

# Update on BGCWG Activities, June 2015

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- PI driven science
- Developments targeted for CESM2
- CESM(BGC) in CMIP6
- Coupled carbon experiments with CESM1.2+

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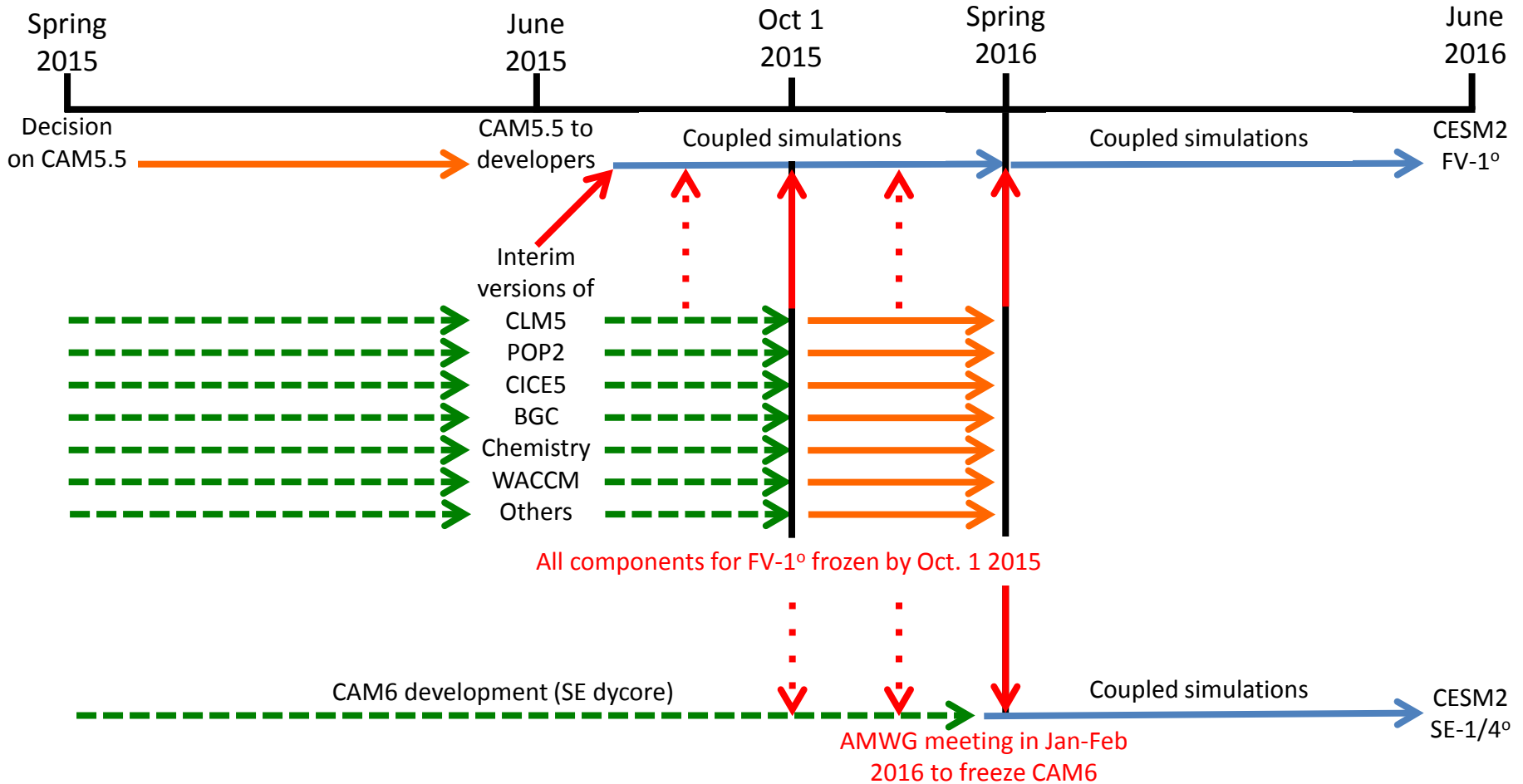
# PI Driven Science

- Analysis of CESM1(CAM5,BGC) Large Ensemble
  - [www2.cesm.ucar.edu/models/experiments/LENS](http://www2.cesm.ucar.edu/models/experiments/LENS)
  - BGC same as in CESM1
  - 1850 Control, 2200 years long
  - 20C,RCP8.5 Transients, 1920-2100
  - 30+ ensemble members
  - 10 new members with different 1920 IC
  - 15 ensemble members have RCP4.5 companion runs

# PI Driven Science (cont)

- Extensions of CESM1(BGC) RCP8.5 experiments to 2300, including climate-carbon cycle feedback sensitivity experiments
- Randerson, et al. (2015), Multicentury changes in ocean and land contributions to the climate-carbon feedback, GBC.

