Improvements and extensions to an existing probabilistic TC genesis forecast tool using an ensemble of global models

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Project goals

• Enhance consensus tracker algorithm.
• Increase probability of detection for TC genesis events in the subtropics.
• Test feasibility of new datasets (NAVGEM).
• Extend guidance to the CP basin.
• Verify TC genesis forecasts from fvGFS.
• Update/re-calibrate regression equations.
2018 product enhancements

Consensus guidance issued every 6 h when data from at least one global model available.

Location and categorical genesis probability from individual models.

Brackets indicate data not available from all three global models.

Guidance for CP basin.

Consensus guidance when data from at least one global model available.

Location of active TCs.

Available models in current guidance cycle (init time):
- CMC [C] (12Z)
- GFS [G] (18Z)

Letters below the genesis probability indicate the models that predicted genesis.

Experimental 0-120 h TC genesis probability
2018-09-28 18Z consensus guidance

http://moe.met.fsu.edu/modelgen
2018 Forecast Verification
EPAC: NHC low bias, CON high bias

Brier Scores
TWO: 0.096
CON: 0.106

Brier Scores
TWO: 0.180
CON: 0.174
NATL: NHC low bias, CON high bias

Brier Scores
TWO: 0.156
CON: 0.143

Larger than normal overprediction
What happened?

2018 CON based 120 hour genesis forecasts through 12/31 12Z

120 h genesis probability (%):
- 0-9
- 10-19
- 20-29
- 30-39
- 40-49
- 50-59
- 60-69
- 70-79
- 80-89
- 90-100

Leslie tropical transition

Genesis occurred within 120 h?
- Yes
- No

Alberto tropical transition

Oscar tropical transition
Alternate universe: Genesis time is time of first (sub)tropical depression or storm

2018 CON based 120 hour genesis forecasts through 12/31 12Z

- 120 h genesis probability (%):
  - 0-9
  - 10-19
  - 20-29
  - 30-39
  - 40-49
  - 50-59
  - 60-69
  - 70-79
  - 80-89
  - 90-100

- Genesis occurred within 120 h?
  - Yes
  - No

Map showing Genesis occurrences and probabilities in the Atlantic Ocean.

- Oscar tropical transition
- Alberto tropical transition
- Leslie tropical transition

Legend:
- Purple: 10-19%
- Yellow: 20-29%
- Red: 30-39%
- Orange: 40-49%
- Green: 50-59%
- Light green: 60-69%
- Light yellow: 70-79%
- Light red: 80-89%
- Light orange: 90-100%
Alternate universe: Genesis time is time of first (sub)tropical depression or storm

Brier Scores
TWO: 0.156
CON: 0.133

Performance more consistent with prior years
• 2015-2018 retrospective period
  • Ended mid-season 2018 (before Hurricane Michael)

• Verification compared a homogeneous set of model initializations

• TC genesis events identified in the tracker out to 120 h

• If genesis occurs within 120 h of model initialization time → “hit”
2015-2018 performance diagram (NATL)

- Frequency bias
- Critical success index

- GFS
- fvGFS
- 2015
- 2016
- 2017
- 2018
- Mean
Difference in maximum lead-time for each Best-Track TC (NATL)

fvGFS has longer maximum lead-time

GFS has longer maximum lead-time

Best-Track TCs (beginning with AL012015)
2015-2018 EPAC GFS 120-h success ratio by forecast hour

Success Ratio

# of cases per bin

<table>
<thead>
<tr>
<th># of cases per bin</th>
<th>GFS</th>
<th>tGFS</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-24</td>
<td>58</td>
<td>48</td>
</tr>
<tr>
<td>30-48</td>
<td>141</td>
<td>85</td>
</tr>
<tr>
<td>54-72</td>
<td>156</td>
<td>125</td>
</tr>
<tr>
<td>78-96</td>
<td>182</td>
<td>120</td>
</tr>
<tr>
<td>102-120</td>
<td>167</td>
<td>145</td>
</tr>
</tbody>
</table>
Difference in maximum lead-time for each Best-Track TC (EPAC)

fvGFS has longer maximum lead-time

GFS has longer maximum lead-time

Best-Track TCs (beginning with EP012015)
Plans for 2019 (last six months of project)

• Continue providing real-time guidance at [http://moe.met.fsu.edu/modelgen](http://moe.met.fsu.edu/modelgen)

• Determine whether the probabilities with the experimental tracker are more reliable than those with the operational tracker.

