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Implementation of CLM into RegCM: What's new and how to use it

A. Tawfik and A. Steiner

University of Michigan
U.S.A.

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CLM MYTHS! (or are they?)

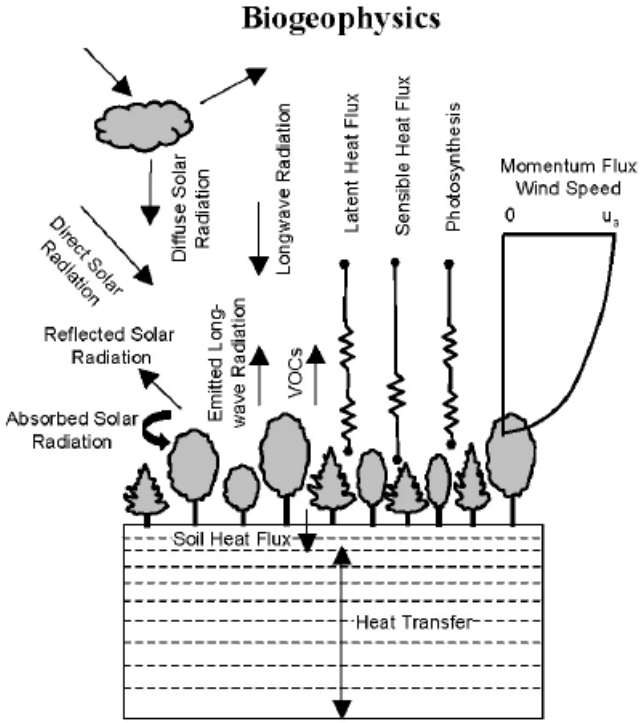
1) "RegCM-CLM is much slower than RegCM-BATS! Not worth it" **TRUE** / **FALSE**

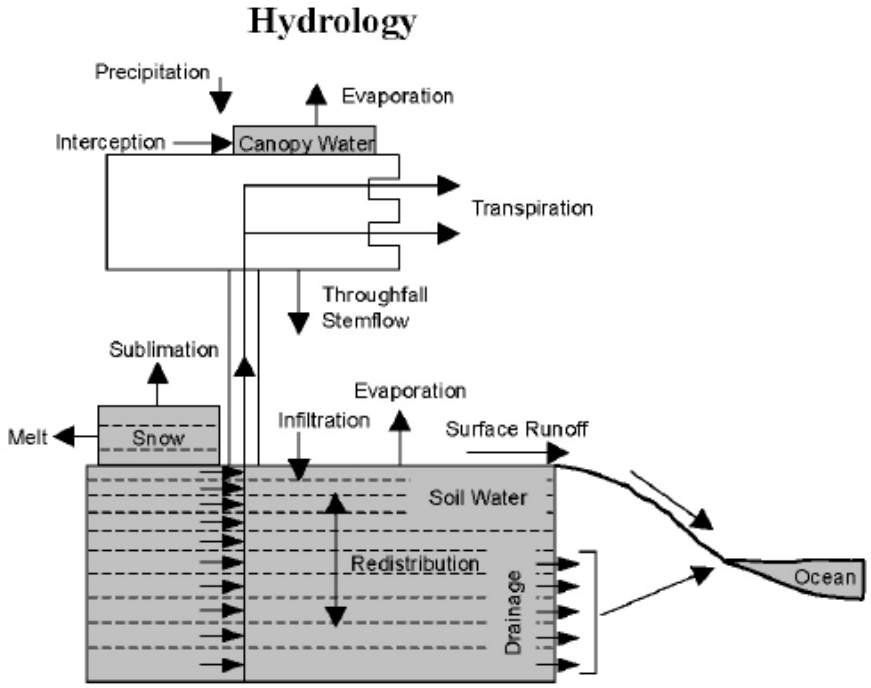
2) "I heard RegCM-CLM isn't even that great…we don't see much improvement. Not worth it" **TRUE** / **FALSE**

What is CLM?

