

Updates on CISM2-CESM coupling, and plans for the CESM1.3 release

Bill Sacks

LIWG Software Engineering Liaison
Climate & Global Dynamics Division
NCAR

In collaboration with
Mariana Vertenstein & Jim Edwards (NCAR)
Bill Lipscomb & Jeremy Fyke (LANL)
Tony Craig & Jon Wolfe (consultants)

Updates on CISM2-CESM coupling, and plans for ~~the CESM1.3 release~~

Bill Sacks

LIWG Software Engineering Liaison
Climate & Global Dynamics Division
NCAR

In collaboration with
Mariana Vertenstein & Jim Edwards (NCAR)
Bill Lipscomb & Jeremy Fyke (LANL)
Tony Craig & Jon Wolfe (consultants)

Updates on CISM2-CESM coupling, and plans for this year

Bill Sacks

LIWG Software Engineering Liaison
Climate & Global Dynamics Division
NCAR

In collaboration with
Mariana Vertenstein & Jim Edwards (NCAR)
Bill Lipscomb & Jeremy Fyke (LANL)
Tony Craig & Jon Wolfe (consultants)

Outline

- CESM1.2 release highlights
- CISM2 in CESM
- Two-way coupling
- Other recent improvements & near-term plans

CESM 1.2 Release Highlights

CESM 1.2 has not been scientifically validated, and should NOT be used for coupled production runs

CISM

- CISM 1.9
 - ▶ Almost CISM 2.0
 - ▶ Release code only supports SIA out of the box
- Changes to some configuration defaults
- Spun-up ice sheet initial conditions, in rough equilibrium with CESM climate (Jeremy Fyke)

CESM 1.2 Release Highlights

CLM

- CLM 4.5
 - ▶ Big focus on biogeochemistry, but also updates some snow parameterizations
 - ▶ Can still run CESM with CLM 4.0
 - ▶ New CLM functionality is mainly restricted to CLM4.5: CLM4.0 mostly frozen except for bug fixes
 - ▶ CLM4.5 not yet validated for coupled simulations
- Bug fix in surface temperature sent from CLM to CISM
 - ▶ Note that this bug affects the current out-of-the-box TG forcing data
- Option to run with 36 elevation classes, rather than 10

CISM2 in CESM – What's Done

- CISM2 code base is in CESM, and was included in the CESM1.2 release
- Higher-order code (GLAM / SEACISM) builds within CESM; some remaining runtime failures
- Confirmed that SLA gives approximately the same answers as before (Bill Lipscomb, Bill Sacks)

CISM2 in CESM – What's Done

- Added parallel capabilities to CESM's GLC component and to glint
- CESM build now supports features needed for CISM:
 - ▶ C++ code
 - ▶ Trilinos
 - ▶ cmake
- Ported to major CESM-supported machines and compilers
- Improved testing support, using CESM's test system

CISM2 in CESM – What's Done

Out-of-the-box support

```
create_newcase -case $CASE -mach yellowstone  
               -compset TGIS2 -res f09_g16_g110
```

CISM1 Compsets

- One CISM task
- Trilinos not included in build
- Configuration file set up for SLA dycore

