

# Testing MMF in a Coupled Climate Simulation

**Cristina Stan and Jim Kinter**

**COLA**



# Models Suite

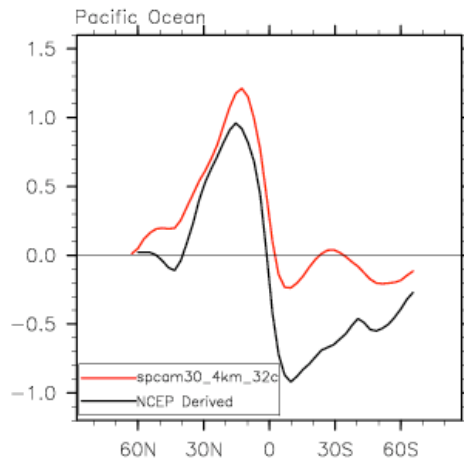
	<b>SP-CAM*</b>	<b>SP-CCSM</b>	<b>CCSM3.0</b>	<b>CCSM3.5**</b>
Horiz. Res.	T42 (sld)	T42 (sld)	T42 (sld)	T85(eul)
Vert. levels	30	30	26	26
Deep conv.	CRM	CRM	ZM	ZM w/ CMT
Shallow conv.	CRM	CRM	Hack	Hack
Horiz. Res.	SST	gx3v5	gx3v5	gx1v3
Vert. levels		25	25	40
Ice model	CSIM4	CSIM4	CSIM4	CICE
Land model	CLM2	CLM3.0	CLM3.0	CLM3.5

\***SP-CAM** from [http://www.cmmmap.org/research/themes/data/spcam30\\_4km\\_32c-obs/](http://www.cmmmap.org/research/themes/data/spcam30_4km_32c-obs/)

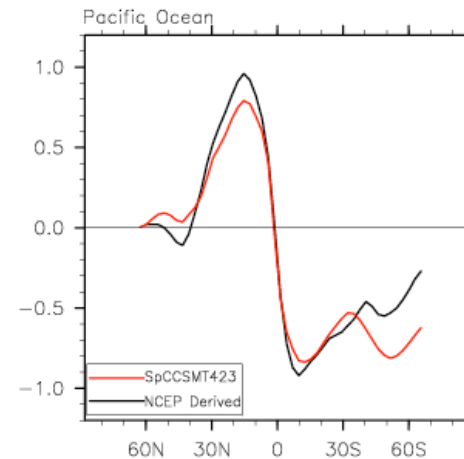
\*\***CCSM3.5** runs are courtesy of Ben Kirtman and Dughong Min, U. Miami

# Implied Northward Ocean Heat Transport - Pacific Ocean

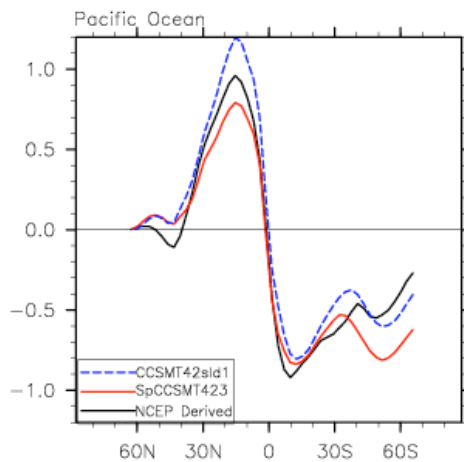
**SP-CAM**  
(yrs 1986-2003)



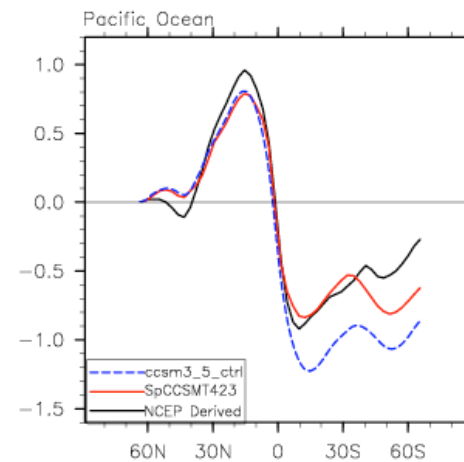
**SP-CCSM**  
(yrs 3-7)



**CCSM3.0**  
(yrs 3-7)

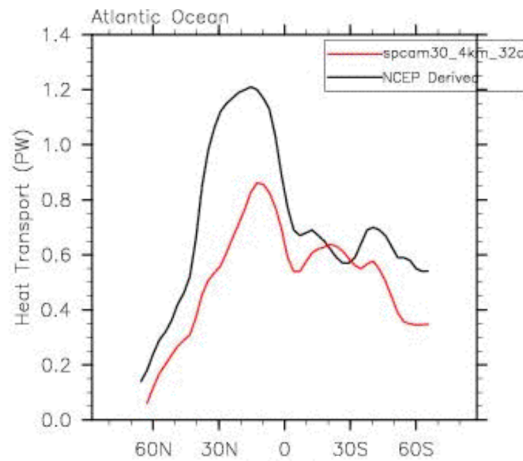


**CCSM3.5**  
(yrs 3-7)

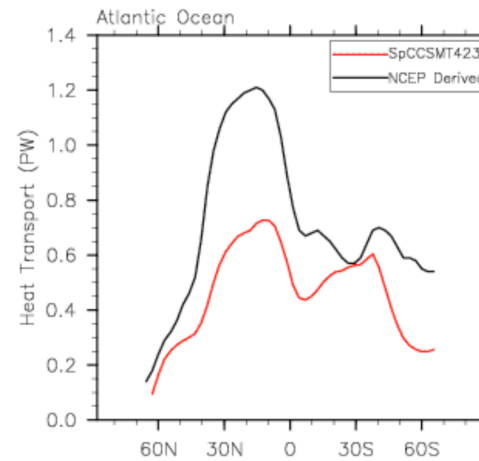


# Implied Northward Ocean Heat Transport - Atlantic Ocean

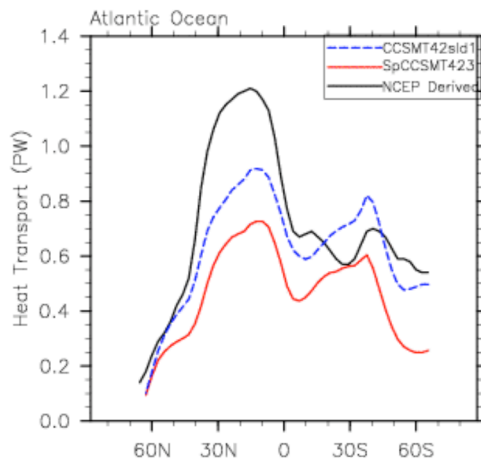
**SP-CAM**  
(yrs 1986-2003)



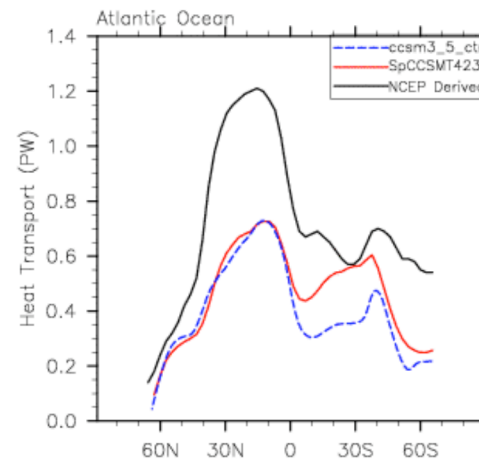
**SP-CCSM**  
(yrs 3-7)



**CCSM3.0**  
(yrs 3-7)

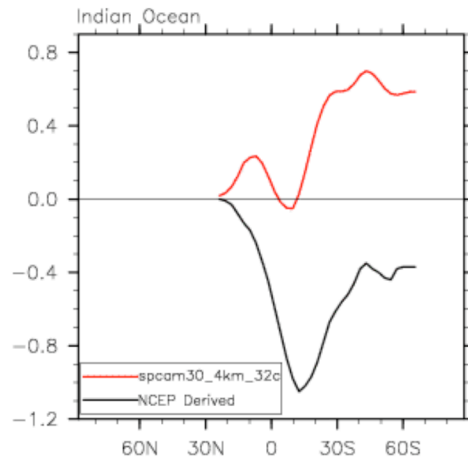


**CCSM3.5**  
(yrs 3-7)

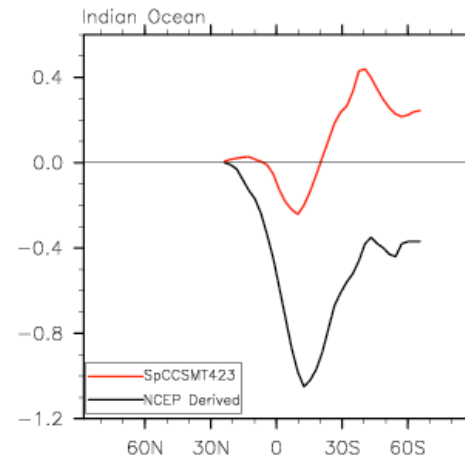


# Implied Northward Ocean Heat Transport - Indian Ocean

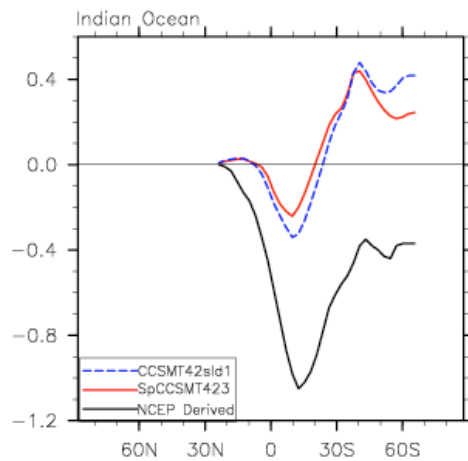
**SP-CAM**  
(yrs 1986-2003)



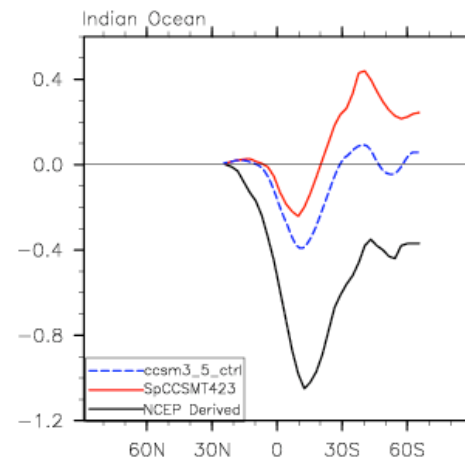
**SP-CCSM**  
(yrs 3-7)



**CCSM3.0**  
(yrs 3-7)

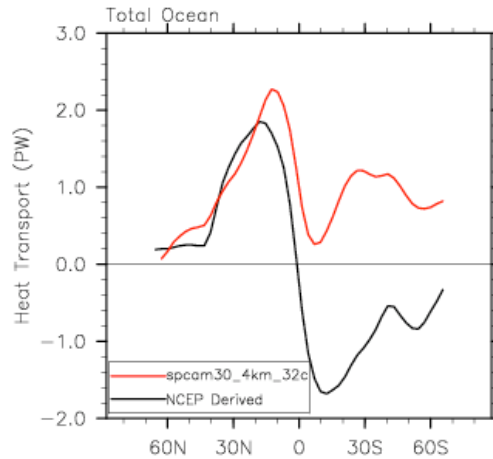


**CCSM3.5**  
(yrs 3-7)

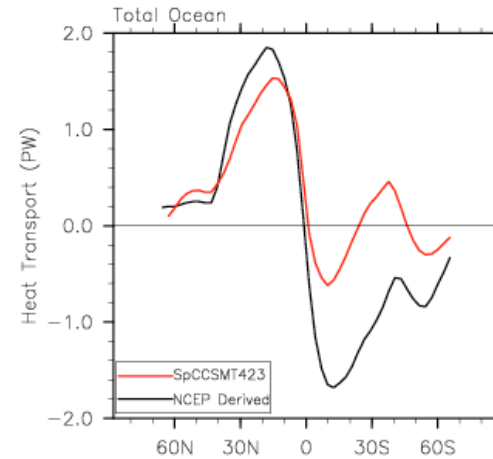


# Implied Northward Ocean Heat Transport - Total Ocean

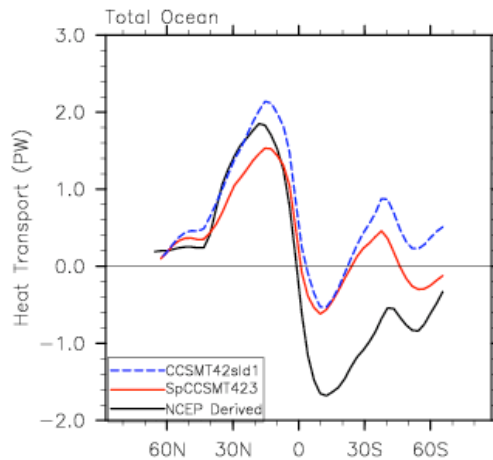
**SP-CAM**  
(yrs 1986-2003)



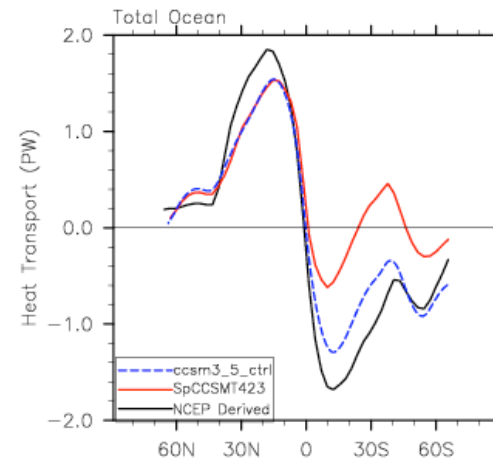
**SP-CCSM**  
(yrs 3-7)



**CCSM3.0**  
(yrs 3-7)



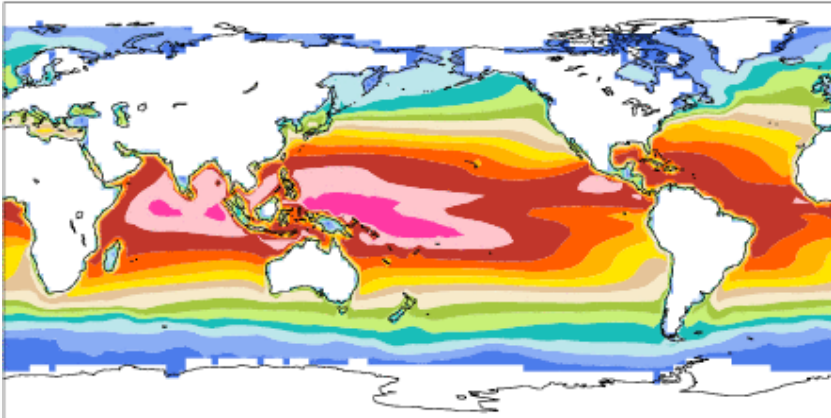
**CCSM3.5**  
(yrs 3-7)



