Sea Level Education for Underrepresented Students Through Collaboration with CABPES

B.D. Hamlington, R.R. Leben

Colorado Center for Astrodynamics Research

University of Colorado, Boulder

Introduction

- While great advances have been made in climate science in recent years, the lack of resources and attention given to this area of science at the K-12 level is cause for concern.
  - This is especially true in underrepresented and minority areas in the Denver-metro area where funding is limited and schools may struggle to meet baseline standards.
  - Through efforts like the Global Climate Change Education (GCCE) project, NASA seeks to increase the number of students interested in climate science.
- Motivated by this, and as part of a NASA ROSES supplemental education proposal, we are collaborating with the Colorado Association of Black Professional Scientists and Engineers (CABPES) to provide an after-school sea level and climate science course to underrepresented and minority students in the Denver-area.

What is CABPES?

- CABPES is a non-profit organization dedicated to encouraging African-American and underrepresented youth to pursue careers in engineering and applied science professions.
  - Comprised of volunteer engineers and scientists in the Denver metropolitan area.
  - Works primarily with students from grades 6 through 12.
  - Teaches after-school courses covering a range of topics in core subjects of engineering, science and math.
  - Offers assistance with schoolwork as well as counseling for students preparing for college.
  - 112 students are enrolled across grades 6 through 12.
  - Have a desire to expand number of students enrolled and courses offered, but funding and resources are extremely limited.

CABPES

Sea Level Education Course

- To supplement the courses on core concepts in math and science, we provide a course on climate change, and more specifically sea level.
  - Course is offered twice a year, once in the Fall and once in the Spring, with each course consisting of 6 classes that are each 2 hours long.
  - Course introduces students to MATLAB and provides experience working with satellite altimetry data.
  - We have attempted to find low-cost ways to explain large-scale sea level concepts on the smaller-scale of a classroom.

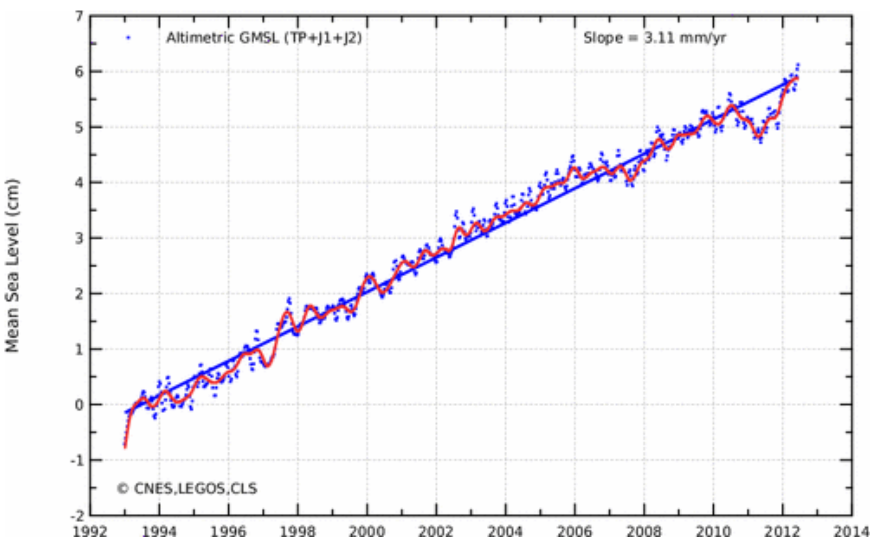
Outline of Course

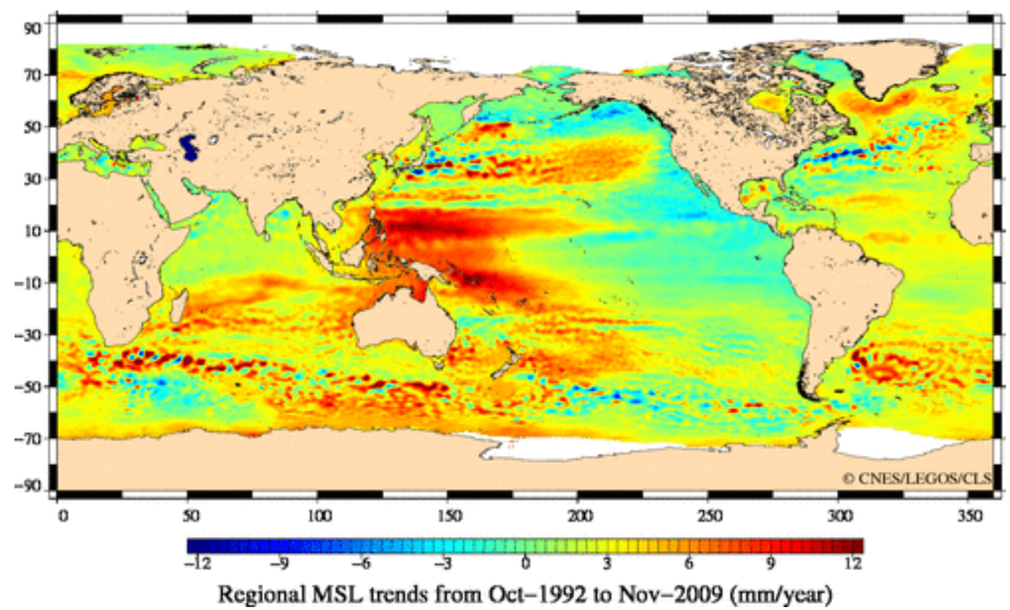
- **Class 1: Introduction to climate/sea level science**
  - Conduct pre-course survey to test the students' incoming level of knowledge.
  - Overview presentation on climate change and more specifically, the study of sea level.
    - Show videos and information from the sea level viewer at climate.nasa.gov.
    - Discuss satellite altimetry.
    - Discuss NASA's role in studying sea level.
  - Outline remainder of course.

