



**Lower Tropospheric Processes; A Control on The Global Mean Precipitation Rate**

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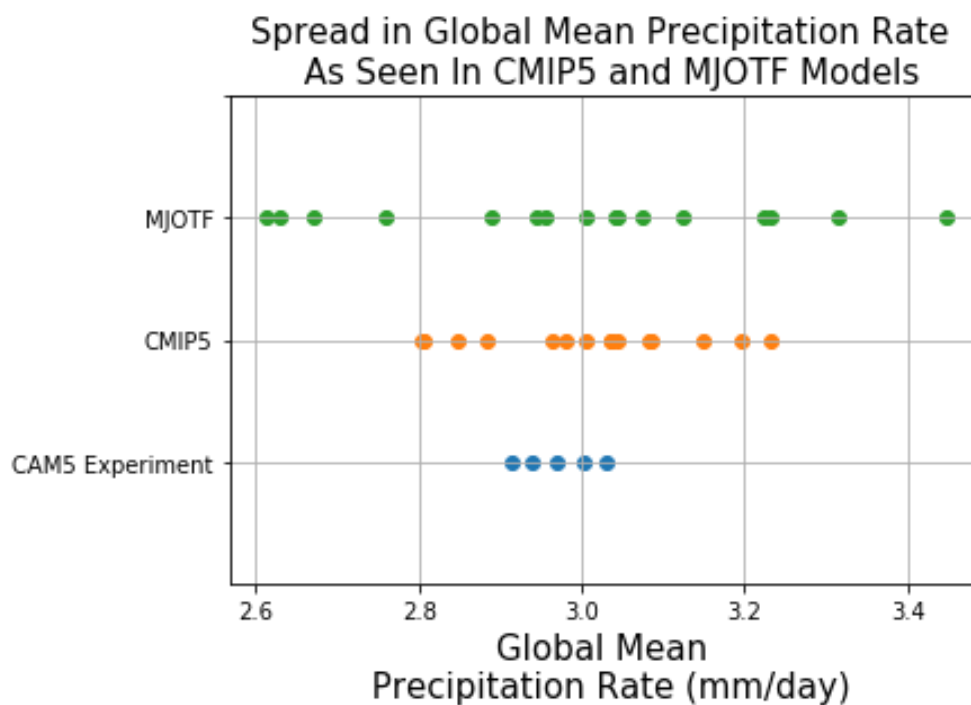
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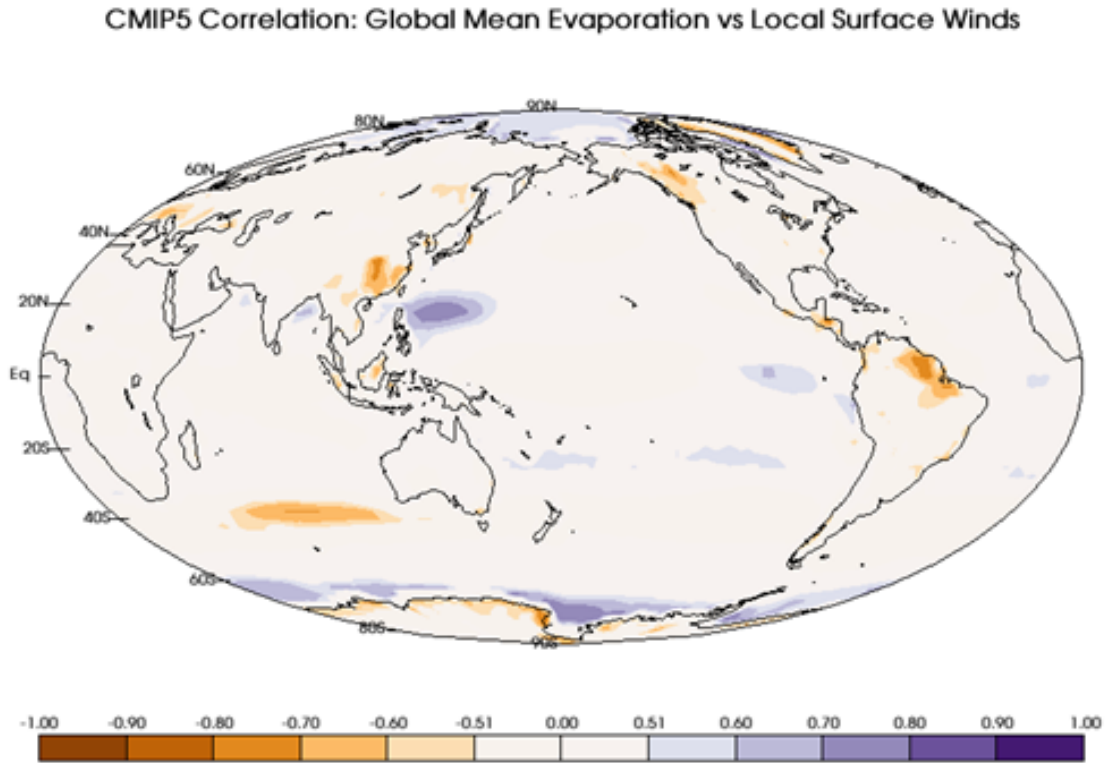
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**Introduction**

