



University Senate TRANSMITTAL FORM

Senate Document #:	10-11-42
PCC ID #:	10039
Title:	Proposal to Establish a Bachelor of Science Degree Program in Atmospheric and Oceanic Science
Presenter:	David Salness, Chair, Senate Programs, Curricula, and Courses Committee
Date of SEC Review:	February 16, 2011
Date of Senate Review:	March 2, 2011
Voting (highlight one):	<ol style="list-style-type: none"> 1. On resolutions or recommendations one by one, or 2. In a single vote 3. To endorse entire report
Statement of Issue:	<p>The College of Computer, Mathematical, and Natural Sciences and the Department of Atmospheric and Oceanic Science wish to establish a new Bachelor of Science degree program in Atmospheric and Oceanic Science.</p> <p>Currently, there are no options for students wishing to major in atmospheric and oceanic science in the state of Maryland, or in the adjacent states of Virginia, Delaware, and West Virginia, that satisfy the Federal requirements to be certified as a meteorologist or oceanographer. The job market for students with this sort of training, however, is strong--notably in the College Park vicinity: NOAA in Silver Spring, NASA in Greenbelt, and the National Centers for Environmental Prediction (NCEP), which is moving to the University's MSquare campus. This program is designed to connect undergraduate students with these prestigious institutions as well as our world class faculty.</p> <p>To earn the degree, students must complete 120 credits, of which 69-70 credits will be required for the major. The first two years of the curriculum will focus on the fundamentals of mathematics, chemistry, physics, and computer science. The final two years will feature a comprehensive survey of atmospheric and oceanic</p>

	<p>science, with specialty courses and guided research that will allow the student to develop expertise in a particular area, such as computer modeling and remote sensing of the atmosphere and ocean, atmospheric chemistry, or climate studies. All students will participate in a research or internship activity. The program will take advantage of the rich Washington, DC area research community to provide students with a guided research project during the senior year. The curriculum satisfies the American Meteorological Society’s guidelines for the B.S. degree in Atmospheric Science, as well as Federal General Service Administration requirements to be certified as a meteorologist or oceanographer.</p> <p>The program is expected to have an initial enrollment of approximately 15 students then grow to 60 within a few years. Along with Federal careers as an meteorologist or oceanographer, graduates will also be prepared for careers in media-related weather forecasting, non-media weather forecasting (in public, military, private, and aviation organizations), and specialized environmental services with state agencies, Federal agencies and the private sector. Another possible career direction is teaching earth science at the high school level, which is a critical need for the State of Maryland.</p>
Relevant Policy # & URL:	N/A
Recommendation:	The Senate Committee on Programs, Curricula, and Courses recommends that the Senate approve this new degree program.
Committee Work:	<p>The Committee considered the proposal at its meeting on February 4, 2011. Jim Carton, Chair of the Department of Atmospheric and Oceanic Science presented the proposal to the committee and responded to questions. After discussion, the Committee voted unanimously to recommend the proposal.</p> <p>The Academic Planning Advisory Committee approved the proposal on January 24, 2011.</p>
Alternatives:	The Senate could decline to approve the proposed program.
Risks:	If the Senate does not approve the proposed program, the University will lose an opportunity to serve the State of Maryland by training students in this key branch of earth system science.

Financial Implications:	There are no significant financial implications with this proposal. Resources will be drawn primarily from a redirection of effort within the Department of Atmospheric and Oceanic Science.
Further Approvals Required: <i>(*Important for PCC Items)</i>	If the Senate approves this proposal, it would still require further approval by the President, the Board of Regents, and the Maryland Higher Education Commission.

**THE UNIVERSITY OF MARYLAND, COLLEGE PARK
PROGRAM/CURRICULUM/UNIT PROPOSAL**

- Please email the rest of the proposal as an MSWord attachment to pcc-submissions@umd.edu.

PCC LOG NO.

10039

- Please submit the signed form to the Office of the Associate Provost for Academic Planning and Programs, 1119 Main Administration Building, Campus.

College/School: College of Computer, Mathematical and Natural Sciences

Please also add College/School Unit Code-First 8 digits: 01203000

Unit Codes can be found at: https://hypprod.umd.edu/Html_Reports/units.htm

Department/Program: Atmospheric and Oceanic Science

Please also add Department/Program Unit Code-Last 7 digits: 1302101

Type of Action (choose one):

- | | |
|---|--|
| <input type="checkbox"/> Curriculum change (including informal specializations) | <input checked="" type="checkbox"/> <i>New academic degree/award program</i> |
| <input type="checkbox"/> <i>Renaming of program or formal Area of Concentration</i> | <input type="checkbox"/> New Professional Studies award iteration |
| <input type="checkbox"/> <i>Addition/deletion of formal Area of Concentration</i> | <input type="checkbox"/> New Minor |
| <input type="checkbox"/> <i>Suspend/delete program</i> | <input type="checkbox"/> Other |

Italics indicate that the proposed program action must be presented to the full University Senate for consideration.

Summary of Proposed Action:

This is a proposal to create a new Bachelor of Science Program at University of Maryland in Atmospheric and Oceanic Science. The objective is to provide the student major with an in-depth understanding, building on two years of basic coursework in mathematics, physics, and chemistry. All students will participate in a research/internship activity. Graduates may easily satisfy the General Services Administration requirements for certification as 'meteorologist' and 'oceanographer' or acquire appropriate background to teach earth system science at the high school level

APPROVAL SIGNATURES - Please print name, sign, and date. Use additional lines for multi-unit programs.

1. Department Committee Chair James A. Carton *James A. Carton*

2. Department Chair James A. Carton *James A. Carton*

3. College/School PCC Chair PAUL J. SMITH *Paul J. Smith 12/17/10*

4. Dean *Paul J. Smith 12/17/10*

5. Dean of the Graduate School (if required) _____

6. Chair, Senate PCC _____

7. University Senate Chair (if required) _____

8. Senior Vice President for Academic Affairs & Provost _____

PROPOSAL FOR
NEW INSTRUCTIONAL PROGRAM
UNIVERSITY OF MARYLAND AT COLLEGE PARK

ATMOSPHERIC AND OCEANIC SCIENCE

COLLEGE OF COMPUTER, MATHEMATICAL AND NATURAL SCIENCES

DEAN STEPHEN HALPERIN

January 27, 2010

Award to be offered
BACHELOR OF SCIENCE DEGREE

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I. OVERVIEW AND RATIONALE

A. Description: This is a proposal to create a new Bachelor of Science Program at University of Maryland in Atmospheric and Oceanic Science. The objective is to provide the student major with an in-depth understanding, building on two years of basic coursework in mathematics, physics, and chemistry. All students will participate in a research/internship activity. Graduates may easily satisfy the General Services Administration requirements for certification as ‘meteorologist’ and ‘oceanographer’ or acquire appropriate background to teach earth system science at the high school level.

B. Need and Connection to the Mission of UMD: Motivation to develop this new undergraduate major here at UMD include the rapid development of atmospheric and oceanic science, recognition of the human impacts of the atmosphere and oceans, the need to fill associated job opportunities for Maryland students in this scientific/technical area, and the availability of world class faculty. In addition to their traditional employment with the National Weather Service or media, students with weather and climate expertise are finding jobs in a broad swath of private industry (discussed below).

Until now an undergraduate enrolled at UMD interested in this field had three options, either majoring in another subject and minoring in meteorology or air chemistry (requiring three 400-level AOSC courses), majoring in Physics and doing the Meteorology track, or enter the Physical Sciences program with an AOSC specialization. However, we feel none of these options provides satisfactory depth or breadth of exposure to the subject, nor do they satisfy national standards certification requirements (discussed below). A student could also choose an environmental science major through the ENST program, but that program does not provide an understanding of atmospheric and oceanic science¹ and as a result does not satisfy national standards certification requirements. Throughout Maryland the Maryland Higher Education Commission website² reveals there are currently no undergraduate degree programs with ‘meteorology’, ‘atmospheric’, ‘ocean’, ‘oceanography’, or ‘climate’ in their titles. More broadly, examination of the Higher Education websites in the neighboring States of Delaware, West Virginia, and Virginia have revealed no undergraduate programs in meteorology or atmospheric science (although Univ. Virginia and Univ. Delaware have Atmospheric Science/meteorology tracks within Departments of Environmental Sciences and Geography).

By providing an opportunity for Maryland students to pursue interests in meteorology, physical oceanography, or global climate without leaving the State this proposal addresses our mission to remain “...*the school of choice for the most talented students in Maryland and for outstanding out-of-state students*”. By creating a new integrative science major this proposal addresses our mission to: “...*continue to elevate the quality of undergraduate education by providing enriched educational opportunities and personally fulfilling and challenging academic curricula*” (www.provost.umd.edu/Strategic_Planning/Mission2000.html). Finally, we note that the proposal will leverage the extensive resources of the Washington DC area to provide research opportunities for all the AOS majors, thus responding to the UMD Strategic Plan’s call “...to

¹ The ENST areas of concentration are: Ecological technology design, Environmental health, Soil and watershed science, and Natural resources management.

² www.mhec.state.md.us/utilities/search_major.asp (7-13-2010)

increase the number of academically-based internship and fellowship opportunities that leverage our locational advantage in the Baltimore-Washington region.”
(www.provost.umd.edu/Strategic_Planning/Plan.html#Init1).

