W258B

THE RELATIONSHIP BETWEEN CARIBBEAN PRECIPITATION, SEA SURFACE TEMPERTURE, AND LARGE-SCALE VERTICAL MOTION IN IPCC AR4 MODELS

Elinor Martin* and Courtney Schumacher

Department of Atmospheric Sciences, Texas A&M University

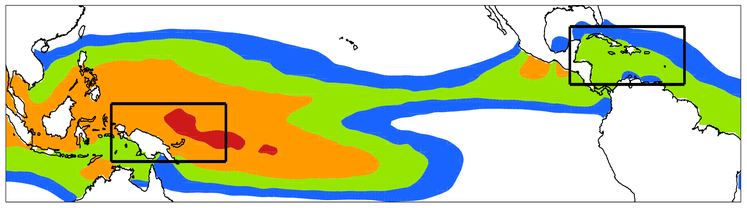
*emartin@atmos.albany.edu (Current Affiliation: Department of Atmospheric and Environmental Sciences, SUNY Albany)

1. Introduction

The Caribbean is part of the Atlantic Warm Pool (AWP) with SSTs exceeding 28.5°C. IPCC AR4 coupled models show a large cold AWP bias (Misra et al. 2009), while underestimating Caribbean precipitation. Conversely, uncoupled models overestimate Caribbean precipitation (Biasutti et al. 2006; Martin and Schumacher 2011).

In the West Pacific Warm Pool (WPWP), SSTs are higher and have a greater spatial extent than the AWP. The well known double ITCZ structure over the tropical Pacific is a major problem in the IPCC AR4 WPWP simulations.

Correctly representing large-scale vertical circulations (represented by ω_{500}) is essential for reproducing heat and moisture transport. The relationship between precipitation, SST, and ω_{500} will be investigated using the regime sorting (compositing) technique of Bony et al. (2004) to determine the source of the precipitation errors.



Annual mean SST (from HadISST), beginning at 26.5°C with intervals of 1°C. Black boxes indicate averaging regions for the West Pacific and Caribbean.

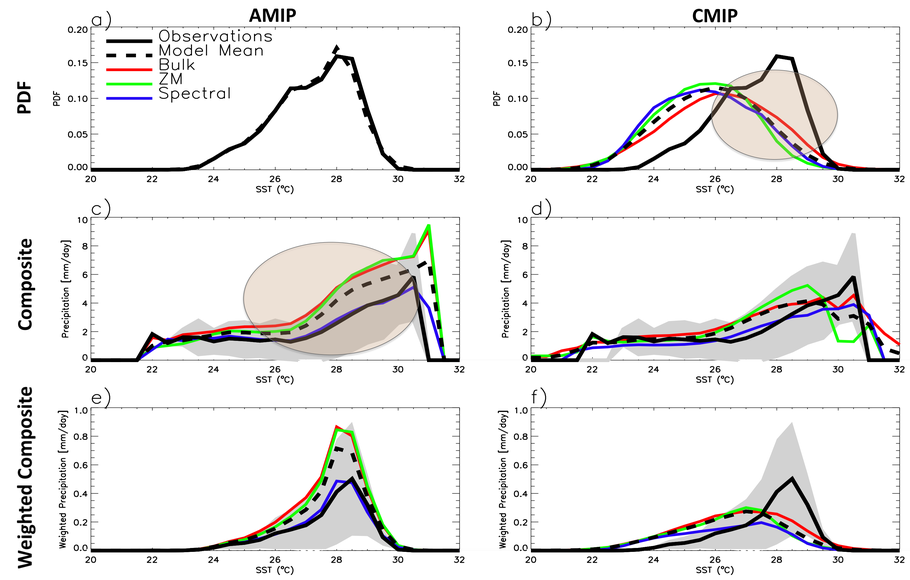
2. Data and Methods

- Monthly, 1979-2009
- Observations: GPCP (2.5°) *All data regridded to GPCP grid
  HadISST
  NCEP/DOE Reanalysis II
- IPCC AR4 Models: coupled 20th century (CMIP) 20 models
  uncoupled (AMIP) 11 models

Convective parameterizations of models. Model names in italics indicate both CMIP and AMIP data were used. Asterisk indicates models where ω was not available

