

# EARTH SCIENCES (ERTH)

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## ERTH 110 Our Dynamic Earth (Units: 3)

Prerequisite: Not open to students who have completed ERTH 112 [formerly GEOL 104].

Investigating the geologic processes that are continually shaping our planet, emphasizing the connections between humans and nature and the process of scientific discovery. Designed for non-science majors. [Formerly GEOL 100]

### Course Attributes:

- B1: Physical Science
- Environmental Sustainability

## ERTH 111 Our Dynamic Earth Lab (Unit: 1)

Prerequisite: ERTH 110 [formerly GEOL 100] (may be taken concurrently), not open to students who have completed ERTH 112 [formerly GEOL 104].

Investigating the geologic processes that are continually shaping our planet, emphasizing the connections between humans and nature and the process of scientific discovery. Hands-on activities to explore Earth processes. Extra fee required. [Formerly GEOL 101]

### Course Attributes:

- B3: Lab Science

## ERTH 112 Our Dynamic Earth Lecture and Lab (Units: 4)

Prerequisite: Not open to students who have completed ERTH 110 [formerly GEOL 100] and/or ERTH 111 [formerly GEOL 101].

Investigating the geologic processes that are continually shaping our planet, emphasizing the connections between humans and nature and the process of scientific discovery. Designed for non-science majors. Classwork, 3 units; laboratory and fieldwork, 1 unit. Extra fee required. [Formerly GEOL 104]

### Course Attributes:

- B1: Physical Science
- B3: Lab Science
- Environmental Sustainability

## ERTH 115 History of Life (Units: 3)

Origin and early development of life; evolution of life through geologic time; extinction and replacement of organisms. [Formerly GEOL 105]

### Course Attributes:

- B2: Life Science
- Environmental Sustainability

## ERTH 160 Our Dynamic Weather (Units: 3)

Prerequisite: Not open to students who have completed ERTH 162 [formerly METR 104].

The nature of weather, including winds, storms, clouds, and precipitation. How and why weather changes, emphasizing the process of scientific discovery.

Weather map interpretation and weather forecasting. Designed for non-science majors. [Formerly METR 100]

### Course Attributes:

- B1: Physical Science
- Global Perspectives

## ERTH 161 Our Dynamic Weather Lab (Unit: 1)

Prerequisite: ERTH 160 [formerly METR 100] (may be taken concurrently), not open to students who have completed ERTH 162 [formerly METR 104].

Weather observations and instruments, weather map and satellite image analysis and interpretation, and weather forecasting, emphasizing the process of scientific discovery. Extra fee required. [Formerly METR 101]

## ERTH 162 Our Dynamic Weather Lecture and Lab (Units: 3)

Prerequisite: Not open to students who have completed ERTH 160 [formerly METR 100] and/or ERTH 161 [formerly METR 101].

The nature of weather, including winds, storms, clouds, and precipitation. How and why weather changes, emphasizing the process of scientific discovery.

Weather map interpretation and weather forecasting. Designed for non-science major. Classwork, 2 units; laboratory, 1 unit. Extra fee required. [Formerly METR 104]

### Course Attributes:

- B1: Physical Science
- B3: Lab Science

## ERTH 170 Our Dynamic Ocean (Units: 3)

Prerequisite: Not open to students who have completed ERTH 172 [formerly OCN 104].

Investigating components and operating principles of the ocean system, including ocean basin features, currents, nutrient cycling, and climatic influences, emphasizing the process of scientific discovery. Designed for non-science majors. Classwork, 3 units. [Formerly OCN 100]

### Course Attributes:

- B1: Physical Science
- Environmental Sustainability

## ERTH 171 Our Dynamic Ocean Lab (Unit: 1)

Prerequisite: ERTH 170 [formerly OCN 100] (may be taken concurrently); not open to students who have completed ERTH 172 [formerly OCN 104].

Investigating ocean processes that play a dominant role in regulating our climate and environment. Emphasizes nature human connections and the process of scientific discovery through hands-on activities. Extra fee required. [Formerly OCN 101]

### Course Attributes:

- B3: Lab Science

## ERTH 172 Our Dynamic Ocean Lecture and Lab (Units: 4)

Prerequisite: Not open to students who have completed ERTH 170 [formerly OCN 100] and/or ERTH 171 [formerly OCN 101].

Investigating components and operating principles of the ocean system, including ocean basin features, currents, nutrient cycling, and climatic influences, emphasizing the process of scientific discovery. Designed for non-science majors. Classwork, 3 units; laboratory and fieldwork, 1 unit. Extra fee required. [Formerly OCN 104]

### Course Attributes:

- B1: Physical Science
- B3: Lab Science
- Environmental Sustainability

**ERTH 205 Techniques in Earth Sciences (Units: 2)**

Prerequisite: An introductory course in one of the earth sciences (geology, meteorology, oceanography) or EARTH 400 [formerly GEOL 401].

Introduction to field and laboratory techniques in the earth sciences, including scientific writing and library research. Laboratory and fieldwork, 2 units. (Plus-Minus letter grading only)

**ERTH 210 Physical Geology (Units: 4)**

Composition, structure, and evolution of the earth; earth materials; tectonic and hydrologic systems; landform development; relation of geologic systems to the human environment. Classwork, 3 units; laboratory and fieldwork, 1 unit. Extra fee required. Plus-minus letter grade only. [Formerly GEOL 110]

**Course Attributes:**

- B1: Physical Science
- B3: Lab Science
- Environmental Sustainability

**ERTH 230 Environmental Geology (Units: 3)**

Human interaction with the geologic environment. Social and political implications, resource and energy exploitation, land use planning, waste disposal, and human modification of nature. Classwork, 2 units; laboratory and fieldwork, 1 unit. Designed for non-science majors. [Formerly GEOL 270]

**Course Attributes:**

- B1: Physical Science
- B3: Lab Science
- Environmental Sustainability

**ERTH 260 Physical Processes in the Atmosphere (Units: 4)**

Prerequisites: MATH 199 [formerly MATH 109] or equivalent or satisfactory score on calculus pretest.

