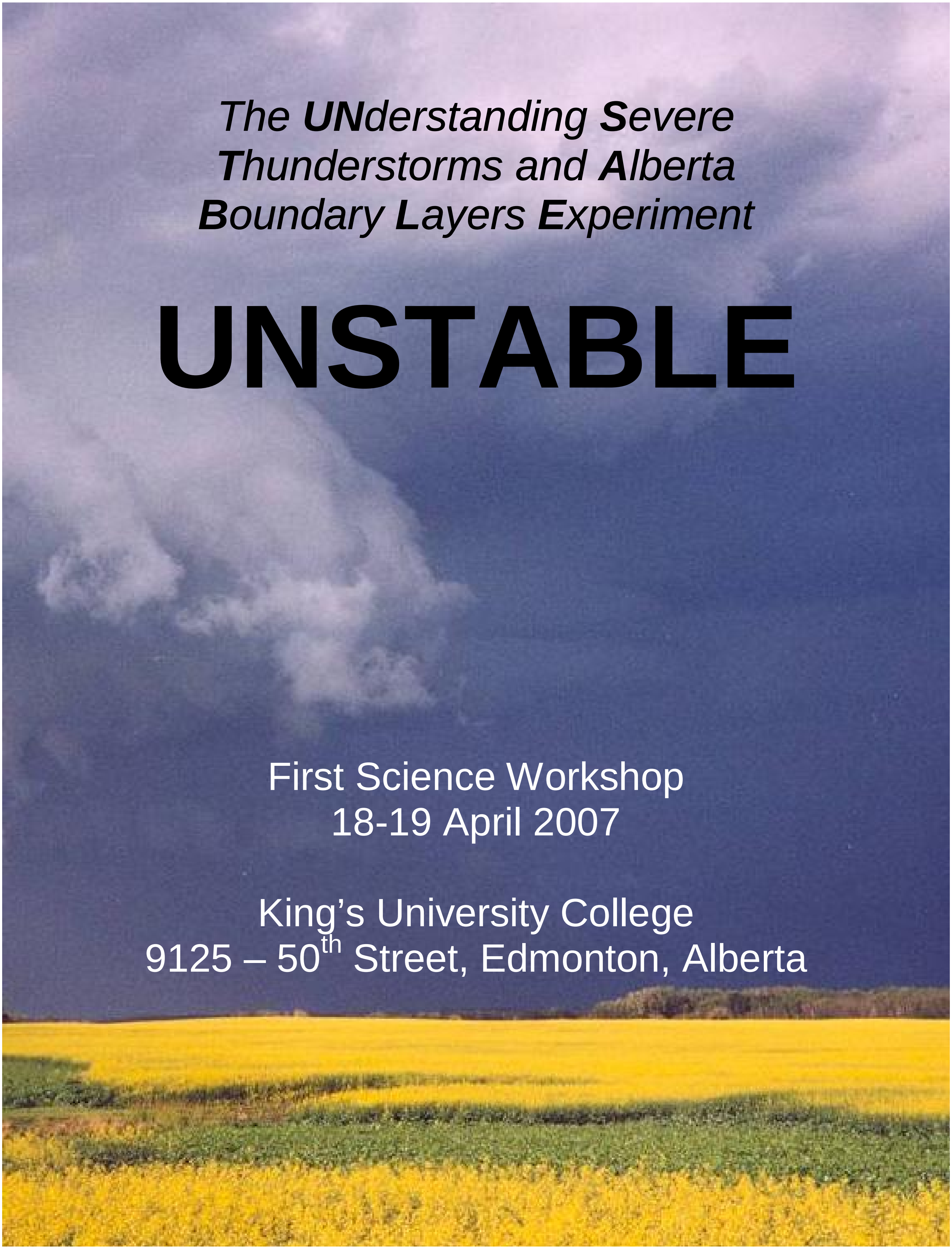

*The **UN**derstanding **S**evere*
***T**hunderstorms and **A**lberta*
***B**oundary **L**ayers **E**xperiment*

