Handbook for Students and Faculty in the MIT-WHOI Joint Program in Physical Oceanography

Prepared by the
Joint Committee for Physical Oceanography

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Table of Contents

1 About this Handbook

The goal of the MIT-WHOI Joint Program in Physical Oceanography (JPPO) is to prepare students to carry out independent and creative research in Physical Oceanography and to demonstrate this ability by writing and defending a PhD dissertation. This handbook describes the roles and responsibilities of the students and the staff who make up the Program. It also discusses the procedures that are used to monitor the academic progress of students through the Program. This handbook was prepared by the Joint Committee for Physical Oceanography (JCPO; Section 2.4), which has the responsibility to oversee and administer all academic aspects of the Program.

Students enter this Program from diverse academic and social backgrounds. Moreover, scientific research is a highly individualistic endeavor the progression of which cannot be preordained or tightly scheduled. Consequently, the procedures and schedules described in this handbook can be altered on a case-by-case basis by making a written petition (request) to JCPO. All such petitions should be addressed directly to JCPO via email to jcpo-whoi@whoi.edu.

For a much wider description of professional and academic policy, students and staff are referred to the MIT Graduate Policies and Procedures (http://odge.mit.edu/gpp/), which applies in full to this Program.

2 Roles and Responsibilities

2.1 Students

From the outset we want to emphasize that the primary responsibility for progress through this Program resides with the student. Consequently, students need to be fully aware of the nominal progression through the Program, described in Section 3 and Appendix A of this handbook. Students should also be aware of the resources available to help them, described in the remainder of this section.

Advice and suggestions from the student's advisor(s) and Thesis Committee are almost always required at certain key stages, such as selecting courses and developing a viable thesis problem. The latter, especially, requires judgment about the status of a research area and the availability of resources. If at any time a student feels that they are not being given appropriate guidance or support, then they are urged to take corrective steps. The first step is to consult with the principal advisor(s). However, the student may prefer to discuss the situation with the Thesis Committee, JCPO, the Education Coordinator, the Physical Oceanography Department Chair at WHOI, the Department Head of Earth, Atmospheric and Planetary Sciences at MIT, the Joint Program Director at MIT, or the Deans, all of whom have a professional commitment to ensure that the Program functions in a fair and efficient way.

These advisory and supervisory committees can function well only when they are kept fully informed of a student's status. There are formal mechanisms for such reporting described below. However, these may not be appropriate or sufficiently timely for every circumstance. It is therefore the student's responsibility to keep their advisor(s) and JCPO informed of significant events or circumstances that may affect their academic progress. Written notification is preferred.

Students with disabilities may be entitled to special accommodations, as described in Section 3.4.

2.2 Advisors

Each entering student is assigned a principal advisor or advisors with whom the student will begin their research work. The importance of a strong working relationship between the student and the principal advisor(s) cannot be overemphasized. The principal advisor(s) will be the student's closest scientific contact and must have an active interest in helping and advising. The advisor's advocacy and assessment of the student's progress at the time of the General Exam can be very important. A checklist of student/advisor responsibilities specific to JPPO is given in Appendix D. A longer description of advisor-student relations may be found at https://mit.whoi.edu/academics/responsibilities/.

Shortly after starting in the Joint Program, students will be matched with a faculty mentor at the opposite institution from their principal advisor. The role of this faculty mentor is to offer advice from the perspective of the other institution. The faculty mentor is not meant to be a 'scientific' advisor, although they may be; their primary role is mentoring and making sure that the student is aware of opportunities at the other institution. Incoming students may choose their faculty mentor, or JCPO can assign a faculty mentor if preferred.

The initial assignment of advisors is made by JCPO before students arrive for their first term. Assignment is based upon indications of scientific interests in the admissions application and, to some degree, upon availability of financial support. It is natural that a student's scientific interests may change as they learn more about the field of Physical Oceanography. A student or the student's advisor(s) may recommend a change of advisor for a variety of reasons, such as the departure of the advisor to another institution, a shift in research interests, or an ineffective student/advisor relationship. Generally, switching advisors should involve discussion with the Education Coordinator, who can facilitate discussions with the initial advisor, help the student to identify a new advisor, and provide guidance toward developing a transition plan.

As soon as it is clear that an advisor switch is desired, the WHOI Dean and/or MIT Joint Program Director (and Associate Directors when necessary) must be consulted, either directly by the student or through the Education Coordinator, in order to help with the transition plan. The transition plan will consider how best to wrap up the research the student has done with the initial advisor, as well as the timing of the move to the new advisor's lab. In cases where advising shifts between WHOI and MIT, it is necessary to notify both the WHOI Dean and the MIT Director of the MIT/WHOI Joint Program. Once a new advisor who is committed to taking on and finding funding for the student has been identified, and once a transition plan is worked out, JCPO will give official approval to the change.

JCPO will work with the student and new advisor to determine whether adjustments to the student's timeline to degree are warranted. For students who have already advanced to candidacy, JCPO will consult with the student and advisor and will determine whether the change will result in a substantial shift in research focus. If so, the student may need to prepare and defend a new thesis proposal. The second thesis proposal defense would be reduced in scope and length to focus on thesis-specific questions.

2.3 Thesis Committee

The Thesis Committee is intended to serve as a resource for the student in planning courses and research. At least one month prior to the thesis proposal defense and in consultation with their advisor(s), students should form a four to five, or more, person Thesis Committee. The principal advisor serves as chair of the Thesis Committee, which must have MIT and WHOI representation. One member of the Thesis Committee must be a member of JCPO, unless the student petitions JCPO and is granted a waiver. One or two of the Thesis Committee members can be external (not from WHOI or MIT), depending on the focus of the research. Some travel funds for one external committee member are available through the WHOI Academic Programs Office.

JCPO must be consulted, in writing, about the proposed composition of the Thesis Committee; JCPO may require changes and must approve the final composition. It may be appropriate and indeed desirable to change the membership of the Thesis Committee as the research develops; approval from the advisor(s) and JCPO is required for such changes.

The Thesis Committee should be the student's primary resource for information and advice; close contact with the members of the Committee is important and two formal meetings per year with the Thesis Committee are required. It is the responsibility of the advisor to document these meetings in a memo to the student, JCPO, and APO; JCPO will confirm that committees have met at the end of each semester.

2.4 Joint Committee for Physical Oceanography

The Joint Committee for Physical Oceanography (JCPO), composed of members of the faculty at MIT and the Scientific Staff at WHOI, oversees the graduate educational program in Physical Oceanography. A list of JCPO members may be found here: https://mit.whoi.edu/curriculum-committees. JCPO is responsible for development of the curriculum and course scheduling, overseeing student admissions and the initial assignment of advisors, setting examination policy, and reviewing student progress. Upon recommendation of the advisor and the student's Thesis Committee, JCPO approves continued registration in the program and accepts the final PhD thesis. In addition, it serves as the first level grievance board for student concerns.

The Education Coordinator of the Physical Oceanography Department at WHOI is a member of JCPO. Their responsibilities include being a liaison with the Academic Programs Office for allocation of financial support to students and other educational activities at WHOI. Advisor(s) and students should feel free to discuss problems with the Education Coordinator or any other member of JCPO. At MIT, the Department of Earth, Atmospheric and Planetary Sciences and the Institute as a whole have Committees on Graduate Students who can respond to concerns.

JCPO can best serve the educational needs of the students if fully informed of their status. Thus it requests notification of changes that may affect a student's academic status and has the final authority for approving them. A written note (email) to JCPO will best ensure careful consideration and a clear response to a student's concerns. Email communications with JCPO should be addressed to jcpo-whoi@whoi.edu.

