Climate modeling Study of Variability about the Seasonal Cycle in the Tropical Eastern Pacific and the Caribbean Sea

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1. Introduction

-The Tropical Eastern Pacific (TEP) extends along the west coasts of the Americas, from the southern tip of the Baja California Peninsula in the north to the northern Peru in the south. It also includes a number of islands and island groups, including the Galapagos, Revillagigedos, Cocos, Malpelo, and Clipperton.

-The Caribbean Sea is bounded to the south by South America, to the west by Central America, and to the north by the Greater Antilles (Cuba, Haiti, Dominican Republic, and Puerto Rico).

-Due to the regular impacts of el Nino or ENSO events, the TEP has one of the most dynamic coastal environments of any tropical region in the world.

-The climate for the Caribbean region is generally tropical, but with strong local variations in climate due to altitude, ocean currents, and the trade winds. This region is important for both weather and climate, since it serves as a source of atmospheric moisture for precipitation across the Americas.

-Climate models typically produce too much precipitation over the Caribbean, and these precipitation biases may affect their ability to realistically simulate extreme events in this region.

2. Objectives

The primary goal of this study is to analyze the variability relative to the seasonal cycle over the Intra-Americas Seas region with two different climate model versions, and to compare that variability with observational data

3. Methodology

Data

- Daily 850 hPa wind and precipitation data from two climate models; One with a Moisture Trigger that produces increased sensitivity to free tropospheric humidity, and one with No-Moisture Trigger.
- Daily 850 hPa data from observations for the years 1998-2006 that were obtained from the NCEP/NCAR Reanalysis data.

-Daily precipitation from 1998-2006 from TRMM 3B42 dataset

Methodology

-June through October climate model runs with CAM3/RAS were used to analyze how mean precipitation and precipitation variability changes when precipitation in the model is more sensitive to humidity above the boundary layer, and then compare the model runs to the observational data for that same period.

-The variability for the climate models and observations was determined by taking the variance relative to the seasonal cycle.

-Calculations and plotting were performed with the programming language NCL.