Observed behaviors of the atmosphere and the processes and principles that explain and predict them. Algebra-based problem solving. Classwork, 3 units; laboratory, 1 unit. Extra fee required. [Formerly METR 201]

**Course Attributes:**

- B1: Physical Science
- B3: Lab Science
- Environmental Sustainability
- Global Perspectives

**ERTH 270 Physical Processes in the Ocean (Units: 3)**

Prerequisite: MATH 199 [formerly MATH 109] or equivalent.

Observed behaviors of the ocean and the underlying processes and principles that explain and predict them. Algebra-based problem solving. Classwork, 2 units; laboratory, 1 unit.

**ERTH 310 The Violent Earth (Units: 3)**

Prerequisite: Upper division standing or consent of instructor.

The catastrophic geological agents that modify the environment. Significance of processes such as earthquakes and volcanic eruptions in the development of our planet. Concept of time in evaluating the magnitude of these violent events. Designed for non-science majors. [Formerly GEOL 302]

**Course Attributes:**

- UD-B: Physical Life Science
- Environmental Sustainability

**ERTH 320 Geology of California (Units: 3)**

Prerequisite: Upper division standing or consent of instructor.

Geology of California, with emphasis on the San Francisco Bay Area. Local field trips and extended excursions to areas of geologic interest. Classwork, 2 units; laboratory and fieldwork, 1 unit. Extra fee required. Designed for non-science majors. [Formerly GEOL 356]

**ERTH 325 Geology of the National Parks (Units: 3)**

Prerequisite: Upper division standing or consent of instructor.

Applying geologic principles to natural environments of North America, focusing on geologic history and landscape evolution of the National Parks. Uniqueness of natural regions and questions of preservation. Classwork, 2 units; laboratory and fieldwork, 1 unit. Designed for non-science majors. (Plus-minus letter grade only) [Formerly GEOL 350]

**Course Attributes:**

- UD-B: Physical Life Science
- Environmental Sustainability

**ERTH 330 California Water (Units: 3)**

Prerequisite: Upper division standing or consent of instructor, designed for non-science majors.

Human interaction with the hydrologic environment; science and politics of water issues facing California; hydrologic cycle, floods, droughts, groundwater, contamination; water needs of cities, farms, ecosystems; effects of climate change on water resources. (Plus-minus letter grade only) [Formerly GEOL 370]

**Course Attributes:**

- UD-B: Physical Life Science
- Environmental Sustainability

**ERTH 335 Global Warming (Units: 3)**

Prerequisite: Upper division standing or consent of instructor.

Scientific understanding of global warming. Greenhouse gases, records of past climate change, warming of the recent past, human impact on climate, projections of future climate and the impact on society. Critical evaluation of popular media coverage of climate change. [Formerly GEOL 375]

**Course Attributes:**

- UD-B: Physical Life Science
- Environmental Sustainability
- Global Perspectives

**ERTH 360 California Weather Events (Units: 3)**

Prerequisite: Upper division standing or consent of instructor.

Investigation of the basic meteorology of normal and abnormal weather events in California. [Formerly METR 356]

**Course Attributes:**

- UD-B: Physical Life Science
- Environmental Sustainability
- Global Perspectives

**ERTH 365 Extreme Weather in a Warming World (Units: 3)**

Prerequisite: Upper division standing or consent of instructor.

Atmosphere and ocean as agents of catastrophic change. Fluctuations in atmospheric and oceanic circulations and their environmental impacts. Implications of human modification of the ocean-atmosphere system. Weather variability as evidenced by recent floods, droughts, and severe weather. Designed for non-science majors. [Formerly METR 302]

**Course Attributes:**

- UD-B: Physical Life Science
- Environmental Sustainability
- Global Perspectives

**ERTH 400 Earth Systems I (Units: 3)**

Prerequisites: At least 9 units of coursework in geoscience, earth sciences, chemistry, or physics.

Exploring the components of Earth's systems: atmosphere, hydrosphere, lithosphere, biosphere, and anthroposphere, with focus on the physical and biogeochemical processes through which the components interact. Classwork, 2 units; laboratory, 1 unit. [Formerly GEOL 401]

**ERTH 410 Volcanology (Units: 3)**

Prerequisite: EARTH 210 [formerly GEOL 110] or consent of instructor.

Volcanic processes, landforms, structures, and rocks; origin and differentiation of magma and relation to plate boundaries; case studies of volcanic events on earth and other planets; applications to archaeology and other disciplines. Classwork, 2 units; laboratory and fieldwork, 1 unit. Extra fee required. [Formerly GEOL 410]

**ERTH 420 Mineralogy and Petrology I (Units: 4)**

Prerequisites: EARTH 210 [formerly GEOL 110], CHEM 115, or consent of instructor.

Minerals: physical properties, crystal chemistry, reactions and stability, and identification of common types, including optical mineralogy. Classwork, 2 units; laboratory and fieldwork, 2 units. [Formerly GEOL 420]

**ERTH 425 Geomorphology (Units: 2)**

Prerequisites for EARTH 825: Graduate or senior standing; and all of the prerequisites listed for EARTH 425.

Prerequisites for EARTH 425: EARTH 210 [formerly GEOL 110], EARTH 505 [formerly GEOL 125] or MATH 226, PHYS 111 and PHYS 112 or PHYS 220 and PHYS 222, or consent of instructor.

