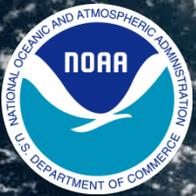# NHC's uses and requirements of ensemble prediction systems
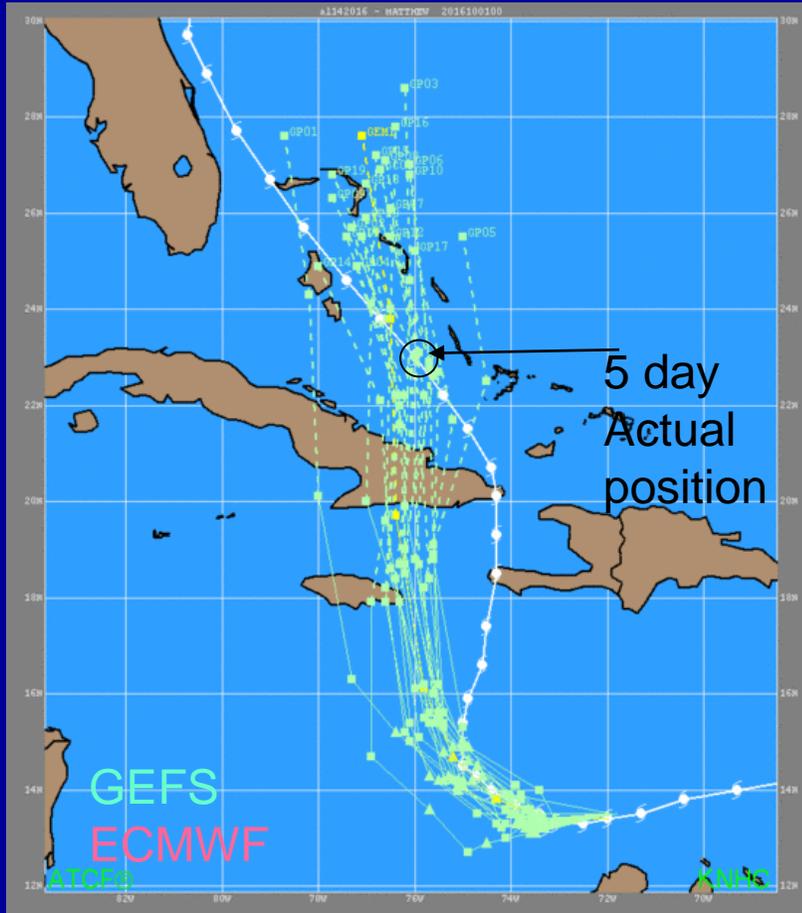
Eric Blake and Andrew Penny
National Hurricane Center
8/27/2019

NHC use of current ensemble system:

1) ECMWF/GFS Ensemble means for track prediction

2) Spread for uncertainty estimates / IDSS

3) Subjective clustering for track / IDSS

4) Genesis forecasts

Matthew ensemble guidance 10/1/2016 0 UTC

5 day
Actual
position

GEFS
ECMWF

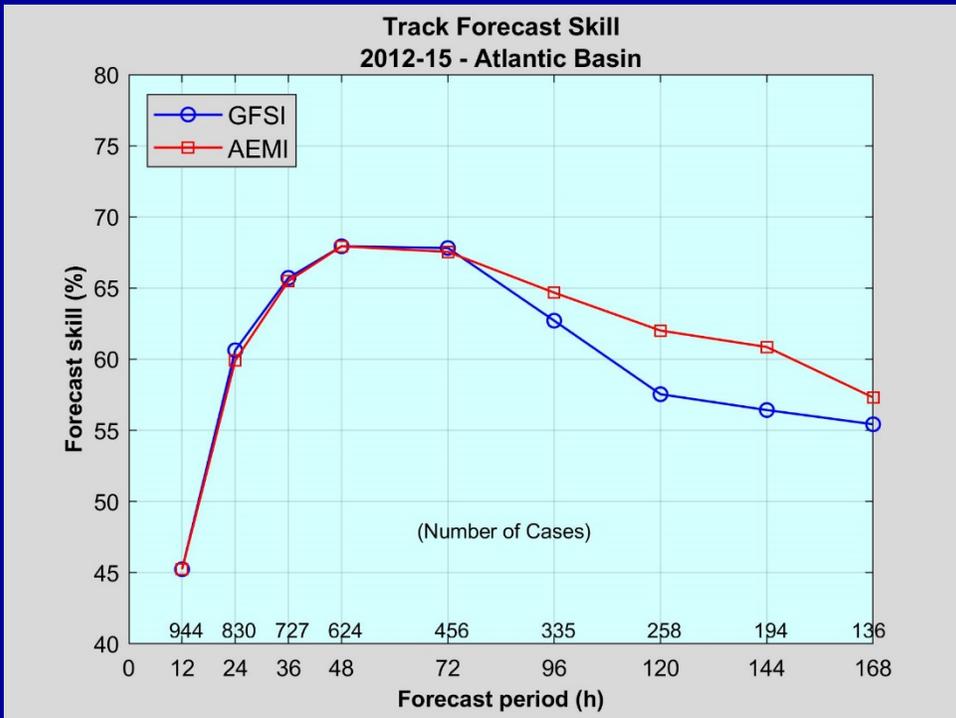GEFS (blue) too underdispersive, especially in Caribbean

