# Chapter 5 Figures for Public Review

# CHAPTER 5

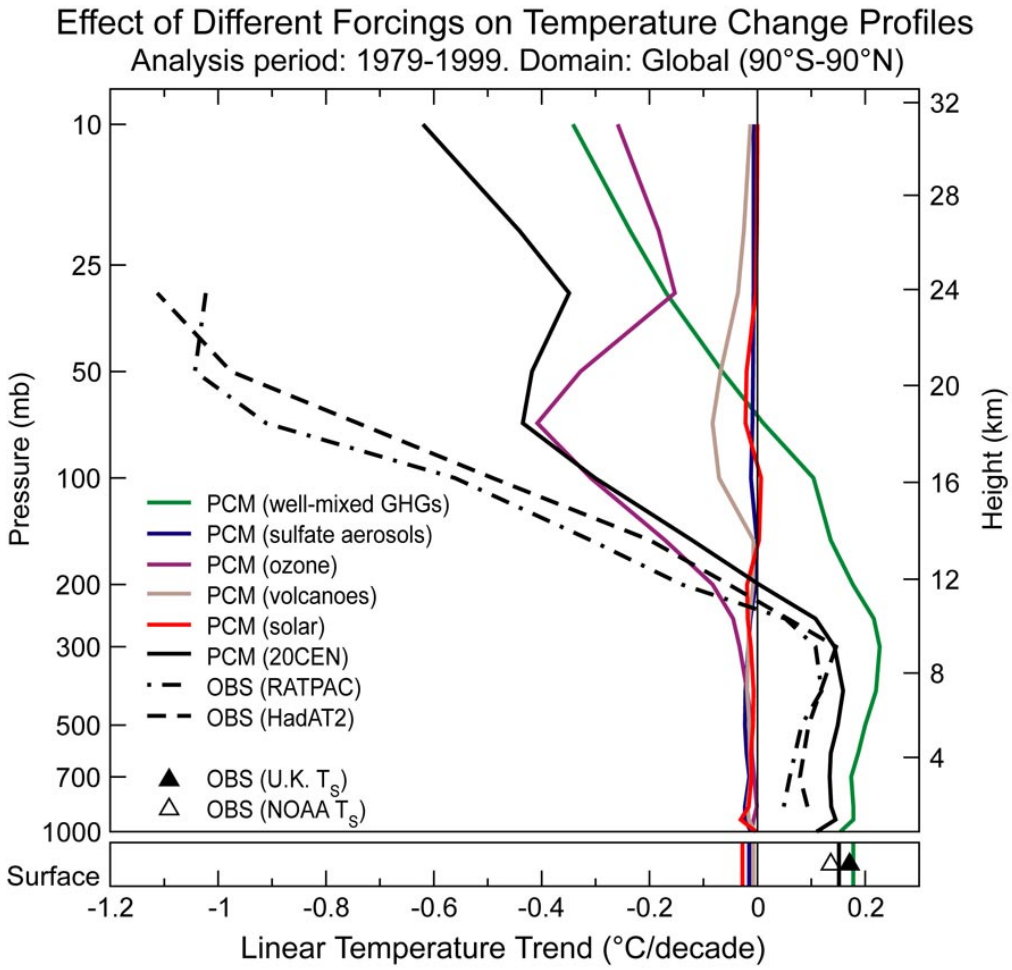


**Figure 5.1:** Vertical profiles of global-mean atmospheric temperature change over 1979 to 1999. Surface temperature changes are also shown. Results are from two different radiosonde data sets (HadAT2 and RATPAC; see Chapter 3) and from single forcing and combined forcing experiments performed with the Parallel Climate Model (PCM; Washington et al., 2000). PCM results for each forcing experiment are averages over four different realizations of that experiment. All trends were calculated with monthly mean anomaly data.

