

# Bias Evolution in CESM2

# Experimental Set-up: transpose-AMIP, “CAPT”

- CESM2 “WACCM6-SC” - specified chemistry high-top atmospheric model
- 1-degree
- Prescribed monthly-mean SSTs
- ERA-I initial conditions
  - Dec 1 2013-Feb 28 2014
  - Jun 1 2014-Aug 31 2014
- 5-day forecasts
- Land spun-up for 1 month prior to Dec 1 in nudged run that continued through JJA
- *Even with specified chemistry, forcing data, e.g., aerosols, land-surface ... etc., became an issue with CESM2*

# Evolution of CAM Model Physics

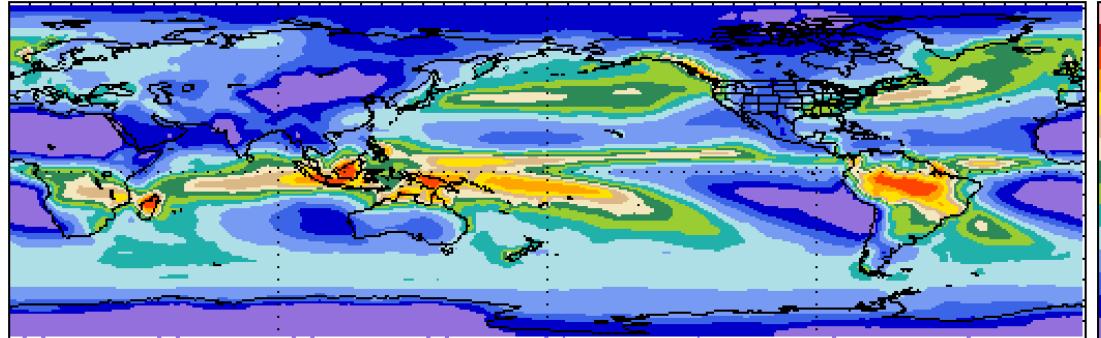
<b>Model</b>	<b>CAM3 CCSM3</b>	<b>CAM4 CCSM4</b>	<b>CAM5 CESM1.0</b>	<b>CAM6 CESM2.1</b>
<b>Release</b>	<b>Jun 2004</b>	<b>Apr 2010</b>	<b>Jun 2010</b>	<b>Dec 2018</b>
PBL	Holtslag-Boville (1993)	Holtslag-Boville (1993)	Bretherton et al (2009)	CLUBB
Orographic form drag			Richter et al. (2010) “TMS”	Beljaars et al. 2003
GW drag	McFarlane (1987)	McFarlane (1987)	McFarlane (1987) (non-orographic sources for WACCM)	Anisotropic/Low-level nonlinearities
Shallow Convection	Hack (1994)	Hack (1994)	Park et al. (2009)	CLUBB
Deep Convection	Zhang-McFarlane (1995)	Neale et al. (2008)	Neale et al. (2008)	Neale et al. (2008) Re-tuning
Microphysics	Rasch-Kristjansson (1998)	Rasch-Kristjansson (1998)	Morrison-Gettelman (2008)	Morrison-Gettelman v2 (2014)
Macrophysics	Rasch-Kristjansson (1998); Zhang et al (2003)	Rasch-Kristjansson (1998); Zhang et al (2003)	Park et al. (2011); Zhang et al (2003)	CLUBB
Radiation	Collins et al. (2001)	Collins et al. (2001)	Iacono et al. (2008)	Iacono et al. (2008)
Aerosols	Bulk Aerosol Model	Bulk Aerosol Model BAM	Modal Aerosol Model (MAM3, Ghan et al., 2011)	Modal Aerosol Model (MAM4, Liu et al., 2016)

= switch parameterization

= significant retuning/modification

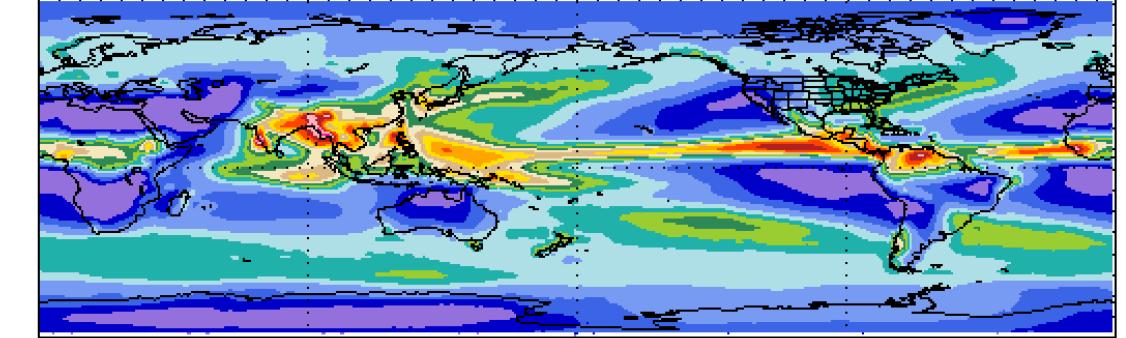
Mean 2.67

GPCP Years1980–2011



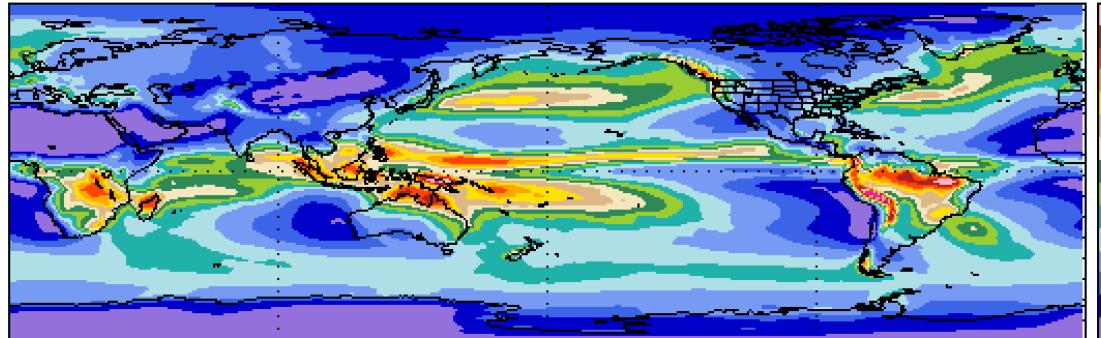
Mean 2.70

GPCP Years1980–2010



Mean 2.87

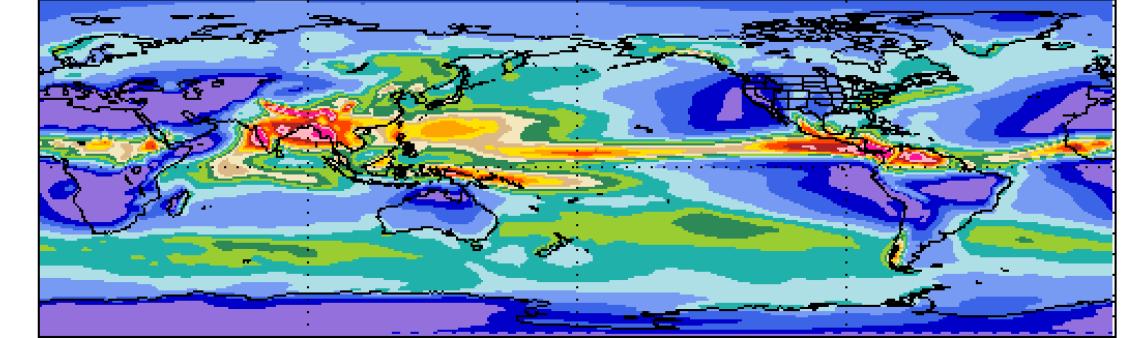
Fx\_e21a1e\_FWscHIST\_f09\_f09\_e01 Years1980–2011



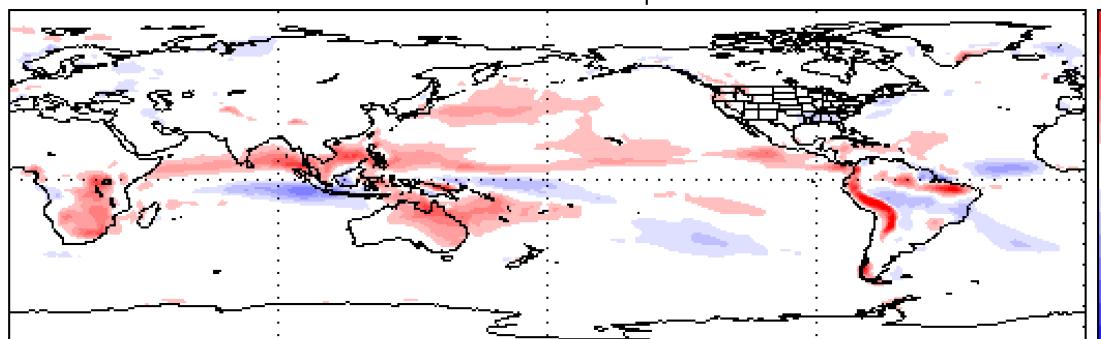
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 PANL: CORR= 0.85; DEV=1.14; RMSE=1.47; BIAS=0.19  
 GLOBAL: CORR= 0.89; DEV=1.12; RMSE=1.16; BIAS=0.19  
 middle minus top

Mean 2.99

Fx\_e21a1e\_FWscHIST\_f09\_f09\_e01 Years1980–2010



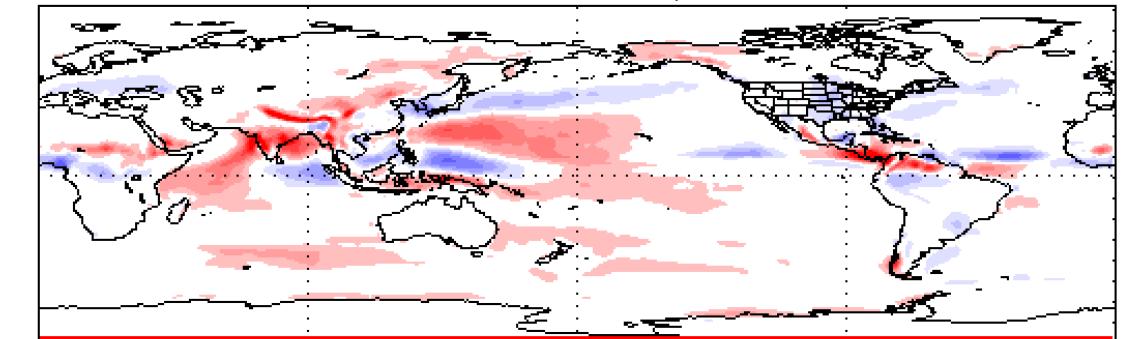
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 GLOBAL: CORR= 0.87; DEV=1.16; RMSE=1.42; BIAS=0.28  
 middle minus top



DJF PRECT

Scale factor= 1.000

7.000  
6.000  
5.000  
4.000  
3.000  
2.000  
1.000  
0.000  
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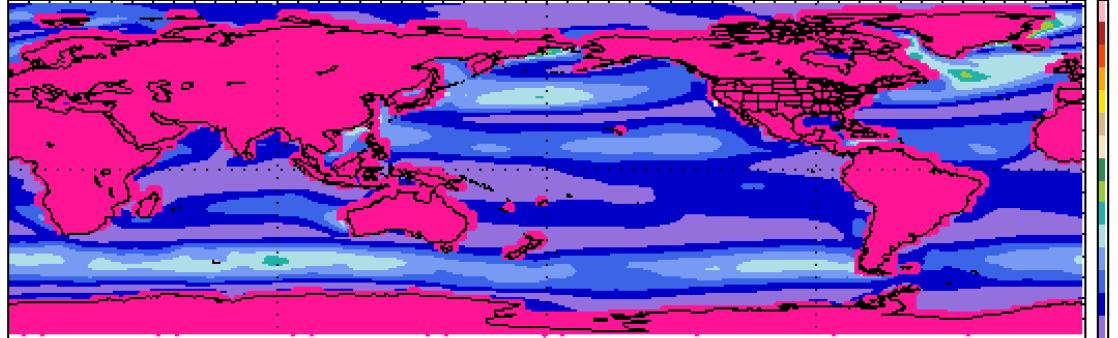
JJA PRECT

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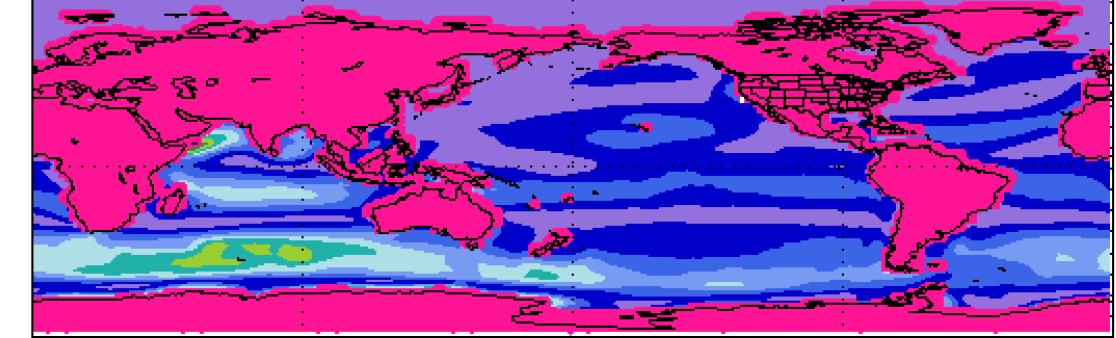
Mean \*\*\*\*\*

Large Yeager Years1980–2011



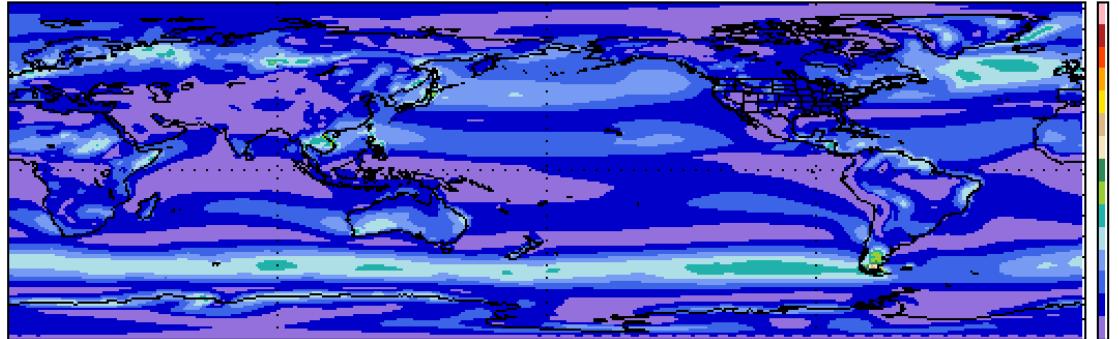
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Large Yeager Years1980–2010



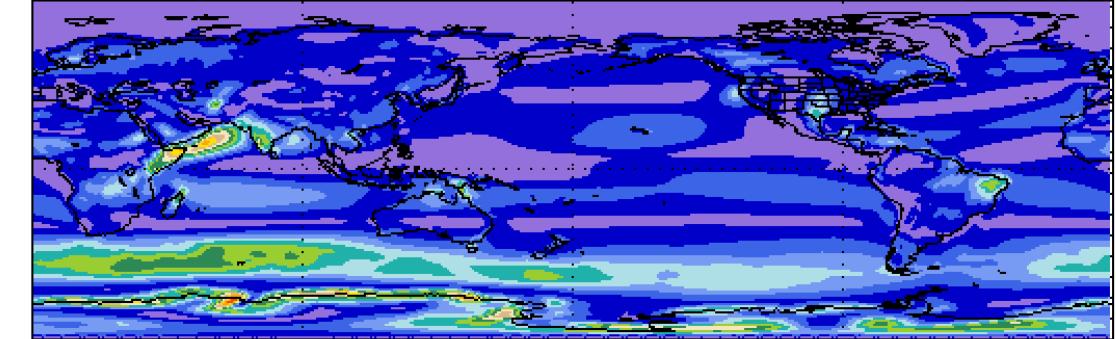
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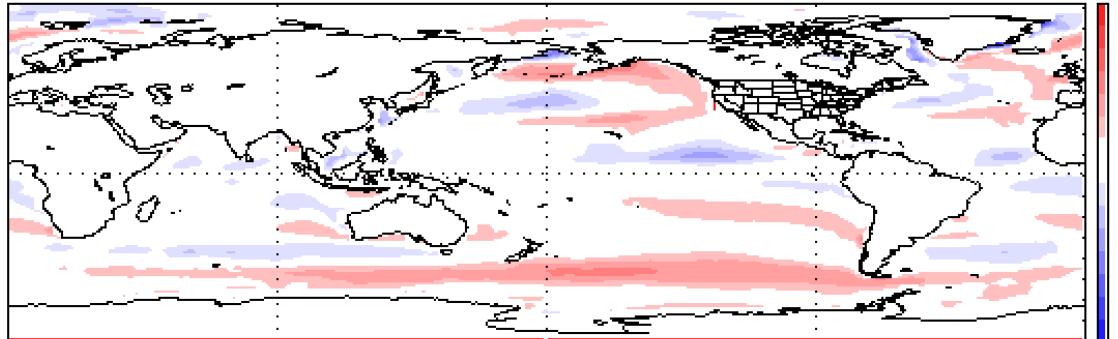


Mean 0.08

Fx\_e21a1e\_FWschIST\_f09\_f09\_e01 Years1980–2010



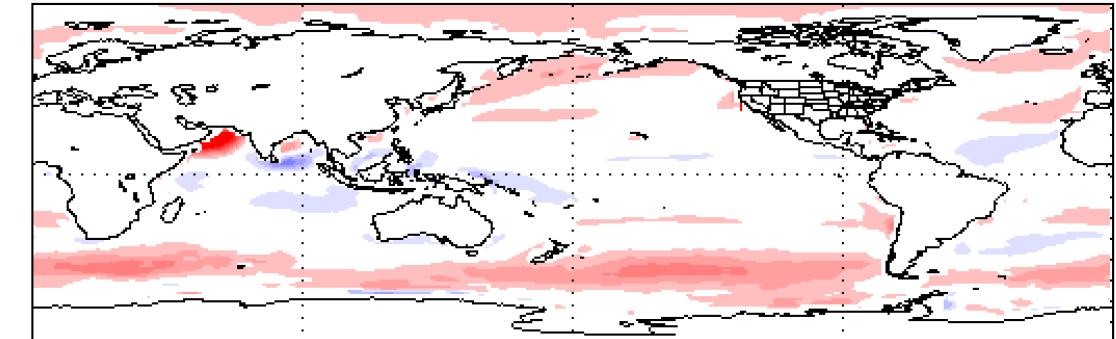
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LAND: CORR= -NaN; DEV=-NaN; RMSE=Inf; BIAS=\*\*\*\*\*  
GLOBAL: CORR= -NaN; DEV=-NaN; RMSE=Inf; BIAS=\*\*\*\*\*  
middle minus top



DJF STRESS

Scale factor= 1.000

OCEAN: CORR= -NaN; DEV=-NaN; RMSE=Inf; BIAS=\*\*\*\*\*  
LAND: CORR= -NaN; DEV=-NaN; RMSE=Inf; BIAS=\*\*\*\*\*  
GLOBAL: CORR= -NaN; DEV=-NaN; RMSE=Inf; BIAS=\*\*\*\*\*  
middle minus top



