Projected Changes in the Seasonal Cycle of Tropical Cyclones

John G. Dwyer, Suzana J. Camargo, Adam H. Sobel, Michela Biasutti, Kerry A. Emanuel, Gabriel A. Vecchi, and Ming Zhao

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CMIP3 & CMIP5 models project changes to the seasonality of tropical precipitation and SST due to increased greenhouse gases.

Two examples:

- NH E. Pac. and Carib. SST
- NH Indian Ocean Rainfall
Projected Precipitation Changes

Seth et al. (2011)
## Projected Precipitation Changes

<table>
<thead>
<tr>
<th></th>
<th>SST</th>
<th>Ocean Precip.</th>
<th>Land Precip.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Δ Annual Mean</td>
<td>2.9 K</td>
<td>0.2 mm day^{-1}</td>
<td>0.1 mm day^{-1}</td>
</tr>
<tr>
<td>Δ Amplitude</td>
<td>4.2%</td>
<td>15.5%</td>
<td>8.2%</td>
</tr>
<tr>
<td>Δ Phase</td>
<td>1.1 days</td>
<td>2.7 days</td>
<td>3.5 days</td>
</tr>
</tbody>
</table>

**Table 2.** Multi-model mean changes in the annual mean, phase, and amplitude over ocean and land in the tropics (25°S–25°N) for the CMIP5 models between 2080–2099 relative to 1980–1999. Seasonal changes were calculated using EOF analysis. Numbers in parentheses indicate the number of models projecting changes of the same sign as the mean for each quantity out of a total of 35 models.
Dwyer et al. (2012)
Sobel & Camargo (2011)
Questions

• Motivated by these projected changes in SST and precipitation, does the timing of tropical storms and their environmental conditions change due to greenhouse gases in the latest models?

• If so, how important is the spatial pattern of SST for these changes?
Data

- CMIP5 (Taylor et al., 2011) & Downscaled TC tracks (Emanuel et al., 2008)
  - Downscaling based on CMIP5 results from various models
- HiRAM (Zhao et al., 2009)
  - 50km resolution
  - Forced by observed SST and CMIP3 projections of SST changes
Dwnscl. ntc NAtl PV=62%

Dwnscl. ntc WPac PV=98%

Dwnscl. ntc EPac PV=84%

Dwnscl. ntc Aust PV=95%

HiRAM NTC NAtl PV=75%

HiRAM NTC WPac PV=96%

HiRAM NTC EPac PV=95%

HiRAM NTC Aust PV=90%
CMIP5 Phase Delay of Surface Temperature [days]

Downscaled Track Density MMM ΔPhase [days]

(Advance) (Delay)
Conclusions

• Both the CMIP5 and the HiRAM simulations show a delay to the timing of PI & GPI in most NH basins and an advance in the SH basins in 21st century simulations

• Downscaled tracks (Emanuel et al., 2008) show a phase delay in NH basins and a phase advance in SH basins

• Results from HiRAM show evidence of an advance in most basins, but more data is needed to characterize

• There’s some evidence of spatial correlation between SST phase changes and downscaled track density phase changes