# SST - Annual Mean

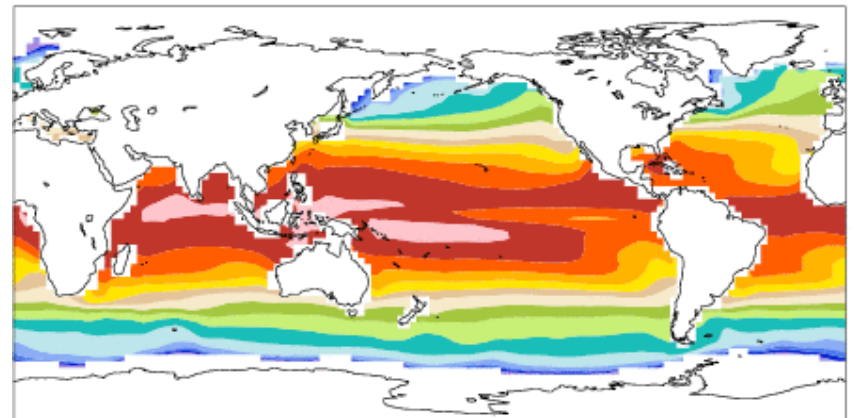
**HadISST(1982-2001)**

Min = 0.00      mean= 17.08      Max = 29.56



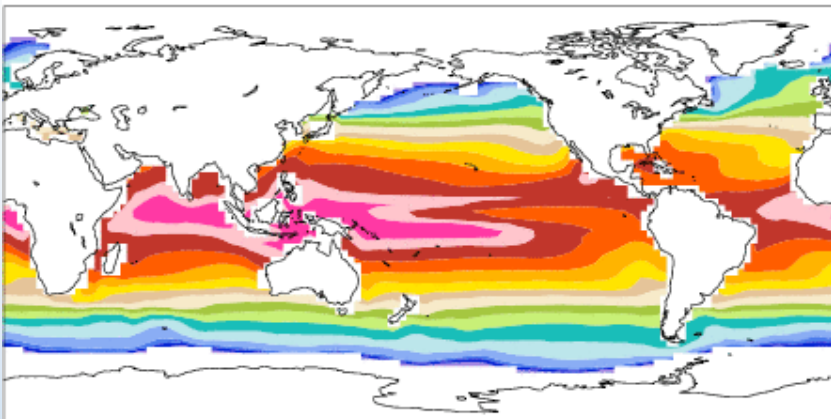
**SPCCSM3.0 (yrs 3-7)**

Min = -4.11      mean= 19.43      Max = 28.67



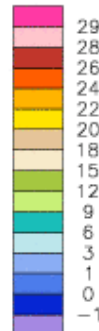
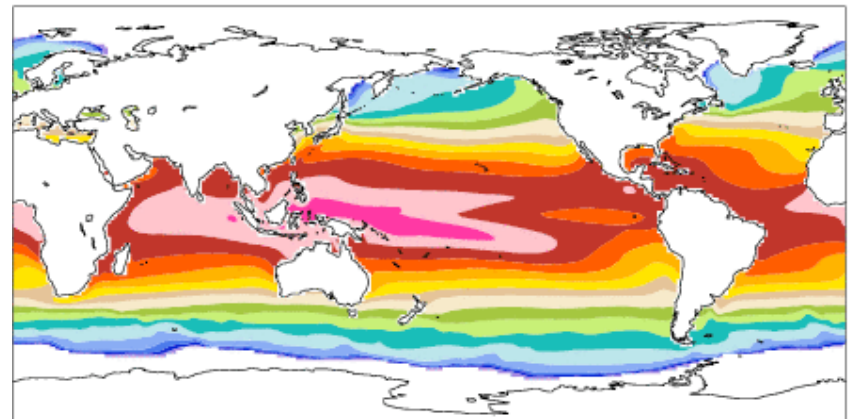
**CCSM3.0 (yrs 3-7)**

Min = -3.76      mean= 19.65      Max = 30.10



**CCSM3.5 (yrs 3-7)**

Min = -3.83      mean= 19.98      Max = 29.43

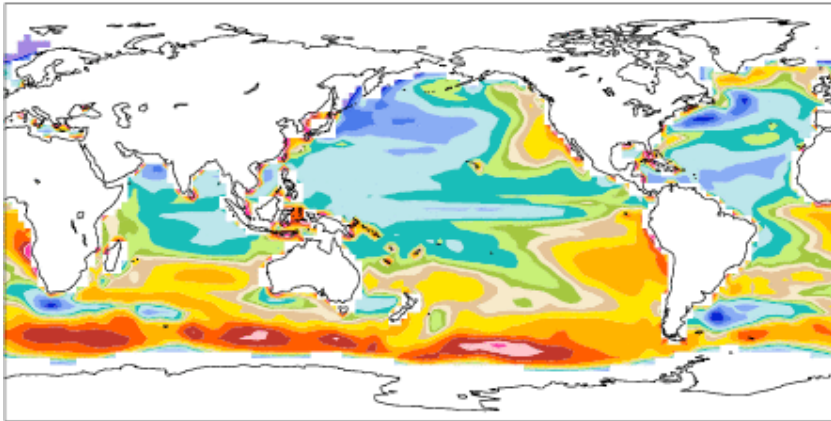


# SST Bias - Annual Mean

## SPCCSM3.0-HadISST

mean = 0.07

rmse = 2.08



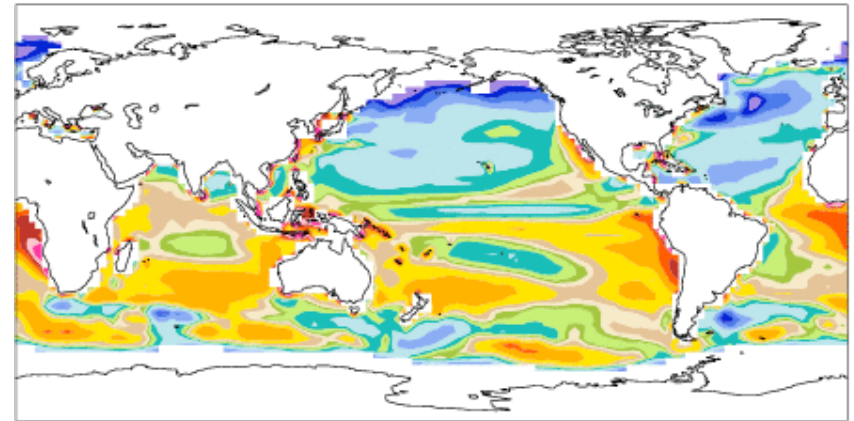
Min = -8.54

Max = 22.36

## CCSM3.0-HadISST

mean = 0.05

rmse = 2.14



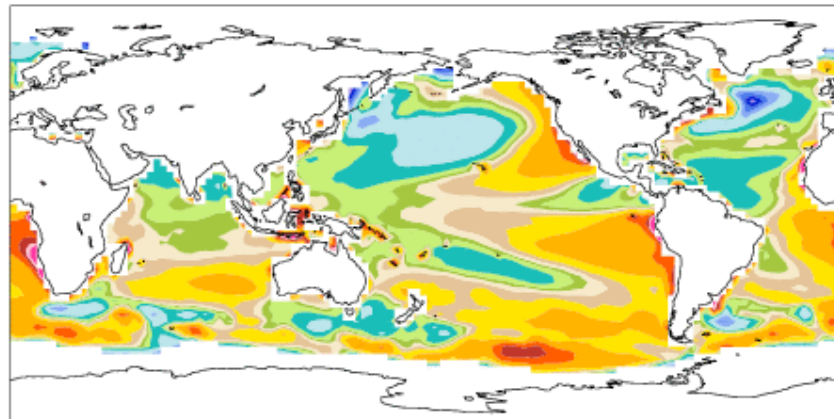
Min = -8.30

Max = 22.96

## CCSM3.5-HadISST

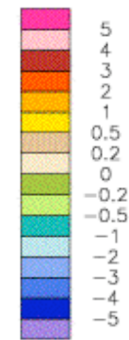
mean = 0.35

rmse = 1.41



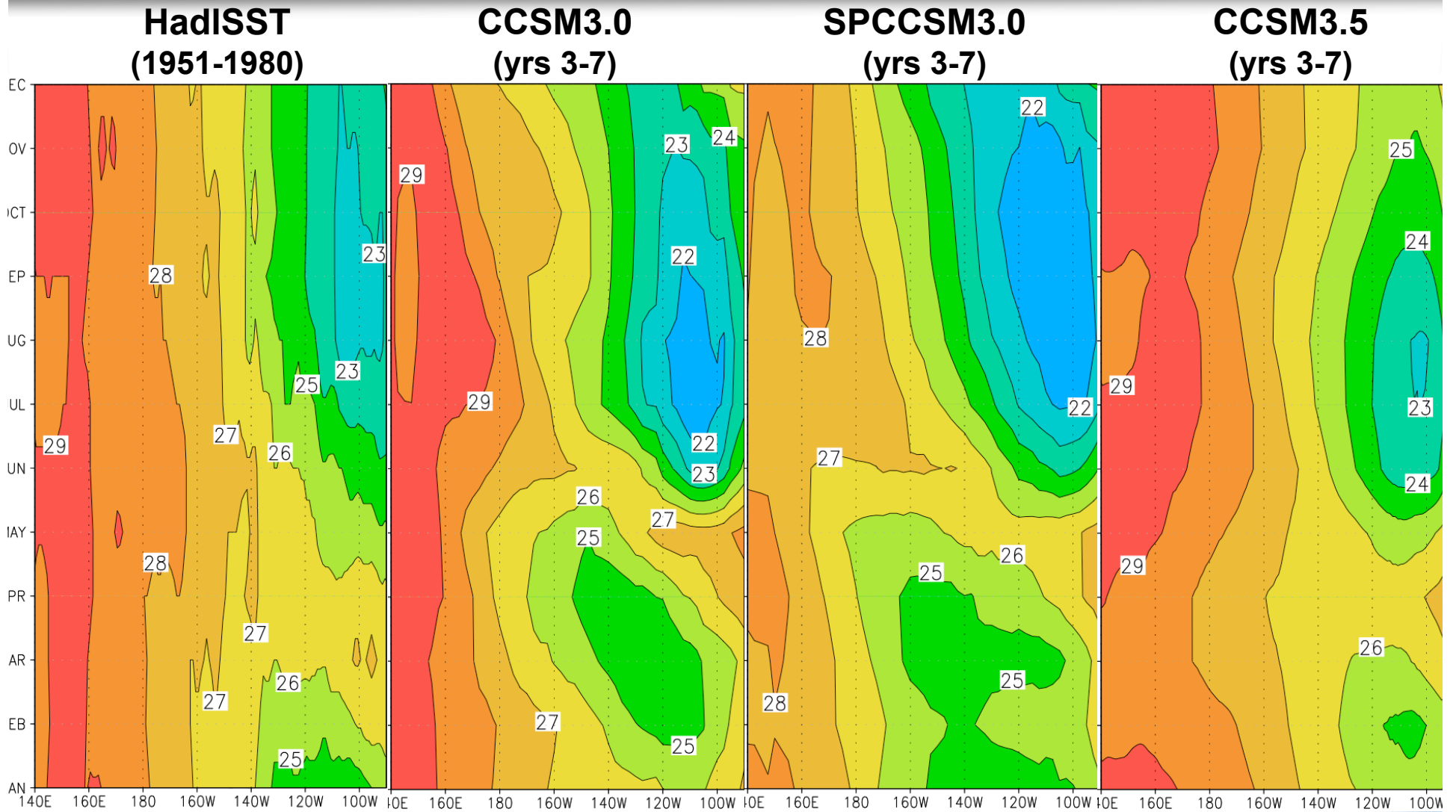
Min = -5.89

Max = 13.14





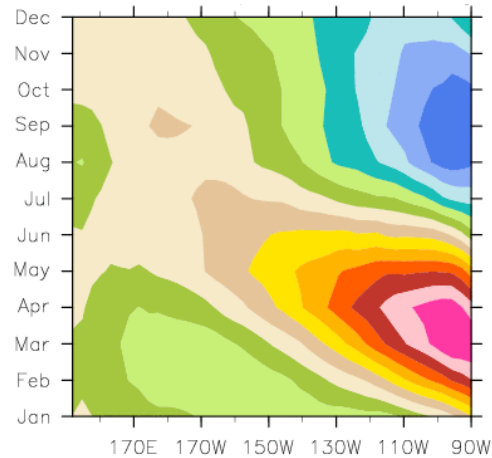
# Equatorial SST - Annual Cycle



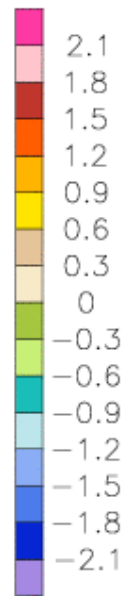
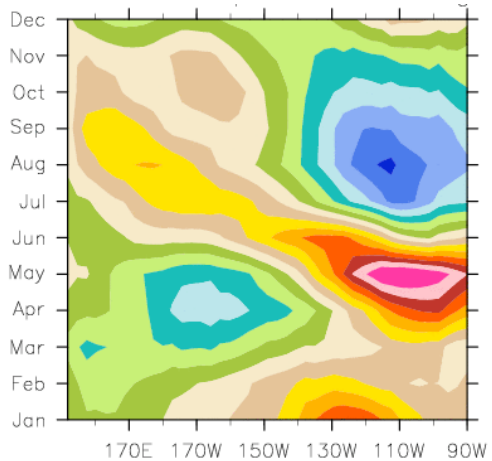
# Equatorial SST - Annual Cycle

