Earth and Oceanographic Science
Spring 2021
Supplemental information to the class finder

The following document should be used with the class finder provided by the Registrar’s office.

(updated 3165 and 3140 on 12/3/2020)

We have included this information here so that you have more information on how EOS faculty are thinking about remote and in-person learning for the Spring 2021 semester.

Part 1: Table of all EOS courses offered

Part 2: Faculty have provided supplemental information for each course

Please contact Faculty for each course if you have additional questions.
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<tr>
<th>Course Code</th>
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<td>Peter Lea</td>
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<td>EOS 1105</td>
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<td>Jacky Baughman, Joanne Urquhart</td>
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<td>Stefan Gary, Cathryn Field</td>
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<td>EOS 2335</td>
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<td>Michelle Fame</td>
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| EOS 2525/   | Marine Biogeochemistry                | Michèle LaVigne, Elizabeth Halliday Walker | Two of: EOS 1100 - 1999 or either ENVS 1102 or ENVS 1104 or ENVS 1515 and EOS 2005 (same as ENVS 2221) | M 1:30pm-2:50pm  
| ENVS 2251   |                                       |             |                                                                               | R 12:30pm-1:50pm    
|             |                                       |             |                                                                               | T 7:00pm-8:20pm     | Fulfills: Ocean Core                       |
|             |                                       |             | Block 2                                                                      |                     |                                            |
| EOS 2540    | Equatorial Oceanography               | Michèle LaVigne | Prerequisite EOS 1105 - 1515 or EOS 2005 (same as ENVS 2221) | M 3:00pm-4:20pm  
|             |                                       |             |                                                                               | R 7:00pm-8:20pm     
|             |                                       |             |                                                                               | W 10:30am-11:50am   | Fulfills: Elective, INS                    |
|             |                                       |             | Block 9                                                                      |                     |                                            |
| EOS 3020/   | Earth Climate History                 | Phil Camill | Prerequisite EOS 2005 (same as ENVS 2221) or ENVS 2221                       | M 10:30am-11:50am  
| ENVS 3902   |                                       |             |                                                                               | R 11:00am-12:20pm   
|             |                                       |             |                                                                               | W 7:00pm-8:20pm     | Fulfills: Senior Seminar                   |
|             |                                       |             | Block 1                                                                      |                     |                                            |
| EOS 3140    | Tectonics and Climate                 | Jacky Baughman | Prerequisite (updated 12/3/20) EOS 1105 or EOS 2005 (same as ENVS 2221)      | T  R 9:30am-10:50am|                                            |
|             |                                       |             | Fulfills: Senior Seminar                                                     |                     |                                            |
| Upper Level Seminar (ULS) 1 | This is the only fully in-person |   |                                                                       |                     |                                            |
| EOS 3165    | Research in EOS: Topics in Petrotectonics | Emily Peterman | Prerequisite (updated 12/3/20)                                               | M 3:00 PM - 6:00 PM  
|             |                                       |             | Three of: either EOS 2115 or EOS 2125 or EOS 2145 or EOS 2155 or EOS 2165 or EOS 2225 and either EOS 2335 or EOS 2345 (same as ENVS 2270) or EOS 2365 and either EOS 2525 (same as ENVS 2251) or EOS 2565 or EOS 2585 (same as ENVS 2282) or EOS 2685 | W 10:30 AM - 11:50 AM  
|             |                                       |             |                                                                               | R 7:00 PM - 8:20 PM  | Fulfills: Senior Research                  |
|             |                                       |             | NEW Time Block 5 (updated 12/3/20)                                           |                     |                                            |
Why sea-level rise?
Ongoing and accelerating sea-level rise creates a “wicked problem” at global, regional and local scales. Among the vexing issues for society are potential displacement of millions of coastal residents, increased disaster impacts, failure of coastal real-estate markets, and exacerbated inequities among diverse coastal residents. Solutions are not straightforward, and will require unprecedented collective action.

