

BGC Practical Lab Notes Coupled & Ocean

Keith Lindsay, NCAR/CGD

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BGC in CESM 1.0 (and beyond)

- CAM CO₂ features
 - 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
- POP Ecosystem model
- CLM features covered elsewhere

BGC Compsets

- Terminology
 - BGC CO₂: what is used by surface components
 - RAD CO₂: what is used by ATM radiative code
 - Prognostic CO₂: predicted ATM concentrations
 - atmospheric constituent computed from surface CO₂ fluxes
 - Diagnostic CO₂: prescribed ATM concentrations
 - Ex: constant, read from file, 1% ramp
- B1850BPRP, B20TRBPRP
 - Coupled model, BGC & RAD CO₂ are prognostic
- B1850BDRD, B20TRBDRD
 - Coupled model, BGC & RAD CO₂ are diagnostic
- CECO
 - Ocean alone, normal year forcing, ocean ecosystem
- GECO (in CESM 1.2 and later)
 - Ocean-Ice, normal year forcing, ocean ecosystem

Initial Conditions (IC)

- Coupled compsets (B)
 - CESM 1.0, 1.1: spun-up IC for CAM4 physics & f09_g16 grid
 - CMIP5 ESM configuration
 - ICs are provided for some other grids, but are not spun-up
 - CESM 1.2: ICs are provided, but none are spun-up
- Ocean Alone (CECO), Ocean-Ice (GECO)
 - ICs are provided for g16 & g37, but are not spun-up
 - ICs for CESM 1.2 differ from 1.0 and 1.1, but neither are spun-up

BGC env*xml variables

- **CCSM_BGC**
 - Controls which CO₂ fields are exchanged between CESM components, see table at end
- **CCSM_CO2_PPMV**
 - Constant CO₂ ref value used in some configurations
- **OCN_CO2_TYPE, LND_CO2_TYPE**
 - Controls CO₂ used by ocean and land components
 - constant, prognostic, diagnostic
- **OCN_TRACER_MODULES**
 - Controls which ocean tracers are used
 - Ocean ecosystem model is called ecosys

Exercise

- Set up different experiments and compare resulting case directories. Do differences make sense?
- Expr 1: B1850CN, f09_g16
- Expr 2: B1850BDRD, f09_g16
 - What changes occur when the carbon cycle is enabled?
- Expr 3: B1850BPRP, f09_g16
 - What changes occur when the carbon cycle is made prognostic?
- Model configuration at f09_g16 is expensive
 - i.e. don't submit job
 - change grid to T31_g37 if you want to examine generated output

POP BGC Specific Output

- `ocn/hist/$CASE.pop.h.ecosys.nday1.????-??-??`.nc
 - Selected ocean ecosys variables at daily resolution
 - Surface flux related, productivity & functional group vertical integrals
- `ocn/hist/$CASE.pop.h.ecosys.nyear1.????`.nc
 - Selected three dimensional ocean ecosys tracer budget terms

UNITS & SIGN CONVENTIONS

- CAM variables CO2, CO2_LND, CO2_OCN, CO2_FFF have units kgCO₂/kg dry air
- This is **NOT** a typical unit for carbon cycle modelers
- To convert ppmv, multiply by $1e6 * 28.966 / 44$
- Same quantity in different component output has
 - Different names
 - Different units
 - Different sign conventions (for fluxes)

UNITS & SIGN CONVENTIONS

Component	Variable Name	Units	Sign Convention
Atmosphere	SFCO2_LND	kgCO2/m ² /s	Positive up
Land	NEE	gC/m ² /s	Positive up
Atmosphere	SFCO2_OCN	kgCO2/m ² /s	Positive up
Ocean	FG_CO2	mmolC/m ³ ·cm/s nmolC/cm ² /s	Positive down

CCSM_BGC settings

	CO2A	CO2B	CO2C
prog CO ₂ -> land	Y	Y	Y
diag CO ₂ -> land	Y	Y	Y
land CO ₂ flux -> atm		Y	Y
prog CO ₂ -> ocean			Y
diag CO ₂ -> ocean			Y
ocean CO ₂ flux -> atm			Y

- CO2A: land only runs
- CO2B: atmosphere-land runs
 - Ocean & Fossil Fuel CO₂ fluxes read from file
- CO2C: fully coupled runs