Mexico Adopts Industrial Country CFC Phaseout

On May 6 the Mexican government announced that it was prepared to adhere to the industrial country requirements of the Montreal Protocol on Substances that Deplete the Ozone Layer. The Montreal Protocol as amended last year in London provides for a complete phaseout of chlorofluorocarbons and some other ozone-depleting substances by 2000 by signatory industrialized countries, but allows developing countries an additional ten years to implement such a phaseout.

The Mexican action, coming just a few weeks after evidence that global levels of stratospheric ozone depletion were much greater than previously anticipated, offers hope that some other large developing countries might launch aggressive efforts to introduce CFC substitutes. The Mexican initiative, announced by Undersecretary for Ecology Sergio Reyes Jujan (pictured on page 6 discussing climate issues in March with the Climate Institute team led by Sir Crispin Tickell) represents a particularly concrete (continued on page 6)

Island Nations, Two Canadian Experts Receive Institute Awards

Two international climate authorities and the Alliance of Small Island States have been selected for awards at the Climate Institute's fifth annual awards dinner on June 13, during the Institute-sponsored international conference, Cities and Global Change, in Toronto.

The conference, running from June 12-14, at the Royal York Hotel, will be held on the third anniversary of the historic Toronto "Conference on the Changing Atmosphere: Implications for Global Security," which resulted, among other measures, in targeting a cut in CO2 emissions by 20 percent by the year 2005. Convened by the Climate Institute, the June 1991 Toronto meeting is being held in partnership with the City of Toronto, the Municipality of Metropolitan Toronto and the Province of Ontario.

On the second evening of the three-day conference, the three awards will be presented to the following recipients:

(continued on page 5)

Climate Change Impact Study Highlights Soil Moisture Change in United Kingdom

According to a report recently issued by the United Kingdom Climate Change Impacts Review Group, reductions in soil moisture are among the most serious potential consequences the U.K. may experience in a warming world. Such changes would, the report suggests, "have a major effect on the types of crops, trees or other vegetation that soils in a particular area can support" and possibly transform the "whole pattern of land use in the U.K. . . . ."

These changes in soil moisture may make cultivation of land more difficult and necessitate introduction of new machinery. Drier, warmer summers and wetter winters as indicated by the climate change scenarios would produce alternating shrinking and swelling and jeopardize the foundations of buildings and other structures. The most severely affected areas are likely to be central, eastern and southern England where there are clay soils vulnerable to this shrinking and swelling.

These anticipated reductions in soil moisture could have wide-ranging ecological consequences, the Committee chaired by Dr. Martin Parry of the University of Birmingham reported. Soil shrinkage during summer would lead to cracks linking the soil surface (continued on page 6)

INSIDE

• Natural Thermostat
• Utilities Limit CO2
Oceans, Clouds May Produce Natural Thermostat Preventing Venus Effect

Two scientists studying the 1987 El Nino event report that data from that tropical climate system suggest a “natural thermostat” may prevent global warming from spinning out of control in a runaway greenhouse or Venus effect. (When the earth was formed it was far enough from the sun and cool enough for water vapor to condense into clouds and fall back to earth. On warmer Venus, instead, water did not condense or precipitate. The sun’s radiation broke water down, and hydrogen molecules escaped into space. Carbon was retained as CO2, forming a dense greenhouse atmosphere.)

In the tropical Pacific Ocean study, the scientists Veerabhadran Ramanathan and William Collins of Scripps Institution of Oceanography in La Jolla, U.S., analyzed data on changes in temperature and sunlight gathered by satellites and ships. When sea surface temperatures rose, water vapor increased substantially in the atmosphere. As the most powerful greenhouse gas, amplifying other causes of heating such as carbon dioxide and sunlight, water vapor creates a “super greenhouse effect.” The hot, moist air gains so much energy that it forms intense convection currents. In the rising air, huge thunderclouds form which, when they reach freezing altitudes, turn into cirrus clouds of ice crystals.

