



**Sub-daily temperature and precipitation extremes  
in T85 SP-CAM simulations  
for present and RCP8.5 SSTs**

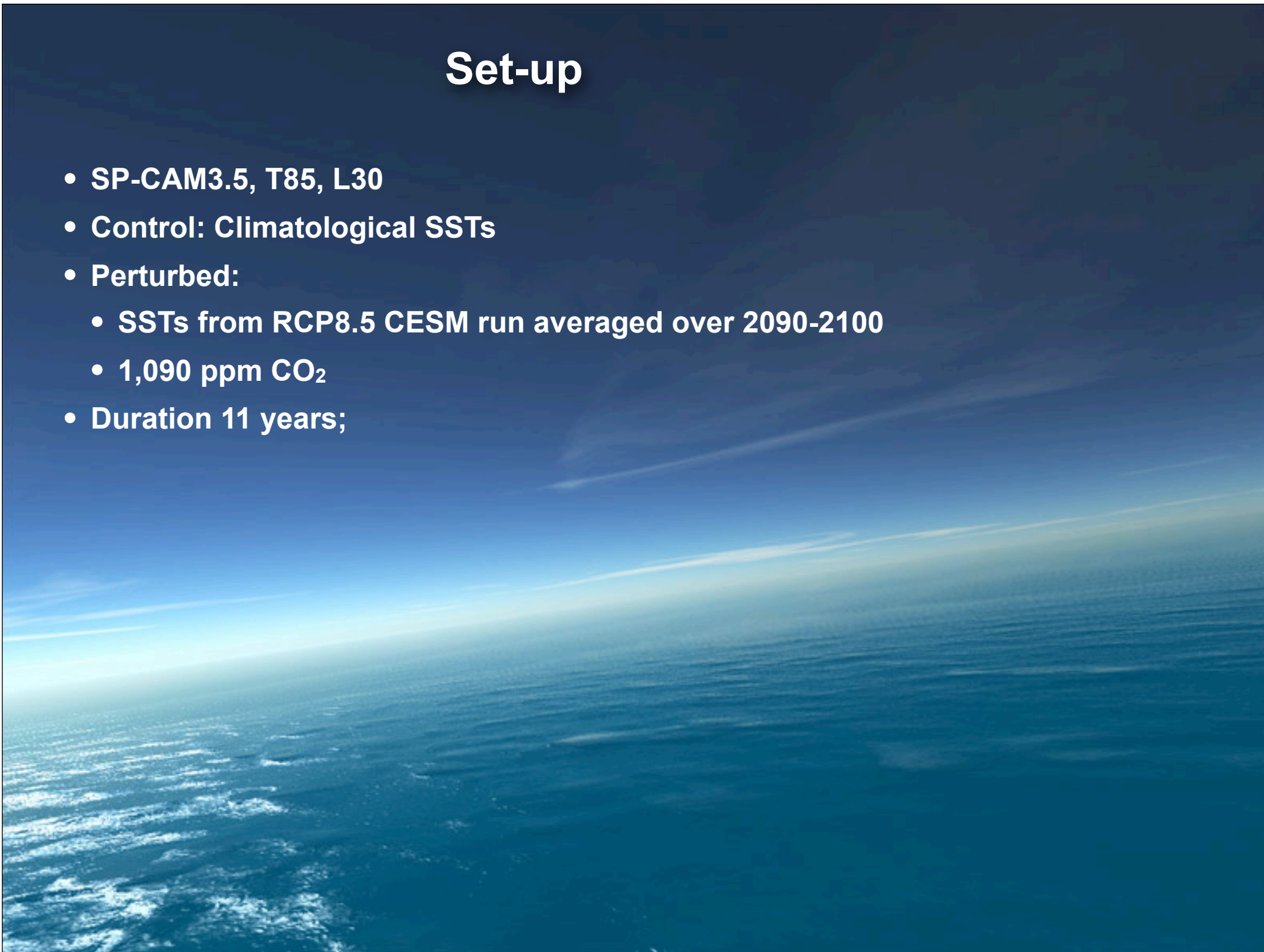
**Xin Zhou and Marat Khairoutdinov**

**Stony Brook University**



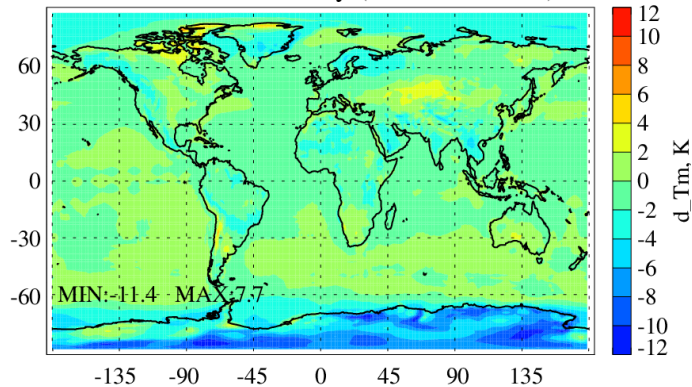
# Set-up

- **SP-CAM3.5, T85, L30**
- **Control: Climatological SSTs**
- **Perturbed:**
  - **SSTs from RCP8.5 CESM run averaged over 2090-2100**
  - **1,090 ppm CO<sub>2</sub>**
- **Duration 11 years;**

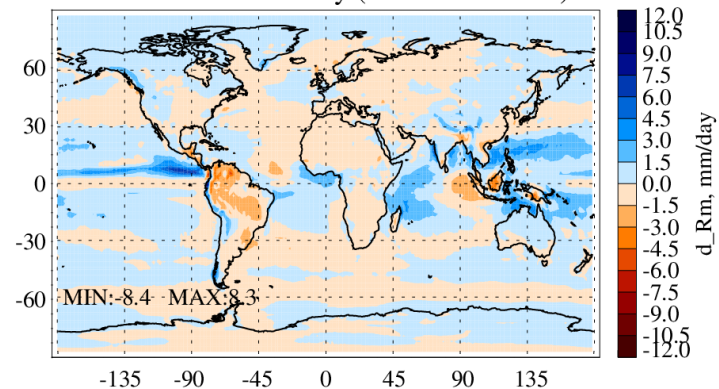


# Control vs Obs

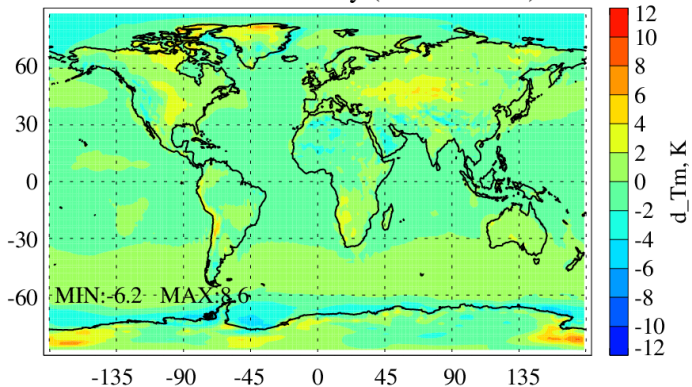
Difference in Tm daily (SPCAM - ERA)



