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An Overview of JULES

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JULES, MOSES AND TRIFFID

- **JULES** (Joint UK Land Environment Simulator) is a new land surface model
- Joint initiative: NERC through the CEH, CLASSIC, QUEST and the Met Office
- JULES has been an **establishing point of weather forecasting and climate modelling in the UK**
- Programming of JULES →
  - MOSES (Met Office Surface Exchange Scheme)
  - TRIFFID (Top-Down Representation of Interactive Foliage and Flora Including Dynamics)
- **MOSES** is a complex energy and water balance model
- TRIFFID is a dynamic global vegetation model which models plant distribution and soil carbon, driven by CO_2 fluxes produced by MOSES (Our interest: The MOSES component of JULES, *i.e. we can turn off TRIFFID*)

Joint UK Land Environment Simulator - JULES

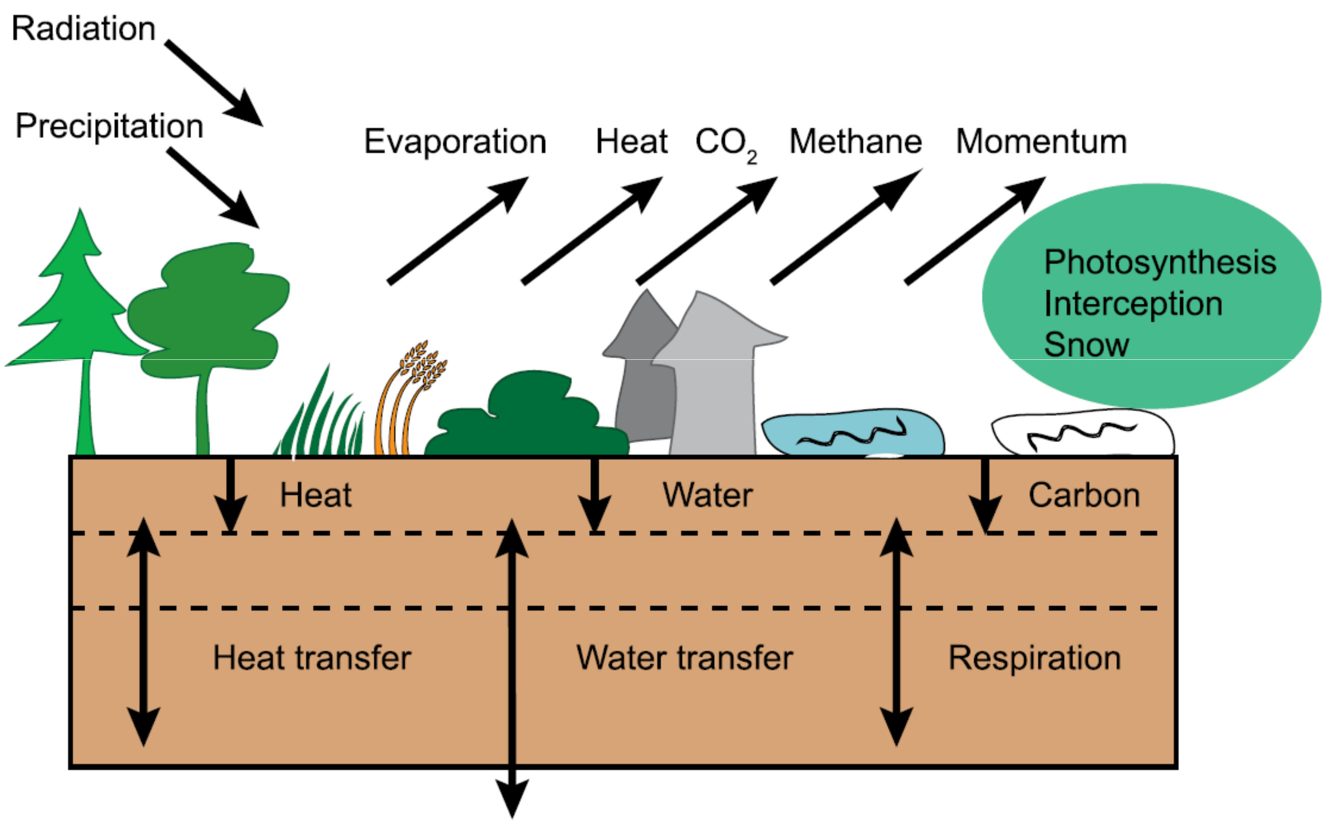

Figure 1. Schematic diagram of the new Land Surface Model, JULES.

