Guidelines for Graduate Students in the AOS Program

The Graduate Work Committee

This is an informal guide and manual for graduate students in the AOS Program at Princeton University. It is meant to help the student navigate through the Program from start to finish by providing advice and guidance on practical matters, and an interpretation of some of the rules. This guide should absolutely not be regarded as providing an authoritative source on rules and regulations. The Graduate School is the ultimate authority on all rules and procedures, and you should consult the Graduate School website (http://gradschool.princeton.edu/) for that, or speak to one of the AOS staff.

1 The Director of Graduate Studies, the Graduate Work Committee, and the Advisor

While the administrative responsibility for the AOS program as a whole (including postdoctoral fellows and research staff) rests with the Director of the AOS program, the oversight of the graduate program and the welfare of the graduate students is the responsibility of the Director of Graduate Studies (DGS). He or she is your point of contact for all academic matters in the program. From the point of view of students the DGS is also the primary faculty contact and guide should problems arise between students and advisors. The DGS also sits on the Faculty Committee on the Graduate School, which makes graduate policy for the university as a whole. Examples of issues that have come before the committee include admissions criteria, who may supervise dissertations, new graduate courses in different departments, and maternal leave policies. The DGS signs off on the readmission of each student each year and approves the final degree list.

The DGS chairs the Graduate Work Committee (GWC) consisting of two or three additional members of the AOS faculty; the GWC provides oversight for the program. Three important components of this are: (i) Recruitment — the GWC reads all the applications each year to help select students and help to coordinate student visits, (ii) Assessment — the DGS and GWC run the general exam each spring and in general monitor the progress of students, (iii) Development — the GWC works with students to help develop programs that meet the needs of the student body. An important principle that guides the GWC is fairness and uniformity, helping to assure that students are treated fairly and that the expectations of students and advisors are clear and reasonable.

The advisor is the main academic guide that you will have over the course of your research, and it is essential that you have good relations him or her. We talk more about the role of the advisor in the sections below.

2 Pre-Generals

The progress through the Ph.D. can be divided into two parts: the pre-general period and the post-general period. The ‘Generals’ are a set of examinations, both written and oral and taken toward the end of your second year, and determine whether you can continue to a
Ph.D. Before your generals, you are doing both course work and research; after your generals, you are primarily doing research.

2.1 Committee and Advisor

The incoming student is normally initially assigned a principal advisor by the Graduate Work Committee (GWC), in consultation with the faculty, on the basis of the research interests of the student expressed in their admissions application, or in other communication with the faculty. However, this initial appointment is not necessarily permanent: the student's scientific interests may evolve, particularly as they become more familiar with the atmospheric and oceanic sciences. The initial principal advisor may then not be the most suitable, and each student should seek out the best advisor for his/her proposed research, subject to scientific and financial considerations. A change of advisor for this reason is not uncommon. If a student wishes to change advisor they must notify the DGS in writing or by email of the proposed change of advisor. The student should have settled on a pre-generals advisor by the end of the second semester of their first year.

A strong working relationship between the student and the advisor is very important to a successful Ph.D. The advisor will be the student's closest scientific contact, and must have an active interest in helping and advising. Both student and advisor should make an effort in ensuring regular communication between them. The student should consult the advisor regarding courses the student plans to take, and explore topics for pre-generals research with the advisor.

When the student has decided on an advisor, the advisor and student should agree upon and organize a pre-generals Advisory Committee, normally consisting of the advisor plus at least two other scientists. These are normally AOS or Geosciences faculty, but in some circumstances faculty from other departments, or GFDL scientists, may be appropriate. At least one other committee member must be an AOS faculty, and the committee must also be approved by the DGS. The committee is to provide, together with the advisor, the student's primary resource for information and advice. The composition of the committee may evolve with time as the research evolves, and the pre-general committee need not be the same as the Ph.D. thesis committee. The DGS should be informed of, and approve changes to the committee.

The main duty of the pre-generals advisory committee is to monitor the student's preparation for the General Exam, and his/her progress in course work and pre-generals research. The student is advised to meet with committee members regularly, and to hold at least one formal committee meeting per semester.

