JULES as a community model and land surface scheme for weather / climate models

Martin Best

JULES meeting

12th January 2012

Overview

- History of JULES

- Current state

- Future plans

History

Origins of JULES
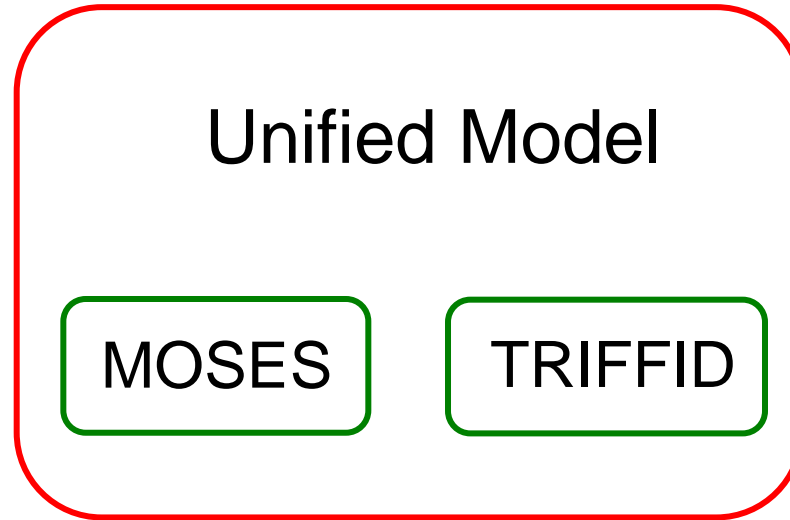
Unified Model

MOSES   TRIFFID
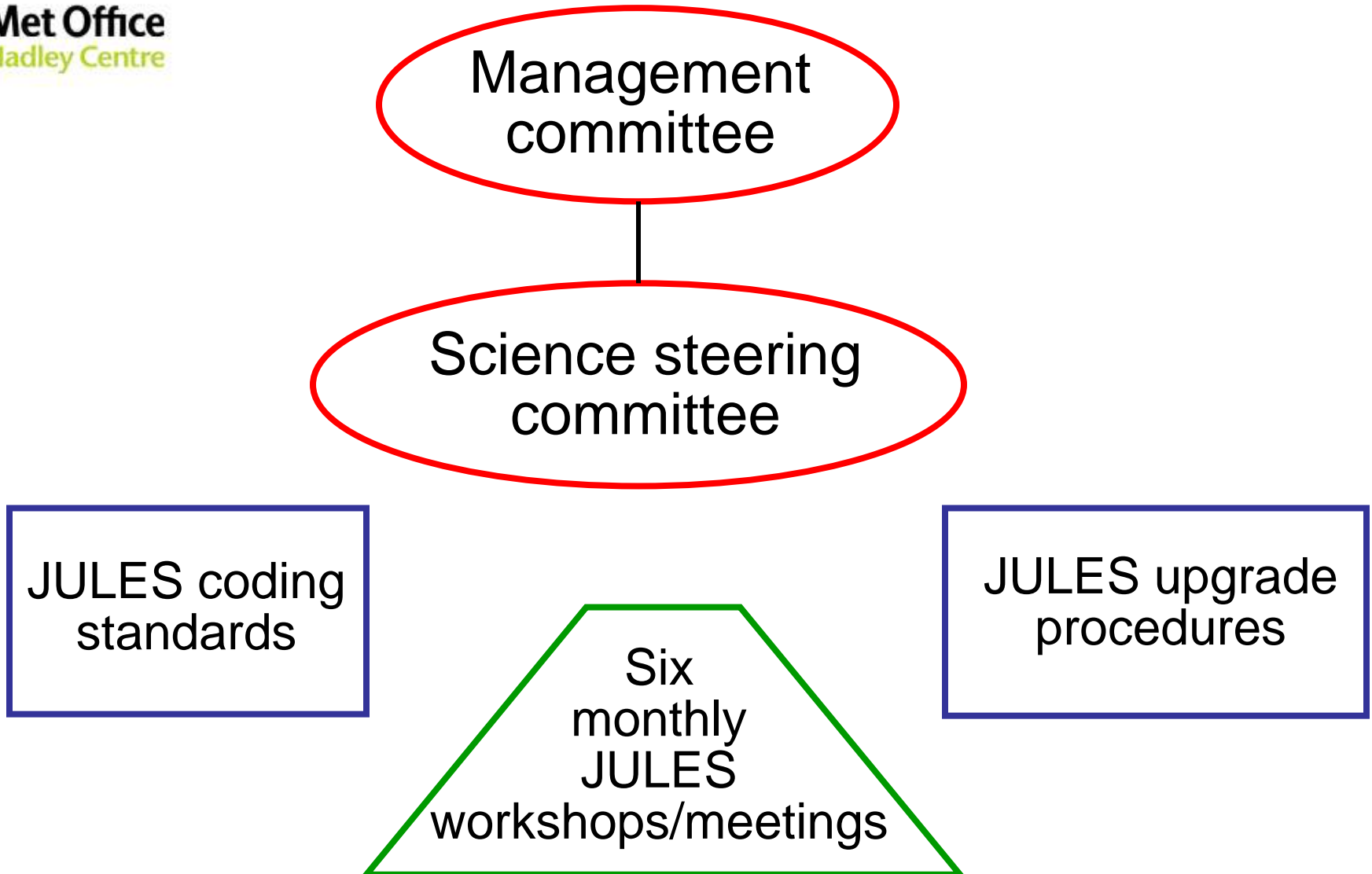
- Met Office Surface Exchange Scheme

