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An analysis of model tropospheric response to various forcings

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An analysis of model tropospheric response to various forcings

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Atlanta, GA
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PCMDI Program for Climate Model Diagnosis and Intercomparison

Model Data:

We emphasize the use of the IPCC climate of the 20th century coupled model integrations.

Monthly-averages (1979-2000), anoanlies are defined as departures from the (1979-1993) annual cycle

Available from esg.llnl.gov

"We acknowledge the international modeling groups for providing their data for analysis, the Program for Climate Model Diagnosis and Intercomparison (PCMDI) for collecting and archiving the model data, the JSC/CLIVAR Working Group on Coupled Modelling (WGCM) and their Coupled Model Intercomparison Project (CMIP) and Climate Simulation Panel for organizing the model data analysis activity, and the IPCC WG1 TSU for technical support. The IPCC Data Archive at Lawrence Livermore National Laboratory is supported by the Office of Science, U.S. Department of Energy."

Observational Estimates:

European Centre for Medium Range Weather Forecasting (ECMWF) Reanalyses (ERA40).

Monthly-averages

Resolutions range from (160,320), 1.125 degree grid to (45,72), a 4 by 5 degree grid.

National Center for Environmental Prediction/Department of Energy (R2) Reanalyses.

Monthly-averages

Observations (Station data):

Where possible we will use the Radiosonde Atmospheric Temperature Products for Assessing Climate (RATPAC) data

Monthly-averages

IPCC Climate of the 20th Century model runs analyzed herein:

Models used: (All are from submitted run1):

bcc_cm1 = Beijing Climate Center, China, BCC-CM1 Model
bccr_bcm2 = Bjerknes Centre for Climate Research, Norway, BCM2.0 Model
cccma_cgcm3_1_t63 = Canadian Centre for Climate Modelling and Analysis, CGCM3.1 Model, T63
cccma_cgcm3_1 = Canadian Centre for Climate Modelling and Analysis, CGCM3.1 Model, T47
csiro_mk3_0 = CSIRO Atmospheric Research, Australia, Mk3.0 Model
gfdl_cm2_0 = NOAA Geophysical Fluid Dynamics Laboratory, CM2.0 Model
gfdl_cm2_1 = NOAA Geophysical Fluid Dynamics Laboratory, CM2.1 Model
giss_aom = NASA Goddard Institute for Space Studies, C4x3
giss_model_e_h = NASA Goddard Institute for Space Studies, ModelE20/HYCOM
giss_model_e_r = NASA Goddard Institute for Space Studies, ModelE20/Russell
iap_fgoals1_0_g = LASG, Institute of Atmospheric Physics, China, FGOALS1.0_g Model
inmcm3_0 = Institute for Numerical Mathematics, Russia, INMCM3.0 Model
ipsl_cm4 = IPSL/LMD/LSCE, France, CM4 V1 Model
miroc3_2_hires = CCSR/NIES/FRCGC, MIROC Model V3.2, high resolution
miroc3_2_medres = CCSR/NIES/FRCGC, MIROC Model V3.2, medium resolution
mpi_echam5 = Max Planck Institute for Meteorology, Germany, ECHAM5 / MPI OM
mri_cgcm2_3_2a = Meteorological Research Institute, Japan, CGCM2.3.2a
ncar_ccsm3_0 = NCAR Community Climate System Model, CCSM 3.0
ncar_pcm1 = Parallel Climate Model (Version 1)
ukmo_hadcm3 = Hadley Centre for Climate Prediction, Met Office, UK, HadCM3 Model
ukmo_hadgem1 = Hadley Centre for Climate Prediction, Met Office, UK, HadGEM1 Model

21 different "run1" submissions used in this study.

