Vegetation Dynamics in JULES v2.0: The TRIFFID model.

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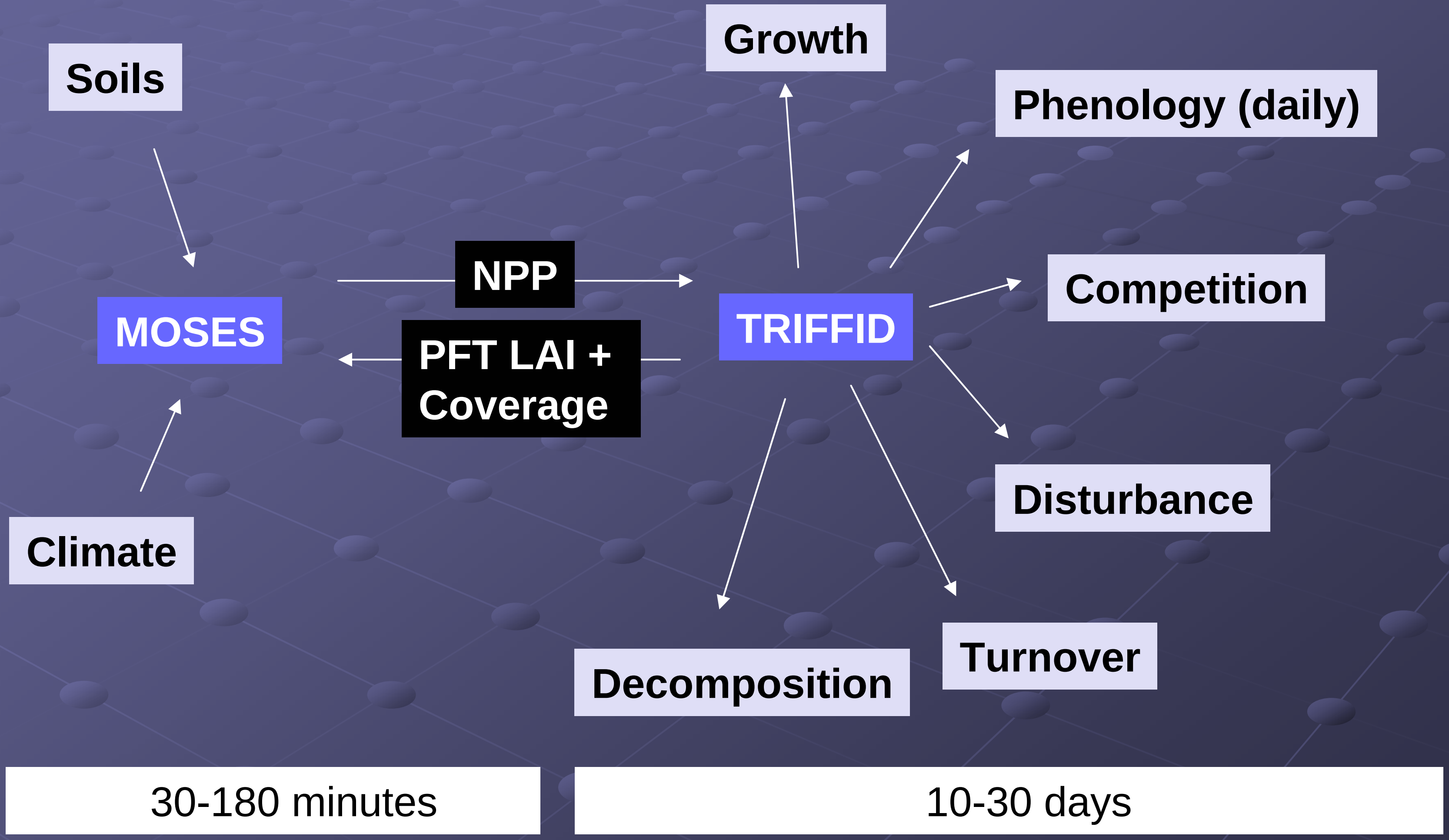
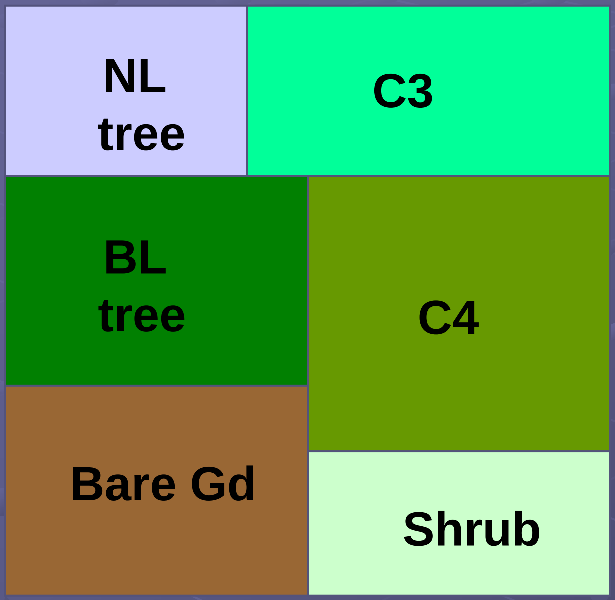
TRIFFID history

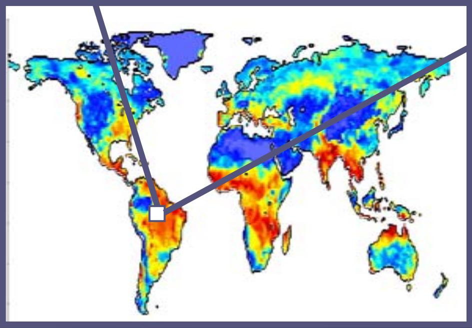
- TRIFFID is the global vegetation model embedded in the Hadley Centre GCM & JULES.
- TRIFFID is similar (not identical) to the majority of DGVMs in terms of physiology & PFT composition.
- Conceptually different in terms of vegetation competition & half-hourly gas exchange.

TRIFFID Structure in JULES



TRIFFID and PFT competition





Change in vegetation carbon

$$\frac{dC_v}{dt} = (1-\lambda)\,\Pi - \Lambda_l$$

Area increase | NPP | Litter

Expansion of PFT area: Lotka Volterra

$$C_v \frac{d\nu}{dt} = \lambda \Pi \nu_* \left\{ 1 - \sum_j c_{ij}\, \nu_j \right\} - \gamma_\nu \nu_* C_v$$

PFT competition

- Competition parameters C_{ij}
- Define how PFT ‘i’ affects PFT ‘j’
- ‘Tree – shrub – grass’ dominance hierarchy.
- These parameters are difficult to define…

Groups working with TRIFFID

- Hadley Centre JCHMR (HADGEM3)
  - First implementation of C-cycle in standard Hadley Model
- Reading – soil moisture parameters
- CLASSIC – snow modelling, physiology
- DGVM intercomparisons – Sitch, Friedlingstein, Cramer.