JJA STRESS

Scale factor= 1.000

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0.480  
0.440  
0.400  
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0.120  
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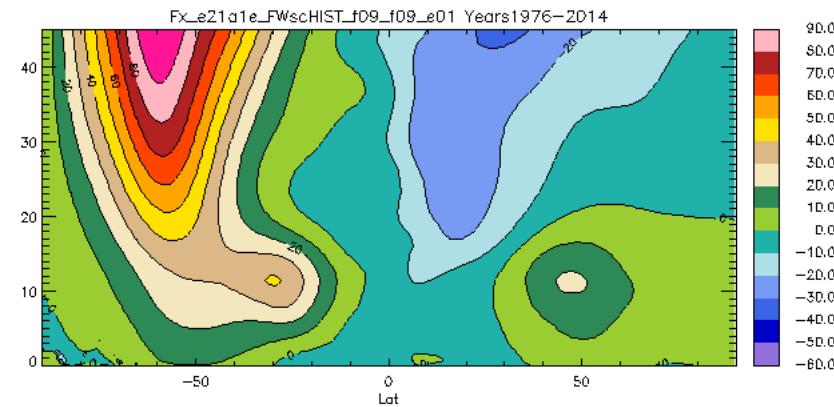
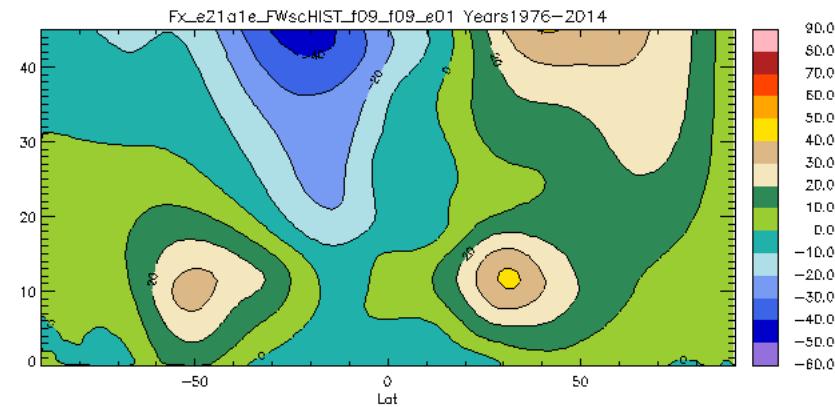
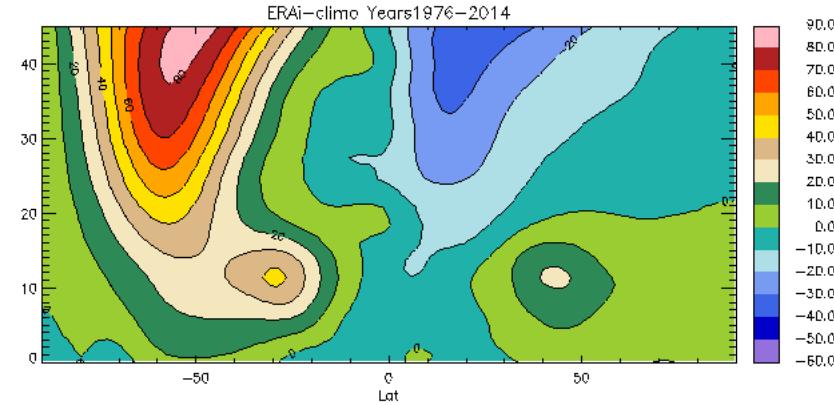
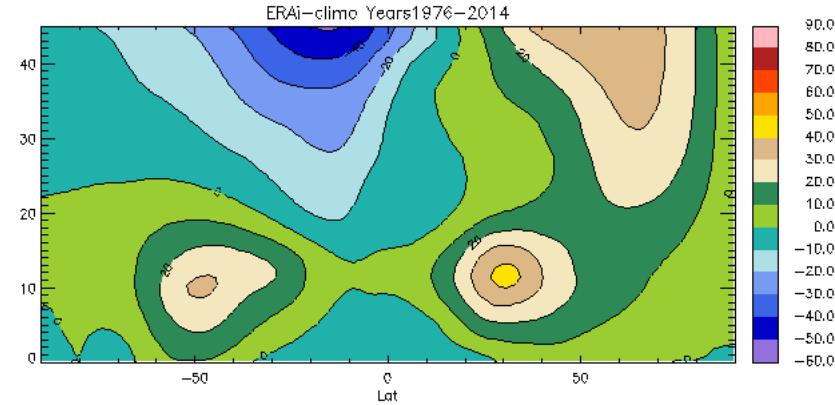
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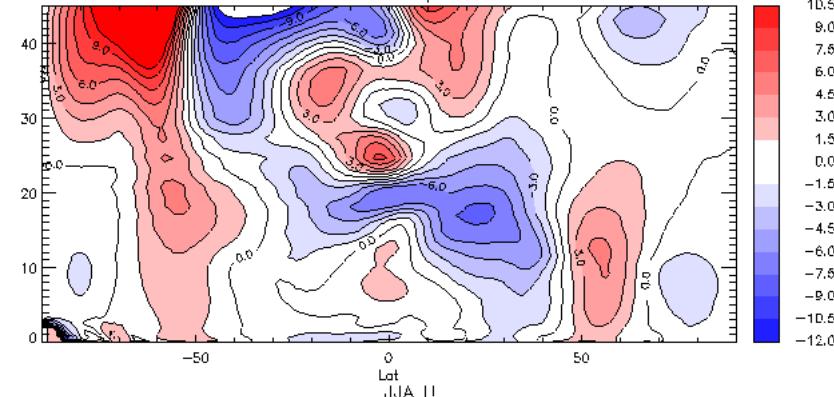
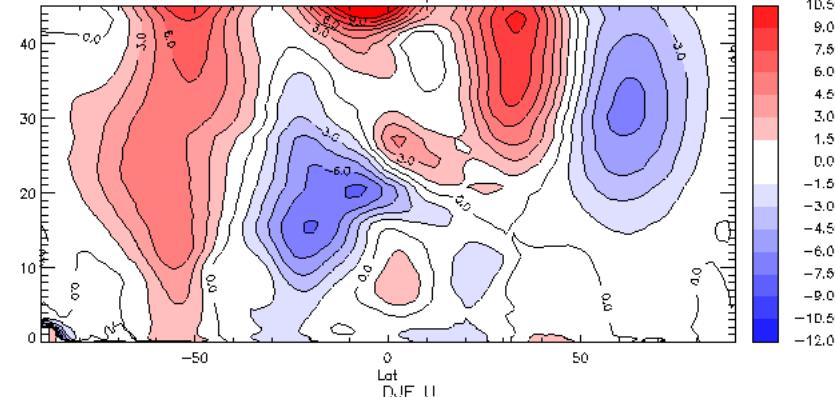


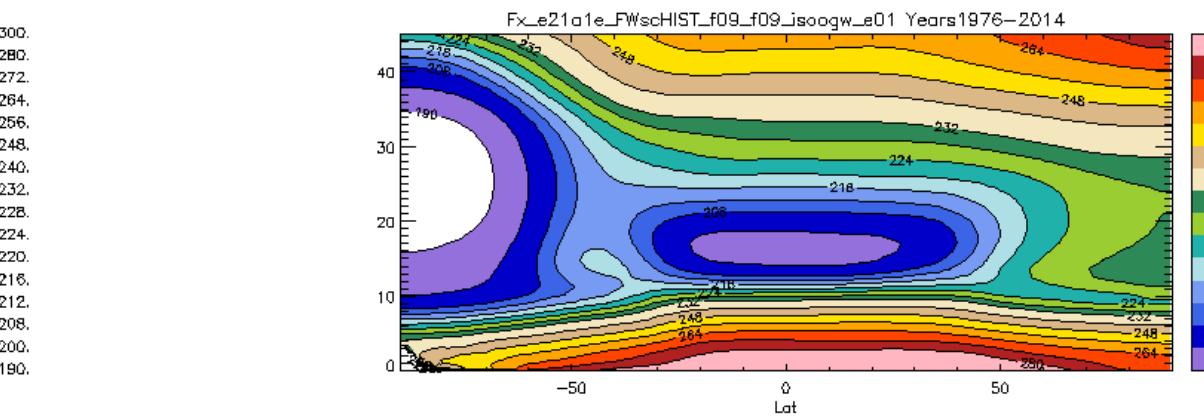
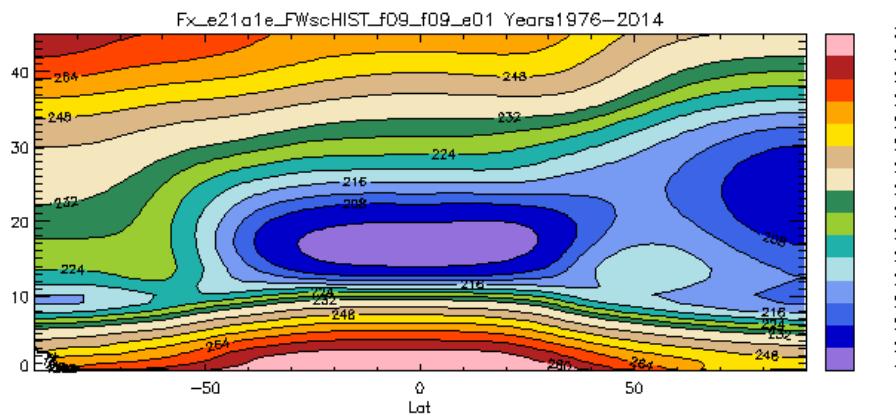
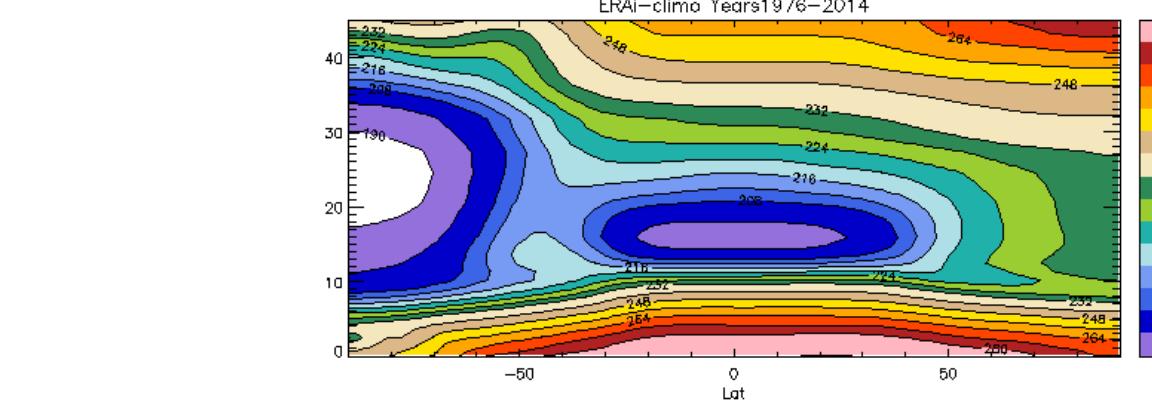
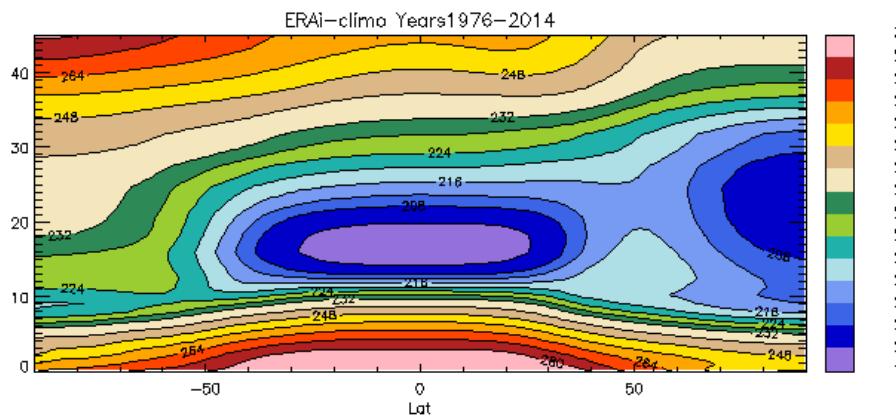
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NH>30N: CORR= 0.86; DEV=0.94; RMSE=2.96; BIAS=0.04

GLOBAL: CORR= 0.98; DEV=1.00; RMSE=3.01; BIAS=0.01

middle-top



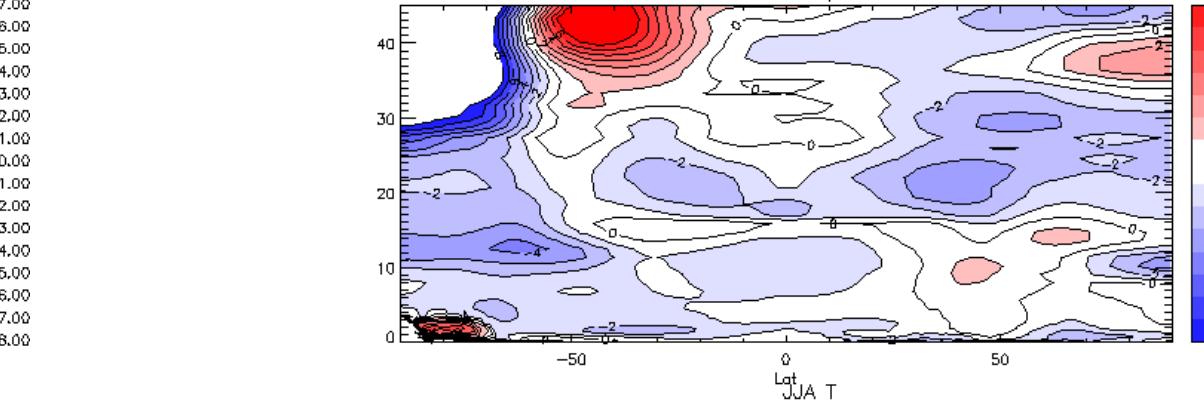
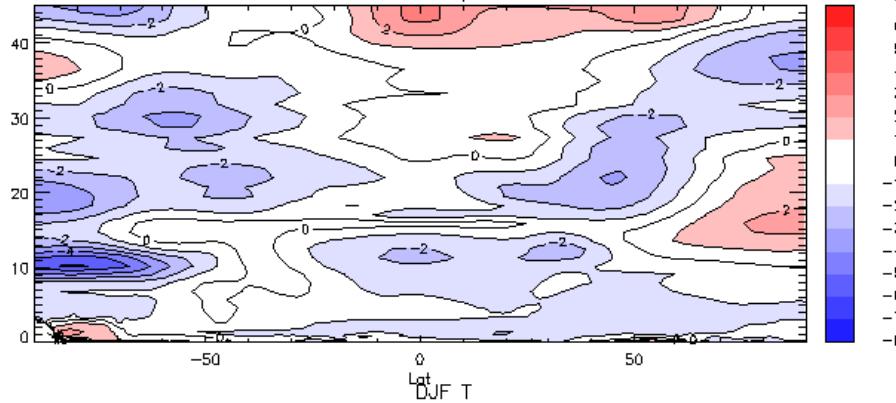


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NH>30°: CORR= 1.00; DEV=1.01; RMSE=1.42; BIAS=-0.84

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middle-top

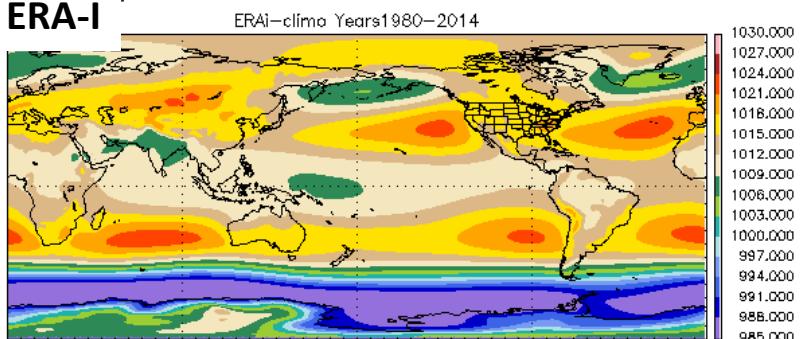


Scale factor= 1.000

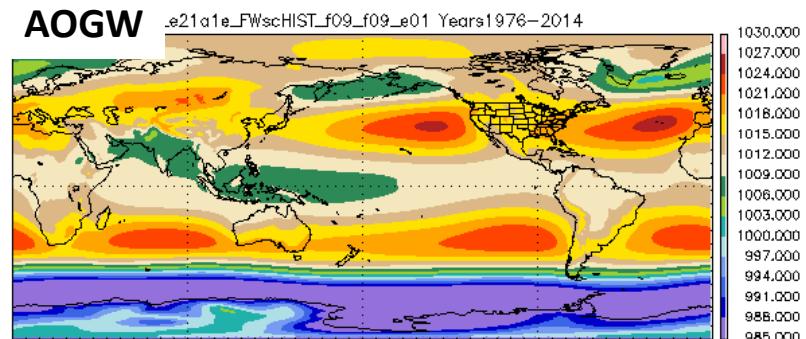
Scale factor= 1.000

# Annual Mean Sea Level Pressure

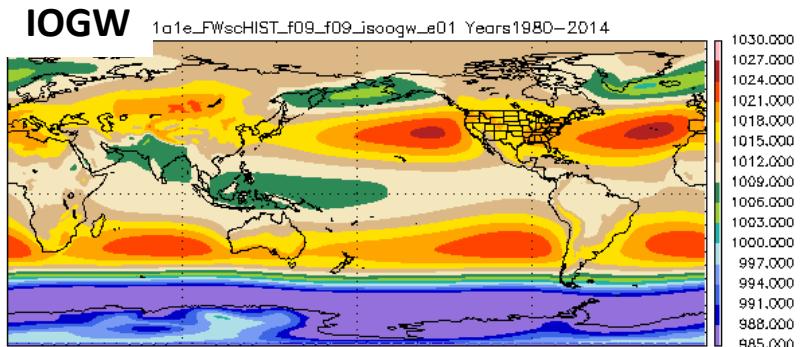
ERA-I



AOGW

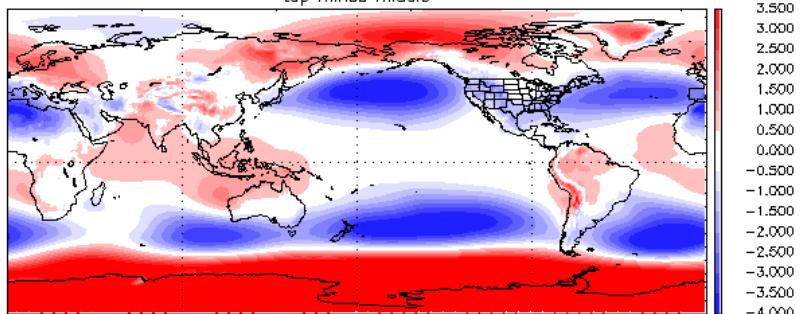


IOGW



OCEAN: CORR= 0.99; DEV=1.17; RMSE=2.12; BIAS=0.24  
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GLOBAL: CORR= 0.96; DEV=1.19; RMSE=2.33; BIAS=-0.07

