Effect of Enhanced Moisture Triggers on Mean Precipitation and Winds in the Tropical East Pacific and the Caribbean

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1. Introduction

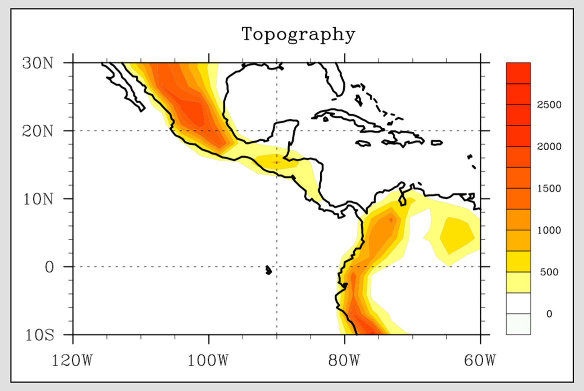

Figure 1. Representation of east Pacific and Caribbean orography in the model.

•Atmospheric General Circulation Models (AGCMs) have difficulty simulating precipitation and winds over the eastern Pacific and the Caribbean during boreal summer (Lee et al. 2007).

•Difficulties include inadequate spatial resolution to resolve details of the land-sea distribution and topography, deficiencies in parameterizations of atmospheric convection and cloud microphysics, and representation of the boundary layer.

•These deficiencies affect model ability to simulate weather phenomena like the Caribbean Low-Level Jet (CLLJ) and easterly wave variability in the Caribbean.

•Simulations are conducted here at T42 resolution (2.8° x 2.8°). Thus, the topography is coarsely resolved (Fig. 1).

2. Objective

•The aim of this study is to compare the ability of two climate model simulations to reproduce mean precipitation and winds in the east Pacific Ocean and Caribbean and the impact of implementing a moisture trigger for precipitation.

3. Data and Methodology

a. Observations

•Monthly mean wind data (1979-2009) were available from the National Centers for Environmental Prediction and the National Center for Atmospheric Research (NCAR) reanalysis dataset.

•Monthly mean precipitation (1998-2009) was obtained from the Tropical Rainfall Measuring Mission product (0.25° x 0.25°).

b. Model

•This study uses the NCAR Community Atmosphere Model (CAM) with the Relaxed Arakawa-Schubert (RAS) convection scheme (Moorthi and Suarez 1992, Maloney and Esbensen 2005).

•A minimum entrainment rate of environmental air is prescribed such that $\mu_{min}=\alpha/D$, where α is a dimensionless constant and D is the depth of the boundary layer (Tokioka et al. 1988).

•The two runs analyzed were defined as: “no moisture trigger” (α=0.0) and “moisture trigger” α=0.6 .

