



Graduate Student Handbook Fall 2022

DEPARTMENT DESCRIPTION: GRADUATE PROGRAM IN ATMOSPHERIC AND OCEANIC SCIENCES

The Department of Atmospheric and Oceanic Sciences (ATOC) at the University of Colorado Boulder provides a world-class, interdisciplinary research and educational environment to examine the dynamical, physical, and chemical processes that occur in the atmosphere and ocean. A major theme is the establishment of a physical basis for observing, modeling, and understanding climate and global change.

The University of Colorado Boulder is located in a region having the greatest concentration of geophysical researchers in the nation and perhaps the world. The proximity of ATOC to this atmospheric and oceanic science excellence is the foundation of our unique philosophy and vision, which elevates our department to one of worldwide prominence. The guiding principle of ATOC is to be the focal point for atmospheric and oceanic science education and research training in this geographic region of world-renowned excellence. The University of Colorado, Boulder was ranked number one in atmospheric science in Shanghai Ranking's 2018, 2019, 2020 and 2021 Global Ranking of Academic Subjects.

ATOC's faculty members study Earth's weather and climate from seafloor to the exosphere and from the tropics to the polar ice sheets. We aim to understand and respond to climate change and improve climate change projections in the atmosphere, cryosphere and oceans.

ATOC has been fortunate to attract the most outstanding graduate students in the field. Our students receive a significant number of fellowships and nationally recognized awards each year. They provide excellent instruction to CU's undergraduates as teaching assistants. They make scientific advances while conducting innovative research. Our graduate students go on to successful careers in academia, national research institutes, and private industry.

Graduate students, research staff, and faculty work together on a wide range of research topics: large-scale dynamics of the ocean and the atmosphere; air-sea interaction; radiative transfer and remote sensing of the ocean and the atmosphere; sea ice and its role in climate; cloud-climate interactions; atmospheric chemistry and aerosols; ocean biogeochemistry; atmospheric technology; extended weather and climate prediction; hydrological processes; boundary layer measurement and modeling; and planetary atmospheres.

Interdisciplinary education and research opportunities exist with the Hydrology Program and the Center for Science and Technology Research Program. Interdisciplinary research opportunities also exist with the Cooperative Institute for Environmental Studies (CIRES), the Institute for Arctic and Alpine Research (INSTAAR), the Laboratory for Atmospheric and Space Physics (LASP), The Renewable and Sustainable Energy Institute (RASEI), and many other labs in the area.

ATOC has extensive computer facilities and laboratories in remote sensing, chemistry, and hydrodynamics. The presence of leading laboratories in the environmental sciences in Boulder, including the National Center for Atmospheric Research (NCAR), the NOAA Environmental Research Laboratories, and the National Renewable Energy Laboratory (NREL) provides additional opportunities for a rich educational experience. Opportunities also exist for involvement in field programs.

Areas of Study and Research

ATOC is an interdisciplinary program that provides an educational and research environment to examine the dynamical, physical, and chemical processes that occur in the atmosphere and the ocean. A major theme is the establishment of a physical basis for understanding, observing, and modeling climate and global change.

Graduate students admitted to ATOC will be eligible to receive an advanced degree in Atmospheric and Oceanic Sciences. Graduate students outside of ATOC can pursue the Graduate Certificate in Atmospheric and Oceanic Sciences or a Graduate Certificate in Oceanography while earning a graduate degree from another department at CU Boulder, or while taking coursework as a non-degree seeking student through Continuing Education's ACCESS Program provided they have already earned a bachelor's degree and meet the course prerequisites.

Department Culture

ATOC strives to provide a learning environment that is supportive, inclusive, accessible, and free of bias, discrimination, and harassment. ATOC is working to create a culture that attracts diverse voices and empowers everyone to be their authentic whole selves as we educate and conduct outstanding research at the forefront of our science. All ATOC graduate students should expect respectful and fair treatment from other department members. Enrolled ATOC graduate students are expected to abide by the CU Boulder student code of conduct at all times, to treat one another with mutual respect, to value and embrace differences, and to support one another in academic coursework and research.

Degrees Offered

Master's Degree (MS) ^{SEP} For both thesis and non-thesis options, a total of 30 credit hours is required with at least 15 credit hours of ATOC courses numbered 5000 and above. Other specific course requirements are in the ATOC Graduate Handbook. For the thesis option, the final examination consists of an oral exam on the thesis. The non-thesis option requires the successful completion of a written final examination based on ATOC regular coursework requirements.

Doctoral Degree (PhD) ^{SEP} A total of 36 credit hours of regular coursework is required, of which 30 hours must be numbered 5000 or above, with at least 18 credit hours of ATOC graduate lecture courses including core ATOC course requirements, and a graduate-level course in applied or computational mathematics. In addition, 30 credit

hours of dissertation must be completed per Graduate School rules and requirements. Students must pass a two-part comprehensive examination before admission into candidacy. Part I of the comprehensive examination is a written exam based on core course material and is normally taken in the second year. Part II of the comprehensive examination is normally taken in the third year and is an oral examination based on an original research paper prepared by the student. After the PhD dissertation has been submitted, a final examination of the dissertation will be conducted. For further information, please contact:

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Web: <https://www.colorado.edu/atoc/>

ADMISSION REQUIREMENTS & APPLICATION PROCEDURES

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ATOC academic requirements

For acceptance into the Department of Atmospheric and Oceanic Sciences (ATOC) graduate program, the following requirements must be met:

- Hold a baccalaureate degree from a college or university of recognized standing, or have done work equivalent to that required for such a degree.
- Show promise of ability to pursue advanced study and research, as judged by the student's previous scholastic record and letters of reference.
- Have had adequate preparation to enter graduate study in the chosen field.
- Have at least a 3.00 (B) undergraduate grade point average.
- We do not require and will not consider General Record Examination (GRE) scores.
- International applicants must also submit official Test of English as a Foreign Language (TOEFL) or International English Language Testing System (IELTS) scores.

Students with undergraduate degrees in the physical sciences (e.g., physics, chemistry, mathematics) and engineering are encouraged to apply. The general background expected of incoming graduate students includes:

- Undergraduate courses in calculus, differential equations, and computer programming.
- One year sequences of undergraduate physics (calculus based) and chemistry.

Students with undergraduate degrees in other fields such as biology, environmental science, geography, or geology, are also invited to apply provided they meet the standards given here. Upper-level undergraduate courses in physics, chemistry, and mathematics are strongly recommended. Research and computer programming experience is also strongly recommended. Undergraduate courses in atmospheric science or oceanography are useful but not required as part of the undergraduate background.

English Proficiency requirements

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All international applicants are required to meet a minimum standard of English proficiency. The Test of English as Foreign Language (TOEFL), or an International English Language Testing System (IELTS) score is required unless English is your native language. If you have completed at least one year full-time academic study at a U.S. institution (or at an institution in a country where English is the native language) at the time you apply, you have fulfilled the English proficiency requirement for the Office of Admissions. The University requires a minimum TOEFL score of 537 (paper based), 203 (computer based), and/or 75 (new internet based). The University requires a minimum IELTS score of 6.0.

