

# Progress and Plans - CESM/MOM6

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In collaboration with: Cecile Hannay, Julio Bacmeister, Keith Lindsay, Frank Bryan, Gokhan Danabasoglu, Alper Altuntas, David Bailey, Adam Herrington, Rich Neale, Kieth Oleson, Will Wieder, Jim Edwards + many others

*CESM OCEAN MODEL WINTER WORKING GROUP MEETING*

February 9th, 2023



# Towards CESM3: preliminary evaluation of new components

## **Goal of Task Force 5**

- Coupled simulations with CAM-dev/SE/L58 + MOM6 + CICE6 at ne30\_T061
- Preliminary evaluation of coupled runs by the end of Summer 2022

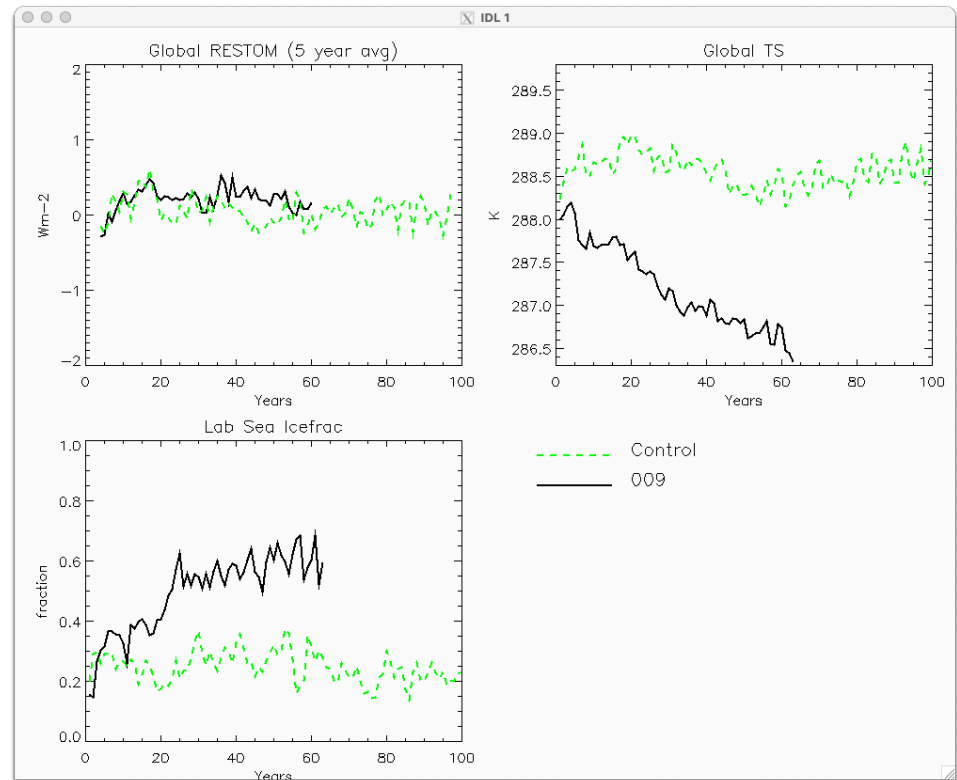
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=> Control looks good

**Target configuration:**  
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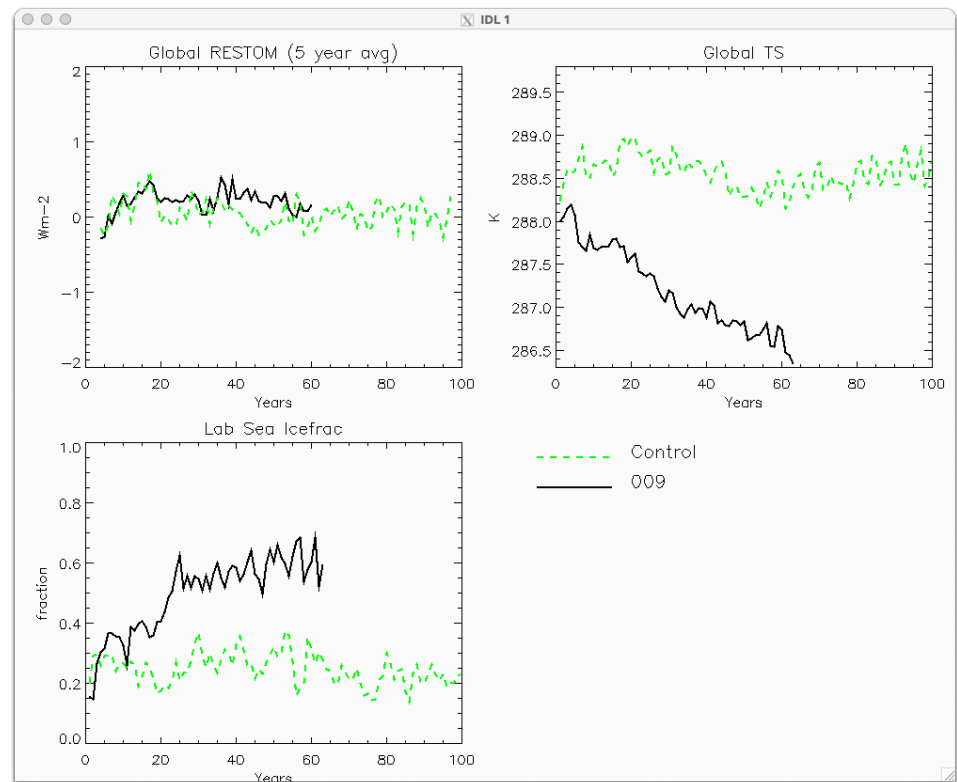
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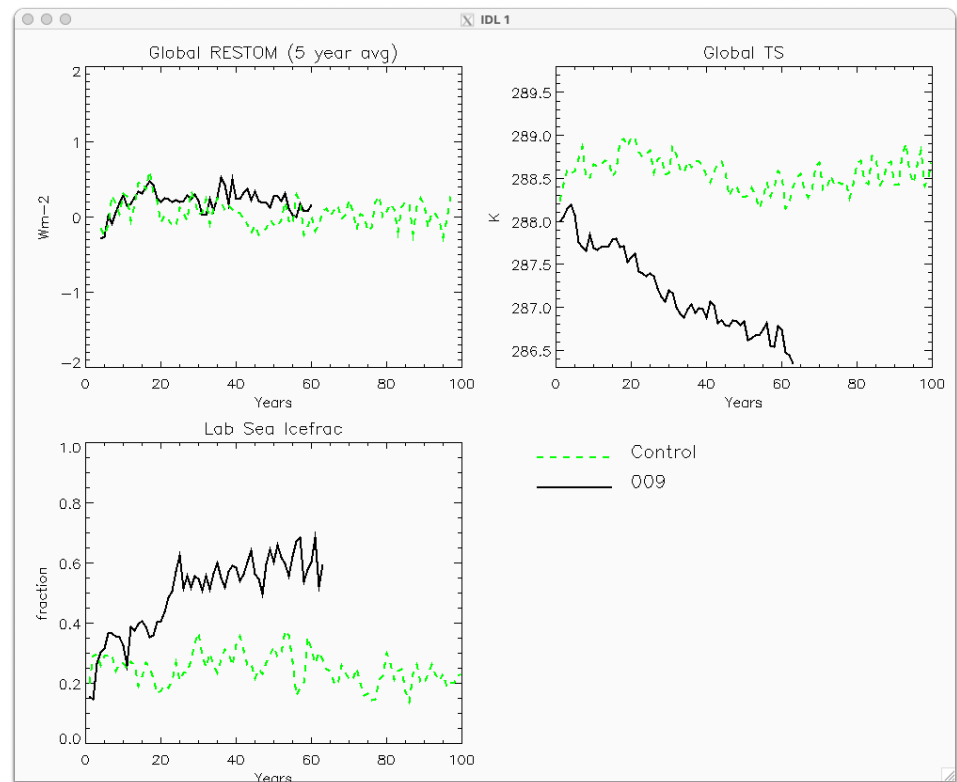
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- **New strategy:** start from control and work towards current configuration by making one modification per simulation, starting with what should matter the least



