Short Course

JULES

Joint UK Land Environment Simulator

Lancaster, 29th-30th June 2016

JULES Short Course

Scope

- Brief introduction to JULES (science, development, resources)
- Practical sessions

Course will not cover

- MAJIC: The online version of JULES (https://majic.ceh.ac.uk/)
- Coupled applications of JULES in the UM (as covered elsewhere)

Introduction to

JULES

Joint UK Land Environment Simulator

Garry Hayman (CEH)

JULES Short Course

Lancaster, June 29th 2016

Introduction

JULES
Joint UK Land Environment Simulator

Scope

- Overview of JULES
- Example applications
- Summary

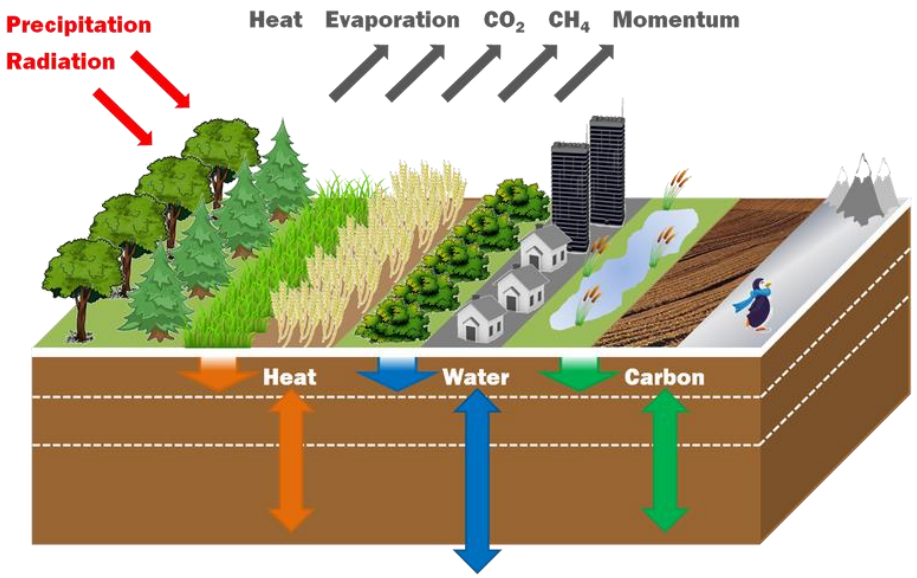
Acknowledgements

- For applications:
  - Emma Robinson (CEH)
  - Eleanor Blyth and Alberto Martinez de la Torre (CEH)
  - Lina Mercado (U. Exeter) and Alex Rap (U. Leeds)

JULES

JULES
Joint UK Land Environment Simulator

- Process-based model of the carbon, energy and water exchange between the land surface and atmosphere
- Community model, available on request
- Development led jointly by the Centre for Ecology & Hydrology and the Met Office
- Used in different configurations ('standalone' or 'coupled')
- Default land surface scheme for the Earth System and climate models of NERC and the Met Office Hadley Centre



http://jules.jchmr.org

Continual Development

JULES
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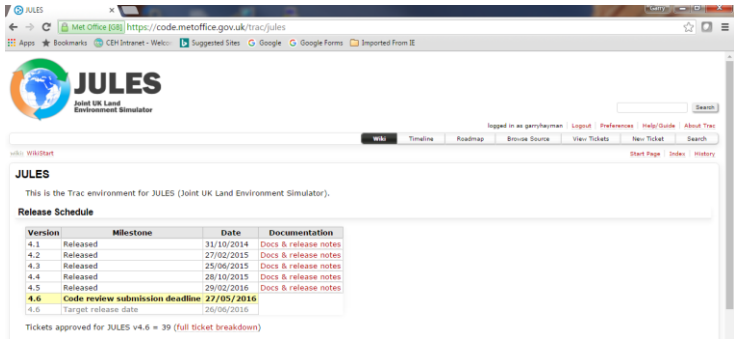
2008
2009
2010
2011
2012
2013
2014
2015
2016