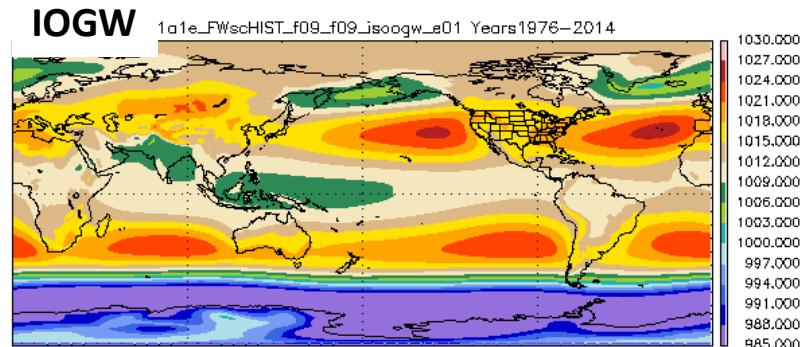
top minus middle



ANN PSL

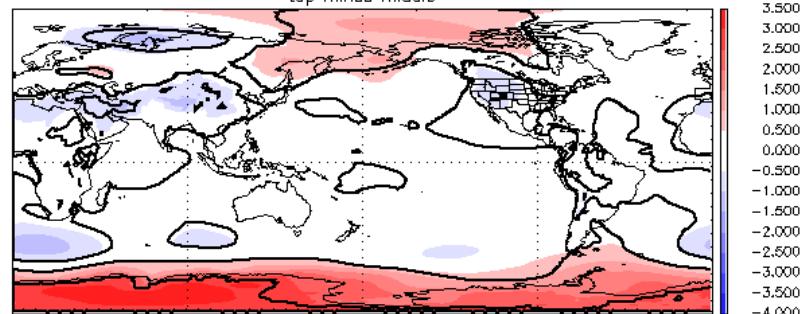
Scale factor= 1.000

IOGW



OCEAN: CORR= 1.00; DEV=1.02; RMSE=0.40; BIAS=0.03  
LAND: CORR= 1.00; DEV=1.10; RMSE=0.94; BIAS=-0.08  
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top minus middle



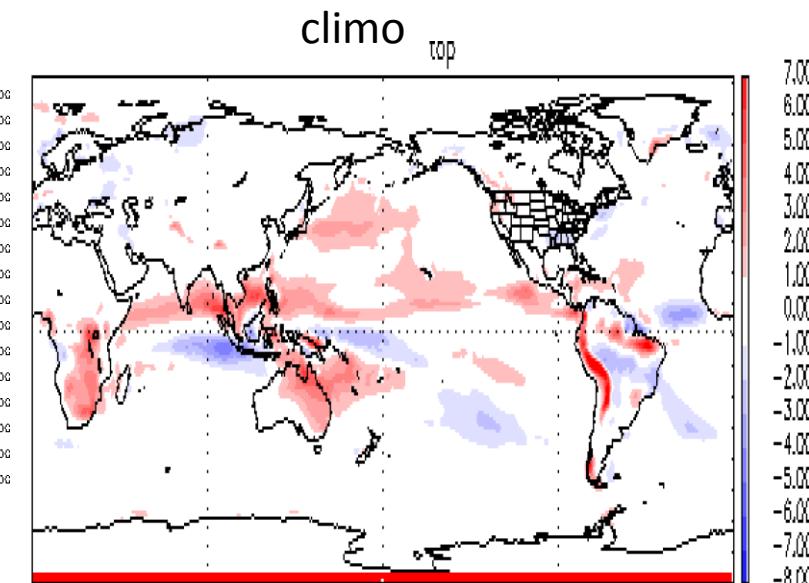
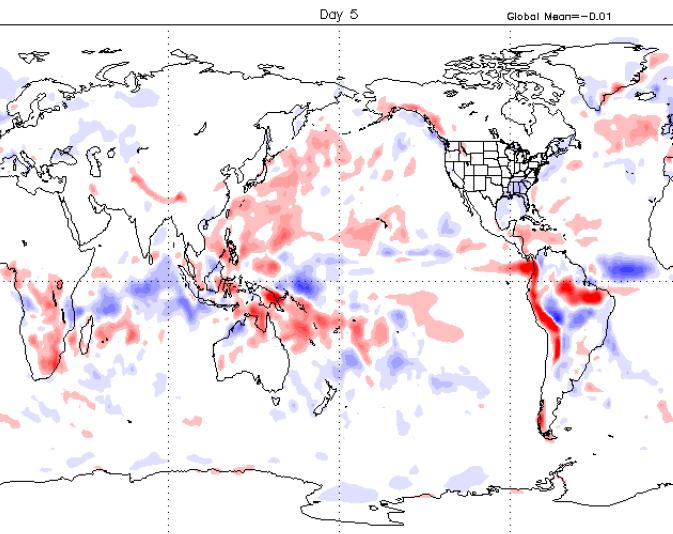
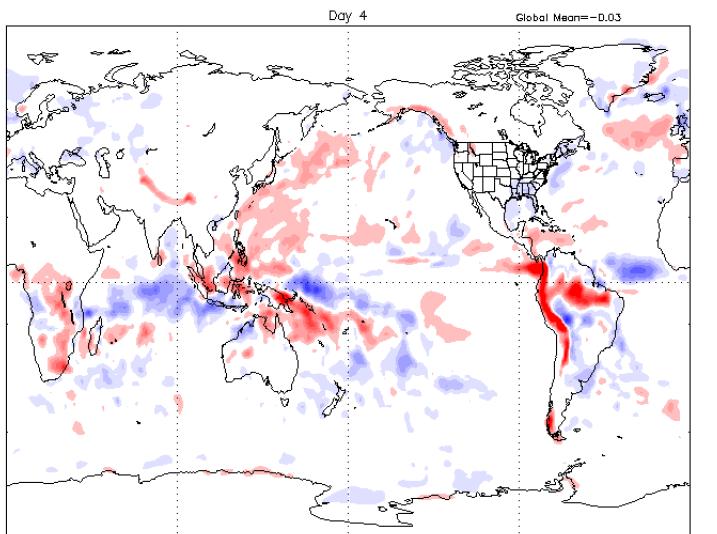
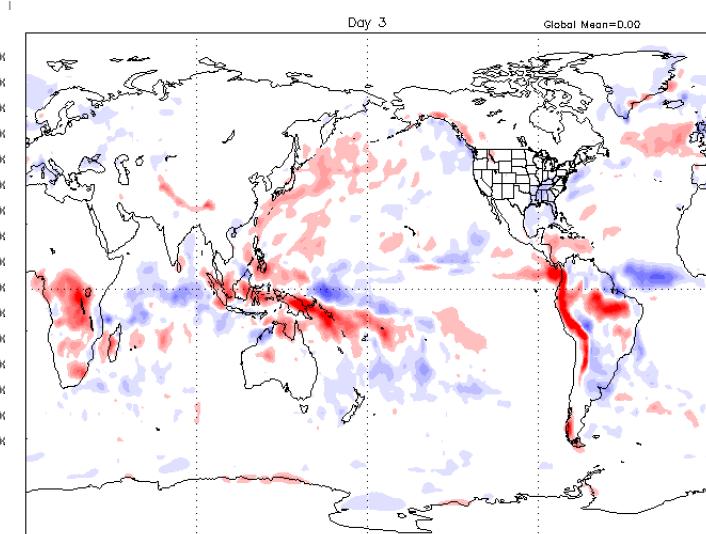
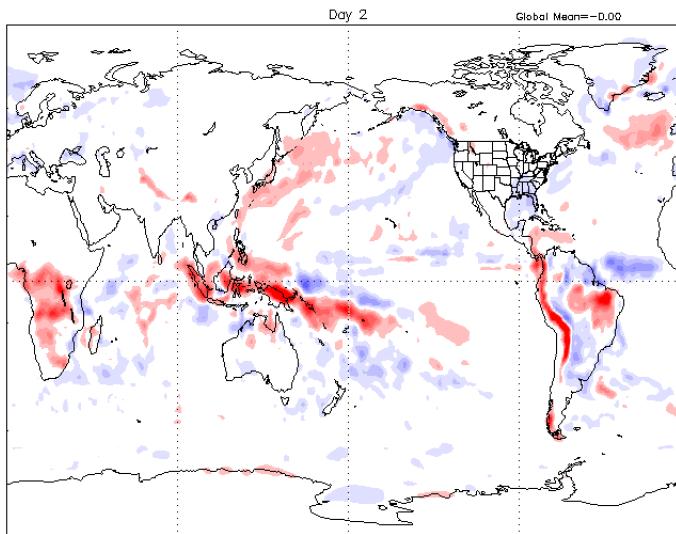
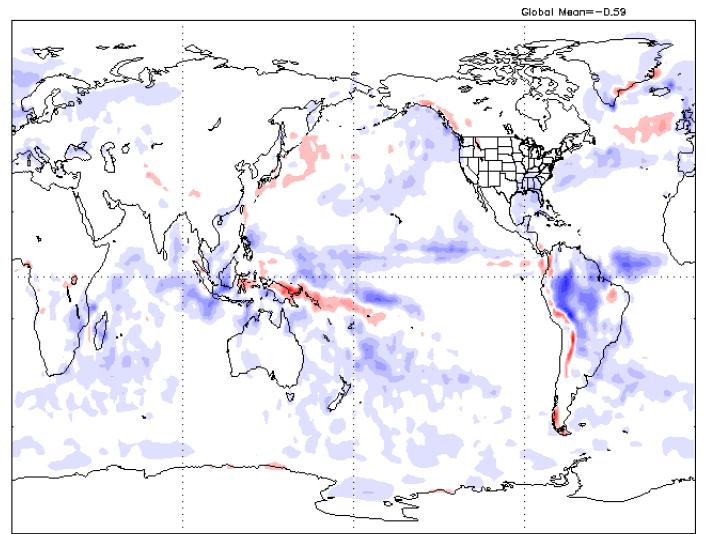
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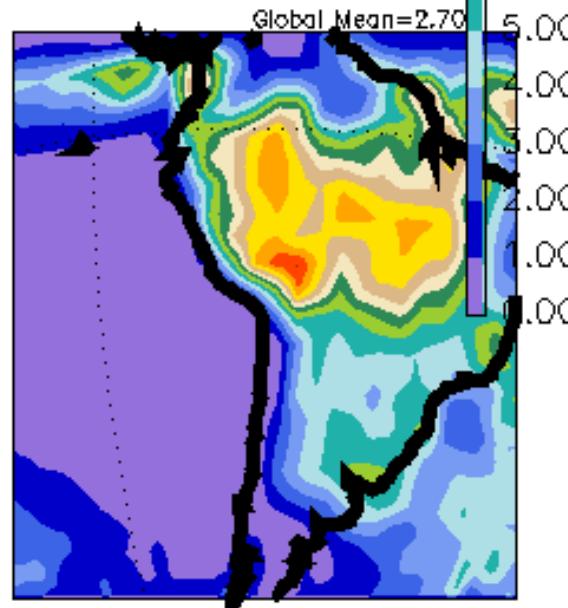
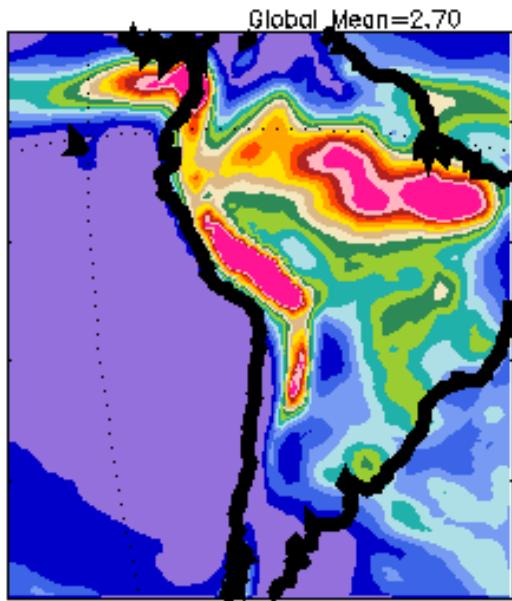
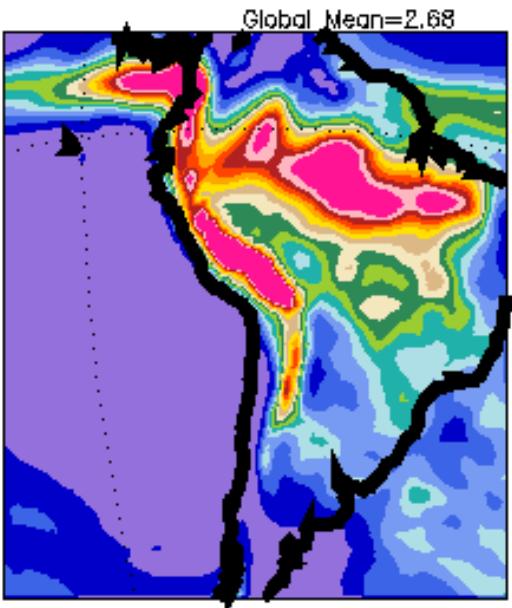
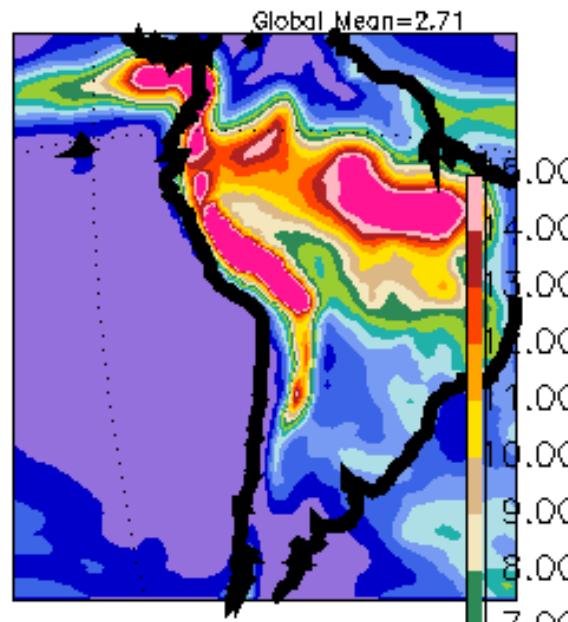
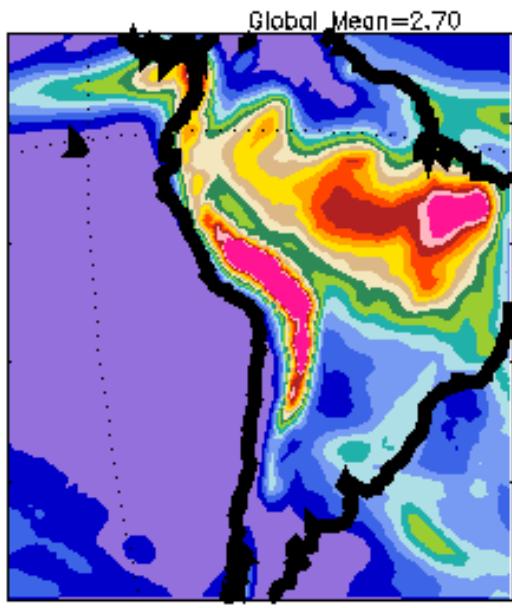
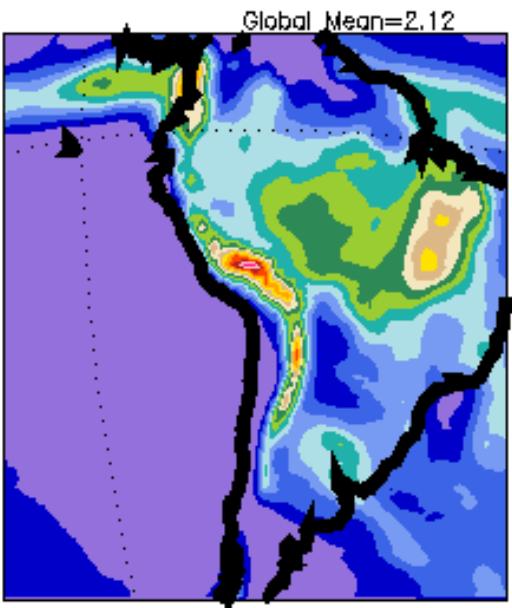
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Significance=85.0000%

