

# HFIP 2012 Global GSI/EnKF hybrid configuration

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# Global GSI/EnKF hybrid now operational

- Became operational for GFS May 22.
- Very similar to configuration run in previous HFIP realtime demo.
- T574 control forecast, 80 member T254 EnKF ensemble.
- TC relocation runs on 6-h forecast (control and ensemble) before DA.

# How is the 2012 HFIP system different than operational system?

- Higher resolution (T878 control/T382 ensemble).
  - T1152/T574 tested with Semi-Lagrangian GFS, but systematic errors led to degraded tropical forecasts.
- No TC relocation.
- 20 member ensemble (to 5 days) initialized from EnKF (operational GEFS still uses Ensemble Transform scheme with degraded vertical resolution).
- ECMWF “stochastically perturbed physics tendencies” (SPPT) scheme implemented in GFS, active in 5-day forecast (not DA cycle).

# ECMWF SPPT method

- Perturbed Physics tendencies

$$X_p = (1 + r\mu)X_c$$

Original tendencies from gbphys

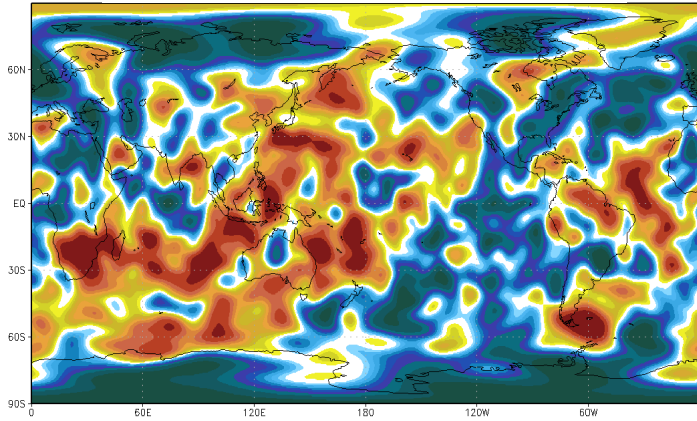
$r$ - vertical weight: 1 from surface to 100 hPa, damps to zero at 50 hPa

$\mu$ - horizontal weights: ranges from -1.0 to 1.0, a red noise process with a

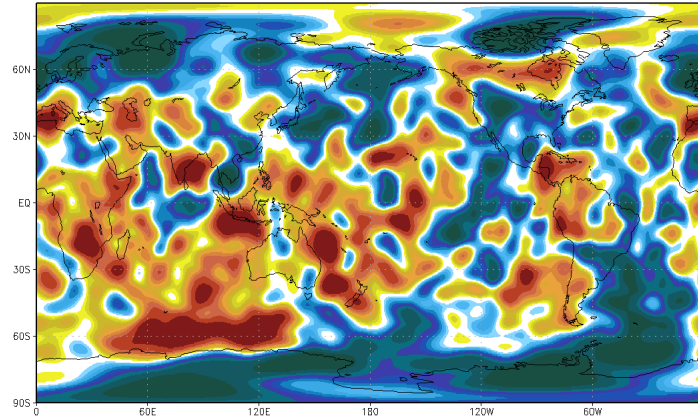
- Temporal timescale of 6 hours
- e-folding spatial scale of 500 km

# Example of horizontal Patterns: $\mu$

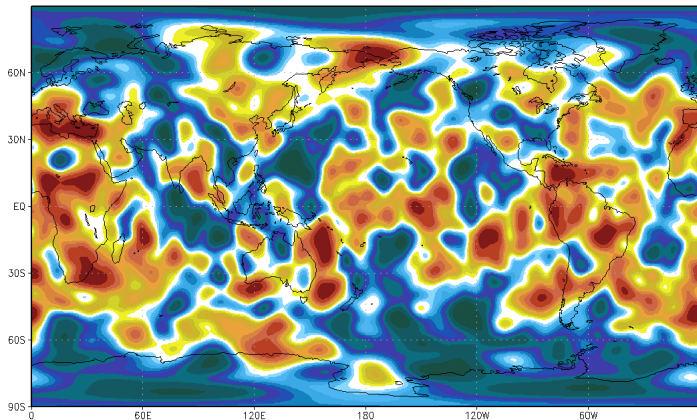
tau=0hr



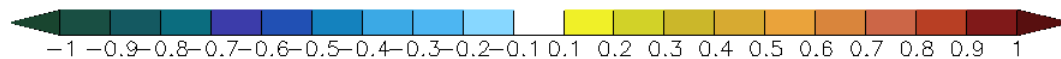
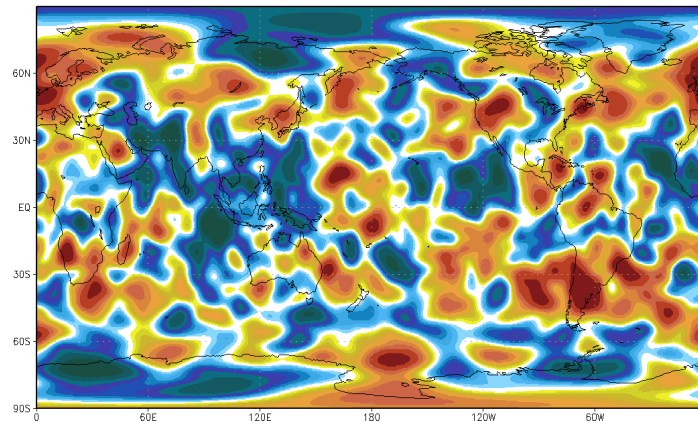
tau=6hr