2.5 WHOI Vice President for Academic Programs/Dean and MIT Dean for Graduate Education

The Deans set the overall policy of the Graduate Program. They generally do not have a direct role in the day-to-day academic operation of the Joint Program. They are, however, very experienced educators and administrators who have a keen interest in the welfare of the students and of the Program overall. They are available to students and staff for personal consultation and are essentially the last stop in the chain of academic governance at both Institutions. The rare problem that cannot be resolved by JCPO will be referred to the Deans.

2.6 Joint Program Administrative Offices

The WHOI Academic Programs Office, which is run by the WHOI Vice President for Academic Programs/Dean, and the Joint Program Administrator's Office at MIT administer services to Joint Program students (registration, admissions, housing, payroll, etc.; see the webpage for current students: http://mit.whoi.edu/current-students). They also maintain official records. The Earth, Atmospheric, and Planetary Sciences Department Office can also provide help with student services.

3 The Academic Program

Most JPPO students are admitted to the program with the intent of pursuing a PhD in Physical Oceanography (Section 3.1). The only exception is for active-duty US Navy officers, who are admitted to the Navy Master of Science Program (Section 3.2). These two tracks are described separately in the following.

3.1 PhD in Physical Oceanography

The completion of a PhD requires roughly five years of sustained effort. For most students, the first two years are devoted mainly to course work, though with some important opportunities for research. The remaining years in the program are devoted mainly to dissertation research and writing. Appendix A summarizes the key one-time and annually recurring events during the PhD program in Physical Oceanography.

Extension beyond the fifth year requires a petition by the student and principal advisor(s) to JCPO each semester. To be approved, these petitions must 1) state why an extension is needed, 2) clearly indicate which parts of the thesis are complete and which parts remain to be completed during the extension period, 3) provide supporting evidence that good progress is being made toward the completion of the thesis, and 4) provide a month-by-month timeline to degree completion including dates of recent and forthcoming committee meetings. In rare instances, unsatisfactory progress or unacceptable behavior can lead to a student being denied permission to continue (see Official Graduate Policies and Procedures http://odge.mit.edu/gpp/). JCPO will ask the student's advisor(s) if they have funding for the extension period. All extension petitions need to be provided to both academic offices (MIT and WHOI) prior to the start of year 6, having already been approved by JCPO.

3.1.1 Financial Support

Students are eligible for fellowships, scholarships, teaching assistantships, and research assistantships. As stated at the time of admission, the Joint Program commits to financial support for a nominal term of five years towards a Ph.D., assuming satisfactory progress. Financial support will continue into the sixth year if an extension is granted. No financial support is available beyond the sixth year. Guidelines for the obligations and benefits for students supported by Research and Teaching Assistantships (e.g., vacation policy) can be found on the ODGE website http://odge.mit.edu.

3.1.2 Leaves of Absence

Students may take a leave of absence for personal or professional reasons. A leave of absence effectively stops the clock on a student's timeline to degree. More information on leaves of absence is available from MIT at: https://studentlife.mit.edu/s3/leaves.

3.1.3 Curricula in Physical Oceanography

Students are expected to take about 9-12 courses during their first two years in the Joint Program (see Appendix F). Typically, these will include 4 core courses, 1-2 data analysis and/or applied math courses, and 4-7 electives. This number is a recommendation and not a requirement – there are no formal course requirements for a PhD in Physical Oceanography from the Joint Program. (Note that an SM degree does require 66 units of classroom activity, see Section 3.1.11.) Although no course is required, students are expected to be knowledgeable about core material in Physical Oceanography and knowledge of that material will be evaluated during the General Exam (Section 3.1.5).

Curricula may vary considerably depending on the focus chosen by the student and advisor(s). Courses should be selected in a way that is consistent with a student's preparation and with their research interests (in consultation with their advisor(s)). Several courses are considered to be 'core courses' that provide the minimum, essential foundation needed by students pursuing research with a strong physical oceanography component; students are strongly encouraged to take these courses during the first year and will be responsible for the content during the General Exam. An understanding of the methods of applied mathematics and data analysis is essential for nearly all research topics, so students are also strongly encouraged to take one or more courses on these topics. The balance of courses should be chosen amongst the wide array of courses available at MIT and WHOI (as well as through agreements with other universities). JCPO will meet with first-year students in order to offer advice in curriculum planning prior to the first semester. Appendix F presents several suggested curricula for common areas of interest for students in Physical Oceanography.

Each student's General Exam (see Section 3.1.5 below) will be tailored to reflect their individual course of study. Performance in the coursework, including the actual grades, is taken into account during the General Exam. It is generally expected that students receive a mix of A and B grades in their coursework. Prior to

the General Exam, students taking courses for credit should be enrolled for a letter grade; if the need arises to switch to pass/fail grading, the student should petition JCPO for permission to do so.

3.1.4 Pre–Generals Research Projects

Students are strongly encouraged to start research as soon as possible to identify a field of interest, develop a firm understanding of the state of knowledge within the field, and single out possible research/thesis topics. It is expected that students focus on research during the summer and IAP (Independent Activities Period, January of each year).

3.1.5 General Exam in Physical Oceanography

The General Exam qualifies the student for PhD research in the Joint Program. The purpose of the exam is to test the ability and potential of the student to function as an independent research scientist. It is intended to assess:

- The student's grasp of material covered in the core curriculum and other courses. The exam emphasizes not only understanding of the basic ideas and concepts presented in the courses but also the ability to draw together and synthesize material from different courses, readings, seminars, etc. For all students, the General Exam will recognize the individualized aspects of their course of study.
- The student's ability to approach a new problem in ways appropriate for an independent scientist. This ability is central to the notion that passing the General Exam qualifies one to prepare the PhD dissertation.

Usually, the General Exam will be taken after two years in the program (typically in June after the spring semester of the second year). Taking the exam at an earlier time may be requested via petition to JCPO; for example, students entering the program with a master's degree in a related field may petition to take the exam after one year.

The General Examination consists of written and oral parts. The written part requires the student to prepare two formal reports describing two distinct research projects that they have conducted. Usually, the first project is supervised by the student's advisor(s) and is on a topic intended for use in the PhD dissertation. The second project is advised by a different faculty member and should focus on a substantially different topic and/or methodology from the first project; if the second project is to be advised by someone outside of MIT and WHOI, JCPO should be consulted. The second project should have a time commitment similar to an extended course project and is not expected to be as comprehensive as the first project. The oral portion of the General Exam consists of presentations and questions about the research project as well as questions about general knowledge of Physical Oceanography. JCPO will meet with students planning to take the General Exam during both the fall and spring semesters before the exam to discuss further details of the exam.

Not later than six months before the General Exam (typically in December of the second year for most students), students must submit an application to take the General Exam to JCPO. (See Appendix B for the application.) The application requests details of both research projects, including advisors, topics, and abstracts of the proposed project(s). JCPO will review these details and approve the proposed projects, possibly with suggested revisions to ensure that they do not overlap significantly and that they will be able to demonstrate the student's ability to approach a problem. The application further requests information about the student's course of study and information that will aid in organizing the General Exam.

The General Exam is administered by a General Exam Committee (GEC). Two JCPO members, one from MIT and one from WHOI, will chair the GEC and be responsible for the logistics. JCPO will appoint

additional faculty members, typically including the student's advisor(s) and others familiar with the individual's research and/or course work, bringing the total membership to 4 or 5 faculty. Students may suggest potential members of the GEC and will be informed of the final membership of the GEC.