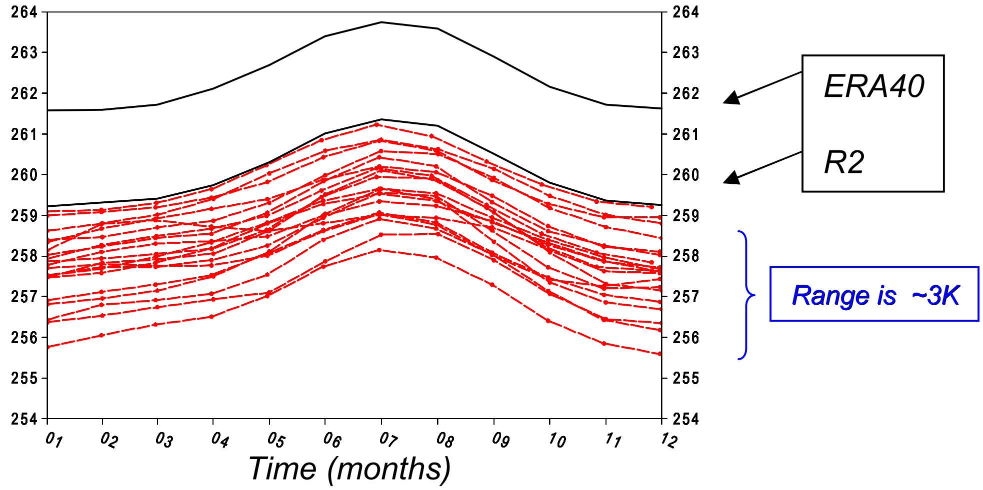
Forcings used in the IPCC "20th century climate change simulations"

Model	Greenhouse	Ozone	Sulfate-Direct	Black-Carbon	Volcanic-Aerosols
UKMO-HadGEM1	y	y	y	y	y
UKMO-HadCM3	y	y	y		
PCM	y	y	y		y
MRI-CGCM2.3.2	y		y		y
MIROS3.2 (hires)	y	y	y	y	y
MIROC3.2 (medres)	y	y	y	y	y
IPSL-CM4	y		y		
INM-CM3.0	y		y		
GISS-ER	y	y	y	y	y
GISS-EH	y	y	y	y	y
GISS-AOM	y		y		
GFDL CM2.1	y	y	y	y	y
GFDL CM2.0	y	y	y	y	y
FGOALS-g1.0	y		y		
ECHAM5/MPI-OM	y	y	y		
CSIRO-Mk3.0	y		y	u	
CNRM-CM3	y	y	y	y	
CCSM3	y	y	y	y	y
CCCma-CGCM3.1(T63)	y		y		
CCCma-CGCM3.1(T47)	y		y		
BCCR-BCM2.0	y		y		

