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Automated extraction of lake ice phenology from NOAA-AVHRR satellite data (1985 – 2012)

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Climatic changes can highly affect lake ice phenology. Even if yearlong exceptions occur, later freeze-up and earlier break-up is a significant trend in the Northern Hemisphere as described in several studies (e.g. Magnuson et al. 2000). Lake ice phenology responds locally and regionally to long-term trends in air temperature driven by large-scale climate forcings and effects regional climate and weather events. According to several authors (e.g. Robertson et al. 1992), lake ice is a proxy for climate variability and change.

The development towards longer ice-free periods of lake systems has impacts on the heat storage, biochemical cycles, survival of aquatic ecosystems and the lake's biodiversity. Within the last years, interest increased for lake ice, overcoming the poor state of knowledge for lake ice in northern hydrology. Since 2006 the Global Climate Observing System (GCOS) has emphasized lakes as one of the Essential Climate Variables (GCOS-107, 2006).

The availability of observed lake ice phenology in cold regions of the world as well as in Switzerland is scarce. Remote sensing can provide a tool for operational monitoring of lake ice and a possibility to fill these data gaps. The Advanced Very High Resolution Radiometer (AVHRR) carried on satellites of the National Oceanic and Atmospheric Administration (NOAA) and the European Meteorological Operational satellite system (MetOp) offers unique potential for climate studies with space observations from the early 1980s until today. Data from the full-resolution archive of the Remote Sensing Group, University of Bern, are used to derive lake ice phenology.

Start and end of freeze-up and break-up dates are retrieved with an automatic extraction method. The developed algorithm follows closely the method of Latifovic and Pouliot (2007). Based on the fact that the reflectance increases with the formation of ice, they used lake specific reflectance profiles to derive start and end dates for freeze-up and break-up of the lake ice. The work presented here focuses on lakes in the Baltic region for which extended observational data is available, used to validate the results of the algorithm. In the future, the method will be applied to Swiss lakes as well.