**JULES Hydrology Community Activities**

**JULES Hydrology Module** - Module leaders: Anne Verhoef & Nic Gedney; TABLE as per June 2017

<table>
<thead>
<tr>
<th>Research/Application area</th>
<th>Names (Affiliation)</th>
<th>Brief description of work</th>
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| Catchment and large-scale hydrology: Routing, lateral flows, wetlands and inundation | - Elias Nkiaka (Uni Leeds)  
- Sarah Shannon (Uni Exeter)  
- Eleanor Blyth, Alberto Martinez de la Torre (CEH)  
- Simon Dadson, Toby Matthews (Uni Oxford), Huw Lewis (UKMO)  
- Nic Gedney (UKMO)  
- Graham Weedon (UKMO)  
- Charlie Williams, Emily Black (Uni Reading), Simon Dadson (Uni Oxford)  
- Emily Black, Anne Verhoef, Peter Cook (Uni Reading), David Macdonald and others (BGS) | - Hydrology of Logone Catchment (C-Africa)  
- Glacier model in JULES; impact of glacier retreat on river run-off.  
- JULES hydrology performance over the UK (testing runoff generating options)  
- RFM implementation; large-scale inundation modelling  
- Large-scale wetlands.  
- River flow multi-spectral evaluation.  
- Paleo-hydrology (Testing the importance of lake/wetland-climate feedbacks for African hydroclimate variability)  
- Water balance and groundwater recharge in West-Africa (BRAVE project) |
| Impacts: Irrigation; climate change; land use change | - Rich Betts (UKMO), Lamprini Papadimitriou (TU Crete)  
- Pete Falloon, Ron Kahana, Karina Williams (UKMO)  
- Pete Falloon, Ron Kahana (UKMO), Michael Holloway (Lancaster)  
- Camilla Mathison (UKMO)  
- Emma Bergin, Wouter Buytaert (Imperial) | - EU HELIX project (high-end climate impacts), focusing on water availability and droughts  
- IMPREX (EU H2020): improving prediction of hydrological extremes  
- NERC NUCAT-2050: nutrient transfers in small UK catchments under climate change  
- Integrated impacts (crops, rivers, glaciers, irrigation) South Asia  
- NERC HYDROFLUXES Hydrology and fluxes of the Upper Ganges basin (landuse change and agriculture) |
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| **Soil water balance & moisture dynamics:**  
  Soil hydraulics & infiltration; plant water stress/root water uptake; groundwater |
| - Heather Rumbold (nee Ashton), Richard Gilham (UKMO) |
|   - Rafael Rosolem (Uni Bristol) |
|   - Chloe Largeron (previously Ania Mueller)/Hannah Cloke/Anne Verhoef (Uni Reading) |
|   - Beena Balan Sarojini (now at ECMWF, replacement to be appointed), Azin Howells, Anne Verhoef, Pier Luigi Vidale, Hannah Cloke (Uni Reading), Chris Jackson (BGS) |
|   - Pier Luigi Vidale, Anne Verhoef (UoR) |
|   - Becky Oliver (CEH) |
|   - Karina Williams (UKMO) and Anna Harper (Uni Exeter) |
| - Evaluation of JULES soil moisture using the Land Validation Toolkit (LVT, from NASA) and global observations. |
| - Evaluation of JULES (stream flows, soil moisture, evaporation) coupled with hydrological models (e.g. RFM) over the UK. |
| - Testing the feasibility of coupling JULES-SHETRAN. |
| - Ongoing work with high resolution soil hydrology. |
| - NERC AMUSED project (In-situ SMC/Cosmic rays/RS) as well as incorporation of macropore flow into JULES |
| - NERC SINATRA project (infiltration-flooding from intense rainfall), now TENDERLY follow-on project |
| - NERC IMPETUS drought project: prediction of 'soil moisture & groundwater drought'; work on plant water stress description in JULES, also linked to JPEG led by Williams and Harper |
| - Investigations into the effect of hydraulic parameterisations via new soil maps and PTFs |
| - Wetland vegetation PFT |
| - modelling the effect of the amount of available water in the soil on vegetation functioning and productivity; leaders of plant water stress JPEG |
| **Organic and chalk soils** |
| - Eleanor Burke, Karina Williams (UKMO), Sarah Chadburn (Uni Exeter) |
|   - Christina Bakopoulou (Imperial) |
|   - Rafael Rosolem, Shams Rahman (Uni Bristol) |
| - organic soil properties |
| - JULES in chalk catchments |
| - Simple macroporosity parameterization and inclusion of soil-chalk layers into JULES, and their influence on surface energy fluxes |
**Camilla Mathison:** New rose stem tests have been added to protect some of the hydrology code (trip, rfm and the irrigation code specifically). Maybe if they are considered less of a technical thing then people working on the code are aware of their worth and perhaps consider doing other rose stem tests that protect their specific area of code/interest.
Meetings: 16 November 2016 (CEH-Wallingford; general) & 12 January (UoR; infiltration sub-meeting)

- A very well-attended JULES Hydrology meeting took place on 16 November 2016, at CEH-Wallingford.

