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Modeling the circulation of the Dead Sea

Steve Brenner (1), Nadav Lensky (2), and Isaac Gertman (3)

(1) Bar Ilan University, Department of Geography and Environment, Ramat Gan, Israel (sbrenner@mail.biu.ac.il), (2) Geological Survey of Israel, Jerusalem, Israel (nadavl@gsi.gov.il), (3) National Institute of Oceanography, IOLR, Haifa, Israel

The Dead Sea is a hypersaline, terminal lake located at the lowest point on the land surface of the Earth. Its current level is more than 429 m below MSL, and due to a negative water balance (mainly anthropogenic), the lake level has been dropping at an average rate of more than 1 m/yr for more than 30 years. The mean salinity has also been steadily increasing and today is close to 280 psu. The region of the Dead Sea is a unique landscape that has important historical, cultural, and economic value and therefore such an extreme change of the lake has significant environmental and economic consequences. In recent years there has been a notable increase in observing and monitoring of the lake through continuous measurements from several fixed buoys as well as during quasi-regular cruises. In order to complement the measurements and improve our understanding of the dynamics of this unique lake a three dimensional circulation model is being developed. Previous modeling efforts were limited mainly to a one dimensional column model which was coupled to a comprehensive physio-chemical model and used for long term multi-decadal simulations. In this study the focus is on understanding the dynamical processes that control the lake-wide circulation on time scales ranging from days to seasons. The first step was to replace the equation of state with an equation appropriate for the hypersaline conditions, in addition to some minor tuning of the turbulence closure scheme. Results will be presented from preliminary simulations of the wind driven circulation in various seasons. A case study of a recent unusual winter flooding event, during which the lake level rose by more than 20 cm over a two month period, will also be presented. The model successfully simulated the observed transition from holomictic to meromictic conditions and epilimnion dilution during this event, as well as the restoration of holomictic conditions when the level started to drop again. The relationship between the water balance and stability of the epilimnion will also be discussed.