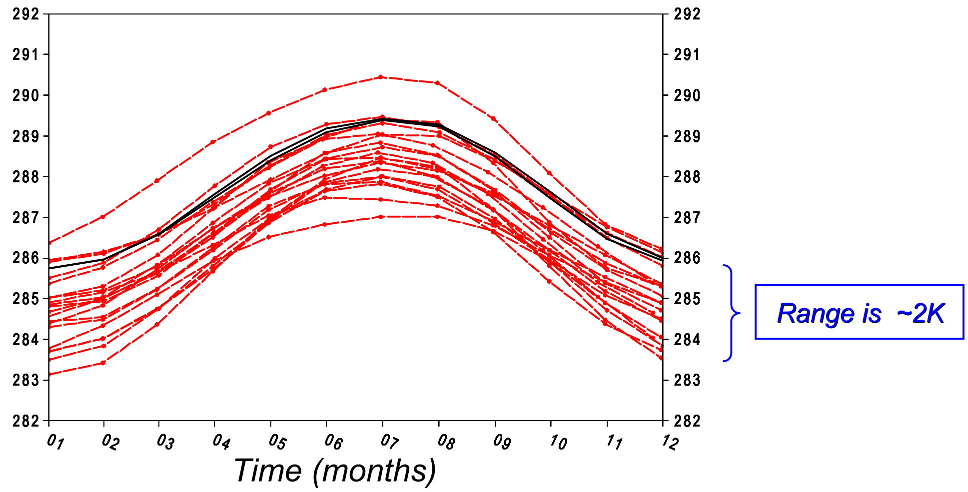
U=unknown, Y=yes

The Global Monthly-averaged Annual Cycle derived over 1979-2000

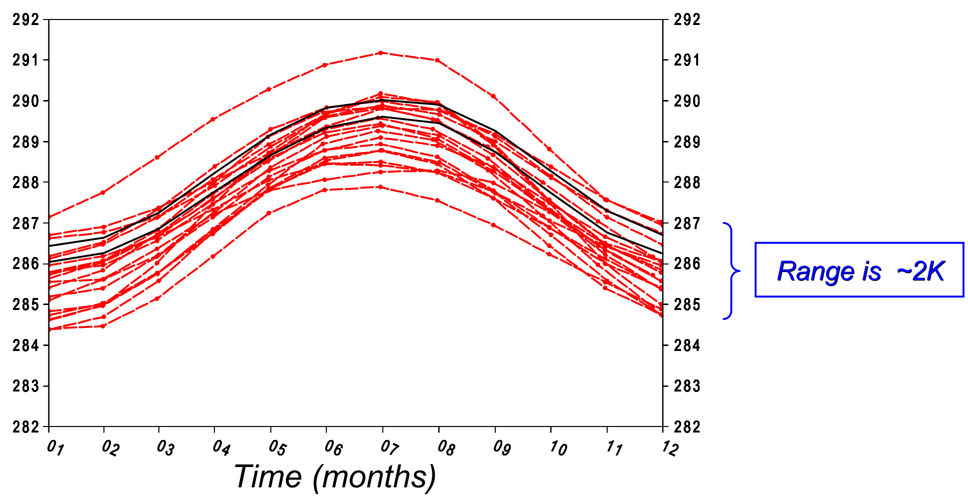
T850-T300



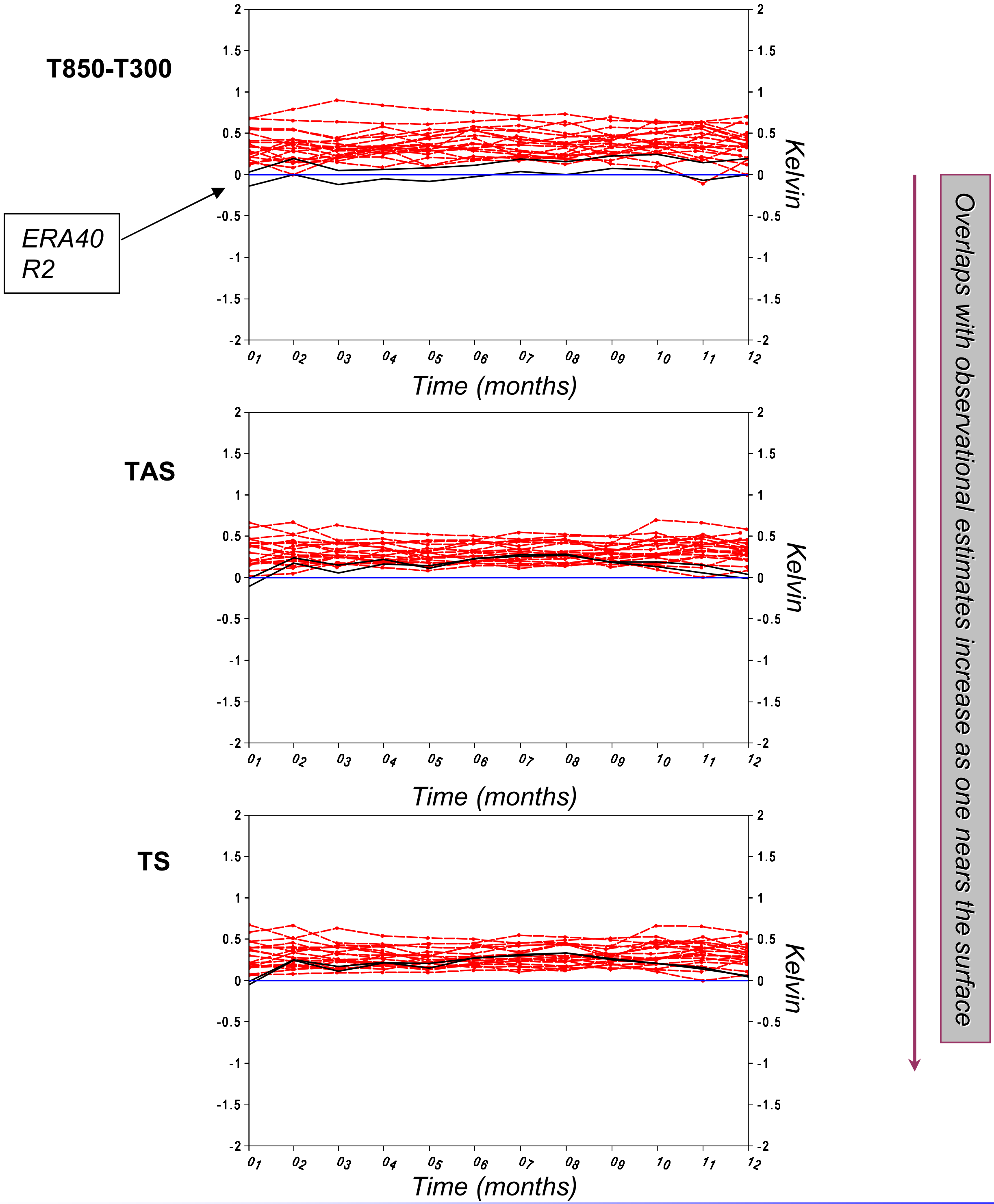
2m Temp



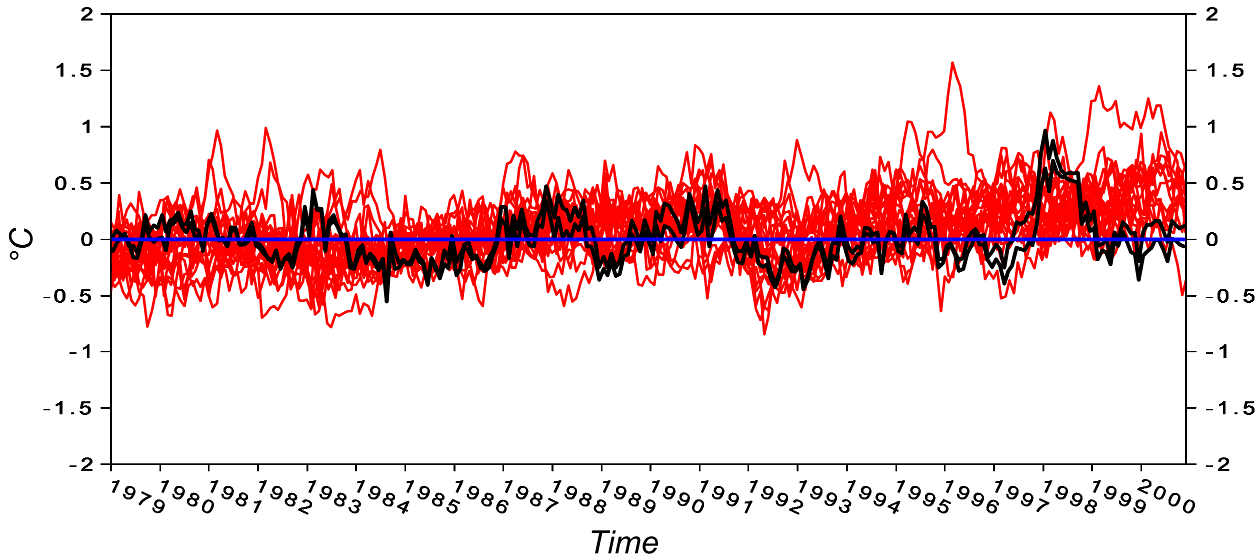
Surface Temp



