The UNderstanding Severe Thunderstorms and Alberta Boundary Layers Experiment - UNSTABLE

An Update on Environment Canada Activities

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Planning continues in preparation for the UNSTABLE field campaign slated for the summer of 2008. We are in the process of developing the formal science plan for the experiment and continue to address issues related to experimental design, available data collection platforms, mesonet site locations, and other planning and logistical issues. During the summer and fall of 2006, the authors were involved in a number of activities directly related to preparation for UNSTABLE. Three of these activities will be briefly described here along with some future planning information.

Deployment of 3 Mesonet Stations

During the summer of 2006, three ATMOS (Automated Transportable Meteorological Observation Stations) stations that are to be used as part of the UNSTABLE surface mesonet were tested in the Caroline area of the Alberta foothills (see Figure 1 below). The stations were deployed with approximately 5 km spacing. The Caroline area was selected for its location relative to known areas of frequent thunderstorm activity and for its close proximity to existing stations from the Foothills Orographic Precipitation Experiment (FOPEX – Smith 2005) as illustrated in Figure 2. Some details on the ATMOS stations are included here in terms of instrumentation and data collected. A photo of one of the stations is shown in Figure 3.

- **10m Wind Speed and Direction**: RM Young 05103-10 wind monitor
- **1.5m Temperature and Humiditiy**: HMP 45C T/H sensor + shield
- **Precipitation (liquid)**: TE 525 tipping bucket rain gauge
- **Dfference in Temperature between 0.5m and 9.5m**: thermocouple + shields
- **Station Pressure**: Vaisala PTB210 pressure sensor + SPH10 static pressure head
- **Incoming Solar Radiation**: SP-Lite radiation sensor (1 component - downwelling solar)
- **Datalogger**: CSI CR1000-55 datalogger + enclosure and power supply
- **Communications**: telemetry (cell phone, hourly access)
- **Power**: solar panel

The deployment of these stations was very much viewed as an experiment to assess the following:

- Feasibility of finding suitable sites for mesonet stations in the foothills region
- The stability of the stations in the summertime convective season over the foothills region
- Reliability of cellular data communication with the stations
- The feasibility of ingesting the data, in real-time, into experimental software used on a Research Support Desk in Prairie and Arctic Storm Prediction Centre (PASPC) operations
- Gains in mesoscale surface measurements given high spatial resolution of the stations

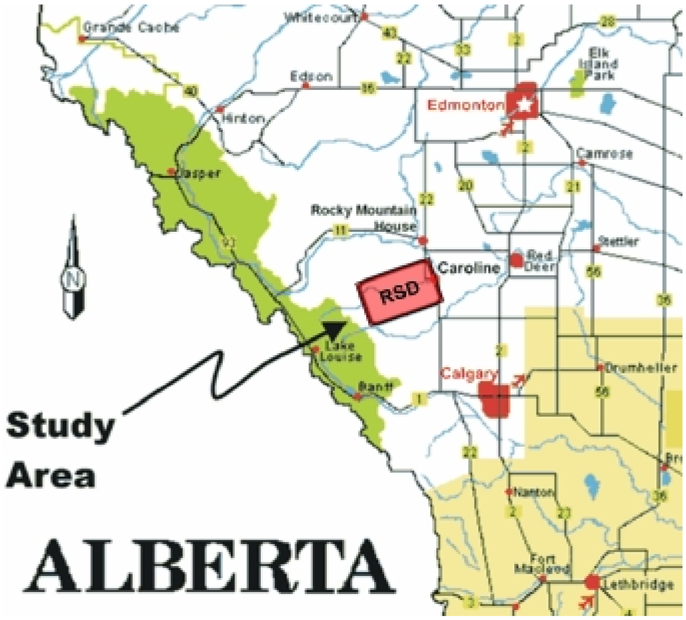

Figure 1: Location of the ATMOS stations in Alberta. The red box marked RSD denotes the locations of the FOPEX and ATMOS stations. Data from these stations were used in real-time on the Research Support Desk (RSD) in PASPC operations.

Figure 2: Locations of the ATMOS stations relative to the FOPEX stations (marked AB1, AB3, AB4).

