EAS Graduate Student Handbook

Academic Year 2021–2022

SAINT LOUIS UNIVERSITY™

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Department of Earth & Atmospheric Sciences

- *A guide to succeeding in our Geoscience and Meteorology graduate programs.*
- *An outline of expectations of students and faculty advisors.*

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(updated from September 2000 Graduate Student Guidebook by Dr. Charles J. Ammon and June 2009 Geoscience Graduate Student Timelines)

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1 Introduction

This guidebook is a collection of information and advice on how to succeed in the Geoscience and Meteorology graduate programs. Some of this information may be valuable immediately, other material may become more useful later. Students should read through this entire handbook in the next week to get an overview of the information and expectations and, if necessary, discuss vague or unclear items with the faculty or more senior students.

This handbook supplements the Graduate Education Catalog and presents information from that catalog in a framework specific to our programs. Some of this information is simple and straightforward, such as which courses are required and which are electives. However, research — not coursework — is the most important part of a scientific graduate degree, so this guide also includes information and advice on becoming a more effective member of our research programs. Every researcher has a slightly different view of the best way to approach and solve problems and to document the work. In the end, each student must develop their own research methods. Students are encouraged to discuss ideas and approaches with other students and the faculty, to experiment with different methods, and then to choose what works best for them.

Completing a research-based graduate degree is a challenge that requires the integration of field, laboratory, and/or numerical modeling abilities with critical thinking and effective communication skills. By the time the thesis or dissertation is complete, the student will be well on their way to mastering a specialty and to developing valuable skills in written and oral communication. In classes and seminars, the faculty try to provide both a classical foundation and the review of recent research that is needed to complete the research. This technical proficiency is the central part of a student's education. The culmination of the graduate program is the publication of research results. Students are expected to complete a thesis or dissertation and are strongly encouraged to publish at least one scientific article (and Ph.D. students should aim to publish three).

Communication is essential in scientific research and requires a lot of effort. The goal of writing is to convince other scientists of the results and interpretation, so students should develop these skills by discussing scientific questions and ideas with their advisor, other faculty, and other students through all stages of research. These scientific discussions will help crystallize the essential elements of the work, will lead to new ideas, and will help successfully complete the work. The faculty expect each student to join our research environment, to participate in our scientific discussions, and to share their insights. The open discussion of ideas and research results stimulates our entire group, energizes everyone to complete the hard work necessary for quality research, and enthuses all with new ideas and understanding. We look forward to the new contributions from each student.

While this guidebook aims to provide information on our programs, students will need to supplement it with information from other offices on campus. In particular, students should check deadlines and access forms and procedures through the Graduate Education website. Links to Graduate Education and other University services are listed in Table 1. The Geoscience and Meteorology programs are part of the broader University community and students are encouraged to take advantage of all that the University offers.

Table 1: SLU information sources and services

Resource	Webpage, Location, Contact Information, etc.
Department of Earth & Atmospheric Sciences (EAS)	https://www.slu.edu/arts-and-sciences/earth-atmospheric-sciences/index.php, 205 O'Neil
Dr. Charles Graves, Department Chair	charles.graves@slu.edu, 205 O'Neil
Dr. Linda Warren, Met. & Geo. Grad. Coord.	linda.warren@slu.edu, 977-3197, 202 O'Neil
TBA, Administrative Assistant	977-3131, 205 O'Neil
Dr. Zhu's LaTeX SLU thesis style files	http://www.eas.slu.edu/People/LZhu/downloads/slu_thesis.tar
Dr. Graves' LaTeX SLU thesis style files	http://www.eas.slu.edu/People/CEGraves/Latex_Sample.zip
College of Arts & Sciences (CAS)	https://www.slu.edu/arts-and-sciences/index.php
Dr. Donna LaVoie, Interim Dean	donna.lavoie@slu.edu, 977-2244
Dr. April Trees, Assoc. Dean Grad. Affairs	april.trees@slu.edu, 977-2973, 220 Verhaegen
Office of Graduate Education	http://www.slu.edu/academics/graduate, 420 DuBourg
Dr. Christine Harper, Doctoral Cand. Advisor	christine.harper@slu.edu, 977-2243
Ms. LaToya Cash, Masters Candidacy Advisor	latoya.cash@slu.edu, 977-2245
Graduate Student Association: *Financial assist. for prof. meetings; annual research symposium.*	https://sites.google.com/a/slu.edu/graduate-student-association gsa@slu.edu, 977-2234
Travel: CAS Travel Policies	https://www.slu.edu/arts-and-sciences/faculty-resources/travel-policy.php
EAS Travel Approval Form	https://docs.google.com/forms/d/e/1FAIpQLSeXXzi8TemClK4m5QdJQrcSI-KPdSLfXhOOF6sscQRrPVnNKw/viewform
Academic Integrity Policy	https://www.slu.edu/provost/policies/academic-and-course/policy_academic-integrity_6-26-2015.pdf
Research Integrity Policy	https://www.slu.edu/research/faculty-resources/docs/policies/research-misconduct-policy-for-responding-to-allegations-of-research-misconduct.pdf
Responsible Conduct of Research training	https://www.slu.edu/research/faculty-resources/research-integrity-safety/responsible-conduct-of-research-rcr.php
Pius Library	http://lib.slu.edu, http://libguides.slu.edu/atmospheric
Ms. Megan Toups, STEM Res. & Instr. Lib.	http://libguides.slu.edu/geoscience, megan.toups@slu.edu
Reinert Center for Transformative Teaching and Learning (CTTL)	http://www.slu.edu/cttl Pius Library, 2nd floor
University Writing Services: *runs workshops; provides one-on-one help with writing.*	http://www.slu.edu/life-at-slu/student-success-center/academic-support/university-writing-services
University Counseling Center	https://www.slu.edu/life-at-slu/university-counseling/index.php
Office of International Services: *Visa/other issues; connects students with similar interests.*	http://www.slu.edu/international-services international@slu.edu, 977-2500, 102 Des Peres
Public Safety & Emergency Preparedness	https://www.slu.edu/about/safety/index.php, 114 Wool Center, 977-3000 (emergency), 977-2376 (general), 977-7433 (safety escort)
Academic Calendar	https://www.slu.edu/registrar/calendars/index.php

2 Degree Requirements

The requirements for a research-based graduate degree include a combination of coursework, exams, and research. The courses are designed to provide each student with broad knowledge of their concentration (Environmental Geosciences, Geology, Geophysics, or Meteorology) and to help them develop the tools required to perform meaningful research. The degree course requirements are relatively rigid, although we may at times transfer credits from another university or make allowances for scheduling conflicts. *Decisions to change any requirement are made collectively by all graduate faculty in the program area, not by any individual student or advisor.*

To receive a degree, all students must complete coursework with a minimum grade point average (GPA) of 3.00 and pass the specified oral and/or written exams. The purpose of the exams is to insure that students have learned the material covered in the courses and have synthesized ideas from all courses into a coherent understanding of the discipline. The purpose of the oral Ph.D. exam is to insure that students are ready to become full-time researchers performing independent, creative research.

Specifying a timeline for graduate study is difficult; every research project requires the completion of many (often unexpected) tasks and every student works at a different pace. Still, having an idea of the expected progress, particularly with regard to student exams and research productivity, is necessary and timelines for "typical" M.S. and Ph.D. students are provided later in this chapter.

Student progress is reviewed each year at the end of the Fall Semester. Students submit a written report of their major activities for the previous year and their plans for the coming year and then meet with the graduate faculty to review their progress. This interview is not an exam. Instead, it is meant for the faculty to assess the progress of each student. Academic and/or scientific questions are not asked during the interview.

Completion of the coursework, exam, and thesis/dissertation requirements is not all that is needed to receive a degree — these milestones must be reported to, checked by, and, in many cases, scheduled with the approval of the Office of Graduate Education. Graduate Education specifies deadlines (and provides forms) for these milestones. Students should check these deadlines and requirements every semester, particularly those in which they plan to advance to candidacy or graduate, to make sure they stay on track. While faculty, staff, and candidacy advisors try to help students meet these requirements, each student is ultimately responsible for ensuring that the deadlines are actually met. *Missing deadlines will delay graduation until the following semester.*

2.1 Academic Integrity, Research Integrity, and Ethical Behavior

While the faculty encourage students to work together on homework and to discuss research problems with others, each student must make sure that any work they submit is truly their own. Falsification, misrepresentation of the work of others as one's own, and plagiarism are serious violations and can result in being expelled from the University, as described in the University's academic and research integrity policies (see links in Table 1). In the real world, such ethical lapses can ruin the careers of the perpetrator and associates.

University policy on academic integrity and ethical behavior, as described in the Graduate Education Catalog, is:

> The University is a community of learning, and its effectiveness requires an environment of mutual trust and integrity. As members of this community, students share with

> faculty and administrators the responsibility to maintain this environment. Academic integrity is violated by any dishonesty in submitting an assignment, test, research report, or any other documentation required to validate the student's learning. In a case of clear indication of such dishonesty, the faculty member or administrator has the responsibility to apply sanctions to protect the environment of integrity.
>
> Although not all forms of academic dishonesty are given here, the instances listed below should be seen as actions that violate academic integrity:
>
> - Soliciting, receiving, or providing any unauthorized assistance in the completion of any work submitted.
> - Copying from another student.
> - Using electronic devices to share information during an exam.
> - Copying from a book or class notes during a closed-book exam.
> - Submitting materials authored by or editorially revised by another person but represented as the student's own work.
> - Copying a passage or text directly from a published source without appropriately citing/recognizing that source.
> - Taking a test or doing an assignment or other academic work for another student.
> - Securing or supplying in advance a copy of an examination without the knowledge or consent of the instructor.
> - Falsifying or fabricating research data.
>
> Any clear violation of academic integrity will be met with sanctions. In a case of dishonesty within a course, the instructor may assign an appropriate grade and/or recommend further sanctions to the Dean, Associate Dean, or Center Director of the particular school/college/center, who is then responsible for the final decision and notification of all associated parties. The final decision of the Dean, Associate Dean or Center Director may be appealed as described in "Procedures for Academic Appeals."
>
> Ethical behavior is also expected of students and faculty in the academic setting and extending into professional life. Sexual harassment will not be tolerated and will be sanctioned. Most major fields require their graduate students to complete an ethics requirement within the curriculum. Coursework or other training in ethical research is required of academic personnel involved in traineeship and investigative programs funded by a number of federal and other agencies.

Within EAS, the Scientific Communications course includes a unit on scientific ethics and professional behavior. Students will learn about examples of scientific misconduct from both their own field of study and other fields and develop their own professional code of ethics. Students can further their knowledge about research integrity by attending the Responsible Conduct of Research trainings offered by the Office of the Vice President for Research.

If a faculty member finds that a student has plagiarized or copied an assignment, the faculty member will assign a grade of zero on the assignment, report the incident to the Graduate Program Coordinator and Department Chair, and the student will be given one warning. Similarly, a first incidence of misconduct in research will result in reporting and a warning. A second incident, whether in the same class, a different class, or as part of research, will result in the student being dismissed from the University. More serious acts, such as falsification of data or sabotage, will result in a student being dismissed from the University without a warning. The dismissal and appeals process is described in the University's Academic Integrity Policy (see Table 1 for link).

2.2 Coursework

2.2.1 Core Graduate Courses

The faculty require all students in our programs to complete a series of courses in Earth or Atmospheric Sciences and scientific communications. The role of the Earth/Atmospheric science courses is obvious: the core courses provide broad overviews of the Earth system and its processes. Communication skills are learned and practiced in (at least) two courses: the Student Research Seminar (previously Geoscience Journal Club and Seminar in Atmospheric Science) and Scientific Communications. We emphasize communication skills because research findings must be communicated to colleagues, to the faculty, and hopefully to others at a professional meeting. Most surveys of potential employers show that they rank effective communication skills at a level almost equal with technical proficiency. Thus, the ability to communicate well is a strong asset for all future careers.

