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On the use of ocean-atmosphere-wave models during an extreme CAO event: the importance of being coupled

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During winter 2012 an extreme meteorological event stroke the whole Europe and particularly its central-southern sector. A strong and persistent spit of cold air coming from Siberian region (a Cold Air Outbreak, CAO) insisted on northern Italy and the Adriatic sea basin, leading to decreases in the sea temperatures up to 6 °C in less than two weeks, ice formation on the Venice lagoon and an exceptional snow fall in the Apennine region. In the sea the CAO was associated to a significant episode of dense water formation (DWF), a crucial phenomenon that heavily impacts the whole Adriatic Sea (from the sinking of water masses and associated ventilation of the northernmost shelf, to the flow along the western coast, until the flushing of southern Adriatic open slope and submarine canyons, with associated sediment transport and bottom reshaping). The extent of the DWF event in the Northern Adriatic sub-basin was estimated by means of coastal observatories, ad hoc measurements and, until now, results from existing one-way coupled atmosphere-ocean models. These are characterized by no SST feedback from the ocean to the atmosphere, and therefore by turbulent heat fluxes that may heavily reflect a non-consistent ocean state.
The study proposes an investigation of the 2012 CAO using a fully coupled, three components, ocean-atmosphere-wave system (COAWST). Results highlight that, although the energy interplays between air and sea do not seem to significantly impact the wind forecasts, when providing heat fluxes that are consistent with the ocean temperature we find modified heat fluxes and air sea temperatures figures. Moreover, the consistent description of thermal exchanges adopted in the fully coupled model can affect the basin circulation, the quantification of dense water produced mass, and the description of its migration pathways and rates of off-shelf descent.