APPENDIX B

STANDARD OPERATING PROCEDURES

1. STATION SETUP

This section to be executed only when installing equipment at a new site.

GPS Station Setup Elevation Procedures

VIZ Setup Program requires three elevation fields to be filled out. Those are:

1. DGPS Antenna Height (with reference to WGS-84 elevations)
2. Geoid Separation
3. MSL Station Height

Knowing any two of the three, the third can be determined using a variation of the following relationship:

DGPS Antenna height = MSL station height + Geoid Separation + Height of GPS antenna off ground level

Station Coordinates and MSL station height can determined from a very accurate site-specific survey.

If you know the Station Coordinates accurately before going to the field, you can obtain the Geoid Separation (from WGS-84 elevations) from the following website:

<http://www.nima.mil/GandG/egm84/intptW.html>

Otherwise the following procedure is recommended:

1. Run the program LOCATE

   To run LOCATE at the DOS prompt type "START LOCATE" (note that ground GPS antenna must be installed and W9000 system turned on). Allow the program to run for at least 10 minutes until stable readings are noted. When the "Escape" key is pressed, the resultant Latitude, Longitude, and Station Height relative to WGS-84 coordinates is shown on the monitor (which is the same as DGPS Antenna Height).

2. Using the surveyed MSL site elevation or the best estimate height with the results from LOCATE, you can calculate the DGPS antenna height in WGS-84 using the equation shown above.

3. Note that the last term in the equation is simply an estimate of the height of the GPS antenna above the ground release point (~2 meters unless mounted on a structure).

Some examples:

At Site A, we were able to determine beforehand the approximate Latitude and Longitude of the site. From the above web site, it was determined that the Geoid separation was -30 meters. Once at the site, LOCATE is run (for a minimum of 10 minutes). The height

shown in LOCATE is "-20 meters", relative to WGS-84 coordinates that must be corrected to actual using the cited relationship.

Station Height = DGPS Antenna Height - Geoid Separation - Antenna height (~2 m)
= -20 meters - (-30 meters) - 2 meters
= 8 meters

At Site B, we had no prior knowledge of its location but the site documentation gives a height of 230 meters. LOCATE is run yielding a height of 210 meters. Again the antenna is mounted on a tripod 2 meters off the ground. From the referenced relationship:

Geoid Separation = DGPS Antenna Height - Station Height - Antenna height
= 210 meters - 230 meters - 2 meters
= -22 meters

For both examples above, it is preferred to use the coordinates obtained from the LOCATE program.

NOTE: if when running the W9000 Flight Program the first time at this site, the error "Base Coordinate Error" or something to that effect, it means the software can not reconcile the height and/or location input in Setup. Run Setup again, checking the input.

Also NOTE: that the last field in the Elevation Setup, **Height Adjustment**, is no longer used.

Special Note When **Using for Audits**: A special version of the post-flight processing programs are available, call finaud.bat and audver.exe. Features of this processing program is that heights output will be meters above ground level, and virtual temperature is included in each record.

T&B Systems processing header information (all radiosonde types)

The ASCII file "SSSinput." must be edited for new sites. This information is what is output in the .DAT header record. Use the DOS or any other editor to edit. Change the fields as necessary. keeping the spacing (blanks). The edited file be must renamed so that the SSS is station ID that is used in the VIZ software.

Wind Computation Setup

GPS : Wind Interval Selection

Select Invervals by Time

	Section Start (seconds)	Smoothing Length (seconds)	Minumum Inteval Samples	Computation Interval (seconds)
1	0	1	1	1
2	6	10	5	1
3	666	20	10	10

GPS : Wind Parameter Setting

Differential GPS Curve Fit Variance 0.90
Raw Wind Sampling Interval (seconds) 1.00

LORAN: Wind Interval Selection

Select Invervals by Time

	Section Start (seconds)	Smoothing Length (seconds)	Minumum Inteval Samples	Computation Interval (seconds)
1	0	60	15	15
2	180	120	30	15
3				

LORAN: Wind Parameter Setting

Loran Curve Fit Variance 0.90
Raw Wind Sampling Interval (seconds) 3.00

The following are procedures for preparing, operating and data retrieval for the Mesonet monitoring network.

