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Joint Weather & Climate Research
Programme – a partnership in weather
and climate research



The JULES Earth System Configuration

Coordinated by Met Office Hadley Centre (Andy Wiltshire)

Partners at University of Exeter (led by **Anna Harper**) and CEH
Wallingford

Large number of contributors: 25+

JULES Science Meeting, Lancaster

Tuesday, 28th June, 2016





Joint Weather & Climate Research
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UK Earth System Model

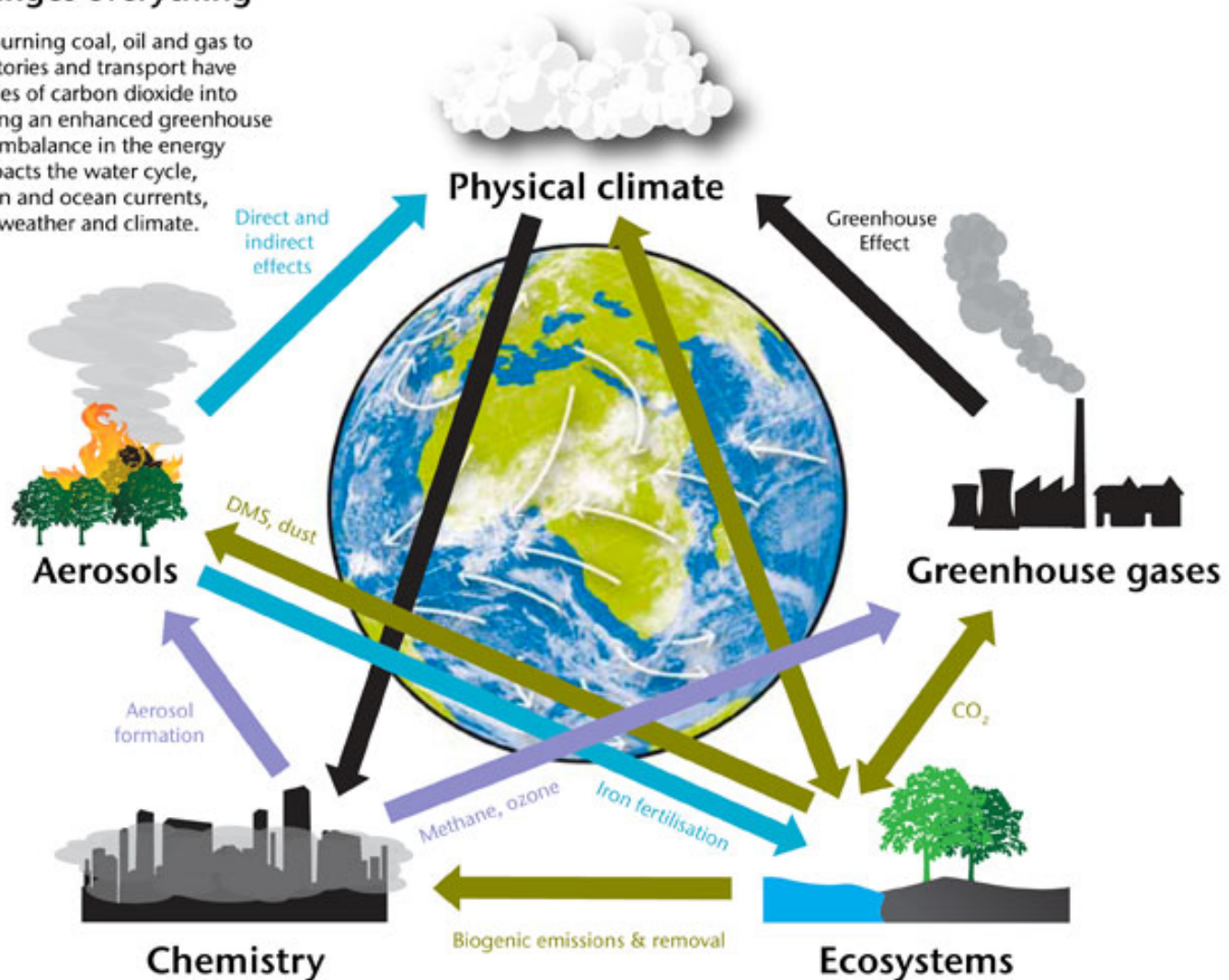
- Next generation model for CMIP6 and beyond
- Collaboration between the Met Office and NERC
- Involves partners and institutions throughout the UK
- Basically the Hadley Centre Climate model with additional Earth System Processes



The Earth System

One thing changes everything

Human activities like burning coal, oil and gas to power our homes, factories and transport have released huge quantities of carbon dioxide into the atmosphere, causing an enhanced greenhouse effect. This causes an imbalance in the energy cycle that, in turn, impacts the water cycle, atmospheric circulation and ocean currents, leading to changes in weather and climate.





