Opportunities with the NASA GMAO & CLM

Randal Koster[1], with considerable inputs from

Fan-Wei Zeng[1,2] and Eunjee Lee[1,3]

[1] Global Modeling and Assimilation Office, NASA's Goddard Space Flight Center

[2] Science Systems and Applications, Inc.

[3] Goddard Earth Sciences Technology and Research, Universities Space Research Association
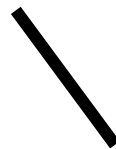
NASA Global-Scale Earth Modeling

GISS (New York City):
-- decadal-to-centennial scales
-- e.g., climate change problems

GMAO (Greenbelt, MD):
-- weather-to-decadal scales
   (mostly seasonal to interannual)
-- heavy emphasis on satellite data

Major Activities in GMAO: from Research to Products

Weather Analysis and Prediction	Seasonal-to-Decadal Analysis and Prediction	Reanalysis **(MERRA-2)**

|	
Global Multiscale Modeling	Observing System Science

- **GMAO develops Earth System analysis and modeling capabilities that demonstrate the value of NASA's observations to (for example) the integrity of forecasts.**

GMAO's forays into the global carbon cycle

Atmosphere: Full tracer capability

7km-G5NR: A 7km-resolution global model simulation, including aerosols and carbon dioxide alongide meteorological fields.
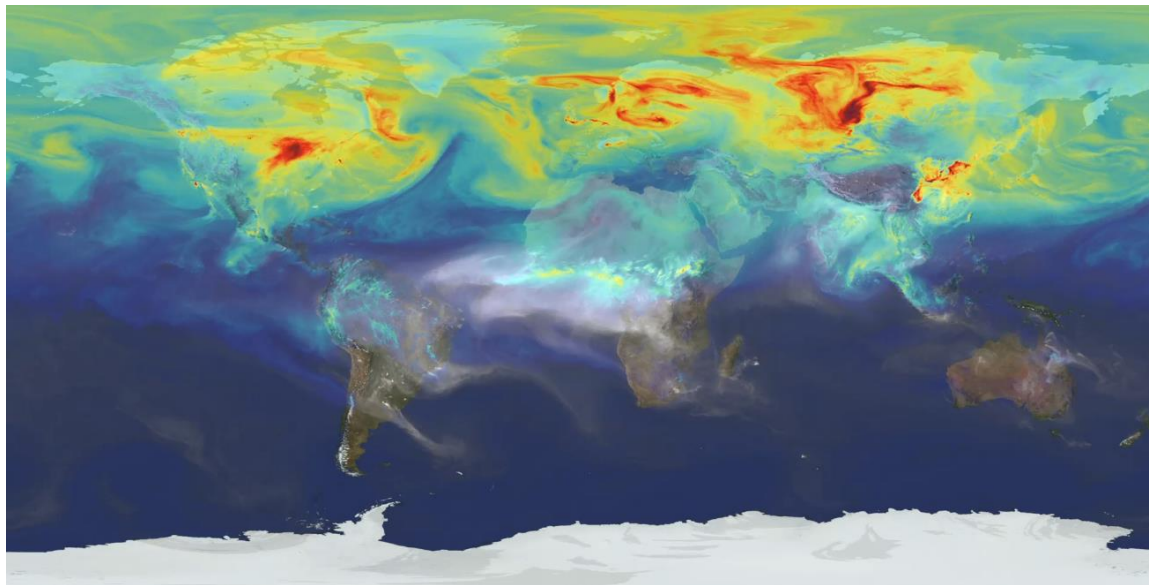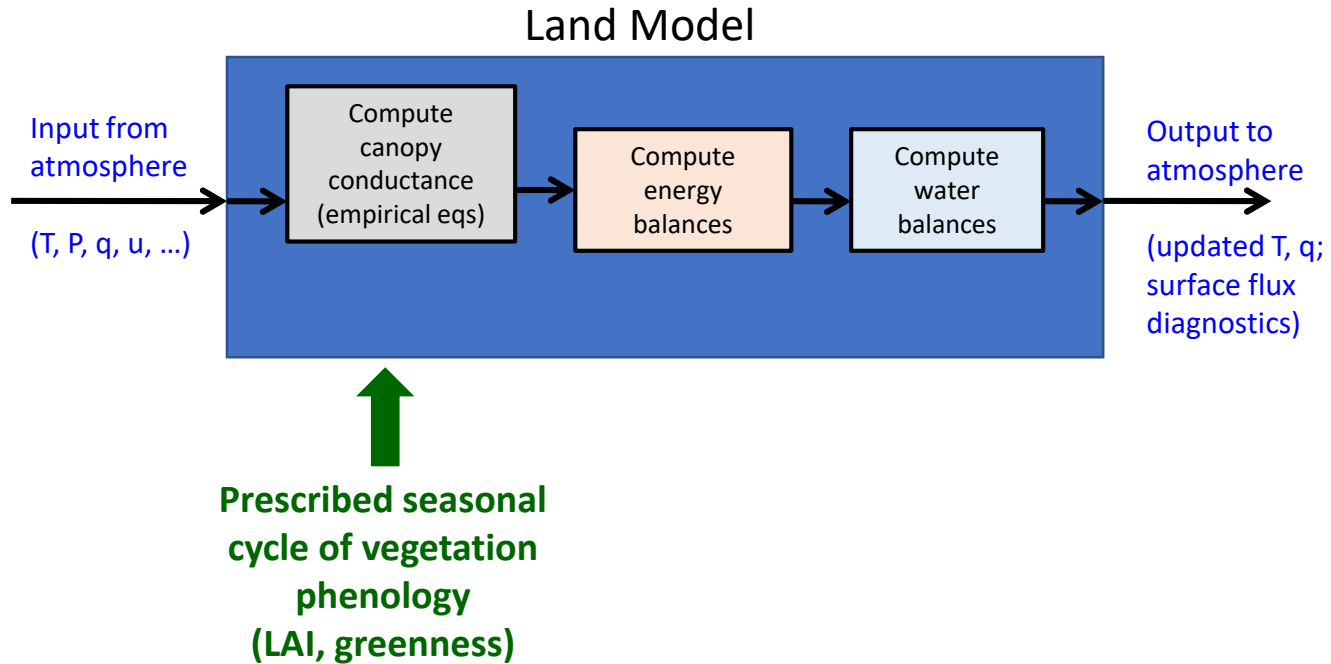
GMAO's forays into the global carbon cycle
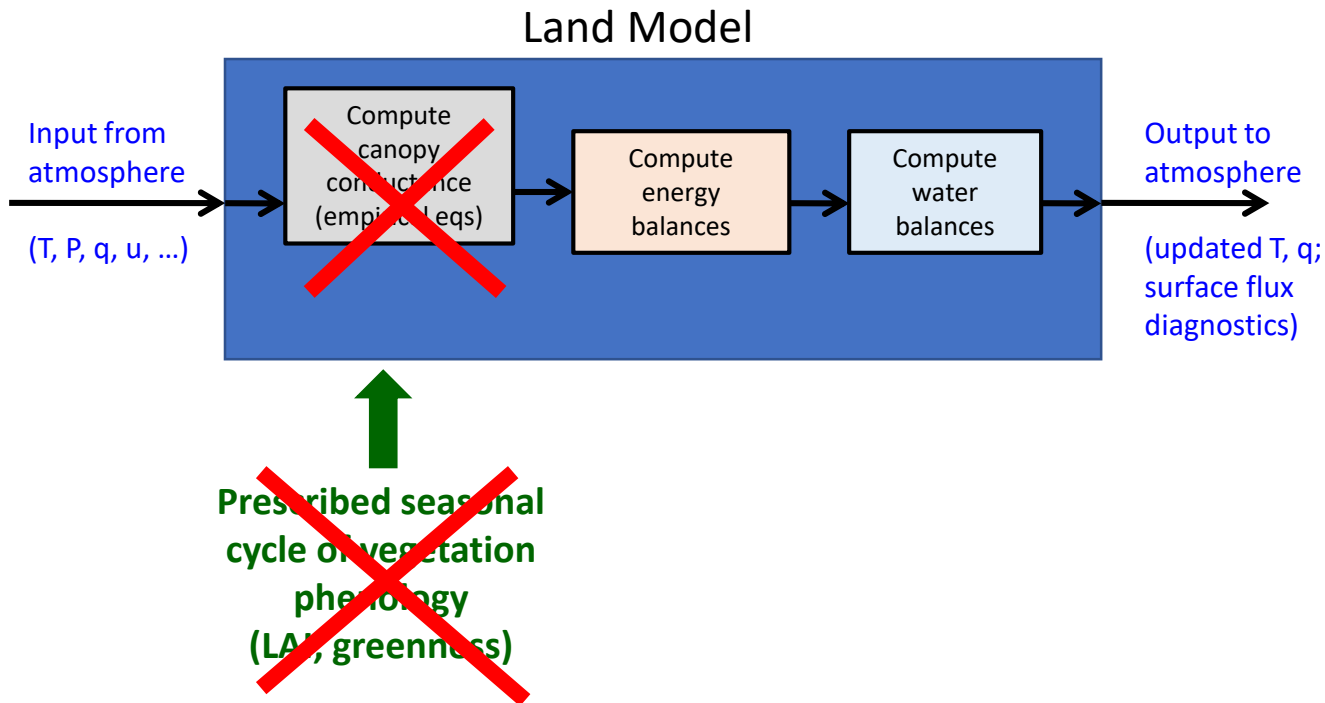
Atmosphere: Full tracer capability