DEADLINES AND PROCEDURES

Deadlines

Fall admission:

Domestic application deadline: December 1

International application deadline: December 1

Your application must be submitted by the deadline, December 1, for admission in the fall semester.

Late application materials (transcripts, letters of recommendation, TOEFL/IELTS scores, etc.) will be considered until all positions are filled. Please note, while the department does accept late application materials it is in the applicant's best interests to submit all application materials as soon as possible.

Procedures

An applicant for admission must present complete application materials that include:

- The graduate application ([online](#))
- For review and decision purposes you are required to upload an unofficial copy of your transcript(s) in the online application (see more information below).
- Three letters of recommendation (submitted online or mailed to the department). If you would like to add additional letters, please contact atocgrad@colorado.edu.
- A personal statement of academic interests
- \$60 non-refundable application fee for domestic applicants or \$80 non-refundable application fee for international applicants

Personal statements should be one to two pages in length and describe the following:

1. Motivation for applying to graduate school;^{SEP}
2. Research experience or important class projects (which do not need to be in atmospheric or oceanic sciences), if available;
3. Other job experience or experience that helps us understand your leadership skills or qualifications relevant for graduate school;^{SEP}
4. Long-term research goals
5. If known, please also describe your ATOC-specific research interests, including faculty members or scientists with whom you would like to work. We recognize that not everyone knows at this point what specific field of interest they will join, but we do want to understand your motivation for studying atmospheric and oceanic sciences.

The personal statement will be evaluated not only for content, but also to gauge writing ability.

If known, please also describe your specific field of interest, including faculty members or scientists with whom you would like to work. The personal statement will be evaluated not only for content, but also to gauge writing ability.

Answers to frequently asked questions regarding the application process can be found [here](#).

How to submit transcripts

For review and decision purposes you are required to upload an unofficial copy of your transcript(s) in the online application. We require one copy of the scanned transcript from each undergraduate and graduate institution that you attended. This includes community colleges, summer sessions, and extension programs. While credits from one institution may appear on the transcript of a second institution, unofficial transcripts must be submitted from each institution, regardless of the length of attendance, and whether or not courses were completed. Failure to list and submit transcripts from all institutions previously attended is considered to be a violation of academic ethics and may result in the cancellation of your admission or dismissal from the university. ONLY after you are recommended for admission will you need to provide official transcripts. [Click here for Instructions for Uploading Unofficial Transcripts to Your Application](#).

MASTER'S DEGREE THESIS OPTION

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ACADEMIC STANDARDS

A student is required to maintain at least a 3.00 (B) average in all work attempted while enrolled in the Graduate School. For the M.S., a course mark below C is unsatisfactory and will not be counted toward fulfilling requirements for the degree.

MASTER'S DEGREE THESIS OPTION REQUIREMENTS

The requirements for an M.S. degree include the following:

1. 24-26 semester hours of coursework, of which 24 hours must be numbered 5000 or above, and at least 15 semester hours must be from ATOC graduate lecture courses, including four of the core ATOC courses. See specific ATOC course requirements for the M.S. below.
2. A minimum of 4 (but no more than 6) ATOC 6950 Master's Thesis hours. Note: ATOC 6950 Master's Thesis credit hours and ATOC 8990 Dissertation hours are NOT interchangeable.
3. Successful completion of a M.S. thesis and oral final examination based on this thesis.
4. Completion of all degree requirements within 4 years of the date of commencing course work, but normally in 2 years. Students may petition the Graduate School for extension(s).

Note: Students planning to pursue a Ph.D. degree may elect to obtain the M.S. degree, but this is not requirement for advancement to the Ph.D. program.

COURSE REQUIREMENTS

1. Up to 6 semester hours of approved 3000- and 4000-level coursework from engineering, math, physics, chemistry, or biology may be applied toward the M.S. degree. No credit will be given toward the M.S. degree for ATOC coursework below the 5000 level.
2. A minimum of 15 semester hours from ATOC lecture courses (independent study courses cannot be used to satisfy this requirement).
3. All of MS students are required to take the following four ATOC core courses, or their equivalent:

[L] [SEP] ATOC 5050: Atmospheric Thermodynamics and Dynamics

ATOAC 5051: Introduction to Physical Oceanography

[L] [SEP] ATOC 5060: Dynamics of the Atmosphere and Oceans

[L] [SEP] ATOC 5235: Intro to Atmospheric Radiative Transfer and Remote Sensing

4. Up to 3 semester hours of independent study (ATOC 5900), and/or seminar (ATOC 6020) may be used toward the 30 hours of regular coursework in the degree requirements.
5. A minimum of 4 (but no more than 6) thesis hours. Note: ATOC 6950 Master's Thesis credit hours and ATOC 8990 Dissertation hours are NOT interchangeable.
6. Up to 9 semester hours may be transferred from another accredited institution and applied toward an M.S. degree. Credit for ATOC core coursework must be approved by the graduate advisor.

GUIDELINES FOR MS THESIS

The M.S. thesis must consist of original and independent research conducted by the graduate student under the supervision of the faculty advisor. The thesis topic must be related to the major field, and:

1. Represent the equivalent of 4 to 6 semester hours of course work.
2. Receive the approval of the major department at least 30 days before commencement at which the degree is to be conferred.
3. Be completed at the time the final examination is held.
4. Comply with the University of Colorado Graduate School Thesis and Dissertation Specifications.
5. Be filed with the Graduate School by posted deadlines for the semester for which the degree is to be conferred.

MS THESIS EXAM COMMITTEE

The examination committee for the M.S. final exam will consist of three graduate faculty members, at least two of whom must be ATOC core faculty members. The examination consists of a 30 minute oral presentation given by the candidate on the thesis subject, followed by a period of questions for the candidate by the committee. The oral presentation is open to anyone that wishes to attend. The full examination typically does not exceed two hours in duration.

Any student with a research advisor outside of ATOC (e.g., an advisor who is from another department, or a full time employee at NCAR, NOAA, etc.), must also have an academic advisor who is an ATOC core faculty member. The academic advisor should be identified by the student in collaboration with their research advisor as soon as possible, and no later than one month, after research begins. Once an ATOC faculty member agrees to act as academic advisor, it is their responsibility to communicate ATOC policies and requirements to the research advisor, and to ensure that the student is meeting all ATOC requirements and making good academic progress toward the degree.

MASTER'S DEGREE NON-THESIS/FINAL EXAM OPTION



ACADEMIC STANDARDS

A student is required to maintain at least a 3.00 (B) average in all work attempted while enrolled in the Graduate School. For the M.S., a course mark below C is unsatisfactory and will not be counted toward fulfilling requirements for the degree.

MASTER'S DEGREE NON-THESIS/FINAL EXAM OPTION REQUIREMENTS

The requirements for an M.S. degree include the following:

1. 30 semester hours of coursework, of which 24 hours must be numbered 5000 or above, and at least 15 semester hours must be from ATOC graduate courses, including four of the core ATOC courses. See specific ATOC course requirements for the M.S. below.
2. Successful completion the ATOC COMPS1 requirement.
3. Completion of all degree requirements within 4 years of the date of commencing course work, but normally in 2 years. Students may petition the Graduate School for extension(s).

