



Climate: Seas of Change

Ocean Systems, Climate, Models

Investigate and analyze the processes that shape and change climate from global surface currents and wind patterns to humans' role in the environment with STEM Professionals:

Katy Croff Bell - Ocean Explorer and National Geographic Fellow

Dawn Wright - Marine Geographer and Geologist, Chief Scientist at ESRI

Claudia Benitez-Nelson - Chemical Oceanographer; Distinguished Professor, University of South Carolina

Diane Stanitski - Climatologist, Deputy Director of the NOAA Global Monitoring Laboratory

John Adler - Climatologist, NOAA Commander

Tracy Romano - Chief Scientist at Mystic Aquarium

Jim Hack - Director National Center for Computational Sciences at Oak Ridge National Laboratory

Atsuhiko Muto - Glaciologist/polar geophysicist, Temple University

Mike Biddle - Chemical Engineer, Director EVOK Innovations

- **Expedition 1: Earth's Ocean System - Beneath the Blue**
- **Expedition 2: Climate Connections - Drift and Flow**
- **Expedition 3: Climate Change - Models and Decisions**

Cross-Curricular Connections

Reading & Writing for Technical Subjects:

LST.1: Read and comprehend science and technical texts independently and proficiently and write effectively for a variety of discipline-specific tasks, purposes, and audiences

LST.2: Extract and construct meaning from science and technical texts using a variety of comprehension skills

LST.2.2: Determine the central ideas or conclusions of a text; provide an accurate, objective summary of the text.

LST.2.3: Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

LST.3.1: Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to texts and topics.

LST.4.1: Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

LST.7.1: Conduct short research assignments and tasks to answer a question (including a self-generated question), or test a hypothesis, drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.

Literature Selections: *The Voyage of The Frog*, by Gary Paulsen; *Journey Under the Sea*, by R.A. Montgomery; *Hoot*, by Carl Hiaasen; *20,000 Leagues Under the Sea*, by Jules Verne; *Black Star, Bright Dawn*, by Scott O'Dell; *Under the Weather: Stories About Climate Change*, edited by Tony Bradman; *How We Know What We Know About Our Changing Climate*, by Lynner Cherry and Gray Braasch

Math: Algebraic Problem Solving, Using Ratios, Creating and Analyzing Graphs (Bar, Pie, Best-Fit Line), Positive and Negative Numbers

Social Studies: Mapping the ocean floor, Spatial Distribution of Ecosystems, Physical Systems Affecting Human Systems, History of SONAR and Satellites; Juan Ponce de Leon, Benjamin Franklin and the Gulf Stream, Second Industrial Revolution

Art: 3D Mapping; Japanese Artist: Motoi Yamamoto; NASA Sun as Art

Grades 4-5 Science Content & Engineering Standards

- 3-5.E.1** Identify a simple problem with the design of an object that reflects a need or a want. Include criteria for success and constraints on materials, time, or cost. (Expeditions 1, 2, 3)
- 3-5.E.2** Construct and compare multiple plausible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem. (Expeditions 1, 2, 3)
- 4.PS.5** Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents. (Expeditions 1, 2, 3)
- 4.ESS.3** Describe how geological forces change the shape of the land suddenly and over time. (Expeditions 1, 2, 3)
- 4.ESS.4** Develop solutions that could be implemented to reduce the impact of humans on the natural environment and the natural environment on humans. (Expeditions 2, 3)
- 4.LS.2** Use evidence to support the explanation that a change in the environment may result in a plant or animal surviving and reproducing, moving to a new location, or dying. (Expedition 3)
- 5.ESS.3** Investigate ways individual communities within the United States protect the Earth's resources and environment. (Expedition 3)
- 5.ESS.4** Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact. (Expeditions 1, 2)

Grades 6-8 Science Content & Engineering Standards

- 6-8.E.1** Identify the criteria and constraints of a design to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. (Expeditions 1, 2, 3)
- 6-8.E.2** Evaluate competing design solutions using a systematic process to identify how well they meet the criteria and constraints of the problem. (Expeditions 1, 2, 3)
- 6-8.E.3** Analyze data from investigations to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. (Expeditions 1, 2, 3)
- 6-8.E.4** Develop a prototype to generate data for repeated investigations and modify a proposed object, tool, or process such that an optimal design can be achieved. (Expeditions 1, 2, 3)
- 7.PS.2** Describe the motion of an object graphically showing the relationship between time and position. (Expeditions 2, 3)
- 7.PS.2** Describe the properties of solids, liquids, and gases. Develop models that predict and describe changes in particle motion, density, temperature, and state of a pure substance when thermal energy is added or removed. (Expeditions 1, 2)
- 7.PS.9** Compare and contrast the three types of heat transfer: radiation, convection, and conduction. (Expedition 2)
- 7.ESS.4** Construct an explanation, based on evidence found in and around Indiana, for how large-scale physical processes, such as Karst topography and glaciation, have shaped the land. (Expedition 3)
- 8.ESS.1** Research global temperatures over the past century. Compare and contrast data in relation to the theory of climate change. (Expedition 3)
- 8.ESS.2** Create a diagram or carry out a simulation to describe how water is cycled through the earth's crust, atmosphere and oceans. Explain how the water cycle is driven by energy from the sun and the force of gravity. (Expeditions 1, 2)

Grades 9-12 Science Content Standards

- ES 3.3:** Analyze and explain how events on one side of the world can alter temperature and precipitation around the globe. Analyze and explain the possible effects of natural and human-driven processes on our atmosphere and climate. (Expeditions 1, 2, 3)
- ES. 4.2:** Create models to demonstrate the circulation, retention, and reflection of heat in regards to the atmosphere, solid land, and bodies of water including lakes and oceans. Demonstrate the effects of cities, various terrain, cloud cover, sea ice, and open water on albedo. Examine local and global heat exchanges, including land & sea breezes, lake effects, urban heat islands, and thermohaline circulation. (Expeditions 1, 2, 3)
- ES. 4.3:** Create a presentation that demonstrates the process of the water cycle on both local and global scales. Illustrate the process of water cycling both from the solid earth to the atmosphere and around the solid earth. Examine the interaction of groundwater, surface water, and ocean circulation. Illustrate the effects of human activity on water systems. (Expeditions 1, 2, 3)
- ES 4.4:** Create a model to demonstrate how the Coriolis effect influences the global circulation of the atmosphere. Explain how changes in the circulation of the atmosphere and oceans can create events such as El Niño and La Niña. (Expedition 2)
- ES. 4.6:** Differentiate between weather and climate. Examine long term, natural climate change and periods of glaciation as influenced by Milankovitch Cycles due to the gravity of other solar system bodies (obliquity and precession of axis and eccentricity of orbit). Explain how these are different from any short term (less than thousands of years) changes to climate. (Expeditions 1, 2)
- Env.1.1** Understand and explain that ecosystems have cyclic fluctuations, such as seasonal changes or changes in population, as a result of migration, birth, and mortality. (Expedition 2)
- Env.1.2** Understand and explain that human beings are part of Earth's ecosystems and give examples of how human activities can, deliberately or inadvertently, alter ecosystems. (Expeditions 2, 3)
- Env.1.6** Describe the difference between weather and climate. Locate, identify, and describe the major Earth biomes. Explain how biomes are determined by climate (temperature and precipitation patterns) that support specific kinds of plants. (Expedition 2)
- Env.1.8** Explain the factors that influence weather and climate, the action of gravitational forces, and the rotation of the Earth. (Expedition 2, 3)
- Env.1.9** Describe how weather can be influenced by global climatic patterns, such as El Niño and La Niña. (Expeditions 1, 2)
- Env.4.1** Explain environmental policies/organizations (Clean Water Act, Clean Air Act, Endangered Species Act, Species Survival Plan, Resource Conservation and Recovery Act, Department of Energy, and the World Health Organization) and identify their impact. (Expedition 3)
- Env.4.2** Understand that environmental policies/decisions have negative and positive impacts on people, societies, & the environment (Exp. 3)

