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Realistic numerical simulations of upwelling and downwelling in the middle Adriatic: the May 2017 episode

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Regional Ocean Modeling System (ROMS) is used to reproduce and analyse upwelling detected in the middle Adriatic Sea during May 2017. The ROMS domain covers the entire Adriatic, with a rectangular grid having horizontal resolution of 2.5 km and 22 unequally spaced s levels along the vertical. Surface momentum, heat and water fluxes in the ROMS simulations are calculated using atmospheric fields from the operational ALADIN model (Tudor et al., 2013; Termonia et al., 2018), having a horizontal resolution of 8 km for scalar fields (air pressure, air temperature, relative humidity, cloudiness, precipitation, and shortwave radiation) and 2 km resolution for wind fields. The ROMS model, in addition to the atmospheric agents, is forced by river inflows, tides and water mass exchange through the Strait of Otranto. Along the Adriatic coast, 41 rivers are discharging into the sea and their climatological flow rates (Raicich, 1994) are used in the simulations. Tidal forcing is applied on the open boundary taking into account seven tidal harmonics (M2, S2, N2, K2, K1, O1 and P1) crucial for the Adriatic dynamics. The open boundary conditions for the free surface, temperature, salinity, and velocity are taken from the wider Adriatic AREG model operationally run under the Adriatic Forecasting System (Oddo et al., 2006). Baseline ROMS simulation is run for the period from 1 August 2016 to 31 December 2018 and its quality is assessed with available CTD and HF radar measurements, satellite sea surface temperatures (SST) and data collected during May 2017 and June 2018 cruises by the yo-yo CTD profiler and shipborne ADCP. Numerical experiments focus on May 2017 when upwelling induced by prevailing NW wind was recorded. Baseline experiment qualitatively reproduces the upwelling but several sensitivity experiments are needed to increase agreement between model and measurements. Various intensities of horizontal viscosity and diffusivity and drag coefficient are tested in sensitivity studies. Moreover, a third order upwind advection scheme is tested as is the behaviour of solar shortwave radiation along the water column. Significant improvement in the model results is obtained using increased drag coefficient. Circulation pattern recorded by shipborne ADCP with inflowing currents in the first 10 km from the eastern middle Adriatic coast and wind-controlled two-layer flow further offshore is also reproduced by the ROMS model. Upwelling was clearly documented in the SST satellite images of 28 and 29 May 2017 by patches of cold water close to the eastern coast. Similar structure is reproduced by ROMS, although the modelled SST underestimates the measured values by approximately 1 °C. The area of upwelling is correctly

located as is the cyclonic circulation indicated by ADCP measurements along the transect.