



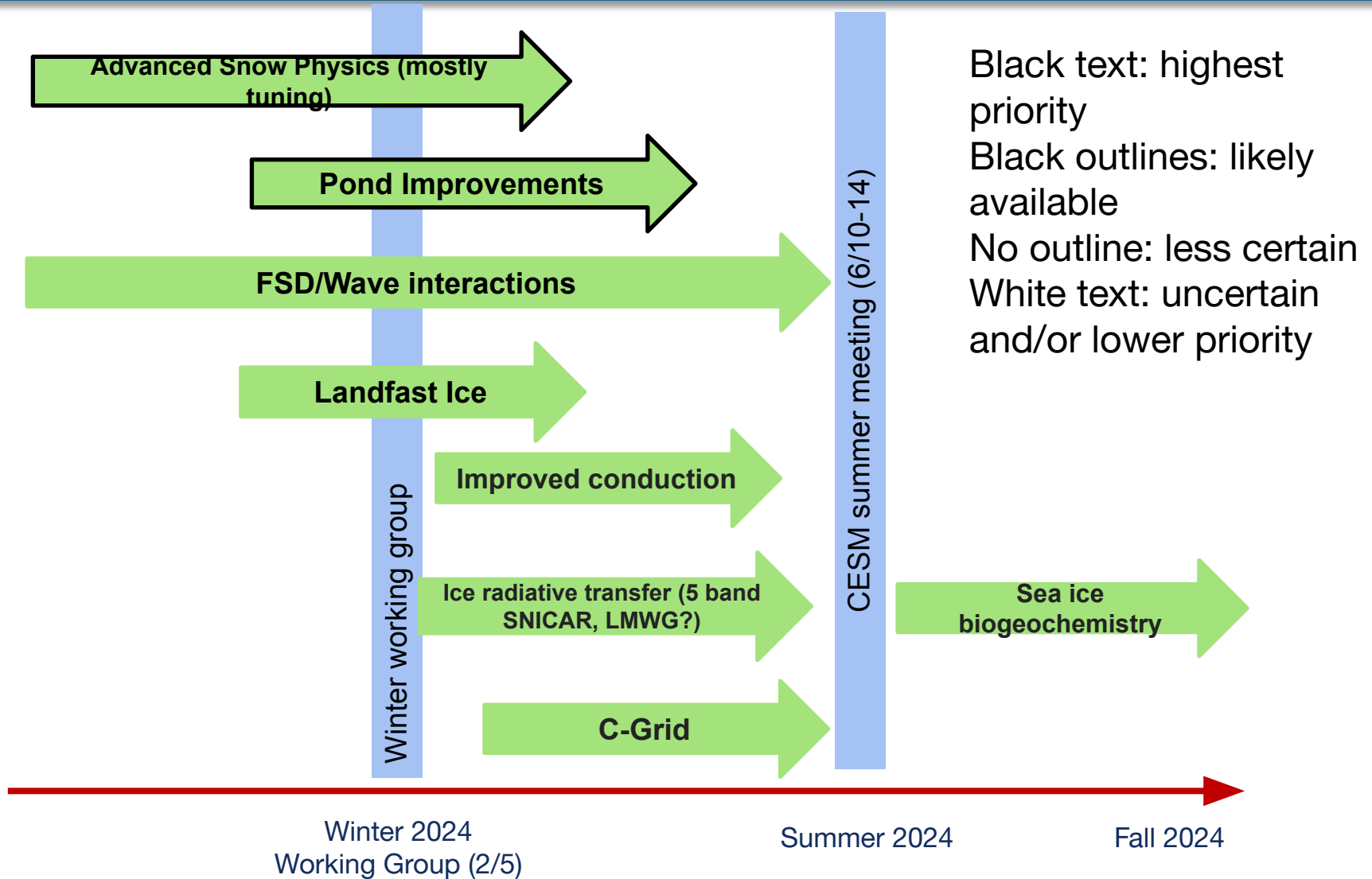
Sea Ice in CESM3

The Good and Bad

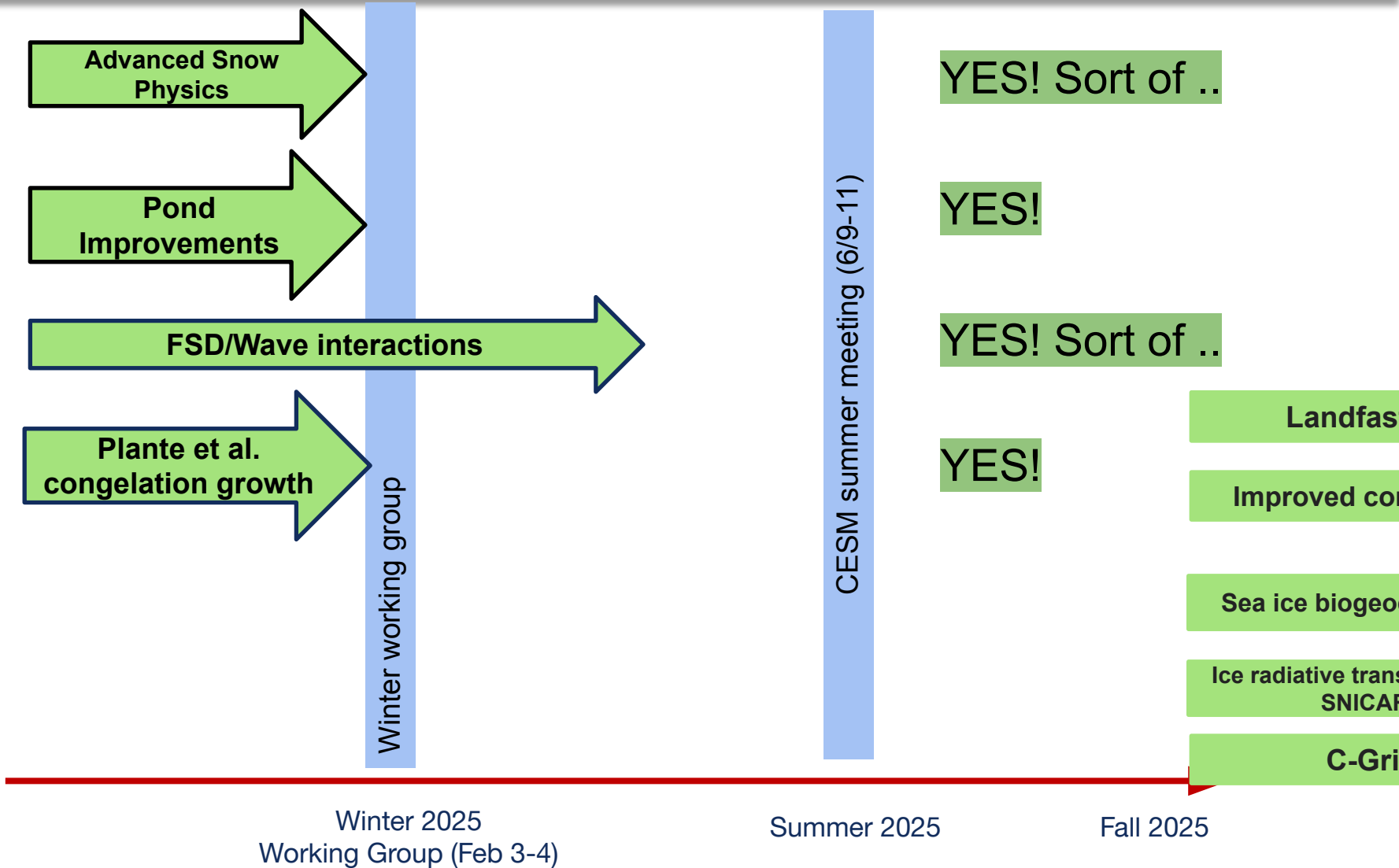
David Bailey and Alice DuVivier
PCWG liaison and co-chair

March 3, 2025

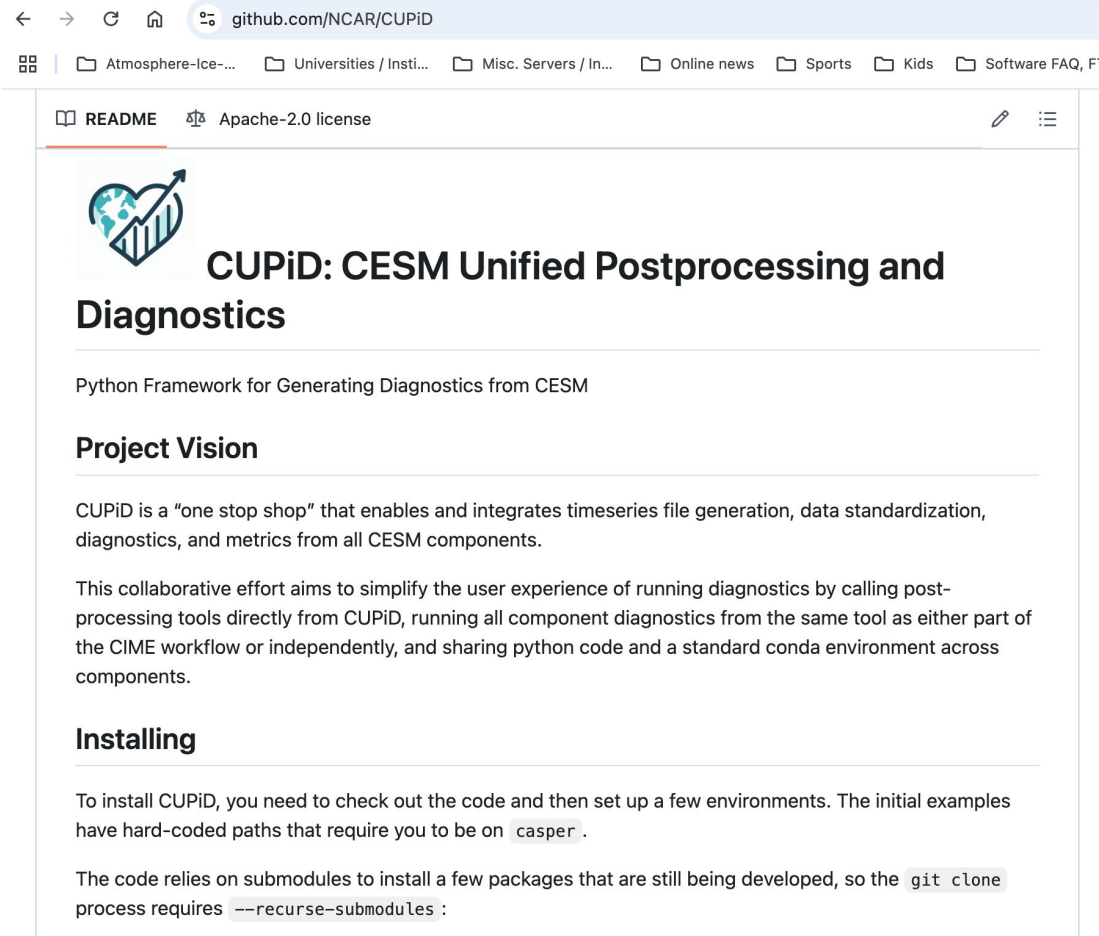
PCWG Sea Ice Plans



PCWG Sea Ice Updated Plans




CESM Unified Postprocessing and Diagnostics



← → ↻ 🏠 github.com/NCAR/CUPiD

📁 Atmosphere-Ice-... 📁 Universities / Insti... 📁 Misc. Servers / In... 📁 Online news 📁 Sports 📁 Kids 📁 Software FAQ, F

📖 README 📄 Apache-2.0 license



CUPiD: CESM Unified Postprocessing and Diagnostics

Python Framework for Generating Diagnostics from CESM

Project Vision

CUPiD is a “one stop shop” that enables and integrates timeseries file generation, data standardization, diagnostics, and metrics from all CESM components.

This collaborative effort aims to simplify the user experience of running diagnostics by calling post-processing tools directly from CUPiD, running all component diagnostics from the same tool as either part of the CIME workflow or independently, and sharing python code and a standard conda environment across components.

