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Remote sensing techniques and in situ fluorometry as alternative methods for the determination of algae pigments in lakes – application to Lake Constance and small lakes

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Satellite based remote sensing techniques were used in order to assess the variability of Chlorophyll-a distributions in Lake Constance and additionally within some smaller lakes in the South of Germany. For Lake Constance we used for most investigations spatially medium resolved satellite scanners with a higher spectral resolution whereas in the case of smaller lakes having a size of 1 ... 10 km spatially highly resolved satellite scanners were used having a lower spectral resolution.

The satellite imagery allowed for a higher spatial as well temporal resolution of information about Chlorophyll-a distribution in these lakes compared to classical methodologies as water sampling and subsequent species analysis using microscopes and/or HPLC analysis for accessory algae pigments.

We found - depending on weather and hydrodynamic conditions - highly variable Chlorophyll-a distributions under some circumstances whereas there are as well time periods when almost perfectly homogeneous distributions of Chlorophyll-a where detected in Lake Constance.

Additionally we used HPLC analysis in order to validate the satellite remote sensing results showing good agreement between in situ measured and remote sensing values for Chlorophyll-a.

During some measurement campaigns in Lake Constance we used an in situ fluorometer probe (BBE FluoroProbe) in order to determine the spatial fluctuations of Chlorophyll-a and additional accessory algae pigments. These algae pigments were measured along horizontal transects using a temporal sampling interval of about dt=2 ... 10 seconds giving a high spatial sampling frequency in the order O[10 ... 50]m. Based on these horizontal records we can get further insight into the spatial fluctuations of algae pigments and their spatial patterns in Lake Constance. Characteristics of these patterns can be quantified using some patchiness state vector (psv) summarizing different specific features of the algae distribution into some vector quantity.

Special focus is given to the use of remote imagery from smaller lakes, where an additional methodology was applied using some basic assumptions in order to estimate the maxima of Chlorophyll-a in these smaller waters. In contrary to classical methods this approach is able to give estimates of maximum Chlorophyll-a content for many lakes at the same time. The potential of this methodology as a monitoring tool giving an indication where harmful developments in lakes (e.g. eutrophication, harmful algae blooms) might occur is analyzed.