2.2.2 Course Selection and Registration

Students are expected to review their course selections with their advisors and then enroll themselves before the registration deadline. Late registration will result in the student being charged a fee. *The Department can neither register students nor waive or pay the late-registration fee.* Instructors need to give permission for students to enroll in certain courses, including Thesis Research and Dissertation Research, so students should ask their advisors to enter registration overrides in Banner.

The University requires continuous registration while a student is enrolled in the graduate program. Full-time students take at least 6 credits hours during the Fall and Spring semesters and 0–3 credit hours during the summer. If an assistantship covers the summer, students must register for a summer course (for 0–3 credit hours, depending on the number of credit hours provided with the assistantship) on time. Once students have completed all required credit hours, they should enroll in 0 credit hours of Thesis or Dissertation Research, as appropriate. This enrollment level is considered full-time status for students who have advanced to candidacy.

At the end of each semester, students should check their grades online to make sure that a grade has been recorded for each course they were enrolled in. Missing or incomplete grades will turn into an "F" after a year and create problems when a student is otherwise ready to graduate. In addition, students will be ineligible for an assistantship if they have more than one missing or incomplete grade.

2.2.3 What to Expect in Courses

Although coursework is secondary to research, many of the courses are designed to provide a framework that supports research. Investing time in courses will allow students to develop the tools and perspectives that make scientific investigations easier and more interesting.

Every faculty member has a different teaching style and different expectations of students. We all expect students to come to class prepared, complete the assigned work on time, ask questions, and think about the material. We also expect students to turn in neat, well-organized assignments. We expect students to ask questions if they are having trouble.

Term Papers. Many courses include term papers or projects. Papers are a way for students to explore interesting or relevant subjects more deeply than in lectures, and they are excellent practice in writing. Students should choose a topic that is interesting, but not so broad as to be overwhelming. Instructors can can help students focus their ideas into a subject that can produce a valuable summary in a reasonable amount of time.

Discipline-Specific Skills. Some degree programs require more math, some more chemistry, some more physics, and others more traditional geology. If a student is uneasy with the level of background knowledge and skills expected in their courses, they should speak to the instructor before falling behind. For example, many of the geophysics and meteorology courses are mathematical. Some courses also require some level of computer skills. We do not teach a course in computer usage but we expect students to pick up elementary skills needed to use common computer programs.

Concentrated Study. In addition to lecture courses, we require each student to complete at least one seminar course. Seminars depend on students to help make the course successful. Most of the meetings in seminar courses are discussions, not lectures. The instructor selects a particular topic and assembles a collection of review and journal articles to read and discuss. Students should carefully read all assigned papers in the seminar since the success of the course depends on each student's ability to carry on a scientific discussion of the material.

Students will also likely take at least one reading or independent study course. These courses are designed to allow students to focus on an aspect of their specialty or pursue a research idea under the guidance of a faculty member. These courses most closely resemble research and are often used as part of the student's research program. These courses require a final written report, such as a term paper or computer program. Since these courses are unstructured, it is essential that students collaborate with the faculty mentor early in the semester to outline the topic and expectations of these courses.

2.3 General Knowledge

While the curriculum is designed to provide students with deep knowledge of their chosen field, students are also expected to gain broader knowledge through research, reading, seminars, and discussions. This general knowledge is tested in written and/or oral exams, as described in the following sections specific to the M.S. and Ph.D. degrees.

Students in all concentrations are expected to have knowledge of research ethics and best practices in the scientific publishing process.

Research projects in environmental geosciences require varied background knowledge, so students in this concentration should consult their advisor and committee for further guidance.

Students with a concentration in geology should consult their advisor and committee for further guidance.

Students with a concentration in geophysics are expected to have a basic knowledge of the various components of the science (even if some of these topics are not explicitly covered by a course): gravity, seismic exploration, electrical and magnetic methods. They are also expected to be competent in mathematics through differential equations and linear algebra. The following texts are recommended for study:

Exploration geophysics:

Dobrin, M. B., and C. H. Savit (1988). Introduction to Geophysical Prospecting, McGraw Hill, New York.

Telford, W. M., L. P. Geldart, and R. E. Sheriff (1990). Applied Geophysics, Cambridge.

Reynolds, J. M. (1997). An Introduction to Applied and Environmental Geophysics, Wiley.

Burger, H. R., A. F. Sheehan, and C. H. Jones (2006). Introduction to Applied Geophysics, Norton.

Earthquake seismology:

Shearer, P. M. (2009). Introduction to Seismology, Cambridge.

Earth history and structure:

Stacey, F. D., and P. M. Davis (2008). Physics of the Earth, Cambridge.

Grotzinger, J., F. Press, R. Siever, and and T. H. Jordan (2006). Understanding Earth, W. H. Freeman & Company.

Students with a concentration in meteorology should consult their advisor and committee for further guidance.

2.4 M.S. Requirements and Timeline

This section describes the general requirements and procedures for completing an M.S. degree, but the Graduate Education website (see section "Information for Current Students") has the most up-to-date information, forms, procedures, and timelines and supercedes this information if they conflict. M.S. students are required to complete at least 24 credit hours of coursework, exactly 6 credit hours of Thesis Research, a thesis, and a comprehensive oral exam. Non-thesis degrees require 30 credit hours of coursework, which may not include credits for Thesis Research.

The nominal time-to-degree for M.S. students is two years; a typical timeline is shown in Table 2. University policy limits financial support of M.S. students to two years and the total time-to-degree to five years.

2.4.1 M.S. Thesis Proposal

During a student's first year, they should begin doing research with their advisor and settle on a thesis topic. The topic will be formally proposed in a written thesis proposal. The expected proposal content is described below in Section 2.8. The student should expect to go through several proposal drafts with their advisor before giving the proposal to their committee no later than the first day of classes of the student's third semester.

The thesis proposal must be reviewed and approved by a three-member committee (which includes the student's research advisor). The other two committee members are selected from the SLU graduate faculty or people external to the University and approved by the Associate Dean for Graduate Affairs, with SLU faculty members comprising $\geq$50% of the committee. For external committee members, the committee chair must submit a letter to the Associate Dean with the external member's CV and justification of that person's expertise on the research topic. Each committee member must agree to be on the committee.

After giving the thesis proposal to their committee, the student will schedule a committee meeting to orally present the proposed research. The proposal presentation should be $\sim$30 minutes in duration and will be followed by questions. This meeting must be scheduled to take place at least two weeks after the committee has received the proposal.

Committee members will provide comments on the written proposal at and before this meeting and the student will revise the proposal as requested. Once the committee approves the thesis proposal, the student completes the Thesis Proposal/Prospectus form and submits it to Graduate Education. The student will advance to candidacy after this form is submitted. The student must also submit electronic copies of the proposal and form to the Graduate Program Coordinator.

2.4.2 M.S. Thesis

The thesis must demonstrate a mastery of the major field of study, the ability to think independently and critically, the potential for original research, and the skills to communicate the results of a scientific study.

The thesis is reviewed and approved by the same three-member committee as the proposal and, once approved, submitted to Graduate Education and ProQuest. The format of the thesis is prescribed by the Office of Graduate Education and the student is responsible for insuring that the formatting requirements are met. Drs. Zhu and Graves have LaTeX style files that will produce a properly-formatted thesis (see Table 1 for link). Students must submit their M.S. thesis to their committee at least two weeks before the oral defense and exam. Since the actual writing of a thesis takes months, students should work with their advisors through early drafts of the thesis well ahead of time.

2.4.3 M.S. Thesis Defense and Comprehensive Oral Examination

During the final semester in residence, every M.S. candidate must pass a comprehensive oral examination to qualify for the degree. The exam includes a thorough review of the major field of study (see Section 2.3) and the content of the thesis. The exam is administered by the three-member thesis committee. The oral exam is administered after the thesis is submitted and begins with a 30-minute-long presentation summarizing the research and results. The presentation is open to all members of the department and invited guests. Following the presentation, the candidate must perform satisfactorily in an oral examination by the committee. This exam is closed to the public.

Table 2: Nominal timeline for M.S. student progress

Semester	Coursework	Research Milestones
	YEAR 1	
Fall	9 credit hours: • EAS 5900 Geoscience Journal Club • Requirements/Electives	• Select thesis advisor • Learn research methods for the field of study • Submit annual report
Spring	9 credit hours: • EAS 5900 Geoscience Journal Club • EAS 5500 Scientific Comm. • Requirements/Electives	• Identify and work on thesis project • Form 3-member thesis committee • Hold committee meeting
Summer	up to 3 credit hours: • EAS 5990 Thesis Research • Requirements/Electives	• Continue thesis research • Finalize thesis proposal
	YEAR 2	
Fall	up to 9 credit hours: • EAS 5900 Geoscience Journal Club • EAS 5990 Thesis Research • Requirements/Electives	• Submit thesis proposal to committee • Orally present proposal to committee • Submit approved thesis proposal and form to Graduate Education • Complete thesis research • Start writing thesis • Present research at a national meeting • Submit annual report
Spring	up to 9 credit hours: • EAS 5900 Geoscience Journal Club • EAS 5990 Thesis Research • Requirements/Electives	• Complete Application for Degree in Banner Self Service • Submit completed Degree Audit to Graduate Education • Finish writing thesis • Present research at on-campus symposium • Submit thesis to committee • Defend thesis and pass oral exam • Revise thesis in response to committee comments • Submit approved thesis to Graduate Education and ProQuest • Submit journal article • Return office key and other SLU supplies • Graduate

2.5 Ph.D. Requirements and Timeline

This section describes the general requirements and procedures for completing a Ph.D. degree, but the Graduate Education website (see section "Information for Current Students") has the most up-to-date information, forms, procedures, and timelines and supercedes this information if they conflict. Ph.D. students are required to complete at least 36 (Geoscience) or 48 (Meteorology) credit hours of coursework, exactly 12 credit hours of Dissertation Research, comprehensive written and oral exams, a dissertation, and a defense of the dissertation. Students with an M.S. from another institution can apply for advanced standing and reduce the number of required credit hours.

Nominal timelines for students continuing from an M.S. at SLU, an M.S. at another institution, and directly from a B.S. are shown in Tables 3–5. The Department typically provides up to 4 years of support for students coming from an M.S. at another institution and 5 years for students coming directly from a B.S. University policy limits financial support of Ph.D. students to five years (which includes the M.S. time for students who earn both degrees at SLU) and the total time-to-degree to 7 years for students who have previously been awarded an M.S. and 8 years for students coming directly from a B.S.

2.5.1 Ph.D. Dissertation Proposal

As soon as a student enters the program, they should begin doing research with their advisor and settle on a dissertation topic. The topic will be formally proposed in a written dissertation proposal. The expected proposal content is described below in Section 2.8. The student should expect to go through several proposal drafts over several months with their advisor before giving the proposal to their committee.

The dissertation proposal must be reviewed and approved by a five-member committee, including the student's research advisor. The other committee members are selected from the SLU graduate faculty or people external to the University and approved by the Associate Dean for Graduate Affairs, with SLU faculty members comprising $\geq$50% of the committee. For external committee members, the committee chair must submit a letter to the Associate Dean with the external member's CV and justification of that person's expertise on the research topic. Each committee member must agree to be on the committee.

