Hydro-JULES
Next Generation Land Surface and Hydrological Predictions

Simon Dadson

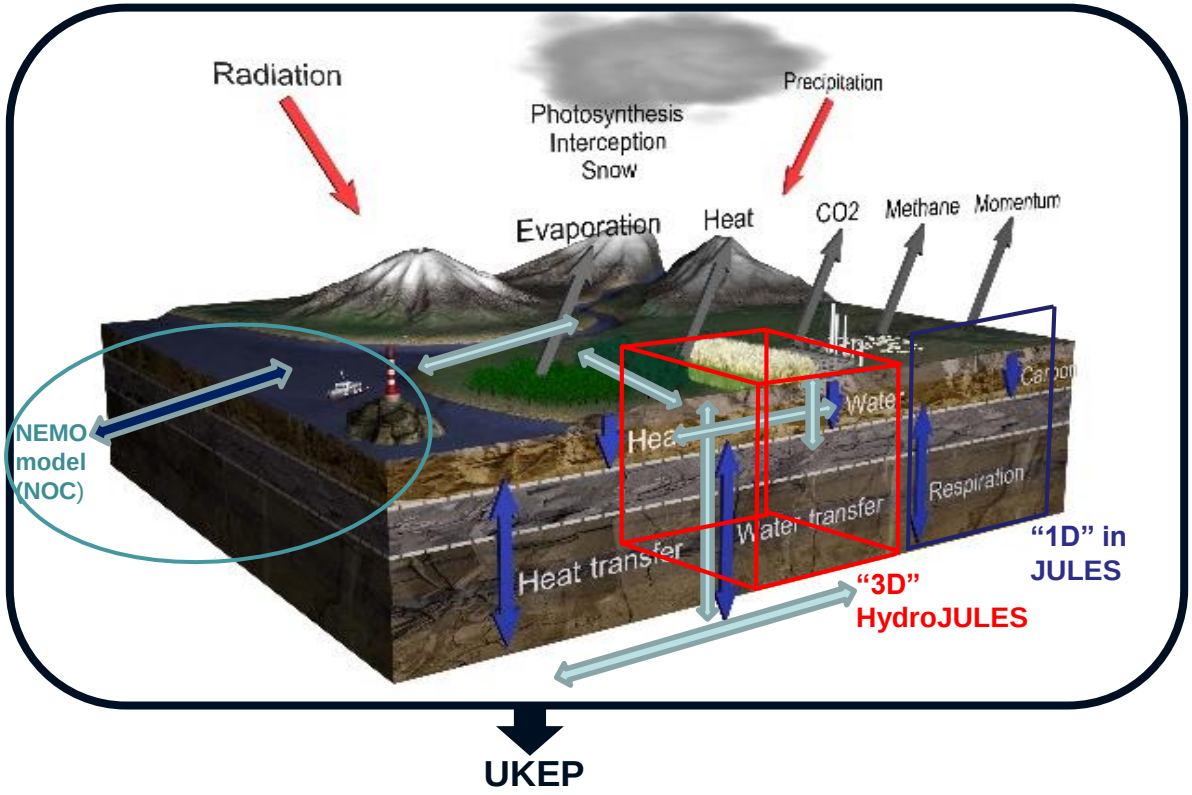
Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL

National Centre for Atmospheric Science
NATURAL ENVIRONMENT RESEARCH COUNCIL

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

NERC SCIENCE OF THE ENVIRONMENT

Hydro-JULES: NERC National Capability Programme



- Aim: To produce a fully integrated, open source coupled model of the terrestrial water cycle linked to the Joint UK Land Environment Simulator (JULES)
- Deliver a major advance in land-surface and hydrological science
- CEH led 5 yr National Capability programme with BGS and NCAS

Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL

National Centre for Atmospheric Science
NATURAL ENVIRONMENT RESEARCH COUNCIL

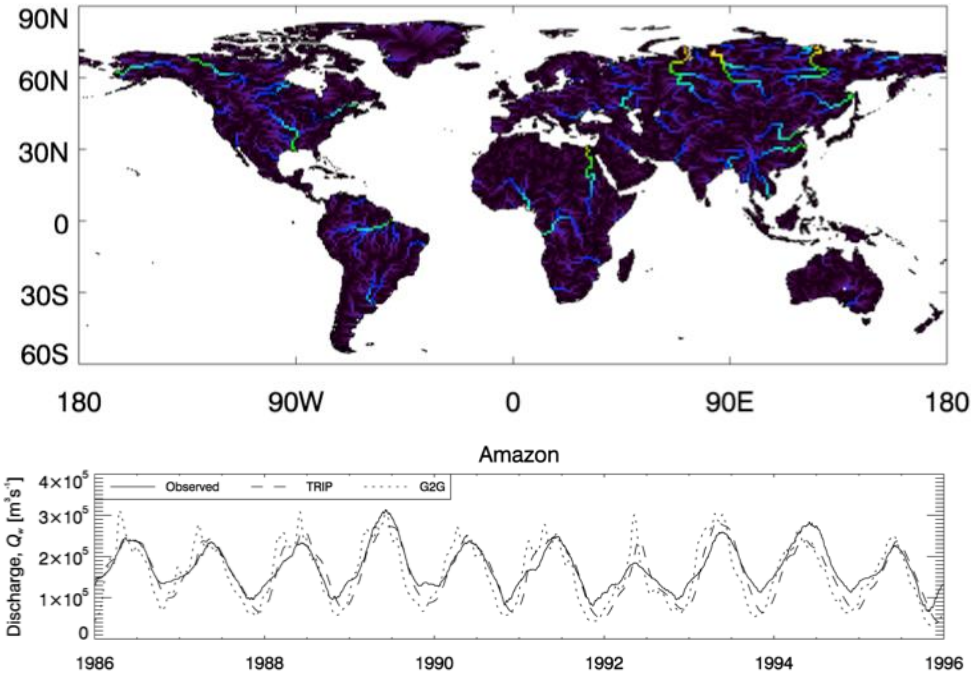
British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

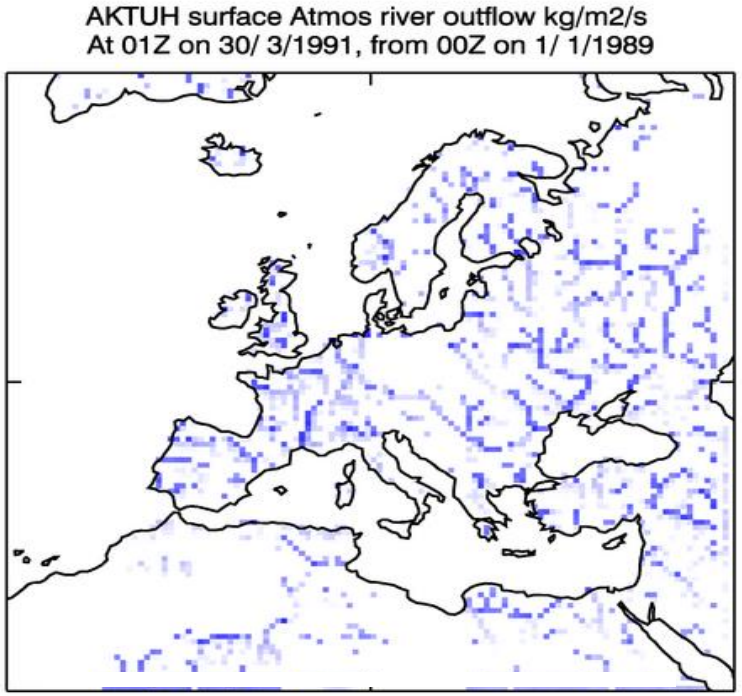
NERC SCIENCE OF THE ENVIRONMENT

Science strategy

- A rigorous, functional water cycle model is needed for:
  - Climate change projections
  - Earth system modelling
    - Palaeoclimate
    - Carbon cycle
    - Ocean circulation
  - Large-scale operational hydrology

