

Vegetation:

which and how much?

Uncertainty in Land Carbon Fluxes Simulated by CMIP6 Models from Treatments of Crop Distributions and Photosynthetic Pathways

Joseph Ovwemuvwose, Colin Prentice & Heather Graven | 09/09/2022



LEMONTREE
Land Ecosystem Models
based On New Theory,
observations and
Experiments



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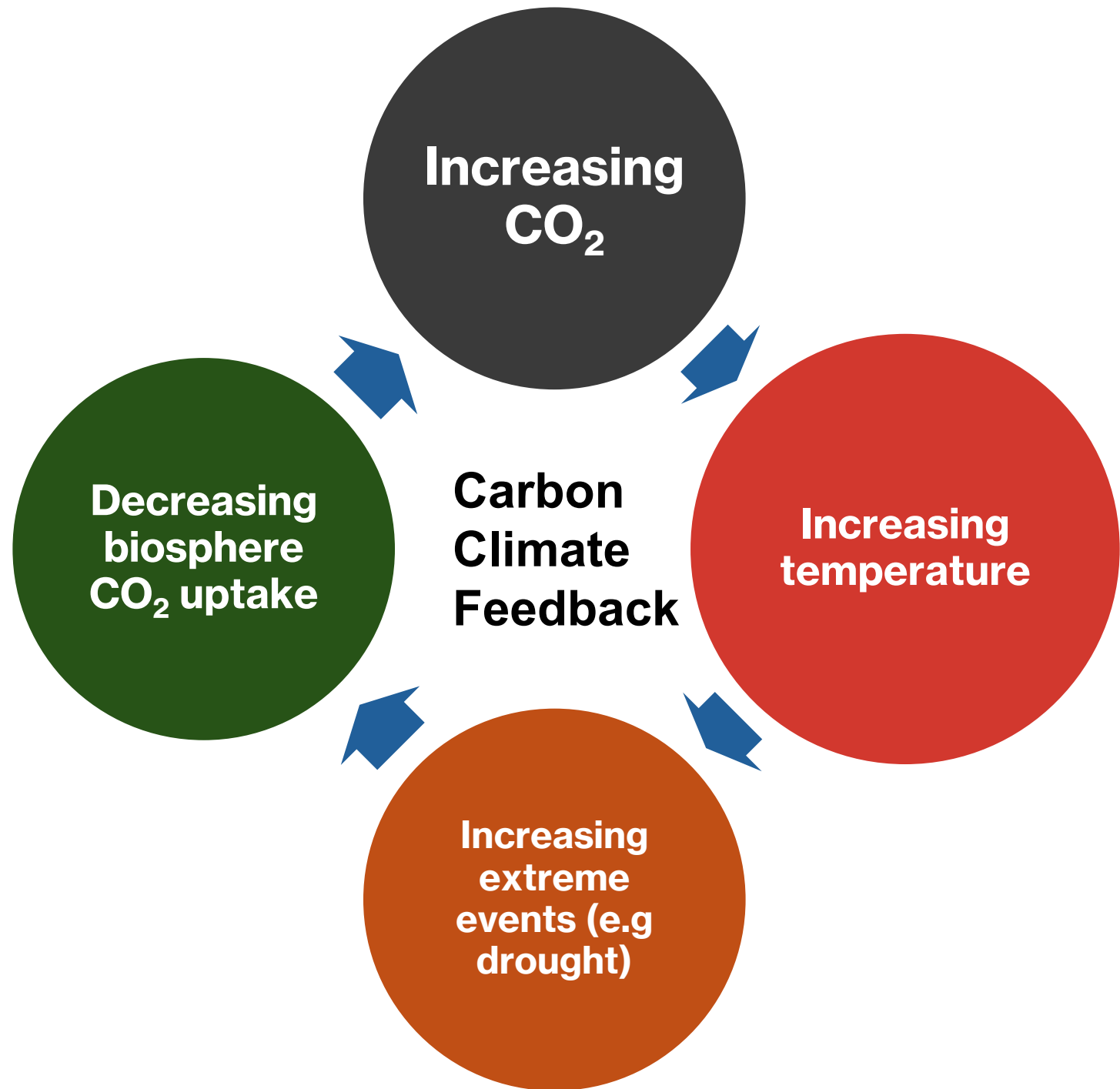


