

JULES and the Warming Induced Emissions Model Intercomparison Project (WIE-MIP)

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UK Centre for
Ecology & Hydrology

**NATIONAL CAPABILITY
FOR GLOBAL CHALLENGES**

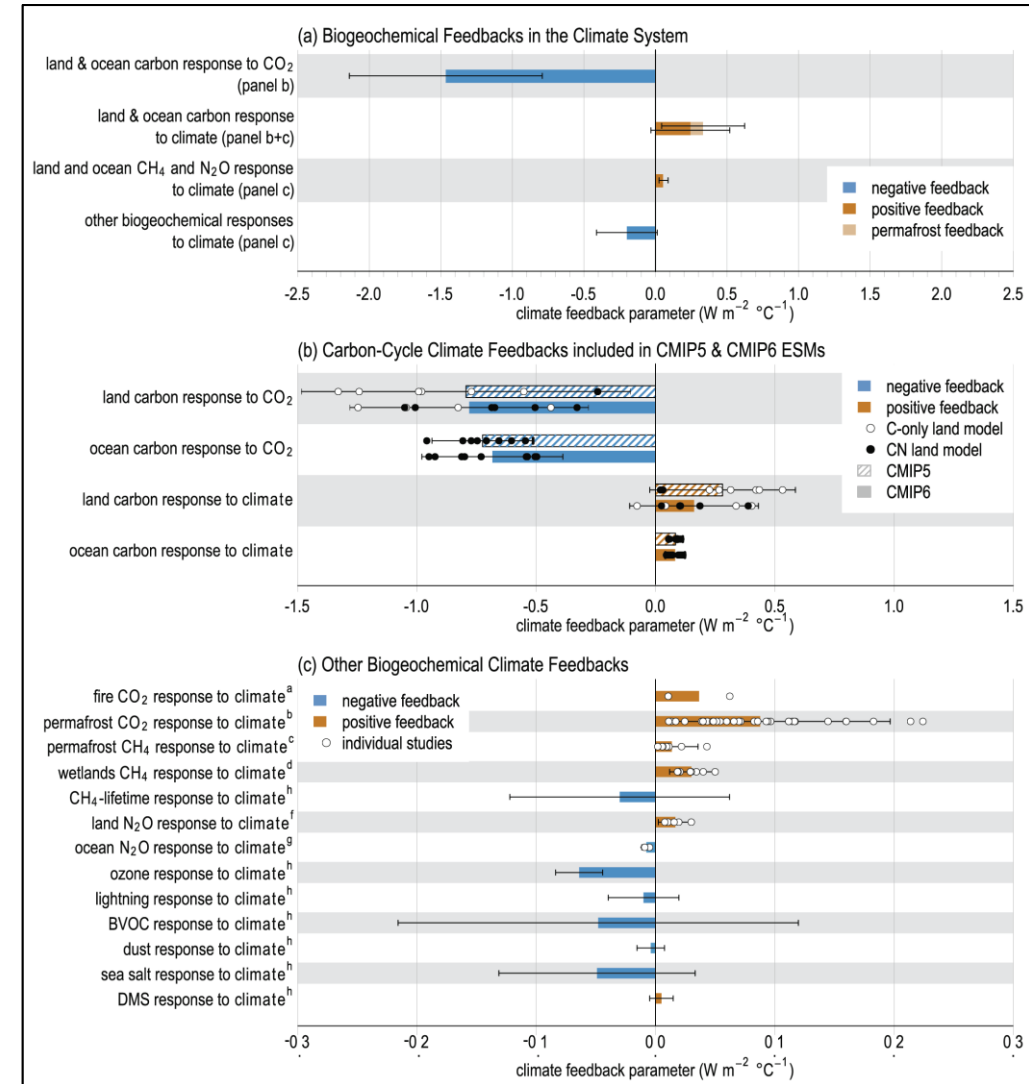
International science for net zero plus



WIE-MIP: Motivation

- Positive or negative climate feedbacks linked to greenhouse gas emissions from natural sources (esp. land)
- Affects the remaining anthropogenic carbon budget to limit global warming to 1.5 or 2 °C above pre-industrial temperatures (Paris Agreement)
- In consequence, increased mitigation of anthropogenic GHG emissions and/or more Carbon Dioxide removal required

