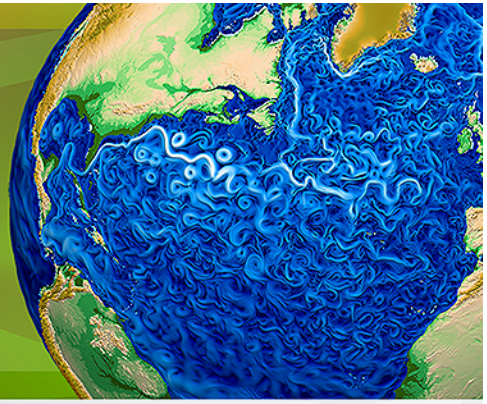
ACME
Accelerated Climate Modeling
for Energy



V1.0 Roadmap Capabilities

William D. Collins
Lawrence Berkeley Laboratory
ACME Chief Scientist

And the ACME Project Team

U.S. DEPARTMENT OF
ENERGY

New Atmospheric Capabilities

New Capability	Epic Lead
✓ Update convective parameterization	Shaocheng Xie
✓ Improve Numerics	Mark Taylor
✓ Addition of elevation class decomposition	Ruby Leung / Steve Ghan
✓ Higher vertical resolution	Po-Lun Ma
✓ New aerosol and cloud updates	Hailong Wang
✓ Polar Project Updates	Peter Caldwell
✓ Surface Model Interactions	Susannah Burrows
✓ Update SCAM for evaluation	Jeffrey Johnson
✓ Implement RRM for model evaluation	Steve Klein
✓ Implement short simulations for evaluation	Yun Qian
✓ Tuning and evaluation	Phil Rasch
Satellite simulator improvements	Yuying Zhang
✓ Maintain chemistry capability	Philip Cameron-Smith

Update convective parameterization

We will evaluate several candidate configurations: (still under discussion/working out details):

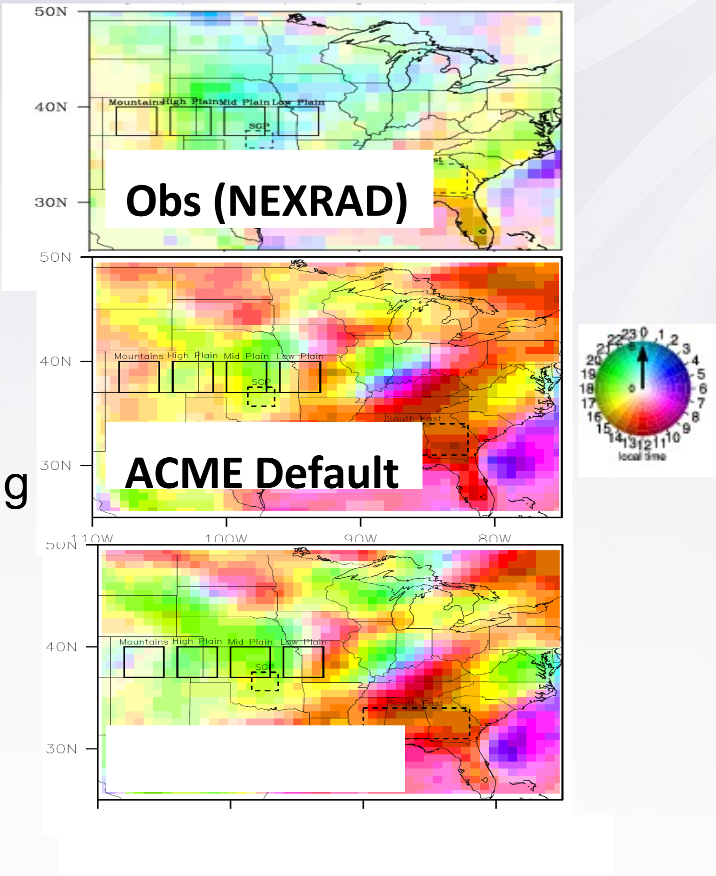
1. CLUBB Shallow + ZM Deep
2. UNICON
3. ZM variants (with/without CLUBB):
   a. Neale's changes (Bechtold et al 2008 convective gustiness)
   b. G. Zhang's innovations (Triggering and closure)

So far, we have developed a convection testbed including

- convection-specific diagnostics
- ability to run in single-column and CAPT mode

One-year 5-Day CAPT hindcasts done for 2008

AMJJ Diurnal Harmonic of Precip

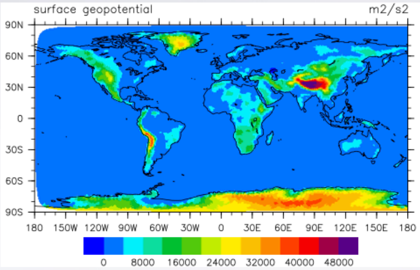


Improved numerics

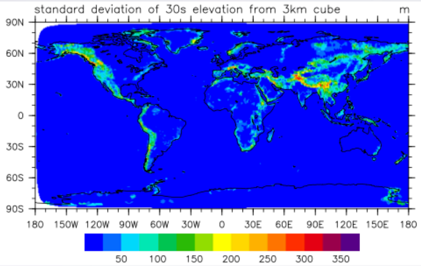
- Improved treatment of pressure gradient term in CAM-SE.
- Will allow for higher resolution topography datasets and reduction in topographically induced noise and associated precip biases.
- **Impact: Increase atmosphere effective resolution**

Default datasets:

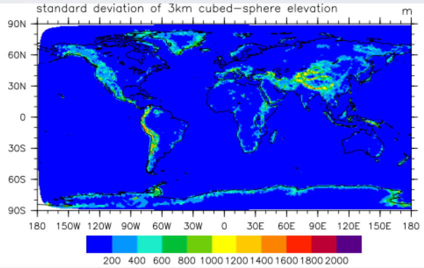
Topography



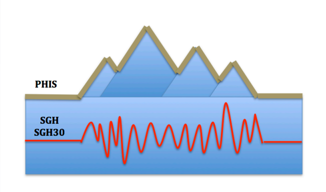
SGH

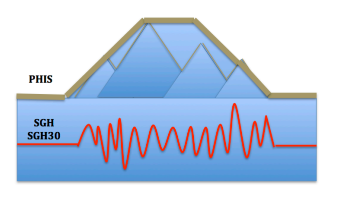


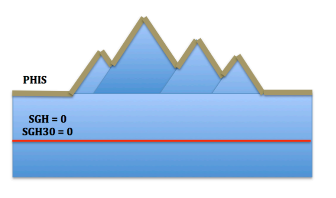
SGH30

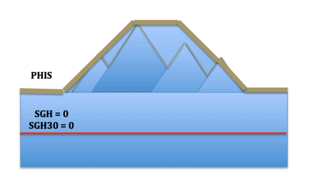


Q4: Idealized simulations varying topography smoothness, SGH, SGH30 for attribution of precip biases between anomalous vertical velocity and surface roughness parameterizations.

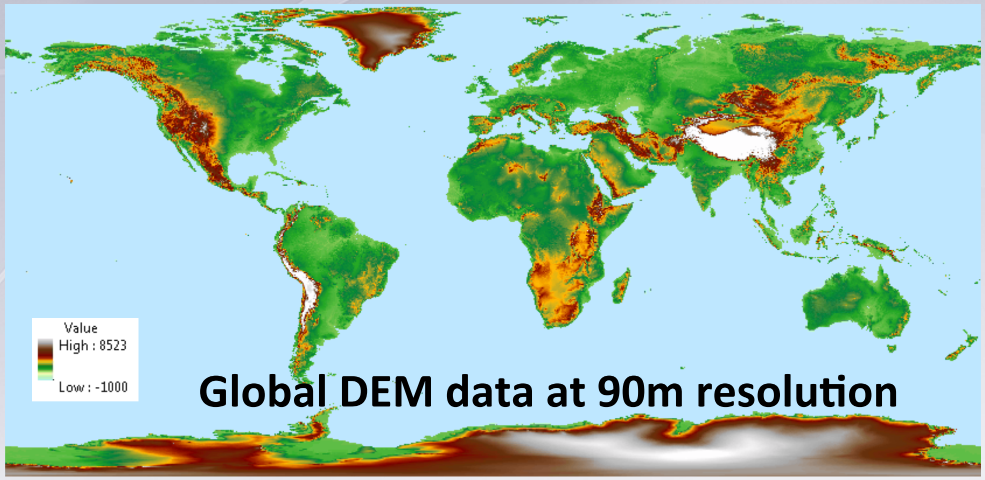






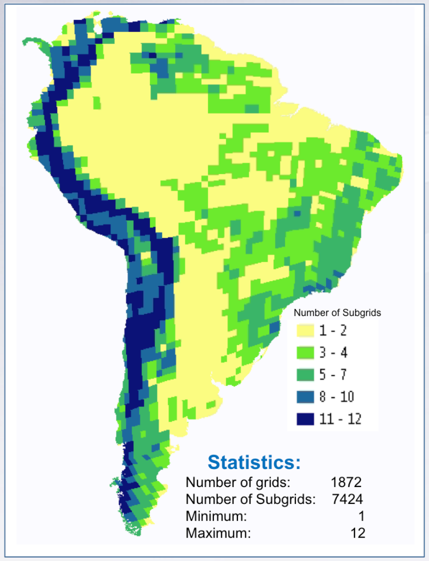


Elevation class decomposition



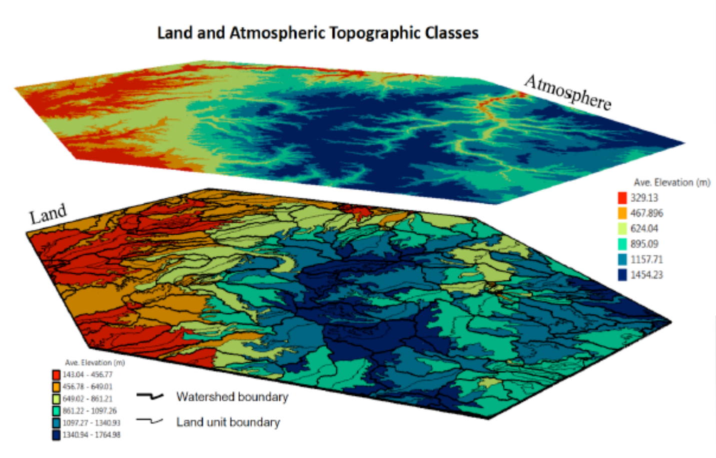
Global DEM data at 90m resolution

- A consistent global high resolution Digital Elevation Model (DEM) has been developed to derive subgrid topographic land units for both atmosphere and land models.
- Using a local elevation classification better captures topographic variations in mountainous regions while reducing the number of subgrid units over flat regions for computational efficiency
- A strategy has been developed for coupling atmosphere and land models that use unstructured grids with subgrid topographic land units, and dynamic ice sheet topography

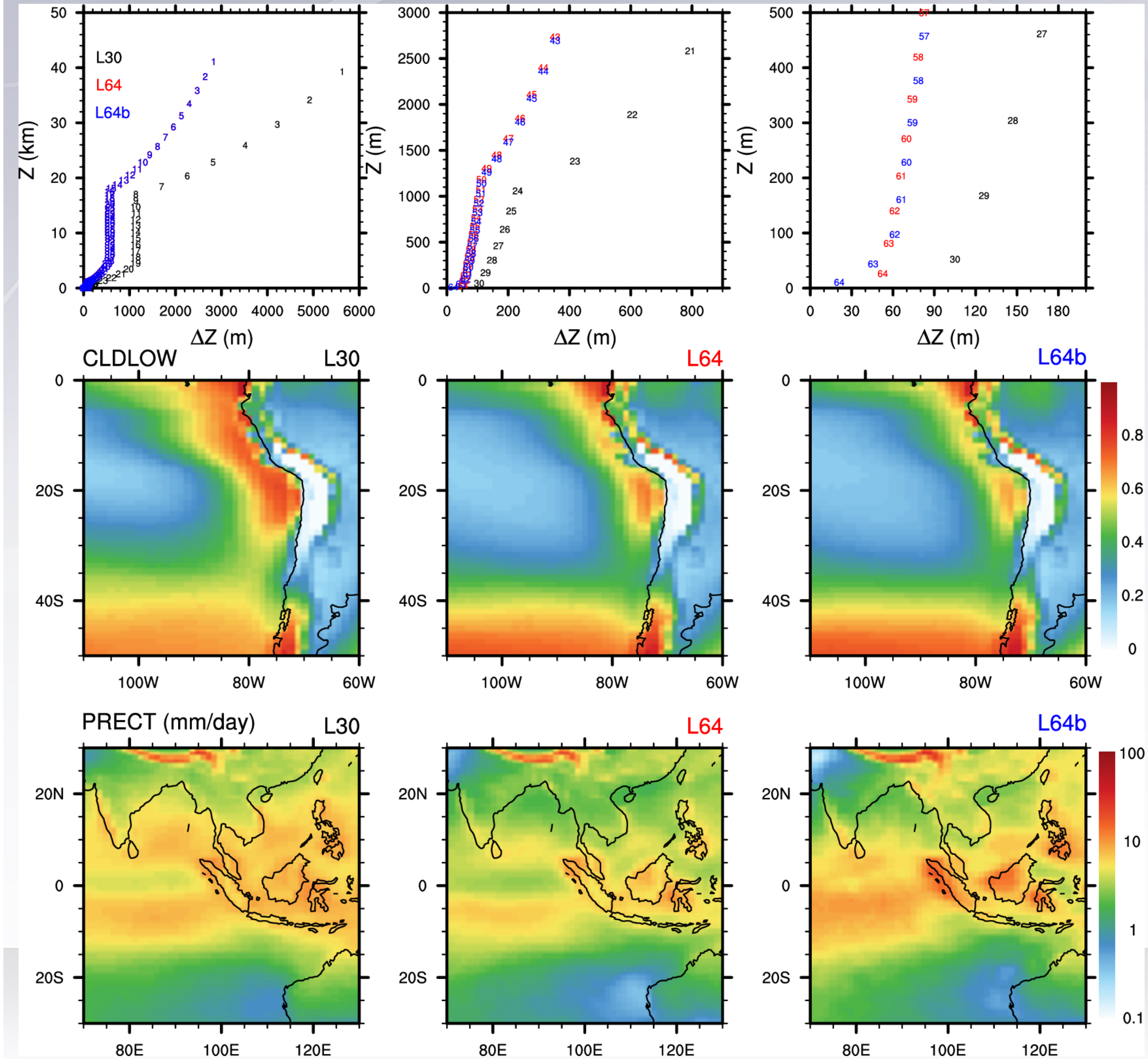


Number of subgrid topo. units per atm. grid

Coupling of atmosphere and land models: vertical interpolation, horizontal remapping, and normalization



Higher vertical resolution



Top row: Configurations for the **standard 30-level and two new 64-level** models, for the atmosphere (left), lower troposphere (middle), and near the surface (right).

