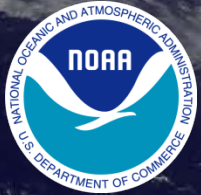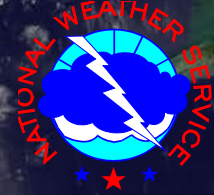# NHC's uses and needs of ensemble prediction systems

Eric S. Blake
National Hurricane Center
11/17/2015

Outline

- **How NHC uses ensemble data currently**

- **Examples of challenging cases during 2015**

- **What NHC is looking for in the future**

NHC use of current ensemble system:

1) GFS/EC Ensemble mean for track prediction

2) Spread for qualitative uncertainty estimates

3) Spaghetti plots for steering environment

4) Less frequent use for genesis forecasts
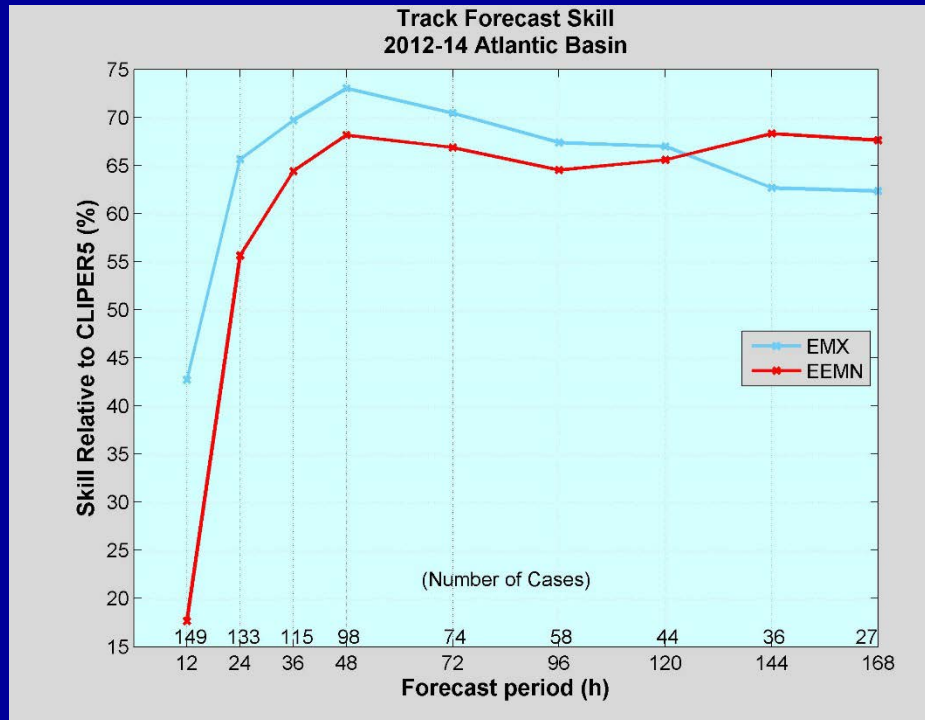
GEFS Mean vs. GFS (2012-2014)
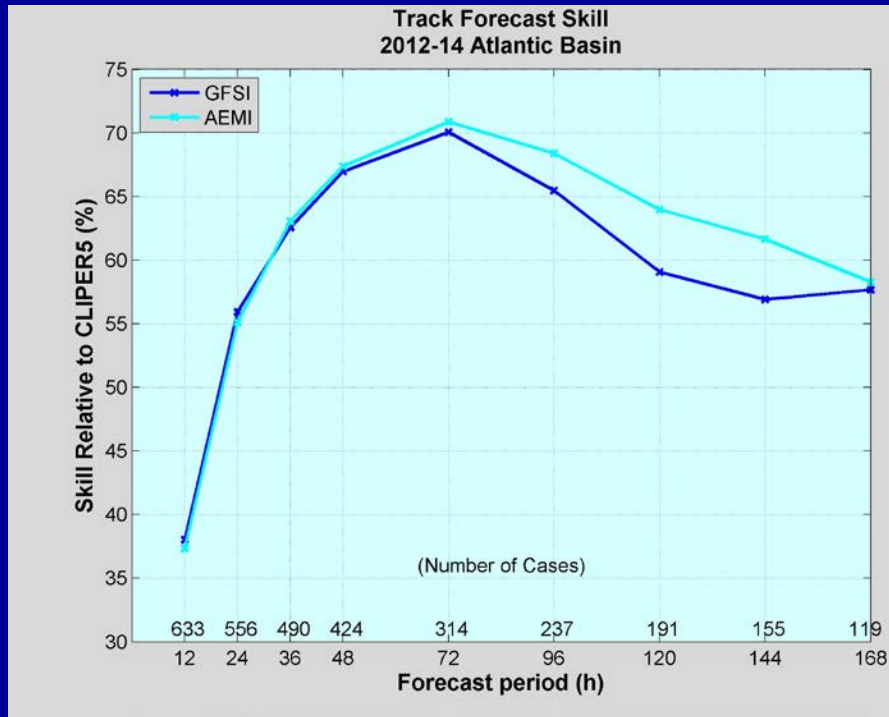
In the Atlantic, the GEFS ensemble mean track forecast (AEMI) is competitive with the deterministic GFS (GFSI) through day 2 and better afterward
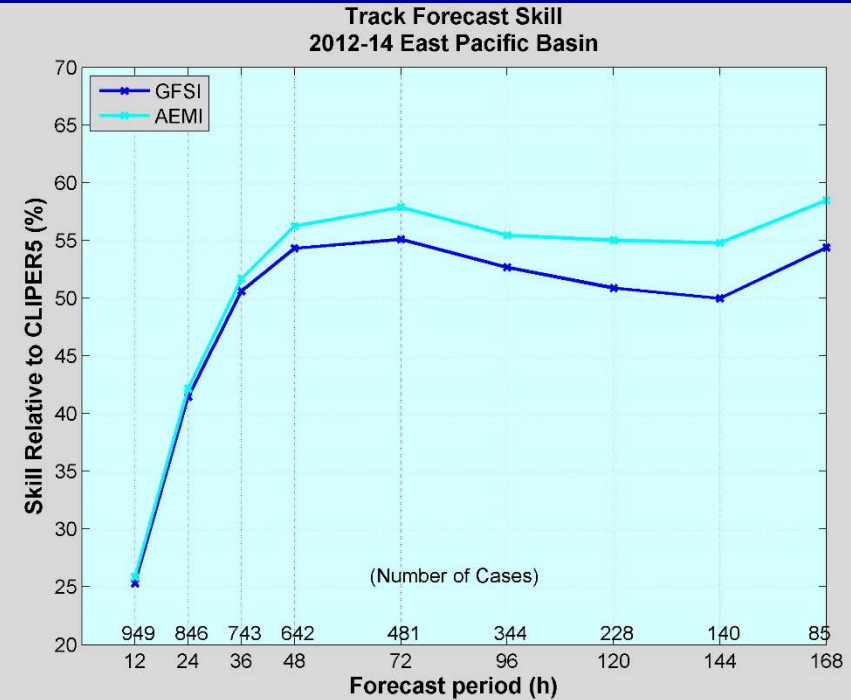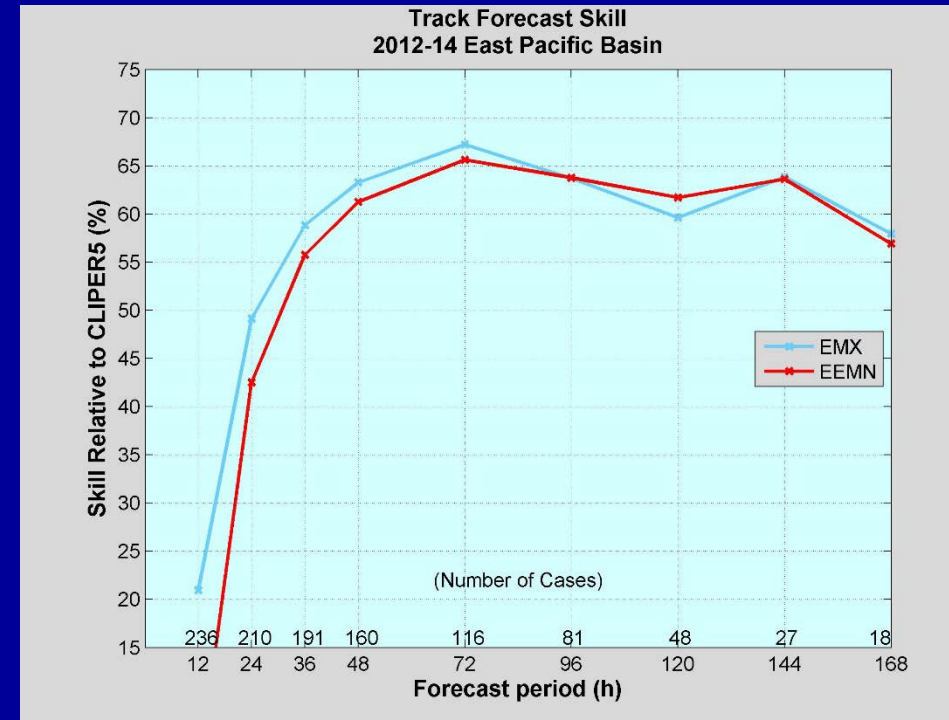
In the east Pacific, AEMI beats GFSI at 36 h and beyond

