2024 CESM Tutorial

Challenge exercices: Lab intro

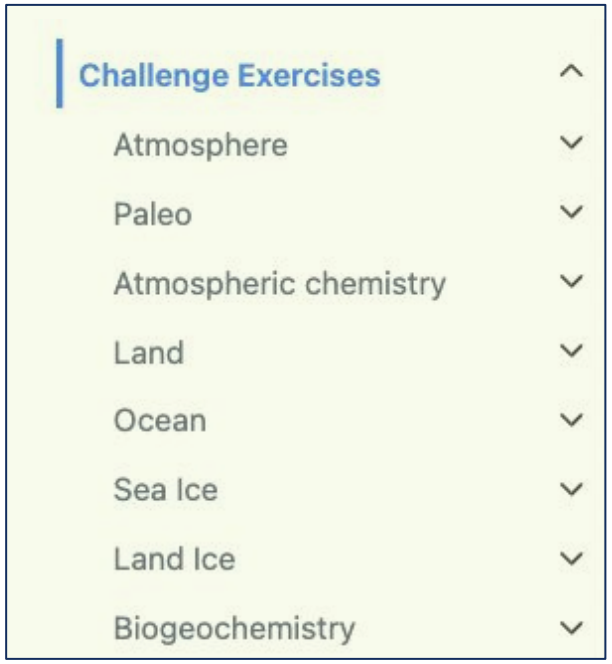
Multiple speakers
CGD

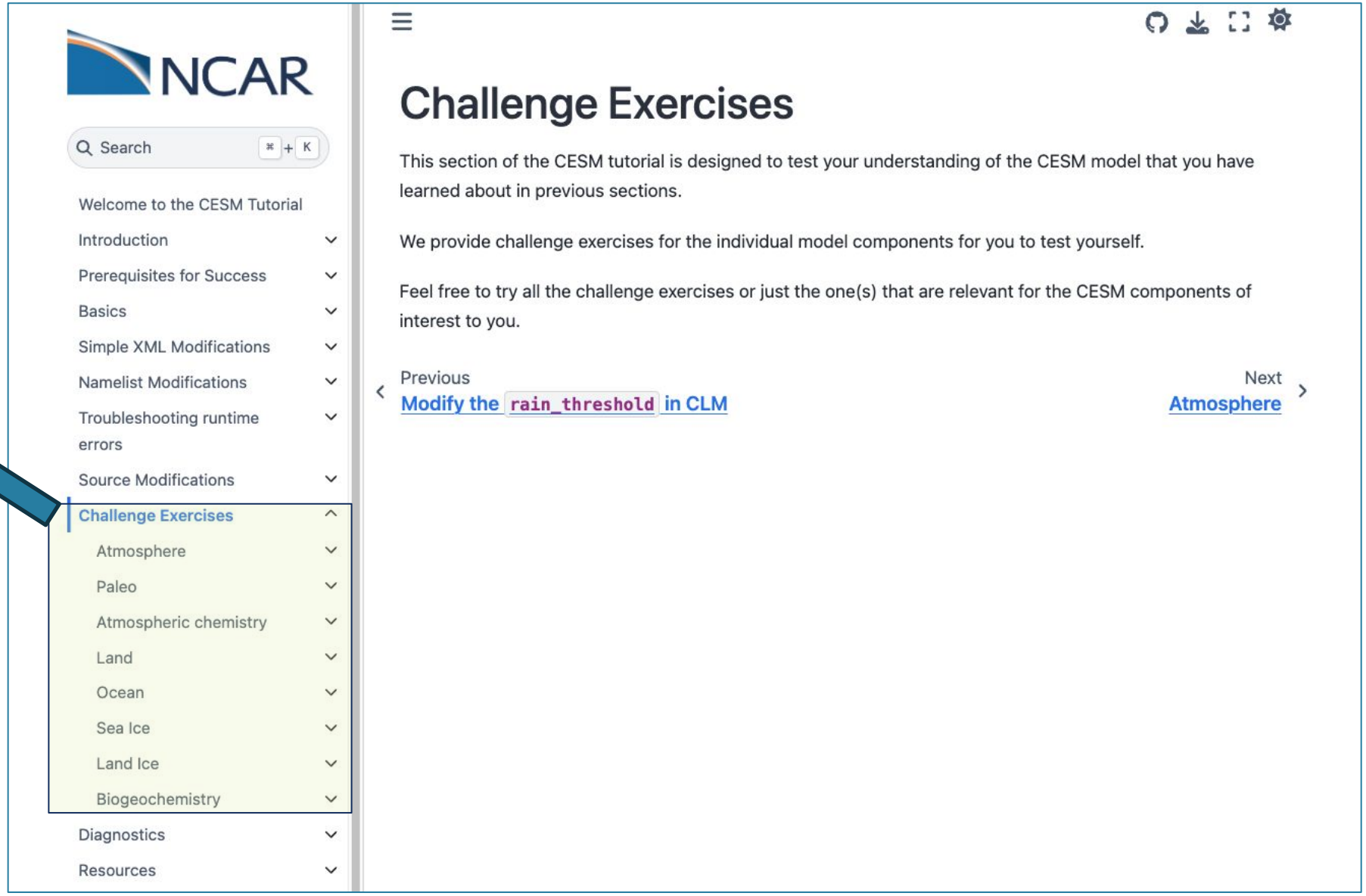
Aug 5-9, 2024

This material is based upon work supported by the National Center for Atmospheric Research, which is a major facility sponsored by the National Science Foundation under Cooperative Agreement No. 1852977.

Challenge Exercises

https://ncar.github.io/CESM-Tutorial/README.html



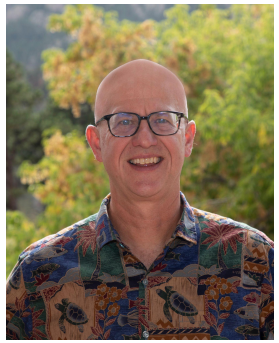


Breakout leads/areas for challenge exercises

Cecile Hannay
Atmosphere

Sophia Macarewich
Paleo

Gunter Leguy
Land Ice



David Bailey
Sea Ice

Rebecca Buchholz
Atmospheric Chemistry

Erik Kluzek
Land (SE)