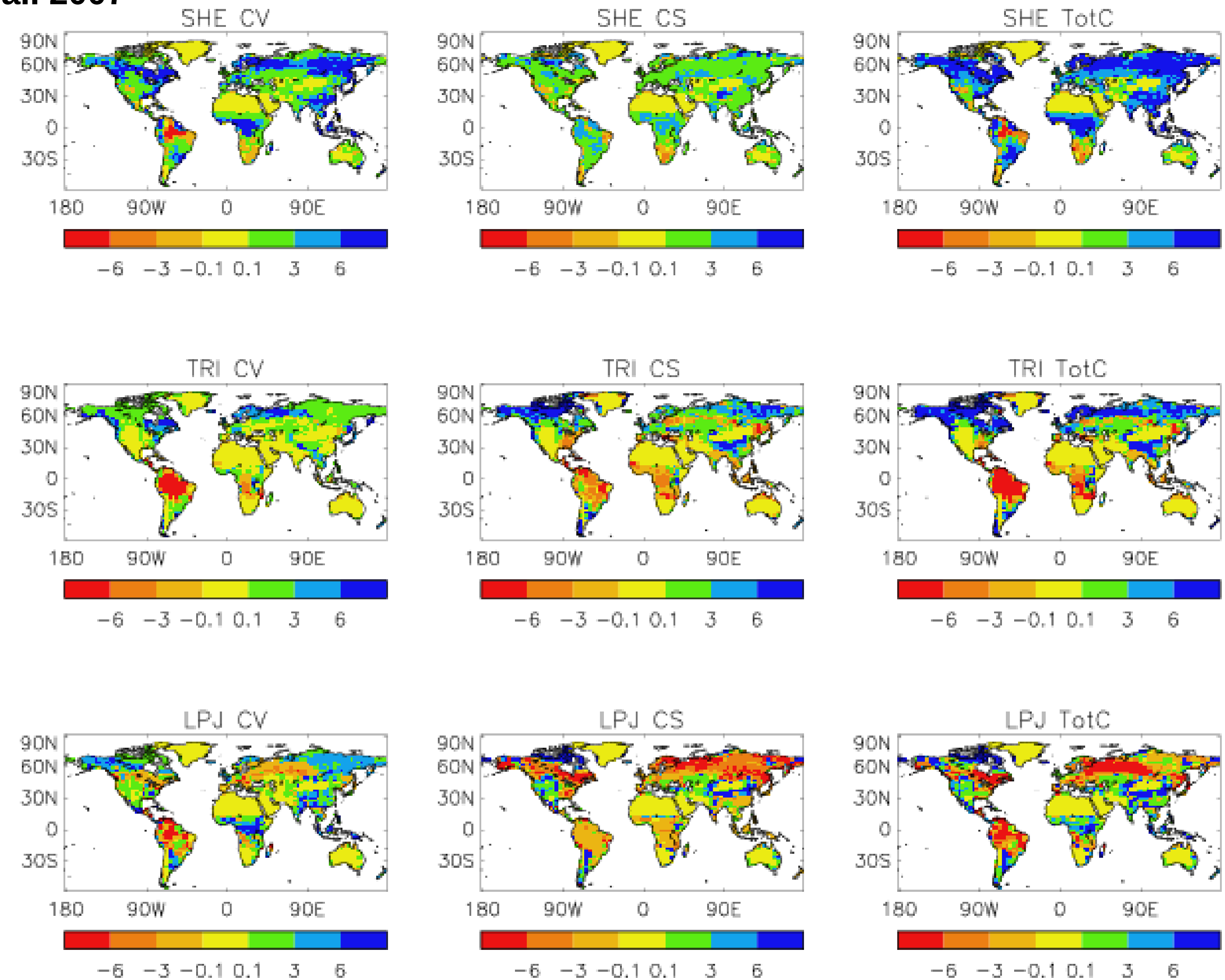
Results from TRIFFID

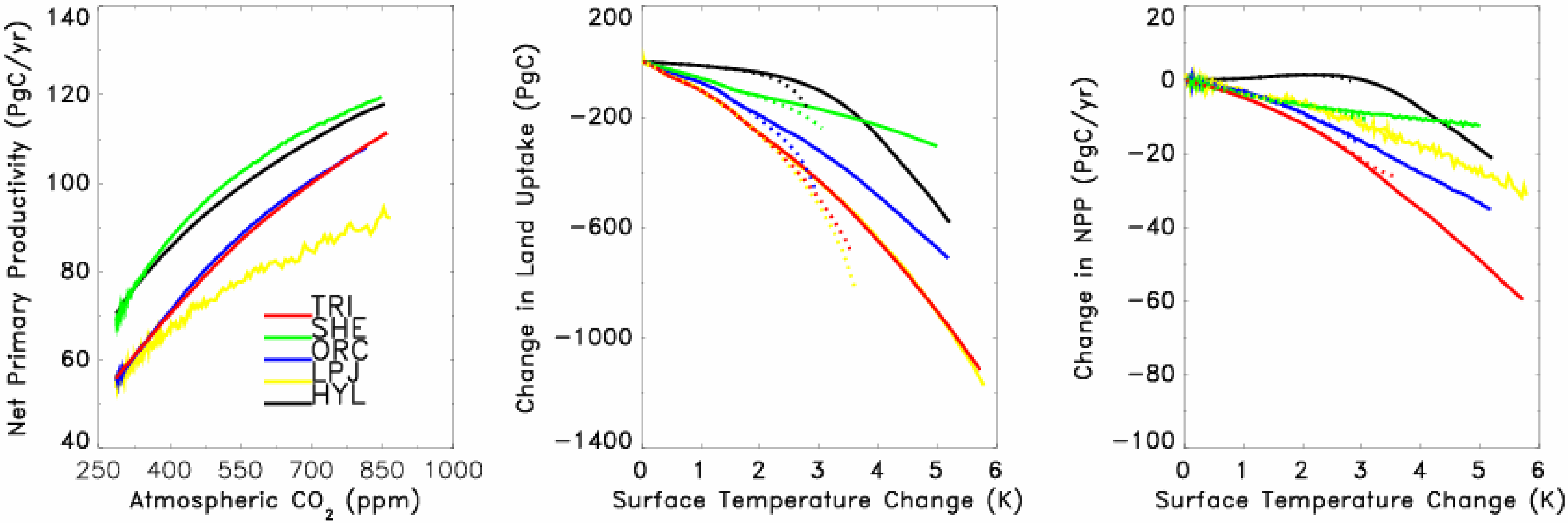
- Inter-comparison with other DGVMs in IMOGEN: Stephen Sitch
- Disaggregation of water and temperature responses in Amazonia: David Galbraith
- Acclimation of respiration to increasing temperature: Owen Atkin & Rosie Fisher

