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The impact of winter 2012 cold outbreak over the Northern Adriatic Sea dynamics: preliminary comparison among data and high resolution operational atmospheric models

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Shelf dense water formation (DWF) events may be taking place during winter time on the broad, shallow shelf in the northern region of the Adriatic basin exposed to the Bora winds, bringing cold, dry air from the north-east down the Dinaric Alps. Indeed, the resulting intense evaporation and cooling of the shelf waters may produce North Adriatic Dense Water (NAdDW), which then tends to sink and "cascade" all the way to the southern basin. During these rather episodic formation processes, more frequent during winter time, the main controlling factors are intense cold wind out- breaks, the ambient water density, preconditioned during late autumn, and also other factors, e.g. river discharges.

When such processes of buoyancy extraction happen, several isopycnic surfaces outcrop and very often the whole water column (20–25 m deep) may be ventilated. However, the general process of northern water masses flowing to the southern part of the Adriatic basin is complex and far from being completely understood. In order to understand and model these processes, it is mandatory to utilize high resolution meteorological forcing fields and circulation models, at least to model particular events in Adriatic marine circulation, if not its longer term (e.g., seasonal) characteristics. The use of low resolution winds in fact necessarily implies a calibration factor to better match surface fluxes and to reproduce wind-driven circulation. This is particularly evident in the case of the cross-basin Bora pattern, because the complexity and small scale of Adriatic orography is often poorly reproduced in atmospheric models, while Bora flow is composed of an alternation of high and low wind speed 'strips' crossing the Adriatic in correspondence of the fine scale (10-100 km) Balkanic orographic gaps.

Within the framework of activities of the Italian flagship Project "RITMARE" and of the FIRB "DECALOGO", we focused on the current meteorological modeling capabilities to describe an event of exceptionally dense water formation, registered during the 2012 winter in the northern Adriatic region. During late January and early February, indeed, the basin was characterized by a persistent and exceptional cold anomaly responsible for large energy losses due to cold and extremely strong winds. Sea waters temperatures dropped to about 6°C and the Venice lagoon got partially covered by ice.

In the period of interest, available measurements in the northern Adriatic Sea (temperature, salinity, density, wind speed, direction and inferred heat fluxes) were used, together with satellite measurements, to carry out a first semi-quantitative comparison among existing meteorological models implemented over the region. Namely, the work presents an intercomparison among three state-of-the-art, non-hydrostatic NWP models: COSMO-I7, WRF and MOLOCH. All models are run in operational mode, and their results are used by several Regional authorities and institutions for weather forecasting and support to civil protection decision. Therefore, this evaluation is a useful assessment preliminary to a full coupling of the above mentioned atmospheric models with existing ocean models already implemented in the region (e.g. ROMS in the COAWST system).

Preliminary results show also some uncommon mesoscale structures reproduced by the models in the proximity of the central-south Italian coast, and highlight their possible influence on the local surface sea circulation. These effects will be soon explored by means of fully-coupled ocean-atmosphere models within on-going projects.