Executive publishable summary, related to reporting period Jan to Dec 2002

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Title	Modelling the Impact of Climate Extremes		

Objectives: To evaluate the ability of global climate models to successfully reproduce the occurrence of extremes at spatial and temporal scales appropriate for impact analysis, by comparison with observations (station and gridded).

To analyse climate model output with respect to future changes in the occurrence of extremes. Statistical analyses will determine changes in (a) return periods of extremes, (b) joint probabilities of extremes (combinations of damaging events such as windstorm followed by heavy rain), (c) sequential behaviour of extremes (whether events are well-separated or clustered) and (d) spatial patterns of extreme event occurrence across Europe. The range of uncertainty in model predictions will be explored by analysing changes in model experiments with different spatial resolutions and forcing scenarios.

To determine the impacts of the predicted changes in extremes on selected activity sectors. For some activities, good quantitative impacts models exist and will be utilized (e.g., forest fire and windthrow models). For others, such as energy use and agriculture, the relationships with climate are well understood, and models exist, but may have to be adapted for the particular case of extremes. For categories such as tourism, models exist only for the physical part of the system, e.g., modelling snow depth, such that in addition an expert-judgement-based approach will be adopted.

Scientific achievements: The first year of the project has concentrated primarily on two areas of activity:

1. Organizing the climate model data into a form suitable for the planned analyses within MICE (WP1)
2. Performing the analyses on extremes drawn from the climate model data. This has involved two work packages:
    a. WP2 is concerned with tracking changes in extreme event occurrence over time.
    b. WP3 is concerned with spatial patterns of extremes, and their changes due to anthropogenic warming. This includes an analysis of storm tracks.

Both external and internal Web pages have been set up for MICE, and can be accessed at http://www.cru.uea.ac.uk/projects/mice/. Within the MICE web page an extremes resource has been created – the 'MICE Gateway to climate extremes', which contains links to references, conferences and software on extremes. This records an average of 50 hits per week.

Climate model data. MICE has successfully constructed an archive from Hadley Centre climate model data supplied by the Link project. These data are taken from the HadCM3, HadRM3 and HadAM3 simulations for the A2 and B2 SRES emissions scenarios, and a limited dataset from the A1FI scenario. MICE is acting as a data provider to the EU-funded STARDEX and SWURVE projects for the HadAM3 datasets. As a project deliverable, we then specified the extremes to be studied in MICE. These consist of three different types:

i. Diagnostic measures, e.g., the number of days per year above the 95th percentile of temperature, where the percentile value is calculated from 1961-90 data.
ii. Impact-related measures, related for example to sectors such as agriculture (e.g. date of the first autumn frost), energy supply/demand (based on degree days) and flood (e.g. greatest 3-day precipitation total per year).
iii. Indices for the calculation of extreme value parameters based on distributions such as the Generalized Extreme Value distribution, e.g., the highest and lowest temperature values in each year, the highest daily rainfall amount in each year.

MICE partners have archived for group use the following types of variables for grid squares in the MICE domain:

- Exceedances of percentile and absolute thresholds of temperature, rainfall and wind speed.
- Highest and lowest daily values occurring in each year

Other variables, for example long runs of high rainfall days, are being processed.

Validation of extreme events and their changes over time.

(a) Validation

This has concentrated on the global model simulations until now, and has taken two forms:

(i) comparison by groups between climate model data and observations (either point station data or gridded reanalyses) for their region. For example, comparison of modelled extremes with station observations for sites in Greece reveals adequate agreement, although the land box in the GCM is excessively continental in character, whereas the sea box is too mild. A comparison of NCEP with station data for Greece revealed relatively poor agreement between temperature and rainfall extremes. In Sweden, statistically significant differences between observed and modelled (HadRM3) temperatures are found. A major challenge in MICE will be to bring these different regional validations together in a coherent manner.

(ii) in addition, some European-wide evaluations have been undertaken. Comparison of indices of extremes in NCEP and HadCM3 has been performed. For example, an analysis of annual extremes of temperature has shown that the shape and scale parameters of annual maxima (GEV distribution) are similar but position parameters for HadCM3 are around double those of NCEP. Significance testing has focussed on the Cramér-von Mises and Anderson-Darling tests as most suitable for working with extremes.

(b) Changes in extremes.

European maps are being generated of changes in extremes over time. These will be displayed on the MICE web site in a visualization framework, which will allow visitors to the site to see the development of changes in extremes over time.

Local studies on changes in extremes are beginning to emerge from MICE. For example, precipitation extremes in Sweden show a tendency towards longer summer droughts and more intense high precipitation events.

Spatial variability of extremes, and changes due to anthropogenic warming.

(a) Work has concentrated on Principal Components Analysis and Canonical Correlation Analysis of daily minimum temperatures over Europe. There is strong similarity between present-day patterns of the observed and modelled EOFs for both winter and summer. In winter, the leading coupled pattern of the minimum temperature field is no more than a response to the NAO. Spatial canonical patterns do not undergo strong changes in the future period (2070-99) although, for some coupled modes, intensification and eastward displacement of their 'centres-of-action" over the North Atlantic is apparent.

(b) Using a modified Murray and Simmonds algorithm, cyclone tracks have been identified and analysed in the HadCM3 IS95a experiment for 1961-90 and 2070-99. Validation has been performed against the NCEP reanalyses, and although this shows similar patterns of tracks, the density of storms is found to be much lower in HadCM3. HadCM3 shows a small decrease in track density in the future period (in contrast to ECHAM4 which shows a noticeable increase). There is a clear increase in storm intensity, with deeper cyclone centres being recorded. Hence, HadCM3 indicates a future climate with fewer but deeper storms over western Europe. Analyses of surface wind speeds are being performed. These are shown to be too low in HadCM3 over land. A shift to more extreme events is found for some areas for the modelled 2070-99 period. A study of HadRM3 output confirms these results.

Socio-economic relevance and policy implications:

It is anticipated that the MICE results, to be disseminated through Work Package 6, will be of substantial socio-economic relevance to end users and policy makers. The dissemination activities aimed at this audience are through the web page (on-going) and through a series of four local and one European-wide workshop to take place in Years 2 and 3.

Conclusions:

MICE has successfully completed its first year. All deliverables due by the end of December 2002 have been completed. A firm foundation has been laid for the activities to be performed in the second year. The next few months will be critical, as we work to produce drafts of papers for publication in the peer-reviewed literature, focussed on the results of the statistical analyses of climate extremes as simulated by the climate models.

Keywords: Climate change Extremes Modelled climates Impacts