The study of Meteorology involves the description of the earth's atmosphere and the processes responsible for its behavior. Students majoring in Meteorology earn the bachelor of science. The major satisfies guidelines specified by the American Meteorological Society and meets education requirements for employment with the National Weather Service and the World Meteorological Organization. Successful preparation for professional or graduate work in Meteorology requires that the student develop and integrate a diverse range of skills and knowledge bases. These include weather observing, the physics and dynamics of the global atmosphere, application of new weather technologies, advanced mathematical tools, computer programming and modeling, and effective oral and written communication. The faculty view the senior thesis (MTEOR 499 Senior Research), in particular, as a capstone experience in which students demonstrate they have achieved this integration. Also, contemporary meteorology is an earth-system science with ties to a variety of human experiences. The electives and general education requirements of the college are further experiences that the meteorology student must integrate with their core meteorology knowledge in order to function effectively in a globally-oriented profession.

Minor - Meteorology

The department offers a minor in Meteorology which may be earned by completing 15 credits including MTEOR 111 Synoptic Applications (only 1 credit may count toward the minor), MTEOR 206 Introduction to Weather and Climate and MTEOR 301 General Meteorology. Further information concerning programs of study, including sample degree programs, is available from the department.

The program requires the following courses:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTEOR 107</td>
<td>Mesoscale Meteorology</td>
<td>3</td>
</tr>
<tr>
<td>MTEOR 452</td>
<td>Climate Modeling</td>
<td>3</td>
</tr>
<tr>
<td>MTEOR 490</td>
<td>Independent Study</td>
<td>1-3</td>
</tr>
<tr>
<td>GEOL 415</td>
<td>Paleoclimatology</td>
<td>3</td>
</tr>
<tr>
<td>or C E 372</td>
<td>Engineering Hydrology and Hydraulics</td>
<td></td>
</tr>
</tbody>
</table>

Supporting work is required in areas at least equivalent to:

One of the following sequences

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 163 &amp; 163L</td>
<td>College Chemistry and Laboratory in College Chemistry</td>
<td>4</td>
</tr>
<tr>
<td>or CHEM 177 &amp; 177L</td>
<td>General Chemistry I and Laboratory in General Chemistry I</td>
<td></td>
</tr>
<tr>
<td>COM S 207</td>
<td>Fundamentals of Computer Programming</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 221</td>
<td>Introduction to Classical Physics I</td>
<td>5</td>
</tr>
<tr>
<td>PHYS 222</td>
<td>Introduction to Classical Physics II</td>
<td>5</td>
</tr>
<tr>
<td>MATH 165</td>
<td>Calculus I</td>
<td>4</td>
</tr>
<tr>
<td>MATH 166</td>
<td>Calculus II</td>
<td>4</td>
</tr>
<tr>
<td>MATH 265</td>
<td>Calculus III</td>
<td>4</td>
</tr>
<tr>
<td>MATH 266</td>
<td>Elementary Differential Equations</td>
<td>3</td>
</tr>
<tr>
<td>STAT 105</td>
<td>Introduction to Statistics for Engineers</td>
<td>3</td>
</tr>
<tr>
<td>SP CM 212</td>
<td>Fundamentals of Public Speaking</td>
<td>3</td>
</tr>
</tbody>
</table>

Total Credits: 38

A grade of C or better (not C-) is required in each of the following courses to meet minimum graduation requirements for a bachelor of science degree in Meteorology:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTEOR 206</td>
<td>Introduction to Weather and Climate</td>
<td>3</td>
</tr>
<tr>
<td>MTEOR 301</td>
<td>General Meteorology</td>
<td>4</td>
</tr>
</tbody>
</table>

Several co-op programs are available for upper division undergraduates. Although a range of opportunities exists for men and women who terminate their studies with a bachelor of science, students who meet the necessary academic standards are encouraged to continue their studies in a graduate program. For these students, additional coursework is recommended in a mathematical or physical science. Other students can choose a wide range of supporting courses that will contribute to their particular area of interest in meteorology.

