JULES-FACE Working Group

Eleanor Burke, Doug Clark, Martin De Kauwe, Hilary Ford, Anna Harper, Debbie Hemming, Felix Leung, Rebecca Oliver, Colin Prentice, Tristan Quaife, Andy Smith, Rebecca Varney, Karina Williams, Andy Wiltshire, Huiyi Yang

Report to JULES annual meeting 2020

JULES-FACE Working Group

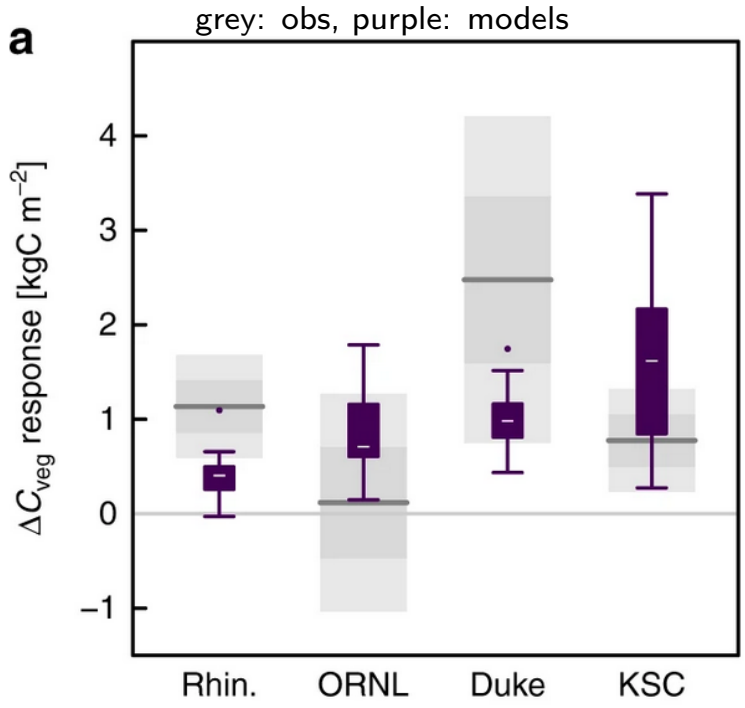
- Free-air CO2 enrichment (FACE) experiments are important for understanding the responses of ecosystems to a future CO_2-enriched atmosphere (for a review, see Walker et al. 2020, New Phyt.).
- The JULES-FACE Working Group is a network of people who are using FACE data to evaluate and improve JULES.
- This talk will summarise some of the JULES runs at FACE sites so far.

image credit: BIFoR

ORNL, Rhinelander, Duke, and KSC - US

Decadal biomass increment in early secondary succession woody ecosystems is increased by CO_2 enrichment
Anthony Walker, Martin De Kauwe, Belinda Medlyn, Snke Zaehle, Colleen Iversen, Shinichi Asao, Bertrand Guenet, Anna Harper, Thomas Hickler, Bruce Hungate, Atul Jain, Yiqi Luo, Xingjie Lu, Meng Lu, Kristina Luus, Patrick Megonigal, Ram Oren, Edmund Ryan, Shijie Shu, Alan Talhelm, Ying-Ping Wang, Jeffrey Warren, Christian Werner, Jianyang Xia, Bai Yang, Donald Zak & Richard Norby **Nature Comms, 2019**

- Four decade-long CO_2-enrichment experiments in temperate, woody ecosystems (2 deciduous, 2 evergreen).
- 12 terrestrial ecosystem models, including JULES.



