Evaluation of Model Microphysics Within Precipitation Bands of Extratropical Cyclones

Brian A. Colle, Ruyi Yu, Andrew L. Molthan, and Steven Nesbitt

School of Marine and Atmospheric Sciences, Stony Brook University / SUNY Stony Brook, New York
NASA Marshall Space Flight Center / Earth Science Office, Huntsville, Alabama
Department of Atmospheric Sciences, University of Illinois

Introduction

- It is hypothesized that microphysical predictions have greater uncertainties/errors when there are complex interactions that result from mixed-phased processes like riming.
- Use Global Precipitation Measurement (GPM) Mission ground validation studies in Ontario, Canada to verify and improve parameterizations.

Motivating Questions

- How well do the various Weather Research and Forecasting (WRF) microphysical schemes predict snowband intensity and microphysics?
- What is the benefit of using more sophisticated double moment ice/snow schemes?

Field Case Study – 18 February 2012

- Figure 1 shows the 9, 3, and 1-km WRF domains, and the case study location (red dot and inset).
- On 18 February 2012 there was a weak cyclone near Lake Huron and a weak warm front approaching from the southwest.
- Surface radar estimate and WRF underestimated precipitation during this event (Fig. 2).

Observed Versus WRF Radar Analysis

- WRF initial and boundary conditions from the 13-km RUC at 00 UTC 18 February. Physics include: YSU PBL, GD CP scheme on 9-km only, and RRTM for LW, Dudhia scheme for SW Radiation.
- At 1100 UTC 18 February there was a warm frontal snowband observed near the field study site.
- Most of the 1-km WRF microphysical members realistically simulated this snowband, except the Thompson run was too weak.

Microphysical Comparisons

- WRF microphysical predictions were averaged within the boxes in Fig. 3, which is location of aircraft spiral.
- At 1100 UTC (north side of band), all WRF schemes realistically predicted the ice water content profiles. The Thompson tended to underpredict, and Goddard/SBM-2YLin overpredict.
- Morrison best predicted the snow distribution (slope), but had difficulty with the intercept. The temperature dependent slope intercept schemes (SBU and WSM) had a closer intercept to the aircraft observations.
- The WSM6 and SBYLin most realistically predicted snow ZR underpredicted the surface precipitation (25-35 dBZ) extending up to 3 km.
- The observed snowband was associated with an enhanced area of reflectivity (25-35 dBZ) extending up to 3 km.
- The Goddard scheme most realistically predicted the structure of the narrow snowband (Thompson too weak).
- There were convective cells aloft that were predicted in the Goddard and SBYLin schemes.
- There was little cloud water (LWC) observed and simulated on the north (cold) side of the precipitation band (Fig 5).

Summary and Conclusions

- The WRF realistically simulated the warm frontal snowband at relatively short lead times (10-14 h).
- The snowband structure is sensitive to the microphysical parameterization used in WRF.
- The Goddard and SBYLin most realistically predicted the band structure, but overpredicted snow content.
- The double moment Morrison scheme best produced the slope of the snow distribution, but it underpredicted the intercept.
- All schemes and the radar derived (which used dry snow Z-R) underestimated the surface precipitation amount, likely because there was more cloud water than expected. The Morrison had the most cloud water and the best precipitation prediction of all schemes.

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