Note: Students planning to pursue a Ph.D. degree may elect to obtain the M.S. degree, but this is not requirement for advancement to the Ph.D. program.

COURSE REQUIREMENTS

1. Up to 6 semester hours of approved 3000- and 4000-level coursework from engineering, math, physics, chemistry, or biology may be applied toward the M.S. degree. No credit will be given toward the M.S. degree for ATOC coursework below the 5000 level.
2. A minimum of 15 semester hours from ATOC lecture courses (independent study courses cannot be used to satisfy this requirement).
3. All of MS students are required to take the following four ATOC core courses, or their equivalent:

[[[
SEP]]] ATOC 5050: Atmospheric Thermodynamics and Dynamics

ATOC 5051: Introduction to Physical Oceanography

[[[
SEP]]] ATOC 5060: Dynamics of the Atmosphere and Oceans

[[[
SEP]]] ATOC 5235: Intro to Atmospheric Radiative Transfer and Remote Sensing

4. Up to 3 semester hours of independent study (ATOC 5900), and/or seminar (ATOC 6020) may be used toward the 30 hours of regular coursework in the degree requirements.
5. Up to 9 semester hours may be transferred from another accredited institution and applied toward an M.S. degree. Credit for ATOC core coursework must be approved by the graduate advisor.

DOCTORAL DEGREE REQUIREMENTS

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ACADEMIC STANDARDS

A student is required to maintain a 3.00 (B) average in all work attempted while enrolled in the Graduate School. For the Ph.D., a course grade of C+ or below is unsatisfactory and will not be counted toward fulfilling requirements for the degree.

DEGREE REQUIREMENTS

The requirements for a Ph.D. degree include the following:

1. 36 semester hours of regular coursework, of which 30 hours must be numbered 5000 or above, and at least 18 semester hours must be from ATOC graduate lecture courses, including core ATOC course requirements.
2. 30 semester hours of dissertation credit with no more than 10 having been accrued prior to the semester the comprehensive examination was passed. Up to 10 hours of dissertation credit may also be taken during the semester the comprehensive examination is passed. Note: students can take a maximum of 10 dissertation credit hours per semester, and a total of 15 credit hours of combined dissertation and general class hours per semester.
3. Successfully passing the Ph.D. Comprehensive Examinations (COMPS1 and COMPS2).
4. Completing a Ph.D. dissertation, with successful defense of the dissertation in a Final Examination.
5. The minimum residence requirement for a Ph.D. is six semesters beyond the attainment of an acceptable bachelor's degree. During this time a student must be full-time. (Two semesters enrolled in a Master's degree program from another institution may be counted towards this requirement).
6. A student is required to register continuously, fall and spring semesters of each year, beginning with the semester following the passing of the Comprehensive Examinations and extending through the semester in which the dissertation is defended (final examination). Students should complete all requirements for the degree within six years of commencing work in the doctoral program, but may petition the Graduate School for extension(s).

COURSE REQUIREMENTS

1. All courses taken for the Master's degree at the 5000 level or above at the University of Colorado may be applied toward the Doctoral degree at the University.
2. Up to 6 semester hours of approved 3000- and 4000-level coursework from engineering, math, physics, chemistry, or biology may be applied toward the

Ph.D. degree. No credit will be given toward the Ph.D. degree for ATOC coursework below the 5000 level.

3. A minimum of 18 semester hours must be taken from ATOC lecture courses. Note: independent study courses and/or seminar courses are not considered lecture courses.
4. All of Ph.D. students are required to take the following four ATOC core courses, or their equivalent:

ATOC 5050: Atmospheric Thermodynamics and Dynamics
ATOC 5051: Introduction to Physical Oceanography
ATOC 5060: Dynamics of the Atmosphere and Oceans
ATOC 5235: Intro to Atmospheric Radiative Transfer and Remote Sensing

All of Ph.D. students are required to take two courses from the following list of core courses, or their equivalent:

ATOC 5151: Atmospheric Chemistry
ATOC 5200 Biogeochemical Oceanography
ATOC 5600: Physics and Chemistry of Clouds and Aerosols
ATOC/ASTR 5400: Introduction to Fluid Dynamics
GEOL 5270: Marine Chemistry and Geochemistry
GEOL 5430: Paleoceanography and Paleoclimatology
MCEN 5021: Introduction to Fluid Dynamics

5. One graduate-level mathematics course must be taken from the following approved list:

ATOC 5860: Objective Data Analysis*
ASTR 5540: Mathematical Methods
APPM xxxx: Any course with number at the 4000 level or above
ASEN 5227: Mathematics for Aerospace Engineering Sciences 1
ASEN 5417: Numerical Computations
ASEN 5327: Computational Fluid Dynamics
CVEN 5454: Statistical Methods for Natural and Engineering Systems
CVEN 6833: Advanced Data Analysis
PHYS 5030: Intermediate Mathematical Physics 1
PHYS 5040: Intermediate Mathematical Physics 2

*strongly recommended by ATOC to fulfill the math requirement

In exceptional cases, the math requirement can be fulfilled through demonstrated, prolonged application of advanced mathematics. This option must be approved by the student's committee and is intended primarily for professionals with ten+ years of experience in advanced applications of mathematics outside of graduate school

6. Up to 6 semester hours of independent study (ATOC 5900), and/or seminar (ATOC 6020) may be used toward the 36 hours of regular coursework in the degree requirements.
7. Up to 21 semester hours may be transferred from another accredited institution and applied toward a Ph.D. degree. 9 of the remaining 15 semester hours must be ATOC courses. However, students must still satisfy the ATOC core course requirement either by taking ATOC core courses or transferring like courses contingent upon approval by the grad advisor.

COMPREHENSIVE EXAMINATION

A student must pass the Ph.D. Comprehensive Examination before admission into Ph.D. candidacy. The Comprehensive Examination is given in two parts, which are referred to as "COMPS1" and "COMPS2".

COMPS1 consists of a hybrid written/oral examination. Students who fail to pass the exam after the second attempt will be dismissed from the Ph.D. program.

After completing the requisite course work and passing COMPS1, a student is eligible to apply for candidacy for the Ph.D. degree by submitting the form "Application for Admission to Candidacy for an Advanced Degree" to the Graduate School. Before admission into candidacy, the student must pass COMPS2, which is an oral exam based primarily upon a written document that represents original research by the student. A successful candidate must receive the affirmative votes of a majority of the members of the examining board. The student is suspended automatically by the Graduate School after a second failure.

DOCTORAL DISSERTATION

A dissertation based on original investigation and showing mature scholarship and critical judgment, as well as familiarity with tools and methods of research, must be written on a subject approved by the student's Ph.D. committee. Each dissertation presented in partial fulfillment of the doctoral degree must:

1. Comply with the "University of Colorado Graduate School Thesis and Dissertation Specifications."
2. Be filed with the Graduate School by the posted deadline for the semester in which the degree is to be conferred.