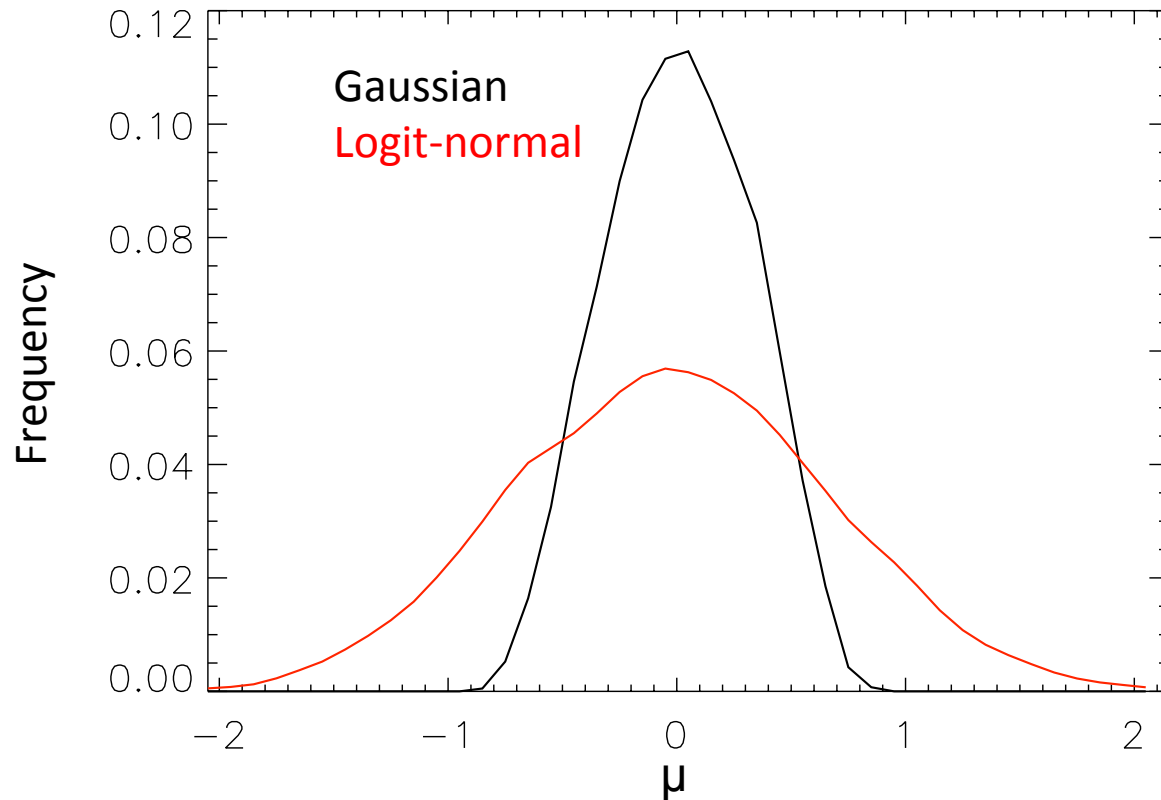
tau=12hr



tau=18hr



# Histogram of perturbations



Original implementation at ECMWF used a Gaussian distribution.

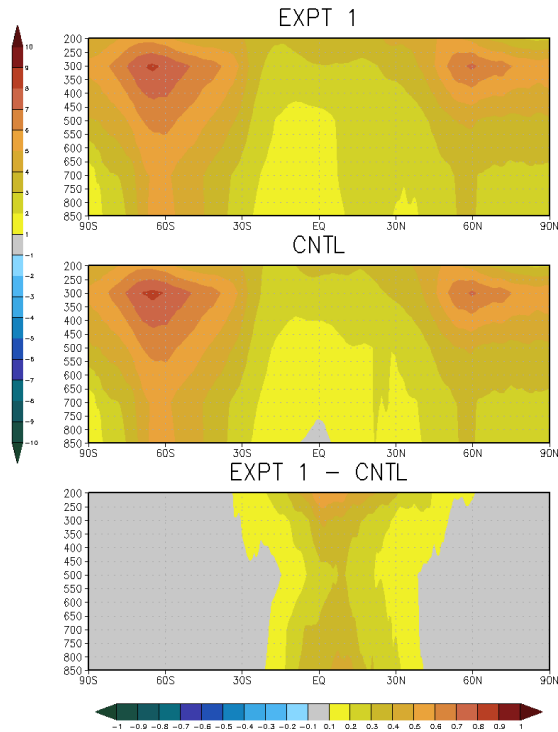
GFS crashed when the sign of the total physics tendency is negative (e.g.  $\mu < -1$ )

