TO: Dev Venugopalan  
Associate Vice Chancellor, Academic Affairs  

FROM: Rodney A. Swain  
Dean, Letters and Science  

DATE: April 13, 2017  

RE: Recommendation of the Department of Mathematical Sciences, the L&S Academic Policies and Curriculum Committee, and the Faculty of the College of Letters and Science to Approve the Authorization to Implement an MS in Atmospheric Sciences  

We have received a recommendation from the above-named groups to approve the Authorization to Implement an MS in Atmospheric Sciences.  

Enclosed please find a copy of the proposal approved as Fac. Doc. No. 1003. This proposal also may be viewed at the L&S faculty document website: http://uwm.edu/letters-science/for-faculty-staff/committees. I endorse this recommendation and am forwarding the proposal to you for further action.  

If you have any questions concerning this matter, please feel free to contact Professor Swanson of the Department of Mathematical Sciences, Interim Associate Dean Kristene Surerus, Assistant Dean Michael Darnell, or me. I look forward to action on this recommendation as soon as possible.

RS/md  
Enclosure  
cc: Vice Chancellor and Provost Johannes Britz  
Interim Associate Dean Kristine Surerus  
Professor Kyle Swanson  
Assistant Dean Michael Darnell, L&S  
Program Assistant Cheryl Andres
Recommendation of the Faculty of the Department of Mathematical Sciences and the L&S Academic Policies and Curriculum Committee to Request Authorization to Implement a MS degree in Atmospheric Sciences

Recommendation:
That the L&S Faculty recommend to the Dean approval of a Request for Authorization to Implement a MS degree in Atmospheric Sciences

Rationale:
The proposed degree, for which no new resources are requested, will replace the existing Atmospheric Science option to the M.S. in Mathematics offered by the UWM Department of Mathematics Sciences. Despite a strong track record of student success, the M.S. offering suffers from poor visibility due to being classified as a concentration rather than degree. This is an atypical arrangement for a graduate-level atmospheric science program, making it difficult for us to recruit the best-possible prospective graduate students and limiting our local, regional, and national exposure.

REQUEST FOR AUTHORIZATION TO IMPLEMENT A MASTER OF SCIENCE DEGREE IN ATMOSPHERIC SCIENCE AT UW-MILWAUKEE PREPARED BY UW-MILWAUKEE

ABSTRACT

The University of Wisconsin-Milwaukee proposes to establish a Master of Science (M.S.) in Atmospheric Science. The proposed program, to replace the existing Atmospheric Science option to the M.S. in Mathematics, will align degree requirements with employer expectations and increase the visibility of existing offerings to prospective students and funding agencies.

PROGRAM IDENTIFICATION

Institution Name
University of Wisconsin-Milwaukee
Title of Proposed Program
Atmospheric Science

Degree/Major Designations
Master of Science

Mode of Delivery
Single institution, face-to-face

Projected Enrollments by Year Five
By the end of year five, it is expected that 29 new students will have enrolled in the program, between five and six per year, and 30 students will have graduated from the program, between five and seven per year. Only full-time students are anticipated. In the last ten years, there has been <5% attrition of students seeking the Atmospheric Science option to the M.S. in Mathematics at UWM; thus, no attrition is factored into the projected enrollments.

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<tr>
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<td>5</td>
<td>6</td>
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Tuition Structure
For students enrolled in the M.S. in Atmospheric Science program, standard tuition and fee rates apply. For the 2016-17 academic year, residential tuition and segregated fees total $5,894.26 per semester for a full-time student enrolled in eight credits per term. Non-resident tuition and segregated fees total $12,412.74 per semester for a full-time student enrolled in eight or more credits per term. Of these amounts, $700.90 is attributable to segregated fees. Students supported as Research or Teaching Assistants receive a full tuition waiver and are thus responsible only for payment of segregated fees.

Department or Functional Equivalent
The proposed program will reside within the Department of Mathematical Sciences.

College, School, or Functional Equivalent
The proposed program will be housed within the College of Letters and Science.

Proposed Date of Implementation
August, 2017

INTRODUCTION

Rationale and Relation to Mission
UWM’s Select Mission Statement emphasizes the development and maintenance of high-quality undergraduate, graduate, and continuing education programs appropriate to a major urban doctoral university; engagement in a sustained research effort that will enhance and fulfill the University's
role as a doctoral institution of academic and professional excellence; the attraction of highly-qualified students who demonstrate the potential for intellectual development, innovation, and leadership for their communities; and service to and collaboration with the state of Wisconsin, its metropolitan areas, and the University of Wisconsin System.