UNSTABLE

First Science Workshop
18-19 April 2007

King's University College
9125 – 50th Street, Edmonton, Alberta

First UNSTABLE Science Workshop – Agenda

18 April 2007 (Room N101)

Introduction

0830 Welcome (Gary Burke, HAL)
0840 UNSTABLE Overview (Taylor)

<u>I: UNSTABLE Observations</u>

0900 Following FOPEX and A-GAME: CRD Interests and Contributions to UNSTABLE (Smith)
0915 The Foothills Climate Array (FCA): A Tool for Examining Horizontal Variability Associated with Summer Convection (Adams)
0930 GPS Measurements of Precipitable Water and support to UNSTABLE (Skone)
0945 Alberta Environment Surface Weather Stations (Keller)
1000 Alberta Agriculture Surface Weather Stations and Data Quality Control (Wright)

1015 – 1045 Break

<u>II: UNSTABLE Collaborators</u>

1045 Exploring Linkages between Plant-Available Soil Moisture, Vegetation Phenology and Convective Initiation (Brimelow)
1100 Of capping Lids, Drylines, and Alberta Thunderstorms (Strong)
1115 Research Interests and Support to UNSTABLE (Reuter)
1130 PASPC Support to UNSTABLE (McCarthy)
1145 UNSTABLE, DRI, and Water Cycling (Stewart)

1200 – 1300 Lunch (Provided – full service cafeteria also available if necessary)

<u>III: Science Discussions</u>

1300 Science Question 1 (Taylor / Sills)
1330 Science Question 2 (Hanesiak)
1400 Science Question 3 (Milbrandt)
1430 Break-out Discussion Instructions

1435 – 1500 Break

1500 Break-out Discussions in Assigned Rooms
1620 Reconvene in Room N101
1630 End for the Day
1800 Dinner at Chianti Café and Restaurant (see map included on last page)

19 April 2007 (Oak Room)

IV: UNSTABLE Science Discussions

0830 – 0850 Group 1 Presentation
0850 – 0910 Group 2 Presentation
0910 – 0930 Group 3 Presentation
0930 Open Discussion

1000 – 1030 Break

1030 Continued Discussion

1200 End of Workshop

Detailed Agenda
Wednesday 18 April, 2007

0900-0915

Following FOPEX and A-GAME: CRD Interests and Contributions to UNSTABLE

Craig Smith
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FOPEX:
In 2001, 6 meteorological stations were installed by the Climate Research Division in an elevation transect between Caroline and Limestone Mountain. The primary objective of the Foothills Orographic Precipitation Experiment was to examine the relationship between precipitation and elevation in this region of complex topography. While precipitation measurements are the focus, all stations are equipped to observe core meteorological variables. Currently, three of these stations remain operational: the Clearwater ranger station (AB1) at 1280 masl, Marble Mountain West (AB3) at 1640 masl, and Limestone East (AB4) at 1950 masl. Observations include precipitation, temperature, humidity, pressure, surface wind speed and direction, and net radiation. All three sites have near-real-time communication capability via cellular or satellite transceivers and will be functional during the UNSTABLE field campaign.

A-GAME:
During the Alberta GPS Atmospheric Moisture Evaluation study, over 80 radiosondes were launched in two summer field campaigns from three locations in southern Alberta. The primary objective of A-GAME was to assess the accuracy of precipitable water vapour (PWV) estimates obtained through the use of GPS receivers against conventional radiosonde techniques. Intercomparisons at co-located sites show a very good agreement between the two techniques suggesting that high resolution GPS derived estimates of PWV in southern Alberta could be very useful for future atmospheric and hydrological research in this region.

Interests:
The above research projects illustrate the interest of the Climate Research Division in precipitation and atmospheric processes as they relate to cold region climate processes. UNSTABLE has the opportunity to examine atmospheric (and surface) processes and their interaction with complex topography in the development and enhancement of heavy precipitation events. UNSTABLE will also provide an opportunity to assess and validate GEM model products which are a useful source of meteorological data in a region of sparse observations.

Contributions:
CRD is planning to contribute manpower and resources to UNSTABLE. These contributions will include an extension to the FOPEX study period so that the existing sites will continue to operate throughout the UNSTABLE field campaign. CRD will also provide up to two (static or mobile) upper-air receivers and the personnel and expendables to operate at least one of these systems. A dual-frequency GPS receiver can be made available for the derivation of integrated precipitable water vapour.

