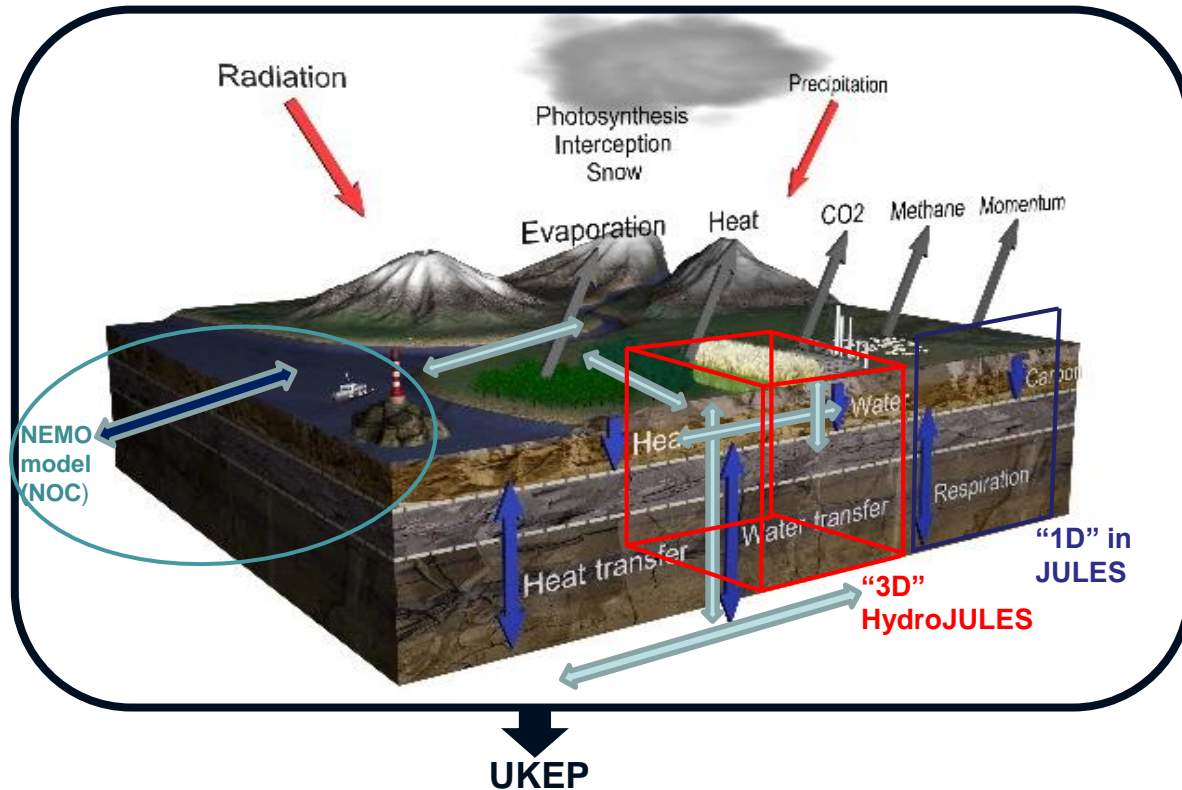


# Hydro-JULES

## Next Generation Land Surface and Hydrological Predictions

**Simon Dadson**

# Hydro-JULES: NERC National Capability Programme

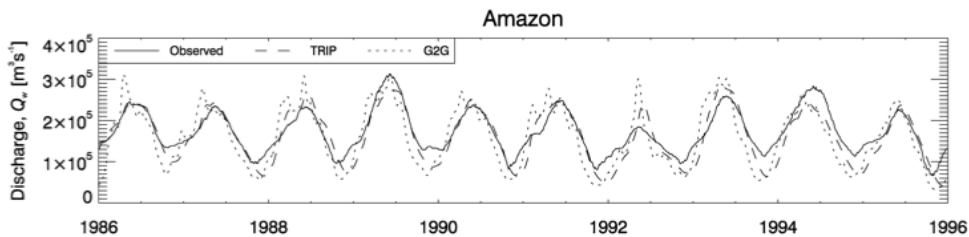
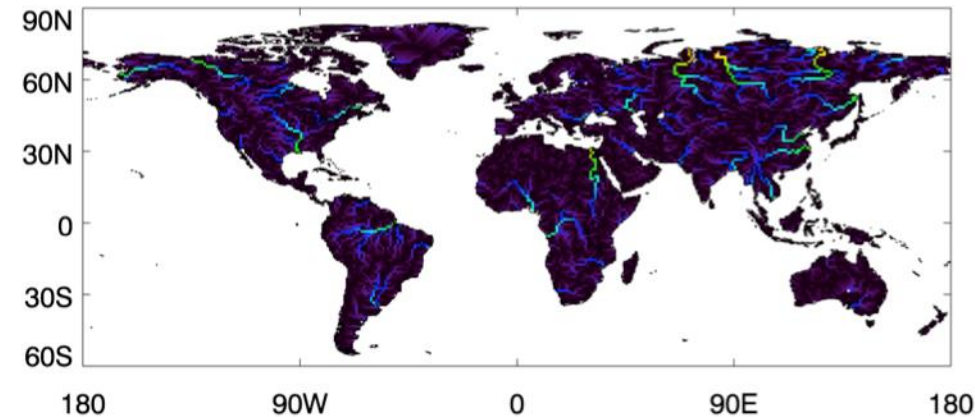