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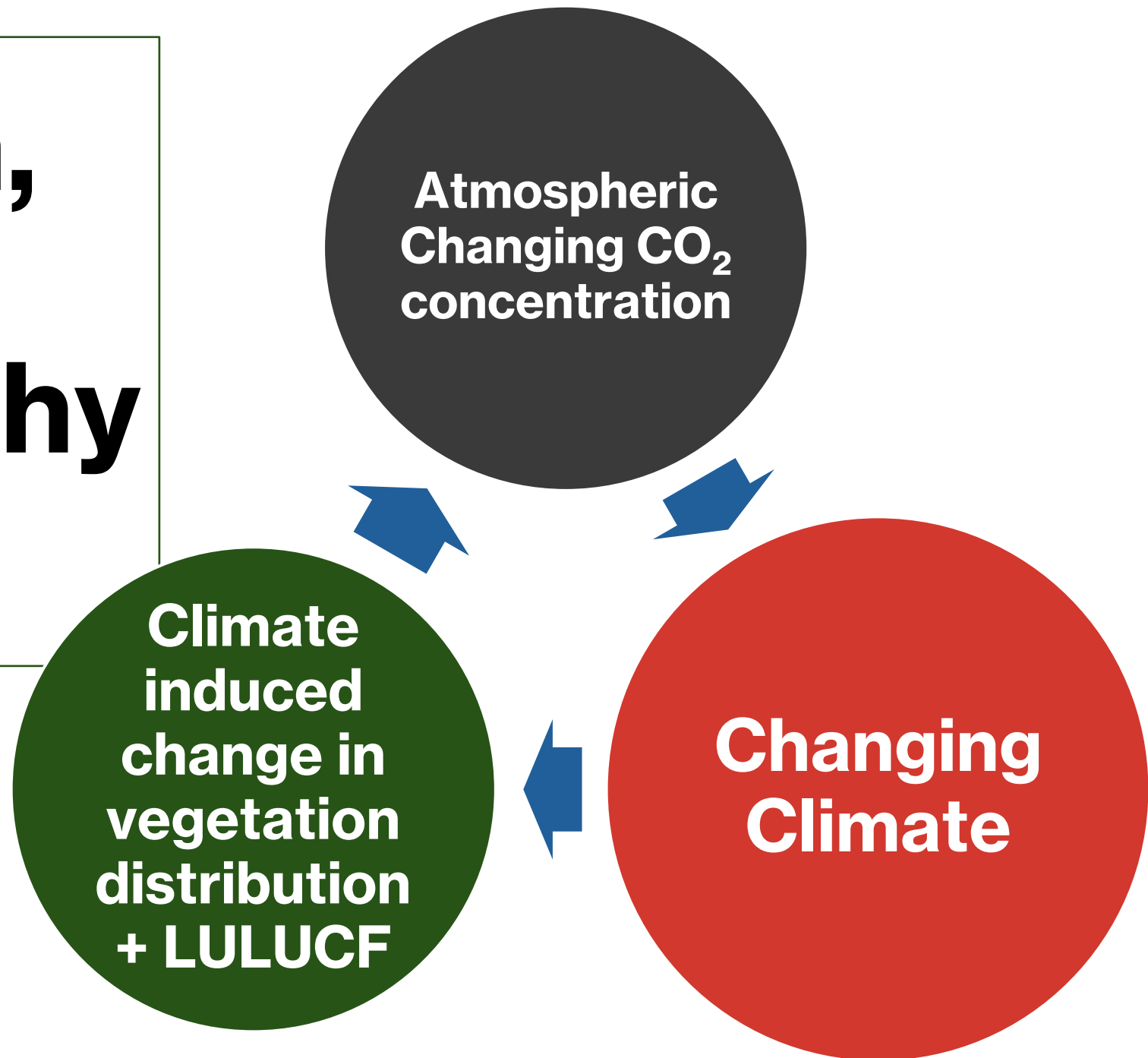
ECMWF