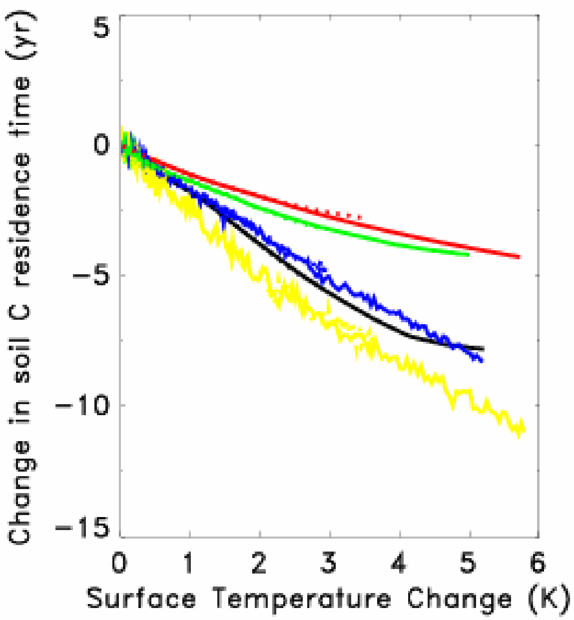
.1. DGVM inter comparison Sitch et al 2007

- Compared 5 DGVMs with the same climate drivers within the IMOGEN framework.
- Previous inter-comparisons (C_4MIP) have used different GCM-DGVM pairs. This is a direct comparison
- Compare predicted change in land carbon over 21st century.
- Separate out the CO_2 and climate response.

Sitch et al. 2007







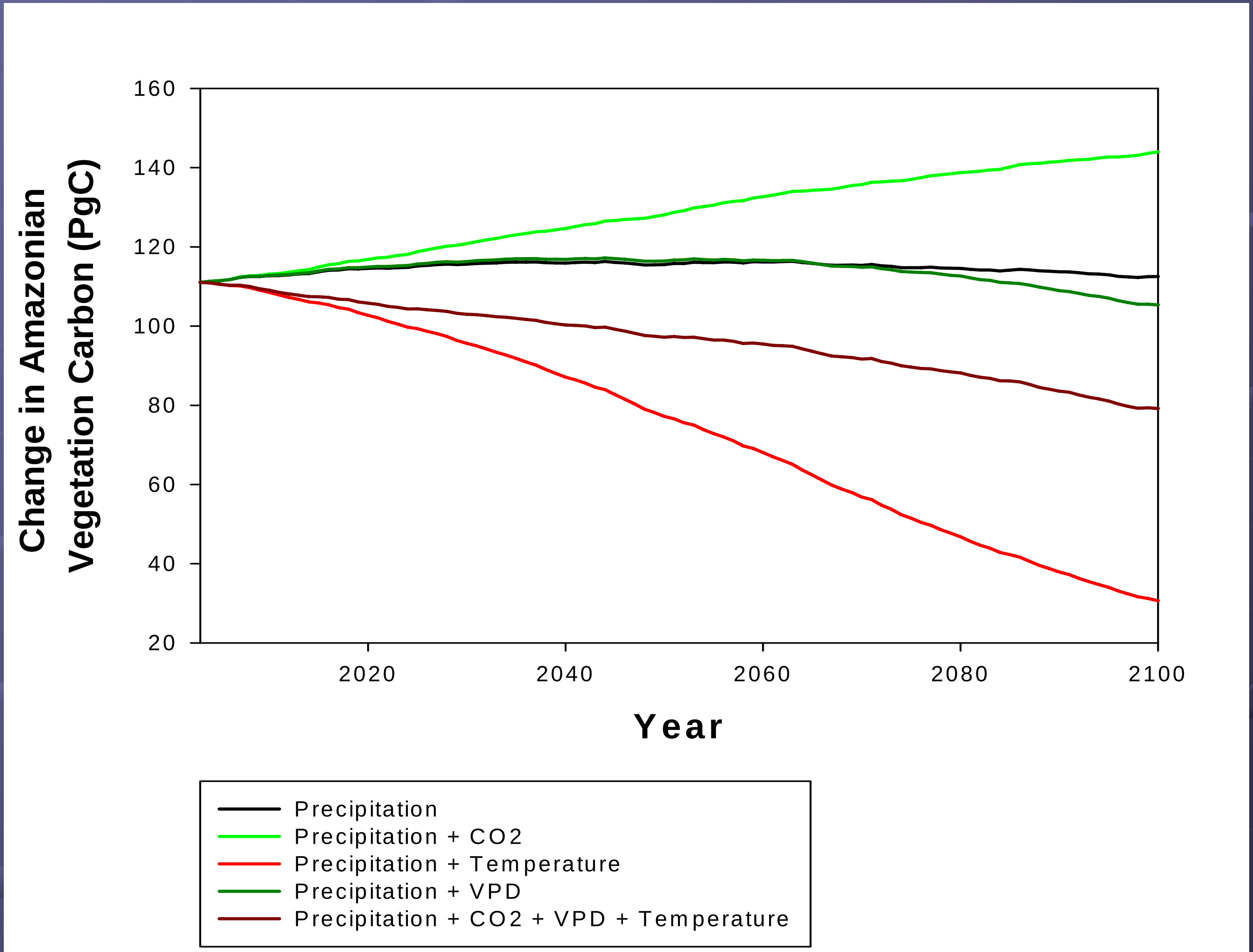
Conclusions:

TRIFFID is much more sensitive to climate changes than the 'mean' model response.

