

# BGC Practical Lab Notes Coupled & Ocean

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# BGC in CESM

- CAM CO<sub>2</sub> features
  - CO<sub>2</sub> constituents that use LND & OCN CO<sub>2</sub> fluxes as surface boundary condition
  - Pass CO<sub>2</sub> to driver for LND & OCN flux computations
  - Couple CO<sub>2</sub> constituents to radiation computations
- POP Ecosystem model
  - uses MARBL library in CESM2
- CLM features covered elsewhere

# Coupled BGC Compsets

- Terminology
  - **BGC CO<sub>2</sub>**: what is used by surface components
  - **RAD CO<sub>2</sub>**: what is used by ATM radiative code
  - **Diagnostic CO<sub>2</sub>**: prescribed ATM concentrations
    - Ex: constant, read from file, 1% ramp
  - **Prognostic CO<sub>2</sub>**: predicted ATM concentrations
    - atmospheric constituent computed from surface CO<sub>2</sub> fluxes
- B1850, BHIST
  - compset long name has BGC%BDRD
  - coupled model, BGC & RAD CO<sub>2</sub> are diagnostic
- use B1850, BHIST longname, replace BDRD with BPRP
  - doesn't currently have corresponding short name
  - coupled model, BGC & RAD CO<sub>2</sub> are prognostic
- `./query_config --compsets allactive`
  - run from same directory as `create_newcase`

# Ocean Specific BGC Compsets

- C1850ECO
  - Ocean alone, 1850 aerosols, normal year forcing
- G1850ECO
  - Ocean-Ice, 1850 aerosols, normal year forcing
- G1850ECOIAF
  - Ocean-Ice, 1850 aerosols, interannually varying forcing
- `./query_config --compsets pop`
  - run from same directory as `create_newcase`

# Initial Conditions (IC)

- Coupled compsets
  - ICs are provided, but are not spun-up
  - Spun-up ICs will be included in CESM2.1 release
    - perhaps only for f09\_g17
- Ocean Alone, Ocean-Ice
  - ICs are provided, but are not spun-up

# BGC env\*xml variables

- CCSM\_BGC
  - Controls which CO<sub>2</sub> fields are exchanged between CESM components, see table at end
- CCSM\_CO2\_PPMV
  - Constant CO<sub>2</sub> ref value used in some configurations
- OCN\_CO2\_TYPE, LND\_CO2\_TYPE
  - Controls CO<sub>2</sub> 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: B1850, f19\_g16
- Expr 2: Take compset long name from Expr 1 and run `create_newcase` with this, changing BDRD to BPRP
  - What happens when you run `create_newcase`?
    - follow instructions to get it working
    - don't do this for real unless you know what you're doing
- Run `case.setup` and `preview_namelists` for each case
- What changes occur when the carbon cycle is made prognostic?

# 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<sub>2</sub>/kg dry air
- This is **NOT** a typical unit for carbon cycle modelers
- To convert ppm, 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 <sup>2</sup> /s	Positive up
Land	NEE	gC/m <sup>2</sup> /s	Positive up
Atmosphere	SFCO2_OCN	kgCO2/m <sup>2</sup> /s	Positive up
Ocean	FG_CO2	mmolC/m <sup>3</sup> ·cm/s nmolC/cm <sup>2</sup> /s	Positive down

# CCSM\_BGC settings

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

- CO2A: land only or ocean only runs
- CO2B: atmosphere-land runs
  - Ocean & Fossil Fuel CO<sub>2</sub> fluxes read from file
- CO2C: fully coupled runs