

THEMIS Education and Public Outreach **Highlights of Evaluation Findings FY06 and FY07**

The THEMIS (Time History of Events and Macroscale Interactions during Substorms) Mission will determine the onset time and location of magnetic substorms of Earth's space environment, a prerequisite to understanding space weather. The nature of THEMIS science holds the potential for inquiry-based instruction at the high school level—in particular, instruction based on the correlation of ground-based measurements of auroral activity with spacecraft-based measurements of changes in the magnetosphere.

The Education and Public Outreach effort associated with the THEMIS Mission encompasses four distinct components...

- GEONS (Geomagnetic Event Observation Network by Students)
- Conference-related workshops for science teachers
- Launch of GEMS site/Carson City, NV
- THEMIS E/PO Web site development

Among the major thrusts of the E/PO efforts is reaching underserved, underrepresented populations in science education. These populations are defined as females and non-White, non-Asian males and are reached through the professional development of teachers responsible for delivering science education to these populations. Additionally, a key component of THEMIS, the Geomagnetic Event Observation Network by Students (GEONS), has established twelve ground-based magnetometer stations in the proximity of rural schools in traditionally underserved communities. The THEMIS E/PO team partners with a teacher at each of these sites who is responsible for the magnetometer data and system as well as using the data in their lesson plans.

This summary report focuses on Fiscal Year 2006 (FY06) from October 1, 2005 through September 30, 2006 and Fiscal Year 2007 (FY07) from October 1, 2006 through September 30, 2007. It features outcomes from two components of the E/PO effort—findings from professional teacher workshops conducted within this time frame and relevant statistics from both fiscal years for the mission's E/PO Web site.

TEACHER WORKSHOP FINDINGS

The THEMIS E/PO team conducted nine workshops for non-GEONS teachers from August 2006 through July 2007 offering topics related to the mission. The majority of these workshops served as a partnership between THEMIS and three other NASA missions—FAST, STEREO-IMPACT and RHESSI—as well as the Sun-Earth Connection Education Forum at Berkeley. A total of 168 of the teachers attending these workshops completed questionnaires regarding their workshop experience. An additional two-day workshop was held in St. Louis in March 2007 for the GEONS teachers. We discuss the findings from this workshop in a separate section due to the unique nature of the workshop and the differing questionnaire.

General Workshops—The 168 teachers who attended the nine workshops offering topics related to the THEMIS mission told us a little about themselves and the environments in which they teach...

- **Experience**—*N=156*. Teachers averaged 11.4 years experience ranging from 1 to 40 years.
- **Grade Levels**—*N=168*. Over two-fifths (41%) taught at the elementary grade level and more than one-quarter at both the high school (28%) and middle school (27%) levels.
- **Setting**—*N=154*. More than half (57%) taught in suburban schools, nearly one-third (31%) in urban schools and a little more than one-tenth (12%) in rural schools.
- **Student Population**—Two-fifths of the teachers responding said they were teaching in Title I schools—*N=110*. On average, half of their students receive free or reduced lunches—*N=106*. Teachers said that more than two-thirds (67%) of their students represented underserved populations in science education, that is, their classes included 47% females and 20% non-White, non-Asian males—*N=117*.

Most (64%) of the teachers told us that they learned about the opportunity from e-mails that piqued their interest in the workshop topics. The nine workshops presented a total of 38 sessions related to the THEMIS Mission.

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Teachers rated their *understanding of the topics* presented in these sessions as being 'clear'. This is evidenced by a mean rating for all participants for all sessions of 3.5 on a 4-point scale ranging from '1-not clear at all' to '4-very clear'. This is in stark contrast to their prior knowledge of the topics. They told us that before attending the workshops, their knowledge of the topics was between 'just a little' and 'moderate'—the translation of our finding of a 2.5 mean rating on a 4-point scale ranging from '1-almost no knowledge' to '4-quite a bit of knowledge'.

Teachers reported that they were 'very likely' to use the materials and ideas in their classrooms offering a mean rating of 4.0 on a 5-point scale ranging from '1-will not present' to '5-certain to present'. A full 61% of the teachers anticipated they would be using the information gleaned from these workshops primarily as integral parts of basic science courses and 46% envisioned using these materials as resources or supplements to basic science courses. This is dramatically different from their use of these topics prior to the workshops. Before THEMIS, an average of 29% said that they never taught the topics presented, 34% had used the topics as resources or supplements to basic science courses, and 31% had used the topics as integral parts of their courses.

Despite the high percentage of teachers eager to implement THEMIS materials and ideas, some expressed concern that their ability to use the materials would be constrained by a lack of financial support to purchase materials, scarce resources and a deficiency in classroom technology. They were also concerned about time constraints.