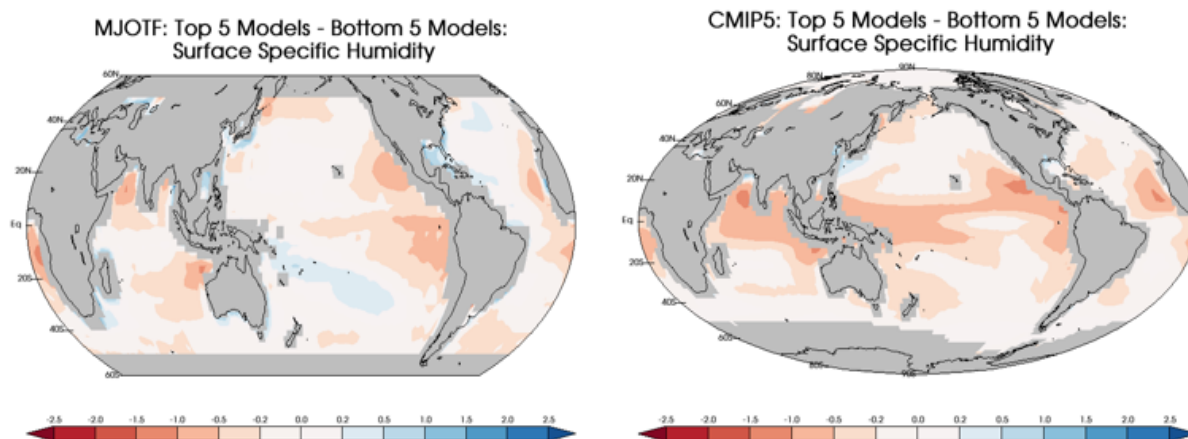
This document contains the supplemental figures referenced in the main manuscript



