

# ATMOSPHERIC AND OCEANIC SCIENCES, B.A.

The study of atmospheric and oceanic sciences includes all aspects of the atmosphere and physical oceanography, their mutual interaction, and their interaction with space and the rest of the earth system. Although a primary goal is to understand the atmosphere and ocean for the purpose of predicting the weather, atmospheric and oceanic sciences embraces much more: motions at large, medium, and small scales; past, present, and future climates; air chemistry and quality; clouds and precipitation; and solar and terrestrial radiation. In many areas, new remote-sensing technology including satellites is used to provide circulation patterns at both global and local scales.

Many undergraduates take an elementary atmospheric and oceanic sciences course to meet part of their natural or physical science breadth requirements. Other students, who have had sufficient mathematics and physics preparation, take higher-level atmospheric and oceanic sciences courses to complement their major work in other fields of natural science. An atmospheric and oceanic sciences major receives a thorough introduction to the basic concepts and tools in the core courses, which cover the physics and dynamics of the atmosphere and ocean. An array of elective courses are offered in the senior year, with tracks in the areas of weather systems, earth/environmental science, and general and applied atmospheric and oceanic sciences. Elective groups are tailored individually. Some students will want preparation for careers in areas such as operational forecasting, environmental consulting, and broadcasting. Others will seek preparation for graduate work leading to a broader range of careers.

## HOW TO GET IN

Students wishing to declare the Atmospheric and Oceanic Sciences major should meet with an AOS undergraduate academic advisor. Contact information for advisors can be found on the Advising and Careers (<https://guide.wisc.edu/undergraduate/letters-science/atmospheric-oceanic-sciences/atmospheric-oceanic-sciences-bs/#advisingandcareerstext>) page.

## REQUIREMENTS

### UNIVERSITY GENERAL EDUCATION REQUIREMENTS

All undergraduate students at the University of Wisconsin–Madison are required to fulfill a minimum set of common university general education requirements to ensure that every graduate acquires the essential core of an undergraduate education. This core establishes a foundation for living a productive life, being a citizen of the world, appreciating aesthetic values, and engaging in lifelong learning in a continually changing world. Various schools and colleges will have requirements in addition to the requirements listed below. Consult your advisor for assistance, as needed. For additional information, see the university Undergraduate General Education Requirements (<http://guide.wisc.edu/undergraduate/#requirementsforundergraduatestudytext>) section of the *Guide*.

General Education	<ul style="list-style-type: none"> <li>• Breadth—Humanities/Literature/Arts: 6 credits</li> <li>• Breadth—Natural Science: 4 to 6 credits, consisting of one 4- or 5-credit course with a laboratory component; or two courses providing a total of 6 credits</li> <li>• Breadth—Social Studies: 3 credits</li> <li>• Communication Part A &amp; Part B *</li> <li>• Ethnic Studies *</li> <li>• Quantitative Reasoning Part A &amp; Part B *</li> </ul>
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\* The mortarboard symbol appears before the title of any course that fulfills one of the Communication Part A or Part B, Ethnic Studies, or Quantitative Reasoning Part A or Part B requirements.

### COLLEGE OF LETTERS & SCIENCE DEGREE REQUIREMENTS: BACHELOR OF ARTS (B.A.)

Students pursuing a bachelor of arts degree in the College of Letters & Science must complete all of the requirements below. The College of Letters & Science allows this major to be paired with either a bachelor of arts or a bachelor of science curriculum.

#### BACHELOR OF ARTS DEGREE REQUIREMENTS

**Mathematics** Complete the University General Education Requirements for Quantitative Reasoning A (QR-A) and Quantitative Reasoning B (QR-B) coursework.

**Foreign Language**

- Complete the fourth unit of a foreign language; OR
- Complete the third unit of a foreign language and the second unit of an additional foreign language.

**L&S Breadth**

- 12 credits of Humanities, which must include 6 credits of literature; and
- 12 credits of Social Science; and
- 12 credits of Natural Science, which must include one 3+ credit Biological Science course and one 3+ credit Physical Science course.

**Liberal Arts and Science Coursework** Complete at least 108 credits.

**Depth of Intermediate/Advanced work** Complete at least 60 credits at the intermediate or advanced level.

**Major** Declare and complete at least one major.

**Total Credits** Complete at least 120 credits.

**UW-Madison Experience**

- 30 credits in residence, overall; and
- 30 credits in residence after the 86th credit.