CLM is the Community Land Model developed at the National Center for Atmospheric Research

CLM is based off of BATS, the NCAR LSM, and the snow model from Chinese Academy of Sciences Institute of Atmospheric Physics Land Surface Model





Land Surface Comparison

BATS

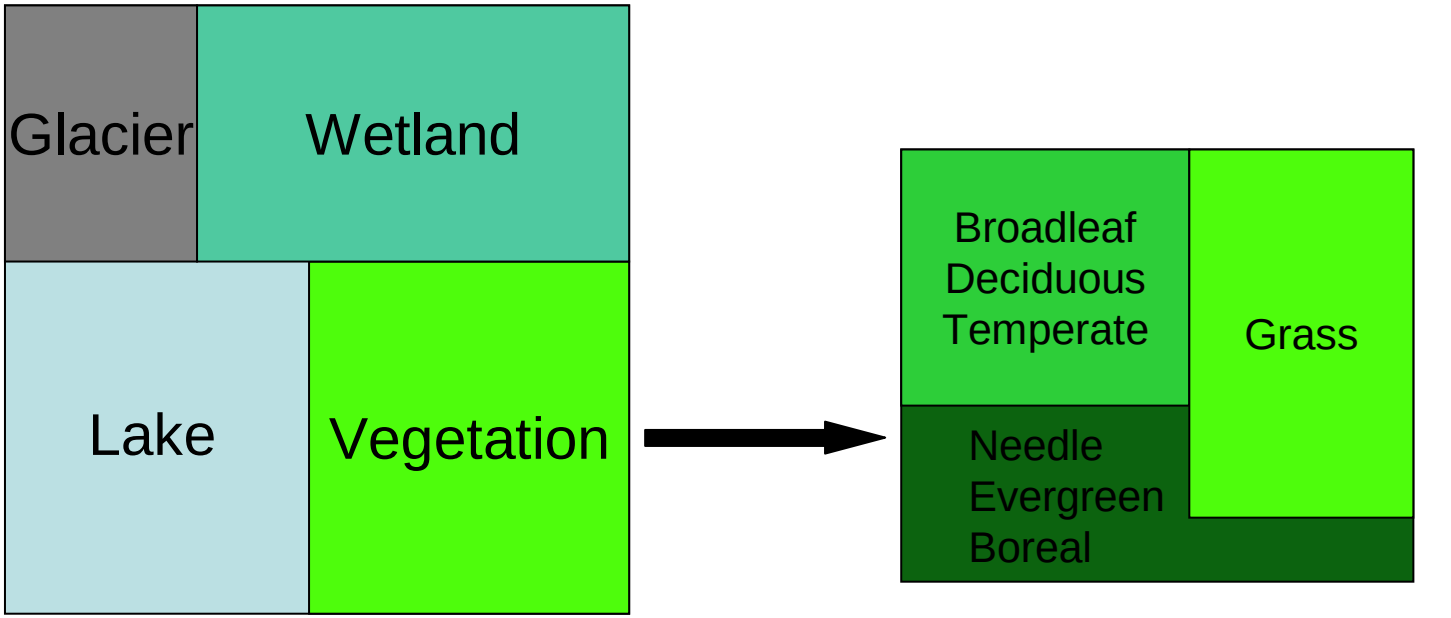
- 3 soil layers; uses force-restore method
- 1 snow layers
- 1 vegetation layer
- Pre-defined soil texture
- Uses Monin-Obukhov similarity theory not adjusted
- All vegetation receives same amount of radiation
- Calculates stomatal conductance using light, moisture, and vapor pressure deficit factors to adjust a minimum stomatal resistance value

CLM

- 10 unevenly spaced soil layers solved for temperature explicitly
- 5 snow layers; trace snow cover
- 1 vegetation layer
- Divides soil textures into percent sand, clay, and silt
- Uses Monin-Obukhov similarity theory adjusted for free convection
- Divides canopy into sunlit and shaded
- Weighted average of land/ocean gridcells
- Calculates stomatal conductance using photosynthetic rates, leaf area, and vapor pressure
- Tile mosaic method

