Attachment 1: Implementation Instructions for Teachers

Rationale

Because of the computational requirements, global climate models (GCMs) were originally developed and housed at national laboratories run by government science agencies. They constitute one of the primary technologies used today in climate research. Forecasting that combines data from such models globally also features prominently in reports by the Intergovernmental Panel on Climate Change (IPCC). The National Aeronautics and Space Administration's climate modeling lab, the Goddard Institute for Space Studies (GISS), is located at Columbia University in New York City (this is also where EdGCM was developed).

As a result of their complexity, GCMs are not well understood by the general public. These laboratory exercises seek to give instructors the tools to teach with a GCM. The educational version of the software, EdGCM, differs from the original climate modeling software only in that it is designed to run on school computers. Consequently, the grid resolution on maps containing global output can be less, with some of the parameters (e.g., dynamic ice, vegetation) not included due to classroom computers having less computing power than the supercomputers used by the national labs. These national laboratories include:

- NASA/GISS National Aeronautics and Space Administration, Goddard Institute for Space Studies
- NSF/NCAR National Science Foundation, National Center for Atmospheric Research
- NOAA/GFDL National Oceanic and Atmospheric Administration, Geophysical Fluid Dynamics Laboratory

Lab 1 Background and Implementation Instructions

This lab is designed to first give students familiarity with EdGCM through individual self-exploration. Start by asking students to read the background and explore the background resources. Then they should work to complete Part B. When students have had sufficient time to explore, they should pay attention to the instructor's explanations about GCMs and walk-thru of setting up experiments. Students should then work in groups or pairs to replicate what the instructor does. Finally, students should begin work on Part C. Additional materials are supplied in the slide deck for the instructor to interrupt with other key concepts when there are pauses in student work.

Lab 2 Background and Implementation Instructions

Instructions: Students begin this lesson by examining decreasing snow and ice coverage. Using this case study as the initial introduction to the technical skills needed to use EdGCM, students can investigate other subjects and questions of their own design. Students can use EdGCM to investigate the impacts of climate change on temperature, precipitation, snow, and ice coverage. Students will relate global processes to changes that affect them at a local level. The contexts or subject areas that this lesson is suited for are broad. The outcome of the discussions will be guided by the parameters set by the individual instructor. The outcome could be social, environmental, or economic.

Steps:

1. IMPORTANT: To undertake this lesson, students will need to work with completed simulation output. While students may have started the model running in the last lab, you will want to ensure EdGCM has the correct completed runs or even add the output to any computers that need it.
2. Begin your lesson with a recent news article or video clip.
3. Use a world map to discuss the concept of the regionalism of climate impacts (see instructor resources for possible maps).
4. Walk students thru making time-series graphs, maps, and anomaly maps.

5. Guide student group inquiry into impacts of climate change on snow and ice cover or other topics using instructions below.
6. Conclude with summary discussion of impacts of climate change.

Instructor Resources:
Earth Exploration Toolbook: Envisioning Climate Change Using A Global Climate Model
Center for Global Development: Mapping the Impacts of Climate Change

Lab 3 Background and Implementation Instructions

Instructions: This lab transitions from learning how to make different visualizations with EdGCM to beginning the writing of hypotheses for students own research with EdGCM. Students should come prepared with scientific theories they have researched or heard of. By the end of class, they will leave (hopefully) with an instructor approved research project.

Steps:
1. Finish leftover impacts work from last class using examples generated by the instructor. Allow students to make difference plots, time-series graphs, maps, zonal averages, and use other scenarios or variables.
2. Hold discussion of theories / hypotheses students bring to class.
3. Discuss how to write research questions and paired hypotheses (i.e. null and alternate) and the importance of control / baseline runs to measure degree of change. Work through slides on anomaly maps or difference plots. If students still do not understand this key concept and how climate scientists use it, then use the “Mini Exercise on Anomaly Maps” slides from the slide deck and/or the slides for “A Temperature and Precipitation Exercise with Absolute and Anomaly Data.”
4. Allow students to begin developing their own research questions and hypotheses for their own research with EdGCM.