Delivering local-scale climate scenarios for impact assessments

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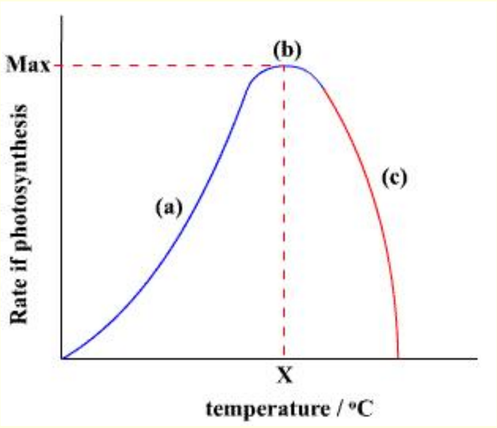
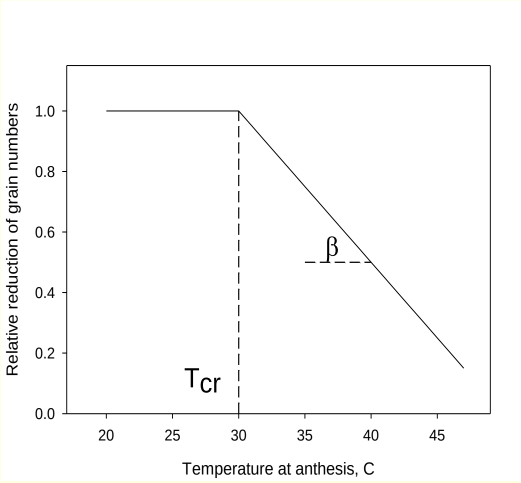
Non-linear responses to environmental variations

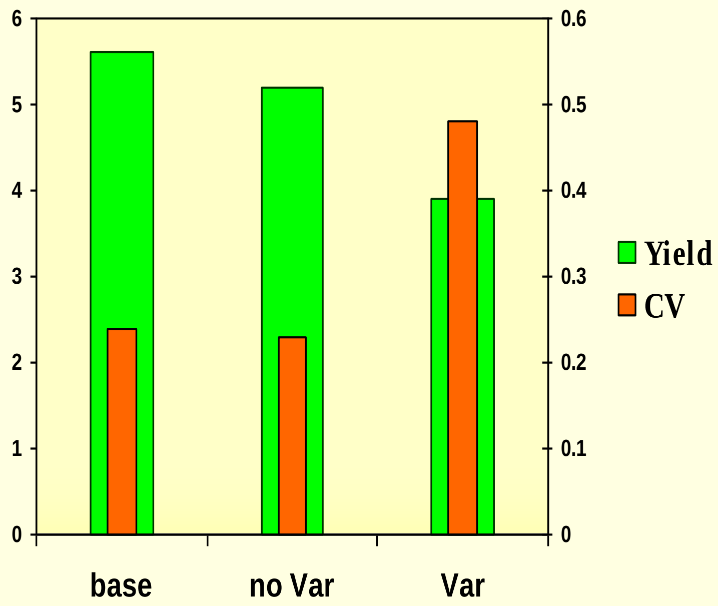


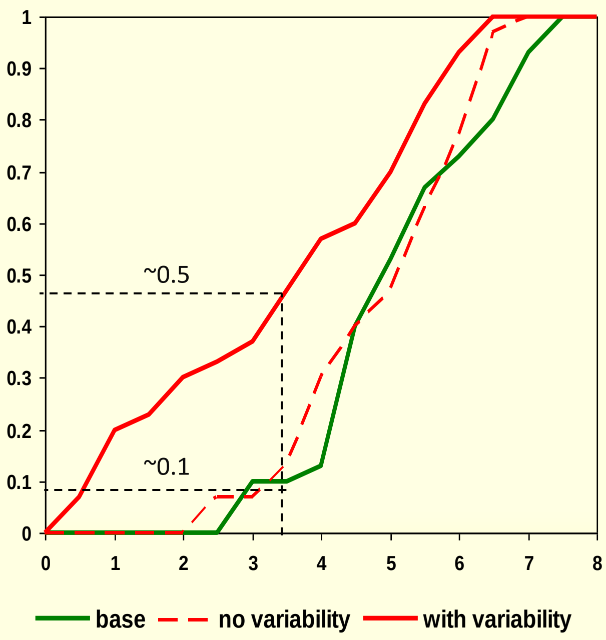
"Averaging" inputs for process-based impact models might produce incorrect results