**Quality of Work**

- 2.000 in all coursework at UW–Madison
- 2.000 in Intermediate/Advanced level coursework at UW–Madison

#### NON–L&S STUDENTS PURSUING AN L&S MAJOR

Non–L&S students who have permission from their school/college to pursue an additional major within L&S only need to fulfill the

major requirements. They do not need to complete the L&S Degree Requirements above.

## REQUIREMENTS FOR THE MAJOR

Code	Title	Credits
<b>Calculus (complete all):</b>		
MATH 221	Calculus and Analytic Geometry 1	5
MATH 222	Calculus and Analytic Geometry 2	4
MATH 234	Calculus–Functions of Several Variables	4
<b>Physics (complete one course from each group):</b>		
PHYSICS 207	General Physics	5
or PHYSICS 201	General Physics	
or PHYSICS 247	A Modern Introduction to Physics	
PHYSICS 208	General Physics	5
or PHYSICS 202	General Physics	
or PHYSICS 248	A Modern Introduction to Physics	
<b>Computer Sciences (complete one):</b>		<b>3</b>
COMP SCI 220	Data Science Programming I	
COMP SCI 310	Problem Solving Using Computers	
COMP SCI 320	Data Science Programming II	
COMP SCI/ E C E 354	Machine Organization and Programming	
COMP SCI 412	Introduction to Numerical Methods	
COMP SCI/I SY E/ MATH 425	Introduction to Combinatorial Optimization	
<b>Total Credits</b>		<b>26</b>

Code	Title	Credits
<b>Core Sequence (complete all):</b>		
ATM OCN 310	Dynamics of the Atmosphere and Ocean I	3
ATM OCN 311	Dynamics of the Atmosphere and Ocean II	3
ATM OCN 330	Physics of the Atmosphere and Ocean I	3
ATM OCN 340	Physics of the Atmosphere and Ocean II	3
<b>Quantitative Analysis (complete one):</b>		<b>3</b>
COMP SCI 412	Introduction to Numerical Methods	
COMP SCI/MATH/ STAT 475	Introduction to Combinatorics	
COMP SCI/ MATH 514	Numerical Analysis	
COMP SCI/I SY E/ MATH/STAT 525	Linear Optimization	
MATH/STAT 309	Introduction to Probability and Mathematical Statistics I	
MATH/STAT 310	Introduction to Probability and Mathematical Statistics II	
MATH 319	Techniques in Ordinary Differential Equations	
MATH 320	Linear Algebra and Differential Equations	
MATH 321	Applied Mathematical Analysis	

MATH 322	Applied Mathematical Analysis
MATH 331	An Introduction to Probability and Markov Chain Models
MATH 340	Elementary Matrix and Linear Algebra
MATH 341	Linear Algebra
MATH 375	Topics in Multi-Variable Calculus and Linear Algebra
MATH 376	Topics in Multi-Variable Calculus and Differential Equations
MATH 407	Topics in Mathematics Study Abroad
MATH 415	Applied Dynamical Systems, Chaos and Modeling
MATH 421	The Theory of Single Variable Calculus
MATH/COMP SCI/ I SY E 425	Introduction to Combinatorial Optimization
MATH/STAT 431	Introduction to the Theory of Probability
MATH/COMP SCI/ E C E 435	Introduction to Cryptography
MATH 441	Introduction to Modern Algebra
MATH 443	Applied Linear Algebra
MATH 461	College Geometry I
MATH 467	Introduction to Number Theory
MATH/ CURRIC 471	Mathematics for Secondary School Teachers
MATH/ HIST SCI 473	History of Mathematics
MATH/COMP SCI/ STAT 475	Introduction to Combinatorics
MATH 490	Undergraduate Seminar
MATH 491	Topics in Undergraduate Mathematics
MATH/ COMP SCI 513	Numerical Linear Algebra
MATH/ COMP SCI 514	Numerical Analysis
MATH 519	Ordinary Differential Equations
MATH 521	Analysis I
MATH 522	Analysis II
MATH/COMP SCI/ I SY E/STAT 525	Linear Optimization
MATH 531	Probability Theory
MATH 535	Mathematical Methods in Data Science
MATH 540	Linear Algebra II
MATH 541	Modern Algebra
MATH 542	Modern Algebra
MATH 551	Elementary Topology
MATH 552	Elementary Geometric and Algebraic Topology
MATH 561	Differential Geometry
MATH 567	Modern Number Theory

