Teaching with a 21st century toolbox
Opportunities and challenges

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Plan for today

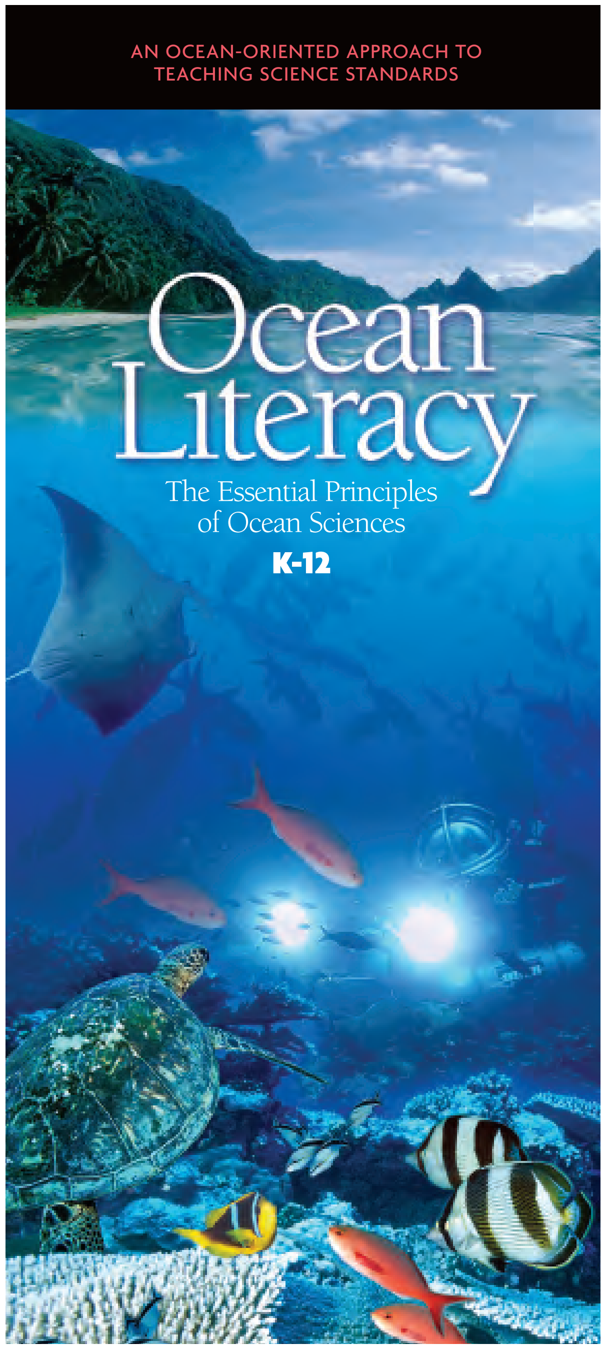
- Background and guiding documents
- Community efforts underway
- Focus on what this community does best
- Ways for you (yes, *you*) to get involved

