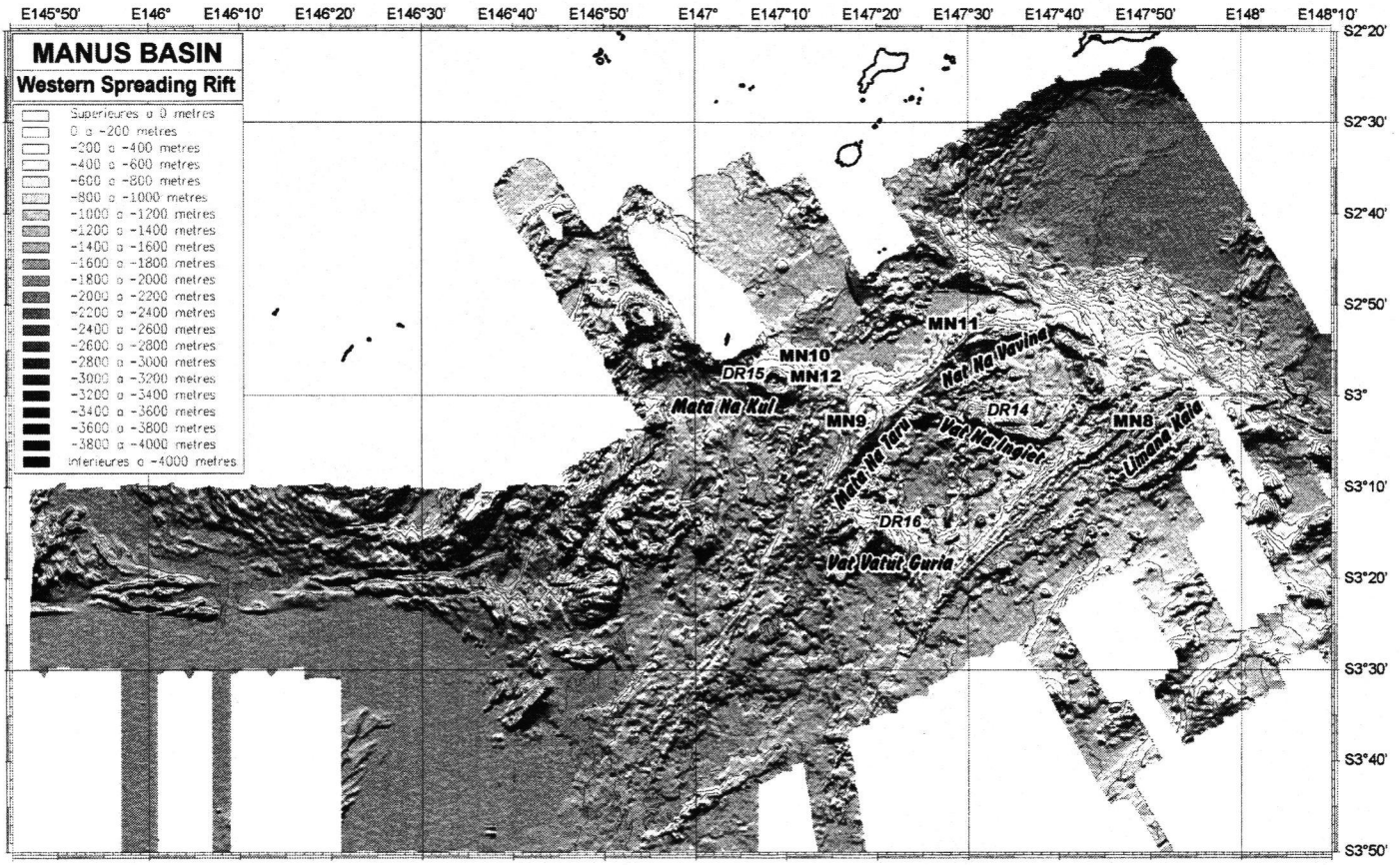

Fig. 4. Simplified swath-map of the western part of the Manus Basin. The contour interval is 50 m; MN: number of Nautile dives; DR: number of dredgings. Mata na Taru: red eye ; Limana Kaia: hand of the spirit ; Mata na Kul: eye of the devil ; Nat na vavina: little lady ; Vat na Ingiet: spirit rock.

