Scientific summary

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

Keywords: Physical Geography, Ecosystem Analysis, Remote Sensing, Data Fusion, Reanalysis Product, Lake Surface Water Temperature, Hydrology

Lake Surface Water Temperature (LSWT) is an important indicator to monitor changes due to climate change on a regional scale. Changes in LSWT alter biological, chemical and physical processes, which affects the ecosystem of the lake. Currently, the methods to obtain LSWT are based on three main methods: in-situ measurements, satellite remote sensing and re-analysis products. However, all three methods come with their limitations, In-situ measurements have a sparse spatial and temporal network and are therefore not suitable to monitor spatial and temporal dynamics, satellite remote sensing is technically able to capture the spatial and temporal dynamics of LSWT, but cloud coverage results in data gaps. Re-analysis products generate hourly LSWT estimations under all weather conditions, although the coarse spatial resolution limits the method to capture small-scale spatial dynamics. Previous studies have used the advantage of satellite remote sensing and re-analysis products to overcome the current limitations of each product to generate a spatially complete and temporal dataset.

The study aims to develop a daily and complete LSWT dataset for Lake Vänern. Therefore, already existing LSWT products (GloboLakes, ARC-Lake, MODIS, TIRS, CGLOPS and ERA5-Land) for Lake Vänern were evaluated by comparing them to in-situ measurements. Further, a new LSWT dataset using ESTARFM was developed. The data fusion was done by combining the cloud-free days of a satellite product with the ERA5-Land data. To account for a systematic bias caused during 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 dataset was able to estimate the lake surface water temperature without data gaps and with a high spatial resolution. The results indicate that the generated product outperformed the MODIS and had similar accuracy as the ERA5-Land data. Further, the analysis of the spatial and temporal dynamics of LSWT in Lake Vänern showed a development of a thermal bar and that the maximum temperatures were reached during July/August.

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Master's degree project 30 credits in Physical Geography and Ecosystem Science, 2023
Department of Physical Geography and Ecosystem Science, Lund University. Student thesis series INES nr 621