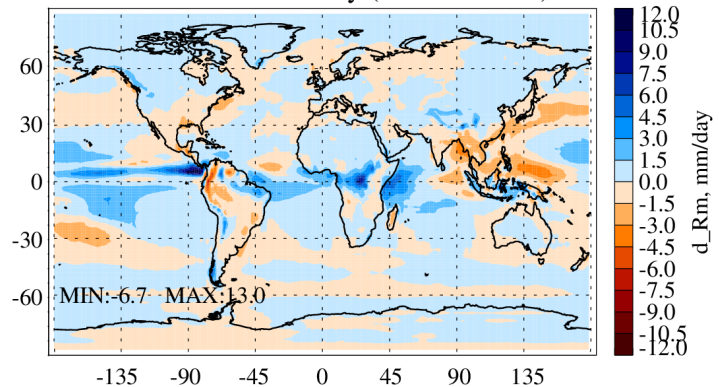
Difference in Rm daily (SPCAM - GPCP)



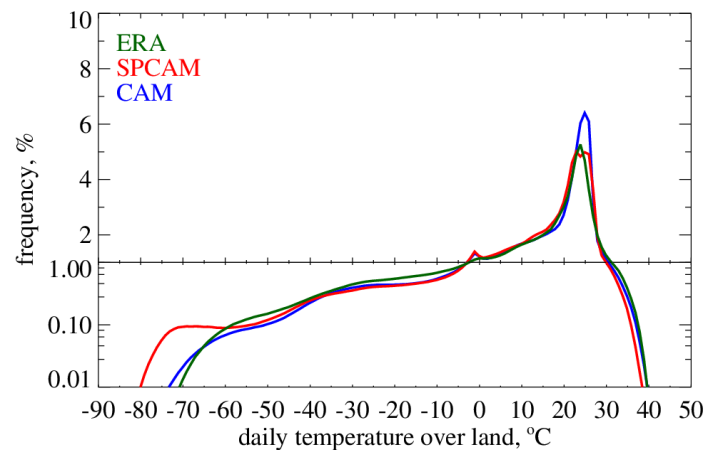
Difference in Tm daily (CAM - ERA)



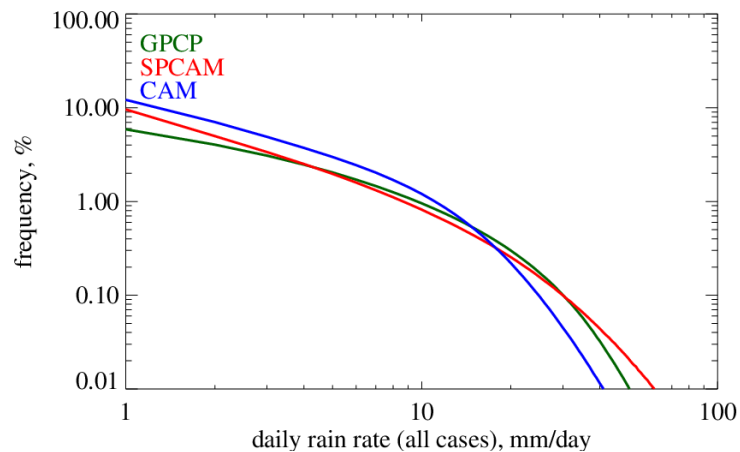
Difference in Rm daily (CAM - GPCP)