Landscapes, their geologic evolution, and the processes which create and modify them. Classwork, 3 units; laboratory and fieldwork, 1 unit. [Formerly GEOL 450/GEOL 750]

(ERTH 825/ERTH 425 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**ERTH 430 Fluid Dynamics in Earth Systems (Units: 3)**

Prerequisites: MATH 227 and PHYS 111 or (recommended) PHYS 220, or consent of instructor.

Introduction to the basic principles of fluid dynamics as applied to the ocean and atmosphere; and related fields in earth sciences, such as surface water flow and groundwater dynamics. Classwork, 2 units; laboratory, 1 unit. [Formerly OCN 320/METR 320]

**ERTH 434 Coastal Processes (Units: 3)**

Prerequisites for EARTH 834: Graduate or senior standing and all of the prerequisites listed for EARTH 434.

Prerequisites for EARTH 434: MATH 226, PHYS 111 or PHYS 220, or consent of instructor.

Dynamics of the nearshore ocean and interactions with the coast and beaches. Topics include tides, coastal waves and currents, sediment transport and beaches, inner shelf processes, and estuarine dynamics. Classwork, 2 units; laboratory and fieldwork, 1 unit. [Formerly OCN 410/OCN 710]  
(ERTH 834/ERTH 434 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**ERTH 436 Atmosphere-Ocean Interactions (Units: 3)**

Prerequisite: EARTH 260 [formerly METR 201] and EARTH 465 [formerly METR 430] or EARTH 470 [formerly OCN 420] or EARTH 430 [formerly OCN/METR 320].

Atmospheric behavior in the marine environment. Fluxes of energy, momentum, and material between the atmosphere and sea surface. Atmospheric/ocean feedbacks. Classwork, 2 units; laboratory and fieldwork, 1 unit. [Formerly METR/OCN 450]

**ERTH 442 Surface Water Hydrology (Units: 4)**

Prerequisites: MATH 226 and EARTH 210 or EARTH 505 are recommended; or consent of instructor.

Introduction to surface water hydrology; exploration of hydrologic processes; how precipitation and snowmelt become streamflow, evapotranspiration, and groundwater; watershed hydrology, streamflow processes, and water quality. (Plus-minus letter grade only) [Formerly GEOL 473]

(This course is offered as EARTH 442 or GEOG 342. May not be repeated under alternate prefix.)

**ERTH 444 Hydrogeology (Units: 4)**

Prerequisites for EARTH 744: Graduate or senior standing; EARTH 210 [formerly GEOL 110], EARTH 505 [formerly GEOL 125] or MATH 226, PHYS 111/PHYS 112 or PHYS 220/PHYS 222 or upper division engineering course; or consent of instructor.

Prerequisites for EARTH 444: EARTH 210 [formerly GEOL 110], EARTH 505 [formerly GEOL 125] or MATH 226, PHYS 111/PHYS 112 or PHYS 220/PHYS 222, or consent of instructor.

Physical and geologic factors controlling the occurrence and dynamics of groundwater. Chemical parameters and distribution. Aquifer testing and analysis. Classwork, 3 units; laboratory and fieldwork, 1 unit. [Formerly GEOL 475/GEOL 775]

(ERTH 744/ERTH 444 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**ERTH 446 Quaternary Geology and Soils (Units: 3)**

Prerequisites for EARTH 846: Graduate standing; EARTH 210 [formerly GEOL 110]; or consent of instructor.

Prerequisites for EARTH 446: Senior standing; EARTH 210 [formerly GEOL 110]; or consent of instructor.

Pleistocene and Holocene environments, and their geomorphic and stratigraphic record. Emphasis on landform evolution, soil genesis, soil genesis, climatic history, sea level changes, neotectonics, and environmental impact. Classwork, 2 units; laboratory and fieldwork, 1 unit. [Formerly GEOL 454/GEOL 754]  
(ERTH 846/ERTH 446 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**ERTH 450 Remote Sensing of the Atmosphere and Ocean (Units: 3)**

Prerequisites: MATH 227, ERTH 260 [formerly METR 201] or ERTH 270 [formerly OCN 200] or ERTH 460 [formerly METR 410], PHYS 230 recommended, senior or graduate student for graduate level (850).

Physical principles and applications of satellite and radar remote sensing of the atmosphere and ocean. Classwork, 2 units; laboratory, 1 unit. (Plus-minus letter grade only) [Formerly METR 415/METR 715.]

(ERTH 850/ERTH 450 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**ERTH 454 Engineering Geology (Units: 3)**

Prerequisite: ERTH 210 [formerly GEOL 110] or an upper division engineering course or consent of instructor.

Mechanical properties of earth materials and application of geologic principles to engineering problems. Classwork, 2 units; laboratory and fieldwork, 1 unit. [Formerly GEOL 474]

**ERTH 456 Use of Computers in the Earth Sciences (Units: 2)**

Prerequisite: A college course in one of the earth sciences (geology, meteorology, oceanography) or ERTH 400 [formerly GEOL 401].

Use of computers to access, display, and analyze earth science data. [Formerly METR/OCN 460]

**ERTH 460 Atmospheric Thermodynamics and Cloud Physics (Units: 4)**

Prerequisites: ERTH 160 [formerly METR 100] or ERTH 260 [formerly METR 201], ERTH 456 [formerly METR 460/OCN 460] (may be taken concurrently), PHYS 220.

Composition, structure, and thermodynamics of the atmosphere; cloud and precipitation formation processes. Classwork, 3 units; laboratory, 1 unit. Extra fee required. [Formerly METR 410]

**ERTH 461 Weather Chart Analysis and Discussion (Unit: 1)**

Prerequisite for ERTH 861: Graduate standing or consent of instructor.  
Prerequisite for ERTH 461: ERTH 260 [formerly METR 201] (may be taken concurrently).