C. Program Size/Job Market: This program is designed to serve students interested in obtaining a strong background in physical science with ‘real world’ application to the atmosphere and oceans. The job market for students with this sort of training is good, indeed similar to what we may expect for students graduating from the Department of Physics. One possible career direction is teaching earth science at the high school level, for which there is strong demand. A second will be to fulfill the Federal GSA requirements for the positions of ‘meteorologist’ and ‘oceanographer’ and work as a science professional in this area. The types of science jobs available are described in the online career guide maintained by the American Meteorological Society (www.ametsoc.org/atmoscareers/) and include: video, audio, and print media; nonmedia weather forecasting (public, military, private, and aviation); specialized environmental services (e.g. air quality, water pollution) with State and Federal Agencies as well as private companies; and an increasing number of diverse applications of weather and climate information (agriculture, architecture, power industry, ...). Other students may combine a major in atmospheric and oceanic science with other training in a complimentary field such as engineering, business, law, or health science. Many positions require only an undergraduate degree. For others, notably the National Centers for Environmental Prediction (NCEP) which is moving to the UMD MSquare campus, some graduate training is expected.

National job placement statistics for the year 2008 are available from the Federal Bureau of Labor Statistics. The BLS estimates the total employment of atmospheric scientists in 2008 to have been 9,400 and they project an above-average job growth of 15% over the next decade. The average salary for meteorologists working for the Federal government was \$93,661 and somewhat higher for oceanographers. However a more cautious picture of the job market for undergraduate meteorologists and oceanographers was put forward by Professor John Knox, University of Georgia, at a national meeting of Department Chairs in 2008³, emphasizing the need for a strong academic program. We have investigated the career paths of BS recipients from other east coast colleges offering related degrees. Of 60 recent alumni of the Millersville University program in southern Pennsylvania, the largest number (21) have gone to work for private companies such as Accuweather. The next largest number (19) have gone on to pursue graduate education. Seven have gone into TV/online weather forecasting, seven have gone to work for the National Weather Service or NASA Goddard, with the remainder going to work for the military, State environmental agency, K12 education, or shifted out of the field. Further information on available jobs in meteorology can be obtained through the Penn State University website: www.met.psu.edu/careers/career-resources. Biographies of a selection of University of Oklahoma students are available at: som.ou.edu/alumniProfiles.php.

In order to estimate the expected size of the program we would offer we examined the size of other programs here at UMD and at other schools in the mid-Atlantic region. Here at UMD the majors in departments most analogous in topic and faculty size, Geology and ENST, have 30-40 and 40-50 majors, respectively. Although the Meteorology Physics track within Physics typically enrolls less than 5 majors per year, we do not believe that it exploits the potential demand for an

³ http://www.ucar.edu/governance/meetings/oct08/followup/head_and_chairs/john_knox.pdf

undergraduate AOSC degree. It is not actively marketed by Physics, does not readily appear in internet searches, and does not have a clear career direction. For example, it does not satisfy GSA requirements.

At other schools within the mid-Atlantic region, the Department of Meteorology at Penn State has 300 students, the Department of Environmental Sciences meteorology program at Rutgers University has 60 students, the Marine, Earth and Atmospheric Sciences Department Meteorology Program at NCSU has 50 students, while the Department of Earth Sciences Meteorology Program at Millersville University has 130 students, having tripled in size in the past two decades. Further away, our aspirational peer, University of Illinois, created an undergraduate major on 2007 which is now flourishing. Perhaps most analogous to our situation, the University of Oklahoma Department of Meteorology, located adjacent to NOAA's Severe Storms Lab, has 320 undergraduate majors. Based on these examples and considering our locational advantage, we estimate that within a few years the number of undergraduate majors will be 60+, and expect an initial enrollment of approximately 15 (the impact of numbers of majors on resource requirements is discussed below in VIII-F. We budget conservatively, assuming 40 majors new to UMD).

D. Innovative Aspects of this Program: While the subject matter addressed in this program resembles that offered in Pennsylvania for example, our program has a stronger basic physics component (12 credits versus 6 credits) and a computer science requirement. Our program exploits our location within the huge Washington area research community to provide guided a research project during the senior year for all Department majors (consistent with the goals of the *Strategic Plan*). This research project is modeled on the Geology Department's successful senior research project, which has been in place for many years. Majors will also be encouraged to attend climate seminars/briefings held regularly in the US Senate, NAS, Carnegie Institution, AGU, and AAAS downtown, and in other ways explore the numerous resources available in the Washington area in addition to those available at UMD.

E. Summary of benefits to UMD

- How does this program leverage the recent growth/changes in AOSC faculty? Recent hires of three faculty in air chemistry (jointly with ESSIC and CHEM), data assimilation (jointly with CSCAMM and IPST), and regional climate modeling (joint with ESSIC) strengthen our expertise in these research areas. We currently are conducting a search for an additional faculty member in data assimilation. We can expect the new faculty to contribute to our ability to expand the variety of courses we offer at the undergraduate level in the broad areas of "physics and chemistry of the atmosphere", and "application of numerical analysis to environmental science".
- What are the benefits to the Departmental research and teaching program? Development of an undergraduate major will strengthen ties to NOAA and NASA laboratories through involvement in teaching and advising and because of the placement of students within laboratories in the Washington area. The undergraduates will benefit the research program by direct contribution and indirectly as a potential source of future graduate students. The undergraduate major will provide teaching opportunities for current graduate students. Finally, growth of the program beyond a certain size will offer TA-ship opportunities for graduate students.

- What are the benefits to the State and the wider UMD community? The program will provide Maryland high school students with access to a major that is currently not available in the State of Maryland and is available in only limited form in Delaware or West Virginia. The program will provide the University with an expanded STEM research-oriented major in a societally relevant discipline, as called for in the *Strategic Plan*. The program will provide the many environmental research laboratories and companies in the Washington metro area (such as: National Centers for Environmental Prediction, National Satellite Data and Information Service, Goddard Space Flight Center, ...) with a source of potential employees.

II. CURRICULUM

A. Full Catalog Description: Fundamental concepts from mathematics, chemistry, physics, and computer science are applied to understand the basic principles that control our weather and climate, from extreme events like tornadoes to the millennial changes of ice ages and the results of human modification of our environment. Coursework in the first two years emphasizes mastery of these fundamentals. Coursework in the last two years provides a comprehensive survey of atmospheric and oceanic science, while specialty courses and guided research allow the student to develop expertise in an area of concentration. The Department has particular strengths in computer modeling and remote sensing of the atmosphere and ocean, atmospheric chemistry, and climate studies. In addition to the Department, nearby research laboratories such as the NOAA National Centers for Environmental Prediction and NASA Goddard Space Flight Center offer the student many research opportunities.

B. Total Number of Credits and Their Distribution: A student must complete 120 credits in order to graduate from the University with a BS degree. Of these the University requires students to take 40-46 credits of General Education/CORE courses⁴. The AOSC Department major requires that the students take either 69 or 70 credits. Under special circumstances such as transfer from another program, a waiver may be requested and approved by the director of undergraduate studies. However, we believe that the major requirements will satisfy 25 of the General Education/CORE requirements leaving a minimum of $120 - (69+46-25) = 30$ credits available for electives.

C. General Degree Requirements/List of Courses

In order to meet the requirements of the AOSC major, students must achieve a grade of C or higher in all courses applied to the major.

1) Required Courses Provided by AOSC

AOSC course at the 200 level		3 credits
AOSC 201	Weather and Climate Laboratory	1 credit
AOSC 431	Atmospheric Thermodynamics	3 credits
AOSC 432	Dynamics of the Atmosphere and Oceans	3 credits
AOSC 494	Seminar	1 credit
AOSC 493	Senior Research Project I	3 credits

⁴ www.provost.umd.edu/GenEdReport/Gen_Ed_Program_ChartAug9.pdf. General Ed requirements we believe will be satisfied: Math (3), Analytic Reasoning (3), I-Series (3), Natural Sciences (7), Scholarship in Practice (6), and Experiential Learning (3). AOSC 493 may additionally satisfy writing and oral communications requirements.

AOSC 498	Senior Research Project II	3 credits
Accumulated total credits		17

2) Required Additional Courses Provided by AOSC

12 credits at the 400 level chosen from among:

AOSC 400	Physical Meteorology of the Atmosphere	3 credits
AOSC 401	Climate Dynamics and Earth System Science	3 credits
AOSC 424	Remote sensing	3 credits
AOSC 434	Air Pollution	3 credits
AOSC 470	Synoptic Meteorology	3 credits
Accumulated total credits		29

3) Required Computer/Computational Course

(One of the following or equivalent)

CMSC 106	Introduction to C Programming	4 credits
CMSC 131	Object-Oriented Programming I	4 credits
Accumulated total credits		33

4) Required Courses Provided by Mathematics and Chemistry

CHEM 135 & CHEM 132 or CHEM 136	General Chemistry & Laboratory	4 credits
MATH 140	Calculus I	4 credits
MATH 141	Calculus II	4 credits
Total credits		45

5) Additional Required Mathematics Courses*

Either Block 1

MATH 241	Calculus III	4 credits
MATH 246	Differential Equations	3 credits

Or Block 2

MATH 340	Multivariable Calculus, Linear Algebra and Differential equations I	3 credits
MATH 341	Multivariable Calculus, Linear Algebra and Differential Equations II	3 credits

Total credits **51-52**

*Block 1 includes courses frequently taken by nonmajors, while Block 2 includes somewhat more rigorous courses taken by math majors.

