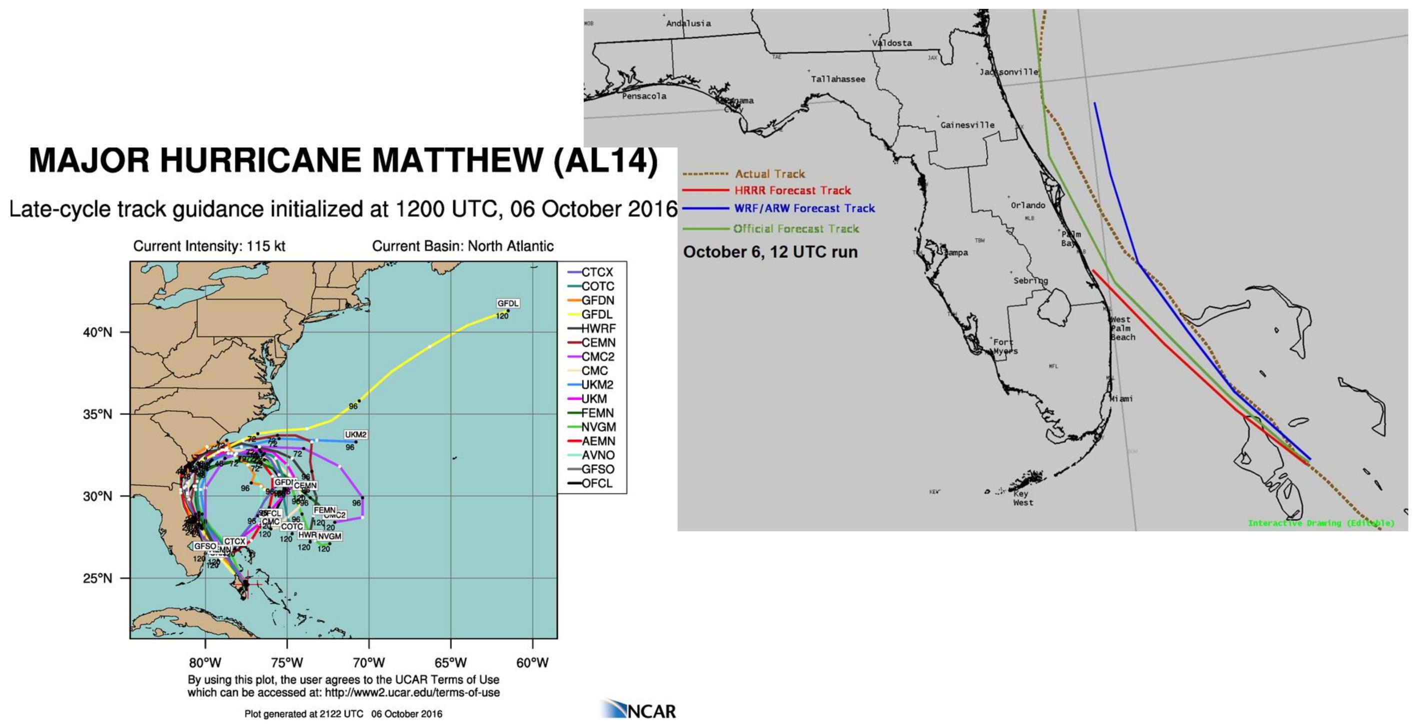
The Benefits of Multiple Short-term Deterministic Model Solutions During Hurricane Events

Peter F. Blottman, Jerry Combs, and David W. Sharp
NOAA/National Weather Service, Melbourne, FL

In life-threatening hurricane situations, accounting for uncertainties within local hazard assessments is critical for effective decision support. Within 120 hours, the average error cone, associated wind speed probabilities, and model spaghetti plots are often used to express forecast uncertainty against the latest forecast track. As impact time gets closer, narrowing the potential wind distribution across shorter time/space scales grows in importance.

