

Atmospheric Science Department Plan

1. Departmental Mission, Goals, and Vision

The Department of Atmospheric Science (ATSC) is a premier research entity at the University of Wyoming. It has distinguished itself within the international community with strong research programs in cloud and aerosol physics, boundary layer meteorology, and instrumentation for state of the art observational systems. The research aircraft (a NSF-funded national facility), stratospheric ballooning, the 95-GHz cloud radar (also an NSF-funded national facility), and the Keck atmospheric aerosol research laboratory are all very strong contributions to the international atmospheric science arena, and have continued to be productive and well-funded over long periods of time. To support this large observational effort, ATSC has put together a strong research support staff of 20 individuals that provides outstanding engineering and technical capabilities that are normally only found in large national laboratories. It is the departmental goal to maintain these programs, and continue to nurture additions and improvements as the scientific needs dictate.

A significant consequence of this strong research component is the ATSC MS and PhD degree programs with a population of about 15 students on average over the past five years. While there is no undergraduate program in ATSC, the faculty is active in teaching at the undergraduate level with significant contributions to the Engineering Science program and to the University Studies program with our long-standing ATSC 2000 introductory meteorology course. Notwithstanding these intellectual contributions, the faculty aspires to participate in an undergraduate program in Earth System Science which will be an exciting and productive effort with positive impact on UW and the nation.

In the discussion below, references to the UW 1999 academic plan will be UW99, and to the ATSC plans ATSC99 and ATSC04 for 1999 and 2004, respectively.

2. Undergraduate programs

a. Progress made on 1999 action items

ATSC99 Action Item: ATSC does not have an undergraduate program in Engineering, and can at best provide a service to the Engineering Science curriculum. We wish to be part of the transitioning of the field of atmospheric science and education at the undergraduate level by developing in atmospheric sciences with the cooperation of faculty in other departments (for example, Civil Engineering, Geology, Botany) and feel that we can play a more important role at the undergraduate level than we do now.

ATSC99 [UW99 Action Item 106]: The department should coordinate exploration of an Earth System Science program with the Vice President for Academic Affairs, the Vice President for Research, and all interested parties, including the Department of Geology and Geophysics (as they begin implementation of a new B.A. degree in Geology and Earth Sciences) Botany, Zoology, Physics, Renewable Resources, Environmental Engineering, and Education (secondary, math and science teaching center).

ATSC99 Action Item: The department will investigate the desirability and feasibility of an undergraduate program in ATSC. This will be done in consideration that the UW initiative in earth system science (ESS) has priority at this point.

ATSC99 Action Item: The department should continue its involvement and participation in the ENR program.

The idea for an undergraduate earth system science (UESS) started during the last academic planning exercise, and resulted in UW99 action item #106. A committee convened by Academic Affairs (J. Steidtmann, Chair) met in Spring 2001 to examine ESS in general. Although both graduate/research and undergraduate possibilities were discussed, the committee chose to recommend a research-centered program. They did not, however, recommend against an undergraduate program. ATSC thinks that a graduate-only ESS program will have minimal impact, and prefers the establishment of an undergraduate ESS program at UW.

Since then, under the leadership of ATSC Prof. Bob Kelly, the idea for a UESS has evolved further through informal discussion with faculty from 14 departments across campus, through discussion within ATSC, and most recently in conversation with Vice Presidents Buchanan and Abernethy in Academic Affairs. The proposal has now (Spring 03) reached the point of discussion within individual units, and the establishing in March of an oversight committee to begin a formal proposal for an UESS at UW, and to make sure that UESS is written into the academic plans of the participating departments and colleges.

Consideration of other undergraduate options, such as the establishment of undergraduate degree in atmospheric science, has been postponed pending the resolution of the UESS proposal since UESS is considered to be a more valuable asset to UW and the nation than a purely atmospheric science major.

On another front, ATSC has established an undergraduate major as a "Physics Plus" option in the Department of Physics. The first students in that program are expected to begin the upper division ATSC courses in Fall 03.

b. Areas of Distinction for undergraduate education

Undergraduate education in research universities requires renewed emphasis on a point strongly made by John Dewey almost a century ago: learning is based on discovery guided by mentoring rather than on the transmission of information. It is our intention to capitalize on our research strengths to make UESS one of the strongest and most popular degrees at the University.