  - Used in both global and regional operational models since late 90's / early 00's

  - Used in HadCM3, HadGEM and HadGEM2

- Top-down Representation of Interactive Flora and Foliage Including Dynamics

 - Used in version of HadCM3 for carbon cycle feedbacks

JULES / UM timeline

JULES governance

Management committee

Science steering committee

JULES coding standards

Six monthly JULES workshops/meetings

JULES upgrade procedures

JULES Module Structure

ATMOSPHERE

VOC, CH$_4$ Fluxes

CO$_2$ Fluxes

CO$_2$, CO and Aerosol Fluxes

τ, H, LE Fluxes

Biogenic Fluxes *Wild*

Plant Physiology *Mercado*

Surface Conductance

Surface Exchange *Best*

Urban *Grimmond*

NPP, Resp Fluxes

Surface Parameters

Evaporative Fluxes

N Availability

Crop Modelling *Osborne*

Vegetation Dynamics (+ Fire) *Sitch*

Snow Cover *Essery*

Surface Hydrology *Blyth*

Runoff

Litterfall

Soil Water Stress

Infiltration

Soil Carbon & Nitrogen *Smith*

Soil T & Moisture

Soil Moisture & Temperature *Gedney*

Technical Group *Best*

Data Assimilation *Williams*

Validation & Calibration *Pryor*

Climate Impacts *Betts*

Radiation interception

- Distribution of radiation through vegetation canopy

- Inclusion on nitrogen availability

- Impact of direct/diffuse radiation

A_n = net carbon uptake

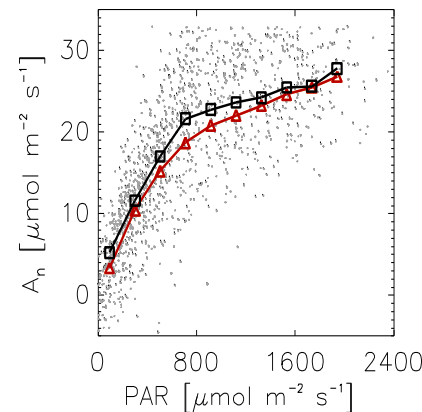= Total photosynthesis (GPP) – leaf respiration
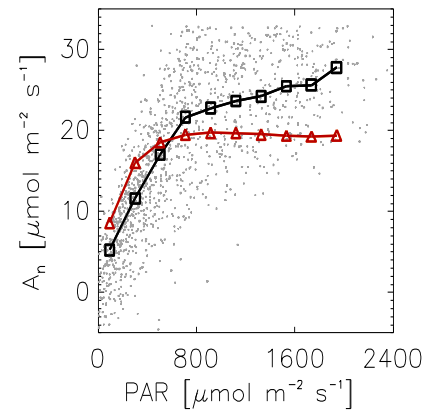
Light response   **diurnal cycle**
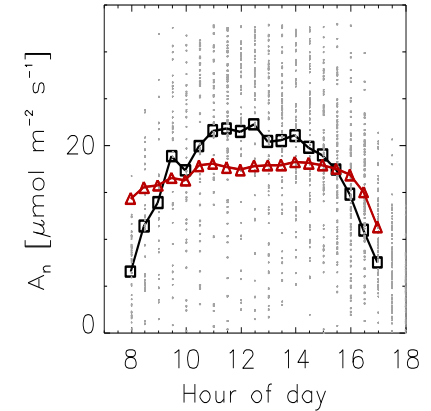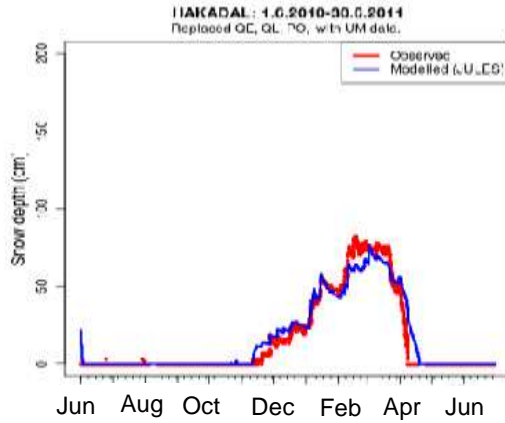
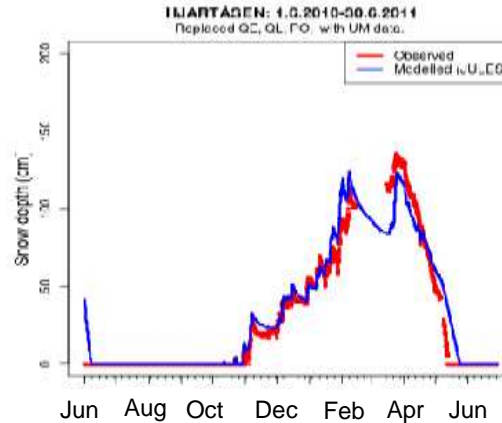Big leaf model

