About AGU

AGU Scientists Host Teacher Workshop in Ethiopia

PAGE 99

When you look at a map of the world showing the location of ground-based space physics instrumentation (radars, magnetometers, ionosondes, GPS dual-frequency receivers, and lidars), you quickly recognize Africa's lack of space physics research infrastructure. One priority of the United Nations–sponsored International Heliophysical Year (IHY) is the development of such an infrastructure in Africa.

Satellite data have shown that the equatorial ionospheric density structures, especially at the equatorial region in the African continent, respond to space weather effects differently than do other parts of the Earth. For example, in the African equatorial region, satellite observations show that depleted density irregularities known as bubbles are much deeper than the bubbles observed in any other longitudinal sectors, and are very active year round in Africa compared with other regions. Observations also show that the depleted density in Africa rises to high altitude (up to 1000+ kilometers) more frequently compared with other longitudes.

However, these responses have not been confirmed, validated, or studied in detail by observations from the ground due to the lack of suitable ground-based instrumentation in the region. Thus, the cause of these unique density irregularities in the continent remains a mystery for the scientific community. To gain a better understanding, the scientific communities are now using the IHY to close the largest land-based gap in ground-based instruments on the continent. One focus of the IHY is the deployment of networks of small instruments, including the development of space science research and educational infrastructures in developing nations.

In addition to new scientific discoveries and advancing space science research in Africa by establishing scientific collaborations between scientists in developed and developing nations, another key IHY objective is to increase the number of space scientists and the scientific awareness about the importance of space science in Africa. The IHY recognizes that in order to develop space science research infrastructure, space science educational infrastructure also needs to be developed to support the long-term operation and use of the science instrumentation.

In response to these needs, the AGU Space Physics and Aeronomy Education and Public Outreach (SPA EPO) Committee organized a Geophysics Information for Teachers (GIFT) workshop for Ethiopian high school physics educators on 10 November 2007 in the Ethiopian capital of Addis Ababa. The workshop, held in conjunction with the IHY-Africa Space Weather Science and Education Workshop, gathered 70 high school physics teachers (though only two of the attendees were women) from around Ethiopia for a 1-day professional development program that focused on fundamental physics concepts relevant to space weather. The program included discussions about space physics; examples of inquiry-based lesson plans; access to hands-on activities relating to magnetism, spectroscopy, and the electromagnetic spectrum; and an overview of the IHY and why it is relevant for their students.

We began the workshop with a discussion of the classroom experiences and needs of Ethiopian teachers. The typical high school physics instructor each day teaches a total of 240 students in four classes, with no laboratory or demonstration equipment. Over 70% of teachers have an Internet connection through their school and 60% have an e-mail address, though most are not associated with their school. Training includes 4 years of college for high school teachers, but only 2 years for elementary and middle school teachers. New teachers earn the equivalent of US$100 per month. None of the teachers at the workshop had traveled outside of Ethiopia. Classes in Ethiopia are taught in English from seventh grade through high school, and all but one of the teacher participants at the workshop indicated that they were very comfortable with English.

One workshop goal was to provide classroom materials and lesson guides for teaching space weather. Learning how to use these materials and engaging in direct hands-on inquiry activities filled most of the day, with the teachers tracing dipole magnetic field lines using compasses, exploring the Earth's magnetic field in comparison with a magnet's using a three-dimensional compass called a Magnaprobe®, and using simple toys such as yo-yos and spinning tops to teach and reinforce basic mechanics principles such as rotational angular momentum and torque.

Our discussions focused on the role of the Sun in space weather and how we know what we know about our star. Teachers enhanced their knowledge of the electromagnetic spectrum by building their own spectrographs, instruments used to separate and identify different wavelengths of light and the chemical composition of the source that generated the light. Teachers used the spectrographs to observe several different spectra and used "ultraviolet beads" (plastic beads that change color when exposed to ultraviolet light) to learn about part of the invisible electromagnetic spectrum. During a solar observing session, the teachers had access to a solar H alpha telescope and neutral density filters to observe the structure of the atmosphere of the Sun and the Sun's angular size (see Figure 1).

Thanks to Rice University and the Houston Museum of Natural Science (HMNS), Ethiopia became only the fourth country in Africa to have its own digital planetarium. Scientists