Ocean: NASA Ocean Biogeochemical Model (oceanic carbon, phytoplankton)

Land: Relatively new effort (the last decade or so), using the Catchment-CN model

Set-up of Original GMAO Catchment Model

Now include C/N dynamic phenology model from CLM

Land Model

Input from atmosphere

(T, P, q, u, …)

Compute canopy conductance (empirical eqs)

Compute energy balances

Compute water balances

Output to atmosphere

(updated T, q; surface flux diagnostics)

Prescribed seasonal cycle of vegetation phenology (LAI, greenness)

Now include CLM C/N physics

"Catchment-CN model"

Land Model

LAI, canopy conductance

Compute energy balances

Compute water balances

Output to atmosphere

(updated T, q; surface flux diagnostics , carbon fluxes)

Input from atmosphere

(T, P, q, u, CO_2,...)

Dynamic veg. module: update carbon prognostics, compute conductance with photosynthesis physics (from CLM4,4.5)

Water and energy dynamics of original Catchment LSM

CLM carbon-nitrogen dynamics
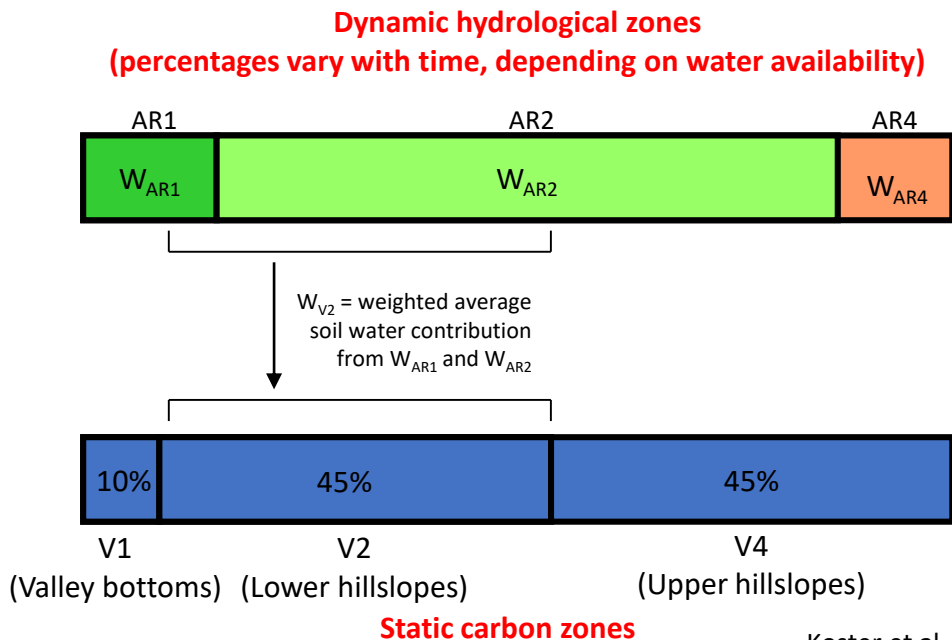
Unique feature of our implementation

Each basic Catchment land surface element is separated into
- Three dynamic hydrological sub-areas that vary with time depending on water availability
- Three non-dynamic sub-areas (10%, 45%, 45%); independent carbon states are saved in each.