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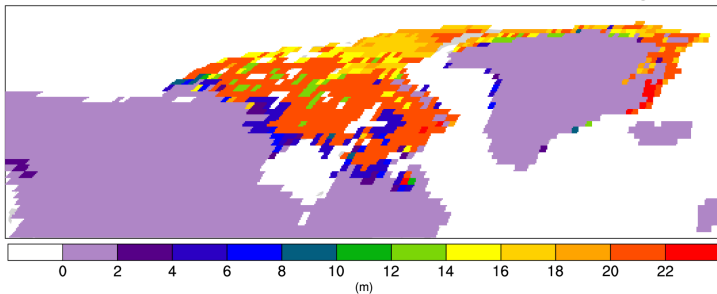
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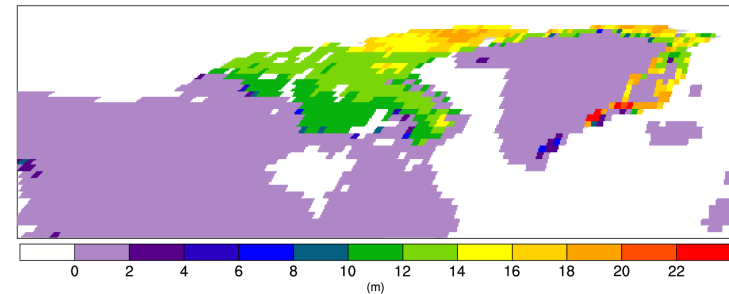
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Control (and all coupled simulations through 026b)



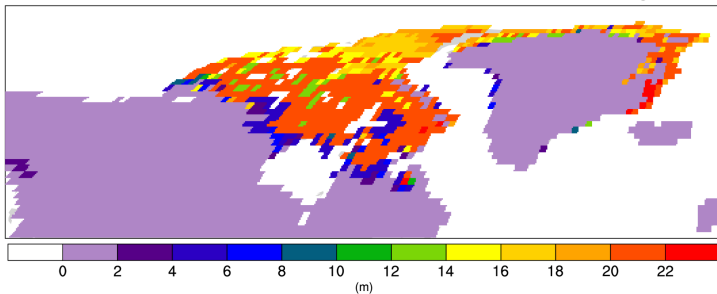
Year 58 of 016



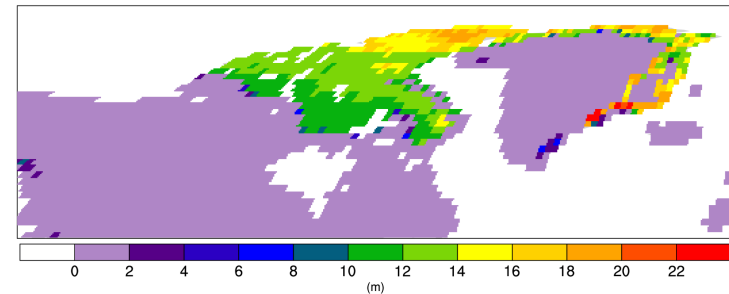
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Year 58 of 016



New approach is to use a “spun-up” initial file to reduce the initial surge in liquid runoff

# Summary of the most recent simulations

	ATM	ICE	Purpose	Nyrs
<b>Control</b>	cam6/L32/FV	CICE5	control: MOM6+CAM6+CICE5	100
<b>016</b>	cam6/L32/FV	CICE5	Repeat control with recent sandbox	58
<b>26c</b>	cam_dev/L58/SE	CICE5	Same as 26a with spunup ice/land	199
<b>26e</b>	cam_dev/L58/SE	CICE6	Same as 26c + cice6	121
<b>26f</b>	cam_dev/L58/SE	CICE5	Same as 26c + <b>pertlim</b> = 1e-14	70
<b>26g</b>	cam_dev/L58/SE	CICE5	Same as 26c + <b>pertlim</b> = 2e-14	205
<b>26h</b>	cam_dev/L58/SE	CICE6	Same as 26c + cice6 + advanced snow physics	244
<b>009</b>	cam_dev/L58/SE	CICE6	Target simulation MOM6+CAM-dev+CICE6	63

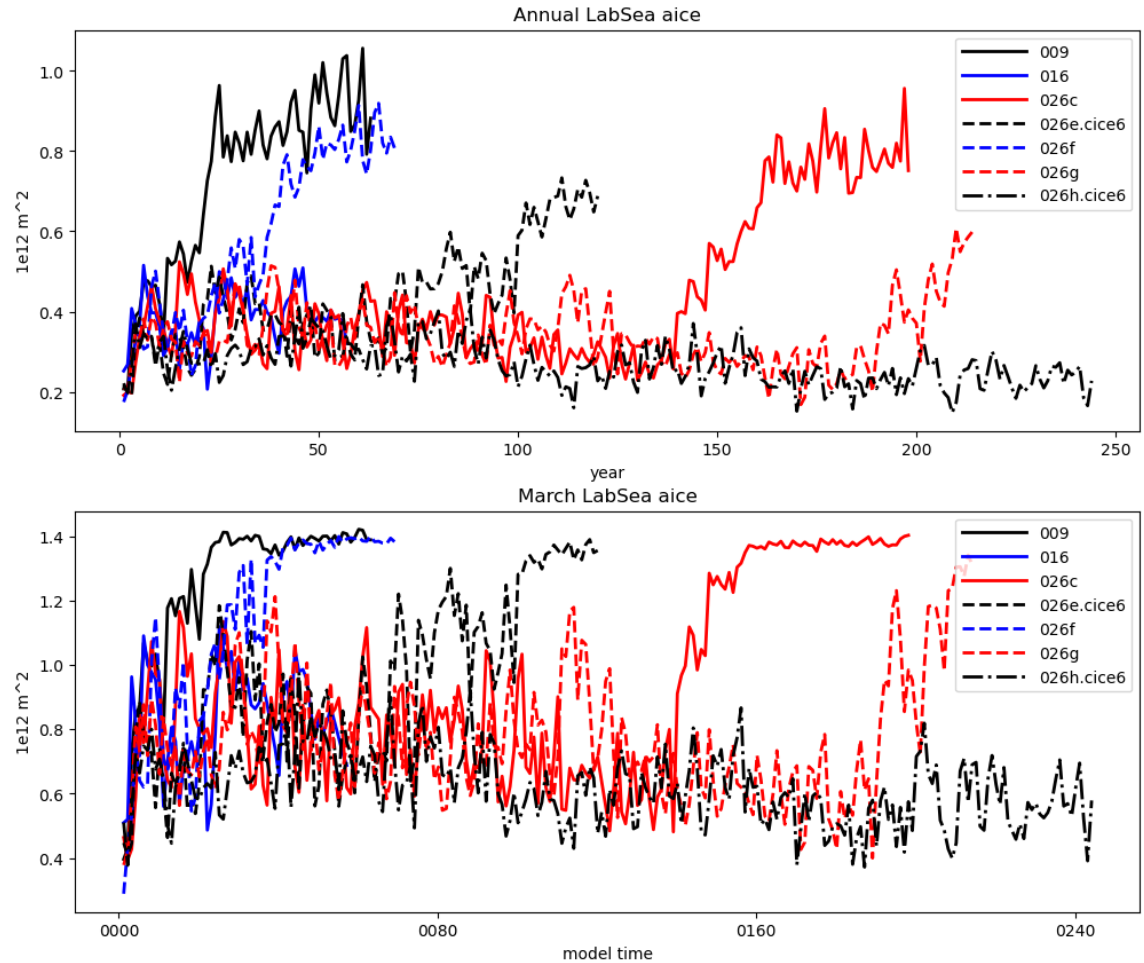
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# Annual & March Lab Sea Ice Area

