Introduction
In the previous investigations you have examined how Earth’s climate has fluctuated over geologic history. You have seen that on a global scale Earth has been warming since the industrial revolution in the late 1880s. But is Earth warming on a regional scale? Are the oceans also warming? Are both hemispheres warming? Are the tropics and poles warming? In the next three explorations, you will analyze temperature trends over different geographic regions to answer these questions.

The temperature data used for the following investigations is derived from NASA’s Goddard Institute of Space Sciences (GISS), which is a laboratory in NASA’s Goddard Space Flight Center. This institute focuses on a broad study of changes to our environment, addressing both natural and man-made changes that occur on various time periods from one-time climate events such as volcanic explosions, to seasonal and annual effects such as El Niño. Program areas include climate forcings, model development, Earth observations, radiation, atmospheric chemistry, climate impacts, paleoclimate, planetary atmospheres, and other earth science-related disciplines.

In the first exploration, you will compare the change in ocean temperature to that of land.

Exploration 1: A Comparison of Change in Land and Ocean Temperature Anomalies
You have learned that temperature has fluctuated several times over Earth’s history. In this exploration, you will investigate if the temperature change of Earth’s ocean is different from the temperature change on land.

Use the interactive, time series graphing tool to answer the following questions.

1. Make a few hypotheses before you begin to compare the 130-year land and ocean temperature anomalies.
   A. Do you think land and ocean temperature anomalies will both show a warming trend?
      _____ Yes _____ No
   B. Do you think that the more recent decades will show an increased rate of warming for both land and ocean?
      _____ Yes _____ No
   C. Which do you think will have a greater range between high and low temperature anomalies?
      _____ Land _____ Ocean
D. Which do you think has more variable temperature anomalies over time?
   _____ Land _____ Ocean

2. To analyze the land temperature anomaly variation, check the Global box beneath the graph to uncheck the global data. Check the box next to Land. You should see the land temperature anomaly data displayed on the graph.
   A. Describe the general temperature anomaly trend over this time period.

   B. What is the lowest temperature anomaly recorded during that time period? What is the highest? What is the range of temperature anomalies (lowest to highest)?

3. To analyze ocean temperature anomaly variation, click on the Land box beneath the graph to uncheck it. Check the Ocean box. You should see the ocean temperature anomaly data displayed on the graph.
   A. Describe the general temperature anomaly trend over this time period.

   B. What is the lowest temperature anomaly recorded during that time period? What is the highest? What is the range of temperature anomalies (lowest to highest)?

4. Use the data you recorded in questions 1 – 3 to complete the table below.

<table>
<thead>
<tr>
<th>Geographic Area</th>
<th>Lowest Temperature Anomaly (˚C)</th>
<th>Highest Temperature Anomaly (˚C)</th>
<th>Range (˚C)</th>
<th>Lowest to Highest Temperature Anomaly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ocean</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Which area has the smallest range in temperature variation? Which has the largest? Explain why you think this difference occurred.

5. Now check the Land box again. You should see temperature anomaly data for both land and ocean. Zoom into the graph for the last 25 years (1985-2010) by moving the slider below the graph. Describe the general temperature anomaly trend over this time period.