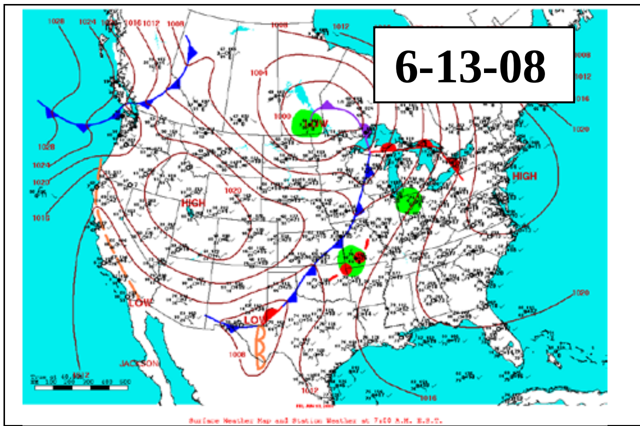
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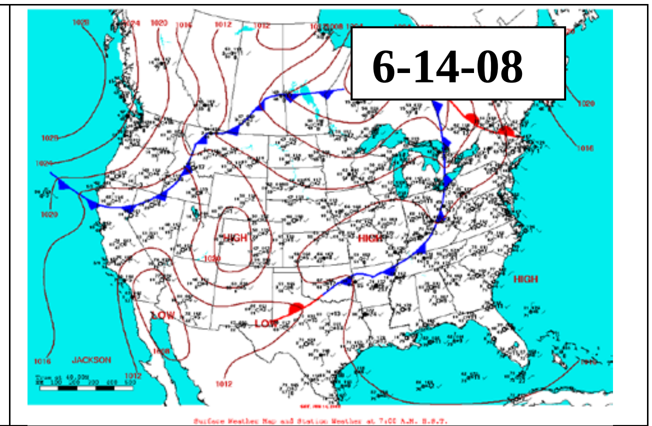
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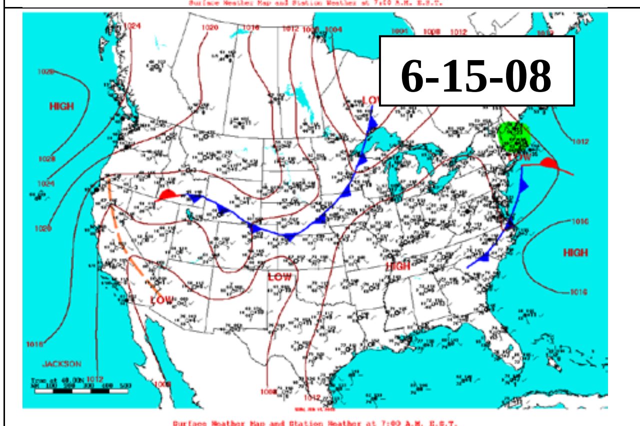
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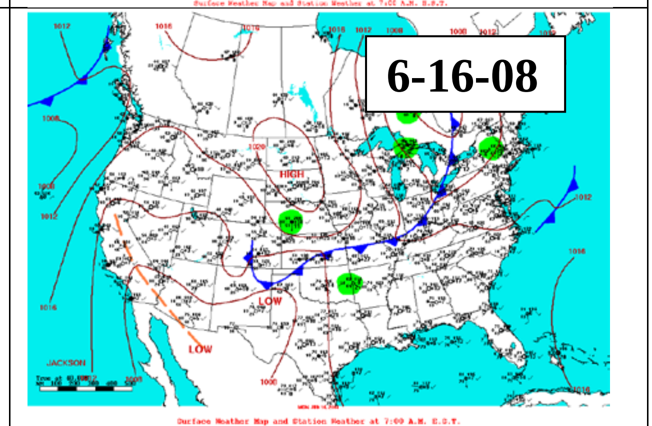
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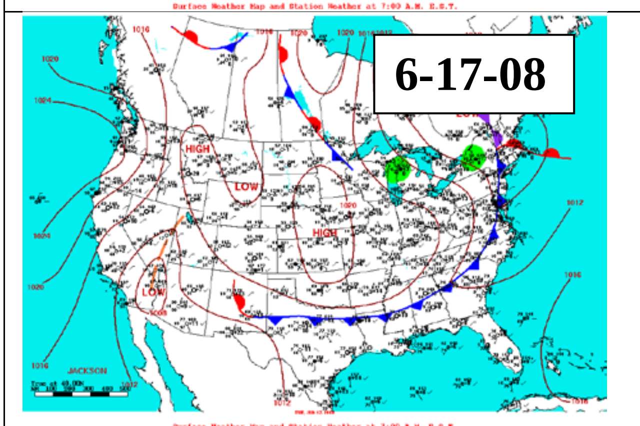
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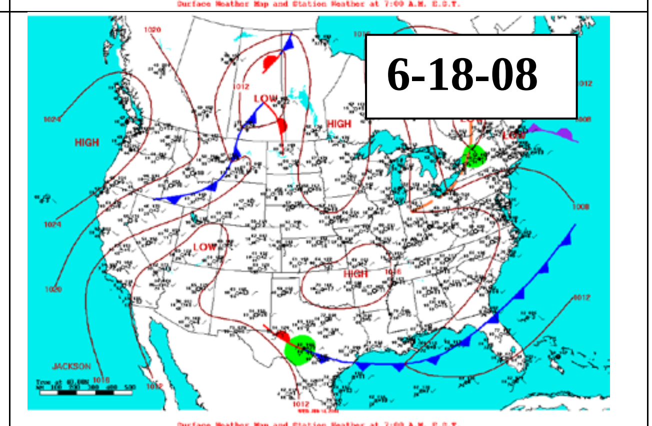
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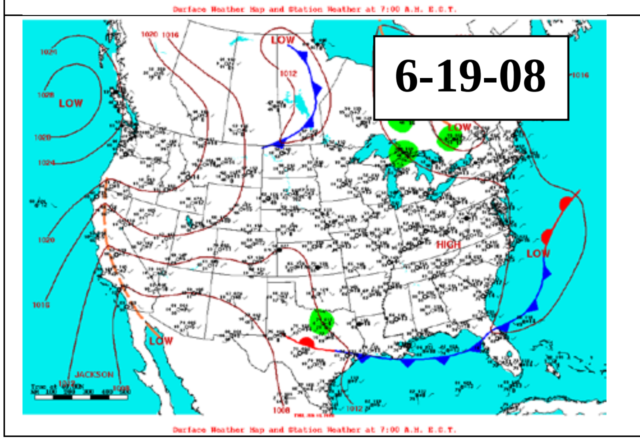
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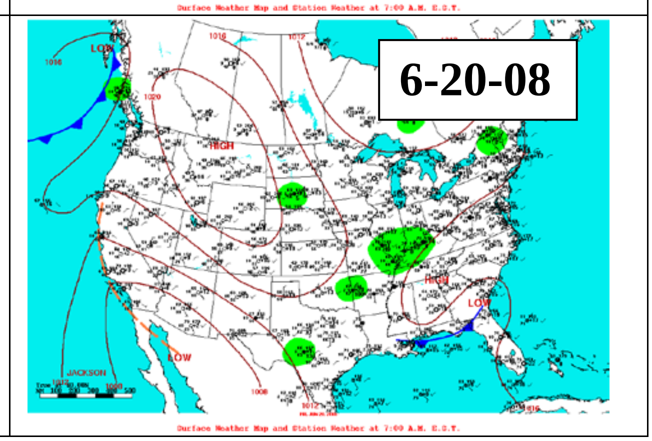
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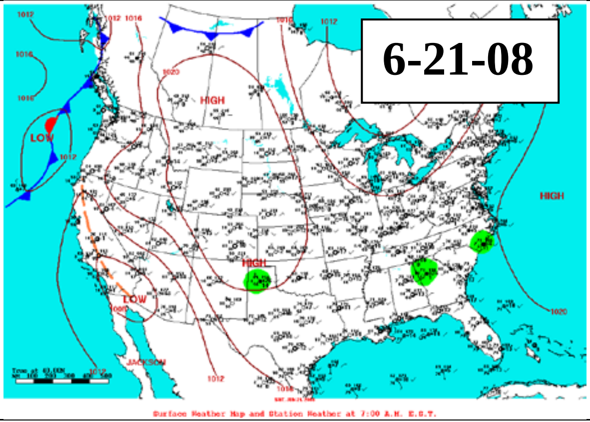
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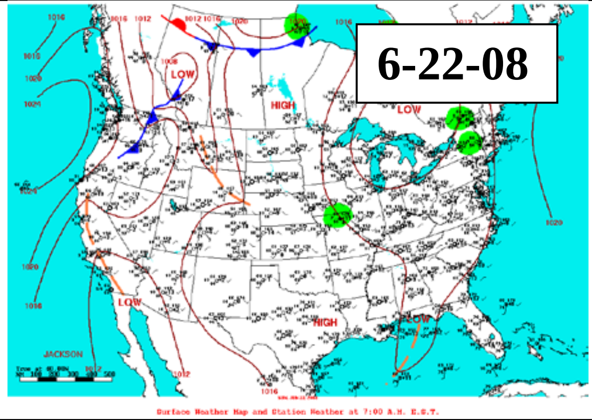
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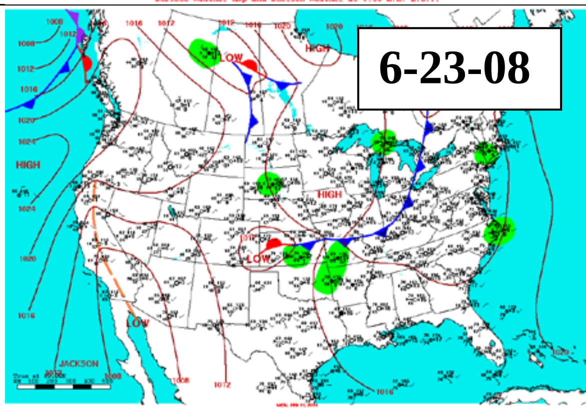
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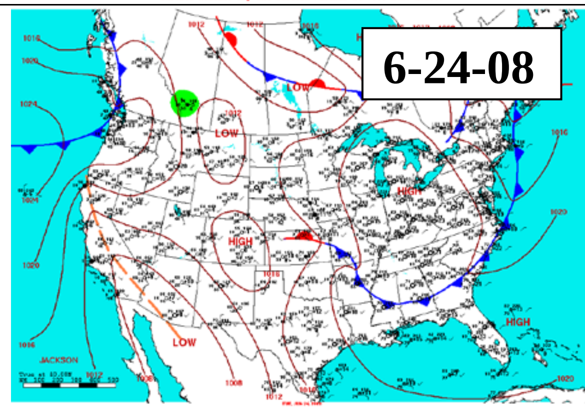
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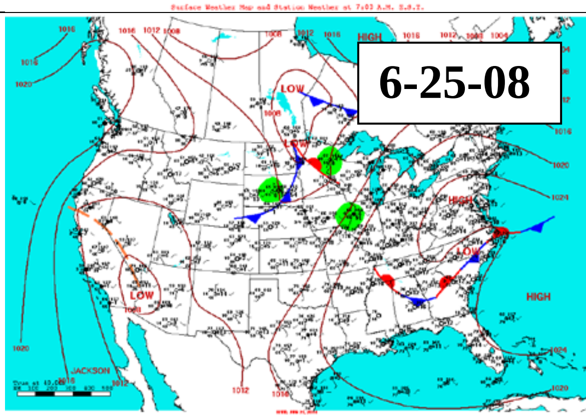
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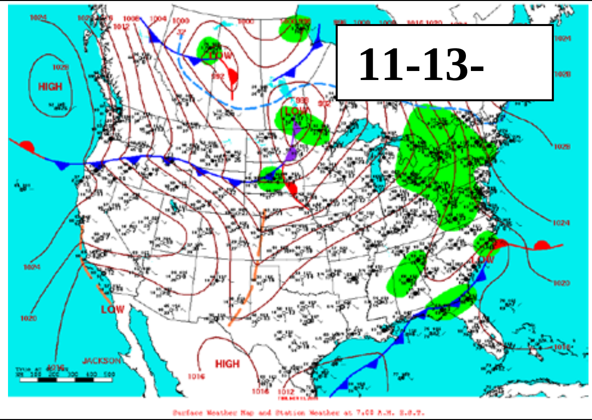