pdf of daily mean temp over land

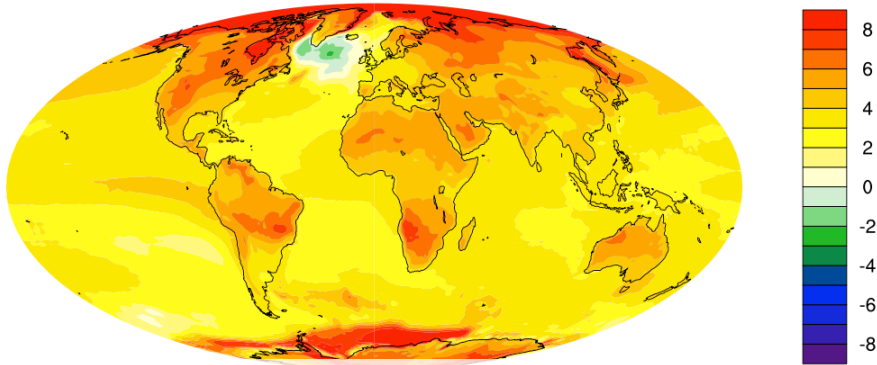


pdf of daily mean precipitation

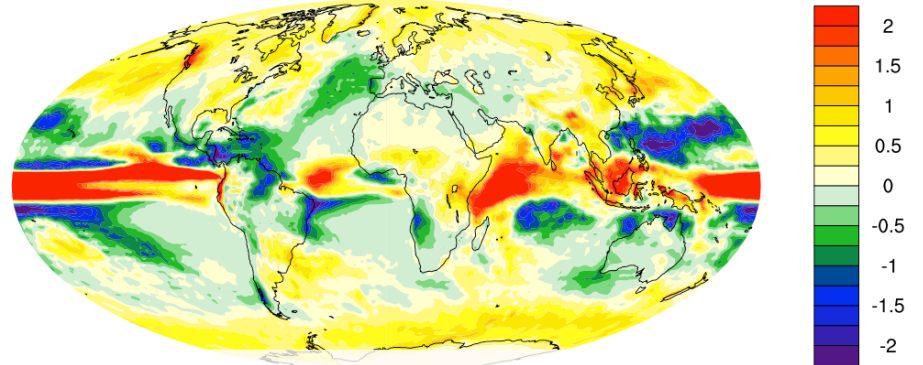


# Mean Annual Change

## Surface Temperature, K



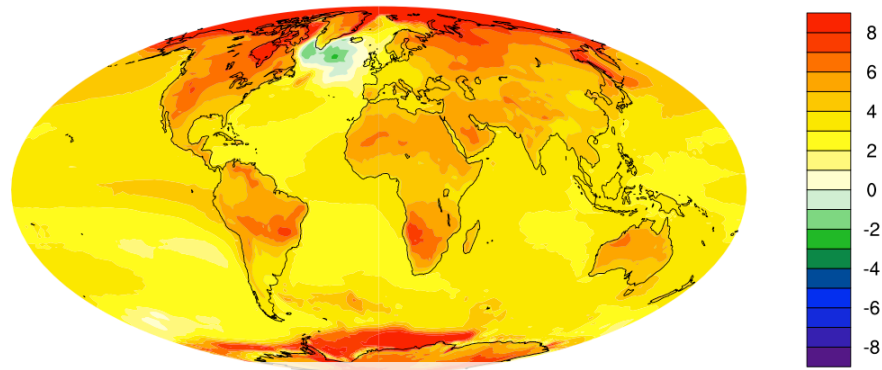
## Rainfall, mm/d



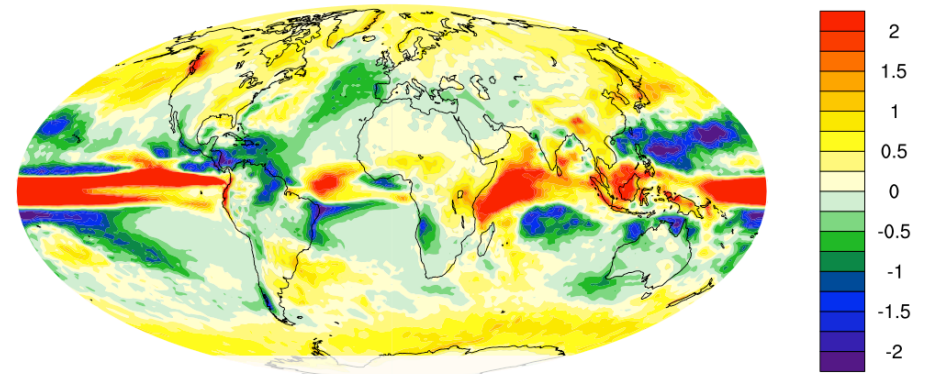
	RCP8.5 minus Control									
	Global			Tropics			Mid-Lat			High-Lat
	Total	Land	Ocean	Total	Land	Ocean	Total	Land	Ocean	Total
SFC Temp, K	4.1	6.1	2.6	3.6	4.8	3.1	3.8	6.5	3.0	6.6
Rainfall, mm/d	0.24 (8.2)	0.23	0.20	0.21 (6.0)	0.12	0.25	0.21 (8.0)	0.09	0.20	0.41 (30.3)
PW, mm	8.35 (33.2)	7.19	8.68	11.97 (32.7)	10.74	12.48	5.53 (33.0)	6.30	5.86	2.95 (44.7)
NET TOA, W/m <sup>2</sup>	0.22	2.42	-2.3	1.40	2.16	1.10	-0.40	6.90	-0.72	-2.39
NET CF, W/m <sup>2</sup>	-1.01 (3.6)	-0.75	-0.60	0.36 (-1.3)	2.51	-0.53	-0.54 (1.64)	0.58	0.20	-7.38 (63.5)



