THE INFLUENCE OF SSTs ON GLOBAL LAND SURFACE TEMPERATURES—M. P. HOERLING IN CONJUNCTION WITH THE NOAA CSI TEAM

Globally averaged land temperatures for 2007 were the warmest since records began in 1880, with a mean annual departure of +0.64°C above the 1971–2000 average based on the CRU/UKMO analysis. Land temperatures were anomalously warm almost everywhere over the globe (Fig. 2.6, top panel).

The connection between the record global land temperatures of 2007 and global SST conditions was investigated with three AGCM simulations forced with the monthly evolution of observed SSTs (so-called AMIP experiments; Gates 1992). For each AGCM, an ensemble of 50 realizations was made without the effects of radiative forcing due to changes in atmospheric chemical composition. The multimodel ensemble averaged land surface temperature response in 2007 is warm at virtually all locations (Fig. 2.6, middle panel), with a mean annual globally averaged land temperature departure of +0.26°C computed with respect to the 1971–2000 climatological mean. The PDF of simulated globally averaged 2007 land surface temperature departures for each of the 150 AMIP runs is shown in Fig. 2.7 (left panel), along with the PDF of 150 members of the control runs that used 1971–2000 climatological SSTs. The PDF indicates that 1) a majority of simulations for 2007 had a positive land surface temperature anomaly and 2) while SSTs in 2007 greatly elevated the chances that global land surface temperatures would be above normal, no single run generated a departure as large as observed. This SST-only-forced analysis suggests that the SST-forced response, although of the same sign as the 2007 observed record land temperatures, was not the leading cause.

The relationship between the record global land temperature of 2007 and GHG forcing was investigated using the coupled model simulations that were used in the IPCC Fourth Assessment

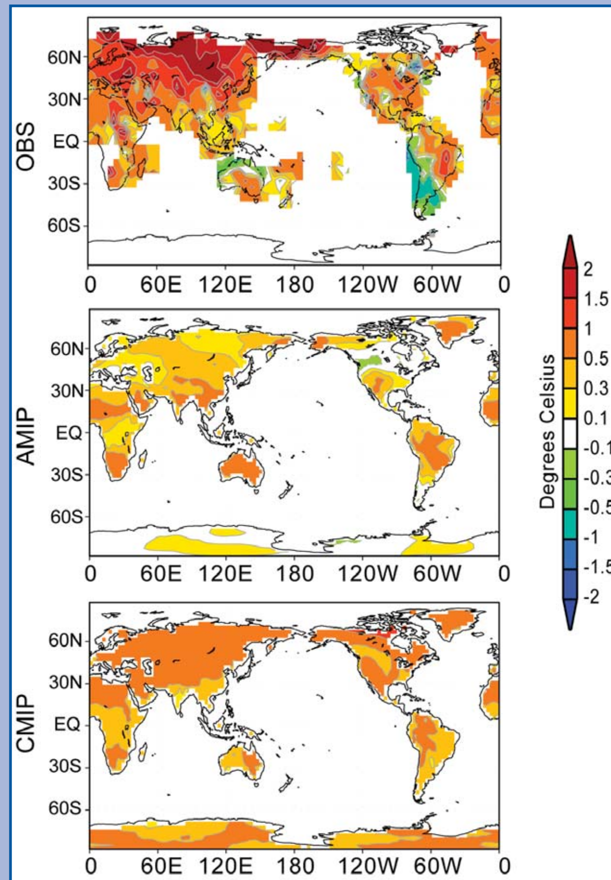

Fig. 2.6. (top) Observed and simulated 2007 annually averaged land surface temperature departure based on (middle) AMIP ensemble and (bottom) CMIP ensemble experiments. Reference is 1971–2000 climatologies. AMIP refers to atmospheric climate models forced with the monthly varying observed 2007 global sea surface temperatures. CMIP refers to coupled ocean–atmosphere climate models forced with estimated 2007 greenhouse gas concentrations. See text for details on model runs. [Source: NOAA CSI Team.]

the case for most of the last few years, there was not a dramatic cooling of the south polar region in the austral spring. Even so, all datasets indicate significant cooling over the period on a global basis (Table 2.1), though since about 1995, the global trends have not been remarkable (Fig. 2.8).