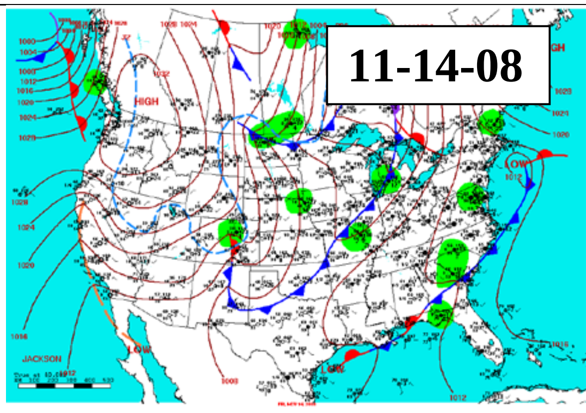

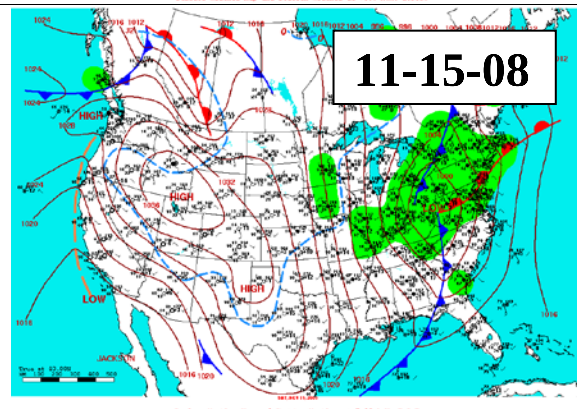

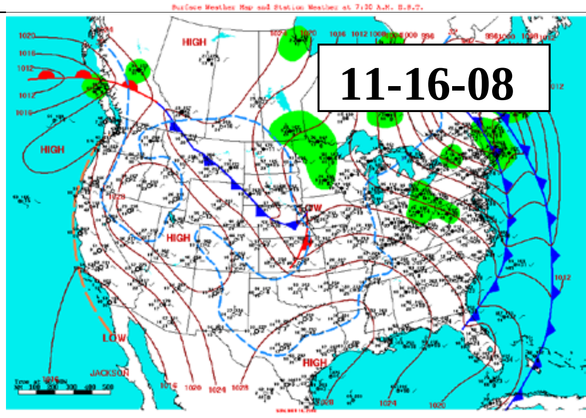

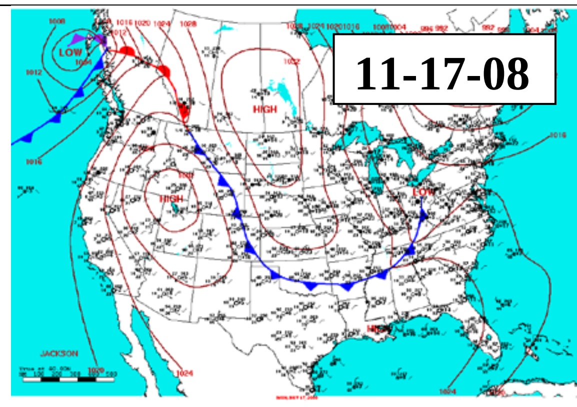

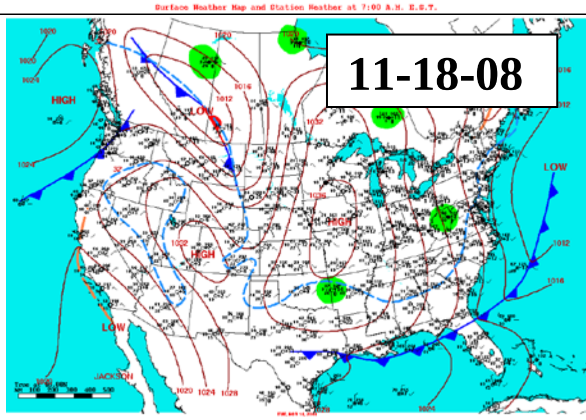

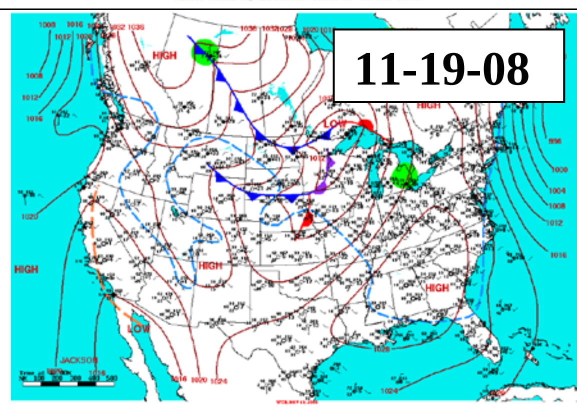

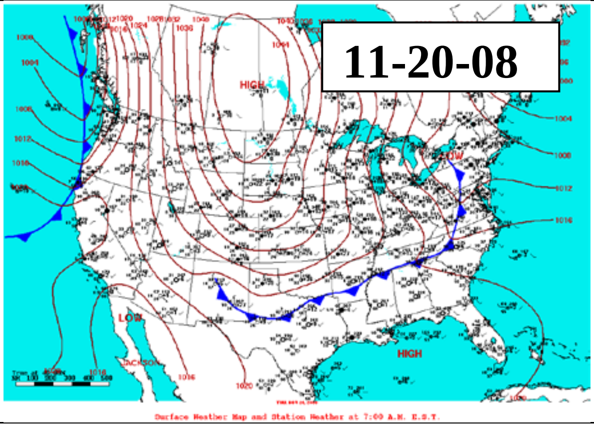
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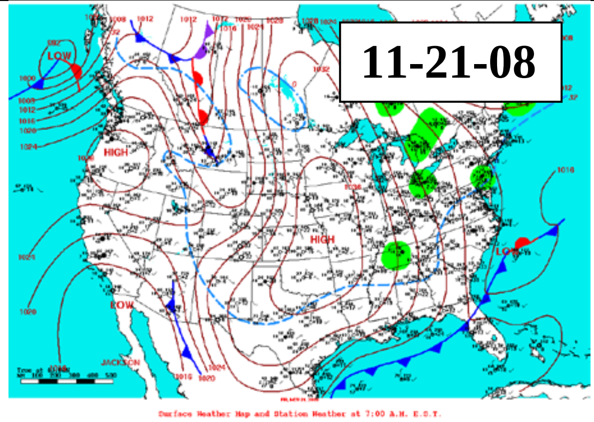
Surface Weather Map and Station Weather at 7:00 A.M. E.S.T.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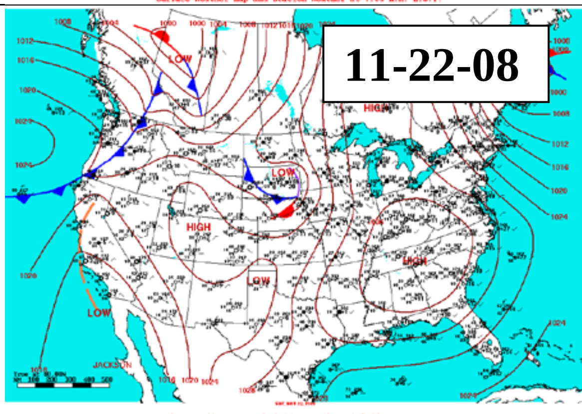
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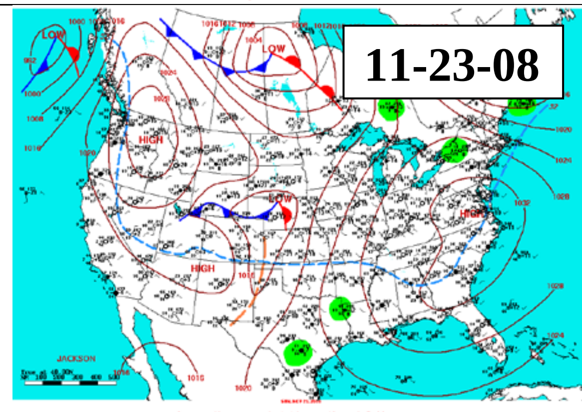
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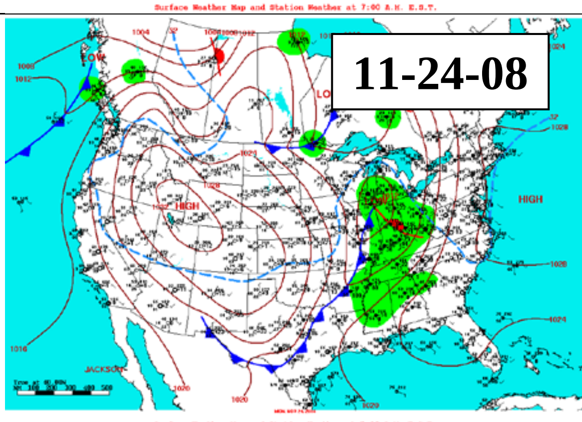
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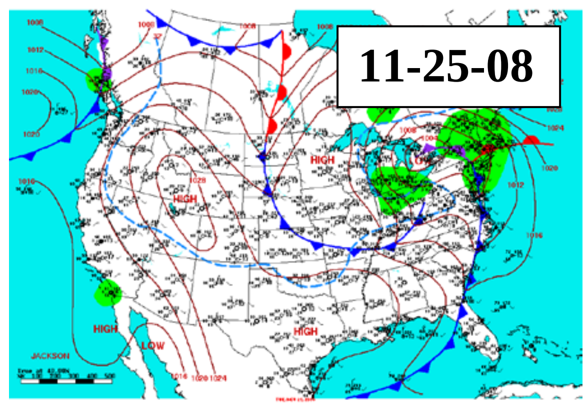
Period 7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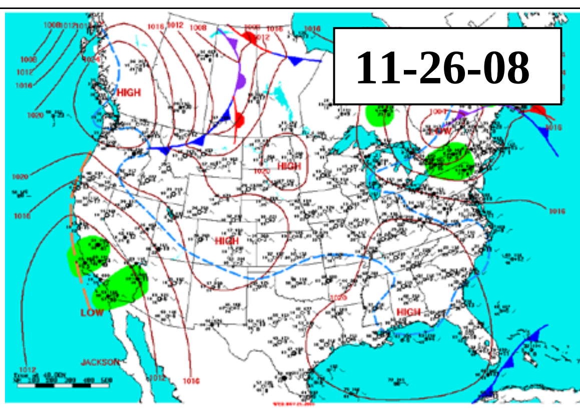
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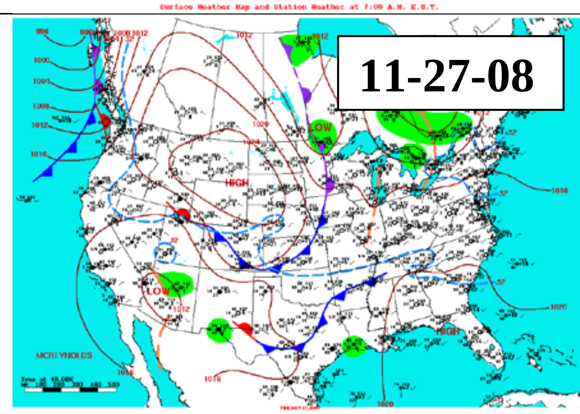
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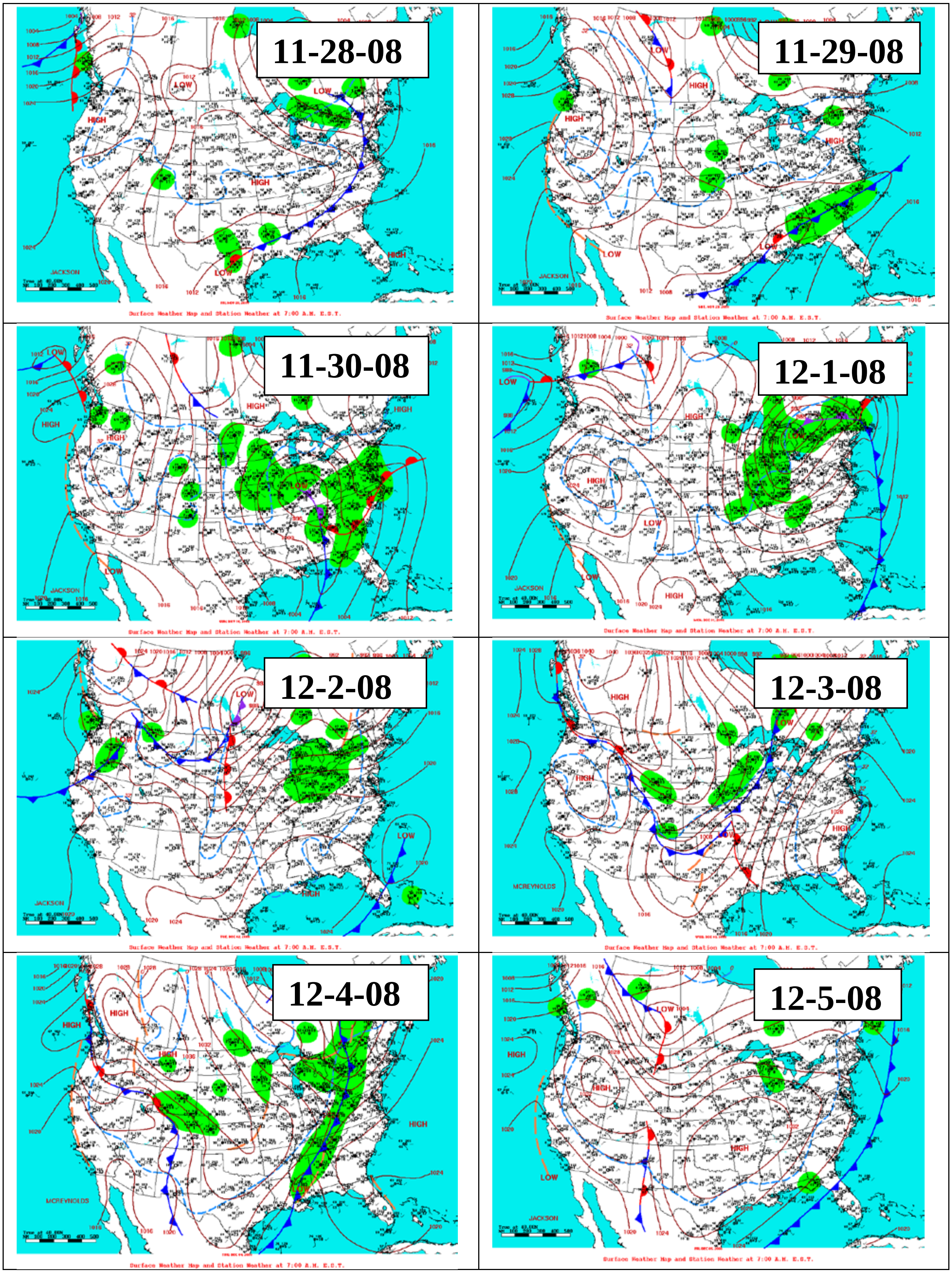
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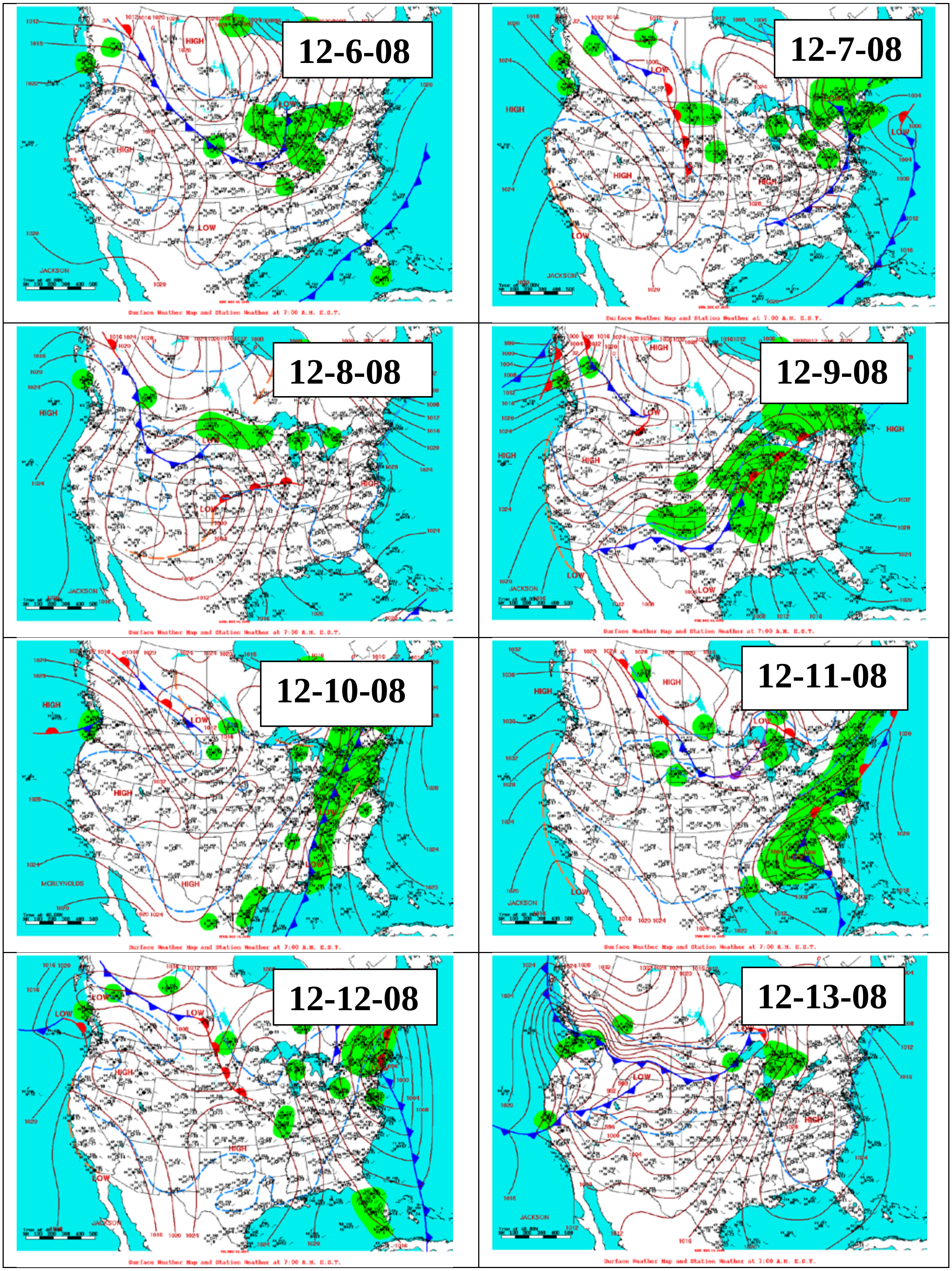
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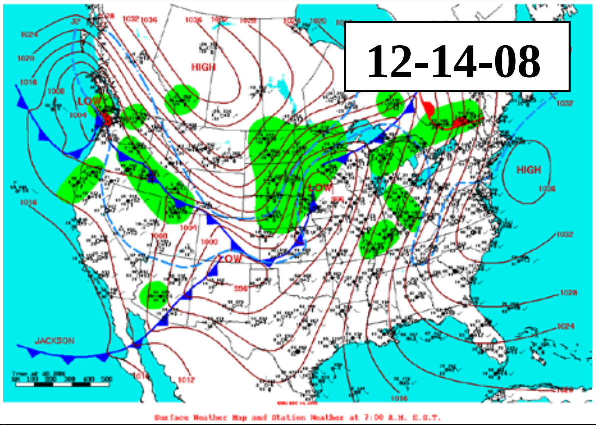

