

Why climate models BUG biologists

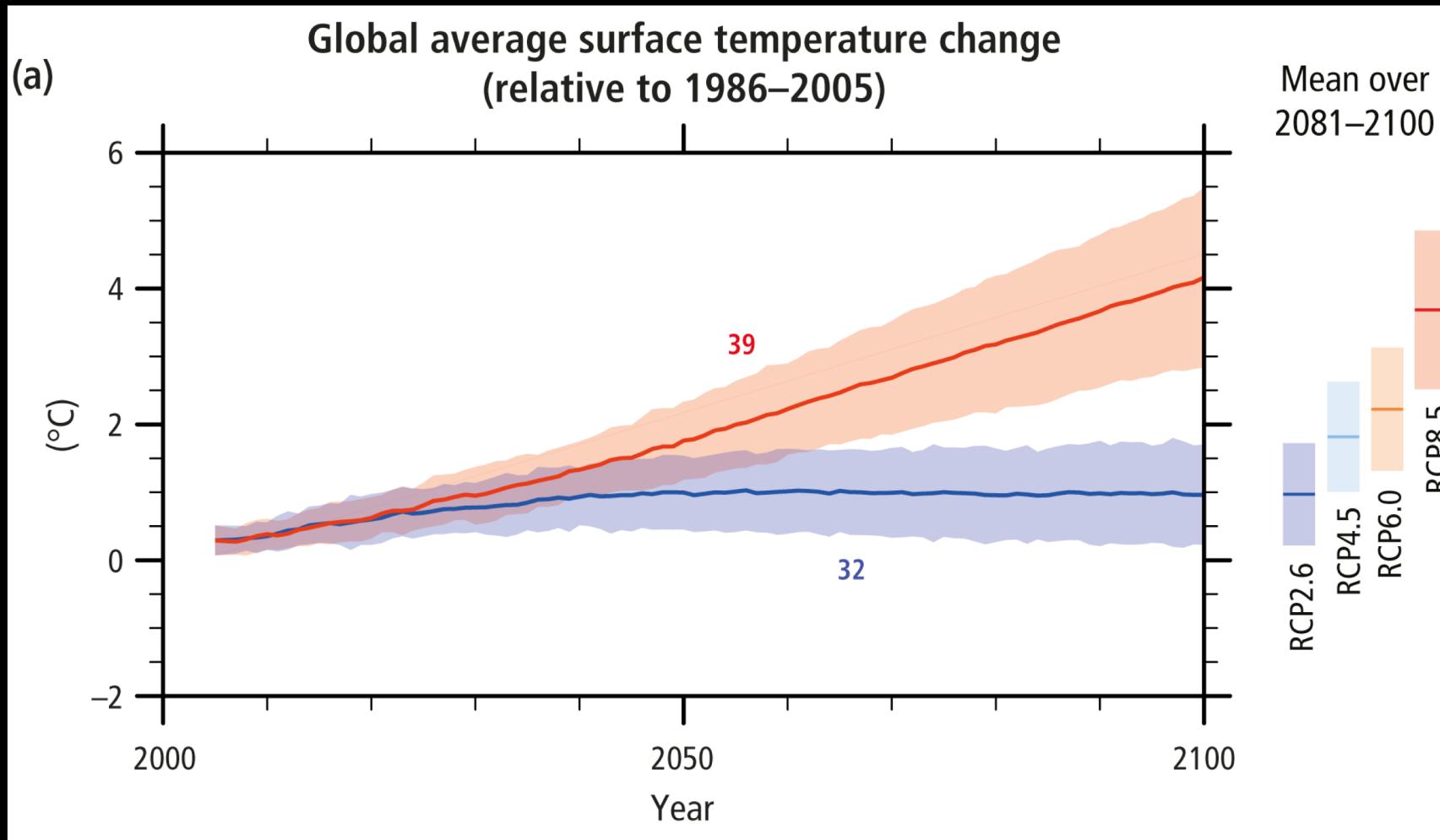


