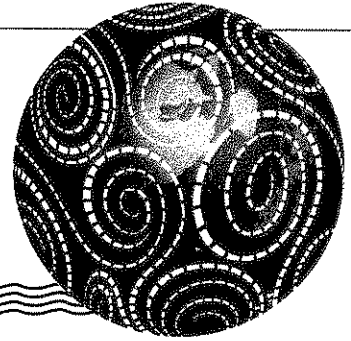


# CLIMATE ALERT



Volume 5, Number 3

July-August 1992

## Marshall Islands Study Measures to Thwart Ocean Rise

The predicament of the Marshall Islands, in the West Central Pacific, if the sea level rises can best be depicted by a few telling statistics. With an average elevation in the Islands of less than eight feet, flooding and coastal erosion are already serious problems. A worldwide sea level rise of between one and 3.3 feet by 2100 is predicted by IPCC scientists under global warming. A one-foot rise and a storm of the size expected once in 50 years would submerge the Marshalls with 7 feet of water; a 3.3 foot rise and a typhoon could overwhelm the islands with 11.3 foot waves.

Many parts of the Marshalls may be unsafe to live on even in the near future because of almost annual floods. Nevertheless, accommodation to the threats of rising seas is possible, a recent study finds, with sufficient financial resources, technical expertise, technology and materials. (The needed measures would require substantial funds from outside sources.) Well-designed protective structures would go a long way to decreasing vulnerability.

Faced with impending perils, the Government of the Marshall Islands commissioned an investigatory study to ob-

(continued on page 4)

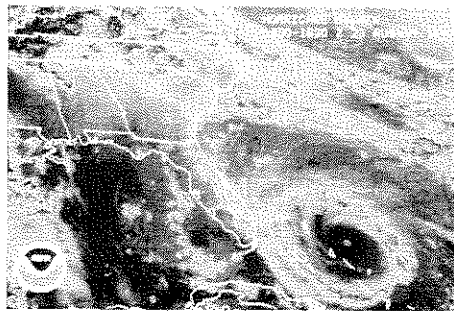
### NEXT ISSUE:

Article on Climate Change and Water Resources in the Mid-East.

Report on the Institute's new briefing program on North American Cities and Climate Change.

## Are We Heading Into an Era of More Intense Hurricanes?

The three recent U.S. hurricanes — Andrew, Omar, and Iniki — have brought us face to face, again, with the dangers the world may confront if global warming generates an increase in storm intensity and/or frequency. Since tropical storms form only when sea surface temperatures (SST) reach 27 degrees C or greater, it is possible that more storms can be expected in a warmer climate. A model by Kerry Emanuel reported in *Nature* in 1987 suggests that an increase of SST of 3 degrees C would raise the intensity (and destructive power) of a tropical storm by 40 percent.



Satellite photo of Hurricane Andrew

For the last 25 years, the United States, especially in much of its most vulnerable coastal areas, has not experienced the number of hurricanes that meteorologists have expected. During this lull, there has been a huge movement of people to storm-prone shores. The devastation from the three hurricanes, and the staggering property losses that resulted from them, are a frightening reminder of what could happen if climate change should produce a shift to more intense hurricanes, if their path shifted farther north or if such

violent storms resumed a pattern of frequency meteorologists consider more normal.

Some research — not agreed to by all scientists — links the frequency of severe hurricanes in the U.S. with rain in the Sahel of sub-Saharan Africa. From 1947 to 1969, rain in the Sahel coincided with 13 hurricanes on the East coast. A prolonged drought from 1970-87, which will almost certainly end in the next few years, was accompanied by only one storm. Since 1987 there have been nine severe hurricanes, raising the question of whether a new cycle may be beginning.

There is a wide disparity between the hurricane-related problems faced by developed and developing countries. Industrial countries have the communications and other infrastructure to minimize loss of life but may experience staggering property losses. Developing countries, on the other hand, less able to warn their populations of impending storms, suffer tragic loss of life on an immense scale.

### United States

Coming out of an El Nino year, 1992 has so far been a quiet year for Atlantic hurricanes, with to date only Andrew amounting to a serious event. Normally there would be 3 hurricanes in September. But the arrival of Iniki, spawned in the same area of the Atlantic only four days after Andrew, and Typhoon Omar which hit the island of

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# Climate Institute News

## INTERNS

The Institute's intern program continues to be an extremely successful element of the Institute's operation. The interns serve during the spring or fall semester, in the monthlong winter break, but most of all in summer. Some receive academic credit; most come for the experience and contacts they make. In the summer of '92, six interns, some part-time, some full-time, came from institutions across the country:

**Katherine Ray**, a junior economics major from Duke University, gathered data and prepared the script for a 30-slide presentation on the effects of ozone depletion and climate change on human health. She undertook much of the research on health effects information herself. The slide set will be used by the National Institutes of Health and other organizations for audiences across the globe. Katherine hopes to go to graduate school in environmental policy after she finishes college.