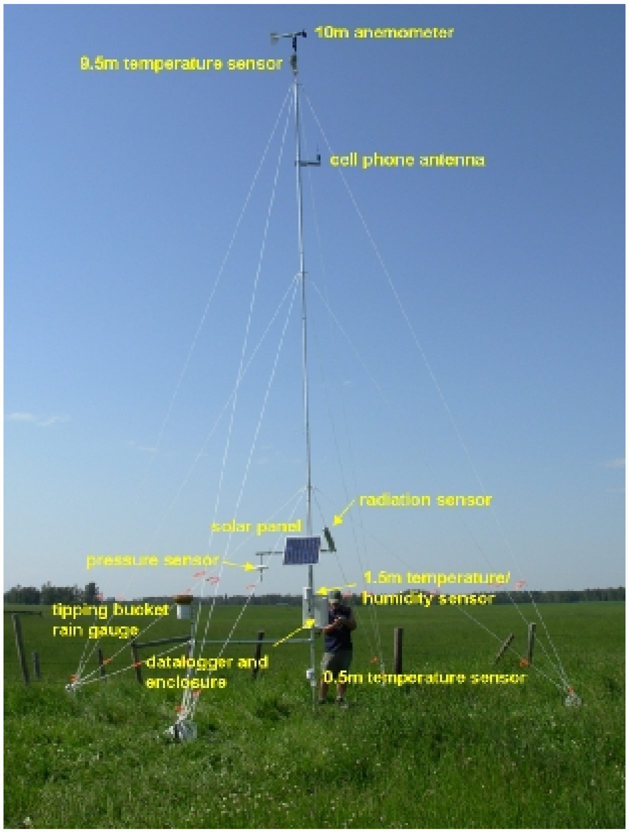

Figure 3: Photo of one of the ATMOS stations during installation. The instrumentation is labelled and the individual in the photo is Jeff Sowiak of MSC Technical Services, Edmonton. The technical group in Edmonton were instrumental in the successful deployment of the three stations.

The deployment of the ATMOS stations during the summer of 2006 was viewed as a success. Some comments are:

- Land owners were found to be accommodating in allowing use of their land as long as the area remained unaltered after the station was removed
- A two person team is able to deploy two ATMOS stations in one day if they are in close proximity. Similarly, two stations can easily be dismantled and packed up in one day. For UNSTABLE, fencing considerations for a number of sites will likely increase the time for each deployment / removal.
- If real-time communications with the stations are in place for UNSTABLE, it is recommended that the data be ingested by a stable LINUX server as opposed to a PC-based software application and phone modem as was the case for the 2006 test. Such an arrangement proved to be unreliable.
- Data from the ATMOS stations were passed on to forecasters at PASPC Edmonton in real-time. The data have yet to be analysed together with synoptic observations and FOPEX data.

Testing of a Vehicle-Mounted Mobile Mesonet Unit

Environment Canada had an engineering firm construct a mobile weather station similar to that developed by the National Severe Storms Laboratory in the United States for the VORTEX field campaigns in the late 1990s. The unit is mounted to the roof of a car using a standard utility roof rack (see Figure 4). The unit was shipped to Edmonton to coincide with Sills' visit to the Edmonton forecast office in July of 2006. Two test runs were conducted with the unit over a weekend in July. On 23 July, the authors drove the unit to the Caroline area to compare the mobile data to that collected by the ATMOS stations in the Caroline area.

Figure 4: Photo by Sills of the mobile mesonet unit during testing on 23 July 2006.

The vehicle was driven to and in between each of the 3 ATMOS stations and mobile measurements collected for comparison with the stationary ATMOS observations. Figures 5 through 7 highlight the comparisons of some measured variables. Each plot is a time series of measurements averaged over 1 minute for the mobile measurements and 5 minutes for the ATMOS stations. The time periods within the vertical lines are when the mobile unit was within the compound occupied by the ATMOS stations. The entire time period extends from the time that the vehicle was first within 5 km of ATMOS 5 (2250 UTC), while the vehicle moved from station to station, and until 0130 UTC when the vehicle was parked in Caroline.

The mobile unit was found to be secure on the vehicle for speeds up to 110 kmh^{-1} and, with the exception of some problems with the datalogger program decoding wind information, performed well as shown in the plots below.