Thus use of a logit-normal distribution prevents  $\mu$  from getting less than -1

# 72hr forecast of zonal wind (1 Aug-17 Sept 2011, 20 member ensembles)

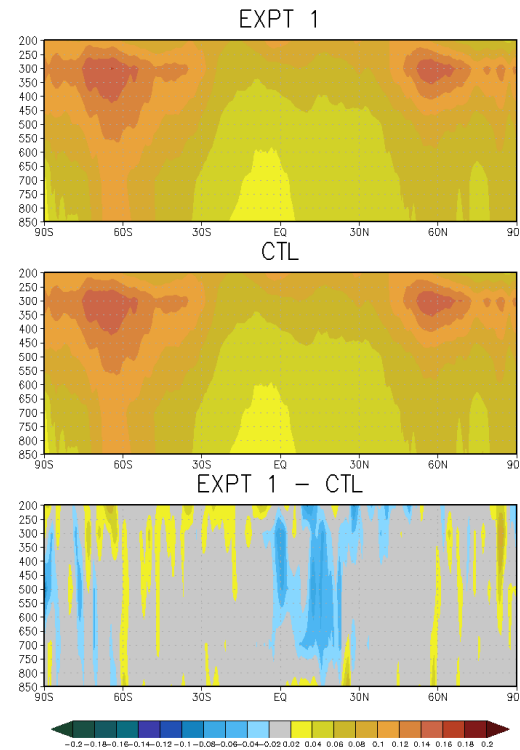
## Spread

Zonal Mean Zonal Wind Spread at 72h



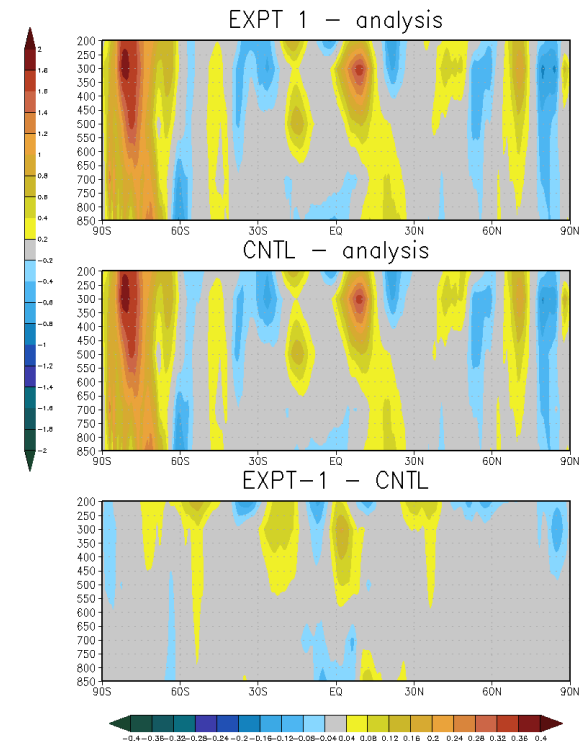
## RMS

Zonal Mean Zonal Wind RMSE at 72h



## Bias

Zonal Mean Zonal Wind Bias at 72h



Zonal wind spread increase is greatest in the tropics.  
Causes a small reduction in the RMS error in the tropics.

# Realtime products online since 1 June

The image is a screenshot of a web browser displaying a NOAA website. The browser's address bar shows the URL [www.esrl.noaa.gov/psd/forecasts/gfsenkf/](http://www.esrl.noaa.gov/psd/forecasts/gfsenkf/). The page header includes the NOAA logo and the text "Earth System Research Laboratory Physical Sciences Division". A search bar is located in the top right corner. Below the header is a navigation menu with links for "About", "Contact", "Research", "Data", "Products", "Outreach", and "Intranet". The main content area is titled "HFIP GFS/EnKF Forecast Graphics" and contains two paragraphs of text. The first paragraph describes the forecast system, and the second paragraph describes the data assimilation system. A red warning message is displayed below the text. A list of dates for experimental forecast ensemble initializations is provided at the bottom of the page.