Hydro-JULES





Dadson, S. J. *et al.*, 2011, *J. Hydrology.*

- Land surface models underpin key results in climate change and studies of Earth system
  - Need to close the energy, water and carbon cycles
- Hydrological models are designed to make predictions
  - Generalised physics; often with calibration
- Converging on commensurable scales (0.5º Global; 1 km National)

Key science questions I

- How will hydrological systems respond to **current and future climate variability**, in data-sparse regions under non-stationary conditions?
- Can new observational and modelling techniques improve our understanding of how **high-intensity convective precipitation** drives flooding?
- How will changes in **land-use and land management** affect surface permeability, soil water storage, runoff, river flows and flood inundation?
- Can a coupled approach quantify risks of of **fluvial, pluvial, coastal and groundwater** flooding more effectively?

Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL

National Centre for Atmospheric Science
NATURAL ENVIRONMENT RESEARCH COUNCIL

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

NERC SCIENCE OF THE ENVIRONMENT

NB: These are the key questions that Hydro-JULES will enable the UK Science Community community to address

Key science questions II

- How will **biogeochemical and nutrient cycles** respond to current and future variability in the hydrological cycle, especially under changing climate and land-cover?
- Can **assimilation of observed hydrological states and fluxes** (e.g., soil moisture and stream flow) improve hydrological and meteorological predictions, and on what time-scales?
- Can **uncertainty in large-scale hydrological predictions** be attributed to specific hydrological processes in order to target future process-based research?
- What is the **sensitivity of Earth system components to changing hydrology** (e.g., vegetation, carbon cycle, aerosols, land ice, sea ice, ocean circulation and biogeochemistry).

Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL
National Centre for Atmospheric Science
NATURAL ENVIRONMENT RESEARCH COUNCIL
British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL
NERC SCIENCE OF THE ENVIRONMENT

NB: These are the key questions that Hydro-JULES will enable the UK Science Community community to address