• Update/re-calibrate logistic regression equations.

• Implement NAVGEM-based guidance.

• Transfer post-season verification and development code to NHC.

• Solicit feedback from NHC through remainder of project period.
• New JHT proposal submitted to further expand the current forecast tool now titled:
  “TCLOGG” – Tropical Cyclone Logistical Guidance for Genesis.

• The proposed new work includes:
  • Changing the GFS GRIB variable for SLP from PRMSL to MSLET
  • Further improvements for high latitude formation (and perhaps subtropicals)
  • Testing feasibility of expanding guidance to Day 6-7
  • Development of ensemble regression equations using GEFS Reforecast V2
  • Development of regression equations for “most-likely time of genesis”
In May 2011, NCEP began outputting a second GRIB variable for SLP (MSLET) for the GFS in addition to the NCEP standard (PRMSL).

The MSLET variable is more consistent in method with the SLP calculation in other global models, and better exploits the improved GFS grid resolution over the past decade. There is now a sufficient archive length to use MSLET in TCLOGG.

Example 1 proposed new deliverable: PRMSL to MSLET

Left: A case of TC genesis illustrating the potentially dramatic impact of using PRMSL (left; open wave at 2mb contour) vs. MSLET (right; closed 1006mb low) on the identification of a closed circulation (pre-TC Bret in 2017) in the current GFS. This has a severe impact on derived TC genesis probabilities using the forecast tool described here. From Hart and Cowan (2018).
Example 2 proposed new deliverable: Most Likely Time of Genesis

• There are cases where the TC genesis time was highly model-dependent, e.g.:

<table>
<thead>
<tr>
<th>Source</th>
<th>CMC</th>
<th>GFS</th>
<th>UKM</th>
<th>Average</th>
<th>Verification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genesis Fcst. Hr.</td>
<td>18hr</td>
<td>114hr</td>
<td>60hr</td>
<td>64hr</td>
<td>78hr</td>
</tr>
<tr>
<td>120hr Genesis Prob.</td>
<td>74%</td>
<td>75%</td>
<td>81%</td>
<td>77%</td>
<td>100%</td>
</tr>
</tbody>
</table>

• Accordingly, one proposed addition to TCLOGG is a means by which to calculate and display a “most-likely time of genesis.”

• This additional information may be critical for the forecaster by helping to more precisely determine when pre-genesis watches or warnings may be required.
A significant proposed expansion for TCLOGG is to use a subset of the 30-year archive of the GEFS Reforecast v2 (GEFSRv2).

The goal is to arrive at genesis probabilities from an ensemble prediction system with a single model configuration rather than an ensemble of unique deterministic models (the latter of which has been the focus of TCLOGG development thus far):

- The first approach would be to apply the GFS or fvGFS tracker and equations to the GEFSRv2 members and then calculate the mean probability of development from the latter.

- The second approach would be to combine all the GEFSRv2 members and develop a single tracker and regression equation. We would then apply these to each member and take the mean of the resulting probabilities.

- The former approach is more straightforward whereas the latter, while time consuming, exploits more greatly the benefit of a large ensemble.
Thank you
Extra Slides
Locations of all forecast hit events, false alarm events, and actual best-track TC genesis during the 2015-2018 study period.
Locations of all forecast hit events, false alarm events, and actual best-track TC genesis during the 2015-2018 study period.