



Exploitation of Ensemble Prediction System Information in Support of Atlantic Tropical Cyclogenesis Prediction

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Objectives

Utilise ensemble forecasts to provide genesis probabilities on existing invests and pre-invest disturbances.

Assess the bias and skill of ensemble systems for forecasting Tropical Cyclogenesis.

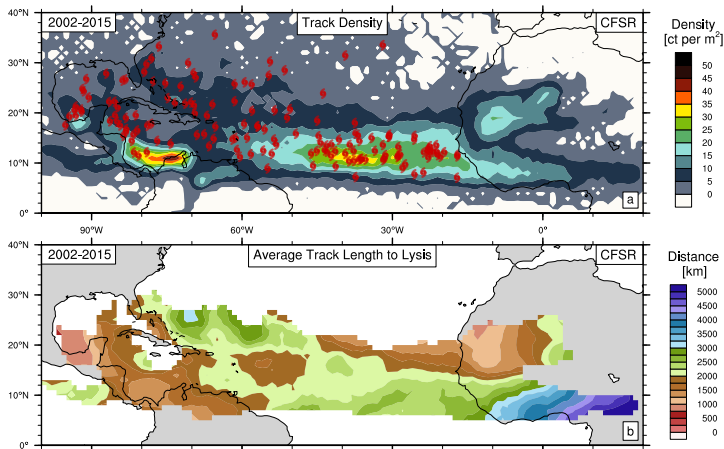
Provide improved real-time ensemble diagnostics to NHC forecasters for 2 & 5 day genesis forecasts.

Tracking and Objectifying AEWs

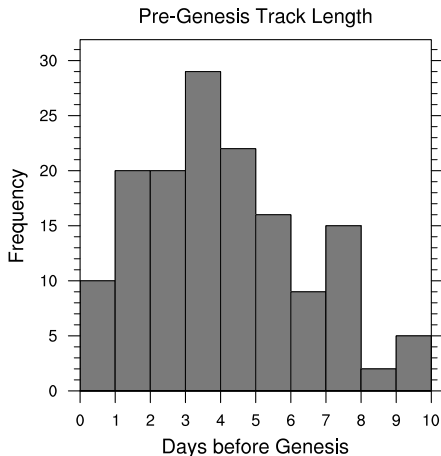
Track a combination of vorticity/circulation fields at 850, 700 and 600 hPa.

This methodology tracks disturbances along the African Easterly Jet as well as lower-level vorticity over the MDR and across the eastern Pacific.

Reanalysis tracking



Pre-genesis tracking



Pre-genesis tracker provides approximately 1-5 days lead time before genesis occurs.

Tracking coherent disturbances prior to genesis will allow for ensembles to be processed, with respect to the same disturbance, more easily.

GEFS tracking

Track each disturbance that exists in CFSR out to 120 hr in GEFS reforecast.

10 ensembles plus control with 6 hr forecast intervals.
Initialised every 00z.

For this talk, verify against CFSR location and intensities.

Approx. 1500 disturbances, 13 years, 120 hrs, 11 ensemble members.

Defining Tropical Cyclogenesis

Following Halperin et al. 2013, 2016 and Majumdar & Torn 2014.

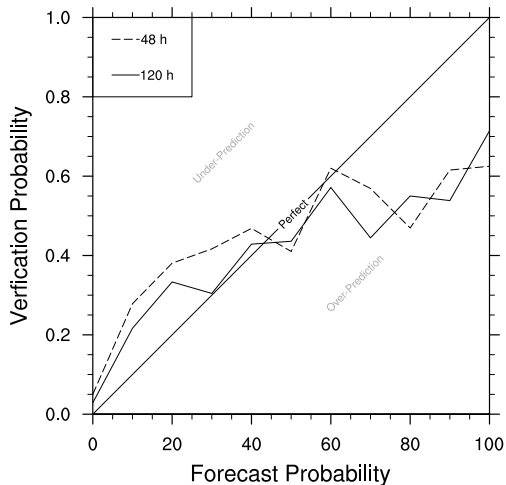
Define TC when system exceeds threshold values for:

- 850 hPa Relative Vorticity
- 200–850 hPa Thickness
- Closed MSLP contour (min + 1hPa)

(925 hPa wind speed was tested but made no difference to outcomes)

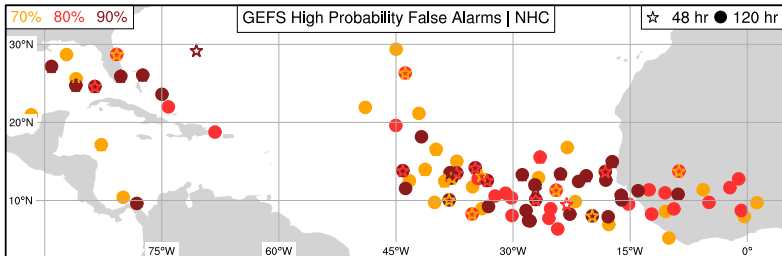
GEFS Genesis Probability Reliability

GEFS-R verified against NHC



Over prediction issue at higher percentages.

