FACULTY AND STUDENT PERCEPTIONS OF LEARNING ON A SPHERICAL DISPLAY SYSTEM

-Preliminary Results from an Exploratory Analysis-

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Objective

Conduct a preliminary, exploratory analysis to characterize:

- The use of a spherical display system, Science on a Sphere (SOS), in the JMU curriculum;
- The nature and application of SOS use;
- Instructors' perceptions of the challenges and benefits of using SOS for undergraduate education; and,
- Future research needs.

Abstract

James Madison University in Harrisonburg, Virginia, is one of the few institutions to incorporate SOS in formal, undergraduate education. This poster provides examples of JMU's use of SOS for undergraduate education over the past three years. This poster discusses the undergraduate audiences (including general education students, pre-service teachers, and geology majors), the types of visualizations employed for JMU's climate education, pedagogical practices of JMU instructors, faculty comments on benefits and challenges with utilizing SOS for college-level lessons, and recommendations for future research. As an example of the pedagogy-related findings that are presented, multiple faculty members use handouts with guiding questions for discussion and note-taking and show each visualization multiple times. An example of an approach is to present the SOS visualization in the dark with the students' full attention on SOS. The second and third repetitions of the visualization are interactive, with the lights dimmed and the projection occasionally paused for discussion so that the instructor could gauge the students' learning in real time, address any possible misconceptions, and answer questions. As an example of the challenges and benefits addressed by this poster, faculty responses to SOS visualizations are presented along with the implications of these responses for teaching about climate with SOS.

Data Collection Methodology

The sources of data for this poster were the authors' experiences teaching with SOS and results of a survey administered to those registered to access the SOS Theater at JMU. There are approximately 95 registered users of SOS at JMU, and some of those users conduct teaching or outreach using SOS. Other SOS applications include scholarship and student special studies.

The survey was developed to address the following questions:

- How many JMU faculty members utilize SOS in college courses?
- What courses and departments incorporate SOS?
- What material is being presented on SOS?
- What climate related education is being conducted using SOS?
- What obstacles do faculty members encounter when utilizing SOS?
- What are the pedagogical impacts of using SOS?
- How do faculty members perceive SOS contributes to student learning?
- What is the student response to SOS?

In early January 2014, the survey was distributed. Preliminary results are reported here.

Overview of Science on a Sphere

Science On a Sphere (SOS) is a spherical display system developed by the National Oceanic and Atmospheric Administration (NOAA) primarily to educate the public about Earth System Science. A computer-projector system displays data sets on a six foot diameter, spherical "screen" creating a variety of images such as animated visualizations of Earth processes based on satellite data, static solar system images such as Earth's moon, or specially-created narrated movies (see Figure 1). The standard SOS Theater configuration is shown in Figure 2. Over 100 installations of SOS have been completed internationally, primarily at museums, and over 33 million people annually see a SOS display according to NOAA.

Figure 1: Students completing an exercise in the SOS Theater.