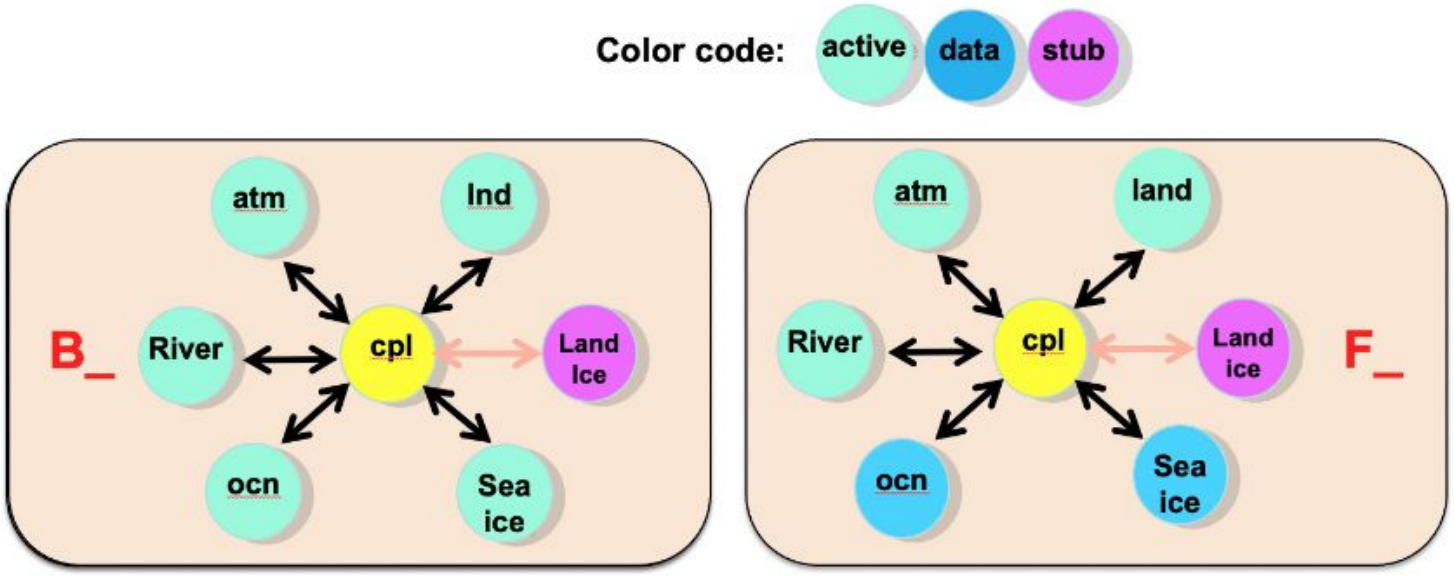
Kristen Krumhardt
Biogeochemistry

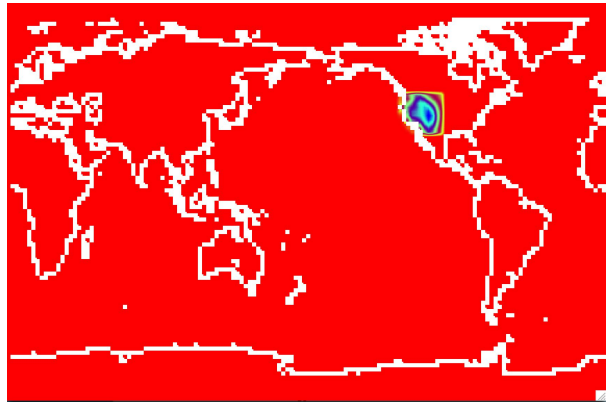
Alper Altuntas
Ocean

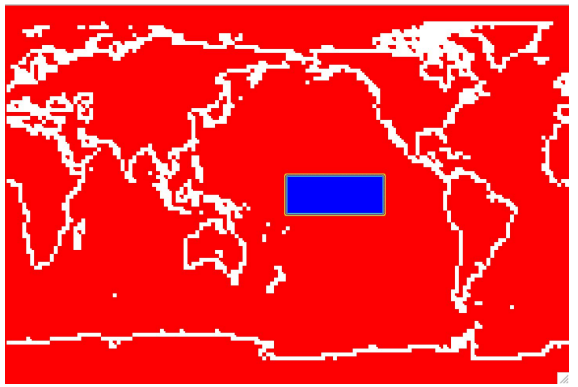
You are welcome to do exercises from different components