Weather chart analysis techniques; weather briefing and discussion. Laboratory. [Formerly METR 301/METR 801]

(ERTH 861/ERTH 461 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**ERTH 465 Weather Analysis and Forecasting I (Units: 4)**

Prerequisites: ERTH 260 [formerly METR 201], ERTH 461 [formerly METR 301], MATH 227, PHYS 111 or (recommended) PHYS 220.

Weather analysis and forecasting as an application of the principles of atmospheric physics and dynamics. Weather satellite analysis techniques. Operational forecasting. Classwork, 2 units; laboratory, 2 units. (Plus/Minus Letter grade only) [Formerly METR 430GW]

**ERTH 470 Physical Oceanography (Units: 4)**

Prerequisites for ERTH 870: Graduate or senior standing and all of the prerequisites listed for ERTH 470.

Prerequisites for ERTH 470: ERTH 170 [formerly OCN 100] or ERTH 172 [formerly OCN 104] or ERTH 270 [formerly OCN 200], PHYS 220; or consent of instructor.

The dynamic character of the ocean environment with emphasis on the properties of sea water, surface heat transfer, Coriolis force, surface and deep ocean circulation, deep and shallow wave phenomena, and underwater sound and optics. Designed for both the physical scientist and marine biologist. Classwork, 3 units; laboratory, 1 unit. [Formerly OCN 420/OCN 720]

(ERTH 870/ERTH 470 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**ERTH 490 Public Weather Forecasting (Units: 1-3)**

Prerequisites: ERTH 160 [formerly METR 100] or ERTH 162 [formerly METR 104] or ERTH 260 [formerly METR 201], and declared Earth Sciences major or participant in the Broadcast Meteorology Certificate program.

Weather forecasting tailored for public use. Forecasting and nowcasting in the media. Weather briefing duties of intern forecaster. May be repeated for a total of 3 units. [Formerly METR 698]

**ERTH 500 Earth Systems II (Units: 3)**

Prerequisite: ERTH 400.

Exploration of how physical and biochemical processes in Earth's systems led to the origin and evolution of the continents, oceans, atmosphere, and life through geologic time. Classwork, 2 units; laboratory and fieldwork, 1 unit.

**ERTH 505 Quantitative Methods in Earth Sciences (Units: 3)**

Prerequisites: ERTH 400, MATH 199 [formerly MATH 109], or sufficient score on calculus pretest.

Quantitative reasoning and techniques, including statistics, applied to problems in earth science. Classwork, 2 units; laboratory and fieldwork, 1 unit. Weekend field trip required. (Plus-minus letter grade only) [Formerly GEOL 125]

**ERTH 510 Structural Geology (Units: 4)**

Prerequisites: ERTH 500, ERTH 420 [formerly GEOL 420], and any one of the following: MATH 199 [formerly MATH 109], satisfactory score on online precalculus test, ERTH 505 [formerly GEOL 125].

Mechanical aspects of rock deformation. Description, classification, and genesis of folds, faults, and other structures of the earth's crust. Evolution of regional structures. Classwork, 2 units; laboratory and fieldwork, 2 units. [Formerly GEOL 430]

**ERTH 515 Sedimentology and Stratigraphy (Units: 4)**

Prerequisites: ERTH 205, ERTH 420 [formerly GEOL 420], ERTH 500.

Sedimentary particles and processes, depositional environments, principles of stratigraphic correlation, and basin analysis. Classwork, 2 units; laboratory and fieldwork, 2 units. (Plus/minus letter grade only) [Formerly GEOL 460GW]

**ERTH 520 Mineralogy and Petrology II (Units: 4)**

Prerequisite for ERTH 820: Graduate standing or consent of instructor.  
Prerequisite for ERTH 520: ERTH 420 [formerly GEOL 420] or consent of instructor.

Advanced mineralogy and igneous and metamorphic petrology with a focus on physical and chemical processes in the earth. Classwork, 2 units; laboratory and fieldwork, 2 units. Extra fee required. [Formerly GEOL 426/GEOL 726]  
(ERTH 820/ERTH 520 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**ERTH 522 Geochemistry (Units: 4)**

Prerequisites: EARTH 420 [formerly GEOL 420], MATH 226 or EARTH 505 [formerly GEOL 125], or consent of instructor.

Chemistry of the earth including cosmochemistry, crystal chemistry, thermodynamics, aqueous geochemistry, stable and radiogenic isotope geochemistry, major and trace element geochemistry, and analytical techniques. Classwork, 3 units; laboratory, 1 unit. [Formerly GEOL 480/GEOL 780] (ERTH 822/ERTH 522 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**ERTH 524 Marine Geology (Units: 3)**

Prerequisite: EARTH 110 [formerly GEOL 100] or EARTH 210 [formerly GEOL 110] or EARTH 112 [formerly GEOL 104], or consent of instructor.

Intended for majors only. Origin, age, and geological history of the ocean basins; source and distribution of marine deposits; geological evidence concerning continental drift, sea floor spreading, and plate tectonics; current research in marine geology. [Formerly GEOL 467]

**ERTH 526 Ore Deposits (Units: 4)**

Prerequisite for EARTH 826: Graduate standing; EARTH 420 [formerly GEOL 420]; or consent of instructor.

Prerequisite for EARTH 526: EARTH 420 [formerly GEOL 420] or consent of instructor.

The origin of ore deposits emphasizing the mineralogic, petrologic, and plate tectonic environments of major deposits from around the world; chemical and physical controls on ore transport and deposition; techniques of mineral exploration and mining. Classwork, 3 units; laboratory and fieldwork, 1 unit. [Formerly GEOL 485/GEOL 785] (ERTH 826/ERTH 526 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**ERTH 535 Planetary Climate Change (Units: 4)**

Prerequisites: At least 9 units of physical sciences coursework.

