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Numerical analysis of the middle Adriatic upwelling

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Extensive, but short oceanographic measurements were conducted in the spring seasons from 2017 to 2021 with an aim to investigate the middle Adriatic upwelling. The exception was cruise in 2020, when measurements were performed in August. As cruises have been conducted under different meteorological and hydrological conditions, high resolution CTD and shipborne ADCP measurements revealed strong variability in the upwelling strength and occurrence. The strongest upwelling, both in the coastal and open sea area, was recorded in May 2017 and it was related to strong NNW winds that had been blowing for several days before and during the 2017 cruise. Field measurements in June 2018, although conducted under upwelling-favourable winds from NW direction, revealed a rather flat pycnocline due to the low wind intensity, except in the first 5 km close to the coast where the pycnocline was rising onshore. Coastal upwelling was also recorded during the following cruises in June 2019, August 2020 and May 2021, whereas rising of thermocline through Ekman pumping in the open sea was detected only in May 2021. To overcome limitations of the measurements and to shed more light on the upwelling dynamics and its occurrence, realistic and idealised ROMS model simulations are conducted. Realistic simulations are performed by Adriatic scale ROMS model forced by surface momentum, heat and water fluxes calculated using results of operational numerical weather prediction model ALADIN-HR. In addition to atmospheric forcings, river discharges, tides and water mass exchange through the Strait of Otranto are also implemented in the realistic simulations. Reliable results of the realistic baseline experiments, assessed with available in situ and satellite data, allowed us to define sensitivity studies. Sensitivity experiments focus on the influence of both local and remote processes, particularly on the Adriatic river discharges and their parameterization in the ROMS simulations, as well as on the external dynamics and its parameterization at the model open boundary. Strength and character of the middle Adriatic upwelling simulated in the experiments with two available Adriatic river climatologies show no significant distinctions. Moreover, sensitivity of the model results to horizontal grid spacing of atmospheric forcing and oceanographic model grid is investigated. To further elucidate upwelling mechanism, additional idealised simulations with homogeneous upwelling-favourable wind for the eastern Adriatic coast from NW direction are set up and run.