# Update on BGCWG for PaleoWG Feb 2012

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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

- 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

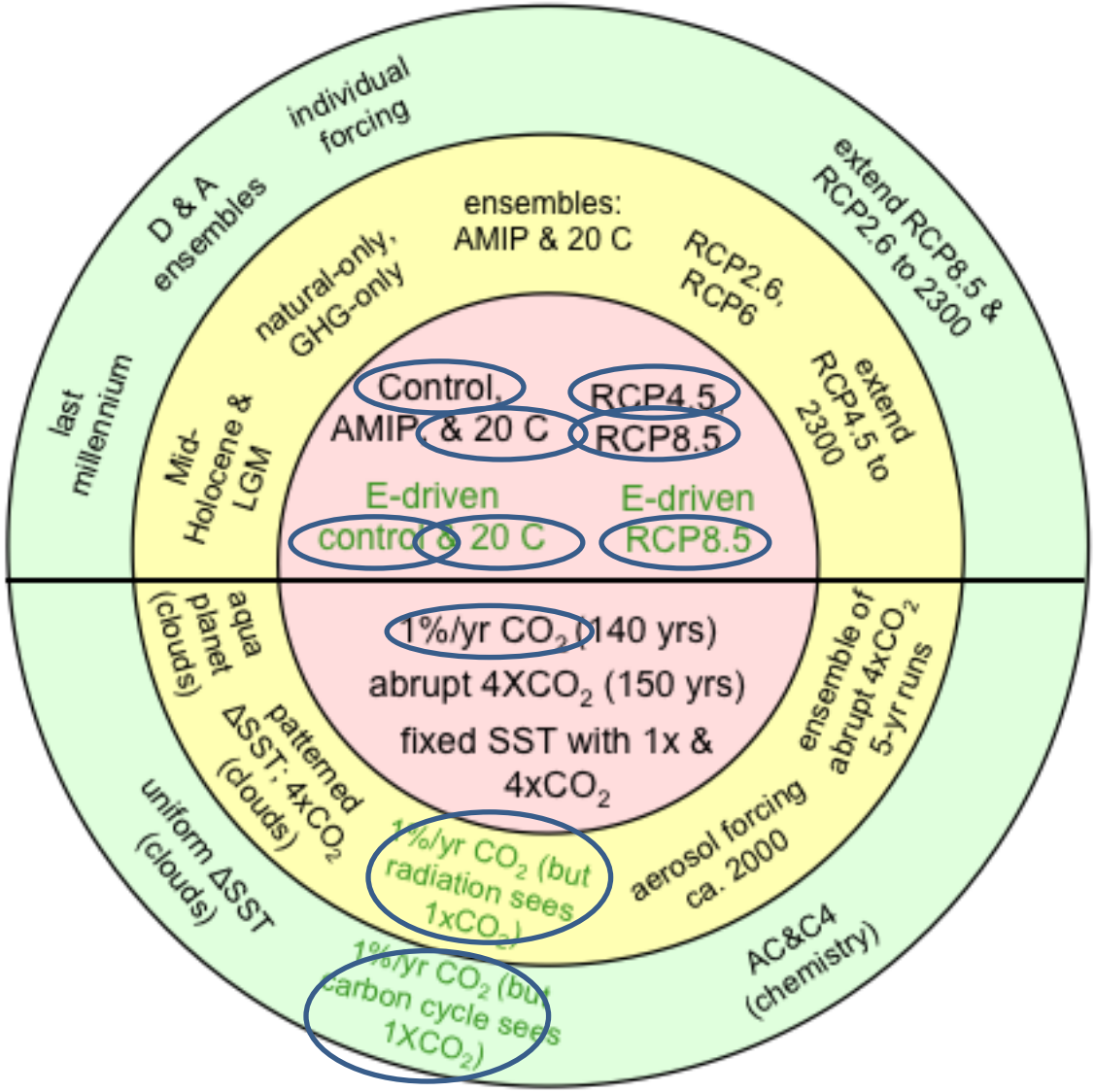
- B_1850_BGC-BPRP
- B_1850-2000_BGC-BPRP
- B_1850_BGC-BDRD
- B_1850-2000_BGC-BDRD

