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Space Weather Outreach: An informal education perspective

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Abstract

Informal science education institutions, such as science centers, play an important role in science education. They serve millions of people, including students and teachers. Within the last decade, many have tried to improve the public's understanding of science and scientific research through informal education projects. The recent success of several space weather-related missions and research programs and the launch of the International Heliophysical Year (IHY) research and education programs make this an ideal time to inform the public about the importance and relevance of space weather to our understanding of heliophysical science. Communication efforts associated with space weather both benefit and are compromised by analogies to terrestrial weather. This paper summarizes the benefits and challenges of the terrestrial weather analogy using two exhibit evaluation studies. The paper also describes three components of the Space Science Institute's *Space Weather Outreach Program* – Space Weather Center Website, Educator Workshops, and Small Exhibits – and how they can help to achieve the education goals of IHY.

Keywords: Informal education; Space Weather Outreach; Website; Workshops; Exhibits

1. Introduction: the changing world of informal science education

People do not stop learning once they leave the classroom. Informal education institutions – such as museums, zoos, nature parks, planetariums, and science centers – are playing an increasingly important role in America's overall education system. They provide children and adults with opportunities to learn by doing. The Association of Science-Technology Centers (ASTC) reports that in 2005 over 96 million people visited its member institutions worldwide (ASTC, 2005). With the popularity of these institutions, it is not surprising that the line between formal and informal education is blurring. Each year, science centers offer more programs designed specifically for school children and teachers. ASTC estimates that in 2005 its members served over 24 million school children (ASTC, 2005). Many education researchers are exploring how people learn in free-choice, informal institutions and publishing their findings (e.g., Hein, 1998; Falk and Dierking, 2000). As an indication of the importance of informal education research, the National Science Foundation's (NSF's) Informal Science Education (ISE) program now requires that its funded projects include research and/or evaluation components that will produce a lasting impact on the field of informal science education. ISE seeks to contribute to the development of a diverse, internationally competitive and globally-engaged workforce of scientists, engineers, and technicians, in addition to informed citizens.

Despite the popularity of science centers and other informal learning environments, there is still a dichotomy between interest in science and knowledge of science. NSF's recently published *Science and Engineering Indicators* (NSB, 2006) shows that most Americans recognize the benefits of science and technology. Another interesting (and possibly surprising) statistic is that Americans in general have a more favorable attitude about science than do

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people in other developed countries. But this *interest* in science and technology does not necessarily correlate to an *understanding* of science, as is evident by the wealth of misconceptions people have about the world in which they live. For example, many college-educated adults do not know what causes seasons and many cannot light a light bulb with a battery and a wire (A Private Universe, 1987; Minds of Our Own, 1997). Within the last decade, many have tried to improve the public's understanding of science and scientific research (Chittenden et al., 2004). But their success has been mixed.

Against this backdrop, many informal educators have been re-examining the role that free-choice learning institutions, such as science centers, should play in their communities. Should they focus only on serving school children or should they also help adults understand the science behind increasingly complex public policy issues, such as climate change? Ann Mintz has written a thought-provoking article that explores the challenges facing science centers and offers some insights on how to face them (Mintz, 2005). Some centers have successfully implemented cutting-edge science and technology programs, such as the current science initiatives at the Maryland Science Center, the Boston Museum of Science, and the Science Museum of Minnesota. Another approach has been the Café Scientifique movement that started in Europe and has taken root in the US and other countries (West, 2005). The concept behind this movement is simple. It is an informal forum for discussing and debating science issues outside a traditional academic context. The Café Scientifique approach offers programs for adult audiences rather than families with young children. Science centers everywhere are re-thinking their identities and missions. Though there is no single approach that will work for all museums, one common theme seems to be emerging: science centers must become vital to their communities and include a more diverse audience in their programs (Chesebrough, 2005).

2. Space Weather Research and Outreach

In the 21st century, developed countries around the world depend on space-based operations for communications, navigation, weather reporting, treaty monitoring, scientific observation, and other critical activities. As a result, we are more susceptible than ever before to dynamic processes in our Sun–Earth environment. Severe space weather events, such as bursts of radiation and magnetic storms caused by the Sun's coronal mass ejections (CMEs), could impact satellite operations, harm astronauts, and result in power outages on Earth (Carlowicz and Lopez, 2002). In our technology-dependent world, the ability to predict which CMEs will reach us and when has become increasingly important (Poppe and Jorden, 2006).

Scientists from around the world now have access to the most powerful array of ground facilities and spacecraft ever assembled for studying the space environment. Sensitive telescopes focus on the Sun's many layers, while spacecraft measure the plasma and magnetic fields of our geospace environment. A web of ground stations records the complex interaction between the Sun and our terrestrial environment, and computer models provide improved forecasting of space weather. The multi-agency National Space Weather Program (NSWP, 2000) encompasses the efforts of the US research scientists who are studying Sun–Earth connections and attempting to provide timely, accurate, and reliable space environment observations and forecasts.

The recent success of several space weather-related missions and research programs makes this an ideal time to inform the public about the importance and value of space weather research. Even before the publicity surrounding the Halloween Storms of 2003, the public demonstrated an interest in space physics and aeronomy topics, as evidenced by the success of projects such as the Space Science Institute's (SSI's) *Electric Space* exhibition (Korn, 1992, 1997; Dusenbery et al., 2004). Space weather offers a particularly compelling topic for both the Current Science and Café Scientifique programs mentioned above due to its visual appeal and the frequency of newsworthy events. It is of particular interest for museums, science centers, and planetaria because:

- Space weather impacts people's lives, both on the ground and in space.
- Space weather is a hot topic, even with the Sun near solar minimum.
- The general public is fascinated by space-related subjects.

Other recent space weather education projects include *SolarMax* (an IMAX film), cable TV documentaries (e.g., *Perfect Disasters*: *Solar Storm* by the Discovery Channel), and a number of teacher workshops and events, such as NASA's Sun–Earth Connection Education Forum's Sun–Earth Day project (which provides outreach materials to a number of informal institutions) (http://sunearthday.nasa.gov). Another indicator that space weather has had an educational impact is the role it plays in professional societies. For example, the American Geophysical Union (AGU) has included a growing number of education sessions on space weather at its meetings. AGU's Space Physics & Aeronomy Education Committee has brought together many researchers and educators in mutually beneficial partnerships. In 2007/2008, the International Heliophysical Year (IHY) will bring together scientists and educators from around the world to explore fundamental heliophysical processes and continue the legacy of the 50th anniversary of the International Geophysical Year (United Nations, 2001). The two primary objectives of IHY's education program are to inspire the next generation of space scientists and spread the knowledge of our Solar System to the people of the world. Space weather can provide a compelling hook to achieve the first objective and the wealth of good space weather education resources can help achieve the second.