# DJF Precip

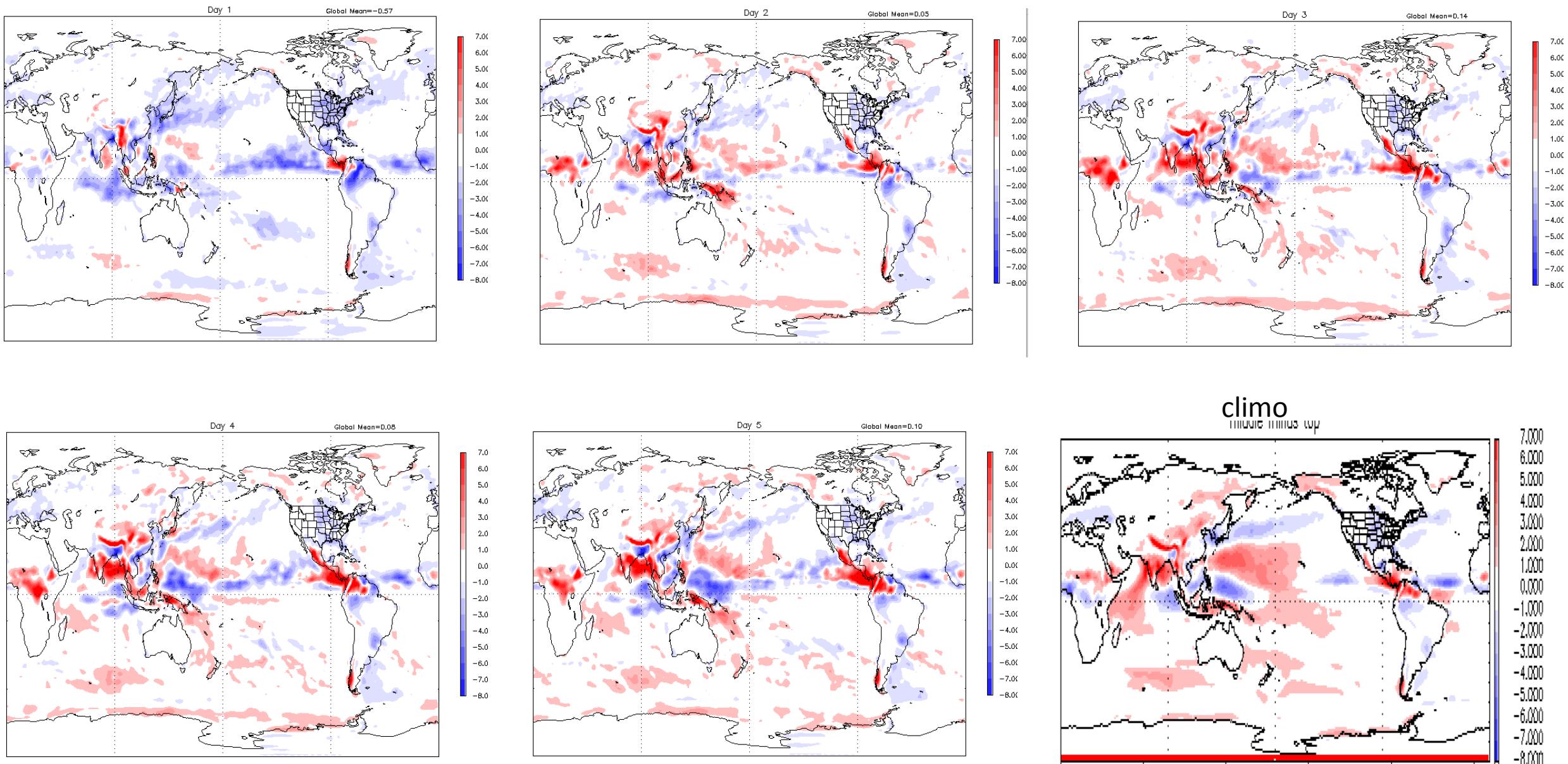
# DJF 2013-2014 biases w/ respect GPCP

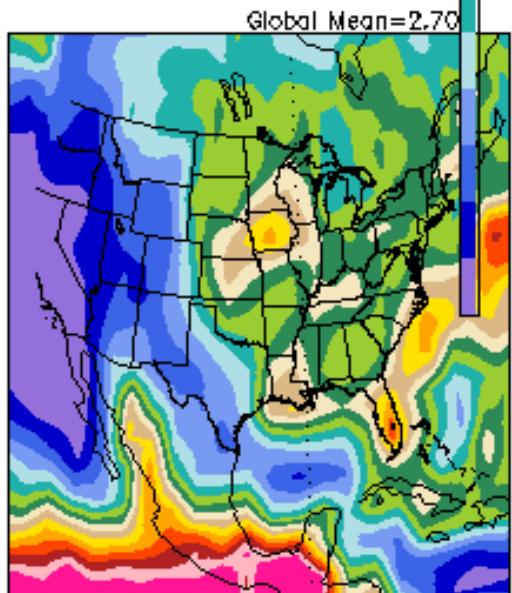
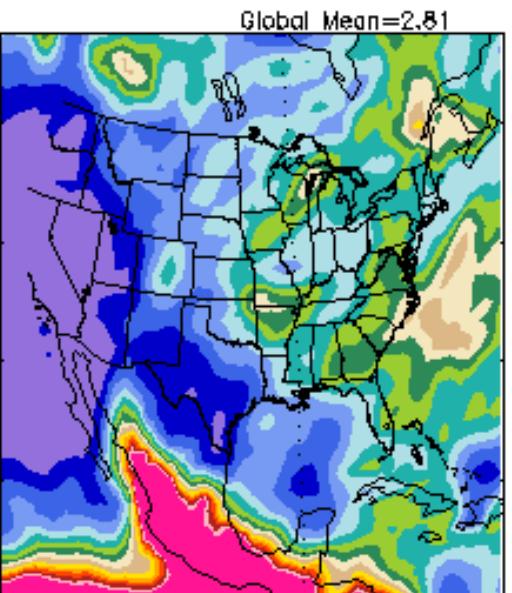
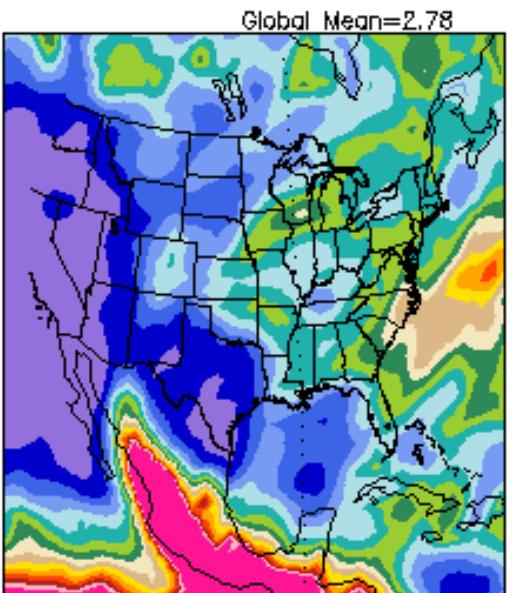
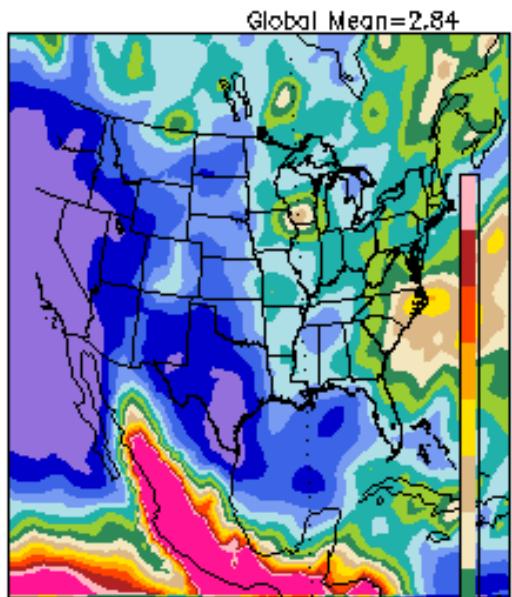
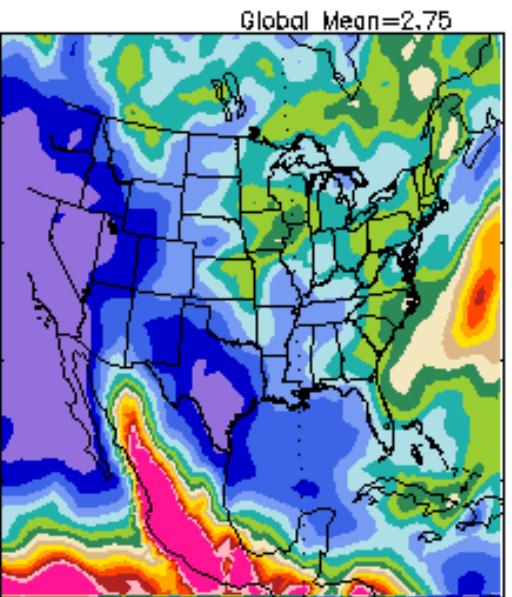
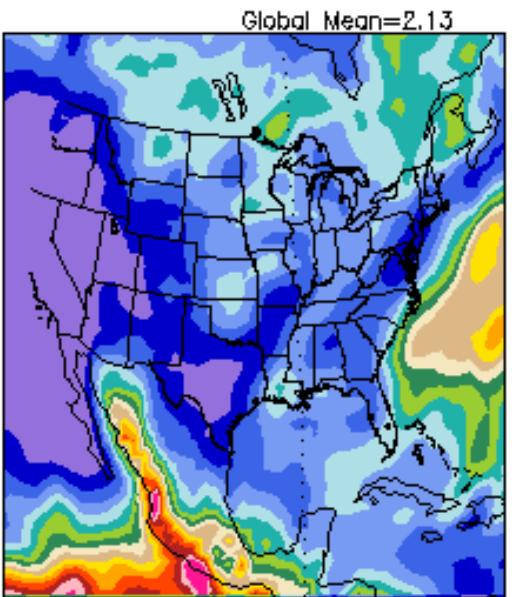