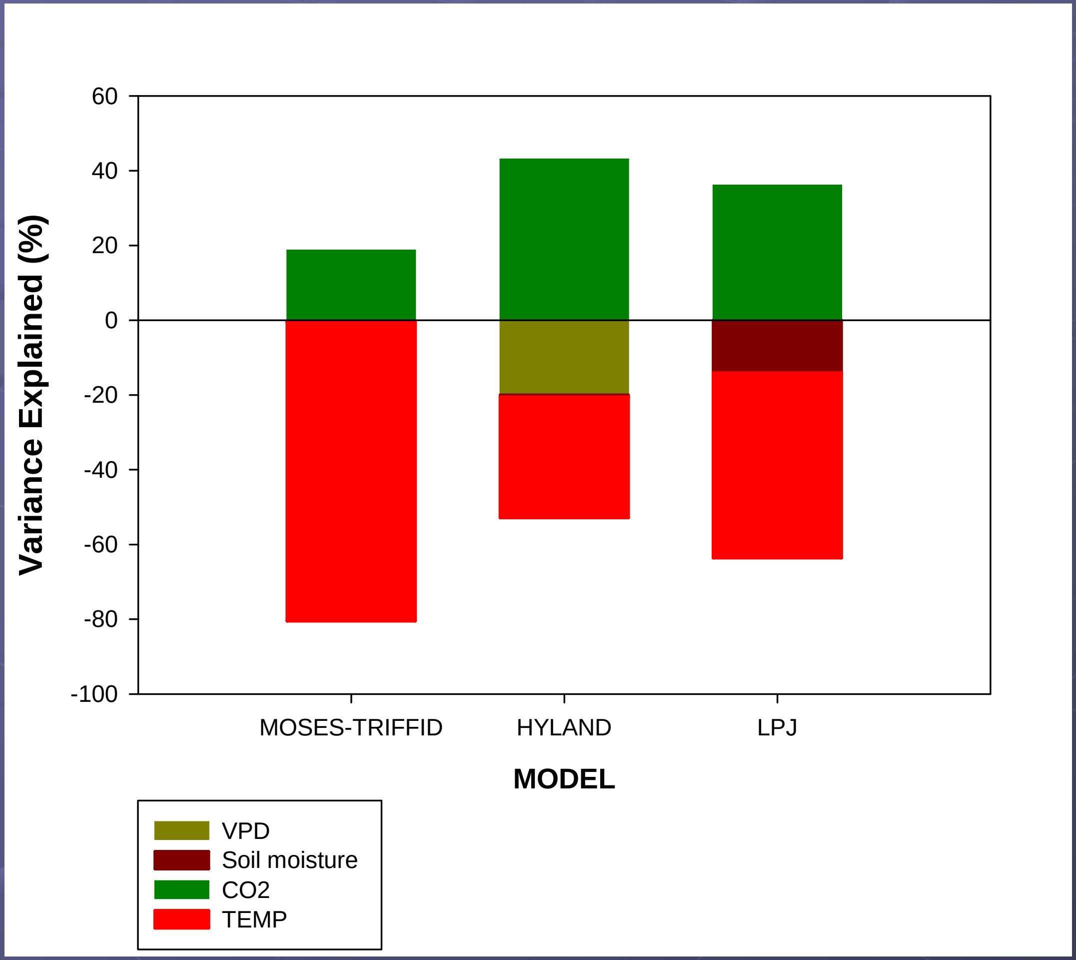
Why is this?