A single extreme event might change substantially model predictions. Heat stress around flowering can decrease grain number and size, significantly reducing yield

Changes in climatic variability vs. changes in mean climate





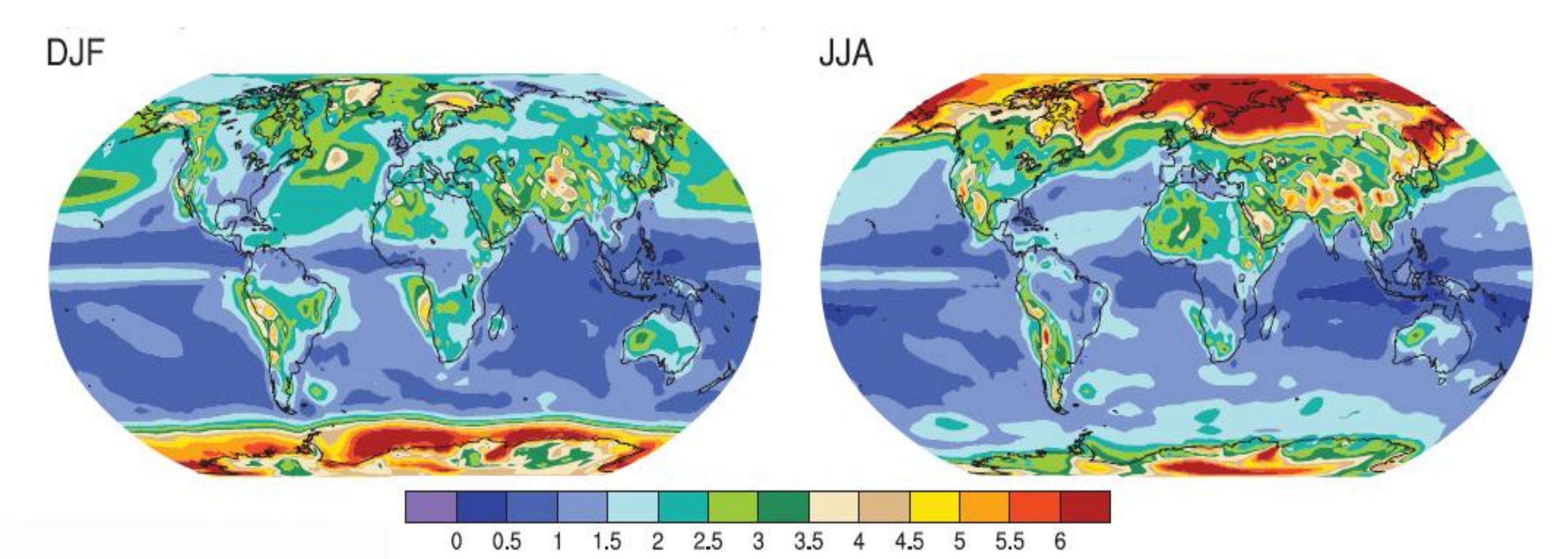
(Semenov & Barrow, 1997)

Requirements for climate scenarios

- Scenarios should be daily and site-specific, and be able to reproduce extreme events
- Should include the full set of climate variables required by impacts models
- Should contain an adequate number of years to permit risk analysis
- Should incorporate predicted changes in mean climate and climate variability

GCMs: predicting the evolution of climate

Absolute bias in 1970–99 average surface temperature from ERA-40 (averaged across all CMIP3 models)



(Knutti et all, 2010)

Downscaling techniques

Statistical downscaling

Derives statistical relationships between observed small-scale variables and larger (comparable to GCM) scale variables

Dynamic downscaling

A regional climate model is nested within GCM and run over a region using boundary conditions from GCM