Middle row: Reduction of **stratocumulus** clouds with increasing vertical resolution

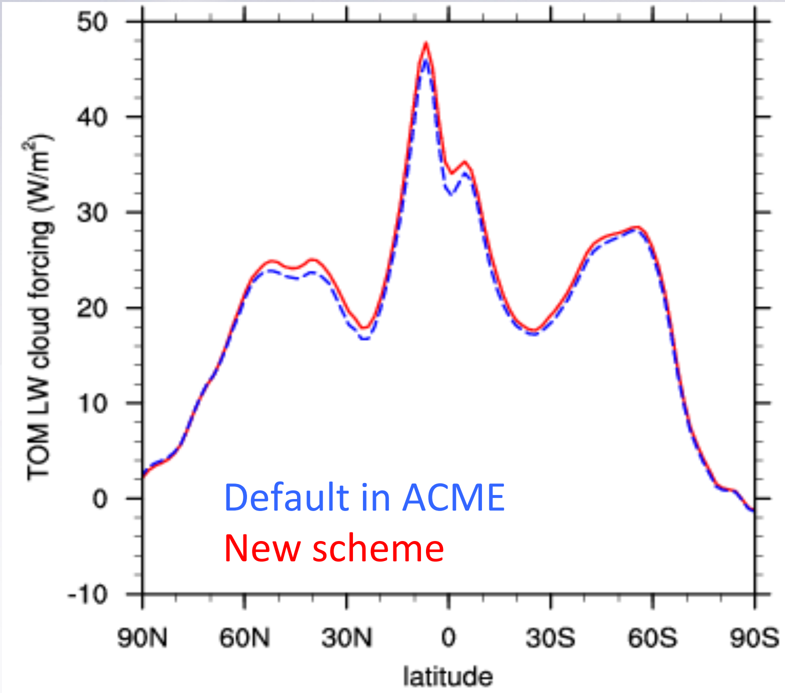
Vertical resolution sensitivity

Bottom row: Vertical resolution sensitivity of **tropical and monsoonal precipitation**

New aerosol and cloud updates

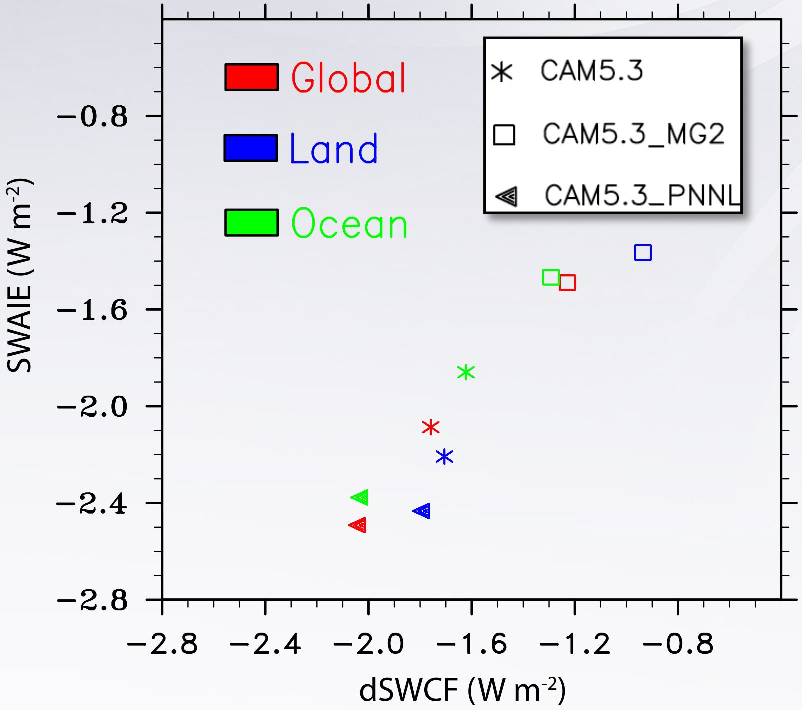
New Aerosol/Cloud task team: H. Wang, S. Burrows, P. Caldwell, R. Easter, S. Ghan,
S. Klein, P.-L. Ma, P. Rasch, B. Singh, M. Wang, K. Zhang

- Using PDF sub-grid updraft distributions and characteristic updraft velocity for ice nucleation



Annual and zonal mean LW cloud forcing has discernable changes (increased by 0.9 Wm^{-2} globally); the default artificial upper bound of sub-grid updraft (0.2 ms^{-1}) is removed in the new scheme. (*Zhang et al., in preparation*)

- Prognostic stratiform precipitation (MG2 cloud microphysics)

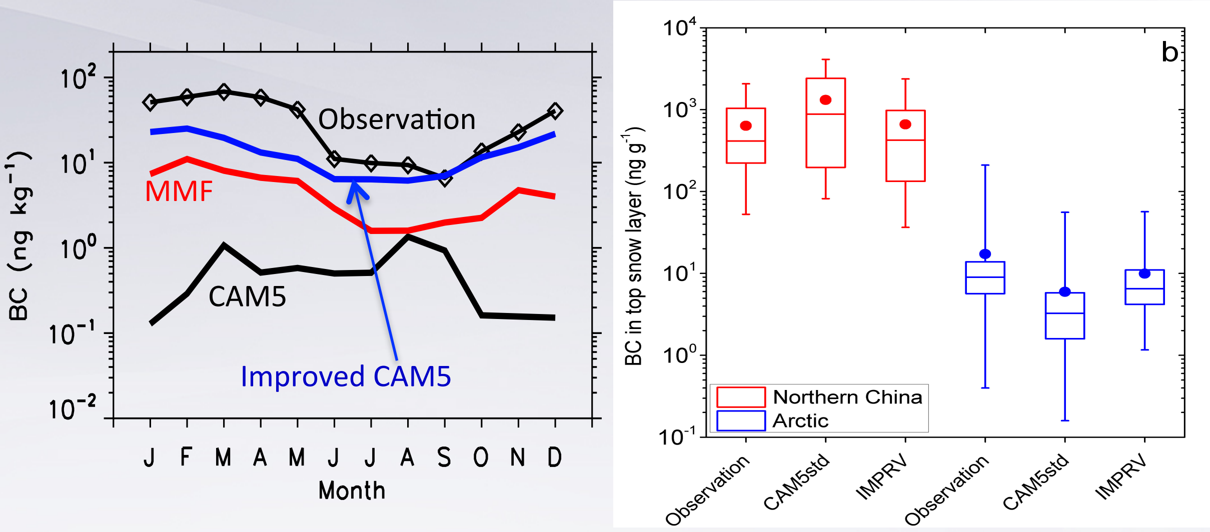


The new scheme (*CAM5.3_MG2*) significantly reduces the SW Aerosol Indirect Forcing (SWAIE) and change in SW cloud forcing; Polar modifications (*CAM5.3_PNNL*) improve aerosol distributions and increase AIE, but the new MG2 scheme will likely bring AIE back to a reasonable range. (*M. Wang et al., in preparation*)

Update with Polar Project capabilities

Polar Aerosol/Cloud mods task team: H. Wang, P. Caldwell, R. Easter, B. Singh

- Modified treatment of aerosol transformation, wet scavenging, convective transport and removal, and evaluated CAM5 using surface and aircraft measurements of aerosol properties and process-oriented MMF model results
- Model improvements made CAM5 a better tool to study the role of aerosols in the climate system (e.g., direct radiative effect, aerosol-cloud interactions, aerosol effect in snow, etc.)



The best combination of improvements gives much better monthly mean near-surface black carbon (BC) in the Arctic (left; Wang et al., 2013) and BC in snow over Northern China and the Arctic (right; Qian et al., 2014).

Sensitivity of remote aerosol distributions to improved representation of cloud–aerosol interactions

- These modifications (under the Polar project) have been ported to the ACME model during Y1Q1

H Wang, Easter RC, Rasch PJ, Wang M, Liu X, Ghan SJ, Qian Y, Yoon J-H, Ma PL, and Vinoj V. 2013. "Sensitivity of remote aerosol distributions to representation of cloud–aerosol interactions in a global climate model." *Geoscientific Model Development* 6, 765-782. DOI:10.5194/gmd-6-765-2013.

Qian Y, H Wang, R Zhang, M Flanner, and PJ Rasch 2014. "A sensitivity study on modeling the black carbon in snow and its radiative forcing over the Arctic and Northern China. *Environmental Research Letters* 9:064001. DOI:10.1088/1748-9326/9/6/064001

Surface model interactions

Susannah Burrows, Phil Rasch, Scott Elliott, Richard Easter, Balwinder Singh

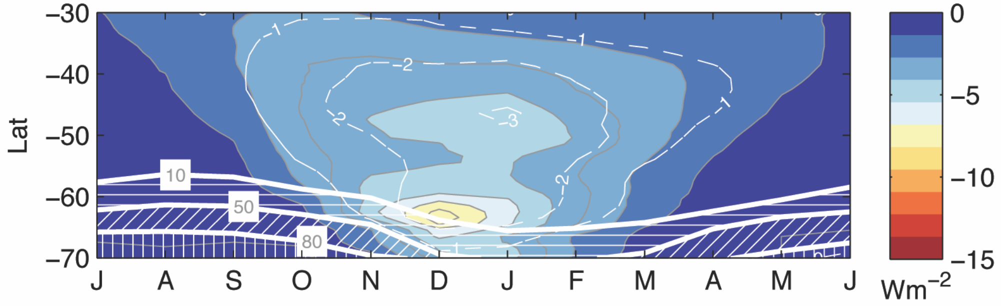
Marine organic matter in sea spray

Adding marine organic matter as a source into ACME

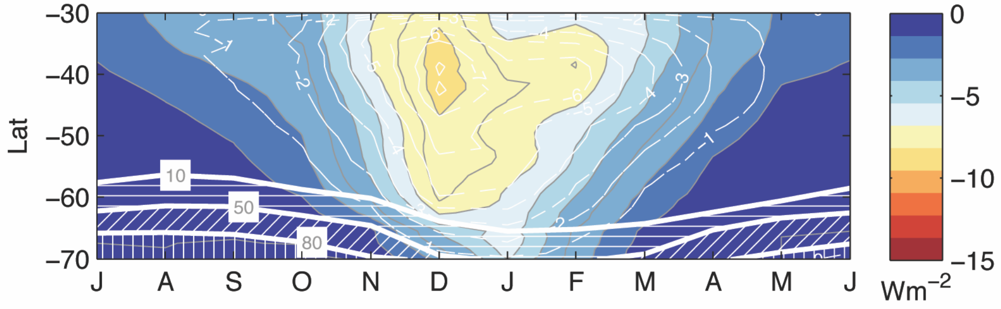
- In Y1, implementation into CESM has been completed, and is being evaluated
- Implementation with offline ocean BGC fields planned for ACME v1

Analysis of satellite-observed CDNC shows that marine organic matter statistically predicts a portion of geographic and seasonal variability over the Southern Ocean, with statistically significant effects on radiation (McCoy, Burrows et al., *under review*).

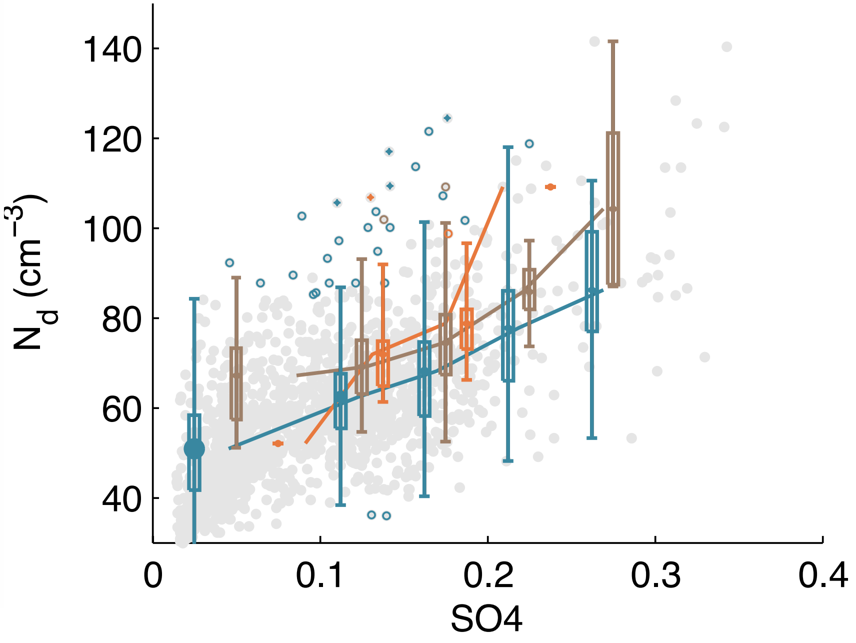
(b) Change in RSW due to OM



(c) Change in RSW due to SO4



(d) SO4–Nd colored by OM concentration



Nd vs. SO4, binned into low-OM, intermediate OM, and high-OM groups

ACME Accelerated Climate Model for Energy

Develop updated SCAM for evaluation

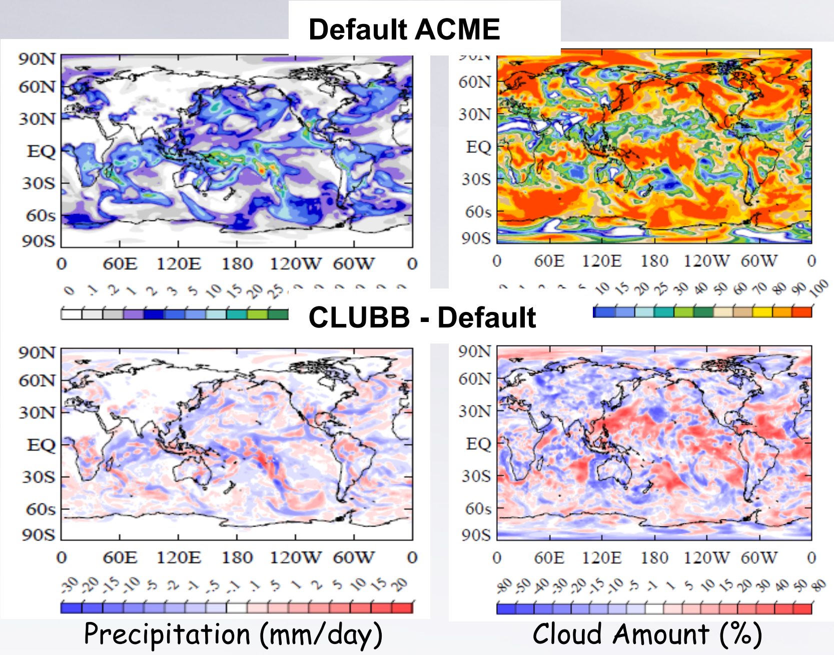
Goals

The first six month goal is to create an infrastructure to facilitate ACME convection tests.