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Chapman Conference Accents Success of Space Weather Program

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Over 160 scientists and students from more than a dozen countries attended the Chapman Conference on Space Weather: Progress and Challenges in Research and Applications to hear 70 talks and peruse 150 posters documenting achievements made during the first 5 years of the National Space Weather Program (NSWP).

Since the advent of the NSWP, space weather research has expanded from a semi-private activity, pursued mostly to address operational concerns of industries and military branches affected by space weather, to a broad subject pursued in part for its capacity to integrate research across the divisions of the SPA community.

The NSWP is a multi-agency program managed by the National Science Foundation (NSF). It integrates and coordinates the space weather interests of the NSF, NOAA, NASA, and the U.S. Departments of Defense, of the Interior, and of Energy. Its goal is to improve the ability of the nation s providers of space weather services to accurately specify, nowcast , and forecast the space environment.

Over the NSWP s first 5 years, progress on long-standing space weather projects has accelerated. An empirical model for predicting solar wind conditions at Earth from solar magnetic observations became markedly more accurate. An empirical model for specifying the magnetospheric magnetic field, already a community workhorse 5 years ago, considerably extended its range of applicability. A model for specifying the radiation environment that solar storms induce along the orbit of the International Space Station reached maturity. A globe-spanning network of radars is now providing data on ionospheric electrodynamics virtually in real time. A program is now working to enable useful nowcasts and forecasts of ionospheric scintillations, which adversely affect communication and navigation. Reports on these advances and, of course, much more made up the program of the conference.

Richard Behnke, originator of the NSWP and director of NSF s Upper Atmosphere Research Section, emphasized in a talk that opened the conference that space weather, despite being often viewed as applied science, is nonetheless an appropriate field for the NSF, the institution responsible for fostering pure science, to advance. After all, he noted, applied comprises the sphere of things that can be put to

practical use. Pure science, on the other hand, comprises the sphere of things that can make quantitative specifications and predictions. Space weather is nothing but the intersection in the space arena of these two spheres. His message was that one should not equate pure science with useless science.

A second message was that as a research topic, space weather is able to integrate disciplines, agencies, economic sectors, and countries. It integrates activities of the three branches of space physics supported by NSF and NASA: aeronomy, magnetospheric physics, and solar and heliospheric physics. During the conference, scientists from these branches were present at all sessions. Representatives from most of the six agencies that the NSWP integrates gave presentations at the conference on their interest in the program. Speakers from Bell Labs and Metatech, who described the little-known but important sectors of industry that space weather adversely affects, covered commercial interests. Representatives from Europe, Russia, and Japan described space weather programs in their countries.

Breakthroughs that might have seemed unfeasible 5 years ago have been made: Halo events sudden brightenings of the solar corona reveal storm clouds approaching from the Sun. Magnetospheric models input with solar wind data demonstrate 80 90% accuracy in forecasting the onset and intensity of geomagnetic storms and the occurrence of relativistic killer electron events. A global magnetospheric magneto-hydrodynamic (MHD) code, which 5 years ago ran much slower than real time, has been streamlined and parallelized so that given upstream solar wind condition, it can compute magnetospheric and geomagnetic conditions faster than real time, a prerequisite for an operational forecast code.

In the same half-decade, significant milestones and trends emerged. The first Sun-to-ionosphere numerical code was demonstrated. Hybrid global numerical codes combining the power of MHD for the outer magnetosphere and particle drift physics for the inner magnetosphere were initiated. Data assimilation moved from a little known topic in ionospheric and magnetospheric modeling to center stage. Powerful empirical prediction models, some of which use neural networks and techniques from nonlinear dynamics, emerged to treat aspects from solar activity to the size of the auroral oval. The first commercial vendors of space weather services, complete with attractive Web sites, have come into being.

The conference itself illustrated the previously mentioned trend toward cross-disciplinary integration. Solar, heliosphere, and magnetosphere physicists and aeronomers have embraced a common program partly out of necessity, since in space weather, each discipline depends on the others.