0915-0930

The Foothills Climate Array (FCA): A Tool for Examining Horizontal Variability Associated with Summer Convection

Manda Adams
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The Foothills Climate Array (FCA), which consists of a mesonet of over 250 weather stations, was established in 2003 as a long-term observational study covering an area 200km by 120km. The FCA weather stations are spaced approximately 5km apart in the east-west direction, 10km in the north-south direction, and vary in elevation from the Continental Divide down to the foothills and plains of Southern Alberta. The mesonet includes observations of temperature, relative humidity and precipitation. The high temporal and spatial resolution of the FCA mesonet makes it an excellent tool for examining the local variability of the boundary layer and precipitation associated with summertime convection. Data from the FCA has already been used to examine the record precipitation in Southern Alberta during the 2005 summer.

0930-0945

GPS Measurements of Precipitable Water Vapour and Support to UNSTABLE

Susan Skone
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Continuously operating GPS reference stations can be used to provide precise measurements of precipitable water vapour (PWV) at high temporal resolution. Networks of such reference stations can be used to derive spatial maps of PWV. The University of Calgary operates a network of GPS reference stations in southern Alberta with coverage in the foothills region. Signatures associated with thunderstorm development have been observed near Sundre during summer months. The University of Calgary also operates a microwave water vapour profiler and a water vapour radiometer; these instruments are portable and can be used to augment atmospheric moisture studies in a given region. Data sources and potential for thunderstorm studies will be discussed.

0945-1000

Alberta Environment Surface Weather Stations

Ray Keller
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1000-1015

Alberta Agriculture Surface Weather Stations and Data Quality Control

Ralph Wright
Alberta Agriculture
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1045-1100

Exploring linkages between plant-available soil moisture, vegetation phenology and convective initiation

Julian Brimelow
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The planetary boundary layer (PBL) and underlying land surface are intrinsically linked. In particular, the amount of moisture available in the root zone (top 1 m of soil for crops) is critical in governing certain processes that are important for the initiation of deep moist convection (CI). For example, the plant-available soil moisture in the root zone regulates both the amount of water vapour that is transpired into the PBL and the partitioning of sensible and latent heat fluxes. The surface heat and moisture fluxes are also governed by vegetation type. Over the UNSTABLE project area, there is a marked transition from coniferous forest over the foothills to cropland over the prairie. The contrasting phenology of these vegetation types likely exerts a marked influence on the surface heat and moisture fluxes.

Our proposed contribution to UNSTABLE will be carried out under the auspices of the Drought Research Initiative (DRI). To ensure continuity between our DRI research objectives and those of UNSTABLE, we will focus on addressing the first two science questions outlined in theme two of the UNSTABLE science plan.

To study the impact of plant-available soil moisture and vegetation type on the structure of the boundary layer, and the initiation of deep moist convection, requires adopting a multi-disciplinary approach. During UNSTABLE, several observation platforms will be employed to quantify and document the structure and evolution of the boundary layer before and during CI episodes. Specifically, surface observations from a mesonet will be complemented by satellite observations of cloud coverage and normalized vegetation index (to quantify the health and density of vegetation), lightning detection network data, and weather balloon and radar data. Data from mobile data collection platforms will also be critical for studying the impact of surface processes on CI. In particular, the Mobile Atmospheric Research Station will provide the capability to obtain ground-based profiles of water vapour, temperature and wind, as well as cloud base heights. Ideally, eddy covariance measurements of moisture and heat fluxes will be available over different vegetation types and areas having contrasting soil moisture.

In addition to the real-time measurements of atmospheric and surface variables, extensive use will be made of the Raddatz crop phenology model of soil moisture simulations to monitor the spatial distribution and evolution of soil moisture. Every day before and during UNSTABLE, maps of plant-available soil moisture will be generated. Ideally, the model will be run using data from all sites in the project area (and adjacent regions) that record temperature and precipitation. The maps will be crucial in identifying areas where the vegetation's water requirements are being met, areas where the vegetation is experiencing water stress, and areas of tight gradients in soil moisture. It would be very beneficial to supplement the crop model output with in-situ measurements of soil moisture at several mesonet sites located over cropped land.

