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# The effect of different types of water column structure on the sea level in the Dead Sea

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Sea level changes in the Dead Sea are linked to inter-annual variability of precipitation/evaporation and anthropogenic reduction in fresh water supply. Radko, et al (2014) indicated, that the vertical flux of salinity, its surface value, and hence the rate of evaporation could depend on the structure of the underlying water column. The main characteristics of the water column in this respect is the existence or non-existence of step-like structures.

The aim of this study is to test the hypothesis that the observed step-like structure of the water column in the Dead Sea has a significant effect on the rate of evaporation and hence the drop of the sea level.

For this study we used the NEMO ocean model with a novel system of vertical discretization, a multi-enveloped s-coordinate system, (see Bruciaferri et al, 2017) and a modified Pacanowsky-Philander mixing parameterization, which was specifically adjusted to the conditions of the Dead Sea. The model has horizontal resolution of 500x 250m, and 99 computational levels. The vertical resolution varies from 1 to 5m. Salinity in the Dead Sea is much higher than in the open ocean (about 340%), so that the usual equations of state ( eg TEOS-2010) do not work.

In order to solve this problem, the concept of quasi-salinity was introduced by Gertman et Zavialov, (2011). By reverse engineering the non-linear equation of state for the Dead Sea and the usual linear equation of state, we converted measured density, quasi-salinity and temperature profiles into 'fictitious salinity'. This approach allowed us to reconstruct high-resolution T/S profiles from measured high-resolution temperature profiles and low-resolution quasi-salinity profiles.

The modelling was carried out using initial temperature, quasi-salinity, density profiles from observations made by IOLR. Meteorological conditions during 2016 were obtained by the University of Jordan- Aqaba. Daily averaged temperature ranges from 12 to 37$^{o}$. Wind speed is in the range 5 to 35 km/h with a typical period of variability of 3-4 days. The initial profiles at 27-08-2012 show 5 well pronounced steps in temperature between 5 and 70 m and 5 weak steps the near bottom layer. The model was run for 6 months. The results show that the steps in the upper 50 m are well preserved, however in a modified form. Two extra small steps are developed in the top 10 m, however the near-bottom steps have disappeared.

The modification of the major steps is probably associated with penetrative convection of the well-mixed part of the step into the stratified layers, which results in the increase of density in the mixed layer, and reduction of density difference across the stratified layer. The formation of small steps in the upper 1 m is likely to be caused by instabilities caused by near-surface currents. The disappearance of the near-bottom steps requires further investigation.

References

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