Building Knowledge for a Changing Climate

Specialist rainfall scenarios and software package

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- **Requirements for rainfall scenarios**
- **The RainClim approach**
  - NSRP model
  - fitting to observed data and extremes
  - disaggregator
  - fitting to future climate data
- **The RainClim package**

Requirements for rainfall series

Time resolution

- hours and minutes, not days

Space resolution

- Specific to sites, not grid boxes

Properties

- realistic amounts, intensities, extremes
- seasonality
- long time series – multiple events

Stochastic rainfall modelling

- To achieve downscaling in time and space
- To generate long series
- To interface with CRU weather generator

Building on:

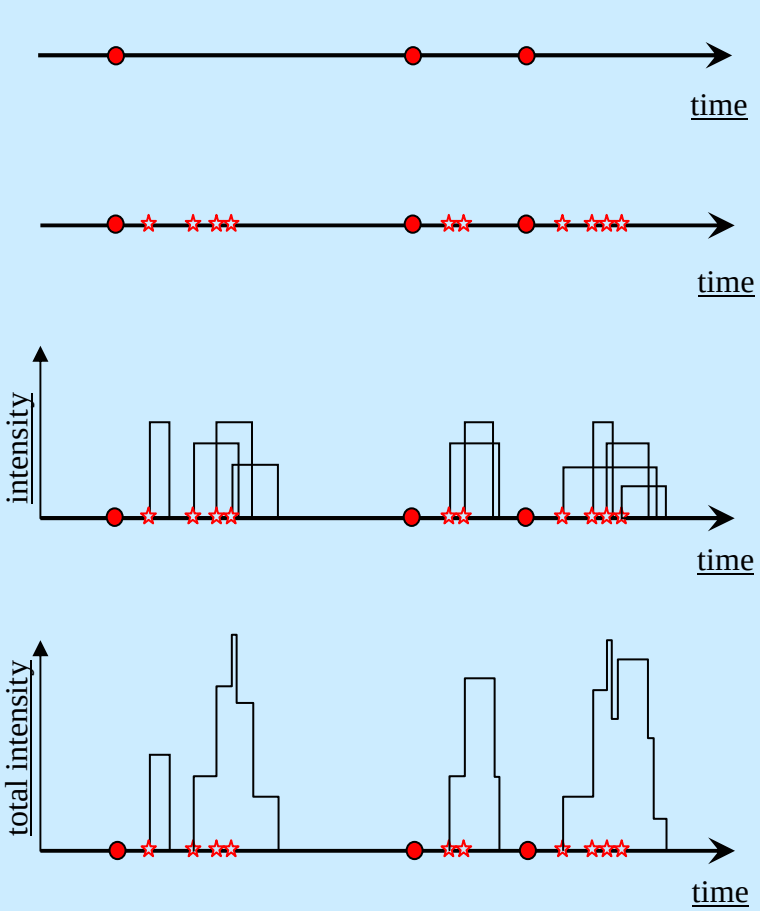
- UKCIP02 scenarios and UKMO climatology
- Consistency with the FEH extremes
- 15 years development at Newcastle
- The StormPac approach

The NSRP model

- A stochastic rainfall modelling system
- Neyman-Scott Rectangular Pulses
- Can generate arbitrarily long series (e.g. 1000 years) of rainfall
- Applied to historic, control and future climates
- Reproduces key statistical properties of rainfall series, e.g. mean, variance, dry hours, 2, 5, 10, 25 year annual maxima);
- Time resolution of 1-day or 1-hour

Rainfall modelling - NSRP

- Storm origins arrive in a Poisson process
- Each origin generates a random number of rain cells
- A rectangular pulse is associated with each rain cell
- The total rainfall at any time is the sum of all active rain cells



Historic case

- Set up the GNSRP model for representative sites in UK
- Parameterise to match observed 1961-1990 rainfall statistics, different parameter set for each calendar month:

  (a) Fit using mean, variance, proportion dry hours, skew etc

  (b) Validate using return period rainfalls - e.g. 2,5,10 or 25 year events using observed data and FEH DDF model

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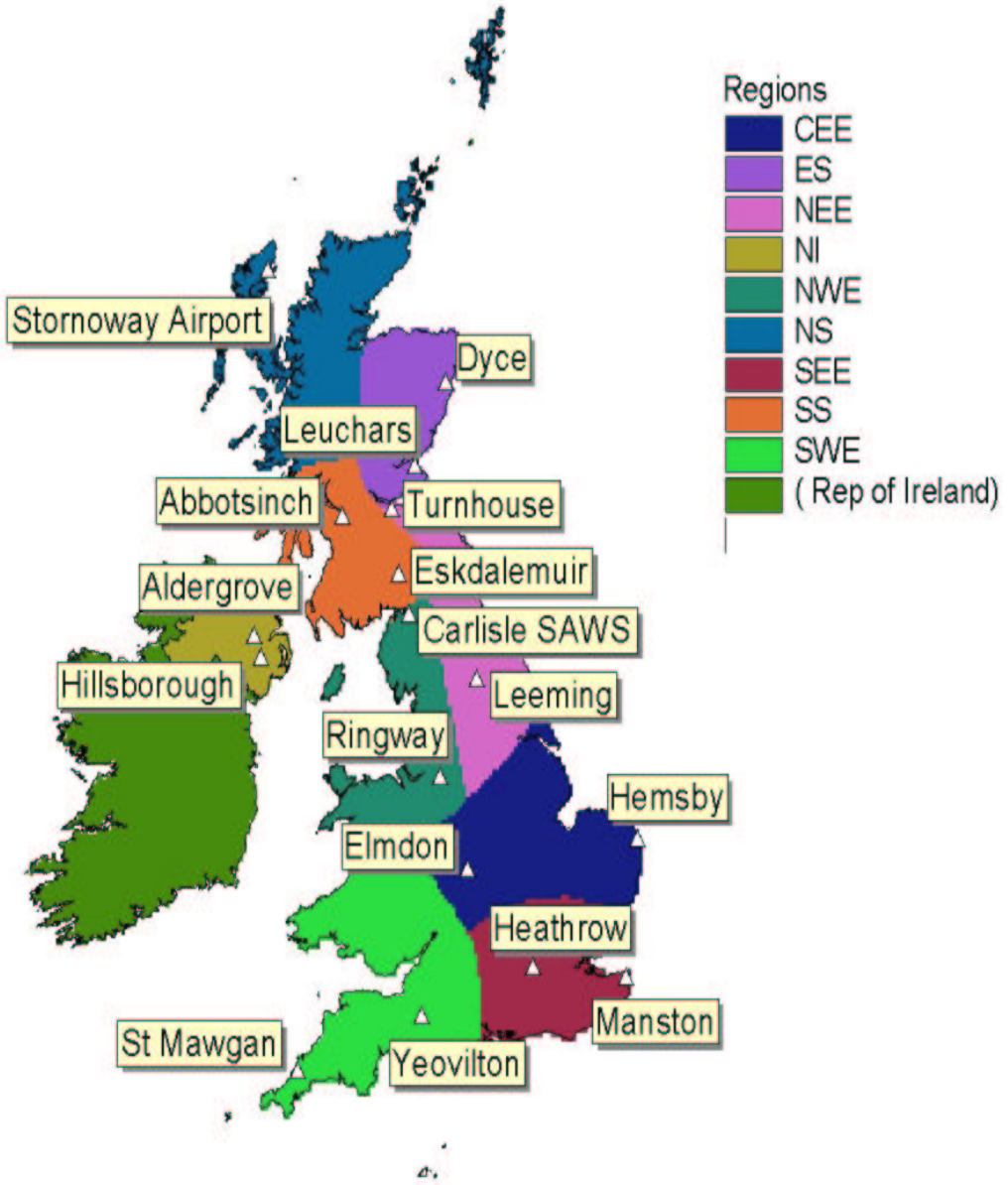
Observed data