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**Model Experiments**

- T878 GFS EnKF/Hybrid Control Experiments
- 20-member T382 GFS Ensemble Experiments

**Relevant Links**

- NOAA/NWS National Hurricane Center
- Experimental Forecast Tropical Cyclone Genesis Potential Fields
- Cyclone Phase Evolution Analyses and Forecasts
- CIMSS Tropical Cyclone Products
- Maximum Potential Hurricane Intensity

## HFIP GFS/EnKF Forecast Graphics

This page provides access to ensemble forecasts using the [National Oceanic and Atmospheric Administration \(NOAA\) National Center for Environmental Prediction \(NCEP\) Global Forecast System \(GFS\)](#) model, initialized with an experimental hybrid variational/Ensemble Kalman Filter (EnKF) data assimilation system.

The data assimilation system utilizes an 80 member ensemble (run at T382 resolution) to initialize a T878 control forecast using the hybrid variational/EnKF system. 20 T382 ensemble members are run out to 5 days, along with a single T878 control forecast 4 times daily (at 0000, 0600, 1200, and 1800 UTC). These experimental forecasts are made possible by support from the NOAA [Hurricane Forecast Improvement Program \(HFIP\)](#).

**WARNING:** These forecast are experimental and not intended to replace the official forecasts issued by the National Hurricane Center and/or the National Weather Service.

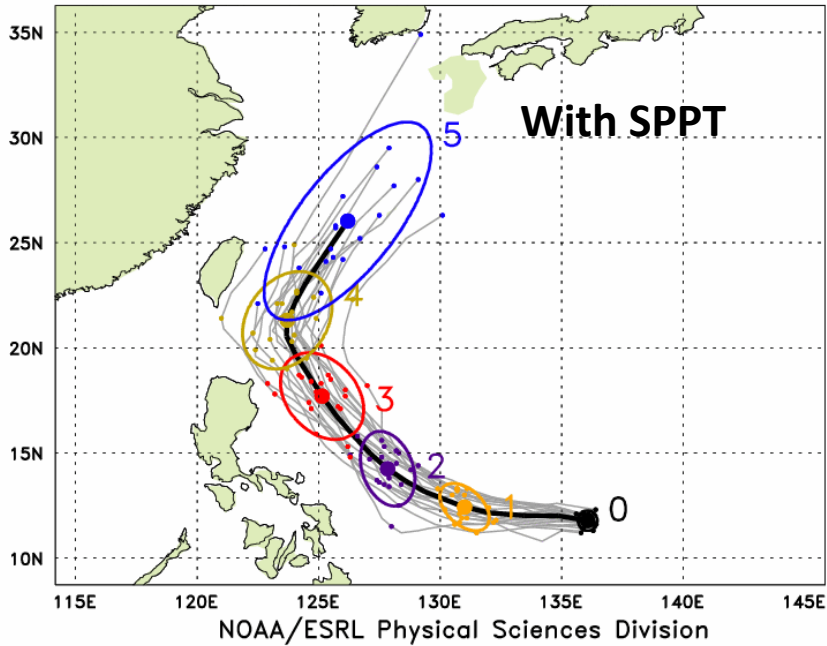
GFS/EnKF T382 Experimental Forecast Ensemble initializations

- [2012061906](#)
- [2012061900](#)
- [2012061818](#)
- [2012061812](#)
- [2012061806](#)
- [2012061800](#)
- [2012061718](#)
- [2012061712](#)

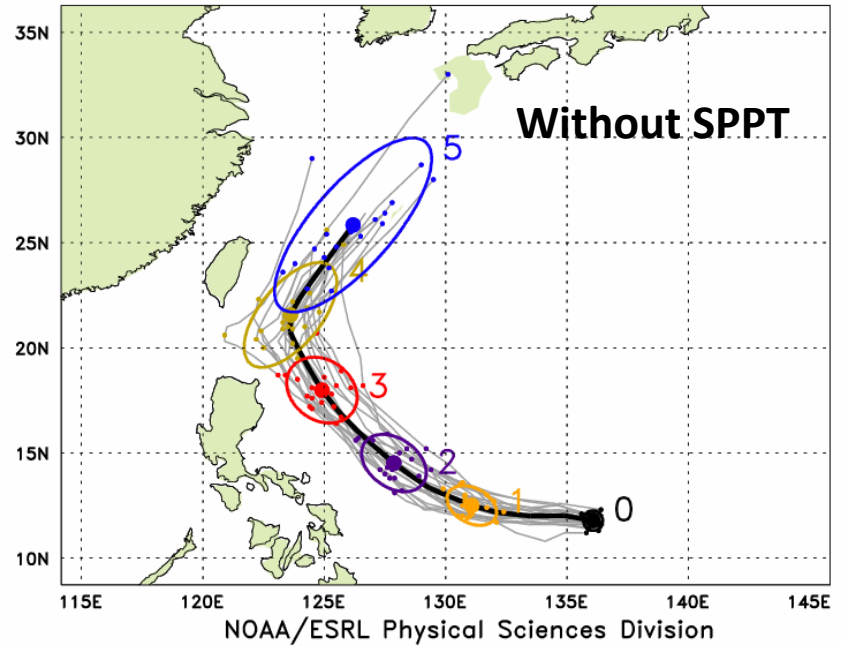


# Example: Forecast for 05W (Guchol)

GFS/EnKF ensembles and ellipses, IC=2012061400 for storm number 05 in the WP basin

