CESM Software Engineering Working Group

A selection of major activities

Presented by Bill Sacks
Credits: Many members of the SEWG and others

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New / vastly expanded components

- Ocean: MOM6 (more details Wed. at 1:25 pm)
  - Functional release in CESM2.2
  - Planned to be primary ocean component in CESM3
  - Work underway includes:
    - Improving forced MOM6 compsets scientifically
    - Improving fully-coupled configuration
    - Adding biogeochemistry coupling
- Sea Ice: CICE6
  - Planned to be available starting in CESM2.3
  - Dynamic memory allocation – allows runtime changes of grid, tracers, etc.
  - Vertical thermodynamics separated – allows column testing

New / vastly expanded components

- Atmosphere: CAM undergoing major changes
  - Rewrite for Common Community Physics Package (CCPP)
  - Support for new dynamical cores: CAM-SE, FV3, MPAS
- Land: CLM now CTSM
  - Support for an expanded range of options for NWP, etc.
  - Moving towards the Functionally Assembled Terrestrial Ecosystem Simulator (FATES) as a default capability
- River: MizuRoute
  - Runs on more accurate Hydrologic Response Units rather than regular grids
  - Will enable dynamic lakes and reservoirs
- Land ice: CISM over Antarctica as well as Greenland

Community Mediator for Earth Predictive Systems (CMEPS)

New coupling architecture based on ESMF's
National Unified Operational Prediction Capability (NUOPC)
(more details Wed. at 1:05 pm)

Benefits to CESM

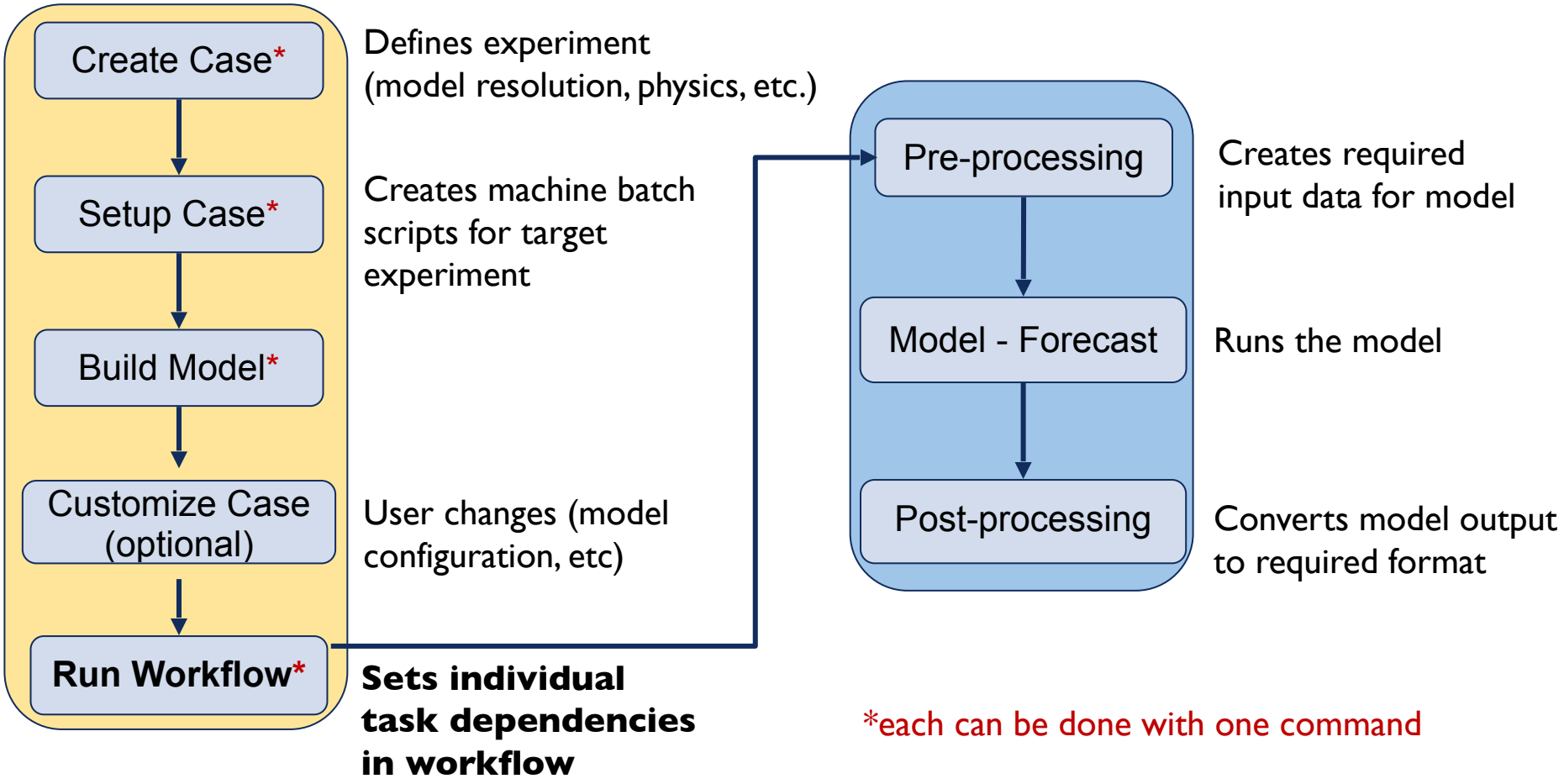
- New online regridding capability – much easier to introduce new refined grids
- New runtime sequencing via simple text file – easier to change run sequence
- New coupling capabilities – e.g., upcoming exchange grid
- New ESMF-based data models will allow online 3-d regridding and other capabilities
- Exercising CMEPS with different components and coupling strategies results in much more robust system

CESM Status

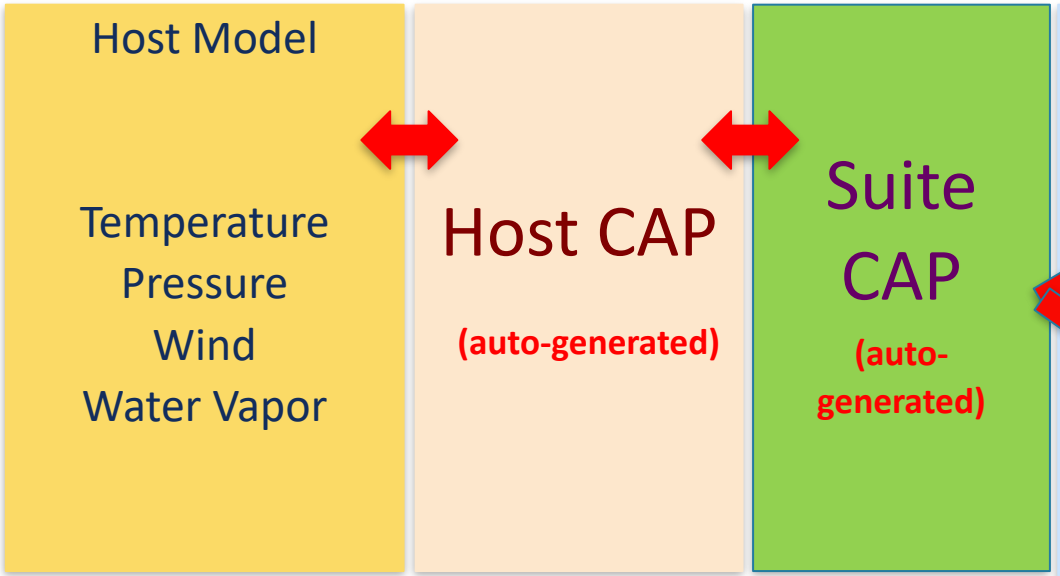
- All CESM components have NUOPC "caps"
- CMEPS planned as default architecture for CESM2.3 and beyond