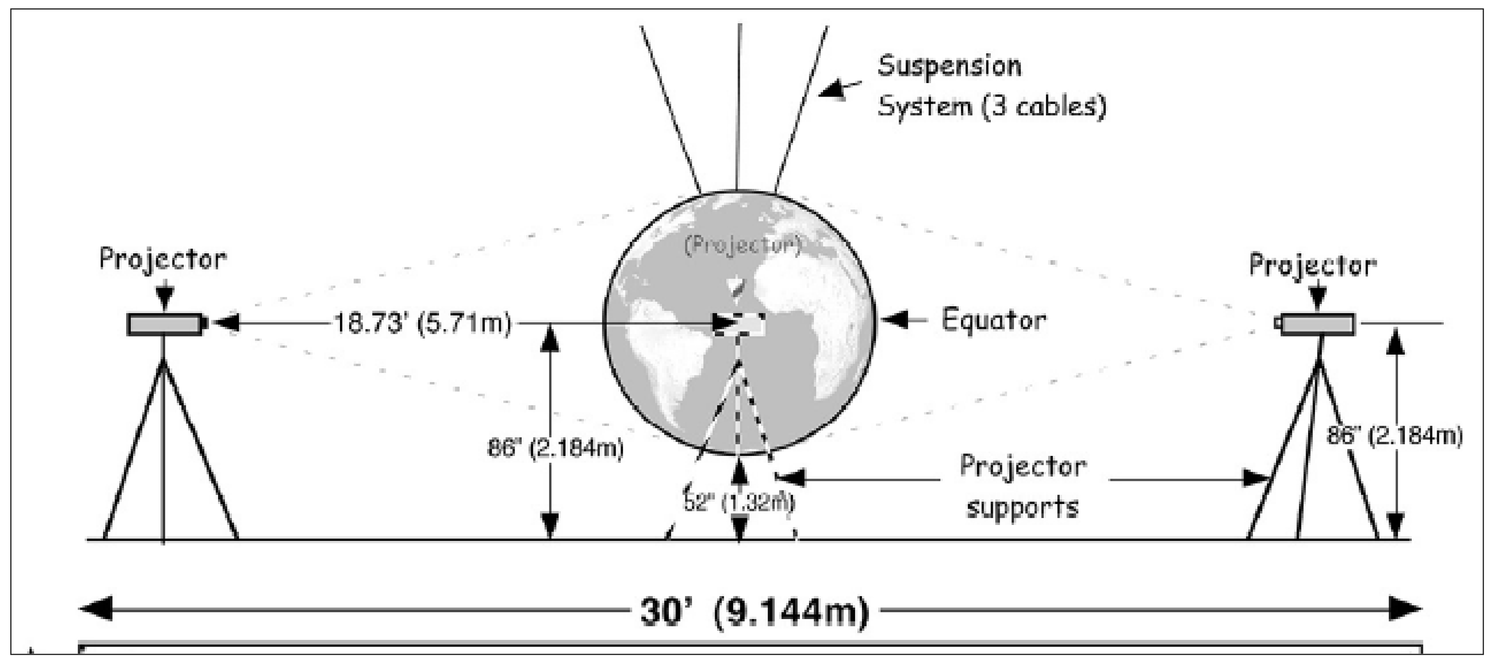


Figure 2: (left) Diagram of SOS Theater configuration (source: National Oceanic and Atmospheric Administration).

Pedagogical Approach

The following pedagogical approach is used by at least three faculty members:

1. Use SOS to reinforce course content (or skills) and learning goals.
2. Provide context for what students will see on SOS.
3. Orient students with the data being projected.
4. Show the data sets/simulations multiple times.
5. Assign tasks to stay engaged (see worksheet example)
6. Include a follow-up assessment.

Figure 3 illustrates how a climate model appears on SOS. Figure 4 illustrates the type of tasks upper-level students are assigned to complete during a paleoclimate lesson in the SOS theater.