The science of sea-level rise is foundational to the problem, and you will learn why such rise is occurring, how and why it varies along the world’s coasts, and how well future rates can be estimated. But science is only one facet of addressing the larger issues, and you will delve into the factors that inform (and often stymie) policy development and social/environmental justice. Among the skills you will learn are 1) applying the scientific basis of present and future sea-level rise to a variety of policy and societal cases associated with populated coasts, 2) articulating how sea-level-rise policies respond to non-scientific influences (e.g., public vs. private, economic, political, risk perception, cognitive biases) for both long-term (decadal) and short-term (e.g., hurricane/storm) time scales, 3) providing examples of how different forms of framing influence perceptions of complex sea-level-rise issues, particularly with respect to inequities and environmental justice, and 4) researching a sea-level-rise topic of your choice, using peer-reviewed and other literature, and preparing a digital poster that clearly communicates your findings.

What will we be doing in this class?
Asynchronous activities will include viewing videos and annotating regular readings on relevant sea-level topics and cases.

The class will meet synchronously on Tuesdays and Fridays in Block 10:
T 8:00am-9:20am
F 10:30am-11:50am

The W 3:00pm-4:20pm session will typically be reserved for student/office hours, and for project check-ins in the last few weeks of the semester.

Synchronous class meetings will emphasize small-group discussions on readings and asynchronous videos that are aggregated for the class at large. Grades will be based on 3 essays and shorter reflections, participation in synchronous activities, and the culminating digital posters (done individually or in pairs).
EOS 1105: Investigating Earth – Spring 2021

Instructors:  Professor Jacky Baughman – jbaughma@bowdoin.edu
Lab Instructor Joanne Urquhart – jurquhar@bowdoin.edu

Time Block 8:  Tuesday @ 12:30-1:50 pm (Eastern Time) – Remote Full class activity and discussion
Thursday @ 8:00-9:20 am (ET) – Remote Lab 1, ½ class only, split based on time zone
Friday @ 2:30-3:50 pm (ET) – Remote Lab 1, ½ class only, split based on time zone

What is “Investigating Earth”?
Dynamic processes, such as earthquakes, volcanoes, and glaciers, shape the earth on which we live. In this class, we will examine these processes using the framework of plate tectonics. You will be asked to make observations, identify patterns in incomplete datasets, and form and test hypotheses to interpret the mechanisms that drive Earth’s dynamic processes. Through a series of laboratory case studies, you will unravel the geologic history and evolution of the Maine Coast and other noteworthy locations using course content knowledge, and real geologic samples, maps, and datasets. Each student will be provided an Investigating Earth kit that includes mineral and rock samples, and tools and materials to complete course activities and laboratory case studies outside of the classroom.

Some of the most pressing challenges of our time and our future include: assessing hazards in active tectonic regions; developing a sustainable Earth resource supply, including energy; predicting Earth’s response to changes in climate, tectonics, and anthropogenic forces; and sharing scientific findings with diverse audiences. These are complex, multi-dimensional problems and addressing these challenges will require the inclusion of diverse perspectives, effective collaboration, working with incomplete datasets, and communicating. Successful completion of this course satisfies INS and “a” requirements.

What are the learning goals of this class?
• Identify patterns and trends within and among datasets
• Create and evaluate hypotheses with rigorous, well-supported data and evidence
• Use data to interpret in 2D, 3D, and predict the 4D evolution of processes
• Work individually and collaboratively
• Communicate your findings clearly and convincingly
• Reflect deeply on your role in the earth system and orient yourself in earth history

What topics will the course cover?
The course will be broken up into 7 modules, each lasting approximately 2-weeks. Modules include:

What will a typical week look like?
You will be responsible for watching ~40 minutes of pre-recorded lecture each week and reading one textbook chapter. This material will prepare you for a live, virtual, full class demonstration, activity, and/or discussion each Tuesday. During our live class on Tuesday, you will have the opportunity to ask questions on course learning material and engage with classmates and instructors. On Thursday OR Friday, you will attend a live, virtual lab session. You will work on lab case studies collaboratively with a small group of students. Each module will culminate in a summative assessment to be completed individually. There are no traditional exams for this course.
EOS 1505
Stefan Gary and Cathryn Field

