Changing Water Cycle
Hydrological Extremes and Feedbacks
Main Objective

Objective

Looking at the hydrological impacts of climate change in the UK

A system approach that couples atmosphere, land surface and groundwater processes
Methodology

Objective
Looking at the hydrological impacts of climate change in the UK

A system approach that couples atmosphere, land surface and groundwater processes

JULES provides a framework to assess the impact of modifying a particular process (surface energy balance, hydrological cycle, carbon cycle, dynamic vegetation, etc.) on the ecosystem as a whole.
Methodology

Objective
Looking at the hydrological impacts of climate change in the UK
A system approach that couples atmosphere, land surface and groundwater processes

Applied at 1x1 km²:
• soil data
• land-use
Methodology

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ZOOMQ3D is a numerical model, which simulates GW flow in aquifers
Objective

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Methodology

Consistent with changing large-scale synoptic conditions as obtained e.g. from reanalysis products or GCMs
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Methodology
Build statistical model for each variable in turn & simulate from these models to produce mutually consistent set of daily time series

Statistical weather generator

ZOOM³QD
Methodology

Statistical weather generator

ZOOM$_3$QD

Discharge flow

Water table
What we learnt

“A new hydrology for JULES” was needed

To provide meaningful hydrological predictions in a deep groundwater chalk catchment:

• Increase standard soil layer depth - UK can have depths to the water table as much as 100 m [Jackson et al. 2008]

• Modify JULES’s lower boundary condition to persistent gradient. It is generally assumed as a unit gradient (free drainage), which can result in drier lower soil layers [Li et al. 2008]

• Modify JULES modules to represent chalk dual behavior of fractures and matrix
What we learnt

“A new hydrology for JULES” was needed

To accurately represent the saturation excess processes regionalized values of BFIHOST (base flow indexes) were used to define the PDM model within JULES

PDM

\[ b = \text{BFIHOST} \]
Results

Kennet at Theale

NS = 0.89
NSlog = 0.87
RBias = +1.1%
Results

Dots: observed levels; black line: JULES+ZOOMQ3D; grey line: Jackson, 2012 (groundwater model)
Thames water drought plan in the Kennet catchment: