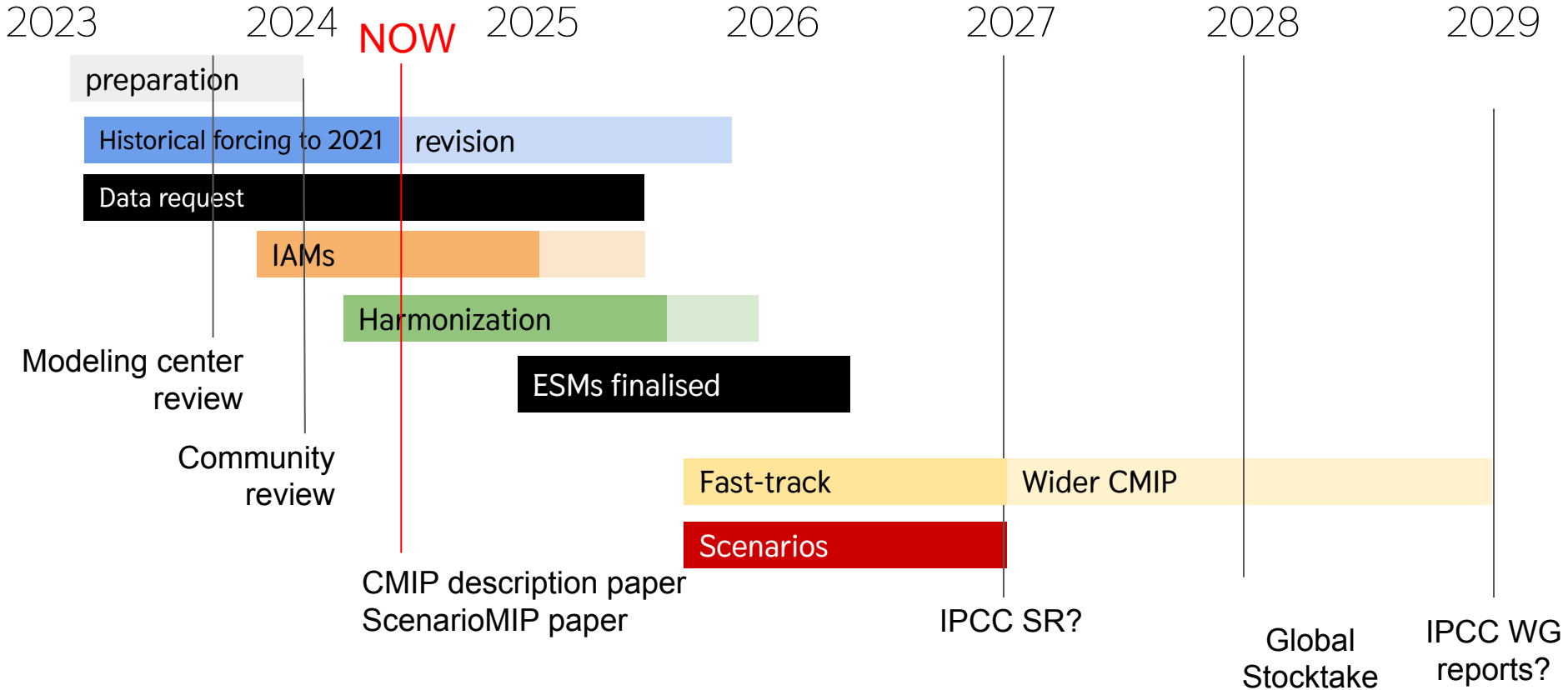# Emissions driven simulations for CMIP7 and beyond

Ben Sanderson

CESM workshop, Jun 12 2024

CMIP7 timeline

CMIP   WCRP
World Climate Research Programme

2023   2024   NOW   2025   2026   2027   2028   2029

preparation

Historical forcing to 2021   revision

Data request

IAMs

Harmonization

ESMs finalised

Modeling center review

Community review

Fast-track   Wider CMIP

Scenarios

CMIP description paper
ScenarioMIP paper   IPCC SR?   Global Stocktake   IPCC WG reports?

The Task Teams

The CMIP Task Teams are active, meeting regularly and feeding into the CMIP Panel and WIP to support the CMIP7 experimental design and subsequent implementation.

- Data access (Robert Pincus and Atef Ben-Nasser)

- Data citation (Martina Stockhause and Sasha Ames)

- Data Request (Martin Juckes and Chloe Mackallah)

- Forcings (Paul Durack and Vaishali Naik) *plus Forcing harmonisation sub-group*

- Model benchmarking (Birgit Hassler and Forrest Hoffman)

- Model documentation (David Hassell and Guillaume Levavasseur)

- Strategic ensemble design (Ben Sanderson and Isla Simpson)

Fast Track

CMIP WCRP World Climate Research Programme

DECK

- amip
- piControl
- esm-piControl
- 1pctCO2
- abrupt-4xCO2
- piClim-control
- piClim-anthro
- piClim-4xCO2
- historical
- esm-hist

Climate Services

ScenarioMIP

- High
- M-OS
- M
- L
- VL-OS
- VL

RFMIP

- piClim-4×CO2
- piClim-histaer
- piClim-aer
- piClim-histall

Process Understanding

C4MIP

- 1%BGC
- 1%rad
- flat10
- TCRE (flat10)
- REV (flat10–cdr)