**A lot is
known
about the
carbon-
climate
feedback**



The Carbon, Climate & Biogeography Nexus

*We need to learn
more about this.*



The questions

1. How has the distribution of vegetation types (C_3 & C_4) changed historically?
2. *How consistent is this change in current models?*



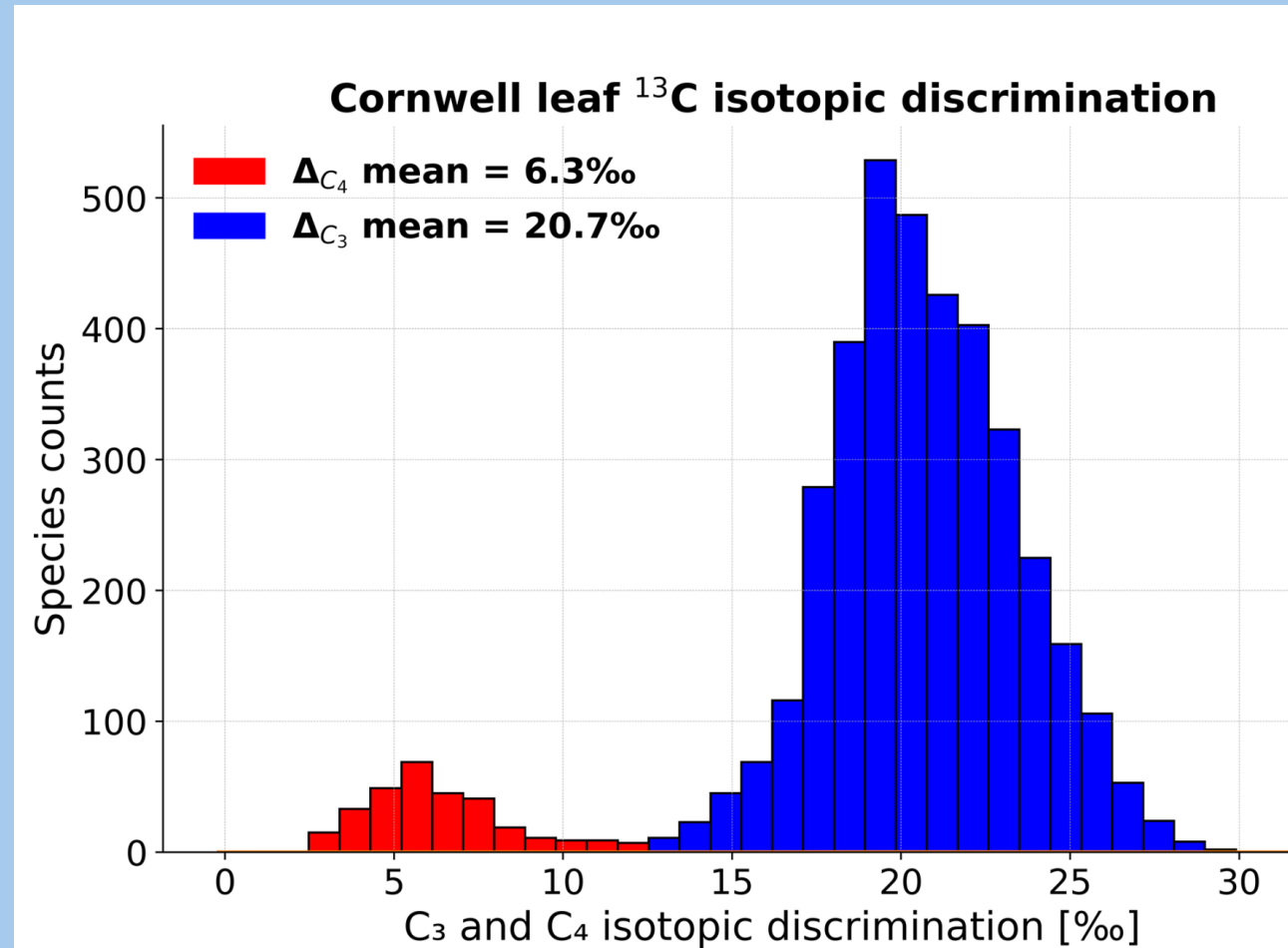
Carbon isotope discrimination (Δ)

Δ helps answer them.

