THE UNIVERSITY OF CHICAGO
DEPARTMENT OF THE GEOPHYSICAL SCIENCES
5734 SOUTH ELLIS AVENUE
CHICAGO, ILLINOIS 60637
(773) 702-8101

2026-27 Course Offerings

The following courses will be offered by the Department of the Geophysical Sciences for the 2024-25 Academic Year. This list is current as of March 21, 2024. Course offerings are subject to change.

Autumn 2026

GEOS 13100 : Physical Geology

This course introduces plate tectonics; the geologic cycle; and the internal and surface processes that make minerals and rocks, as well as that shape the scenery. Topics include: plate tectonics; Earth structure; natural hazards including earthquakes and volcanoes; crustal deformation and mountain building; and surface processes (erosion, groundwater). Laboratory exercises introduce identifying features of rocks and minerals, and interpreting geological maps.

Instructor(s): E. Kite, , A. Campbell

Cross Listings:

Prerequisites:

Notes:

GEOS 21000 : Mineralogy

This course covers structure, chemical composition, stability, and occurrence of major rock-forming minerals. Labs concentrate on mineral specimen identification and optical microscopy. (L)

Instructor(s): D. Heinz

Cross Listings: GEOS 31000

Prerequisites: CHEM 10100 & 10200 or equivalent

Notes:

GEOS 21210 : Global Seismology

This course covers theories of seismic wave propagation and fundamental concepts of global seismology. Topics include stress/strain, wave equation, ray theory, surface waves, earthquake source, etc.

Instructor(s): S. Park

Cross Listings: GEOS 31210

Prerequisites: Multivariable calculus (e.g., MATH 15300) and mechanics (e.g., PHYS 13100). If not, permission of instructor.

Notes:

GEOS 22200 : Geochronology

This course covers the duration of planetary differentiation and the age of the Earth (i.e., extinct and extant chronometers); timescales for building a habitable planet (i.e., the late heavy bombardment, the origin of the atmosphere, the emergence of life, and continent extraction); dating mountains (i.e., absolute ages, exposure ages, and thermochronology); the climate record (i.e., dating layers in sediments and ice cores); and dating recent artifacts (e.g., the Shroud of Turin). (L)

Instructor(s): A. Davis

Cross Listings: GEOS 32200

Prerequisites: Background in college-level geology, physics, and mathematics

Notes:

GEOS 23900 : Environmental Chemistry

The focus of this course is the fundamental science underlying issues of local and regional scale pollution. In particular, the lifetimes of important pollutants in the air, water, and soils are

examined by considering the roles played by photochemistry, surface chemistry, biological processes, and dispersal into the surrounding environment. Specific topics include urban air quality, water quality, long-lived organic toxins, heavy metals, and indoor air pollution. Control measures are also considered. This course is part of the College Course Cluster program: Climate Change, Culture, and Society.

Instructor(s): C. Blättler

Cross Listings: ENSC 23900, GEOS 33900

Prerequisites: CHEM 11100-11200 or equivalent, and prior calculus course

Notes:

GEOS 24230 : Geophysical Fluid Dynamics: Foundations

This course is for incoming graduate students in physical sciences intending to take further courses in geophysical fluid dynamics, fluid dynamics, condensed matter physics, and other areas requiring this fundamental skill set. It sets the stage for follow-on courses that present the detail of the behavior of fluids and continuums in geophysical, physical, chemical, and other settings. The material may be a student's first contact with continuum mechanics or a remedial or review for students who have previously taken similar courses. Topics include description of material properties in a continuum, including displacement, velocity, and strain rate; scalar, vector, and tensor properties of continuums, strain, strain rate, and stress; derivations and understanding of mass, momentum, and energy conservation principles in a continuum; applications of conservation principles to simple rheological idealizations, including ideal fluids and potential flow, viscous fluids and Navier-Stokes flow, elasticity and deformation; introductory asymptotic analysis, Reynolds number; heat transfer by conduction and convection, convective instability, Rayleigh number; fluids in gravitational fields, stratification, buoyancy; elliptic, parabolic, and hyperbolic partial differential equations, typical properties of each**.**

Instructor(s): N. Nakamura

Cross Listings: GEOS 34230

Prerequisites: Vector calculus, linear algebra, advanced classical mechanics, basic knowledge of computing. Undergrads who take this course should intend to complete a second fluid-dynamics course in Geophysical Sciences.