Nick Smith

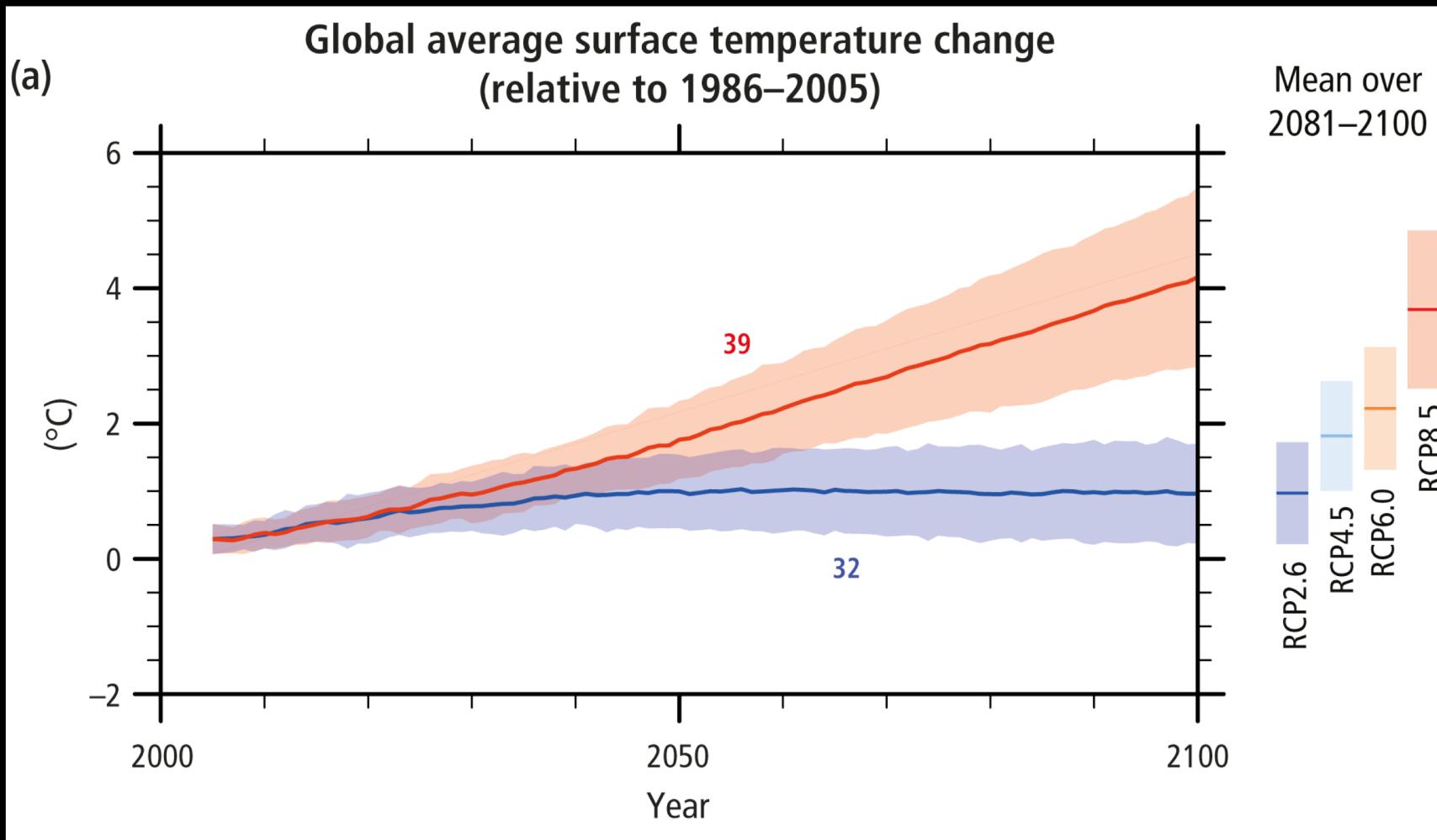
BUGS

March 30, 2019