These findings suggest that the workshops have presented complex materials to teachers in a clear manner that gives them the confidence to present the materials to their students. Additionally, they are now more likely to include the materials and ideas as integral parts of or resources to supplement their basic science courses.

GEONS Workshops—Eight of the GEONS teachers attended a two-day St. Louis workshop conducted specifically for them. This professional development event marked the third meeting of GEONS teachers since the beginning of the project. Five of the teachers have been participants since the 2004 inception of GEONS, two since 2005 and one joined the project in 2006. These teachers told us a little about themselves and the environments in which they teach...

- **Experience**— $N=7$. GEONS teachers averaged 18.6 years experience ranging from 4 to 34 years.
- **Grade Levels**— $N=8$. Most (88%) taught at the high school level and 12% at the middle school level. One of the GEONS teachers, teaching at the high school level, also teaches a junior college course in physical science.
- **Setting**— $N=7$. All of the teachers are teaching in rural settings, a reflection of the need to place magnetometers in locations with minimal electromagnetic interference.
- **Student Population**—GEONS teachers report that, on average, half of their students are female with class composition ranging from 30% to 65% females— $N=7$. They also said that more than three-fifths (61%) of their classes are comprised of minority students—both male and female—ranging from 2% to 100% minorities— $N=8$.

GEONS teachers actively participate in the development of materials such as the classroom activity guides developed by the E/PO team and available to all science teachers from the THEMIS E/PO Web site. At the GEONS two-day workshop the focus was on the presentation of activities included in the fourth guide being rolled out for classroom use. The fourth guide includes activities previously developed, but revised based on feedback from GEONS teachers and research done by one teacher during the Summer 2006.

GEONS teachers indicated that presentations of the six activities included in the fourth guide were 'clear', offering a mean rating of 3.5 on a 4-point scale ranging from '1-not clear at all' to '4-very clear'. Nearly two-thirds (65%) of the GEONS teachers had not yet tried the activities before this workshop. Teachers who had not yet tried the activities signaled that they were 'very likely' to do so in the future, as indicated by their 4.4 mean rating on a 5-point scale, ranging from '1-will not use' to '5-certain to use'. When asked if they could foresee any barriers to implementation for these activities, most (63%) of the GEONS teachers cited their concerns about fitting them into the curriculum and time constraints.

Since the GEONS teachers at this point had as much as three years of project experience, they were asked to provide information about their successes in implementing all activities and student reactions to them, as well as their efforts in dissemination and professional development...

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- **Implementation**—All of the teachers are using THEMIS materials, ideas, the Web site, etc. and do so primarily for courses in Earth Science/Geology (31%), Astronomy (23%) Physics/Physical Science (23%), General Science (15%) and Math (8%). Once the project ends, they reported that they will continue to use the materials and data from the magnetometer. Many (57%) feel they will not need additional help to do so, but would like to see teleconferences, updating activity guides and networking continue.

Three-quarters of the teachers had used the THEMIS-GEONS Users Guide in the last school year. The majority (88%) reported using all or part of the four activity guides containing 20 THEMIS-related activities. On average, almost five of the eight teachers have tried each activity, with anywhere from one to eight teachers trying out any one activity.

- **Student impact**—The GEONS teachers who tried the activities report, on average, that the students have responded with interest as evidenced by a mean rating of 3.8 on a 5-point scale ranging from '1-extremely disinterested; bored' to '5-extremely interested; enthusiastic'. By activity, the mean ratings ranged from 3.0 to 4.0.

Nearly three-fifths (57%) of the GEONS teachers reported seeing increased general interest in science among the elementary, middle and high school populations in their schools and school districts. Nearly three-fifths (57%) said that active participation in the project (real science) has sparked interest as students feel a vital connection to the mission. Students are inspired by the materials and instructor enthusiasm. Teachers have also reported science course enrollment increases.

- **Dissemination**—GEONS teachers engage in multiple means of disseminating THEMIS materials, both informally and formally. Most (86%) of the GEONS teachers said that they share THEMIS materials on an informal basis with their colleagues in department meetings, at lunch, in teachers' rooms, etc. More than two-fifths (43%) of the teachers shared THEMIS materials by making presentations at state teachers' conferences and within the community.

Nearly three-fifths (57%) of the teachers have gained local or national media exposure—most notably with one teacher being featured on the Jim Lehrer News Hour on PBS. GEONS teachers also reported that they update the school's Web site with THEMIS news, make presentations at local community groups and are planning activities for future dissemination.

- **Professional development**—Inspired by involvement in THEMIS, the GEONS teachers have gotten involved in other NASA-related projects such as Cosmic Times and the WISE Mission, in attending NSTA conferences, in research/student activity projects and in the Teacher Leaders Research Based Science Education program (NOAO—National Optical Astronomy Observatory).