Special Notes:

- Data connections are made using the RF401 wireless connection module. Make sure power is provided to the module and that the serial connection is made to the proper connector on the RF401 and the antenna is connected.
- Each of the data loggers is assigned a PAKBUS address that is equivalent to the site number. You can only access the data logger by using the correct site program with the corresponding PAKBUS address, i.e., site 3 can only be accessed using the program/configuration configured for PAKBUS address 3. The following is a list of the site names/numbers:

  Cora Area – 1
  The Mesa – 2
  Warbonnet – 3
  Haystack Butte – 4
  Simpson Gulch – 5
  Speedway Pit – 6
  Big Piney – 7
  La Barge – 8

- Before proceeding to the field verify that the clock in the field computer is correct to within 1 minute of **true** Mountain Standard Time. This can be best performed using the integral Internet Time function in Windows and verifying that the time was truly set when it is complete. If not then find an appropriate time standard before leaving for the field and set the computer clock manually. Again, verify it has the proper time.
- The file naming convention for each site and data interval is critical and should not be changed. If a different computer is used for downloading data then the setup for data access and collection must be consistent with the following standard and example shown for site 3:

  Wy Site 3_min_5.dat
  Wy Site 3_min_60.dat

  Note that there is a space between 'Wy' and 'Site', as well as between 'Site' and '3'.

1.1 Data Download from Data Logger

- Enter the arrival time at the site in the site log.

- When parked within radio range of a desired site, press the “Connect” button and select the proper site.
- When connected, verify the time on the data logger is within 1 minute of the computer time. If the times differ by more than one minute then synchronize the data logger clock to the computer
- Press the “Collect Now” button and wait for the complete download. Sometimes the connection may take some time through the wireless connection.
- When the collection is complete use the view data mode for 5 minute and 60 minute files to verify all data to the present has been collected. Note the date and time of the data collection in the log.
- Review all the values for any anomalies during the period collected. In particular review the battery voltage to verify a proper battery charge. The battery voltage will read about 1.5 to 2 volts low. If you ask Bob why then be prepared for too long an explanation. However, if any values look suspicious then contact either Bob or Dave Bush regarding the operations.
- Press the “Disconnect” button, you are done at this site.

1.2 Data FTP Upload to the T&B Systems FTP Server

Special Notes: The FTP upload process should only be performed in the time window from 10 minutes past the hour to 10 minutes prior to the hour. This will minimize the chances of the server trying to process data that is in the middle of an upload. This server process will be running at the top of every hour. Additionally, any data downloads must be performed in a consistent manner. The file naming convention for the two indicated upload accounts below is critical. If a computer change is made then it is imperative that the assigned file naming convention is maintained.

- Use an appropriate FTP program such as Filezilla or you can use Internet Explorer. Be aware that FTP through Internet Explorer version 7 requires an additional step to view the FTP site in an Explorer window. This is not required in Internet Explorer version 6.
- Log into the proper account for the data uploads. If you log into the wrong account then the data may not be properly registered and a potential loss of data may occur. **Nobody else should upload data to these accounts! If you have data to be uploaded then contact Bob to set up an account and obtain the proper file naming convention. This file naming convention is critical to assure no data are lost!**
    - **Jennifer Frazier (Wyoming DEQ):**
      URL: ftp://70.133.103.202
      Username: wydeqdataup
      Password: ugwosdata
    - **MSI:**
      URL: ftp://70.133.103.202
      Username: msidataup
      Password: ugwosdata
- Copy the full files that have been downloaded from the data loggers into the FTP server. This includes both the 5-minute and 60-minute files. Do not attempt to create any new folders underneath the FTP root login, or edit, or rename the files in any way, as this will

disable the automated update process. However, it is OK to overwrite the existing files that were previously uploaded to the FTP server as those files are automatically backed up daily.

- If all goes well then the newly uploaded data will appear on the web site within an hour. Send an email to Bob (bbaxter@tbsys.com) to let him know that new data have been uploaded. He will verify that the new data have been registered properly in the database and will contact you as appropriate with any issues.