Forecasters can handle overdispersive, but underdispersive is a severe problem

Every single GEFS member also too fast at 5 days

ECMWF (red) has more realistic spreads, albeit potentially too large

Recent GEFS performance

2012-2015

Track Forecast Skill
2012-15 - Atlantic Basin

(Number of Cases)

944 830 727 624   456   335   258   194   136

In the Atlantic, the GEFS ensemble mean track forecast (AEMI) is competitive with the deterministic GFS (GFSI) through day 3 and better afterward

2016-2018

Track Forecast Skill
2016-18 - Atlantic Basin

(Number of Cases)

1043 949 856 764   600   449   360   279   219
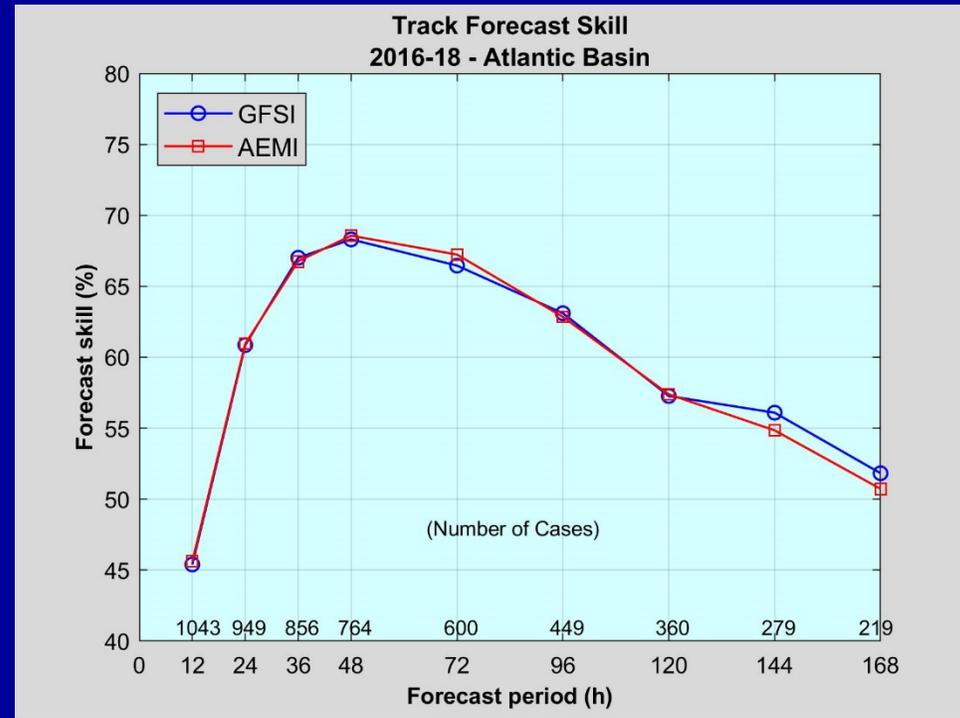
Since 2016, no advantage to using the GEFS ensemble mean track forecast (AEMI), and les skill beyond day 3

Ensemble Models

Spread (dashed) vs error (solid)

