# Research Statement for Manda Adams

My primary research interests can be classified as mesoscale phenomena, processes, and modeling with an emphasis on phenomena that involve boundary layer processes and/or topographic influences. There are several different, yet complimentary, topics that I foresee building my research group around; 1.) impacts of wind energy on the atmosphere, 2.) topographic flows in Antarctica, 3.) atmosphere-glacier interactions, and 4.) dry-line evolution in Alberta.

The majority of mesoscale modeling related to wind energy has been aimed at determining where to place wind turbines to maximize the available wind and ensure that the wind turbines are spaced far enough apart that they do not draw energy from each other. However, as the size and number of wind farms grows their impact on the atmosphere must be considered. Large wind farms directly influence the atmospheric boundary layer by (1.) reducing wind speeds, (2.) generating blade scale turbulence in the wake of the turbines, and (3.) generating shear driven turbulence due to the difference in wind speed between the turbine wake and the ambient flow. Consequentially, large wind turbines can also have indirect effects on the local climate by influencing surface fluxes, advection of heat and moisture, and turbulent transport in the boundary layer. Through development of a wind farm parameterization for mesoscale models, the local weather and climate impacts of wind farms can be investigated. My research thus far has focused on changes to the basic meteorological fields such as temperature, moisture, wind speed and direction. However, in the future I plan to focus on some specific phenomena, and thus would like to write my first proposal to study the impacts of large wind farms on the low level jet of the Great Plains. The decoupling of the surface layer from the rest of the boundary layer through the development of a radiation inversion in the evening plays a critical role in the development of the low level jet. I wish to investigate the role the extra mixing produced by wind turbines has on the development of the nocturnal radiation inversion, and explore the question “Could wind turbines delay the onset of the radiation inversion and thus delay the onset of the low level jet?”. The timing and strength of the low level jet can often play an important role in the development of severe storms in the Great Plains. The strength and location of the low level jet can also have an impact on the production of wind energy itself due to damage to turbines.

The study of topographic flows in Antarctica is particularly challenging due to the lack of observations, and the need for numerical models that can competently handle both the steep topography and the extremely stable (low Froude number) flow. However the drainage of cold stable air off of Antarctica plays a role in global circulation and thus provides motivation to tackle this challenging topic. In West Antarctica, much of the mass transport occurs in a narrow corridor of the Ross Ice Shelf and is referred to at the Ross Ice Shelf Airstream (RAS). Work from my dissertation showed that some of the variations in the day to day strength of the RAS could be explained by the presence of topographically trapped waves along the Transantarctic Mountains. Characteristics of the topographically trapped waves were identifiable in observations from automated weather stations, however what remains yet to be investigated is how often these topographically trapped waves occur and how predictable they are. The topographically trapped waves were initiated due to a southward surge of cold air from the Ross Sea onto the Ross Ice Shelf. Further research is needed to understand the origins of the cold air over the Ross Sea, as well as to try to quantify how much of the RAS is due to northward transport of continental air versus maritime air that is simply circling around the Ross Ice Shelf and not part of northward mass transport.

The Foothills Climate Array of Alberta consists of 320 backcountry weather stations covering an observational grid of 200 km by 120 km, extending from the continental divide to the agricultural lands east of Calgary. The first phase of the Foothills Climate Array (FCA) will operate for 10 years in the foothills region and is in its fourth year. The primary objective of the FCA is to characterize the spatial-temporal patterns of meteorological variability and to develop physically-based models of the controls of topography and surface environment on surface weather patterns. Data from the FCA will play a critical role in two of my planned research projects: glacier-atmosphere interactions and the Alberta dry-line.

Accurate glacier mass balance depends on accurate understanding of the meteorological fields over the glacier. However, the remote location of most glaciers limits the meteorological observations available. The complex topography surrounding many glaciers can lead to complicated atmospheric circulations, but are not resolved in the available observations. For example, in the boundary layer of an alpine glacier it is not unusual to have two complete wind reversals due to the juxtaposition of a micro scale glacier wind, mesoscale upslope flow, and synoptic scale westerlies. Mesoscale modeling provides an avenue for better understanding the circulations and meteorological fields over mountain glaciers by connecting the limited observations to the processes occurring. The albedo of a glacier can vary from 20-100% over the course of a melt season, thus the usefulness of meteorological fields from mesoscale models for glacier mass balance is dependent on the mesoscale model faithfully representing the glacier surface. Integrating the glacier surface characteristics and processes into a mesoscale model will lead to better simulations and improved understanding of the glacier boundary layer. The FCA includes several stations on the Haig and Opabin glaciers and their fore-fields, which will allow for continued opportunity to understand the processes occurring at the atmosphere-glacier interface. Additionally, I am currently involved in writing a proposal to get us a portable tether sonde that could be placed on the Haig Glacier to measure the meteorological variables associated with the complex flow over the glacier.

The Calgary to Edmonton corridor of Alberta experiences the most thunderstorms in the prairies of Canada. Convective initiation in this region is highly dependent on local moisture gradients. A lack of observations to capture the local gradients in this region led to a two week pilot field project in July 2008 called UNderstanding Severe Thunderstorms and Alberta Boundary Layers Experiment (UNSTABLE). Weather stations in the FCA were modified in sampling strategy to record minute observations during the field campaign. Though both play a role in convective initiation, the dry-line of the Canadian Rockies is dynamically different from the dry-line of the U.S. Plains. The Alberta dry-line is not as tied to the diurnal mountain-valley circulation, and has a higher dependence on the synoptic scale flow pattern, thus is not as consistently present. The lack of a large scale moisture source on the eastern side of the Alberta dry-line means that the evolution and propagation of the dry-line is sensitive to small scale moisture sources due to varying land use. The FCA data, along with other data collected during UNSTABLE will provide the opportunity to study the formation and evolution of the dry-line in Alberta and identify the important processes involved in strengthening and weakening of this mesoscale feature.