- Aim: To produce a fully integrated, open source coupled model of the terrestrial water cycle linked to the Joint UK Land Environment Simulator (JULES)
- Deliver a major advance in land-surface and hydrological science
- CEH led 5 yr National Capability programme with BGS and NCAS

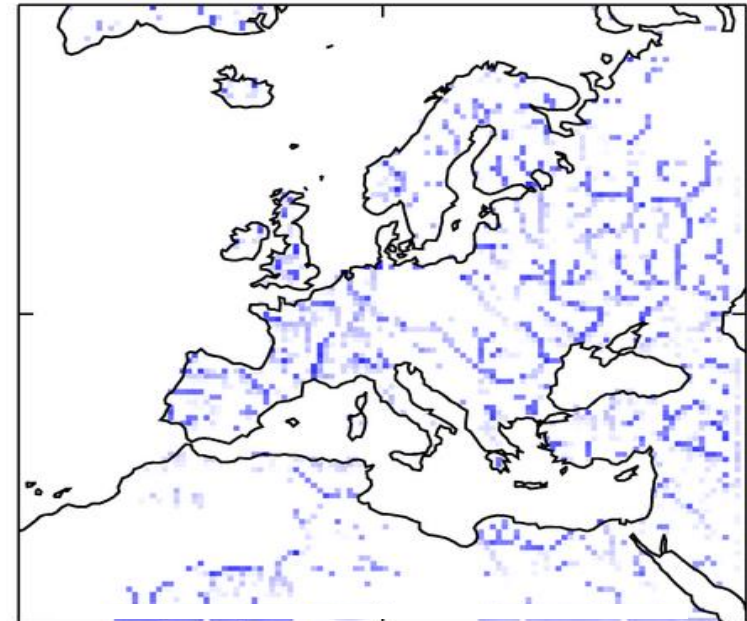
# Science strategy

- 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



AKTUH surface Atmos river outflow  $kg/m^2/s$   
At 01Z on 30/ 3/1991, from 00Z on 1/ 1/1989



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 ( $0.5^\circ$  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 **fluvial, pluvial, coastal and groundwater** flooding more effectively?



