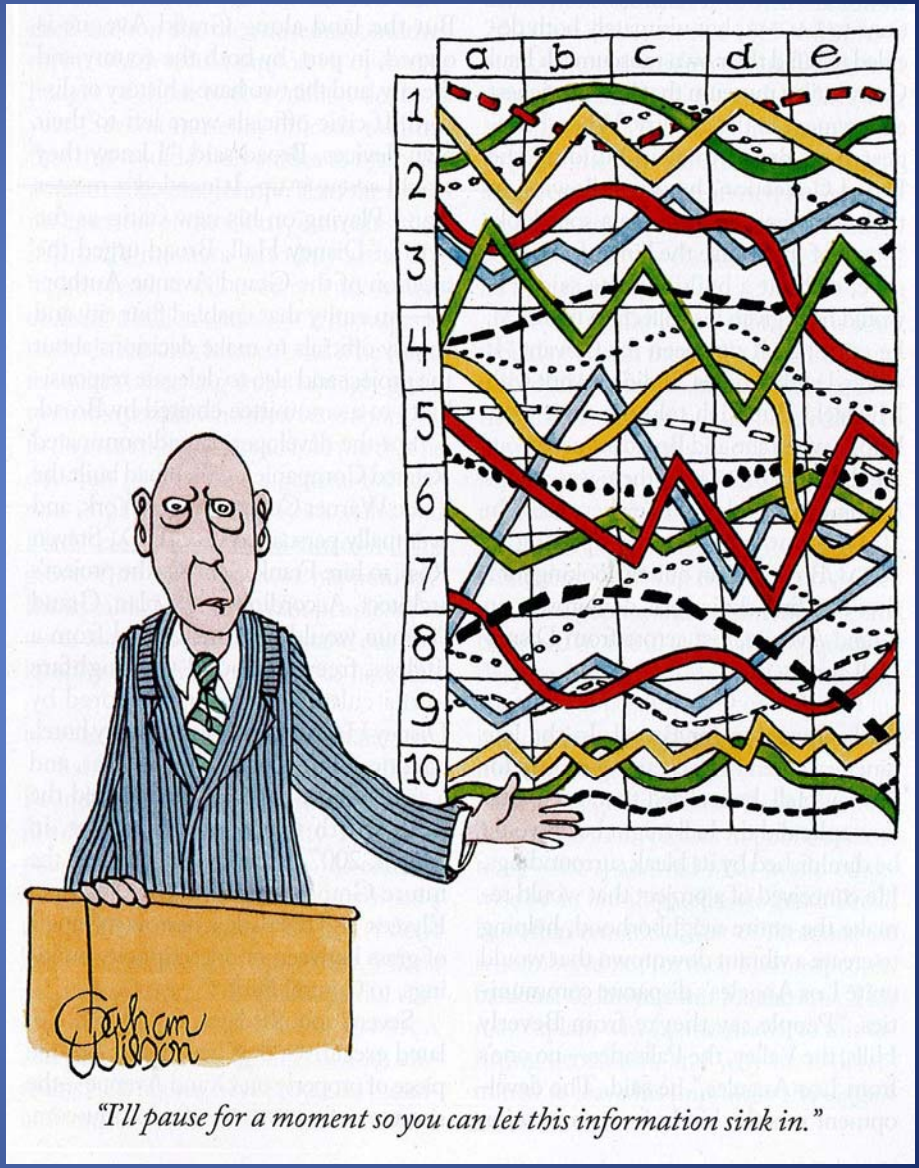
DR K–12 Exploratory Project:

Oceans of Data— *In what ways can research on learning inform the design of interfaces and technology tools to be used by students accessing large scientific databases?*

October 2010–October 2012

Education Development Center, Inc. and Scripps Institution of Oceanography



"I'll pause for a moment so you can let this information sink in."

Source: *The New Yorker*, December 6, 2010.

EDC Learning transforms lives.

Realizing the potential of scientific cyberinfrastructures to change the way science is taught

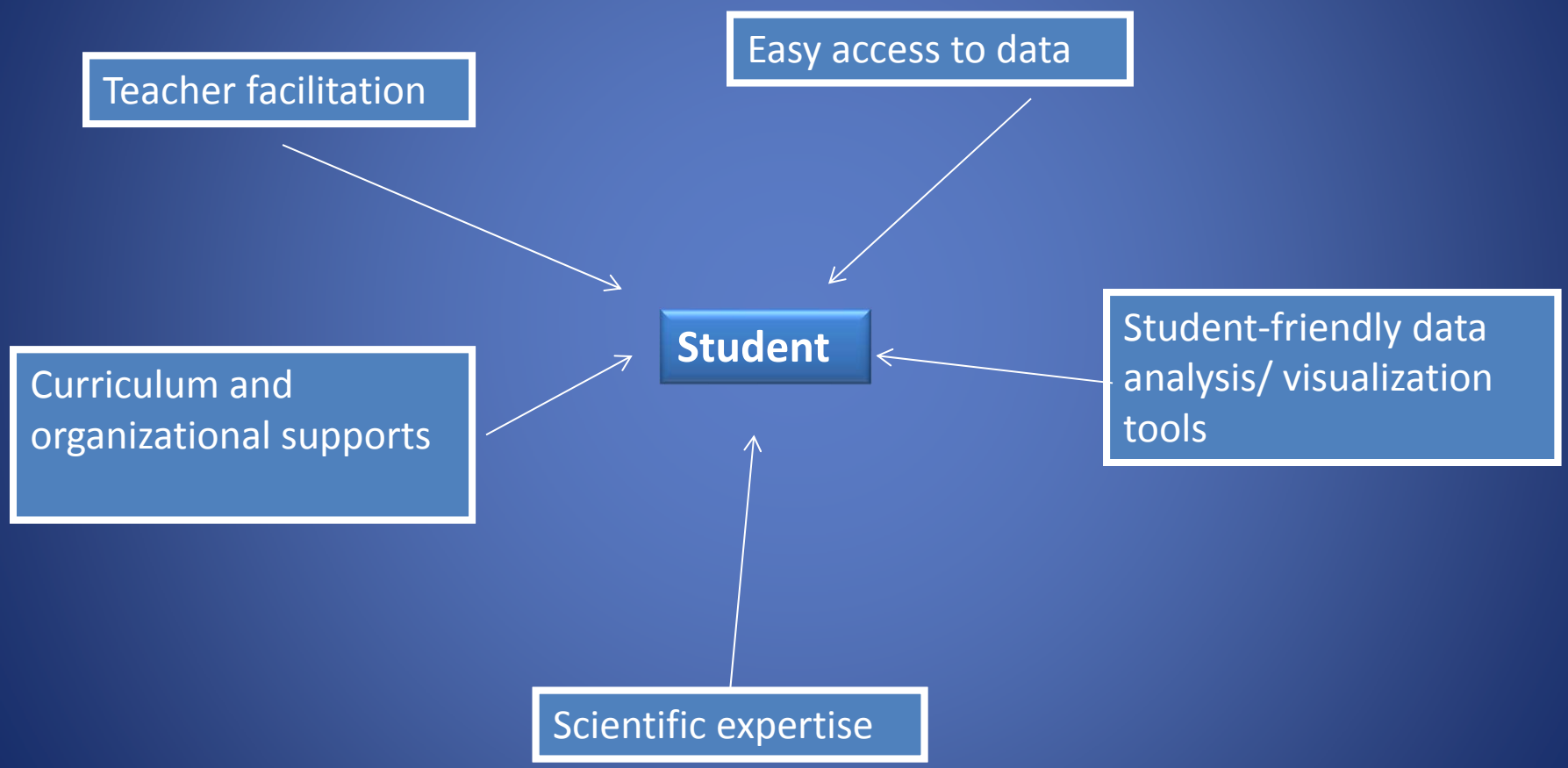
Science is not just a body of knowledge that reflects current understanding of the world; it is also a set of practices used to establish, extend, and refine that knowledge. Both elements— knowledge and practice—are essential.