The written reports should each describe a significant open problem, outline the present state of knowledge in the appropriate field, propose an approach for addressing the problem, and discuss progress made towards reaching a solution. The two reports should combine to total approximately 40 pages (double-spaced, 12-point font, including figures, but excluding references), and should have the nature of paper drafts. The reports must be submitted to the GEC at least two weeks prior to the scheduled General Exam.

The oral part of the General Exam consists of short presentations by the student on the research papers, totaling approximately 40 minutes of prepared material. Each presentation is followed by an oral questioning period in which committee members question the candidate in depth about the papers, about important aspects of the student's field of specialty, and about the general topics in related fields. The scope of general knowledge questions will be guided by the student's chosen discipline(s) and the subject areas of classes the student has taken. At least 30 minutes of the exam will be reserved for general questioning on topics not directly related to the research projects. A maximum of two hours should be scheduled for the exam.

Passing the General Examination requires meeting each of the following criteria:

1. Both written project reports are deemed acceptable to the GEC.
2. Oral presentations of both research projects are acceptable to the GEC.
3. General knowledge of Physical Oceanography is demonstrated at a level acceptable to the GEC.

In evaluating whether these criteria have each been met, the GEC will assess the extent to which the student meets the following standards:

- The student demonstrates that they have obtained a depth of familiarity with their research projects, as well as a breadth of knowledge in other topics of Physical Oceanography.
- The student has acquired and can utilize an analytical skill set to critically assess scientific problems and to arrive at sensible conclusions.
- The student shows promise of independence, including, but not limited to, the formulation and investigation of interesting research questions or sub-questions, and an evaluation of the state of knowledge and potential future directions related to their research topic(s).

To maintain a level of fairness for students taking the exam in the same year, JCPO will seek to have one or two faculty members serve on the GEC for all students taking the General Exam in a given year.

Possible outcomes of the General Exam are:

1. Pass: All criteria above are satisfied.
2. Conditional Pass: If one or more of the criteria above have not been satisfied, the GEC may require that some or all of those components of the General Exam be redone or may prescribe other ways to satisfy the requirements of passing the General Exam (e.g., preparing a research report that may become either a chapter of the PhD thesis or a terminal Master's thesis). Conditions for passing the General Exam must be completed before or as part of the Thesis Proposal Defense.
3. The student is recommended to either prepare a Master's thesis and then leave the program with an MS degree or, in extraordinary circumstances, withdraw immediately.

The GEC will inform the student of the outcome of the General Exam at the conclusion of the Exam (typically after private discussion by the GEC). The outcome of the General Exam will be documented in a memo to the student, JCPO, and APO that includes a full discussion of the strong and weak points of the

exam as well as any requirements or recommendations for next steps in the program and a clear timeline for completion of next steps.

3.1.6 Committee Formation, Thesis Proposal, and Advancement to Candidacy

Upon successfully passing the General Exam, the student should successfully defend a thesis proposal within four months. At least one month before the thesis proposal defense, the student should form a Thesis Committee (see section 2.3). The complete thesis proposal should be submitted to the Thesis Committee at least two weeks before the thesis defense. A modest extension of the preparation period may be approved by JCPO, but delaying the thesis proposal defense to produce additional results or prepare a manuscript for publication is not recommended.

The purpose of the thesis proposal is to demonstrate the ability to formulate a tractable, interesting research problem. The proposal is a written document (typically 10-15 pages of text, 20-30 pages with figures and references) that should outline:

1. the scope of the problem
2. its significance
3. previous work done by others
4. the methods of research to be used
5. a timeline with a detailed plan for the immediate 6-12 months

Preliminary results can be presented mainly to indicate the direction the work will take but are not a necessary component of a successful proposal. The proposal is not in itself expected to be a completed piece of research. Students are urged to solicit the response of individual Thesis Committee members to the proposal before the thesis proposal defense.

The thesis proposal is to be defended before the Thesis Committee, potentially supplemented by representation from the General Exam Committee depending on the outcome of the General Exam. The length of the presentation should be discussed with the principal advisor(s).

Possible outcomes of the thesis proposal defense are:

1. Pass: The thesis proposal is acceptable to Thesis Committee as presented.
2. Conditional Pass: If the Thesis Committee finds substantial faults in the thesis proposal or the student's preparation to conduct the proposed research, they may define specific conditions that must be satisfied before the thesis proposal is accepted and the student advances to candidacy.
3. In exceptional circumstances, the Thesis Committee may deem the thesis proposal unacceptable. The student may be allowed to substantially revise the Thesis Proposal and defend it a second time, possibly before a reconstituted Thesis Committee. If the Thesis Proposal Defense is not ultimately passed, then the student will leave the program, possibly after completing a Master's thesis.

Regardless of the outcome, the chair of the Thesis Committee will provide a detailed memo to the student, the Thesis Committee, JCPO, and APO documenting the outcome of the proposal defense and including detailed feedback from the defense and recommendations and/or requirements for next steps (with clear deadlines as appropriate).

Upon acceptance of the thesis proposal by the Thesis Committee, a student formally advances to candidacy for the PhD. An electronic copy of the accepted thesis proposal should be submitted to the WHOI Academic Programs Office.

Given the nature of research, thesis work may evolve away from the path originally outlined in the thesis proposal; guidance in this evolving process is one of the roles of the advisor(s) and the Thesis Committee (see Section 2.3). It may occur that after acceptance of the proposal, the student wishes to change thesis

problems (and perhaps advisor(s)) completely. This can be done with approval of the Thesis Committee and JCPO; it will sometimes involve defending a new thesis proposal.

3.1.7 PhD Progress

Progress towards a PhD may suffer short interruptions and periods of slow progress. However, prolonged delays (e.g., a month) are a cause for concern. The timely recognition of a research dead end and the selection of a new research direction are best done in consultation between the student, the principal advisor(s) and the Thesis Committee. It is important that students maintain close, informal contact with their Thesis Committee and, of course, with their principal advisor(s) to avoid excessive delays.

Students are expected to arrange meetings with their Thesis Committee at least twice per year in order to review progress and discuss plans. It is the responsibility of the advisor(s) to prepare a memo summarizing each committee meeting and to provide that memo to the student, Thesis Committee, and JCPO. JCPO will verify that committee meetings have occurred and that related memos have been written at the end of each semester.

3.1.8 PhD Thesis

In general, a thesis consists of four parts:

1. an introductory chapter with a historical review and setting of the problem,
2. chapters developing the original contribution toward the solution of the problem,
3. a final section summarizing the work and its significance,
4. a bibliography.

Theses should meet the requirements set forth by both MIT and the Joint Program, which are detailed at the following sites:

- https://libraries.mit.edu/distinctive-collections/thesis-specs/
- https://mit.whoi.edu/academics/thesis/

A student may incorporate as part of the main chapters manuscripts that have been prepared for publication, submitted for publication, or already published, if most of the work is their own original contribution. Inclusion in a thesis of multiple-authored sections is possible but requires the student to establish their own contribution. Both MIT and APO provide guidance on properly attributing previously published work. Students planning to include submitted or published manuscripts as thesis chapters should solicit feedback on those manuscripts from members of the Thesis Committee *before* submitting the manuscript to a journal and during the revision process; this provides an opportunity for the Thesis Committee to have input and offer advice on the content of the thesis before it is finalized in the publication process.

