

Using SERC's *Teaching Computation in the Sciences Using MATLAB* activity collection

in a “MATLAB for the Geosciences” course for undergraduate and graduate students

Teaching Activities

Initial Publication Date: August 7, 2018
[DOI](#) | [Cite this](#)

The Teaching Computation in the Sciences Using MATLAB activities are submitted by workshop participants, community members, and other SERC community participants. All of the activities in the collection use MATLAB in some capacity and cover a variety of STEM courses and topics.

[View the Exemplary Reviewed Collection »](#) [Share an activity »](#) [Actividades en Español »](#)

Search or Browse Teaching Activities

Current Search Limits: [Subject](#) [Geoscience](#)

Results 1 - 10 of 94 matches

Refine the Results ↓

Subject	Show all
Geoscience	
46 matches	General/Other
7 matches	Atmospheric Science
2 matches	Biogeosciences
47 matches	Geology



Kendra E Murray • Idaho State University • Department of Geosciences

Today

- Course origin story and overview
- Initial course design in 2018 and searching for activities to use or modify
 - I've used at least 8 SERC-hosted MATLAB activities/assignments
 - modified, or as inspiration
- My workflow for using the *Teaching Computation in the Sciences Using MATLAB* activity collection
- Looking ahead

course origin story

- My experience as a graduate student in Geosciences at University of Arizona
- Wanting to learn to use MATLAB to process and visualize data, but not in an engineering or linear algebra context
- A graduate course offered in the Soils, Water, and Environmental Sciences Department

Using MATLAB for Environmental Data Processing

Dr. Shirley Papuga, hydrologist
(formerly at University of Arizona,
now at Wayne State)



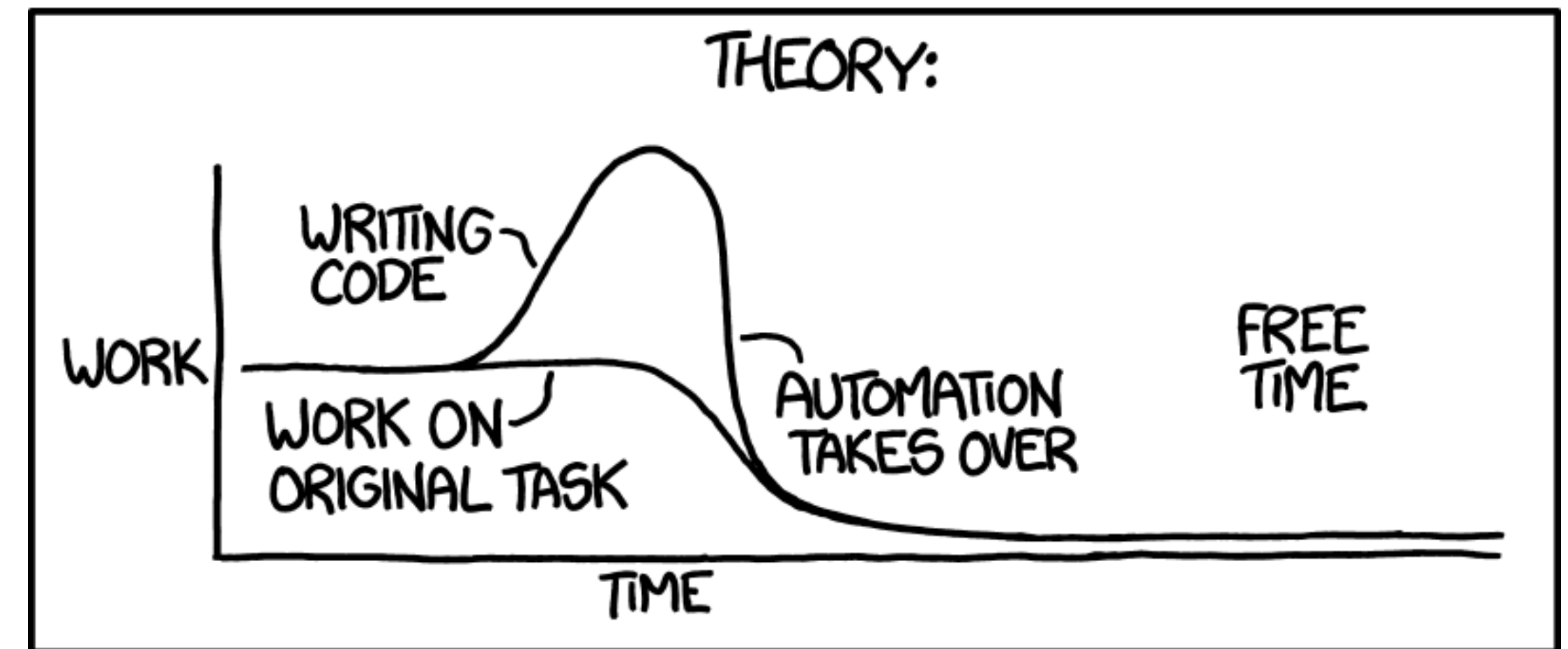
my *MATLAB in the Geosciences* course is strongly based on Shirley's approach (and materials!)

course objective

By the end of this course, my goal is that students will be empowered to open MATLAB to solve a problem, explore a dataset, or visualize data...

...and have enough experience with the program to decide when and how they could use it to complete a task.

"I SPEND A LOT OF TIME ON THIS TASK.
I SHOULD WRITE A PROGRAM AUTOMATING IT!"

