

Term Information

Effective Term Spring 2022

General Information

Course Bulletin Listing/Subject Area Earth Sciences
Fiscal Unit/Academic Org School of Earth Sciences - D0656
College/Academic Group Arts and Sciences
Level/Career Graduate, Undergraduate
Course Number/Catalog 5656
Course Title Ecohydrology
Transcript Abbreviation Ecohydrology
Course Description Physical and ecological processes of plant-water interaction. Principles of water transport in the soil-plant system, plant drought response, and feedbacks of plants on energy-water-carbon cycles, with examples from observational studies and ecohydrological models.
Semester Credit Hours/Units Fixed: 3

Offering Information

Length Of Course 14 Week, 12 Week, 8 Week, 7 Week, 6 Week, 4 Week
Flexibly Scheduled Course Never
Does any section of this course have a distance education component? No
Grading Basis Letter Grade
Repeatable No
Course Components Lecture
Grade Roster Component Lecture
Credit Available by Exam No
Admission Condition Course No
Off Campus Never
Campus of Offering Columbus

Prerequisites and Exclusions

Prerequisites/Corequisites Math 1141 or 1151 above; and Physics 1250 or above; or graduate standing; or permission of instructor.
Exclusions
Electronically Enforced Yes

Cross-Listings

Cross-Listings

Subject/CIP Code

Subject/CIP Code 40.0601
Subsidy Level Doctoral Course
Intended Rank Junior, Senior, Masters, Doctoral

Requirement/Elective Designation

The course is an elective (for this or other units) or is a service course for other units

Course Details

Course goals or learning objectives/outcomes

- Outline principles governing water transport through the soil-plant-atmosphere system
- Identify key roles of vegetation on water and carbon cycles in the context of climate change
- Apply a basic ecohydrological model to describe drought responses
- Interpret ecohydrological observations across spatial scales and create case studies

Content Topic List

- Overview on ecohydrology
 - Fundamentals on energy and mass transfer
 - Surface energy fluxes, evapotranspiration
 - Flux measurements
 - Soil moisture and drought
 - Root water uptake
 - Xylem water transport
 - Plant hydraulics
 - Stomatal conductance
- Photosynthesis
 - Phenology and canopy processes
 - Remote sensing ecohydrology
 - Ecohydrological models and case studies

Sought Concurrence

No

Attachments

- Syllabus_Ecohydrology_SP22_submitted.docx: Ecohydrology syllabus
(Syllabus. Owner: Griffith, Elizabeth M)
- CURRICULAR MAP OF COURSES AVAILABLE IN EARTH SCIENCES B.docx: updated curriculum map with course highlighted
(Other Supporting Documentation. Owner: Griffith, Elizabeth M)
- Concurrence from EEOB.pdf: concurrence--EEOB
(Concurrence. Owner: Vankeerbergen, Bernadette Chantal)
- Concurrence from SENR - EARTHSC5656Ecohydrology.pdf: concurrence--ENR
(Concurrence. Owner: Vankeerbergen, Bernadette Chantal)

Comments

- Thanks. I uploaded an updated curriculum map. *(by Griffith, Elizabeth M on 09/08/2021 05:03 PM)*
- If course can count in your major(s) even as an elective, please provide updated curriculum map. *(by Vankeerbergen, Bernadette Chantal on 09/08/2021 03:23 PM)*

COURSE REQUEST
5656 - Status: PENDING

Last Updated: Vankeerbergen, Bernadette
Chantal
10/19/2021

Workflow Information

Status	User(s)	Date/Time	Step
Submitted	Griffith, Elizabeth M	08/30/2021 08:03 PM	Submitted for Approval
Approved	Griffith, Elizabeth M	08/30/2021 08:05 PM	Unit Approval
Revision Requested	Vankeerbergen, Bernadette Chantal	09/08/2021 03:23 PM	College Approval
Submitted	Griffith, Elizabeth M	09/08/2021 05:03 PM	Submitted for Approval
Approved	Griffith, Elizabeth M	09/08/2021 05:03 PM	Unit Approval
Approved	Vankeerbergen, Bernadette Chantal	10/19/2021 12:39 PM	College Approval
Pending Approval	Cody, Emily Kathryn Jenkins, Mary Ellen Bigler Hanlin, Deborah Kay Hilty, Michael Vankeerbergen, Bernadette Chantal Steele, Rachel Lea	10/19/2021 12:39 PM	ASCCAO Approval

