



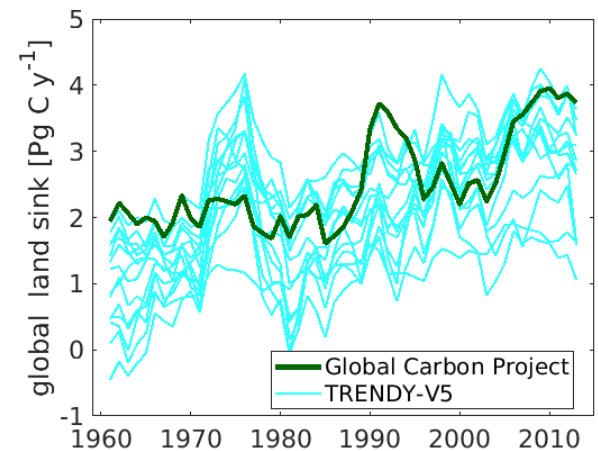
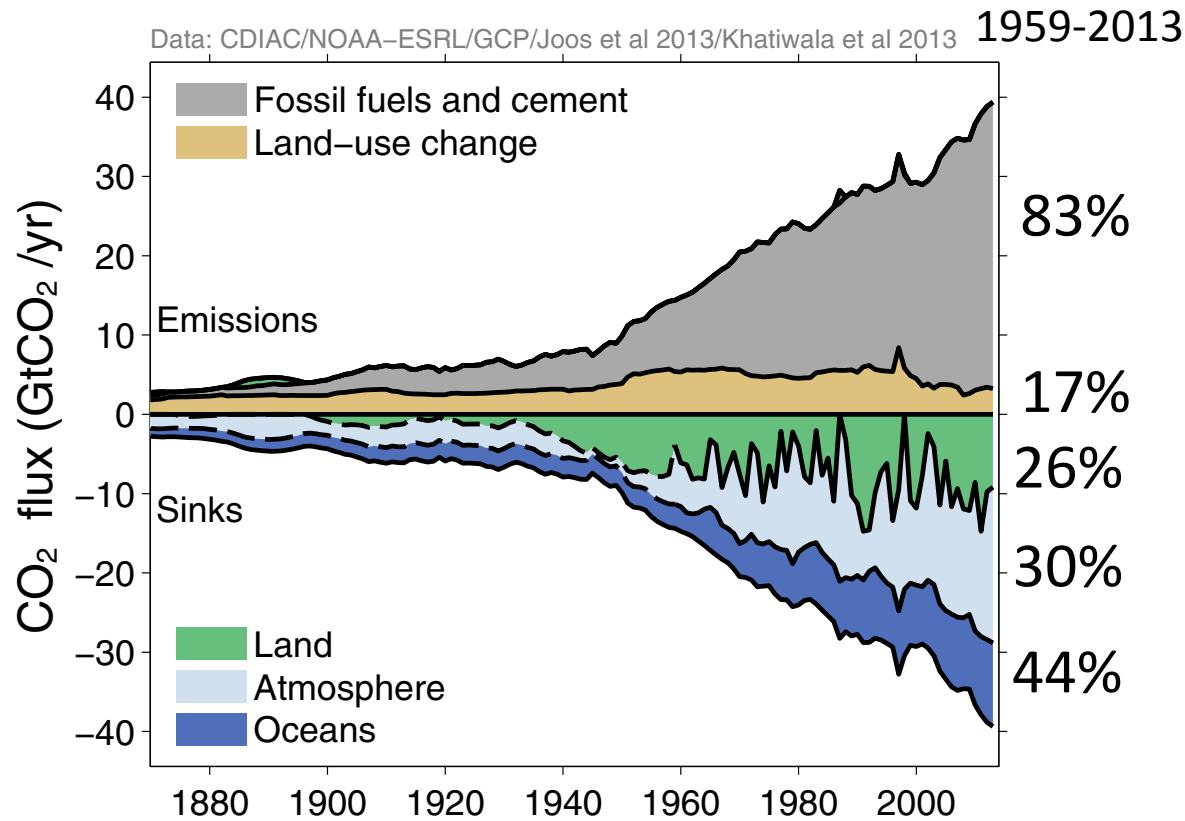
Multiple constraints from leaf to globe on land surface impacts on radiative forcing