The following are procedures for installing and operating the 2B Technologies model 202 ozone analyzers for the UGWOS Mesonet ozone monitoring network.

Ozone Analyzer Setup

1. Prior to the installation of the analyzer, condition all sample lines by drawing air with concentrations of at least 50 ppb ozone through the lines for a period of 24 hours.
2. Place the analyzer in the designate site cooler, making sure that the number on the analyzer matches the number on the cooler.
3. Connect the 47 mm filter holder, with filter, and the associated sample line onto the inlet port of the analyzer. Make sure that flow through the filter holder is in the correct direction - it should follow the arrows on the filter holder. Loop any excess line in the cooler.
4. Install a fully charged 12 V battery, with power cord adapter, in the cooler. If necessary, the 2B analyzer can be turned on its side.
5. Connect the 12 V power cord to the battery and to the 2B analyzer.
6. Turn on the analyzer and allow it to warm up for at least one hour prior to calibration in order to let internal temperatures stabilize. Note that analyzers can be powered up using a vehicle 12 V cigarette lighter receptacle in transit to the Mesonet sites in order to reduce or eliminate warm up time at the site.
7. Connect the analyzer to the Campbell Scientific CR206 data logger using the stereo jack connector labeled “1”.
8. Verify that the small heater light is connected and operating.

Ozone Analyzer Calibration

1. Position the 2B Model 306 ozone transfer standard near the station analyzer such that the calibration line reaches the sample inlet. Connect the sample inlet to the calibration line using a suitable connector.
2. Connect the calibrator’s power cord adapter to the 12 V lighter receptacle in your vehicle. Turn on the transfer standard and allow it to warm up. The calibrator display will read “Warming up …” while doing so. When the indicated delT reading is within 1°C, the display will read “Temperature Set Press Select”. The calibrator is sufficiently warmed up whenever the delT reading is within 1°C. Note that the calibrator may be kept running while in transit to the Mesonet sites in order to eliminate warm up time at the site.
3. Record the calibration “begin time” in the logbook. All calibration and check activity will influence the hourly averages, which will need to be invalidated.
4. The 2B Model 306 transfer standard has a single output port, with a venting tee contained within the transfer standard. Thus, no external vent should be used. Connect

one end of the calibration Teflon tubing to the transfer standard output port and the other to the analyzer sample inlet line, using an appropriate adapter.

5. If not already done, program the Model 306 transfer standard to produce the zero and two span points. Hold down the rotary switch until the main menu is displayed. Rotate the rotary switch to move the cursor under "Cfg" for the automatic calibration sequence configuration. Follow the menu prompts to create a five-point calibration, with points at 200, 150, 100, 50 and 0, spaced at 10-minute intervals.
6. Start the calibration sequence at approximately one minute after a five-minute clock division (e.g. 10:01, 10:06, 10:11, etc.). Since 5-minute averages are being recorded by the data logger, this will result in an approximately 4-minute stabilization period and a full 5-minute average of the calibration input for each input concentration. Start the calibration sequence by going to the main menu and selecting "Stp".
7. Using the procedures presented in the SOP "Operating Procedure for Mesonet Data Handling", connect to the data logger and download the most current 5-minute data. Record the resulting calibration values into the site logbook.
8. Contact Dave Bush for current ozone output concentrations for the 2B transfer standard settings and record these in the logbook.