4. Results

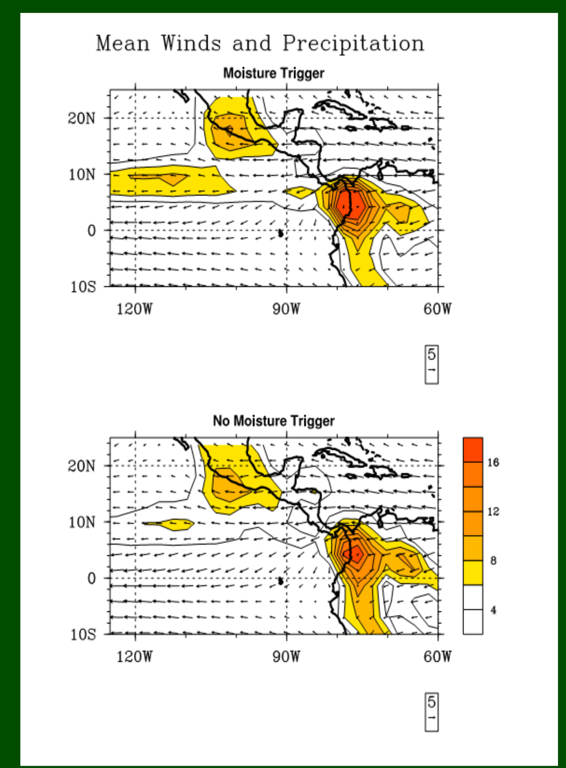

Fig 1. Mean 850 hPa Winds and precipitation for all seasons for the models

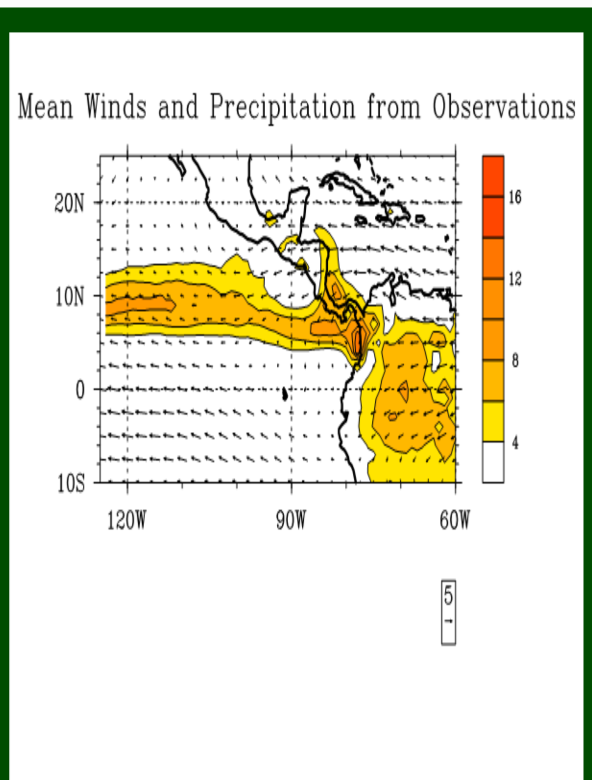

Fig.2. Mean 850 hPa winds and precipitation for all seasons for the observations.

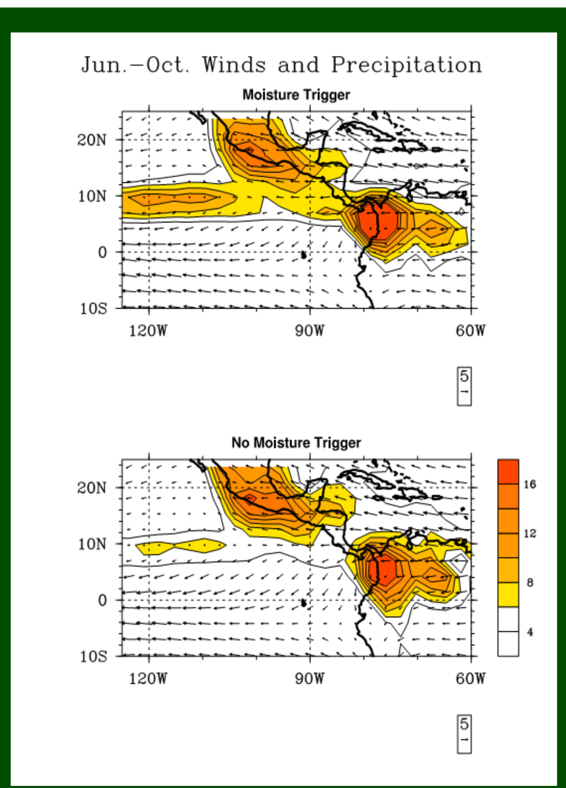

Fig.3 . Mean June-October 850 hPa winds and precipitation for the models.

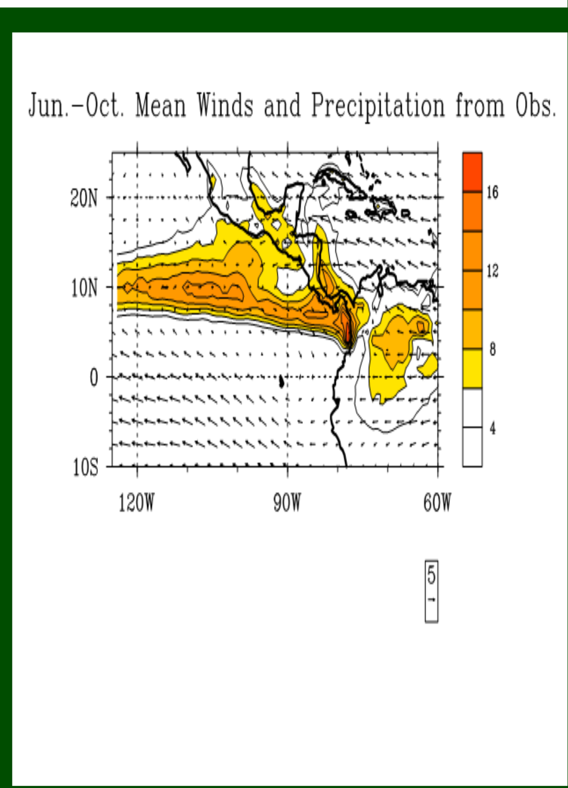

Fig.4. Mean June-October 850 hPa winds and precipitation for the observations.