4. Analysis of enhanced moisture sensitivity

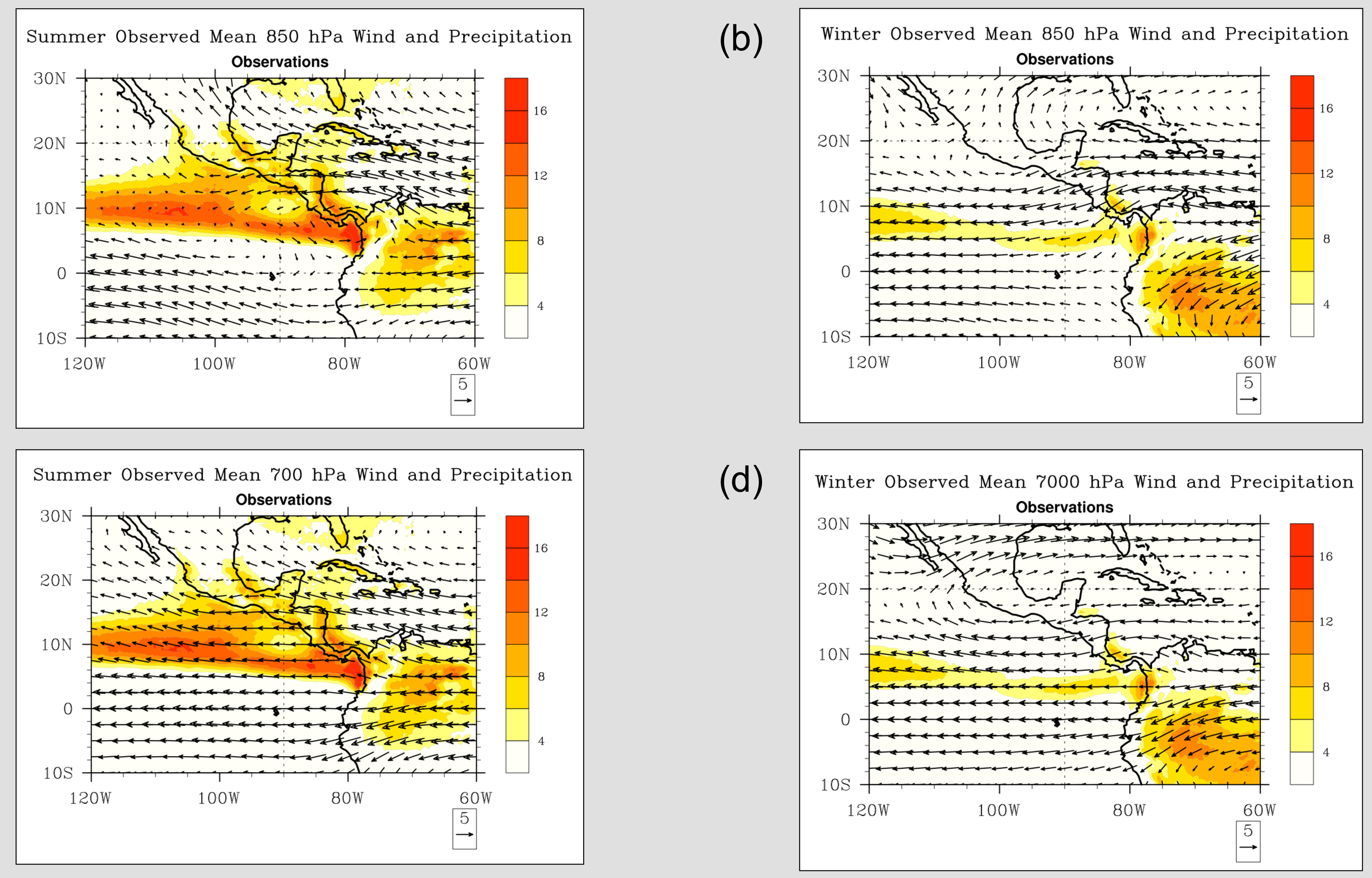

Figure 2. Observed Mean 850 hPa zonal wind and precipitation for (a) June-October, and (b) November-April. Observed Mean 700 hPa zonal wind and precipitation for (c) June-October, and (d) November-April. The reference wind vector (ms^{-1}) of each plot is located at the bottom right.

•When comparing to observations (Fig. 2a), the moisture trigger run does a more reasonable job in reproducing the mean precipitation distribution (Fig. 3a), although substantial biases remain.

