Proposed Model Simulations

The idea is for several modeling groups to do identical (somewhat idealized) experiments to address issues of model dependence on the response to SSTs (and the role of soil moisture), and to look in more detail at the physical mechanisms linking the SST changes to drought

PARTICIPANTS

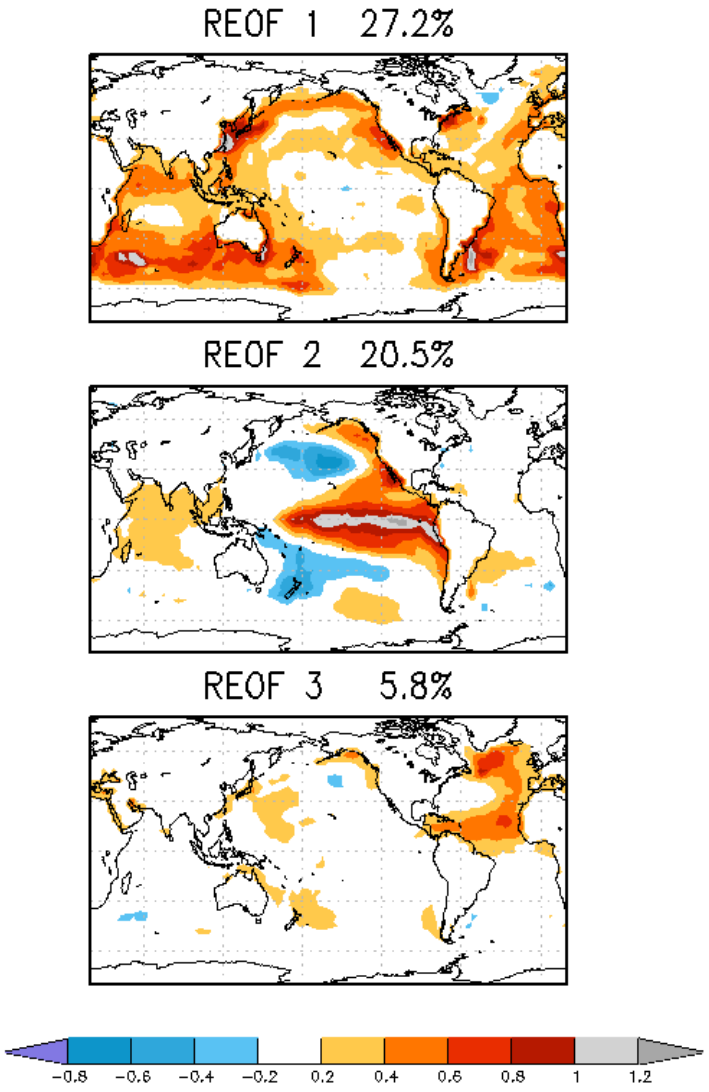
-Siegfried Schubert
-Richard Seager
-Mingfang Ting
-Rong Fu
-David Rind
-Tom Delworth
Arun Kumar
-Phil Pegion
Max Suarez
Marty Hoerling
-Randy Koster
-Kingtse Mo
-Jae Schemm
-Alfredo Ruiz-Barradas
Dave Gutzler
-Sumant Nigam

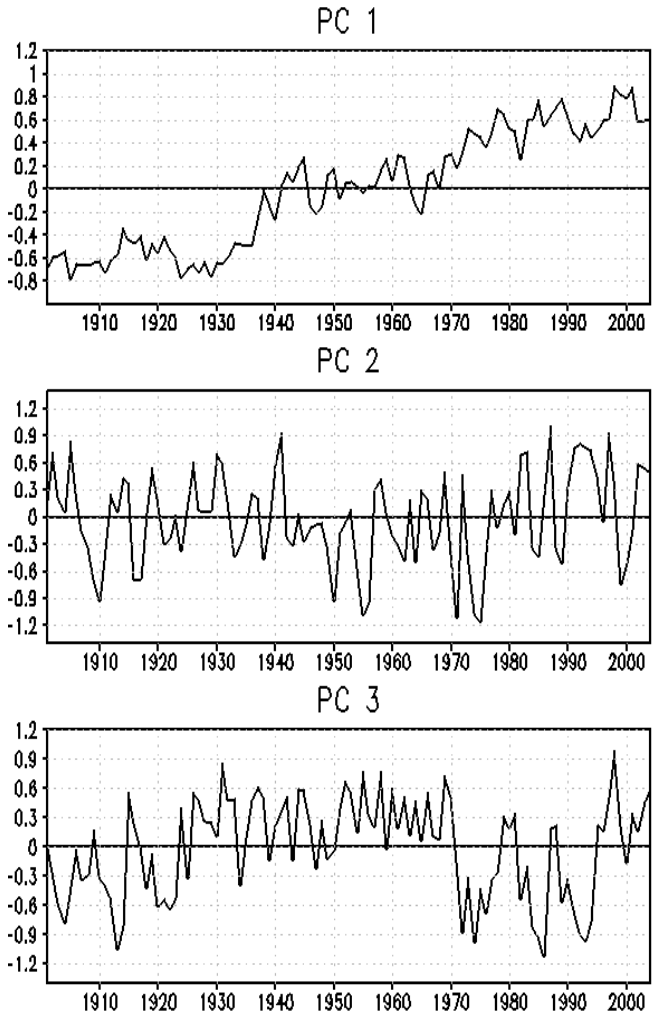
Leading EOFs and Time series (annual mean SST - 1901-2004)