- **Class 2: MATLAB Tutorial**
  - Students work in teams of 2 to complete tutorial.
  - Introduce students to MATLAB.
  - Created a simple tutorial for highlighting some of MATLAB's basic functions.
  - Discuss simple computer programming structures with students.
  - Learn how to compute the mean and the trend of a simple set of data.

Outline of Course

- **Class 3: MATLAB Exercises**
  – Students write simple MATLAB code to compute GMSL and map of regional sea level rise from satellite altimetry data, like those shown below.



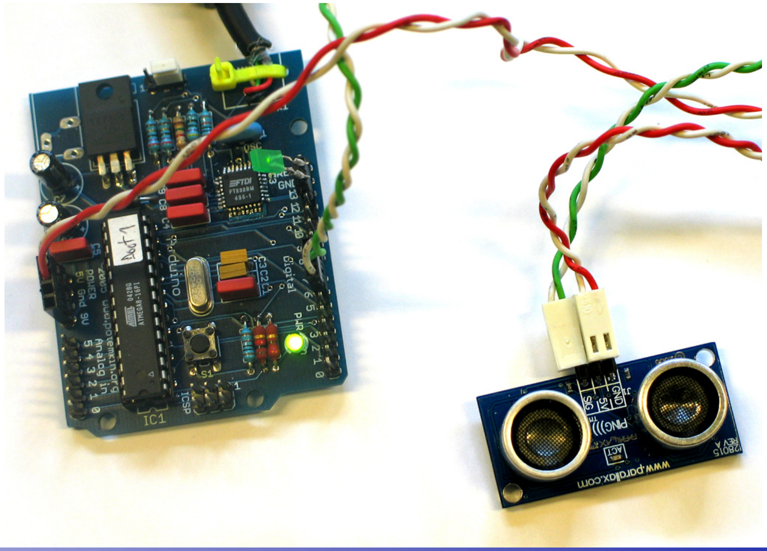


http://www.aviso.oceanobs.com/en/news/ocean-indicators/mean-sea-level/

Outline of Course

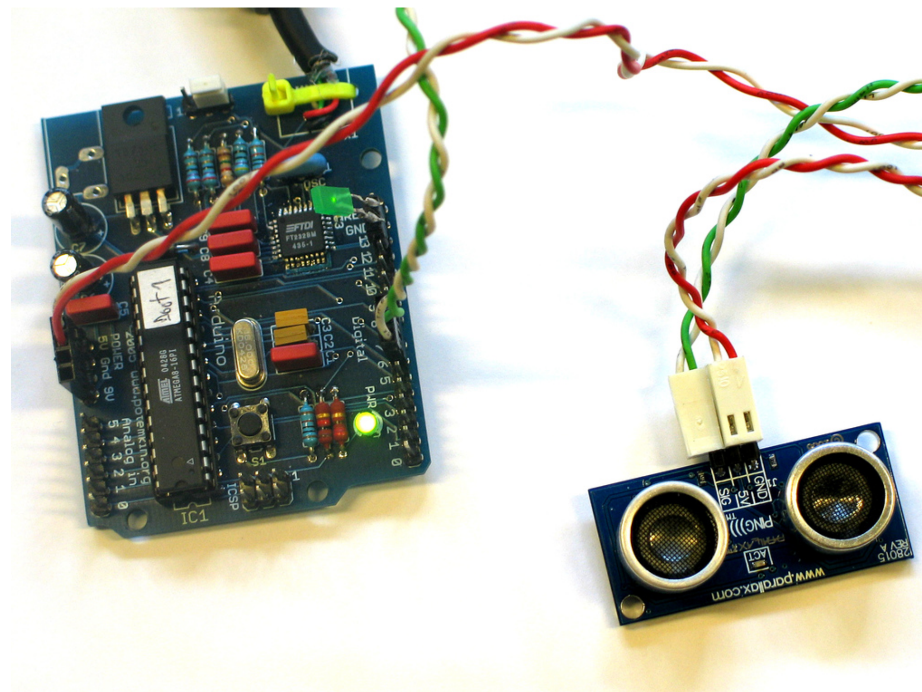
- **Class 4: Introduction to satellite altimetry**
  - Discuss operation and how satellite altimeters measure the height of the ocean from space.
  - Students explore sealevel.jpl.nasa.gov to learn more about satellite altimeters.
  - Discuss past, present and future of satellite altimetry.
  - Create model satellite altimeters from simple ultrasonic rangefinder and programmable microcontroller.

The rangefinder incorporates a simple ultrasonic sensor with an Arduino microcontroller. The sensor sends out a burst of ultrasound and then listens for the echo when it bounces off an object (working range is between 2 cm and 3 m).