Infrastructure for ACME Convection Tests

- Build-up test beds
    - SCMs – selected field campaign cases
    - CAPT – short range hindcasts
    - Regional refined – combined with CAPT
- Develop metrics/diagnostics
    - Focus on precipitation, clouds, and radiation related processes
    - Evaluated at regional and global scale
    - Emphasize on long-standing model errors
- Collect observations
    - Satellite data
    - Regional observations
    - Field campaigns (ARM)
- Facilitate comparison
    - Scripts to generate automatic metrics/ diagnostics packages
    - Online sharing results

Progress Highlight – ACME CAPT runs



Mean (Default ACME) and difference (CLUBB – Default) of precipitation and total cloud amount for days 2 - 4 forecasts from 0 UTC 02/01/2010 initial conditions produced by CAPT.

Key Accomplishment

- Developed and tested procedures to run ACME SCM
- Added CAPT capacity to ACME model
- Developed whitepaper for metrics/diagnostics
- Created a website to share results
- Performed initial runs for ACME default model

Participants

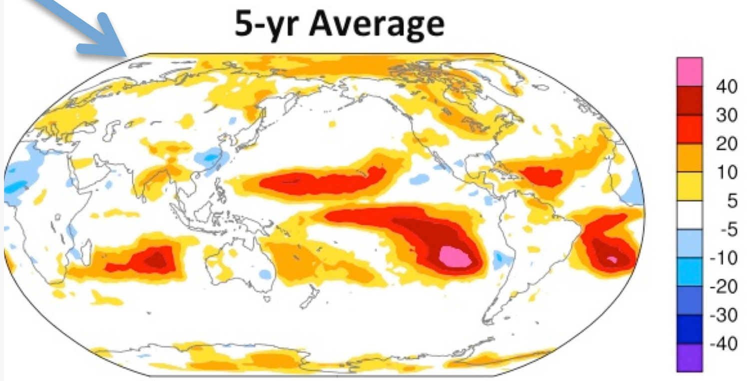
S. Xie, W. Lin, Y. Zhang, J. Bacmeister, M. Wang, H. Wang, K. Zhang, J.-H. Yoon, Q. Tang, R. Neale, S. Mahajan

Implement RRM for model evaluation

- Regional refinement
  - Allows evaluation at high resolution for different regimes.
  - Cost ~10% of uniform global simulation
- Ensembles of short simulations
  - Expose features that develop rapidly (<5days)
  - Cost ~6% of a 5 year global simulation
- Single Column Model
  - we envision a suite of standard test cases
  - Still deciding on best implementation plan

New strategies to ensure code behaves well

- Convergence tests
  - run 1 step with Δt of decreasing size
  - tests appropriateness of mathematical formulation
- Novel unit tests
  - ensure parameterizations are working correctly


5-yr Average

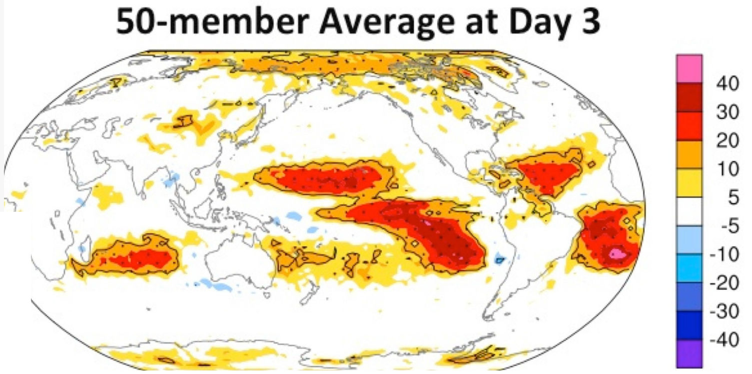

50-member Average at Day 3

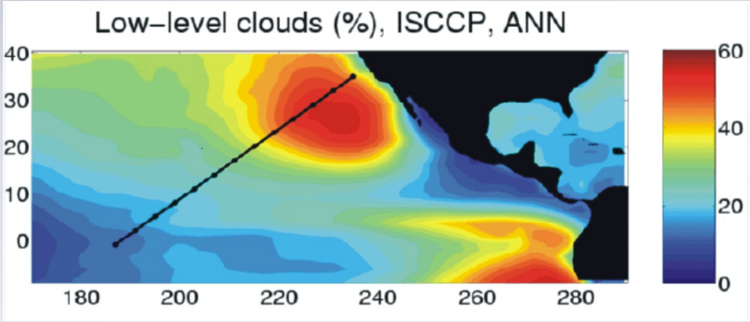
Fig: Cloud cover difference between dt=4 min and dt=30 min runs using traditional and short ensemble strategies (Wan, Rasch, Qian, Ma, Xie, Lin, 2014)

Short simulations for evaluation

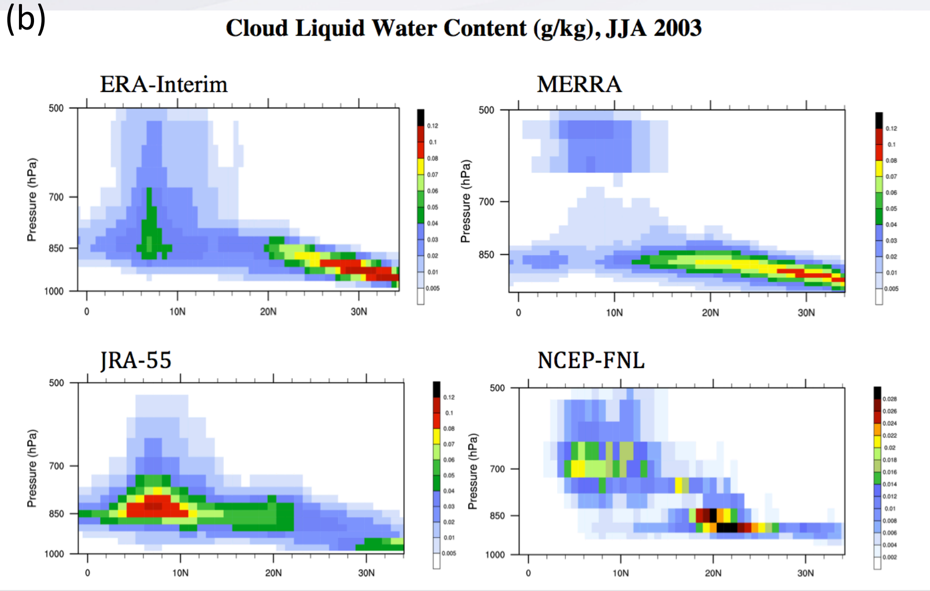
Exploring the Strategy for Parametric Sensitivity Analysis and Auto-tuning Based on CAPT-type Short Simulations Along the GPCI Cross-section

Atmosphere Team, Short Simulations Task (Lead: Yun Qian, PNNL)

(a)



(b)



The cloud regime transition from stratocumulus to shallow and deep convection along the GPCI cross-section (black line in panel (a)) is a big challenge for current global climate and weather forecast models to represent correctly. Even the reanalysis products show large discrepancies among each other (panel (b)) .

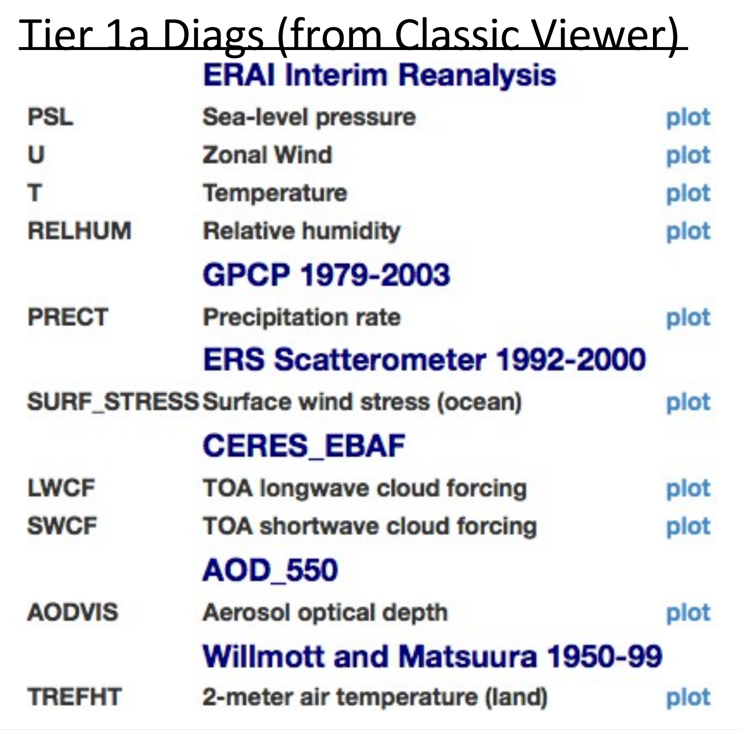
In Y1Q1 we made the decision to take the GPCI cross-section as the focus region of our exploration on parametric sensitivity study and auto-tuning using CAPT.

We've also evaluated against satellite data the cloud properties in 4 different reanalysis datasets (panel (b)), and identified ERA-Interim as the most reliable reference for our tuning and analysis.

Tuning and evaluation

Diagnostics organized into overlapping groups centered around science questions:

- *Tier 1a = ‘top 10’ that we always try to optimize*
- *Tier 1b = collections of fields relevant to ACME regions or phenomena:*
  - *{Amazon, US, Asia} Hydrologic Cycle*
  - *S. Ocean/Antarctic meteorology,*
  - *Tropical/Extratropical modes of variability with strong influence on water cycle,*
  - *Global clouds and the water cycle*
- Tier 2 = other diagnostics
  (e.g. everything in AMWG diagnostics)



Tier 1a Diags (from Classic Viewer)

	ERAI Interim Reanalysis	
PSL	Sea-level pressure	plot
U	Zonal Wind	plot
T	Temperature	plot
RELHUM	Relative humidity	plot
	GPCP 1979-2003	
PRECT	Precipitation rate	plot
	ERS Scatterometer 1992-2000	
SURF_STRESS	Surface wind stress (ocean)	plot
	CERES_EBAF	
LWCF	TOA longwave cloud forcing	plot
SWCF	TOA shortwave cloud forcing	plot
	AOD_550	
AODVIS	Aerosol optical depth	plot
	Willmott and Matsuura 1950-99	
TREFHT	2-meter air temperature (land)	plot

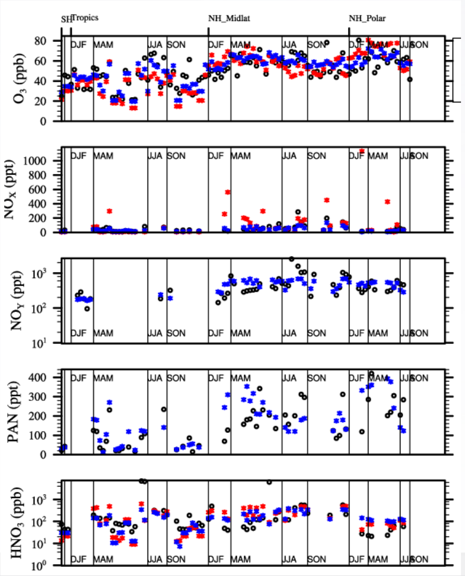
- ACME is developing diagnostics in the UV-CDAT framework

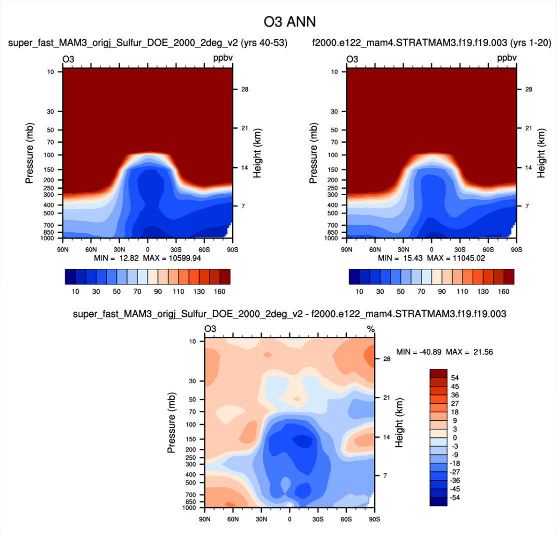
Atmospheric Chemistry (progress)

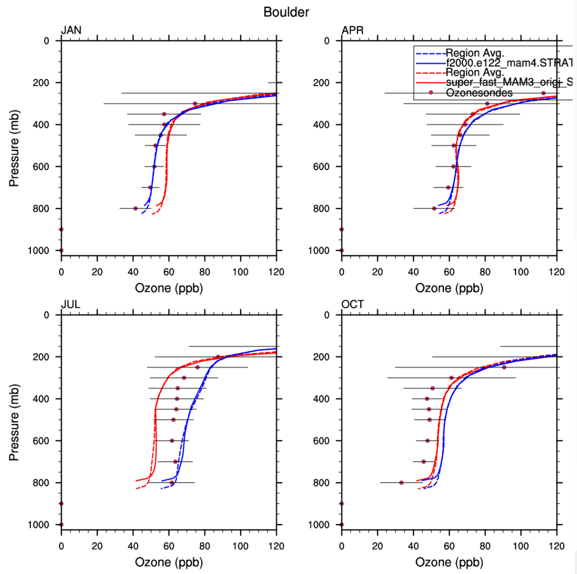
Philip Cameron-Smith (LLNL)

Atmospheric Chemistry Progress

- Atmospheric chemistry working in ACME (v0.1).
- Installed & debugged latest AMWG diagnostics, which now include chemistry diagnostics (OLCF).
- Developed strategic plan for atmospheric chemistry in ACME.