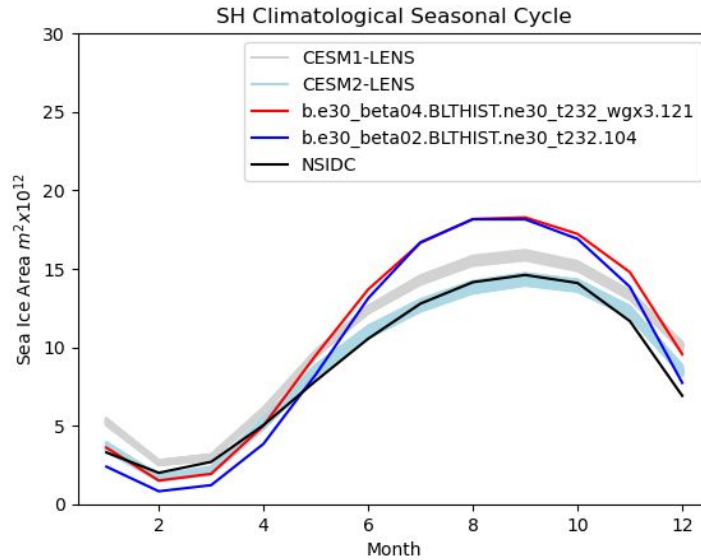
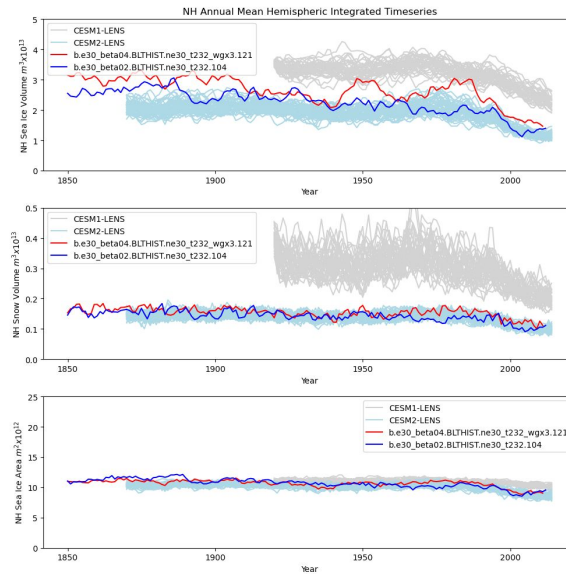
Installing

To install CUPiD, you need to check out the code and then set up a few environments. The initial examples have hard-coded paths that require you to be on `casper`.

The code relies on submodules to install a few packages that are still being developed, so the `git clone` process requires `--recurse-submodules`:

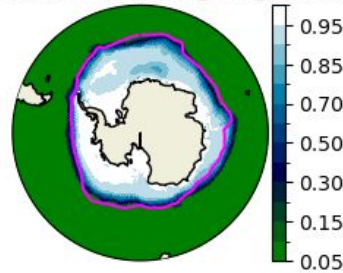
<https://github.com/NCAR/CUPiD>

Sea Ice Key Metrics Notebooks

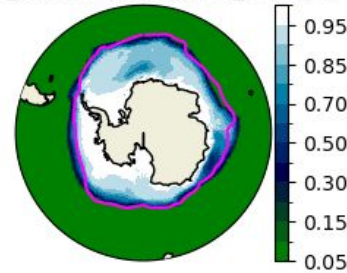


Sea Ice Concentration

b.e30_beta04.BLTHIST.ne30_t232_wgx3.121



b.e30_beta02.BLTHIST.ne30_t232.104



https://webext.cgd.ucar.edu/BLTHIST/b.e30_beta04.BLTHIST.ne30_t232_wgx3.121/ice/html/infrastructure/index.html

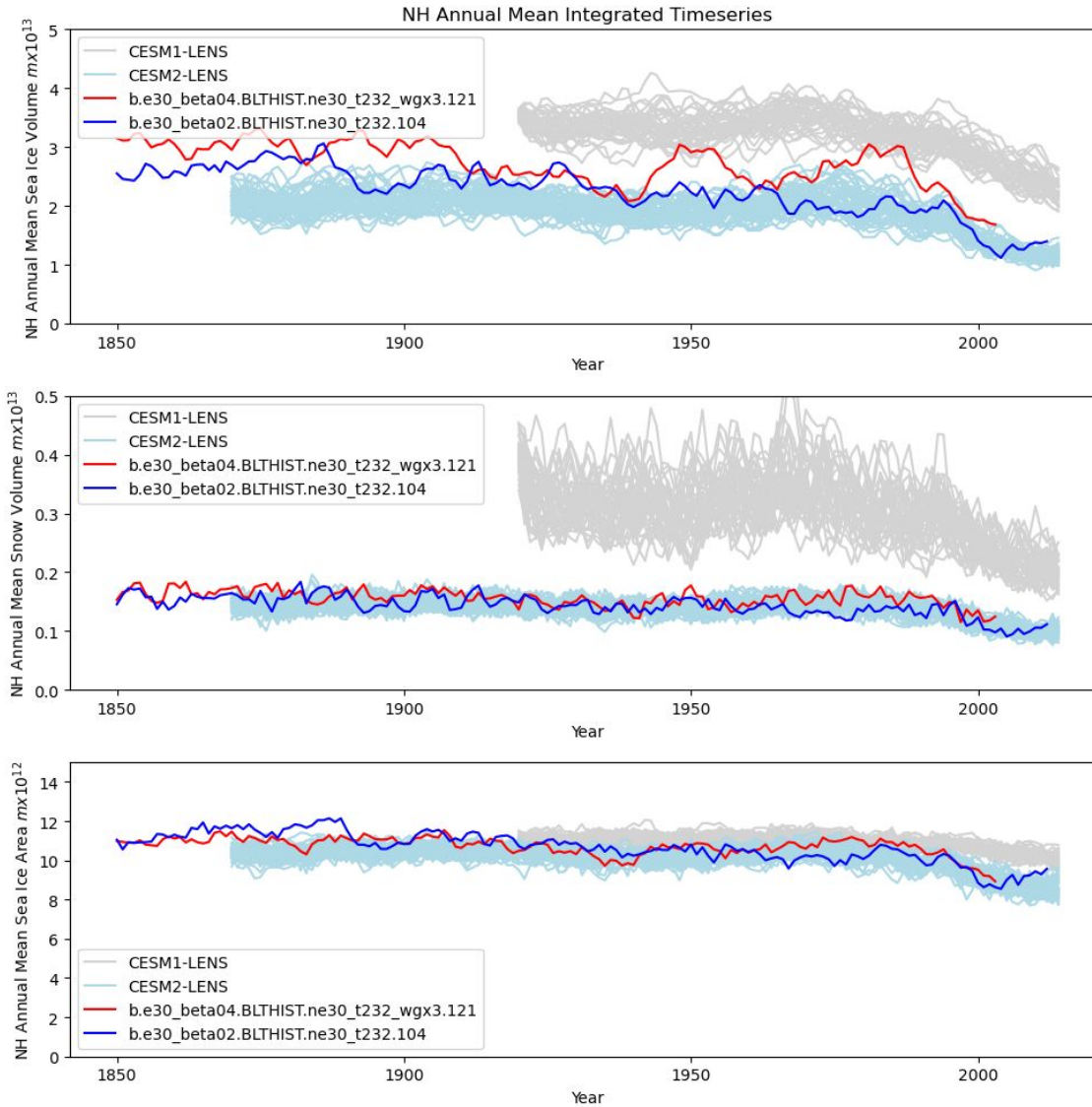
Ongoing CESM Runs

- All CESM development runs that are candidates are listed here:
 - https://github.com/NCAR/cesm_dev/issues
- **Run 121** is latest run with both a PI control and Historical
 - [PI Control Info](#)
 - [Historical Info](#)