2.2 Courses

A student will typically take about three courses per semester in the first year, two or three in the first semester of the second year, and one or two in the second semester of the second year. A student is normally examined on about nine courses. Not all students will take the same courses, and some courses may be taken in other departments, although the majority of the courses taken are usually in AOS, and some core courses are usually taken by all students. A list of all courses currently offered in AOS is given in the Appendix, and below we give examples of tracks or pathways that might be taken by a student. Other pathways are possible — for example, a climate dynamics track might be a combination of
the first two tracks below. Note that some classes (like AOS 577 and AOS 547) are offered in alternate years, so that the semester in which they are taken may vary. *You should regard these pathways as examples only* — they are not formal tracks in any way.

**Atmospheric and/or Oceanic Dynamics Pathway**

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**Atmospheric Physics and/or Chemistry Pathway**

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**Biogeochemistry Pathway**

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2.3 AOS/GEO Courses Offered

Fall Semester
GEO 425 Introduction of Physical Oceanography
GEO 427 Introduction to Atmospheric Science
AOS 527 Atmospheric Radiative Transfer
AOS 571 Introduction to Geophysical Fluid Dynamics (GFD I)
AOS 576 Current Topics in Dynamic Meteorology
AOS 578 Chemical Oceanography (taught alternate years)

Spring Semester
AOS 537 Atmospheric Chemistry (taught alternate years)
AOS 547 Atmospheric Thermodynamics and Convection (taught alternate years)
AOS 572 Atmospheric and Oceanic Wave Dynamics (GFD II)
AOS 573 Physical Oceanography (taught alternate years)
AOS 575 Numerical Prediction of the Atmosphere and Ocean (taught alternate years)
AOS 577 Weather and Climate Dynamics (taught alternate years)

GEO 425 Introduction of Physical Oceanography
An upper undergraduate/introductory graduate level oceanography class. Topics include mixed layer dynamics, large-scale flows driven by wind and pressure gradients (Ekman and Sverdrup balances), models of ocean overturning, El Nino, and oceanic waves. Offered every year, in the fall.

GEO 427 Introduction to Atmospheric Science
An upper undergraduate/introductory graduate level atmospheric science class. Topics include atmospheric composition and thermodynamics, simple radiative transfer, elementary circulation models, comparison with atmospheres on other planets. Offered every year, in the fall.

AOS 527 Atmospheric Radiative Transfer
Introductory graduate level course covering the basic principles of radiative transfer in the Earth's atmosphere, with applications to contemporary issues in climate and climate change. Offered every year, in fall.

AOS 537 Atmospheric Chemistry
Natural gas phase and heterogeneous chemistry in the troposphere and stratosphere. Applications to local and regional air pollution, and chemistry-climate interactions are also studied. Offered every other year, in the spring.

AOS 547 Atmospheric Thermodynamics and Convection
A graduate-level course (but suitable for advanced undergraduates) covering the application of thermodynamic principles to Earth's atmosphere, convection, and basic cloud microphysics. Taught every other year, in the spring.

AOS 571 Introduction to Geophysical Fluid Dynamics (GFD I)
Fundamentals of atmospheric and oceanic dynamics and thermodynamics. Offered every year, in the fall.
AOS 572 Atmospheric and Oceanic waves dynamics (GFD II)
A more advanced class in atmospheric and oceanic dynamics. Waves and instabilities, including baroclinic instability and an introduction to turbulence, and their effect on the large scale circulation. Offered most years, in the spring.

AOS 573 Dynamical Oceanography
The dynamics and circulation of the world's oceans. Topics include wind- and buoyancy-driven flow, gyres, meridional overturning circulation, the general circulation of the world's oceans, and topics of current interest. Offered every other year, in the spring.

AOS 575 Numerical Methods
Numerical algorithms and techniques used in construction models of the atmosphere and ocean. Offered every other year, in the spring.

AOS 576: Special Topics in Atmospheric Dynamics
An advanced graduate course on atmospheric dynamics. Primary focus is developing an understanding of the large-scale structure of the atmospheric circulation; covers traditional theories and introduces topics of current interest. Offered every other year in the fall.

AOS 577 Weather and Climate Dynamics
Observed structure and physical interpretation of principal tropospheric circulation systems, and their role in the general circulation of the atmosphere. Atmospheric variability on intraseasonal and interannual time scales. Offered every other year, in the spring.