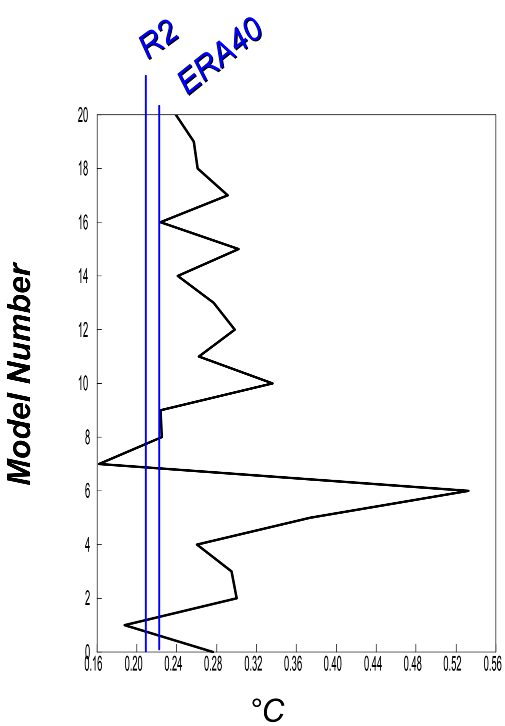
The Change in the Global Annual Cycle for two differing time periods. The Annual cycle from (1996-2000) – The Annual Cycle from (1979-1983)



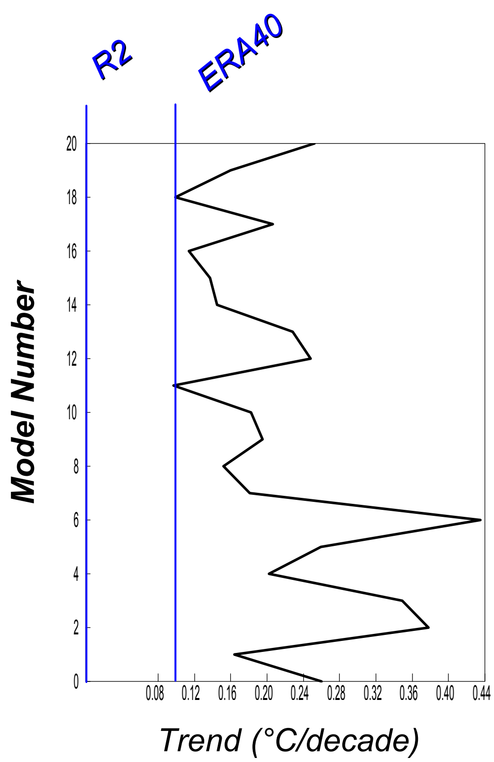
Time series of global layer average temperature (850-300hPa) anomalies for 21 IPCC models and two reanalyses