Weather generator

Weather generator

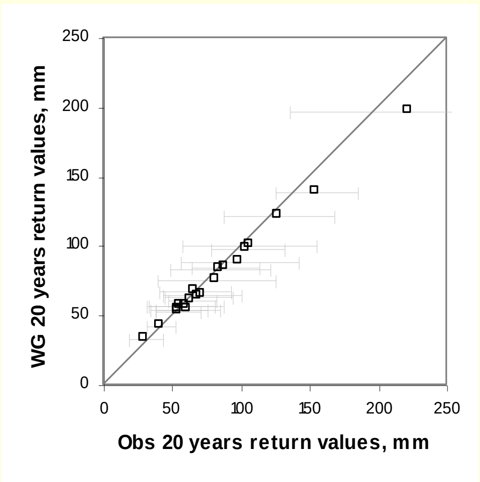
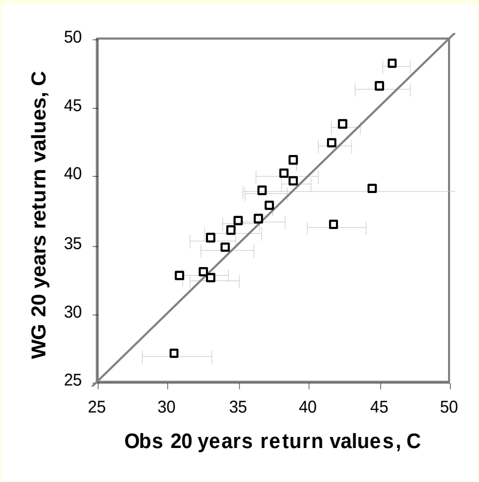
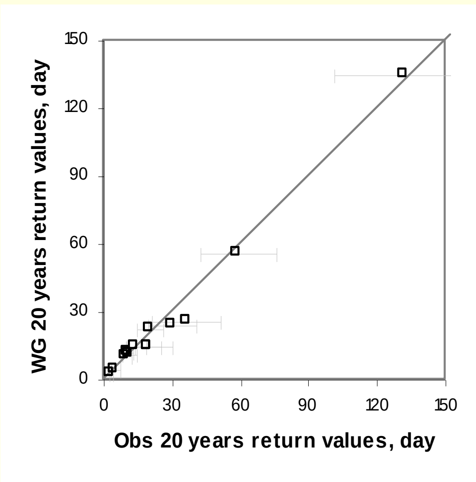
Weather generator is a stochastic model to generate daily weather series “statistically similar” to observed. It can be used:

- to generate long weather time-series suitable for risk assessment including extreme events
- to provide the means of extending the simulation of weather to unobserved locations
- to serve as a computationally inexpensive downscaling tool to produce local-scale climate scenarios

LARS-WG weather generator

- Generates precipitation, min and max temperature, radiation and potential evapotraspiration
- Modelling of precipitation event is based on wet/dry series
- Semi-empirical distributions are used for distribution of climatic variables
- LARS-WG is used in more than 70 countries for research and as an educational tool
- LARS-WG is available for academic, governmental and non-profit organizations from http://www.rothamsted.bbsrc.ac.uk/mas-models/larswg.php

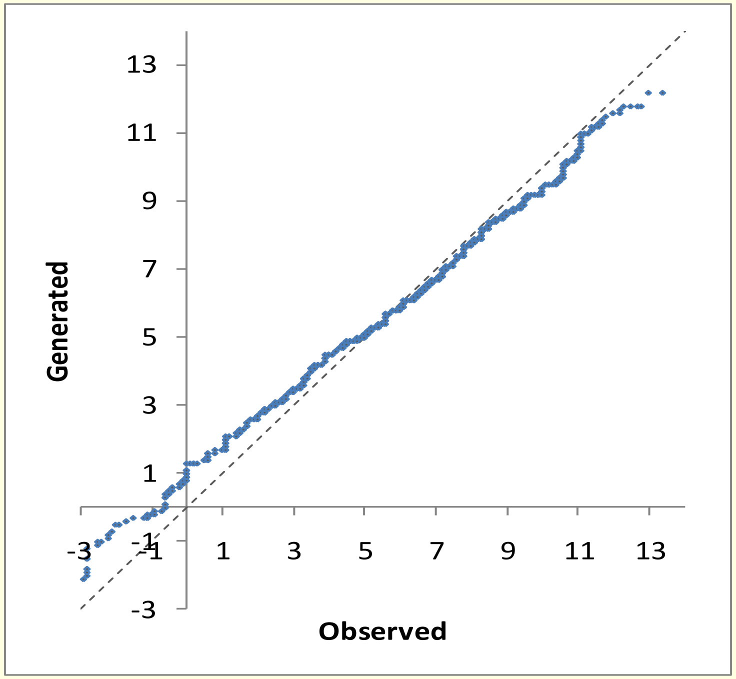
Performance of LARS-WG: simulation of extremes

