Experimental Real-Time Forecasts during the 2012-2013 North-Western Pacific basin with the NCEP Operational HWRF model

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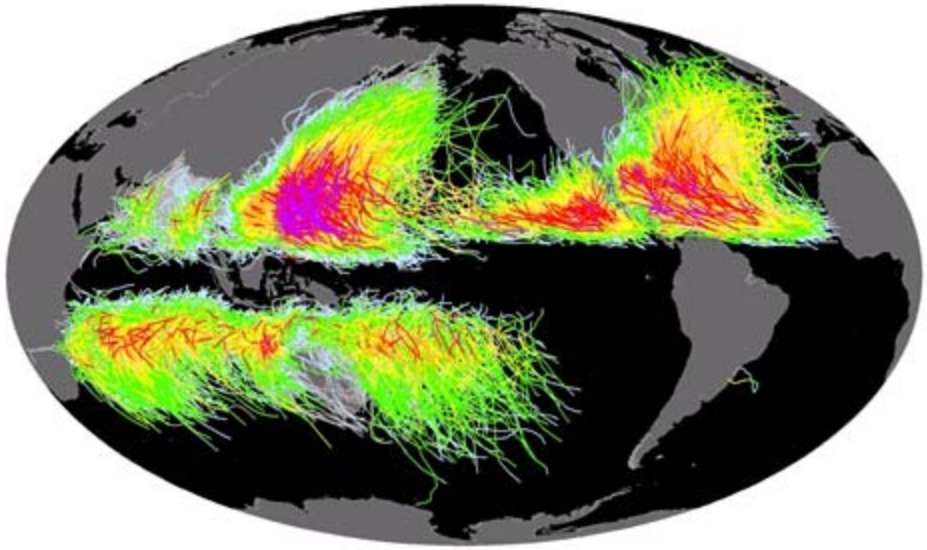
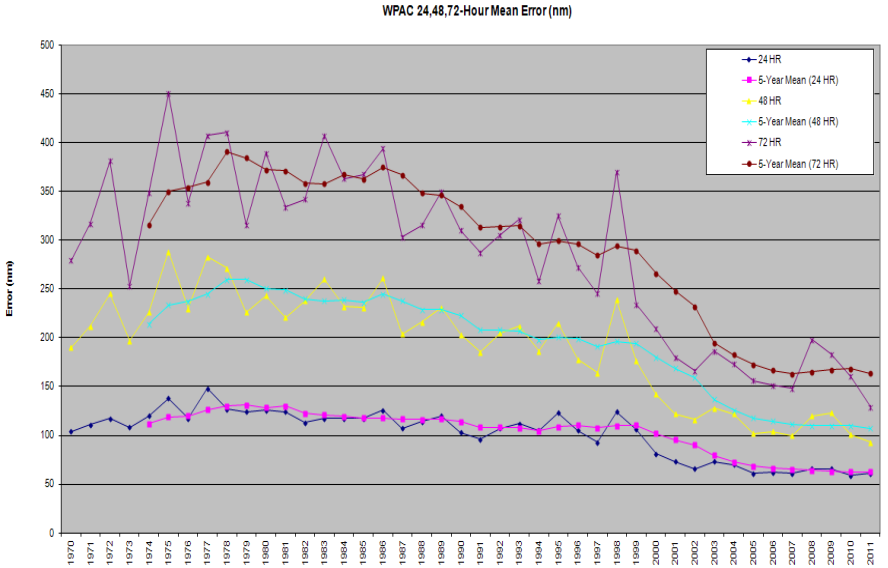
Outline

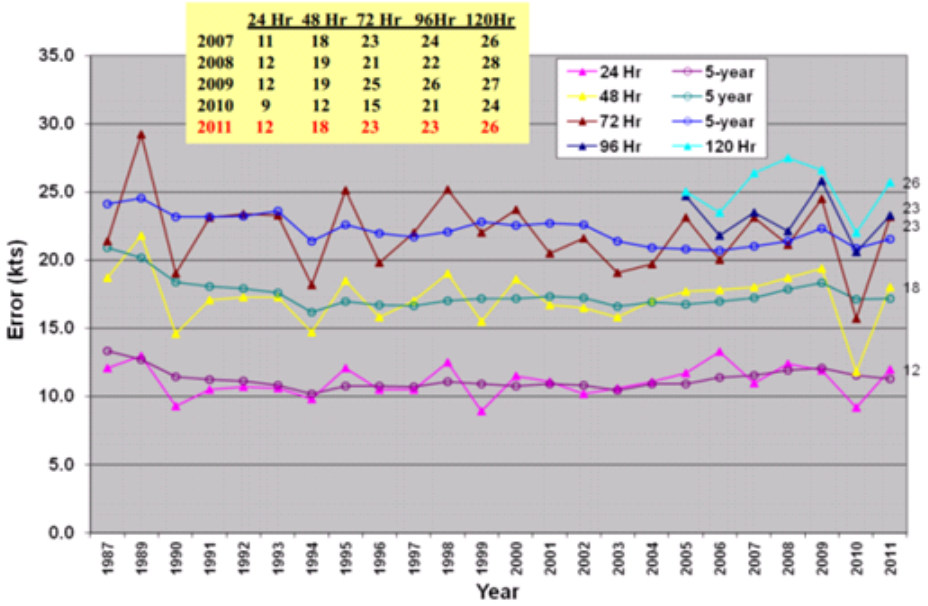
- Introduction
- FY2012-2013 real-time performance
- Rapid intensification and extreme limit
- HWRF genesis capability
- Concluding remarks

Introduction



- WPAC has more TCs than any other ocean basins;
- TC tracks are often more complicated due to frequent appearance of multiple TCs co-existing and interaction with monsoonal environment;
- Complicated topography with influence from high terrain over Tibetan plateau.
- TC intensity is generally stronger in WPAC (last year had 27 storms with 16 reaching cat 1+);
- Larger track errors than either NATL or EPAC basin (3-day error ~ 155 nm);
- Intensity skill shows no improvement with 3-day error ~ 26 kt (compared to ~ 17 kt in NATL).





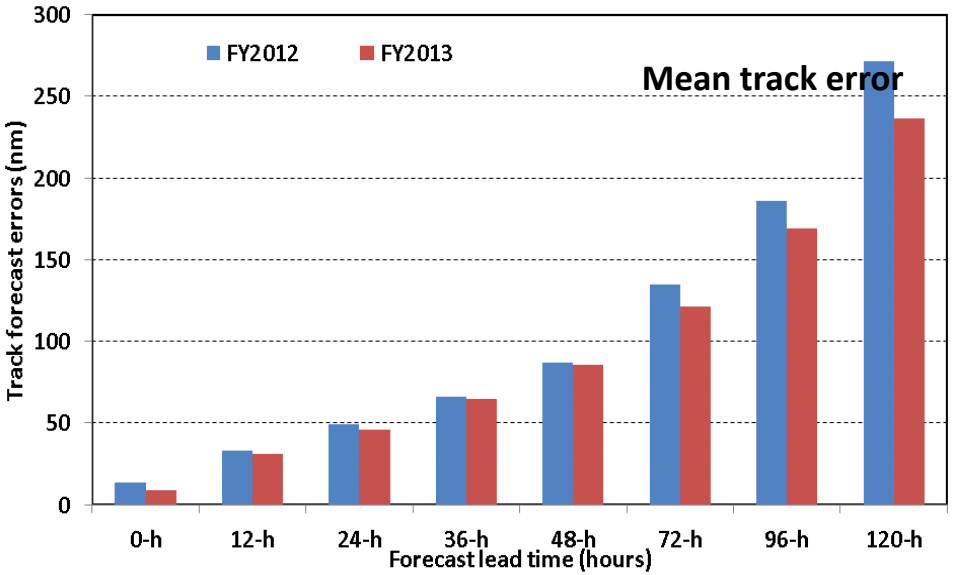
Introduction

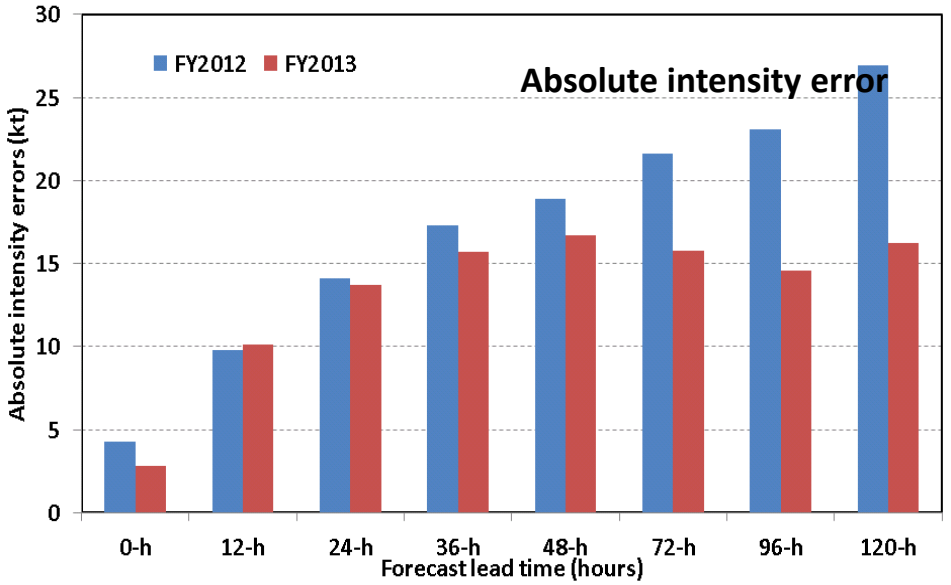
- Starting in 2012, EMC HWRF team has been experimenting real-time forecasts for the WPAC basin, using NCEP Operational HWRF system, thanks to the support from NOAA's HFIP program;
- Forecasts of all storms in WPAC basin including Invests and Depressions using the same configuration as for North Atlantic/Eastern Pacific basins except for ocean coupling;
- ~ 85% reliability in delivering forecast products to JTWC was accomplished using dedicated resources on HFIP machines;
- Starting with the 2013 typhoon season, JTWC decided to include HWRF as one of their track and intensity consensus guidance tools;
- Continue delivering real-time forecast guidance for all tropical systems in the WPAC, Indian Ocean, and Southern Hemisphere basin in 2014.

2012-2013 WPAC real-time configuration

- The operational HWRF based on the latest community version WRF-NMM (V3.4a);
- Triple nested domains 27/9/3 km; 43 vertical levels, the outermost domain is fixed, 9-km and 3-km domains follow the storm center;
- Model physics includes the GFS PBL scheme; improved GFDL surface physics; Ferrier Microphysics parameterization schemes; new GFS shallow convection parameterization (27/9 km only);
- Lateral boundary conditions updated every 6 h. Model physics called every 3 minutes with explicit convection in the 3km domain;
- Vortex initialization capability for high resolution configuration. No ocean coupling!
- Revised vortex initialization to work in all ocean basins;
- Increased the top of model sigma levels to 300 hPa. This reduced the steepness of the lower level sigma surface and prevented the model failures;
- Stopped nest movement if crossing over high terrain.

HWRF 2012-2013 real-time verification

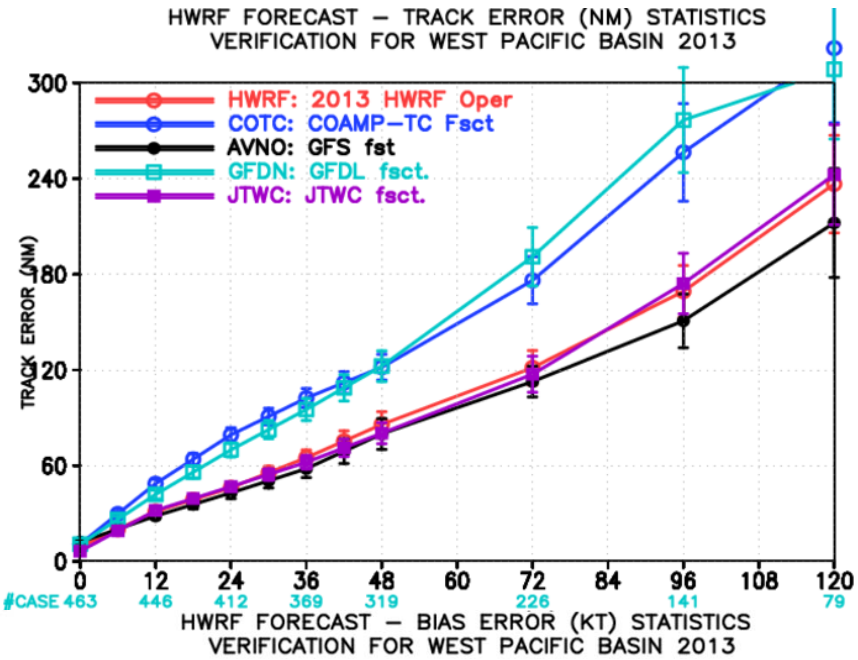


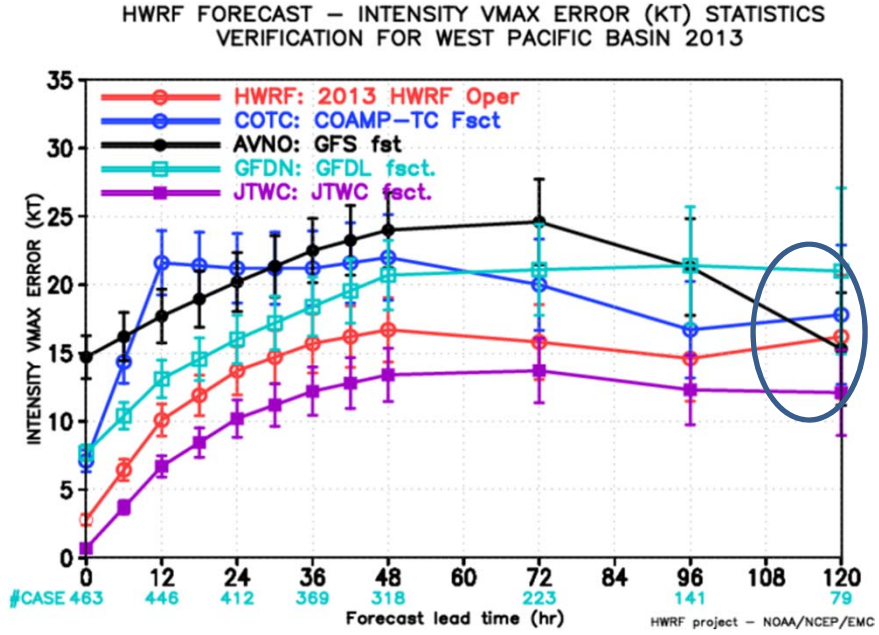


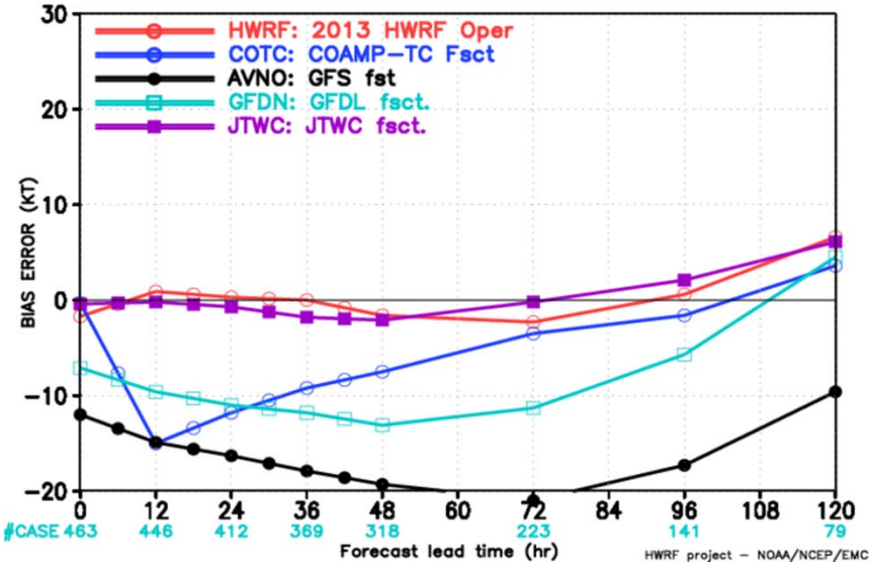
HWRF real-time experiments during 2012-2013 WPAC season showed:

- HWRF greatly improved from 2012- to 2013 with substantial track and intensity error reduction at all forecast lead times;
- 2013 season was dominated by strong storms (7 super typhoons), and HWRF was able to produce better intensity forecast;
- Intensity error reduction is most significant at 3, 4, 5 day lead times!!!

HWRF w.r.t. other operational models

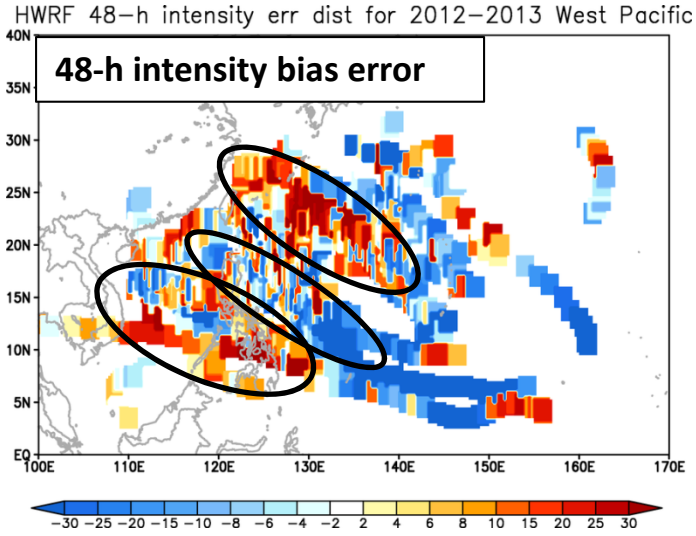


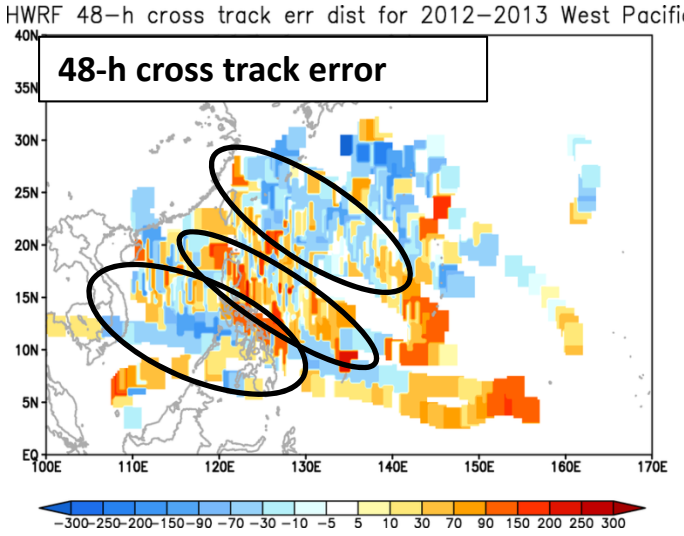


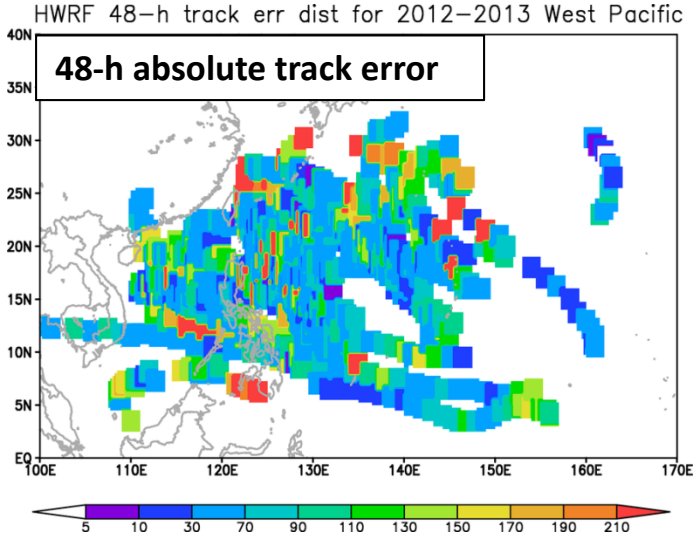


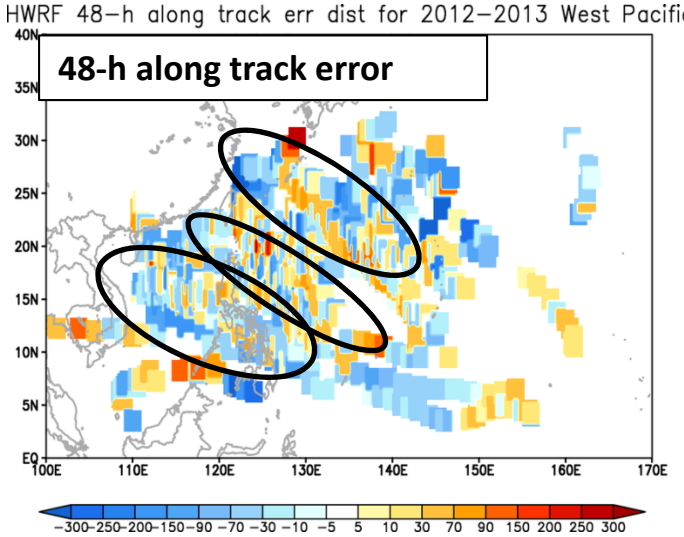
- HWRF track forecasts outperformed all regional models; very close to GFS forecasts in the 2013 season;
- Intensity forecast skill was superior than all other models during both 2012-2013 season;
- Still possessed some positive intensity bias near the end of 5-day forecast;

HWRF error distribution



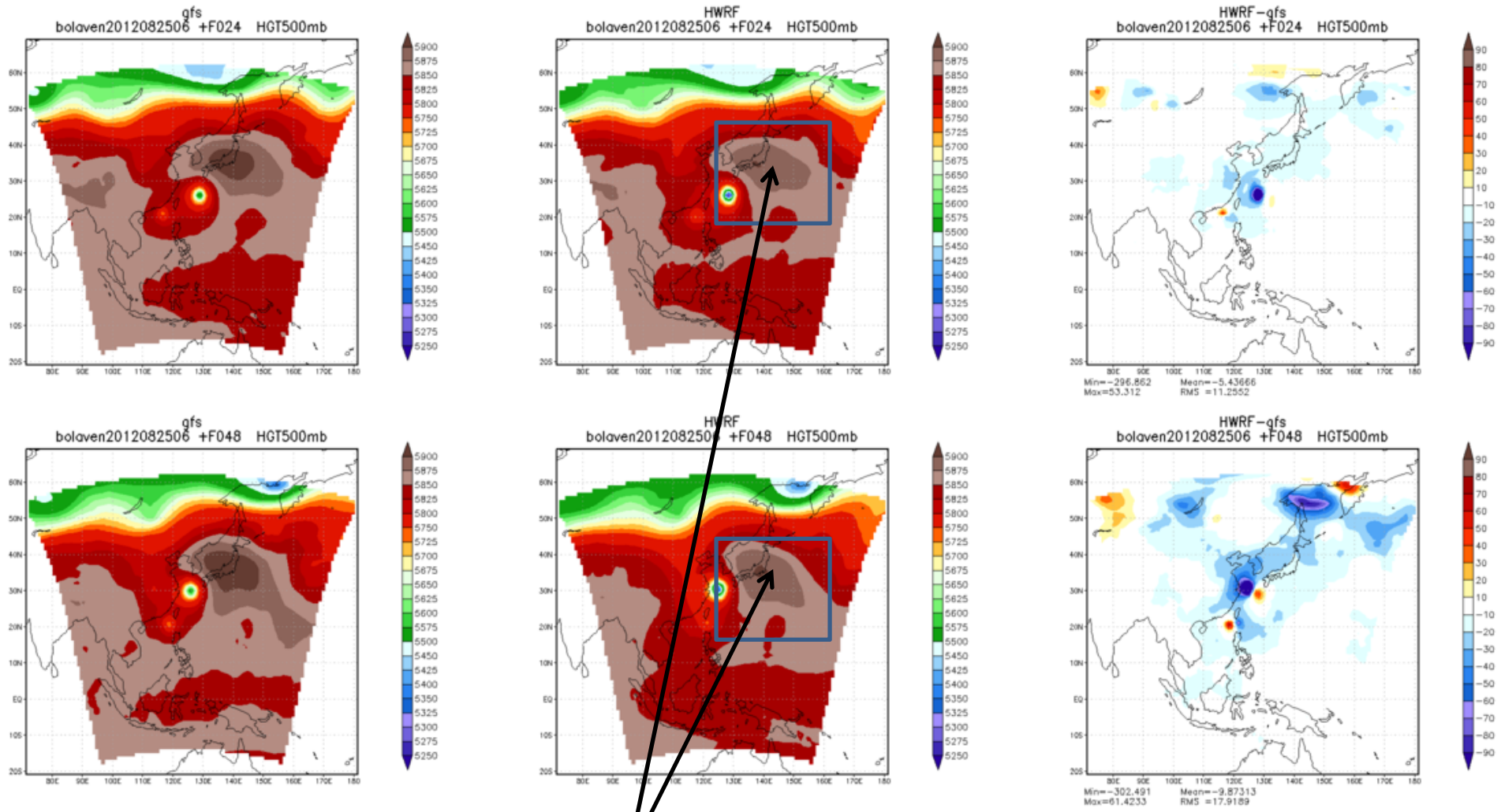






- Positive intensity errors are correlated to the track errors; right bias track errors (higher latitude) are related to the negative intensity bias, and vice versus;
