Advanced Observations for Microphysics Scheme Evaluation Using GCPEx Data

B. M. Notaros[1], V. N. Bringi[1], A. J. Newman[2], G.-J. Huang[1], W.A. Petersen[3], D. Hudak[4], P. Rodriguez[4], L. Bliven[3], and L. Xue[2]

[1] Department of Electrical and Computer Engineering, Colorado State University, Fort Collins, Colorado; [2]National Center for Atmospheric Research, Boulder, Colorado
[3]NASA/Wallops Flight Facility, Wallops Island, Virginia; [4]Environment Canada, Downsview, Ontario, CA

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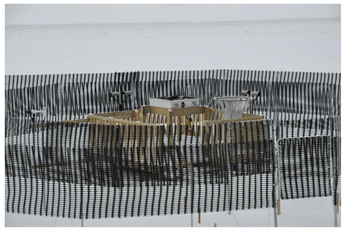
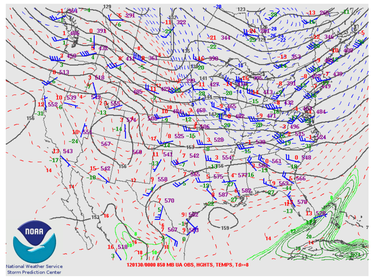
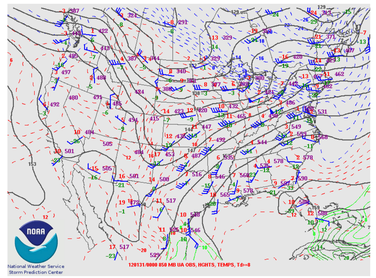
Introduction

- GCPEx had many advanced *in situ* and remote sensing observations for ground validation and microphysical studies
- Focus on 30-31 January 2012 lake effect and large-scale synoptic snowfall events at the Huronia and CARE sites
- Proposal goal: Use 2DVD, PVI, scanning radar, POSS, MRR, etc. for comparisons to WRF bin microphysics simulations



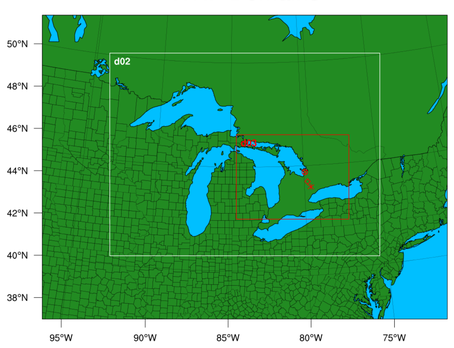
Synoptic Overview





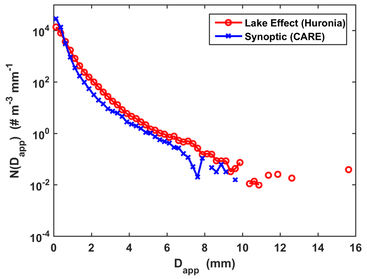
- Lake-effect precipitation (left)
  - Cold air advection across Great Lakes with water ~2-4°C, 850 mb temps ~-15°C
- Frontal precipitation (right)
  - Warm front progressed West to East with strong warm air advection, frontal overrunning leading to precipitation shield

Model Configuration & Testing

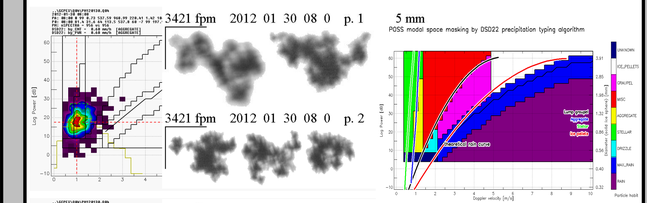


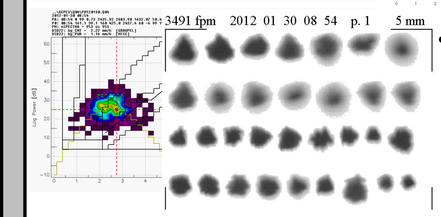
- Nested configuration: 4, 1.5, 0.5 km
- 500 m domain run will be run with bin microphysics selectively using 1-way nesting
- Initial testing focusing on ICs/BCs, PBL and surface scheme
- Use high-resolution NASA MUR SST product for lake temperature

Microphysical Differences

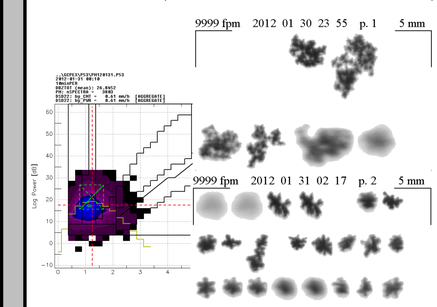


- Time averaged PSDs have similar N_0 and slope
- Lake-effect has more mid-size particles (1.5-6 mm)
- Also has very large flakes > 1cm

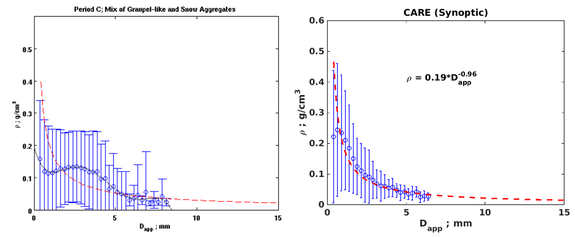




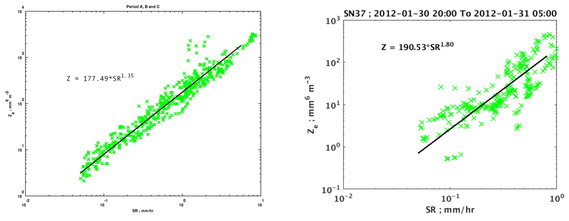
- Extreme aggregation and graupel present in lake-effect cells