FINAL EXAMINATION

After a preliminary copy of the dissertation has been accepted for defense by the student's committee, a final examination on the dissertation and related topics is conducted. The following rules must be observed:

1. A student must be registered as a regular degree student on the Boulder Campus for a minimum of 5 dissertation hours during the semester in which the final examination is scheduled.
2. The examination consists of an oral presentation given by the candidate on the dissertation subject, followed by a period of questions for the candidate by the committee. The oral presentation is open to anyone who wishes to attend. The full examination typically does not exceed two hours.
3. The examination will be conducted by the Ph.D. Committee.
4. More than one dissenting vote will result in failure. In case of failure, the examination may be attempted once more. A second failure will result in automatic suspension by the Graduate School. Signatures from 5 committee members are required.
5. Students must notify the Graduate School at least two weeks in advance of the scheduled date of the final examination.

Ph.D. COMPREHENSIVE EXAMINATION

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The Ph.D. Comprehensive Examination is conducted in two parts, referred to as "COMPS1" and "COMPS2. COMPS1 consists of a hybrid written/oral exam. COMPS2 is an oral exam based upon a written report of original student research. Successful completion of the Comprehensive Examination is required before a student is admitted into Ph.D. candidacy.

COMPS1

The Ph.D. Comprehensive Examination is conducted in two parts, referred to as "COMPS1" and "COMPS2". The goal of COMPS1 is to demonstrate mastery of foundational ATOC concepts. This can be achieved either by passing the 4 common required core classes (ATOC 5050, ATOC 5051, ATOC 5060, ATOC 5235) with a defined minimum combination of grades or by taking an exam with a written and oral component to show mastery to reach the minimum grade requirement. COMPS2 is an oral exam based upon a written report of original student research. Successful completion of the Comprehensive Examination is required before a student is admitted into Ph.D. candidacy.

COMPS1 SUMMARY:

COMPS1 consists of students demonstrating mastery of the core concepts in ATOC, based upon the four common required core classes (ATOC 5050, ATOC 5051, ATOC 5060, ATOC 5235). A pass in COMPS I is automatically achieved by earning a combination of two A- and two B grades in the above listed core classes. If one or more of the grades fall below the minimum requirement, or students did not take some or all of these core classes, students can pass COMPSI by taking an individualized exam in some or all of these courses, with a written and oral component to show mastery. In that case, students have two attempts to pass COMPS1.

Interim COMPS1 Fall 2022:

COMPS1 consists of students demonstrating mastery of the core concepts in ATOC. This can be achieved either by passing the 4 common required core classes (ATOC 5050, ATOC 5051, ATOC 5060, ATOC 5235) with a defined minimum combination of grades or by taking an exam with a written and oral component to show mastery to reach the minimum grade requirement. The minimum combination of grades that gives students an automatic pass for COMPS1 is two A- grades and two B grades across the four common core classes listed above. If these minimum grades are not reached, students have to take a combined written and oral exam in some or all of the common core classes (depending on the grades already earned) to demonstrate mastery at the required minimum level. Students have two attempts at taking the combined written and oral exam to pass COMPS1 if they do not pass by meeting the minimum core class grade requirements.

This interim COMPS1 format will apply to any graduate starting in fall 2022 and will remain in place until a permanent COMPS1 is instituted.

Any ATOC graduate students who started in the program prior to fall 2022 and who have not yet passed COMPS1 will have two options as listed below:

Option 1 - Pass a 6-hour written exam consisting of 7 questions, of which you will need to answer 4 questions from the following: ATOC 5050 OR 5060, plus 3 from the remaining 5 courses ATOC 5051, 5151, 5200, 5235, and 5600. For more information, please contact ATOC's Graduate Program and ATOC's Graduate Advisor.

Option 2 - Pass [x] questions on topics taken from the courses listed below. This Interim Comps1 exam is a combination of written and oral. For more information, please contact ATOC's Graduate Program and ATOC's Graduate Advisor.

For masters students (thesis and non-thesis): We will require showing mastery in the topics of the four common core classes at a minimum level of B. This can be achieved through grades in the core courses, or by passing an exam with the same format as the interim COMPS1 in core classes where a grade below a B was earned. As for the exam for COMPS1, students will have two attempts to achieve the required mastery through the exam.

For students who entered the graduate program in AY21/22 or earlier and who have not yet passed COMPS1: Students must pass either the old-style 6-hour, 4-question written exam, which was in place when they entered the program, or the interim COMPS1. The minimum threshold for passing the interim COMPS1 is four B grades in the common core classes (ATOC 5050, ATOC 5051, ATOC 5060, ATOC 5235). If students do not meet this minimum grade requirement in one or more of the core classes, they have to take the combined written and oral exam in the format described elsewhere in this interim proposal in all of those core classes where they did not earn a grade of B or better.

As part of this interim COMPS1 proposal, the ATOC faculty also commits to discussing a revision of the ATOC core curriculum over the next year, with the goal of ensuring students gain a solid understanding of foundational concepts of atmospheric and oceanic sciences, including the ability to apply this knowledge of key topics to actual applications (a discussion of a list of key core curriculum learning goals could be part of this process, similar as was done for the [undergraduate introductory classes](#)).

Furthermore, the ATOC faculty commits to discussing whether we should introduce additional requirements to the ATOC PhD program, such as whether we want to require a colloquium talk before the PhD defense and whether we want to require students to propose their research to their committee well before COMPS2 (in individual meetings or a committee meeting; both of these would not be part of a COMPS exam).

Details about the combined written and oral exam (required only if COMPS1 is not already passed by meeting or exceeding the minimum grade threshold in the core classes, as defined above)

Which core classes will the exam be taken in: The exam will focus on topics from all classes that fell below the minimum grade requirement, or where the core class was not taken in ATOC (e.g., in the case of transfer students), to ensure understanding of the concepts in those classes is at the minimum required level of mastery for COMPS1. The required minimum grade distribution for the four core courses can be achieved through a combination of core class grades and exam grades. This implies that there may be situations in which students can choose which core courses would be the focus of the exam. The student will need to make that choice and communicate it to the COMPS1 committee within 4 weeks after completing the last common core classes. If no choice is made by the student, the COMPS1 committee decides in which courses the exam will be given.

Example of when students could choose: if a student earned 3 Bs and 1 A in the four common course classes, the student can choose in which of the three classes they earned a B they want to take the exam to show a higher level of mastery (at A- level); if they earn a B-, B, B, A- in the core classes, they have to take the exam in the class they earned a B- in. If they think they will be able to meet A- or better mastery in the exam, that course would be the only one they would take the exam in. If they assume they will only show mastery at B level in that course, they should additionally choose to take the exam in one of the two courses they earned a B in, to show A- or better mastery in that course.

When is this exam taken: The exam process will be started in the semester after the last common core class is completed. If some or all core classes were not taken in ATOC (e.g., transferring credit from another university), the exam should occur within 1 year of starting in ATOC or in the semester after all common core classes taken in ATOC have been completed, whichever is sooner. If a student does not earn a passing grade in a core class (i.e., a grade below B-) and needs to or wishes to repeat the core class, they can choose to take the COMPS1 exam before or after re-taking the core class. Students will be able to apply for COMPS 2 only after they have passed COMPS1.

Format of the exam: Students will take a combined written and oral exam, to show mastery of the material they did not yet show mastery of in the core classes. An exam committee of at least 3 ATOC faculty members will administer and judge the exam.