http://www.igbp.net/documents/NL_66-3.pdf

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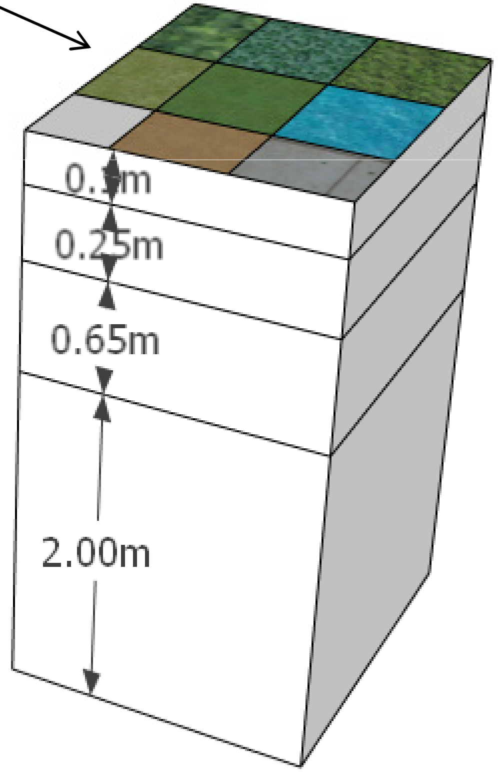
Sub-grid heterogeneity

The surface of each cell comprises fractions of 9 different surface types.

5 Plant Functional Types
- •Broadleaf trees
- •Needleleaf trees
- •Temperate grass
- •Tropical grass
- •Shrubs

4 Non Vegetated Surfaces
- •Urban
- •Inland water
- •Bare Soil
- •Ice



Outputs from each surface type are aggregated and passed into the soil column

JULES inputs and outputs

Driving inputs:

•Precipitation

(Rainfall /Snowfall rate)

•Air temperature

•Windspeed

•Air pressure

•Specific Humidity

•Downward SW radiation

•Downward LW radiation

Outputs:

•Soil temperature

•Soil moisture

•Surface runoff

•Drainage (from the lower boundary)

•Plant transpiration

•Soil evaporation

•Plant growth

•Soil respiration (i.e. CO_2 emitted)

•Surface fluxes of heat and carbon (CO_2 and methane)

Processes modelled by MOSES (1)

- Soil Thermodynamics
  - Subsurface temperatures: Discretized form of heat diffusion equation
  - Temperature of the nth layer: Diffusive fluxes into and out of the layer and the net heat flux advected from the layer by the moisture flux

- Soil Hydrology

Based on a finite difference approximation of Richards' equation

Water fluxes: Darcy's law

Hydraulic conductivity and soil water suction can be represented as functions of soil moisture concentration
(Brooks and Corey or van Genuchten representations)

Processes modelled by MOSES (2)

•Surface Hydrology: Partitioning of precipitation into interception, throughfall, runoff and infiltration applied separately on each tile.

•Surface Energy Balance (for each tile) → Fluxes of sensible heat and moisture; → Latent heat flux of vaporization for snow-free tiles

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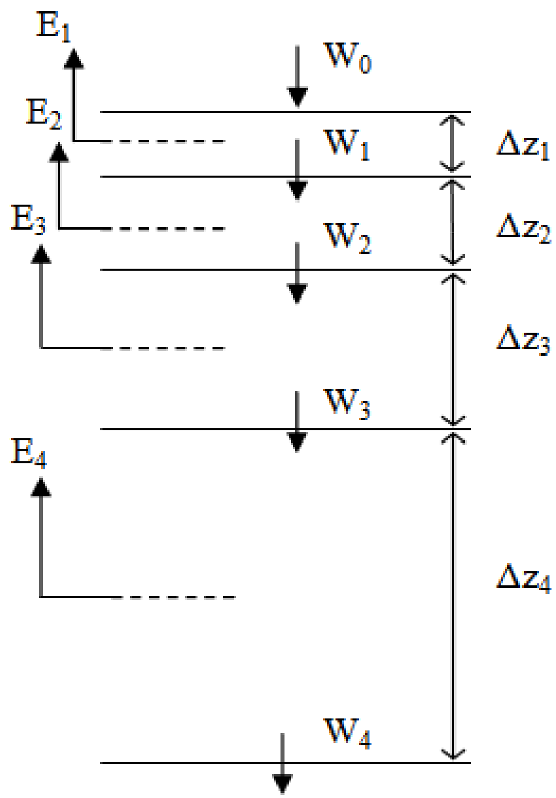
Soil Moisture calculation

Change of total soil moisture content within the n[th] soil layer over time:

$dM_n/dt = W_{n-1} - W_n - E_n$



Boundary conditions

- W_0 = Infiltration (=Throughfall+Snowmelt-Surface Runoff
- $W_N = K_N$ (free drainage boundary)

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Issues for examination

- Soil moisture and soil properties are lumped across the gridbox

- Impact of the lower boundary condition

- JULES does not incorporate the impacts of groundwater system and deeper unsaturated zone on evaporative fluxes and also does not account for groundwater storage or slow transfer via the groundwater pathway in aquifers