Next Generation Framework for K-12 Science Education, NRC 2011, p. 2-3

The Challenge: Bridging interfaces built for scientists to novice users

- Remotely-collected data
- Large, complex data sets
- Expert data access and data representations may be baffling to students

What does it take to engage students in scientific data that are accessible online?



Interface Design: Building a Foundation

Scientific CI → Electronic interfaces and technology tools for educational use → Curricula involving data accessed using CI → Teaching and classroom practices

What we did: reviewed/coded literature

- Annals of the Association of American Geographers
- Applied Cognitive Psychology
- Behavior and Information Technology
- The Cartographic Journal
- Computers in Human Behavior
- Contemporary Educational Psychology
- Educational Studies in Mathematics
- Ergonomics
- European Journal of Psychology and Education
- Geoforum
- Geographical Research
- Instructional Science
- Journal of the American Statistical Association
- Journal of Computing in Higher Education
- Journal of Educational Psychology
- Journal of Experimental Psychology: General
- Journal of Experimental Psychology: Learning, Memory, and Cognition
- Journal of Geography
- Journal of the Learning Sciences
- Journal of Research in Mathematics Education
- Journal of Science, Education and Technology
- Learning and Instruction
- Professional Geographer
- Review of Educational Research
- Science
- Science Education
- Technical Communications Quarterly
- Technology Innovations in Statistics Education
- Technology, Pedagogy and Education

EDC Learning transforms lives.

What we did: consulted experts

Oceans of Data Advisory Board

Yi Chao, Principal Scientist, Jet Propulsion Laboratory

Daniel Edelson, Vice President of Education, National Geographic

William Finzer, Senior Scientist, KCP Technologies

Allison Fundis, Research Scientist and Education and Public Outreach Liaison, Oceans Observatories Initiative RSN, University of Washington

Boris Goldowsky, Director of Technology, Center for Applied Special Technology

James Hammerman, Senior Research & Evaluator, TERC

Kim Kastens, Doherty Senior Research Scientist, Lamont-Doherty Earth Observatory, Columbia University

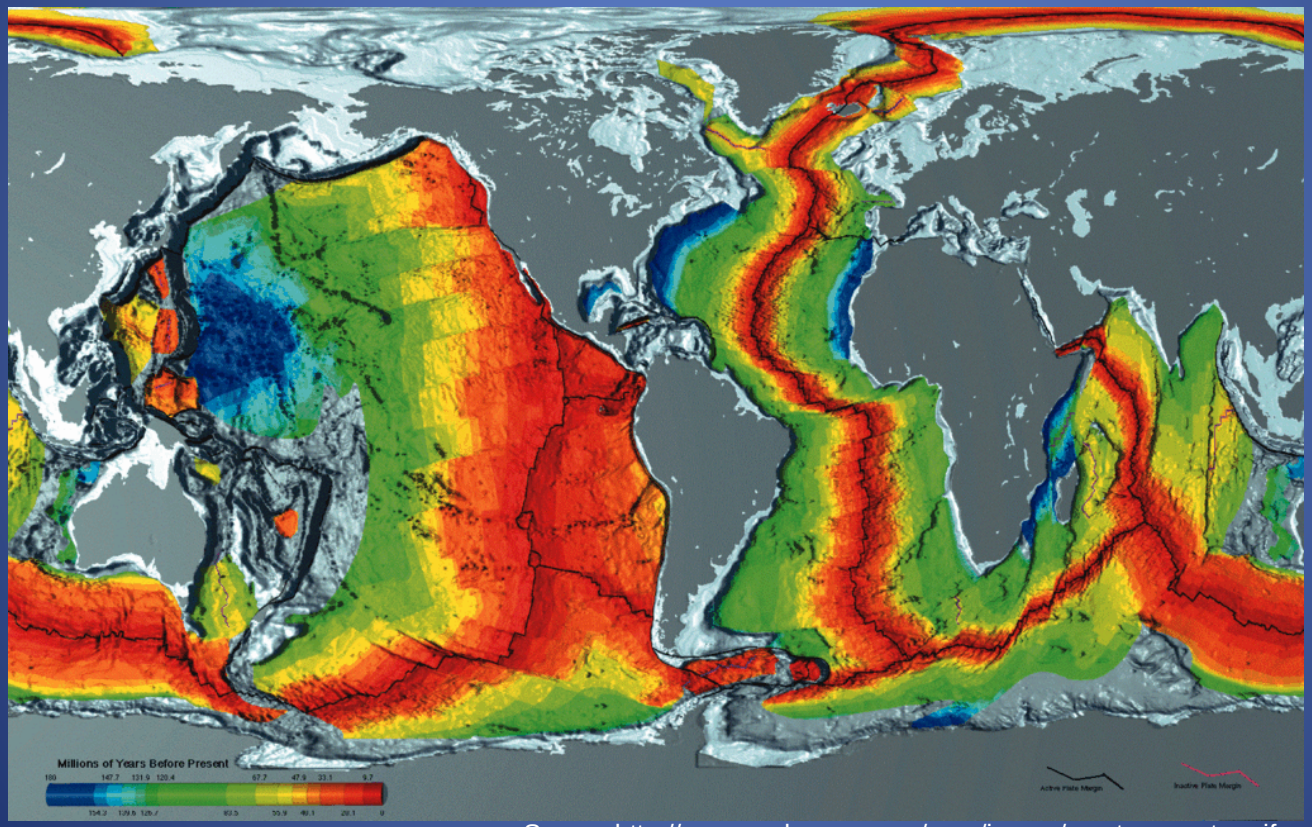
Julianne Mueller-Northcott, Biology and Earth Science Teacher, Souhegan High School, Amherst, NH

John Orcutt, Professor of Geophysics, Scripps Institution of Oceanography, UCSD

William Sandoval, Associate Professor of Psychological Studies in Education, Graduate School of Education and Information Studies, UCLA

