CSEG Update

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CESM Software Engineering Group
1. Inter-component: addition of new component – MOM6
2. Inter-component: new interoperability for CTSM – LILAC
3. Inter-component: regional CESM capability - CRESM
4. Intra-component: configuring MARBL in the ocean host model
5. Workflow in CMIP6
Addition of new component to CESM - MOM6

Alper Altuntas
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Frederic Castruccio
Scott Bachman
Two new *layered* GitHub repositories based on GFDL’s repository organization to facilitate CESM coupling and to streamline collaboration with GFDL:

- **github.com/NCAR/MOM6:**
  - Core MOM6 source code + MCT/NUOPC caps

- **github.com/NCAR/MOM6-cases:**
  - CIME compatibility is here (**not** MCT/NUOPC caps)
  - FMS inclusion is here
  - Encapsulates NCAR/MOM6 as a submodule
  - Analogous to (yet independent of) GFDL’s MOM6-examples

**Online Wiki:** [https://github.com/NCAR/MOM6-cases/wiki](https://github.com/NCAR/MOM6-cases/wiki)

Installation, usage, quick-start, etc.
MOM6 in CESM

• **Compliance with CIME case control system:**
  • Interfaces MOM6 with CIME scripts.
  • Contains FMS code base
  • Controls build, configuration, model inputs, outputs, archiving, etc.

• **Compliance with CIME MCT driver:**
  • Added to MOM6 repository.
  • Makes use of CIME and FMS (GFDL) libraries.
  • Implemented MCT interfaces
    • ocn_init_mct, ocn_run_mct, ocn_final_mct
  • NUOPC cap will go here as well
  • Fully Doxygenized.
MOM6 in CESM

• **Current Status**
  • Repository organization and synchronization with GFDL established.
  • Addition of MCT cap
  • Implementation of C and G compsets
  • Established operational testing workflow (both internally and collectively with GFDL).
    • continuous integration using Travis for each PR submitted to MOM6-cases
    • MOM6 regression tests (55 in total) run when NCAR and GFDL forks are merged

• **Next Steps:**
  • Complete implementation of parameterizations used in POP (e.g., CVMix, EBM).
  • Implement CIME system testing infrastructure
  • Add lightweight diagnostic tools (based on GFDL's diagnostics approaches)
  • Develop additional compsets and run additional experiments
  • Release a CESM2+MOM6 branch tag by Summer 2018.
Current MOM6-CESM Validation Status

Control experiments (C and G compsets):
• G compsets successfully run for 100 years. (Normal year forcing)
• Ocean coupling interval set to 30 mins.

Grids: (all have 62 vertical levels)
• gx1v6
  • Based on 1° POP grid.
• tx0.66v1
  • A new grid for MOM6+CESM
  • Tripolar, nominal 2/3° horizontal resolution.

• Performance (G compsets, gx1v6, 360 cheyenne cores)
  • POP:~43 years/day   MOM6: ~22 years/day
New Interoperability for CLM (CTSM)
LILAC
Lightweight Infrastructure for Land Atmosphere Coupling

A tool for easy integration of the Community Land Model into multiple modeling systems

Ben Andre and Bill Sacks
Key LILAC Goals:

• Develop lightweight, coupling infrastructure to facilitate an atmosphere model directly calling CTSM from its init and run loop rather than requiring host atmosphere to be a component of CESM to couple to CTSM

• Develop capabilities for CTSM to fill in required missing fields (e.g., aerosol deposition) not provided by host atmosphere model

• Simplify CTSM's tool-chain for creating input datasets

• Develop faster methods for creating spun-up CTSM initial conditions required for target host model

• Target atmosphere components to couple CTSM via LILAC - WRF, MPAS-A, SAM, COSMO
CPL7 requires one run phase for any coupled component. CAM must finish its run phase before communicating with driver.

With LILAC, atmospheric component is not restricted to one run phase, and CLM can couple to atmosphere anywhere in its run phase.
Grid file for ocean domain

Create TATM-Ocean mapping file

TATM-Ocean mapping file

Create land mask (on land grid)

CLM domain file

Input to tool-chain

Mapping file for each CLM raw dataset (15)

Create surface dataset (on land grid)

CLM surface dataset

Intermediate file

Input to CLM

Program that must be run manually

LILAC goal - develop a next-generation implementation of tool chain making it easy for non-experts to perform this task.
Regional CESM

Kate Thayer-Calder (CSEG)
Jaison Kurian (TAMU)
Rafaelle Montouro (CIRES)
Ping Chang (TAMU)
Community **Regional** Earth System Model (CRESM)

- Joint TAMU (Texas A and M University) and NCAR effort
- Build a regional version of CESM using WRF (atm) and ROMS (ocn)
- All components are coupled with and integrated into the CIME case control system and coupling architecture
- Provide a more user-friendly experience than typical for regional models.
- Allow for higher resolution modeling in both time and two way atmosphere-land-ocean feedbacks
CRESM Status