**Lisa Trovato** came from Cornell University where she is now a senior, majoring in biology with a concentration in environment and society, particularly focusing on the legal field. She has had previous experience working in the office of an environmental law firm and hopes to attend law school after graduation. Assisting the Asian Development Bank project director, she helped compile an annotated bibliography for use by the teams of scientists involved in the ADB regional impact studies and also assisted in preparation of the Institute's six-year report.

**Mike Nelson**, a senior biology major at the University of North Carolina at Chapel Hill, and **Doug Gatlin**, a political science graduate of Duke University, assisted the Institute's fund raiser, Dan Power, both in developing funding proposals and laying the groundwork for the North American Cities and Climate Change Project which was inaugurated this fall. Mike also lent support to the operation of the Institute's publications. Mike continues to have a strong interest in the environmental field but has not yet decided on a specific area for concentration.

**Doug Gatlin** took over the Institute's computer organization and operations. His assistance was so valuable that the Institute hired him to take over some of the administrative duties and to continue as a support person on the Cities project. His title is now project coordinator and assistant director for the Cities and Climate Change project.

**Amy Palmer**, a junior at UCLA who is majoring in Physics, carried out research on the energy alternatives of China. She also prepared a bibliography on studies of budget priorities for climate research and policy response programs.

**Blair Rich**, a Harvard Wesley High School senior from Los Angeles, was responsible for keeping the varied and unpredictable daily operations of the Institute running smoothly, as well as reorganizing the Institute's library and slide collection and upgrading Institute files. She also assisted in the preparation of the Institute's report on its first six years.

During the spring '92 semester, two interns contributed valuable back-up to the Institute staff for conferences, symposia and a variety of other activities:

**Sara Zimmerman**, of West Chester University in Pennsylvania, did background research for a Mexico country paper and on the Seychelles. In the fall she was admitted to Portland State University to begin her graduate studies, continuing her environmental interests under the aegis of the Geography Department. She has been awarded an assistantship and is starting a research project on trees in urban areas.

**Alex Hirtle**, of the University of Maryland, worked on a Portuguese language version of the Institute's greenhouse effect slide set. After graduation, Alex spent the summer in London, on a project connected with his church. He is now back in this country and job-hunting.

Two more interns have signed on for the Fall '92 semester: **Michele Clagg**, from Westminster, Maryland, a senior at George Mason University in Virginia, majoring in public administration, is as-

sisting with the Institute's new project on North American Cities and Climate Change. Her special focus is climate change and pollution. She is undecided about her plans after graduating but may go to graduate school.

**Diane Ruth**, a math major at the University of Maryland, will graduate next spring. She is doing background research for the Institute's environmental refugees project. Diane first became interested in global warming when she wrote a paper on it in high school. She has taken courses in environmental policy and ecopolitics and is considering going to law school after graduation, with a special focus on environmental law. Diane is providing research assistance on proposals.



Left to Right: Blair Rich, Mike Nelson, Kathy Ray, Doug Gatlin, Lisa Trovato, Director of Impacts Research - David Hobbie and Amy Palmer



## CLIMATE ALERT

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# Climate News Around the World

## Lagging Food Production

While global food production has exceeded population growth for the last 30 or 40 years, except in parts of Africa, world crop yields have leveled off or dropped in the past few years. This has happened in the potato fields of Mexico and the rice paddies of Asia. If the climate becomes warmer or drier in key production areas, the trend toward reduced global agricultural production could be worrisome.

Food production lagged behind population growth in 69 out of 102 developing countries between 1978 and 1989 according to the latest projections from the United Nations Population Fund. But the population grew less between those years than it is projected to grow in the next four decades.

There are several reasons for the yield declines. The benefits of the Green Revolution with high-yield crop strains, accompanied by intensive use of pesticides, fertilizers and irrigation, have sparked counteractions—pest resistance, high costs of pesticides and fertilizer and health concerns about their use, new diseases, loss of irrigated lands from waterlogging and salinization, loss of water as irrigation drains lakes or ground water. There is an additional loss of arable land itself from top soil erosion and explosive urban growth.

Climate model predictions of drought in the American Midwest and the threat of rising oceans submerging fertile lands such as the Ganges delta raise fears of possible famine in the future.

