Global Climate Change: Science, Engineering, and Policy: A new course at Clarkson University

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Overview

- NASA grant: Climate Change Literacy within New York State, NASA (PI: Prof. Susan Powers); Initiated in January 2010
- **Create/disseminate inquiry/project-based climate change curricular modules based on NASA data and models**
- Three-tiered approach for New York State audiences.
  - **College class:**
    - "Global Climate Change: Science, Engineering, and Policy" for engineering students taught S10 and S11 semesters
  - **Teacher Workshops:**
    - Middle school STEM and high school earth and environmental science teachers from across New York
    - Develop project-based learning experiences and lessons that highlight and integrate NASA data and models (2010 and 2011)
  - **Teacher Conferences:**
    - NYSERDA-sponsored state-wide Climate Change Conference for Teachers (2012)
    - Regional workshops, and one-day workshops

Climate Change Class

- Breadth of topics – science of climate change causes, consequences and mitigation
- Depth of knowledge through independent inquiry-based project defined by each student
- Highly quantitative
  - Accessing data, importing and working within Excel/Matlab
  - Data manipulation, statistics (Excel functions)
  - Effective graphing strategies
  - Global Climate Models
- Climate literacy survey developed and piloted for assessment

Climate Change Class

- Co-taught by Susan Powers (Env. Engrg.) and Suresh Dhaniyala (Mech. Engrg.)
- Offered Spring semesters, 2010 and 2011
- Aimed at engineering students
  - 2011 demographics (25 students)
    - 21 Undergrads, 4 MS students
    - 40% Women
      (18% engrg. women at CU)
    - 2 non-engineers
      (Env. Science & Policy)

Topical Outline

Fundamental questions:

- How is the global Earth system changing?
- What are the primary causes of change in the Earth system?
- How does the Earth system respond to natural and human-induced changes?
- What are the consequences for human civilization?

Unit 1: Historical evidence of climate changes

- Climate cycles – historical patterns, recent trends
- Climate data acquisition / interpretation

Unit 2: Science of climate and climate change

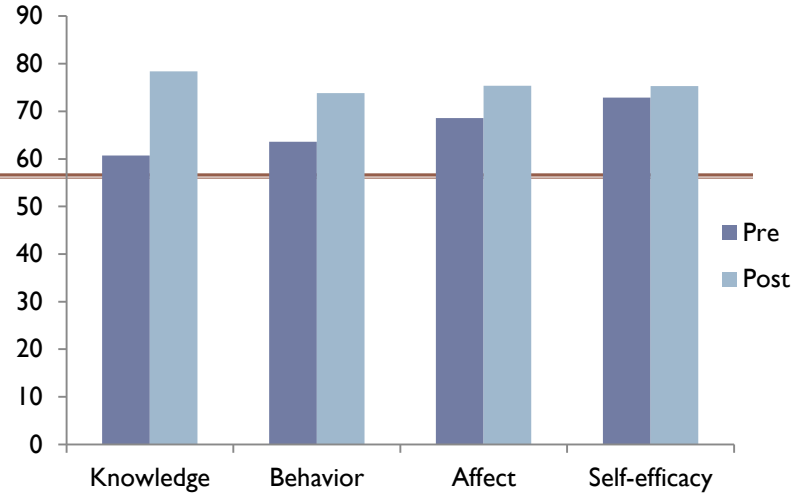
- Earth's energy balance and the greenhouse effect
- Wavelengths, absorption by atmospheric species, radiation
- Greenhouse gases / carbon cycling

Unit 3: Human Influences on Climate and Mitigating/Adapting to Change

- Sources /emissions of GHGs
- Energy consumption patterns
- Estimating GHG emissions
- Mitigation measures

Assessment results

- Some sample results:



Sample questions	Pre-course	Post-course
... most important problem facing US today	22% identified climate change	74% identified climate change
Global warming caused mostly by human activities	14.8%	82.6%
Climate change only impacts future generations	18.5%	4.3%
Currently … try to save energy …	29.6%	39.1%

Challenges

- Curriculum
  - Climate science background typically offered in departments such as: Earth Sciences, Geological and Planetary Sciences, etc
  - No obvious reference books to underpin a climate-change course for engineering students
  - Need to make it relevant and appealing to an engineering audience
- Difficulty in housing this course
  - No obvious "Engineering department home" for a climate change course
    - ABET concerns
  - At Clarkson, offered as an Engineering Science (ES) course
    - Difficult to get TA support as a ES course
- Additional teaching load
  - As the climate change course was offered on our own initiative, we were still required to teach our required department courses
- Broad range of student backgrounds
- The faculty need to be up-to-date on material that evolves very quickly

Opportunities

- Introducing climate science to engineers
  - Climate change will become integral to engineers in their career and knowledge of the problem is critical to success in their field
- Team-teaching
- Integration of our research activities with teaching
- Teaching an interdisciplinary set of students and bringing them together to solve problems
- Tie-in with K-12 efforts
- ASEE paper
  - Powers, S., DeWaters, J., Dhaniyala, S., & Small, M. (2011). *Teaching climate science and policy to engineering students.* Paper presented at the 2011 ASEE Annual Conference & Exposition

Recommendations to include in Engineering curriculum

- Funding for course development
  - Advantage – Minimizes any potential department/school concern (political or otherwise)
- Online repositories of course modules, case studies, problem sets, etc
  - Advantage – Eliminates course setup time
  - Aiding faculty who are not experts in climate science to teach such a course
- New course
  - Advantage – sufficient class time to provide climate science background
  - Disadvantage – faculty time commitment, only limited time available for Engineered Systems course material