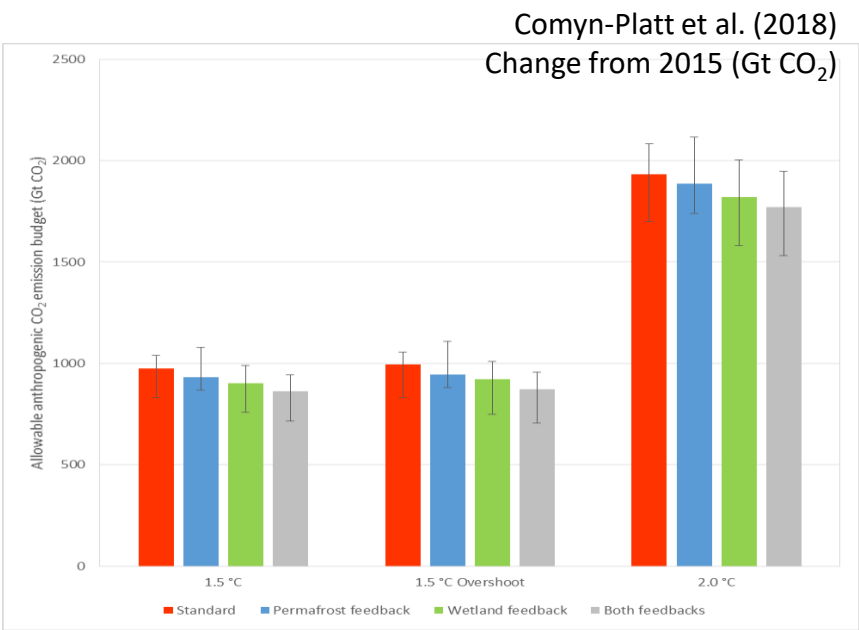
IPCC AR6, carbon cycle and biogeochemical feedbacks
Canadell et al, 2021, figure 5.29



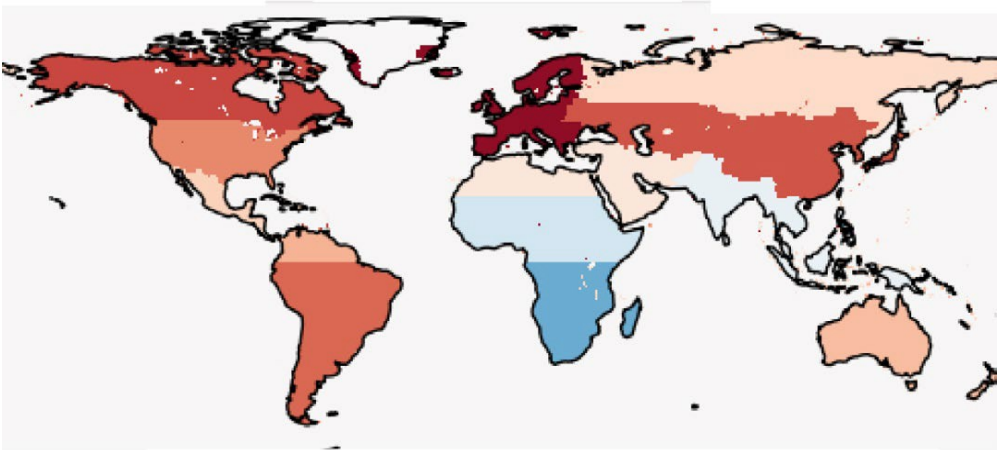
Process studies with JULES



- Using IMOGEN-JULES, Comyn-Platt et al. showed ~8-12% reduction in the remaining C budget from permafrost thaw & wetland methane
- Using JULES with different climate model inputs, Burton et al. showed ~5% reduction in the remaining C budget from fire