For additional information, contact:
Philip Cameron-Smith
Task Leader: Atmospheric Chemistry

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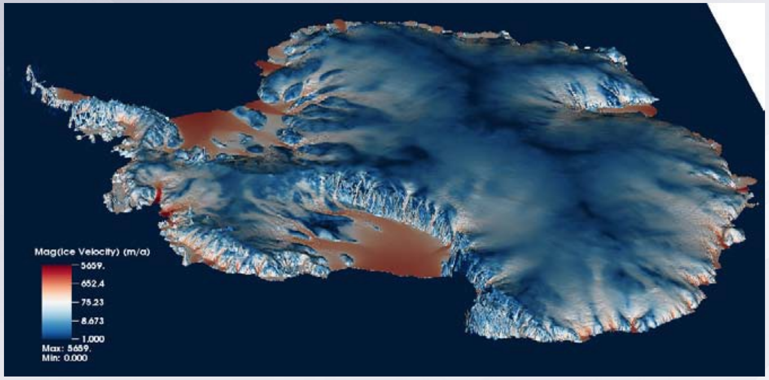
(925) 423-6634
pjc@llnl.gov

New Land Ice Capabilities

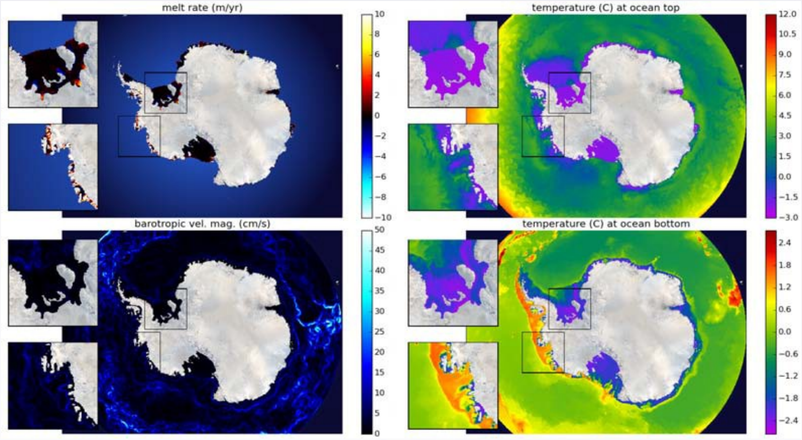
New Capability	Epic Lead
✓ Stand-alone Antarctica simulations with MPAS	Steve Price
✓ Stand-alone Antarctica mass-balance simulations	Steve Price
✓ Ocean/sea-ice runs with data atmos./ice sheet	Steve Price
Coupled ocean/sea-ice/land-ice runs w/data atm.	Steve Price
Fully coupled simulations	Steve Price
Gravitationally self-consistent SLR model	Steve Price

Stand-alone Antarctica MPAS tests

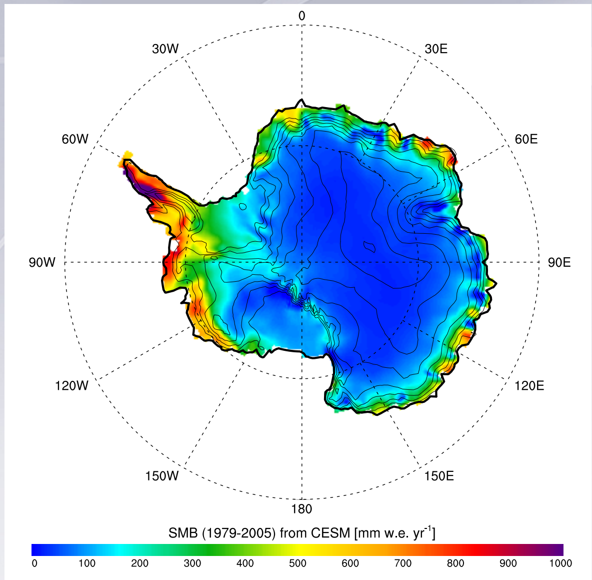
- Complete MPAS-LI
  - Heat balance (Q3)
  - Optimal ICs from PISCEES (Q5)
  - Calving (Q4,Q5)
  - Test full standalone model (Q5-Q6)
  - Higher-order thick solver (Q5-Q6)
- Antarctic SMB
  - Downscaling (Q3-Q4)
  - Multiple ice sheets (Q3-Q4)
- Ocean/ice coupling
  - Finish BL work (Q3-Q4)
  - Coupler interfaces
  - Redo static, dynamic tests with MPAS-O



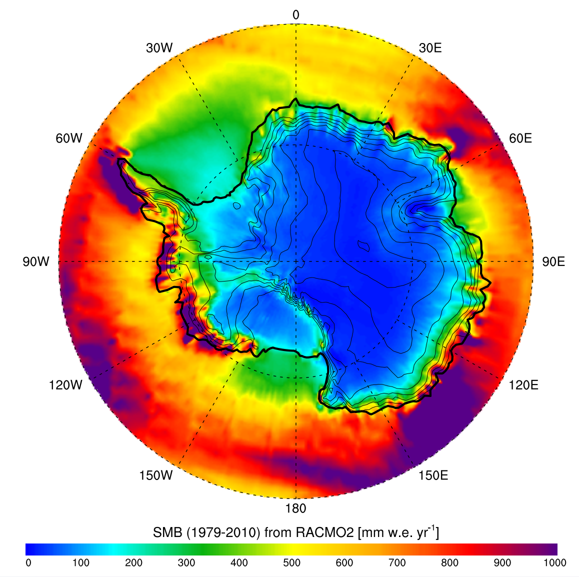
From PISCEES, D. Martin,LBL



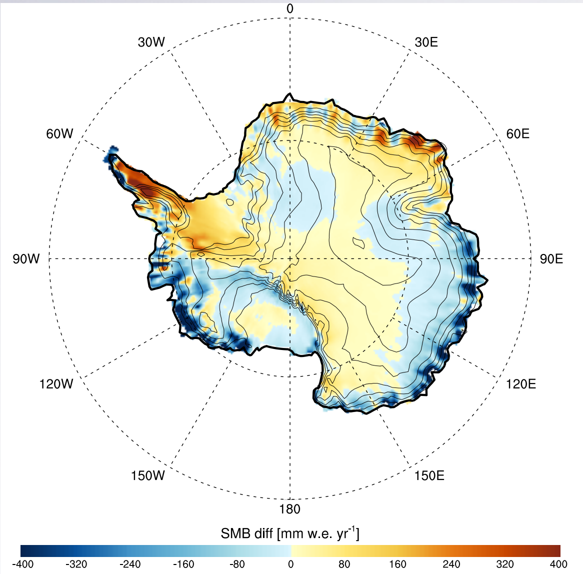
Stand-alone Antarctica mass-balance



CESM SMB



RACMO2 SMB



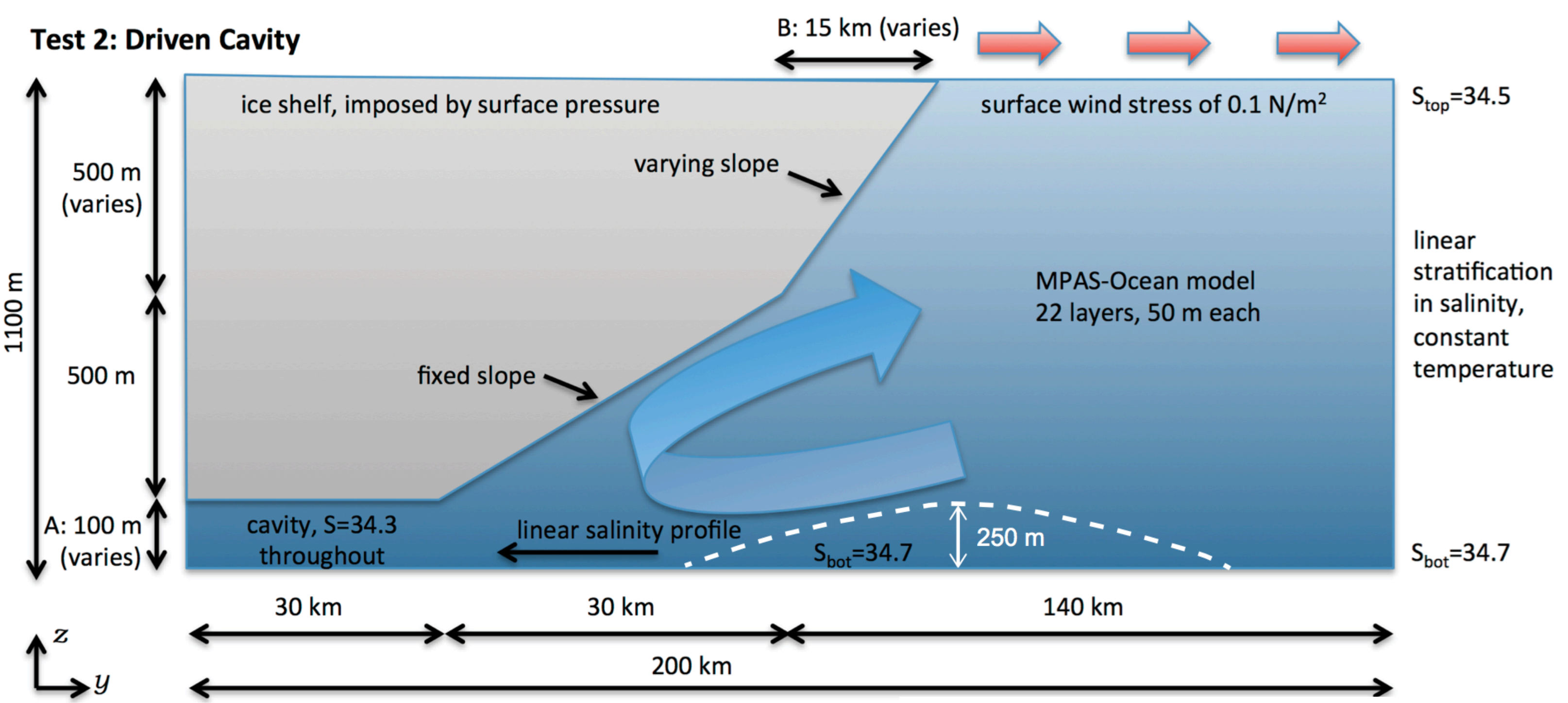
CESM - RACMO2

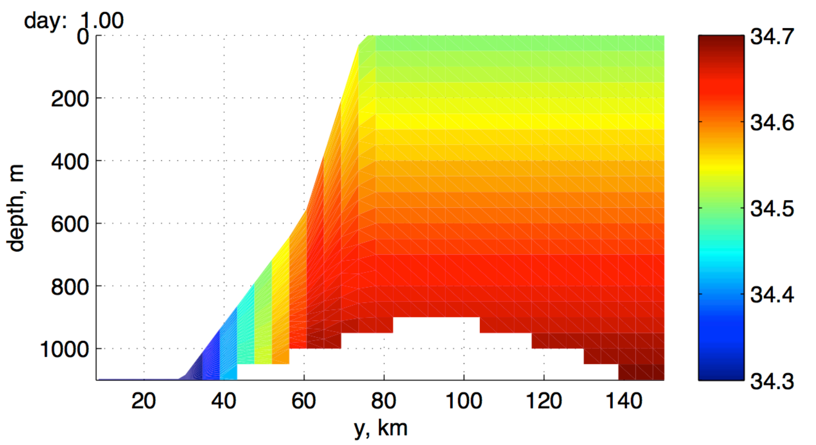
Component	units	CESM	RACMO2
		This study	Lenaerts et al., 2012
AIS area	10^6 km^2	14.25	13.93
SMB	Gt yr^{-1}	2549 (130)	2418 (116)

Figures & table courtesy of J. Lenearts (Utrecht Univ.)

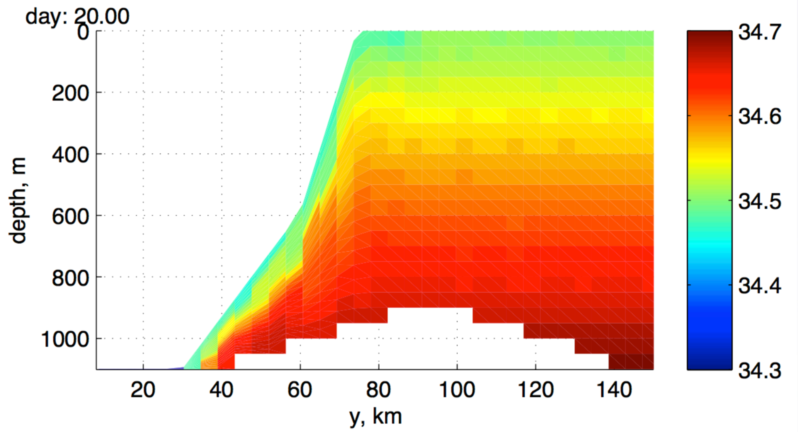
Ocean/sea-ice with data atm./land ice

Test 2: Driven Cavity





Initial sub-shelf salinity for the idealized test case with a 1 m high subglacial cavity (at y=0-30 km). Other parameters for the problem are detailed in the figure above.

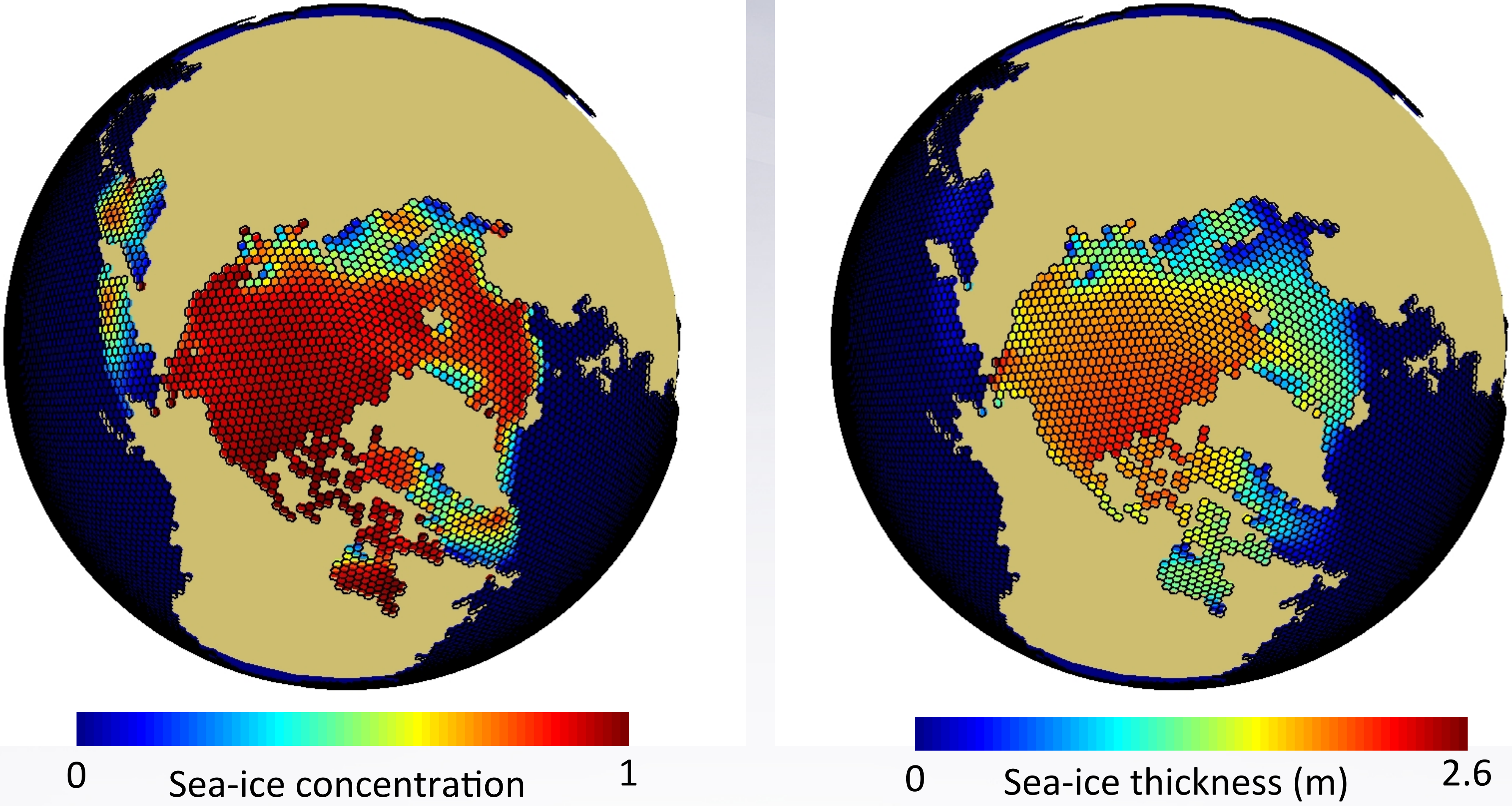


After 20 days of foward model integration, a plot of the sub-shelf salinity indicates turbulent mixing relative to the initial condition and the development of a stable, relatively fresh-water plume circulation beneath the shelf.