2.5.2 Ph.D. Written Examination

The purpose of the Ph.D. written exam is to assess the student's knowledge of the major field of study and to ensure that they is prepared to pursue independent research in that field. The content includes the knowledge gained in courses and background knowledge in (as appropriate) geology, geophysics, environmental science, meteorology, math, physics, chemistry, biology, engineering, and computer programming and questions specific to the proposed research. The exam lasts three hours and must be completed without any outside resources. The questions may require essay or mathematical answers.

The nominal timeline for taking the written Ph.D. exam depends on a student's academic history:

- For students coming directly from a B.S., the written exam is normally taken during the second semester of the second year.

- For students coming from an M.S. at another institution, the written exam is normally taken during the second semester of the second year.
- For students continuing from an M.S. at SLU, the written exam is normally taken during the first semester of the fourth year at SLU (the third semester in the Ph.D. program).

The written exam is offered each semester on a set date. For the 2021–2022 academic year, the fall written exam is scheduled for Thursday, October 14, 2021, and the spring written exam is scheduled for Thursday, March 24, 2022. The exams will be given from 1–4pm. Students planning to take the exam must notify the Graduate Program Coordinator at least 2.5 weeks prior to the exam date (Monday, September 27, 2021, and Monday, March 7, 2022, respectively) by submitting their written dissertation proposal, which has already been approved by their advisor, to the Graduate Program Coordinator and their five committee members. Students should also email a list of the committee members and their email addresses to the Graduate Program Coordinator. If the written proposal is not submitted on time, the written exam will be delayed to a later semester after the written proposal is submitted.

The Graduate Program Coordinator will solicit two questions from each committee member and then assemble ten questions for the exam. The student must answer one question from each committee member. All examination committee members read the answers and vote on the outcome of the exam. Four of the five committee members must approve the answers for the student to pass. If a student does not pass the exam, the exam committee may recommend that the student retake the exam the following semester or leave the Ph.D. program.

No notification of the University is necessary for this exam.

2.5.3 Ph.D. Oral Examination

After passing the written exam, the student proceeds to the Ph.D. oral exam. At least two weeks before the oral exam, the student must notify the Office of Graduate Education by submitting the appropriate form.

The oral exam is a research-oriented presentation of the dissertation research topic designed to assess the student's ability to integrate knowledge across the discipline. The exam begins with the student's presentation of the proposed research to the committee and is followed by questions from the committee. The presentation should be 30–40 minutes long, and questions usually last 1–1.5 hours.

The student will pass the exam if four of the five committee members agree that the student has passed the exam. If a student does not pass the exam, the exam committee may recommend that the student retake the exam the following semester or leave the Ph.D. program.

To advance to candidacy, the student must pass the oral exam and revise the proposal in response to any comments from committee members. Committee members will provide comments on the written proposal at or before the oral exam. The ballots for the oral exam will not be submitted to Graduate Education until the oral exam has been passed and the proposal has been satisfactorily revised.

2.5.4 Ph.D. Dissertation

The SLU Graduate Catalog describes the goals of a Ph.D. dissertation:

> The ability to extend the knowledge base in the major field is one of the qualifications distinctive to the Ph.D. degree. A candidate for this degree must present substantial evidence of this ability by submitting and defending a piece of original and independent research on a topic of importance that has been previously unresolved within the major field.

We encourage dissertations that are composed of a collection of peer-reviewed scientific publications. Although material will have to be reformatted to meet the University dissertation formatting directives, this approach has several advantages. First, a compilation including published articles insures that the amount of editing required is minimal since it's already been done for publication. Second, it spreads the dissertation writing over the entire Ph.D. student years — not into a crunch in the last semester. Third, designing the work to be published during a student's career helps insure that the student leaves SLU with a solid research reputation — and can help secure the desired career.

The dissertation is reviewed and approved by a committee and, once approved, submitted to Graduate Education and ProQuest. The committee includes the student's research advisor and at least two other readers who are selected by the student's research advisor in consultation with the student from the graduate faculty, or people external to the University, and approved by the Associate Dean for Graduate Affairs. The format of the dissertation is prescribed by the Office of Graduate Education and the student is responsible for insuring that the formatting requirements are met. Drs. Zhu and Graves have LaTeX style files that will produce a properly-formatted thesis (see Table 1 for links). The dissertation must be given to the committee at least two weeks before the dissertation defense.

2.5.5 Ph.D. Dissertation Defense

The final exam of a student seeking a Ph.D. is the dissertation defense, which includes a 45-minute-long oral presentation of the completed research, a time for questions from the general audience, and then a final examination by members of the student's dissertation committee. The oral presentation should be similar to a departmental seminar. The presentation is open to all members of the department and invited guests. The public presentation will be followed by a closed exam with the committee. The student must schedule the defense and reserve the room at least four weeks in advance.

2.6 Transitioning from an M.S. to a Ph.D. Student

Some students who start as M.S. students would like to continue their education by pursuing a Ph.D. at SLU. A key difference between the M.S. and Ph.D. degrees is the independence of the research, so a student wishing to make this transition must show initiative and the ability to conceive, execute, interpret, and write up experiments in a timely manner.

Students should start discussing the possibility of transitioning between degrees with their advisor and committee as early as possible (and no later than their third semester). The advisor and committee (and new advisor, if the student intends to change advisors) will consider the student's work on the M.S. project and ability to conduct independent research and then make a written recommendation to the Graduate Program Coordinator. Submitting the recommendation at the beginning of the Spring semester will allow the student to be considered for funding along with new applicants to the graduate programs; funds will likely not be available if the recommendation is submitted later.

If a student is recommended to continue to the Ph.D. program after completing the M.S. degree, and funding is available, the student will submit a "Petition for Admission into a Doctoral Program" to Graduate Education. Per University policy, students will receive a total of five years of funding for the two degrees.

2.7 Time Limits

By University policy, the time to degree is limited to 5 years for M.S. students, 7 years for Ph.D. students with an M.S., and 8 years for Ph.D. students with only a B.S. However, as mentioned earlier, financial support is permitted over a shorter time period. The time to degree can only be extended under extenuating and compelling circumstances. To request an extension, students should first discuss plans with their advisor and the Graduate Program Coordinator and then submit the Petition for Extension for Time to Degree to Graduate Education. If approved, up to two extensions beyond the time to degree limit may be allowed. Petitions must be submitted prior to the expiration of the time to degree or the current extension period.

Credit hours are valid for 10 years. After that time, students may request a review of expired course work by their program director. The Graduate Program Coordinator will determine if the expired course needs to be retaken, or if a revalidation experience can be offered. Revalidation opportunities are offered at the discretion of the program, and may not be offered in all situations. If offered, a revalidation experience may include a special examination or other written assignment, a portfolio, a new comprehensive or preliminary examination, or another academically appropriate experience.

Table 3: Timeline for Ph.D. student progress (after SLU M.S.)

Semester	Coursework	Research Milestones
	YEAR 1 of PhD / YEAR 3 at SLU	
Fall	9 credit hours: • EAS 6900 Geoscience Journal Club • Requirements/Electives	• Identify dissertation projects and begin dissertation research • Submit annual report
Spring	9 credit hours: • EAS 6900 Geoscience Journal Club • Requirements/Electives	• Continue dissertation research • Form 5-member dissertation committee • Hold committee meeting
Summer	up to 3 credit hours	• Continue dissertation research • Write dissertation proposal
	YEAR 2 of PhD / YEAR 4 at SLU	
Fall	9 credit hours: • EAS 6900 Geoscience Journal Club • Requirements/Electives	• Continue dissertation research • Take written qualifying exam • Submit dissertation proposal to exam committee • Submit candidacy application to Graduate Education • Take oral qualifying exam • Present research at a national meeting • Submit journal article on first project • Submit annual report
Spring	9 credit hours: • EAS 6900 Geoscience Journal Club • Requirements/Electives	• Continue dissertation research • Present research at on-campus symposium • Hold committee meeting
Summer	up to 3 credit hours	• Continue dissertation research
	YEAR 3 of PhD / YEAR 5 at SLU	
Fall	up to 9 credit hours: • EAS 6900 Geoscience Journal Club • EAS 6990 Dissertation Research • Requirements/Electives	• Continue dissertation research • Present research at a national meeting • Submit journal article on second project • Submit annual report
Spring	up to 9 credit hours: • EAS 6900 Geoscience Journal Club • EAS 6990 Dissertation Research • Requirements/Electives	• Present research at on-campus symposium • Finish writing dissertation • Submit journal article on third project • Apply to graduate • Complete and submit Degree Audit • Submit dissertation to committee • Defend dissertation • Revise dissertation in response to committee comments • Submit approved dissertation to Graduate Education and ProQuest • Return office key and other SLU supplies • Graduate

Table 4: Timeline for Ph.D. student progress (after M.S. from another institution)

Semester	Coursework	Research Milestones
	YEAR 1	
Fall	9 credit hours: • EAS 6900 Geoscience Journal Club • Requirements/Electives	• Select dissertation advisor • Learn research methods for the field of study • Submit annual report
Spring	9 credit hours: • EAS 6900 Geoscience Journal Club • EAS 5500 Scientific Comm. • Requirements/Electives	• Identify and work on first dissertation project • Form 5-member dissertation committee • Hold committee meeting
Summer	up to 3 credit hours	• Continue dissertation research
	YEAR 2	
Fall	9 credit hours: • EAS 6900 Geoscience Journal Club • Requirements/Elective	• Continue dissertation research • Write dissertation proposal • Present research at a national meeting • Submit annual report
Spring	9 credit hours: • EAS 6900 Geoscience Journal Club • Requirements/Electives	• Continue dissertation research • Take written qualifying exam • Submit dissertation proposal to exam committee • Submit candidacy application to Graduate Education • Take oral qualifying exam • Present research at on-campus symposium • Submit journal article on first project
Summer	up to 3 credit hours	• Continue dissertation research
	YEAR 3	
Fall	up to 9 credit hours: • EAS 6900 Geoscience Journal Club • EAS 6990 Dissertation Research • Requirements/Electives	• Continue dissertation research • Present research at a national meeting • Submit annual report
Spring	up to 9 credit hours: • EAS 6900 Geoscience Journal Club • EAS 6990 Dissertation Research • Requirements/Electives	• Continue dissertation research • Present research at on-campus symposium • Submit journal article on second project • Hold committee meeting
Summer	0 credit hours	• Continue dissertation research

Semester	Coursework	Research Milestones
	YEAR 4	
Fall	0 credit hours: • EAS 6900 Geoscience Journal Club • EAS 6990 Dissertation Research	• Continue dissertation research • Present research at a national meeting • Submit annual report
Spring	0 credit hours: • EAS 6900 Geoscience Journal Club • EAS 6990 Dissertation Research	• Present research at on-campus symposium • Finish writing dissertation • Submit journal article on third project • Apply to graduate • Complete and submit Degree Audit • Submit dissertation to committee • Defend dissertation • Revise dissertation in response to committee comments • Submit approved dissertation to Graduate Education and ProQuest • Return office key and other SLU supplies • Graduate

Table 5: Timeline for Ph.D. student progress (directly from B.S.)