The written component of the exam consists of students answering questions about topic areas from the applicable core courses, identified by an exam committee in consultation with the instructors of those classes of which students did not show mastery. Students will receive the list of topics from the core classes of which they did not show mastery once it is clear which classes they will take the exam in, so they can start preparing. Students will receive the specific questions for the written exam four weeks before the date of the oral exam, and they will have three weeks to provide their

answers in writing to the exam committee. The written answers will not be graded but will form the basis for the oral exam. During the oral exam, the exam committee will use the written answers from the student to ask further questions to probe areas in which the student does not appear to be demonstrating sufficient knowledge, or to ask the student to expand upon their written answers, while limiting the scope of the oral exam to the topics the written questions were about. The goal of this two-part exam is to ensure the student has developed the required level of mastery of these topics, allowing for follow up questions and the probing of areas that continue to show weaknesses or misunderstanding in the written responses. The oral part of the exam will not exceed one hour.

Students may seek help in preparing for the exam, if needed, by consulting faculty who taught the common core classes, as well as other students and faculty. However, this help should focus on understanding the general topics, not the question(s) itself. Students should answer the written questions individually and the written answer should reflect their own understanding, which will be probed in the oral exam.

What is the exam about: The specific topic areas of focus for the exam will be based on identified specific weaknesses of the student in the class(es) to be examined, if possible. The COMPS committee will request a list of topics that the student showed weaknesses in from the instructor(s) of the respective core class(es). Once received, the COMPS1 committee will forward these to the exam committee and to the student. The exam committee will then decide on specific questions based on this list of topics and send them to the student four weeks before the oral exam.

To ensure weaknesses of specific students are recalled by the instructor, instructors should make a list of specific weaknesses of any students who earn less than a B in the common core courses as soon as the course concludes. For students who did not achieve the required A- mastery, the COMPS1 committee will inform instructors of the need to compile a list of topics specific for the student as soon as the student has chosen the core classes for the exam. For students who have not taken the ATOC core classes, a general list of topics to be examined for each core course will be created.

Who administers the exam: The COMPS1 committee will appoint an exam committee consisting of no fewer than three core ATOC faculty (and, typically four). The exam committee will include the instructors of the relevant core classes. If that is not possible, it will include instructors who have taught the relevant core class in other years, or who have relevant expertise in the subject area. It will also include at least one additional ATOC core faculty member who has not recently taught a core graduate course, to familiarize all faculty members with the core curriculum, as well as to include all ATOC core faculty in the COMPS1 process over time. A student's research advisor will not be part of the exam committee, to minimize potential conflicts of interest.

Role of the COMPS1 committee: The COMPS1 committee will inform students and their advisor within two weeks after the common core classes are completed if they have passed COMPS1 through their grades in ATOC core courses or not. The identities of

the students who have passed COMPS1 through grades, and those students who have not, will be treated confidentially at all times. Only the students themselves, their advisor, the COMPS1 committee, ATOC staff keeping the academic records, and the exam committee will know the identity of the students who take the COMPS1 exam. The COMPS1 committee collects the topic areas the exam will focus on from core instructors, appoints the exam committee for each student, and forwards the topic areas for the exam to the exam committee and the student, as well as schedules the COMPS1 oral exam. For any second exam attempt, at least one member of the COMPS1 committee will also participate in the exam as an observer, to ensure consistency between the level of mastery required for a pass at A- and B level. Participating as an observer means they will not provide or ask questions, but they will contribute to the committee discussion about the level of mastery after the exam has concluded.

What happens after the exam: Students will receive a written report after the exam. That report will list the topic areas covered during the exam, and a performance evaluation for each area (e.g., pass at A- or above, pass at B level, below B (not a pass)). Specific feedback will be provided in areas where the students showed weaknesses and/or excellence. This feedback will be provided for all students, including those who pass. The intent of the report to all students is to make this a learning opportunity. The exam committee will write this report and send it to the COMPS1 committee within a week of the oral exam. The written answers of the students will not be graded but the committee report should comment on areas of concern from the written responses, as well as areas of concern from the oral exam. The COMPS1 committee is responsible for ensuring the report is received and for sending it to the student.

For students who do not pass the first attempt at the exam, a second attempt will follow. The questions of the second attempt should be focused on the weaknesses identified in the first exam, and be aligned with the goal of ensuring the student shows mastery of the material. The process for the second exam should begin within three weeks after the first exam process concluded, and follow the same timeline (questions to student four weeks before the exam, written answers due one week before the oral exam).

COMPS2

Successful completion of the COMPS2 is required before a student is admitted into Ph.D. candidacy. The following are guidelines for the comprehensive examination:

1. At least one week before the Exam, the candidate must provide each member of the Ph.D. committee with a written document representing original research by the student.
2. The form "Application for Admission to Candidacy for an Advanced Degree" must be completed by the student. The application with all required signatures must be submitted to the Graduate School at least 14 days before the COMPS2 Exam is taken.

3. The COMPS2 exam must be taken by November 15 of the third year. This assumes that COMPS1 was first attempted just prior to the start of the second year in August; exceptions will be dealt with on a case-by-case basis. The student is responsible for scheduling the Examination. If the student is not ready for the examination at this time or if committee member travel schedules preclude scheduling, the student should submit an Official Request for Time Extension. Failure to take the exam in the allotted time frame constitutes a failure of the exam (see #6 below).
4. The COMPS2 Exam typically requires 2 hours. The candidate makes an oral presentation on the research, typically of about 40 minutes duration, for which attendance is open. The remainder of the Exam consists of questions directed to the candidate by the committee members (closed attendance; only the candidate and the committee). The questions typically pertain to the subject matter and content of the research, but may also be asked on topics outside this area, at the committee's discretion.
5. The Exam is conducted by the Ph.D. Committee. The student's advisor cannot be the chair of the Examination Committee (although the advisor typically serves on the Committee).
6. A successful candidate must receive the affirmative votes of a majority of the members of the examining board. In case of failure, the examination may be attempted once more after a period of time determined by the Ph.D. committee, which typically does not exceed 3 months. The student is automatically suspended after a second failure.

GOALS and EXPECTATIONS

The goal of the second comprehensive exam (COMPS2) is to demonstrate the candidate's ability to conduct independent research. The objective is not to eliminate poor students, but to teach students how to do research, and confirm they are learning the process. COMPS2 consists of writing a paper on, and orally presenting the results of, a research project. The oral presentation is followed by questions from a 5-member exam committee (which is selected by the student). The questions are meant to probe whether the student is familiar with the literature in the area, whether they understand the basic techniques and science related to the problem, and whether they have the ability to work and generate research ideas independently. Generally, it is desirable that the research be of a quality that could be published, or lead to something later that could be published. Indeed, at this point some students are able to submit (or have already submitted) a paper on their Comps II project to a peer-reviewed journal.