AOS 578 Chemical Oceanography
The chemical composition of the oceans and the nature of the physical and chemical processes governing this composition in the past and present. The cycles of oceanic constituents, including interactions with the biosphere. Offered every other year, usually in the spring.

3 The General Exam

The purpose of the general exam is to establish two things: (i) Is the student capable of attacking a research problem? (ii) Has the student acquired a sufficient background knowledge of the field to put their research in the proper context and to function as an independent scientist and colleague? The first part of this is largely addressed with an oral exam, the second is largely addressed by a written exam based on the coursework.

The generals process really begins in earnest toward the end of the first year of coursework, at which time the student selects a generals committee from the AOS faculty who are cognizant of the particular area of research. This committee is primarily responsible for consulting with the student about the research project and the student is expected to meet with the committee over the course of the second year to apprise them of progress made on the project.

The oral exam takes place during the spring semester, typically in March or April, and is usually chaired either by the student's adviser or the Director of Graduate Studies. It consists of a 45-minute presentation generally attended by the faculty only (although members of the GFDL technical staff who have specific knowledge of the project may be
asked to attend to provide the benefit of their expertise). During this presentation questions from the audience should only be asked to clarify points raised by the student. The presentation is then followed by an extensive question period in which first the advisor and committee, then the faculty as a whole, ask questions about the research. These questions may extend to questions about the broader context of the work and may examine the student in detail about the theoretical or numerical underpinnings of the work in a way that would be more detailed than would be appropriate in a public seminar. The student then withdraws, the faculty discuss the presentation, the quality of the work and the level of answers to questions and assign a preliminary grade for the oral portion.

The written exam takes place about 4-6 weeks, and normally in May, after the oral presentation to allow students adequate time to prepare. The written exam is customized to each student. The DGS in consultation with the student, the student's advisor and the generals committee chooses a set of courses on which the student will be examined; typically each student has taken about nine courses. A total of 12 questions is usually selected, with at least one from each course, and additional questions from courses that correspond to the student’s area of specialization. The total list of questions is then reviewed by the DGS to ensure that the individual exams are roughly comparable in level of difficulty. To the extent possible, questions are overlapped between students. The exam is administered on two consecutive days, with approximately six questions offered each day of which the student must normally answer five, with about 5 hours are allowed for each test. (However, details may vary from year to year, and from student to student.)

The faculty then meet to discuss the overall performance on the written and oral sections of the exam. The weighting between the sections is not rigid as the point of the generals is to decide whether the student has provided sufficient evidence of potential ability to function as an independent scientist. Four actions may be taken at this point. First, the student may be recommended unreservedly to continue on to a Ph.D. Second, if the student has performed well on the oral section but poorly on the written section, and if the latter reflects poor performance in the classes, the student may be asked to retake the written portion of the exam. Third, if the student has performed well in classes and the written exam but poorly on the oral and/or research portion, the student may be asked to retake the oral examination and/or to write up some results to the satisfaction of the student's committee before a passing mark can be awarded. Finally, in relatively rare cases, the faculty may decide that the student is unlikely to be able to complete a Ph.D. within the program, and recommend that the student not be re-enrolled the following year.

4 Toward a Ph.D

After passing the general exam, the student begins in earnest on the research for his or her Ph.D. The student should by now have settled on an advisor — which in many cases will be the pre-generals advisor, and the student and advisor should form a committee, typically consisting of the advisor and two or three other scientists. These maybe other AOS faculty members, or faculty members in other departments or even other universities, or GFDL scientists. At least one member of the committee, in addition to the advisor, should be an AOS faculty member. The student should normally meet with the committee once per semester, although practices may vary.

Each year the student needs to be re-admitted to the Program, and this is normally
made on the recommendation of the advisor, and approved by the DGS, based on the student making satisfactory progress toward his/her thesis. The re-enrollment process takes place late in the spring semester. In partial satisfy these requirements, the AOS Program requires that each student write a short annual progress report, and submit it to the GWC. Such a report maybe quite short, about two pages for example, and summarizes the work completed in the past year. The report is due a few weeks before the end of spring semester. Sometimes, the fellowship or research grant that is supporting the student will also require an annual report, and in such cases, the two reports may be the same. Students will not be re-admitted without a satisfactory report.