ECMWF Mean vs. ECMWF (2012-2014)

In the Atlantic, ECMWF ensemble mean (EEMN) still not as good as the ECMWF (EMX) through 4 days, but is about equal at day 5 and is better at days 6-7
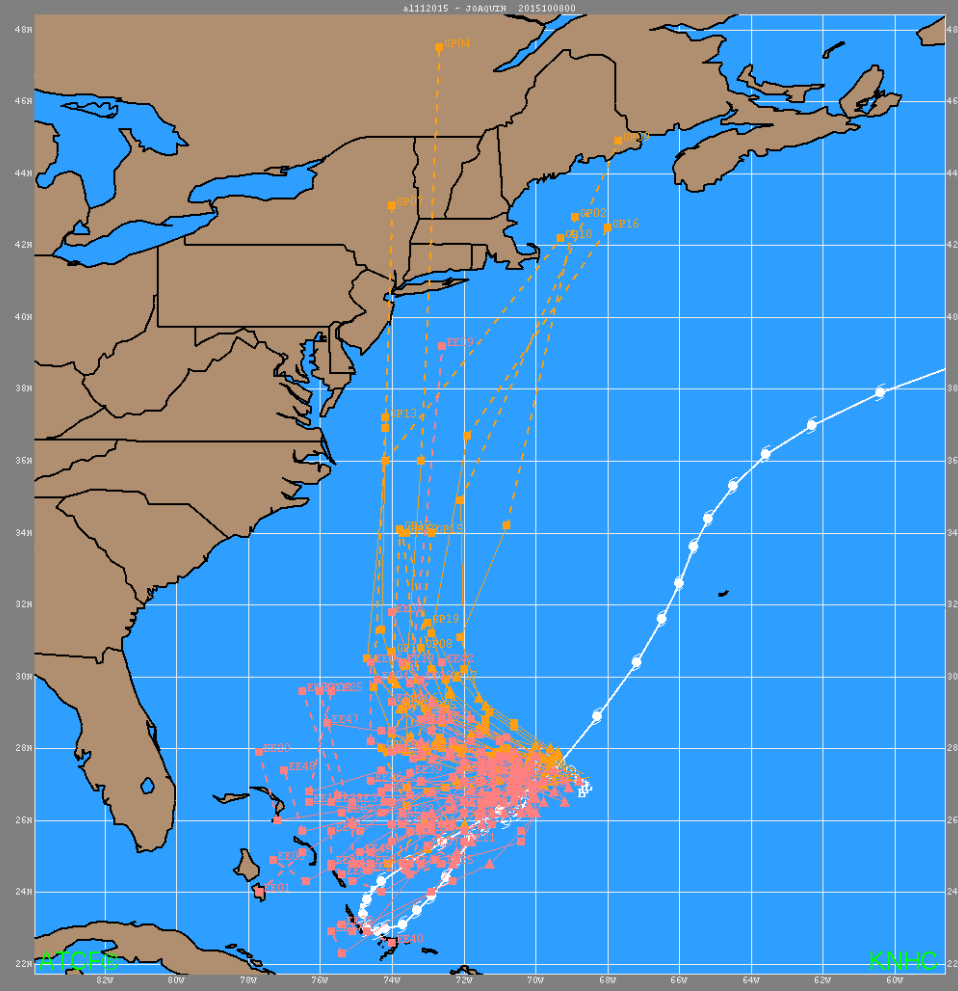
In the east Pacific, EEMN trails EMX through 3 days, and is about equal at days 4-7

Example of NCEP Global Ensemble Forecast System
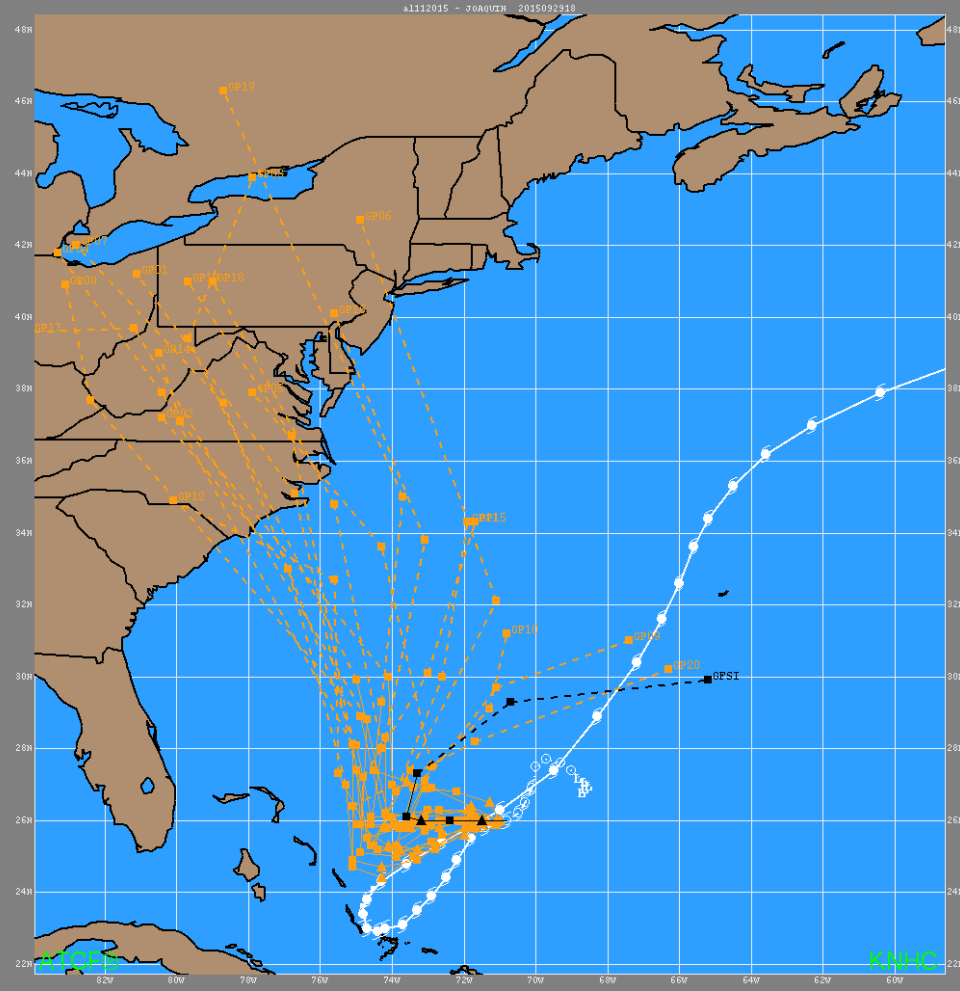## Guidance on Forecast display (ATCF)