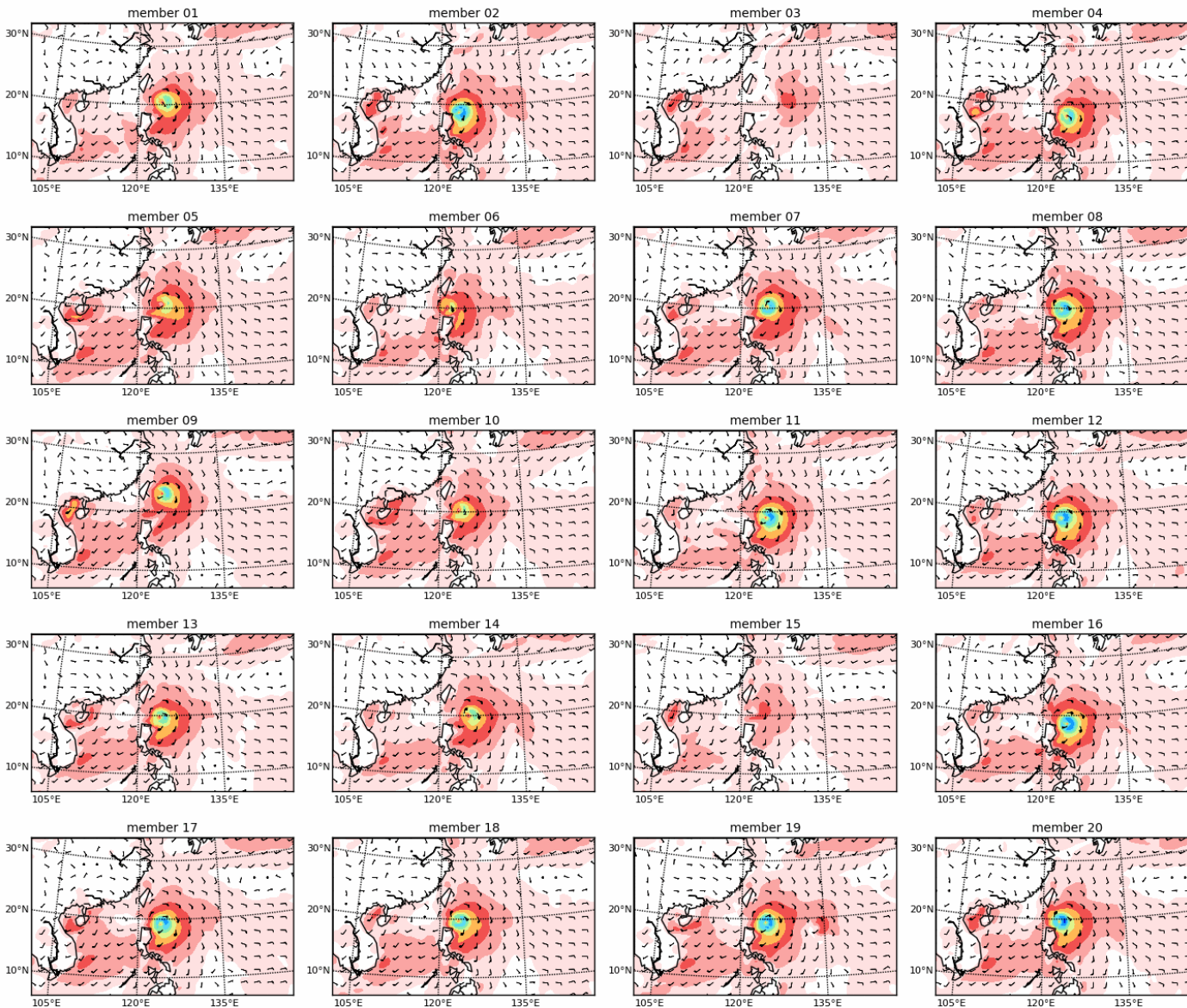


S/EnKF w/ SPPT ensembles and ellipses, IC=2012061400 for storm number 05 in the WP basin