Communication Proficiency requirement: The department requires a grade of C or better in:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGL 150</td>
<td>Critical Thinking and Communication</td>
<td>3</td>
</tr>
<tr>
<td>ENGL 250</td>
<td>Written, Oral, Visual, and Electronic Composition</td>
<td>3</td>
</tr>
<tr>
<td>or ENGL 250H</td>
<td>Written, Oral, Visual, and Electronic Composition: Honors</td>
<td></td>
</tr>
<tr>
<td>ENGL 309</td>
<td>Proposal and Report Writing</td>
<td>3</td>
</tr>
</tbody>
</table>

Path 1 for students preparing to start in calculus

Freshman

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 163 or 177¹</td>
<td>4 MTEOR 206</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 163L or 177L¹</td>
<td>1 MATH 166</td>
<td>4</td>
</tr>
<tr>
<td>ENGL 150</td>
<td>3 PHYS 221</td>
<td>5</td>
</tr>
<tr>
<td>LIB 160</td>
<td>1 Humanities/Social Science Choice</td>
<td>3</td>
</tr>
</tbody>
</table>

1. Offered by the Department of Geological and Atmospheric Sciences.

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MTEOR 111 Synoptic Applications
MTEOR 201 Introductory Seminar
MTEOR 206 Introduction to Weather and Climate
MTEOR 301 General Meteorology
MTEOR 311 Introduction to Synoptic Meteorology
MTEOR 341 Atmospheric Physics I
MTEOR 342 Atmospheric Physics II
MTEOR 411 Synoptic Meteorology
MTEOR 417 Mesoscale Forecasting Laboratory
MTEOR 432 Instrumentation and Measurements
MTEOR 443 Dynamic Meteorology I
MTEOR 454 Dynamic Meteorology II
MTEOR 499 Senior Research

Total Credits: 33

An additional 9 credits must be chosen from:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTEOR 402</td>
<td>Watershed Hydrology</td>
<td>3</td>
</tr>
<tr>
<td>MTEOR 404</td>
<td>Global Change</td>
<td>3</td>
</tr>
<tr>
<td>MTEOR 405</td>
<td>Environmental Biophysics</td>
<td>3</td>
</tr>
<tr>
<td>MTEOR 406</td>
<td>World Climates</td>
<td>3</td>
</tr>
</tbody>
</table>
### Path 2 for students needing preparatory mathematics

**Freshman**

<table>
<thead>
<tr>
<th>Semester</th>
<th>Credits</th>
<th>Fall</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td></td>
<td>MATH 165</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MTEOR 111</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MTEOR 112</td>
<td>1</td>
</tr>
<tr>
<td>Choice</td>
<td></td>
<td>Humanities/Social Science</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>18</td>
<td>15</td>
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</tr>
</tbody>
</table>

**Sophomore**

<table>
<thead>
<tr>
<th>Semester</th>
<th>Credits</th>
<th>Fall</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td></td>
<td>MATH 265</td>
<td>4 MATH 266</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MTEOR 201</td>
<td>0 MTEOR 301</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MTEOR 227</td>
<td>3 SP CM 212</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ENGL 250</td>
<td>3 STAT 105</td>
</tr>
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<td>PHYS 222</td>
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</tr>
<tr>
<td></td>
<td>15</td>
<td>16</td>
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</table>

**Junior**

<table>
<thead>
<tr>
<th>Semester</th>
<th>Credits</th>
<th>Fall</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td></td>
<td>MATH 166</td>
<td>4 MATH 265</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MTEOR 111</td>
<td>1 MTEOR 301</td>
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<tr>
<td></td>
<td></td>
<td>MTEOR 201</td>
<td>0 PHYS 222</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MTEOR 227</td>
<td>3 STAT 105</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PHYS 221</td>
<td>5</td>
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<tr>
<td></td>
<td></td>
<td>ENGL 250</td>
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</tr>
<tr>
<td></td>
<td>16</td>
<td>16</td>
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</tbody>
</table>

**Senior**

<table>
<thead>
<tr>
<th>Semester</th>
<th>Credits</th>
<th>Fall</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall</td>
<td></td>
<td>MTEOR 411</td>
<td>2 MTEOR 342</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MTEOR 454</td>
<td>3 MTEOR 443</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MTEOR 499</td>
<td>2 Meteorology Elective/Elective Choice^2,^3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Meteorology Elective/ elective Choice^2,^3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Meteorology Elective/Elective choice^2,^3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>15</td>
<td></td>
</tr>
</tbody>
</table>

**Total Credits: 124-122**

LAS majors require a minimum of 120 credits, including a minimum of 45 credits at the 300/400 level. You must also complete the Communication Proficiency and LAS World Language Requirements. Six semesters of one foreign language in high school satisfies the World Language requirement.

