GISS 2007 Temperature Analysis through November

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James Hansen, Reto Ruedy, Makiko Sato, Ken Lo

Through the first 11 months, 2007 is the second warmest year in the period of instrumental data, behind the record warmth of 2005, in the Goddard Institute for Space Studies (GISS) analysis. The unusual warmth in 2007 is noteworthy because it occurs at a time when solar irradiance is at a minimum and the equatorial Pacific Ocean has entered the cool phase of its natural El Nino – La Nina cycle.

Analysis of the full year will be prepared in mid-January and presented on the GISS web site. It is likely that 2007 will remain as the second warmest year after December data is added, but it could slip to third in our analysis if December is unusually cold. Ranking relative to other years is likely to vary among results of different groups that make global temperature analyses, because of differences in data sources, methods of combining data sets, and areas included in the averaging. A difference in recent years arises from Arctic data, as our analysis extrapolates limited data to cover the entire Arctic, a region that is important for determining the true global temperature change because of the large temperature anomaly there. Comparison with satellite infrared data indicates that our estimated temperature anomalies there are not excessive.

Figure 1 shows temperature anomalies during the first 11 months of 2007 relative to 1951-1980 base period mean temperatures. The global mean temperature anomaly, about 0.6°C (about 1°F) warmer than the 1951-1980 mean, continues the strong warming trend of the past thirty years that has been confidently attributed to the effect of increasing human-made greenhouse gases (http://pubs.giss.nasa.gov/docs/2007/2007_Hansen_etal_1.pdf). The six warmest years in the GISS record have all occurred since 1998, and the 15 warmest years in the record have all occurred since 1988.

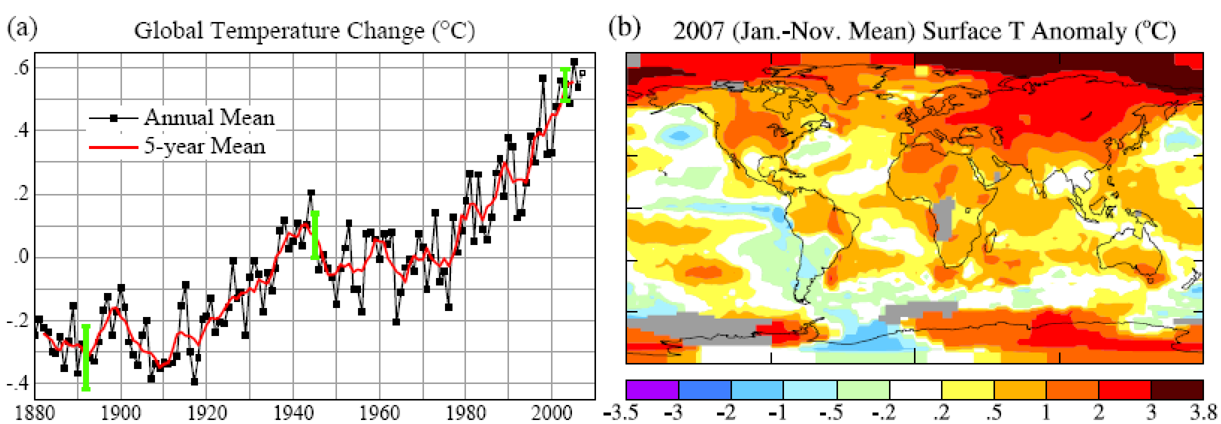

***Figure 1.** (a) Annual surface temperature anomaly relative to 1951-1980 mean, based on surface air measurements at meteorological stations and ship and satellite measurements of sea surface temperature; the 2007 point is the 11-month anomaly. Green error bar is estimated 2σ uncertainty based on quantified effect of incomplete spatial coverage and partly subjective estimate of data quality problems, (b) Global map of surface temperature anomalies for first 11 months of 2007.*

Note that the ranking of different years will vary in the analyses of different groups, because of the small temperature differences among some years. However, the different analyses are in good agreement on the nature and magnitude of the global warming over the past century, and on the fact that the 2007 temperature is close to the warmest level in the period of instrumental data.

