Proficiency Scale: Energy Budget

Standard ESS.3.3 - Construct an explanation for how energy from the Sun drives atmospheric processes and how atmospheric currents transport matter and transfer energy. Emphasize how energy from the Sun is reflected, absorbed, or scattered; how the greenhouse effect contributes to atmospheric energy; and how uneven heating of Earth's atmosphere combined with the Coriolis effect creates an atmospheric circulation system. (PS3.A, ESS1.B, ESS2.A, ESS2.D)

4 **Advanced**	**3** **Proficient**	**2** **Approaching Proficiency**	**1** **Beginning Proficiency**
I can: **Construct an explanation** based on evidence and scientific reasoning to show how energy from the Sun drives the movement of matter in the atmosphere and the transfer of energy. AND Predict how changes in energy output from the sun and/or the composition of the atmosphere could change patterns of atmospheric circulation.	I can: **Construct an explanation** based on evidence and scientific reasoning to show how energy from the Sun drives the movement of matter in the atmosphere and the transfer of energy.	I can: **Construct an explanation** to show how energy from the Sun drives the movement of matter in the atmosphere and transfers energy.	I can: Explain that energy from the sun drives processes on Earth.

Items 1 & 2 are not graded.

Reading 1

About every two to seven years, the westward-blowing Pacific trade winds die down. Without these winds, warm water piles up off the coast of Peru instead of the coast of Indonesia. Pressure systems, rainfall, and weather patterns change, first in the Pacific and eventually globally, signaling that an El Niño has arrived. (**Diagrams 1 and 2**)

One of the most predictable consequences of a strong El Niño is a change in rainfall patterns over Indonesia. During El Niño years, rain that is normally centered over Indonesia shifts eastward into the central Pacific; as a result, parts of Indonesia experience drought. That is what happened in 2015. Satellite observations of rainfall over Indonesia reveal less than normal rainfall over parts of Borneo and Sumatra (islands in Indonesia) in September 2015. In **Diagram 3**, white represents areas that received the most rainfall. Gray areas received little to no rain.

The dry weather experienced in Indonesia was especially problematic because it intensified seasonal fires, which are intentionally lit by farmers to clear land and manage crops. However, many fires escaped their handlers and burned uncontrolled throughout September and October, blanketing Indonesia in dangerous levels of smoke for several weeks. On September 24, NASA's Terra satellite acquired an image (**Diagram 4**) of smoke darkening Indonesian skies. Red outlines and red arrows indicate hot spots where the sensor detected fires.

The severe fire season in Indonesia may be a warning for other parts of the world. The Amazon forests of Central and South America face an increased risk of fires in 2016 due to the ongoing El Niño. (Adapted from: https://earthobservatory.nasa.gov/images/87204/el-nino-brought-drought-and-fire-to-indonesia)

