BGC Practical Lab Notes
Coupled & Ocean

Keith Lindsay, NCAR/CGD

NCAR is sponsored by the National Science Foundation

BGC in CESM

- Features available since CESM 1.0
- On by default in CESM 2

- 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
  - uses MARBL library in CESM2

- CLM features covered elsewhere

Coupled BGC Compsets

- Terminology
  - BGC CO_2: what is used by surface components
  - RAD CO_2: what is used by ATM radiative code
  - Diagnostic CO_2: prescribed ATM concentrations
    - Ex: constant, read from file, 1% ramp
  - Prognostic CO_2: predicted ATM concentrations
    - atmospheric constituent computed from surface CO_2 fluxes
- B1850, BHIST
  - compset long name has BGC%BDRD
  - coupled model, BGC & RAD CO_2 are diagnostic
- B1850_BPRP, BHIST_BPRP
  - shortnames introduced in CESM 2.1.1
  - compset long name has BGC%BPRP
  - coupled model, BGC & RAD CO_2 are prognostic

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 BDRD compsets (BDRD is default)
  - default RUN_REFCASE set for f09_g17 and f19_g17 res
  - provided ICs were spun-up with f09_g17 res
    - carbon cycle not balanced with f19_g17 res as well as with f09_g17 res
- Coupled BPRP compsets
  - default RUN_REFCASE set for f09_g17
- Ocean Alone, Ocean-Ice
  - ICs are provided, but are not 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?

- Experiment 1: B1850, f19_g17
- Experiment 2: B1850_BPRP, f19_g17
  - 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 $kgCO_2/kg$ dry air
- This is NOT a typical unit for carbon cycle modelers
- To convert ppmv, multiply by 1.0e6*28.966/44.0
  - 28.966 and 44.0 are molecular weights of dry air and CO_2 respectively

- 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		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 CO_2 fluxes read from file
- CO2C: fully coupled runs