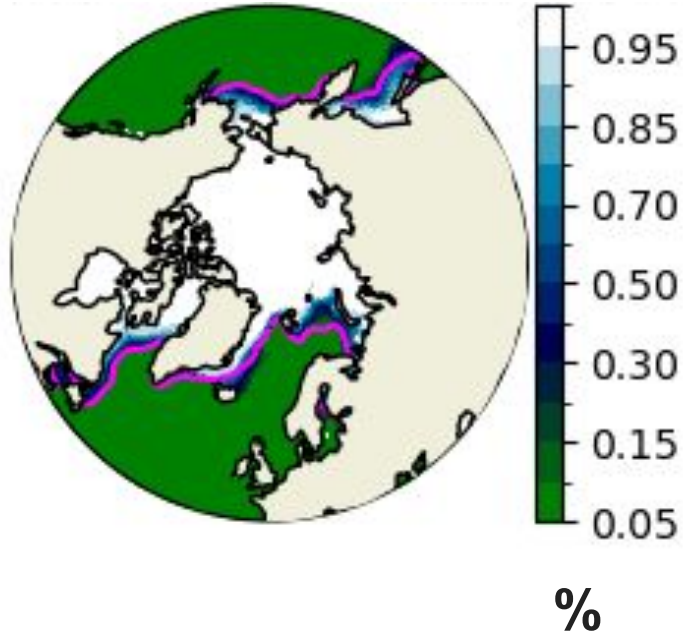
121 Historical - Northern Hemisphere

Focus on **121**

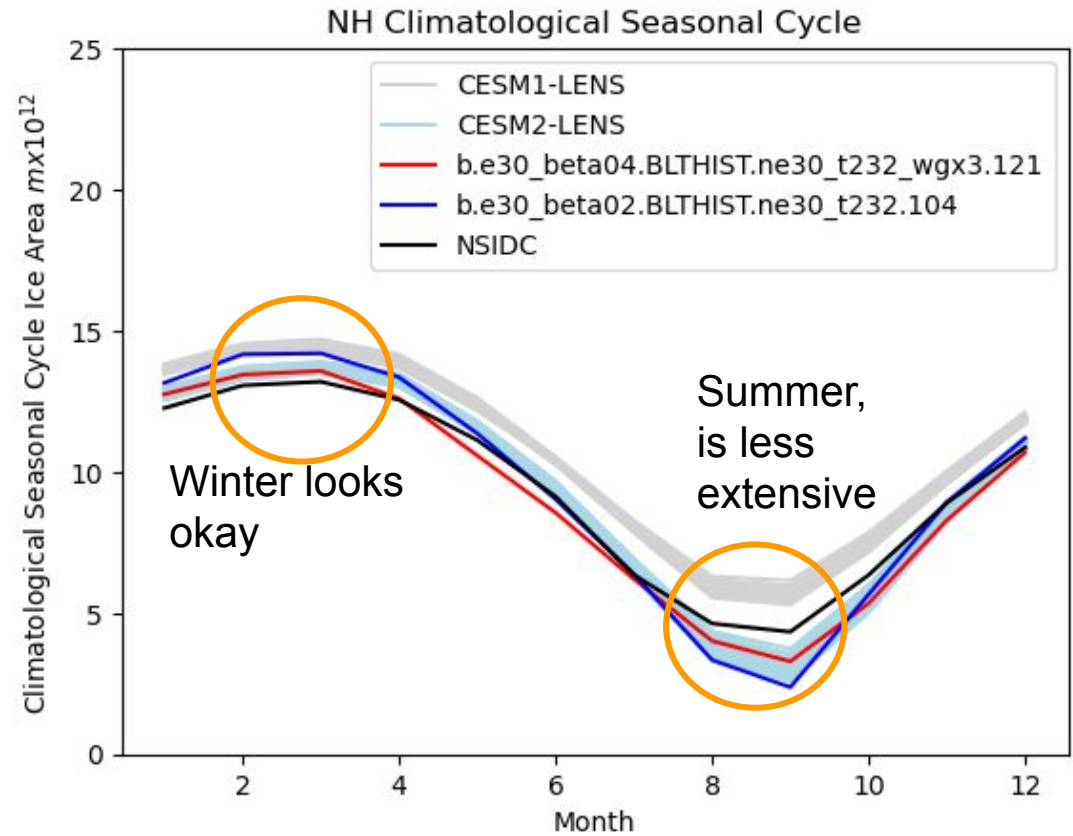


121 Historical - sea ice concentration

121 and NSIDC

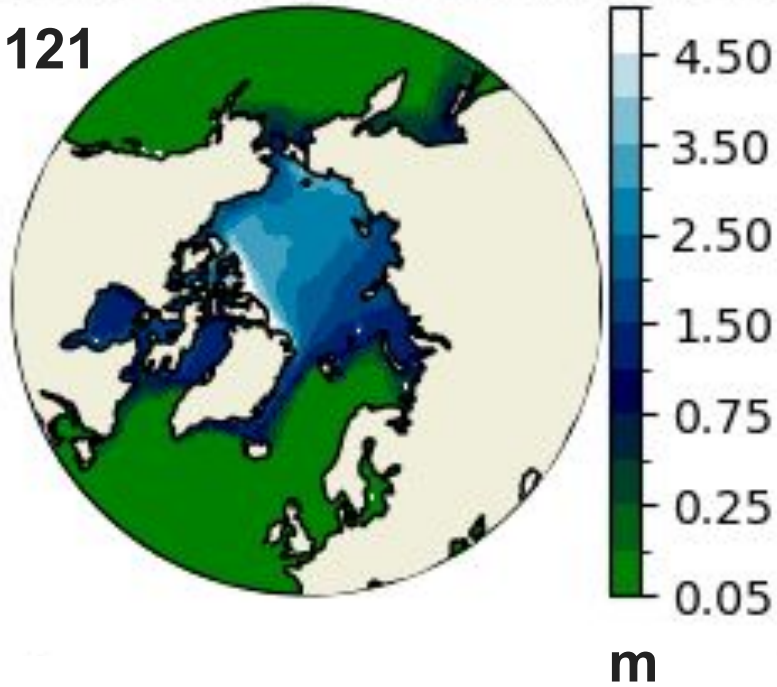


Focus on 121

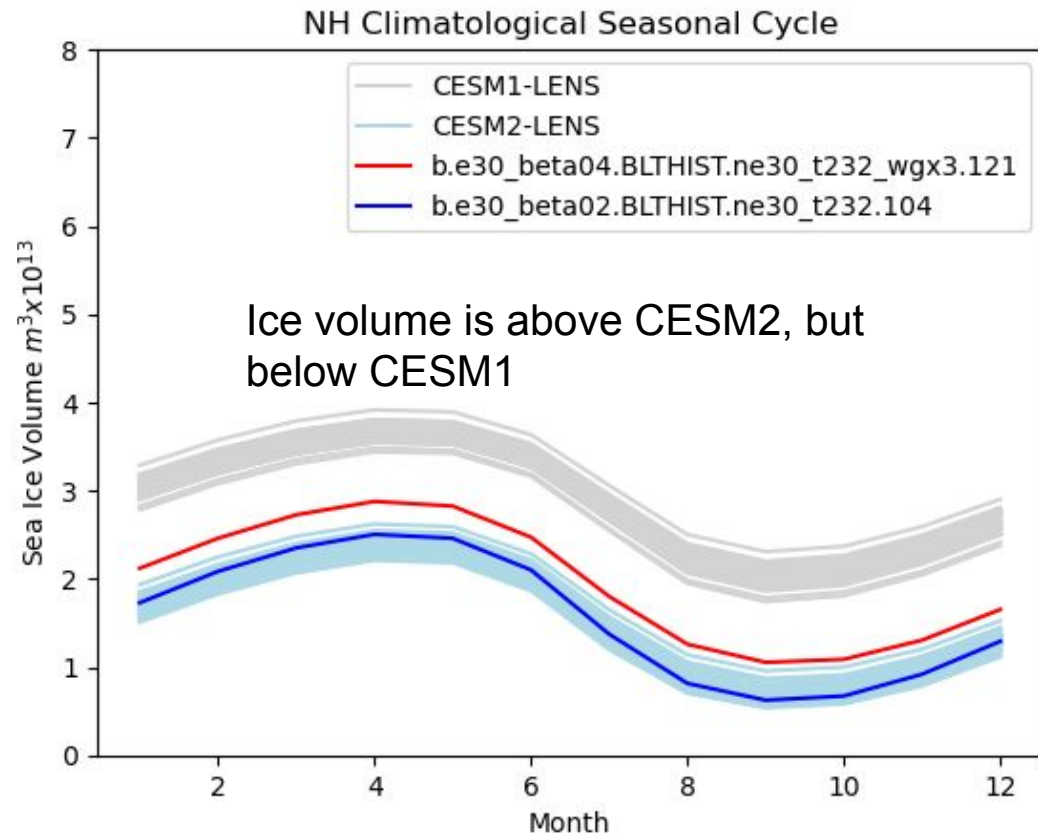


121 Historical - sea ice thickness

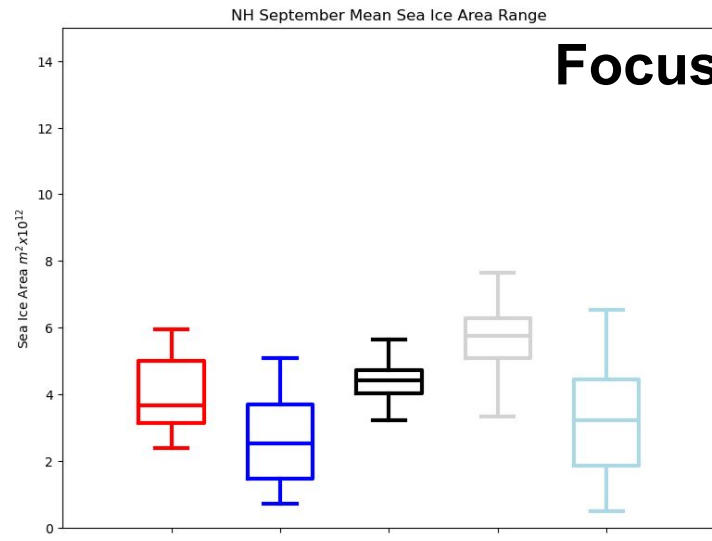
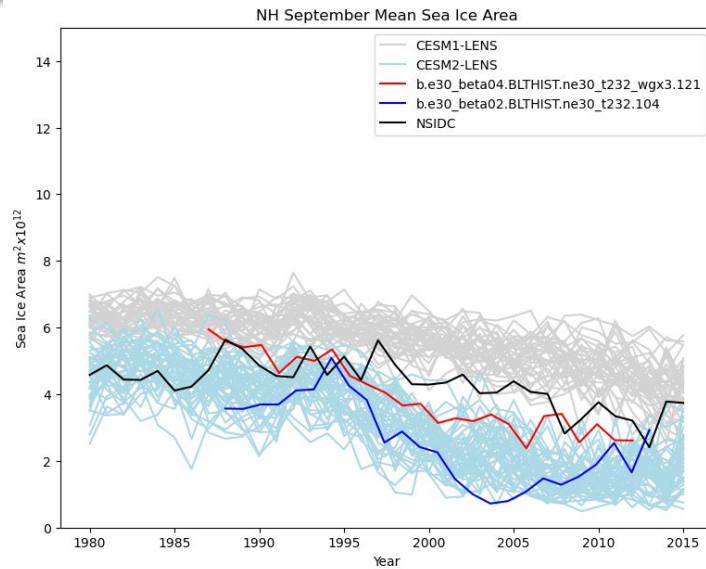
121



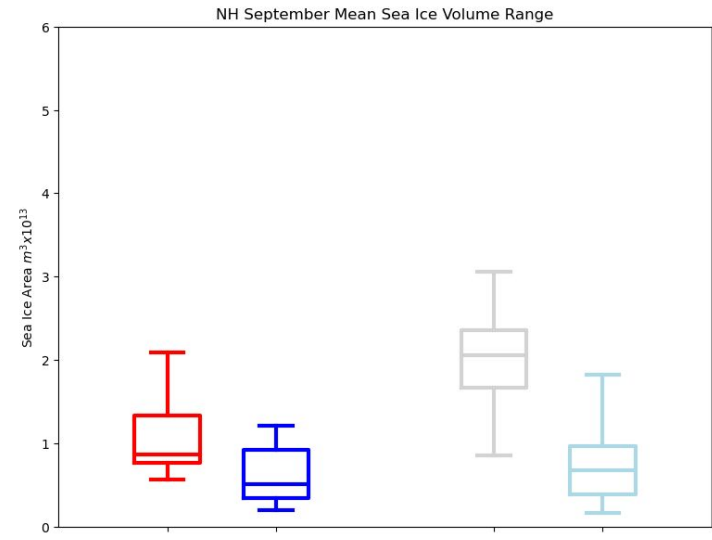
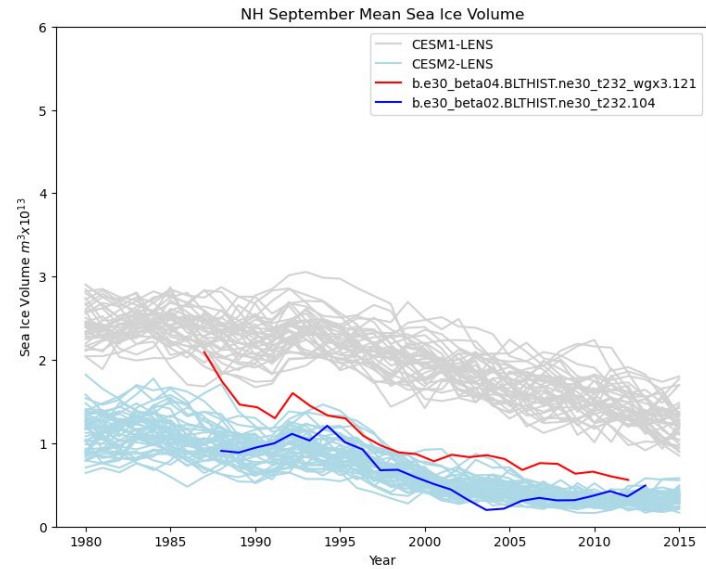
Focus on 121