Notes:

GEOS 25450 : Foundations of AI for Geosciences

Instructor(s): P. Hassanzadeh

Cross Listings: GEOS 35450

Prerequisites:

Notes:

GEOS 26300 : Invertebrate Paleobiology and Evolution

This course provides a detailed overview of the morphology, paleobiology, evolutionary history, and practical uses of the invertebrate and microfossil groups commonly found in the fossil record. Emphasis is placed on understanding key anatomical and ecological innovations within each group and interactions among groups responsible for producing the observed changes in diversity, dominance, and ecological community structure through evolutionary time. Labs supplement lecture material with specimen-based and practical application sections. Several "Hot Topics" lectures introduce important, exciting, and often controversial aspects of current paleontological research linked to particular invertebrate groups. (L)

Instructor(s): M. Webster

Cross Listings: BIOS 23261, EVOL 32400, GEOS 36300

Prerequisites: GEOS 13100 and 13200 or equivalent; completion of the general education requirement in the Biological Sciences, or consent of instructor.

Notes:

GEOS 30200 : Introduction to Research in the Geophysical Sciences

This course is mandatory for all incoming graduate students in the department. Its purpose is to introduce the faculty's current research themes/areas and to familiarize incoming graduate students with research areas they might contemplate for further specialization. Lectures are presented by individual faculty on either 1) a general survey of a research area, or 2) a specialized topic of interest. Student activity varies from year to year and is based on a combination of oral and written presentations.

Instructor(s): L. Reji

Cross Listings:

Prerequisites:

Notes:

GEOS 30250 : Communicating Science: Talks, Papers, and Proposals

This course provides a hands-on way of delving into how science gets communicated and gives students the opportunity to strengthen skills in all elements of scientific presentation. The class will cover the basic principles of great presenting and the practicalities of how to give scientific talks, including the difference between conference talks, seminars, and job talks, and how to design and present great posters. It will also cover how to write compelling and clear scientific papers and persuasive grant proposals. The course is designed as a seminar and will allow students to practice all of these skills. It is designed to be maximally beneficial to graduate students who are in the process of preparing talks, conference presentations, papers, and/or proposals or fellowship applications.

Instructor(s): M. Ranganathan

Cross Listings:

Prerequisites:

Notes:

GEOS 36900 : Topics in Paleobiology

In this seminar we investigate paleobiological or multidisciplinary topics of current interest to students and faculty. Previous subjects include the origin of phyla, historical and macro-ecology, the stratigraphic record and evolutionary patterns, and climate and evolution.

Instructor(s): D. Jablonski; T. Price

Cross Listings: ECEV 36900, EVOL 31900

Prerequisites:

Notes:

Courses in the Common Core

Core offerings may be taught in different quarters than listed in this PDF, please email geosci@uchicago.edu for the most up-to-date information on our core courses.

PHSC 10800 : Earth as a Planet: Exploring Our Place in the Universe

This course explores the diversity of bodies in our Solar System, and the physical and chemical processes that have shaped them over their histories. We will also discuss how these studies have carried us away from an Earth-centered view of the universe to one where Earth is just one of billions of planets that exist in our galaxy. Topics to be covered include: early observations of the Solar System and the laws of planetary motion, the formation and evolution of the Moon, the structure and geophysical evolution of the planets, and the search for habitable environments outside of Earth.