Atmosphere

Difference between a B case and a F case

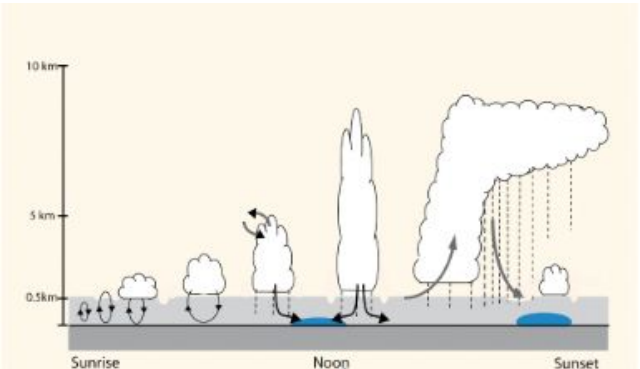






Proposed exercises

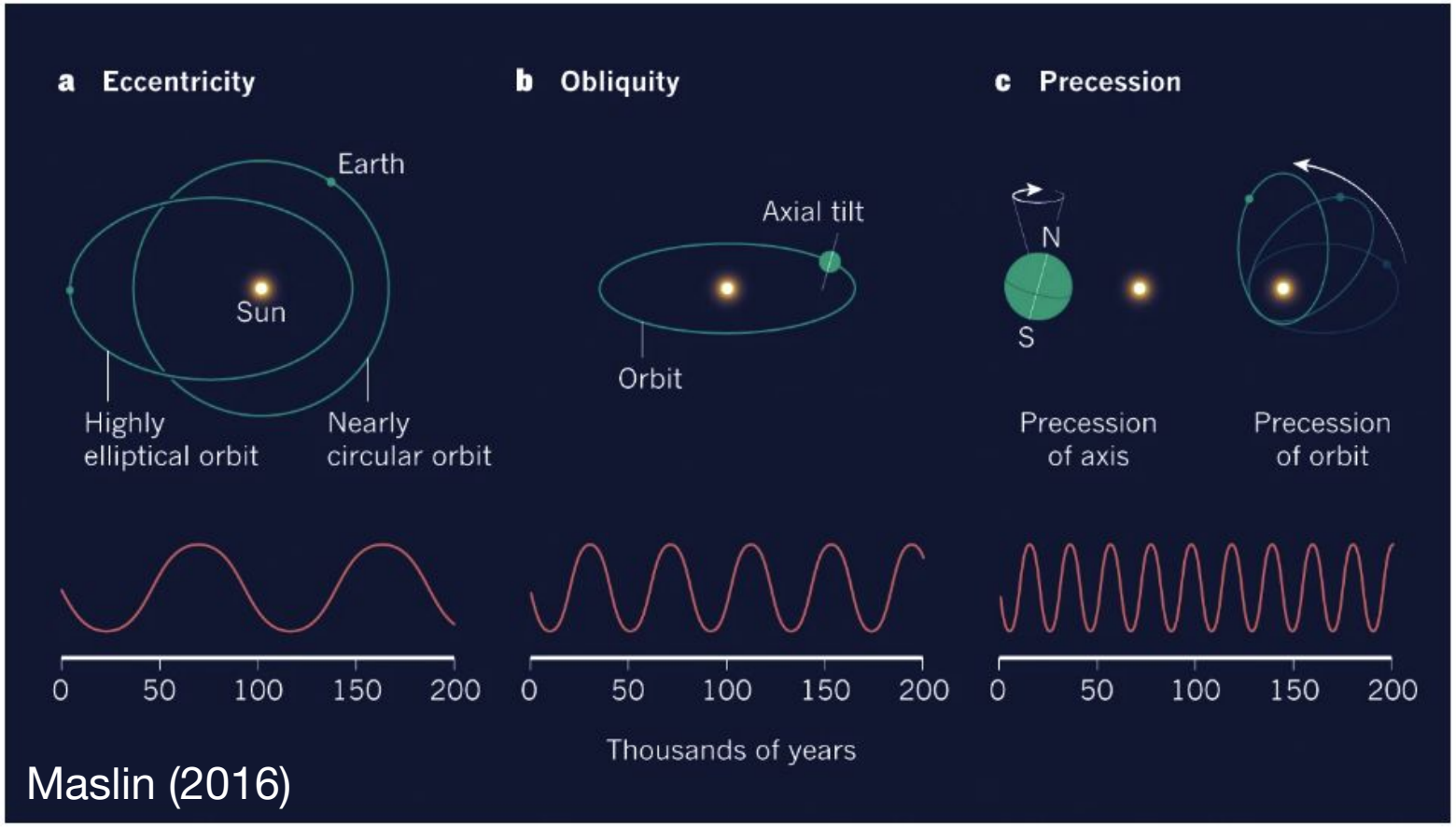
- Use historical SSTs/forcings instead of fixed forcing
- Change run starting date
- Increase orographic height over the western US
- Modify sea surface temperature in the tropics
- Increase the triggering threshold for deep convection over land