GEMN = GEFS Ensemble Mean
GFS = Deterministic GFS
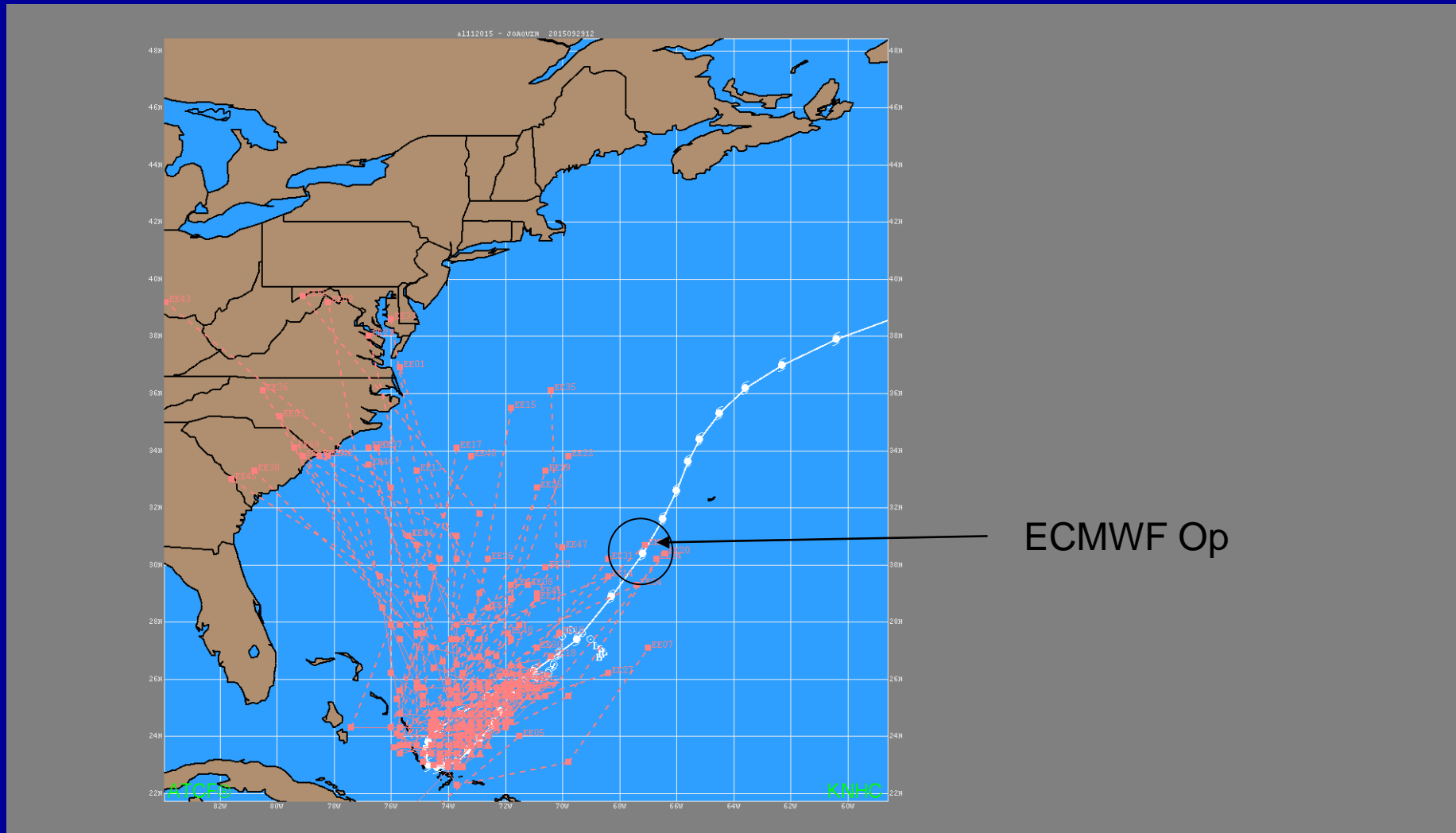
Joaquin ensemble guidance

GEFS

EC Ensemble

GFS Joaquin ensembles 29 Sep 1200 UTC

ECMWF Joaquin ensembles 29 Sep 1200 UTC

ECMWF Op

Genesis Guidance

Little objective guidance is seen with ensembles now, though they help subjectively.

In-house product→

shading: combined probability of 70 ensemble members (GEFS + ECENS):
- 850 – 700 hPa RH > 70%
- 200 – 850 hPa vertical wind shear < 20 kt

contours: 850 hPa relative vorticity (8 x 10^{-5} s^{-1} intervals)
thin green: ECENS members
thick green: **ECMWF deterministic**
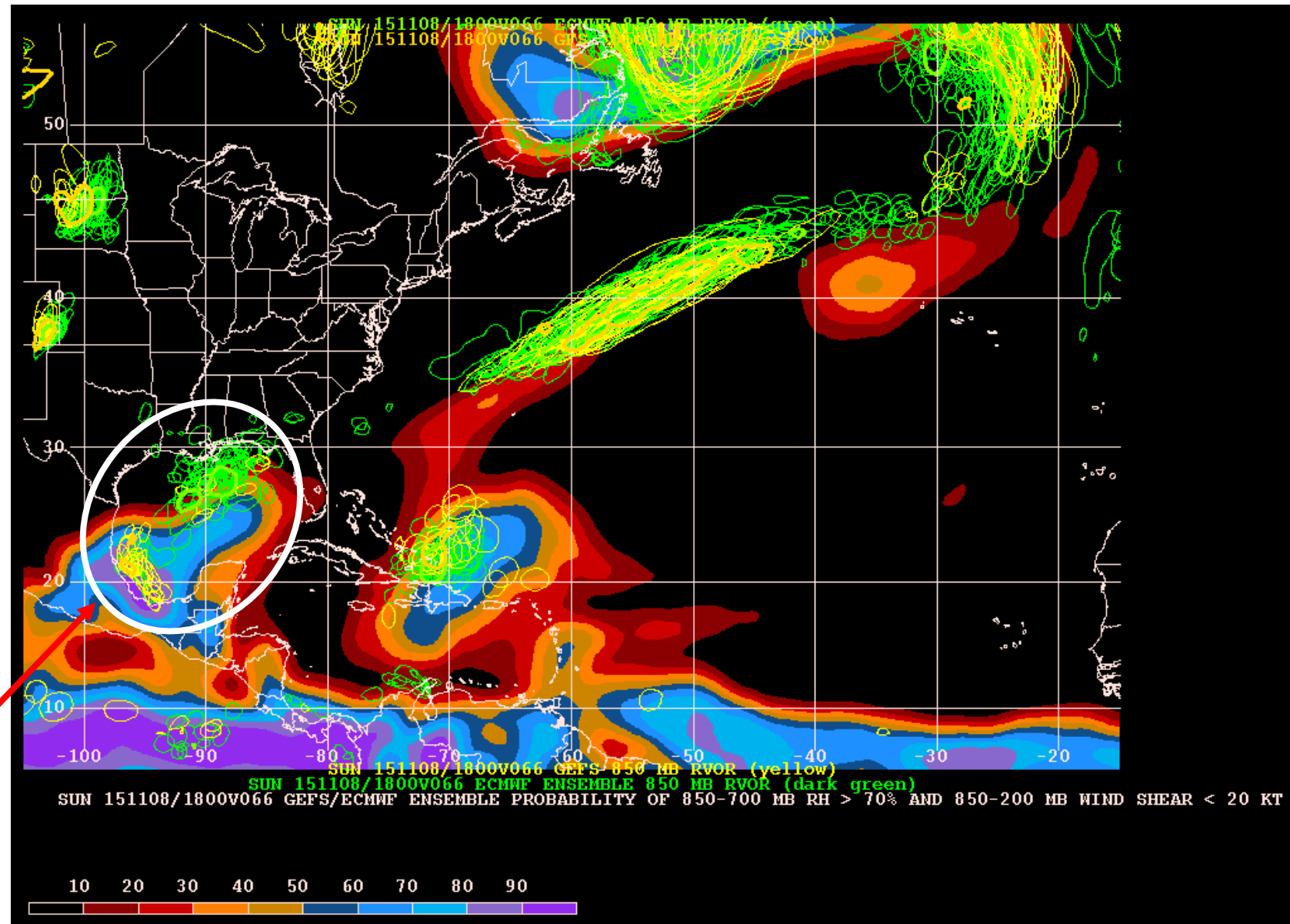thin yellow: GEFS members
thick yellow: **GFS deterministic**