To allow adequate time for review prior to the Thesis Defense (Section 3.1.10), students must submit the defendable draft of their complete thesis to the Thesis Committee at least three weeks prior to the planned defense date, if not earlier. Copies of the defendable draft should also be provided to the Department Office at MIT, the Academic Programs Office at WHOI, and the Defense Chair (see section 3.11). Additional information on timing of the thesis submission, particularly with respect to the deadlines for degree lists, is available at https://mit.whoi.edu/academics/thesis/.

3.1.9 Pre-Defense Seminar

About four months before the formal PhD defense (Section 3.1.10), students should give a public seminar covering either the entire thesis or a significant and coherent subsection of it. This seminar should be given at the institution (MIT or WHOI) that is *not* hosting the student's upcoming defense. Comments from attendees at this seminar may be helpful in drafting the final version of the thesis, so students are encouraged to present the pre-defense seminar early enough to incorporate edits to the thesis. If possible, avoid scheduling pre-defense seminars at times when attendance by individuals at that institution will be limited

(e.g., avoid breaks between semesters at MIT). Once scheduled, students should let JCPO know the date of their Pre-Defense Seminar.

3.1.10 Thesis Defense and Final Thesis Submission

The thesis defense provides an open forum for presentation of the results of the research and final decision on the acceptability of the work. The defense consists of a public presentation (typically about 50 minutes long) of the thesis, a period of detailed questions from the public, and private discussion with the Thesis Committee and other faculty. At this time, the student is presenting the work to the scientific public and must be ready to explain and defend it.

The thesis defense is moderated by a faculty member not on the Thesis Committee. This person, the Defense Chair, is selected by the student in consultation with the advisor and Thesis Committee, subject to JCPO approval. Students should select a Defense Chair prior to submitting their defendable draft and setting a defense date.

At the conclusion of the defense, the Thesis Committee renders a recommendation on the acceptability of the thesis. They may recommend that the thesis be accepted as is or they may accept it subject to minor revisions. In exceptional circumstances, the Thesis Committee may request further work before the thesis can be accepted. In such cases, another defense may be required. The Defense Chair will relay the outcome of the defense and any required revisions of the thesis to the student in writing, with a copy to JCPO. Ultimately, the Chair of JCPO accepts and signs the final thesis upon the recommendation of the Thesis Committee.

Per MIT-WHOI Joint Program policy, unless major revisions are required, the thesis must be submitted to the MIT and WHOI Education Offices no later than two (2) weeks after the defense. If major revisions are required, the student's Thesis Committee, through the Defense Chair, will make a recommendation to the Chair of JCPO for the deadline by which the final revised thesis must be submitted. The Chair of JCPO has the responsibility to seek advice as rapidly as practicably possible from JCPO and then set a deadline, communicate that deadline to the student, the Thesis Committee and the Joint Program Director at MIT and Dean at WHOI. Failure to meet the deadline can result in denial of further stipend and tuition support by either the Director of the Joint Program at MIT in consultation with the Department Head at MIT or by the Dean at WHOI in consultation with the Department Chair at WHOI.

APO maintains detailed instructions regarding final thesis submission and details of defense planning and procedures at https://mit.whoi.edu/academics/thesis/.

3.1.11 Master of Science (SM) in Physical Oceanography

With the exception of active-duty US Navy officers (see Section 3.2), there is no formal program resulting in an SM degree in Physical Oceanography. However, the decision that a student should terminate their studies in the Joint Program with an SM degree can be made for a variety of reasons (e.g., a student's personal reasons for not proceeding to a PhD, unsatisfactory performance in formal classes or on the General Examination, etc.). The point at which this decision is made will depend on each specific case. Nevertheless, students should typically plan to complete the requirements for a Master's degree within a year of the decision. Students considering an SM degree are encouraged to discuss the possibility with their advisor(s), the Education Coordinator, and/or JCPO.

The basic requirements for a Master's Degree are as follows:

1. Completion of at least 66 units worth of formal subjects (exclusive of thesis units; 44 units at a graduate level, and 34 units in a given field). It is expected that, in most cases, much

of this course work will have been completed prior to the decision that a student will terminate with a Master's Degree.
2. Completion of an acceptable Master's thesis, based on original research by the student. The Master's thesis must make an original contribution to a particular field of study.

All requirements for an SM degree at MIT and within EAPS must be met; see the MIT Bulletin for details.

As soon as the student has determined a research topic through discussion with their advisor(s), a Thesis Committee consisting of at least one member from each of the partner institutions will be formed (exceptions must be approved by JCPO); for students having previously formed a committee for PhD research, the same committee may oversee completion of the SM. The student will take responsibility for keeping all members apprised of their progress. At the beginning of their research, the student will also submit a short abstract of the proposed thesis and the members of the Thesis Committee to JCPO for approval.

The SM thesis will consist of:

1. Abstract
2. Historical review and background of the problem
3. Presentation of the original research and its contribution toward solution of the problem
4. Summary
5. Bibliography

The Chair of JCPO will formally accept the completed SM thesis upon recommendation of the Thesis Committee. A public presentation of the SM thesis is not required but is encouraged.

3.2 Navy Master of Science in Physical Oceanography

The Navy Master of Science (S.M.) program within the MIT-WHOI Joint Program is governed by OPNAVINST 1520.31 (series) and NPSINST 1520.1 (series) and designed to be completed in 27 months (two years and a summer). Navy students typically will report during June of their first summer and depart in September two years following. The first year is typically spent taking courses and beginning research with an advisor of their choice. In the second year, the student primarily focuses on research, culminating in a Master's thesis. While Navy students are physically assigned to MIT/WHOI Joint Program in Physical Oceanography, they administratively report to the Boston NROTC Consortium, where they are obligated to maintain and adhere to administrative communications and procedures (i.e., FITREP/PFA/LEAVE/etc.).

3.2.1 Residency and Summer Math Class

All incoming Joint Program Navy students are strongly encouraged to spend their first summer at WHOI, prior to the official start of the first academic year. A math refresher class taught by current Joint Program students is normally offered to all incoming students. Navy students returning from the Fleet, who may have been out of school for a number of years, can also consider enrolling in MIT course 18.089 "Review of Mathematics", which offers a more in-depth review of single- and multi-variable calculus. These class will help prepare Navy officers for the upcoming semester of Joint Program classes.

3.2.2 Advisors

Each Navy Master's student in Physical Oceanography is assigned two advisors, one from MIT and one from WHOI. One of these is designated as *research advisor;* the other is designated as *academic advisor.* The research advisor helps the student develop a thesis topic, supervises the thesis research, and ensures that the student takes all the classes necessary to support the research. The academic advisor provides an additional perspective on curriculum and research ideas and helps the student to ensure that they meet the requirements to receive a Master's Degree in Physical Oceanography from MIT/WHOI. Although the research advisor is normally the principal source of input and direction, each student should meet with their

academic advisor at the beginning each semester for registration and is encouraged to have a broader discussion with the academic advisor.

Any MIT faculty member in any MIT department participating in the MIT/WHOI Joint Program or any member of the WHOI Scientific Staff may serve as research or academic advisor for a Navy Master's student in Physical Oceanography. Many incoming Joint Program Navy Master's students have already been matched with research advisors prior to their arrival in the Joint Program. However, some students may spend the initial portion of the first summer in the program identifying a research advisor. Students must notify the Chair of JCPO, the WHOI Academic Program Office, and the MIT Department of Earth and Planetary Sciences Graduate Office of their thesis advisor within six weeks of arrival.