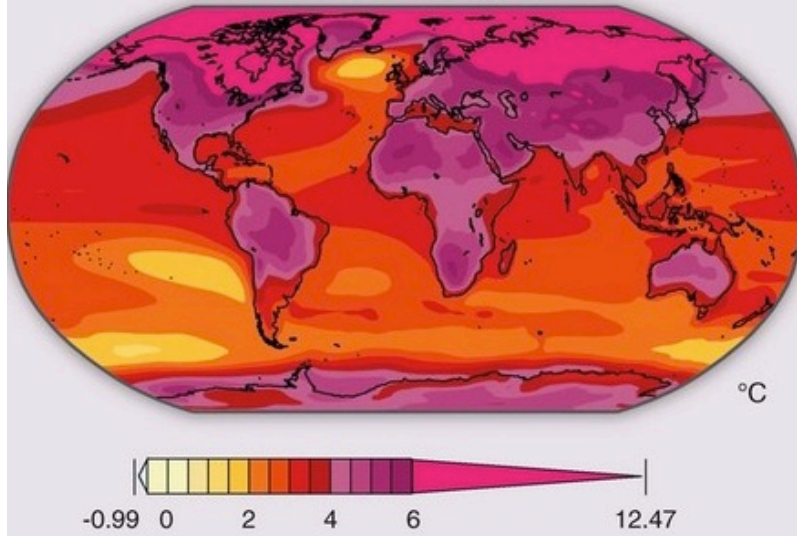
Surface Temperature, K



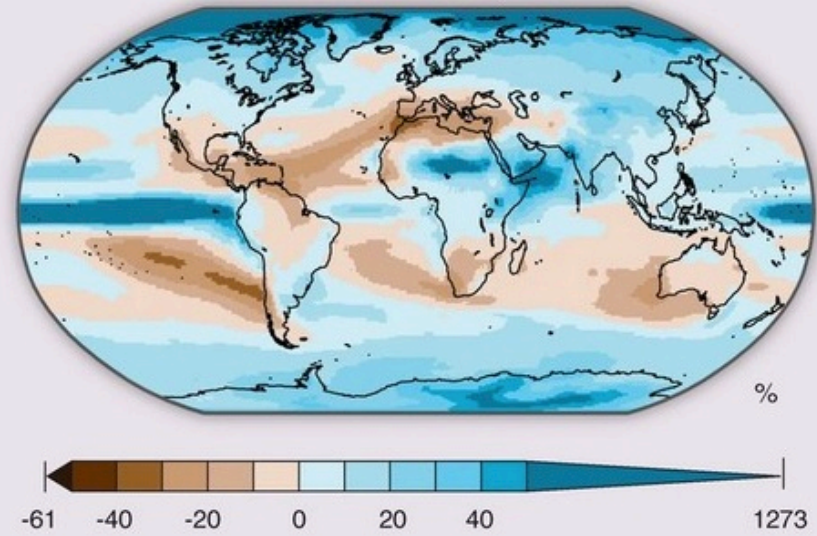
Rainfall, mm/d



CMIP5 late-21st-century RCP8.5



CMIP5 late-21st-century RCP8.5



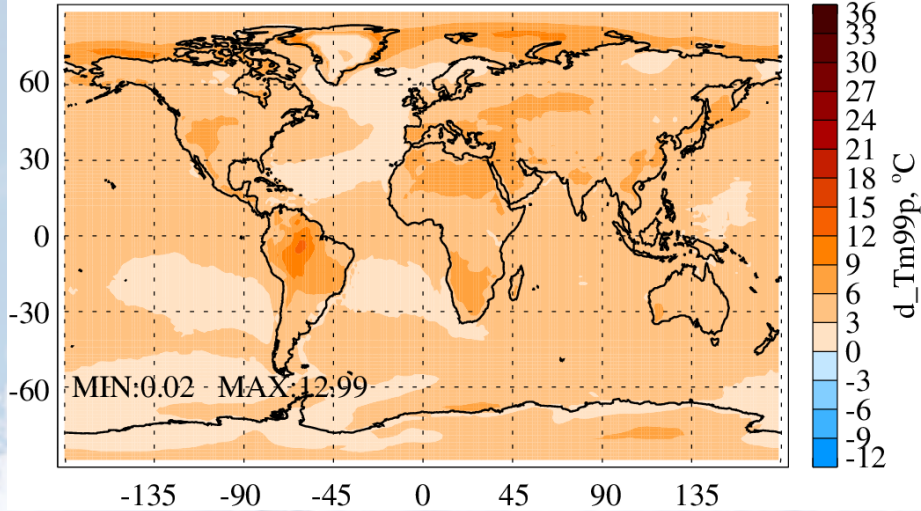
# 3-hourly extremes

- **Extremes: cases exceed 99<sup>th</sup> percentile of a variable in the simulated period.**
  - Comparable across different regions
  - Sample the same portion of distribution
  - Moderate, reoccur on a yearly basis
- **Precipitation**
  - All cases
  - Wet cases only (>0.1 mm/h)

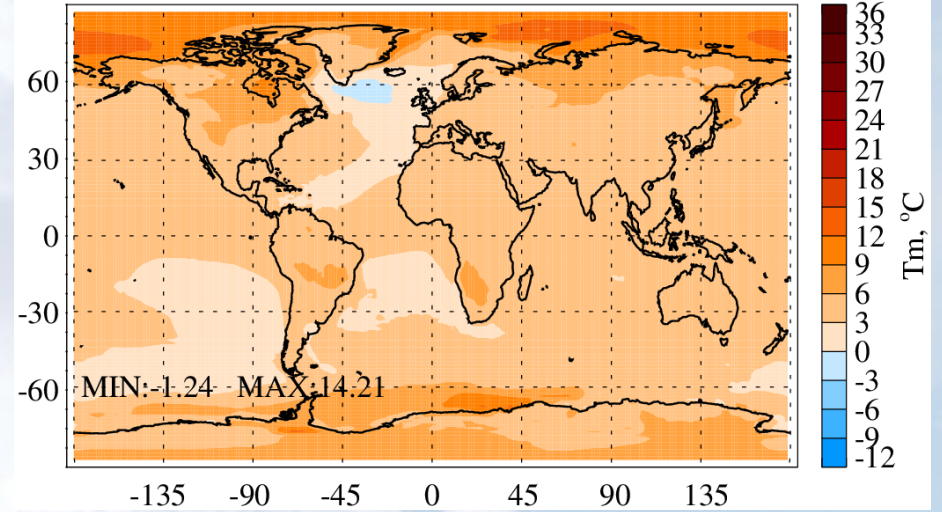


# Temperature Extremes

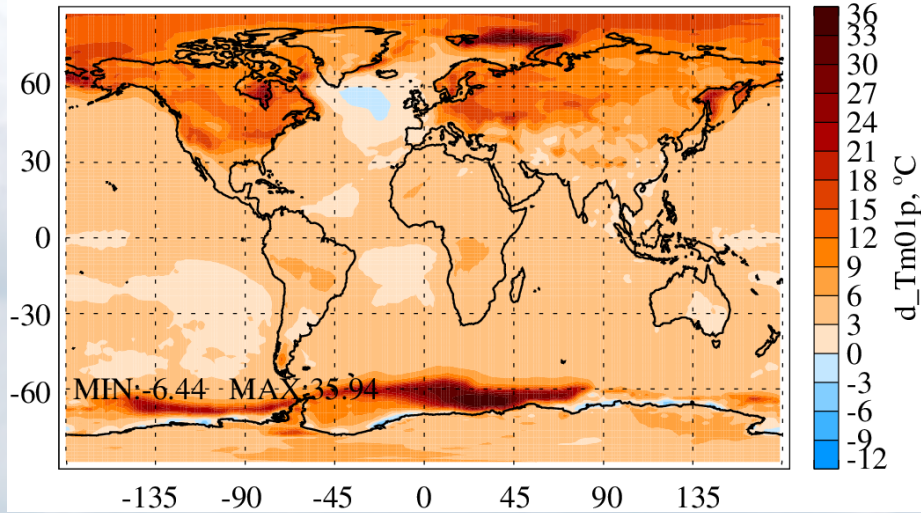
### Change in Tm99p (RCP8.5 - CTL)



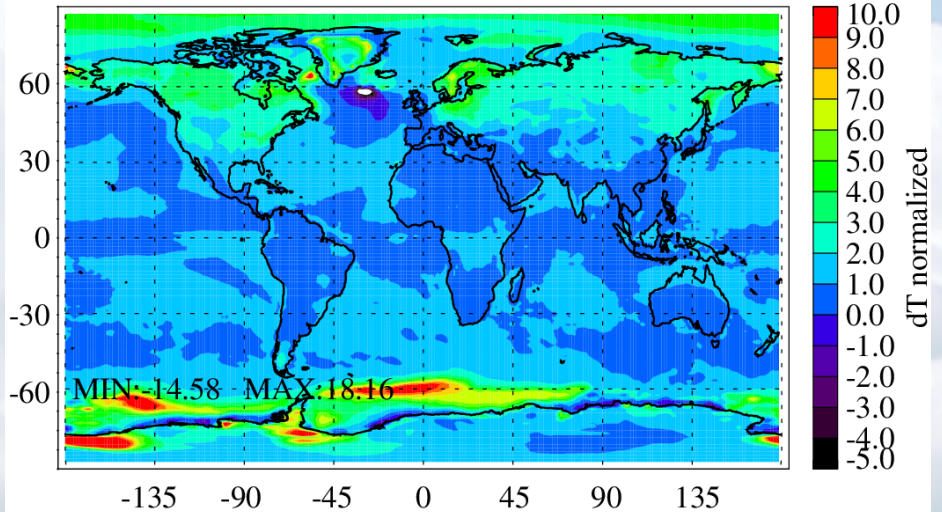
### Change in Tm (RCP8.5 - CTL)