+ **CRESCENDO**, Eleanor Burke, Andy Wiltshire, Debbie Hemming

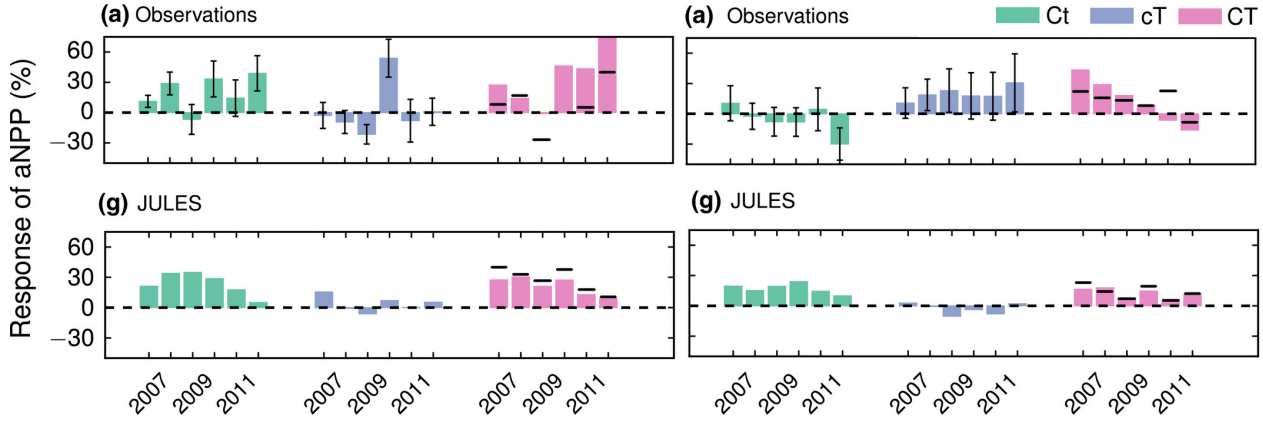
PHACE - US

Challenging terrestrial biosphere models with data from the longterm multifactor Prairie Heating and CO_2 Enrichment experiment
Martin De Kauwe, Belinda Medlyn, Anthony Walker, Snke Zaehle, Shinichi Asao, Bertrand Guenet, Anna Harper, Thomas Hickler, Atul Jain, Yiqi Luo, Xingjie Lu, Kristina Luus, William Parton, Shijie Shu, YingPing Wang, Christian Werner, Jianyang Xia, Elise Pendall, Jack Morgan, Edmund Ryan, Yolima Carrillo, Feike Dijkstra, Tamara Zelikova, Richard Norby, **GCB 2017**

Gross primary production responses to warming, elevated CO_2, and irrigation: quantifying the drivers of ecosystem physiology in a semiarid grassland
Edmund Ryan, Kiona Ogle, Drew Peltier, Anthony Walker, Martin De Kauwe, Belinda Medlyn, David Williams, William Parton, Shinichi Asao, Bertrand Guenet, Anna Harper, Xingjie Lu, Kristina Luus, Snke Zaehle, Shijie Shu, Christian Werner, Jianyang Xia, Elise Pendall, **GCB, 2016**

+ **nitrogen limitation effect**, Rebecca Varney.

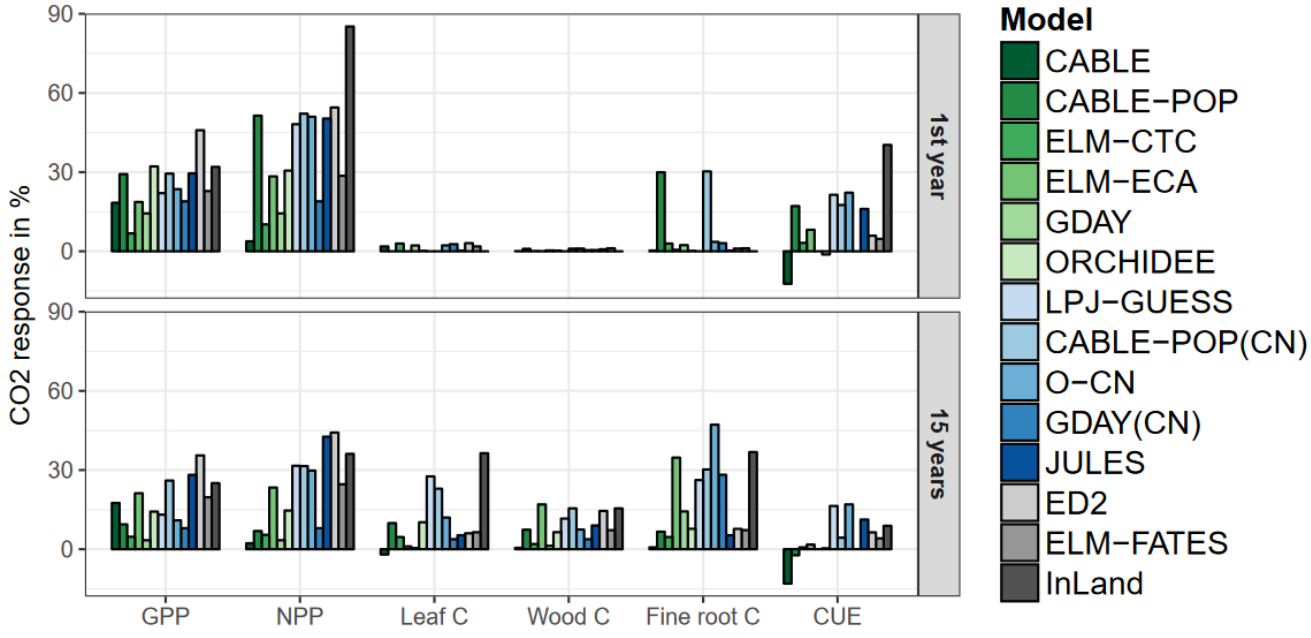
- The 10 models "performed poorly in ambient conditions.... Performance against the observations from single-factors treatments was also relatively poor." (De Kauwe et al. 2017)