The test of the mobile mesonet unit is considered a success. Similarities between data collected from the mobile and ATMOS stations when the vehicle was in close proximity to them are encouraging. Both the mobile and ATMOS observation platforms provide opportunities to obtain high resolution spatial and temporal measurements of atmospheric characteristics that are well beyond what can be resolved by the current synoptic observing network of surface stations. During UNSTABLE such observations will be used to resolve the small-scale processes involved in convective initiation and other storm-related processes and weather. There are plans to increase the mobile sampling frequency to resolve fine scale boundaries and discontinuities.

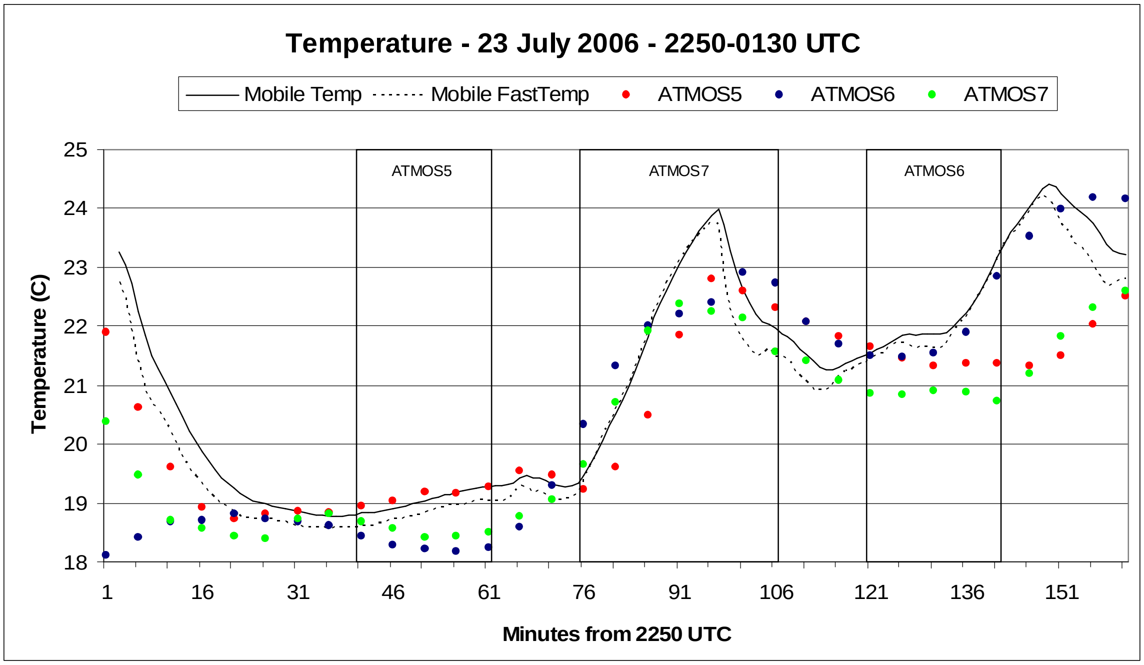

Figure 5: Time series of mobile and ATMOS temperature observations from 2250 UTC to 0130 UTC. The periods between the vertical lines highlight when the vehicle was in close proximity to the ATMOS station as indicated at the top of the graph. The spike in temperature during the period near ATMOS7 is due to the aspirator fan for the temperature sensor being turned off for approximately 20 minutes to assess impacts on temperature measurements.