Hourly rainfall data

17 sites

in 9 regions



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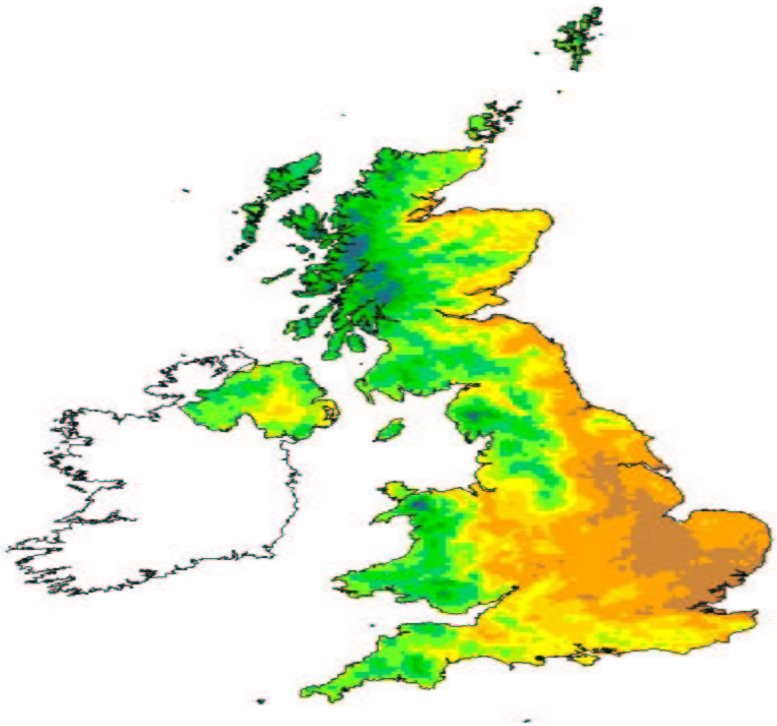
Observed data

Daily rainfall data

- **UK Met Office**
- **5 km grid of daily data**
- **1958-2002**
- **Interpolated from gauges**

+ 204 daily sites records

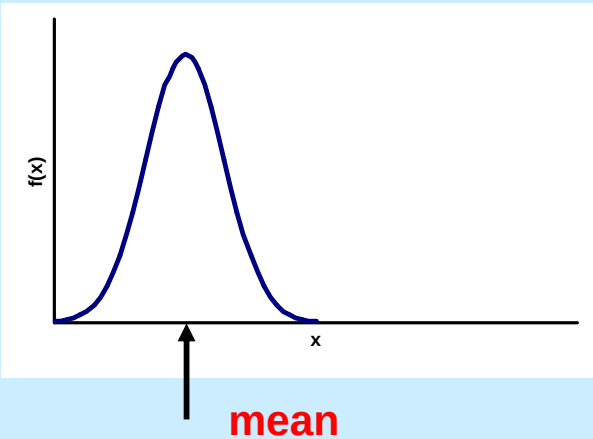


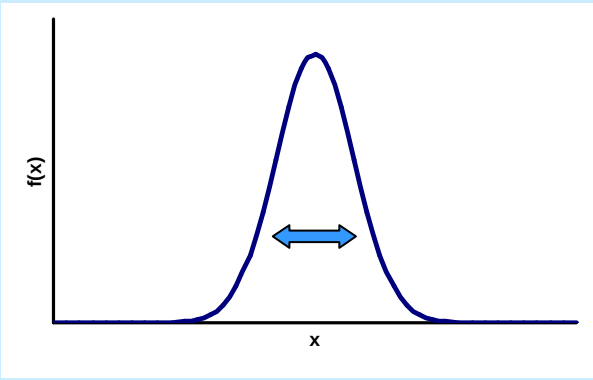
Fitting to observed data

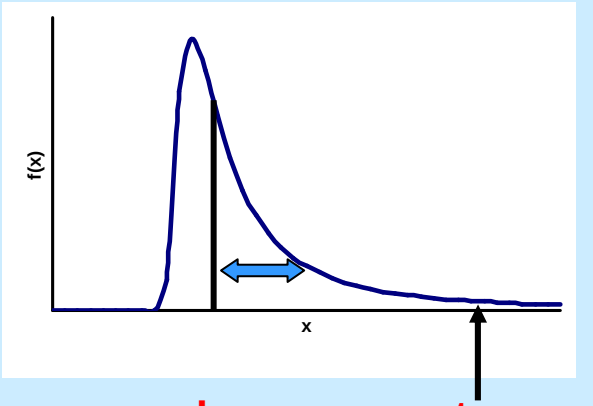
Some trade-off needed between matching extremes and mean:pd:var

- **Good matching of mean, PD, variance, skewness (3rd moment)**
- **Good reproduction of extreme values (annual maxima) using skewness to fit**
- **Good fits at both daily and hourly levels**