Left: C3, right: C4.

AmazonFACE - Brazil

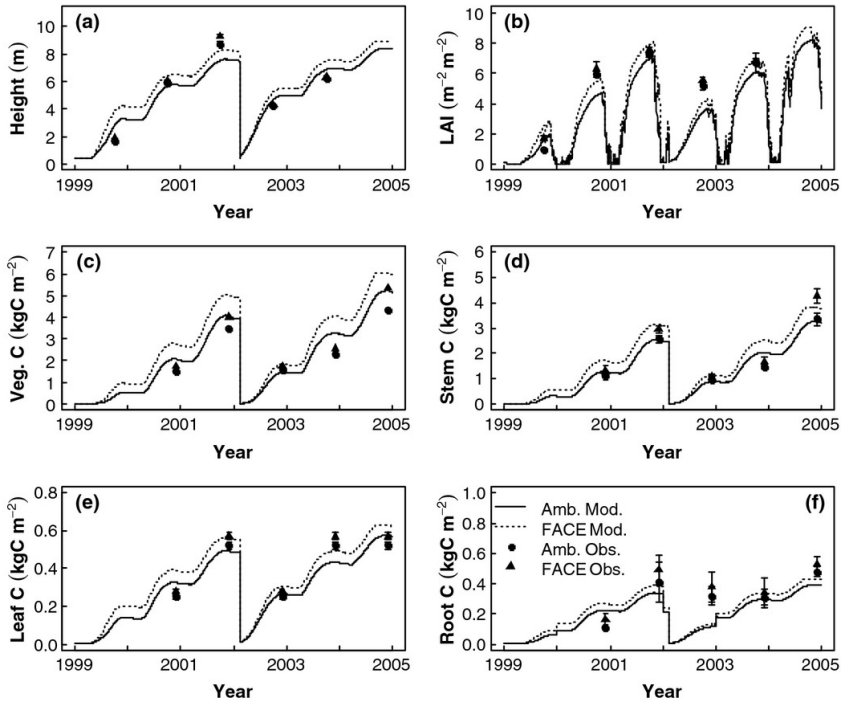
Amazon forest response to CO_2 fertilization dependent on plant phosphorus acquisition
Katrin Fleischer, Anja Rammig, Martin De Kauwe, Anthony Walker, Tomas Domingues, Lucia Fuchslueger, Sabrina Garcia, Daniel Goll, Adriana Grandis, Mingkai Jiang, Vanessa Haverd, Florian Hofhansl, Jennifer Holm, Bart Kruijt, Felix Leung, Belinda Medlyn, Lina Mercado, Richard Norby, Bernard Pak, Celso von Randow, Carlos Quesada, Karst Schaap, Oscar Valverde-Barrantes, Ying-Ping Wang, Xiaojuan Yang, Snke Zaehle, Qing Zhu & David Lapola
Nature Geoscience 2019



Blue: CNP, green: CN, grey: C.