6) Required Physics Courses*

Either Block 1

PHYS 161 & PHYS 174	General physics: Mechanics and Particle Dynamics & Laboratory	4 credits
PHYS 260 & PHYS 261	General Physics: Vibration, Waves, Heat Electricity & Laboratory	4 credits

PHYS 270 & PHYS 271	General Physics: Electrodynamics, Light Relativity& Laboratory	4 credits
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Or Block 2

PHYS 171 & PHYS 174	Introductory physics: Mechanics & Laboratory	4 credits
PHYS 272 & PHYS 275	Introductory Physics: Fields& Laboratory	5 credits
PHYS 273	Introductory Physics: Waves	3 credits

Accumulated total credits

63-64

*Block 1 includes courses frequently taken by nonmajors, while block 2 includes somewhat more rigorous courses taken by physics majors.

7) Required Elective Courses

(6 credits. May not be satisfied by the courses used to fulfill the previous requirements)⁵.

	AOSC 346	Cycles in the Earth System	3 credits
	AOSC 375	Introduction to the Blue Ocean	3 credits
	AOSC 400	Physical Meteorology of the Atmosphere	3 credits
	AOSC 401	Climate Dynamics and Earth System Science	3 credits
	AOSC 424	Remote Sensing	3 credits
	AOSC 434	Air Pollution	3 credits
	AOSC 470	Synoptic Meteorology	3 credits
	CMSC 206	Introduction to Matlab	1 credit
either	CMSC/AMSC 460	Computational Methods	3 credits
or	CMSC 466	Introduction to Numerical Analysis I	3 credits
	BSCI 106	Principles of Biology II	4 credits
	BSCI 373	Natural History of the Chesapeake Bay	3 credits
	BSCI 375	Biological Oceanography (not offered every year)	3 credits
	CHEM 231	Organic Chemistry I	3 credits
	GEOG 201	Geography of Environmental Systems	3 credits
	GEOG 472	Remote Sensing: Digital Processing and Analysis	3 credits
	GEOG 415	Land Use Climate Change and Sustainability	3 credits
	GEOL 120	Environmental Geology	3 credits
	GEOL 437	Global Climate Change: Past and Present	3 credits
	GEOL 451	Groundwater	3 credits
	GEOL 452	Watershed and Wetland Hydrology	3 credits
either	MATH 240	Linear Algebra	3 credits
or	MATH 461	Linear Algebra for Scientists and Engineers	3 credits
	MATH 416	Applied Harmonic Analysis: An Introduction to Signal Processing	3 credits
	MATH 452	Introduction to Dynamics and Chaos	3 credits
	MATH 462	Partial Differential Equations for Scientists and Engineers	3 credits
	STAT 400	Applied Probability and Statistics I	3 credits

⁵ We are in conversation with other programs including Bioscience and Geography regarding identification of additional courses that would serve this requirement.

AOSC Honors

Each year, the AOSC Honors Program Committee will review the academic records of AOSC majors. Students with a minimum 3.00 overall GPA and a minimum 3.30 major GPA will be added to the AOSC Honors List. For students on the AOSC Honors list certain graduate courses are open. To receive a citation of "with honors in atmospheric and oceanic science" the student must:

- Have earned a 3.00 or higher overall GPA and a 3.30 or higher GPA for all AOSC major required courses at graduation time
- Pass two approved AOSC graduate level classes with a grade of B- or better.
- Pass an Honors Oral Examination in his or her senior year.

To receive a citation of "with *high* honors in atmospheric and oceanic science" he or she must complete the requirements for honors and receive a high pass for the thesis.

Sample semester by semester plans

The following are two suggested courses of study for students (these are not formal Areas of Concentration). The first assumes the student is prepared to take MATH 140, while the second begins with MATH 115. Both suggested course plans satisfy the guidelines given by the American Meteorological Society for the B.S. degree in Atmospheric Science, as well as the Federal Civil Service GS 1340 requirements for 'meteorologist', and the GS 1360 requirements for 'oceanographer'⁶.

1. Beginning with MATH 140 allows the student to complete required courses earlier. We wish to draw student attention to the Master of Professional Studies program in atmospheric and oceanic science, which could be completed following the BS degree in an additional year.

Freshman		Sophomore	
<i>Fall (14 credits)</i>	<i>Spring (15 credits)</i>	<i>Fall (15 credits)</i>	<i>Spring (16 credits)</i>
MATH 140 (4)	MATH 141 (4)	MATH 241 (4)	MATH 246 (3)
CHEM 135 (3) &	PHYS 171 (3)	PHYS 272 (3)	PHYS 273 (3)
CHEM 132 or 136 (1)	PHYS 174 (1)	PHYS 275 (2)	CMSC 106 or 131 (4)
ENGL 101 (3)	AOSC 200 & 201 (4)	CORE (3)	CORE (3)
CORE (3)	Elective (3)	Elective (3)	CORE (3)
Junior		Senior	
<i>Fall (16 credits)</i>	<i>Spring (15 credits)</i>	<i>Fall (15 credits)</i>	<i>Spring (15 credits)</i>
AOSC 431 (3)	AOSC 401 (3)	AOSC 424 (3)	AOSC 434 (3)
STAT 400 (3) or	AOSC 432 (3)	AOSC 470 (3)	AOSC 498 (3)
MATH 462 (3)			

⁶http://www.ametsoc.org/policy/2010degree_atmosphericscience_amsstatement.html,
www.opm.gov/qualifications/standards/IORs/GS1300/1340.htm
www.opm.gov/qualifications/standards/IORs/GS1300/1360.htm

AOSC 400 (3)	AOSC 434 (3)	AOSC 493 (3)	CORE (3)
AOSC 494 (1)	ENGL 390 (3)	AOSC 375 (3)	Elective (3)
CORE (3)	CORE (3)	Elective (3)	Elective (3)

Any student who wishes to be recommended for a research-oriented graduate program should maintain at least a B average.

2. Beginning with MATH 115 precalculus, this plan offers a broader survey of geoscience while still satisfying GS requirements.

Freshman		Sophomore	
<i>Fall (15 credits)</i>	<i>Spring (15 credits)</i>	<i>Fall (15 credits)</i>	<i>Spring (14 credits)</i>
MATH 115 (3)	MATH 140 (4)	MATH 141 (4)	MATH 241 (4)
GEOL 120 (3)	AOSC 200 & 201 (4)	PHYS 161 (3)	PHYS 260 (3)
CORE (3)	CMSC 106 (4)	PHYS 174 (1)	PHYS 261 (1)
CORE (3)	CORE (3)	CHEM 135 (3)	CORE (3)
Elective (3)		CHEM 136 or 132 (1)	Elective (3)
		Elective (3)	
Junior		Senior	
<i>Fall (16 credits)</i>	<i>Spring (16 credits)</i>	<i>Fall (15 credits)</i>	<i>Spring (15 credits)</i>
MATH 246 (3)	AOSC 401 (3)	AOSC 424 (3)	AOSC 498 (3)
PHYS 270 (3)	AOSC 432 (3)	AOSC 470 (3)	AOSC 434 (3)
PHYS 271 (1)	AOSC 494 (1)	AOSC 493 (3)	CORE (3)
AOSC 431 (3)	CORE (3)	AOSC 375 (3)	Elective (3)
AOSC 400 (3)	Elective (3)	Elective (3)	Elective (3)
CORE (3)	Elective (3)		

D. Research/Internship Opportunities: Many of our present undergraduate students, regardless of their major, have sought out and obtained productive internships in the Washington area. These experiences (whether at NASA, NOAA, EPA, DOE or other federal or state agencies) are important both to our students' academic careers, as they provide context and generate ideas for independent research projects, and to their professional careers. As we prepare to inaugurate the major in Atmospheric and Oceanic Science, we are working to strengthen and formalize our relationships with these organizations, so that we may offer internship opportunities for all AOSC undergraduate majors. As part of this effort we expect to introduce summer courses for rising sophomore students to expose them to internship opportunities in the region via field trips to research and forecasting laboratories in the region and to provide some oversight for the students involved in internships. We envision that when a student participates in an internship, the work will generally develop into a project that will be the focus of the student's independent research (AOSC 498).

All AOSC majors will complete a two-semester undergraduate research requirement (AOSC493 and AOSC498) modeled on the successful Geology Department undergraduate senior thesis (www.geol.umd.edu/undergraduates/Senior_Thesis_Description.html). The first semester (AOSC493) is a single-instructor led course leading to a nontrivial 'falsifiable hypothesis' that can be tested during a semester (AOSC498). AOSC493 provides training in conducting

appropriate background literature search specific to atmospheric and oceanic science, written and oral communication instruction, as well as help with construction of a research plan, and identification of an individual research advisor specific to that project (who will then serve as instructor for AOSC498). One student might, for example, choose to develop a hypothesis regarding the relationship between annual atmospheric CO₂ levels and surface air temperatures that will involve examination of proxy estimates of these quantities obtained from the 1,000,000 year long ice core record at the Russian Vostok station in Antarctica⁷. Exploration of this data set might then lead to a need to explore time series analysis techniques, understand potential error sources associated with air chemistry and ice formation, explore the degree to which a single measurement in Antarctica might reflect global average values, etc.

