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Step-by-step diagnostics and changes of JULES to represent flows in a groundwater dominated catchment

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Outline

- Data
- Kennet at Theale
- JULES
- Stepwise changes:
  - Parameterisation
  - Lower boundary condition
  - Groundwater
  - Surface runoff
  - Surface runoff routing
- Summary and future work

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Data

JULES input type	Source data description	Source
1 km catchment grid	1) 50 m resolution raster file 2) catchment outlet	http://edina.ac.uk/digimap/ ttp://www.environmentagency.gov.uk/hiflows/station.aspx?39016
Vegetation cover	1) 50 m IGBP 2007 land cover map 2) Land use reclassification scheme (from 17 IGPB classes to 9 JULES classes) (Smith et al, 2006)	http://webmap.ornl.gov/wcsdown/dataset.jsp?ds_id=10004
Soil parameters	1) 1 km NSRI soil maps (Brooks and Corey parameterisation) based on Mayr & Jarvis (1999) 2) Chalk parameters from Ireson et al (2009)	http://www.landis.org.uk/data/
Meteorological inputs	Daily, 1 km CHESS data	CEH (personal communications)
Observations	Daily flow data	http://www.ceh.ac.uk/data/nrfa/data/search.html

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• A mainly pervious catchment, but the lowest quarter is largely impermeable.

• A primarily rural catchment.

•Area = 1,033.4 km^2.

• Average annual rainfall = 759 mm.

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JULES

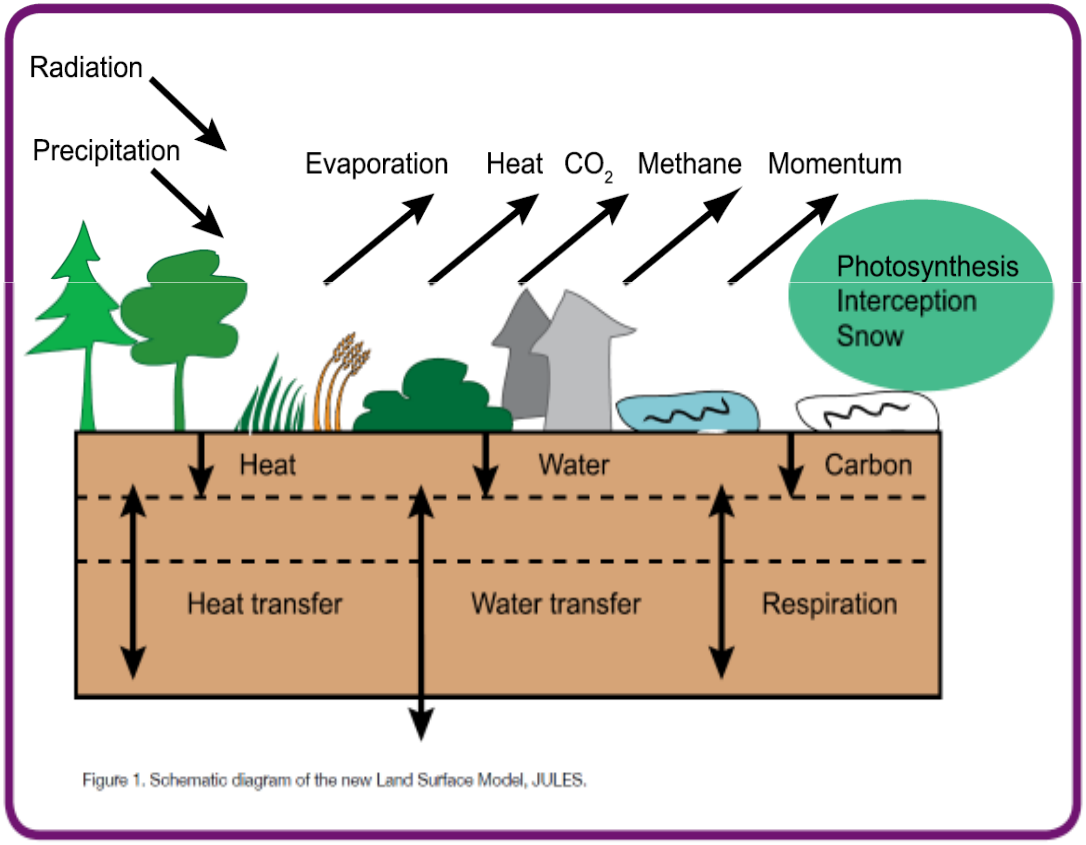

Figure 1. Schematic diagram of the new Land Surface Model, JULES.

Note:

Hydrology in JULES assumes

- Free drainage lower boundary;
- No interaction between grids;
- No groundwater routing;
- No surface water routing.