- 26c, and “pertlims” of it, have all frozen. Date of freeze onset varies widely
- 26e, using cice6, also froze
- 26h, using cice6, not frozen through 245 years



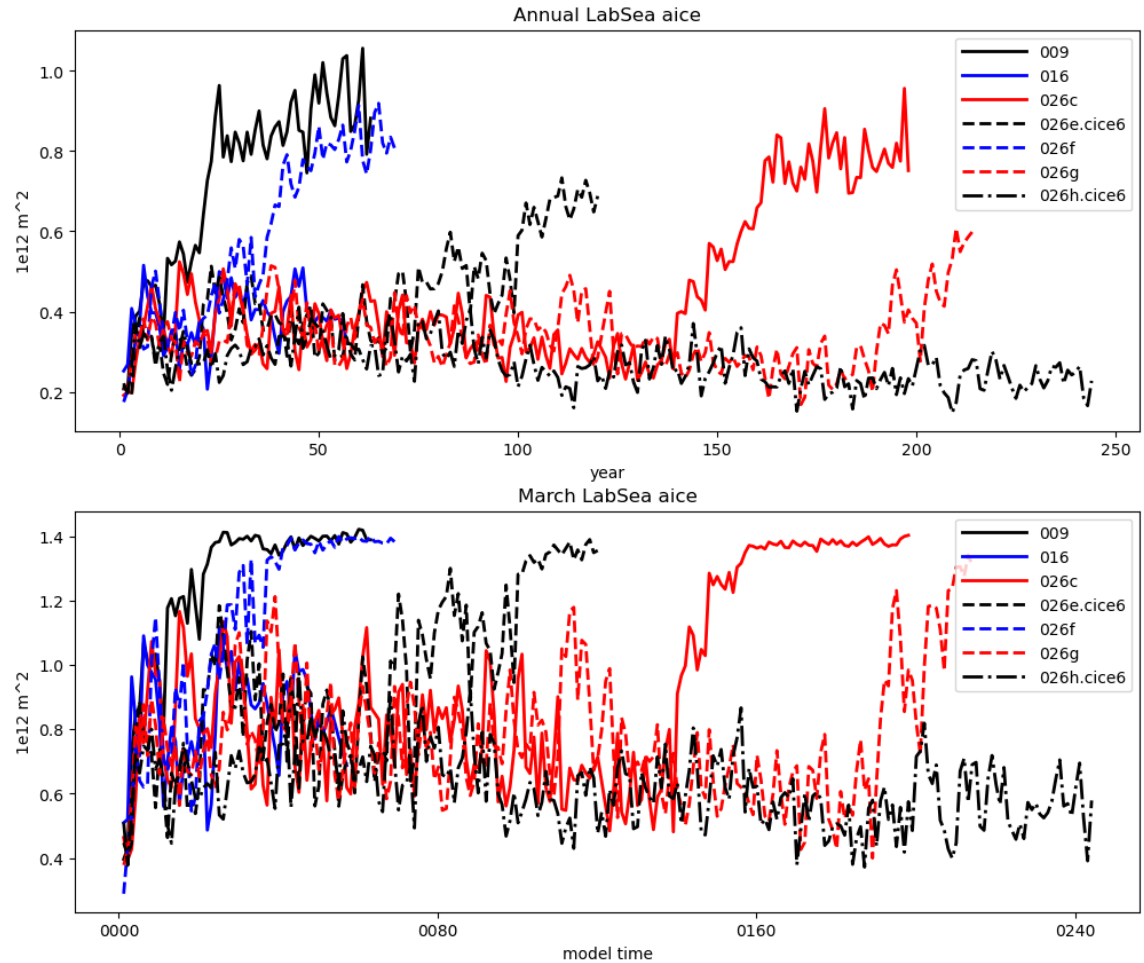
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The winner is:



climate model trophy for best fully-coupled simulation



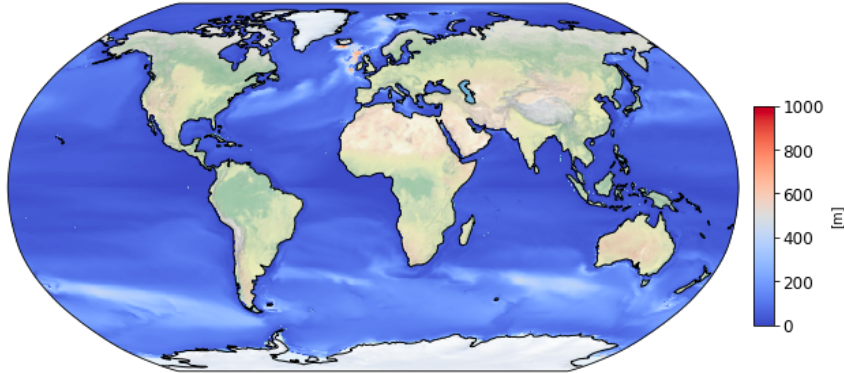
# Winter mixed layer depth [m], 0.03 kg/m<sup>3</sup> density criteria

## 026c: 26a + spunup ice/land (178-198)

max=787.43  
min=1.8632

case026c, Winter MLD (m)

mean=86.514 sd=70.936  
rms=111.88

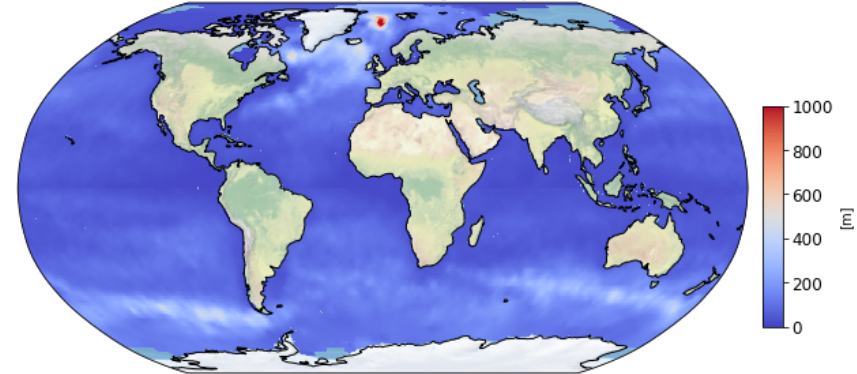


## Observation-based

max=1251.1  
min=10.288

Winter MLD from de Boyer Montegut et al., JGR 2004

mean=89.381 sd=66.013  
rms=111.12

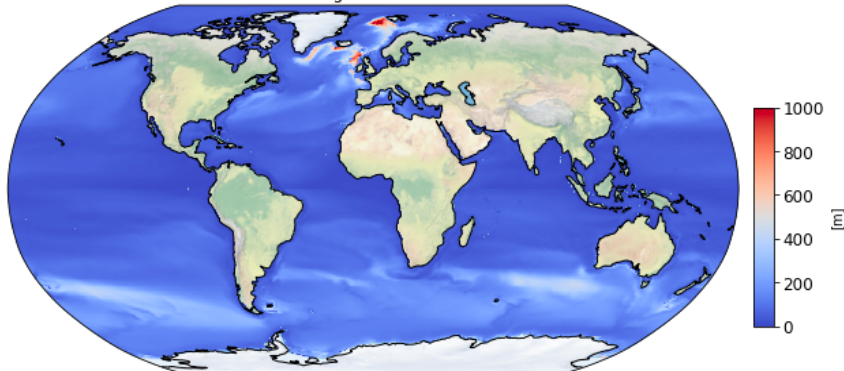


## 026g: same as 26c + pertlim (185-205)

max=1328.3  
min=1.9369

case026g, Winter MLD (m)