Normally cirrus clouds contribute to trapping heat in the atmosphere. But when they become thick enough, they become reflective and prevent sunlight from reaching the ocean. In the data studied, the clouds shaded up to four million square miles of the earth’s surface and were thick enough to counterbalance warming below; the sea surface was prevented from warming further. As the cooling begins, the thunderclouds and cirrus dissipate, and the process starts again.

According to the study’s authors, their findings constitute experimental evidence of an important feedback phenomenon. If the feedback is large enough, the cooler oceans outside the tropics could also warm, possibly bringing the oceans around the world toward a uniform temperature. Such a condition could have enormous repercussions as differences among ocean temperatures produce the planetary winds that influence regional climate. Without the differentials, there would be vast changes in regional climates.

However, Ramanathan points out there are many other feedbacks, about which little is understood and any number of them could have profound climate effects. He also says that global warming could still cause vast climatic disruptions as the natural thermostat operating on a global scale would lead to radical changes in the patterns of jet streams and other atmospheric circulation, with unpredictable regional results. In addition, most of the world’s oceans are too cool for the thermostat effect to kick in.

Collins noted that cirrus feedback requires a large supply of moisture which has only been observed in the tropical Pacific. Only 15-20 percent of the Earth’s surface is covered by tropical oceans.

California Utilities Promise to Cut CO2 Emissions 20 Percent

Two large California utilities have announced they will reduce their emissions of carbon dioxide by 20 percent in the next 20 years, the first American utilities to make such a promise. (The companies were the two industrial participants in the pilot environmental awareness program, “Children Light the Way,” chaired by Institute Board Member Lynne Edgerton and reported in the May issue of Climate Alert.)

Southern California Edison, the nation’s second largest utility, serves a population of 10 million. It is already paying bonuses to homebuilders for constructing energy-efficient houses, subsidizing customers who buy energy-efficient fluorescent light bulbs and adding alternative energies produced by small companies to its system.

The Los Angeles Department of Water and Power, the largest municipal utility in the country, serves a population of 3.5 million. The companies said the reductions — which would be keeping 23 million tons of CO2 from the atmosphere — would be achieved through improved efficiency in lighting, cooling, heating and other uses. They said that if they took no action, the rapid growth of population and demand in their service areas would lead to substantial rises in carbon dioxide.

Without the new planned steps, Southern California’s CO2 emissions would be expected to increase from 32 million tons in 1988 to 39 million tons in 2010, and the L.A. Water Department’s from 18 million tons in 1989 to 24 million tons. By fulfilling the proposed measures, the emissions are expected to fall to 25.9 million and 14 million tons respectively.

Officials said their actions were triggered by the recent report, Policy Implications of Greenhouse Warming, published by the National Academy of Sciences, National Academy of Engineering and Institute of Medicine. They said most of the steps would be required in any case, to reduce smog and keep electric rates as low as possible.

The European Community has promised to stabilize carbon dioxide emissions by 2000 at 1990 levels and some countries, such as Germany, have promised to go further.
Europe

Drought, landslides, stressed plants, more frequent severe storms, and salt marsh changes are among the impacts in store for Europe if climate change materializes. A series of workshops has studied the impacts of climate and land-use changes in Europe and a summary of the findings and recommendations, Potential Impacts of Climatic Change in Europe, has been published.

The Netherlands government has worked with the World Climate Program, the International Institute for Applied Systems Analysis and the European Community Climate Program in conducting the workshops and has published a summary of the findings and recommendations in a report entitled, Potential Impacts of Climatic Change in Europe. Some of the many conclusions, recommendations and research proposals delineated in this slim volume are listed below:

- More drought will hamper river navigation, soils will become more prone to erosion and, in Southeastern Europe, to salinization, and air and water pollution will place further stress on forests, according to the conclusions of a workshop, "Interrelated Bioclimatic and Land-Use Changes."