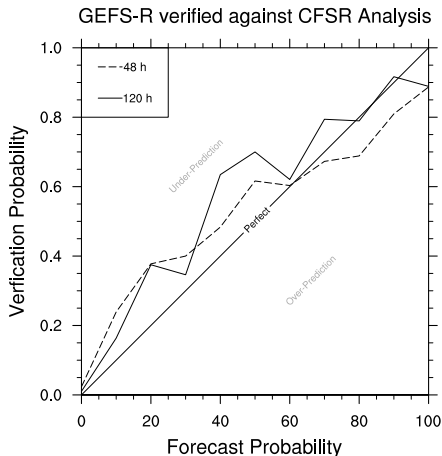
GEFS Genesis Probability Reliability



Hour 0 locations of high probability false alarm forecasts.

GEFS Genesis Probability Reliability

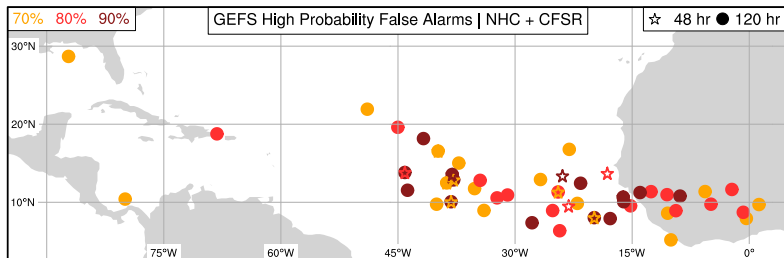
Verify against objective “Genesis” in the analysis.



When verified against objective genesis in the analysis, ensemble is quite reliable across all probabilities.

General under-prediction at lower percentages.

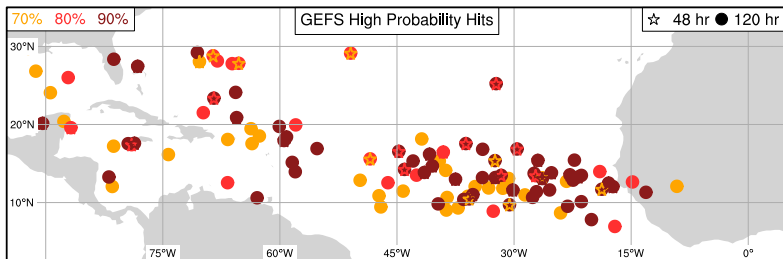
GEFS Genesis False Alarms



Hour 0 locations of high probability false alarm forecasts.

False alarms still regionally biased to the eastern Atlantic.

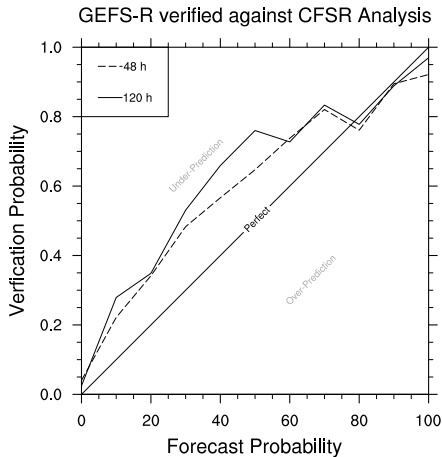
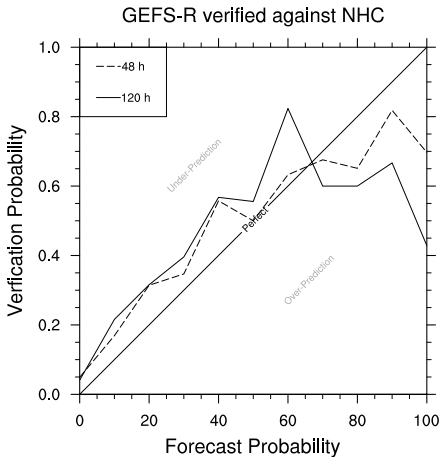
GEFS Genesis Hits



Hour 0 locations of high probability hit forecasts.