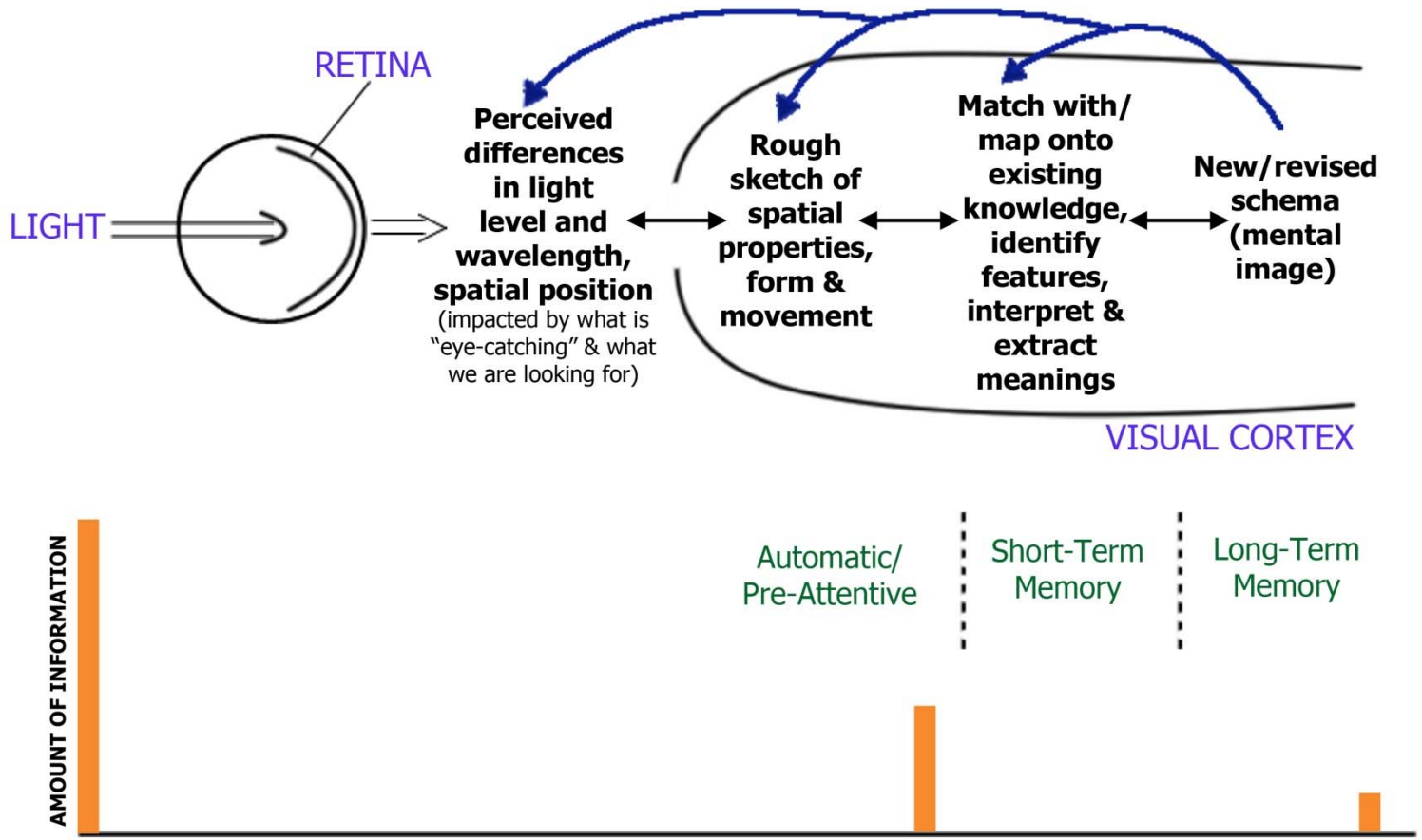
What we've learned

What an expert sees on a data access page or in a visualization will not be what a novice sees



Source:http://www.ngdc.noaa.gov/mgg/image/crustageposter.gif

Visual perception = information processing



Cross Cutting Guideline: **Adjust Cognitive Load**

Short-term (working) memory – limited capacity

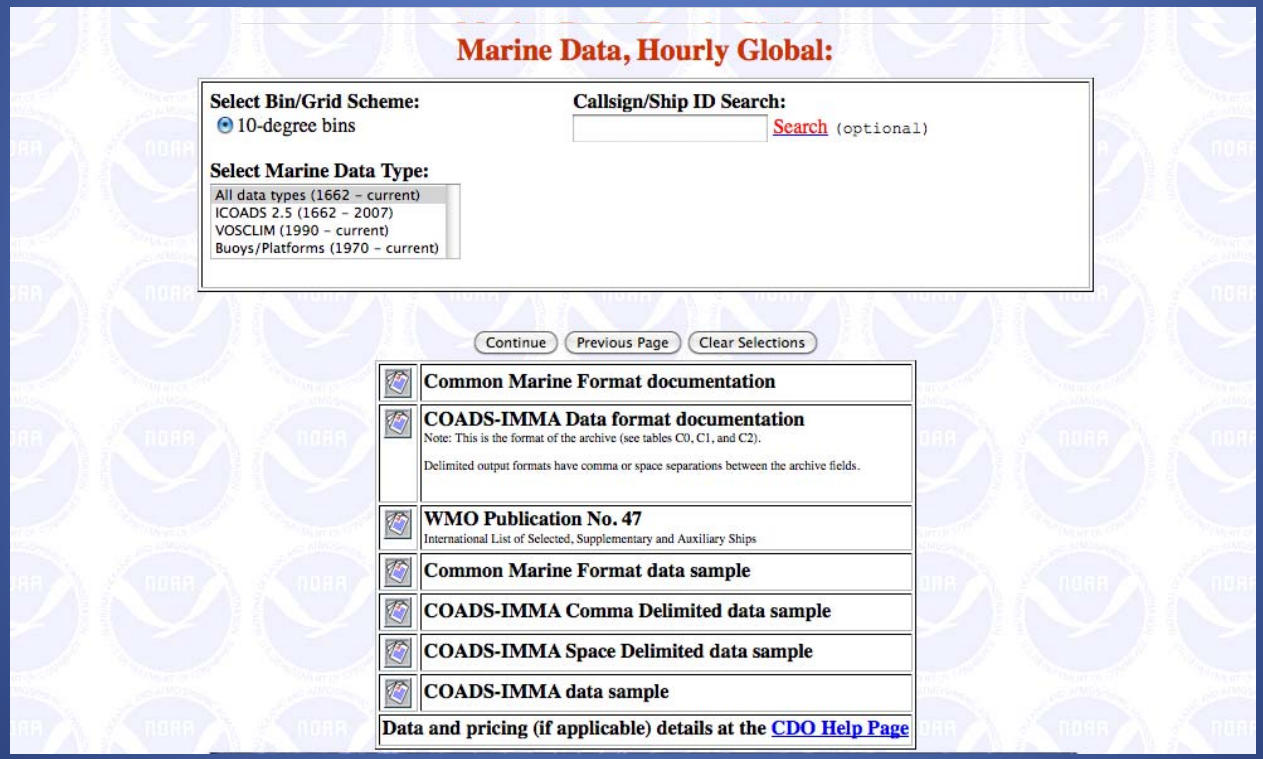
Intrinsic Cognitive Load	Germane Cognitive Load	Extraneous Cognitive Load