With Permafrost & Methane Feedbacks	862 (715-942)	873 (704-957)	1771 (1532-1947)
% Change	12 (9-15)%	12.5 (9-15)%	8.5 (6-10)%



nature geoscience

Article
<https://doi.org/10.1038/s41561-024-01554-7>

Fire weakens land carbon sinks before 1.5 °C

Received: 10 April 2024

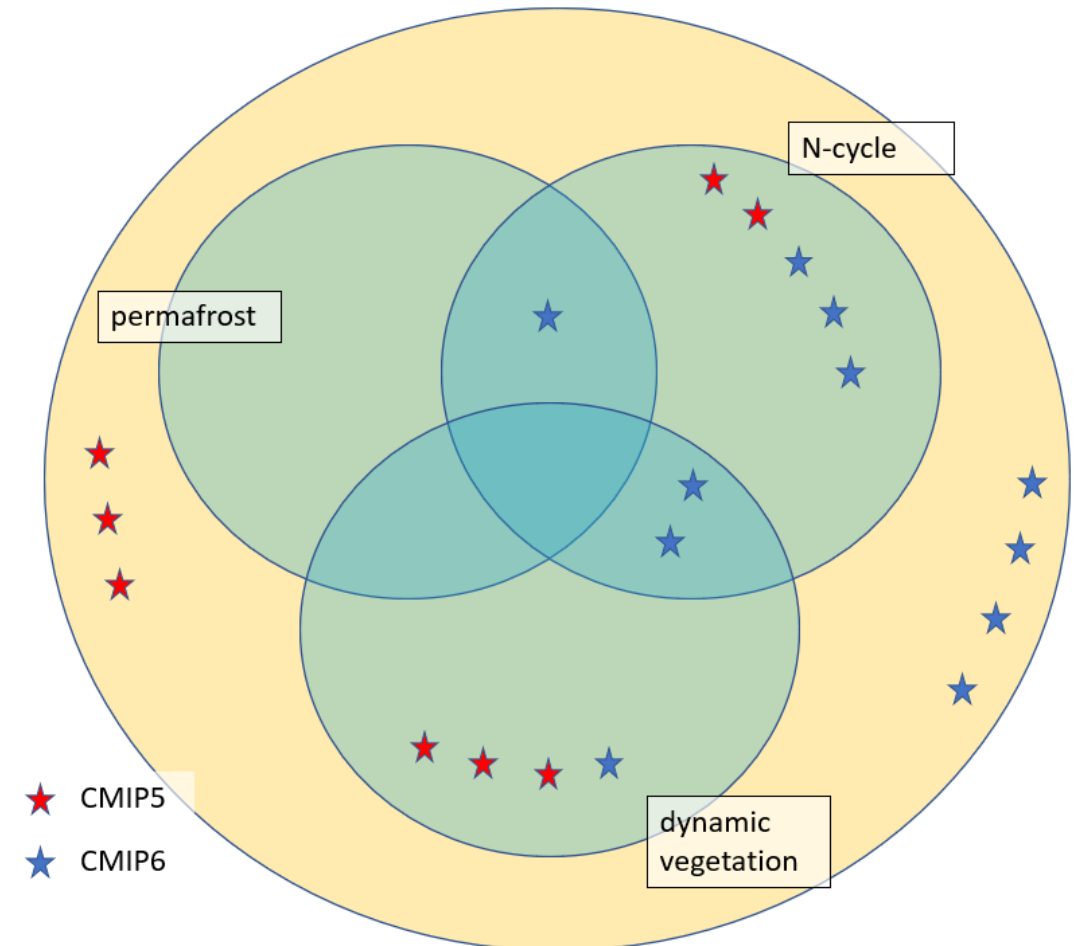