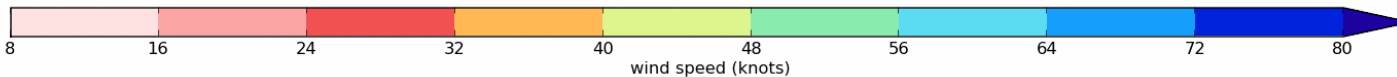


# Without SPPT

T382 GFS/EnKF no SPPT 10-m wind ens 084-hr fcst for 05W from 2012061400

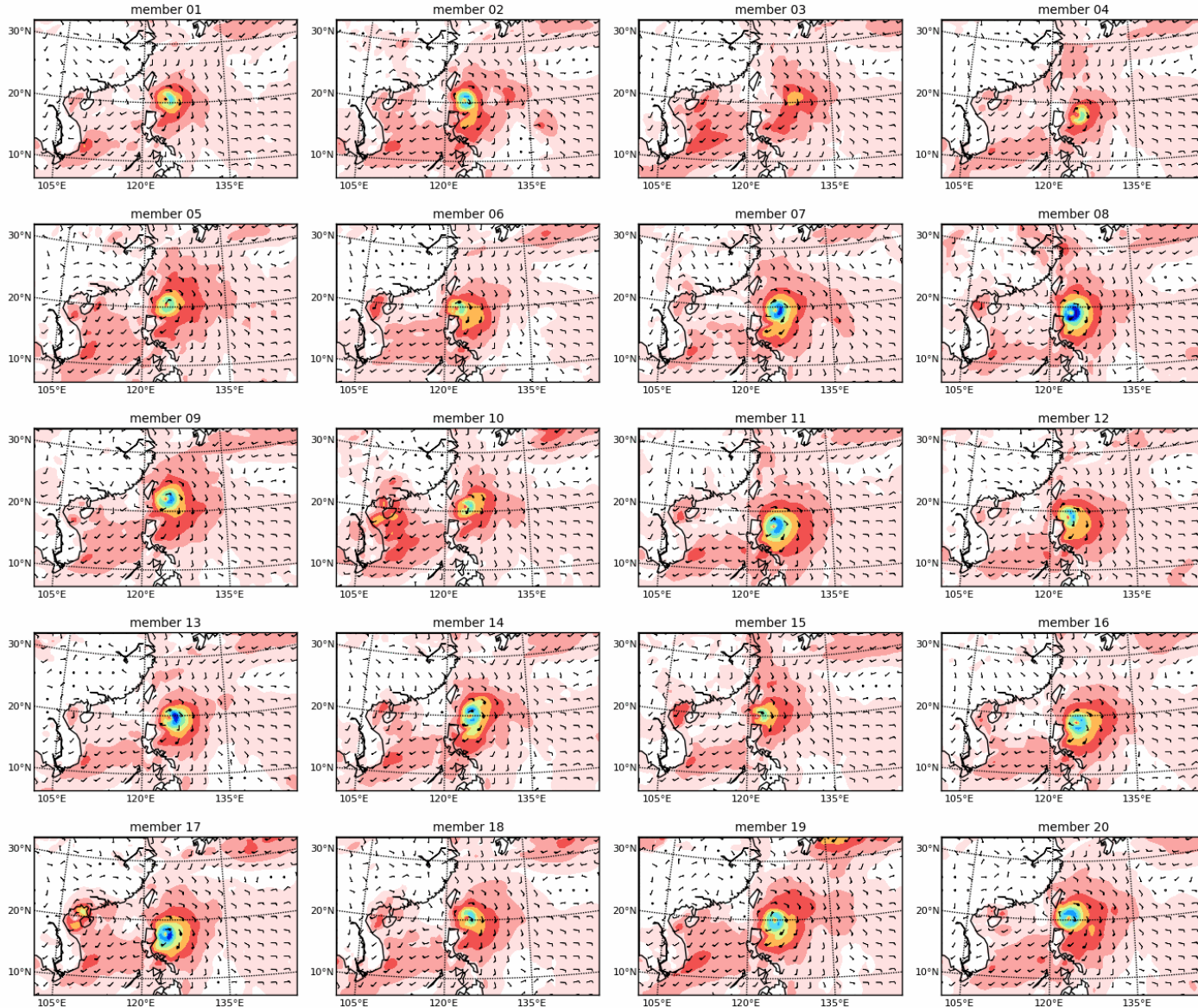


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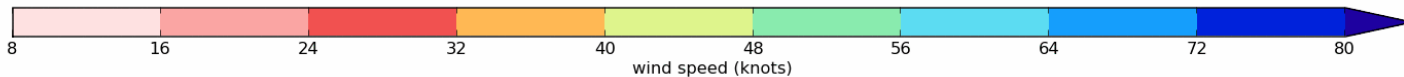


