BGC Practical Lab Notes
Coupled & Ocean

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BGC in CESM 1.0 (and beyond)

- CAM CO_2 features
  - 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
- POP Ecosystem model
- CLM features covered by Sam

BGC Compsets

- Terminology
  - BGC CO_2: what is used by surface components
  - RAD CO_2: what is used by ATM radiative code
  - Prognostic CO_2: predicted ATM concentrations
    - atmospheric constituent computed from surface CO_2 fluxes
  - Diagnostic CO_2: prescribed ATM concentrations
    - Ex: constant, read from file, 1% ramp
- B1850BPRP, B20TRBPRP
  - Coupled model, BGC & RAD CO_2 are prognostic
- B1850BDRD, B20TRBDRD
  - Coupled model, BGC & RAD CO_2 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 CO_2 fields are exchanged between CESM components, see table at end
- CCSM_CO2_PPMV
  - Constant CO_2 ref value used in some configurations
- OCN_CO2_TYPE, LND_CO2_TYPE
  - Controls CO_2 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 $kgCO_2/kg$ 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	$mmolC/m^3 \cdot cm/s$ $nmolC/cm^2/s$	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 CO_2 fluxes read from file
- CO2C: fully coupled runs