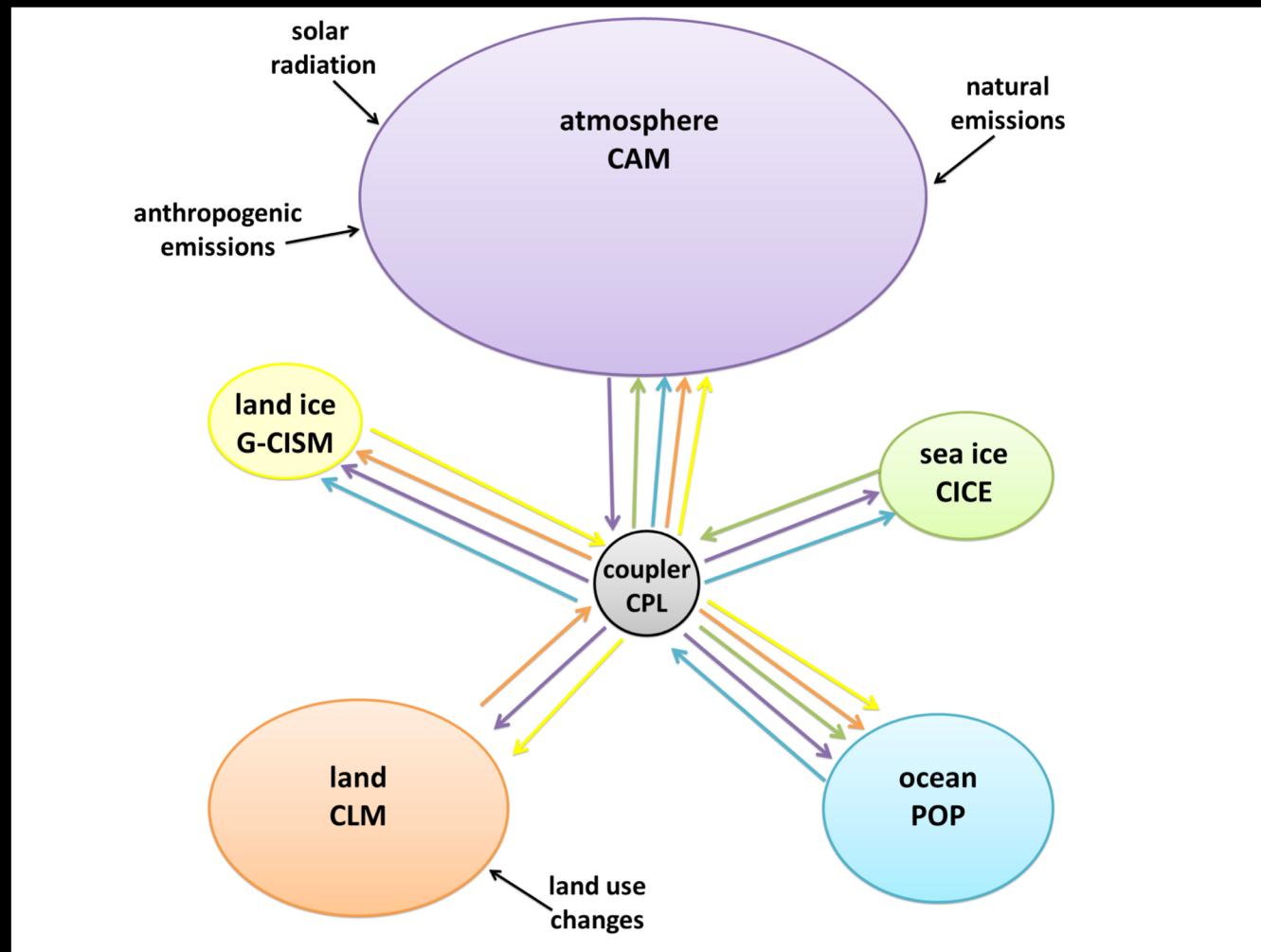
The world is projected to war 4°C by 2100



