Evaluating Tropical Cyclone Prediction in MPAS

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The 18th WRF Users' Workshop, Boulder, CO

Outline

- Objective
- Real-time experiment design
- Real-Time forecast results
  - Improvements in the last season
- Summary

Objective

Evaluating MPAS's NWP capability and its performance in forecasting tropical cyclones:

- Comparing MPAS performance against operational forecasts

- Identifying deficiencies in the model

- Exploring model's capability to forecast tropical cyclone beyond 5-7 days

A Short History of MPAS RT Testing

- Real-time testing of MPAS started in 2013;
- In 2014, two configurations were tested:
  - Quasi-uniform 15 km global grid,
  - Three 60-15 km variable grids over Atlantic, Eastern Pacific and Western Pacific basins;
- 2014 season results were summarized in Davis et al. 2016
  - Variable and uniform grids performed similarly up to 7 days
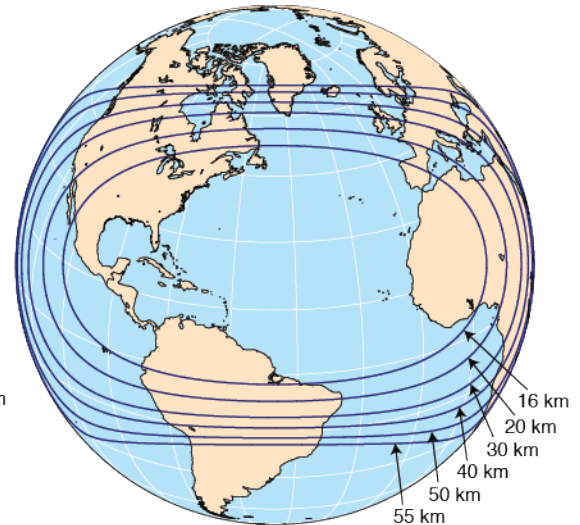- 2015, 2016 seasons: variable grids only

Variable Grid Meshes: 60/15 km
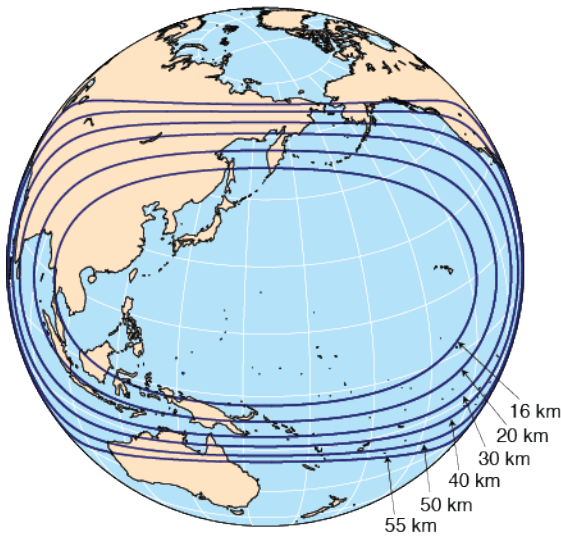
WP
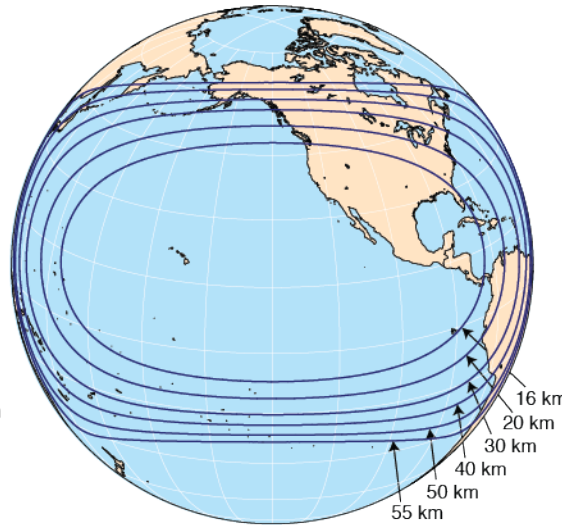
EP

AL

MPAS Setup in 2016

- Testing period: July – Oct 31, 2016
- Variable resolution 60/15 km grid
- WP: full 4 months; EP and AL: part of the period
- Once per day from 0000 UTC, 10 day forecast from GFS (model-level) analysis
- MPAS 4.0+: 55 model levels, 30 km model top
- Physics: new Tiedtke cu, WSM6 mp, YSU PBL, Noah LSM, RRTMG radiation, mixed-layer ocean model, gravity-wave drag, and COARE 3.0 surface physics with limiting C_d
- Runtime: 85 min using 1024 cores on Yellowstone

Storm Verification

- Use GFDL tracker program
- MPAS data interpolated to 0.5 degree lat/lon
- Wind speed data from MPAS is from native grid

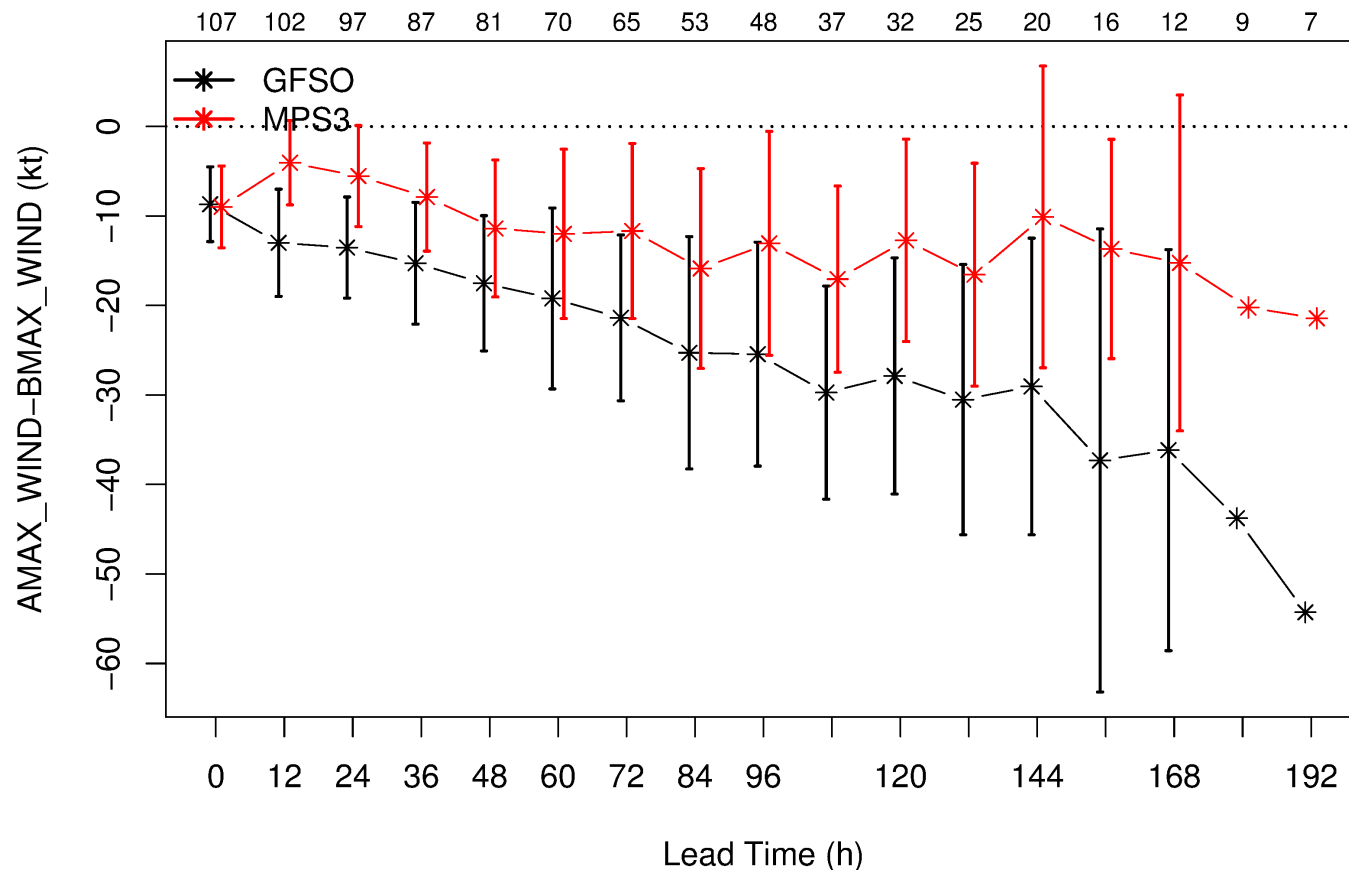- GFS data is at 0.25 degree, including wind speed