Dynamic hydrological zones
(percentages vary with time, depending on water availability)

AR1   AR2   AR4

W_{AR1} W_{AR2} W_{AR4}

W_{V2} = weighted average soil water contribution from W_{AR1} and W_{AR2}

| 10% | 45% | 45% |

V1   V2   V4
(Valley bottoms) (Lower hillslopes) (Upper hillslopes)

Static carbon zones

Koster et al. (2014)

Our treatment of subgrid-scale hydrology can thus capture topographical effects on vegetation distributions.
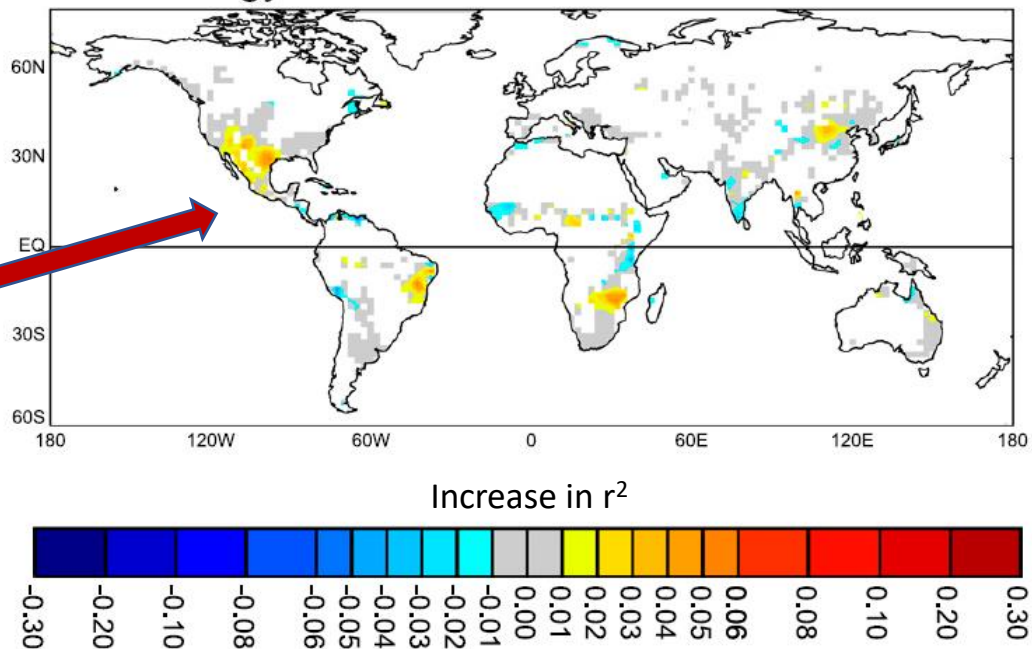
Given the GMAO's emphasis on weather-to-interannual timescales, we have focused on the dynamic phenology aspects of CLM rather than CLM's treatment of vegetation competition and succession.

Sample Science Results


b. Phenology Contribution to Forecast Skill: T-air

By initializing the carbon reservoirs in CatchmentCN more accurately, we increase the skill of forecasted monthly temperature

Increase in r²

DOI: 10.1175/JHM-D-14-0205.1

Sample Science Results

In an ensemble of two-way coupled land-atmosphere simulations, an idealized meteorological drought is imposed here…