- Aggregation and pristine crystals with little riming during frontal precipitation event



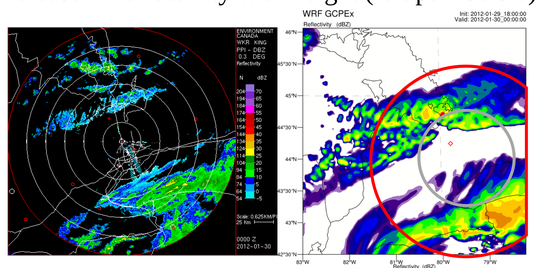
- Lake effect: Slightly higher density due to graupel
- Frontal: traditional density relationship of aggregates

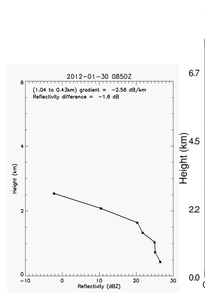


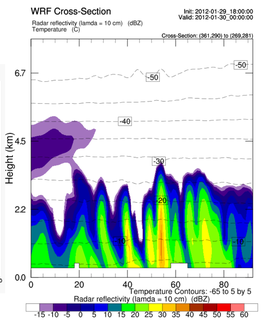
- Storm average Z-SR relationships generated for both events: lake-effect (left) and frontal (right) primarily differ in exponent
- Generated snow accumulation maps, critical for model evaluation

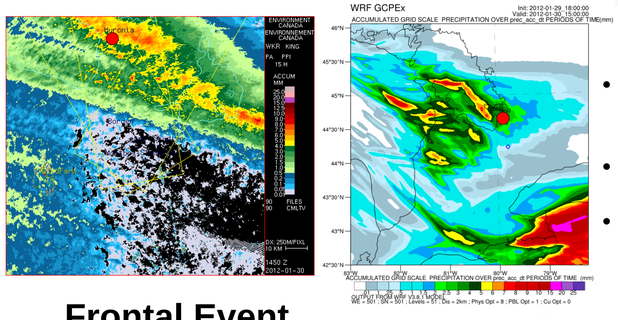
Initial Model Performance – Lake Effect

- Initial testing using RUC ICs/BCs, NASA MUR SSTs, Thompson microphysics, YSU PBL
- Model qualitatively captures both events: key spatial features are present in model simulation
- Lake effect: Intense cellular structure of bands (right pair below), shallow spatial extent with rapid increase in reflectivity with height (left pair below). Obs are on left, model right panel of all pairs.



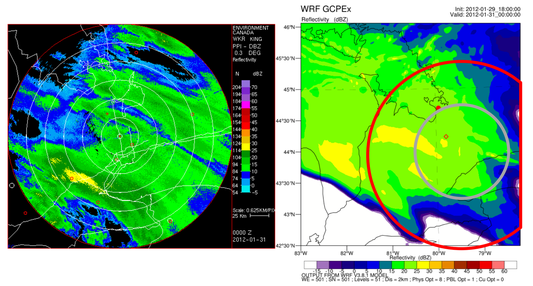


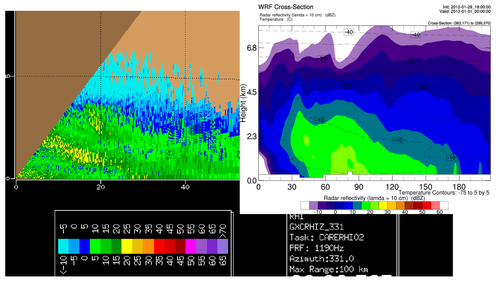


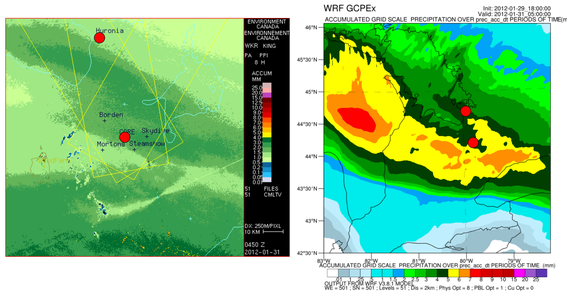


- Snowfall accumulation shows large spatial heterogeneity, highly banded structures (left panel pair)
- Spatial displacement west of Huronia (red dots) in WRF
- Maximal magnitude of precipitation accumulation correct

Frontal Event







- Spatial structure of frontal event more homogeneous (left pair)
- Over-prediction of coverage in WRF – likely an IC/BC issue
- Depth of precipitating layer well simulated (right pair)
- Over-prediction of precipitation in WRF (bottom left pair)
- May be related to bulk scheme, or ICs/BCs due to larger precipitation shield
- Dynamics generally well simulated, but room for some improvement

Conclusions

- Multiple *in situ* and remotely sensed instruments from GCPEx will enable holistic model evaluation and process understanding
- 30-31 January lake effect and frontal precipitation offer diverse frozen phase microphysics
  - Initial lake effect has intense aggregation and riming
  - Frontal precipitation has little riming, more pristine crystals and smaller aggregates
- WRF is able to capture dynamics of event, should lead to successful bin simulations

Next Steps

- Finalize WRF configuration
- Bin simulations for both events
  - Sensitivity analysis focused on key uncertain parameters, diffusional growth, collection efficiency
  - Quantitative comparisons to observations

Acknowledgments

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