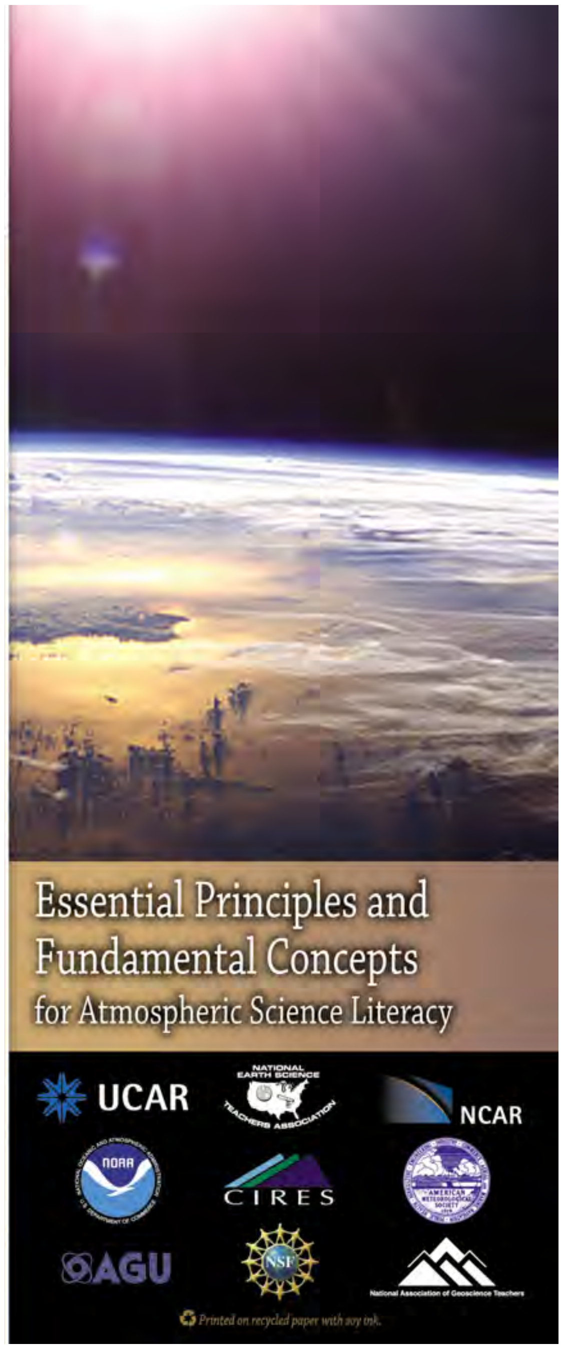
Learning outcome

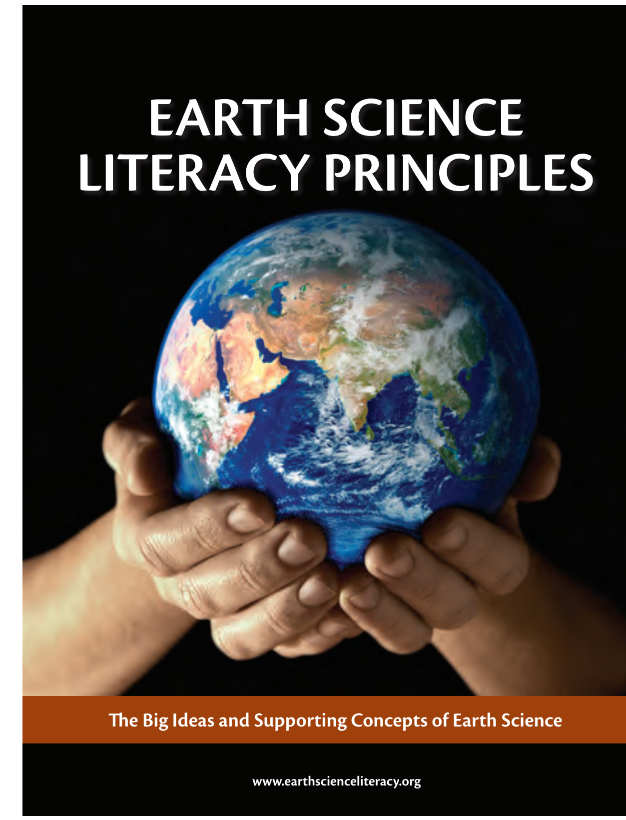
By this end of this talk, you will either find a "tool" you want to use or see where you can contribute something that you have.

There will be an assessment

Background and guiding documents







NEXT GENERATION SCIENCE STANDARDS

From the Earth Science Literacy Principles:

BIG IDEA 1. Earth scientists use repeatable observations and testable ideas to understand and explain our planet.

1.1 **Earth scientists find solutions to society's needs.** Earth scientists work on challenging problems that face humanity on topics such as climate change and human impacts on Earth. Earth scientists successfully predict hazards to humans and locate and recover natural resources, making possible the flourishing of humans on Earth.

1.2 **Earth scientists use a large variety of scientific principles to understand how our planet works.** Earth scientists combine study of Earth's geology with aspects of biology, chemistry, physics, and mathematics in order to understand the complexities of the Earth system.

1.3 **Earth science investigations take many different forms.** Earth scientists do reproducible experiments and collect multiple lines of evidence. This evidence is taken from field, analytical, theoretical, experimental, and modeling studies.

1.4 **Earth scientists must use indirect methods to examine and understand the structure, composition, and dynamics of Earth's interior.** With the exception of wells and mine shafts drilled into Earth, direct observations of Earth's interior are not possible. Instead, Earth scientists observe the interior of the planet using seismic waves, gravity, magnetic fields, radar, sonar, and laboratory experiments on the behavior of materials at high pressures and temperatures.

1.5 **Earth scientists use their understanding of the past to forecast Earth's future.** Earth science research tells us how Earth functioned in the past under conditions not seen today and how conditions are likely to change in the future.