Instructor(s): F. Ciesla

Cross Listings:

Prerequisites:

Notes: Quarter offered may change

PHSC 11000 : Environmental History of the Earth

This course considers how physical and biological processes determine environmental conditions at the surface of the Earth. The Spring Quarter version stresses how environments and life have changed over the 4.5 billion-year history of Earth (Webster). Topics include the methods of historical inference in geology; major transitions in the history of life, including the origin of life, the evolution of oxygen-producing photosynthesis, the origin of animals, and the series of massive extinctions that have repeatedly re-set ecosystems both on land and in the sea; and ecosystem evolution, including the environmental effects of human evolution. The Autumn Quarter version covers the same methodological ground but places greater stress on evaluating environmental and ecological changes within our present-day, increasingly human-dominated Anthropocene (Kidwell). In both versions, labs involve hands-on study of rock and fossil specimens, and analysis and interpretation of datasets drawn from the scientific literature and/or faculty research programs.

Instructor(s): M. Webster; S. Kidwell

Cross Listings:

Prerequisites:

Notes:

Winter 2027

GEOS 13200 : Earth History

This courses covers principles of historical inference in Earth science; the physical, chemical, and biological data that are used to reconstruct Earth history; and the geographic, biotic, and environmental development of Earth. Weekly labs focus on observation and interpretation of sedimentary rocks and fossil assemblages in hand samples. (L)

Instructor(s): M. Foote; G. Slater

Cross Listings:

Prerequisites: GEOS 13100

Notes:

GEOS 13900 : Biological Evolution

This course is an introduction to evolutionary processes and patterns in present-day organisms and in the fossil record and how they are shaped by biological and physical forces. Topics emphasize evolutionary principles. They include DNA and the genetic code, the genetics of populations, the origins of species, and evolution above the species level. We also discuss major events in the history of life, such as the origin of complex cells, invasion of land, and mass extinction. This course is part of the College Course Cluster program: Climate Change, Culture and Society.

Instructor(s): D. Jablonski

Cross Listings: BIOS 13123

Prerequisites: BIOS 10130 or BIOS 10140

Notes:

CCSG 20100 : Climate and Sustainable Development: The Science of Climate Change

This course provides non-science majors with a rigorous yet accessible foundation in the science of climate change, equipping students to engage critically with climate impacts, policy debates, and emerging interventions. Topics covered include methods of climate science, Earth's energy balance and greenhouse effects, natural and anthropogenic perturbation to climate, extreme weather and climate change, role of oceans and carbon cycles, and geo-engineering.

Instructor(s): B.B. Cael

Cross Listings:

Prerequisites:

Notes:

GEOS 24240 : Geophysical Fluid Dynamics: Rotation and Stratification

This course is an introduction to geophysical fluid dynamics for upper-level undergraduates and starting graduate students. The topics covered will be the equations of motion, the effects of rotation and stratification, shallow water systems and isentropic coordinates, vorticity and potential vorticity, and simplified equations for the ocean and atmosphere.

Instructor(s): M. Jansen

Cross Listings: GEOS 34240

Prerequisites: GEOS 24230 or equivalent; Knowledge of mechanics (PHYS 13100 or equivalent), thermodynamics (PHYS 19700 or equivalent), vector calculus and linear algebra (MATH 20000-20100-20200 or equivalent)

Notes:

GEOS 24300 : Paleoclimatology

This course will cover the theory and reconstruction of the evolution of Earth’s climate through geologic time. After reviewing fundamental principles that control Earth’s climate, the course will consider aspects of the climate reconstructions that need to be explained theoretically, such as the faint young sun paradox, snowball Earth episodes, Pleistocene glacial/interglacial cycles, and long-term Cenozoic cooling. Then we will switch to a temporal point of view, the history of Earth’s climate as driven by plate tectonics and biological evolution, and punctuated by mass

extinctions. This will allow us to place the theoretical ideas from the first part of the course into the context of time and biological progressive evolution.

Instructor(s): T. Karp

Cross Listings: GEOS 34300

Prerequisites: One quarter of chemistry

Notes:

ENSC 24550 : Global Change Microbiology

Instructor(s): L. Reji

Cross Listings: GEOS 26700, GEOS 36660

Prerequisites:

Notes:

GEOS 24800 : Climate Systems Engineering

How might humans use geoscience and engineering to intervene in the climate system with the goal of limiting the impacts of historical carbon emissions? Climate Systems Engineering is the intersection of Climate Systems Science and Systems Engineering. Topics will include (1) solar geoengineering with a focus on stratospheric aerosols, (2) open-system carbon removal such as the addition of alkalinity to soils or directly to the ocean, and (3) local interventions to reduce glacial melting; along with crosscuts on (4) systems engineering and (5) policy implications. Foundational knowledge of climate-related geoscience is a required prerequisite. About a third of class time will be devoted to student presentations and discussion. Class work includes problem sets, peer-graded technical micro-essays, and a collaborative project.

Instructor(s): D. Keith

Cross Listings: ENSC 24800, GEOS 34800

Prerequisites: GEOS 13300 The Atmosphere is required. GEOS 24220 Climate Foundations is strongly recommended.

Notes:

GEOS 24810 : Removing Carbon Dioxide from the Atmosphere

This class will survey the science of removing fossil fuel carbon dioxide from the atmosphere, using industrial equipment or by altering soils or natural waters. The various potential strategies have different capacities, costs, and environmental impacts, and some are more verifiable than others. We will evaluate them within the context of the geochemistry of groundwaters and the oceans, and Earth's changing climate and carbon cycle, to get a picture of just how big a pickle we are in.

Instructor(s): B.B. Cael

Cross Listings: CCSG 22509

Prerequisites: Familiarity with chemistry will be helpful.

Notes:

GEOS 27300 : Biological Evolution-Advanced

This course is an overview of evolutionary processes and patterns in present-day organisms and in the fossil record, and how they are shaped by biological and physical forces. Topics emphasize evolutionary principles. They include DNA and the genetic code, the genetics of populations, the origins of species, and evolution above the species level. We also discuss major events in the history of life, such as the origin of complex cells, invasion of land, and mass extinctions. Aimed at Geophysical Sciences and Environmental Science majors, this course differs from GEOS 13900 in requiring a term paper, topic chosen from a list provided by the instructor.

Instructor(s): D. Jablonski

Cross Listings:

Prerequisites: BIOS 10130

Notes:

GEOS 32305 : Topics in Cosmochemistry

Topics in Cosmochemistry, different each year at the discretion of the instructor.

Instructor(s): A. Davis

Cross Listings:

Prerequisites:

Notes:

GEOS 34270 : Air Quality and Climate Change

Human activities since the industrial revolution have led to a sharp increase in greenhouse gases and air pollutants. These emissions, after undergoing chemical and physical processes in the atmosphere, cause air pollution and global warming. This course explores the sources, transformations, and fates of key atmospheric constituents and the underlying interactions between atmospheric science and climate change. Topics covered include: atmospheric composition, chemical forcing of climate, stratospheric ozone, tropospheric pollution, atmospheric methane, atmospheric aerosols, and solar geoengineering. The course is appropriate for graduate students and upper-level undergraduates.

Instructor(s): M. Wang

Cross Listings:

Prerequisites: CHEM 11100-11200 or equivalent

Notes:

GEOS 36000 : Morphometrics

This graduate-level course serves as an introduction to the field of morphometrics (the analysis of organismal shape). Quantitative exploratory and confirmatory techniques involving both traditional (length-based) and geometric (landmark-based) summaries of organismal shape are introduced in a series of lectures and practical exercises. Emphasis is placed on the application of morphometric methods to issues such as (but not restricted to) quantification of intraspecific variability, interspecific differences, disparity, ontogenetic growth patterns (allometry), and phylogenetic changes in morphology. Relevant statistical and algebraic operations are explained assuming no prior background. Students are required to bring personal laptop computers, and are expected to acquire and analyze their own data sets during the course. (L)

Instructor(s): M. Webster

Cross Listings: EVOL 36700

Prerequisites:

Notes:

GEOS 36900 : Topics in Paleobiology

In this seminar we investigate paleobiological or multidisciplinary topics of current interest to students and faculty. Previous subjects include the origin of phyla, historical and macro-ecology, the stratigraphic record and evolutionary patterns, and climate and evolution.