CLM Grid Representation

CLM Grid Mosaic

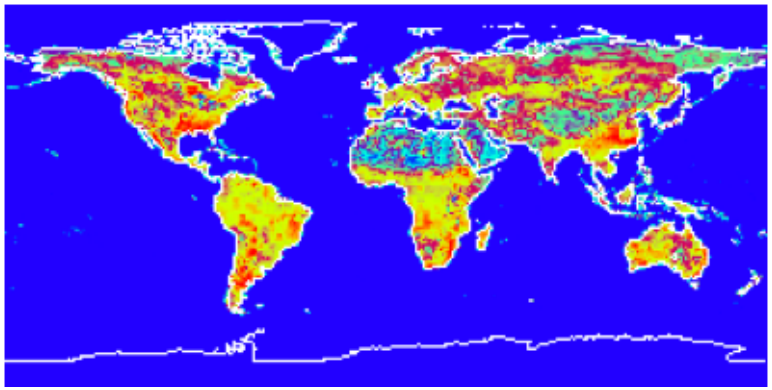


* Possible landcover types are: Lake, Wetland, Glacier, & Vegetated

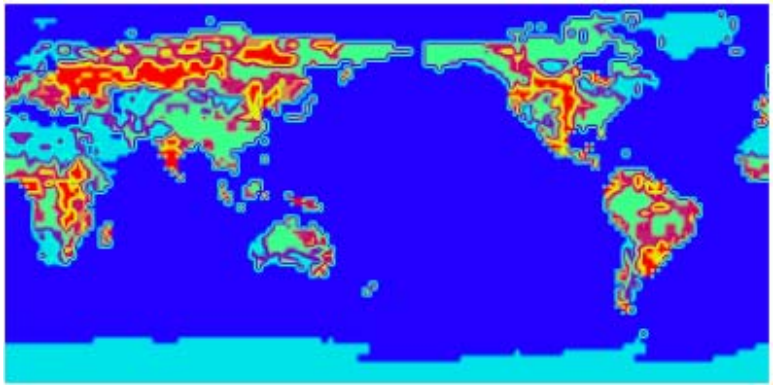
* There are 17 plant functional types

Updated for Regional Scale

Hi-res Soil Color



NCAR CLM Soil Color



Input files

- Monthly average PFT *
- Soil color type *
- Soil texture *
- Percent Lake *
- Percent Wetland *
- Percent Glacier *
- Percent Land *
- Max. Fractional Saturation area *
- Monthly average LAI/SAI *
- Canopy heights *

* 0.05 x 0.05 degree data (hi-res)
* 0.5 x 0.5 degree
*** Hi-resolution input data not currently used in the NCAR version of CLM3.5

(Lawrence and Chase et al., 2007)

Updated for Regional Scale

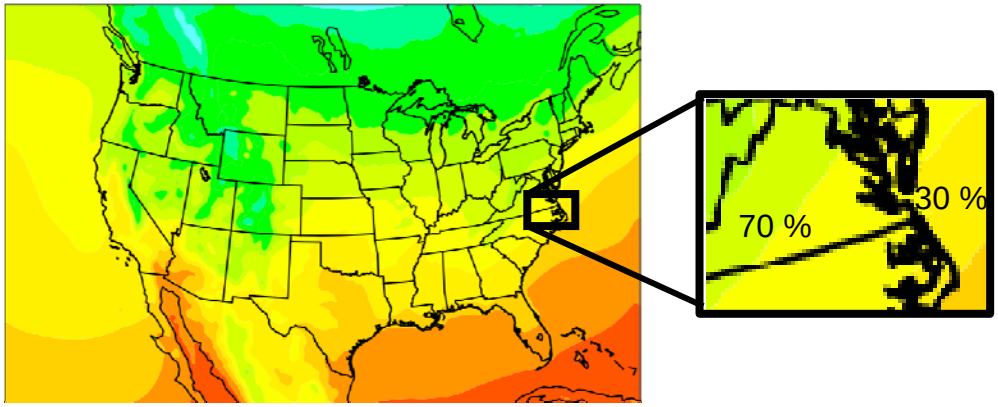
Soil moisture initialization

- Soil moisture uses BATS initialization method instead of initializing entire grid to constant soil moisture field

- This allows for less model spin-up time especially with regards to the deep soil layer