Accepted: 4 September 2024

Published online: 03 October 2024

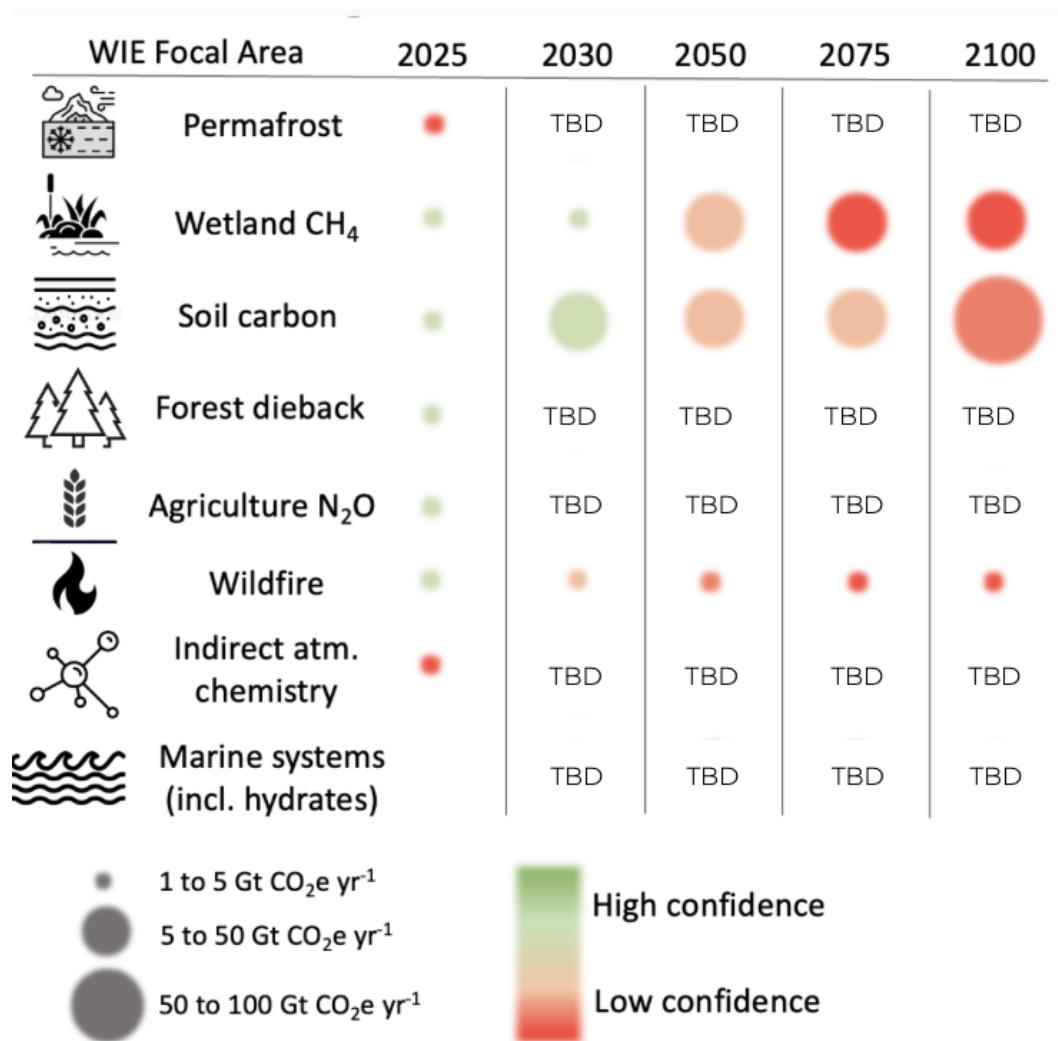
Chantelle A. Burton¹, Douglas I. Kelley², Eleanor Burke¹, Camilla Mathison^{1,3}, Chris D. Jones^{1,4}, Richard A. Betts^{1,5}, Eddy Robertson¹, João C. M. Teixeira^{1,6}, Manoel Cardoso⁶ & Liana O. Anderson⁷

