COURSE SYLLABUS
ATSC 5040 – Climate Science and Climate Change
Spring Semester 2015

Instructor Information:

Instructor: Dr. Xiaohong Liu
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Office: ENG 6050 **Office Hours: WF 1:30-2:30**

Course Information:
Credits: 3
Lecture: TR 1:20-2:35

Prerequisites: ATSC5010, ATSC5011, ATSC5015, ATSC5016, or consent of instructor

Course Description:
The principal goal of this course is to introduce graduate students to modern climate science through discussions of global climate system components, and their interactions; radiative, dynamic, thermodynamic, chemical, and feedback processes affecting the climate system; natural and anthropogenic drivers of climate change; past and present climate variability and sensitivity, and its simulation; the structure of climate models, their components, parameterizations, and attributes; and current climate modeling results and predictions of future climate.

Course Objectives:
The course aims to provide students with a broad picture of the climate system, the scientific principles of climate change, and the character and weaknesses of climate models. After completing the course successfully, students are expected to understand interactions within the climate system, and external forcings arising from changing environmental factors, such as those resulting from greenhouse gas and aerosol concentration variations, and be able to run a climate model to predict future changes in the climate.

Text(s) and Readings:
Course materials as PowerPoint files will be posted online. Required readings (articles and papers) will be distributed in class.

Required text book:
1. Hartmann, D.L., *Global Physical Climatology*, Academic Press, San Diego, 1994.

Students are encouraged to read the other text books and reports:
2. Pierrehumbert, Raymond T., *Principles of Planetary Climate*, Cambridge University Press, 2010.
3. Neelin, J. D., *Climate Change and Climate Modeling*, Cambridge University Press, 2011.
4. Intergovernmental Panel on Climate Change (2013), Climate Change 2013: The Physical Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge Univ. Press, New York. Chapters 7 and 8.

Course Requirements/Assignments:
In addition to regularly attending class and completing assignments and exams, students are expected to conduct a modeling project running the NCAR Community Earth System Model on the UW supercomputer (Mount Maron) or the NCAR-Wyoming Supercomputer (Yellowstone). They can choose one topic from (1)

Aerosol effects on climate; (2) Arctic climate change. They are expected to present their project results in class. And a 4-6 pages of report of their project is due in the last day of the class.

Grading Standards:
The overall course grade will be based on (i) the homework (30%), (ii) the mid-term exam (30%), and (iii) the course project (40%). Homework will be given out periodically throughout the course, and will be due one week later, unless prior approval of the instructor has been obtained. Make-up examinations will only be considered under special circumstances and must be approved in advance by the instructor.

Disability Statement:
If you have a physical, learning, sensory or psychological disability and require accommodations, please inform the instructor as soon as possible. You will need to register with, and provide documentation of your disability to University Disability Support Services (UDSS) in SEO, room 330 Knight Hall.

Academic Honesty:
The University of Wyoming is built upon a strong foundation of integrity, respect and trust. All members of the university community have a responsibility to be honest and the right to expect honesty from others. Any form of academic dishonesty is unacceptable to our community and will not be tolerated. University Regulation 6-802 outlines and prescribes University policies concerning academic dishonesty; it can be found at http://www.uwyo.edu/generalcounsel/_files/docs/UW-Reg-6-802.pdf. Other University regulations can be found at: http://www.uwyo.edu/generalcounsel/new-regulatory-structure/index.html.

Course Topics:
(1) Overview of the Global Climate System
- Components and interactions in the climate system
- Atmosphere
- Ocean
- Cryosphere
- Land surface

(2) Global Energy Balance
- Earth's energy balance
- Greenhouse
- Insolation variability
- Energy transport
- Cloud forcing

(3) Radiative Transfer
- Fundamentals
- Infrared radiative transfer
- Radiative equilibrium
- Clouds

(4) Energy Budgets of the Surface
- Soil heat
- Turbulent energy transfer: Sensible and latent heat
- Surface albedo and emissivity
- Boundary layer
- Surface flux variability

(Mid-term exam)

(5) Hydrological Cycle
- Global hydrological cycle
- Global precipitation and P-E
- Water storage
- Sea-level change

(6) Climate Sensitivity and Climate Feedbacks
- Climate sensitivity
- Stefan-Boltzmann feedback
- Ice-Albedo feedback
- Water vapor feedback
- Dynamical feedback
- Lapse rate feedback
- Cloud feedback
- Surface energy feedbacks

(7) Climate Models and Climate Modeling
- Dynamical core
- Temporal and spatial resolutions of climate models
- Resolved processes
- Parameterizations
- Character of climate models
- Uncertainties with climate modeling

(8) Climate Variability and Climate Change
- El Niño and La Niña
- Seasonal, decadal, centennial, and longer timescale variability of air temperature, wind, precipitation, aerosols and gases, etc.
- Internal forcing mechanisms: ocean variability
- External forcing mechanisms: orbital variations, solar output, volcanism, human influences

(Course project presentation)

The instructor may make changes to the syllabus as the course proceeds. If necessary, these changes will be announced in class. Substantive changes made to the syllabus shall be communicated in writing to the students.