Popular summary

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Development of a new spatially complete and daily continuous lake surface water temperature dataset for Lake Vänern, Sweden

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Lake surface water temperature is an important indicator to monitor changes on a regional scale caused by climate change. Changes in lake surface water temperature alter biological, chemical and physical processes, which affects the ecosystem of the lake. Currently, the main methods to obtain lake surface water temperature are based on three approaches: in-situ measurements, satellite estimations and modeling. However, all three methods come with their limitations: the in-situ measurements only represent the temperature at a point rather than the whole lake. The satellite estimates are, in the best case, available for the whole lake but due to cloud contamination these estimates have missing data. The modeling products generate hourly lake surface water temperature estimations without data gaps, although the coarse spatial resolution limits this method to capture small-scale variations in lake surface water temperature. Previous studies have used the advantages of the satellite and modeling products to overcome the current limitations by combining the data to gain a high spatial resolution and complete dataset.

The study aims to develop a daily and complete lake surface water temperature dataset for Lake Vänern. Therefore, already existing lake surface water temperature products (GloboLakes, ARC-Lake, MODIS, TIRS, CGLOPS and ERA5-Land) were evaluated for Lake Vänern by comparing them to in-situ measurements. Further, a new lake surface water temperature dataset using a data fusion approach, the combination of two datasets, was developed. The data fusion was conducted using the cloud-free days of a satellite product and the estimations of the modeling data. To account for a systematic error caused from the data fusion a bias correction was conducted. The generated product was then evaluated against in-situ measurements. Finally, the spatial and temporal dynamics of Lake Vänern were analyzed based on the generated dataset.

The evaluation of the lake surface water temperature products showed that each product performed with high accuracy. It was found that ATSR2 and GloboLakes performed the best for Lake Vänern. Due to its technical advantages, it was decided to conduct the data fusion with MODIS. The results indicated that the generated product outperformed the MODIS and had similar accuracy as the ERA5-Land data. The dataset was able to estimate the lake surface water temperature without data gaps and with a high spatial resolution. Further, the analysis of the spatial and temporal dynamics of lake surface water temperature in Lake Vänern showed a development of a thermal bar and that the maximum temperatures were reached during July/August.

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