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Titel des Beitrags: Water Constituents and Water Depth Retrieval from Sentinel-2A—A First Evaluation in an Oligotrophic Lake

Abstract: Satellite remote sensing may assist in meeting the needs of lake monitoring. In this study, we aim to evaluate the potential of Sentinel-2 to assess and monitor water constituents and bottom characteristics of lakes at spatio-temporal synoptic scales. In a field campaign at Lake Starnberg, Germany, we collected validation data concurrently to a Sentinel-2A (S2-A) overpass. We compared the results of three different atmospheric corrections, i.e., Sen2Cor, ACOLITE and MIP, with in situ reflectance measurements, whereof MIP performed best ($r = 0.987$, $\text{RMSE} = 0.002 \text{ sr}^{-1}$). Using the bio-optical modelling tool WASI-2D, we retrieved absorption by coloured dissolved organic matter (aCDOM(440)), backscattering and concentration of suspended particulate matter (SPM) in optically deep water; water depths, bottom substrates and aCDOM(440) were modelled in optically shallow water. In deep water, SPM and aCDOM(440) showed reasonable spatial patterns. Comparisons with in situ data (mean: 0.43 m$^{-1}$) showed an underestimation of S2-A derived aCDOM(440) (mean: 0.14 m$^{-1}$); S2-A backscattering of SPM was slightly higher than backscattering from in situ data (mean: 0.027 m$^{-1}$ vs. 0.019 m$^{-1}$). Chlorophyll-a concentrations (~1 mg·m$^{-3}$) of the lake were too low for a retrieval. In shallow water, retrieved water depths exhibited a high correlation with echo sounding data ($r = 0.95$, residual
standard deviation = 0.12 m) up to 2.5 m (Secchi disk depth: 4.2 m), though water depths were slightly underestimated (RMSE = 0.56 m). In deeper water, Sentinel-2A bands were incapable of allowing a WASI-2D based separation of macrophytes and sediment which led to erroneous water depths. Overall, the results encourage further research on lakes with varying optical properties and trophic states with Sentinel-2A.