Vanessa Haverd, Ben Smith, Cathy Trudinger, Peter Briggs, Pep Canadell
5 September 2017

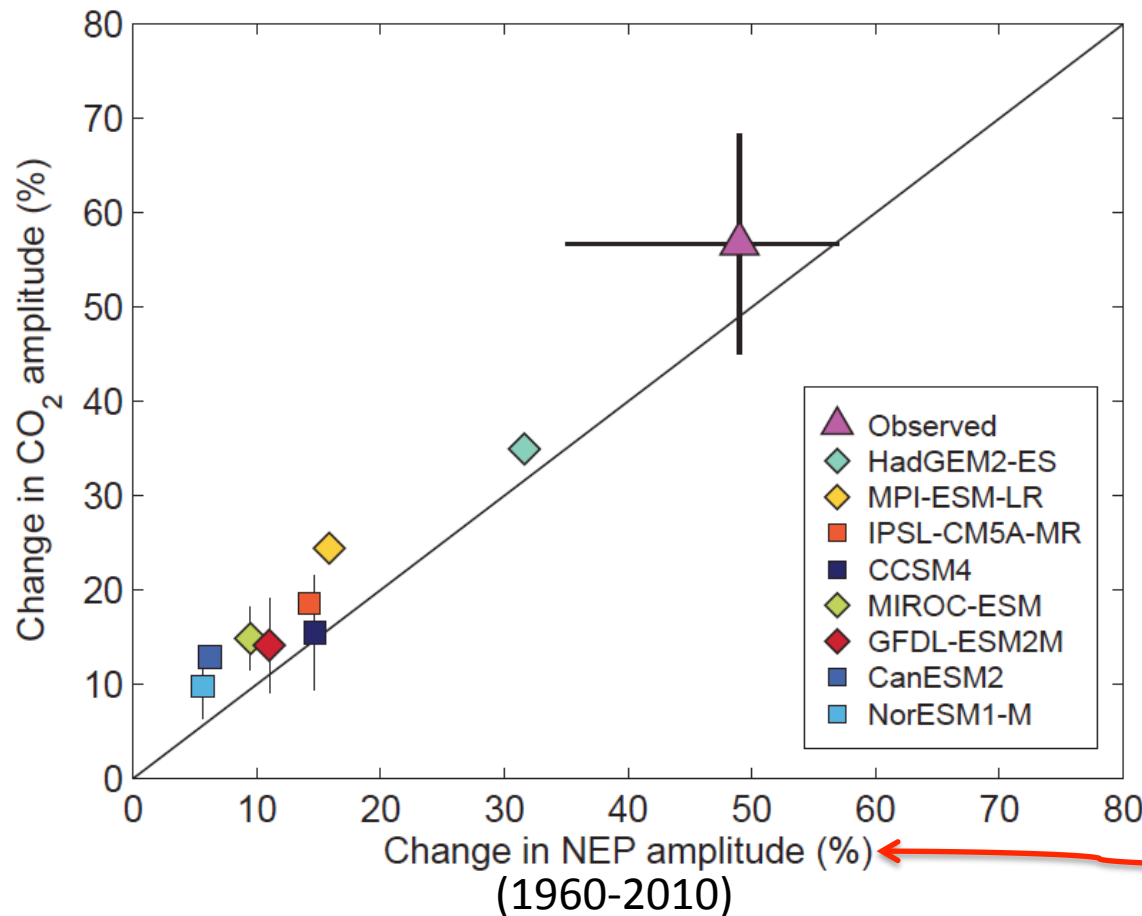
OCEANS AND ATMOSPHERE
www.csiro.au



Land Carbon Sink: Important for radiative forcing, but land model predictions are highly variable.



