

## Department of Meteorology Strategic Plan 2014-2019

### **Mission Statement:**

The Department of Meteorology expands the reaches of the atmospheric sciences, prepares students for emerging careers, and advances the well being of the University and society.

### **Values:**

- Scientific integrity
- Dedication to teaching, research, and service
- Innovation in academics and research
- Collaboration and collegiality in all that we do

### **Vision:**

To have world-renowned excellence in meteorology, atmospheric science and climate science research and teaching, attracting the best and brightest students.

### **Introduction:**

The past five years have clearly shown how expanding populations, increasing urbanization and globalization, and a changing climate combine to create an increased societal and economic vulnerability to weather, particularly for weather extremes. Droughts, floods, tropical cyclones, winter storms, tornadoes, and other forms of hazardous weather remind us of our vulnerability to these weather extremes on a monthly, and sometimes daily, basis. Air quality remains a significant health concern for millions of people across the globe, causing pain and suffering, increasing health care costs and negatively influencing economic growth. Climate change is upon us, yet we are unable to determine confidently how these changes will affect regional weather and weather extremes. The effective communication of weather and climate information in the context of scientific uncertainty remains a challenge.

Simultaneously, explosive growth of observational and computational technologies and the data they generate gives new opportunities to improve prediction of the Earth system and our understanding of its predictability. Advances in traditional and non-traditional observational capabilities, data assimilation, numerical weather prediction and ensemble forecasting have led to steady improvements in weather forecast skill over the past decades and approaches to providing forecast confidence information are being used and refined. These improvements have changed how people and institutions respond to weather forecasts, with the transportation, energy, agriculture

and public sectors taking proactive measures when provided with high forecast confidence: airports, schools, towns, and industries routinely shut down or close early due to winter storms, hazardous weather and hurricane forecasts; energy producers use weather forecasts to predict power load; and agriculture uses daily and seasonal forecasts to help make decisions regarding planting, irrigation and pesticide application, with positive influences on sustainability.

The potential for atmospheric and decision sciences to intersect and provide enhanced value to society is only limited by our imagination and the number of trained personnel who have a solid understanding of the Earth system and an ability to solve problems. The Department of Meteorology - where weather and climate meet - is well placed to advance our capabilities not only in atmospheric sciences but also in the interdisciplinary zone where weather and climate information is applied to solve problems in the private and public sectors.

In the context of society's increased vulnerability to weather, a changing climate, and new opportunities to advance knowledge, educate students and solve problems, six initiatives are defined: prepare students for the careers of the future; empower faculty and students to solve weather and climate risk problems; advance data assimilation and uncertainty quantification; strengthen Penn State climate science; enhance faculty and student diversity; and build the Penn State meteorology brand.

## **Initiative 1: Prepare students for the careers of the future**

The Department of Meteorology has a talented faculty with broad expertise that covers meteorology, atmospheric chemistry, oceanography and climate. It provides undergraduate and graduate students with expertise in weather and climate processes and the use of weather and climate data to solve problems. The success of our undergraduates in finding suitable employment and entering graduate school highlights the strength of the overall program. However, in order to remain one of the best teaching and research programs we can never be complacent. We need to ensure that we provide our graduates with the tools needed to solve problems, opportunities to hone their skills outside the classroom through real-world problem-solving experiences, and programs that help students learn to communicate effectively to a wide variety of audiences.

*Goal: To have the best meteorology, atmospheric science and climate science program in the world, attracting a large number of highly qualified students.*

The Department seeks to better connect and utilize our existing talents and resources to further this goal. We want to leverage our strength in e-Education for recruitment by open sourcing a small portion of our online material; use some e-education materials as course aides; increase our international student population; increase student and faculty diversity; enhance student professional development; integrate discussions of integrity, ethics and sustainability into our courses; upgrade teaching laboratories and associated instrumentation to research-grade quality, including instrumentation for field use by students; and continue to strengthen communication, statistical analysis and computer programming skills in all of our course offerings. At the graduate level, we will adjust the academic core to meet the needs of students with broader interests, elevate the importance of research tools in addition to core knowledge, and vigorously aid students in applying for graduate fellowships.

We will engage our alumni as student mentors to enrich the student experience, develop entrepreneurship and help us to better understand the skill needs of all sectors in the atmospheric and climatic science communities. We also will continue our efforts to track our graduates throughout their careers and engage them more effectively as alumni.

Expansion of our e-Education offerings is also important to our long-term success, especially materials related to weather and climate risk and the development of a professional master's degree in weather and climate risk.

*Needs:* Upgrade computer and teaching laboratories to have research-quality instrumentation and computer systems, including instrumentation for field use (\$380K), and faculty time to contribute to upgrading and updating curricula as well as e-Education course development (\$60K/year). Completion of the weather risk

professional master's degree coursework will require expertise in finance to be provided by someone outside the Department.