Atlantic 2016-2018
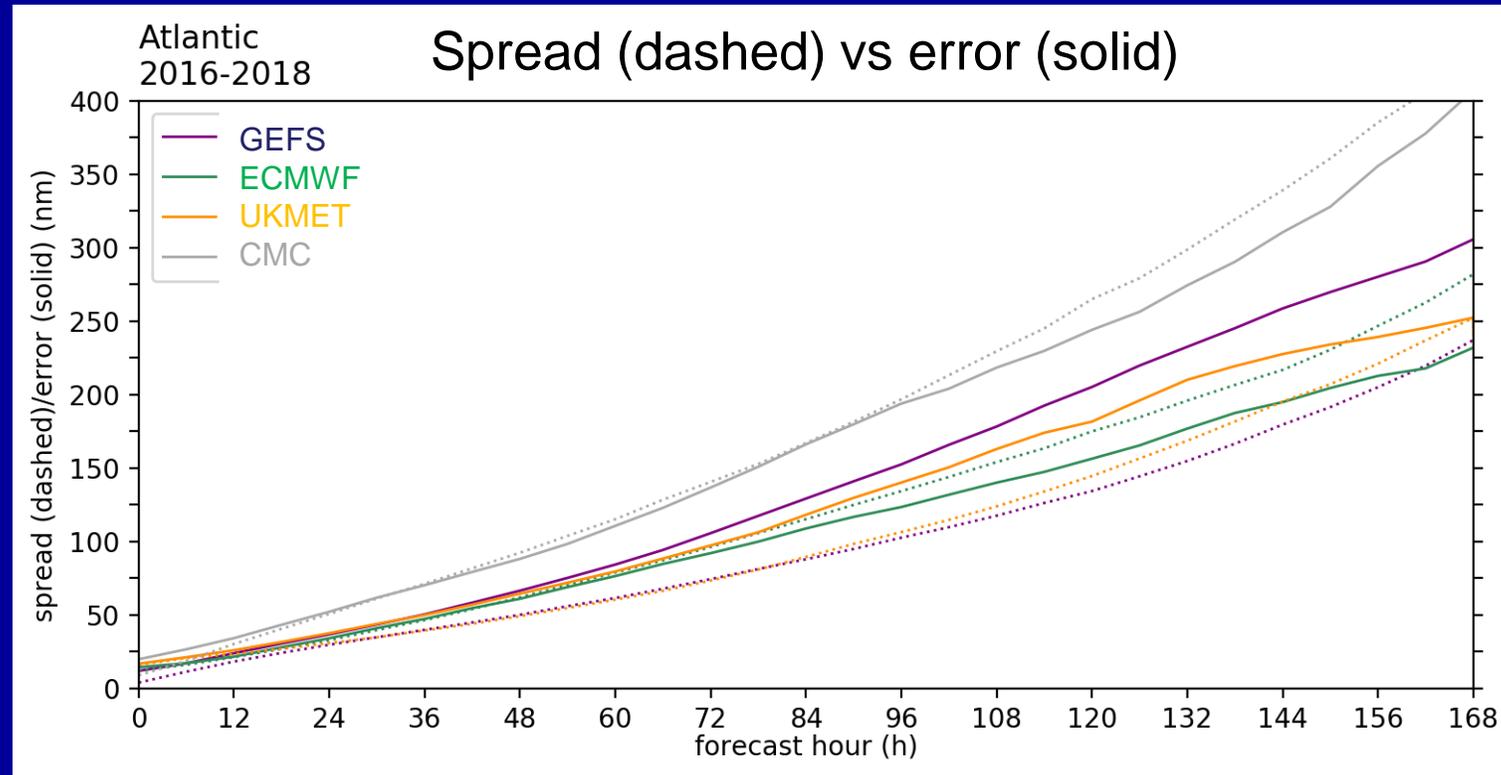
- – GEFS is very underdispersive and not as skillful as UKMET