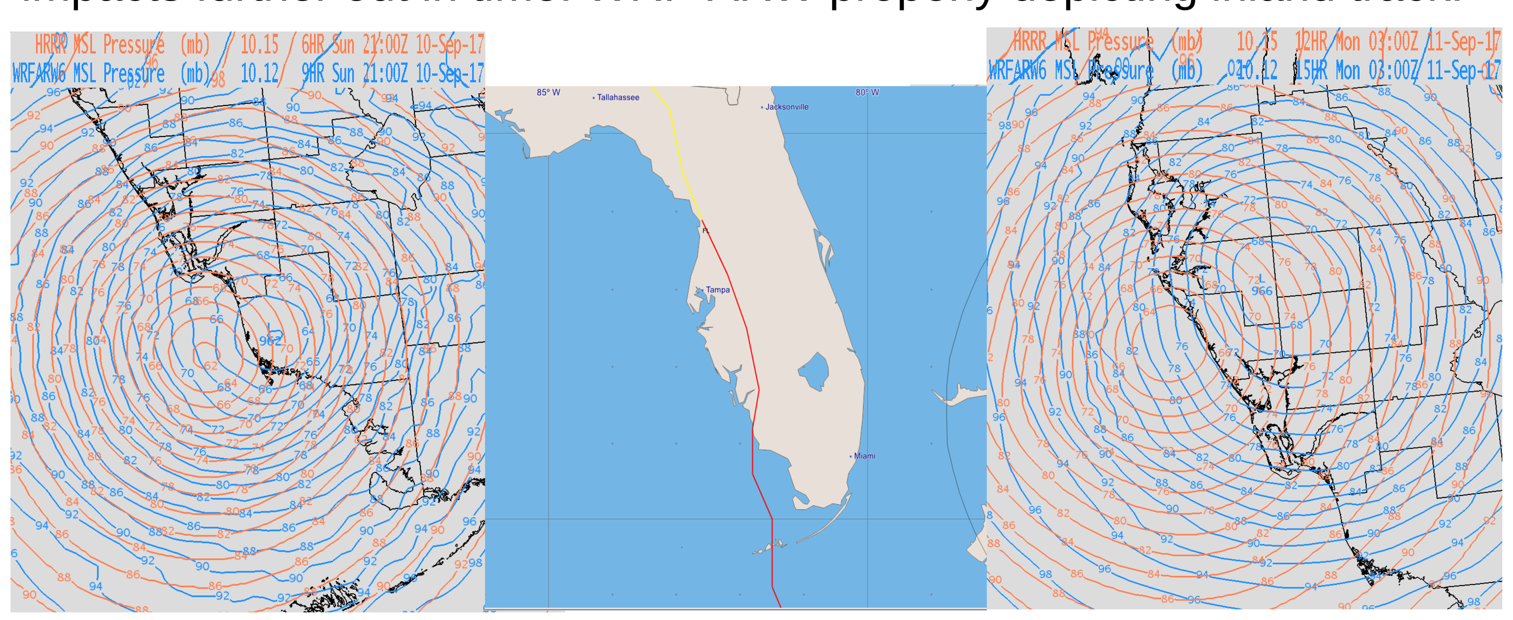
Deterministic forecast models often have their greatest value in these shorter-term (3-12 hour) time scales, especially when offered at higher-resolution. Weather models such as NOAA's HRRR (High Resolution Rapid Refresh), RAP (Rapid Refresh), and locally configured WRF/ARW (Weather Research and Forecasting; Advanced Research WRF core) can be used to elevate confidence in the latest forecast and/or identify a short-term *"most likely alternate scenario"* within the existing spread of uncertainty.