3.2.3 Master's Thesis

Unlike Joint Program Doctoral students, Joint Program Navy Master's students do not form a thesis committee, do not take the General Examination, and do not publicly defend a thesis. The Master's thesis is signed off by the research advisor and by the chair of JCPO. However, Navy students nearing the end of their time in the Joint Program are encouraged to present their work at a PO departmental seminar.

3.2.4 Navy Master of Science Course Requirements and Electives

Students must obtain at least 66 credit units of coursework, not including credit received for thesis work. Graduate subjects at MIT are classified as one of two types: G-level and U-level. A G-level subject indicates a subject approved for graduate credit. A U-level subject is an undergraduate subject. Of the 66 units of required coursework, at least 48 must be G-level graduate subjects. The remaining 18 units may be for U-level subjects. Students must maintain a minimum grade point average of 3.5 (A=5, B=4, C=3, D=2, F=0).

In addition to physical oceanography course work, Navy PO students who are METOC officers (designator 1800) should consider atmospheric science electives (see Appendix F). These courses cover similar topics to the meteorology courses taken by METOC officers at the Naval Postgraduate School. Additionally, Navy students may consider elective options through cross-registration at Harvard. In particular, courses through Harvard Law such as "International Law of the Sea", "New Technologies and the Law of War", and "Laws of War" have parallels with Joint Professional Military Education (JPME) Phase I.

3.2.5 Credit Transfer

Students are allowed to transfer credit toward their Master's degree from graduate subjects taken previously at MIT or another accredited institution, and not used as part of the credits required for an undergraduate or graduate degree. The limit is 24 credit units if the subjects were taken outside MIT. Transferred subjects must have a grade of B or higher. No thesis units may be transferred.

3.2.6 Navy Educational Skill Requirements (ESRs)

The Navy requires that students understand the fundamental concepts and be familiar with certain basic functional areas within the Department of Navy and the DoD and be able to apply them in future meteorology and oceanography billets. The ESRs that a Navy Student is required to meet are those for Curriculum 375, Oceanography Operational Sciences, Subspecialty Code 6402P. As of the writing of this guide, these areas include mathematics, physical oceanography, sensing, dynamics, acoustics, prediction, and problem solving and practical applicability. The student should consult with their advisors in designing an education plan that ensures that all such ESRs are covered in the coursework. The WHOI Academic Programs Office maintains a list of ESRs and courses that satisfy each requirement on their website (https://mit.whoi.edu).

3.2.7 Navy Approval of Education Plan

It is the student's responsibility to fulfill all Navy requirements for the Master's degree. This includes

developing an Education Plan in consultation with their advisors and submitting the Education Plan for Navy approval via NPS CIVINS. This plan should be submitted to the Navy at least 30 days prior to the beginning of the first-year fall semester. In cases in which the student has not received any communication about an Education Plan or has been told to wait to submit an Education Plan (e.g., as happens for USNA Immediate Graduate Education students), they will be contacted by NPS CIVINS office with detailed instructions, possible after formally starting in the Joint Program.

This Education Plan lists the courses that the student expects to take in each of the four semesters. Though the courses offered and/or taken by the student each semester may change, the initial Education Plan should cover every semester in the Joint Program. As time progresses, unexpected changes in class or cruise schedules and/or research directions may require alterations to the original plan. It is the student's responsibility to submit amended Education Plans to NPS CIVINS for their awareness and approval. Only the initial Education Plan is required to be formally signed off on by the student's research advisor.

3.2.8 Thesis Requirements

The Master's thesis is considered to be the centerpiece of a student's graduate experience. The thesis is an original work of research, design, or development. The research advisor and the Chair of JCPO sign and accept the thesis upon completion.

3.3 Annual Review

Each spring, JCPO conducts a general review in order to monitor student progress and to make sure that the student/advisor relationship is functioning well. Students are asked to fill out a questionnaire (see Appendix E) focused on past and future milestones in the program, the student-advisor relationship, other aspects of professional preparation, and general comments or concerns. Students may choose whether to discuss their responses with their advisor(s). If the student's advisor is a member of JCPO, the questionnaire may be returned to the Chair of JCPO or another unconflicted member. Separately, advisors are asked to provide information on student progress (see Appendix E). It is the principal advisor's responsibility to give an objective and candid assessment of the student's performance at fairly frequent intervals. The student and advisor(s) should discuss the annual progress report in detail, especially when problems are identified. It is the principal advisor's responsibility to ensure that these written evaluations are transmitted to JCPO, which will use them to evaluate the student's progress toward a degree. These reports will be filed with the MIT Joint Program Office and WHOI Academic Programs Office.

Students will meet individually with two members of JCPO (not including their advisor, if applicable) to discuss their responses and any other issues they wish to bring up. Forms are typically sent out in April and the review meetings typically take place in May. JCPO will provide a written summary of the meeting and feedback to the student and the advisor. Outside of the Annual Review, students are always welcome to meet with JCPO.

3.4 Procedures for Students with Disabilities

Students with disabilities can receive assistance from the MIT Student Disability Services (SDS) (http://studentlife.mit.edu/sds). SDS has identified an individual within each academic department who serves as a logistical coordinator/Disability Services liaison, assisting students and faculty with the implementation of accommodations. The Logistical Coordinator for EAPS is the department Academic Administrator.

A student with a disability may be entitled to receive an accommodation for course exams or the general exam, based upon the functional impact of the disability. Some examples of test accommodations include: having someone write down a student's dictated answers (using a "scribe"), accessing a written test through auditory means (using a reader, assistive technology, or a taped version of the exam), or completing the

exam with an additional time allotment. To qualify for an accommodation, the student must first make a request through SDS and follow the SDS procedure, which is detailed at http://studentlife.mit.edu/sds/

If the student qualifies, they will be provided with a letter specifying the accommodation(s). The student must make an appointment with each faculty member/instructor during office hours to provide them with the accommodation letter and discuss their accommodation needs. This is typically done at the beginning of the semester, but at a minimum, should be done two weeks in advance of the first test. Thereafter, students are expected to remind their faculty member and Departmental Logistical Coordinator of their accommodation needs at least two weeks before each exam date. Students are strongly encouraged to interact directly with faculty/instructor regarding their accommodation needs. Additionally, the student must deliver an accommodation letter to the Department Logistical Coordinator.

The knowledge of a student's disability is confidential. Information is provided at the student's request or with a signed consent on a "need to know" basis only. This typically means that SDS will share information related to the student's accommodations requests for reasons directly related to the request or for personal safety.

A student seeking an accommodation as part of the General Exam (GE) should be prepared to describe the format of the exam to SDS as laid out in Section 3.1.5 of this handbook. Once an accommodation is approved, the student should present the SDS-authored letter to the two Chairs of the General Exam Committee and the Departmental Logistical Coordinator. In addition, students are strongly encouraged to inform their advisors of their approved accommodations. We strongly recommend that the student initiate the accommodation request process several months in advance of the General Exam, as the approval process takes some time. Further, students are strongly encouraged to share their approval decision/accommodation letter with the General Exam Committee Chairs six weeks in advance of the date of the General Exam, to allow sufficient time for implementation. Once notified, the two Chairs will consult with the student in order to develop a procedure by which the accommodation can be implemented and confidentiality can be safeguarded. The Departmental Logistical Coordinator is available to assist the faculty member and student with implementation logistics. The Chairs are instructed to disclose the accommodation to other committee members only on a need-to-know basis.