Results

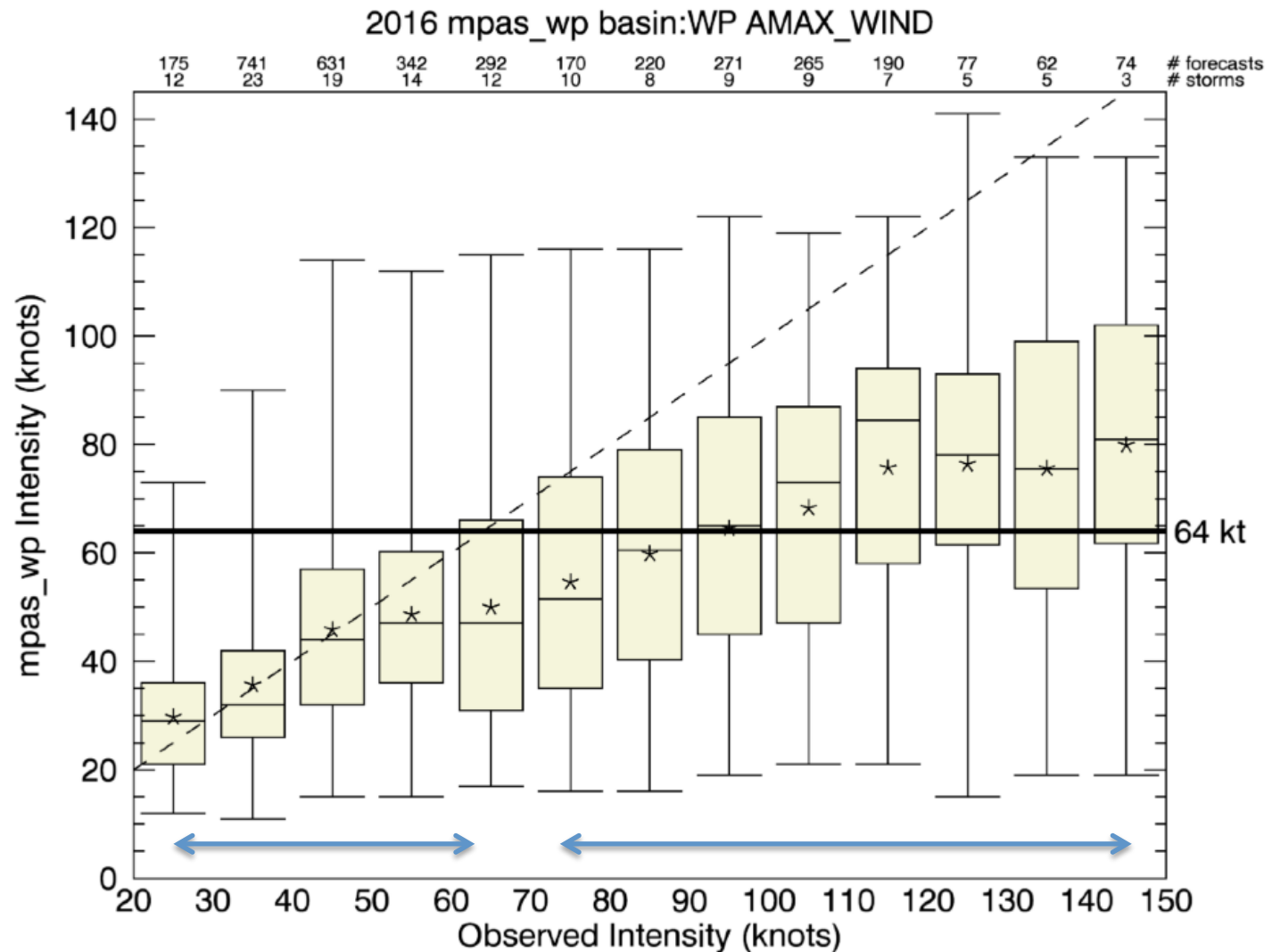# MPAS TC Forecasts for 2016 over WP: Track Error
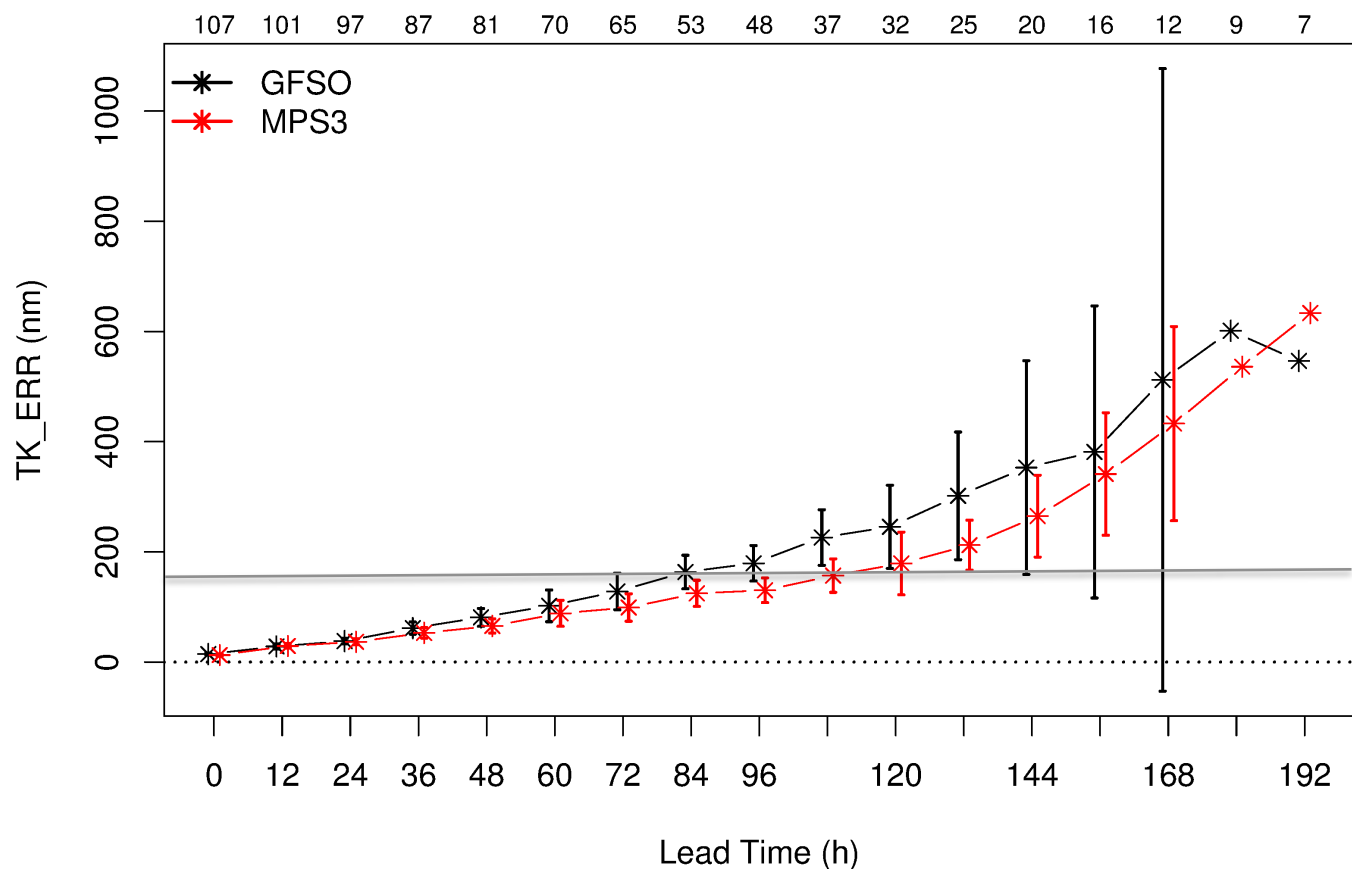
Lead Time (h)
FILTER: −amodel GFSO,MPS3 −column_thresh bmax_wind ge0 −event_equal true