Land models under-estimate recent trends in seasonal amplitude of land carbon uptake



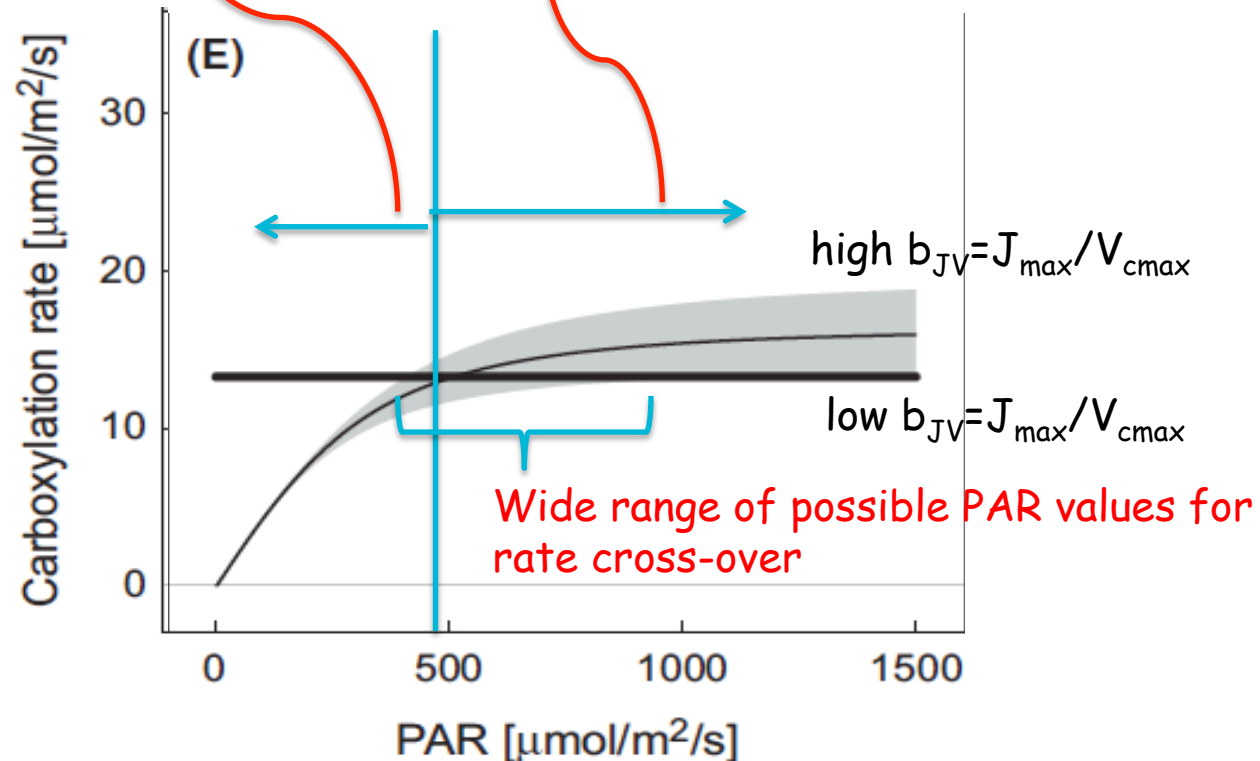
Graven et al. 2013,
Science, 341,
1085-1089.

Related to trend in
GPP which strongly
influences land
carbon sink

Rate-limiting process in photosynthesis depends on the ratio of maximum rate of electron transport (J_{\max}) to maximum rate of carboxylation (V_{\max})