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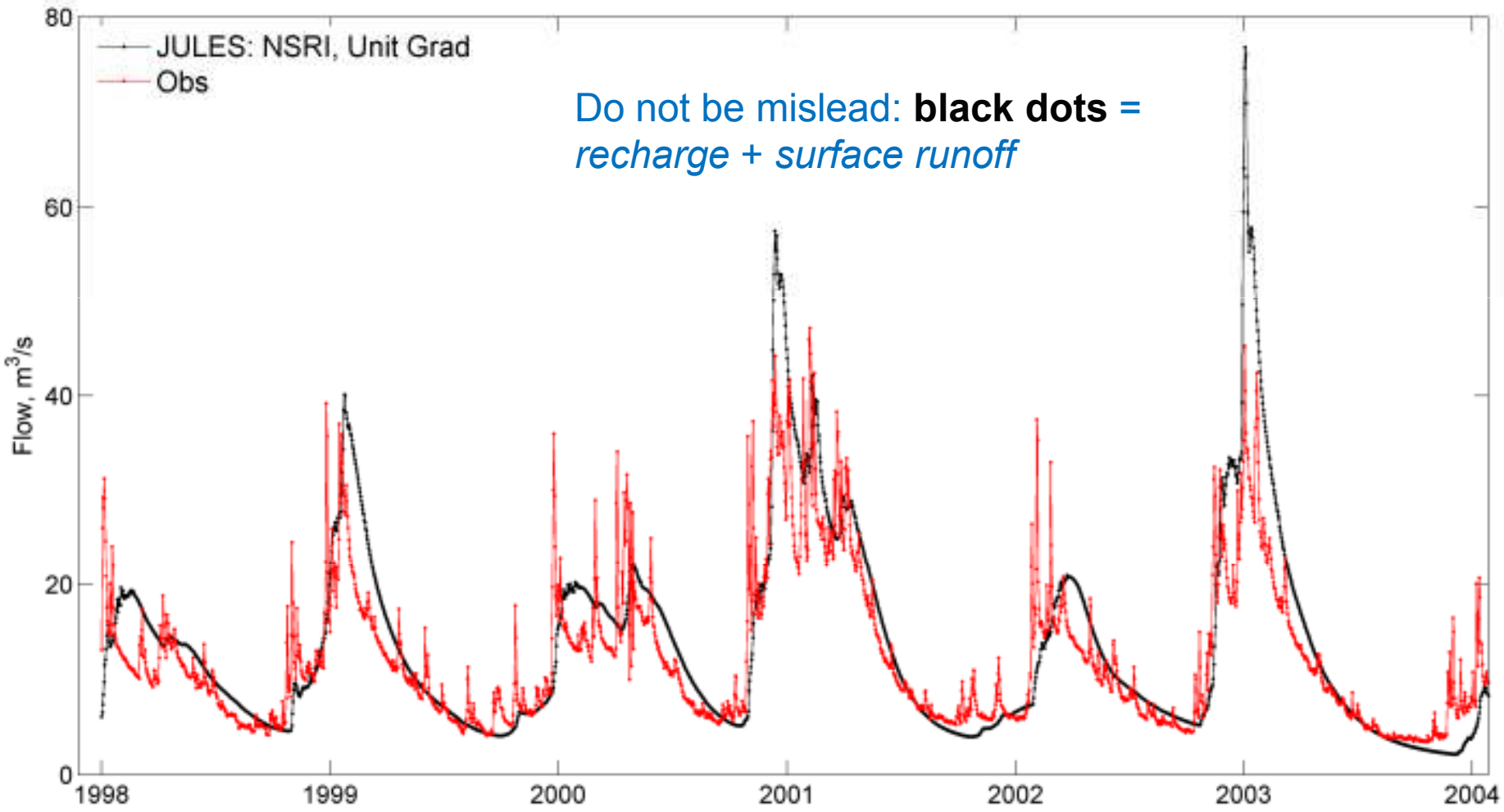
Right answers for the wrong reasons?



