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 Ph.D. in Atmospheric Sciences

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

Enclosed please find a copy of the proposal approved as Fac. Doc. No.1004. 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 Kristine Surerus, Assistant Dean Michael Darnell, or me. I look forward to action on this recommendation as soon as possible.

RS/md
Enclosure

c: 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 PhD degree in Atmospheric Sciences

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

Rationale:
The proposed degree, for which no new resources are requested, will replace the existing Atmospheric Science option to the Ph.D. in Mathematics offered by the UWM Department of Mathematical Sciences. Pursuing a Ph.D. in Atmospheric Science prepares students for a post-graduation research-focused career in academia, government, or the private sector. An earned Ph.D. thus reflects that a graduate has become an expert within their chosen sub-discipline of atmospheric science. The existing Atmospheric Science option to the Ph.D. in Mathematics at UWM is not well-aligned with employer expectations for degree holders.

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

ABSTRACT
The University of Wisconsin-Milwaukee proposes to establish a Doctor of Philosophy (Ph.D.) in Atmospheric Science. The proposed program, to replace the existing Atmospheric Science option to the Ph.D. 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
Doctor of Philosophy

Mode of Delivery
Single institution, face-to-face

Projected Enrollments by Year Five
By the end of year five, it is expected that seven new students will have enrolled in the program, between one and two per year, and five students will have graduated from the program, between zero and two 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 Ph.D. in Mathematics at UWM; thus, no attrition is factored into the projected enrollments.

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Tuition Structure
For students seeking the Ph.D. in Atmospheric Science, standard tuition and fee rates apply. 

For students who have not become dissertators: 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. 

For students who have become dissertators: For the 2016-17 academic year, residential tuition and segregated fees total $4,464.66 per semester for a full-time student enrolled in eight credits per term. Non-resident tuition and segregated fees total $6,064.66 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, whether they have or have not achieved dissertator status, 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 Ph.D. in Mathematics offered by the UWM Department of Mathematical Sciences. Pursuing a Ph.D. in Atmospheric Science prepares students for a post-graduation research-focused career in academia, government, or the private sector. An earned Ph.D. thus reflects that a graduate has become an expert within their chosen sub-discipline of atmospheric science. The existing Atmospheric Science option to the Ph.D. in Mathematics at UWM is not well-aligned with employer expectations for degree holders. Students in the existing program are required to complete twelve credits in applied computational mathematics and mathematical analysis and specialize in at least one area of mathematics. This requires students to invest substantial effort on courses addressing topics not often used in most sub-disciplines of the field, with an equivalent reduction in effort spent on relevant course work and dissertation research. Programmatic changes accompanying the proposed degree will better align the curriculum with employer expectations for degree holders.

Further, despite a strong track record of student success, the Ph.D. 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 to recruit the best-possible graduate students and limiting our local, regional, and national exposure. In turn, this limits the quality of research that can be conducted with students, hindering the program’s ability to attract the most-possible external funding. Eliminating the non-atmospheric science degree requirements that can serve as a barrier to entry will also improve the recruitment and retention of successful graduate students. Thus, the Ph.D. in Atmospheric Science is proposed so
as to better enable the 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.

**Need as Suggested by Current Student Demand**

Entering the 2016-17 academic year, there is one degree-seeking student enrolled in the Atmospheric Science option to the Ph.D. in Mathematics at UWM. There were three degree-seeking students enrolled in each of the 2014-15 and 2015-16 academic years. Between one and three degree-seeking students were enrolled in each academic year dating back to 2006-07. These enrollment trends are consistent with the continuing need for advanced degrees to acquire gainful employment within the field and doctoral enrollments 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 Ph.D. degrees, 71% indicated that program enrollments are steady, increasing gradually, or increasing rapidly. Job prospects for Ph.D. degree recipients were subjectively rated as fair.

The primary occupational classifications for atmospheric scientists with an earned Ph.D. degree are “Atmospheric and Space Scientists” (SOC Code 19-2021) and “Atmospheric, Earth, Marine, and Space Sciences Teachers, Postsecondary” (SOC Code 25-1051). For the former, the Wisconsin Department of Workforce Development projects a 7.51% increase in employment, from 213 in 2012 to 229 in 2022. For the latter, a 7.29% increase in employment is projected, from 343 in 2012 to 368 in 2022. Projected growth rates exceed that for all occupations (7.14%), and annual wages at the 25th, 50th, 75th, and 90th percentiles are 1.6-2.6 times their respective values for all occupations. Nationwide, the United States Bureau of Labor Statistics projects a 9% increase in employment in each occupation through 2024, outpacing that for all occupations (7%). For “Atmospheric and Space Scientists,” employment is projected to increase from 11,800 in 2014 to 12,900 in 2024. For “Atmospheric, Earth, Marine, and Space Sciences Teachers, Postsecondary,” employment is projected to increase from 13,200 in 2014 to 14,300 in 2024.