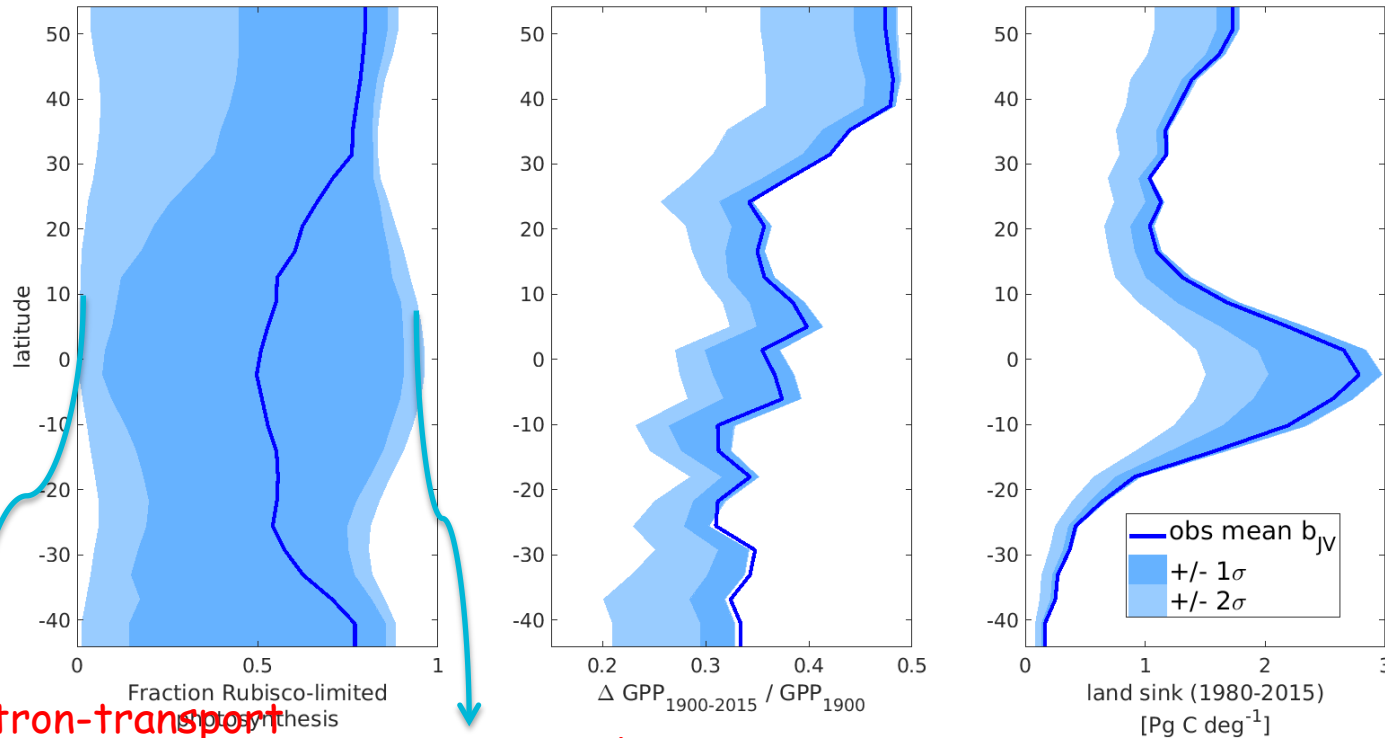
Electron transport-limited
(low sensitivity to CO_2)

Rubisco-limited
(high sensitivity to CO_2)



Walker et al. 2014
Ecology and Evolution 4: 3218-3235

Fixed observed mean value of $b_{jv} = J_{\max}/V_{\max}$ gives unconstrained predictions of Rubisco- vs electron transport-limited photosynthesis.