1.6 **Earth scientists construct models of Earth and its processes that best explain the available geological evidence.** These scientific models, which can be conceptual or analytical, undergo rigorous scrutiny and testing by collaborating and competing groups of scientists

From the Next Generation Science Standards:

HS-ESS3 Earth and Human Activity

How to read the standards »
Go back to search results
Related Content »
Views: Disable Popups / Black and white / Practices and Core Ideas / Practices and Crosscutting Concepts / PDF

Students who demonstrate understanding can:

HS-ESS3-1. **Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.** [Clarification Statement: Examples of key natural resources include access to fresh water (such as rivers, lakes, and groundwater), regions of fertile soils such as river deltas, and high concentrations of minerals and fossil fuels. Examples of natural hazards can be from interior processes (such as volcanic eruptions and earthquakes), surface processes (such as tsunamis, mass wasting and soil erosion), and severe weather (such as hurricanes, floods, and droughts). Examples of the results of changes in climate that can affect populations or drive mass migrations include changes to sea level, regional patterns of temperature and precipitation, and the types of crops and livestock that can be raised.]

Science and Engineering Practices

Analyzing and Interpreting Data

Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.

- Analyze data using computational models in order to make valid and reliable scientific claims. (HS-ESS3-5)

Using Mathematics and Computational Thinking

Mathematical and computational thinking in 9-12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.

- Create a computational model or simulation of a phenomenon, designed device, process, or system. (HS-ESS3-3)
- Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations. (HS-ESS3-6)

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to

Disciplinary Core Ideas

ESS2.D: Weather and Climate

- Current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to rise. The outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year and by the ways in which these gases are absorbed by the ocean and biosphere. *(secondary to HS-ESS3-6)*

ESS3.A: Natural Resources

- Resource availability has guided the development of human society. (HS-ESS3-1)
- All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors. (HS-ESS3-2)

ESS3.B: Natural Hazards

- Natural hazards and other geologic events have shaped the course of human history; [they] have significantly altered the sizes of human populations and have driven human migrations. (HS-ESS3-1)

ESS3.C: Human Impacts on Earth Systems

- The sustainability of human societies and the biodiversity that supports them requires

Crosscutting Concepts

Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-ESS3-1)

Systems and System Models

- When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. (HS-ESS3-6)

Stability and Change

- Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. (HS-ESS3-3),(HS-ESS3-5)
- Feedback (negative or positive) can stabilize or destabilize a system. (HS-ESS3-4)

Connections to Engineering, Technology, and Applications of Science

Influence of Science, Engineering, and Technology on Society and the Natural World

- Modern civilization depends on major technological systems. (HS-ESS3-1),(HS-ESS3-3)

Key themes

- Emphasis on **human interactions with Earth**
  - How Earth affects us *(hazards, climate)*
  - How we affect Earth *(sustainability, climate)*
- Emphasis on the **process of science**
  - Science and engineering practices - learning by doing
  - Techniques and tools that *Earth scientists* use

These two themes provide a great opportunity, especially for this community.

Community efforts underway

Goals of InTeGrate material development

- New materials that:
    - Can be used in geosciences and beyond
    - Cover the breadth of geoscience & societal issues
    - Will be adopted and adapted broadly
- Development and testing process
    - Team-based (three people, three institutions)
    - Rigorous, **rubric-based** development

Guiding principles for InTeGrate materials design

- Address one or more Earth-related grand challenges facing society;
- Develop students’ ability to address interdisciplinary problems;
- Improve students’ understanding of the nature and methods of geoscience and develop their geoscientific habits of mind;
- Make use of authentic and credible geoscience data in the context of geoscienctific methods of inquiry; and
- Incorporate systems thinking.

What’s the difference?