Appendix A Timeline to PhD and Responsibilities

Recurring Events:

1. **JCPO Group Meetings with Students:**

   August: JCPO + 1st-year students to discuss course selection, advising/faculty mentors, etc.

   November: JCPO + students taking General Exam (1/2)

   April: JCPO + students taking General Exam (2/2)

   September: JCPO with all students

2. **Annual Review**

   April: JCPO solicits student and advisor feedback

   May: Students meet individually with JCPO

   May: JCPO provides memos documenting meetings

3. **Committee Meetings (at least twice per year following advancement to candidacy)**

   Student: updates full committee on progress toward degree

   Committee: provides feedback and suggestions

   Advisor: prepares summary memo for student/JCPO/APO

   June/December: JCPO confirms that meetings occurred and memos were submitted in preceding semester

One-time Events (*JCPO may grant extension):

1. **General Exam Application (December, Year 2)**

   Student: complete application, including details of proposed projects

   Advisor: sign off

   JCPO: review project proposals; approve and/or offer suggestions on projects

2. **General Exam (June, Year 2)**

   JCPO: form GE committee; schedule exams

   Student: submit written reports >2 weeks before exam; oral presentation to GE committee

   Advisor: serve on GE committee

   GE Committee Chair: prepare memo documenting result for student/JCPO/APO

3. **Form Thesis Committee (September, Year 3*)**

   Student: propose committee to JCPO at least 1 month prior to thesis proposal defense

   JCPO: approve committee makeup

4. **Thesis Proposal Defense (October, Year 3*)**

Student: submit written proposal to committee >2 weeks before defense; oral presentation to committee; edits as requested by committee; final proposal submitted to JCPO/APO

Advisor: organize and chair; write memo to student/JCPO/APO/committee summarizing result

Committee: review proposal; participate in defense

5. **6th-Year Petition (June, Year 5, if needed)**

   Student: submit petition to APO/JCPO with timeline to defense

   Advisor: sign off

   JCPO: approve

6. **Pre-Defense Presentation**

   Student: present selection of thesis results in public seminar at institution (MIT or WHOI) not hosting defense ~4 months before Thesis Defense

7. **Thesis Defense**

   Student: select Defense Chair; submit defendable draft of thesis >3 weeks before defense; complete revisions as requested after defense

   Advisor: read and comment on thesis; attend defense

   Committee: read and comment on thesis; attend defense

   Defense Chair: coordinate defense; prepare memo detailing outcome

   JCPO: approve Defense Chair

8. **Final Thesis Submission**

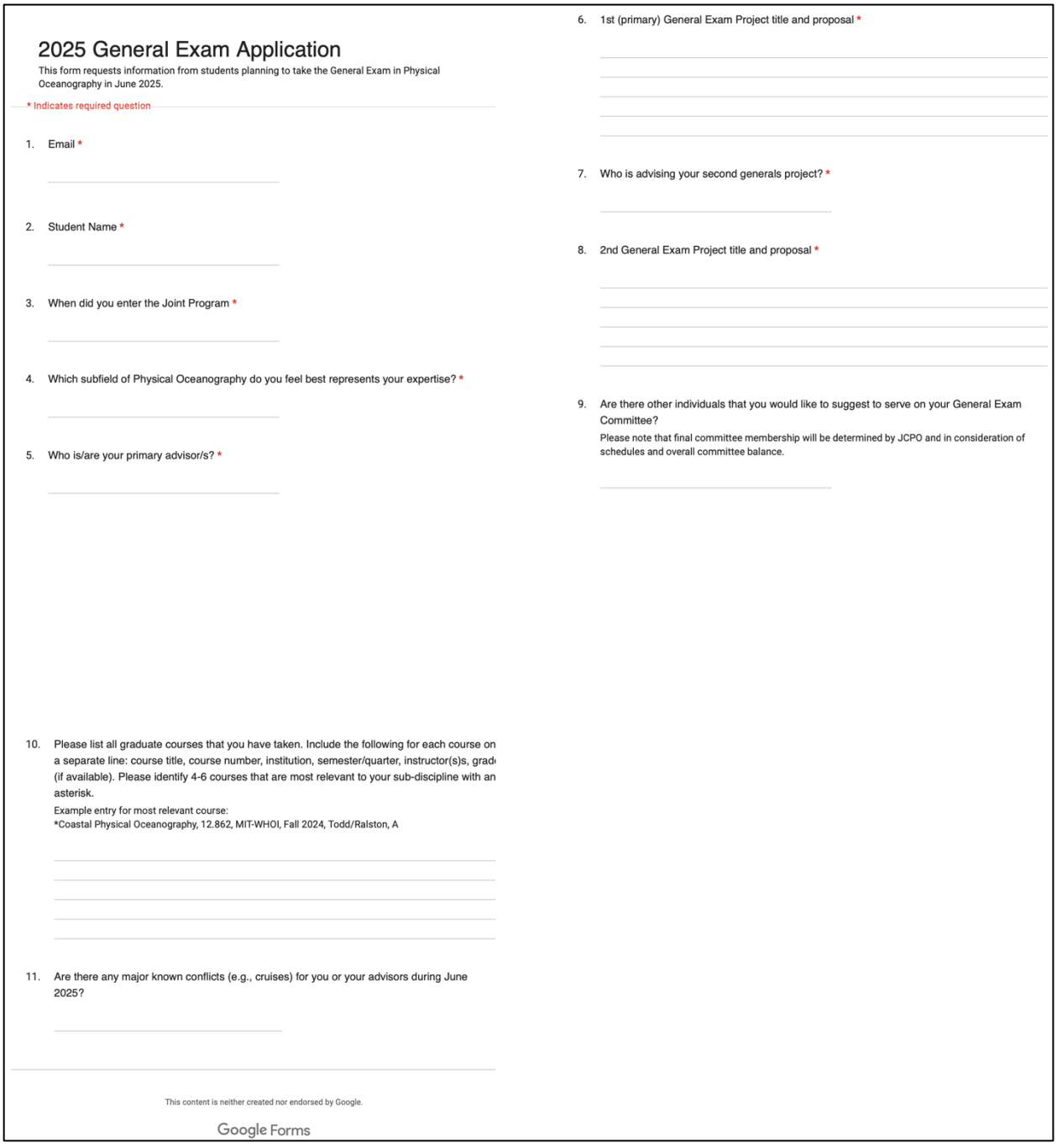
   Student: complete revisions per discussions at Thesis Defense; deadline is two weeks after the defense unless major revisions are required and a different deadline is given

   Advisor: sign off on final thesis

   JCPO: Chair of JCPO formally accepts and signs off on final thesis

Appendix B General Exam Application Form

Below is a copy of the 2025 General Exam application form.



2025 General Exam Application

This form requests information from students planning to take the General Exam in Physical Oceanography in June 2025.

* Indicates required question

1. Email *
2. Student Name *
3. When did you enter the Joint Program *
4. Which subfield of Physical Oceanography do you feel best represents your expertise? *
5. Who is/are your primary advisor/s? *
6. 1st (primary) General Exam Project title and proposal *
7. Who is advising your second generals project? *
8. 2nd General Exam Project title and proposal *
9. Are there other individuals that you would like to suggest to serve on your General Exam Committee?
   Please note that final committee membership will be determined by JCPO and in consideration of schedules and overall committee balance.
10. Please list all graduate courses that you have taken. Include the following for each course on a separate line: course title, course number, institution, semester/quarter, instructor(s)s, grad (if available). Please identify 4-6 courses that are most relevant to your sub-discipline with an asterisk.
    Example entry for most relevant course:
    *Coastal Physical Oceanography, 12.862, MIT-WHOI, Fall 2024, Todd/Ralston, A
11. Are there any major known conflicts (e.g., cruises) for you or your advisors during June 2025?