MATH 570	Fundamentals of Set Theory	STAT/COMP SCI/ I SY E/MATH 525	Linear Optimization	
MATH/PHILOS 571	Mathematical Logic	STAT/B M I 541	Introduction to Biostatistics	
MATH 605	Stochastic Methods for Biology	STAT/B M I 542	Introduction to Clinical Trials I	
MATH/B M I/ BIOCHEM/ BMOLCHEM 606	Mathematical Methods for Structural Biology	STAT/B M I 546	Practicum in Clinical Trial Data Analysis and Interpretation	
MATH 607	Topics in Mathematics Study Abroad	STAT/F&W ECOL/ HORT 571	Statistical Methods for Bioscience I	
MATH 608	Mathematical Methods for Physical Modeling in Biology	STAT/F&W ECOL/ HORT 572	Statistical Methods for Bioscience II	
MATH/B M I/ BIOCHEM/ BMOLCHEM 609	Mathematical Methods for Systems Biology	STAT 575	Statistical Methods for Spatial Data	
MATH 619	Analysis of Partial Differential Equations	STAT 601	Statistical Methods I	
MATH 621	Analysis III	STAT 602	Statistical Methods II	
MATH 623	Complex Analysis	STAT 605	Data Science Computing Project	
MATH 627	Introduction to Fourier Analysis	STAT 609	Mathematical Statistics I	
MATH 629	Introduction to Measure and Integration	STAT 610	Introduction to Statistical Inference	
MATH/I SY E/ OTM/STAT 632	Introduction to Stochastic Processes	STAT 615	Statistical Learning	
STAT/MATH 309	Introduction to Probability and Mathematical Statistics I	STAT 627	Professional Skills in Data Science	
STAT/MATH 310	Introduction to Probability and Mathematical Statistics II	STAT 628	Data Science Practicum	
STAT 311	Introduction to Theory and Methods of Mathematical Statistics I	STAT/I SY E/ MATH/OTM 632	Introduction to Stochastic Processes	
STAT 312	Introduction to Theory and Methods of Mathematical Statistics II	STAT/B M I 641	Statistical Methods for Clinical Trials	
STAT 324	Introductory Applied Statistics for Engineers	STAT/B M I 642	Statistical Methods for Epidemiology	
STAT 327	Learning a Statistical Language	STAT 679	Special Topics in Statistics	
STAT 333	Applied Regression Analysis	STAT 681	Senior Honors Thesis	
STAT 340	Introduction to Data Modeling II	STAT 682	Senior Honors Thesis	
STAT 349	Introduction to Time Series			
STAT 351	Introductory Nonparametric Statistics	<b>Capstone</b>		
STAT 360	Topics in Statistics Study Abroad	ATM OCN 405	AOS Senior Capstone Seminar	1
STAT 371	Introductory Applied Statistics for the Life Sciences	<b>Electives</b>		<b>11</b>
STAT 411	An Introduction to Sample Survey Theory and Methods	ATM OCN 401	Topics in Meteorology	
STAT 421	Applied Categorical Data Analysis	ATM OCN 404	Meteorological Measurements	
STAT/M E 424	Statistical Experimental Design	ATM OCN 425	Global Climate Processes	
STAT/MATH 431	Introduction to the Theory of Probability	ATM OCN 441	Radar and Satellite Meteorology	
STAT 456	Applied Multivariate Analysis	ATM OCN 452	Synoptic Laboratory I: The Frontal Cyclone	
STAT 461	Financial Statistics	ATM OCN 453	Synoptic Laboratory II: Mesoscale Meteorology	
STAT/COMP SCI 471	Introduction to Computational Statistics	ATM OCN 508	Teacher Workshop in Satellite Meteorology	
STAT/COMP SCI/ MATH 475	Introduction to Combinatorics	ATM OCN 509	Teacher Workshop in Earth System Science - Web	
STAT 479	Special Topics in Statistics	ATM OCN/ ENVIR ST 520	Bioclimatology	
		ATM OCN 522	Tropical Meteorology	
		ATM OCN/ ENVIR ST/ GEOG 528	Past Climates and Climatic Change	
		ATM OCN/ AGRONOMY/ SOIL SCI 532	Environmental Biophysics	
		ATM OCN/ ENVIR ST 535	Atmospheric Dispersion and Air Pollution	