*Performance indicators:* Percentage increase in undergraduate and graduate students enrolled; quality of student applicants; number of international students enrolled; percentage of under-represented students and faculty members; percentage of graduates with jobs in the field within a year of graduation; and continued assessment of student learning outcomes via surveys and other means.

## **Initiative 2: Empower Faculty and Students to Solve Weather and Climate Risk Problems**

Weather and climate risk are defined broadly and range from personal decisions such as whether to leave work early to avoid an impending storm, yet not be stranded on the roads, to company or government decisions on locating long-term infrastructure to improve air quality, and to societal responses to long-term challenges such as climate change. Solutions to weather and climate risk apply to all decisions for which weather and climate information would help to solve a problem or assess an opportunity. Any discussion of risk must include the issues of integrity and ethics, as risk management is based upon a respect for others. Risk analysis also can be used to help inform decisions related to sustainability.

*Goal: To become internationally recognized as the pre-eminent academic institution for Weather and Climate Risk, Decision, and Asset Allocation (health, alternative and conventional energy, commodities, finance, etc.)*

With the Center for Solutions to Weather and Climate Risk (CSWCR) as part of the Department, we are well placed to be the international leader at the intersection between weather and climate information and decision support. Our undergraduate students in the weather risk option have been highly successful after graduation, highlighting the need for this type of professional training in preparation for the careers of the future. The success of the CSWCR is an important component of the Department plan and its links with education and e-Education at the undergraduate and graduate level.

We are fostering large research proposals to help advance the CSWCR and strengthen linkages with faculty in the Department, College, ESSC, ESSI, Sustainable Climate Risk Management (SCRiM), Industrial Engineering / Operations Research, Smeal Business, Agriculture and PSIEE. We are also pursuing relationships with the public and private sectors, as well as other academic institutions. We will collaborate with the Global Water Center and strengthen collaborations with hydrologists to foster interdisciplinary research projects.

This goal also requires a Department outreach and education effort to communicate to students, industry, government, non-governmental organizations and the public the way in which weather and climate information can inform decisions and promote sustainability. We will leverage the expertise of the Penn State Meteorology Weather Communications Group to assist in our outreach effort. We will develop a certificate followed by a professional master's degree in weather risk with the Dutton e-Education Institute.

*Needs:* Faculty time to contribute to upgrading and updating curricula and e-Education course development on weather and climate risk (\$60K), including needed expertise in finance, policy and ethics. Research associate to assist in developing proposals for

decision support and asset allocation studies, results from which will then be used to further solicit external funding for the center (\$100K/year for 3 years).

*Performance indicators:* Research grants funded through CSWCR and in the field of weather and climate risk; number of supporting partners; number of faculty members involved with the Center; completion of on-line certificate program in weather and climate risk; and completion of on-line professional master's degree in weather and climate risk.

### **Initiative 3: Advance data assimilation and uncertainty quantification**

Improvements to how we assimilate observations into numerical weather prediction models account for roughly a third of the improvements in weather forecast skill over the past decade. The use of ensembles for weather forecasting allows us to quantify the confidence of the resulting forecasts and has direct ties to the assessment of risk. It is not surprising that data assimilation and ensemble prediction are being used in a wide range of applications (e.g., global weather prediction, tropical cyclone prediction, thunderstorm prediction and analysis, carbon budgets) and that several Department faculty members are leaders in data assimilation technique development.

*Goal: To make Penn State the leading national center for data assimilation and uncertainty quantification (ensemble forecasting and predictability), partnering with operational centers to support public needs and advance sustainability.*

A data assimilation center would further enhance the Department's activities and prepare us for anticipated future growth in this discipline from within the College and from mathematics, statistics, and engineering. The center will build and enhance Penn State's leadership in data analysis, assimilation, integration, and uncertainty quantification for both observations and model ensemble output. The center will help the Department build synergies with the Global Water Center, Institute for Cyberscience, the Center for Solutions to Weather and Climate Risk, and other institutes. The center will also provide numerous opportunities for student learning, particularly at the graduate level, with applications to solve real-world problems.

We will include data assimilation and predictability content in course offerings; engage national laboratories and operational weather prediction centers as partners; add faculty partners across disciplines at Penn State; and submit a proposal to become a National Science Foundation Science and Technology Center (STC) at the next available opportunity.

*Needs:* Research associate for development work, part-time assistant to support center, and general support of center activities (\$150K/year for 5 years).

*Performance indicators:* Number of national laboratories and operational weather prediction centers as partners; number of disciplines represented by faculty partners; number of students funded by center grants; and STC proposal submission.