WIE-MIP: Motivation

- CMIP ESMs include a range of different processes
- No 2 models have the same combination of nitrogen cycle, permafrost, fire, vegetation dynamics, etc ...
- Impossible to make clear statements of the importance of each process
- WIE-MIP proposes a systematic, multi-land-model intercomparison to quantify the importance of each process



WIE-MIP: Processes of interest



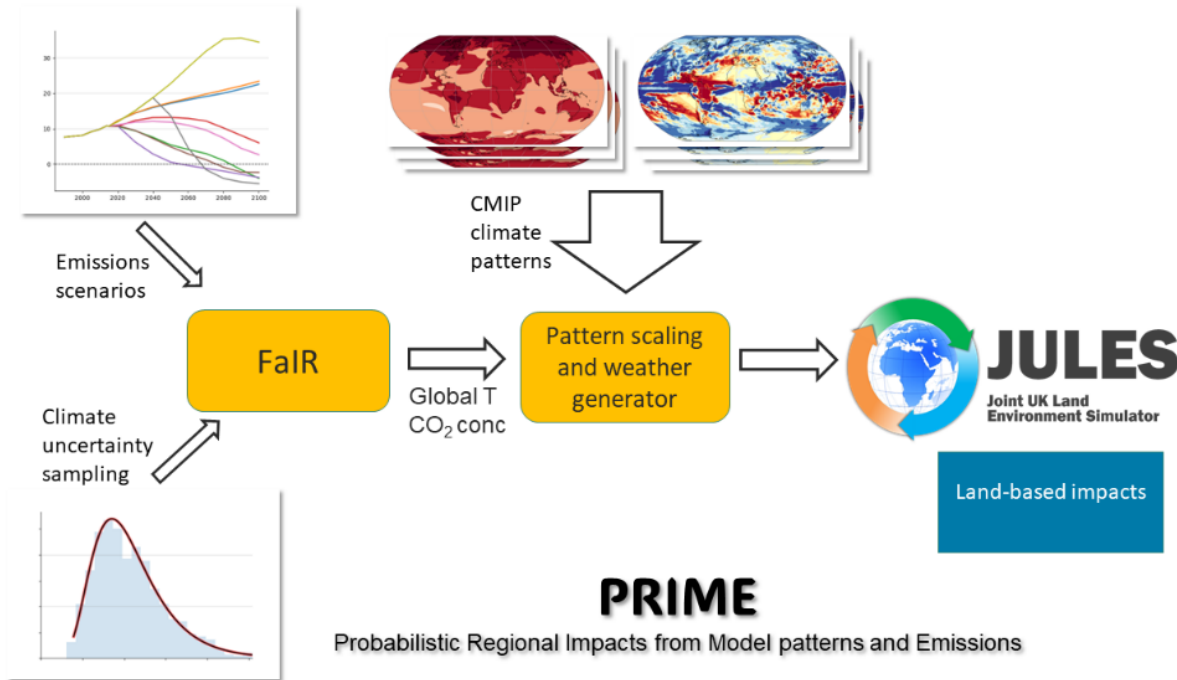
- Magnitude of warming-induced emissions
- Large uncertainties or not yet evaluated

WIE-MIP: Scope & Protocol



- Scope discussed at workshop held in July
- Protocol
 - 5 scenarios:
 - idealized (1% per annum increase in atmospheric CO₂) to quantify climate-carbon cycle feedbacks
 - overshoot (3 scenarios, modifying peak, duration, and stabilization level) – hopefully drawing on latest ScenarioMIP CMIP7 scenarios
 - unmitigated
 - Land surface modelling with PRIME
 - Factorial: permafrost, wildfire, wetland methane, soil biogeochemistry, forest dieback, BVOC
 - For CO₂/CH₄/N₂O, other processes also welcome (i.e., disease/insects)
 - Aim to submit Protocol paper to Geosci. Mod. Devel. by November 2025
- Outputs to inform WCRP TCRE report, remaining carbon budget and Zero Emission Commitment

PRIME (see poster)