4.1 The thesis and its requirements

To be awarded a Ph.D., a student must write a thesis, and defend this thesis in a public lecture, called the Final Public Oral (FPO, also known simply as the thesis defense) which is followed by questions from the audience. The formal requirements for the printed copy of the thesis maybe found at http://www.princeton.edu/~mudd/thesis/ and http://www.princeton.edu/~mudd/thesis/requirements.pdf. The thesis must be read by two readers and the advisor, and examined by three examiners (see the Graduate School web site http://gradschool.princeton.edu/academics/policies).

The timescales for these are as follows, working back from the FPO.

1. The FPO.

2. Two weeks prior to the FPO:

   (a) The two readers' reports and the advisor's report.
   (b) The degree application
   (c) Two unbound thesis copy for public display. Four copies of the abstract, title page and copyright. See the AOS office to confirm these details, which may change.

3. Three weeks prior to the reports being due, a copy of the thesis must be given to the readers, examiners, and advisor. (The readers may agree to a shorter reading period, or may request more time. In any case, the reports are due two weeks before the FPO.)

   After the FPO, at least three bound copies of the thesis are required, and 1 electronic copy on a CD in a pdf. One copy of the thesis is placed in the GFDL library, and others go to the University library — check the website above, and consult with AOS staff to confirm what is required.

4.1.1 Readers and Examiners

The readers and examiners are formal University positions. In most circumstances they correspond to your previously-formed thesis committee, but need not. The readers and examiners may partially overlap, and typically one person is both reader and examiner, but two of the examiners may not have been readers. The readers read your thesis and provide a written report; the examiners question you after your FPO. The readers and
examiners are chosen by you and your advisor, and must be approved by the DGS and by
the Graduate Dean. In particular, any non-Princeton faculty will require justification, and
their CV and an explanation of why the person should be on your committee will need to
be submitted to the Graduate Dean. Normally, outside members of your committee must
have 'equivalent status' to an assistant professor. The AOS Program requires that at least
one reader and one examiner are AOS faculty members, in addition to the advisor.

4.1.2 Time Frames and Publishing

The AOS Program is formally a four year program. This means that students are
couraged to finish their research, and defend their thesis, within four years after first
enrolling. If it is apparent that a student will need more time, for example to write up results
for publication, or because they have been involved in teaching or in the STEP program,
then a student should request an extension; if the grounds for the request are reasonable
such an extension will be granted. Normally, financial support will not be continued after
the fifth year. A Ph.D. thesis is expected to contain work that is publishable in the peer-
reviewed literature, and students are expected to submit at least some of their work for
publication before defending. Typically, a Ph.D. thesis would contain material for at least
two substantial journal articles.

4.1.3 The Defense

The defense takes the form of a seminar by the student, normally lasting 45 minutes to an
hour, followed by questioning from the examiners, followed by questioning from the public.
After that, the public and the candidate are excused, and the examiners, readers and AOS
faculty discuss the candidate's performance, and (hopefully) sign the form approving the
thesis. The candidate should ensure that the committee has the appropriate forms to sign.

4.2 The STEP Program

The Program in Science, Technology and Environmental Policy (STEP, see also the web
site http://www.princeton.edu/step/) is based in the Woodrow Wilson School of Public
and International Affairs and has strong ties to the Princeton Environmental Institute. It
offers an opportunity for students in the AOS Program, and elsewhere, to take some time to
study the policy implications of their work. Thus, an AOS student may take a year in the
STEP program doing research on some issue that connects science and policy — the
economic impacts of global warming, understanding how states might deal with pollution,
and so on. Normally, a student will make contact with one of the faculty in STEP program to
discuss possible projects, and will then apply for a one year fellowship to work on a
problem of mutual interest — see the STEP web site for more details. Often, partaking in
the STEP program may add to the time needed for completion of a Ph.D., but many
students find it very worthwhile.

4.3 Teaching

Students are encouraged to teach — that is, to be a Teaching Assistant (TA), or, as they
are called in Princeton, an Assistant in Instruction (AI) — for two semesters during their time here, and teaching for at least one semester is a requirement. This normally comes after the general exam, in the third and fourth years in the Program. Most students find this to be a rewarding time, and it provides valuable experience for their future careers. Because the AOS Program does not have an undergraduate program, this teaching comes through the Geosciences Department or through PEL. You should contact the AOS staff to arrange this. If no teaching is available, the teaching requirement is waived. If financial support is required for a fifth year, the student is normally expected to have taught for two semesters, subject to availability. You will need to plan ahead for this, as teaching is generally not feasible in the fifth year itself.