- A conference on "Landscape-Ecological Impact of Climatic Change" concluded that rapid shifts of vegetation in decades instead of centuries will force plants and animals onto soils and under daylight regimes to which they cannot adapt. Weeds and pests will take advantage of destabilization and spread rapidly. While the disappearance of glaciers is estimated to have only minor effects, more unstable moraine slopes will contribute to landslides, mud-flows and sediment in rivers and reservoirs. Natural forest fires may accelerate permafrost degradation.

- Coasts will be subject to possible changes of ocean currents, changes in frequency and duration of storms and other extreme events, and shifts in sediment discharge, according to a workshop, "Expected Effects of Climatic Change on Marine Coastal Systems."

The entire west coast and some parts of the eastern coast are subject to erosion which is acute along the coast of Orissa, Bengal and Kerala. A one meter rise of sea level would cause shore recession of from about 270 to 615 meters in various east and west coast areas. On the Kerala coast, about three to five meters a year have been lost because of a lack of sediment deposition. Other coasts have suffered because of the removal of sands for construction materials. The Arabian Sea islands are particularly vulnerable to sea level rise as they have an elevation of three to five meters.

Many of the areas vulnerable to erosion are subject to repeated hazards of surging sea waves and heavy rainfall accompanying cyclonic winds. Possible sea level rise would also accentuate the problem of increased salt water intrusion, especially in the estuarine regions and deltas of the east coast, already a problem in some areas.

Most of the floods in the country occur during the monsoons and are associated with either the monsoon itself or tropical storms or depressions. The lower reaches of the rivers generally overflow their banks during heavy rainfalls.

Although a strong base exists for management and control of flood damage, there has been an upward trend in damages during recent years because of a number of factors. The population explosion has put a severe stress on housing and sanitation facilities.

In the unplanned growth of large and medium-sized cities, housing has been built in river beds and catchment areas, causing heavy loss of life and property damage when waters rise. These settlements have also blocked the natural drainage channels of flood waters which then sweep away habitations in their way. Although expenditures on flood control have increased over the years, they are not sufficient and much more effort will be needed in the future, especially under a climate change regime, according to Chatterjee.

Erosion, sedimentation, soil chemistry and changes in competitive ability will affect salt-marsh vegetation. Diatoms and animals in tidal pools may receive higher UV-B radiation.

- In a session on "The Greenhouse Effect and Primary Productivity in European Agro-Ecosystems," the participants urged a close distinction between the beneficial, neutral, and detrimental effects of warming and of increased CO2 concentrations. While the direct plant-physiological effect of CO2 concentration on annual agricultural plants can be assessed with some confidence, models of perennials are much more uncertain. Glass-house experiments with some species suggest that CO2 enrichment fades away after prolonged exposure.

- IIASA held a meeting on "Future Environments for Europe: Some Implications of Alternative Development Paths" at which a major issue for consideration was climate and chemical time bombs. A chemical time bomb is a phenomenon in which certain man-made chemicals accumulate in ecological systems with no apparent adverse effects for a number of years until a threshold is reached. Then a sudden explosion into the wider environment may occur. Climatic change may provide the trigger: increased storm strength may stir sediments in which toxic chemicals have been stored for years, or dessication of the soil can lead to aeration and oxidation and mobilization of substances hidden in it. IIASA with support of the Netherlands government has started a project on "Chemical Time Bombs in Europe:" climate change and land-use changes are among the forcing factors considered.