Invest AL93

0000 UTC November 6, 2015 **+ 66 h**

SUN 151108/1800V066 GEFS 850 MB RVOR (yellow)
SUN 151108/1800V066 ECMWF ENSEMBLE 850 MB RVOR (dark green)
SUN 151108/1800V066 GEFS/ECMWF ENSEMBLE PROBABILITY OF 850-700 MB RH > 70% AND 850-200 MB WIND SHEAR < 20 KT
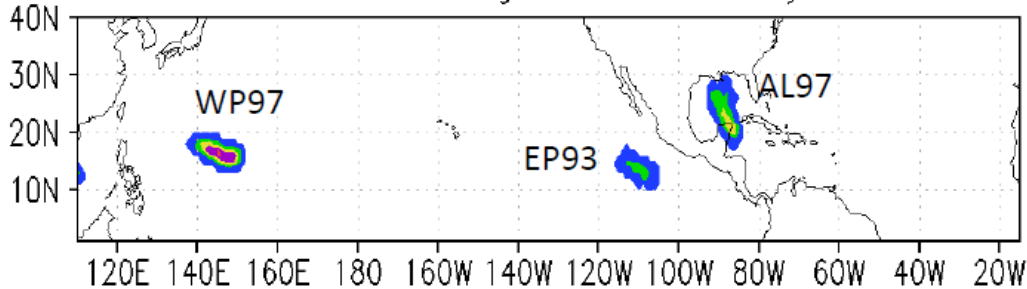
10 20 30 40 50 60 70 80 90

NCEP TC Ensemble page

TC Genesis Target Area: 0-40N, 110E-350E
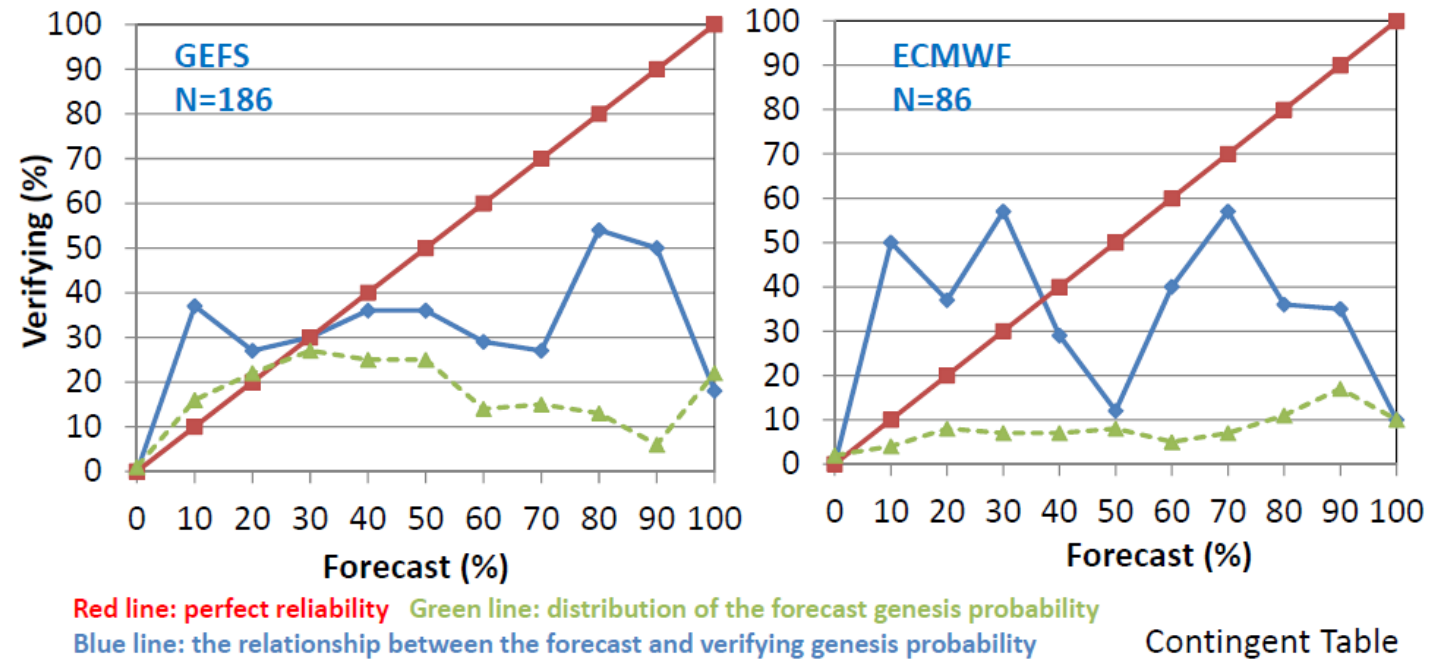Forecast Time Window: 48-hour genesis

NCEP GEFS TC Genesis Probability Forecast Within 48 hours

2013100300 TC-genesis Probability 48hr

WP97 will form "DANAS" (WP23, 10/03 06Z)
EP93 will form "NARDA"(EP14, 10/06 18Z)
AL97 will form "KAREN" (AL12, 10/03 06Z)

2013 Atlantic TC Genesis Forecast Reliability Diagram

Red line: perfect reliability   Green line: distribution of the forecast genesis probability
Blue line: the relationship between the forecast and verifying genesis probability

Contingent Table

- Verification not so good for some years, but haven't seen 2015 yet.

Ensemble genesis guidance

- Many different types of ensemble guidance

- Not easy to use

- Hard to find forecast verification and reliability information

- Efforts should be made to document forecast skill and simplify for forecaster use

My expectations with ensembles:

- Verification suggest most useful at long range

- Could be a powerful tool for ~Day 4 track and beyond (new GEFS implementation is a concern here)

- Should help to make better genesis forecasts
    * Can help reduce jumpiness of operational model
    * A way to assess consistency of forecasts
    * Post-processing and use of hindcasts have potential

What NHC is looking for:

1. Ensemble mean forecasts with superior track error, especially at long range.

2. More realistic ensemble spread to help with uncertainty estimates.

3. Innovative ways to display ensemble data and integrate into NHC operations to improve the official forecast

4. Objective ensemble genesis guidance, potentially using both raw output and a skillful calibrated scheme.
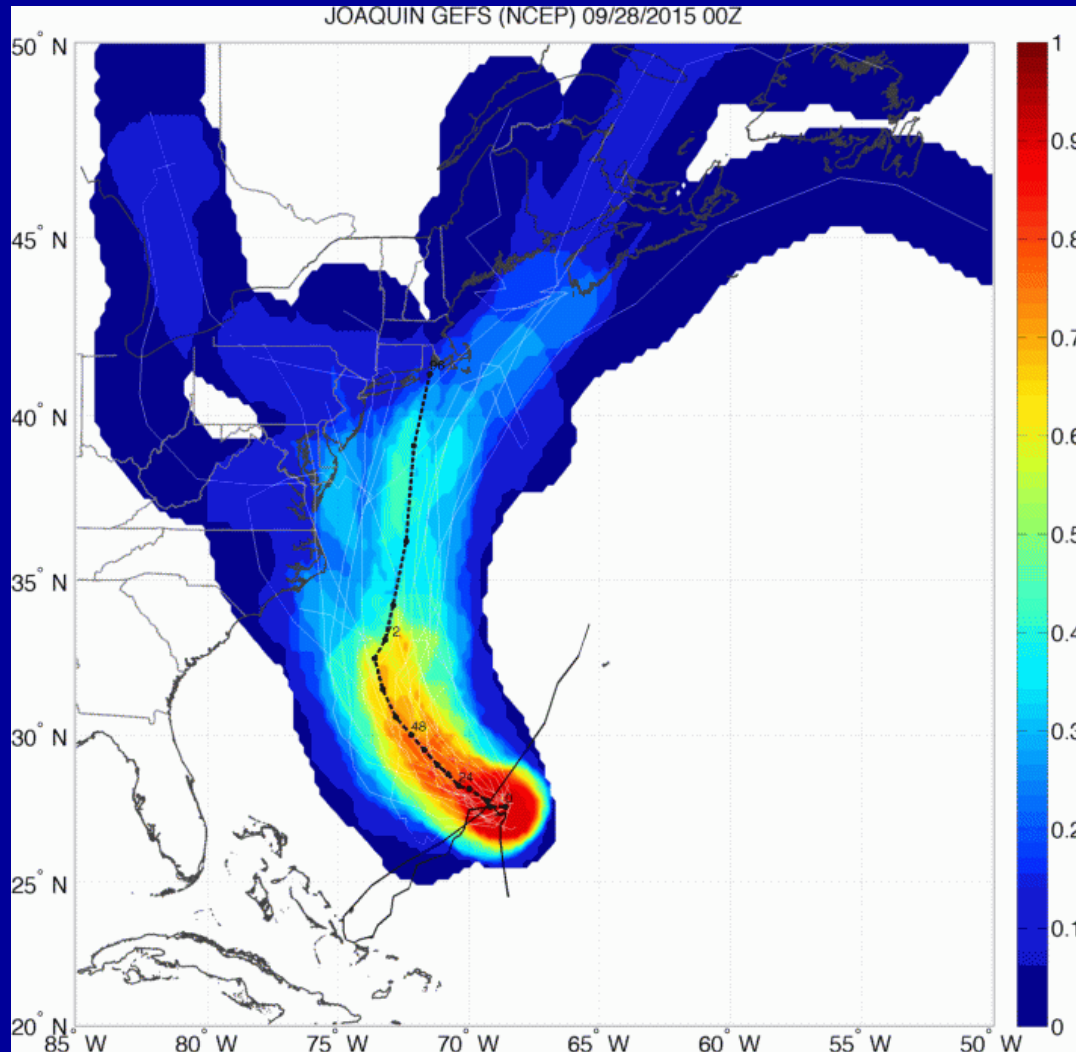
Ideal case: Sandy
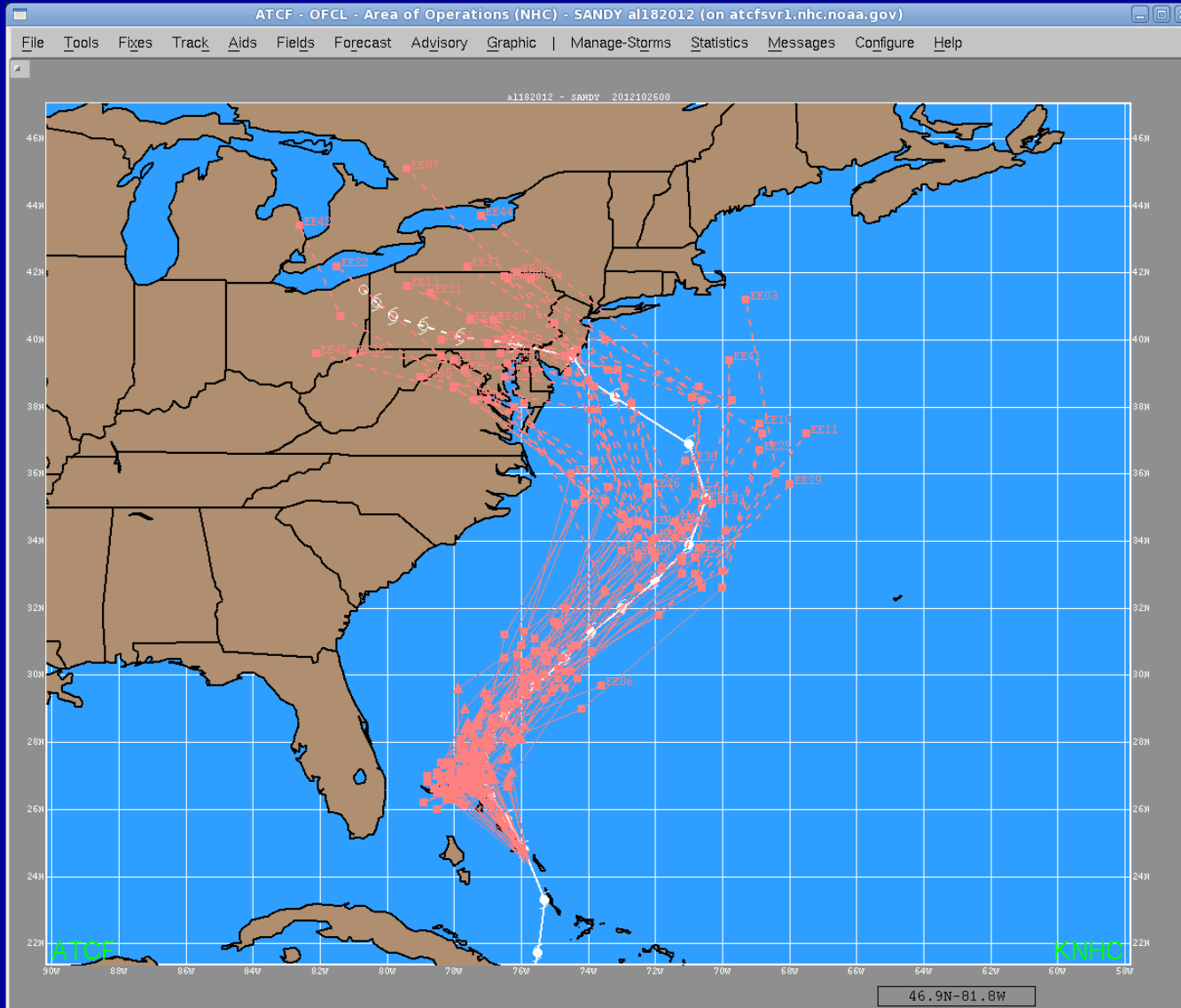
-Realistic spread