New Sea Ice Capabilities

New Capability	Epic Lead
✓ MPAS-CICE model	Adrian Turner
✓ Improved snow model	Elizabeth Hunke
✓ Biogeochemistry	Elizabeth Hunke

MPAS-CICE Model



Simulated output of the MPAS-CICE model on a 120km SCVT grid. (*left*) Arctic sea-ice concentration. (*right*) Arctic sea-ice thickness (m). Simulation was performed with the full velocity solver using the weak spatial operators, upwind advection, zero-layer thermodynamics and modified CORE 2 atmospheric forcing.

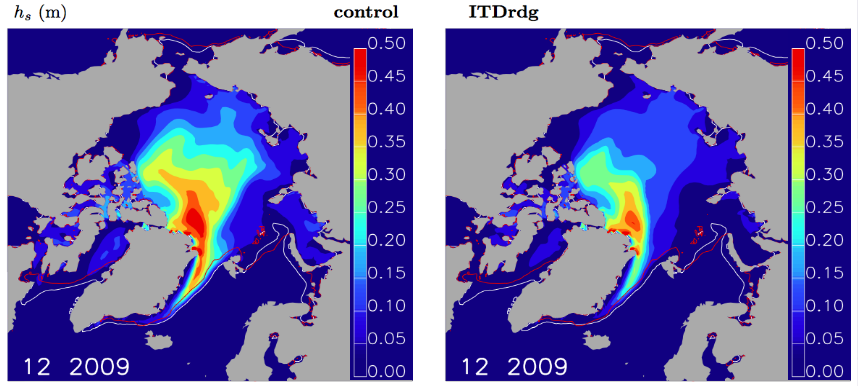
Improved snow model

Objective

To better represent snow physical processes in sea ice models, for improved estimates of pack ice evolution and predictability at seasonal and climate scales.

Approach

- Parameterize redistribution and compaction of snow by wind, utilizing modeled sea ice topography. This affects the snow pack via snow loss through leads and varying snow depths over sea ice.
- Parameterize snow grain metamorphism by both wet and dry processes. Snow grain radius is then used to compute albedo and radiative transfer through the snow to the sea ice and ocean.
- Column-based physics allows implementation in both CICE and MPAS-CICE, with multiple vertical snow layers.



Snow depth over sea ice in the Arctic Ocean for CICE simulations: (left) control, (right) including wind compaction and redistribution, accounting for the deformed sea ice thickness distribution.

Impact

With more snow blown into leads, sea ice thins regionally and fresh water flux to the ocean increases. Conversely, altered albedo characteristics due to snow grain metamorphism leads to thicker sea ice. In both cases, snow density variations can affect many sea ice model features and offer a rich avenue for future study.

Elizabeth Hunke and Nicole Jeffery, Los Alamos National Laboratory

Work in Progress

Sea-ice biogeochemistry

Simulations of Ice Algae in the Weddell Sea from a simple Nitrate-Algal model in CICE

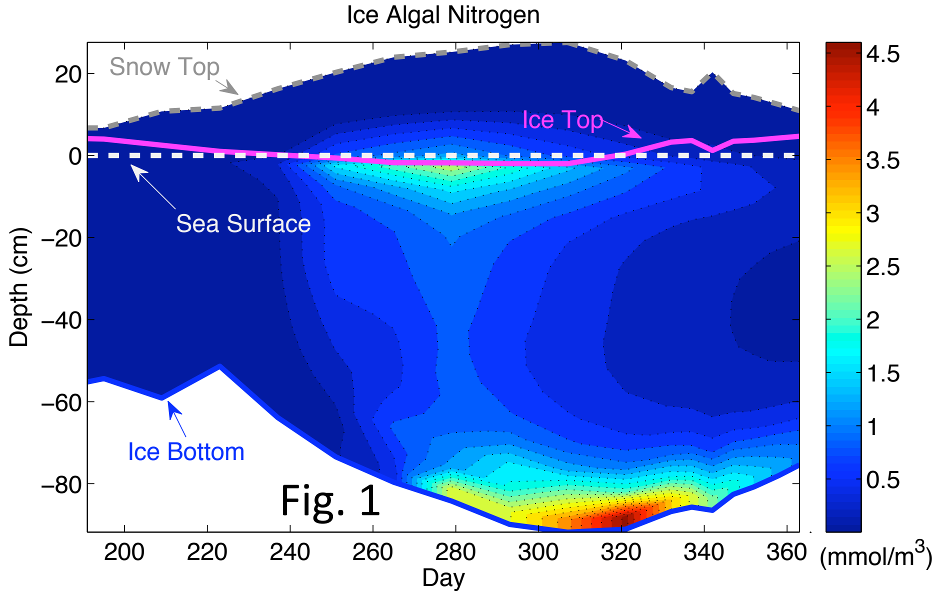


Fig. 1

1. **(Fig. 1)** Algae first accumulate in the upper ice depleting the snow-brine intrusion of nitrate. Bottom accumulation follows with increasing irradiance.

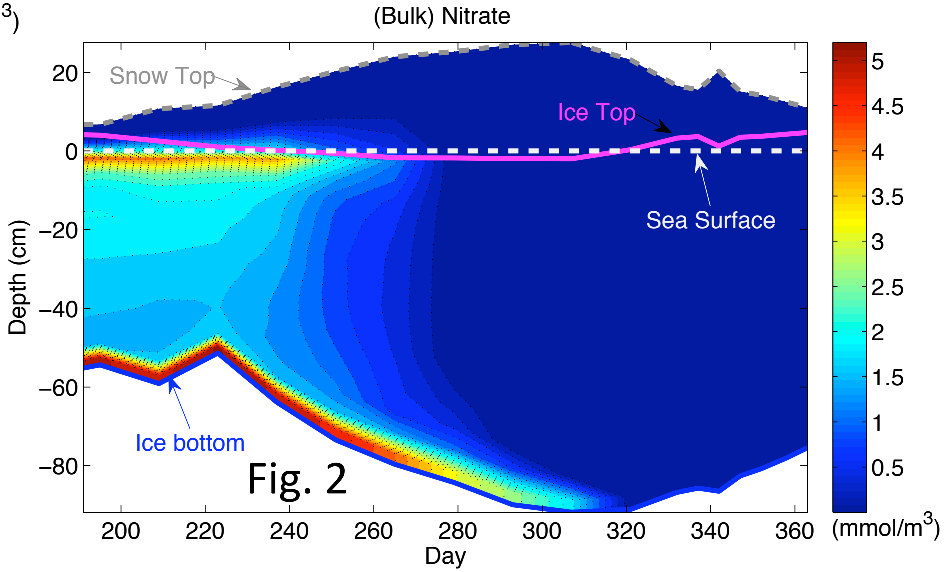


Fig. 2

2. **(Fig. 2)** Nitrate in young ice mirrors salinity until irradiance levels support algal growth.

3. Currently, a higher complexity ice algal model (multilple algal and Doc groups) have been recently developed and are in testing in CICE.

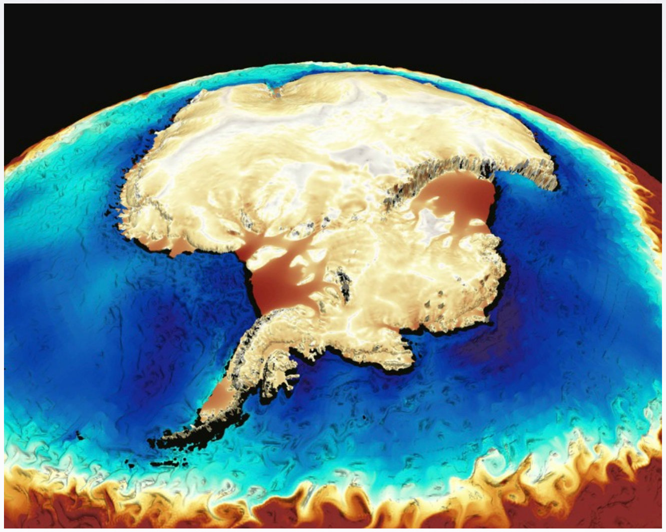
ACME Accelerated Climate Model for Energy

New Ocean Capabilities

New Capability	Epic Lead
✓ Stand-alone ocean validation	Todd Ringler
✓ Ocean analysis core	Todd Ringler
✓ Biogeochemistry	Todd Ringler
✓ Hybrid vertical coordinate	Todd Ringler

Stand alone ocean validation

- MPAS v3 released
  - Includes CVMix, Eddy mixing (GM)
- Focus on Validation (CORE)
  - Grid generation (RR, SO, SOE)
  - Initial state
  - Coupled interface
- Ocean analysis
  - Design/analysis document (CMIP6)
  - Begun working w/ workflow
- Vert coordinate (hybrid)
  - Finished first vert coord publication
    - Z variants, but w/ ALE infrastructure
  - Staged approach for new grids
- BGC
  - Design, spinup (related SciDAC)
  - Refactoring in v0



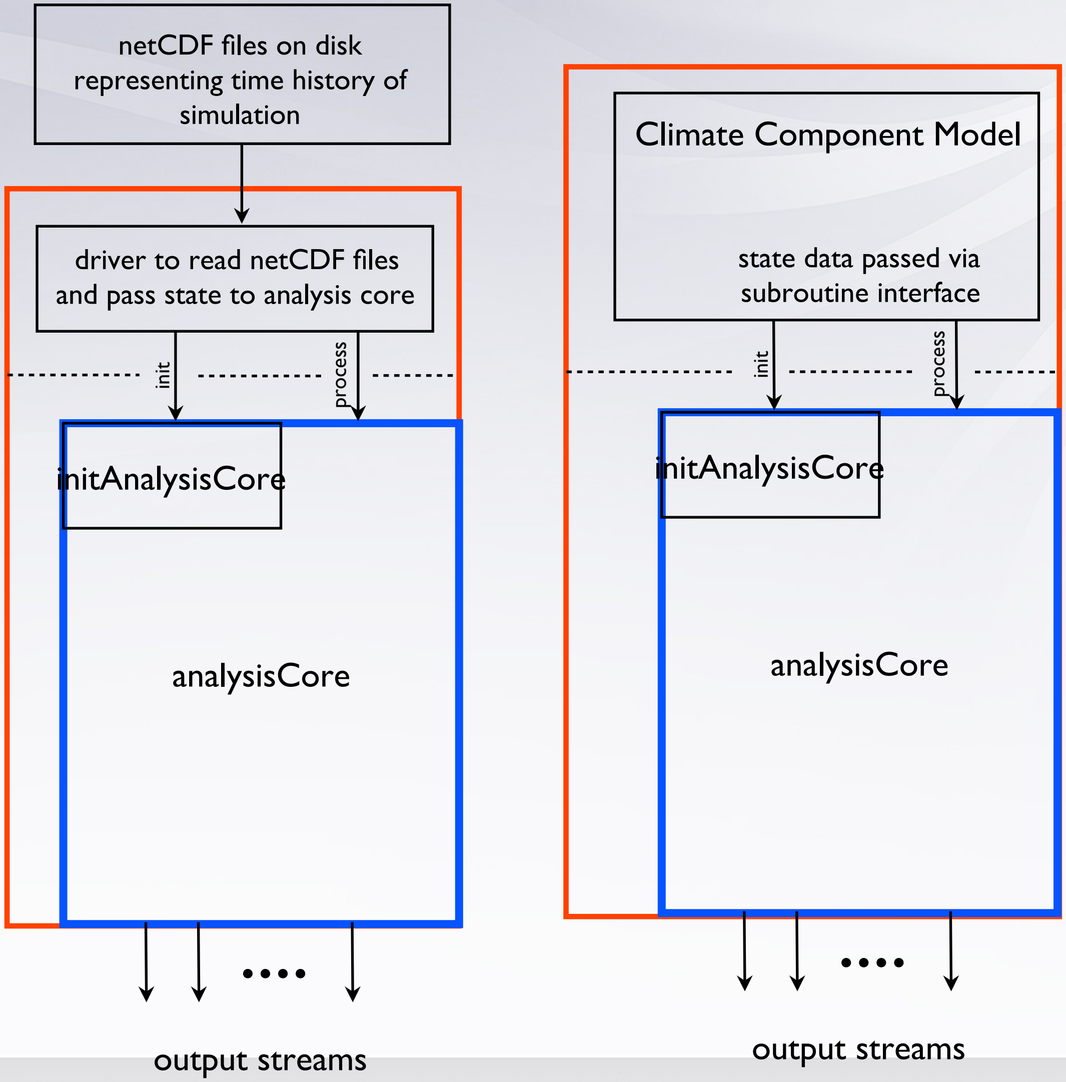
Southern Ocean SST from MPAS simula6on

Ocean analysis core

We are designing a ocean analysis work flow with MPAS-Ocean whereby the exact same analysis procedures can be instantiated in post processing (left) or in-situ mode (right).