India

The Government of India has invested in a major research study of the impacts of possible sea level rise due to global warming along the Indian coast and islands. The study is expected to be completed in December 1991 and will be particularly pertinent for the 25 percent of the population living along the coast, according to a paper prepared by Dr. Kalipada Chatterjee, Ministry of Environment and Forests, Government of India, for a January conference in Nagoya, Japan, the Asian Pacific Seminar on Climate Change.
Climate Institute News

Tickell

Sir Crispin Tickell, Chairman of the Climate Institute, presented the Fourteenth Annual Lecture at St. George's Chapel, Windsor in the United Kingdom on April 26. The lecture entitled, "Climate and Life: Change and Diversity," discusses the relationship between climatic change and biological evolution in the framework of history, economics and ethics. The lecture highlights the inadequacy of traditional economic analysis to assign proper value to forests or wilderness which besides timber may yield such benefits as increased genetic diversity, protection for soil erosion, maintenance of rainfall and hydrological systems, and generation of tourism revenue. It goes on to suggest elements of a new value system vital to the good health of our planet. Individual copies of the lecture are available directly from the Climate Institute.

In early May Sir Crispin received former Prime Minister Thatcher for a visit and a tea party at Green College (of which Sir Crispin is President) at Oxford University. Mrs. Thatcher and the other participants including Dr. Martin Parry discussed environmental issues and Oxford's new Environmental Change Unit.

Parry

Board member Martin Parry has been appointed to head the new Environmental Change Unit at the University of Oxford, a joint initiative of the Departments of Zoology, Forestry and Geography. The Unit was launched in February to coordinate research into environmental change and to provide training and consultation in environmental protection.

Dr. Parry is now Professor of Environmental Management at the University of Birmingham and will take up his new post in October. He will take with him to Oxford his internationally-renowned Atmospheric Impacts Research Group. The AIR Group works on the effects of climatic change on agriculture and is currently supported by grants totalling over one million pounds from the US Environmental Protection Agency, the European Commission, and the Ministry of Agriculture, Fisheries and Food.

Professor Parry is Chairman of the UK Climate Change Impacts Review Group and is an international leader in studies of the impact of climatic change on global agricultural production. News of his latest book, Climate Change and World Agriculture, was reported in the last issue of Climate Alert.

In his new post, he will have the title of IBM Director, IBM UK Ltd. has provided £250,000 pounds to fund the Director's post and will donate computing equipment for the Unit.

Guerra

Since his election March 11 to the Climate Institute Board of Directors, Luis Manuel Guerra, Director General of Instituto Autonomo de Investigaciones Ecológicas, A.O. (INAINE), has spearheaded a strong climate change and environmental awareness effort throughout Mexico.

After helping arrange a very successful visit in March by a Climate Institute-UENP team with President Salinas de Gortari and other senior Mexican officials he has been asked to serve as an advisor to Ecology Minister Patricio Chirinos. INAINE has reached an agreement with the National Council for Science and Technology to distribute 500 sets of climate change color slides among the main Mexican universities.

These sets with text in Spanish were developed jointly by the Climate Institute and Guerra's Mexico City based environmental group. INAINIE is seeking to train 500 lecturers to carry climate change discussions to universities throughout Mexico. Coupled with this ambitious environmental awareness effort Guerra has also launched a campaign seeking the electrification of 10,000 Mexican villages with renewable energy. Such an initiative seeks to provide electricity to ten million Mexican rural dwellers without any increase in carbon dioxide emissions.

Funding for Institute

In April 1991 the Climate Institute received a $100,000 grant from the Rockefeller Foundation to support its program to conduct head of state and ministerial briefings on climate change in developing countries and Eastern Europe. This program is being carried out in cooperation with the Intergovernmental Panel on Climate Change and the United Nations Environment Program. Support for this project has also come from a $100,000 grant in 1990 from the Rockefeller Foundation and $45,000 in related grants this year from the Netherlands Climate Program. The Climate Institute also was awarded a renewal of its $50,000 general operating fund grant from the William Bingham Foundation. The Charles Stewart Mott Foundation has also awarded a renewal of a general operating fund grant of $35,000 to the Institute.

Leatherman

Dr. Stephen Leatherman, who is Co-Chairman of the Climate Institute Board and Director of the Laboratory for Coastal Research at the University of Maryland, teaches a course on "Beaches and Coasts." He is often asked which are the best beaches in the country. Intrigued by the question, he made a survey of more than 600 beaches and hopes that someone will be stimulated to make a worldwide survey.