Semester	Coursework	Research Milestones
	YEAR 1	
Fall	9 credit hours: • EAS 6900 Geoscience Journal Club • Requirements/Electives	• Select dissertation advisor • Learn research methods for the field of study • Submit annual report
Spring	9 credit hours: • EAS 6900 Geoscience Journal Club • EAS 5500 Scientific Comm. • Requirements/Electives	• Identify and work on first dissertation project • Form 5-member dissertation committee • Hold committee meeting
Summer	up to 3 credit hours	• Continue dissertation research
	YEAR 2	
Fall	9 credit hours: • EAS 6900 Geoscience Journal Club • Requirements/Elective	• Continue dissertation research • Write dissertation proposal • Present research at a national meeting • Submit annual report
Spring	9 credit hours: • EAS 6900 Geoscience Journal Club • Requirements/Electives	• Continue dissertation research • Take written qualifying exam • Submit dissertation proposal to exam committee • Submit candidacy application to Graduate Education • Take oral qualifying exam • Present research at on-campus symposium
Summer	up to 3 credit hours	• Continue dissertation research

Semester	Coursework	Research Milestones
	YEAR 3	
Fall	up to 9 credit hours: • EAS 6900 Geoscience Journal Club • EAS 6990 Dissertation Research • Requirements/Electives	• Continue dissertation research • Present research at a national meeting • Submit journal article on first project • Submit annual report
Spring	up to 9 credit hours: • EAS 6900 Geoscience Journal Club • EAS 6990 Dissertation Research • Requirements/Electives	• Continue dissertation research • Present research at on-campus symposium • Hold committee meeting
Summer	0 credit hours	• Continue dissertation research
	YEAR 4	
Fall	up to 9 credit hours: • EAS 6900 Geoscience Journal Club • EAS 6990 Dissertation Research • Requirements/Electives	• Continue dissertation research • Present research at a national meeting • Submit annual report
Spring	up to 9 credit hours: • EAS 6900 Geoscience Journal Club • EAS 6990 Dissertation Research • Requirements/Electives	• Continue dissertation research • Present research at on-campus symposium • Submit journal article on second project • Hold committee meeting
Summer	0 credit hours	• Continue dissertation research
	YEAR 5	
Fall	0 credit hours: • EAS 6900 Geoscience Journal Club • EAS 6990 Dissertation Research	• Continue dissertation research • Present research at a national meeting • Submit annual report
Spring	0 credit hours: • EAS 6900 Geoscience Journal Club • EAS 6990 Dissertation Research	• Present research at on-campus symposium • Finish writing dissertation • Submit journal article on third project • Apply to graduate • Complete and submit Degree Audit • Submit dissertation to committee • Defend dissertation • Revise dissertation in response to committee comments • Submit approved dissertation to Graduate Education and ProQuest • Return office key and other SLU supplies • Graduate

2.8 Research Proposals

The purpose of the proposal is for the student to demonstrate their capability for critical scientific thinking about and broad background knowledge of the selected research topic. The proposal will be evaluated by the committee members based on the following criteria:

1. How were the scientific questions and problems formed and presented in the proposal?
2. How significant is the research in contributing to and advancing our current knowledge of the field?
3. Does the student have adequate knowledge and understanding of the scientific question and previous work on the topic?
4. Are the methods that the student proposed to use scientifically sound? Will they allow the problem to be solved?
5. What are the anticipated results and their implications?

The proposal should be double-spaced and limited to 15 letter-sized, numbered pages, excluding the reference list. While the proposal format does not have margin, font, or citation-style specifications, it should follow a standard scholarly format and look professional. Figures and tables may either be distributed throughout the proposal or be placed at the end of the document. All figures and tables must be numbered, be referred to in the text in order, and have captions.

The proposal must start with a title and the student's name and contain the following sections:

1. **Introduction.** The Introduction should introduce the broad question of interest, narrow the problem to what will be investigated by the proposed research, and set up the rest of the proposal.
2. **Previous Work/Literature Review.** The Literature Review should place the research in the context of what has already been done on the problem and describe the current state of the field, including the research gap. This section should focus on previous work without being a history of the development of the field.
3. **Proposed Work and Preliminary Results.** The Proposed Work and Preliminary Results should include the hypothesis, data, methods, and results (but not interpretation) of preliminary analyses.
4. **Anticipated Results and Discussion.** The Discussion should interpret the preliminary results and describe how future results will be interpreted to address the scientific question. In particular, what results would support or refute the hyopthesis? How will answering the scientific question advance the field?
5. **List of Proposed Chapter Names.** For an M.S. thesis, the chapters will typically be the standard sections of a scientific article. For a Ph.D. dissertation, the chapters will typically be Introduction, three middle chapters that are publishable scientific articles, and Conclusions.
6. **References.** The References must list all articles and other materials cited in the main text. The formatting should follow a standard scientific format.

2.9 Degree Requirement Checklists

The checklists on the following pages can help students plan their curriculum and keep track of their progress towards degree completion. If any substitutions or changes are necessary, students should start the paperwork early and keep copies of any letters or forms submitted or received.

2.9.1 Committee Members

Each student, in consultation with their advisor, should form a thesis/dissertation committee by the end of the first year of study and hold annual meetings of the entire committee. Committee members must be members of the graduate faculty, but do not have to be members of the Department of Earth & Atmospheric Sciences or even SLU as long as they have appropriate expertise to evaluate the research topic. Students are encouraged to meet individually with committee members outside of their annual committee meetings. The rows belong show the minimum number of committee members required by SLU, but students may have more than the minimum required number of committee members.

M.S. Oral Examination and Thesis Committee:

Advisor ______________________________

Member ______________________________

Member ______________________________

Ph.D. Written and Oral Examination Committee:

Advisor ______________________________

Member ______________________________

Member ______________________________

Member ______________________________

Member ______________________________

Ph.D. Dissertation Committee:

Advisor ______________________________

Member ______________________________

Member ______________________________

2.9.2 Coursework Checklists

Course requirement checklists for the M.S. and Ph.D. degrees are given in Tables 6– 12. The checklists include suggested elective courses for each concentration. These are courses that previous students have taken, but none are required. Students are not limited to classes in our department — courses in chemistry, biology, computer science, engineering, and mathematics may also satisfy the credit requirements. In addition, some courses at Washington University may be appropriate. However, outside course selections must be pre-approved by the Geoscience or Meteorology faculty.

Up to ten credits from 4000-level courses may count towards the graduate degree provided that they are approved by the Geoscience or Meteorology faculty. However, if a course is dual-listed (i.e., it is offered at both the 4000- and 5000-levels), students must enroll in the 5000-level course.

We offer several types of independent study courses. The combined number of credit hours from Research Topics (EAS 5970/6970), Graduate Reading Course (EAS 5980/6980), and Independent Study (EAS 5981/6981) is limited to 6 for M.S. students and 12 for Ph.D. students.

With approval, a limited number of graduate credit hours from other institutions can be transferred for credit.

Table 6: Geoscience (Environmental Geosciences) M.S. coursework checklist

M.S. in Geoscience (Environmental Geosciences) Total credits: 30		Credit Hours	Year 1 F	Year 1 S	Year 2 F	Year 2 S
THESIS RESEARCH (thesis students only)						
EAS 5990	Thesis Research	6				
REQUIRED CORE COURSES						
EAS 5900	Geoscience Journal Club *(enroll every semester, exactly once for credit)*	1				
EAS 5500	Scientific Communications	3				
EAS 5190	Seminar in Geoscience	2				
SUGGESTED ELECTIVES						
EAS 5140	Soil Science	3				
EAS 5260	Environmental Geochemistry	3				
EAS 5410	Hydrology	3				
EAS 5WU	Minerals in Aqueous Environment	3				
EAS 5WU	The Earth's Climate System	3				
GIS 5010 *or* SOC 5650	Introduction to GIS Introduction to GIS	3 3				
BST 5000	Principles of Biostatistics	3				
BST 5400	Applied Data Management	3				
CVNG 5370	River Engineering	3				
CVNG 5930	Special Topics	3				

Table 7: Geoscience (Geology) M.S. coursework checklist

M.S. in Geoscience (Geology) Total credits: 30		Credit Hours	Year 1 F	Year 1 S	Year 2 F	Year 2 S
THESIS RESEARCH (thesis students only)						
EAS 5990	Thesis Research	6				
REQUIRED CORE COURSES						
EAS 5900	Geoscience Journal Club *(enroll every semester, exactly once for credit)*	1				
EAS 5500	Scientific Communications	3				
EAS 5190 *or*	Seminar in Geoscience	2				
EAS 5390 *or*	Seminar in Seismology	2				
EAS 6190	Advanced Seminar in Geophysics	2				
REQUIRED COURSES						
EAS 5060	Physics of the Solid Earth	3				
EAS 5170	Divergent and Convergent Margins	3				
SUGGESTED ELECTIVES						
EAS 5260	Environmental Geochemistry	3				
EAS 5410	Hydrology	3				
EAS 5450	Advanced Petrology	2				
GIS 5010	Introduction to GIS	3				

Table 8: Geoscience (Geophysics) M.S. coursework checklist

M.S. in Geoscience (Geophysics) Total credits: 30		Credit Hours	Year 1 F	Year 1 S	Year 2 F	Year 2 S
THESIS RESEARCH (thesis students only)						
EAS 5990	Thesis Research	6				
REQUIRED CORE COURSES						
EAS 5900	Geoscience Journal Club *(enroll every semester, exactly once for credit)*	1				
EAS 5500	Scientific Communications	3				
EAS 5190 *or*	Seminar in Geoscience	2				
EAS 5390 *or*	Seminar in Seismology	2				
EAS 6190	Advanced Seminar in Geophysics	2				
REQUIRED COURSES						
EAS 5060	Physics of the Solid Earth	3				
EAS 5170	Divergent and Convergent Margins	3				
Any 2 of the following 3 courses are required; the third may be taken as an elective.						
EAS 5040	Potential Theory	3				
EAS 5160	Exploration Seismology	3				
EAS 5400	Continuum Mechanics in Wave Propagation	3				
SUGGESTED ELECTIVES						
EAS 5120	Time Series Analysis in Geophysics	3				
EAS 5460	Geodynamics	3				
EAS 5530	Geophysics Inverse Theory	3				
EAS 5620	Introduction to Earthquake Seismology	3				
EAS 5720	Seismological Instrumentation	3				
EAS 6310	Advanced Seismology I	3				
EAS 6320	Advanced Seismology II	3				

Table 9: Meteorology M.S. coursework checklist

M.S. in Meteorology Total credits: 30		Credit Hours	Year 1 F	Year 1 S	Year 2 F	Year 2 S
THESIS RESEARCH (thesis students only)						
EAS 5990	Thesis Research	6				
REQUIRED CORE COURSES						
EAS 5900	Geoscience Journal Club *(enroll every semester, exactly once for credit)*	1				
EAS 5500	Scientific Communications	3				
SUGGESTED ELECTIVES						
EAS 5080	Dynamics of the Atmosphere	3				
EAS 5090	Physics of the Atmosphere	3				
EAS 5110	Computing in Atmospheric Science	3				
EAS 5200	Numerical Method of Prediction	3				
EAS 5230	Boundary Layer Meteorology	3				
EAS 5240	Tropical Meteorology	3				
EAS 5270	Meteorology of Severe Storms	3				
EAS 5290	Mesometeorology	3				
EAS 5340	Cloud Physics	3				
EAS 5380	Stat. Methods in Meteorology	3				
EAS 5360	Principles of Radiative Transference	3				
EAS 5600	Atmospheric Chemistry	3				
EAS 5610	Satellite Meteorology	3				
EAS 5650	Radar Meteorology	3				
EAS 5700	Convection in the Atmosphere	3				
EAS 6480	Gen. Circulation of Atmosphere	3				
GIS 5010	Introduction to GIS	3				