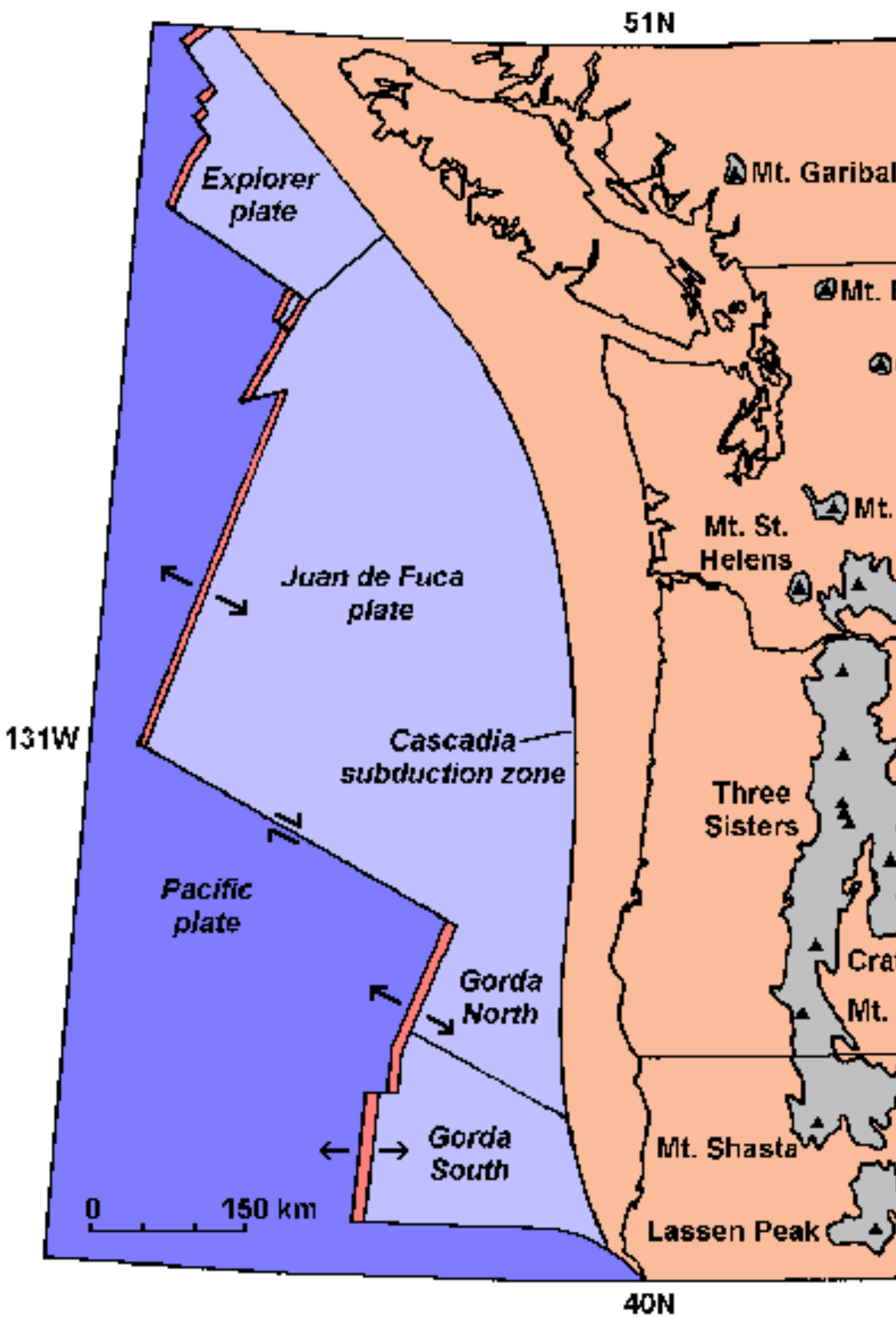
Traditional

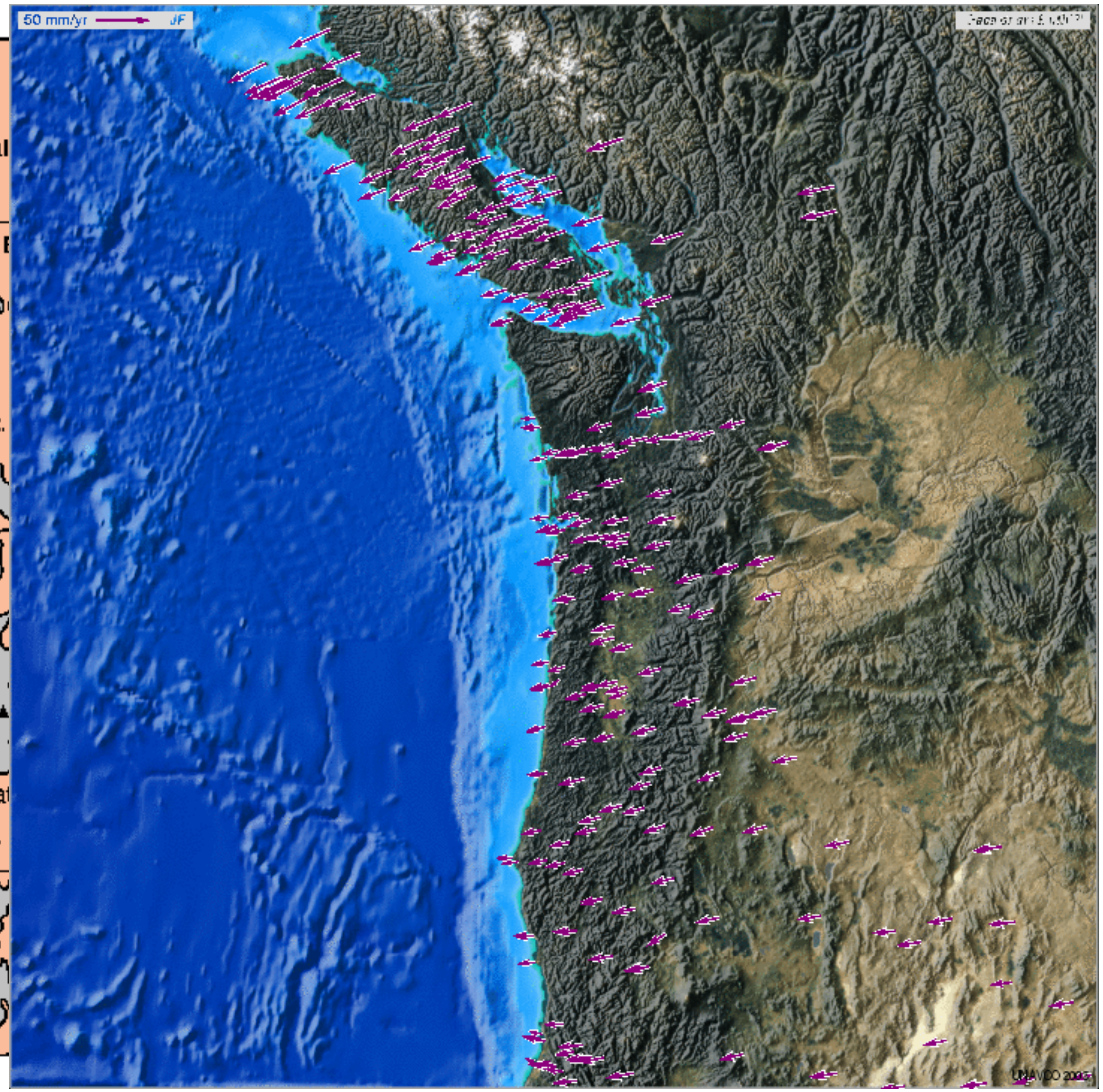
“Let me tell you a lot of stuff about plate boundaries, where there are volcanoes and earthquakes, which are natural hazards.”

InTeGrate

“Natural hazards like earthquakes/hurricanes affect us, here. What do we know about them? How can we find out more in order to be prepared?”

What’s the difference?





InTeGrate

Interdisciplinary Teaching about Earth for a Sustainable Future

Search the Sit Go

InTeGrate's Earth-focused Modules and Courses for the Undergraduate Classroom

Edit

Learn More

Climate of Change: Interactions and Feedbacks Between Water, Air, and Ice

100 200 300 400

Intro Level

3 Weeks

6 Units

Cindy Shellito (University of Northern Colorado)

Becca Walker (Mt San Antonio College)

Cynthia Fadem (Earlham College)

Summary

In this 2-3 week module, students explore short-term climate variability resulting from atmosphere-ocean-ice interactions. The module promotes awareness of past and contemporary cultures and regions strongly affected by permanently altered or increasingly uncertain climates as students consider human adaptation to climate fluctuations. Students investigate the dynamics and impacts associated with climate variability by examining and analyzing atmosphere, ocean, and ice data; completing a series of readings; and engaging in group discussions. Materials and teaching descriptions for gallery walks, interactive discussions, group work, and lab exercises are provided.

Strengths of the Module

This module has a **positive focus on adaptations to climate change**. Activities provide students opportunities to think locally, regionally, and globally. They drive thinking about climate change and social vulnerability. This leads to better informed citizens, empowered to make more responsible decisions. See an example adaptation activity

Students use real, current ocean, atmosphere, and ice data to learn about climate change. Activities provide concrete ways to learn abstract concepts like uncertainty, anomalies, and feedback. Students consider questions about climate and society for which they can't Google the answer.See an example data-rich activity

It gets students out of their chairs. A diverse suite of activity types (gallery walks, games, discussions, lab exercises and small group activities) provide students opportunities to be involved. This engages quieter students, and both professors and students have fun! See an example role-playing activity

A great fit for courses in:

- Environmental Science
- Meteorology
- Geology
- Oceanography
- Geological Hazards
- Global Change

