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The JULES Integrated Impacts Configuration

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Leeds Uni, Exeter Uni

Who?

- Andy Wiltshire, Rich Betts, Chris Jones
- Crops – Jemma Gornall, Tom Osborne (Reading), Josh Hooker
- Urban – Mark McCarthy, Maggie Hendry, Arora Porson, Ian Harmon (Reading), Sylvia Bohnenstengel, Peter Clark, Stephen Belcher, ...
- Rivers – Doug Clark (CEH)
- Shallow Groundwater – Nic Gedney
- Irrigation – Nic Gedney, Rutger Dankers
- LUC – John Hughes (Leeds)
- Ancillaries – Ron Kahana
- Others – Stephen Sitch (Exeter), Lina Mecardo, Pete Falloon, Camilla Mathison, ...



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Why do we need a Configuration?

Why do we need a configuration?

- JULES has many data requirements
 - Parameters, Ancillaries
 - Model Switches
 - Meteorological Forcing
- Standard will make life easier
- Complete experiments in a consistent way to help understand improvements due to model development
- Understand how new physics and experiments complement on our existing climate HadGEM2-ES model simulations



What is in the 'Configuration'

- Model Code – based on JULES 3.0
- Model Configuration Files
- Parameter Files (HadGEM2-ES tuning)
- Ancillary Files (from the Central Ancillary Program)
- Meteorological Forcing Data (including future climate projections from MOHC)



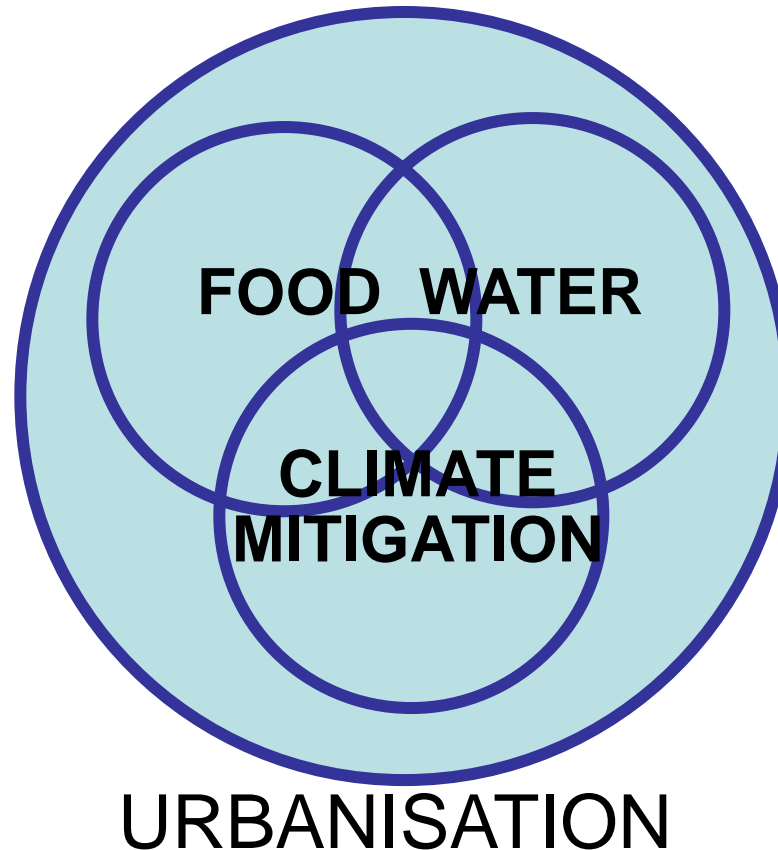
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Why do we need an Impacts Configuration?

2030's perfect storm

'Demand for food and energy will jump 50 per cent by 2030 and for fresh water by 30 per cent, as the global population tops 8.3 billion' John Beddington, 2009