## Global Mean Climatology

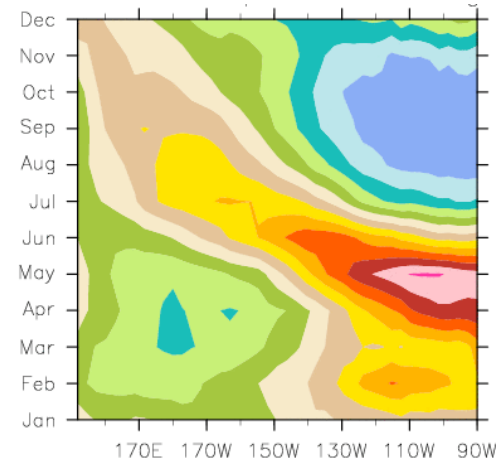
**HadISST**  
(1982-2001)



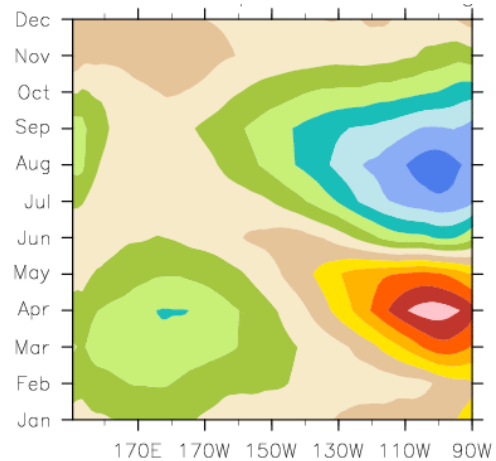
**CCSM3.0**  
(yrs 3-7)



**SP-CCSM**  
(yrs 3-7)



**CCSM3.5**  
(yrs 3-7)



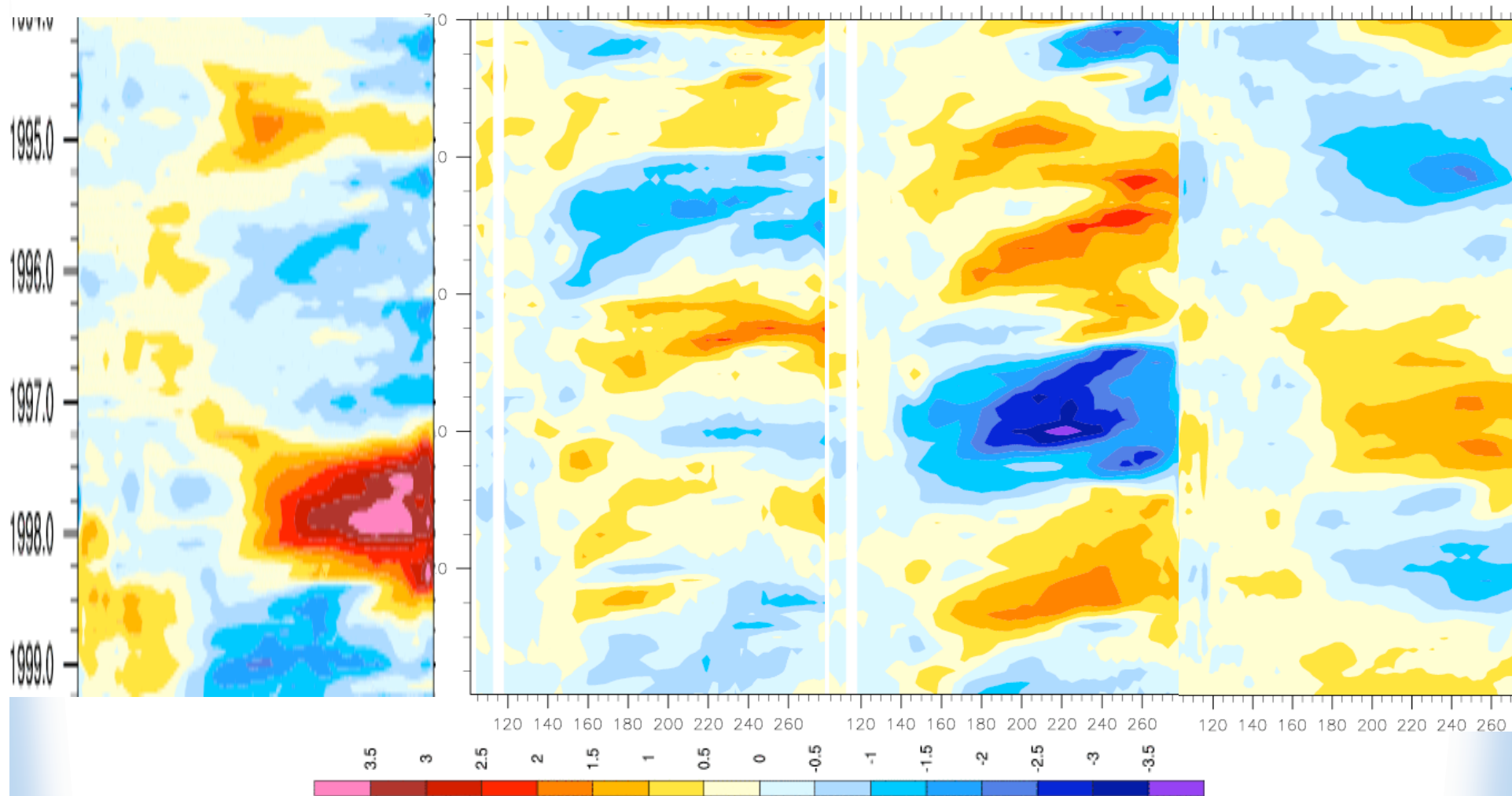
# Equatorial SST - Monthly Anomaly

**NCEP**

**CCSM3.0**

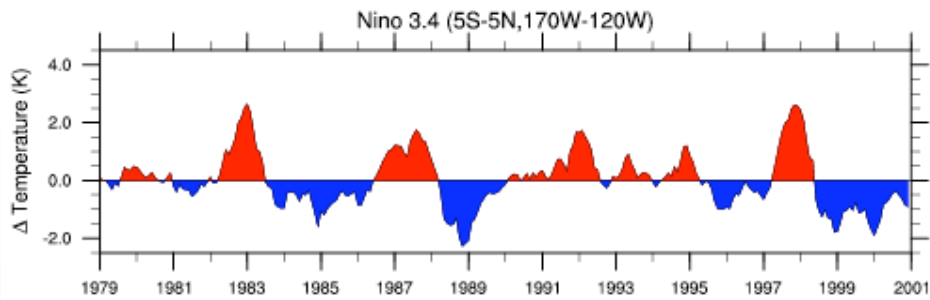
**SPCCSM3.0**

**CCSM3.5**

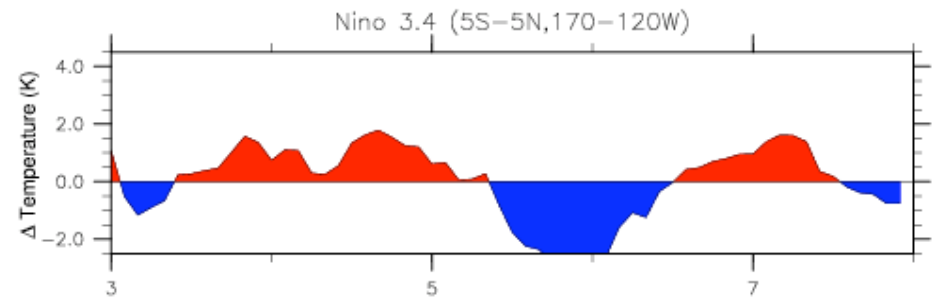


# Niño-3.4

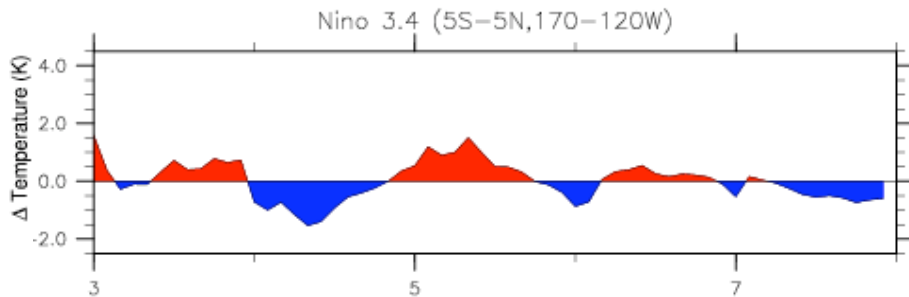
**NCEP**



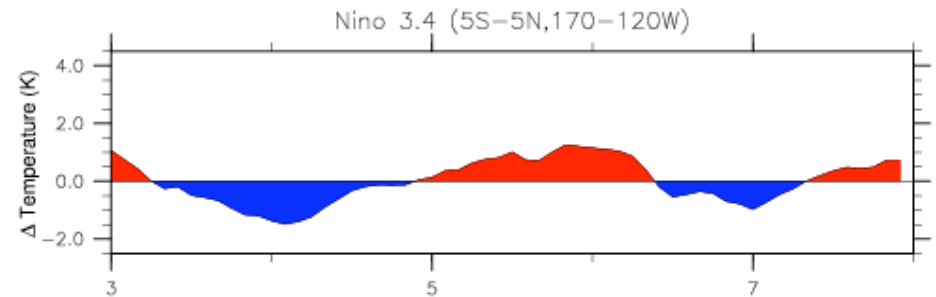
**SPCCSM3.0**



**CCSM3.0**



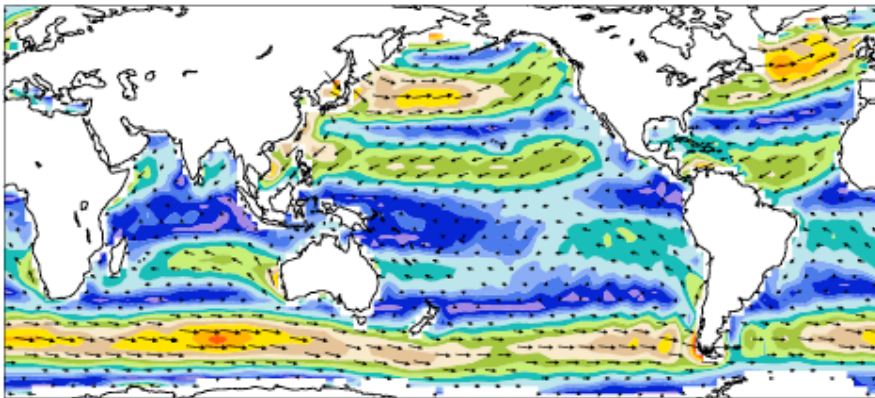
**CCSM3.5**



# Ocean Surface Wind Stress - DJF

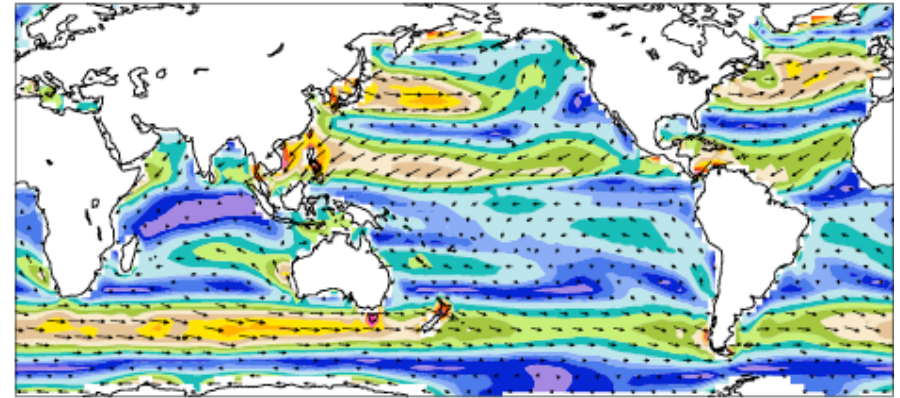
**NCEP**

MIN = 0.00      mean= 0.07      MAX = 0.27



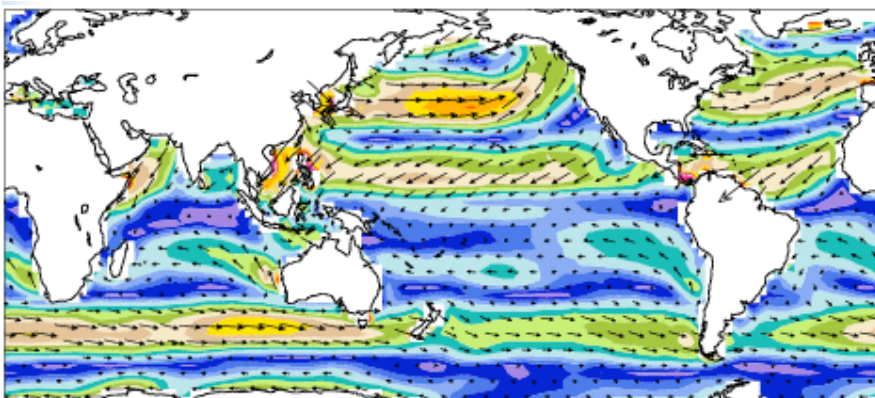
**SPCAM**

MIN = 0.00      mean= 0.07      MAX = 0.63



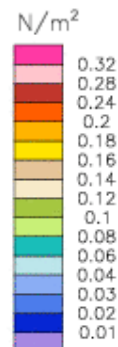
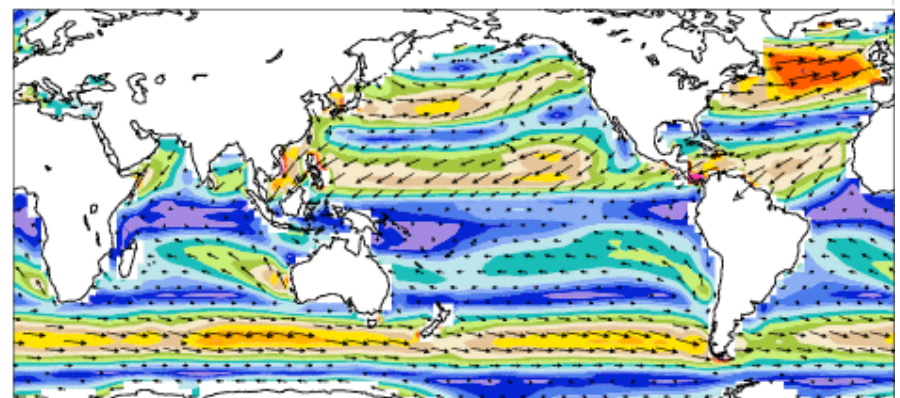
**SPCCSM3.0**