Routine Station Checks

1. Station checks should be conducted every other day during IOPs, as well as at the beginning and end of each IOP.
2. Upon reaching the site, enter the date and time in the station logbook, along with the technicians initials.
3. Complete a visual inspection of the system. Note any anomalous situations both in the site's logbook.
4. If not already done, program the Model 306 transfer standard using the procedures in the Calibration section above to produce a three-point calibration sequence, with points at 200, 50 and 0, spaced at 10-minute intervals.
5. Using the procedures in the "Calibration" section above, conduct the described three-point zero/span check.
6. Using the procedures presented in the SOP "Operating Procedure for Mesonet Data Handling", connect to the data logger and download the most current data. Review the 5-minute data file and record the resulting calibration values into the site logbook.
7. Contact Dave Bush for current ozone output concentrations for the 2B transfer standard settings.
8. If either of the span checks deviated by more than 10% from the standard, or if the zero is off by more that 5 ppb, alert Dave Bush or Bob Baxter.
9. It is not anticipated that any inlet filter changes will be necessary during the study. However, if a filter change is required, use the following procedures. Record the current ozone reading from the analyzer display in the log book. Disassemble the filter holder and replace the filter. Reassemble the filter holder and record, wait approximately one minute, and record the ozone reading from the analyzer display. Note if the before and after readings change by more than 5 ppb. Note that any filter changes should be conducted after the scheduled zero/span/precision check.

10. Write down the current readings for the following measurements in the station log book: battery voltage, station temperature, ozone, WS, and WD. Verify that the WS and WD readings are consistent with current conditions.
11. Verify that the monitoring system is operating appropriately. Verify that the display on the analyzer is normal, that the red light on the Campbell Scientific Model 206 data logger is blinking, and that the heater light is on. Note in the logbook the period that the ozone analyzer was off-line for the checks.

1. Preparation, Operation and Data Handling

The following are procedures for preparing, operating and data retrieval for the tethered balloon sampling systems.

Special Notes:

- First and foremost, safety is the number one priority. No operation should be performed that could pose a hazard to the operator or to property at the site. If there are any questions as to whether the balloon system can be operated safely then the Field Manger, Don Lehrman, or Bob Baxter should be contacted. No operations under windy conditions that could limit the operators ability to safely operate the system will be performed.
- The samplers have been serialized so that the EN-SCI sonde serial number, internal interface board serial number and internal data logger serial number are a matched set. Furthermore, this matched set is placed into a Styrofoam enclosure with a unique "Unit" number. This enclosure has the EN-SCI serial number on the outside as well. Keep all units and instruments together as matched sets, as the calibrations are keyed to the unique set of parts.
- When working with the ANODE and CATHODE solutions, take great care not to mix the syringes and solutions, otherwise all will be lost!
- When the samplers and spare cells are transported, never tip them as the fluids might leak.

1.1 Tethered Ozone Sampler Servicing – Laboratory Cell Preparation

- Prepare the initial sample cells. The following steps assume that the cells to be used have been previously flushed with distilled water and are dry (or been in storage since the last flushing and drying), and that the cells will be put into use within 24 hours of preparation.
    - Place an appropriate amount of CATHODE and ANODE solutions in their respective cups. As none of this solution should be returned to the original bottle, take care to only use what is necessary for the cells to be prepared.
    - Fill the CATHODE syringe and charge (fill) each of the CATHODE cells up to the bottom ridge line (approximately 1/3 of the way from the bottom of the cell).
    - Fill the ANODE syringe and charge each of the ANODE cells to the bottom ridge line on the cell. Place the cap with the short lines on the ANODE cell.
    - Using the CATHODE syringe, withdraw all CATHODE fluid from the CATHODE cell and discard. Take care not to damage or deform the platinum screen or Teflon rod. Immediately following the removal of the CATHODE fluid, fill the CATHODE cell with fresh fluid to the top ink-marked line.

- Carefully place the cap with the long lines on the CATHODE cell. Make sure the Teflon rod on the bottom of the cell is inserted into the long tube and the long tube is not forced to deform the Platinum screen. Make sure that the long tube on top is aligned to have the arc toward the cell wires and Velcro strip.

- Check the cell voltage. It should be positive and above about 25 mv. If the cell voltage is negative the start the preparation process over. If the repeated check is a negative voltage then the cell is bad.

- If the cells are used after 24-hours from initial preparation then the cathode solution should be replaced (anode is fine).