Table of Contents

View the Instructor Materials »

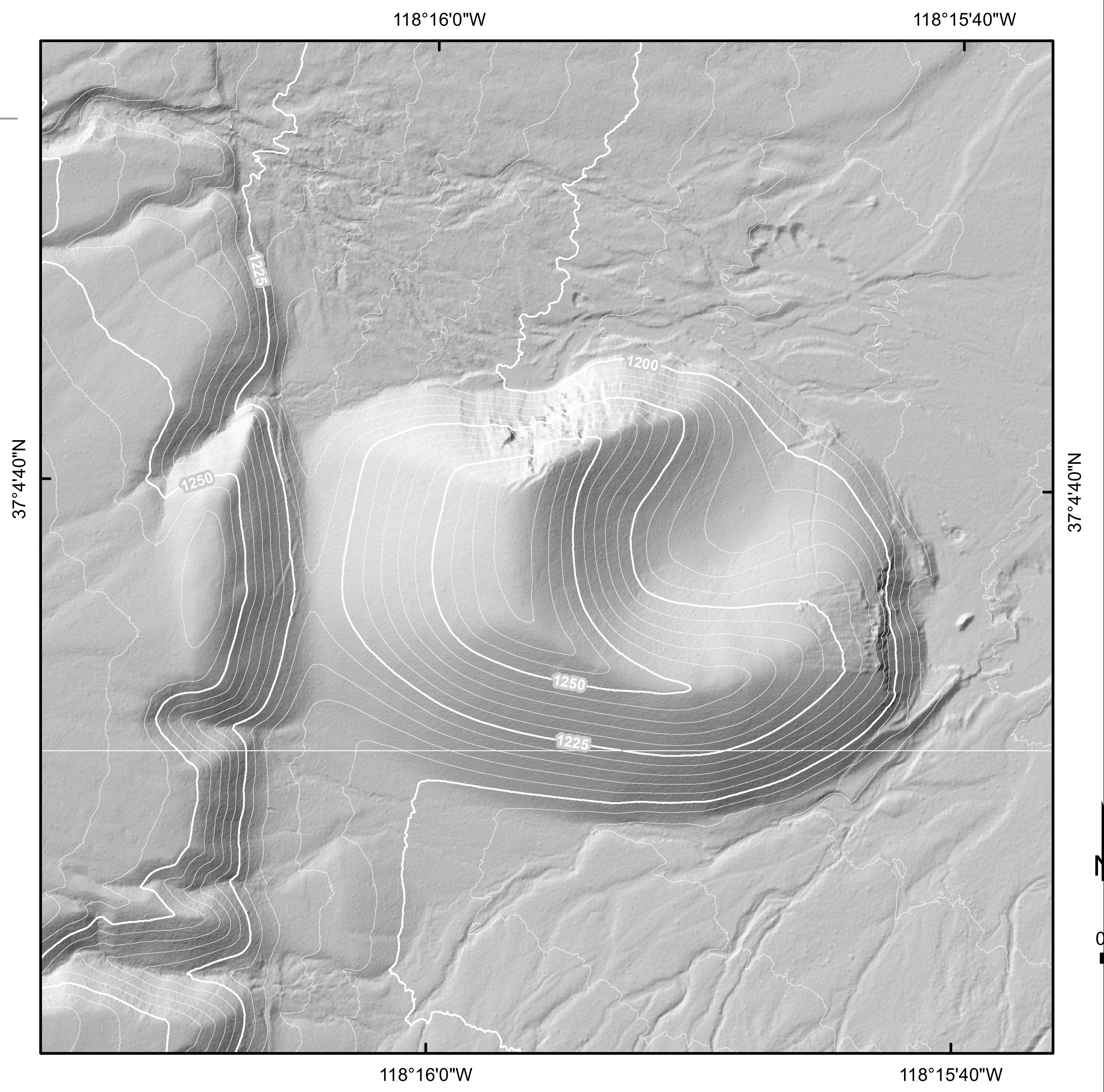
“Authentic and credible geoscience data”

- Airborne and terrestrial lidar
- Real-time and historic earthquake data
- Real-time, long-term, high-rate GPS data
- InSAR, radar, interferograms
- Climate data, sea-surface temperature, ice core data, etc.

…but

Data alone is not good enough

- Give students the opportunity to interpret data as it applies to their own lives
- Give students high quality data to interpret



ESSAY

IBI* SERIES WINNER

Engaging Students in Earthquakes via Real-Time Data and Decisions

Seismicity and Relative Risk, the IBI Prize–winning module, utilizes freely available earthquake data to help students apply their knowledge to risk-related decision-making.