Following UNSTABLE, data from all of the aforementioned resources will be integrated and subjected to statistical analysis in an attempt to quantify the linkages and possible feedbacks between the terrestrial components and deep moist convection.

1100-1115

Of Capping Lids, Drylines, and Alberta Thunderstorms

Geoff S. Strong
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The *multi-scale model of Alberta thunderstorms* was first proposed (Strong, 1986) to explain why and how severe thunderstorms have a preference to form along the east slopes of the Alberta foothills, rather than closer to their primary source of boundary layer moisture over the plains east of the foothills. Cyclogenesis evolving over southern Alberta induces an easterly component of moist boundary layer air over central Alberta. This moisture moves upslope into the foothills, underruning a strong *capping lid*. The lid temporarily caps convection until the point where mesoscale convergence and resulting boundary layer ascent weakens and removes the lid over the higher foothill slopes through adiabatic cooling. The *mountain-plains circulation* so induced with the formation of these storms helps maintain them, and in the right circumstances, allows smaller-scale foothill storms to grow in size and intensity once over the prairie moisture source, sometimes becoming the more familiar mesoscale convective complex (MCC) of the eastern prairies and the U.S. High Plains.

However, we have now demonstrated how, in some cases, a *dryline*, induced by a southwest flow of dry air aloft, subsides in the immediate lee of the Rockies, becoming in effect a summer *Chinook*, then interacts with the back side of the moisture-laden capping lid. This interaction helps dynamically to trigger a severe storm in some instances, but plays no significant role in other cases. The current study, begun under A-GAME (2003), will continue to investigate this particular aspect of drylines over the foothills during UNSTABLE-2008, using fixed and mobile surface transects, together with any available sounding profiles and the high temporal resolution of GPS moisture. In this presentation, LIMEX-85 data and recent mobile transects are used to demonstrate the effects of *dryline-capping lid* interactions.

1115-1130

Research Interests and Support to UNSTABLE

Gerhard Reuter
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1130-1145

Prairie and Arctic Storm Prediction Centre (PASPC) Support to UNSTABLE

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1145-1200

UNSTABLE, DRI, and Water Cycling

Ronald Stewart
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The convective activity along the eastern flanks of the Rockies is a critical feature of the region's climate. This convection is sometimes severe but it always results in the redistribution of moisture within the atmosphere and between the surface and the atmosphere. In this presentation, the importance of convective activity to water cycling is highlighted and it is shown that, even in times of drought, some convective activity is often present. During drought and in other instances as well, the convective activity often produces virga which acts to moisten the boundary layer from above. Given UNSTABLE's interest in surface interactions and moisture, it will benefit from the numerous observational and modelling datasets as well as analysis products that are being assembled or generated by DRI. In turn, DRI will benefit from UNSTABLE's focus on better understanding the convective processes that play a crucial role in the cycling of water over the Prairies.

1300-1430

During this session science question leads will present motivation and strategies for answering their respective questions as defined in the draft scientific overview document.

1500-1630

Break-out discussions in respective meeting rooms. Groups are asked to discuss the following general items for each science question:

- Refinement of the UNSTABLE science questions (**see page 11**)
- Identification of who plans to be directly involved in the UNSTABLE field campaign and how
- Funding strategies and opportunities for in-kind support
- Data requirements, instrumentation and deployment strategies necessary to answer the science questions
- Champions for data analysis and QC (e.g., instrument owners and their students?)
- Any additional items or comments identified by the group that are important to consider for UNSTABLE

The following rooms will be used for the discussions:

- Science Question 1 – will remain in room N101
- Science Question 2 – room N204 (upstairs above N101)
- Science Question 3 – room N205 (upstairs above N101)

A laptop and presentation template will be provided to document discussion points. One member of each group will be asked to make a short presentation (20 minutes maximum) of the discussion results on Thursday morning.

1630 End Workshop for the Day

Thursday 19 April, 2007

0830-0930

Each discussion group is asked to make a short presentation of results from their discussion on Wednesday Afternoon.