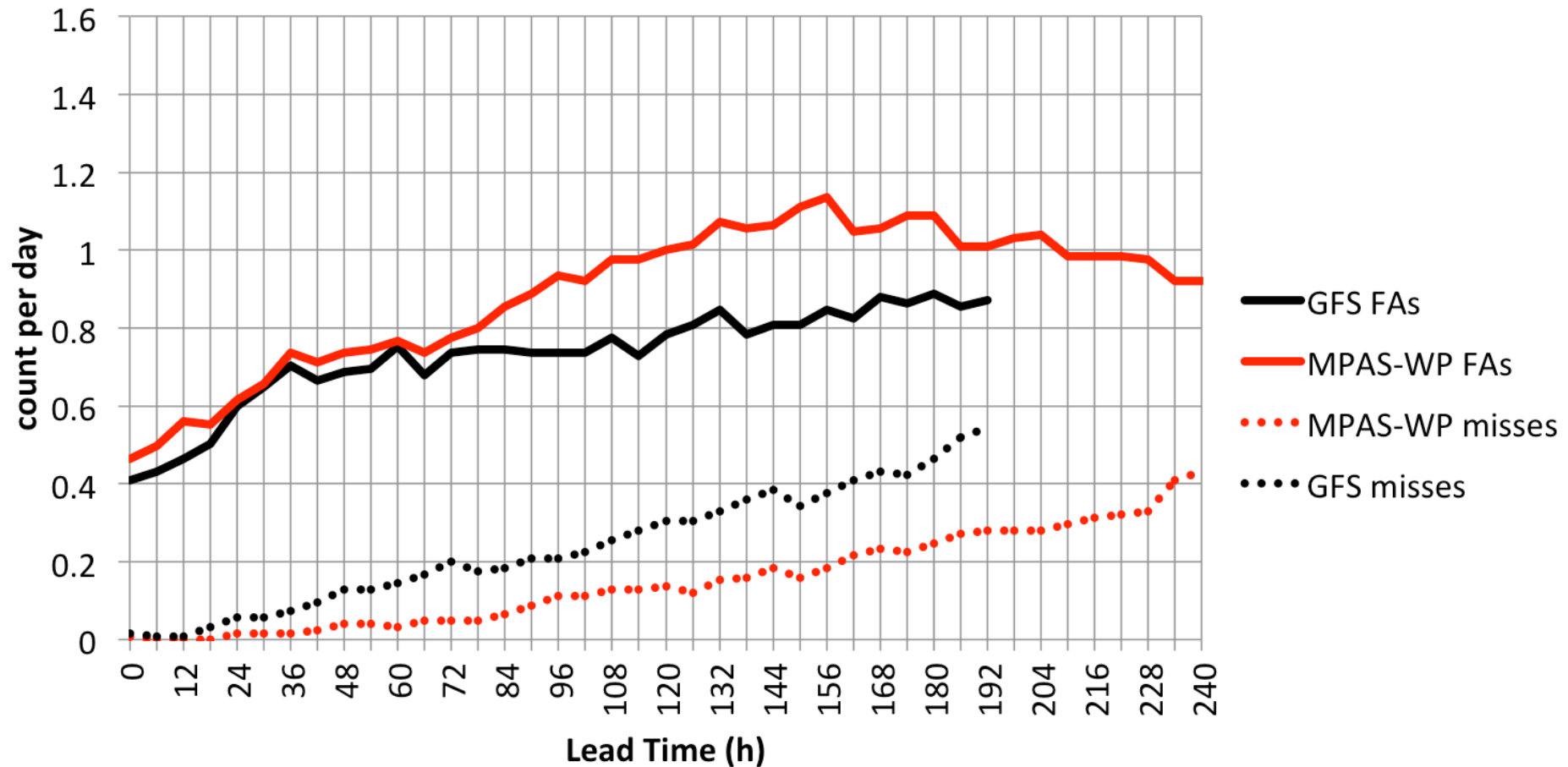# MPAS TC Forecasts for 2016 over WP: Intensity Error

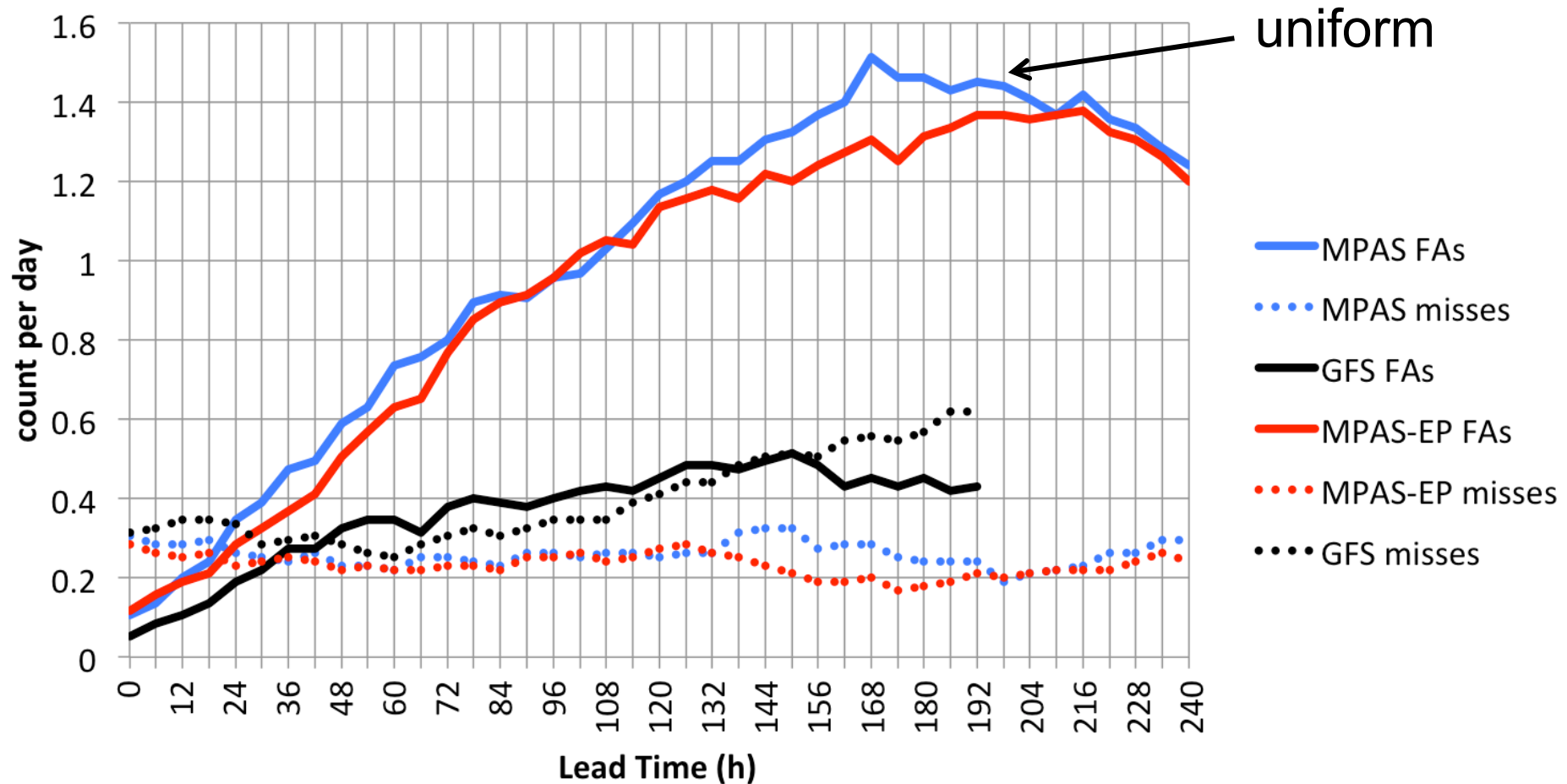FILTER: −amodel GFSO,MPS3 −basin WP −column_thresh bmax_wind ge0 −event_equal true

