The new Black Sea Reanalysis System within CMEMS

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Ocean reanalyses are becoming increasingly important to reconstruct and provide an overview of the ocean state from the past to the present-day. These products require advanced scientific methods and techniques to produce a more accurate ocean representation. In the scope of the Copernicus Marine Environment Monitoring Service (CMEMS), a new Black Sea (BS) reanalysis, BS-REA (BSE3R1 system), has been produced by using an advanced variational data assimilation method to combine the best available observations with a state-of-the-art ocean general circulation model. The hydrodynamical model is based on Nucleus for European Modeling of the Ocean (NEMO, v3.6), implemented for the BS domain with horizontal resolution of 1/27° x 1/36°, and 31 unevenly distributed vertical levels. NEMO is forced by atmospheric surface fluxes computed via bulk formulation and forced by ECMWF ERA5 atmospheric reanalysis product. At the surface, the model temperature is relaxed to daily objective analysis fields of sea surface temperature from CMEMS SST TAC. The exchange with Mediterranean Sea is simulated through relaxation of the temperature and salinity near Bosporus toward a monthly climatology computed from a high-resolution multi-year simulation, and the barotropic Bosporus Strait transport is corrected to balance the variations of the freshwater flux and the sea surface height measured by multi-satellite altimetry observations. A 3D-Var ocean data assimilation scheme (OceanVar) is used to assimilate sea level anomaly along-track observations from CMEMS SL TAC and available in situ vertical profiles of temperature and salinity from both SeaDataNet and CMEMS INS TAC products. Comparisons against the previous Black Sea reanalysis (BSE2R2 system) show important improvements for temperature and salinity, such that errors have significantly decreased (about 50%). Temperature fields present a continuous warming in the layer between 25-150 m, within which there is the presence of the Black Sea Cold Intermediate Layer (CIL). SST exhibits a positive bias and relatively higher root mean square error (RMSE) values are present in the summer season. Spatial maps of sea level anomaly reveal the largest RMSE close to the shelf areas, which are related to the mesoscale activity along the Rim current. The BS-REA catalogue includes daily and monthly means for 3D temperature, salinity, and currents and 2D sea surface height, bottom temperature, mixed layer fields, from Jan 1993 to Dec 2019. The BSE3R1 system has produced
very accurate estimates which makes it very suitable for assessing more realistic climate trends and indicators for important ocean properties.