Subseasonal Tropical Cyclone Prediction at CPC:  
A New Forecasting Tool for Weeks 1-4

Lindsey N. Long  (Lindsey.Long@noaa.gov)
NOAA/NWS/NCEP/Climatological Prediction Center;  Innovim, LLC

1. INTRODUCTION

The Climate Prediction Center (CPC) currently produces a tool called the Global Tropical Hazards and Benefits Outlook (GTH) which highlights areas of TC formation and above- and below-average rainfall for the upcoming Week 1-2 forecast period (See below). CPC is working to shift this product to weeks 2 and 3 (and/or week 4) and make it a probabilistic forecast. The goal of this research is to provide tools to support weeks 2-4 TC and precipitation forecasts.

An example of the GTH Tool which is issued each Tuesday for Weeks 1-2.

In addition to the graphic on the left, there is a live briefing and a detailed discussion included. A Friday update is released during peak NH TC season (Jun – Nov).

2. DATA & METHODS

<table>
<thead>
<tr>
<th>Model</th>
<th>Components</th>
<th>Frequency</th>
<th>Forecasts</th>
<th>Hindcasts</th>
<th>Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFSv2</td>
<td>NCEP GFS (T126,L48), Noah LSM, GFDL MCM4</td>
<td>Daily</td>
<td>16 Members, 6-hr</td>
<td>1999-2012, 4 Members*, 6-hr</td>
<td>1 x 1</td>
</tr>
<tr>
<td>CMC</td>
<td>ERA-Interim (4.5x4.5), SPS (IBBA, LSM, Persistent SST anomaly)</td>
<td>Thursdays</td>
<td>20 Members, 6-hr, 1995-2014, 4 Members, Daily</td>
<td>0.45 x 0.45</td>
<td></td>
</tr>
<tr>
<td>ECMWF</td>
<td>Integrated Forecasting System (IFS version 45r1 since June 2018)</td>
<td>Mondays &amp; Thursdays</td>
<td>51 Members, 12-hr, 1998-2011, 11 Members, 12-hr</td>
<td>0.5 x 0.5</td>
<td></td>
</tr>
</tbody>
</table>

* Use 5-days to make 20 member ensembles

3. STORM TRACK FILTERING

- Real-time forecasts of bias-corrected storm counts are included with the storm track forecast
- Bias-corrected performance using model hindcasts. Skill scores are below.

4. STORM TRACK SKILL SCORES

The Heidke Skill Score (HSS) is used as a track verification tool. This score only gives credit to correct forecasts of an observed storm. No skill is given for correctly predicting a lack of activity. Therefore, months with little or no activity will have a zero score, and skill is not inflated by a lack of prediction.

- HSS utilizes a 2x2 contingency matrix of Hits, Misses, False Alarms, and Correct No Forecasts.
- A “Hit” is defined as having a forecasted storm within 3 grid points of an observed storm (within a 7x7 box).

The HSS for each basin by month:
- At Weeks 1 & 2, ECMWF outperforms GFSv2 and CMC with scores surpassing 0.4 during peak season.
- With longer leads, the ECMWF is more consistent with the other models, rarely breaking the 0.2 mark.

5. STORM COUNTS

- Models produce a high number of False Alarms (FA), storms that do not occur in observations.
- Using storm track density values, the weekly storm track climatology and FA climatology are removed from the daily storm track density.
- Remaining track density points are considered forecasted TCs.

6. FORECASTER’S TOOL

In addition to this dynamical tool, we hope to produce two other TC tools:
- 1. Dynamical-Statistical Hybrid Model
  Initial results using CFS are promising
- 2. Forecast of Equatorial Waves and Mode
  Collaboration with Carl Schreck at NC State

This project includes precipitation research for Weeks 3-4. Verification results of anomalies show model skill in the ECMWF. Currently investigating different bias-correction and consolidation methodologies to increase skill.

TC Detection and Tracking
- Based on Camargo & Zebiak (2002):
  - Point must meet 7 criteria to be considered a storm
  - Guarantee that point is a warm-core system, minimum in SLP, wind maxima within a 7x7 grid box of the point.
  - Detection thresholds unique to model, calculated using model hindcasts
  - Tracking forward and backward in time following vorticity maxima

Verification
- HURDAT2 and JTWC Best Track Datasets
- Oceans broken up into regions:
  

5. STORM COUNTS

- Real-time forecasts of bias-corrected storm counts are included with the storm track forecast
- Bias-correction is performed using model hindcasts. Skill scores are below.

WNP Storm Count Anomaly Correlations

Correlations averaged (during peak season) over all years for remaining basins:
- CFS and ECMWF continue to outperform CMC. Note: ECMWF not yet available for SH basins (bottom row).
- S. Indian and 3 Pacific regions (ENP, SLP, and WNP) show highest skill overall.