Multi-layer model

Courtesy of Lina Mercado
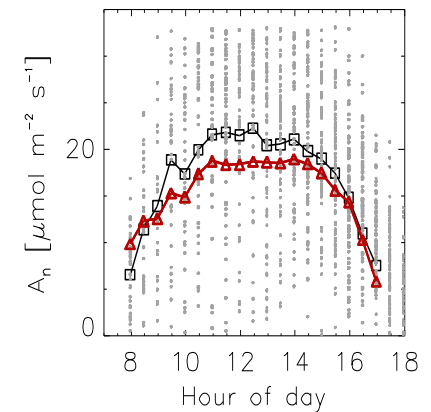
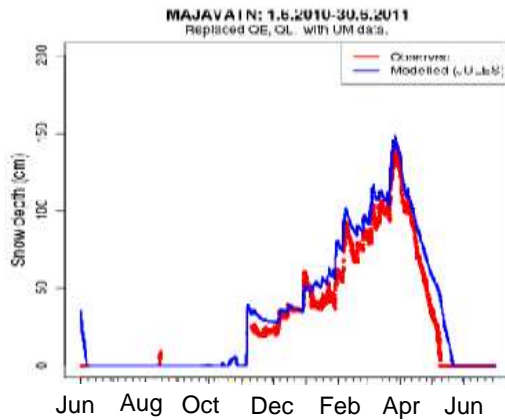# New snow scheme (Comparison by MetNo.)

— Observed
— Modelled 3-layers

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Courtesy of Dagrun Schuler
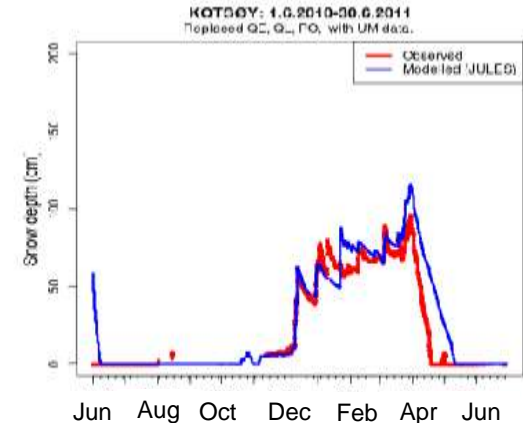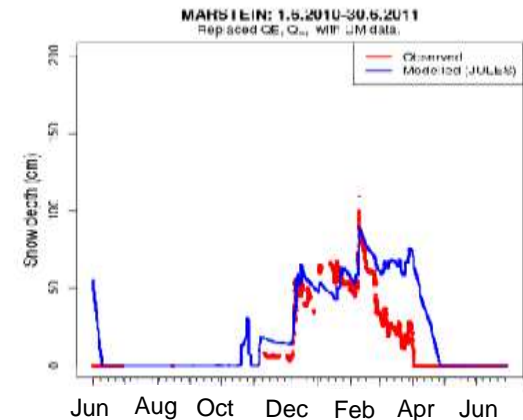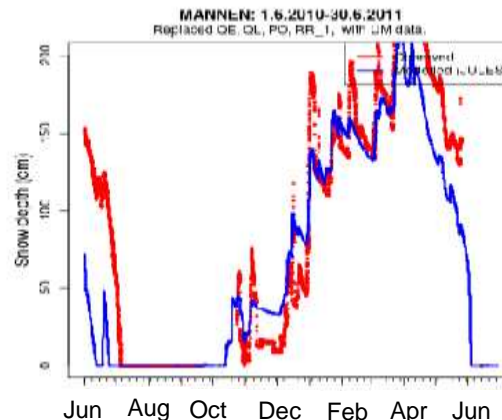
Current state

