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COMPARATIVE ANALYSIS OF EVAPORATION ESTIMATION METHODS
FROM THE CASPIAN SEA WATER AREA FOR WATER BALANCE CALCULATIONS

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The improvement of water balance calculation methods for large closed basins, such as the Caspian Sea, requires verification of traditional approaches using modern global databases. This study presents a comparative analysis of three evaporation estimation options for the Caspian Sea water area over the period 1990–2020. The first option is based on the standard methodology of the State Oceanographic Institute (SOI), where evaporation is calculated using empirical formulas based on meteorological observations from five key coastal stations. The second option reproduces the SOI algorithm but uses ERA5 reanalysis data interpolated to the locations of the same stations as input parameters (wind, temperature, humidity). The third option represents direct evaporation obtained from the ERA5 reanalysis, where this parameter results from the H-TESSEL land surface scheme, which describes turbulent heat and moisture transfer. It is shown that the traditional methodology, which provides point estimates, is sensitive to the heterogeneity of meteorological element distribution and to systematic errors of coastal measurements. In contrast, ERA5, through satellite data assimilation and a global grid structure, provides spatially continuous evaporation fields, including direct calculation of evaporation from open water surfaces. Statistical analysis shows that the traditional SOI method systematically overestimates annual evaporation (up to 1535 mm/year at “Tyulenyi” station) and exhibits higher variance and positive skewness compared to ERA5-based approaches. The best convergence between all three methods is observed at the “Ogurchinsky” station on the Eastern South Caspian, while the largest discrepancies occur at Western coastal stations (RMSE exceeding 1100 mm between methods 1 and 2). Correlation between the SOI method with ERA5 inputs and direct ERA5 evaporation reaches 0.55–0.82, confirming the systematic biases in ground-based observations likely caused by the transport of dry continental air masses from Central Asia under easterly wind conditions. A clear geographical pattern emerges: the convergence of methods progressively deteriorates from the Eastern shore of the South Caspian to the Western shore, reflecting regional atmospheric circulation features. The identified discrepancies between the empirical SOI method and the physically based ERA5 reanalysis highlight the need for careful validation of both approaches before updating operational water balance calculations for the Caspian Sea. The comparative analysis of the three options allows for quantitative assessment of discrepancies between empirical and physical approaches, identification of their appropriate application areas, and determination of the potential of using reanalysis data to refine long-term evaporation series, which is critically important for reliable reconstruction of the Caspian Sea water balance.

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