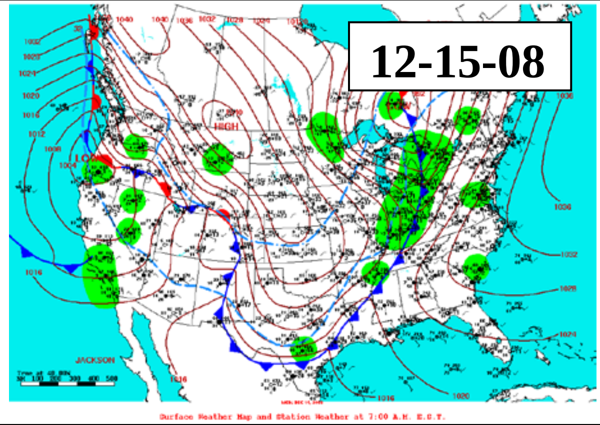

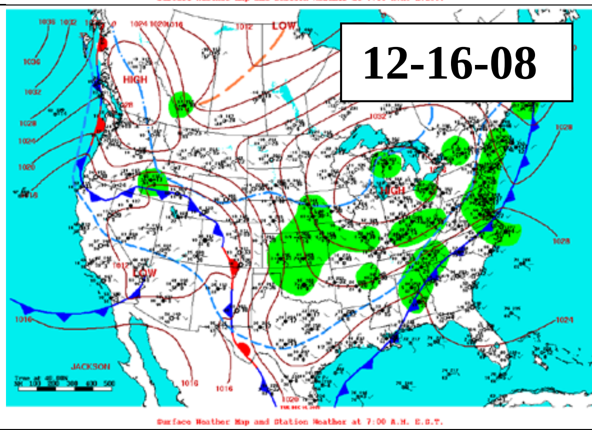

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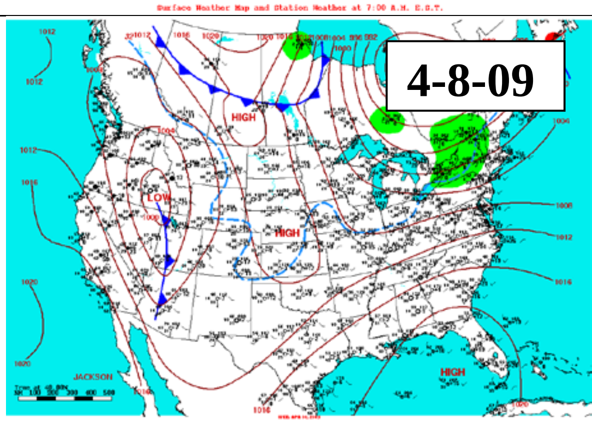

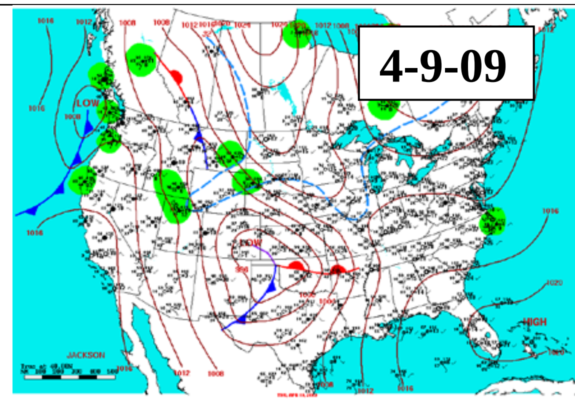

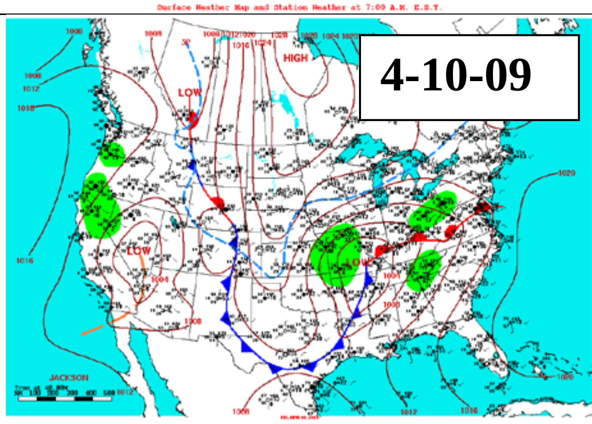

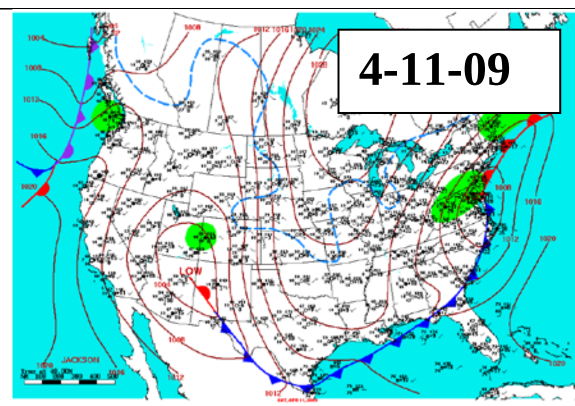

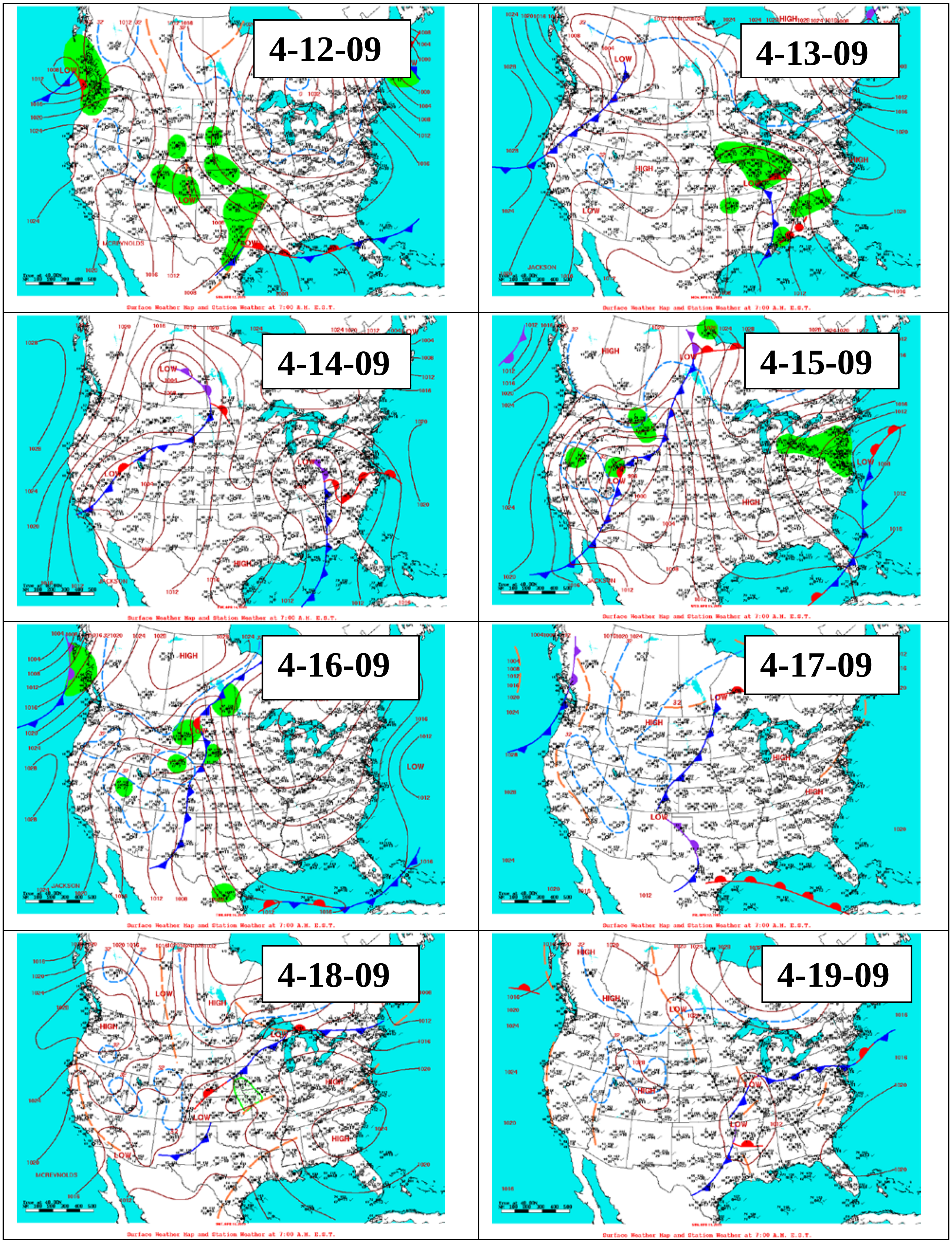
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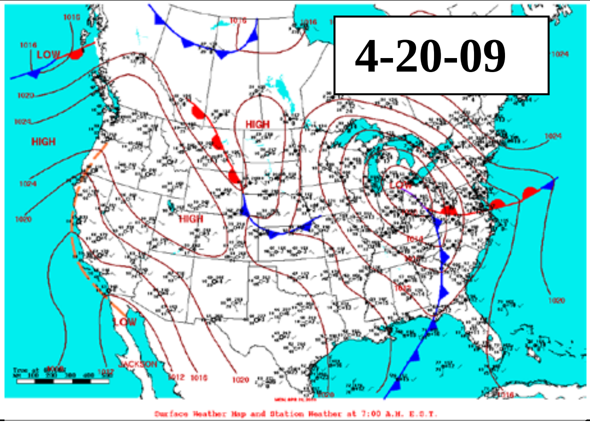
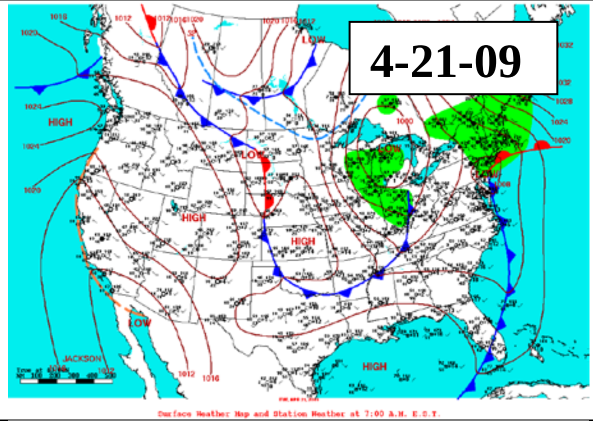
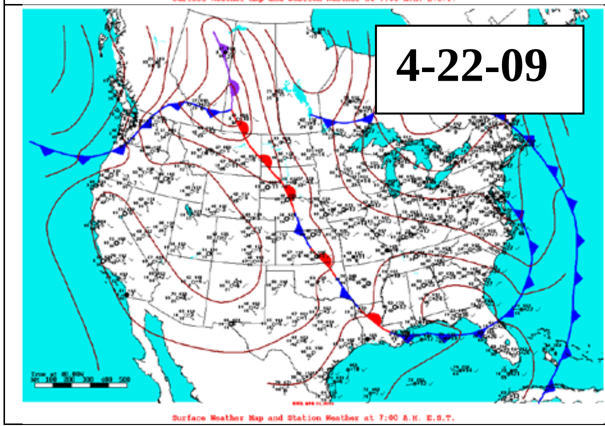
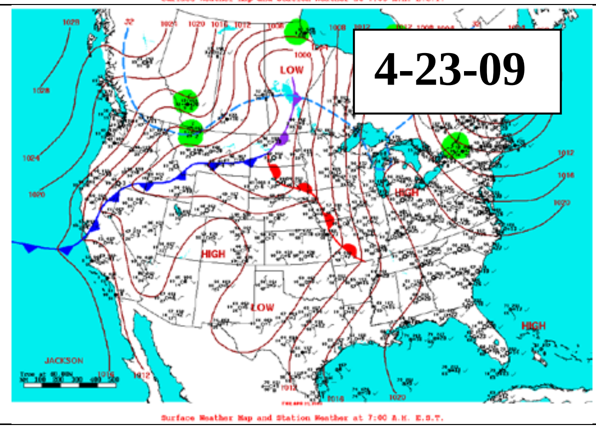
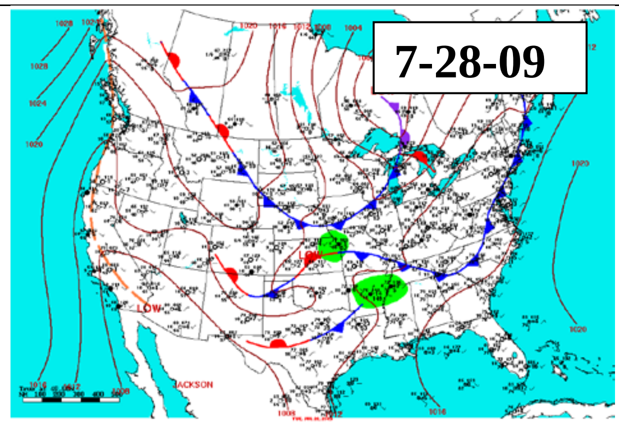