# JJA Precip

# JJA 2014 biases w/ respect GPCP

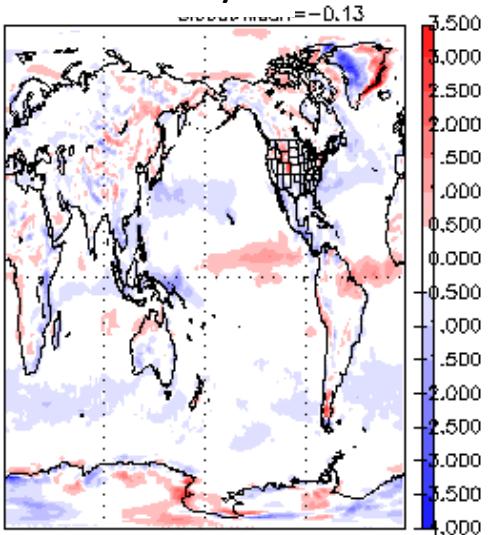




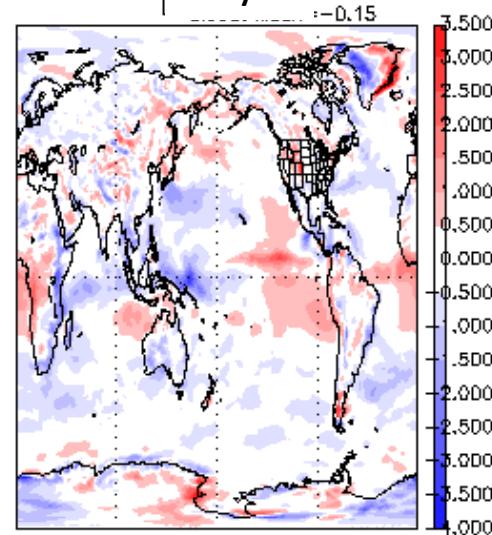
# Winds

# DJF near surface zonal wind (~50m) bias w/resp ERA-i

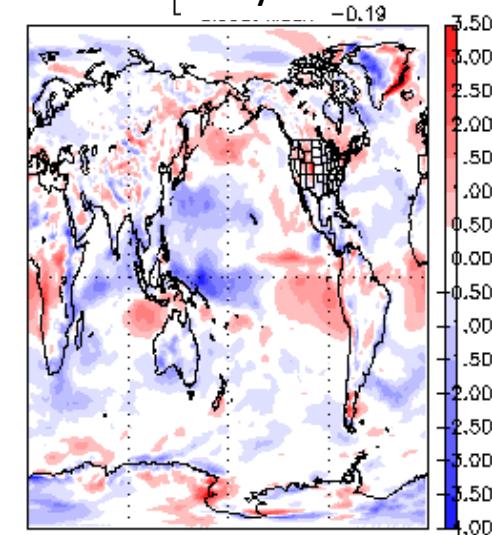
Day 1



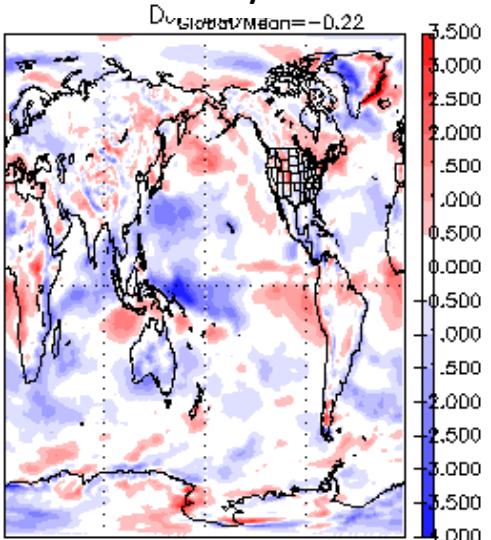
Day 2



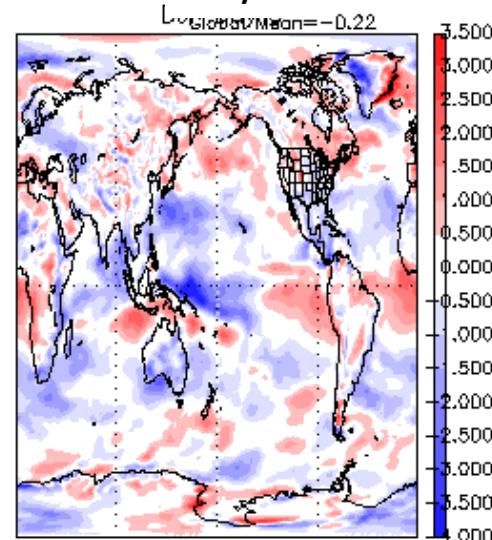
Day 3



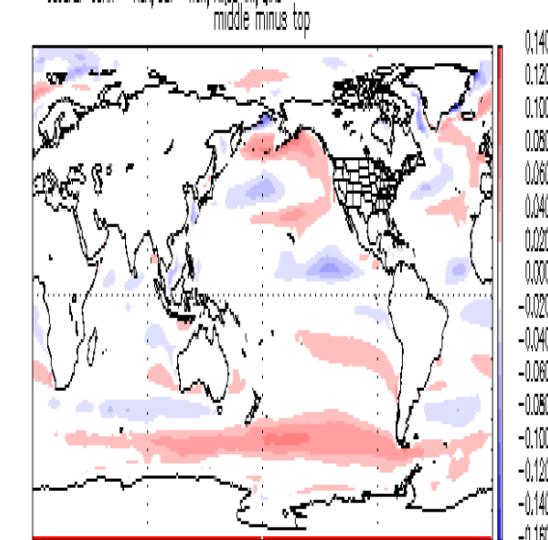
Day 4



Day 5

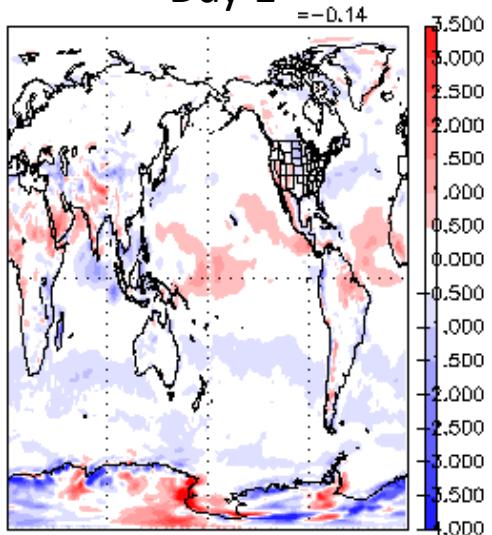


Stress bias  
middle minus top

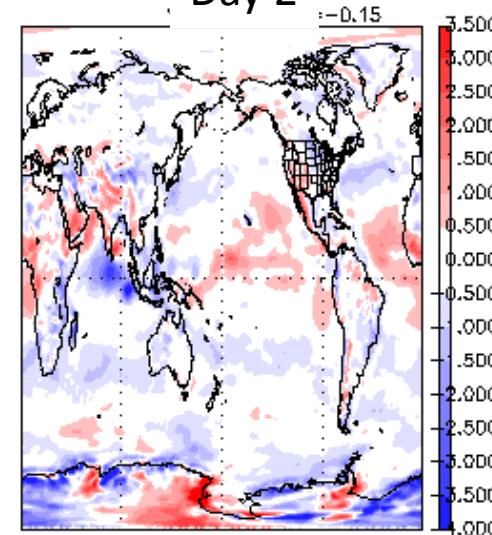


## JJA near surface zonal wind (~50m) bias w/resp ERA-i

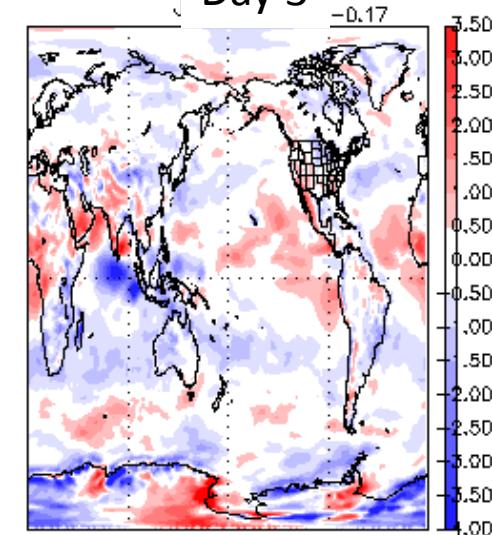
Day 1



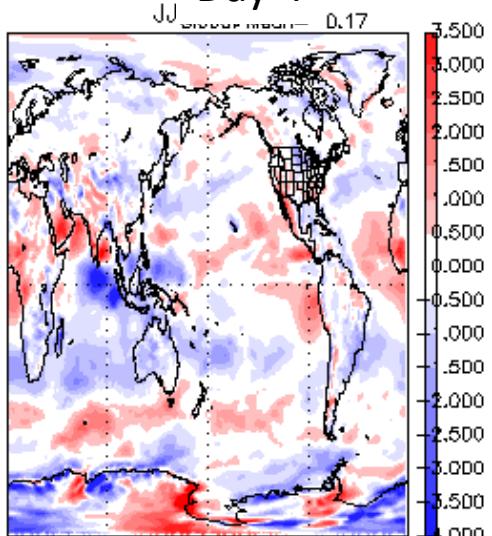
Day 2



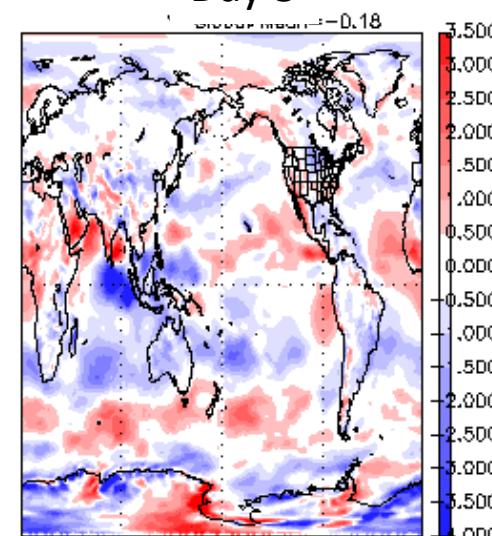
Day 3



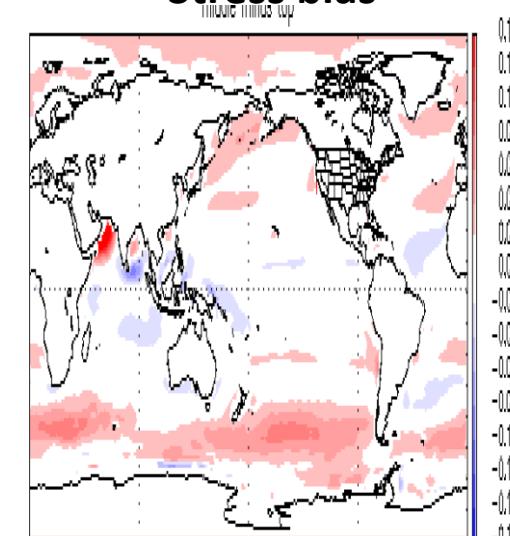
Day 4

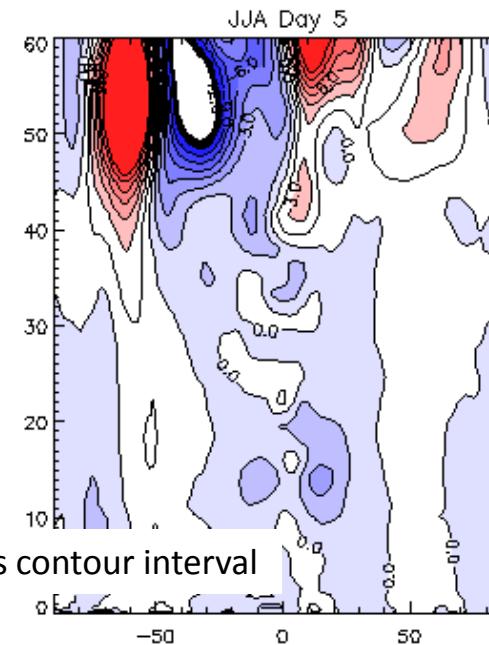
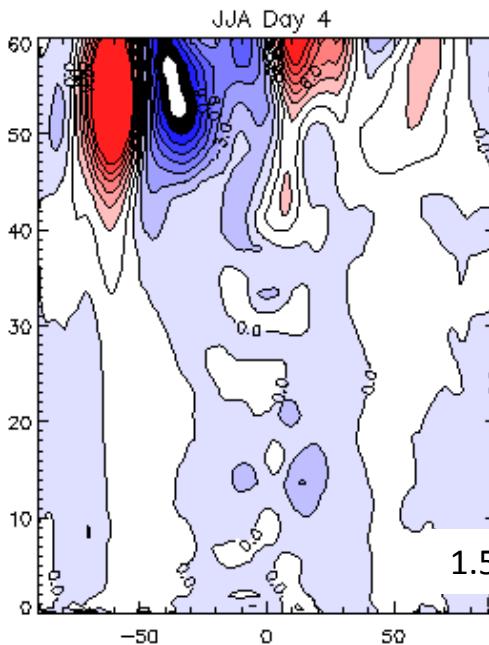
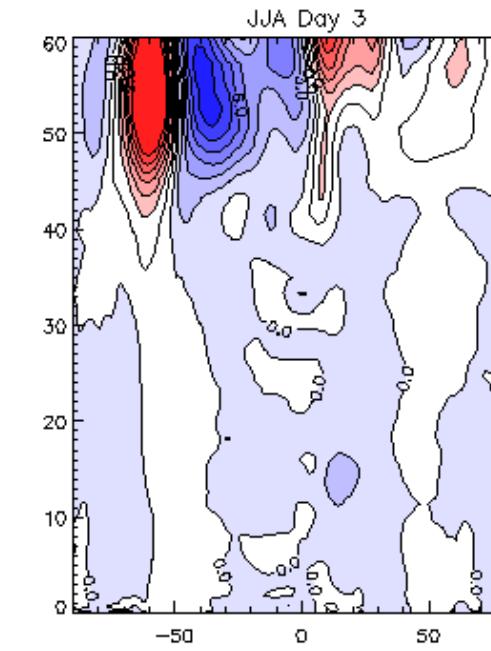
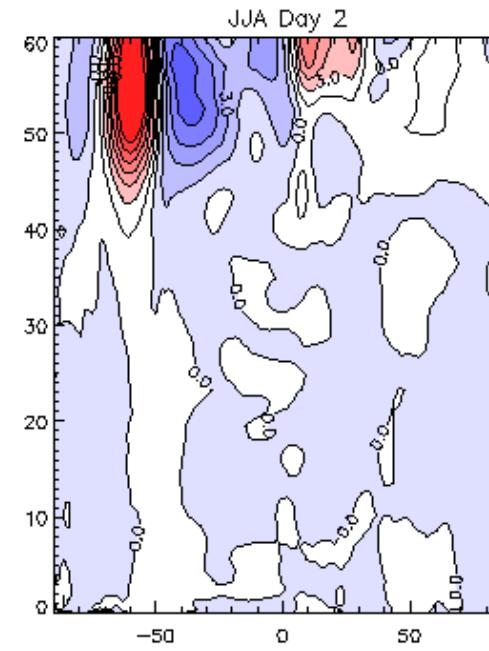
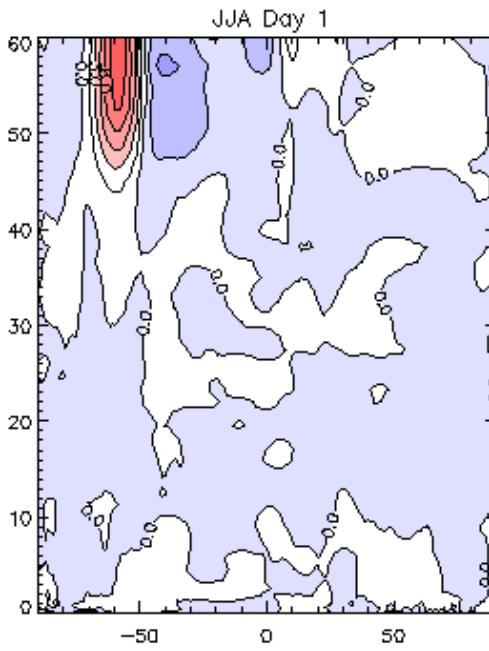


Day 5

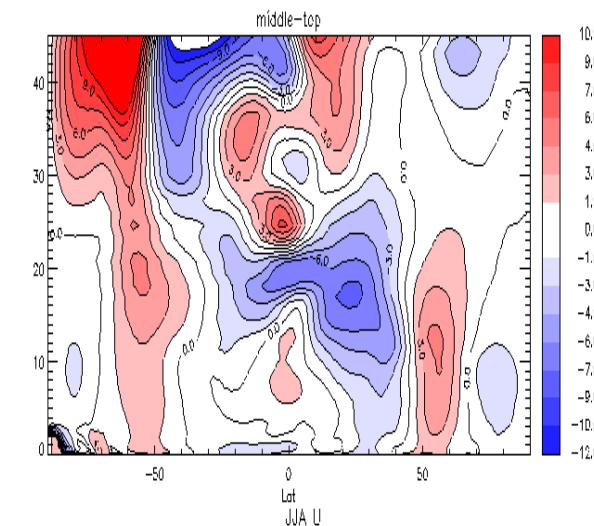


Stress bias

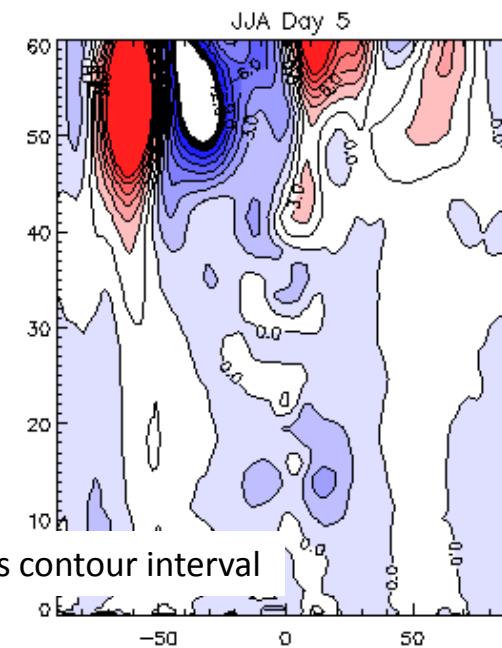
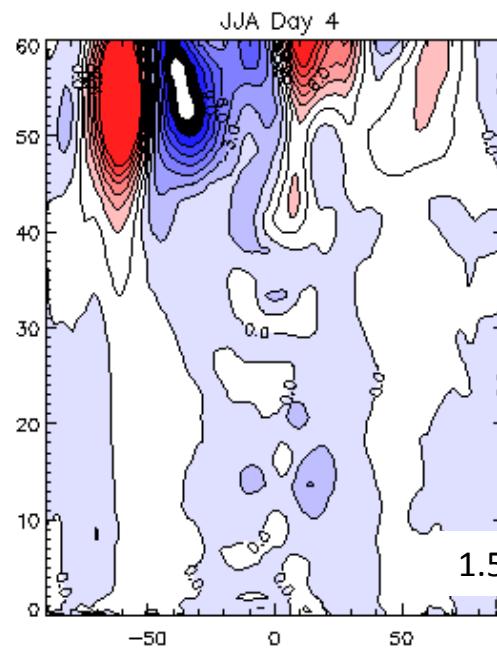
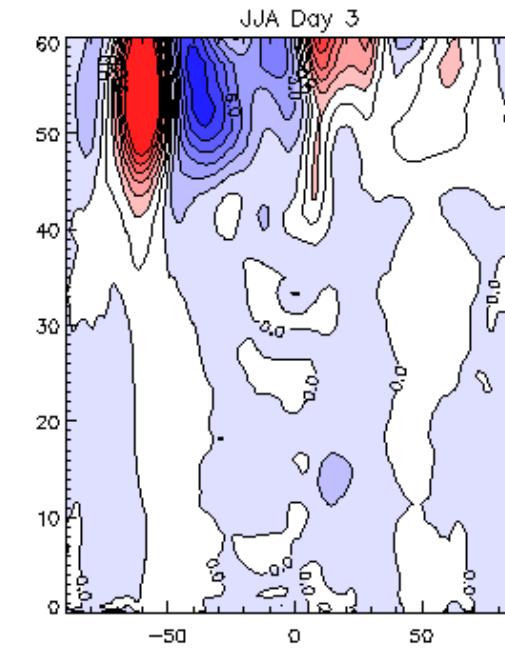
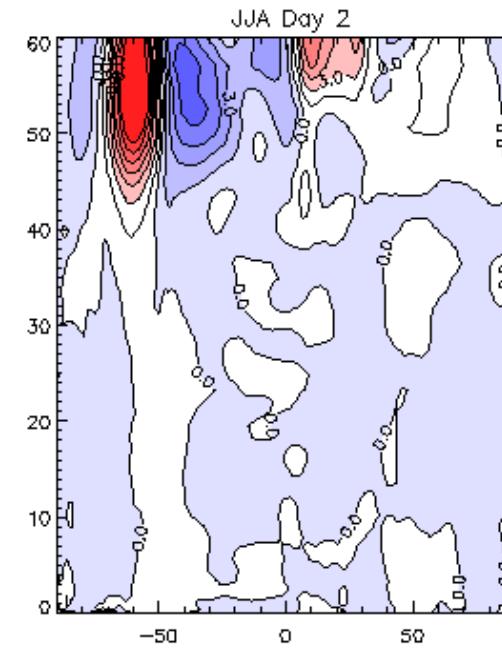
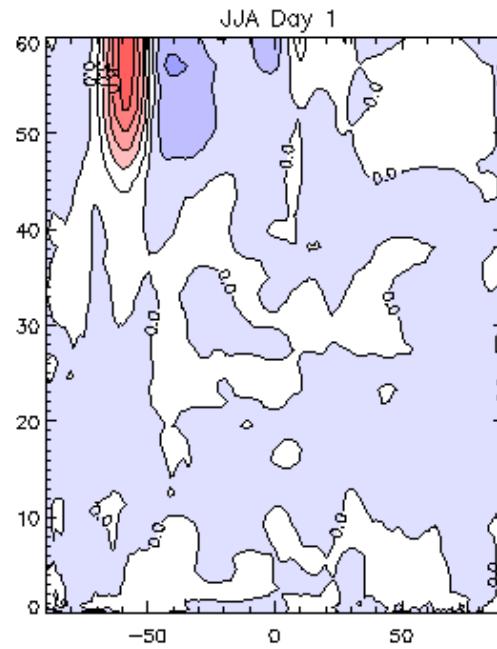




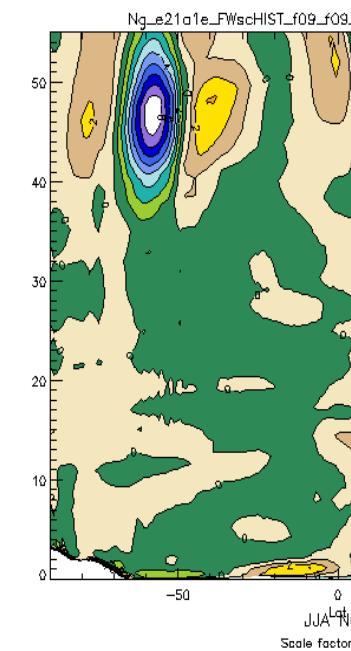
1.5 m/s contour interval

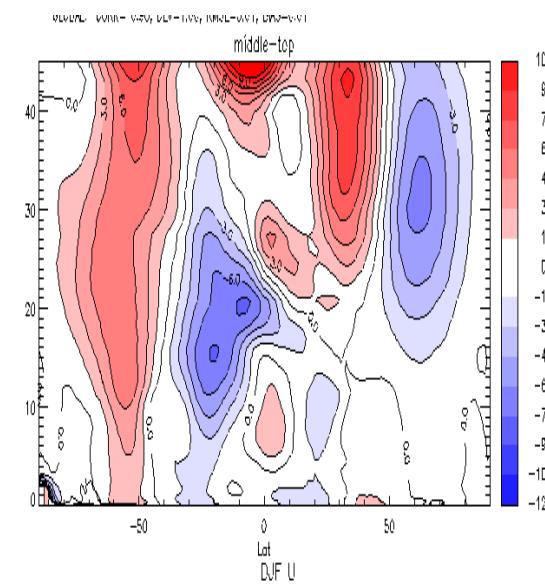
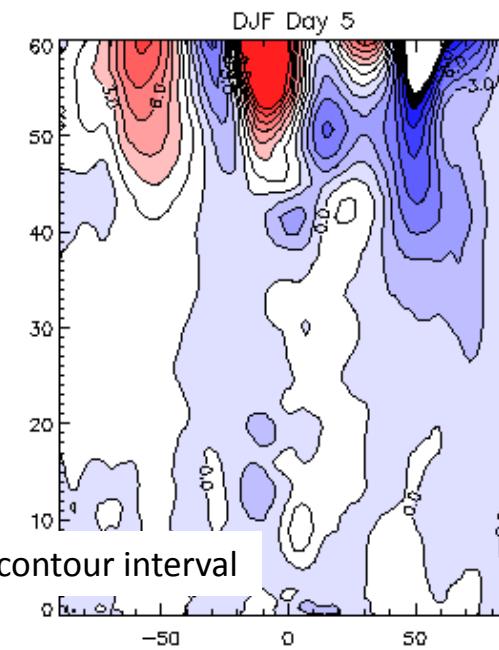
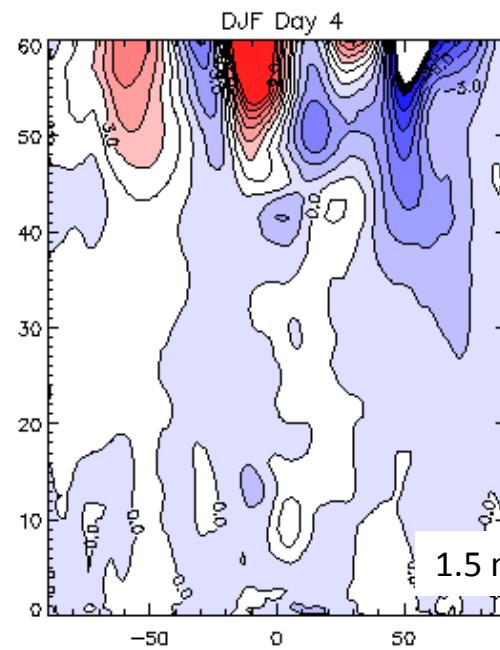
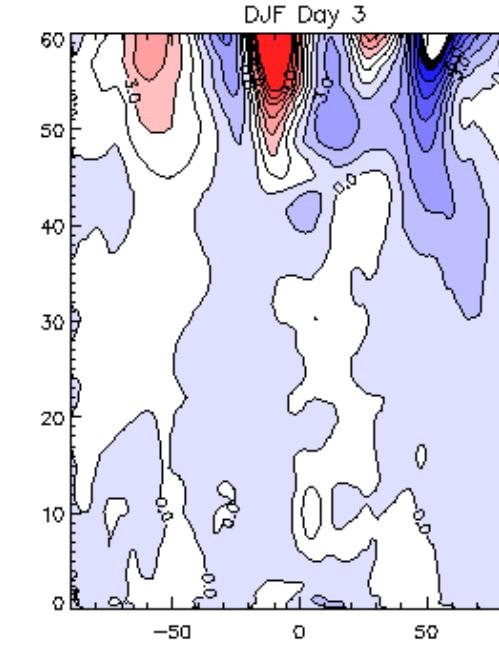
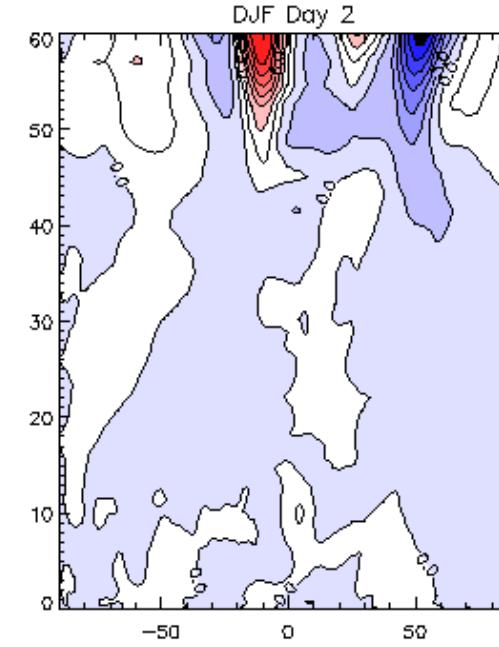
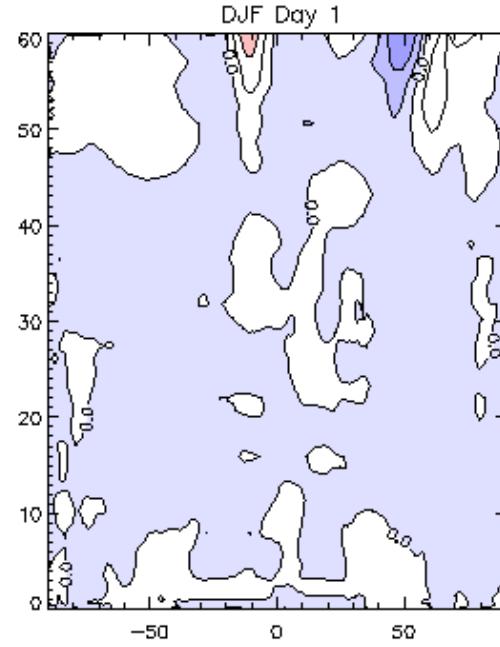


10.50  
9.00  
7.50  
6.00  
4.50  
3.00  
1.50  
0.00  
-1.50  
-3.00  
-4.50  
-6.00  
-7.50  
-9.00  
-10.50  
-12.00

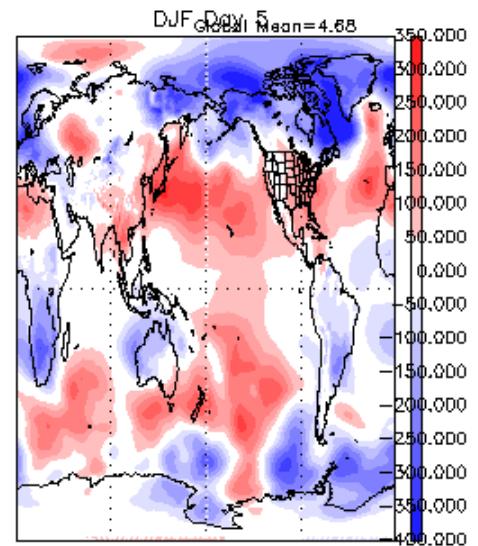
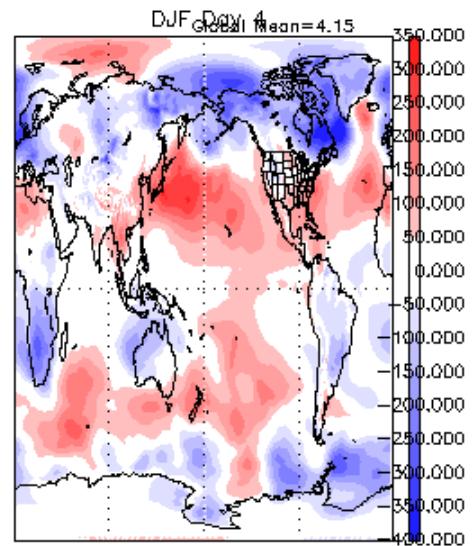
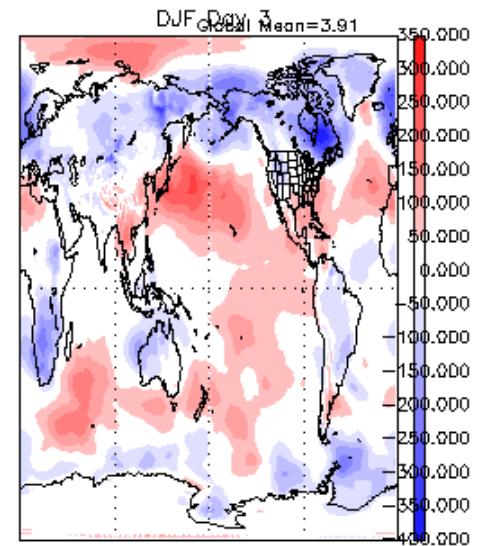
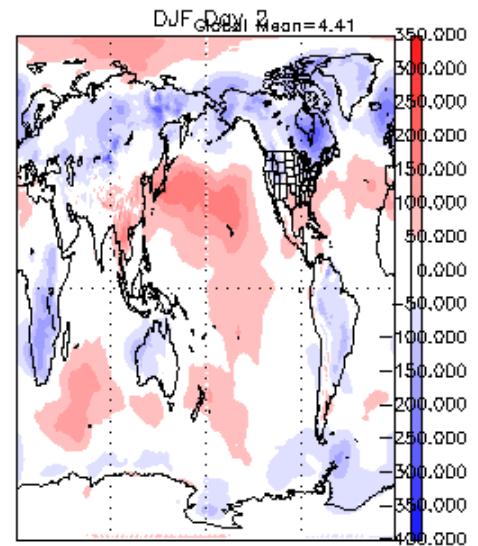
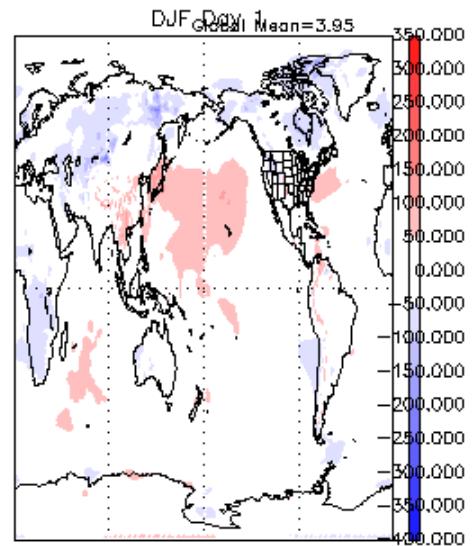


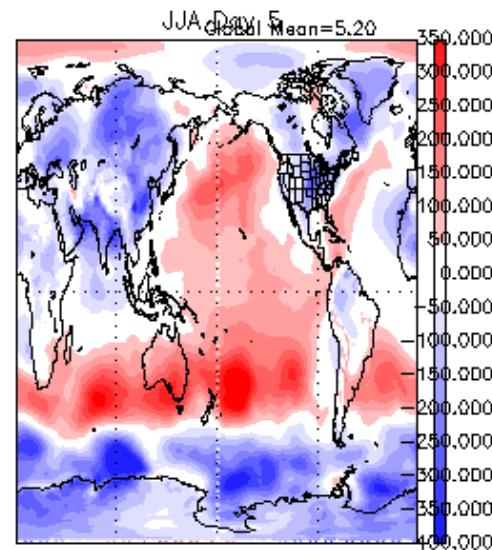
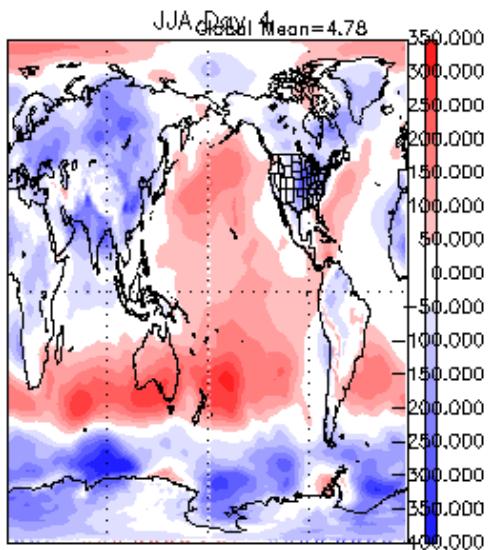
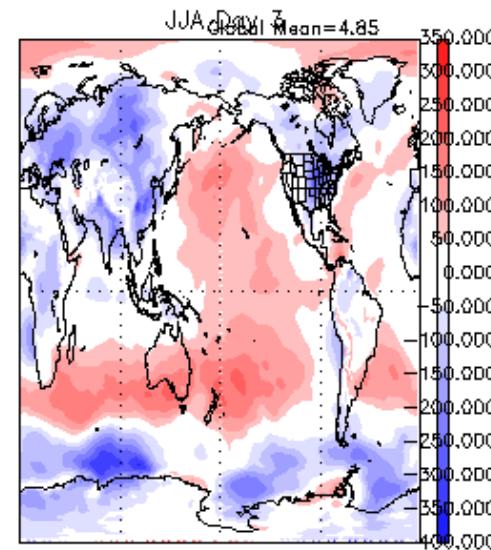
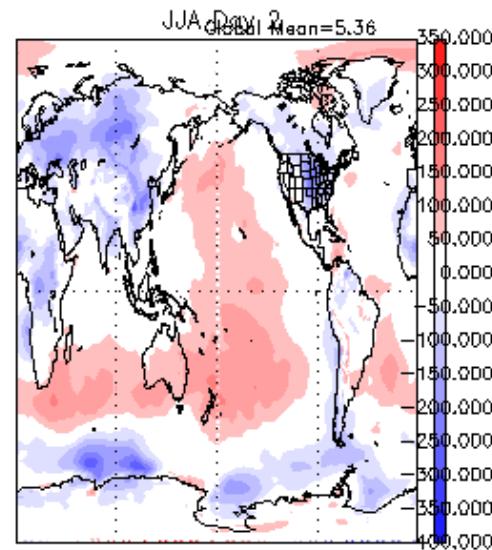
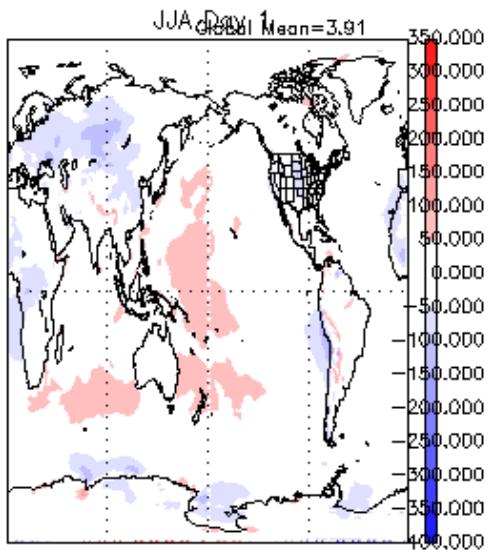
1.5 m/s contour interval



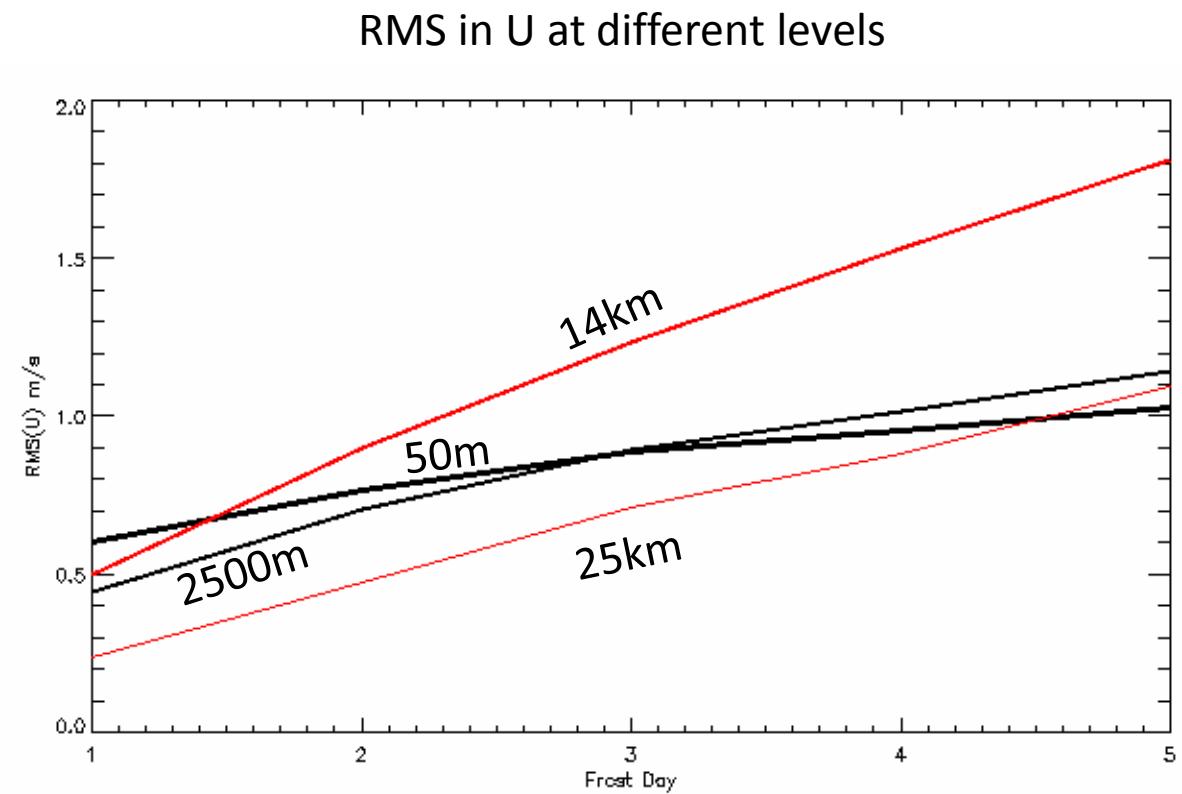
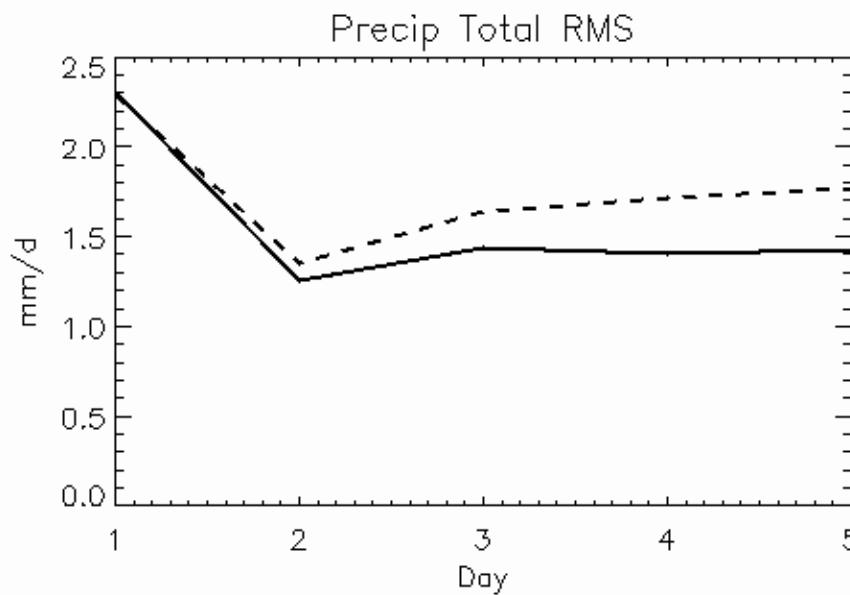
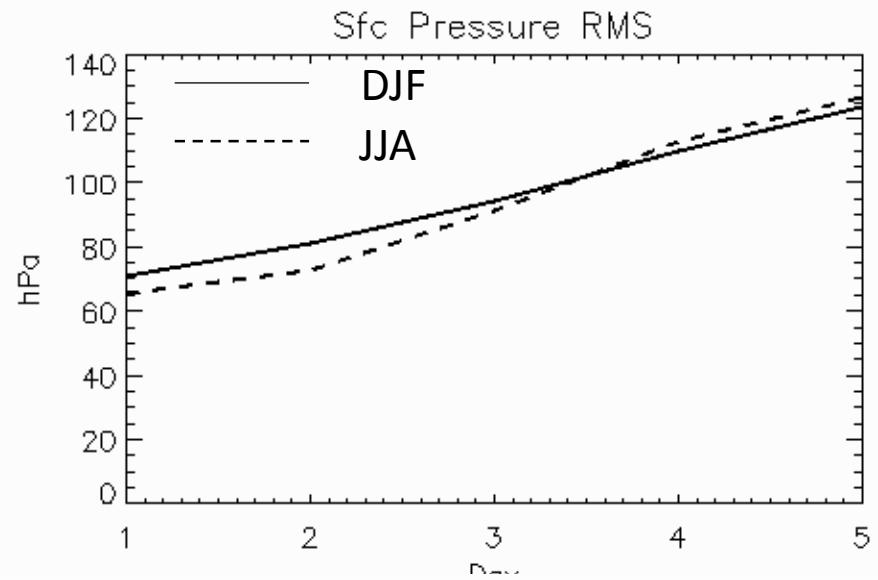


# Surface Pressure





# RMS error evolution



# CESM2/t-AMIP Initial results

- Precipitation approaches model climate quickly - within 2 days
  - Significant spin-up hinders interpretation
- Dynamical variables PS, U take longer

## Next steps

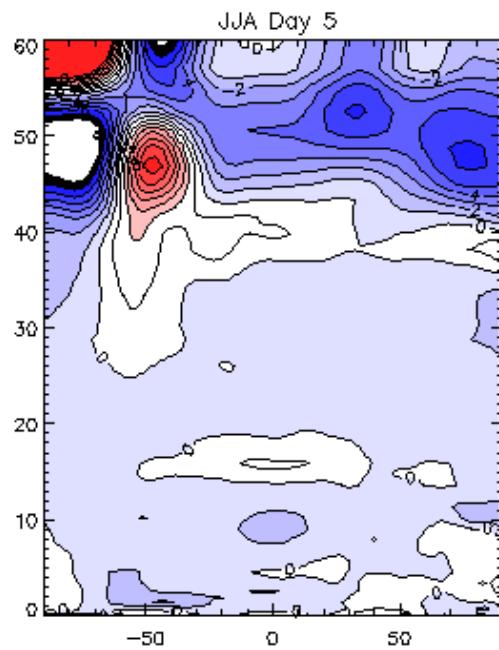
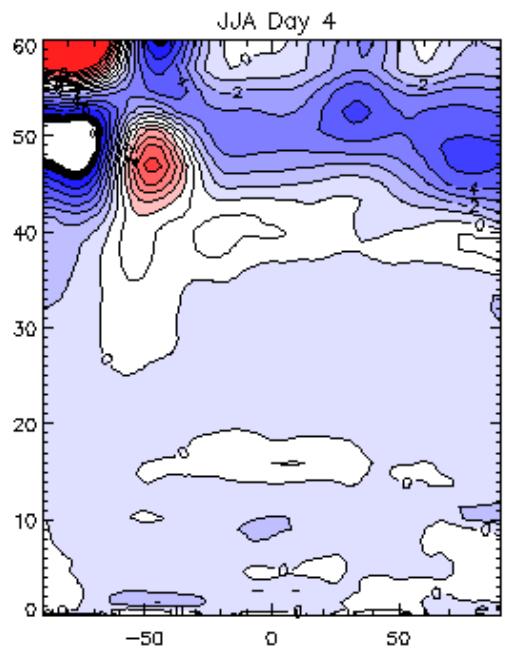
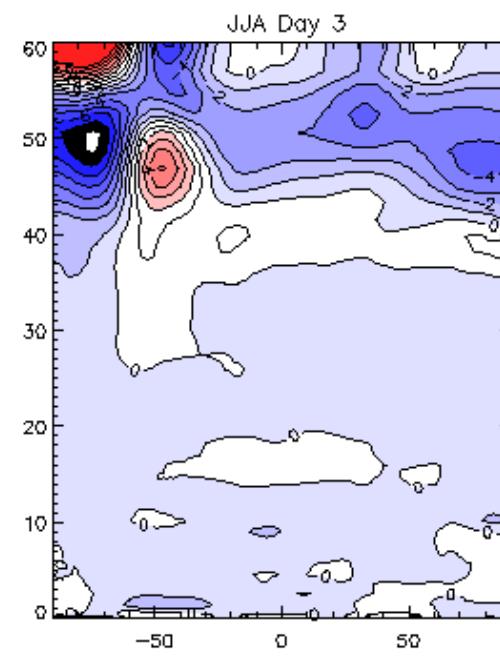
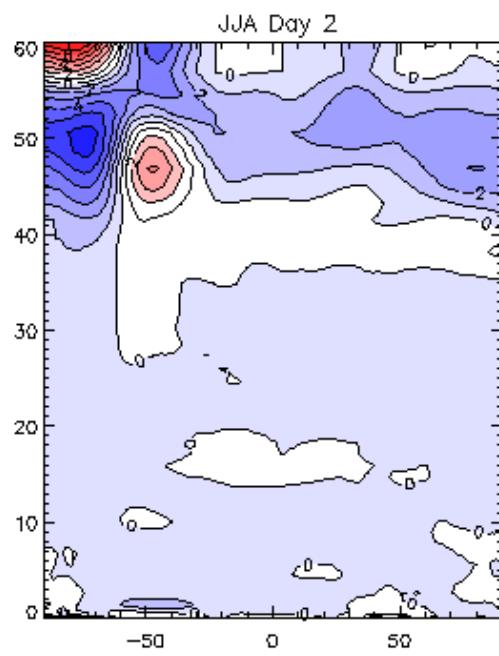
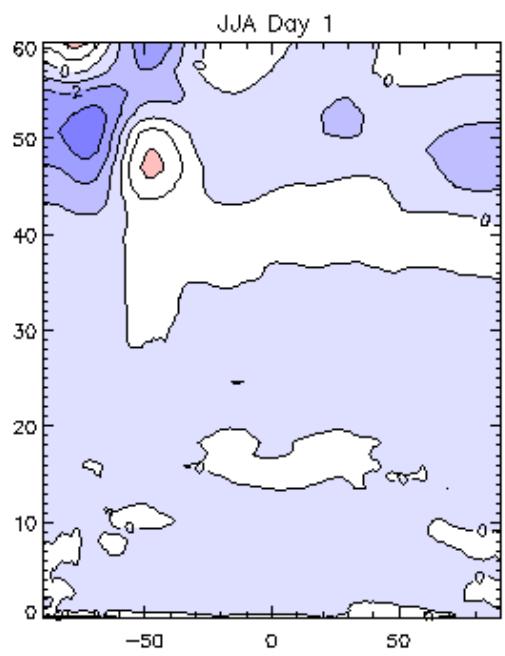
- Next time (hope this fall) will run 10-15 day forecasts
- Physics “swaps”, e.g., UW PBL for CLUBB etc.