1. Students taking CHEM 177 should plan to take CHEM 178 as well.
2. Students must select at least 9 credits from a list of optional courses.
3. Students should select a humanities or social science course based on need. If these LAS requirements have been satisfied, students may select a meteorology elective or alternate course. Students should discuss possible alternate course options with their adviser.

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**LAS majors require a minimum of 120 credits, including a minimum of 45 credits at the 300/400 level. You must also complete the Communication Proficiency and LAS World Language Requirements. Six semesters of one foreign language in high school satisfies the World Language requirement.**
Students in all ISU majors must complete a 3 credit course in U.S. diversity and a 3 credit course in international perspectives. Discuss with your adviser how the two courses that you select can be applied to address general education requirements. Check for a list of approved courses at: http://www.registrar.iastate.edu/courses/div-ip-guide.html

1 Students taking CHEM 177 should plan to take CHEM 178 as well.
2 Student must select at least 9 credits from a list optional courses.
3 Students should select a humanities or social science course based on need. If these LAS requirements have been satisfied, students may select a meteorology elective or alternate course. Students should discuss possible alternate course options with their adviser.

Courses primarily for undergraduates:

MTEOR 107: Severe and Hazardous Weather
(2-0) Cr. 1. F.
Understanding of atmospheric processes that play a role in creating severe and hazardous weather. Focus on thunderstorms, tornadoes, hurricanes, floods, blizzards, ice storms, and temperature extremes. Impacts on lives and property.

MTEOR 111: Synoptic Applications
(1-0) Cr. 1. Repeatable. F.
Prereq: Credit or enrollment in MATH 165
Current weather discussions and introduction to synoptic-scale interpretation of meteorology. Application and use of calculus in meteorology. Course restricted to majors. Others with permission of instructor.

MTEOR 112: Geoscience Orientation
(Cross-listed with GEOL). (1-0) Cr. 1. F.
Orientation course for students enrolled in the Earth, Wind and Fire Learning Community. Provides an introduction to Iowa State University and meteorology, geology, and Earth science programs for students enrolled in the department's learning community. Activities include academic and social activities, talks and presentations on academic success, resume writing, and study abroad, as well as research talks by faculty members.

MTEOR 160: Water Resources of the World
(Cross-listed with AGRON, ENV S, GEOL). (3-0) Cr. 3. S.
Study of the occurrence, history, development, and management of world water resources. Basic hydrologic principles including climate, surface water, groundwater, and water quality. Historical and current perspectives on water policy, use, and the role of water in society and the environment. Meets International Perspectives Requirement.

MTEOR 201: Introductory Seminar
Cr. R. F.
Prereq: Credit or enrollment in PHYS 221
An overview of the atmospheric sciences, the meteorology program at Iowa State, and the major research journals used in the discipline.

MTEOR 206: Introduction to Weather and Climate
(Cross-listed with AGRON). (3-0) Cr. 3. F.S.
Basic concepts in weather and climate, including atmospheric measurements, radiation, stability, precipitation, winds, fronts, forecasting, and severe weather. Applied topics include global warming, ozone depletion, world climates and weather safety.

MTEOR 227: Computational Meteorology I
(3-1) Cr. 3. F.
Prereq: Credit or concurrent enrollment in MTEOR 206, credit or concurrent enrollment in PHYS 221
An introduction to computer programming using FORTRAN with focus on meteorological applications. Emphasis on basics of good programming techniques and style through extensive practice in top-down design, writing, running, and debugging small programs. Topics include operations and functions, selective execution, repetitive execution, arrays, input/output, file processing, and subprograms. This course is designed for majors.

MTEOR 265: Scientific Balloon Engineering and Operations
(Cross-listed with AER E). (0-2) Cr. 1. Repeatable. F.
Engineering aspects of scientific balloon flights. Integration of science mission objectives with engineering requirements. Operations team certification. FAA and FCC regulations, communications, and command systems. Flight path prediction and control.

