Fifteen Years of Science and Space Weather Studies

Fifteen years ago, on 25 August 1997, NASA launched the Advanced Composition Explorer (ACE) spacecraft. In operation for more than a solar cycle, ACE has provided numerous important scientific results while at the same time becoming a key component of the space weather-monitoring system. It is composed of the fleet of four small, yet highly capable spacecraft that make up the Heliophysics Great Observatory.

ACE is located on the sunward side of Earth about 1.3 million kilometers away, or 4 times as far from Earth as is the Moon. This puts ACE well outside the Earth’s magnetosphere and in an ideal position to monitor the solar wind environment “upwind” of Earth. ACE has six high-resolution spectrometers that measure the elemental, isotopic, and ionic charge-state composition of ions from hydrogen to iron, it also includes these particles and field monitors. One of the nine instruments has now failed (Solar Energetic Particle kinetic Charge Analyzer (SEPICA)), and two others are partially degraded (Solar Wind Ion Composition Spectrometer (SWICS) and Solar Wind Electron, Proton, and Alpha Monitor (SWEPMS)), however, the other six are working well. Instrument descriptions are available on the ACE Web site at http://www.srl.caltech.edu/ACE/.

The Spectra of Particles Observed by ACE

Figure 1 shows the particle fluence (total number of particles in space) over a given period of time) of oxygen at the same time becoming a key component of the space weather-monitoring system. The primary goal of CycloneCenter, which launched in mid-September, is to resolve discrepancies in the recent global TC record arising principally from inconsistent development of tropical cyclone intensity data.

The Spectra of Particles Observed by ACE

A new cloud sourcing project called CycloneCenter enables the public to analyze historical global tropical cyclone (TC) intensities. The primary goal of CycloneCenter, which launched in mid-September, is to resolve discrepancies in the recent global TC record arising principally from inconsistent development of tropical cyclone intensity data.

The historical TC record is composed of data sets called “best tracks,” which contain a forecast agency’s best assessment of TC tracks and intensities. Best track data have improved in quality since the beginning of the geostationary satellite era in the 1960s (because TCs could no longer disappear from view). However, a global compilation of best track data (International Best Track Archive for Climate Stewardship (IBTrACS)) has brought to light large interagency differences between some TC best track intensities, even in the recent past [Knapp et al., 2010]. For example, maximum wind speed estimates for Tropical Cyclone Gay (1988) differ by as much as 70 knots as it was tracked by three different agencies.

The heart of the problem is that TCs are very rarely directly observed. Thus, forecasters rely almost exclusively on the Dvorak technique [Velden et al., 2006], a method developed during the 1970s and early 1980s by American meteorologist Vern Dvorak to classify TC intensity based on cloud patterns and temperatures from a single geostationary satellite image. The technique calls for the analyst to determine the cloud location of the system, the cloud pattern type, the degree of organization of the pattern, and the intensity type. A maximum surface wind speed is determined after the application of a number of rules and constraints. The Dvorak technique has been used for many years at all global tropical cyclone forecasting centers and has been shown in many cases to yield a good estimate of maximum TC wind speed [Knaff et al., 2007] when applied properly. However, a level of analyst subjectivity is inherent in the procedure: the cloud patterns are not always clear, it is sometimes difficult to accurately determine the storm center, and the rules and constraints have been interpreted and applied differently across agencies. This introduces heterogeneity in the global TC record because the Dvorak technique is usually the only available tool for assessing the maximum wind speed.

Recent work has tried to eliminate the human element in the Dvorak technique by automating the procedure. The advanced Dvorak technique (ADT) [Völdner and Velden, 2007] uses objective storm center and cloud pattern schemes to remove the subjectivity. All other classification rules and constraints are then applied and combined with additional statistical information to produce automated intensity estimates. Although the ADT skill is comparable to experienced human Dvorak analysts, large errors can occur if the cloud pattern (e.g., “eye,” “shear,” “curved band”) is not identified properly.

CycloneCenter embraces the human element. It standardizes the classification procedure by codifying the Dvorak technique to a few simple questions that can be answered by global, nonprofessional collaborators. Each collaborator (“user”) is presented with an enhanced-color infra-red satellite image of a tropical cyclone and is guided through a sequence of questions, ultimately leading to the determination of a single maximum surface wind speed. One of the main advantages of this approach is the inclusion of the human expert’s judgment of the one to three who would normally classify a TC image. This allows the computation of maximum TC wind speed [Knaff et al., 2007] when applied properly. However, a level of analyst subjectivity is inherent in the procedure: the cloud patterns are not always clear, it is sometimes difficult to accurately determine the storm center, and the rules and constraints have been interpreted and applied differently across agencies. This introduces heterogeneity in the global TC record because the Dvorak technique is usually the only available tool for assessing the maximum wind speed.

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The directorate’s programs have focused on important source of funding for geoscience. The Directorate for Geosciences (GEO) is an U.S. federal Water Resources Development (WRDA) legislation is operating under different circumstances. For its projects, it was also criticized as being navigation channels—received some praise in 2007 when the Senate voted 79–14 in broad bipartisan support to override President George W. Bush’s veto of the $23 billion bill. Second, although the U.S. Army Corps of Engineers—which manages, operates, and maintains a vast water resources infrastructure—receives considerable social, economic, and environmental harm while often failing to solve critical water resources problems.” She said that the Corps “continues to prioritize environmentally destructive and costly structural projects where less costly and environmentally protective non-structural and restoration solutions are available.”

—Randy Steinnick, Staff Writer

Earth and space science organizers are encouraged to read the “Dear Colleague” letter (http://go.diggingdeep.com), containing 363–376, doi:10.1175/BAMS-87-9-1195. Good (a program that seeks to improve public understanding of Earth system science) is undergoing review and restructuring, and Opportunities for Enhancing Diversity in the Geosciences (OEDG), a program aimed at enhancing minority representation in science, is also undergoing review and restructuring. Comments concerning the OEDG program, in particular, are being requested by NSF. NSF is soliciting community input in two areas: (1) identifying the critical needs regarding efforts to engage, recruit, and retain underrepresented students in the geosciences and broaden public Earth system science literacy among diverse groups, and (2) contributing ideas for how to best engage relevant stakeholders and communities for addressing these needs and key challenges.

Members of the Earth and space science education community are encouraged to read the “Dear Colleague” letter (http://go.diggingdeep.com), containing OEDG can be submitted at http://go.diggingdeep.com. The deadline to comment is 1 November 2012.

—EMILY HUGGARD, Education and Outreach Coordinator, AGU