Standard deviation of global anomalies



Global decadal layer average temperature trend

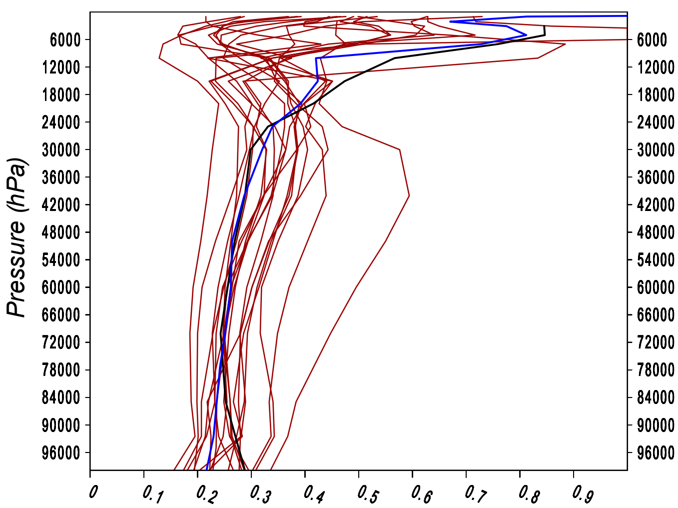


PCMDI *Program for Climate Model Diagnosis and Intercomparison*

Do models agree better with use of station data, instead of reanalyses?

