JULES-IMOGEN and the Paris targets:

A story of feedbacks, mitigation and inversion

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NERC SCIENCE OF THE ENVIRONMENT

NERC Programme – Understanding the Pathways to and Impacts of a 1.5˚C Rise in Global Temperature

- Evidence for the UK Committee on Climate Change, with regard to their statutory advice on national carbon budgets.
- Input to the special report of the Intergovernmental Panel on Climate Change (IPCC): “Impacts of global warming of 1.5°C above pre-industrial levels ……”, publication in 2018

Three projects with common methods (JULES-IMOGEN) formed an “Intra-Consortia”

CLIFFTOP

Climate feedbacks from wetlands and permafrost thaw in a warming world

Garry Hayman, Sarah Chadburn, Eddy Comyn-Platt, Toby Marthews, Eleanor Burke, Nic Gedney, Eleanor Blyth and Hanna Lee

CLUES

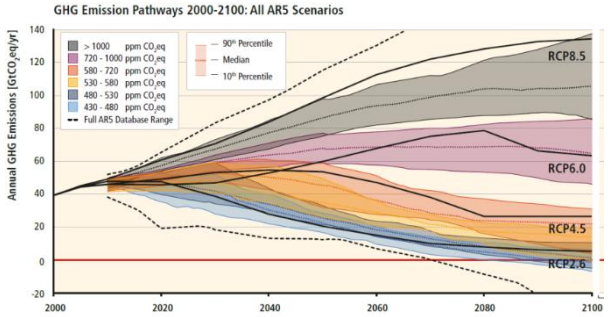
Climate, Land-Use, and Ecosystem Services at 1.5°C

Anna Harper, Peter Cox, Stephen Sitch, Tim Lenton, Tom Powell, Jo House, Chris Huntingford

MOC1.5

Methane, Ozone and the Carbon Budget for 1.5°C

Bill Collins, Peter Cox, Stephen Sitch, Jason Lowe, Chris Webber, Chris Huntingford



Prescribed Anthropogenic Emissions

Atmospheric Composition

Simple Ocean Uptake Model

Energy Balance Model

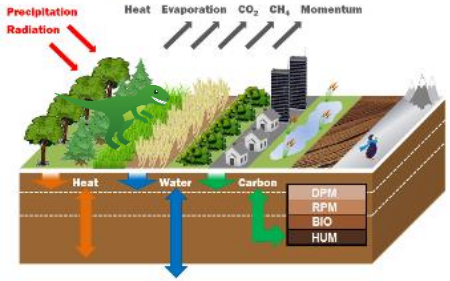
IMOGEN

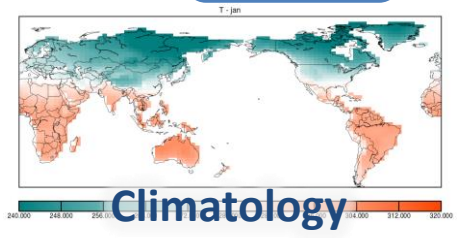
Global Warming

Pattern Scale of Met Data from 34 GCMs

JULES Estimates Land Carbon Exchange

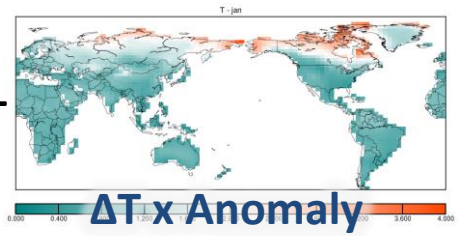
JULES
Joint UK Land Environment Simulator





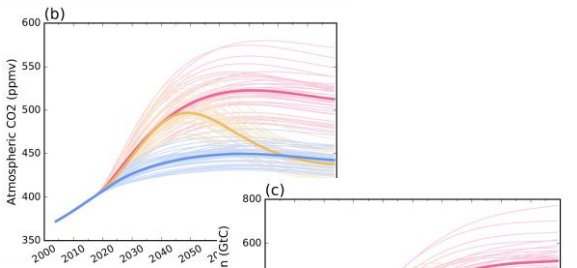
Climatology

+



ΔT x Anomaly

Huntingford, C., et al. (2010). IMOGEN: an intermediate complexity model to evaluate terrestrial impacts of a changing climate, Geosci. Model Dev., 3, 679–687, doi: 10.5194, gmd-3-679-2010.