Diagram 1: Normal Conditions

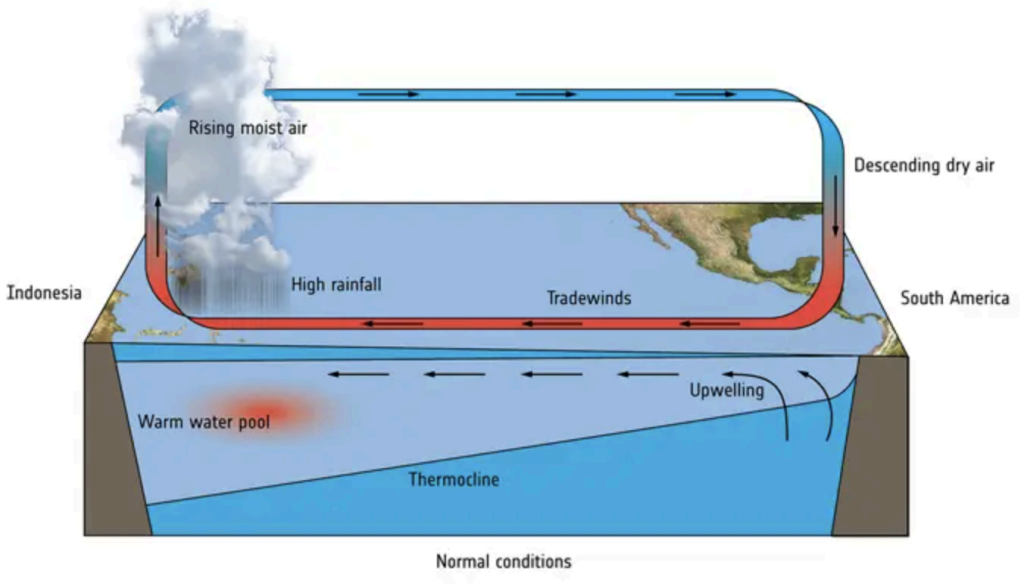
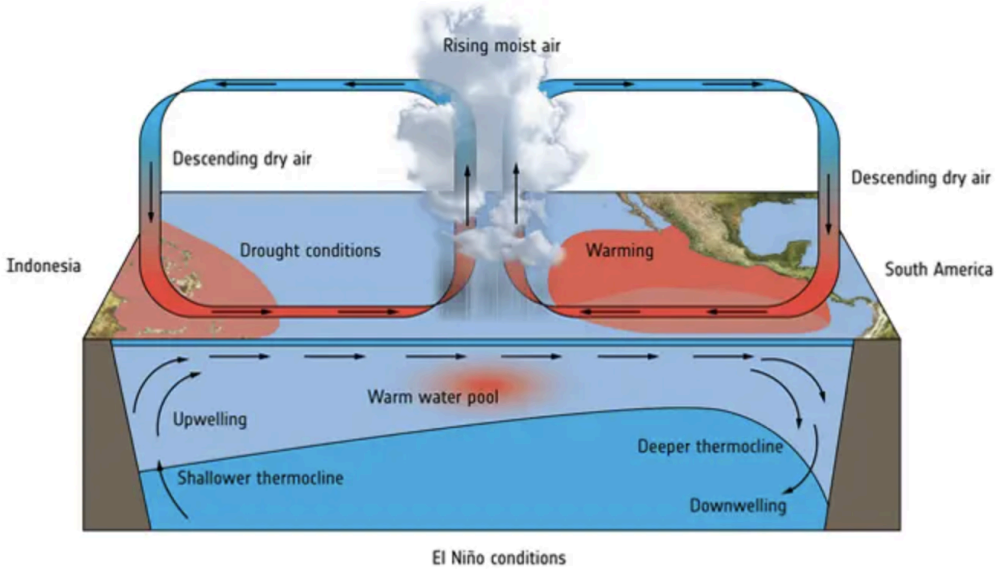