- – CMC/EC closer to 1:1 spread:error ratio

- – This problem results in an overconfident forecast
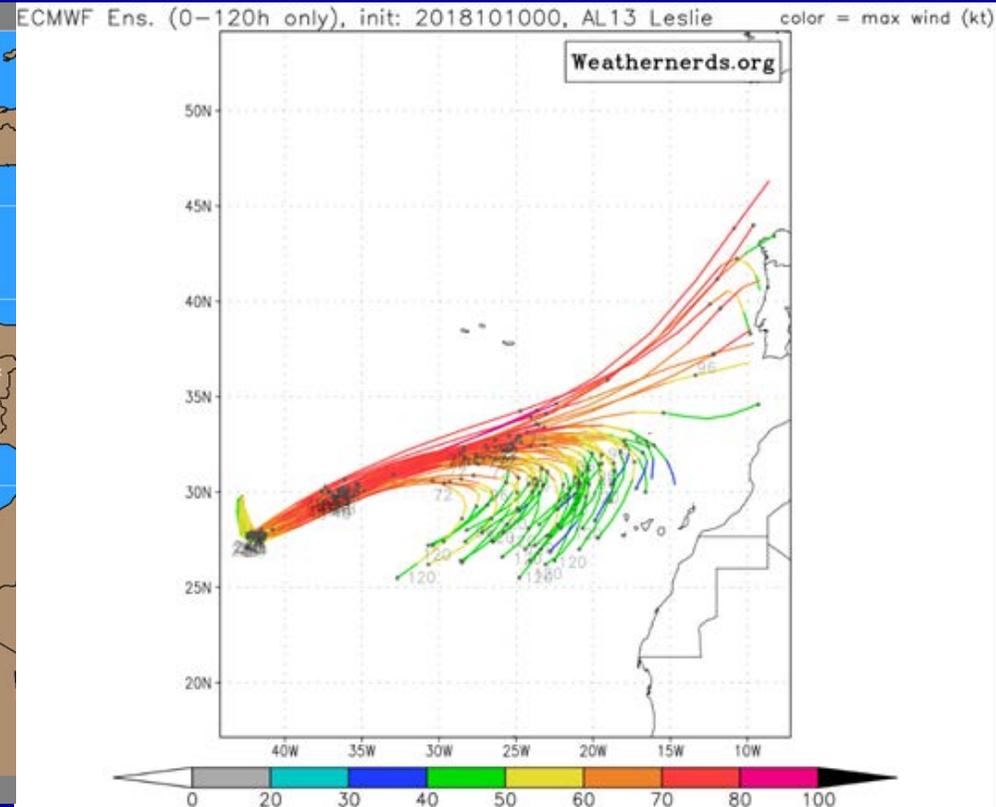
2018 Example
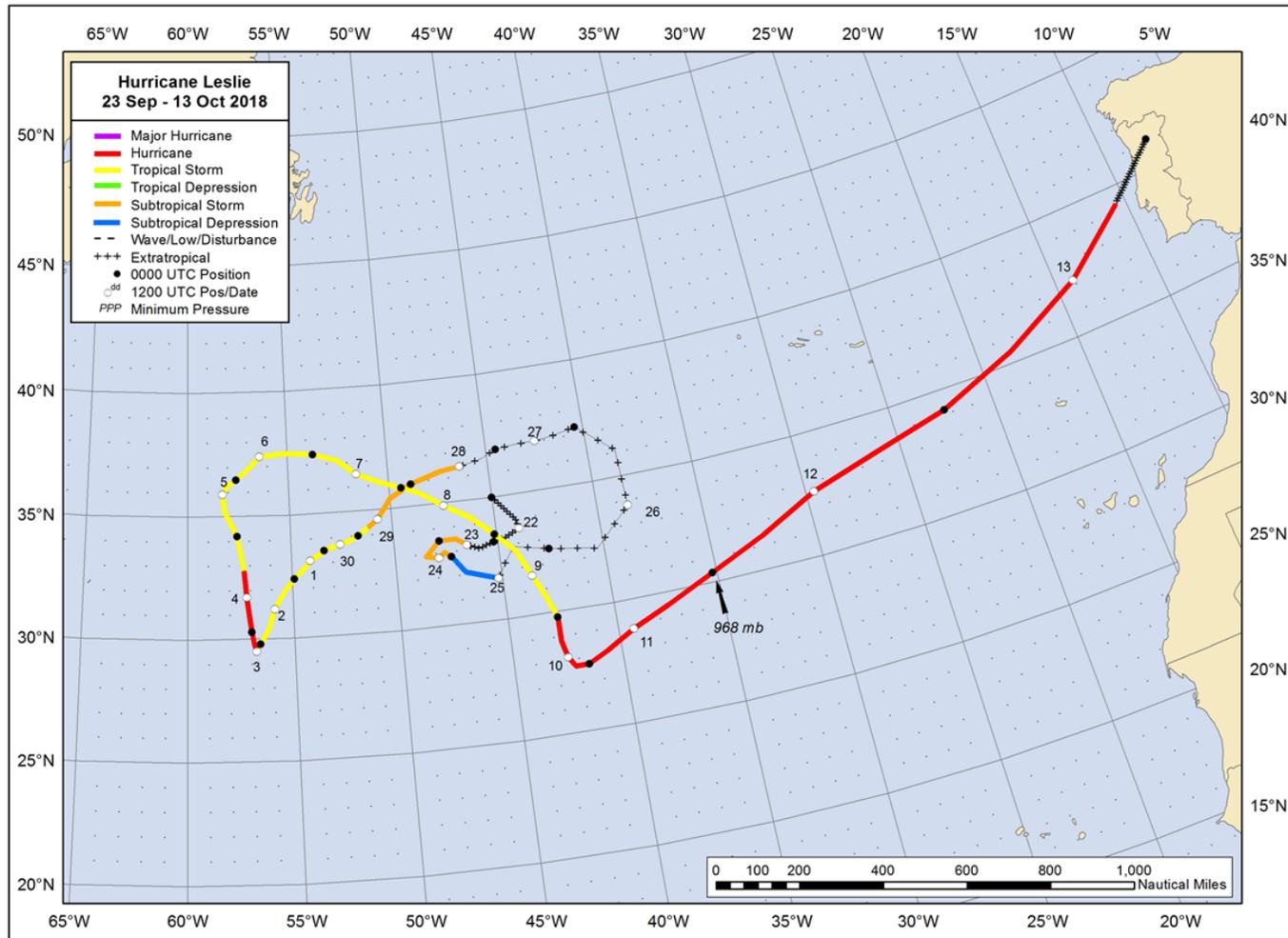
Hurricane Leslie

Long lasting and *highly* annoying

Difficult forecast!


Normal guidance suite

ECMWF ensembles

Much different answer if you use full ensembles rather than just the typical guidance suite. Also note spread by intensity (upper right)

TC Intensity Ensemble Forecasting

- No skill above single-model deterministic currently

- Resolution is a serious hindrance

- Very computational expensive to run high-resolution (<3 km) intensity ensembles