DAMIP

- hist-nat
- hist-aer
- hist-ghg

AerChemMIP

- piClim-X
- hist-piSLCF
- hist-piAer
- SSPX-SLCF

PMIP

- lig127k

GeoMIP

x

LMIP

- land-hist

CFMIP

- amip-p4K
- amip-piForcing
- abrupt-2×CO2

Emissions-driven simulations in CMIP7
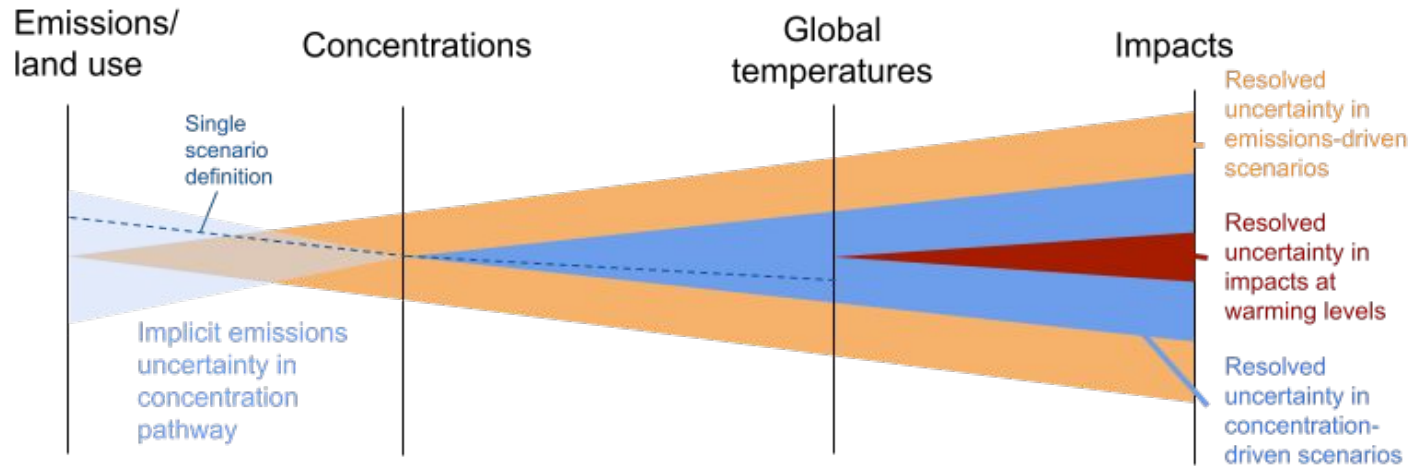
Emissions-driven simulations in CMIP7
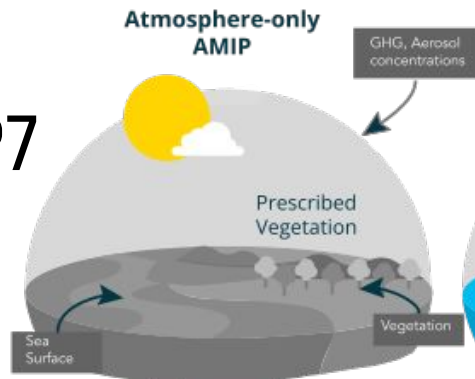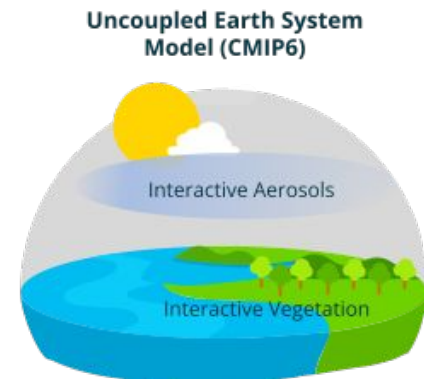
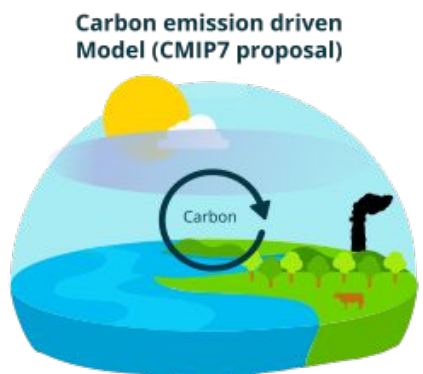# E-driven historical simulations in CMIP6 have a larger spread of historical warming