- C_NORMAL_YEAR_ECOSYS

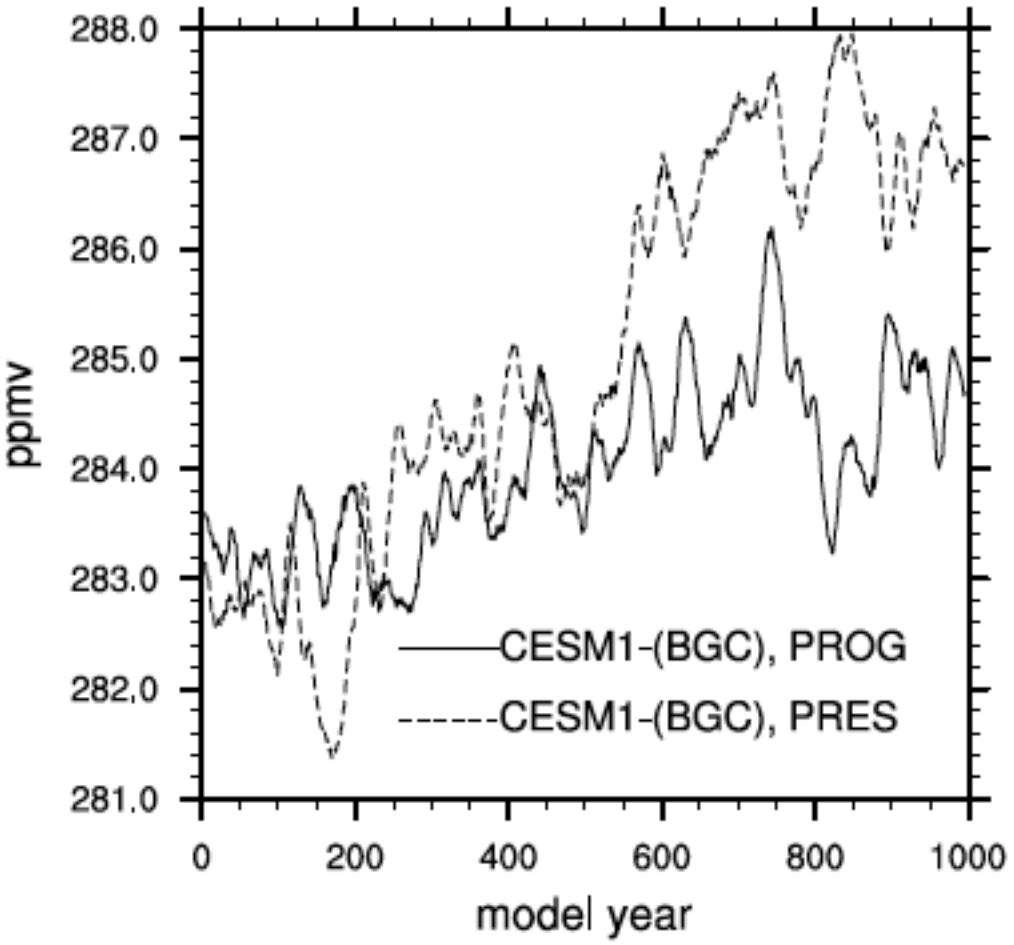
# Spun-up Initial Conditions

- 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

# CMIP5 Long-Term Experiments



# Preindustrial Control Simulations



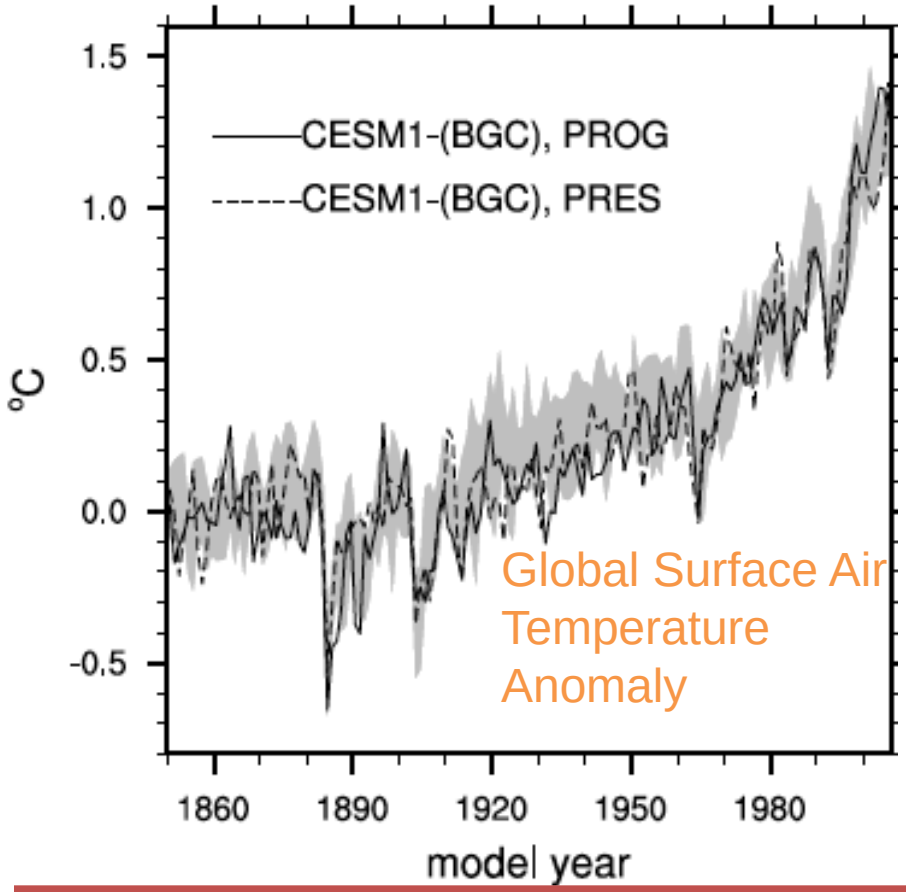