NERC Council Recommendations

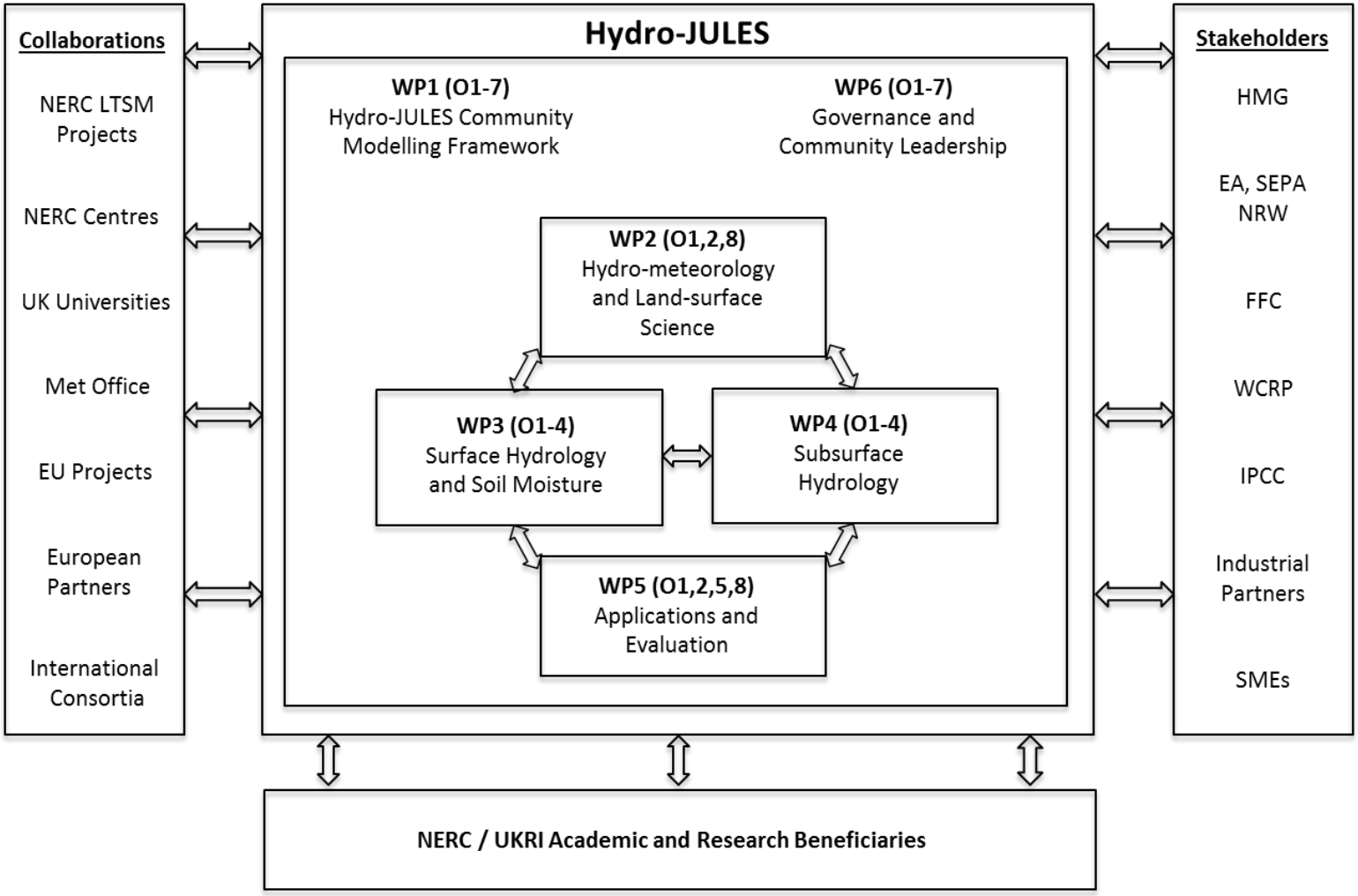
- Integrated 3-d water cycle model
- Integration with atmosphere; precip, evaporation, terrestrial hydrology, flooding
- Integration with coastal ocean & estuaries
- Integration with energy, C, N, other cycles
- Flexibility for data assimilation
- Flexibility for coupling to other models (eg, UM)
- Formal uncertainty quantification

Objectives prioritised in consultation with community

Key process-based advances required

- State of the art **process** representation
  - Groundwater (lateral; heterogeneous)
  - Soil hydraulics (macropore flow; spatial properties)
  - Evaporation (soil, vegetation, and canopy)
  - Inundation (fluvial, groundwater)
  - Anthropogenic influences (dams, irrigation)
- Evaluate uncertainties in the process chain.
- Infrastructure for interoperable model components
- Data assimilation using novel data sources

Programme Structure



Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL

National Centre for Atmospheric Science
NATURAL ENVIRONMENT RESEARCH COUNCIL

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

NERC SCIENCE OF THE ENVIRONMENT

Progress and time-line

- Community consultations March 2018
- Detailed implementation plan May 2018
- Community meeting September 2018
- International workshop planned Spring/Summer 2019

Partnerships, engagement, sustainability

- Mobilise and convene the UK hydrological community
  - Awareness raising and engagement
  - Community building, outreach
  - Met Office, HEIs, Defra/EA, DfID, Private Sector
  - UK and International
- Additional funding opportunities
  - Highlight topics
  - Strategic programmes
  - Joint funding calls
  - Capital investment

Summary

- The interplay between land surface and hydrological models presents an unprecedented opportunity.
- Hydro-JULES will focus on:
  - Building a robust technical platform;
  - Enabling key advances in hydrological science;
  - Mobilising the UK hydrological & land-surface communities around a common goal.

