Representation of the Extratropical Transition of Tropical Cyclones using Global Models

Allison Michaelis[1] and Gary Lackmann[1]

NC STATE UNIVERSITY

[1]Department of Marine, Earth, and Atmospheric Sciences, North Carolina State University

Background

- Recurving and extratropically transitioning (ET) tropical cyclones (TC) can:
  - Impact highly populated areas outside the tropics
  - Pose threats to transoceanic shipping routes
  - Affect weather conditions farther downstream
- **Project Goal:** Examine how intensity, frequency, and location of recurving and ET TCs will be affected by climate change
  - **Case study analysis:** compare representation of Super Typhoon Nuri in the Model for Prediction Across Scales (MPAS) and the Global Weather Research and Forecasting (GWRF) model
  - Evaluate MPAS treatment of large-scale, mean fields over seasonal timescales

Methods

- Model for Prediction Across Scales (MPAS) v. 4.0
  - 60 km uniform mesh and 15-60 km variable resolution mesh
  - Mesoscale reference physics suite:
    - WSM6 microphysics scheme
    - YSU planetary boundary layer scheme
    - Noah land-surface model
    - Tiedtke convective parameterization scheme
  - Longwave and shortwave radiation schemes: CAM
- Global Weather Research and Forecast (GWRF) Model v. 3.7.1
  - 0.5° x 0.5° horizontal grid spacing
  - Physics choices same as MPAS
- Global Forecast System Analysis (GFS-FNL)
  - 0.5° x 0.5° horizontal grid spacing
  - Used for initial conditions and surface update fields for STY Nuri simulation as well as for model comparison
- Observational Analyses:
  - International Best Track Archive for Climate Stewardship (IBTrACS) → 04 Nov. 00Z – 07 Nov. 06Z
  - Ocean Prediction Center (OPC) Pacific West Surface Analysis → 07 Nov. 12Z – 24 Nov. 18Z
  - Used for model comparison
- Simulations spanned 04 November 2014 – 24 November 2014

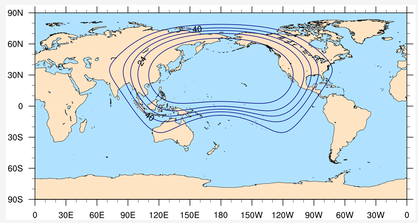

Figure 1. MPAS model domain for STY Nuri simulations showing the high resolution (15 km) mesh centered over the northern Pacific Ocean expanding out to 60 km elsewhere.

Transition of Super Typhoon Nuri

- GFS-FNL storm track strongly agrees with observations
- GWRF and MPAS follow analyses until around 06Z on 7 November
  - Track slightly more to the east and dissipate farther northward

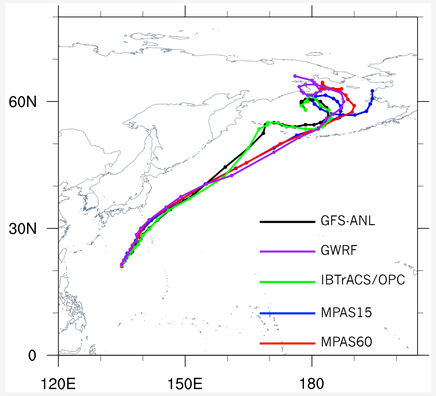

Figure 2. Tracks of STY Nuri from 00Z 04 November 2014 to 12Z 12 November 2014.

- All models reach peak intensity within 12 hours of observations and within ~10 hPa

	Minimum SLP (hPa)	Corresponding Date/ Time
GFS-ANL	930.7	00Z Nov. 8th
GWRF	934.8	12Z Nov. 8th
IBTrACS/OPC	924.0	06Z Nov. 8th
MPAS15	922.9	18Z Nov. 8th
MPAS60	926.9	18Z Nov. 8th

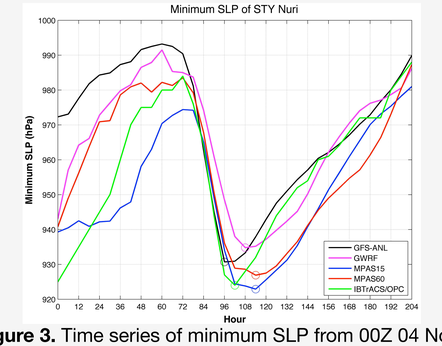

Figure 3. Time series of minimum SLP from 00Z 04 Nov. 2014 to 12Z 12 Nov. 2014. Time of peak intensity is denoted with an open circle.