The Earth’s oceans are one Ocean, spanning the globe, covering nearly 70% of the surface, teeming with life, boiling in the deep sea, and frozen in the Polar Regions. The Ocean regulates global climate and global trade, provides sustenance and recreation, impacts weather and economies. In the worst circumstances, it can have devastating impacts on human existence and yet is the basis for poetry, art, literature. While vast, the Ocean is fragile and in need of protection and regulation. This course will cover the basic principles of oceanography: the tectonic evolution of the ocean basins; the sedimentary processes covering the ocean floor and recording the story of Earth’s climate; chemical properties of seawater that support life; global circulation; waves and tides; marine ecosystems.

For remote learning, the two daytime blocks will be used for synchronous meetings: one 80 minute block devoted to class and the other to lab. Students will be expected to attend both of these synchronous blocks. Evening blocks will be used for optional meetings or office hours. In addition to synchronous blocks, course work may include prerecorded content, readings, homework assignments, occasional quizzes, research projects, hands-on lab activities, a midterm and a final. This class will aim to facilitate community in a remote learning environment via group work in class and lab. Research projects will be implemented as labs that span multiple weeks. Virtual field trips will include Q&A sessions about real-world oceanographic ship, satellite, and robotic observations and ocean/climate models. For the computational aspects of the labs, this course will use the same open-source, cloud-based collaboration tools that globally distributed teams of scientists and programmers use; group work will be supported by a powerful collaborative infrastructure that builds real-world skills.

Please do not hesitate to contact Stefan Gary (sgary@bowdoin.edu) or Cathryn Field (cfield@bowdoin.edu) for more information about learning goals, course content or course logistics.
Earth, Ocean & Society – EOS 2020 | ES 2250 – Spring 2021

Professor: Emily Peterman  
Contact: epeterma@bowdoin.edu  
Prerequisites: an EOS intro course (EOS 1105, 1305 or 1505) OR EOS 2005

What will we learn about?
In this class, we will explore the historical, present-day, and future demands of society on the natural resources of the Earth and the Ocean. What resources do we consume? What Earth System processes are responsible for concentrating these resources? How does society assign value to these resources? Is our resource consumption sustainable?

We will discuss the formation and extraction of a variety of resources that have traditionally been viewed as high-value resources, including salt, gold, diamonds, rare earth elements, water, coal, oil, natural gas, nuclear power, and renewable energies (e.g. tidal, geothermal, solar, wind). In addition to understanding the science of how these resources form and are extracted, we will also examine how policies for these resources are written and revised to reflect changing societal values and needs.

What will we be doing in this class?
This course will be broken into three learning modules: (1) Earth processes & minerals (2) metals & water, and (3) energy resources. Learning materials will include readings, videos, scientific literature, films and podcasts. We will engage with these critical topics through breakout room discussions, collaborative writing, class-wide Town Hall Forum, and mini-presentations. You will also select a resource and create a 5-minute video in which you construct an original research question related to this resource that explores the themes of this course. These videos will be presented to the whole class during the final week of the semester. Example questions might include: Is geothermal energy a viable source of power for my hometown? Does the US have sufficient access to Critical Minerals (lithium, rare earth elements, platinum group elements) to sustain the technology needs of the next two decades? Can the US be carbon free by 2050? What would it take to build climate-ready fisheries and sustainable aquaculture?

What might a typical synchronous class meeting look like?
A typical synchronous class meeting might begin with your questions about the learning materials (readings, videos, papers) that were assigned, breakout rooms where you interpret diagrams, plot data, and/or work on a short problem set in small groups. We’d then listen to mini-presentations from these groups back to the class—and hopefully spur some lively debate and discussion. Class will culminate with either reflective writing or a collaborative synthesis of the key themes of the class.
EOS 2335: Sedimentary Systems - Supplement to class finder- Spring 2021

EOS 2335
Michelle Fame

Sedimentary Systems Spring 2021

What can I expect from a course in Sedimentary Systems?