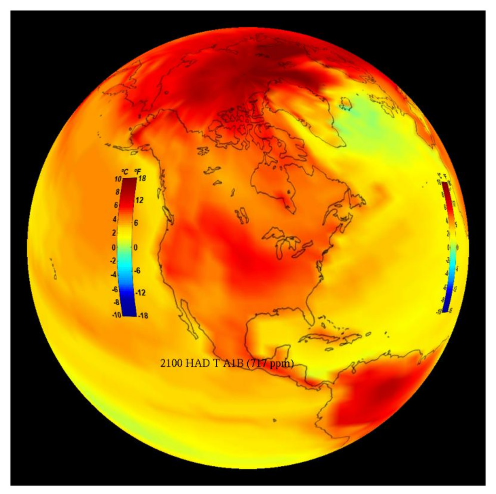
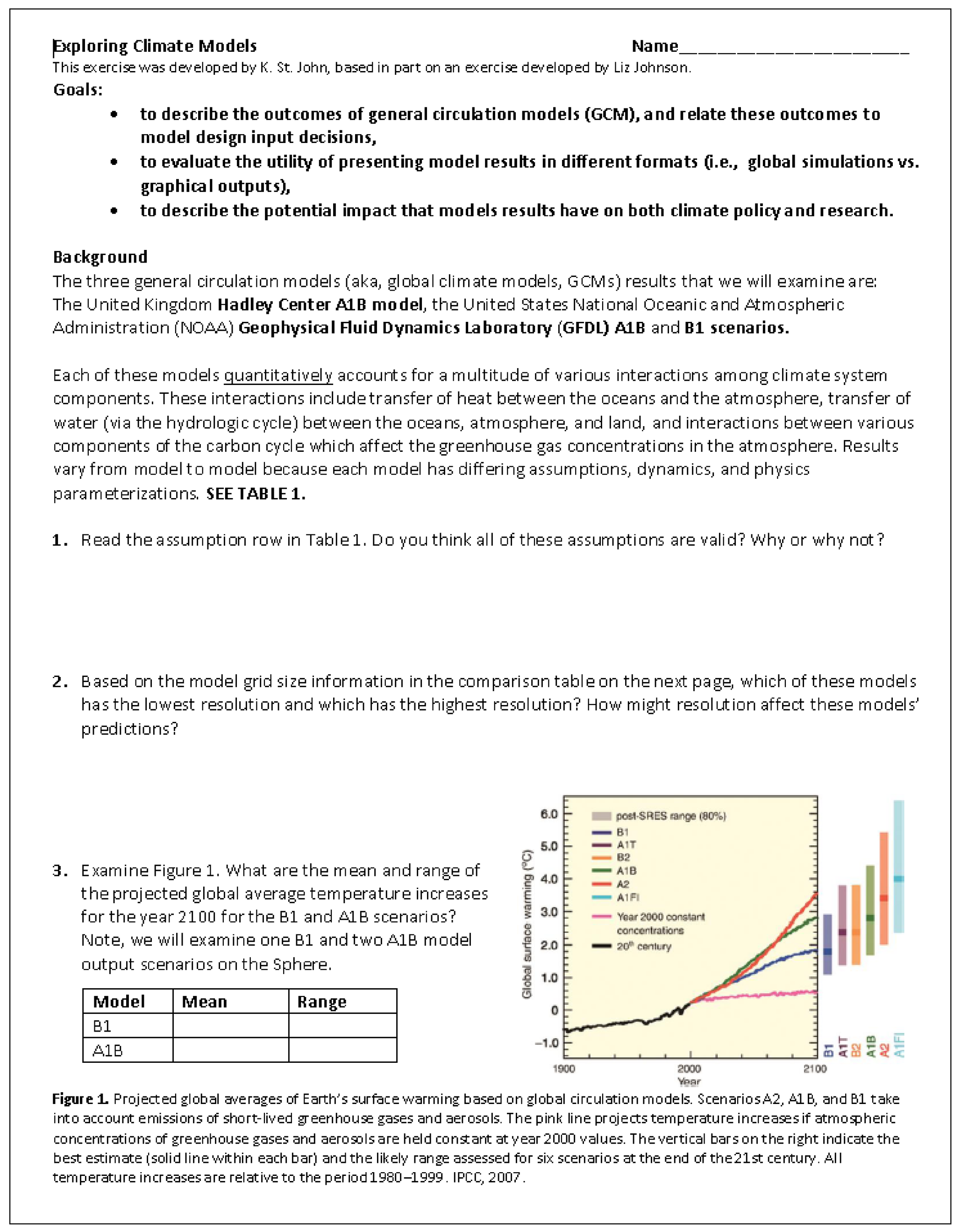


Figure 3: Climate model displayed on SOS.



Exploring Climate Models **Name**______________________

This exercise was developed by K. St. John, based in part on an exercise developed by Liz Johnson.