Says who?



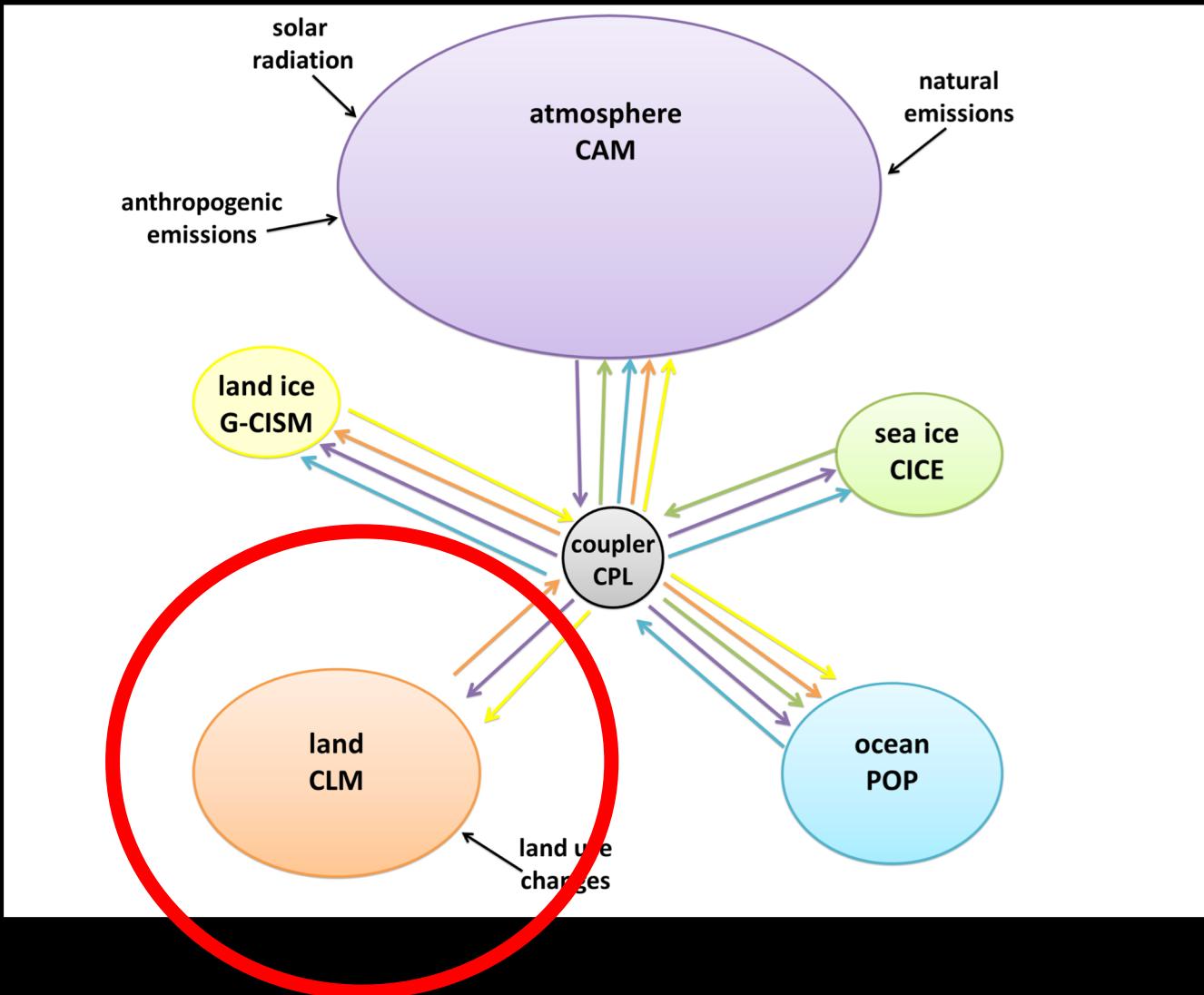
Earth System Models



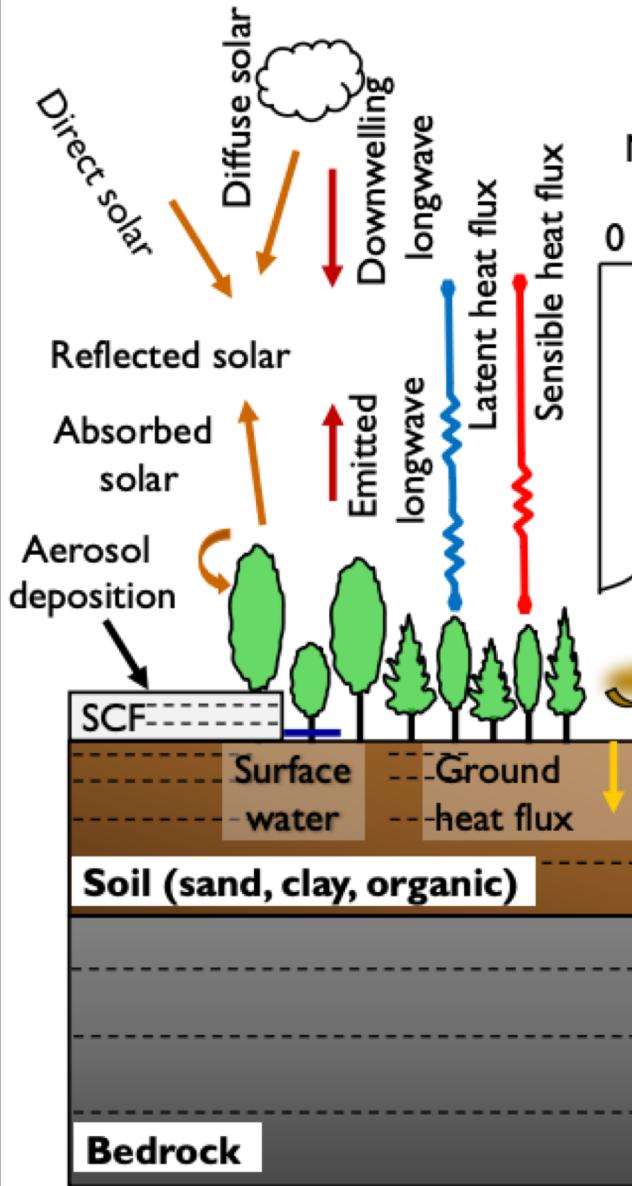
Why do Biologists care?

Why do Biologists care?

