The Average Temperature of 2014
Results from Berkeley Earth

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Berkeley Earth has constructed an estimate of the global average temperature during 2014, including land and sea. The key findings are:

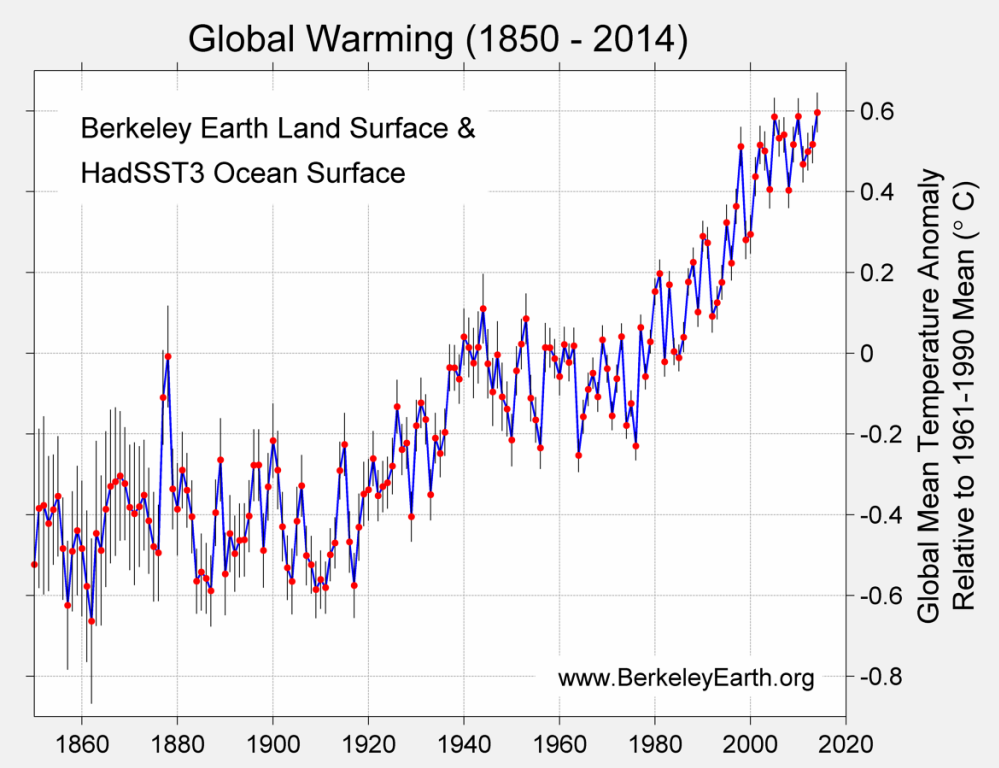
1. The global surface temperature average (land and sea) for 2014 was nominally the warmest since the global instrumental record began in 1850; however, within the margin of error, it is tied with 2005 and 2010 and so we can't be certain it set a new record.
2. For the land, 2014 was nominally the 4th warmest year since 1753 (when the land surface temperature record began)
3. For the sea, 2014 was the warmest year on record since 1850
4. For the contiguous United States, 2014 ranked nominally as the 38th warmest year on record since 1850.

Global Averages (land and sea)

The nominal ranking of the top ten years according to our analysis is given in the table below. (All temperatures are given compared to the 1961-1990 average)

rank	year	average (deg C)	margin of uncertainty
1)	2014	0.596	± 0.049
2)	2010	0.586	± 0.045
3)	2005	0.585	± 0.047
4)	2007	0.541	± 0.044
5)	2006	0.533	± 0.046
6)	2013	0.517	± 0.046
7)	2009	0.517	± 0.044
8)	2002	0.516	± 0.048
9)	1998	0.512	± 0.048
10)	2003	0.501	± 0.048

A plot of the temperature since 1850 is shown below.



Discussion:
Numerically, our best estimate for the global temperature of 2014 puts it slightly above (by 0.01 C) that of the next warmest year (2010) but by much less than the margin of uncertainty (0.05 C). Therefore it is impossible to conclude from our analysis which of 2014, 2010, or 2005 was actually the warmest year.