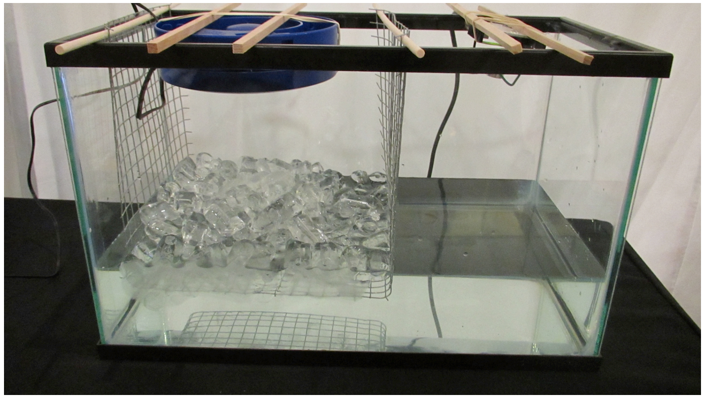
Model "Altimeter"

- We model a satellite altimeter by creating a simple ultrasonic rangefinder.
- The rangefinder incorporates an ultrasonic sensor with an Arduino microcontroller.
- The sensor sends out a burst of ultrasound and then listens for the echo when it bounces off an object (working range is between 2 cm and 3 m).
- Microcontroller is connected to a computer where measurements are output.
- Cost:
  - Arduino Microcontroller: $22
  - Ping Parallax Ultrasonic Sensor: $15
  - Connectors: $1
  - **Total Cost: $38**

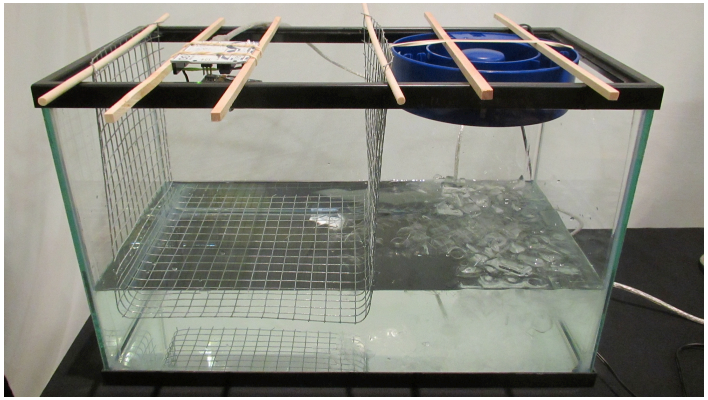


Outline of Course

- **Class 5: Sea Ice vs. Continental Ice:**
  - Students complete a simple experiment to understand the difference between melting sea ice and melting continental ice in terms of their contribution to sea level change.
  - Experiment runs for 20 minutes and results are output to MATLAB for further analysis.



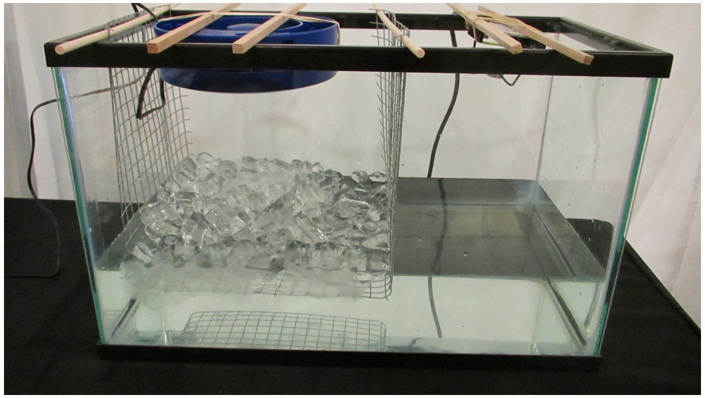
Continental Ice: To simulate melting continental ice (A), we positioned the ice in a wire mesh basket sitting slightly above the surface of the water, using a fan to improve air circulation and speed the melting of ice.



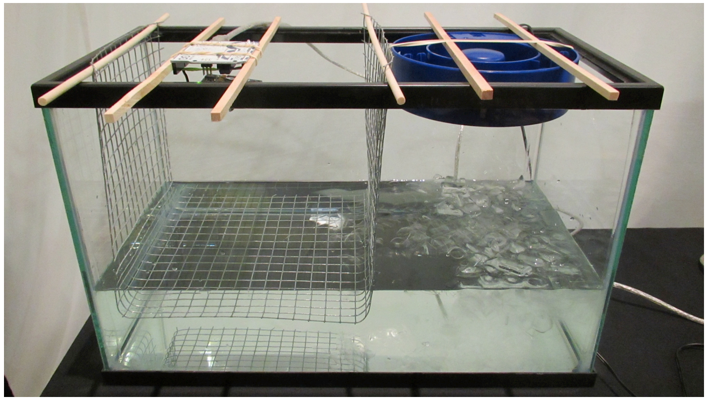
Sea Ice: To simulate melting continental ice (A), we positioned the ice in a wire mesh basket sitting on the surface of the water, using a fan to improve air circulation and speed the melting of ice.

Continental Ice vs. Sea Ice Experiment

- **Cost:**
  - Aquarium - $15 , USB Fan - $5, Wire Mesh $2, Model Altimeter - $38
  - **Total Cost: $60**



Continental Ice: To simulate melting continental ice (A), we positioned the ice in a wire mesh basket sitting slightly above the surface of the water, using a fan to improve air circulation and speed the melting of ice.