This course investigates modern and ancient sedimentary systems, both continental and marine, with emphasis on the dynamics of sediment transport, interpretation of depositional environments from sedimentary structures and facies relationships, stratigraphic techniques for interpreting earth history, and tectonic and sea-level controls on large-scale depositional patterns.

How will Sedimentary Systems be run as a remote course?

This course will be run under the ‘flipped classroom model’ meaning that lectures will be prerecorded and assigned as homework along with a reflection assignment and readings in preparation for synchronous class meetings. This course also includes a lab section which will be carried out as a combination of instructional videos, sample analysis, computer-based assignments, field trip videos, data analysis, group projects, writing assignments, and oral presentations. Two of the three weekly time blocks allotted to this course will generally be used for a different synchronous purpose, though the specific needs of the enrolled students will dictate exactly how this will look. Therefore, with some variability, you can expect one block each week will be used for: (1) synchronous active learning activities and small group discussion related to lecture content and (2) synchronous discussion of the lab assignment or individual and small group meetings with the professor.
Marine Biogeochemistry:

*Marine Biogeochemistry* (EOS 2525) offers students the opportunity to explore global oceanic cycles of carbon, oxygen, and nutrients and the role that these cycles play in linking global climate change, marine primary productivity, and ocean acidification.

The course builds on the global perspective on Earth’s elemental cycles provided by *Biogeochemistry* (EOS2005: a pre-requisite).

In *Marine Biogeochemistry*, students develop an understanding of the processes driving chemical cycling in the modern ocean as well as how past and future changes in climate impact these interconnected marine geochemical cycles (and vice-versa). To complement content covered through lectures and activities, chemical cycles are explored locally with a course project focused on the impacts of ocean acidification in Maine coastal ecosystems.

This spring, students will engage with local datasets from coastal Maine habitats as part of the course project, and there will be an emphasis on developing scientific writing skills throughout the semester.
ES 2540
Michèle LaVigne

Equatorial Oceanography

In this elective course, students study an area with little seasonal variability, yet the strongest inter-annual to decadal climate variations of any region of the ocean.

The course begins with an introduction to the mechanisms driving ocean circulation and surface ocean-atmospheric interactions in this key region where the El Niño Southern Oscillation originates.

The course then moves into highlighting the interconnections among the ocean, atmosphere, biological production, climate, and carbon cycling in this important yet highly variable natural source of carbon dioxide to the atmosphere. Students work collaboratively to interpret real-time data available from an array of buoys stretching across the equatorial oceans in data analysis activities. There will be opportunities to engage with articles from the scientific literature published from this region.
What's exciting about Earth Climate History?

Hardly a day goes by without something appearing in the news related to climate change. Greenhouse gas concentrations are rising in the atmosphere. Temperatures are warming. Polar ice caps and permafrost soils are thawing. Sea level is rising. Species are migrating and, in some cases, are threatened with extinction.

How do we know that what we're experiencing in the modern world isn't "natural"? Perhaps we are in the warm phase of a natural climate cycle. Perhaps Earth has been warmer in the past, and our modern world is an anomaly. How can we figure this out?

We need historical information about the Earth system and how climate and its drivers have changed over time. The great news is that Earth offers several kinds of historical archives that help us indirectly assess how temperature and CO$_2$ have changed over time. Over the past few decades, scientists have developed an incredible story about Earth system climate dynamics over surprisingly long periods of time. Imagine knowing how atmospheric CO$_2$ has changed over the past 500 million years or how temperature has changed over billions of years! What makes this such a compelling story, perfect for an EOS/ES senior seminar, is that it requires the integration of all the spheres of the Earth system—the atmosphere, hydrosphere, biosphere, lithosphere, and cryosphere.

