**JULES Process Evaluation Group (JPEG) Session**

*28th June 2017*

**Introduction & session aims** (Martin Best)

* Emphasised the need to identify success criteria, i.e. see Best et al 2015 paper ‘The Plumbing of Land Surface Models: Benchmarking Model Performance’

<http://journals.ametsoc.org/doi/abs/10.1175/JHM-D-14-0158.1>

**Background on known process issues & biases in JULES**

**JPEG on soil moisture stress on vegetation** (Karina Williams)

*Introduction…*

* At the JULES 2016 meeting, a cross-community group was set up to discuss and evaluate this process within JULES.
* There were many groups within the community already working on this process, so made sense to combine efforts.
* Currently 38 members on the mailing list. 3 face-to-face meetings and 6 teleconference meetings so far (minutes available on the JULES wiki).
* This group has benefited from the involvement of experts in other parts of JULES, flux tower and satellite observations, plant physiology, other models.

*Progress so far…*

* Documenting and evaluating the current representation (JULES 4.8) using site observations - paper in progress.
* Sensitivity studies - regional and global runs (WFDEI), offline and online UKESM1 runs.
* Comparison to methods used in other models.
* New options introduced to JULES: pft-dependent wilting and critical soil water potentials, stress function can be linear in soil water potential, soil moisture can be prescribed (vn4.9 needs var name=var=’sthuf’).
* In addition to the code added to the JULES trunk and the shared Rose suite, 11 extra python scripts (5000+ lines), have also been shared across the group.

*Work planned over the next year…*

* detailed site modelling
* sensitivity studies to the new options
* how these options may be incorporated into JULES configurations
* evaluation of regional runs using satellite data
* work on the relative contributions of the soil layers to plant stress
* interaction between the stomatal response to VPD and soil moisture
* more explicit modelling of plant hydraulics

**Global, regional & linking with GC developments** (Sean Milton)

*Overview & identification of key biases relevant to JULES…*

* Global Climate (GC) model development process – inc Global Land (GL) and JULES

*Summary of key biases / errors related to JULES…*

* Key global systematic errors in **Air Temperature, and near surface humidity, soil moisture, GPP**
* **Warming over summer continents – Cooling in Winter in N Hemisphere**
* **Rapid warming–drying of summer monsoon regions – India, Africa**
* **Wet East Asian Summer Monsoon, Amazon and Andes/Himalayas**
* How do known JULES biases (offline evaluation vs FLUXNET) relate to water and energy cycle biases in fully coupled GC versions – CAUSES style study at other locations (e.g. India)?
* More rapid translation of JULES science development into GL versions – how to encourage ‘push’ from JULES community?

**Key aspects of land surface model for UKESM** (Alistair Sellar)

*Overview of UKESM1…*

* JULES relevant aspects: Terrestrial carbon-nitrogen cycle - TRIFFID vegetation dynamics (9 PFTs), RothC soil carbon, simple N-limitation scheme (Wiltshire in prep), diagnostic wildfire, improved diagnostic permafrost extent and wetland CH4 emission.
* Currently UKESM1 is in final tuning phase, aiming for freeze by end July.

*Top priorities for UKESM developments long-term…*

* Impacts of vegetation distribution on physical climate
* Particularly excessive bare soil → dust, albedo, roughness
* More generally: impacts of veg distribution biases on albedo, snow cover, energy fluxes
* Online-offline differences
* Reduces the usefulness of JULES for tuning and carbon cycle spinup.

**Summary of email survey & 2016 workshop** - JULES process issues & biases

Soil moisture & vegetation responses – current group (Karina, Anna et al)

* *Influence on NPP, veg distribution (Alistair Sellar)*

Soil hydrology (moisture) in general

* *Turbulent fluxes of heat and moisture – currently drying out below canopy soils too quickly (Eleanor Blyth et al)*
* *Soil hydrology schemes & parameters, soil evaporation, infiltration (Anne Verhoef SoilWat activities)*
* *Regional focus: Tropics and Arctic (Rich Betts, Sarah Chadburn)*

Soil carbon stocks, root distributions, decomposition, soil respiration

* *2016 TCC workshop – soil carbon decomposition (Eleanor, Chris Sarah)*
* *Carbon stocks, root distributions, soil respiration (Reading/NCAS)*

Vegetation distribution

* *Bare soil fraction & impact on dust emission & surface albedo (Alistair Sellar)*
* *Vegetation biases in northern mid-latitudes affecting albedo esp where snow cover sensitive to veg height (Alistair)*
* *Arctic veg not represented so carbon stocks & fluxes too small (Sarah Chadburn)*