Instructor(s):

Cross Listings:

Prerequisites:

Notes:

GEOS 23800 : Global Biogeochemical Cycles

This survey course covers the geochemistry of the surface of the Earth, focusing on biological and geological processes that shape the distributions of chemical species ,in the atmosphere, oceans and terrestrial habitats. Budgets and cycles of carbon, nitrogen, oxygen, phosphorous, and sulfur are discussed, as well as chemical fundamentals of metabolism, weathering, acid-base and dissolution equilibria, and isotopic fractionation. The course examines the central role that life plays in maintaining the chemical disequilibira that characterize Earth's surface environments. The course also explores biogeochemical cycles change (or resist change) over time, as well as the relationships between geochemistry, biological (including human) activity, and Earth's climate.

Instructor(s): J. Waldbauer

Cross Listings: ENSC 23800, GEOS 33800

Prerequisites: CHEM 11100-11200 or consent of instructor

Notes:

Courses in the Common Core

Core offerings may be taught in different quarters than listed in this PDF, please email geosci@uchicago.edu for the most up-to-date information on our core courses.

PHSC 13600 : Natural Hazards

This course presents the current understanding of high-impact weather and geologic events and an introduction to risk assessment and mitigation. Topics include an overview of geography, statistics, and societal impacts of the world's natural hazards; physics and forecasts of hurricanes, extratropical cyclones, tornadoes, earthquakes, tsunamis, volcanic eruptions, droughts, floods and wildfires; climate change and extreme weather events; quantifying and managing risks. (L)

Instructor(s): N. Nakamura

Cross Listings:

Prerequisites:

Notes:

Spring 2027

GEOS 13300 : The Atmosphere

This course introduces the physics, chemistry, and phenomenology of the Earth's atmosphere, with an emphasis on the fundamental science that underlies atmospheric behavior and climate. Topics include (1) atmospheric composition, evolution, and structure; (2) solar and terrestrial radiation in the atmospheric energy balance; (3) the role of water in determining atmospheric structure; and (4) wind systems, including the global circulation, and weather systems.

Preference will be given to Geosci and Environmental Sci majors/prospective majors. If you are a prospective major, please include this information in your consent request.

Instructor(s): T. Shaw; N. Nakamura, P. Hassanzadeh

Cross Listings: ENSC 13300

Prerequisites: MATH 13100-MATH 13200

Notes:

GEOS 23600 : Chemical Oceanography

This course explores the chemistry of the ocean system and its variations in space and time. The oceans play an essential role in most (bio)geochemical cycles, interacting in various ways with the atmosphere, sediments, and crust. These interactions can be understood through studying the geochemical and isotopic properties of the ocean, its inputs and outputs, and its evolution as recorded in marine sediments and sedimentary rocks. Topics include: the marine carbon cycle, nutrient cycling, chemical sediments, and hydrothermal systems.

Instructor(s): C. Blättler

Cross Listings: CHEM 13600, ENSC 23600, GEOS 33600

Prerequisites: Completion of one of the following Chemistry Sequences: CHEM 10100-10200-11300 Introductory General Chemistry I-II; Comprehensive General Chemistry III or CHEM 11100-11200-11300 Comprehensive General Chemistry I-II-III or CHEM 12100-12200-12300 Honors General Chemistry I-II-III AND either GEOS 13100 or GEOS 13200.

