Ocean Heat

This indicator describes trends in the amount of heat stored in the world's oceans.

Background

When sunlight reaches the Earth's surface, the world's oceans absorb some of this energy and store it as heat. The amount of heat in the ocean, or ocean heat content, plays an important role in the Earth's climate system for several reasons. First, the amount of heat absorbed by the ocean affects its temperature. Sea surface temperature is especially important (see the Sea Surface Temperature indicator on p. 38) because surface waters exchange heat with the air and influence weather patterns. Deeper waters also absorb heat, however. Water also has a much higher heat capacity than air, meaning the oceans can absorb larger amounts of heat energy with only a slight increase in temperature.

Greenhouse gases are trapping more energy from the sun, and the oceans are currently absorbing a significant fraction of this extra heat.[1] If not for the large heat storage capacity provided by the oceans, the atmosphere would grow warmer at a much faster rate.[2] Increased heat absorption can change the dynamics of the ocean, however, because many currents are driven by differences in temperature. These currents influence climate patterns and sustain ecosystems—for example, coastal fishing grounds that depend on upwelling currents to bring nutrients to the surface. Because water expands slightly as it gets warmer, an increase in ocean heat content will also increase the volume of water in the ocean, which is one cause of the observed increases in sea level (see the Sea Level indicator on p. 40).

About the Indicator

This indicator shows trends in global ocean heat content to a depth of 700 meters (nearly 2,300 feet) from 1955 to 2008. The indicator measures ocean heat content in joules, which is a unit of energy.

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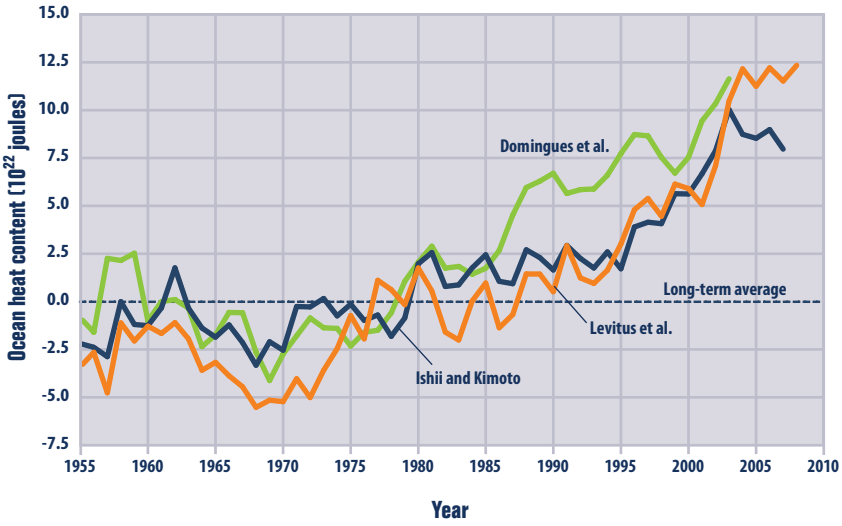
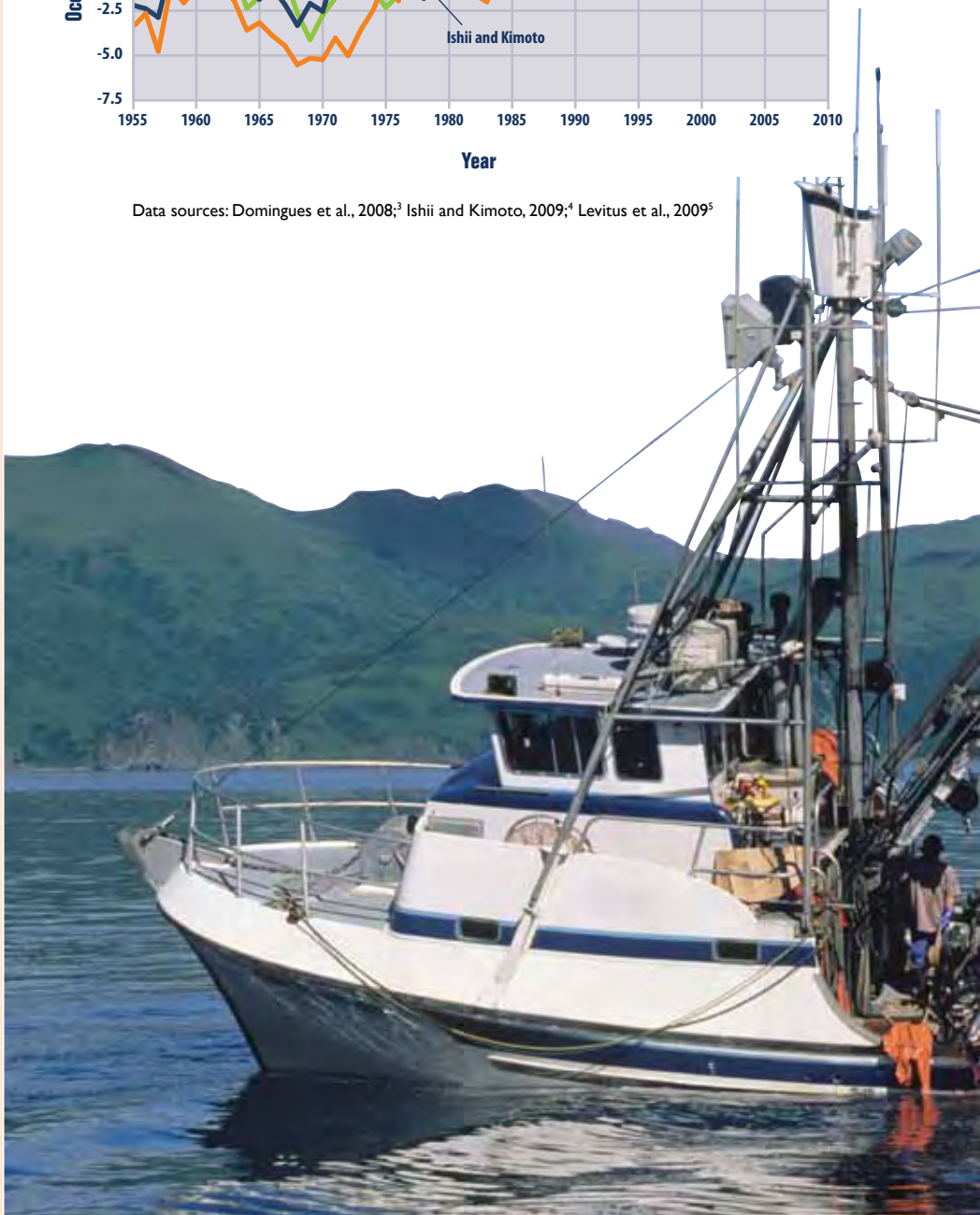
Figure 1. Ocean Heat Content, 1955–2008