1.2 Tethered Ozone Monitor Setup

- For the first sounding in the morning load fresh AA batteries (8 each) into the battery holders, discard and DO NOT reuse any old batteries. Run times will be calculated during the first several IOPs that will determine the change interval.
- Prepare the sample cell by removing the shorting clip and connecting the plug to the respective jack. If the sampler has been prepared prior to the first use at the office then this step may have already been performed. Verify that the cell is connected if you are unsure by removing the sampler top and visibly checking the connection.
- Start the Hobo Pro software and connect the data cable.
- Press the launch button to monitor values. Verify the time interval is set to 2 seconds.
- Connect the battery pack to the sampler and observe the values on the data screen. The voltage channel 1 should be greater than 0.005 volts and may fluctuate as the cell first starts sampling air. If the cell remains at .005 volts then there is a problem. Either the cell is not connected, or the something has failed.
- The three temperatures should reflect the ambient conditions in the sampler and outside. Temperature channel 2 is the sampler temperature. Temperature channel 3 is the ambient temperature sensor with the metal sheath. Temperature channel 4 is the ambient temperature bead thermister. Make sure all channels are reading proper before proceeding with the actual launch of the data logger.
- Launch the data logger and make sure that no errors are reported with the launch. If errors are encountered then go back to the prior step to relaunch.
- Verify that the GPS has been downloaded. If you are unsure then download the data using the file naming convention: Sitename mmddyy hhmm where:
  Sitename is either Boulder, Daniel or Jonah
  mmddyy is the twodigit month day and year
  hhmm is the two digit 24-hour designated hour and minute that the data is downloaded
- Clear the track memory in the GPS. Verify that the GPS is set to record data at the fixed interval of 2 seconds.

- Tape the GPS to the side of the sampler and make sure that the tape has been properly wrapped around the sampler to secure the lid to the sampler.
- Make sure that the battery pack is secured by tape covering the compartment.
- Secure the instrument package to the tether line making sure that the side of the sampler that has nothing protruding is against the line. Take care in making sure the temperature shield is not damaged.
- If it will be a time between the preparation and the actual sounding, the battery may be disconnected. But take care to reconnect it and verify the pump is operational before performing the sounding.

1.3 Procedures Following a Sounding

- Allow the sampler to run for five minutes following the return to the ground with the sampler located about 10 feet above the ground. Note the date, time and ozone readings from the site analyzer front panel during this run time.
- Verify the pump is still running in the sampler. Place the zero filter on the sampler taking care not to crimp the inlet. Use the fine sandpaper strip if needed to grip the line. Allow the sampler to zero for two minutes.
- Carefully remove the zero filter from the inlet taking care not to pull the tube from the sampler. Use the fine sandpaper strip if needed to grip the Teflon line.
- Disconnect the battery from the sampler. This will save both battery and cell life.
- Download the sampler using the BoxCar version 4.3 software. The file naming convention is as follows: Sitename_sonde_s/n-interface_s/n_mmddyy_hhmm.dtf where:
  Sitename is either Boulder, Daniel or Jonah
  sonde_s/n-interface_s/n is the prepared values in the description. *These are also written on the metal portion of the sampler and abbreviated on the outside of the sampler case. This sampler case also has a letter that designates the sampler for **B**oulder, **D**aniel or **J**onah. Verify you have the correct sampler for your site*
  hhmm is the hour and minute the data are downloaded.
  Additional notes: The filenames will contain spaces and the spaces are denoted by the "_" character above. An example of a actual filename is:

  Boulder 2Z0583-102 012907 1637.dtf

- Download the data from the GPS using the EasyGPS software. Select the download of all data, even though some categories will not be present. Save the file in the .GPX format with the following naming convention: Sitename_mmddyy_hhmm.gpx where:
  Sitename is either Boulder, Daniel or Jonah
  mmddyy is the two digit month day and year
  hhmm is the two digit 24-hour designated hour and minute that the data is downloaded
  Additional notes: The filenames will contain spaces and the spaces are denoted by the "_" character above. An example of a actual filename is:

  Boulder 013007 1625.gpx

1.4 Procedures for Inflation and Operation of the Tethered Balloon

- As indicated above, first priority is safety. No operation should be performed that could pose a hazard to the operator or to property at the site. If there are any questions as to whether the balloon system can be operated safely then the Field Manger, Don Lehrman, or Bob Baxter should be contacted. No operations under windy conditions that could limit the operators' ability to safely operate the system will be performed.