Working on his own time and with his own financing, he sent out questionnaires to beach managers and other local experts, asking them to rank their beaches on 50 physical, biological, and human characteristics, such as width of beach at low tide, water temperatures, litter, views and vistas, and turbidity.

More than 100 newspapers around the country, including the Washington Post Travel Section and the three major wire services reported the results. Winner was Kapalu, Hawaii, and Florida and Hawaii were the big winners nationally. Leatherman said he intends to keep the study updated, since beaches are constantly changing.
Island Nations
(continued from page 1)

JIM MACNEILL who is cited for his efforts in advancing public understanding of potential responses to challenges to the global environment. In 1984, he became Secretary General of the World Commission on Environment and Development (the Brundtland Commission), headquartered in Geneva, and while there was the principal architect and primary author of the Commission's Report, Our Common Future, a new global agenda for sustainable development. The Report, published in 1987, has sold over one-half million copies in 19 languages.

MacNeill is now a Senior Fellow at the Institute for Research on Public Policy in Ottawa, a Senior Adviser to the Secretary General of the United Nations Conference on Environment and Development and President of MacNeill and Associates.

His most recent book, Beyond Interdependence: The Matching of the World's Economy and the Earth's Ecology, will be published by Oxford University Press in August. Written together with Pieter Winsemius, a Director of McKinsey and Company in Amsterdam and former Dutch Minister of Housing, Physical Planning and Environment, and Taizo Yakuishi, Professor of Technology and International Relations at the Graduate School of Policy Science at Saitama University in Japan, the new book argues that environmental degradation, resource depletion, and the need to secure access to increasingly scarce global reserves of energy and other raw materials could become the principal source of interstate conflict in the post cold war world. It shows how nations can take unilateral and regional action to address environmental threats and act intelligently to advance our common future.

Before joining the World Commission, MacNeill was Director of Environment for the Organization for Economic Cooperation and Development in Paris, and earlier Canada's Commissioner General and Ambassador Extraordinary and Plenipotentiary for the 1976 UN Conference on Human Settlements (Habitat) in Vancouver.

In keeping with his peripatetic life, MacNeill will not be present to receive his award because he will be in Bangkok attending an International Conference on Global warming and Sustainable Development, but members of his family will be present at the awards dinner to accept his award for him.

DR. KEN HARE, Chancellor of Trent University, has been chosen for his long time contributions to our understanding of the science of climate and climate change. Prominent both internationally and in Canada in furthering scientific inquiry into climate change, he served for a number of years as Chairman of the Canadian Climate Change Planning Committee during which time Canada established world leadership in studies of potential impacts of climate change. He was the Scientific Keynoter of the 1988 Toronto Conference on the Changing Atmosphere and won the 1988 International Meteorological Organization Prize, the most prestigious in the meteorological community.

A member of the Institute Board of Advisors, Ken Hare served as Honorary Chairman of the Institute-sponsored Symposium on the Arctic and Global Change in Ottawa in October 1989 and provided the final wrap up of the three-day meeting. One of the pioneers in urban climatology, he is performing a similar function at the June Cities and Global Change Conference in Toronto.

The third Institute award will be presented to a new organization, the Alliance of Small Island States, AOSIS, which since its inception six months ago has galvanized a truly global response to the climate change problem. Two dozen small island countries in the Pacific and Indian Oceans and Caribbean and Mediterranean regions, all with a common vulnerability to global sea level rise, banded together at the Second World Climate Conference in Geneva last October and injected a new sense of urgency into international climate change discussions. During the greenhouse negotiations in February 1991 in Chantilly, Virginia, the Alliance forged a very close working relationship among many island nations.

The Alliance is urging early action to curb greenhouse gases and avert the growing threats of not only sea level rise but also storm surge, cyclones, tropical storms, salt-water intrusion and coral bleaching.

