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The exceptional Winter 2012 conditions in the Northern Adriatic Sea: an analysis using the COAWST Modelling System

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An exceptional cold anomaly during late January and early February 2012 characterized the Mediterranean area, associated to a persistent cyclonic circulation.
The resulting atmospheric patterns induced large energy losses in the Northern Adriatic sea (NA sea), mostly due to intense and cold Bora winds blowing from NE and producing a sea water temperature drop down to 6°C.
These series of exceptionally cold air outbreak episodes are investigated by means of data availabel at coastal stations and model results from the Coupled Ocean–Atmosphere–Wave–Sediment Transport (COAWST) Modeling System, based on the oceanic ROMS models, the atmospheric WRF model and the wave model SWAN.

Particular emphasis was devoted to the atmosphere-ocean interactions and at disentangling the different contributions of the interplay between ocean-atmosphere and waves.
The work discusses results obtained using the atmospheric model in stand-alone configuration (WRF S.A., with initial Sea surface Temperature derived from different sources, including the NOAA/NCEP radiometer); the one-way forced situation (no feedback to the atmosphere from the ocean model ROMS); the two-way atmosphere-ocean coupled case (Run AO) and the same further coupled with the wave model (Run AOW).

Results highlight the relevance of the ocean presence when applying an atmospheric model. Albeit limited by lack of in situ measurements, we demonstrate through the use of "Acqua Alta" tower data that SST at the tower is followed rather well by WRF run forced by the SST acquired via radiometer after the cloudy period. However, for the same runs, the air temperature is too warm.
A better agreement in the SST (and in the heat fluxes) is obtained with WRF-ROMS (atmosphere-ocean coupling); however, the best agreement in the turbulent fluxes is reached with WRF-ROMS-SWAN (atmosphere-ocean-wave coupling). The presence of a relatively cold basin in this coupling needs to be more carefully assessed.
ROMS model seems to play a significant role in getting a “correct atmosphere”, but it is pivotal when employed in conjuction with the wave models. Run AOW provides a larger roughness and shows a greater impact on the air temperature.
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