Ecohydrology Syllabus

[EARTHSC 5656 | ENR 5656] [Spring 2022]

Course Information

- **Course times and location:** Tue/Thu afternoon, TBD (1hr 20min blocks each)
- **Credit hours:** 3
- **Mode of delivery:** Two lectures per week (in person)

Instructor

- **Name:** Yanlan Liu
- **Email:** liu.9367@osu.edu
- **Office location:** Room 223, Mendenhall Laboratory Bldg.
- **Office hours:** TBD

Teaching Assistant

- **Name:** TBD
- **Email:** TBD
- **Office hours and location:** TBD

Course Prerequisites

Math 1141 or 1151 above; and Physics 1250 or above; or graduate standing; or permission of instructor.

Course Description

This course is about physical and ecological processes of plant-water interactions. We will cover the principles of water transport in the soil-plant system, plant drought response, and feedbacks of plants on energy-water-carbon cycles, with examples from observational studies and ecohydrological models. Students will get hands-on experience analyzing ecohydrological datasets based on ground and remote sensing measurements.

Learning Outcomes

By the end of this course, students should successfully be able to:

- Outline principles governing water transport through the soil-plant-atmosphere system



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- Identify key roles of vegetation on water and carbon cycles in the context of climate change
- Apply a basic ecohydrological model to describe drought responses
- Interpret ecohydrological observations across spatial scales and create case studies

Course Materials

Required Materials

- Bonan, G. (2019). *Climate change and terrestrial ecosystem modeling*. Cambridge University Press. [open online access]
- Review articles [all available online through university library]
 - Guswa et al. (2020). Advancing ecohydrology in the 21st century: A convergence of opportunities. *Ecohydrology*, 13(4), e2208.
 - D'Odorico et al. (2010). Ecohydrology of terrestrial ecosystems. *BioScience*, 60(11), 898-907.
 - Brodrribb et al. (2020). Hanging by a thread? Forests and drought. *Science*, 368(6488), 261-266.
 - McDowell et al. (2019). Hydraulics in the 21st century. *New Phytologist*, 224(2), 537-542.
 - Fatichi et al. (2016). Modeling plant–water interactions: an ecohydrological overview from the cell to the global scale. *Wiley Interdisciplinary Reviews: Water*, 3(3), 327-368.

Recommended Materials

- Chapin III, F. S., Matson, P. A., & Vitousek, P. (2011). *Principles of terrestrial ecosystem ecology*. Springer Science & Business Media. [open online access]
- Campbell, G. S., & Norman, J. (2012). *An introduction to environmental biophysics*. Springer Science & Business Media.
- Rodríguez-Iturbe, I., & Porporato, A. (2007). *Ecohydrology of water-controlled ecosystems: soil moisture and plant dynamics*. Cambridge University Press.
- Additional journal articles to be listed



Grading

How Your Grade is Calculated

Assignment Category	Points
Written Assignments	40%
In class quizzes	20%
Group project	35%
Participation	5%

Descriptions of Major Course Assignments

Written Assignments

There will be eight short written assignments (2-3 problems each), including conceptual questions and calculations, and coding exercises. Coding experiences using any programming language, e.g., Python, R, Matlab, C, would be preferred. However, for students who had limited coding experience, we will offer one session in the second week going through the basics of Python. Materials on other preferred languages will be provided. Assignments will be due on Tuesday and graded by Thursday in the same week. Students have one chance to redo the assignments marked as incorrect and resubmit by the next Tuesday.

In-class quizzes

There will be two in-class quizzes (15 mins each) focusing on conceptual questions.