Notes:

GEOS 24250 : Geophysical Fluid Dynamics: Understanding the Motions of the Atmosphere and Oceans

This course is part of the atmospheres and oceans sequence (GEOS 24220, 24230, 24240, 24250) and is expected to follow Geophysical Fluid Dynamics: Rotation and Stratification (GEOS 24240). The course demonstrates how the fundamental principles of geophysical fluid dynamics are manifested in the large-scale circulation of the atmosphere and oceans and their laboratory analogs. Topics include: balance of forces and the observed structure of the atmospheric and oceanic circulations, statistical description of the spatially and temporally varying circulation, theory of Hadley circulation, waves in the atmosphere and oceans, baroclinic instability, wind-driven ocean circulation.

Instructor(s): N. Nakamura

Cross Listings: GEOS 34250

Prerequisites: GEOS 24230 and 24240, or consent of the instructor. Knowledge of vector calculus, linear algebra, and ordinary differential equations is assumed.

Notes:

GEOS 24600 : Introduction to Atmosphere, Ocean, and Climate Modeling

This hands-on course will discuss how we model atmosphere- ocean- and climate-dynamics using numerical models of varying complexity. We will discuss both the relevant physics as well as numerical techniques, including finite-difference methods for ordinary and partial differential equations, as well as spectral methods. The primary focus of the course will be on relatively simple models, including 1D energy balance models, radiative-convective columns, and quasi-geostrophic models for atmosphere and ocean dynamics, which can be fully understood and applied in the context of a quarter-long course. We will end with an overview of the physics and numerics used in more complex general circulation and coupled climate models. The course will be structured using a combination of lectures, in-class exercises, and discussion of homework exercises. Homework will include programming exercises as well as simulations and analysis using existing model code.

Instructor(s): M. Jansen

Cross Listings: GEOS 34600

Prerequisites: GEOS 24220/34220 "Climate foundations"; knowledge of vector calculus, linear algebra, and partial differential equations; basic knowledge of python (could potentially be replaced by significant programming experience in other languages).

Recommended: Geophysical fluid dynamics 24220/34220 and 24240/34240.

Notes:

GEOS 25460 : Practical AI Methods in Data and Modeling for Weather and Climate

This is a practical course meant to complement theoretical development in "Scientific ML for Climate and Chaos." The student will develop the technical skills to use AI methods to investigate data and to run and analyze AI models in weather and climate.

This course will be taught in a hackathon format. We will learn a technique together, then each student will be responsible for defining and complementing an individual project using the technique.

Instructor(s): D. Abbot

Cross Listings: GEOS 35460

Prerequisites:

Notes:

GEOS 25600 : Getting Something for Nothing

We can learn an incredible amount about the physical world with simple tools of estimation. So-called Fermi problems involve estimating quantities of interest to within an order of magnitude, or factor of 10, on the "back of an envelope." There are leanable techniques that we can use to approach these problems. Developing these skills is incredibly useful for physical scientists because it allows us to quickly estimate whether an idea is worth pursuing with expensive resources and time. More generally, order-of-magnitude estimation can keep you from getting fooled by journalists and politicians, or give you a trading edge in a competitive market. Finally, Fermi problems are common in interviews for jobs in finance, consulting, and software. Students in this course will develop techniques to quickly estimate physical science quantities to within an order of magnitude.

Instructor(s): D. Abbot

Cross Listings: PHSC 11900

Prerequisites:

Notes:

GEOS 26600 : Geobiology

Geobiology seeks to elucidate the interactions between life and its environments that have shaped the coevolution of the Earth and the biosphere. The course will explore the ways in which biological processes affect the environment and how the evolutionary trajectories of organisms have in turn been influenced by environmental change. In order to reconstruct the history of these processes, we will examine the imprints they leave on both the rock record and on the genomic makeup of living organisms. The metabolism and evolution of microorganisms, and the biogeochemistry they drive, will be a major emphasis.