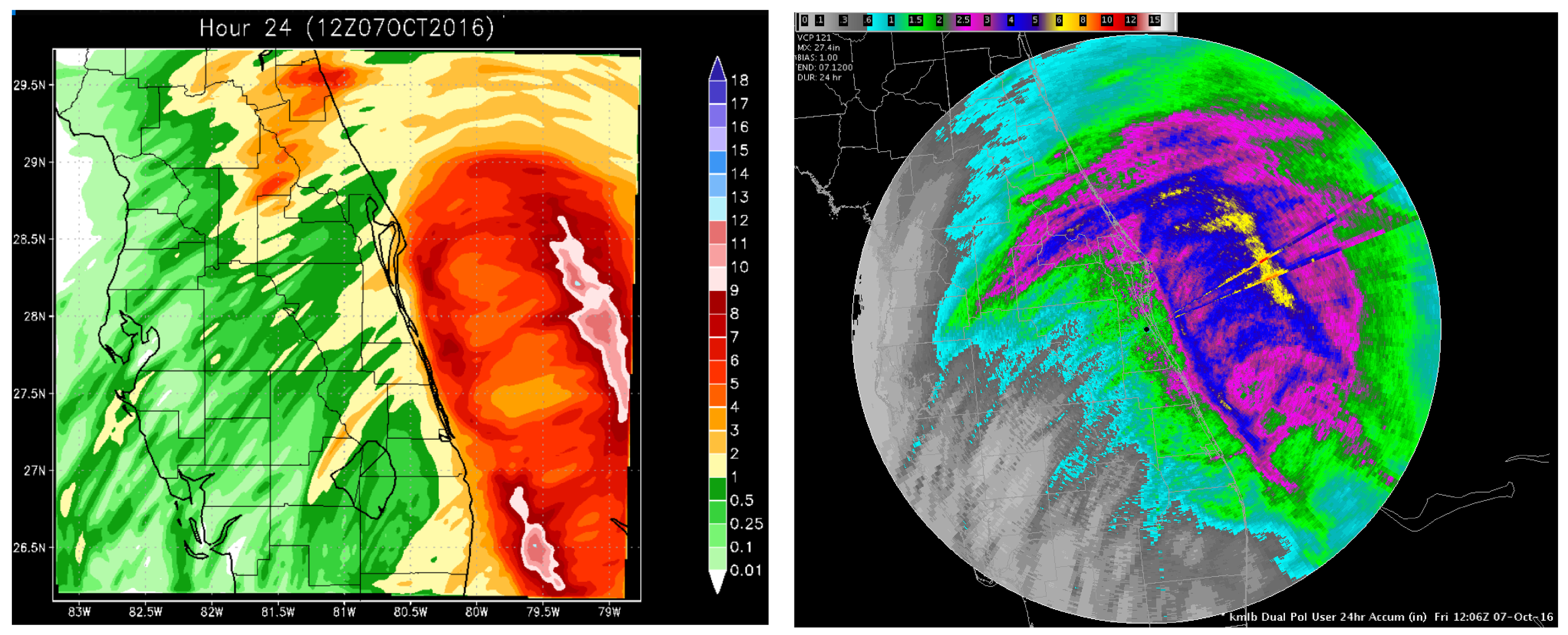
A particular deterministic solution that has been performing well in the short term can offer insights to potential variations in NHC's latest forecast. These variations, even if average in nature, can result in big differences in impacts realized at particular locations. This same model solution can also assist in providing a measure of specifics in the timing and magnitude of forecast elements. A model that performs well in one cycle, may not be the best performer in the next; data assimilation toward initial conditions is key.

A 3-hourly strategy with updated initial conditions provided by the RAP and its enhanced data assimilation can refine trends in track positioning and resultant impacts at a more frequent interval than large scale guidance.

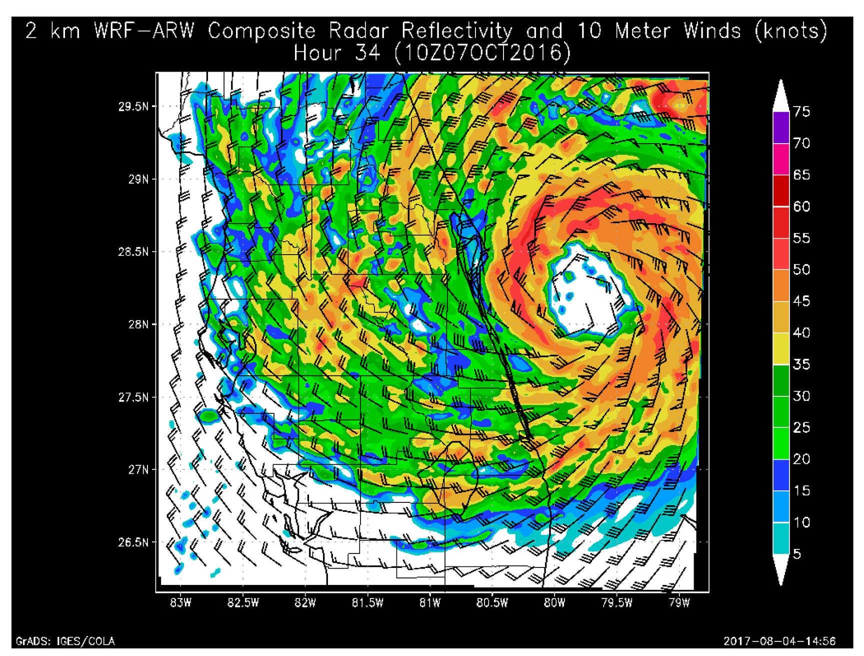
Major Hurricane Irma – Choosing the best performing model in the short term provides much improved assessment of the potential impacts further out in time. WRF-ARW properly depicting inland track.