Land fraction

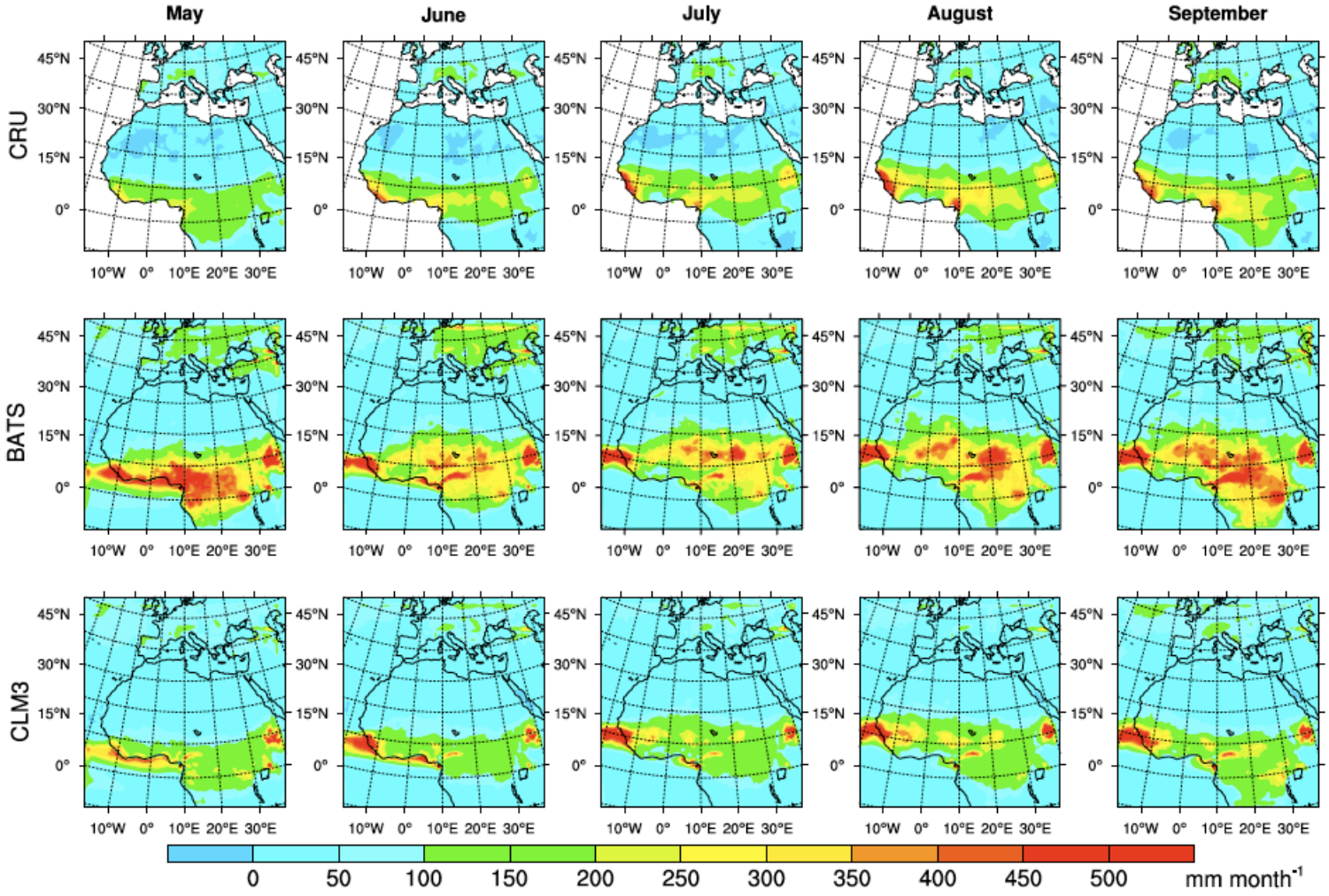
- For land/ocean grid cells a weighted average of prognostic variables is performed