We believe that the area in which the atmospheric sciences and ATSC will grow most in the coming decades is in the integration of remotely sensed and in situ data into coupled global circulation models (GCMs), in order to better understand, on a global scale, the interactions between the atmosphere (mainly the hydrologic cycle) and the living surface (the oceans and the land ecosystems). To further our understanding of climate dynamics, we need to better grasp water vapor, clouds, and precipitation, because their feedbacks are the main uncertainty in today's climate predictions. This is not just about modeling. Only through observations can models be improved further. Recent large NSF lower atmosphere observing initiatives are framed into this global perspective, and so is the array of NASA's new EOS satellites.

Clearly the atmospheric science community will be moving closer to earth system science, with its global, integrative, and inter-sphere perspectives. We see the UESS opportunity also as one

whereby our department evolves from mainly collecting in situ and remote atmospheric data, towards also using them to interpret and improve GCMs. This motivates our significant participation in the new UESS program at UW.

c. Goals for 2004-2009

i. Curriculum

A draft proposal for a UESS program at UW is available on the web (<http://www.atmos.uwyo.edu/~rkelly/ess.html>). The UESS program addresses priorities stated in Moving Forward III: 1) maintaining and enhancing distinction in the area of environment and natural resources to which UW has built a distinct competitive advantage; 2) building stronger interdisciplinarity to increase the breadth and attain critical mass in the areas of distinction; and 3) to foster the diversity, internationalization, and access which a strong interdisciplinary program will engender.

Briefly, curriculum as envisioned consists of (in addition to the University Studies Program electives) 18 hrs of earth-as-system courses, 47 hrs of foundation (physics, chemistry, math, geology, biology, atmospheric science, oceanography, anthropology/sociology/history), 25 hrs in the focus discipline, an internship at the upper division level, and 14-20 hrs electives. ATSC role in the UESS program will involve about 28 semester hours per year of classroom effort. In this, 3-6 hours are existing courses leaving about 22 hours of new course development. The additional workload will require our withdrawal from the College ES teaching, consistent with our goal statement in the 1999 ATSC academic plan, and adding one new faculty hire.

Several other departments have incorporated the UESS concept into their plans. Specifically

- **Geology and Geophysics** has implemented an ESS degree option in its department. This is in response to the UW99 Action item 75: "[Geology and Geophysics should] initiate a new degree program: B.A. in Geology and Earth Sciences. The Department should coordinate this degree development, over the long-term, with faculty interested in Earth System Science." GEOL currently has seven majors enrolled in its new program; three have already graduated. In its 2004-2009 plan, GEOL states: "As part of this emphasis we fully endorse the proposed development of the University's ESS Program. While cross college programs involve logistical issues, we support the program in concept and will work towards its integration with our existing programs. To build towards this focus we propose adding three positions to the Department of Geology and Geophysics over the next 5 years. We view these positions as ones that would integrate with various programs on campus including the School for Environment and Natural Resources, botany, chemistry, physics and astronomy, atmospheric sciences, geography, and WyGISC."
- The **Department of Zoology and Physiology** in its 2004-2009 plan states its goal to "Interface with undergraduate Earth System Science Program conditional upon an acceptable curriculum and costs."
- The **Department of Botany** indicate "faculty members will play important roles in the new Undergraduate Earth System Science (UESS) program, offering courses and undergrad research experience in biosphere-atmosphere flux studies, earth system history, global ecology, stable isotopes and biogeochemistry".
- The **Department of Anthropology** in their plan states: "We have a contribution to make in these two programs [ENR and UESS], which should be developed in the next five years. Several faculty members have been involved in some of the discussions of the earth system sciences group under the leadership of Robert Kelly, Atmospheric Sciences. Sarah

Strauss studies cultural ideas about water resources in Switzerland and is on the committee to develop the formal proposal for the new program. Bob Kelly studies foraging societies of the past and present. Mary Lou Larson's use of GIS is applicable to a number of ESS fields. In addition, we have recently hired Todd Surovell, a geoarchaeologist whose work, based in a lab in the geology building, will foster collaboration with other ESS researchers. We will follow the ESS development closely (see 04-09 Action Item Anth 3)."

- The **Department of Geography and Recreation** states as a goal: "The Department of Geography will contribute to the development of an undergraduate program in Earth Systems Sciences by: having a faculty member serve on the advisory committee for the proposed UESS major; offer as soon as the program is implemented at least one existing course (Geography 1010: Introduction to Physical Geography) as part of a new UESS core curriculum; develop by 2004 at least one new course (Geography 3XXX: Human Modifications of Environmental Systems) as part of the UESS core curriculum; request in the CPM process of spring 2003 one faculty position in climatology to work directly with the undergraduate earth systems science program."

As discussed in ATSC99, ATSC has participated fully in undergraduate teaching in the College (specifically, Engineering Science). While there is a good match between our expertise and the goals of the Engineering Science program, it is felt that we can better direct our efforts. ATSC does not have an undergraduate program in Engineering, and can at best provide a service to the Engineering Science curriculum. This is an important effort, but falls short of meeting faculty goals for development and growth. We see enrollments increasing in earth science programs on the national scene, and wish to be part of this transitioning of the field of atmospheric science. By developing courses in atmospheric sciences with the cooperation of faculty in other departments (specifically the UESS initiative), we feel that we can provide play a more important and professionally stimulating role at the undergraduate level than we do now.

ii. Assessment

Assessment will become a departmental issue once the UESS program is established at UW. The steering committee that has been appointed by VPAA is currently developing the UESS program plan which will the assessment issues of the new undergraduate major.

d. Action items for 2004-2009

ATSC fully endorses the proposed development of the UESS program, supporting the program in concept, and will work towards its integration with our existing programs. ATSC will work with the Dean to add a faculty position to teach in the ESS Earth-as-System core curriculum and to specialize in the collection of in situ and remotely sensed atmospheric data and the integration of these observations into global atmospheric circulation and climate models, coupled to geological, biological, and hydrological processes. This direction is being recognized by the scientific community as being an essential next step towards solving the climate change puzzle. This direction also will bring atmospheric science at UW, as a research area and an academic discipline, closer to ESS. The position in the area of climate dynamics, called for here in the context of the ESS initiative, would therefore be integral to the objectives of both UESS and ATSC.

It should be noted here, as in the draft UESS proposal, that while the proposal has originated in ATSC, we are not proposing that the program necessarily be housed within ATSC. Instead, ATSC would be one of many academic units participating in the program, and the decision about where and how to base the program will be part of the ongoing discussion, proposal preparation,

and academic planning process. ATSC encourages UW to provide sufficient resources to make UESS at UW a success.

We thus establish the following action items:

ATSC04 Action Item: ATSC will work through the Colleges to develop the plan to implement the UESS degree program and the allocation campus-wide of 3-5 faculty positions to support the UESS start-up during the period 2004-2009.

ATSC04 Action Item: ATSC will work with the Engineering Dean to withdraw from participation in the Engineering Science program as we develop undergraduate courses and programs that are more important to our discipline and more challenging and stimulating to us professionally.

3. Research and graduate programs

a. Progress made on 1999 action items

ATSC99 Action Item: The department is in the process of curriculum revision having formed sub- committees. The goal is to have the revisions in place by Fall 2001.

Our last graduate curriculum revision took place in 1985. We planned to review and revise our curriculum to address changes of emphasis in the field. Current emphasis is on the multi-faceted problem of global change in which all atmospheric processes play a role. Our curriculum presently does not specifically focus on global changes issues. This revision does not change our fundamental goal: to be a center of excellence in the discipline with emphasis place on probing of the atmosphere with state-of-the-art instruments.

Action on graduate curriculum development was halted pending the disposition of the UESS program development, so this item remains uncompleted.

ATSC99 Action Item: The department will move to active graduate recruitment by means of visits to colleges and improving our web page. These are underway.

ATSC has made visits to colleges with atmospheric science departments but no graduate program. It also has had tables at professional career fairs in the past two years. Other actions included offering financial support to applicants for visits to Laramie, offering a \$2,000 "startup bonus" for the first semester, and increasing stipend levels by \$5,000. It is still not clear that any of these actions had any beneficial effect.

b. Areas of Distinction

ATSC has distinguished itself within the international community with strong research programs in cloud and aerosol physics, boundary layer meteorology, and instrumentation for state of the art observational systems. One measure of this success has been a consistently high level of extramural funding, all competitively peer reviewed, which totaled \$20M over the last 8 years (~\$400K/year for each FTE faculty position), generating \$3.5M in indirect cost returns to the university during this period. Our research program is thoroughly internationalized with our

faculty collaborating with scientists world-wide.