Linear Trend Pattern (LT)

Pacific Pattern (Pac)

Atlantic Pattern (Atl)





Highest Priority: impact of the leading three patterns (LT, Pac, Atl)

-prescribe each pattern on top of seasonally varying SST climatology

- each run should be at least 51 years (first year is spin-up)

-need a 50+ year control with climatological SST

1) Pac and Atl patterns

   a) All combinations of patterns (see Appendix IV - 8 X 50 years)

2) Runs involving the LT pattern (see Appendix I)

   a) +/- LT pattern

   b) +/- LT added to (Pac- and Atl+)

   c) +/- LT added to (Pac+ and Atl-)

   (6 X 50 years = 300 years of simulation)

3) Uniform SST warming pattern that has the same global mean SST as + LT

   (0.16° added to climatology)

   (1 X 50 years =50 years of simulation)

Other runs:

1) Tropical part of Pac and Atl patterns (see Appendix IV)

a) Tropical only +/-Pac and +/- Atl patterns (4X50 years)

2) Separate the impacts from low frequency and ENSO patterns in the Pacific

+/- 2std of low frequency REOF 2 (see Appendix II)

+/- 2std of residual REOF 1 (see Appendix II)

(4X50 years)

3) Soil moisture experiments

a) Fix soil moisture as described in Appendix III. Ideally this would be based on an ensemble of C20C runs, but could also be from 1950+ runs.

b) Redo runs in 1 and 2 with fixed (climatological) soil moisture as described in Appendix III, but taken from 50 year control with climatological SST

SST Forcing patterns to be provided (on 3.0 X 3.75 degree grid**):**

-Pac, Atl, and LT SST anomalies (see Appendix IV)

anomalies are +/- 2 std for Pac and Atl

anomalies are +/- 1 std for LT

note that for uniform SST case add 0.16° to climatology

-1901 to 2004 HadISST climatology on same grid

-tropical part of Pac and Atl patterns (see Appendix IV)

-low frequency Pacific pattern (REOF 2 of six-year filtered SST) - Appendix II

-ENSO pattern (REOF 1 after first removing six-year filtered variability) - Appendix II

Output for sharing

-monthly mean Tsfc, precipitation, soil wetness, z200, u,v,q 850, evaporation, sensible heat flux, monthly mean atmospheric fluxes (uv,uq,vq,uT,vT, etc., -e.g. can save ubar,vbar and uvbar to get transients), sfc net radiation, total run-off, snow water equivalent, slp, monthly mean diurnal cycle (priority here is for Tsfc, precipitation, evaporation, sensible heat flux, net radiation, lower tropospheric winds and fluxes), root zone soil moisture, (also will need to save soil moisture in each layer if you plan to do the soil moisture experiments)

-encourage saving daily fields

Sharing output

-we have a GDS server that can easily handle all the monthly fields

Some common/coordinated analysis of the runs (ideas?)

-Randy's analysis of drought index

-changes in variance/predictability

-validation/verification of mechanisms

Appendix I

An Analysis of the Trends (by Phil Pegion)

Slide 1: Using Hadley SST

a) 1st EOF rotated

b) 1st EOF unrotated

c) Linear trend at each grid point

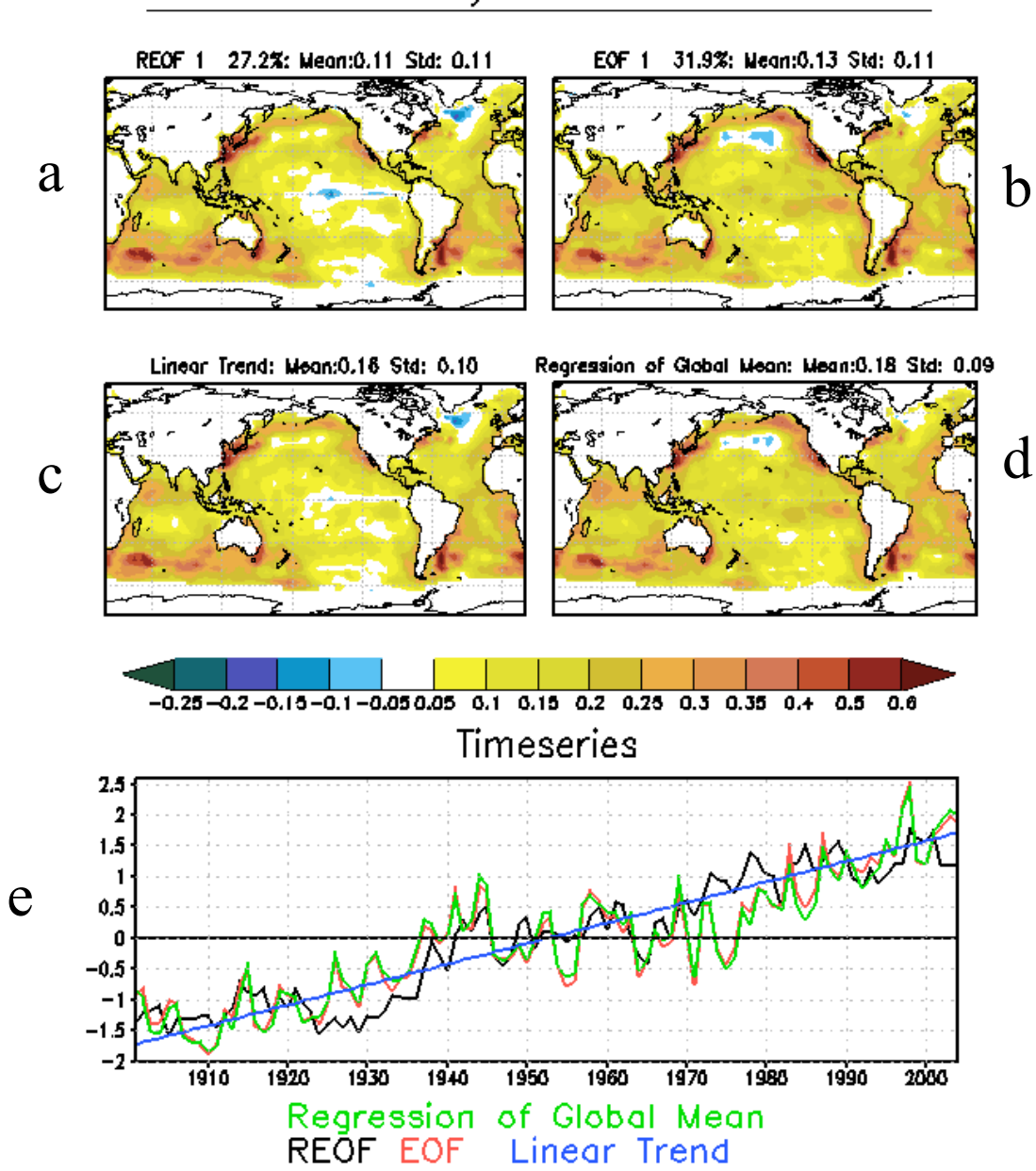
d) Regress SST at each gridpoint against global mean SST

