COMPUTER VISUALIZATIONS FOR K-8 SCIENCE TEACHERS IN PROFESSIONAL DEVELOPMENT WORKSHOPS AT THE PLANETARY SCIENCE INSTITUTE. S.J. Kortenkamp, A.M. Baldridge, L.F. Bleamaster, S.R. Buxner, T.L. Cañizo, D.A. Crown, E.C.S. Joseph, L.A. Lebofsky, Planetary Science Institute, 1700 East Fort Lowell, Tucson, AZ 85719-2395 (kortenka@psi.edu).

Summary: The Planetary Science Institute (PSI), in partnership with the Tucson Regional Science Center, offers a series of professional development workshops targeting K-8 science teachers in southern Arizona. Using NASA data sets, research results, and a team of PSI scientists and educators, our workshops provide teachers with in-depth content knowledge of fundamental concepts in astronomy, geology, and planetary science. Current workshops are: *The Moon-Earth System, Exploring the Terrestrial Planets, Impact Cratering, Asteroid-Meteorite Connection, Volcanoes of the Solar System, Deserts of the Solar System,* and *Astrobiology and the Search for Extrasolar Planets.*

Moon-Earth System Workshop

- Photogeology
- Understanding lunar phases and eclipses
- Observing the moon
- Determining the age of the lunar surface
- Past, present, and future exploration of the moon

Observing craters during third-quarter moon.

Since September 2008, 147 (100 elementary, 43 middle school, 1 K-8, 3 high school) science teachers from 88 schools in Tucson (AZ), Green Bay (WI) and San Antonio (TX) have attended 21 offerings of our workshops. Fifty-one teachers have attended more than one workshop, and thirty-five have attended three or more of the workshops. We actively recruit teachers who have participated in previous workshops to attend additional workshops so that we can sustain a long-term relationship with them. Teachers who have participated in our Tucson workshops represent schools with minority student populations ranging from 46% to 95%.

Computer Visualizations: Many of our workshops incorporate customized computer simulations developed at PSI (see www.psi.edu/epo). Studies have shown that incorporating computer simulations into regular classroom settings has positive effects. For example, Mintz [1] studied the use of computer simulations to supplement inquiry-based classroom work. He concluded that the simulations expanded and improved the students' understanding by enhancing motivation and interest. Lavoe and Good [2] found that computer simulations were effective at improving students' prediction skills. Computer simulations are also helpful in equalizing gender differences in science education. Choi and Gennaro [3] found that girls and boys performed equally well on post-tests following experiences with computer simulations, while boys significantly out-performed girls in post-tests following hands-on experiences of the same science concept. Thomas and Hooper [4] and McKinney [5] found that the best use of computer simulations is as in-class supplemental material within the existing curriculum. This finding is supported by a recent review of studies on the use of technology in elementary and secondary schools [6].

Computer simulations in our workshops are designed to help teachers overcome the common misconceptions students have in fundamental areas of space science. For example, the simple geometric relationship between the sun, the moon, and Earth is a concept that is rife with misconceptions. How can the arrangement of these objects account for the constantly changing phases of the moon as well as the occasional eclipses of the sun and moon? Students at all levels often struggle to understand the explanation for phases and eclipses even after repeated instruction over many years. Traditional classroom techniques have proven to be insufficient at rooting out entrenched misconceptions. One problem stems from the difficulty of developing an accurate mental picture of the Earth-Moon system in space when a student's perspective has always been firmly planted on the ground. To address this problem our visualizations take the viewers on a journey beyond Earth, giving them a so-called "god's eye" view of how the Earth-Moon system would look from a distance (see Figure 1). To make this journey as realistic as possible we use ray-tracing software, incorporate NASA mission images, and accurately portray rotational and orbital motion.

Workshops: During a workshop our visualizations are used in conjunction with more traditional classroom techniques. This combination instills a greater confidence in teachers' understanding of the concepts and therefore increases their ability to teach their students. For example, during the *Asteroid-Meteorite Connec-*

tion Workshop teachers participate in hands-on activities with meteorite kits developed at PSI for use in classrooms. They also work with computer simulations of the distribution and motion of asteroids (see Figure 2). One measure of the success of PSI's workshops is that nearly 50% of our teachers have attended multiple workshops, and teachers often cite the visualizations as one of the top benefits of their experience