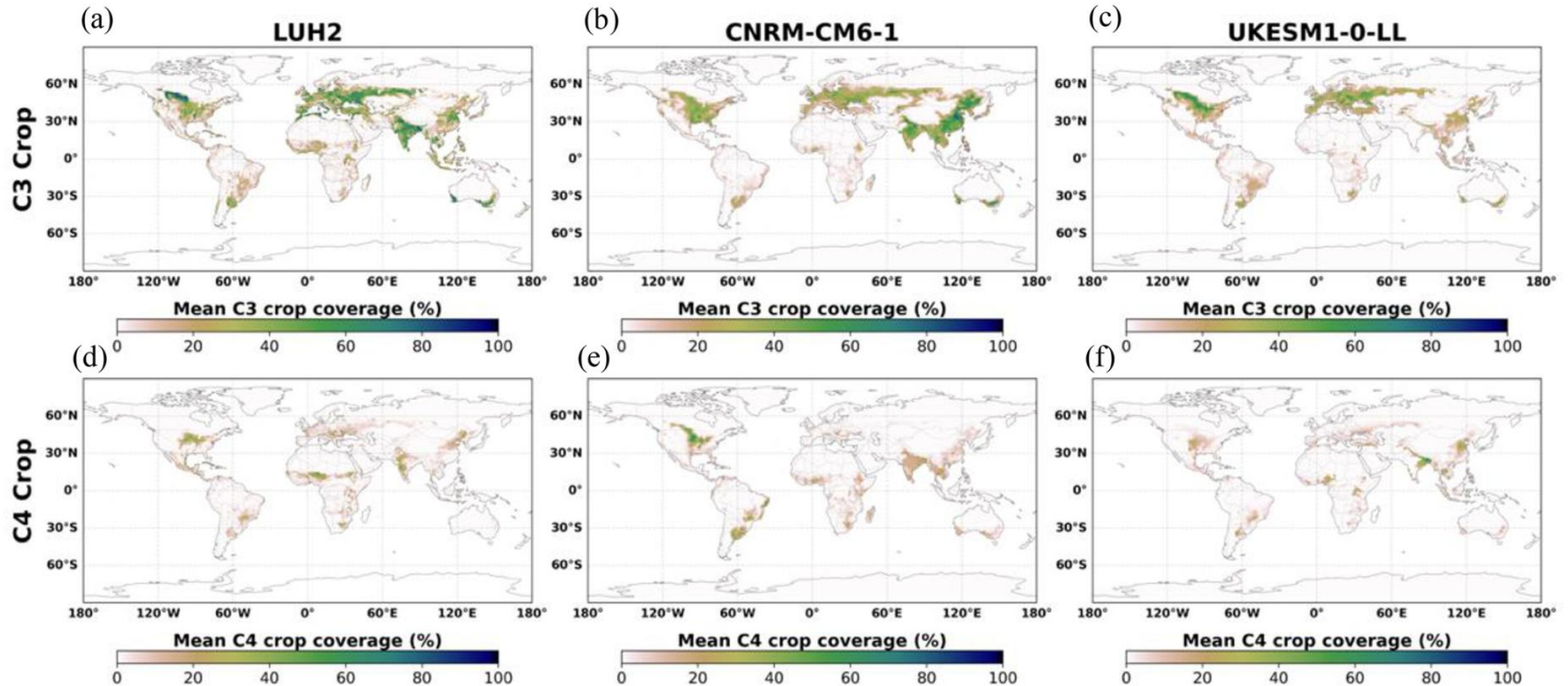
Δ is vegetation's preferential uptake of $^{12}\text{CO}_2$ over $^{13}\text{CO}_2$.

Larger in C_3 than in C_4 .

Its trend is affected by changes in CO_2 , climate & biogeography.