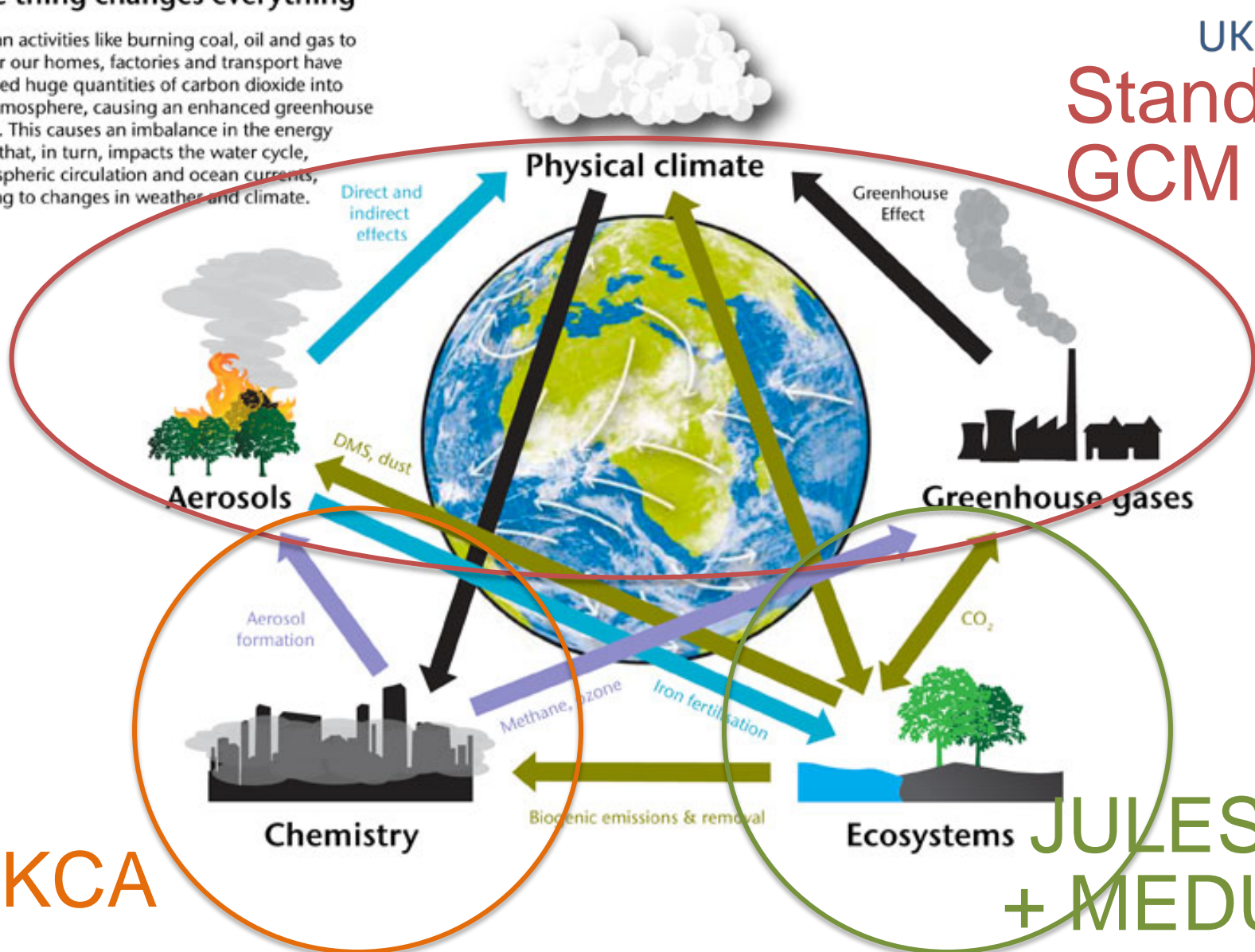
UKESM

Standard
GCM

The Earth System

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UKCA

JULES-ES
+ MEDUSA

What is JULES Earth System? JULES-ES




- Heat
- Moisture
- Momentum



Standard
JULES

What is JULES Earth System? JULES-ES

- 
- Heat
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Standard
JULES



- Heat
- Moisture
- Momentum

- CO₂, BVOCs, Nitrogen
- Dynamic vegetation



JULES-ES
for UKESM

- The land surface, particularly the vegetation distribution, is allowed to respond to climate and feed back.