POPFACE - Italy

Water use and yield of bioenergy poplar in future climates: modelling the interactive effects of elevated atmospheric CO_2 and climate on productivity and water use, Rebecca Oliver, Eleanor Blyth, Gail Taylor, Jon Finch, **GCB-Bioenergy 2014**



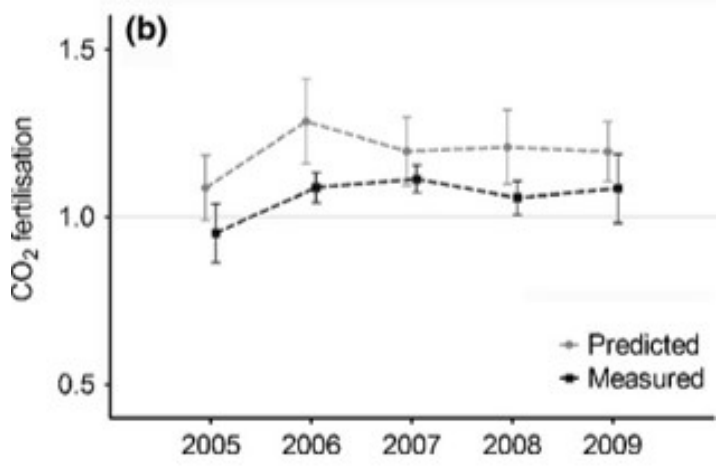
P. nigra

- Data from POPFACE used to calibrate 2 genotypes of short rotation coppice poplar, for ambient and elevated (550 ppm) CO_2 in JULES.

Bangor-FACE - UK

Hilary Ford, Debbie Hemming, Andy Smith, Karina Williams

- Alder, beech, birch saplings (60cm) planted in mono- and polycultures
- Trees were exposed to ambient or elevated CO_2 (580 ppm) for 4 years.



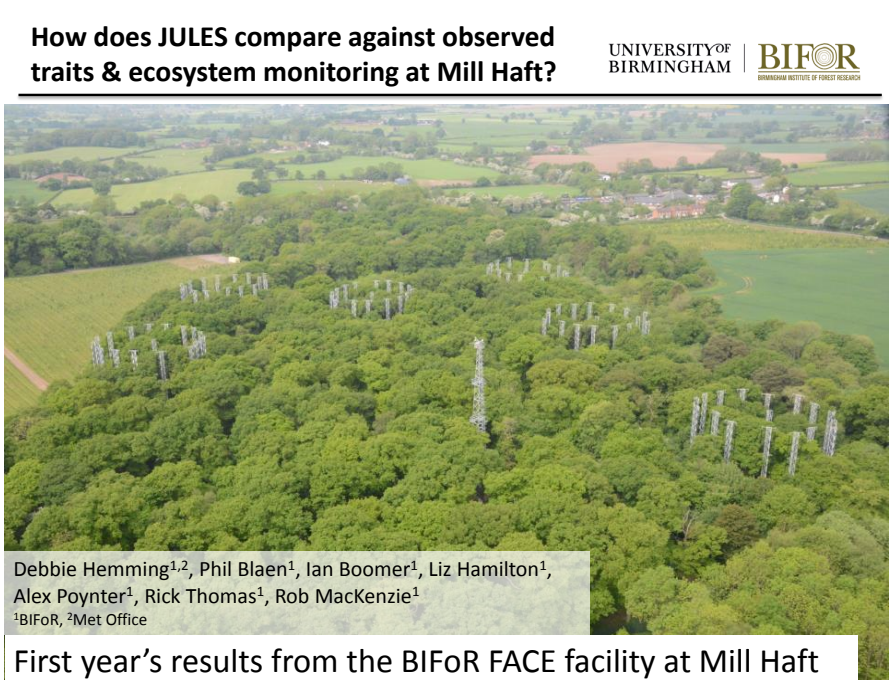
Smith et al. 2013

Ratio of polyculture AG biomass in elevated compared to ambient.

(predicted = based on monoculture)

BIFoR - UK

See Debbie's slides from the 2016 JULES meeting:



Oak bud burst, leaf nitrogen content and leaf mass through canopy.