-Sequential spin-up procedure for land & ocean components

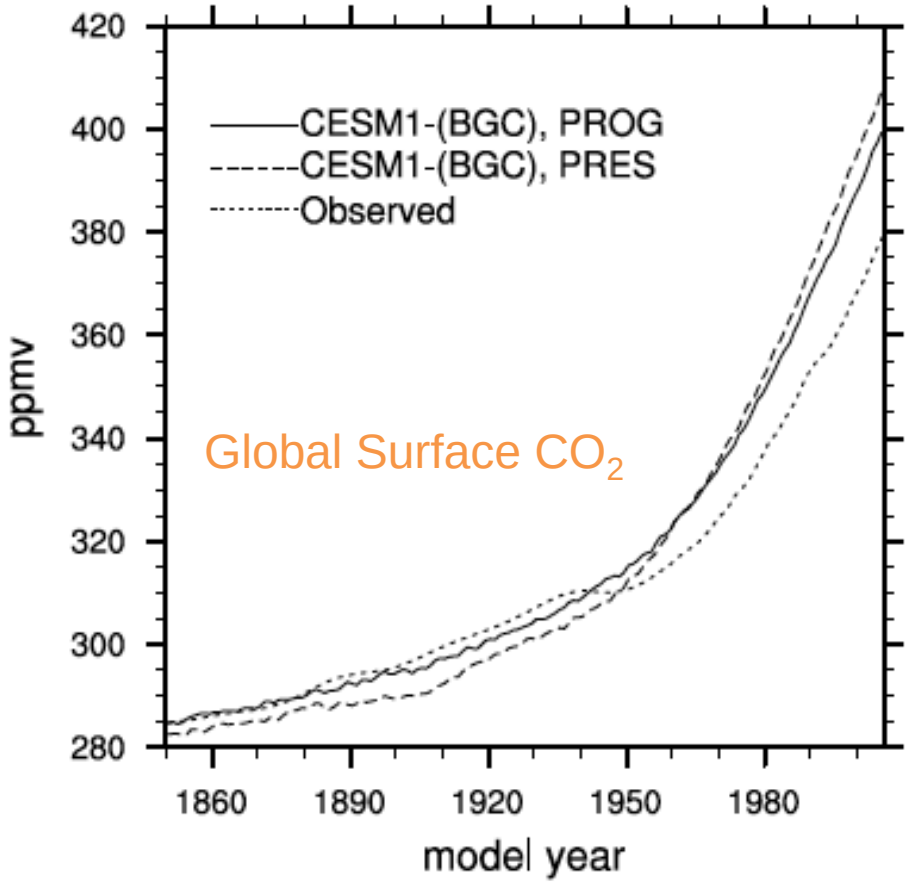
-Stable preindustrial controls

- 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 $CO_2$)

