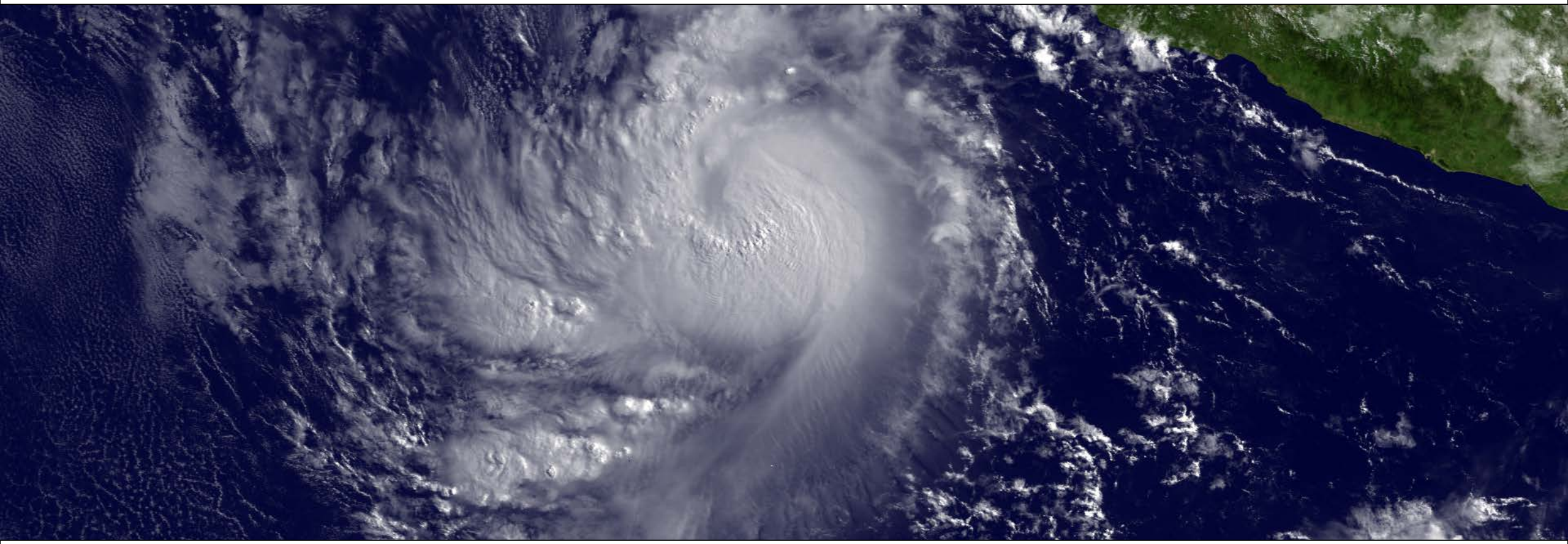
Operational Challenges of Forecasting Tropical Cyclogenesis at NHC