- Greater focus on coupled calibration
- New challenges in the clear communication of the multi-model ensemble
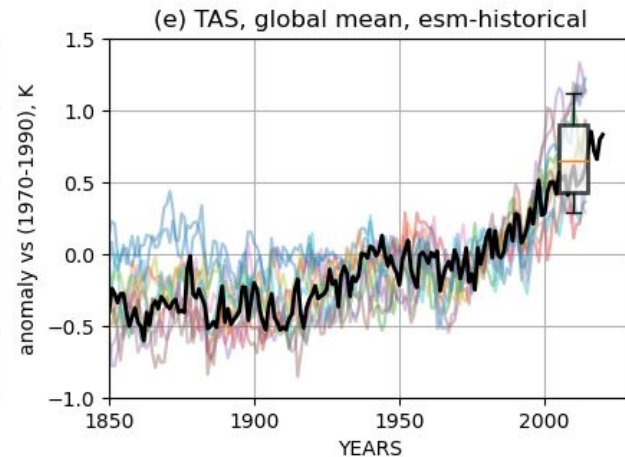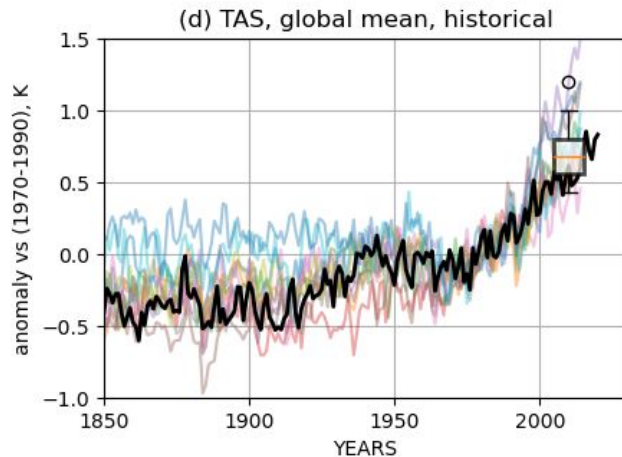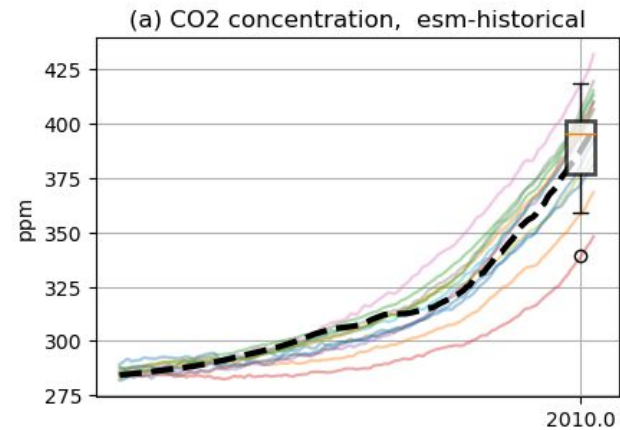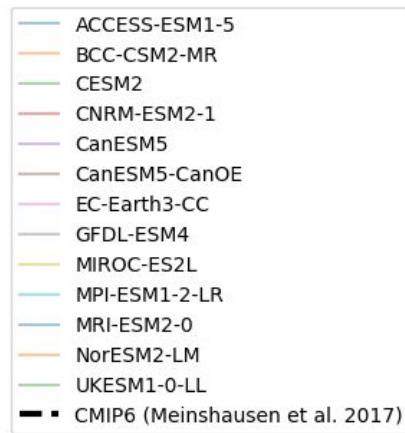
Spinup protocols

Case A: For models planning to run with CO2 concentrations:

- Historical, abrupt_4xCO2 &1pctCO2 branch from year 100 of picontrol.

- Request minimum 400 years total picontrol (550 *if* doing c-driven scenariomip ext)

Case B: For models planning to run with **Both** CO2 concentrations (historical) and emissions (esm-historical):

- esm-historical (plus flat10, etc) branches from year 100 of esm-picontrol

- Request minimum 400 years total esm-picontrol (550 years if doing e-scenariomip ext)

- pictrl as in case A.

Case C: For models planning to run with CO2 emissions and **NOT** planning to run a historical:

- esm-historical (plus flat10, etc) branches from year 100 of esm-picontrol.

- picontrol, abrupt_4xCO2 &1pctCO2 branch from year 100 of esm-picontrol using avg concentrations from year 50-100 of esm-picontrol.

- Request 400 year minimum for esm-picontrol (550 years *if* e-scenariomip with extensions)
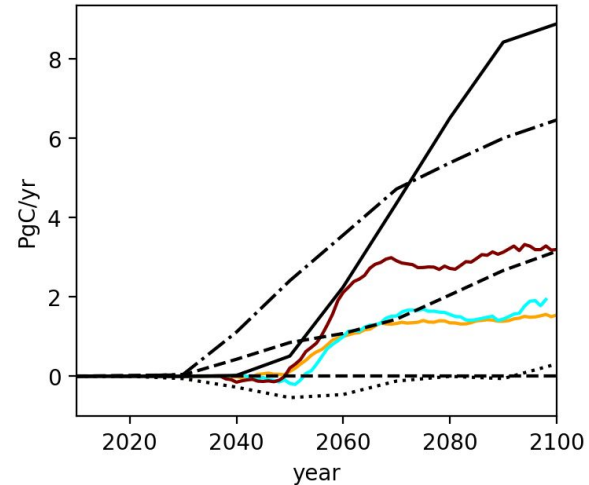
IAM assumed negative emissions fluxes are subject to significant model uncertainty