121 Historical - Sept. Ice Area and Volume Ranges

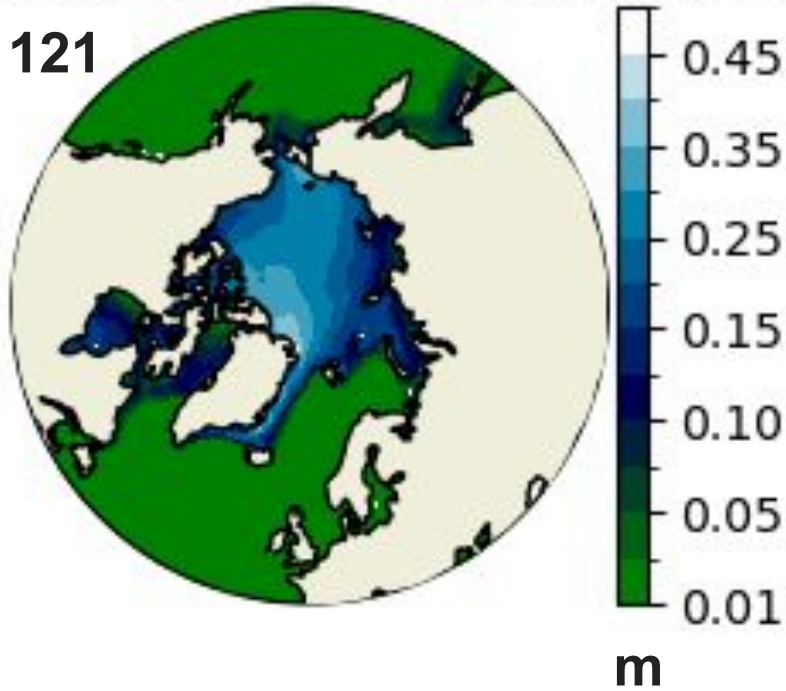


Focus on 121

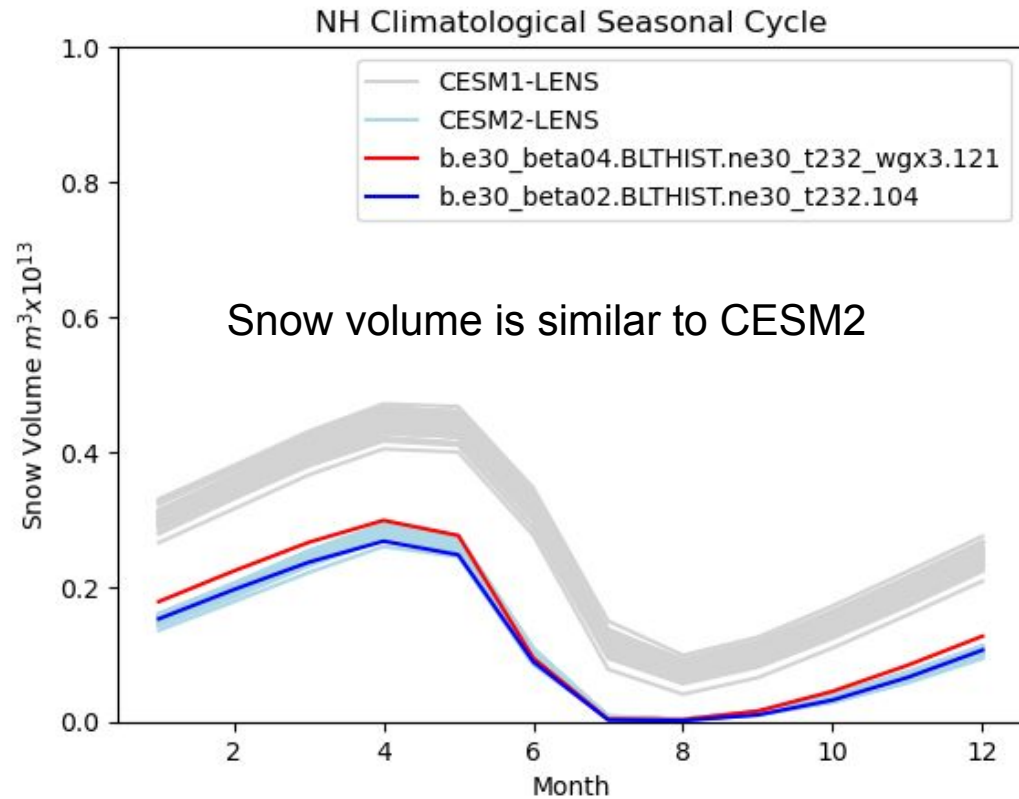


121 Historical - snow on sea ice

121

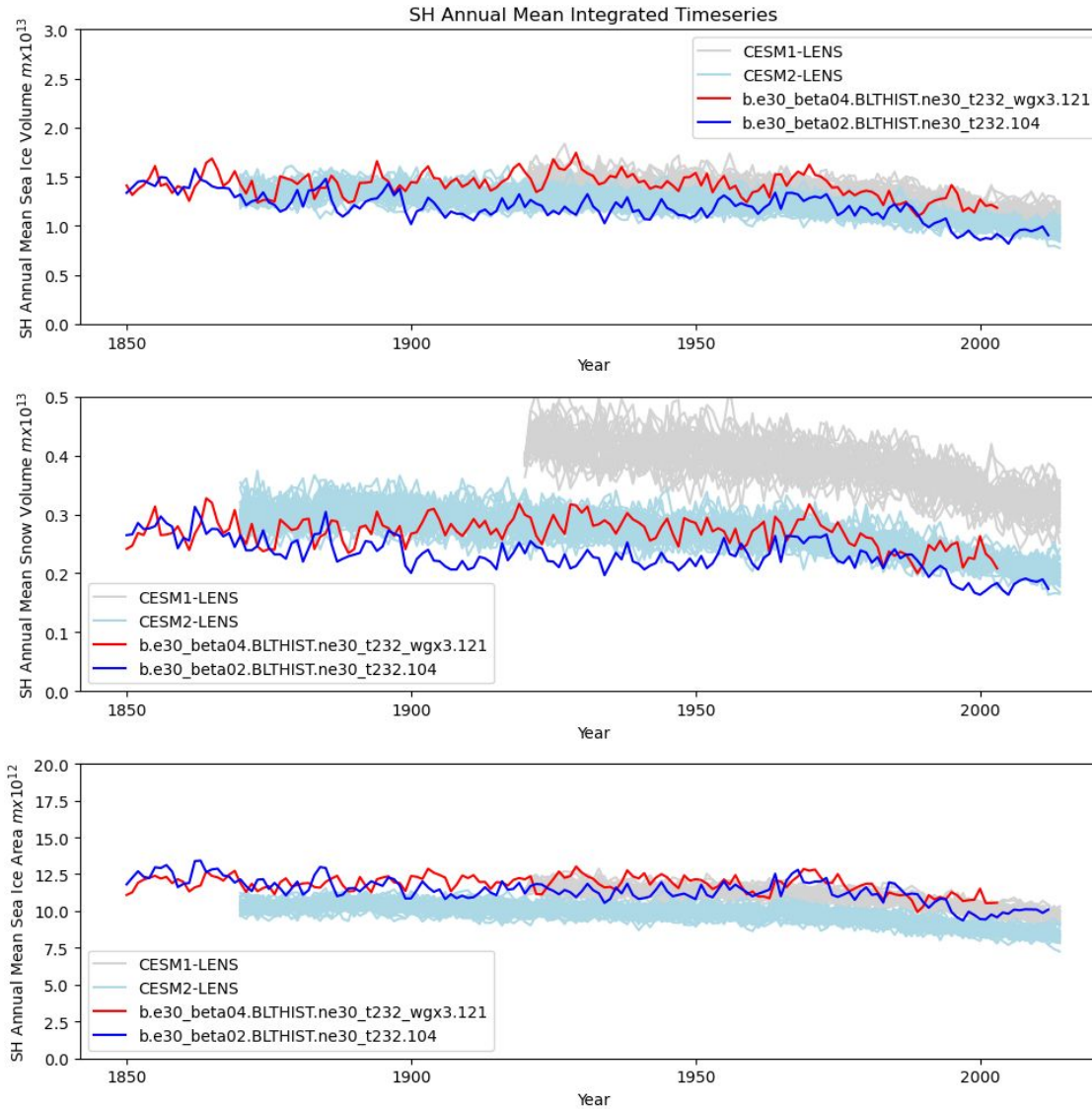


Focus on 121



121 Historical - Southern Hemisphere

Focus on **121**

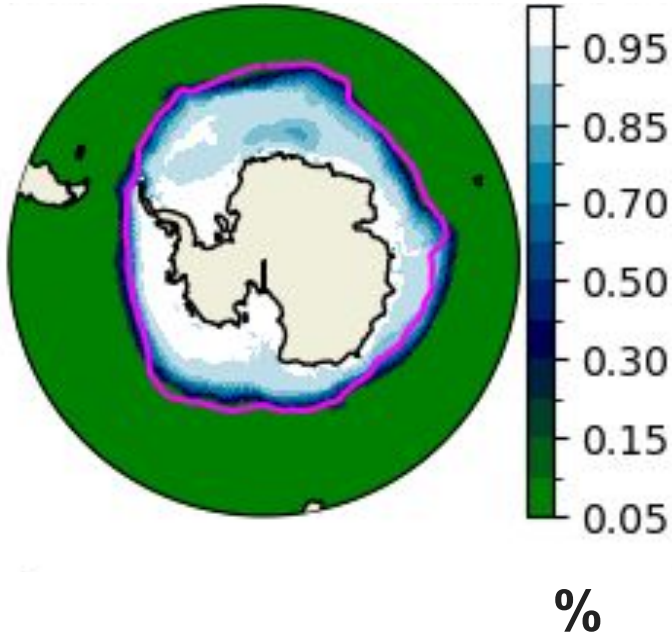


[PI Control Info](#)
[Historical Info](#)