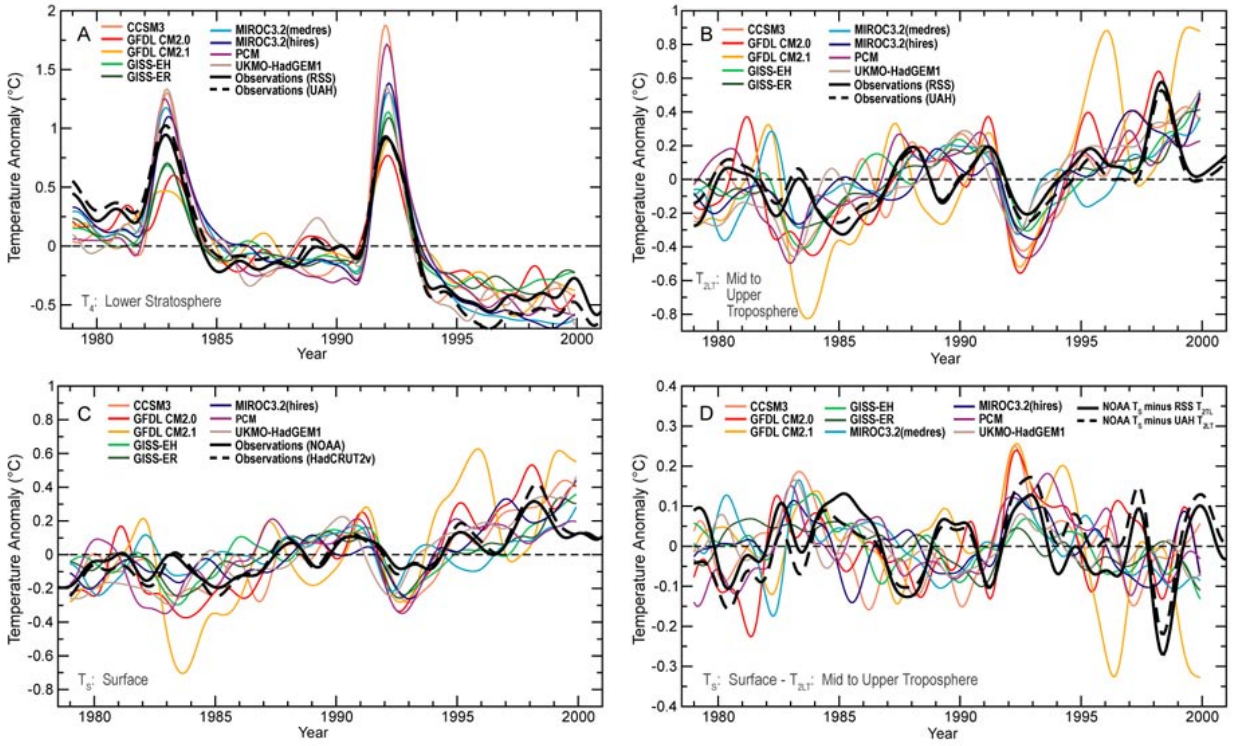


**Figure 5.2A:** Modeled and observed changes in global-mean monthly-mean lower stratospheric temperature (T4). A simple weighting function approach (Box 2.2) was used to calculate a "synthetic" T4 (equivalent to the MSU T4 monitored by satellites) from model temperature data. Synthetic T4 results are from "20CEN" experiments performed with nine different models (see Table 5.1). These models were chosen because they satisfy certain minimum requirements in terms of the forcings applied in the 20CEN run: all nine were driven by changes in well-mixed GHGs, sulfate aerosol direct effects, tropospheric and stratospheric ozone, volcanic aerosols, and solar irradiance (in addition to other forcings; see Table 5.2). Observed satellite-based estimates of T4 changes were obtained from both RSS and UAH (see Chapter 3). All T4 changes are expressed as departures from a 1979 to 1999 reference period average, and were smoothed with the same filter. To make it easier to compare the variability of T4 in models with different ensemble sizes (see Table 5.1), only the first 20CEN realization is plotted from each model. This also facilitates comparisons of modeled and observed variability.

**Figure 5.2B:** As for Figure 5.2A, but for time series of global-mean, monthly-mean lower tropospheric temperature anomalies (T2LT).

**Figure 5.2C:** As for Figure 5.2A, but for time series of global-mean, monthly-mean surface temperature anomalies (TS).