JULES v1 (=MOSES)
- v1.0: Point configuration

JULES v2 (2009-2011)
- v2.0: Gridded configuration
- v2.1: Multi-layer snow scheme, Roth C carbon pools used in TRIFFID, Improved I/O (netCDF)
- v2.2: Urban tile, O_3 plant damage, diffuse/direct radiation



JULES repository: https://code.metoffice.gov.uk/

JULES v3 (2011-2014)
- v3.0: IMOGEN climate emulator
- v3.1: Namelists introduced, JULES repository
- v3.2: Biogenic VOCs added,
- v3.3: JULES parallelised
- v3.4: improved output

JULES v4 (2014-present)
- v4.0: Crops, science namelists
- v4.1: Irrigation demand, C-cycle
- v4.2: River routing, fire, bedrock, trait pft updates
- v4.3: Snow, wetlands, crops
- v4.4: Nitrogen, wetland CH_4
- v4.5: JULES-CN, Lake, dry deposition, fires (INFERNO)
- v4.6: June 2016

JULES Management

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Management
- Martin Best (MO) - Chair
- Chris Jones (MO)
- Nick Reynard (CEH)
- Doug Clark (CEH)

Science Modules
- Surface, including snow and urban
  (Helen Ward , Reading*, Richard Essery, Edinburgh)
- Hydrology
  (Anne Verhoef, Reading; Nic Gedney, MO)
- Vegetation, including physiology, dynamics and fire
  (Anna Harper, Exeter*; Lina Mercado, Exeter)
- Biogeochemistry, including soil carbon and nitrogen
  (Sarah Chadburn, Exeter; Mat Williams, Edinburgh)
- Biogenic fluxes
  (Oliver Wild, Lancaster; Gerd Folberth, MO)
- Evaluation, calibration and data assimilation
  (Tristan Quaife, Reading; Eleanor Blyth, CEH*)

* co-chairs

Applications
- UKESM1 Colin Jones (MO)
- UKEP Huw Lewis (MO)
- GM David Walters (MO)
- Impacts Richard Betts (MO)

Outreach
- Stephen Sitch (Exeter)
- Emily Black (Reading)
- Eleanor Blyth (CEH)

Technical
(Richard Gilham, MO)