We compare with the monthly-averaged Radiosonde Atmospheric Temperature Products for Assessing Climate (RATPAC) data

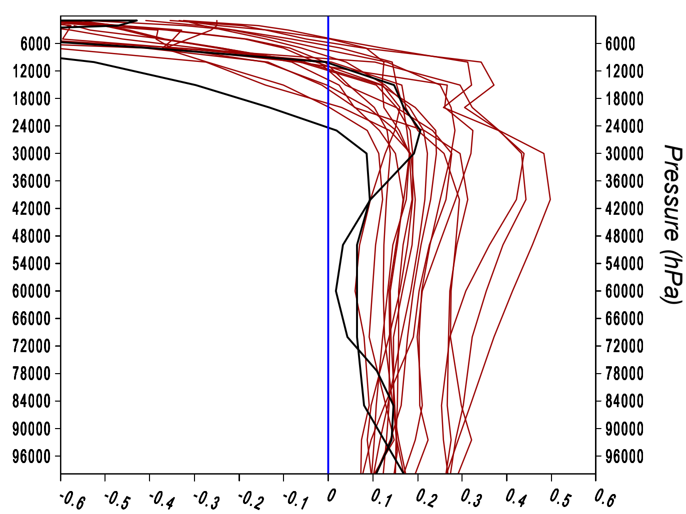
Original RATPAC data is binned to all participant model grids (masking which matches as close as possible the spatio-temporal coverage of the RATPAC data)



Global Standard Deviation of Level Temperatures

MODELS
RATPAC
ERA40

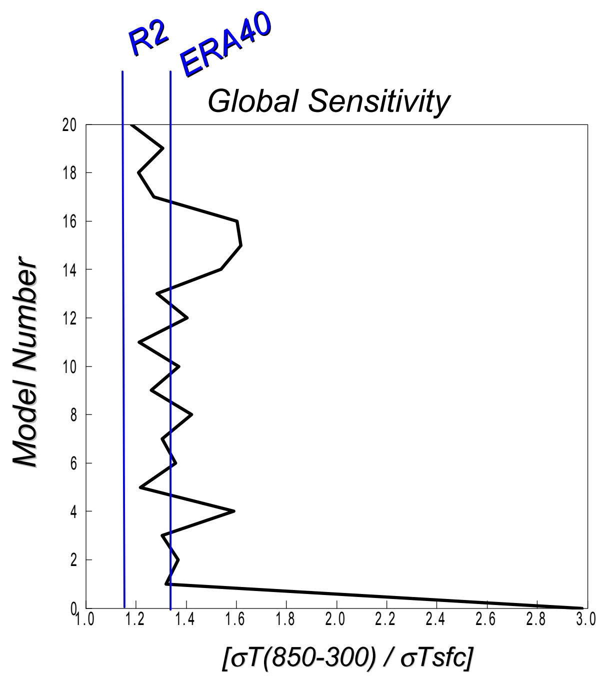
Global Decadal Pressure Level Temperature Trends (C/decade)



MODELS
RATPAC/ERA40

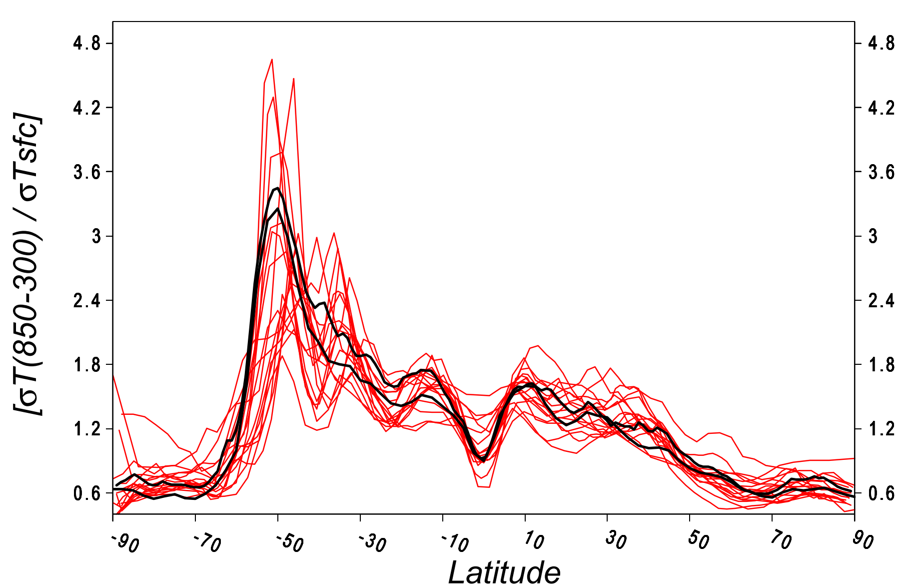
Layer average temperature sensitivity to anomalous surface forcing