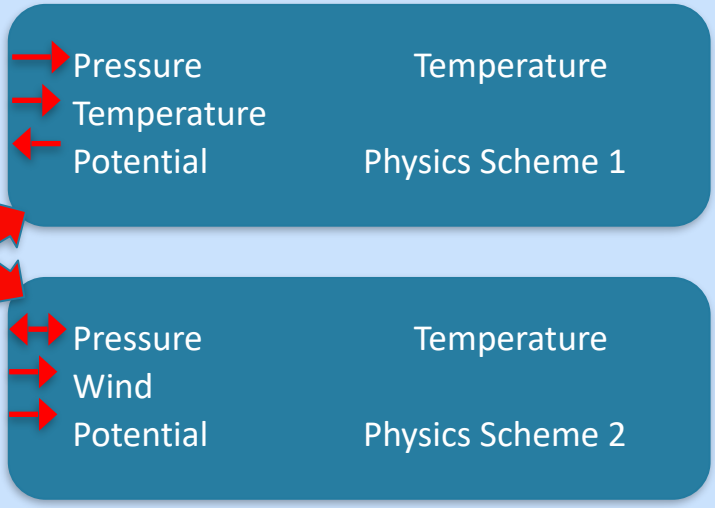
New Predictive Workflow using CIME

(more details Wed. at 1:40 pm)



Common Community Physics Package Framework (CCPP)





Each scheme comes with metadata (as does the host)

The schemes are assembled into a suite

The CCPP Framework then **auto-generates the CAP code so the host model can call the suite**

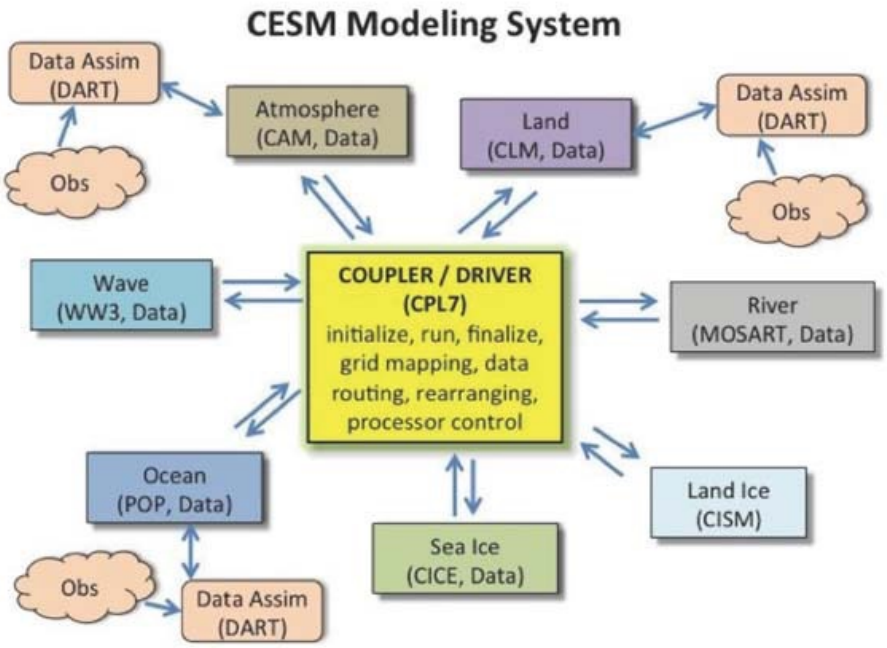
Key benefits:

- Supports portable atmospheric physics
- Physics testbed enables functional development and testing of new or existing physics schemes

```
<suite name="sample"
                version="1.0">
  <group name="physics">
    <scheme>scheme1</scheme>
    <scheme>scheme2</scheme>
  </group>
</suite>
```

