Common Infrastructure for Modeling Earth (CIME) and MOM6

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Outline

- What is CIME?
- New CIME coupling infrastructure and MOM6
- CESM2/DART Data Assimilation
- Next Steps in CIME/CESM development
CIME
(new python-based CESM infrastructure)

Paradigm for DOE, NOAA, NSF Infrastructure Collaborations

- Infrastructure
  - PUBLIC Open Source Github Repository

- Driver-Coupler Data Models
- Scripts
- System/Unit testing
- Mapping Utilities

Science code
- Restricted or Public Repositories
  - CESM
  - MPAS/WRF
  - DOE/ACME
  - ESPC and/or NOAA/NEMS

addresses needs of multiple efforts
Configure/Build/Testing/Archiving Scripts
all python based as of CIME5

Mapping weight generation and checking tools (ESMF_Regrid and runoff map maker)

Statistical Verification Tool (PyCECT)

 workflow Tool (Cylc)

Post Processing/ Diagnostics

CIME

Data Models

Driver/Coupler

Externals

PIO

MCT

Timers
Both MCT and NUOPC caps

Configure/Build/Testing/Archiving Scripts
all python based as of CIME5

Data, Stub, CPLTest Models

Configure/Build/Testing/Archiving Scripts

CORE CIME functionality

CMEPS: Community Mediator for Earth Predictive Systems In Progress

CPL7

MCT Driver/Mediator

CMEPS

NUOPC Driver/Mediator

Externals

PIO

Timers

MCT
CIME – New Coupling Infrastructure and MOM6
Current CESM Coupling (cpl7) – data components permit flexible activation/deactivation of feedbacks

Short term – MOM6 will be made CPL7 compatible – HOWEVER – CESM is moving to a new ESMF NUOPC Driver/Mediator
Moving Forwards: New NUOPC Driver/Mediator will enable community collaboration with NGGPS
Advantages of NUOPC Infrastructure

- Data-driven run-time configurable sequencing of driver phases
  - currently this is all hard-coded and fragile
- Run-time generation of mapping weights
  - Eliminates need to compute AND maintain growing number of mapping files generated offline
- Support of ESMF/NUOPC
  - The ESMF group is committed to supporting the needs of CESM as this infrastructure is implemented and deployed
CMEPS
Community Mediator for Earth Predictive Systems

- An alternative inter-component coupling infrastructure in CIME
- Based on the NOAA Environmental Modeling Center (NEMS) mediator.

- Goals:
  - have CMEPS v0 replicate the current CPL7 functionality
  - have all CESM components be CMEPS v0 compliant by year’s end.

- Status: have a version working with CIME data and cpl-test components and CIME testing infrastructure
  - Thanks to Tony Craig and lots of partnership from the ESMF group
Possible new CMEPS collaborations

- **NOAA EMC:**
  - CMEPS could be run at NOAA EMC as a possible replacement for the NEMS mediator since it is so closely based on the NEMS mediator.

- **GFDL:**
  - Weekly calls started with ESMF and GFDL to explore collaborating on a common CMEPS mediator

- Increasing collaborating with NOAA research and operations was a recommendation from NCAR NSF SVT.
Coupling Infrastructure and CESM/DART Data Assimilation
Data Assimilation in CESM

- CESM uses the DART ensemble Kalman Filter for file-based data assimilation.
- Requires CESM to run multiple-instance simulations.
- **Two big performance bottlenecks:**
  1. Only *one* coupler instance versus *multiple* component instances.
  2. CESM and DART are run as separate executables, system must start and stop for each assimilation cycle.
Current DART/CESM architecture

- Atmosphere (CAM)
- Land (CLM)
- Ocean (POP)
- SEA ICE (CICE)
- River-Runoff

DART

atm obs

ocn obs
Solution to Bottleneck 1: Multiple couplers (imminent)

Multi-coupler functionality created by Rafaelle Montuoro (NOAA/ESMF)
Solution to Bottleneck 2:
New ESP component allows DART to interact directly with component data via I/O files
New ESP component will facilitate coupling with data assimilation

- **Status**
  - New data ESP component introduced in CIME
  - Pause/Resume has been implement in coupler and POP

- **Next Steps**
  - DART will be a prognostic ESP component of CESM coupled system
  - Other CESM components will implement Pause/Resume (CAM is next)

- **Future enhancements**
  - Pause/Resume can also be extended to Pause/Rewind – to explore new approaches to fault tolerance
  - Implement in-memory communication between DART and CESM

New ESP component created by Steve Goldhaber (NCAR)
Next Steps for CESM/CIME development
Next Steps in CIME/CESM development

- Move all CESM prognostic components to github!
- Create CMEPS v0 NUOPC driver/mediator in CIME that duplicates the functionality of the current CESM cpl7 MCT driver/mediator
- Incorporate DART as an ESP component and pause/resume functionality in the CESM system
Thank you!

Questions?