- A separate activity is improving ice sheet processes (Robin Smith – Reading University) for UKESM. This is not included in JULES-ES.

Route from JULES to JULES-ES

- JULES-C1p1
- JULES-TRIFFID2
- JULES-CN
- JULES-ML
- JULES-ES



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JULES Configurations

JULES-C-1p1 (Carbon only, vn 1.1)

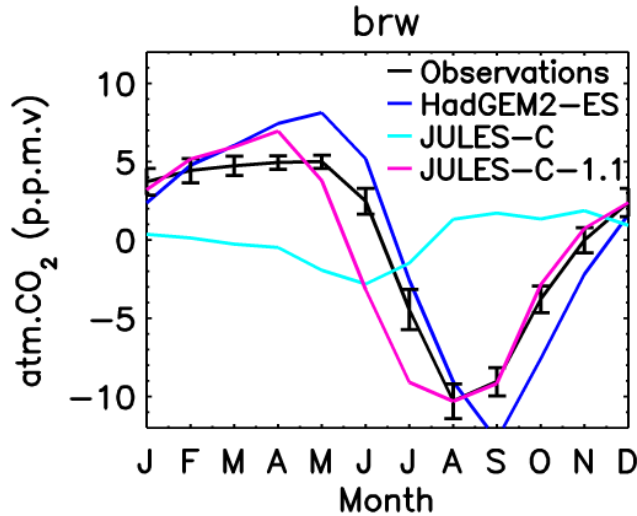
- Comparable to HadGEM2-ES (note HadGEM2-ES used MOSES)
- 5 PFT TRIFFID
- Roth-C Soil Biogeochemistry
- Interactive land-use change
- A number of JULES fixes



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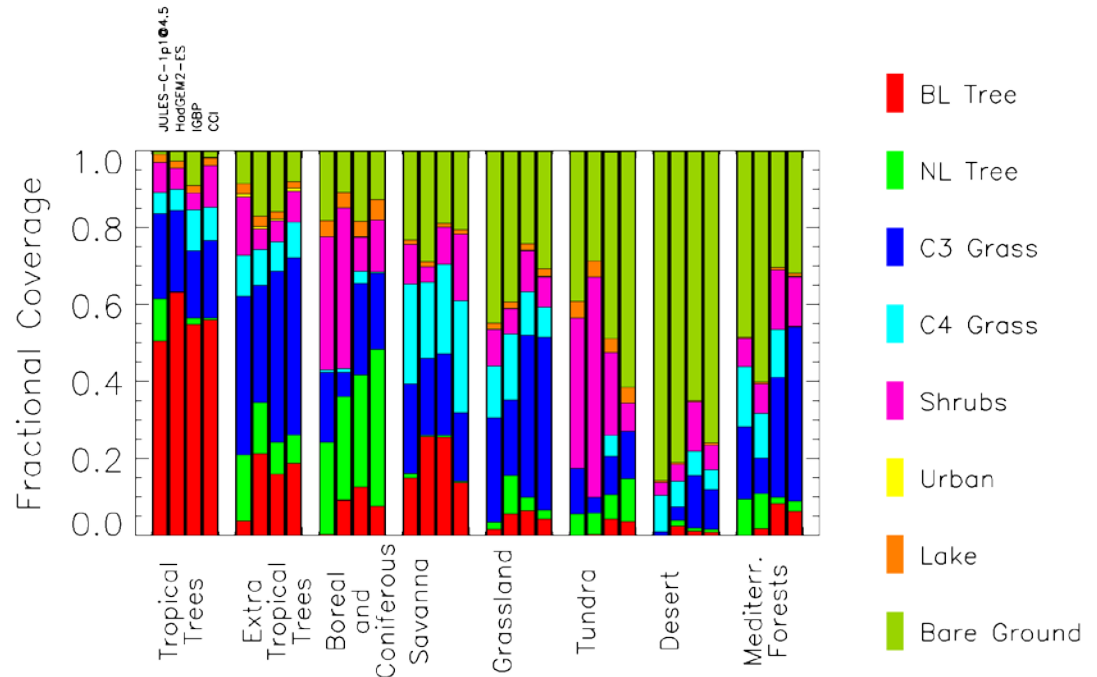
JULES-C-1p1