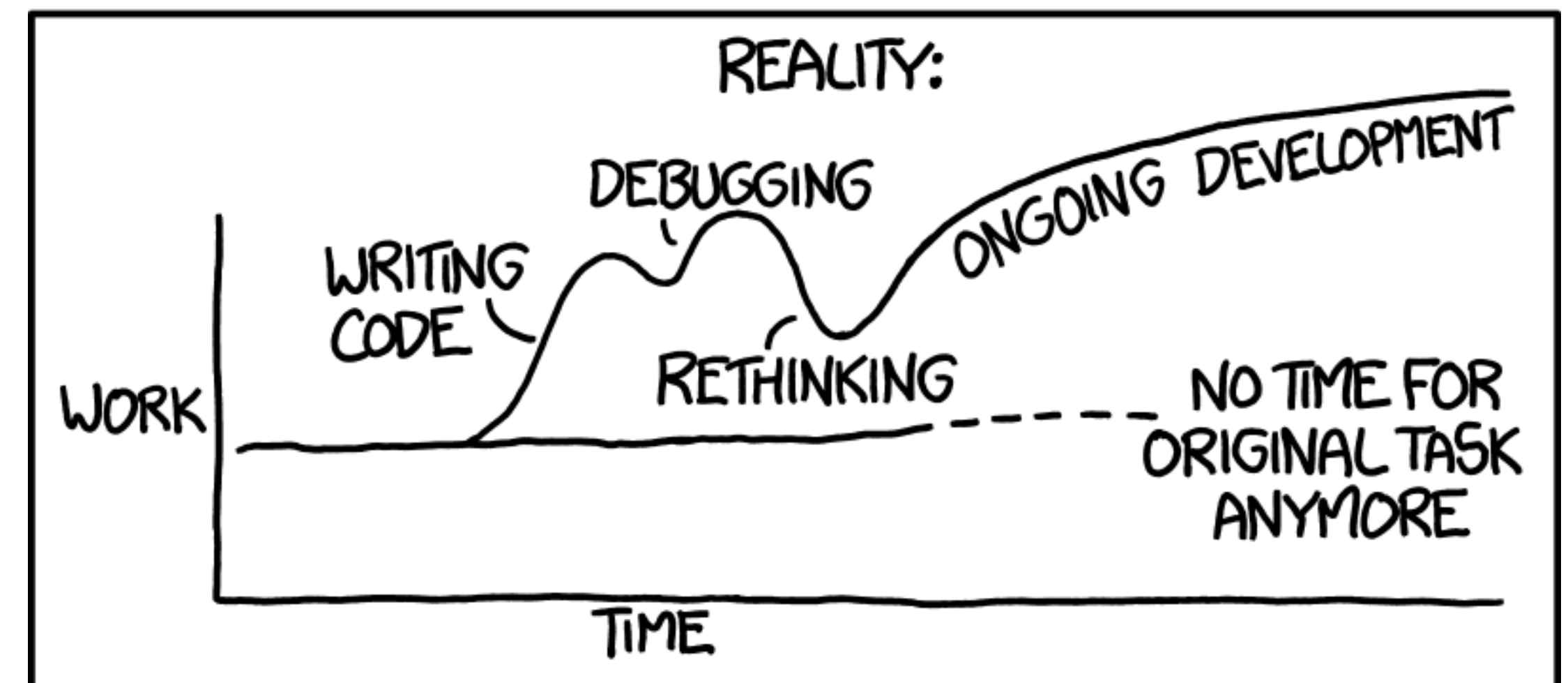
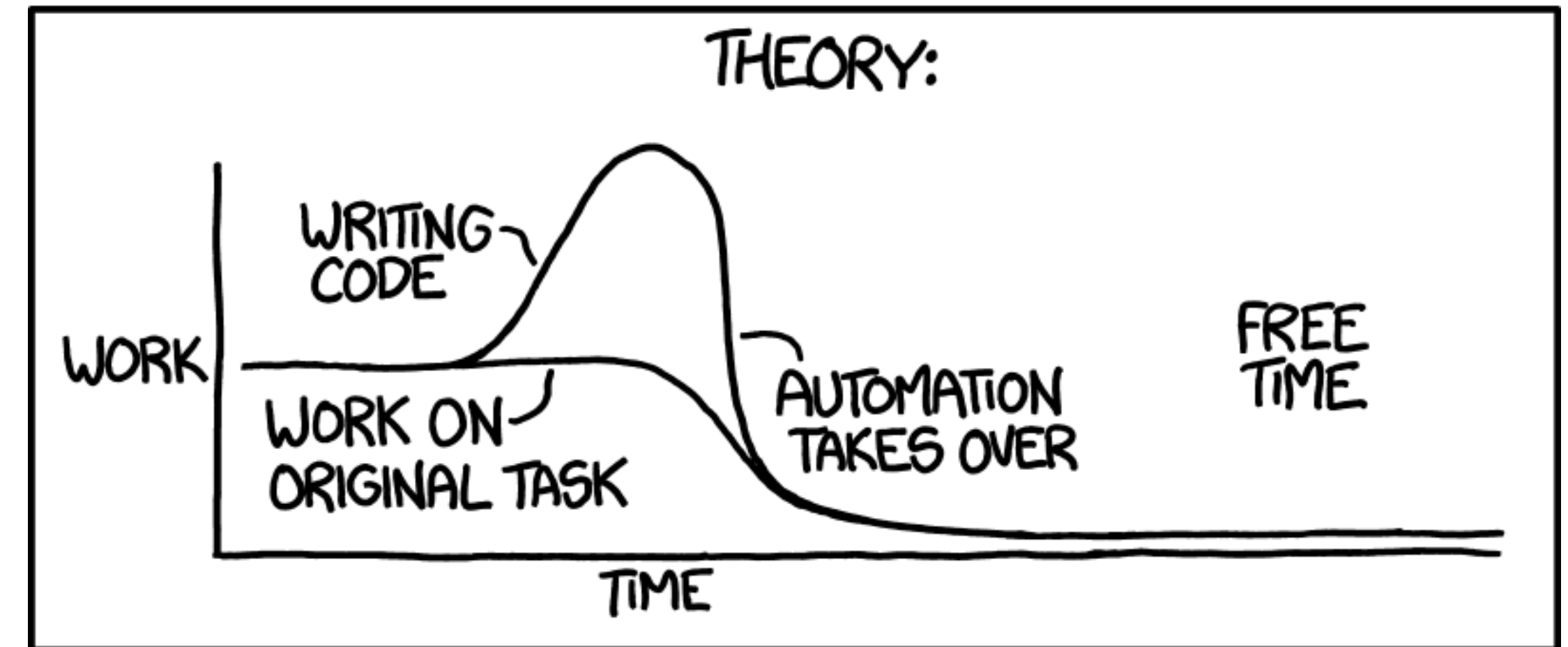


