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

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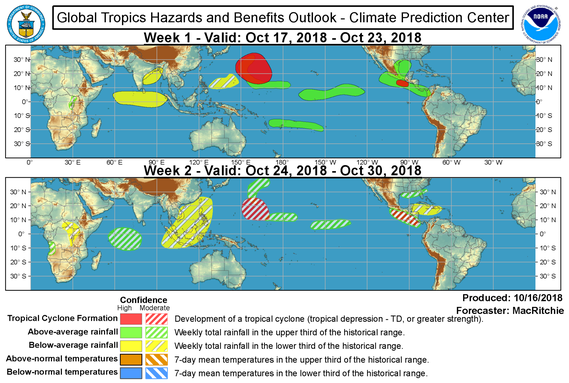
1. INTRODUCTION

The Climate Prediction Center (CPC) currently produces a tool called the Global Tropics 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 (Jun1 – Nov30)

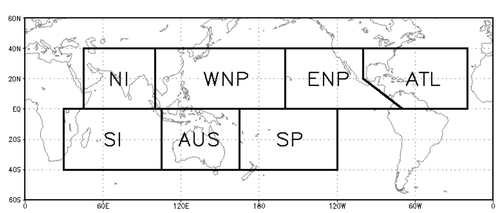
2. DATA & METHODS

Model	Components	Frequency	Forecasts	Hindcasts	Resolution
CFSv2	NCEP GFS (T126/L64), Noah LSM, GFDL MOM4	Daily	16 Members, 6hrly	1999-2012 4 Members*, 6-hrly	1º x 1º
CMC	ERA-Interm (0.45º/L40), SPS (ISBA) LSM, Persistent SST anomaly	Thursdays	20 Members, 6-hrly	1995-2014 4 members, Daily	0.45º x 0.45º
ECMWF	Integrated Forecasting System (IFS, version 45r1 since June 2018)	Mondays & Thursdays	51 Members, 12-hrly	1998-2017 11 members, 12-hrly	0.5º x 0.5º

* Use 5 days to make 20 member ensm

TC Detection and Tracking

- Based on Camargo & Zebiak (2002)[1]
  - 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
  - Tracked forward and backward in time following vorticity maxima
- Verification
  - HURDAT2 and JTWC Best Track Datasets
- Oceans broken up into regions:

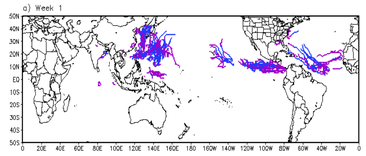


1. Camargo, S.J. and S. E. Zebiak, 2002: Improving the Detection and Tracking of Tropical Cyclones in Atmospheric General Circulation Models. *Weather and Forecasting*, **17**, 1152-1162.

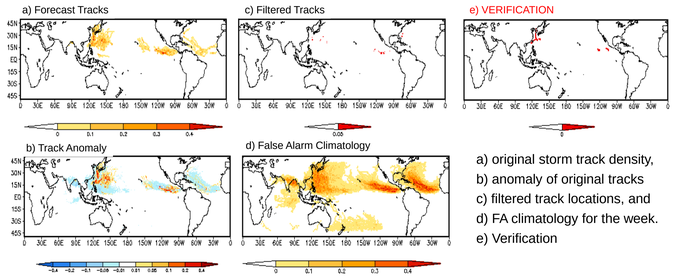
3. STORM TRACK FILTERING

- 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.

Original Forecasted Storm Tracks



Filtering Example



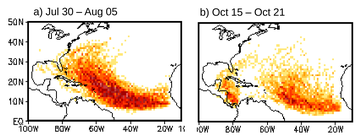
a) original storm track density,
b) anomaly of original tracks
c) filtered track locations, and
d) FA climatology for the week.
e) Verification

This forecast for August 1, 1999 shows a high confidence for storms in the WNP, ENP and ATL basins (c).

Observations show one storm in the WNP and two in the ENP (e).

Using a weekly climatology is important, because False Alarms can vary greatly week to week. For example, in the CFSv2, the Atlantic has a high number of False Alarms beginning in the MDR and moving northwest during early August. By late October, these storms have become less prevalent, and there is a larger occurrence of false alarms in the Caribbean Sea.