The map reveals that the greatest warming has been in the Arctic. Polar amplification is an expected characteristic of global warming, as the loss of ice and snow engenders a positive feedback via increased absorption of sunlight. The large Arctic warm anomaly of 2007 is consistent with observations of record low Arctic sea ice cover in September this year.

The cooler than normal equatorial region to the west of South America reflects the building La Nina phase of the Southern Oscillation. In the La Nina phase of the El Nino-La Nina cycle the equatorial winds in the Pacific Ocean blow with stronger than average force from the east, driving warm surface waters toward the Western Pacific. This induces an upwelling of cold deep water near Peru, which then spreads westward along the equator.

Figure 2, the surface temperature anomaly for July-November, shows that the La Nina equatorial cooling is strong in the second half of the year. The La Nina is thus likely to continue to affect global temperatures into 2008.

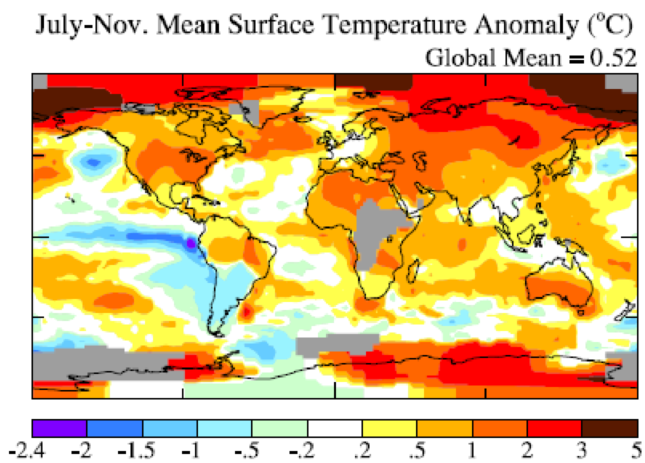

Figure 2. Surface temperature anomalies for July-November 2007.

The sun is another source of natural global temperature variability. Figure 3, based on an analysis of satellite measurements by Richard Willson, shows that 2007 is at the minimum of the current 10-11 year solar cycle. Another analysis of the satellite data (not illustrated here), by Judith Lean, has the 2007 solar irradiance minimum slightly lower than the two prior minima in the satellite era. The differences between the two analyses are a result primarily of the lack of accurate absolute calibrations and inadequate overlap of measurements by successive satellites.

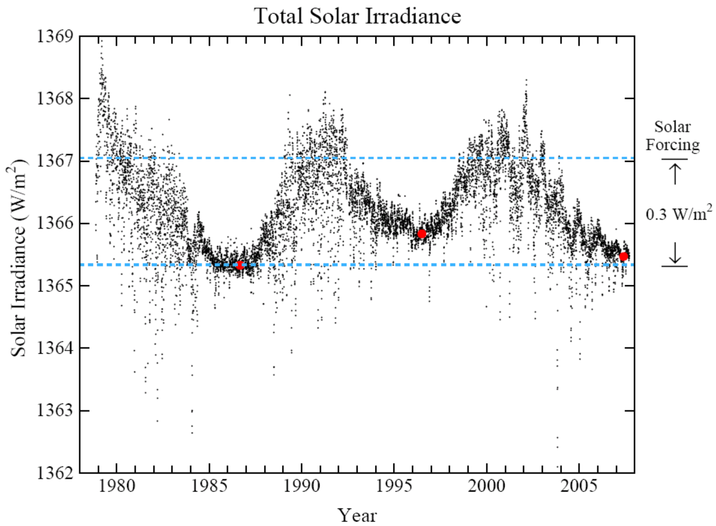

Figure 3. Solar irradiance from analysis of satellite measurements by Willson and Mordvinov (Geophys. Res. Lett. 30, no. 5, 1199, 2003) and update (private communication).

This cyclic solar variability yields a climate forcing change of about 0.3 W/m^2 between solar maxima and solar minima. [Although solar irradiance of an area perpendicular to the solar beam is about 1366 W/m^2, the absorption of solar energy averaged over day and night and the Earth's surface is about 240 W/m^2.] Several analyses have extracted empirical global temperature variations of amplitude about 0.1°C associated with the 10-11 year solar cycle, a magnitude consistent with climate model simulations, but this signal is difficult to disentangle from other causes of global temperature change including unforced chaotic fluctuations.