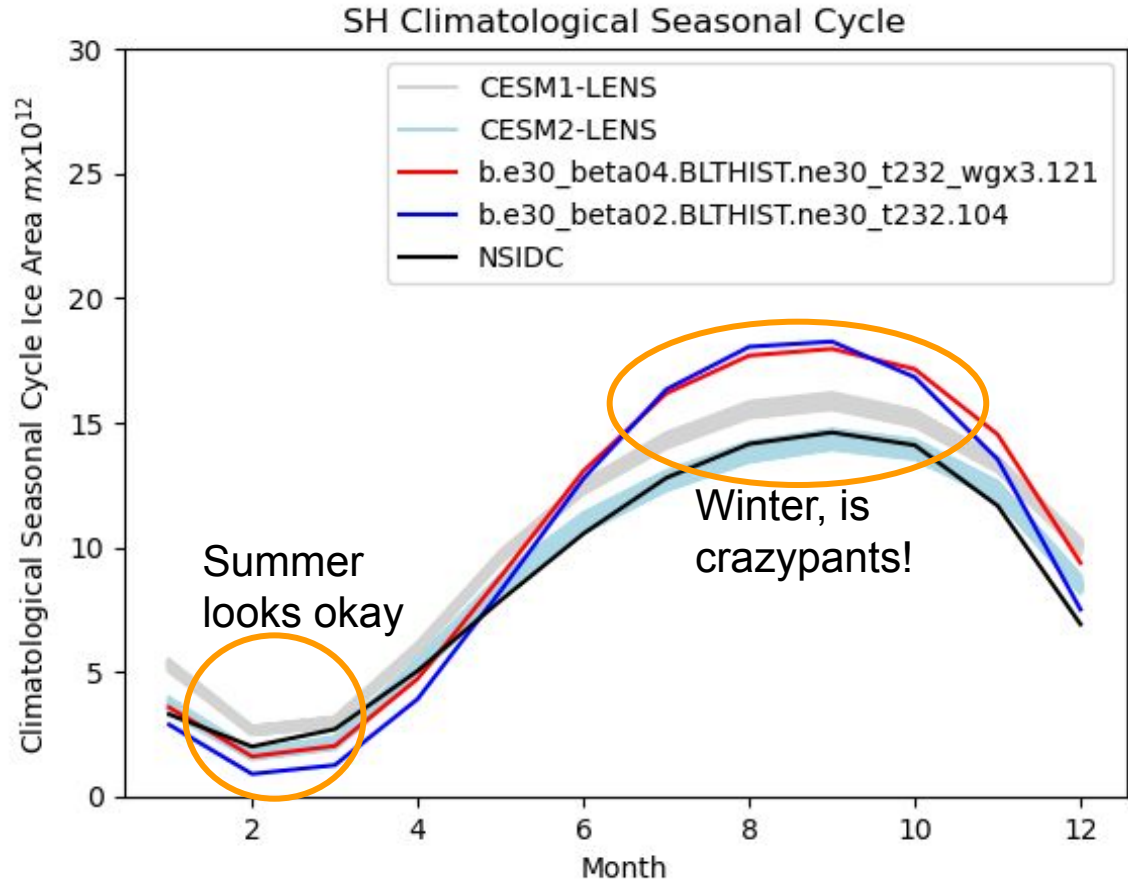


121 Historical - sea ice concentration

121 and NSIDC

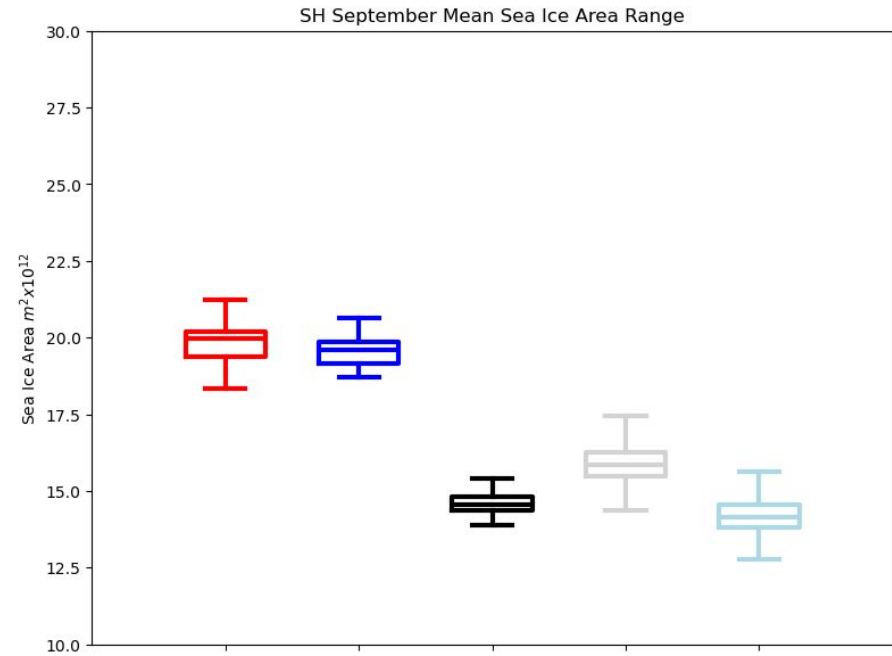
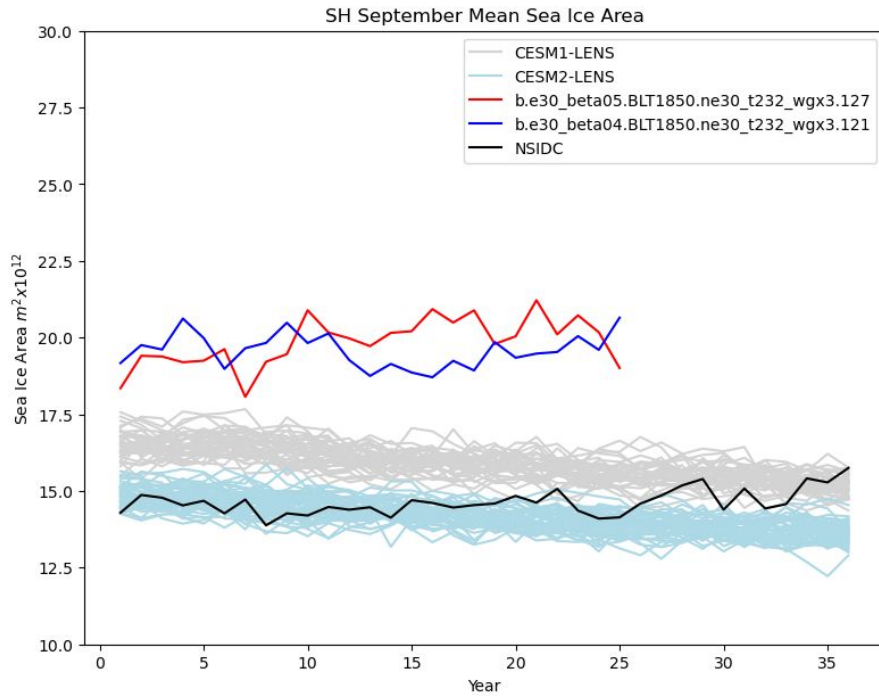


Focus on 121

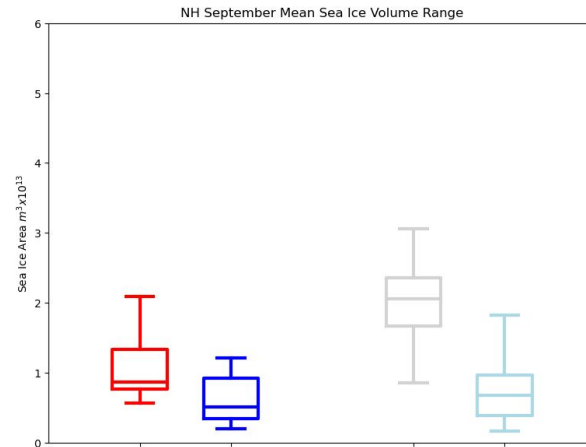
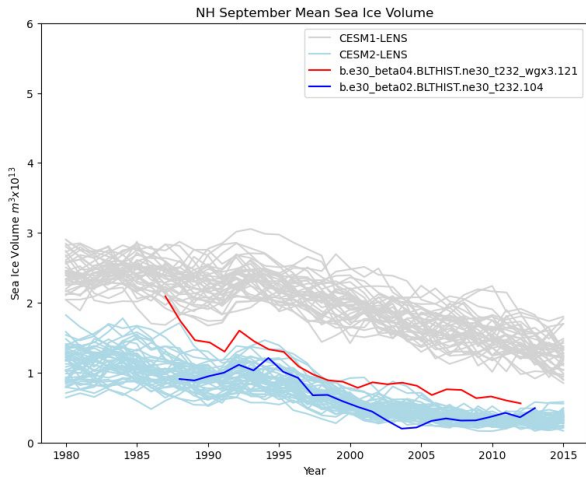


121 Historical - Sept. Ice Area and Volume Ranges

Focus on **121**

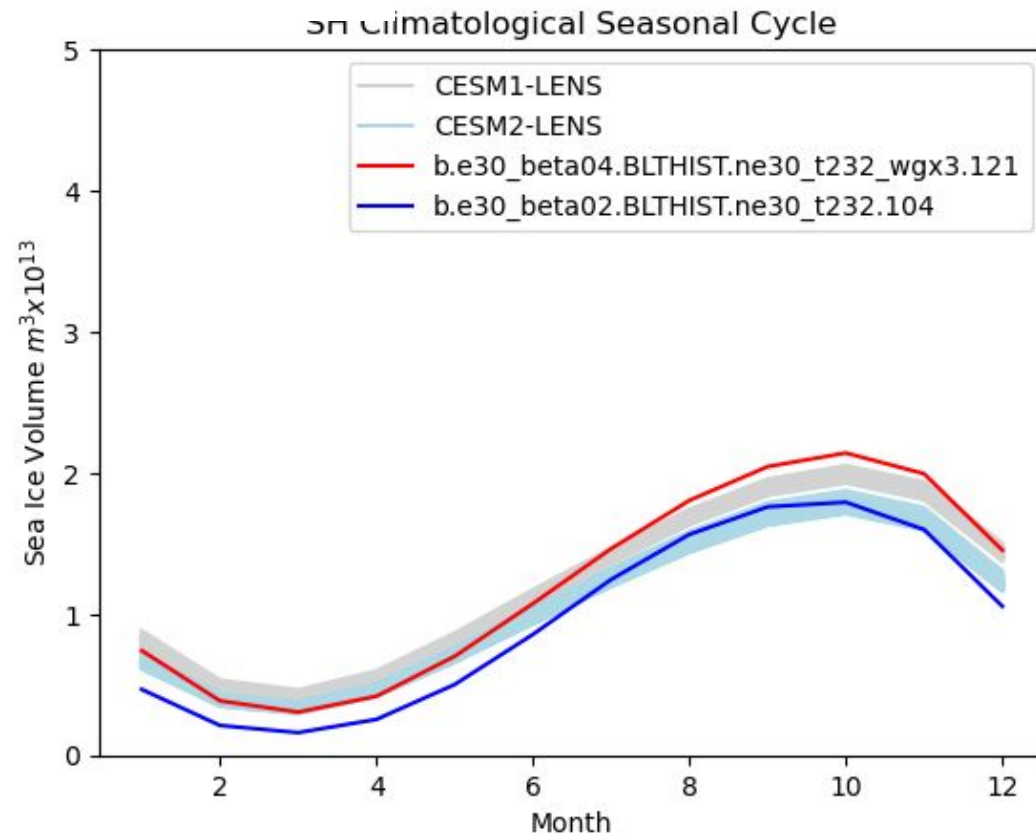


121 Historical - sea ice thickness



Focus on **121**

Ice volume is similar to CESM1, but it's more because it's so extensive, not because it's thick.



Southern Hemisphere - What's going on??

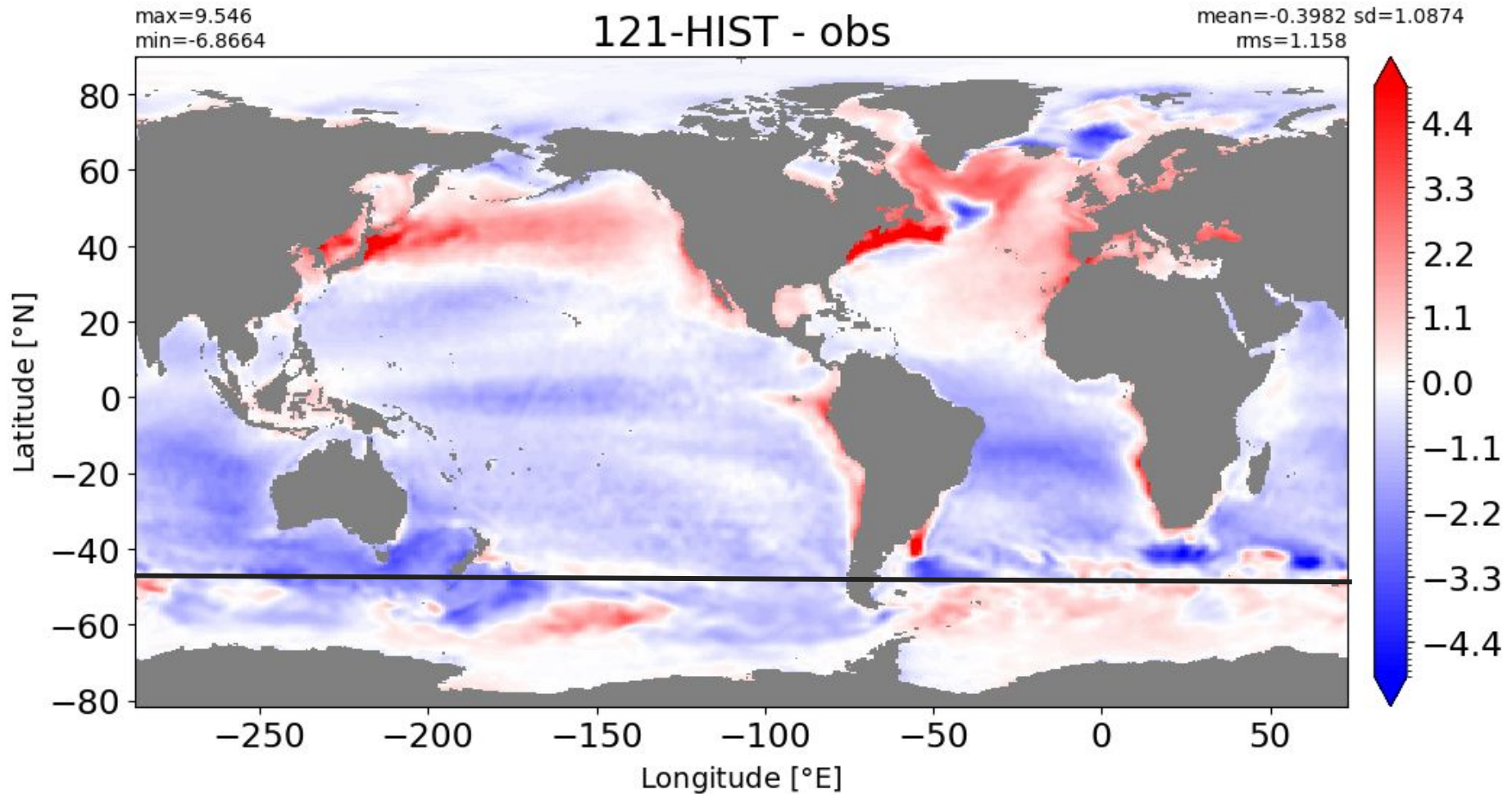
- Antarctic sea ice is a showstopper
 - Not physically realistic
 - Will affect the whole global climate (ocean and atmosphere circulation, etc.)
 - **We want feedback from PCWG community about how this will impact their ability to do science!**
- Sea ice albedo tuning hasn't fixed the problem
 - We need help with this from other WG!
 - Cloud mod testing (e.g. [124](#)) haven't fixed things
 - Ocean mods (e.g. [127](#)) haven't fixed things

Southern Hemisphere - What's going on??