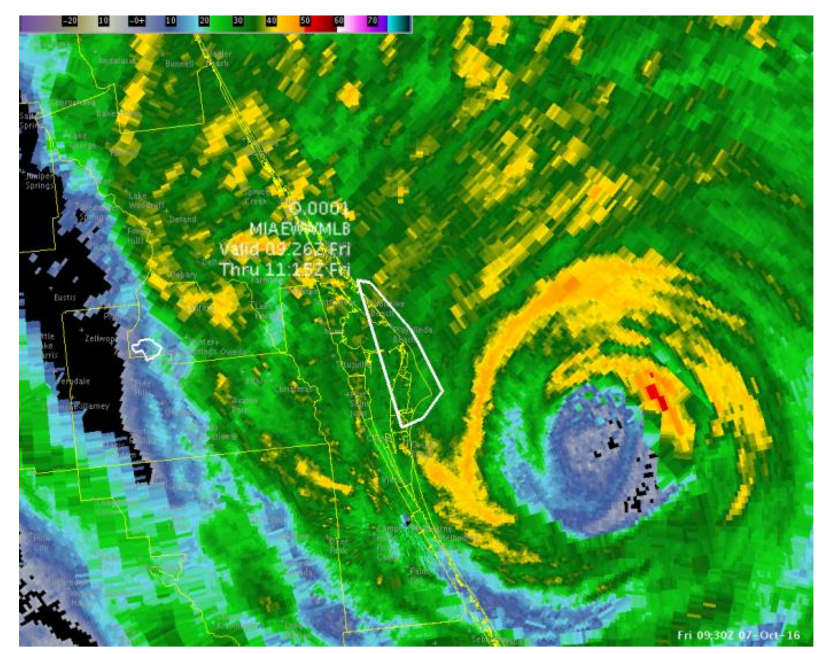
- The (NHC) forecast track remains the official source for track information to maintain unified messaging throughout the hurricane event.
- As the preparation phase closes and the impact phase opens (0-12 hours), alternate deterministic solutions can offer confidence if well-aligned with the latest forecast track, or provide insights to potential variations that could result in significant differences in impacts and subsequent response/recovery operations.
- Deterministic models can provide additional detail in the timing and location of wind, rainfall, and tornadic potential (having appreciation for storm structure).
- In most hurricane situations, probabilistic guidance has its greatest decision-making value in the longer-term and deterministic guidance in the shorter-term. Using a well-performing dynamical model in the very short term (0-3 hours) offers local forecasters an additional tool to more effectively support community decision-makers.



Simulated 24-hr accumulated precipitation from WRF-ARW left, and radar observed right. The model solution provides confidence to forecaster that rainfall is not the primary threat from Matthew, as the highest QPF stays just offshore.



WRF-ARW simulation at 600 AM EDT (34-hour forecast), depicting eyewall approaching Cape Canaveral.