- For safety reasons and for more efficient handling, two operators will be required for the initial balloon inflation. If possible, the inflation should take place during daylight hours on the day before the commencement of actual IOP sampling so that extra personnel can be utilized and any problems that arise can be rectified without delaying or canceling scheduled soundings. Attach the 10' safety chain to the main balloon tether connection loop at the bottom of the balloon before starting inflation. While one operator holds the balloon, the other operator will insert the furnished balloon filler tube into one of the two inflation inlet-valves at the bottom of the balloon. The inflation operator will hold the filler tube in place while the helium cylinder is turned on. As the balloon inflates in this manner, the second operator will maintain control of the balloon until it is estimated that it is fully inflated. Additional helium can be added to the balloon by one person during the period of operations, but care must be taken to insure that the balloon is connected to the 10' safety chain and that additional tethers are holding the balloon in position for inflation. Total inflation of the balloon will require just less than two (2) cylinders of helium.

- The inflated balloon will be tethered to ground stakes with ropes from the top and bottom of the balloon as well as the 10' safety chain. It will be "parked" in this manner as close to the ground as possible during periods of no sounding operations such as over night or between IOP's. However, if strong winds in excess of 15 kts are expected, it is recommended that the balloon be deflated enough to be temporarily stored in the onsite shelter. This will be up to the judgment of the site operator, and the Field Manager. The balloon will be completely deflated and stored away in its transport container after the termination of IOP field operations.

- IOP tethersonde operations at each of the three tethersonde sites will consist of at least six (6) "flights" per day, every 1.5 hours, starting at 0830 MST. More flights, and an earlier starting time may be required at some or all sites during the course of the project. Flight schedule changes will be determined by the Field Manager.

- A flight will consist of the raising of the balloon to the full length of the 1000' (330 m) tether, holding the position for at least five (5) minutes and then lowering it back to near the surface. The zero and "ground truth" checks (described above) will be carried out at the end of the flight with the sounding package elevated above the ground at the most appropriate height for a representative comparison with the stationary onsite measurements. The balloon will then be secured to the ground using the 10' safety chain and the main tether line until the next flight. Data downloading procedures described above will then be accomplished. It may be desirable under very light wind conditions to "park" the balloon at some intermediate height above the ground during periods between flights. This will be done only when requested by the Field Manager.

During such instances, the balloon and instrument package will be particularly vulnerable, as the entire systems will be secured to the ground only by the main tether line. The operator should maintain a close observation of conditions during such times. Data downloading will by necessity take place at the first available opportunity.

The following are procedures for preparing, operating and data retrieval for the aircraft sampling systems.

Special Notes:

- First and foremost, safety is the number one priority. No operation should be performed that could pose a hazard to the operator or aircraft. If there are any questions regarding safety concerns for the flight, the Field Manger (Don Lehrman or Bob Baxter) should be contacted.
- When working with the ANODE and CATHODE solutions, take great care not to mix the syringes and solutions, otherwise all will be lost!
- When the samplers and spare cells are transported, never tip them as the fluids might leak.

1 Ozone Sampler Servicing – Laboratory Cell Preparation

- Prepare the initial sample cells. The following steps assume that the cells to be used have been previously flushed with distilled water and are dry (or been in storage since the last flushing and drying), and that the cells will be put into use within 24 hours of preparation.
    - Place an appropriate amount of CATHODE and ANODE solutions in their respective cups. As none of this solution should be returned to the original bottle, take care to only use what is necessary for the cells to be prepared.
    - Fill the CATHODE syringe and charge (fill) each of the CATHODE cells up to the bottom ridge line (approximately 1/3 of the way from the bottom of the cell).
    - Fill the ANODE syringe and charge each of the ANODE cells to the bottom ridge line on the cell. Place the cap with the short lines on the ANODE cell.
    - Using the CATHODE syringe, withdraw all CATHODE fluid from the CATHODE cell and discard. Take care not to damage or deform the platinum screen or Teflon rod. Immediately following the removal of the CATHODE fluid, fill the CATHODE cell with fresh fluid to the top ink-marked line.
    - Carefully place the cap with the long lines on the CATHODE cell. Make sure the Teflon rod on the bottom of the cell is inserted into the long tube and the long tube is not forced to deform the Platinum screen. Make sure that the long tube on top is aligned to have the arc toward the cell wires and Velcro strip.
    - Check the cell voltage. It should be positive and above about 25 mv. If the cell voltage is negative the start the preparation process over. If the repeated check is a negative voltage then the cell is bad.