Catchment area of study

Kennet, Pang and Lambourn catchments

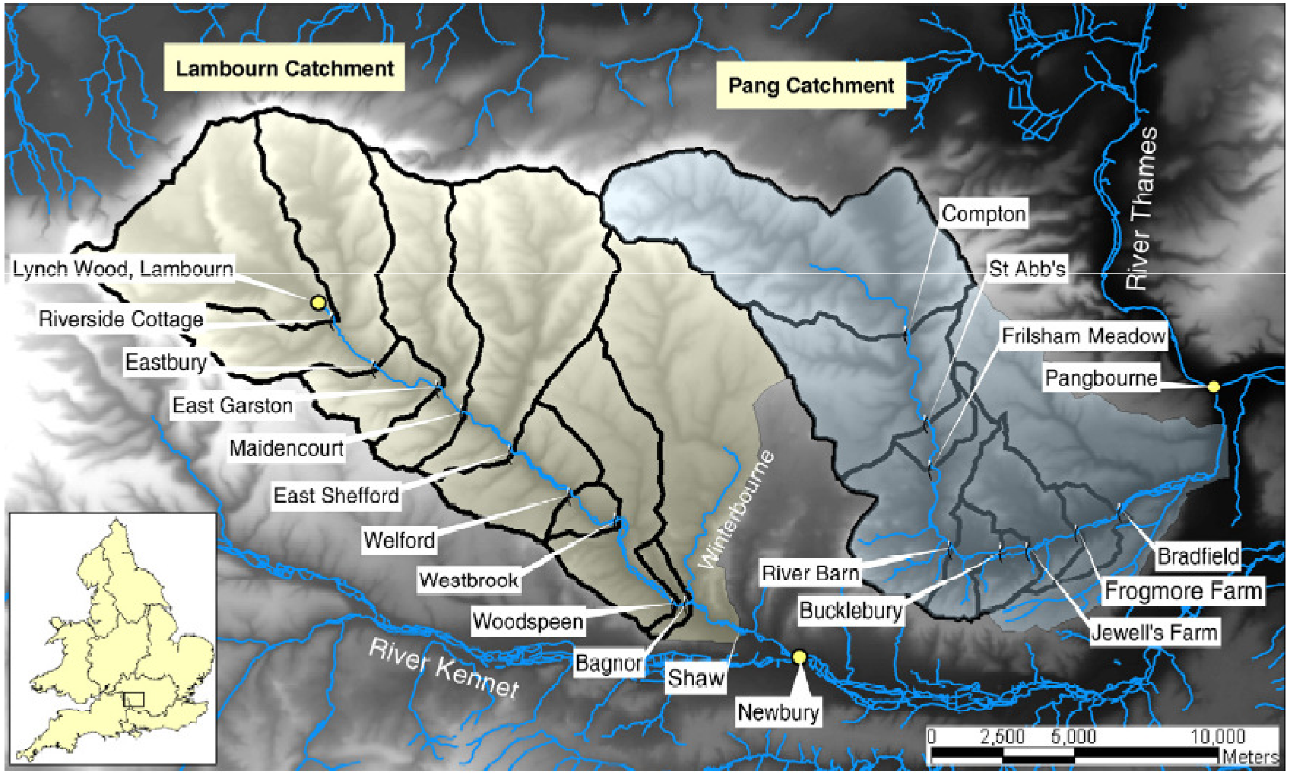

Figure 2: Pang and Lambourn catchment boundaries

http://www.es.lancs.ac.uk/people/amb/Publications/pdfs/Griffiths_et_al_2006.pdf

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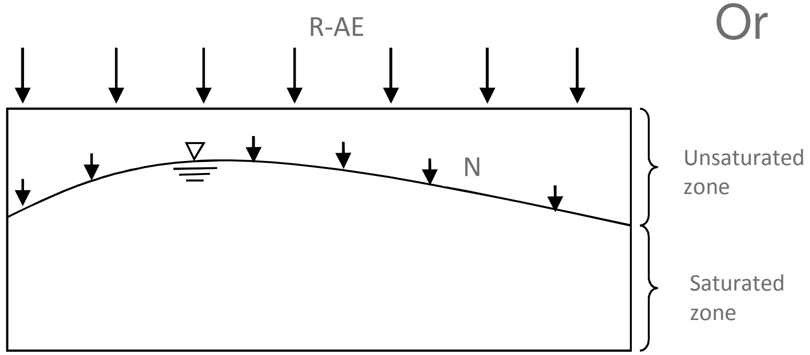
Possible groundwater models

•Develop a 2D Richard's equation, as the horizontal distribution of soil moisture in a grid square needs to be represented