# With SPPT

T382 GFS/EnKF 10-m wind ens 084-hr fcst for 05W from 2012061400

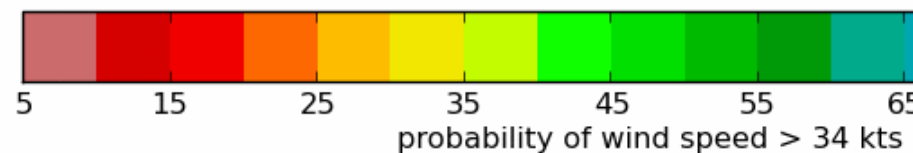
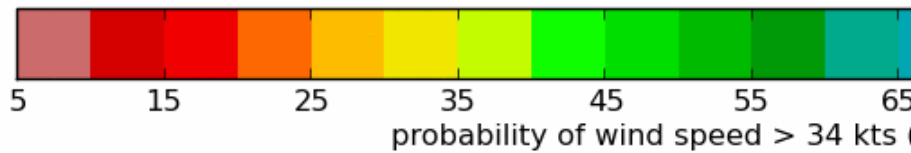
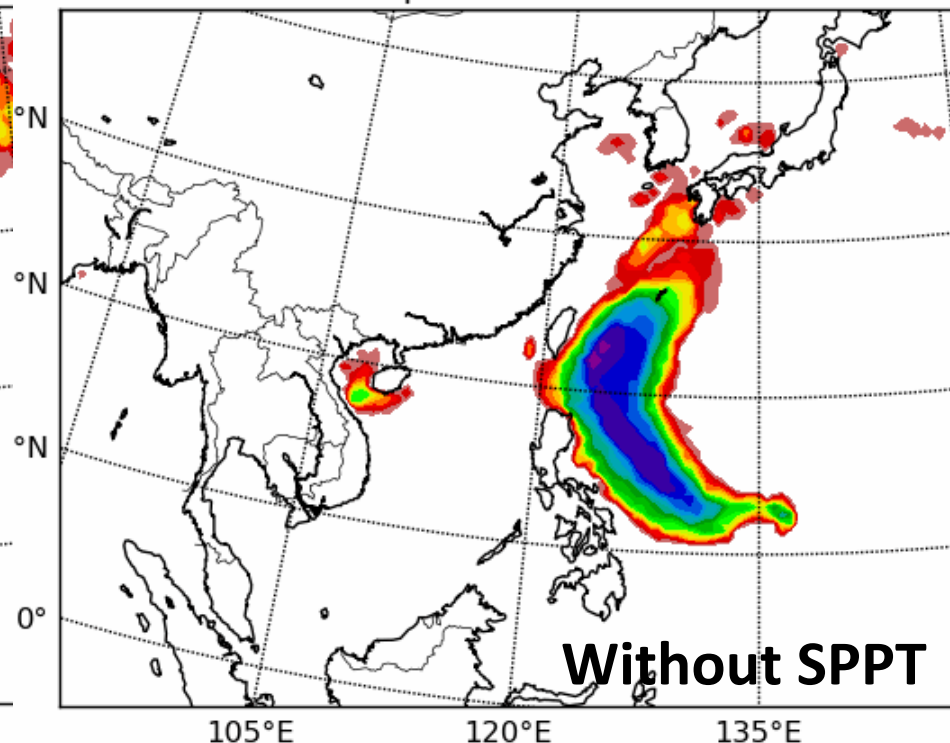
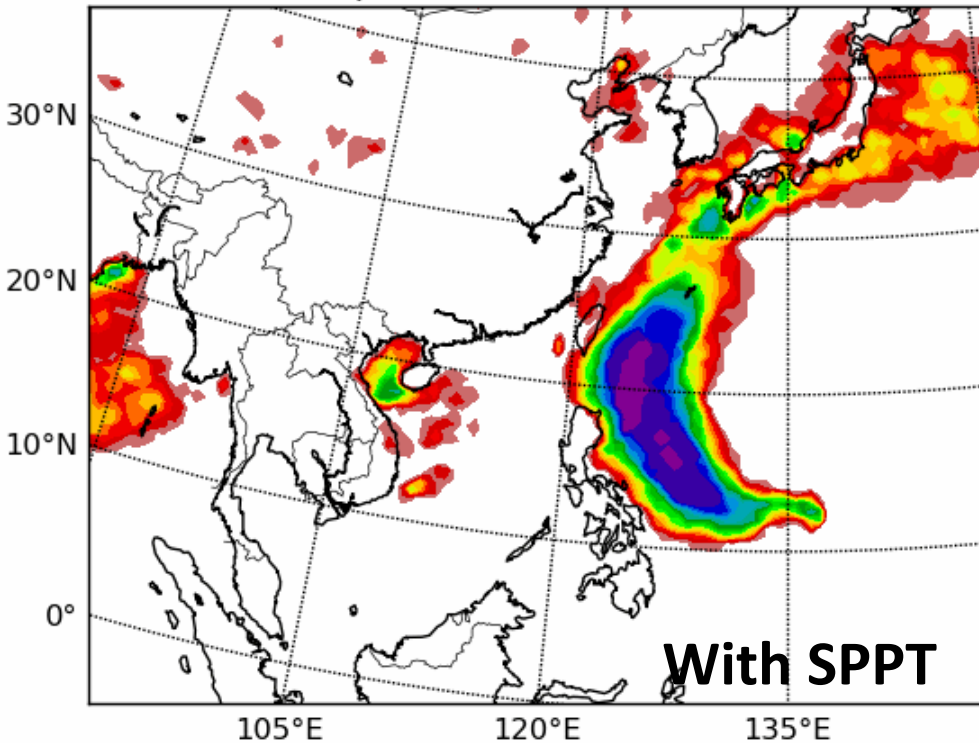