-Figures 1 and 2 show mean 850 hPa precipitation and winds for all seasons, while figures 3 and 4 represent June-October means for the models and the observations, respectively. The plots show that the Moisture Trigger runs have the highest amounts of precipitation and that the observations look very similar to these runs in comparison to the No Moisture Trigger runs.

-The Moisture Trigger run creates higher mean precipitation in the east Pacific ITCZ, and slightly reduced precipitation in the Caribbean and near the base of the Sierra Madre. demonstrating modest improvements in the precipitation distribution with enhanced moisture triggering. However, substantial biases remain, some of which are likely due to the poor representation of topography in the model.

-The winds for observations and the models are strong (between 10-15 m/s) and predominantly from the east all through the Caribbean region, transitioning to weak monsoon flow over the TEP.

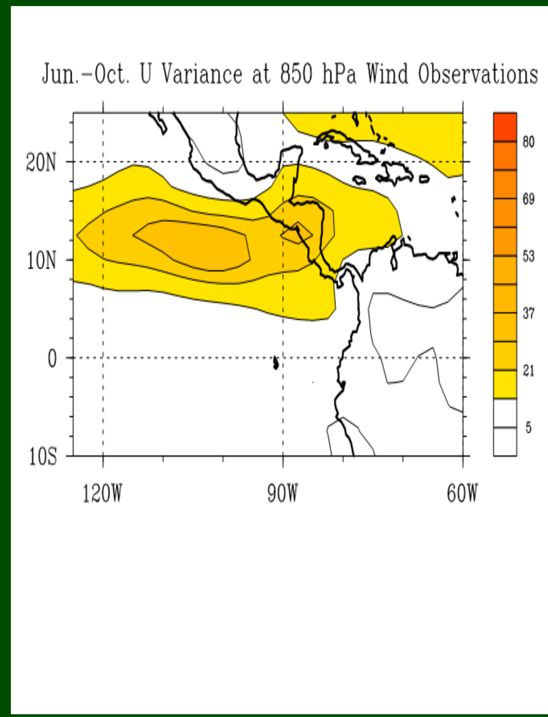

Fig.5. June-October 850 hPa zonal winds variance from the models.

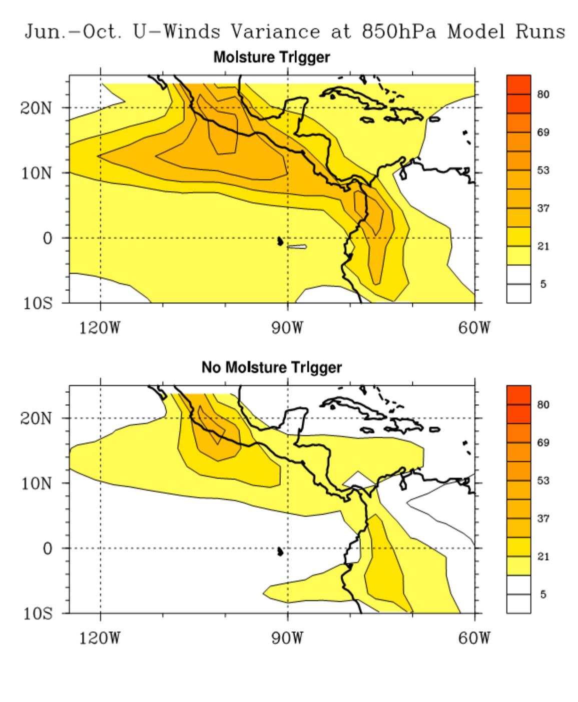

Fig.6. June-October 850 hPa zonal wind variance from the observations.