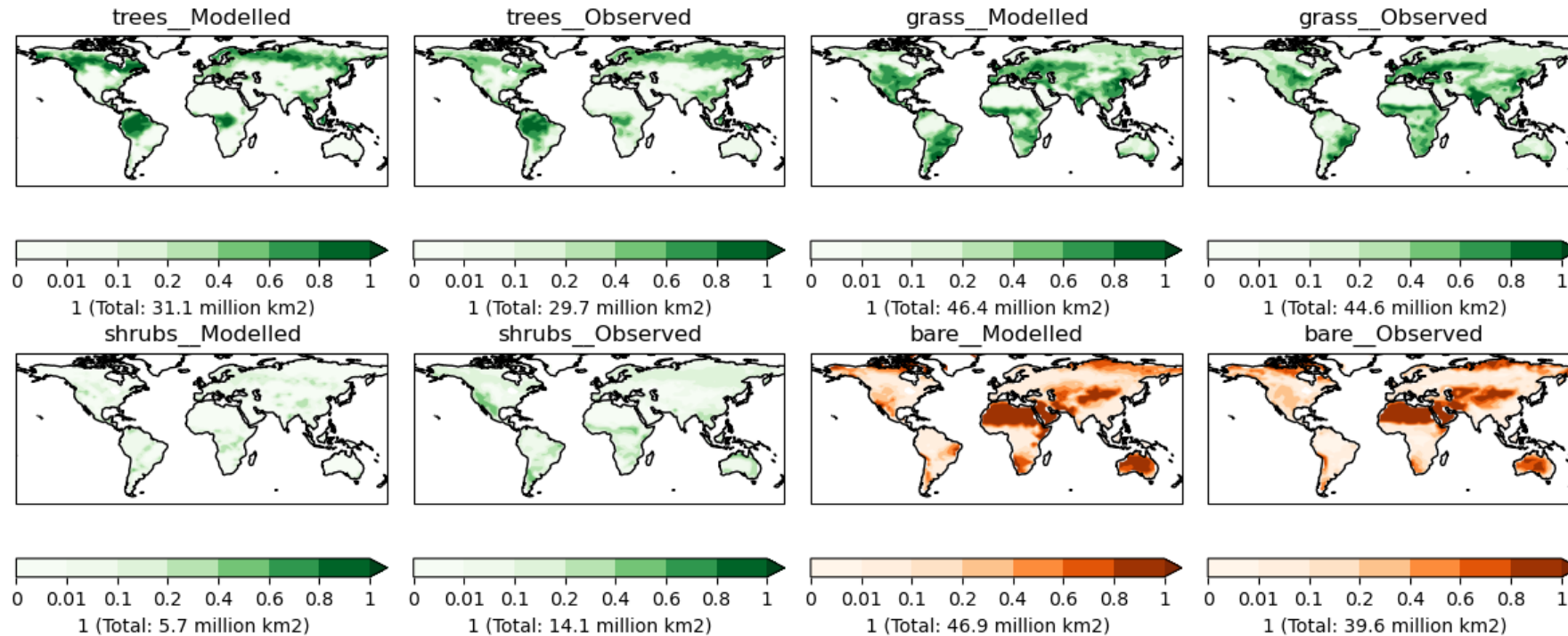
- Combines global climate emulation, pattern scaling and land modelling
- A flexible probabilistic framework able to efficiently run new scenarios without the overheads of larger more complex Earth system models (ESMs)
- Developed to run with JULES, providing the capability to sample:
 - different emissions/conc pathways
 - different global climate feedbacks
 - different climate patterns
- Provide driving data for other land surface models