"Automation" <https://xkcd.com/1319/>

course overview

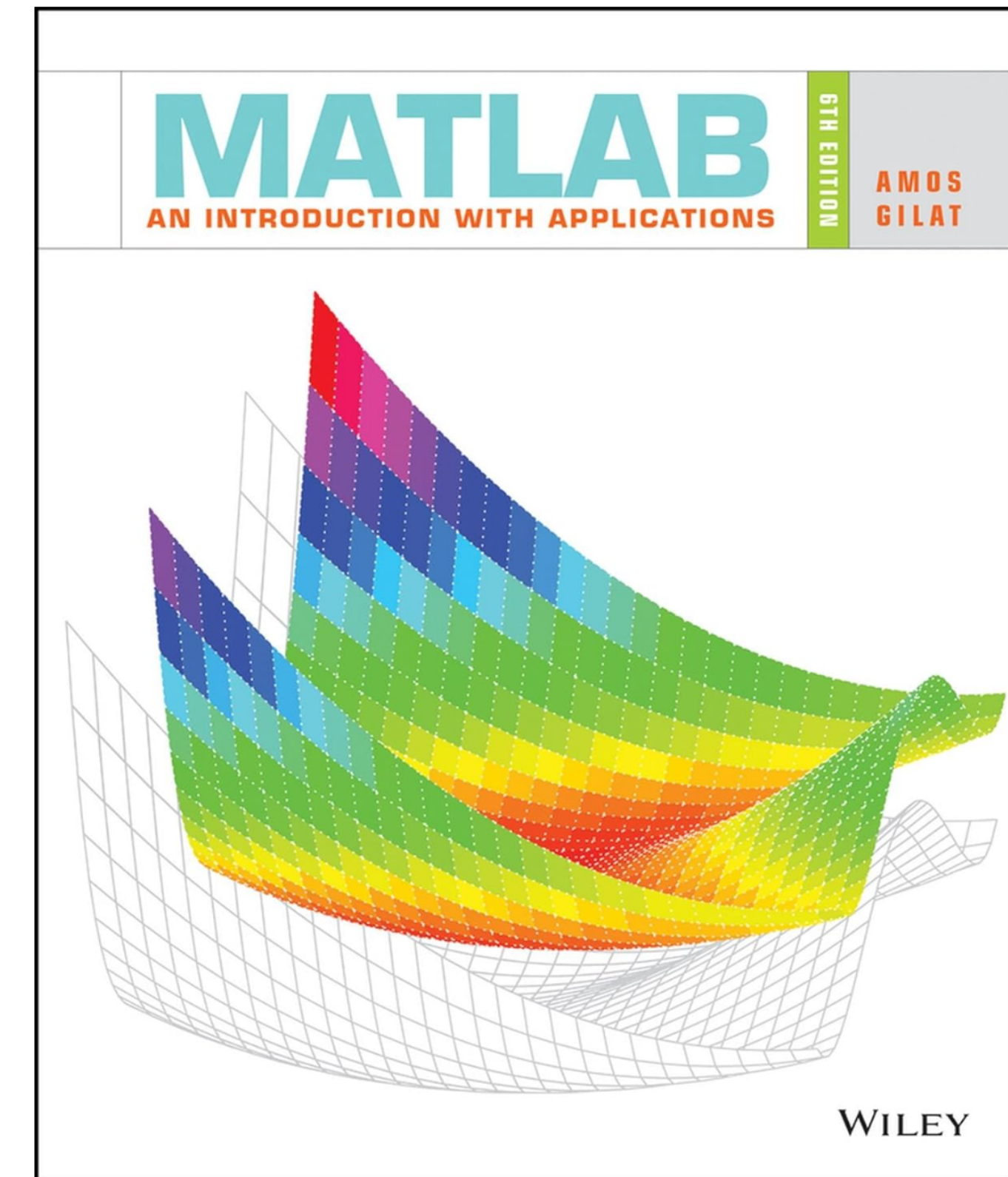
- course provides **an introduction to the MATLAB programming language and computing environment**
- for students with little or **no background in computer programming**
- Current learning goals include the ability to:
 - write well-documented scripts and functions in a variety of ways, to solve scientific problems and complete tasks
 - load and work with large datasets
 - create effective illustrations of scientific data
 - effectively communicate the design and use of a script or function you wrote to others

"I SPEND A LOT OF TIME ON THIS TASK.
I SHOULD WRITE A PROGRAM AUTOMATING IT!"



the course is an appointment to practice programming 2-3 times a week

- A “flipped” classroom, 2x week for 75 minutes
 - students read textbook and take online quiz prior to class
 - students work together on in-class activities
- **Weeks 1-4: Basic operations and built-in functions**
 - variables, built-in functions and commands
 - basic scripts and plots
 - intro to arrays, mathematical operations
- **Weeks 5-8: Intro to programming**
 - relational/logical operators, conditional statements, loops
 - user-defined functions
 - structure and cell arrays
- **Weeks 9-15: Geosciences applications, including student final projects**



Teaching Activities
Initial Publication Date: August 7, 2018
[DOI](#) | [Cite this](#)

The Teaching Computation in the Sciences Using MATLAB activities are submitted by workshop participants, community members, and other SERC community participants. All of the activities in the collection use MATLAB in some capacity and cover a variety of STEM courses and topics.