mean=87.827 sd=76.154  
rms=116.25

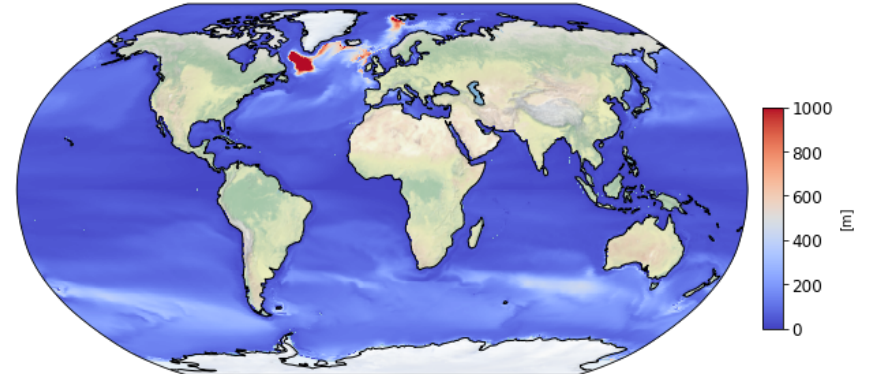


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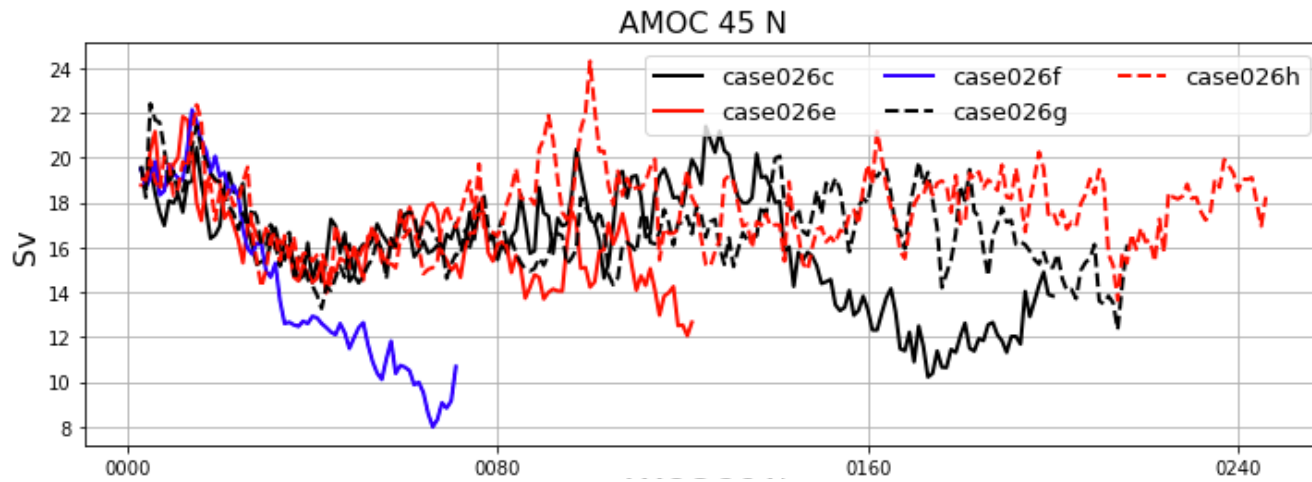
max=2274.3  
min=1.924

case026h, Winter MLD (m)