- HFIP is funding efforts to find products that could be operationally useful

Intensity Change Probability Distributions

GPMN 2016093006 MATTHEW (AL14)
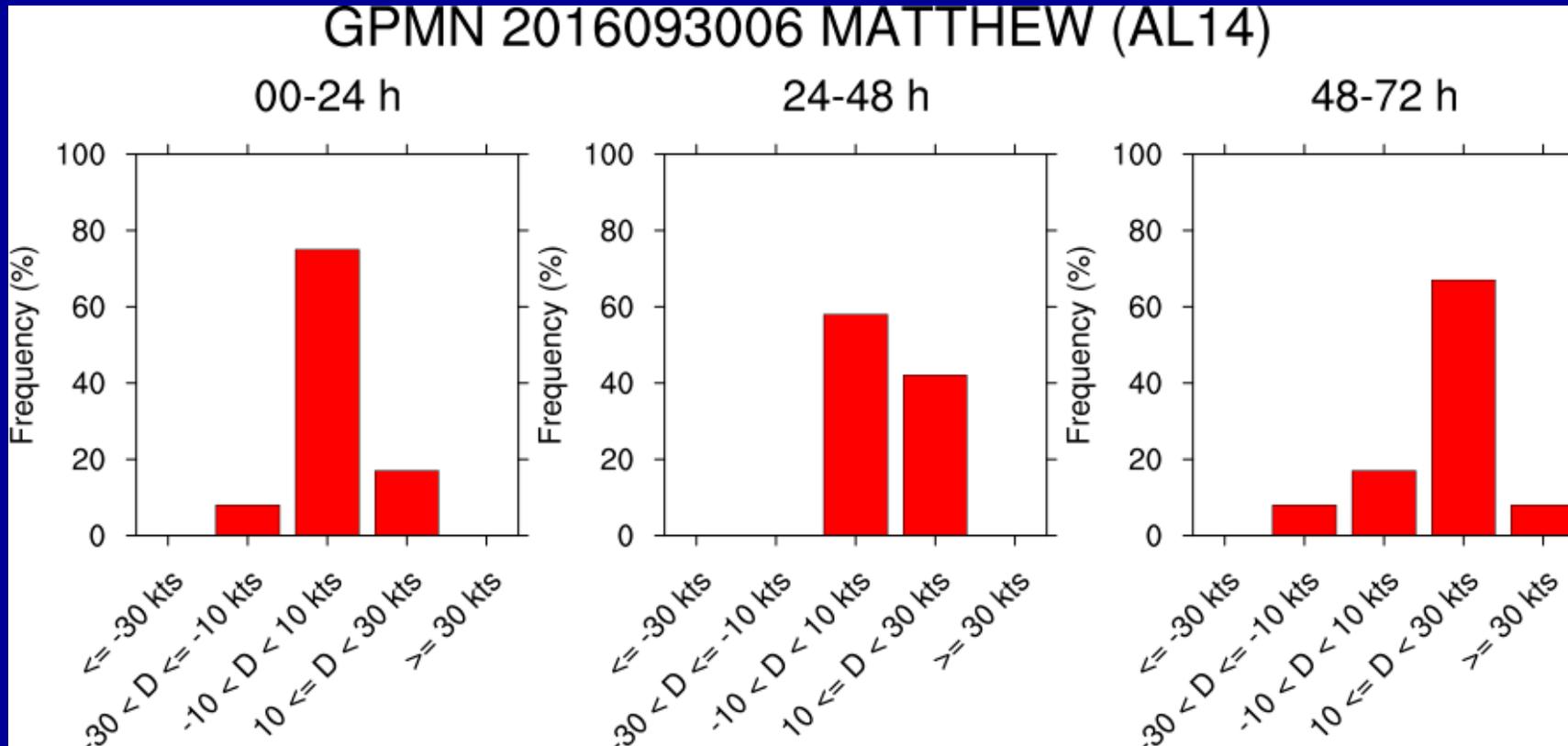
Ensemble genesis guidance

- No standard ensemble guidance (how many members?)

- Hard to find forecast verification and reliability information

- Efforts should be made for simplification for forecaster use

Genesis Display

In-house product:

shading: combined probability of 70 ensemble members (GEFS + ECENS):