e) time series (all normalized to have 0 mean and unit variance)

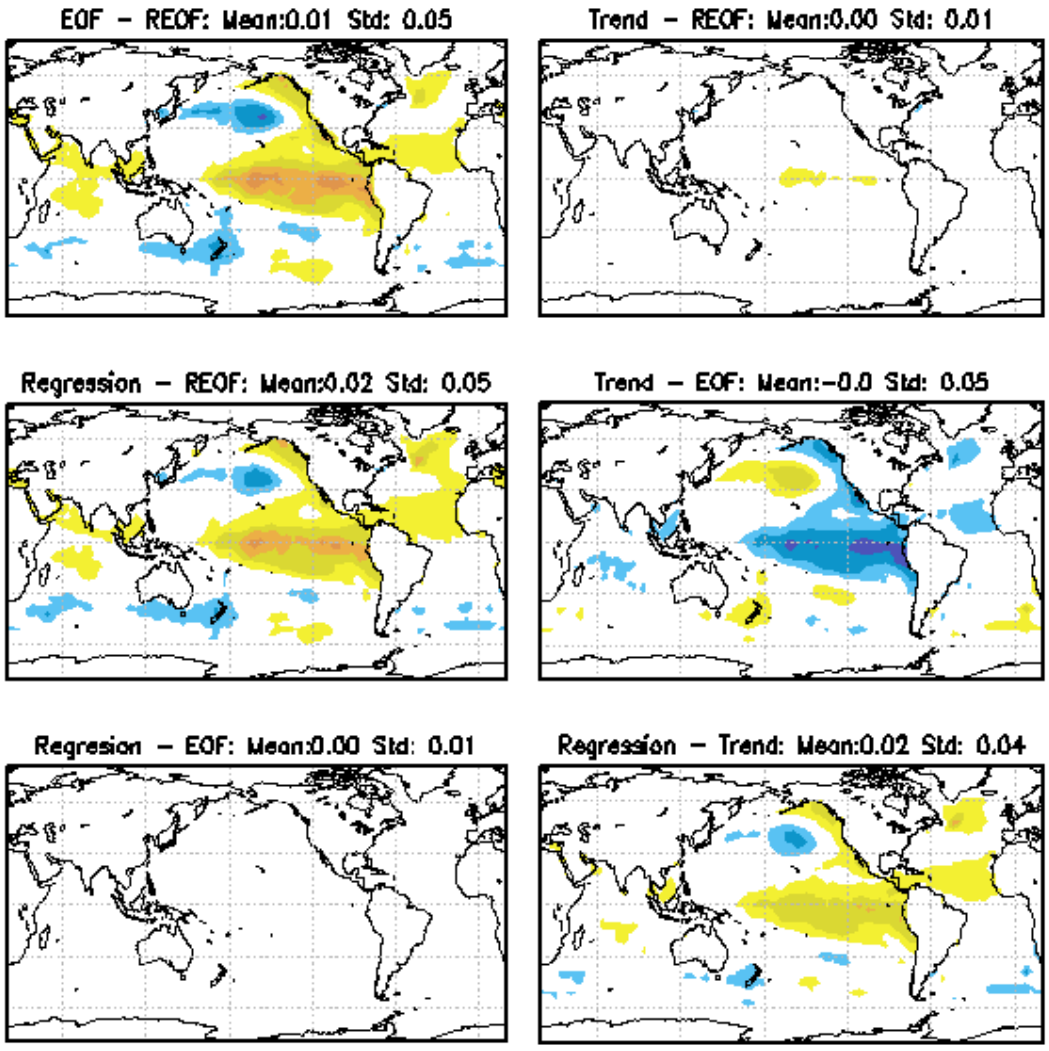
Slide 2 Difference plots

Slides 3 and 4: Repeat with ERSST

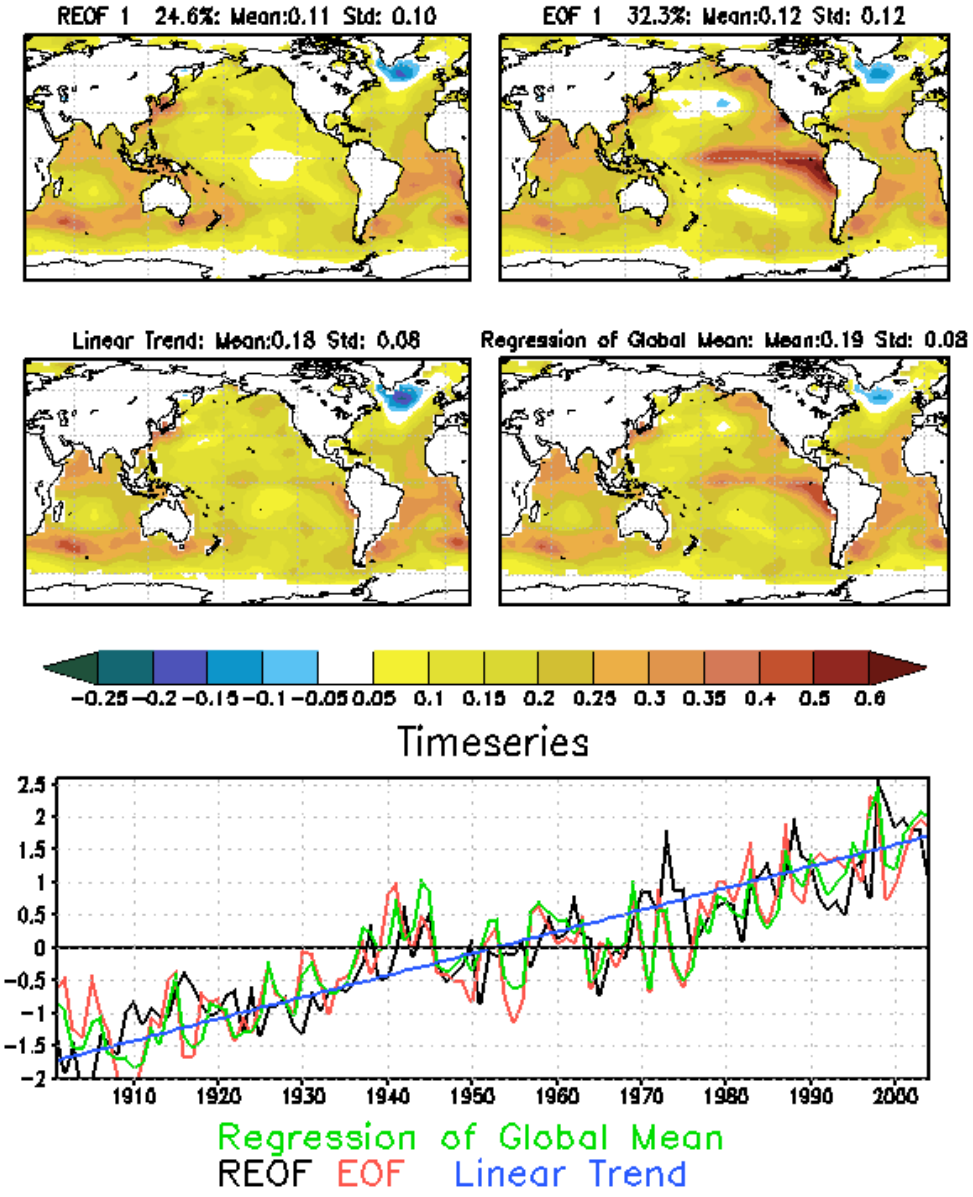
Results show that a) and c) are very similar, and b) and d) are very similar. Also, there are substantial regional differences in the trends between the two SST datasets. Apparently ERSST removed a 15-year running mean before analyzing the SST, while Hadley removed the trend.


Hadley Annual SST
REOF 1 27.2%: Mean:0.11 Std: 0.11
EOF 1 31.9%: Mean:0.13 Std: 0.11
a
b
Linear Trend: Mean:0.16 Std: 0.10
Regression of Global Mean: Mean:0.18 Std: 0.09
c
d
−0.25 −0.2 −0.15 −0.1 −0.05 0.05 0.1 0.15 0.2 0.25 0.3 0.35 0.4 0.5 0.6
Timeseries
e
2.5
2
1.5
1
0.5
0
−0.5
−1
−1.5
−2
1910 1920 1930 1940 1950 1960 1970 1980 1990 2000
Regression of Global Mean
REOF EOF Linear Trend

