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Spatial heterogeneity in Dead Sea surface temperature caused by evaporation

Pavel Kishcha, Boris Starobinets, and Pinhas Alpert
Tel Aviv University, Department of Geophysics, Tel Aviv, Israel (pavel@cyclone.tau.ac.il)

The Dead Sea is a terminal hypersaline lake at a unique location at ~430 m below sea level. Over the last several decades the Dead Sea has been drying up due to climate change: its water level has dropped at the rate of ~1 m year^{-1}. In this study we investigated the diurnal cycle of spatial heterogeneity in Dead Sea surface temperature (SST) using METEOSAT geostationary satellite data (2005-2015). METEOSAT data showed that, in the summer months, SST peaked at the same time, 13 LT (local time), as land surface temperature (LST) over surrounding land areas. In the presence of water mixing, the maximum of SST should be observed several hours later than that of LST due to thermal inertia of bulk water. The fact that SST and LST peaked at the same time, 13 LT, is evidence that there was no noticeable vertical water mixing. We consider that, in the absence of noticeable water mixing and under uniform solar radiation in the summer months, inhomogeneity in evaporation was the main causal factor of the observed spatial heterogeneity in Dead Sea SST. METEOSAT showed that spatial heterogeneity in SST was pronounced throughout the daytime. In summer, SST peaked at 13 LT, when SST reached 38.1 ^{o}C, 34.1 ^{o}C, and 35.4 ^{o}C being averaged over the east, middle and west parts of the lake, respectively. The above mentioned spatial heterogeneity in daytime SST caused a pronounced asymmetry in land surface temperature between land areas adjacent to the east and west sides of the lake. Maximal evaporation (causing maximal surface water cooling) took place at the middle part of the Dead Sea, while minimum evaporation took place at the east side of the lake. In the nighttime, METEOSAT data showed that SST values were minimal and SST spatial distribution was much more uniform compared to the daytime. We found that, in winter, when maximal solar radiation reached ~500 W/m^2 compared to ~900 W/m^2 in summer, daytime SST non-uniformity was less pronounced than that in summer. As the characteristic feature of the diurnal cycle, SST daily temperature range was equal to 7.2 °C, 2.5 °C, and 3.8 °C over the east, middle and west parts of the Dead Sea, respectively, in summer, compared to 5.3 °C, 1.2 °C, and 2.3 °C in winter.

Evaporation causes significant drying up of the Dead Sea, especially in the summer months, as the main contributor to maximal water level drop in the lake. However, no measurements of spatial distribution of Dead Sea evaporation have ever been conducted, either in situ or from space. Our findings allowed us to visualize spatial inhomogeneity in evaporation using the obtained heterogeneity in Dead Sea SST.

Reference: Kishcha P. and Starobinets B. (2021). Spatial heterogeneity in Dead Sea surface

temperature associated with inhomogeneity in evaporation. *Remote Sensing* (Special Issue: Remote Sensing of Lake Properties and Dynamics), 13(1), 93; https://doi.org/10.3390/rs13010093.