-Verification near the center of the mean

Possible enhancements to guidance

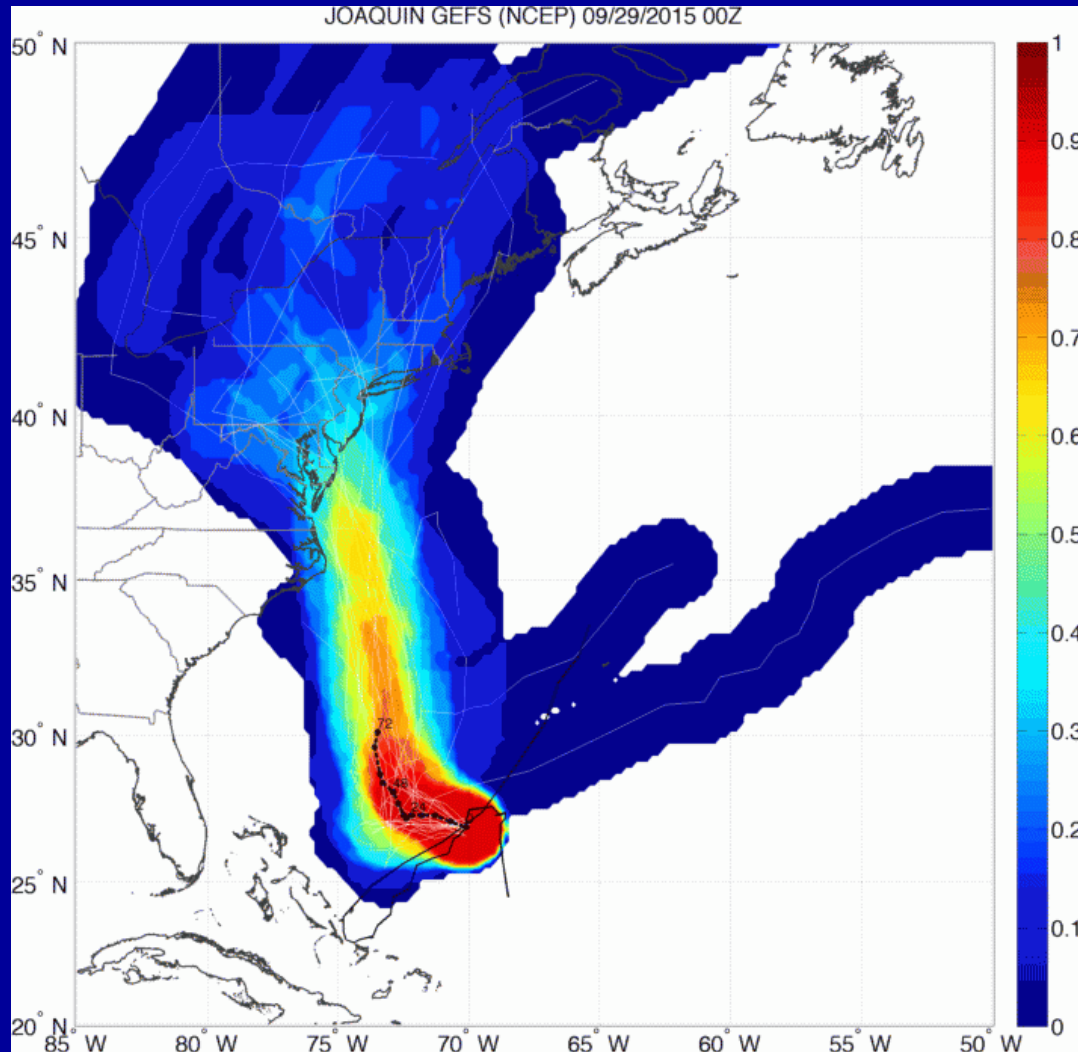# GEFS vs EC Ensemble 28 Sep 0000 UTC

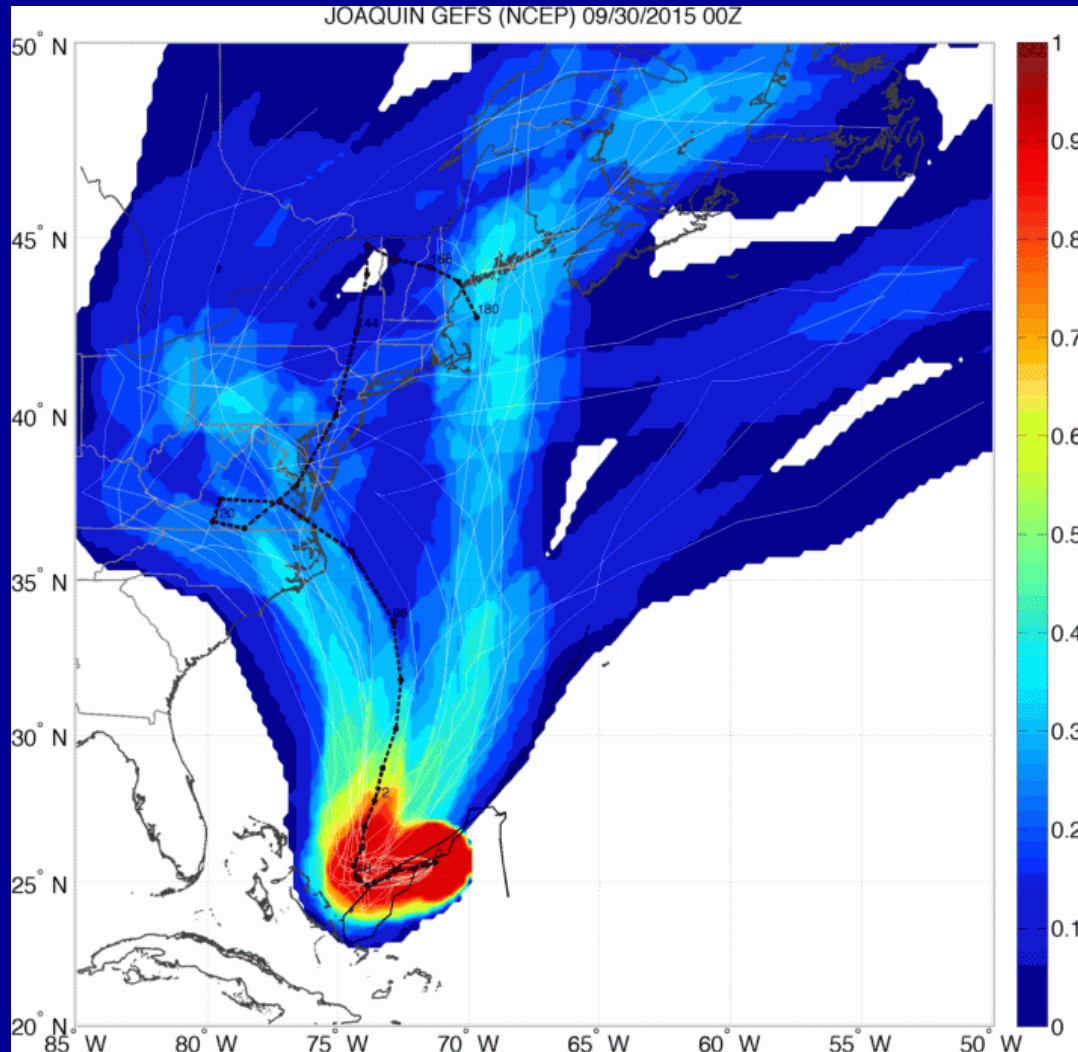JOAQUIN GEFS (NCEP) 09/28/2015 00Z

- Shading is fraction of members within 150 km of a point

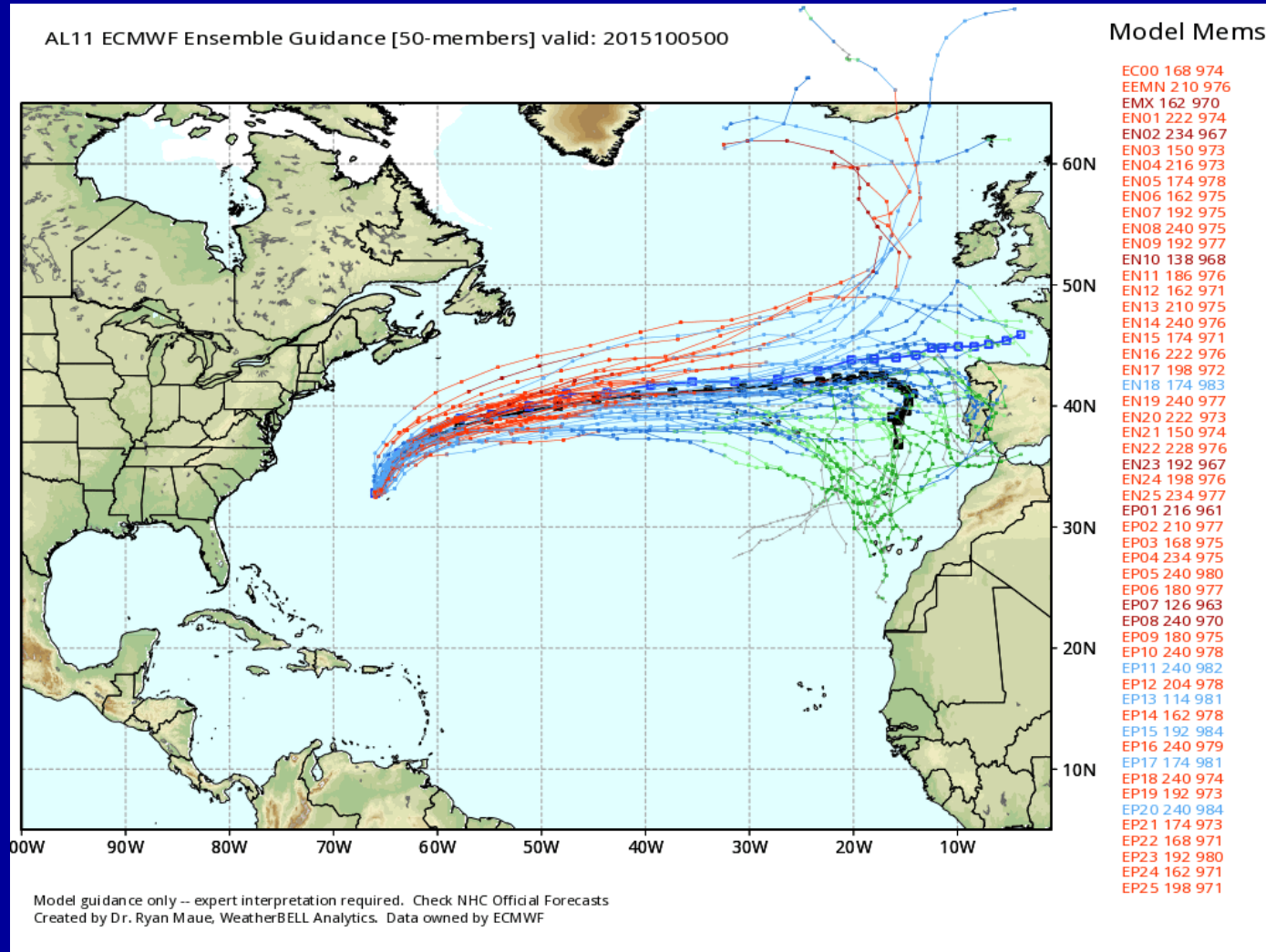- Makes differences much easier to see than a regular spaghetti plot

