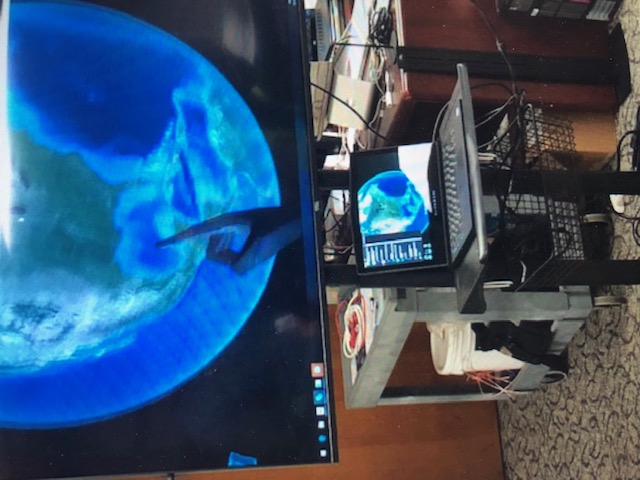
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**The Boulder Center for Interactive Learning at Dawson (BCILD) offers a companion resource to some of the SOS Explorer datasets.**

**This resource offers suggestions for possible discuss topics, and additional web resources on the various topics presented.**

Authors: David Sutton, Dawson School; Hilary Peddicord, NOAA SOS Explorer

[**www.bcild.org**](http://www.bcild.org)

<https://sos.noaa.gov/SOS_Explorer/>

**In addition to this resource, the SOS team at NOAA Boulder has put together a Phenomena-Based Learning Modules page on our website. Check it out!**

<https://sos.noaa.gov/education/phenomenon-based-learning/>

[**360 media – National Marine Sanctuaries**:](https://sos.noaa.gov/datasets/360-media-national-marine-sanctuaries/)

1. What is a wreck?
2. Why do scientists place old ships, buses and other vehicles purposefully on the sea bed?
3. What do you observe about old sunken ships?
4. What is the difference between plastic trash in the ocean and old wrecks placed on the sea beds?

* National Marine Sanctuaries Intro Video -<https://www.youtube.com/watch?v=lNKLVNF6U2o>
* The Atlantic: Artificial Reefs Around the World - <https://www.theatlantic.com/photo/2011/04/artificial-reefs-around-the-world/100042/>
* NOAA Ocean Service: Artificial Reefs - <https://oceanservice.noaa.gov/facts/artificial-reef.html>

[**Acidifying Oceans: Oceans and Climate Change (narrated movie)**](https://sos.noaa.gov/datasets/acidifying-oceans-oceans-and-climate-change/)

1. What is carbon dioxide (CO2)?
2. How is it formed?
3. Is it good or bad for our planet?
4. Why is carbon dioxide going up in the oceans?
5. Why are oceans critical to our planet?
6. How does increased CO2 affect the oceans and life in them?

* Climate.nasa.gov: The relentless rise of carbon dioxide -https://climate.nasa.gov/climate\_resources/24/graphic-the-relentless-rise-of-carbon-dioxide/
* Climate Central: Plants need carbon to live so isn't more of it a good thing? https://www.climatecentral.org/library/faqs/plants\_need\_co2\_to\_live\_so\_isnt\_more\_of\_it\_a\_good\_thing

[**Agriculture: Cropland and Pastureland Comparison**](https://sos.noaa.gov/datasets/cropland-and-pastureland-comparison/)

1. What do you notice?
2. What’s the difference between cropland and pastureland?
3. In 1968, the human population on Earth was 3.54 billion. In 2018, the human population on Earth was 7.70 billion. The estimated population by 2068 is about 10.50 billion. At the moment, agricultural land covers about 40% of the earth’s land surface. How are we going to feed all these people?
4. We have to choose between a combination of meat and crops. Cropland currently covers about 16 million sq. kilometers (size of South America), and pastureland (to feed animals) covers about 30 million square kilometers (about the size of Africa). How do we increase the amount of food produced? Which is more efficient?
5. What are the benefits/costs/water use of producing either plants/seeds/vegetables or meat?
6. If we create more cropland or pastureland, what do we give up? Forests. What are the benefits of forests to our planet?