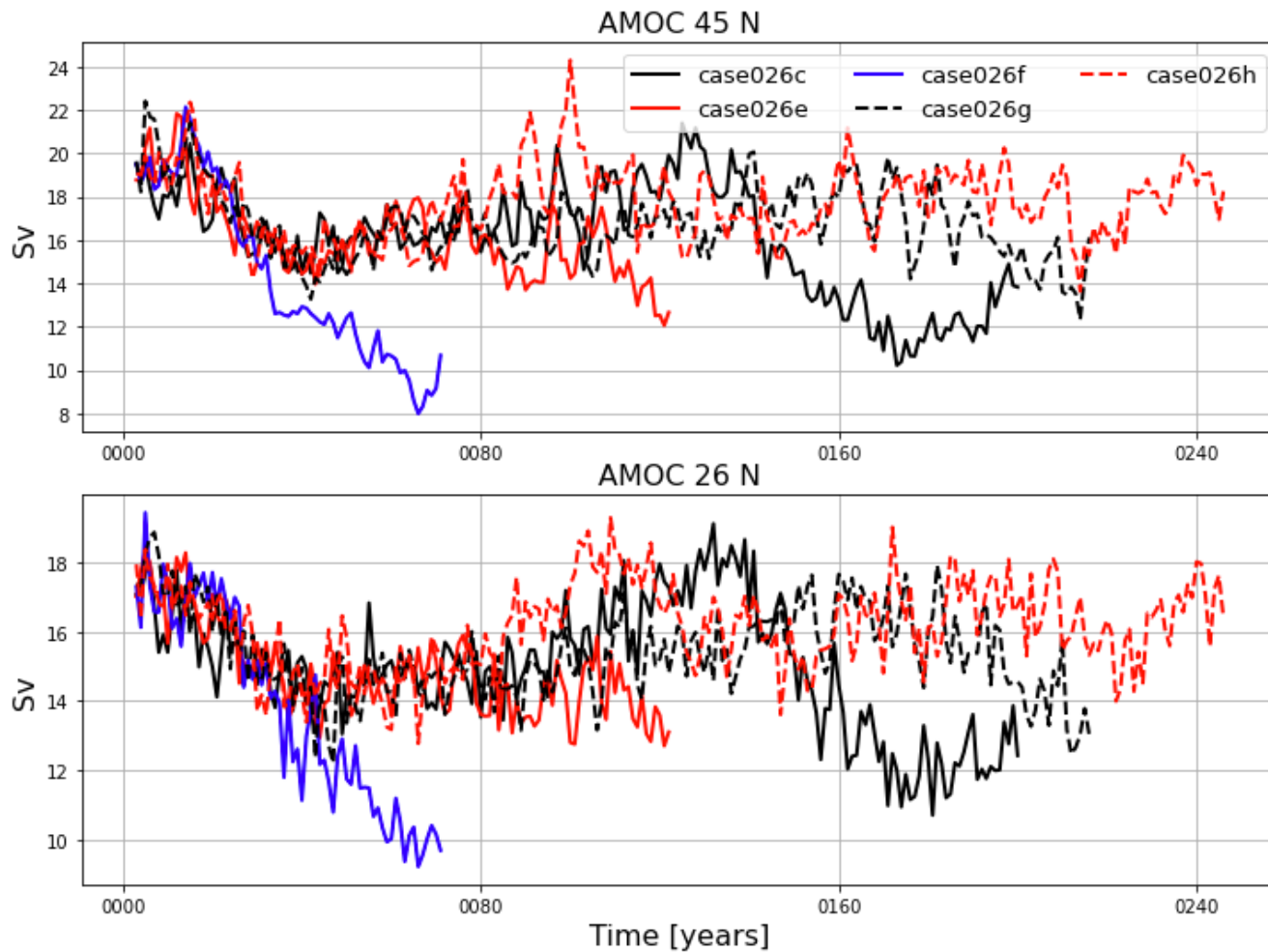
mean=90.231 sd=97.473  
rms=132.83



# Maximum AMOC time series



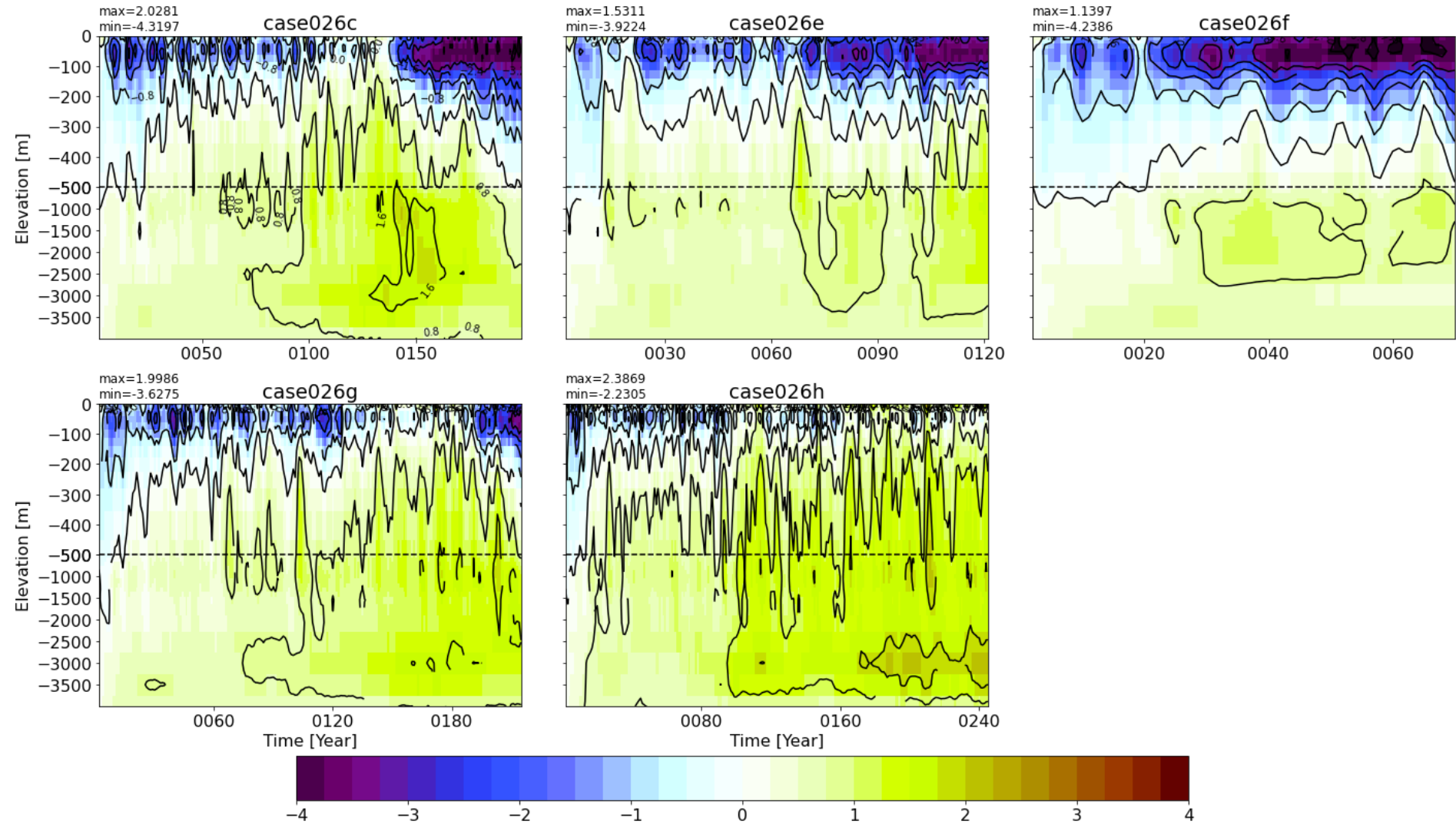
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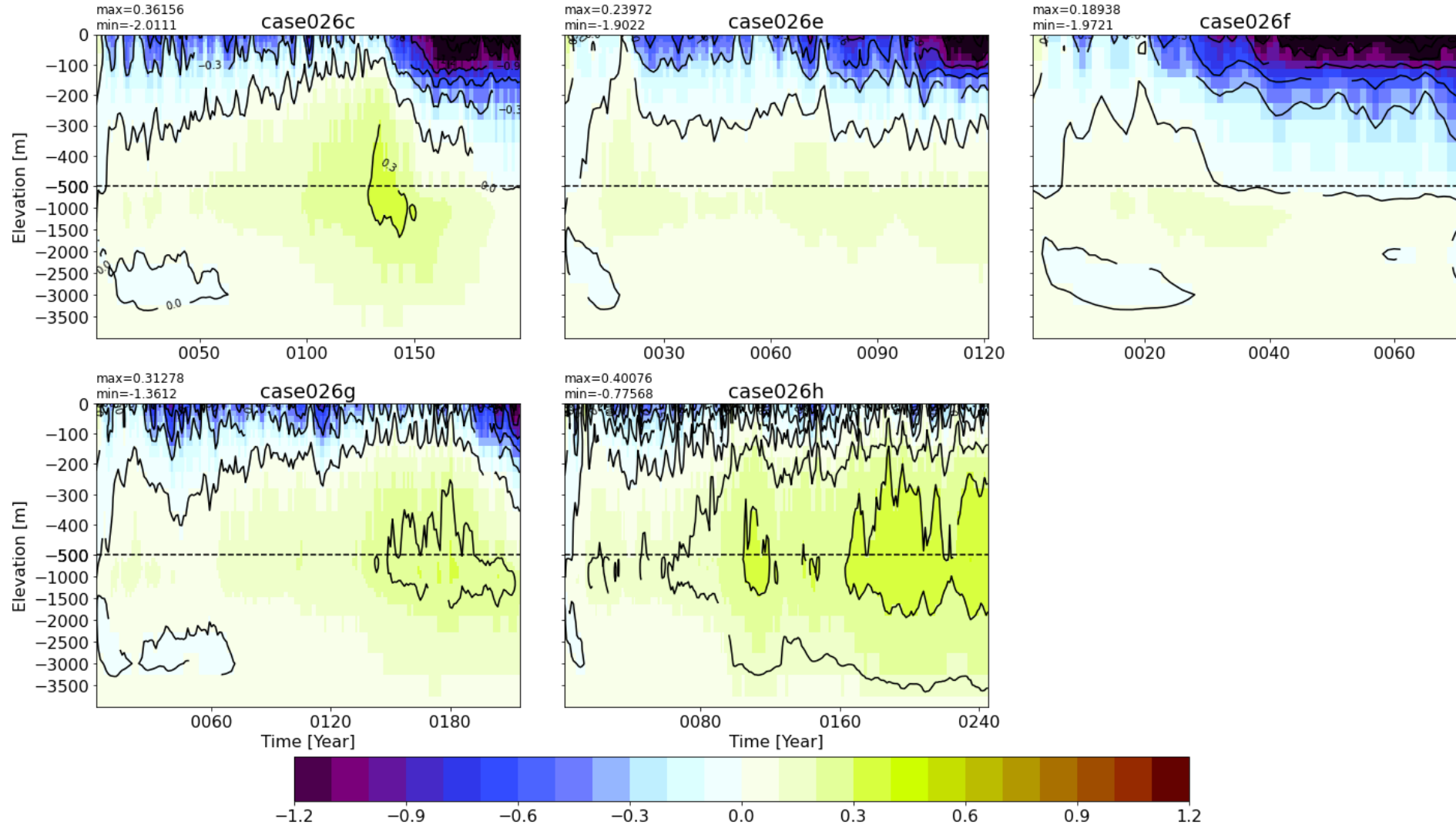
# Temperature drift (Lab Sea)

LabSea, Potential Temperature bias [C], (model - obs)