UWM’s Strategic Plan emphasizes the graduation of highly-skilled individuals at all levels and the generation of societally-relevant scholarship that is recognized within the global research community. Particular strategic initiatives include the development of a top-tier research environment that promotes growing research impact, including focused research clusters such as the atmospheric and related sciences; and the development and delivery of relevant, engaging, innovative, and distinctive academic programs.

The UWM Atmospheric Science Program is a group of scholars, including six full-time faculty members, who engage in a wide array of distinguished, societally-relevant research currently supported by over $3 million in external funding. Faculty are world-renowned researchers in their areas of expertise. Over its twenty-plus years of existence, the program has a history of innovation in both education and research, with the Innovative Weather program and first-of-its-kind “Air Pollution and Ancient Cultures” faculty-led study abroad course being two representative examples of innovative educational opportunities. Students graduating from the program, particularly with graduate degrees, have a long history of acquiring gainful employment with top-tier public and private sector institutions in Wisconsin and beyond.

The proposed degree, for which no new resources are requested, will replace the existing Atmospheric Science option to the M.S. in Mathematics offered by the UWM Department of Mathematics Sciences. Despite a strong track record of student success, the M.S. offering suffers from poor visibility due to being classified as a concentration rather than degree. This is an atypical arrangement for a graduate-level atmospheric science program, making it difficult for us to recruit the best-possible prospective graduate students and limiting our local, regional, and national exposure. In turn, this imposes a limit upon the quality of research we can conduct with our students, therein hindering our ability to attract the most possible external funding. Thus, the M.S. in Atmospheric Science is proposed so as to better enable our program to advance UWM’s institutional mission, particularly those elements relating to student recruitment, research excellence, and educational leadership, and contribute to maintaining UWM’s R1 classification. Further, minor programmatic changes proposed herein will better align academic requirements with those expected by prospective employers.

Need as Suggested by Current Student Demand

Entering the 2016-17 academic year, there are eleven degree-seeking students enrolled in the Atmospheric Science option to the M.S. in Mathematics at UWM. There were nine degree-seeking students enrolled in each of the 2014-15 and 2015-16 academic years. Between six and eight degree-seeking students were enrolled in academic years dating back to 2006-07. These enrollment trends are consistent with the increasing need for advanced degrees to acquire gainful employment within the field and enrollment demands in other graduate Atmospheric Science programs in recent years, evidence for which is documented below.

Need as Suggested by Market Demand

According to the 2014-15 United States Bureau of Labor Statistics Occupational Outlook Handbook, 36% of those employed as atmospheric or space scientists are employed within the private sector; 29% are employed by the federal government, primarily by the National Weather Service; 19%
are employed by an academic institution; and 8% are employed in broadcasting. Increasingly, an advanced degree is required for graduates to obtain a job in the field. To that end, the Occupational Outlook Handbook states that, “Workers with a graduate degree should enjoy better prospects than those whose highest level of education is a bachelor’s degree.” At the 19th Biennial American Meteorological Society and American Geophysical Union Heads and Chairs Meeting, held in Boulder, Colorado in 2014, twenty-nine chairs of atmospheric science academic programs in the United States were surveyed with respect to programmatic enrollment trends. Of the twenty-three programs that offer M.S. degrees, 87% indicated that program enrollments are steady, increasing gradually, or increasing rapidly. Job prospects for M.S. degree recipients were subjectively rated as strong.

The primary occupational classification for atmospheric scientists with an earned M.S. degree is “Atmospheric and Space Scientists” (SOC Code 19-2021). For the period 2012-2022, the Wisconsin Department of Workforce Development projects a 7.51% increase in employment, from 213 in 2012 to a projected 229 in 2022, outpacing that for all occupations (7.14%). Seven average annual openings are projected, with two due to growth and five due to replacements. Annual wages at the 25th, 50th, 75th, and 90th percentiles are 1.6-2.6 times their respective values for all occupations. Nationwide, for the period 2014-2024, the United States Bureau of Labor Statistics projects a 9% increase in employment, from 11,800 in 2014 to 12,900 in 2024, again outpacing that for all occupations (7%).

