Sea Surface Temperature

Sea surface temperature—the temperature of the water at the ocean surface—is an important physical attribute of the world's oceans. The surface temperature of the world's oceans varies mainly with latitude, with the warmest waters generally near the equator and the coldest waters in the Arctic and Antarctic regions. As greenhouse gases trap more energy from the sun in the atmosphere, the oceans are absorbing more heat, resulting in an increase in sea surface temperatures. As sea surface temperatures increase, the ocean circulation patterns that transport warm and cold water around the globe will change.

Changes in sea surface temperature can alter marine ecosystems in several ways. For example, variations in ocean temperature can affect what species of plants and animals are present in a location, alter migration and breeding patterns, and threaten sensitive ocean life such as corals. Increases in temperature have been associated with the timing of breeding in sea turtles (Weishampel et al., 2004), stress and bleaching of coral reefs (Brown, 1997; Woodbridge and Done, 2004), changes in ecological system extent and composition (Helmuth et al., 2002), and changes in the frequency or extent of blooms of harmful algae (Ostrander et al., 2000).

Over the long term, increases in sea surface temperature could also alter the circulation patterns that bring nutrients from the deep sea to surface waters. Changes in reef habitat and nutrient supply can lead to declines in fish populations, which in turn could affect people who depend on fishing for food or jobs (Pratchett et al., 2004).

Because the oceans continuously interact with the atmosphere, sea surface temperature can also have profound effects on global climate. Based on increases in sea surface temperature, the amount of atmospheric water vapor over the oceans is estimated to have increased by about 5 percent during the 20th century (Trenberth et al., 2007). This water vapor feeds weather systems that produce precipitation, increasing the risk of heavy rain and snow. Because of increased sea surface temperatures, the U.S. Global Change Research Program and the Intergovernmental Panel on Climate Change project that tropical cyclones will likely become more intense over the 21st century, with higher wind speeds and heavier rains. Changes in sea surface temperature can also shift storm tracks, potentially contributing to droughts in some areas.

This indicator tracks average global sea surface temperature from 1880 through 2012 using data compiled by the National Oceanic and Atmospheric Administration (NOAA). Techniques for measuring sea surface temperature have evolved since the 1800s. For instance, the earliest data were collected by inserting a thermometer into a water sample collected by lowering a bucket from a ship. Today, temperature measurements are collected more systematically from ships, as well as at stationary and drifting buoys.

NOAA has carefully reconstructed and filtered the data for this indicator to correct for biases in the different collection techniques and to minimize the effects of sampling changes over various locations and times. The data are shown as anomalies, or differences, compared with the average sea surface temperature from 1971 to 2000. This reconstruction also includes 95 percent confidence intervals based on the quality and quantity of underlying measurements. The long-term average change obtained by this method is very similar to those of "unanalyzed" measurements and reconstructions developed by other researchers (e.g., Rayner et al., 2003).

What the Data Show

Sea surface temperature increased over the 20th century and continues to rise. From 1901 through 2012, temperatures rose at an average rate of 0.13°F per decade (Exhibit 1). Increases in sea surface temperature have largely occurred over two key periods: between 1910 and 1940, and from about 1970 to the present. Sea surface temperatures appear to have cooled between 1880 and 1910, although confidence intervals are wider over the early period of record. Sea surface temperatures have been higher during the past three decades than at any other time since reliable observations began in 1880. Overall, warming for the period from 1900 forward is statistically significant.

Limitations

- Because this indicator tracks sea surface temperature at a global scale, the data shown in Exhibit 1 do not necessarily reflect local or regional trends.
- Due to denser sampling and improvements in sampling design and measurement techniques, newer data are more precise than older data. The earlier trends shown by this indicator have less certainty because of lower sampling frequency and less precise sampling methods, as shown by the width of the confidence band in Exhibit 1.

Data Sources

This extended reconstruction of SST, called ERSST.v3b, was described in Smith et al. (2008). Data for this indicator were provided by NOAA's National Climatic Data Center and are available online at www.ncdc.noaa.gov/ersst/ (NOAA, 2013a), along with a mapping utility that allows the user to calculate average anomalies over time and space (http://nomads.ncdc.noaa.gov/#climatencdc). The ERSST.v3b reconstruction is based on in situ measurements of water temperature, which are available from online databases–for example, NOAA (2013b) (http://icoads.noaa.gov).

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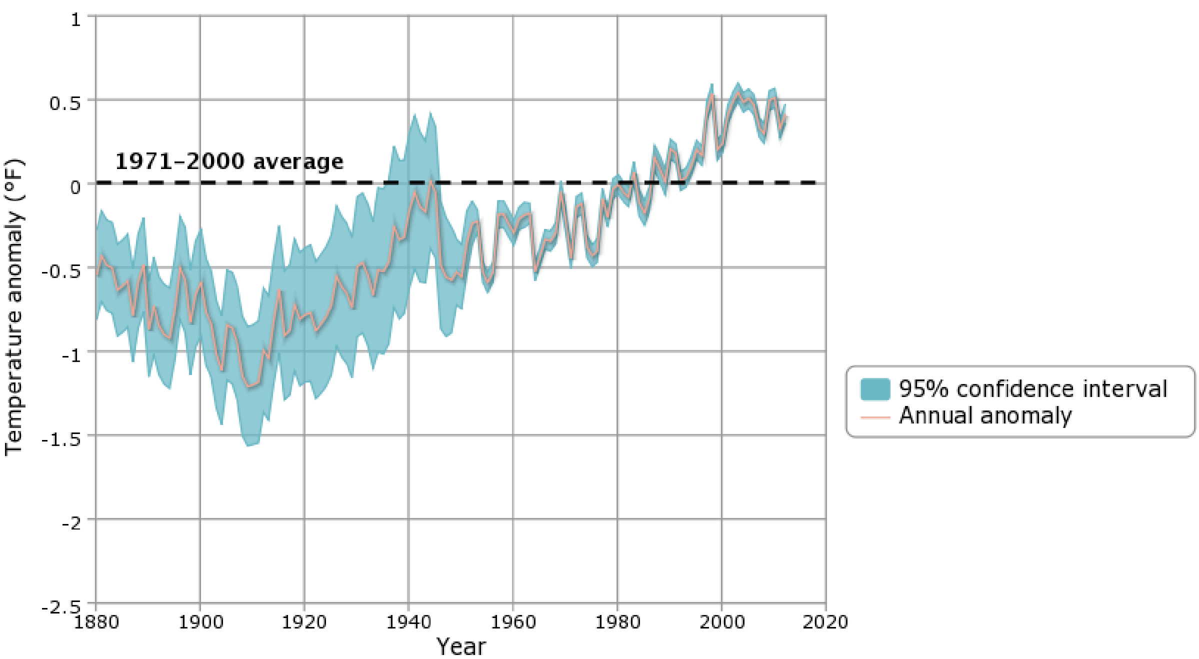
Exhibit 1. Annual global sea surface temperature anomaly, 1880-2012



Anomaly is with respect to the 1971–2000 average, which is plotted at zero.

Analysis shows that this trend is statistically significant. For more information about uncertainty, variability, and statistical analysis, view the technical documentation for this indicator.

Data source: NOAA, 2013a