This figure shows changes in ocean heat content between 1955 and 2008. Ocean heat content is measured in joules, a unit of energy, and compared against the long-term average, which is set at zero.



Data sources: Domingues et al., 2008;[3] Ishii and Kimoto, 2009;[4] Levitus et al., 2009[5]



Key Points

- In three different data interpretations, the long-term trend shows that ocean heat content has increased substantially since 1955 (see Figure 1).
- Although concentrations of greenhouse gases have risen at a steady rate over the past few decades (see the Atmospheric Concentrations of Greenhouse Gases indicator on p. 14), the rate of change in ocean heat content can vary greatly from year to year (see Figure 1). Year-to-year changes are influenced by events such as volcanic eruptions and recurring ocean-atmosphere patterns such as El Niño.

The National Oceanic and Atmospheric Administration and the National Aeronautics and Space Administration collected these data using a variety of ocean profiling instruments launched from ships and airplanes and, more recently, underwater robots. Thus, the data must be carefully adjusted to account for different measurement techniques. Scientists' understanding of how to correct the data has evolved over time, leading to changes in the trend line. Figure 1 shows three different interpretations of the same underlying data.

Indicator Limitations

Data must be carefully reconstructed and filtered for biases because of different data collection techniques and uneven sampling over time and space. Various methods of correcting the data have led to slightly different versions of the ocean heat trend line. Scientists continue to compare their results and improve their estimates over time. They also test their ocean heat estimates by looking at corresponding changes in other properties of the ocean. For example, they can check to see whether observed changes in sea level match the amount of sea level rise that would be expected based on the estimated change in ocean heat.

Data Sources

Data for this indicator were collected by the National Oceanic and Atmospheric Administration and the National Aeronautics and Space Administration, and were analyzed by Domingues et al. (2008),[6] Ishii and Kimoto (2009),[7] and Levitus et al. (2009).[8]