Update on BGCWG Activities
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• BGC features in CCSM4/CESM1
• CMIP5 Runs with BGC
• Developments in Progress
What is in the CESM1 release

- POP Ecosystem model (first release)
  - Default: Off
  - Online User’s Guide
  - Scientific Reference in prep

- CLM features (in CCSM4 release)
  - Carbon-Nitrogen Model, Default: On
  - Land Cover & Land Use Change (LCLUC)
  - Dynamic Global Vegetation Model (DGVM)
  - Crops (CESM 1.0.3)

- CAM CO$_2$ features (first release)
  - Default: Off
  - CO$_2$ constituents that use LND & OCN CO$_2$ fluxes as surface boundary condition
  - Pass CO$_2$ to driver for LND & OCN flux computations
  - Couple CO$_2$ constituents to radiation computations
What is in the CESM1 release

- New BGC compsets (i.e. works out of the box)
  - Spun-up Initial Conditions

- Diagnostics from 30 year segment of 1850 controls
  - no ATM CO$_2$ or Ocean BGC yet

- Model Output from 30 year segment of 1850 controls
New BGC Compsets

• Model configurations that work out of the box

• Coupled
  • BGC & Radiation uses prognostic (predicted) CO$_2$
  • BGC & Radiation uses diagnostic (prescribed) CO$_2$
  • 1850 Pre-industrial & 20$^{th}$ Century configurations

• Ocean Alone w/ BGC
New BGC Compsets

• Terminology
  – BGC CO₂: used by BGC in surface components
  – RAD CO₂: used by ATM radiative code
  – Prognostic CO₂: predicted ATM concentrations
  – Diagnostic CO₂: prescribed ATM concentrations

• B_1850_BGC-BPRP
  • BGC CO₂ = Prognostic, RAD CO₂ = Prognostic

• B_1850-2000_BGC-BPRP

• B_1850_BGC-BDRD

• B_1850-2000_BGC-BDRD

• C.NORMAL_YEAR_ECOSYS
Spun-up Initial Conditions

• IC’s are provided for coupled compsets
  – Uses physics of CAM4

• Resolution
  – ATM/LND: 0.9x1.25
  – OCN/ICE: gx1v6

• Ocean Alone IC are provided for gx1v6, gx3v7, but are not spun-up
CMIP5 Long-Term Experiments
Preindustrial Control Simulations

- Sequential spin-up procedure for land & ocean components
- Stable preindustrial controls
  - atmosphere within either +2 or +4 ppmv over 1000 yrs
- Some small drift with ocean outgassing & land uptake (15-20 Pg C or ~7-10 ppmv CO₂)
- Run with CO$_2$ emissions (prognostic CO$_2$) or prescribed CO$_2$
- CESM1 positive atmospheric CO$_2$ bias (+20 ppmv) for both Prognostic & Prescribed CO$_2$
- no significant temperature impact from CO$_2$ bias
20th Cent. Carbon Fluxes

Global Carbon Project estimates (2000-2009) w/ 1σ error

Le Quere et al., Nat. Geosci. 2009
Friedlingstein et al. Nat. Geosci. 2010

2.4 +/− 0.7
Land Developments

- Unstructured Grids
- Revised GPP and multi-layer canopy
- Cold region hydrology
- 2-way CLM-RTM interactions
- Process based methane emissions
- Vertically resolved C & N dynamics
- Revised lake model
- Faster C cycle spinup procedure

- Riverine transport of BGC quantities
Ocean BGC Developments

• Functioning Diagnostics Package
• Fe/C stoichiometry, growth and grazing updates
• River Inputs of Nutrients
• Improved DOM cycling
• Coupling to a simple sediment model
• NH$_3$, N$_2$O surface emissions
• Ocean Acidification Feedbacks
• Enhancement of Calcifying Functional Groups
• Treatment of Sea-Ice Heterogeneity
  – PAR yes, sinking particles maybe
• Isotopes (C, O$_2$, N)
• Couple to Sea-Ice Algae
• Methane
• Get Newton-Krylov fast spinup working at x1