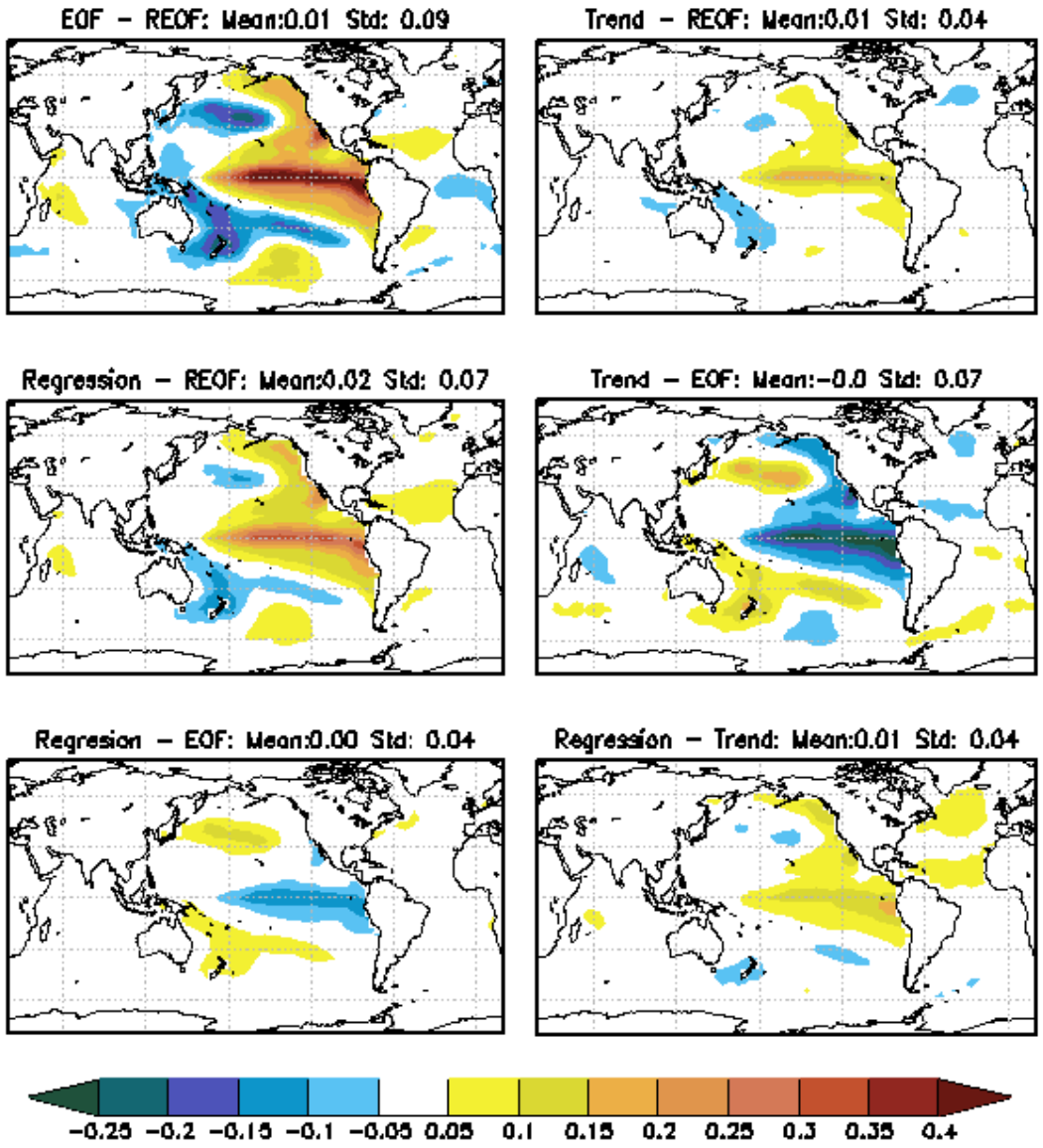
Hadley Annual SST



ERSST Annual SST



ERSST Annual SST



Appendix II

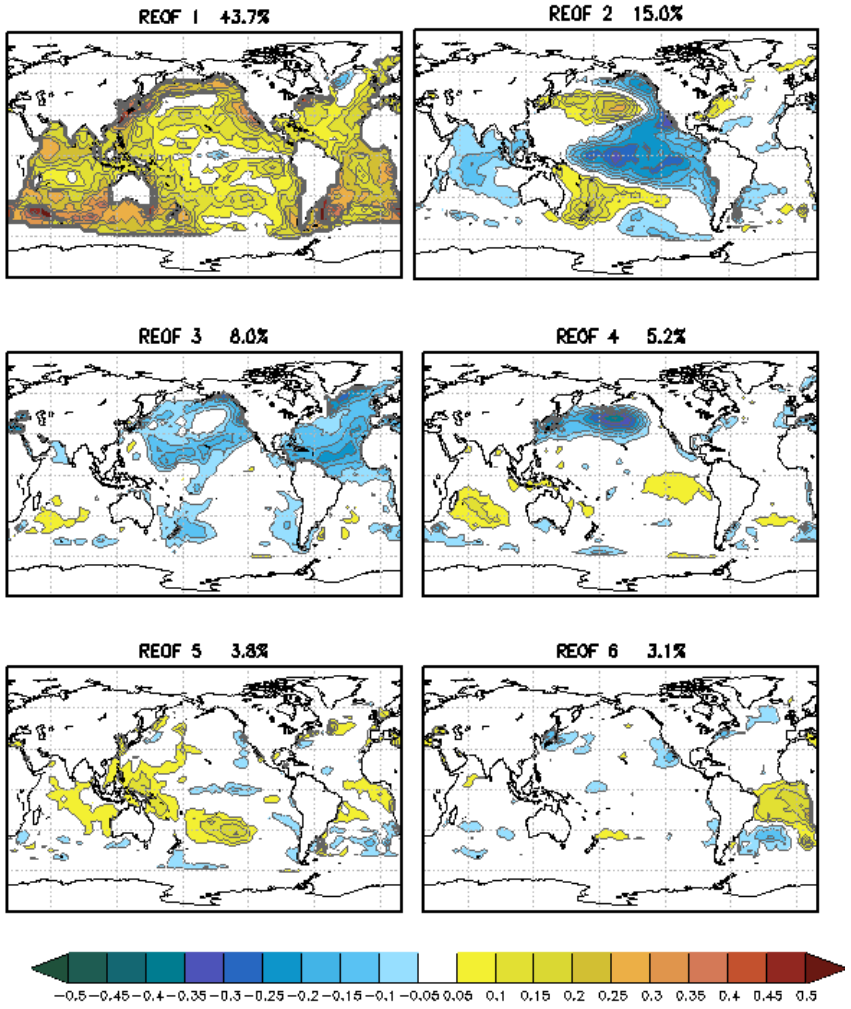
Low Frequency versus High Frequency EOFs

