

# The Warming-Induced Emissions Model Intercomparison Project (WIEMIP): JULES-WIEMIP configuration, planned outputs and preliminary results

JULES annual meeting - 9th September 2026

Juliette Bernard, Eleanor Burke, Joe Clarke, Carolina Duran Rojas, Pierre Friedlingstein, Rémi Gaillard, Angela Gallego-Sala, Nicola Gedney, Garry Hayman, Daniel Hooke, Chris D.Jones, Stephen Sitch, Noah Smith, Mike O'Sullivan, Rachael Turton, Rebecca Varney

# Warming-Induced Greenhouse Gas Emissions Model Intercomparison Project (WIEMIP)

- assess WIE from land that are not well represented in fully coupled ESM
- not CO<sub>2</sub>-only WIE : CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, BVOC

- ~20 LSMs including some of the following process :



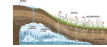
wetland CH<sub>4</sub>



dynamic vegetation



fires



permafrost



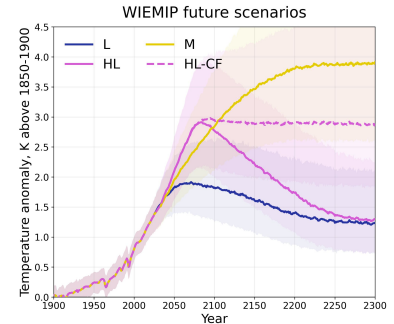
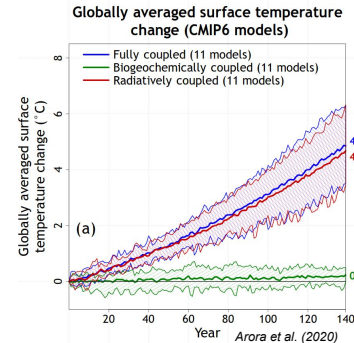
N cycle



BVOCs

runs:

- historical
- 1% CO<sub>2</sub> run (COU, BGC, RAD)
- Overshoot scenarios from ScenarioMIP

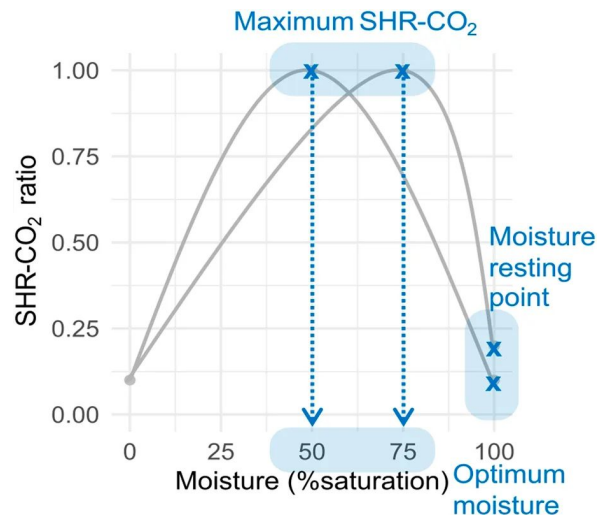


# JULES-WIEMIP : a new JULES configuration for WIEMIP

- Dependence of soil respiration on soil moisture *@Elise Dehaen et al. (2025)*
- Geothermal Heat flux *@Noah Smith*
- Biogenic heating of soil carbon decomposition *@Joe Clarke*
- Permafrost developments *@Eleanor Burke & Rémi Gaillard*
- BVOC Emissions, emission factors as used in UKESM2 *@Garry Hayman*
- Changes in soil ancillaries
  - account for organic matter *@Rémi Gaillard's talk*
  - account for tropical altered soils *@Juliette Bernard&Nic Gedney*
- Wetland methane emissions *@Sarah Chadburn&Juliette Bernard*
- Fires: dependence of flammability on environmental conditions *@Eleanor Burke & Eddy Robertson & Chantelle Burton*

