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

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

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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
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.
<table>
<thead>
<tr>
<th>BATS</th>
<th>CLM</th>
</tr>
</thead>
<tbody>
<tr>
<td>• 3 soil layers; uses force-restore method</td>
<td>• 10 unevenly spaced soil layers solved for temperature explicitly</td>
</tr>
<tr>
<td>• 1 snow layers</td>
<td>• 5 snow layers; trace snow cover</td>
</tr>
<tr>
<td>• 1 vegetation layer</td>
<td>• 1 vegetation layer</td>
</tr>
<tr>
<td>• Pre-defined soil texture</td>
<td>• Divides soil textures into percent sand, clay, and silt</td>
</tr>
<tr>
<td>• Uses Monin-Obukhov similarity theory not adjusted</td>
<td>• Uses Monin-Obukhov similarity theory adjusted for free convection</td>
</tr>
<tr>
<td>• All vegetation receives same amount of radiation</td>
<td>• Divides canopy into sunlit and shaded</td>
</tr>
<tr>
<td>• Calculates stomatal conductance using light, moisture, and vapor pressure deficit factors to adjust a minimum stomatal resistance value</td>
<td>• Weighted average of land/ocean gridcells</td>
</tr>
<tr>
<td></td>
<td>• Calculates stomatal conductance using photosynthetic rates, leaf area, and vapor pressure</td>
</tr>
<tr>
<td></td>
<td>• Tile mosaic method</td>
</tr>
</tbody>
</table>
* Possible landcover types are: Lake, Wetland, Glacier, & Vegetated

* There are 17 plant functional types
Updated for Regional Scale

Hi-res 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)
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

\[ T_{\text{grid}} = (T_{\text{clm}} \times 0.7) + (T_{\text{ocean}} \times 0.3) \]
Performance
How does CLM Perform?

(Steiner et al., 2009)
How does CLM Perform?

(Steiner et al., 2009)
How does CLM Perform?

- Temp (K)
  - CLM
  - BATS
  - CRU

- Precip (mm/day)
  - CLM
  - BATS
  - CRU

Image of a map highlighting regions NP, SP, and SE.
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 loooong 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
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**