### Change in Tm01p (RCP8.5 - CTL)

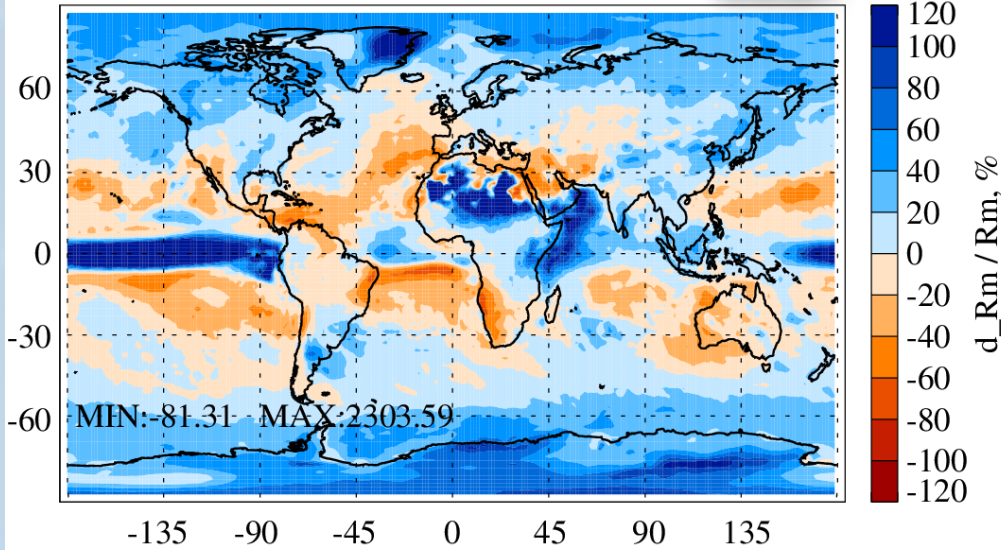


### $d\_Tm01p / d\_Tm99p$

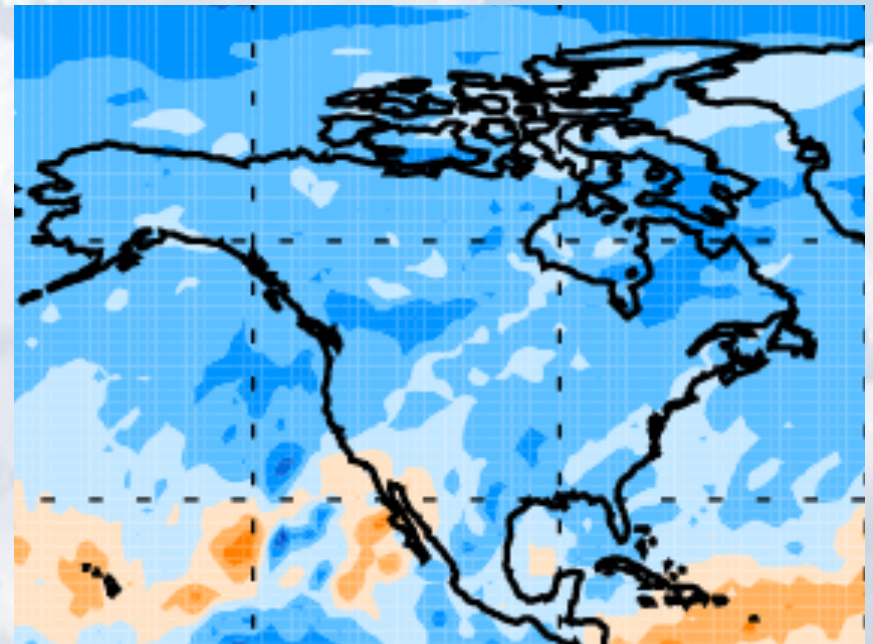
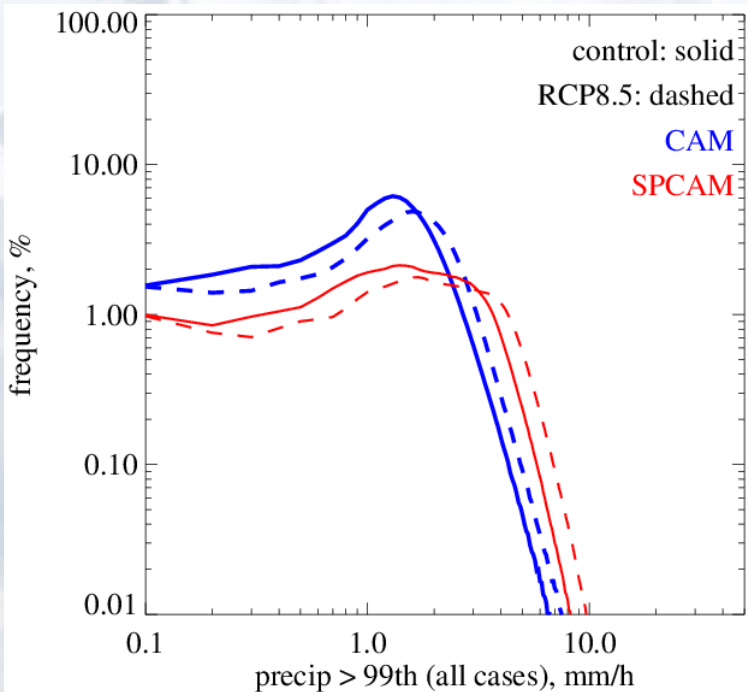
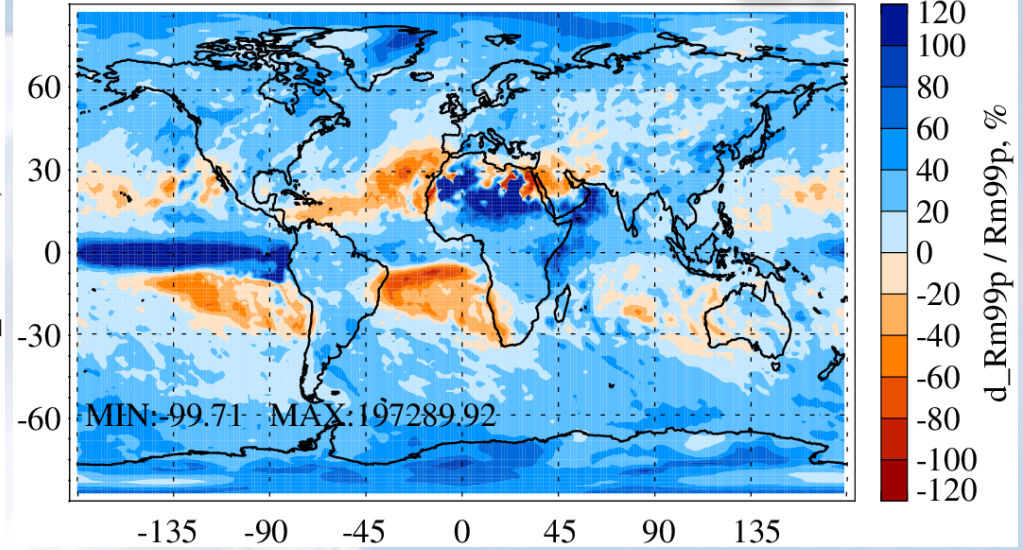