MTEOR 290: Independent Study
Cr. 1-4. Repeatable.
Prereq: Permission of instructor
Independent study for freshman and sophomore students.

MTEOR 298: Cooperative Education
Cr. R. F.S.S.
Prereq: Permission of the department cooperative education coordinator; sophomore classification
Required of all cooperative education students. Students must register for this course prior to commencing the work period.

MTEOR 301: General Meteorology
(4-0) Cr. 4. S.
Prereq: MATH 166, credit or enrollment in PHYS 222
Global distribution of temperature, wind, and atmospheric constituents; atmospheric thermodynamics, radiative transfer, global energy balance, storms and clouds, introductory dynamics.

MTEOR 311: Introduction to Synoptic Meteorology
(1-2) Cr. 2. F.
Prereq: MTEOR 301
Concepts of weather map plotting and analysis. Introduction to forecasting and to the use of real-time UNIDATA computer products.

MTEOR 321: Meteorology Internship
Cr. 1-2. Repeatable, maximum of 3 credits. F.S.SS.
Prereq: MTEOR 311; junior or senior standing; permission of co-op program coordinator; acceptance by sponsoring agency
Supervised practical experience in a professional meteorological agency. Experiences may include providing weather information for radio, TV, utilities, government agencies, construction, or agribusiness.

MTEOR 324: Energy and the Environment
(Cross-listed with ENSCI, ENV S, GEOL). (3-0) Cr. 3. S.
MTEOR 341: Atmospheric Physics I
(3-0) Cr. 3. F.
Prereq: PHYS 222, credit or enrollment in MATH 266, MTEOR 301.
Basic laws of thermodynamics, thermodynamics of water vapor, mixtures
of gases, stability, hydrostatics, cloud physics.

MTEOR 342: Atmospheric Physics II
(3-0) Cr. 3. S.
Prereq: MTEOR 341
Precipitation physics, radar, atmospheric radiation, atmospheric optics,
atmospheric electricity.

MTEOR 398: Cooperative Education
Cr. R. F.S.S.
Prereq: Permission of the department cooperative education coordinator;
junior classification
Required of all cooperative education students. Students must register
for this course prior to commencing the work period.

MTEOR 402: Watershed Hydrology
(Dual-listed with MTEOR 502). (Cross-listed with ENSCI, GEOL, NREM).
(2-3) Cr. 3. F.
Prereq: Four courses in physical or biological sciences or engineering; junior standing
Examination of watersheds as systems, emphasizing the surface
components of the hydrologic cycle. Combines qualitative understanding
of hydrological processes and uncertainty with quantitative
representation. Laboratory emphasizes field investigation and
measurement of watershed processes.

MTEOR 404: Global Change
(Dual-listed with MTEOR 504). (Cross-listed with AGRON, ENSCI, ENV S).
(3-0) Cr. 3. S.
Prereq: Four courses in physical or biological sciences or engineering; junior standing
Recent changes in global biogeochemical cycles and climate; models
of future changes in the climate system; impacts of global change on
agriculture, water resources and human health; ethical issues of global
environmental change. Also offered online Alt. F, even-numbered years.

MTEOR 405: Environmental Biophysics
(Dual-listed with MTEOR 505). (Cross-listed with AGRON, ENSCI). (3-0) Cr.
3. Alt. S., offered odd-numbered years.
Prereq: MATH 165 or MATH 182 or equivalent and some computer
programming experience (any language)
A description of the physical microenvironment in which organisms
live. Emphasis on the movement of energy (heat and radiation) and
mass (water and carbon) among organisms, the soil, and atmosphere.
Applications to humans, other animals, plants, and plant communities.

MTEOR 406: World Climates
(Cross-listed with AGRON, ENSCI). (3-0) Cr. 3. S.
Prereq: AGRON 206/MTEOR 206
Distribution and causes of different climates around the world. Effects
of climate and climate variations on human activities including society,
economy and agriculture. Current issues such as climate change and
international efforts to assess and mitigate the consequences of a
changing climate. Semester project and in-class presentation required.
Meets International Perspectives Requirement.