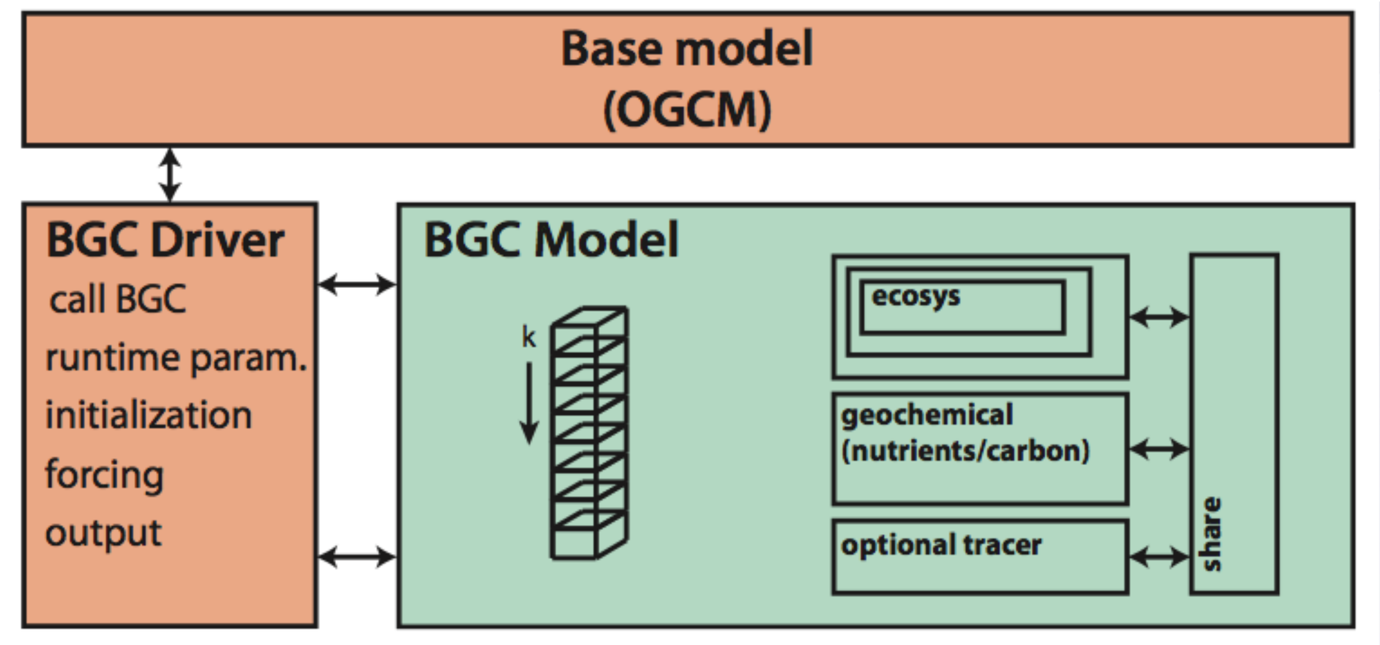
We have successfully tested the analysisCore (blue box) in both of these modes.

The conceptual framework is extensible to "third-party plug ins" such as Paraview Catalyst, UV-CDAT, etc.



Ocean biogeochemistry

Vision for a community BGC model as presented by Matt Long, NCAR

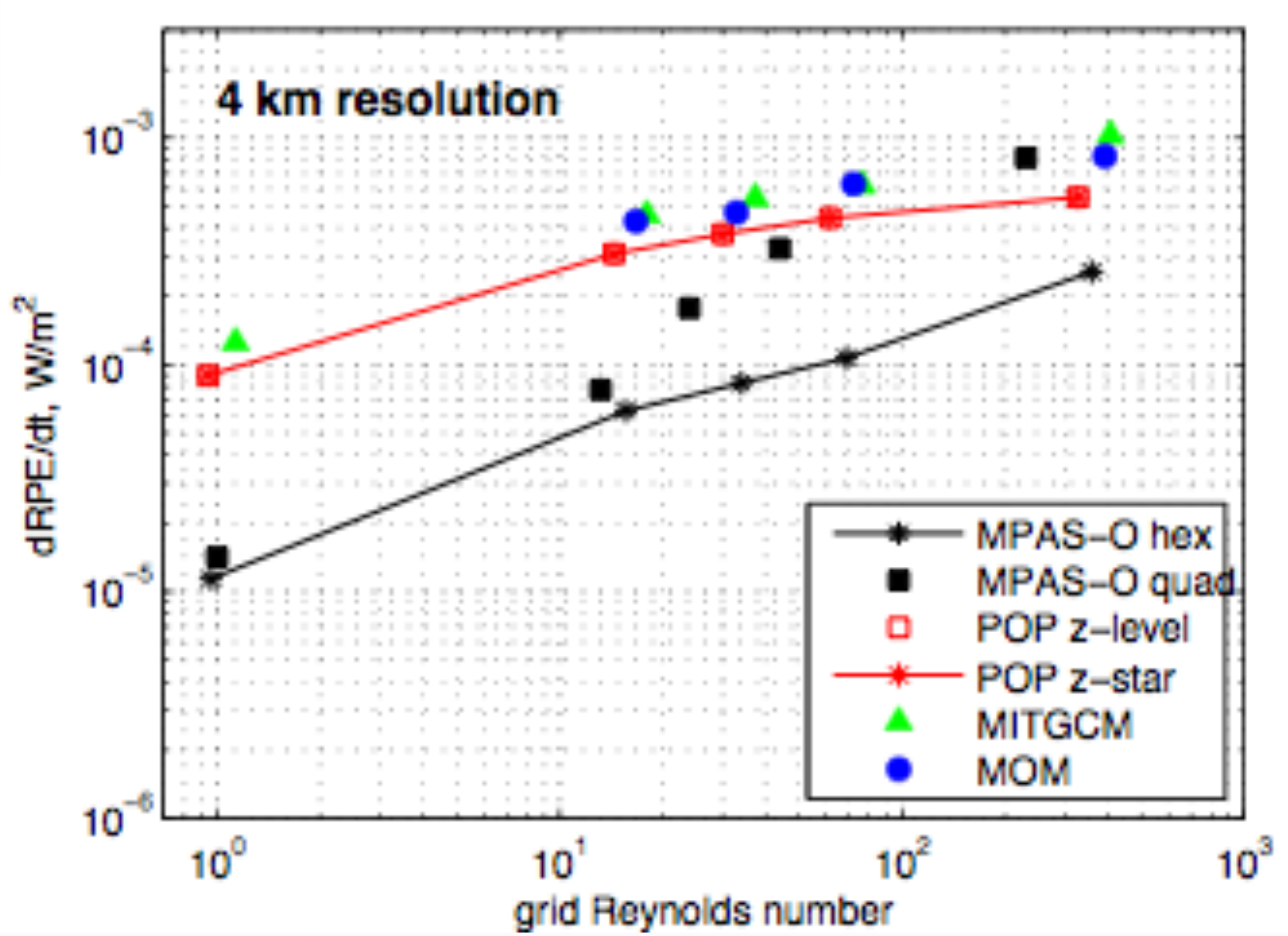


Our long term plan is to use a community developed BGC model that is independent of the “host” ocean model (effort funded by SciDAC). As a bridge to this solution, we are re-implementing the POP BGC model such that it can be used within MPAS-Ocean.

Design document is complete. Recoding will begin in Y1Q2.

Hybrid vertical coordinate

Figure shows spurious vertical diffusion as a function of grid Reynolds number. (smaller is better!)



We have completed a quantitative evaluation of spurious vertical mixing within MPAS-Ocean. Based on eddy-resolving test cases, it appears that MPAS-Ocean is a factor of 3 to 10 less diffusive than other ocean models.

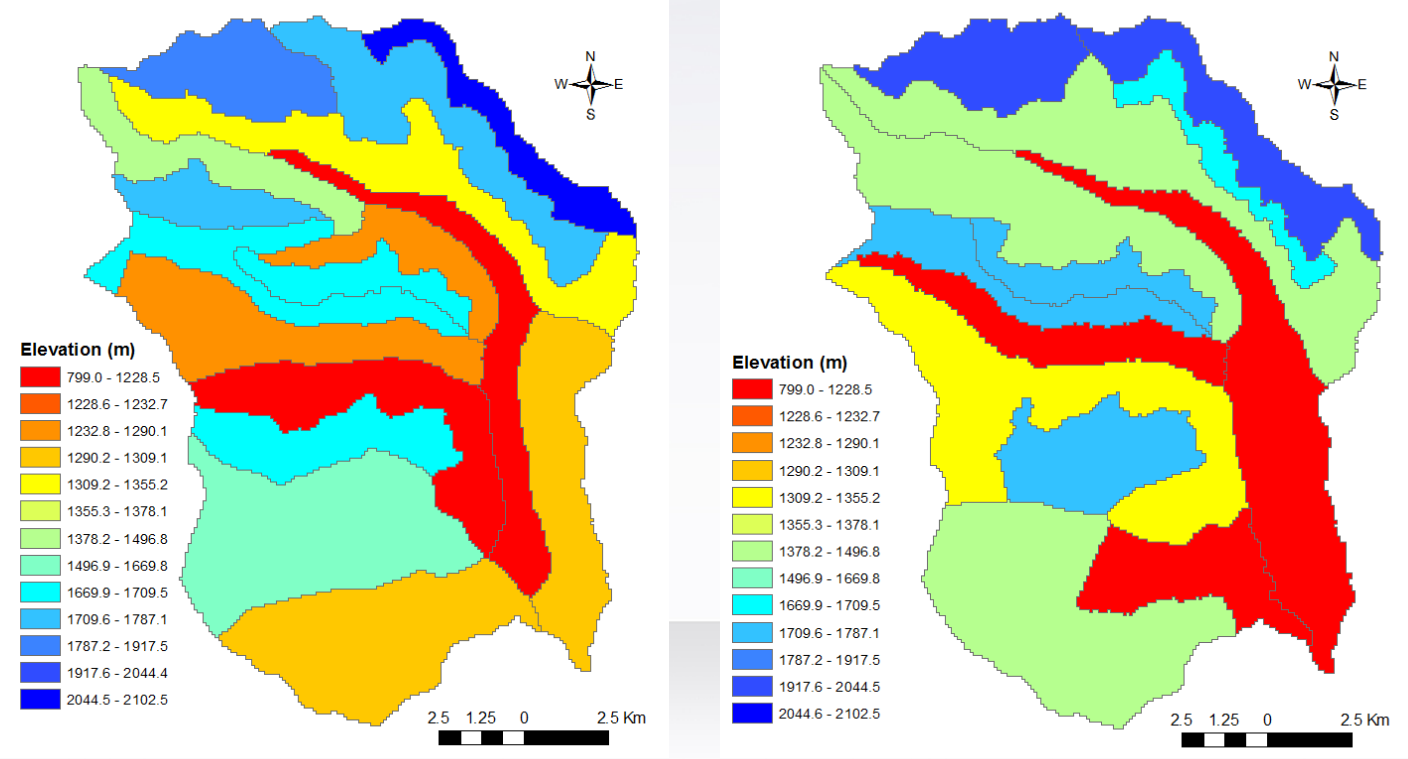
New Land Capabilities

New Capability	Epic Lead
✓ Orographic downscaling	Ruby Leung
✓ Head-based soil hydrology	Gautam Bisht
✓ Coupled C-N-P cycles	Xiaojuan Yang
✓ Alternative plant-microbe competition (ECA)	Bill Riley
✓ Initial crop model improvements	Beth Drewniak
✓ New (uncoupled) river routing	Ruby Leung
✓ V1 land model UQ framework	Khachik Sargsyan
✓ V1 land benchmarking framework	Forrest Hoffman

Orographic downscaling

- DEM data at 30-arcsec resolution are used to delineate subbasin boundaries
- Two approaches, global and local, to define subgrid topographic classes in CLM are compared in two subbasins with contrasting subgrid heterogeneity in the Columbia river basin
- Both approaches have similar ability to capture topographic heterogeneity, but the local approach resulted in fewer landunits in steep subbasins