* University of Minnesota Institute on the Environment Videos: <http://environment.umn.edu/discovery/gli/videos/>

[**Agriculture: Food vs Feed**](https://sos.noaa.gov/datasets/agriculture-food-vs-feed/)

1. What’s the difference between food and feed?
2. What do you notice?
3. What correlations can you make between the countries show as red or green and the demand for different types of food (meat vs. plant-based)?
4. How do you suspect this trend will change as resources (like water and cropland) grow scarcer?
5. Not eating meat and not flying are two of the most impactful choices you can make as an individual to decrease your carbon footprint. What other personal choices affect your carbon footprint?

* University of Minnesota Institute on the Environment Videos: <http://environment.umn.edu/discovery/gli/videos/>
* Carbon Footprint Calculator: <https://www.nature.org/en-us/get-involved/how-to-help/carbon-footprint-calculator/?gclid=EAIaIQobChMIrfOA6qfe5wIVCI7ICh1YVA4VEAAYBCAAEgIkw_D_BwE&gclsrc=aw.ds>

[**Air Traffic**:](https://sos.noaa.gov/datasets/air-traffic/)

1. What do you see?
2. How has the ability to fly affected world cultures? Economics? Societies?
3. If people could not fly, how else would they get around either their own countries, or around the world?
4. At what time of day do most flights occur in different countries, or parts of the world?
5. What do you observe about how busy certain parts of the world are compared with other parts? What could account for this? What impact on the environment do these busy places have?
6. What is the impact of air travel on our environment?
7. **One** 10-hour flight in a 737 requires 36,000 gallons of fuel. That fuel when burned turns into 702,000 pounds of carbon dioxide. One gallon of gasoline weighs 6 pounds, when burned yields 19.5 pounds of CO2 (hydrogen weighs less than oxygen). Not eating meat and not flying are two of the most impactful choices you can make as an individual to decrease your carbon footprint. What other personal choices affect your carbon footprint?

* Smithsonian Magazine: How bad is air travel for the environment? <https://www.smithsonianmag.com/travel/how-bad-is-air-travel-for-the-environment-51166834/>
* Carbon Footprint Calculator: <https://www.nature.org/en-us/get-involved/how-to-help/carbon-footprint-calculator/?gclid=EAIaIQobChMIrfOA6qfe5wIVCI7ICh1YVA4VEAAYBCAAEgIkw_D_BwE&gclsrc=aw.ds>

[Bird Migration: Western Hemisphere](https://sos.noaa.gov/datasets/bird-migration-patterns-western-hemisphere/)

1. Why do birds migrate?
2. Where do birds migrate?
3. What patterns do you see about when they migrate?
4. Have migration patterns changed? Why?
5. If you were a bird, where would you migrate to for six months of every year?

* Youtube: Cornell Lab of Ornithology’s Naturalist Outreach – Bird Migration - <https://www.youtube.com/watch?v=CwIT9pv4khw>
* The Cornell Labs website - <https://www.allaboutbirds.org/news/the-basics-how-why-and-where-of-bird-migration/>

[**Coral Reefs in Hot Water**:](https://sos.noaa.gov/datasets/coral-reefs-in-hot-water/)

1. What are coral reefs?
2. Why are they important?
3. How are reefs effected by changes in ocean temperature?
4. Are oceans getting warmer? If so, why?

* Smithsonian Ocean: Coral Reefs - <https://ocean.si.edu/ocean-life/invertebrates/corals-and-coral-reefs>
* NOAA Education: Coral Reef Ecosystems - <https://www.noaa.gov/education/resource-collections/marine-life-education-resources/coral-reef-ecosystems>

[**Drought Risk: Real-time**](https://sos.noaa.gov/datasets/drought-risk-real-time/)

The dataset predicts/shows where plants and other vegetation have shown stress through drought conditions. It does not reflect soil conditions on the ground.

1. What is a drought?
2. How do we measure drought risk from space?
3. When looking at the dataset, what do you see? What general observations can you make?
4. Where is drought happening now? What about this time last year?