**Figure 5.2D:** As for Figure 5.2A, but for time series of global-mean, monthly-mean temperature differences between the surface and T2LT.

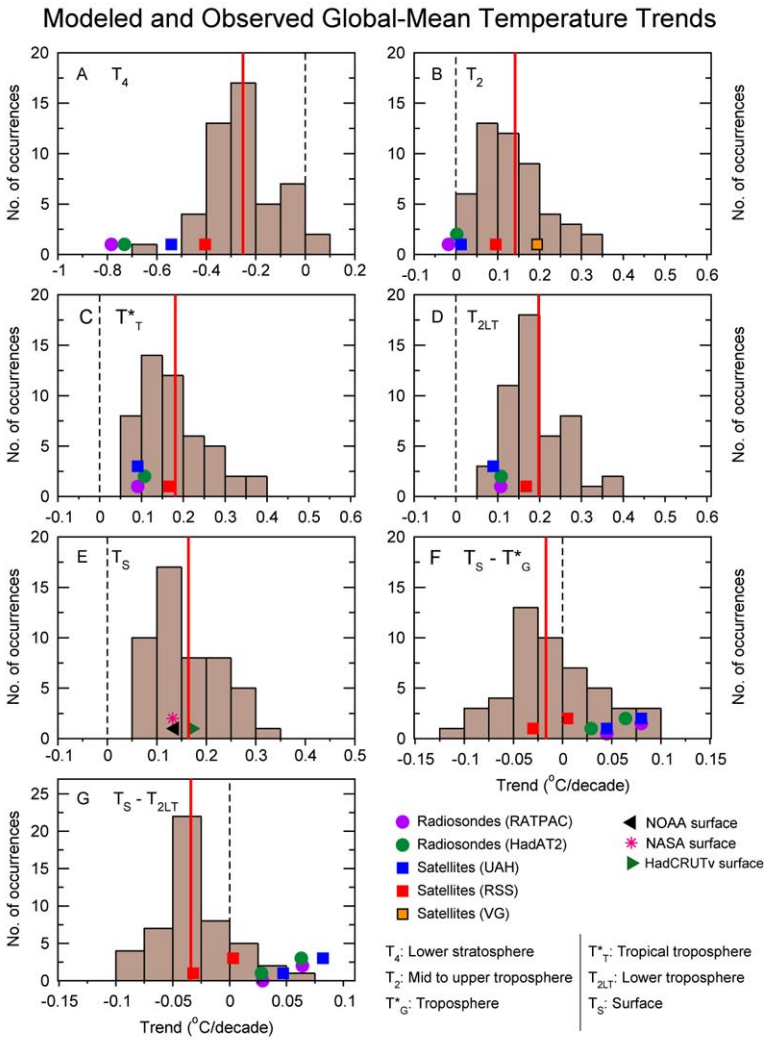


**Figure 5.3:** Modeled and observed trends in time series of global-mean T4 (panel A), T2 (panel B), T*G (panel C), T2LT (panel D), TS (panel E), TS minus T*G (panel F), and TS minus T2LT. All trends were calculated using monthly-mean anomaly data. The analysis period is 1979 to 1999. Model results are displayed in the form of histograms. Each histogram is based on results from 49 individual realizations of the 20CEN experiment, performed with 19 different models (Table 5.1). The applied forcings are listed in Table 5.2. The vertical red line in each panel is the mean of the model trends, calculated with a sample size of n = 19 (see Table 5.4A). Observed trends are estimated from two radiosonde and three satellite datasets (T2), two radiosonde and two satellite datasets (T4, T*G and T2LT), and three different surface datasets (TS) (see Chapter 3). The bottom "rows" of the observed difference trends in panels F and G were calculated with NOAA TS data. The top "rows" of observed results in F and G were computed with HadCRUT2v TS data. The vertical offsetting of observed results in these panels (and also in panels B-E) is purely for the purpose of simplifying the visual display – observed trends bear no relation to the y-axis scale. To simplify the display, the Figure does not show the statistical uncertainties arising from the fitting of linear trends to noisy data. GISS TS trends (not shown) are very close to those estimated with NOAA TS data (see Chapter 3).