# Dependence of soil respiration on soil moisture

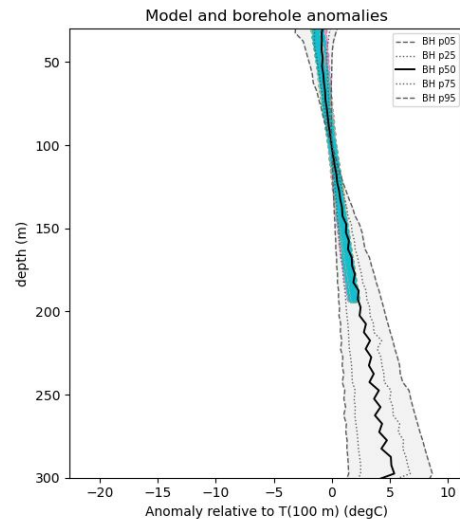
@Elise Dehaen et al. (2025)



- Change the respiration rates to be more accurate in very wet soils, including peatlands.

# Geothermal Heat flux

@Noah Smith



- Change in bedrock temperature with depth - JULES compared with boreholes

# Biogenic heating of soil carbon decomposition

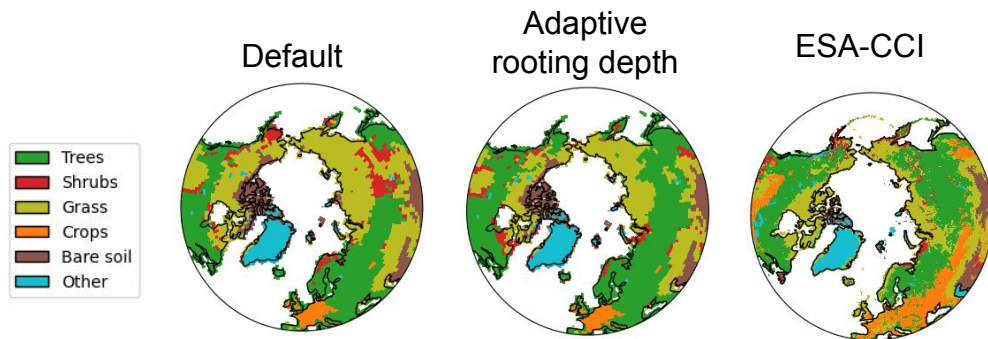
@Joe Clarke

- Heat is released from microbial respiration
- This heat now affects soil temperatures
- Leads to interesting R-tipping possibilities (the “compost bomb”)
- Most likely to be impactful in well insulated soils

# Permafrost

@Rémi Gaillard (talk Tues 2pm)

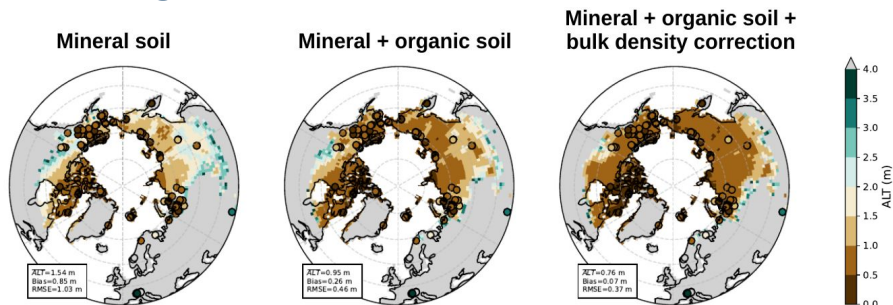
- Improved cryoturbation scheme (soil carbon burial through freeze/thaw cycles)
- Adaptive PFT rooting depth to the active layer thickness. Allows larch trees to grow on top of permafrost soils with shallow active layers.