* NOAA NESDIS: Here’s One Way Satellite Observations Can Alert Farmers and Ranchers to Impending Flash Droughts - <https://www.nesdis.noaa.gov/content/here%E2%80%99s-one-way-satellite-observations-can-alert-farmers-and-ranchers-impending-flash>
* NOAA NESDIS: The Value of the Data: Monitoring Drought Video - <https://www.nesdis.noaa.gov/content/value-data-monitoring-drought>
* National Geographic Article: Drought - <https://www.nationalgeographic.org/encyclopedia/drought/>

**Earthquakes: Real-time**

NOTE: Use this dataset in conjunction with Tectonic Plate Boundaries.

NOTE TO USERS: USE COUNTRY BORDER OVERLAYS

1. What is an earthquake?
2. What do notice about where earthquakes occur?
3. Have you learned about tectonic plates? How would you describe them?
4. Looking at the simulation of where earthquakes occur, can you guess where the tectonic plates are?
5. Click on the dots to learn more about the recent earthquakes around the globe. Based on the earthquake data in the last two weeks, where do you prefer NOT to live?

* YouTube: National Geographic Earthquakes 101 - <https://www.youtube.com/watch?v=VSgB1IWr6O4>
* USGS: Live Earthquake Map - <https://earthquake.usgs.gov/earthquakes/map/>
* USGS: Did you feel it? Citizen Science for Earthquakes - <https://earthquake.usgs.gov/data/dyfi/>

[**Exploring the Unknown Ocean**:](https://sos.noaa.gov/datasets/exploring-the-unknown-ocean/)

1. What are some of the reasons the ocean is so important to life on Earth? (there are many!)
2. Why do we want to explore the ocean?
3. How much of the ocean have we mapped/explored? Why is it so difficult?
4. What is a citizen scientist?

* NOAA: Ocean Exploration and Research - <https://oceanexplorer.noaa.gov>
* NOAA: National Ocean Service – How much of the ocean have we explored? <https://oceanservice.noaa.gov/facts/exploration.html>
* National Geographic: Download and print your favorite marine ecosystem illustrations <https://www.nationalgeographic.org/media/marine-ecosystem-illustrations-grades-3-5/>
* NOAA Ocean Service: Why should we care about the ocean? <https://oceanservice.noaa.gov/facts/why-care-about-ocean.html>

[**Fisheries Species Richness**:](https://sos.noaa.gov/datasets/fisheries-species-richness/)

NOTE TO USERS: USE COUNTRY BORDER OVERLAYS

1. What is an ecosystem?
2. Why are marine ecosystems important to us?
3. ORANGE/YELLOW areas show the greatest number of different species of fish in an area of the ocean. What observations can you make about where they are, and why they might be there? Hints: insect life, agriculture, run-off, shallower, and warmer waters.
4. Look at the space between Australia and Vietnam. What do you observe, and can you explain your observation?

* The Coral Triangle: Get to know the richest marine habitats on this planet - <https://coraltriangle.org/biodiversity/Biodiversity-CoralTriangle-MarineConservation-Culture-Fisheries.html>
* National Geographic: Download and print your favorite marine ecosystem illustrations <https://www.nationalgeographic.org/media/marine-ecosystem-illustrations-grades-3-5/>
* NOAA Ocean Service: Why should we care about the ocean? <https://oceanservice.noaa.gov/facts/why-care-about-ocean.html>

[**Frozen (narrated movie)**](https://sos.noaa.gov/datasets/frozen/)**;** [**Sea Ice Extent - September Only**](https://sos.noaa.gov/datasets/sea-ice-extent-september-only/)**;** [**Sea Ice Extent: 1978 - Present**](https://sos.noaa.gov/datasets/sea-ice-extent-1978-present/)

1. Why are the poles frozen?
2. Why is ice important to our planet? (hint: white reflects light and heat, dark blue does not) More CO2 makes the earth hotter which melts ice. When ice becomes sea water it gets darker, which absorbs more heat, which melts ice, which becomes darker…
3. How does snowfall impact our fresh water resources on land?
4. What is permafrost?
5. What happens when permafrost melts?
6. What would the earth be like without ice?