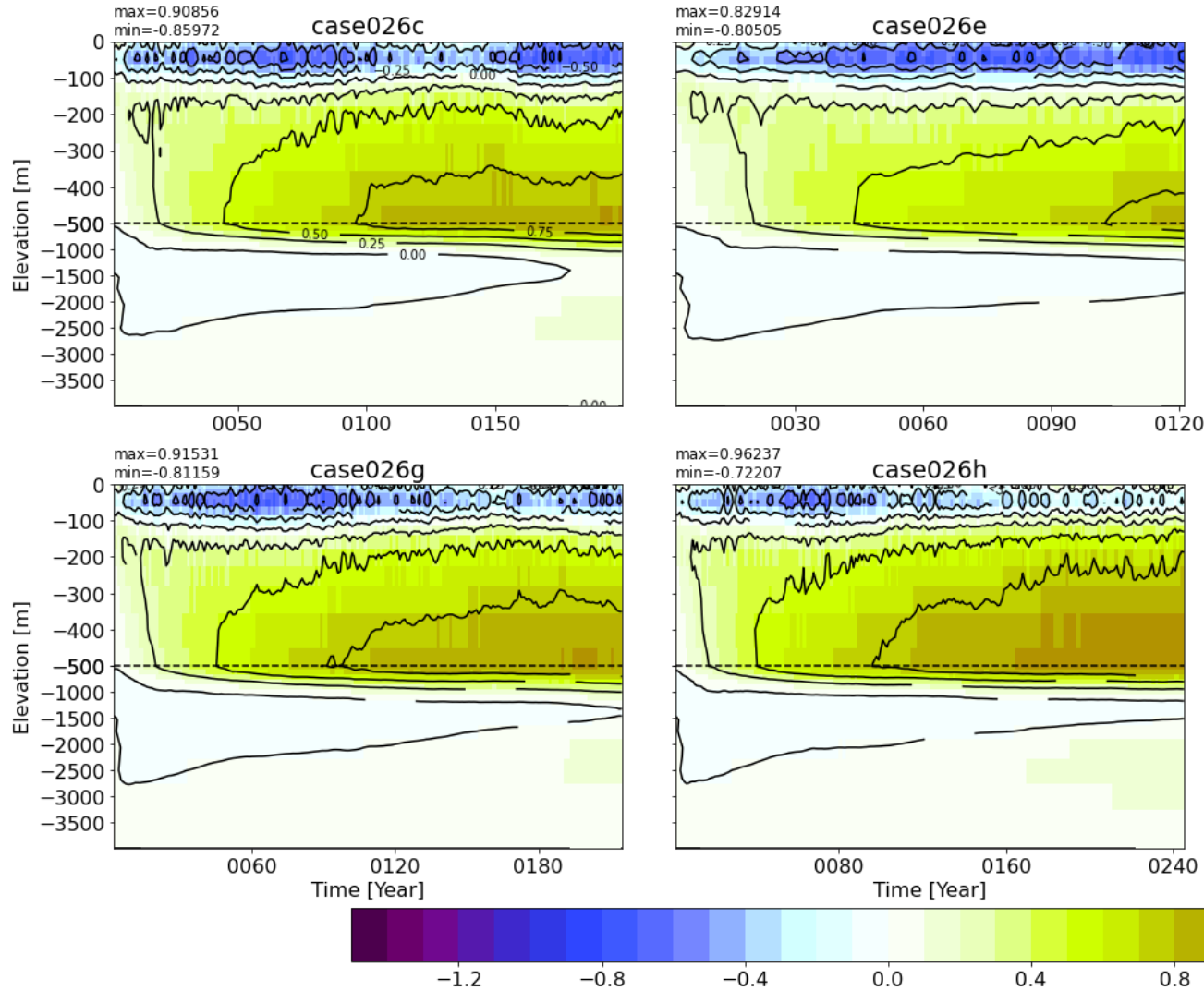
# Salinity drift (Lab Sea)

LabSea, Salinity bias [psu], (model - obs)



# Temperature drift (Global)

Global, Potential Temperature bias [C], (model - obs)



A similar temperature bias pattern occurred in CESM1 + CAM-SE



# Summary and next steps

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- Re-tune mixing coefficients and implement option to apply depth-dependent isopycnal diffusion (Redi)

# New and revised configurations

**Revised workhorse configuration;**  
2/3° resolution (tx2\_3):

Many thanks to Frank Bryan  
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This will be used to leverage work done by the CPT
- **Eddy-resolving**; 1/12° resolution (tx1\_12),  
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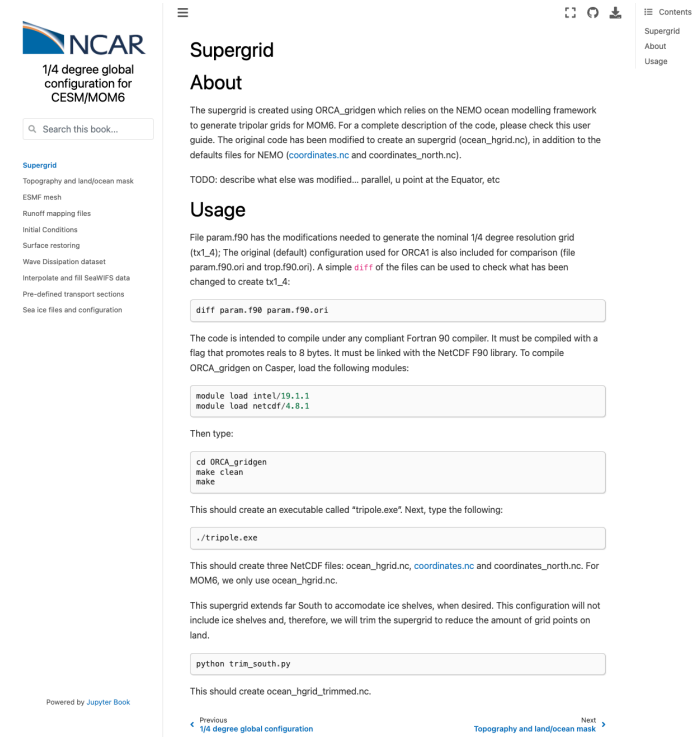
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Configurations will be fully documented on GitHub



The screenshot shows the GitHub repository page for 'Supergrid'. The page title is 'Supergrid' and the subtitle is 'About'. The main content area contains the following text:

The supergrid is created using ORCA\_gridgen which relies on the NEMO ocean modelling framework to generate tripolar grids for MOM6. For a complete description of the code, please check this user guide. The original code has been modified to create an supergrid (ocean\_hgrid.nc), in addition to the defaults files for NEMO (coordinates.nc and coordinates\_north.nc).

TODD: describe what else was modified... parallel, u point at the Equator, etc

### Usage

File param.f90 has the modifications needed to generate the nominal 1/4 degree resolution grid (tx1\_4). The original (default) configuration used for ORCA1 is also included for comparison (file param.f90 ori and trop.f90 ori). A simple diff of the files can be used to check what has been changed to create tx1\_4:

```
diff param.f90 param.f90.ori
```

The code is intended to compile under any compliant Fortran 90 compiler. It must be compiled with a flag that promotes reals to 8 bytes. It must be linked with the NetCDF F90 library. To compile ORCA\_gridgen on Casper, load the following modules:

```
module load intel/19.1.1
module load netcdf/4.8.1
```

Then type:

```
cd ORCA_gridgen
make clean
make
```

This should create an executable called "tripole.exe". Next, type the following:

```
./tripole.exe
```

This should create three NetCDF files: ocean\_hgrid.nc, coordinates.nc and coordinates\_north.nc. For MOM6, we only use ocean\_hgrid.nc.

This supergrid extends far South to accommodate ice shelves, when desired. This configuration will not include ice shelves and, therefore, we will trim the supergrid to reduce the amount of grid points on land.

```
python trim_south.py
```

This should create ocean\_hgrid\_trimmed.nc.