Emerging Knowledge and Advancing New Directions

Atmospheric science is a discipline at the forefront of the “big data” movement. The rate at which new data from observations and numerical model simulations are generated to advance predictive abilities and fundamental understanding outpaces the ability to interpret the data using existing techniques. The proposed degree leverages existing programmatic strength in this area to develop an educated workforce that is well-prepared to solve the challenges posed and take advantage of the opportunities provided by “big data” in the atmospheric and related sciences (e.g., catastrophe modeling, risk assessment, renewable resources, agriculture). In this regard, degree-seeking students may elect to complete a two-course sequence in statistical analysis and interpretation of geophysical data sets and a special topics course in data analytics applied to the atmospheric sciences. Further, program faculty in recent years have received external funding in support of the application of predictive data analytics, distributed infrastructure, and cloud computing for weather prediction. As a result, the proposed degree is well-positioned to advance new directions within the field.

DESCRIPTION OF PROGRAM

General Structure

Institutional Program Array

At present, UWM offers seven M.S. degrees in natural science disciplines: Biological Sciences, Chemistry, Engineering, Freshwater Sciences, Geosciences, Mathematics, and Physics. No academic programmatic overlap, existing or planned, exists between these programs and the proposed M.S. in Atmospheric Science. Due to the multidisciplinary nature of the atmospheric sciences, graduate courses in Freshwater Science, Mathematics, and to lesser extent Chemistry, Communication, English, Geography, Geosciences, and Physics, may be of benefit to students
seeking the M.S. in Atmospheric Science. Student interest in these areas will be accommodated through standard degree requirements. In turn, graduate courses in Atmospheric Science may be of benefit to graduate degree-seeking students in Freshwater Sciences and Mathematics. In research, significant potential for interdisciplinary research collaboration exists between Atmospheric Science and Freshwater Sciences.

Other Programs in the University of Wisconsin System

There exists only one other institution in the UW System offering a Ph.D. degree in the atmospheric or related sciences: UW-Madison. UW-Madison has unique programmatic expertise in aerosol, air-sea interaction, biogeochemistry, ecology and biosphere-atmosphere interactions, middle atmosphere dynamics, polar meteorology, radiative transfer, remote sensing, satellite meteorology, and tropical convection. UWM has unique programmatic expertise in cloud parameterization, data analytics, non-linear data analysis, and systems modeling. Where shared research expertise exists in specialties represented in a supermajority of graduate atmospheric science programs, specific research foci differ between each institution’s faculty. Further, there exist major centers or programs unique to each campus. At UW-Madison, these include the Cooperative Institute for Meteorological Satellite Studies, Nelson Institute for Environmental Studies, Space Science and Engineering Center, and Wisconsin State Climatology Office. At UWM, these include Innovative Weather and the School of Freshwater Sciences. With the exception of minor research overlap between the Nelson Institute for Environmental Studies and School of Freshwater Sciences, these are unique programs with which faculty and students at their respective institutions have active research collaborations.

Collaborative Nature of the Program

In the Intent to Plan stage of this process, faculty at UW-Madison and UWM jointly identified areas of potential collaboration. To leverage each program’s respective expertise, parallel course offerings may be considered, with video conferencing and alternating on-campus meetings fostering interaction between institutions. A joint research symposium alternating between the two campuses would allow students and faculty to discuss potential collaborations. Faculty are involved with proposed field experiments in Wisconsin that offer the opportunity to expose students to a more diverse range of field study than possible at only one institution. Collaborative efforts to recruit prospective graduate students may lead to the attraction of higher-quality students to each program.

Diversity

According to the National Science Foundation, from 2002-2012, 36.8% of earned M.S. in Atmospheric Science degrees in the United States were awarded to women and 12.4% were awarded to persons from ethnic or racial minority groups. By comparison, from 2000-2016, 27.7% of earned M.S. in Mathematics, Atmospheric Science option, degrees at UWM were awarded to women and 6.4% were awarded to those from ethnic or racial minority groups. Of these, one degree was awarded to a student supported by a UWM Advanced Opportunity Program fellowship. Internal and external efforts to maintain diversity in the graduate ranks are proposed. At UWM, the STEM-Inspire, Wisconsin Alliance for Minority Participation, and McNair initiatives seek to improve retention and persistence in science, technology, engineering, and mathematics (STEM) fields of students from underrepresented backgrounds. This goal is shared by the STEM CELL initiative, except targeted to a broader student cohort. Externally, the Significant Opportunities in
Atmospheric Research and Science program seeks to broaden participation of students from underrepresented backgrounds at the graduate level via engagement in intensive research, mentorship, and community activities. Events such as the Undergraduate Leadership Workshop afford students the opportunity to explore atmospheric science careers and develop their leadership potential.