Vegetation dynamics / competition

* *2016 TCC workshop (Tristan, Andy, Eddy, Pierre, Sarah, Anna, Chantelle)*
* *Competition for space (Reading/NCAS)*

Phenology

* *2016 TCC workshop (Karina, Debbie, Tristan-obs)*
* *Esp how phenology reacts to soil water (Reading/NCAS)*

Vegetation & soil C:N dynamics *(Chris Jones, Debbie)*

Proper vegetation aerodynamics scheme *(Reading/NCAS)*

Could Vcmax be improved? *(Reading/NCAS)*

**Prioritise known process issues & biases in JULES**

**Identify & prioritise key process issues & biases** (Breakout groups)

Four Breakout Groups **(Blue, Green, Orange, Pink)**. Each filled out separate templates for each process/bias they could identify inc info on:

* Key processes / biases
* Ideas on how to address
* Criteria for success
* People interested and/or already working on each
* people interested in leading a focus group
* Prioritise the processes/biases

*Summary…*

19 templates completed, focused on:

* 8 on Soil hydraulics, soil moisture, river flow
* 4 on Surface fluxes (inc bare soil and evapotranspiration)
* 3 on Online vs Offline
* 2 on Phenology
* 1 on Vegetation distribution
* 1 on Ancillaries

See Annex, below, for each template…

**Annex – Priority issues and biases completed templates**

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| Blue group | Priority rank: 1 |
| Brief description of process/bias:  Soil moisture / hydraulics | |
| Names of people interested:  Imtiaz Dharssi (BoM), Nic Gedney, Reading Group (Anne Verhoef…), Eleanor Blyth, Elberto Martinez, Martin Best, Heather Rumbold | |
| Name of person/people interested in leading this proposed JPEG:  Eleanor Blyth | |
| Ideas on how to address this (ie. methods, JULES runs, observations for evaluation…):   * Document current issues * Split into sub-tasks * Get ancillaries of soil properties ‘right’ * Which is the best set of ancillaries * Relevant to science being addressed * Why does JULES have more than 1 hydraulics scheme? | |
| How to measure success?:   * Make a recommendation on which of the two existing schemes is best for different specific purposes * Clear documentation of which scheme is useful for which purpose | |

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| Blue group | Priority rank: 2 |
| Brief description of process/bias:  Online vs Offline biases | |
| Names of people interested:  Karina Williams, Huw Lewis, Helen J, Adrian Lock et al, Doug | |
| Name of person/people interested in leading this proposed JPEG:  Someone with access / experience in running with UM-JULES | |
| Ideas on how to address this (ie. methods, JULES runs, observations for evaluation…):   * ‘Toolkit’ default STASH, scripts etc, methodology * Rose stem demonstration 🡪 what is ‘close enough’ comparison? * Understand under what circumstance offline / online differs and doesn’t * Understand drifts over time | |
| How to measure success?:   * Existance of toolkit & rose stem capability * Documentation / solving of issues | |

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| Blue group | Priority rank: 3 |
| Brief description of process/bias:  Canopy structure (diurnal cycle issue) – surface energy budget | |
| Names of people interested:  John Edwards, Gary Hayman, Eleanor Blyth, others… | |
| Name of person/people interested in leading this proposed JPEG:  Eleanor Blyth | |
| Ideas on how to address this (ie. methods, JULES runs, observations for evaluation…):   * Document current issues / biases * Capturing requirements of different communities e.g. ESM… * What other avenues would be opened up if this was improved i.e. if skin T was reliable it could be assimilated to improve forecast * Several other aspects e.g. diurnal T cycle, BVOC deposition | |
| How to measure success?:   * Depending on different requirements | |

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| Blue group | Priority rank: 4 |
| Brief description of process/bias:  Ancillaries {included as part of configs} | |
| Names of people interested:  Toby Marthews, Eddy C.P. | |
| Name of person/people interested in leading this proposed JPEG:  Eleanor Blyth | |
| Ideas on how to address this (ie. methods, JULES runs, observations for evaluation…):   * There need to be a set of JULES ancils that are available to the entire community. It needs to be clear where they’ve come from. * Ancils need to be specified as part of configurations | |
| How to measure success?:   * At next JULES meeting people state in their talks which configuration of JULES they’ve used and give a suite ID. | |

