SUB-SEASONAL FORECASTS OVER THE CARIBBEAN, CENTRAL AMERICA AND MEXICO AND VERIFICATIONS

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Introduction

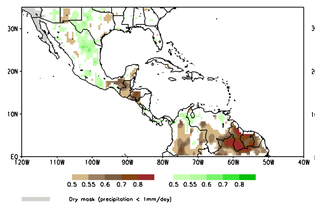
Over the past several years, there has been a growing demand for operational forecasts on the sub-seasonal time scale ranging from one week to one month, as many decisions in socio-economic sectors fall into this time range.

The NOAA's Climate Prediction Center (CPC) is developing a set of forecasting tools to address the gap in sub-seasonal forecasting. It has developed **week 1**, **week 2** and **week 3-4** probabilistic forecasts for:

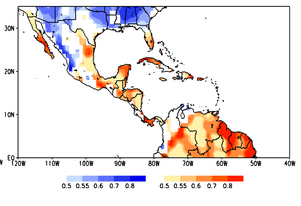
- precipitation
- 2m air temperature
- heat wave days.

These sub-seasonal forecasts cover the area encompassing **the Caribbean, Central America and Mexico**.

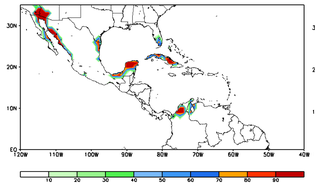
Week 3-4 precipitation forecast



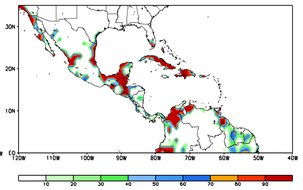
Week 3-4 temperature forecast



Week 1 heat wave day forecast ($NOAA's\ Heat\ Index \geq 38°C$)



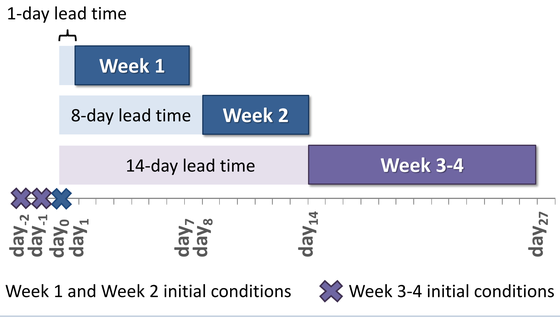
Week 1 heat wave day forecast ($T_{max} \geq\ 90^{th}\ percentile$)



Week 3-4 calibrated 2-category precipitation anomaly (top left) and temperature anomaly (top right) probabilistic forecasts, valid from 31 July to 13 August 2017 (IC: 15-16 July 2017) and week 1 heat wave day forecasts based on the NOAA's Heat Index (bottom left) and based on the exceedance of the 90th percentile (bottom right), valid from 31 July to 6 August 2017 (IC: 30 July 2017).

WEEK 1 and WEEK 2 FORECASTS
Model: NCEP GEFS
21 ensemble members

WEEK 3-4 FORECASTS
Model: NCEP CFSv2
32 ensemble members



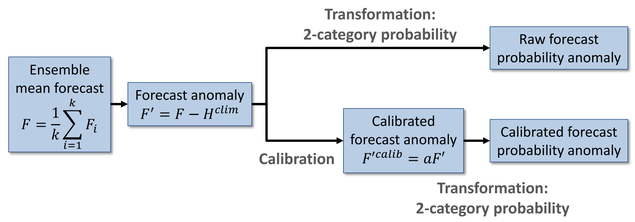
Methodology

Precipitation and 2m air temperature forecasts

Data

Observation climatology (1999-2017):
- CPC unified gauge-based analysis of daily precipitation
- Gridded CPC mean temperature

Hindcast climatology (1999-2017) and **real-time forecasts** (2017-2018):
- NCEP GEFS
- NCEP CFSv2



Calibration

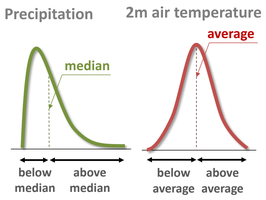
Regression model: $H' = aO' + b$

- $H' = H - H^{clim}$: hindcast anomalies
- $O' = O - O^{clim}$: observed anomalies
- $a = \frac{cov(H',O')}{sd^2_{H'}}$: regression coefficient
- b: intercept

Calibrated forecast anomaly $F'^{calib} = aF'$

✱ *For precipitation, F' is transformed into a normal distribution.*

Transformation: 2-category probability



Heat wave day forecasts

Data

Observation (1980-2010):
- Gridded CPC maximum temperature

Real-time forecasts (2017-2018):
- NCEP GEFS and NCEP CFSv2

In this study, a heat wave is defined as a period of:

- at least 3 consecutive days with daily $NOAA's\ Heat\ Index \geq 38°C$, or
- at least 3 consecutive days with daily $T_{max} \geq 90^{th}\ percentile$ in the 30-year climatological record from 1981 to 2010

$$p(heat\ wave) = \frac{number\ of\ ensemble\ members\ favourable\ for\ heat\ wave}{total\ number\ of\ ensemble\ members}$$

Verification

Verification metrics are computed to provide an objective evaluation of the forecast quality.