POPULATION GROWTH



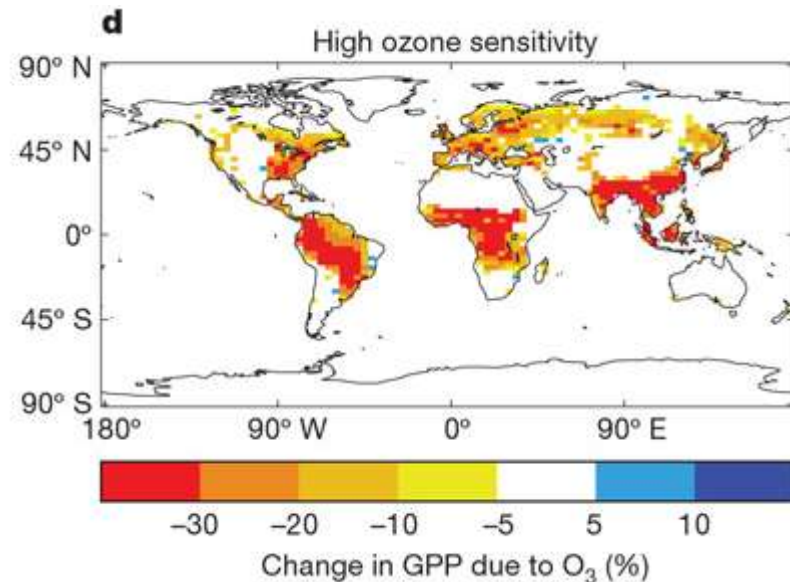
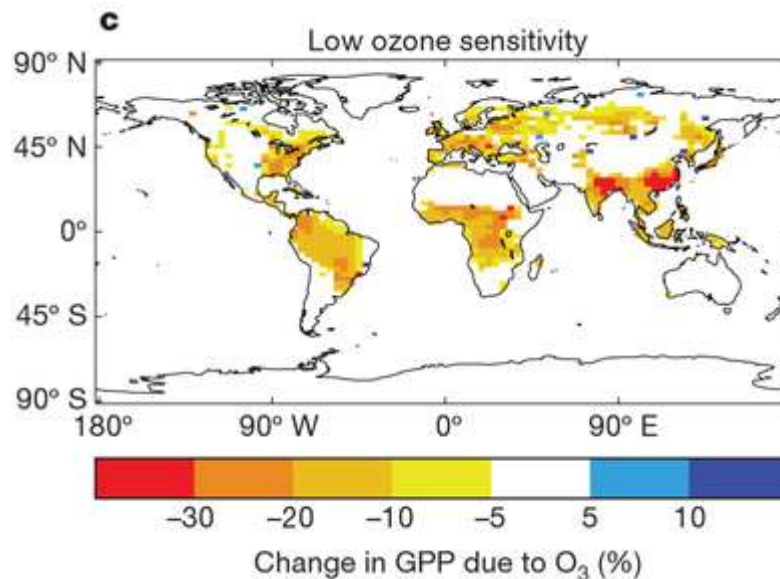


Integration is Important

- Water and Food is closely connected, cannot interpret impacts of food and water independently
- Crops, land-use change exert a significant effect of regional climate and through carbon cycle feedbacks.
- Earth-System processes are critically related to the impacts

Ozone

- Ozone exerts a direct influence of plant stomatal control
- Potential Impact of Crop Yield