Table 10: Geoscience (Environmental Geosciences) Ph.D. coursework checklist

Ph.D. in Geoscience (Environmental Geosciences) Total credits: 48		Hrs	Y1 F	Y1 S	Y2 F	Y2 S	Y3 F	Y3 S	Y4 F	Y4 S	Y5 F	Y5 S
DISSERTATION RESEARCH												
EAS 6990	Dissertation Research	12										
REQUIRED CORE COURSES												
EAS 6900	Geoscience Journal Club (*enroll every semester, exactly twice for credit)*	1										
EAS 5500	Scientific Communications	3										
EAS 5190	Seminar in Geoscience	2										
SUGGESTED ELECTIVES												
EAS 5140	Soil Science	3										
EAS 5260	Environmental Geochemistry	3										
EAS 5410	Hydrology	3										
EAS 5WU	Minerals in Aqueous Environment	3										
EAS 5WU	The Earth's Climate System	3										
GIS 5010 *or* GIS 5650	Introduction to GIS Introduction to GIS	3 3										
BST 5000	Principles of Biostatistics	3										
BST 5400	Applied Data Management	3										
CVNG 5330	Open-Channel Flow	3										
CVNG 5370	River Engineering	3										
CVNG 5930	Special Topics	3										

Table 11: Geoscience (Geophysics) Ph.D. coursework checklist

Ph.D. in Geoscience (Geophysics) Total credits: 48		Hrs	Y1		Y2		Y3		Y4		Y5	
			F	S	F	S	F	S	F	S	F	S
DISSERTATION RESEARCH												
EAS 6990	Dissertation Research	12										
REQUIRED CORE COURSES												
EAS 6900	Geoscience Journal Club (*enroll every semester, exactly twice for credit)*	1										
EAS 5500	Scientific Communications	3										
EAS 5190 *or* EAS 5390 *or* EAS 6190	Seminar in Geoscience Seminar in Seismology Advanced Seminar in Geophysics	2 2 2										
REQUIRED COURSES												
EAS 5390	Seminar in Seismology	2										
EAS 5060	Physics of the Solid Earth	3										
EAS 5120	Time Series Analysis in Geophysics	3										
EAS 5170	Divergent and Convergent Margins	3										
EAS 6310	Advanced Seismology I	3										
EAS 6320	Advanced Seismology II	3										
Any 2 of the following 3 courses are required; the third may be taken as an elective.												
EAS 5040	Potential Theory	3										
EAS 5160	Exploration Seismology	3										
EAS 5400	Continuum Mechanics in Wave Propagation	3										
SUGGESTED ELECTIVES												
EAS 5460	Geodynamics	3										
EAS 5530	Geophysics Inverse Theory	3										
EAS 5620	Introduction to Earthquake Seismology	3										
EAS 5720	Seismological Instrumentation	3										

Table 12: Meteorology Ph.D. coursework checklist

Ph.D. in Meteorology Total credits: 60		Hrs	Y1 F	Y1 S	Y2 F	Y2 S	Y3 F	Y3 S	Y4 F	Y4 S	Y5 F	Y5 S
DISSERTATION RESEARCH												
EAS 6990	Dissertation Research	12										
REQUIRED CORE COURSES												
EAS 5900	Geoscience Journal Club *(enroll every semester, exactly once for credit)*	1										
EAS 5500	Scientific Communications	3										
SUGGESTED ELECTIVES												
EAS 5080	Dynamics of the Atmosphere	3										
EAS 5090	Physics of the Atmosphere	3										
EAS 5110	Computing in Atmospheric Science	3										
EAS 5200	Numerical Method of Prediction	3										
EAS 5230	Boundary Layer Meteorology	3										
EAS 5240	Tropical Meteorology	3										
EAS 5270	Meteorology of Severe Storms	3										
EAS 5290	Mesometeorology	3										
EAS 5340	Cloud Physics	3										
EAS 5380	Stat. Methods in Meteorology	3										
EAS 5360	Principles of Radiative Transference	3										
EAS 5600	Atmospheric Chemistry	3										
EAS 5610	Satellite Meteorology	3										
EAS 5650	Radar Meteorology	3										
EAS 5700	Convection in the Atmosphere	3										
EAS 6480	Gen. Circulation of Atmosphere	3										
GIS 5010	Introduction to GIS	3										

3 Working in the EAS Department

One of the most important aspects of our program is diversity. We educate students from many different societies and cultures. The different cultures produce different attitudes that many enjoy. Mixed with the various cultural backgrounds are different personalities. While attitudes and viewpoints vary, everyone deserves to be treated politely and with respect. Mutual respect must be the most important aspect of our interactions.

3.1 COVID-19 Restrictions

We normally expect students to be working at their desks or in the lab during the day. During the 2020–2021 academic year, the pandemic required people to maintain physical distance from one another and students spent more time working remotely, only coming to campus for essential research, teaching, and coursework responsibilities. The University hopes to return to more normal operations during the 2021–2022 academic year, but some activities may take some time to return to normal and increased infection rates may lead to increased restrictions. When a mask mandate is in effect, all members of the community must wear masks in indoor spaces. Masks may only be removed while eating or when in a private office with the door closed. For the latest campus coronavirus information, people should visit `https://www.slu.edu/health-advisory/index.php` and `https://www.slu.edu/back-to-slu/index.php`.

3.2 The Department: Your Home Away From Home

Each student is assigned a desk, a bookcase, and a computer. They are also given an office key and after-hours access to O'Neil or Ritter Hall or the ISE building. Desks are assigned based on seniority. If a student wants to change desks, they need to wait until another student graduates and then ask permission from the Graduate Program Coordinator.

The shared office helps foster a sense of community — students can work together on homework, students can discuss research with each other and the faculty, and someone (student, faculty, or staff) is always easily accessible when questions or problems arise.

O'Neil Hall is located along a busy street, so we occasionally have unexpected visitors. Unknown people should be directed to the Department office for assistance. Offices should be locked when they are not occupied. In the evening or over the weekend, suspicious behavior or unlocked exterior doors should be reported to campus security.

Students have mailboxes in O'Neil 205. Only professional mail should be sent to the department; personal mail and packages must be sent to a home address. The copier, scanner, printers, and fax are also located in O'Neil 205. Please help conserve paper and ink by printing only what is necessary. The Department also has a poster printer in Ritter Hall; either Bob Wurth or Eric Haug must print the poster on it.

The kitchenette on the second floor of O'Neil has a refrigerator, microwave, and kettle. All building occupants are welcome to use these appliances as long as they clean up after themselves and only eat their own food.

SLU is a tobacco free campus (`https://www.slu.edu/human-resources/pdfs/policies/tobacco-free-campus.pdf`) and all tobacco products (including, but not limited to, cigarettes, e-cigarettes, cigars, pipes, bidis, clove cigarettes, and smokeless or spit tobacco) are banned everywhere on all SLU campuses, indoors and outside. This ban includes all hallways, laboratories, restrooms, and classrooms within research and teaching buildings.

3.3 Department and Program Activities

Graduate students are expected to participate in several important department activities. Many of the activities described in this section will be limited or modified until the coronavirus is under control.

The Departmental Seminar Series. Central to any active research program is an active seminar series (these seminars are distinct from seminar courses). Many Fridays during the Fall and Spring semesters, we invite scientists from other institutions to visit and to present the results of some of their recent research in a 50-minute-long presentation followed by a question-and-answer session. Such seminars are one way that we stay in touch with other researchers and learn about work proceeding at other institutions. The speakers typically visit for one day and usually meet with members of the faculty and interested students. These visits are a great opportunity for students to meet successful, practicing scientists and to discuss their work with other researchers. The faculty expect all students to attend all seminars and hope that students will choose to meet with at least some of the visitors to discuss their work.

While students probably won't understand everything the speaker presents in a seminar, they should try to learn something new in each presentation and always listen actively. Reading some of the speaker's more recent publications before their visit will help understand the background necessary to follow the talk. Attentive listeners will bring paper and pen to take notes and jot down ideas that come to mind during the talk and ensuing discussion. Audience members should never bring anything else to read during another person's presentation — that's rude and insulting to the speaker and embarrassing to the program.

Geoscience Journal Club/Student Research Seminar. Students gain experience in public speaking in Geoscience Journal Club. Each student is required to enroll in Geoscience Journal Club every semester – once or twice for credit, for zero credits all other semesters — and every student makes a presentation every semester. Journal Club presentations are not high-pressure events, but students want to prepare a good talk since they are taking the time of 15–20 people during the presentation. Junior students are usually scheduled later in their first semester so they have sufficient examples of the expectations.

Field Trips. Field trips are an integral part of any geologic education. Throughout the year the geology faculty run many short trips to nearby locales as part of the undergraduate programs. Space permitting, faculty are happy to take graduate students along. These short trips are excellent opportunities to develop an understanding of the basics of field geology and to learn about local Earth history. Longer trips are often organized immediately after the Spring semester. These trips are open to all students and have been enjoyable and educational for students in all concentrations. Although the majority of the trip costs are covered by the department, some expenses are the student's responsibility.

Social Events. Each year also has opportunities for social interaction at departmental picnics and faculty-student parties. These important events bring members of the program closer together to celebrate holidays and achievements. In addition, there is a weekly Friday afternoon Happy Hour at a local bar.

3.4 Graduate Assistantships

While not guaranteed, we try to support each student in our program with full tuition and a modest, but adequate stipend. To be eligible for an assistantship, students must be in good academic

Table 13: Financial support for one graduate student for one year

Category	Cost
Eleven-month stipend	$22,000
Health insurance	$3,784
Tuition (21 credit hours)	$25,620
Travel to one meeting	$1,500
Subtotal	$52,904
Grant indirect costs (51.5% of above except tuition)	$14,051
Total	$66,955

standing. Good academic standing means a cumulative GPA $\geq$3.0, no more than one missing or incomplete grade, and addressing of any conditions on admission (for example, submission of an official final transcript showing degree conferral for a previous degree). *For continued financial support, students must be in good academic standing, be making good progress on research, and participate in department activities.*

The Department awards two types of scholarships: research assistantships (RAs) and teaching assistantships (TAs). Both positions have the same stipend and include health insurance, but do not include other fees charged by the University. The assistantships are typically contracted for nine months during the first year (mid-August through mid-May) and for eleven months (July through May) in subsequent years. Payment is made on the last business day of the month. For students on nine-month contracts, the two partial-month salaries are paid together in August and no salary is paid in May. Neither contract duration includes stipend or health insurance for June, so students should save funds to support themselves and purchase health insurance during the summer gap of one or two months. Students have the potential to secure summer support through professional organizations or advisors.

Students are expected to be working at SLU (or perhaps doing fieldwork off-campus) during the entire contract period. In addition, students with assistantships may not hold outside employment or internships (including during the summer, if summer is included in the contract period). *Students must receive permission from their advisors ahead of time if they will be absent from campus for any part of the contract period, even if classes are not meeting.*

Assistantships provide support for more than a student's stipend (Table 13), so the total cost is much more than the student sees. Each year of support is a substantial investment by the faculty and/or University. In return, we expect that each student will perform solid research and, if possible, present that work within the University and at professional meetings. These presentations show that our program is active and productive, and eventually leads to more students and sustained funding for the program.

RAs. A student awarded a research assistantship is expected to help faculty with research. Usually this research is associated with the student's thesis or dissertation, but not always. RAs may be supported by external grant money or by the University. Formally, each week, RAs are expected to provide 20 hours of work on the research project. Even though students don't fill out time sheets, they should provide that much assistance. Duties will vary from performing high-level research to simply helping a faculty member with the day-to-day tasks of research, including routine computer work, figure preparation, proofreading abstracts, papers, posters, performing literature searches, etc. Note that students supported by external grants may have contracts covering different time periods than for University-supported assistantships.

TAs. Other students are supported by the University to help with undergraduate education. Like RAs, TAs are expected to provide 20 hours of work each week while classes are in session — but this work contributes to teaching. TAs assist with undergraduate education, some work in the introductory geology laboratory courses, others help with lecture-course grading, photocopying, proctoring of exams, showing videos when the professor is out of town, and completing other tasks associated with teaching a university-level science course.