Group project

Students will form self-organizing teams, each with 2-4 people. Each team will identify their topic of data analysis project with the help of the instructor and propose their project topic before the spring-break. Final presentations will be held in the last week of class.

Grading Scale

93–100: A 90–92.9: A- 87–89.9: B+ 83–86.9: B 80–82.9: B-
 77–79.9: C+ 73–76.9: C 70–72.9: C- 67–69.9: D+ 60–66.9: D
 Below 60: E



Course Schedule

Refer to the CarmenCanvas course for up-to-date due dates.



Week	Lecture Topics	Assignments	Readings
1	Overview on ecohydrology		D'Odorico et al. (2010). Ecohydrology of terrestrial ecosystems. <i>BioScience</i> , 60(11), 898-907. Guswa et al. (2020). Advancing ecohydrology in the 21st century: A convergence of opportunities. <i>Ecohydrology</i> , 13(4), e2208.
2	Fundamentals on energy and mass transfer	Assignment 1	Bonan, Chapter 3: Fundamentals of Energy and Mass Transfer
3	Surface energy fluxes, evapotranspiration	Assignment 2	Bonan, Chapter 7: Surface Energy Fluxes
4	Flux measurements	Assignment 3 (coding exercise)	
5	Soil moisture and drought	Assignment 4	Bonan, Chapter 8: Soil Moisture Brodrigg et al. (2020). Hanging by a thread? Forests and drought. <i>Science</i> , 368(6488), 261-266.
6	Root water uptake	In-class quiz 1	
7	Xylem water transport	Assignment 5 (coding exercise)	McDowell et al. (2019). Hydraulics in the 21st century. <i>New Phytologist</i> , 224(2), 537-542.
8	Plant hydraulics	Project proposal	Bonan, Chapter 13: Plant Hydraulics
9	Spring break		
10	Stomatal conductance	Assignment 6	Bonan, Chapter 12: Stomatal Conductance
11	Photosynthesis	Assignment 7 (coding exercise)	Bonan, Chapter 11: Leaf photosynthesis
12	Phenology and canopy processes	Assignment 8	Bonan, Chapter 15: Plant Canopies
13	Overview on remote sensing ecohydrology	In-class quiz 2	



14	Overview on ecohydrological models and case studies		Bonan, Chapter 1: Terrestrial Biosphere Models Fatichi et al. (2016). Modeling plant–water interactions: an ecohydrological overview from the cell to the global scale. <i>Wiley Interdisciplinary Reviews: Water</i> , 3(3), 327-368.
15	Final presentation	Final presentation	



Other Course Policies

Statement on academic misconduct

It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term “academic misconduct” includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the committee (Faculty Rule 3335-5-487). For additional information, see the Code of Student Conduct <https://studentconduct.osu.edu/>

Statement on disability services

The University strives to make all learning experiences as accessible as possible. If you anticipate or experience academic barriers based on your disability (including mental health, chronic or temporary medical conditions), please let me know immediately so that we can privately discuss options. To establish reasonable accommodations, I may request that you register with Student Life Disability Services. After registration, make arrangements with me as soon as possible to discuss your accommodations so that they may be implemented in a timely fashion. SLDS contact information: slds@osu.edu; 614-292-3307; slds.osu.edu; 098 Baker Hall, 113 W. 12th Avenue.

Statement on mental health

As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance or reduce a student’s ability to participate in daily activities. The Ohio State University offers services to assist you with addressing these and other concerns you may be experiencing. If you or someone you know are suffering from any of the aforementioned conditions, you can learn more about the broad range of confidential mental health services available on campus via the Office of Student Life’s Counseling and Consultation Service (CCS) by visiting ccs.osu.edu or calling [614-292-5766](tel:614-292-5766). CCS is located on the 4th Floor of the Younkin Success Center and 10th Floor of Lincoln Tower. You can reach an on call counselor when CCS is closed at [614-292-5766](tel:614-292-5766) and 24 hour emergency help is also available through the 24/7 National Suicide Prevention Hotline at 1-800-273-TALK or at suicidepreventionlifeline.org.

Statement on sexual misconduct/relationship violence

Title IX makes it clear that violence and harassment based on sex and gender are Civil Rights offenses subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories (e.g., race). If you or someone you know has been sexually harassed or assaulted, you may find the appropriate resources at <http://titleix.osu.edu> or by contacting the Ohio State Title IX Coordinator at titleix@osu.edu



Statement on diversity and inclusion

The Ohio State University affirms the importance and value of diversity in the student body. Our programs and curricula reflect our multicultural society and global economy and seek to provide opportunities for students to learn more about persons who are different from them. We are committed to maintaining a community that recognizes and values the inherent worth and dignity of every person; fosters sensitivity, understanding, and mutual respect among each member of our community; and encourages each individual to strive to reach his or her own potential. Discrimination against any individual based upon protected status, which is defined as age, color, disability, gender identity or expression, national origin, race, religion, sex, sexual orientation, or veteran status, is prohibited.



Re: Concurrence Request EARTHSC 5656 Ecohydrology

Hamilton, Ian <hamilton.598@osu.edu>

Fri 9/24/2021 12:49 PM

To: Lower, Steven <lower.9@osu.edu>; Griffith, Elizabeth M. <griffith.906@osu.edu>

Dear Liz,

EEOB offers concurrence on the proposed offering of EARTHSC 5656. The proposed course does not have substantial overlap with our offerings. I expect that some EEOB undergraduate and graduate students will be interested in taking this class.

Best regards,
Ian



THE OHIO STATE UNIVERSITY

Ian Hamilton

Professor

Vice Chair of Undergraduate Studies, EEOB

[College of Arts & Sciences](#)

Department of Evolution, Ecology and Organismal Biology & Department of Mathematics

390 Aronoff Laboratory, 318 W 12th Ave, Columbus, OH 43210

hamilton.598@osu.edu

Pronouns: he/him/his

From: Freudenstein, John <freudenstein.1@osu.edu>

Sent: Wednesday, September 15, 2021 9:47 AM

To: Hamilton, Ian <hamilton.598@osu.edu>

Subject: FW: Concurrence Request EARTHSC 5656 Ecohydrology

Ian:

A concurrence request.

Thanks, John

From: Lower, Steven <lower.9@osu.edu>

Sent: Tuesday, September 14, 2021 11:24 AM

To: Griffith, Elizabeth M. <griffith.906@osu.edu>

Cc: Freudenstein, John <freudenstein.1@osu.edu>

Subject: Fw: Concurrence Request EARTHSC 5656 Ecohydrology

Brian begins as Chair next year. John Freudenstein is still steering the ship in EEOB

From: Griffith, Elizabeth M. <griffith.906@osu.edu>

Sent: Tuesday, September 14, 2021 11:02 AM

To: Carstens, Bryan C. <carstens.12@osu.edu>

Cc: Lower, Steven <lower.9@osu.edu>

Subject: Concurrence Request EARTHSC 5656 Ecohydrology

Dear Prof Bryan Carstens (Chair EEOB),

Please find attached a proposal for a new EARTHSC course (cross-listed with ENR) on ecohydrology to be taught by our new Assistant Professor Yanlan Liu in Spring 2022. The syllabus is attached. Our School of Earth Sciences is seeking concurrence for the new course (a response to be uploaded with the proposal for the panel review). After discussions with Bernadette Vankeerberghen (Assistant Dean, Curriculum, CAS), we thought it would be a good idea to seek concurrence from EEOB for this new course to add to our proposal for consideration.

Please email your responses/concurrences to me (griffith.906@osu.edu) and our chair also copied to this email, lower.9@osu.edu. *Responses are due by **Tuesday, September 28, 2021***. Concurrence will be assumed if no response is received within two weeks.