Precipitation	Maximum temperature	Heat waves
		

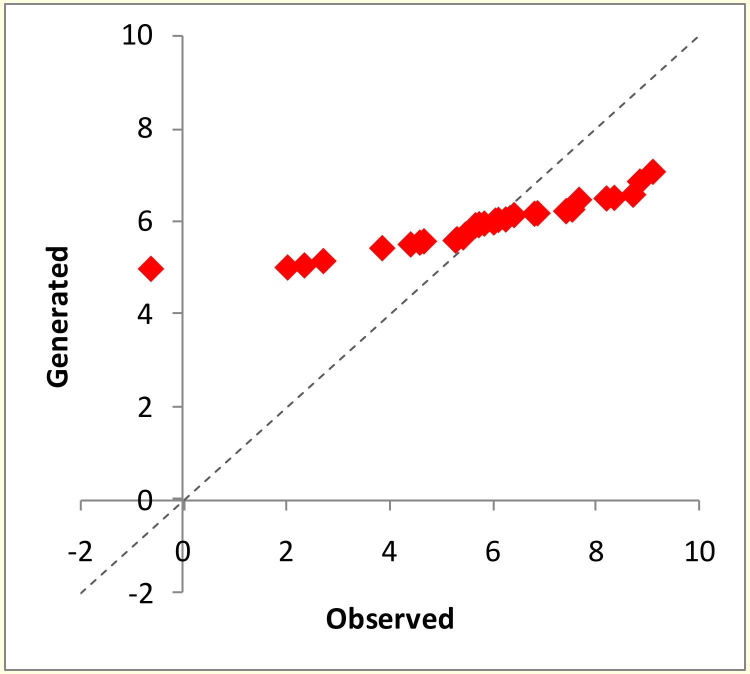
Underestimation of interannual variability