- ScenarioMIP unlikely to include process-driven BECCS
- Significant interest in process CDR satellite MIP (LUMIP/CDRMIP?)
- Version 0 protocol to establish additional IAM-ESM coupling variables (building on RESCUE)
- Virtual workshop on BECCS implementation this fall to finalise
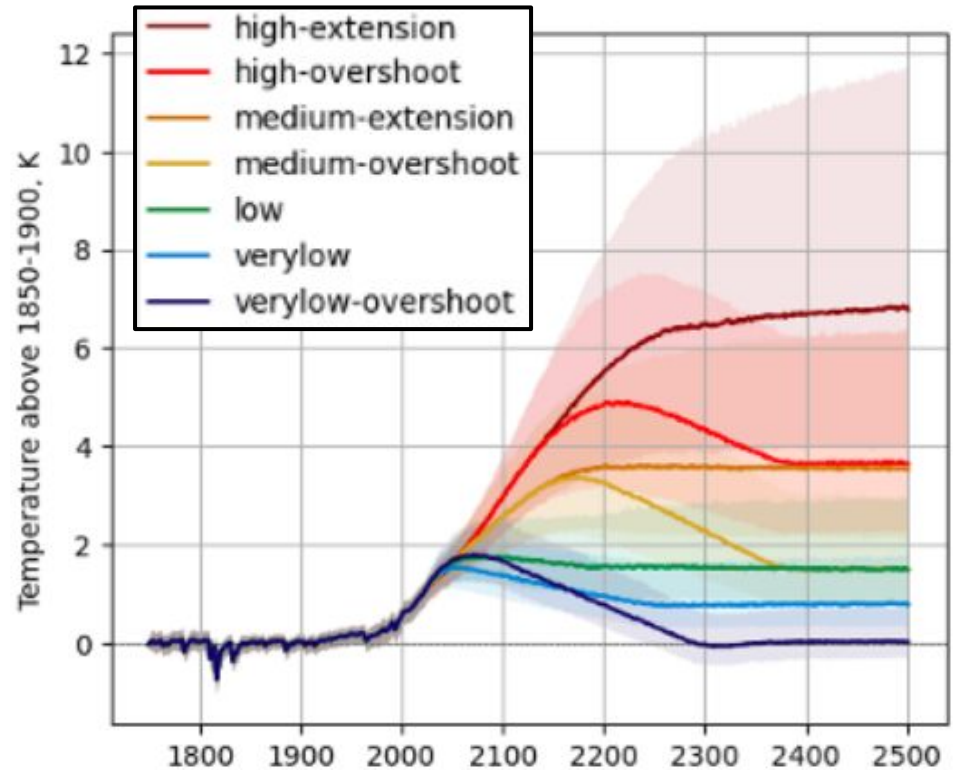

