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On the use of coupled ocean-atmosphere-wave models in the Adriatic Sea: lessons from an intense CAO event

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An extreme atmospherical event hit the whole Europe, and particularly its central-southern sector, during February 2012. Coming from Siberian regions, strong and persistent spits of cold air (Cold Air Outbreak, CAO) impacted the northernmost part of the Mediterranean Sea, leading to significant decreases of water temperature (up to 6 °C in less than two weeks) in the northern Adriatic Sea (NA) region. One of the most interesting effects of the CAO was the heavy snowfall along the eastern Italian coast, not foreseen by any numerical weather prediction operational model. Furthermore, the CAO was at the origin of a significant episode of Dense Water Formation (DWF) in the NA, a crucial phenomenon that has paramount effects in the whole basin. Resulting dense water masses started to flow along the western Adriatic coast, until flushing out nearby the southern Adriatic margin through submarine canyons, in this ventilating the shelf, and mobilizing nutrients and also sediments that contribute to the bottom reshaping. Until very recently, the extent of DWF events in the NA sub-basin was estimated by means of coastal observatories measurements, and results from existing one-way coupled atmosphere-ocean models. Though representing still a very common practice, such an approach is characterized by the absence of Sea Surface Temperature (SST) feedback from the ocean to the atmosphere, and therefore the resulting turbulent heat fluxes at the sea surface are calculated are not fully consistent.We propose an investigation on the 2012 CAO event by means of the fully coupled, three components, ocean-atmosphere-wave system (within the COAWST framework). Results show that not all the air fields are equally influenced by the coupling with oceanic models. The 2 m temperature and the 10 m wind do not show strong variations, most likely because of the very intense dynamic event , driven by general circulation. On the other hand, the coupled models approach provides estimates of heat fluxes between the atmosphere and the ocean improved with respect to the uncoupled run. In addition to this, the coupling and the use of a high resolution spatiotemporal SST strongly affects vapour fluxes from the ocean to the atmosphere, that are significantly overestimated by the uncoupled simulations. This may have direct consequences on precipitation along the Italian coasts, that remain however very complex to be adequately predicted. Additionally, a consistent description of air-sea energy exchanges contributes to a more accurate quantification of newly dense water mass volumes, thermohaline water properties and energy content of the seas.