Derived Anthropogenic Emissions

Atmospheric Composition

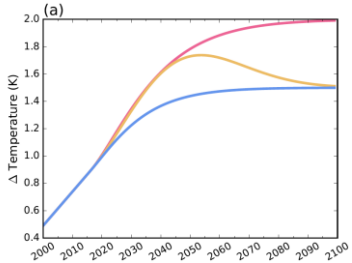
Simple Ocean Uptake Model

Inverted Energy Balance Model

IMOGEN^{-1}

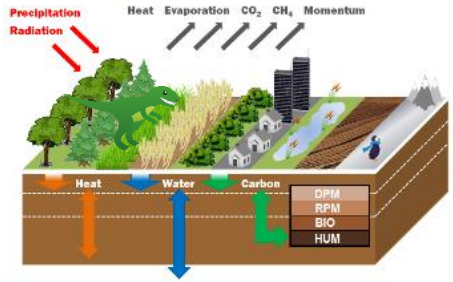
JULES Estimates Land Carbon Exchange

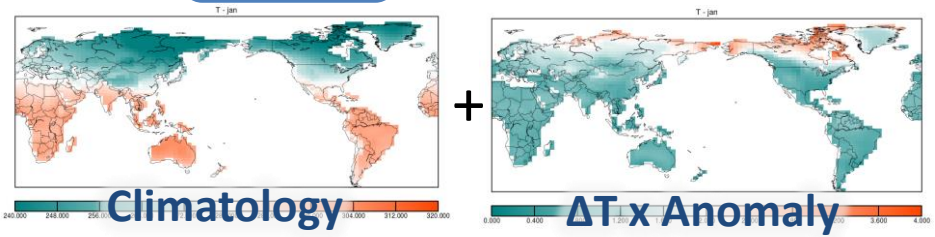
Global Warming



Pattern Scale of Met Data from 34 GCMs

JULES
Joint UK Land Environment Simulator





Climatology + ΔT x Anomaly

Comyn-Platt et al., 2018, Carbon budgets for 1.5 and 2°C targets lowered by natural wetland and permafrost feedbacks. Nature Geoscience