Diagram 2: El Niño Conditions



El Niño conditions

Diagram 3: Rainfall in Indonesia

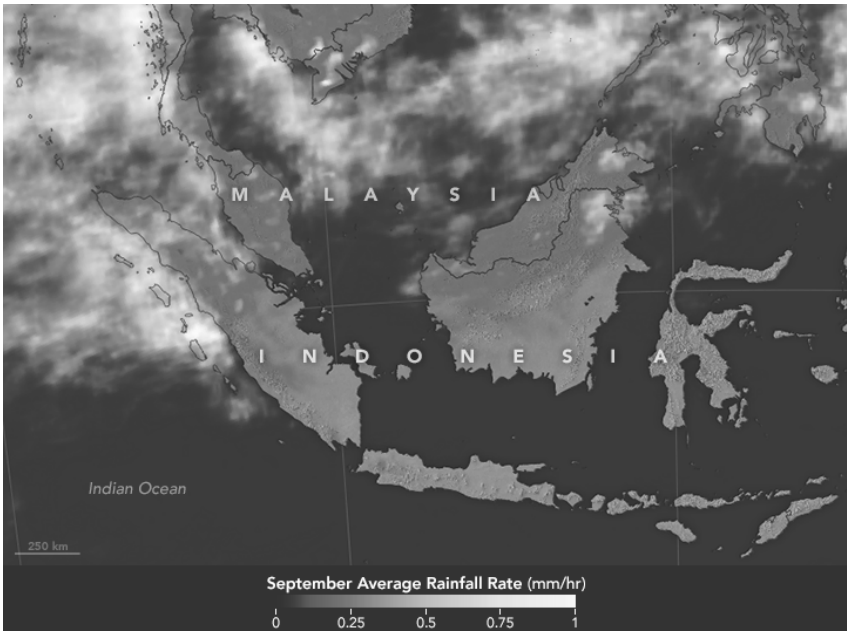
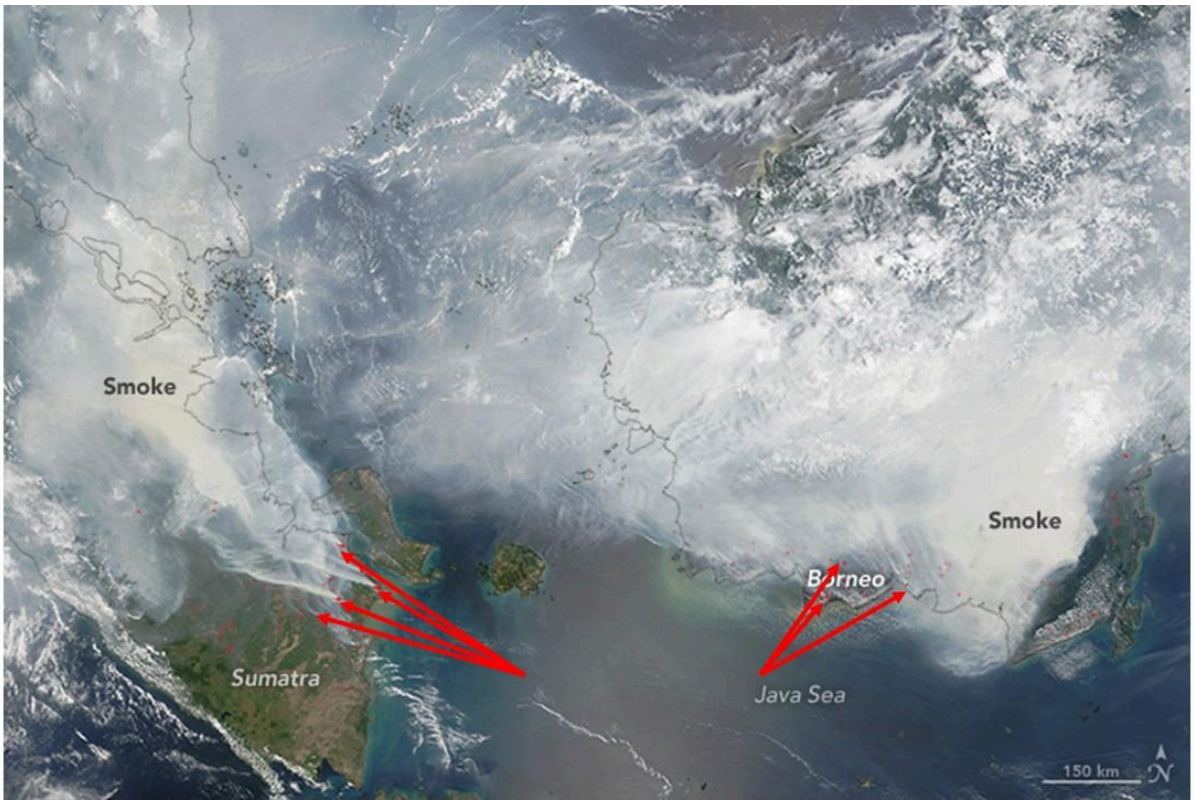


Diagram 4: Smoke from Indonesian Fires



1. To better understand El Niño conditions, we first have to understand normal conditions. Describe the normal conditions in the Pacific, shown in **Diagram 1**, including ocean currents, wind direction, the Coriolis effect, and water temperatures.

2. Compare and contrast normal conditions and El Niño conditions using **Diagram 1** and **Diagram 2**. Make sure to include energy transfer, ocean currents, wind direction, the Coriolis effect, and water temperatures.

	Normal Conditions Observations	El Niño Conditions Observations
Energy Transfer		
Ocean Currents		
Wind Patterns		
Coriolis Effect		
Air Temperatures (warm or cool)		
Location of Warm Water Pool		
Precipitation Patterns		

3. Construct an explanation based on the evidence you have gathered and scientific reasoning to show how energy from the Sun drives the movement of matter in the atmosphere and the transfer of energy **during an El Niño event**.

4. Extreme El Niño events may increase in frequency from about one every 20 years to one every 10 years by the end of the 21st century because of climate change. Using **Diagrams 3 & 4,** predict the conditions of a more intense El Niño year, and the effects it would have on Indonesia. Make sure to include the following:
    - ☐ Energy Flow
    - ☐ Matter Transport
    - ☐ Effects on Indonesia