- Introduce land-use change from HadGEM2-ES (Jones et al. 2013)
- Introduce time varying CO₂ forcing
- Numerous fixes and improvements (available from v4.6).



- Massive improvement in seasonal cycle of atmospheric CO₂

- Reasonable vegetation distribution





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JULES-C-1p1

JULES Configurations

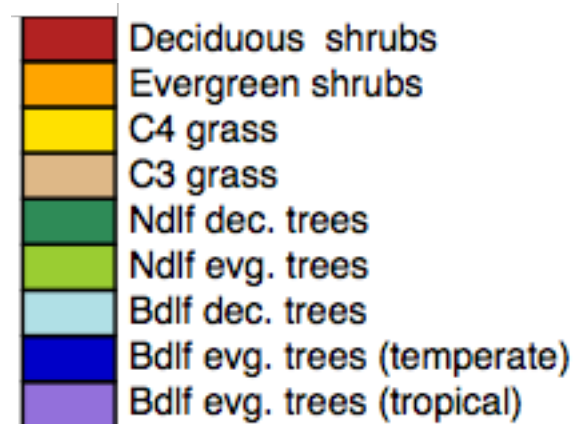
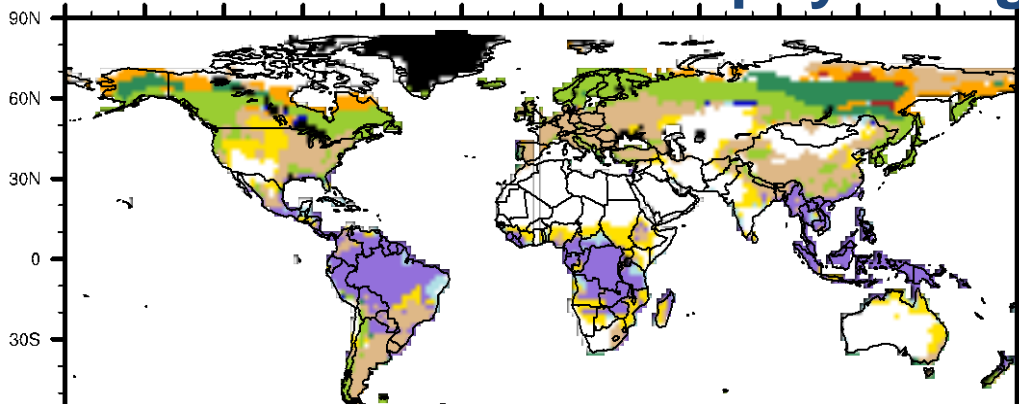
JULES-TRIFFID2

- Major upgrade to TRIFFID to move to 9 PFTs
- Trait based parameterisation

JULES-TRIFFID2

- 9 PFTs plus flexible tiles
- Trait-based physiology for photosynthesis and plant nitrogen components (Harper et al. 2016, *GMD*)