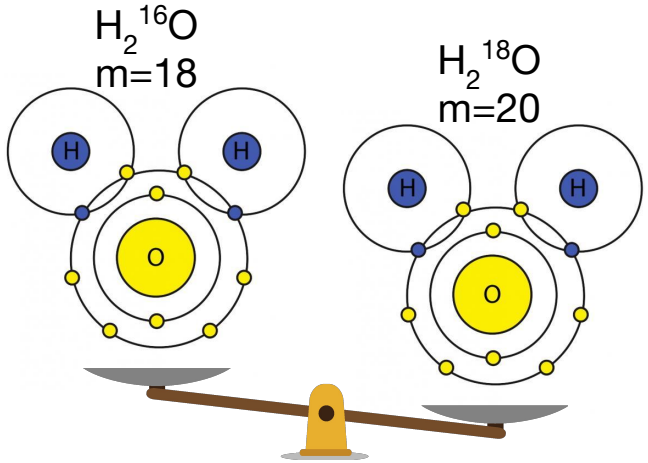
Paleo

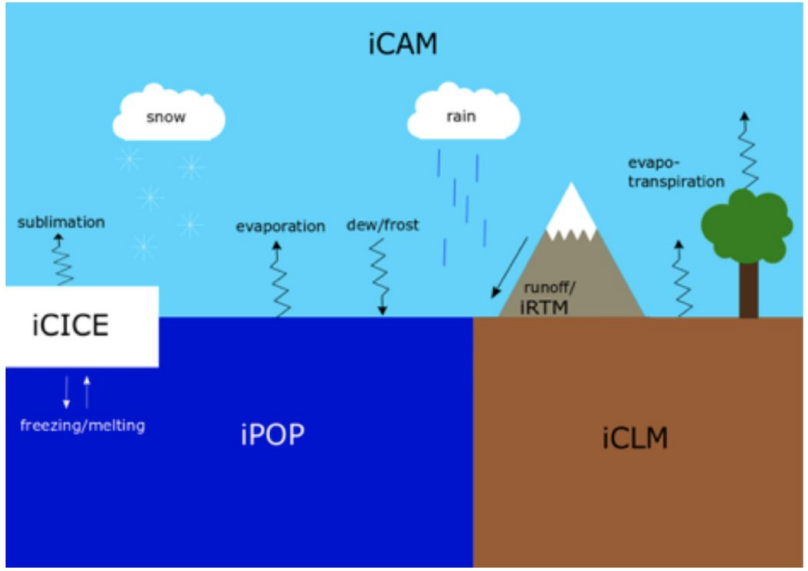
Proposed exercises

- Modify orbital parameters to mid-Holocene (~6 ka)
- Run a CESM simulation with water isotope tracers



Maslin (2016)





Atmospheric Chemistry: CAM-chem or WACCM

Using F cases

Proposed exercises with CAM-chem (FCHIST) or WACCM (FWHIST)

1. **Control**: Run chemistry with daily output
2. **Test**: Change reaction rate in the chemical mechanism
3. **Test**: Change emissions

Bonus

4. **Visualization**: Quick analysis using GEOV tool

e.g. of super-simple chemistry mechanism

```
 SPECIES
     Solution
O3, O, O1D -> O, O2, O2_1S -> O2, O2_1D -> O2
     End Solution

     Fixed
M, N2
     End Fixed
 End SPECIES

 Solution Classes
     Explicit
      CH4, N2O, CO, H2, CH3CL, CH3BR, CFC11, CFC12
     End explicit
     Implicit
      O3, O, O1D, O2, O2_1S, O2_1D
     End implicit
 End Solution Classes

 CHEMISTRY
     Photolysis
[jo2_a] O2 + hv -> O + O1D
     End Photolysis

     Reactions
 [cph1,cph] O + O3 -> 2*O2       ; 8e-12, -2060
     End Reactions
END CHEMISTRY
```

https://ncar.github.io/CESM-Tutorial/notebooks/challenge/cam-chem_waccm/cam-chem_waccm.html#

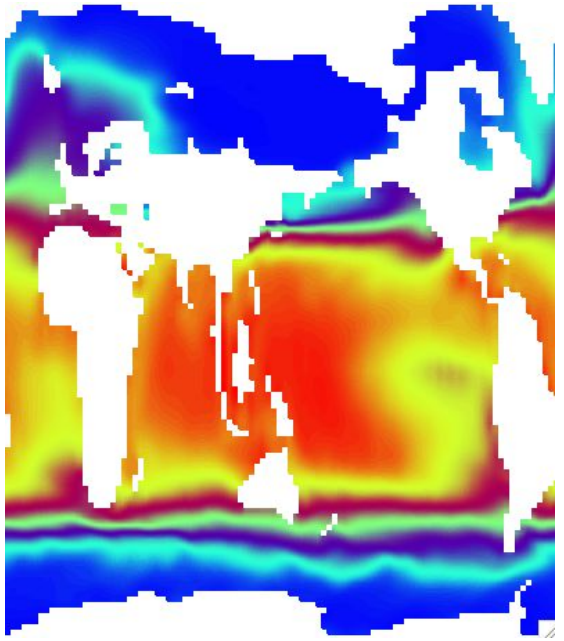
Land

Overview of land exercises

Ocean

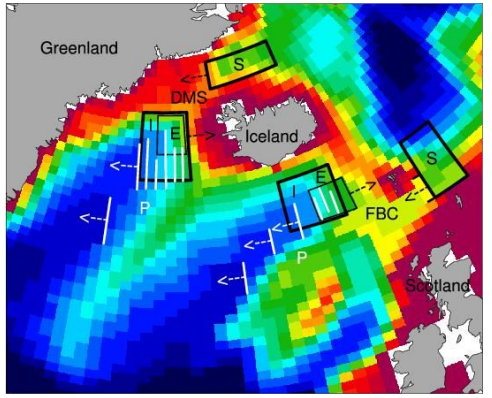
CESM-POP2 exercise:

1. Run a G compset with “normal year forcing” as a control case.
2. Turn off overflow parameterization to assess its impact.
3. Modify wind stress.
4. Turn on the ecosystem.