Even those researchers who are skeptical of global warming scenarios are nevertheless concerned that budgets for agricultural research, especially in Latin American and Africa, have been flat or declining, an ominous portent with millions more people to feed every year.

## Recent UV-B Developments

According to US National Center for Atmospheric Research estimates, total annual UV-B reaching the surface in the middle latitudes of both hemispheres between 1979 and 1989 rose 4 to 12 percent, in Antarctica by about 50 per-

cent, while in the tropics there were no statistically significant changes. Because tropospheric ozone interferes with transmission of UV-B, the NCAR study estimates that the air pollution over even nonurban areas of industrialized countries has led to a decline of ultraviolet radiation levels of 5 to 18 percent since the industrial revolution. As industrial countries reduce their emissions which lead to tropospheric ozone and sulfate aerosols, UV-B doses may increase.

The network for monitoring global UV-B trends is patchy and data show variation even in similar latitudes. A recent study has found that UV-B levels in New Zealand are nearly twice that of Germany although the two countries are at comparable latitudes in their hemispheres. In New Zealand it is possible that the Antarctic ozone hole drained the upper-atmosphere ozone from surrounding areas. In Germany a cloud of air pollution, which includes tropospheric ozone, may have provided protection.

The eruption of Mt. Pinatubo may have increased UV-B as well as producing a mild cooling of the earth which could last 2-4 years. The aerosols thrown into the stratosphere from the blowout may have been the reason there was a 45 percent increase in UV-B reaching the earth under clear skies in Colorado last November at a time when ozone over the region was 20 percent below normal. While sulfate aerosols from the eruption reflect sunlight and therefore reduce the amount of ultraviolet light reaching the surface of the earth, a more dominant effect results from aerosols in the stratosphere which facilitate ozone depletion.

A recent study shows that UV radiation induces HIV (human immunodeficiency virus) gene activation. In 1988, research suggested that UV light activates the AIDS virus (see *Climate Alert*, vol. 1, No. 2, Summer 1988), but the latest research was performed with living animals (transgenic mice) rather than a cultured cell. Although not necessarily completely applicable to humans, the findings are cause for concern.

While scientists have till now believed that some plants are more suscep-

tible to UV-B damage than humans, a recent research project at Brookhaven National Laboratory has found that alfalfa seedlings have already received a damaging dose to their DNA in nature, and ozone depletion would only add a very small amount of injury. But a study of phytoplankton under the ozone hole in the Antarctic found that primary production in phytoplankton was reduced by 6-12 percent over the course of the year. Similar research has found that shorter-wave radiation reaching the earth from ozone depletion would add little to the harmful UV radiation already being absorbed by phytoplankton.

However, other scientists have commented that the response of plants to UV radiation varies widely, and it is not known whether the alfalfa seedlings are particularly resistant. The damage might have been more severe if the plants had reached the stage of performing photosynthesis.

## Possible Harm to Plants from CO2 Increase

A Swiss study indicates a possible further threat to plant life, in this case in a simulated rain forest. Two sets of plants were exposed to different CO2 levels, one at 340 parts per million, corresponding to the earth's present atmosphere, and the other at 640 parts per million, a level which may be reached in the next century if current trends continue. Plants exposed to the higher CO2 levels formed massive amounts of starch grains in their top leaves. Starch can slow photosynthesis, and a starch buildup can cause leaves to behave abnormally. Increased CO2 can also lead to increases in the fine-root structure of plants, doubling the amount of CO2 given off by the surrounding soil. The researchers were alarmed by such a loss of soil carbon and the release of nutrients.

The Swiss research is the first to concentrate on whole ecological systems. Preliminary results of these experiments suggest two conclusions: that food production may be reduced by increased CO2 and that the world's plants may be near a saturation point for the rate at which they can remove CO2 from the atmosphere.

## Marshall Islands

(Continued from page 1)

tain scientific information on the potential vulnerability of the nation and a preliminary view of possible adaptive response strategies. A 6-month study was carried out by the U.S. National Oceanic and Atmospheric Administration (NOAA), using scenarios and methodology developed by the Coastal Zone Management Subgroup of IPCC's Working Group III on Response Strategies. The study results, released in June, are the first of about 25 case studies being conducted around the world under the auspices of the IPCC. The purpose of the study was to provide information for conceptual planning only.

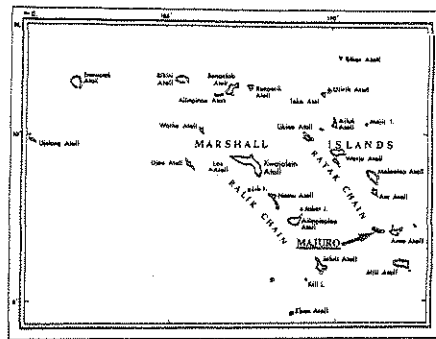
The Marshall Islands form a nation whose territory is more than 99 percent water. The 43,000 population has a high growth rate of 4.2 percent. The study which concentrated on four areas on Majuro atoll, one of the 34 atolls and islands in the Marshalls and its capital, shows present-day overcrowding, with little space for building, gardening or recreation — or refuge for people fleeing from even lower elevation outlying atolls. Population increase on Majuro is 6.3 percent annually. In the urban section of Majuro, population density of approximately 29,000 per square mile makes it one of the most densely populated areas in the world. The Gross Domestic Product (GDP) of the Marshalls (exclusive of \$50 million in foreign aid) amounts to \$25 million, yielding a per capita income of between \$200 and \$500. The nation relies on foreign imports, expertise, and aid, and the economy is increasingly sustained by the U. S. Army facility on Kwajalein, the source of 40 percent of the GDP. Future economic development, according to the study, will depend largely on marine resources.

The severe impacts of accelerated sea level rise are not likely to start for 20 to 30 years, depending on the rate of rise. But institutional changes should not wait; considering political and bureaucratic lags the time to start is now, the study advises.

Steps toward accommodation and protection for most of the high value areas are already being taken on an ad hoc basis in response to current conditions and flood-

ing. One of the best and most urgent adaptive measures is development and implementation of coastal zone management legislation as soon as possible to help minimize existing flooding and erosion and plan for the future.

However, shore protection for two study areas alone, under one scenario would cost \$127 million, more than four times the current GDP. Costs in a more extreme scenario amount to \$175 million. A future construction program would therefore have to be spread over many years; even \$6 million extended over 30 years would be prohibitive for the economy.



Majuro Atoll, Marshall Islands

Overall, it would be desirable to raise the general ground elevation of the Majuro atoll above the stillwater level, the study states. As suitable landfill from lagoons and reefs is limited, and imported landfill is expensive, the Marshall Islands may need to consider using portions or all of some islets — perhaps those that could not be defended or which might be lost to erosion — as a source of fill.

The cost of raising the land one meter in one study site (less than a square mile in area) would total \$40 - \$50 million. To this must be added the cost of temporarily moving homes and buildings. Highways and roads would also need to be elevated eventually.

But protection is not an all or nothing alternative. Priorities can be established and goals achieved, especially with outside assistance. The areas less vulnerable to wave overtopping and flooding can be identified as part of planning for new development and as havens during disaster. In areas with many important buildings at risk, such as on the ocean shoreline, structures can be put on stilts or pilings. New structures can be planned with raised first levels.

In flooded areas, it would be possible to encourage adaptive economic activities: aquaculture; growing of halophytes, plants such as saltbrush or sea lavender which grow in salty soil; heavier reliance on cultivating marine organisms as a source of revenue; and development of floating cities, platforms located in lagoons which would provide both tourist accommodations and safe havens when disaster threatens.

Land in the Marshalls is 100 percent in private hands, and the government has no authority to use it without the owner's consent. New legal arrangements, breaking with traditional land use practices (not an easy step), will be needed, for public easements along coastlines, for instance, or to concentrate population in less vulnerable areas, or to accommodate those displaced from outer islands.

With land in short supply, it may be impossible to continue growing local foods — yams, taro, bananas and coconuts — on family lands. As the sea level rises, loss of arable land would lead to increased reliance on imported foods; in fact 40 percent of the GDP is already spent on them. Shore protection structures may hinder access to the ocean in canoes and fishing boats, important to the subsistence population. Urbanization and reliance on foreign aid have already undermined the traditional subsistence system.

The greatest threat to the Marshallese, the study warns, would come from aspects of climate change such as shifting typhoon "alleys" which would threaten life despite protective measures and might force abandonment. The rate of sea level rise and storm patterns will have to be monitored carefully. There is an urgent need for more data — better tide gauges and global monitoring initiatives. There is also a need for increased regional cooperation, the sharing of techniques and experiences.

Faced with very limited options, after examining the study's conclusions, the Marshallese will make their own decisions, identifying the risks, establishing priorities, evaluating their goals and capabilities and surveying potential support from outside sources. The study concludes total abandonment should not be necessary under lower accelerated sea rise projections.