ATM OCN 573	Computational Methods in Atmospheric and Oceanic Sciences
ATM OCN 575	Climatological Analysis
ATM OCN 610	Geophysical Fluid Dynamics I
ATM OCN 611	Geophysical Fluid Dynamics II
ATM OCN 615	Laboratory in Rotating Fluid Dynamics
ATM OCN 630	Introduction to Atmospheric and Oceanic Physics
ATM OCN 637	Cloud Physics
ATM OCN 638	Atmospheric Chemistry
ATM OCN 640	Radiation in the Atmosphere and Ocean
ATM OCN 651	Synoptic-Dynamic Laboratory
ATM OCN 660	Introduction to Physical Oceanography
ATM OCN 681	Senior Honors Thesis
ATM OCN 682	Senior Honors Thesis
ATM OCN 691	Senior Thesis
ATM OCN 692	Senior Thesis
ATM OCN 698	Directed Study <sup>2</sup>
ATM OCN 699	Directed Study <sup>2</sup>

**Total Credits****27**

## RESIDENCE AND QUALITY OF WORK

- 2.000 GPA in all ATM OCN and major courses
- 2.000 GPA on 15 upper-level credits in the major, taken in Residence.<sup>3</sup>
- 15 credits in ATM OCN, taken on campus

## HONORS IN THE MAJOR

Students may declare Honors in the Atmospheric and Oceanic Sciences Major in consultation with the Atmospheric and Oceanic Sciences undergraduate advisor.

### REQUIREMENTS

To earn Honors in the Major in Atmospheric and Oceanic Sciences, students must satisfy both the requirements for the major (above) and the following additional requirements:

- Earn a 3.300 University GPA
- Earn a 3.400 GPA for all ATM OCN courses, and all courses accepted in the major
- Complete the following additional coursework:
  - ATM OCN 610 or ATM OCN 611 and
  - ATM OCN 681 and ATM OCN 682 for a total of 6 credits

## FOOTNOTES

- <sup>1</sup> Note that core sequence begins in the fall semester only.
- <sup>2</sup> A maximum 2 credits of Electives may come from Internship or Directed Study courses.
- <sup>3</sup> ATM OCN 300 through ATM OCN 699 are upper-level in the major.

## UNIVERSITY DEGREE REQUIREMENTS

**Total Degree** To receive a bachelor's degree from UW–Madison, students must earn a minimum of 120 degree credits. The requirements for some programs may exceed 120 degree credits. Students should consult with their college or department advisor for information on specific credit requirements.

**Residency** Degree candidates are required to earn a minimum of 30 credits in residence at UW–Madison. "In residence" means on the UW–Madison campus with an undergraduate degree classification. "In residence" credit also includes UW–Madison courses offered in distance or online formats and credits earned in UW–Madison Study Abroad/Study Away programs.

**Quality of Work** Undergraduate students must maintain the minimum grade point average specified by the school, college, or academic program to remain in good academic standing. Students whose academic performance drops below these minimum thresholds will be placed on academic probation.

## LEARNING OUTCOMES

1. Recognize and describe the fundamental principles and processes associated with the dynamics and thermodynamics of geophysical fluid flows, the basic physics of clouds, aerosols, and precipitation.
2. Recognize and describe the fundamental principles and processes associated with radiation and atmospheric and oceanic radiative transfer.
3. Demonstrate critical thinking skills by identifying a problem, identifying the required information to solve that problem; and formulating and interpreting solutions to that problem using appropriate analytical and/or computational techniques.
4. Apply diagnostic tools to analyses and numerical model output to diagnose, describe, and interpret the fundamental dynamical and thermodynamical processes at work in synoptic-scale, mesoscale, and large-scale weather systems and climate circulations.
5. Apply fundamental radiative transfer theory to interpret remotely-sensed observations of atmospheric and oceanic phenomena.
6. Design and conduct experiments and/or analyze data to test hypotheses in an area of atmospheric or climate sciences.
7. Demonstrate effective scientific communication skills through development and delivery of oral presentations (including poster presentations) and written reports and case studies.

## FOUR-YEAR PLAN

### SAMPLE FOUR-YEAR PLAN

This Sample Four-Year Plan is a tool to assist students and their advisor(s). Students should use it—along with their DARS report, the Degree Planner, and Course Search & Enroll tools—to make their own four-year plan based on their placement scores, credit for transferred courses and approved examinations, and individual interests. As students become involved in athletics, honors, research, student organizations, study abroad, volunteer experiences, and/or work, they might adjust the

order of their courses to accommodate these experiences. Students will likely revise their own four-year plan several times during college.