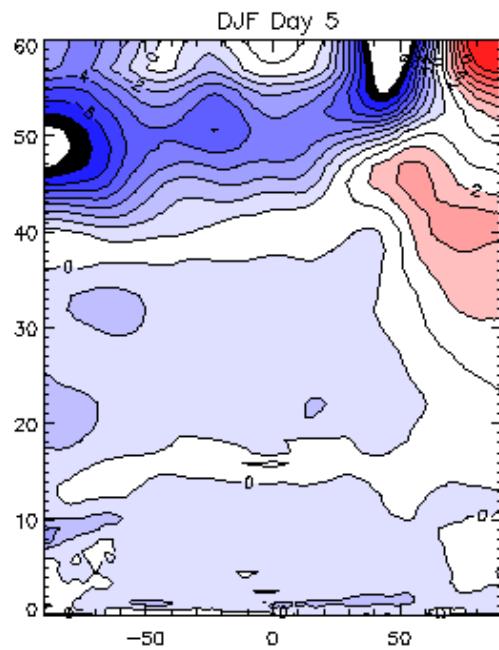
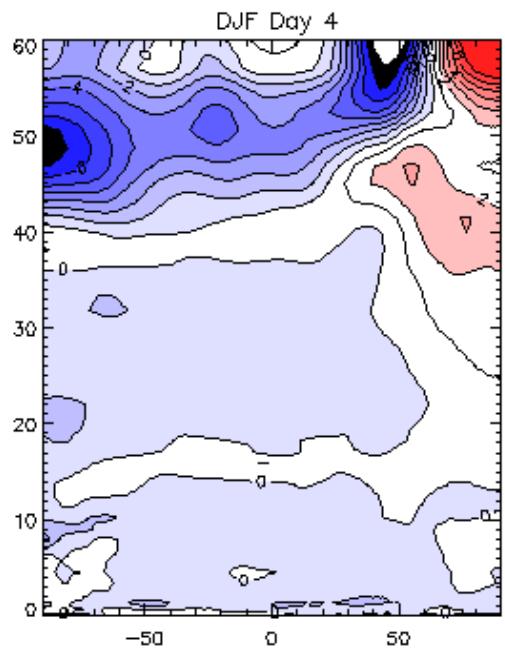
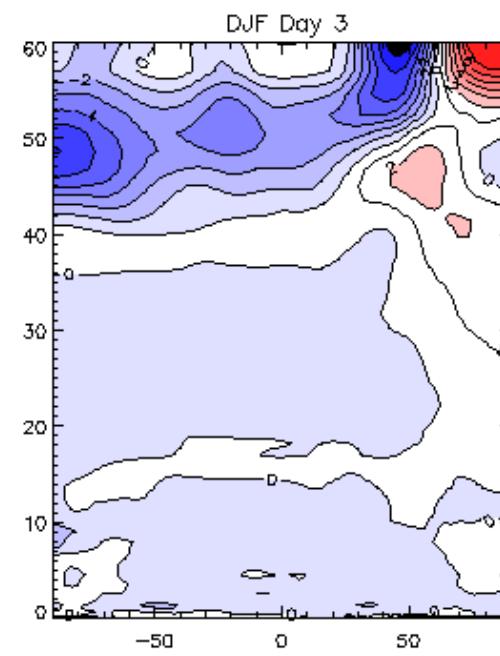
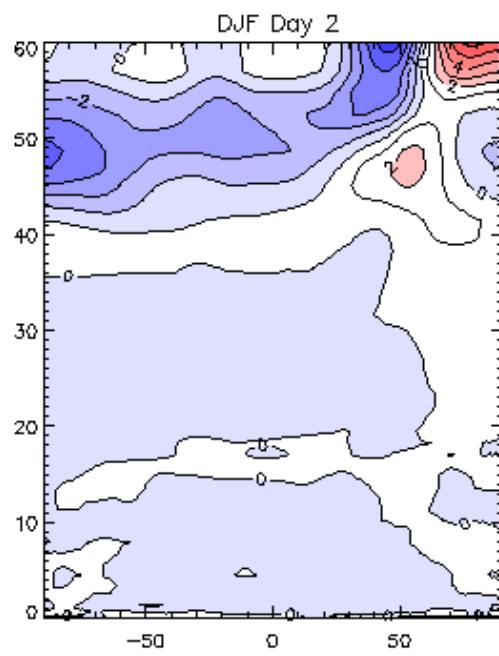
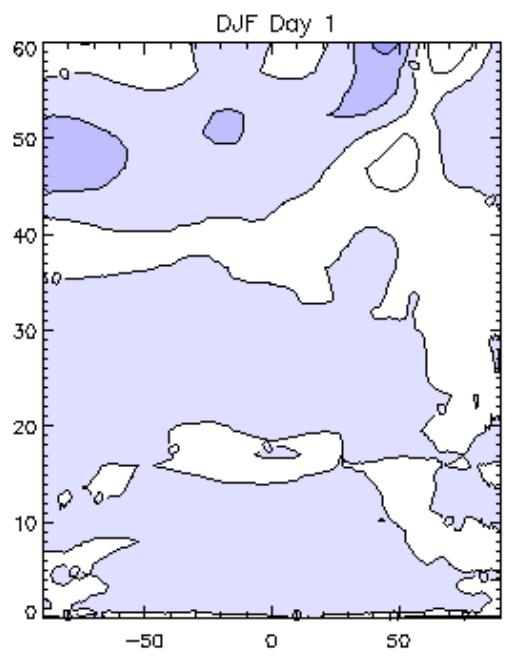
# Why not participate in more forecast intercomparisons?

- Lack of personnel. Focus on CMIP6
- CAPT framework has gotten “stale” during CAM development
  - “Present day” forcing data for land, aerosols etc sometimes not continued past 2014