Mathison et al., 2025

<https://doi.org/10.5194/gmd-18-1785-2025>

Planned JULES configuration based on UKESM2+

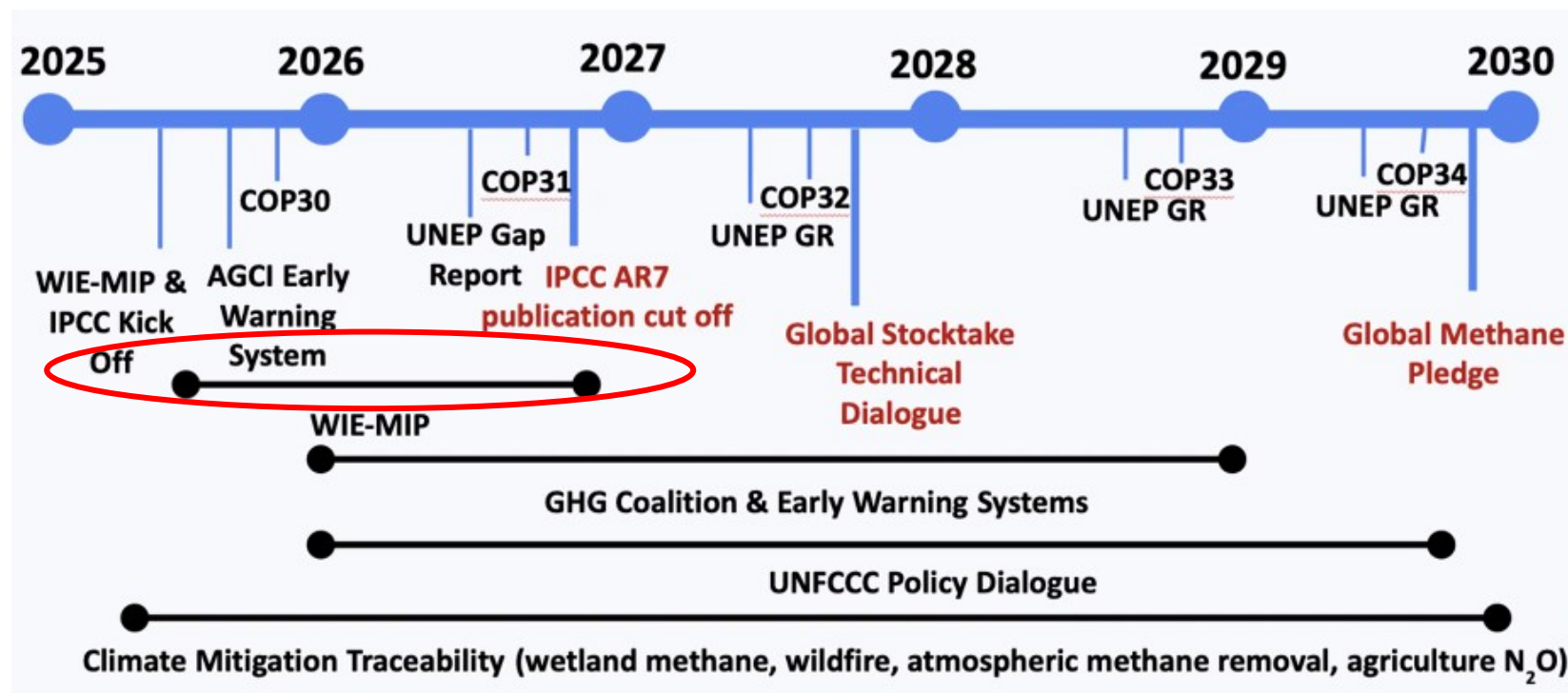
JULES-ES + fire + permafrost + vegetation acclimation



Contributions to configuration development welcome (eleanor.burke@metoffice.gov.uk)

WIE-MIP: Timeline

- 2025 Nov: Protocol available
- 2026-01: Data distributed
- 2026 Spring: Model simulations
- 2026 Summer: Analysis including workshop
- 2026 Q4: Paper writing and submission
- 2027-03: Submission deadline for IPCC AR7 WG1



Opportunity to participate



- Contribute to the 'JULES ES' configuration to be used in WIE-MIP
- Funding secured for WiE-MIP to cover
 - Core activities (Data, PRIME, workshops)
 - To enable community participation: light-touch application planned
- Speak to Chris Jones (chris.d.jones@metoffice.gov.uk) or Garry Hayman (garr@ceh.ac.uk)