The solar minimum forcing is thus about 0.15 W/m^2 relative to the mean solar forcing. For comparison, the human-made greenhouse gas climate forcing is now increasingly at a rate of about 0.3 W/m^2 per decade (http://pubs.giss.nasa.gov/docs/2004/2004_Hansen_Sato.pdf). If the sun should remain 'stuck' in its present minimum for several decades, as has been suggested (http://news.independent.co.uk/sci_tech/article3223603.ece) in analogy to the solar Maunder Minimum of the seventeenth century, that negative forcing would be balanced by a 5-year increase of greenhouse gases. Thus such solar variations cannot have a substantial impact on long-term global warming trends.

The natural variations of the Southern Oscillation and the solar cycle thus have minor but not entirely insignificant effects on year-to-year temperature change. Given that both of these natural effects were in their cool phases in 2007, it makes the unusual warmth this year all the more notable. It also suggests that, barring the unlikely event of a large volcanic eruption, a record global temperature exceeding that of 2005 can be expected within the next 2-3 years.

Finally, we note that a minor data processing error found in the GISS temperature analysis in early 2007 does not affect the present analysis. The data processing flaw was failure to apply NOAA adjustments to United States Historical Climatology Network stations in 2000-2006, as the records for those years were taken from a different data base (Global Historical Climatology Network). This flaw affected only 1.6% of the Earth's surface (contiguous 48 states) and only the several years in the 21st century. As shown in Figure 4 and discussed elsewhere (http://www.columbia.edu/~jeh1/distro_realdeal.16aug20074.pdf), the effect of this flaw was immeasurable globally (~0.003°C) and small even in its limited area. Contrary to reports in certain portions of the media, the data processing flaw did not alter the ordering of the warmest years on record. Obviously the global ranks were unaffected. In the contiguous 48 states the statistical tie among 1934, 1998 and 2005 as the warmest year(s) was unchanged. In the published GISS analysis (http://pubs.giss.nasa.gov/docs/2001/2001_Hansen_etal.pdf), in the flawed analysis, and in the current analysis 1934 is the warmest year in the contiguous states (not globally) but by an amount (magnitude of the order of 0.01°C) that is an order of magnitude smaller than the uncertainty.

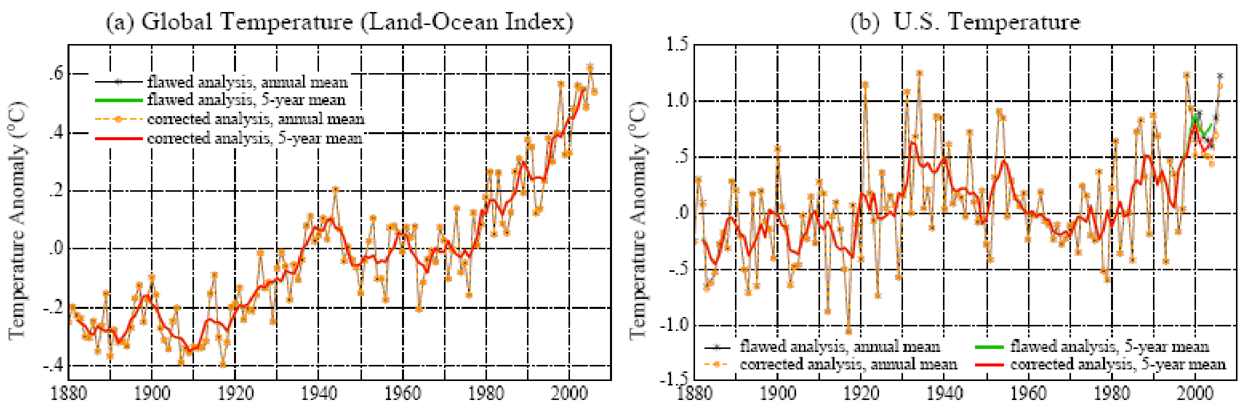

Figure 4. Global and U.S. temperatures with and without the data processing flaw. The difference between the flawed and corrected analyses is detectable only in part (b) and only beginning in 2000.