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Partners Project:
"Determining the abilities of operational numerical models to forecast tropical cyclogenesis"

UCAR Award No.: Z12-93225

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1. SUMMARY OF PROJECT OBJECTIVES

The main objective of this research project was to determine how well various operational global models predict tropical cyclone (TC) genesis in their forecast fields. Specifically, the project aimed to calculate basic verification statistics (e.g., probability of detection, false alarm rate, critical success index, etc.) for each model. This end goal required intermediate objectives such as defining a TC in the model forecast fields, creating an automated script to identify model-indicated TC genesis events, track TCs in the model fields, and classify each event as a success, partial success, or false alarm.

2. PROJECT ACCOMPLISHMENTS AND FINDINGS

The following research tasks listed in the project proposal were accomplished during the award period:

- Accumulate forecast data from the four global models
- Develop and test scripts to identify genesis cases and track them
- Perform the tracking of all genesis cases within the models, and output relevant characteristics.
- Compare each model genesis case to Best-Track data to classify each event as either a: hit, false alarm, or miss
- Present results at the AMS 30th Conference on Hurricanes and Tropical Meteorology
- Analyze evolution of forecast skill over time in each model
- Analyze evolution of forecast skill spatially in each model
- Write M.S. thesis
- Defend M.S. thesis
- Submit manuscript for publication in *Weather and Forecasting*

The following research tasks were completed during the award period, but were not listed in the original project proposal:

- Convert the TC genesis identification and tracking algorithm to run in real-time during the 2012 North Atlantic hurricane season.
- Calculate the probability of a hit for each real-time TC genesis forecast.
- Calculate the probability of TC genesis within 0-48 h of the real-time model cycle
- Display the TC genesis events and above probabilities in real-time at http://moe.met.fsu.edu/modelgen

Our results indicate that the global models are indeed able to predict TC genesis in their forecast fields. Model performance generally has improved over time. The "best" ranking model varies from year to year and depends on which statistical metric is being examined (Figs. 1, 2). The models' performance varies geographically as well (Fig. 3). For example, some models exhibit a rather low probability of detection in the Gulf of Mexico, but the false alarm rate here is also quite low. This indicates that although the models may miss many genesis events in the Gulf of Mexico, when they do predict genesis, it usually occurs. In contrast, the models have no problem predicting TC genesis over the main development region. This suggests that the models may be able to better predict certain modes of genesis.

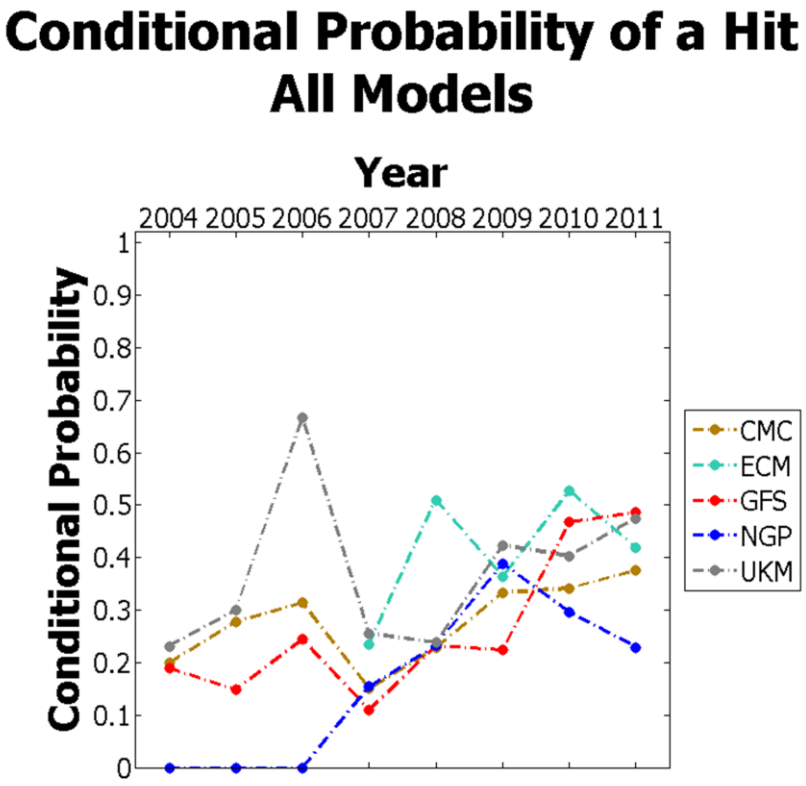

FIG. 1. The conditional probability of a hit (successful forecast) for each model by season. Genesis events from all forecast hours (06 to 96) are included.