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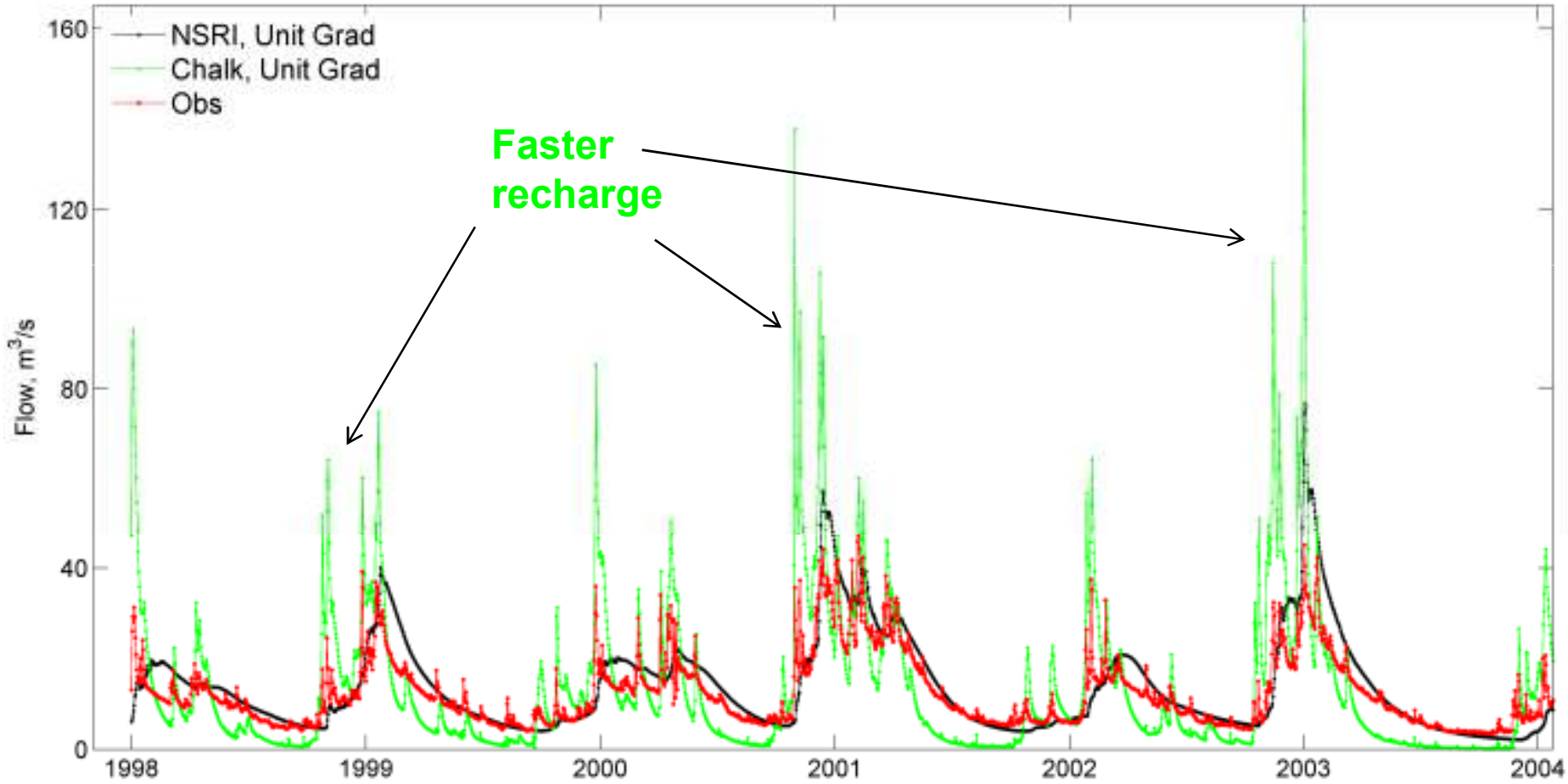
Account for chalk hydraulics



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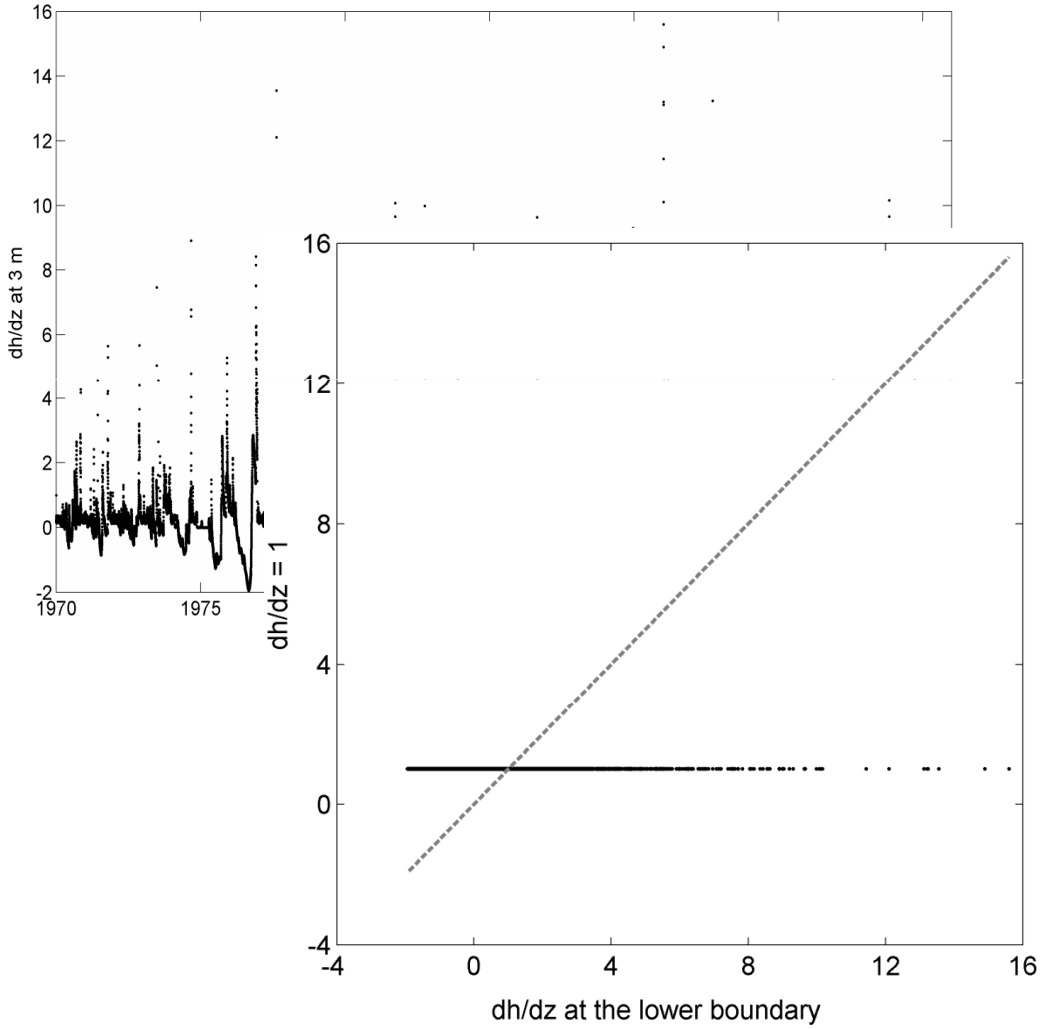
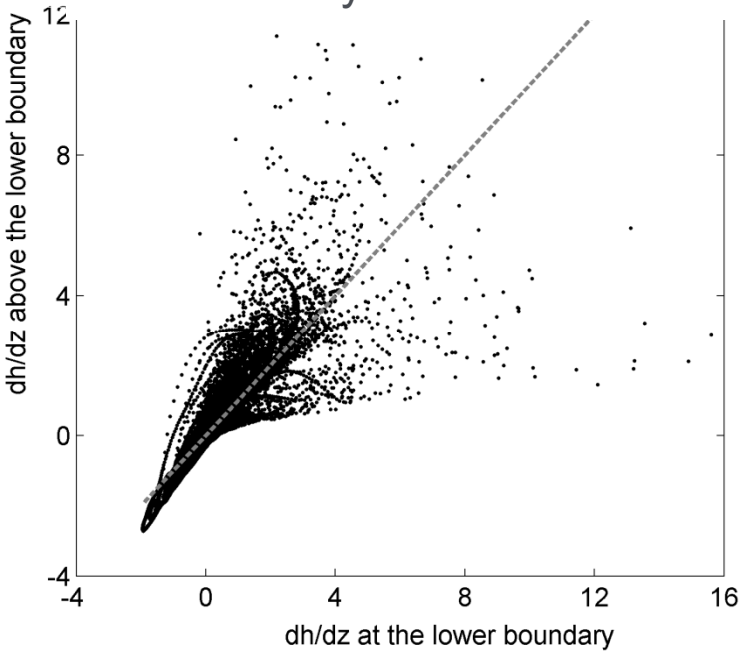
Which Lower Boundary Condition? (1 of 2)



‘Persistant gradient’ correlates well with modelled gradient at the boundary



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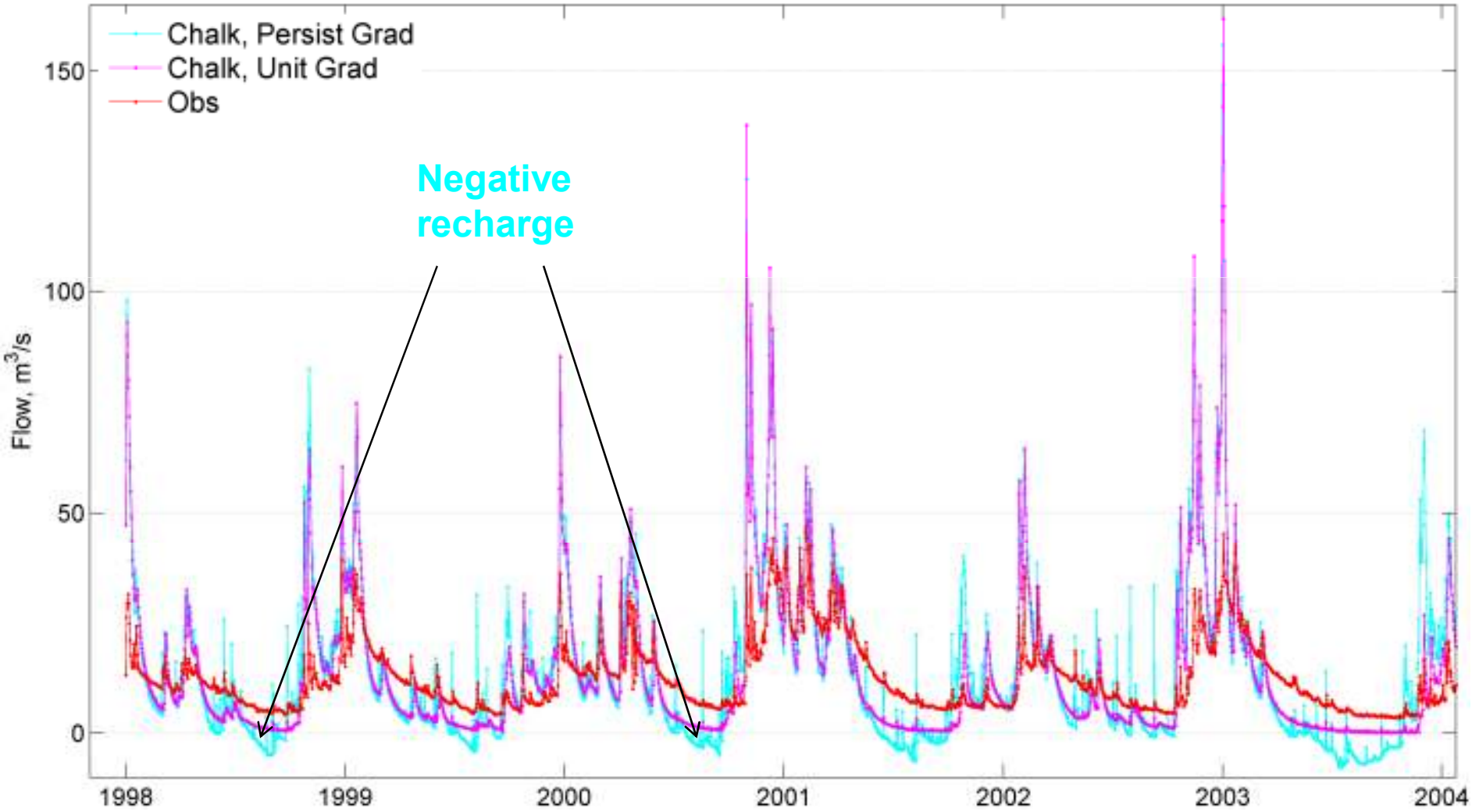
Which Lower Boundary Condition? (2 of 2)



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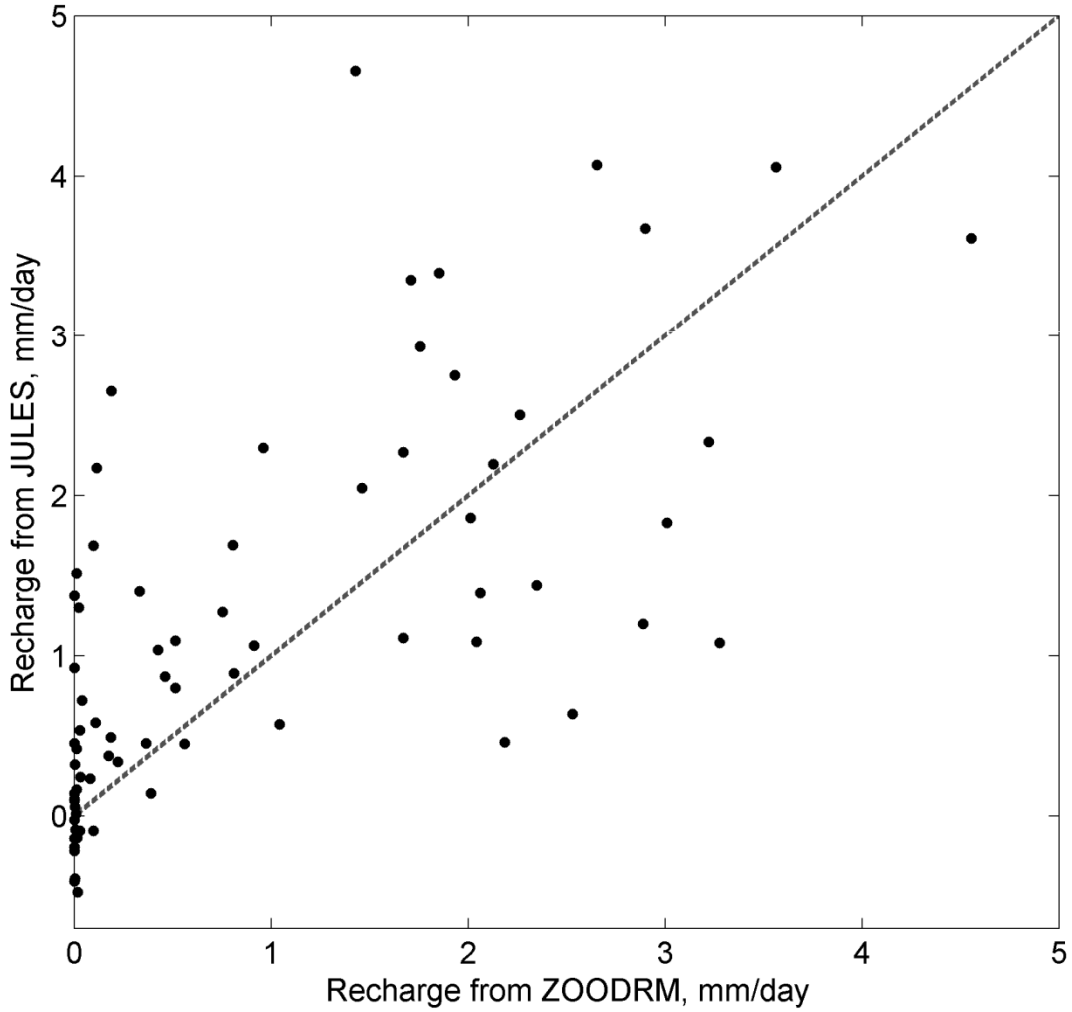
Groundwater representation: ZOOMQ3D (1 of 2)



- JULES' recharge can be negative;
- Recharge from JULES is higher than from ZOOM (~25%).

