Modeling extreme weather

Our Ever Warmer World

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With more global warming imminent, the MICE project is trying to peer into the future of the Earth's climate and tell just what it holds for Europeans

The ongoing process of global warming, attributable to a large extent to the enhanced greenhouse effect caused by increased burning of fossil fuels and land-use change, has had, and will increasingly have, a substantial impact on natural systems and on human activities. Changes have been occurring both in mean values and in the extremes of the variables examined, but the latter are more difficult to study and are hence less well understood. Extreme events are greatly underrepresented in both observations and in modeling work. Such extremes are of interest, however, due to their potentially serious impact.

The importance of extremes (such as floods, droughts, gale winds and heat waves) has recently gained greater recognition, following the occurrence of numerous destructive climate-related events. The floods in Central and Eastern Europe in 1997, 2001 and 2002 caused numerous fatalities and wrought material damage amounting to several billion euros. The catastrophic forest damage seen in Scandinavia in recent decades has been indisputably weather-related. The heat wave in Southern Europe in summer 2003, accompanied by low precipitation, led to extensive wildfires, crop failures and water supply and energy problems. Over 12,000 excess deaths were registered

Werner Lahmer

Catastrophic flood in Germany in 2002. The number of intense precipitation events is likely to increase as the climate warms

in France during the record-hot month of August 2003. Excess heat is likely to have considerably, and adversely, affected summer tourism on the Mediterranean coast. A string of winters with less reliable snow cover has jeopardized the economy of some ski resorts located at lower altitudes.

The Polish MICE

The *Modelling the Impact of Climate Extremes* (MICE) project, encompassed under the 5th Framework Programme of the European Union and carried out in 2002-2004, uses information from climate models to examine future changes in climate extremes and their impact across Europe. The three tasks of the Project deal with the occurrence of extremes in climate models. The first involves extracting extremes from model simulation results, and identifying temporal and spatial patterns of extremes. Various types of impact are evaluated in two subsequent tasks, via quantitative modeling and an expert-judgment based approach.

Coordinated by Professor Jean Palutikof from the University of East Anglia, the project is being implemented by a consortium composed of eight research units in eight countries (the UK, Germany, Greece, Italy, Poland, Portugal, Sweden and Switzerland). The Polish partner in this MICE Consortium is the PAN Research Center for Agricultural and Forest Environment in Poznań. The center's principal contributions focus on the issues of temporal and spatial patterns of change and impact analysis, in particular as concerns intense precipitation and floods. Four thematic areas have been considered: the impact of changes in snow cover on winter sports in Alpine regions; the impact of changes in precipitation on the flood hazard in central Europe; the impact of weather extremes on forest damage in Scandinavia, and the impact of temperature extremes on beach holidays in the Mediterranean.

A series of regional workshops are being held for the purposes of interacting with stakeholders and the end-users of information, and in order to determine how they perceive the impact of the changes predicted in weather extremes. Due to a lack of broadly accepted and reliable mathematical models to describe what kind of impact changes in climate extremes will have on different sectors, an expert-judgment based approach was found to be useful. The workshops also serve as a vehicle for disseminating state-of-the-art scientific knowledge.

Ominous rankings

Information on future changes in temperature, precipitation, and wind speed is extracted from the results of climate models. Daily climate model data (produced by the Hadley Centre model simulations) have been provided to MICE by the LINK project, funded by the UK Department of the Environment, Food and Rural Affairs. The observations and models generate a spatial-temporal data field. The Project compares spatial variability for two 30-year windows (1961-1990 vs. 2070-2099).

An analysis of temperature observations reported by the Intergovernmental Panel on Climate Change (IPCC) demonstrates that the 1990s were probably the warmest decade of the second millennium in the Northern Hemisphere. All ten of the globally warmest years in the period since instrumental records began to be kept have occurred since 1990, with the three warmest years being 1998, 2002 and 2003. Projections for the year 2100 anticipate a 1.5-5.4°C increase in the global mean surface temperature, i. e. from two to ten times greater than the average warming already observed over the 20th century. The results of the MICE Project, based on climate model simulations, explain the details of the anticipated changes in extremes and their associated impact.

And this impact is projected to be significant. The average number of hot and dry summertime days is likely to increase in Europe. Increased summer drying may lead to problems related to water quantity and quality, decreased crop yields, greater damage to building foundations caused by ground shrinkage, and increased forest fire risk. Moreover, the number of days with intense precipitation is likely to increase in the warmer world. More intense precipitation events may lead to increased flood, landslide, avalanche and mudslide damage, greater soil erosion, and increased pressure on flood insurance and disaster relief.

It should be noted that future projections of climate extremes involve a great deal of uncertainty. They depend heavily on developmental scenarios (e. g. concerning the emission of greenhouse gases) and numeric climate models, which are but an approximation of natural systems. Projections should thus only be regarded as illustrations of possible futures. Yet, despite the inherent uncertainties, the seriousness of the potential impact and the lack of alternative tools for evaluation justify attempts at predicting changes in climate extremes based on climate model simulations. ■

Further reading:

The homepage of the MICE project: http://www.cru.uea.ac.uk/cru/projects/mice.

Kundzewicz, Z. W., Ulbrich, U., Brücher, T., Leckenbusch, G., Menzel, L., Przymusińska, I., Radziejewski, M., Szwed. M. (2004). *Summer floods in Central Europe - climate change track?* Natural Hazards (Special Issue on "Flooding in Europe: Risks and Challenges") (in press).