During the second semester students will complete the research. Requirements include two ~10 minute oral presentations before the assembled faculty (a progress report and the final presentation) as well as a final written report. The availability of local summer science internship opportunities will offer raising seniors who want to exploit it, the opportunity to progress even more deeply into a research problem than is possible in a single semester course (AOSC498).

E. Program Management: Development of this new major places three burdens on our faculty: additional undergraduate teaching, research advising, and administrative oversight. To minimize the need for additional resources the coursework for the major has been carefully designed so that only one additional course has been added to our undergraduate curriculum (the other courses are redesigned versions of current courses). As a result AOSC teaching loads should be unaffected.

Research advising is a critical aspect of the new major. We expect our academic faculty to advise ~2-3 students each in the spring semester. We expect additional students will be advised by research and adjunct faculty, so that each student can be assigned a faculty advisor, and put together a course of study and a senior research project that is challenging, meets our department standards, and will lead to a clear career path. Administrative oversight will be provided by the AOSC Undergraduate Director (a tenure track faculty member) and the Associate Director of Undergraduate Studies (a non-tenure position).

III. STUDENT LEARNING OUTCOMES AND ASSESSMENT

Program Goals: The Atmospheric and Oceanic Science B.S. program seeks to educate majors in the basic principles that control our weather and the interactions between atmosphere and ocean that regulate Earth's climate. Students will be provided with practical experience as researchers and creators of knowledge, and equipped with the requirements for a full range of careers in Atmospheric and Oceanic Science, as well as for related areas in secondary education, graduate school, industry, and public service.

Relevance of goals to the mission statements and/or strategic plans of the University, College, or Program as applicable:

⁷ www.ncdc.noaa.gov/paleo/icecore/antarctica/vostok/vostok.html

These program goals are aligned with the strategic plans of the College and University to equip our graduates with the skills and knowledge to lead the next generation of scientists and innovators. Through their emphasis on research, our goals also support the University's mandates to create and advance knowledge for the benefit of the economy and the culture of the State, the region, the nation and beyond.

Student Learning Outcomes Assessment Measures and Criteria Assessment Schedule

<p>1. Students will demonstrate competence in the design and execution of research in Atmospheric and Oceanic Science</p>	<p>Measure: AOSC 493, AOSC 498 <i>Senior Research Project</i> I, II forms the two-semester required senior project in which the student writes a formal proposal of research and at the conclusion presents a final oral and written presentation. This project represents the capstone of the Atmospheric and Oceanic Science Major and aims to test the full range of a student's professional skills. The sequence, therefore, ideally suits the need for the evaluation of programmatic learning outcomes. We will assess performance in the senior research project using a rubric that independently evaluates the following aspects of the student's thesis work:</p> <ul style="list-style-type: none"> • Research Design: Knowledge and implementation of proper methods of research design • Research subject knowledge: Depth and quality of specific research-related knowledge <p>Research methodology competence will be addressed through the first of these components.</p> <p>Criteria: At least 75% of students attempting to complete AOSC 493/498 receive at least a satisfactory evaluation in the "research design" component of their senior thesis evaluation.</p>	<p>Satisfactory completion rate is analyzed annually beginning in 2012 for all students completing the major. Results to be shared with departmental faculty</p>
<p>2. Students will demonstrate a competence in the standard media of professional communications in the Atmospheric and Oceanic Sciences, including written manuscripts, oral presentations, and poster</p>	<p>Measure: Work for the senior research project includes oral presentations in AOSC 493 as well as a written prospectus. The final presentation for AOSC 498 consists of a poster and research paper. Together, these form a broad and substantive basis for the evaluation of student communication</p>	<p>Satisfactory completion rate is analyzed annually beginning in 2012 for all students completing the major. Results to be shared with departmental faculty</p>

presentations.

proficiency. Evaluations will focus on the prospectus and final presentations to facilitate a longitudinal assessment of student improvement during the thesis sequence.

Criterion: At least 75% of all presentations in AOSC 498 will receive a satisfactory evaluation in the "Presentation Skills" component of their senior project evaluation.

3. Students will demonstrate competent knowledge of a broad cross-section of Atmospheric and Oceanic science subject material.

Measure: Although students pursue specialized research topics during AOSC 493 and AOSC 498, success demands general familiarity with the broad range of concepts in Atmospheric and Oceanic science, and a substantial depth of general factual knowledge *a priori*. The typical student creatively integrates and recombines this knowledge while pursuing their final presentation. Evaluations will focus on the initial proposal presentation and the final presentations in AOSC 498 to facilitate a longitudinal assessment of student improvement during the thesis sequence.

Satisfactory completion rate is analyzed annually beginning in 2012 for all students completing the major. Results to be shared with departmental faculty

Criterion: At least 75% of all proposal presentations and 65% in the final presentation for AOSC 498 will receive a satisfactory evaluation in the "General subject knowledge" component of their senior project evaluation.

4. Students will demonstrate the ability to gain in-depth knowledge of a specific area of Atmospheric and Oceanic science in the context of active research.

The "research subject knowledge" component of the senior project evaluations will assess the student's command of this specialized knowledge. Evaluations will focus on initial presentations of the proposal of AOSC 493 and final presentations of AOSC 498 in to facilitate a longitudinal assessment of student

Satisfactory completion rate is analyzed annually beginning in 2012. Results to be shared with departmental faculty

improvement during the thesis sequence.

Criterion: At least 75% of all presentations of the proposals and 65% in the final presentation will receive a satisfactory evaluation in the "Research subject knowledge" component of their senior thesis evaluation

IV. FACULTY AND ORGANIZATION

Academic direction and oversight for the program will be the responsibility of a faculty member serving as *Undergraduate Director* who will be assisted by the Associate Director for Undergraduate Studies, and who will report to the Department Chair. The Undergraduate Director will have overall responsibility for assigning advisors and monitoring senior research projects in AOSC 498 and will oversee AOSC 493 (taught by the Associate Director). The Undergraduate Director will also have oversight in selection of Teaching Assistants when available. The Undergraduate Director will be expected to present and discuss major decisions regarding the structure of the program at the regular AOSC faculty meetings. Assignment of faculty to needed courses will be the responsibility of the AOSC Curriculum Committee.

V. COMMITMENT TO DIVERSITY

In keeping with the established tradition at the University of Maryland we will make every effort to attract women and underrepresented minority students to the program. AOSC has about 50% women students enrolled in our Graduate Program and we expect to be similarly successful at the undergraduate level. We expect to need to complement our efforts to attract minority students through recruiting efforts in the Maryland high schools.

VI. RECRUITMENT AND ADVERTISING

We will work with the Office of Undergraduate Admissions to design a recruiting program for the AOSC major. We think the AOSC B.S. program could be effectively advertised directly to high schools and Community Colleges through conversations with the science teachers and counseling coordinators. This contact work would be one of the responsibilities of the Associate Director of Undergraduate Studies. This effort will be accompanied by an attractive Department website devoted to the undergraduate program, addressing such information as career paths for AOSC majors.

VII. REQUIRED PHYSICAL RESOURCES

A. Library Resources

- A relative handful of reserve copies of course textbooks may need to be added for the new courses.
- Most research projects simply require online access to science journals (already available). Additional library resources are available, if needed, through the NASA/Goddard and the NOAA central libraries.

B. Additional facilities, facility modifications, and equipment

- Undergraduate student lounge (2000 ft²) to be provided by Department.

- Equipment for student lounge: white boards, couch, several comfortable chairs, microwave, two workstations, printer, (~\$4,000) to be provided by the Department
- Office for Associate Director for Undergraduate Studies to be provided by Department.

C. Impact, if any, on the use of existing facilities and equipment

- The Department maintains an instructional laboratory with 25 PCs, and accompanying storage and printers which will be available to the Undergraduate Majors. This facility is currently up-to-date and we expect to use annual Tech Fees to maintain it. We expect the undergraduate majors to make extensive use of this facility.
- The Department computer system (computational, mail, and data servers, basic software, etc) is maintained by a combination of Department and Research grants. We have budgeted a modest \$10K/yr for augmented system support. We expect to handle the hardware requirements of the undergraduate program within our current extensive resources.
- Expanded enrollment in current AOSC undergraduate courses will eventually require Teach Assistants for which we have no base funds. We budget for \$10K in 2013/4, doubling by 2014/15.

VIII. RESOURCE NEEDS and SOURCES

A. List new courses to be taught, and needed additional sections of existing courses

- New courses (see Appendix A for descriptions):
 - AOSC 470 Synoptic Meteorology
 - AOSC 493 Senior Research Project I
 - AOSC 498 Senior Research Project II
 - AOSC 494 Department Seminar
- Modified courses (see Appendix A for descriptions):
 - AOSC 431 becomes AOSC 431 Atmospheric Thermodynamics
 - AOSC 432 becomes: AOSC 432 Dynamics of the Atmosphere and Ocean
 - AOSC 400 becomes: AOSC 400 Physical Meteorology of the Atmosphere
 - AOSC 401 becomes: AOSC 401 Climate Dynamics and Earth System Science

The course AOSC 470 Synoptic Meteorology will be taught by adjunct faculty. The reason for this is 1) synoptic meteorology is a specialized topic which cannot be covered as well by our current faculty, but 2) the Washington DC area has the world's largest concentration of scientists with the expertise to teach this material.