(a) Total Crop Harvest

Legend:
- CESM2-WACCM
- UKESM1-0-LL
- IPSL-CM6A-LR
- GCAM4
- IMAGE
- REMIND-MAGPIE
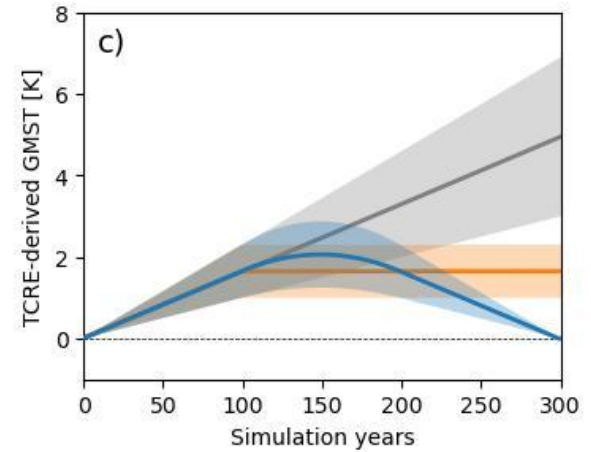- AIM/CGE
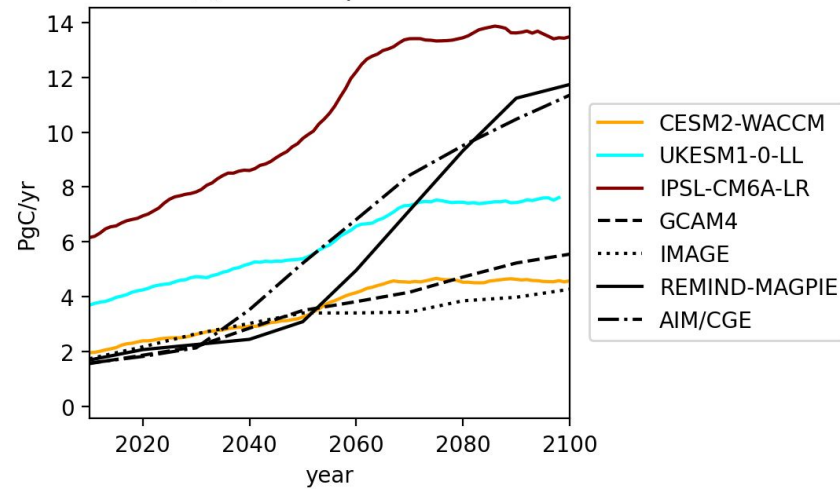
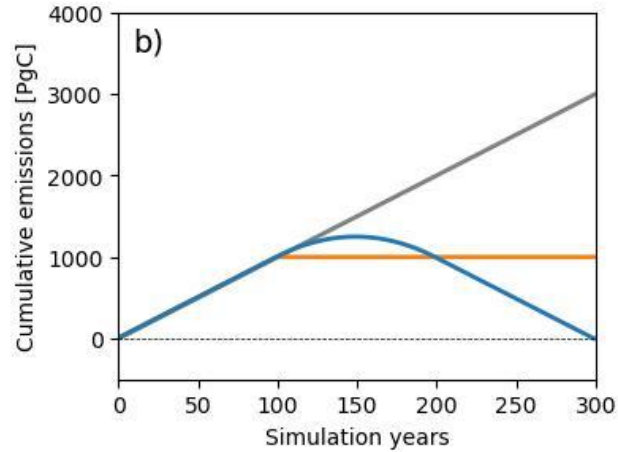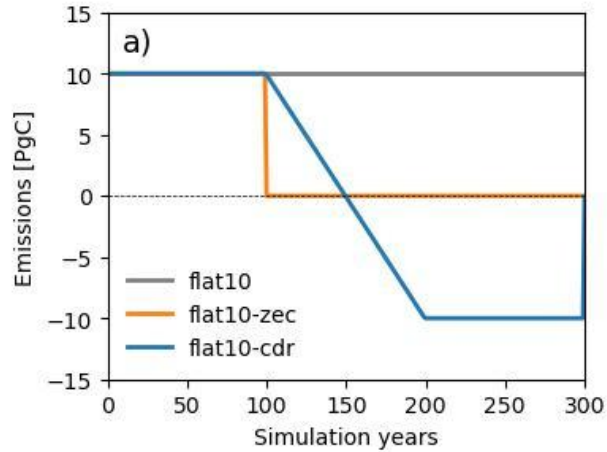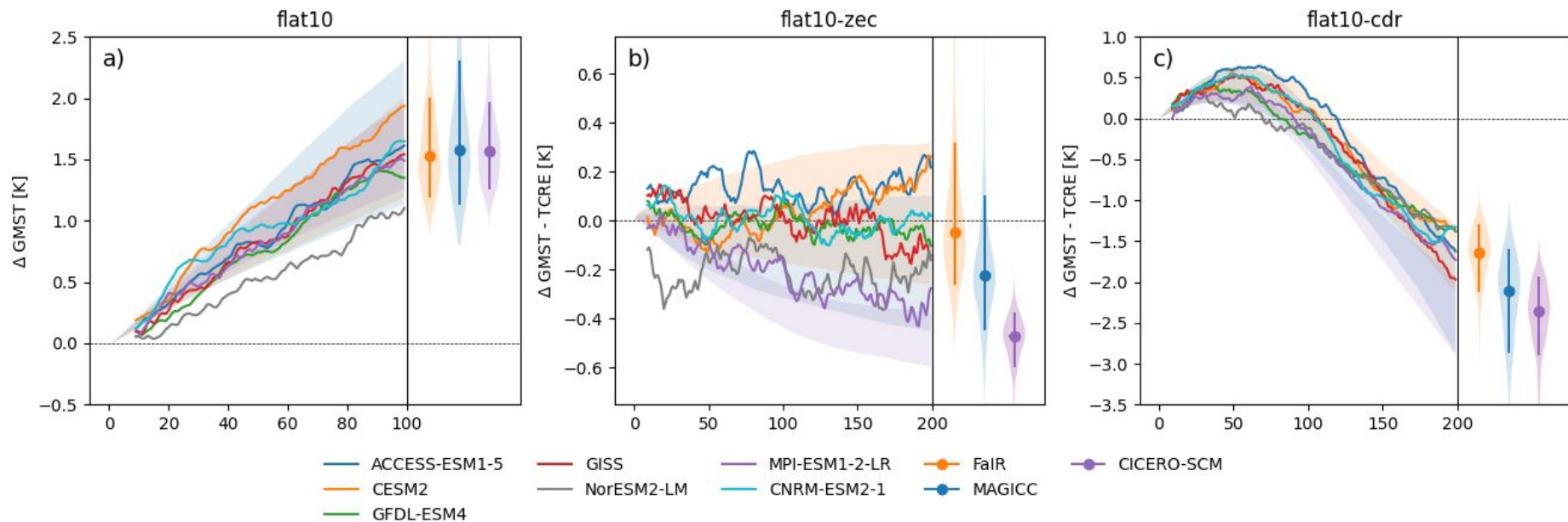(b) Difference in Harvest (SSP534over - SSP585)

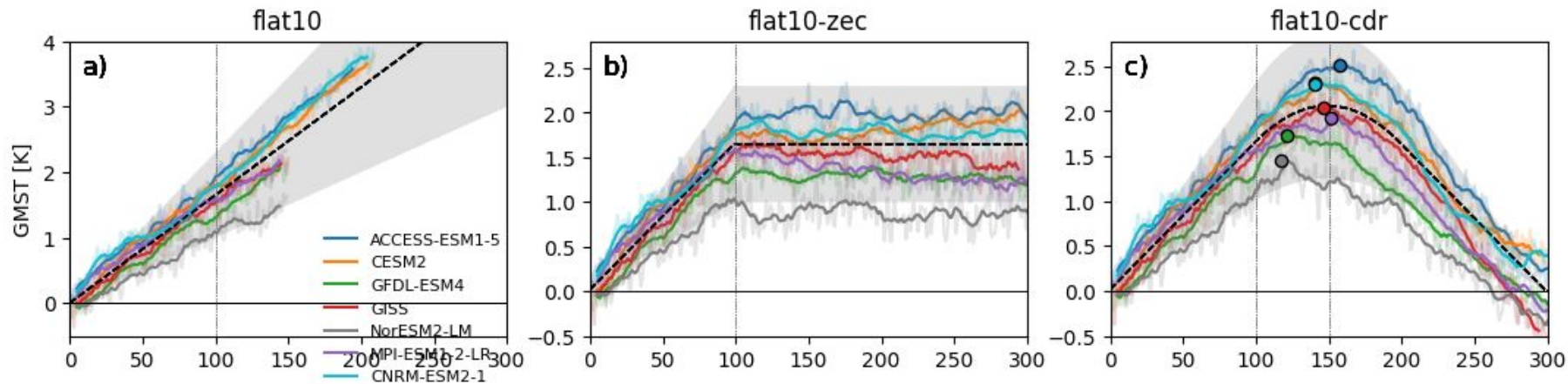# CMIP7 emissions-driven scenarios and extensions will explore pairings to assess climate reversibility