Navigation links: Previous 1/4 degree global configuration, Next Topography and land/ocean mask

[ncar.github.io/tx1\\_4/](https://ncar.github.io/tx1_4/)

# MOM6-DART development

**In progress: Global 2/3° MOM6-DART** (Alper Altunas, Helen Kershaw, Dan Amrhein, Jeff Anderson)

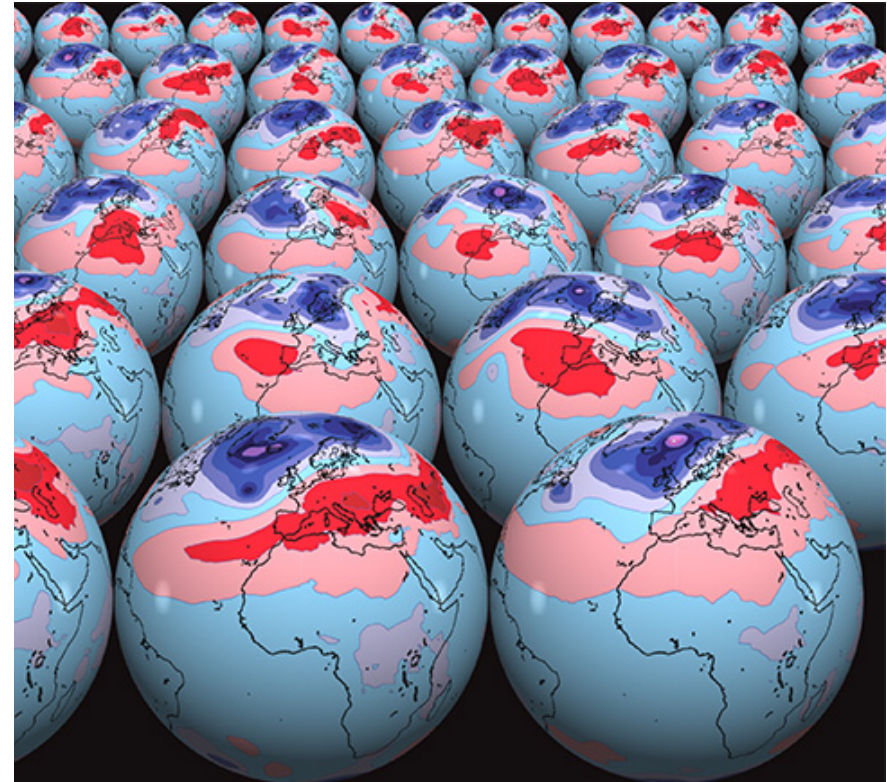
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Focusing on **2/3°**: Moving towards a “DA workhorse” release of CESM3 + DART enabled for ocean, atmosphere, sea ice, and land

**NSF CSSI proposal**: Regional high-res MOM6-DART + MARBL with rapid prototyping of model grids, forcing files, and observations for DA with a Python front end and multiple post-processing options

Community input on priorities for CESM DA capabilities is highly welcome!

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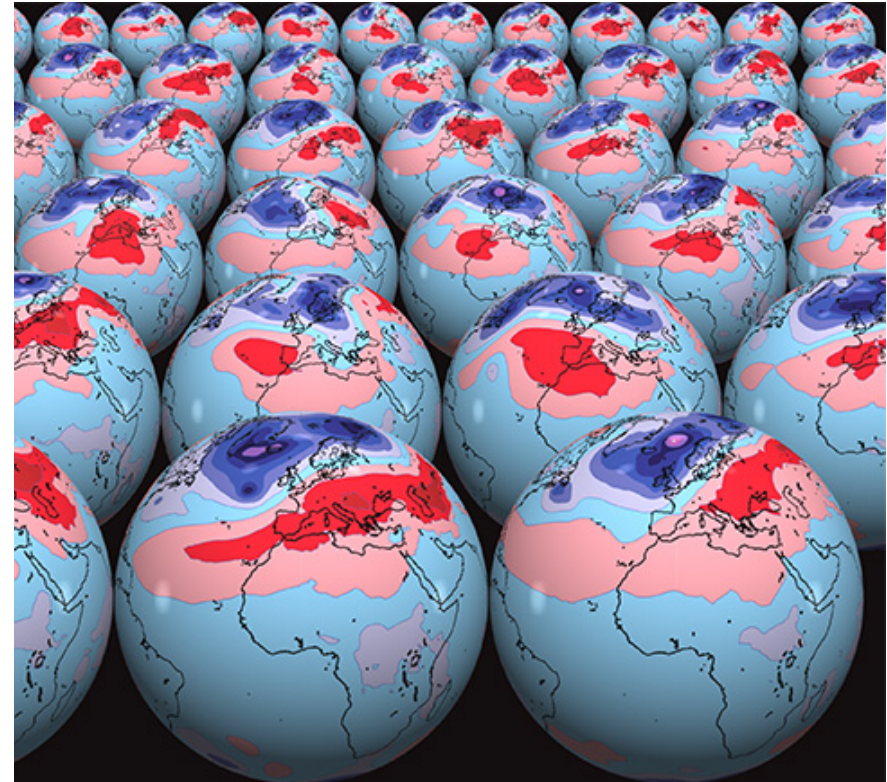
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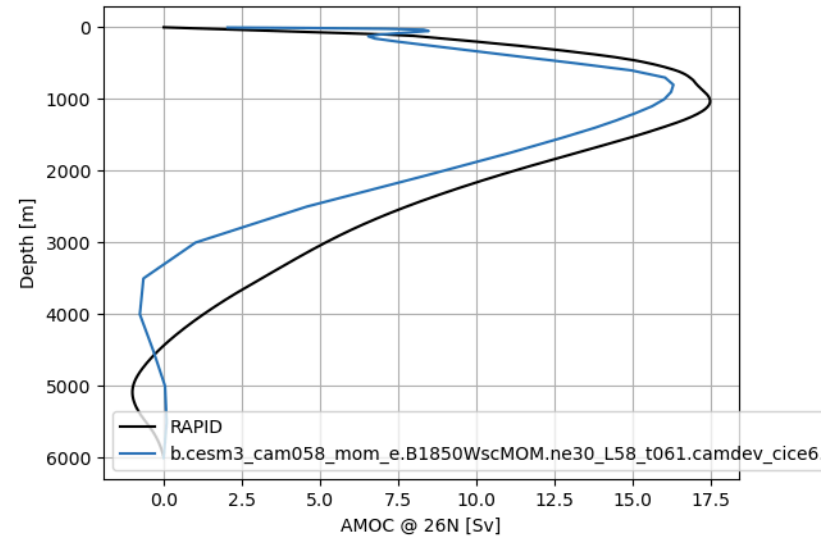
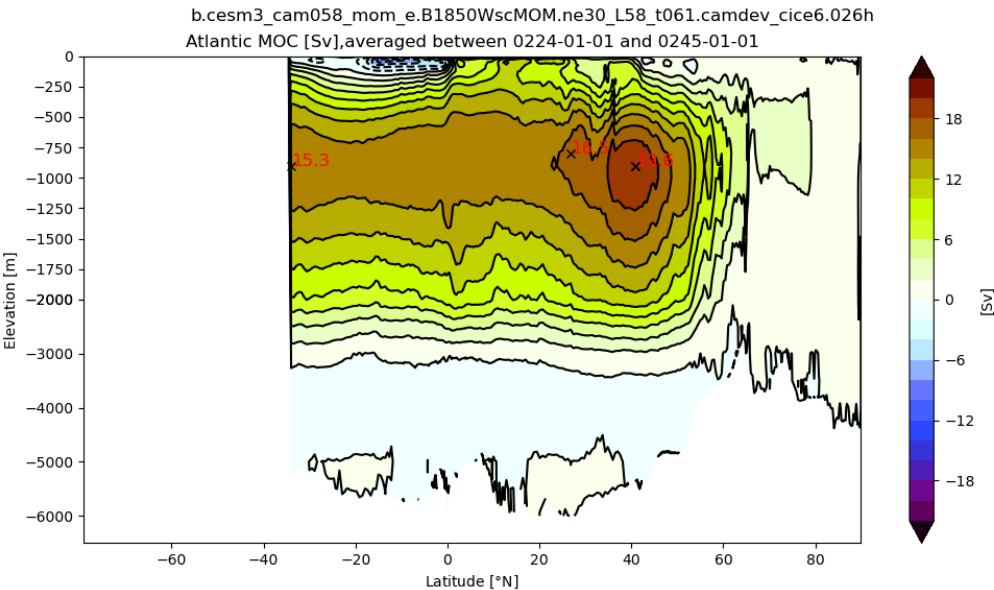
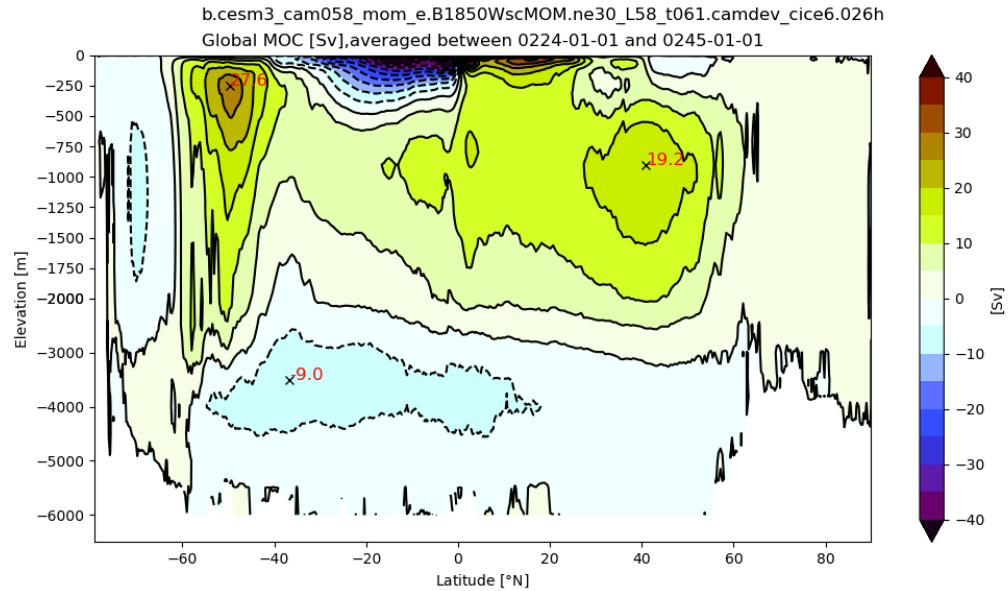
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**Thank you!**