We intend to identify students in our undergraduate program early in their academic careers who would benefit from participation in one or more of these initiatives. Faculty mentors will be identified to provide individual guidance specific to achievement within the major and matriculation to the graduate program. As feasible, funding from the UWM Office of Undergraduate Research will be sought to support these students as undergraduate research assistants to engage them in activities similar to those that they would complete if they were to attend graduate school. These integrated efforts offer the potential of increasing diversity through improved matriculation of students to graduate-level study. Success at accomplishing this goal is likely to increase the appeal of our program to students from underrepresented backgrounds at other institutions, further increasing diversity.

Student Learning Outcomes and Program Objective

Reflecting sufficient preparation for gainful post-graduation employment or admission to a Doctor of Philosophy program at a peer or aspirational institution, students who obtain the M.S. in Atmospheric Science degree at UWM will:

1. Demonstrate the ability to conduct supervised research that builds upon existing theory and methods to result in an original contribution to understanding in the atmospheric sciences. This requires demonstrated criticality and creativity of thought and mastery of appropriate analysis, interpretation, and synthesis techniques.

2. Demonstrate broad knowledge of fundamental tenets in the atmospheric sciences and advanced knowledge of existing understanding and future directions specific to the chosen research specialization in the atmospheric sciences.

3. Demonstrate the ability to clearly and effectively communicate, in multiple media, fundamental tenets of the atmospheric sciences and specialized research findings to diverse audiences, including students, professionals, and the general public.

Assessment of Objectives

Institutional program review is described in the Institutional Review section below. At the program level, multiple measures are used to assess success at achieving program objectives:

1. This outcome will be assessed through evaluation of the quality of each student’s thesis research by a three-member evaluation committee of Atmospheric Science faculty.

2. This outcome will be assessed through evaluation of the quality of each student’s thesis research by a three-member evaluation committee of Atmospheric Science faculty.

3. This outcome will be assessed through evaluation of the quality of the oral and written components of each student’s thesis defense, course assignments, and presentation at departmental seminars and professional conferences. For teaching assistants, student, peer, and supervisor teaching evaluations will be used as part of this assessment.

Informal evaluation of student progress toward all student learning outcomes will be periodically conducted by the student’s major professor, who will provide the results to both the
student and the Atmospheric Science Program Coordinator. Exit interviews and post-graduation surveys will be used to acquire further subjective feedback as to the effectiveness of program initiatives toward fostering the successful completion of all student learning outcomes.

Assessments will be conducted using a 1-5 scale, where 1 = poor, 2 = fair, 3 = good, 4 = very good, and 5 = excellent. Atmospheric Science faculty will collect and review graduate cohort assessment data at the end of each academic year. For average cohort assessments below 3.5, an investigation will be conducted to identify potential underlying causes. Corrective means will subsequently be developed and implemented into the curriculum as needed. All objectives will be reviewed periodically to ensure continued effectiveness of relevant program initiatives.

Program Curriculum

Students enrolled in the M.S. in Atmospheric Science degree program must complete a total of thirty (30) credits. Of these credits, twelve (12) must be uniquely earned at the Atm Sci 700-level or greater; six (6) must be earned in approved graduate elective courses; six (6) must be earned in either Math 601 and Math 602 or Atm Sci 500 and Atm Sci 950 (as “Topics in Statistical Analysis and Interpretation of Geophysical Data Sets: Part II”); and six (6) must be earned in Atm Sci 990. Students receiving financial support from the Department of Mathematical Sciences must enroll in a minimum of fifteen (15) credits offered by the department during each academic year. Prior to graduation, students, under the direction of a major professor and supervision of a three-member evaluation committee comprised of Atmospheric Science graduate faculty, must complete and orally defend an acceptable thesis. An acceptable thesis is defined as one representing an original contribution in the atmospheric sciences of sufficient caliber for publication in a peer-reviewed journal.

