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 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

$$C_v \frac{dv}{dt} = \lambda \Pi \nu^* \left\{ 1 - \sum_j c_{ij} \nu_j \right\} - \gamma_v \nu^* C_v$$
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 (C₄ MIP) have used different GCM-DGVM pairs. This is a direct comparison.
- Compare predicted change in land carbon over 21st century.
- Separate out the CO₂ and climate response.
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

Graph showing change in Amazonian Vegetation Carbon (PgC) from 2020 to 2100 under different climate drivers:
- Precipitation
- Precipitation + CO2
- Precipitation + Temperature
- Precipitation + VPD
- Precipitation + CO2 + VPD + Temperature

The year scale ranges from 2020 to 2100, with the y-axis representing the change in vegetation carbon in PgC.
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.
Acclimation of respiration

Acclimation-dependent change in plant \( R \) (% control)

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.