Lake-effect Observations by the Doppler on Wheels 2010-11 & DOW Educational Deployments by SUNY Oswego 2012

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Introduction

- SUNY Oswego received an NSF-EAGER grant to use the Doppler on Wheels (DOW) to study long lake-axis-parallel (LLAP) lake-effect snow storms between mid-December 2010 and mid-February 2011 in upstate New York. LLAP storms are intense, localized snowstorms which typically produce snowfall rates >= 5 cm hr^{-1} and occasionally produce lightning (Moore and Orville 1990).
- This unique high-resolution data set gives insight into the kinematics, dynamics and microphysics of cold season, mixed-phase convective processes that will aid in the testing of hypotheses for convective-to-mesoscale and vice-versa effects, boundary layer development over water, vortex growth and decay, and the threshold for lightning initiation.
- SUNY Oswego was also fortunate to have the DOW as part of an educational deployment during the spring of 2012 where student teams led several field deployments.

Data and Methods

Fig. 1

Fig. 2

- Seven LLAP events were studied during the 2 months of operation during the EAGER grant, all over Lake Ontario.
- Figure 1 shows a typical deployment of the DOW on the Lake Ontario shoreline.
- Rawinsondes were also launched within the core and near the edges of lake-effect bands, along with during our educational deployments (Fig. 2).

Results I: Lake-effect Vortices

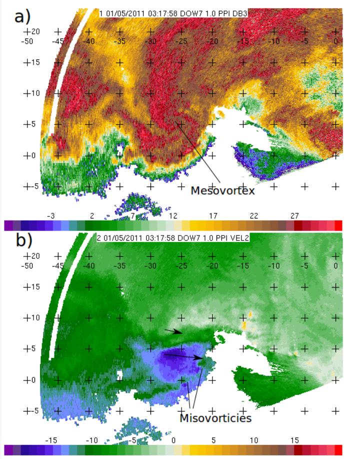


Fig. 3. DOW reflectivity (a) and radial velocity (b) measurements show an example of the various vortices observed along LLAP band axes. Misovortices wrapped into the mesovortex with time.

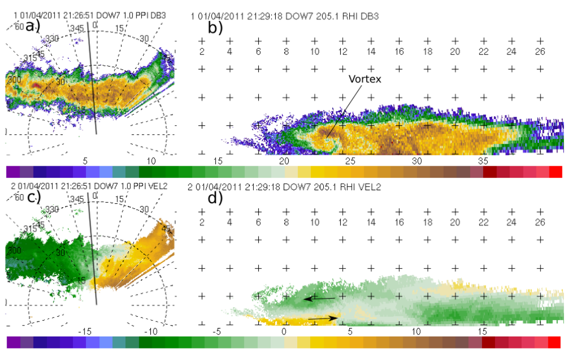
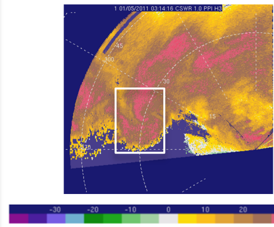
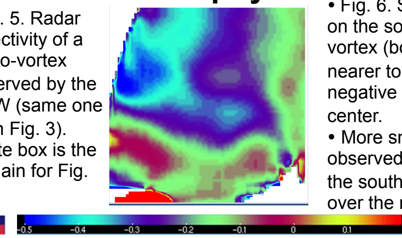


Fig. 4. Reflectivity PPI and RHI (a, b) and radial velocity PPI and RHI (c, d) during a LLAP lake-effect event. Note the asymmetrical structures in the vertical cross sections. Vertical wind shear on the southern side of the band (towards the left in the RHIs) induced a horizontal vortex (~ 2 km deep) there. Lines in (a) and (c) show where RHIs were taken.

Results II: Lake-effect Storm Microphysics



•Fig. 5. Radar reflectivity of a meso-vortex observed by the DOW (same one as in Fig. 3). White box is the domain for Fig. 6.



- Fig. 6. Shows greater Z_{dr} on the southern flank of a vortex (bottom of fig.; values nearer to 0 dB), while more negative values were in the center.
- More snow pellets were observed at the ground as the southern flank passed over the radar.

Results III: Spring 2012 Educational Deployments

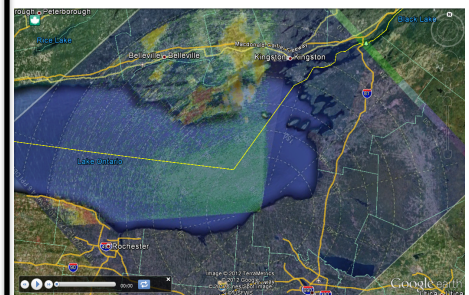


Fig. 7. Reflectivity data collected at 1740 UTC 22 March 2012 during a lake-breeze day maps the shoreline of Lake Ontario.

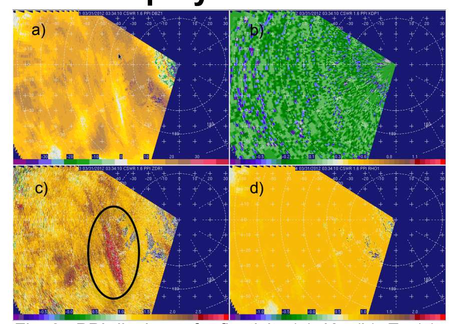


Fig. 8. PPI displays of reflectivity (a), K_{dp} (b), Z_{dr} (c), and ρ_{hv} (d) taken during a synoptic snow event near Syracuse, NY. Virga was observed nearby.

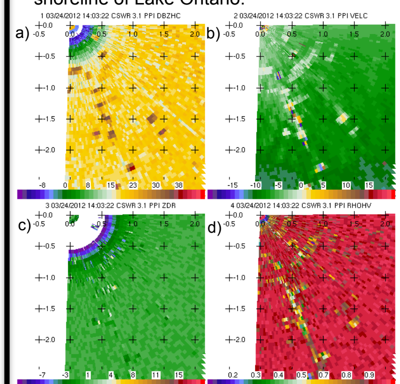


Fig. 9. Reflectivity (a), radial velocity (b), Z_{dr} (c), and ρ_{hv} (d) of a wind farm near Buffalo, NY. Since the blades have velocity, a better method for distinguishing turbines may be low ρ_{hv} values.

References available upon request.

Discussion and Conclusions

- Over 1100 miso- (<= 4 km) and mesovortices were observed in two lake-effect LLAP cases that have been studied so far. Horizontal shear instability is the likely cause.
- Dual-pol signatures in lake-effect storms include greater differential reflectivity (near 0) within convective cells (not shown) and the leading edges of vortices. There were also correlation coefficient signatures in these bands that are currently under investigation.
- The educational depoyments were well-run by the undergraduate students! Groups of four studied wind farm signatures in DOW dual-pol data, lake breezes, a synoptic-scale snow storm, and thunderstorms in IL and MO (several students came with the DOW to drop it off at its next deployment at University of Illinois). Steiger et al. (2012, under review for MWR) discuss more details from our lake-effect grant.

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