[View the Exemplary Reviewed Collection »](#) [Share an activity »](#) [Actividades en Español »](#) [« Back to Teaching Computation in the Sciences](#)

Search or Browse Teaching Activities

Current Search Limits: [Subject](#) [Geoscience](#)

Results 1 - 10 of 94 matches

Refine the Results ↓

Subject	Show all
Geoscience	
46 matches General/Other	
Atmospheric Science 7 matches	
Biogeosciences 2 matches	
Geology 47 matches	

 **Teach the Earth**
the portal for Earth Education

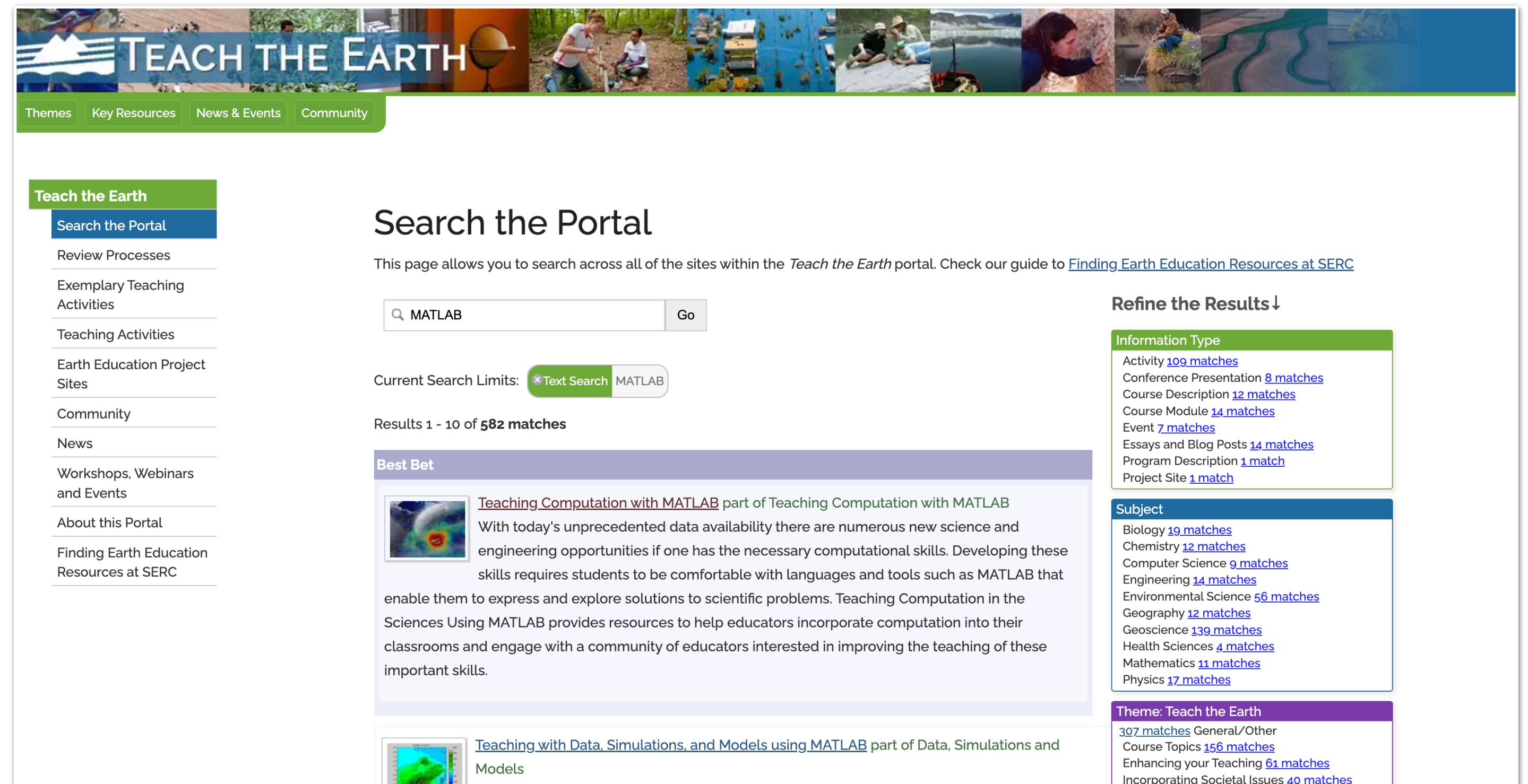
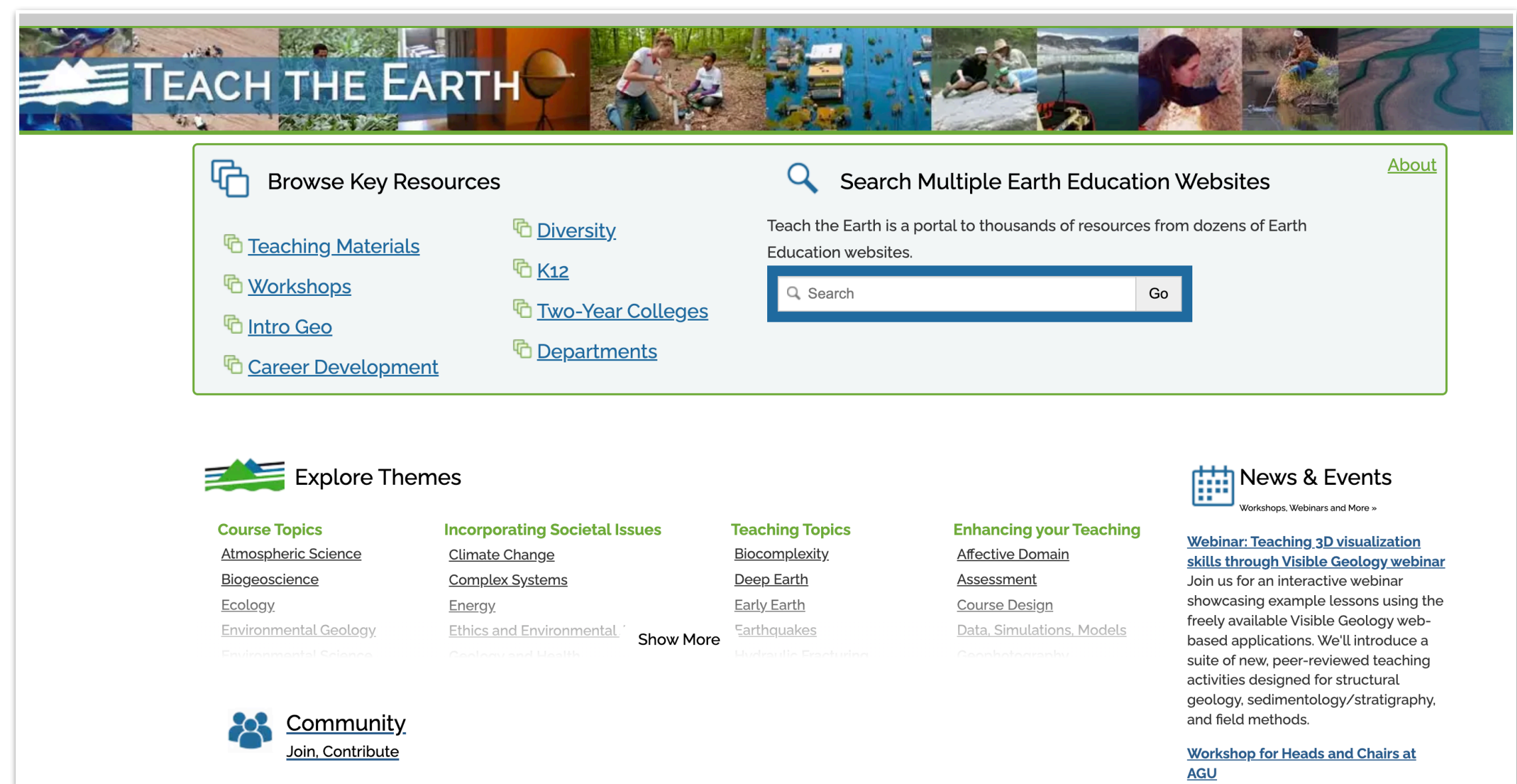
my workflow for finding MATLAB resources on SERC

