Ocean BGC Plans for CESM2

BGCWG Co-Chairs

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- Scientific Developments in CESM 1.2
- Scientific Developments for CESM 2.0
- Infrastructure Developments for CESM 2.0
- Coupled BGC Runs with CESM 1.2+

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Ocean BGC Dev: CESM1.2 release

- Address model biases identified in CESM 1.0
  - Excessively Large Subsurface Oxygen Minimum Zones
  - Surface Chl distributions
  - Distribution of Fe:C ratios
- New Functionality
  - Generalization of functional group implementation
  - Riverine Inputs of BGC tracers (prescribed for now)
  - Loss to Sediments
  - Diagnostic PI DIC tracer
- Evaluated in Ocean-Ice Experiments

Key Coupled Biases and Functionality being targeted with CESM2: BGCWG

- Reduce bias in global carbon budget in 20C experiments
- Coupled Isotopes
- Enhanced BGC-Chem coupling
  - Fully coupled CH_4 cycle
  - More N cycle couplings
  - Ocean → Atmosphere (e.g. DMS)
- More BGC coupling
  - Sea Ice ←→ Ocean Sea
  - Land → Ocean

Scientific Developments Targeted at CESM 2.0

color denotes coupling to non-ocean components

- H_20, C, C, N Isotopes
- Treatment of light under sea ice categories
- Ocean Acidification feedbacks
- Methane module (air-sea flux)
- Couple to sea ice BGC
- DMS module (air-sea flux)
- Fe in Sea-Ice
- Optional Phaeocystis functional group
- Coupled riverine inputs
- N emissions (NH_4, N_2O)
- Spatially varying iron ligand
- Explicit calcifier functional group

Infrastructure Developments Targeted at CESM 2.0

- Infrastructure for NK spinup
- Support for offline tracer tools
- Modularized BGC core

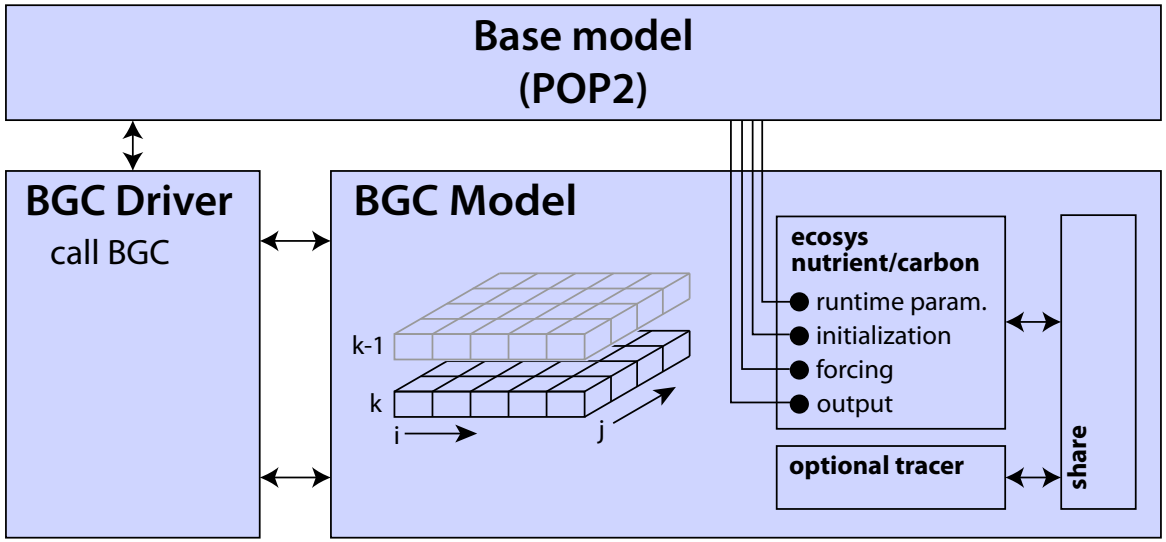
Modular biogeochemical modeling for next-generation ocean models