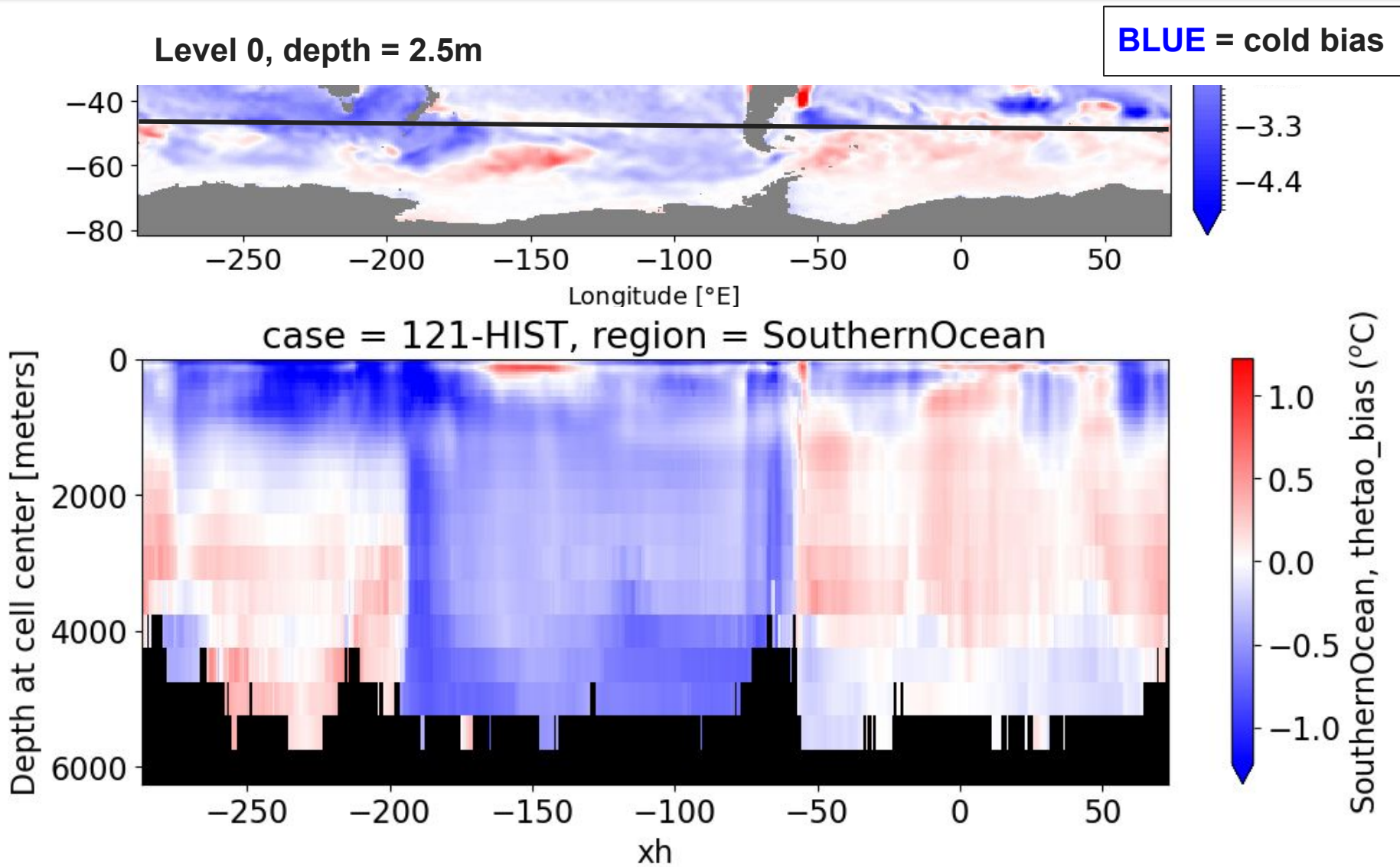
- What is causing the excessive winter ice concentration?
(Focus on Winter: June - October)
 - Hypothesis 1: Cold ocean temperatures are leading to excess sea ice growth.
 - Hypothesis 2: Too strong zonal winds may lead to excessive northward Ekman sea ice transport.
 - Hypothesis 3: Cloud cover impacting radiation biases may lead to cold surface biases (and ice growth).
 - Hypothesis 4: Too much precipitation could lead to excess sea ice growth (snow ice formation or freshening ocean).

MOM6 Temperature biases: 121-obs (level 0, depth = 2.5m)

Temperature bias [C] at depth = 2.5 m (level = 0)