$$T_{grid} = (T_{clm} * 0.7) + (T_{ocean} * 0.3)$$

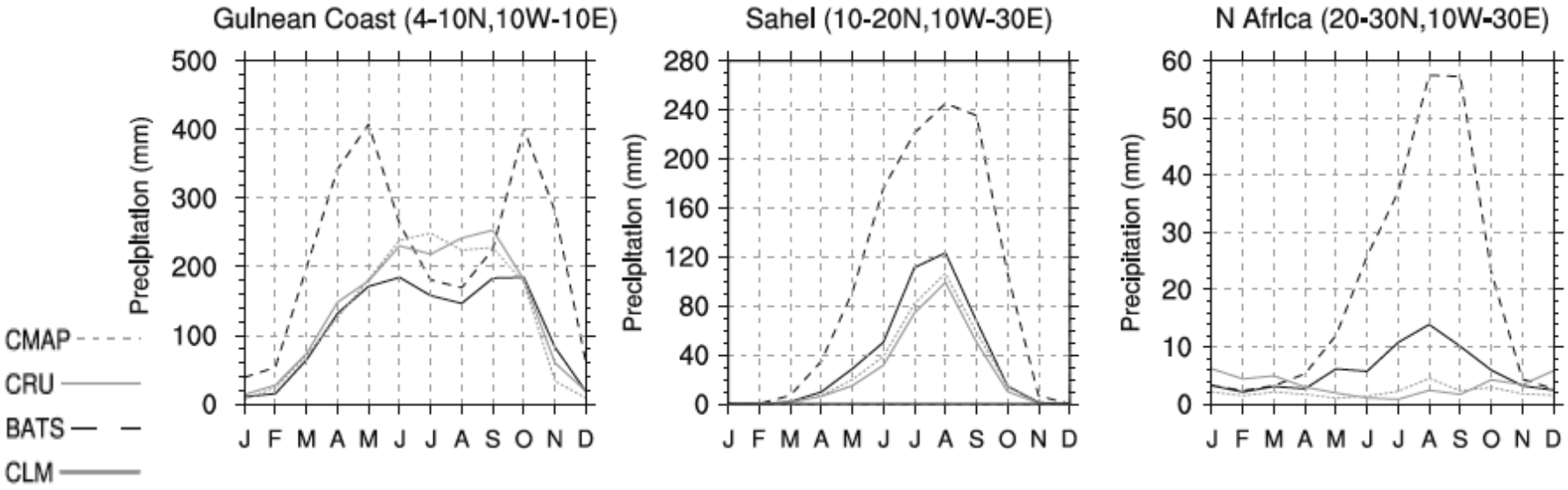
Performance

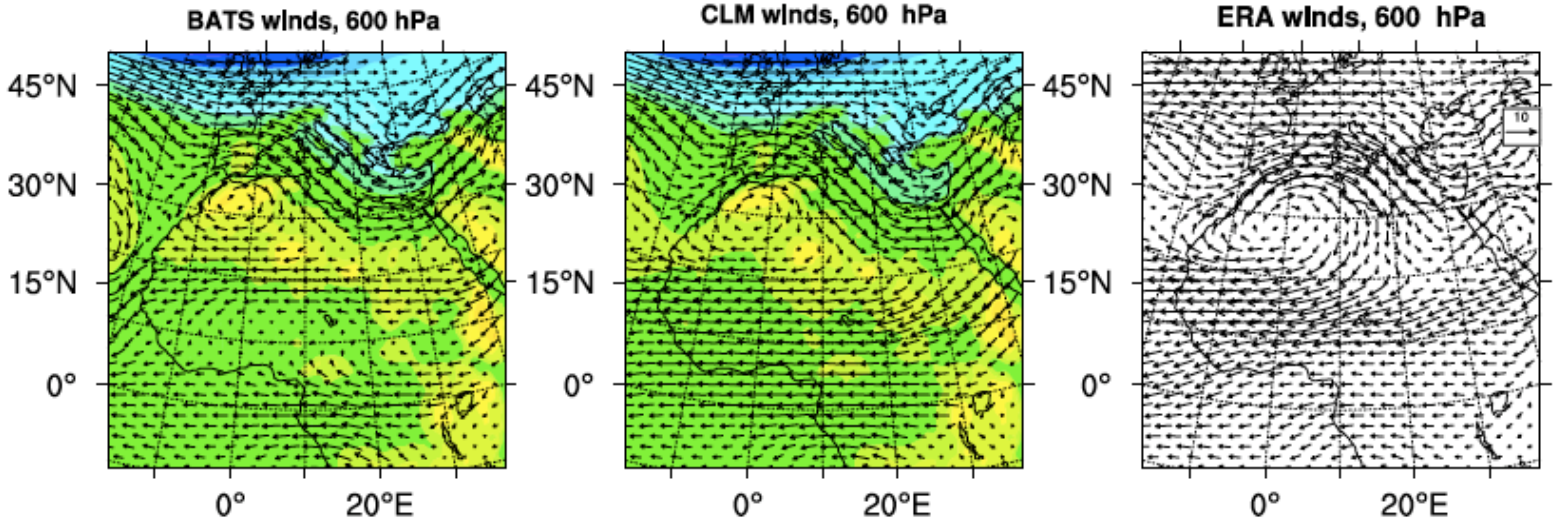
How does CLM Perform?