Interdisciplinary investigation of physical processes, principles, and tools contributing to our understanding of climate and climate change. Classwork, 3 units; laboratory, 1 unit. [Formerly GEOL/METR/OCN 405]

**ERTH 544 Groundwater Contamination (Units: 3)**

Prerequisites for EARTH 844: Graduate or senior standing; EARTH 744 [formerly GEOL 775].

Prerequisites for EARTH 544: EARTH 444 [formerly GEOL 475] or consent of instructor; CHEM 115 recommended.

Application of hydrogeologic principles to solution of groundwater contamination problems. Classwork, 2 units; laboratory and fieldwork, 1 unit. [Formerly GEOL 476/GEOL 776]

(ERTH 844/ERTH 544 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**ERTH 556 Computer Programming with Applications in the Earth Sciences (Units: 3)**

Prerequisites: An introductory course in one of the earth sciences (geology, meteorology, oceanography) or EARTH 400 [formerly GEOL 401], EARTH 456 [formerly METR/OCN 460] recommended.

Principles of computer programming, illustrated with applications in the earth sciences. [Formerly METR/OCN 465]

**ERTH 558 Consulting Meteorology and Oceanography (Units: 2)**

Prerequisites: Senior or graduate standing in meteorology, oceanography, geology, or geography, consent of instructor.

Forensic meteorology and climatology, climatological and meteorological site assessments, site specific operational forecasting, AMS program for professional certification as consulting meteorologist, the meteorologist as expert witness, depositions and court testimony. [Formerly METR 590/METR 790] (ERTH 858/ERTH 558 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**ERTH 560 Atmospheric Dynamics I (Units: 4)**

Prerequisites: PHYS 220, MATH 228, EARTH 460 [formerly METR 410], or consent of instructor. MATH 245, EARTH 556 [formerly METR 465] recommended.

Basic dynamical equations governing atmospheric motions, particularly on large scales. Classwork, 3 units; laboratory, 1 unit. Extra fee required. [Formerly METR 420]

**ERTH 565 Weather Analysis and Forecasting II (Units: 3)**

Prerequisites for EARTH 865: Graduate standing and all of the prerequisites listed for EARTH 565.

Prerequisites for EARTH 565: EARTH 430 [formerly OCN 320/METR 320], EARTH 465 [formerly METR 430GW], or consent of instructor.

Quasi-geostrophic theory in the understanding of mid-latitude synoptic systems. Evolution and motion of mid/upper tropospheric waves. Fronts and jet streaks. Mesoscale and severe weather meteorology. Classwork, 2 units; laboratory, 1 unit. [Formerly METR 500/METR 800] (ERTH 865/ERTH 565 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**ERTH 600GW Earth's Climate History - GEAR (Units: 3)**

Prerequisites: ENG 214 with a grade of C- or better, CHEM 115, EARTH 500 (may be taken concurrently).

Examination of Earth's climate history over the last 50 million years; analysis of different mechanisms of climate forcing including tectonic changes, greenhouse gas forcing on long and short time scales, orbital forcing, and internal climate feedback. Classwork, 2 units; laboratory, 1 unit. (ABC/NC grading only) [Formerly GEOL 458GW]

**Course Attributes:**

- Graduation Writing Assessment

**ERTH 610 Neotectonics (Units: 3)**

Prerequisites for EARTH 810: Graduate or senior standing; EARTH 510 [formerly GEOL 430]; or consent of instructor.

Prerequisites for EARTH 610: Senior standing; EARTH 510 [formerly GEOL 430]; or consent of instructor.

Principles of earthquake geology: plate tectonics, fault mechanics, basic seismology, geodesy, tectonic geomorphology, seismic hazard analysis, and case studies of large historical earthquakes. Classwork, 2 units; laboratory and fieldwork, 1 unit. (Plus-minus letter grade only) [Formerly GEOL 470/GEOL 770]

(ERTH 810/ERTH 610 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**ERTH 620 Field Methods in Geology (Units: 2)**

Prerequisites: EARTH 210 [formerly GEOL 110], EARTH 510 [formerly GEOL 420], EARTH 515 [formerly GEOL 460GW], satisfactory standing in the major, or consent of instructor.

Field methods: plotting features on topographic maps and aerial photographs, use of field instruments, mapping, and preparation of geologic reports. Laboratory and fieldwork. [Formerly GEOL 695]

**ERTH 642 Watershed Assessment and Restoration (Units: 4)**

Prerequisites: GEOG 101 or EARTH 210, GEOG 603, MATH 199 or sufficient score on calculus pretest.

Assessing and restoring watersheds and streams. Hydrologic and watershed processes; variables influencing runoff and erosion; hillslope and stream restoration techniques. Classwork, 3 units; fieldwork and GIS laboratory, 1 unit. [CSL may be available]

(This course is offered as GEOG 642 and EARTH 642. Students may not repeat the course under an alternate prefix.)

**ERTH 643 Biogeomorphology of Sierra Nevada Streams and Meadows (Units: 2)**

Prerequisite: GEOG 101 or EARTH 110.

Understanding the complex interactions of hydrologic and biogeomorphic systems on streams and meadows in the northern Sierra Nevada, and learning field methods for assessing stream function as they respond to long-term impacts related to glacial history and short-term human impacts of timber extraction, road construction, and grazing. Laboratory.

(This course is offered as GEOG 643 and EARTH 643. Students may not repeat the course under an alternate prefix.)

**ERTH 652 Geoscience Partners in K-12 Education (Units: 4)**

Prerequisite: Completion of at least one upper division course in your major field of study.