CLIFFTOP Results - Permafrost

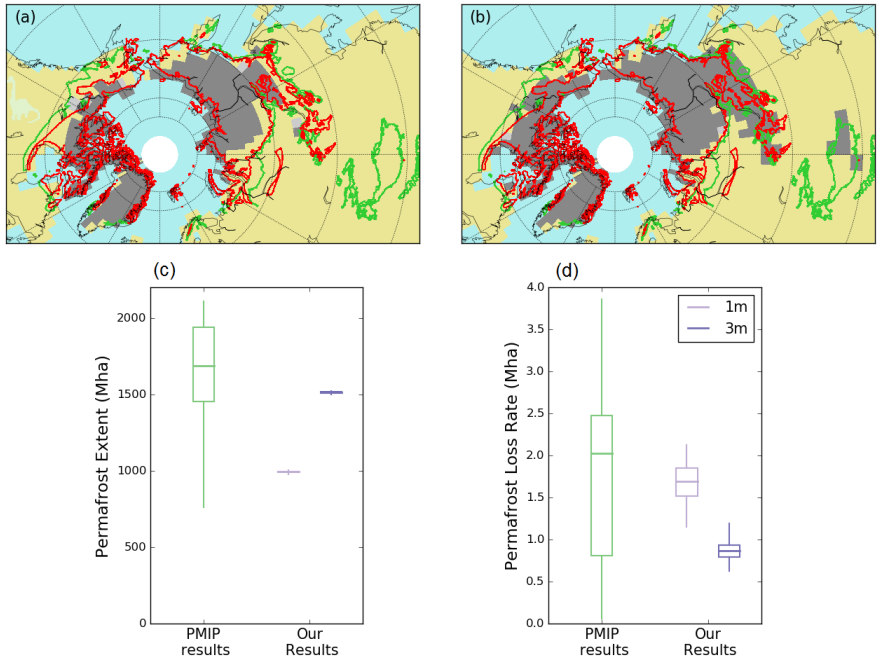


Figure SI.3

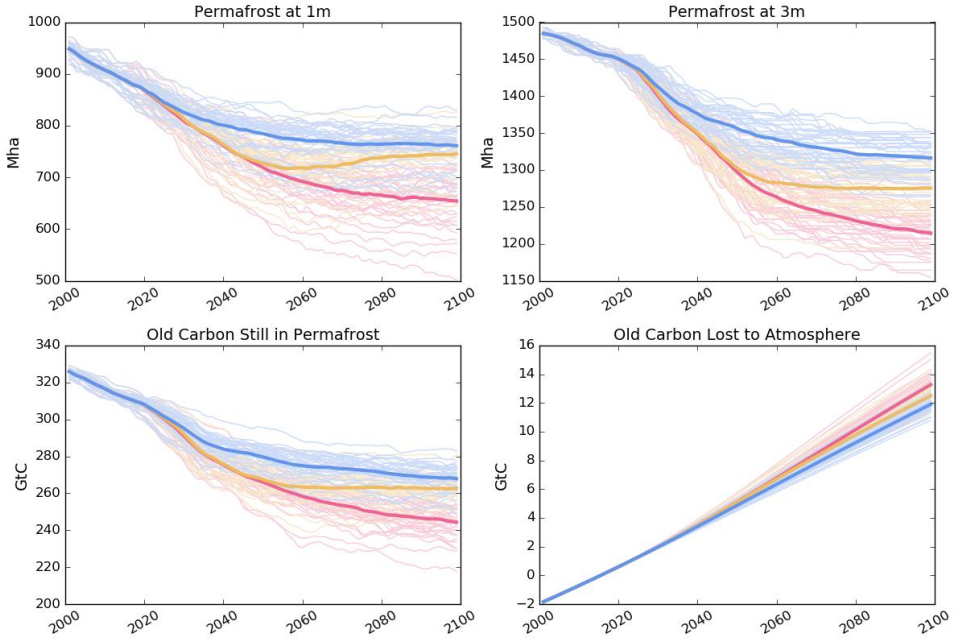


Figure 2

Comyn-Platt et al., 2018, Carbon budgets for 1.5 and 2°C targets lowered by natural wetland and permafrost feedbacks. Nature Geoscience