# Precipitation Extremes

Relative change in Rm Mean



Relative change in Rm99p 99%

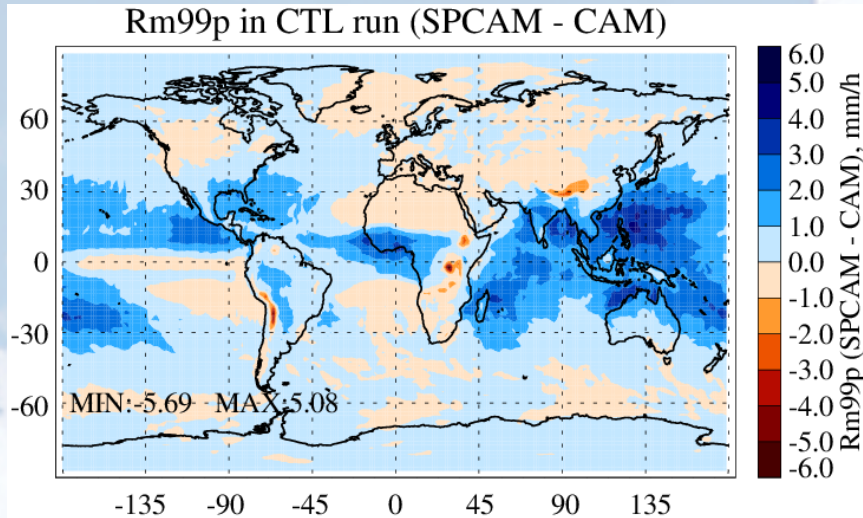


20-40% increase of extreme precipitation rate

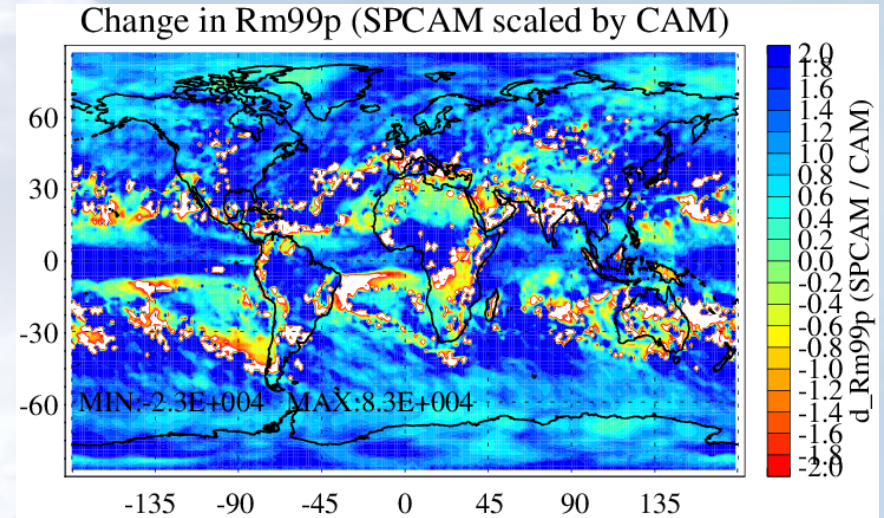


# SP-CAM vs CAM

Control 99% (SP-CAM-CAM) mm/h

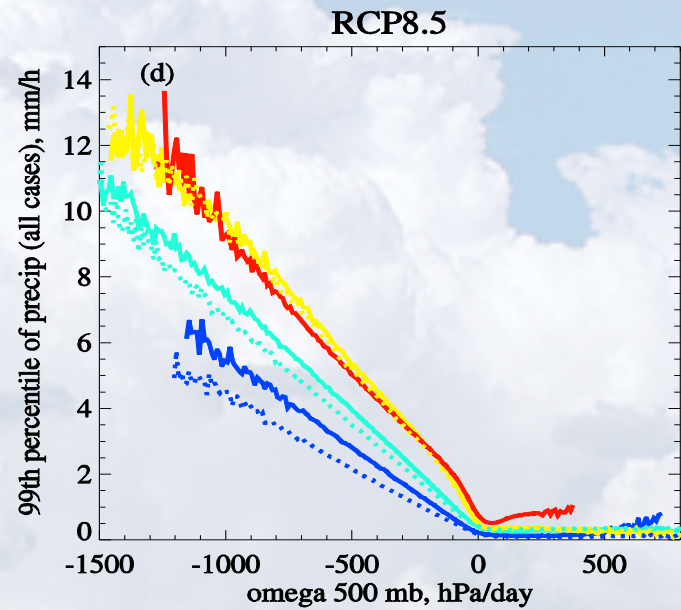
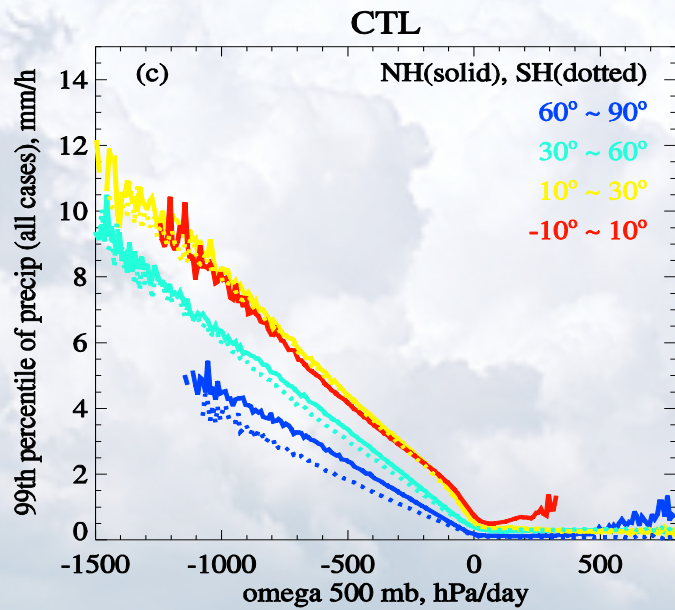