Introduction to geoscience K-12 teaching and learning; examine understanding of geoscience, discuss science education literature, and analyze science lessons and student learning. Classwork, 2 units; fieldwork, 2 units. [Formerly GEOL/OCN/METR 652]

**ERTH 660 Atmospheric Dynamics II (Units: 2)**

Prerequisites: EARTH 560 [formerly METR 420], MATH 245, PHYS 240 recommended.

Development of the vorticity equation and the quasi-geostrophic approximation to the full dynamical equations governing atmospheric behavior. Classwork, 1 unit; laboratory, 1 unit. [Formerly METR 520]

**ERTH 668 Analysis and Prediction of Severe Storms (Units: 3)**

Prerequisites: Senior or graduate standing in meteorology; EARTH 465 [formerly METR 430GW], EARTH 660 [formerly METR 520]; consent of instructor.

Large and local-scale controls on severe storms. Morphology of severe thunderstorms. Thunderstorm spectrum. Tornadoic storms. Severe storms forecasting and analysis techniques. [Formerly METR 535/METR 835] (ERTH 868/ERTH 668 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**ERTH 690 Earth Sciences Capstone Presentation (Unit: 1)**

Prerequisite: Restricted to Earth Sciences seniors (BS/BA), EARTH 695 or EARTH 698 (may be taken concurrently).

Principles and best practices of presenting scientific information orally and by poster. Practice presenting senior project or senior thesis research. Presentation of senior project at a poster session or oral thesis defense open to the public. (Plus-minus letter grade only)

**ERTH 693 Cooperative Education Program (Units: 6-12)**

Prerequisites: ENG 114, COMM 150, consent of instructor. Intended for Earth Sciences majors.

Objectives are career development, occupational experience, and educational subsidy. Units do not count toward the degree. (CR/NC grading only) [Formerly GEOL 693]

**ERTH 694 Cooperative Education in Earth Sciences (Units: 1-3)**

Prerequisite: Intended for Earth Sciences majors.

Objectives are career development, occupational experience, and educational subsidy. Units do not count toward degree. [Formerly GEOL 694]

**ERTH 695 Senior Project (Units: 1-3)**

Prerequisites: Senior standing in Earth Sciences, 3.0 GPA in major course work, and consent of Earth Sciences faculty adviser.

Directed, original research on an Earth Sciences-related problem. [Formerly GEOL 697, METR 697, and OCN 697]

**ERTH 697 Undergraduate Research (Units: 2)**

Prerequisites: Senior standing, consent of instructor.

Research activities, including literature review, project design, data collection, and analysis. [Formerly GEOL 697]

**ERTH 698 Senior Thesis (Units: 2)**

Prerequisite: EARTH 697 [formerly GEOL 697] (may be taken concurrently).

Undergraduate research, to include a written report and oral presentation approved by the thesis committee. [Formerly GEOL 698]

**ERTH 699 Independent Study (Units: 1-3)**

Prerequisite: Consent of instructor.

Independent study in the laboratory, field, or library under the direction of a faculty member. The student must present a written report of the work accomplished to the faculty. [Formerly GEOL/METR/OCN 699]

**ERTH 700 Graduate Seminar in Geosciences (Units: 2)**

Prerequisite: Graduate standing.

Introduction to the graduate program; discussion of interdisciplinary geoscience topics; format to include speakers and assigned readings. [Formerly GEOL/METR/OCN 700]

**ERTH 701 Research Methods in Geosciences (Units: 3)**

Prerequisite: EARTH 700 [formerly GEOL/METR/OCN 700] or consent of instructor.

Application of research methods: problem formulation, literature searches, proposal writing, scientific report writing, and oral presentation. Preparation of proposal for master's thesis. [Formerly GEOL/METR/OCN 701]

**ERTH 702 Quantitative Methods in Geosciences (Units: 3)**

Prerequisites: Courses in basic statistics, calculus, and computer applications, or consent of instructor.

Quantitative methods and computer techniques necessary for geoscience problem-solving. Classwork, 2 units; laboratory and fieldwork, 1 unit. (Plus-minus letter grade only) [Formerly GEOL/METR/OCN 702]

**ERTH 730 Paleoclimate (Units: 2)**

Prerequisite: Graduate standing or consent of instructor.

Reading and discussion of primary cutting edge literature on climate science. (Plus-minus letter grading only) [Formerly GEOL 794]

**ERTH 735 Science of Anthropogenic Climate Change (Units: 3)**

Prerequisite: EARTH 535 [formerly GEOL/METR/OCN 405] or GEOG 313 or consent of instructor.

Examination of the current scientific understanding of anthropogenic climate change. IPCC Report observations of climate change, paleoclimate, climate feedbacks, climate models, and climate projections. [Formerly GEOL 756]

**ERTH 741 Electron Microscopy (Units: 4)**

Prerequisite: Graduate or senior standing, or consent of instructor.

Preparation of biological and inorganic materials for scanning and transmission electron microscopy, x-ray microanalysis, EBSD, CL, operation of the electron microscope(s), and data interpretation. Classwork, 1 unit; laboratory, 3 units.

Extra fee required.

(This course is offered as BIOL 741, CHEM 741, and EARTH 741. Students may not repeat the course under an alternate prefix.)

**ERTH 744 Hydrogeology (Units: 4)**

Prerequisites for EARTH 744: Graduate or senior standing; EARTH 210 [formerly GEOL 110], EARTH 505 [formerly GEOL 125] or MATH 226, PHYS 111/PHYS 112 or PHYS 220/PHYS 222 or upper division engineering course; or consent of instructor.

Prerequisites for EARTH 444: EARTH 210 [formerly GEOL 110], EARTH 505 [formerly GEOL 125] or MATH 226, PHYS 111/PHYS 112 or PHYS 220/PHYS 222, or consent of instructor.