CLIFFTOP Results – Natural Wetlands

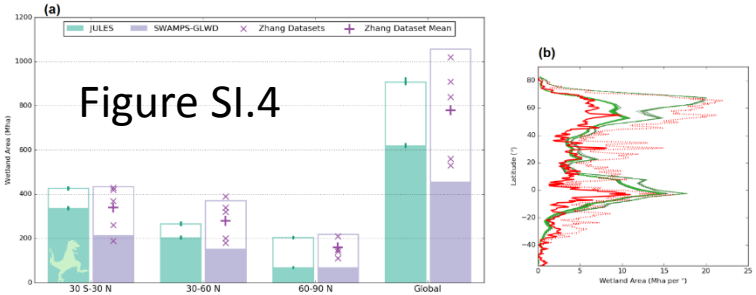


Figure SI.4

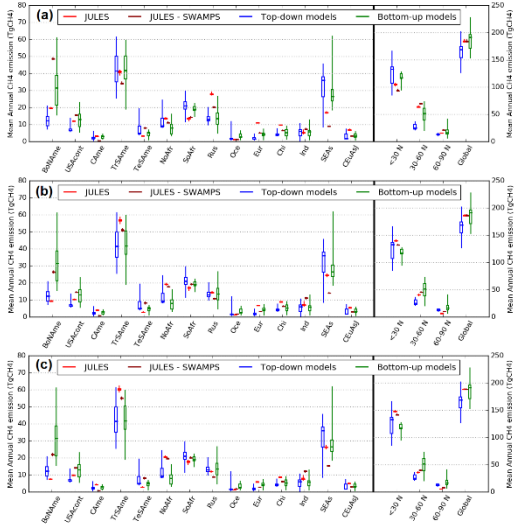


Figure SI.5

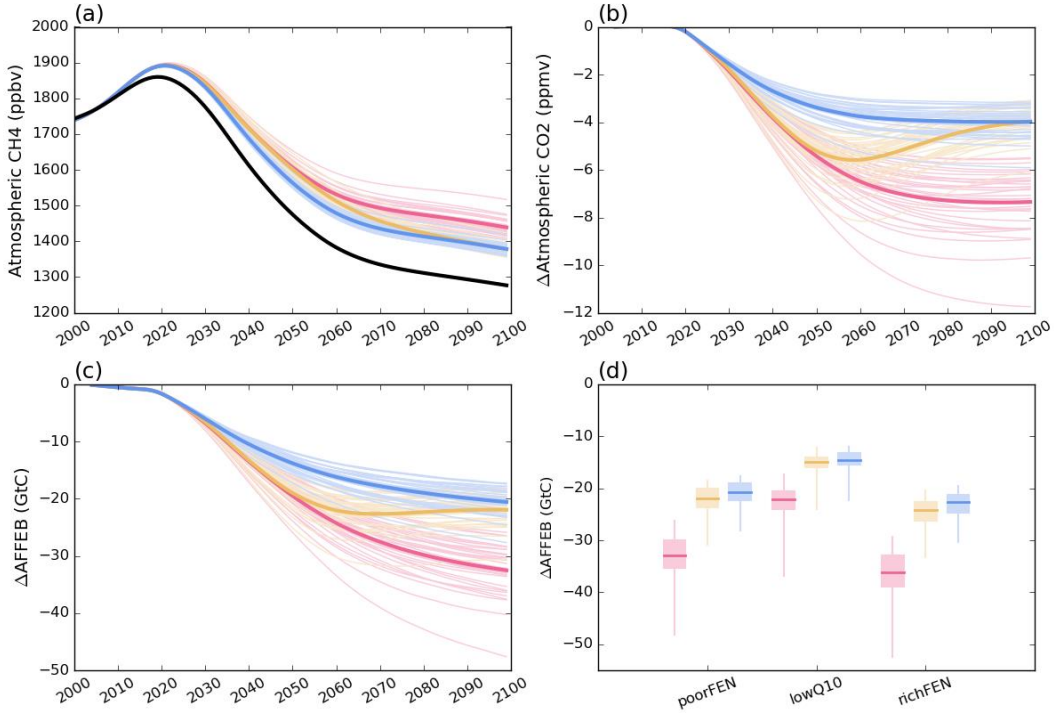
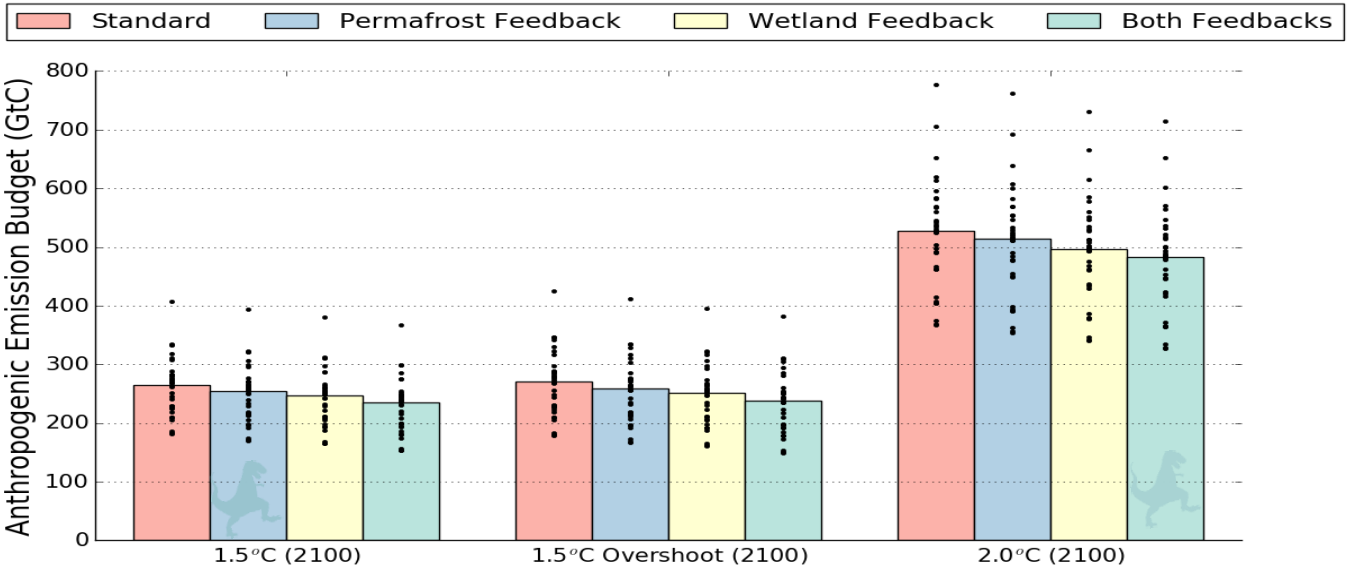


Figure 3 - Correction

Comyn-Platt et al., 2018, Carbon budgets for 1.5 and 2°C targets lowered by natural wetland and permafrost feedbacks. Nature Geoscience