Occasionally some students have trouble with COMPS2. A common problem is that students are not given a well defined problem by their advisor that is uniquely their own,

as opposed to a group effort. Students have to demand a problem from their advisors that is well defined, and depends mainly on their own work. If a student is uncertain about the problem, they should form their exam committee early and have the committee assess the problem. Another common issue is that some projects take longer than expected, resulting in a delay in taking the exam. In this event, the student should discuss the delay with their committee to ensure that they are proceeding as efficiently as possible in a fruitful direction. Rarely a student's project is destroyed by events beyond their control, such as a satellite malfunction. This can result in a very substantial delay. In this case a new question related to the thesis (so that the thesis is not delayed) may be posed, and the COMPS2 delayed until that project is developed. Such a decision would need to be approved by the ATOC Chair, in consultation with the ATOC graduate advisor.

If the student is funded as a research assistant, then the research topic is typically selected to fall within the scope of the research grant providing the financial support for the student. However, the student is expected to select and articulate their own research topic. Varying degrees of guidance may be provided by the research advisor and other members of the research group; it is generally expected that the research advisor will work closely with the student to ensure the research project is of publication quality. However, the student must still demonstrate the ability to conduct independent research.

The length of the research papers of successful candidates has varied widely. A typical length is 25 pages; 10 pages is likely to be too short, while 40 pages may be unnecessarily long. A successful written research paper and examination convinces the Ph.D. committee that the candidate has:

- A thorough understanding of the research literature in the chosen field
- Addressed an original research problem
- Familiarity with the tools and methods of research
- Demonstrated a capability to conduct independent research
- The writing skills to satisfactorily communicate their research

Ph.D. EXAM COMMITTEE

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The student will establish a Ph.D. committee of at least 5 members of the CU graduate faculty. Three of the committee members must be regular CU faculty members, comprised of 2 ATOC core faculty, and one faculty member outside the ATOC core faculty. The remaining committee members may be regular faculty members or others (including scientists from other institutions) that have been approved as members of the CU Graduate Faculty. The Chair of the Ph.D. Committee must be a regular CU faculty member. The membership of this committee must be approved by the Department Chair and the Graduate School. This committee will serve as the examining board for the Comprehensive Examination and the Final Examination and is expected to meet

with the student on an annual basis (Note: the membership of this committee may differ from that of the Comps II Exam committee).

Any student with a research advisor outside of ATOC (e.g., an advisor who is from another department, or a full time employee at NCAR, NOAA, etc.), must also have an ATOC academic advisor who is an ATOC core faculty member. The academic advisor should be identified by the student in collaboration with their research advisor as soon as possible, and no later than the first attempt at the Comps I exam, after research begins. Once an ATOC faculty member agrees to act as academic advisor, it is their responsibility to communicate ATOC policies and requirements to the research advisor, and to ensure that the student is meeting all ATOC requirements and making good academic progress toward the degree. Generally, the academic advisor will also be a member, but not chair, of the student's COMPS II and dissertation committees.

DOCTORAL DISSERTATION AND FINAL EXAM/DEFENSE

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The Ph.D. thesis is based upon original research and shows mature scholarship and critical judgment, as well as familiarity with tools and methods of research. The Ph.D. thesis differs from a M.S. thesis or a single journal publication in terms of the scope and/or originality and significance of the research.

The subject of the Ph.D. thesis should be approved by the student's Ph.D. Committee in a meeting with the student within 18 months of admission into Ph.D. candidacy. Some research advisors may request a written thesis proposal; others may require only an oral presentation. The Ph.D. Committee may provide advice on the scope and methods of the research, and will provide an assessment of the suitability of the proposed research for a Ph.D. thesis. The Ph.D. candidate is expected to meet with the committee annually to discuss research progress. A written report will be provided to the student by the research advisor after each meeting with the committee.

The content of a Ph.D. thesis should include:

- Motivation for the research
- Hypotheses, scientific questions, and/or unique observational or analytical tools addressed in the research
- Survey of relevant literature
- Description of research tools and methods
- Research results
- Conclusion that assesses the significance of the results, limitations of the research, and future applications of the research

Theses that emphasize development of observational or analytical tools (e.g. development of instrumentation or numerical models) are expected to include in the thesis research some application of the tool to a scientific problem.

The format of the thesis may be that of the conventional thesis, where individual chapters correspond to topics such as those described above. If the student has published or submitted for publication several manuscripts, the student may elect to include these manuscripts as appendices in the thesis. These manuscripts should only include those for which the student is first author (Note: student's contributions to non-first-authored papers can be included in the body of the thesis). The body of the thesis may then be relatively short, describing the overall motivation, hypotheses, tools, highlights of results (including any results not in the appendices), and conclusions.

Scheduling the Final Examination (defense) is the responsibility of the student. The student should schedule a meeting with his or her entire committee approximately one year prior to when the student thinks he or she will be ready to defend to determine if completion of the dissertation along this timeline is feasible. Scheduling of the actual defense date is normally done only after the research advisor and other committee members have read at least a preliminary copy of the written dissertation and have given approval to proceed with the Exam. Once the defense date has been set, the ATOC guideline for submitting a polished copy of the written dissertation to each committee member is one month prior to the date of the defense.

The format of the Final Examination (defense) is similar to that of the Comprehensive Examination. However, the entire Final Examination is open to any interested person. The candidate gives an oral presentation of the thesis research that is about 45 minutes in length. After the presentation, questions from the audience are addressed. More detailed questions are then asked by the committee members. After the Exam, the Ph.D. Committee meets in closed session to decide upon the outcome.

FINAL EXAMINATION

After a preliminary copy of the dissertation has been accepted for defense by the student's committee, a final examination on the dissertation and related topics is conducted. The following rules must be observed:

1. A student must be registered as a regular degree student on the Boulder Campus for a minimum of 5 dissertation hours during the semester in which the final examination is scheduled.
2. The examination consists of an oral presentation given by the candidate on the dissertation subject, followed by a period of questions for the candidate by the committee. The oral presentation is open to anyone who wishes to attend. The full examination typically does not exceed two hours.
3. The examination will be conducted by the Ph.D. Committee.
4. More than one dissenting vote will result in failure. In case of failure, the examination may be attempted once more. A second failure will result in

automatic suspension by the Graduate School. Signatures from 5 committee members are required.

5. Students must notify the Graduate School at least two weeks in advance of the scheduled date of the final examination.

Ph.D. DISSERTATION

A dissertation based on original investigation and showing mature scholarship and critical judgment, as well as familiarity with tools and methods of research, must be written on a subject approved by the student's Ph.D. committee. Each dissertation presented in partial fulfillment of the doctoral degree must:

1. Comply with the "University of Colorado Graduate School Thesis and Dissertation Specifications."
2. Be filed with the Graduate School by the posted deadline for the semester in which the degree is to be conferred.

PART TIME STUDENT GUIDELINES FOR COMPLETION OF DEGREE

ATOC Departmental Definition: A part time student is a student who does not receive financial support in the form of a graduate student appointment (teaching assistant or research assistant) from ATOC, another academic department, or university research institute.

PLEASE NOTE: This definition is separate from university and graduate school definitions of a full or part time student. This definition applies only to ATOC departmental rules. The student will still need to adhere to university and graduate school rules regarding continuous enrollment, time limits, and enrollment past the oral comprehensive exam (COMPS2).