- 850 – 700 hPa RH > 70%
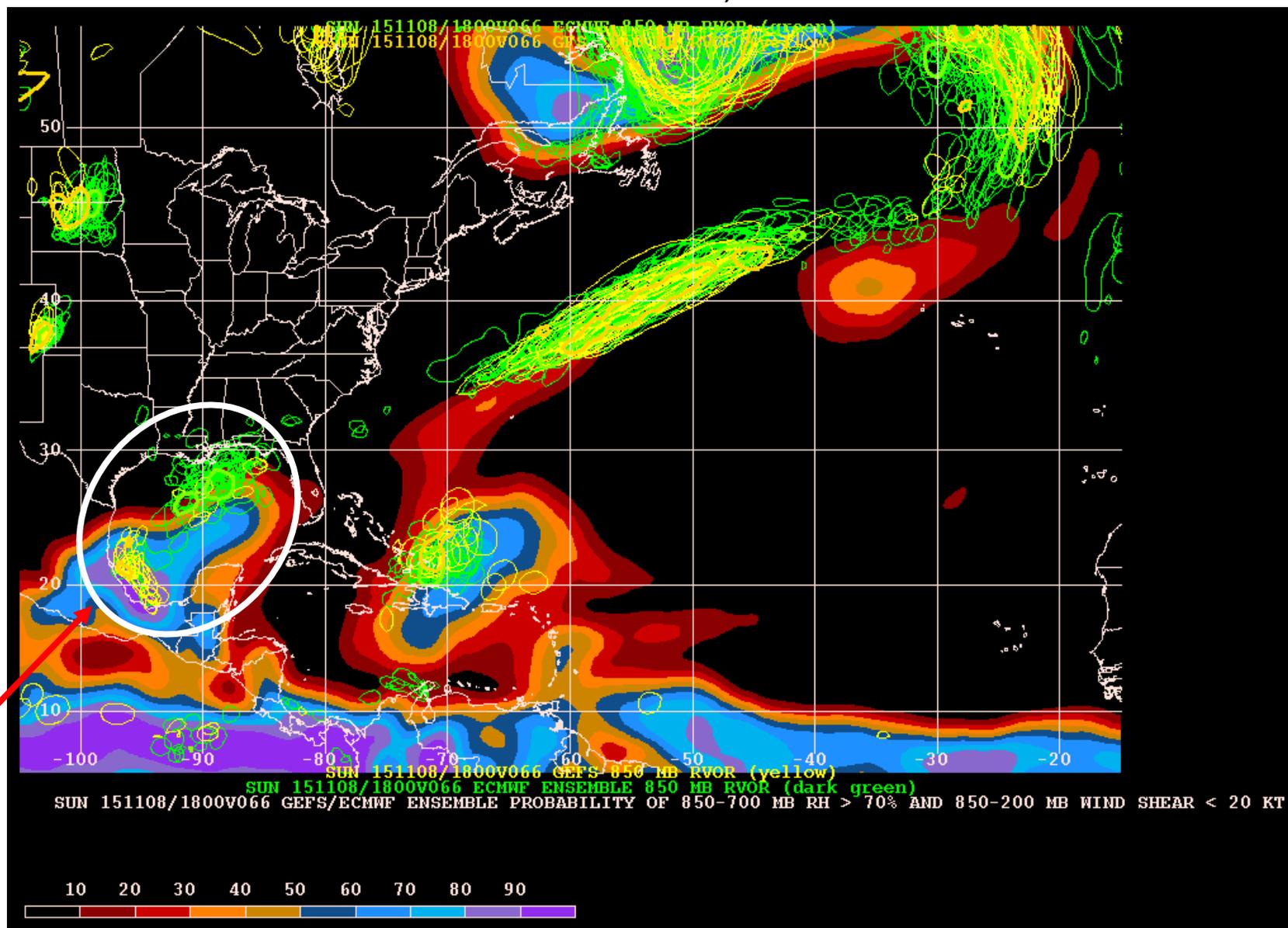- 200 – 850 hPa vertical wind shear < 20 kt

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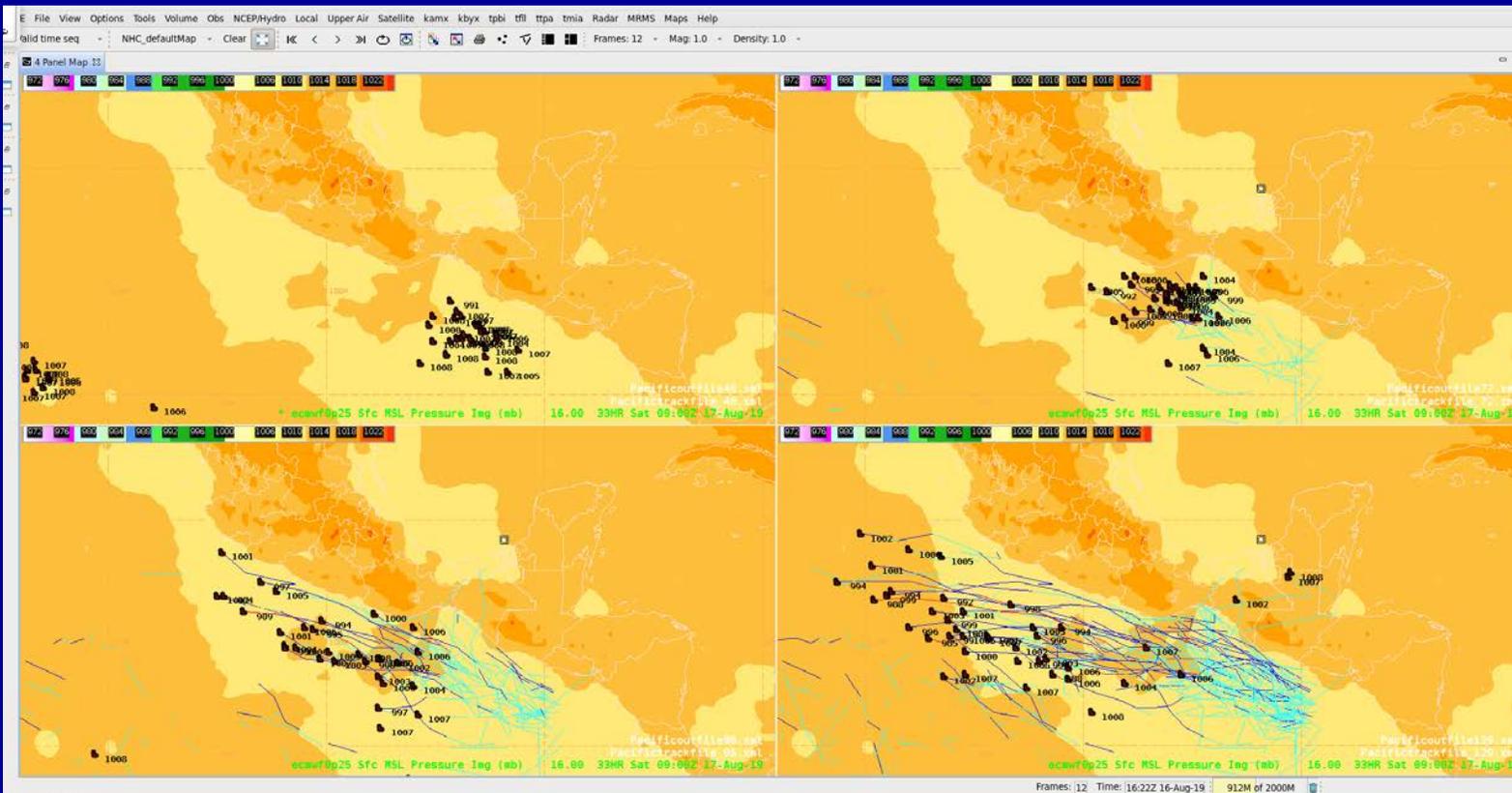thick yellow: **GFS deterministic**