Goals:

- **to describe the outcomes of general circulation models (GCM), and relate these outcomes to model design input decisions,**
- **to evaluate the utility of presenting model results in different formats (i.e., global simulations vs. graphical outputs),**
- **to describe the potential impact that models results have on both climate policy and research.**

Background

The three general circulation models (aka, global climate models, GCMs) results that we will examine are: The United Kingdom **Hadley Center A1B model**, the United States National Oceanic and Atmospheric Administration (NOAA) **Geophysical Fluid Dynamics Laboratory (GFDL) A1B** and **B1 scenarios.**

Each of these models quantitatively accounts for a multitude of various interactions among climate system components. These interactions include transfer of heat between the oceans and the atmosphere, transfer of water (via the hydrologic cycle) between the oceans, atmosphere, and land, and interactions between various components of the carbon cycle which affect the greenhouse gas concentrations in the atmosphere. Results vary from model to model because each model has differing assumptions, dynamics, and physics parameterizations. **SEE TABLE 1.**

1. Read the assumption row in Table 1. Do you think all of these assumptions are valid? Why or why not?

2. Based on the model grid size information in the comparison table on the next page, which of these models has the lowest resolution and which has the highest resolution? How might resolution affect these models' predictions?

3. Examine Figure 1. What are the mean and range of the projected global average temperature increases for the year 2100 for the B1 and A1B scenarios? Note, we will examine one B1 and two A1B model output scenarios on the Sphere.

Model	Mean	Range
B1		
A1B		

Figure 1. Projected global averages of Earth's surface warming based on global circulation models. Scenarios A2, A1B, and B1 take into account emissions of short-lived greenhouse gases and aerosols. The pink line projects temperature increases if atmospheric concentrations of greenhouse gases and aerosols are held constant at year 2000 values. The vertical bars on the right indicate the best estimate (solid line within each bar) and the likely range assessed for six scenarios at the end of the 21st century. All temperature increases are relative to the period 1980–1999. IPCC, 2007.

Figure 4: Worksheet used with SOS climate model lesson.

Study Population

Of the forty respondents to the survey, seventeen reported they had used SOS in courses since the Fall semester of 2011. Ten respondents who had used SOS in courses provided one or more additional comments. The respondents included three authors of this poster. A survey of the students will be conducted in the Spring semester of 2014.

Findings

Program Use:
SOS is used in courses across multiple departments, including Integrated Science and Technology, Geology and Environmental Science, and Interdisciplinary Liberal Studies (the pre-service teachers' major at JMU). It is also used in the general education curriculum in Cluster 3: The Natural World. There is evidence of considerable use of SOS for outreach and informal education.

Data Sets Used:
Data sets the respondents reported using include *global climate change models (including the HADLEY and GFDL models), the Earth at night, astronomical data, circulation models, weather data, and SOS "movies".* Five respondents used climate-related data sets.

Summary of SOS Benefits:
Respondents' perceptions included that:

- SOS provides a unique way to incorporate technology/visualization.
- It reinforces the educational use of technologies.
- It allows information to be presented in less time than in a traditional lecture.
- It leads to better content retention.
- While Google Earth or other visualizations could have been used, the level of student enthusiasm with SOS is greater.
- Students are interested.

Effect on Student Learning:

- One respondent stated that students displayed high performance on a worksheet used with SOS.
- Several respondents reported that students were engaged.
- No formal evaluation results about student learning with SOS were reported.

Challenges to Using SOS:
One or more respondents indicated that:

- There is a desire for more social science content.
- Functions, such as misaligned or non-functioning projectors, non-adjustable lighting, and tethered SOS controls are areas for improvement. There is not an indication these prevented faculty from using SOS.
- The location and capacity of the SOS Theater limit some use.

Further Research Questions

Research questions the authors are beginning to examine include:

- What are students' perceptions of learning with SOS, and how do those compare to faculty perceptions?
- How does student learning with SOS compare to learning with other methods?
- How does SOS use in formal education measurably affect student learning about climate?
- Are there student reactions to SOS other than enthusiasm, such as the anecdotally noted anxiety or confusion?
- What are the best pedagogical practices for using SOS?