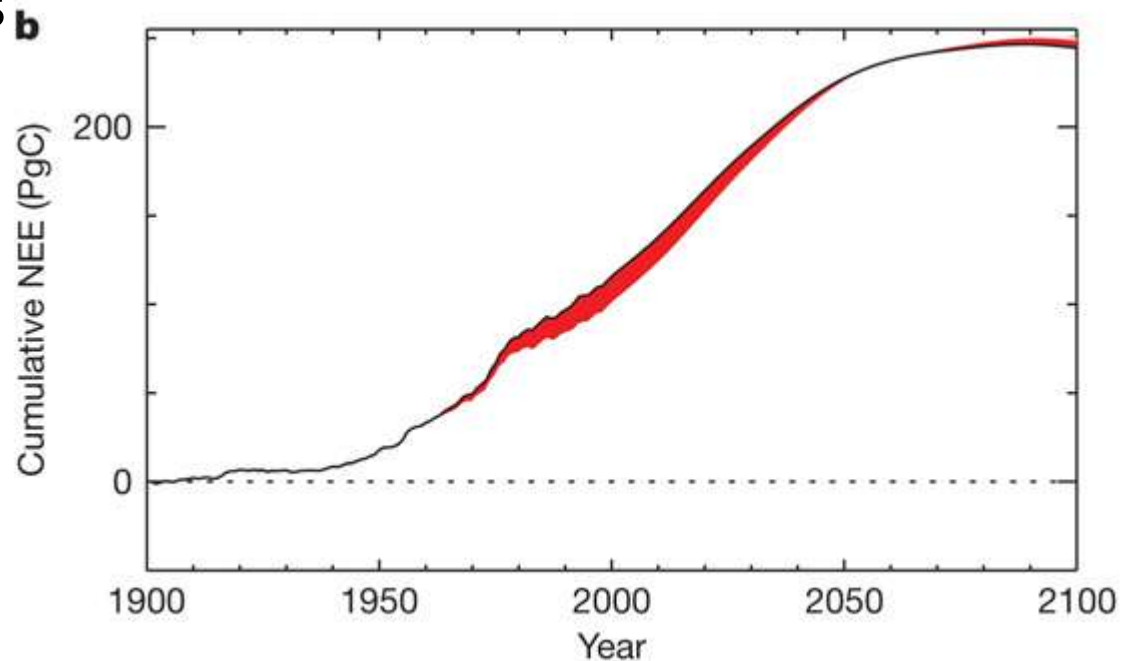
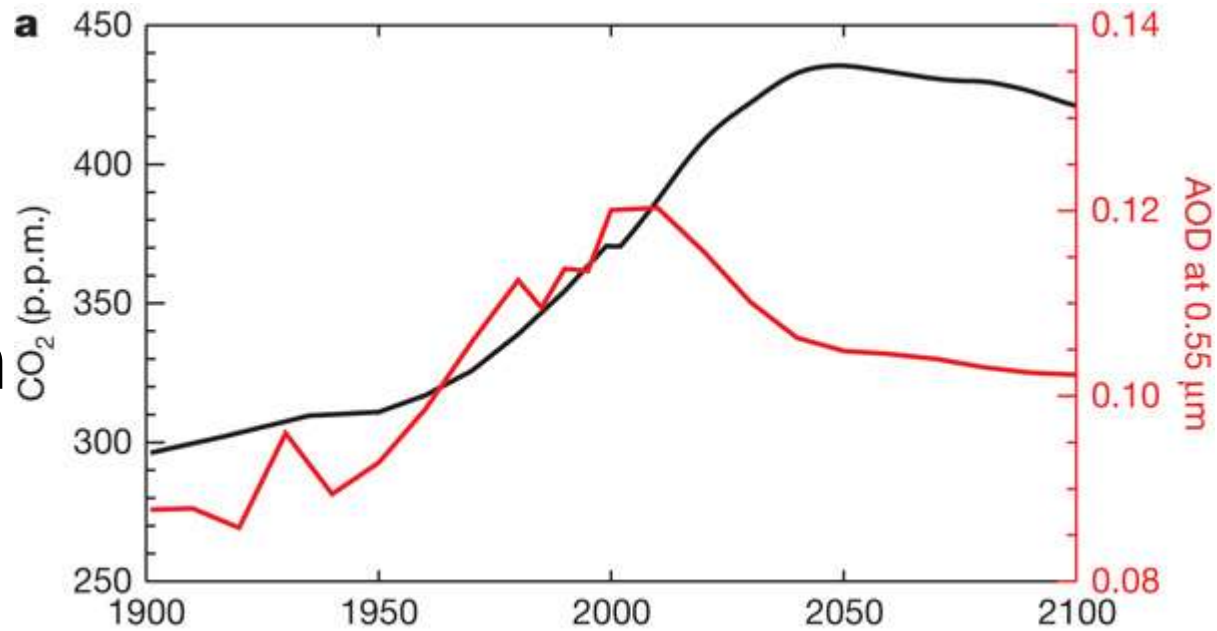