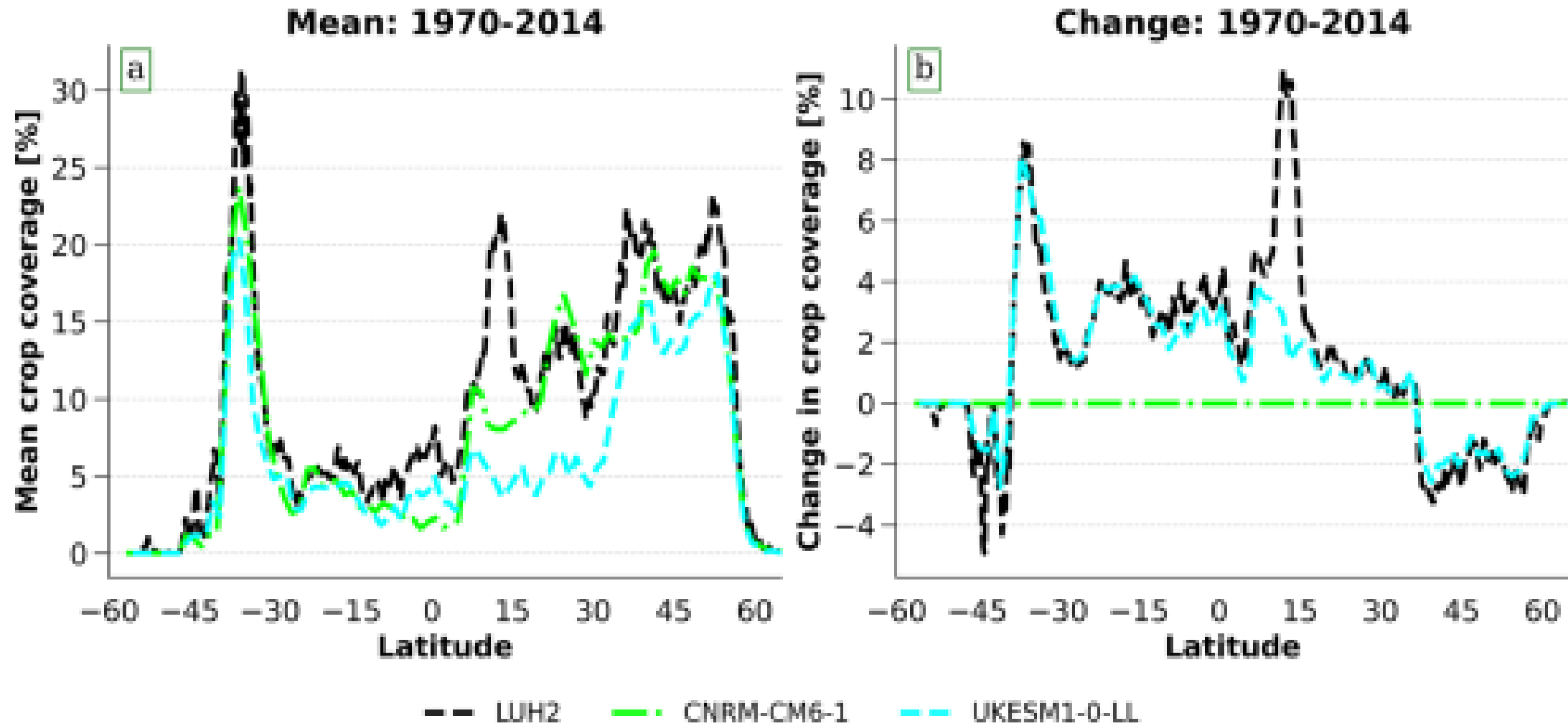


Finding 1: ESMs disagree on vegetation cover

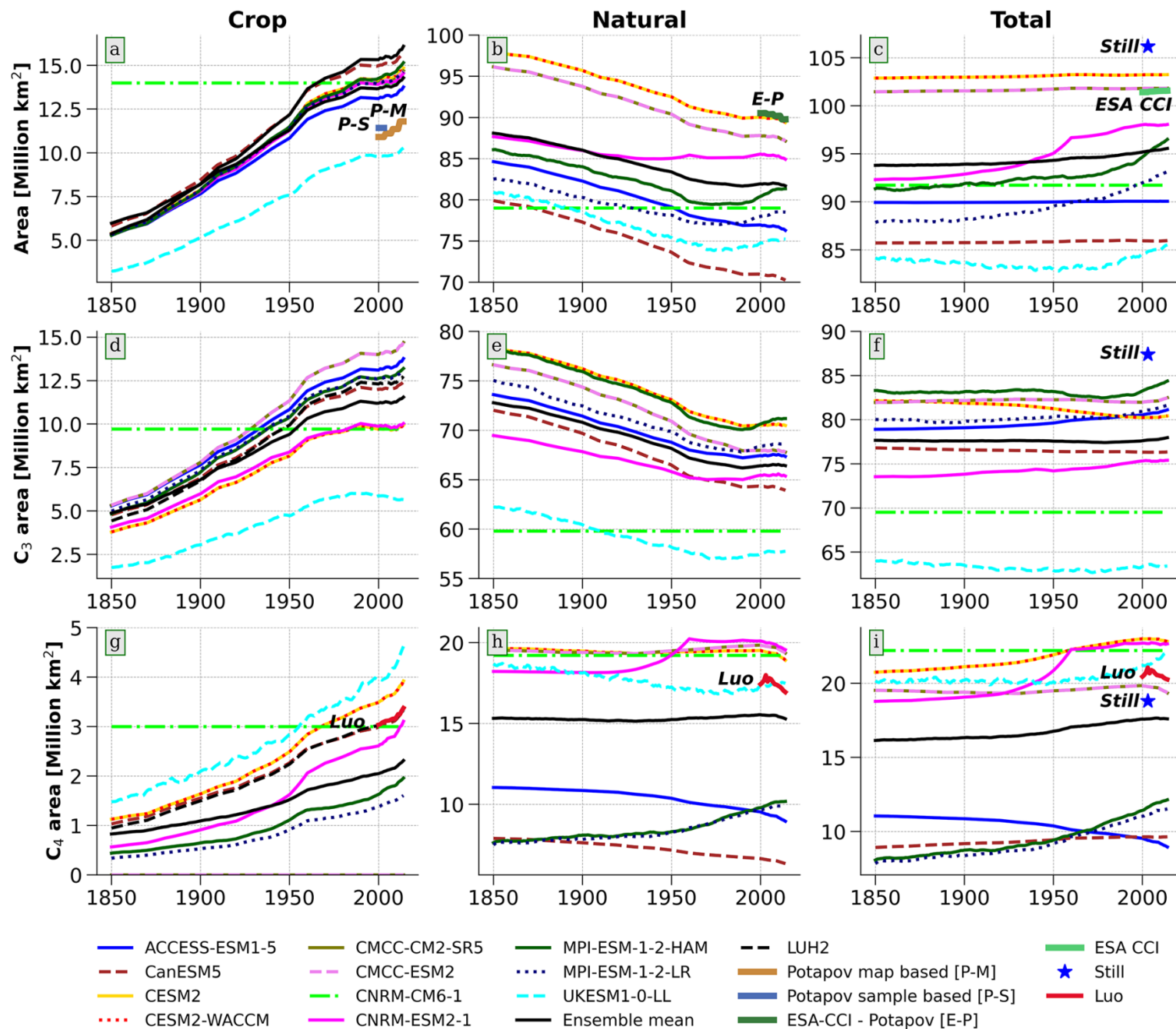


UKESM1 underestimates crops in Africa and Asia compared to LUH2

Finding 1: ESMs disagree on vegetation cover



UKESM1 underestimates crops in Africa and Asia compared to LUH2



Finding 2: Spread in C₃ & C₄ area abundance of crop, natural and total vegetation.

7 models underestimate total vegetation area abundance compared to ESA-CCI.

All the models underestimate natural vegetation area abundance.