Standard references

Best et al.: The Joint UK Land Environment Simulator (JULES), model description – Part 1: Energy and water fluxes, Geosci. Model Dev., 4, 677–699, doi:10.5194/gmd-4-677-2011, 2011
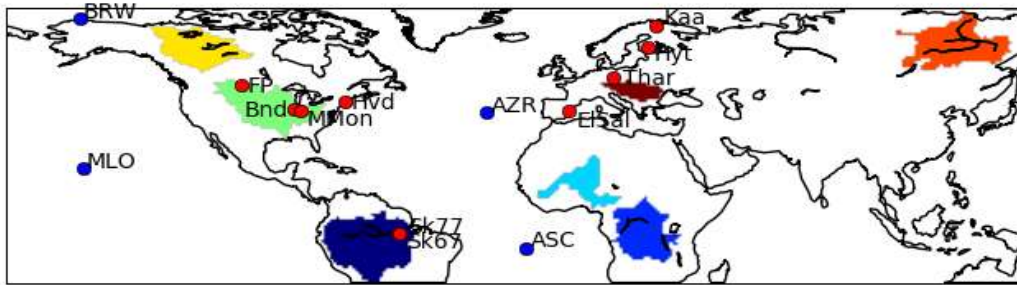
Clark et al.: The Joint UK Land Environment Simulator (JULES), model description – Part 2: Carbon fluxes and vegetation dynamics, Geosci. Model Dev., 4, 701–722, doi:10.5194/gmd-4-701-2011, 2011
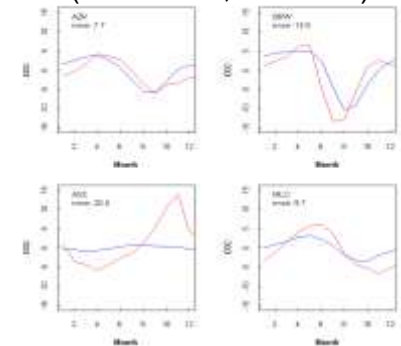
Multiple forcing framework
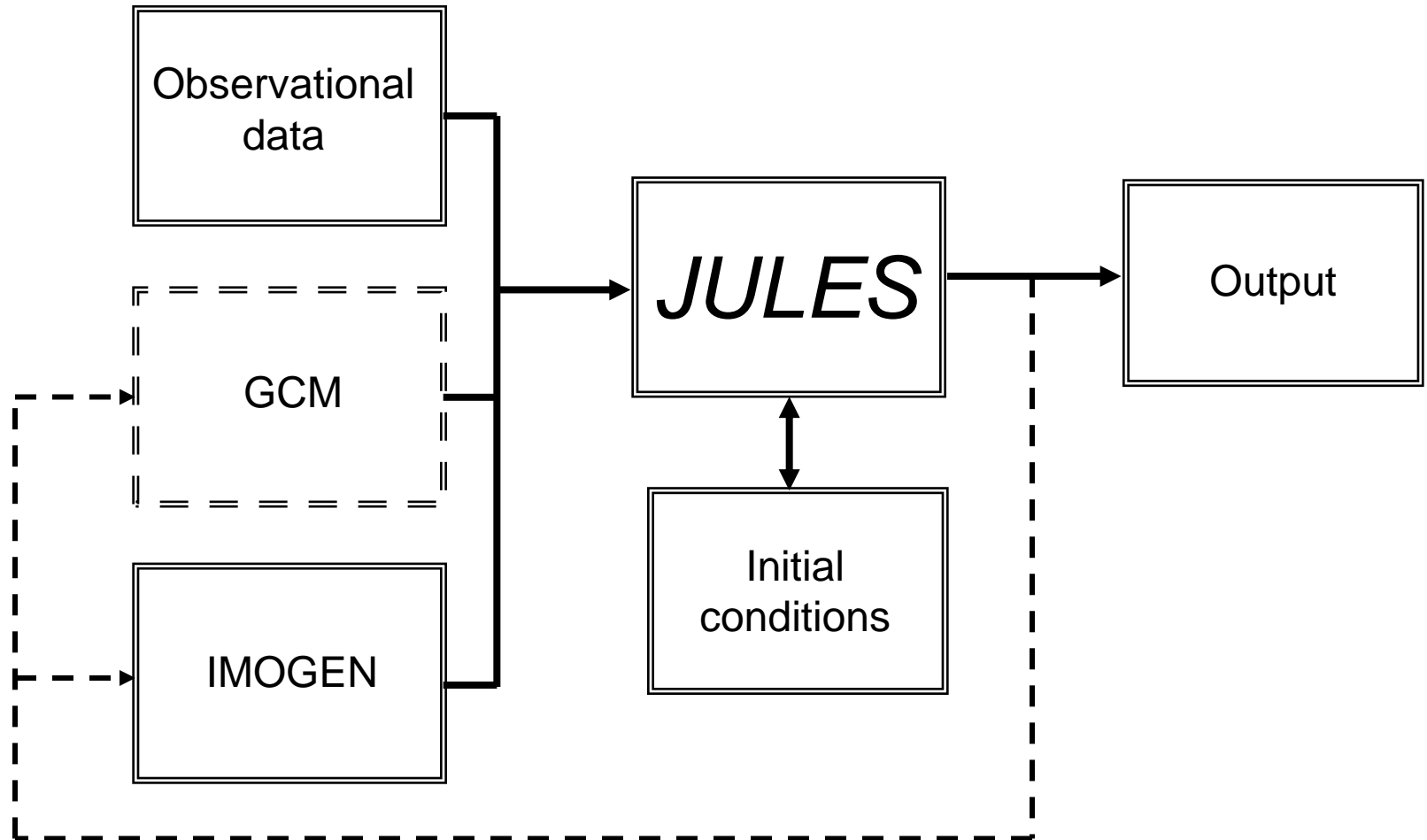
JULES benchmarking: 1