Goal: demonstrate the breadth of Geoscience applications while supporting course learning goals

1. search

- use filters and keywords
- browse by topic or search for specific terms
- consider starting with the **MATLAB Exemplary Collection**, which are the most complete and reviewed activities

<https://serc.carleton.edu/teachearth/index.html>



1. search

- use filters and keywords
- browse by topic or search for specific terms
- **consider starting with the MATLAB Exemplary Collection**, which are the most complete and reviewed activities

https://serc.carleton.edu/teaching_computation/index.html

Teaching Computation With MATLAB®

Teaching Computation with MATLAB

Why Teach Computation?

Skills and Techniques

Computational Thinking

Visualization

Modeling

Data Analysis

Teaching Strategies

Building Self-Efficacy

Cooperative Learning

Assessment

Developing Skills Within a Degree Curriculum

Teaching Online

Events

Workshops and Webinars

Resources

Teaching Materials

Community

For Team Members

Teaching Computation with MATLAB

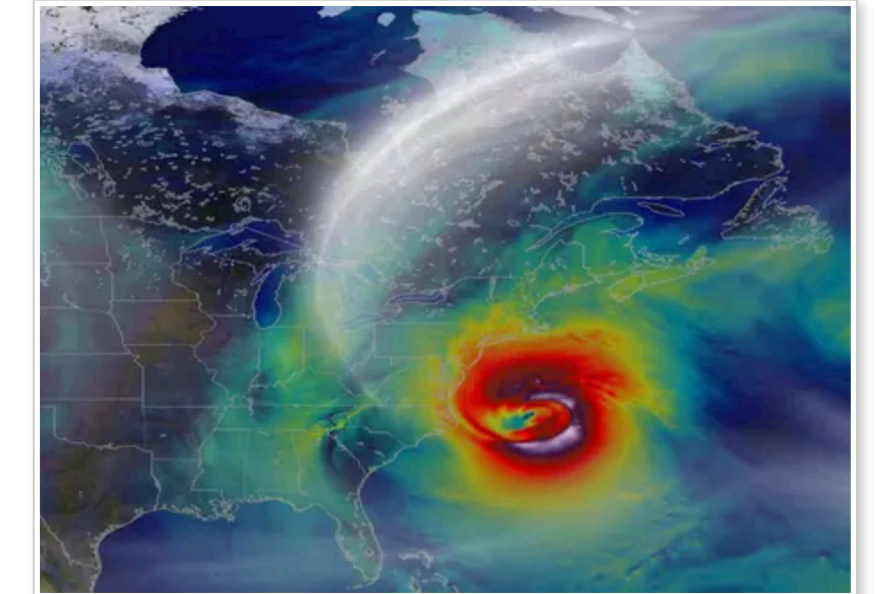
Content on these pages is derived from participant presentations, discussions, and breakout groups at the [Teaching Computation with MATLAB workshops](#).