Physical and geologic factors controlling the occurrence and dynamics of groundwater. Chemical parameters and distribution. Aquifer testing and analysis. Classwork, 3 units; laboratory and fieldwork, 1 unit. [Formerly GEOL 475/GEOL 775]

(ERTH 744/ERTH 444 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**ERTH 750 Our Dynamic Classroom (Unit: 1)**

Prerequisite: Graduate standing or consent of instructor.

Teaching and Learning Community. Exploration of innovative pedagogical techniques and integrating laboratory and lecture components for introductory geosciences courses. (Plus-minus letter grade only) [Formerly GEOL/METR/OCN 792]

**ERTH 765 Synoptic Meteorology of Mid-latitude Oceans (Units: 3)**

Prerequisites: Graduate standing or consent of instructor.

Synoptic scale analysis and discussion of the extratropical systems of the mid-latitude oceans. Organized convective systems in the eastern Pacific and adjacent coastal margins. California weather patterns. [Formerly METR 825]

**ERTH 790 Advanced Public Weather Forecasting (Units: 1-3)**

Prerequisite: EARTH 490 [formerly METR 698] and/or consent of instructor.

Direction of a forecast office. Students assume lead forecaster responsibilities in administration of the SF State Public Weather Forecast Center. [Formerly METR 798]

**ERTH 795 Selected Topics in the Geosciences (Units: 3)**

Prerequisite: Graduate standing or consent of instructor.

Topic to be specified in Class Schedule. May be repeated for a maximum of 12 units when topics vary. (Plus-minus letter grade only) [Formerly GEOL 795]

**ERTH 810 Neotectonics (Units: 3)**

Prerequisites for EARTH 810: Graduate or senior standing; EARTH 510 [formerly GEOL 430]; or consent of instructor.

Prerequisites for EARTH 610: Senior standing; EARTH 510 [formerly GEOL 430]; or consent of instructor.

Principles of earthquake geology: plate tectonics, fault mechanics, basic seismology, geodesy, tectonic geomorphology, seismic hazard analysis, and case studies of large historical earthquakes. Classwork, 2 units; laboratory and fieldwork, 1 unit. (Plus-minus letter grade only) [Formerly GEOL 470/GEOL 770]

(ERTH 810/ERTH 610 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**ERTH 820 Mineralogy and Petrology II (Units: 4)**

Prerequisite for EARTH 820: Graduate standing or consent of instructor.

Prerequisite for EARTH 520: EARTH 420 [formerly GEOL 420] or consent of instructor.

Advanced mineralogy and igneous and metamorphic petrology with a focus on physical and chemical processes in the earth. Classwork, 2 units; laboratory and fieldwork, 2 units. Extra fee required. [Formerly GEOL 426/GEOL 726]

(ERTH 820/ERTH 520 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**ERTH 822 Geochemistry (Units: 4)**

Prerequisites: EARTH 420 [formerly GEOL 420], MATH 226 or EARTH 505 [formerly GEOL 125], or consent of instructor.

Chemistry of the earth including cosmochemistry, crystal chemistry, thermodynamics, aqueous geochemistry, stable and radiogenic isotope geochemistry, major and trace element geochemistry, and analytical techniques. Classwork, 3 units; laboratory, 1 unit. [Formerly GEOL 480/GEOL 780]

(ERTH 822/ERTH 522 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**ERTH 825 Geomorphology (Units: 4)**

Prerequisites for EARTH 825: Graduate or senior standing; and all of the prerequisites listed for EARTH 425.

Prerequisites for EARTH 425: EARTH 210 [formerly GEOL 110], EARTH 505 [formerly GEOL 125] or MATH 226, PHYS 111 and PHYS 112 or PHYS 220 and PHYS 222, or consent of instructor.

Landscapes, their geologic evolution, and the processes which create and modify them. Classwork, 3 units; laboratory and fieldwork, 1 unit. [Formerly GEOL 450/GEOL 750]

(ERTH 825/ERTH 425 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**ERTH 826 Ore Deposits (Units: 4)**

Prerequisite for EARTH 826: Graduate standing; EARTH 420 [formerly GEOL 420]; or consent of instructor.

Prerequisite for EARTH 526: EARTH 420 [formerly GEOL 420] or consent of instructor.

The origin of ore deposits emphasizing the mineralogic, petrologic, and plate tectonic environments of major deposits from around the world; chemical and physical controls on ore transport and deposition; techniques of mineral exploration and mining. Classwork, 3 units; laboratory and fieldwork, 1 unit. [Formerly GEOL 485/GEOL 785]

(ERTH 826/ERTH 526 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**ERTH 834 Coastal Processes (Units: 3)**

Prerequisites for EARTH 834: Graduate or senior standing and all of the prerequisites listed for EARTH 434.

Prerequisites for EARTH 434: MATH 226, PHYS 111 or PHYS 220, or consent of instructor.

Dynamics of the nearshore ocean and interactions with the coast and beaches. Topics include tides, coastal waves and currents, sediment transport and beaches, inner shelf processes, and estuarine dynamics. Classwork, 2 units; laboratory and fieldwork, 1 unit. [Formerly OCN 410/OCN 710]  
(ERTH 834/ERTH 434 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**ERTH 844 Groundwater Contamination (Units: 3)**

Prerequisites for EARTH 844: Graduate or senior standing; EARTH 744 [formerly GEOL 775].

Prerequisites for EARTH 544: EARTH 444 [formerly GEOL 475] or consent of instructor; CHEM 115 recommended.