AUC — **Area Under the ROC Curve**
Assesses the discriminative ability of the model
$0 \leq AUC \leq 1$
$AUC = 1$ perfect forecast

HSS — **Heidke Skill Score**
Compares the proportion of correct forecasts to a no skill random forecast

$$HSS = \frac{(hits + correct\ negatives) - (expected\ correct)_{random}}{n - (expected\ correct)_{random}}$$

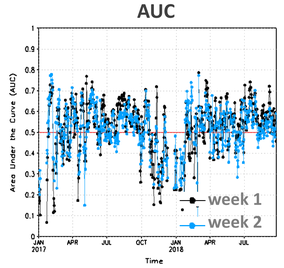
with $(expected\ correct)_{random} = \frac{1}{n}\left[\frac{(hits + misses) \times (hits + false\ alarms) + (correct\ negatives + misses) \times (correct\ negatives + false\ alarms)}{n}\right]$
and n the number of grid points

$-1 \leq HSS \leq 1$
$HSS = 1$ perfect forecast

Verification Results

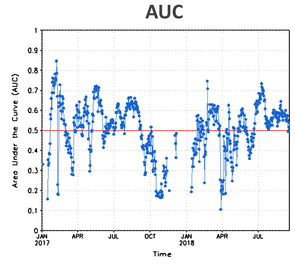
Heat wave days ($NOAA's\ Heat\ Index \geq 38°C$)

Week 1/Week 2 AUC



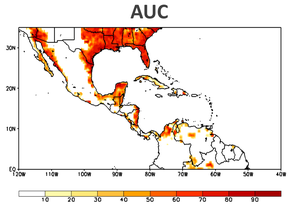
$AUC_{week\ 1} = 0.52$
$AUC_{week\ 2} = 0.52$

Week 3-4 AUC

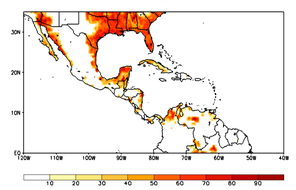


$AUC_{week\ 3-4} = 0.51$

Week 1 AUC



Week 2 AUC

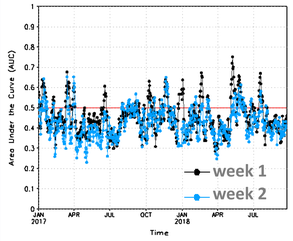


July-August-September 2015-2018

July-August-September 2015-2018

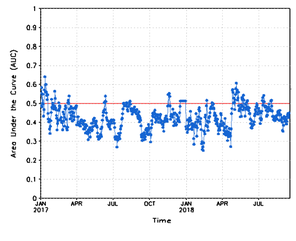
Heat wave days ($T_{max} \geq\ 90^{th}\ percentile$)

Week 1/Week 2 AUC



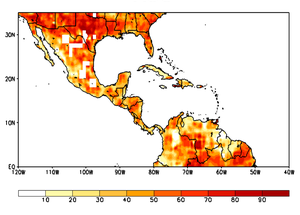
$AUC_{week\ 1} = 0.45$
$AUC_{week\ 2} = 0.42$

Week 3-4 AUC

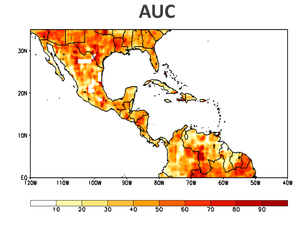


$AUC_{week\ 3-4} = 0.43$

Week 1 AUC



Week 2 AUC



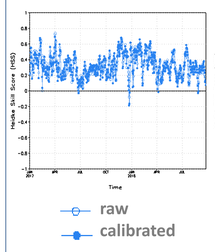
July-August-September 2015-2018

July-August-September 2015-2018

Verification Results

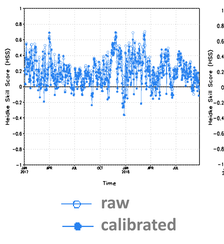
Precipitation

Week 1 HSS



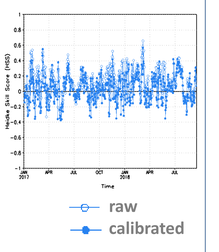
$HSS_{raw} = 0.33$
$HSS_{calibrated} = 0.32$

Week 2 HSS



$HSS_{raw} = 0.24$
$HSS_{calibrated} = 0.17$

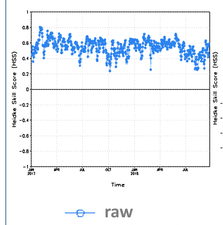
Week 3-4 HSS



$HSS_{raw} = 0.12$
$HSS_{calibrated} = 0.03$

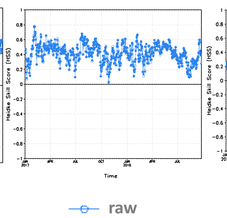
2m air temperature

Week 1 HSS



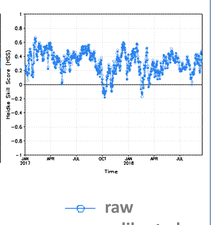
$HSS_{raw} = 0.53$
$HSS_{calibrated} = 0.53$

Week 2 HSS



$HSS_{raw} = 0.41$
$HSS_{calibrated} = 0.40$

Week 3-4 HSS



$HSS_{raw} = 0.31$
$HSS_{calibrated} = 0.29$

Conclusion

- Verification reveals skillful forecasts at time ranges of week 1 and week 2.
- Results suggest that the NCEP models perform reasonably well in depicting heat wave events in the Caribbean, Central America and Mexico.
- The heat wave day forecasts, when made available in real time, can help mitigate the impact of heat on human health in vulnerable populations.
- Efforts will be done in performing bias corrected forecasts to help increase the skills, at all time scales.