High-Resolution Mesoscale Model Setup for the Eastern Range and Wallops Flight Facility

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Outline

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Project Goal

• Mesoscale conditions affect space launch, landing, and ground processing at the Eastern Range (ER) and Wallops Flight Facility (WFF)
• Need high resolution mesoscale model output to forecast unique weather phenomena at each range
• Provide a properly tuned data assimilation (DA)/numerical forecast model optimized for the ER and WFF
Background

• Phase I work
  – Compared model forecasts while varying the dynamical core, grid spacing, domain size, and forecast length
  – Varied model physics to determine which produced best forecasts
  – Ran test cases in the warm and cool seasons at the ER and for the spring and fall seasons at WFF
  – Results: Advanced Research Weather and Research Forecasting (WRF ARW) model, Lin microphysical scheme, Ferrier microphysical scheme (WFF only), and Yonsei University (YSU) planetary boundary layer (PBL) scheme
Cycled DA/NWP System

- NCEP’s Gridpoint Statistical Interpolation (GSI)/WRF
- NASA Short-term Prediction Research and Transition Center (SPoRT) Perl scripts
  - Easy-to-use interface for users to execute GSI/WRF
  - Cycled GSI system similar to operational North American Mesoscale (NAM) model

* Figure is a recreation of a NASA SPoRT produced schematic
Data and Model Configuration

• Test cases:
  – 1 km single domain (ER)
  – 2 km outer, 0.67 km inner domain (ER)
  – 9 km outer, 3 km middle, 1 km inner domain (ER & WFF)
  – 4 km outer, 1.33 km inner domain (WFF)
Data and Model Configuration, cont.

- WRF Initialization:
  - 35 irregularly spaced, vertical sigma levels
  - 12-h forecast run four times per day at 00, 06, 12, and 18 Z
  - 13-km Rapid Refresh (RAP) model for BCs and as the background model first-guess field
  - SPoRT Land Information System (LIS) data
  - Sea surface temperature (SST) data from both NCEP’s Real-time Global SSTs and the SPoRT 2-km SST composites
  - Initial conditions created using GSI/WRF scripts
    - Conventional/radar/satellite observations from NCEP PrepBUFR files
  - Period of record: 12Z 27 Aug 2013 to 06Z 10 Nov 2013
Model Validation

- Validated forecasts with local METAR and mesonet data
- Used Model Evaluation Tools (MET)
  - Point-Stat
  - MODE
- Verified surface forecasts using Mean Error (ME), Root Mean Square Error (RMSE), Pearson Correlation Coefficient (PCC)
- Verified precipitation using centroid distance, area ratio, and total interest value
ER Results: Surface Forecasts

- Overall, triple-nest configuration (5 doms) performed best, followed by nested domain (2 doms), and single domain (1 dom) for ME
- Similar results for RMSE
ER Results: Surface Forecasts

- Overall, triple-nested configuration performed best, followed by single domain, and nested domain for PCC
ER Results: Precipitation

- Compared 1-hr forecast to observed accumulated rainfall using NCEP Stage-IV analysis data for entire POR
- Overall, the nested domain outperformed both triple-nest and single domain configurations
WFF Results: Surface Forecasts

- Overall, triple-nest configuration (5 doms) performed better than the nested domain (2 doms) for ME
- Similar results for RMSE
WFF Results: Surface Forecasts

- Overall, triple-nested configuration performed best, followed by single domain, and nested domain for PCC
WFF Results: Precipitation

- Compared 1-hr forecast to observed accumulated rainfall using NCEP Stage-IV analysis data for entire POR
- Overall, the nested domain outperformed both triple-nest and single domain configurations
Summary

• Ran GSI/WRF model system for each range while varying grid resolutions on which DA was run and varying nesting configurations to determine the impact on model skill

• In general for both the ER and WFF, the triple-nest configuration outperformed the other configurations
  – However, nested configuration did the best in predicting precipitation for the ER

• Recommendation:
  – Either nested or triple-nest configuration is optimal for the ER
  – Triple-nest configuration is optimal for WFF

• Continuing to fine-tune modeling system for both ranges