# Calendar of Climate Related Events, 1992-93

- November 1-5** *Valletta, Malta*  
**Pacem in Maribus Conference — Ocean Governance: A Model of Global Governance in the 21st Century. Legal and institutional implications of Law of the Sea Convention and applications to energy, food, atmosphere, outer space, and science and technology.**  
 Contact: Anna Mallia, 356 236596
- November 1-5** *Reno, Nevada, USA*  
**Managing Water Resources During Global Change: 28th Annual Conference and International Symposium, organized by American Water Resources Association**  
 Contact: Michael Fink, 301/493-8600
- November 2-6** *Accra, Ghana*  
**Toward Sustainable Environmental and Resource Management Futures for Sub-Saharan Africa**  
 Contact: W. Manshard, 49-7633-3488
- November 6** *Washington, DC, USA*  
**Maurice Strong, Secretary-general of UNCED, will speak on problems and opportunities which have emerged from UNCED and hopes for the future. Rev. Dr. Frederick Quinn of Episcopal Diocesan Commission on Peace will respond. Moderator: Joan Martin-Brown, special advisor of UNEP. Washington National Cathedral, 8 pm.**  
 Contact: Michael Hamilton, 202/537-6226
- November 17-19** *Venice, Italy*  
**Managing the Mediterranean — Information for Decision Making. Workshop on feasibility and usefulness of practical action under auspices of national and international organizations.**  
 Contact: Kele & Teo, 39 41 5208722
- November 23-27** *Niamey, Niger*  
**International Year for the Geosphere and Biosphere Project Regional Conference for Africa**  
 Contact: IGBP Secretariat, +46-8-166405
- November 30-December 4** *Arusha, Tanzania*  
**Meteorological Research in Eastern and Southern Africa, will complement activities of Drought Monitoring Centres of region. Among topics: climate change issues in region, monsoon circulation over tropical Africa.**  
 Contact: W.S.M. Minja, FAX: 255-051-32591
- December 28-31** *Jerusalem, Israel*  
**Climate and Climate Change, Yale Mintz Memorial Symposium, sponsored by Israeli Meteorological Soc. et al.**  
 Contact: E. H. Steinberger, 9722-639926
- 1993
- January** *Tucson, AZ, USA*  
**Modeling, Remote Sensing, and Paleorecord Analyses in the Hydroclimatology of Global Change, held by University of Arizona**  
 Contact: Soroosh Sorossian, Dept. Hydrol., Bldg. 11, Univ. Arizona, Tucson AZ 85718 USA
- January** *New Delhi, India*  
**International Conference on Sustainable Development Strategies and Global/Regional/Local Impacts on Atmospheric Composition and Climate, sponsored by Indian Inst. Technol. et al.**  
 Contact: M.P. Singh, 91-11-651-842
- January 17-22** *Anaheim, CA, USA*  
**Symposia and Special Sessions as part of American Meteorological Society Annual Meeting: 1. Meteorological Instrumentation and Observations.**  
 Contact: C.B. Baker, 704/259-0330
- 2. Conference on Applied Climatology.**  
 Contact: same as #1 above.
- 3. Challenges in Atmospheric and Earth Science.**  
 Contact: Donald Johnson, 608/262-2538
- 4. Fourth Symposium on Global Change Studies.**  
 Contact: Eric Barron, 814/865-1619
- 5. Profiling of Water Vapor in the Free Troposphere and Stratosphere.**  
 Contact: R. M. Hoff, 705/458-1411
- 6. Atmospheric Chemistry.**  
 Contact: Jeremy Hales, 509/735-9480
- February 8-11** *Pasadena, CA, USA*  
**Geologic Remote Sensing: Exploration, Environment, and Engineering, organized by Environmental Research Institute of Michigan**  
 Contact: Nancy Wallman, 313/994-1200, x. 3234
- February 8-19** *North Ryde, New South Wales, Australia*  
**Coupled Climate Systems Modeling: A Southern Hemisphere Perspective, workshop hosted by Macquarie Univ. for postgraduate students. Participation as postgraduate member of workshop will be fully funded.**  
 Contact: Julia Porter, FAX: 61-2-805-8428
- February 8-21** *Palmerston North, New Zealand*  