B. List new faculty, staff, and teaching assistants needed

- Associate Director for Undergraduate Studies will provide day-to-day advising on subjects such as course selection as well as career guidance. Resources are requested to support the hiring of this person at ½ time.
- The Department will need some TA support as the program grows to enable us to handle the larger classes.

C. Teaching, advising, and administrative duties to be covered by existing faculty and staff

- Undergraduate Director. His/her responsibility will be to: provide overall leadership for the undergraduate program, and supervise the Associate Director for Undergraduate Studies and teach *AOSC 493 Senior Research Project I*. This position represents an

expansion of duties of the current Undergraduate Director. The teaching of AOSC 493 will count as fulfilling part of his/her annual expected teaching.

- AOSC Computer Services. The duties of Computer services will be expanded to accommodate the additional Undergraduate Majors.
- Graduate Secretary. The Graduate Secretary, who is currently working ½ time will be expanded to fulltime in order to handle the additional work associated with maintaining the paperwork for the undergraduate majors.
- Additional help for the teaching program will be supplied by two new anticipated faculty hires in progress.

D. Identify the source to pay for the required physical resources identified in B.

Funds will be provided by CMNS to cover hiring of the Associate Director for Undergraduate Studies and TA support.

E. List any other required resources and the anticipated source for them

- There will be some impact on MATH, PHYS, CMSC, and CHEM (possibly including the need for additional sections of certain courses) for our prerequisite courses.
- Because the total number of classes remains nearly constant there shouldn't be a need for additional classrooms.
- AOSC currently maintains a computer laboratory for its graduate program. Eventually as this laboratory requires refurbishment there will be a need for some additional funds requested of CMNS.

F. Financial Tables (www.provost.umd.edu/PCC_DOCUMENTS/MHEC_Proposal.htm).

F. Financial Tables

TABLE 1: RESOURCES					
Resources Categories	(Year 1)	(Year 2)	(Year 3)	(Year 4)	(Year 5)
1. Reallocated Funds ¹	504,498	552,598	552,598	597,057	621,787
2. Tuition/Fee Revenue ² (c+g below)	n/a	n/a	n/a	n/a	n/a
a. #F.T Students	15	25	40	50	60
b. Annual Tuition/Fee Rate (assumes 70% instate, 30% out-of-state, 3% tuition increase each year)					
c. Annual Full Time Revenue (a x b) Note: a=(add current yr students + previous yr students X b.) * 70% for amt of AOSC classes)					
d. # Part Time Students					
e. Credit Hour Rate (same assumptions as in b.)					
f. Annual Credit Hours					
g. Total Part Time Revenue (d x e x f) (@ 70& AOSC classes)					
3. Grants, Contracts, & Other External Sources ³	0	0	0	0	0
4. Other Sources	0	0	0	0	0
TOTAL (Add 1 - 4)	504,498	552,598	552,598	597,057	621,787

TABLE 2: EXPENDITURES

Expenditure Categories	(Year 1)	(Year 2)	(Year 3)	(Year 4)	(Year 5)
1. Total Faculty Expenses (b + c below)	366,600	366,600	366,600	366,600	366,600
a. # FTE	2	2	2	2	2
b. Total Salary	282,000	282,000	282,000	282,000	282,000
c. Total Benefits	84,600	84,600	84,600	84,600	84,600
2. Total Assoc. Director of UG Expenses (b + c below)	6,500	54,600	54,600	54,600	54,600
a. # FTE	.5	.5	.5	.5	.5
b. Total Salary	5,000	42,000	42,000	42,000	42,000
c. Total Benefits	1,500	12,600	12,600	12,600	12,600
3. Total Administrative Staff Expenses (b + c below)	27,479	27,479	27,479	27,479	27,479
a. # FTE	.5	.5	.5	.5	.5
b. Total Salary	21,138	21,138	21,138	21,138	21,138
c. Total Benefits	6,341	6,341	6,341	6,341	6,341
4. Total Teaching Assistants Expenses (b + c below)	98,918	98,918	98,918	148,378	173,107
a. # FTE	4	4	4	6	7
b. Total Salary	77,280	77,280	77,280	115,920	135,240
c. Total Benefits	21,638	21,638	21,638	32,458	37,867
5. Equipment	0	0	0	0	0
6. Library	0	0	0	0	0
7. New or Renovated Space	5,000	5,000	5,000	0	0
8. Other Expenses	0	0	0	0	0
TOTAL (Add 1 - 8)	504,498	552,598	552,598	597,057	621,787

Budget Narrative: additional information

Resources

1. The origin of the reallocated funds is primarily reassigned Instructional Tenure Faculty, taking into account two new hires. Additional reallocated funds come from the assumption of redistribution of funds associated with one faculty retirement and restructuring of the duties of an office staff member to include the role of undergraduate secretary. Reduction in teaching at the graduate level will result in a several low enrollment graduate courses being taught, e.g., every other year instead of every year, which we do not expect to significantly impact graduate student progress. The impact on the existing graduate program will be positive in net due to the expansion of teaching opportunities for AOSC graduate students.
2. Tuition/fee revenue is not included in the budget. We estimate a steady state enrollment of 60 majors, with a starting enrollment of about 15 students. While we expect that some students will migrate into the program from similar majors on campus, we also expect that many will be students who might not otherwise attend UMCP. Overall, the program is small enough that we do not, at this time, anticipate it to grow the overall enrollment at the university and thus do not include new tuition revenue as part of the available resources.

The overall impact on the institution will be to expand educational opportunities for undergraduate students in the areas of atmospheric and oceanic science, while it will open up new opportunities for graduate students to get exposure to undergraduate education. The impact on existing programs will be a slight increase in demand for seats in introductory courses in, e.g. mathematics, physics, chemistry, and computer science.

Expenditures

- 1-3. Faculty expenses are estimated based on an average faculty salary for the equivalent of two faculty dedicated to the major. Additional expenses include funds to support an Associate Director of the Undergraduate Program (with reduced duties in the first year) and administrative staff support.
4. Support is included for Teaching Assistants, the need for whom will grow as the program expands.
5. The department currently supports a computer laboratory. No additional equipment is budgeted for the undergraduate program.
6. No expansion of library resources is anticipated.
7. \$5,000 is allocated for each of the first three years for renovation of space to allow for student space.

IX. APPENDIX ACOURSES

A. Catalog description of currently approved courses

AOSC 123 Causes and Implications of Global Change; (3 credits) Grade Method: REG/P-F/AUD. CORE Physical Science (PS) Course.

Also offered as GEOG 123, and GEOL 123. Credit will be granted for only one of the following: AOSC 123, GEOG 123, GEOL 123, or METO 123. Formerly METO 123. This course offers a unique experience in integrating physical, chemical, geological and biological sciences with geographical, economic, sociological and political knowledge skills toward a better understanding of global change. Review of environmental science relating to weather and climate change, acid precipitation, ozone holes, global warming and impacts on biology, agriculture and human behavior. Study of the natural, long-term variability of the global environment, and what influence mankind may have in perturbing it from its natural evolution. Concepts of how physical, biological and human behavioral systems interact, and the repercussions which may follow from human endeavors. The manner in which to approach decision and policy making related to issues of global change.

AOSC 200 Weather and Climate. CORE Physical Science (PS) Course.

CORE Physical Science Lab (PL) course only when taken concurrently with AOSC 201. Prerequisites: MATH 110 or MATH 115. Recommended as a co-requisite: AOSC 201. Broad survey of the state of knowledge and problems of atmospheric science. Origin and structure of the atmosphere, meteorological observations, weather maps, forecasting, satellites, energetics, wind, general circulation, storms, severe weather, climate change, air pollution.

AOSC 346 Cycles in the Earth System (3)

Prerequisite: MATH 140, AOSC/GEOG/GEOL 123, or permission of department.

Recommended: MATH 141, PHYS 141, PHYS 171, or PHYS 161. Also offered as GEOG 346, GEOL 346. The Earth System operates through some fundamental cycles such as water, energy, and the carbon cycles. This course will build on GEOL/GEOG/AOSC 123 starting with concept of feedbacks within the Earth System, global energy balance and the Greenhouse Effect. A brief introduction to the atmospheric and oceanic circulation will lead to the water cycle connecting the land, ocean, and atmosphere to the Earth System. Introduction to the Global carbon, nitrogen, and sulfur cycles will be followed by the concept of long-term climate regulation and short-term climate variability. The concepts of cycles, feedbacks, forcings, and responses in the Earth System will be applied to Global Warming and Ozone Depletion.

AOSC/GEOL 375 Introduction to the Blue Ocean (3)

Prerequisite: MATH 140. Recommended: MATH 141, PHYS 161, or PHYS 171.

Introduction to physical, chemical, and biological properties of the ocean. Role of the ocean in climate as a component of the Earth system. El Nino and the ocean, impact of global warming on the ocean and marine habitats including fisheries.

AOSC 386 Experiential Learning (3-6) Prerequisite: Learning Proposal approved by the Office of Experiential Learning Programs, faculty sponsor and student's internship sponsor. Junior standing. Formerly METO 386.

AOSC 400 The Atmosphere; (3 credits) Grade Method: REG/P-F/AUD.

Prerequisites: MATH 141, PHYS 161, PHYS 171 or permission of department. Formerly METO 400. The atmosphere and its weather and climate systems. Composition of the atmosphere, energy sources and sinks, winds, storms and global circulation. The application of basic classical physics, chemistry and mathematics to the study of the atmosphere.