Sitch, 2007

Diffuse Radiation

Light quality influences
C sequestration

Mecardo, 2009

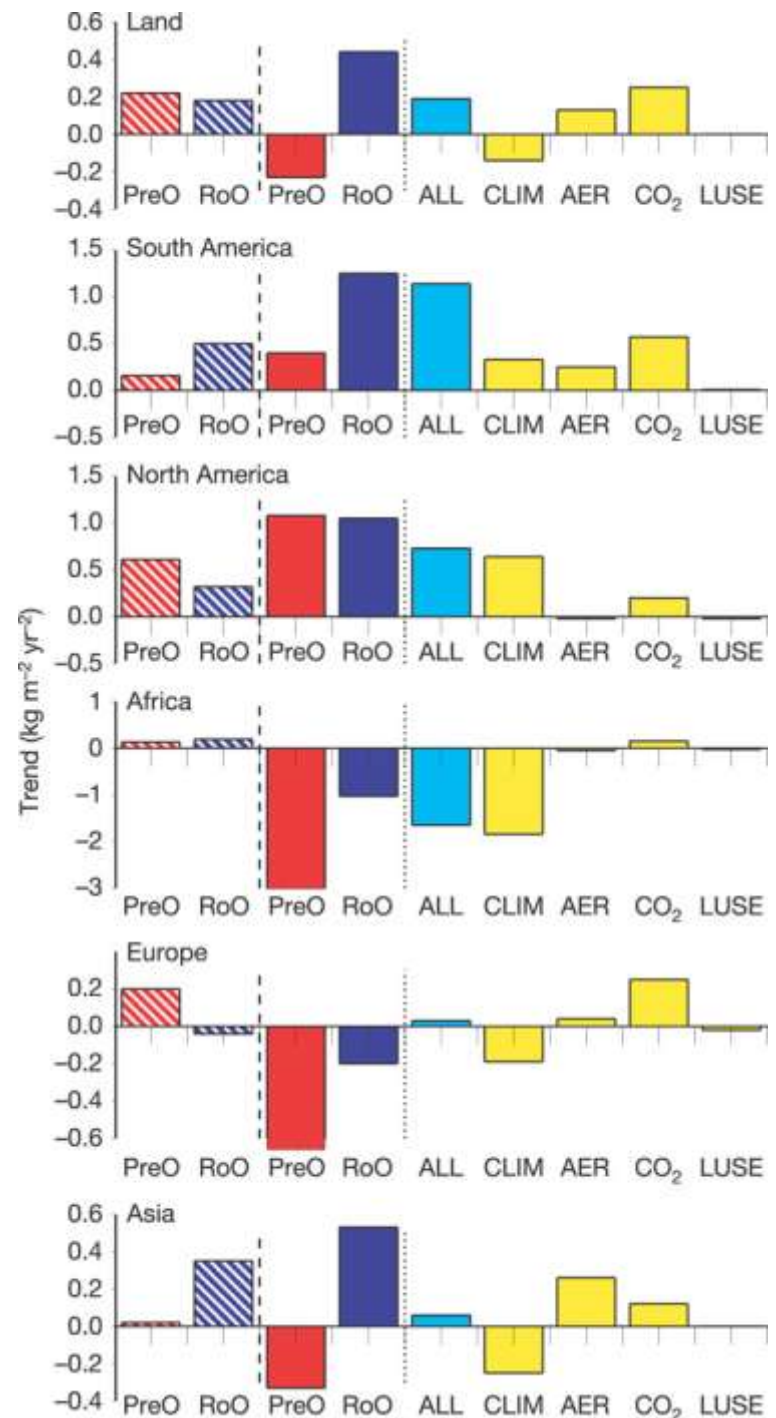




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Runoff

- Water Resources Influenced by
 - Land-Use Change
 - CO₂ physiological forcing



Gedney, 2006



Earth System Processes are Important

- Land-Use Change is in HadGEM2-ES but not JULES
- Ozone is in JULES but not HadGEM2-ES
- Diffuse Radiation is in JULES but not HadGEM2-ES