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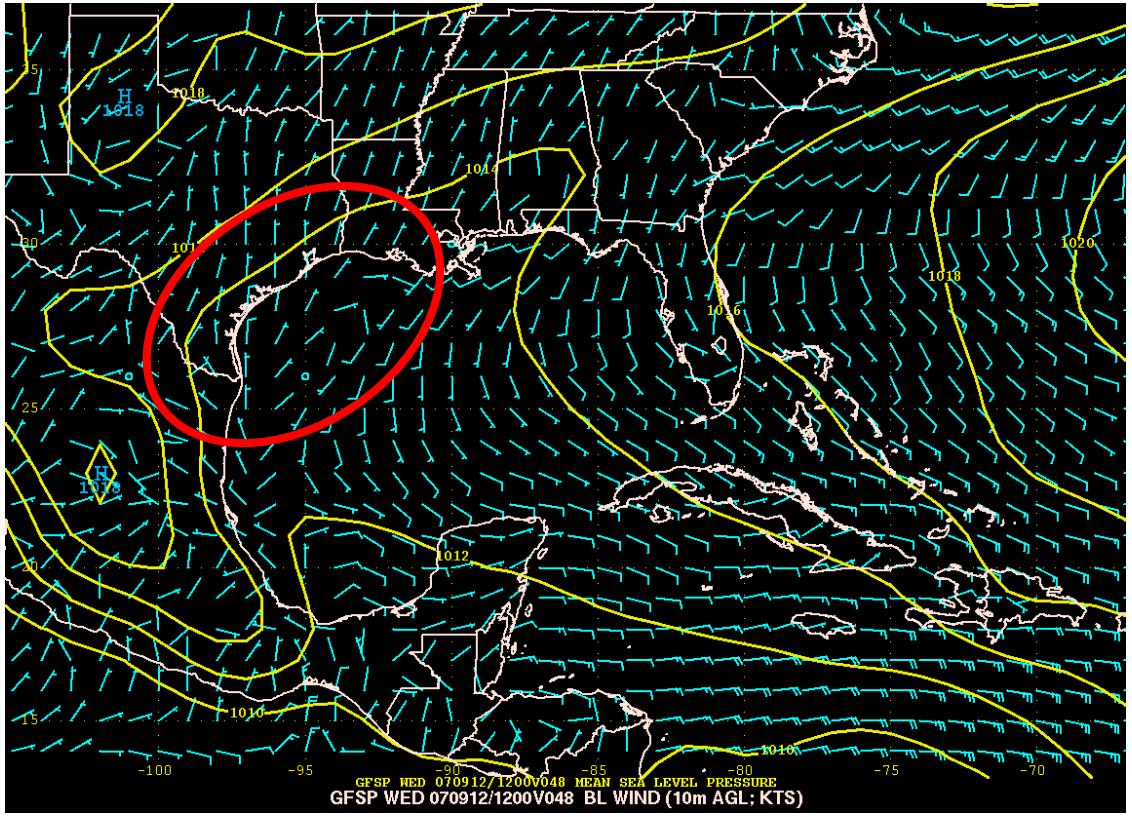
Motivation

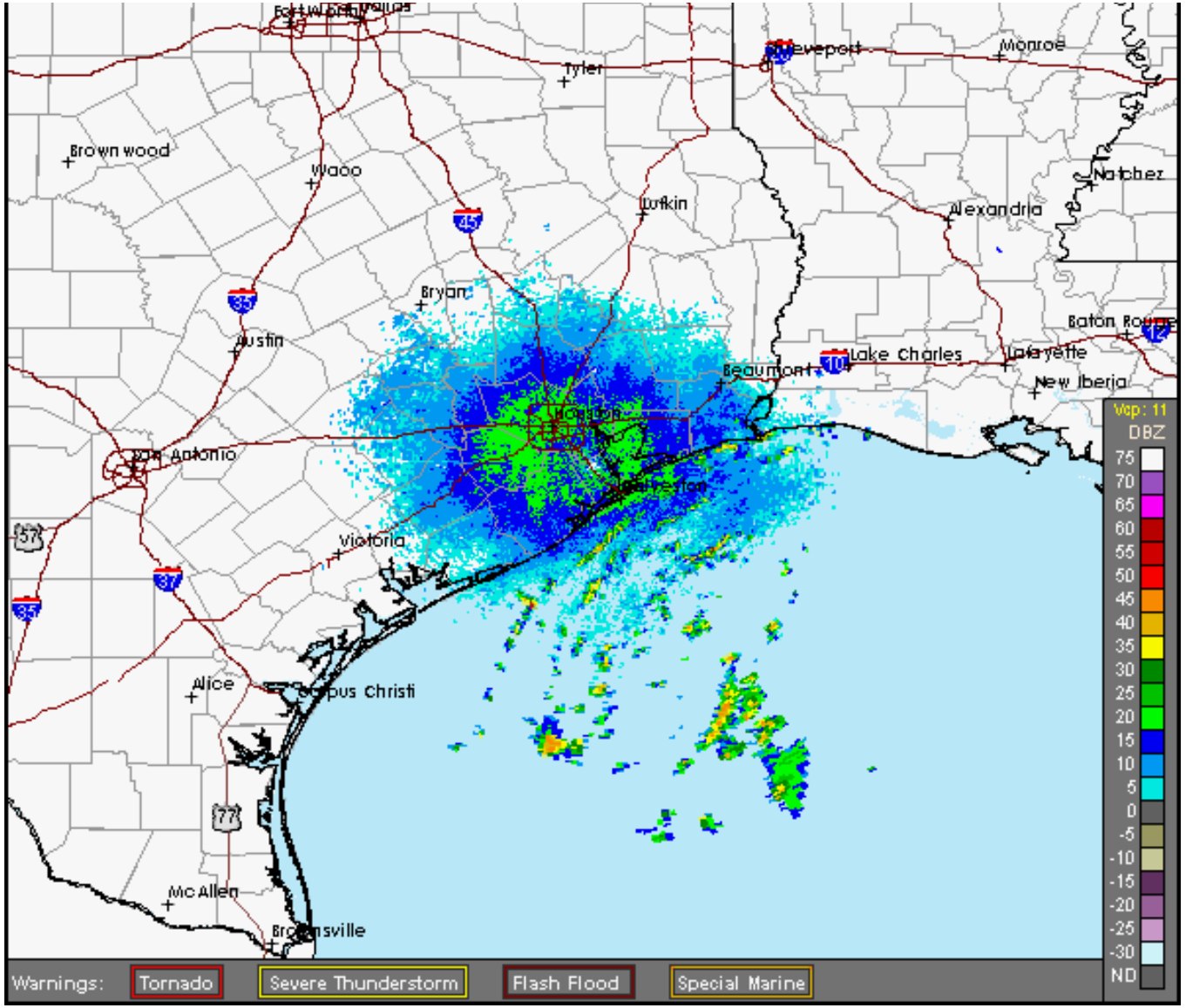
Forecasting TC genesis with adequate lead time is especially important for systems that rapidly develop near land.

