### Data examples that students can use…

- **Aerosols:** Tiny liquid or solid particles dispersed in the atmosphere; can be caused by natural processes or human activity.
- **Black Marble/Earth at Night:** Nighttime view of Earth, showing visible light emanating from man-made sources, e.g., city lights.
- **Blue Marble Next Generation:** Composite images showing how the surface would look to a human in space if our world had no clouds and no atmosphere.
- **Climate:** Solar Insolation, temperature, precipitation, albedo, greenhouse gases/carbon, aerosols, and topography.
- **Earth System:** Solar insolation, surface temperature, cloud fraction, aerosols, precipitation, and vegetation index.
- **Land Cover Classification:** Maps displaying the Earth’s natural and human-made landscapes as color-coded categories.
- **Land Surface:** Since 1972, Landsat satellites have been observing Earth’s land surfaces and coastal regions.
- **MODIS Near-Real-Time Data:** Data for applications related to natural hazards and disasters (e.g., volcano ash plumes, drought, fires, severe storms, and sea ice conditions).

### Data examples that educators can use…

- **Air quality and pollution (ESS3.C)**
- **Earth’s energy budget (ESS2.A)**
- **Weather & climate (ESS2.D)**
- **Urban growth/heat Islands (ESS3.C)**
- **Power outages (ESS3.C)**
- **Seasonal migration (LS2.C)**
- **Factors contributing to global and regional climate (ESS2.D)**
- **Earth system and cycles (ESS2.A)**
- **Land cover changes (ESS3.C, LS2.C)**
- **Coastline changes (ESS2.C)**
- **Deforestation (ESS3.C)**
- **Ecosystems (LS2.C)**
- **Natural hazards & disasters (ESS3.B)**
- **Sea ice movement (ESS3.B)**
- **Water & land use changes (ESS2.C)**

### …to investigate these types of phenomena…

- Aerosols
- Black Marble/Earth at Night
- Blue Marble Next Generation
- Climate
- Earth System
- Land Cover Classification
- Land Surface
- MODIS Near-Real-Time Data

### …to make connections to K–12 content and practices…

- Air quality and pollution (ESS3.C)
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- Sea ice movement (ESS3.B)
- Water & land use changes (ESS2.C)

### …using these online sources of data.

- **Precipitation Measurement Missions**
  - [https://pmm.nasa.gov/data-access/visualization](https://pmm.nasa.gov/data-access/visualization)
  - Google Earth Engine Time Lapses • [https://earthengine.google.com/timelapse](https://earthengine.google.com/timelapse)
  - Worldview • [http://worldview.earthdata.nasa.gov](http://worldview.earthdata.nasa.gov)

This table lists examples of NASA datasets and imagery that could be used for student investigations related to content and practices in the Framework for K-12 Science Education. Explore the data on the left using the online sources listed on the right. Many datasets are available through multiple sources; each source provides unique features, analytical tools, and time periods. Sources are color coded for relative level/ease-of-use: BLUE (introductory), ORANGE (intermediate), and GREEN (advanced).
<table>
<thead>
<tr>
<th>Data examples that <strong>students</strong> can use…</th>
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</tr>
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<tbody>
<tr>
<td><strong>Land Surface Temperature:</strong> Temperature of what is on the land surface (e.g., snow and ice, grass, roads), which is different from air temperature. Land temperature anomaly maps show higher or lower than average temperatures.</td>
<td>Global warming (ESS3.D) Urban heat islands (ESS3.C) Weather/seasons (ESS2.D)</td>
<td>Earth system and feedback loops (ESS2.A) Electromagnetic radiation (PS4.B) Earth's energy budget (PS3.D) Solar insolation — amount of Sun's energy that reaches the surface; Solar radiation — amount of sunlight reflected by Earth's surface, clouds, &amp; atmosphere (shortwave) or absorbed then emitted by Earth's surface, water vapor, gasses, and aerosols (longwave).</td>
</tr>
<tr>
<td><strong>Sea Ice:</strong> Sea ice changes the normally dark blue ocean into solid white ice. This affects weather and climate — sunlight that would be absorbed by the ocean is now reflected back by the ice, due to its high albedo.</td>
<td></td>
<td>Earth system and feedback loops (ESS2.A) Electromagnetic radiation (PS4.B)</td>
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<td><strong>Sea Surface Temperature:</strong> Temperature of the very top layer of the ocean and other large bodies of water.</td>
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<td><strong>Vegetation and Leaf Area Indices:</strong> Measure of the “greenness” of Earth’s landscapes — where and how much green leaf vegetation was growing during a time period.</td>
<td>Deforestation (ESS3.C, LS2.C) Forest and crop health (LS2.C) Plant growth patterns (LS2.C) Seasonal changes (green up/down) (LS2.A)</td>
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<td><strong>Weather:</strong> Atmospheric temperature, pressure, radiation, and water vapor, precipitation.</td>
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- **MY NASA DATA**
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- **NEO**
- **Google Earth Engine Time Lapses**
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### Data examples that educators can use…

- …to investigate these types of phenomena…
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#### Aerosols
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- Earth’s energy budget (ESS2.A)
- Weather & climate (ESS2.D)

#### Black Marble/Earth at Night
- Urban growth/heat islands (ESS3.C)
- Power outages (ESS3.C)
- Seasonal migration (LS2.C)

#### Blue Marble Next Generation
- Seasonal changes on land surfaces (spring greening, snowmelt, drought, etc.) (LS2.A, ESS2.D)