WGs often fail to capture interannual variability

Daily temperature



Monthly temperature



WG as a downscaling tool

1. Estimate site parameters:

$$WG: O_{t0} \rightarrow q_{t0}$$

2. Derived Δ-changes from GCM/RCM:

$$\Delta_{t1,t0} = M_{t1} - M_{t0}$$

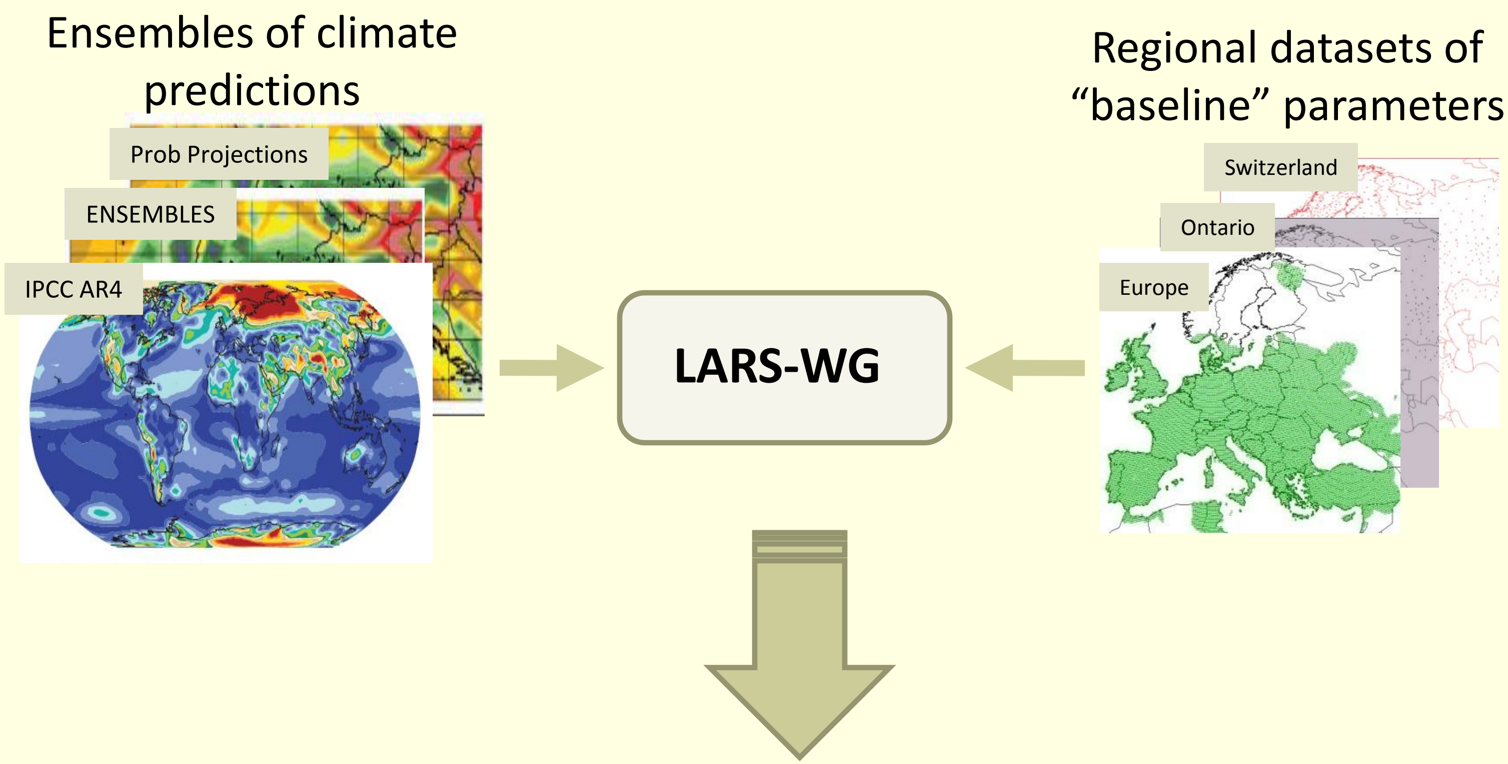
3. Adjust site parameters with Δ-changes:

$$q_{t1} = q_{t0} + \Delta_{t1,t0}$$

4. Using adjusted parameters generate future scenarios:

$$WG: q_{t1} \rightarrow Y_{t1}$$

ELPIS: open architecture



Local-scale climate scenarios for impact assessment

ELPIS-Europe: a dataset of local-scale climate scenarios

- Underlying observed daily weather from the European Crop Growth Monitoring System dataset from the EC Joint Research Centre
- Climate predictions from multi-model ensembles, including IPCC AR4 (CMIP3) and ENSEMBLES ensembles
- LARS-WG stochastic weather generator

