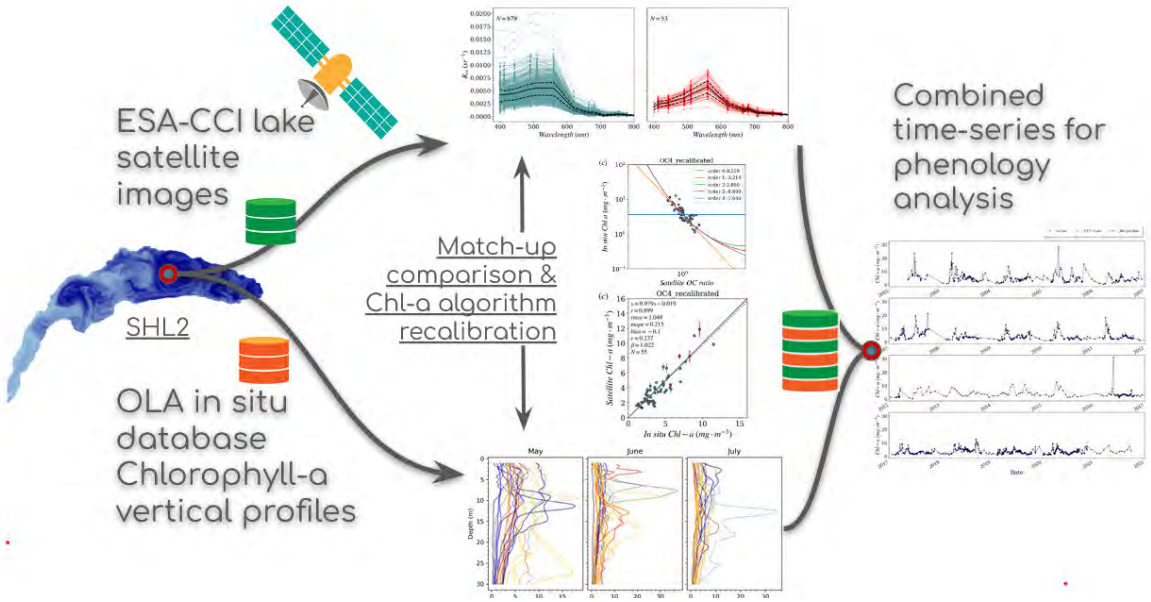
Investigation on Lake Geneva

Assessing satellite data for monitoring phytoplankton abundance and phenology in deep lakes



Summary of strategies for comparing different datasets of Chl-a concentrations for the analysis of phytoplankton phenology.

Monitoring the water quality of Lake Geneva necessitates quantifying phytoplankton abundance, particularly through chlorophyll-a (Chl-a) concentration measurements (Chang et al., 2022). Optical satellite imagery facilitates regular mapping of Chl-a concentration on a lakewide scale. The European Space Agency Climate Change Initiative (ESA-CCI) provides global Chl-a concentrations using medium-resolution satellite data. This study evaluated the accuracy of ESA-CCI optical products in depicting the seasonal dynamics and phenology of phytoplankton in Lake Geneva. By integrating in situ data sets, it aims to establish a comprehensive long-term time series of Chl-a concentrations, essential for lake management and understanding environmental changes. These datasets were assessed through match-up comparisons.

The satellite data used in this study are derived from the CCI-lake processing chain, applied to the Medium Resolution Imaging Spectrometer and two Ocean and Land Colour Instrument satellite missions (Carrea et al., 2023). The in-situ data were collected as part of the environmental monitoring coordinated by the French and Swiss commission for the protection of Lake Geneva water, available through the OLA database (Rimet et al., 2020). To evaluate long-term phytoplankton variability, data from sampling station SHL2, used for Water Framework Directive monitoring and located on the deepest part of the lake (pictured at left in image above) were focused on.

Since the underlying algorithms do not consider the vertical distribution of phytoplankton, a specific analysis was conducted to evaluate potential biases in remote sensing estimation and their impact on observed phenological trends. Various data averaging approaches were applied to reconstruct Chl-a estimates from remote sensing algorithms. A strong correlation (R-value >0.89) and acceptable discrepancies (rmse~1.4 mg/m^3) were observed for the ESA-CCI data. This facilitated the recalibration of ESA-CCI data for Lake Geneva. Ultimately, merging satellite and in situ data produced a consistent time series for long-term analysis of phytoplankton phenology and its interannual variability since 2002. This combination enhanced the temporal resolution of the time series, enabling a more precise identification of specific spring events characterizing phytoplankton phenology.

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