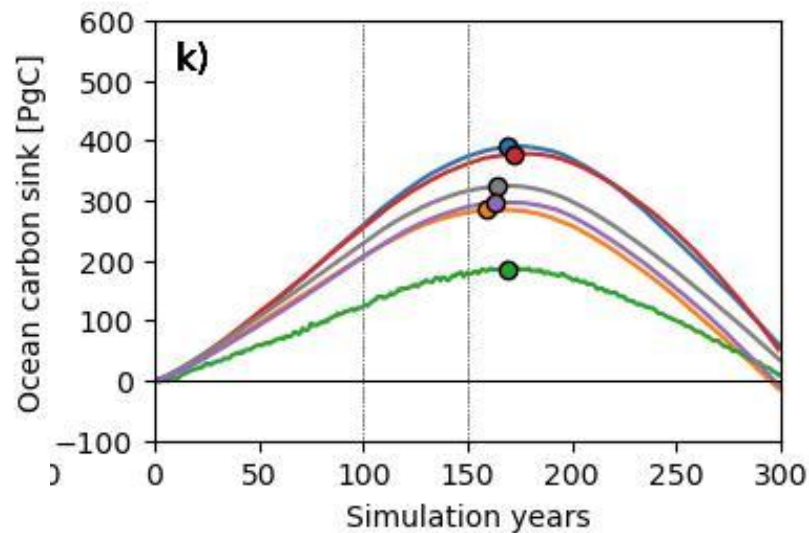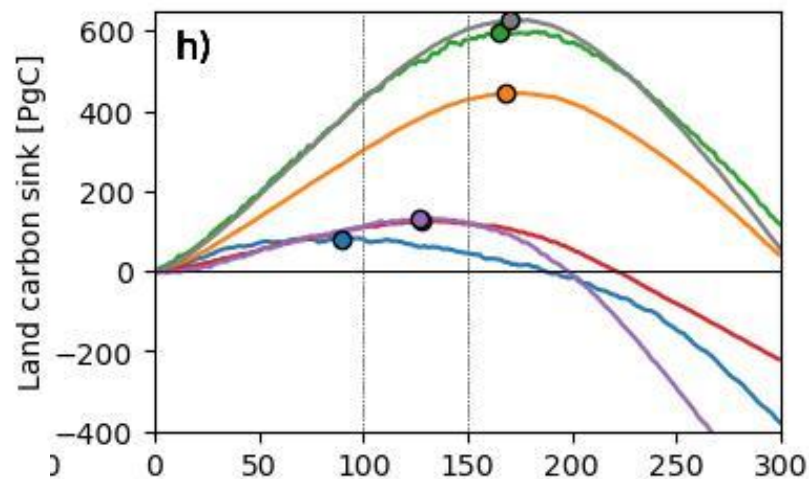# 'flat10MIP' experiments will measure idealsed emissions-driven response - TCRE, ZEC & reversibility