**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). Degree-seeking students can 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, faculty in recent years have received external funding in support 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 Ph.D. degrees in natural science disciplines: Biological Sciences, Chemistry, Engineering, Freshwater Sciences, Geosciences, Mathematics, and Physics. No academic programmatic overlap, current or planned, exists between these programs and the proposed Ph.D. 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 Ph.D. in Atmospheric Science. Student interests in these areas will be accommodated through standard degree requirements. In turn, graduate courses in Atmospheric Science may be of benefit to 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](https://www.nsf.gov), from 2002-2012, 31.4% of earned Ph.D. in Atmospheric Science degrees in the United States were awarded to women and 17.7% were awarded to persons from ethnic or racial minority groups. By comparison, from 2000-2016, 42.9% of earned Ph.D. in Mathematics, Atmospheric Science option, degrees at UWM were awarded to women and 57.1% were awarded to persons from ethnic or racial minority groups.

Internal and external efforts to maintain diversity in the graduate ranks are proposed. At UWM, the [STEM-Inspire](https://www.uwm.edu/units/stem-inspire/), [Wisconsin Alliance for Minority Participation](https://www.uwm.edu/units/wamp/), and [McNair](https://www.uwm.edu/units/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](https://www.nsf.gov) 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](https://www.uwm.edu/units/undergrad-lab-workshop/) afford students the opportunity to explore careers and develop 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 of graduate students. These integrated efforts offer the potential of increasing diversity through improved matriculation 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, students who obtain the Ph.D. in Atmospheric Science degree at UW-Milwaukee will:

1. Demonstrate the ability to conduct independent, cutting-edge research that, through the application of existing and development of novel theory and methods, results in one or more original contributions 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 dissertation research by a five-member evaluation committee.

2. This outcome will be assessed through evaluation of the quality of each student’s dissertation research by a five-member evaluation committee and performance on the doctoral preliminary examination.

3. This outcome will be assessed through evaluation of the quality of the oral and written components of each student’s dissertation proposal hearing, dissertation defense, course assignments, and presentation of research at departmental seminars and professional conferences. For students who are 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 Ph.D. in Atmospheric Science program must complete a total of fifty-four (54) graduate credits beyond the bachelor’s degree with at least twenty-seven (27) earned in residence at UWM. 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. As part of their 54 credits, students admitted directly to the Ph.D. program without an earned Master of Science in Atmospheric Science must complete the following twenty-four (24) credits: twelve (12) at or above the Atm Sci 700-level, six (6) in approved graduate elective courses, and six (6) 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”). Students admitted to the Ph.D. program with an earned Master of Science in Atmospheric Science from UWM or elsewhere have fulfilled these requirements. In consultation with their major professor, students are expected to identify additional graduate courses that benefit their research or professional development. It is expected that most students will elect to supplement their formal Atmospheric Science coursework with formal coursework from other curricular areas. With the approval of the student’s major professor, any graduate-level course at UWM may fulfill degree requirements.
Assuming an earned M.S. degree, a typical Ph.D. student’s curriculum will consist of twelve credits of formal graduate coursework, at least half of which will be completed at the 700-level or above; three credits of Atm Sci 999, Advanced Independent Reading; and nine to twelve credits of Atm Sci 998, Doctoral Dissertation.

To qualify for dissertator status, students must successfully pass a preliminary examination in Atmospheric Science, focusing on three sub-disciplines of the field, and complete a dissertation proposal hearing. With approval of their major professor, students may elect to substitute an area of mathematics for one of the three Atmospheric Science sub-disciplines on the preliminary examination. The preliminary examination must be attempted prior to the start of the third year of study, and students who fail the examination are permitted one retake. The preliminary examination and dissertation proposal hearing must both be completed no later than the end of the fourth year of study. To receive the degree, students, under the direction of a major professor and supervision of a five-member evaluation committee, must complete and successfully defend a dissertation representing an original contribution to the field of sufficient caliber for publication in a peer-reviewed journal. The evaluation committee is to be comprised of four Atmospheric Science graduate faculty members and one member external to the program.

Formal 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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<th>Course</th>
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<tr>
<td>Atm Sci 330</td>
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<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 511</td>
<td>Seminar in Atmospheric Radiation and Remote Sensing</td>
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<td>Atm Sci 750</td>
<td>Nonlinear Time Series Analysis</td>
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<td>Atm Sci 761</td>
<td>Advanced Synoptic/Mesoscale Meteorology</td>
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<td>Atm Sci 950</td>
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<tr>
<td>Atm Sci 999</td>
<td>Advanced Independent Reading (1-4 cr)</td>
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Students seeking admission to the Ph.D. in Atmospheric Science degree program must meet all UWM Graduate School admission requirements. An earned Master of Science degree is not a prerequisite for admission; however, it is expected that most applicants will have an earned Master of Science degree in Atmospheric Science or a closely-related discipline. GRE General Test scores are recommended but not required. Entering students without an earned Master of Science degree 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 with an earned Master of Science degree are expected to complete all degree requirements within three to four years of first enrollment. Entering full-time students without an earned Master of Science degree are expected to complete all degree requirements within five to six years of first enrollment. All degree requirements must be completed within ten 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.