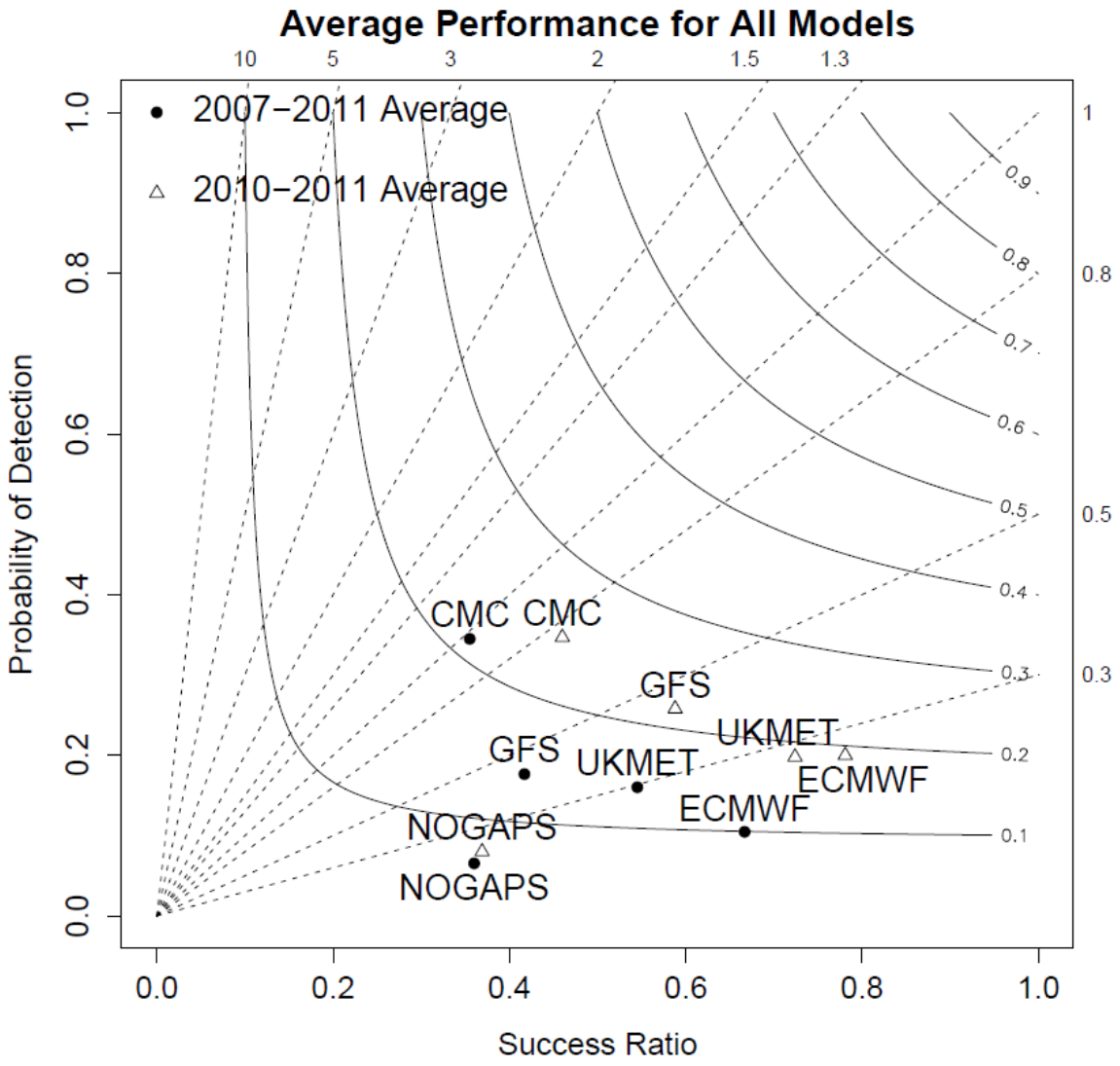

FIG. 2. Performance diagram with the average 2007-2011 and 2010-2011 performance for each model. The dashed lines represent the bias, and the curved lines represent the critical success index. Genesis events from all forecast hours (06 to 96) are included.