- Very fruitful meeting consisting of about a dozen talks, ranging from representation of bypass flow in chalk, to river routing and plant water stress parameterisations.

- There were also in-depth discussions, e.g. on how to best represent groundwater flow in JULES.
Towards a simple representation of chalk hydrology for large-scale land surface modelling

Rafael Rosolem
Bristol University

Acknowledgements: Shams Rahman and Joost Iwema

Fracture
- Low porosity = 10^{-4}
- High permeability = 10^{-5}-10^{-4} m s^{-1}

Matrix
- High porosity = 0.30-0.40
- Low permeability = 10^{-9}-10^{-8} m s^{-1}

Very thin layer of soil with some mixture of chalk
Bedrock chalk and flint. Highly fractured - water runs straight trough
Performance of JULES
Evapotranspiration in the UK

Eleanor Blyth, Alberto Martinez de la Torre, Emma Robinson
At the November 2016 meeting, three JULES Hydrology Working Groups were established

1. River routing and related issues: lead Simon Dadson (meeting took place 25 January 2017, in Oxford)
2. Soil spatial resolution, switches related to soil fluxes, averaging of soil hydraulic properties etc: Lead Sarah Chadburn
3. JULES Hydrology model configurations: Lead Toby Marthews (a follow-on teleconference has since taken place, 12 December, 2016)
ISMCGEWEX-SoilWat initiative on comparing soil hydraulic & thermal properties description and pedotransfer functions in LSMs

Anne Verhoef, Harry Vereecken, Matthias Cuntz, Lukas Gudmundsson, Lutz Weihermuller, Carsten Montzka, Michael Herbst, Kris van Looy

**JULES**: Anne Verhoef (inputs from Imtiaz Dharssi, Toby Marthews, Pier Luigi Vidale, Heather Ashton, Karina Williams, Nic Gedney, Martin Best & John Edwards)

**Inputs**
- Continuous PTF
  - Soil texture (sand, silt, clay %)
  - Bulk density
  - Organic carbon content
  - ...
- Soil Class PTF
  - Soil classes (e.g., sand, loam, clay)

**PTF**
- Brooks Corey
  - Rawls, Cosby, etc.
- Campbell
  - Clapp & Hornberger, etc.
- Mualem van Genuchten
  - Vereecken, Rosetta, Weynands, Wosten, Rawls, Toth etc.

**Hydraulic Parameters**
- Brooks Corey
  - $h_b$, $b$, $\theta_v$, $\theta_s$, $K_s$
- Campbell
  - $h_b$, $b$, $\theta_v$, $K_s$
- Mualem van Genuchten
  - $\alpha$, $n$, $\theta_v$, $\theta_s$, $K_s$

**Hydraulic Functions**
- Water Retention
- Hydraulic Conductivity
- Calculation of
  - Field Capacity
  - Wilting Point

$\theta_s$ = saturated volumetric water content
$\theta_r$ = residual volumetric water content
$K_s$ = saturated hydraulic conductivity
$b$ = Brooks Corey or Campbell shape parameter
$h_b$ = air entrapment value for Brooks Corey and Campbell (often also $\phi$)
$\alpha$ = reciprocal of the air entrainment value for Mualem van Genuchten
$n$ = shape parameter for Mualem van Genuchten

JULES meeting, 26 June 2017
OVERVIEW

• GEWEX and the soil and critical zone communities: improve interactions and integration of soil and subsurface processes in present climate models

• Planning workshop aimed at designing and prioritizing interactions took place in June 28-30, 2016 in Leipzig

• Various initiatives: (1) Evaluation of pedotransfer functions and related functional descriptions for calculation of hydraulic and thermal soil properties in global climate and hydrological models. A joint GEWEX-SoilWAT-ISM C project, led by Harry Vereecken and Anne Verhoef
Montzka, Carsten; Herbst, Michael; Weihermüller, Lutz; Verhoef, Anne; Vereecken, Harry (2017): A global data set of soil hydraulic properties and sub-grid variability of soil water retention and hydraulic conductivity curves, link to model result files in NetCDF format.
doi:10.1594/PANGAEA.870605,

*Supplement to:* Montzka, C et al. (in prep.): A global data set of soil hydraulic properties and sub-grid variability of soil water retention and hydraulic conductivity curves. *Earth System Science Data Discussions*

Always quote above citation when using data! You can download the citation in several formats below.

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Global hydraulic parameter map plus data set; Montzka et al.

Proposed method to aggregate soil hydraulic properties and sub-grid variability of soil water retention and hydraulic conductivity curves.

JULES meeting, 26 June 2017
Figure 6: Global map of $\text{var}(\log_{10} \hat{\lambda}_i)$ calculated from SoilGrids1km data set and the Rosetta PTF (Schaap et al., 2001) for 0.25° resolution.