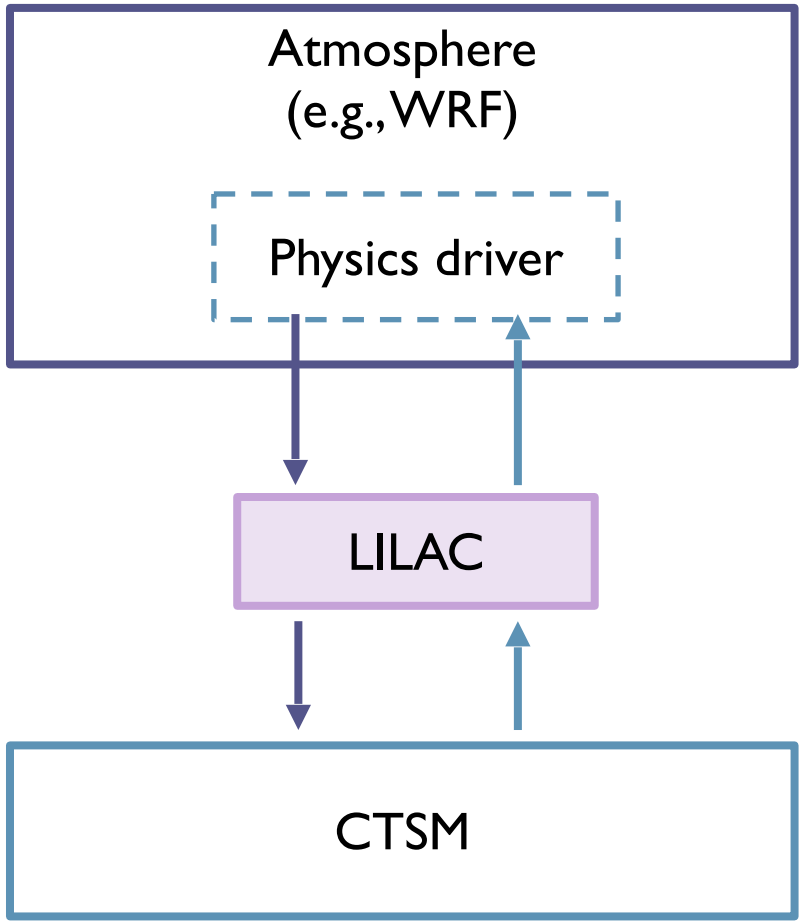
Lightweight Infrastructure for Land-Atmosphere Coupling (LILAC)

CESM hub and spoke architecture



(more details *Tuesday* at 8:45 am)

LILAC architecture



CESM Simpler Models: Update and Near-Term Plans

Currently available configurations

- SCAM (including a containerized version), Dry dynamical core, Dynamical core with idealized moisture, Radiative Convective Equilibrium aquaplanet, Aquaplanet

Configurations under development

- Gray radiation aquaplanet
- Coupled ocean aquaplanet (quasi-aqua and ridge-world)
- Pencil ocean model
- Single column earth system model (SCESM) – SCAM coupled to single-column ocean

