WINTER MONEX

A Quarter-Century and Beyond

BY RICHARD H. JOHNSON AND CHIH-PEI CHANG

Not unexpectedly, East Asian countries are becoming more vulnerable to weather extremes as their populations grow and economies increase in complexity. Monsoon circulation systems, although not yet fully understood and often not accurately predicted, are major contributors to these extremes. The nations of the region are becoming increasingly aware of this situation and realize that international cooperation is needed to make meaningful progress on monsoon prediction and its applications. To facilitate this international cooperation, dozens of scientists, researchers, and other participants gathered in Malaysia's capital and largest city in April for an international symposium on the East Asian monsoon. "Winter MONEX: A Quarter-Century and Beyond," or WMONEX25+ as the symposium was dubbed, was held to commemorate the 25th anniversary of the 1978/79 Winter Monsoon Experiment (W-MONEX), to highlight more recent research on the East Asian monsoon, and to look ahead at the prospects of scientific cooperation and collaboration in monsoon prediction.

The WMONEX25+ symposium consisted of two-and-a-half days of scientific presentations (keynote, invited, and contributed papers), mostly on current research but with a look back to the contributions of W-MONEX, and then a half-day panel discussion on future cooperation on monsoon research and forecasting. Opening keynote lectures dealt with observations and modeling of tropical convection (Taroh Matsuno, Japan), dominant modes of monsoon variability (Bin Wang, United States), predictability of the South China Sea (SCS) monsoon onset (Ding Yihui, China), and monsoon predictability (In-Sik Kang, Korea). Subsequent sessions included the following topics: observations of the monsoon, diurnal and mesoscale processes, interannual variations, monsoon modeling studies, winter monsoon and cold surges, forecasting and predictability of the monsoon, the annual cycle, and long-term and decadal variations.

THE WMONEX25+ SYMPOSIUM

WHAT: More than 100 participants from nearly 20 countries participated in a symposium to review the achievements of the 1978/79 Winter Monsoon Experiment, report on subsequent progress in East Asian monsoon research, and discuss future plans for cooperation on weather and climate research and forecasting over the broad East Asian–Australian monsoon region.
WHEN: 4–7 April 2006
WHERE: Kuala Lumpur, Malaysia

THE 1978/79 WINTER MOON EXPERIMENT. Malaysia often experiences significant flooding during the Asian winter monsoon (Fig. 1), and this country and other nations of the region have a great interest in advancing monsoon research and

AFFILIATIONS: JOHNSON—Colorado State University, Fort Collins, Colorado; CHANG—Naval Postgraduate School, Monterey, California
CORRESPONDING AUTHOR: Richard H. Johnson, Department of Atmospheric Science, Colorado State University, Fort Collins, CO 80523
E-mail: johnson@atmos.colostate.edu

DOI:10.1175/BAMS-88-3-385

In final form 28 September 2006

prediction. W-MONEX, a subprogram of the First Global Atmospheric Research Program (GARP) Global Experiment (FGGE), was the first truly international atmospheric–oceanic experiment in the Eastern Hemisphere. Its goal was to study both the global and regional aspects of the winter monsoon circulation over East Asia, the maritime continent, and Australia. A wide array of observing systems—research aircraft, ships, soundings, research radar, and surface stations—was deployed to investigate the circulation features of the winter monsoon. The W-MONEX Operations Centre, which was located in Kuala Lumpur, was hosted by the Malaysian Meteorological Service.[1]