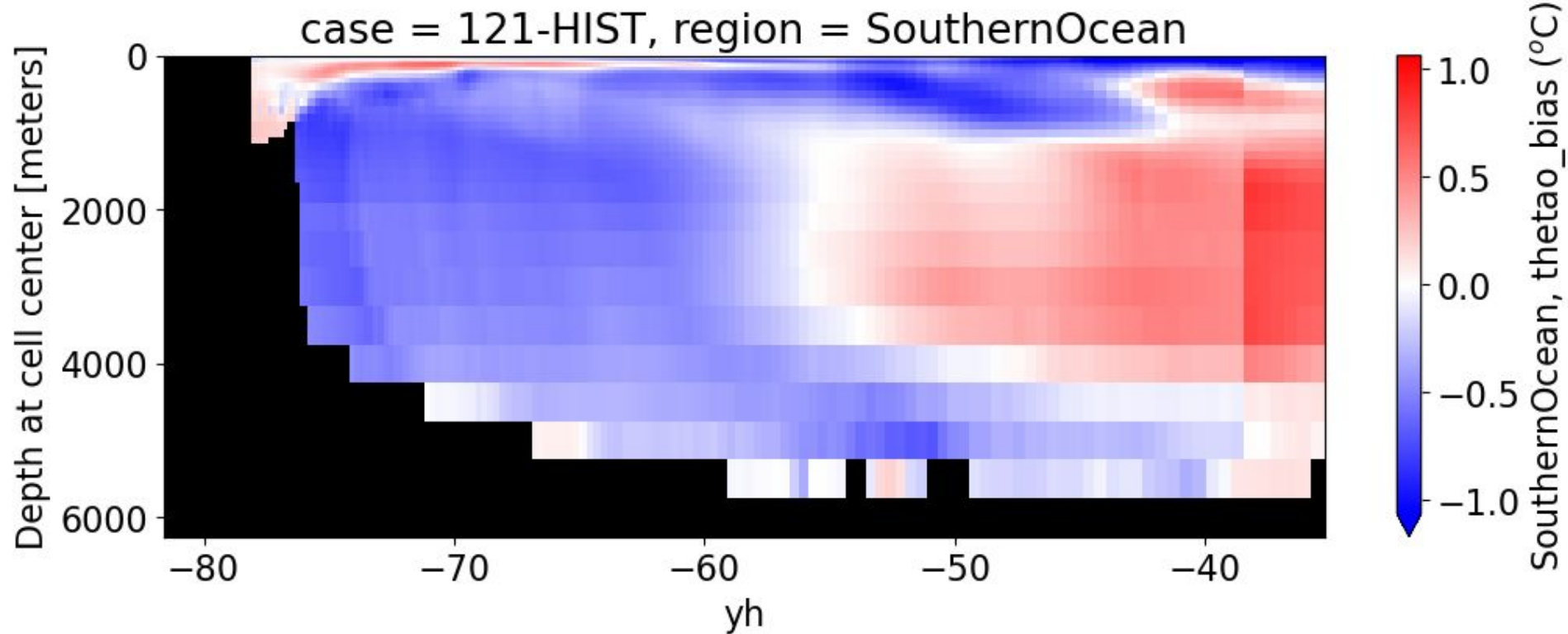


MOM6 Temperature biases: 121-obs



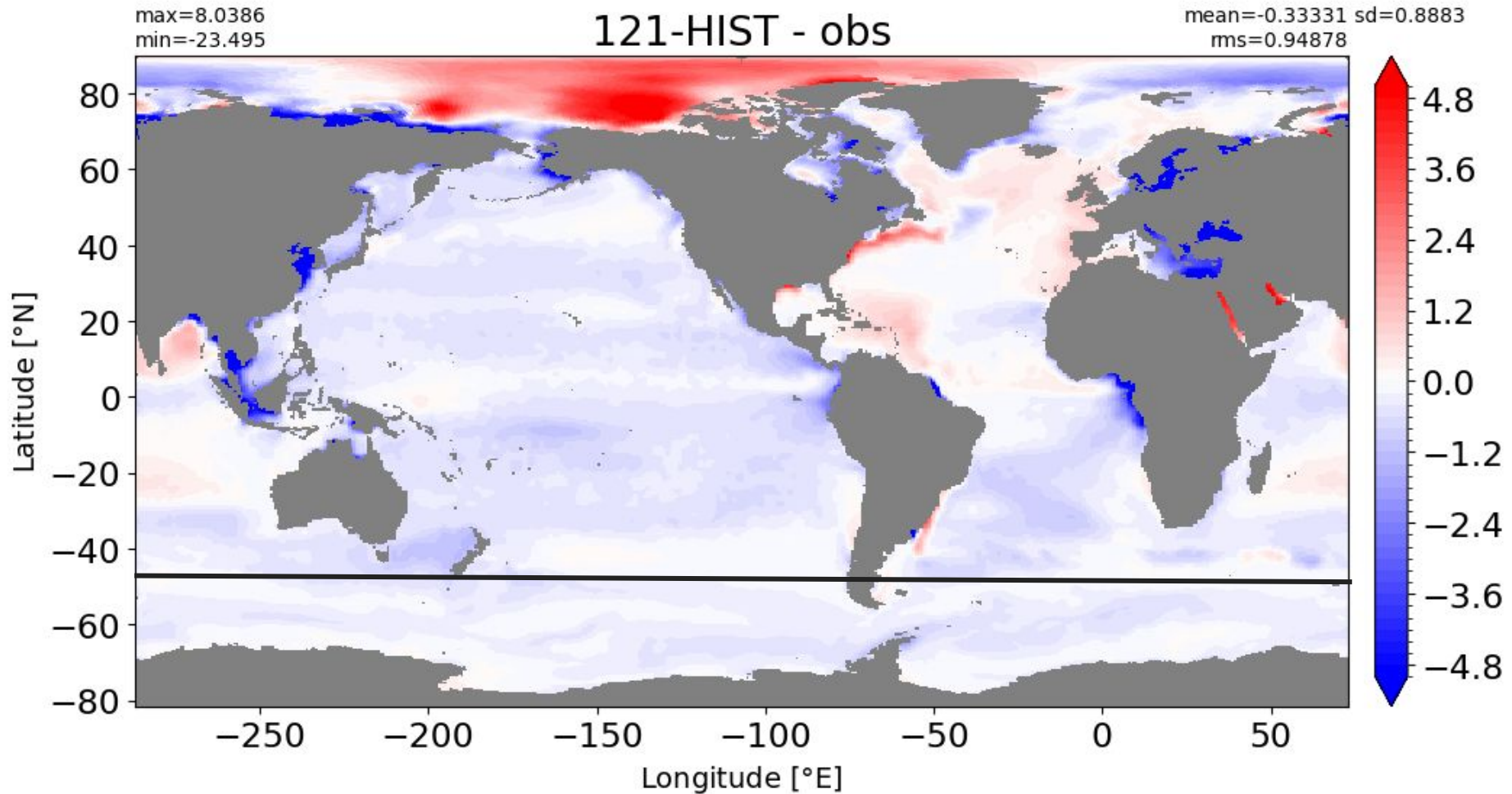
MOM6 Temperature biases: 121-obs

BLUE = cold bias

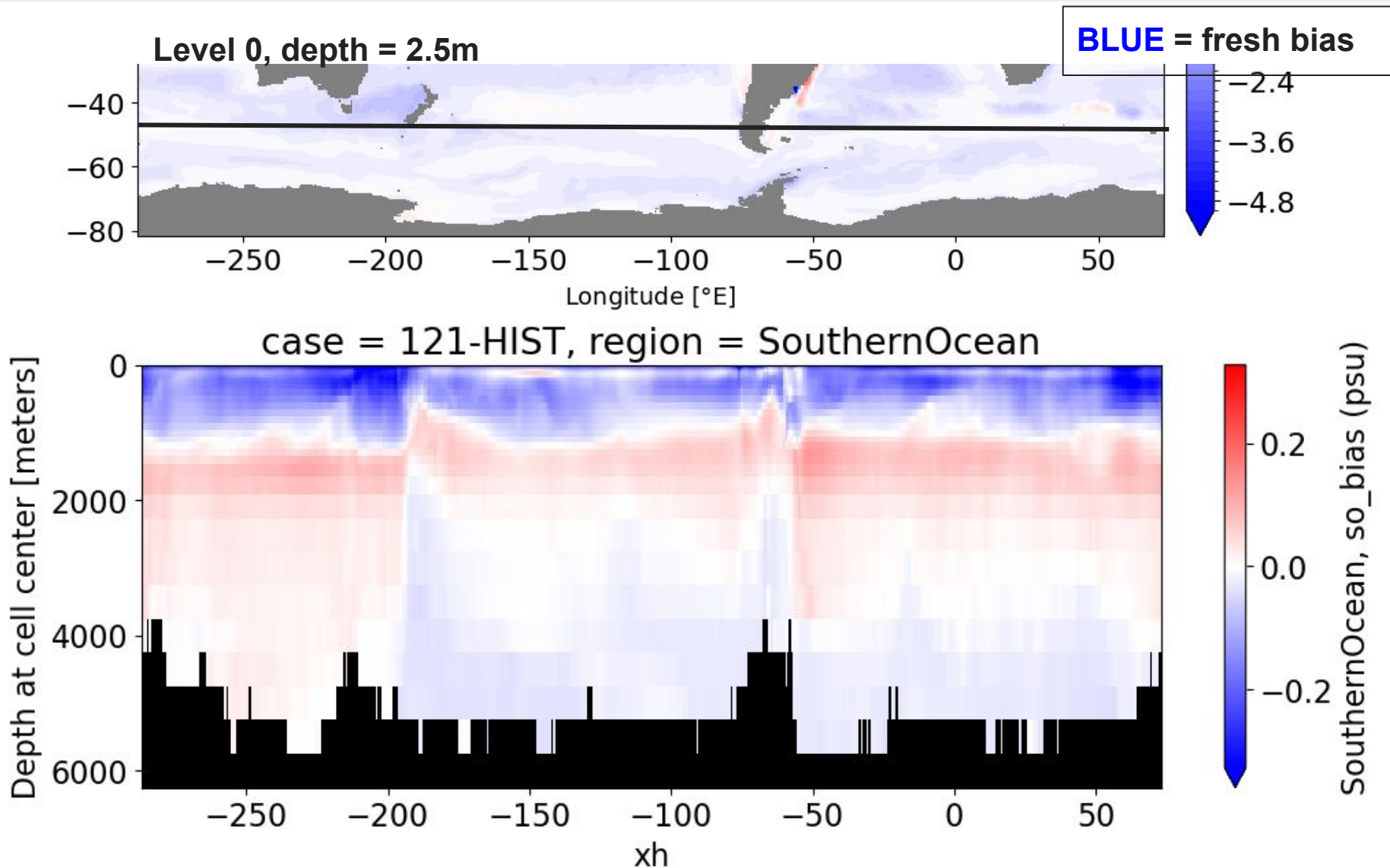


MOM6 Salinity biases: 121-obs (level 0, depth = 2.5m)

Salinity bias [psu] at depth = 2.5 m (level = 0)

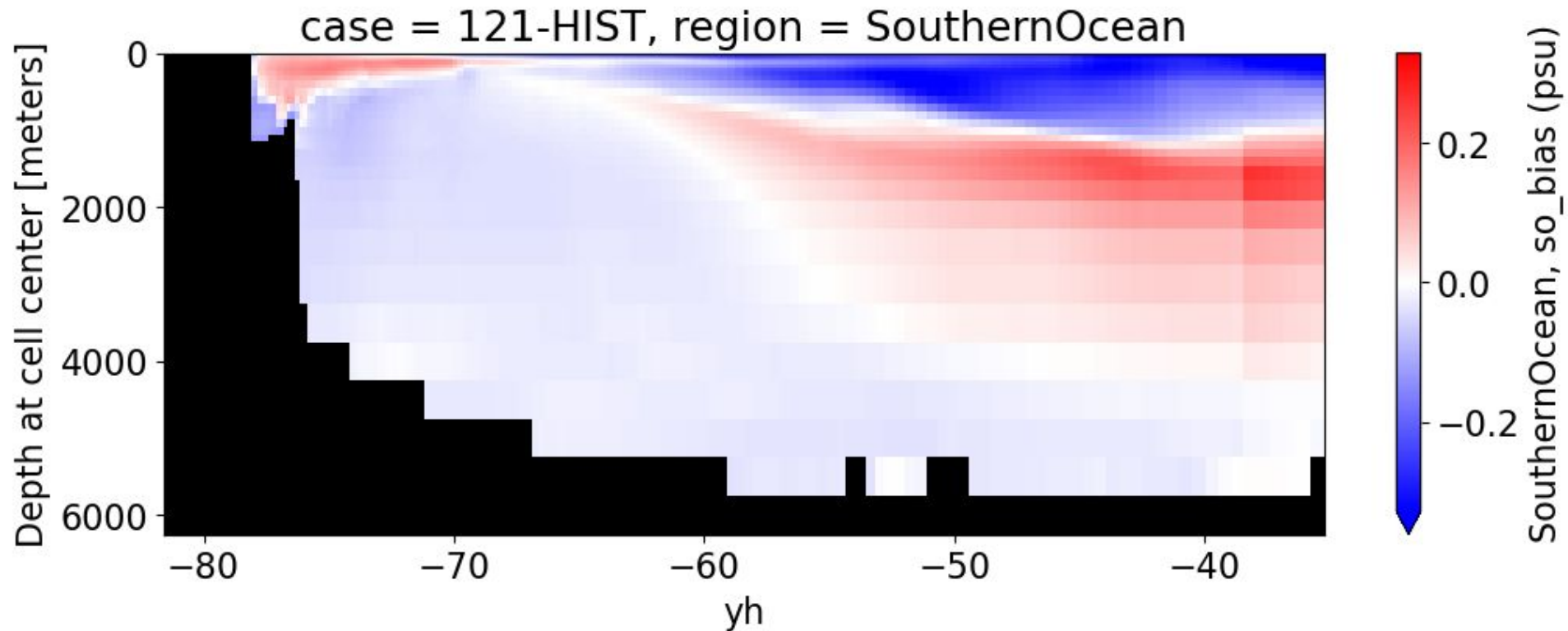


MOM6 Salinity biases: 121-obs



MOM6 Salinity biases: 121-obs

BLUE = fresh bias

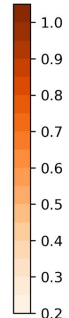
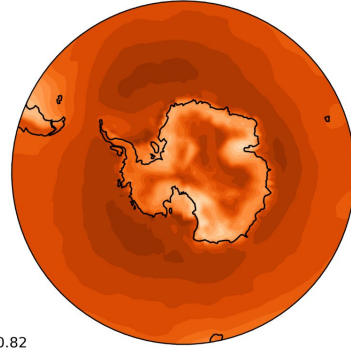
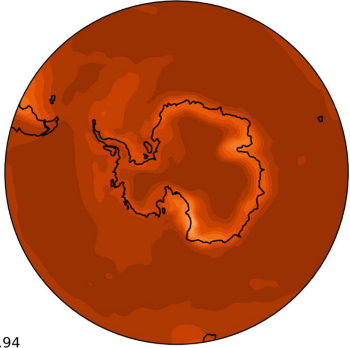


CAM cloud fields: 121- ERA

CLDTOT - JJA - SHPolar

Test: b.e30_beta04.BLTHIST.ne30_t232_wgx3.121
years: 1980-2005

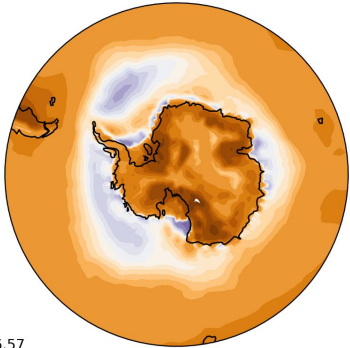
Baseline: ERAI_all_climo
Variable: CLDTOT



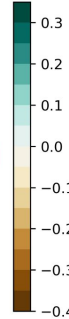
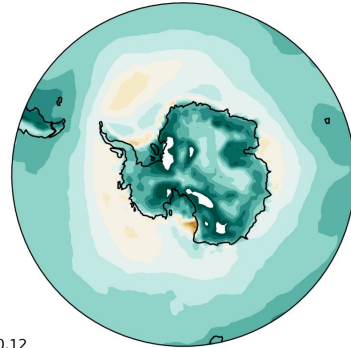
Mean: 0.94
Max: 1.00
Min: 0.54

Mean: 0.82
Max: 0.98
Min: 0.36

$\mathbf{\hat{m}}(\text{Test \% diff Baseline})$



Test - Baseline

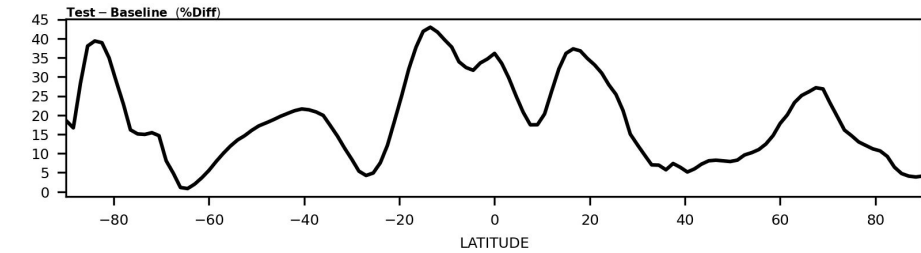
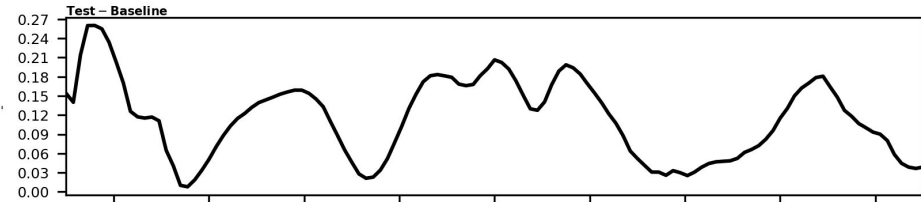
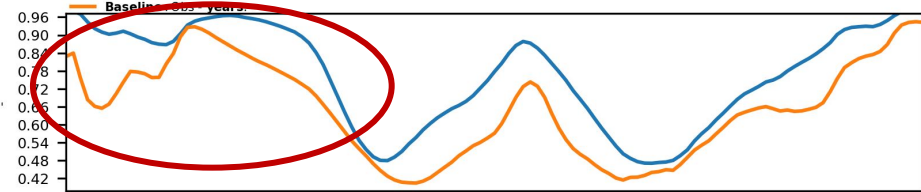


Mean: 16.57
Max: 106.75
Min: -32.22

Mean: 0.12
Max: 0.45
Min: -0.28

CLDTOT - JJA - Zonal

Test: b.e30_beta04.BLTHIST.ne30_t232_wgx3.121 - years: 1980-2005

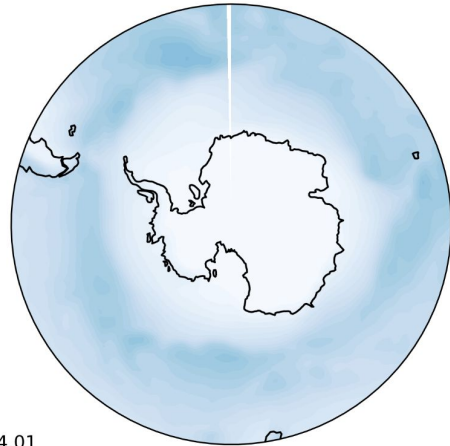


Cloud coverage is much higher in CESM3 than ERA-I

CAM cloud fields: 121- ERA

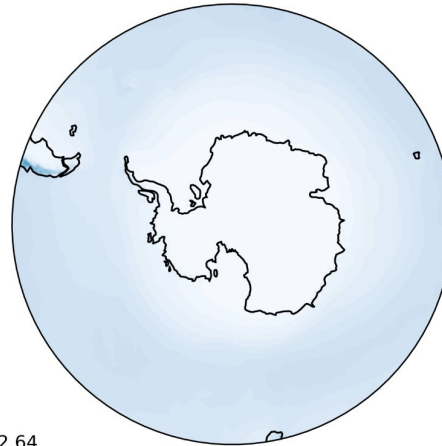
TGCLDLWP - JJA - SHPolar

Test: b.e30_beta04.BLTHIST.ne30_t232_wgx3.121
years: 1980-2005

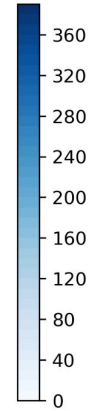


Mean: 74.01
Max: 160.97
Min: 0.00

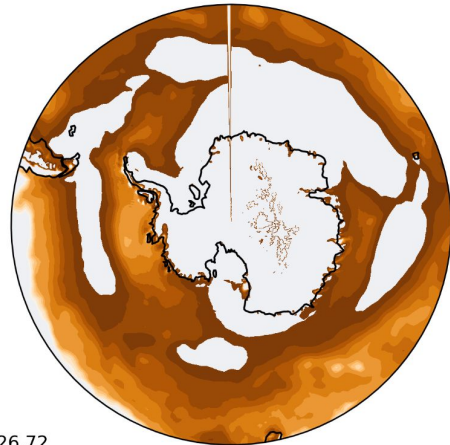
Baseline: TGCLDLWP_ERA5_monthly_climo_197901-202112
Variable: TGCLDLWP



