Status of BGC in CESM1

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What is in the CESM1 release

• POP Ecosystem model (first release)
  – Online User’s Guide
  – Scientific Reference in prep

• CLM features (in CCSM4 release)
  – Carbon-Nitrogen Model
  – Land Cover & Land Use Change (LCLUC)
  – Dynamic Global Vegetation Model (DGVM)

• CAM CO₂ features (first release)
  – CO₂ constituents that use LND & OCN CO₂ fluxes as surface boundary condition
  – Pass CO₂ to driver for LND & OCN flux computations
  – Couple CO₂ 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
  – in progress
New BGC Compsets

• Terminology
  – BGC CO$_2$: used by surface components
  – RAD CO$_2$: used by ATM radiative code
  – Prognostic CO$_2$: predicted ATM concentrations
    • computed from LND and OCN CO$_2$ fluxes
  – Diagnostic CO$_2$: prescribed ATM concentrations

• B_1850_BGC-BPRP
• 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
Status of Runs
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• Prognostic CO$_2$
  – 1850 Control 526 years
  – 20$^{\text{th}}$ Century 1 run done
  – 20$^{\text{th}}$ Century, 1850 RAD 1850-1871

• Prescribed CO$_2$
  – 1850 Control 308 years
  – 20$^{\text{th}}$ Century 1 run done
  – 20$^{\text{th}}$ Century, 1850 RAD 1850-1869
Prognostic CO$_2$ 1850 Control
Prognostic CO₂ 1850 Control

cumulative SFCO₂, black:net, red:ocn, green:Ind
Prescribed CO$_2$ 1850 Control

0.019 PgC/y
0.007 PgC/y
-0.013 PgC/y

Cumulative SFCO2, black: net, red: ocn, green: lnd
Nino 3.4 Variability

CCSM4, $\sigma=1.039$ (Obs=0.824)

CESM1, $\sigma=0.955$ (Obs=0.824)
Surface $\text{CO}_2$ in 20$^{th}$ Century Runs
Surface CO₂ in 20th Century Runs

![Graphs of Surface CO₂ Anomaly and Growth Rate](image-url)
CO$_2$ Surface Fluxes

![Graph showing CO$_2$ surface fluxes from 1860 to 2000 with different categories: Net, Ocean, Land (no LCLUC), LCLUC, and Fossil Fuel. The graph illustrates the increase in CO$_2$ fluxes over time, with significant contributions from Fossil Fuel emissions.]
Cumulative CO$_2$ Surface Fluxes
Cumulative Uptake vs. Surface CO$_2$

Graph showing cumulative uptake vs. surface CO$_2$ with lines representing different categories:
- Ocean, Prog CO$_2$, $\beta \sim 1.057$
- Ocean, Pres CO$_2$, $\beta \sim 1.0515$
- Land, Prog CO$_2$, $\beta \sim 0.67904$
- Land, Pres CO$_2$, $\beta \sim 0.75628$
Cumulative Land Uptake vs. Surface CO$_2$
Cumulative Ocean Uptake vs. Surface CO₂

- CESM1, Prog CO₂, $\beta \sim 1.057$
- CESM1, Pres CO₂, $\beta \sim 1.0515$
- CCSM3, Prog CO₂, $\beta \sim 0.93186$
Ocean Anthropogenic CO₂ & CFC11

CCSM3 - GLODAP

CESM1 - GLODAP