- Slower translation speed (negative along track errors) is related to the positive intensity bias errors.

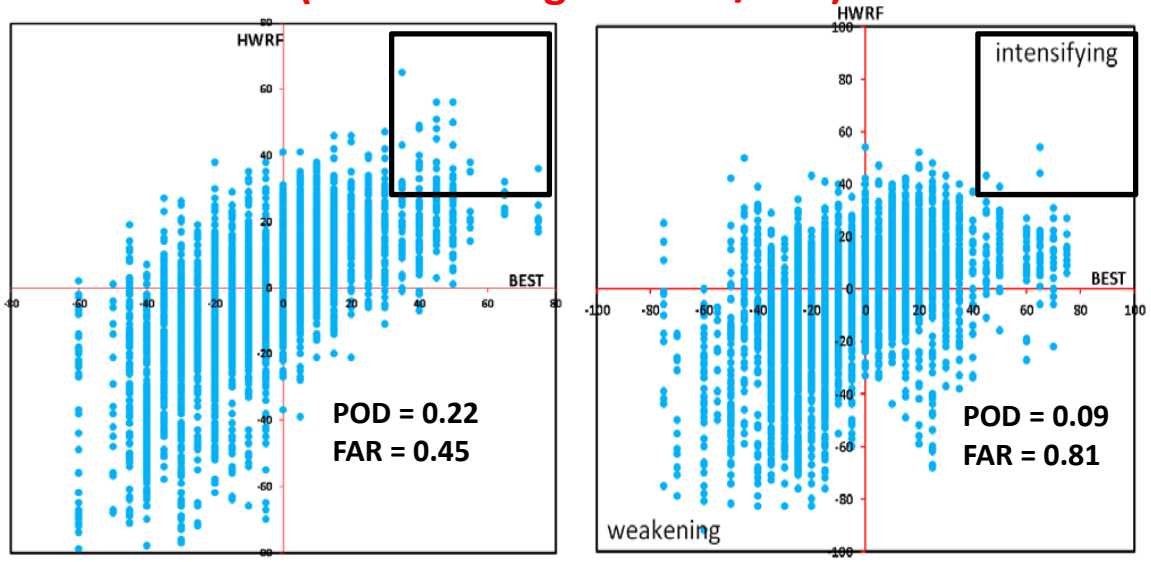
HWRF error distribution: potential issue



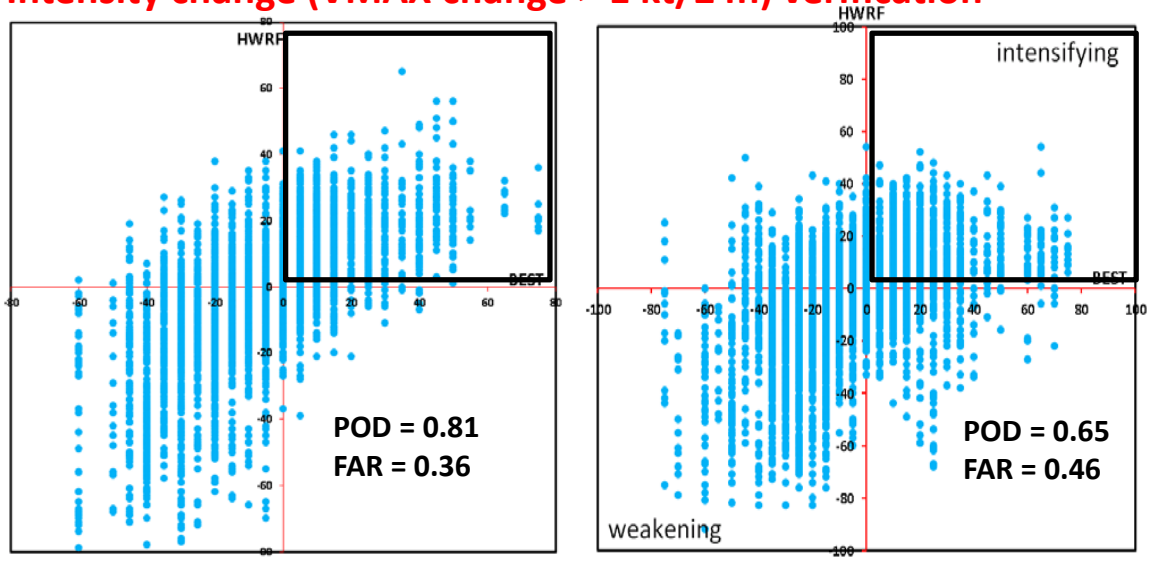
Weaker sub-tropical high compared to GFS forecasts