WEB SITE STATISTICS

The THEMIS E/PO Web site has been up and running since December 2003. Our focus for this section is on the Web site statistics for FY06 and FY07 during which time the actual mission launch was successfully completed on February 17, 2007.

Visitor Profile—In each of the fiscal years, the domain names for visitors to the Web site were catalogued. This offers an avenue for identifying visitors' countries of origin. We found that during the two years, about half of the site's visitors can be identified as residents of the United States. Specifically our findings are...

- **FY06**—We found 45% of the visitors were from domain names located in the United States, and 2% were from countries other than the US—with Canada, Spain and the United Kingdom leading the list. An additional 53% were from numerical address that could not be identified.
- **FY07**—We found 51% of the visitors were from domain names located in the United States and 3% were from countries other than the US—with Canada, Switzerland and Germany leading the list. An additional 46% were from numerical addresses that could not be identified.

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We found that the visitors to the site enjoyed an 83% 'hit' rate in FY06 and FY07, that is, the percentage of times (requests) a visitor was successful in accessing the specific files of which a Web page is composed and did so without receiving an error message

A single Web page can be made up of any number of unique files (hundreds even). Since there may be multiple files making up a Web page—resulting in hundreds of 'hits'—counting those requests may not be the most accurate reflection of Web traffic. Consequently, for the remainder of this discussion we will refer to the Web site's activity levels in terms of requests for a page—a page that has been viewed by a visitor rather than all of the files that make up the Web page.

Activity Levels—A general summary below indicates activity levels as reflected in successful requests for pages. For the number counts and averages for FY06 and FY07, we will discuss specific patterns of activity by month, day-of-the-week and hour. We note that activity for FY07 was 46% higher than that for FY06, most likely due to the February 2007 launch.

<u>Requests</u>	<u>FY06</u>	<u>FY07</u>
Total # Successful Requests for Pages	168,756	246,261
Average Successful Requests for Pages per Month	16,298	20,522
Average Successful Requests for Pages per Day	462	674
# of Page Requests in Peak Month for Entire Year—Oct/Mar	31,275	41,130
# of Page Requests on Peak Day for Entire Year—Thursday	33,772	42,474
# of Page Requests in Peak Hour for Entire Year—7amET	9,417	14,657

- **Monthly**—In FY06, above average activity of 31,275 pages was noted in October 2005. The week of October 15 brought a partial eclipse of the Sun which may have accounted for the above average activity.

For FY07, it was the period from January to April 2007 that saw the greatest spike in activity as the build up to the launch generated higher than average requests, crescendoing in 41,130 requests in March. It is noteworthy that in addition to the February launch, the Sun-Earth Day Forum highlighted all missions during a March 22 Webcast. This exposure also may have contributed to the higher than average activity.

- **Daily**—For FY06 and FY07, the number of average successful requests per day was 462 and 674, respectively. In FY06, successful requests from Tuesday through Saturday ran higher than average, while requests on Sunday and Monday fell below average. In FY07, the pattern was similar with requests falling above average on the weekdays and below on the weekends. For both years, Thursdays were the peak request days (33,772 requests for all Thursdays in FY06 and 42,474 for FY07) and Sundays were the lowest request days (18,730 for FY06 and 25,825 for FY07).
- **Hourly**—For both FY06 and FY07, the peak hours for successful requests ran from approximately 4am to noon ET—we take the liberty to use Eastern Time as our point of reference since about half of the site users were from the US. Across the country, these hours spanned the first half of the day—from the wee hours of the morning until lunch time. The peak hour for both FY06 and FY07 was 7am with 9,417 and 14,657 requests, respectively.

The daily- and hourly-use statistics indicate high traffic during the work/school week and during months in which school is in session—October and March. While these monthly and daily activity patterns immediately point to student traffic, the early morning pattern of peak requests is unlikely to be due to student activity. This finding is quite different from the Web statistics for the FAST and STEREO-IMPACT missions where the monthly, daily and hourly patterns all point to student use, thus indicating that those Web sites are powerful tools for formal education as well as for informal public outreach.

We suspect that the early morning hours Eastern Time may be reflecting a strong European contingency that checked onto the THEMIS Web site between 9am and 5pm. With almost half of the THEMIS Web site users having unidentifiable addresses, we speculate that many of these may be Europeans, drawn to the site after seeing PR events—particularly in Germany, France, Austria and Great Britain. Furthermore, since the THEMIS science Web site was temporarily off-line at this time, all THEMIS traffic around launch time was coming to the THEMIS E/PO site.

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