Convective Parameterization	Model
Bulk	*CNRM*, CSIRO 3.0*, CSIRO 3.5*, GISS EH, *GISS ER*, INGV, MIUB*, *MPI **, UKMO HADCM, *UKMO HADGEM*
Spectral	GFDL 2.0, *GFDL 2.1, MIROC HI, MIROC MED,MRI*
Zhang & McFarlane	CCCMA, CCCMA T63, *IAP FGOALS, NCAR CCSM, NCAR PCM*

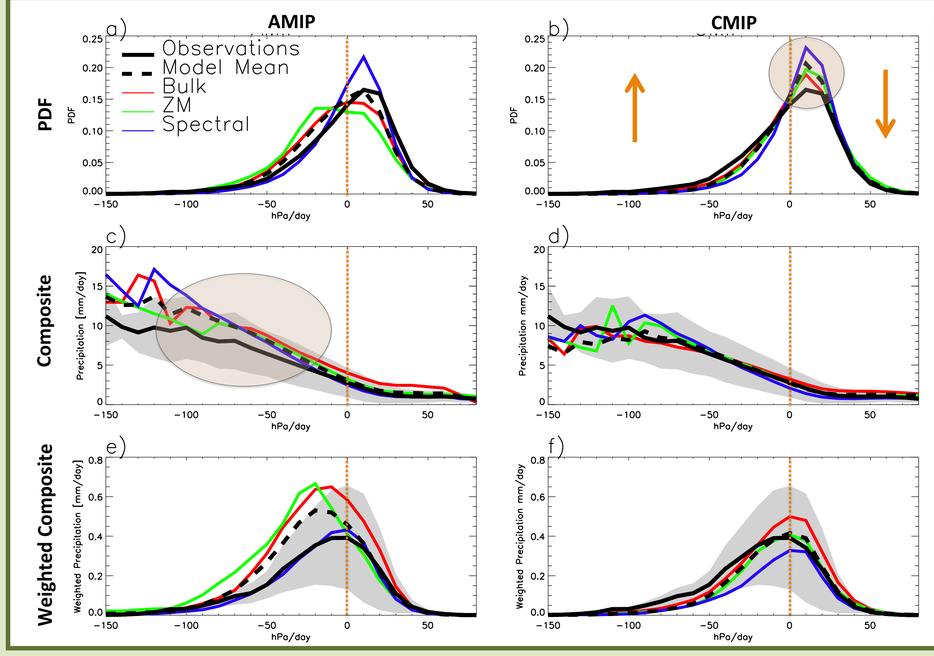
3. Regime Sorting Analysis: SST



*Caribbean (AWP) regime sorting analysis for precipitation and **SST**. Shading indicates +/- 1 standard deviation of observations.*

- Major AWP cold bias evident in majority of CMIP models causes underestimation of precipitation, particularly above 28°C
- Too much rainfall for a given SST above 26°C
- Oversensitivity of precipitation to SST dominant factor in AMIP models overestimating Caribbean rainfall
- Spectral type convective parameterizations performing better than either bulk or ZM type parameterizations in AMIP
- Similar results in WPWP

4. Regime Sorting Analysis: Vertical Motion



*Caribbean (AWP) regime sorting analysis for precipitation and **ω_{500}**. Shading indicates +/- 1 standard deviation of observations.*

- Subsidence regimes too frequent in spectral convective parameterization simulations
- AMIP overestimates and CMIP underestimates upward motion
- Precipitation too sensitive to vertical motion
- AMIP precipitation overestimation: too much precipitation at given vertical circulation
- CMIP precipitation underestimation: Infrequent deep convection occurrence
- WPWP results similar, but CMIP ω_{500} distribution is shifted to a downward motion regime causing a large underestimation of rainfall between 0 and -75 hPa/day.

5. Conclusions

- Regime sorting analysis shows oversensitivity of precipitation to SST and vertical motion is inherent to the atmospheric models in both regions
- Models using a spectral type convective parameterization perform best in the Caribbean but less separation between parameterization groups is seen in the West Pacific
- In coupled models, errors in the frequency of occurrence of SSTs (cold biased) and deep convective vertical circulations (reduced frequency) lead to an underestimation of warm pool mean precipitation

FOR FURTHER DETAILS: Martin, E.R. and C. Schumacher, 2011: The Relationship Between Tropical Warm Pool Precipitation, Sea Surface Temperature, and Large-Scale Vertical Motion in IPCC AR4 Models. *J. Atmos. Sci*. In Press.