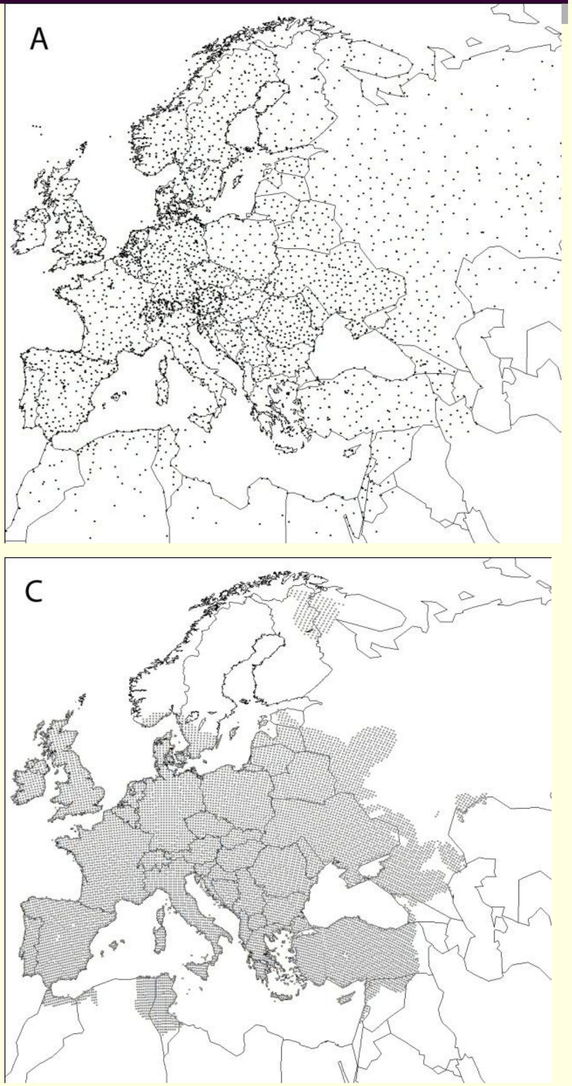
(Semenov et al, 2010)

CGMS meteorological dataset

•Daily data from ~3000 stations for 1982-09 have been interpolated to a regular 25-km grid over Europe

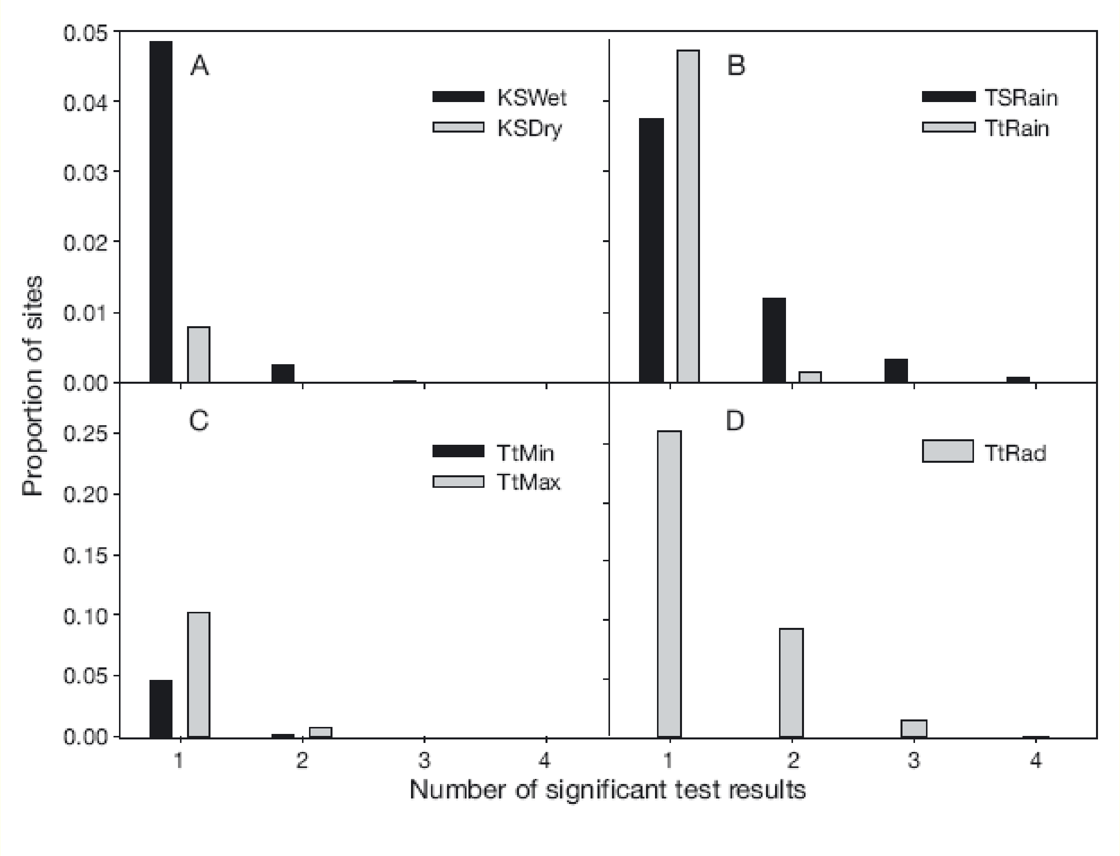
•Interpolated data represents weather at a typical site from the grid used for agricultural production