MIN = 0.00      mean= 0.07      MAX = 0.47



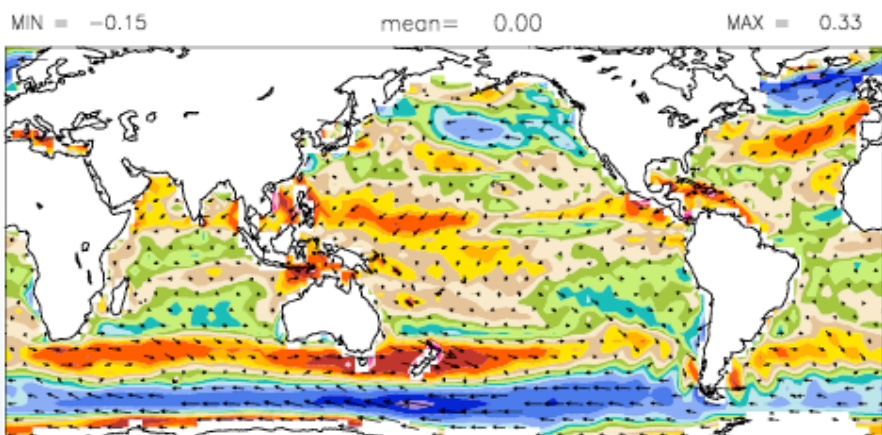
**CCSM3.0**

MIN = 0.00      mean= 0.08      MAX = 0.53

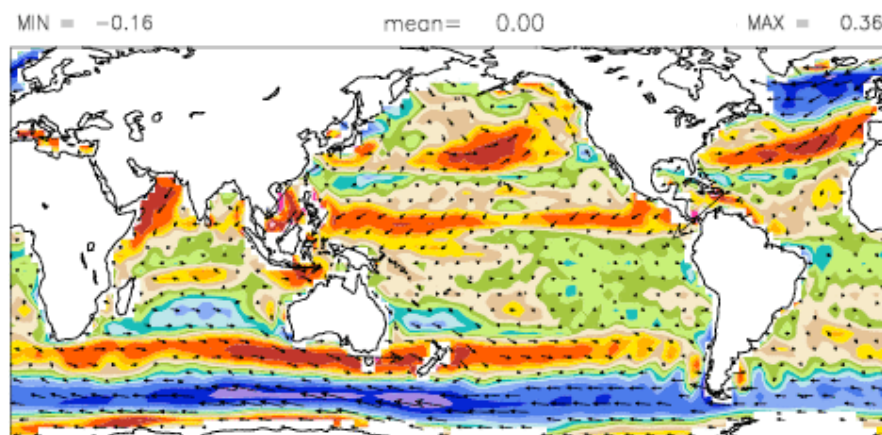


# Ocean Surface Wind Stress Bias - DJF

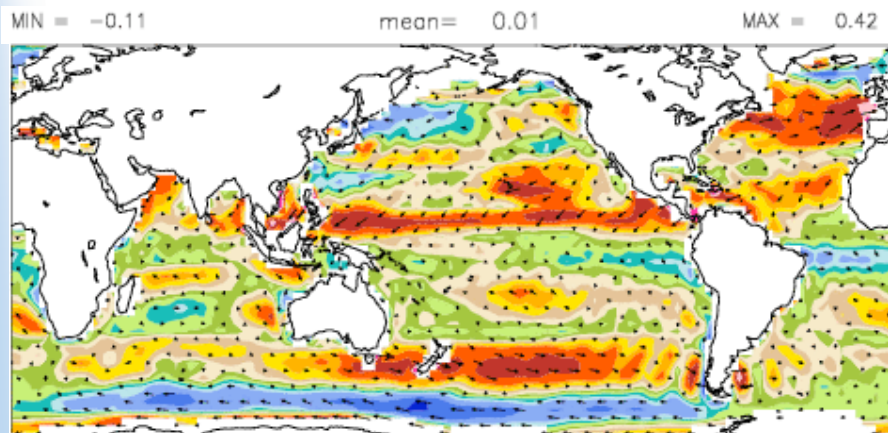
## SPCAM-NCEP



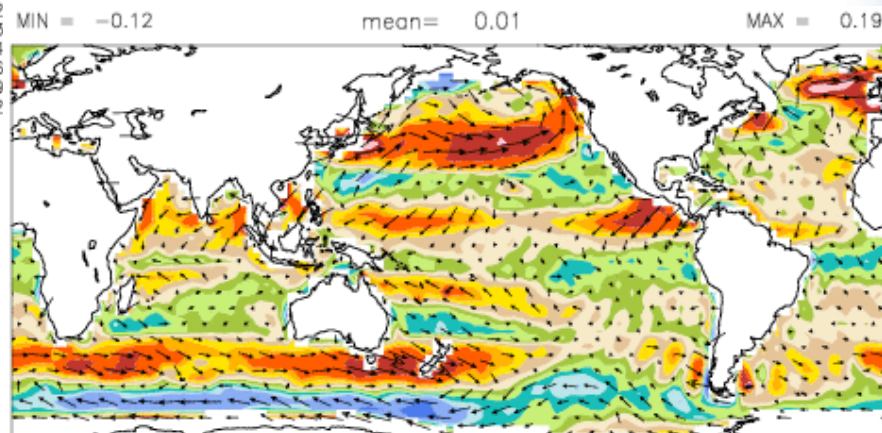
## SPCCSM3.0-NCEP



## CCSM3.0-NCEP



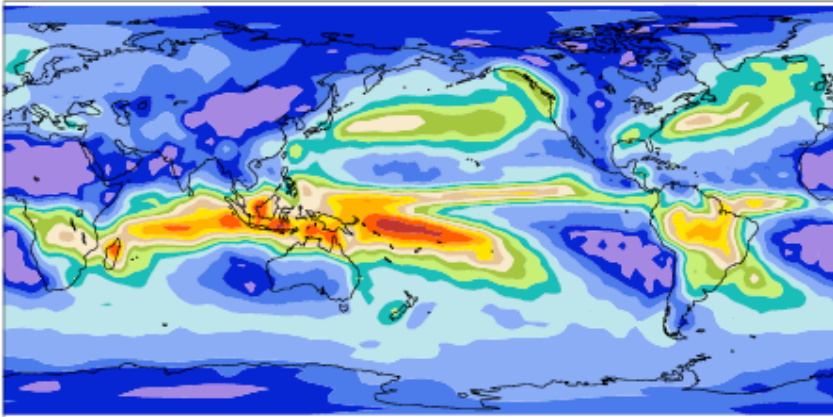
## CCSM3.5-NCEP



# Precipitation Rate - DJF

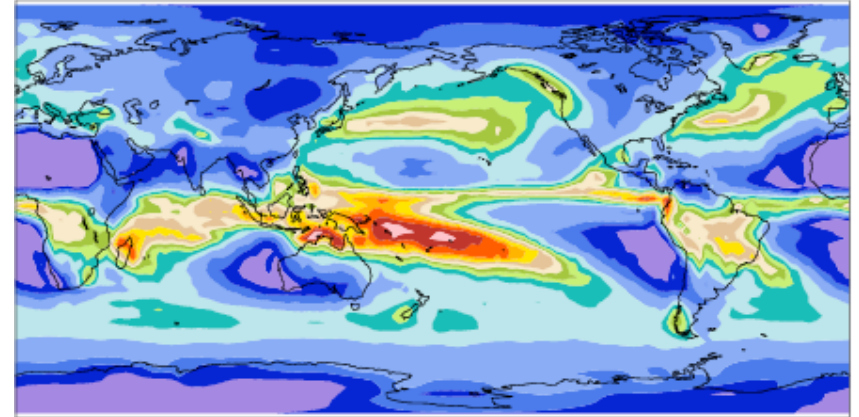
**CMAP**

Min = 0.00      mean= 2.64      Max = 13.55



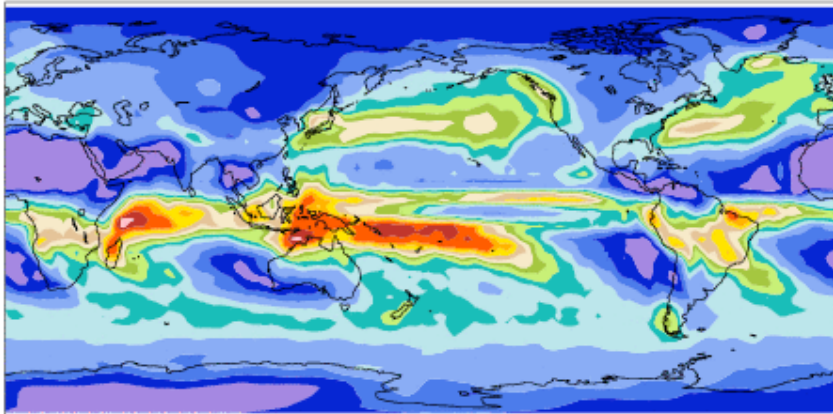
**SPCAM**

Min = 0.00      mean= 2.80      Max = 15.10



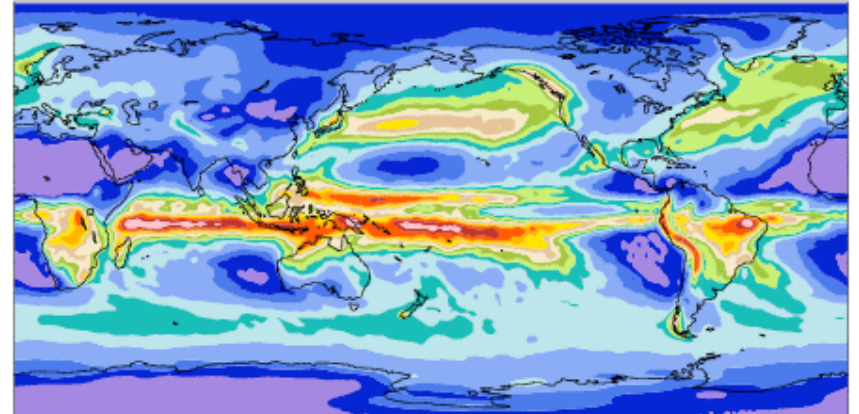
**SPCCSM3.0**

Min = 0.00      mean= 2.83      Max = 15.10

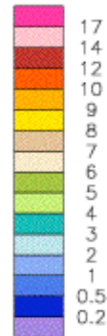


**CCSM3.5**

Min = 0.00      mean= 2.94      Max = 16.83

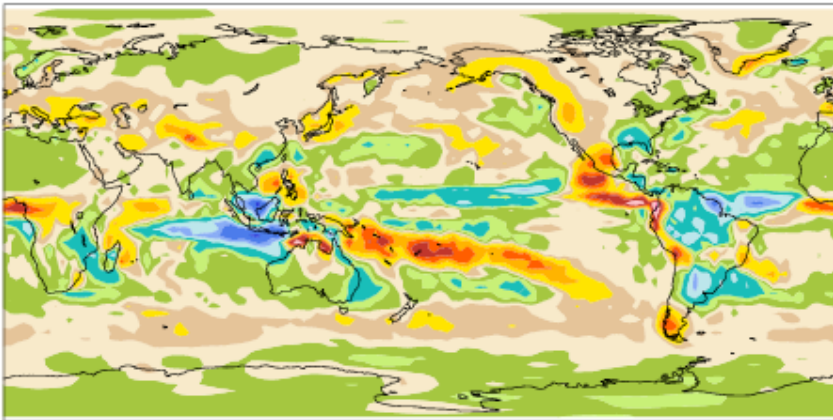


mm/day



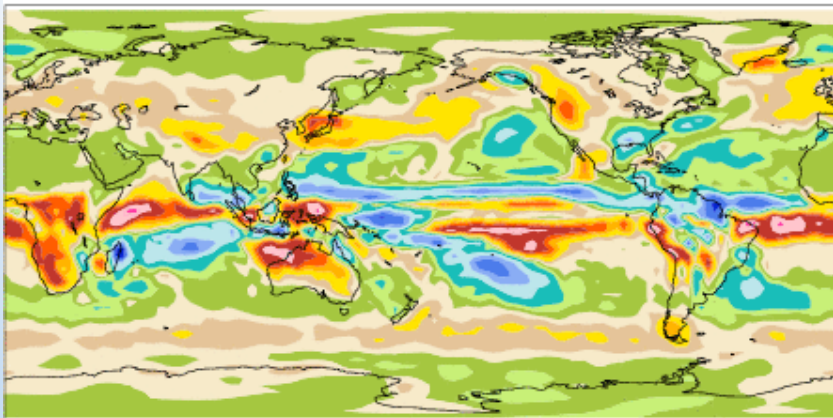
# Precipitation Rate Bias - DJF

mean = 0.16 **SPCAM-CMAP** rmse = 1.17



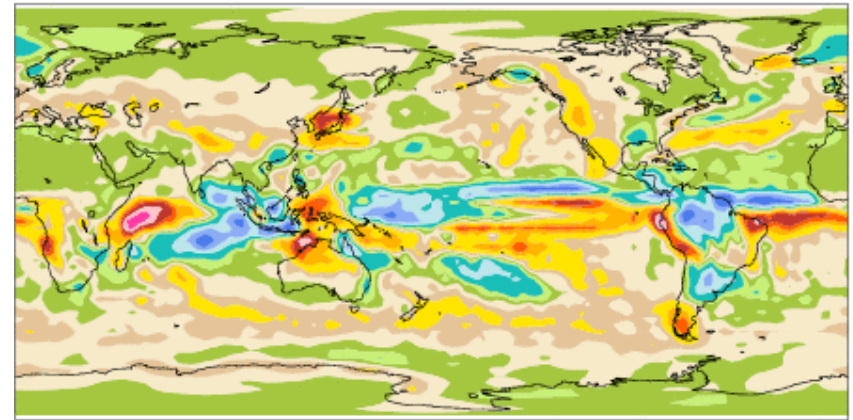
Min = -6.49 Max = 8.73

mean = 0.16 **CCSM3.0-CMAP** rmse = 1.77



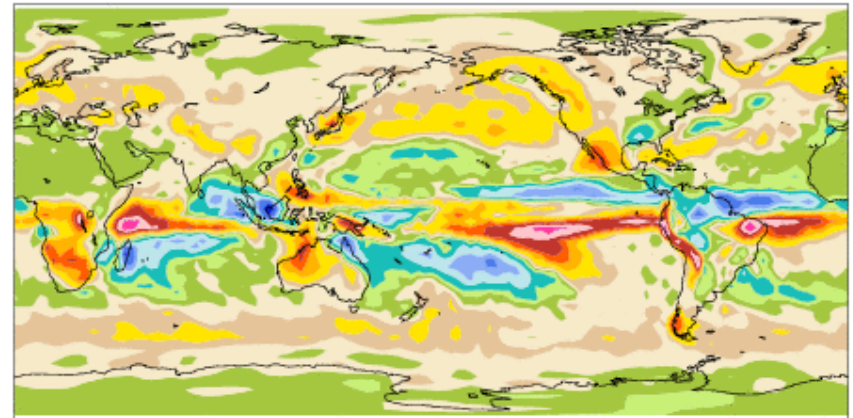
Min = -7.81 Max = 9.05

mean = 0.19 **SPCCSM3.0-CMAP** rmse = 1.40



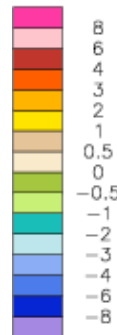
Min = -5.63 Max = 10.47

mean = 0.30 **CCSM3.5-CMAP** rmse = 1.60



Min = -7.34 Max = 11.19

mm/day

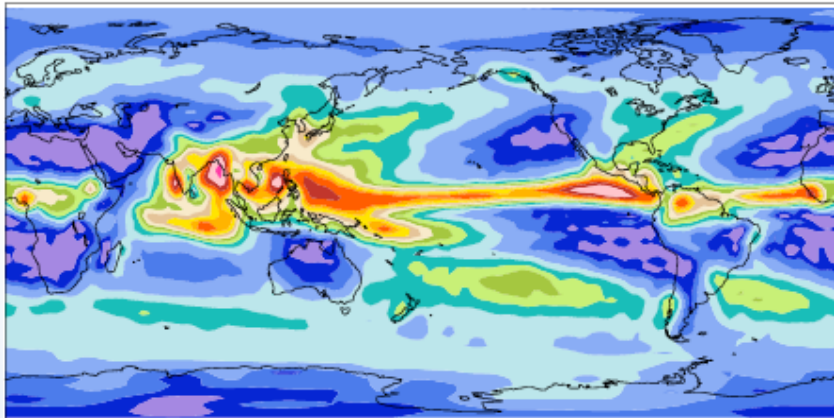




