

BGC Practical Lab Notes Coupled & Ocean

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BGC in CESM

- Features available since CESM 1.0
- On by default in CESM 2
- 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
 - uses MARBL library in CESM2
- CLM features covered elsewhere

Coupled BGC Compsets

- Terminology
 - BGC CO₂: what is used by surface components
 - RAD CO₂: what is used by ATM radiative code
 - Diagnostic CO₂: prescribed ATM concentrations
 - Ex: constant, read from file, 1% ramp
 - Prognostic CO₂: predicted ATM concentrations
 - atmospheric constituent computed from surface CO₂ fluxes
- B1850, BHIST
 - compset long name has BGC%BDRD
 - coupled model, BGC & RAD CO₂ are diagnostic
- use B1850, BHIST longname, replace BDRD with BPRP
 - doesn't currently have corresponding short name
 - coupled model, BGC & RAD CO₂ 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 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 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: 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 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		Y
diag CO ₂ -> ocean	Y		Y
ocean CO ₂ flux -> atm			Y

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