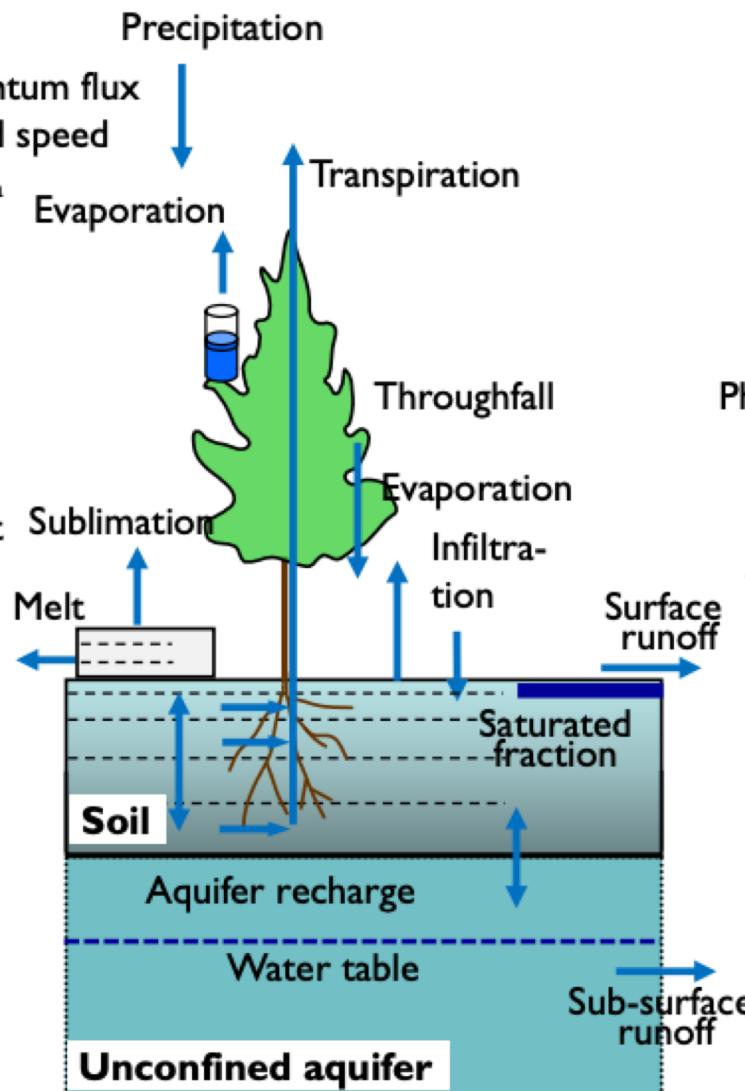
1. There is a lot of Biology in ESMs



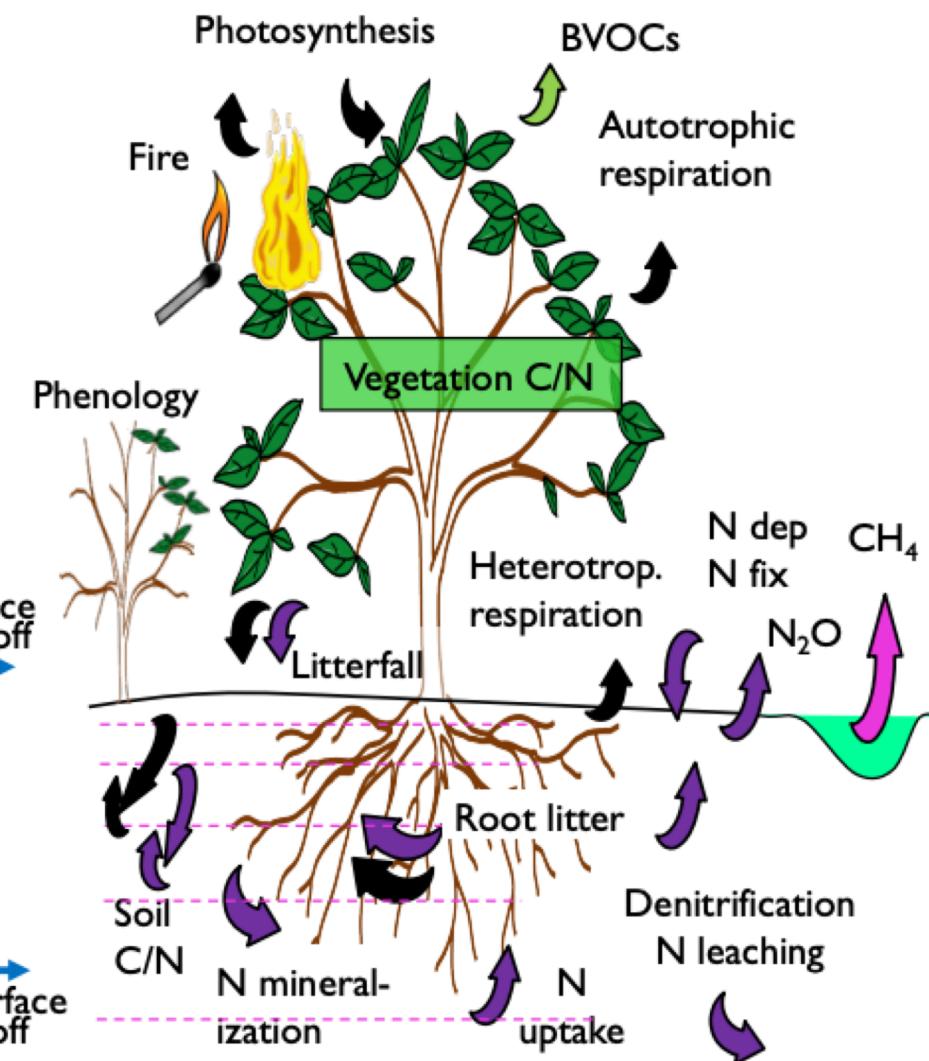
Surface energy fluxes



Hydrology



Biogeochemical cycles



Why do Biologists care?

1. There is a lot of Biology in ESMs
 - And that Biology matters!

Photosynthesis
120 PgC/yr



Soil microbial
respiration
60 PgC/yr



Fossil fuel burning
<10 PgC/yr



Why do Biologists care?