**XVII International Grassland Congress. Four climate change sessions: 1) impact on grassland ecosystems, 2) prediction of effects on plants and their biotic environment, 3) adaptation, 4) role of grassland agriculture in modifying climate change.**  
 Contact: Bruce Campbell, 64 6 356 8019
- February 15-16** *Palmerston North, New Zealand*  
**Climate Change Symposium, XVII International Grassland Congress**  
 Contact: Agronomy Dept. FAX: 64-6-350-5614
- March 19-April 2** *Hobart, Tasmania, Australia*  
**Southern Hemisphere Meteorology and Oceanography, 4th International Conf.**  
 Contact: David Karoly, 61 3 565 4413 or Richard Rosen, 617/547-6207
- April 4-8** *Graz, Austria*  
**Remote Sensing and Global Environmental Change, 25th international symposium, conducted by Environmental Research Institute of Michigan et al.**  
 Contact: Dorothy Humphrey, 313/994-1200, x. 2290
- April 5-7** *Wageningen, The Netherlands*  
**Predictability and Nonlinear Modeling in Natural Sciences and Economics. Among subjects: prediction of climate.**  
 Contact: Congress Office, +31-8370-82029
- April 5-8** *Chicago, IL, USA*  
**Global Warming: A Call for International Coordination. Fourth international conference on scientific and policy issues facing all governments, including water shortage, floods, and acid rain.**  
 Contact: Thomas Cobb, 419/372-8207
- April 18-22** *Eilat (on Red Sea Coast), Israel*  
**Global Atmospheric-Biospheric Chemistry: First IGAC Scientific Conf. Foci: regional studies (marine, tropical, mid-latitude, boreal, polar), global studies, and fundamental laboratory studies.**  
 Contact: IGAC Core Project Office, 617/253-4902
- May** *Stockholm, Sweden*  
**Conference on population issues, organized by U.S. National Academy of Sciences and Royal Society of London, hosted by Royal Swedish Academy of Sciences**
- May 11-13** *Albuquerque, NM, USA*  
**Halon Alternatives Technical Working Conference, organized by Center for Global Environmental Technologies and New Mexico Engineering Research Institute. University of New Mexico.**  
 Contact: Robert Tapscoft, 505/272-7252
- May 17-21** *Birmingham, AL, USA*  
**International Coalbed Methane Symposium, sponsored by Univ. of Alabama.**  
 Contact: Coll. of Continuing Studies, 205/348-6222
- May 19-21** *Portland, Maine, USA*  
**A Regional Response to Global Climate Change: New England and Eastern Canada, sponsored by Conf. of New England Governors and Eastern Canadian Premiers, US National Oceanic and Atmospheric Administration and Canadian Climate Center. Sonesta Hotel.**  
 Contact: Nick Houtman, 207/581-1491
- May 20-22** *Albuquerque, NM, USA*  
**Environmental Information Management and Analysis: Ecosystem to Global System Scales, sponsored by National Science Foundation.**  
 Contact: William Michener, 803/777-3926
- May 26-29** *Beijing, PRC*  
**Climate Change, Natural Disasters and Agricultural Strategies, international symposium, sponsored by Chinese Assoc. of Agri. Science Societies et al, at Beijing Agricultural University.**  
 Contact: Lu Guangming, FAX: 86-01-2582332
- June 7-11** *Fredericton, New Brunswick, Canada*  
**27th Annual Congress of Canadian Meteorological and Oceanographic Society, at University of New Brunswick**  
 Contact: Dave Daugharty, 506/453-4501
- July** *Oxford, UK*  
**Climate Change and World Food Security, NATO Advanced Research Workshop, hosted by Environmental Change Unit, Oxford Univ.**  
 Contact: Martin Parry, FAX 44-865-28-11-81
- July 5-9** *Beijing, PRC*  
**International Conference on Permafrost, organized by Chinese Organizing Committee**  
 Contact: (U.S.) Mark Meier, 303/492-6387
- July 11-23** *Yokohama, Japan*  
**International Association of Hydrological Sciences and International Association of Meteorology and Atmospheric Physics**  
 Contact: Takeo Kinoshita, 81-298-51-1611

## Intense Hurricanes

(Continued from page 1)

Guam — three big hurricanes in only 18 days — turned September 1992 into a banner year for big storms.

Despite the fact that Andrew was only a category 4 hurricane (winds of 131-155 miles per hour) with only 35 people killed, the National Hurricane Center dubbed it the third most intense storm to hit land in the U.S. in this century. Ahead of it in rank were Camille which hit the Mississippi coast in 1969, killing 256 people, and the 1935 Labor Day hurricane that struck the Florida Keys, killing 600.

While the U.S. National Academies of Sciences and Engineering study, *Policy Implications of Greenhouse Warming*, reported average annual U.S. hurricane losses ranging from \$800 million to \$1.8 billion, losses from Hugo in 1989 were much above that average, at more than \$5 billion, and from Andrew an estimated \$30 billion.



Hurricane aftermath in Galveston, Texas, 1900

The three hurricanes also brought out other disturbing trends. It is reassuring that the loss of life in such severe storms has declined precipitously. (In 1900 a hurricane in Galveston left 6000 dead. No subsequent hurricanes in the U.S. have matched that enormous loss.) But there has been a rush toward unbridled coastal development that places life and property at risk. Severe damage from Hurricane Iniki to most of Kauai's 70 resort hotels suggests that regulations requiring setbacks of 100 feet from the beach should be adopted, a measure that may be very unpopular with hotel owners and tourists.

Although Andrew left 250,000 temporarily homeless, 10 percent of the residents of Dade County, on this occasion it missed most of the very expensive real estate of Miami just to the north and all the major

population centers of Louisiana. A different path in the next hurricane might cause even more astronomic property losses and much greater loss of life.

Andrew revealed the failure of local building codes or their enforcement in the widespread destruction of homes and trailers. Despite warnings from Hurricane Hugo, immediate relief efforts were heavily criticized and the sudden, urgent need on such a large scale in Florida in 1992 presented almost insurmountable difficulties. While evacuation routes and procedures worked fairly well in the instance of Andrew, if there had been more rain and storm surges in critical spots, many people could have drowned in their cars.

Iniki also illustrated the dangerous weakness in current U.S. hurricane prediction facilities. U.S. satellites are antiquated and poorly positioned. The U.S. would like to have two Geostationary Operational Environmental Satellites (GOES) on duty 22,300 miles above the earth. One has already failed. The other, GOES-7, passed its 5-year predicted lifetime last February and is out of maneuvering fuel and beginning to drift. This raises the risk of forecast errors. In its current position at 112 degrees west longitude, GOES-7 cannot see the hurricane breeding grounds in the Atlantic. If it were at its normal position, 135 degrees west longitude, it would have been able to see into the Pacific where hurricanes like Iniki hit Hawaii. It is conceivable that in this normal position, it might have given a forewarning when Iniki suddenly shifted to a northerly path just before landfall and smashed into Kauai instead of taking its predicted path between the islands.

It is common for hurricanes to change course sharply and unexpectedly. Fortunately, Andrew moved in a straightforward way as it approached southern Florida, crossed the state and headed for Louisiana, creating few problems for forecasters despite antiquated equipment.

Five replacement satellites, known as GOES-NEXT are being built but the first launch has been delayed from 1989 to 1994 because of technical failures. The U.S. has borrowed an old surplus satellite from Europe, Meteosat-3, which is now at 50 degrees west longitude and unable to go further west till a ground station at

Wallops Island, Virginia, is completed late this year. Normally it would be stationed at 75 degrees west longitude. Besides not being in the most advantageous position, Meteosat-3 has no sounder, a sensor which measures infrared energy from the earth's atmosphere, yielding temperature, humidity and wind speed data that meteorologists find significantly improve forecasts.

### Worldwide

Throughout history a disproportionate number of devastating tropical cyclones causing huge loss of human life have occurred in the Asian Pacific Region, with a very large number affecting Bangladesh. (From 1891 to 1985, 174 severe storms were formed in the Bay of Bengal.)

Some major past hurricanes, ranked by loss of life, are:

Year	Location	Deaths
1970	Bangladesh	300,000
1937	India	300,000
1881	China	300,000
1923	Japan	250,000
1897	Bangladesh	175,000
1991	Bangladesh	138,000
1876	Bangladesh	100,000

As development proceeds in newly industrializing countries, more sophisticated warning and emergency response systems and improved living conditions will be in place. Hong Kong lost 10,000 people, many of them living in boats, in a 1906 typhoon and 10,000 in a 1937 typhoon. In spite of considerable population growth, the number of boat people residing in the harbor has declined greatly. Such socioeconomic changes have probably significantly reduced Hong Kong's vulnerability to loss of life in future typhoons, but the value of economic assets at risk has greatly increased.



A typhoon strikes Hong Kong, 1906

(Continued on page 7)

## Intense Hurricanes

(Continued from page 6)

Around the world, at present, the casualties and level of property loss due to natural phenomena are increasing for a number of reasons — population growth, improvements in living standards (people able to buy more things and able to afford to insure them), increasing concentration of people and capital in urban areas, global migration of people and industries to coasts. One report states that annual economic loss from large scale natural disasters averaged \$3.7 billion worldwide in the 1960s, tripling to \$11.4 billion in the 1980s. Insured losses in the same period increased not by a factor of 3 but by 4.8.

Poor nations suffer more from hurricanes than rich nations. Crowded out lowlands, in some cases the people have no shelters or high land to retreat to, and no evacuation routes and procedures. They have slender financial resources to help restore their lands and homes. When a crisis comes, the international community may be preoccupied with its own problems. In 1985, when high winds and waves swept seven islands of Bangladesh, leaving 12,000 dead and 250,000 homeless, the Bangladesh Red Cross asked for \$2 million to help survivors and the International Red Cross appealed for \$1.7 million. The U.S. made \$525,000 available.