Mean: 42.64
Max: 135.12
Min: 0.00

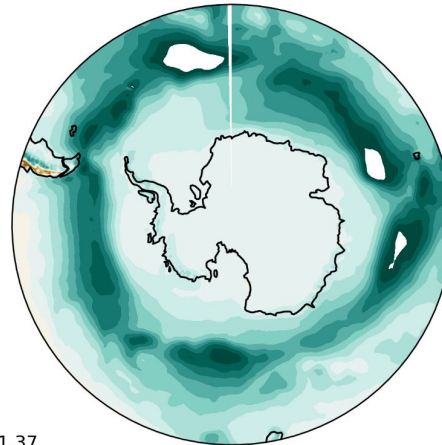


$\text{Test} \% \text{ diff Baseline}$

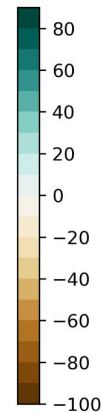


Mean: 926.72
Max: 465938.74
Min: -63.31

Test - Baseline



Mean: 31.37
Max: 103.59
Min: -39.47



Higher LWP in some areas around Antarctica

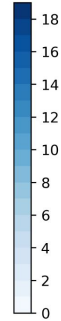
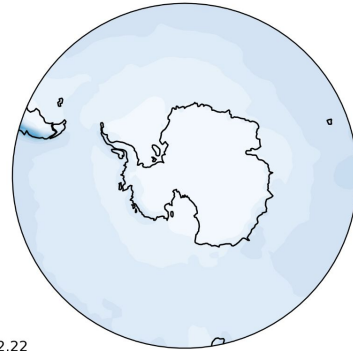
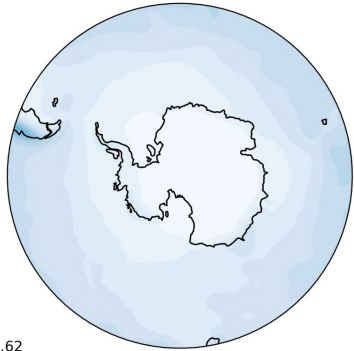


CAM precipitation: 121- ERA

PRECIP - JJA - SHPolar

Test: b.e30_beta04.BLTHIST.ne30_t232_wgx3.121
years: 1980-2005

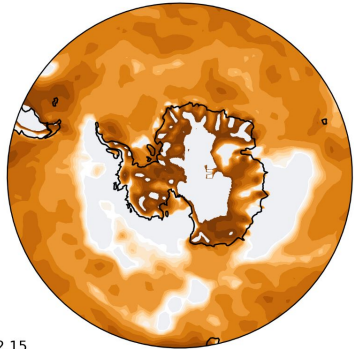
Baseline: ERAI_all_climo
Variable: PRECIP



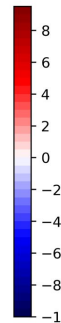
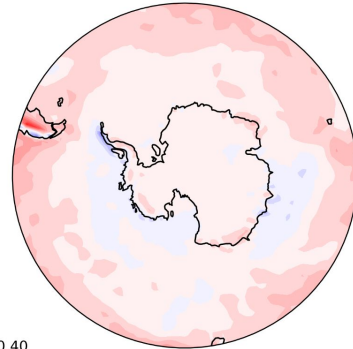
Mean: 2.62
Max: 5.51
Min: 0.05

Mean: 2.22
Max: 5.27
Min: 0.00

$\mathbf{\{Test \% diff Baseline\}}$



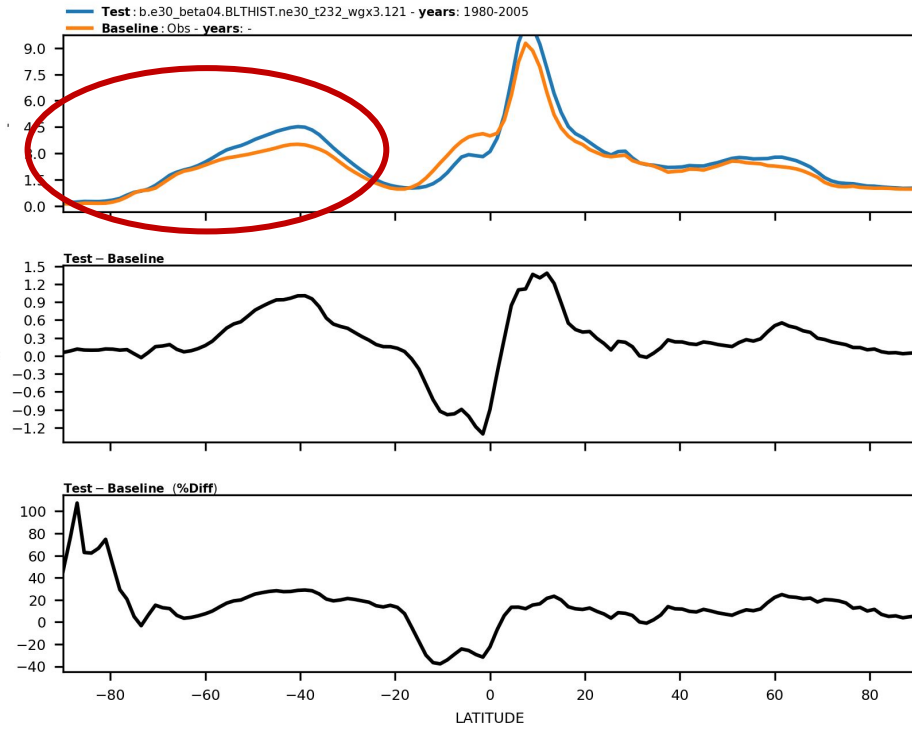
Test - Baseline



Mean: 72.15
Max: 6123.68
Min: -54.34

Mean: 0.40
Max: 1.71
Min: -1.46

PRECIP - JJA - Zonal

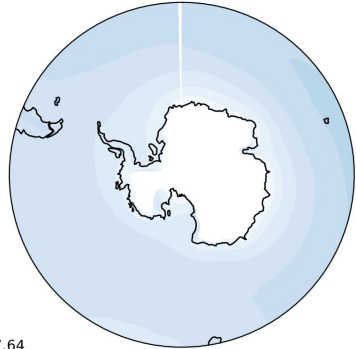


There's more precipitation in CESM3 than ERA-I

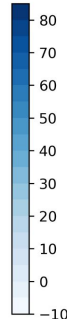
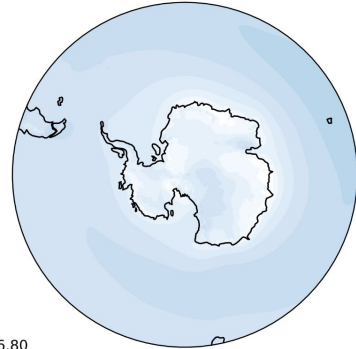
CAM winds: 121- ERA

U - 850hpa - JJA - SHPolar

Test: b.e30_beta04.BLTHIST.ne30_t232_wgx3.121
years: 1980-2005



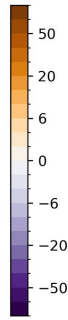
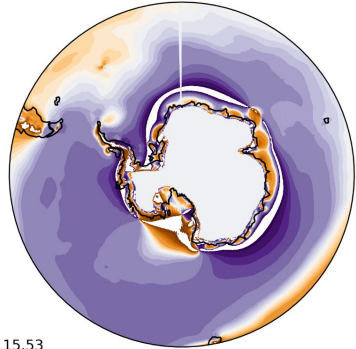
Baseline: U_ERAS_monthly_climo_197901-202112
Variable: U



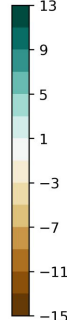
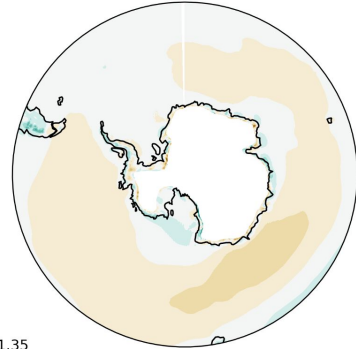
Mean: 7.64
Max: 15.90
Min: -20.54

Mean: 6.80
Max: 16.79
Min: -19.32

$\mathbf{\hat{m}}(\text{Test \% diff Baseline})$



Test - Baseline

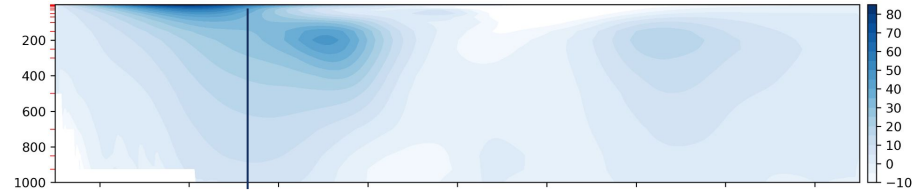


Mean: -115.53
Max: 47329.16
Min: -9477986.61

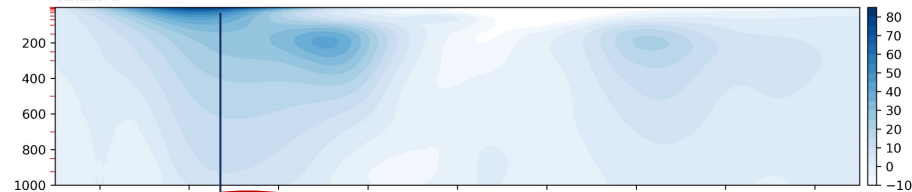
Mean: -1.35
Max: 11.50
Min: -12.64

U - JJA - Zonal

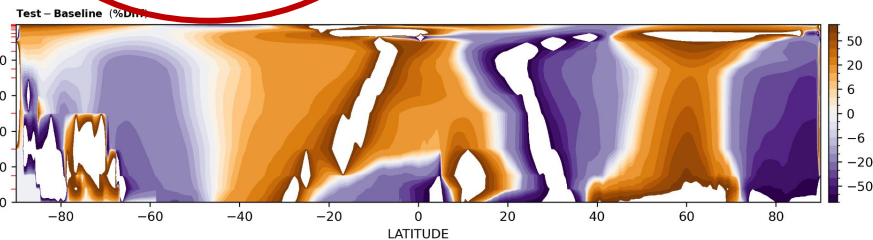
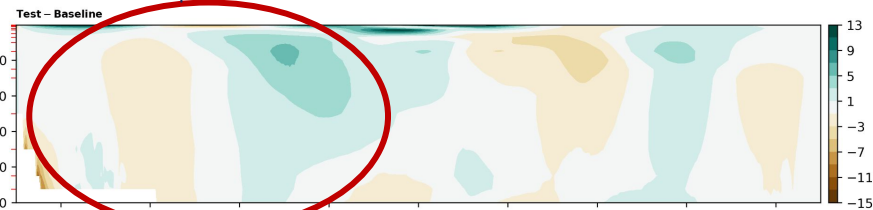
Test: b.e30_beta04.BLTHIST.ne30_t232_wgx3.121
years: 1980-2005



Baseline: U_ERAS_monthly_climo_197901-202112
Variable: U



PRESSURE [hPa]



LATITUDE

The zonal jet is shifted a bit northward



CVDP shows that SAM looks substantially different in CESM3 from CESM2

SAM Pattern (JAS)

© CVDP