MPAS TC Forecasts for 2016 over WP Intensity Distributions
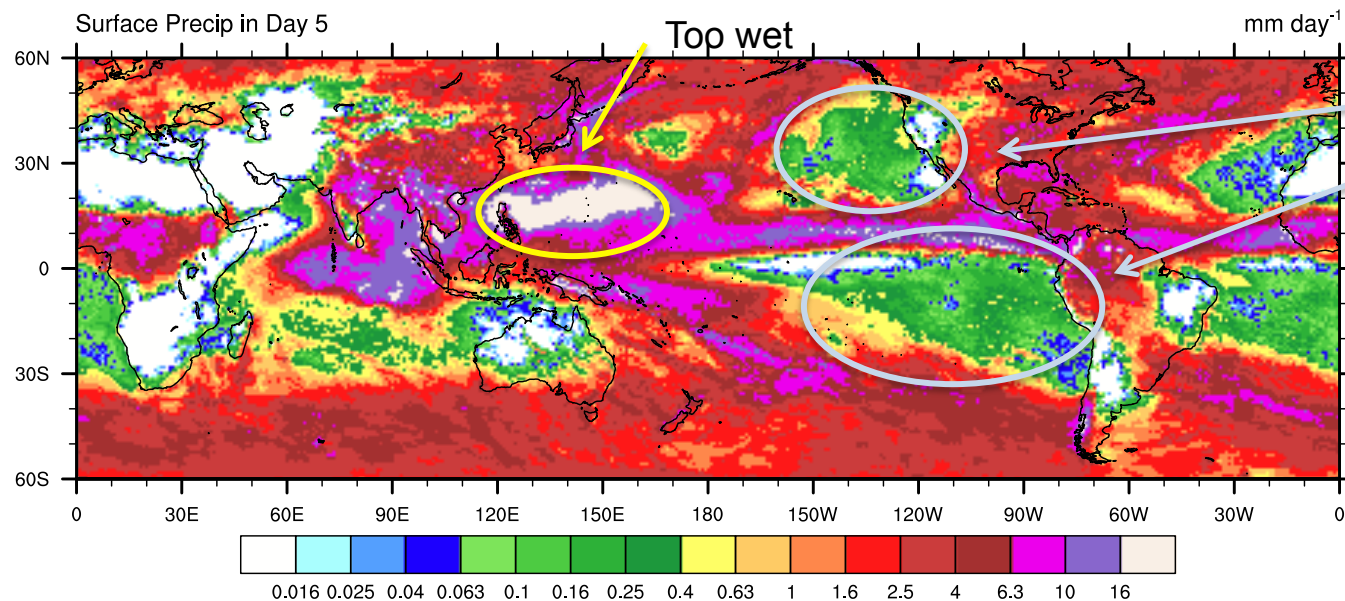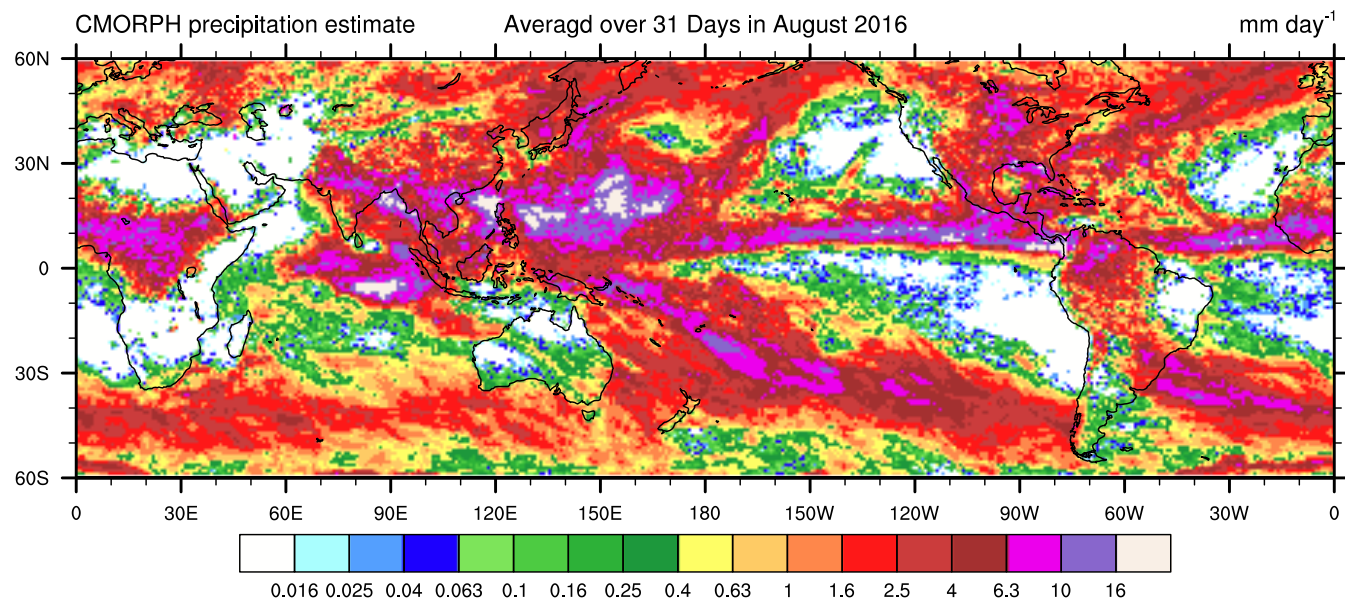