Regards,

Liz

Associate Professor & Associate Director of Administration
School of Earth Sciences

Re: new cross-listed course in Spring 2022

Griffith, Elizabeth M. <griffith.906@osu.edu>

Mon 10/11/2021 2:12 PM

To: Brooks, Jeremy S. <brooks.719@osu.edu>; Sharp, Jeff <sharp.123@osu.edu>

Cc: Lower, Steven <lower.9@osu.edu>; Johnston, Renee <johnston.230@osu.edu>

Thanks for considering the request and I am happy to proceed without cross-listing and will use your email as concurrence from SENR. No need for a formal document/signature.

Sincerely,

Liz

From: Brooks, Jeremy S. <brooks.719@osu.edu>

Sent: Monday, October 11, 2021 1:20 PM

To: Sharp, Jeff <sharp.123@osu.edu>; Griffith, Elizabeth M. <griffith.906@osu.edu>

Cc: Lower, Steven <lower.9@osu.edu>; Johnston, Renee <johnston.230@osu.edu>

Subject: Re: new cross-listed course in Spring 2022

Hi Elizabeth,

We've had some extensive conversations about Ecohydrology and it seems like the easiest way forward – and the quickest way for SES to get this course on the books by Spring is to remove the need for cross-listing with SENR. From our perspective, it doesn't seem necessary.

Instead, I think we can treat this as a concurrence request and with Rachel Gabor and Steve Lyon reviewing the course and speaking with Yanlan, there are no problems from our end.

So, if you are able to accept this email as providing concurrence, from SENR's perspective, there's no problem proceeding. If you need an official concurrence form signed, I'd be happy to do that as well.

Apologies for the delay – and please let us know if you think there's a need to keep the course cross-listed.

Best
Jeremy



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Jeremy Brooks

Associate Professor

College of Food, Agricultural, and Environmental Sciences

School of Environment and Natural Resources

469D Kottman Hall, 2021 Coffey Rd, Columbus, OH 43212

614-292-9787 Office

brooks.719@osu.edu / <https://u.osu.edu/brooks.719/>

Buckeyes consider the environment before printing.

From: Sharp, Jeff <sharp.123@osu.edu>

Date: Tuesday, September 21, 2021 at 9:56 AM

CURRICULAR MAP OF COURSES AVAILABLE IN EARTH SCIENCES B.S.

Course Number	Course Title	PLO A: Read/ evaluate Earth Sci literature	PLO B: Present Earth Sci info	PLO C: Apply Earth Sci data	PLO D: Apply appropriate techniques/ methods	PLO E: Identify Earth Sci problems, develop solutions	PLO F: Apply other sciences	BS program required /elective
Earth Sciences 1100	Planet Earth: How it works	B	B	B	B	B	B	O-prep
Earth Sciences 1105	Geology of the National Parks	B	B	B		B	B	O-prep
Earth Sciences 1108	Gemstones	B	B	B		B	B	O-prep
Earth Sciences 1121	The Dynamic Earth	B	B	B	B	B	B	O-prep
Earth Sciences 1151	Natural Hazards	B	B	B	B	B	B	O-prep
Earth Sciences 2203	Environmental Geoscience	B	B	B		B	B	O-prep
Earth Sciences 2205	The Planets	B	B	B		B	B	O-prep O-PS
Earth Sciences 2206(&S)	Principles of Oceanography	B	B	B		B	B	O-prep O-SS
Earth Sciences 1200	Introductory Earth Science Lab		B	B	B	B	B	O-prep
Earth Sciences 2000	Preparation for Thesis and Careers in the Earth Sciences	B-I	B-I	B-I		B-I		R-GS R-GP R-CWE
Earth Sciences 2122	Climate and Life over Billions of years on Earth	B-I	B-I	B-I	B-I	B-I		O-SS R-GS
Earth Sciences 2155	Energy and Environment	B-I	B-I	B-I	B-I	B-I		O-SS
Earth Sciences 2203	Environmental Geoscience	B-I	B-I	B-I	B-I	B-I		O-SS
Earth Sciences 2204	Exploring Water Issues	B-I	B-I	B-I	B-I	B-I		O-SS
Earth Sciences 2210	Energy, Mineral Resources, and Society	B-I	B-I	B-I	B-I	B-I		O-SS
Earth Sciences 2212	Intro to Earth Materials	B-I	B-I	B-I	B-I	B-I		O-CWE
Earth Sciences 3411	Water Security for the 21 st Century	I	I	I	I	I		O-SS