# Temperature

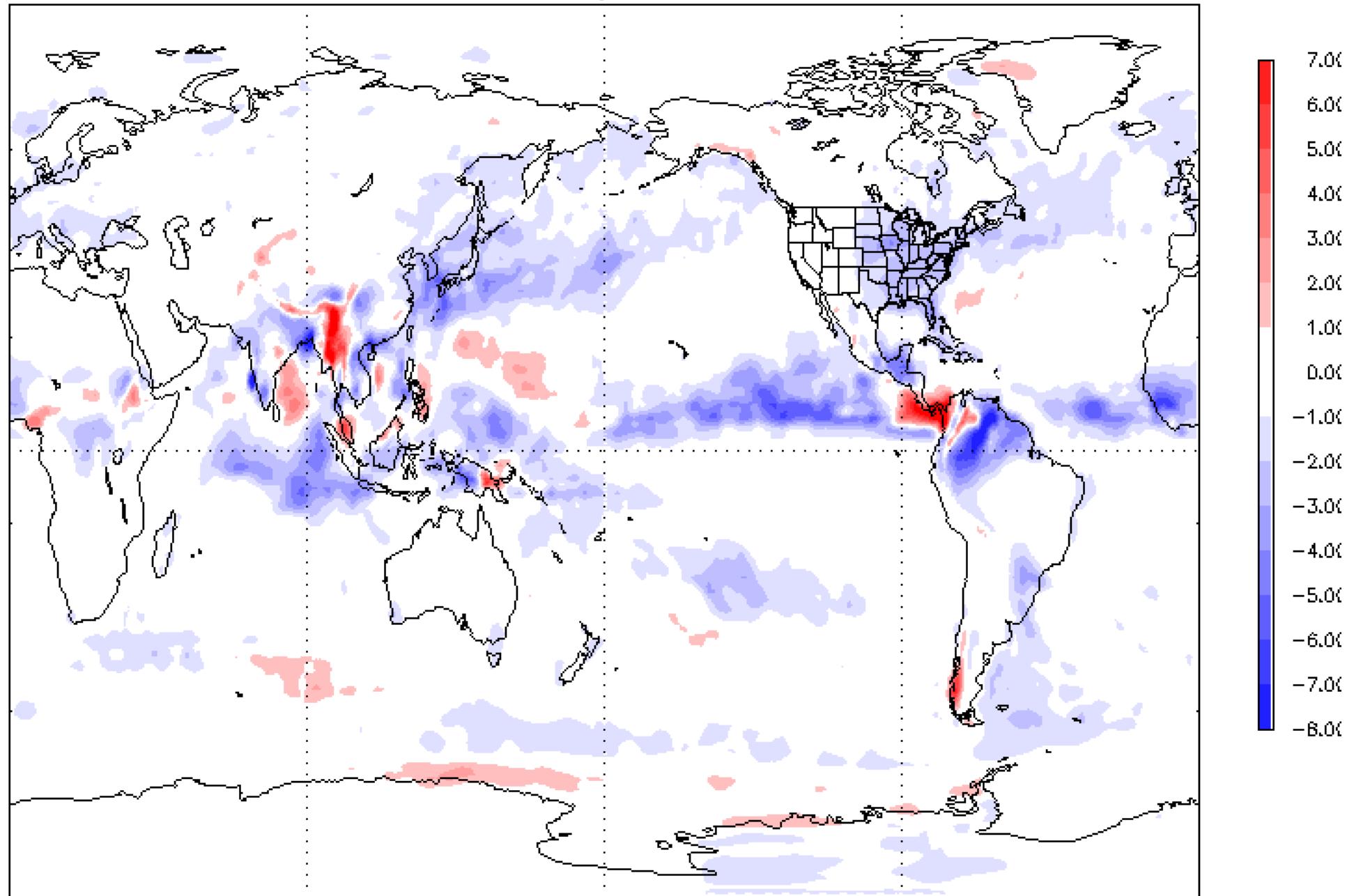
# Extra Slides





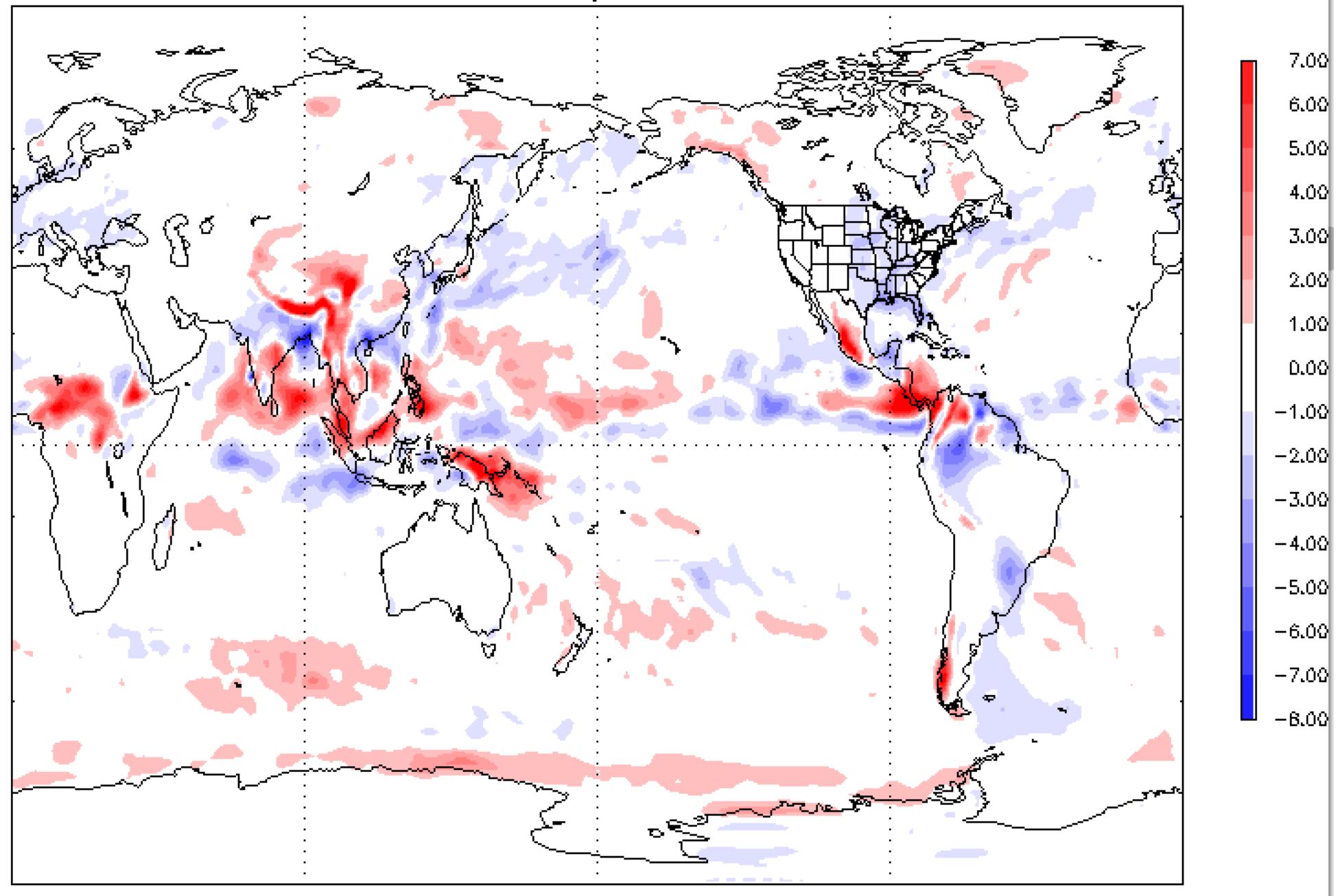
Day 1

Global Mean=-0.57



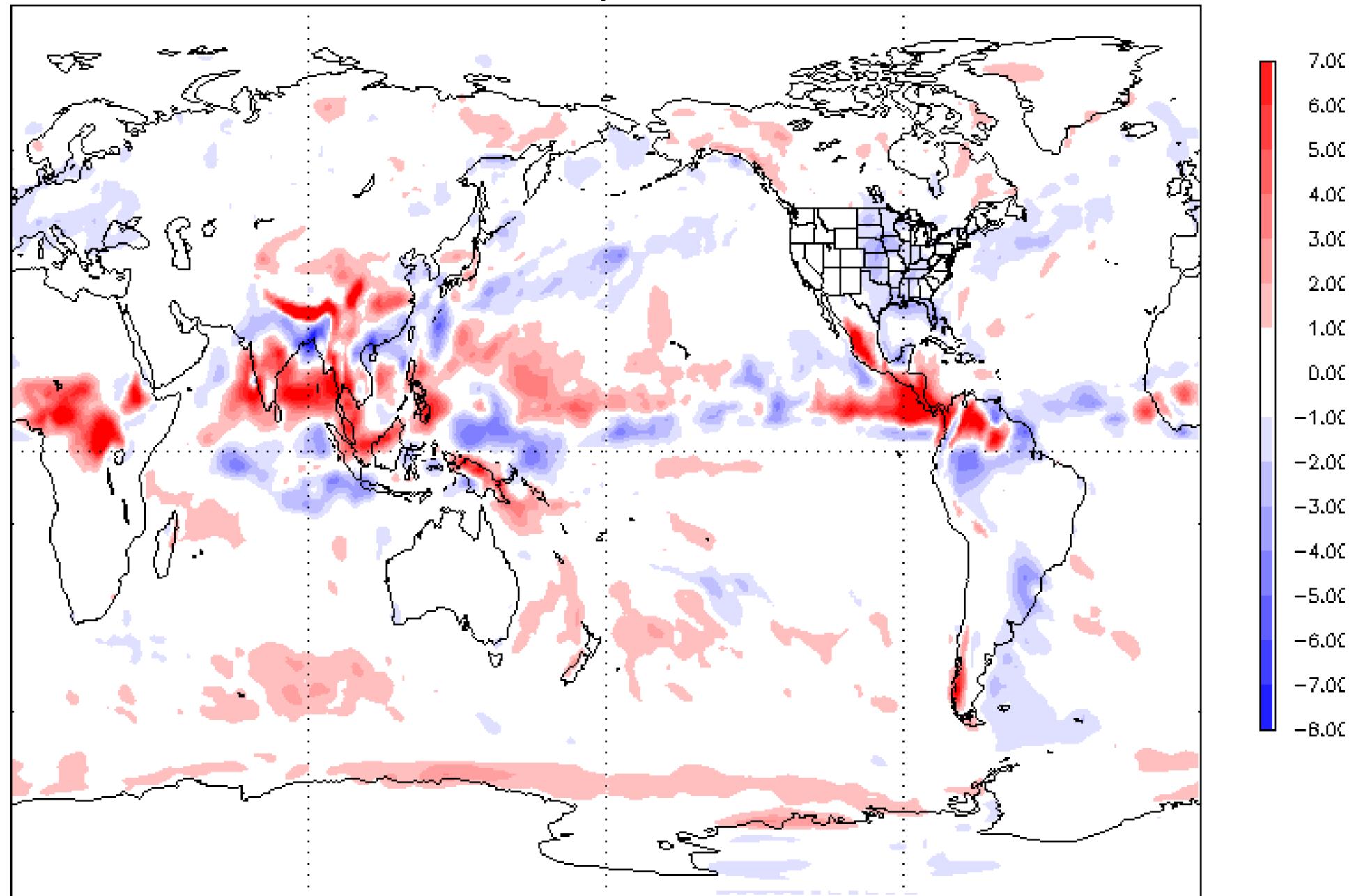
Day 2

Global Mean=0.05



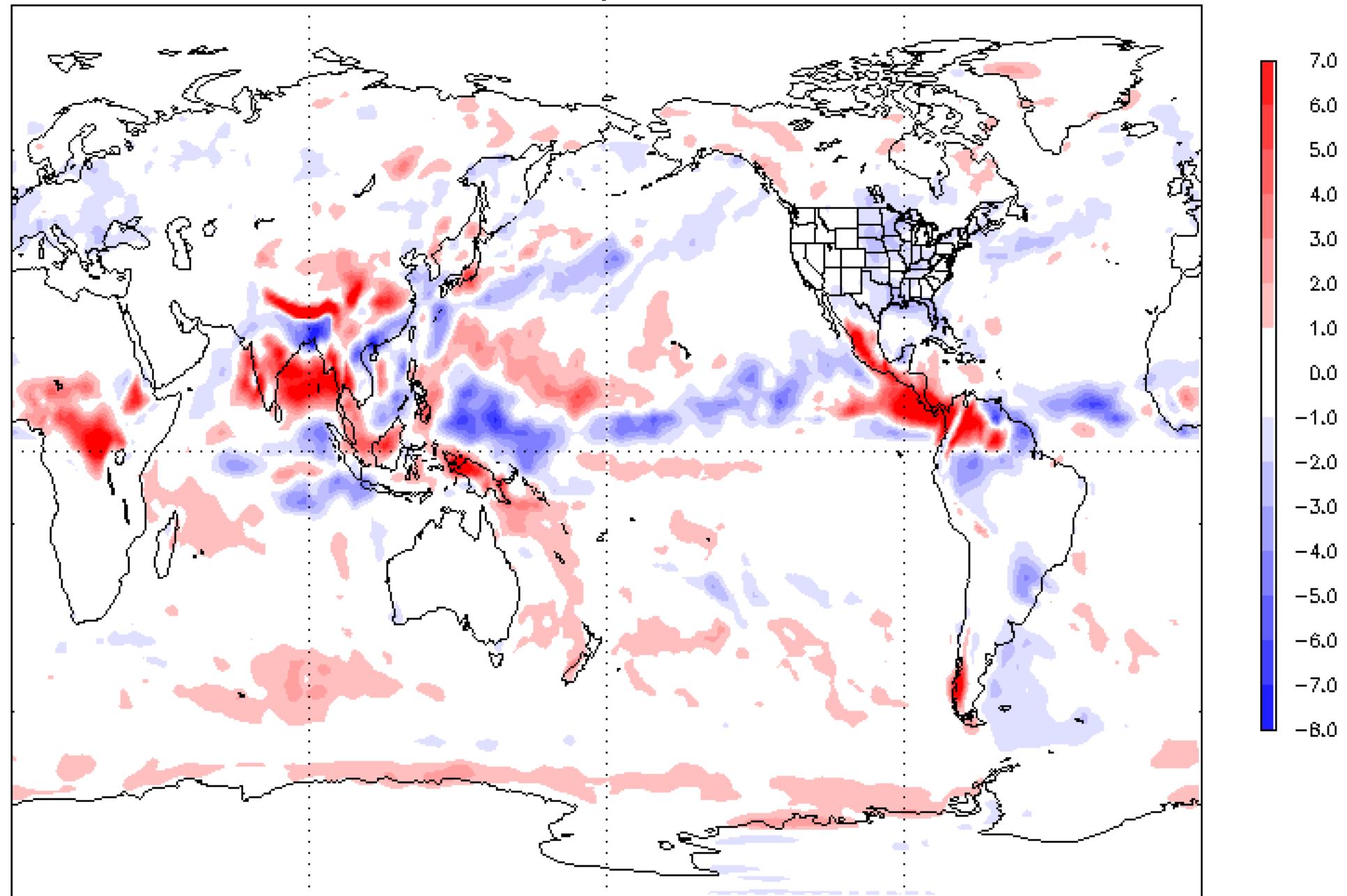
Day 3

Global Mean=0.14



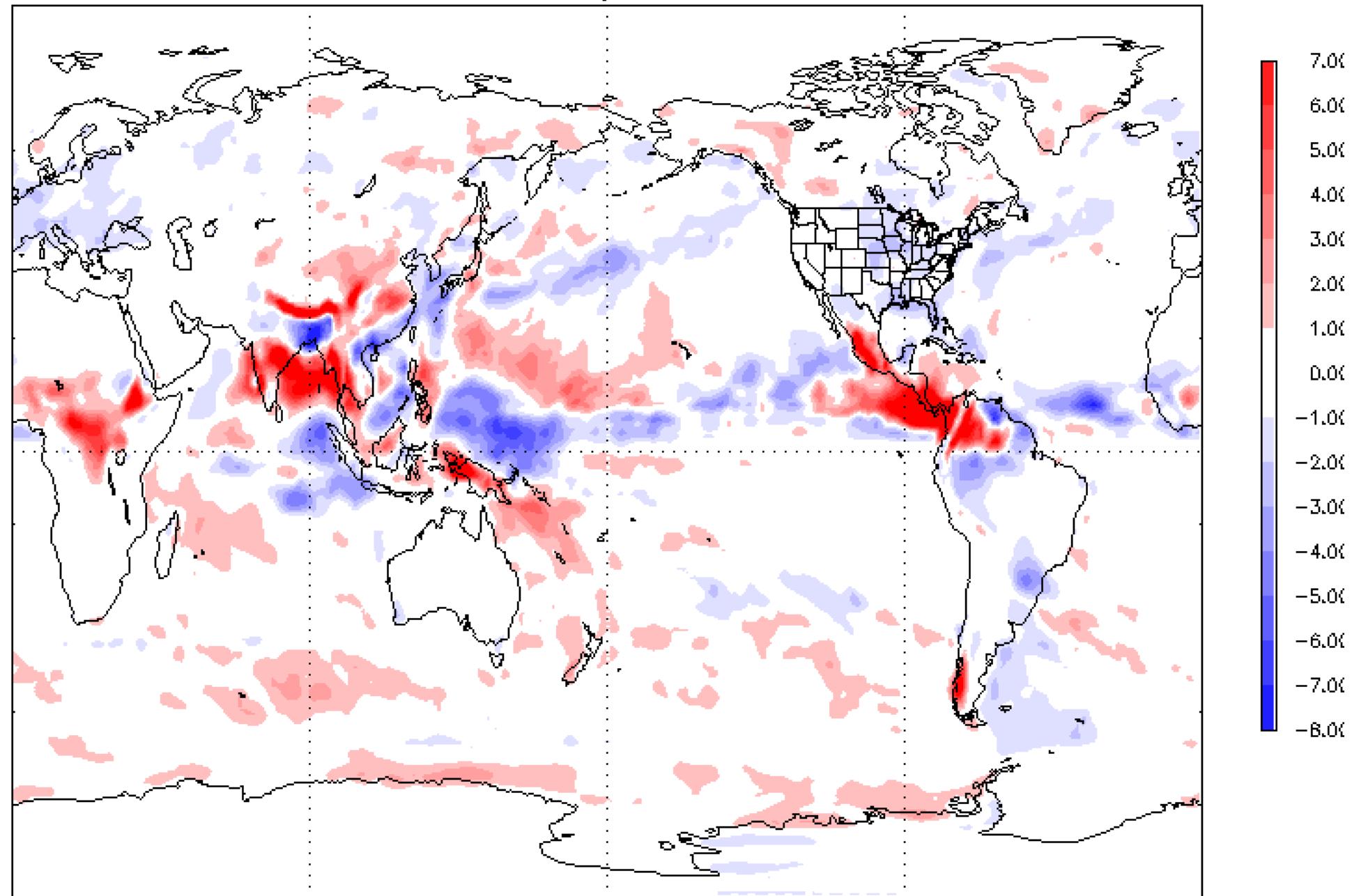
Day 4

Global Mean=0.08

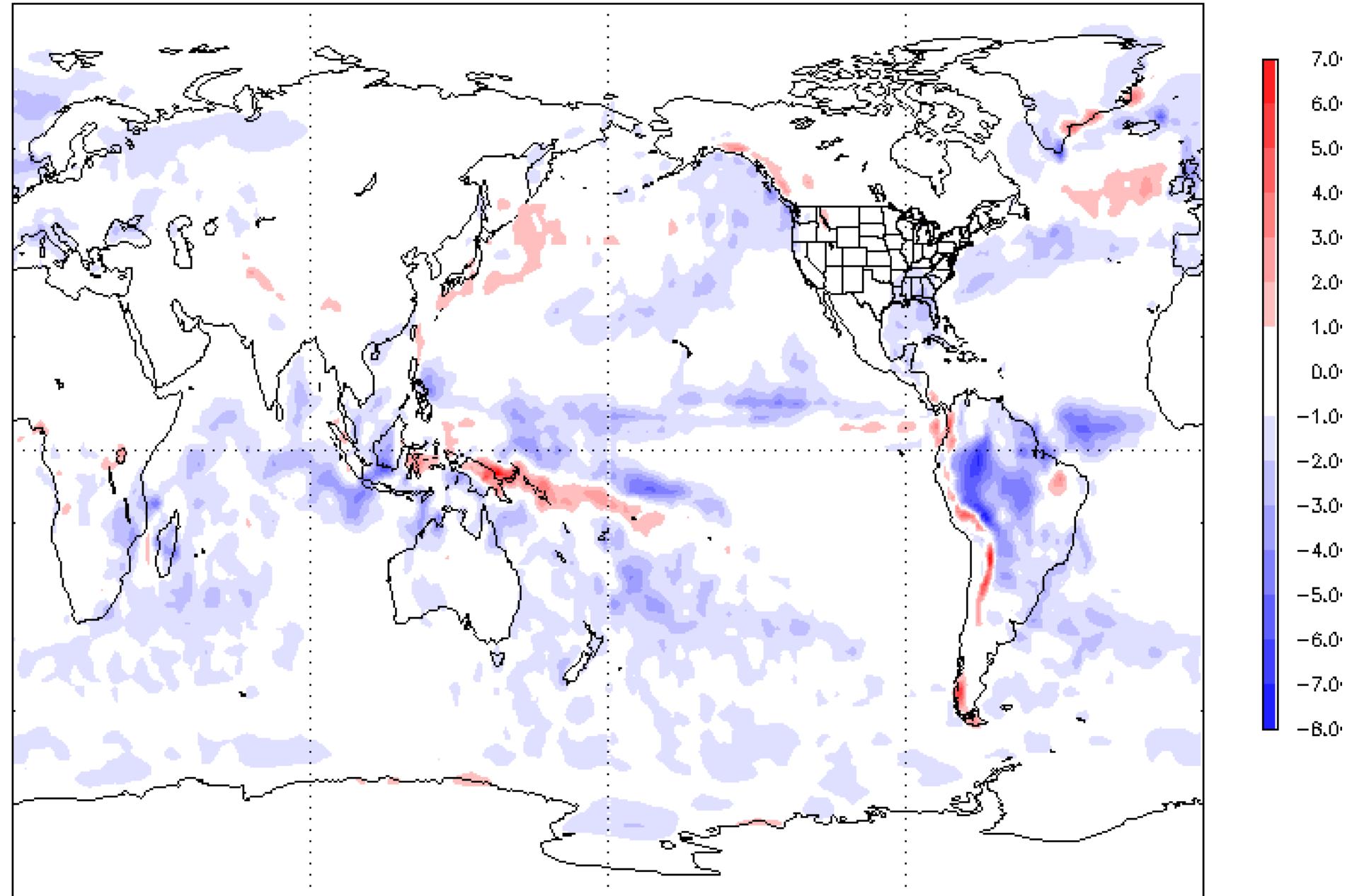


Day 5

Global Mean=0.10

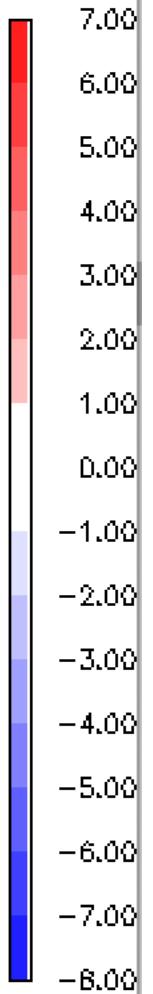
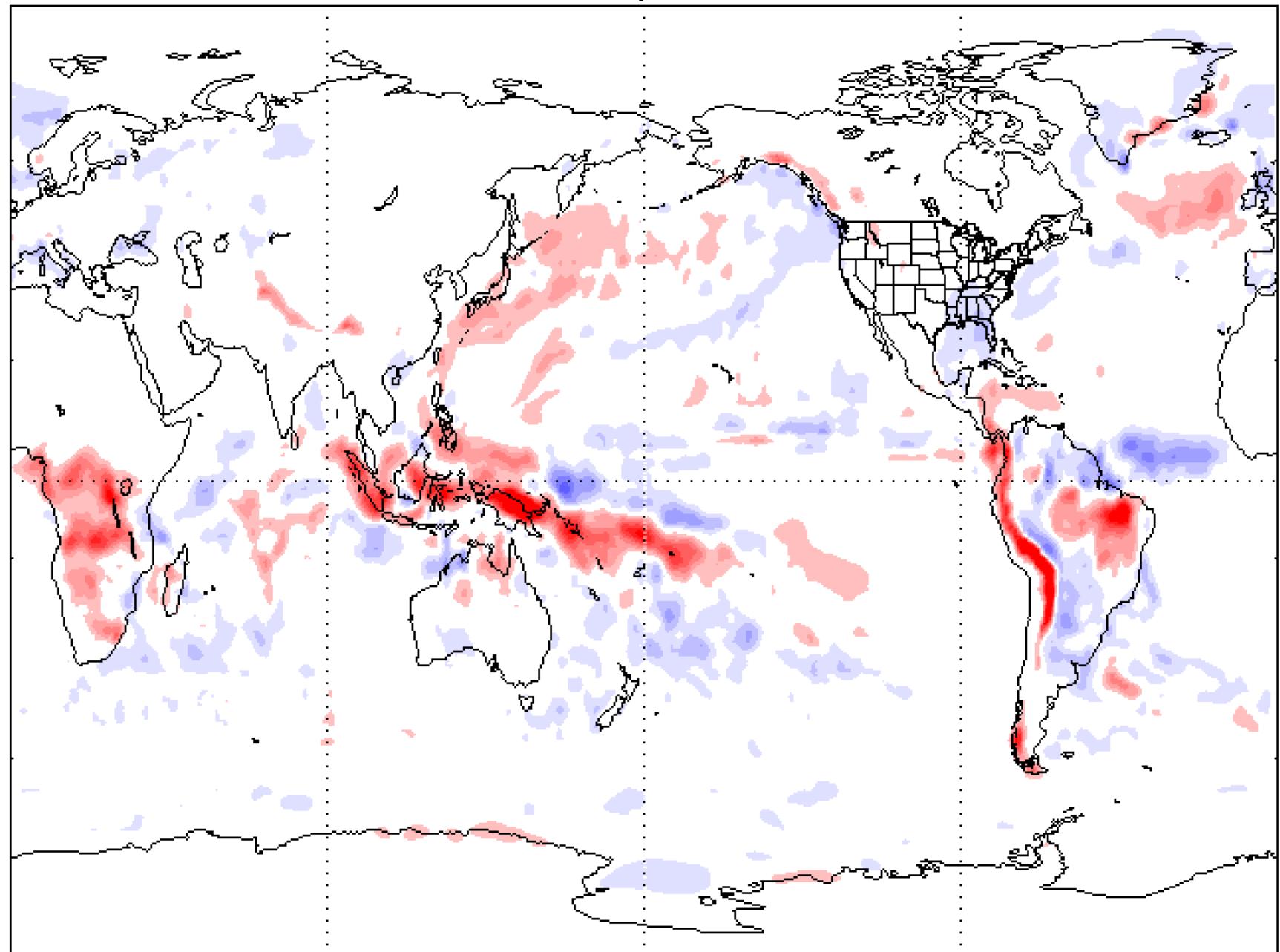


Global Mean=-0.59



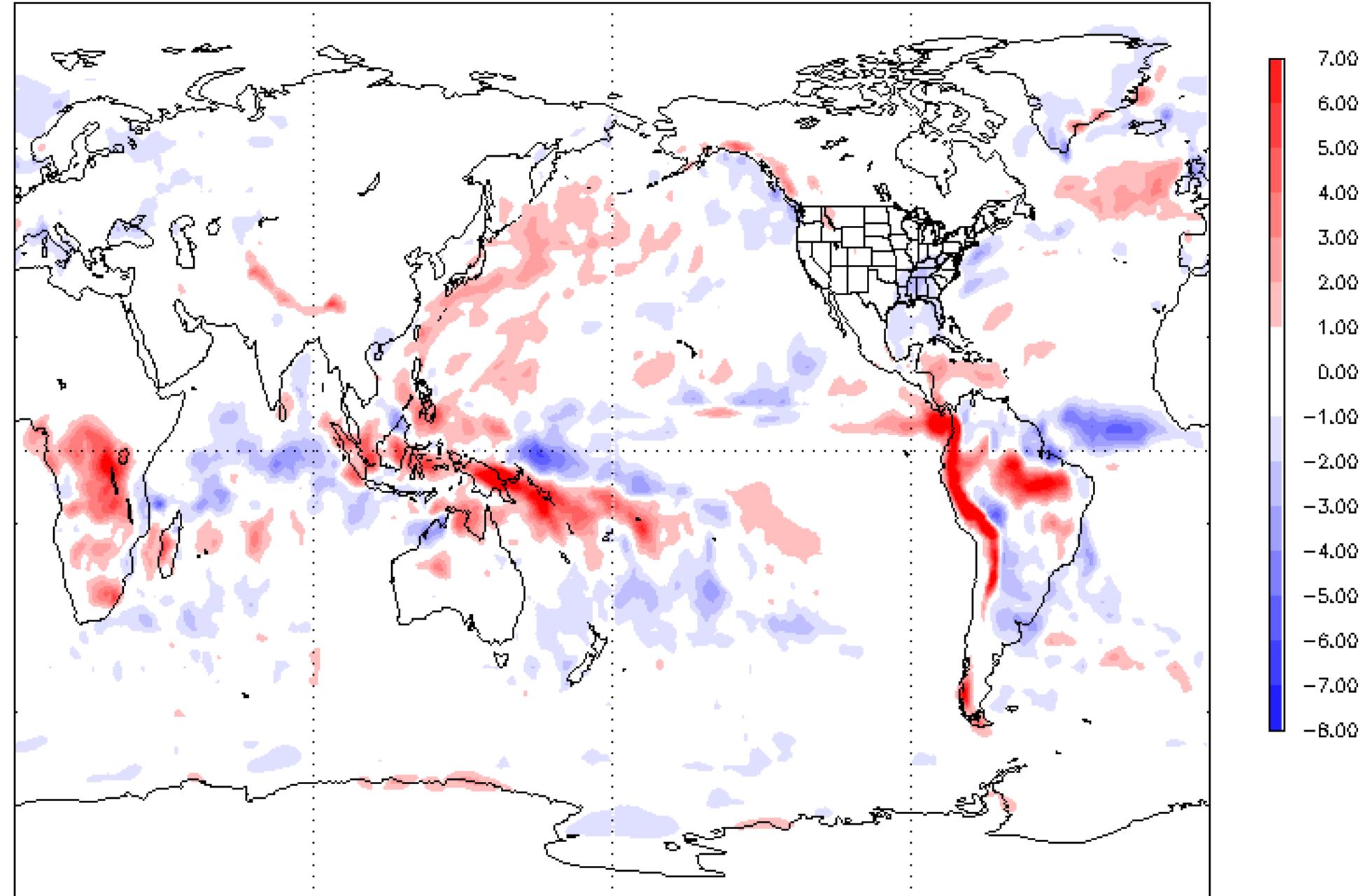
Day 2

Global Mean=-0.00



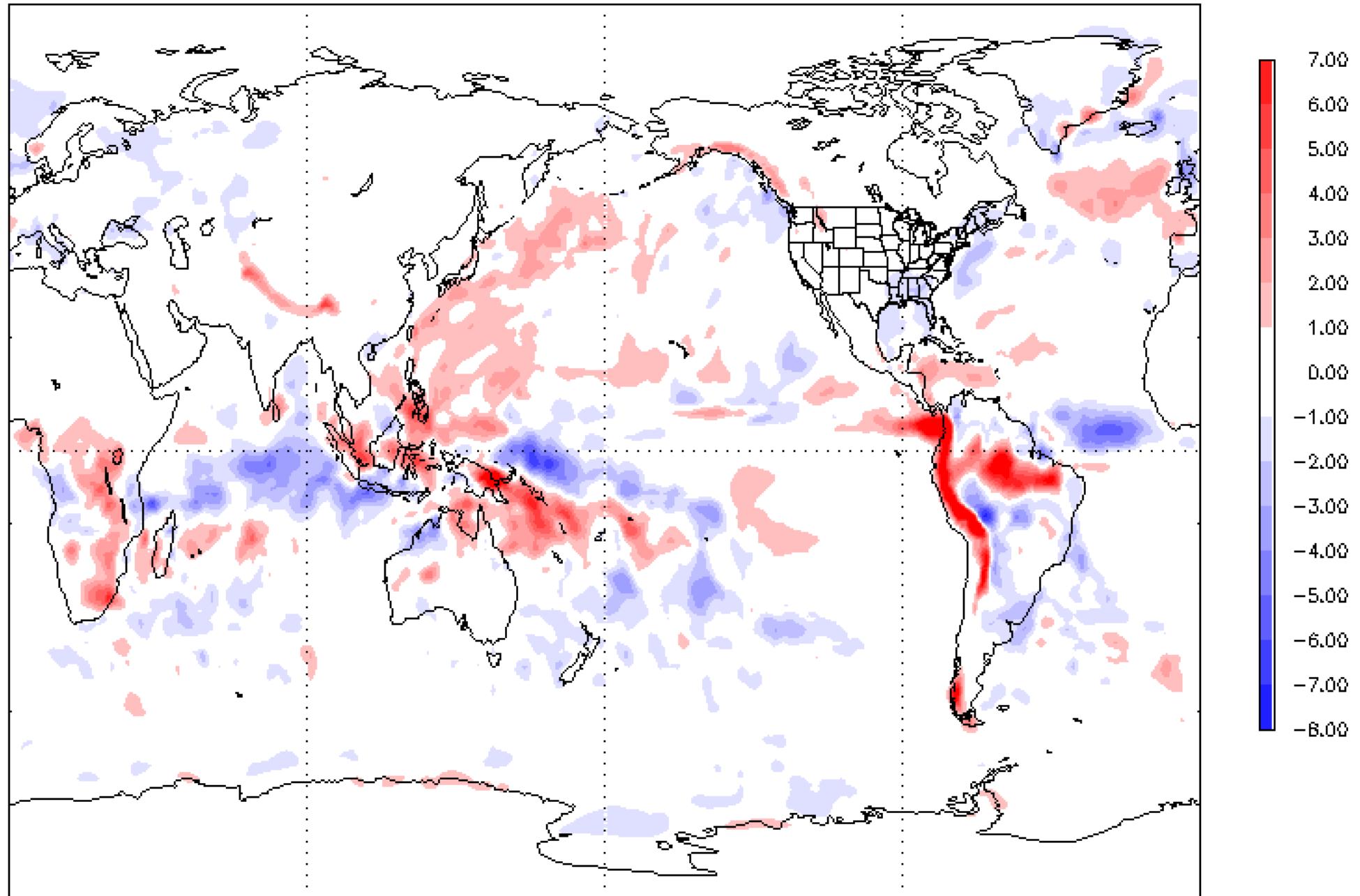
Day 3

Global Mean=0.00



Day 4

Global Mean=-0.03



Day 5

Global Mean=-0.01