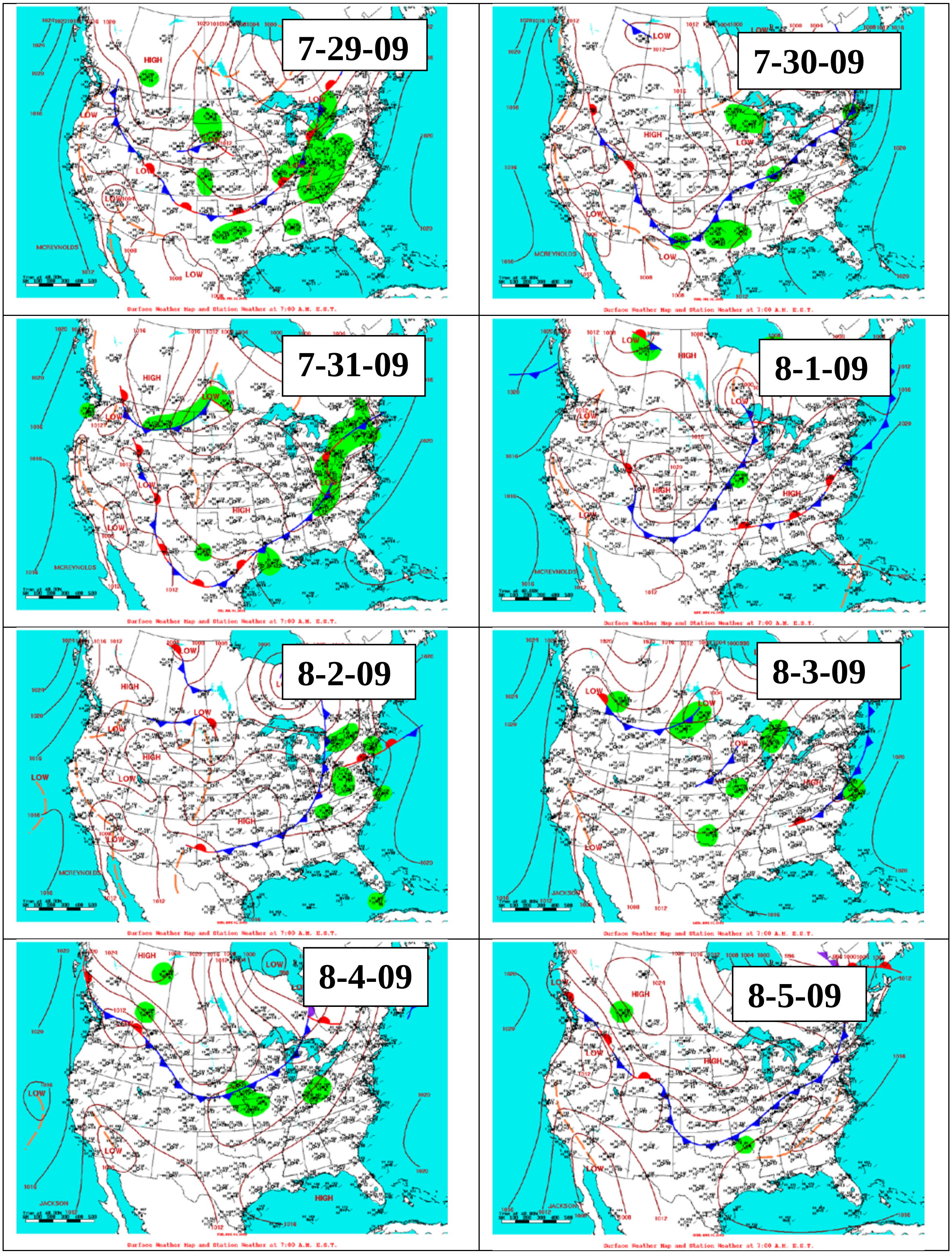






Period 9

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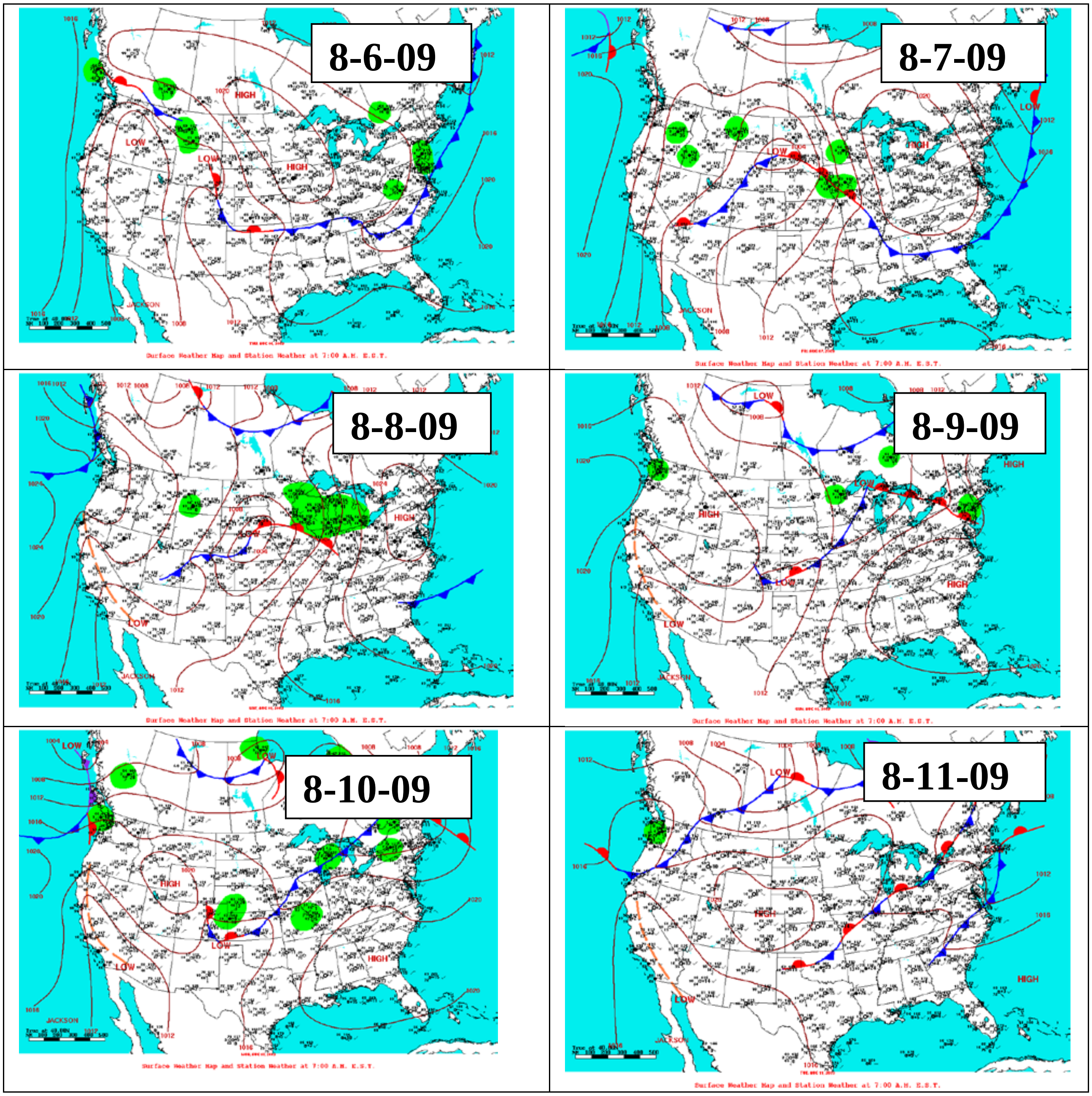
8-2-09
8-3-09
8-4-09
8-5-09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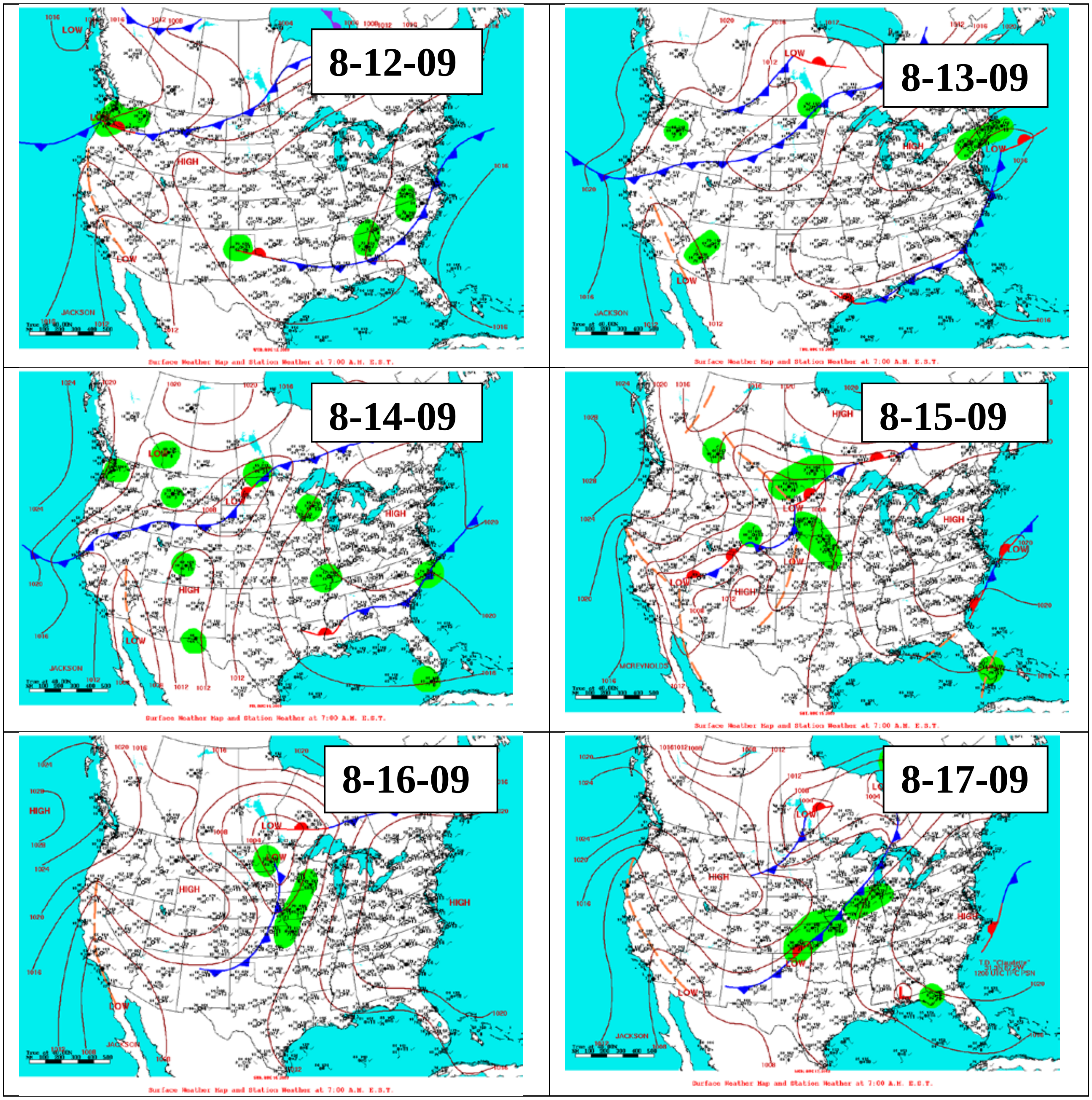
8-11-09


8-12-09
8-13-09
8-14-09
8-15-09
8-16-09
8-17-09

6.8 Daily weather conditions

Date	Barometric pressure (kPa)	Max solar radiation (Wm^{-2})	Wetness (%)	Avg. air temperature (°C)
Period 2				
8/30/2007	98.25	437	N/A	24.6
8/31/2007	98.27	809	N/A	18.9
9/1/2007	98.20	817	N/A	19.5
9/2/2007	97.99	798	N/A	20.3
9/3/2007	97.95	799	N/A	22.9
9/4/2007	97.57	789	N/A	22.8
9/5/2007	97.23	808	N/A	23.4
9/6/2007	97.03	796	N/A	22.9
9/7/2007	97.02	869	N/A	22.3
9/8/2007	97.73	764	N/A	18.4
9/9/2007	97.99	725	N/A	17.8
9/10/2007	98.23	565	N/A	13.5
9/11/2007	97.83	797	N/A	13.8
9/12/2007	98.00	755	N/A	11.2
9/13/2007	97.40	794	N/A	17.2
9/14/2007	98.10	892	N/A	10.7
9/15/2007	98.62	692	N/A	7.0
9/16/2007	97.88	797	N/A	14.0
9/17/2007	97.22	743	N/A	22.5
9/18/2007	97.20	351	N/A	22.6
9/19/2007	97.94	739	N/A	18.2
9/20/2007	97.90	712	N/A	19.3
9/21/2007	97.03	752	N/A	24.3
9/22/2007	97.89	770	N/A	16.0
9/23/2007	97.75	741	N/A	18.5
9/24/2007	97.21	817	N/A	23.8
9/25/2007	97.56	707	N/A	16.9
9/26/2007	97.94	733	N/A	10.9
Period 3				
12/19/2007	97.44	92	N/A	-0.7
12/20/2007	97.04	417	N/A	-3.3
12/21/2007	96.89	219	N/A	-2.3
12/22/2007	97.01	152	N/A	-2.1
12/23/2007	97.03	440	N/A	-10.6
12/24/2007	97.61	226	N/A	-5.7
12/25/2007	97.41	463	N/A	-2.3