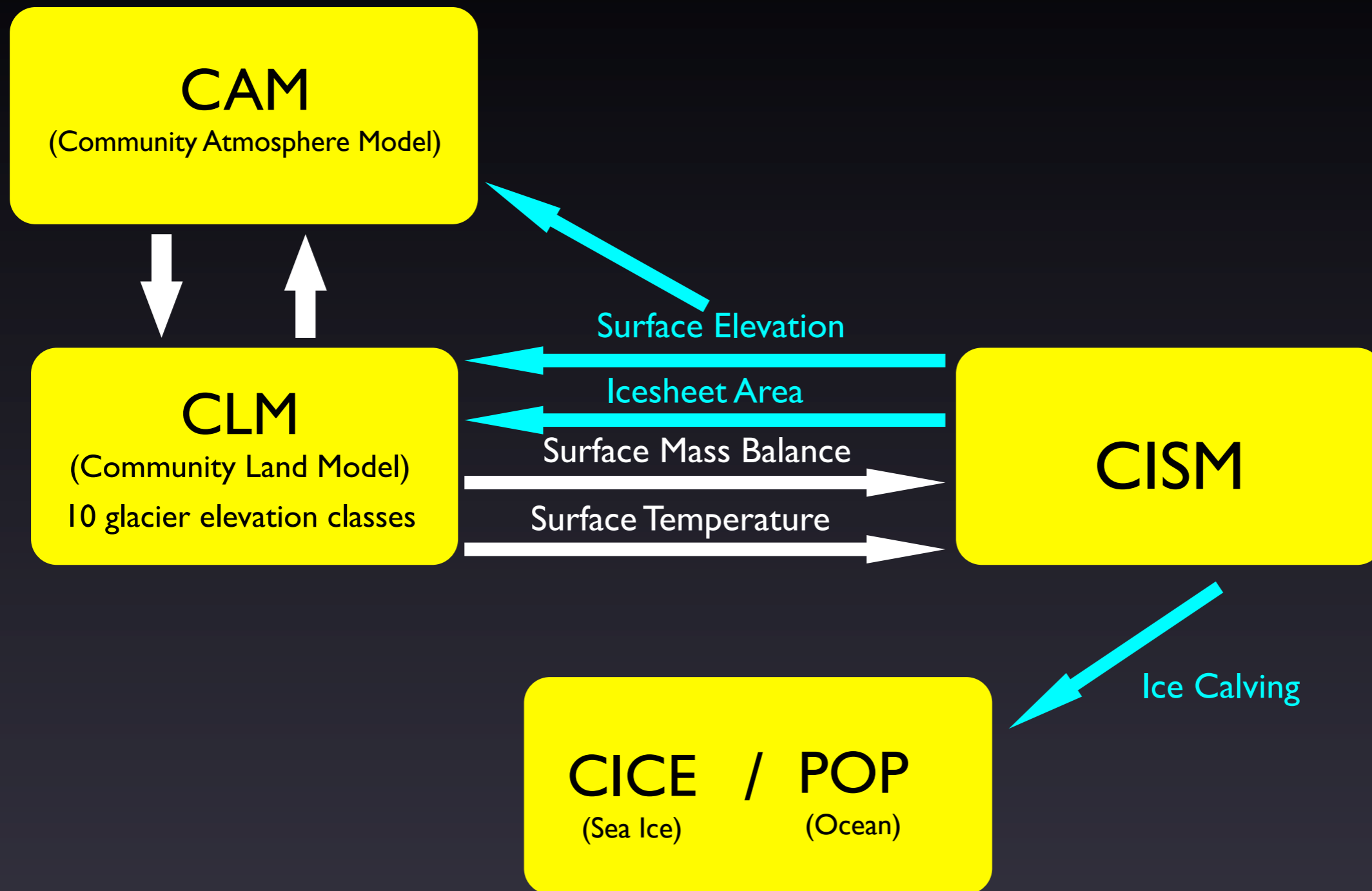
CISM2 Compsets

- Multiple CISM tasks
- Trilinos included in build
- Configuration file set up for SEACISM dycore