Fitting to observed data







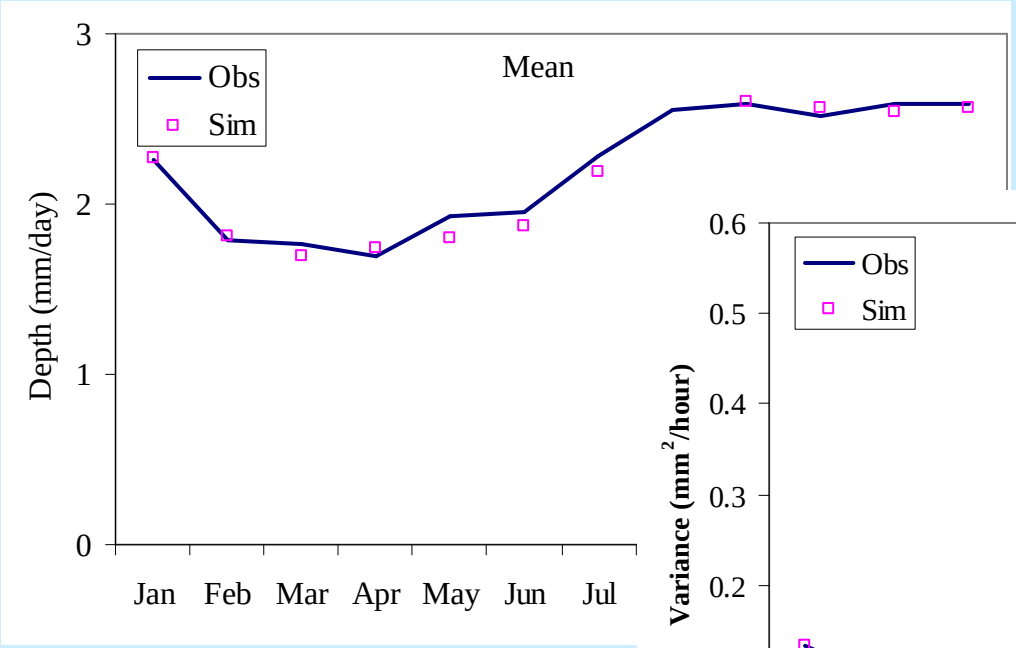
Definition sketches for moments

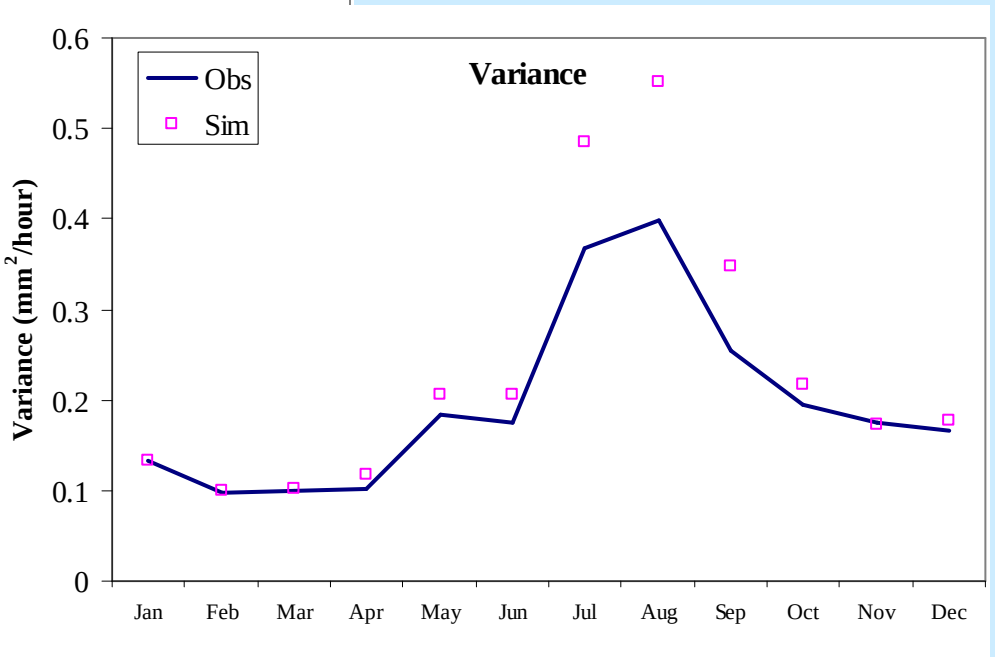
- **mean, variance and skew**

Fitting to observed data

Mean

Variance

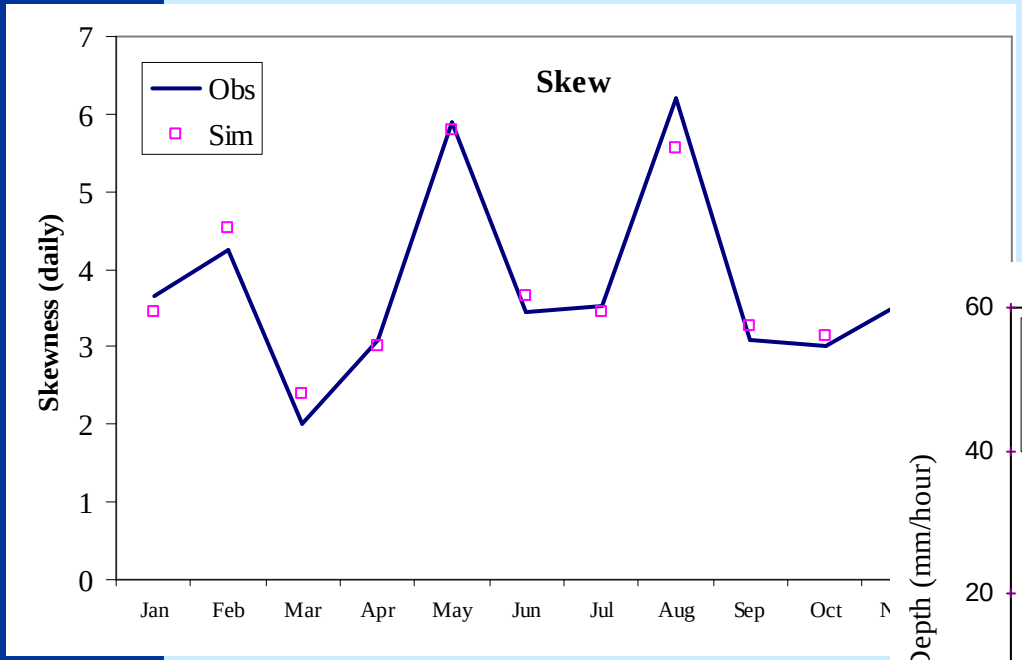