# Timeline for CESM2



→ Code delivery

...→ Potential code delivery

- - - → Potential code development

→ Assembling and optimizing coupled model

# Key Coupled Biases and Functionality being targeted with CESM2: BGCWG

- Bias Reduction
  - Global carbon budget in 20C experiments
  - Ocean BGC biases ( $O_2$  min zones, surface Chl, ...)
- Inclusion of Coupled Isotopes ( $H_2O$ , C)
- Enhanced BGC-Chem coupling
  - Fully coupled  $CH_4$  cycle
  - More N cycle couplings
  - Ocean  $\rightarrow$  Atmosphere (e.g. DMS)
- More BGC coupling
  - Sea Ice  $\leftrightarrow$  Ocean Sea
  - Land  $\rightarrow$  Ocean

# Ocean BGC Scientific Developments in CESM 2.0

color denotes coupling to non-ocean components

- $H_2O$ , C, C, N Isotopes
- Treatment of light under sea ice categories
- NH emissions
- Methane module (air-sea flux)
- DMS module (air-sea flux)
- Optional Phaeocystis functional group

# Ocean Infrastructure Developments Targeted at CESM 2.0

- Modularized BGC core
  - MARBL project (SciDAC funded)
- Infrastructure for Newton-Krylov based fast tracer spinup
- Support for offline tracer tools

# Target CESM2 Model Configurations for CMIP6

- CAM5.5, FV-1°
  - WACCM, Atm Chem, Atm-Lnd-Ocn BGC (8.5x)
  - Atm-Lnd-Ocn BGC (1.6x)
  - Lnd BGC (1x)
- CAM6, SE-¼°
  - Lnd BGC (150x)
- Standard CMIP Runs
  - AMIP (~1979-2014), PI Control, 1%/yr CO<sub>2</sub> increase, Abrupt 4xCO<sub>2</sub> increase, Historical (1850-2014)



# Candidate MIPS for CESM(BGC)

- C4MIP: Coupled Climate Carbon Cycle
- DAMIP: Detection and Attribution
- DCPP: Decadal Climate Prediction Project
- GeoMIP\*: Geoengineering
- PMIP: Paleoclimate
- ScenarioMIP

# CESM 1.2+ Coupled Carbon Cycle Experiment Objectives

- 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
  - C isotopes ( $^{13}\text{C}$ ,  $^{14}\text{C}$ )
- CESM 1.2+ version of BEC
  - Treatment of light under sea ice categories
  - DOM, Fe:C updates
  - C isotopes ( $^{14}\text{C}$ )