CISM2 in CESM – To Do

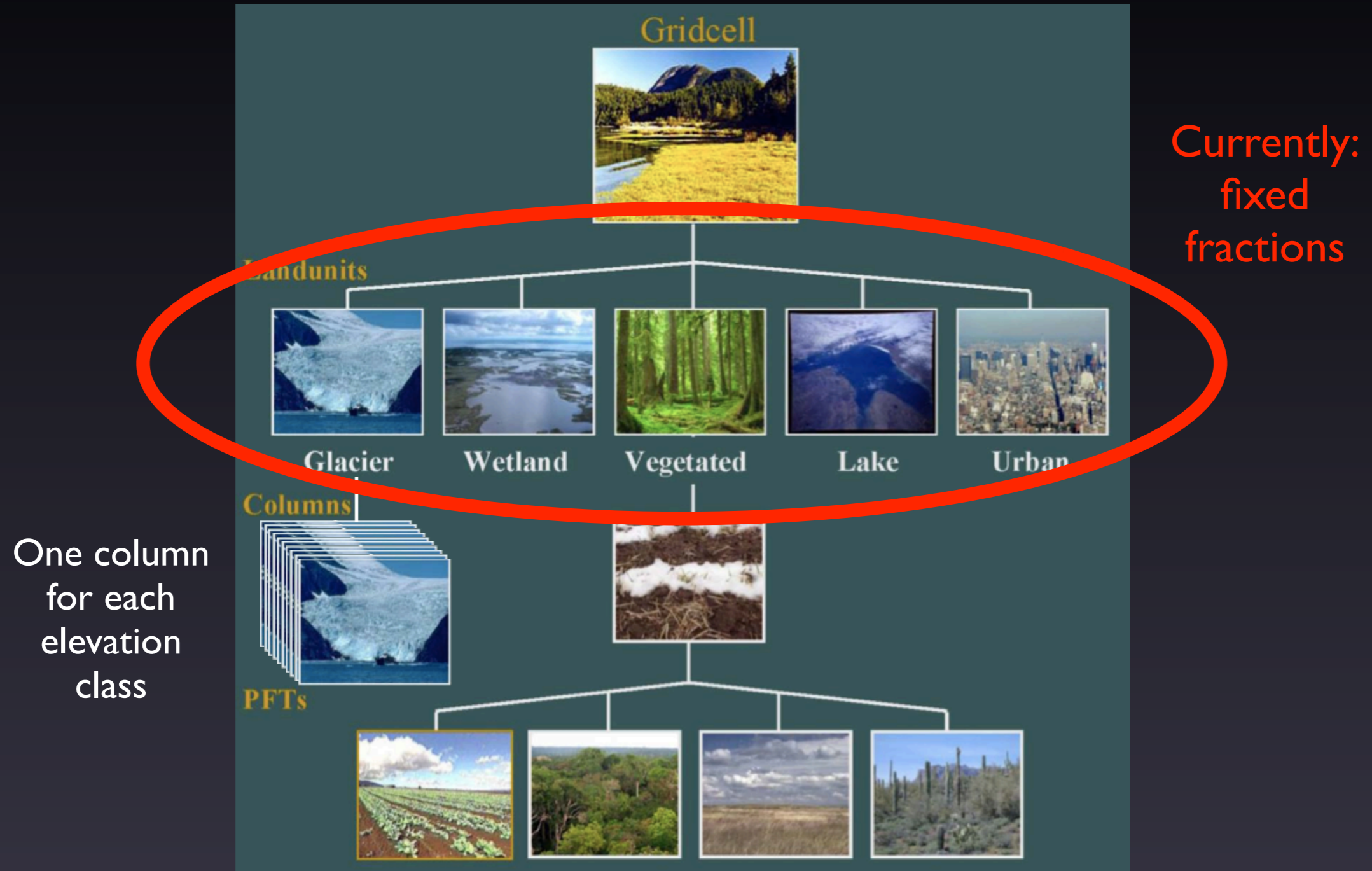
- Address runtime failures, further testing
 - ▶ Failures could be due to bugs in parallelization of glint, or could be due to instabilities in the dynamics – needs further investigation
- Create input datasets for Greenland at multiple resolutions
 - ▶ Requires getting the projection information right

Two-Way Coupling – Intro



Two-Way Coupling – Intro

Dynamic Landunits in CLM



Atmosphere & Ocean Coupling

Mostly complete

- Atmosphere topography sees ice sheet evolution (Jeremy Fyke)
 - ▶ Offline coupling: stop & restart model, coupling with files & external programs
 - ▶ Possible to-do: Handle atmosphere coupling online, through CESM coupler?
- Liquid & solid runoff fluxes (calving) sent to ocean / sea ice (Bill Lipscomb, Jeremy Fyke, Tony Craig, Bill Sacks)
 - ▶ Ice calving can be sent to ocean or sea ice
 - ▶ Soon, CICE will handle this with its iceberg model
- Other aspects of ice sheet – ocean coupling: a separate, longer-term effort