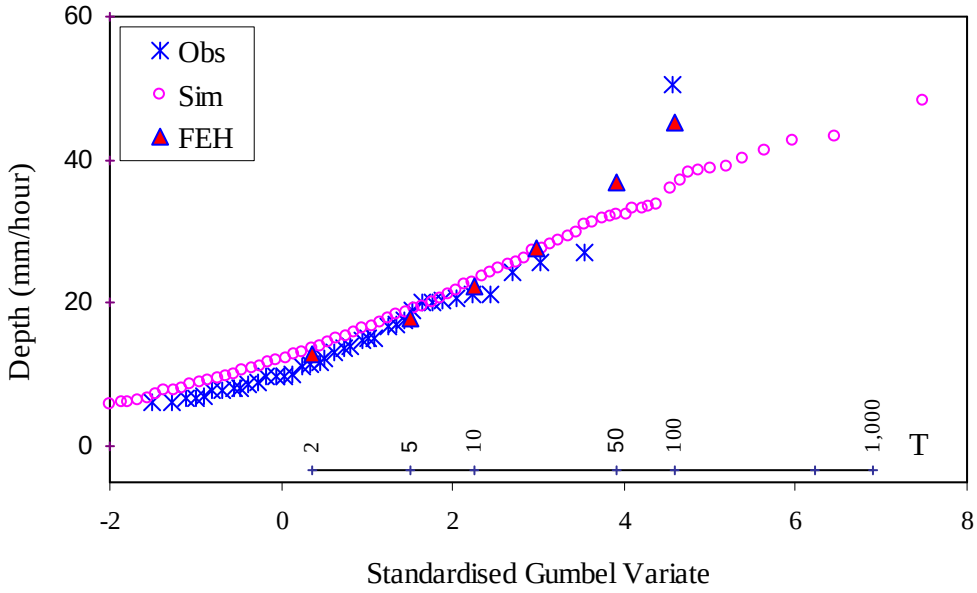
Ringway

Fitting to observed data

Skewness



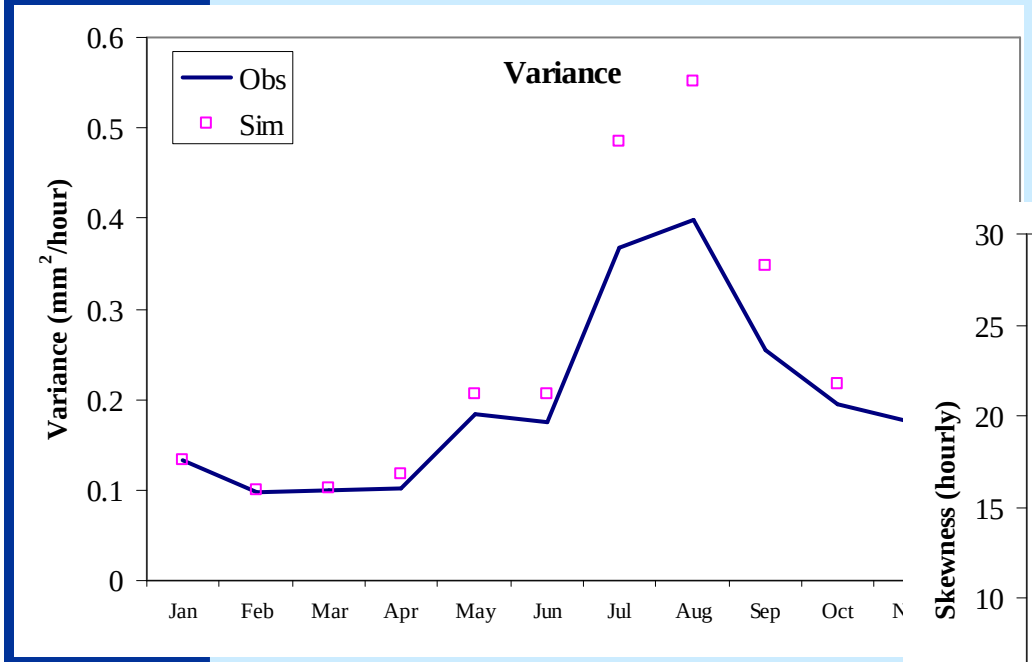
Extremes



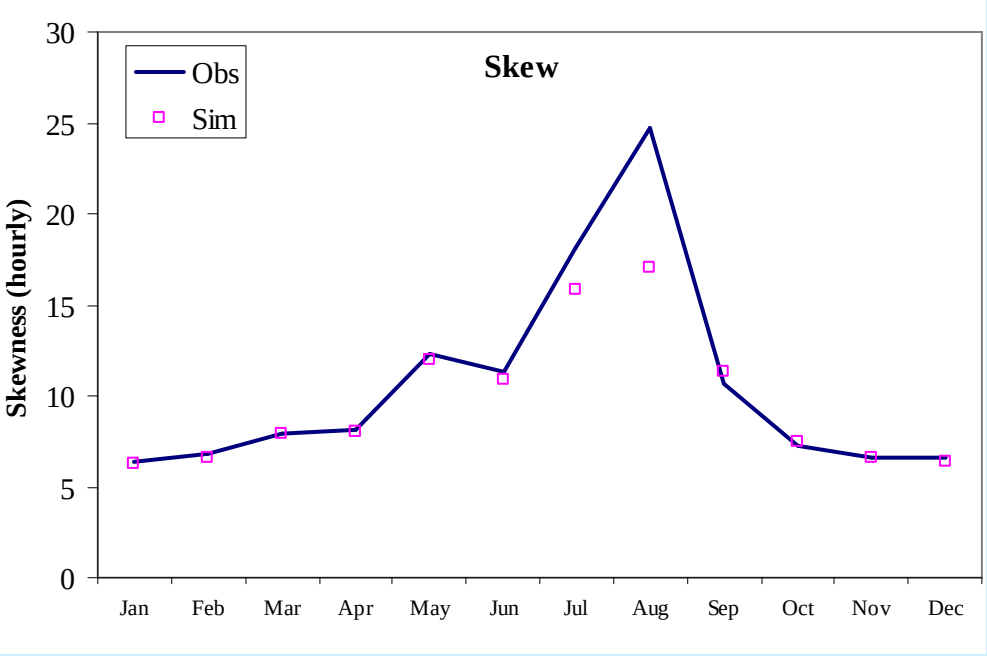
Ringway

Fitting to observed data

Variance - hourly



Skewness – hourly