Cross Cutting Guideline: **Adjust Cognitive Load**

Short-term (working) memory – limited capacity

Accessing data should be fast and easy

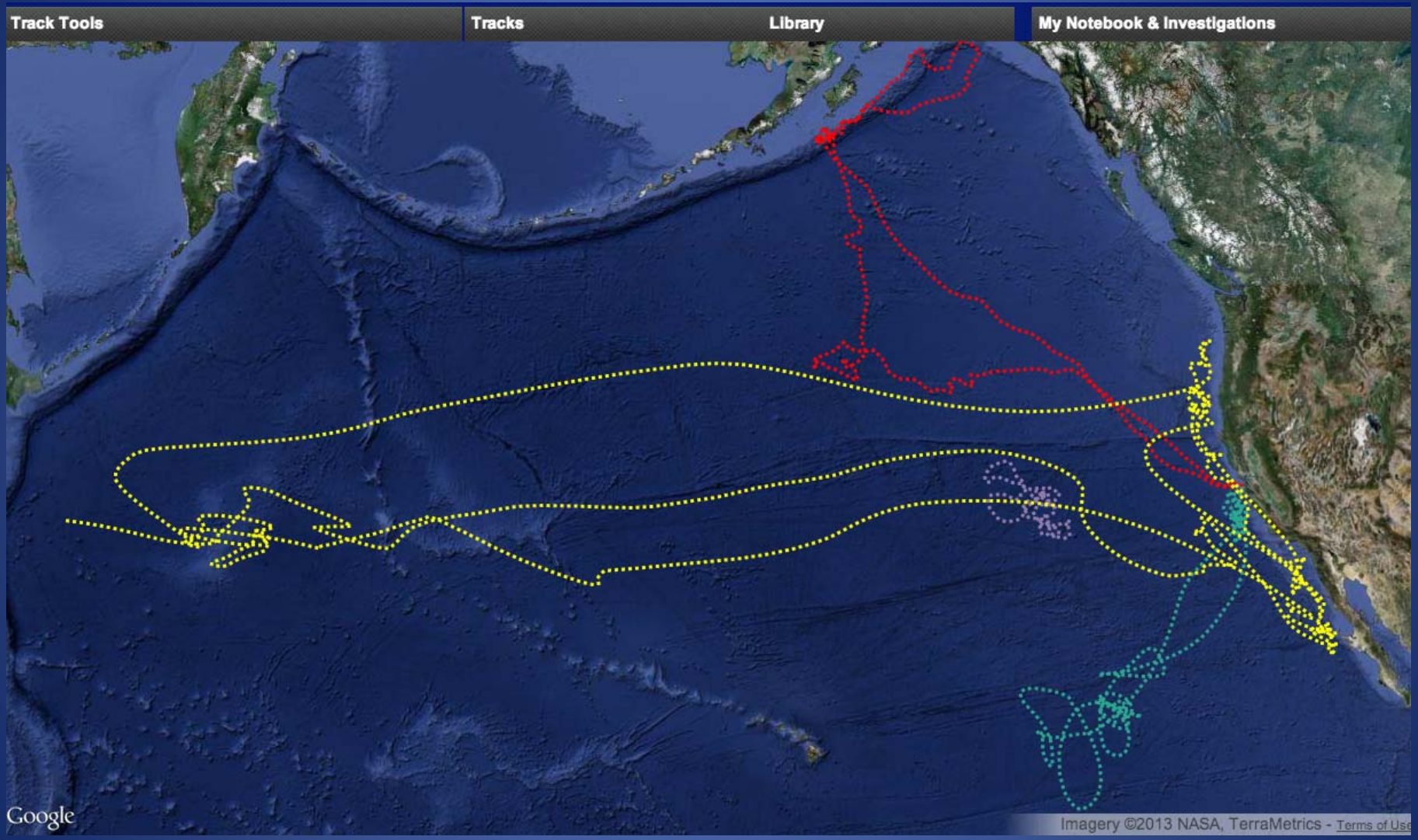
- There should be low to no barriers to downloading and visualizing a data set
- Minimize expert terminology



http://www7.ncdc.noaa.gov/CDO/CDOMarineSelect.jsp

There should be low to no barriers to downloading and visualizing a data set

Automate processes not important to the learning goals

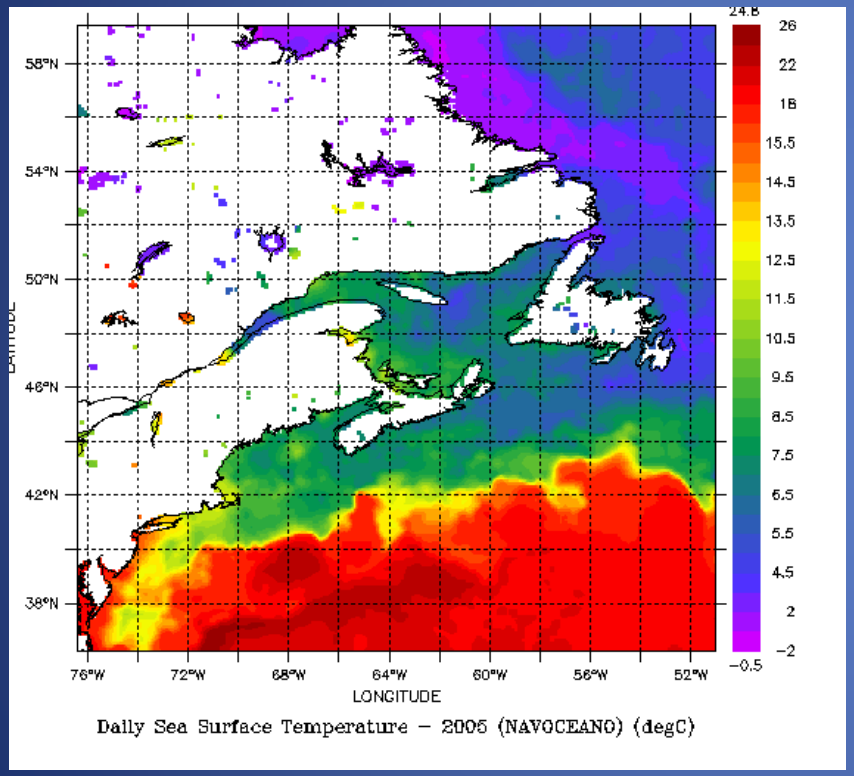


EDC Learning transforms lives.

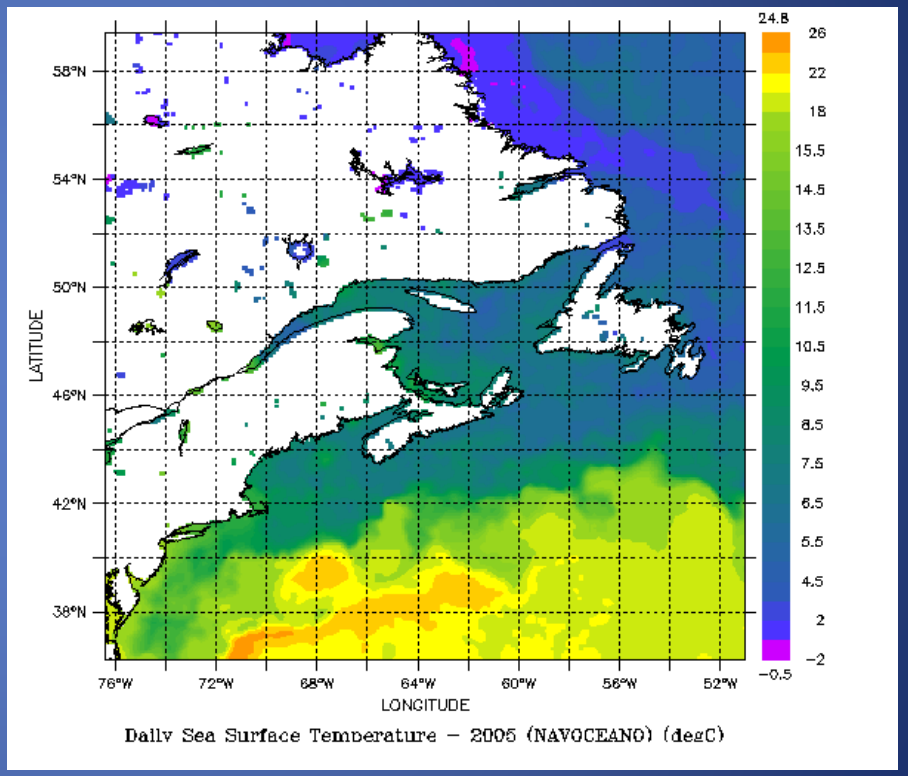
ANALYZINGOCEANTRACKS
Investigating Marine Migrations in a Changing Ocean

