# 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, most of this energy—in fact, more than 90 percent of the energy accumulated by the climate system between 1971 and 2010 (IPCC, 2013)—accumulates as heat in the ocean, 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, animals, and microbes are present in a location, alter migration and breeding patterns, threaten sensitive ocean life such as corals, and change the frequency and intensity of harmful algal blooms such as "red tide" (e.g., 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. Increases in sea surface temperature have led to an increase in the amount of atmospheric water vapor over the oceans (IPCC, 2013). This water vapor feeds weather systems that produce precipitation, increasing the risk of heavy rain and snow. Changes in sea surface temperature can also shift storm tracks, potentially contributing to droughts in some areas (IPCC, 2013).

This indicator tracks average global sea surface temperature from 1880 through 2014. 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.

The National Oceanic and Atmospheric Administration (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 2014, temperatures rose at an average rate of 0.13°F per decade (Exhibit 1). Sea surface

temperatures have been higher during the past three decades than at any other time since reliable observations began in 1880. 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. Over the entire period of record (starting at either 1880 or 1901), the warming trend is highly 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.
- This indicator is based on instrumental measurements of surface water temperature. 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, 2015a), 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 (2015b) (http://icoads.noaa.gov).

### References

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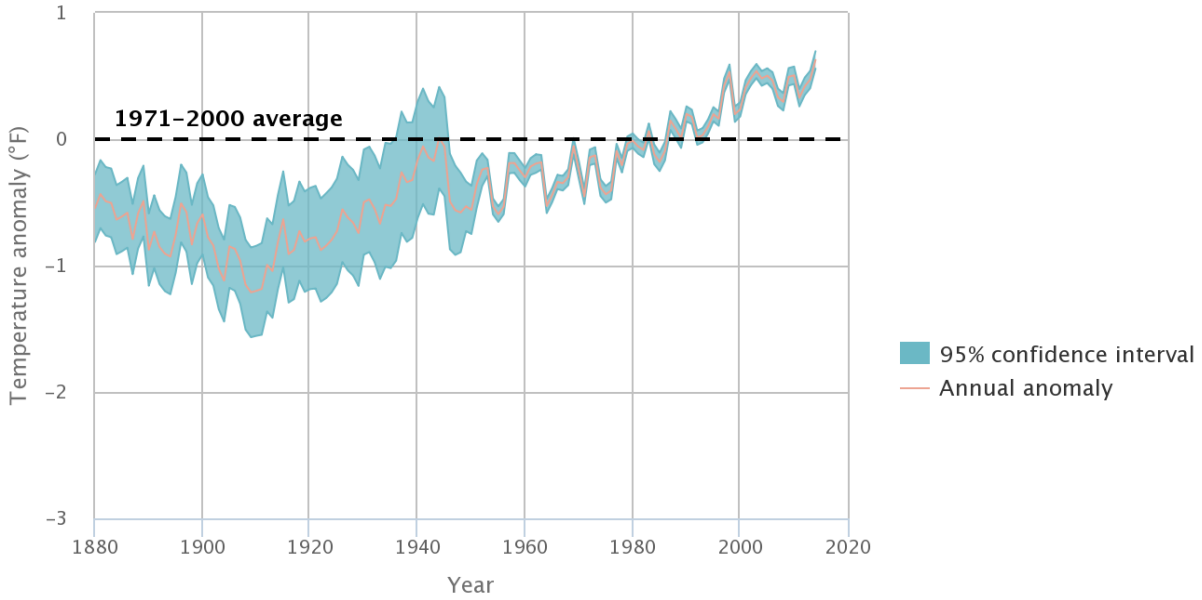
historical merged land-ocean surface temperature analysis (1880–2006). J. Climate 21(10):2283-2296.

**Exhibit 1. Annual global sea surface temperature anomaly, 1880–2014**




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, 2015a