- Useful to see how these processes complement the HadGEM2-ES AR5 simulations



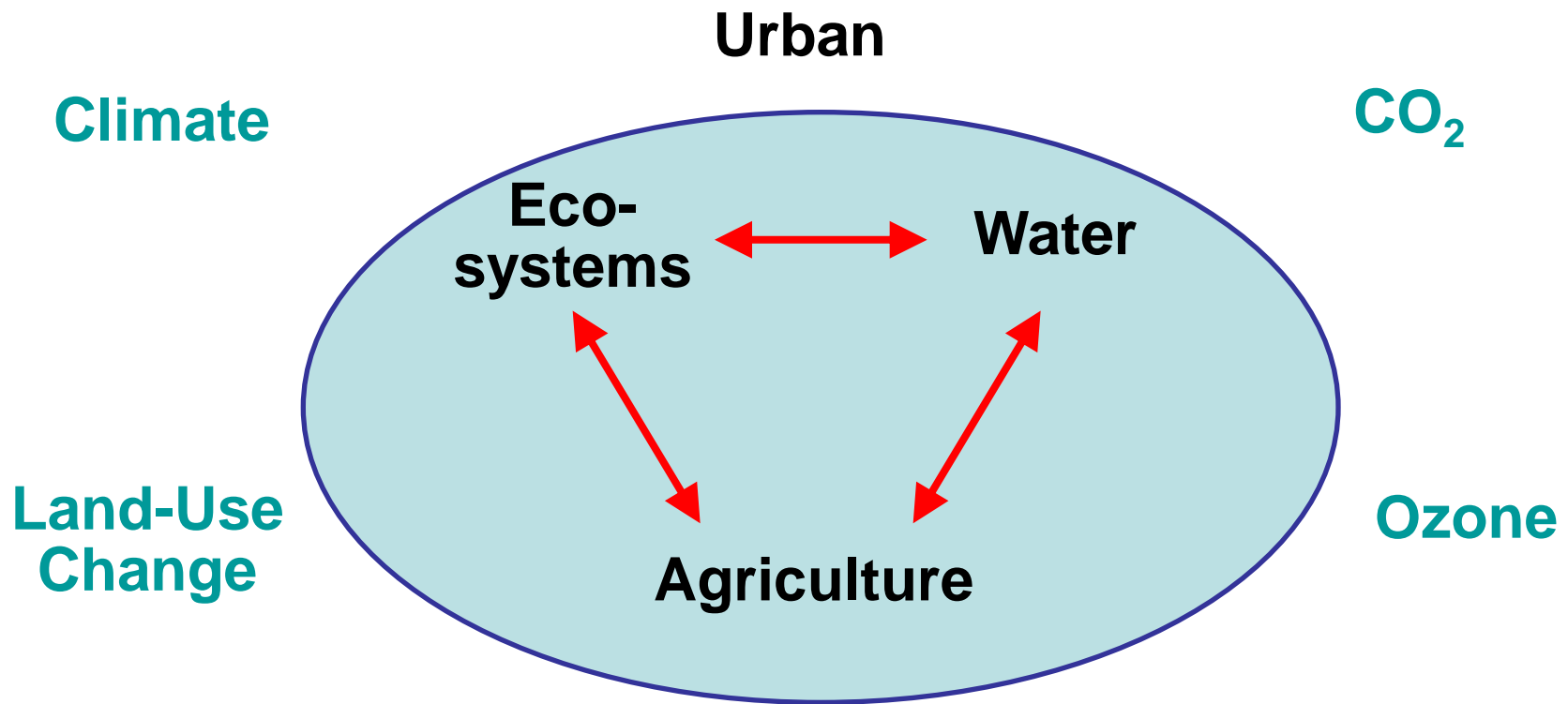
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What is in JULES-Impacts?

Impacts Components

Built on JULES version 3





Base Configuration Configuration 1

- Built on JULES 3.0
- Model parameters, switches, ancillaries configured to match HadGEM2-ES
- Using HadGEM2-ES forcing should be able to closely replicate HadGEM2-ES evolution of land-surface
- Available Forcing:
 - 150 years pre-industrial control (pool spin-up)
 - 1860 - 2005 Historical
 - 2005 – 2100 RCP2.6, 4.5, 6.0, 8.5 Climate Scenarios
 - Atmospheric CO₂, O₃, IAM Land-Use Scenarios

New Crop Model (Reading)

- Crop Model – Crop Types
 - Wheat, GroundNut, Lentil, Potato, Rape, Soya, Cassava, Cotton, Millet, Maize, Sugar
- Simulates
 - Crop Phenology, Crop yield, Carbon Cycle, Pasture (Natural Grasses)
- Biogeophysical interaction
 - Albedo, roughness, surface conductance