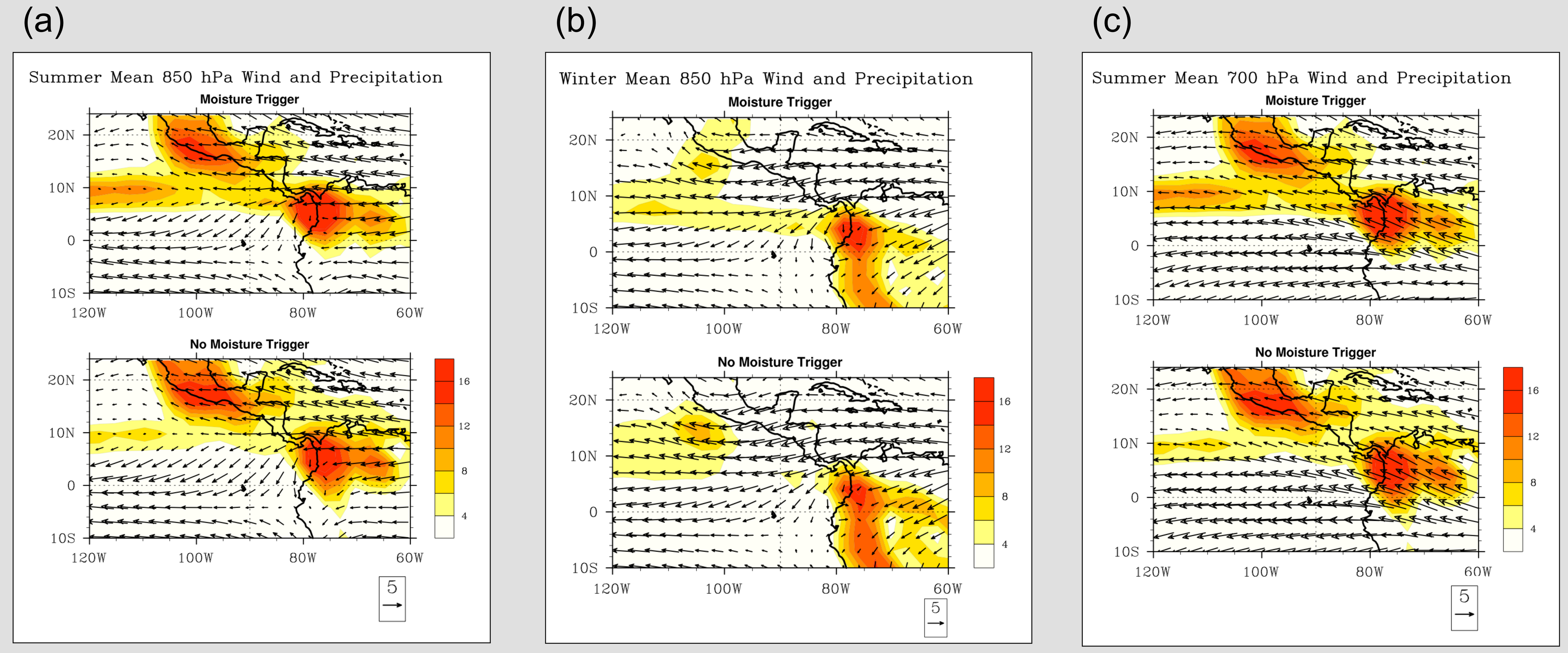

Figure 3. Mean 850 hPa zonal wind and precipitation for runs α = 0.6 (top) and α = 0.0 (bottom) *of each plot for (a) June-October, and (b) November-April. (c) Summer Mean 700 hPa zonal wind and precipitation for model runs. The reference wind vector (ms^{-1}) is located at the bottom right.*

•As seen in Fig. 3a and Fig. 3c, both model runs produce excessive summertime precipitation over Mexico and Northern South America likely due to the coarse resolution.

•For the summer season (Fig. 4), the run with higher moisture sensitivity reduces precipitation over the Caribbean region and increases it in the east Pacific ITCZ, making it more realistic compared to observations (Fig. 2a).

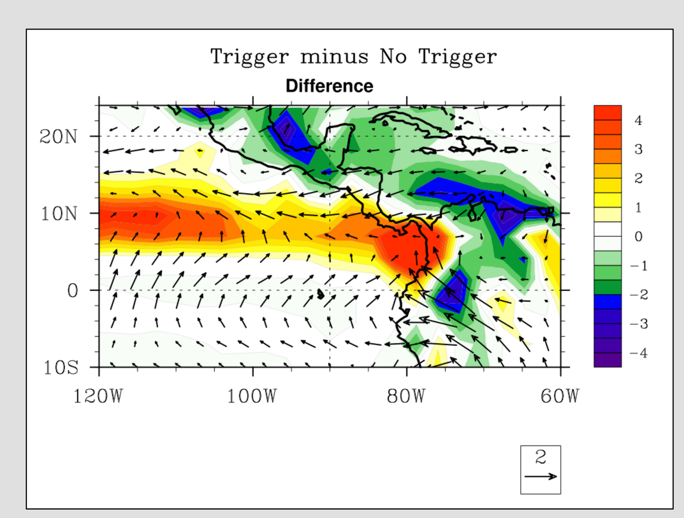

Figure 4. Differences between moisture trigger and no moisture trigger for the summer season at 850 hPa.

5. Conclusions

•Results for the summer season show that a moisture trigger makes precipitation weaker over the Caribbean, and reduces precipitation biases over the eastern Pacific and over land.

•Both model runs (control and moisture trigger) show excessive precipitation over land likely due to the coarse resolution of the model.

•Overall, higher moisture sensitivity results in an improved ability of the model to represent mean precipitation over the eastern Pacific and Caribbean.

• The low-level wind is not well represented along the coastlines in the models, likely due to problems in representing topography.

•The winds become more cyclonic over the eastern Pacific associated with increased mean precipitation there in the moisture trigger run, and enhanced easterlies over the Caribbean are associated with a decrease of precipitation.

•Differences in mean winds are relatively slight between both models.

6. References

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7. Acknowledgements

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