•CGMS is used by JRC for various agricultural assessments for the EC in conjunction with agricultural models.

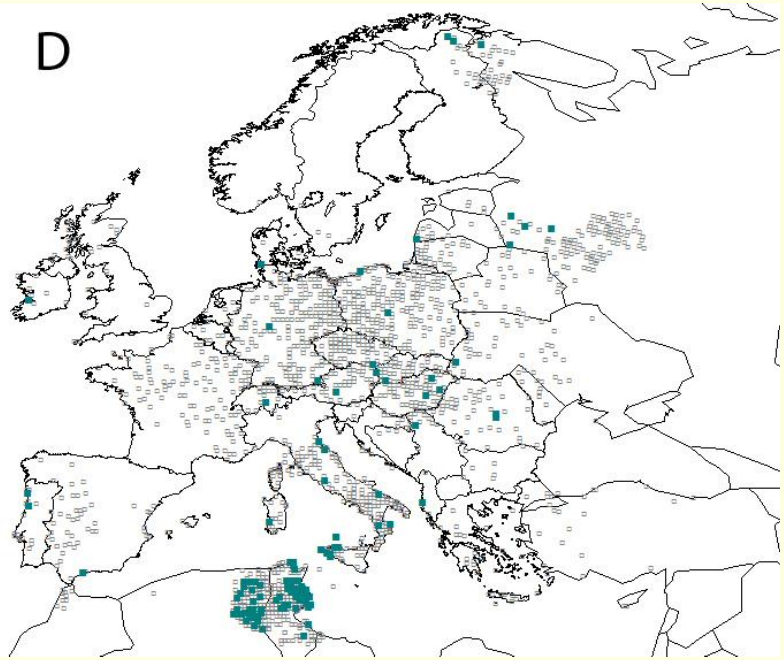


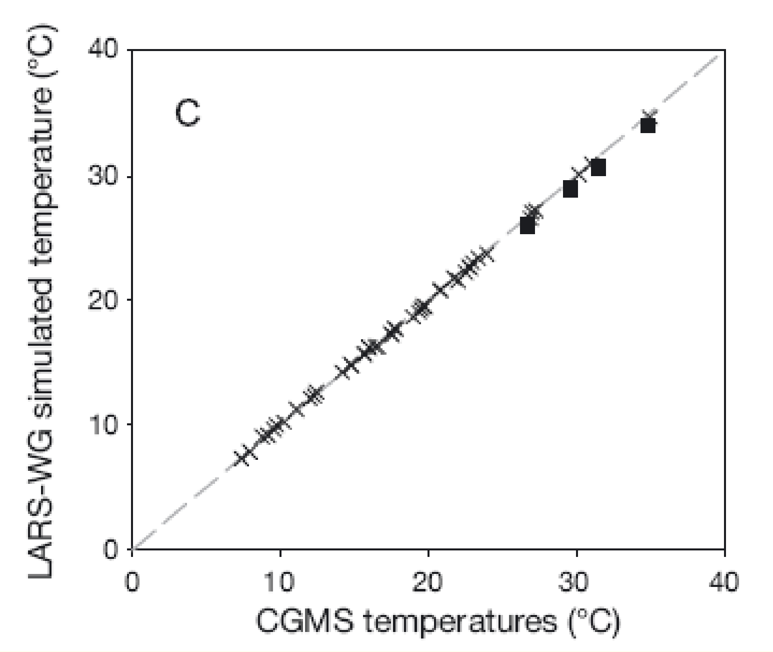
Performance of LARS-WG in Europe

Proportion of grids with the number of significant test results at the significance level α = 0.01