2016 mpas_wp basin:WP AMAX_WIND
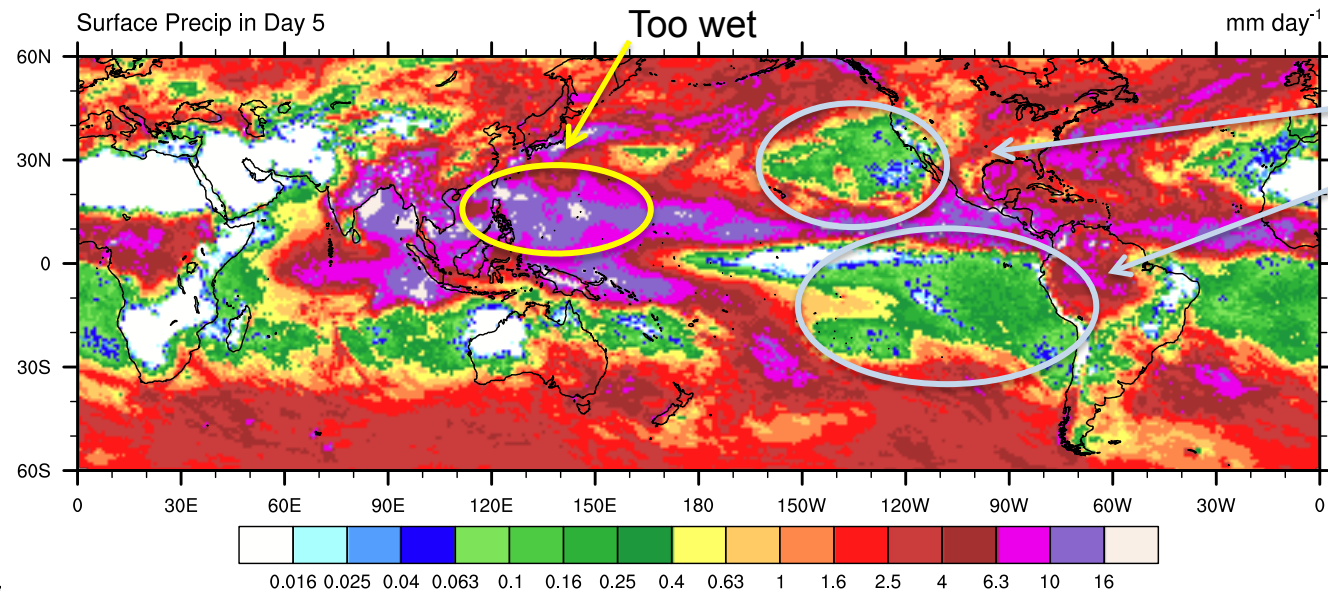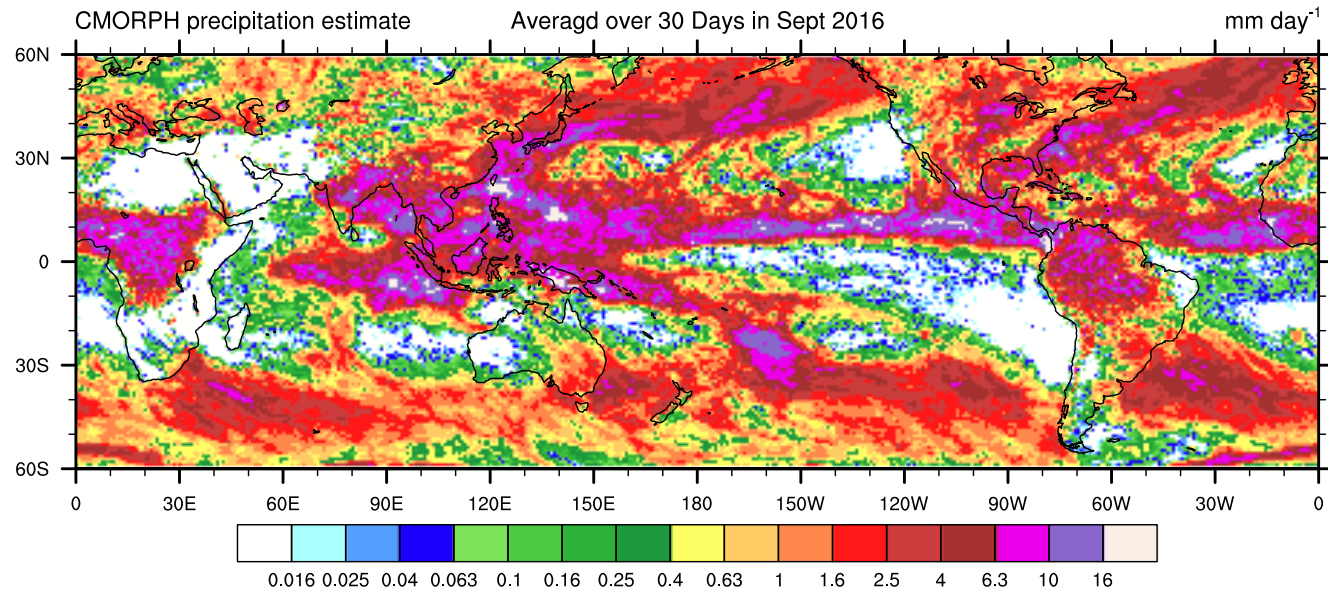
MPAS TC Forecasts for 2016 over WP
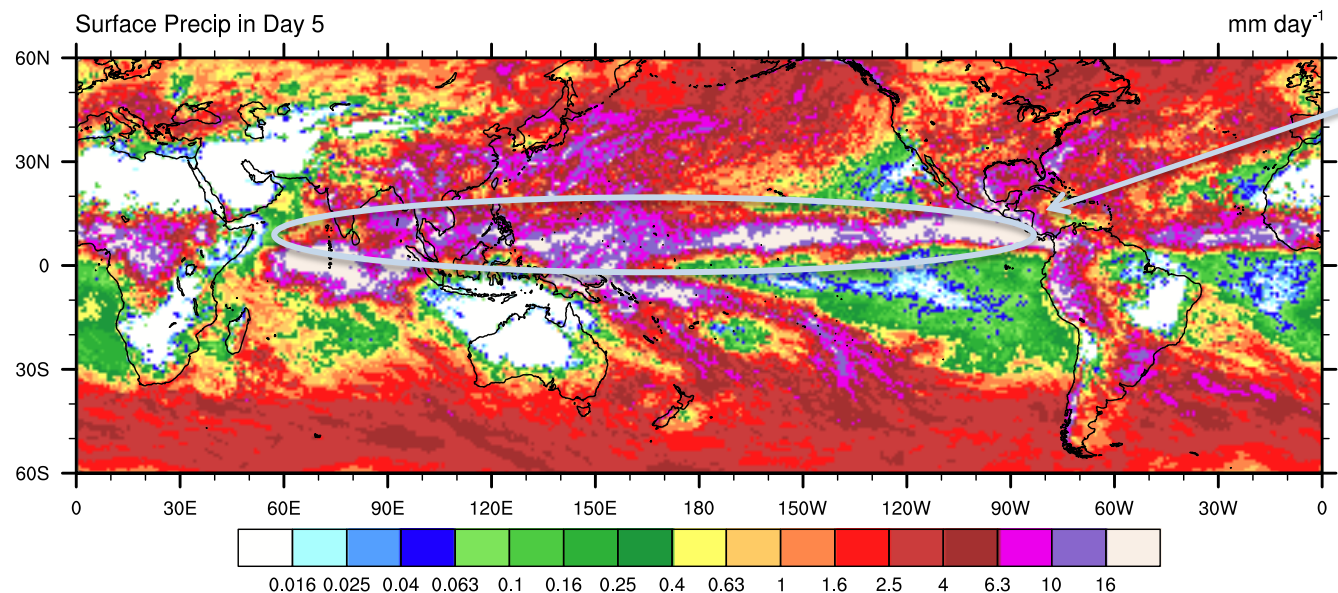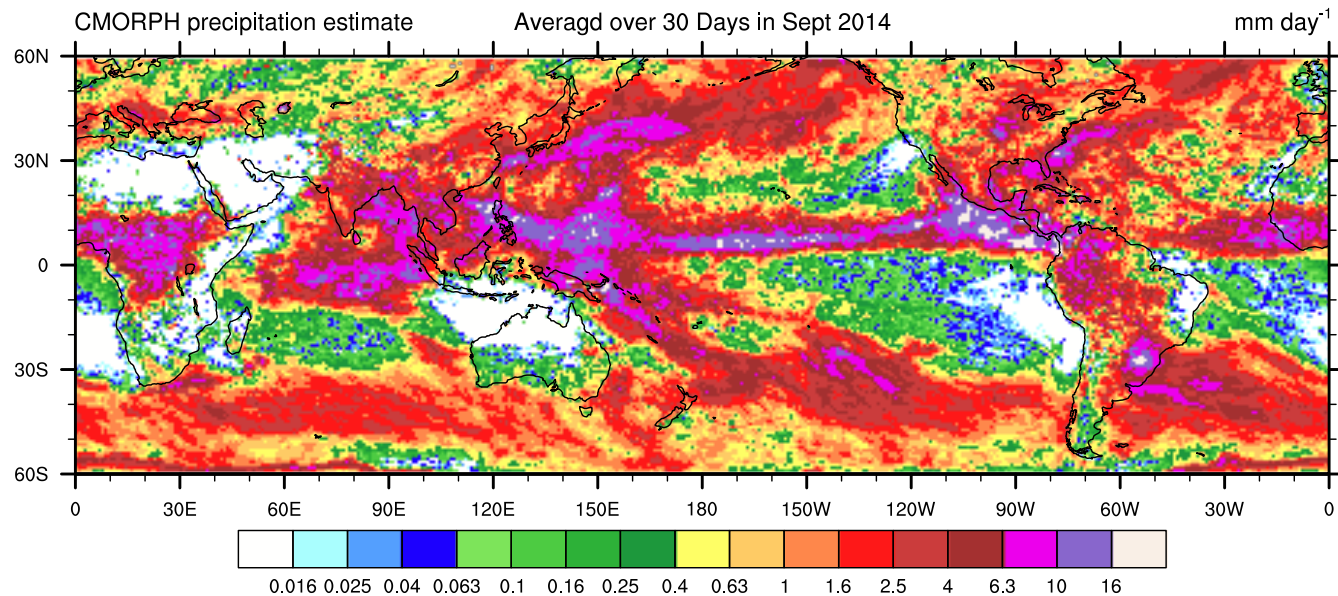
MPAS TC Forecasts for 2014

