# Dual-Title Doctoral Program

# in Climate Science (CLSCI) Handbook

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## Program Overview

The Climate Science dual-title degree program is administered by the Department of Meteorology and Atmospheric Science for the participating graduate programs. The program director chairs a Climate Science program committee with representatives from each participating department. The program committee maintains program definition, identifies courses appropriate to the program, and recommends policy and procedures for the program's operation to the dean of the Graduate School and to the deans of the participating colleges. The dual-title degree program is offered through participating programs in the College of Earth and Mineral Sciences and, where appropriate, other graduate programs in the University. The program enables students from several graduate programs to gain the perspectives, techniques, and methodologies of Climate Science, while maintaining a close association with major program areas of application. Climate Science is a field devoted to the study of Earth’s climate in the past, present, and future. A particular focus is understanding the effects of human activities (anthropogenic impacts) and natural forcing on climate.

The Climate Science dual-title doctoral degree program will:

* Provide a rich curriculum in climate dynamics and observations, numerical and statistical methods, the physical climate system, biogeochemistry, and human dimensions of climate change to ensure that all Climate Science students have a broad and deep understanding of the science and its application to society.
* Develop a cohort of Ph.D. students across departments, leading to enhanced appreciation for and understanding of the various facets of Climate Science.
* Supply highly trained Ph.D. graduates to the academic, government and private sectors to meet the growing need for climate information and climate impacts.

## Admission Requirements

Students must be admitted to their primary graduate program and The Graduate School before they can apply for admission to the dual-title degree program. Students must be admitted into the dual-title degree program in Climate Science **no later than the end of the fourth semester (not counting summer semesters) of entry into the primary Ph.D. program and before taking the comprehensive exam**.

Graduate students with research and educational interests in climate science may apply to the Climate Science Dual-Title Degree Program. Students must submit to the program director transcripts of their undergraduate and graduate course work, a written personal statement indicating the career goals they hope to serve by attaining a Climate Science dual title, and a statement of support from their dissertation adviser. A strong preparation in the basic sciences is expected, with evidence of an interest in multiple disciplines.

## Degree Requirements

To qualify for a dual-title degree, students must satisfy the requirements of the primary graduate program in which they are enrolled. In addition, they must satisfy the degree requirements for the dual-title in Climate Science, listed below.

Students are required to take 15 credits of approved courses, detailed below.

The qualifying examination in the primary graduate degree program satisfies the qualifying exam requirement for the dual-title degree program in Climate Science.

In addition to the [general Graduate Council requirements for Ph.D. committees,](https://gradschool.psu.edu/graduate-education-policies/gcac/gcac-600/gcac-602-phd-committee-formation/) the Ph.D. committee of a Climate Science dual-title doctoral degree student must include at least one member of the [Climate Science Graduate Faculty](https://secure.gradsch.psu.edu/gpms/index.cfm?searchType=fac&prog=CLSCI). Faculty members who hold appointments in both programs’ Graduate Faculty may serve in a combined role. If the chair of the doctoral committee is not also a member of the Graduate Faculty in Climate Science, the member of the committee representing Climate Science must be appointed as co-chair. The Climate Science representative on the student’s doctoral committee will develop questions for and participate in the evaluation of the comprehensive examination.

Students in the dual-title program are required to write and orally defend a dissertation on a topic that is approved in advance by their doctoral committee and reflects their original research and education in both their primary graduate program and Climate Science. Upon completion of the doctoral dissertation, the candidate must pass a final oral examination (the dissertation defense) to earn the Ph.D. degree. The dissertation must be accepted by the doctoral committee, the head of the graduate program, and the Graduate School.

## Student Aid

Graduate assistantships and other forms of student aid may be available through the student’s primary graduate program; these are described in the [Student Aid](https://gradschool.psu.edu/graduate-funding/) section of the *Graduate Bulletin*. Students on graduate assistantships must adhere to the [course load limits set forth in the *Graduate Bulletin.*](https://gradschool.psu.edu/graduate-education-policies/gsad/gsad-900/gsad-901-graduate-assistants/)

## Courses

Graduate courses carry numbers from 500 to 699 and 800 to 899. Advanced undergraduate courses numbered between 400 and 499 may be used to meet some graduate degree requirements when taken by graduate students. Courses below the 400 level may not; a graduate student may register for or audit these courses in order to make up deficiencies or to fill in gaps in previous education but not to meet requirements for an advanced degree.