Land Coupling – What's Done

- CISM to CLM fields now computed correctly in CISM (Bill Lipscomb, Jeremy Fyke)
- Worked through many design issues for the CLM portion of this work
- Extensive rework of CLM infrastructure to support bringing in dynamic landunits robustly and maintainably
- Major refactoring of CLM's existing code for dynamic subgrid areas, to support bringing in dynamic landunits
 - ▶ Introduced top-level driver for dynamic subgrid areas
 - ▶ Introduced lower-level classes shared between different code
 - ▶ Introduced first unit tests into CLM
- Compute and send surface mass balance over vegetated landunits, for glacial inception (Jeremy Fyke)

Land Coupling – To Do

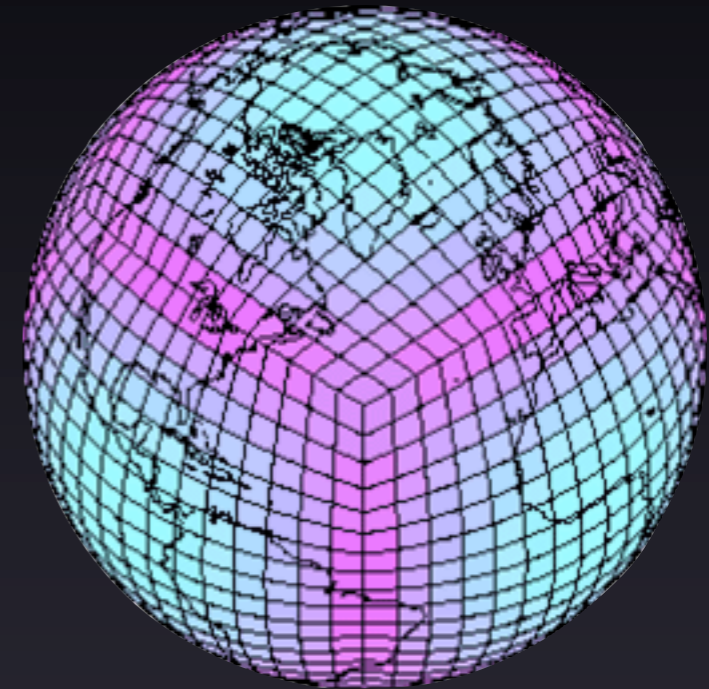
- Add the “dynamics” – CLM areas adjusted annually to match CISM areas
 - ▶ Actually not too difficult at this point
- Track changes in energy, water, carbon for conservation
- Initialize new landunits in a reasonable way
- Conservative mapping between CLM and CISM (Bill Lipscomb, Jon Wolfe)

Improved Mapping Functionality

(Jon Wolfe, Bill Lipscomb)

Goals:

- Allow mapping to/from irregular land grids – e.g., Spectral Element grid
- Allow mapping to/from multiple ice sheets, plus a global grid of smaller glaciers & ice caps
- Use new conservative mapping functions from Bill Lipscomb
- Parallelize mapping routines



Other Recent Improvements

- Downscaling of additional fields to elevation classes in CLM – beyond temperature and humidity (Bill Lipscomb, Bill Sacks, Jeremy Fyke)
 - ▶ Precipitation (rain/snow partitioning) (non-conservative, and thus disabled by default)
 - ▶ Longwave radiation (conservative)
 - ▶ Included a refactor to allow downscaling over vegetated and other landunits
- 3-d snow history fields (Jeremy Fyke, Bill Sacks)
- Standalone CISM ported to yellowstone-intel

Other Near-Term Plans

- Data GLC model, allowing simulations with prescribed transient glacier areas; useful for:
 - ▶ Testing the behavior of the coupled system
 - ▶ Paleoclimate runs
 - ▶ “What-if?” scenarios
- Improved snow / firn model in CLM (Bill Lipscomb, Bill Sacks)
- Fix CLM’s interpinic for GLC-MEC (Mariana Vertenstein, Bill Sacks)
- Support for running BISICLES within CESM
- Improved testing support for CESM-CISM

CESM Simulations to Evaluate SMB with CAM5

All with SIA

- Fully coupled (BG), CAM5, 1 degree (Miren Vizcaino, will begin soon)
- Fully coupled (BG), CAM5, 2 degree (Nan Rosenbloom, recently completed)
 - ▶ Evaluating potential for 2 degree CAM5 to generate reasonable SMB over Greenland