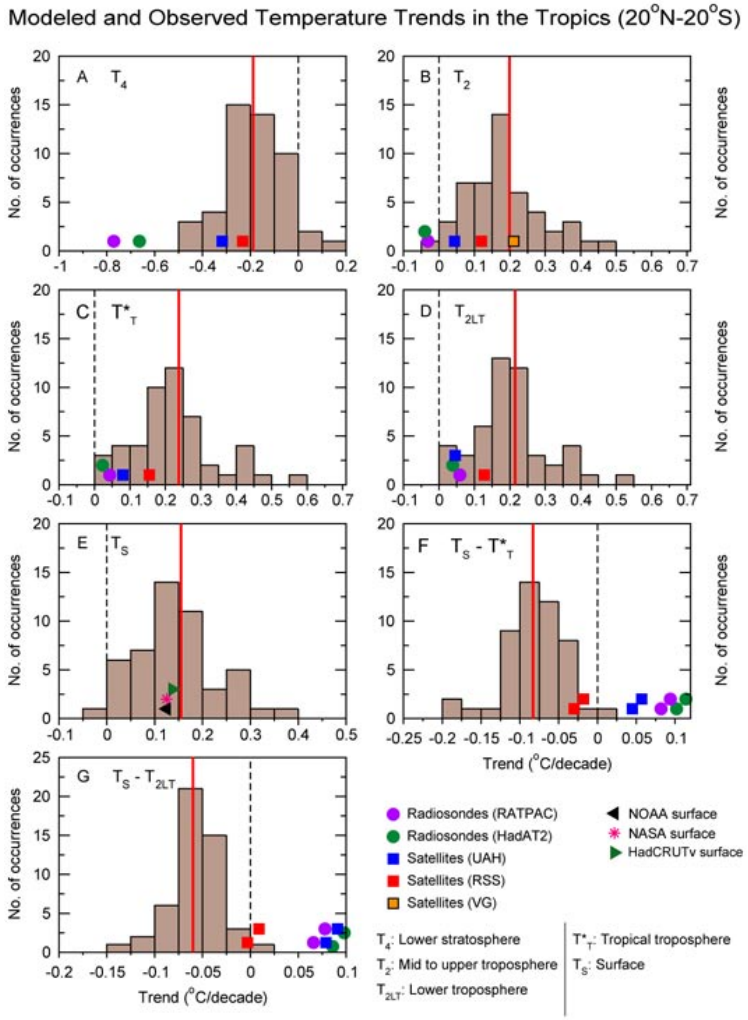


**Figure 5.4:** As for Figure 5.3, but for trends in the tropics (20°N-20°S).

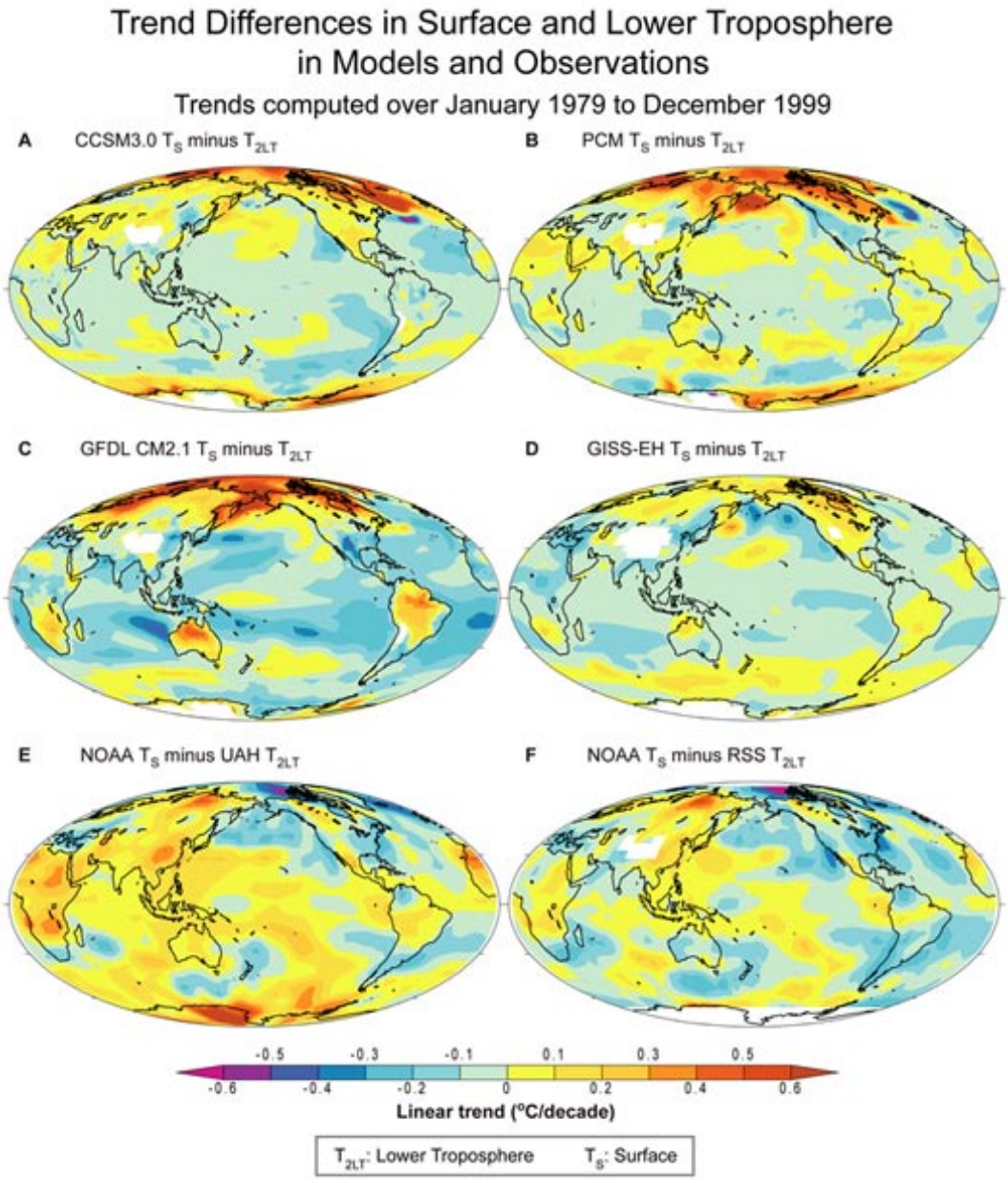


**Figure 5.5:** Modeled and observed maps of the differences between trends in TS and T2LT. All trends in TS and T2LT were calculated over the 252-month period from January 1979 to December 1999. Model results are ensemble means from 20CEN experiments performed with CCSM3.0 **(panel A)**, PCM **(panel B)**, GFDL CM2.1 **(panel C)**, and GISS-EH **(panel D)**. Observed results rely on NOAA TS trends and on two different satellite estimates of trends in T2LT, obtained from UAH **(panel E)** and RSS **(panel F).** White denotes high elevation areas where it is not meaningful to calculate synthetic T2LT **(panels A-D)**. Note that RSS mask T2LT values in such regions, while UAH do not **(c.f. panels F, E).**

