InquirySpace Teacher Guides: Climate Change

1) Summary

The Climate Change activity was designed to be the last game in the InquirySpace sequence and serves as a bridge for students to apply what they learned about the experimental process and the CODAP environment to a different domain. The purpose of this activity is to allow for open exploration of four variables using a climate model that affect the Earth's climate: albedo, CO2, cloud cover, and sun brightness. Students are asked to select a variable, adjust the parameter and observe the changes to the climate.

The climate model is different than other models used in InquirySpace because climate is not a deterministic system. This may be a challenge for students. When variables are set to the same values in the spring-mass model or the parachute model, the outcomes will always be the same. In the climate model, there is a degree of random variation due to the chaotic nature of the Earth's climate. For climate, students need to think about *trends*, as opposed to absolute outcomes. They need to figure out how many times the model should be run before they can judge the effect of different variables, and how they can represent the data and understand the trends. Additional information on the climate model is found toward the end of this guide.

2) Learning Goals

Students will:

- Explore the climate model to understand variability in the climate system.
- Create experiments using the climate model to investigate relationships between various factors that affect climate (sun brightness, albedo, CO2, or cloud cover).
- Create graphs in the CODAP environment that best demonstrate the effect of the variables they are investigating, and use the graphing tools such as scaling, hide/show, connecting-lines and movable-line, or coloring the runs with different attributes, to interpret the data.
- Use the CODAP graphs and analysis tools to demonstrate trends and explain findings made with the climate model.

3) Teacher Preparation

The most important step in preparing to run InquirySpace activities with students is to run the "Teacher Version" of each activity prior to classroom activities. In this climate change activity, it will be especially important to try the climate model before your students, as it behaves quite differently than other InquirySpace models. By trying out the model and attempting to answer the questions in the activity, you will be in a good position to help you students.

Teacher versions of InquirySpace activities are available on the InquirySpace portal.

http://inquiryspace.portal.concord.org

Teacher versions are essentially duplicates of the student versions with the addition of tips for successful classroom use. These tips are written in red within each activity. By running the activities yourself, you will become familiar with many important elements of the activity including the:

- flow of the activity between Lab and Experiment Tabs,
- variables in the climate model,
- functionality with the CODAP environment,
- questions that students will be asked to answer, and
- approximate amount of time needed to complete it.

4) Materials

Break students into groups of two or three. Each group will need the following:

An account on the InquirySpace Portal. For help on registration and class set up, please see the Portal and Quick Start Guide.

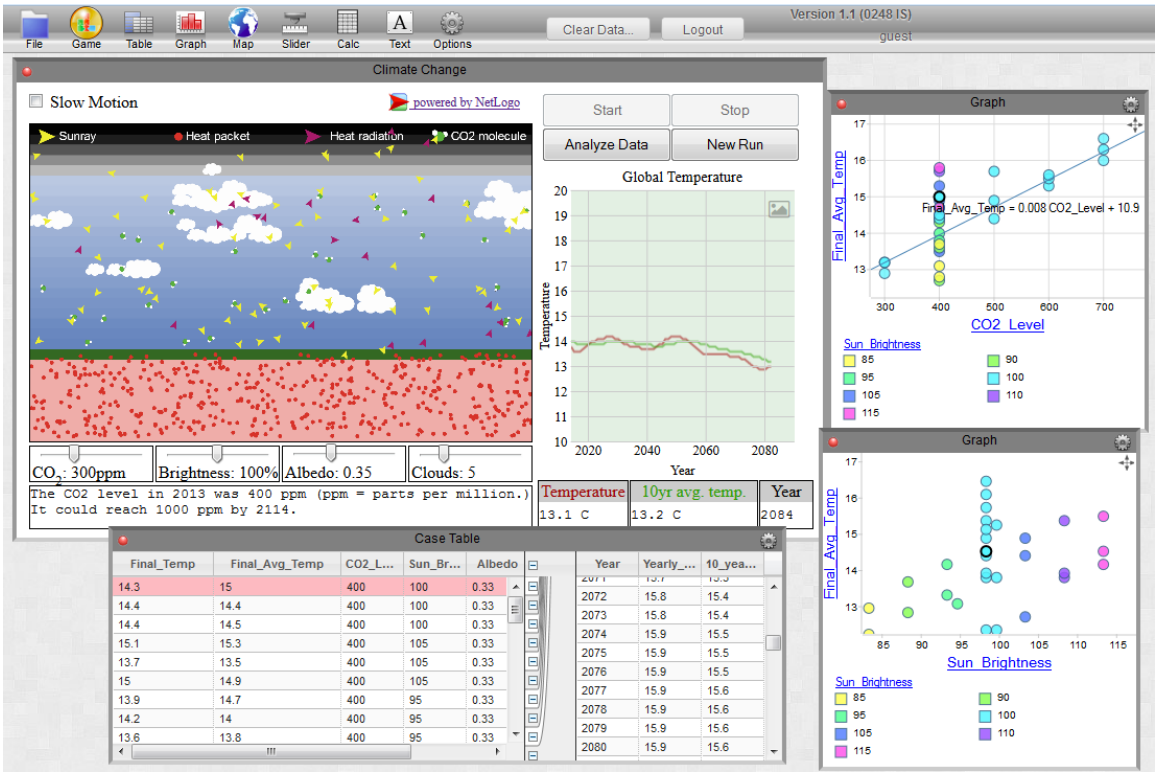
Materials:

- Computer
- Internet connection

5) The Student Experience

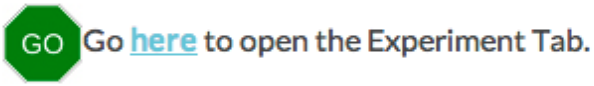
When you run the Teacher Version of the activity, you will become more familiar with the flow of InquirySpace activities. The student version of each activity follows the same flow. When the student clicks the **Run** button under an activity, the activity will open in a new tab. Students should follow the steps of the activity in sequence (shown below). Any answers to questions within the activity are automatically saved to their account.

Each InquirySpace activity has two parts, the Lab Report (a page example shown above) and the Experiment Tab (an example screenshot shown below).



The Lab Report Tab is launched first by the Portal. The Lab Report for each activity gives background information and instructions for setting up experiments, asks questions, and automatically saves answers. Eventually, the instructions within the Lab Report will ask students to collect and analyze data using the CODAP environment, which is referred to as the Experiment Tab. A link in the Lab Report (see below) will launch the Experiment Tab where students will run the climate model to collect data, create graphs, and analyze data.

When it is time to use CODAP, students will see this sign in the Lab Report on Step 3:



The CODAP environment will open in a new browser tab. CODAP is a separate piece of software. In order to preserve their work, *students need to name and save their work while in CODAP using the File menu*—it is not saved automatically as it is in the Lab Report Tab. Work in the Experiment Tab is not yet shown in the Portal Reports (this feature is in development). As students work through the InquirySpace activity, they will move back and forth from the Experiment Tab to the Lab Report Tab. Remind students when they are in CODAP to check back to the Lab Report Tab for instructions about what to do, and to answer questions.

6) Potential trouble spots

- This is a very open-ended activity. More so than other InquirySpace activities, you will need to establish expectations for your students, otherwise, students will rush through and be done in 15 minutes and get little out of the activity.
- The complexity of this activity comes from the non-deterministic nature of the climate model. Students will need to come to grips with examining multiple runs of same-setting experiments, and determining the climate trends.

7) Discussion Topics

Students will need your help to make their work with InquirySpace activities a meaningful experience. Help them make sense of their observations by facilitating full class and small group discussions at appropriate times. Stopping often in the middle of an activity for discussion can be difficult because groups work at their own pace. However, leading discussions at the start of an activity or bringing the class together at the end is an important role for teachers to play.

Suggestions for discussions with the Climate Change activity are included as Teacher Tips throughout the teacher version of the activity. The main points of the discussion topics are also included here.

- A full-class, teacher-led discussion early in the work on this activity is appropriate. As suggested on the third page of the activity, have students play with the model in the CODAP environment for several minutes, asking them to be sure to try running the model with the same settings several times. Then immediately hold a brief discussion about what they noticed. Did they notice the variability of the climate outcomes? Challenge them to think about how they can establish cause and effect when the outcomes vary. Challenge them to think about how to represent their data to make claims about the cause and effect of variables.
- As students work, you may be able to look over their shoulders to see if they are struggling with the data analysis. You will probably be able to determine if helping students individually or stopping the class for a short discussion is the most appropriate way to help them. Remind them that they will need to employ techniques of manipulating graphs, building new graphs selecting the most appropriate variables. The movable line tool maybe useful to visually establish averages and trends.
- You may find it valuable to discuss techniques for running controlled experiments that can establish cause and effect of variables. Such a discussion might include the need for holding other variables constant, running trails multiple times, and varying the variable of interest over a wide enough span to see trends.
- For the final page of the activity, be sure to establish expectations that meet your teaching needs. Students can go in great depth or treat this lightly. You might want to have different students investigate different variables and then have them compare their results at the end. Or, for more depth, have students investigate two variables, determining first their individual effect, the how they affect each other.

8) The Climate Change Model

- Concord Consortium has produced several versions of the Climate Change model. Some versions concentrate on the mechanics of climate change, such as the absorption and reflection of short- and long-wave radiation. This version concentrates on long-term trends (50 – 80 years). It provides access for four variables, CO2, sun brightness, albedo, and clouds. These variables are NOT linked or fed-back in this version of the model. That is, as the Earth warms, say, from greater concentrations of CO2, more clouds do not form from greater evaporation of water. The cloud variable will only change when it is set independently.
- Students need to explore the extent of variability for a particular setting. Although it may be impossible to predict the exact outcome of a particular setting, students should run the model enough to determine the range of possible outcomes. This can give them an appreciation for the challenges that professions climate scientists have predicting future climates.
- You may want to discuss the extent to which this model is realistic. Will students notice the lack of feedback—that one variable does not affect another? You may want to explain that this is a learning model designed for investigation the effects of individual variables. More realistic models do account for variable feedback.