Early results from ESM experiments show differences in reversibility

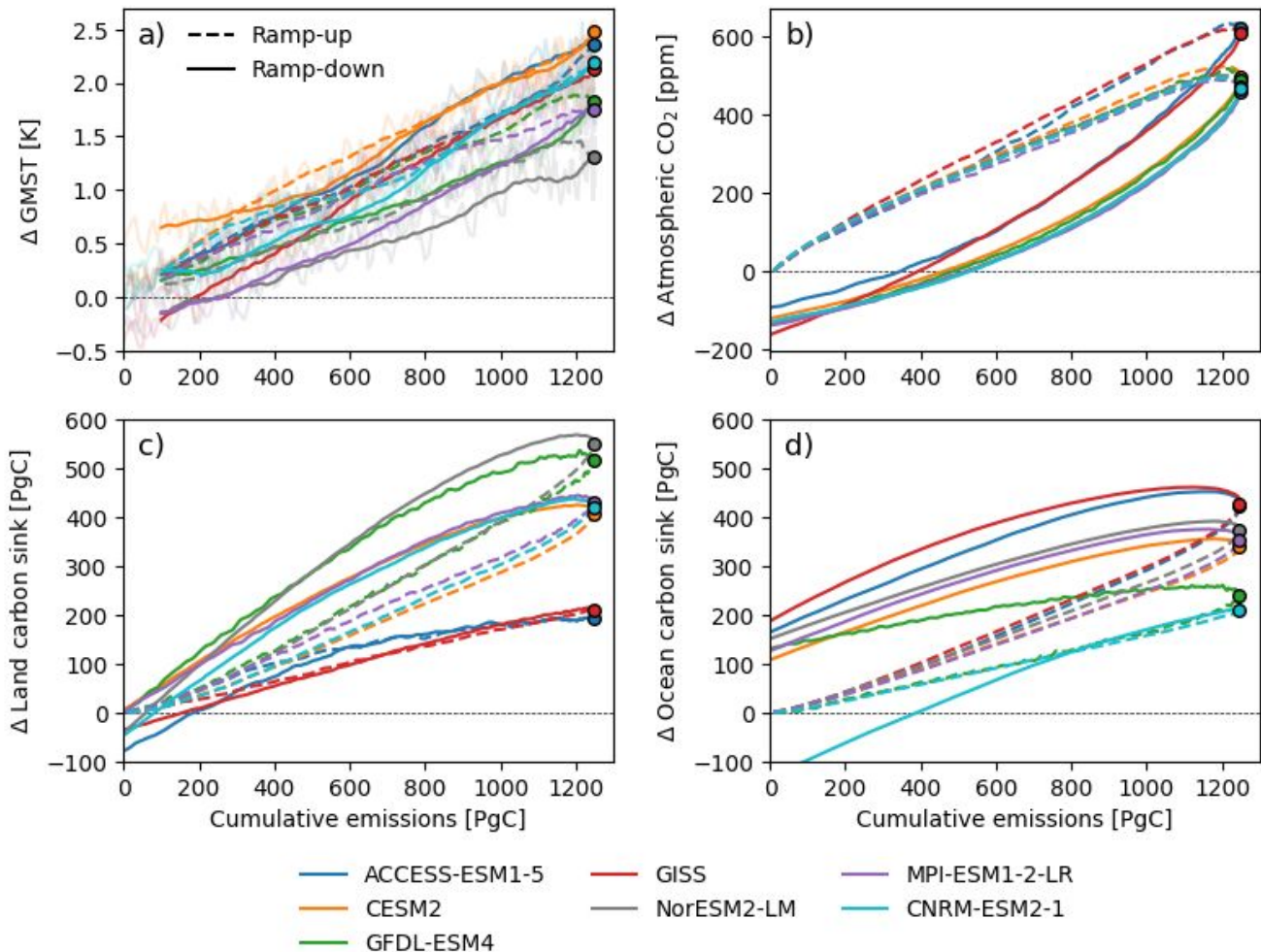# Peak warming can occur before…
or after net zero.

Large differences in timing of land sink reversal (ocean sink behaviour is more consistent amongst ESMs)
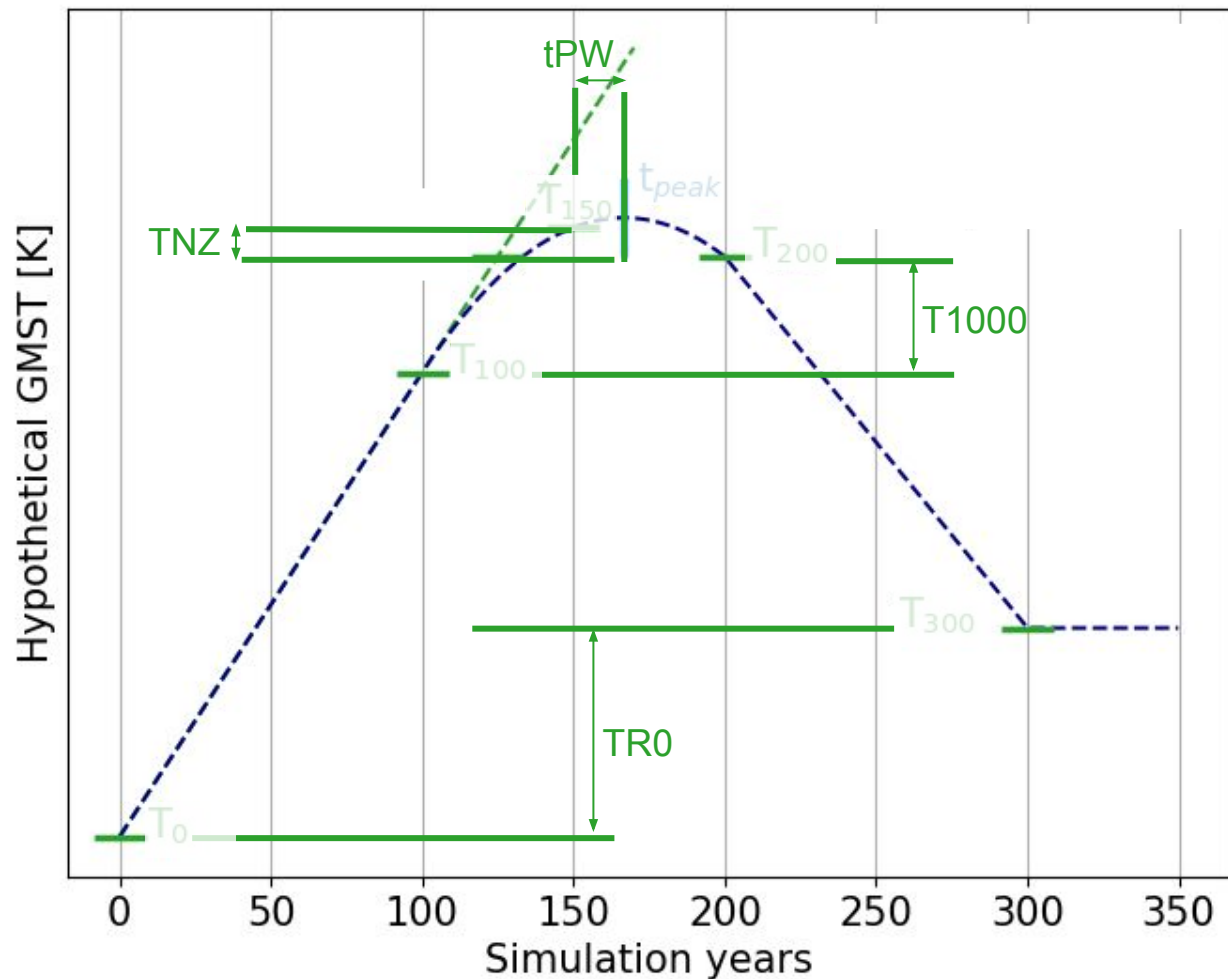
T–CE
hystereses
due to AMOC
responses

