JULES: New plant functional types, vegetation dynamics and drought impacts.

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Outline

• New PFTs
  – Introduction
  – Data
  – Global model results: Fluxes and Vegetation Dynamics
  – Evaluation of GPP

• Applications
  – 2010 Amazon drought
JULES Plant Functional Types
(from 5 to 9)

- Distinction between deciduous & evergreen.
- Tropical & temperate broadleaf evergreen.
What’s new?

- 9 plant functional types (but flexible # is possible)
- Trait-based physiology:
  - data-derived parameters $N_{mass}$ (kg N kg leaf$^{-1}$) and leaf mass per unit area (LMA: kg leaf m$^{-2}$) replace $N_{l0}$ and $\sigma_L$.
    \[ N_{area} = LMA \times N_{mass} \]
  - $V_{cmax}$ is calculated from regressions from global dataset, so a slope ($v_{sl}$) and intercept ($v_{int}$) replace $n_{eff}$.
    \[ V_{cmax,25} = v_{sl} \times N_{area} + v_{int} \]
    \[ V_{cmax,25} = n_{eff} \times N_{l0} \]
- Switch between old and new approach with l_trait_phys.
- Height-based competition so number of PFTs is flexible
  - Switch between old and new with l_height_dom.
New physiology and PFTs

$V_{cmax}$ = maximum rate of carboxylation of Rubisco, related to Rubisco and export limited rates of photosynthesis in JULES

- Represents larger diversity of ecosystems.
- Updated $V_{cmax}$ based on:
  - Observed leaf nitrogen, LMA, and $V_{cmax}$ relationships
  - In progress: Optimizing $V_{cmax,25}$ against Fluxnet observations (NEE, GPP, and LH).

Global vegetation with new PFTs

"TRENDY S3" style simulation: Uses time-varying climate, CO2, and land use from 1860-2012

JULES3.2 New PFTs vegetation, 2010

JULES3.2 TRENDY S3 vegetation, 2010
Vegetation coverage with new PFTs

JULES3.2 New PFTs vegetation, 2010

ESA LCCS: Observed land cover, 2000
(Andy Hartley, Mike Sanderson)

- Tropics mostly good, boreal forest is lacking.
- The DGVM parameters are untuned, so it can likely get much better.
GPP with new PFTs

**JULES3.2 Old PFTs GPP, 1982-2012**
Global = 148 GtC/yr

**JULES3.2 New PFTs GPP, 1982-2012**
Global = 142 GtC/yr

**MTE GPP*, 1982-2012**
Global = 115 GtC/yr

**New PFTs - MTE GPP, 1982-2012**

*Model tree ensemble, based on upscaled Fluxnet data: Jung et al. 2011, JGR*
Biome-scale GPP

- Annual GPP is too high in most biomes according to MTE and Fluxnet individual sites.
- Fluxnet exceptions: It is too low in Tropical Savannah & Tundra.
- Seasonally: Spring GPP is too high in forests and grasslands.
- Savannah
Biome-scale LH

- JULES LH is close to the Jung et al. dataset – a little low in forests.
- Tropical savannah and tundra sites: JULES has low LH (GPP was also low).
- In ADJULES we will try to optimize both of these fluxes together with the net ecosystem exchange of carbon.