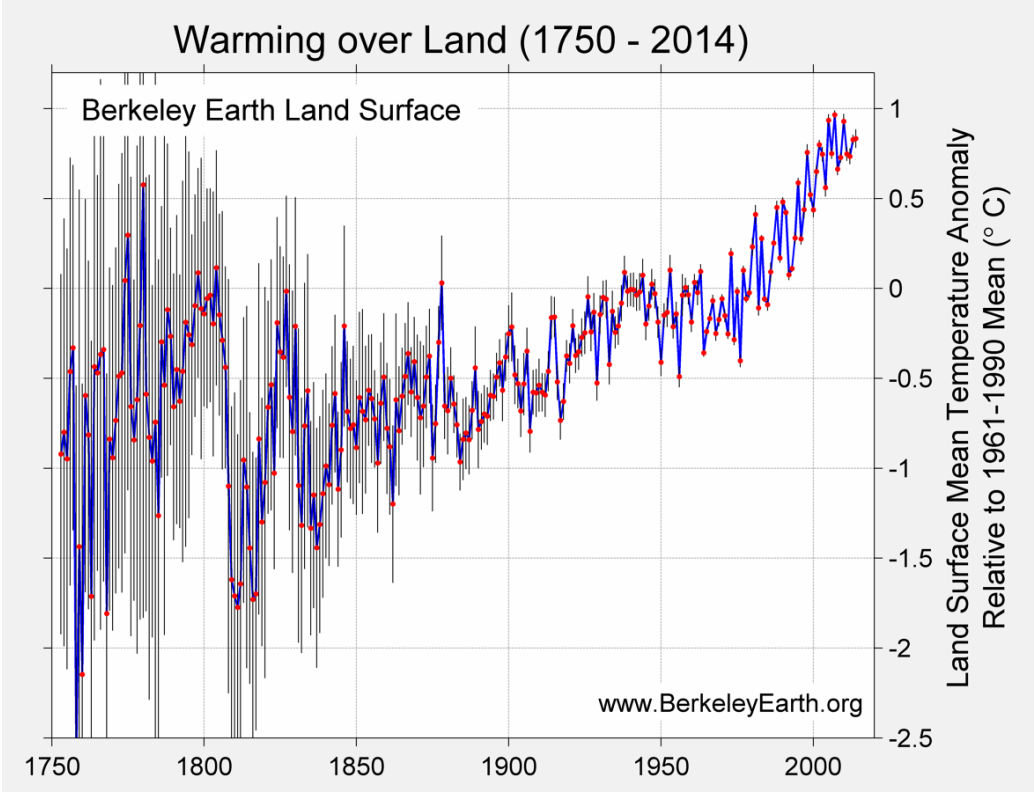
The margin of uncertainty we achieved was remarkably small (0.05 C with 95% confidence). This was achieved this, in part, by the inclusion of data from over 30,000 temperature stations, and by the use of optiized statistical methods. Even so, the highest year could not be distinguished. That is, of course, an indication that the Earth's average temperature for the last decade has changed very little. Note that the ten warmest years all occur since 1998.

Land Surface Averages

The nominal ranking of the top ten years for temperature of the Earth's land surface is given in the table below. (All temperatures are given compared to the 1961-1990 average). The uncertainties are smaller than those for the global average because of more extensive records on land and more complete coverage.

rank	year	average (deg C)	margin of uncertainty
1)	2007	0.966	± 0.024
2)	2005	0.935	± 0.034
3)	2010	0.929	± 0.042
4)	2014	0.834	± 0.051
5)	2013	0.827	± 0.027
6)	2002	0.800	± 0.025
7)	1998	0.756	± 0.045
8)	2006	0.751	± 0.030
9)	2011	0.748	± 0.038
10)	2003	0.747	± 0.040