CLIFFTOP Results

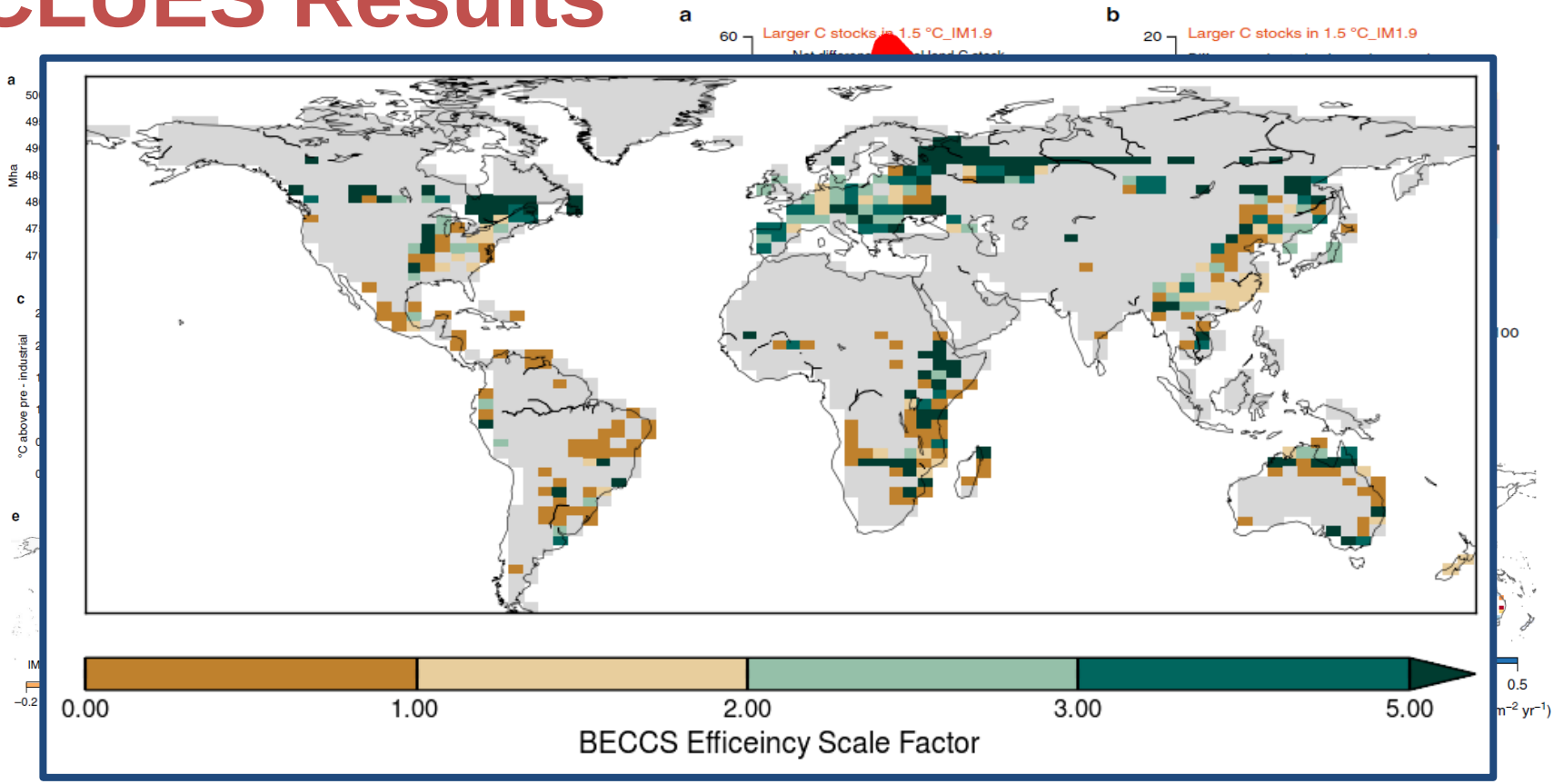
Relative to present day



Control	265 GtC	271 GtC	527 GtC
Both Feedbacks	235 GtC	238 GtC	483 GtC
Additional Reductions	12.0 %	12.5 %	8.5%

Comyn-Platt et al., 2018, Carbon budgets for 1.5 and 2°C targets lowered by natural wetland and permafrost feedbacks. Nature Geoscience

CLUES Results



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Harper Anna B et al., 2018, Land-use emissions play a critical role in land-based mitigation for Paris climate targets. Nature Communications, 9

NERC SCIENCE OF THE ENVIRONMENT

MOC1.5 Results

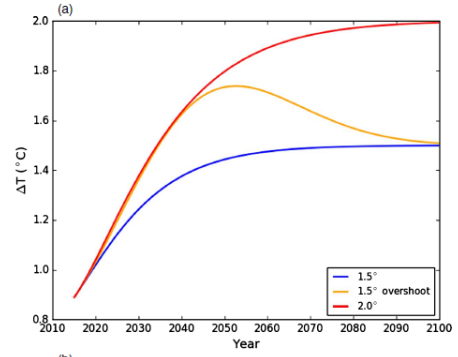


Figure 1. (*a*) The three temperature pathways used (surface temperature increases with respect to 1850). (*b*) Global mean atmospheric concentrations of CH_4 for the four scenarios.

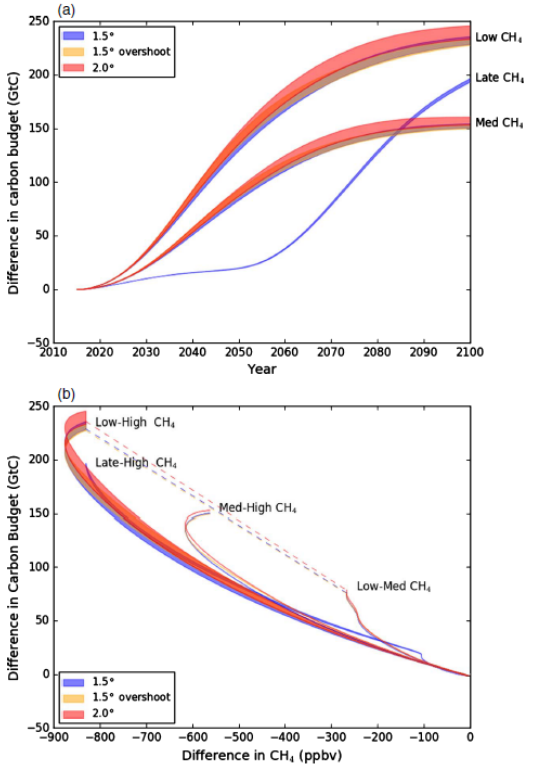
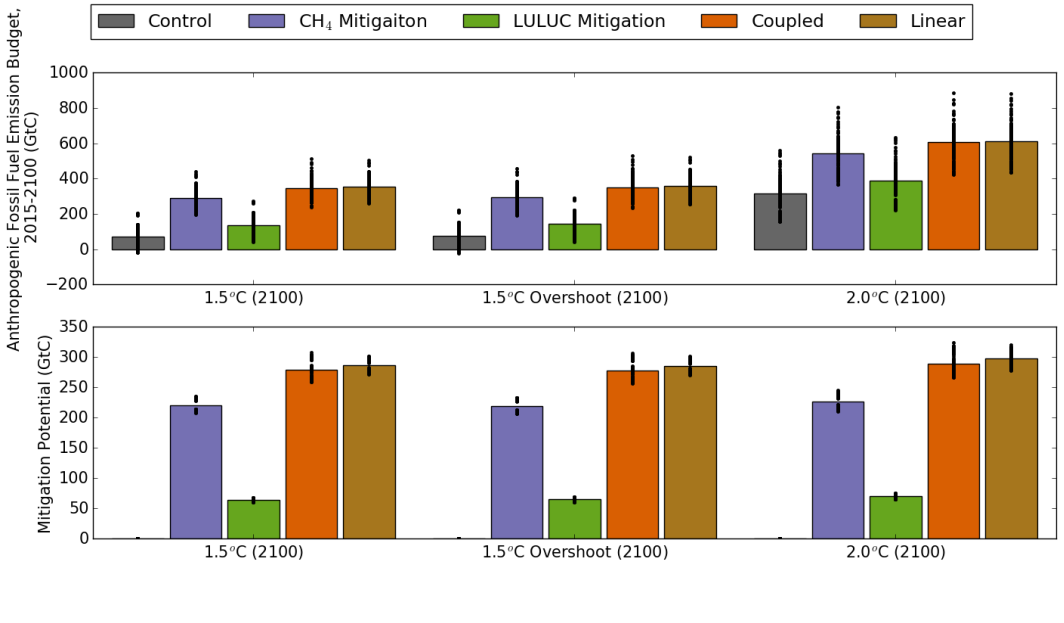
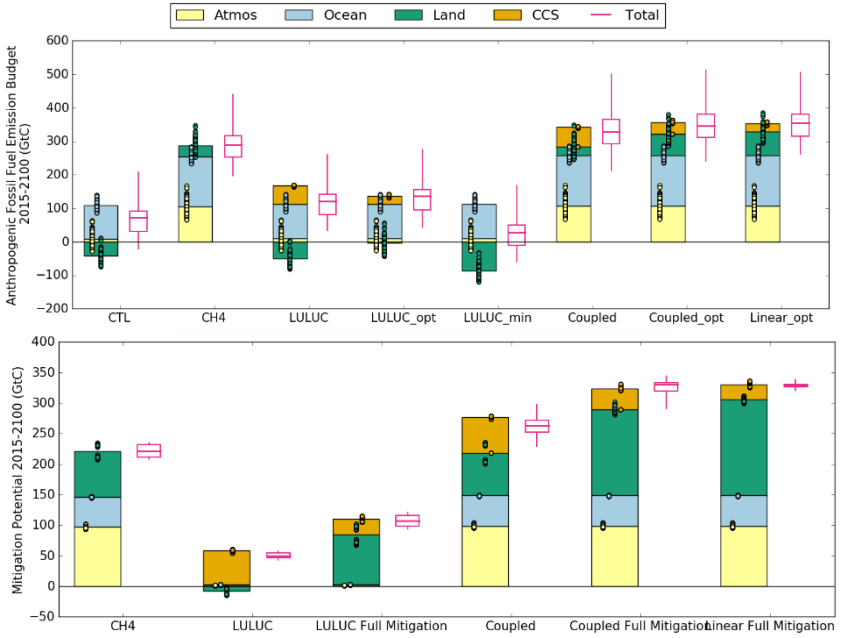


Figure 2. Impact of CH_4 mitigation on the carbon budget for the three temperature profiles. (*a*) Increase in allowable carbon emissions compared to the High CH_4 scenario. Data are shown for the three temperature profiles. The widths of the lines cover the range of the CMIP5 models. (*b*) Difference in allowable carbon emissions between pairs of CH_4 scenarios, as a function of difference in CH_4 concentration for each year 2015–2100. The widths of the lines cover the range of the CMIP5 models. The dashed lines connect the differences in 2100 carbon budget against 2100 CH_4 concentrations for the Low, Medium and High CH_4 scenarios. For the Late vs High CH_4 scenario only the 1.5° temperature profile is shown.

SYNTHESIS

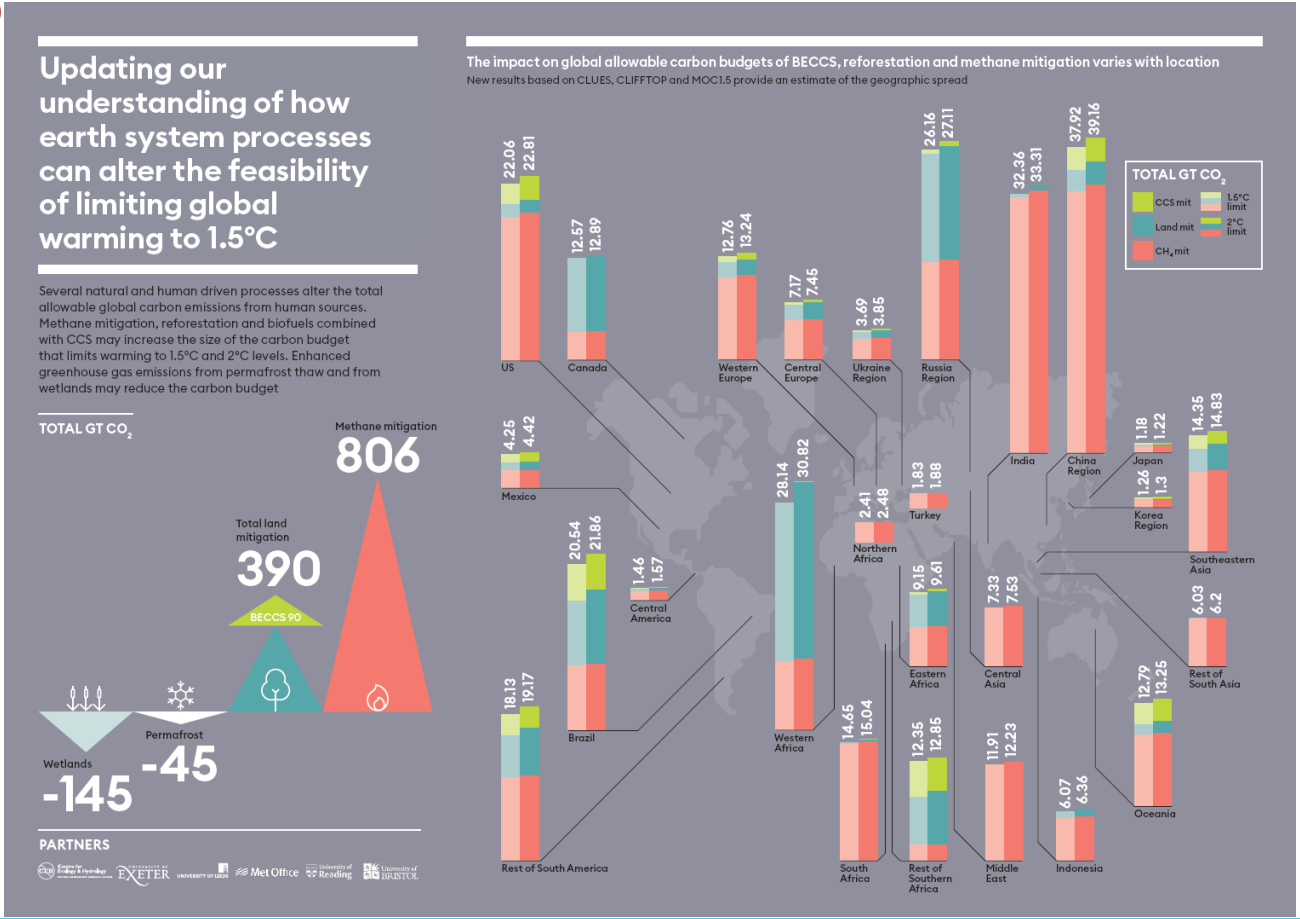

Control
CH_4 Mitigaiton
LULUC Mitigation
Coupled
Linear
Anthropogenic Fossil Fuel Emission Budget, 2015-2100 (GtC)
1000
800
600
400
200
0
−200
1.5°C (2100)
1.5°C Overshoot (2100)
2.0°C (2100)
Mitigation Potential (GtC)
350
300
250
200
150
100
50
0
1.5°C (2100)
1.5°C Overshoot (2100)
2.0°C (2100)