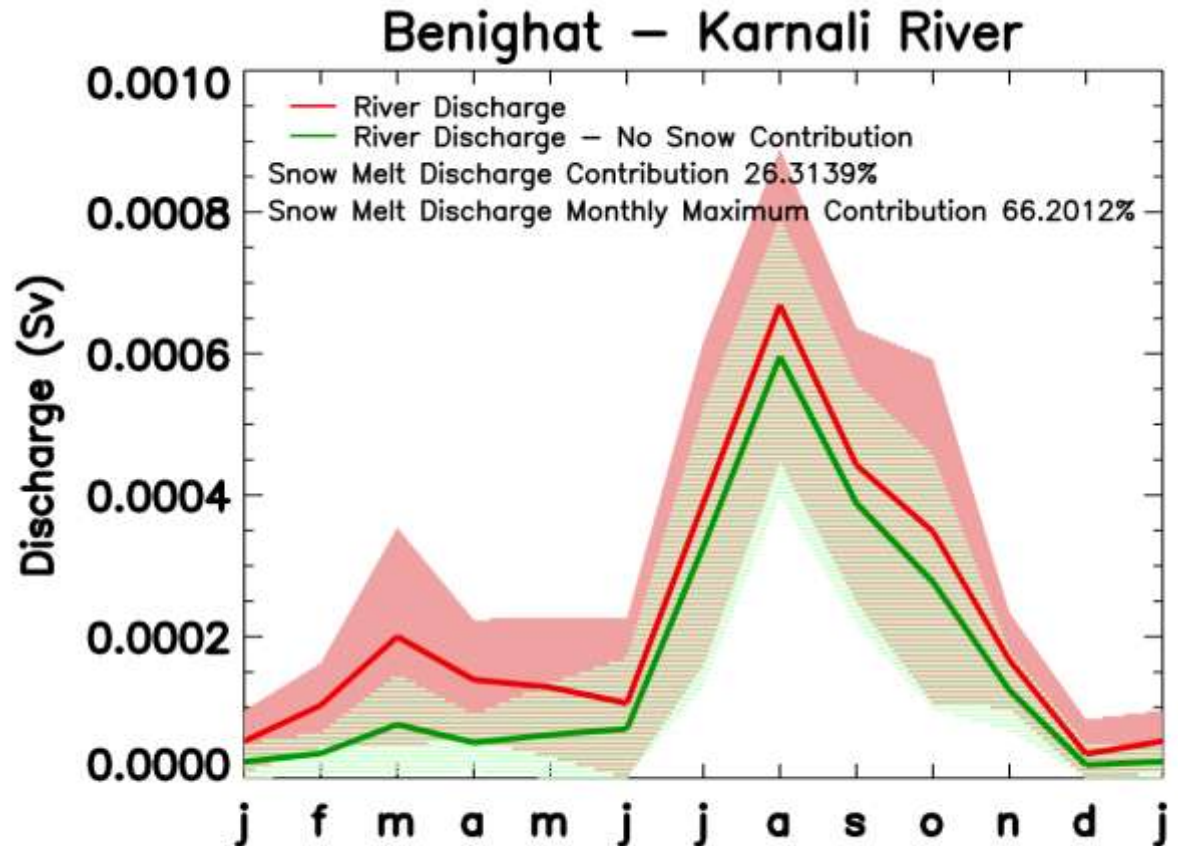
New Irrigation Module



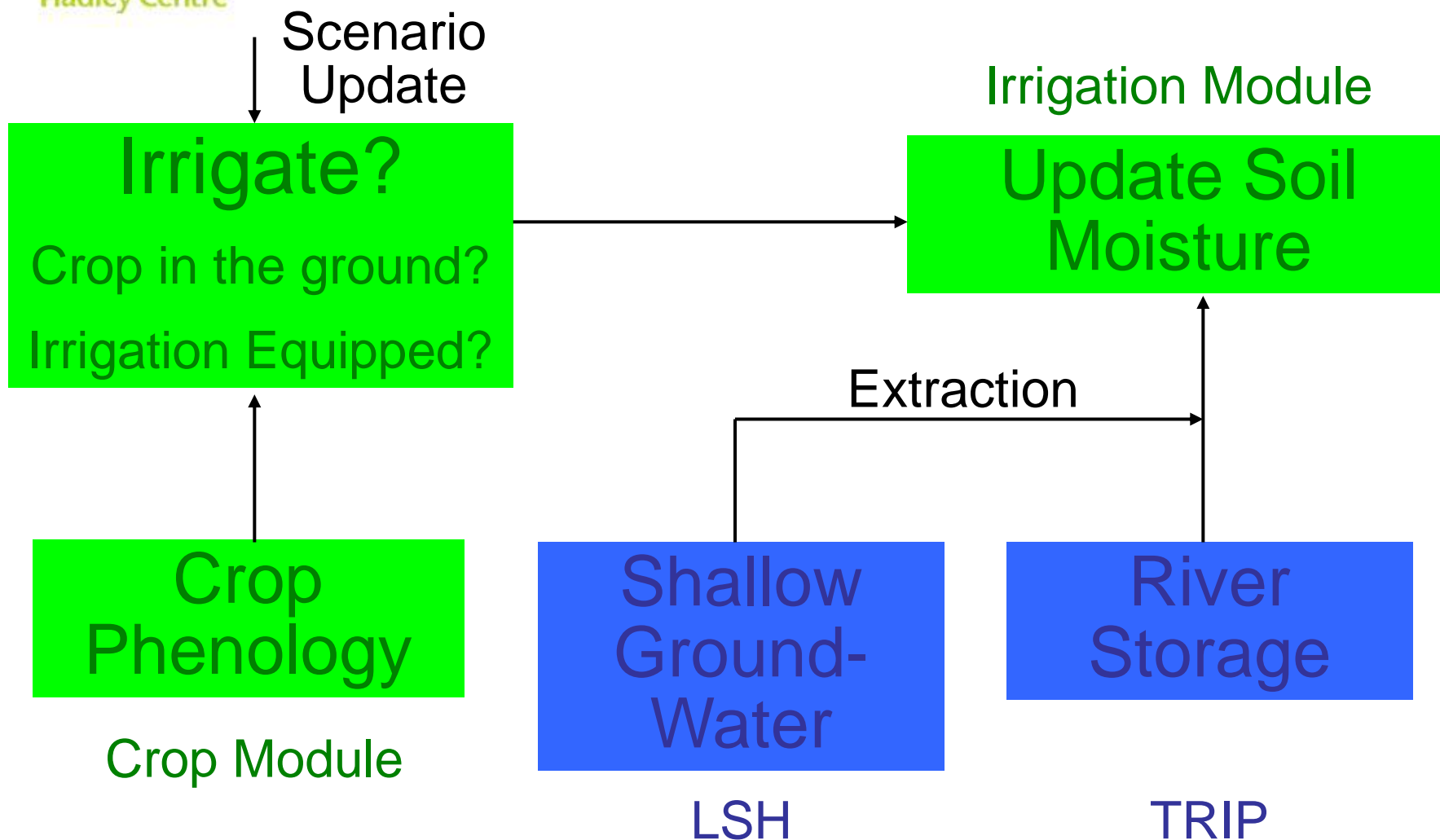
- Nic Gedney, Rutger Dankers
- ‘partial soil tiling’ – soil moisture in irrigated fraction is kept at critical point during growing season
 - Separate surface fluxes and soil hydrology
 - Soil temperature homogeneous for entire grid box

River Flow (Doug Clark)