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Google Forms

Appendix C List of Useful Seminar Series

Title	Location	Time
PAOC Colloquium	MIT 54-911	Mon, 12pm – 1pm
WHOI PO Seminar	Clark 507	Tue, 3pm – 4pm
SACK Lunch Seminar	MIT 54-911	Wed, 12pm – 1pm
Climate and Paleo Lunch Seminar	WHOI, Clark 237	Thursdays 12:15
COFDL – Coastal Ocean Fluid Dynamics Laboratory Seminar	Bigelow 114	Fri, 12:15-1:15 pm
SLUSSPO – Student Lunch Seminar Series in Physical Oceanography	MIT / WHOI (videoconferenced)	Tue, 12pm – 1pm

Appendix D Student / Advisor Checklist

The following are recommended issues to discuss at different stages in our program:

Year 1, 2:

- Coursework and grades.
- External funding options: generally, applications are due Nov-Jan.
- Research project and expectations for its progress before the General Exam.
- Annual review (spring).

Years 3, 4, 5+:

- Publication and conference presentation of research (including the General Exam project). Soliciting feedback from the thesis committee prior to journal submission is strongly recommended. Publication of a manuscript does not guarantee approval of material as a thesis chapter.
- Relevant summer schools.
- TA opportunities: there are few TA opportunities in the PO program, so early discussion is advised.
- Fieldwork: if this is not a part of proposed research, volunteering to assist others may be advisable.
- Opportunities to mentor undergraduates or K-12 students.
- Co-writing a grant proposal.
- Thesis defense date and progress toward completion.
- Post-doctoral positions and non-academic job prospects.
- 6th year petition if required (Spring of 5th year).
- Annual review (spring of each year).

Appendix E Annual Review Questions

Below are copies of the questions sent to both students (separate questionnaires for PhD and Navy students) and advisors for the 2024 Annual Review.

2024 Annual Review PO PhD Students

Overview:

1. Your name

2. Your email

3. Where are you in the program? (year, engaged in thesis research, etc.) What are your most recent and next major milestones? (exams, thesis committee meetings, thesis defense, start of research project, etc.)

4. General exam date:

5. Thesis proposal date:

6. Thesis proposal title:

7. Date of last committee meeting:

Advising:

8. Who is your principal advisor and, for pre-generals students, who is your secondary advisor?

9. How often do you meet with your advisor?

10. Is your advisor generally helpful in answering questions? Do you get the support that you want?

11. If in you are in the first or second year, does your advisor respect that you have other responsibilities other than research such as assignments, exams etc.?

12. Name one thing that could be improved in your student/advisor relationship and one thing that you would like continued? (e.g. frequency of meeting, type of feedback, expectations)

22. If applicable: If you are thinking of a career in academia, do you feel you are getting prepared well for that (e.g. publishing papers/preparing conferences etc.)? If not, what would help?

Anything else

23. Is there anything else that you would like to share? Are there ways in which the JP could serve you better?

24. Have you discussed this review with your advisor (yes, no)? You may choose whether to do so.

Courses:

13. If you took, or are taking, courses either this spring or fall, what were they and how did you do?

14. What classes are you planning to take in the coming year?

15. Have you been a TA or do you plan to TA in the future (when)?

16. What topics would you like to see for a course or to be covered better in existing courses?

Research:

17. Please briefly describe (or give titles of) your primary and secondary generals research projects and name the advisor for each. Do you feel these are good topics for you -- why did you choose them?

18. If you are working on a thesis what is its title or topic and please briefly describe it. Who is on your thesis committee?

19. Do you have any publications (in preparation, submitted, or out)? If you are a post-generals student, have you and your advisor spoken about publications?

Future:

20. Are you on track to finish in 5 years?

21. If applicable: Do you feel you are getting prepared well for a career as a scientist, whether it be in industry, government, research, teaching or anything else? If not, what would help?

2024 Annual Review PO Navy S.M. Students

Overview:

1. Your name

2. Your email

3. Where are you in the program? (year, engaged in thesis research, etc.) What are your most recent and next major milestones? (exams, start of research project, thesis, etc.)

4. Expected graduation date:

Advising:

5. Who is your principal advisor? Is there anyone else advising you (e.g. a co-advisor)?

6. How often do you meet with your advisor?

7. Is your advisor generally helpful in answering questions? Do you get the support that you want?

8. Does your advisor respect that you have other responsibilities other than research such as assignments, exams etc.?

9. Name one thing that could be improved in your student/advisor relationship and one thing that you would like continued? (e.g. frequency of meeting, type of feedback, expectations)

Courses:

10. If you took, or are taking, courses either this spring or fall, what were they and how did you do?

11. What classes are you planning to take next year (if applicable)?

12. What topics would you like to see for a course or to be covered better in existing courses?

Research:

13. What is the title or topic of your thesis? Please briefly describe it.

14. Do you have what is needed (resources, data, skills) to complete it? Are there any resources or information that you lack?

Future:

15. Are you on track to finish in 2 years?

16. Do you feel that your time in the Joint Program has been a time of intellectual growth and will benefit your career? If not, what would help?

Anything else

17. Is there anything else that you would like to share? Are there ways in which the JP could serve you better?

18. Have you discussed this review with your advisor (yes, no)? You may choose whether to do so.

Advisor feedback to JCPO 2024

As part of the Annual Review for Joint Program students, JCPO is soliciting a progress report from each advisor. Your response can be short, but please be sure to address the following questions.

* Indicates required question

1. Email *

2. Your name *

3. Student's name *

4. (1) Is the student on track? *

5. (2) Do you have any concerns? *

6. (3) Anything else you would like share or discuss with JCPO? (optional)

7. (4) Will you have (or have you recently had) a followup conversation with your student about their progress and plans?

Mark only one oval.

- Recently had such a conversation
- Will have a conversation in the next few days
- NA

Appendix F List of Courses and Sample Curricula

Here we present a list of courses of interest, divided into general areas, followed by sample curricula for several main tracks. Note that these lists are not exhaustive and that courses are subject to change in time. Please consult the MIT course catalog for the most up-to-date course listings: https://catalog.mit.edu/

List of courses within their relevant areas:

Physical Oceanography
12.758 Classic Papers Physical Oceanography
12.800 Fluid Dynamics of the Atmosphere and Ocean
12.801 Large-scale Ocean Dynamics
12.802 Waves, Instability and Turbulence at Small Scales
12.808 Introduction to Observational Physical Oceanography
12.809 Hydraulic Phenomena in Geophysical Fluid Flows
12.820 Turbulence in the Ocean and Atmosphere
12.824 Stability Theory for Oceanic & Atmospheric Flows
12.843 Large-scale Atmosphere and Ocean Dynamics
12.853 Advanced Geophysical Fluid Dynamics
12.862 Coastal Physical Oceanography
12.870 Air-Sea Interaction: Boundary Layers

Data Analysis/Modeling
1.073 Introduction to Environmental Data Analysis
2.29 Numerical Fluid Mechanics
7.410 Applied Statistics
12.714 Computational Data Analysis
12.747 Modeling, Data Analysis, and Numerical Techniques for Geochemistry
12.805 Data Analysis in Physical Oceanography
12.823 Modeling the Biology and Physics of the Ocean
12.850 Computational Ocean Modeling