(Steiner et al., 2009)

How does CLM Perform?





(Steiner et al., 2009)

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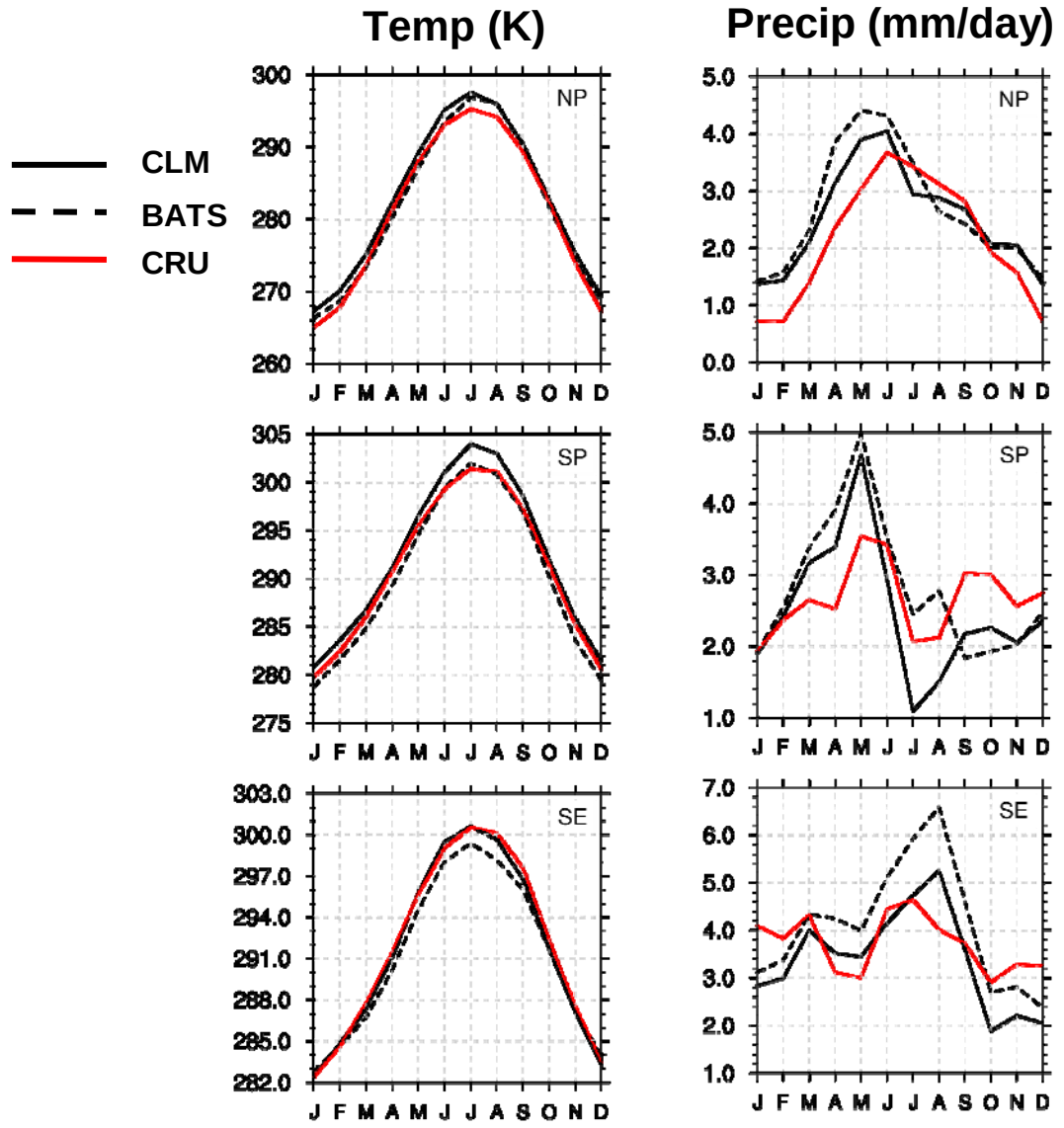
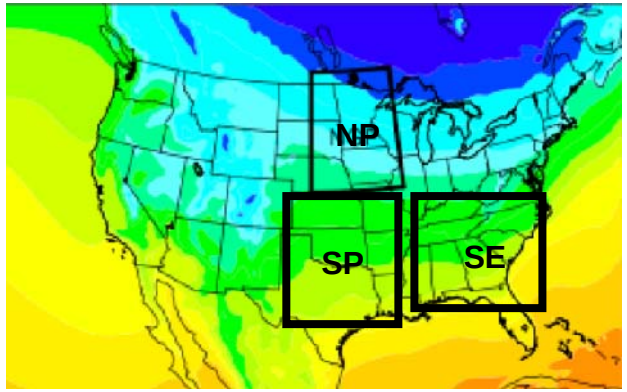
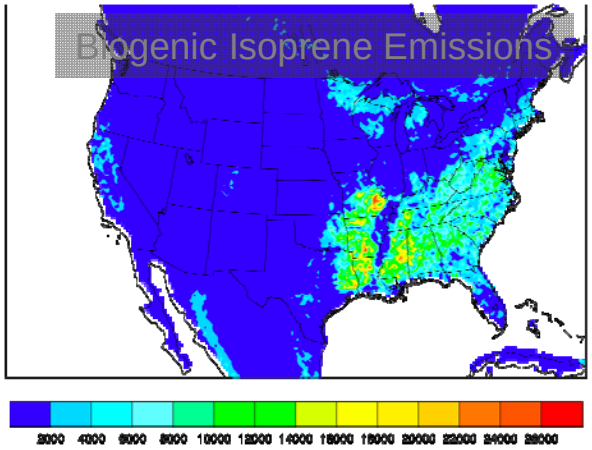