GFS SLP forecast 9/10/07 1200 UTC + 48 h



The GFS failed to depict the genesis of Hurricane Humberto (2007)

HUMBERTO (2007) INTENSIFIED FROM A WEAK AREA OF LOW PRESSURE INTO A HURRICANE IN LESS THAN 24 HOURS!



Procedure

- During the hurricane season, a 5-day Tropical Weather Outlook (TWO) is issued every 6 hours
- The TWO highlights existing disturbances, and ones predicted to develop, that have potential for tropical cyclone formation within 5 days
- Probabilistic forecasts are given for both the short range (0 - 48 h) and longer range (0 - 5 days)
- Text and graphical products are issued

Tropical Weather Outlook Text

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ZCZC MIATWOEP ALL
TTAA00 KNHC DDHHMM

TROPICAL WEATHER OUTLOOK
NWS NATIONAL HURRICANE CENTER MIAMI FL
1100 AM PDT TUE SEP 22 2015

For the eastern North Pacific...east of 140 degrees west longitude:

1. An area of low pressure could form several hundred miles south of
the southern coast of Mexico by late this week.  Some slow
development is possible thereafter while the system slowly
northward.
* Formation chance through 48 hours...low...near 0 percent
* Formation chance through 5 days...low...20 percent

Forecaster Beven
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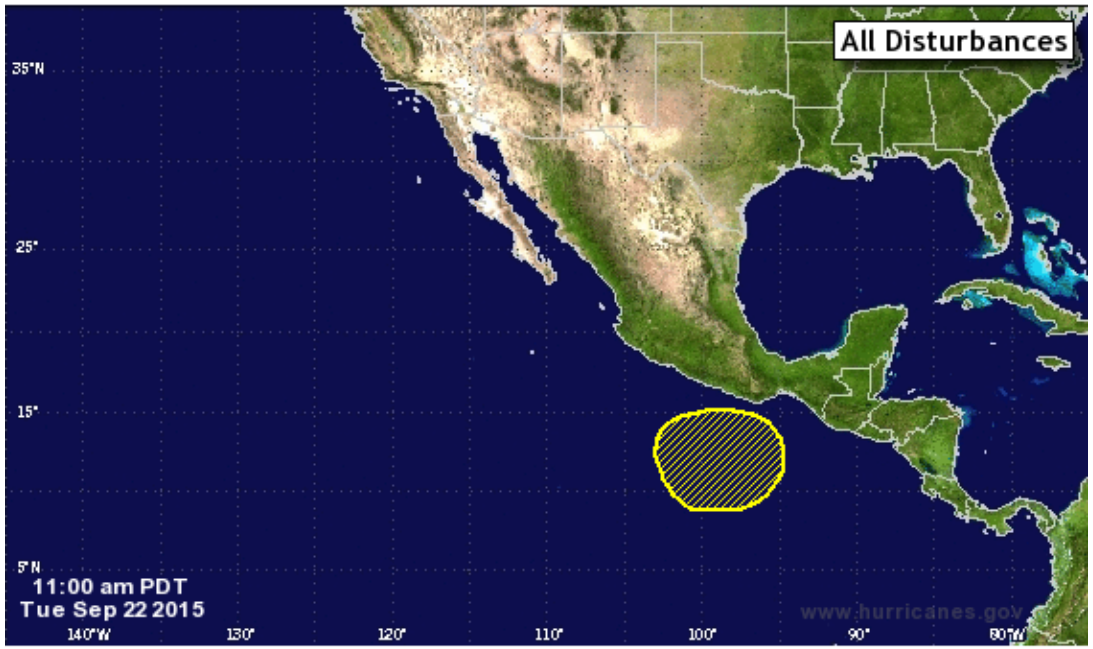
Five-Day Graphical Tropical Weather Outlook
National Hurricane Center Miami, Florida