In contrast, seven years later, the American Red Cross has estimated its Hurricane Andrew expenditures at \$59 million for the people of Florida, \$6 million for those in Louisiana, plus \$10 million for Hurricane Iniki and \$5 million for Omar.

The Alliance of Small Island States (AOSIS) and other NGOs successfully pressed for inclusion of disaster insurance as an issue to be addressed by the UN Framework Convention on Climate Change. AOSIS plans to push for a disaster insurance pool for developing nations to be funded by the industrialized countries, based on the argument that the developed world is responsible for many of the conditions that may precipitate climate change, including hurricanes, floods, rising seas. The insurance pool would give industrialized countries an incentive to help developing nations instigate disaster prevention programs, saving lives as well as reducing property damage.

Natural population growth means the tremendous loss of life in developing countries is likely to increase. Rising living standards with skyrocketing property values bring much greater vulnerability to disasters. There is no agreement that global warming will strengthen the forces that create storms. But if climate

change brings a rise in sea level, an increase in storm intensity, as many scientists believe, and possibly an increase in frequency, the prospects are frightening.



## Record Low Ozone Again

Ozone depletion over Antarctica began earlier this year than in 1991 according to scientists of the National Oceanic and Atmospheric Administration at Boulder, Colorado and proceeded more rapidly. By September 23 the south polar territory under a depleted ozone area became the largest on record, Goddard Space Flight Center scientists reported. Ozone readings over the South Pole in mid-September were 15 percent lower than those taken during the same week in 1991. Readings in 1987 and 1991 reached record lows. The seasonal low is not expected for several weeks. According to the scientists the low readings may result not only from CFCs but also from the sulphur dioxides thrown into the atmosphere by eruptions of Mount Pinatubo in the Philippines and Mount Hudson in Chile. These volcanic aerosols are present seven to 13 miles above Antarctica, in the same region where ozone readings are lowest.

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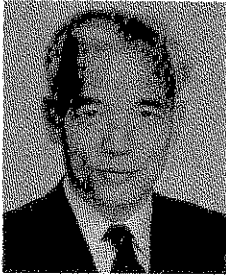
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## Asahi Foundation Awards First Blue Planet Prizes

The first winners of the Blue Planet Prize, an American scientist and a U.K.-based institute, were announced at Rio Centro Convention Center, the main site of the Earth Summit, on June 8. Dr. Syukoro Manabe of the U.S. National Oceanic and Atmospheric Administration won the academic award; the International Institute for Environment and Development (IIED) received the development and implementation award. Institute Board Chairman Sir Crispin Tickell is also chairman of IIED.

The Blue Planet Prize has been established by the Asahi Glass Foundation and



**Dr. Syukoro Manabe, Geophysical Fluid Dynamics Laboratory**

will be presented annually for significant accomplishments in environmental studies. Award recipients receive a certificate of merit, a commemorative gift and a supplementary prize of 50 million Yen.

Dr. Manabe, an internationally known meteorologist, has developed computer models at the NOAA Geophysical Fluid Dynamics Laboratory which have contributed to a better understanding of global climate. One model simulates the circulation of the atmosphere, another shows the effects of ocean currents on atmospheric movements. His work has helped strengthen scientists' ability to predict global warming and climatic changes.

IIED is an independent, nonprofit think tank founded in 1971 by Barbara Ward, famous for her exhortation, "Think globally, Act locally." The Institute was an early advocate of sustainable development and has made important contributions in energy policy and environmental economics.

## Pacific Ocean Level Up

A scientist at the Scripps Institution of Oceanography, Dr. Dean Roemmich, has reported a sea level rise of one to 1 1/2 inches in the last 42 years in the Pacific Ocean off southern California. After analyzing thousands of ocean measurements by research ships, Roemmich tracked a 42-year warming trend of about 1.5 degrees over 77,000 square miles of ocean.

The Asahi Glass Foundation was established in 1934 to commemorate the 25th anniversary of the Asahi Glass Company, Ltd. Its aim is to promote industrial, economic and social progress throughout the world. It has provided financial assistance to researchers in applied chemistry at public and private universities in Japan and abroad. Recently it expanded the scope of its funding to physics, information technology, electronics, metallurgy, architecture, urban engineering and human and social sciences.

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*The Climate Institute is a private nonprofit organization formed to advance public understanding of climate change including the greenhouse effect and of strategies to avert stratospheric ozone depletion.*