Geophysical Research Abstracts
Vol. 16, EGU2014-4992-1, 2014
EGU General Assembly 2014

Dense water formation in the eastern coastal Adriatic during an extreme cooling event

Hrvoje Mihanovic (1), Ivica Janekovic (2), Ivica Vilibic (1), and Martina Tudor (3)

(1) Institute of Oceanography and Fisheries, Split, Croatia (hrvoje.mihanovic@izor.hr), (2) Rudjer Boskovic Institute, Zagreb, Croatia, (3) Meteorological and Hydrological Service of Croatia, Zagreb, Croatia

Dense water formation (DWF) that occurred in both open and coastal waters of the Adriatic Sea during extreme cooling event in January/February 2012 was reproduced by coupled high-resolution atmosphere-ocean modelling system. Regional Ocean Modeling System (ROMS) ocean model has been applied with resolution of 2 km and with lateral boundaries coming from the operational AREG Adriatic model. The model has been forced at the sea surface by the operational NWP model ALADIN/HR, providing winds at 2 km spatial resolution via dynamical adaptation technique every 3 hours, while other bulk variables were computed at 8 km resolution and used every 3 hours. Two model experiments were conducted (simulations starting in 2008): the first with real river fluxes in January 2011 – July 2012 period, for Po River, all available Croatian rivers and power-plants outflows and recently compiled Slovenian river data, together with mean year daily fluxes for other Adriatic rivers. The second experiment used climatological perpetual river fluxes computed from all available hydrological data throughout the model run. Eastern Adriatic coastal river fluxes turned out to have a dramatically lower both perpetual and real freshwater fluxes compared to traditionally used climatological river fluxes documented by Raicich (1994) and mostly used in previous Adriatic modelling studies.

We found that, aside the 'convenient' DWF area located at the northernmost Adriatic shelf, a similar amount of dense water with slightly lower densities was formed in the eastern Adriatic coastal area. This area was subjected to extreme heat losses of up to 2000 W/m2 during peak cooling periods, while cumulative heat losses estimated for some locations during the whole cooling episode (24 January – 14 February 2012) reached 1.8 GJ/m2. Transport of dense water (PDA > 29.2 kg/m3) towards the middle Adriatic had a peak value of about 0.6 Sv, while the speed of bottom density currents during the first 10 days of its flowing was estimated to 40-50 cm/s, several times larger than during past events. The contribution of the dense water coming from coastal eastern Adriatic through connecting channels was about 40%, equalling to the amount of dense water generated in the northernmost part of the Adriatic shelf, while the rest of dense waters was formed in the rest of the northern Adriatic shelf. By comparing model runs using climatological versus real river discharges, we found a slight decrease (10-30%) in DWF when climatological river fluxes were used instead of real river discharges. Therefore, the contribution of the coastal eastern Adriatic waters to the DWF is expected to be significant not only in dry years, but also during normal years with large cooling wintertime events occurring in the area.

This is the very first study that modelled the DWF in the eastern coastal Adriatic. There are several important reasons why previous studies were not able to reproduce it: (1) this area has rather complex topography which was hard to capture by low-resolution numerical models, as it is separated from open sea by a number of connecting channels, and therefore modelling studies avoided to include this area as important for the Adriatic-wide dynamics, (2) surface heat and water fluxes in this area are hard to reproduce, even by mesoscale meteorological models, as horizontal variability in wind forcing during strong bora events is occurring at scales of hundred meters, and (3) the knowledge about river fluxes along the eastern coastline was based on the largely overestimated river discharge rates, widely used in Adriatic ocean modelling studies. The latter item turned to be the most important, while the item (2) has been improved as well in our study, as we used ALADIN/HR numerical model which is operationally run for weather prediction in Croatia and is adopted for the eastern Adriatic coastal orography.