-> Include information to minimize confusion

-> Provide color palette options to match the nature of the data and task



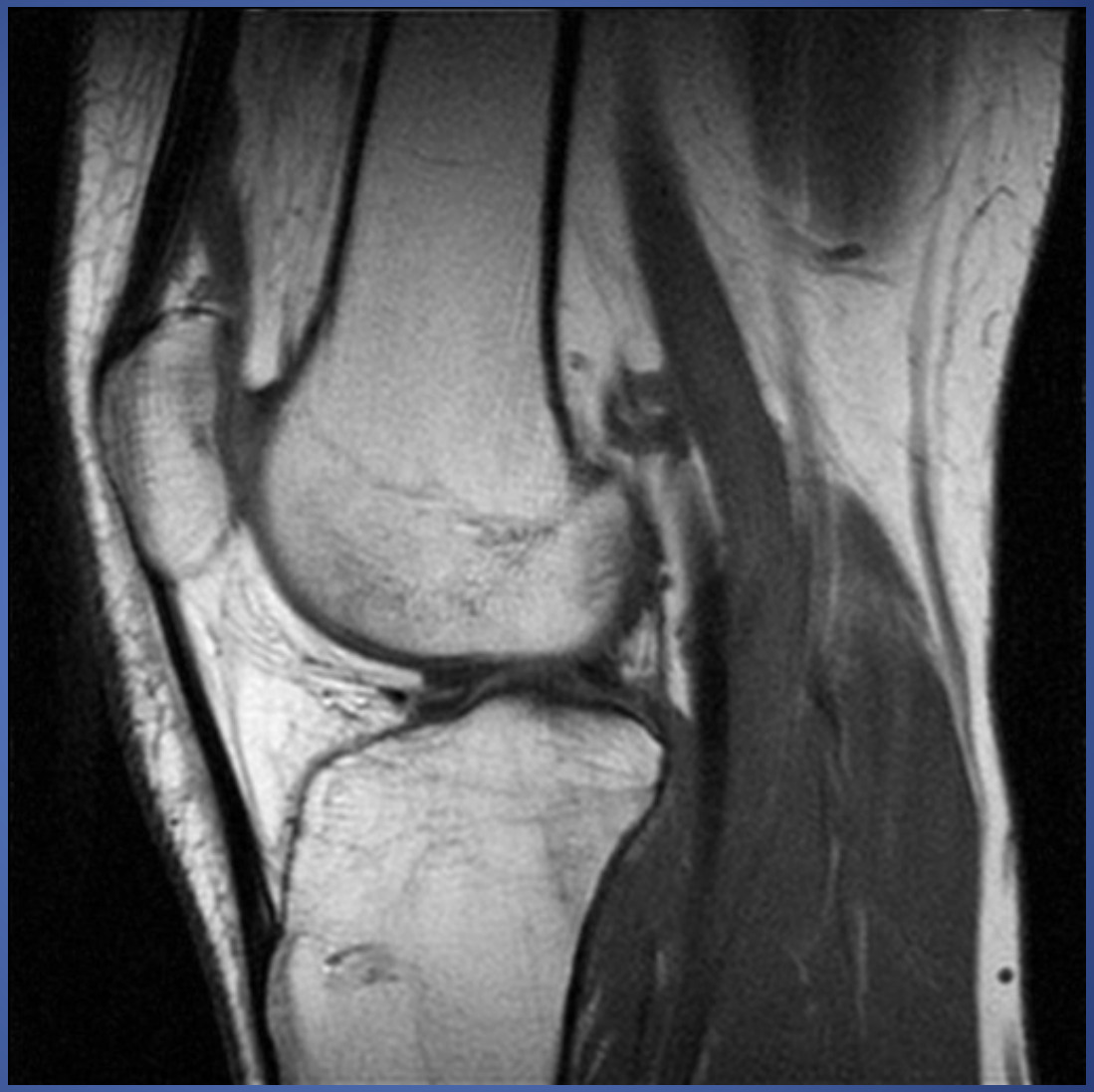
Default color palette



Alternative color palette

Source: http://mynasadata.larc.nasa.gov/

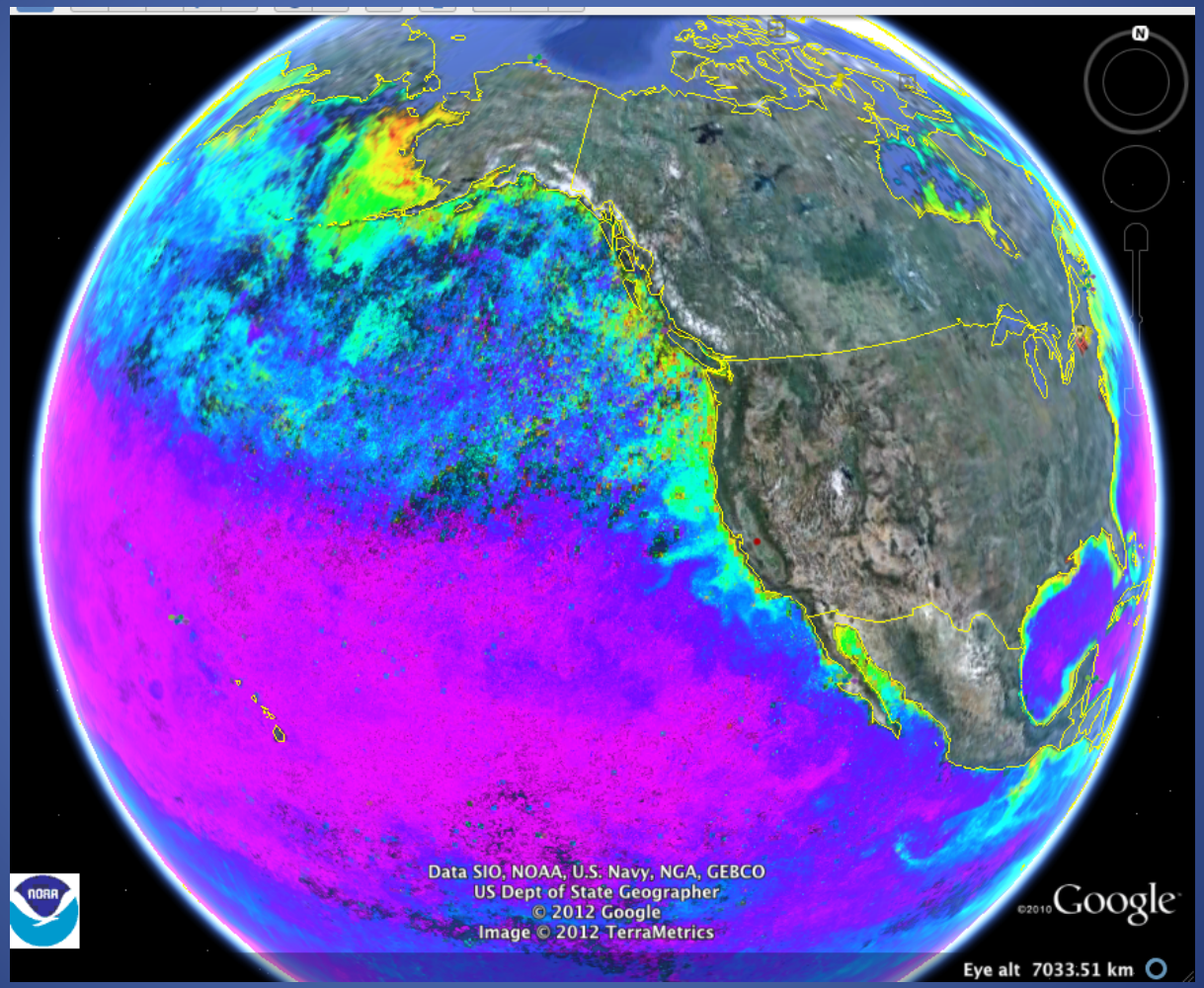
Variations in luminance (rather than hue) are best for showing fine structure and shape