Tropical Cyclone Formation Potential for the 5-Day Period Ending 11:00 am PDT Sun Sep 27 2015
Chance of Cyclone Formation in 5 Days: Low < 40% Medium 40-60% High > 60%
X indicates current disturbance location; shading indicates potential formation area.

EP17 Marty

T + 96 h

Declared a TD at 1800 UTC September 26

Guidance

How do forecasters come up with these probabilities? **It's mostly subjective**

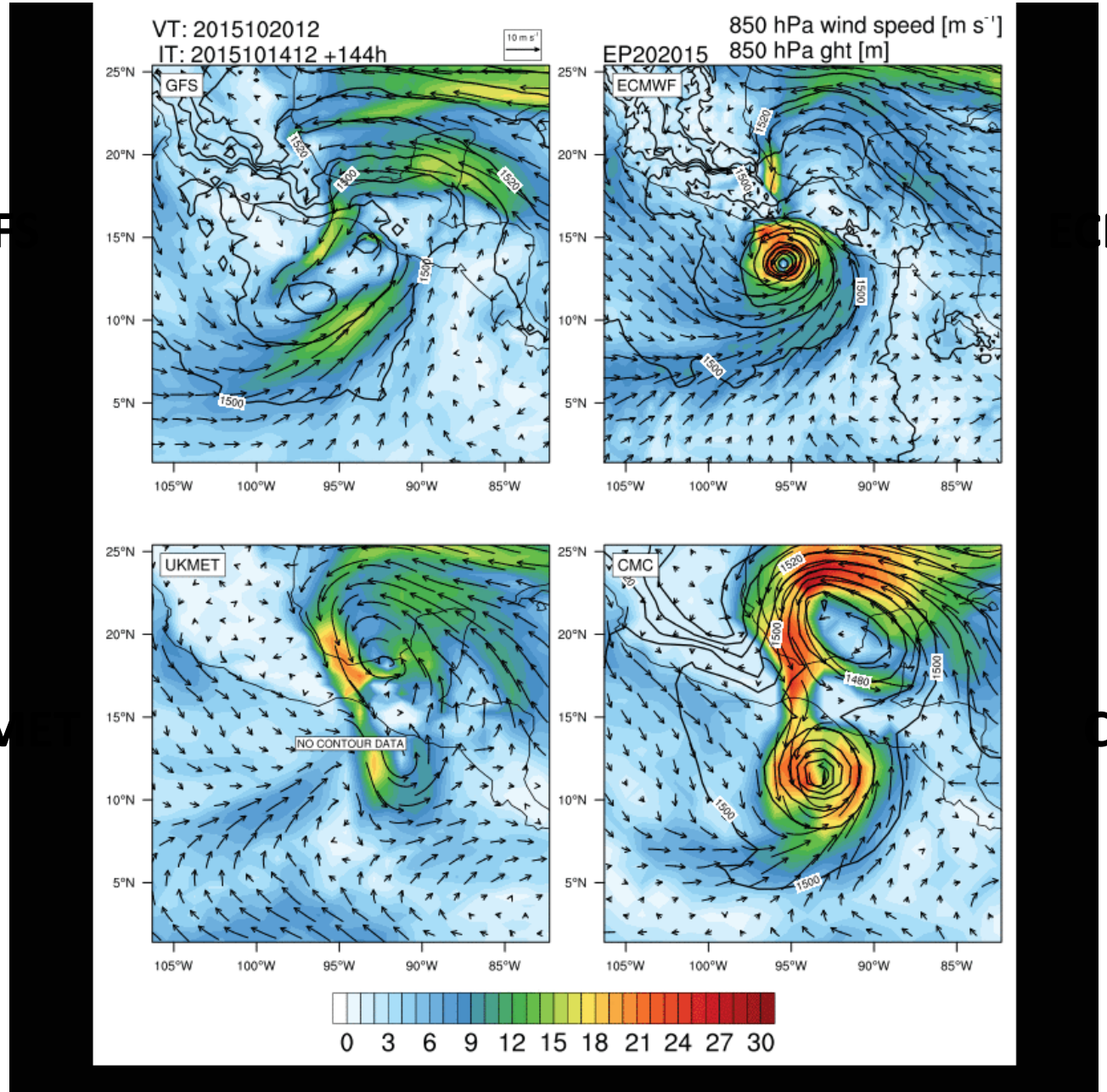
Short Range:
- organization/appearance of the system based on the satellite presentation
- Dvorak classifications from TAFB/SAB
- observable environmental conditions (recent pressure falls, ship/land/buoy obs, water vapor/TPW, vertical wind shear)

