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The necessity of salt precipitation for the Dead Sea modeling

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The Dead Sea is a hypersaline terminal lake with a composition that differs significantly from regular seawater. During the winter the DS is well mixed but in the spring a thermocline develops and the lake becomes stratified. Evaporation, mainly during summer leads to the development of a destabilizing halocline together with a stabilizing thermocline. Thus, the upper mixed layer is warmer due to heating and more saline due to evaporation than the lower layer. In the autumn, when the upper layer cools sufficiently, the lake overturns and becomes mixed again. To model this behavior one has to take into account the unique features of the Dead Sea. These features include the need for a special equation of state, determination of water activity and its impact on the evaporation rate, water inflow, including rejected brine (end brine) from the Dead Sea works and salt precipitation from the DS water body. The modeling of the water activity and salt precipitation requires a multicomponent (rather than usual salinity-based) model which enables determination of the degrees of saturation for specific salts and the calculation of the corresponding amount of precipitated salt required to maintain saturation. This precipitated salt accumulates on the bottom of the lake thus making the water deficit greater than surmised from observed water level drop.

In the present study we modified the 1-D Princeton Oceanographic Model (POM) incorporating a new equation of state. The model correctly reproduces the measured temperature and salinity profiles, sea level drop and seasonal stratification and overturn of the DS. Our results show that the timing of the overturn is determined by the interplay between the temperature and the salinity of the mixed upper layer. The greater amount of salt in the water in the case of no salt precipitation results in premature overturn. Thus, salt precipitation and its impact on the mixed layer salinity were

found to be of utmost importance.