Simulations of Lake-effect Storms during the Ontario Winter Lake-effect Systems Project

Using the SUNY Oswego version of the Weather Research and Forecast modeling system (WRF) during the Ontario Winter Lake-effect Systems (OWLeS) Project in the 2013-14 winter season proved to be a useful forecasting tool during several Intensive Observation Periods (IOPs) by simulating correct lake-effect snow band structure, movement, and location. However, in many other IOPs, the model was inaccurate with one or several of these properties. The objective of this research is to identify combinations of physics parameterization options and model domain geometry to produce the most accurate WRF simulations. Model evaluation is based on comparison with field observations such as radar, surface, upper-air, and profiler data collected by student researchers. Several experiments involved changes in domain geometry such as expanding the outer domain, increasing grid resolution, and using more frequent lateral boundary condition updates.

A doubly-nested grid was set up to determine the capabilities and limitations of the WRF to simulate small-scale circulations (e.g., meso-vortices) that were observed during the field program. The outer grid (9-km resolution) covers the eastern two-thirds of the continental United States; a 3-km domain spans the Great Lakes and Northeastern states, and a 1-km fine grid covers the Lake Ontario region. An important finding in regards to the WRF model's capabilities using the 1-km fine grid is the simulation of meso-vortices of approximately 5 km in diameter along sharp reflectivity gradients located within lake-effect snow bands (e.g., IOP 7, 6-7 Jan 2014). IOP 7 field observations match the model output as radar data support numerous meso-vortices along an observed sharp reflectivity gradient on the north side of the band. Another case, IOP 22 (27-28 Jan 2014), produced numerous meso-vortices along a sharp reflectivity gradient located on the south side of the observed snow band. The model agreed with these observations.

Key Words: numerical modeling, lake-effect storms, OWLeS, meso-vortices