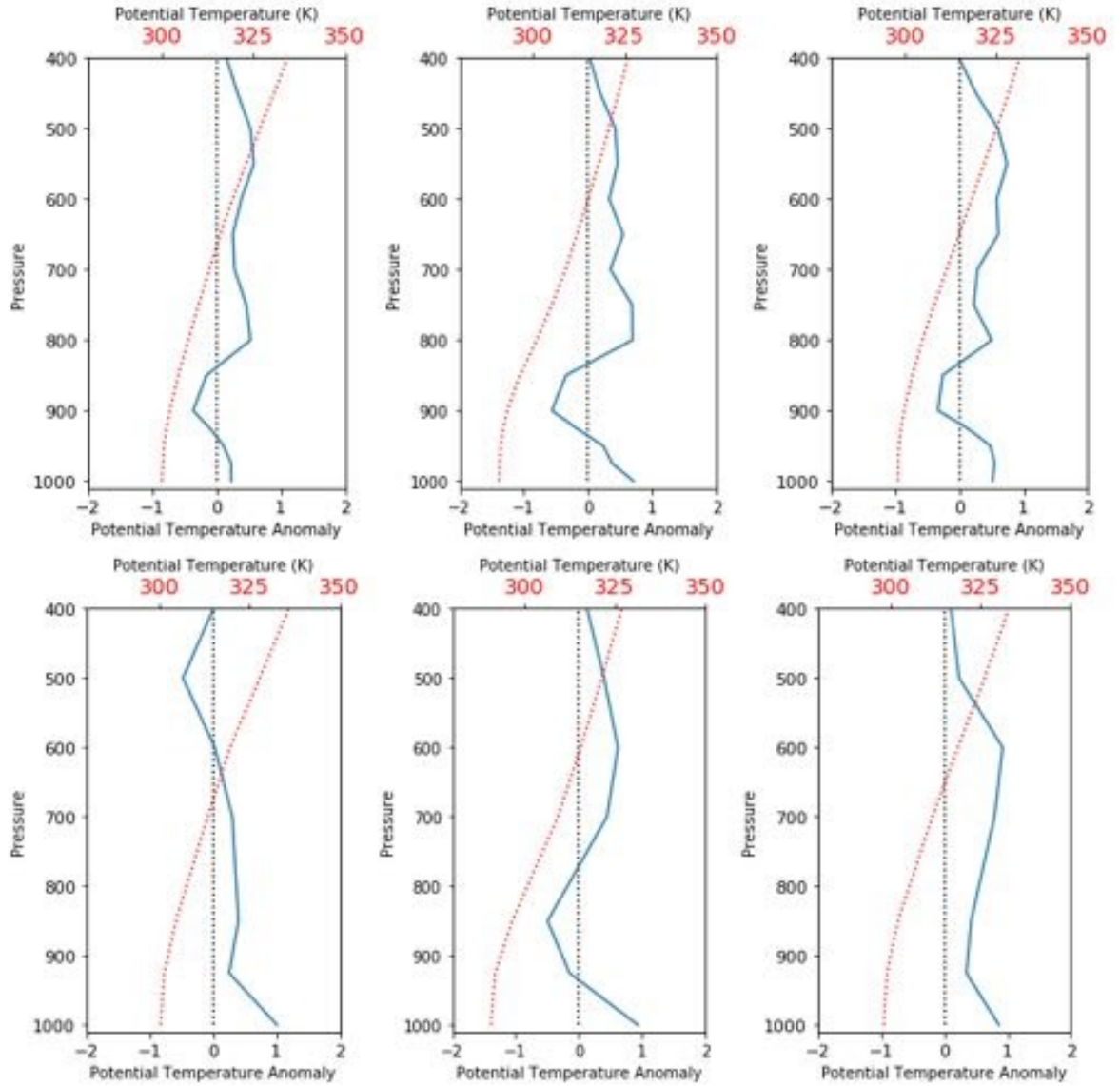
**Figure S1.** The global mean precipitation rate from atmosphere-only climate model simulations participating in the MJO Task Force intercomparison (MJOTF - green), the Atmospheric Model Intercomparison Project of CMIP5 (CMIP5 - orange), and from five configurations of the CAM5 model where the threshold relative humidity for stratiform low clouds ( $rh_{minl}$ ) is perturbed (blue).