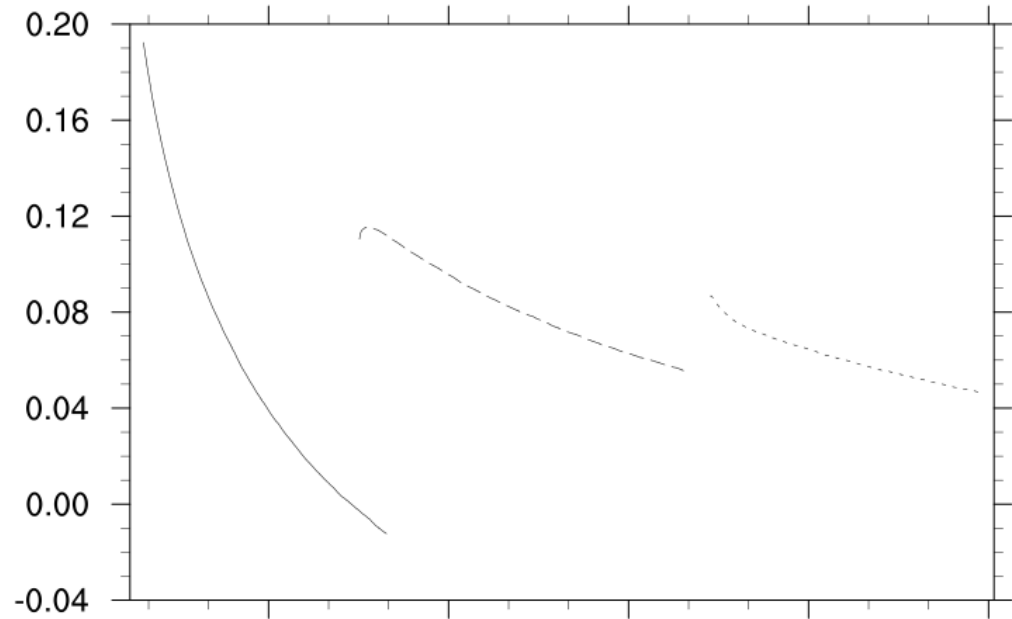
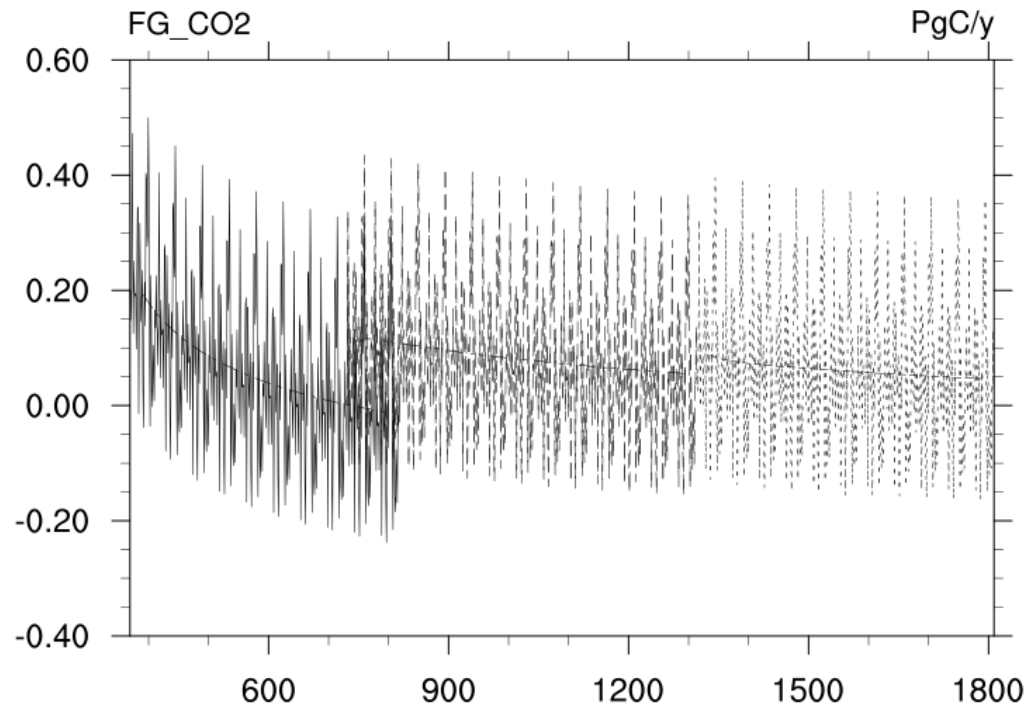
# Status of CESM 1.2+ Runs

- Ocean spinup is ongoing
  - total tracer run length = 1530 years
  - has run 495 years in final configuration
  - CO<sub>2</sub> flux is ~0.045 PgC/yr into ocean
  - Separate fast spinup for <sup>14</sup>C in prep
- Land spinup (with C isotopes) done
  - spinup mode: 450 years
  - post spinup mode: 540 years
  - Negative XSMRPOOL values seem potentially problematic for isotopes. The issue is under investigation.