MTEOR 407: Mesoscale Meteorology
(Dual-listed with MTEOR 507). (Cross-listed with AGRON). (3-0) Cr. 3. Alt.
S., offered even-numbered years.
Prereq: Math 166 and Mteor 443
Physical nature and practical consequences of mesoscale atmospheric
phenomena. Mesoscale convective systems, fronts, terrain-forced
circulations. Observation, analysis, and prediction of mesoscale
atmospheric structure.

MTEOR 411: Synoptic Meteorology
(Dual-listed with MTEOR 511). (1-4) Cr. 3. F.
Prereq: MTEOR 311, Credit or enrollment in MTEOR 454
Current weather forecasting and discussion. Applications of atmospheric
physics and dynamics in real-time weather situations. Use of UNIDATA
computer products.

MTEOR 416: Hydrologic Modeling and Analysis
(Dual-listed with MTEOR 516). (Cross-listed with ENSCI, GEOL). (2-3) Cr. 3.
Alt. S., offered odd-numbered years.
Prereq: Four courses in Earth science, meteorology, or engineering; junior
standing
Study of the basic principles of hydrologic modeling, including rainfall-
runoff analysis, lumped and distributed modeling, conceptual and
physical models, parameter estimation and sensitivity analysis, input
and validation data, uncertainty analysis, and the use of models in
surface water hydrology. A range of common models are applied to
study hydrologic topics such as flood forecasting and land use change
impacts. Previous experience with Matlab or other programming
language is needed.

MTEOR 417: Mesoscale Forecasting Laboratory
(1-5) Cr. 3. S.
Prereq: Credit or enrollment in MTEOR 411
Real-time computer analysis of current weather, with emphasis on small-
scale features. Studies of severe weather, lake-effect snow, CSI, cold-air
damming.

MTEOR 432: Instrumentation and Measurements
(2-2) Cr. 3. S.
Prereq: Credit or enrollment in MATH 266, PHYS 222
Principles of meteorological sensing and data analysis. Thermometry,
barometry, hygrometry, anemometry, precipitation measurements,
radiometry, radar, remote sensing, visibility, and cloud height. Calibration
and measurement uncertainties. Digital signal processing. Field trip to
the National Weather Service. Labs emphasize dataloggers and modern
weather stations.

MTEOR 435: Radar Applications in Meteorology
(3-0) Cr. 3. F.
Prereq: Credit or enrollment in MTEOR 341
Fundamentals of radar meteorology with emphasis on applications.
Topics presented include theory of radar, engineering principles, Doppler
radar, polarimetric radar, and applications to remote sensing of clouds
and precipitation.

MTEOR 443: Dynamic Meteorology I
(3-0) Cr. 3. S.
Prereq: MTEOR 341
Conservation laws, governing equations, circulation and vorticity.
Development of quasi-geostrophic theory.
MTEOR 452: Climate Modeling
(Dual-listed with MTEOR 552). (3-0) Cr. 3. Alt. F., offered odd-numbered years.
Prereq: Mteor 301
Developing and working with climate models based on fundamental physical principles that govern the climate systems of the Earth and other planets. Emphasis on coupled, nonlinear-system interactions of physical processes such as circulation dynamics, radiative transfer, and cloud/precipitation physics, starting with fairly simple 0- and 1-dimensional analytical and numerical models based on energy, mass, and momentum conservation. Observational study of seasonally evolving weather patterns that form climates around the world.

MTEOR 454: Dynamic Meteorology II
(3-0) Cr. 3. F.
Prereq: MTEOR 443
Planetary boundary layer, linear perturbation theory, atmospheric wave motions, baroclinic and convective instability, mesoscale circulations.

MTEOR 471: History of Modern Meteorology
(Dual-listed with MTEOR 571). (1-0) Cr. 1. Alt. S., offered even-numbered years.
Prereq: MTEOR 341, MTEOR 342, MTEOR 411, MTEOR 443, MTEOR 452
Development of meteorological theories and numerical weather prediction, discoveries of important meteorological phenomena, and impact of weather and climate on important historical events.

MTEOR 489: Survey of Remote Sensing Technologies
(Dual-listed with MTEOR 589). (Cross-listed with E E, GEOL, NREM). (3-0) Cr. 3. S.
Prereq: Four courses in physical or biological sciences or engineering
Electromagnetic-radiation principles, active and passive sensors, multispectral and hyperspectral sensors, imaging radar, SAR, thermal imaging, lidar. Examples of applications. Also offered online S.