[Computation](#) is the use of computers to perform calculations, model data, make predictions, and test hypotheses. Computational skills are necessary to employ quantitative methods in complex scientific contexts and with large data sets. With today's unprecedented data availability there are numerous new science and engineering opportunities if one has the necessary computational skills. Developing these skills requires students to be comfortable with languages and tools such as [MATLAB](#) that enable them to express and explore solutions to scientific problems.

In order to provide students with the computational skills they need to be successful, the teaching of computation must change to reflect the changing landscape of computation. Teaching Computation in the Sciences Using MATLAB provides resources to help educators incorporate computation into their classrooms and engage with a community of educators interested in improving the teaching of these important skills.

Why teach computation?

Explore the teaching materials »



Participate in the 2026 Educator Workshop: October 25-27

Now in its 12th year, the *Teaching Computation with MATLAB workshop* brings together educators to learn about trends in teaching, share experiences, and develop curriculum that improves student learning. The workshop program combines training sessions introducing teaching tools, brief talks by experienced educator peers, and group breakouts. Educators will spend dedicated work-time developing course curriculum.

Learn more and apply to participate by July 1, 2026 »

Teaching Computation With MATLAB®

Teaching Computation with MATLAB

Why Teach Computation?

Skills and Techniques

Computational Thinking

Visualization

Modeling

Data Analysis

Teaching Strategies

Building Self-Efficacy

Cooperative Learning

Assessment

Developing Skills Within a Degree Curriculum

Teaching Online

Events

Workshops and Webinars

Resources

Teaching Materials

Teaching Activities

Essays

Courses

Teaching Materials

Explore the collection of community-contributed activities, essays, and course descriptions. Members of the Teaching Computation in the Sciences Using MATLAB [community](#) and [workshop participants](#) have contributed to this growing resource for teaching materials.

Teaching Activities

Classroom activities, laboratory exercises, problem sets, projects, and other assignment that instructors use to teach with MATLAB.

[Exemplary reviewed activity collection](#) | [All teaching activities collection](#) | [Actividades en Español](#) | [Share an activity](#)

Essays

Instructor perspectives on how teaching with MATLAB can enhance the student learning environment in undergraduate STEM courses.

[Essay collection](#) | [Share an essay](#)

Course Descriptions

Descriptions and syllabi for courses that integrate MATLAB.

[Course description collection](#) | [Share a course description](#)

Don't see what you need? Join the community

[Join the community of educators](#) interested in teaching computation in the sciences with MATLAB. You can:

- **Ask a question.** This group includes instructors who have classroom experience teaching computation using MATLAB from Intro to Upper Levels as well as MATLAB technical experts.

Teaching Activities

Initial Publication Date: August 7, 2018

[DOI](#) | [Cite this](#)

The Teaching Computation in the Sciences Using MATLAB activities are submitted by workshop participants, community members, and other SERC community participants. All of the activities in the collection use MATLAB in some capacity and cover a variety of STEM courses and topics.

- View the Exemplary Reviewed Collection »
- Share an activity »
- Actividades en Español »

Search or Browse Teaching Activities

search

Results 1 - 10 of 410 matches

[Procrustes Skull Analysis](#) part of Teaching Computation with MATLAB:Past Workshops:MATLAB Workshop October 2022:Activities
Emily Dosmar, University of Illinois - Chicago; Glen A. Livesay, Rose-Hulman Institute of Technology, Biology and Biomedical Engineering
Procrustes analysis is a form of statistical shape analysis used to analyze the distribution of a set of shapes. The goal of this assignment is to compare different skull types to a reference skull to determine ...

MATLAB Exemplary Collection

[Bouncing Ball Explorer](#) part of Teaching Computation with MATLAB:Past Workshops:MATLAB Workshop October 2022:Activities
Duncan Carlsmith, University of Wisconsin-Madison
Exploration of the sound of a bouncing ball dropped on a hard surface, the sound recorded with a mobile phone or laptop microphone, is the basis for an accessible experiment in elementary mechanics. For ...

« Back to Teaching Computation in the Sciences

Refine the Results ↓

Subject
Biology [35 matches](#)
Chemistry [20 matches](#)
Computer Science [51 matches](#)
Engineering [185 matches](#)
Environmental Science [35 matches](#)
Geography [8 matches](#)
Geoscience [94 matches](#)
Health Sciences [18 matches](#)
Mathematics [100 matches](#)
Physics [38 matches](#)

Resource Type: Activities
[88 matches](#) General/Other
Problem Set [77 matches](#)
Classroom Activity [172 matches](#)
Lab Activity [156 matches](#)
Project [108 matches](#)
Field Activity [7 matches](#)
Virtual Field Trip [2 matches](#)
Writing Assignment [17 matches](#)