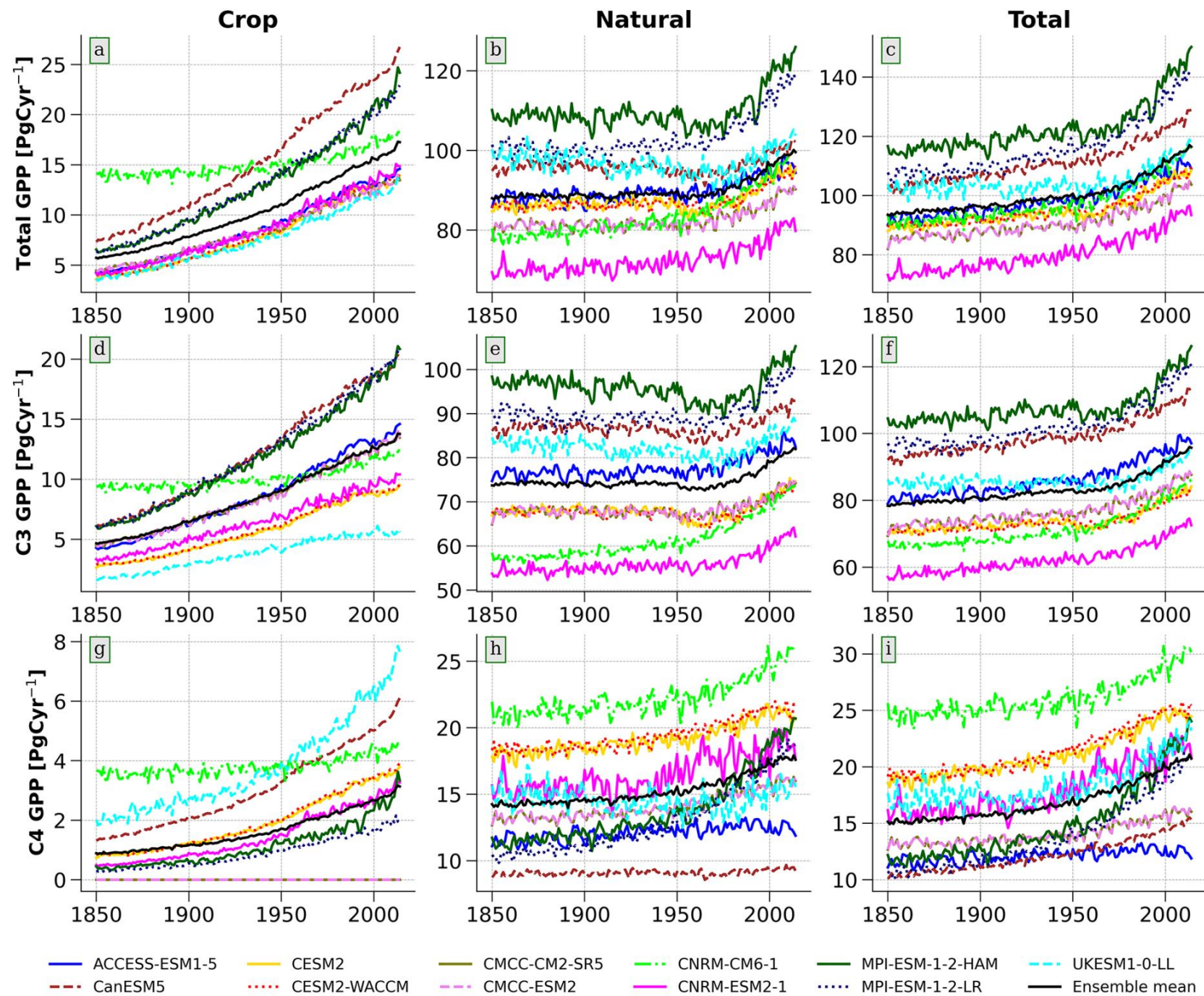
The decline in C₃ natural vegetation stopped in the late 90s.

UKESM1 does not have enough C₃ crops.

Finding 3: Spread in C_3 & C_4 GPP of crop, natural and total vegetation.