Key processes and timescales

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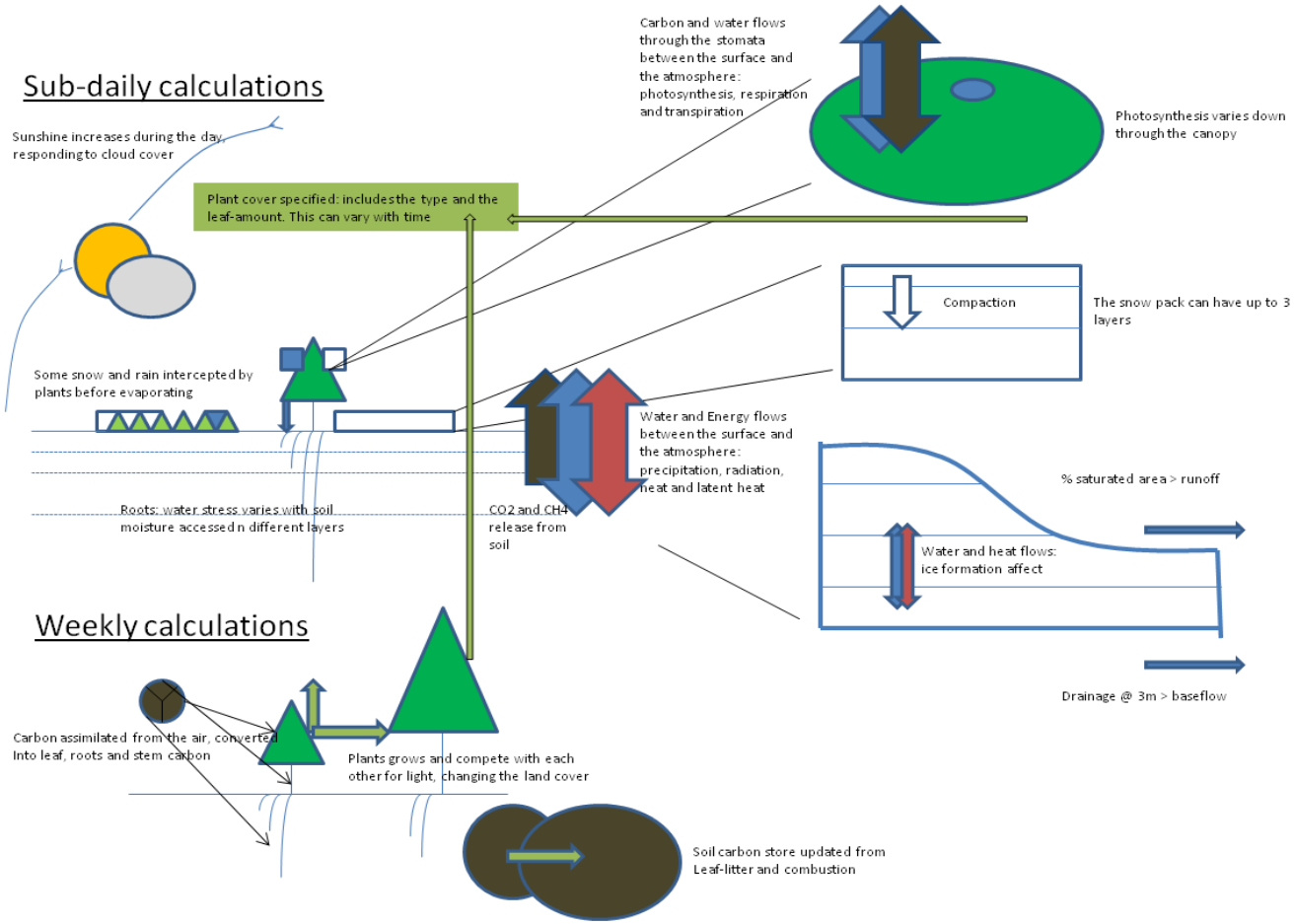
- Radiation
- Energy balance
- Water cycle and Hydrology
- Vegetation (seasonal growth and longer-term changes)
- Soils



Best et al., Geoscientific Model Development, 2011, 4, 677
Clark et al., Geoscientific Model Development, 2011, 4, 701

Evaluation

- JULES has been evaluated [Blyth et al., GMD, 4, 255 (2011)] against:
  - Various flux measurements
  - River flow data
  - Vegetation indices (LAI, NDVI)
- Use as benchmarking datasets
- Other evaluations undertaken since (snow, radiation, soil temperature, ...)

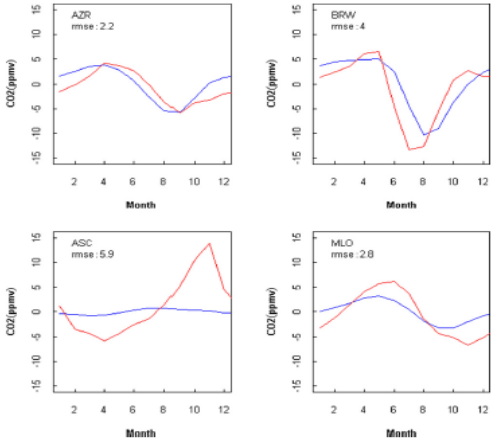


Fig. 5. Modelled (red) and observed (blue) seasonal variation of atmospheric CO_2 at four stations: Azores (AZR), Barrow (BRW), Ascension (ASC), and Mauna Loa (MLO).