Instructor(s): M. Coleman, J. Waldbauer

Cross Listings: ENSC 24000, GEOS 36600

Prerequisites: GEOS 13100-13200-13300 or college-level cell & molecular biology

Notes:

GEOS 29002 : Field Course in Modern and Ancient Environments

This course, in its many iterations, has had consistent aims: to provide students with hands-on experience of the processes that produce sedimentary rocks, exposure to standard field methods and fieldwork safety, and experience in developing and conducting an original research project. We consider biological as well as physical processes of sediment production, dispersal, accumulation, and post-depositional modification, and methods of paleoenvironmental analysis. We give significant attention to humans as geological agents: field areas today almost always exhibit legacy and/or ongoing effects from human activities. This year we explore the theme of Coasts and Coastal Resilience, using Lake Michigan shorelines as exemplars of coastal responses to key forcers — water (wave) regime, water level, and sediment supply — on societally relevant time scales. The spectrum of environments will include built structures such as seawalls, jetties, and hardened shorelines, and both natural and engineered "soft" shorelines. We will meet on Tuesdays and Thursdays 3:30-5:00, with approximately half devoted to lectures and discussion, and the other half to labs, which will be either indoors (using research wave tanks in Hinds) or outdoors (using nearby segments of the Lake Michigan shoreline). A day-long Saturday field excursion is also possible.

Instructor(s): S. Kidwell

Cross Listings: CHST 29002, ENSC 29002

Prerequisites: GEOS 13100 and 13200 recommended; contact instructor

Notes:

GEOS 31260 : Topics in Geodesy

In this seminar, we focus on the application of geodesy to seismological and other geophysical problems. Topics include, but are not limited to: the Earth's deformation, geodetic techniques, seismogeodesy and other emerging subjects in geodesy. The specific focus for each class offering will be determined by the interests of the faculty and students. Can be taken multiple times for credit since the specific topic will change each quarter.

Instructor(s): S. Park

Cross Listings:

Prerequisites: GEOS 21205/31205, 21210/31210 or permission of instructor

Notes:

GEOS 33350 : Sea Level Change

This course explores the drivers and implications of sea level change. It will cover how and why sea level changes, the difference between global and regional sea level, and how sea level has changed in time. The last part of the class will discuss future sea level rise, uncertainties underlying sea level rise projections, and implications for coastal communities. This course is best suited for advanced undergraduate students with some previous preparation in math, physics, or geophysical sciences, or graduate students interested in climate science, paleoclimate, geodynamics, and glaciology.

Instructor(s): M. Ranganathan

Cross Listings: GEOS 23350

Prerequisites: Prior knowledge of single- and multi-variable calculus. Prior physics course (e.g. mechanics) and programming experience useful but not required.

Notes:

GEOS 33825 : Topics in Microbial Biogeochemistry

In this seminar we explore the role of microorganisms in biogeochemical cycles. Topics include microbial metabolism, physiology, ecology and evolution in natural habitats, responses to short- and long-term climate change, and coevolution of life and its environment over Earth history. Can be taken multiple times for credit since the specific topic will change each quarter.

Instructor(s): M. Coleman; J. Waldbauer

Cross Listings:

Prerequisites:

Notes:

GEOS 33950 : Topics in Organic Geochemistry

In this seminar we discuss organic molecules preserved in the geologic record with a focus on reconstructing past life and environments. This course covers a different subject in depth each year. This year's topic is Biomarker Proxy Primer— we will gain an overview of commonly used tools for reconstructing past temperature, hydrology, vegetation, pCO2, oxygen, fire, and

more. Since the specific topic will change each year, this course can be taken multiple times for credit.

Instructor(s): T. Karp

Cross Listings:

Prerequisites:

Notes:

GEOS 34450 : Topics in Aerosols-Cloud-Climate Interactions

The major remaining uncertainty in climate projection comes from aerosol-cloud-climate interactions in the atmosphere. Consequently, an accurate representation of aerosols and clouds is the foundation of any effort to predict long-term climate change. In this seminar, we will discuss topics including, but not limited to: (1) chemical and physical processes driving aerosol and cloud formation; (2) ground-based, airborne, and remote measurements of aerosols and clouds; (3) regional and global modeling of preindustrial and present-day aerosol and cloud state; and (4) model validation and climate assessment for climate system engineering technologies (e.g., stratospheric aerosol injection and marine cloud brightening). Specific topics for each seminar will be determined by faculty and student interests.