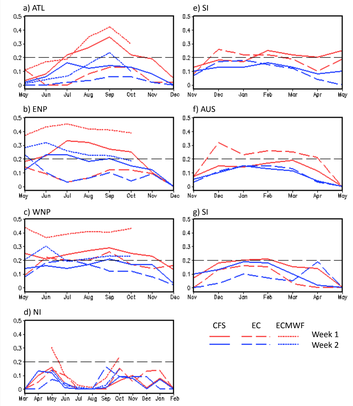
Examples of Weekly FA Climatology



4. STORM TRACK SKILL SCORES

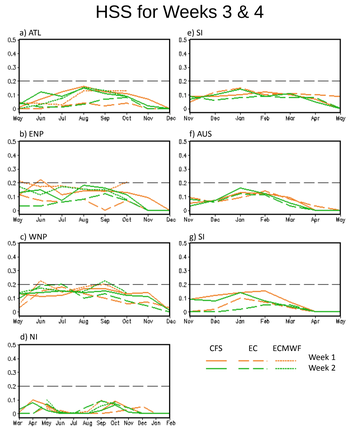
The Heidke Skill Score (HSS) is used as a track verification tool. This score only gives credit to correct forecasts of an observed storm. No skill is given for correctly predicting a lack of activity. Therefore, months with little or no activity will have a zero score, and skill is not inflated by a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

HSS for Weeks 1 & 2



- 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).

HSS for Weeks 3 & 4



The HSS for each basin by month:

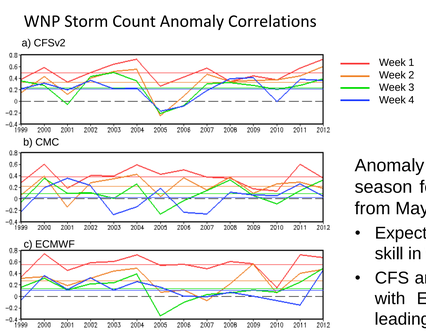
- At Weeks 1 & 2, ECMWF outperforms CFSv2 and CMC with scores surpassing 0.4 during peak season.
- With longer leads, the ECMWF is more consistent with the other models, rarely breaking the 0.2 mark.

Note: ECMWF has only been available since May, so values for Nov – Apr are blank, including all SH basins.

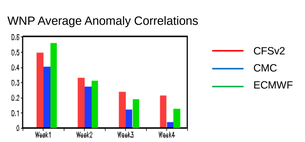
5. STORM COUNTS

- 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



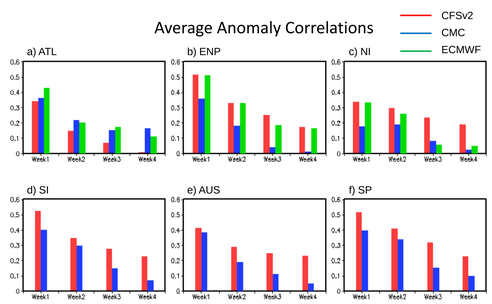
WNP Average Anomaly Correlations



Anomaly correlations are computed using TC peak season for each year. For example, WNP correlations from May–Nov by year (left) and over all years (above).

- Expected skill drop with increase in lead, but still some skill in Week 3 & 4.
- CFS and ECMWF tend to outperform CMC on average, with ECMWF performing best at week 1 and CFS leading in later leads.

Average Anomaly Correlations

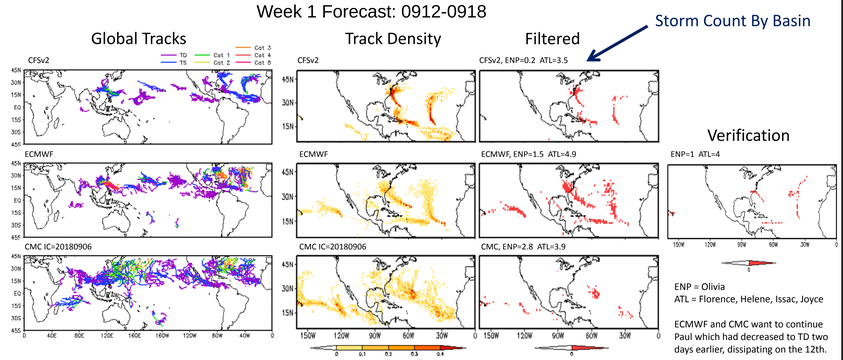


Correlations averaged (during peak season) over all years for remaining basins

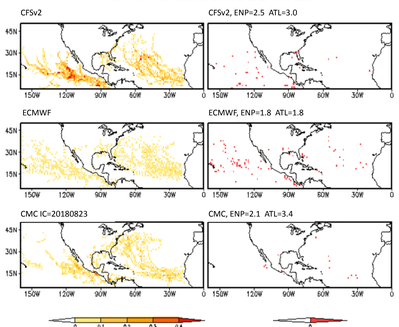
- CFS and ECMWF continue to outperform CMC. Note: ECMWF not yet available for SH basins (bottom row).
- S. Indian and 3 Pacific regions (ENP, SP, and WNP) show highest skill overall

6. FORECASTER'S TOOL

Week 1 Forecast: 0912-0918



Week 3 Forecast: 0912-0918



Additional Tools

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 Modes
   - 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.