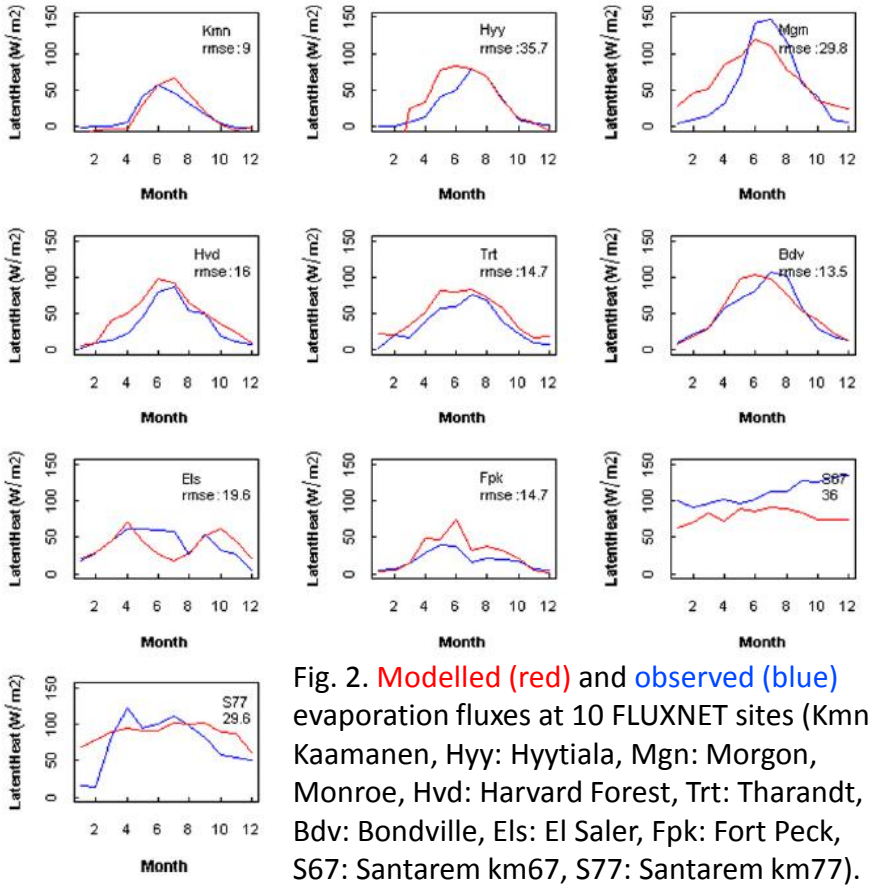
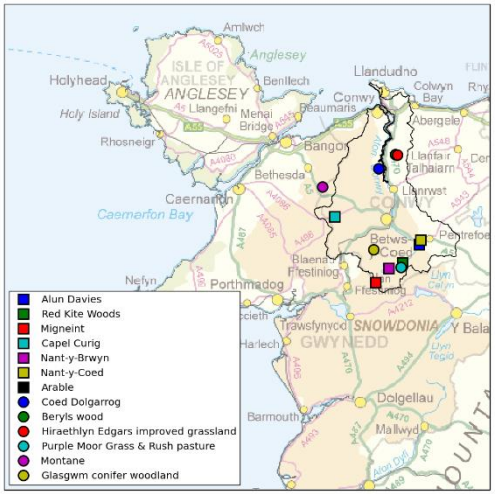


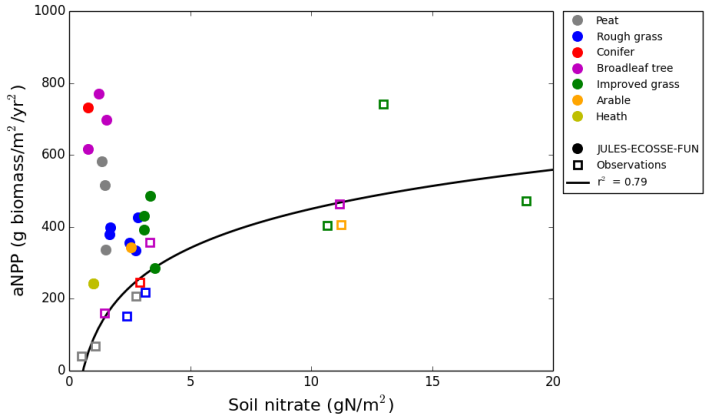
Fig. 2. Modelled (red) and observed (blue) evaporation fluxes at 10 FLUXNET sites (Kmn: Kaamanen, Hyy: Hyytiala, Mgn: Morgon, Monroe, Hvd: Harvard Forest, Trt: Tharandt, Bdv: Bondville, Els: El Saler, Fpk: Fort Peck, S67: Santarem km67, S77: Santarem km77).