Refine the Results ↓

Subject
Biology [35 matches](#)
Chemistry [20 matches](#)
Computer Science [51 matches](#)
Engineering [185 matches](#)
Environmental Science [35 matches](#)
Geography [8 matches](#)
Geoscience [94 matches](#)
Health Sciences [18 matches](#)
Mathematics [100 matches](#)
Physics [38 matches](#)

Resource Type: Activities
[88 matches](#) General/Other
Problem Set [77 matches](#)
Classroom Activity [172 matches](#)
Lab Activity [156 matches](#)
Project [108 matches](#)
Field Activity [7 matches](#)
Virtual Field Trip [2 matches](#)
Writing Assignment [17 matches](#)

Location
Cutting Edge [13 matches](#)
GETSI [6 matches](#)
Integrate [4 matches](#)
MARGINS Data in the Classroom [2 matches](#)
Quantitative Skills [2 matches](#)
Starting Point-Teaching Entry Level Geoscience [3 matches](#)
Starting Point: Teaching and Learning Economics [1 match](#)
Teach the Earth [2 matches](#)
Teaching Computation with MATLAB [377 matches](#)

Teaching Activities

Initial Publication Date: August 7, 2018

[DOI](#) | [Cite this](#)

The Teaching Computation in the Sciences Using MATLAB activities are submitted by workshop participants, community members, and other SERC community participants. All of the activities in the collection use MATLAB in some capacity and cover a variety of STEM courses and topics.

[« Back to Teaching Computation in the Sciences](#)

[View the Exemplary Reviewed Collection »](#)

[Share an activity »](#)

[Actividades en Español »](#)

Search or Browse Teaching Activities

Current Search Limits: [✕ Subject](#) [Geoscience](#) > Geology

Results 1 - 10 of 47 matches

[Modeling River Long Profiles](#) part of Teaching Computation with MATLAB:Past Workshops:MATLAB Workshop 2016:Teaching Activities

Andrew Darling, Colorado State University-Fort Collins

This project or multi-lab activity is designed to teach students about modeling landscape change caused by rivers over large time and spatial scales (e.g., the incision of Grand Canyon). Basic working knowledge of ...

[MATLAB Exemplary Collection](#)

[Choice of geophone layout in a simple near-surface seismics setting](#) part of Teaching Computation with MATLAB:Past Workshops:MATLAB Workshop 2016:Teaching Activities

Alain Plattner, California State University-Fresno

Refine the Results ↓

Subject	Show all
Geoscience > Geology	
30 matches General/Other	
Environmental Geology 3 matches	
Geomorphology 9 matches	
Geophysics 23 matches	
Historical Geology 1 match	
Mineralogy 1 match	
Sedimentary Geology 1 match	
Structural Geology 9 matches	
Tectonics 10 matches	

Resource Type: Activities
10 matches General/Other
Problem Set 12 matches
Classroom Activity 13 matches
Lab Activity 18 matches
Project 5 matches
Field Activity 1 match
Virtual Field Trip 2 matches
Writing Assignment 1 match

Location	Show all
Cuttina Edae 8 matches	

2. skim through the description and materials

Estimating the spreading rate of Atlantic and Pacific ridges

Audrey Huerta, Central Washington University [Author Profile](#)

Initial Publication Date: June 1, 2012
[DOI](#) | [Cite this](#)

Summary

Given maps of bathymetry of Atlantic and Pacific Ocean, students estimate spreading rate of each ridge writing a matlab script that plots a line of bathymetry, and calculated bathymetry as a function of spreading rate. They then vary the estimated spreading rate manually until they produce a bathymetric curve that closely resembles the real bathymetry.

Systematics and Phylogenetic Reconstruction , Field Techniques | College Upper (15–16), Graduate/Professional

Expand for more detail and links to related resources

- what are the target scientific topics and/or programming skills?
- **You:** how far outside your scientific or programming expertise are you willing to go?
- **Students:** what level of scientific background and/or programming skills are needed?
- how much modification are you willing to do?
- how much documentation is provided?
 - student handouts, starting scripts
 - instructor guidance, answer keys and other assessment tools, complete scripts
- how old is the activity? (legacy datasets, MATLAB version control)

3. download and modify

- work through activity yourself
 - as time allows
- modify materials to fit your course
 - style
 - add/remove background info
 - deliverables from students
- look for **challenges**

Geodynamics, Spring 2014 Lab #3 Due: May 1, 2014

Geodynamics
G456-556

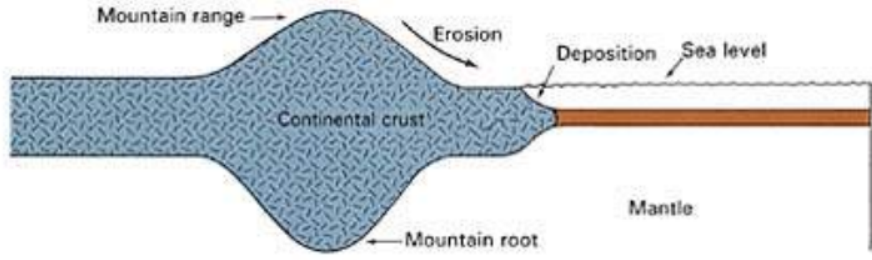
Lab #3: Seafloor Subsidence

Objectives: 1) determine plate velocities by modeling thermal subsidence of oceanic lithosphere
2) develop matlab skills:

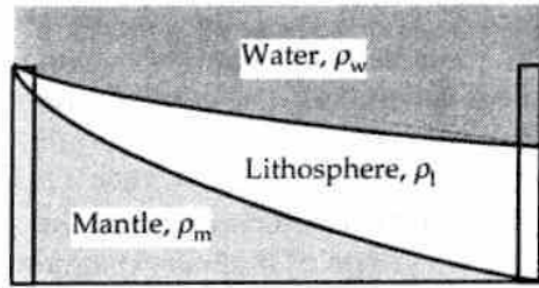
- Make figures with multiple data sets
- use "for" loops in matlab

Thermal Subsidence

The tectonic plates of the Earth "float" on the asthenosphere. The concept of isostasy tells us that more buoyant plates "float higher", and less buoyant plates "float lower", and thus the dense oceanic plates (composed of dense minerals) are at a lower elevation than continental parts of the plates (composed of less dense minerals).