2. Interactions between climate drivers using MOSES-TRIFFID **(40% Precip Reduction to 2100)**

Slides by David Galbraith



Interactions with other climate drivers: Partitioning the 'dieback' response

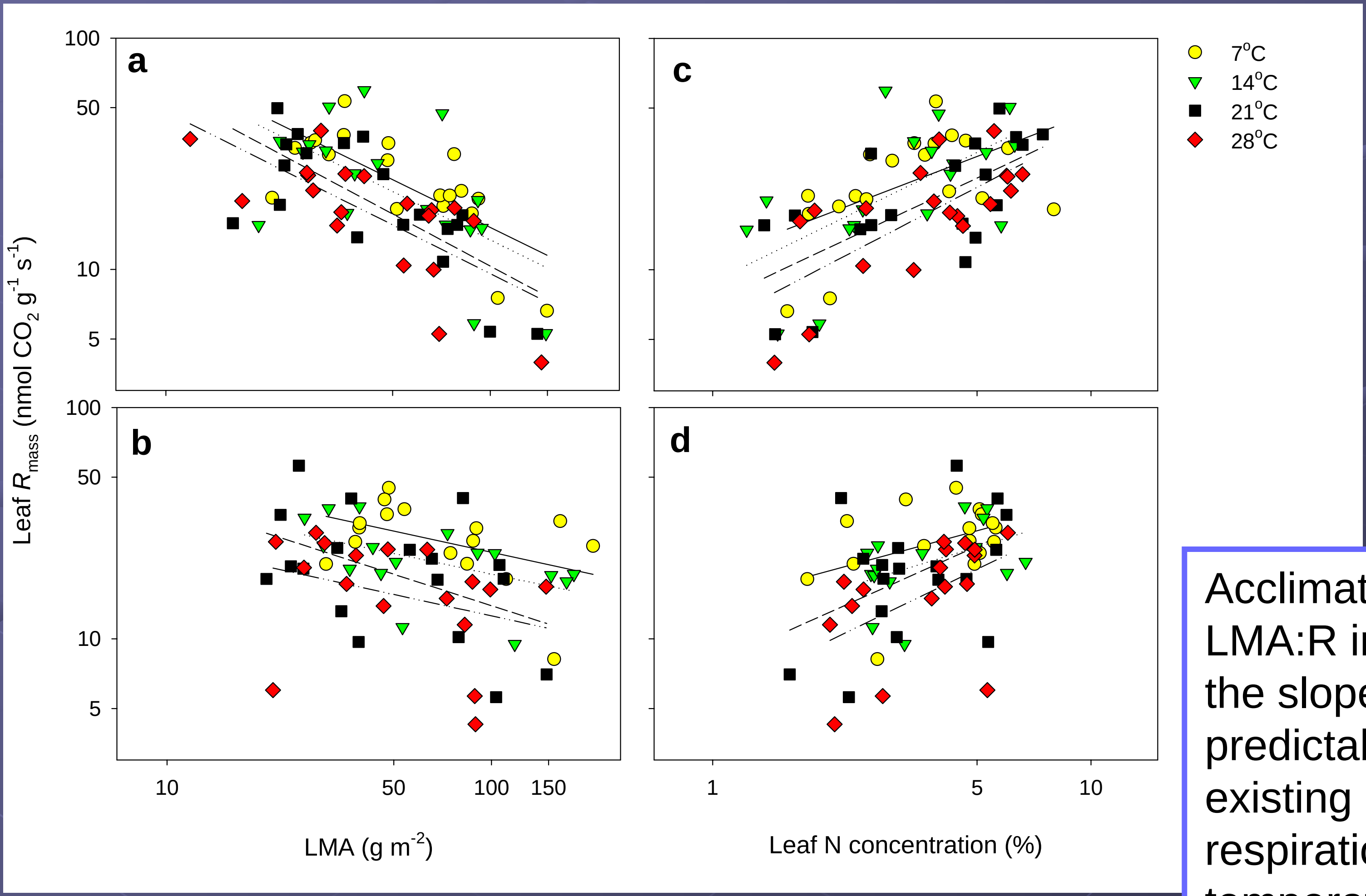


Which aspect of temperature is causing the dieback?

Respiration increase or photosynthetic decline?