HWRF rapid intensification forecast

RI verification (VMAX change > 30 kt/24h)

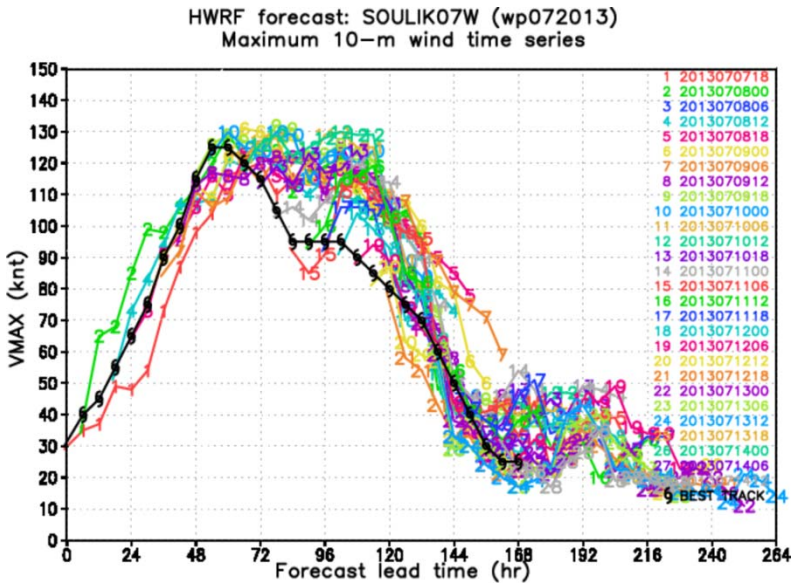


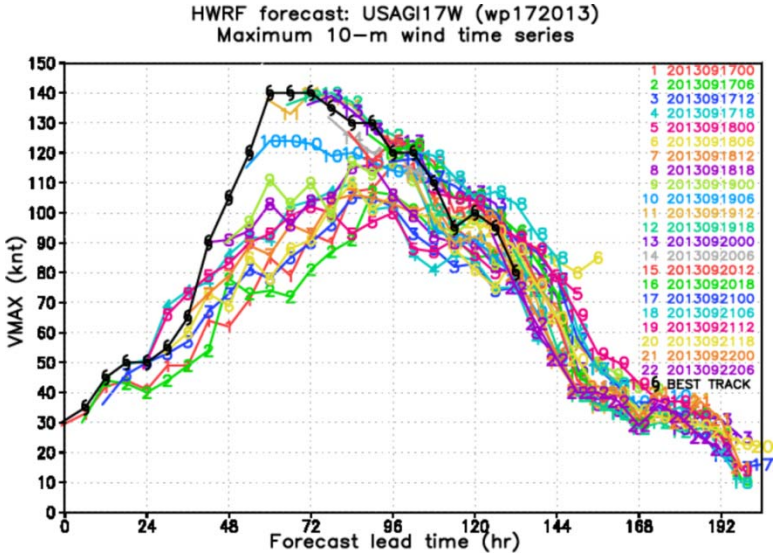
Intensity change (VMAX change > 1 kt/24h) verification



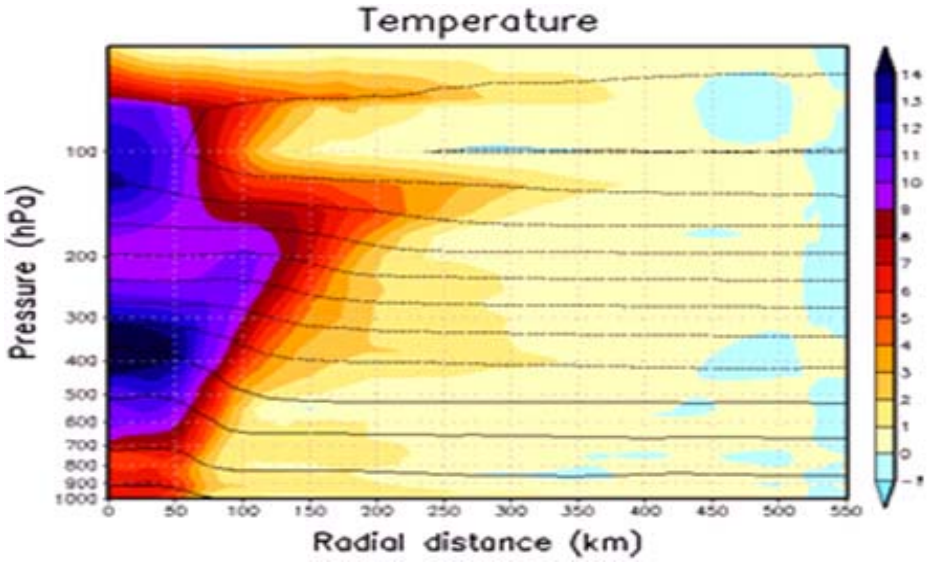
- If one define an RI event as > 30 kt / 24 h, then HWRF RI POD skill is ~ 22 % and by far has higher POD index as compared to other models and in other basins *(previous analysis of RI for WPAC from 2012 HWRF showed <10% skill)*.
- The POD index is much higher if one simply considers the intensity change tendency, say 6-h change of VMAX > 1 kt.
- POD index varies with different intensity change threshold. For VMAX > 5 kt, POD ~ 53%