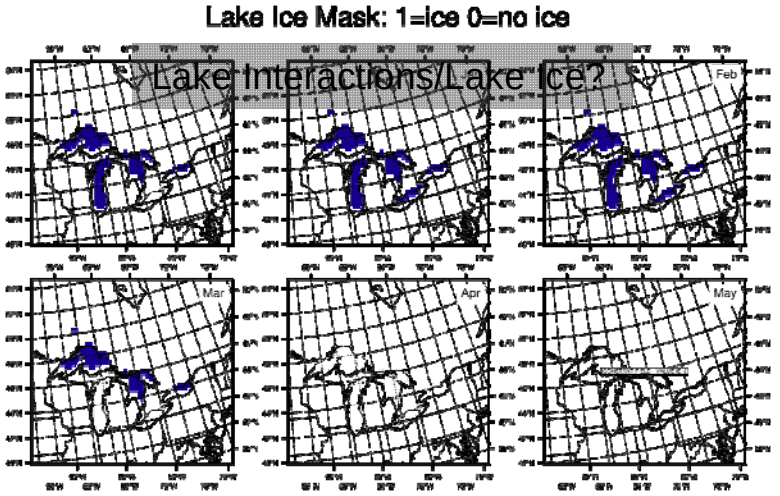


Current/Possible Uses

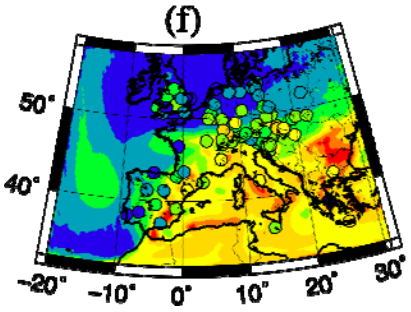
Biogenic Isoprene Emissions



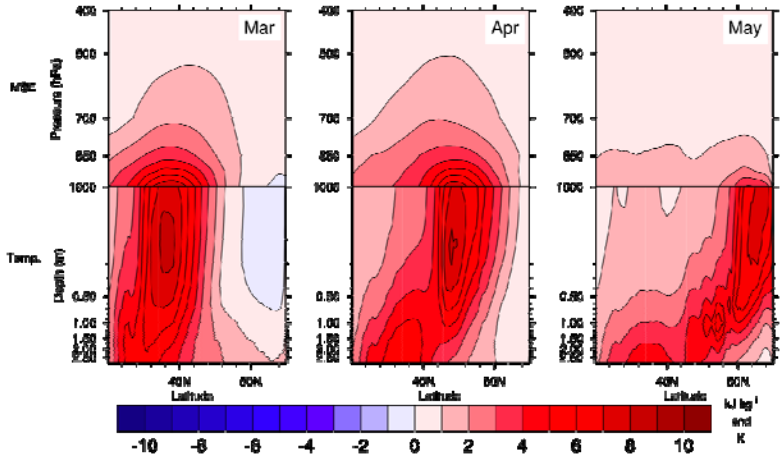
Lake Interactions/Lake Ice?



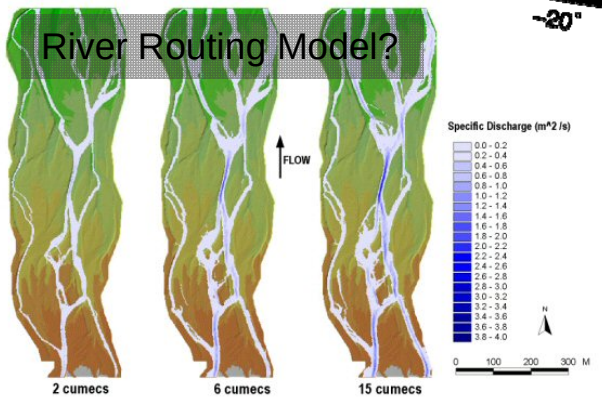
Gas-phase Chemistry



Land Atmosphere Interactions



River Routing Model?



www.geog.cam.ac.uk/research/ep/hfp/

Technical

Before Compilation Checklist

- ✓ Input data
- ✓ Version of NetCDF >= 3.5.1 and OpenMPI libraries
- ✓ Moved pft.physiology file to Input directory
- ✓ Set CLM namelist variables to desired settings
- ✓ Select CLM when prompted during ./configure

Before You Compile

You need specific surface input data!!

mksrf_* ---------->	glacier.nc	lanwat.nc
	soicol_clm2.nc	soitex.10level.nc
	pft.nc	lai.nc
	fmax.nc	navyoro_20min.nc

Also place the file pft-physiology.c070207 in your Input directory
http://www-personal.umich.edu/~abtawfik/newest_version/surface_inputdata.tar.gz

CLM does not work in serial mode (but you can trick it into running on one processor)

Best to compile using PGI compiler; Intel compiler takes a looooong time

Before You Compile

CLM has a long list of output variables
so choose your output frequency wisely

Set ***clmfrq*** in regcm.in:
- (+) is in hours
- (-) is in number timesteps
- Zero is output every month