# Changes in soil ancillaries

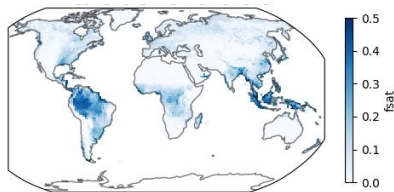
- accounting for organic matter effect on soil hydraulic and thermal properties

@Rémi Gaillard (talk Tues 2pm)

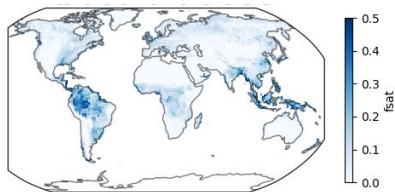


- accounting for altered tropical soils hydraulic properties @Nic Gedney & Juliette Bernard

mineral soils + OM



mineral soils + OM + trop soils



# BVOC emissions

@Garry Hayman

- emission factors as used in UKESM2

# Wetland microbial methane with WTD subgrid

- microbial module

@Sarah Chardburn et al. (2020)

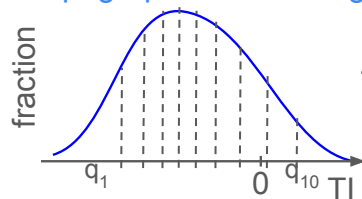
Modeled Microbial Dynamics Explain the Apparent Temperature Sensitivity of Wetland Methane Emissions

Sarah E. Chardburn<sup>1</sup>, Tuula Aalto<sup>2</sup>, Mika Aurela<sup>2</sup>, Dennis Baldocchi<sup>3</sup>, Christina Biasi<sup>4</sup>, Julia Boike<sup>5,6</sup>, Eleanor J. Burke<sup>7</sup>, Edward Comyn-Platt<sup>8</sup>, A. Johannes Dolman<sup>9</sup>, Carolina Duran-Rojas<sup>1</sup>, Yuanchao Fan<sup>10,11</sup>, Thomas Friborg<sup>12</sup>, Yao Gao<sup>7</sup>, Nicola Gedney<sup>13</sup>, Mathias Göckede<sup>14</sup>, Garry D. Hayman<sup>15</sup>, David Holt<sup>16</sup>, Gustaf Hugelius<sup>17</sup>, Lars Kutzbach<sup>18</sup>, Hanna Lee<sup>19</sup>, Annalea Lohila<sup>2,18</sup>, Frans-Jan W. Parmentier<sup>19,20</sup>, Torsten Sachs<sup>21</sup>, Narasinha J. Shurpali<sup>22</sup>, and Sebastian Westermann<sup>19</sup>

- accounting for a water table subgrid

@Sarah Chardburn & Juliette Bernard

10 topographic index subgrid



JULES  
calculation

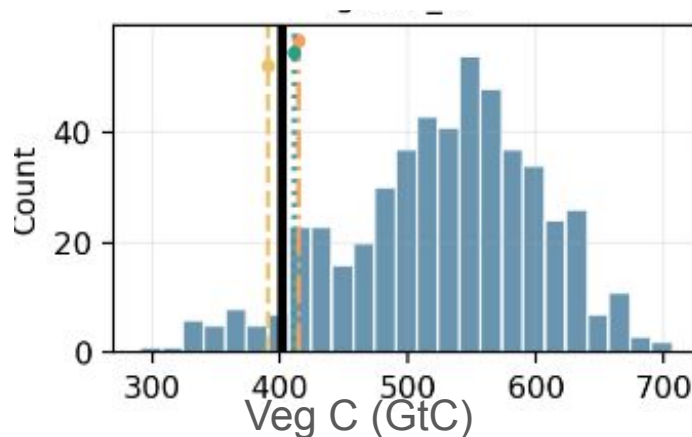
10 water table subgrids

topographic index (TI) distribution provided as ancillaries derived from *Marthews et al. (2015)*