JULES: New PFTs and physiology





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JULES Configurations

JULES-C-1p1

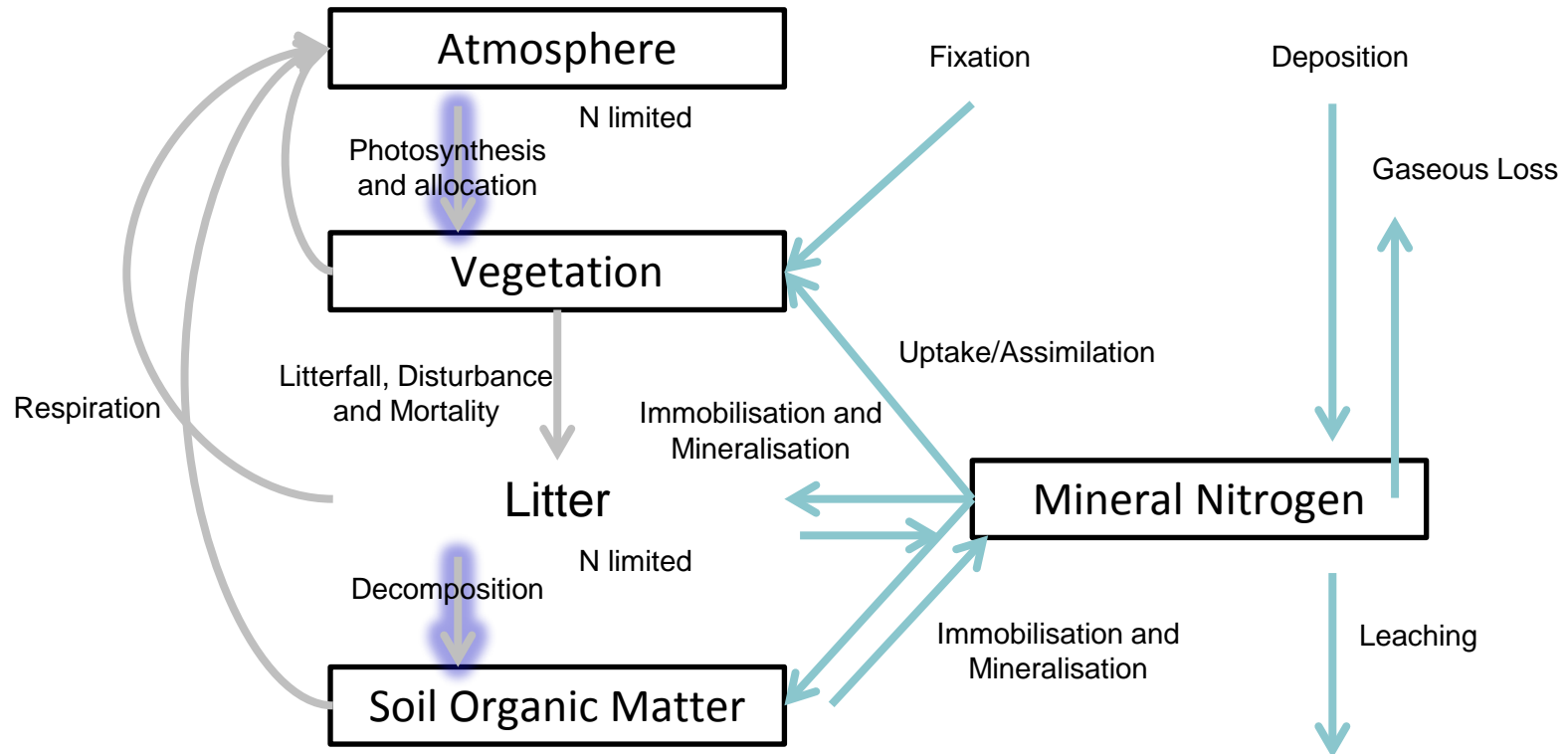
JULES-TRIFFID2

JULES-CN (Carbon - Nitrogen)

- New Vegetation and Soil Biogeochemistry model
- Interacts through vegetation dynamics
- Based on JULES-C-1p1

JULES-CN

- Limited Nitrogen availability now affects ability of vegetation to sequester Carbon
- Reduces CO₂ fertilisation effect
- Enhances warming effect through enhances Nitrogen mineralisation



Configuration expected to be available to the community in from 4.7

Andy Wiltshire



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JULES Configurations

JULES-C-1p1

JULES-TRIFFID2

JULES-CN

JULES-ML (Lanaged Land)

- Introduces crop and pasture PFTs
- Crop Harvest and Nitrogen fertilisation
- Note this is not JULES-crop but a simplified version compatible with TRIFFID and land-use change



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JULES Configurations

JULES-C-1p1

JULES-TRIFFID2

JULES-CN

JULES-ML

JULES-ES – Due to be finalised next spring

- All the above! Including couplings between new components
- Plus:
 - 4 species BVOC emission model
 - Updated wetland and CH₄ emission model
 - Fixed canopy radiation scheme (CanRad6)