Both RAs and TAs should meet with their faculty supervisor early each semester to discuss the duties and expectations of the work. Students should try to identify when the professor will need the most help and budget their time to be free to assist then. Common crunch times include exams, field trips, abstract or proposal deadlines, etc. As the semester progresses, needs may change. If assigned duties take <20 hours per week, students should show initiative and actively seek to help reduce their supervisor's work. Tasks — preparing a figure, grading a lab or homework set, performing a literature search, completing a calculation — should be done in a reasonable time frame.

3.5 Working with Other Graduate Students

Graduate students learn a lot from each other. Junior students may rely heavily on senior students to help clarify the way things work in the program and to fill in the gaps in explanations received from faculty and staff. As students progress through the program, they will return the favor to future students. And senior students continue to learn from other students who are working on different projects. Collaborations can last for decades. Friendships can last a lifetime.

Graduate students are an integral part of our research program and their behavior and level of commitment has a great impact on the working environment in the department. Students should take time to talk with each other about their research, share and discuss interesting results, and help one another succeed. A group of students that respects each other, actively engages in scientific discussions, and works hard can create an invigorating intellectual atmosphere.

3.5.1 Congeniality

The faculty expect all students to treat each other with respect. The foundation of a successful program is the cooperation of all those involved, both faculty and students. Everyone is entitled to a basic level of respect. Faculty can write stronger, more positive reference letters for students who have exemplified congeniality, cooperation, and commitment during their time at SLU.

3.5.2 Cooperation

The faculty expect students to share resources.

The faculty expect senior students to assist junior students. This does not mean doing their work for them or spending hours training them. But often a simple question about what they are doing and a hint on a source of information can save a novice hours of frustration. We count on the more experienced students to take the time to help us prepare students for the world of research. Junior students should realize that sometimes the senior students are working on a deadline to submit an abstract on time, prepare for an exam, or finish their thesis or dissertation and shouldn't expect much help from someone as crunch-time nears.

The faculty expect students to maintain a healthy study environment. While we encourage any discussion of science anywhere, long or loud conversations about social activities or non-science related subjects don't belong in shared office or computer rooms. Instead, students should take phone calls and non-science conversations into the vestibule or outside. Other students studying nearby will appreciate the quiet. Multilingual students should realize that it is impolite to speak in a language not understood by everyone when it can be avoided. No one minds a brief digression to communicate an idea to a colleague more effectively, but longer conversations are distracting.

3.5.3 Commitment

The faculty expect all students to commit to their program of study. We want students to enjoy themselves, their colleagues, the University, and the community. However, we also want students to understand that we are committed to our work and we believe that they should commit to theirs. We expect students to pursue their degree with an energy and drive that insures steady progress towards a timely and satisfactory completion. If we are supporting a student's education with an assistantship, we expect the student to perform assigned research and/or teaching duties well. Students should expect to be challenged and expect to work hard.

3.6 Working with and Understanding the Faculty

Our faculty, like those everywhere, are perpetually over-committed, juggling many different tasks, and trying to make schedules work. At SLU we teach a heavier load than many other institutions but we work hard to maintain comparable research programs. We're counting on students to help us.

Proposals and Funding. Several times each year faculty become exceedingly busy as they prepare proposals to secure external funding for future years. It usually takes at least one year to submit a proposal and receive the funding (assuming the proposal was successful). While we work with the resources from current projects, we are planning for the future. We use the money we raise in our grants to supplement our nine-month salaries from the University, and to pay for student support and research-related travel and expenses. Most of the funds supporting the geosciences and meteorology in the U.S. come from the government.

Most programs at the U.S. National Science Foundation (NSF) accept proposals at anytime, although some programs have deadlines once or twice a year. The U.S. Geological Survey has a rather consistent request-for-proposals in the Spring, and other agencies have deadlines in Fall and Summer. When a proposal deadline draws near, faculty may respond to requests more slowly as submission deadlines approach and proposal writing intensifies. Helping to prepare a proposal — even just making a figure for it — can be a great way for a student to gain some experience in proposal preparation. More senior students may be asked to do some preliminary calculations to aid in the proposal development, and to review sections of the proposal as they are produced by the faculty.

Reading proposals is a good way to learn what professors are working on and how scientific funding is awarded. Students should ask their advisors if they can read some of their proposals. The proposals often have valuable background information on projects the students may find themselves working on and usually have fairly comprehensive reference lists that can provide suggestions for reading material.

Faculty Travel. Part of being an active participant in scientific research is the need to travel. Some faculty travel more than others, but all at a minimum journey to professional meetings. Additional trips to proposal or editorial panel meetings or committee meetings often take up more time. Some faculty have additional travel associated with field work. As a result, faculty may be gone for long stretches of time throughout the year, especially during the summer. All students must plan for potential faculty absences and insure that important exams, thesis/dissertation committee meetings, and defenses are scheduled well in advance to assure that the important participants are on campus when they are needed.

Faculty Sabbaticals. A sabbatical is a research leave offered to faculty after every six years of service. The idea is to provide faculty the opportunity to focus on research free of distractions of teaching, faculty meetings, etc. A professor may choose to spend their sabbatical at SLU or off campus. All faculty are encouraged to take sabbaticals to promote vigorous research and to form or to maintain strong research connections with colleagues at other institutions. SLU supplies one semester of sabbatical salary but the professor can take a year leave with financial supplements from other institutions or external funding.

3.7 Selecting a Research Advisor

One of the most important choices in graduate school is selection of an advisor. Many students arrive with an advisor already selected based on the type of research. If a student already has an advisor, they should meet early in the semester to get started on a research project. If a student does not have an advisor, they should use the first semester to meet with prospective advisors to learn about possible research projects and to learn the tools of the research field.

If a student's interests change, it is possible for a student to switch advisors. It is also possible for students to work under the direction of collaborative advisors, or for Ph.D. students to research different projects with different faculty or with other students. To maintain an environment where students have the flexibility to switch advisors part way through their program, it is critical that students conscientiously perform their assistantship duties. In particular, if a student has been supported for two years on a grant by one faculty member but has done little research, it is unprofessional and may damage the professional relationship into the future. The initial professor invested considerable resources supporting the student, so the student should reciprocate by helping them with their research. If the advisor feels that the student has provided 20 hours a week assistance, an advisor change will be smoother.

3.8 Mental Health

Graduate school demands a lot of students and managing these competing academic, professional, and personal demands can be stressful and even debilitating. Everyone, including highly-accomplished professionals, struggles with these issues. Students don't have to manage their struggles alone — the University has experienced counseling professionals that can help and we encourage students to make use of available resources. The University Counseling Center can help with concerns such as eating disorders, sexual assault, depression, anxiety/stress, panic attacks, self-harming behaviors, sleep disturbance, adjustment problems, relationship issues, drug and alcohol abuse, uncontrollable mood swings, obsessive-compulsive behaviors, attention/concentration problems, identity/orientation confusion, family or origin concerns, cultural/diversity concerns, and post-traumatic stress. They permit ten free individual therapy sessions per academic year. In addition, the University offers a zero-credit-hour Graduate Wellness Course (UNIV 5010).

4 Making the Transition from Coursework to Research

Perhaps the most important transition students make between undergraduate and graduate programs is the transition from working on well-constructed homework problems to complex and often convoluted real-world research endeavors. In coursework, students are often asked to perform calculations or draw maps of structures that have direct and clear interpretations. Research is different: it can be messy and non-unique and lack a clear endpoint. A beginning researcher may expect to go from point A to point B, but research progresses in unexpected ways and will likely end up following a circuitous path to point C (Figure 1). Upon arriving at point C, the researcher has learned something about Earth that no one else knows — a place much more rewarding than coursework!

Fortunately the coursework-to-research transition is not made in isolation — that's why we study in groups and that's why universities exist. Faculty, postdocs, and other students are happy to talk about what they're working on and why they find it worth their time. Students in a research program often learn as much (if not more) from each other as they do from the faculty.

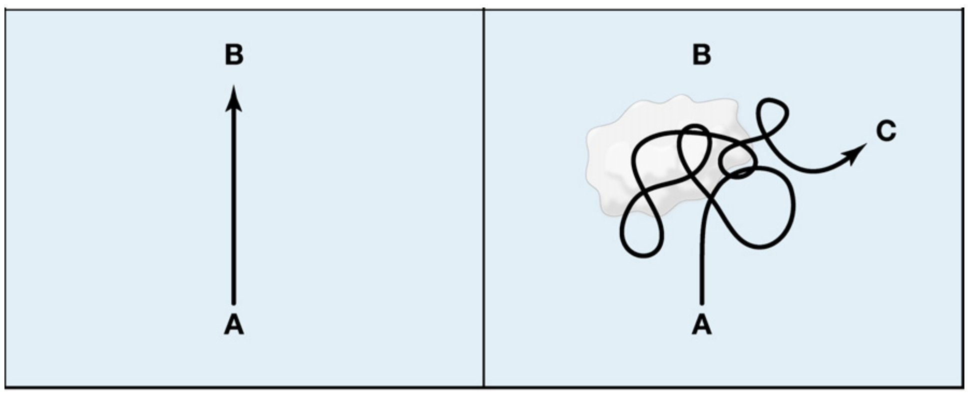

Figure 1: Research starts at point A and heads towards point B, but will likely end up at point C. Figure from Alon (2009), How to choose a good scientific problem, *Molecular Cell*, doi:10.1016/j.molcel.2009.09.013.

4.1 Reading

Science is a cumulative effort — our work is built upon the efforts of other scientists. To know where to begin, one has to read what has come before — textbooks, notes, review articles, popular science books, articles, and of course, journals. The more one reads, the more easily one will see the pervasive inter-relationships among research projects and the more one will appreciate how their work contributes to the overall scientific enterprise. In addition, one can save time by not reinventing the wheel.

4.1.1 Professional Journals

Scientific research is recorded in professional journals. Electronic access to most of the important journals is available through the library. One can browse the table of contents online and find links to abstracts or entire articles available in electronic format. To keep track of recent research, I recommend subscribing so table-to-content alerts from important journals and reviewing them as new articles are published. More information on professional societies is given in Section 4.3.2.

4.1.2 Libraries and Information Services

Two SLU libraries that will be particularly useful are the Department collection in the Woker library and the University library (Pius).

The Woker Library. The Woker library, located in 206 O'Neil, is a collection of works owned and shared by faculty. The fact that we subscribe to certain journals and place them in a central location creates a great convenience.

SLU Pius Library. Although we have a library in the Department, more extensive collections are available in the University's Pius Library. Pius hosts an extensive geophysics collection and a growing collection of geologic references. It also has good math, physics, chemistry, and biology resources and guides to computers, programming, and writing. Our librarian is happy to help students use the available resources and find what they need.

Interlibrary Loan Services. If a particular reference is not availabe in either of these places, Pius has an excellent interlibrary loan program. Material can be requested from the Interlibrary Loan website at no charge.

Databases. We have access to several online data bases that include geoscience and meteorology literature. Popular databases are Google Scholar, GeoRef, and the Web of Science. These databases can be accessed from the Geoscience and Atmospheric Science library guides.

4.1.3 Reading Scientific Articles

The Art of Skimming. Scientific articles can be read at different levels of detail depending on how important the paper is to one's research. Skimming, or previewing, is always a good first step to assess an article's relevance. Often, when one doesn't have the time to carefully read a paper, one can still get a lot out of the work by skimming the article. Previewing is an important skill to develop: preview by reading the abstract, the introduction, and the conclusions (or discussion). Then read the figure captions and study the figures. These sections don't tell all the details of the analysis, but the reader should gain a good idea of the main points, or at least have some questions about the work, from reading these parts.