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| Orange group | Priority rank: |
| Brief description of process/bias:  Offline vs Online discrepancy of spin, eval and tuning | |
| Names of people interested:  Hugh Zhang, Sean Milton, Alistair Sellars, Kate Halladay, Eleanor Burke, Eddy C-P, Seb Gargue | |
| Name of person/people interested in leading this proposed JPEG:  Rich Ellis | |
| Ideas on how to address this (ie. methods, JULES runs, observations for evaluation…):   * SCM runs & coupled runs * Need technical changes to JULES link to UM * Impacts on UKESM tuning, spinup – makes future developments (discretised soil carbon/nitrogen, permafrost carbon) impossible | |
| How to measure success?: | |

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| Orange group | Priority rank: |
| Brief description of process/bias:  Vertical soil physics – resolution & soil depth, soil properties | |
| Names of people interested:  Sean Milton, Eleanor Blyth, Eleanor Burke | |
| Name of person/people interested in leading this proposed JPEG:  Eleanor Blyth, Anne Verhoef | |
| Ideas on how to address this (ie. methods, JULES runs, observations for evaluation…):   * Layer depths * Soil properties * Organic soils * Soil moisture obs (not in UK) * LST analysis | |
| How to measure success?: | |

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| Orange group | Priority rank: |
| Brief description of process/bias:  Horizontal transfer of water | |
| Names of people interested:  Eddy C-P, Eleanor Blyth, Ross Woods, Rob Parker, Heather Ashton, Toby Marthews | |
| Name of person/people interested in leading this proposed JPEG:  Simon Dadson | |
| Ideas on how to address this (ie. methods, JULES runs, observations for evaluation…):   * Overbank inundation * But how to treat the flood water * Into soil column? * Into lake/river? | |
| How to measure success?: | |

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| Orange group | Priority rank: |
| Brief description of process/bias:  Northern lats (cold) hydrology, soil physics | |
| Names of people interested:  Eleanor Burke, Eleanor Blyth, Eddy C-P, Ross Woods, Sean Milton | |
| Name of person/people interested in leading this proposed JPEG:  Ross Woods | |
| Ideas on how to address this (ie. methods, JULES runs, observations for evaluation…):   * Freezing of soil * Layer thickness | |
| How to measure success?: | |

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| Orange group | Priority rank: |
| Brief description of process/bias:  Phenology – no soil moisture dependence, lack of high latitude | |
| Names of people interested:  Eleanor Burke, Eddy C-P, Eleanor Blyth, Darren Slevin, Anna Harper | |
| Name of person/people interested in leading this proposed JPEG: | |
| Ideas on how to address this (ie. methods, JULES runs, observations for evaluation…):   * LAI at high lats to constant not enough seasonality * Drought deciduous Broadleaf Tree and the soil moisture dependence | |
| How to measure success?: | |

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| Orange group | Priority rank: |
| Brief description of process/bias:  Evapotranspiration | |
| Names of people interested:  Eleanor Blyth, Ruth Lewis, Alistair Sellars, Seb Gangue, Hugh Zhang | |
| Name of person/people interested in leading this proposed JPEG:  Eleanor Blyth | |
| Ideas on how to address this (ie. methods, JULES runs, observations for evaluation…): | |
| How to measure success?: | |

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| Orange group | Priority rank: high impact for UKESM |
| Brief description of process/bias:  Bare soil biases | |
| Names of people interested:  Sebastian Garrigues, Eleanor Burke, Alistair Sellar | |
| Name of person/people interested in leading this proposed JPEG:  Rich Ellis | |
| Ideas on how to address this (ie. methods, JULES runs, observations for evaluation…):   * Links to moisture stress & evapotranspiration * To what extent is veg dynamics responsible? | |
| How to measure success?: | |

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| Yellow Group | Priority rank: 1 |
| Brief description of process/bias:  River flow / routing & inundation | |
| Names of people interested:  Nic Gedney, Camilla Mathison, Heather Rumbold, Alberto Martinez, Doug Clark, Toby Marthews, Huw Lewis, Andy Wiltshire | |
| Name of person/people interested in leading this proposed JPEG:  Simon Dadson | |
| Ideas on how to address this (ie. methods, JULES runs, observations for evaluation…):  On going   * Target – evaporation, latent heat, CH4 * ESM, NWP * Satellite obs of wetland inundation * Runoff generation & links to soil hydraulics * Spectral properties of river flow | |
| How to measure success?:   * Wetland inundation in ESM – better than previous model * Riverflow comparable with other LSMs & obs | |

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| Yellow Group | Priority rank: 1 |
| Brief description of process/bias:  Online vs Offline biases | |
| Names of people interested:  Doug Kelly, Alistair Sellar, Andy Wiltshire, Eddy Robertson, Alex Priestley | |
| Name of person/people interested in leading this proposed JPEG:  Doug Kelly / Alistair Sellar | |
| Ideas on how to address this (ie. methods, JULES runs, observations for evaluation…):   * Force JULES with fluxes from coupled models or ??? to state vars | |
| How to measure success?: | |