Applied a filter to monthly SST data that retains time scales of about 6 years and longer (Zhang et al. 1997)

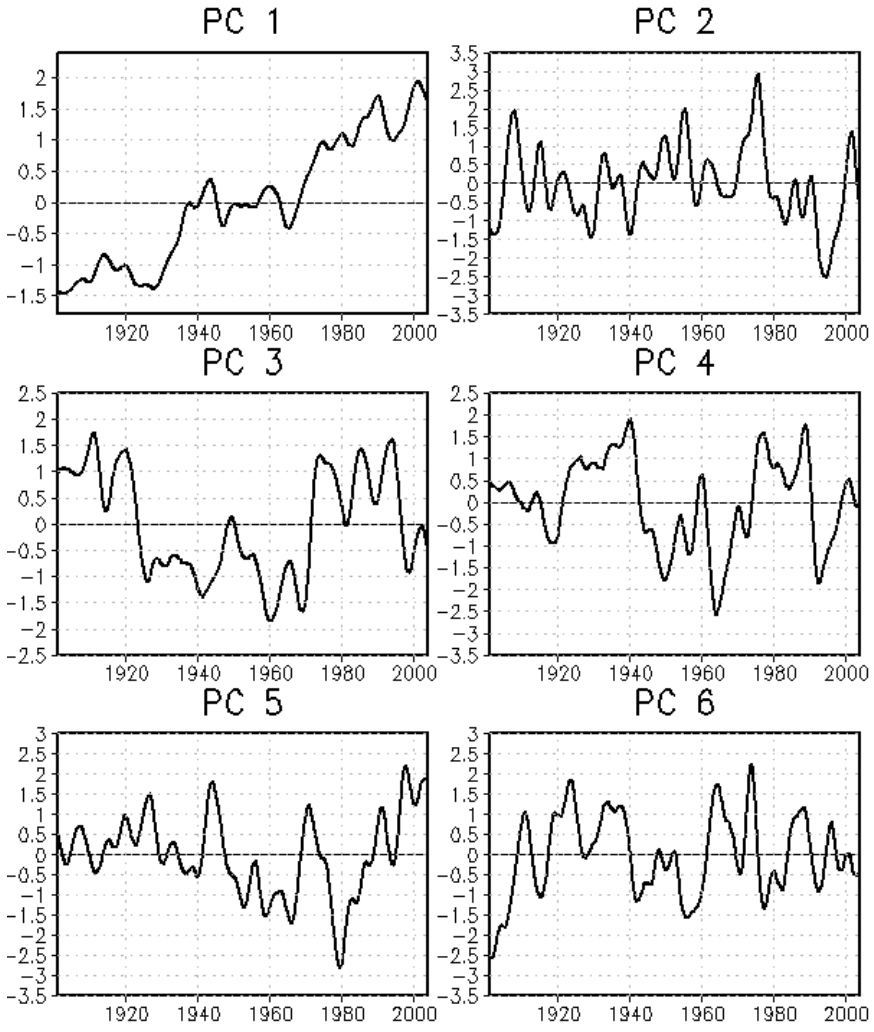
1) compute rotated EOFs from filtered data

2) also computed rotated EOFs from residual monthly data (after removing low frequency variability)