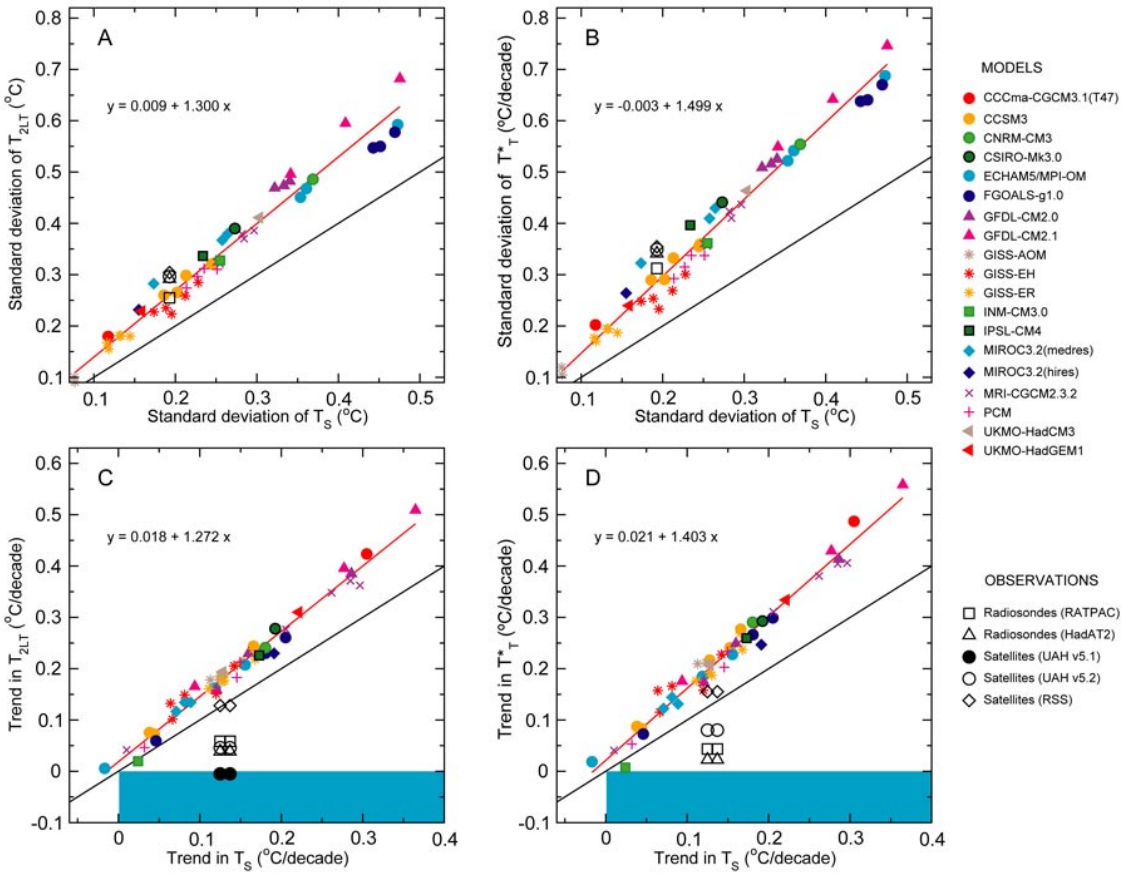


**Figure 5.6:** Scatter plots showing the relationships between tropical temperature changes at Earth's surface and in two different layers of the troposphere. All results rely on temperature data that have been spatially-averaged over the deep tropics (20°N-20°S). Model data are from 49 realizations of 20CEN runs performed with 19 different models (Table 5.1). Observational results were taken from four different upper-air datasets (two from satellites, and two from radiosondes) and two different surface temperature datasets (see Chapter 3). The two upper panels provide information on the month-to-month variability in TS and T2LT **(panel A)** and in TS and T*T **(panel B)**. The two bottom panels consider temperature changes on multi-decadal timescales, and show the trends (over 1979 to 1999) in TS and T2LT **(panel C)** and in TS and T*T **(panel D)**. The red line in each panel is the regression line through the model points. Its slope provides information on the amplification of surface temperature variability and trends in the free troposphere. The black line in each panel is given for reference purposes, and has a slope of 1. Values above (below) the black lines indicate tropospheric amplification (damping) of surface temperature changes. There are two columns of observational results in C and D. These are based on the NOAA and HadCRUT2v TS (0.12 and 0.14°C/decade, respectively). Note that panel C show results from published and recently-revised versions of the UAH T2LT data (versions 5.1 and 5.2). Since the standard deviations calculated from NOAA and HadCRUT2v monthly TS anomalies are very similar, observed results in A and B use NOAA standard deviations only. The blue shading in the bottom two panels defines the region of simultaneous surface warming and tropospheric cooling.