CESM-MOM6 exercise:

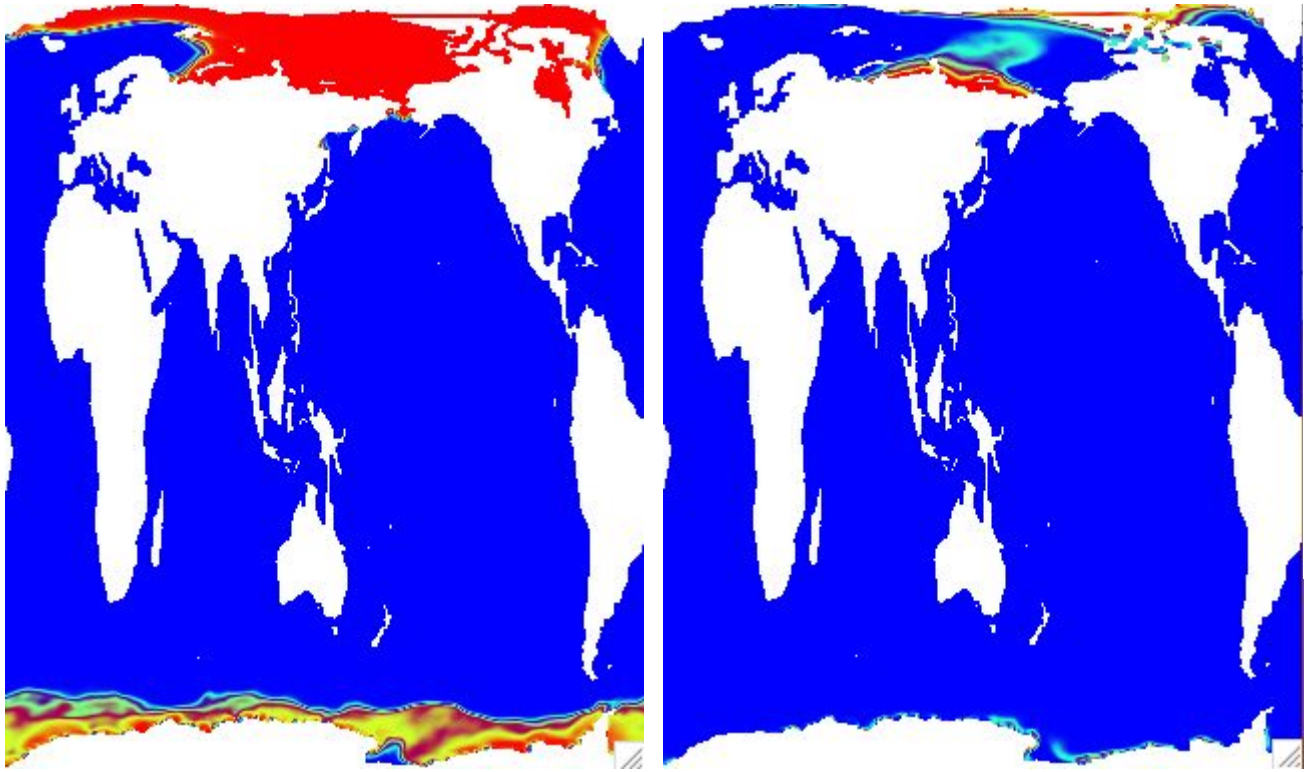
5. Download a CESM version including MOM6.
6. Run a G compset with “normal year forcing” as a control case.