AOSC 401 Global Environment; (3 credits) Grade Method: REG/P-F/AUD.

Prerequisite: AOSC 400/METO 400. The global weather and climate system; the natural variability of the atmosphere-ocean-biosphere. Potential human effects: greenhouse effects, deforestation, acid rain, ozone depletion, nuclear winter. Social, political and economic effects of changes in global environment. Policy options.

AOSC 424 Remote Sensing of the Atmosphere and Ocean; (3 credits) Grade Method: REG/P-F/AUD.

Prerequisite: MATH 141; MATH 240; PHYS 161; or permission of instructor. Many of the properties of the atmosphere, ocean, and land surface are most easily observed from satellite remote sensing. This course will provide students with a hands-on introduction to a variety of passive and active sensing techniques and sensors observing our changing environment. Topics include: orbital dynamics and electromagnetic properties of the atmosphere and surface; atmospheric emission characteristics and scattering; chemical composition and spectroscopy; temperature retrievals; detection and retrieval of aerosol, cloud and rain; ocean surface properties; sea surface temperature and color; active sensing of wind stress, sea level, and internal waves; time-dependent gravity; properties of vegetation and ice.

AOSC 431 Atmospheric Physics and Thermodynamics;(3 credits) Grade Method: REG/P-F/AUD.

Prerequisites: MATH 240 or MATH 461; PHYS 270 and PHYS 271 (Formerly: PHYS 263); CHEM 135 and CHEM 132/136 (Formerly: CHEM 103). Recommended: MATH 246. The general character of the atmosphere and its weather and climate systems, phenomena and distributions of variables (winds, temperature, pressure and moisture). The formal framework of the science; the application of basic classical physics, chemistry, mathematics and computational sciences to the atmosphere.

AOSC 432 Large Scale Atmospheric Dynamics; (3 credits) Grade Method: REG/P-F/AUD.

Prerequisite: AOSC 431/METO 431. Corequisite: MATH 246. 3 semester hours. Credit will be granted for only one of the following: AOSC 432, METO 432, or AOSC 632. Formerly METO 432. The physics of the atmospheric motions that control mid-latitude weather; physics of hurricanes; mathematics of climate change.

AOSC 434 Air Pollution; (3 credits) Grade Method: REG/P-F/AUD.

Prerequisites: CHEM 135 and MATH 241 or permission of department.

Production, transformation, transport and removal of air pollutants. The problems of photochemical smog, the greenhouse effect, stratospheric ozone, acid rain and visibility. Analytical techniques for gases and particles. Also offered as AOSC 658R or CHEM678A.

AOSC 499 Special Problems in Atmospheric Science (1-3) Prerequisite: permission of department. Repeatable to 6 credits. Formerly METO 499. Research or special study in the field of meteorology and the atmospheric and oceanic sciences.

B. Catalog descriptions of the new or revised courses and relationship to current courses

As discussed above, this program leverages off the current graduate program and undergraduate curriculum. However a number of changes will be required, many cosmetic (changing names to satisfy various Civil Service requirements), but some more substantive. The current course AOSC 400 *The Atmosphere* will evolve into AOSC 400 *Physical Meteorology of the Atmosphere*; AOSC 401 *Global Environment* will evolve into AOSC 401 *Climate Dynamics and Earth System Science*; AOSC 431 *Atmospheric Physics and Thermodynamics* will evolve into AOSC 431 *Atmospheric Thermodynamics*; AOSC 432 *Large Scale Atmospheric Dynamics* will evolve into AOSC 432 *Dynamics of the Atmosphere and Oceans*. The following four new courses will be created: AOSC 494 *Seminar* which will rely on the AOSC weekly seminar series, AOSC 470 *Synoptic Meteorology* which will share lectures with the graduate course, of the same name (AOSC 600); and AOSC 493 and 498 *Senior Research Project I, II*. Below are listed the catalog descriptions for the new or newly revised courses required for this major.

A slight change in the course description of AOSC 200:

AOSC 200 Weather and Climate (3 credits) Grade Method: REG/P-F/AUD. CORE Physical Science (PS) Course. CORE Physical Science Lab (PL) course only when taken concurrently with AOSC 201. Prerequisites: MATH 110 or MATH 115. Recommended as a corequisite: AOSC 201. Broad survey of the state of knowledge and problems of atmospheric science. Origin and structure of the atmosphere, meteorological observations, analysis and prediction of weather systems (synoptic and mesoscale), satellites, energetics, wind, general circulation, storms, severe weather, climate change, air pollution.

AOSC 400 alters its title and description:

AOSC 400 Physical Meteorology of the Atmosphere;(3 credits) Grade Method: REG/P-F/AUD.

Prerequisites: MATH 141, PHYS 161/171 with grade of C or higher or permission of department. The application of basic classical physics, chemistry and mathematics to the study of the atmosphere. Composition of the atmosphere; energy sources and sinks (radiation in the atmosphere; radiative balance and radiative forcing of atmospheric processes); atmospheric thermodynamics; clouds and precipitation physics; atmospheric electricity and optics; mesoscale processes (e. g., orographic mesoscale phenomena and instabilities); air mass boundaries; severe weather; tropical cyclones; storms; global circulation.

AOSC 401 becomes:

AOSC 401 Climate Dynamics and Earth System Science;(3 credits) Grade Method: REG/P-F/AUD.

Prerequisite: AOSC 200 or AOSC 431 or permission of instructor. The global weather and climate system; the natural variability of the atmosphere-ocean-biosphere; carbon cycle and biogeochemistry. Potential human effects: greenhouse effects, deforestation, acid rain, ozone

depletion, nuclear winter. Social, political and economic aspects of changes in global environment. Policy options.

AOSC 424 drops the requirement for Math 240:

AOSC 424 Remote Sensing of the Atmosphere and Ocean; (3 credits) Grade Method: REG/P-F/AUD.

Prerequisite: MATH 141; PHYS 161; or permission of instructor. Many of the properties of the atmosphere, ocean, and land surface are most easily observed from satellite remote sensing. This course will provide students with a hands-on introduction to a variety of passive and active sensing techniques and sensors observing our changing environment. Topics include: orbital dynamics and electromagnetic properties of the atmosphere and surface; atmospheric emission characteristics and scattering; chemical composition and spectroscopy; temperature retrievals; detection and retrieval of aerosol, cloud and rain; ocean surface properties; sea surface temperature and color; active sensing of wind stress, sea level, and internal waves; time-dependent gravity; properties of vegetation and ice.

AOSC 431 becomes:

AOSC 431 Atmospheric Thermodynamics (3 Credits) Grade Method: REG/P-F/AUD.

Prerequisites: MATH 141, PHYS 161 with grade of C or higher. Classical thermodynamics applied to both the dry and the moist atmosphere. Composition; phase changes of water; stability concepts; Properties of aerosols and clouds, cloud nucleation and precipitation processes, atmospheric electricity, cloud and precipitation chemistry.

AOSC 432 becomes:

AOSC 432 Dynamics of the Atmosphere and Ocean (3 Credits) Grade Method: REG/P-F/AUD.

Prerequisites: MATH 241, MATH 246, PHYS 260/270 with grade of C or higher. Equations of motion and their approximation, scale analysis for the atmosphere and the ocean. Conservation properties. Fluid motion in the atmosphere and oceans. Circulation and vorticity, geostrophic motion and the gradient wind balance. Turbulence and Ekman Layers. Kinematics, balanced and unbalanced flows, vorticity and potential vorticity, and introduction to the boundary layer and numerical weather prediction. Ocean currents and tides.

The following course is created which parallels AOSC 600:

AOSC 470 Synoptic Meteorology (3 Credits) Grade Method: REG/P-F/AUD.

Prerequisites: AOSC 431/432 with grade of C or higher. Atmospheric properties and observations, meteorological analysis and charts, operational numerical forecasts. Application of quasigeostrophic theory, baroclinic instability, midlatitude and mesoscale weather systems. Tropical meteorology. Weather forecasting using numerical and statistical models. Prediction of weather phenomena on the global, synoptic, meso, and local scales. Analysis of surface and upper air data; Norwegian cyclone model; introduction to weather forecasting. Will be taught concurrently with AOSC 600.

The following seminar course is created:

AOSC 494 Atmospheric and Oceanic Science Seminar (1 credit) Grade Method: REG/P-F/AUD.

Prerequisite: AOSC 431/432 with grade of C or higher.

Exposure to a wide range of contemporary topics in atmospheric, oceanic, and climate sciences, to foster research interests and promote critical thinking through the weekly AOSC departmental seminar series.

The following twin senior research courses are created (further discussion of these on p.10):

AOSC 493 Senior Research Project I (3) *Prerequisites: For AOSC majors only; permission of department. In addition, non-degree-seeking students require the permission of the instructor.* Technical writing and oral presentation skills. Planning, writing, and presenting a plan for research in the geosciences.

AOSC 498 Senior Research Project II (3) *Prerequisite: AOSC 493.* Individual Instruction course: contact department or instructor to obtain section number. Project will be based on the research or development plan developed in AOSC 493. May be completed with the approval of a faculty advisor in conjunction with an internship. Final written thesis and oral defense will be expected.