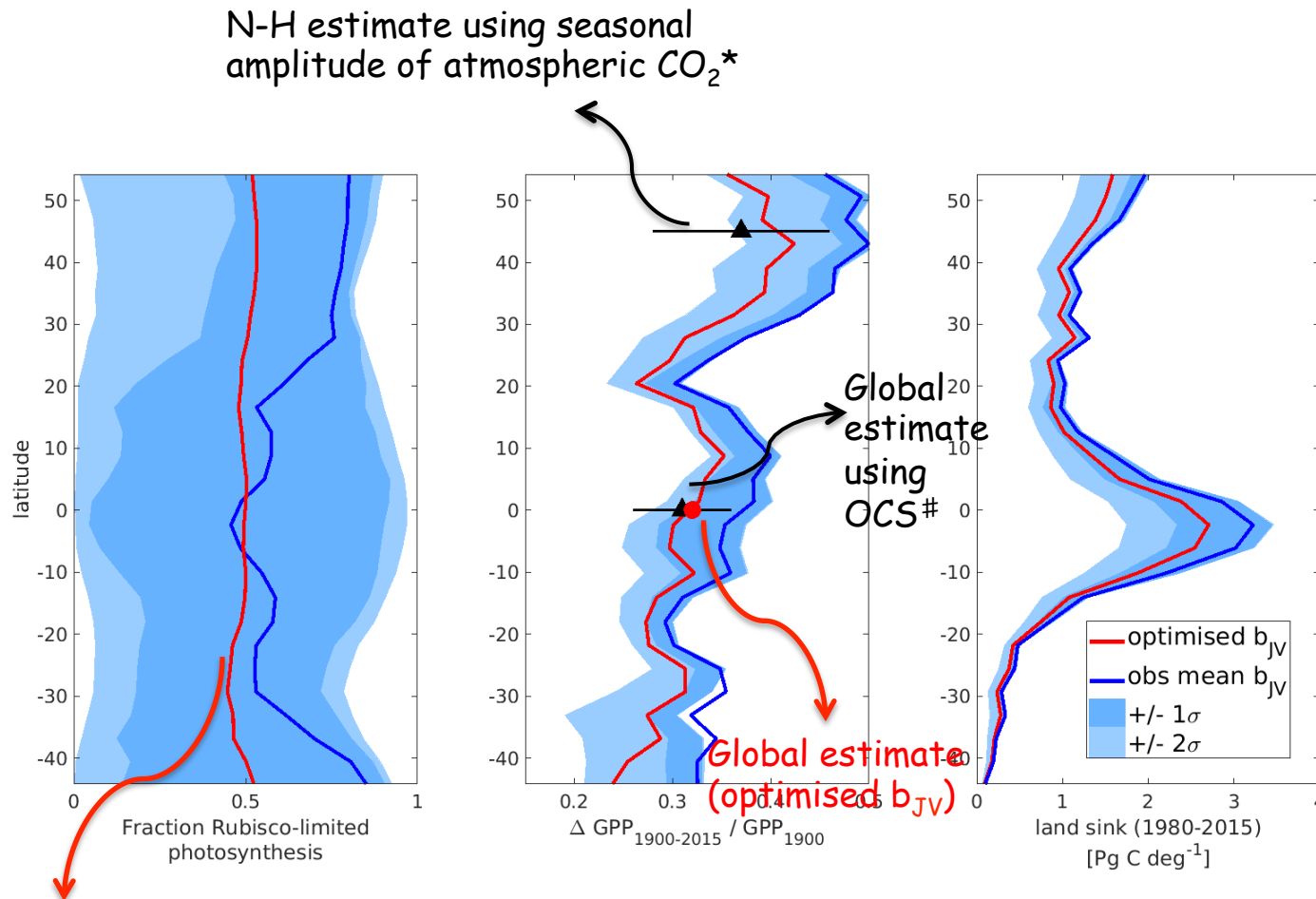
Electron-transport
limitation dominates
(low CO_2
fertilisation effect)

Rubisco limitation
dominates (high CO_2
fertilisation effect)

Additional constraint : optimal plant investment in Rubisco- vs electron transport-limited photosynthesis.