MARBL

Marine Biogeochemistry Library

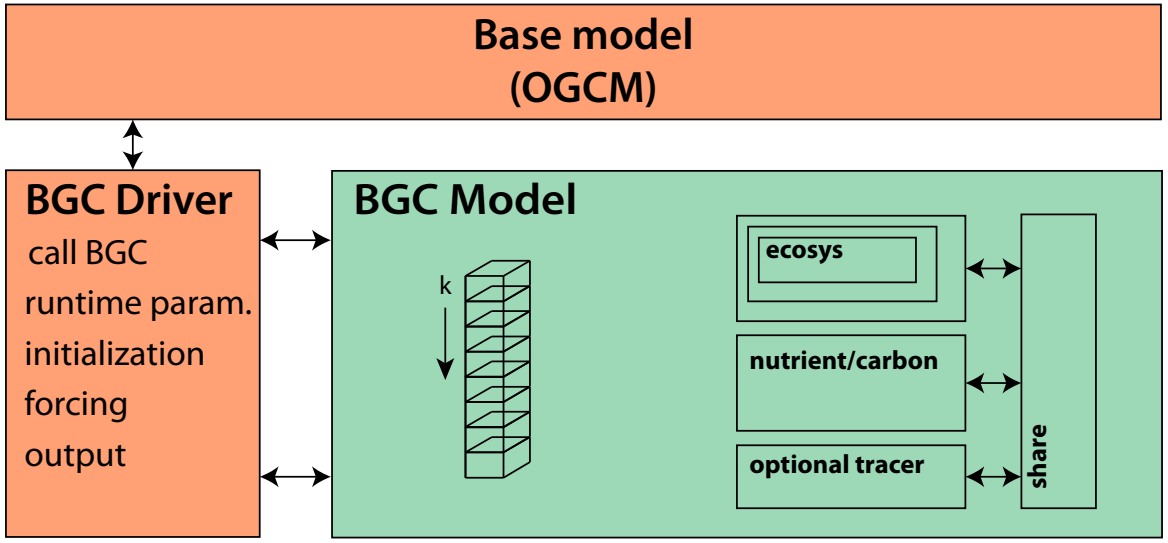
Objectives

1. Enable portability to alternate physical frameworks.
2. Enable question-dependent configuration.
3. Improve physiological and ecological realism.



⟸ Existing model

Proposed re-design ⟹



Benefits of MARBL Infrastructure Planned for CESM2

- Portability of BGC code to GCMs beyond POP
  - MPAS-O
  - ROMS
  - Offline transport models
- Online computation of Jacobian of BGC tendency terms (for fast spinup)

Objectives of Coupled Carbon Cycle Runs w/ CESM 1.2+

- Determine impact of updated model on biases from CESM1(BGC)
- Identify remaining/new biases in time to address for CESM2(BGC)
- Do science that is not possible with CESM1(BGC)
- Practice run for BGC coupling before CESM 2

Model Updates in CESM 1.2+ Runs

- CAM5 physics, Finite Volume Dy Core
  - Include radiation bug fixes since Large Ensemble
- POP physics
  - Increased lateral mixing
- CLM45BGC
  - Fire module fix since CESM 1.2
  - Updated historical land use dataset
- CESM 1.2 version of BEC
  - Treatment of light under sea ice categories
  - DOM, Fe:C updates

Original Timeline for CESM 1.2+ Runs

- Put together physical model (2 weeks)
- Tune radiation for 1850 (2 weeks)
- Run coupled model for O(200-300) years (2-3 weeks)
- Generate surface forcing for surface BGC spinups (days)
- *Merge ocean BGC updates (1 week)
- Brute force surface BGC component spinups (4-6 weeks)
- Incrementally coupled BGC (1 week)
- Coupled Carbon 1850 Control Experiment (2 weeks)
- Coupled Carbon Transient Experiments
  - 1 week for historical
  - More for RCP, ECP extensions

Status of CESM 1.2+ Runs (and lessons learned)

- About to start brute force spinups
  - First 2 months of work has taken 3+ months
- Parts of infrastructure for CPLHIST runs was broken
  - If you don't test it, it gets broken
  - We are coordinating w/ CSEG to avoid this breakage between now and CESM 2
- Code merges take longer than you expect
  - Get code to trunk ASAP
    - Getting code trunk ready takes longer than you expect