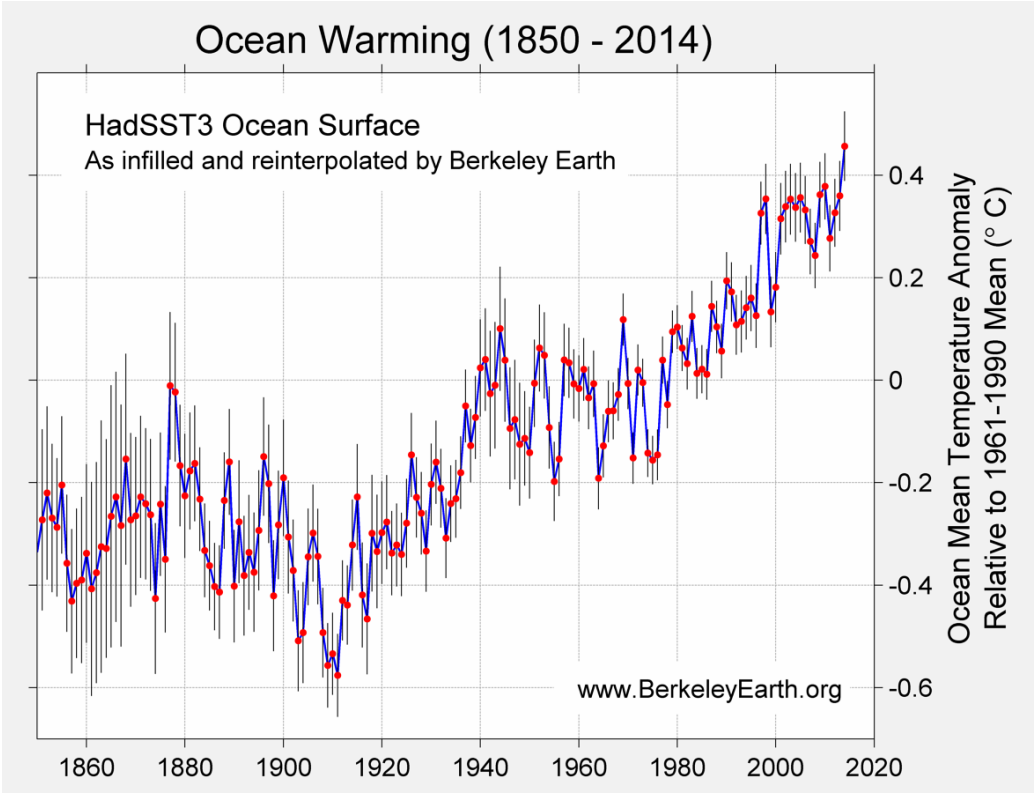
Discussion: 2014 was approximately the fourth warmest year for land, about 0.8 C above the 1961-1990 average. The ten warmest years in the land all occur since 1998. A graph of the Berkeley Earth land temperature results is shown below.



Ocean Surface Averages

rank	year	average (deg C)	margin of uncertainty
1)	2014	0.457	± 0.068
2)	2010	0.378	± 0.065
3)	2009	0.362	± 0.064
4)	2013	0.360	± 0.068
5)	2005	0.356	± 0.068
6)	1998	0.354	± 0.069
7)	2003	0.353	± 0.069
8)	2002	0.339	± 0.070
9)	2004	0.337	± 0.067
10)	2006	0.332	± 0.066

