Development of high-resolution weather scenarios for the EPSRC/UKCIP Building Knowledge for a Changing Climate (BKCC) initiative

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Aims and objectives
The principle aims and objectives of this project are:

- to provide high spatial/temporal resolution state-of-art climate scenarios for selected case-study locations as a common service to projects funded under the EPSRC/UKCIP BKCC initiative; and,
- to provide continuing support and advice to the users of these scenarios.

Background and methodological approaches
The EPSRC/UKCIP BKCC initiative is primarily aimed at impact assessment and end user strategy rather than scenario provision. It is, however, clear that the overall success of the initiative depends to a large degree on the quality and consistency of the climate scenarios used. Thus this project will act as a service to the other EPSRC-funded projects in the initiative and develop best practice in the application of climate change scenarios. At the end of the project, the new data generated will be made more widely available.

The starting point for scenario construction is the four generic IPCC SRES emissions scenarios and the UKCIP02 scenarios which are the most recent, detailed and reliable scenarios for the UK. Thus, the main (but not the only) source of climate model output will be the HadRM3 simulations carried out by the Hadley Centre. These simulations, however, have a number of disadvantages with respect to the BKCC initiative:

1) they were run for 1961-1990 and 2071-2100 only, whereas many stakeholders require information for intermediate periods (e.g., the 2020s and 2050s), and longer trend-free time series are required for the estimation of many extreme events, such as 50-year return period events;
2) output is only available at the daily timescale, not sub-daily;
3) the spatial resolution of 50 km x 50 km is still coarser than required for some applications and some degree of averaging occurs in the model parameterisation so that further downscaling, to obtain point rainfall, for example, is required;
4) some features of present-day climate, particularly with respect to extreme events such as wind gust speed, high temperatures and extreme rainfall, are poorly represented;
5) a limited number of emissions scenarios are represented, few ensemble runs are available and the use of a single model all mean that the full range of uncertainty cannot be quantified; and,
6) urbanized portions of the land surface are neglected, thus ignoring potential changes in the urban heat island effect and the impacts of additional heat sources in cities.

A number of different approaches could be used to address these disadvantages. The most appropriate with respect to points 1 to 5, given the need for (a) self-consistent scenarios for a number of variables, and (b) sub-hourly precipitation scenarios, in the form of mean changes, time series and probability distributions in both cases, involve:

- two (i.e., daily and hourly) weather generators (WG) available in CRU (Tasks 1 to 5); and,
- the development and application of the Generalised Neyman-Scott Rectangular Pulses (GNSRP) model for the construction of specialised rainfall scenarios by WRSRL (Tasks 6 to 11).

Point 6 will be addressed by the Hadley Centre using a new representation of urban areas in General Circulation Model simulations of climate change (Task 12). Task 13 involves dissemination of the scenarios developed by Tasks 1 to 12 to the successful projects, together with the organisation of two project workshops and provision of ongoing support and advice in the use of climate scenarios.

Detailed and sector-specific analyses of the scenarios will be carried out in other projects in the BKCC initiative. As part of the CRANIUM project on risk and uncertainty, for example, CRU and WRSRL will carry out novel and detailed analyses of extreme events, including joint probability events.

Project tasks

Tasks 1-5: CRU weather generators and work on storm-track changes

Task 1: Modification and updating of the daily WG focusing on the development of generic, user-friendly, efficient subroutines for perturbing the parameters in climate change studies.

Task 2: Development of methodologies for perturbing the WG parameters based on the UKCIP02 scenarios and to quantify some of the uncertainties relating to emissions scenarios and inter-/intra-model variability.

Task 3: Improvements to the daily WG, focusing on secondary variables such as vapour pressure/relative humidity, sunshine and wind.

Task 4: Development of the hourly WG.

Task 5: Development of wind scenarios based on storm-track changes.

Tasks 6-11: WRSRL specialised rainfall scenarios

Task 6: Set up the GNSRP model for the whole UK using the MetOffice/UKCIP 5 km climatology. This will allow long rainfall series to be generated for any site in the UK.

Task 7: Parameterise the GNSRP model to match observed 1961-1990 return periods (e.g., 10 or 25 year annual maxima) for daily rainfall.

Task 8: Parameterise the GNSRP model for the whole UK for future climates, also at 5 km, incorporating trend analysis and regional frequency analysis of HadRM3 from the SWURVE project.

Task 9: Reparameterise and validate the GNSRP model for hourly and 15 minute rainfall consistent with daily totals (present/future) using observed sub-daily time series and statistics.

Task 10: Interface from GNSRP model to CRU daily WG.

Task 11: Extend model to allow for changing proportion of convective/frontal rainfall in future climate (e.g., from HadRM3), i.e., allowing for increased variance, more intense rainfall etc., using 'storm type' parameter sets as has been done previously for a hierarchical model based on 'weather types'.

Task 12: Development of scenarios of climate change in urban areas (Hadley Centre for Climate Prediction and Research)

This work will allow investigation of (a) the Urban Heat Island (UHI) effect at the present day, (b) the importance of changes to the UHI effect, and whether climate change impacts assessments have over- or under-estimated the potential effects of climate change in the urban environment, and (c) the importance of urban heat sources in the current climate and how this might change in a future world.

Task 13: Workshops, dissemination and ongoing support/advice in the use of climate scenarios

Project deliverables

- D1 and D2 from CRU: Daily and hourly time series of precipitation, min/max temperature, vapour pressure/relative humidity, sunshine duration, wind speed and PET for up to 8 case-study locations.

- WRSRL deliverables - D1: Example of model output. D3: Software package to run the GNSRP model for any given UK location (at a 5 km resolution) in order to produce precipitation scenario time series at daily, hourly or 15 minute time resolution and of any length (e.g., 10, 1000, 10,000 years) for the present-day and the future.

- Hadley Centre deliverable D4: A report describing the analysis of changes to urban and rural temperatures and extremes, and humidity.

- All groups will contribute to D5: Technical briefing notes on issues such as the models used and underlying assumptions, uncertainties and confidence limits, and guide to good practice in scenario use.

All project deliverables will be made available *via* the project web site as follows:

D1:	June/December 2003
D2/D3/D4:	April 2004
D5:	December 2003 and April 2004