*We observed
strong
fertilisation
effects in C_3 .*

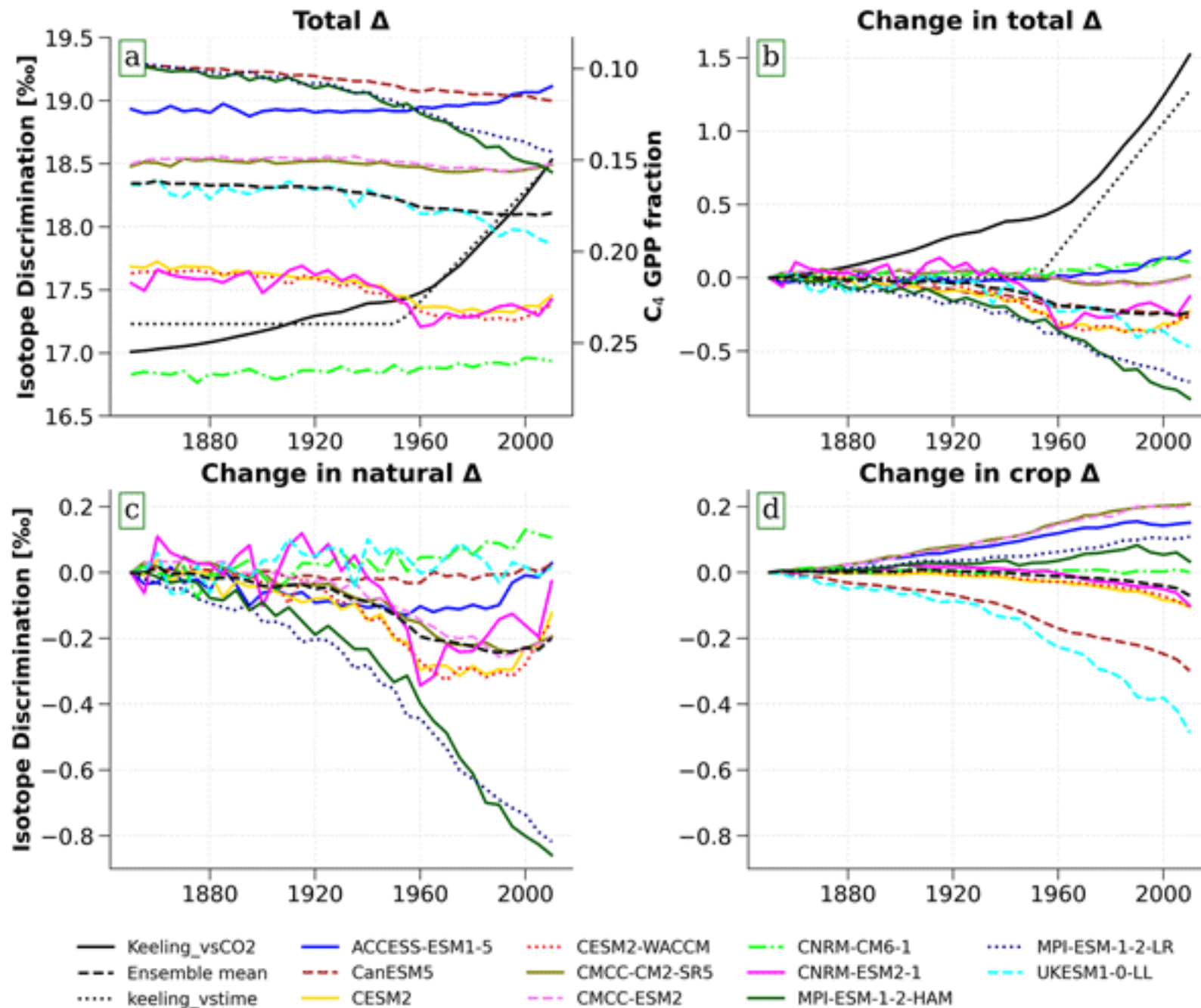
*Models disagree
on the trend of C_4
GPP*



Large spread in Δ

Models disagree with observations in trend and magnitude

UKESM1 seems to have too many C_4 crops.



Explicit simulation of actual C_3 and C_4 GPP

A review of the C_3 and C_4 crop and natural vegetation abundance.

See our paper for further recommendations:

<https://doi.org/10.5194/bg-23-5593-2026>

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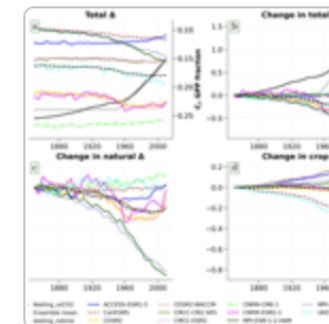
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13 Aug 2026

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Short summary

This work examines the roles of cropland representation and the treatment of photosynthetic...

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Abstract

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