*Wenzel et al. 2016
Nature 548, 499-501

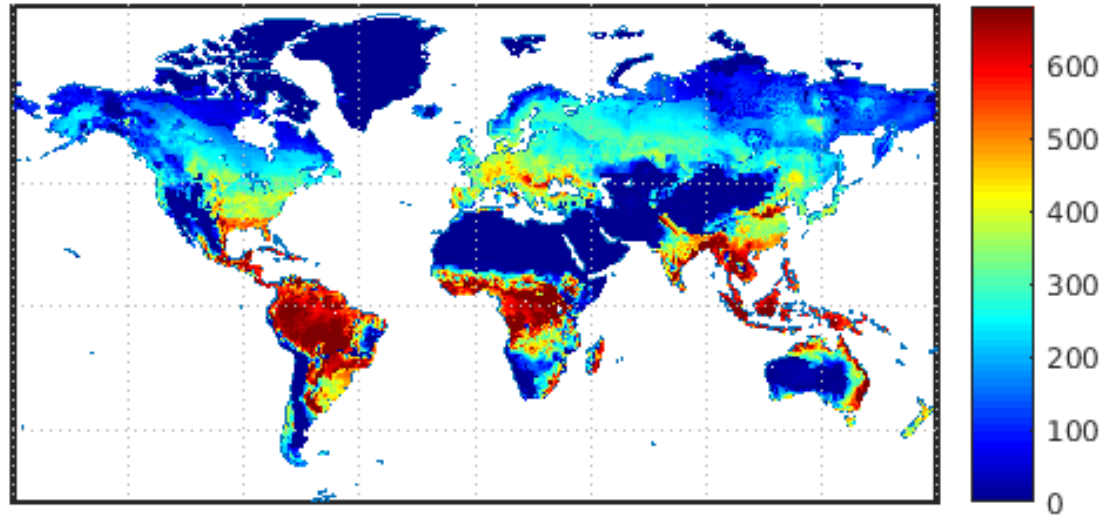
#Campbell et al.
2017
Nature 544, 84-87



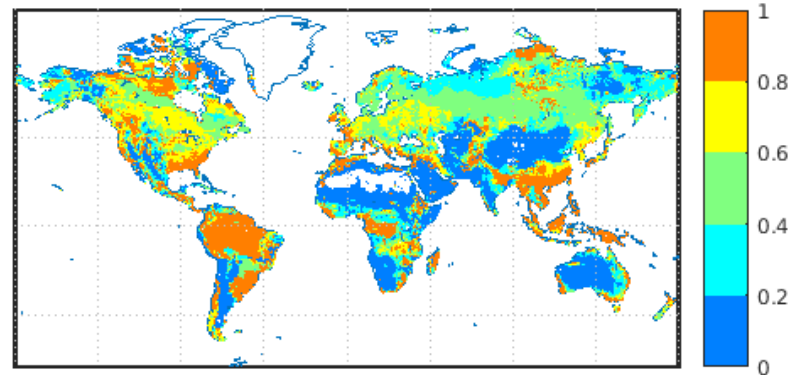
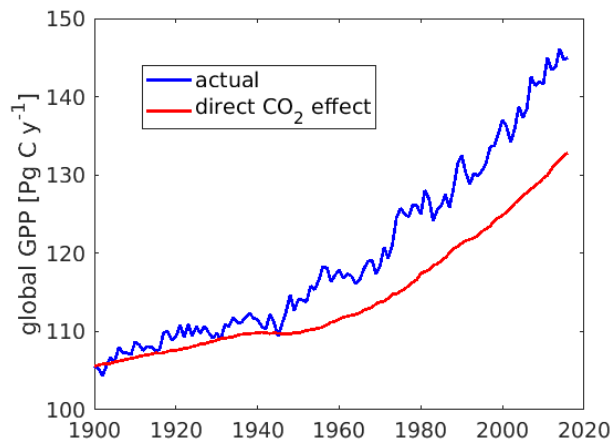
Optimal b_{JV} minimises cost of photosynthesis and yields equal limiting-rate contributions

Increase in Gross Primary Production since 1900 dominated by biochemical CO₂ fertilisation effect, particularly in the tropics