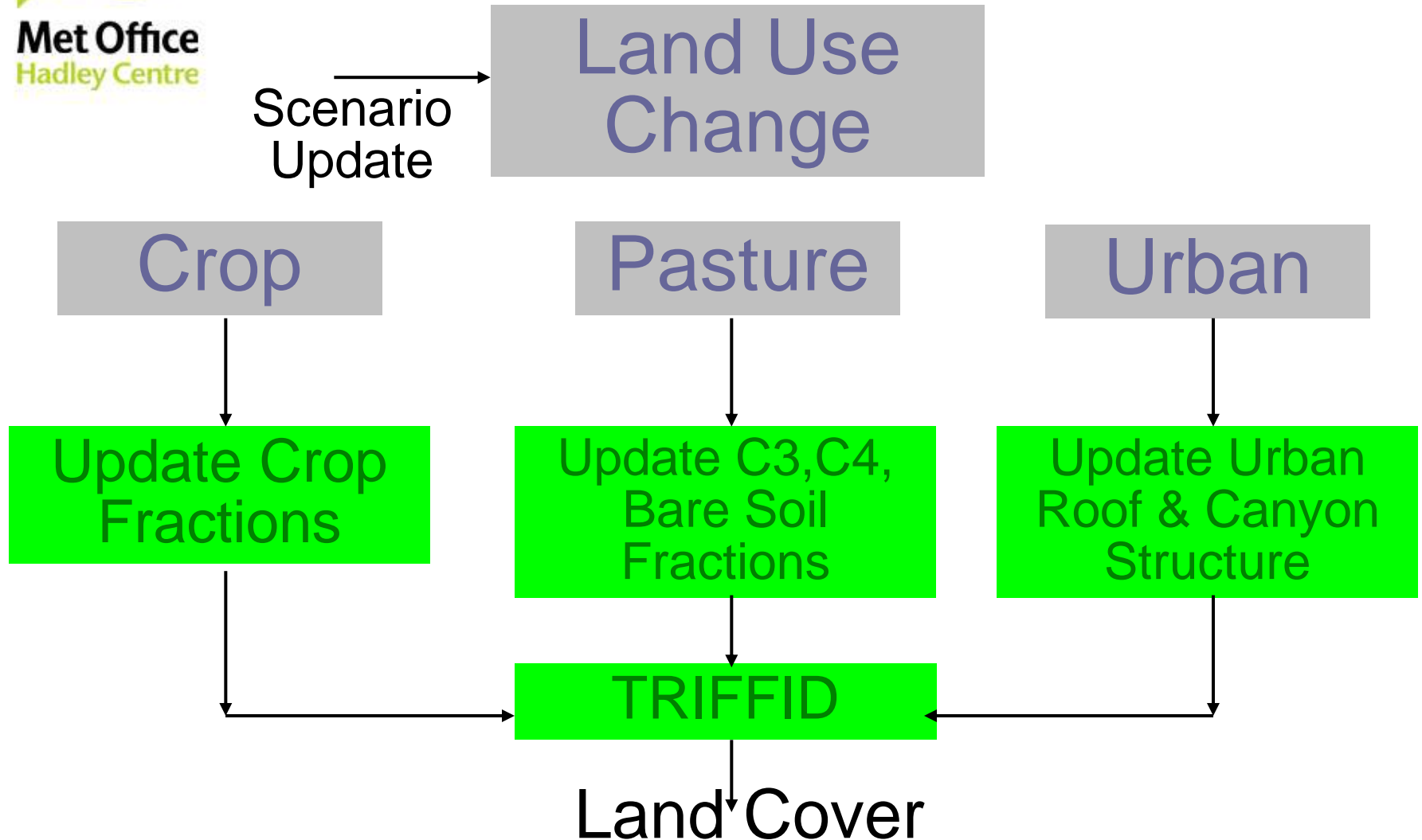
TRIP river
routing model



Irrigation: Crop – Water Interaction



Land-Use Change



Ecosystems

- TRIFFID Dynamic Vegetation Model
 - Broadleaf Trees, NeedleLeaf trees, C3 Grass, C4 Grass, Shrubs and Bare Soil
- Interacting with Climate
- Interacting with Land-Use
- Interacting with non-climatic forcing – CO₂, O₃, Direct/Diffuse Radiation
- Ability to ‘managed’ vegetation distribution as opposed to ‘potential’



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Time-Varying Ancillaries

- Updating Atmospheric CO₂, O₃ fields
- Updating Pasture, Crop, Urban Fraction Fields

JULES: One system, many choices...



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Vegetation dynamics:

TRIFFID

TRIFFID+LUC

Soil carbon:

Single-pool

RothC

...

River routing:

TRIP

Grid2Grid

HG2

Canopy Rad:

HG2

1

2

3

4

5

JIM

Groundwater:

LSH

Irrigation:

No Tile

Partial Tile

Canopy Model:

1

2

3

4

Crops:

JULES-CROP

JULES-SUCROS

Snow:

Single layer

Multi-layer

Urban:

1-Tile

2-Tile

MORUSES

Additional Forcing:

Diffuse Radiation

Ozone



Testing and Evaluation

- Configuration will pass relevant JULES benchmarks
- Configuration performance will be independently evaluated
- Not an 'official' JULES release
- Relevant components (Crops, Irrigation, Rivers) will be submitted for official release
- Future JULES releases will eventually supersede the Impacts Configuration



What questions can JULES-Impacts help answer?

- Impacts of CC and Socio-economic change on food, water and urban and natural environments?
- How do we mitigate climate change, but provide ecosystem resilience, food, water and poverty alleviation for a growing population whilst adapting to CC?
- Deforestation and food production?
- Food production and water resources?
- Adapting Urban environments to CC?

Conclusions

- A community configuration of JULES
- A setup of JULES easy to run, as all data requirements are available
- Actually two configurations
 - One to help understand HadGEM2-ES AR5 simulations
 - One to help understand the impacts of and adaptation to climate change
- Not all about Impacts
- Not subverting the JULES process



Getting hold of the JULES Impacts Configuration

- Still working on it...
- Hopefully, finished, benchmarked, documented and evaluated by Summer 2012
- Configuration will then be made available through BADC (hopefully).



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Questions and answers