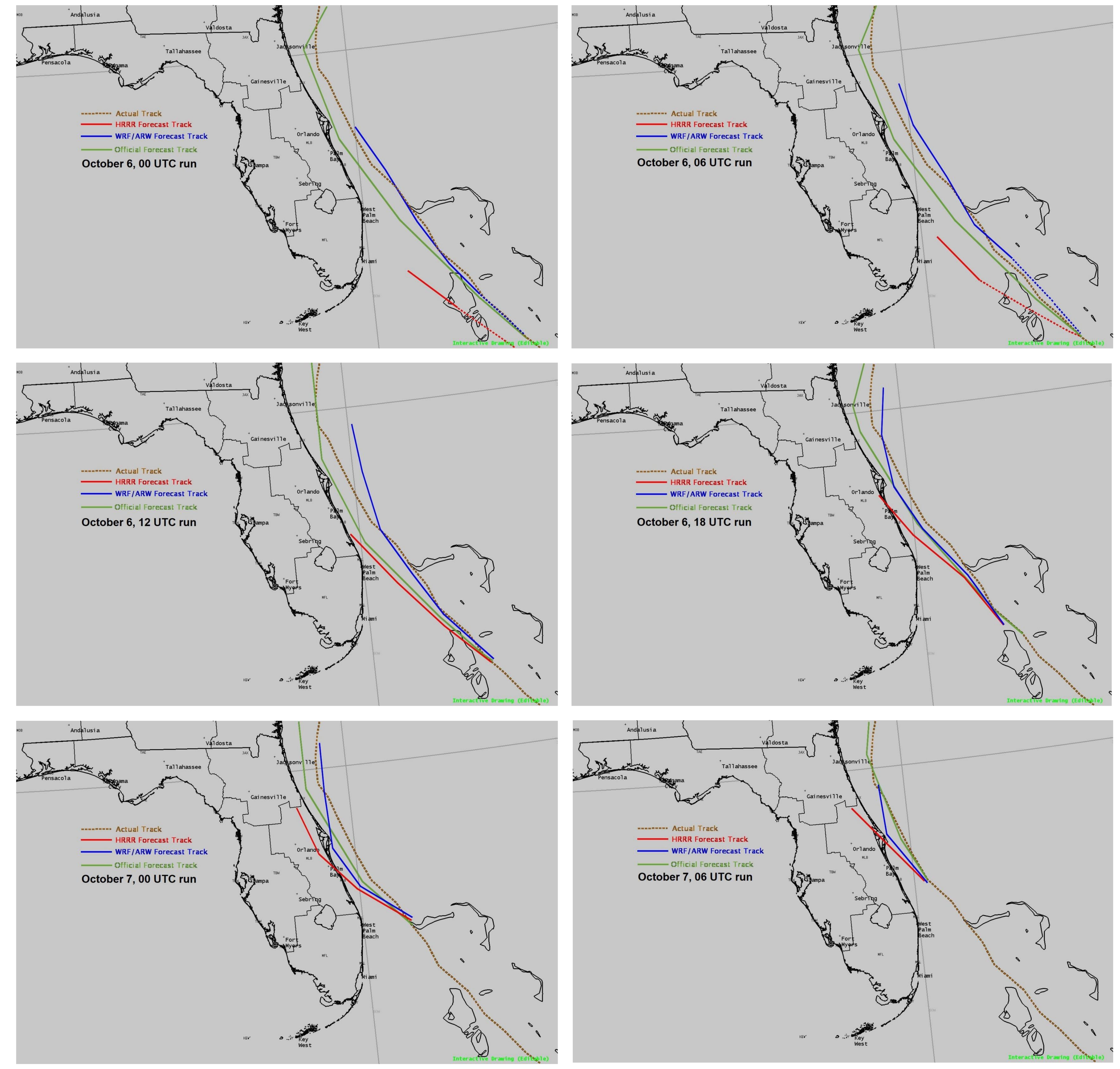


Extreme Wind Warning – 526 AM to 715 AM EDT October 7. Western eyewall impacting Cape Canaveral.

Local WRF-ARW Configuration

- 6km outer and 2km inner – 2 way nest
- ARW core, EMS version 3.4
- RAP initialization
- NAM boundary conditions
- SPoRT MODIS SST data
- SPoRT Land Information System
- 45 vertical levels
- Explicit convection
- Run 8 times / day

Six simulations – Hurricane Matthew, October 6, 00 UTC – October 7, 06 UTC



	Mean Absolute Error (km)		
Run Initialization	**WRF - ARW**	**HRRR**	**NAM**
10/6 00 UTC	26	76	33
10/6 06 UTC	42	84	46
10/6 12 UTC	21	42	29
10/6 18 UTC	34	48	33
10/7 00 UTC	33	53	18
10/7 06 UTC	20	47	23
Overall (19 samples)	**29**	**54**	**29**
WRF- ARW (30 samples)	36		

References:

Blaylock, B.K., J.D. Horel, S.T. Liston, 2017: Cloud Archiving and Data Mining of High Resolution Rapid Refresh Forecast Model Output. Computers & Geosciences, Volume 109, 43-50.

Case, J. L., W. L. Crosson, S. V. Kumar, W. M. Lapenta, and C. D. Peters-Lidard, 2008: Impacts of High-Resolution Land Surface Initialization on Regional Sensible Weather Forecasts from the WRF Model. J. Hydrometeor., 9, 1249-1266.

Haines, S. L., G. J. Jedlovec, and S. M. Lazarus, 2007: A MODIS sea surface temperature composite for regional applications. IEEE Trans. Geosci. Remote Sens., 45, 2919-2927.