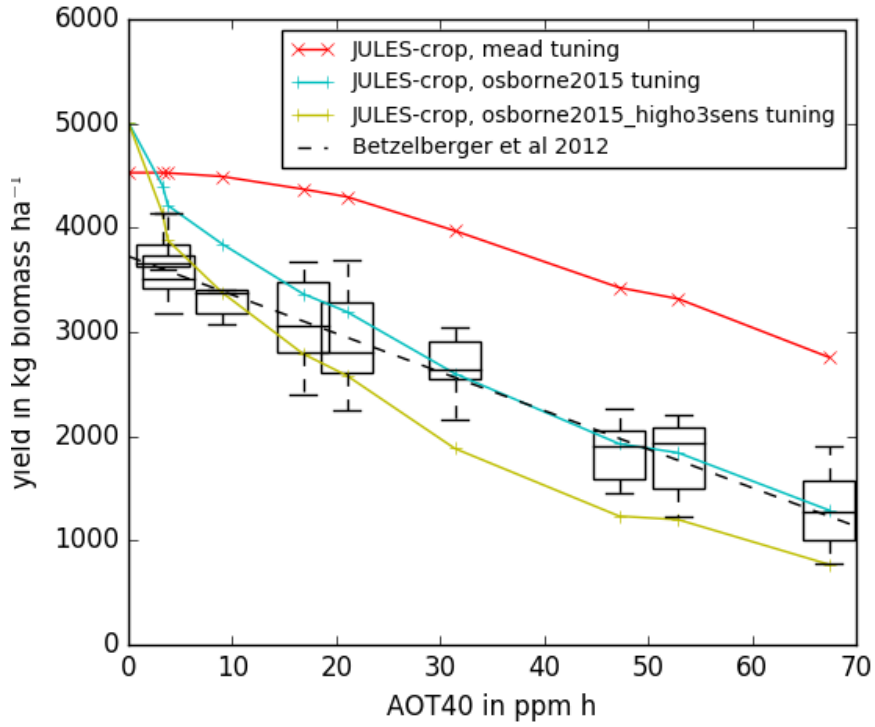
New project: **QUINTUS**

- "Quinquennial (half-decadal) carbon and nutrient dynamics in temperate forests: Implications for carbon sequestration in a high CO_2 world"
- a 3.7m NERC funded research project, led by the University of Birmingham's Institute of Forest Research (BIFoR)
- Oct 2019 - Sep 2024.

SoyFACE-O_3 - US

Calibrating soybean parameters in JULES5.0 from the US-Ne2/3 FLUXNET sites and the SoyFACE-O3 experiment,
Felix Leung, Karina Williams, Stephen Sitch, Amos P.K. Tai, Andy Wiltshire, Jemma Gornall, Elizabeth A. Ainsworth, Timiothy Arkebauer, and David Scoby, **GMDD, April 2020**

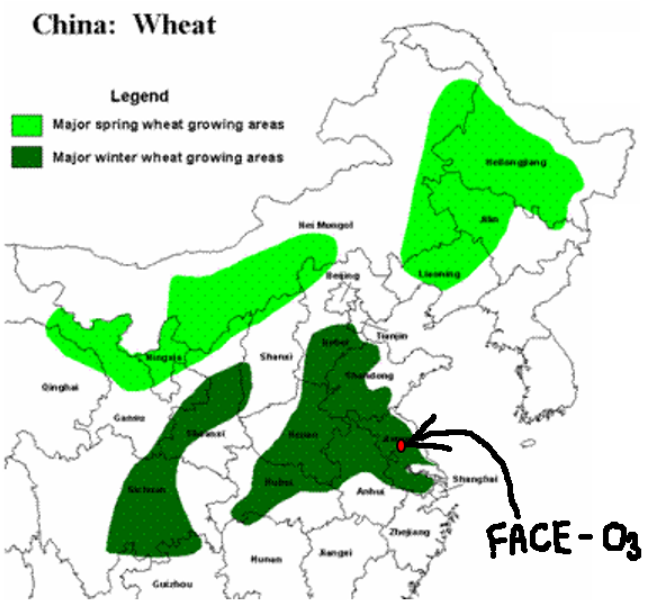
- JULES-crop runs for soybean in ambient and elevated ozone rings.