# 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).

# 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

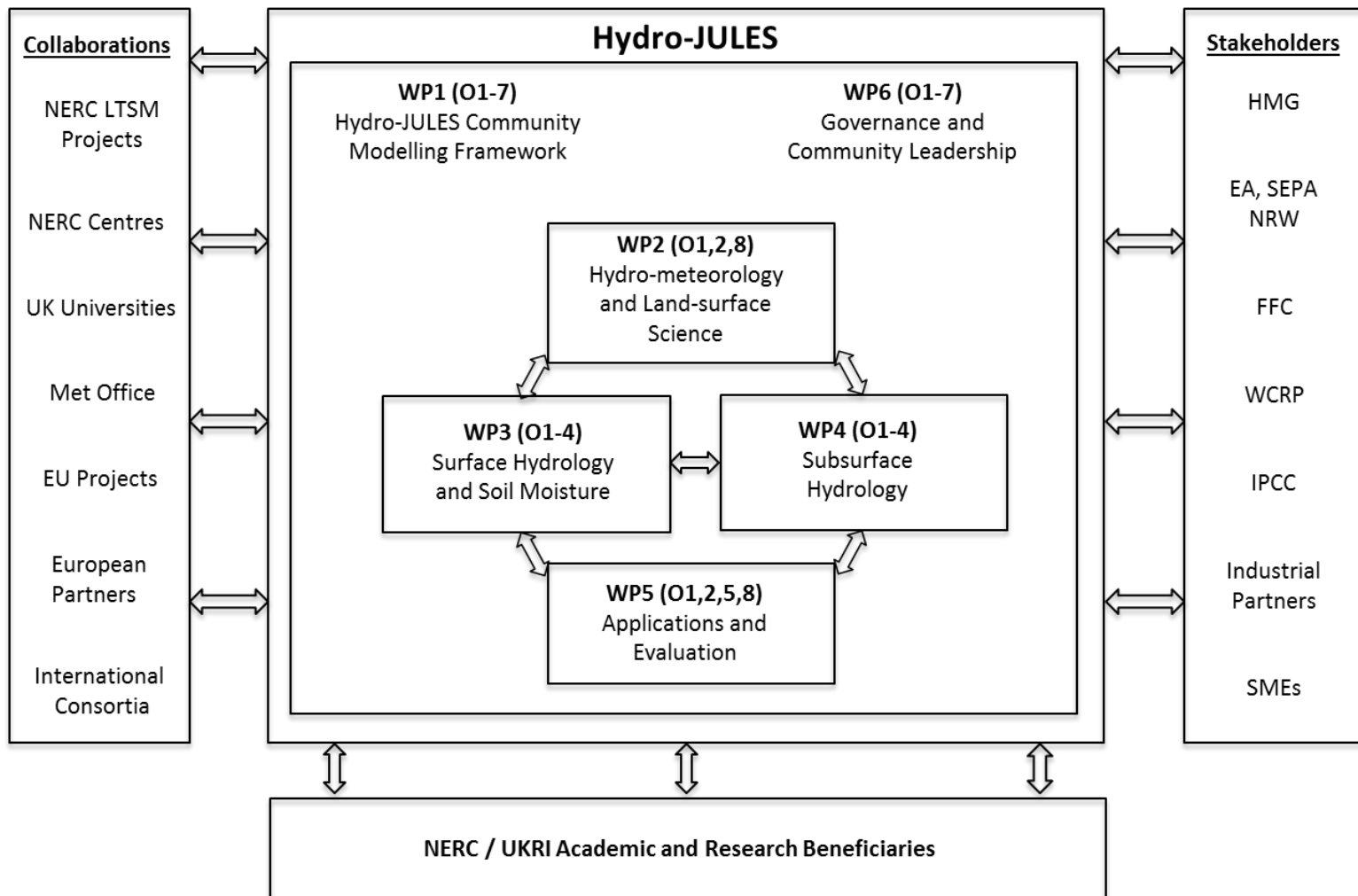
*Objectives prioritised in consultation with community*

# 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



# 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.



Photo: iStock/Photo

# Q&A



# Programme Structure

TASK	Owner	2018-19				2019-20				2020-21				2021-22				2022-23			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
<b>WP1: Hydro-JULES Community Modelling Framework</b>																					
Task 1.1 Design and implement Hydro-JULES modelling framework and interfaces	CEH																				
Task 1.2 Consult research community and stakeholders on requirements and implementation	CEH																				
Task 1.3 Build archive of driving data, model configurations, and supporting datasets	CEH																				
Task 1.4 Provide user training support and managed access via JASMIN	NCAS																				
<b>WP2: Hydro-meteorology and land-surface science</b>																					
Task 2.1 Improve understanding of hydro-meteorological extremes	NCAS																				
Task 2.2 Develop current and future scenarios for flood and drought risk modelling	CEH																				
Task 2.3 Quantify uncertainty in precipitation extremes for hydrological modelling	CEH																				
Task 2.4 Improve understanding of canopy processes and evaporation from multiple sources	CEH																				
<b>WP3: Surface Hydrology and Soil Moisture</b>																					
Task 3.1 Improve model representation of infiltration, soil hydraulics and runoff generation	CEH																				
Task 3.2 Improve river routing and inundation mechanisms	CEH																				
Task 3.3 Enhance model representation of nutrient transport along river pathways	CEH																				
Task 3.4 Include anthropogenic influences on the water cycle	CEH																				
<b>WP4: Subsurface Hydrology</b>																					
Task 4.1 National scale groundwater process model	BGS																				
Task 4.2 Novel supporting datasets for groundwater science	BGS																				
<b>WP5: Applications and Evaluation</b>																					
Task 5.1 Enable science for hydrological applications	CEH																				
Task 5.2 Exploit data assimilation techniques for soil moisture observations from multiple sources	CEH																				
Task 5.3 Participate in international benchmarking and intercomparison projects	CEH																				
<b>WP6: Governance, engagement and community leadership</b>																					
Task 6.1 Convene project board and establish governance protocols	CEH																				
Task 6.2 Create knowledge exchange opportunities with academic and research community	CEH																				
Task 6.3 Engage with stakeholders to raise awareness and create engagement opportunities	CEH																				
Task 6.4 Establish platforms for public relations and outreach	CEH																				