Invest AL93

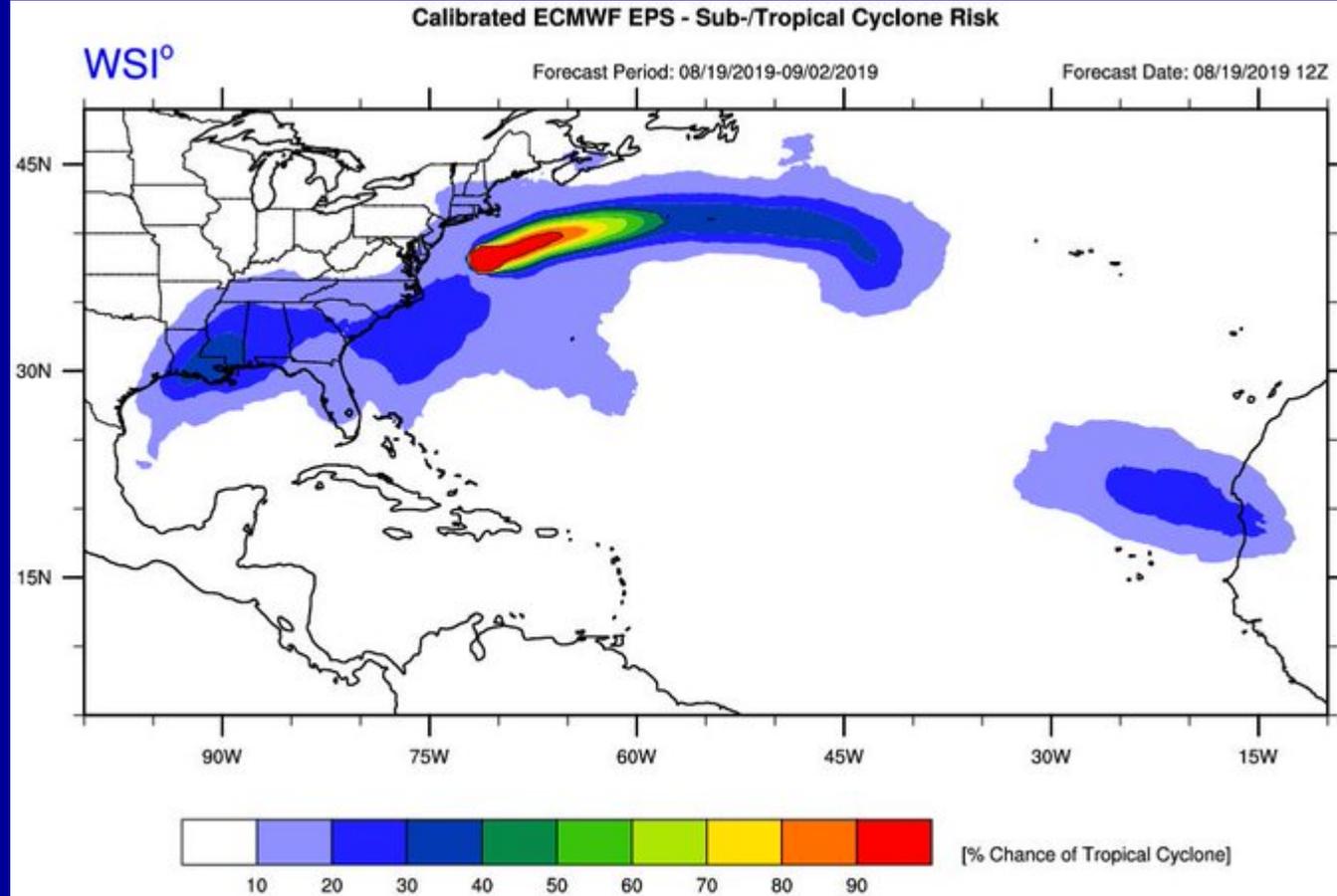# Possible enhancements to guidance

Products in test mode

-All 50 EC Ensembles members shown

-Combines mean and member information

-Sensitive to low pressure threshold chosen

-Could also consider other fields such as 850 vorticity, mid-level moisture,etc.

Calibrated ECMWF Ensembles for track/genesis

- Using 20 year re-forecasts for calibration
- Post-processed to add uncertainty (ensemble under-dispersive)
- Possible use for new GEFS

14

NHC requirements:

1. Ensemble mean forecasts with superior track error, especially at long range days 3-7.

2. Realistic track uncertainty estimates (likely derived from the ensemble spread).

3. Innovative ways at displaying the data and integrating into NHC operations

4. Better ensemble genesis guidance, potentially using both raw output and a skillful calibrated scheme.