Average elevation of subgrid landunits in a steep subbasin

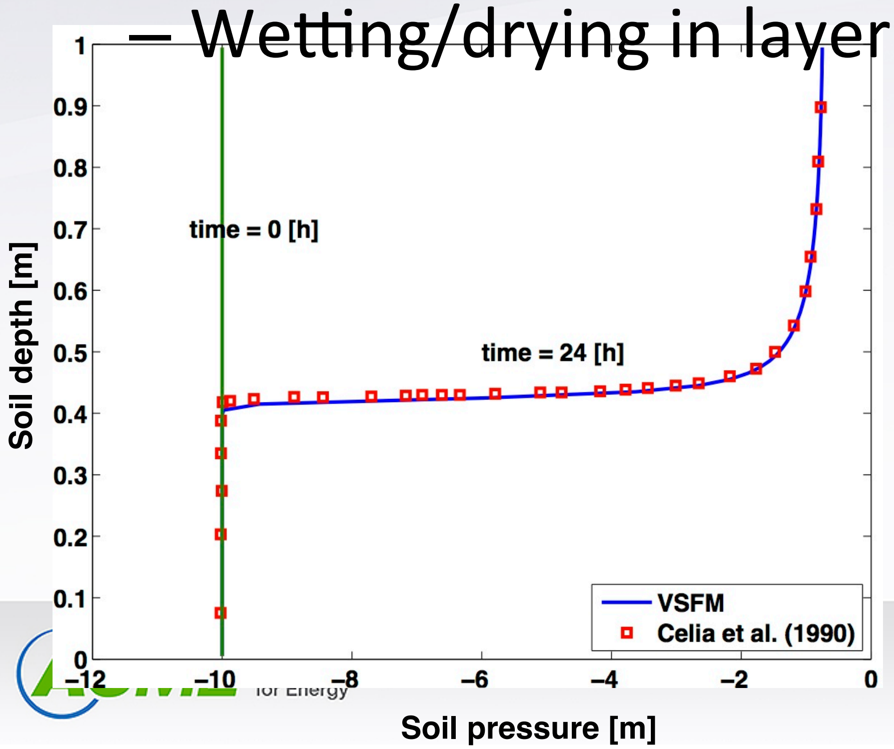


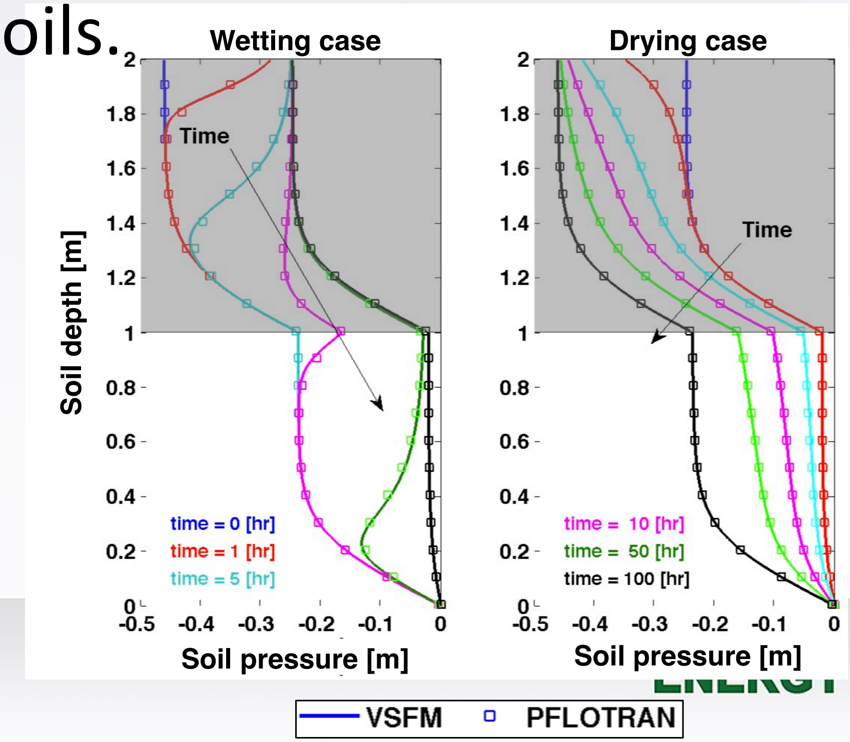
Global approach

Local approach

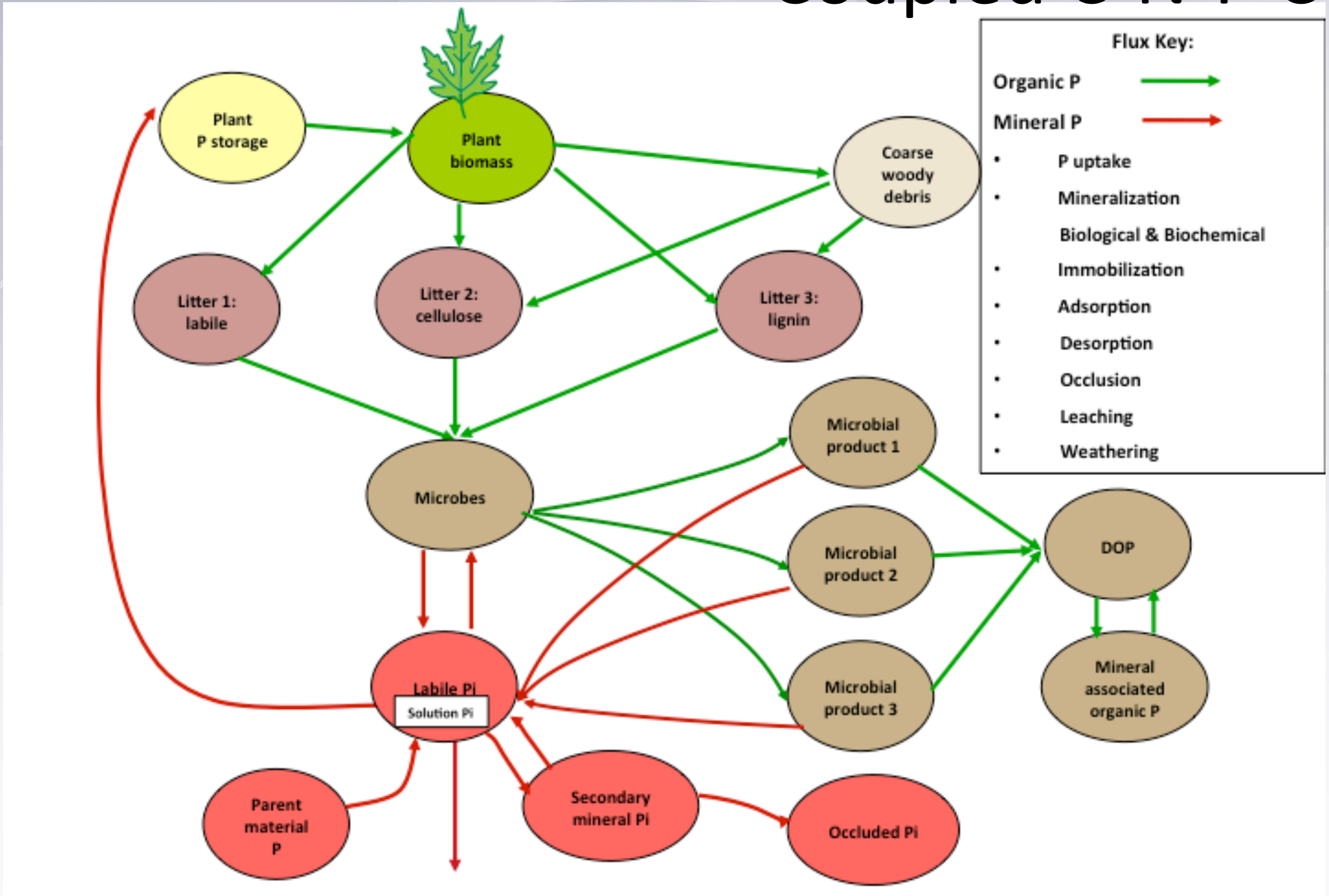
Head-based soil hydrology

- Prototype MATLAB scripts were developed for the **V**ariably **S**aturated **F**low **M**odel (VSFM).
- Two schemes for temporal integration were implemented.
- The VSFM was tested for two benchmark problems:
  - Infiltration in a dry soil column,
  - Wetting/drying in layered soils.





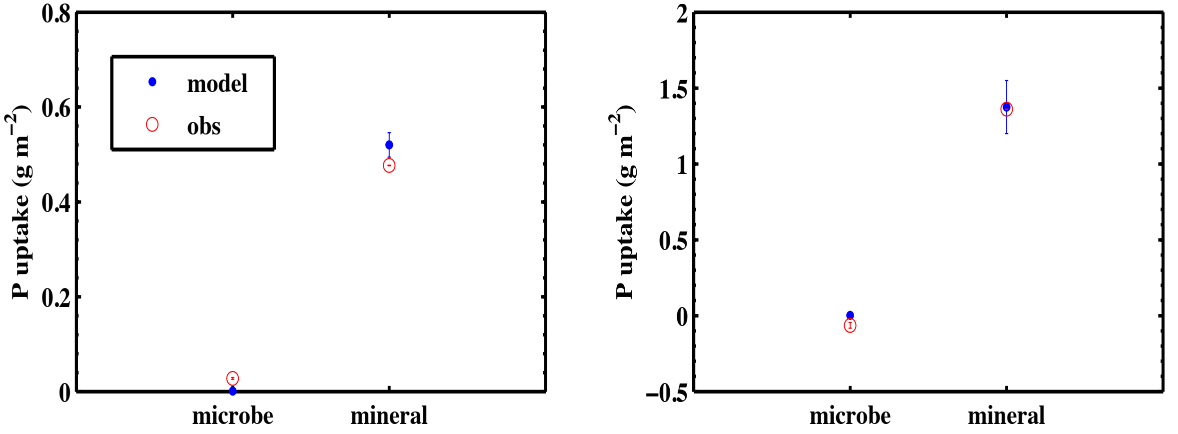
Coupled C-N-P Cycles



- Model structure for the prognostic phosphorus (P) cycle has been developed.
- Code development is ongoing.
- Benchmarking datasets and evaluation metrics for P dynamics and C-N-P interactions are being developed.

Alternate plant-microbe competition

- CLM's current representation of nutrient constraints leads to large biases in ecosystem carbon exchanges
- We are implementing the ECA (Tang and Riley 2013; 2014) to simultaneously resolve multiple nutrient constraints
- leaf N&P constraints based on the TRY database (Ghimire et al. 2014)
- Initial offline implementation of ECA competition complete; manuscript in co-author review



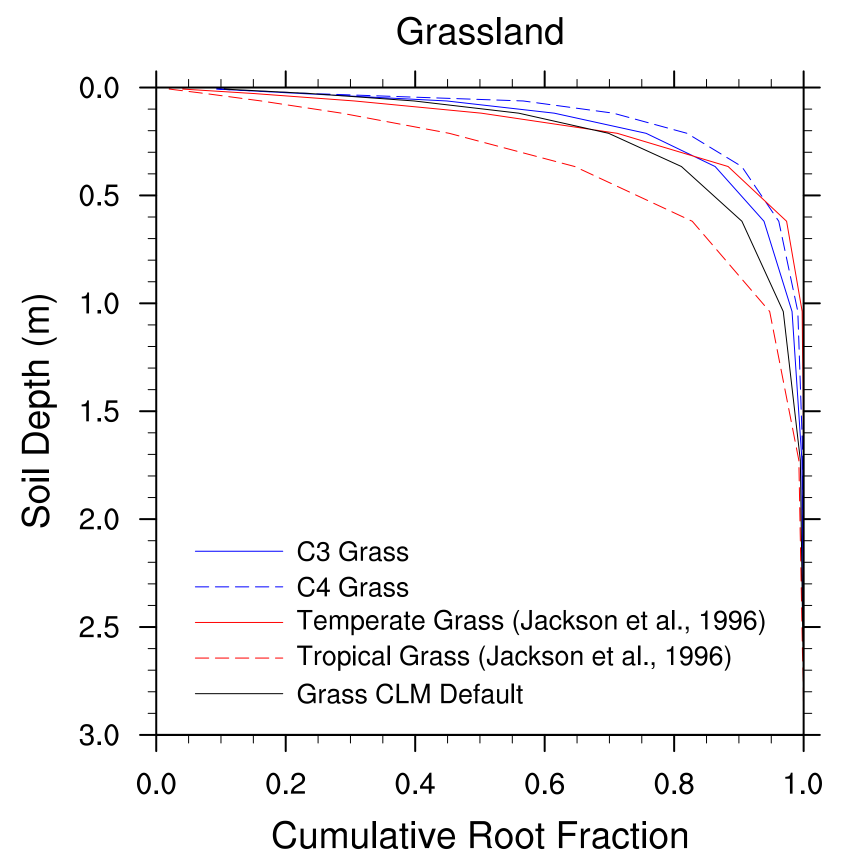
Hawaii 20ky-old soil
Phosphate added: 0.51 g m^{-2}

Hawaii 4.1My-old soil
Phosphate added: 1.36 g m^{-2}

Figure. Predicted and observed microbial and mineral-surface phosphorus uptake in response to experimental addition of phosphorus in two tropical sites (Zhu et al., in prep)

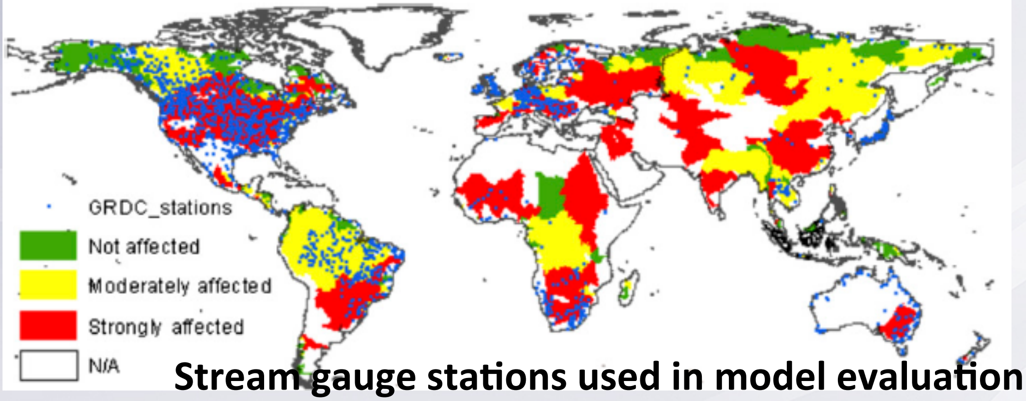
Crop model improvements

- Harvest
  - Yield calculator
  - Residue harvest
  - C/N respired to atmosphere via product pools
- Dynamic Roots
  - Carbon in the root profile determined by water stress and nitrogen availability
- Dual planting/growing length options
  - Allows fixed or climate-based plant dates and growing season length



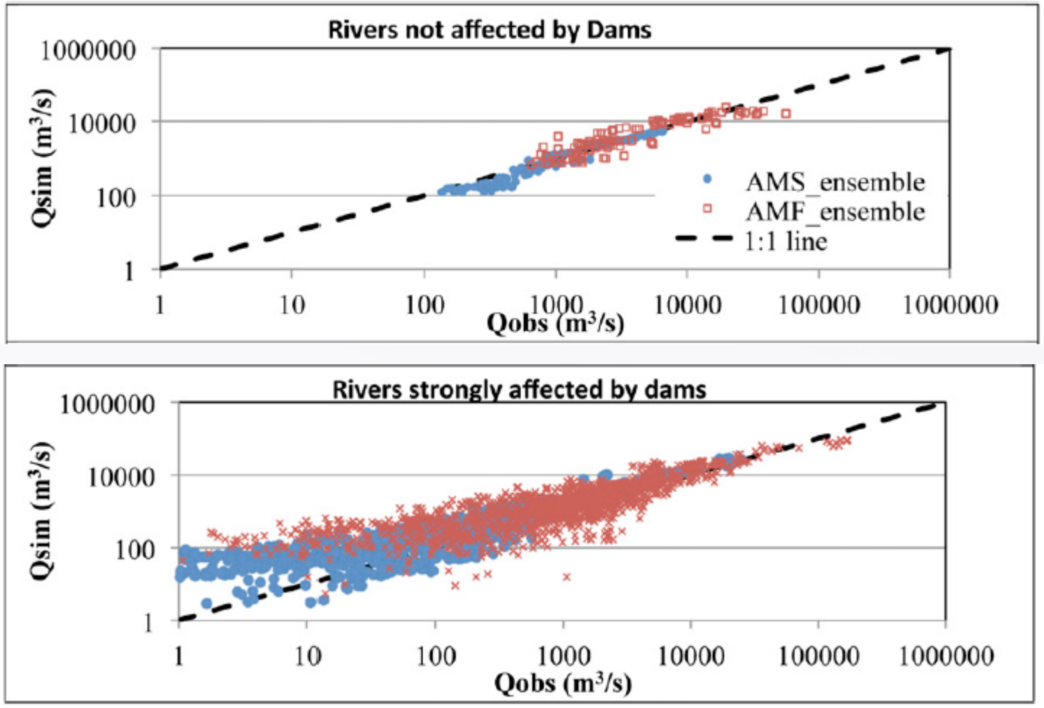
New (uncoupled) river routing

- The MOSART river routing model has been coupled with CLM and evaluated globally with satisfactory performance
- MOSART provides a global framework for modeling streamflow, stream temperature and river biogeochemistry
  - MOSART-h for stream temperature has been developed and tested over the U.S. for global implementation in ACME
  - Basic framework for MOSART-sediment has been developed for further improvement

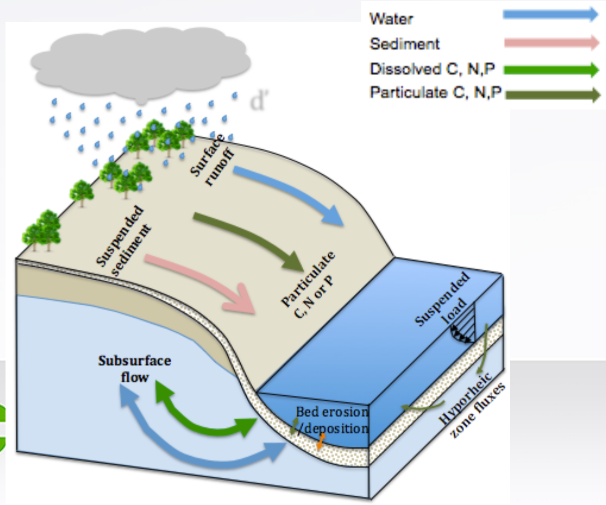


Stream gauge stations used in model evaluation

Comparison of simulated and observed annual mean streamflow (AMS) and annual maximum flood (AMF) at for rivers not affected or strongly affected by dams

