P.126 PROGRAM ON EDUCATION, RESEARCH AND INTERNATIONAL TRAINING FOR STUDENTS AND JUNIOR SCIENTISTS IN ATMOSPHERIC SCIENCES

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1. INTRODUCTION

Stimulated by rapid economic development and the need for better environmental prediction, the atmospheric science communities in East Asian countries have enjoyed considerable growth over the past 10 years. As a result, the East Asian countries have established many exciting and innovative research facilities and projects focusing on atmospheric sciences. Two outstanding examples are the GEONET (GPS Earth Observing Network) 1200-station ground based GPS network in Japan and the Constellation Observing System for Meteorology, Ionosphere, and Climate (COSMIC) Project in Taiwan. These facilities and projects hold great promise for significant advancement in atmospheric sciences, and present important opportunities for education, research, and international training for American scientists, engineers and educators.

Under the support of the International Programs Division of the National Science Foundation, UCAR (University Corporation for Atmospheric Research) has established an AWARE (American Workforce And Research and Education) program at the UCAR COSMIC Project Office. The purpose of this program is to establish an international linkage between the U.S. university community, the National Center for Atmospheric Research (NCAR), and educational, research and operational institutions in East Asia. Through this program, we provide opportunities for U.S. students and junior scientists to participate in important collaborative research projects between U.S. and East Asia countries. In this paper, we will describe the program and the various on-going collaborative research projects. We will also discuss the education, research, and international training experiences of U.S. students in these collaborative research projects. Information on this program can be found at:
http://www.cosmic.ucar.edu/aware.htm

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2. BRIEF DESCRIPTION OF THE COSMIC MISSION

COSMIC (Constellation Observing System for Meteorology, Ionosphere and Climate) is a joint mission between Taiwan and the U.S., with a goal to demonstrate the use of GPS radio occultation (RO) data in operational weather prediction, climate analysis, and space weather forecasting. COSMIC will launch six LEO satellites in late 2005. Each satellite will carry three atmospheric science payloads: (1) a GPS radio occultation receiver for ionospheric and neutral atmospheric profiling and precision orbit determination; (2) a Tiny Ionospheric Photometer (TIP) for monitoring the electron density via nadir radiance measurements along the sub-satellite track; and (3) a Tri-Band Beacon (TBB) transmitter for ionospheric tomography and scintillation studies. With the ability of performing both rising and setting occultations, COSMIC is expected to produce approximately 2,500 GPS RO soundings per day, uniformly distributed around the globe. Further information on the COSMIC Program can be found at: http://www.cosmic.ucar.edu/

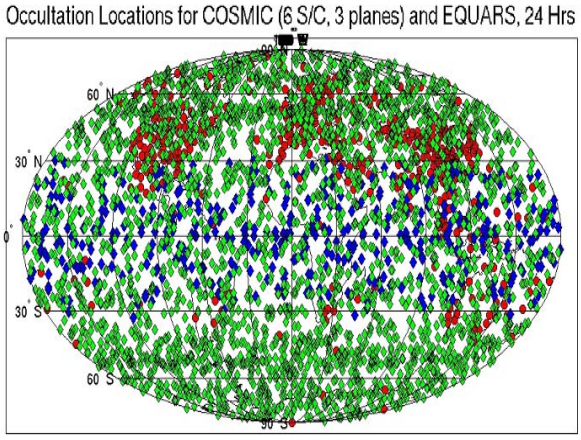

Figure 1. Typical GPS RO sounding locations from COSMIC (in green) and radiosonde sites (in red). The figure also shows, in blue, the expected sounding locations from the Brazilian EQUARS mission. EQUARS is expected to overlap with at least part of the COSMIC mission and will nicely complement COSMIC in the tropics.