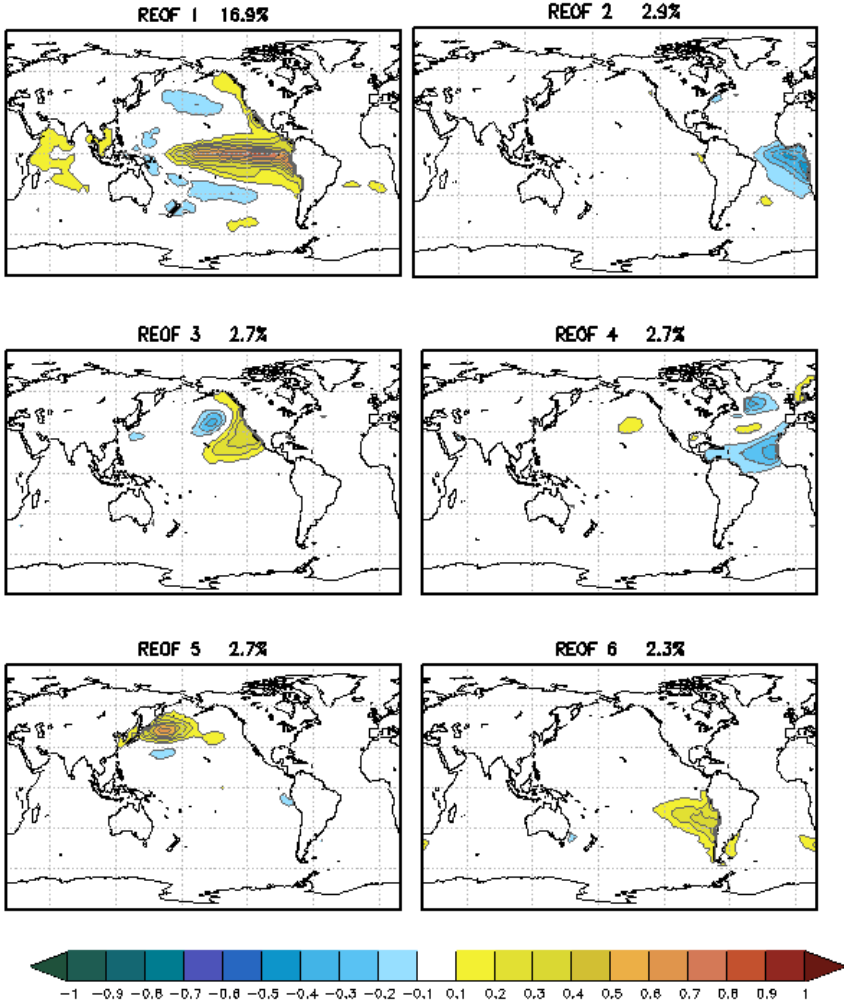
Hadley: Lopass Rotated



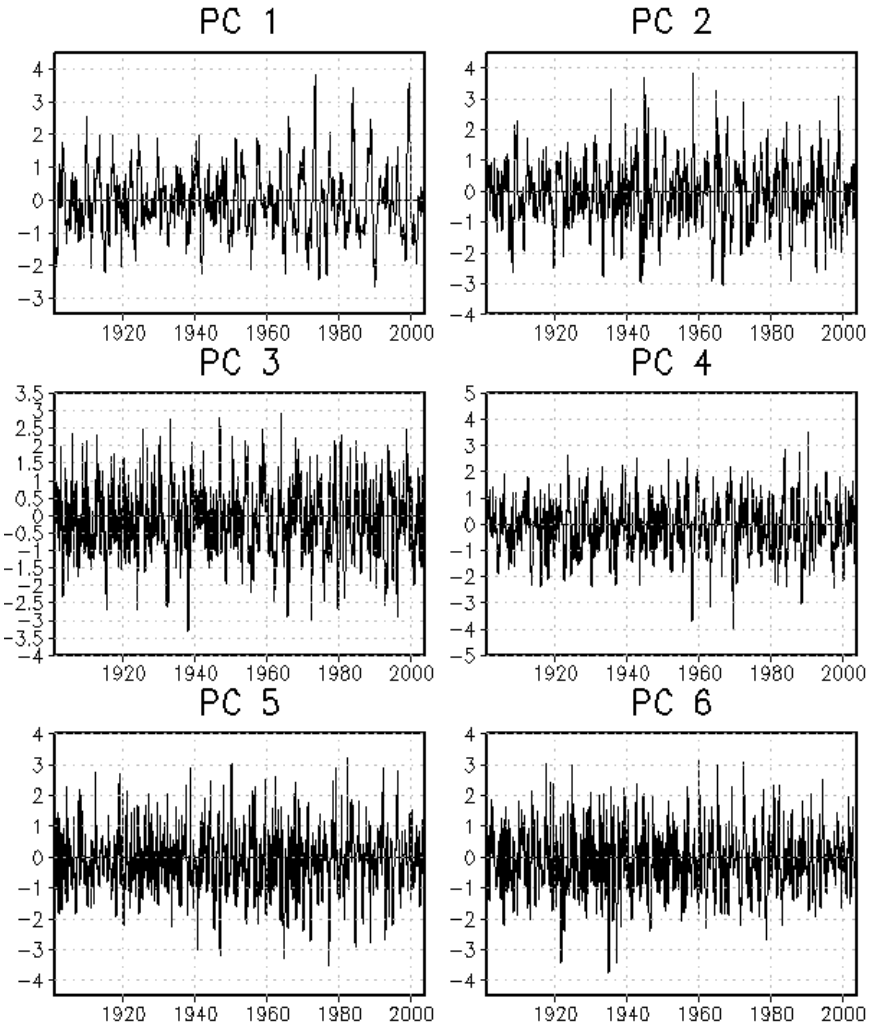
Hadley: Lopass Rotated



Hadley: Residual Rotated



Hadley: Residual Rotated

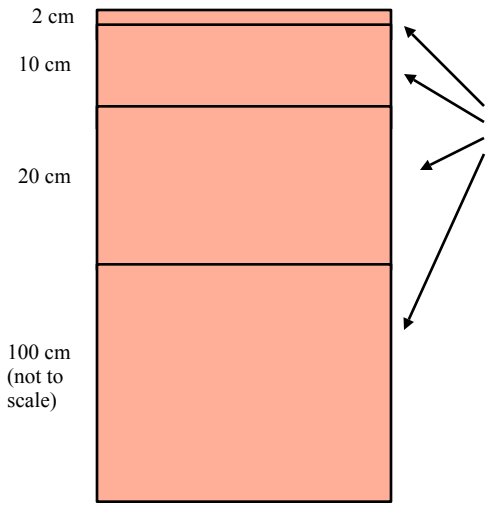


Appendix III

Soil Moisture Experiment

Goal: To determine if the feedback of soil moisture on precipitation can amplify the magnitude of simulated droughts.