GEFS Genesis Probability Reliability

EPAC



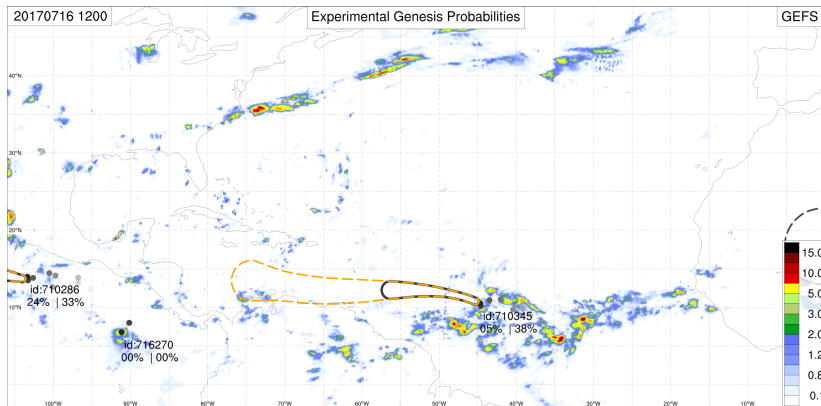
Ensemble Genesis Reliability

Issue remains for verifying objective genesis against the human records of genesis. Partly an issue of definition and partly representation of non-developing disturbances in the analysis.

Model has reasonable reliability when verified against objective definition. Encouraging for utility in realtime forecasts.

Realtime Example Forecast Products

www.atmos.albany.edu/facstaff/abrammer/maps/genesis/



Precipitation from Global Precipitation Measurement (GPM) Satellite, previous 6 hours.

Solid (dashed) cone 2 (5) day, track and genesis probability.

Cones based on ensemble mean track $\pm 1\sigma$ of across track variability.

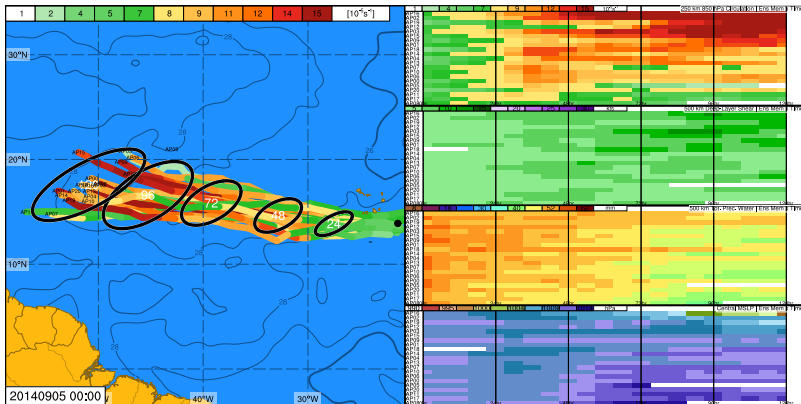
Objectives

Provide more detail about the ensemble forecasts prior to genesis.

Forecasters can then interpret the ensemble output easier.

We're automatically producing system relative graphics for any pre/post genesis disturbance.

GEFS operational Forecast



Forecast tracks and characteristics along tracks. Time-series are all sorted vertically by 850hPa vorticity.

Ensemble Based Sensitivity Analysis

Use the 120 hr forecast 850 hPa vorticity magnitude to correlate with differences in environmental conditions at earlier lead times.

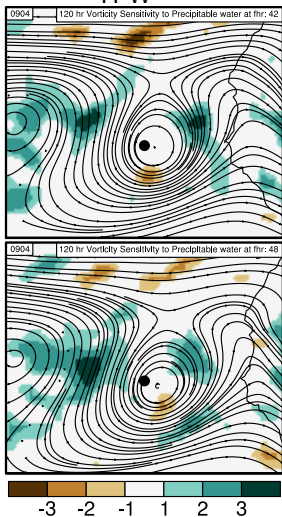
$$\frac{\delta J}{\delta x} = \frac{\text{cov}(J, x)}{\text{var}(x)}$$