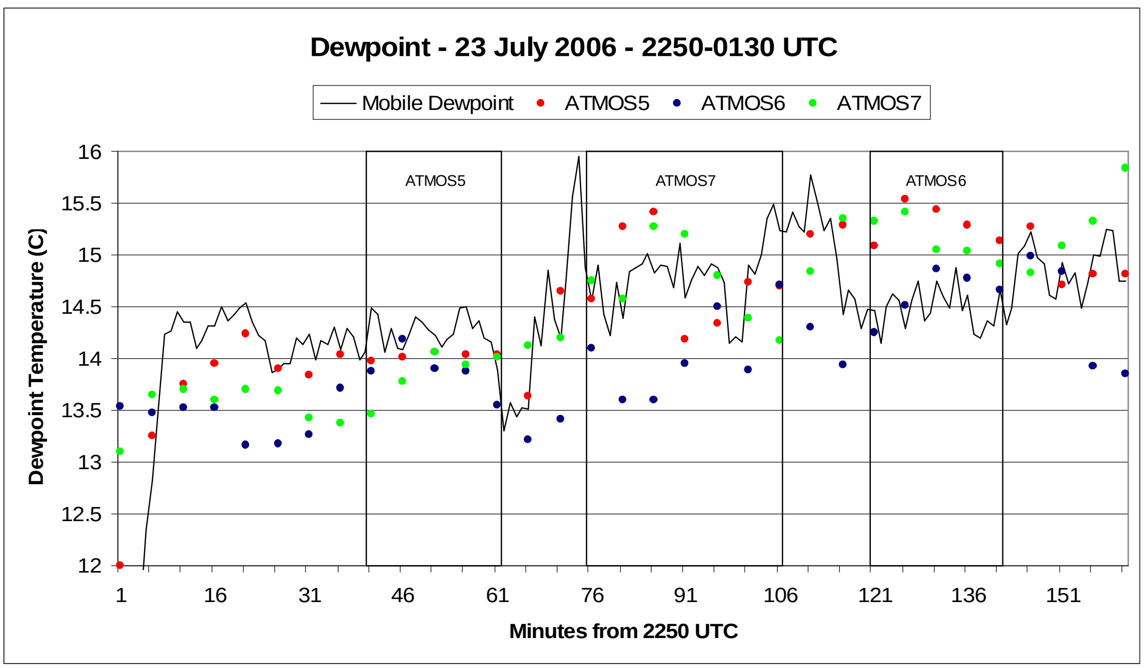

Figure 6: As in Figure 5 but for dewpoint temperature. 1 minute averaged measurements of dewpoint from the mobile unit showed significant variability as compared to the 5 minute averages recorded by the ATMOS stations, even when the vehicle was stationary beside the station. The high spatial and temporal measurements of these two platforms highlight variations in boundary layer moisture that can not be resolved by synoptic surface observations available to operational forecasters.

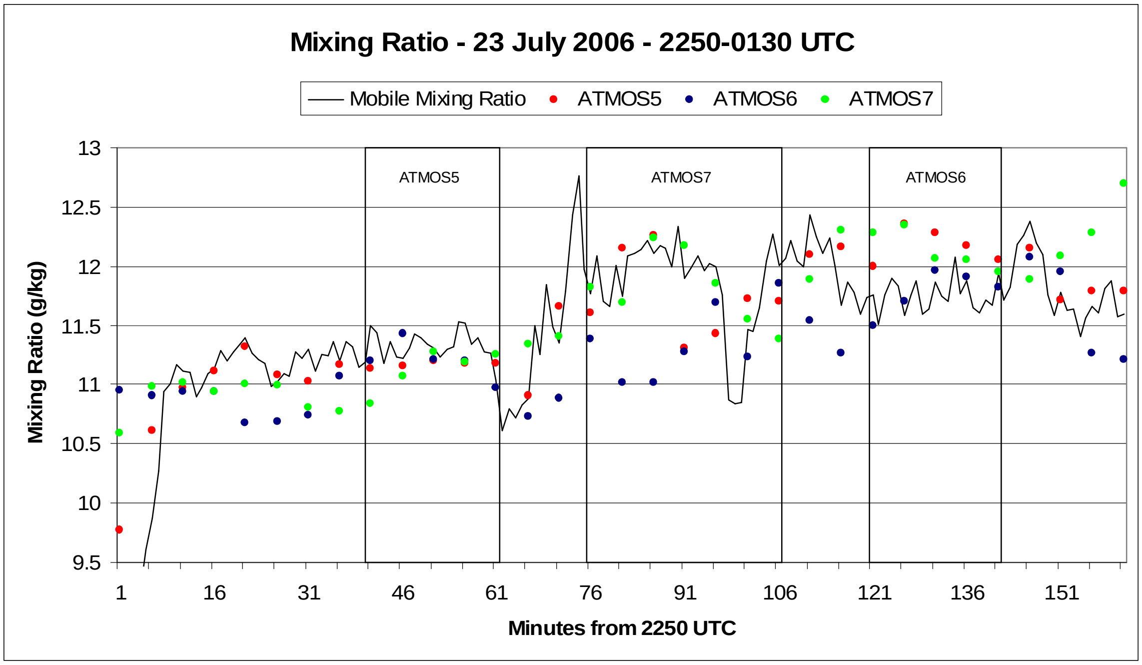

Figure 7: As in Figure 5 but for mixing ratio.