3. Acclimation of respiration to temperature.

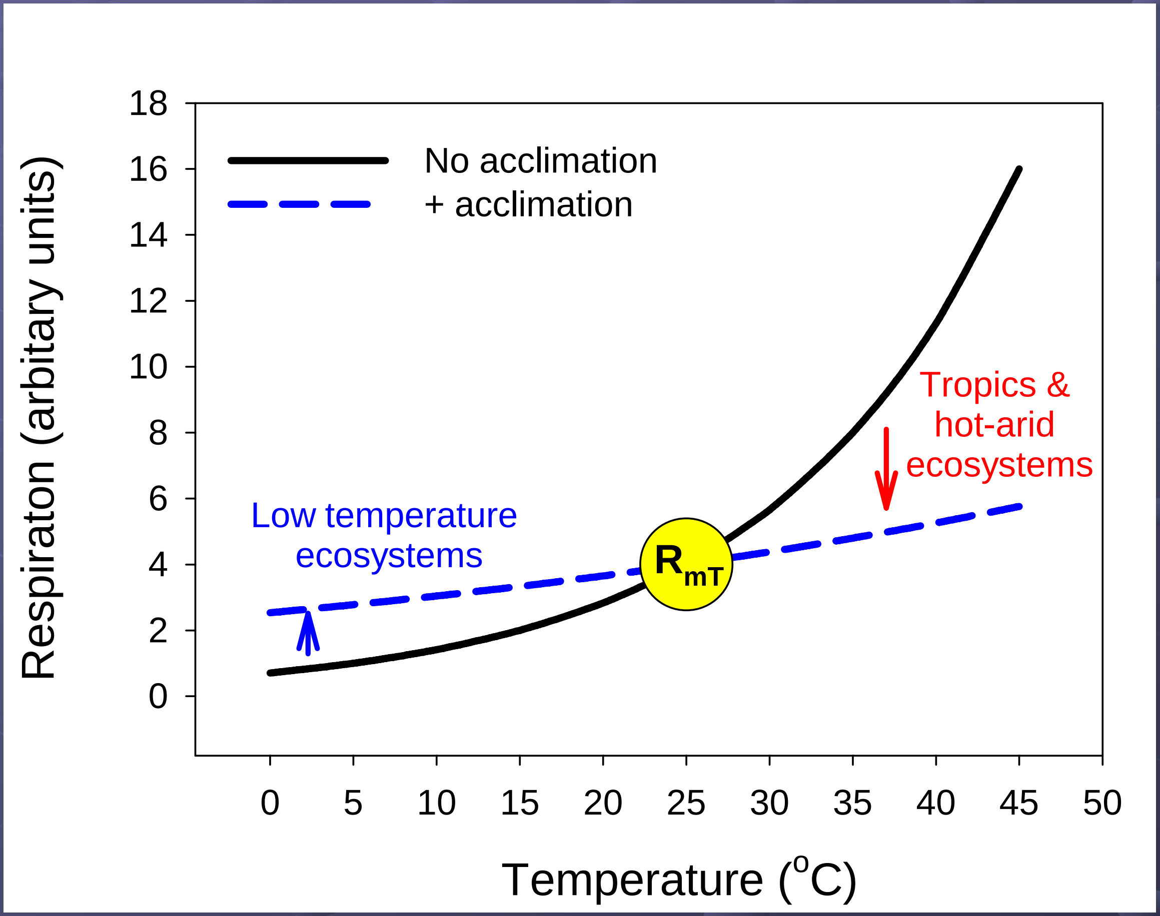
Atkin O, Zaragoza-Castells J, Fisher R et al. in review