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| Yellow Group | Priority rank: |
| Brief description of process/bias:  High latitude hydraulics / soil hydraulics | |
| Names of people interested:  Sarah Chadburn, Simon Dadson, Toby Marthews, Nic Gedney, Ross Woods, Eleanor Blyth, Eleanor Burke, Alex Priestley | |
| Name of person/people interested in leading this proposed JPEG:  Ross Woods | |
| Ideas on how to address this (ie. methods, JULES runs, observations for evaluation…):   * Site simulations – in situ soil moisture, satellite (ASCAT) * Try to separate influence of different processes * Incorporate understanding from observationalists * Need to be able to simulate perched watter table, saturated / boggy soil in permafrost region (will affect CH4 emissions, soil carbon stocks, active layer 🡪 nitrogen, veg growth, land temperatures) | |
| How to measure success?:   * Don’t make other things worse | |

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| Yellow Group | Priority rank: |
| Brief description of process/bias:  Tropical soil moisture bias | |
| Names of people interested:  Doug Kelly, Andy Wiltshire, Simon Dadson | |
| Name of person/people interested in leading this proposed JPEG:  Toby Marthews | |
| Ideas on how to address this (ie. methods, JULES runs, observations for evaluation…):  Current tropical soil moisture biases often coincide with area of oxisol soil type. One possible hypothesis is (says Toby) that oxisols are microaggregated soils and these are odd soils; although they are clays, hydraulically they act a bit like sands (Marthews et al 2014, GMD). Recent work at CEH by Nic Gedney and Toby Marthews showed improved wetland extend prediction in South Amercia if you swap the clay parameterisation for sand in oxisol areas. A theoretically more robust way of doing this might be to allow non-zero residual soil water in JULES. | |
| How to measure success?:   * Better simulation of soil moisture in S. America | |

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| Yellow Group | Priority rank: |
| Brief description of process/bias:  Phenology – esp dry areas | |
| Names of people interested:  Debbie Hemming, Hilary Ford, Doug Kelly, Andy Wiltshire, Lucy Rumbolt, Sarah Chadburn | |
| Name of person/people interested in leading this proposed JPEG: | |
| Ideas on how to address this (ie. methods, JULES runs, observations for evaluation…):   * Drought deciduous * Needle phenology * Look at effect of competition on phenology * Avoiding leaf-on mid-way through winter * How to set up phenology for a site simulation? | |
| How to measure success?:   * Don’t make other things worse | |

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| Pink group | Priority rank: 1 |
| Brief description of process/bias:  Surface fluxes (momentum, moisture, energy, carbon) | |
| Names of people interested:  Marin Best, John Edwards, Alberto Martinez, Antonio Manzi, Rafael Rosolem, Eleanor Blyth | |
| Name of person/people interested in leading this proposed JPEG: | |
| Ideas on how to address this (ie. methods, JULES runs, observations for evaluation…):   * Modelled fluxes need to beat linear regression * Single site runs - FLUXNET | |
| How to measure success?:  Be able to beat defined empirical benchmarks | |

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| Pink group | Priority rank: 2 |
| Brief description of process/bias:  Global vegetation distribution (unrealistic in some areas) | |
| Names of people interested:  Rich Betts, Martin Best, (ARGU? Vegetation people), Manoel Cardoso | |
| Name of person/people interested in leading this proposed JPEG: | |
| Ideas on how to address this (ie. methods, JULES runs, observations for evaluation…):   * Compare against ESA Landcover CCI dataset * Start with small group to establish what the key issues are then bring in others once this is known * Single-point JULES simulations to explore model sensitivities in areas of major bias | |
| How to measure success?:  JULES to have a better representation of global PFT fraction than other DGVMs, when driven with observed climate | |

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| Pink group | Priority rank: 3 |
| Brief description of process/bias:  Spectral characteristics of stream flow | |
| Names of people interested:  Graham Weedon, Heather Rumbold, Martin Best, Alberto Martinez, Rafael Rosolem | |
| Name of person/people interested in leading this proposed JPEG: | |
| Ideas on how to address this (ie. methods, JULES runs, observations for evaluation…):   * Match signatures in model & obs. spectral analyses * Sub-daily flows * Sub-daily snowmelt runoff | |
| How to measure success?:  To match observations to within tolerance (e.g. match amplitude ration – to be refined) | |