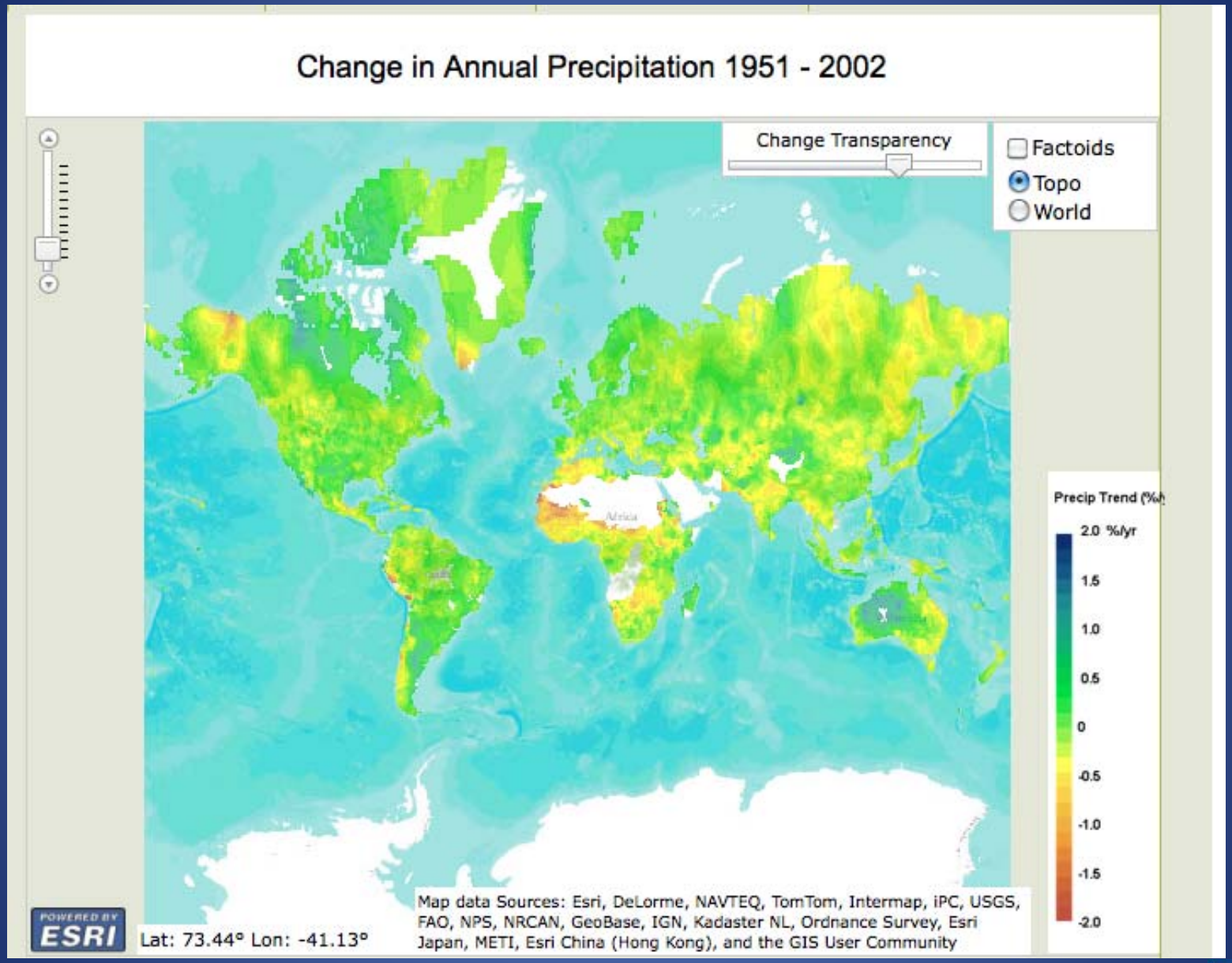


Source: http://en.wikipedia.org/wiki/File:MR_Knee.jpg

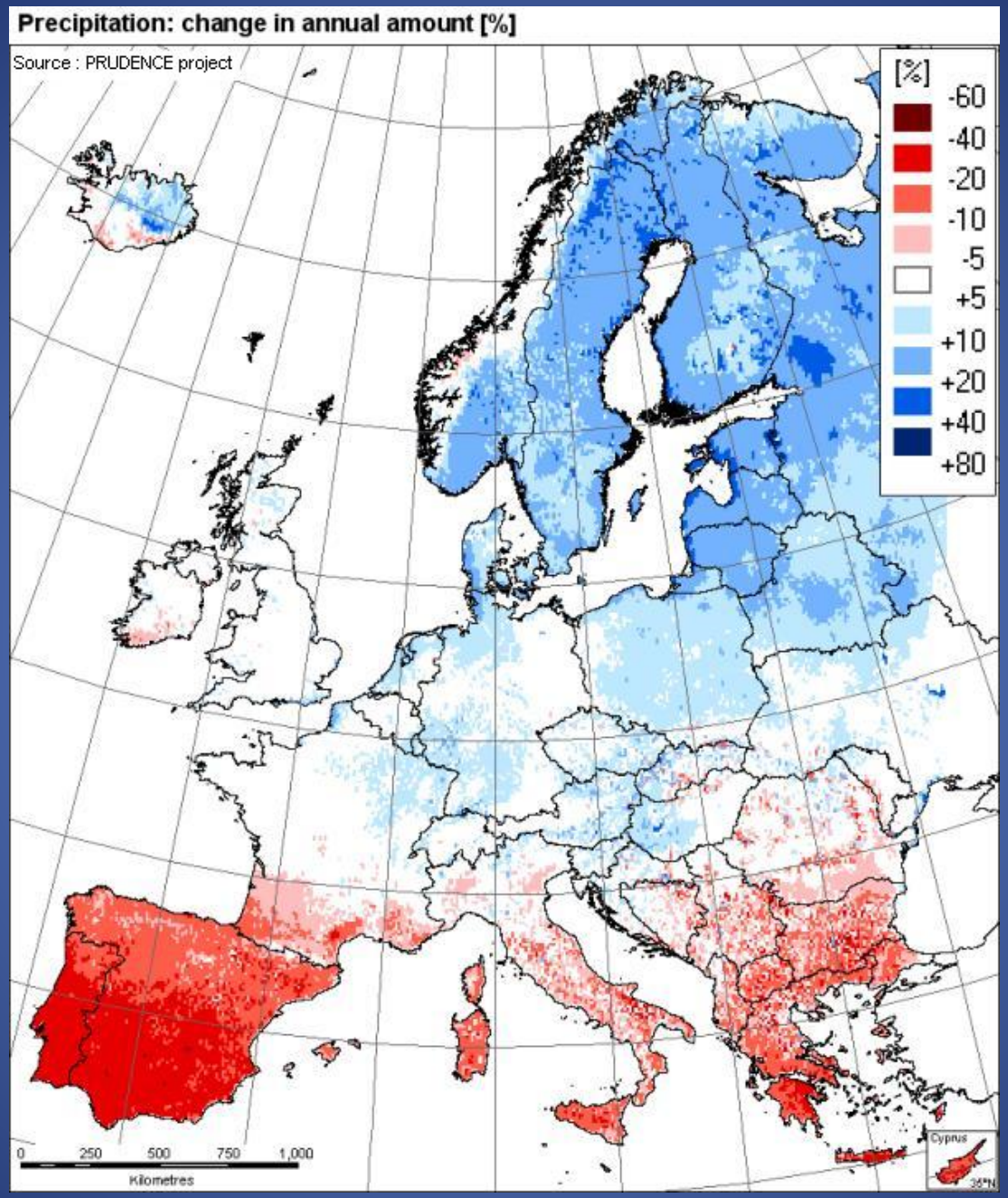
There are issues with the common default spectral color palette