5 Financial Support

Graduate students in the AOS program are normally provided with funding for tuition and stipends (living expenses). Funding comes from a variety of sources, including outside (external) fellowships, research grants, GFDL funds, teaching positions (AIs), and the University. In return for support, graduate students are expected to make adequate progress on research and coursework (as determined by their Advisory Committees). First Year: All incoming graduate students in science and engineering are awarded a fellowship from the University at the prevailing rate. Other fellowships from the graduate school may be available on a competitive basis, and students are encouraged to apply for them. Additional information on these fellowships may be found on the graduate school website: http://gradschool.princeton.edu/financial/fellowships/competitive/ Second Year-End of Program: After the first year, graduate students not on external fellowships maybe supported as Assistants in Research (AR) or Assistants in Instruction (AI).

1. AR: Most students in the Program are supported by Assistantships in Research (AR). A full AR appointment requires the student to spend the majority of his or her working time on research relevant to the supporting grant and, as appropriate, to carry on a program of study (e.g., taking classes). These appointments are for the period September 1 to June 30. Support for Assistants in Research in the AOS program derives either from individual faculty member external grant funds or from funding from the Cooperative Institute for Climate Science (CICS), a collaborative research institute between the University and GFDL/NOAA (http://web.princeton.edu/sites/cics/). Students funded in total or in part by CICS are expected to prepare yearly progress reports on their research and to participate in any CICS science reviews when available. The prevailing rate for an AR stipend can be found on the graduate school website: http://gradschool.princeton.edu/financial/assistantships/research/

2. AI: AOS students may be funded in all or in part by teaching positions held within other departments (e.g., GEO or ENV). AI funding is not guaranteed for AOS students since AI allocations will first be used to meet the funding needs of other departments. However, AOS students are encouraged to seek out AI appointments during their tenure as a graduate student since the faculty feels that teaching experience is an important aspect of graduate education. The prevailing rate for an AI stipend can be
found on the graduate school website:
http://gradschool.princeton.edu/financial/assistantships/teaching/

External Fellowships: AOS graduate students are encouraged to apply for external funding. Such external funding enables the department to support more students and also is a mark of high achievement for the student receiving the award. A comprehensive list of external fellowships is available on the graduate school website: http://gradschool.princeton.edu/financial/fellowships/external/. In the recent past, AOS students have held external fellowships from the following organizations, and we encourage students to apply for one or more of them.

National Science Foundation
(https://www.fastlane.nsf.gov/grfp/):
The National Science Foundation Graduate Research Fellowship provides three years of support for graduate study leading to research-based master’s or doctoral degrees and is intended for students who are at the early stages of their graduate study. Applicants must be United States citizens or nationals, or permanent resident aliens of the United States. Fellowships are intended for individuals in the early stages of their graduate study. Applicants must have completed no more than twelve months of full-time graduate study at the time of their application. Applications due early November.

NASA Earth Systems Science (NESSF) Fellowship
(http://nspires.nasaprs.com/external/solicitations/):
The NASA Earth and Space Science Fellowship (NESSF) solicits applications from accredited U.S. Universities on behalf of individuals pursuing Master of Science (M.Sc.) or Doctoral (Ph.D.) degrees in Earth and space sciences, or related disciplines, at respective institutions. The purpose of NESSF is to ensure continued training of a highly qualified workforce in disciplines needed to achieve NASA’s scientific goals. Awards resulting from the competitive selection will be made in the form of training grants to the respective universities with the advisor serving as the principal investigator. The NESSF Program is open to all students enrolled fulltime at accredited U.S. institutions; however, U.S. citizens and permanent residents will be given preference when two or more proposals are of equal scientific merit. Applications due early February.

DOE Graduate Research Environmental Fellowship (GREF)(http://www.atmos.anl.gov/GCEP/):
The GREF program began in June 1999 to support graduate students in the Office of Biological and Environmental Research-funded collaborative global change research at universities and national laboratories. All qualified students (US citizens only) are encouraged to apply, but minority and female students are particularly encouraged. The fellowship program makes three-year appointments, renewable annually, and pays an annual stipend, a Research Education Supplement in March and October, and tuition and fees. Applicants must have completed their first year in graduate school, unless they have participated previously in SURE. Applications due early February.

EPA Science to Achieve Results (STAR) Fellowship (http://es.epa.gov/ncer/fellow/):
The U.S. Environmental Protection Agency (EPA), as part of its Science to
Achieve Results (STAR) program, is offering Graduate Fellowships for masterOs and
doctoral level students in environmental fields of study. Doctoral students may be
supported for a maximum of three years, usable over a period of four years.
Applicants must also be citizens of the United States or its territories or
possessions, or be lawfully admitted to the United States for permanent residence
(i.e., have a green card). Applications due late November.

Hertz fellowships.
(http://www.hertzfndn.org/dx/Fellowships/) These are highly competitive and very
prestigious fellowships, with an attractive financial package. You may apply only in
the first year of grad school, or as an undergraduate. Awards are based on merit,
not need. You must be a citizen or permanent resident, and have an excellent
academic record and 'display evidence of exceptional creativ-ity.'

Of course, not all fellowships are appropriate for all students, but often there will be a
match to one or more fellowships.

4. Summer Support: Students in AOS are normally supported through the Program or
by fellowships for summer (July and August) at the prevailing rate. Summer
appointments are full-time and therefore students are expected to be working full-time
during this period. Travel for non-research related purposes is not normally encouraged
during this time, and stipends will be pro-rated to account for time away or vacations
taken during this period.

6 Travel to Meetings

The intention of the travel provision for graduate students is to provide educational
experiences that will be of direct benefit to their dissertation work. We encourage students
to go to meetings to present results of their research, and to become acquainted with the
'business of research'. Of course all travel is subject to the availability of funding and is
subject to the approval of the advisor. Please note:

- Funding for travel will be decided on a case-by-case basis with no specific
  limit set. Typically, a post-generals student might go to one domestic meeting
  per year, provided there are new results to present. Under most circumstances,
  we can only fund travel to meetings in which the student presents the results of
  research.

- The Program attempts to treat all graduate students equally regardless of grant
  source or funding. However, some advisors may have additional travel money
  for their own students, and those students with fellowships may have access to
  travel funds.

- Graduate students are entitled to reimbursement of all reasonable expenses
  associated with their travel, including transportation, room, board, and
  registration fees. At the same time, graduate students should spend travel
  money as if it were there own, and seek to minimize transportation costs, hotel
  room costs etc.
• Attendance at smaller meetings and workshops relevant to a student's research is seen as an opportunity for enrichment and interaction with other researchers and is highly encouraged.

• In order to maximize the students' opportunity to travel, the Program encourages students to apply for travel funding from outside sources such as AMS, AGU, external summer-school funds, and travel funds from the graduate school (the Deans Fund for Scholarly Travel during the academic year and the APGA Summer Travel Grant for the summer: http://gradschool.princeton.edu/financial/travel).

7 Vacation Policy

You should regard your graduate studentship as a full-time position that extends throughout the year, including the summer months. That is, regardless of the source of financial support, graduate students are expected to work essentially full time fulfilling their degree requirements. Graduate students accrue no specific vacation time other than the normal short holiday periods observed by the University, such as winter recess, spring break, and the inter-term period, and vacation time may not be accumulated for later use.

We recognize that the typical graduate student schedule is flexible and that occasional vacations or leaves of absence are to be expected. Normally, though, students should be 'in residence' throughout the academic year, except in cases that a special arrangement has been made with the advisor and with the approval of the DGS, or when it is during the normal recess periods. Vacations at other times of more than a few days must be approved by the advisor, and if longer than a week also by the DGS.

If the student is receiving financial support over the summer then he or she is expected to work correspondingly over that time. In particular, a student receiving the full summer stipend may not take any summer vacation. Summer support will be proportionally reduced if vacation is taken during that period, and students should inform the AOS office about their summer plans.

Having said all this, it is of course expected that students will wish to take vacations from time to time, as do most scientists and professors, and as a rule of thumb, a total of a few weeks of vacation per year is quite reasonable.