Overview of approach:
-- Repeat multi-decadal AMIP-type climate simulation (C20C or standard AMIP) imposing climatological seasonal cycles of soil moisture.



Step 1: From archives of C20C (preferably) or standard multi-decadal AMIP simulations, derive the climatological seasonal cycles of soil moisture content for each soil layer at each land point on the globe. Weekly resolution is great; monthly is probably adequate.

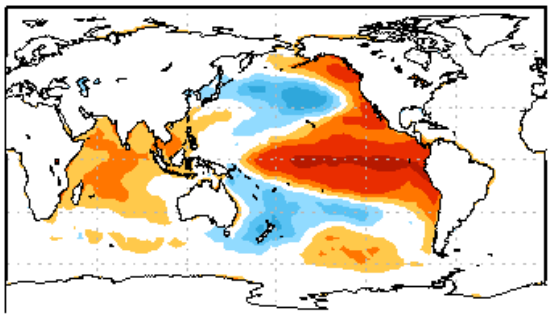
Step 2: Repeat the C20C or AMIP simulation. At each time step, throw out the simulated soil moisture states and replace them with states interpolated from the climatological values established in Step 1.

-- Compare precipitation variability (in particular, drought strength and occurrence) in this run with that in original run.

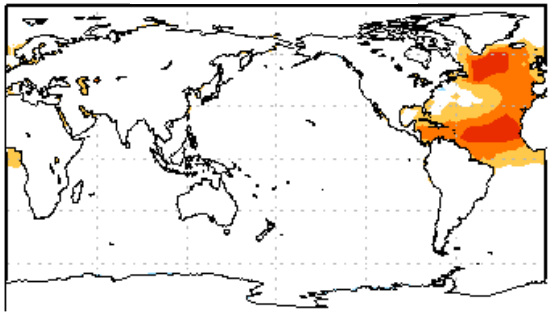
Appendix IV

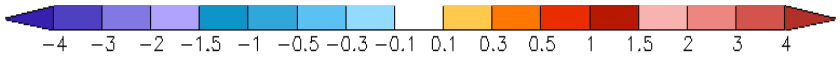
Idealized Experiments with Atl and Pac

Pac



Atl





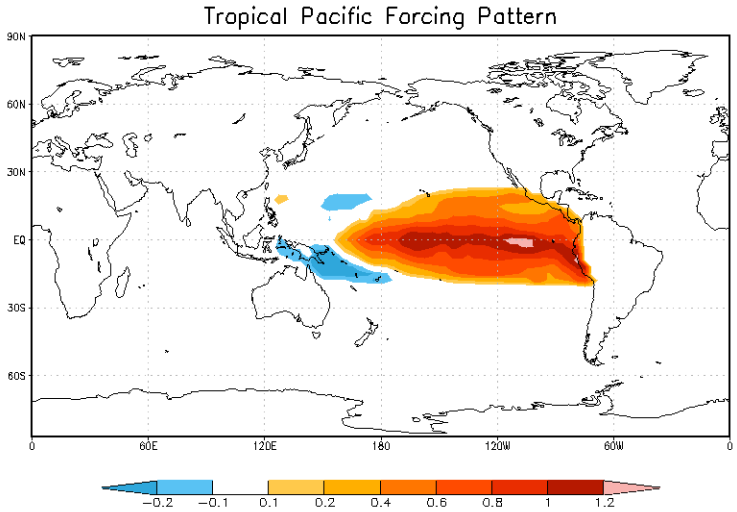
SST Forcing patterns
(warm phase)

Pac

Atl

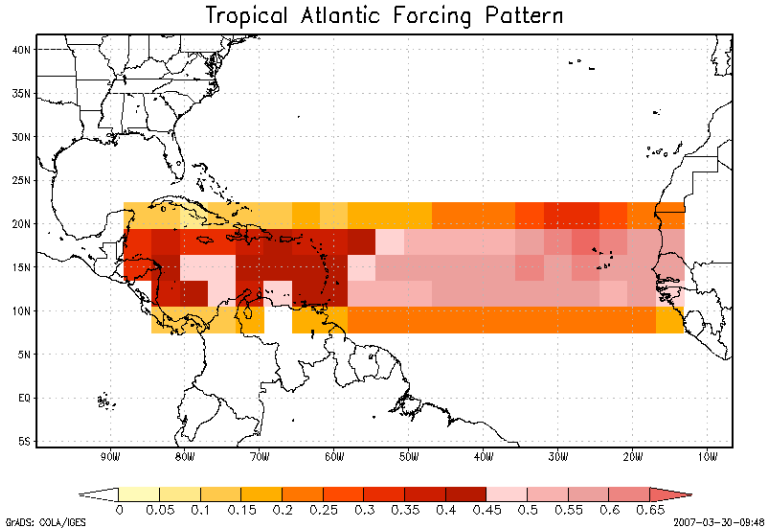
	warm	neutral	cold
warm	ww	wn	cw
neutral	nw		nc
cold	wc	cn	cc

Tropical Only (Pac and Atl)



Tropical Pac

The tropical Pacific region is -21S to 21N, with a taper between 21 and 15. The anomaly is 0 at 21-degrees, 1/2 of the full anomaly at 18-degrees, and the full anomaly equator-ward of 15-degrees.



Tropical Atl

The edges of the box with the full anomalies were chosen as 88W to 13W, and 12 N to 18N. The anomalies were tapered linearly north and south, with latitudes 9N and 21N getting 1/2 the anomaly, and with the anomaly going to 0 at latitudes 6N and 24N.