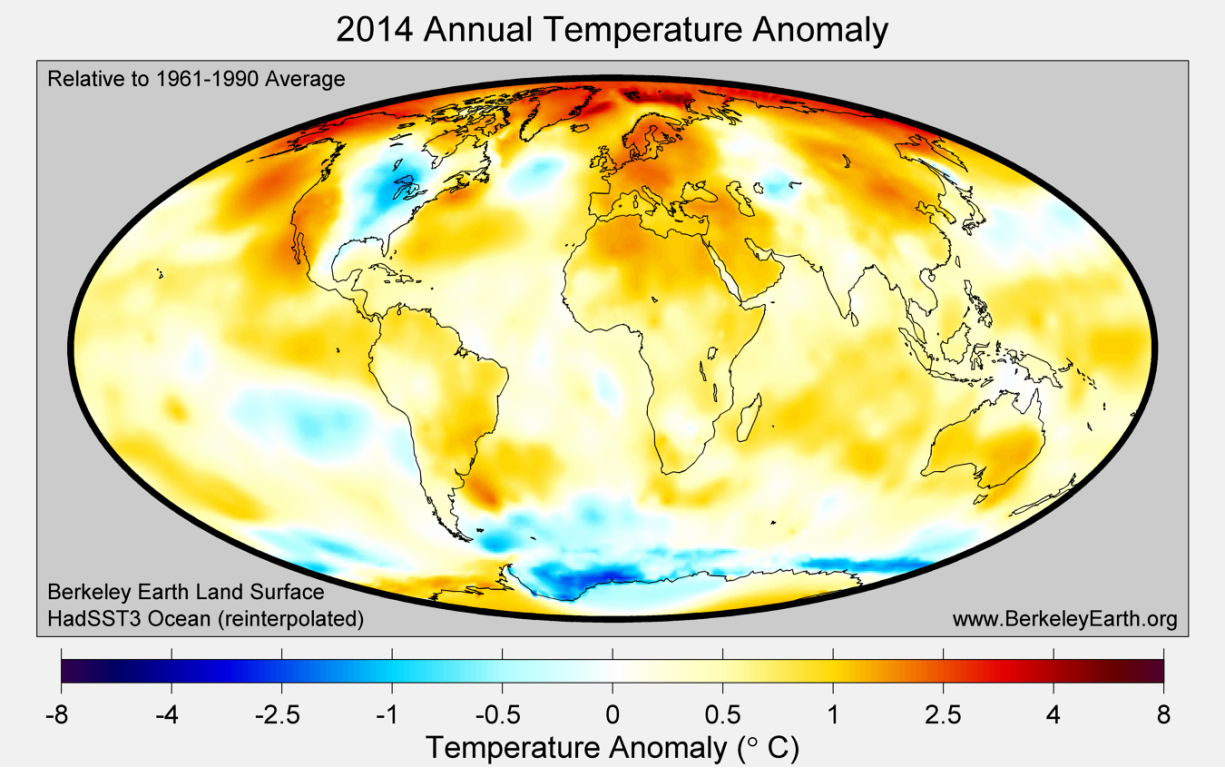
Discussion: 2014 is the warmest year in the oceans since useable records began to be kept in 1850. The second warmest year was 2010, and 2014 exceeds this by a clear amount (+0.078 C). As with the land and the globe as a whole, the ten warmest years in the ocean all occur since 1998. A plot of the ocean surface temperature record is shown below.



Hot and Cold Locations

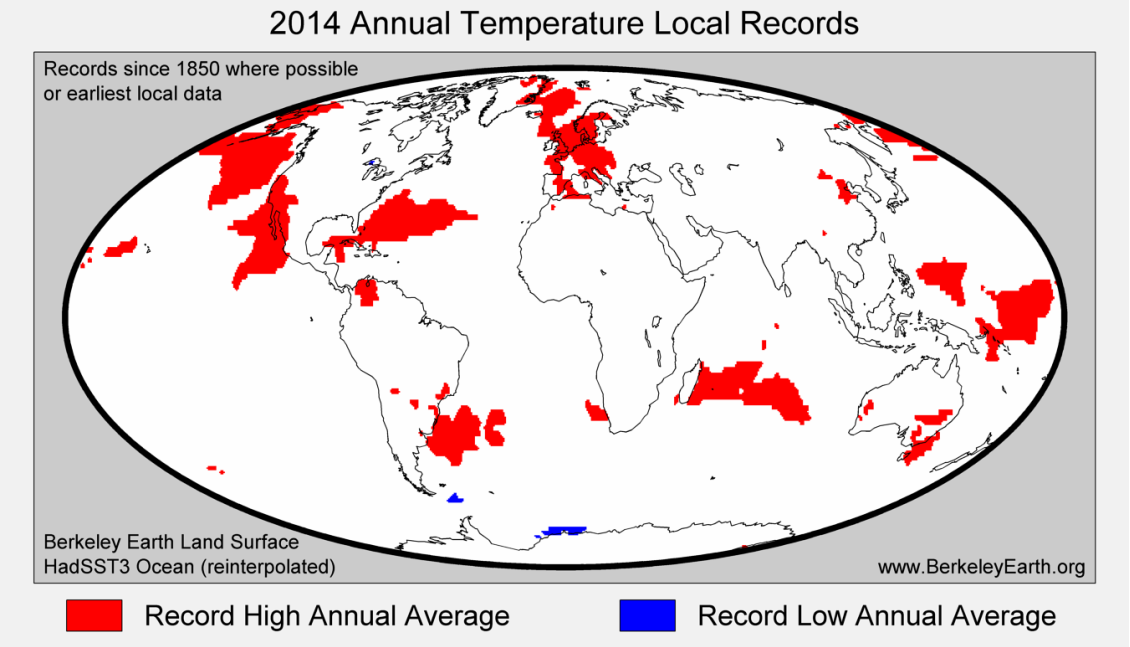
The warmth in 2014 is not uniform across the Earth. After experiencing unusually low temperatures in January-March of 2014, the US state of Michigan in 2014 recorded its 14th coldest year (-1.12 C relative to the 1961-1990 average). By contrast, the US state of California, in the midst of a severe drought, recorded by far its warmest year to date (+1.92 C) besting the previous record by 0.76 C. Overall, the contiguous United States had its 38th warmest year (+0.23 C).