Climate and Paleoclimate
12.707 The History of the Earth's Climate
12.708 Topics in Paleoceanography
12.740 Paleoceanography
12.757 Climate Change Science and Communication
12.842 Climate Science
12.848 Global Climate Change: Economics, Science, and Policy
12.860 Climate Variability and Diagnostics
12.885 Science, Politics, and Environmental Policy
EPS208 Physics of Climate (Harvard)
EPS231 Climate Dynamics (Harvard)

Atmosphere
12.810 Dynamics of the Atmosphere
12.811 Tropical Meteorology
12.812 The General Circulation of the Atmosphere and Climate Change
12.818 Introduction to Atmospheric Data and Large-scale Dynamics

Biology

7.431 Topics in Marine Ecology
7.434 Topics in Zooplankton Biology
7.435 Topics in Benthic Biology
7.436 Topics in Phytoplankton Biology
7.437 Topics in Molecular Biological Oceanography
7.439 Topics in Marine Microbiology
7.440 An Introduction to Mathematical Ecology
7.470 Biological Oceanography

Chemistry
12.742 Marine Chemistry
12.744 Marine Isotope Chemistry
12.746 Marine Organic Geochemistry
12.849 Mechanisms and Models of the Global Carbon Cycle

The following are suggested curricula for the following common areas of interest for students in Physical Oceanography:
1. General Physical Oceanography
2. Physical Oceanography and Climate
3. Physical-biological-chemical Interactions
4. Coastal/Nearshore Physical Oceanography and Engineering

The curricula consist of:
A. Core Courses.
Four area-specific core courses are highly recommended, with possible exceptions for students who have already completed similar courses. They are intended to provide the minimum, essential foundation needed by students pursuing research with a strong physical oceanography component. They can be completed within the first year.

Two core courses are recommended to all students within Physical Oceanography:
12.800 Fluid Dynamics of the Atmosphere and Ocean (F)
12.808 Introduction to Observational Physical Oceanography (F)

Plus two area-relevant core courses that may vary depending on the focus

General Physical Oceanography
12.801 Large-scale Ocean Dynamics (S)
12.802 Waves, Instability and Turbulence at Small Scales (S)

Physical Oceanography and Climate
12.801 Large-scale Ocean Dynamics (S)
12.812 The General Circulation of the Atmosphere and Climate Change (F)

Physical-biological-chemical Interactions
7.470 Biological Oceanography (S)
12.742 Marine Chemistry (F)

Coastal/Nearshore Physical Oceanography and Engineering
1.69 Introduction to Coastal Engineering (F)
12.802 Waves, Instability and Turbulence at Small Scales
12.862 Coastal Physical Oceanography (F)

B. Applied Mathematics and Data Analysis Techniques.

An understanding of the methods of applied mathematics and data analysis is essential for all research topics. The choice of course(s) is dictated by the student's preparation and interests and is made in consultation with the advisor.

Early in their studies, most students in Physical Oceanography are recommended to take:
12.805 Data Analysis in Physical Oceanography

Those seeking to learn additional numerical analysis techniques may be interested the following sets of courses:
18.085 Computational Science and Engineering I
18.086 Computational Science and Engineering II
-or-
18.305 Advanced Analytic Methods in Science and Engineering
18.306 Advanced Partial Differential Equations with Applications
-or-
18.075 Methods for Scientists and Engineers

C. Electives Courses.

The core curricula have been kept to a minimum in order to allow each student the time to define a program of elective courses that are tailored to their research interest. Some of the most common and relevant electives are indicated within the different curricula by an asterisk (*). In addition, to help prepare for research on these diverse topics, Joint Program students may choose elective courses from the offerings of any MIT or WHOI department and cross-registration is available with Harvard. The list of possible electives is thus very extensive. Students are encouraged to consult the sample curricula as well as the appropriate course catalogs. Students are expected to define their own, personal paths through an elective course program, with advice from their major advisor and other academic staff members.

Focus: General Physical Oceanography
12.758 Classic Papers in PO (S)
12.809 Hydraulic Phenomena in Geophysical Fluid Flows (F)
12.820 Turbulence in the Atmosphere and Oceans
12.824 Stability Theory for Oceanic & Atmospheric Flows
12.843* Large-scale Atmosphere and Ocean Dynamics
12.850 Computational Ocean Modeling
12.853 Advanced Geophysical Fluid Dynamics
12.862 Coastal Physical Oceanography
12.870 Air-Sea Interaction: Boundary Layers (S)

Focus: Physical Oceanography and Climate
12.707 The History of the Earth's Climate (S, odd)
12.708 Topics in Paleoceanography
12.740* Paleoceanography (S, even)
12.742 Marine Chemistry (F)
12.744 Marine Isotope Chemistry
12.746 Marine Organic Geochemistry
12.747 Modeling, Data Analysis, and Numerical Techniques for Geochemistry
12.756* Climate Variability and Diagnostics (S, odd)
12.757 Climate Change Science and Communication (S)

12.802* Waves, Instability and Turbulence at Small Scales (S)
12.810 Dynamics of the Atmosphere
12.811 Tropical Meteorology
12.818 Introduction to Atmospheric Data and Large-scale Dynamics
12.842* Climate Science (F)
12.843 Large-scale Atmosphere and Ocean Dynamics (F)
12.848 Global Climate Change: Economics, Science, and Policy (S)
12.849 Mechanisms and Models of the Global Carbon Cycle
12.850 Computational Ocean Modeling
12.853 Advanced Geophysical Fluid Dynamics (F)
12.860* Climate Variability and Diagnostics (F, even)
12.885 Science, Politics, and Environmental Policy (F)
EPS208 Physics of Climate (Harvard, F)
EPS231 Climate Dynamics (Harvard, S)

Focus: Physical-Bio-Chemical Interactions

Interconnection between physics, biology, and chemistry of the ocean arises from three basic sources: (1) hydrodynamic flows continually redistribute material in the ocean; (2) environmental fluctuations impact biological and chemical rates; and (3) organisms are capable of directed motion through the water. Research in physical-biological-chemical interactions requires an interdisciplinary curriculum with depth in the native disciplines, as well as coursework at their interfaces. Relevant courses include:

1.073 Introduction to Environmental Data Analysis
2.29 Numerical Fluid Mechanics
7.410* Applied Statistics (F)
7.430 Genetics of Marine Organisms
7.431 Topics in Quantitative Marine Ecology
7.434 Topics in Zooplankton Biology
7.435 Topics in Benthic Biology
7.436 Topics in Phytoplankton Biology
7.437 Topics in Molecular Biological Oceanography
7.439 Topics in Marine Microbiology
7.440 An Introduction to Mathematical Ecology
12.702 Elements of Modern Oceanography (F)
12.714 Computational Data Analysis
12.746 Marine Organic Geochemistry
12.801 Large-scale Ocean Dynamics
12.802* Waves, Instability and Turbulence at Small Scales
12.820 Turbulence in the Ocean and Atmosphere
12.823* Modeling the Biology and Physics of the Ocean (S)
12.860 Climate Variability and Diagnostics
12.862 Coastal Physical Oceanography

Focus: Coastal/Nearshore Physical Oceanography and Engineering

1.64 Physical Limnology
1.72 Groundwater Hydrology
2.29 Numerical Fluid Mechanics
12.754 Coastal geomorphology
12.809 Hydraulic Phenomena in Geophysical Fluid Flows
12.820* Turbulence in the Ocean and Atmosphere
12.850 Computational Ocean Modeling