Lake Ice Detection From VIIRS Data

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Lakes featuring a seasonal cycle of ice cover represent a major component of the terrestrial landscape. Ice cover on lakes plays a key role in the physical, chemical, and biological processes of freshwater systems (e.g., ice duration controls the seasonal heat budget of lakes), and it also has many economic implications (e.g., concerning hydroelectricity or transportation). The seasonal cycle of ice cover, such as the timing of freeze-up and break-up, is highly sensitive to climate conditions. Therefore, variability and trends in lake ice dynamics (i.e., lake ice phenology) represent robust and direct indicators of climate change; thereby emphasizing the importance of monitoring lake ice and of collecting recordings of freeze-up, break-up, and ice thickness.

Satellite remote sensing has a great potential for observing ice cover on lakes, and different systems have been successfully used to measure the occurrence of lake ice and increase the spatial and temporal coverage of ground-based observations. Therefore, within the Global Climate Observing System (GCOS) Swiss project, „Integrated monitoring of ice in selected Swiss lakes," initiated by MeteoSwiss, satellite images from various sensors and different approaches are used and compared to perform investigations aimed at integrated monitoring of lake ice in Switzerland and contributing to the collection of lake ice recordings. Within the framework of this project, the Remote Sensing Research Group of University of Bern (RSGB) employs data acquired in the fine resolution I-bands (1-5) of the Visible Infrared Imaging Radiometer Suite (VIIRS) sensor that is mounted onboard the SUOMI-NPP. Visible and near-infrared reflectances and thermal infrared derived lake surface water temperatures (LSWT) are used to retrieve lake ice phenology dates. Taking into account the surface temperature increases the accuracy of ice detection, since —depending on the view angle— the roughness of the water surface, sun glint, shadows, and type of lake ice may impair the determination of lake ice from VIS and NIR reflectances. The VIIRS instrument, which combines a high temporal resolution (~2 times per day) with a reasonable spatial resolution (375 m), is equipped with a single broad-band thermal I-channel (I05). Thus, a single-channel LSWT retrieval algorithm is employed to correct for the atmospheric influence. The single channel algorithm applied in this study is a physical radiative transfer-based mono-window (PMW) model and is based on Radiative Transfer for the Television Infrared Observation Satellite Operational Vertical Sounder code (RTTOV) runs using atmospheric profiles from ECMWF ERA-interim.

We present the first retrievals of LSWT and ice features from corrected clear-sky channel I05 data of the VIIRS sensor. Based on these first results, the project now aims to retrieve ice-on/off dates for selected Swiss lakes by applying a threshold method on processed temperature and VIS and NIR reflectance values.