Results of JULES vn.2.1.2 for atmospheric CO2 concentrations, river flow and LAI

Map showing 4 Atmospheric CO2 concentration stations
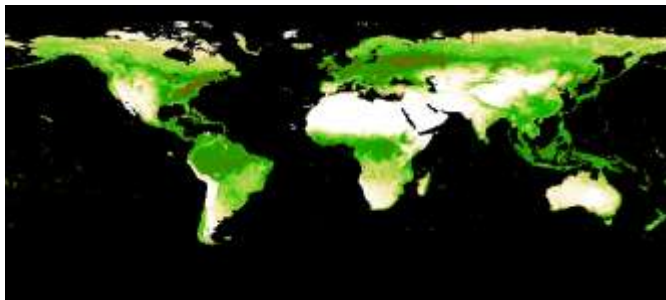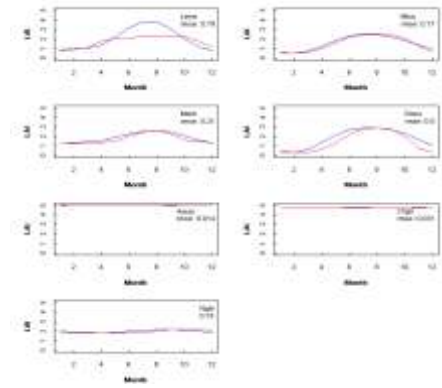10 FLUXNET stations
7 rivers basins

CO2 concentration
(model red, obs blue)

River Flow
(model red, obs blue)
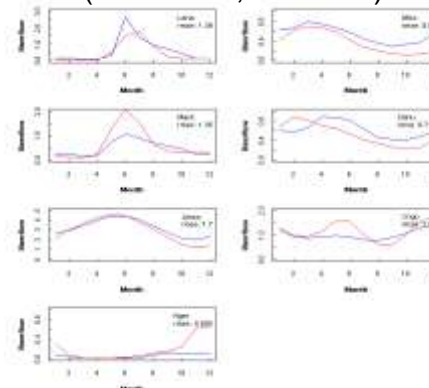
LAI
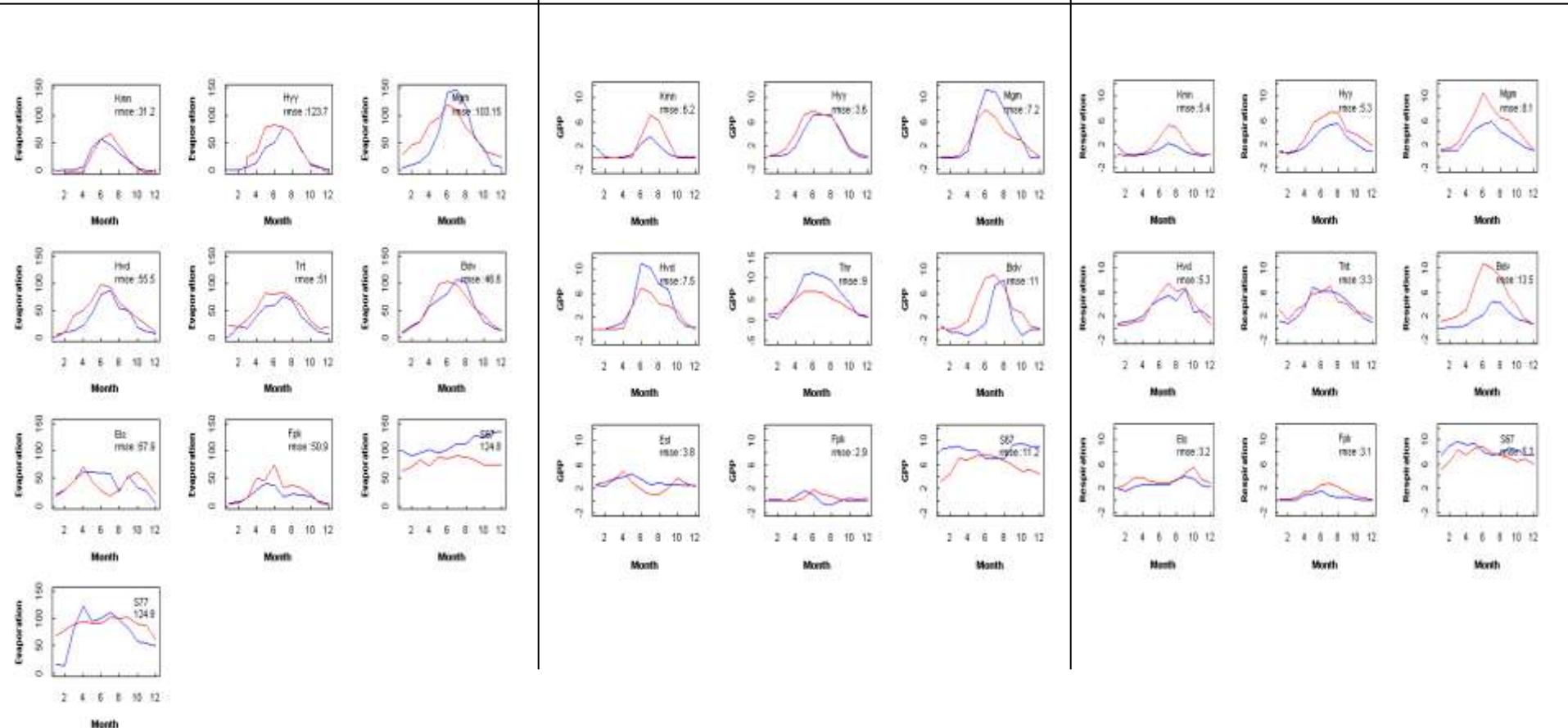(model red, obs blue)