MTEOR 489L: Satellite Remote Sensing Laboratory
(Dual-listed with MTEOR 589L). (Cross-listed with E E, GEOL, NREM). (0-3) Cr. 1. S.
Prereq: Completion or concurrent enrollment in MTEOR/GEOL/NREM/EE 489/589
Processing and analysis of satellite sensor data (optical and radar). Provides practical applications in an environmental context.

MTEOR 490: Independent Study
Cr. 1-3. Repeatable, maximum of 9 credits.
Prereq: 6 credits in meteorology, permission of instructor
No more than 9 credits in Mteor 490 may be counted toward graduation.

Cr. 1-3. Repeatable, maximum of 9 credits.
Prereq: 6 credits in meteorology, permission of instructor
No more than 9 credits in Mteor 490 may be counted toward graduation.

MTEOR 490B: Independent Study: Dynamic Meteorology.
Cr. 1-3. Repeatable, maximum of 9 credits.
Prereq: 6 credits in meteorology, permission of instructor
No more than 9 credits in Mteor 490 may be counted toward graduation.

MTEOR 490C: Independent Study: Physical Meteorology,
Cr. 1-3. Repeatable, maximum of 9 credits.
Prereq: 6 credits in meteorology, permission of instructor
No more than 9 credits in Mteor 490 may be counted toward graduation.

MTEOR 490D: Independent Study: Instrumentation.
Cr. 1-3. Repeatable, maximum of 9 credits.
Prereq: 6 credits in meteorology, permission of instructor
No more than 9 credits in Mteor 490 may be counted toward graduation.

Cr. 1-3. Repeatable, maximum of 9 credits.
Prereq: 6 credits in meteorology, permission of instructor
No more than 9 credits in Mteor 490 may be counted toward graduation.

MTEOR 498: Cooperative Education
Cr. R. F.S.S.
Prereq: Permission of the department cooperative education coordinator; senior classification
Required of all cooperative education students. Students must register for this course prior to commencing each work period.

MTEOR 499: Senior Research
(2-0) Cr. 2. F.
Required of all senior meteorology majors. Research projects in collaboration with faculty. Written and oral presentations of results at the end of the semester.

Courses primarily for graduate students, open to qualified undergraduates:

MTEOR 502: Watershed Hydrology
(Dual-listed with MTEOR 402). (Cross-listed with ENSCI, GEOL, NREM). (2-3) Cr. 3. F.
Prereq: Four courses in physical or biological sciences or engineering; junior standing
Examination of watersheds as systems, emphasizing the surface components of the hydrologic cycle. Combines qualitative understanding of hydrological processes and uncertainty with quantitative representation. Laboratory emphasizes field investigation and measurement of watershed processes.

MTEOR 504: Global Change
(Dual-listed with MTEOR 404). (Cross-listed with AGRON, ENSCI). (3-0) Cr. 3. S.
Prereq: Four courses in physical or biological sciences or engineering; junior standing
Recent changes in global biogeochemical cycles and climate; models of future changes in the climate system; impacts of global change on agriculture, water resources and human health; ethical issues of global environmental change. Also offered online Alt. F, even-numbered years.

MTEOR 505: Environmental Biophysics
(Dual-listed with MTEOR 405). (Cross-listed with AGRON, ENSCI). (3-0) Cr. 3. Alt. S., offered odd-numbered years.
Prereq: MATH 165 or MATH 182 or equivalent and some computer programming experience (any language)
A description of the physical microenvironment in which organisms live. Emphasis on the movement of energy (heat and radiation) and mass (water and carbon) among organisms, the soil, and atmosphere. Applications to humans, other animals, plants, and plant communities.
MTEOR 507: Mesoscale Meteorology
(Dual-listed with MTEOR 407). (Cross-listed with AGRON). (3-0) Cr. 3. Alt. S., offered even-numbered years.
Prereq: Math 166 and Meteor 443
Gallus. The physical nature and practical consequences of mesoscale atmospheric phenomena. Mesoscale convective systems, fronts, terrain-forced circulations. Observation, analysis, and prediction of mesoscale atmospheric structure. Semester project and in-class presentation required.