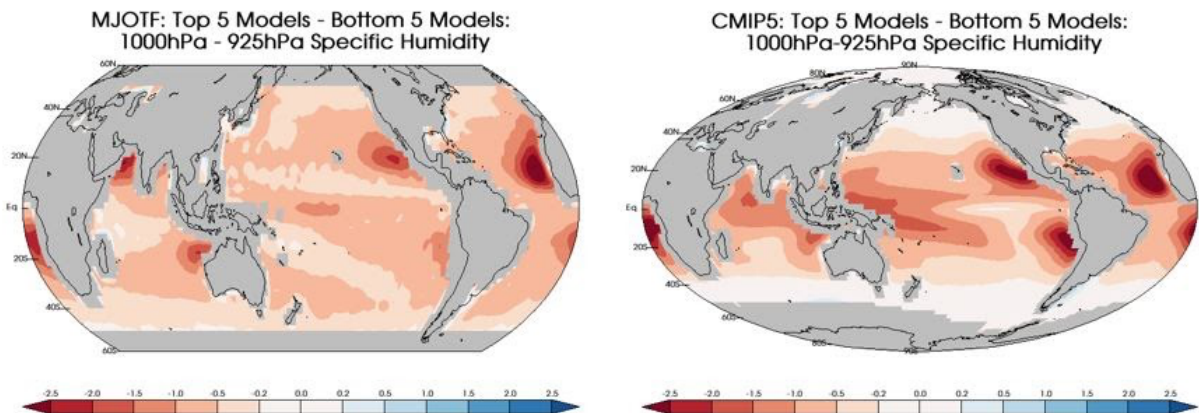
**Figure S2.** Correlation map of the global mean precipitation rate from climate models participating in the Atmospheric Model Intercomparison Project of CMIP5 vs time averaged near surface winds. Correlations with magnitudes below 0.51 are in gray because they are not significant at the 95% level for a sample size of fifteen.



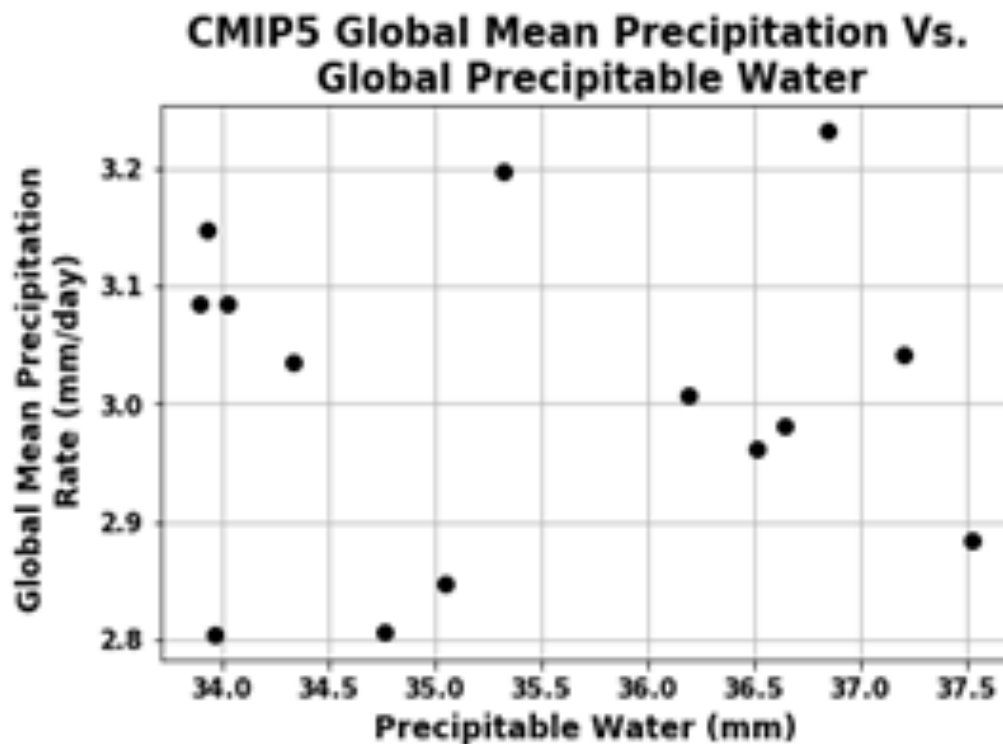
**Figure S3.** Time averaged surface specific humidity anomalies derived from climate models participating in the MJO Task Force intercomparison (MJOTF - left) spanning 1991 to 2010, and from climate models participating in the Atmospheric Model Intercomparison Project of CMIP5 (CMIP5 - right ) spanning 1991 to 2005



**Figure S4.** Time averaged potential temperature anomalies over the SPCZ, a region of persistent stratocumulus clouds and a region characterized by trade cumulus clouds (oriented from left to right). They are derived from climate models participating in the MJO Task Force intercomparison (MJOTF - top) spanning 1991 to 2010, and from climate models participating in the Atmospheric Model Intercomparison Project of CMIP5 (CMIP5 - Bottom) spanning 1991 to 2005.