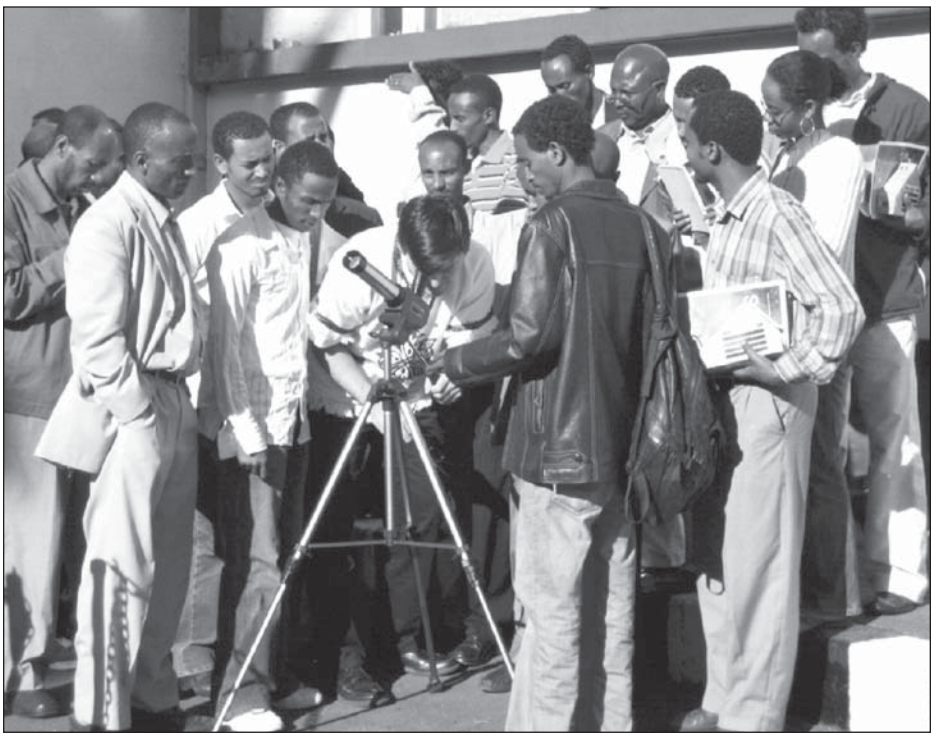

Fig. 1. UCLA researcher Mark Moldwin demonstrates to GIFT attendees how to use an H alpha solar telescope to observe features in the atmosphere of the Sun.

from Rice and HMNS had brought to the workshop a Discovery Dome, a portable planetarium developed using NASA REASoN (Research, Education, and Applications Solutions Network) program resources to teach Earth and space sciences. The system, which has been on display at many recent AGU poster sessions, includes a dome, a laptop, an LCD or DLP digital projector, and a hemispherical mirror to project the movies onto the round dome. The system is easily transportable by a single person in a car or as checked airline luggage, making such systems available to thousands of students who do not have access to full-sized planetariums. The 5-meter-diameter Discovery Dome, which can seat about 50 people, was demonstrated to the GIFT teachers, and later to the IHY conference attendees and a high school class, before being donated to the Ethiopian National Museum in Addis Ababa.

The donation and demonstration coincided with HMNS's exhibit of the fossilized bones of Lucy, an Ethiopian hominid believed to be one of mankind's earliest ancestors. The teachers were shown an HMNS-produced planetarium program, *Lucy's Cradle: Birth of Wonder*, as well as segments of several shows that teach space weather, including *Force 5* and *Heart of the Sun*. These plus six other HMNS- and Rice-produced science planetarium programs were included with the donation. Colleagues from the museum and from Addis Ababa University were trained in the use of the planetarium, and they plan to create a special facility for the dome at the museum as well as to use the portable device to show the Lucy program and others to school children throughout Ethiopia. The planetarium will allow thousands of students to learn about their country's most famous ancestor and about the forces that shape our planet and solar system. For details on the donation, see http://www.media.rice.edu/media/NewsBot.asp?MODE=VIEW&ID=10452.

The teachers were also provided with packets of resources including CDs and DVDs on space weather and the NASA THEMIS (Time History of Events and Macroscale Interactions During Substorms) Mission, Magnaprobes® and magnetic teaching supplies, a collection of 40 simple toys and games along with a video demonstrating how to use the toys to instruct about microgravity, and class sets of spectrometers for students to build.

The workshop concluded with a wide-ranging discussion about space science, space eather, differences between the U.S. and Ethiopian educational systems, and information on how teachers could best use the classroom materials they received. A post-workshop survey indicated that most of the teachers learned much, enjoyed the workshop, and found ample material to use in their classrooms. Most comments related to the need for future and follow-on workshops—that just one was not enough.

The goal of the IHY-Africa workshop was to think long-term and to help develop the next generation of African space scientists, who will lead the space science efforts in their own countries and ensure improvement of the research infrastructure in Africa.

Traditionally, GIFT workshops are held in conjunction with AGU spring and fall meetings. Most of the workshops have been organized by the SPA section, often through its Education and Public Outreach Committee. A trial-run GIFT workshop was provided for teachers from Mexico at the Acapulco AGU spring 2007 Joint Assembly. The Ethiopian workshop represents a major attempt to expand the GIFT program to developing countries. The EPO Committee encourages other AGU sections to consider hosting GIFT workshops as well.

A brief Web documentary of the GIFT workshop, produced by Geoffrey Haines-Stiles and NASA's Passport to Knowledge team, is available at http://sun.stanford.edu/~deborah/spa-epo/GIFTWorkshopEthiopia.mov.

Acknowledgment

Funding for the workshop was provided by the International Heliophysical Year and NASA.

—MARK MOLDWIN and ENDAWOKE YIZENGAW, Institute of Geophysics and Planetary Physics, University of California, Los Angeles; DEBORAH K. SCHERRER, Solar Center, Stanford University, Calif.; E-mail: dscherrer@solar.stanford.edu; M. CRISTINA RABELLO-SOARES, W. W. Hansen Experimental Physical Laboratory, Stanford University; PATRICIA REIFF, Rice Space Institute, Rice University, Houston, Tex.; and CAROLYN SUMNERS, Houston Museum of Natural Science, Tex.