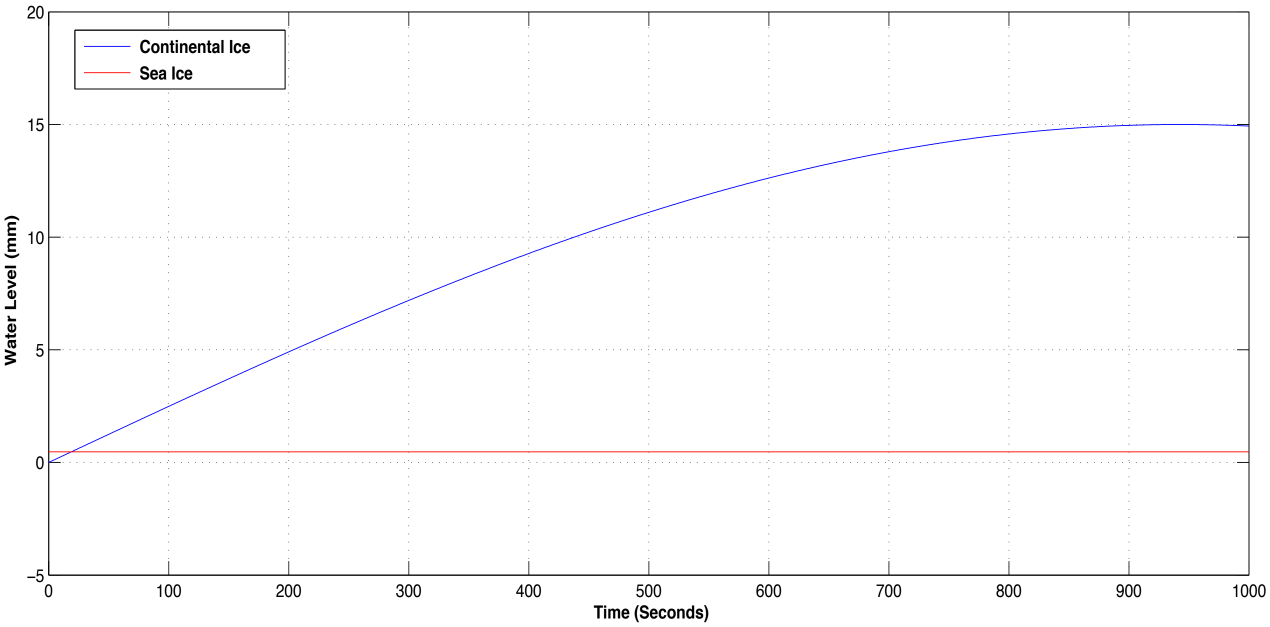


Sea Ice: To simulate melting continental ice (A), we positioned the ice in a wire mesh basket sitting on the surface of the water, using a fan to improve air circulation and speed the melting of ice.

Outline of Course

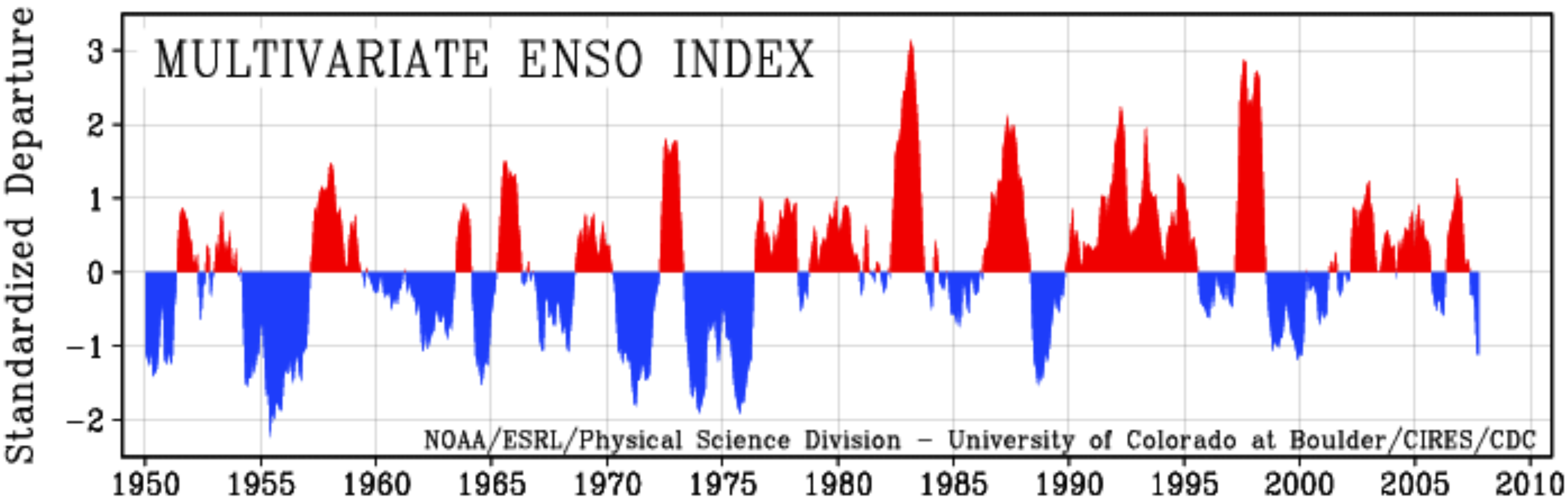
- **Class 5: Sea Ice vs. Continental Ice:**

The results of the experiment show that the melting "continental" ice caused the water level to change significantly more than the melting "sea" ice. The students then used MATLAB to estimate the rate and acceleration of the changing sea level. (Note, the results have been smoothed to remove measurement noise).