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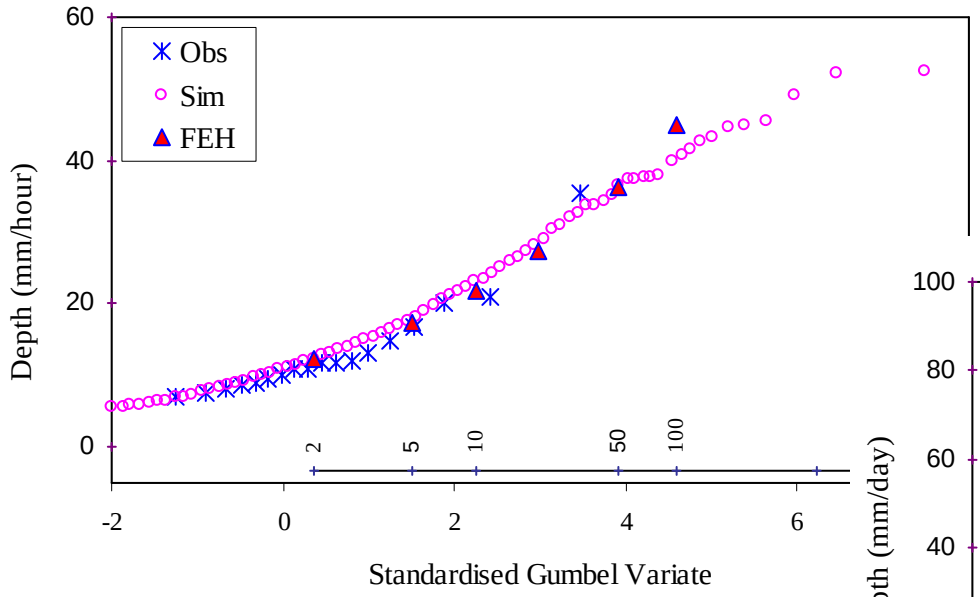
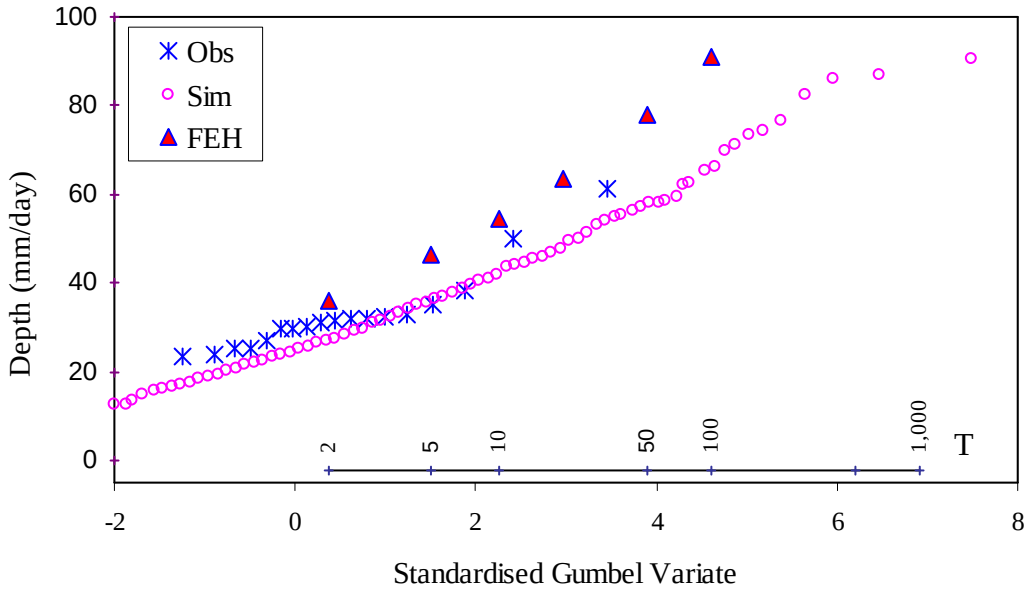
Fitting to observed data

Extremes - hourly



Extremes – daily



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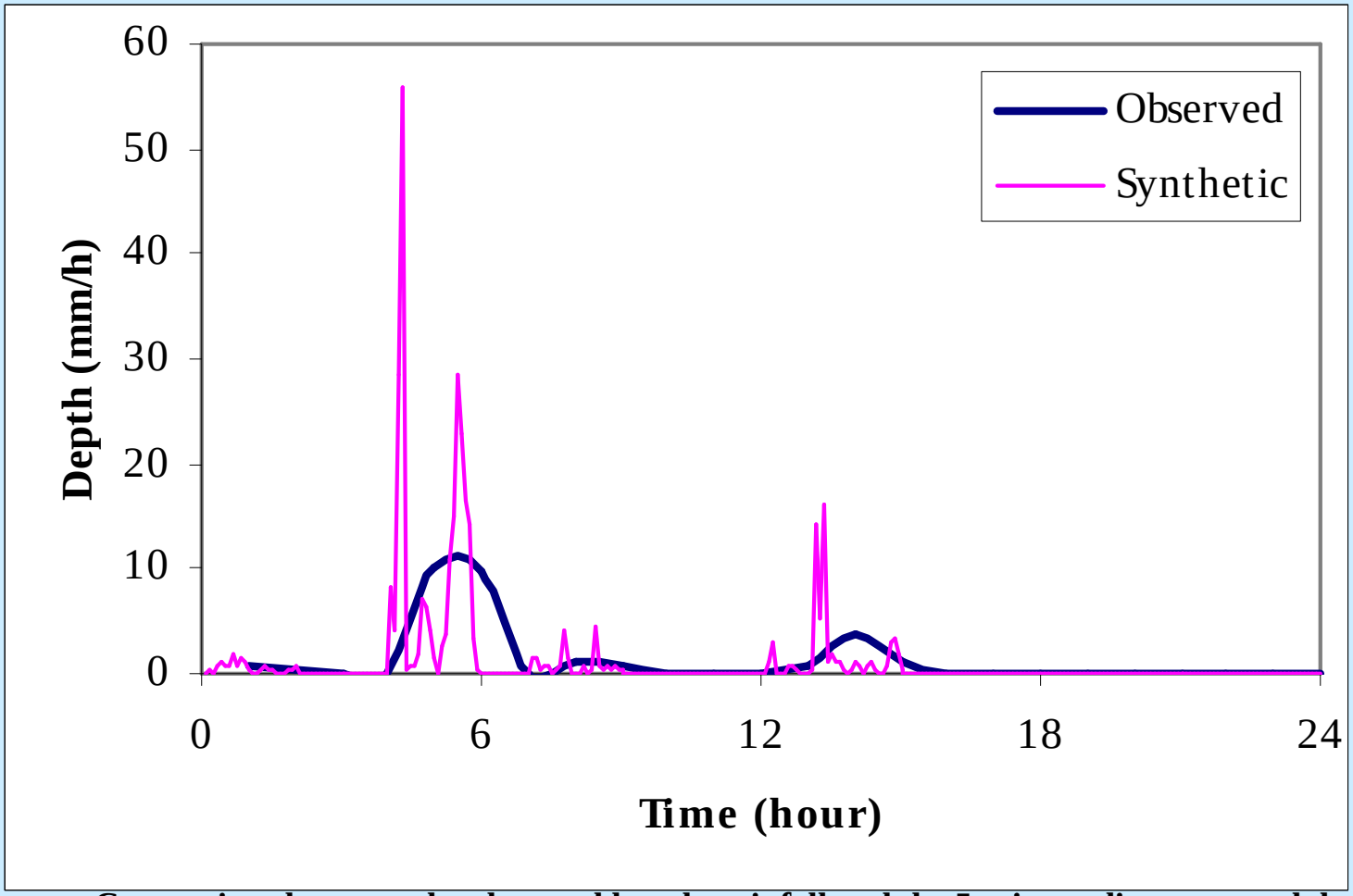
Sub-hourly rainfall