## Description of Required Climate Science Coursework

The minimum academic requirements for the dual-title Ph.D. degree in Climate Science begin with the course work and other requirements of the primary program. Students must also take a total of at least 3 credits of approved 400-, 500-, or 800-level courses in each of two specific areas: 1) Climate dynamics seminar and 2) Climate dynamics and observations, as well as 3 credits of approved 400-, 500-, or 800-level courses in each of three of the four remaining areas: 3) Physical climate system, 4) Biogeochemistry of the climate system, 5) Numerical methods and data analysis, and 6) Human dimensions of climate change, for a total of 15 credits. Students are not eligible to take a 400-level course in any one of the areas if the course is offered by their primary graduate program. All students must take at least one 500-level course, and at least one course must be from outside of their core disciplinary expertise. Finally, all of the courses offered in Climate dynamics and observations will include sufficient material in radiative transfer and the greenhouse effect to ensure that the students clearly understand the underlying physics of climate and climate change. Students or faculty may request that the Climate Science program committee consider approval of elective designations for any course, including temporary approvals for experimental or variable-title courses.

Students enrolled in the dual-title degree program should expect to spend one additional semester in order to obtain the dual-title degree, as some of the required course work should also serve their major graduate degree program. Advisers will work with the students to select the courses in order that the requirements are met in a timely manner. Funding for graduate student support will come from the home graduate program.

The approved courses for the Climate Science dual-title program are:

1. **Climate dynamics seminar (3 credits total required)**

 METEO 575—Climate dynamics seminar (1 or 2 credits)

This course is key to building the student cohort each year. It will involve reading and discussing papers of current interest that span the disciplines involved in the dual-title program. Students will take the course twice, once for 1 credit (reading and discussion only) and once for 2 credits (with requirements for writing papers). Faculty members involved in the dual-title program are expected to participate in the seminar regularly.

1. **Climate dynamics and observations (3 credits required)**

 GEOG 412—Climatic change and variability (3)

GEOG 417—Satellite climatology (3)

METEO 470—Climate dynamics (3)

METEO 570—Climate system dynamics (3)

These courses are critical for developing a foundational understanding of climate science and include sufficient material in radiative transfer and the greenhouse effect to ensure that the students clearly understand the underlying physics of climate and climate change.

1. **Physical climate system (3 credits, this is one of four remaining categories)**

C E 561—Surface hydrology (3)

GEOG 413—Cryosphere and climate systems (3)

GEOSC 405 (SOILS 405)—Hydropedology (3)

METEO 421—Atmospheric dynamics (4)

 METEO 422—Advanced atmospheric dynamics (3)

 METEO 436—Radiation and climate

 METEO 451—Introduction to physical oceanography (3)

 METEO 521—Dynamical meteorology (3)

 METEO 535—Radiative transfer (3)

 METEO 551—Physical oceanography (3)

METEO 563—Bioclimatology (3)

These courses delve deeper into the physical processes that govern the climate system.

1. **Biogeochemistry of the climate system (3 credits, this is one of four remaining categories)**

C E 475—Water quality chemistry (4)

GEOSC 410—Marine biogeochemistry (3)

 GEOSC 419—The organic geochemistry of natural waters and sediments (3)

GEOSC 502—Evolution of the biosphere (4)

 METEO 532—Chemistry of the atmosphere (3)

METEO 561—Global carbon cycle (3)

These courses explore the relationships between climate and the chemical reactions in the atmosphere, oceans, land, and living organisms that create the composition of the natural environment.

1. **Numerical methods and data analysis (3 credits, one of four remaining categories)**

C E 461—Water-resource engineering (3)

C E 555—Groundwater hydrology: Modeling and analysis (3)

FOR 565—GIS based socio-ecological landscape analysis (3)

GEOG 464—Advanced spatial analysis (3)

GEOSC 450—Risk analysis in the Earth sciences (3)

METEO 473—Application of computers to Meteorology (3)

METEO 515—Practical statistics for atmospheric sciences (3)

METEO 523—Modeling the climate system (3)

METEO 527—Data assimilation (3)

STAT 414—Introduction to probability theory (3)

STAT 415—Introduction to mathematical statistics (3)

STAT 463—Applied time series analysis (3)

STAT 500—Applied statistics (3)

STAT 505—Applied multivariate statistical analysis (3)

STAT 557—Data mining I (3)

These courses provide advanced training in the quantitative techniques used to predict climate and/or interpret observations of the climate system.

1. **Human dimensions of climate change (3 credits, one of four remaining categories)**

ANTH 432—Environmental archaeology (3)

GEOG 438—Human dimensions of global warming (3)

 GEOG 510—Seminar in physical geography (3)

These courses explore how climate change impacts society and the natural environment.

## Degree Conferred

Students electing this degree program through participating programs earn a degree with a dual title in the Ph.D., i.e., Ph.D. in (graduate program name) and Climate Science. The following graduate programs offer dual degrees in Climate Science:

* Ph.D. in Anthropology and Climate Science
* Ph.D. in Civil Engineering and Climate Science
* Ph.D. in Geography and Climate Science
* Ph.D. in Geosciences and Climate Science
* Ph.D. in Meteorology and Atmospheric Science and Climate Science
* Ph.D. in Statistics and Climate Science