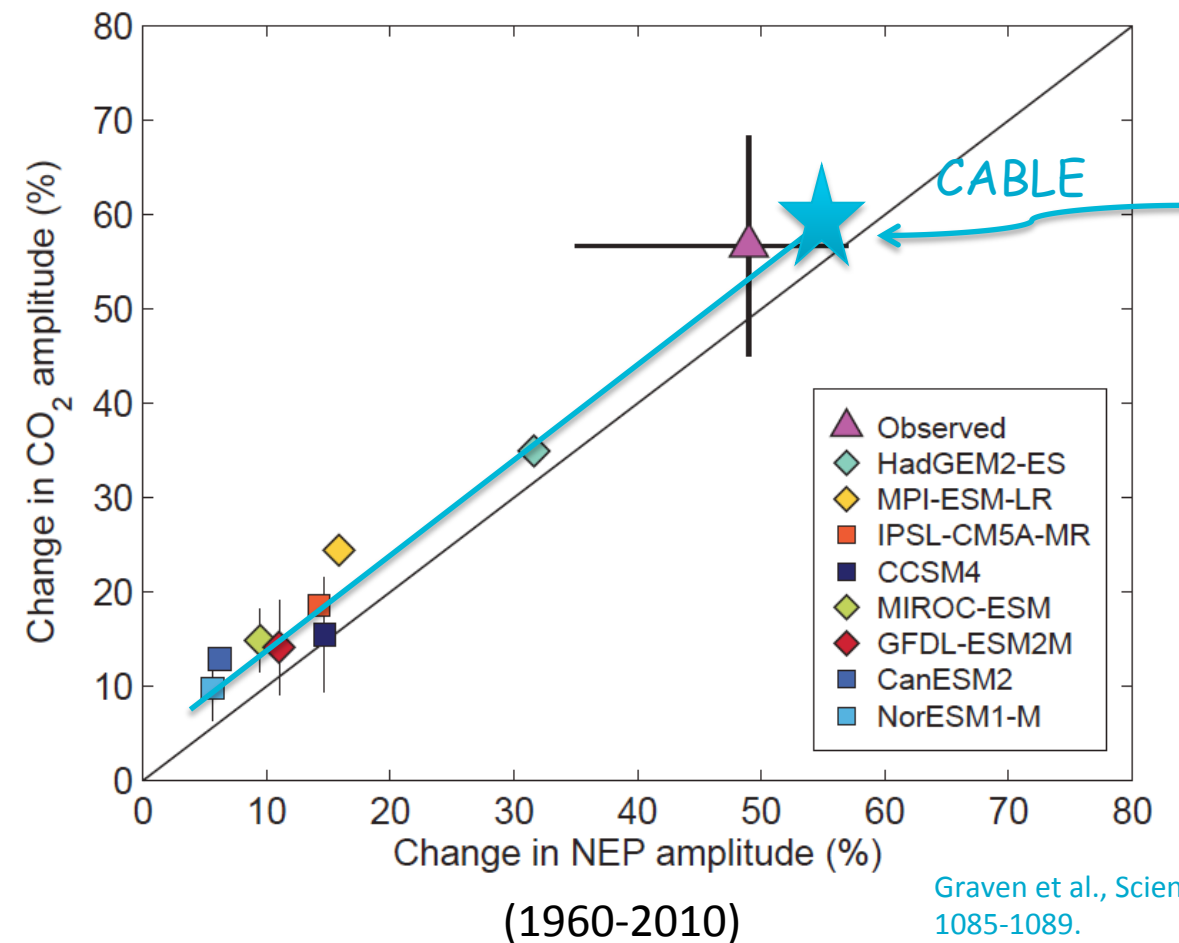
Increase in GPP (1900-2016) [gC m⁻² y⁻¹]



Fraction increase in GPP from biochemical (direct) CO₂ fertilisation (1900 baseline)



Land models under-estimate trend in seasonal amplitude of land carbon uptake: optimisation of plant investment in electron transport vs Rubisco-limited photosynthesis may resolve this.



Graven et al., Science (2013), 341, 1085-1089.

CABLE Detrended Monthly Carbon Uptake