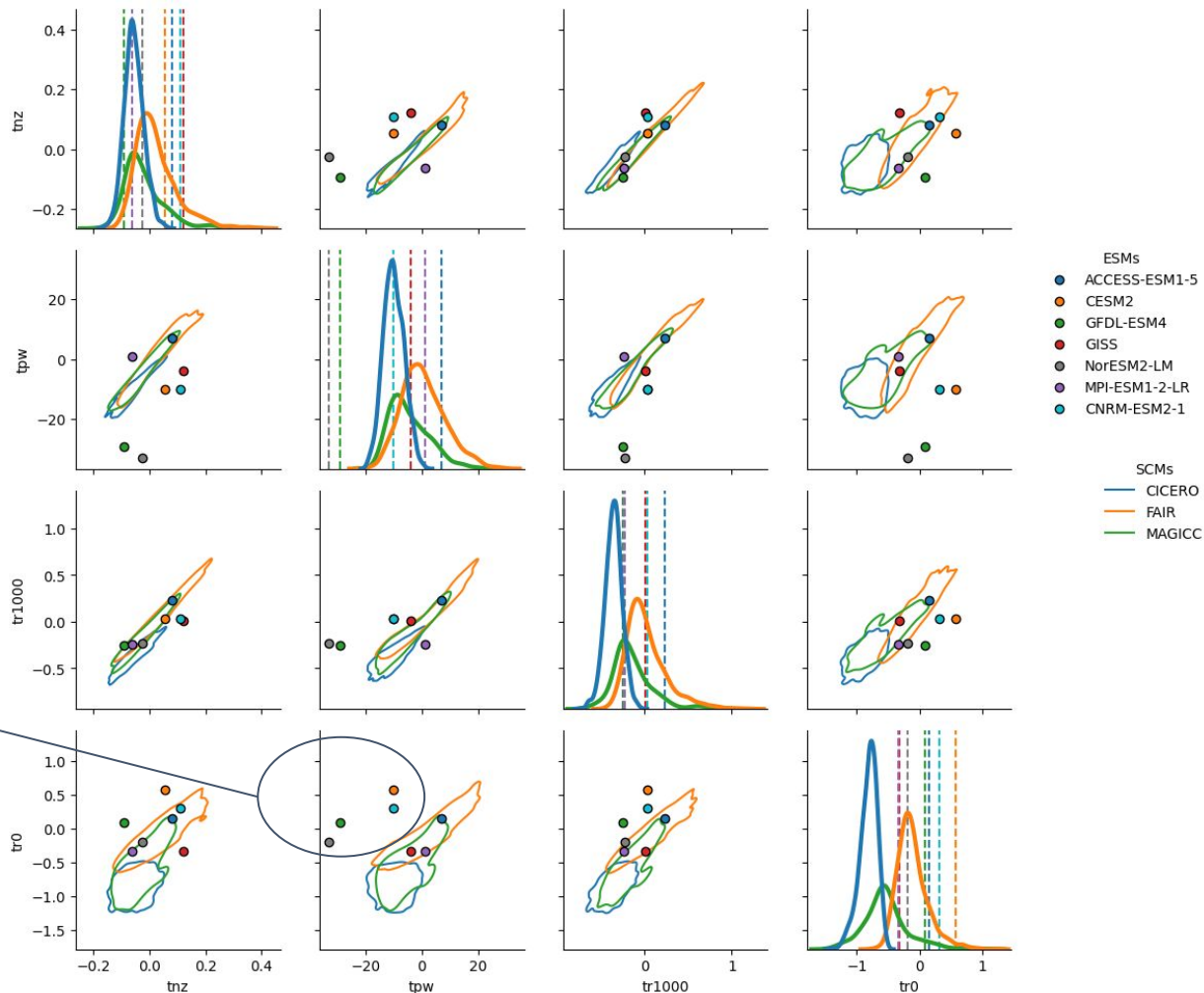Diversity in
land sink
reversibility

New metrics for climate reversibility

ESM members lie outside of SCM joint distributions

Early peak warming & residual warming at end of experiment

Conclusions

- CMIP7 will contain more options for emissions-driven simulations
- Protocol will allow for centers to focus on either c- or e- driven [but minimal c-driven DECK required]
- Flat10 fast track experiments provide a clean assessment of TCRE, ZEC and reversibility
- Greater focus needed on coupled esm-historical calibration
- BECCS satellite MIP is desirable - workshop needed to finalise protocol