COMPS1: For students who have been continuously enrolled as full time students and started the program in a fall semester, the four common required core classes (ATOC 5050, ATOC 5051, ATOC 5060, ATOC 5235) should be completed by the end of the spring semester. For students who started the program in a spring semester, the four common required core classes (ATOC 5050, ATOC 5051, ATOC 5060, ATOC 5235) should be completed by the end of the spring semester in the second year.

Part time students often do not complete the ATOC core coursework necessary for the COMPS1 exam during the first year. Instead, the part time student is expected to complete the four common required core classes (ATOC 5050, ATOC 5051, ATOC 5060, ATOC 5235) no later than the fourth year, and are expected to meet with an ATOC advisor yearly.

COMPS2: The COMPS2 exam must be taken by November 15 of the third year. This assumes that COMPS1 was first attempted just prior to the start of the second year in August; exceptions will be dealt with on a case-by-case basis. The student is responsible for scheduling the examination. If the student is not ready for the examination at this time or if committee member travel schedules preclude scheduling, the student should submit an Official Request for Time Extension. Part time students are also expected to submit this official request so that the department can insure that good academic progress is being made.

A part time student is expected to complete the COMPS2 exam on the same schedule as a full time student, that is by November 15 of their third year. A part time student may choose to complete the oral comprehensive exam (COMPS2) before the written/oral comprehensive exam (COMPS1) has been accomplished. The student should carefully discuss this option with his or her research advisor and other committee members. This does not relax the requirement for the successful completion of the written /oral comprehensive exam (COMPS1).

STUDENT CODE OF CONDUCT

ATOC graduate students are expected to abide by the [CU Boulder student code of conduct](#), the [honor code](#), the [sexual misconduct policy](#), and the [discrimination and harassment policy](#) at all times, to treat one another with mutual respect, to value and embrace differences, and to support one another in academic coursework and research. This handbook lists selected conduct and policy violations from the full code and policy documents. Students are encouraged to read the full codes of conduct and policy documents for further information.

[Student Conduct](#) violations, including, but not limited to:

- Physical misconduct: any intentional physical forces that could cause bodily harm
- Threats of endangerment of person(s): verbal or written threats that endanger the safety of others
- Abusive conduct: including severe, persistent, or pervasive verbal abuse, threats, intimidation, coercion, or other conduct which causes substantial emotional distress
- Theft: possessing property known to be stolen, or taking property of another without consent
- Drugs: possessing, using, providing, manufacturing, or selling drugs in violation of university policies or law. This includes a prohibition of any marijuana or other drug use or possession, either on campus or while participating in university sponsored activities, such as fieldwork or conference-related travel.
- Alcohol: intoxication to the point of endangering oneself or another person's health or safety

[Honor Code](#) violation, including, but not limited to:

- Plagiarism: portrayal of another's work or ideas as one's own
- Cheating: use of prohibited notes or study aides, copying another student's course work
- Resubmission: submitting the same or similar work for credit more than once without permission from all course instructors involved
- Aiding academic dishonesty: facilitating any act which may help a student to gain an unfair academic advantage, including sharing a previous semester's course materials

[Sexual Misconduct, Intimate Partner Violence, and Stalking Policy](#) violations, including, but not limited to:

- Engaging in unwelcome sexual advances or behaviors
- Stalking or domestic violence
- Failure to report: all TOC graduate students are considered responsible employees to report incidents and concerns of sexual misconduct, intimate partner violence, stalking, or related violations to the [Office of Institutional Equity and Compliance](#), regardless of their mode of financial support (TA/RA/fellowship)

[Discrimination and Harassment Policy](#) violations, including but not limited to:

- Protected class harassment or discrimination: Protected class refers to age, color, disability, gender, expression, gender identity, national origin, political affiliation, political philosophy, pregnancy, race, religion/creed, sex, sexual orientation, veteran status
- Failure to report: all ATOC graduate students are considered responsible employees and expected to report incidents and concerns of protected-class discrimination and harassment or related violations to the [Office of Institutional Equity and Compliance](#), regardless of their mode of financial support (TA.RA/fellowship).

GRIEVANCE POLICY

Student Ethics

Students are expected to adhere to the highest codes of personal and professional ethics. Students who do not adhere to written guidelines regarding academic honesty, academic or research ethics, may be dealt with according to the policies for academic dishonesty, academic ethics, or research misconduct as published in the appropriate policy documents available in the Graduate School. Students found guilty of misconduct in any of these areas may have sanctions imposed, or may be dismissed from CU-Boulder.

Grievances

The Graduate School Grievance Process and Procedure (“the Grievance P&P” or “P&P”) establishes and describes the process through which graduate students can communicate concerns related to academic issues or academic conflicts, with the goal of ensuring that the student filing a grievance is better able to achieve academic success. This is a non-adversarial, non-judicial process. The rules of evidence, and any other rules that typically govern a criminal or civil court, are not applicable to the Grievance Procedure.

Information regarding this policy can be found on the Graduate School’s website at https://www.colorado.edu/graduateschool/sites/default/files/attached-files/grievance_process_and_procedures_2019_final.pdf.

CERTIFICATES

The University of Colorado recognizes that interdisciplinary study at the graduate level may involve coursework and formal requirements that exceed those of established degree programs. To recognize this additional work by graduate students, interdisciplinary faculty may establish a certificate program within the Graduate School.

Graduate students can pursue a graduate level certificate while earning a graduate degree at CU-Boulder or while taking coursework as a non-degree seeking student through Continuing Education's ACCESS Program, provided they have already earned a bachelor's degree and meet the course prerequisites.

CERTIFICATE IN ATMOSPHERIC AND OCEANIC SCIENCES

Requirements for a Graduate Certificate in Atmospheric and Oceanic Sciences:

If you are currently a graduate student at CU, or if you have a bachelor's degree and are a non-degree seeking ACCESS student, you may pursue the ATOC Graduate Certificate by satisfactorily completing four ATOC graduate level courses* or their cross-listed equivalents (ie ATOC 5151 or CHEM 5151) provided the cross-listed equivalents are not offered through your home department(s). To satisfactorily complete a course, you must earn a grade of B or better.

Students must meet course pre-requisites prior to enrollment. Most of the ATOC Graduate Certificate Courses require at least one year of Calculus and one year of Calculus-based Physics. During the final semester of coursework or upon completion of the ATOC Graduate Certificate requirements, students should contact the ATOC Graduate Program Assistant (atocasst@colorado.edu).

*ATOC graduate level courses are considered those above the 5000 level. ATOC 5000: Critical Issues in Climate and the Environment cannot be applied towards the ATOC certificate requirements.

CERTIFICATE IN OCEANOGRAPHY

Graduate students can pursue the Graduate Certificate in Oceanography while earning a graduate degree at CU-Boulder or while taking coursework as a non-degree seeking student through Continuing Education's ACCESS Program, provided they have already earned a bachelor's degree and meet the course prerequisites. The Graduate Certificate in Oceanography is noted on the official CU transcript.

Requirements for a Graduate Certificate in Oceanography:

To earn a Graduate Certificate in Oceanography, students must take at least three qualifying oceanography courses (see below) passed with grade B or better. An independent study course may replace one of the qualifying oceanography courses.