MTEOR 511: Synoptic Meteorology
(Dual-listed with MTEOR 411). (1-4) Cr. 3. F.
Prereq: MTEOR 311, Credit or enrollment in MTEOR 454
Current weather forecasting and discussion. Applications of atmospheric physics and dynamics in real-time weather situations. Use of UNIDATA computer products.

MTEOR 516: Hydrologic Modeling and Analysis
(Dual-listed with MTEOR 416). (Cross-listed with ENSCI, GEOL). (2-3) Cr. 3. Alt. S., offered odd-numbered years.
Prereq: Four courses in earth science, meteorology, or engineering; junior standing
Study of the basic principles of hydrologic modeling, including rainfall-runoff analysis, lumped and distributed modeling, conceptual and physical models, parameter estimation and sensitivity analysis, input and validation data, uncertainty analysis, and the use of models in surface water hydrology. A range of common models are applied to study hydrologic topics such as flood forecasting and land use change impacts. Previous experience with Matlab or other programming language is needed.

MTEOR 518: Microwave Remote Sensing
(Cross-listed with AGRON, E E). (3-0) Cr. 3. Alt. S., offered even-numbered years.
Prereq: Math 265 or equivalent
Microwave remote sensing of Earth's surface and atmosphere using satellite-based or ground-based instruments. Specific examples include remote sensing of atmospheric temperature and water vapor, precipitation, ocean salinity, and soil moisture.

MTEOR 542: Physical Meteorology
(3-0) Cr. 3. Alt. F., offered odd-numbered years.
Prereq: MTEOR 342, MATH 266, PHYS 222
Planetary atmospheres, radiative equilibrium models, radiative transfer, the upper atmosphere, remote sounding from satellites.

MTEOR 543: Advanced Dynamic Meteorology I
(3-0) Cr. 3. Alt. F., offered even-numbered years.
Prereq: MTEOR 455
The first half of a two semester sequence. Governing equations, scale analysis, simple types of wave motion in the atmosphere, instability theory.

MTEOR 544: Advanced Dynamic Meteorology II
(3-0) Cr. 3. Alt. S., offered odd-numbered years.
Prereq: MTEOR 543
Continuation of 543. General circulation and dynamics of zonally symmetric circulations, atmospheric energetics, nonlinear dynamics of planetary waves.

MTEOR 552: Climate Modeling
(Dual-listed with MTEOR 452). (3-0) Cr. 3. Alt. F., offered odd-numbered years.
Prereq: Meteor 301
Developing and working with climate models based on fundamental physical principles that govern the climate systems of the Earth and other planets. Emphasis on coupled, nonlinear-system interactions of physical processes such as circulation dynamics, radiative transfer, and cloud/precipitation physics, starting with fairly simple 0- and 1-dimensional analytical and numerical models based on energy, mass, and momentum conservation. Observational study of seasonally evolving weather patterns that form climates around the world.

MTEOR 571: History of Modern Meteorology
(Dual-listed with MTEOR 471). (1-0) Cr. 1. Alt. S., offered even-numbered years.
Prereq: MTEOR 341, MTEOR 342, MTEOR 411, MTEOR 443, MTEOR 452
Development of meteorological theories and numerical weather prediction, discoveries of important meteorological phenomena, and impact of weather and climate on important historical events.

MTEOR 589: Survey of Remote Sensing Technologies
(Dual-listed with MTEOR 489). (Cross-listed with E E, GEOL, NREM). (3-0) Cr. 3. S.
Prereq: Four courses in physical or biological sciences or engineering
Electromagnetic-radiation principles, active and passive sensors, multispectral and hyperspectral sensors, imaging radar, SAR, thermal imaging, lidar. Examples of applications. Also offered online S.

MTEOR 589L: Satellite Remote Sensing Laboratory
(Dual-listed with MTEOR 489L). (Cross-listed with E E, GEOL, NREM). (0-3) Cr. 1. S.
Prereq: Completion or concurrent enrollment in MTEOR/GEOL/NREM/EE 489/589
Processing and analysis of satellite sensor data (optical and radar). Provides practical applications in an environmental context.

MTEOR 590: Special Topics
Cr. 1-3. Repeatable.
Prereq: Permission of instructor
Topics of current interest.