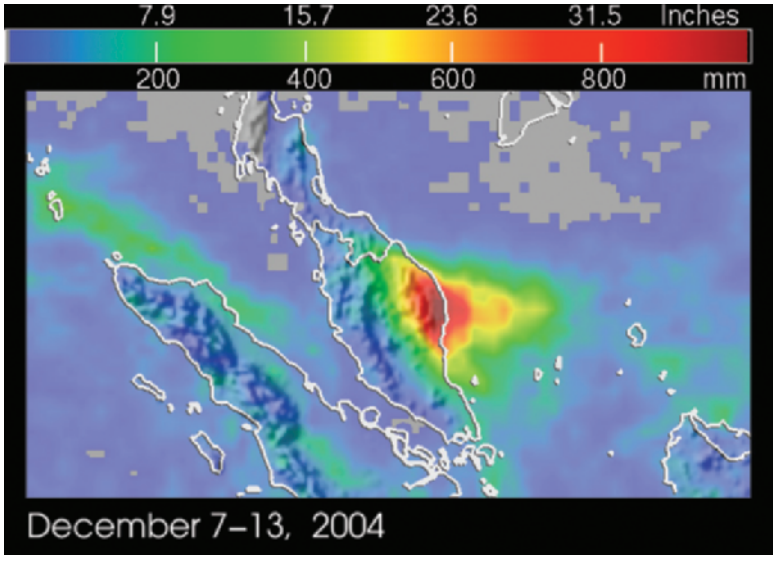

Fig. 1. Rainfall totals (mm) for 7–13 Dec 2004. Northeast monsoon flow impinging on the coastal mountains of Malaysia triggered heavy rains—the worst in more than 40 years—that killed at least 11 people and forced the evacuation of more than 10,000. Image from TRMM-based Multi-Satellite Precipitation Analysis of the National Aeronautics and Space Administration Goddard Space Flight Center.

Among the major findings of W-MONEX were the identification of the role of easterly wave disturbances from the western Pacific in weather over the southern SCS, the structure and dynamics of cold surges over the South China Sea and their interaction with the planetary-scale circulations, the structure and evolution of vortices over the southern SCS, the behavior of cross-equatorial flow, the structure of convective systems in this region, and mechanisms of the diurnal cycle of convection.

One of the more significant results from W-MONEX concerns the diurnal convection cycle. Some of the earliest definitive studies of the diurnal cycle of coastal oceanic convection were achieved during the experiment using the Massachusetts Institute of Meteorology's research radar at Bintulu along the north coast of Borneo. A regular convective cycle was observed, with deep convection developing over land in the afternoon and evening followed by new convection forming just offshore around midnight. This latter convection later developed into a mature mesoscale convective system in the early morning hours (Houze et al. 1981). In recent years, these W-MONEX findings have drawn renewed attention as the international modeling community begins to address the current poor simulation of the diurnal cycle of precipitation, and new satellite observing systems, such as the Tropical Rainfall Measuring Mission (TRMM), now permit documentation of global characteristics of the diurnal cycle.

Another important scientific finding from W-MONEX was the observation of synoptic-scale vortices over the southern SCS near the coast of Borneo. These circulation systems regularly developed in association with the low-level, northeasterly monsoon flow and served to organize convection in the region. The vortices affect weather in the vicinity of the southern SCS by producing torrential rainfall, and influence the planetary-scale circulation through the release of enormous amounts of latent heat. An extreme case of the Borneo vortex occurred in December 2001 when Typhoon Vamei formed at an unusually low latitude (near 1.5°N) and moved onto the eastern shore of Malaysia just north of Singapore (Fig. 2). It caused damage to two U.S. Navy ships, including an aircraft carrier, and flooding and mudslides on southern peninsular Malaysia in the Johor and Pahang States where more than 17,000 people were evacuated and 5 lives were lost. While it is generally regarded that tropical cyclones cannot develop this close to the equator because of the weak Coriolis force, the unusual occurrence of Vamei was attributed by Chang et al. (2003) to be a result of an increased background relative vorticity that is produced from an interaction of the winter monsoon cold surge and the unique geography around the equatorial SCS.

[1] The Malaysian Meteorological Service and the World Meteorological Organization (WMO) organized and sponsored WMONEX25+.