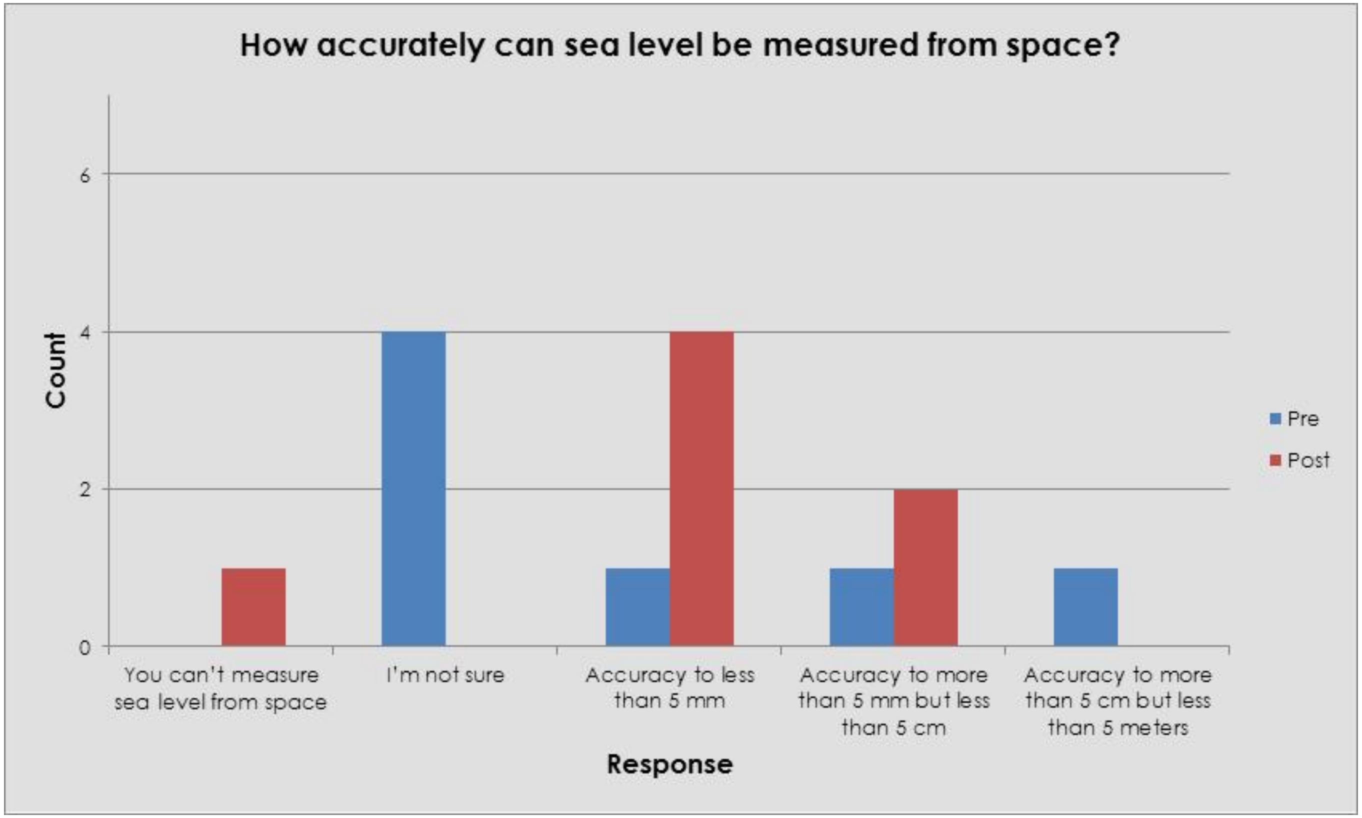
Outline of Course

- **Class 6: ENSO, Summary and Wrap-up**
  - Discuss climate signals (ENSO, in particular) and how they affect sea level.
  - Students compute an ENSO index from the satellite altimeter data using MATLAB.
  - Students re-take the survey given in class 1.