This will be our goal for the semester in Earth Climate History (ECH)—to learn this cool, life-altering story. Working as a team of climate sleuths, we will unravel this story using environmental clues from rocks, soils, ocean cores, ice cores, lake cores, fossil plants, and tree rings to assemble proxies of past changes in climate, atmospheric CO$_2$, and disturbance. These records will help us understand hothouses and ice ages, the arrival and extinction of major groups of organisms, the climate context of the rise of human civilizations and how climate changes in the past, such as drought, brought some human civilizations to an end. We will learn how past climate can help us understand the context of our modern climate warming.

Earth Climate History (EOS 3020/ENVS 3902) is the perfect bookend to Biogeochemistry (EOS 2005/ENVS 2221). Whereas BGC mainly focused on the bgc of local ecosystems in the modern world, ECH focuses on the bgc of the whole Earth over deep time.

Here's a taste of what's in store:

- Would you be surprised to learn that Earth was warmer—a LOT warmer—than today over the past half billion years? Might that change your opinion about the severity/urgency of modern climate warming?
- How does the rate and magnitude of modern warming compare to warming in the past? Is what we're experiencing geologically unprecedented? Does that matter?
- How about the fact that we are currently in an ice age? Or the proposal that Earth was once almost frozen like a snowball?
- Can you imagine extinction events where Earth underwent such extreme changes that life was brought to its knees? Not once, but five times!
What will I take away from this course?

- the ability to integrate processes from the different spheres of the Earth system to describe the dynamics of CO$_2$ and climate over time;
- an improved understanding of the geological timeline, including important eras, periods, and epochs, and how geoscientists develop and actively debate the time boundaries of major events in earth history (like the Anthropocene);
- understanding specific methods appropriate for measuring CO$_2$ and temperature changes over different time scales, such as rock carbonates, ocean sediment cores, lake sediment cores, tree rings, ice cores;
- understanding specific analyses useful to CO$_2$ and climate reconstructions, including carbon and oxygen isotopes, nutrient ratios, pollen analyses, and radiocarbon dating;
- why an understanding of natural changes in CO$_2$ and climate is essential for discussions of modern climate warming;
- understanding of the issues that climate scientists face and the ways they address these issues;
- appreciation for the relevance of climatic issues to your personal life and how to apply these concepts to real-world issues;
- ability to read and understand primary literature;
- an appreciation that science is not a "done deal" as is often portrayed by textbooks;
- confidence in the ability to engage discussions with anyone about modern climate change;
- the opportunity to engage in learning communities of all sizes, from small groups to the whole class;
- the opportunity to engage in a diverse learning community, where inclusiveness is valued, supported, and encouraged;
- the chance to showcase the culmination of your knowledge in the EOS and/or ES majors by synthesizing material learned over your four-year course of study.

What will a typical week look like and what types of assignments will I have?

Each week, our class is scheduled to meet for three sessions (two daytime and one evening), but we will only be using the two daytime sessions for synchronous class meetings. The evening session will be used for asynchronous learning.

Since this is a senior seminar, learning will be based primarily on readings from the scientific primary literature, with supplemental readings from required texts. During our synchronous meeting times, we will focus on active, student-group-led discussions and whole-class synthesis. There will be periodic case study presentations developed and led by student teams and occasional mini lectures by the instructor. Outside of class, you will have readings and will make contributions to a discussion board that primes the pump for class discussions. Course assessments include two take-home synthesis projects (akin to take-home exams), case study presentations, and active participation in class discussions and discussion posts.
EOS 3140: Tectonics and Climate – Spring 2021

Instructor:  Professor Jacky Baughman – jbaughma@bowdoin.edu

Upper Level Sem Block 1: Tuesday @ 9:30-10:50 am (ET) – *In-person topic/tool lecture and discussion
Thursday @ 9:30-10:50 am (ET) – *In-person scientific article discussion

* If COVID-19 restrictions allow, then EOS 3140 will be held in-person only.
Students seeking to register for a virtual only course should not select this class.