Chairman of AOSIS is Robert F. Van Lierop, Vanuatu's Ambassador to the U.N. The Republic of Vanuatu, formerly New Hebrides, is a nation of more than 80 islands in the South Pacific Ocean, between Hawaii and Australia, with a population of 165,000. Its terrain is mostly mountains, of volcanic origin, with narrow coastal plains. Subsistence farming provides a living for about 80 percent of the population. The climate is tropical and the islands are subject to tropical cyclones or typhoons. Volcanism causes minor earthquakes. A storm in 1987 which came in a different direction from most previous ones caused flooding and wind damage to buildings, houses and crops, with losses reaching $28 million. Damage to the capital city, Port-Vila, amounted to ten times the national budget.

Senator Gore Looks for Signs of Global Warming at North Pole

Concern about global warming is high on the agenda of Senator Albert Gore, Jr., who has recently returned from the North Pole and reports scientists there told him profound changes are underway. He said he was told the average temperature in March 1990 in Siberia, within the Arctic Circle, was 18 degrees warmer than any March on record. Also, the Arctic tundra has warmed 5 to 8 degrees in the last few decades.

Gore journeyed to the North Pole on a Navy submarine which was making its annual trip there to check ice buildup and gather other data. He visited three different ice stations, traveling by ski planes and snowmobiles.

Senator Gore was a featured speaker in December 1988 at the Climate Institute's Second North American Conference.
Mexico Adopts
(continued from page 1)

e inple example of the technology leapfrogging strategy advocated by Dr. Jose Goldemberg, currently Secretary of State for Science and Technology for Brazil. In moving for an early phaseout of CFCs from its growing electronics industry, Mexico appears likely to surpass even such highly technologically developed countries as Japan.

The Mexican stratospheric ozone protection initiative is only the latest in a series of remarkable environmental initiatives adopted by Mexico since the inauguration of President Carlos Salinas de Gortari in December 1988. In late 1989 drivers in the world's most populous city, Mexico City, were made subject to a ban on driving their cars one day each week. This March following a major air pollution episode President Salinas personally ordered the closing of a Mexico City oil refinery and its conversion to a park. This action, designed to reduce the city's severe air pollution problem, is likely to cost 3,000 refinery jobs and as much as $500 million.

Climate Change
(continued from page 1)

doing so he also builds on a base of past national activism with Mexico the first nation to ratify the Montreal Protocol.

On May 6 Dr. Sergio Reyes Lujan, Mexico's Undersecretary for Ecology; Eileen Claussen, Director of the Atmospheric and Indoor Air Pollution Division of the US Environmental Protection Agency; and Dr. Margaret Kerr, Vice President of Northern Telecom, announced a partnership of their three organizations to develop a program that will eliminate ozone-depleting CFC solvent emissions from Mexico's electronic manufacturing industries. Northern Telecom had already committed to the phaseout of CFC solvents from its global operations by December 1991 — almost a decade earlier than required by the Montreal Protocol. Working with the staff of the US EPA's Global Change Division, Northern Telecom, the leading global supplier of fully digital telecommunications switching systems, will assist the Mexican government and electronics industry in converting electronic manufacturing facilities in Mexico to alternative technologies.

In making environmentalism a hallmark of his administration President Salinas appears to be in tune with growing grass roots sentiment in Mexico. Moreover, now that a vacuum in leadership on global environmental issues has developed following Margaret Thatcher's stepping down as British Prime Minister and a growing focus on short-term economic concerns by current world leaders, President Salinas appears to be staking out Mexico's claim to world leadership on international environmental issues. In

Besides these potential consequences of changes in soil moisture within the U.K., this report, entitled, The Potential Effects of Climate Change in the United Kingdom, also projects potentially large impacts on plants and animals as a result of a rapid shift of climatic zones, outpacing the ability of most tree species to adapt. Many native species of plants and animals are likely to vanish from the U.K. with the largest losses likely within montane communities, salt marsh and coastal communities, confined "island" habitats and wetlands and peatlands.