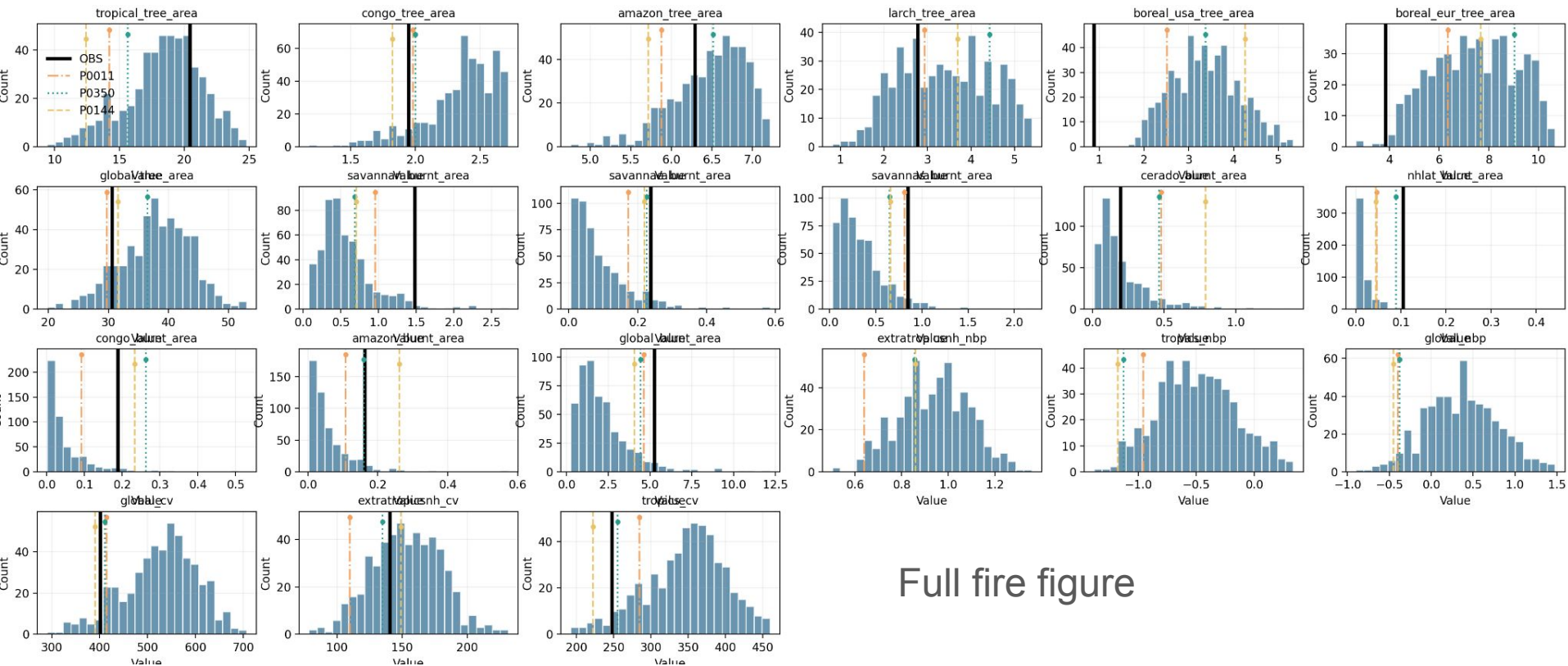
# Fires

@Eleanor Burke & Eddy Robertson & Chantelle Burton

- Perturbing the parameters relating flammability to environmental conditions. Find best set from comparison with obs tree cover, vegetation carbon and burnt area
- Global vegetation carbon obs (black) and selected ensemble members