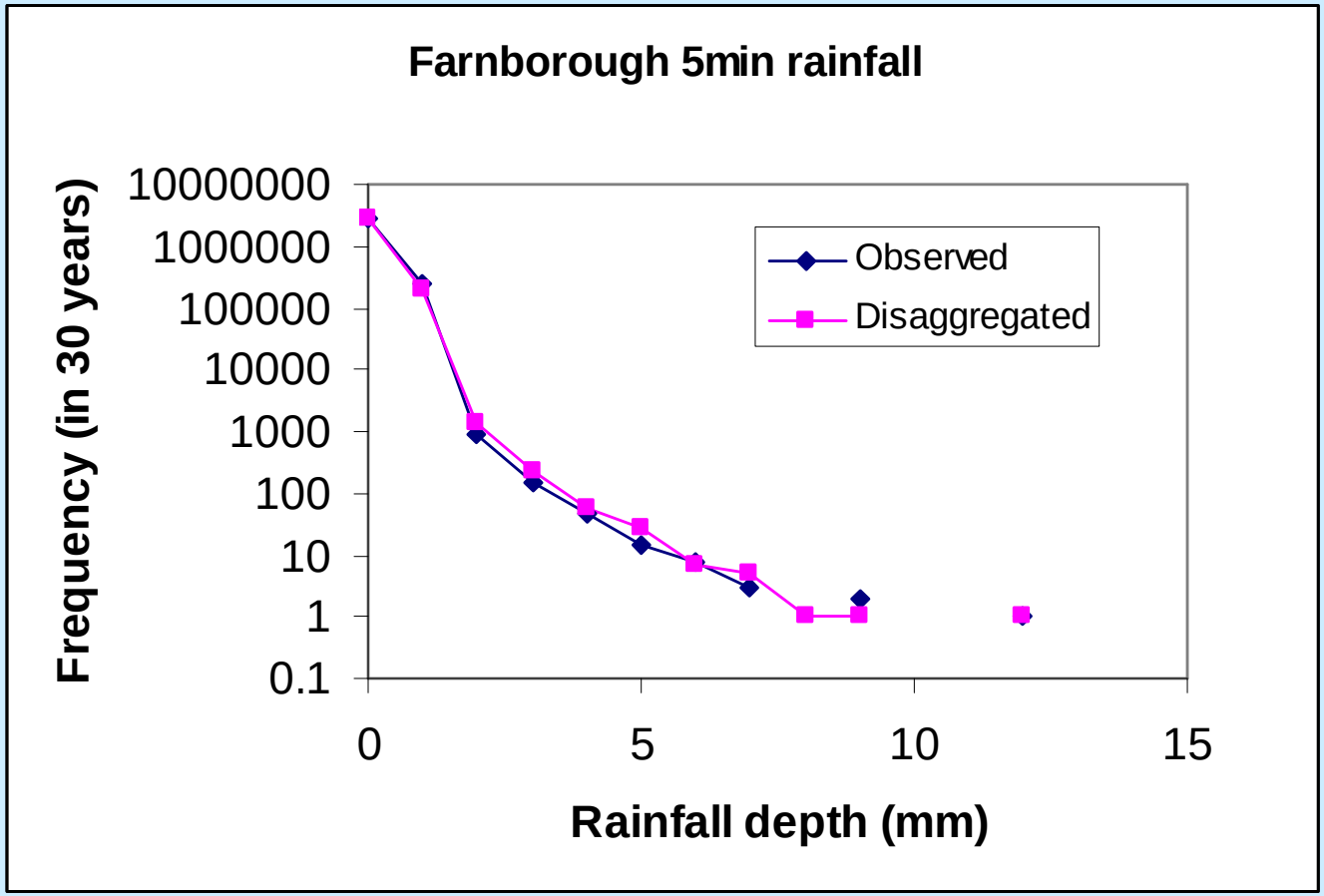
- Requirement for 5, 10, 15-minute rainfall for urban drainage and roof drainage
- Approach is to disaggregate 1-hour data
- Use a separate stochastic Poisson cluster model
- Conserves hourly amounts (microcanonical) unlike other cascade or fractal models
- Previous models (e.g. Ormsbee method used in StormPac) under-estimate intensities
- Calibrated on observed data; validated on 30 year Farnborough data set.

Sub-hourly rainfall



Comparison between the observed hourly rainfall and the 5-minute disaggregated data.

Sub-hourly rainfall



Validation
- Farnborough 5min data aggregated to hourly
- Then disaggregated to 5min.
- Comparison with observed 30 year record shows good agreement.

Method

- perturb the observed rainfall statistics (m, pd, var, skew)
- change factors derived from climate model

Issues

- HadRM3 rainfall statistics not always realistic
- extremes are sensitive to changes in skew
- hourly statistics must be derived from daily for future cases, and are not well conditioned

