Activity: Exploring the Link Between Hurricanes and Climate Using GCM Results

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This page contains detailed instructions for conducting this activity, as well as prompts to give students. A template for the student handout is in the file HurricaneGCMActivity.doc.

Activity Description (from webpage):
This is a two-part activity, requiring two to three 50-minute class periods. During the first class period, students review the factors affecting tropical cyclone initiation and evolution (role of sea surface temperatures, etc), then examine output from NCAR's Community Climate System Model experiment which tested model climate sensitivity to 4x 1990 atmospheric CO2 levels. In groups, students compare the 4xCO2 experiment with a 1990 Control experiment in terms of surface temperature, upper level winds, and lapse rate in hurricane-prone regions. Each group considers whether tropical cyclones would be more likely to develop in the 4xCO2 experiment, then provides a brief oral report to the class on the result of their discussion. For homework, students read two short journal articles examining the connection between hurricanes and climate change. In preparation for discussion on these articles, students create a brief written summary of the main points in each article and a list of discussion questions. Class discussion is driven by students' written summaries and questions. Students consider the hypotheses developed in the previous class regarding hurricanes in a warmer world in context of what they have read in the articles.

PART I: Examining climate in a warmer world
Time allotted: 50 minutes
Materials: White board, computers with Ethernet or wi-fi access
GOAL: Consider factors that influence tropical storm growth and development and make a hypothesis regarding effects of climate change on hurricanes.

Begin class with a review of hurricanes:

Note: If students are unfamiliar with this topic, it may be necessary to review this in a class or two prior to introducing the activity.

> "As a class, we are going to consider the potential impact of global warming on tropical cyclones. First, let's review how cyclones form, and what factors are favorable for formation."
>
> Brainstorm the factors that promote tropical cyclone development – including warm SSTs and weak winds aloft. Now ask students to consider how will these factors change in a warmer world.
>
> We will examine climate mode results from the NCAR CCSM (Take a few moments to show them the web page and the types of images they will be looking at if they have never been to this web site.)

Handout instructions for students (See HurricaneGCMActivity.doc)

> Divide students into four groups (you may do more with a larger class). Each group will focus on one ocean basin:

The Atlantic
West Pacific
East Pacific
Indian Ocean

Allow students ~20 minutes to examine the model results (if they are unfamiliar with GCM results, and the NCAR website in general, they will require longer). While students are examining the GCM results, create a grid on the white-board where students can fill-in observations they have made about the climate in each ocean basin:

Example:

	Change in surface Temperature?	**Change in upper level winds?**	**Change in lapse rate, if available?**
Atlantic			
W. Pacific			
E. Pacific			
Indian			

After students have reported their results on the white-board, hold a short class discussion summarizing what they have discovered from their investigations. Also assign homework (to prepare for class discussion below).

PART II: Exploring hurricane-climate connections in the literature

GOALS: Become familiar with literature and be able to summarize results from studies by other scientists in your own words.

PREPARATION:
Prior to this class, students must read the following two papers:

Emanuel, K., 2005. Increasing destructiveness of tropical cyclones over the past 30 years. Science, 436, p. 686-688.

Webster, P.J., et al., 2005. Changes in tropical cyclone number, duration, and intensity in a warming environment. Science, 309, 1844-1846.

Students must also do the following for homework:

1) Briefly summarize answers to the following questions (2-3 sentences each). Do this for each paper.
   What question/problem is the paper attempting to address?
   How did the authors complete their research? (What methods do they use?)
   What are the primary results/conclusions?
2) Write three questions on each paper to bring in for discussion.
3) For the Webster paper, students are divided into 4 groups. Each group will become an expert on one of the four figures in the paper. Each group will be required to explain their figure to the rest of the class.

ON DISCUSSION DAY:

- Begin by summarizing student comments/hypotheses from looking at model results in the previous class.
- As a class, summarize the papers. Student groups explain individual figures from Webster paper.
- After reviewing the content of the papers, hold a general discussion about the papers (based on questions formulated before class).
- Finally, ask students to reconsider their hypotheses developed in the previous class. For example: **Can we draw any conclusions about what will happen? What other type of information would we need to better answer the question as to whether or not climate change is affecting hurricanes?**
- End class by having students list 1-2 key points they feel they have learned from this, as well as 1-2 questions they still have.