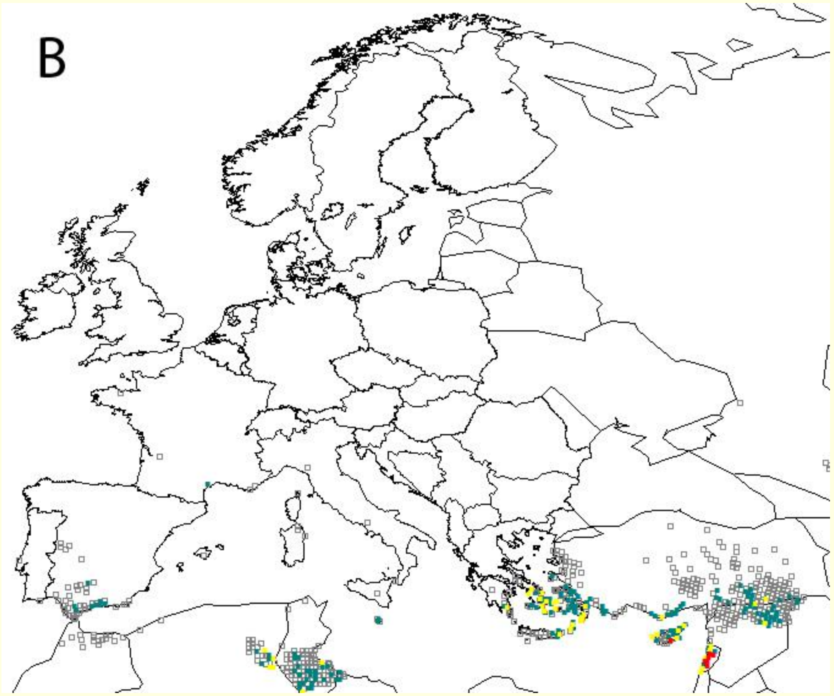
Test results for min and max temperature

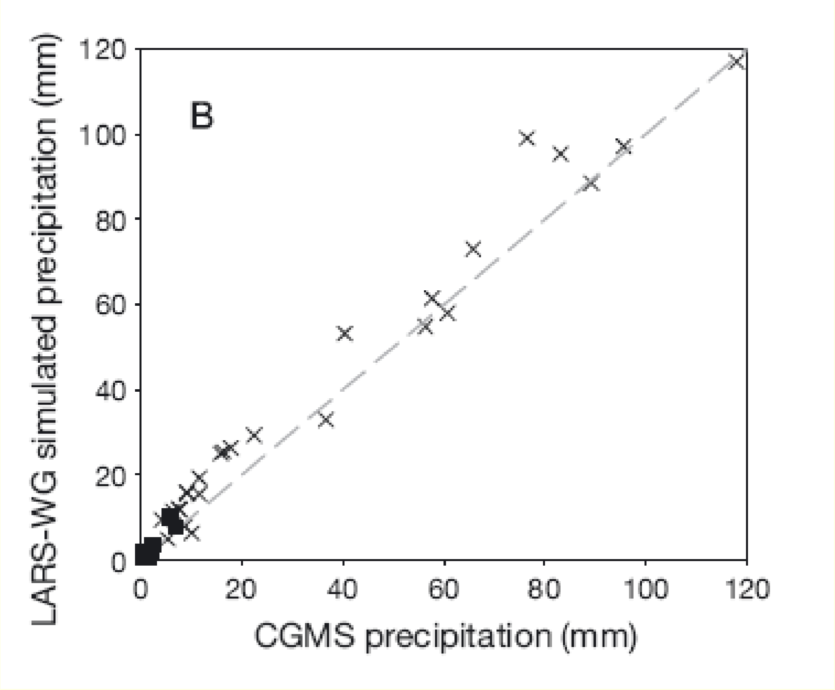




(Semenov et al, 2010)

Test results for distribution of daily precipitation and means





(Semenov et al, 2010)

Publications

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