Courses:

- ATOC 5051: Introduction to Physical Oceanography. Provides fundamental knowledge of observations, theory, dynamics and modeling in physical oceanography. Promotes critical thinking and the development of skills for data analysis and interpretation. Recommended prerequisites: one year of calculus-based physics and math up through differential equations. ATOC graduate core course. Offered once per year (3 credits).
- ATOC 5060: Dynamics of the Atmosphere and Oceans. Examines large-scale motions in a stratified rotating atmosphere and ocean, and quasi-geostrophic flow, barotropic and baroclinic instabilities, cyclogenesis, global circulations and boundary layer processes. Ageostrophic motions, including Kelvin waves, internal gravity waves and the theory of frontogenesis are also considered. Recommended prerequisite: ATOC 5050, one year of calculus-based physics and math up through differential equations.
- ATOC 5061: Advanced Ocean Dynamics and Air-Sea Coupled ENSO Mechanisms. Explores the existing theories of the El Niño and Southern Oscillation (ENSO) ocean-atmosphere coupled mechanisms, theory of the thermocline in a quasi-geostrophic system, and dynamics of the Atlantic Meridional Overturning Circulation (AMOC). Covers physical mechanisms, associated mathematical equations, and numerical model simulations. Discusses their direct research applications in understanding the past, present and future climate variability and change. Offered once per year. Recommended prerequisites: ATOC 5400, ATOC 5051 or ATOC 5060 and one year of calculus-based physics and math including differential equations.
- ATOC 5200: Biogeochemical Oceanography. Provides a large-scale synthesis of the processes impacting ocean biogeochemistry. Transforms theoretical understanding into real-world applications using oceanographic data and models. Topics include: chemical composition, biological nutrient utilization and productivity, air-sea gas exchange, carbonate chemistry, ocean acidification, ocean deoxygenation, iron fertilization, biogeochemical climate feedbacks, and much more. Same as ATOC 4200. Offered once per year (3 credits).
- ATOC 5300: The Global Carbon Cycle. Covers the role of the ocean, terrestrial biosphere, and atmosphere in the global carbon cycle. Specific topics include marine carbonate chemistry, biological production, terrestrial fluxes, anthropogenic emissions, and the evolution of the global carbon cycle in a changing climate (3 credits).
- ATOC 5730: Physical Oceanography and Climate. Introduces the field of physical oceanography, with emphasis on the ocean's interaction with the global atmosphere. Analysis of the ocean's heat, salt, and momentum budgets, wind-driven and thermohaline circulations, climate cycles including El Niño, and the ocean's role in climate change. Theory complemented by state-of-the-art

observations and models. Department recommended prerequisites: ATOC 1060 or ATOC 3070 or ATOC 3600 and one semester of calculus. Same as ATOC 4730. Offered once per year (3 credits).

- ASTR 5400: Introduction to Fluid Dynamics. Covers equations of fluid motion relevant to planetary atmospheres and oceans, as well as stellar atmospheres; effects of rotation and viscosity; and vorticity dynamics, boundary layers, and wave motions. Introduces instability theory, nonlinear equilibration, and computational methods in fluid dynamics (3 credits).
- ASTR 5410: Fluid Instabilities, Waves, and Turbulence. Involves linear and nonlinear analyses of small-scale waves and instabilities in stratified fluids, with effects of rotation. Studies internal gravity and acoustic waves with terrestrial, planetary, and astrophysical applications. Also studies thermal and double-diffusive convection, homogeneous and stratified shear flow instabilities. Examines these topics from the onset of small amplitude disturbances to their nonlinear development and equilibration (3 credits).
- GEOL 5270: Marine Chemistry and Geochemistry. Examines the chemical, biological, geological, and physical processes affecting (and affected by) the chemistry of the oceans. Topics include: chemical speciation in seawater; the marine carbon cycle and its long-term control on atmospheric CO₂; the large-scale interdependence of nutrient distributions and biological productivity; chemical tracers of ocean circulation; and the chemistry of marine sediments, including early diagenesis. (3 credits)
- GEOL 5430: Paleoceanography and Paleoclimatology. Examines scientific tools, data, and theories related to the dramatically varied past climate of the Earth. Focus will be on marine records of climate change and ocean circulation, but ice core and continental archives will also be discussed. Course will cover the Cretaceous Period to the present, with particular emphasis on the past 150,000 years (the last ice age cycle). (3 credits)
- Graduate Level INDEPENDENT STUDY (3 credits). Students are allowed to take an “independent study” course to replace one of the core courses. The students may choose any member from the Oceanography Certificate Coordinating Committee or any professor who contributes to teaching the core courses to complete the “independent study” course. It is subject to the Certificate Program Director’s approval if the students choose independent study advisors from someone other than the above list. The course should combine textbook knowledge with real research experience, and thus provide the students with some basic research experience in oceanography. The course will also increase choices for the students who wish to obtain research experience.

FUNDING

This section of the handbook addresses policies, guidelines, helpful hints, and opportunities for graduate students.

RESEARCH ASSISTANTSHIPS

During the academic year, graduate students who are conducting research with a faculty member typically receive a 50% research assistantship. This assistantship includes a stipend for living expenses plus tuition remission that is paid out of the research grant. The student is expected to work 20 hours per week in support of the research project in return for this stipend and tuition remission. Typically, this research is directly related to the student's thesis work. During the first two semesters, when students have a heavier course load, they may spend less than 20 hours per week on research upon approval of their research advisor. During subsequent years, when the course load is light, students typically spend substantially more than 20 hours per week doing research. During summer, students spend full time on research and typically receive a 100% research assistantship for a period of two and a half months. Note that a student does not receive paid vacations as a research assistant; 2 weeks of unpaid vacation are typically allotted during the summer. Additional (or less) vacation time is per prior agreement between the student and the advisor. Note that all research assistantships are subject to availability of federal research funds. Continuation of a research assistantship requires that a student maintain a B (3.00) GPA and perform satisfactorily in research.

TEACHING ASSISTANTSHIPS

During the academic year, some students may receive a 25% or 50% teaching assistantship. This assistantship includes a stipend for living expenses plus tuition remission depending on the percentage of the appointment.

TUITION CLASSIFICATION - RESIDENCY

For information about tuition classification, call the automated phone service at 303-492-6868. Information on petitioning for in-state tuition classification, as defined by Colorado law, is printed in the tuition classification guidelines available from the Tuition Classification Office, Regent 1B 54. The guidelines are also available on the web at:

<https://www.colorado.edu/registrar/students/state-residency>

Read the guidelines carefully, and be certain you understand the petition process and deadlines. If you have questions about your particular circumstances, call 303-492-0907 to make an appointment with a staff member. **In brief: *In-state status will be required after one year for all students who are eligible and supported by a teaching assistant or research assistant position.*** In-state status requires domicile (legal,

primary residence) in Colorado for the year immediately preceding the first day of class. The only exceptions to the one-year domicile requirement, as provided by law, are for active-duty military personnel on permanent duty station in Colorado and for Olympic athletes in training at the United States Olympic Training Center in Colorado Springs, Colorado. *Domicile is defined as your true, fixed, and permanent home and place of habitation.* Domicile is a legal characteristic that everyone has, and you can have only one domicile at any one time. Your domicile is your legal, primary residence.