1. There is a lot of Biology in ESMs
 - And that Biology matters!
2. There is a lot of Biology missing from ESMs

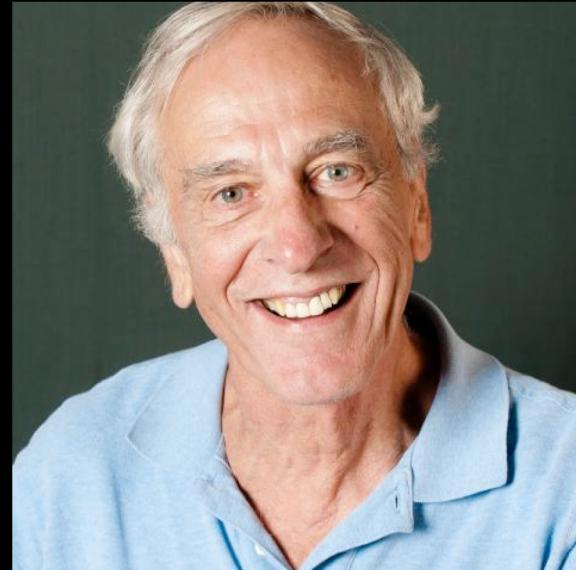
1980's: plant models are developed

A Biochemical Model of Photosynthetic CO₂ Assimilation in Leaves of C₃ Species

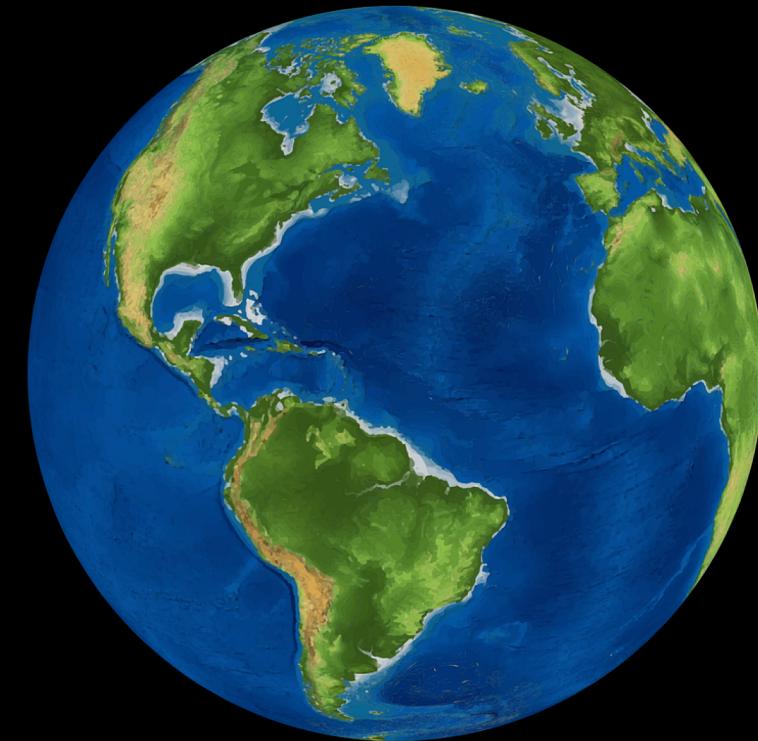
G.D. Farquhar¹, S. von Caemmerer¹, and J.A. Berry²

¹ Department of Environmental Biology, Research School of Biological Sciences, Australian National University, P.O. Box 475, Canberra City ACT 2601, Australia and

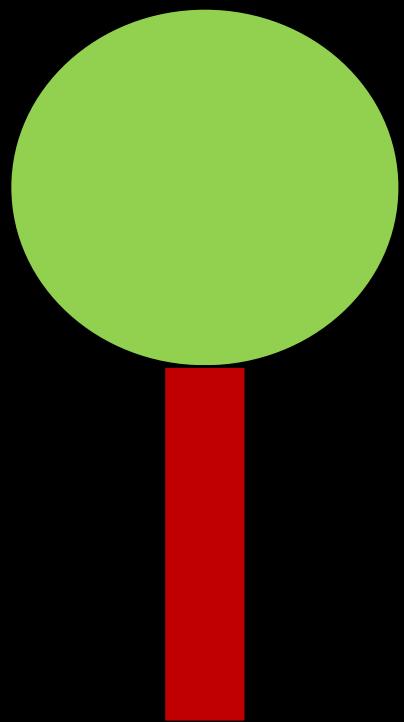
² Carnegie Institution of Washington, Department of Plant Biology, Stanford, Cal. 94305, USA



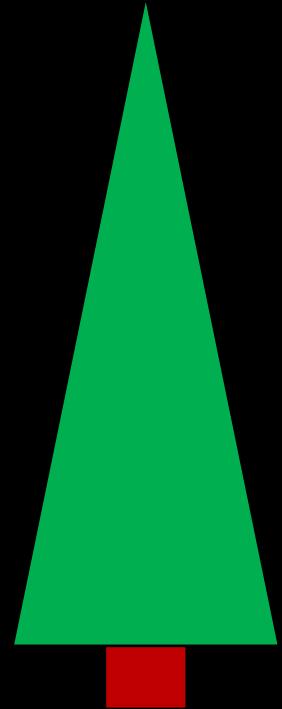
90's to 2000's: spinach world!