Brian Tang

GEFS vs EC Ensemble 29 Sep 0000 UTC

JOAQUIN GEFS (NCEP) 09/29/2015 00Z

GEFS vs EC Ensemble 30 Sep 0000 UTC

JOAQUIN GEFS (NCEP) 09/30/2015 00Z

ECMWF ensemble colored by intensity

AL11 ECMWF Ensemble Guidance [50-members] valid: 2015100500

Model guidance only -- expert interpretation required. Check NHC Official Forecasts
Created by Dr. Ryan Maue, WeatherBELL Analytics. Data owned by ECMWF
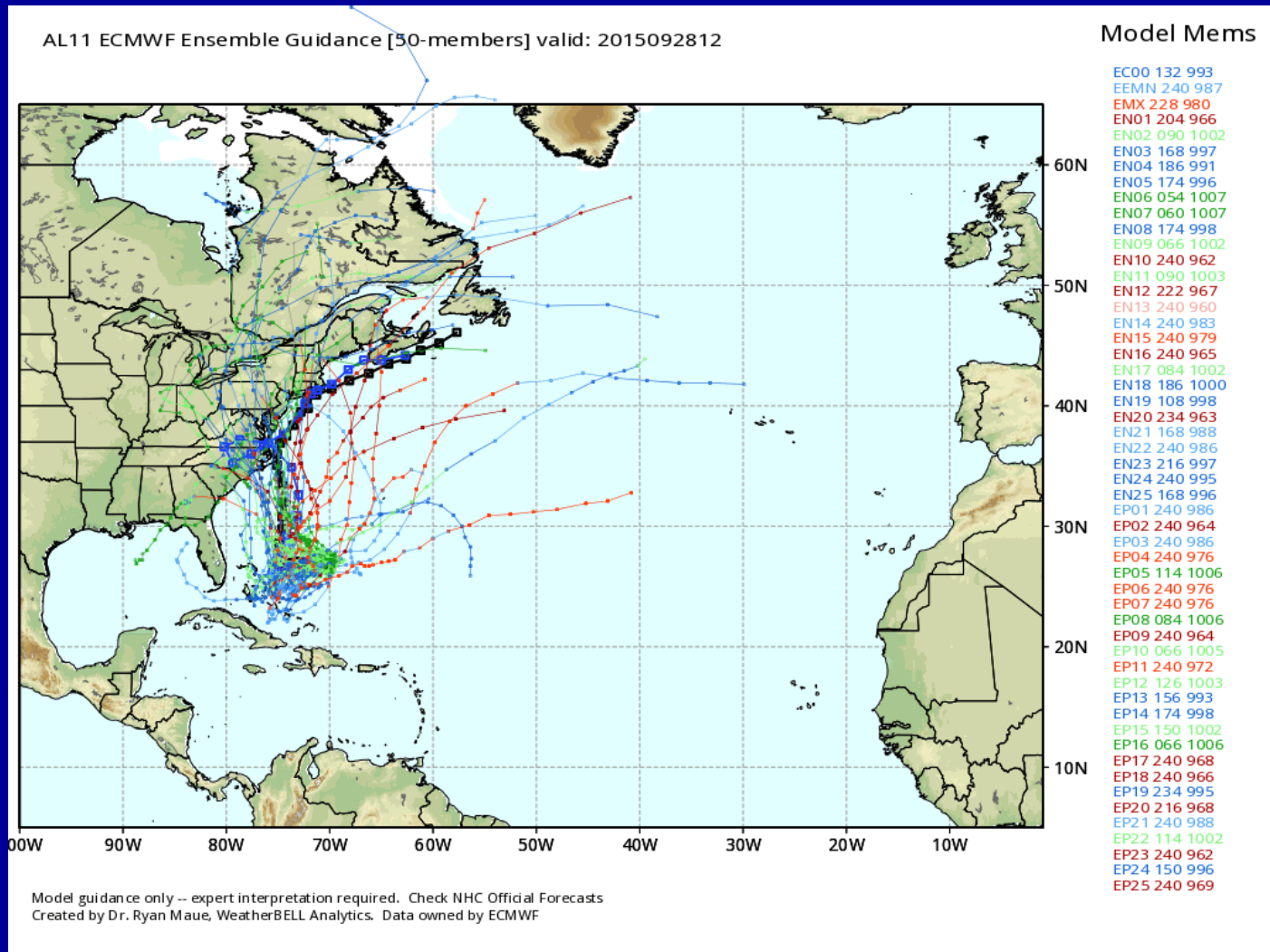
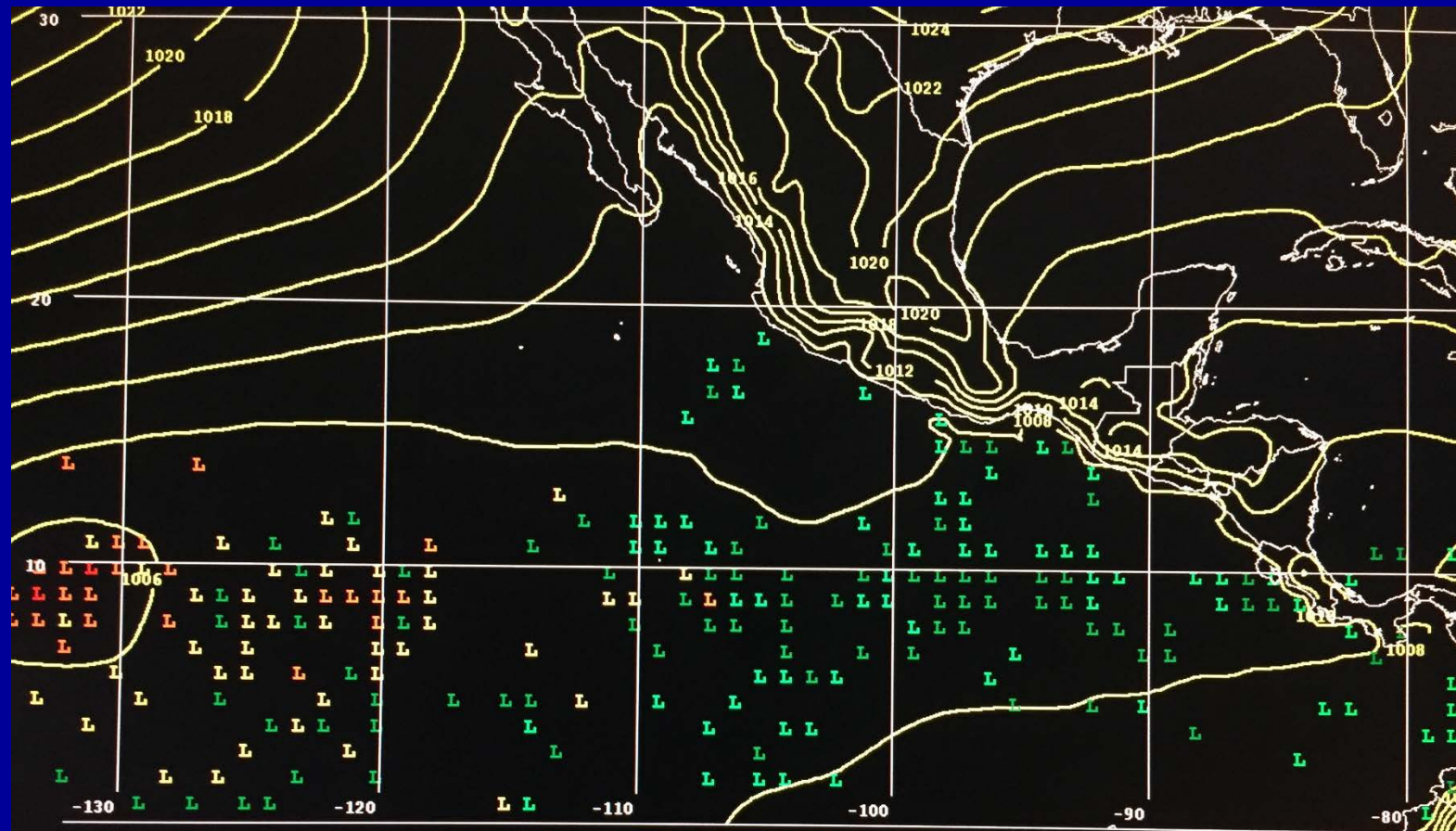Easy to see trends using this scheme