The conference s 5-year assessment of the NSWP or, more broadly, the international space weather enterprise, revealed more progress than one might have expected 5 years ago. Models have matured to the point where their forecasts, could they be implemented, are accurate enough to save customers of space weather services pain and money. The conference participants did not consider, however, the difficult problem of how to transition scientific models into operational models. The conference nonetheless demonstrated that the NSWP has accelerated progress in the science needed to improve the quality of space weather services. In the space arena, the sphere of useful pure science is rapidly growing.

After the Chapman Conference on space weather was conceived, NASA proposed implementing a new program that stresses space weather. With this program, named Living with a Star (LWS), NASA intends to put spacecraft in strategic locations around the Sun and Earth to gather data that will give simultaneous views of aspects of the Sun-to-ionosphere system pertinent to space weather. The program s emphasis will be on system-wide data gathering and modeling. The originator of LWS, George Withbroe, director of the Sun-Earth Connections (SEC) Theme at NASA headquarters, briefed the conference on the program. The impact of LWS on space weather research could be enormous.

The Chapman Conference on Space Weather: Progress and Challenges in Research and Applications was held March 20 24 in Clearwater, Florida.

The conferences invited talks will appear in an AGU monograph. Also, authors of contributed talks and posters will have an opportunity to publish their contributions in a special issue of the *Journal of Geophysical Research*.

Authors

George Siscoe, Center for Space Physics, Boston University, Mass., USA; and *Paul Song*, Space Physics Research Laboratory, University of Michigan, Ann Arbor, Mich., USA

India and U.S. Work Toward Improving Science Ties

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Two years after India set off several underground nuclear tests that rattled sabers and Indian-U.S. ties, the two countries now are edging back to normalization. One measure of that return to friendlier diplomatic relations is discussions on science and technology issues held during a recent, high-level roundtable meeting timed to Indian Prime Minister Atel Behari Vajpayee s official visit to the United States in September.

During Vajpayee s state visit, U.S. President Bill Clinton told his counterpart, I think we have worked hard together to move our relationship from one of too little contact and too much suspicion, to one of genuine efforts to build a long-term partnership that is in the interests of the people of India and the people of the United States.

Vajpayee noted the move toward cooperation in a September 14 address to the U.S. Congress. Security issues have cast a shadow on our relationship. I believe this is unnecessary. We have much in common and no clash of interests. We both share a commitment to ultimately eliminating nuclear weapons. We have both declared voluntary moratoriums, he said.

As we talk with candor, we open the doors to new possibilities and new areas of cooperation in advancing democracy, in combating terrorism, in energy and environment, in science and technology, and in international peacekeeping, Vajpayee added.

In the separate September 15 roundtable, an Indian delegation met with U.S. government and private sector scientists at the second U.S.-India High Level Roundtable on Science and Technology, held at the National Institutes of Health in Bethesda, Maryland.

Indian Secretary of Science and Technology V. S. Ramamurthy, who co-chaired the meeting with Assistant to the U.S. President for Science and Technology Neal Lane, called the roundtable a mechanism for transforming the current donor-recipient model prevalent in science and technology to one of partnership and cooperation between the two countries.

Ramamurthy told *Eos* that while the U.S. government took steps following the 1998 nuclear tests to ensure that certain technology does not reach India, my own feeling is, that phase is over in most instances. A number of U.S. sanctions, including those on technical assistance from the U.S. Environmental Protection Agency and Department of Energy, have been lifted.

From our perspective, certainly [the testing] was considered worth it, and that s why we did carry it out, he said. There could be perception differences. But each country has its own security perception and its own assessment. And for a step which has no unanimity across the world, there is always also a price to pay. But ours was a conscious decision by the Indian government that there was a need, and we did carry out the test.

The semigovernmental roundtable, established during President Clinton s visit to India in March 1999, covered a range of issues during the September meeting, including highspeed computing for modeling atmospheric phenomena and other uses.

The two countries agreed to cooperative efforts in weather and climate prediction and Earth observations. Delegates specifically discussed mutual benefits of collaborative efforts in collecting and distributing data, including the Argo Ocean Profiling Network. That network, which is anticipated to include 3,000 floats within 3 years, is an international effort to