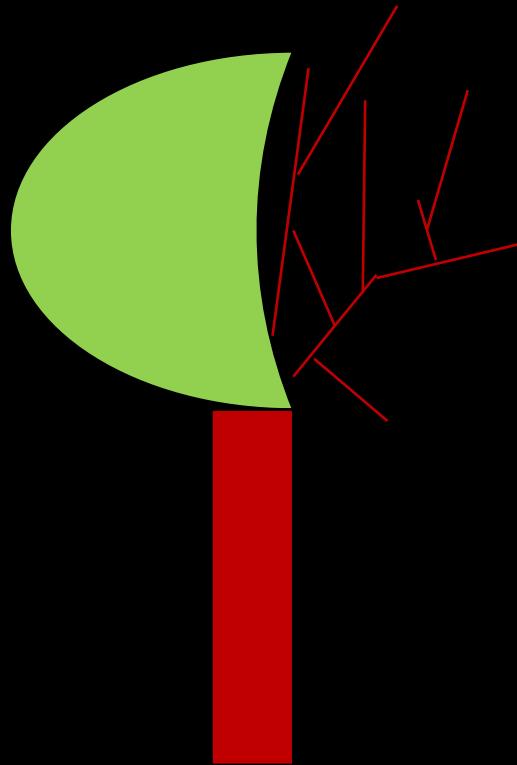
2000's: 5 – 10 plant “types”



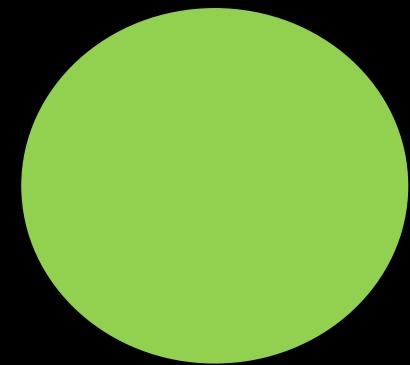
Broadleaf tree



Needleleaf tree



Deciduous tree



Shrub



Grass

2010's: "Smart" plants

With time, plants will acclimate to environmental perturbations, such as elevated temperature and CO₂.



Global Change Biology (2013) 19, 45–63, doi: 10.1111/j.1365-2486.2012.02797.x

REVIEW

Plant respiration and photosynthesis in global-scale models: incorporating acclimation to temperature and CO₂

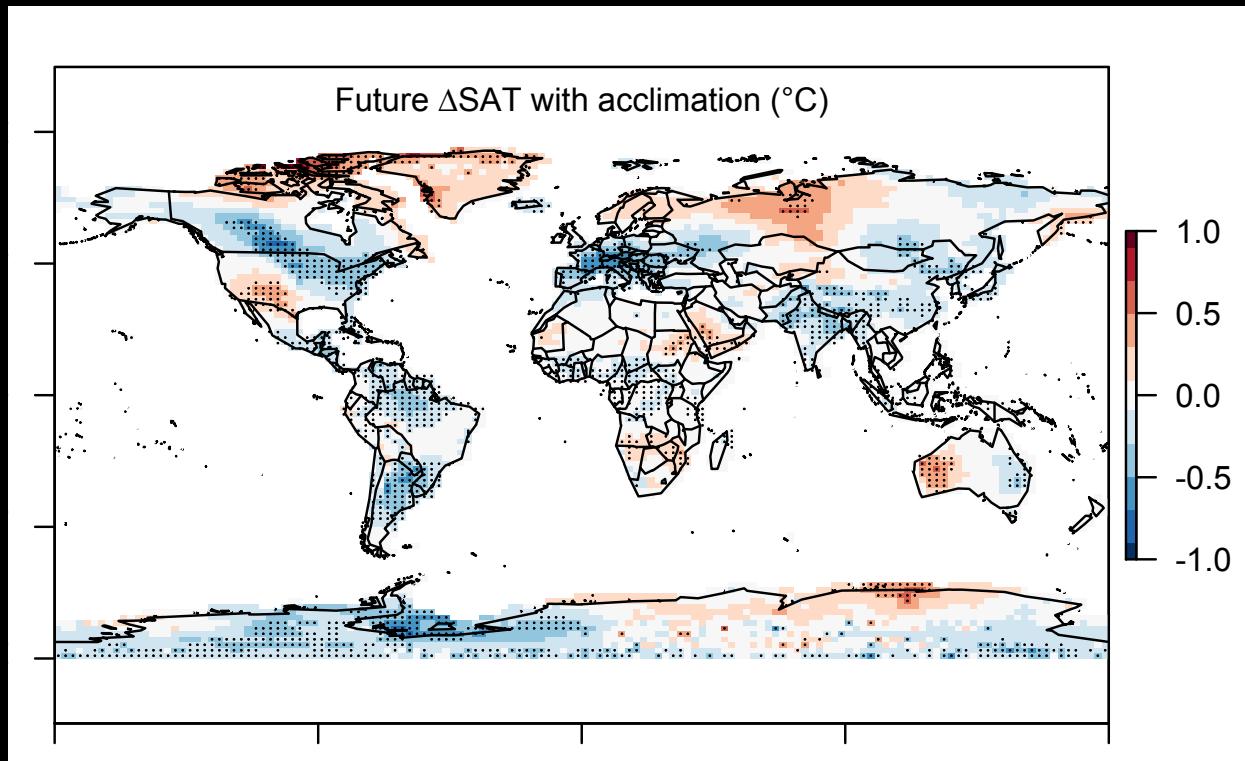
NICHOLAS G SMITH* and JEFFREY S DUKES*†

Why do Biologists care?

