Remarkable 2023 North Atlantic Ocean Warming
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Data sets

Figure 1 uses the monthly averaged SST from OISSTv2.1 (www.ncei.noaa.gov/data/sea-surface-temperature-optimum-interpolation/v2.1).

Figure 2 uses the monthly averaged SST from OISSTv2.1 and monthly averaged 5m temperature from the simulation described in Section 2, listed below as: *soda3.15.2.0_sst_mn.nc*.

Figure 3 upper panel uses monthly mixed layer temperature and depth computed from SODA3.15.2, available at www.soda.umd.edu, with mixed layer temperature from the simulation described in Section 2. The lower panel uses monthly temperature anomaly and monthly mixed layer depth from SODA3.15.2.

Figure 4 presents terms from the monthly simulation mixed layer heat budget described in Equation 1:

$$\underset{TZ}{\rho_o C_p \int_{-D}^{\eta} \frac{\partial \theta}{\partial t} dz} = -\rho_o C_p \int_{-D}^{\eta} [\underset{ADVZ}{\nabla \cdot (\mathbf{u}\theta)} + \underset{SBMESOZ}{\text{submesoscale}} + \text{other}] dz + \underset{SWHEATZ}{(Q_{z=0} - Q_{z=-D})} \qquad (1$$

TZ contains the time tendency of mixed layer integrated potential energy. ADVZ contains the time tendency of mixed layer integrated 3D divergence of mixed layer integrated potential energy. SBMESOZ contains the mixed layer integrated sum of submesoscale tendency plus vertical diffusion of heat due to diff_cbt plus the nonlocal tendency from KPP plus the potential energy contribution from river discharge. SWHEATZ contains the vertical integrated diffusion of heat due to surface heat flux. The figure also presents SURFZ, which includes the heat flux due to frazil ice formation, the surface temperature smoother, the heat flux associated with precipitation, and evaporation across the surface-air interface.

Figure 5 presents monthly net surface heat flux estimates downloaded directly from output distributed by the ECMWF ERA5 project (www.ecmwf.int/en/forecasts/dataset/ecmwf-reanalysis-v5). These files are produced from either the data assimilation cycle (units of Wm^{-2}) and by the forecast cycle (units of Jm^{-2}). The sign convention (positive into or out of the ocean) also changes from one variable to another (which is different from the convention used by MERRA-2) For readers unfamiliar with these issues we include our own combined ERA5 monthly net surface heat flux estimates: nethflx.mn.nc.

Figure 6 presents monthly 10m winds also downloaded directly from output distributed by the ECMWF ERA5 project (www.ecmwf.int/en/forecasts/dataset/ecmwf-reanalysis-v5)10m reanalysis winds don't have any complications and can be obtained directly from the ERA5 website.

File format

The simulation 10m temperature and the various terms in Equation 1 are available as 71Mb monthly netcdf (CF-1.6):

1) soda3.15.2.0_sst_mn.nc
2) tz.mn.nc, advz.mn.nc
3) sbmesoz.mn.nc
4) swheatz.mn.nc
5) nethflx.mn.nc

Each contain 411x473=199606 grid points, which span the Atlantic domain 30.13169S to 65.02602N latitude and 90.125W to 15.125E longitude and cover the time period beginning January 2020 and extending through October, 2023. The grid definitions are included in the files.