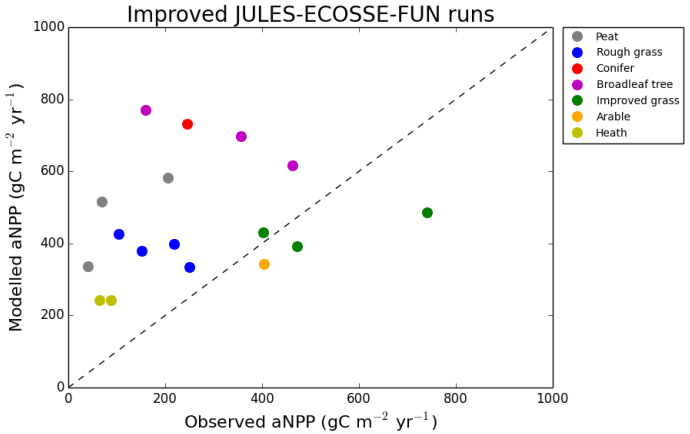
Application 1: Nutrient cycles

Courtesy of Emma Robinson (CEH)

- Carbon and nitrogen (and phosphorus) cycling
  - Field measurements in Conwy Catchment as part of NERC Macronutrient project: Turf2Surf
  - Soil nitrate was a strong predictor of vegetation productivity
- JULES-ECOSSE-FUN in 'offline point-mode' using UK 1 km x 1km CHESS driving met data
- JULES has smaller fertility gradient than observed







Application 2: UK-scale runs

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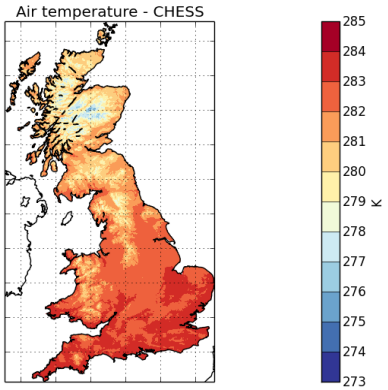
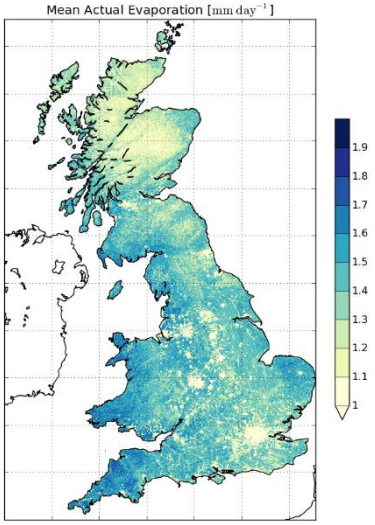
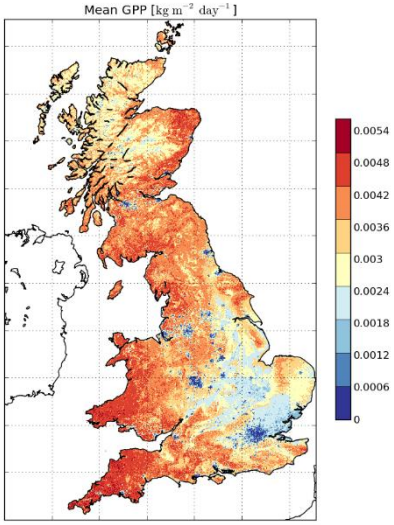
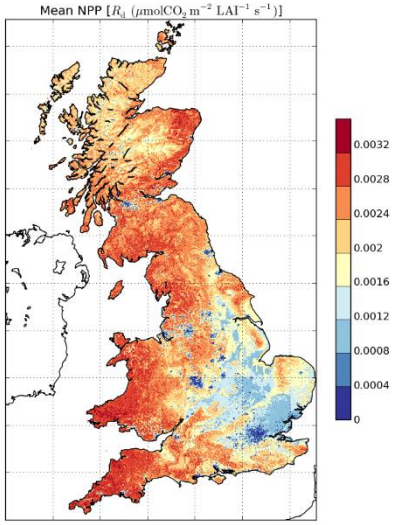
Courtesy of Eleanor Blyth, Alberto Martinez de la Torre (CEH)