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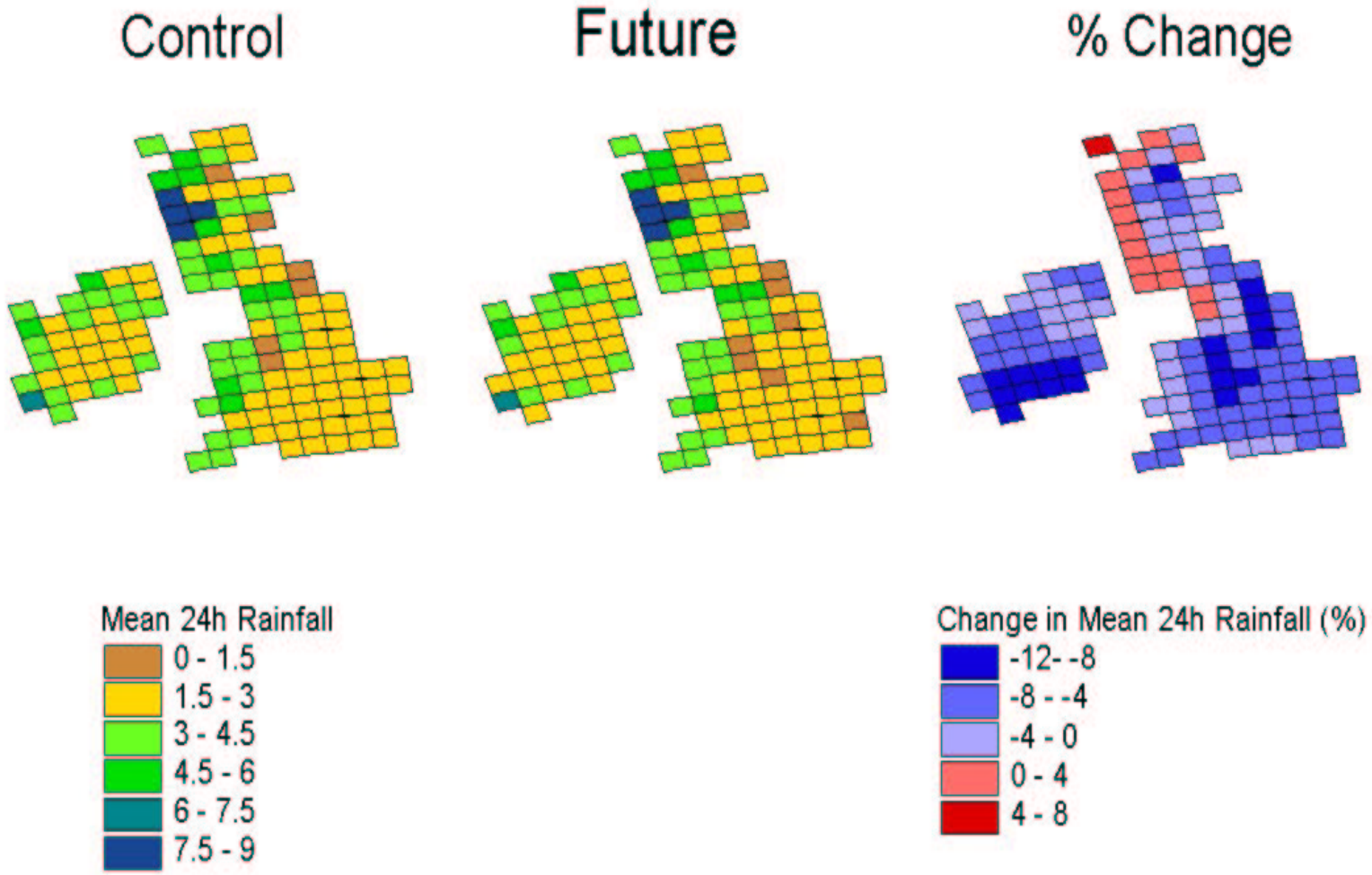
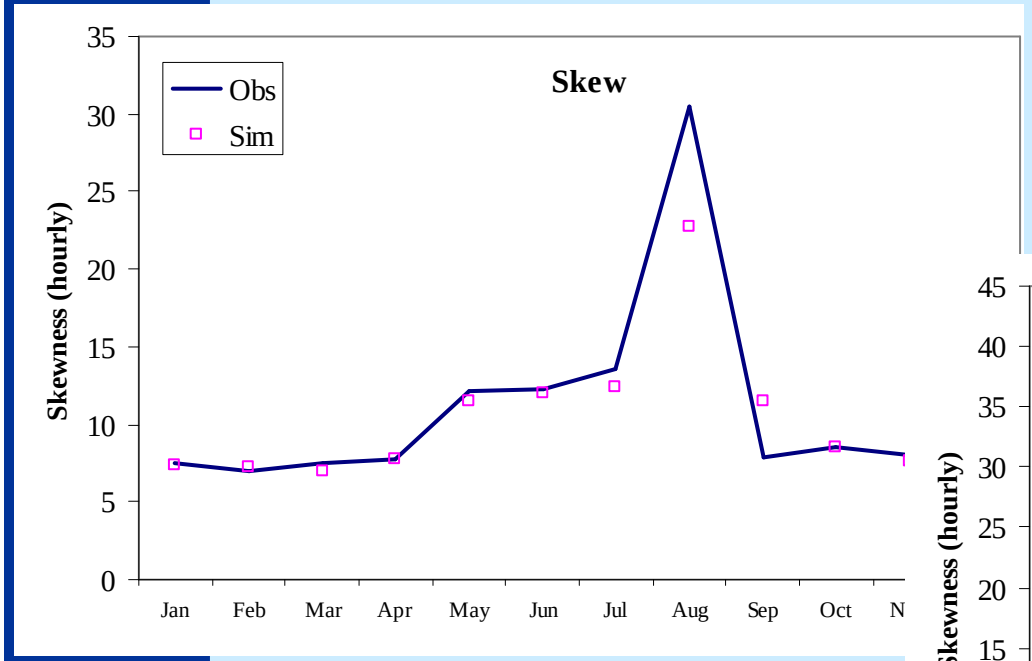
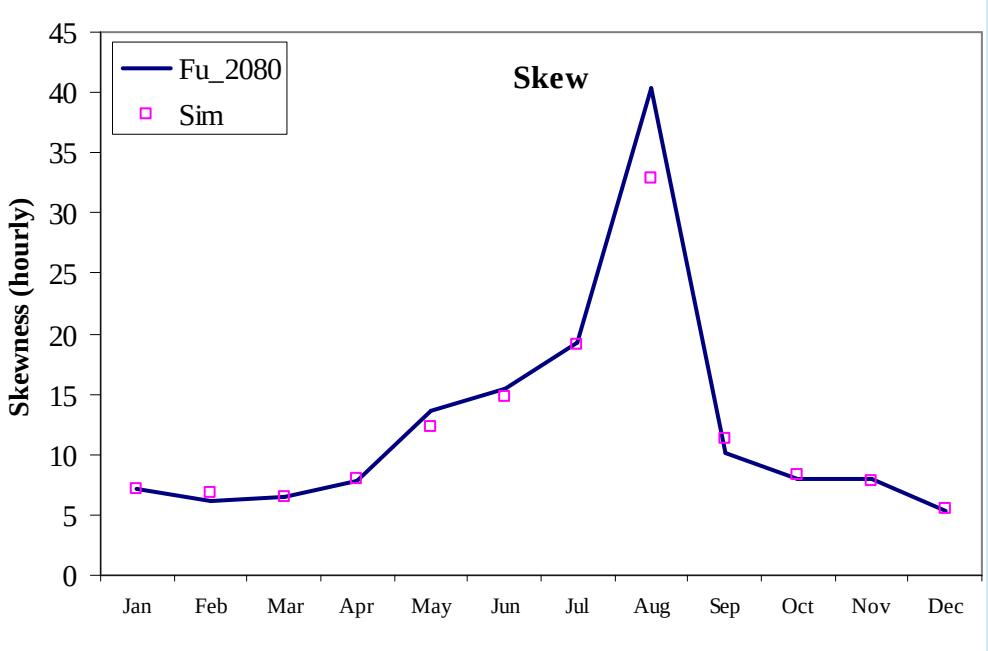
Future climate change factors