Date	Barometric pressure (kPa)	Max solar radiation (Wm^{-2})	Wetness (%)	Avg. air temperature (°C)
12/26/2007	97.48	412	N/A	-3.5
12/27/2007	97.79	175	N/A	-6.9
12/28/2007	97.58	368	N/A	-4.8
12/29/2007	97.47	439	N/A	-6.6
12/30/2007	97.05	523	N/A	-9.1
12/31/2007	97.06	452	N/A	-11.3
1/1/2008	98.71	450	N/A	-12.9
1/2/2008	99.88	446	N/A	-14.8
1/3/2008	98.96	454	N/A	-9.1
1/4/2008	97.52	650	N/A	-2.7
1/5/2008	96.61	439	N/A	-0.7
1/6/2008	96.25	338	N/A	1.2
1/7/2008	96.63	479	N/A	0.4
1/8/2008	96.93	314	N/A	-0.1
1/9/2008	97.57	273	N/A	-2.4
1/10/2008	96.76	174	N/A	-1.1
1/11/2008	96.73	456	N/A	-3.5
1/12/2008	97.23	169	N/A	-3.5
1/13/2008	97.88	588	N/A	-7.2
1/14/2008	98.32	476	N/A	-8.7
1/15/2008	98.24	198	N/A	-14.6
Period 4				
5/16/2008	97.43	1124	0	17.1
5/17/2008	96.73	1088	0	20.7
5/18/2008	96.74	1029	0	16.1
5/19/2008	96.35	1014	0	17.6
5/20/2008	96.81	1157	0	14.3
5/21/2008	96.87	1025	0	13.7
5/22/2008	96.88	525	0	14.6
5/23/2008	97.35	396	0	13.2
5/24/2008	97.59	772	1	12.0
5/25/2008	97.02	1000	1	19.9
5/26/2008	96.93	1079	0	19.9
5/27/2008	97.77	488	1	12.9
5/28/2008	98.57	885	0	11.4
5/29/2008	97.82	694	0	14.5
5/30/2008	96.83	1104	1	19.8
5/31/2008	97.20	1017	0	20.5

Date	Barometric pressure (kPa)	Max solar radiation (Wm^{-2})	Wetness (%)	Avg. air temperature (°C)
Period 5				
6/1/2008	97.45	1055	0	21.6
6/2/2008	97.27	1167	0	21.8
6/3/2008	96.40	723	1	19.6
6/4/2008	96.20	460	1	17.7
6/5/2008	95.98	787	1	21.5
6/6/2008	95.96	1085	0	20.3
6/7/2008	96.63	1008	0	24.3
6/8/2008	96.46	777	1	22.2
6/9/2008	96.94	1029	0	20.0
6/10/2008	97.11	981	0	20.5
6/11/2008	96.75	908	0	21.9
6/12/2008	96.63	1121	0	20.4
6/13/2008	97.30	1086	0	20.2
6/14/2008	97.37	1150	0	22.0
6/15/2008	97.18	1089	0	23.4
6/16/2008	97.69	1015	0	19.1
6/17/2008	97.97	1017	0	19.0
6/18/2008	97.58	1173	0	22.3
6/19/2008	97.37	1083	1	21.8
6/20/2008	97.53	1095	1	21.6
6/21/2008	97.85	1111	0	22.8
6/22/2008	97.69	1017	0	21.0
6/23/2008	97.75	1194	0	20.8
6/24/2008	N/A	273	N/A	19.3
Period 6				
11/14/2008	97.15	158	0	5.6
11/15/2008	97.90	577	0	0.2
11/16/2008	97.67	419	0	0.4
11/17/2008	98.72	573	0	-0.5
11/18/2008	99.14	429	0	-4.7
11/19/2008	97.65	482	0	1.1
11/20/2008	99.02	459	0	-2.0
11/21/2008	99.40	420	0	-9.5
11/22/2008	98.41	206	0	-3.3
11/23/2008	97.85	640	1	-5.2
11/24/2008	97.77	441	1	0.9

Date	Barometric pressure (kPa)	Max solar radiation (Wm^{-2})	Wetness (%)	Avg. air temperature (°C)
11/25/2008	98.12	428	1	-4.5
11/26/2008	97.65	427	1	-1.4
11/27/2008	97.73	455	1	-0.9
11/28/2008	97.71	437	0	0.1
11/29/2008	97.02	124	0	-1.4
11/30/2008	96.24	294	1	-1.7
Period 7				
12/1/2008	96.92	482	1	-5.1
12/2/2008	96.92	417	0	-4.8
12/3/2008	97.35	421	0	-3.0
12/4/2008	98.72	548	0	-8.3
12/5/2008	98.52	461	0	-8.1
12/6/2008	97.28	443	0	-2.5
12/7/2008	98.03	447	0	-9.2
12/8/2008	96.82	140	0	-4.2
12/9/2008	97.18	177	1	-5.3
12/10/2008	98.38	307	1	-10.6
12/11/2008	97.82	502	1	-2.9
12/12/2008	97.98	392	1	-3.4
12/13/2008	96.40	381	0	2.3
12/14/2008	95.85	163	1	-2.8
12/15/2008	98.68	382	0	-19.1
12/16/2008	99.21	158	0	-18.8
Period 8				
4/8/2009	96.92	833	0	13.2
4/9/2009	97.07	624	1	3.9
4/10/2009	97.45	887	0	6.9
4/11/2009	98.31	883	0	6.3
4/12/2009	98.15	874	0	7.1
4/13/2009	97.31	432	0	6.6
4/14/2009	97.43	887	0	6.9
4/15/2009	97.97	944	0	9.9
4/16/2009	98.41	900	0	12.3
4/17/2009	98.46	881	0	12.4
4/18/2009	97.77	549	0	13.2
4/19/2009	97.54	851	1	10.7
4/20/2009	97.34	685	0	7.0
4/21/2009	97.28	1073	0	7.6

Date	Barometric pressure (kPa)	Max solar radiation (Wm^{-2})	Wetness (%)	Avg. air temperature (°C)
4/22/2009	97.19	894	0	12.9
4/23/2009	96.88	955	0	16.1
Period 9				
7/28/2009	97.28	935	0	23.7
7/29/2009	97.30	886	0	18.0
7/30/2009	97.29	1062	1	18.0
7/31/2009	97.53	982	0	18.2
8/1/2009	97.38	1049	0	19.2
8/2/2009	97.33	891	0	19.2
8/3/2009	96.93	882	1	23.6
8/4/2009	97.29	928	1	22.1
8/5/2009	97.96	996	1	17.8
8/6/2009	98.02	907	1	19.2
8/7/2009	97.36	892	1	22.6
8/8/2009	96.86	854	0	27.8
8/9/2009	97.23	949	1	24.1
8/10/2009	97.59	875	1	22.1
8/11/2009	97.89	862	1	21.6
8/12/2009	97.83	850	1	23.5
8/13/2009	97.63	810	1	24.2
8/14/2009	97.66	702	1	23.7
8/15/2009	97.35	820	1	21.7
8/16/2009	97.14	857	1	22.1
8/17/2009	97.63	835	1	19.1
8/18/2009	97.80	548	1	15.7

6.9 Daily Site emissions and data completeness

6.9.1 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 ($\mu gm^{-2}s^{-1}$): 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	Missing downwind NH_3	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 2										
8/31/2007	0	0	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9/1/2007	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9/2/2007	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9/3/2007	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9/4/2007	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9/5/2007	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9/6/2007	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9/7/2007	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9/8/2007	0	6	42	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9/9/2007	20	4	24	605.0	183.6	309.1	872.7	115.0	29.9	221.8
9/10/2007	25	8	14	260.9	53.7	181.8	363.6	49.6	12.9	95.7
9/11/2007	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9/12/2007	0	2	39	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9/13/2007	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Date	Valid	Direction limited	Missing downwind NH_3	Emission average ($\mu gm^{-2}s^{-1}$)	Emission SD ($\mu gm^{-2}s^{-1}$)	Emission minimum ($\mu gm^{-2}s^{-1}$)	Emission maximum ($\mu gm^{-2}s^{-1}$)	Emission average (kgd^{-1})	Emission average ($gd^{-1}hd^{-1}$)	Emission average ($gd^{-1}AU^{-1}$)
9/14/2007	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9/15/2007	0	1	45	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9/16/2007	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9/17/2007	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9/18/2007	10	1	37	477.7	93.0	359.1	704.5	90.8	23.6	175.2
9/19/2007	3	2	39	489.4	41.2	445.5	527.3	93.0	24.2	179.4
9/20/2007	1	0	46	4.5	N/A	4.5	4.5	0.9	0.2	1.7
9/21/2007	1	0	47	272.7	N/A	272.7	272.7	51.8	13.5	100.0
9/22/2007	10	0	36	119.5	62.4	45.5	254.5	22.7	5.9	43.8
9/23/2007	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9/24/2007	0	0	38	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9/25/2007	3	0	42	419.7	97.2	359.1	531.8	79.8	20.8	153.9
9/26/2007	12	0	13	162.5	52.9	77.3	250.0	30.9	8.0	59.6
Period 3										
12/20/2007	0	0	41	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/21/2007	0	0	34	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/22/2007	0	0	44	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/23/2007	0	0	38	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/24/2007	1	0	30	90.9	N/A	90.9	90.9	17.3	4.5	33.3
12/25/2007	1	0	36	209.1	N/A	209.1	209.1	39.7	10.4	76.7
12/26/2007	0	1	46	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/27/2007	0	2	41	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/28/2007	0	0	37	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/29/2007	17	0	16	87.7	27.1	36.4	140.9	16.7	4.3	32.2
12/30/2007	1	0	34	54.5	N/A	54.5	54.5	10.4	2.7	20.0
12/31/2007	3	0	27	63.6	34.3	27.3	95.5	12.1	3.2	23.3
1/1/2008	2	0	32	143.2	80.4	86.4	200.0	27.2	7.1	52.5
1/2/2008	6	0	26	49.2	12.0	36.4	63.6	9.4	2.4	18.1
1/3/2008	19	0	18	104.1	51.5	27.3	200.0	19.8	5.2	38.2
1/4/2008	3	0	33	110.6	37.8	68.2	140.9	21.0	5.5	40.6
1/5/2008	2	0	32	70.5	16.1	59.1	81.8	13.4	3.5	25.8
1/6/2008	0	0	44	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/7/2008	0	0	45	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/8/2008	2	0	41	84.1	3.2	81.8	86.4	16.0	4.2	30.8
1/9/2008	7	0	34	166.2	52.7	81.8	227.3	31.6	8.2	61.0
1/10/2008	0	0	46	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1/11/2008	5	0	31	91.8	67.2	18.2	186.4	17.5	4.5	33.7
1/12/2008	2	0	33	18.2	0.0	18.2	18.2	3.5	0.9	6.7
Period 4										

Date	Valid	Direction limited	Missing downwind NH_3	Emission average ($\mu gm^{-2}s^{-1}$)	Emission SD ($\mu gm^{-2}s^{-1}$)	Emission minimum ($\mu gm^{-2}s^{-1}$)	Emission maximum ($\mu gm^{-2}s^{-1}$)	Emission average (kgd^{-1})	Emission average ($gd^{-1}hd^{-1}$)	Emission average ($gd^{-1}AU^{-1}$)
5/15/2008	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/16/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/17/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/18/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/19/2008	2	0	45	163.6	38.6	136.4	190.9	31.1	8.1	60.0
5/20/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/21/2008	0	3	38	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/22/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/23/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/24/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/25/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/26/2008	10	0	37	534.5	174.3	372.7	927.3	101.6	26.5	196.0
5/27/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/28/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/29/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/30/2008	5	0	41	269.1	123.5	90.9	390.9	51.1	13.3	98.7
5/31/2008	17	0	27	368.2	161.9	181.8	650.0	70.0	18.2	135.0
6/1/2008	18	0	28	550.0	223.7	268.2	1150.0	104.5	27.2	201.7
6/2/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6/3/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6/4/2008	0	0	27	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period 5										
6/5/2008	1	2	42	40.9	N/A	40.9	40.9	7.8	2.0	15.0
6/6/2008	2	0	40	179.5	54.6	140.9	218.2	34.1	8.9	65.8
6/7/2008	6	0	37	151.5	26.0	127.3	190.9	28.8	7.5	55.6
6/8/2008	0	0	20	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6/9/2008	0	0	24	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6/10/2008	9	0	37	199.5	55.1	109.1	272.7	37.9	9.9	73.1
6/11/2008	3	0	45	156.1	41.2	109.1	186.4	29.7	7.7	57.2
6/12/2008	4	6	36	370.5	352.0	22.7	704.5	70.4	18.3	135.8
6/13/2008	0	0	47	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6/14/2008	5	0	40	186.4	30.2	163.6	236.4	35.4	9.2	68.3
6/15/2008	17	0	27	383.7	221.9	127.3	800.0	72.9	19.0	140.7
6/16/2008	26	0	13	424.1	191.7	140.9	859.1	80.6	21.0	155.5
6/17/2008	26	4	15	229.4	111.2	95.5	513.6	43.6	11.4	84.1
6/18/2008	18	1	25	259.6	124.5	90.9	540.9	49.3	12.9	95.2
6/19/2008	2	21	18	522.7	70.7	472.7	572.7	99.4	25.9	191.7
6/20/2008	2	0	42	227.3	90.0	163.6	290.9	43.2	11.3	83.3
6/21/2008	0	2	45	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Date	Valid	Direction limited	Missing downwind NH_3	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 ($gd^{-1}AU^{-1}$)
6/22/2008	10	0	27	316.8	193.8	100.0	622.7	60.2	15.7	116.2
6/23/2008	10	7	16	231.4	100.4	77.3	427.3	44.0	11.5	84.8
Period 6										
11/14/2008	0	0	14	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11/15/2008	3	0	44	118.2	13.6	104.5	131.8	22.5	5.9	43.3
11/16/2008	0	0	48	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11/17/2008	2	0	42	70.5	3.2	68.2	72.7	13.4	3.5	25.8
11/18/2008	7	0	11	37.0	8.1	22.7	45.5	7.0	1.8	13.6
11/19/2008	6	0	10	64.4	33.3	36.4	127.3	12.2	3.2	23.6
11/20/2008	4	0	14	71.6	63.8	9.1	150.0	13.6	3.5	26.3
11/21/2008	3	0	15	97.0	101.7	27.3	213.6	18.4	4.8	35.6
11/22/2008	3	0	27	148.5	29.6	118.2	177.3	28.2	7.4	54.4
11/23/2008	0	0	33	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11/24/2008	12	0	8	86.4	46.4	31.8	181.8	16.4	4.3	31.7
11/25/2008	1	1	2	100.0	N/A	100.0	100.0	19.0	5.0	36.7
Period 7										
11/26/2008	3	1	8	78.8	60.5	9.1	118.2	15.0	3.9	28.9
11/27/2008	4	0	6	72.7	9.8	63.6	86.4	13.8	3.6	26.7
11/28/2008	14	0	1	90.6	36.3	36.4	168.2	17.2	4.5	33.2
11/29/2008	5	4	4	51.8	23.7	31.8	81.8	9.8	2.6	19.0
11/30/2008	0	0	4	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/1/2008	12	0	7	59.1	31.1	27.3	109.1	11.2	2.9	21.7
12/2/2008	2	0	9	118.2	45.0	86.4	150.0	22.5	5.9	43.3
12/3/2008	0	0	22	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/4/2008	29	0	1	80.1	32.5	40.9	190.9	15.2	4.0	29.4
12/5/2008	0	0	13	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/6/2008	7	0	17	83.8	26.7	54.5	131.8	15.9	4.1	30.7
12/7/2008	0	6	19	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/8/2008	0	27	4	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/9/2008	2	2	6	31.8	0.0	31.8	31.8	6.0	1.6	11.7
12/10/2008	0	0	22	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/11/2008	6	0	15	56.8	30.5	18.2	86.4	10.8	2.8	20.8
12/12/2008	4	0	15	70.5	19.1	50.0	90.9	13.4	3.5	25.8
12/13/2008	3	0	15	56.1	2.6	54.5	59.1	10.7	2.8	20.6
12/14/2008	1	6	2	86.4	N/A	86.4	86.4	16.4	4.3	31.7
12/15/2008	0	0	12	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period 8										
4/8/2009	0	0	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/9/2009	9	14	13	141.9	59.1	86.4	245.5	27.0	7.0	52.0