P\* Distributions by Metric with OBS Lines



Full fire figure

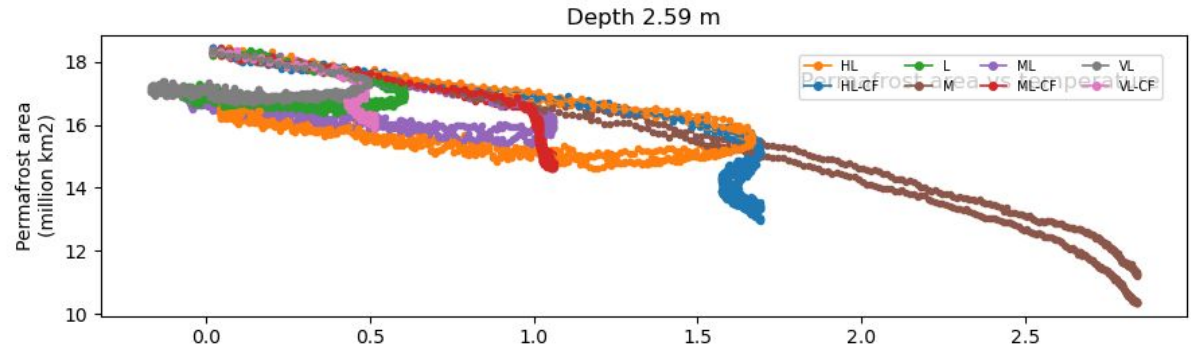
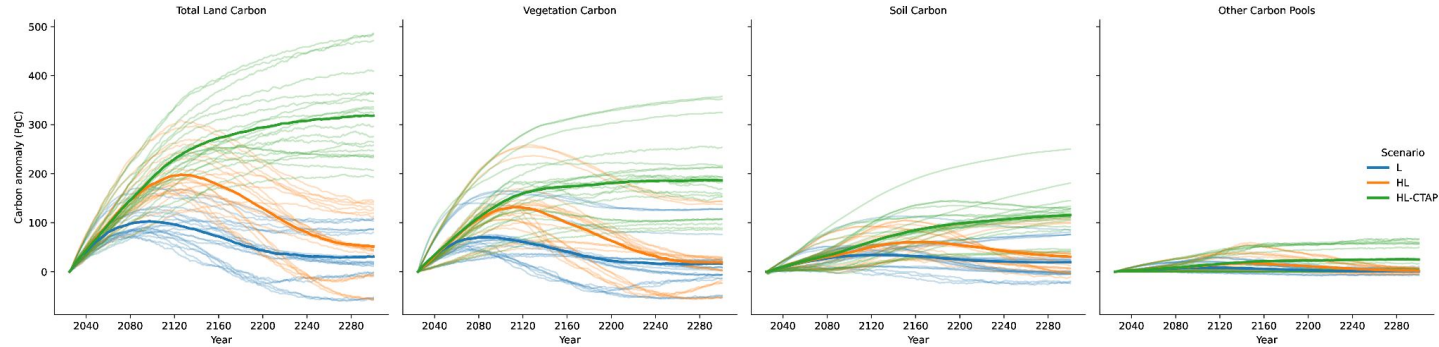
# Intercomparison papers led by Exeter's group

- Overshoot effect on land [\*@Joe Clarke\*](#)
- TCRE  $\beta$  and  $\gamma$  : the role of processes included in ESMs [\*@Rebecca Varney and Rémi Gaillard\*](#)
- non-CO2 GHG WIE effect on TCRE, Carbon Budget, ZEC [\*@Juliette Bernard\*](#)
- WIE from the soils [\*@Rebecca Varney\*](#)
- BVOCs [\*@Garry Hayman\*](#)