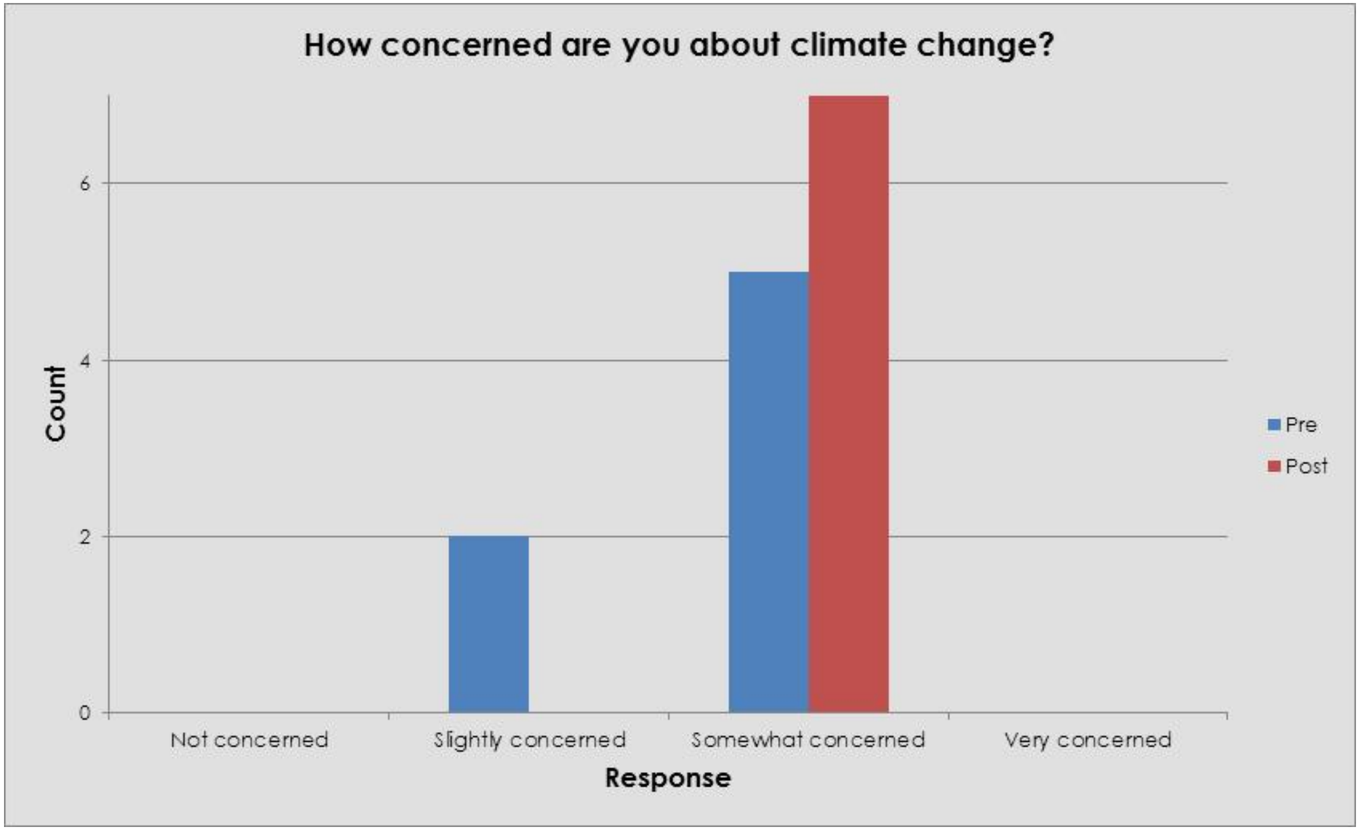


Pre- and Post- Survey Results

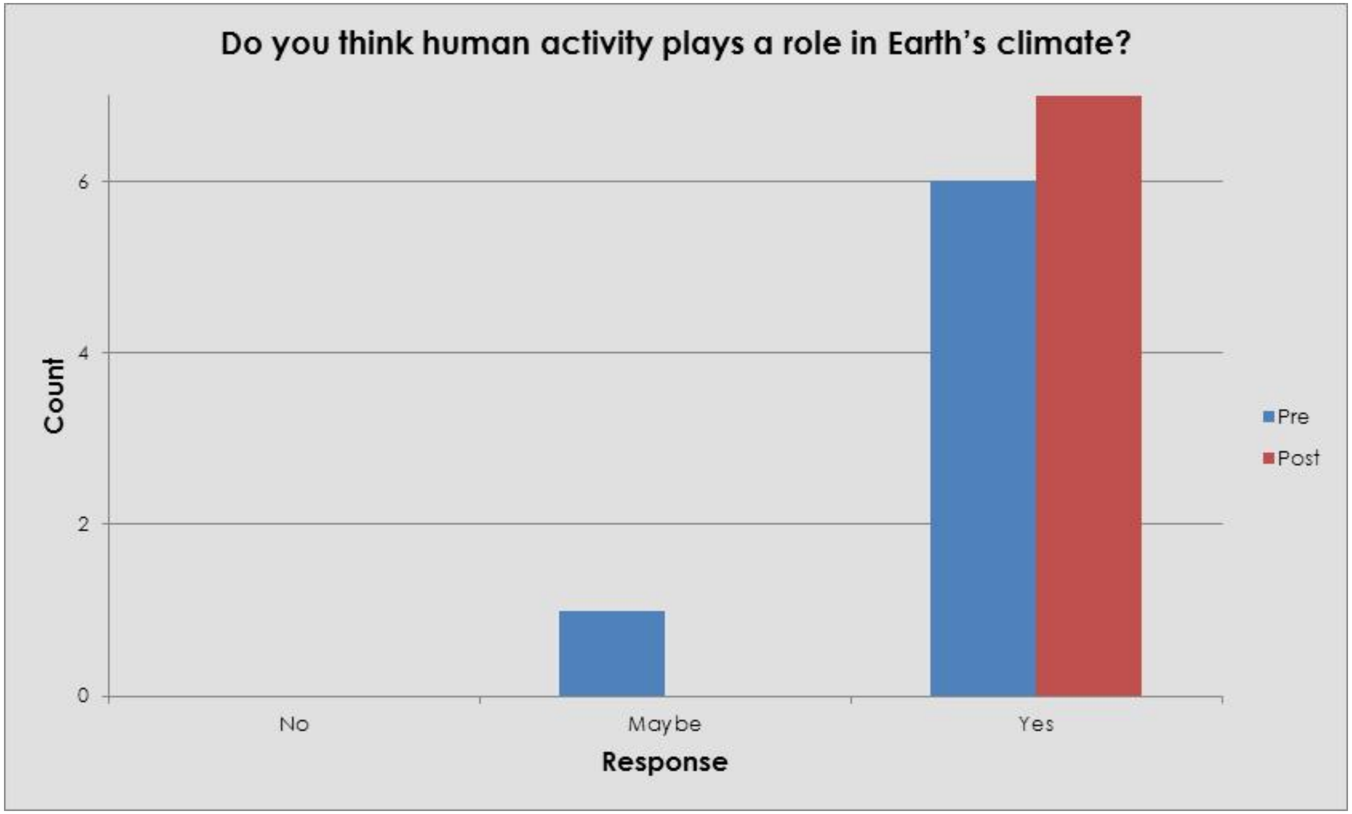
- Pre- and post-course survey was given to the students to gauge how successful the course was.
- With the help of an outreach evaluator at CU, results were compiled and analyzed.
- Results for some of the questions are shown on the following slides:



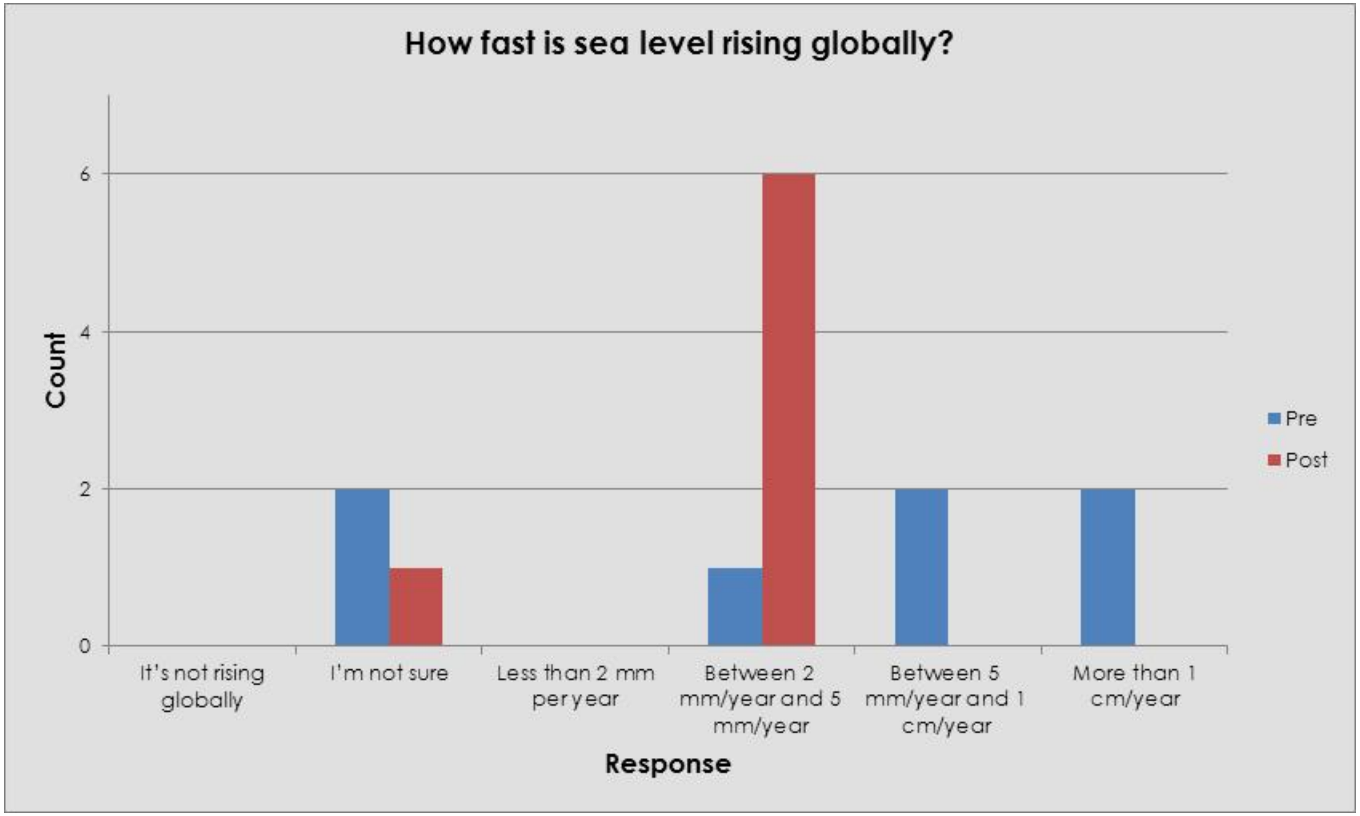
Pre- and Post- Survey Results



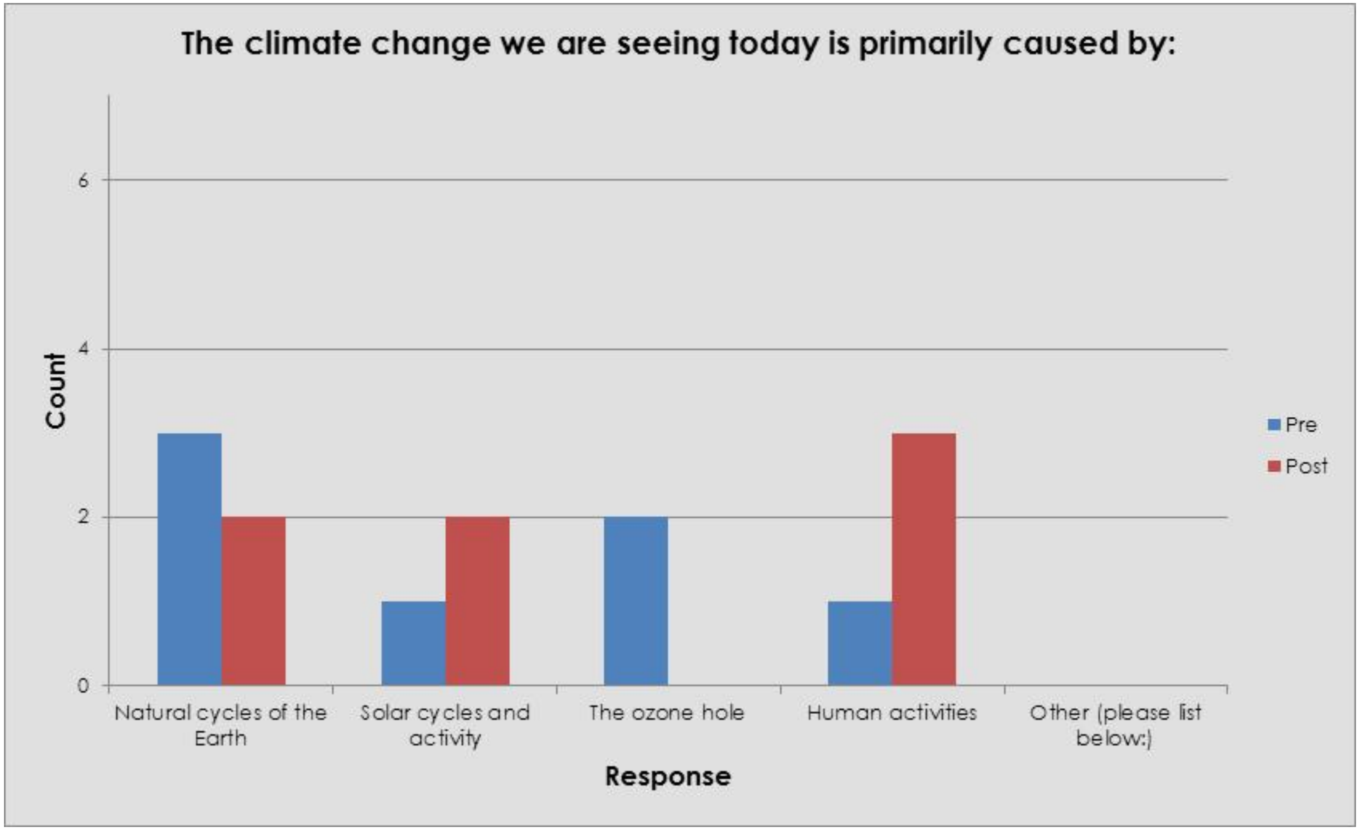
Pre- and Post- Survey Results



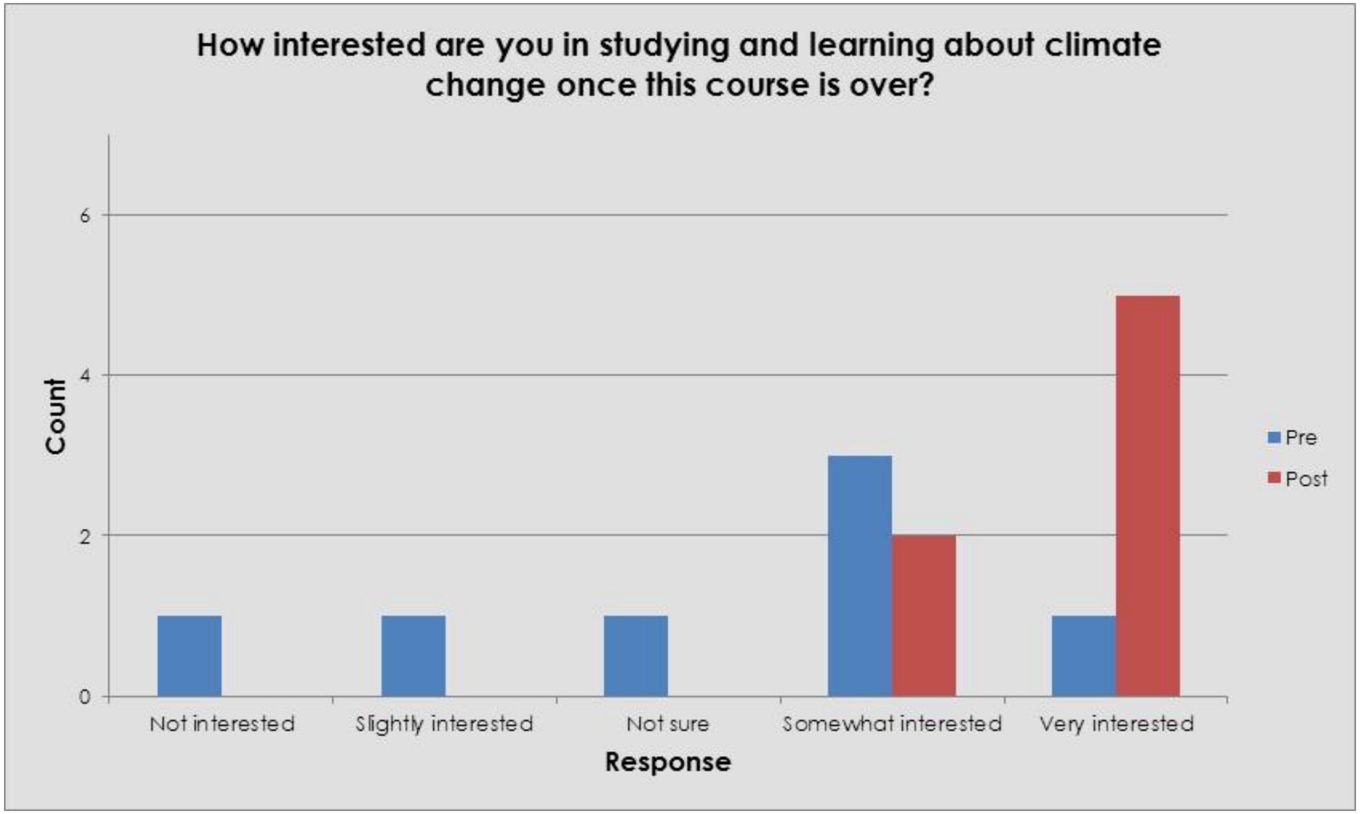
Pre- and Post- Survey Results



Pre- and Post- Survey Results



Pre- and Post- Survey Results



Progress and Future of Course

- Overall, students were very enthusiastic and enjoyed learning about sea level and climate science.
  - In particular, hands-on experiments and MATLAB exercises were very popular.
- Results from pre- and post-course surveys suggest that students gained knowledge regarding sea level and climate change.
  - Survey has been modified after analyzing the results, and process will continue to find the best way to gauge students' knowledge before and after course.
- Next course will begin on October 25th.
  - 13 students are currently enrolled.
  - Course will again be 6 classes, and will subsequently be taught twice a year for the next two years.
  - Class expected to grow to around 20 students per session.
- At the end of the course, the goal is to create classroom modules so that the course can continue to be taught by instructors at CABPES, and also extended to other students outside of CABPES.