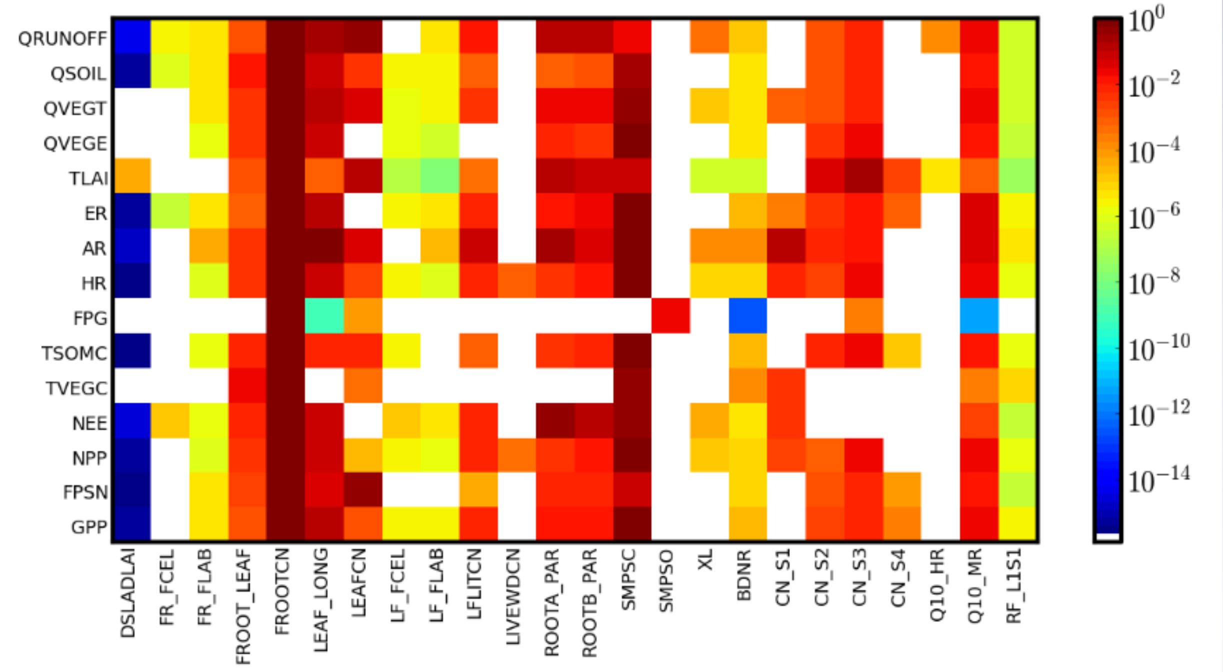


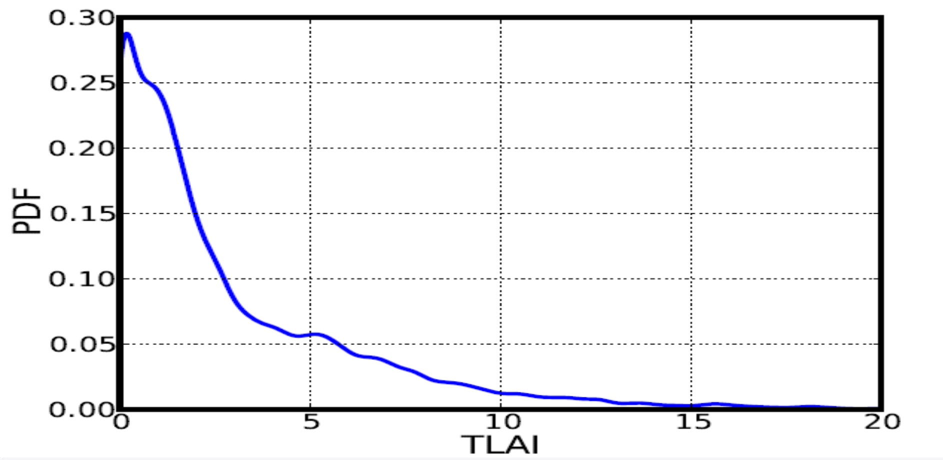
MOSART extension for riverine biogeochemistry



(Li et al. 2015, JHM)

Land model UQ framework

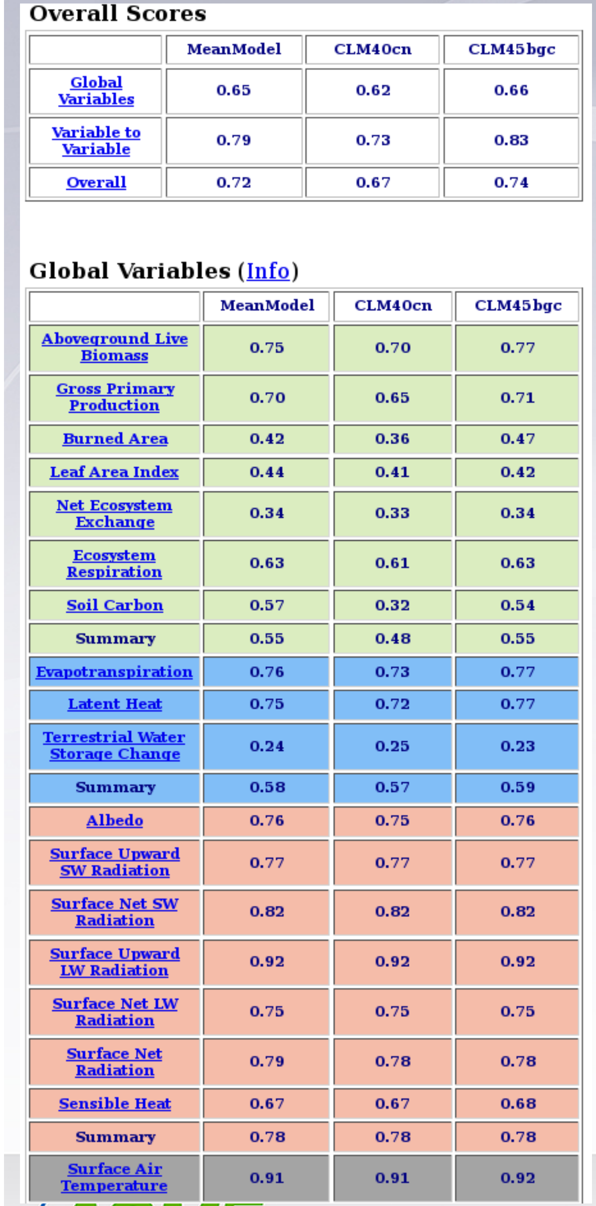




- Using code from the ACME repository, we performed 10,000 CLM4.5 simulations at the Niwot Ridge flux tower site in Colorado.
- Additional 7 sites to be simulated in Q2
- 56 model parameters were varied. Key sensitivities shown on upper left, derived using global PC fit.

- Lower left shows distribution of leaf area index (TLAI) derived from the 10k simulations

Land model benchmarking framework



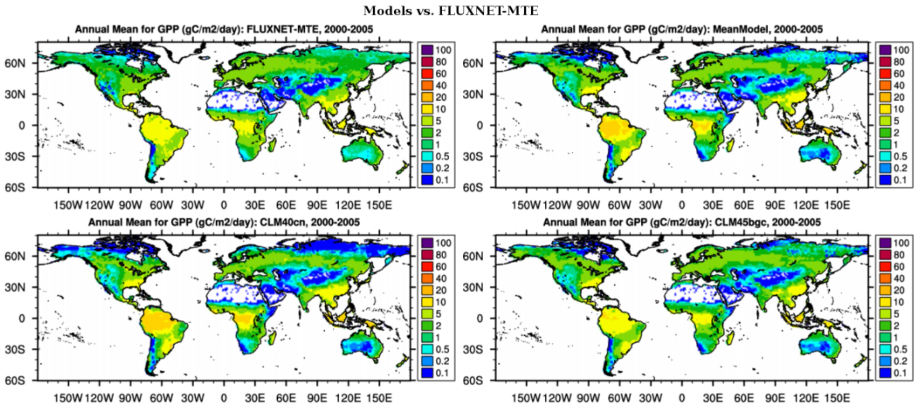
Overall Scores

	MeanModel	CLM40cn	CLM45bgc
Global Variables	0.65	0.62	0.66
Variable to Variable	0.79	0.73	0.83
Overall	0.72	0.67	0.74

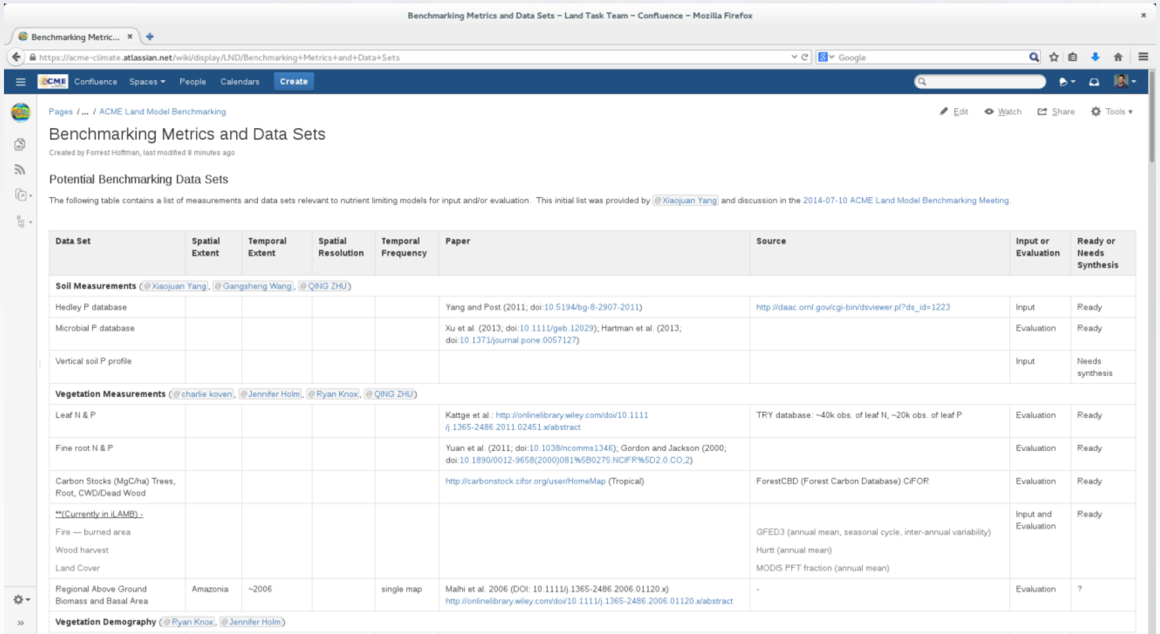
Global Variables (Info)

	MeanModel	CLM40cn	CLM45bgc
Aboveground Live Biomass	0.75	0.70	0.77
Gross Primary Production	0.70	0.65	0.71
Burned Area	0.42	0.36	0.47
Leaf Area Index	0.44	0.41	0.42
Net Ecosystem Exchange	0.34	0.33	0.34
Ecosystem Respiration	0.63	0.61	0.63
Soil Carbon	0.57	0.32	0.54
Summary	0.55	0.48	0.55
Evapotranspiration	0.76	0.73	0.77
Latent Heat	0.75	0.72	0.77
Terrestrial Water Storage Change	0.24	0.25	0.23
Summary	0.58	0.57	0.59
Albedo	0.76	0.75	0.76
Surface Upward SW Radiation	0.77	0.77	0.77
Surface Net SW Radiation	0.82	0.82	0.82
Surface Upward LW Radiation	0.92	0.92	0.92
Surface Net LW Radiation	0.75	0.75	0.75
Surface Net Radiation	0.79	0.78	0.78
Sensible Heat	0.67	0.67	0.68
Summary	0.78	0.78	0.78
Surface Air Temperature	0.91	0.91	0.92

Left: The ILAMB prototype benchmarking package developed in the Carbon–Climate Feedbacks Project will be extended to provide model evaluation for ACME.



Above: Comparison of GPP from CLM4.0 and CLM4.5BGC with Fluxnet-MTE product.



Benchmarking Metrics and Data Sets

Created by Forrest Hoffman, last modified 8 minutes ago

Potential Benchmarking Data Sets

The following table contains a list of measurements and data sets relevant to nutrient limiting models for input and/or evaluation. This initial list was provided by @Xiaojuan Yang and discussion in the 2014-07-10 ACME Land Model Benchmarking Meeting.

Data Set	Spatial Extent	Temporal Extent	Spatial Resolution	Temporal Frequency	Paper	Source	Input or Evaluation	Ready or Needs Synthesis
Soil Measurements (@Xiaojuan Yang, @Gangsheng Wang, @QING ZHU)								
Hedley P database					Yang and Post (2011; doi:10.5194/bg-8-2907-2011)	http://daac.ornl.gov/cgi-bin/dsviewer.pl?ds_id=1223	Input	Ready
Microbial P database					Xu et al. (2013; doi:10.1111/geb.12029); Hartman et al. (2013; doi:10.1371/journal.pone.0057127)		Evaluation	Ready
Vertical soil P profile							Input	Needs synthesis
Vegetation Measurements (@charlie koven, @Jennifer Holm, @Ryan Knox, @QING ZHU)								
Leaf N & P					Kattge et al.: http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2486.2011.02451.x/abstract	TRY database: ~40k obs. of leaf N, ~20k obs. of leaf P	Evaluation	Ready
Fine root N & P					Yuan et al. (2011; doi:10.1038/ncomms1346); Gordon and Jackson (2000; doi:10.1890/0012-9658(2000)081%5B0275:NCIFR%5D2.0.CO;2)		Evaluation	Ready
Carbon Stocks (MgC/ha) Trees, Root, CWD/Dead Wood					http://carbonstock.cifor.org/user/HomeMap (Tropical)	ForestCBD (Forest Carbon Database) CiFOR	Evaluation	Ready
**(Currently in iLAMB) - Fire — burned area Wood harvest Land Cover						GFED3 (annual mean, seasonal cycle, inter-annual variability) Hurtt (annual mean) MODIS PFT fraction (annual mean)	Input and Evaluation	Ready
Regional Above Ground Biomass and Basal Area	Amazonia	~2006		single map	Malhi et al. 2006 (DOI: 10.1111/j.1365-2486.2006.01120.x) http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2486.2006.01120.x/abstract	-	Evaluation	?
Vegetation Demography (@Ryan Knox, @Jennifer Holm)								

Above: A large table of observational datasets useful for evaluating new processes being implemented in the ACME model has been built. Metrics are being developed based on these datasets for assessing changes in model fidelity.

Questions?