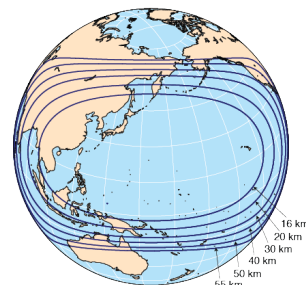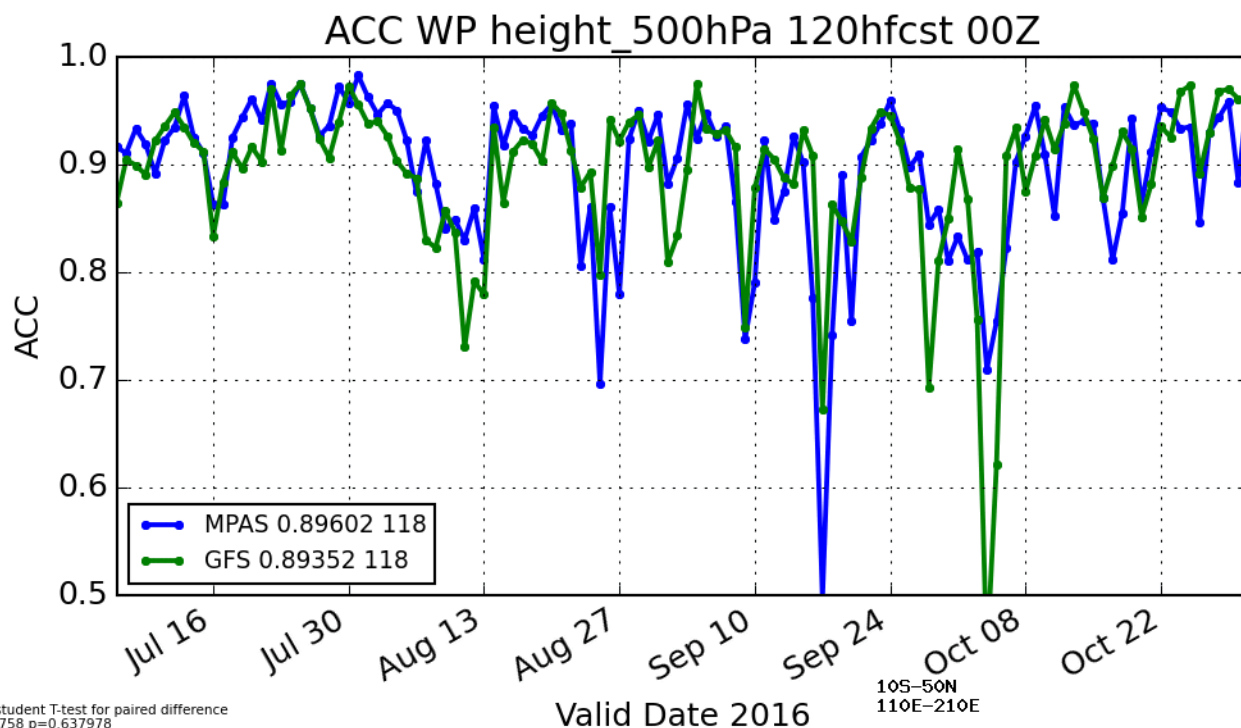# CMORPH (top) and MPAS Day 5 (bottom) Surface Rainfall, August 2016

# CMORPH (top) and MPAS Day 5 (bottom) Surface Rainfall, Sept 2016

CMORPH precipitation estimate   Averagd over 30 Days in Sept 2016   mm day⁻¹

Surface Precip in Day 5   mm day⁻¹

Too wet

Too much light rain

CMORPH (top) and MPAS Day 5 (bottom) Surface Rainfall, Sept 2014

CMORPH precipitation estimate   Averagd over 30 Days in Sept 2014   mm day⁻¹

Surface Precip in Day 5   mm day⁻¹

Too much rain

Anomaly Correlation Coefficient for Western Pacific Basin

ACC WP height_500hPa 120hfcst 00Z

Some Forecast Examples

WP - Nepartak: 7/3 – 7/9 (cat 5)

