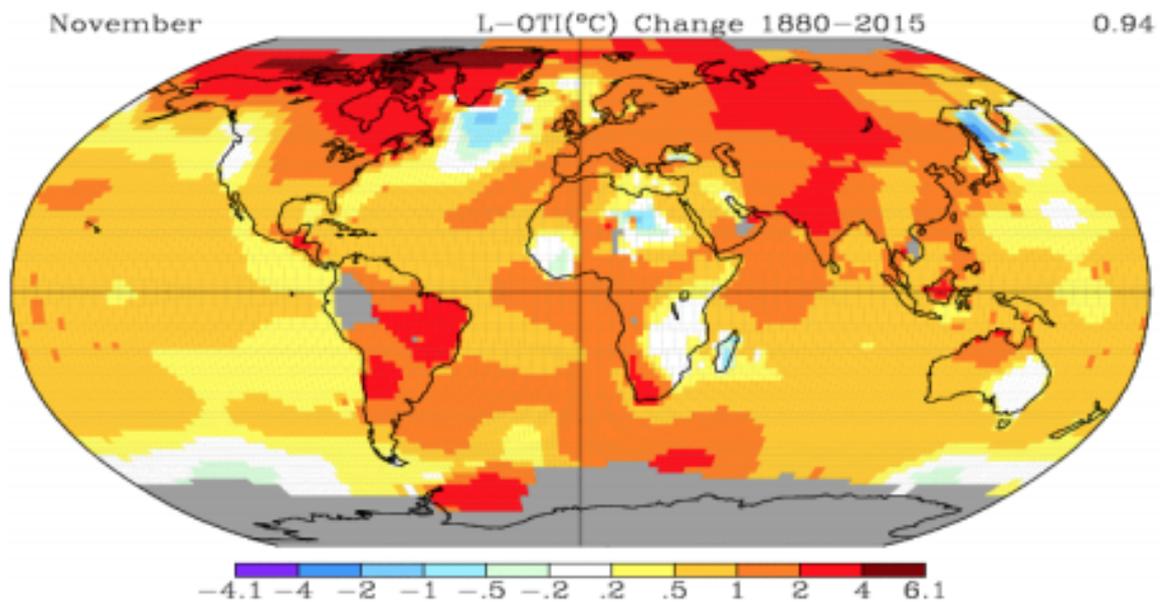

My NASA Data - Lesson Plans

Earth's Energy Budget, Applied Research STEM Curriculum Unit Plan

Unit Title: Earth's Energy Budget
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Purpose

This unit, created through the NASA Goddard Institute for Space Studies (GISS) Climate Change Research Initiative (CCRI), helps students learn about each component of the energy budget formula and how the contribution of each component changes based on the location and the time of the year.

Learning Objectives

Lesson 1: Deriving Earth's Energy Balance Equation

- Students will be able to derive the formula that describes Earth's radiation equilibrium (energy budget) by reading, analyzing, and completing a graphic organizer based on the content in a NASA Earth Observatory article titled Climate and Earth's Energy Budget.

Lesson 2: Analyzing NASA CERES Energy Budget Data

- Students will be able to analyze each component of Earth's energy budget formula by using NASA GISS Panoply software to read and display incoming solar radiation, outgoing longwave, outgoing shortwave, and net energy data from the NASA CERES satellite.

Lesson 3: Learning RStudio for NASA CERES Data Analysis

- Students will be able to write a code in RStudio that loads and displays netCDF insolation data from the NASA CERES satellite by completing a step-by-step guide that shows students how to perform calculations and other analyses in RStudio.

Lesson 4: Earth's Energy Budget Capstone Project

- Students will be able to create a code in RStudio that allows them to analyze and compare the different components of Earth's energy budget for different cities and time slices on Earth.

Why Does NASA Study This Phenomenon?

As Earth's climate continues to change, it is essential for the general public to understand that climate change will impact locations differently. This unit plan allows students to learn how and why the energy budget differs from one location to the next and more specifically, how climate change might alter the energy budget in the future. Educating this current generation of students about climate change is crucial as we head towards a global debate regarding impacts and mitigation strategies. If educators can effectively communicate how climate change will impact different regions of the world, our global society can be better equipped to make social, economic, and political changes regarding climate change.

Essential Questions

- How does change over seasons and latitude affect energy transfer in and out of the Earth System?
- How do scientists monitor these changes?

Materials Required

The Unit may be accessed [here](#).

Lesson 1: Deriving Earth's Energy Balance Equation

- [NASA Earth Observatory Article](#)
- [NASA GEEBITT Model](#)
- Deriving Earth's Energy Balance Equation organizer

Lesson 2: Analyzing NASA CERES Energy Budget Data

- [NASA CERES Satellite data](#)
- [NASA GISS Panoply](#)
- [NASA CERES article \(from Daily Press\)](#)
- Computers

Lesson 3: Learning RStudio for NASA CERES Data Analysis

- [NASA CERES Satellite data](#)
- Class set of computers
- [RStudio Download](#)

Lesson 4: Earth's Energy Budget Capstone Project

- [NASA CERES Satellite data](#)
- Class set of computers
- [RStudio Download](#)

Technology Requirements

- Internet Required
- One-to-One (tablet, laptop, or CPU)
- One-to-a-Group
- Visualization Tool Required
- Advanced technical equipment/expertise required

Teacher Background Information

Energy Cycle

Energy from the Sun is the driver of many Earth System processes. This energy flows into the Atmosphere and heats this system up. It also heats up the Hydrosphere and the land surface of the Geosphere, and fuels many processes in the Biosphere. Differences in the amount of energy absorbed in different places set the Atmosphere and oceans in motion and help determine their overall temperature and chemical structure. These motions, such as wind patterns and ocean currents redistribute energy throughout the environment. Eventually, the energy that began as Sunshine (short-wave radiation) leaves the planet as Earthshine (light reflected by the Atmosphere and surface back into space) and infrared radiation (heat, also called longwave radiation) emitted by all parts of the planet which reaches the top of the Atmosphere. This flow of energy from the Sun, through the environment, and back into space is a major connection in the Earth system; it defines Earth's climate.

Procedure

Visit the [link](#) to access the entire unit that features Pre/Post Evaluations, the lesson plans, and other resources.