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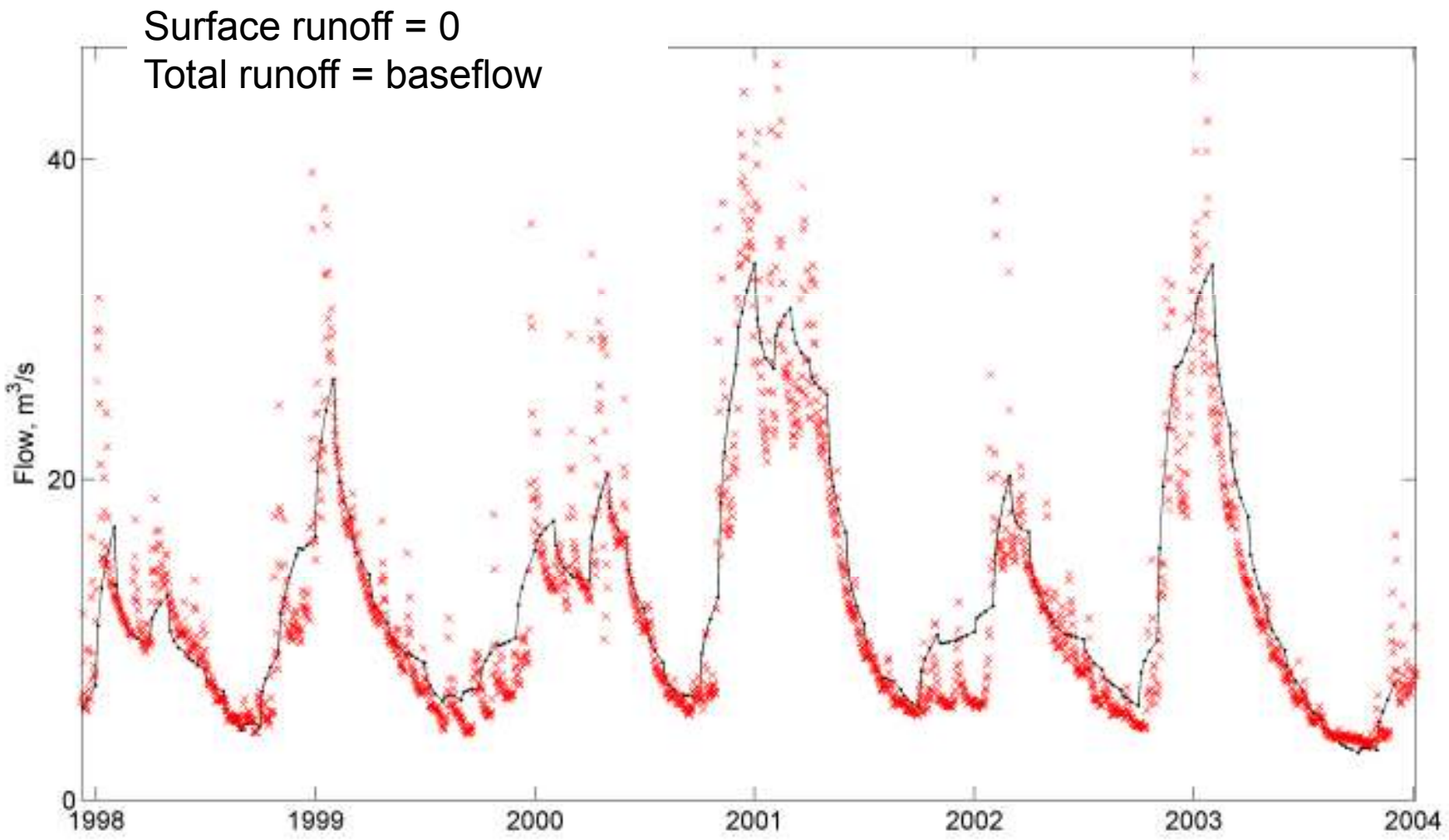
Groundwater representation: ZOOMQ3D (2 of 2)



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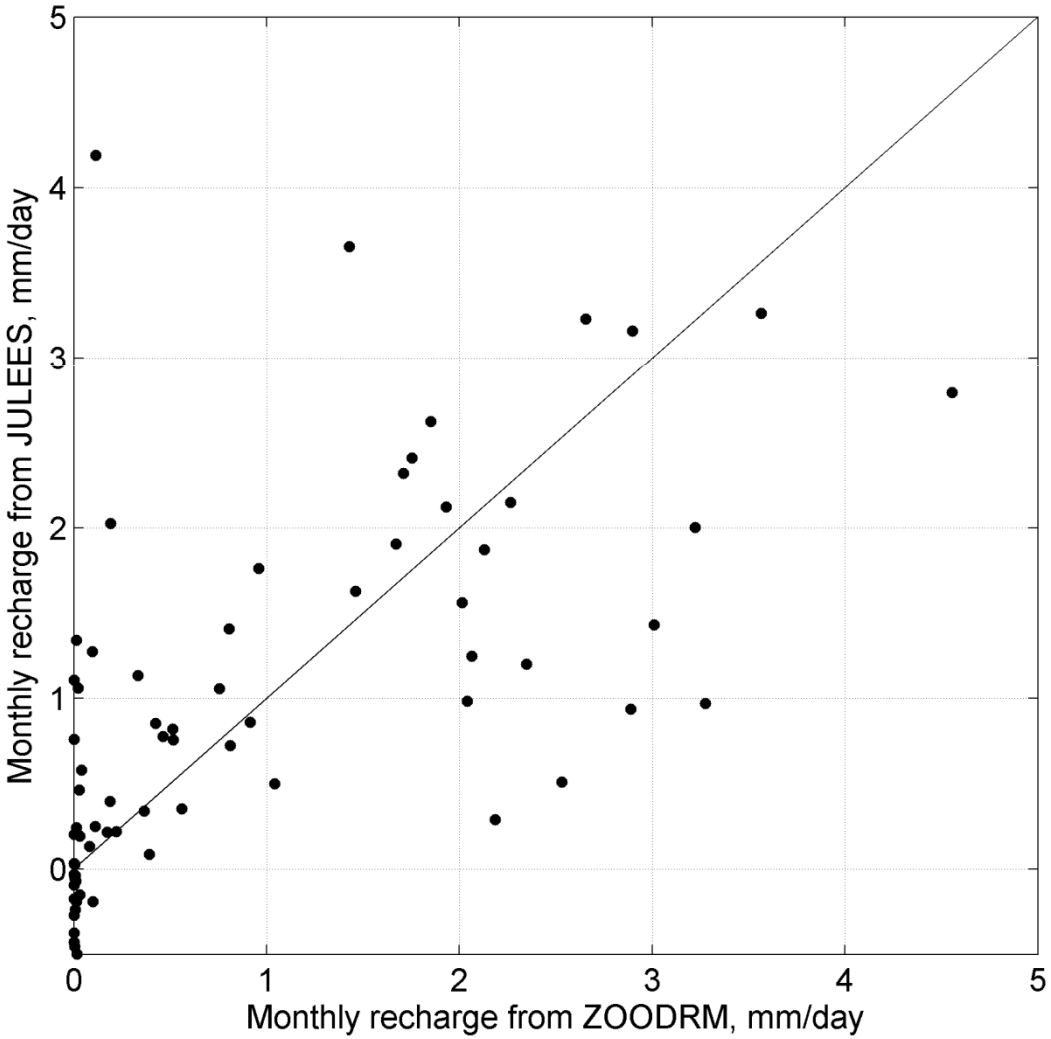
Surface Runoff (1 of 3)