Critical Reading. When the material applies directly to one's research, the article must be read carefully. Following the preview (as described above), the reader should identify the key terms, phrases, and concepts. Then they should read the entire paper. The goal in the first reading is to complete an overview and to identify key concepts and difficult passages that require additional work. However, the reader shouldn't get bogged down in difficult passages — those can be deciphered during a second reading. During a second (or third...) reading, the reader can imagine being engaged in a discussion with the authors by asking and answering questions while they reads. The reader should write down any questions that they can't answer and follow up by reading works cited in the original article and discussing the work with local experts.

The difficult parts of an article require many readings, but re-reading an article or at least parts of an article is a necessary component of reading science. As a scientist reads more papers, they develops the skills to read faster, which will allows them to read even more. Reading is the best

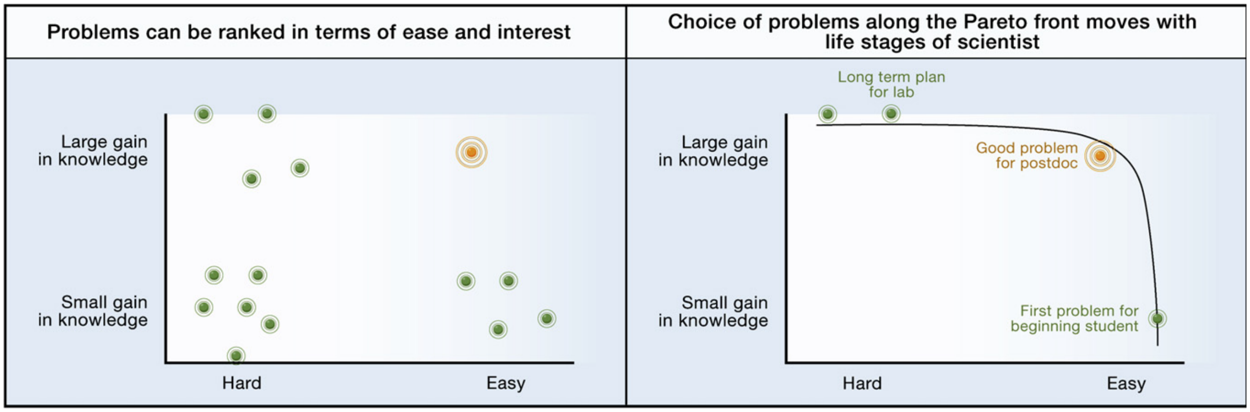

Figure 2: Feasibility-interest considerations for research projects. Figure from Alon (2009), How to choose a good scientific problem, *Molecular Cell*, doi:10.1016/j.molcel.2009.09.013.

way to develop a broad perspective of science and to develop a clear understanding of how one's work fits into the science. This is an important step in becoming a mature scientist.

4.2 Researching

Everyone performs research differently and different research projects are formulated in different ways. Some projects are hypothesis tests whereas others are driven by new data. The type of study that one pursues will depend on one's talents and the choices that the student and advisor make. Research invariably begins with background reading to become familiar with the research area, the methods used in it, and what the outstanding questions are. As a research project becomes more developed, both the feasiblity of the research and how much interest there is in the question should be considered (Figure 2). Ideally, a project will maximize either feasibility or interest — a hard project that results in only a small gain in knowledge may not be a worthwhile use of time. A good first project will be relatively easy to complete and produce a small gain in knowledge. In choosing a project, students should be ambitious but realistic. Students should also be aware that research does not follow a set schedule, so they should plan to spend evenings, weekends, and summers working on the research. Summer, when classes are not in session, is an especially important time to make progress.

4.2.1 Keeping Notes

In any study, the importance of organization should not be underestimated. Organized notes, files, and lines of investigation will help a researcher be efficient in performing and interpreting research. Good notes with summaries help researchers track their progress and effectively discuss their ideas with others. Logically-named files and folders help researchers find a particular figure when discussing ideas and results with other scientists. To be prepared for unexpected, but possibly productive discussions, one should periodically create a summary of their current thoughts or results. Research completed at at the University is the intellectual property of the University, so we are entitled to a record of the work and students should expect to provide their advisors with originals or copies of their notebooks, notes, data sets, and computer codes. Students should ask their advisors about these expectations at the start of their graduate studies.

4.2.2 Exploring Scientific Observations

Observations are at the center of any scientific investigation. The transition to data interpretation is the biggest leap students make. Interpretation also requires scientists to feel comfortable with uncertainty and non-uniqueness. I've heard it said in the "game" of geology the one who looks at the most rocks before they die "wins." This is clearly a simplification of research goals, but underlying the jest is the importance of experience working with observations. The more data one explores, the better equipped they is to interpret new information. Data force researchers to view material from coursework in many different ways and to creatively apply what is learned in lectures.

Reading journals is one way to explore observations and what they can tell us about Earth and about geologic processes. Students should also learn to access databases in their field — USGS water quality and stream discharge data, USDA soil survey data, IRIS seismograms — and explore the data on their own. Such exploration will help students learn how to use software packages in their field and and develop independent research skills.

4.2.3 Mastering the Tools of the Trade

Associated with any scientific discipline are specific instruments used to record, process, examine, and display data. The instrument could be a Brunton compass, a computer program, or a mass spectrometer. In any case, students must become proficient with the tools of the trade and should do so before the instrument is absolutely needed. The better the student knows how to use the equipment, the more effective and efficient they will be wielding those tools. All students will use illustration and word processing tools to prepare visually effective and well-written articles, theses, and/or dissertations. One can use these tools in a limited fashion without awareness of their true power, or one can learn to use them intelligently.

One will not learn the power of any package by browsing menus. Modern graphics and word processing tools are sophisticated drafting and publishing tools. One must look at examples, read the manual, and use the help system. Browsing the help system is a good way to learn something about the strengths and weaknesses of different packages. Some features of these programs can save a lot of time, but they also require time and effort to master.

4.2.4 Working as Part of a Group

Science is not a solitary activity. Each student is part of a group with other members — a faculty mentor, other students, outside collaborators — and discussions and sharing of ideas within the group are crucial for forward progress. Thus, students are expected to proactively seek out their advisor and other group members to talk about the latest data and analyses and the next steps in the research. Students should check in with their advisors at least once a week and not wait for advisors to inquire about progress.

4.3 Publishing Research — Meetings and Conference Presentations

The first place research usually appears is in a preliminary presentation at a professional society meeting or conference. Students should take advantage of as many presentation opportunities as possible.

4.3.1 The Annual SLU Graduate Student Research Symposium

Each spring, the SLU Graduate Student Association organizes a research symposium for graduate students to present poster or oral presentations describing their research. The purpose of this event is to highlight interesting research performed at the University and to provide students with experience needed to compose abstracts and to prepare presentations describing their work. We strongly encourage all students to present their work each year in the exhibition. A strong showing by our group illustrates our programs' strong emphasis on quality research. Our students have done very well in recent years, both by winning awards and just by participating. Participation shows that students are thinking about how to communicate their ideas and work. The participation of our students is a valuable way for us to share our work with the University community — and for us to learn about the research of other students in our program, our department, and our University.

An abstract is usually due in late February and the symposium is held in the Busch Center in April. Presenting a poster means placing it on an easel or tacking it onto a bulletin board and then explaining the details to all who stop by to ask about the work. Interacting at a poster is one of the most efficient ways to receive constructive criticism about the work and ideas. Many new avenues for research are a result of these fruitful discussions.

4.3.2 Professional Scientific Societies

Every major scientific discipline has established professional societies. The societies were organized to facilitate the sharing of research results at professional meetings and through non-profit publication of journals. Some societies are very large with a vast array of scientific interests, others are smaller and more focused. Joining a scientific society usually allows members to purchase the society's publications at a discount, receive notices of meetings and activities, and receive a newsletter that reports on the latest scientific initiatives in the field and that lists job openings. The societies often offer small research grants specifically for students, which can support unfunded projects (and look good on a resume). The existence of professional societies is important for the progress of science and in a small way it is the responsibility of scientists to collaborate in such unions. Some of the societies that members of our department belong to are listed in Table 14. I recommend joining at least one society as a way to begin a professional career. Advisors and fellow students can advise on which societies are most relevant to a particular field of study. Professional societies usually offer student memberships at reduced rates.

4.3.3 Professional Meetings and Conferences

Another reason for joining professional societies is the opportunity to attend professional conferences. Professional meetings usually last a few days to a couple of weeks and range in size from a few tens of people to thousands of participants. Scientists at the meetings present recent research

Table 14: Professional societies

Society	Website
Acoustical Society of America (ASA)	acousticalsociety.org
American Association of Petroleum Geologists (AAPG)	www.aapg.org
American Geophysical Union (AGU)	sites.agu.org
American Meteorological Society (AMS)	www.ametsoc.org
American Shore & Beach Protection Association (ASBPA)	www.asbpa.org
American Society of Civil Engineers (ASCE)	www.asce.org
Association for the Sciences of Limnology and Oceanography (ASLO)	www.aslo.org
Coastal and Estuarine Research Federation (CERF)	www.erf.org
Ecological Society of America (ESA)	www.esa.org
European Geosciences Union (EGU)	www.egu.eu
Geochemical Society (GS)	www.geochemsoc.org
Geological Society of America (GSA)	www.geosociety.org
International Association for Hydro-Environment Engineering and Research (IAHR)	www.iahr.org
Mineralogical Society of America (MSA)	www.minsocam.org
National Weather Association (NWA)	nwas.org
Seismological Society of America (SSA)	www.seismosoc.org
Society of Exploration Geophysicists (SEG)	www.seg.org
Society of Wetland Scientists (SWS)	www.sws.org
Soil Science Society of America (SSSA)	www.soils.org

results in short talks or poster presentations. The most important meetings are those run by the professional societies listed in Table 14.

The large conferences are not the only valuable meetings. Frequently more narrowly focussed meetings with fewer participants are convened for two- or three-day discussions of problems and research. These are often great meetings to participate in scientific discussions, and to make contacts and friends in the field. They are more exclusive than the national meetings, but they are worth the time. These meetings are usually announced in society newsletters.

Abstracts. Several months before the conference, scientists planning to attend submit abstracts describing the work that they will present. An abstract is a self-contained, concise description of the major aspects of the study. The abstract should entice other scientists to come to the presentation, so the abstract will need to go through several iterations of revisions with co-authors to make sure the message is clear. All co-authors (which should include the student's advisor and other people who contributed to the work) must consent before the abstract is submitted. In addition, by submitting an abstract, the author is agreeing to present the material at the time and in the form designated by the meeting. Once the meeting program is published, changes cannot be made and the author is obligated to present the research as assigned.

Meeting Expenses. We want students to attend professional meetings. Travel to a meeting requires that expenses are paid, which usually comes from external support for a project. If a student works on research not funded by external support, the funds to cover meeting expenses may not be available and students may be asked to share the expense if they choose to attend. Meeting registration, abstract submittal fees, airfare, housing, and "per diem" can exceed $1,000.

Although we try to cover the cost of the meetings with external funds, we can't send students to all meetings. To help us cover the costs of the trip, student should apply for student travel grants to each meeting they plan to attend. Students should show initiative and check the qualifications for the awards and note and meet the deadlines. This information is available in the society newsletters. In addition, the Graduate Student Association (GSA) provides funding for students to attend meetings. The present limit on funds (for only one meeting per academic year per student) is 50% of costs, up to $300, for students presenting their work at the meeting and 50% of costs, up to $200, for students attending but not presenting their work. Funding is only available to students from a Department that sends a representative to the SLU GSA monthly meetings, so that means at least one student from our department must commit the time to the organization for us to maintain good standing and for students to qualify for the financial assistance.