X. APPENDIX B SATISFYING PROFESSIONAL CERTIFICATION

Federal civil service requirements for meteorologist positions (GS 1340, effective 3/1/98)
(www.opm.gov/qualifications/standards/IORs/GS1300/1340.htm)

Degree: meteorology, atmospheric science, or other natural science major that included:

- I) At least 24 semester (36 quarter) hours of credit in meteorology/atmospheric science including a minimum of:
 - 1) Six semester hours of atmospheric dynamics and thermodynamics;
Satisfied by AOSC 431, AOSC 432
 - 2) Six semester hours of analysis and prediction of weather systems (synoptic/mesoscale);
Satisfied by AOSC 200, AOSC 470
 - 3) Three semester hours of physical meteorology;
Satisfied by AOSC 400
 - 4) Two semester hours of remote sensing of the atmosphere and/or instrumentation
Satisfied by AOSC 424
- II) Six semester hours of physics, with at least one course that includes laboratory sessions.
Satisfied by PHYS 161, PHYS 260-261 or PHYS 171-261, PHYS 272
- III) Three semester hours of ordinary differential equations
Satisfied by MATH 246 or MATH 340-341
- IV) At least nine semester hours of course work appropriate for a physical science major in any combination of three or more of the following: physical hydrology, statistics, chemistry, physical oceanography, physical climatology, radiative transfer, aeronomy, advanced thermodynamics, advanced electricity and magnetism, light and optics, and computer science.
AOSC 498 and additional courses from e.g.: AOSC 375, AOSC 401, AOSC 434, as well as a variety of courses in CHEM and PHYS.

Appendix American Meteorological Society Bachelor's Degree in Atmospheric Science
(http://www.ametsoc.org/policy/2010degree_atmosphericsscience_amsstatement.html)

3. Basic Components of an Undergraduate Degree in Atmospheric Science

a. Prerequisite Topics in Mathematics and Physical Sciences

Mathematics **Satisfied by MATH 140, 141, and 246 or MATH 340-341, STAT 400**

Physics **Satisfied by PHYS 161, 260, and 270 or PHYS 171, 272, and 273**

Chemistry **Satisfied by CHEM 135**

b. Required Skills and Competencies

Scientific Computing **Satisfied by CMSC 106 or 131, AOSC coursework**

Oral, Written, and Multimedia Communication **Satisfied by ENGL101 and 390, and AOSC 493**

c. Required Topics in Atmospheric Science

Meteorological Measurements **Satisfied by AOSC 424**

Physical Meteorology **Satisfied by AOSC 431 and AOSC 400**

Dynamic Meteorology **Satisfied by AOSC 432**

Synoptic Meteorology **Satisfied by AOSC 200 and AOSC 470**

Mesoscale Meteorology **Satisfied by AOSC 400 and AOSC 470**

Climate Dynamics **Satisfied by AOSC 401**

Capstone Experience **Satisfied by AOSC 493 and AOSC 498**

Federal civil service requirements for oceanographer positions (GS 1360, effective 1 March 1998) (www.opm.gov/qualifications/standards/IORs/GS1300/1360.htm)

Basic Requirements:

Degree: major study of at least 24 semester hours in oceanography or a related discipline such as physics, meteorology, geophysics, mathematics, chemistry, engineering, geology, or biology, **Satisfied by the required AOSC coursework plus AOSC 375 and BSCI373 or 375**

20 additional semester hours in any combination of oceanography, physics, geophysics, chemistry, mathematics, meteorology, computer science, and engineering sciences.

Satisfied by the prerequisites external to AOSC

XI. APPENDIX C COMMUNICATIONS WITH ASSOCIATED PROGRAMS
(Mathematics, Physics, Chemistry, Computer Science, the Library, and ESSIC)



UNIVERSITY OF MARYLAND

Department of Atmospheric and Oceanic Science

Appendix

Computer and Space Sciences Building
University of Maryland
College Park, Maryland 20742-2425 USA
Tel: (301)405-5365 Fax: (301)314-9482
carton@atmos.umd.edu
<http://www.atmos.umd.edu/~carton>

August 3, 2010

Brian Hunt
Associate Chair for Undergraduate Education, Mathematics
MTH 1105
CAMPUS

Dear Brian,

As you may know, the Department of Atmospheric and Oceanic Science is proposing to create an undergraduate degree program in Atmospheric and Oceanic Science. Motivations include the growing interest in these aspects of environmental science among UMD students, the availability of jobs in this discipline in our region, the impending shift of significant portions of the National Weather Service onto our MSquare campus, and the associated strengthening of our faculty. We roughly estimate having initially 15 majors eventually growing to a steady state of ~60.

Since the physics, chemistry, and biology of the atmosphere and oceans is expressed in the language of differential equations I am writing to request that you allow us to require our majors to take math courses through MATH 246.

Required courses.

	MATH 140	Calculus I	4 credits
	MATH 141	Calculus II	4 credits
Either:	MATH 241	Calculus III	4 credits
	MATH 246	Differential Equations	3 credits
or:	MATH 340	Multivariable Calculus, Linear Algebra and Differential equations I	3 credits
	MATH 341	Multivariable Calculus, Linear Algebra and Differential Equations II	3 credits

In addition, we would like to list the following courses as electives:

either	MATH 240	Linear Algebra	3 credits
or	MATH 461	Linear Algebra for Scientists and Engineers	3 credits
	MATH 416	Applied Harmonic Analysis: An Introduction to Signal Processing	3 credits
	MATH 452	Introduction to Dynamics and Chaos	3 credits
	MATH 462	Partial Differential Equations for Scientists and Engineers	3 credits

Permission to include your courses will be critical to the success of our major and thus to our proposal, and we would deeply appreciate your support. If you are willing to provide permission an email to me (carton@atmos.umd.edu) will be fine. We hope to submit our application soon after the beginning of the fall semester. If I can provide any additional information, please let me know (301-405-5365).

Yours,

Jim Carton

REPLY

Subject:Re: AOSC request associated with AOSC UG Major proposal
 From:Brian Hunt <bhunt@umd.edu>
 Date:Tue, 3 Aug 2010 18:18:11 -0400
 To:Jim Carton <carton@atmos.umd.edu>
 CC:bhunt@ipst.umd.edu, dng@math.umd.edu

Dear Jim, I hereby give permission to require the courses described in your attachment. Good luck with your proposal.

-- Brian Hunt Associate Chair for Undergraduate Studies Department of Mathematics, University of Maryland On Tue, Aug 3, 2010 at 2:25 PM,



UNIVERSITY OF
MARYLAND

Department of Atmospheric and Oceanic Science

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carton@atmos.umd.edu
<http://www.atmos.umd.edu/~carton>

August 3, 2010

Richard Ellis
Associate Chair for Undergraduate Education, Physics
0201 Energy Research Facility
CAMPUS

Dear Rick,

As you may know from talking with Nick Hadley, the Department of Atmospheric and Oceanic Science is proposing to create an undergraduate degree program in Atmospheric and Oceanic Science. Motivations include the growing interest in these aspects of environmental science among UMD students, the availability of jobs in this discipline in our region, the impending shift of significant portions of the National Weather Service onto our MSquare campus, and the associated strengthening of our faculty. We roughly estimate having initially 15 majors eventually growing to a steady state of ~60.

We feel that a strong grounding in basic physics is essential for the success of our majors. I am writing to request that you allow us to require our majors to take three introductory physics classes (and two or three associated labs).

Required courses. Either the first three rows or the 2nd three:

PHYS 161 & PHYS 174	General physics: Mechanics and Particle Dynamics & Laboratory	4 credits
PHYS 260 & PHYS 261	General Physics: Vibration, Waves, Heat Electricity & Laboratory	4 credits
PHYS 270 & PHYS 271	General Physics: Electrodynamics, Light Relativity & Laboratory	4 credits
PHYS 171 & PHYS 174	Introductory physics: Mechanics & Laboratory	4 credits
PHYS 272 & PHYS 275	Introductory Physics: Fields & Laboratory	5 credits
PHYS 273	Introductory Physics: Waves	3 credits



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carton@atmos.umd.edu
<http://www.atmos.umd.edu/~carton>

August 3, 2010

Michael P. Montague-Smith
Lecturer and Director of Undergraduate Studies
2102A Chemistry
CAMPUS

Dear Dr. Montague-Smith,

As you may know, the Department of Atmospheric and Oceanic Science is proposing to create an undergraduate degree program in Atmospheric and Oceanic Science. Motivations include the growing interest in these aspects of environmental science among UMD students, the availability of jobs in this discipline in our region, the impending shift of significant portions of the National Weather Service onto our MSquare campus, and the associated strengthening of our faculty. We roughly estimate having initially 15 majors eventually growing to a steady state of ~60.

The program we envision has a significant and growing component of atmospheric and oceanic chemistry. To prepare our majors I am writing to request that you allow us to require them to take Chem 131 and its associated lab.

Required courses.

	CHEM 131 & CHEM 132	General Chemistry & Laboratory	4 credits
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In addition, we would like to list the following course as an elective:

CHEM 231	Organic Chemistry I	3 credits
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Permission to include your courses in the requirements for our major will be critical to its success and thus to our proposal, and we would deeply appreciate your support. If you are willing to provide permission an email to me (carton@atmos.umd.edu) will be fine. We hope to submit our application soon after the beginning of the fall semester. If I can provide any additional information, please let me know (301-405-5365).