Atmos
Ocean
Land
CCS
Total
Anthropogenic Fossil Fuel Emission Budget 2015-2100 (GtC)
600
500
400
300
200
100
0
−100
−200
CTL
CH4
LULUC
LULUC_opt
LULUC_min
Coupled
Coupled_opt
Linear_opt
Mitigation Potential 2015-2100 (GtC)
400
350
300
250
200
150
100
50
0
−50
CH4
LULUC
LULUC Full Mitigation
Coupled
Coupled Full Mitigation
Linear Full Mitigation

SYNTHESIS

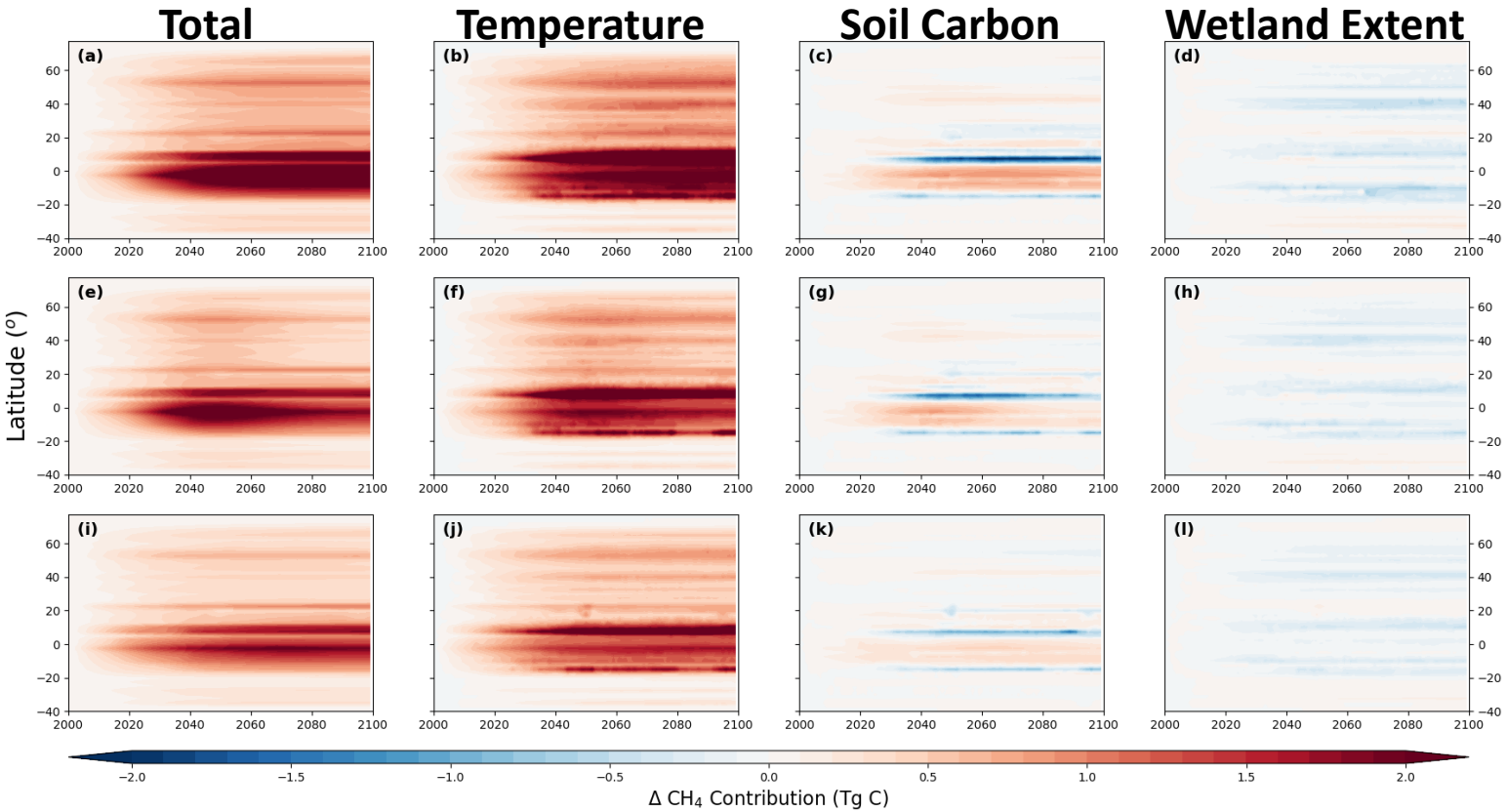
- Summary policy card for BEIS meeting.

- These results with additional water demand analysis to form synthesis paper



Additional Material Section

CLIFFTOP - Increased Methane Emission Sources



BECCS efficiency sensitivity