Courses in Atmospheric Science that may be taken for graduate credit are listed below. Only courses offered in the last ten years are listed. Courses at the 700-level and higher are graduate-only; those at the 600-level and lower carry graduate credit only when special graduate student requirements indicated by the course instructor on the course syllabus are successfully completed. All courses are for three credits unless otherwise denoted.

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<tr>
<th>Course</th>
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<tr>
<td>Atm Sci 330</td>
<td>Air Pollution Meteorology</td>
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<tr>
<td>Atm Sci 350</td>
<td>Atmospheric Thermodynamics</td>
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<td>Atm Sci 351</td>
<td>Dynamic Meteorology I</td>
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<td>Atm Sci 361</td>
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<td>Mesoscale Circulations</td>
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<td>Atm Sci 464</td>
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<td>Atm Sci 470</td>
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<td>Atm Sci 480</td>
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<td>Atm Sci 497</td>
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<td>Atm Sci 500</td>
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<td>Atm Sci 505</td>
<td>Micrometeorology</td>
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<tr>
<td>Atm Sci 511</td>
<td>Seminar in Atmospheric Radiation and Remote Sensing</td>
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<tr>
<td>Atm Sci 690</td>
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<td>Atm Sci 705</td>
<td>Air Pollution Modeling</td>
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<tr>
<td>Atm Sci 711</td>
<td>Cloud Dynamics</td>
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Students seeking admission to the M.S. in Atmospheric Science degree program must meet all UWM Graduate School admission requirements. GRE General Test scores are recommended but not required. Entering graduate students should have a general background in both physics and mathematics, including calculus and ordinary differential equations. Students who lack this background may be admitted if the deficiencies amount to no more than two courses, and deficiencies must be made up within three enrolled semesters of graduate study.

Projected Time to Degree
Entering full-time students without deficiencies are expected to complete all degree requirements within two years of first enrollment. All degree requirements must be completed within five years of first enrollment, consistent with UWM’s campus-wide policy.

Program Review Process

Institutional Review
The Sub-Committee on Graduate Program Reviews of the Graduate Faculty Committee supervises a systematic and continuing review of existing graduate programs at UWM. The procedures for qualitative reviews of graduate programs at UWM are described in detail in Graduate Faculty Committee Document No. 951. In brief, graduate program reviews are conducted to assess and ensure the continuity of the quality of each graduate program, provide the Graduate Faculty Committee with a basis for evaluating proposals to expand, modify, or discontinue programs, and guide deans and the Provost in administrative decision-making and reporting related to graduate programs.

New graduate programs undergo full-scale reviews involving external consultant site visits five years after implementation to supply the data and evaluation required by the UW System for its mandated review of new academic programs. Continuing graduate programs undergo reviews using external consultants every ten years after the initial program review. Five years after closure of the most recent program review, graduate programs are required to provide a mid-cycle status report discussing the implementation of the recommendations adopted by the Graduate Faculty Committee in the last program review.

Program reviews are conducted by an internal review team, composed of two members of the graduate faculty, and at least two external consultants expert in the discipline. Each program is required to submit a self-study and supplementary documentation at least six weeks prior to a site visit by the external consultants. The self-study provides the program with the opportunity to evaluate all facets of program operation and outcomes, engage in critical self-examination, and formulate curricular and research objectives, benchmarks, and milestones for the next ten years. Included in the self-study are a description and evaluation of the program, its faculty, students, curriculum, outcomes and assessment thereof; the research and scholarship environment and
productivity therein; resources; and additional supplementary information.

External consultants jointly prepare a report submitted to the Graduate School within four to six weeks of the site visit. This report contains general conclusions about the state of the graduate program, specific recommendations for action and a statement of rationale for each, and an analysis of the program’s major strengths to be maintained and weaknesses to be addressed. Programs are permitted the opportunity to respond to the consultants’ report before submission to and evaluation by the Graduate Faculty Committee. The Provost, Dean and Associate Dean of the relevant School or College, and the Dean of the Graduate School then meet to discuss implementation and prioritization of the Graduate Faculty Committee’s recommendations.

Accreditation

There exists no accrediting authority for atmospheric science graduate degrees.