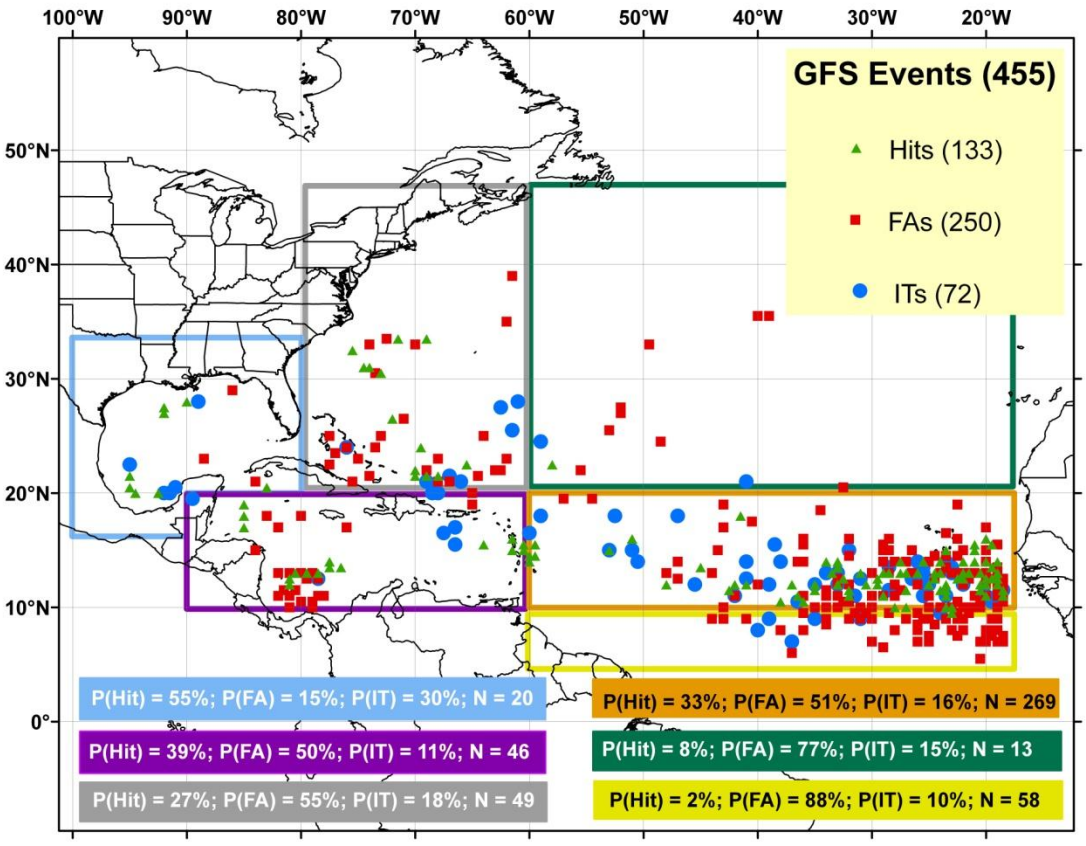

FIG. 3. 2004-2011 GFS hit (green triangle), false alarm (red square), and incorrect timing (blue circle) event locations. Numbers in parentheses are the number of model-indicated events. Outlined polygons represent sub-regions where conditional probabilities were calculated. These conditional probabilities are given in the lower portion of the figure.

3. BENEFITS AND LESSONS LEARNED: OPERATIONAL PARTNER PERSPECTIVE

The prediction of TC genesis is an important operational task at the NHC. Currently, the NHC issues a 48-hour forecast of TC genesis every 6 hours, and this year an experimental 5-day genesis prediction will be issued along with the 2-day forecast. These forecasts are contained in the Tropical Weather Outlook (TWO), which consists of text and graphical products that include specific probabilities of TC formation over the NHC's areas of responsibility (north Atlantic and eastern North Pacific basins). The primary numerical guidance tools used by NHC forecasters for these activities are global dynamical models. Up until recently, our assessment of the models abilities to forecast genesis was based mainly on subjective experience. This research has enhanced and quantified our knowledge of the global model's capabilities to predict TC formation, and

is extremely relevant to NHC's operations. The real-time website depicting model-based genesis probabilities is a useful tool to aid the issuance of the TWO.

4. BENEFITS AND LESSONS LEARNED: UNIVERSITY PARTNER PERSPECTIVE

The FSU team has gained insight about the challenges faced by specialists at NHC regarding TC genesis forecasts. We have learned about the decision making process when issuing the Tropical Weather Outlook product and have become better informed about which tools and data the forecasters frequently utilize. We believe this knowledge allowed us to display our results for our real-time TC genesis probabilities them in a format that was easy for the NHC specialists to quickly read and interpret in a real-time operational setting.

Our main problem during the course of this project was obtaining UKMET model output during 2010 and 2011 and ECMWF output from 2007 to 2011. The time it took to download the data initially delayed parts of the project, but we were still able to complete our research tasks during the proposed award period.

5. PUBLICATIONS AND PRESENTATIONS

Journal publications:

Halperin, D.J, H.E. Fuelberg, R.E. Hart, R.J. Pasch, J.H. Cossuth, and P. Sura, 2013: An evaluation of TC genesis forecast from global numerical models. *Wea. Forec*, in review.

Conference presentations:

Halperin, D.J., H.E. Fuelberg, R.E. Hart, P. Sura, J.H. Cossuth, R. Truchelut, and R.J. Pasch, 2012: Evaluating tropical cyclogenesis forecasts from four global numerical models. *30th Conf. on Hurricanes and Tropical Met.*, AMS, Ponte Vedra Beach, FL, April 2012, 3A.3.

Halperin, D.J., J.H. Cossuth, H.E. Fuelberg, R.E. Hart, 2013: Short and extended range probabilistic tropical cyclone genesis forecasts based on a climatology of global numerical model output. *93rd AMS Annual Meeting*, AMS, Austin, TX, January 2013, P. 481.

6. SUMMARY OF UNIVERSITY/OPERATIONAL PARTNER INTERACTIONS AND ROLES

These research tasks were primarily carried out by Dan Halperin, the graduate student supported by the grant. The PIs on the project (Fuelberg, Hart, Pasch) provided invaluable guidance during the research process.