1. There is a lot of Biology in ESMs
 - And that Biology matters!
2. There is a lot of Biology missing from ESMs
 - ...which may or may not matter

2010's: "Smart" plants

Acclimation reduces plant sensitivity to climate, which increases future evaporative cooling.



AGU PUBLICATIONS

Journal of Advances in Modeling Earth Systems

RESEARCH ARTICLE

10.1002/2016MS000732

Biophysical consequences of photosynthetic temperature acclimation for climate

Key Points:
• We assessed the biophysical influence of photosynthetic

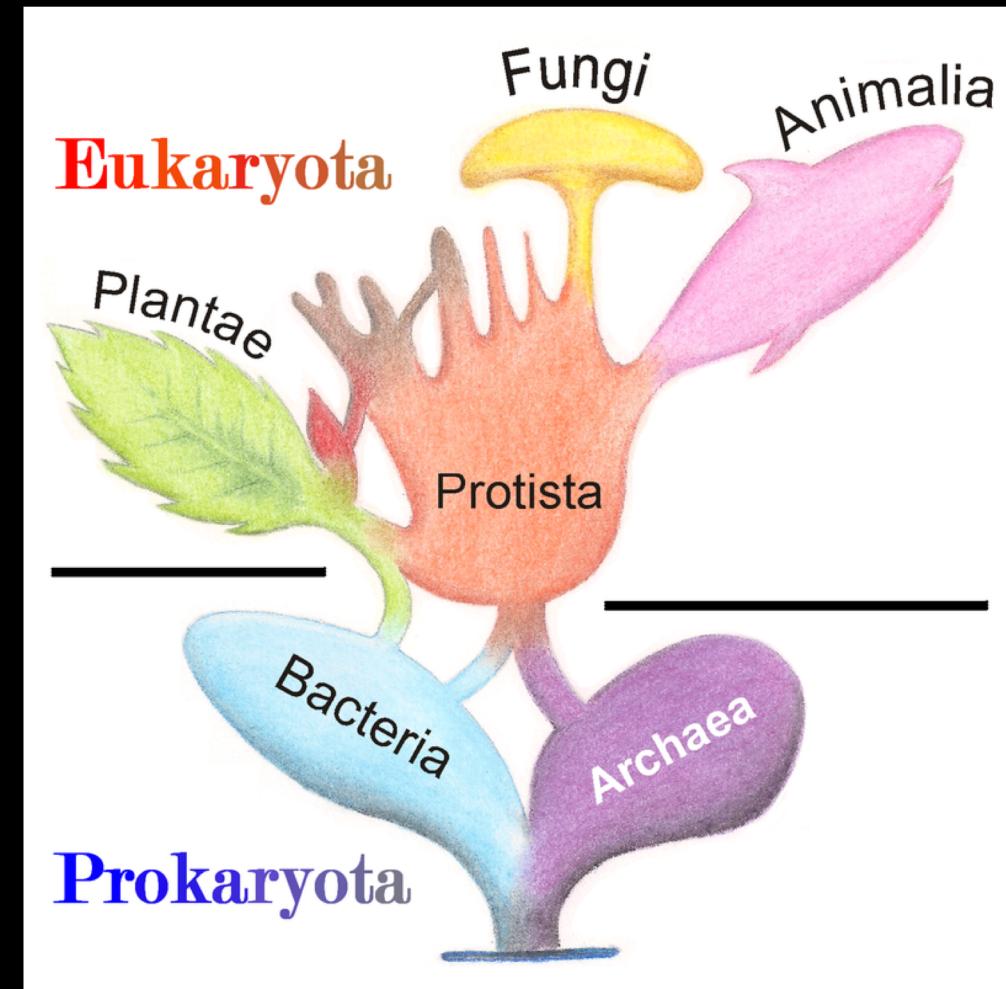
Nicholas G. Smith^{1,2,3,4}, Danica Lombardozzi⁵, Ahmed Tawfik³, Gordon Bonan⁵, and Jeffrey S. Dukes^{1,2,3}

Biology in ESMs

- Plant “types”
 - Photosynthesis, respiration, transpiration, nutrient cycling
- “Living” soils
 - Respiration, nutrient cycling
- Humans
 - Not really doing any biology directly; mostly just burning fossil fuels and changing land use

Biology missing from ESMs

- Individual species
- Animals, bacteria, fungi
- Reproduction



Which leads to...

Models should this important
process that I measured!

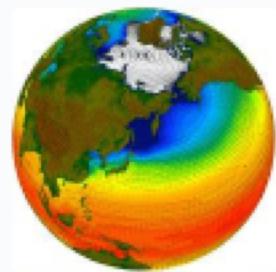
I'm convinced, what do I need to
know to get my Biology in an
ESM?



Search or jump to...



Pull requests Issues Marketplace Explore



Earth System Community Modeling Portal

<https://escomp.github.io/>

Repositories 21

People 2

Projects 0

Pinned repositories



cesm
The Community Earth System Model

● Python

★ 59

ψ 40



ctsm
Community Terrestrial Systems Model (includes
the Community Land Model of CESM)

● Fortran

★ 82

ψ 77

<https://github.com/ESCOMP>