[σT(850-300) / σTsfc]



For global measures of sensitivity the models appear to be in line with Observational estimates

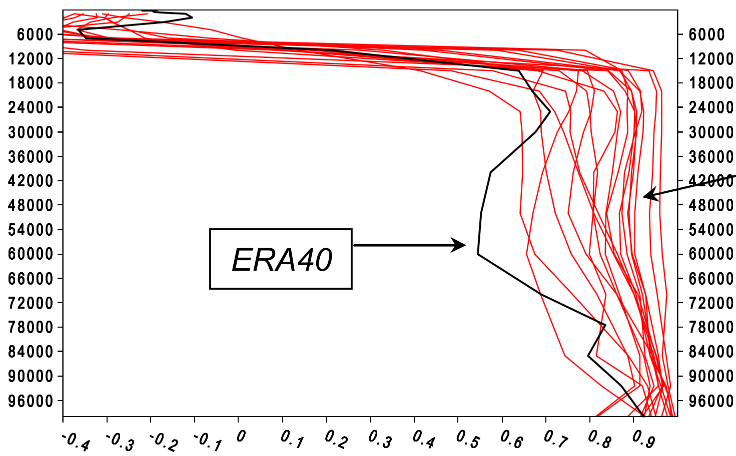
Anomalies are defined as departures from the 1979-2000 annual cycle



For zonal values the picture is not so clear, the largest differences occur in the southern hemisphere

The picture is not so clear…

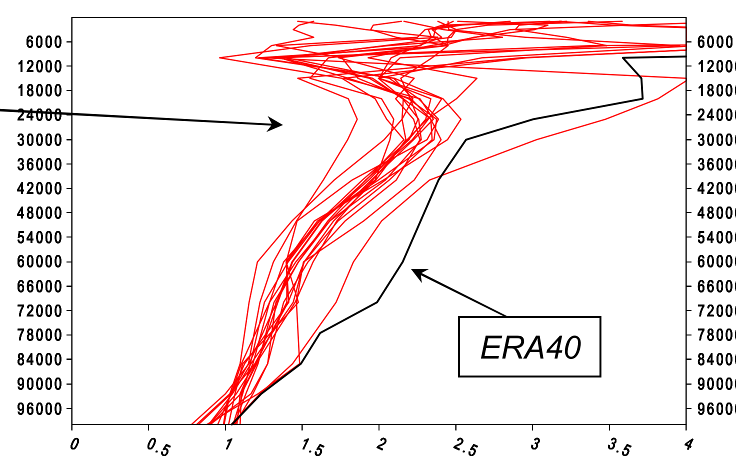
Linear correlation of of area-averaged surface temperature (-30 to 30) all longitudes to pressure level temperatures (same latitude)



All models appear to be too strongly coupled to the surface

The ratio of standard deviation of surface temperature to that at each pressure level

Less sensitive to anomalous surface forcing



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CONCLUSIONS

- *The annual cycle of temperature at the surface and in the troposphere is cooler in magnitude than observational estimates and possesses on average a 2K range for all models in this study*

- *The annual cycle difference exhibit some signs of uniform warming with no clear preference for particular season or month*

- *Deep layer temperature exhibits some reasonable variability, however some problems persist*

- *In general, subsampling acts to make the models better overlap station data variability, though decadal temperature trends are nearly the same as in larger scale measures.*

- *A zonal plot of a temperature sensitivity shows significant differences between observations and model values.*

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