Note on Canopy Radiation

- 6 Canopy Radiation Options – which to use?
- 1 or 6 are recommended – JULES 4.6 will include bug fixes to CRM1 to 5 on a switch (l_leaf_n_resp_fix in jules_vegetation namelist).
- CRM1 is the big-leaf model as used in HadCM3
- CRM6 is the scheme for UKESM including direct and diffuse light effects
 - Note knl (from 4.6) should be set around 0.2 and diffuse_frac to 0.4



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Note on Configurations

- The UKESM development process has relied on configurations – groups of parameter settings and switches combined with ancillaries.
- These enable new processes and understanding to be compared to standard results.
- Standard configurations allow for easier access to results by having an initial setup known to produce good output.
- With the exception of minor bug fixes, these are bit-comparable between model releases these ensure the code is in good order and enables users to upgrade to latest version.
- Look out for ES configuration documentation papers over the next 12 months.



Note on Configurations

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Met Office [GB] <https://code.metoffice.gov.uk/trac/jules>

JULES

This is the Trac environment for JULES (Joint UK Land Environment Simulator).

Release Schedule

| Version | Milestone | Date | Documentation |
|------------|--|-------------------|--|
| 4.1 | Released | 31/10/2014 | Docs & release notes |
| 4.2 | Released | 27/02/2015 | Docs & release notes |
| 4.3 | Released | 25/06/2015 | Docs & release notes |
| 4.4 | Released | 28/10/2015 | Docs & release notes |
| 4.5 | Released | 29/02/2016 | Docs & release notes |
| 4.6 | Released | 27/06/2016 | Docs & release notes |
| 4.7 | Code review submission deadline | 30/09/2016 | |
| 4.7 | Target release date | 26/10/2016 | |

Tickets approved for JULES v4.7 = 1 ([full ticket breakdown](#))

General documentation

[JULES User Guide and release notes \(from vn3.3 onwards\)](#)

[Model description papers](#)

[JULES Governance](#)

[Plan and schedule for adding soil tiling to JULES](#)

[JULES-crop](#)

[Information for running with 9 PFTs and trait physiology](#)

<https://code.metoffice.gov.uk/trac/jules/wiki/9PFTs>



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Summary

- UKESM will hopefully be a major upgrade to our capability at modelling biogeochemical processes in the Earth System.
- Most significant upgrade since TRIFFID was first introduced in HadCM3LC.
- JULES-ES and UKESM will be community models and configurations – please feel free to make use of them as they become available.



UNIVERSITY OF
EXETER

New Post-Doc position on biogeochemistry in JULES and UKESM:

- 3 years at Exeter, supervised by P. Friedlingstein
- Focus on either nitrogen cycle or land use/management.
- Evaluate and analyse CMIP6 simulations
- Part of CRESCENDO project



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Questions?

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Proposed guidelines for traceable JULES setups

Richard Betts, Anna Harper etc etc.



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JULES release

Difference between JULES release and JULES configuration

Configuration

- Set of choices for different code options
- Parameter settings
 - Hidden switches!
- Domain and resolution
- Ancillary files
- Sometimes a configuration can/should only be used with specific driving data
- Online (in UM – related UM suite) or offline

3 guiding principles for runs that will be published (aspirational?)

Always take a branch from the latest JULES release*

Always base on an established configuration*

Keep record of changes made relative to baseline configuration:

- New code
- Different namelist settings
- Different ancillaries
- Anything else?

*Implication -> established configurations will be required to be migrated to new JULES releases

Worked examples

Examples of describing a configuration:

- <https://code.metoffice.gov.uk/trac/jules/wiki/JulesCrop#JULES-cropconfigurations>
- <https://code.metoffice.gov.uk/trac/jules/wiki/9PFTs>

Previously defined configurations:

- Namelists: <https://code.metoffice.gov.uk/trac/jules/browser/doc/trunk/configurations>
- Descriptions: <http://jules-lsm.github.io/vn4.5/science-configurations.html>

Information for JULES runs contributed to a specific MIP:

<https://code.metoffice.gov.uk/trac/jules/wiki/AgmipMaizeEt>

EX: JULES Impacts

- JULES-crop
- Irrigation
- Rivers
- (Glaciers later)
- Aim is to do integrated simulations of hydrological and agricultural impacts