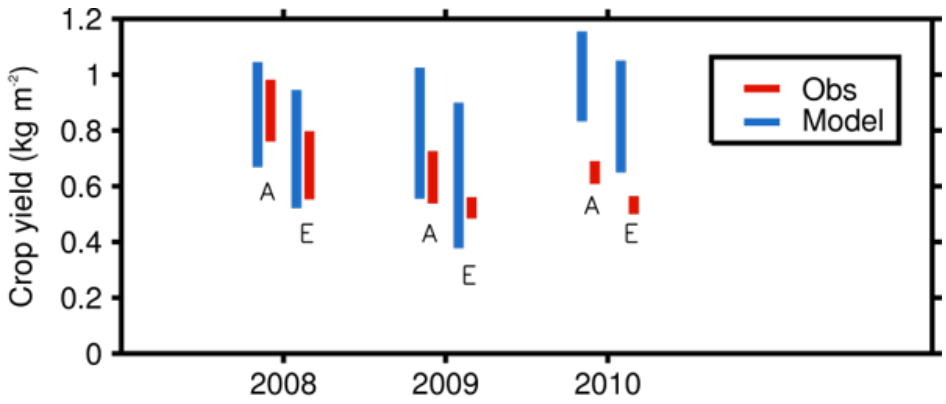


FACE-O_3 - China

See Huiyi Yang's talk from Thursday.

- Calibrated JULES-crop winter wheat runs, at ambient and elevated ozone.
- Next: calibrate rice in JULES-crop.





JULES-FACE Working Group

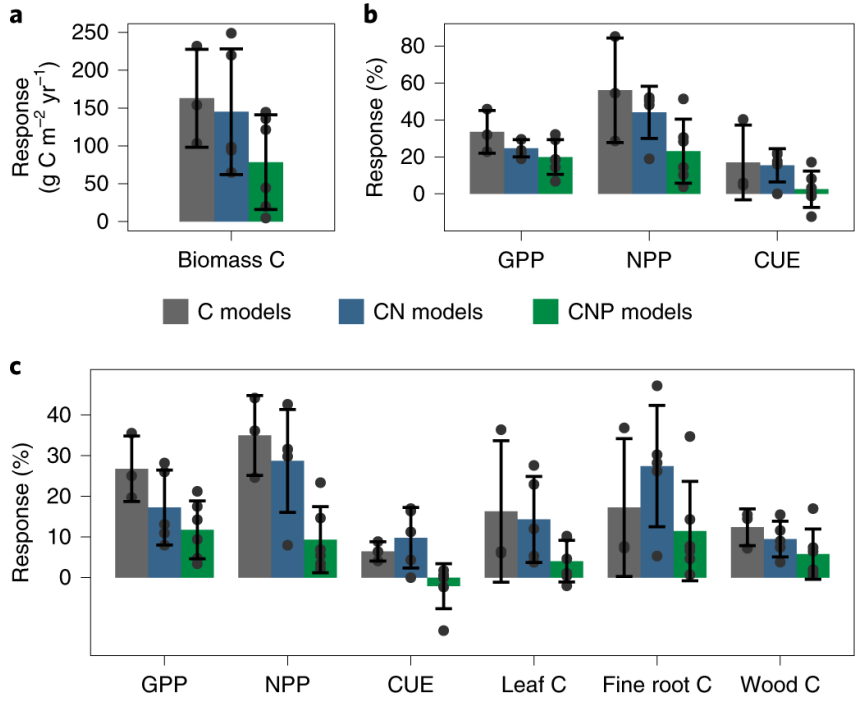
- FACE experiment results are a very useful resource for understanding and improving JULES response to CO_2 and O_3.
- Activities in the first year: build network, compile studies and suites.
- Lots of ongoing and planned work at these sites across the network.
- Link to rainfall manipulation experiment simulations (SM-stress JPEG).
- Still plenty of sites that haven't yet been simulated with JULES (the FACE-MDS website lists 39 FACE experiments!).