J = 120 hr vorticity magnitude

x = environmental variable at forecasts 6-48 hr

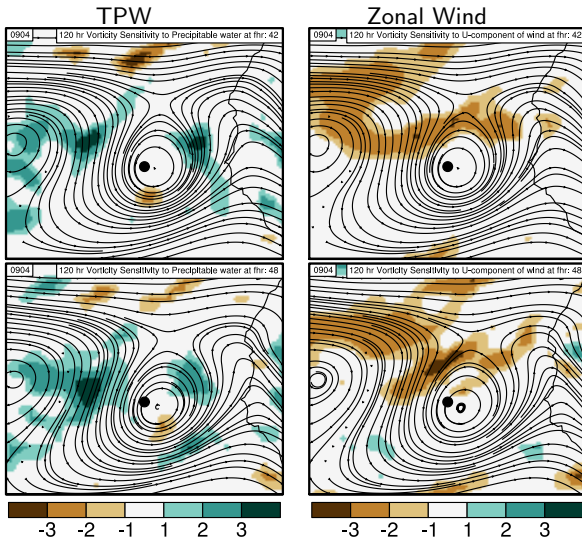
Ensemble Based Sensitivity Analysis

TPW



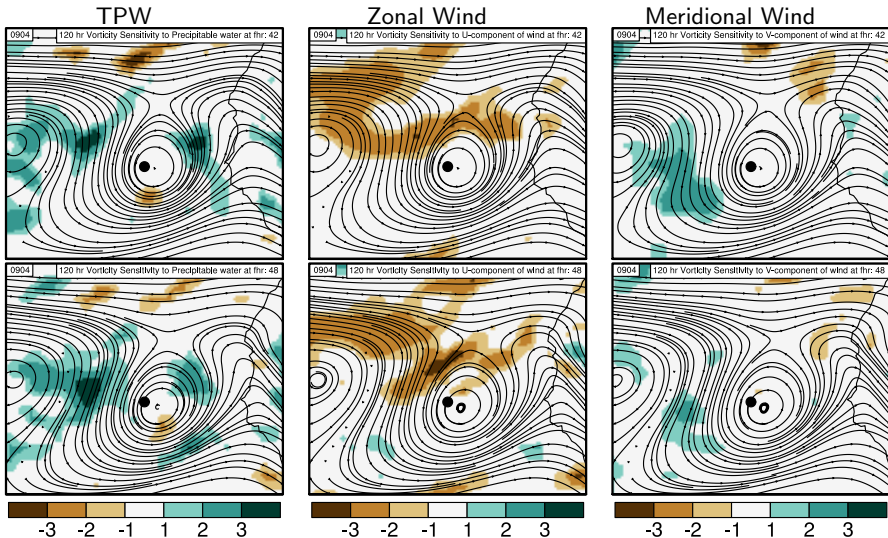
Intensifying members have increased moisture west of disturbance at earlier lead times.

Ensemble Based Sensitivity Analysis



Intensifying members have stronger relative zonal winds on northern side of circulation

Ensemble Based Sensitivity Analysis



Ensemble Based Sensitivity Analysis

Strengthening members show correlation with

- increased moisture outside circulation to the west & northwest and increased moisture on edge of circulation to NE.
- negative zonal wind, increased relatively easterly flow on northern side of circulation, slower phase speed?
- positive meridional wind, weaker northerly flow outside of circulation on western edge. Weaker circulation but also reduced equatorward advection of dry air?

Project So Far

Research

- Developed a pre-genesis tracker (variables suited to tracking pre-genesis disturbances).
 - Enables system relative analysis for pre-genesis systems.
 - As presented last year, positive vorticity bias existed in the GEFS-R over the eastern Atlantic. Linked to systems leaving West Africa.
- Assessed ensemble skill for genesis forecasts across GEFS-R. Operational statistics are ongoing.
- Individual cases are being analyzed to determine key factors in high probability false alarms.
- System relative bias correction has been developed, but is currently not implemented due to the differences in model versions.

Project So Far

Operations

- Implemented a real-time pre-genesis tracker providing probabilistic TC genesis forecasts for the Atlantic and East Pacific, runs every 6 hours. Output is generated within 5 minutes of the dissemination of the 148 hr GRIB.
- Webpage has been constructed with realtime basin scale graphics and system relative graphics. Currently receives around 100 unique views per day. Has been introduced to NHC forecasters and HRD daily forecast discussions. We're in communication with Chris Landsea and Mark DeMaria to improve utility for forecasters.
- Available at www.atmos.albany.edu/facstaff/abrammer/genesis

Project – Remaining Aims

- Operational forecast skill scores will be assessed over the 2017 and 2018 season.
- Assess the utility of implemented ensemble information into statistical genesis products e.g. Tropical Cyclone Genesis Index (JHT: Dunion et al).
- Transition graphics and tracking software to GitHub for community use.

Questions?

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