#### Climate
- Factors contributing to global and regional climate (ESS2.D)
- Earth system and cycles (ESS2.A)

#### Earth System
- Earth system and cycles (ESS2.A)

#### Land Cover Classification
- Land cover changes (ESS3.C, LS2.C)

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- Coastline changes (ESS2.C)
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#### Change Matters Viewer

#### Worldview
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### 1) Click on URL to go to online resource.

### 2) Click on topic to explore background resources and additional information (e.g., Aerosols).

### 3) Mouseover NGSS code for K–12 content topic (e.g., LS2.C: Ecosystem Dynamics, Functioning, and Resilience.)

### 4) Click on a ‘bullet’ to go to data resources for this topic.

### 5) Click to learn more about the key features of online data sources.
Online Resources: **KEY FEATURES**

Explore key features of online Earth science data tools that can be useful for K–12 student investigations. Sources are color coded for relative level/ease-of-use: BLUE (introductory); ORANGE (intermediate) and GREEN (advanced).

**Google Earth Engine: Time Lapses**

https://earthengine.google.com/timelapse

Global, zoomable video that lets you see how the Earth has changed over the past 32 years. The majority of the images come from Landsat, a joint USGS/NASA program.

*IMAGE CREDIT: Las Vegas and Lake Mead, Landsat, USGS/NASA.*
Precipitation Measurement Missions

Data visualization tools for viewing near-real-time, global precipitation data, and flood and landslide nowcasts. Includes links to download data.


IGES, 2017 • http://k12datapaths.strategies.org
Online Resources: **KEY FEATURES**

**NASA Earth Observations (NEO)**

Browse, download and explore imagery of NASA satellite data for over 50 global datasets—related to atmosphere, energy, land, life, and ocean.

**START HERE:**


**About this dataset:**

3 levels provided—Basic, Intermediate, Advanced.

- **Zoom, analyze, and compare up to 3 datasets.**
- **Download different file formats and resolutions (CSV, PNG, Google Earth, GeoTIFF).**

**INTRODUCTORY Source**


**Online Resources:**

- **Browser datasets by broad category.**
- **Return to Quick Start Guide**

**NASA Earth Observations (NEO)**

[https://neo.sci.gsfc.nasa.gov](https://neo.sci.gsfc.nasa.gov)

IGES, 2017 • [http://k12datapaths.strategies.org](http://k12datapaths.strategies.org)
The GLOBE Program: Visualization System & Advanced Data Access Tool (ADAT)


International GLOBE schools and citizen scientists collect environmental data related to the atmosphere, biosphere, hydrosphere, and soils. Use the visualization system to locate and visualize GLOBE data, with maps, graphs, and data tables.

Start with tutorial at the URL on the left.

Use the ADAT to find, retrieve, and download the data into a csv file for detailed analysis—https://www.globe.gov/globe-data/retrieve-data
Browse, download, print and explore NASA satellite data available for Earth system’s spheres: atmosphere, biosphere, hydrosphere, and pedosphere (soils). Overview of the datasets and time periods covered: https://mynasadata.larc.nasa.gov/live-access-server

Interactive browse global, full-resolution satellite imagery and download the underlying data. Most of the 400+ available products are updated within three hours of observation, essentially showing the entire Earth as it looks “right now.”

This supports time-critical application areas such as wildfire management, air quality measurements, and flood monitoring. Arctic and Antarctic views of several products are also available for a “full globe” perspective. Browsing on tablet and smartphone devices is generally supported.

**NASA Worldview**

*https://worldview.earthdata.nasa.gov*

**Online Resources: KEY FEATURES**

- Download data and find images of recent events (e.g., severe storms, volcanoes, fires).
- Additional tools: create a URL, switch projection, and take a snapshot of your image to download (JPEG, PNG, or GeoTIFF).
- Browse and choose imagery to display. Add image layers to explore correlations. Click the “eye” icon to show/hide layers.
- Drag timeline to see past imagery or to animate the timescale.

**ADVANCED Source**

IMAGE CREDIT: Corrected reflectance (true color), May 31, 2017, Terra/MODIS.

**IGES, 2017 • http://k12datapaths.strategies.org**
Online Resources: **KEY FEATURES**

![Change Matters](http://www.esri.com/software/landsat-imagery/viewer)

Compare change over time using Landsat imagery from six Landsat missions beginning in 1972 to 2010.

The first two panels show a region for the selected years with the selected image type (e.g., this infrared image shows different life forms of vegetation, which are shown in shades of red). The third image shows changes in vegetation (green=increase, pink=decrease).

**ADVANCED Source**

Image credit: Landsat Infrared images of New York City, 1990 and 2010 (NASA/USGS) shown in ESRI’s Change Matters Viewer.

IGES, 2017 • http://k12datapaths.strategies.org
Change Matters: Advanced Features

Full Screen launches additional options.

(1) Check the ‘Overlay Change’ box.

(2) Select date range, and from the drop down menu select ‘Image Map.’

(3) Select ‘Vegetation Analysis.’

(4) To see the increase or decrease, click ‘Adjust Change Map.’

(5) Click ‘Launch in ArcGIS Online’ (limited options without an account).
Change Matters
Launched in ArcGIS Online

(6) Add additional imagery (including latest Landsat-8) in ArcGIS Online, click ‘Modify Map’ at the top right, select ‘Add’ from the drop down menu.

(7) Search for: Layers, Landsat 8. Click ‘Add’ and when finished adding layers, select ‘Done Adding Layers.’

(8) Check or uncheck the visible layers. The top layer is the current view.

(9) Zoom in and out.

(10) Explore timelapses of the available imagery.

Return to Quick Start Guide

IGES, 2017 • http://k12datapaths.strategies.org