0930-1200 (break from 1000-1030)

Open discussion

1200 End of UNSTABLE Science Workshop

Acknowledgements:

Thanks to Gary Burke (HAL) for supporting this workshop in the form of venue fees and stylish coffee mugs, CMOS for providing hospitality, and Stacey Draganiuk for assisting with arrangements.

Environnement Canada Environment Canada

Canadian Meteorological and Oceanographic Society
La Société canadienne de météorologie et d'océanographie

UNSTABLE Science Questions

Science Question 1: What are the contributions of ABL processes to the initiation of deep moist convection and the development of severe thunderstorms in the Alberta Foothills region?

a. What is the diurnal evolution of the ABL during periods of interest?
b. What is the 4-dimensional characterization of ABL water vapour prior to and during CI?
c. What role do mesoscale boundaries and circulations (mountain-plain circulation, dryline, etc.) play in CI and the development of severe thunderstorms? Can their influence be seen in the severe weather climatology of the region?
d. How does the highly varied terrain in the region influence the development of mesoscale boundaries and circulations?
e. How do mesoscale circulations and boundaries affect the movement, intensity, and morphology of severe thunderstorms in this region?
f. What is the 4-dimensional characterization of the dryline, and how often is it a key factor in the development / evolution of severe thunderstorms?
g. How are mesoscale circulations influenced by synoptic-scale processes?
h. What synoptic / mesoscale processes act to inhibit CI in the region?
i. Under what conditions do thunderstorms generated in the central Alberta Foothills intensify and move southeast over the Calgary area?
j. What factors determine which storms become severe? How do these storms relate to observed boundaries associated with their initiation?
k. Are existing conceptual models for CI and severe thunderstorm development / evolution in this region adequate?
l. How can the current observational network be improved to better represent ABL processes that contribute to the initiation and development of severe thunderstorms?

Science Question 2: What are the contributions of surface processes to the initiation of deep moist convection and the development of severe thunderstorms in the Alberta Foothills region?

a. Is there a noticeable difference in storm initiation and evolution between wet and dry areas over the cropped region (as defined by a crop model) over the duration of the project?
b. Are there noticeable gradients of surface and ABL water vapour across the major wet/dry areas and how do these evolve over the project?
c. Are mesoscale circulations detectable in the vicinity of boundaries between wet and dry areas? If so how do they appear to influence storm initiation and evolution?
d. What are the latent and sensible heat fluxes over the region, especially across any wet/dry areas that may exist? How do they influence temperature and water vapour stratification?
e. How does the orientation of synoptic (background) flows modify b.–d. above on a day-to-day basis?
f. Can the surface contributions of ET to total ABL moisture be quantified?
g. How can the existing observational network be improved to better represent surface processes that contribute to the initiation and development of severe thunderstorms?

Science Question 3: To what extent can high-resolution numerical weather prediction models contribute to forecasting the initiation and development of severe convective storms that originate in the Alberta foothills?

a. What defines a "success" for a high-resolution simulation in terms providing useful numerical guidance from the current GEM-LAM-2.5 configuration?
b. How can the model's ability to accurately simulate the general nature of the observed convection be quantified?
c. Can the atmospheric state be classified a priori as "predictable" or "non-predictable" in terms of recommended use of the GEM-LAM-2.5 run to guide the forecast?
d. How realistic is the evolution of the ABL and surface processes in the foothill regions for the high-resolution model simulations?
e. How realistic are the simulated storm structures and microphysical fields?
f. Can deficiencies in the current physical parameterizations be identified?
g. What would be the effect of performing a subsequent nest to a higher-resolution (e.g. 1-km) grid, driven from the 2.5-km run?
h. Can an ensemble of high-resolution runs improve the prediction of convective triggering?
i. Can a high-resolution analysis, created using the additional observations, improve the prediction of convective initiation and subsequent storm development?

Dinner 6:00 pm Wednesday 18 April
Chianti Café and Restaurant
10501 82 Avenue NW - (780) 439-9829

Directions:

South on 50th Street to West Argyll Road Ramp
Merge with Sherwood Park Freeway and stay right for 82nd Ave.
Chianti's in on SW corner of 82nd Ave. and 105th St.
Parking is available on the street or in a paid lot 1 block south