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# TS wind prob swaths

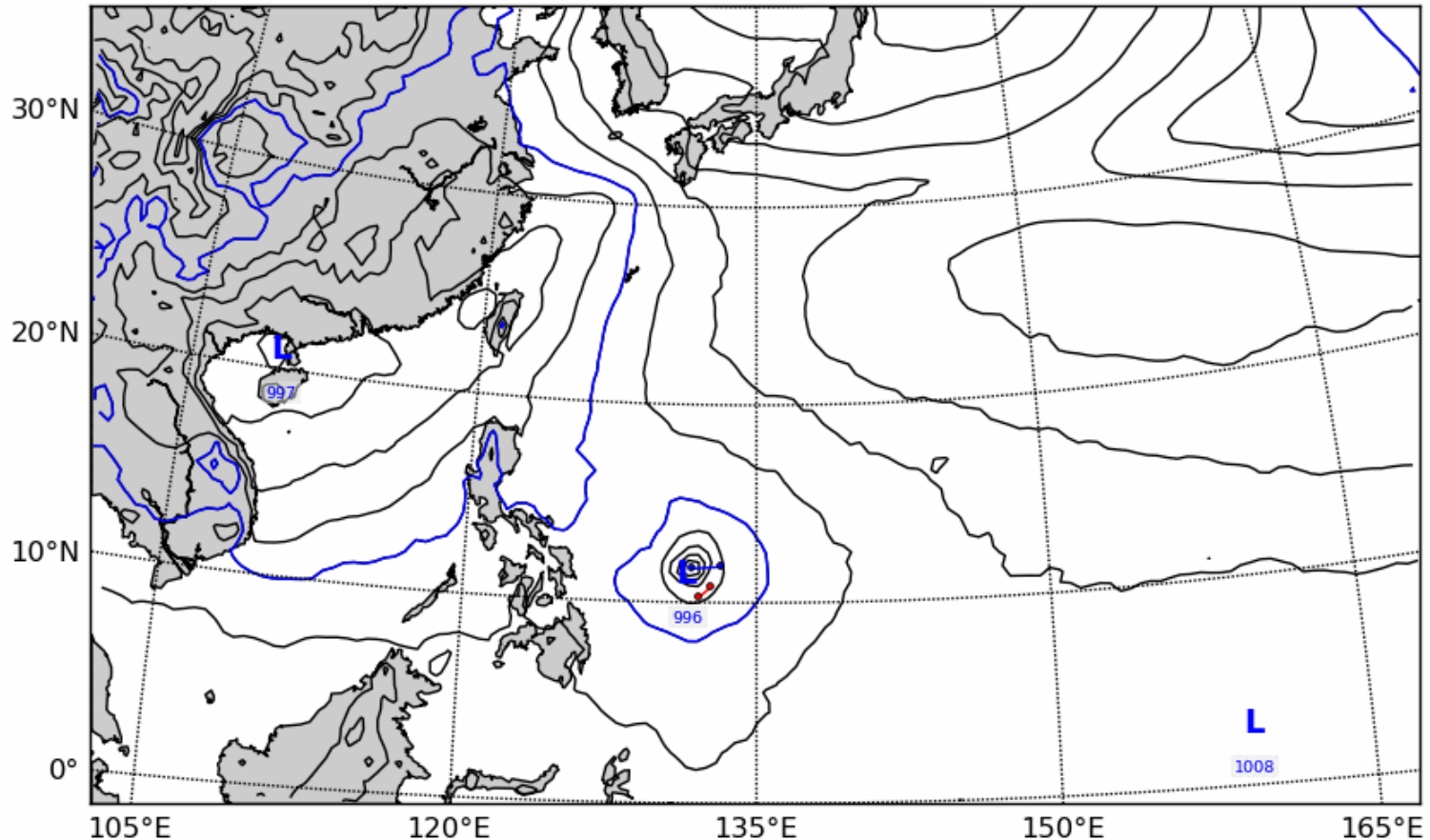
EnKF Ens Trop Storm Force Wind Probabilities 12 EnKF no SPPT Ens Trop Storm Force Wind Probabilities



# A recurring problem ...

- storm spins up in the wrong place
- all the ensemble spread goes with the model storm
- obs cannot correct the forecast

T878 GFS/EnKF MSLP cntl 06-hr fcst for WPAC from 2012061412



# Plans

- LGEM/SPICE post-processing (with CSU).
- Evaluate impact of enhanced resolution and stochastic physics (input to EMC for planning next GFS/GEFS upgrade).
- Test stochastic physics in DA after the hurricane season.
- Feed boundary conditions to HWRF hybrid DA.