Another generally adverse impact from climate change would be likely increased vulnerability to coastal flooding. Among the most vulnerable areas to sea level rise, the U.K. Department of Environment sanctioned report projects, are the coasts of East Anglia, Lancashire and the Yorkshire/Lancashire area, the Essex mudflats, the Sussex coastal towns, the Thames estuary, parts of the North Wales Coast, the Clyde/Forth estuaries and Belfast Lough.

A warmer U.K. climate would be expected to produce somewhat more mixed results for agricultural and energy use. Yields of cereal crops such as wheat could be expected to decline, but yields of crops such as potatoes and sugar beets might rise. Some agricultural and forest pests might spread northward to the U.K.

Meanwhile, the anticipated warmer temperatures would facilitate the introduction of new tree species and crops. Maize and sunflower might be grown for their seed/grain yield as well as for fodder over much of the U.K. if temperatures were to increase 1.0 to 1.5 degrees C.

Total U.K. energy demand is likely to fall as a result of climate change. Spare heating demand could be expected to decrease substantially, but increased air conditioning demand would be likely to increase electricity demand.

The new U.K. report is available for 18.50 net from HMSO Publications Centre, P.O. Box 276, London, SW8 5DT.
Information on Ordering IPCC Working Group Reports

1. CLIMATE CHANGE
The IPCC Scientific Assessment

Report prepared for IPCC by Working Group I

Edited by J. T. Houghton, G.J. Jenkins and J. J. Ephraums (Meteorological Office, Bracknell, United Kingdom)
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2. CLIMATE CHANGE
The IPCC Impacts Assessment

Report prepared for IPCC by Working Group II

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Report prepared for IPCC by Working Group III

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Climate Change in Australia Would Bring Heat and Extreme Rainstorms

Australia would be warmer, especially in the interior, and extreme rainfall events would probably be more common, according to a study by Barrie Pittock, "Developing Regional Climate Change Scenarios: An Australian Approach." The paper was presented at the "International Conference on Climatic Impacts on the Environment and Society" at Tsukuba, Japan, January 27-February 1, 1991. Dr. Pittock is a member of the Climate Impact Group, CSIRO Division of Atmospheric Research, in Mordialloc, Australia.

Pittock reports that in a doubling of CO2, the average surface warming of the Australian continent would be 4.0 degrees C, according to CSIRO4 model, close to the average of other GCMs. Pittock experimented with regional climate change conditions under most of the major General Circulation Models (GCMs) for a number of variables and found that for his purposes the CSIRO4 was "marginally better." Warnings would occur in both January (summer) and July (winter) of about 2 to 3 degrees C in northern coastal areas, 3 to 4 degrees C in southern coastal areas, and 4 to 5 degrees inland.

The southwest of Western Australia is likely to be drier under enhanced greenhouse conditions and the northern and eastern parts of the continent likely to be wetter. This tends to conform with paleoepoch data from the Holocene Maximum.

Because climatic impact is determined more by the magnitude and frequency of extreme events than by changes in average conditions, Pittock examined the sensitivity of the frequency of temperature extremes to assumed increases, based on climate station observed data. Assuming a uniform daily increase of 1, 2 or 3 degrees C, there is a dramatic decrease in the estimated frequency of frosts in the eastern highlands of the State of Victoria. The implications for the management of hydro-electric and water supply projects, and the skiing industry, are serious.

For some crops in horticulturally important areas in three Australian States, a minimum accumulated winter chill of 700 chilling units is required. Study results indicate that in some agriculturally marginal areas of Australia the viability of some present crops would be threatened by even a 1 or 2 degree C increase in mean temperature.

According to Pittock, there are good reasons for believing that high rainfall events will become more frequent with global warming, regardless of local changes in average rainfall. Records are not yet complete enough to make reliable estimates, but under doubled CO2 in a preliminary analysis, the percentage increase in the frequency of high rainfall events is large with serious implications for flood frequencies and soil erosion.