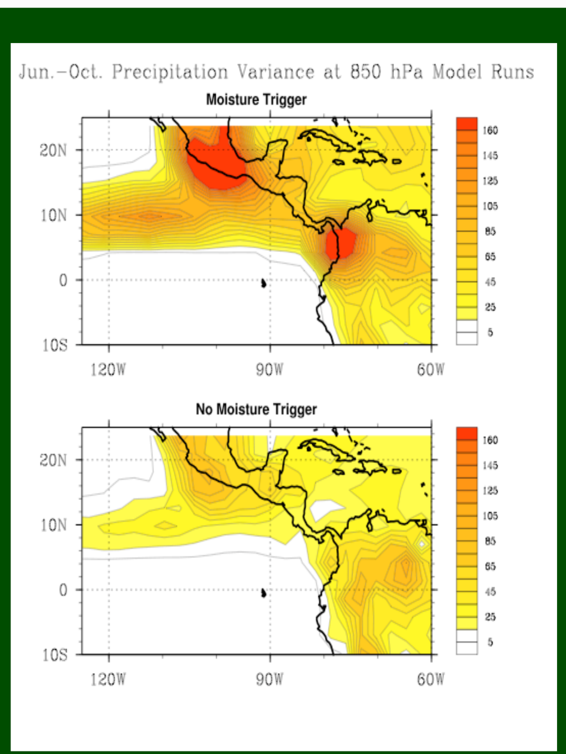

Fig.7. June-October precipitation variance from the models.

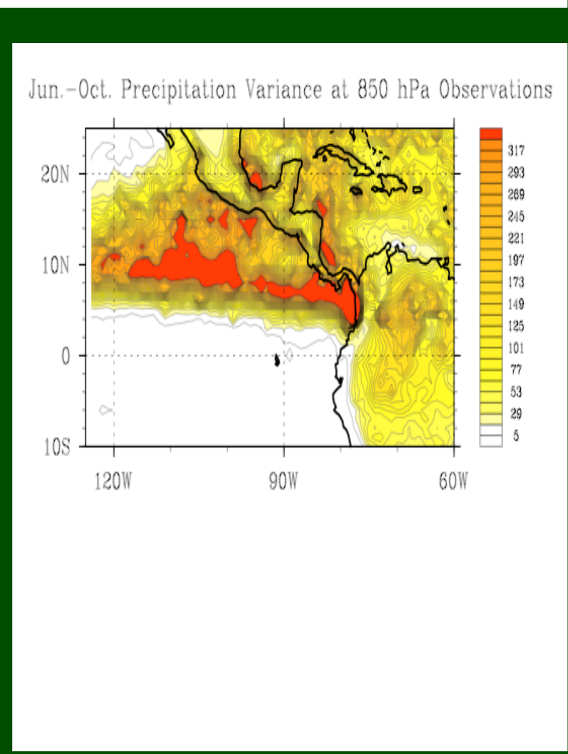

Fig.8. June-October precipitation variance from observations.

-The variance plots in Figures 5 – 8 represent the variance of each dataset about the June-October mean.

-Wind and precipitation variance is increases in the east Pacific in the run with the enhanced moisture trigger, with some modest improvements in the spatial distribution of such variance. Hence, making precipitation more sensitive to free tropospheric humidity appears to increase variance in the model. Variance in both precipitation and winds is too high in the models over southern Mexico, likely as a result of the poor representation of topography in those regions.

-Higher resolution simulations in which topography is better resolved may help to ameliorate some of these biases in variance.

5. Summary

-Daily 850 hPa winds and precipitation data from two model runs with different precipitation sensitivities to free tropospheric humidity were used to analyze variability in the east Pacific Ocean and Caribbean Sea. The climate model runs were then compared to data from observations for the years 1998-2006.

-Generally, climate models produce too much precipitation over the Caribbean, and these precipitation biases may affect their ability to simulate things like the Caribbean low-level jet and the easterly wave variability. The simulation with an enhanced moisture trigger slightly reduces precipitation biases in the Caribbean and east Pacific

-The simulation with enhanced moisture trigger exhibits stronger variance across the east Pacific as compared to the control simulation, with a better variance distribution compared to observations.

-Substantial model biases remain even with the enhanced moisture trigger employed, including excessive variance over southern Mexico, which may be contributed by the coarse representation of North and Central American topography.

-Future simulations will be conducted at higher horizontal resolution to determine whether these biases can be mitigated

6. Acknowledgements

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7. References

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