University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE

Earth and Ocean Foundation

3 credits

MEES 640
Fall 2020

Course Objectives / Overview

Earth and Ocean Sciences is an interdisciplinary field incorporating fundamental and applied studies of the land-estuarine-ocean system. Students will gain a fundamental understanding of the movement and transformation of materials and energy between mountain headwater and estuarine, coastal, and oceanic systems, including geomorphology and landscape dynamics, physical circulation and transport, chemical transformation, and biological reaction.

Expected Course Learning Outcomes

1. Students will gain a fundamental understanding of the physical and biogeochemical dynamics of the earth-estuarine-ocean system including:

- General transport processes governing movement of materials and energy within and across different environments
- Understand connections linking physical and biogeochemical processes in the atmosphere, land, estuaries and the ocean.
- Understand concepts of conservation of energy (conduction, convection, radiation), atmospheric scattering and absorption (e.g., effects of water vapor, aerosols, ozone) across systems.
- Linking theoretical knowledge with real world examples (case studies).

2. Students will gain process-based knowledge of the earth-estuarine-ocean system from theoretical, experimental, and empirical vantage points. Students will be expected to:

- Demonstrate both qualitative and quantitative understanding of fundamental physical and biogeochemical processes, and their interactions
- Synthesize and apply information from multiple scientific disciplines (e.g., hydrology, biogeochemistry, physical oceanography)
- Formulate testable hypotheses through integration of theory and observational data

3. Students will gain experience in reviewing and summarizing research papers as part of oral presentations in class, as well as through written assignments.

INSTRUCTOR DETAILS:

Victoria Coles (Lead)
vcoles@umces.edu
410-228-6372

Mark Castro (Co-lead)
mcastro@umces.edu
301-689-7163

Laura Lapham (Co-lead)
lapham@umces.edu
410-326- 7291

Keith Eshleman
keshleman@umces.edu
301-689-7170

Michael Gonsior
gonsior@umces.edu
410-326-7245

Cindy Palinkas
cpalinkas@umces.edu
410-221-8487

CLASS MEETING DETAILS:

Dates: Tuesday, Thursday
Times: 11am-12:15
Originating Site: Zoom
Link: https://zoom.us/j/94160274050
Passcode: 370244
ID: 941 6027 4050

Instructor office hours: TBD

CURRICULUM FULLFILMENT:

MEES 640 fulfills a foundation MEES requirement.
Prerequisites: None
Teaching Assistant: None

Course Organization / Assessment / Grading

Class time will mostly be lecture (~75 minutes). Three times through the semester, the lecture will be accompanied by a paper discussion, as indicated in the following schedule. After each course module, there will be a case study where students will be required to present on a particular topic. There will be take-home homework sets, one take-home midterm and one take-home final exam.

Student learning outcomes will be assessed by in-class presentations (20%); paper discussions (10%); take-home exercises graded for completion only (Primers) and involving quantitative analysis of actual observational/experimental data (20%); a take-home mid-term examination (25%); and an integrative in-class final examination (25%). For paper discussions, papers will be assigned a week before and each student will provide a summary statement and list 3 questions about the paper, due on moodle at 5 p.m. the day before discussion.

Tentative Course Schedule

Module	#	Date	Topic (the instructors initials)	Assignments
Situating humans in the Earth System Introduction to the earth-estuarine-ocean system	1	Sept 1	(All) Intro to class. Overview of course structure and introduction to everyone's research interests. (MC) The Anthropocene (Preparation for case study#1). (MG) Start lecture on Evolution of Elements.	HW 1 Dimensional Primer due 9/6
	2	Sept 3	(MG) Evolution of Earth, Elements and the oxygen cycle. (VC) Atmospheric circulation.	
	3	Sept 8	(KE) Introduction to the hydrological cycle; water's unique chemical and physical properties; phase changes; global and continental scale water balances; measurement of dynamic hydrological processes.	HW 2 Redox primer due 9/13
	4	Sept 10	(LL) The fast carbon cycle, slow carbon cycle (adding in volcanoes, weathering), acid rain, chemical weathering, carbonates, sedimentary rocks, and the global sulfur cycle.	
	5	Sept 15	(CP) plate tectonics, ocean basin morphology; Sources of energy, meridional heat flux in ocean and atmosphere, concepts of long and shortwave radiation, sensible, latent, and specific heat; Earth's radiative balance	HW 3 Primer due 9/20
	6	Sept 17	(VC) Earth albedo, ice-albedo feedback, atmospheric chemistry impact on radiation balance. Concepts: residence time, dependence of variability on flux/reservoir ratio	
	7	Sept 22	(MSC) **Case study #1:** The Anthropocene: Debate.	
Land Surface Dynamics	8	Sept 24	(KE) Precipitation, evapotranspiration, and runoff; the watershed as a fundamental hydrological system; hydrographs and hydrographic analysis; hydrologic tracers. Paper assigned for discussion (KE).	
	9	Sept 29	(KE) The critical zone; runoff generation processes; surface water, soil water and groundwater dynamics; infiltration; groundwater and surface water interactions.	