# Precipitation Rate - JJA

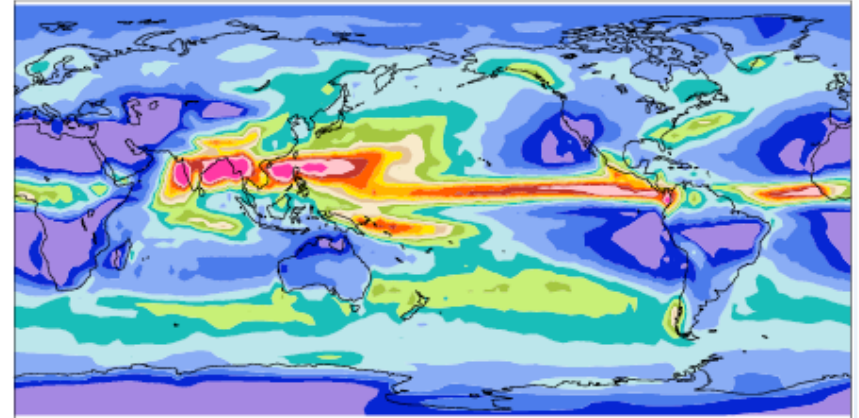
## CMAP

Min = 0.00      mean = 2.78      Max = 18.23



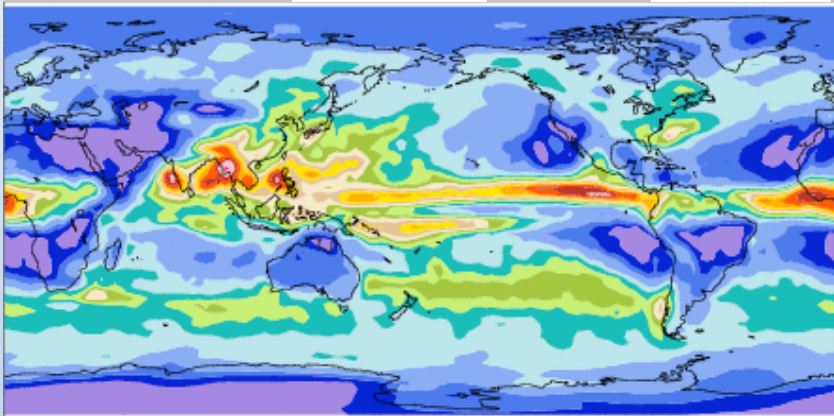
## SPCAM

Min = 0.00      mean = 2.85      Max = 31.59



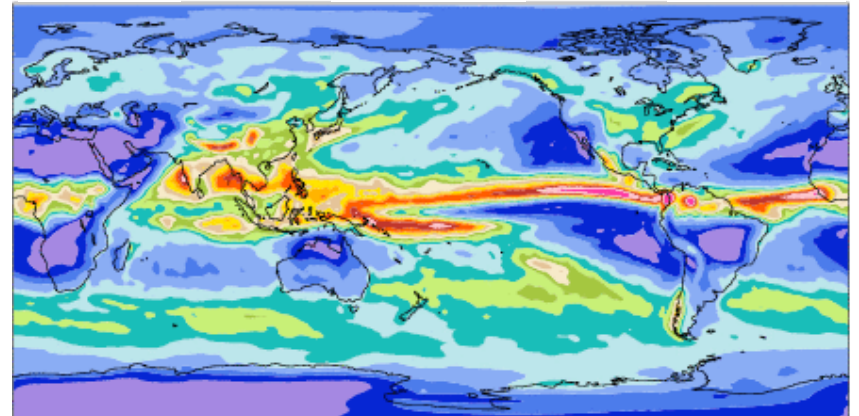
## SPCCSM3.0

Min = 0.00      mean = 2.84      Max = 18.08

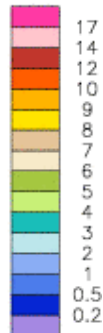


## CCSM3.5

Min = 0.00      mean = 2.99      Max = 26.23

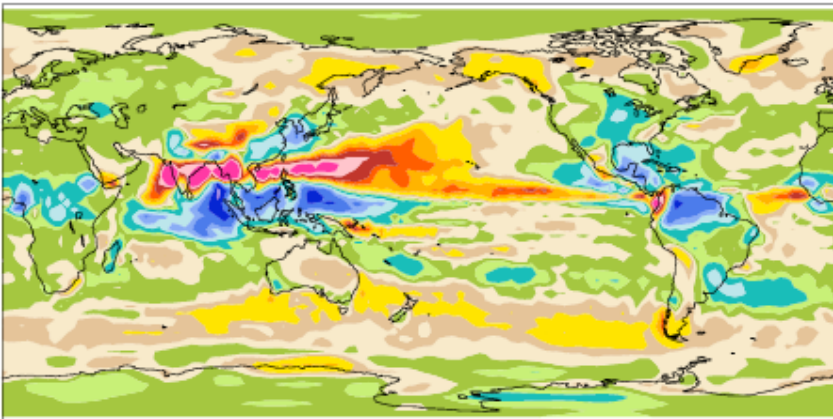


mm/day



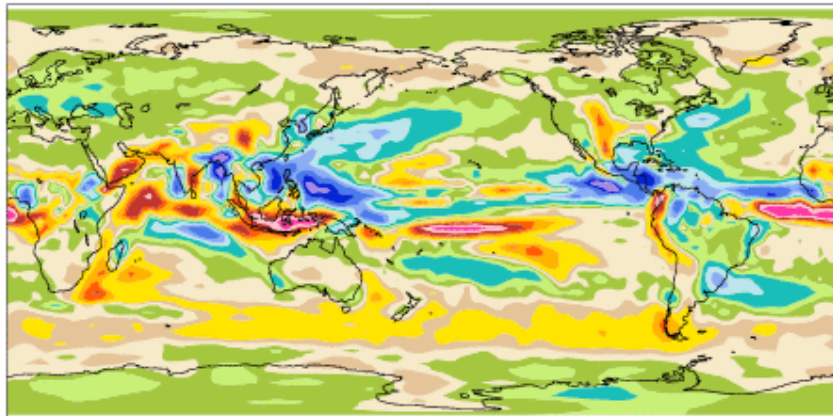
# Precipitation Rate Bias - JJA

mean = 0.06      **SPCAM-CMAP**      rmse = 1.80



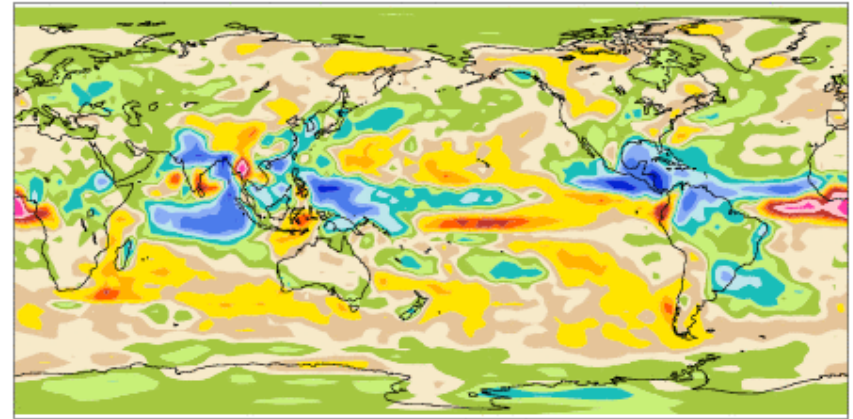
Min = -8.53      Max = 19.41

mean = 0.02      **CCSM3.0-CMAP**      rmse = 1.91



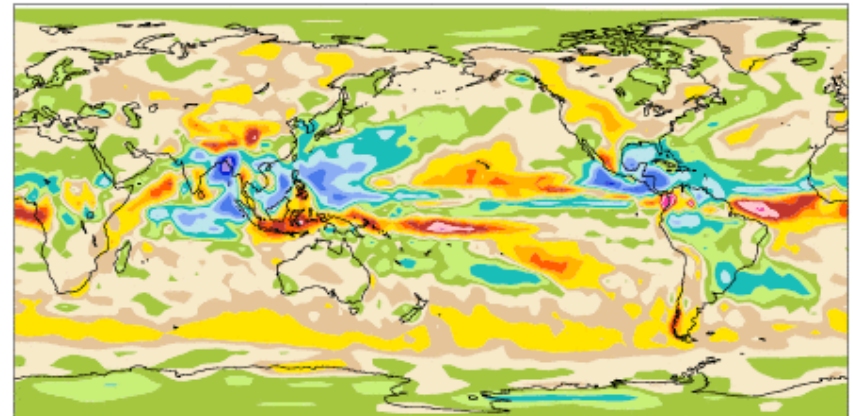
Min = -11.84      Max = 12.75

mean = 0.06      **SPCCSM3.0-CMAP**      rmse = 1.57



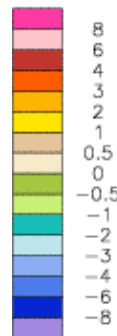
Min = -7.81      Max = 10.62

mean = 0.21      **CCSM3.5-CMAP**      rmse = 1.45



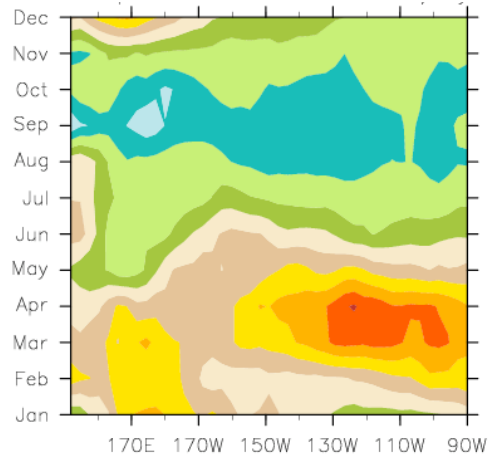
Min = -9.95      Max = 13.28

mm/day

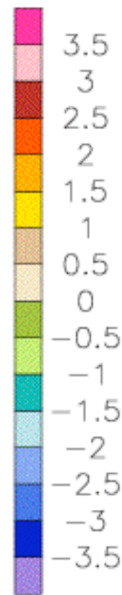


# Equatorial Precipitation Annual Cycle Global Mean Climatology

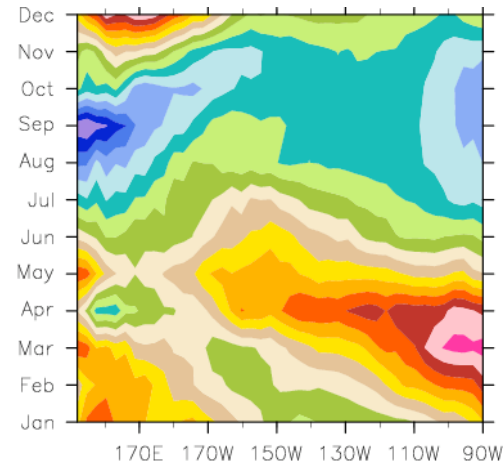
**GPCP  
(1979-2000)**



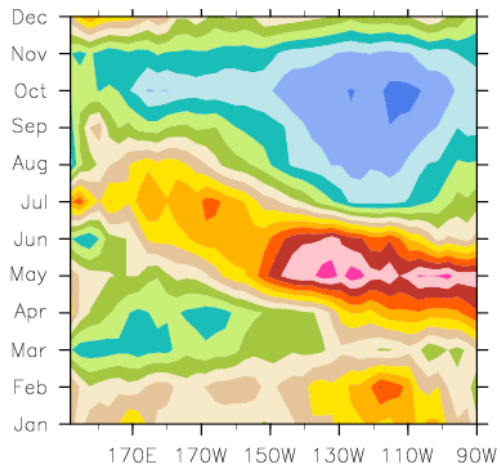
mm/day



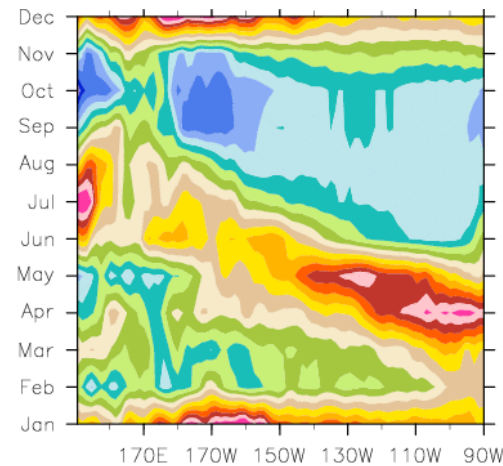
**SPCAM  
(1986-2003)**



**SPCCSM3.0  
(yrs 3-7)**