Yours,
Jim Carton
Subject :

Fwd: request associated with proposal by AOSC for a new UG major
From: Michael Doyle <mdoyle3@umd.edu>
Date: Tue, 7 Sep 2010 12:10:31 -0400
To: Jim Carton <carton@atmos.umd.edu>
CC: Michael P Montague-Smith <mpms@umd.edu>

Dear Jim,

We see the advantages in this curricular arrangement. Obviously, we believe that understanding of chemistry is critical to the solution of environmental problems. This is agreeable to Michael Montague-Smith and myself, and we will obtain formal approval from the department at our next meeting.

Mike



UNIVERSITY OF MARYLAND

Department of Atmospheric and Oceanic Science

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carton@atmos.umd.edu
<http://www.atmos.umd.edu/~carton>

August 3, 2010

Professor Jeff Hollingsworth
Chair of the Undergraduate Program, Computer Science
4155 A.V. Williams
CAMPUS

Dear Jeff,

As you may know the Department of Atmospheric and Oceanic Science is proposing to create an undergraduate degree program in Atmospheric and Oceanic Science. Motivations include the growing interest in these aspects of environmental science among UMD students, the availability of jobs in this discipline in our region, the impending shift of significant portions of the National Weather Service onto our MSquare campus, and the associated strengthening of our faculty. We roughly estimate initially having 15 majors eventually growing to a steady state of ~60.

We think would be very important to require some background in computer science. I am writing to request that you allow us to require our majors to take one of the following courses

Required Computer/Computational Course

(3-4 credits: one of the following or equivalent)

CMSC 106	Introduction to C Programming	4 credits
CMSC 131	Object-Oriented Programming I	4 credits

In addition, we would like to list the following courses as electives:

CMSC 206	Introduction to Matlab	1 credit
either CMSC/AMSC 460	Computational Methods	3 credits
or CMSC 466	Introduction to Numerical Analysis I	3 credits

Permission to include your courses will be critical to the success of our major and thus to our proposal, and we would deeply appreciate your support. If you are willing to provide permission an email to me (carton@atmos.umd.edu) will be fine. We hope to submit our application soon

after the beginning of the fall semester. If I can provide any additional information, please let me know (301-405-5365).

Yours,

Jim Carton

Subject:Re: AOSC request associated with AOSC UG Major proposal
From:Jeff Hollingsworth <hollings@cs.umd.edu>
Date:Mon, 06 Sep 2010 20:27:55 -0400
To:Jim Carton <carton@atmos.umd.edu>

This seems reasonable to me. I didn't get the original request, I was traveling then and reading mail so I am not sure what happened to it.

Jeff

Response from ESSIC

Hi Jim, Needless to say this is a no brainer. While I appreciate the courtesy of this email, the answer of course is an emphatic yes.

Cheers..Tony

At 03:48 PM 9/6/2010, you wrote:

>Tony,

> As you know we are finally going to submit a plan to create an undergraduate major in >Atmospheric and Oceanic Science. A key aspect of the planed major is undergraduate >research. I am writing to request permission to list ESSIC as a potential resource for >research advising for the new major.

>Jim

--

>James Carton, Professor and Chairman
>Department of Atmospheric and Oceanic Science
>3413 Computer & Spaces Sci. Bldg., Univ. MD., College Park, MD 20742
>301-405-5391, (fax) 301-314-9482, www.atmos.umd.edu/~carton



UNIVERSITY OF
MARYLAND

THE UNIVERSITY LIBRARIES

College Park, Maryland 20742

DATE: August 13, 2010

TO: Dr. Jim Carton
Chair of the Department of Atmospheric and Oceanic Science

FROM: Dr. Desider Viktor *DV*
Director for Collection Management and Special Collections

Gerri Foudy *GF*
Manager of Collections and Scholarly Communication

Bob Kackley *BK*
Library Liaison to the Department of Atmospheric and Oceanic Science

RE: Library Collection Assessment

This assessment is in response to the Undergraduate Degree proposed by the Atmospheric and Oceanic Sciences (AOSC) Department, to which I am the Library Liaison, located in the College of Computer, Mathematical and Physical Sciences (CMPS). First, it must be stated that there is already a Masters Degree Program in AOSC with very strong resources already available in print and electronically. Plus, there will only be four distinct new classes, three of which are seminars or research projects, and they are AOSC494 -- Department Seminar (1 credit), AOSC493 -- Sr. Research Project I (3 credits), and AOSC498 -- Research Project II (3 credits). The one unique class proposed for this new undergraduate major is AOSC470 -- Synoptic Meteorology (3 credits). Also, the following information resources listed below help to demonstrate that the criteria satisfy the requirements for not only this new AOSC470 but the whole proposed AOSC Undergraduate Program.

Books

The Libraries' purchase plan automatically supplies many new books in Atmospheric and Oceanic Sciences and related subjects. Also, orders can be placed for additional materials including back orders of periodical ranges or direct requests from faculty or students. The 15 other USMAI libraries will have some items NOT at UMCP; and Interlibrary Loan (ILL) can adequately fill the vast majority of additional research needs.

Journals

Going to the database, Journal Citation Reports (JCR), located in our Research Port portal from www.lib.umd.edu, here is a list of the top twenty peer-reviewed journals by Impact Factor under the category of Meteorology and Atmospheric Sciences ---- all of which we have electronically available via Research Port except for #19, Climate Research, which the last four years we do not have access. Dates given may include access from more than one vendor:

1. **Bulletin of the American Meteorological Society** (0003-0007) 1970-
2. **Atmospheric chemistry and physics** (1680-7316) 2001-
3. **Global biogeochemical cycles** (0886-6236) 1987-
4. **Tellus. Series B, Chemical & physical meteorology** (0280-6509) 1997-
5. **Climate dynamics** (0930-7575) 1997-
6. **Climate of the Past** (1814-9324) 2005-
7. **International journal of greenhouse gas control** (1750-5836) 2007-
8. **Climatic Change** (0165-0009) 1997-
9. **Journal of Climate** (0894-8755) 1988-
10. **Environmental research letters** (1748-9318) 2006-
11. **Agricultural and forest meteorology** (0168-1923) 1995-
12. **Atmospheric environment** (1352-2310) 1995-
13. **Journal of the Atmospheric Sciences** (0022-4928) 1944-
14. **Aerosol science and technology** (0278-6826) 1988-
15. **Journal of hydrometeorology** (1525-755X) 2000-
16. **Journal of aerosol science** (0021-8502) 1995-
17. **Quarterly journal of the Royal Meteorological Society** (0035-9009) 2002-
18. **International journal of climatology** (0899-8418) 1996-
19. **Climate research** (0936-577X) 1990-2006 (*last four years not available*)
20. **Monthly Weather Review** (0027-0644) 1963-

Databases

1. **Academic Search Premier** – for the same searches as listed under Books, these are the results in Words anywhere 1) quasigeostrophic* -- 481 hits 2) baroclinic* -- 1,796 hits 3) "tropical meteorology" – 203 hits 4) weather and synoptic – 964 hits 5) mesoscal* and (weather or climat*) – 2,138 hits 6) "upper air" and data – 335 hits
2. **Web of Science** – for the same searches as listed under Academic Search Premier, these are the results in the TITLE 1) "quasigeostrophic*" -- 185 hits 2) baroclinic* -- 1,826 hits 3) "tropical meteorology" -- 39 hits 4) weather and synoptic – 126 hits 5) mesoscal* and (weather or climat*) – 200 hits 6) "upper air" and data – 29 hits
3. **ScienceDirect** - for the same searches as listed under Web of Science, these are the results in the TITLE 1) quasigeostrophic* -- 32 hits 2) baroclinic* -- 195 hits 3)

- “tropical meteorology” –8 hits 4) weather and synoptic – 19 hits 5) mesoscal* and (weather or climat*) – 13 hits 6) “upper air” and data – 3 hits
4. **Aerospace Database**- for just these three searches 1) in the TITLE quasigeostrophic* -- 124 hits 2) in Words anywhere baroclinic* gets 1,245 hits 3) in TITLE “tropical meteorology” –44 hits
 5. **NASA Technical Reports Server** – for just these three searches 1) in the Words anywhere quasigeostrophic* -- 40 hits 2) in Words anywhere baroclinic* gets 571 hits 3) in Words anywhere “tropical meteorology” – 592 hits
 6. **Google Scholar** – for just these three searches 1) “quasigeostrophic theory” – 1,310 hits 2) “baroclinic instability” gets 10,900 hits 3) “tropical meteorology” – 28,300 hits. When Google Scholar is accessed through Research Port, many journal articles will become available that we subscribe to that could not be accessed if off campus and not a UM current faculty, student, or staff member.

Conclusion

Two more helpful resources to be considered are the Technical Report Center at the Engineering & Physical Sciences Library (EPSL) with over 2 million microfiche available to complement those technical reports that have already been put online. Plus, EPSL is a US Patent and Trademark Depository Library with access to many patent resources as well as experienced librarians. The University of Maryland McKeldin Library is a Federal Depository Library with many helpful resources and guides to mostly online material. Finally, the staff at all UM libraries are exceptionally experienced and service-oriented, especially at EPSL when dealing with physical science and engineering queries. Thus, it is felt that the UM Libraries’ collections provide a strong base and continued growth to support adequately the curricular and research needs of the new proposed undergraduate degree in Atmospheric and Oceanic Sciences.