Chlorophyll



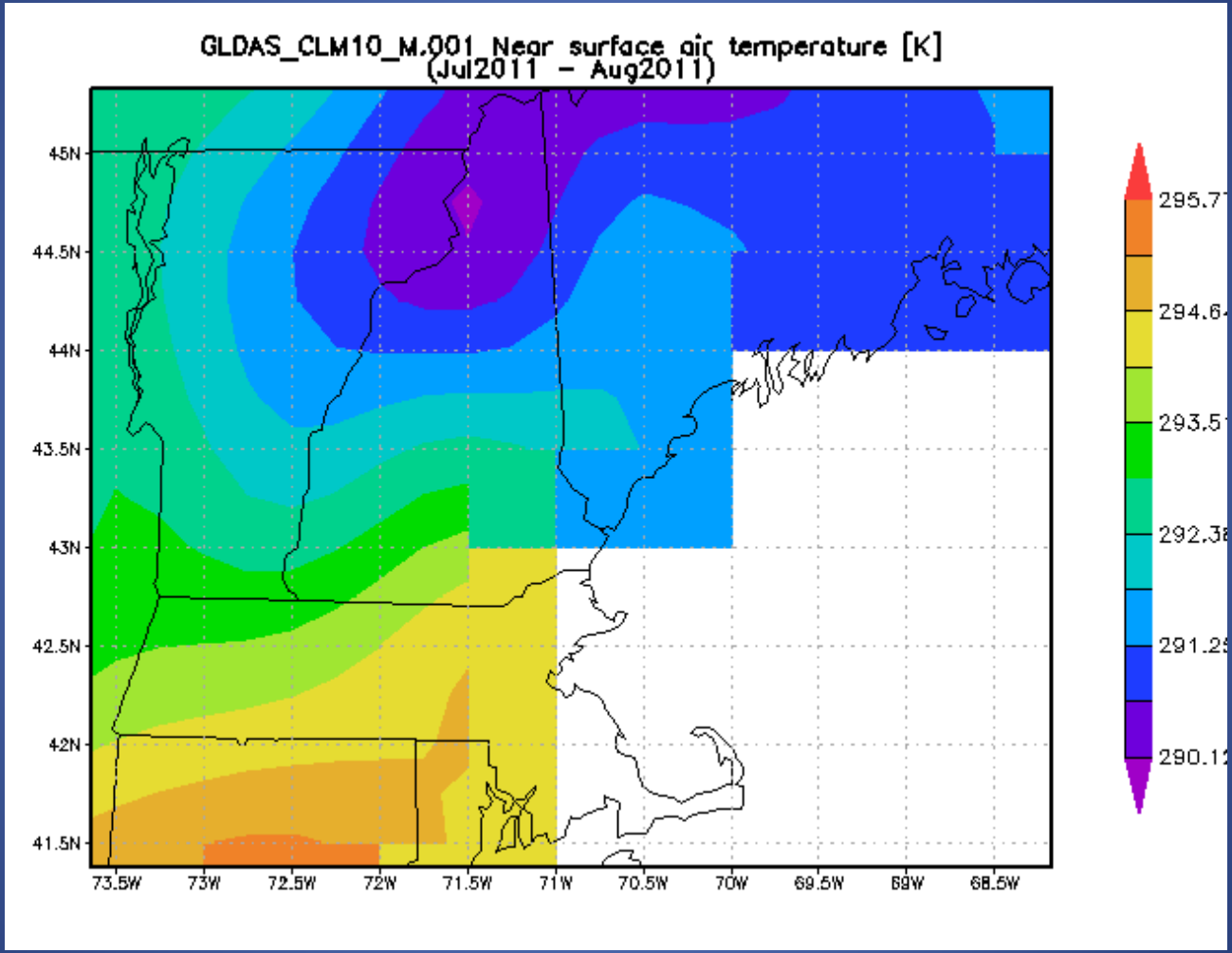


Source: generated at http://www.climatewizard.org/



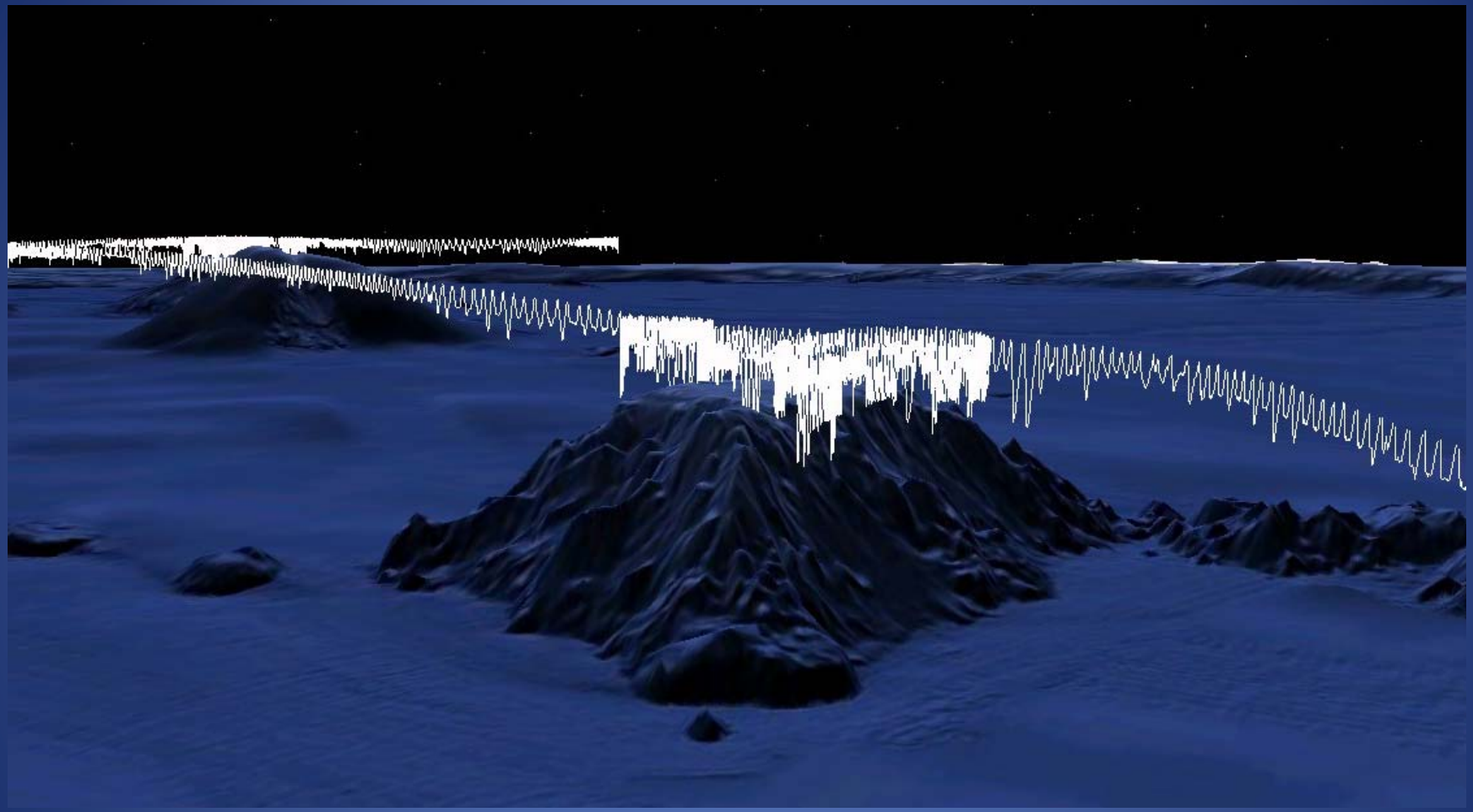
Source:
http://peseta.jrc.ec.europa.eu/docs/ClimateModel.html