Set ***imask*** in regcm.in:
- imask=1 using BATS land mask
- imask=2 uses hi-res land mask

How to Compile

1) Must compile each component individually

2) make terrain; make icbc like normal

3) Go to PreProc/CLM and type make

4) Go to Main/ and type make; will create an executable regcm_clM in your run directory

5) Compilation complete!!

Things to be Aware of

- CLM is more computationally expensive than BATS (10%-20% slower)
- Lots of output variables so be aware of disk space (or ask me how to remove some)
- CLM currently does not work with SeaIce
- CLM is does work with Diurnal SSTs
- Do not use some atmospheric variables from the CLM output;
  ***Rule of thumb: if the same output variable is in SRF, ATM, or RAD use that instead of CLM equivalent
- There is a dynamic vegetation model and a river routing model present within CLM but they are NOT tested (my guess is they will not work right away and will take some modifying)

CLM MYTHS! (or are they?)

1) "RegCM-CLM is much slower than RegCM-BATS! Not worth it" **TRUE** / **FALSE**

Answer: BOTH…it is slightly slower; but it is worth.
Really depends on what you think.

2) "I heard RegCM-CLM isn't even that great…we don't see much improvement. Not worth it" **TRUE** / **FALSE**

Answer: BOTH…shows dramatic improvement over some regions
Really depends on what you think