HWRF extreme rapid intensification forecast





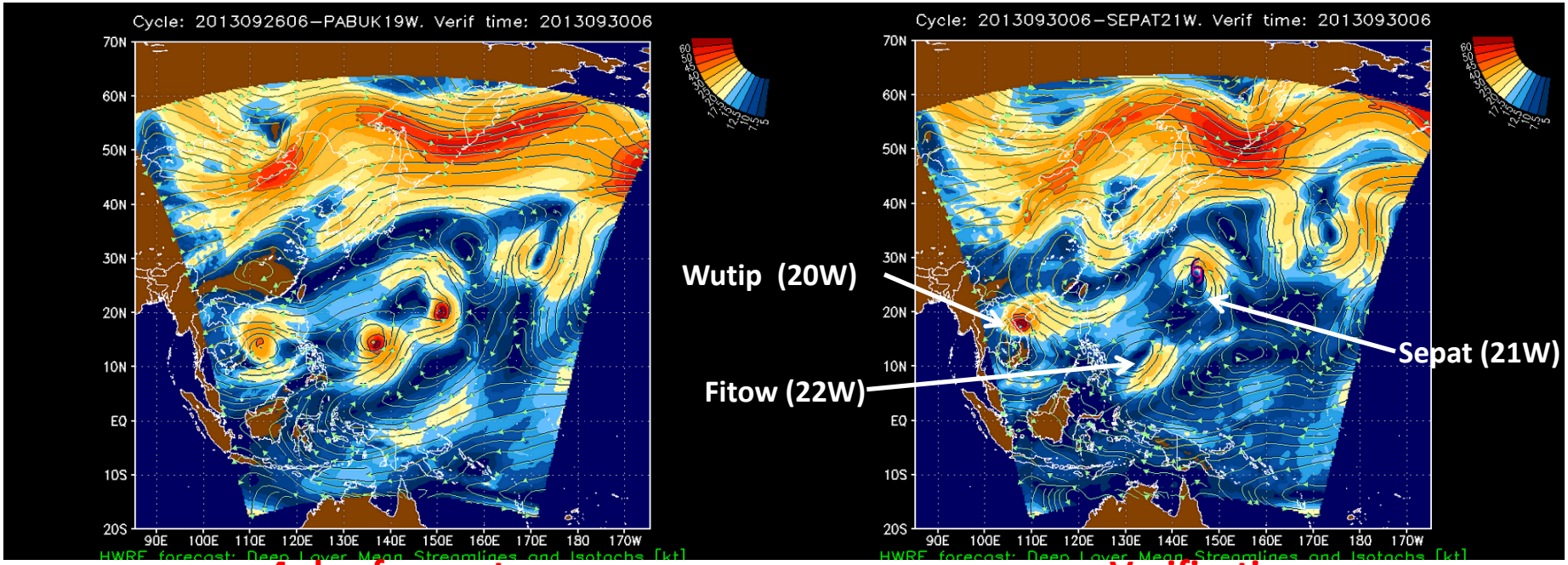
- HWRF captured well the RI for typical RI; However for exteme RI (e.g., Usagi RI as large as 70 kt in 24 hours), HWRF still has issue;
- HWRF had issue with RI after storm intensity > 80-90kt;
- Peak intensity > 120-kt is a very special regime that could put any model in vigorous test of model physics and stability. HWRF captured consistently double warm core during the peak intensity (110 kt +);
- The upper warm core appears to be related to the inflow at the upper levels. Higher resolution at the upper levels seems to have large impact for this situation



HWRF genesis capability forecast

	Observed developing	Observed non-developing
HWRF forecast developing	**14**	**3**
HWRF forecast non-developing	**2**	**10**

- HWRF in 2013 showed very nominal performance in genesis forecast. If we tabulates the number of successful genesis forecasts and compared to observed system, POD ~ 0.88, FAR ~ 0.18;
- 2013 season has been very active with multiple vortices, HWRF could capture several such instances very well.



Concluding remarks

- HWRF has been performing consistently better than other regional models in the WPAC so far despite no major tuning specific to that basin;
- HWRVC could capture RI very well but had difficulty with the extreme RI. Location of warm core should be a factor;
- HWRF still has potential issues with large-scale environmental control, which caused systematical correlation in track/intensity bias errors;
- HWRF showed some persistent vortex structure at very intense wind limit (double warm core, intense thin inflow layer at the upper level above the outflow). New features or the model artifact???
- Continue providing support for JTWC 2013 season over all ocean basins including Southern Hemisphere starting from January 2014, making HWRF a truly global tropical cyclone model.