Students should choose meetings carefully, but attend as many as possible and present their work every chance they get. All students have that opportunity at least once each year — at the Graduate Student Association's spring research symposium.

4.4 Travel Policies

Travel reimbursement is complicated, so students must get approval ahead of time from the department chair, follow the current guidelines for making air and lodging reservations, keep all receipts, and submit reimbursement forms as soon as possible after return.

Students should first talk to their advisors about a budget and a fund number for expenses. Next, they must fill out the EAS Google travel form and name their advisor (or whomever is paying for the trip) in the sponsor field. This form goes to the department chair, who will email approval to the student and sponsor. Once travel is approved, the student can proceed with booking airfare and lodging in accordance with the CAS travel policies. Bookings outside of Concur need approval ahead of time from the department chair. To use Concur, the student will need a travel profile; the Departmental administrative assistant can help set this up.

4.5 Publishing Research — Manuscripts

Writing publication-quality papers takes time and effort. Publications are the ultimate goal of any research project and can be considered the "currency" of scientific work. Unpublished work is much less valuable than material that has been critically reviewed and is widely available in journals. If no one can read your work, it doesn't advance the science.

As soon as students start on a research project, they should start to think about the paper. What sections will make up the manuscript? What will the key figures be? Figures take a lot of time to perfect, so they shouldn't be finalized until the paper is nearly complete. If a student is working on something that is important and interesting, there is a good chance someone else has a similar idea or is looking at a similar project. Scientific results are best when they are fresh — when a project is almost done, the manuscript should be finished and submitted promptly. Delay could result in being scooped – having someone else publish similar results first — and much, if not all, of the impact of the work being lost.

4.5.1 An Overview of the Scientific Publication Process

Publishing a paper requires many skills, much work, and more time than one might think. Once the manuscript is completed and all co-authors consent, the manuscript is submitted to an appropriate journal. Specifics on how to format the article, limitations on length, and other mechanical aspects are listed on the journal's web site.

Papers published in reputable journals require peer review. Peer review is an anonymous process whereby a manuscript submitted to a journal is sent to several experts in the field for their critical evaluation of the correctness and importance of the research. The experts critique the work under the protection of anonymity and try to insure that only quality work is published. The reviewers are volunteers, and they contact only the editor. Authors usually don't know their identity. The review process takes time — an author may wait months to hear back from the editor. The editor sends a decision (such as accepted as is; accepted pending revisions, which can will be classified as minor, moderate, or major; rejected) and a set of comments by the editor and the anonymous reviewers. These comments usually include a summary of items that must be changed to make the paper suitable for publication and a list of items that can changed to improve the clarity.

The next step is to revise the manuscript and write a response letter to the editor documenting the changes and justifying any requested changes that were not made. In some cases the paper may be sent out for another review or, if the initial reviews are positive, the editor may examine the revisions and decide to accept the manuscript for publication. Once a paper is accepted, it is sent by the editor to the typesetter, who creates a set of proofs of the final version of the manuscript. At this stage, the author must read the proofs to insure that the translation was accurate and fix any minor errors. Any final modifications are sent to the journal's printer and one waits for the paper to show up in print.

Authorship. The purpose of an author list is to give credit to everyone who made a significant contribution, both scholarly and writing, to the work. An author must make a significant contribution to the conception, design, execution, and/or analysis and interpretation of the data. In addition, an author must participate in drafting, reviewing, and/or revising the manuscript for intellectual content. An author must approve the manuscript for submission and publication. Honorary authorship, which is when an individual is made an author, often out of respect or the belief that the individual will lend credibility to the paper, is unacceptable. Leaving out an individual who made substantial contributions to the research and/or writing, which is called ghost authorship, is also unacceptable. Individuals who contributed to the work but did not meet the criteria for authorship can be credited in the Acknowledgements. The order of authors can vary between fields. For example, some fields list authors by the amount they contributed to the work whereas other fields list all authors alphabetically. The first/lead author typically made the largest contribution to the research and takes responsibility for managing the writing and submission of the manuscript.

Page Charges. Many of the best journals are produced by non-profit scientific organizations and the cost of publishing the material is the responsibility of the authors. The costs of publication are usually borne by research grants that are obtained by the faculty.

It Takes Time. The most important point of the above description is that it can easily take one year after submission for an article to be reviewed, revised, and then published. Some journals streamline the process by limiting submissions to short articles. The fact that it takes a long time to see a work make it into print requires those planning a career in research to work diligently on research, long after some colleagues may have gone home. Waiting until the final years of a graduate career may be too late to have published papers prior to degree completion and the search for employment. Publications are used as the most important measure of talent in a scientist. Publications in quality peer reviewed journals are valued as an indicator of research skill and potential. Plan ahead.

4.5.2 Choosing a Journal

Research articles are targeted to a specific audience and journal. Among things to consider are the manuscript's subject, the time to publication, the impact of the research, and the quality of the journal. Not all journals carry the same prestige, and not all publications carry the same weight on a resume. Estimating the quality of a journal is a difficult task, but statistics are routinely computed. Important papers will have a large number of citations both in the short run and the long run, so one measure of a journal's importance is calculated by counting the number of citations a journal receives (accounting for the number of papers a journal publishes). Of course, these numbers are not the only, nor the best, way to select a journal. Usually the faculty will guide students in selecting the appropriate journal for their work. As students read through journals, they should see if they can identify the type of study that best matches a particular journal. The quality of a journal reflects the "average" quality of papers in a journal and says nothing about the quality of any single paper found in that journal. There are gems in "low impact" journals and papers that should never have been published in some of the more "reputable" publications.

However, there are certain types of journals that must be avoided. Some journals, informally known as "predatory" journals, do not run a rigorous peer-review process and will publish just about anything in a short amount of time. The draw of these journals is a short publication time and relatively low publication fee, but papers in these journals often have major flaws or errors that would not make it through a rigorous peer-review process. Thus, publishing in these journals will tarnish the reputations of all authors.

5 Preparing the Thesis or Dissertation

"Hard writing makes easy reading." — Wallace Stegner

The goal at the end of research is publication. Performing careful, good work that is published earns a researcher a solid reputation as a productive scientist. But even if research comes naturally, writing is not always an easy task. Writing and rewriting (which is the key to good writing) takes time, effort, and practice. Each student is responsible for finishing their dissertation or thesis. Procrastinating on the writing will likely delay graduation. Students are required to give all written documents to their committee members two weeks before scheduled exams and defenses so that the faculty have a reasonable amount of time to review the document — faculty shouldn't be expected to drop what they are doing just because students have a deadline.

Even if a student has done superb research, a poorly prepared and carelessly written thesis or dissertation will disappoint everyone, including the student. Students should begin writing as soon as they begin research (or even do a literature search) and document the work along the way. While students may end up with passages that are never used, or section fragments that require subsequent modification, that's an enviable situation compared with the alternative. Keeping good notes and writing along the way will dramatically reduce the stress experienced by both student and advisor during the final months. If that's not reason enough to start writing early, consider this: Writing helps one think and organize ideas, which are good things at any stage of research.

5.1 The Importance of Clear Writing

Clear writing is an indication of clear thinking, and when we read papers, theses, etc., we look for indications that the writer knows how to organize ideas, to separate what is assumed from what is known, and to form reasonable conclusions. However, we can't recognize any of that if the writer doesn't write well. None of the faculty really consider themselves good writers because we are familiar with the effort required to construct a well-written manuscript. Fortunately writing gets easier for most people the more they do it, so my early advice is to practice writing. Capitalize on every opportunity to practice, including homework, term papers, e-mail messages, abstracts, and manuscripts.

5.2 Beginning to Write

Everyone has a different approach to writing, but it usually starts with an outline, followed by a first draft, and then revisions. In our line of work we don't always have the luxury of knowing the outcome of a manuscript when we get some time to begin work on the text. Instead, we may have time to write the introduction while the computer is crunching, the samples are cooking, or we are so sick of programming that we want to begin drafting the text for a change of pace.

Outlines are important, and they are necessary to check document organization, but sometimes it's just easier to start writing. I like to write around the figures that I will use to describe my research and ideas. That doesn't mean that I perfect each illustration before I begin to write, it's just that I have a good idea of what will warrant a figure and what I can explain with only prose. To get started, a writer may just sit down at the computer and begin to write. It can help to visualize a particular reader and imagine engaging that person in a conversation about the subject.

5.3 Revising

Revising is the most important step in producing a well-written text, so plan to invest time and effort in revising. I invariably rewrite each sentence many times, and usually reorder sentences and shuffle paragraphs to improve the flow of ideas. Never hesitate to try different arrangements and never be embarrassed by the need to revise. Below, I list steps that I've collected to help with revisions.

- For each sentence:
  - ☐ Do the subject and verb agree?
  - ☐ Are the verb and object easily identified, or are they buried beneath layers of pronouns?
  - ☐ Can I replace vague words or phrases with more precise expressions?
  - ☐ Are any words or phrases redundant?
  - ☐ Have I over-used the passive voice? Writing in the passive voice often comes naturally, but you should only use the passive voice intentionally, when you want it for balance, rhythm, or emphasis. Otherwise use the active voice.
  - ☐ Can I change compound verbs and nouns to enhance parallelism?
  - ☐ Is the main point emphasized at the end of the sentence?
  - ☐ Does the sentence start with known information that gives context?
- For each paragraph:
  - ☐ Is the topic of the paragraph identified in the first sentence? Underline the topic sentences.
  - ☐ Does every sentence convey a useful idea or valuable information?
  - ☐ Does each sentence belong in this paragraph?
  - ☐ Does each sentence connect with the sentences before and after it?
  - ☐ Does this paragraph naturally follow the previous one? Does is connect with the next one?
  - ☐ Do I use any words or phrases over and over and over?
  - ☐ If I read the paragraph out loud, can I find grammatical problems?
- For the document:
  - ☐ Does the abstract include the key results and represent the entire study?
  - ☐ Does the introduction place the work in the appropriate scientific perspective?
  - ☐ Have I summarized the important contributions of others to this line of research?
  - ☐ Have I concisely summarized the results in the introduction?
  - ☐ Have I clearly identified the reasons I performed this research?
  - ☐ Are my section headings informative?
  - ☐ Are my assumptions consistent?
  - ☐ Do my arguments support my inferences? Do I believe what I have written?
  - ☐ Do my conclusions give meaning to my analysis of the observations?
  - ☐ Have a I identified the implications and consequences of my work?

6 What Next?

I've covered many different aspects of our graduate program in the earlier sections, but students should also have an idea of what to expect when they finish their degree. Clearly, the more they know what the career they desire expects of them, the sooner they can begin to develop the intellectual assets needed to achieve their career goals. Whatever a student's career ambition — be it working in academia, industry, government, or elsewhere — we hope that the technical knowledge and communication and problem-solving skills developed here will provide them with the needed foundation for success.

Our recent graduates have found employment in a broad range of fields. A few of our alumni return each year in our Friday Seminar Series to give talks about their jobs and the path they took after graduation. Students should also ask more senior students about the types of jobs they are considering. Job announcements are posted online and in newsletters and listservs by professional societies.

Whether students are applying for jobs or for a Ph.D. program at another institution, they will likely need letters of recommendation from our faculty. Students should ask for the letters early and provide those faculty members with the information they need to write a strong, supportive letter. For example, faculty can make use of a copy of transcripts and a vita that includes any awards, grants, publications, or other honors. For job applications, students should give faculty a copy of the job description and a brief summary of why/how they are qualified for the positions. For applications to Ph.D. programs, students should give faculty their statement of purpose and a description of why they are interested in a particular program.