Q&A

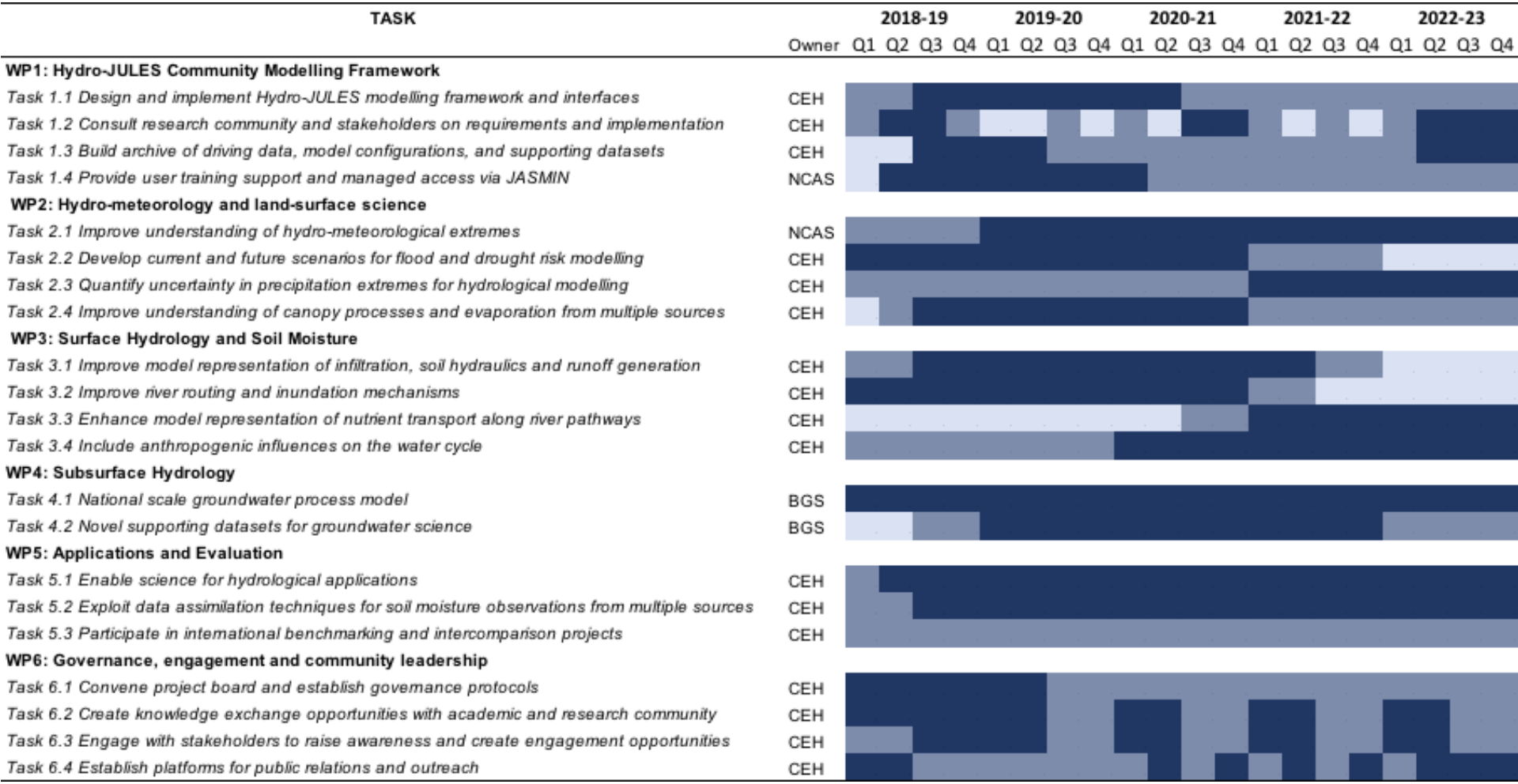
Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL

National Centre for Atmospheric Science
NATURAL ENVIRONMENT RESEARCH COUNCIL

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

NERC SCIENCE OF THE ENVIRONMENT

Programme Structure



Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL

National Centre for Atmospheric Science
NATURAL ENVIRONMENT RESEARCH COUNCIL

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

NERC SCIENCE OF THE ENVIRONMENT