Date	Valid	Direction limited	Missing downwind NH_3	Emission average ($\mu gm^{-2}s^{-1}$)	Emission SD ($\mu gm^{-2}s^{-1}$)	Emission minimum ($\mu gm^{-2}s^{-1}$)	Emission maximum ($\mu gm^{-2}s^{-1}$)	Emission average (kgd^{-1})	Emission average ($gd^{-1}hd^{-1}$)	Emission average ($gd^{-1}AU^{-1}$)
4/10/2009	2	38	4	93.2	16.1	81.8	104.5	17.7	4.6	34.2
4/11/2009	22	17	1	109.7	33.8	36.4	172.7	20.9	5.4	40.2
4/12/2009	0	33	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/13/2009	0	28	9	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/14/2009	11	21	2	161.6	96.7	81.8	331.8	30.7	8.0	59.2
4/15/2009	8	20	1	88.6	54.9	36.4	195.5	16.8	4.4	32.5
4/16/2009	0	39	4	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/17/2009	0	20	3	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/18/2009	7	25	1	130.5	44.2	63.6	177.3	24.8	6.5	47.9
4/19/2009	19	0	6	209.1	47.5	127.3	290.9	39.7	10.4	76.7
4/20/2009	9	0	17	114.6	29.4	81.8	168.2	21.8	5.7	42.0
4/21/2009	2	0	29	159.1	38.6	131.8	186.4	30.2	7.9	58.3
4/22/2009	34	0	4	242.0	164.7	77.3	700.0	46.0	12.0	88.7
Period 9										
7/28/2009	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7/29/2009	41	1	2	201.6	57.1	95.5	345.5	38.3	10.0	73.9
7/30/2009	17	2	18	435.6	225.1	54.5	686.4	82.8	21.6	159.7
7/31/2009	37	0	10	277.9	121.8	100.0	550.0	52.8	13.8	101.9
8/1/2009	41	0	1	275.8	148.4	54.5	609.1	52.4	13.7	101.1
8/2/2009	47	0	1	235.9	134.1	59.1	472.7	44.8	11.7	86.5
8/3/2009	35	1	2	270.4	163.0	50.0	604.5	51.4	13.4	99.1
8/4/2009	15	9	22	353.0	106.9	140.9	563.6	67.1	17.5	129.4
8/5/2009	3	10	19	142.4	21.5	118.2	159.1	27.1	7.1	52.2
8/6/2009	11	14	10	197.5	100.9	68.2	413.6	37.5	9.8	72.4
8/7/2009	8	10	6	348.9	126.5	159.1	495.5	66.3	17.3	127.9
8/8/2009	21	8	0	398.9	138.5	204.5	622.7	75.8	19.7	146.3
8/9/2009	22	9	6	236.8	71.3	77.3	345.5	45.0	11.7	86.8
8/10/2009	23	1	24	433.2	147.8	122.7	704.5	82.3	21.4	158.8
8/11/2009	29	1	11	243.9	93.6	100.0	418.2	46.4	12.1	89.4
8/12/2009	14	4	26	377.3	107.1	209.1	536.4	71.7	18.7	138.3
8/13/2009	23	0	24	525.9	165.0	181.8	831.8	100.0	26.0	192.8
8/14/2009	23	0	25	641.9	216.7	245.5	986.4	122.0	31.8	235.4
8/15/2009	4	1	35	247.7	98.1	145.5	368.2	47.1	12.3	90.8
8/16/2009	27	0	16	487.2	225.7	181.8	972.7	92.6	24.1	178.6
8/17/2009	13	1	26	482.5	133.6	272.7	704.5	91.7	23.9	176.9

6.9.2 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 2												
8/31/2007	0	0	0	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9/1/2007	0	1	15	25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9/2/2007	0	0	1	26	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9/3/2007	0	0	2	27	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9/4/2007	0	0	0	21	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9/5/2007	0	2	14	23	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9/6/2007	0	0	19	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9/7/2007	18	3	10	0	0.19	515.9	172.0	241.7	822.7	94.3	24.6	181.9
9/8/2007	1	16	3	24	0.24	-157.2	N/A	-157.2	-157.2	-28.7	-7.5	-55.4
9/9/2007	23	4	3	15	0.09	441.3	167.2	216.4	780.5	80.7	21.0	155.6
9/10/2007	35	9	0	4	0.12	198.2	60.4	108.5	322.5	36.2	9.4	69.9

Date	Valid	Direction limited	Touchdown limited	Turbulence limited	Background (ppm)	Emission average ($\mu gm^{-2}s^{-1}$)	Emission SD ($\mu gm^{-2}s^{-1}$)	Emission minimum ($\mu gm^{-2}s^{-1}$)	Emission maximum ($\mu gm^{-2}s^{-1}$)	Emission average (kgd^{-1})	Emission average ($gd^{-1}hd^{-1}$)	Emission average ($gd^{-1}AU^{-1}$)
9/11/2007	19	0	2	3	0.15	534.3	150.4	268.3	830.4	97.7	25.4	188.4
9/12/2007	0	3	18	22	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9/13/2007	5	1	13	4	0.13	354.5	55.7	287.1	414.7	64.8	16.9	125.0
9/14/2007	32	0	10	2	0.12	377.3	187.7	117.8	795.2	69.0	18.0	133.1
9/15/2007	1	2	10	13	0.12	128.3	N/A	128.3	128.3	23.5	6.1	45.2
9/16/2007	0	11	30	7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9/17/2007	0	13	13	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9/18/2007	11	4	6	0	0.20	837.9	170.4	555.3	1148.9	153.2	39.9	295.5
9/19/2007	22	15	1	5	0.28	352.8	127.4	201.3	681.3	64.5	16.8	124.4
9/20/2007	6	20	1	15	0.39	590.0	154.5	443.0	872.4	107.9	28.1	208.1
9/21/2007	39	9	0	0	0.19	325.8	175.1	165.1	797.8	59.6	15.5	114.9
9/22/2007	13	18	0	16	0.14	240.3	166.9	96.9	623.3	43.9	11.4	84.8
9/23/2007	6	27	0	14	0.33	396.4	90.8	311.9	553.5	72.5	18.9	139.8
9/24/2007	9	26	0	2	0.29	209.8	54.0	105.4	294.5	38.4	10.0	74.0
9/25/2007	46	1	0	0	0.19	189.7	57.0	74.5	343.5	34.7	9.0	66.9
9/26/2007	3	0	0	20	0.12	138.4	48.6	90.2	187.4	25.3	6.6	48.8
Period 3												
12/20/2007	0	20	0	19	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/21/2007	0	16	5	5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/22/2007	23	16	4	2	0.11	-68.2	119.1	-459.2	-11.4	-12.5	-3.2	-24.1
12/23/2007	47	0	0	0	0.33	-192.1	230.7	-815.8	43.6	-35.1	-9.1	-67.8
12/24/2007	43	0	0	5	0.07	23.5	60.7	-342.3	90.2	4.3	1.1	8.3
12/25/2007	23	12	0	13	0.32	-43.5	72.4	-194.5	19.6	-7.9	-2.1	-15.3
12/26/2007	36	5	1	5	0.04	-4.8	8.4	-35.8	10.1	-0.9	-0.2	-1.7
12/27/2007	27	16	0	5	0.04	4.8	17.7	-17.6	54.4	0.9	0.2	1.7
12/28/2007	10	28	5	5	0.01	15.7	10.2	0.9	32.6	2.9	0.7	5.5
12/29/2007	15	9	1	22	0.21	11.9	46.8	-112.1	44.0	2.2	0.6	4.2
12/30/2007	4	23	0	20	0.05	10.9	6.8	4.1	19.9	2.0	0.5	3.8
12/31/2007	20	1	0	21	0.09	-23.3	44.9	-174.2	15.5	-4.3	-1.1	-8.2
1/1/2008	48	0	0	0	0.11	-42.8	99.5	-417.1	49.2	-7.8	-2.0	-15.1
1/2/2008	39	0	0	9	0.08	-6.2	19.9	-72.4	12.4	-1.1	-0.3	-2.2
1/3/2008	31	7	0	10	0.15	-24.1	50.7	-217.8	17.1	-4.4	-1.1	-8.5
1/4/2008	37	10	0	0	0.07	12.4	18.0	-32.9	46.5	2.3	0.6	4.4
1/5/2008	16	22	0	10	0.22	-13.5	30.9	-74.2	20.1	-2.5	-0.6	-4.8
1/6/2008	4	15	4	24	0.05	7.4	7.8	1.2	18.8	1.4	0.4	2.6
1/7/2008	4	7	1	31	0.38	53.3	261.2	-133.4	433.8	9.8	2.5	18.8
1/8/2008	37	1	0	10	0.03	10.6	13.9	-7.1	56.2	1.9	0.5	3.7
1/9/2008	13	24	0	11	0.55	-64.3	59.9	-136.3	18.2	-11.8	-3.1	-22.7
1/10/2008	16	28	0	4	0.07	-2.7	11.7	-37.6	8.3	-0.5	-0.1	-0.9
1/11/2008	34	10	0	4	0.25	-18.3	67.0	-210.6	120.4	-3.3	-0.9	-6.4
1/12/2008	20	2	0	14	0.12	-23.1	31.1	-104.9	35.2	-4.2	-1.1	-8.2
Period 4												
5/15/2008	0	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/16/2008	33	5	0	9	0.12	73.2	64.6	-29.4	214.4	13.4	3.5	25.8
5/17/2008	35	0	0	11	0.06	46.5	62.9	-33.7	225.7	8.5	2.2	16.4
5/18/2008	38	0	0	10	0.09	-28.0	25.8	-89.2	33.3	-5.1	-1.3	-9.9