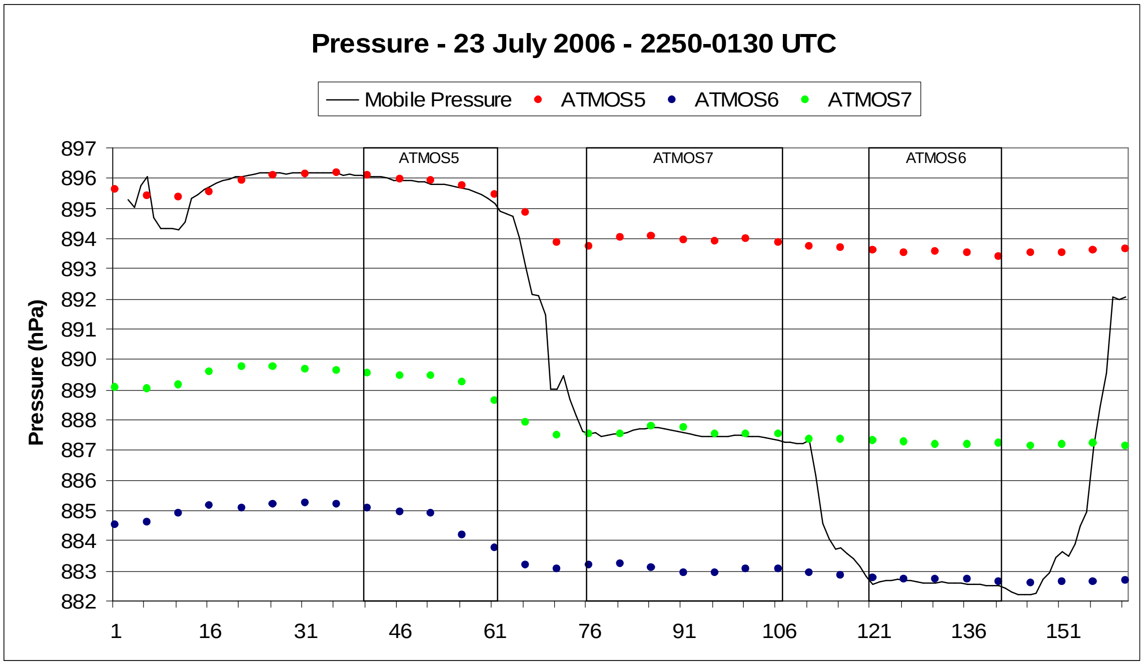

Figure 8: As in figure 5 but for atmospheric pressure.

UNSTABLE Mesonet Preliminary Site Selection

From 27 to 29 September 2006, staff from the Hydrometeorology and Arctic Lab conducted preliminary site selections for the UNSTABLE mesonet that was proposed at the meeting at the 40th CMOS Congress in Toronto (Taylor and Sills 2006). Using a hand-held GPS unit and Google Earth imagery, clearings on the order of 100 m^2 were able to be located within heavily forested regions of the Alberta foothills. As shown in Figure 8, the sites that were considered acceptable for mesonet station locations are in close proximity to the proposed locations of the mesonet array. Further work is required to obtain land use agreements with land owners or those that lease the land. It is anticipated that the number of mesonet stations will exceed 10 so the original 14 station array (including existing stations) has been expanded to the southeast so that Calgary will be included in the study area.