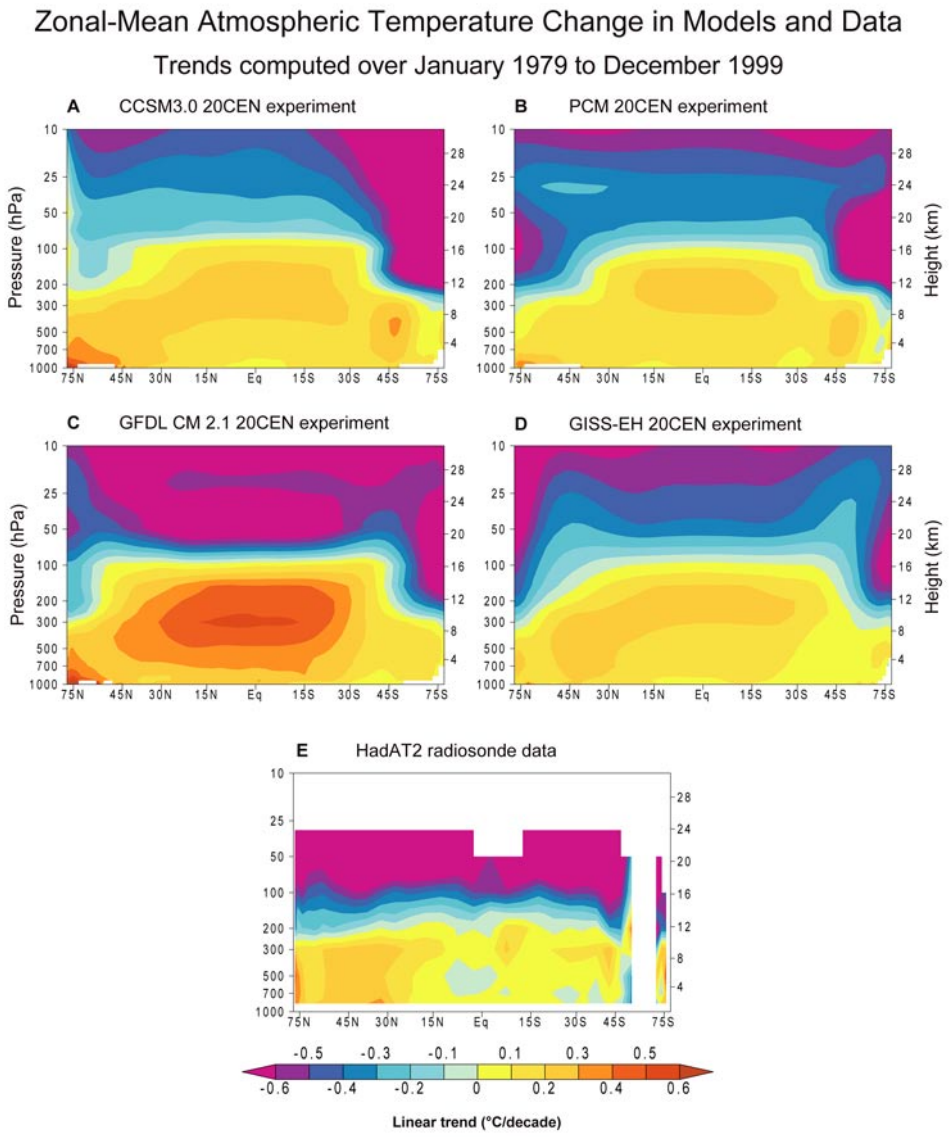


**Figure 5.7:** Zonal-mean patterns of atmospheric temperature change in "20CEN" experiments performed with four different climate models and in observational radiosonde data. Model results are for CCSM3.0 **(panel A),** PCM **(panel B),** GFDL CM 2.1 **(panel C),** and GISS-EH **(panel D).** The model experiments are ensemble means. There are differences between the sets of climate forcings that the four models used in their 20CEN runs (Table 5.3). Observed changes **(panel E)** were estimated with HadAT2 radiosonde data (Thorne et al., 2005, and Chapter 3). The HadAT2 temperature data do not extend above 30 hPa, and have inadequate coverage at high latitudes in the Southern Hemisphere. All temperature changes were calculated from monthly-mean data and are expressed as linear trends (in °C/decade) over 1979 to 1999.