ENVIRONMENTAL SCIENCES GRADUATE
PROGRAM AREA OF CLIMATE CHANGE

PURPOSE

The Area of Concentration in Climate Change is designed for students who have some modeling background and want to develop a better understanding of climate processes and impacts. Climate change is considered by many scientists and high-level decision makers in government, business and civil society to be one of the most pressing challenges facing humankind. Examples of climate change include global trends in climate variables and changes in their variability. Direct effects include ecosystem responses outside their range of historical variability particularly obvious in species with climate-related physiological thresholds. Indirect effects include changes in disturbance regimes. Within the Climate Change track, students may choose to focus on integrated aspects of terrestrial, aquatic, atmospheric, and marine systems.

PROGRAM OF STUDY

The Climate Change track includes courses in 6 categories: the CC Core courses, Numerical Skills courses, Basic Earth System courses, Science Focal Area courses, Elective courses, and Thesis. Total credits required are a minimum of 45 Cr for the M.S. and M.A. degrees and 108 Cr for the Ph.D. degree. Typical Programs of Study will include minimum credits as follow:

<table>
<thead>
<tr>
<th>Subject Area</th>
<th>M.S. &amp; M.A. Degrees</th>
<th>Ph. D. Degree</th>
</tr>
</thead>
<tbody>
<tr>
<td>ES Core Courses</td>
<td>12 Cr</td>
<td>15 Cr</td>
</tr>
<tr>
<td>Methods and Numerical Skills</td>
<td>12 Cr</td>
<td>15 Cr</td>
</tr>
<tr>
<td>Science Focal Area Courses</td>
<td>12 Cr</td>
<td>24 Cr</td>
</tr>
<tr>
<td>Electives</td>
<td>0 Cr</td>
<td>0-14 Cr</td>
</tr>
<tr>
<td>Thesis</td>
<td>9 Cr</td>
<td>36-50 Cr</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>45 Cr</strong></td>
<td><strong>108 Cr</strong></td>
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**ES CORE COURSES**

ATS 421/521 Climate modeling (4 credits)
GEOG 240 Climate change, water and society (3 credits)
PS 455/555 The politics of climate change (4 credits)
FW345 Global Change Biology (4 credits)

**NUMERICAL SKILL COURSES**

8 Cr for the M.S. and M.A. degree and 12 Cr for the Ph.D. degree. These courses are to ensure students have sufficient skills in research methods including mathematics, statistics, and computer science. Courses are to be selected by the student, advisor, and advising committee from the list below and from other offerings.

BA 575 Data Exploration and Visualization (3)
BOT 540 Field Methods in Plant Ecology (4)
CH 584 Instruments and Online Interactions in the sciences (3)
CH 590 Computer Programming for Scientists (3)
FES 522 Research Methods in Social Science (4)
FES 523 Quantitative Analysis in Social Science (4)
FOR 526 Forest Carbon Measurements and Analysis (4)
GEO 308 Global change and earth sciences (3)
GEO 544 Remote Sensing (4)
GEO 565 Geographic Information Systems (4)
GEO 566 Digital Image Processing (3)
GEO 580 Advanced GIS Applications in the Geosciences (4)
H 524 Introduction to Biostatistics (4)
MTH 551 Numerical Linear Algebra (3)
MTH 552 Numerical Solutions of Ordinary Differential Equations (3)
MTH 553 Numerical Solutions of Partial Differential Equations (3)
OC 682 Oceanographic and Atmospheric Data Analysis I (4)
OC 683 Oceanographic and Atmospheric Data Analysis II (4)
OC 675 Numerical Modeling in Ocean Circulation (4)
ST 511, 512, 513 Methods of Data Analysis (4 each)
ST 515 Design and Analysis of Planned Experiments (3)
ST 517 Data Analytics I (4)
ST 522 Introduction to Mathematical Statistics (4)
ST 531 Sampling Methods (3)
ST 535 Quantitative Ecology (3)

SCIENCE FOCAL AREA COURSES

9 Cr for the M.S. and M.A. degree and 24 Cr for the Ph.D. degree. Focal area Courses are intended to develop depth of student understanding of climate change. The courses below are a suggested partial listing and are to be selected by consensus of the graduate advisor, advising committee, and student.

ANTH 447. Arctic perspectives on global problems (4)
ATS 515 Atmospheric Dynamics I (4)
ATS 546 Experimental Energy and Gas Exchange (4)
ATS 630 Climate Dynamics (3)
BEE 511 Global Environmental Change: using spatial data to inform decisions (3)
BEE 525 Stochastic Hydrology (3)
BEE 549 Regional Hydrologic Modeling (3)
BI 301. Human impacts on ecosystems (3)
COMM 550 Communication and the Practice of Science (3)
FE 532 Forest Hydrology (4)
FE 535 Water Quality and Forest Land Use (3)
FE 536 Watershed Impacts of Forest Disturbance (4)
FES 536. Carbon sequestration in Forests
FW 620 Ecological Policy (3)
GEO 518 Geoscience Communication (3)

MNR 500. Market tools for managing greenhouse gas emissions (3)
MNR 538. Adapting Forests to Climate Change (3)
MNR 550. Climate Change Impacts on Forest Ecosystems (3)
PHL 540 Environmental Ethics (3)
PHL 543 World Views and Environmental Values
RNG 536 Wildland Fire Science and Management (4)
RNG 555 Riparian Ecology and Management (3)
RNG 662 Rangeland Ecology (3)
SNR 511. Sustainable Natural Resource Development (1)
SNR 530. Ecological Principles of Sustainable Natural Resources (3)
SOIL 513 Properties, Processes & Functions of Soils (4)
SOIL 555 Biology of Soil Ecosystems (4)
SOIL 568 Soil Landscape Analysis (4)
WRP 521 Water Conflict Management and Transformation (3)
WRP 523 Environmental Water Transactions (3)
ELECTIVE COURSES

0 Cr for the M.S. and M.A. degree and 0-14 Cr for the Ph.D. degree. Students will work with their graduate advisor and committee to select elective courses to develop necessary background to add breadth and depth to the student’s Program of Study.

THESIS:

9 Cr for the M.S. and M.A. degree and 36-50 Cr for the Ph.D. degree