Total JULES recharge is only 2% higher than ZOODRM recharge (6 years)

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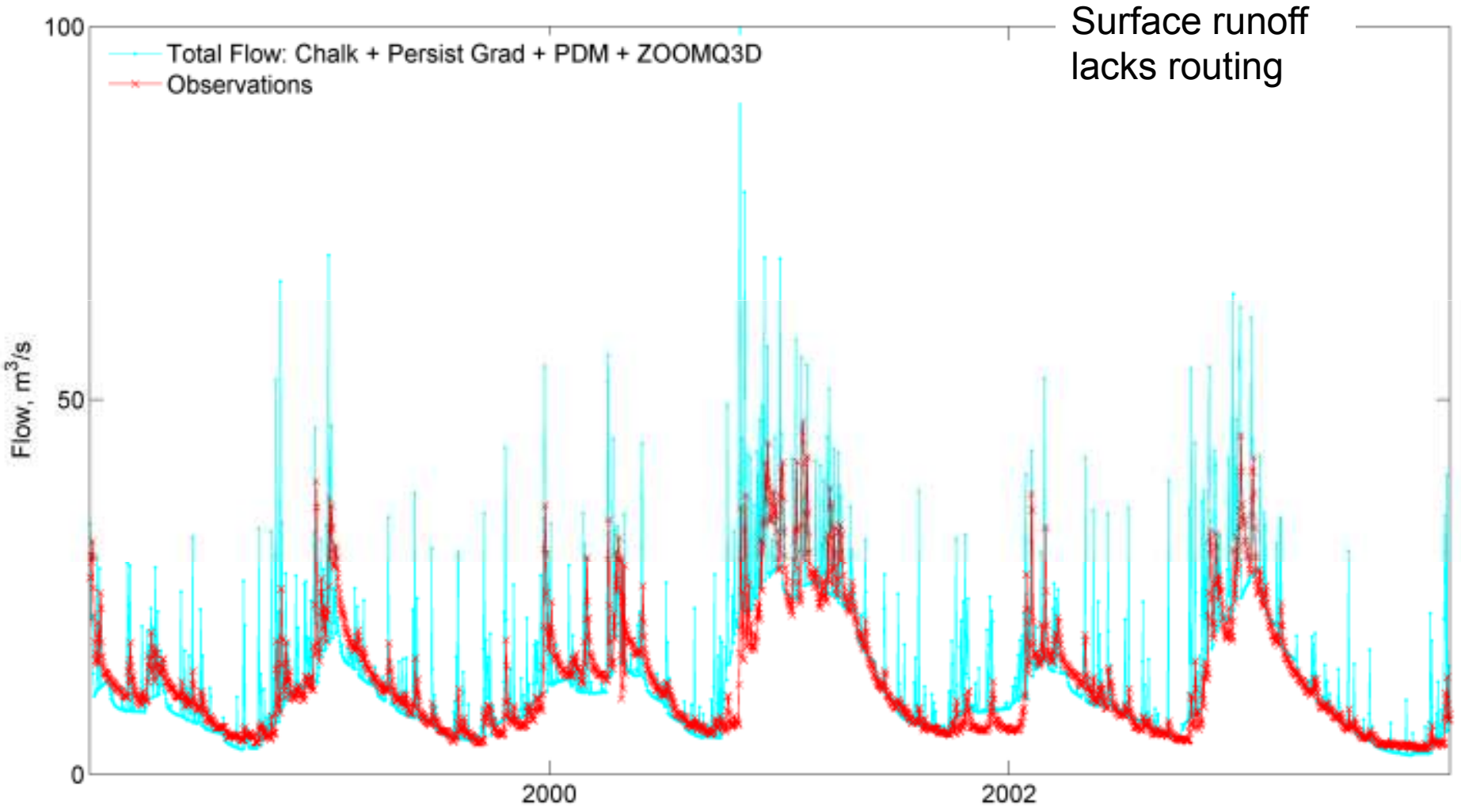
Surface Runoff (2 of 3)