**CCSM3.5  
(yrs 3-7)**

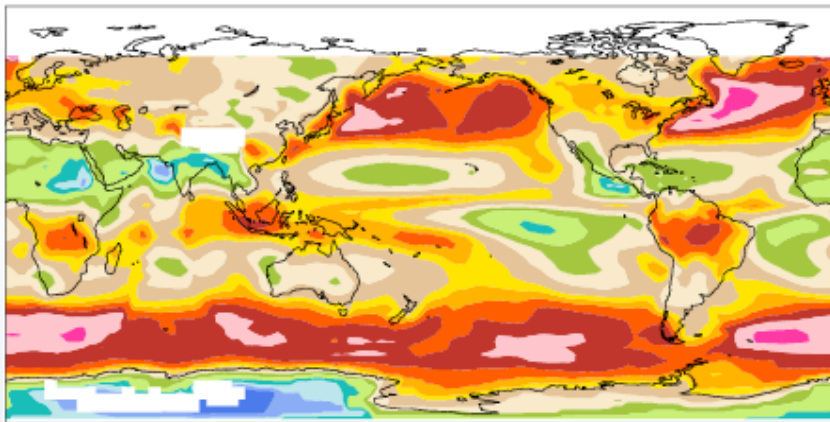


# Total Cloud Amount - DJF

## VIS/IR/NIR clouds

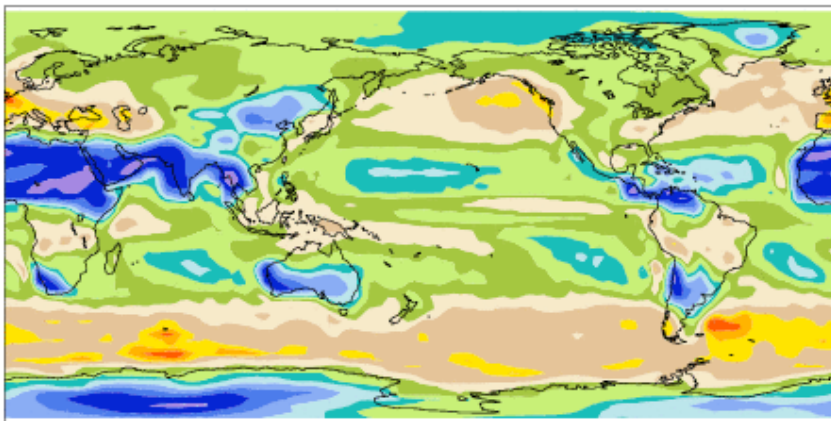
### ISCCP2-D2

Min = 10.03      mean= 66.92      Max = 99.05



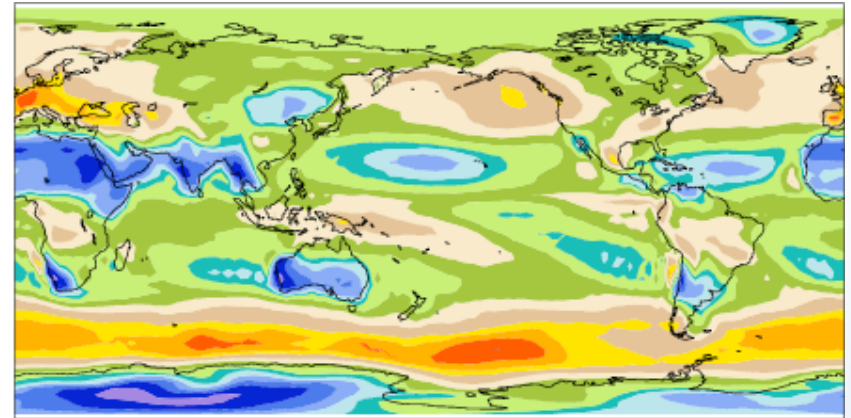
### SPCCSM3.0

Min = 2.55      mean= 42.53      Max = 85.41



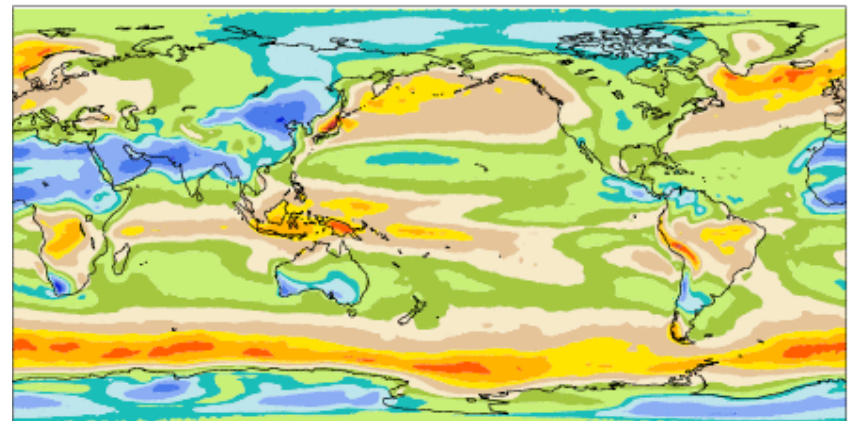
### SPCAM

Min = 2.35      mean= 44.29      Max = 85.16

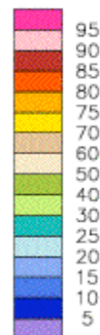


### CCSM3.5

Min = 5.41      mean= 47.56      Max = 89.21



percent

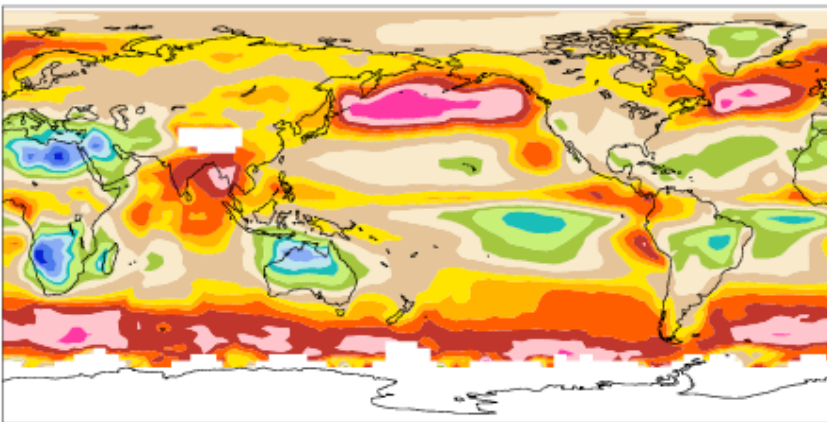


# Total Cloud Amount - JJA

## VIS/IR/NIR clouds

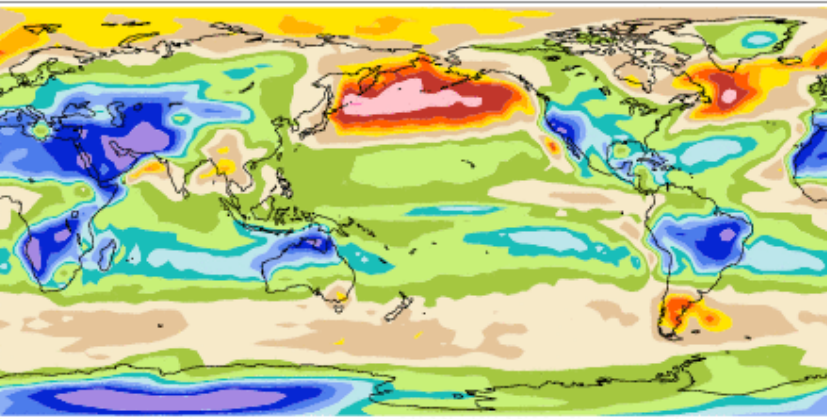
### ISCCP2-D2

Min = 0.76      mean= 44.38      Max = 94.27



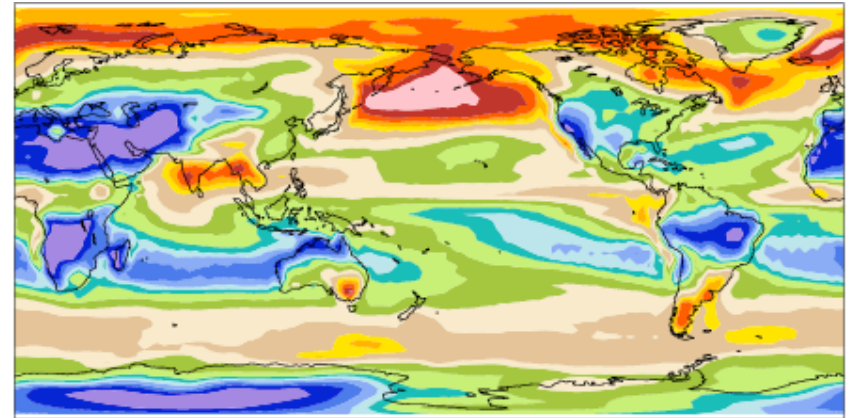
### SPCCSM3.0

Min = 0.63      mean= 42.95      Max = 95.42



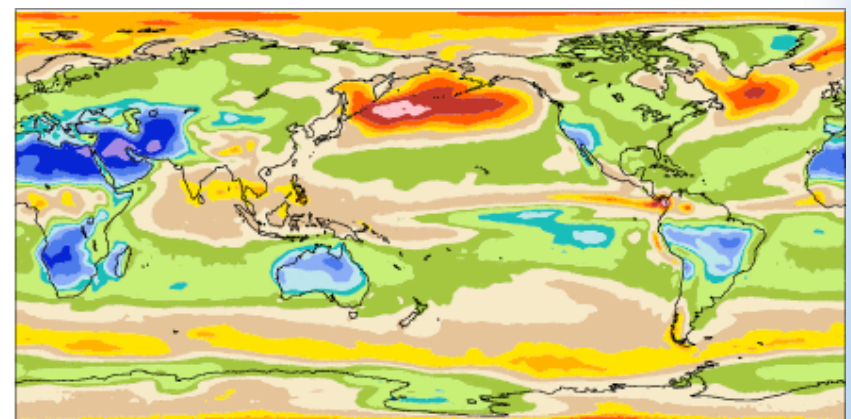
### SPCAM

Min = 8.69      mean= 66.22      Max = 99.23

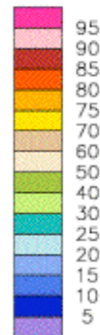


### CCSM3.5

Min = 2.63      mean= 48.97      Max = 93.07



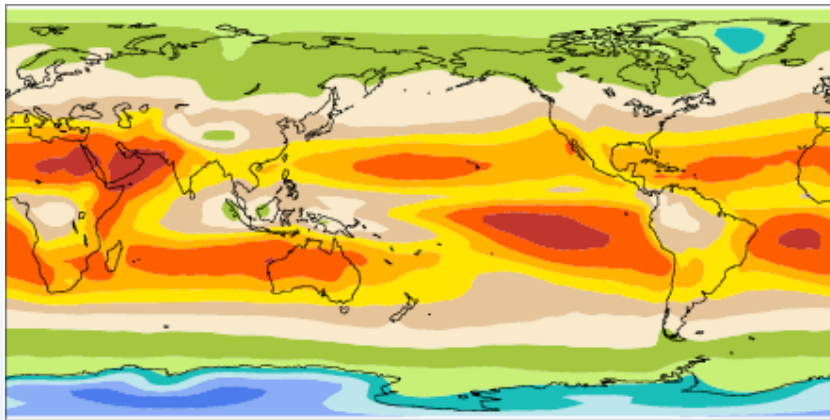
percent



# OLR - Annual Mean

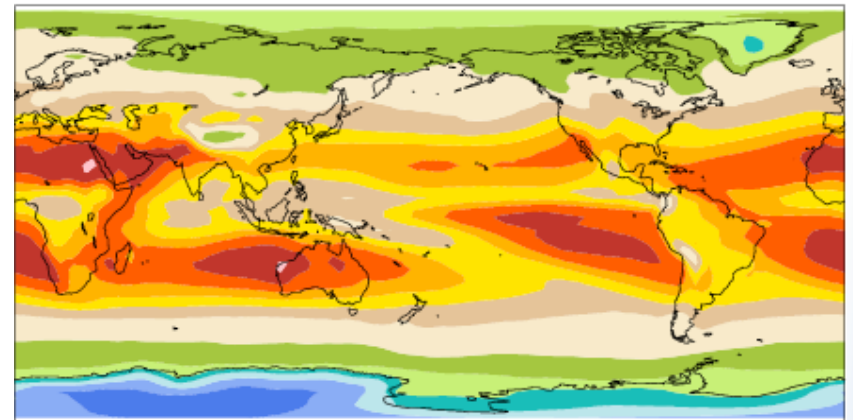
**ERBE**

Min = 124.45      mean= 233.95      Max = 292.40



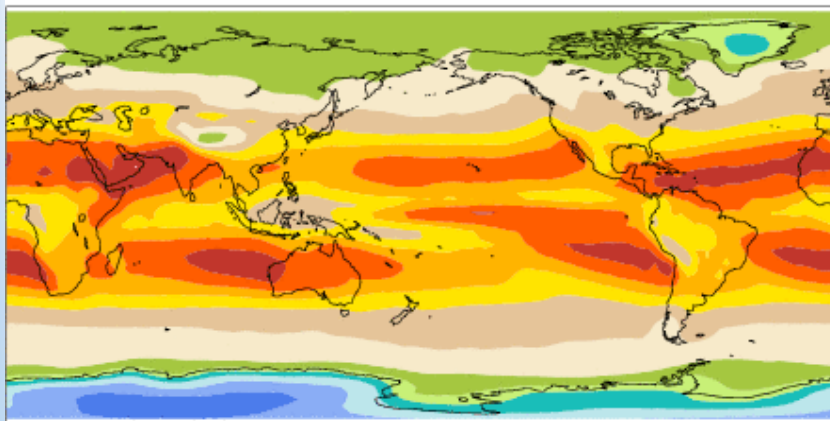
**SPCAM**

Min = 118.35      mean= 238.31      Max = 297.54



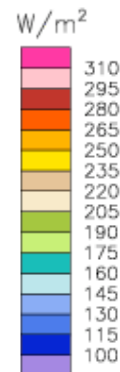
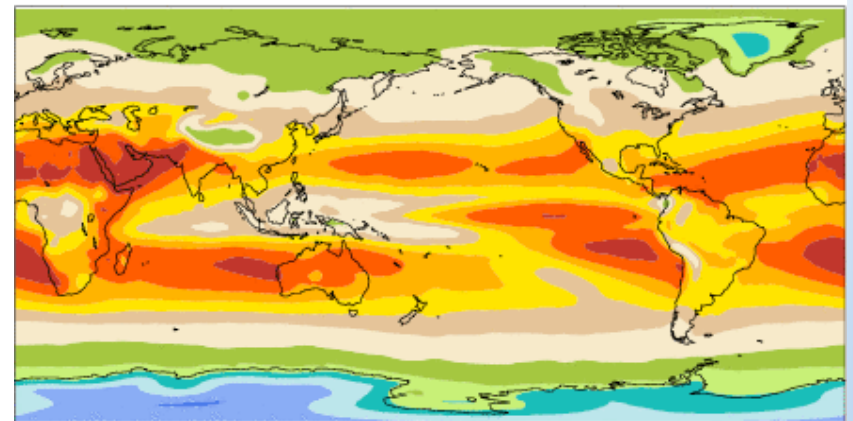
**SPCCSM3.0**

Min = 119.14      mean= 241.30      Max = 295.65



**CCSM3.5**

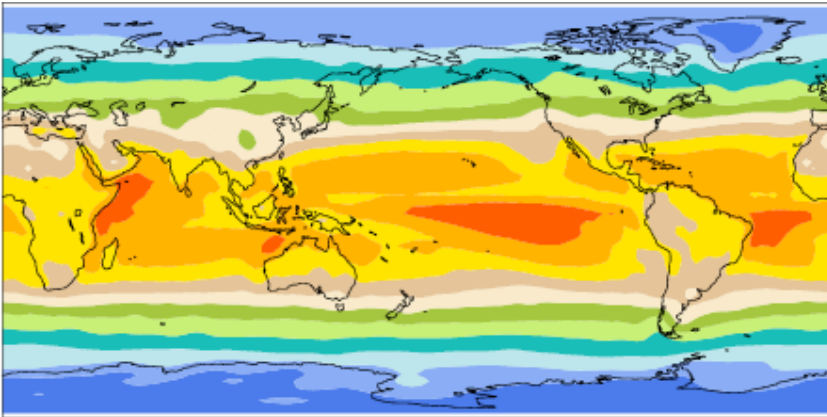
Min = 128.52      mean= 237.84      Max = 295.41



# TOA NetSW - Annual Mean

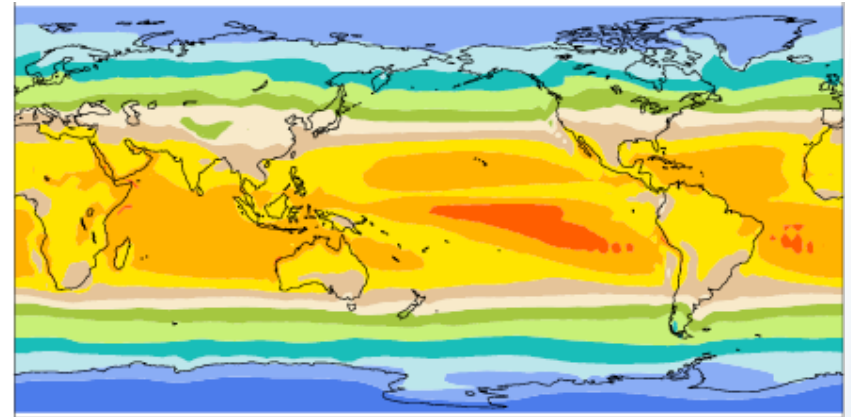
**ERBE**

Min = 43.32      mean= 234.00      Max = 352.95



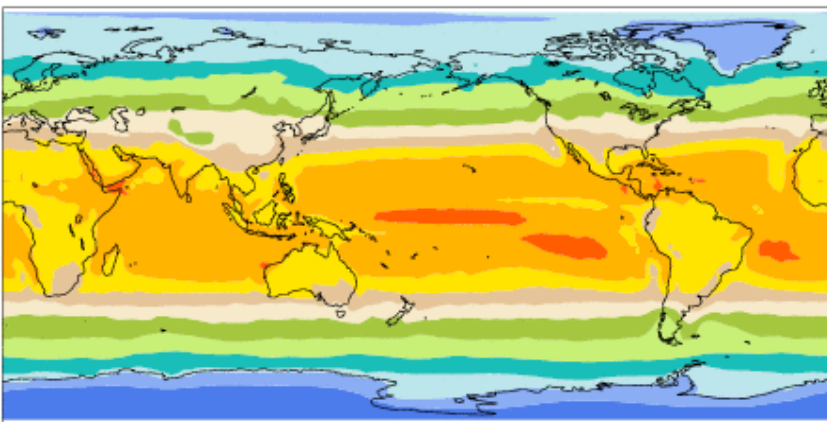
**SPCAM**

Min = 52.83      mean= 237.63      Max = 348.37



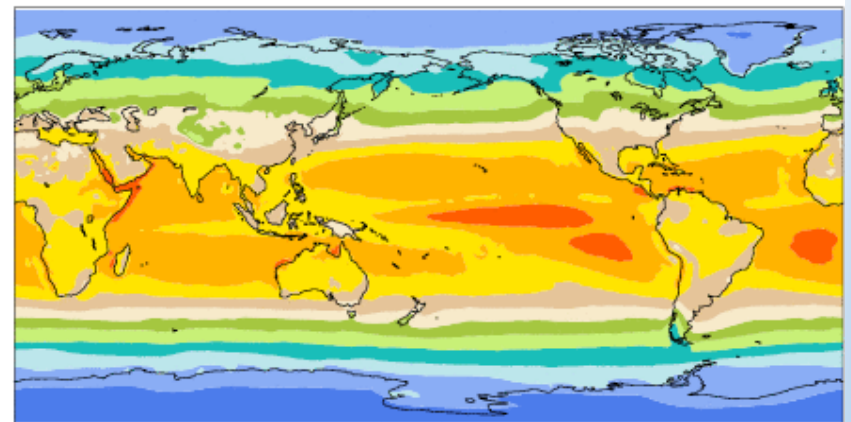
**SPCCSM3.0**

Min = 52.95      mean= 243.66      Max = 349.41

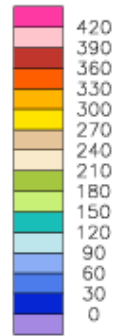


**CCSM3.5**

Min = 54.48      mean= 240.28      Max = 354.76



W/m<sup>2</sup>



# TOA Radiation Budget

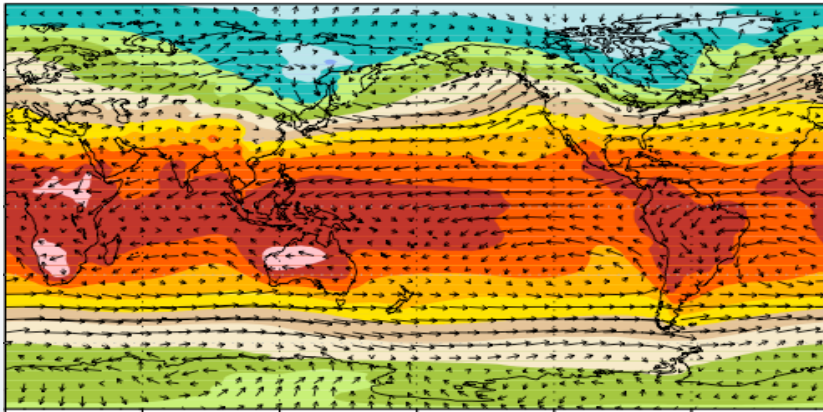
	Observed		AMIP simulation	Coupled simulation		
	ERBE	CERES2	SPCAM	CCSM 3.0	SPCCSM 3.0	CCSM 3.5
<b>OLR</b> (W/m <sup>2</sup> )	<b>233.95</b>	<b>239.57</b>	<b>238.31</b>	<b>232.54</b>	<b>241.30</b>	<b>237.84</b>
<b>NetSW</b> (W/m <sup>2</sup> )	<b>234.00</b>	<b>240.38</b>	<b>237.63</b>	<b>233.18</b>	<b>243.66</b>	<b>240.28</b>
<b>SW-LW</b> (W/m <sup>2</sup> )	<b>0.05</b>	<b>0.81</b>	<b>-0.68</b>	<b>0.64</b>	<b>2.33</b>	<b>2.44</b>



# 850hPa Temperature and Wind - DJF

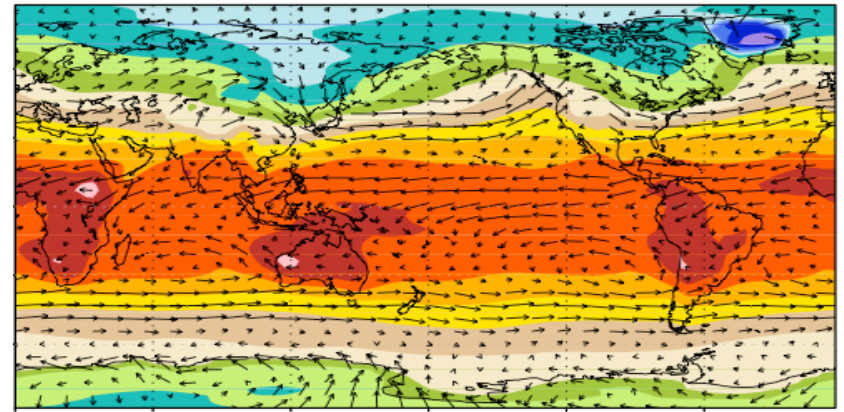
## ECMWF (1979-1993)

min = 243.45      mean = 279.52      max = 299.02



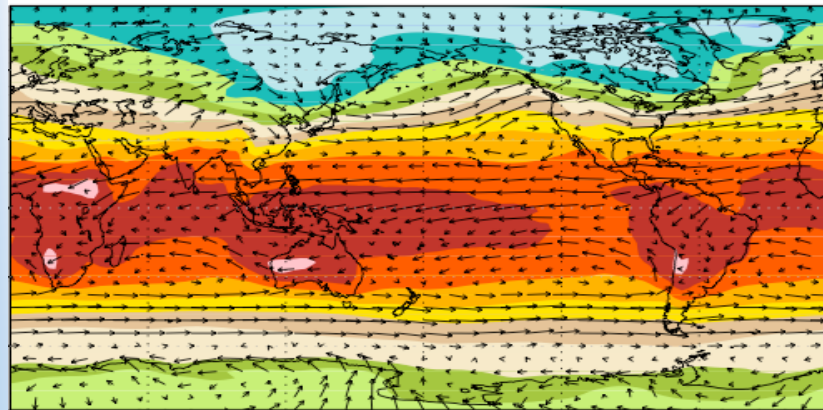
## SPCCSM3.0

min = 227.24      mean = 278.60      max = 296.10



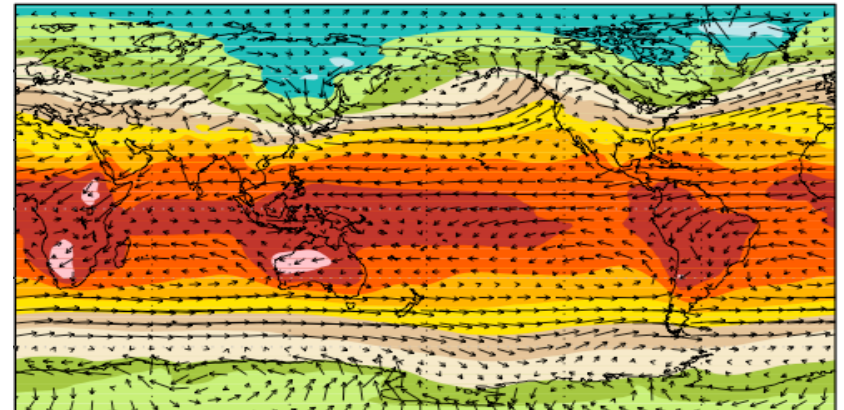
## CCSM3.0

min = 243.78      mean = 279.02      max = 297.12



## CCSM3.5

min = 245.73      mean = 279.55      max = 297.92

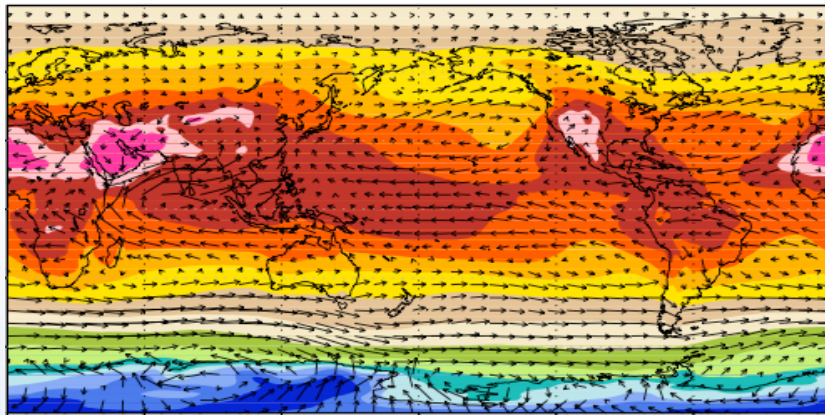


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# 850hPa Temperature and Wind - JJA