What is “Tectonics and Climate”?
This course will focus on exploration of the complex interactions between tectonics and climate. Discussion of current research is emphasized by reading primary literature, through class discussions and presentations, and by writing scientific essays. The emphasis on current research means topics may vary, but include: the rise of continents, the evolution of plate tectonics on Earth over the last 4.5 billion years, ancient mountain belts, supercontinents, the record of earth system processes preserved in the geologic record, predictions of how the modern earth system will be recorded in the future rock record, the topographic growth of mountain belts, and Cenozoic climate change.

What will a typical week look like?
Each Tuesday, a pair of students will present on a topic that is pertinent to the scientific article that we will collectively discuss on Thursday. All students will have the opportunity to choose a topic and corresponding scientific article that allows them to more deeply explore their EOS interests. On Thursdays, we will carefully discuss scientific articles focusing on the question asked by the authors, data presented, the effectiveness of figures, and whether or not we agree with the proposed interpretations. This course will have a strong focus on well-evidenced scientific communication through student led presentations and bi-weekly writing assignments. The course will culminate in a final writing assignment and presentation in which students will explore what they consider “the most important problem facing the tectonics and climate scientific community today”.

Who should take this class?
This course satisfies the EOS senior seminar major requirement. Upper-level EOS majors are encouraged to take this course. To enroll you must have completed EOS 2005: Biogeochemistry and/or EOS 1105: Investigating Earth. This course will touch on all EOS sub disciplines (Solid Earth, Oceanography, Surface Processes), with particular focus on Solid Earth Science. This course requires significant student participation and emphasizes scientific writing. Students may only register for this course if they plan on residing in on-campus housing in Spring 2021. Reach out to Jacky at jbaughma@bowdoin.edu with any questions.
EOS 3165 – Research in EOS: Topics in Petrotectonics – Spring 2021

Professor: Emily Peterman  
Contact: epeterma@bowdoin.edu

This course fulfills the senior research experience course requirement for the EOS major.

What is petrotectonics?

“Petrology” is the study of the origin, small-scale structure, and composition of rocks. “Tectonics” is an examination of the large-scale processes that affect the structure and properties of the Earth’s lithosphere and its evolution in time and space. “Petrotectonics” focuses on the intersection of petrology and tectonics—specifically, we will focus on examining the geologic history recorded in rocks by their chemistry, mineral assemblage, texture and structure and the relationship(s) of rocks to tectonic environments. We will also discuss natural hazards, natural resources, and how petrotectonic research along these themes intersects with society and the environment.

What will we be doing?

This semester, students in EOS 3165 will apply the research skills they have developed in their previous EOS courses to complete three research projects related to petrotectonics. The exact format of the course will depend on enrollment, but I anticipate that our scheduled time blocks will be used for synchronous class discussion, small group work on Challenge Questions, independent work and/or small research group meetings. I will also use a variety of asynchronous learning materials (videos, papers, textbook readings) to support your learning. Depending on enrollment and covid-19 restrictions, there may be in-person components to this course during which you will gather in small groups during synchronous class sessions to use the petrographic microscopes, the scanning electron microscope (SEM), rock and mineral samples, and geologic maps.

Will there be opportunities for independent research projects?

Yes. At the start of the semester, students will work in small groups on guided research questions as they learn the skills of petrologic analysis. Example projects include the geologic archives of: the opening of the Atlantic Ocean, the suturing of Pangea into a supercontinent, and the exhumation of the roots of mountain belts to the surface.

Towards the end of the semester, I will be involving students in a new research project that I am actively working on in my lab involving collaborators at institutions across the US. This research project is tentatively focused on the rocks of the Lower Gorge of the Grand Canyon (!) and is an incredibly exciting new avenue of my research program. Because our team of collaborators are located in several time zones, we are beginning the project by discussing papers and sampling strategies over zoom conference calls, shipping samples to each other as we collect pilot datasets, and writing papers and proposals collaboratively online. This type of remote work is how much of petrotectonic research is accomplished. By engaging you in this research, you will have the opportunity to contribute to an authentic research experience alongside me and my collaborators. The course activities and projects emphasize developing research and communication skills – these skills will serve you in any career path you choose.