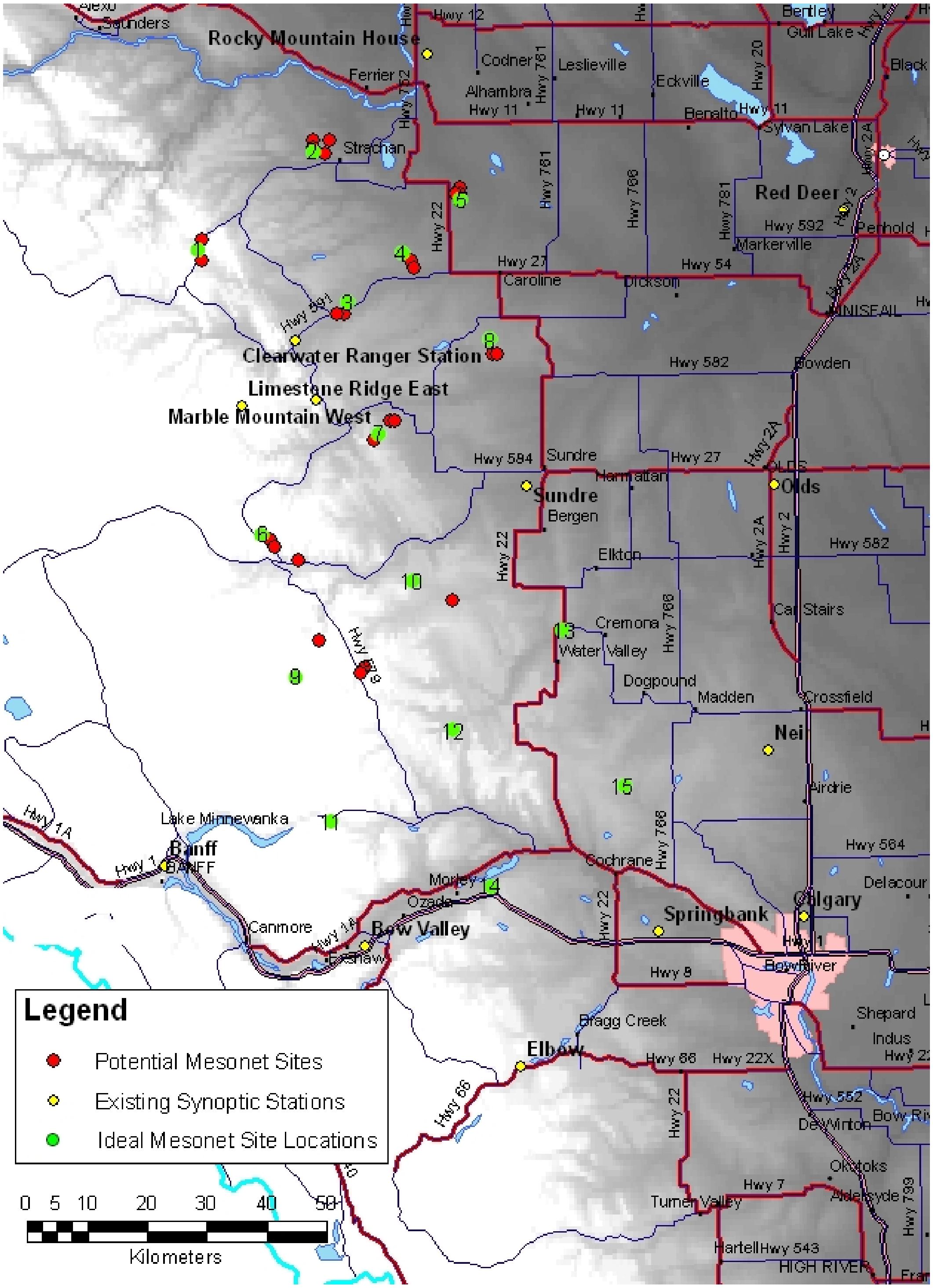

Figure 8: Map of the proposed UNSTABLE study area. Yellow points are existing synoptic stations (includes the FOPEX stations adjacent to mesonet site number 3) and green numbered points are ideal locations for mesonet stations. Red points are sites that were visited in the fall of 2006 that may serve as suitable mesonet station locations for the UNSTABLE field campaign in 2008.

Future Work

Much work remains to develop the science plan and prepare for the UNSTABLE project in 2008 and work in this regard will occupy a large portion of our efforts over the next 18 months. A first step is a review, by UNSTABLE participants and other interested parties, of proposed ‘science questions’ to be answered via the experiment (the questions are attached in a separate document). Comments and feedback on the questions will be used to refine the basis of the science plan under development.

References

Smith, C., 2005: The relationship between elevation and monthly precipitation accumulations in the Alberta foothills. Presented at the *39th Annual CMOS Congress*, Vancouver, BC.

Taylor, N. M. and D. M. L. Sills, 2006: Understanding severe thunderstorms and Alberta Boundary Layers Experiment (UNSTABLE). *Report on the meeting at the 40th CMOS Congress*, Sheraton Centre Hotel, Toronto, May 30th 2006.