Anne E. Egger

29 JUNE 2012 VOL 336 **SCIENCE** www.sciencemag.org

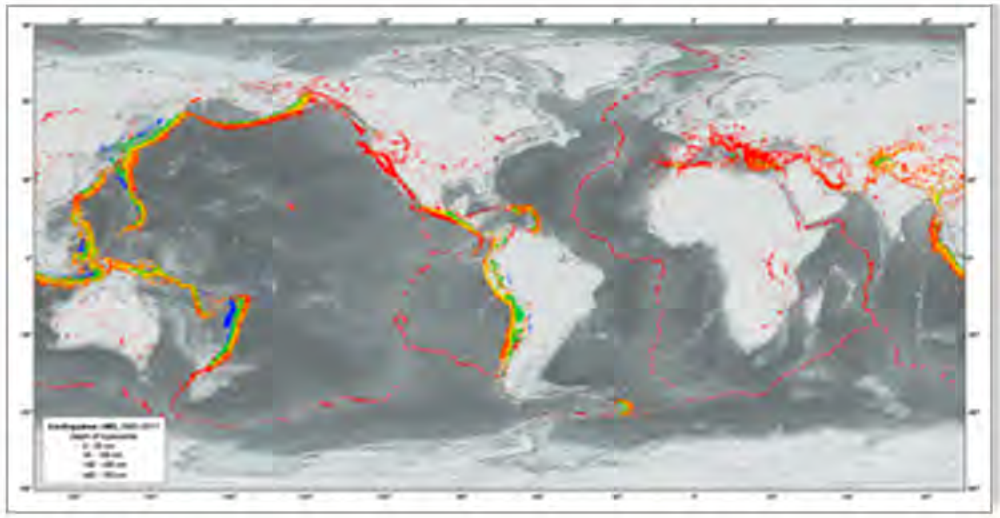
Published by AAAS

Seismicity and Relative Risk

Anne Egger, Central Washington University (formerly at Stanford University) Author Profile

Summary

This module provides an introduction to earthquakes using a guided inquiry exploration of the USGS earthquake website followed by an open-ended application of that knowledge to personal decision-making. It helps students move from thinking about single earthquakes to the longer term record, how they relate to plate boundaries, and the risks that we encounter with respect to earthquake hazards. The module consists of three parts:



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Learning Goals

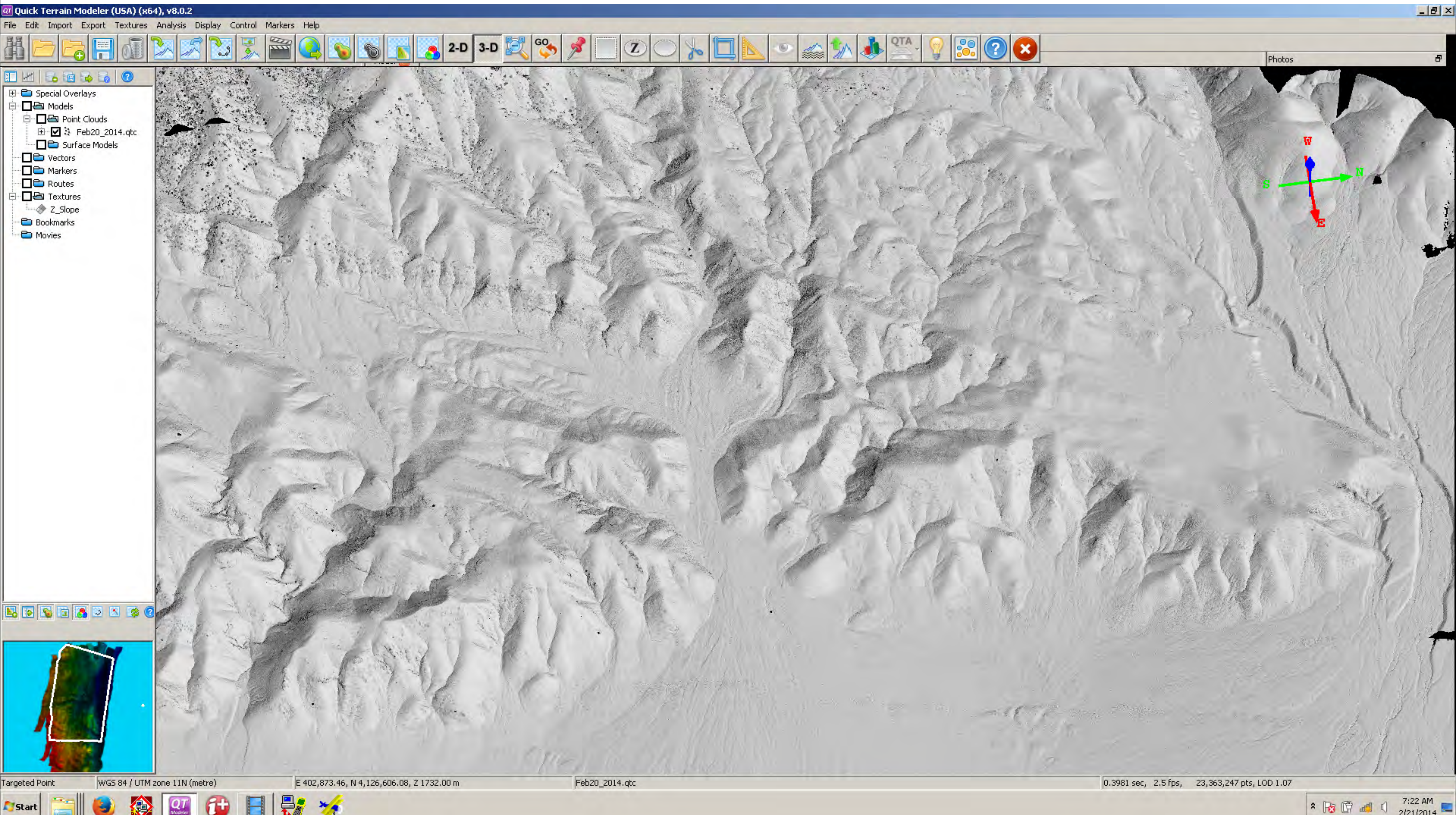

Tour Guide
1993
Imagery Date: 8/9/2013 37°18'51.97" N 118°05'28.66" W elev 5591 ft eye alt 7703 ft
Google earth

Collaboration to collect lidar for a better basemap

w/ Chris Larsen at UAF

Universities involved

- CWU
- WWU
- UCLA
- Caltech
- UC Davis
- CSU Sacramento
- OSU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File Edit Import Export Textures Analysis Display Control Markers Help
2-D
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2/21/2014

Going beyond the classroom

Connecting with the communities where we work

Why are the **hot springs** where they are in Surprise Valley?

That's what we want to know, too. Come find out more about what scientists from the U.S. Geological Survey, NASA, and Central Washington University are doing to learn more about faults and hot water in the valley.

Two events in Cedarville on

Wednesday, September 5

1:00-4:00 pm Open House
Cedarville airport
See the SIERRA aircraft (shown in the picture to the right) and talk to NASA engineers.

7:30 pm Public Talk
Surprise Valley Community Church, Cedarville
Meet the scientists and hear about why we are working here and what we've learned so far.

Questions?

Contact Anne Egger at (650) 793-5231, or eggera@cwu.edu


Finding faults

A few upcoming ways to get involved

InTeGrate workshop

Teaching about Risk and Resilience: Sea Level Rise, Flooding, and Earthquakes

Florida Center for Environmental Studies, Florida Atlantic University
Boca Raton, FL
May 14-16, 2014
Application deadline extended to March 9, 2014

Preparing for or responding to an environmental disaster requires knowledge from many disciplines and real time interdisciplinary problem solving. The interaction between the extreme event, people in its path and the response mechanisms of government and business combine at one place and time. How do we prepare students for careers where they can make useful and valuable contributions that mitigate risks and increase resilience in the face of a growing population and changing environment? What do students need to know about risk and resilience? What foundational knowledge will prepare them to communicate with, learn from, and work with experts from the range of disciplines that are needed to address these problems?

serc.carleton.edu/integrate/participate

Other opportunities

- GETSI project here at UNAVCO - talk to Bruce Douglas or Beth Pratt-Sitaula or Shelley Olds
- GeoPRISMS (formerly known as MARGINS) mini-lessons
- InTeGrate call for proposals for new materials
- Give a public talk next time you go into the field
- Got nice data? Talk to someone to share it…
- Not sure where to start? annegger@geology.cwu.edu

Assessment

Raise your hand if you learned about an educational “tool” you’d like to use in the future.

Raise your hand if you are thinking you might be able to contribute to the toolbox (dataset, collaborative project, etc.)