Earth Sciences 5189.02	Field Geology II	A	A	A	A	A	A	R-GS O-PG
Earth Sciences 5191	Internship in the Earth Sciences	I - A	I - A	I - A	I - A	I - A	I - A	
Earth Sciences 5191.01	Museum Internship	A	A	A	A	A	A	
Earth Sciences 5193.xx	Individual Studies	I - A	I - A	I - A	I - A	I - A	I - A	
Earth Sciences 5194	Group Studies	I - A	I - A	I - A	I - A	I - A	I - A	
Earth Sciences 5203	Geo-environment and Human Health	A	A	A	A	A	A	O-CWE O-HG
Earth Sciences 5205	Planetary Science	A	A	A	A	A	A	R-PS
Earth Sciences 5206	Advanced Oceanography	A	A	A	A	A	A	R-MS O-CWE
Earth Sciences 5268	Soils and Climate Change	A	A	A	A	A	A	O-CWE O-HG
Earth Sciences 5501	Museum Databases	A	A	A	A	A	A	O-MC
Earth Sciences 5550	Geomorphology	I-A	I-A	I-A	I-A	I-A	I-A	O-PS O-HG
Earth Sciences 5600	Siliciclastic Depositional Systems	A	A	A	A	A	A	
Earth Sciences 5601.01	Sedimentary Petrology: Sandstones	A	A	A	A	A	A	
Earth Sciences 5601.02	Sedimentary Petrology: Carbonate Rocks and Shales	A	A	A	A	A	A	
Earth Sciences 5602.01	Carbonate Depositional Systems I	A	A	A	A	A	A	
Earth Sciences 5602.02	Carbonate Depositional Systems II	A	A	A	A	A	A	O-MS
Earth Sciences 5603	Stratigraphy	A	A	A	A	A	A	
Earth Sciences 5604	Sequence Stratigraphy	A	A	A	A	A	A	
Earth Sciences 5605	Paleoceano graphy	A	A	A	A	A	A	
Earth Sciences 5613	Micropaleon tology	A	A	A	A	A	A	
Earth Sciences 5614	Paleobiology	A	A	A	A	A	A	
Earth Sciences 5615	Paleoecology	A	A	A	A	A	A	

Earth Sciences 5617	Petrology of Earth and Planets	A	A	A	A	A	A	
Earth Sciences 5618	Advanced Historical Geology	A	A	A	A	A	A	
Earth Sciences 5621	Introduction to Geochemistry	A	A	A	A	A	A	O-CWE O-HG
Earth Sciences 5622	Stable Isotope Biogeochemistry	A	A	A	A	A	A	O-MS
Earth Sciences 5625	Igneous Petrology	A	A	A	A	A	A	
Earth Sciences 5627	Global Biogeochemical Cycles	A	A	A	A	A	A	
Earth Sciences 5628	Environmental Isotope Geochemistry	A	A	A	A	A	A	
Earth Sciences 5629	Principles of Petrology	A	A	A	A	A	A	
Earth Sciences 5636	Advanced Topics in Mineralogy and Crystallography	A	A	A	A	A	A	
Earth Sciences 5641	Geostatistics	A	A	A	A	A	A	O-GP
Earth Sciences 5642	Geomathematical Analysis	A	A	A	A	A	A	
Earth Sciences 5644	Tectonic Evolution of Continents	A	A	A	A	A	A	
Earth Sciences 5645	Advanced Structural Geology	A	A	A	A	A	A	
Earth Sciences 5646	Geodynamics	A	A	A	A	A	A	O-GP O-PS
Earth Sciences 5650	Glaciology	A	A	A	A	A	A	O-CWE
Earth Sciences 5651	Hydrogeology	A	A	A	A	A	A	O-CWE O-GP R-HG
Earth Sciences 5655	Land Surface Hydrology	A	A	A	A	A	A	O-CWE O-HG
Earth Sciences 5656	Ecohydrology	A	A	A	A	A	A	O-CWE O-HG
Earth Sciences 5660	Geology of Metallic Deposits	A	A	A	A	A	A	
Earth Sciences 5661	Petroleum Geology	A	A	A	A	A	A	O-PG
Earth Sciences 5663	Global Change and Sustainability in the Earth System	A	A	A	A	A	A	O-SS

Earth Sciences 5670	General and Economic Geology of Selected Areas	A	A	A	A	A	A	
Earth Sciences 5676	Elemental Chemical Analysis using Inductively Coupled Plasma Optical Emission and Mass Spectrometry	A	A	A	A	A	A	
Earth Sciences 5680	Deep Earth Geophysics	A	A	A	A	A	A	O-GP O-PS
Earth Sciences 5687	Borehole Geophysics	A	A	A	A	A	A	O-GP O-PG
Earth Sciences 5703	Principles of Biostratigraphy	A	A	A	A	A	A	
Earth Sciences 5713	Taxonomy and Phylogeny in the Fossil Record	A	A	A	A	A	A	
Earth Sciences 5714	Biometry	A	A	A	A	A	A	
Earth Sciences 5717	Critical Issues in World Freshwater Resources	A	A	A	A	A	A	
Earth Sciences 5718	Aquatic Geochemistry	A	A	A	A	A	A	
Earth Sciences 5719	Environmental Organic Geochemistry	A	A	A	A	A	A	
Earth Sciences 5746	Seminar in Rheological Properties of Solids	A	A	A	A	A	A	
Earth Sciences 5751	Quantitative Ground-Water Flow Modeling	A	A	A	A	A	A	O-PG O-HG
Earth Sciences 5752	Contaminants in Aqueous Systems	A	A	A	A	A	A	
Earth Sciences 5754	Risk Assessment and Management in Earth Systems	A	A	A	A	A	A	
Earth Sciences 5779	Seminar in Physical Properties of Minerals and Rocks	A	A	A	A	A	A	
Earth Sciences 5780	Reflection Seismology	A	A	A	A	A	A	O-MS O-PG
Earth Sciences 5781	Gravity Exploration	A	A	A	A	A	A	
Earth Sciences 5782	Magnetic Exploration	A	A	A	A	A	A	

Geod Sci 5781	Geodesy and Geodynamics	A	A	A	A	A	A	O-GP O-PS
Electives from other departments (Geog, AtmosSC, EEOB, ENR, Chem, Math, etc.)							I-A	

Program Learning Goals:

- A) Students critically read and evaluate Earth Science literature
- B) Students present Earth Science information in a clear and logical manner, both orally and in writing.
- C) Students apply knowledge of Earth Science data to understand the dynamic physical, chemical, and biological processes of the Earth and its history.
- D) Students apply knowledge of appropriate techniques, field methods, field mapping, and numerical methods to measure, portray, analyze, and interpret Earth Science data in specific subdisciplines.
- E) Students identify Earth Science problems and develop solutions.
- F) Students apply knowledge of modern applications from chemistry, physics, biology, mathematics, statistics, and computing to the solution of Earth Science problems.

Key: B = Beginning level; I = Intermediate level; A = Advanced level

Program Course Listing:

- R- Required
- O - one of multiple option
- prep - preparation (all BS programs)
- SS – science of sustainability (all BS programs)
- GS – Geological Sciences subprogram
- CWE- Climate Water Environment subprogram
- GP- Geophysics subprogram
- MS – Marine Science certificate
- PS- Planetary Science certificate
- HG- Hydrogeology certificate
- MC – Museum Curation certificate
- PG- Petroleum Geology certificate