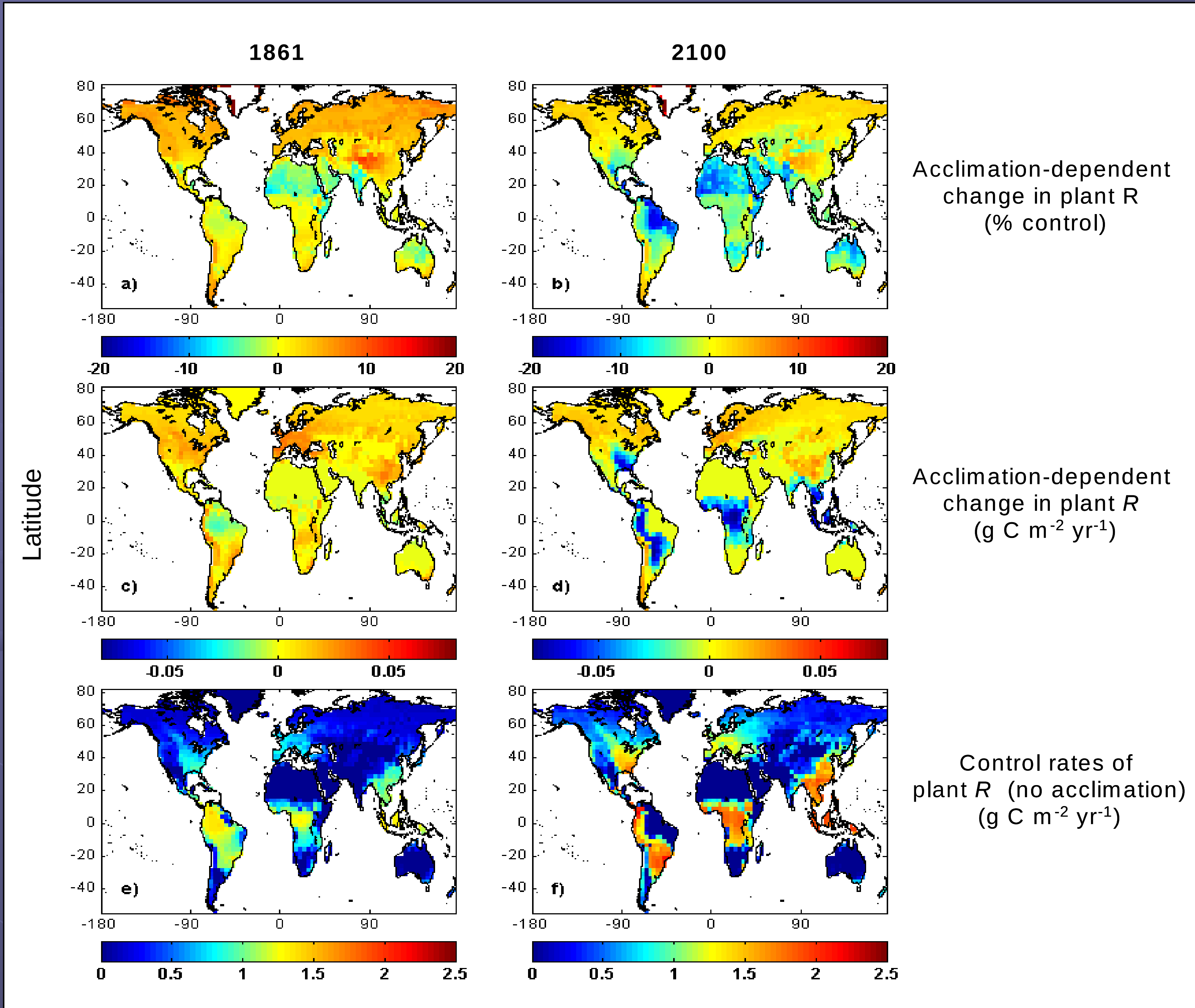


Acclimation adjusts the LMA:R intercept, but not the slope, so is predictable from the existing rate of respiration and the temperature change from the reference value

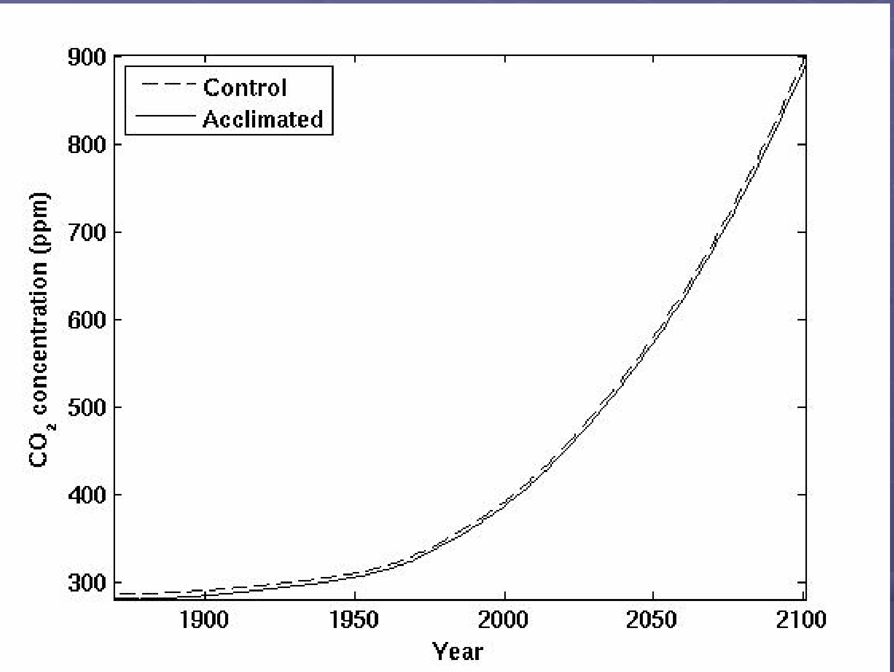
Inclusion of temperature acclimation in JULES

- We assume that the 'reference temperature' for respiration is 25°C




1861
2100
Latitude
a)
b)
c)
d)
e)
f)
80 60 40 20 0 -20 -40
-180 -90 0 90
-20 -10 0 10 20
-0.05 0 0.05
0 0.5 1 1.5 2 2.5
Acclimation-dependent
change in plant R
(% control)
Acclimation-dependent
change in plant *R*
(g C m^{-2} yr^{-1})
Control rates of
plant *R* (no acclimation)
(g C m^{-2} yr^{-1})

Conclusions



- Expectation is that acclimation reduces respiration with increasing temperature.
- Our net result is no change in carbon balance as +ve acclimation in boreal zone cancels out -ve acclimation in tropical zone