# CESM1 20th Century Transient Simulations



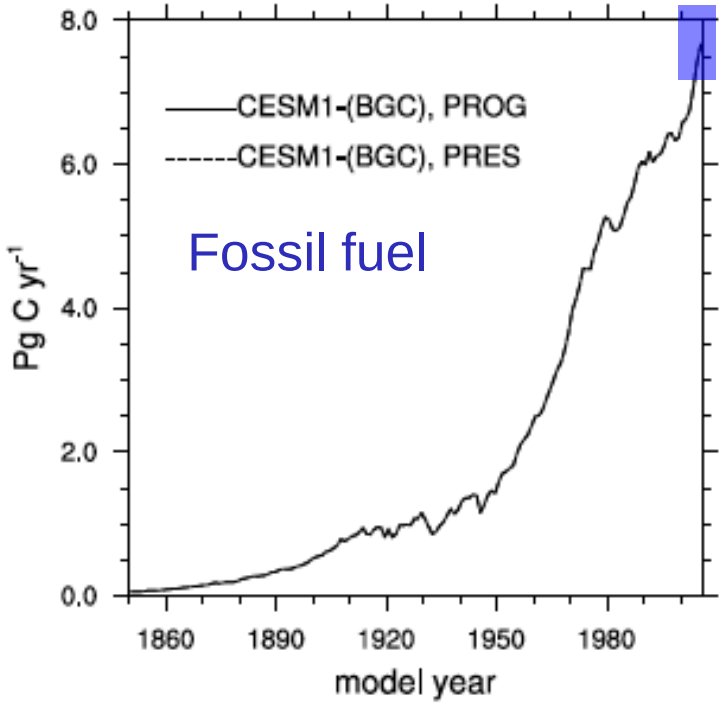



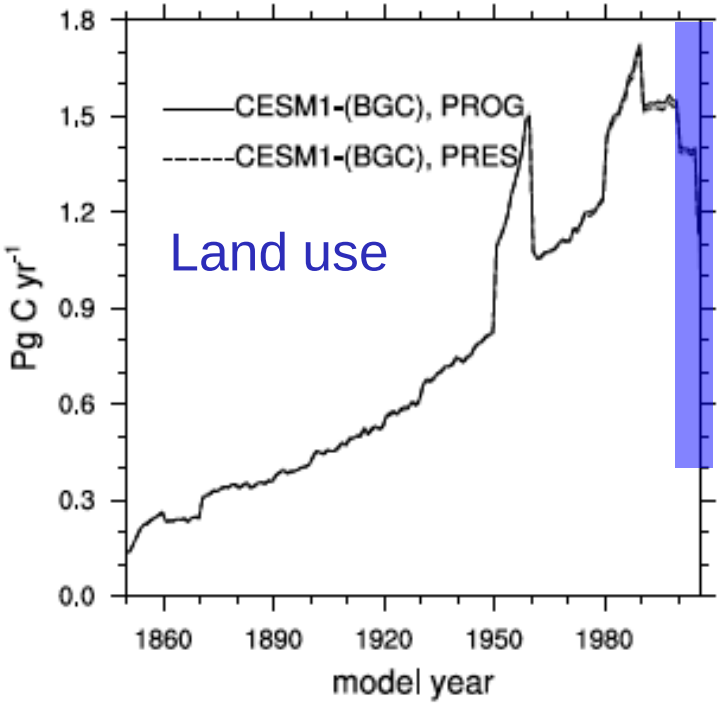

-Run with $CO_2$ emissions (prognostic $CO_2$) or prescribed $CO_2$

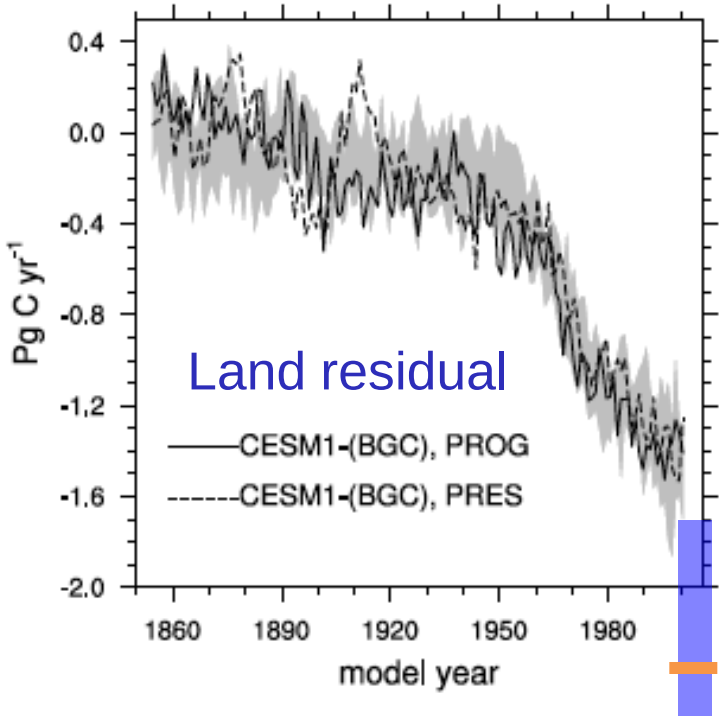
-CESM1 positive atmospheric $CO_2$ bias (+20 ppmv) for both Prognostic & Prescribed $CO_2$

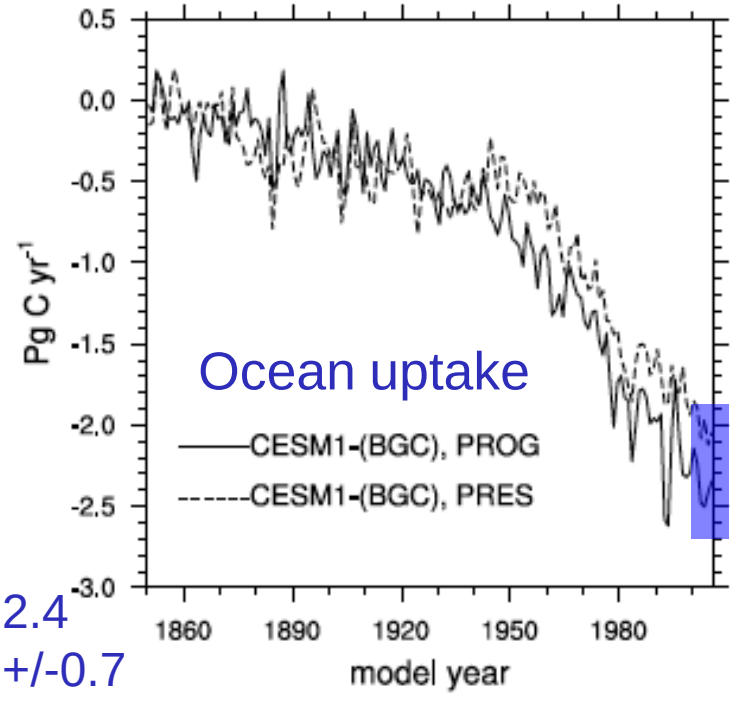
-no significant temperature impact from $CO_2$ bias

# 20th Cent. Carbon Fluxes




2.4
+/-0.7

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

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

# 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 tranport 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
- $NH_3$, $N_2O$ 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