* YouTube Alfred-Wegener-Insitut: What is Permafrost - <https://www.youtube.com/watch?v=lxixy1u8GjY>
* National Snow and Ice Data Center – Articles <https://nsidc.org/>
* Climate.NASA.gov – Global Climate Change- Vital Signs of the Planet <https://climate.nasa.gov/resources/education/pbs_modules/lesson2Engage/>

[**Forest Change: Extent, Gain, and Loss (2000-2014)**:](https://sos.noaa.gov/datasets/forest-change-extent-gain-and-loss-2000-2014/)

1. What are some of the causes of deforestation?
2. What are some of the problems associated with deforestation?

* Yale Environment 360: Conflicting data: How fast is the world losing its forests? <https://e360.yale.edu/features/conflicting-data-how-fast-is-the-worlds-losing-its-forests>
* World Resources Institute: Deforestation accelerating despite mounting efforts to protect tropical forests. What are we doing wrong? <https://www.wri.org/blog/2018/06/deforestation-accelerating-despite-mounting-efforts-protect-tropical-forests>
* World Wildlife Fund: Causes of Deforestation: <https://wwf.panda.org/our_work/forests/deforestation_causes2/>

[**Human Transportation**:](https://sos.noaa.gov/datasets/human-transportation/)

1. What do the colored lines represent?
2. What do the colored lines have in common?
3. What effect does human transportation have on the globe?
4. How much energy do we use to move people and goods around the world?

* National Academy of Sciences: What you need to know about energy -<http://needtoknow.nas.edu/energy/energy-use/transportation/>
* The Maritime Executive: Transport uses 25% of World Energy - <https://www.maritime-executive.com/article/transport-uses-25-percent-of-world-energy>
* The Guardian: Scientists answer toughest energy questions -<https://www.theguardian.com/environment/2010/nov/03/scientists-answer-energy-questions>

[**Hurricane Harvey**](https://sos.noaa.gov/datasets/hurricane-harvey-clouds-with-precipitation-2017/)**;** [**Hurricane Maria**](https://sos.noaa.gov/datasets/hurricane-maria-2017/)**;** [**Hurricane Tracks 1950 – 2005**](https://sos.noaa.gov/datasets/hurricane-tracks-cumulative-1950-2005/)**;** [**Hurricane Season 2017**](https://sos.noaa.gov/datasets/hurricane-season-2017/)**;** [**Forecast: Tropical Cyclone (narrated movie)**](https://sos.noaa.gov/datasets/forecast-tropical-cyclones/)

1. What are hurricanes?
2. How do they form?
3. Where do they form?
4. Are they expected to increase (in frequency or strength) with increasing global temperatures?

* NOAA Education: Hurricanes - <https://www.noaa.gov/education/resource-collections/weather-atmosphere-education-resources/hurricanes>
* Woods Hole Oceanographic Institution: Know Your Ocean: <https://www.whoi.edu/know-your-ocean/ocean-topics/hazards/hurricanes/>
* Skeptical Science: What’s the link between hurricanes and global warming - <https://skepticalscience.com/hurricanes-global-warming.htm>

[**Population Density at Night (Interactive)**](https://sos.noaa.gov/datasets/population-density-at-night-interactive/)

1. Where in the world is most densely populated? Why do you think?
2. Where in the world is least densely populated? Why do you think?
3. How has population changed over time?
4. What is the population expected to be in the future?

* YouTube: American Museum of Natural History – Human population through time - <https://www.youtube.com/watch?v=PUwmA3Q0_OE>

[**Satellite and Space Trash**](https://sos.noaa.gov/datasets/space-trash-and-satellites/); [**Satellite Positions**](https://sos.noaa.gov/datasets/satellite-positions/)**;** [**Satellite Models**](https://sos.noaa.gov/datasets/satellite-models/)

1. What are satellites?
2. What do satellites do for us?
3. What is space trash?
4. Can you create a plan to collect and dispose of space trash?
5. Why is all significant space trash monitored 24 hours a day? Who needs that information?

* NASA: What is a Satellite - <https://www.nasa.gov/audience/forstudents/5-8/features/nasa-knows/what-is-a-satellite-58.html>
* NASA: Orbital Debris - <https://www.nasa.gov/mission_pages/station/news/orbital_debris.html>
* NOAA: Satellite and Information Service - <https://www.nesdis.noaa.gov/>