A geographic plot of the warming for 2014 is shown below:



Internationally, Germany (+2.10 C), the United Kingdom (+1.33 C), Sweden (+2.23 C) and several other European countries also set all-time records for high annual average temperature, as did the continent of Europe as a whole (+1.69 C).

In total, we estimate that 8.4% of Earth's surface and 5.6% of its land surface set all-time record high annual averages in 2014; 0.11% of the Earth's surface and 0.03% of land set all-time record low annual averages in 2014. A map of regions where record highs and lows were set is shown in the figure below.



The use of air temperatures in sea ice regions helps reveal changes in the Arctic and Antarctic not easily seen from sea surface temperatures. In particular, the Arctic Ocean has experienced some of the strongest warming of any region in 2014. At the same time, the area around Antarctica is implied to have been relatively cold in 2014, a year that also saw an all-time record in Antarctic sea ice extent since satellite measurements began in 1979.

Including 2014, there have been 11 years since 1950 where the global average temperature numerically exceeded all years that came before. Of these, 8 were also the hottest year on land and 6 were also the hottest year in the oceans. In 3 cases, the hottest year set both land and ocean records at the same time. 2014 is one of the less common examples where high global temperatures followed primarily from record warmth in the ocean without also setting a record over the land.

Details

The "margin of uncertainty" represents the 95% confidence limit, obtained principally by comparison of results from subdividing the data into independent sets. The global temperature estimate is compiled as combination of a land-only temperature estimate constructed by Berkeley Earth directly, and an ocean temperature estimate produced by the Hadley Centre in the UK and modified by Berkeley Earth.

The preliminary Berkeley Earth estimate for land surface temperatures in 2014 has been constructed from 10,685 weather stations that provide comprehensive global coverage and have already reported data through December 2014.

For the ocean component of the global temperature analysis, Berkeley Earth relies on a modified version of the HadSST3 data product produced by the Hadley Centre in the

UK. Two primary modifications are made. First, local interpolation via Kriging is applied to infill missing grid cells (this reduces the uncertainty associated with missing data). Secondly, for global reconstructions we use the HadISST ice field (also produced by the Hadley Centre) to mask out ocean regions covered by sea ice. Temperature patterns in sea ice regions are then estimated from air temperatures rather than from sea surface temperatures. Air temperatures more effectively capture the surface temperature variability in sea ice covered regions where the differences in temperature between the air above sea ice and the water below it can be very large. For the preliminary 2014 temperature estimate, the HadISST sea ice mask for December 2014 was not available, so the December 2013 mask was used instead.

The current temperature analysis over land relies on more than 10,000 stations that were available to us early in 2015. Following delays in reporting and data integration, we expect an additional ~9000 stations with 2014 data will gradually be added to future analyses. Such additional data will ultimately refine the land and global temperature estimates and their associated spatial patterns. Based on previous experience, adding additional stations to the already comprehensive network is unlikely to change the estimated global average more than 0.01 C, or cause large changes in most spatial patterns.