### First Year

Fall	Credits	Spring	Credits
MATH 221 (QR-B)		5 MATH 222	4
ATM OCN 100 or 101		4 ATM OCN/ENVIR ST 171 (Comm B)	3
Communication A		3 Literature Breadth	3
Foreign Language		4 Biological Science Breadth	3
	<b>16</b>		<b>13</b>

### Second Year

Fall	Credits	Spring	Credits
MATH 234		4 Humanities Breadth	3
PHYSICS 207		5 PHYSICS 208	5
Biological Science Breadth		3 COMP SCI 220	4
Ethnic Studies		4 Social Science Breadth	3
	<b>16</b>		<b>15</b>

### Third Year

Fall	Credits	Spring	Credits
ATM OCN 310		3 ATM OCN 311	3
ATM OCN 330		3 ATM OCN 340	3
Literature Breadth		3 Biological Science Breadth	3
ADV MATH/COMP SCI/STATS		3 Humanities Breadth	3
Social Science Breadth		4 Elective	3
	<b>16</b>		<b>15</b>

### Fourth Year

Fall	Credits	Spring	Credits
ATM OCN 400 or higher		3 ATM OCN numbered 400 or higher	3
ATM OCN 400 or higher		4 ATM OCN numbered 400 level or higher	4
Elective		4 ATM OCN 699 (or elective)	3
Social Science Breadth		4 ATM OCN 405	1
		Elective	3
	<b>15</b>		<b>14</b>

**Total Credits 120**

## ADVISING AND CAREERS

### GENERAL ADVISING

Any student interested in the atmospheric and oceanic sciences major should meet with the AOS undergraduate advisor, Eric Schueffner, to discuss steps to complete the necessary prerequisite coursework for the major. Eric can be reached at 608-890-3231 or [elschueffner@wisc.edu](mailto:elschueffner@wisc.edu). A Major Declaration Form must be completed by the student and authorized by Professor Michael Morgan to complete the major declaration process. Professor Morgan can be reached at 608-265-8159

or [mcmorgan@wisc.edu](mailto:mcmorgan@wisc.edu). Students should bring a current DARS report to their individual advising appointment.

### CAREER ADVISING

The Department of Atmospheric and Oceanic Sciences encourages majors to begin working on their career exploration and preparation soon after arriving on campus. We partner with SuccessWorks at the College of Letters & Science. L&S graduates are in high demand by employers and graduate programs. It is important that students are career ready at the time of graduation, and we are committed to your success.

### L&S CAREER RESOURCES

SuccessWorks at the College of Letters & Science helps students leverage the academic skills learned in their major, certificates, and liberal arts degree; explore and try out different career paths; participate in internships; prepare for the job search and/or graduate school applications; and network with professionals in the field (alumni and employers). In short, SuccessWorks helps students in the College of Letters & Science discover themselves, find opportunities, and develop the skills they need for success after graduation.

SuccessWorks can also assist students in career advising, résumé and cover letter writing, networking opportunities, and interview skills, as well as course offerings for undergraduates to begin their career exploration early in their undergraduate career.

Students should set up their profiles in Handshake (<https://careers.ls.wisc.edu/handshake/>) to take care of everything they need to explore career events, manage their campus interviews, and **apply to jobs and internships from 200,000+ employers around the country.**

- SuccessWorks (<https://careers.ls.wisc.edu/>)
- Set up a career advising appointment (<https://careers.ls.wisc.edu/make-an-appointment/>)
- INTER-LS 210 L&S Career Development: Taking Initiative (1 credit, targeted to first- and second-year students)—for more information, see Inter-LS 210: Career Development, Taking Initiative (<https://careers.ls.wisc.edu/inter-ls-210-career-development-taking-initiative/>)
- INTER-LS 215 Communicating About Careers (3 credits, fulfills Com B General Education Requirement)
- Handshake (<https://careers.ls.wisc.edu/handshake/>)
- Learn how we're transforming career preparation: L&S Career Initiative (<http://ls.wisc.edu/lsci/>)

## PEOPLE

### PROFESSORS

Ackerman, Steve  
Desai, Ankur  
Hitchman, Matt  
Holloway, Tracey  
L'Ecuyer, Tristan  
Martin, Jonathan  
Morgan, Morgan  
Petty, Grant  
Pierce, Brad  
Tripoli, Greg (chair)  
Vimont, Dan

### ASSOCIATE PROFESSORS

Back, Larissa

**ASSISTANT PROFESSORS**

Adames-Corraliza, Angel

Henderson, Stephanie

Maroon, Elizabeth

Rowe, Angela