Medium – Long Range:
- deterministic global model forecasts (GFS, ECMWF, UKMET) and regional model forecasts (HWRF)
- global model ensemble guidance: GFS ensemble (GEFS), ECMWF Ensemble Prediction System (ENS), Met Office ensemble system (MOGREPS)
- interannual / intraseasonal variability (ENSO, MJO, CCKW)
- probabilistic guidance:
  - FSU (Dvorak) – Cossuth et al. http://moe.met.fsu.edu/genesis/
  - FSU (global models) – Halperin et al. http://moe.met.fsu.edu/modelgen/
  - CIRA – Schumacher et al. http://www.ssd.noaa.gov/PS/TROP/TCFP/index.html
  - NCEP/EMC – Marchok http://www.emc.ncep.noaa.gov/gmb/tpm/emchurr/tcgen/
  - NCEP/EMC – Peng et al. http://www.emc.ncep.noaa.gov/gmb/jpeng/TC_ens_V1.html
  - TCGI – Dunion et al. http://rammb.cira.colostate.edu/research/tropical_cyclones/tc_genesis_index/

Global Model Guidance

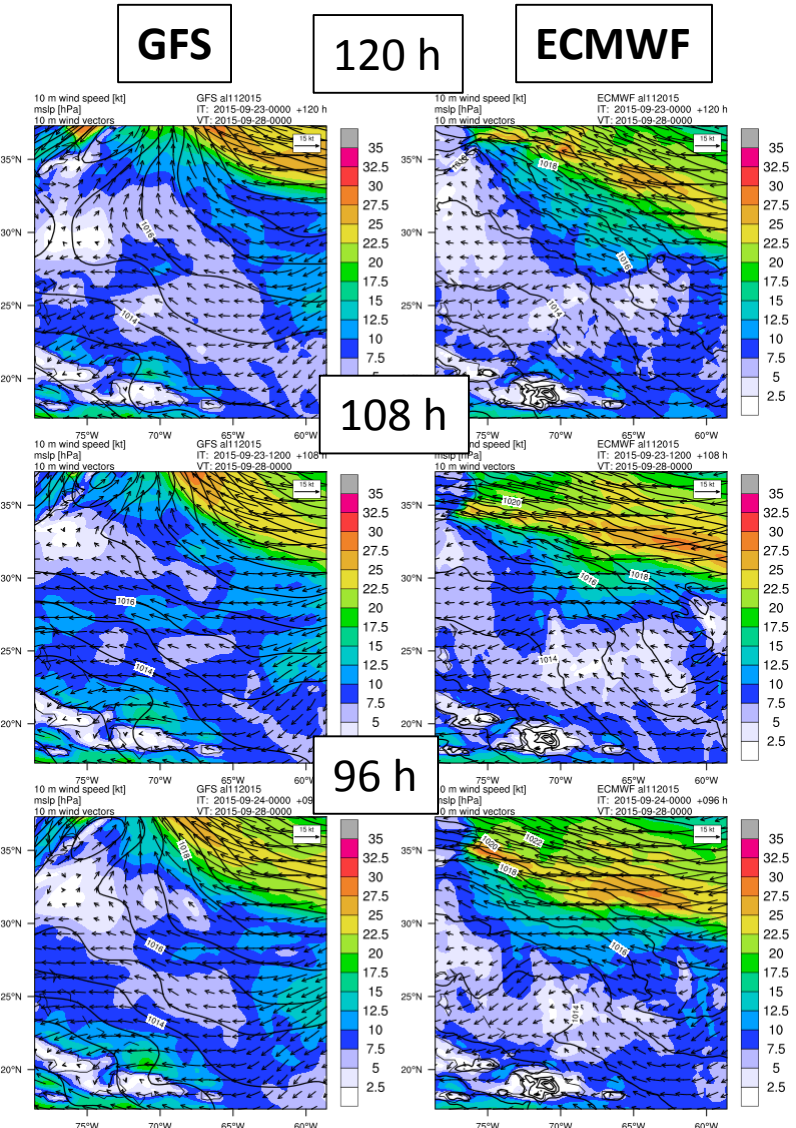
Hurricane Patricia (EP202015)
1200 UTC October 20