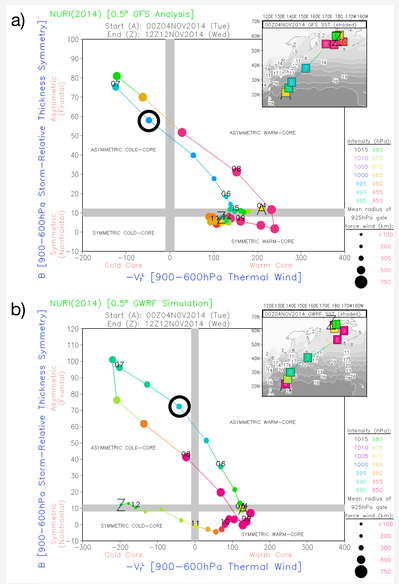

Figure 4. Cyclone Phase Space (CPS) diagrams for (a) GFS-FNL and (b) GWRF simulation. "A" corresponds to hour 00. "Z" corresponds to hour 204.

GFS-FNL
Time of ET:
18Z Nov. 6th

IBTrACS
Time of ET:
18Z Nov. 6th

GWRF
Time of ET:
12Z Nov. 6th

Downstream Effects

- Blocking pattern over Pacific Northwest less robust in GWRF and MPAS60
- Cold air outbreak over the NE US not as harsh or widespread in MPAS
  - Not captured in GWRF

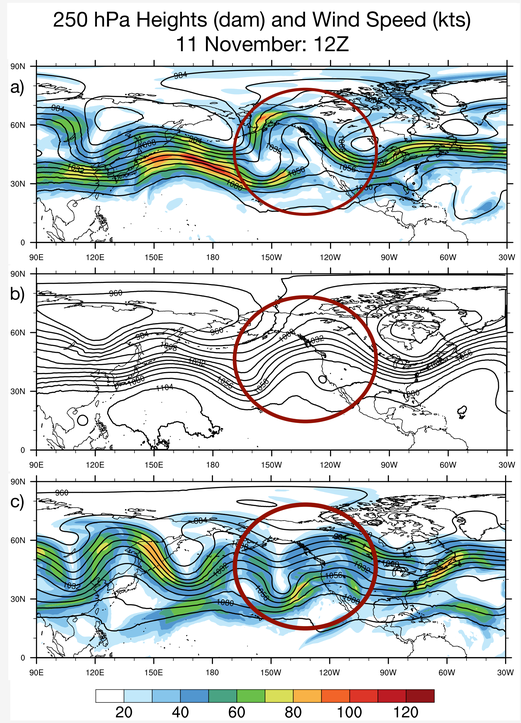

Figure 5. 250 hPa heights (dam; contours) and wind speed (kts; shaded) for (a) GFS-FNL, (b) MPAS60, and (c) GWRF.

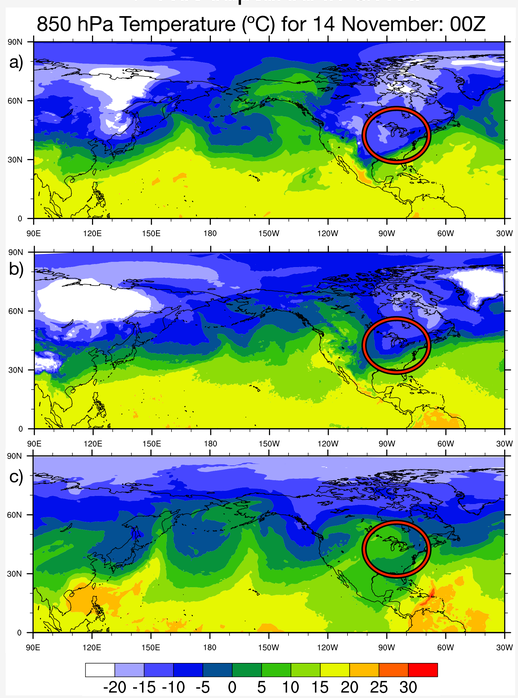

Figure 6. 850 hPa temperature (K) for (a) GFS-FNL, (b) MPAS60, and (c) GWRF.

Conclusions

- All *tracks* in *agreement until* ~12 hours *after ET*
- Models and analysis *capture observed peak intensity* reasonably well
  - MPAS60 and MPAS15 closest (+/- 2.9 hPa)
- MPAS60 and GWRF *block* and *cold air outbreak* downstream *not as strong* or widespread as analysis
- GWRF and MPAS simulated cyclone *track, intensity, and ET reasonably well*, but *underestimate downstream impacts*
- **Future work:** compare how models simulate TCs over seasonal timescales

Acknowledgements

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