Land and Atmospheric Science Graduate Studies Program: Graduate Student Learning Outcomes and Assessment

Program Overview and Historical Perspective
During the 2008/2009 academic year we proposed a major revision to our Soil Science graduate program. That revision included a name change and an overhaul of the curriculum that better reflected our faculty expertise, research interests, and new departmental vision for a multidisciplinary program focused on land-atmosphere interactions. The Land and Atmospheric Science (LAAS, www.LAAS.umn.edu) graduate program was approved by the Graduate School in spring 2009.

LAAS is a science-based interdisciplinary program focused on the fundamentals of Earth system processes related to land and atmosphere and their coupled interactions. Students have the option to develop a program based on one of the more traditional areas in atmospheric science or soil science or to design their own interdisciplinary course of study bridging the two disciplines. Research topics in Land and Atmospheric Science are diverse and highly interdisciplinary. Graduate students and faculty work together on both applied and basic science problems. Current research is focused on: biogeochemical cycles of carbon, nitrogen, and phosphorus; impacts of climate variation on natural and managed ecosystems; the sources, transport, and fate of pollutants in soil, air, and water; improving and protecting land, air, and water quality; developing sustainable agricultural practices to ensure high quality agricultural products; and modeling the complex interactions between the land and atmosphere.

The program includes unifying core classes that emphasize the multidisciplinary nature of Land and Atmospheric Science and aim to build strong connections among students and faculty. These courses are also designed to build graduate student cohorts and morale. The LAAS MS program requires a total of 30 credits, including: 5 credits in required LAAS core courses; 9 credits in other LAAS (or related) courses relevant to the student’s research; 6 credits in minor/related courses; and 10 thesis credits. The Plan B MS degree (project/coursework option) requires 20 credits in core and minor courses along with the required LAAS core courses.

The LAAS PhD requires a total of 50 credits, including: 10 credits in required LAAS core courses; 6 credits in LAAS courses relevant to the student’s research; 10 credits in minor/related courses; and 24 thesis credits. The student’s graduate committee and graduate advisor approve the selection of appropriate courses to meet this requirement; depending on the student’s emphasis and background, additional coursework may be required.

Research in LAAS is funded through many sources including the National Science Foundation, Department of Energy, United States Department of Agriculture, National Aeronautics and Space Administration, National Oceanic and Atmospheric Administration, Environmental...
Protection Agency, state agencies, commodity groups, industry, endowments and other sources.

Graduates of our program have strong career opportunities and occupy positions in academic research and teaching institutions; agricultural industries; state and federal government agencies; international agricultural and environmental agencies and foundations; environmental consulting firms; and others. Graduates find careers closely related to their graduate training. Over the period 1995 to 2014 over 85% of our graduates found employment in their respective disciplines. Graduates from the LAAS program (2009-2014) have all entered the work force in a related discipline or have pursued a PhD.

**Process for Developing Student Learning Outcomes and Assessment Plans**

The LAAS program has identified a set of core student learning outcomes and assessment methods to evaluate if student learning outcomes are being achieved. Significant emphasis has been placed on using these assessment tools to improve the quality and relevance of the LAAS program. LAAS learning outcomes and assessment strategies have been developed through consultation and feedback from the LAAS Graduate Committee, Graduate Faculty Members, Graduate Students, the Departmental Faculty Consultative Committee (FCC), a recent LAAS Graduate Studies Retreat, and employers.

**Student Learning Outcomes and their Assessment**

LAAS aims to educate and train students in the fundamentals of Earth system processes related to land and atmosphere and their coupled interactions. The program is highly multidisciplinary and deals with environmental problems occurring at local, regional, and global scales. Our goal is to prepare students to become leading scholars and highly skilled problem solvers that can make contributions to both theoretical advances and practical environmental problems concerning the interactions at the land-air-water interface. Our student learning outcomes and assessment tools can be organized into the following three domains:

1. **Scientific Expertise, Critical Thinking, and Technical Competency**

   We strive to develop graduate students who are experts in their discipline and who have the critical thinking and technical skills to solve complex science problems that are relevant to society. LAAS course offerings and their format are continuously evolving to help achieve these outcomes. In addition, research experiences, preparation of peer-reviewed publications, and participation in conferences and extension outreach activities help our students to meet these goals. We assess our progress toward meeting these goals on an annual basis using the following expected outcomes:

   - Demonstrated proficiency of general concepts and principles in Land and Atmospheric Science
   - Demonstrated expertise in the student’s specialty subject
• Ability to identify and articulate important and relevant research questions related to Land and Atmospheric Science

• Ability to conceptualize, articulate, and execute a plan for conducting research related to the student’s area of emphasis

• Demonstrated competency in measurement, analytical, or modeling techniques

• Ability to apply critical thinking skills to multidisciplinary problems

• Demonstrated commitment to the ethical conduct of research and professional activities

Overall, the assessment of these learning outcomes is based on student progress and success in LAAS research and course work. Our required LAAS courses have been designed to improve communication and presentation skills (LAAS 8128) and proposal writing skills (LAAS 5051). Further, at the PhD level, critical and creative thinking is evaluated through the use of a comprehensive preliminary exam that evaluates an original hypothesis-driven research proposal and the student’s ability to defend the theoretical and practical components of their proposed research. Every MS and PhD student is required to take an ethics class (LAAS 8123) related to conducting research in an academic environment. In all courses and research activities, student work is assessed with respect to proper data use and management, citation of appropriate referenced works, and plagiarism. Finally, the LAAS program uses an annual evaluation report to assess and track overall student progress. This report is evaluated by the student’s Faculty Advisor and one of the LAAS Directors of Graduate Studies.

2. Multidisciplinary Learning and Global Perspectives

We strive to develop graduate students who take a multidisciplinary approach to research and problem solving. The grand challenges we face today in science are rarely confined to a single discipline or geographic location. Our goal is to develop graduate students that appreciate the need for collaboration in order to solve the world’s most complex and pressing problems. By design, LAAS is highly multidisciplinary and we continue to develop a global perspective within the program through unique course offerings, research opportunities in other countries, and through visiting graduate students and scholars from other countries. We assess our progress toward meeting these goals on an annual basis using the following expected outcomes:

• Demonstrated ability to address complex science problems through multidisciplinary approaches and through collaborative initiatives

• Demonstrated awareness of environmental problems that cross political and geographic boundaries (i.e. greenhouse gas emissions and radiative forcing, agricultural production and water quality, long distance transport of air pollutants, etc)

The LAAS core course (LAAS 5050), required by all incoming MS and PhD students, strives to provide a multidisciplinary and global perspective to environmental problems at the land-air-
water interface. Student performance in LAAS 5050 is used to help assess if the program is meeting these desired learning objectives. In addition, the required departmental seminar course (LAAS 8128) exposes our graduate students to a diverse set of special topics that are typically multidisciplinary and range in scope from local to global scales.

3. Effective Communications and Leadership Skills
We strive to develop graduate students who will have excellent communication and leadership skills. It is recognized from our job placement statistics and employer feedback that one of the most important skills of our graduates is to effectively communicate their ideas and discoveries. This is critical for raising funds in academic, government, and private research endeavors. Development of leadership skills is essential for conducting large scale research endeavors, working in multidisciplinary and collaborative teams, and working as extension scientists in local communities. We assess our progress toward meeting these goals on an annual basis using the following expected outcomes:

- Ability to effectively communicate new ideas and scientific knowledge using different media (oral, written, social media, etc)
- Demonstrated commitment to serve the profession and society at large
- Demonstrated proficiency in pedagogy at the PhD level
- Evidence of leadership in the classroom, program, and scientific discipline

Required course work in communication and presentation skills (LAAS 8128) and proposal writing (LAAS 5051) are used to help assess these learning outcomes. The successful completion of a PhD dissertation or MS thesis, and their oral public defense, are also used to assess communication skills. Further, it is an expectation that our graduate students publish their research in peer-reviewed journals. Publications are tracked and quantified using our annual review assessment. A required course in pedagogy (GRAD 8101) is used to assess and develop teaching skills for our PhD students. Finally, course group work; LAAS program committee participation; and presenting or volunteering at relevant society conferences (i.e. American Geophysical Union, Soil Science Society of America, American Meteorological Society, etc), as well as public outreach opportunities, are used to help assess progress of our students toward leadership roles.

**Improving the LAAS Program**
Results from the assessment of student learning outcomes are evaluated annually and reviewed by the LAAS Graduate Studies Committee and are presented to the FCC and Faculty. Based on the feedback from these reviews, appropriate adjustments are made to the LAAS program.