SLIM and mizuRoute: Two New Components in CESM One Simple and One Complex

Erik Kluzek
Marysa Lague
Naoki Mizukami
Sam Levis and Chris Fischer and Mariana Vertenstein
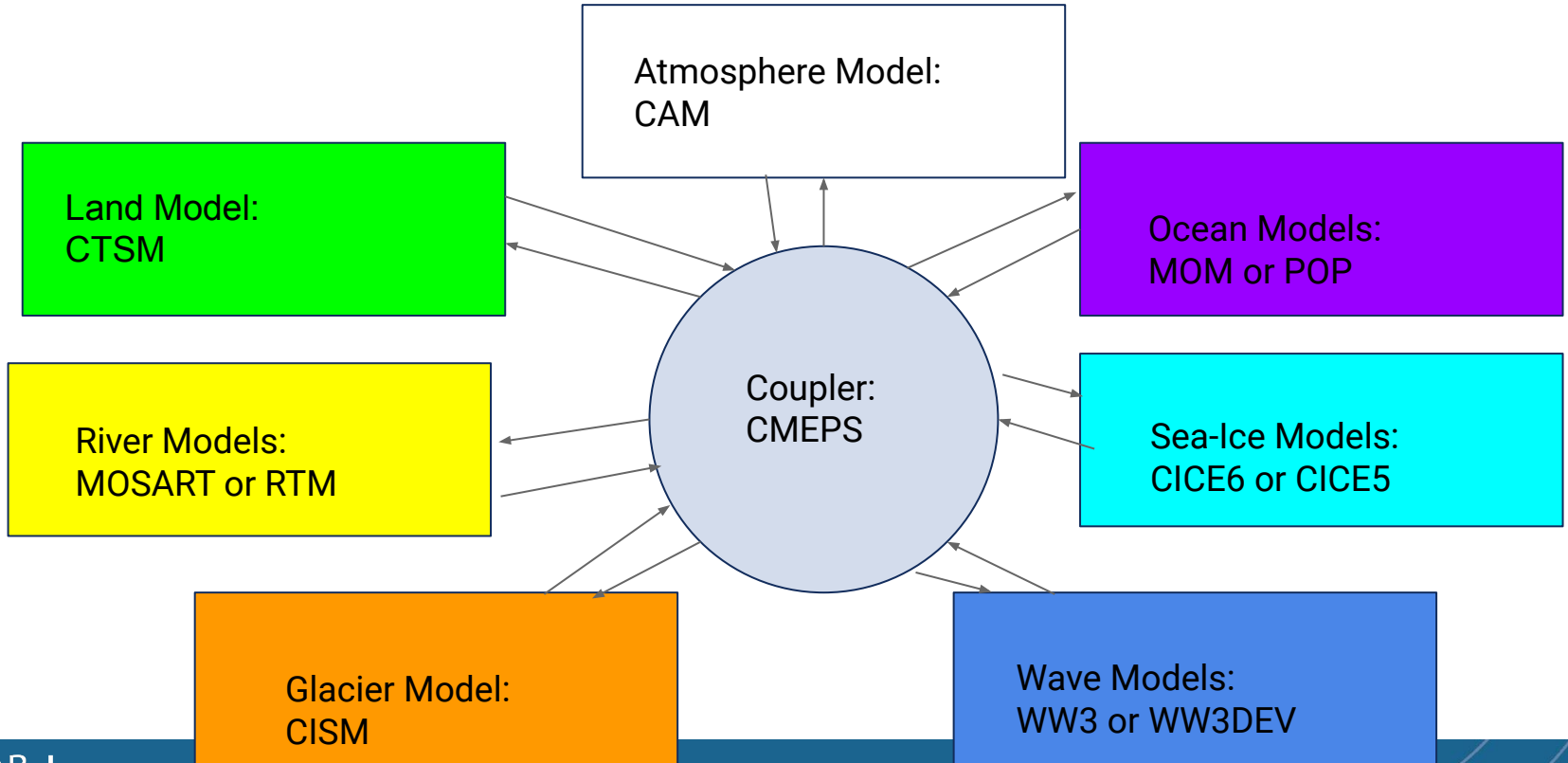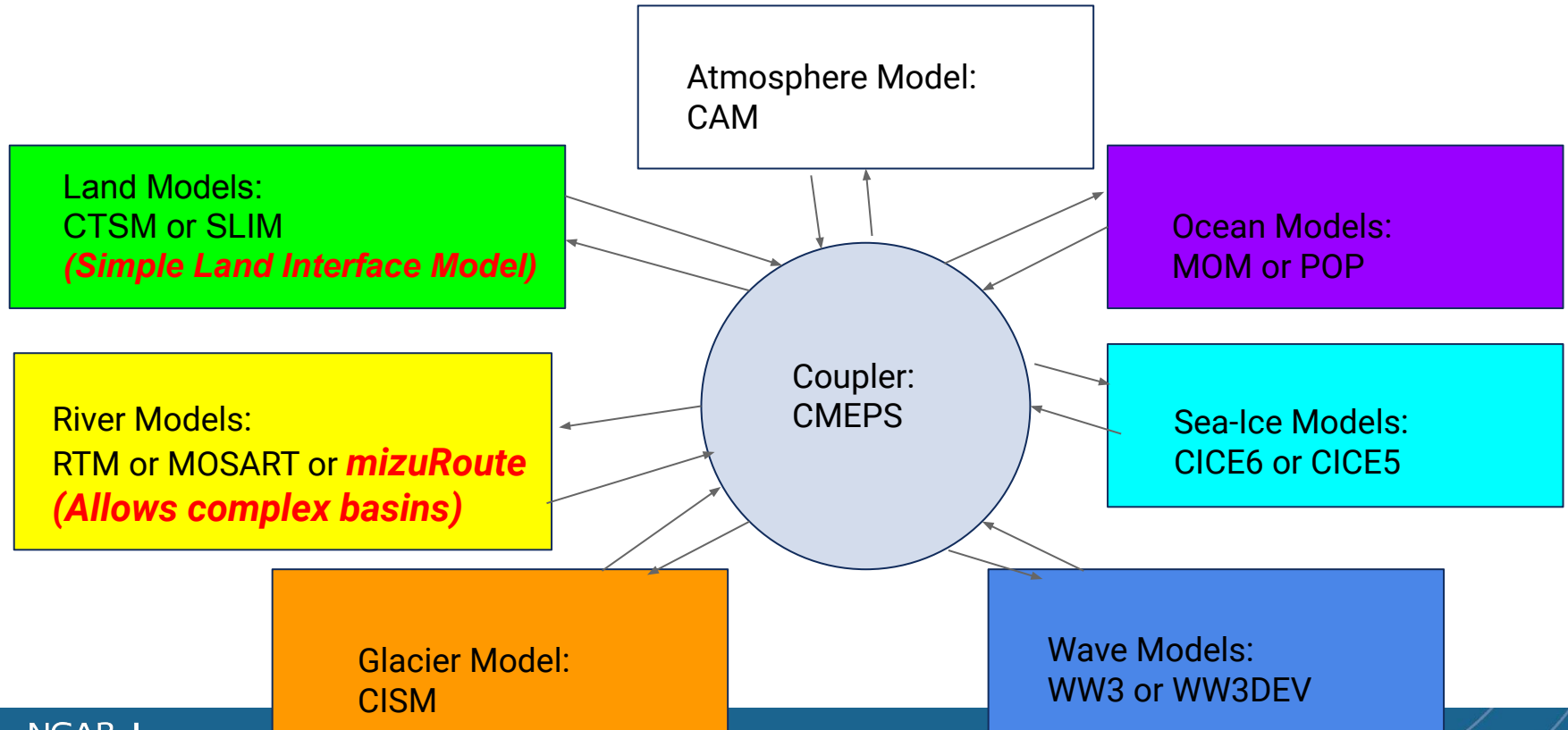Isla Simpson and Scott Bachman
Dave Lawrence and Yaga Richter

Outline

- Go over CESM components and the two new ones: SLIM and mizuRoute
- Go over SLIM a bit about it's science and purpose
- Talk about SLIM as a software component of CESM3
- Talk about mizuRoute and a bit about it's science and purpose
- Talk about mizuRoute as a software component of CESM3

Current Components in CESM2

SLIM and mizuRoute two new components in CESM3

Atmosphere Model:
CAM

Land Models:
CTSM or SLIM
(Simple Land Interface Model)

River Models:
RTM or MOSART or *mizuRoute*
(Allows complex basins)

Glacier Model:
CISM

Coupler:
CMEPS

Ocean Models:
MOM or POP

Sea-Ice Models:
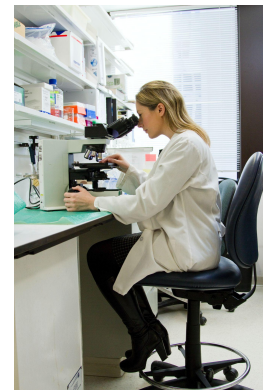CICE6 or CICE5

Wave Models:
WW3 or WW3DEV

NCAR
UCAR

SLIM

SLIM Science developed by Dr. Marysa Lague

- Dr. Marysa Lague developed a simple land model called SLIM (Simple Land Interface Model)
- Based on the CLM5.0 code
- To study land-atmosphere interactions.
- There are papers and presentations on her work
- Here we will concentrate on SLIM becoming a component of CESM.

Why SLIM?

Terrestrial science…
- Simple model interface to understand basic land-atmosphere interaction
- Allows you to change basic surface properties without it being connected to complex surface physics
- Idealized experiments to understand these interactions

Atmosphere science…
- Paleo work?
- Upper atmosphere CESM where land surface not critical
- Other planets?

What is SLIM?

Simple land model that can be used to replace CTSM to understand land atmosphere interactions without the same complexity that an ecosystem model has
No exchange of dry-deposition, B-VOC's or CO_2 from land surface
No connection to river model
No connection to glacier model
No impact of solar angle on land albedo , only driven by ATM SW
"Soil" is a simple bucket model with only a few layers
It's essentially a land model similar to what was used 50 years ago

SLIM surface dataset

- The SLIM surface dataset is characterized by:
- 23 surface characteristics (CTSM has over 80…)
- No subgrid heterogeneity, only description over the gridcell
- Commonly these come from CLM simulations (average 1850, average 2000)
- Includes: albedos, roughness, emissivity, snow-mask, dust-emission, simple "soil" description

Taking SLIM from the CTSM code base to something simpler

- Starting point is CLM5.0 with over 400k lines of source code
- Has hundreds of namelist items, history fields, and complexity of externals most of which is unneeded for SLIM
- We had to slim – SLIM down! Cue – Rocky music…
- Now has about 40k lines of code, just a few namelist and XML items, much simpler and more straightforward to use
- We think this is about the right BMI…

SLIM as a software package

- Single developer → multiple
- Personal repository → ESCOMP organization repository (bulk of CESM repos are here)
- No formal testing → Standard testlist with multiple compilers on cheyenne and izumi
- No tags → tag naming convention, and now have 28 tags
- Only worked with cesm2.1 release → working in cesm2_3 development versions now
- Borrowed "clm" component name → "slim" recognized as a component in cime
- Creation of SLIM input files ad hoc → tools in the repository to help with this

Things being worked on…

- Need to update from cesm2_3_beta10 to latest cesm2_3 alpha tag
- Start adding to CESM tags (only MCT version)
- Finish development of the NUOPC cap for SLIM
- Update testing to using CICE6 and CAM-Dev
- Evaluate the science in these latest configuration and ensure similar to the SLIM development
- Plan to have SLIM as an additional optional component of CESM going forward with some standard testing (for NUOPC version)
- Will also add as an optional component to CAM standalone checkout
- Only works with distributed memory parallelism (MPI)

mizuRoute
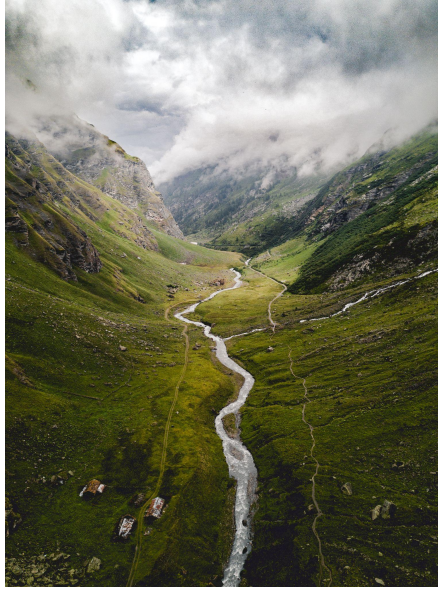
Why another River Model?

- In CESM we already have both RTM and MOSART – why a new one?
- We don't have in-house ability to create new grids for MOSART
- As such RTM is needed to run Paleo simulations, MOSART for current
- MOSART can not run on grids that hydrologists use
- Advanced ability to model lakes and reservoirs is desired in CESM/CTSM
- Ultimately mizuRoute should allow us to retire both RTM and MOSART

mizuRoute – both regular grid and HRU's

- mizuRoute hydrological science developed by Dr. Naoki Mizukami
- Can run on our standard 2D regular grids like we do with RTM/MOSART
- Can also run on more complex Hydrologic Response Units (HRU's)
- Several different scientific options for solving hydrology
- Ability to model lakes and reservoirs has been added
- Runs hybrid, shared memory and distributed memory parallelism (OpenMP and MPI)

mizuRoute catchment data

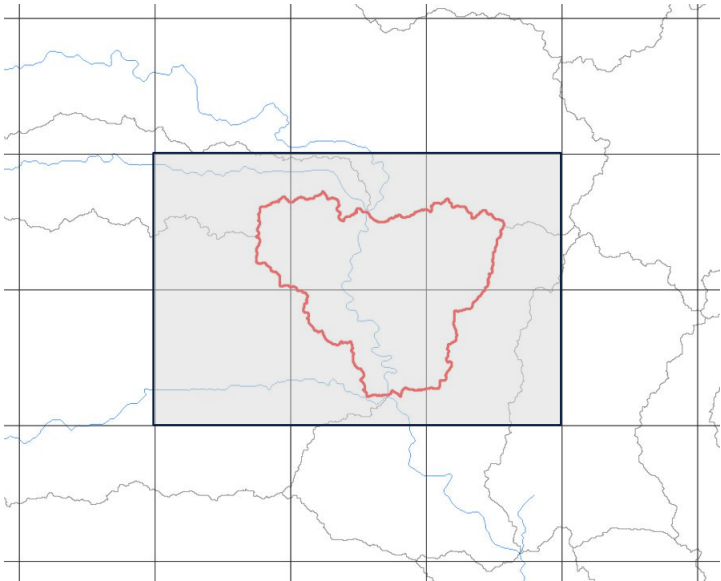| Grid name	Domain	# of elements
rHDMA	Global	295,335 catchments
	CONUS	20,924 catchments
rMERIT	Global	2,996,635 catchments
	CONUS	227,247 catchments
rHDMAlk	Global	298,277 catchments and 4236 lakes
f05	Global	99,427 grid boxes

Precomputed re-grid mapping file (land grid and mizuRoute catchment).

- rHDMA : nldas2(conus 1/8°), f19 (2.0°), f09 (1.0°), hcru (0.5°)

- rHDMAlk : f19 (2.0°), f09 (1.0°), hcru (0.5°)

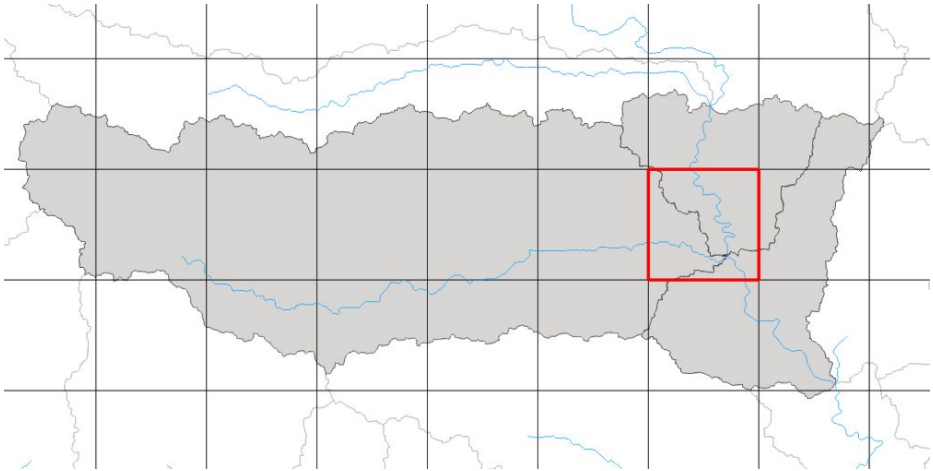- rMERIT: nldas2 (conus 1/8°), f19 (2.0°), f09 (1.0°), hcru (0.5°)

NCAR
UCAR

Regridding between CTSM grid and mizuRoute catchment

e.g., mapping CTSM grid (gray) to mizuRoute catchment (red)

e.g. Mapping mizuRoute catchment (gray) to CTSM grid (red)

❑ River volume

❑ Discharge

❑ Flood (not active)

❑ Runoff: surface, subsurface, and qgwl (glacier, wetland, lake)

❑ Irrigation demand from surface

HDMAlk (HDMA+HydroLake) grid

Greenland, Antarctica missing
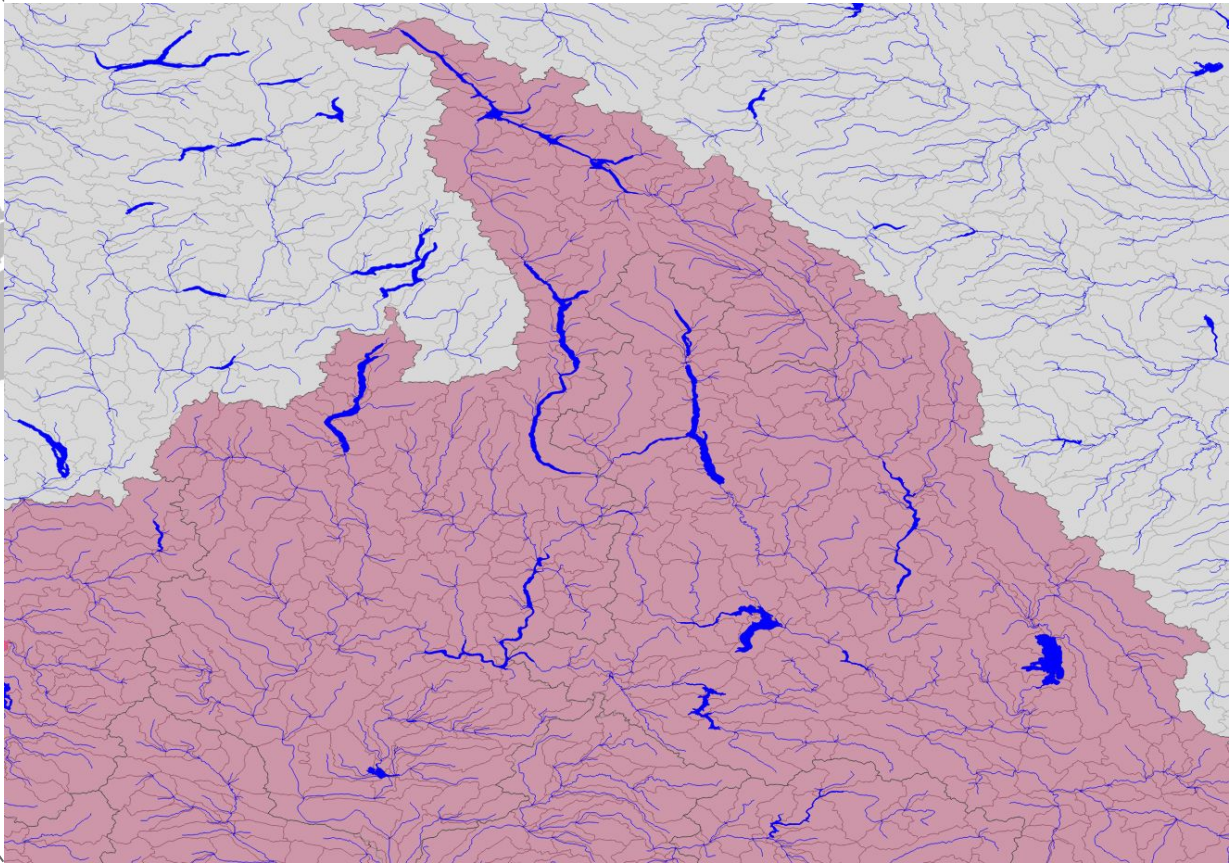
mizuRoute as a component of CESM

- Only worked offline, now can run as a component of CESM
- Retaining the ability to work standalone outside of CESM
- Created a NUOPC cap and ability to build/run in CESM/CTSM
- Developing a standard test list for cheyenne and izumi
- Added history averaging ability
- Added ability to output for a list of gauges
- Added handling of irrigation
- Added handling of negative runoff from CTSM and passing to ocean
- Added standard CESM filenames restart and startup options
- Moved repository from NCAR to ESCOMP
- Theading is always helpful, MPI tasks load balancing changes with the grid
- When restarting with different number of tasks, HRU Id's aren't sorted

Developments to finish

- Finalize the test list
- Add as an option to CTSM tags
- Add to CESM tags
- More work in sending fields from CTSM to mizuRoute for lakes
- Start evaluating it when coupled to the ocean model

Questions?