Design for errors



Source: Data-enhanced Investigations for Ciimate Change Education (development site) PI Dan Zalles,

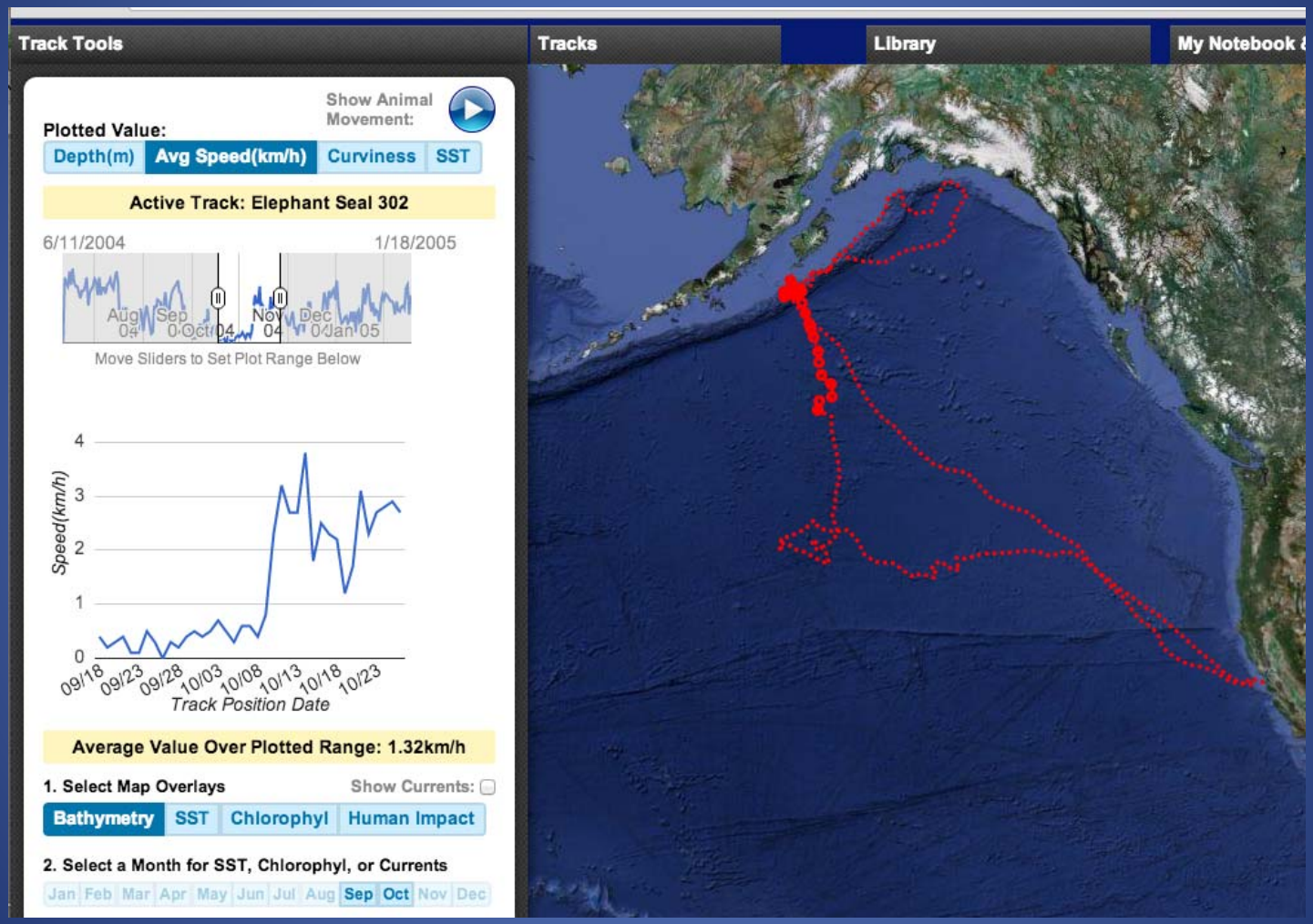
Use interactive features, 2D and 3D displays, shading, and other visual effects to help students visualize spatial data



Data visualization created by Patrick Robinson
Citation: Maxwell, S.M., J.J. Frank, G.A. Breed, P.W. Robinson, S.E. Simmons, D. Crocker, J. Gallo-Reynoso, and D.P. Costa (2012) Benthic foraging on seamounts as a specialized foraging behavior by a deep diving marine mammal, *Marine Mammal Science* 28(3): E333-E344

EDC Learning transforms lives.

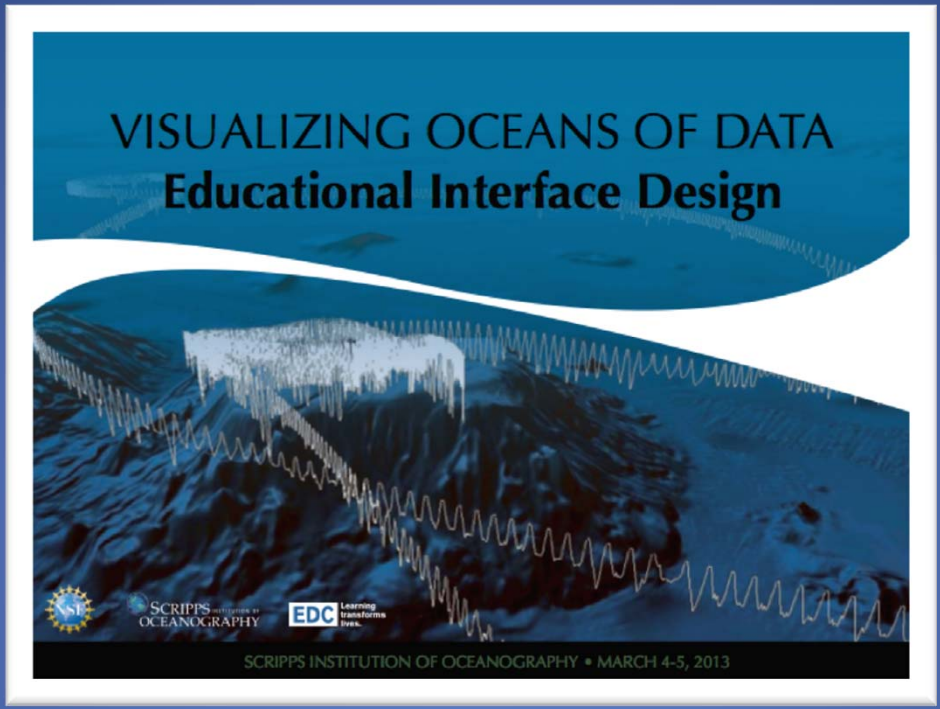
Provide data visualizations and tools that support the teaching of scientific practices



EDC Learning transforms lives.

ANALYZINGOCEANTRACKS
Investigating Marine Migrations in a Changing Ocean

Complete set of guidelines and explanations are in



The Oceans of Data Project Team:

Ruth Krumhansl, PI, Education Development Center, Inc. (EDC) **rkrumhansl@edc.org**
Cheryl Peach, PI, Scripps Institution of Oceanography **cpeach@ucsd.edu**
June Foster, co-PI, EDC
Amy Busey, EDC
Irene Baker, EDC
Jackie DeLisi, EDC

EDC Learning transforms lives.