Oceanic plates are formed at mid-ocean ridges, where they are very thin. As the plate (lithosphere) "ages", it cools and becomes thicker



1

handout on SERC

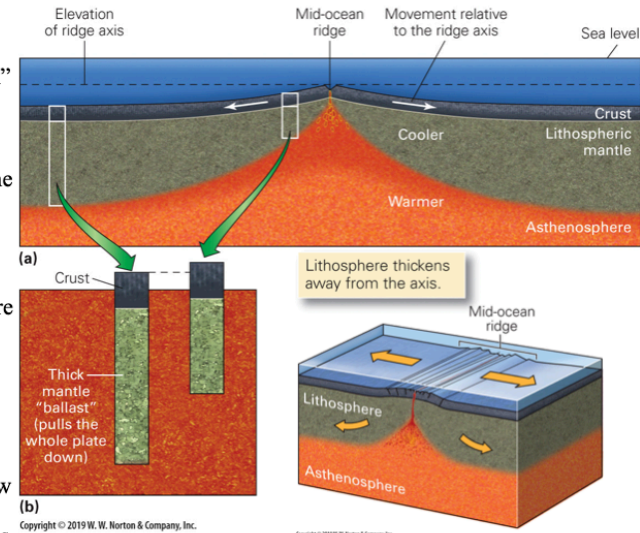
HW 5: Thermal Subsidence of the Oceanic Lithosphere

OVERVIEW¹

Your objective is to estimate tectonic plate velocities at the Atlantic and Pacific mid-ocean ridges by modeling the thermal subsidence of the oceanic lithosphere.

REVIEW: THE OCEANIC LITHOSPHERE

The Earth's tectonic plates are made of the *lithosphere*, which is made of the crust and the part of the upper mantle that is relatively cold, "frozen" to the crust, and therefore behaves as a part the rigid tectonic plate. The Earth's tectonic plates "float" on the *asthenosphere*, which is defined as the part of the upper mantle that is hot enough to convect and flow.



The depth of lithosphere-asthenosphere boundary, and therefore the thickness of the lithosphere, is controlled by the *rheological* difference between the stiff cold lithospheric mantle and the hot convecting asthenospheric mantle.

The concept of *isostasy* describes how more buoyant lithospheric plates "float higher", and less buoyant plates "float lower". Thus, the dense oceanic plates (composed of dense minerals) are at a lower elevation than continental parts of the plates (composed of less dense minerals).

Oceanic crust is formed at mid-ocean ridges (MORs), which are hot topographic highs on the ocean floor. Initially, the oceanic lithosphere is very thin because it is very hot at the MOR. As the oceanic lithosphere moves away from the ridge axis and gets older over millions of years, the upper mantle cools and transforms into progressively thicker lithosphere. As the oceanic lithosphere becomes thicker and denser, it weighs more, so it "sinks" into the asthenosphere due to isostasy. *Thus, where the oceanic lithosphere is older, the ocean is deeper.* Check out the figures on page 2.

By understanding how oceanic lithosphere cools, geologists have been able to estimate the relationship between the age of the oceanic lithosphere and the depth of the ocean floor below the height of the MOR. On ocean-basin scales, this oceanic topography can be modeled by conductive cooling:

$$d = 3.2 \times 10^{-5} \text{ deg}^{-1} \left(\frac{3300}{-2300} \right) (-1350 \text{ deg}) \left(2 \sqrt{\frac{25 \text{ km}^2 \text{ Myr}^{-1}}{\pi}} \right) \sqrt{t}$$

which simplifies to the equation you will use in this assignment:

$$\text{depth below MOR high (km)} = 0.35 * \sqrt{\text{age of lithosphere (Myr)}}$$

With this simple relationship, you can predict the depth of the ocean (km) *relative to the mid-ocean ridge height it came from* anywhere on the sea floor, if you know the age of the oceanic lithosphere (t, Myr). You can also use the topography of the ocean floor to calculate the estimate the spreading rate (km/Myr) at the MOR where that oceanic crust formed. There are, of course, other things impacting the topography of the ocean floor, but this simple models does a good job matching our observations to first order. "All models are wrong, some models are useful." (George E. P. Box)

¹ based on an activity written by Audrey Huerta, Central Washington University

1

my assignment

common challenges

- **The obvious**
 - the activity may be outside of your direct scientific or programming experience
 - it's rare that an activity will directly plug into your course without modification
- **The things that may only come up once students are working on the activity**
 - broken links to databases or data sets
 - changes to data file formatting, especially if accessing public databases
 - changing MATLAB syntax and function support

Summary

- The *Teaching Computation in the Sciences Using MATLAB* collection is an outstanding resource
 - for general inspiration
 - to find an activity that can address a specific instructional need
- Guiding principle: How do I want to use the activity to address a **scientific** learning objective or a **programming** learning objective (or both)?
- Workflow:
 - search & skim activity pages online
 - download materials and modify for your course
 - keep an eye out for common challenges
- **The collection grows every time there is a workshop**, so periodically revisit it

This is what I'm going to do next. My course is ready for a revamp....