20 years of NDVI data
(co Sietse Los, Swansea)

JULES benchmarking: 2

Comparison of JULES vn.2.1.2 against 10 (9 for CO_2) Fluxnet Sites

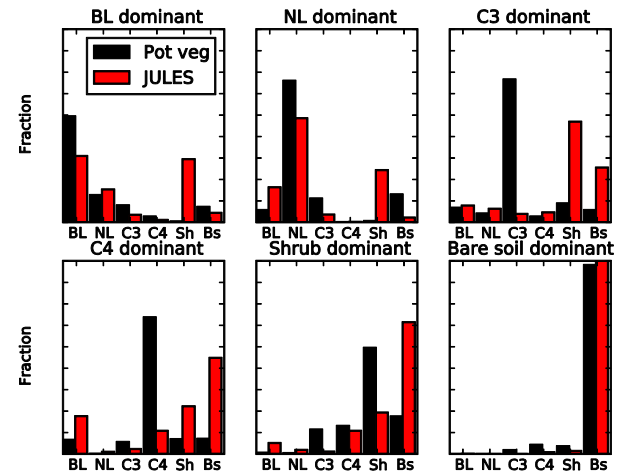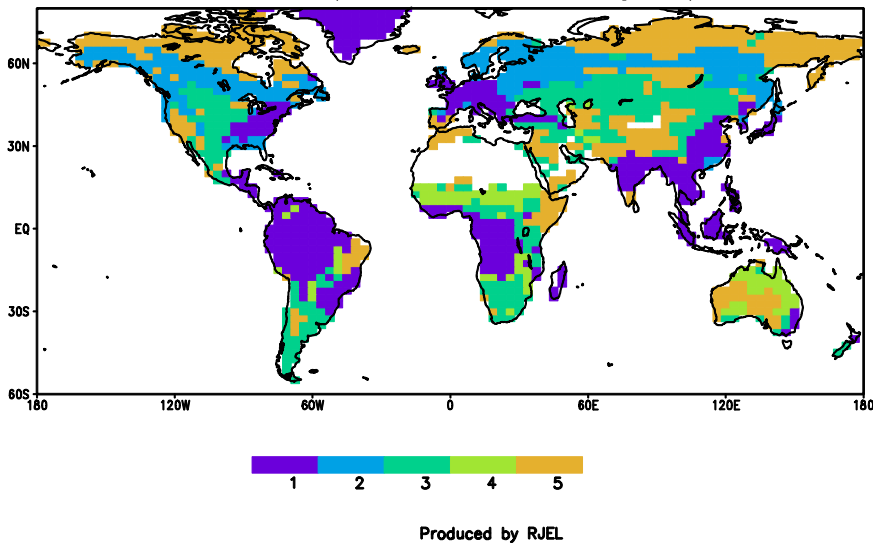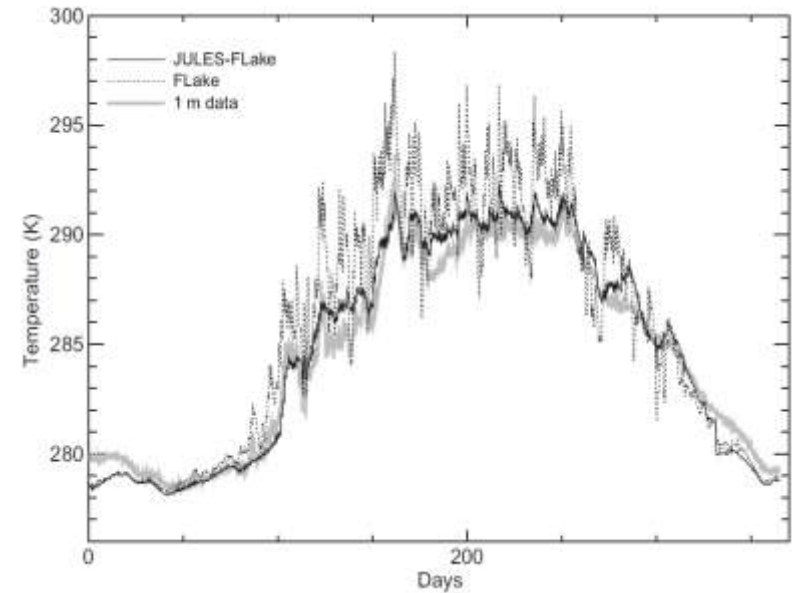| Normalised Evaporation	Photosynthesis	Respiration
(model red, obs blue)	(model red, obs blue)	(model red, obs blue)