ATSC does not envision a substantial shift of research emphasis during the next five years. Nonetheless, the normal process of adjusting focus to meet national priorities and funding necessities will no doubt continuously take place. One example is our involvement in the UESS initiative which includes request for a new faculty hire in the area of climate dynamics as discussed above.

c. Goals for Graduate Programs for 2004-2009

i. Curriculum

With the draft of the UESS proposal in place, we will proceed now with the revision of the graduate curriculum revision as envisioned in the ATSC99 plan. The objective of this revision is to update our course materials to be relevant to the science as it has developed into the 21st century (global change, etc.) so that it better addresses the needs of our students both academically and in the workplace, and state and national needs generally. This revision will consider collaborations with other departments on campus as well (for example, in the areas of computational fluid dynamics and instrumentation).

We have struggle with the difficulty of increasing the number of PhD students in our program. We have a rigorous program with international recognition, but recruiting students to Laramie has been a problem for us (and for other departments here and elsewhere). We are taking steps which we hope will help (raising stipend levels from external funds, attending career fairs), but feel that we ultimately will benefit as the research stature of the University improves.

ii. Assessment

There have been about 130 advanced degrees awarded by ATSC since its inception in the early 1970's, but we feel that this group includes a substantial number of influential and productive practitioners in our field. While past assessments of the ATSC graduate program have been intermittent and informal, a program for assessment will be formally implemented during this period. Ideas presently being developed for this include: a) compilation of publications resulting from thesis and dissertations; and b) surveys of alumni after three and again at six years following graduation to determine position status and degree of satisfaction with the ATSC program.

d. Action items for graduate programs

ATSC04 Action Item: ATSC will revise its graduate program curriculum, and have this in place for Fall 2004.

ATSC04 Action Item: ATSC will seek to increase the number of students in its graduate degree program with emphasis on PhD production.

ATSC04 Action Item: ATSC will implement a routine assessment of the results of its MS and PhD program including surveys of recent graduates as discussed above.

e. Goals for Research

It is felt that ATSC productivity is limited primarily because of shortage in scientific staff and PhD students. We see opportunities in the following areas that could be beneficially impacted specifically by addition of AP staff:

- **Aerosol science:** With the acquisition of the aerosol mass spectrometer (AMS) under W. M. Keck Foundation funding, ATSC will be positioned among the few university groups to have the capability of defining aerosol composition along with size and concentration. This additional capability is essential for characterization of aerosol optical properties and chemistry. We think that hiring a post-doctoral researcher would be very productive during this period.
- **Cloud physics:** ATSC has one of the few observational cloud physics programs currently in the US, and has been active in this area since its inception in 1971. Retaining this focus is considered essential. The addition of the 95-GHz radar to the NSF-funded national facility pool will open opportunities for science internationally as well as providing ATSC faculty with a unique observational tool.
- **Stratospheric ballooning:** The redesign and rebuilding of the balloon package including particle sensing and the data acquisition package is considered under NSF/MRI funding will provide significant improvements in this program at UW which dates back to the 1970's.

i. Assessment

Virtually all of the research conducted in ATSC is externally funded and peer reviewed, and we feel that this review-funding process is a primary indicator of our program quality. Also, lists refereed publications are maintained as an indicator of productivity. However, we feel that periodic departmental review (such as the ATSC review conducted with outside visitors in the early 1980's) is beneficial in gauging the relevance of our program so that course corrections can be made. We feel that such a review should be conducted in the next period.

f. Action items for research

ATSC04 Action Item: ATSC will seek to recruit scientific staff to the goal of increasing research productivity. Recruitment will be in the areas indicated in the above discussion, and will include both research scientists and post-doctoral researchers. Funding will come from external grants and departmental resources.

4. Other Goals

a. Other Goals and Action Items

ATSC has maintained a safe and accident free environment since its inception. A safety program targeting the Flight Center has been initiated, and will be developed fully in the next few years.