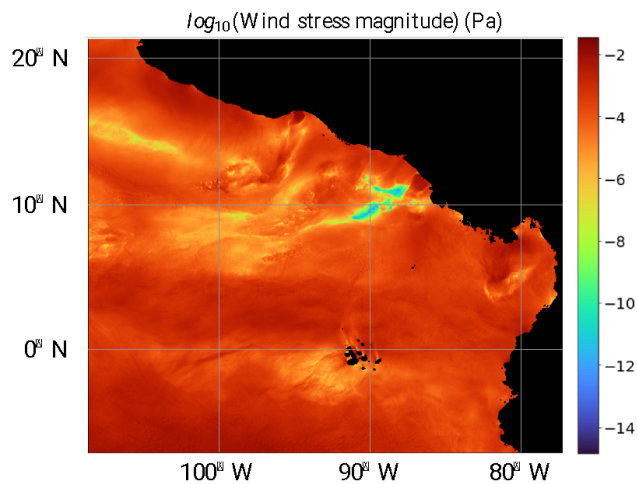
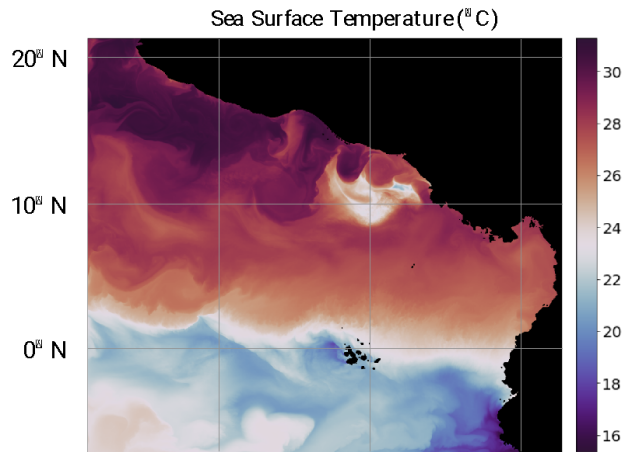


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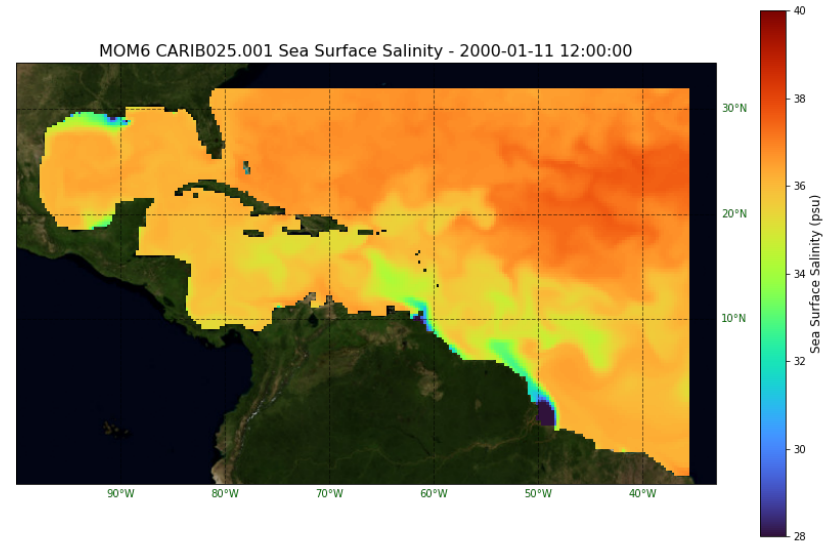


# Regional Ocean Modeling Using CESM-MOM6

Eastern Tropical Pacific CESM-MOM6 (1 km) Driven by MPAS-A (3 km) Bachman et al

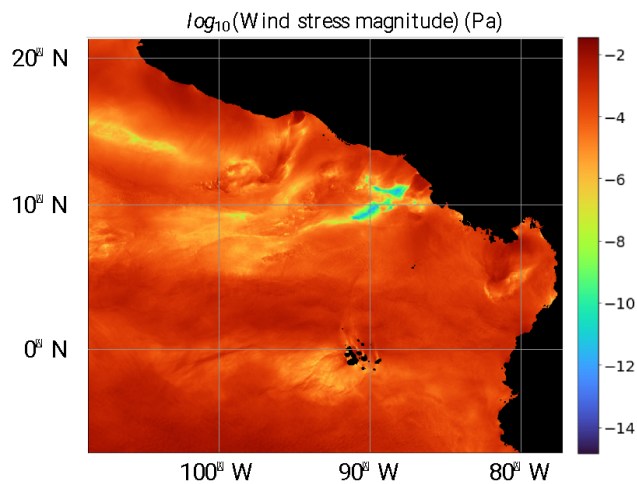
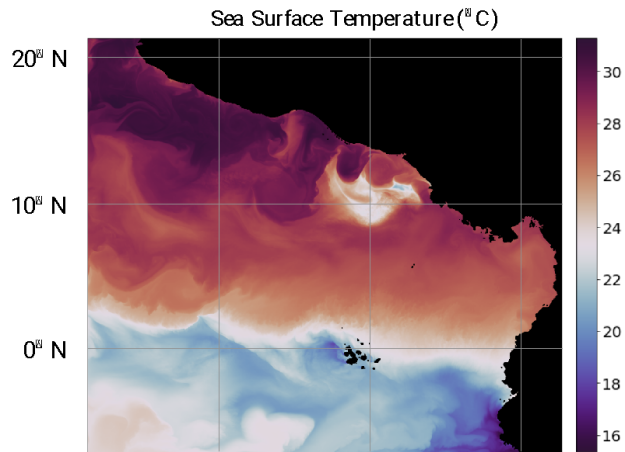


Caribbean Sea/Gulf of Mexico MOM6 (25 km) Driven by CESM-LE (100 km) Seijo et al



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Working towards **support** for easily configurable/re-locatable **regional ocean model in CESM** framework using CESM-MOM6 codebase and CESM/CIME infrastructure.

Caribbean Sea/Gulf of Mexico MOM6 (25 km) Driven by CESM-LE (100 km) Seijo et al