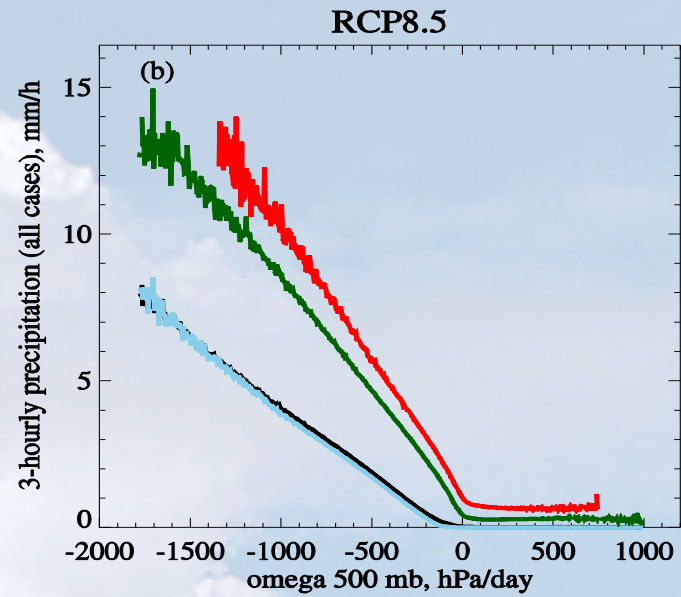
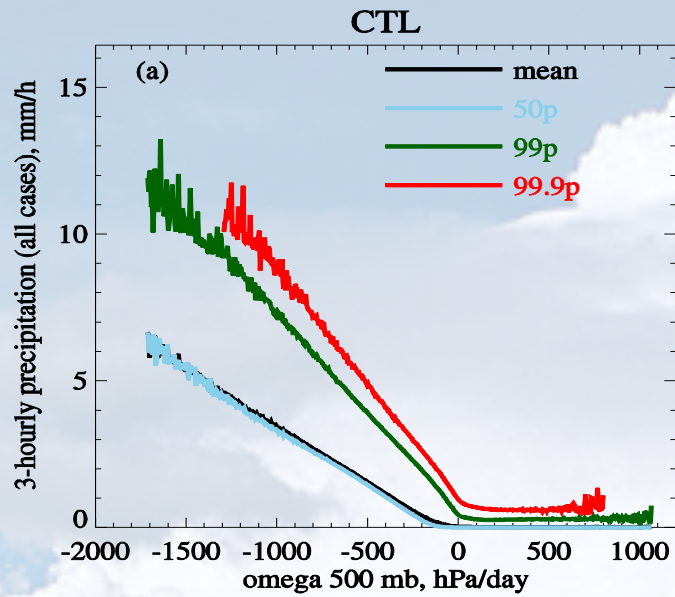


RCP8.5 Change 99% SP-CAM/CAM



SP-CAM predicts larger change in precipitation extreme in RCP8.5 than CAM

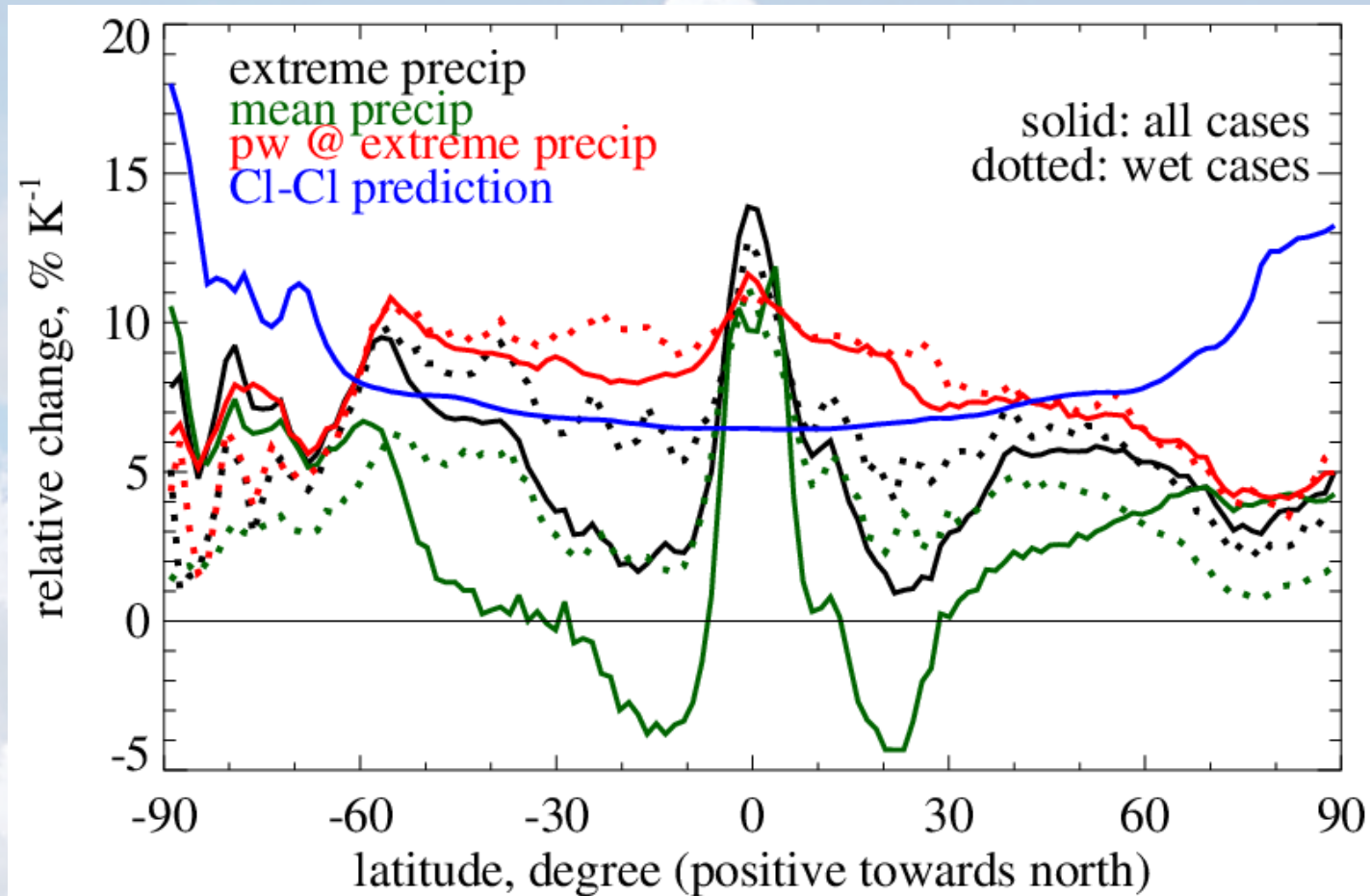
# 3-hourly Precipitation and Vertical velocity (500 mb)



Sensitivity of precipitation to dynamical uplifting is higher in warmer climate.