# First results : overshoot effect on land

@Joe Clarke

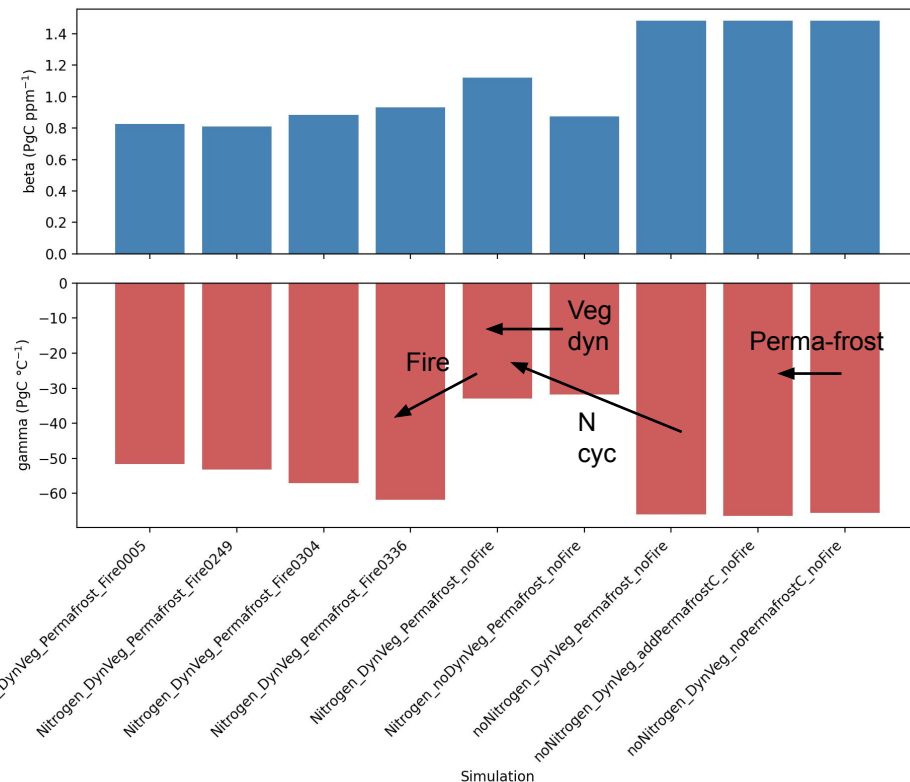
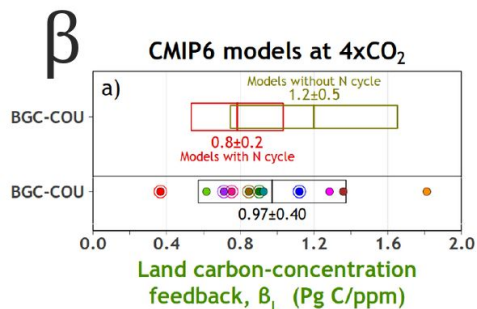
- Evidence of reversibility in global carbon stocks
- Slower processes (e.g. permafrost) show more irreversibility



Permafrost extent reversibility teaser with JULES-WIEMIP.

# First results : TCRE $\beta$ and $\gamma$ : the role of processes included in ESMs

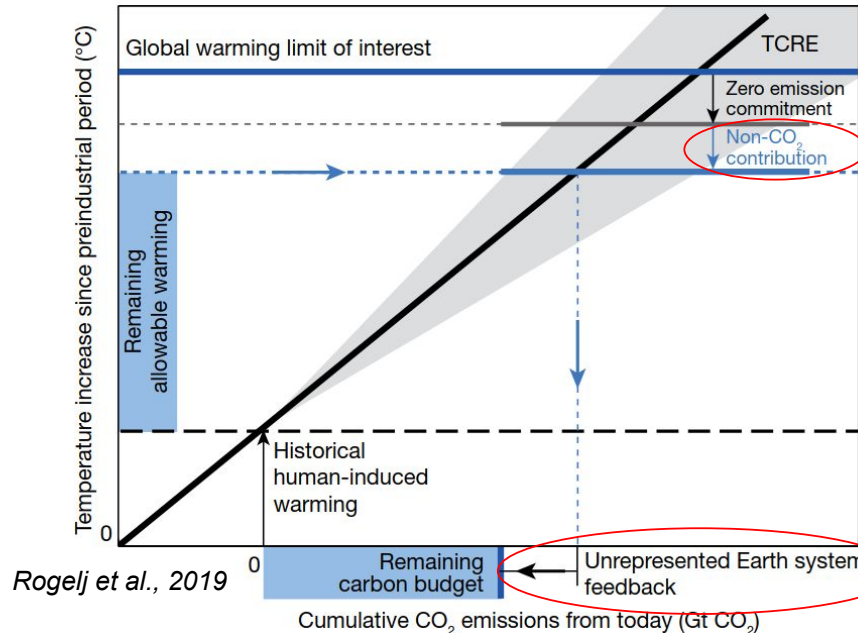
@Rebecca Varney



- Isolate and calculate the sensitivity of land carbon to both CO<sub>2</sub> & subsequent climate changes.
- Use WIEMIP factorial simulations to attribute the role of specific processes.