- JULES in 'offline gridded-mode'
- UK 1 km x 1 km grid: 315,000+ grid points
- Daily driving met data for 1961-2015 (CHESS)
- Wide range of output parameters
- Compare with observations
- Use for new science





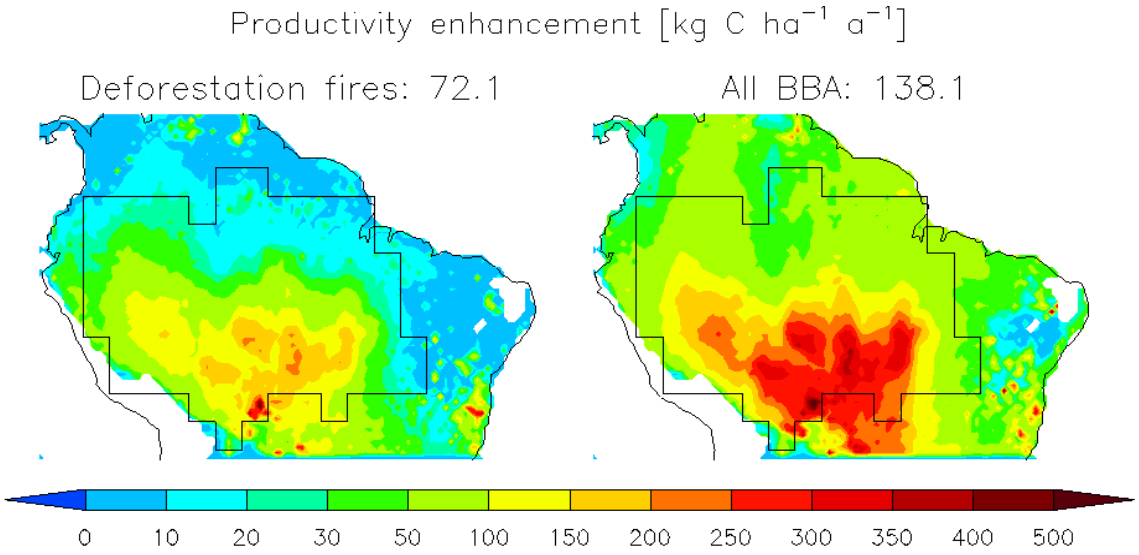




Application 3: Radiation effect on vegetation

Courtesy of Lina Mercado (Exeter) and Alex Rap (U. Leeds)

- Biomass burning generates aerosols, which affect proportions of direct and diffuse radiation
- Impact on photosynthesis and vegetation productivity



- Amazon-basin NPP enhancement of 83 Tg C a^{-1} during the period 1998-2008
- Offsets ~27% of the annual rate of carbon loss from fire emissions
- Estimate 32 Tg C a^{-1} as woody NPP enhancement ~6.6 % of the observed carbon sink across mature Amazonian forests

Summary

- JULES is a state-of-the-art land surface model
- Available to the research community
- Examples given of range of science applications

- Welcome to the JULES community
- Enjoy this short course

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