#### **Initiative 4: Strengthen Penn State climate science**

Climate Science at Penn State University is a broad enterprise spanning multiple departments within EMS and multiple institutes and colleges across the University. Recognizing this landscape and that climate science has evolved beyond studying physical components of the climate system and their predictability, the Department will lead College and University discussions on ways to build and strengthen climate science across Penn State. With the importance of climate change to society, we cannot afford to let this situation languish.

*Goal: To strengthen Penn State climate science, adding value to the College and University, and attract qualified students who would not otherwise apply to Penn State.*

Achieving this goal is aligned with our teaching and research missions, and will ensure that the College and University remain a hotbed of Climate Science research and education. An initial meeting of all faculty involved in climate science occurred several years ago, with the goal to strengthen climate science via improved collaboration. We will lead the rekindling of these discussions with increased emphasis on growing interdisciplinary Penn State climate science research. Our goal will be to establish an internationally recognized initiative at Penn State on climate science and impacts that connects Departments, Institutes, and Centers. Some initial resources for these activities are available through PSIEE.

In tandem with our broader University-wide leadership on Climate Science, we will explore all available options to increase recognition of climate science within the Department's contributions to graduate education (interdisciplinary graduate degree program, climate science as a degree option, dual-title degree programs, a name change for the current graduate Meteorology degree program). The initial step is to commission a task force of key Department faculty and staff, including at least one member from outside the Department, to conduct due diligence into the pros and cons of each option and provide recommendations. These recommendations will be brought to the faculty and used to guide discussions with other departments and the College on strengthening Climate Science at Penn State. The resulting changes will attract a new pool of graduate students to the existing Meteorology department cohort.

*Needs:* Continued college support for University-wide discussions and workshops on strengthening Penn State climate science and education in climate science (\$50K); Department faculty to incorporate climate science into discussions of ethics and integrity in science, sustainability, and the communication of weather and climate information.

*Performance indicators:* Number of students applying with interest in climate sciences; number of interdepartmental research grants funded and students supported by these grants; and success of climate science graduate students in their careers.

### **Initiative 5: Enhance faculty and student diversity**

A key to achieving our goals of attracting a talented cohort of undergraduates and graduate students is to have an inclusive environment and a diverse faculty. One important element in creating this environment is to have the composition of the faculty look like the desired composition of the students. Right now, 30-40% of our students are women and 5-10% are from under-represented groups. Both of these percentages are increasing with time. However, the number of female faculty members has declined to 15% and the number from under-represented groups has not increased. This mismatch is quite evident.

*Goal: To have the faculty and student body of the 21<sup>st</sup> Century*

We will aggressively recruit from the pool of qualified women and minority candidates; act to recruit the family in addition to the person; be aware and advertise family friendly policies; and emphasize the need for greater diversity at every opportunity. We will engage in opportunistic faculty hires whenever qualified faculty candidates are identified. When a new hire arrives, we will work with them to identify their specific needs and to facilitate mentoring and support within and outside the department. Faculty members will augment recruitment strategies to attract minority students. Qualified minority students will be nominated for national fellowships (e.g., National Science Foundation, NASA, etc.).

*Needs:* Increased funds for scholarships (\$300K/year), funds for faculty to recruit a diverse student body (\$20K/year), and continued college support.

*Performance indicators:* Increase in the representation of under-represented groups within the student population, faculty and Department colloquium speakers and visitors.

## **Initiative 6: Build the Penn State Meteorology brand**

The Department of Meteorology is internationally known for its meteorology program, but it is much less well known for its programs in atmospheric physics, atmospheric chemistry and climate science. Yet atmospheric physics, atmospheric chemistry and climate science have been a central part of the Department for over a decade. The science is clear that weather, atmospheric physics, atmospheric chemistry and climate are all interrelated. Thus, we must find a way to build our brand to emphasize the broad expertise that the Department faculty members bring to the University and to student learning.

*Goal: To ensure that employers, prospective students, parents, and professional colleagues have an accurate perception of the breadth of our program, the value of a Penn State Meteorology degree, and the skillsets that Penn State Meteorology graduates possess.*

We will open a discussion with the Smeal College to discuss how the Department brand is recognized and may conduct a brand equity analysis. We will routinely engage our alumni in Department news and highlight the breadth of faculty expertise and student learning. We will elevate atmospheric physics, atmospheric chemistry and climate science activities in our discussions with peers at workshops, meetings, conferences and seminars, and on our webpage. We will make effective use of social media to distribute our message by leveraging our efforts with other social media initiatives across the College and University. We will invite our alumni to act as goodwill ambassadors for the program.

*Needs:* Funds to support a brand equity analysis and to implement recommendations.

*Performance indicators:* Number of times we share Department news with alumni; evaluation of branding approach by the Department's external advisory board; evaluation of alumni involvement in student mentoring; and alumni contributions to the Department for specific activities (e.g., laboratory upgrades, student scholarships, etc) and change in the number of student applications in response to these branding activities.