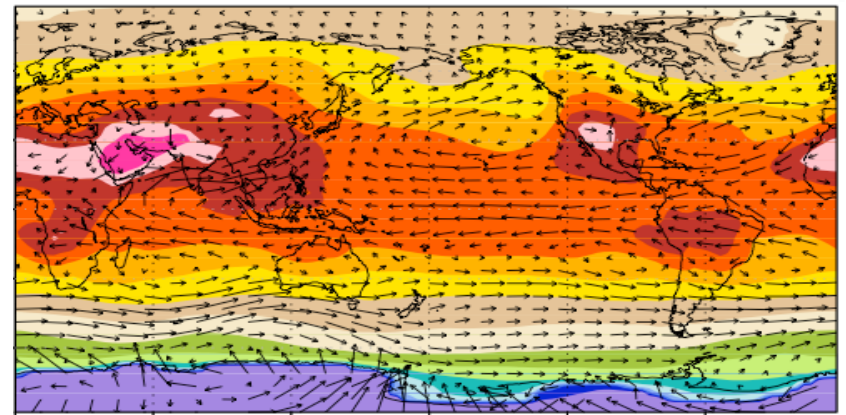
**ECMWF (1979-1993)**

min = 230.72      mean = 282.24      max = 304.94



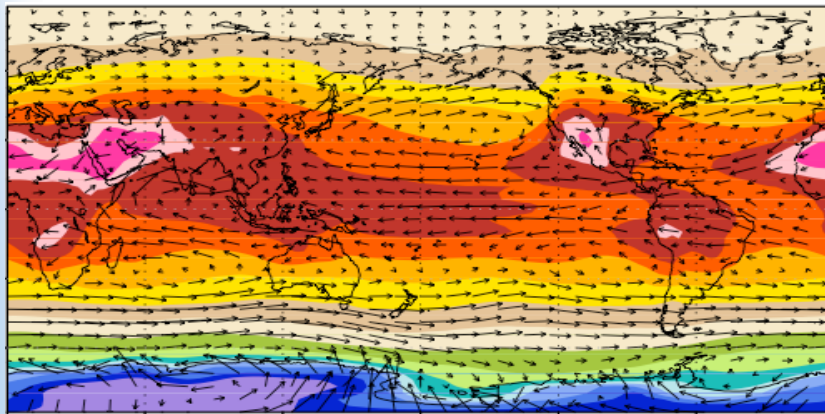
**SPCCSM3.0**

min = 200.89      mean = 281.01      max = 302.96



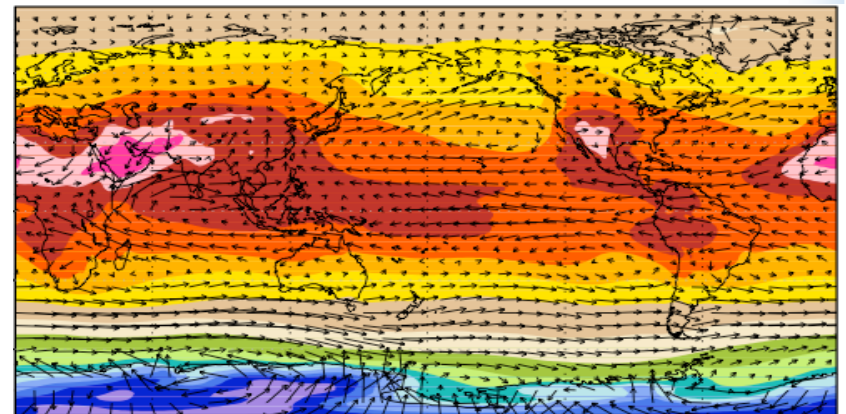
**CCSM3.0**

min = 213.31      mean = 281.79      max = 304.55



**CCSM3.5**

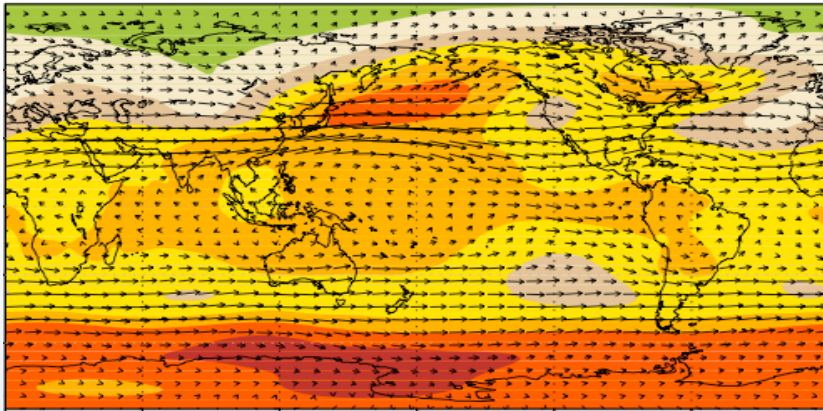
min = 226.35      mean = 282.12      max = 302.82



# 200hPa Temperature and Wind - DJF

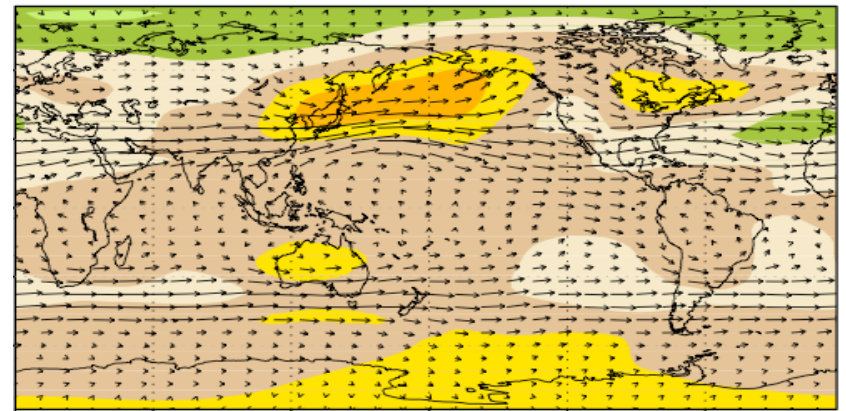
## ECMWF (1979-1993)

min = 209.89      mean = 219.40      max = 227.88



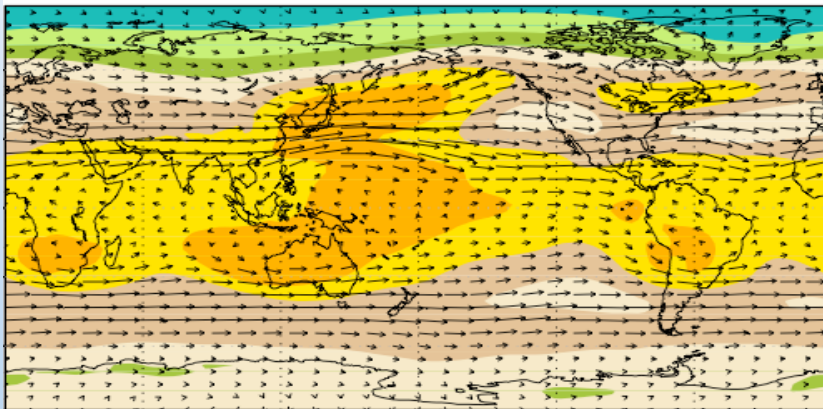
## SPCCSM3.0

min = 207.88      mean = 215.03      max = 222.22



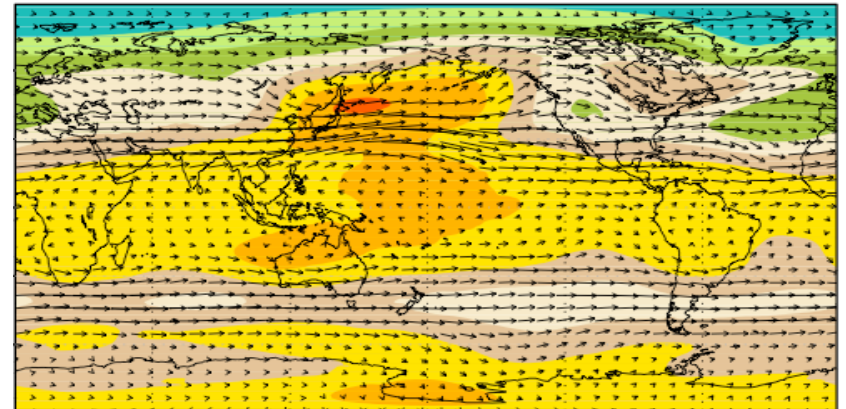
## CCSM3.0

min = 203.08      mean = 216.80      max = 222.85



## CCSM3.5

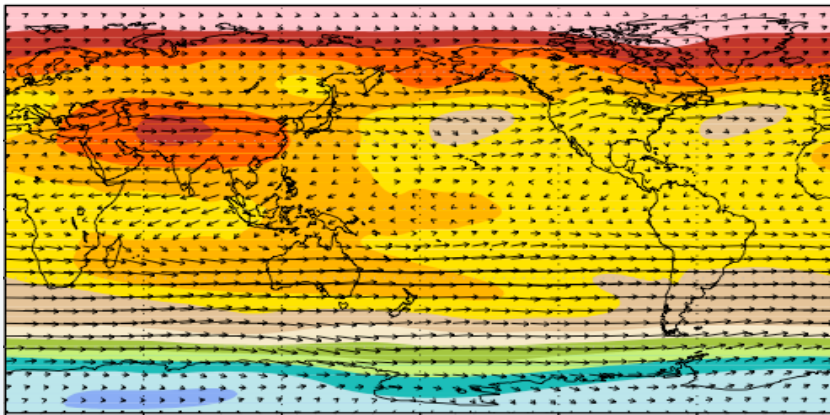
min = 203.13      mean = 216.54      max = 223.53



# 200hPa Temperature and Wind - JJA

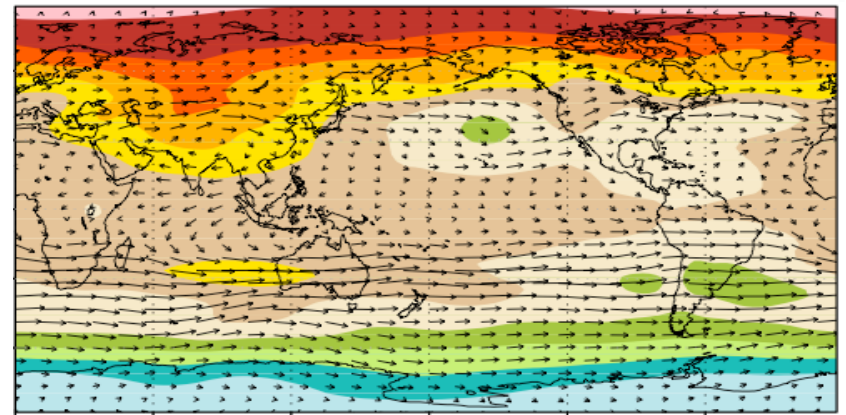
## ECMWF (1979-1993)

min = 198.62      mean = 218.74      max = 231.15



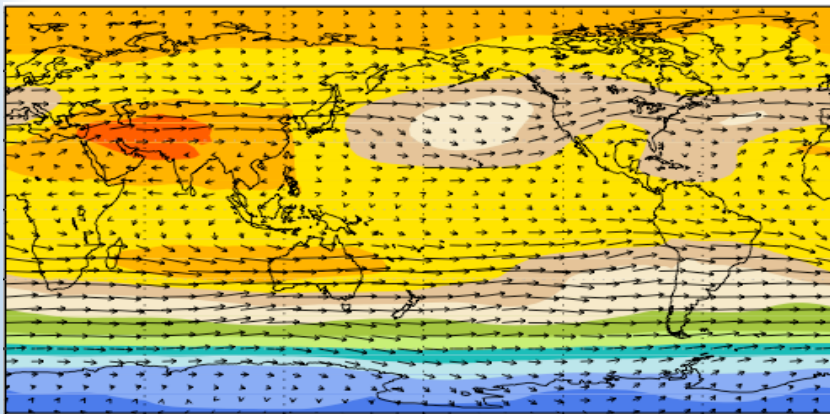
## SPCCSM3.0

min = 199.29      mean = 214.66      max = 229.46



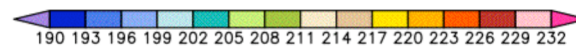
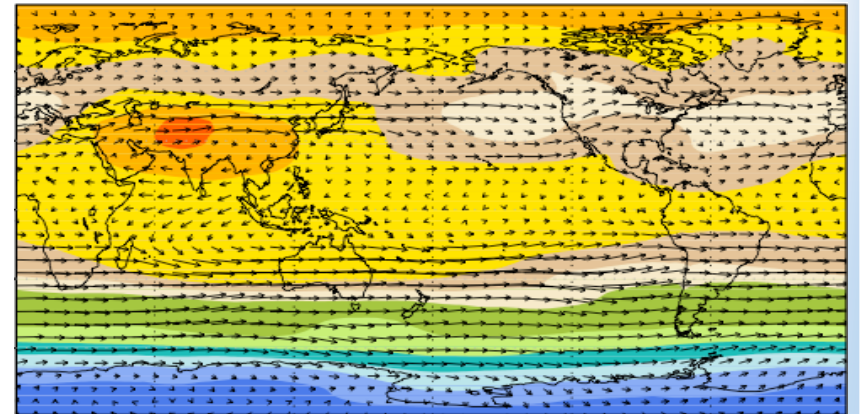
## CCSM3.0

min = 195.24      mean = 216.02



## CCSM3.5

min = 194.49      mean = 214.82      max = 224.06



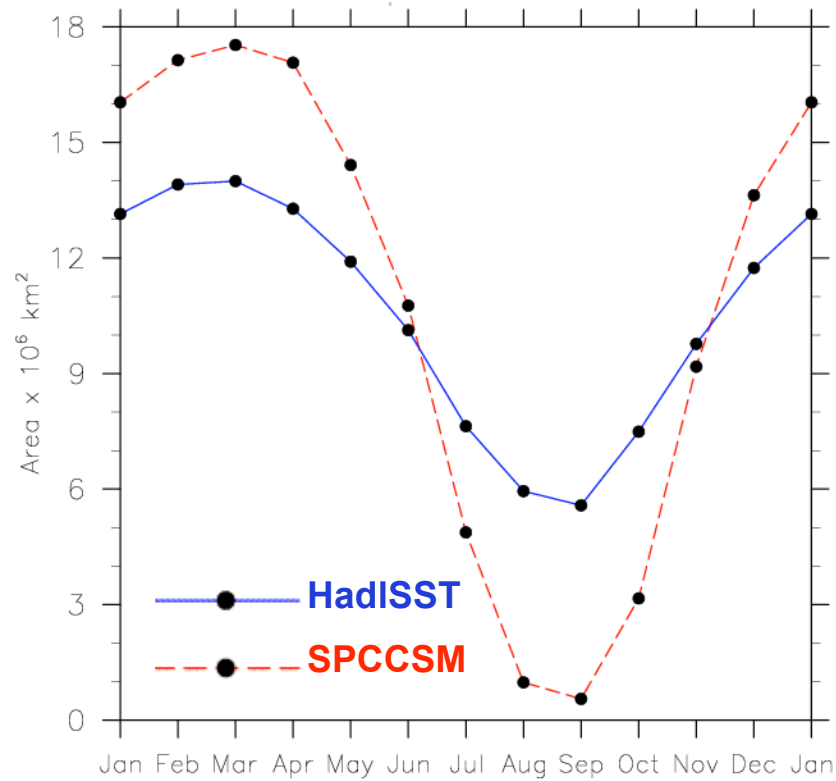
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# **Known Problems in SPCCSM3.0**

# Sea-ice Area - Annual Cycle Global Mean Climatology

## Northern Hemisphere



## Southern Hemisphere

