Simulation tools for space-time rainfall with climate change scenarios

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York, October 2000 (Yorkshire Post) and Sussex, August 2005 (Daily Mail)

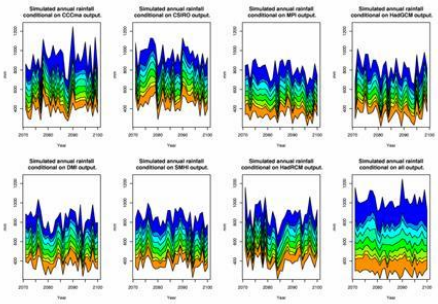
Main aims

To provide tools to generate realistic artificial rainfall sequences suitable for use in, e.g., flood risk assessment and climate change impacts studies. Sequences should:

- Reproduce features of real rainfall sequences
- Represent spatial and temporal variability realistically, including effects of climate change, at scales of interest
- Have high space-time resolution (in some applications)

Motivation

- Rainfall is main input to many hydrological processes
- System response is often sensitive to detailed spatial and temporal structure of rainfall
- Therefore useful to simulate rainfall over extended time periods
- Also often necessary to account for future climate change
- Ideally use numerical climate models (GCMs & RCMs) for this, but:
  - Climate model spatial resolution is too coarse for many hydrological applications – need to **downscale**
  - Climate models are better at representing some climatic variables (e.g. temperature) than they are others (e.g. rainfall)
  - Future projections can vary substantially between climate models – need to account for climate model uncertainty:



Simulated annual rainfall distributions at Heathrow, 2071-2000. Top row conditioned on output from four different GCMS; first three plots in bottom row are conditioned on output from three different RCMs; and final plot merges the other distributions.

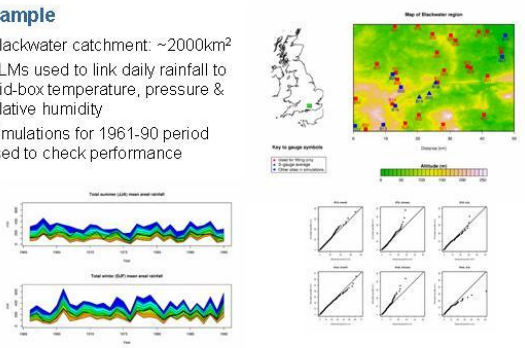
The workhorse – GLIMCLIM

At the centre of the toolkit is the GLIMCLIM software package for generation of daily rainfall sequences at single or multiple sites:

- Takes advantage of relative abundance of daily rain-gauge data
- Allows for spatial and temporal nonstationarities in rainfall sequences.
- Based on **Generalised Linear Models (GLMs)** – probability distributions linked to spatially and temporally varying predictors representing, e.g., seasonality, autocorrelation, regional variability & climatic drivers
- Probability of rainfall occurrence modelled separately from wet day amounts

Example

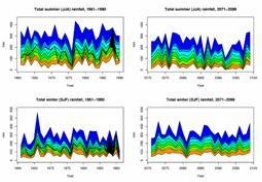
- Blackwater catchment: ~2000km²
- GLMs used to link daily rainfall to grid-box temperature, pressure & relative humidity
- Simulations for 1961-90 period used to check performance



Left: simulated distributions of seasonal rainfall totals (10-site average, 1961-90), with observed values in black. Right: simulated vs observed distributions of wet-day amounts.

Tools (based on Poisson cluster models) are also available for subdaily rainfall generation, conditional on GLIMCLIM output

Future scenarios

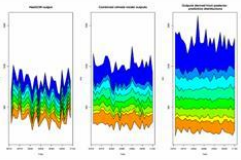


Use climate model outputs to drive GLM simulations:

- Results agree with other studies e.g. wetter winters and drier summers in SE
- *Example: Heathrow, future scenarios driven by HadCM3*

GCM uncertainty handled in hierarchical model (not part of GLIMCLIM):

- Acknowledges potential for other GCMs to yield more extreme projections
- *Example: Heathrow future annual rainfall distributions using HadCM3, all available GCMs and hierarchical model*



Find out more...

Links, reports and software available from web page for DEFRA project FD2113 *Spatial-temporal rainfall modelling with climate change scenarios:*
http://www.ucl.ac.uk/Stats/research/Rainfall/index.html

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