MTEOR 590A: Special Topics: Boundary-layer Meteorology
Cr. 1-3. Repeatable.
Prereq: Permission of instructor
Topics of current interest.

MTEOR 590B: Special Topics: Tropical Meteorology
Cr. 1-3. Repeatable.
Prereq: Permission of instructor
Topics of current interest.

MTEOR 590C: Special Topics: Mesoscale Meteorology
Cr. 1-3. Repeatable.
Prereq: Permission of instructor
Topics of current interest.

MTEOR 590D: Special Topics: Global Climate Systems
Cr. 1-3. Repeatable.
Prereq: Permission of instructor
Topics of current interest.
MTEOR 590E: Special Topics: Climate Modeling
Cr. 1-3. Repeatable.
Prereq: Permission of instructor
Topics of current interest.

MTEOR 590F: Special Topics: Numerical Weather Prediction
Cr. 1-3. Repeatable.
Prereq: Permission of instructor
Topics of current interest.

MTEOR 590G: Special Topics: Satellite Observations
Cr. 1-3. Repeatable.
Prereq: Permission of instructor
Topics of current interest.

MTEOR 590H: Special Topics: Statistical Methods in Meteorology
Cr. 1-3. Repeatable.
Prereq: Permission of instructor
Topics of current interest.

MTEOR 590I: Special Topics: Field Observations
Cr. 1-3. Repeatable.
Prereq: Permission of instructor
Topics of current interest.

MTEOR 590J: Special Topics: Low Frequency Modes
Cr. 1-3. Repeatable.
Prereq: Permission of instructor
Topics of current interest.

MTEOR 590K: Special Topics: Cloud Physics
Cr. 1-3. Repeatable.
Prereq: Permission of instructor
Topics of current interest.

MTEOR 590L: Special Topics: Atmospheric Radiation
Cr. 1-3. Repeatable.
Prereq: Permission of instructor
Topics of current interest.

MTEOR 590M: Special Topics: Hydrology
Cr. 1-3. Repeatable.
Prereq: Permission of instructor
Topics of current interest.

MTEOR 590N: Special Topics: Geophysical Fluid Dynamics
Cr. 1-3. Repeatable.
Prereq: Permission of instructor
Topics of current interest.

MTEOR 590O: Special Topics: Radar Meteorology
Cr. 1-3. Repeatable.
Prereq: Permission of instructor
Topics of current interest.

MTEOR 595: Graduate Seminar
(Cross-listed with GEOL). Cr. 1. Repeatable. F.S.
Prereq: Senior or graduate classification
Weekly seminar on topics of current research interest. All students seeking a graduate degree in geology must enroll during each semester of residence. Students pursuing a non-thesis option for the M.S. in Earth Science must enroll for one semester. Offered on a satisfactory-fail basis only.

MTEOR 595A: Graduate Seminar: Presentation Required
(Cross-listed with GEOL). (1-0) Cr. 1. Repeatable. F.S.
Prereq: Senior or graduate classification
Weekly seminar on topics of current research interest. All students seeking a graduate degree in geology must enroll during each semester of residence. Students pursuing a non-thesis option for the M.S. in Earth Science must enroll for one semester. Offered on a satisfactory-fail basis only.

MTEOR 595B: Graduate Seminar: Attendance Only
(Cross-listed with GEOL). Cr. R. Repeatable. F.S.
Prereq: Senior or graduate classification
Attendance only. Weekly seminar on topics of current research interest. All students seeking a graduate degree in geology must enroll during each semester of residence. Students pursuing a non-thesis option for the M.S. in Earth Science must enroll for one semester. Offered on a satisfactory-fail basis only.

Courses for graduate students:

MTEOR 605: Boundary-Layer Meteorology
(Cross-listed with AGRON). (3-0) Cr. 3. Alt. F., offered even-numbered years.
Prereq: MTEOR 443 or equivalent-level course in engineering fluids
Atmospheric boundary-layer structure and dynamics. Diurnal and seasonal variations, turbulent fluxes and turbulence kinetic energy. Measurements and empirical relations for wind and temperature near the ground. Numerical simulation and applications to wind energy.

MTEOR 699: Research
Cr. arr. Repeatable.