• Current development version supports several configurations including:
  → WRF atmosphere, CLM land, Data Ocean (PK compsets)
  → fully CROMS Ocean, Data Atmosphere (PR compsets)
  → coupled WRF, CLM, and ROMS (PB compsets)
• Current – all compsets are now working – but need a clean-up and testing phase.
• Future – addition of user-friendly support for more grids and boundary forcings, scientific applications (e.g. tropical waves), a more recent WRF version
Community Regional Earth System Model (CRESM)

- Fully Coupled Gulf of Mexico January 2010 test case

WRF surface skin temp
WRF is seeing the ROMS surface temp

ROMS surface temperature
Smaller ROMS domain (e.g. see Florida) with missing edge data filled from the data ocean component does not seem to effect results

Atm/Ocn fluxes
Look reasonable
Interoperability of parameterizations: New python capability in MARBL

Mike Levy
Keith Lindsay
Matthew Long
Python Scripts in MARBL (1)

• New MARBL capability to generate MARBL input parameters (marbl_in)
  • MARBL input parameters and diagnostic variables are defined in YAML (not XML)
  • Why YAML: human-readable (and comments are allowed!)
  • Drawback of YAML: PyYAML not in standard lib
  • Solution: developers edit YAML and then run a script to convert to JSON. Python scripts read the JSON (which is in standard lib).

• Longer term goal: auto-generate Fortran code
  • Use JSON dictionaries to generate F90 code that define parameters (lots of repeated code)
  • (Currently, information is duplicated between F90 and YAML files)

Example from the diagnostics YAML dictionary; this particular diagnostic is only enabled when running with the carbon isotope tracers.
Python scripts in MARBL (2)

• New MARBL diagnostic capability
  • MARBL now provides a list of diagnostics with associated averaging frequencies (via python + YAML)
  • Ocean host model (e.g. POP) reads this list and updates its history file configuration to include the MARBL diagnostics appropriately
  • Ocean host model should not need any semantic knowledge of MARBL parameters or its diagnostic - doesn’t know anything about MARBL configuration unless MARBL explicitly shares it

• Example
  • “ciso_on” is a MARBL variable enabling carbon isotopes
  • If “ciso_on” is true, MARBL tells POP to expect 14 more tracer tendencies from MARBL and include additional diagnostics
Workflow in CMIP6

Alice Bertini
Sheri Mickelson
Kevin Paul
John Dennis
CESM2.0 Experiment Database (expert knowledge – manual)
experiment case reservations, metadata archival and status information

Cylc Workflow Engine (state machine that is automated)

CESM python based parallel post-processing tools

Cylc Workflow Engine

CESM2.0 Experiment Database

Conversion to Time Series

Conform to Experiment Specification

Diagnostics

Publication ESG & DSET
CESM python based parallel post-processing tools
http://github.com/NCAR/CESM_postprocessing

• Diagnostics
  • NCL-based atmosphere, land, land-ice, sea-ice, ocean
  • Python-based ILAMB/IOMB land and ocean biogeochemistry
  • High-resolution ocean (0.1 degree)

• Single variable time series generation

• CF-compliant conformer tool

• Support for Cheyenne and Geyser

Thanks to Alper Altuntas(NCAR), Ben Andre(NCAR), Nate Collier (ORNL), Jan Laenerts (CU)

* Updates in the last year
CESM Workflow Automation for CMIP6 using Cylc

You can now run a script that will:

- create the CESM case
- setup the full post-processing environment
- create a Cylc suite for them customized to user’s settings.
- once you build CESM and hit a run button on the Cylc GUI - everything will be ran for you (archiving, diagnostics, timeseries conversion, variable standardization)
- order dependencies will be preserved
- An example workflow is shown here.

https://cylc.github.io/cylc/
https://github.com/NCAR/CESM-WF
Experiment database provides ability to reserve a case name, track the status of the various runs that are occurring and interface with the publication of the data.
Questions?
Extra Slides
How do CESM Users Change MARBL Configuration?

• Changing parameters in `marbl_in`
  - Edit `user_nl_marbl` in `$CASEROOT` (note that this file is not automatically created by CIME scripts otherwise process is identical to any other CESM component)
  - POP will not allow changes in `user_nl_marbl` that change tracer count if `BUILDCOMPLETE=TRUE`

• Changing diagnostic output from MARBL
  - Python scripts generate `$CASEROOT/Buildconf/popconf/ecosys_diagnostics`, which can be copied to `SourceMods/src.pop/` and edited
  - For consistency, this file also contains ecosystem-related diagnostics that POP generates (e.g. forcing fields and tracer state)
Cylc, CMIP6 and CESM2.0 Experiments Database Workflow Steps

1. Reserve a CESM casename for a CMIP6 experiment using the CESM2.0 web interface
2. Setup a cylc suite for new reserved casename
3. Cylc automatically calls caseroot archive_metadata script to interact with CESM2.0 experiments database
4. Cylc suite sends automatic status email updates to CESM2.0 experiments database
5. CESM2.0 web interface manual interaction for publication to ESG and DSET
Subroutine in buildnml uses a wrapper to a [MARBL-owned] python class to create marbl_in