Application of hydrogeologic principles to solution of groundwater contamination problems. Classwork, 2 units; laboratory and fieldwork, 1 unit. [Formerly GEOL 476/GEOL 776]  
(ERTH 844/ERTH 544 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**ERTH 846 Quaternary Geology and Soils (Units: 3)**

Prerequisites for EARTH 846: Graduate standing; EARTH 210 [formerly GEOL 110]; or consent of instructor.

Prerequisites for EARTH 446: Senior standing; EARTH 210 [formerly GEOL 110]; or consent of instructor.

Pleistocene and Holocene environments, and their geomorphic and stratigraphic record. Emphasis on landform evolution, soil genesis, soil genesis, climatic history, sea level changes, neotectonics, and environmental impact. Classwork, 2 units; laboratory and fieldwork, 1 unit. [Formerly GEOL 454/GEOL 754]  
(ERTH 846/ERTH 446 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**ERTH 850 Remote Sensing of the Atmosphere and Ocean (Units: 3)**

Prerequisites: MATH 227, EARTH 260 [formerly METR 201] or EARTH 270 [formerly OCN 200] or EARTH 460 [formerly METR 410], PHYS 230 recommended, senior or graduate student for graduate level (850).

Physical principles and applications of satellite and radar remote sensing of the atmosphere and ocean. Classwork, 2 units; laboratory, 1 unit. (Plus-minus letter grade only) [Formerly METR 415/METR 715.]  
(ERTH 850/ERTH 450 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**ERTH 858 Consulting Meteorology and Oceanography (Units: 2)**

Prerequisites: Senior or graduate standing in meteorology, oceanography, geology, or geography, consent of instructor.

Forensic meteorology and climatology, climatological and meteorological site assessments, site specific operational forecasting, AMS program for professional certification as consulting meteorologist, the meteorologist as expert witness, depositions and court testimony. [Formerly METR 590/METR 790]  
(ERTH 858/ERTH 558 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**ERTH 861 Weather Chart Analysis and Discussion (Unit: 1)**

Prerequisite for EARTH 861: Graduate standing or consent of instructor.

Prerequisite for EARTH 461: EARTH 260 [formerly METR 201] (may be taken concurrently).

Weather chart analysis techniques; weather briefing and discussion. Laboratory. [Formerly METR 301/METR 801]  
(ERTH 861/ERTH 461 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**ERTH 865 Weather Analysis and Forecasting II (Units: 3)**

Prerequisites for EARTH 865: Graduate standing and all of the prerequisites listed for EARTH 565.

Prerequisites for EARTH 565: EARTH 430 [formerly OCN 320/METR 320], EARTH 465 [formerly METR 430GW], or consent of instructor.

Quasi-geostrophic theory in the understanding of mid-latitude synoptic systems. Evolution and motion of mid/upper tropospheric waves. Fronts and jet streaks. Mesoscale and severe weather meteorology. Classwork, 2 units; laboratory, 1 unit. [Formerly METR 500/METR 800]  
(ERTH 865/ERTH 565 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**ERTH 868 Analysis and Prediction of Severe Storms (Units: 3)**

Prerequisites: Senior or graduate standing in meteorology; EARTH 465 [formerly METR 430GW], EARTH 660 [formerly METR 520]; consent of instructor.

Large and local-scale controls on severe storms. Morphology of severe thunderstorms. Thunderstorm spectrum. Tornadoic storms. Severe storms forecasting and analysis techniques. [Formerly METR 535/METR 835]  
(ERTH 868/ERTH 668 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**ERTH 870 Physical Oceanography (Units: 4)**

Prerequisites for EARTH 870: Graduate or senior standing and all of the prerequisites listed for EARTH 470.

Prerequisites for EARTH 470: EARTH 170 [formerly OCN 100] or EARTH 172 [formerly OCN 104] or EARTH 270 [formerly OCN 200], PHYS 220; or consent of instructor.

The dynamic character of the ocean environment with emphasis on the properties of sea water, surface heat transfer, Coriolis force, surface and deep ocean circulation, deep and shallow wave phenomena, and underwater sound and optics. Designed for both the physical scientist and marine biologist. Classwork, 3 units; laboratory, 1 unit. [Formerly OCN 420/OCN 720]  
(ERTH 870/ERTH 470 is a paired course offering. Students who complete the course at one level may not repeat the course at the other level.)

**ERTH 896 Directed Reading in the Geosciences (Units: 3)**

Prerequisite: Graduate status or consent of adviser.

Supervised literature research in a specific area chosen on the basis of individual student need. Readings, tutorial discussion, and research report or creative projects. May be repeated for a total of 6 units. [Formerly GEOL 896]

**ERTH 897 Research Project (Units: 1-3)**

Prerequisites: Graduate standing, EARTH 700 [formerly GEOL 700/METR 700/OCN 700], EARTH 701 [formerly GEOL 701/METR 701/OCN 701].

Thesis research incorporates all aspects of investigative studies from data collection to data analysis. May be repeated for a total of 6 units. [Formerly GEOL 897]



**ERTH 898 Master's Thesis (Units: 3)**

Prerequisites: Graduate standing, ERTH 700 [formerly GEOL 700/METR 700/OCN 700], ERTH 701 [formerly GEOL 701/METR 701/OCN 701], ERTH 702 [formerly GEOL 702/METR 702/OCN 702], consent of instructor and approval of Advancement to Candidacy (ATC) and Culminating Experience (CE) forms by Graduate Studies.

Advancement to Candidacy (ATC) and Proposal for Culminating Experience Requirement forms must be approved by the Graduate Division before registration. [Formerly GEOL/METR/OCN 898]

**ERTH 899 Independent Study (Units: 1-3)**

Prerequisites: Graduate status and consent of adviser.

Independent study in the laboratory or field under the direction of a faculty member. Student must present a detailed written report of the work accomplished to the department. May be repeated for a total of 3 units. [Formerly GEOL 899]