Sampling strategies for TC recon

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HFIP Annual Meeting

Support From NOAA: NA19OAR4590129
Overview

• Sensitivity analysis provides an objective method of identifying potential high-impact observation locations for a given forecast outcome or metric, like TC track or hazards.

• Ensemble-based techniques, such as the ensemble-based sensitivity method, may be better suited for TC applications because it allows for TC-specific metrics.

• Collaboration with NHC since 2018 for observation targeting for TC track utilizing this guidance.

Goal: Describe ensemble sensitivity targeting method for TC track forecasts.
Ensemble Sensitivity

\[
\frac{\partial J}{\partial x_{t-\delta t,j_e}} \equiv \text{cov}(J, \delta X_{t-\delta t,j}) D^{-1}_j = \frac{\text{cov}(J, X_j)}{\text{var}(X_j)}
\]

Ancell and Hakim 2007, Torn and Hakim 2008

• Ensemble-based method of computing the sensitivity to model state variables at earlier time
• Above equation is linear regression based on ensemble:
  – Dependent variable is ensemble estimate of a forecast metric that is a function of the model output (here a measure of TC track)
  – Independent variable is ensemble estimate of state variable (i.e., steering wind, vorticity, PV, height) at a given location and earlier time with observations
Sensitivity of Dorian’s 120 h position to the steering flow at earlier time.

Ensemble mean steering wind (300-850 hPa layer-average wind)

TC winds removed using the Galarneau and Davis (2013) method (subtract vorticity and divergence within 300 km of center.)
2019083100 ECMWF forecast of dorian05l, 0.603 of variance
Fred (2021)
0000 UTC 13 Aug.

Ida (2021)
1200 UTC 27 Aug.
Precipitation Sensitivity
Summary

• Ensemble sensitivity provides a computationally inexpensive, flexible method for estimating the sensitivity of various forecast outcomes to model state

• EOF decomposition of forecast latitude/longitude forecasts is an efficient forecast choice for TC track sensitivity

• Vast majority of position forecasts sensitive to near-storm steering wind variability and/or weaknesses in subtropical ridge – Few cases of far-upstream sensitivity with troughs, etc.

• Future work will extend to other metrics (intensity, hazards)

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