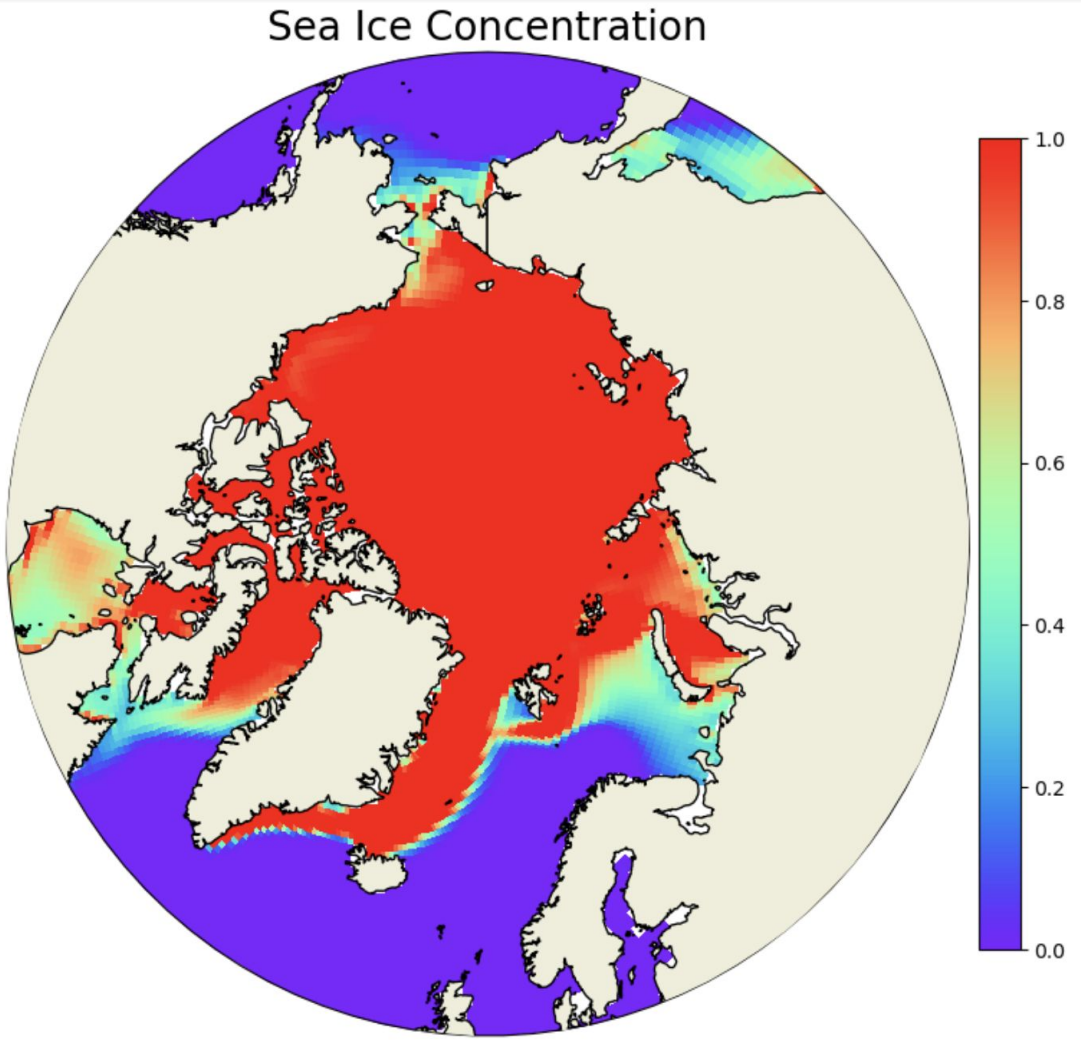


Sea ice

Proposed exercises

- Run a G compset with “normal year forcing”.
- Adjust the sea ice “albedo”.
- Modify the snow conductivity.



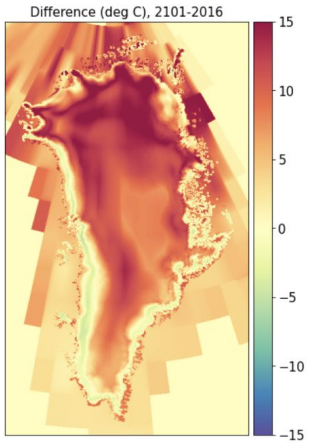


Land ice

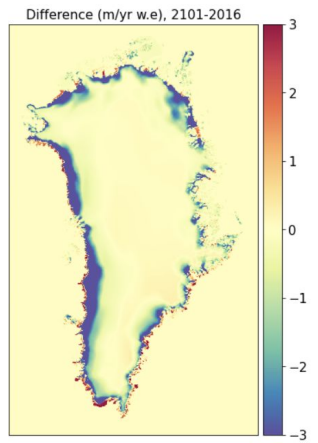
Proposed exercises

- Run a T compset and simulate the Greenland ice sheet evolution in CESM.
- Compute offline global sea level contribution from ice sheet.