- If the cells are used after 24-hours from initial preparation then the cathode solution should be replaced (anode is fine).

2 Aircraft Monitor Setup

- Install the sampling lines for ozone and $PM_{2.5}$, as well as the temperature sensor. The $PM_{2.5}$ sample line is ¼" copper tubing, providing a rigid base. Strapped to it is 1/8" Teflon tubing and the wiring leading to the temperature sensor. Using the Cessna cabin air vents, insert the tubing into the air vent such that the temperature probe and $PM_{2.5}$ sample tubing are just visible in the vent opening on the leading edge of the wing. The ozone sample tubing should bend and stick out of the vent opening about 1". Using duct tape, cover up a portion of the vent opening, leaving approximately a ¼" slit, in order to restrict the volume and velocity of the air going past the $PM_{2.5}$ inlet.
- At the beginning of each day, load fresh AA batteries (8 each) into the battery of the ozone/logger package and the GPS unit, and C batteries into the DustTrak; discard and DO NOT reuse any old batteries. Batteries will last for at least 6 hours of flight time.
- Prepare the ozone sample cell by removing the shorting clip and connecting the plug to the respective jack.
- Place ozone/logger package and DustTrak in the rear passenger area and connect the samplers to their respective sample lines. Connect the data logger plug jacks, making sure that the male and female labels match. Jacks must be connected for $PM_{2.5}$ and temperature. Connect the GPS using its cable to the serial port of the data logger and place it on the dashboard at the front of the cabin, with good exposure out the window.
- Connect the Campbell Scientific logger readout unit to the data logger and select the appropriate data screen for viewing the data.
- Connect the battery pack in the ozone/logger package and turn on the DustTrak. Using the logger readout unit, scroll to the Cessna data tables and check the ozone value. Initially, the ozone channel should be greater than 0 ppb and may fluctuate as the cell first starts sampling air. If the cell remains at 0 ppb then there is a problem. Either the cell is not connected, or the something has failed.
- Turn on the power for the DustTrak and GPS unit.
- Conduct a zero check of the ozone sampler by place a ozone scrubbing cartridge at the end of the sampling line. It should be less than 5 ppb. After removing the zero filter, compare the reading with ambient ozone readings from a reference analyzer, if available. Prior to connecting the sample line to the DustTrak, conduct a flow check and zero check of the sampler using the supplied rotameter and zero filter, respectively. The flow should be 1.7 lpm and the zero less than 5 $\mu g/m^3$. Record all check values. Verify that the temperature reading is representative of ambient conditions and that the GPS unit is reporting a location. All above checks are made using the logger readout unit.

3 In-flight Procedures

- Periodically review the logger readout unit to check for instrument performance. The ozone reading should not be noisy (variations greater than ±5 ppb). Noise may be an indication of drying cells. The spare cell can be used if problems are noted.
- Make sure that none of the GPS values (speed, heading, altitude, position) read zero or invalid. If zero or invalid readings are noted, the most likely cause is a poor cable connection most likely at the GPS unit. If bad readings are still noted after checking the cable, reposition the GPS unit in the window.
- Temperature readings should agree within a couple of degrees with the aircraft sensor.
- Extra batteries should be taken on all flights. Any of the batteries can be changed in flight if needed.

4 Procedures Following a Flight

- Verify that the pumps for the ozone sampler and DustTrak are still running.
- Turn of the DustTrak and GPS unit.
- Download the data logger as quickly as possible using the LoggerNet software version 3.3.1.
- Disconnect the battery pack in the ozone/logger package. This will prevent the data logger from continuing to log data, writing over existing data with null data.