Get in touch if you'd like to join the network:

`https://code.metoffice.gov.uk/trac/jules/wiki/JulesFace`

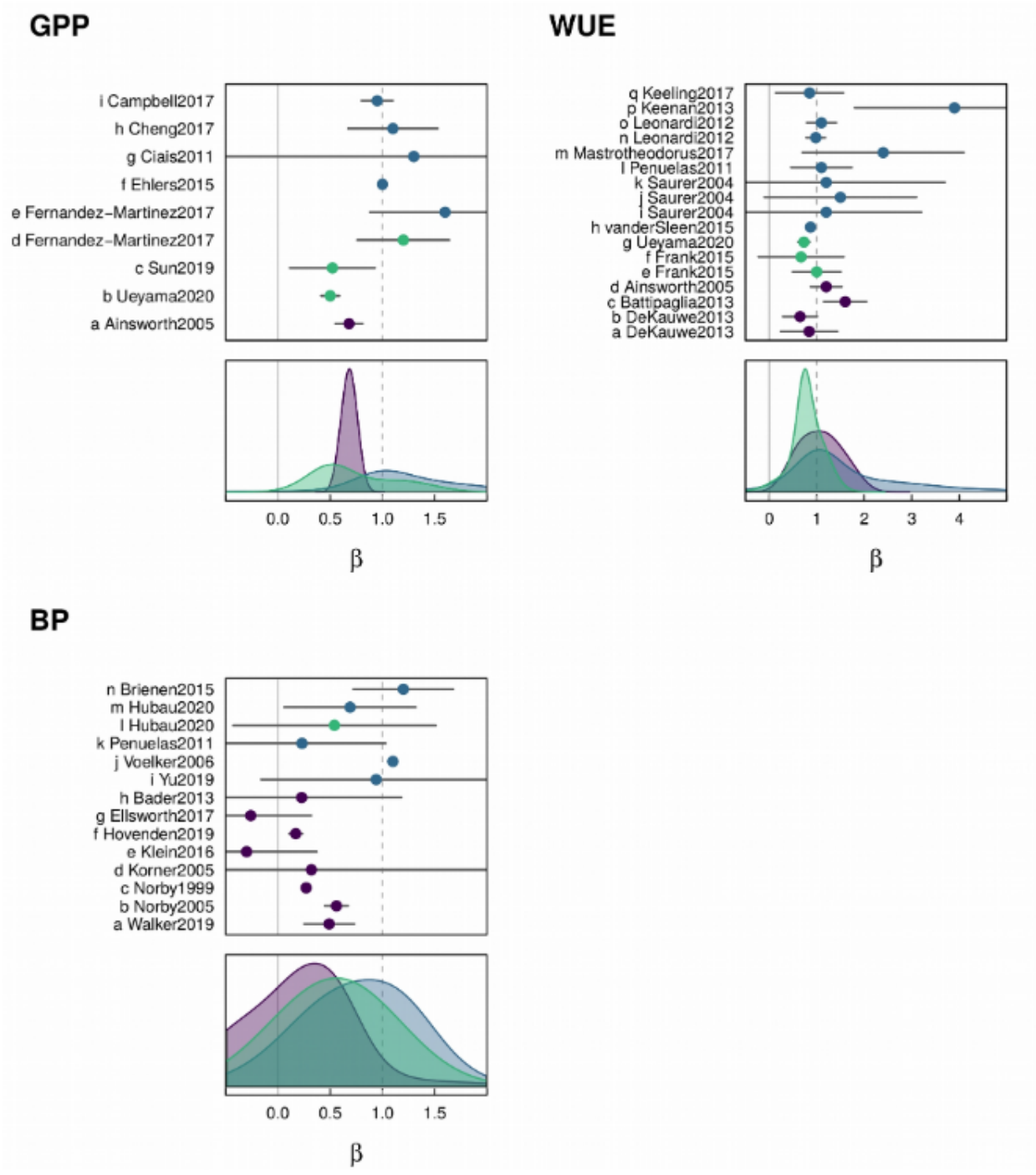
Additional slides

Fleischer et al 2019 Fig 1, The predicted effect of eCO2 on biomass C, productivity and biomass compartments for C, CN and CNP models.



a, The final response of biomass growth, calculated as the mean annual response over 15years of eCO2. b, The first-year response of productivity (GPP and NPP) and CUE. c, The 15-year response of productivity, CUE and leaf, fine root and wood C (calculated as the mean response of the 13th to 17th years). Responses to eCO2 are the differences between the elevated and ambient model run, shown as mean and s.d. (black lines) per model group, with individual model results as dots.

Walker et al. 2020, Fig S2



Norby et al. 2015, Fig 4