c. Hydrologic cycle

1) Global precipitation

(i) Over land—D. H. Levinson and J. H. Lawrimore

The focus of this section is on land-based precipitation and the spatiotemporal variations observed in 2007 using in situ gauge data from the GHCN dataset (Peterson and Vose 1997). The annual and seasonal

Report. This "CMIP archive" of model data (which included 22 coupled atmosphere–ocean models and a total ensemble size of 48 simulations for 2007) used projected GHG concentrations based on a business-as-usual scenario (A1B) extended from the historical climate of the twentieth century runs that ended in 1999. The 2007 land surface temperature anomalies averaged across all 48 model simulations are shown in Fig. 2.7 (right panel). Warm surface temperature departures (relative to the CMIP model climatologies of 1971–2000) occur over all land points, with a mean annual globally average land temperature departure of +0.40°C. The PDF of simulated globally averaged land surface temperature departures for each of the 48 runs is shown in Fig. 2.7 (right panel), along with the distribution of all CMIP simulated global land surface temperatures during the reference period of 1971–2000 (comprising 1,440 samples; 30 yr × 48 runs). The PDF indicates that 1) almost all simulations for 2007 had a positive land surface temperature anomaly and 2) 2007 GHG forcing greatly elevated the chances that global land surface temperatures would be above normal, with a few runs generating 2007 departures larger than the record observed warmth. The magnitude of the land surface warmth is appreciably greater in the CMIP ensemble than in the AMIP ensemble, suggesting that GHG forcing was a leading cause for the 2007 record land temperatures.

In conclusion, the analysis indicates that greenhouse gas forcing was a likely attributing factor raising global mean land temperatures in 2007. That signal (defined as the multimodel mean response) alone, however, cannot explain the record warmth that was observed. Further, the increase of GHG forcing in 2007 led to a 100-fold increase in the probability of land temperatures exceeding the 2007 observed +0.64°C record (from a less than 0.1% chance for 1971–2000 GHG forcing to a 10% probability under the 2007 GHG forcing scenario). At least one pathway by which GHG forcing raised land temperature was via their influence on the observed SSTs, although as judged from the AMIP simulations this alone cannot explain the record warmth.

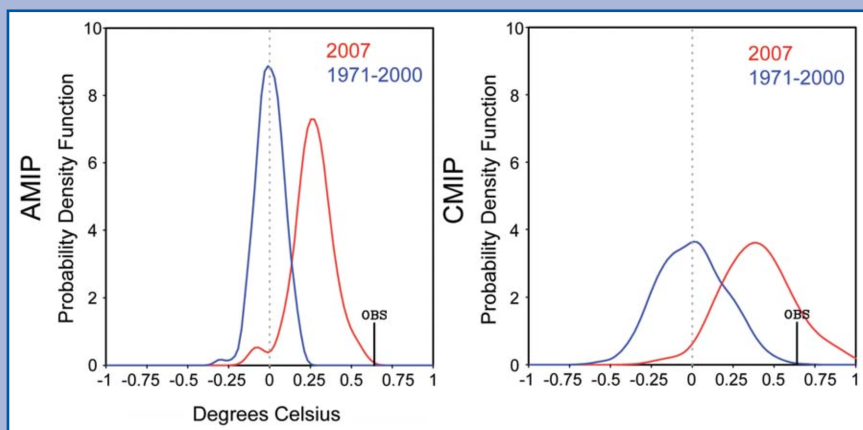

Fig. 2.7. PDFs of the simulated globally averaged 2007 (red) annual land surface temperatures based on (left) individual 150 AMIP runs and (right) the individual 48 CMIP runs. The PDFs of simulated globally averaged annual land surface temperatures during the reference period of 1971–2000 are shown as the blue PDF curves. The observed globally averaged 2007 annual land surface temperature departure of +0.64°C is plotted by the vertical tic mark. [Source: NOAA CSI Team.]

departures covering the period 1901 to 2007 were analyzed, and precipitation anomalies determined with respect to the 1961–90 mean for those stations with a minimum of 25 yr of data during the 30-yr base period (Vose et al. 1992). In addition, highlights of selected regional precipitation anomalies are also included below (see chapter 6 for more complete details of regional precipitation patterns and variability).

In 2007, the annual precipitation averaged over all global land surfaces was approximately 8 mm (0.7%) above the 1961–90 base period mean (Fig. 2.9a). It was the fourth consecutive year with above average global precipitation, although the anomaly was sig-