3. NCAR 2004 SUMMER COLLOQUIUM ON ATMOSPHERIC REMOTE SENSING USING THE GLOBAL POSITIONING SYSTEM

Significant progress has been made in the science and technology of both ground-based and space-based atmospheric remote sensing over the past decade. The ground-based and space-based GPS atmospheric sensing data are expected to have a major impact on climate monitoring, global and regional weather prediction, ionospheric research, and space weather forecasting. In an effort to provide students with an overview, from the basic GPS atmospheric measurements to their applications in weather prediction, climate analysis, and ionospheric research, the UCAR COSMIC Project Office and NCAR Advanced Study Program jointly organized an NCAR 2004 Summer Colloquium on Atmospheric Remote Sensing using the GPS, from 20 June through 2 July 2004. During the two-week colloquium, lectures were given on: physics of microwave propagation, principles of the Global Positioning System, precipitable water vapor and slant-path GPS water vapor sensing, radio occultation, assimilation of GPS measurements, analysis of results from recent GPS radio occultation missions, applications of GPS data in numerical weather prediction, ionospheric research, space weather, and climate analysis, and development of advanced techniques such as the cross-link technology. The lectures were broadcast through webcast, and were recorded. Approximately 60 students from a dozen countries attended the NCAR colloquium. The presentations are available through the following link:
http://www.cosmic.ucar.edu/colloquium_2004/colloquium_schedule.html
The webcast is available through:
http://www.cosmic.ucar.edu/colloquium_2004/colloquium_realmedia.html

4. VISITS TO GPS METEOROLOGY INSTITUTIONS IN JAPAN AND TAIWAN

Following the colloquium, ten selected U.S. students visited key GPS meteorology facilities, including the Meteorological Research Institute (MRI), Geographical Survey Institute, Japan Meteorology Agency and the Kyoto University in Japan, and the National Science Council, the National Applied Research Laboratories, the Central Weather Bureau, the National Space

Photo1: Participants of the NCAR 2004 Summer Colloquium on Atmospheric Remote Sensing Using the Global Positioning System.

Program Office (NSPO), and the National Central University (NCU) in Taiwan. The U.S. students saw the actual integration of the COSMIC satellites at the NSPO Integration and Test Facility. The visit extended from 3 July through 14 July 2004. The National Central University arranged for 8 NCU students to accompany the 10 U.S. students during their entire visit to Taiwan, and provided ample opportunities for student interactions. Scientific lectures, research and educational activities were carried out during these site visits to Japan and Taiwan. The visit also offered considerable opportunities for culture exchange for the U.S. students. Information on these scientific visits, including the visit schedule, participants, presentations, and photos taken during the trip can be found at:
http://www.cosmic.ucar.edu/colloquium_2004/colloquiumA04.html

As part of the educational experiences, students were required to prepare summaries of these scientific visits. With regard to the visit to GPS meteorology institutions in Japan, the participants offered the following comments about their interactions with the Japanese scientists and prospects for future collaboration:

"*Beyond lectures, at our dinner in Tsukuba, we had the opportunity to talk freely with Japanese researchers about differences in culture, and we were given the chance to share our ideas and opinions on many topics*."

"*Although the motivation for some branches of research may be different in Japan, it is apparent that the methods used by Japanese scientists are*

much the same as in the United States. For this reason, and also considering the wonderful interaction that we had with our hosts and lecturers at all the institutes, we find the idea of collaborating with scientists in East Asia to be very appealing."

"*In any such cooperative work, the contributions from East Asian collaborators would be invaluable; in addition, the resulting cultural interaction would be interesting and enjoyable*."

The summaries of the visit to the Japanese and Taiwanese GPS Meteorology institutions are available from:
http://www.cosmic.ucar.edu/colloquium_2004/fieldTripJapanA.html
http://www.cosmic.ucar.edu/colloquium_2004/fieldTripTaiwanA.html

As a summary of the Taiwan report, the students wrote: "*This field trip was a fantastic experience, especially for the younger students. Such experiences will encourage them in their current studies and may lead to ongoing international cooperation in their future careers. We can hope that, as a nation, the U.S. will continue to promote international cooperation. We as Americans can sometimes be provincial, and therefore ignorant of what is going on in the world. During the GPS colloquium in Boulder, Bill Kuo mentioned the abbreviation "NIH", meaning "not invented here". Although this phrase was meant to apply to institutions, Americans tend to apply this idea to the world. This field trip educated the students to the fact that innovative research and technical progress are being made in other parts of the world. Indeed, some of the most interesting projects using GPS for atmospheric research are being developed in Taiwan and Japan. Examples in Taiwan, and GEONET and "downward looking" of these projects are the COSMIC satellite project ground- and aircraft-based GPS stations in Japan. There is no doubt that this field trip was beneficial to both groups, the Taiwanese as well as the U.S. contingents*."

Photo 2: The Golden Palace in Kyoto.

Photo 3: U.S. students listening to Dr. Hatanaka's explanation of the GEONET system at GSI in Tsukuba, Japan.

Photo 4: U.S. students visited the MU radar, an observing facility of Kyoto University, at shigaraki village near Kyoto.