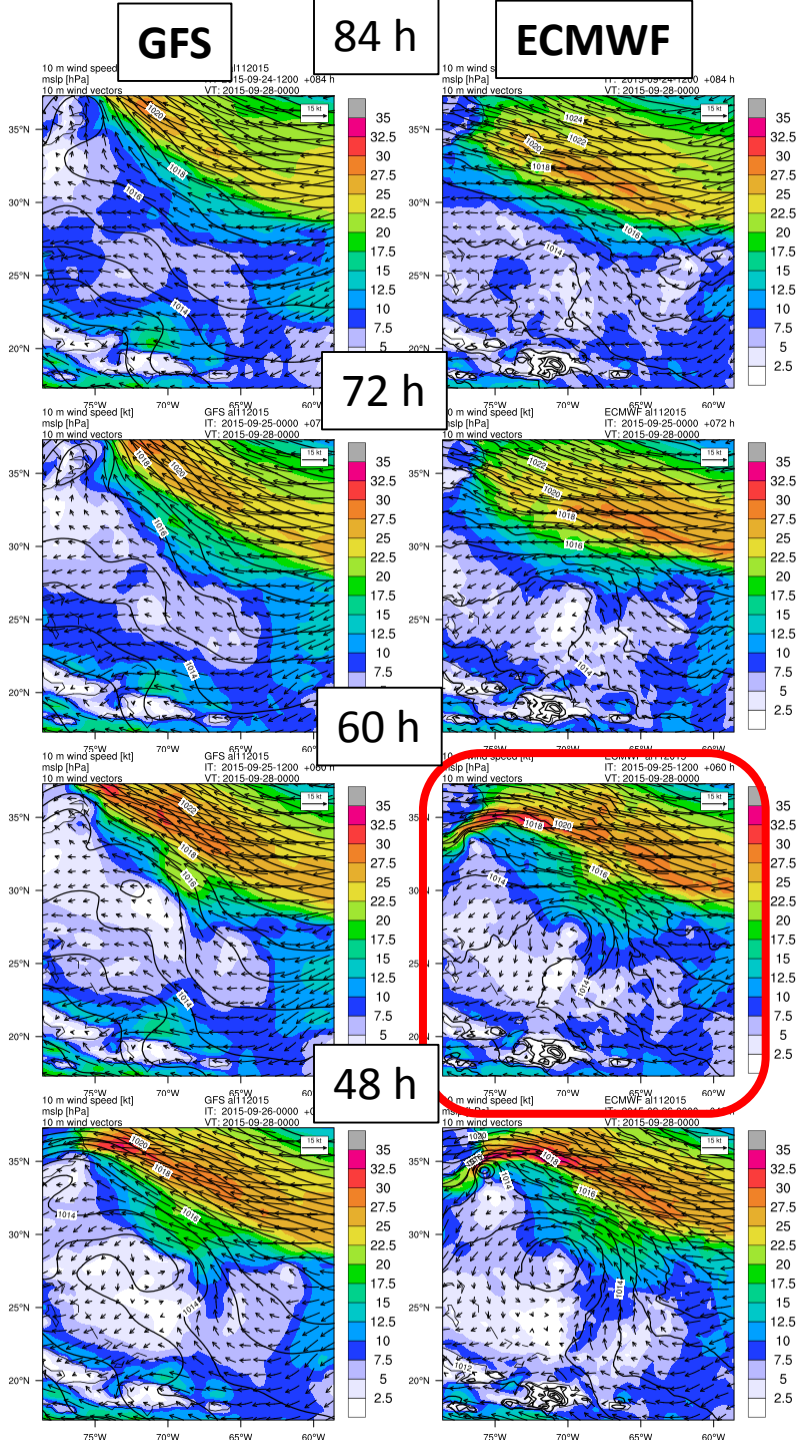
- consistency from forecast to forecast in the strength, timing, and location is an important consideration
- increased confidence when additional models indicate genesis
- some models may handle certain types of genesis better than others (e.g., the ECMWF generally handles east Pacific TC genesis better than the GFS)