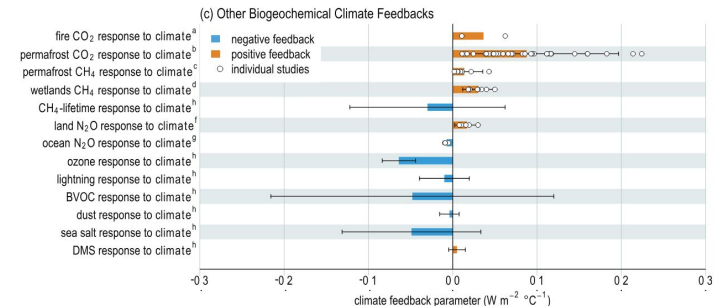
# First results : non-CO2 GHG WIE effect on TCRE, Carbon Budget, ZEC

@Juliette Bernard



non-CO2 anthropogenic emissions

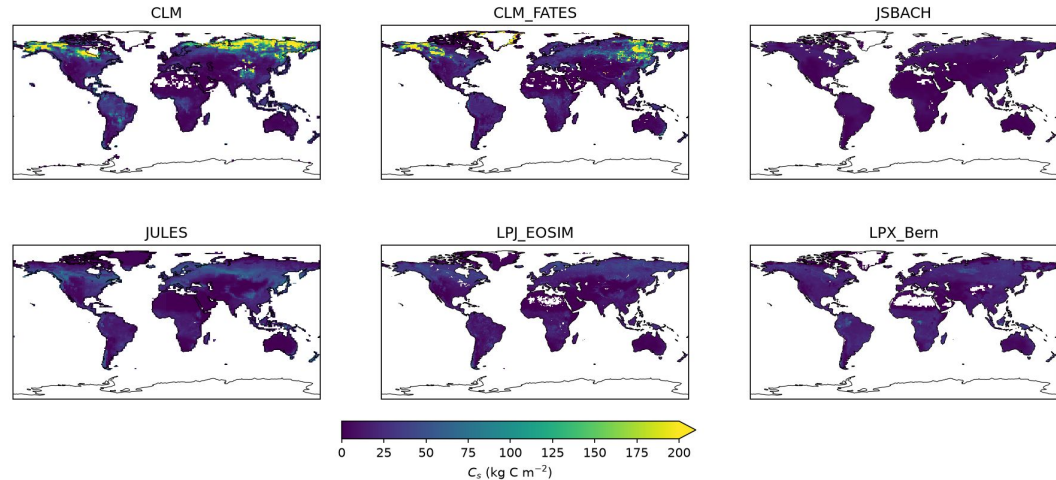
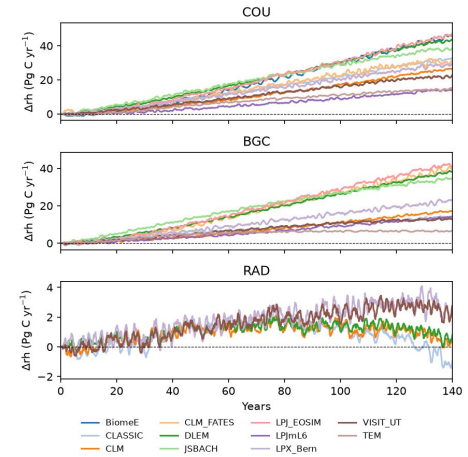
correction, including non-CO2 Earth System Feedbacks



# First results : WIE from the soils

@Rebecca Varney

- Soil carbon stocks in the historical simulation vary significantly across LSMs.
- More WIEMIP LSMs explicitly include permafrost processes than any ensemble so far.
- We can use WIEMIP simulations to investigate the sensitivity of biogeochemical fluxes to climate changes.



# First results : BVOCs

*@Garry Hayman*

- Little information in the literature on the response of BVOCs to temperature overshoot
- Output from 7 land surface models, including JULES-WIEMIP
- Emulator approach to simulate atmospheric processes (trace gases and aerosols) to get BVOC climate feedback
- Links to AerCHEM-MIP2 activity (James Weber and others)
- Publication planned for input into the IPCC AR7

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Thanks for your attention!

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