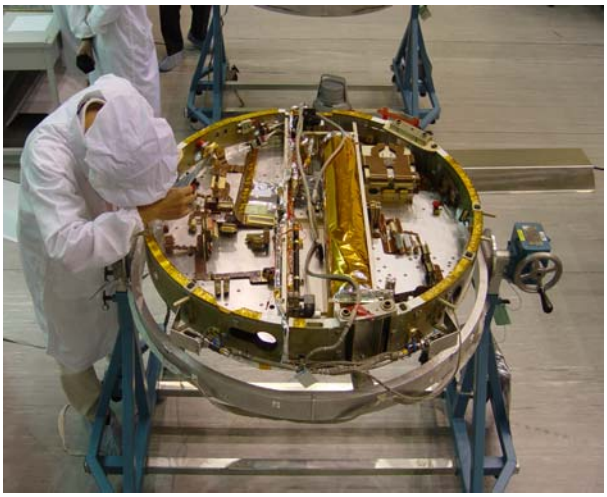

Photo 5: The assembly of COSMIC satellites at the NSPO Integration and Test Facility.

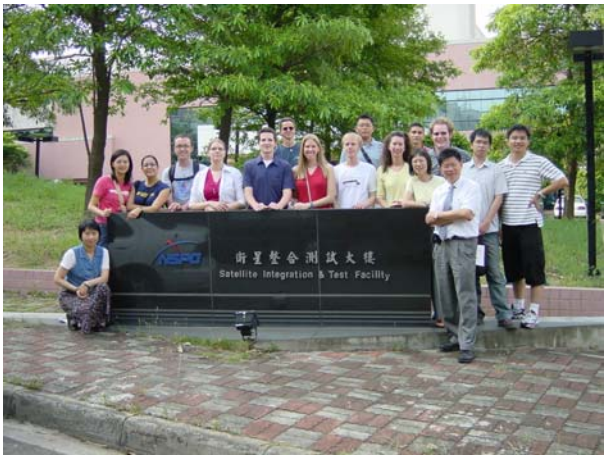

Photo 6: U.S. students posed in front of the NSPO Integration and Test Facility.

Photo 7: Erick Adame (Oneonta State College, State University of New York, left), Dee Rossiter (U. of California at Berkeley, right) posed with Vicky Fang (National Central University in Taiwan, middle) at a busy street in Taipei.

Photo 8: Picture of Taipei 101, the tallest building in the world.

Each participating U.S. student also wrote a report, summarizing the educational, scientific and cultural experiences he or she gained through these scientific visits. These reports are available from: http://www.cosmic.ucar.edu/colloquium_2004/fieldTripStudentsA.html

5. OTHER ON-GOING PROJECTS

The COSMIC AWARE program also hosts several on-going projects, with a goal to provide education, research and international training experiences to U.S. students and junior scientists in atmospheric sciences. These projects include (i) Hurricane-Mountain Interaction with Taiwan (P.I.: Prof. Yuh-Lang Lin, North Carolina State University), (ii) Land-Surface Modeling and Verification with China (P.I.s: Prof. Dev Niyogi, North Carolina State University, and Dr. Fei-Chen, NCAR), (iii) WRF Model Development and Verification with China, Korea, and Taiwan (P.I.s: Dr. Joseph B. Klemp and Dr. Bill Kuo, NCAR) and (iv) Mesoscale Ensemble Prediction (P.I.: Prof. Cliff Mass, U. of Washington). Over the past year, we have provided support for several U.S.

students and junior scientists to visit Korea, China and Taiwan, to attend international workshops, scientific visits, and participation of field activities. Through these international collaborative projects, the U.S. students become keenly aware of the research and development programs currently conducted and opportunities existing in those countries. More importantly, this leads to several new collaborative efforts between US and East Asian research institutions that involve the participation of US students and junior scientists. The international training and educational experiences allow the future U.S. atmospheric scientists to develop a global perspective of the field and the necessary skills to interact well with foreign researcher. The global perspective, the in-depth understanding of different cultures, and collaborative skills are important for them to succeed in the international atmospheric science community.

6. PROGRAM IN 2005

In the summer of 2005, we plan to conduct a "COSMIC Science Summer Camp" in Taiwan. The details are yet to be defined. Most likely, this program will last about 10 days, and will include invited lectures from leading researchers on GPS atmospheric remote sensing and East Asian atmospheric sciences, scientific visits to key research and operational institutions, student presentations and workshops. Announcement of the program will be made on the COSMIC AWARE web site:
http://www.cosmic.ucar.edu/aware.html

For U.S. students, junior scientists, or university faculties, interested in participating in this program, please feel free to contact: Dr. Bill Kuo (Email: kuo@ucar.edu).

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