	10	Oct 1	(KE) Human impacts on hydrologic processes and the critical zone; importance of land use (forest, agriculture, urban) and climate change. **Paper discussion (KNE)**	HW4 assigned (MSC lead)
	11	Oct 6	(MSC) Important soil characteristics including weathering, cation ion exchange reactions and soil horizons	
	12	Oct 8	(MSC) Interactions amongst human activities, the atmosphere and watershed nutrient export.	HW4 DUE
	13	Oct 13	(MSC) The global nitrogen problem, your N footprint and watershed nitrogen dynamics.	
	14	Oct 15	(KE) **Case Study #2** (SS loads from land to Chesapeake Bay?) Paper assigned for discussion (VC).	Take home mid-term assigned
Ocean system: Ocean, atmosphere, climate, biogeochemistry	15	Oct 20	(VC) Coupled ocean-atmosphere climate: Effects of Earth's rotation (Coriolis and geostrophy); transport processes in oceanic environments; interactions with the atmosphere (i.e., wind-driven flow, gyres); large-scale ocean circulation, meridional overturning Paper assigned for discussion (VC).	
	16	Oct 22	(VC) Coupled ocean-atmosphere climate: Ekman/wind driven circulation, coastal and equatorial upwelling,	Take home mid-term DUE
	17	Oct 27	(CP) Coupled ocean-atmosphere climate: Fill up ocean basins w/sediments; other fun geo processes in ocean; tsunami and deep-water waves; hydrothermal vents, **Paper discussion (VC)**	
	18	Oct 29	(MG/LL) Biogeochemical processes: Major ions in seawater, marcet's principle, density, brines, air-sea gas exchange, carbonate system, alkalinity.	HW5 assigned (LL lead)
	19	Nov 3	(MG) Biogeochemical processes: Primary production variability (and control by light/mixed layer and nutrients), Redfield ratios and the concept of limiting nutrients, including trace metal limitation, respiration,	
	20	Nov 5	(MG) Biogeochemical processes: Plankton, Oxygen minimum zones, biological carbon pump, marine dissolved organic carbon, make up of ocean sediments.	HW5 DUE
	21	Nov 10	(VC,CP) **Case study**: Sea Level Rise blog - steric vs meltwater, impacts on coasts, impacts on nutrients and acidification (more integrated with land, estuarine systems?)	
Estuaries	22	Nov 12	(VC) Physical processes linking land and ocean: Estuarine classification and circulation; river plumes; Residence time.	
	23	Nov 17	(CP) Physical processes linking land and ocean: tides; tide-driven circulation; interactions with the atmosphere, mixing, erosion.	

			Concepts: advection, diffusion, turbulence/mixing, buoyancy and stratification. Paper assigned (LL)	
	24	Nov 19	(CP) Coastal/estuarine habitats.	HW6 assigned (VC lead)
	25	Nov 24	(LL) Biogeochemical processes: transformations of materials in estuarine environments; nutrient cycling and limitation (C, N, P), including the role of sediments. **Paper Discussion (LL)**	
		Nov 26	**NO CLASS-Thanksgiving Break**	
	26	Dec 1	(LL) Biogeochemical processes: Sediment biogeochemistry.	HW6 DUE
	27	Dec 3	(LL) Biogeochemical processes: Physical and nutrient controls on hypoxia/anoxia, impacts of hypoxia/anoxia on biogeochemistry/ecology/ microbiology	
	28	Dec 8	(LL) **Case study**: Dead Zones (integrated across land, estuarine and ocean processes).	
	29	Dec 10	(LL) Case study continued, (All) General discussion, Q&A, course evaluation. Assign take home Final Exam	Assign take home Final Exam
		Dec 16		Take Home Final Exam due

Required textbooks, reading and/or software or computer needs

There are no required textbooks for this course. Journal articles, textbook excerpts, and other supplemental materials will be assigned during the course as needed.

Course Communication

All course information, assignments, and as requested video of lectures will be available through the MEES 640 moodle site. Students will be given access during the first week of class. Please contact the instructors via email, in person, or via phone in that order of precedence.

Resources

The Course website is on moodle. For issues relating to moodle please contact: moodle-feedback@umces.edu
Additional resources will be listed in the lecture notes.

Campus Policies

The University of Maryland Center for Environmental Science has drafted and approved various academic and research-related policies by which all students and faculty must abide. Please visit the following website for more

information on the University of Maryland Center for Environmental Science Code of Academic Integrity and Policy III-1.00: Policy on Faculty, Student and Institutional Rights and Responsibilities for Academic Integrity.

Course-Specific Policies and Expectations

This classroom is a place where all individuals will be treated with respect, and individuals of all ages, backgrounds, beliefs, ethnicities, genders, gender identities, gender expressions, national origins, religious affiliations, sexual orientations, ability – and other visible and nonvisible differences - are welcome. All members of this class are expected to contribute to a respectful, welcoming and inclusive environment for every other member of the class.