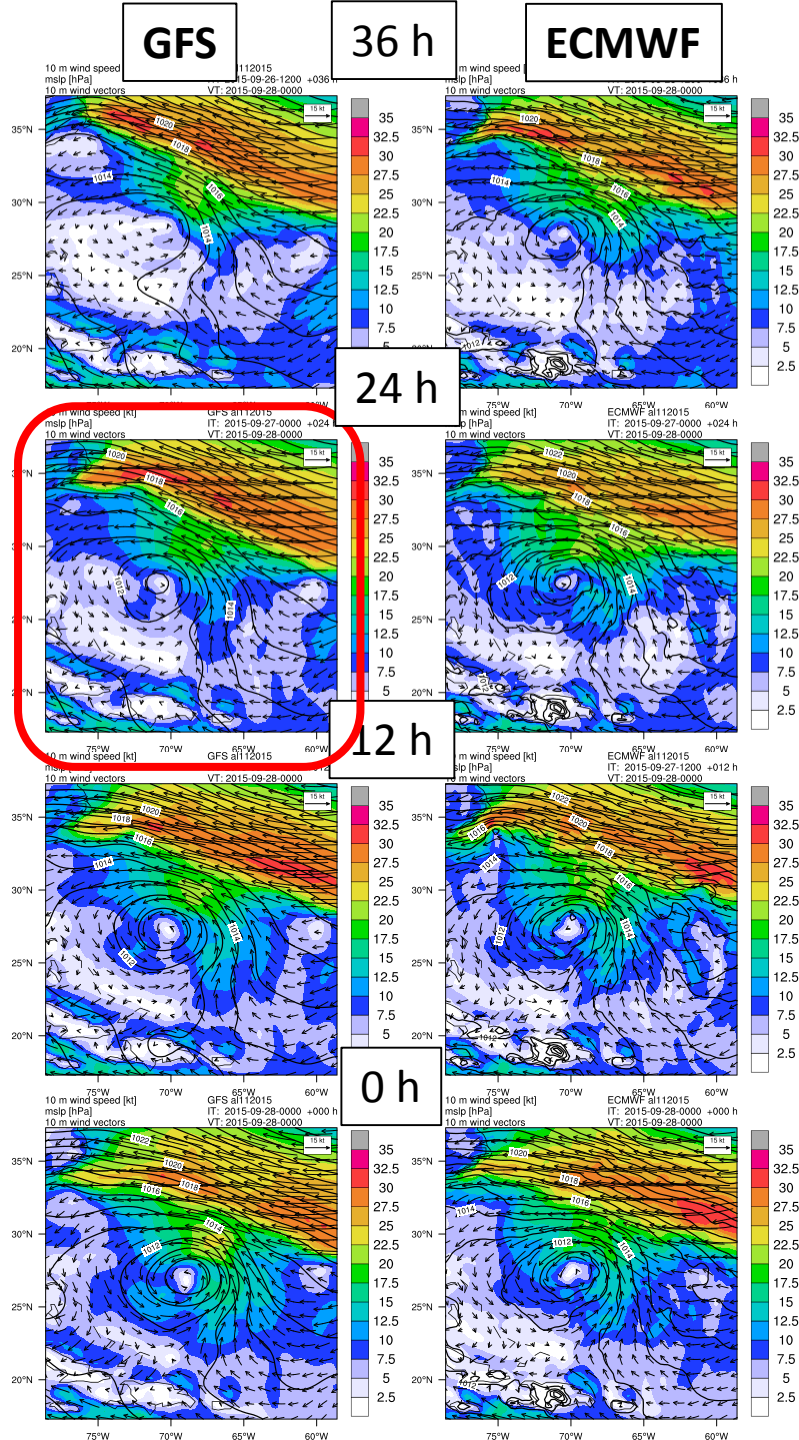


AL112015 Joaquin 2015-09-28-0000

10 m wind speed (kt, shading, vectors)
SLP (hPa, contours)