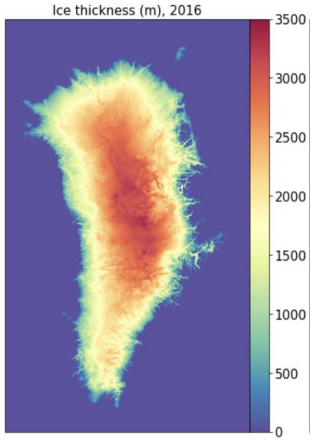
SMB

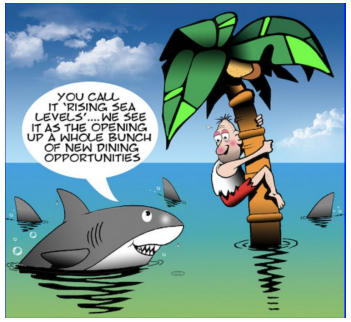


Temperature



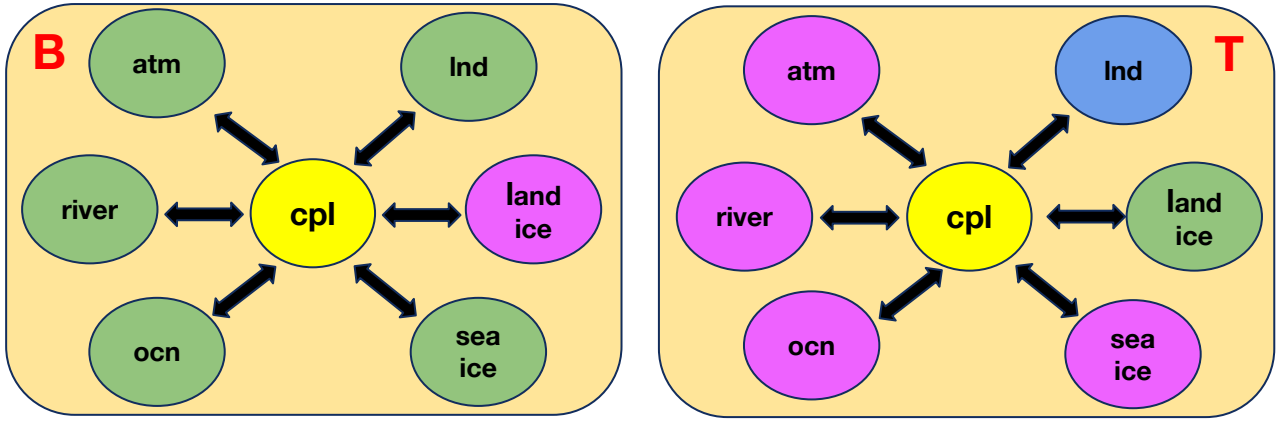
Ice thickness





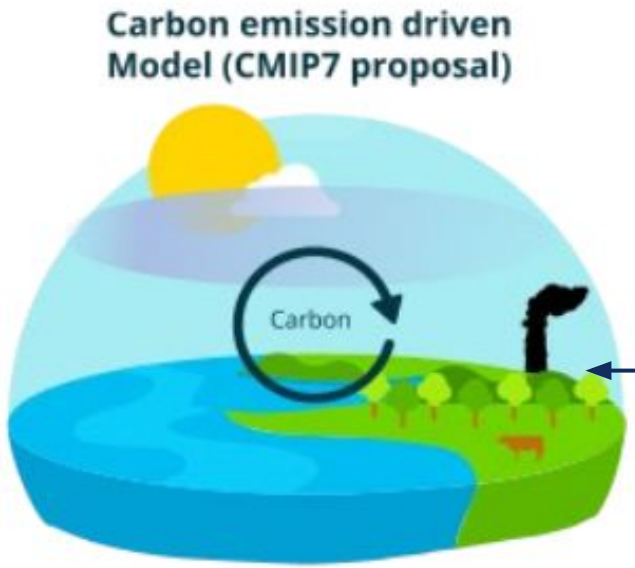
Difference between a B and a T case

Color code: active data stub



Proposed exercises

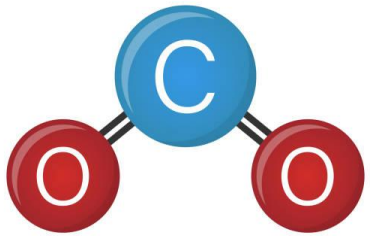
- Set up two different BGC cases and compare case directories (you will **not** be running the model for this exercise)
- Compsets: B1850 and B1850_BPRP
- Both have f19_g17 resolution



Closed carbon cycle. CO_2 concentrations, aerosols and calculated as a function of human emissions and land use

Figure from Sanderson et al., 2023

Differences concern how CO_2 is handled:



Prognostic CO_2

- Compset = B1850_BPRP
- "Emission-driven"
- Predicted atmospheric CO_2 concentrations, computed from surface fluxes

Diagnostic CO_2

- Compset = B1850
- "Concentration-driven"
- Prescribed atmospheric CO_2 concentrations that are read from a file