## Clausius-Clapeyron and Extremes

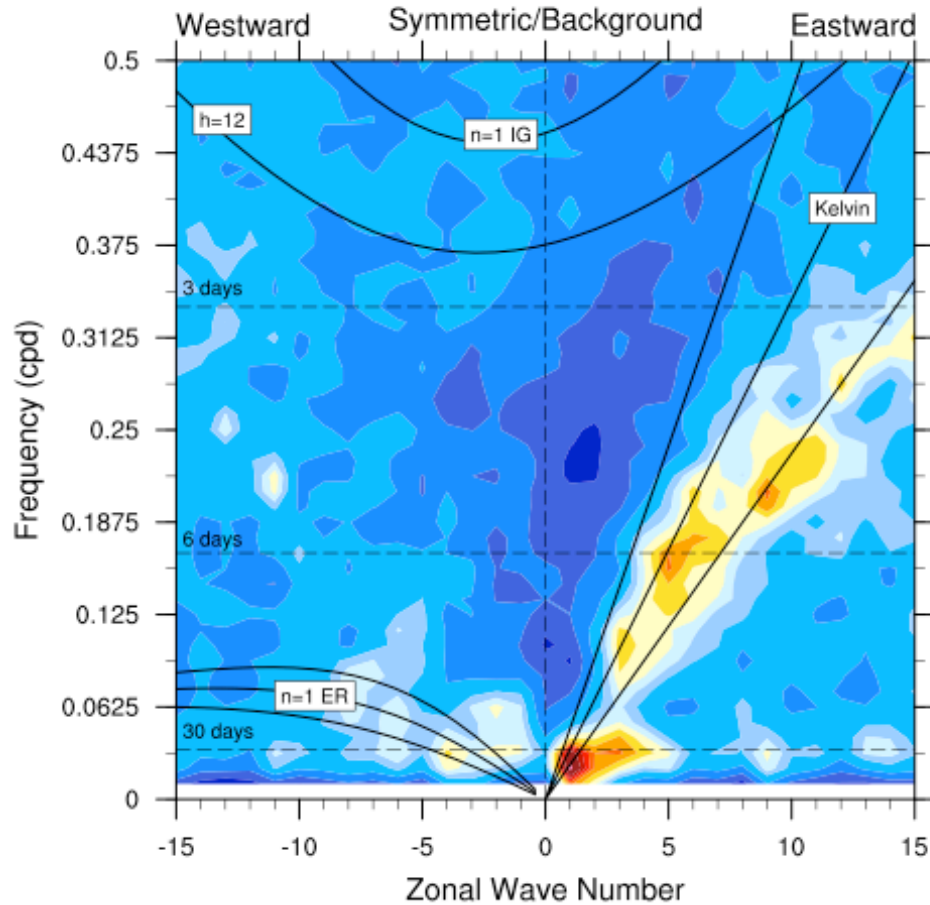


**While Cl-Cl is a poor predictor of mean precipitation change (“thermodynamic argument”), it is much better predictor of extreme precipitation increase in mid-latitudes.**

# Intra-seasonal variability in Tropics

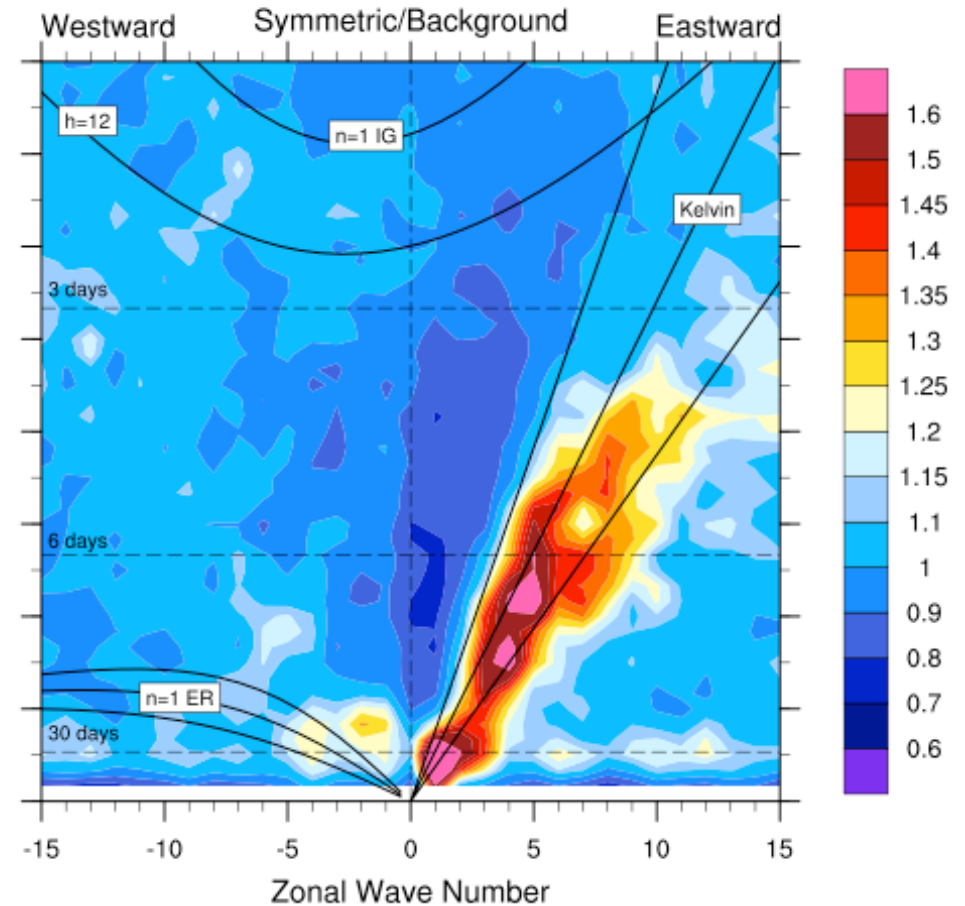
**Control**

WK\_PRECT LOG[Power: 20S-20N]



**RCP8.5**

WK\_PRECT LOG[Power: 20S-20N]



Much stronger MJO and Kelvin waves in warmer climate.