Instructor(s): M. Wang

Cross Listings:

Prerequisites:

Notes:

GEOS 35100 : Data Analysis for the Geophysical Sciences

A graduate-level introduction to probability, modeling, and data analysis. Though some emphasis is given to paleontological problems, the goal is to keep approaches sufficiently general that they should be relevant to students across the geophysical sciences as well as evolutionary biology. Required work includes coding exercises and a term project based on original research.

Instructor(s): M. Foote

Cross Listings:

Prerequisites:

Notes:

GEOS 35500 : Scientific machine learning for climate and chaos

This course introduces the applications of scientific machine learning to improve the understanding and modeling of the Earth system. The emphasis is on the intersection of fundamentals of statistical learning, climate physics, and applied and computational mathematics. In particular, using methods of deep learning and equation discovery for multi-scale modeling (parameterization) and spatio-temporal prediction are discussed. The course involves a number of lectures by the instructor and presentations of recent papers by the students.

Instructor(s): D. Abbot, P. Hassanzadeh

Cross Listings: DATA 35510, GEOS 25500

Prerequisites:

Notes:

GEOS 36800 : Macroevolution

Patterns and processes of evolution above the species level, in both recent and fossil organism. A survey of the current literature, along with case studies.

Instructor(s): D. Jablonski

Cross Listings:

Prerequisites:

Notes:

Courses in the Common Core

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PHSC 11000 : Environmental History of the Earth

This course considers how physical and biological processes determine environmental conditions at the surface of the Earth. The Spring Quarter version stresses how environments and life have changed over the 4.5 billion-year history of Earth (Webster). Topics include the methods of historical inference in geology; major transitions in the history of life, including the origin of life, the evolution of oxygen-producing photosynthesis, the origin of animals, and the series of massive extinctions that have repeatedly re-set ecosystems both on land and in the sea; and ecosystem evolution, including the environmental effects of human evolution. The Autumn Quarter version covers the same methodological ground but places greater stress on evaluating environmental and ecological changes within our present-day, increasingly human-dominated Anthropocene (Kidwell). In both versions, labs involve hands-on study of rock and fossil specimens, and analysis and interpretation of datasets drawn from the scientific literature and/or faculty research programs.

Instructor(s): M. Webster; S. Kidwell

Cross Listings:

Prerequisites:

Notes:

PHSC GeoSciFi

A new offering in the physical science core.

Instructor(s): G. Slater

Cross Listings:

Prerequisites:

Notes:

Field Courses and Independent Study

GEOS 29700. Reading and Research in the Geophysical Sciences.

Independent study; regular meetings with Geophysical Sciences faculty member required. Topics available include, but are not limited to: Mineralogy, Petrology, Geophysics, High Pressure Geophysics, Geodynamics, Volcanology, Cosmochemistry, Geochemistry, Atmospheric Dynamics, Paleoclimatology, Physical Oceanography, Chemical Oceanography, Paleoceanography, Atmospheric Chemistry, Fluid Dynamics, Glaciology, Climatology, Radiative Transfer, Cloud Physics, Morphometrics, Phylogeny, Analytical Paleontology, Evolution, Taphonomy, Macroevolution, Paleobiology, Paleobotany, Biomechanics, Paleoecology, Tectonics, Stratigraphy.

Instructor(s): Staff

Cross Listings:

Prerequisites: Consent of instructor and departmental counselor

Notes: Students are required to submit the College Reading and Research Course Form. Available to nonmajors for P/F grading. Must be taken for a quality grade when used to meet a requirement in the major