… which induces changes in both meteorological conditions and carbon fluxes – both locally and remotely.
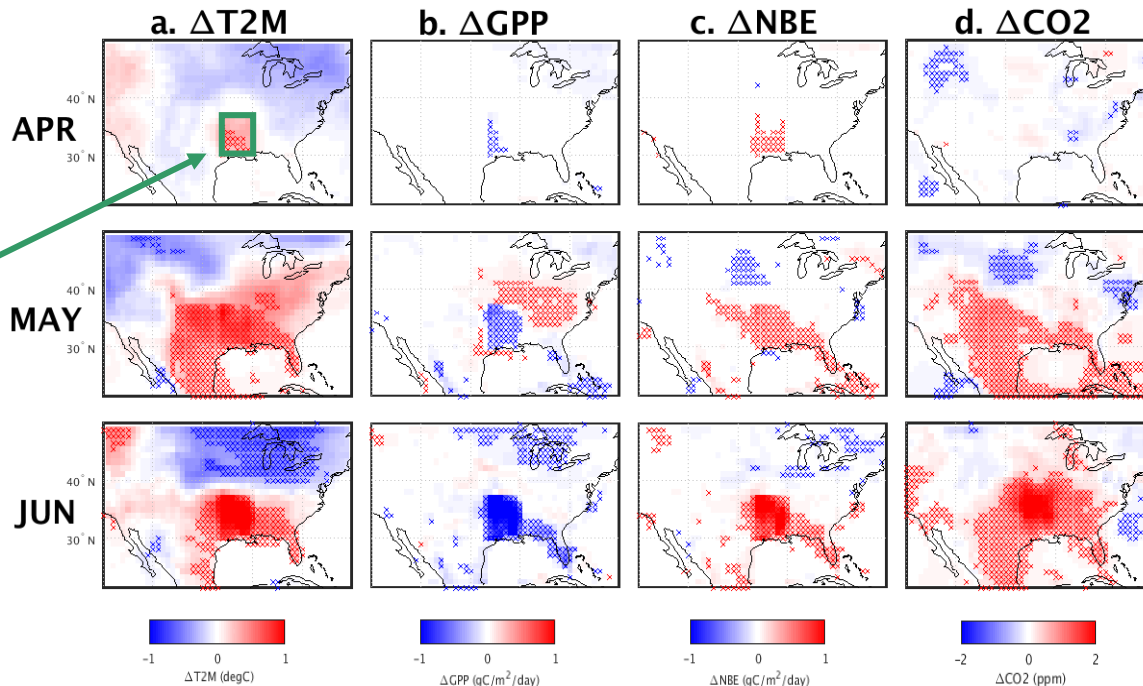
Lee et al, in review

The GMAO is excited about its continued use of CLM physics in its study of the coupled energy, water, and carbon cycles within the atmosphere, ocean and land, bringing to the table a strong connection to the satellite data record.

We're currently in need, however, of a software developer to forward our utilization of CLM physics.

(Cue advertisement)

SSAI SCIENCE SYSTEMS AND APPLICATIONS, INC.
Science and Technology with Passion

| HOME | ABOUT | CUSTOMERS | CAPABILITIES | CAREERS | CONTACT |

SSAI is an Equal Employment Opportunity and Affirmative Action Employer.
EOE/Minorities/Females/Veterans/Disabled

GEOS Land Model Developer

Reference #:	20-2824
Open Date:	2/18/2020
Location:	Greenbelt, MD
US Citizenship Required:	No

Job Description:
SSAI is seeking a Land Modeling Developer to support the Global Modeling and Assimilation Office at the NASA Goddard Space Flight Center in Greenbelt, MD.

This position is designed for an early-career to mid-career scientist/programmer or numerical modeler with commensurate experience using and/or running coupled atmosphere and land models. The selected staff member will contribute to the maintenance and development of the carbon-physics version of the GEOS land model used by the NASA Global Modeling and Assimilation Office (GMAO). This implies the following expected duties:

➤ Become the subject matter expert in the use of the GEOS land model with carbon physics.
➤ Develop and implement, under advisement of civil service staff, improvements in the land modeling system.
➤ Perform numerous simulations with the standalone land model and with the full GEOS Earth system model; process results as required.
➤ Assist in solving daily technical problems and needs (as opposed to strictly scientific problems).
➤ Ensure proper coordination with other model development groups in the GMAO.
➤ Maintain appropriate standards and interfaces to facilitate coupling of Land-Atmosphere-Ocean models in the broader NASA GEOS system.

We currently have a position open!

https://www.ssaihq.com/employment/careers/careers.aspx

We also aim to develop strong, direct ties to the NCAR land modeling group; with luck, there may be $$ for that in the not-too-distant future. Stay tuned!