Long-term goals:
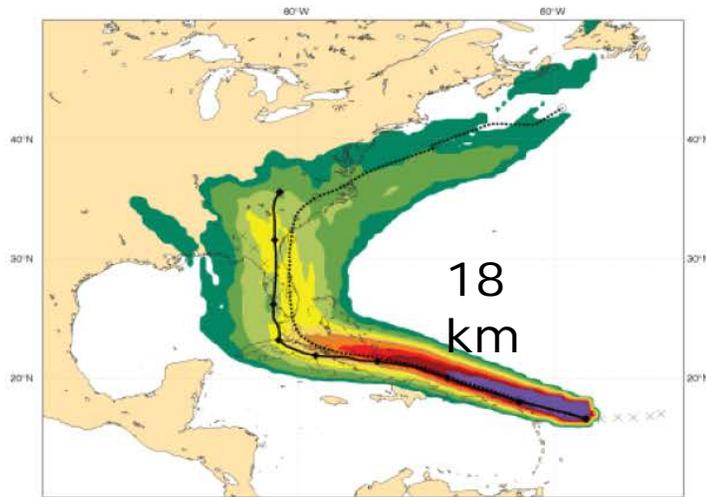
1. Use ensemble probabilities for other products, such as the cone graphic size, storm surge (P-surge), wind speed probabilities.

2. This requires a shift from 5-year average error distribution to trusting the ensemble system enough that the error in every case has a very high relationship with ensemble spread.

3. Very high need for a tool that is easy for forecasters to use
   - Use ensemble clusters to make better track forecasts
   - Ability to form a smart consensus of members based on forecaster input
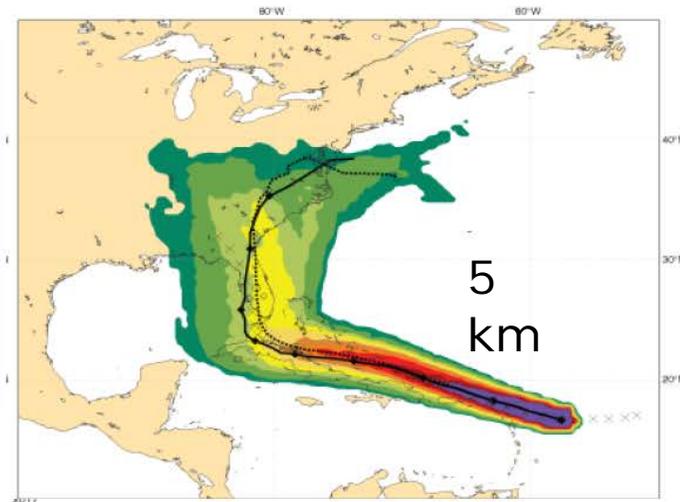
If I'm dreaming in 2030:

Richardson, ECMWF, 2018
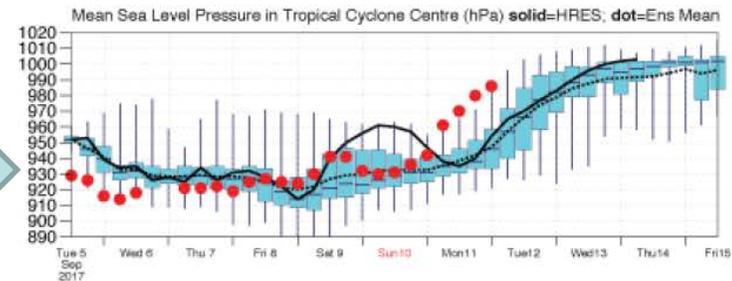
Thank you!

Questions?

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