Date	Valid	Direction limited	Touchdown limited	Turbulence limited	Background (ppm)	Emission average ($\mu gm^{-2}s^{-1}$)	Emission SD ($\mu gm^{-2}s^{-1}$)	Emission minimum ($\mu gm^{-2}s^{-1}$)	Emission maximum ($\mu gm^{-2}s^{-1}$)	Emission average (kgd^{-1})	Emission average ($gd^{-1}hd^{-1}$)	Emission average ($gd^{-1}AU^{-1}$)
5/19/2008	10	31	0	5	0.09	127.1	149.5	-64.0	414.5	23.2	6.1	44.8
5/20/2008	39	3	0	6	0.08	17.2	31.4	-26.8	124.8	3.1	0.8	6.1
5/21/2008	12	15	0	16	0.12	67.8	102.3	-30.9	348.7	12.4	3.2	23.9
5/22/2008	0	39	0	8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/23/2008	0	44	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/24/2008	1	47	0	0	0.15	10.9	N/A	10.9	10.9	2.0	0.5	3.9
5/25/2008	18	30	0	0	0.23	271.6	99.1	94.0	411.4	49.7	12.9	95.8
5/26/2008	33	3	0	11	0.06	274.3	149.5	-82.4	578.0	50.1	13.1	96.7
5/27/2008	3	43	0	1	0.22	113.7	32.7	77.1	139.8	20.8	5.4	40.1
5/28/2008	0	48	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/29/2008	0	46	0	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/30/2008	31	15	0	0	0.12	210.7	127.0	-18.9	551.1	38.5	10.0	74.3
5/31/2008	43	0	0	5	0.05	198.6	70.2	104.3	338.4	36.3	9.5	70.0
6/1/2008	18	1	0	29	0.10	277.5	240.6	-14.3	665.7	50.7	13.2	97.9
6/2/2008	5	22	0	19	0.25	128.7	120.3	-17.5	292.3	23.5	6.1	45.4
6/3/2008	1	47	0	0	0.37	-83.6	N/A	-83.6	-83.6	-15.3	-4.0	-29.5
6/4/2008	0	32	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period 5												
6/5/2008	4	37	0	0	0.60	8.5	71.4	-45.6	113.5	1.6	0.4	3.0
6/6/2008	35	13	0	0	0.03	132.4	51.2	9.0	318.6	24.2	6.3	46.7
6/7/2008	46	2	0	0	0.23	92.9	88.6	-0.9	272.4	17.0	4.4	32.8
6/8/2008	19	0	1	0	0.31	166.7	100.4	55.8	457.6	30.5	7.9	58.8
6/9/2008	9	0	2	0	0.12	239.6	98.0	90.5	393.8	43.8	11.4	84.5
6/10/2008	34	0	1	10	0.14	119.3	63.8	20.4	262.7	21.8	5.7	42.1
6/11/2008	7	41	0	0	0.29	108.4	148.9	32.4	444.0	19.8	5.2	38.2
6/12/2008	27	15	0	6	0.32	55.7	74.7	-30.6	304.4	10.2	2.7	19.7
6/13/2008	32	1	0	15	0.25	54.4	40.3	-11.8	154.4	9.9	2.6	19.2
6/14/2008	41	0	0	7	0.29	5.2	94.4	-165.5	160.4	1.0	0.2	1.8
6/15/2008	37	0	0	10	0.40	86.3	90.6	-39.5	242.1	15.8	4.1	30.4
6/16/2008	42	0	0	6	0.22	106.2	56.5	13.2	248.6	19.4	5.1	37.4
6/17/2008	21	6	0	17	0.29	99.6	68.1	11.3	250.0	18.2	4.7	35.1
6/18/2008	22	5	0	18	0.30	147.0	111.5	17.9	532.5	26.9	7.0	51.9
6/19/2008	8	17	0	20	0.60	24.1	53.9	-70.5	86.2	4.4	1.1	8.5
6/20/2008	26	2	0	19	0.29	54.1	86.3	-24.9	428.3	9.9	2.6	19.1
6/21/2008	32	4	0	12	0.28	15.9	40.8	-105.5	86.5	2.9	0.8	5.6
6/22/2008	38	2	0	8	0.26	113.1	85.2	-17.3	342.2	20.7	5.4	39.9
6/23/2008	3	12	0	17	0.28	174.4	47.9	137.3	228.5	31.9	8.3	61.5
Period 6												
11/14/2008	10	0	0	0	0.04	6.6	15.0	-24.5	31.8	1.2	0.3	2.3
11/15/2008	47	0	0	1	0.05	9.3	27.0	-28.8	69.8	1.7	0.4	3.3
11/16/2008	40	0	0	8	0.04	26.5	28.0	-9.9	112.9	4.8	1.3	9.4
11/17/2008	43	0	0	5	0.04	15.8	14.0	-15.9	58.8	2.9	0.8	5.6
11/18/2008	22	8	0	16	0.12	-3.9	15.0	-30.6	24.9	-0.7	-0.2	-1.4
11/19/2008	34	7	0	6	0.09	-0.3	22.1	-47.9	48.0	-0.1	0.0	-0.1
11/20/2008	48	0	0	0	0.07	-16.5	13.9	-46.9	20.2	-3.0	-0.8	-5.8
11/21/2008	26	8	0	14	0.11	-2.1	13.9	-25.9	32.7	-0.4	-0.1	-0.8

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 ($gd^{-1}AU^{-1}$)
11/22/2008	6	31	0	4	0.29	-3.9	30.7	-37.9	46.9	-0.7	-0.2	-1.4
11/23/2008	2	17	0	15	0.02	20.4	20.3	6.0	34.7	3.7	1.0	7.2
11/24/2008	46	0	0	1	0.06	10.3	23.0	-33.3	43.3	1.9	0.5	3.6
11/25/2008	12	1	0	17	0.06	1.2	12.3	-12.6	31.9	0.2	0.1	0.4
Period 7												
11/26/2008	15	2	0	30	0.12	-8.0	15.8	-31.1	20.5	-1.5	-0.4	-2.8
11/27/2008	24	0	0	23	0.05	14.1	14.3	-24.8	41.4	2.6	0.7	5.0
11/28/2008	40	0	0	7	0.04	33.0	24.7	-4.8	141.9	6.0	1.6	11.6
11/29/2008	12	7	0	25	0.06	27.9	16.8	1.1	50.5	5.1	1.3	9.9
11/30/2008	14	0	0	0	0.04	6.7	23.1	-45.1	31.8	1.2	0.3	2.4
12/1/2008	48	0	0	0	0.05	17.8	31.3	-34.6	91.9	3.3	0.8	6.3
12/2/2008	25	11	0	12	0.12	14.9	36.6	-36.1	89.6	2.7	0.7	5.3
12/3/2008	33	7	0	6	0.03	9.8	22.2	-46.6	51.9	1.8	0.5	3.5
12/4/2008	48	0	0	0	0.05	24.5	18.2	-4.0	66.3	4.5	1.2	8.6
12/5/2008	40	0	0	8	0.05	11.3	14.0	-18.7	57.8	2.1	0.5	4.0
12/6/2008	48	0	0	0	0.03	19.4	16.4	-27.7	52.1	3.5	0.9	6.8
12/7/2008	16	30	0	2	0.11	-23.5	14.2	-59.0	-0.9	-4.3	-1.1	-8.3
12/8/2008	0	48	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/9/2008	5	4	0	0	0.08	-25.7	7.0	-34.4	-19.0	-4.7	-1.2	-9.1
12/10/2008	27	4	0	17	0.11	-12.5	14.0	-57.5	24.1	-2.3	-0.6	-4.4
12/11/2008	30	0	0	17	0.05	17.1	17.2	-28.7	47.8	3.1	0.8	6.0
12/12/2008	24	17	0	6	0.05	9.2	25.0	-19.1	66.6	1.7	0.4	3.2
12/13/2008	21	27	0	0	0.17	-15.9	24.2	-64.5	9.0	-2.9	-0.8	-5.6
12/14/2008	20	27	0	1	0.04	-3.5	29.8	-43.8	83.7	-0.6	-0.2	-1.2
12/15/2008	0	0	9	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period 8												
4/8/2009	0	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/9/2009	0	26	0	17	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/10/2009	2	46	0	0	0.05	32.9	1.3	31.9	33.8	6.0	1.6	11.6
4/11/2009	7	22	0	15	0.05	69.9	25.4	39.1	108.4	12.8	3.3	24.7
4/12/2009	0	43	0	5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/13/2009	2	46	0	0	-0.01	103.6	4.3	100.6	106.7	18.9	4.9	36.5
4/14/2009	13	21	0	12	0.03	121.4	95.6	10.2	290.6	22.2	5.8	42.8
4/15/2009	0	23	0	18	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/16/2009	0	48	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/17/2009	0	40	0	7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/18/2009	4	18	0	25	0.09	138.7	56.4	72.2	201.7	25.4	6.6	48.9
4/19/2009	47	0	0	1	-0.02	144.4	46.6	57.4	265.3	26.4	6.9	50.9
4/20/2009	43	0	0	4	0.00	85.2	36.0	25.5	169.6	15.6	4.1	30.0
4/21/2009	48	0	0	0	-0.02	86.8	53.7	11.7	200.3	15.9	4.1	30.6
4/22/2009	20	1	1	19	-0.01	280.0	249.6	-72.0	759.9	51.2	13.3	98.7
Period 9												
7/28/2009	0	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7/29/2009	16	1	0	21	0.05	204.6	78.9	95.2	374.9	37.4	9.7	72.2
7/30/2009	30	7	0	10	0.07	246.4	139.8	17.1	496.7	45.1	11.7	86.9
7/31/2009	23	0	0	25	0.09	317.5	106.1	107.4	544.7	58.0	15.1	112.0

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 ($gd^{-1}AU^{-1}$)
8/1/2009	44	0	0	4	0.11	192.5	106.9	58.3	431.5	35.2	9.2	67.9
8/2/2009	32	0	0	16	0.03	255.5	149.1	50.1	551.4	46.7	12.2	90.1
8/3/2009	40	5	0	3	0.10	161.4	96.9	19.1	350.2	29.5	7.7	56.9
8/4/2009	20	9	0	17	0.19	152.4	68.7	8.2	266.3	27.9	7.3	53.8
8/5/2009	1	14	0	30	0.23	41.0	N/A	41.0	41.0	7.5	2.0	14.5
8/6/2009	4	17	0	25	0.14	204.5	135.5	41.2	358.8	37.4	9.7	72.1
8/7/2009	12	33	0	3	0.25	211.1	130.9	7.8	438.8	38.6	10.0	74.4
8/8/2009	33	15	0	0	0.11	293.3	124.5	149.9	492.0	53.6	14.0	103.4
8/9/2009	30	12	0	4	0.16	149.7	62.9	6.8	313.5	27.4	7.1	52.8
8/10/2009	23	5	0	14	0.08	310.2	111.3	31.0	445.8	56.7	14.8	109.4
8/11/2009	10	3	0	35	0.13	159.0	72.4	59.2	260.8	29.1	7.6	56.1
8/12/2009	18	7	0	23	0.04	404.7	84.3	272.3	596.9	74.0	19.3	142.7
8/13/2009	20	0	0	28	0.11	455.5	120.9	185.4	717.5	83.3	21.7	160.6
8/14/2009	24	4	0	19	0.21	422.2	185.2	121.9	701.7	77.2	20.1	148.9
8/15/2009	3	24	1	12	0.43	145.4	59.0	79.6	193.8	26.6	6.9	51.3
8/16/2009	31	16	0	1	0.11	277.6	139.3	75.9	558.7	50.8	13.2	97.9
8/17/2009	11	3	1	26	0.06	347.4	54.2	283.2	455.2	63.5	16.5	122.5

6.9.3 Daily H_2S emission using Ratiometric emissions model

Column headings for the following table are:

Date: Month/Day/Year

Valid: Number of ½ h periods with valid emissions data

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

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

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

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

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

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

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

Date	Valid	Emission average ($\mu gm^{-2}s^{-1}$)	Emission SD ($\mu gm^{-2}s^{-1}$)	Emission minimum ($\mu gm^{-2}s^{-1}$)	Emission maximum ($\mu gm^{-2}s^{-1}$)	Emission average (kgd^{-1})	Emission average ($gd^{-1}hd^{-1}$)	Emission average ($gd^{-1}AU^{-1}$)
Period 4								
5/15/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/16/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/17/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/18/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/19/2008	2	12.2	105.1	8.6	15.8	2.3	0.6	4.5
5/20/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/21/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/22/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/23/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/24/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/25/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/26/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/27/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/28/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/29/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/30/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/31/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6/1/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6/2/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6/3/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6/4/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period 5								
6/5/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Date	Valid	Emission average ($\mu gm^{-2}s^{-1}$)	Emission SD ($\mu gm^{-2}s^{-1}$)	Emission minimum ($\mu gm^{-2}s^{-1}$)	Emission maximum ($\mu gm^{-2}s^{-1}$)	Emission average (kgd^{-1})	Emission average ($gd^{-1}hd^{-1}$)	Emission average ($gd^{-1}AU^{-1}$)
6/6/2008	2	-0.1	0.0	-0.4	0.2	0.0	0.0	0.0
6/7/2008	6	0.1	5.6	-1.3	2.1	0.0	0.0	0.0
6/8/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6/9/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6/10/2008	9	-0.5	0.0	-5.0	2.5	-0.1	0.0	-0.2
6/11/2008	3	0.1	9.6	-1.2	1.9	0.0	0.0	0.0
6/12/2008	3	25.9	129.0	1.0	41.3	4.9	1.3	9.5
6/13/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6/14/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6/15/2008	7	36.4	134.0	17.3	49.9	6.9	1.8	13.3
6/16/2008	19	47.4	142.8	17.9	122.8	9.0	2.3	17.4
6/17/2008	11	31.7	121.4	1.2	78.5	6.0	1.6	11.6
6/18/2008	7	17.9	95.8	7.1	31.7	3.4	0.9	6.6
6/19/2008	2	45.5	198.8	43.4	47.6	8.7	2.3	16.7
6/20/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6/21/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6/22/2008	6	55.5	164.6	38.0	77.3	10.6	2.7	20.4
6/23/2008	6	54.4	162.5	12.7	95.9	10.3	2.7	20.0
Period 6								
11/14/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11/15/2008	3	23.1	122.5	8.9	31.1	4.4	1.1	8.5
11/16/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11/17/2008	2	0.5	21.7	-0.2	1.2	0.1	0.0	0.2
11/18/2008	4	0.6	19.8	-0.4	2.3	0.1	0.0	0.2
11/19/2008	3	8.7	76.2	3.5	17.0	1.6	0.4	3.2
11/20/2008	4	0.9	22.9	-4.0	8.1	0.2	0.0	0.3
11/21/2008	1	3.4	0.0	3.4	3.4	0.6	0.2	1.2
11/22/2008	3	3.9	51.9	1.0	7.4	0.8	0.2	1.4
11/23/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11/24/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11/25/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period 7								
11/26/2008	1	2.0	0.0	2.0	2.0	0.4	0.1	0.7
11/27/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11/28/2008	3	2.7	42.8	2.3	3.4	0.5	0.1	1.0
11/29/2008	5	10.5	76.4	-0.5	46.6	2.0	0.5	3.9
11/30/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/1/2008	5	-0.3	0.0	-2.4	0.8	-0.1	0.0	-0.1
12/2/2008	2	3.5	56.8	0.6	6.4	0.7	0.2	1.3
12/3/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/4/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/5/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/6/2008	1	1.3	0.0	1.3	1.3	0.2	0.1	0.5
12/7/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/8/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Date	Valid	Emission average ($\mu g m^{-2} s^{-1}$)	Emission SD ($\mu g m^{-2} s^{-1}$)	Emission minimum ($\mu g m^{-2} s^{-1}$)	Emission maximum ($\mu g m^{-2} s^{-1}$)	Emission average ($kg d^{-1}$)	Emission average ($g d^{-1} hd^{-1}$)	Emission average ($g d^{-1} AU^{-1}$)
12/9/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/10/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/11/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/12/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/13/2008	3	2.4	40.2	1.8	3.1	0.5	0.1	0.9
12/14/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/15/2008	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period 8								
4/8/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/9/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/10/2009	2	17.3	123.3	10.1	24.5	3.3	0.9	6.3
4/11/2009	10	2.7	36.9	0.3	7.3	0.5	0.1	1.0
4/12/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/13/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/14/2009	5	5.1	53.4	2.1	6.9	1.0	0.3	1.9
4/15/2009	5	1.0	23.8	-0.7	2.3	0.2	0.0	0.4
4/16/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/17/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/18/2009	6	3.1	40.8	2.1	4.7	0.6	0.2	1.1
4/19/2009	19	119.9	207.0	3.9	294.4	22.8	5.9	44.0
4/20/2009	2	15.5	116.8	8.3	22.6	2.9	0.8	5.7
4/21/2009	2	153.7	314.5	80.3	227.1	29.2	7.6	56.4
4/22/2009	9	1.7	29.9	0.9	2.7	0.3	0.1	0.6
Period 9								
7/28/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7/29/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7/30/2009	5	67.2	190.8	27.2	124.7	12.8	3.3	24.6
7/31/2009	12	54.3	155.1	29.0	75.7	10.3	2.7	19.9
8/1/2009	16	62.1	161.8	33.9	116.1	11.8	3.1	22.8
8/2/2009	38	48.5	142.5	31.0	105.0	9.2	2.4	17.8
8/3/2009	19	52.6	149.8	39.3	63.2	10.0	2.6	19.3
8/4/2009	14	97.6	195.5	77.7	174.0	18.6	4.8	35.8
8/5/2009	2	69.7	233.9	32.4	107.0	13.3	3.5	25.6
8/6/2009	1	69.6	0.0	69.6	69.6	13.2	3.4	25.5
8/7/2009	8	107.9	212.0	86.1	148.6	20.5	5.3	39.6
8/8/2009	17	93.8	190.8	48.7	138.4	17.8	4.6	34.4
8/9/2009	13	93.8	195.1	56.0	131.0	17.8	4.6	34.4
8/10/2009	2	85.9	265.2	83.9	87.8	16.3	4.2	31.5
8/11/2009	7	38.8	137.5	8.0	99.0	7.4	1.9	14.2
8/12/2009	14	916.9	0.0	3.8	3469.8	174.3	45.4	336.2
8/13/2009	23	125.9	208.0	1.9	579.9	23.9	6.2	46.2
8/14/2009	23	24.4	104.7	0.8	158.0	4.6	1.2	8.9
8/15/2009	4	11.6	83.1	7.7	14.9	2.2	0.6	4.3
8/16/2009	7	11.5	77.1	2.5	25.5	2.2	0.6	4.2
8/17/2009	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A