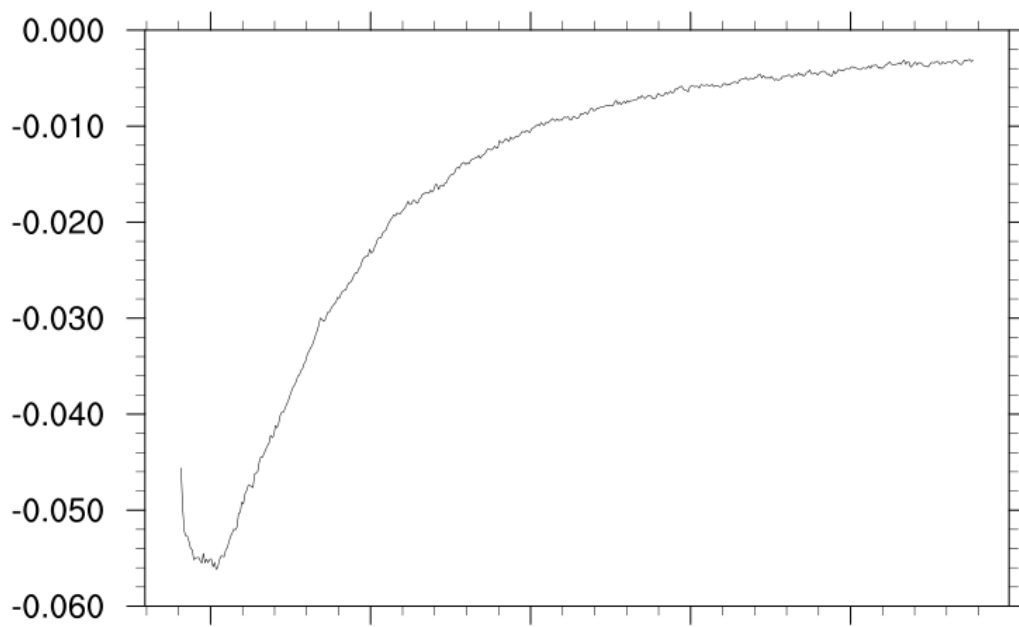
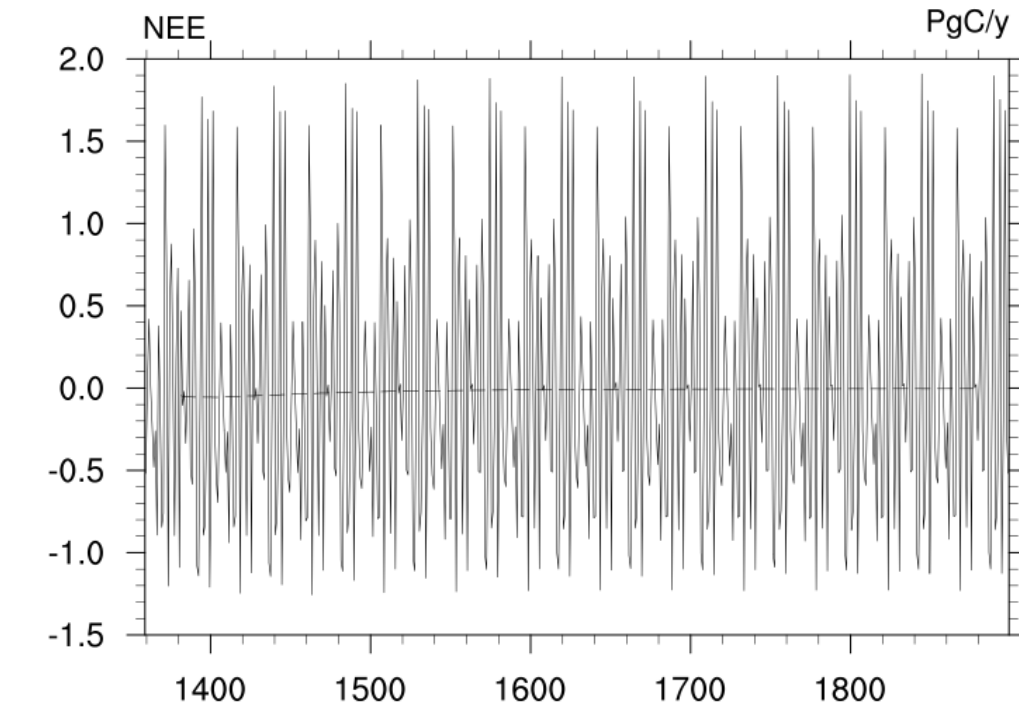
# Global C Budget Issue Uncovered

- Riverine C inputs to ocean are prescribed and not coupled to CLM
- Burial of C in sediments is lost from system
- Source and sink did not balance
- Implemented solution is to scale sediment burial (on the fly) to balance riverine inputs

# g.e13b13.GECO\_Bforced.f09\_g16.007



# i.e13b13.l\_Bforced.f09\_g16.004



# Next Steps for CESM 1.2+ Runs

- Incrementally couple BGC components together using spunup state, leading to 1850 control run
  - first run with prescribed atm CO<sub>2</sub>
  - switch to prognostic prognostic atm CO<sub>2</sub>
- Branch 20C transient runs from control