Not easy to do in an operational setting currently

-Stronger members farther right
-Weaker members farther north

Current NHC display of ensemble pressure/lows
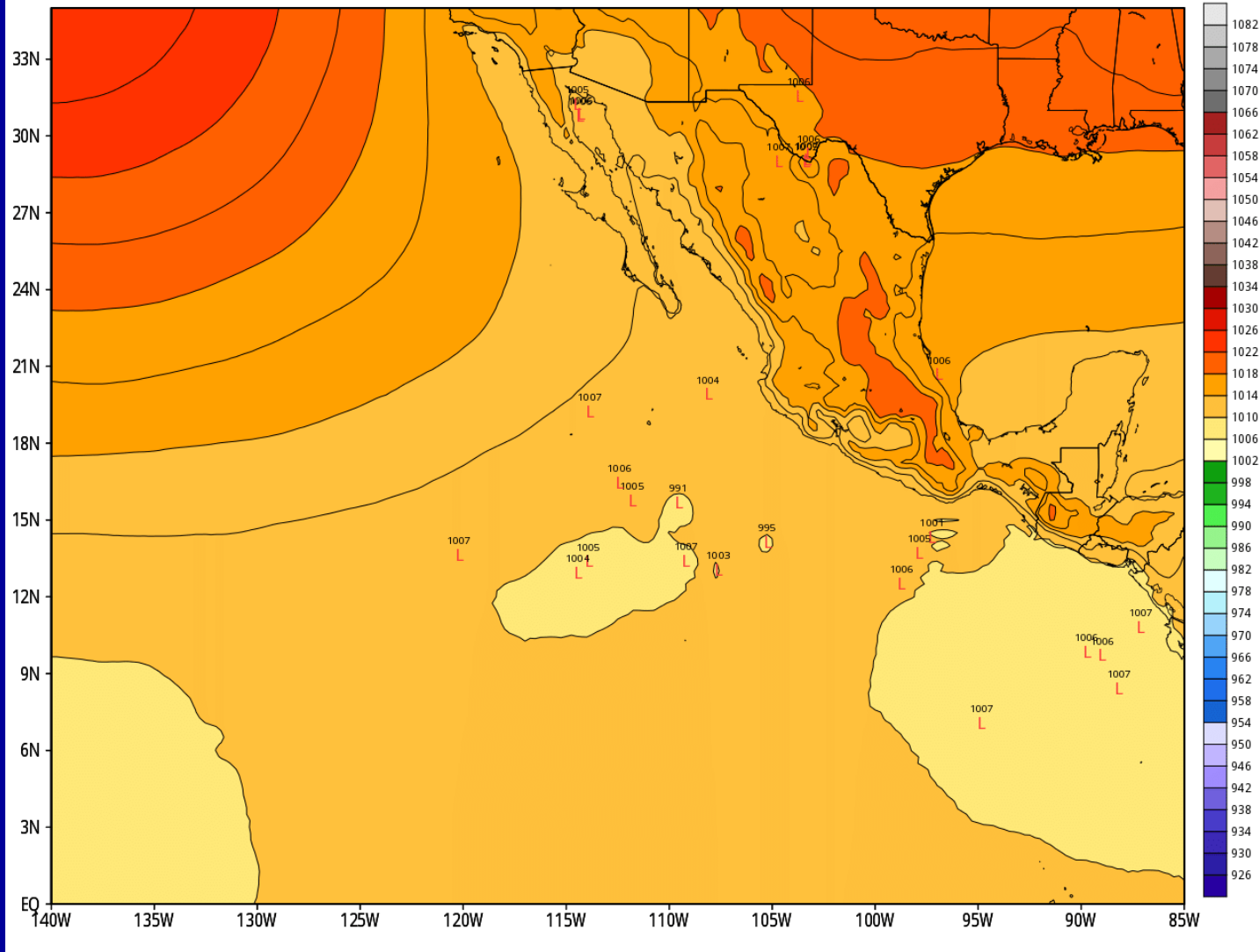
Possible long-term idea

ECMWF EPS 6-hourly MSLP [hPa]
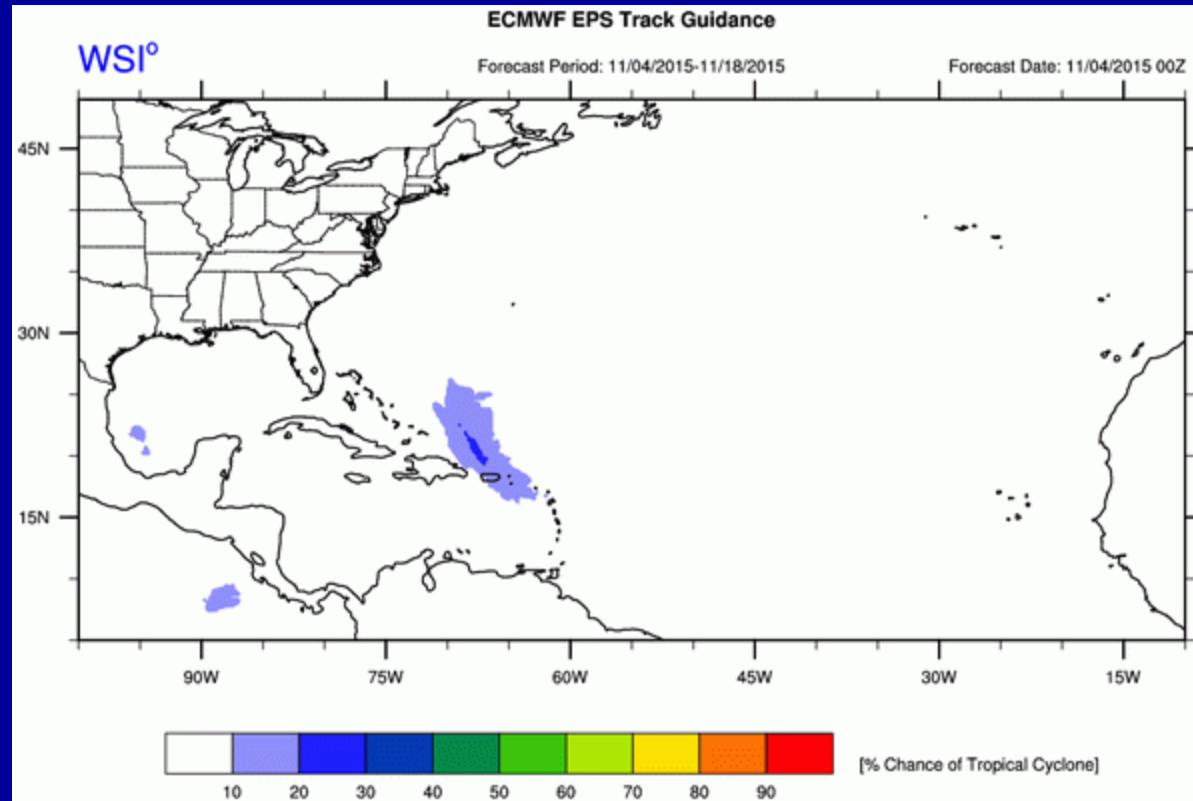INIT: 12Z13NOV2015 fx: [210] hr --> Sun 06Z22NOV2015 -- Ensemble Mean

-Way to combine mean and member information

-Sensitive to low pressure threshold chosen

-Could also consider other fields such as 850 vorticity

Calibrated ECMWF Ensembles for track/genesis

- Using 20 year re-forecasts for calibration
- Post-processed to add uncertainty (ensemble under-dispersive)
- Easy to track trends in both magnitude and direction

Ideas

1. Use of ensemble clusters to help make better track forecasts

2. Ability to form a smart consensus of ensemble members based on NHC input, e.g. intensity or location

3. Outlook seems bleak for global-scale intensity help

4. Some benefit to HWRF ensemble intensity, although status of project unknown.