•Combination of 1D Richard's equation for the unsaturated zone and Boussinesq equation for the saturated zone



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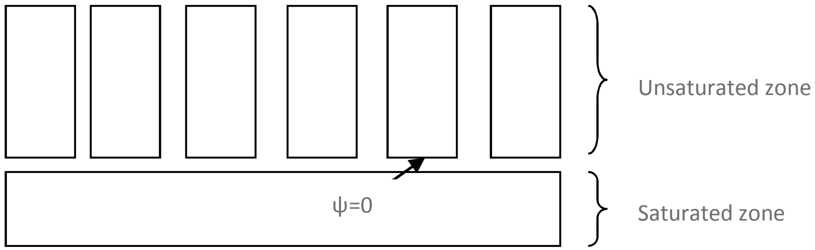

There is the need to couple these with **BGS groundwater models**

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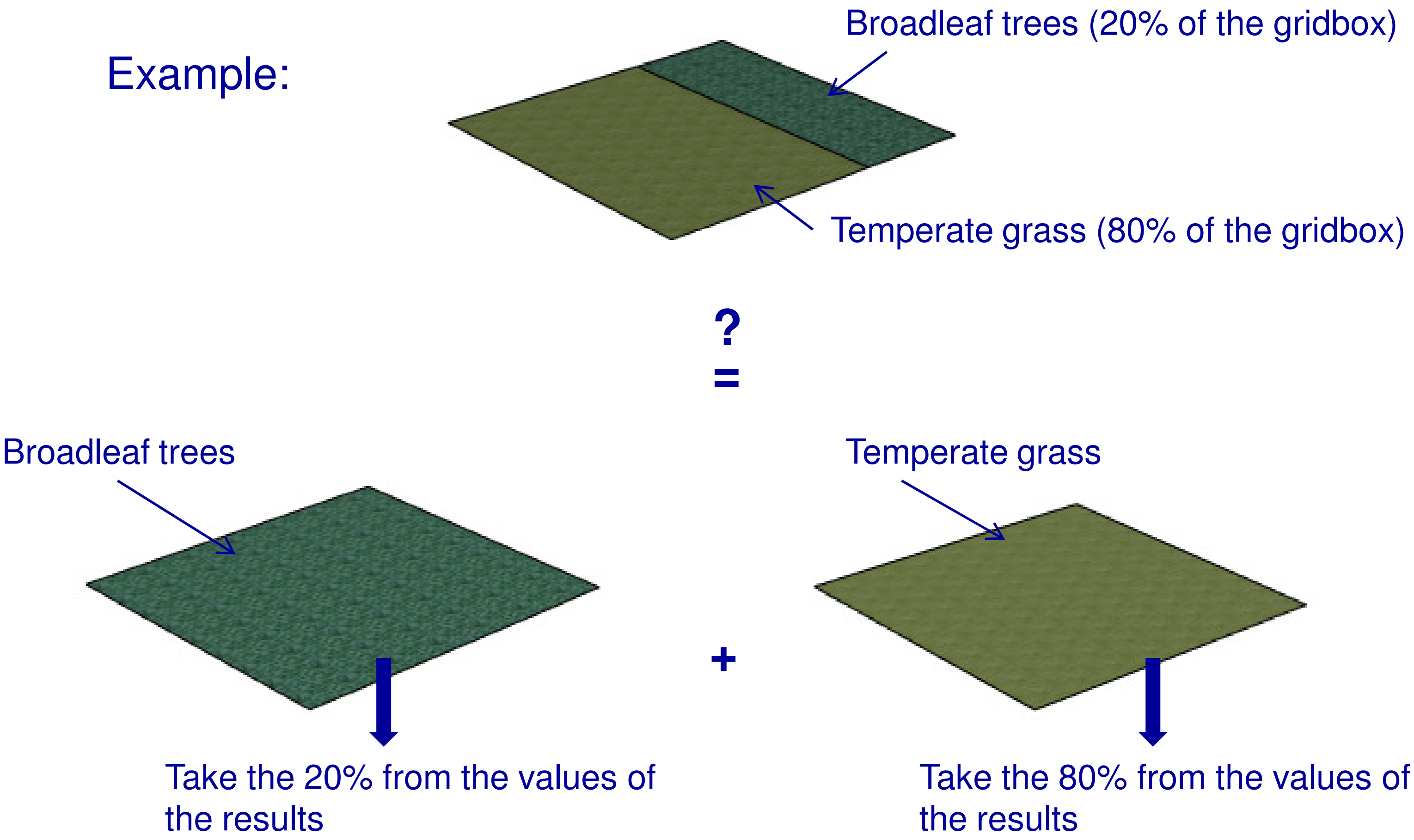
Heterogeneity investigation for different tiles

Examination of the ‘tiling’ process of JULES and checking its sensitivity

Example:



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Thank you