Ensemble Guidance

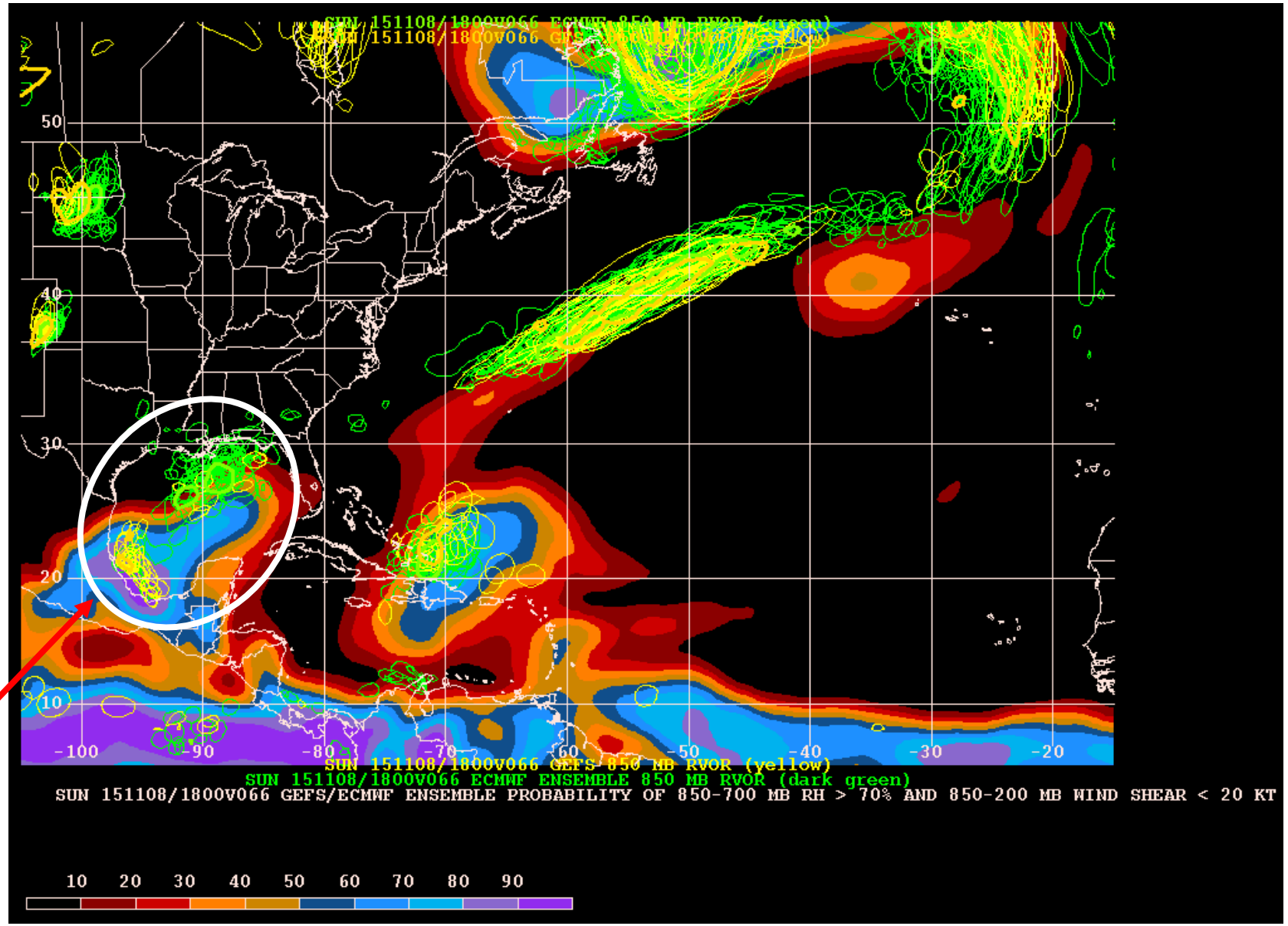
- ensemble guidance supporting a deterministic genesis solution adds confidence

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**

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



Invest AL93

Challenges

- TC genesis is a complex multi-scale (spatial and temporal) process/phenomenon in which the inherent predictability can vary greatly from case to case.

- with the ongoing cycle of model upgrades, forecasters need to continually re-calibrate their interpretation of model output with respect to genesis

- recent work by Dan Halperin et al. has shown that the current version of the GFS is less reliable with respect to forecasting TC genesis compared to the previous GFS implementation, which matches forecasters' impressions: prior to this year, a genesis solution depicted by both the ECMWF and GFS was generally enough to issue an extended range high probability genesis forecast; without GFS support at the extended range, the lead time of high-probability genesis forecasts has been reduced

What we need:

- clearly defined metrics for evaluating TC genesis in models
- include objective TC genesis verification in the evaluation of model upgrades
- additional feedback from forecasters (and others) of their impressions during & after the season
- in-season verification of TC genesis skill to assist forecasters in identifying tendencies
- new/refined tools to help reduce some of the subjectivity in the forecasting process