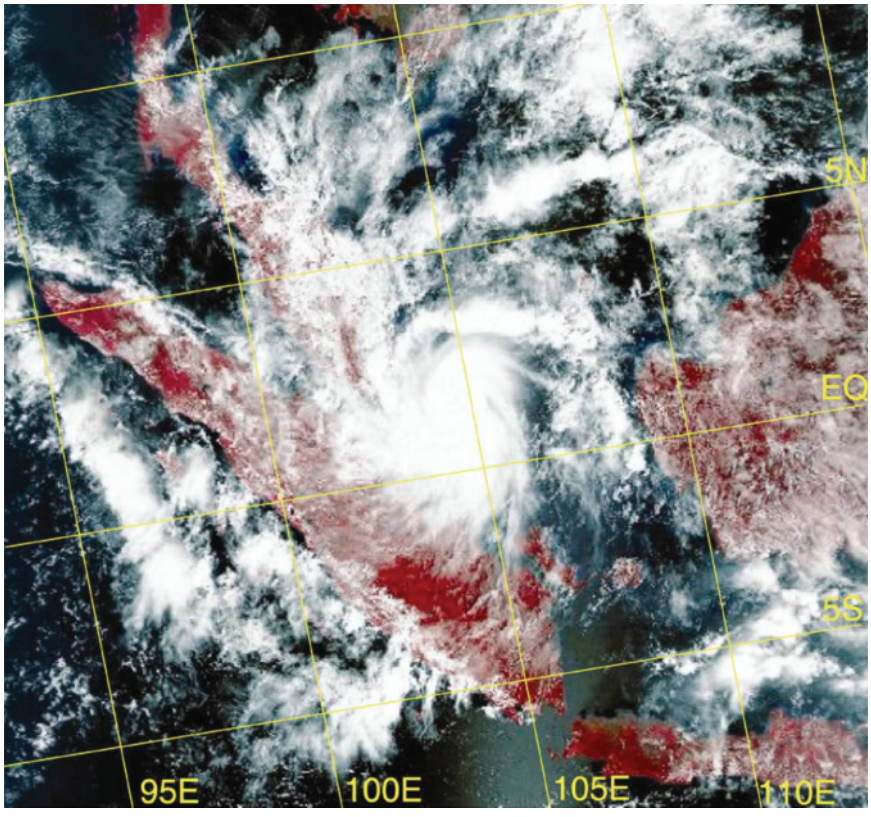

Fig. 2. Moderate Resolution Imaging Spectroradiometer satellite image of Typhoon Vamei on 27 Dec 2001, with circulation on both sides of the equator. The land areas are the Malay Peninsula and Sumatra to the west of the typhoon, and Borneo to the east.

CURRENT RESEARCH. A broad scope of research activities is currently underway, involving both observations and modeling of the East Asian monsoon. Observational studies span a wide range of scales, from the diurnal cycle of convection over the maritime continent to synoptic, intraseasonal, and interannual variations over midlatitude East Asia and tropical Southeast Asia using both reconstruction and analysis of historical rainfall data and newly available and emerging satellite data. Current research on modeling the East Asian monsoon includes high-resolution general circulation modeling, atmosphere–ocean–land coupling, explicit representation of convective processes, and regional downscaling. A new, important area of emphasis is the multiple-ensemble predictability and forecasts, and studies of the impact of global warming under global change scenarios. New studies on interannual and interdecadal variations of the East Asian monsoon are also being initiated, with the realization that in addition to El Niño, other factors influence the variability. Process studies and modeling of weather systems such as cold surges, vortices, and the diurnal cycle over the SCS and Maritime Continent are being carried out, with the effects of the complex terrain of this region on all scales of motion being one of the important focuses.

FUTURE COOPERATION. Regional and international cooperation is a high priority for future studies of weather and climate of the East Asian monsoon. Current programs and new initiatives discussed at the symposium include the Asia–Pacific Economic Cooperation (APEC) Climate Center, which is formed by 21 members to cooperate in producing real-time prediction and to share and apply climate information; the WMO Tropical Meteorology Research Programme (TMRP), which focuses on both tropical cyclone and monsoon meteorology, with the primary goal of promoting the interactions between research and operational communities; and the Monsoon Asian Hydro-Atmosphere Scientific Research and Prediction Initiative (MAHASRI), which is proposed by Japan as a follow-on to the Global Energy and Water Cycle Experiment (GEWEX) Asian Monsoon Experiment (GAME). Multinational and regional cooperation also includes the joint meetings on seasonal prediction of the East Asian monsoon, which have been rotationally hosted by the national meteorological services of China, Korea, and Japan twice a year to make seasonal forecasts of the summer and winter monsoons; and the annual International Symposium of the Asian Monsoon (ISAM), hosted by the academic communities of these countries. Both of these meetings have been attended by an increasing number of countries from East Asia and other parts of the world.

The panel discussion on "International cooperation to improve extended and seasonal forecasts and their applications" was cochaired by Chung-Kyu Park of the Korea-based APEC Climate Center and Steve Zebiak of the U.S.-based International Research

Institute for Climate and Society. It focused on strategies for sharing climate information, including data, observations, and forecasts, as well as international cooperation to promote research in the countries of Southeast Asia. The current and proposed initiatives described above will serve to foster these future cooperative activities.

The WMONEX25+ Symposium was revered as an initial and important step toward nations in the region developing a long-range plan for collaboration on monsoon prediction, which is so important to a third of the world's population.

REFERENCES

Chang, C.-P., C. H. Liu, and H. C. Kuo, 2003: Typhoon Vamei: An equatorial tropical cyclone formation. *Geophys. Res. Lett.,* **30,** 1150, doi:10.1029/2002GL016365.

Houze, R. A., S. G. Goetis, F. D. Marks, and A. K. West, 1981: Winter monsoon convection in the vicinity of north Borneo. Part I: Structure and time variation of clouds and precipitation. *Mon. Wea. Rev.,* **109,** 1595–1614.