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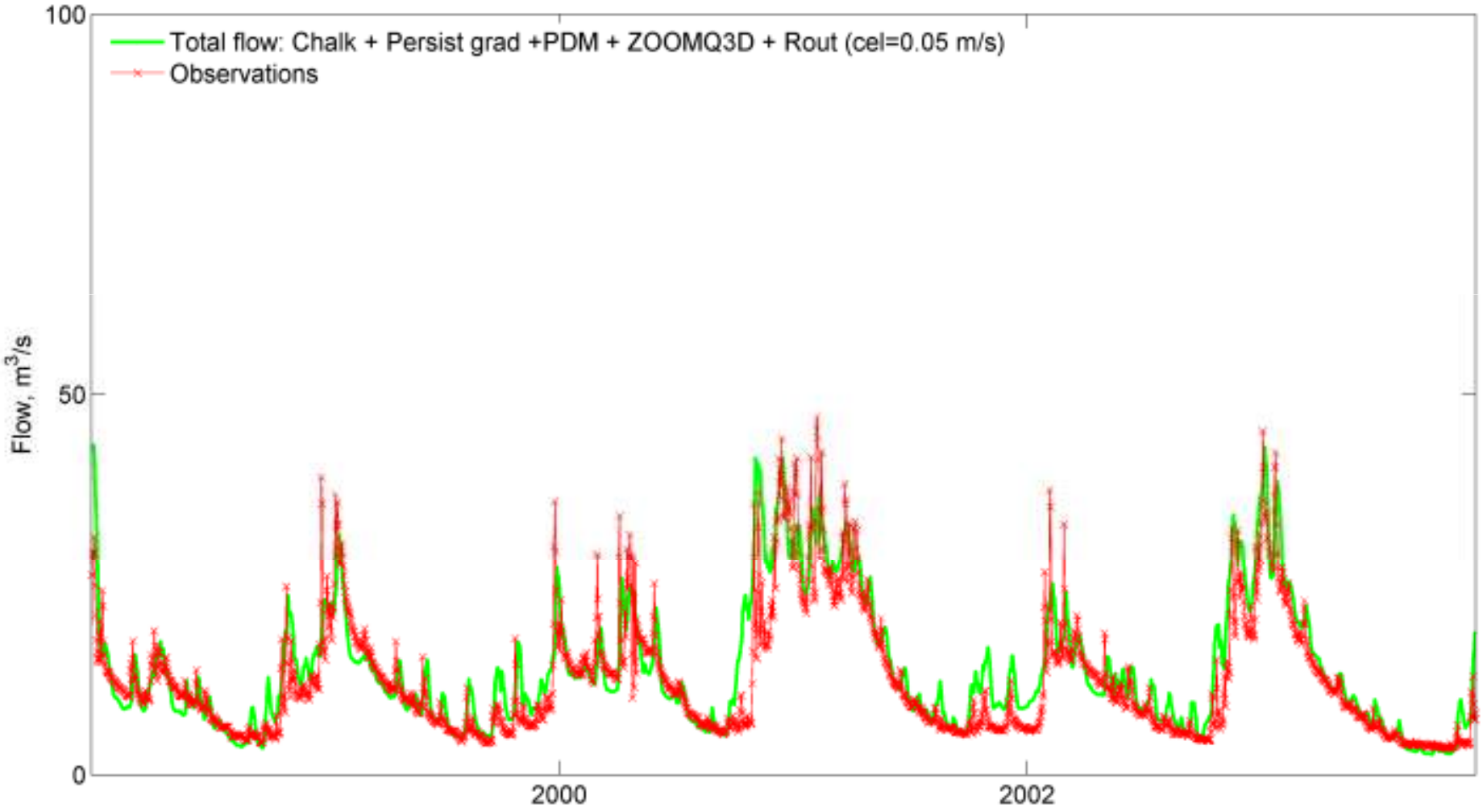
Surface Runoff (3 of 3)



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Summary

The following changes were introduced to standard JULES configuration (and soil physical properties data):

1)NSRI data set was complemented with chalk;

2)Lower boundary condition was chosen to be a ‘persistent’ hydraulic gradient condition;

3)Groundwater model ZOOMQ3D was used to model baseflow;

4)PDM model was used to represent near-surface heterogeneity and allow producing surface runoff;

5)Surface runoff was routed using a simple constant celerity model.

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Future work

•Multi-process and multi-scale tests of the modified JULES using

- Flow data for Kennet sub-catchments (data from Reading?)
- Soil moisture profiles for sites in the Kennet;
- FLUXNET data (?, depends on availability);

•Simpler groundwater model investigation to extend to the Thames and Eden;

•Parameter estimation for JULES (Christina);

•Parameter uncertainty propagation into forecasts;

•Use of downscaled weather inputs for past/future conditions (data sets from UCL and Reading?).

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Recharge vs. Fluxes at 3 m in chalk