Resources: To date we have produced over 100 unique visualizations to demonstrate many different fundamental concepts in the earth and space sciences. Participants in each workshop are provided with digital copies of the visualizations in a variety of file formats. They also receive Keynote and PowerPoint templates pre-embedded with the visualizations to facilitate straightforward use on Macs or PCs in their classrooms. Further details of our workshops as well as downloadable examples of some visualizations can be found at: www.psi.edu/epo. This work is supported by NASA EPOESS award NNX10AE56G: Workshops in Science Education and Resources (WISER): Planetary Perspectives

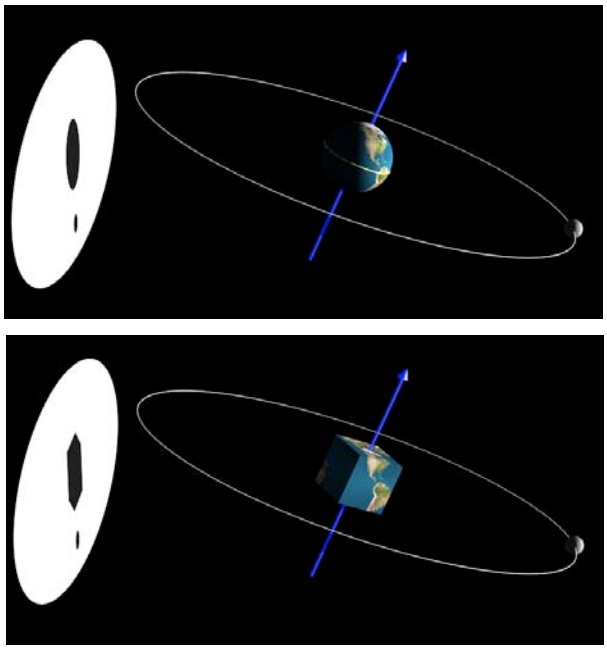

Figure 1: Initial frames from animations demonstrating the Earth-moon geometry for spherical and "flat" Earths. The motion of the shadows aids in understanding why eclipses do not occur every month.

Asteroid-Meteorite Connection Workshop

- Introduction to Solar System formation
- Compositions of meteorites and asteroids
- Densities of materials
- Activity on the stories rocks can tell
- Understanding the geohistories of Ceres, Vesta
- Using PSI's meteorite kits in the classroom

Working with meteorites

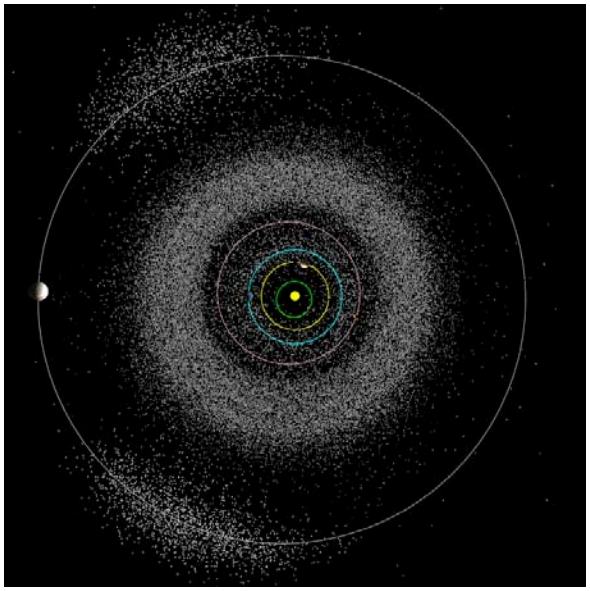

Figure 2: Initial frame from an animation demonstrating the distribution and orbital motion of asteroids in the solar system.

References: [1] Mintz R., Computerized simulation as an inquiry tool. *School Science and Mathematics* **93**, 76-80 (1993). [2] Lavoe D.R. and Good R., The nature and use of prediction skills in a biological computer simulation. *Journal of Research in Science Teaching* **25**, 335-360 (1988). [3] Choi B.S. and Gennaro E., The effectiveness of using computer simulated experiments on junior high students' understanding of the volume displacement concept. *Journal of Research in Science Teaching* **24**, 539-552 (1987). [4] Thomas R. and Hooper E., Simulations: An opportunity we are missing. *Journal of Research on Computing in Education* **23**, 497-513 (1991). [5] McKinney W.J., The educational use of computer based science simulations: Some lessons from the philosophy of science. *Science and Education* **6**, 591-603 (2001). [6] Kulik J., Effects of using instructional technology in elementary and secondary schools: What controlled evaluation studies say. Final Report, SRI Project Number P10446.001, SRI International Science and Technology Policy Program, Arlington, VA (2003).