NEPARTAK BEST and MPS3 tracks intensity
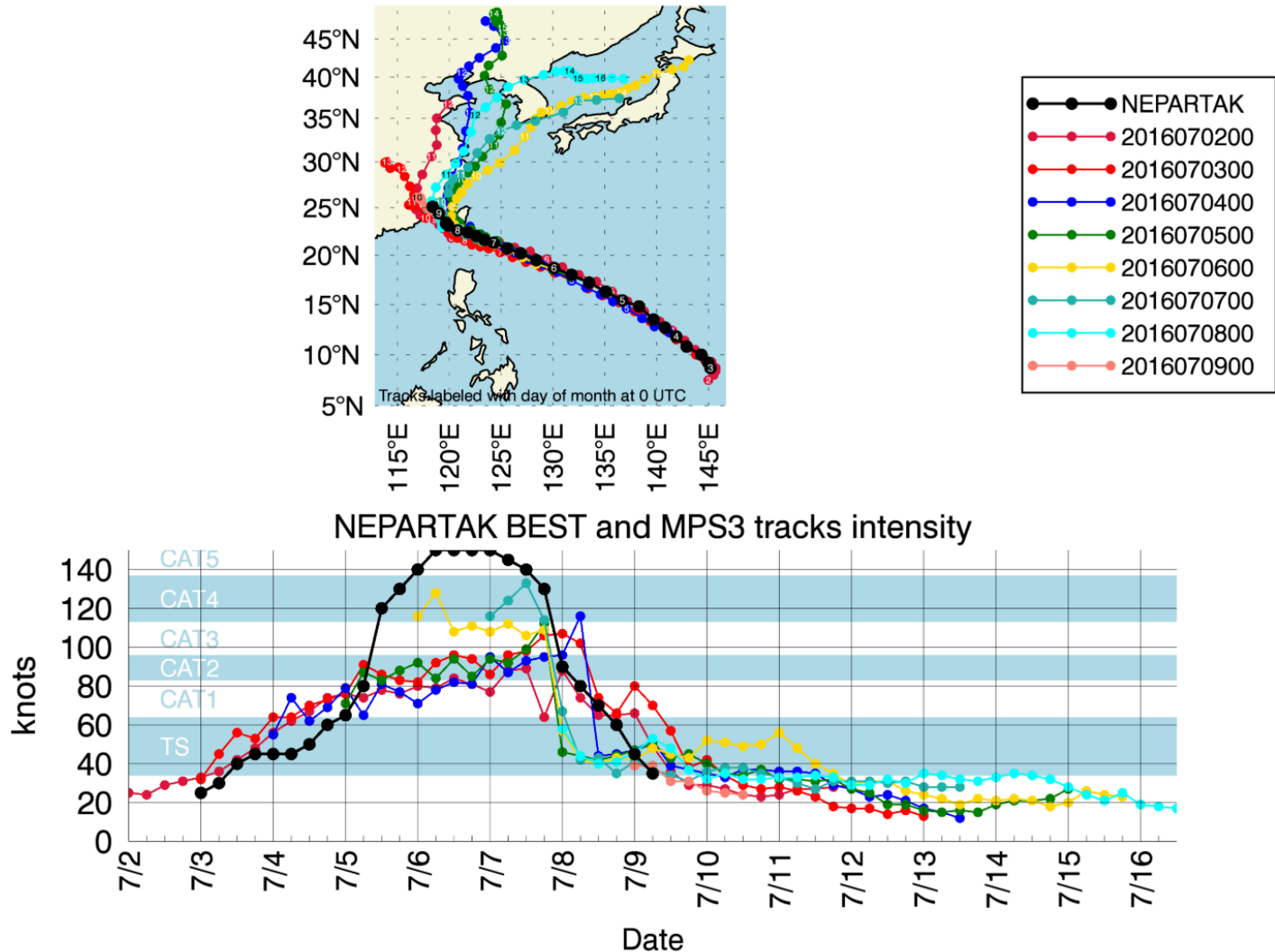
WP - Lionrock: 8/18 – 8/30 (cat 4)
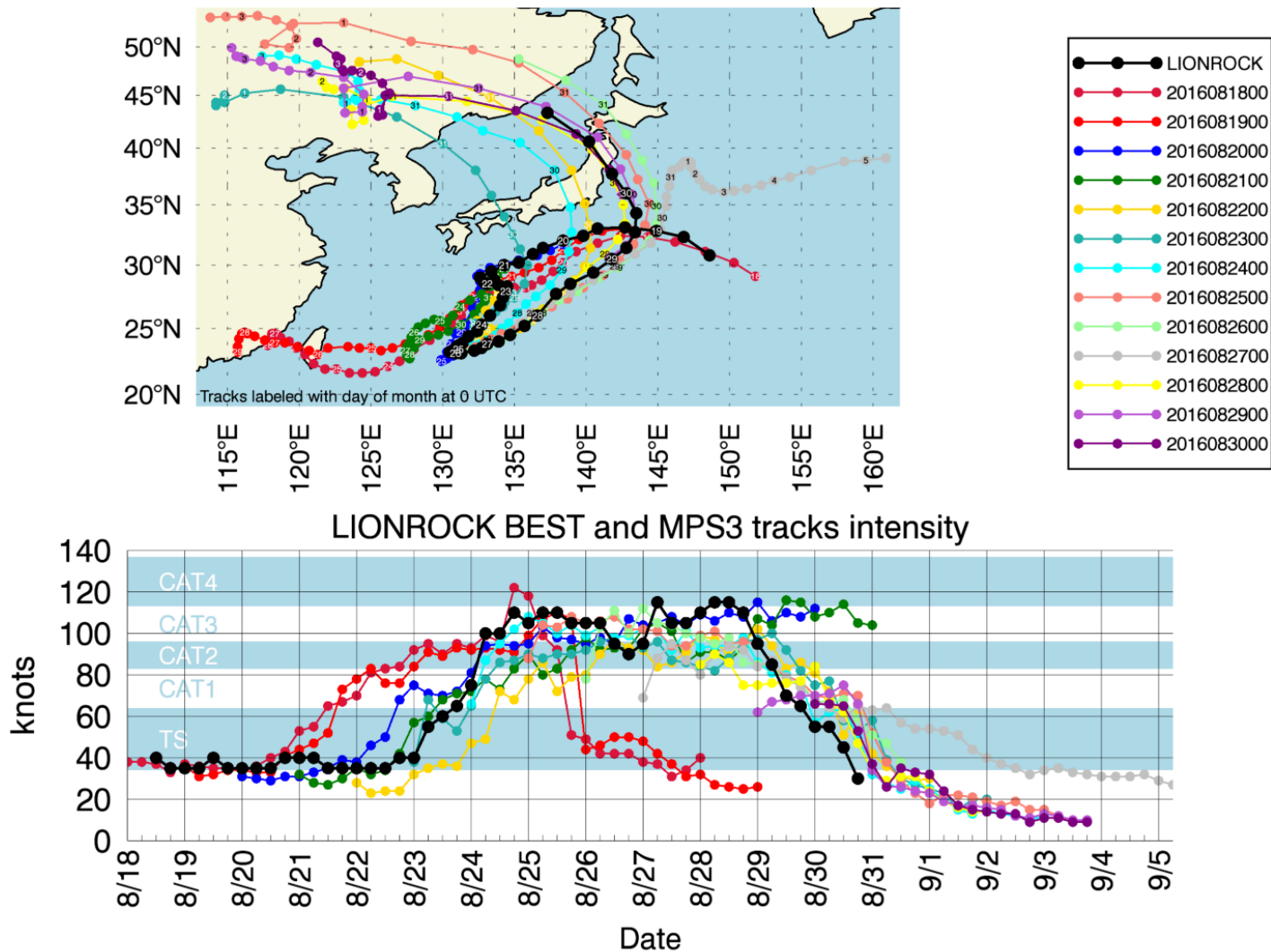
WP - Chaba: 9/28 – 10/5 (cat 5)
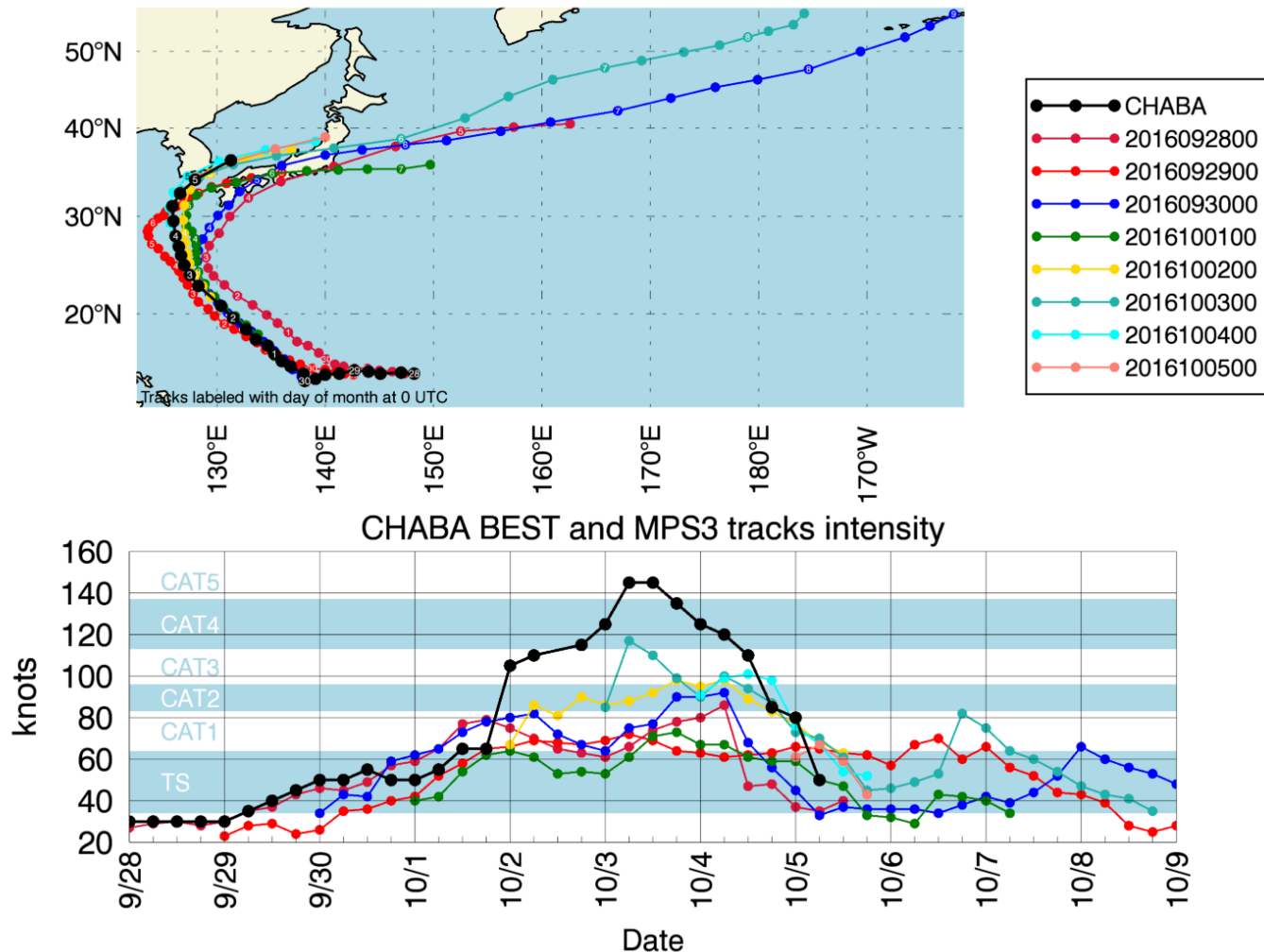
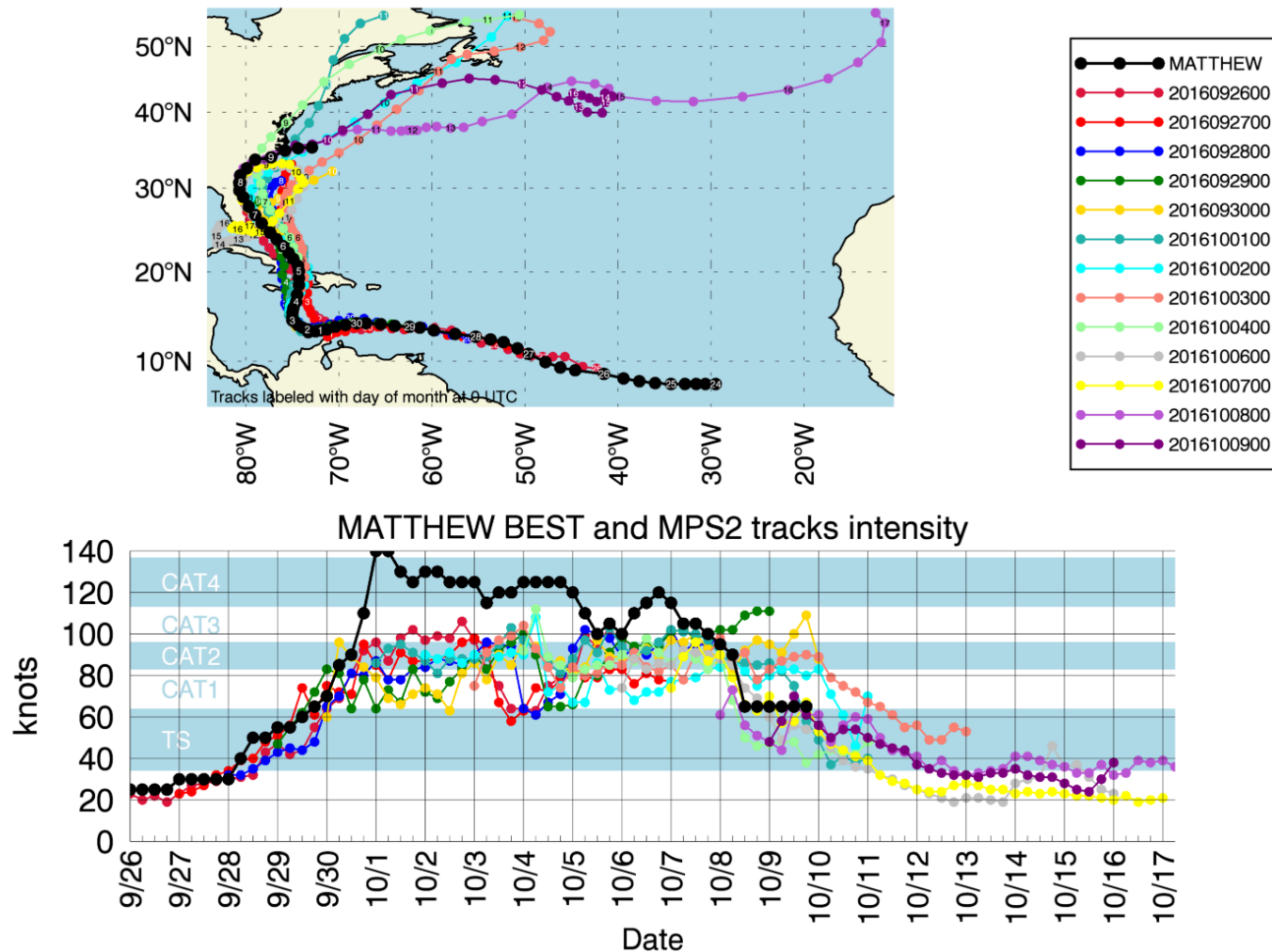# WP - Haima: 10/15 – 10/21 (cat 5)
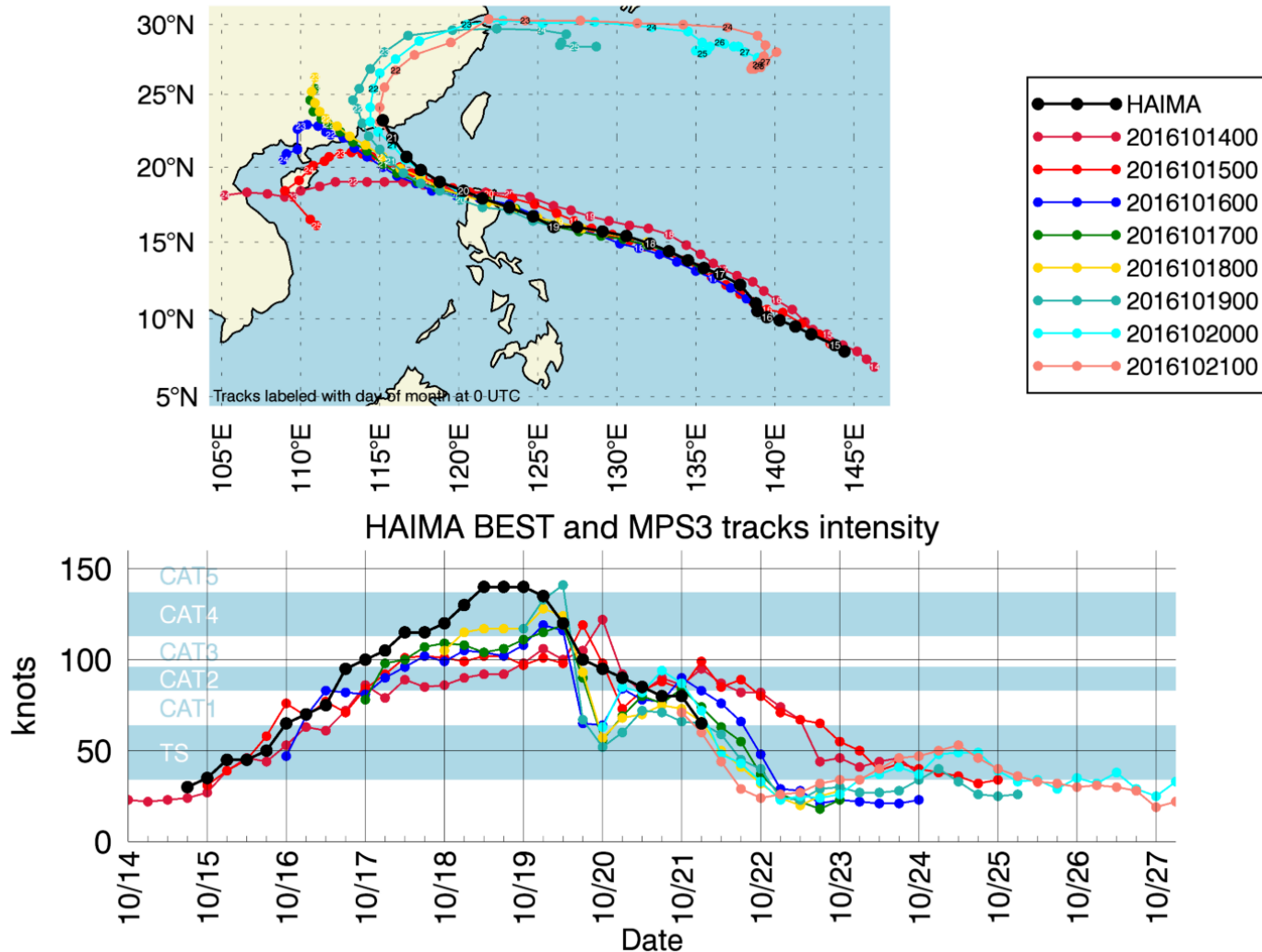
AL - Matthew: 9/28 – 10/10 (Cat 5)

Summary

- MPAS has been run for a few tropical storm seasons over multiple basins, and model performance has been improved in the last two seasons:
  - Variable resolution grid is an economical way to forecast for a basin
  - Challenges remain for forecasts beyond 5-7 days
- The model's performance to predict tropical storm's track and intensity is competitive with other global models;
  - This set of physics is designated as 'tropical' suite in WRF 3.9.
- Model improvements to be tested in 2017:
  - Improved gravity wave drag input fields, flow blocking
  - Imporved filtering