JULES benchmarking: 3

Comparison of JULES vn.2.1.2 predicted land cover with SAGE (Ramankatty and Foley, 1999) map of potential land cover
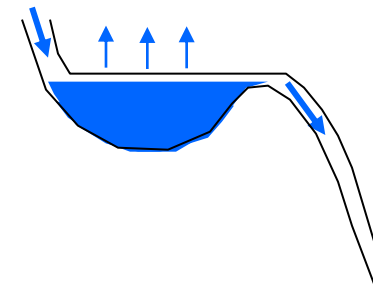

Dominant pft from Potential veg map

Produced by RJEL

FLake

- Adjustments to standard FLake

  ➢ JULES surface exchange

  ➢ Coupled via surface heat flux

  ➢ Thermal conductivity calculated from FLake temperature gradients

1m buoy T   v   surface T

- Issues to be addressed

  ➢ Conservation of energy during snow and ice melt

  ➢ Conservation of water for climate applications

Choice of 3 urban schemes

Urban comparison stage 4 average RMS errors
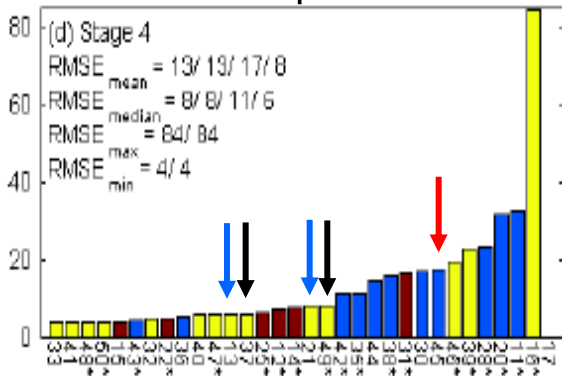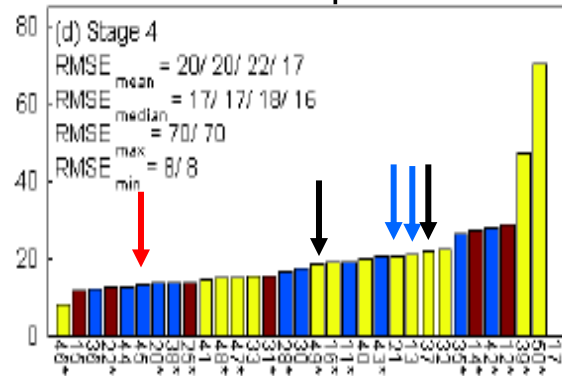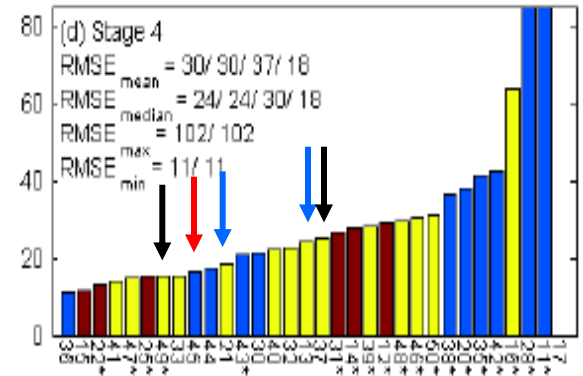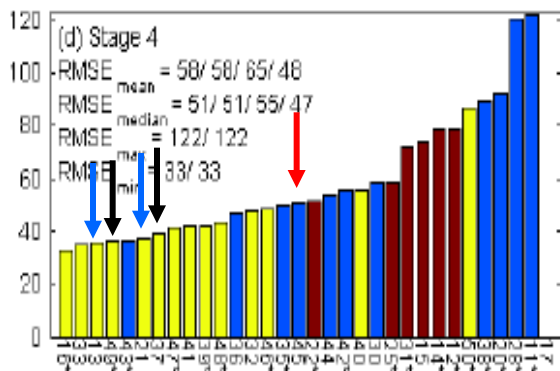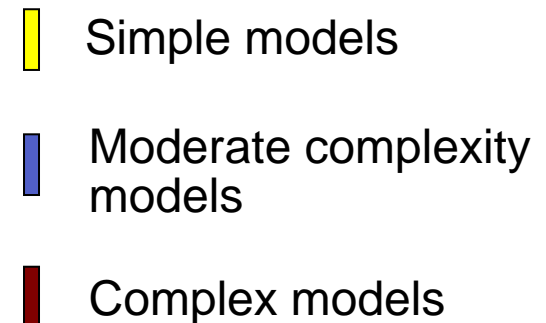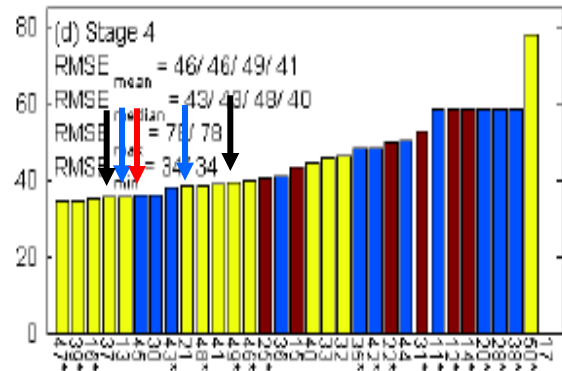

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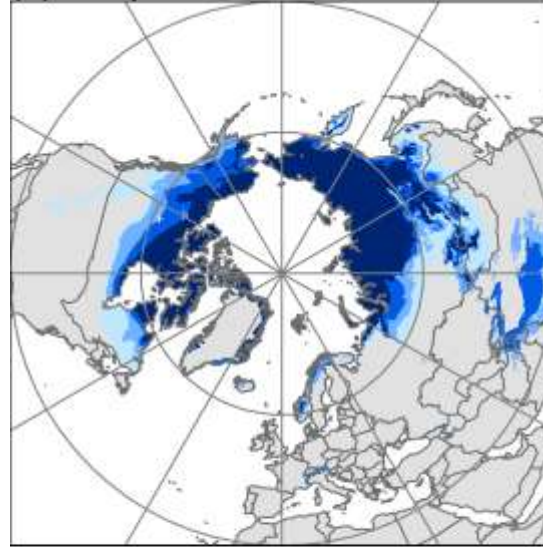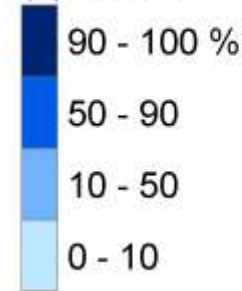
Permafrost

- Can simulate physical extent of permafrost

- Issues with soil moisture drainage affecting soil temperatures

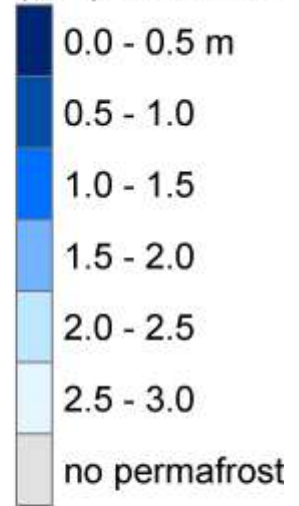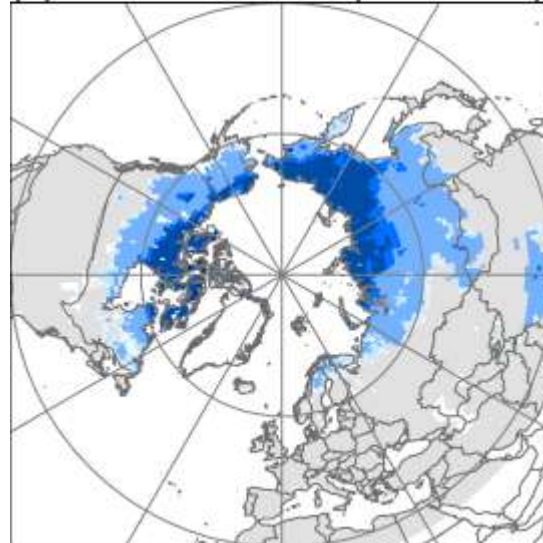- Need to include biophysical processes (such as CO_2 or CH_4 release)

Courtesy of Eleanor Burke

(a) IPA permafrost extent

(a) extent
- 90 - 100 %
- 50 - 90
- 10 - 50
- 0 - 10

(b+c) mean ALT
- 0.0 - 0.5 m
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- 2.5 - 3.0
- no permafrost

(b) JULES / GSWP2 (1983-1995)

(c) JULES / WATCH (1960-2000)

Future plans

Planned JULES developments

JULES version	New science
3.1	Flake
	New I/O interface
	Full JULES repository
	Removal of mirror in UM at next subsequent UM release
3.2	Crops
	TRIP
	Irrigation
	MEGAN
3.3	ECOSSE
	FUN
3.4	ED?

Merging JULES and CABLE

JULES framework

JULES

CABLE

JULES framework

CABLE crops · JULES surf exch · JULES soil · JULES veg · CABLE snow · CABLE veg · JULES urban · CABLE soil · CABLE urban · CABLE surf exch · JULES crops · JULES snow

JULES configurations

Questions