**Figure S5.** Time averaged anomalies of the lower tropospheric mixing metric, defined as the specific humidity gradient between 1000hPa and 925hPa, derived from climate models participating in the MJO Task Force intercomparison (MJOTF - left) spanning 1991 to 2010, and from climate models participating in the Atmospheric Model Intercomparison Project of CMIP5 (CMIP5 - right) spanning 1991 to 2005.



**Figure S6.** The global mean precipitation rate from climate models participating in the Atmospheric Model Intercomparison Project of CMIP5 plotted against global precipitable water. A consistent ocean mask is used across the MJOTF and CMIP5 models to compute these averages.

<b>CMIP5</b>	<b>GMP/ <math>\sigma</math> (<math>mm\ d^{-1}</math>)</b>	<b>MJOTF</b>	<b>GMP/ <math>\sigma</math></b>
Miroc5	3.23	CWB-GFS	3.45
ACCESS1-3	3.20	GISS-E2	3.31
GISS-E2-R	3.15	MIROC5	3.22
ACCESS1-0	3.09	NCEPCPC-CFS2	3.23
Hadgem2-A	3.08	MetUM-GA3	3.12
<b>Top 5 Multi-Model Mean</b>	3.15	<b>Top 5 Multi-Model Mean</b>	3.27
<b>Top 5 Model <math>\sigma</math></b>	0.06	<b>Top 5 Model <math>\sigma</math></b>	0.11
IPSL-CM5A-LR	2.81	NavGEM1	2.61
CanAM4	2.80	ECGEM	2.63
IPSL-CM5B-LR	2.85	BCC-AGCM2.1	2.67
NORES1-M	2.88	FGOALS-s2	2.76
CCSM4	2.96	ISUGCM	2.89
<b>Bottom 5 Multi-Model Mean</b>	2.86	<b>Bottom 5 Multi-Model Mean</b>	2.71
<b>Bottom 5 Model <math>\sigma</math></b>	0.06	<b>Bottom 5 Model <math>\sigma</math></b>	0.10
CESM1-CAM5	3.04	GMAO_GEOS5	2.94
CNRM-CM5	3.04	MRI-AGCM	3.01
GFDL-CM3	3.04	NCAR-CAM5	3.04
MPI-ESM-LR	2.98	CNRM-AM	3.04
MPI-ESM-MR	3.01	LLNL-CAM5	3.07
		SMHI-ecearth3	2.95

**Table S1.:** Global mean precipitation rate (GMP), 5 model mean and 5 model standard deviation from the top 5 and bottom 5 CMIP5(left column) and MJOTF(right Column) AMIP ensemble members. The rest of the ensemble members, from each ensemble, are also listed below the bottom 5 model standard deviation.

<b>CAM5 Model Experiment</b>			
<b>Model Configuration</b>	<b>RH Threshold for the Formation of Low-Clouds</b>	<b>GMP(<math>mm\ d^{-1}</math>)</b>	<b><math>\Delta q</math> Averaged over Tropical Oceans (<math>g\ kg^{-1}</math>)</b>
Rhmin81	81%	3.03	1.74
Rhmin85	85%	3.00	1.83
Rhmin8875	88.75%	2.97	1.92
Rhmin925	92.5%	2.94	2.06
Rhmin965	96.5%	2.91	2.15

**Table S2.** Five CAM5 model experiment configurations, relative humidity thresholds for the formation of low-level clouds(rhminl), global mean precipitation rate and the lower tropospheric mixing metric ( $\Delta q$ ) averaged over tropical oceans.