Upcoming developments

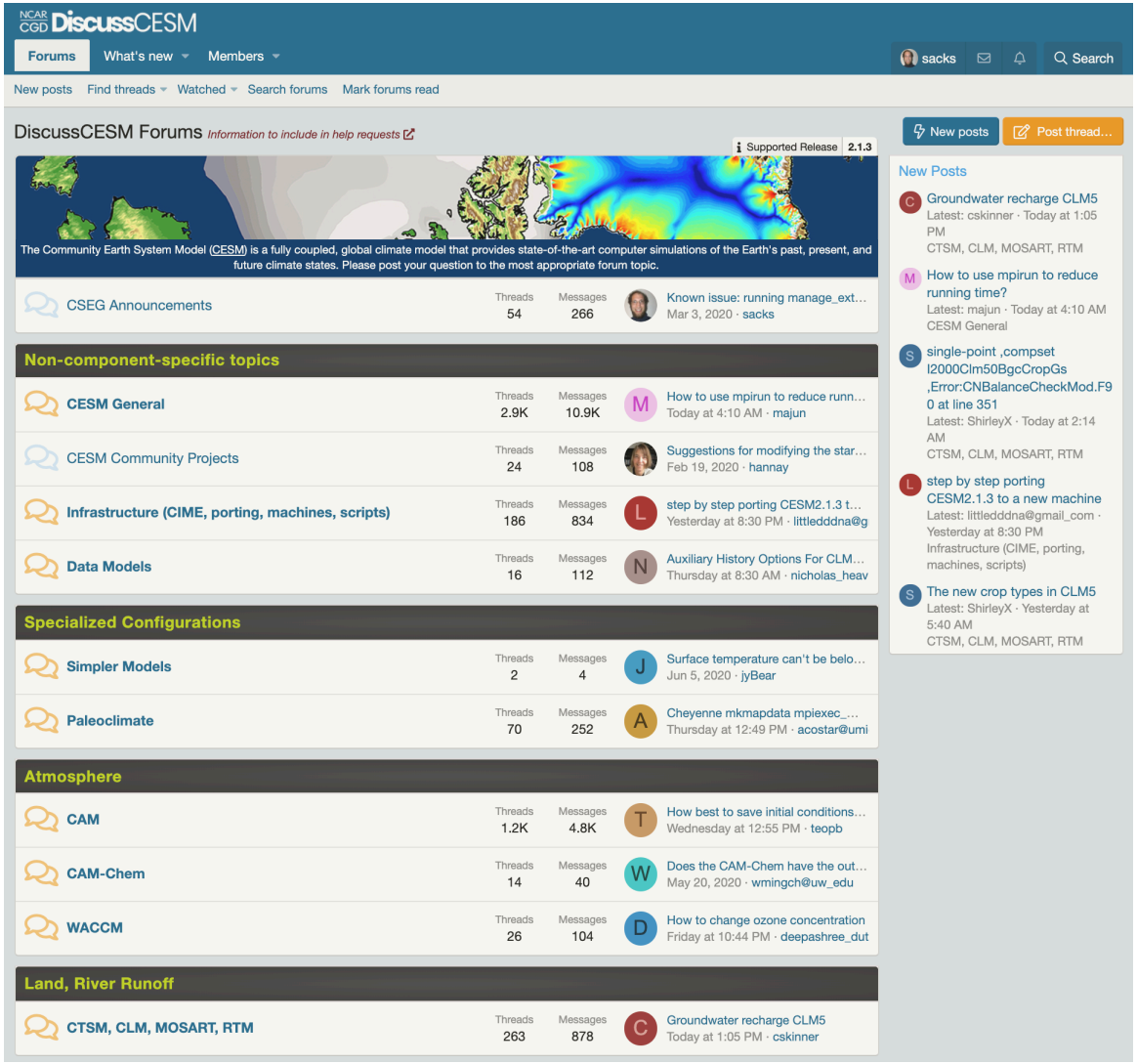
- Incorporation of Simple Land Interface Model (SLIM) into CESM
- Development of idealized coupled modeling toolkits: simpler models query tool, tools for generation of user-defined bathymetry, continental geometries, land surface types
- Incorporation of weak temperature gradient parameterizations into SCAM

CESM in the Cloud

Present	Researchers can use a validated, pre-installed CESM via Amazon Web Services (AWS): Standard Linux cluster environment, accessed via SSH Uses: • Research (Yale University, 200+ CESM runs on AWS) • Training (AGU/AMS workshops & others)
Coming Soon (2020)	Features: • Simpler deployment (single command!) • Expanded AWS regions, node types and networks • Automatic selection of most cost effective region, node and network! Information: • Performance benchmarks & cost estimates for common cases
Benefits	• Standard platform – easier problem-solving; all have identical "systems" • Fully configurable – we can manage dependencies, libraries, tools, etc.

Improved Community Forums

https://bb.cgd.ucar.edu/cesm/



Managing Model Output for CESM3

Please consider attending this discussion
Wednesday 2:45 – 4:30 pm

We'd like input from scientists as well as software engineers on these topics

- Standardizing model output across components
- MIP compliance
- Default output volumes
- Compression (lossy & lossless)
- Timestamps for averaged fields
- Time slice vs. time series format (output from model)
- How do we get funding for I/O initiatives?