Fitting to factored mean, var etc





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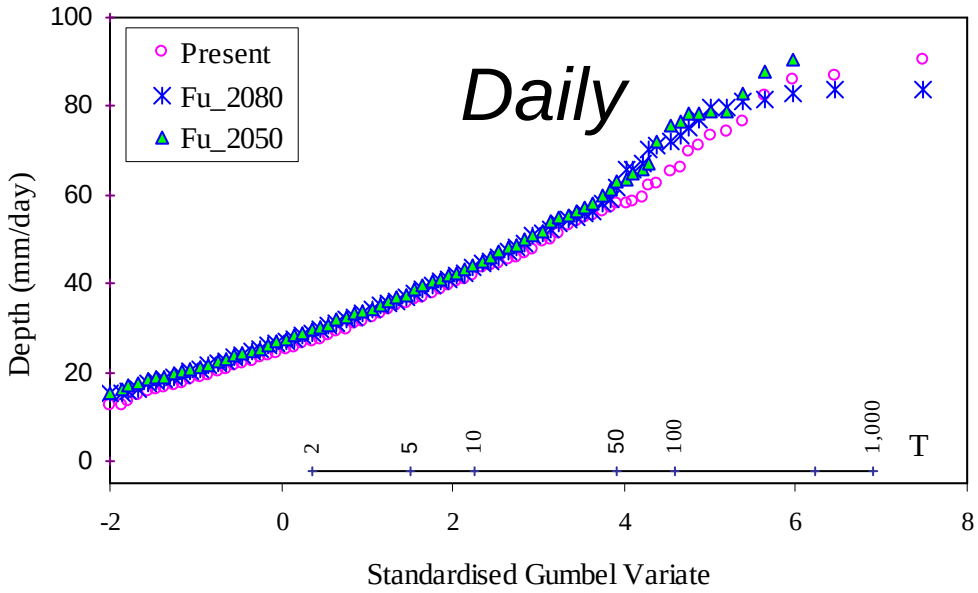
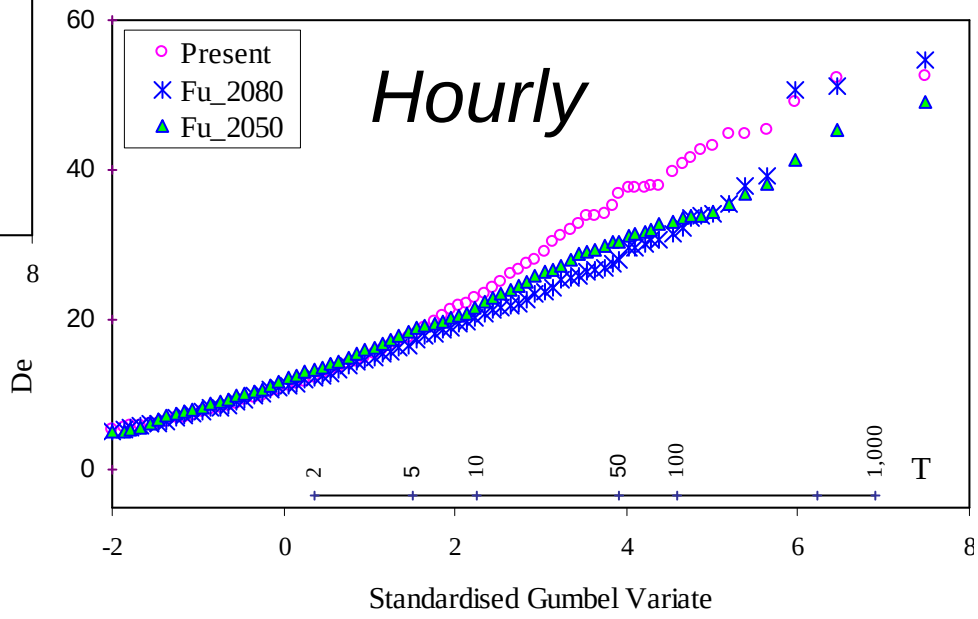
Fitting to factored mean, var etc





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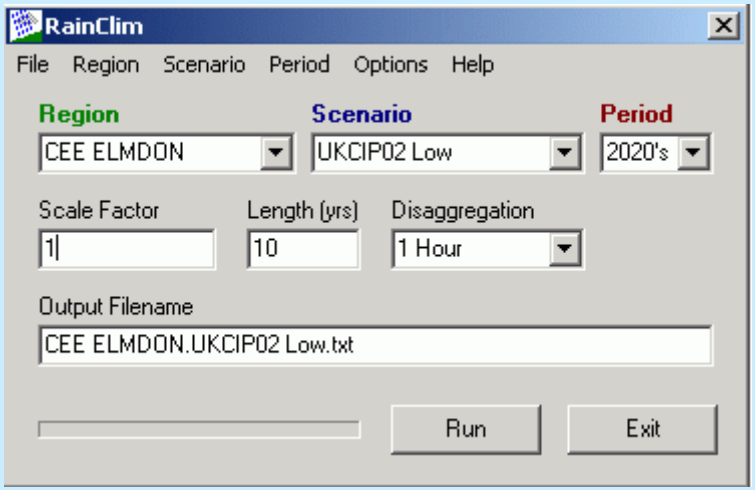
- Package developed for generating rainfall series, combining *NSRP* and *disaggregator* in a *user interface*
- RainClim v1.0 available for download:
  - 17 sites around UK (+scale factors)
  - Hourly and 5-minute series
  - Graphing of time series and means
  - 4 UKCIP02 future scenarios and 3 time-slices
  - *(Present climate only in v1.0)*
- Later version:
  - Whole UK (5km grid)

- More tomorrow on:
  - how to use RainClim
  - future climate information (skew) – how reliable is it, and how can we use it in RainClim



- **That's all for now !**