6.9.4 Daily H_2S emission using bLs emissions model

Column headings for the following table are:

Date: Month/Day/Year

Valid: Number of ½ h periods with valid emissions data

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

Angle limited: Number of ½ h periods invalidated because angle of attack to the downwind side was greater than 60 degrees

Turbulence limited: Number of ½ h periods that the bLS model was not run because either u_* < 0.15 ms^{-1} or |L| < 2 m

Background (ppb): bLS model calculated daily average background concentration (ppb); average is over the ½ h periods included in the valid column

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

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

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

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

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

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

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

Date	Valid	Direction limited	Angle limited	Turbulence limited	Background (ppb)	Emission average ($\mu gm^{-2}s^{-1}$)	Emission SD ($\mu gm^{-2}s^{-1}$)	Emission minimum ($\mu gm^{-2}s^{-1}$)	Emission maximum ($\mu gm^{-2}s^{-1}$)	Emission average (kgd^{-1})	Emission average ($gd^{-1}hd^{-1}$)	Emission average ($gd^{-1}AU^{-1}$)
Period 4												
5/16/2008	4	0	21	8	0.8	5.7	0.7	5.1	6.7	1.1	0.3	2.1
5/17/2008	9	0	22	13	0.6	13.6	5.9	5.9	24.7	2.6	0.7	5.1
5/18/2008	30	0	8	10	0.2	11.2	6.4	1.5	26.4	2.2	0.6	4.2
5/19/2008	7	31	3	5	0.1	30.5	58.1	1.5	161.5	5.9	1.5	11.4
5/20/2008	28	3	11	6	1.6	10.6	5.1	-0.4	20.1	2.1	0.5	4.0
5/21/2008	9	15	3	21	0.9	3.4	2.5	-0.4	8.2	0.7	0.2	1.3
5/22/2008	0	39	0	8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/23/2008	0	46	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/24/2008	1	47	0	0	-0.2	25.8	N/A	25.8	25.8	5.0	1.3	9.6
5/25/2008	18	30	0	0	2.0	96.4	28.2	37.0	146.4	18.7	4.9	36.0
5/26/2008	15	3	17	11	-11.6	102.3	127.0	14.9	509.1	19.8	5.2	38.2
5/27/2008	3	43	0	1	0.8	39.4	8.2	31.0	47.4	7.6	2.0	14.7

Date	Valid	Direction limited	Angle limited	Turbulence limited	Background (ppb)	Emission average ($\mu gm^{-2}s^{-1}$)	Emission SD ($\mu gm^{-2}s^{-1}$)	Emission minimum ($\mu gm^{-2}s^{-1}$)	Emission maximum ($\mu gm^{-2}s^{-1}$)	Emission average (kgd^{-1})	Emission average ($gd^{-1}hd^{-1}$)	Emission average ($gd^{-1}AU^{-1}$)
5/28/2008	0	48	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/29/2008	0	46	0	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5/30/2008	10	15	16	0	-4.9	89.9	137.9	8.2	441.2	17.4	4.5	33.6
5/31/2008	3	0	21	5	1.1	21.4	5.9	17.6	28.1	4.1	1.1	8.0
6/1/2008	9	1	9	29	1.7	14.2	7.8	1.9	24.8	2.8	0.7	5.3
6/2/2008	4	22	1	20	2.2	43.0	30.9	22.7	88.0	8.3	2.2	16.1
6/3/2008	1	47	0	0	-10.1	529.2	N/A	529.2	529.2	102.5	26.7	197.8
6/4/2008	0	23	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period 5												
6/6/2008	33	13	2	0	6.8	0.3	1.5	-2.6	5.0	0.1	0.0	0.1
6/7/2008	46	2	0	0	21.0	0.2	1.5	-3.0	4.3	0.0	0.0	0.1
6/8/2008	18	0	1	0	26.0	0.2	1.4	-2.0	3.2	0.0	0.0	0.1
6/9/2008	3	0	17	0	7.8	0.5	0.4	0.1	0.9	0.1	0.0	0.2
6/10/2008	30	3	4	10	16.9	-0.2	1.4	-3.9	2.8	0.0	0.0	-0.1
6/11/2008	7	41	0	0	9.2	0.5	1.1	-1.3	1.7	0.1	0.0	0.2
6/12/2008	10	15	12	6	-14.9	60.1	139.6	1.3	452.3	11.6	3.0	22.5
6/13/2008	3	1	19	15	2.9	8.7	1.2	7.7	10.0	1.7	0.4	3.2
6/14/2008	26	0	13	7	1.1	24.0	17.4	9.4	73.1	4.7	1.2	9.0
6/15/2008	25	0	12	10	1.1	12.7	4.8	2.2	21.7	2.5	0.6	4.7
6/16/2008	28	0	13	6	0.8	13.8	4.3	5.3	22.0	2.7	0.7	5.2
6/17/2008	13	6	8	21	1.6	4.8	3.7	0.1	11.4	0.9	0.2	1.8
6/18/2008	12	5	10	19	0.6	7.4	4.5	1.3	16.1	1.4	0.4	2.8
6/19/2008	8	17	0	21	6.6	9.6	6.0	2.0	21.2	1.9	0.5	3.6
6/20/2008	17	2	9	19	1.9	8.5	4.0	1.2	15.3	1.7	0.4	3.2
6/21/2008	0	4	26	12	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6/22/2008	19	2	17	8	1.2	29.9	32.1	1.9	155.5	5.8	1.5	11.2
6/23/2008	2	0	0	22	0.8	19.9	0.7	19.4	20.4	3.9	1.0	7.4
Period 6												
11/15/2008	36	0	11	1	0.4	2.7	2.0	0.0	9.2	0.5	0.1	1.0
11/16/2008	17	0	18	8	0.3	0.1	0.4	-0.5	1.0	0.0	0.0	0.0
11/17/2008	37	0	6	5	0.3	0.3	0.6	-1.2	2.8	0.1	0.0	0.1
11/18/2008	21	8	1	17	0.7	0.4	0.7	-0.3	2.5	0.1	0.0	0.2
11/19/2008	28	7	5	7	0.6	1.2	1.2	-0.6	3.4	0.2	0.1	0.4
11/20/2008	48	0	0	0	0.3	0.4	0.8	-1.9	2.0	0.1	0.0	0.1
11/21/2008	25	8	0	14	0.1	0.3	0.5	-0.8	1.0	0.1	0.0	0.1
11/22/2008	13	31	0	4	0.3	1.0	1.1	-0.4	2.8	0.2	0.0	0.4
11/23/2008	2	17	0	18	4.3	-0.2	0.3	-0.4	0.0	0.0	0.0	-0.1
11/24/2008	14	0	13	2	0.7	0.1	0.5	-0.8	1.0	0.0	0.0	0.0
Period 7												
11/26/2008	12	0	2	10	1.0	0.2	0.4	-0.2	1.2	0.0	0.0	0.1
11/27/2008	4	0	16	24	1.3	-0.1	0.5	-0.9	0.3	0.0	0.0	0.0
11/28/2008	0	0	15	8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11/29/2008	11	7	2	27	0.3	6.4	15.9	-0.3	51.4	1.2	0.3	2.4
11/30/2008	14	0	0	0	0.5	5.2	3.1	0.7	9.9	1.0	0.3	1.9
12/1/2008	37	0	7	0	0.3	0.9	2.5	-1.5	13.0	0.2	0.0	0.3
12/2/2008	21	11	3	12	0.5	0.8	0.7	-0.1	3.2	0.2	0.0	0.3

Date	Valid	Direction limited	Angle limited	Turbulence limited	Background (ppb)	Emission average ($\mu gm^{-2}s^{-1}$)	Emission SD ($\mu gm^{-2}s^{-1}$)	Emission minimum ($\mu gm^{-2}s^{-1}$)	Emission maximum ($\mu gm^{-2}s^{-1}$)	Emission average (kgd^{-1})	Emission average ($gd^{-1}hd^{-1}$)	Emission average ($gd^{-1}AU^{-1}$)
12/3/2008	25	7	8	8	0.5	0.1	0.8	-1.3	2.2	0.0	0.0	0.0
12/4/2008	0	0	36	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/5/2008	29	0	10	8	0.3	0.4	0.6	-0.7	2.2	0.1	0.0	0.2
12/6/2008	28	0	15	0	0.4	-0.2	0.8	-2.0	1.2	0.0	0.0	-0.1
12/7/2008	16	30	0	2	0.4	0.2	0.5	-0.5	1.4	0.0	0.0	0.1
12/8/2008	0	48	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/9/2008	5	4	0	0	0.5	0.0	0.4	-0.5	0.5	0.0	0.0	0.0
12/10/2008	24	4	3	17	0.4	0.1	0.5	-1.1	1.0	0.0	0.0	0.1
12/11/2008	16	0	13	18	0.2	0.4	0.5	-0.8	1.4	0.1	0.0	0.1
12/12/2008	17	17	6	6	0.1	0.4	0.4	-0.4	1.3	0.1	0.0	0.1
12/13/2008	21	27	0	0	0.5	0.9	1.0	-0.6	3.3	0.2	0.0	0.3
12/14/2008	0	27	5	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12/15/2008	0	0	19	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Period 8												
4/10/2009	2	46	0	0	0.0	8.2	5.3	4.4	12.0	1.6	0.4	3.1
4/11/2009	4	22	3	19	-0.2	2.6	0.4	2.4	3.2	0.5	0.1	1.0
4/12/2009	0	43	0	5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/13/2009	2	46	0	0	0.9	26.3	5.6	22.4	30.3	5.1	1.3	9.8
4/14/2009	5	21	5	14	0.2	3.8	1.7	0.9	5.2	0.7	0.2	1.4
4/15/2009	0	23	0	25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/16/2009	0	48	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/17/2009	0	40	0	8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4/18/2009	4	18	0	25	1.2	2.2	0.5	1.6	2.6	0.4	0.1	0.8
4/19/2009	46	0	1	1	0.8	63.4	49.4	1.6	172.7	12.3	3.2	23.7
4/20/2009	17	0	18	5	1.0	142.6	93.4	2.9	331.8	27.6	7.2	53.3
4/21/2009	22	0	23	0	0.7	54.0	34.7	17.2	139.8	10.5	2.7	20.2
4/22/2009	1	0	5	18	0.8	0.9	N/A	0.9	0.9	0.2	0.0	0.3
Period 9												
7/30/2009	11	7	19	10	3.4	26.9	11.4	14.1	52.9	5.2	1.4	10.1
7/31/2009	11	0	12	25	3.1	59.0	12.2	46.4	87.5	11.4	3.0	22.1
8/1/2009	18	0	24	4	3.0	36.9	17.7	10.7	62.6	7.1	1.9	13.8
8/2/2009	31	0	1	16	2.7	43.2	9.4	27.3	75.1	8.4	2.2	16.2
8/3/2009	26	5	14	3	2.3	46.0	9.8	23.1	71.8	8.9	2.3	17.2
8/4/2009	19	9	1	18	6.0	38.8	15.3	0.1	62.1	7.5	2.0	14.5
8/5/2009	1	14	0	33	5.6	9.1	N/A	9.1	9.1	1.8	0.5	3.4
8/6/2009	2	17	2	27	5.0	32.6	18.3	19.7	45.6	6.3	1.6	12.2
8/7/2009	12	30	0	3	2.8	93.0	17.9	62.9	127.5	18.0	4.7	34.8
8/8/2009	28	0	0	0	3.9	88.0	17.4	47.7	116.5	17.0	4.4	32.9
8/9/2009	24	12	6	4	5.3	52.5	26.3	1.9	107.7	10.2	2.6	19.6
8/10/2009	4	5	20	14	3.2	65.6	34.3	23.4	107.2	12.7	3.3	24.5
8/11/2009	5	3	5	35	3.0	18.4	15.4	2.9	38.3	3.6	0.9	6.9
8/12/2009	18	7	0	23	-8.2	993.1	1296.6	3.6	3846.5	192.4	50.1	371.1
8/13/2009	20	0	0	28	5.9	116.4	156.7	1.7	539.3	22.6	5.9	43.5
8/14/2009	25	4	0	19	4.0	22.6	36.8	0.6	124.2	4.4	1.1	8.5
8/15/2009	3	33	0	12	2.1	8.4	1.4	7.1	9.8	1.6	0.4	3.2
8/16/2009	10	16	21	1	4.3	7.5	3.7	2.0	14.0	1.5	0.4	2.8

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 ($g d^{-1} AU^{-1}$)
8/17/2009	1	1	0	22	1.6	1.3	N/A	1.3	1.3	0.3	0.1	0.5