climate change initiative

→ LAKES NEWSLETTER

Issue n. 3 | May 2020

In this newsletter

This newsletter highlights the generation of the Lake Ice Cover (LIC) product. LIC refers to the extent (or area) of a lake that is covered by ice. According to GCOS (2016), the LIC Essential Climate Variable is needed with daily observation frequency, 300-m spatial resolution, better than 10% measurement uncertainty and stability of 1% per decade.
We also briefly present the current status of the project and a description of the upcoming first release of the Lakes_cci climate research data package.

Project status

February marked the first year of this three-year project. More than 25 participants participated (from home) in the annual review to discus progress towards the first Lakes ECV data set, interactions with the user community and upcoming research tasks. We welcomed the new ESA Technical Officer, Clément Albergel, and thanked Stephen Plummer for his contributions to date.
The major project deliverable at the end of this year is the CRDP (Climate Research Data Product), which was being finalized at the time of the Annual Review . The CRDP will contain 30 years of satellite observations over 250 lakes and will be availbale by the end of May.
Next, the CRDP will be used in five use cases internal to the project while the project team is keen to learn of its use by other groups.

Product highlight: Lake Ice Cover

Claude Duguay (H2O Geomatics and University of Waterloo)

LIC is highly sensitive to changes in weather and climate. Lake-wide ice phenology can be derived from LIC, including freeze onset to complete freeze over (CFO) dates during the freeze-up period, melt onset to water clear of ice (WCI) dates during the break-up period, and ice cover duration derived from number of days between CFO and WCI dates over an ice year. For lakes that do not form a complete ice cover every year or in some years (e.g. Laurentian Great Lakes of North America), maximum ice cover extent (timestamped with date) is also a useful climate indicator that can be determined. Similarly, minimum ice cover extent (timestamped with date) can be derived for High Arctic lakes that do not completely lose their ice cover in summer. Knowledge of the presence/absence or fractional coverage/concentration of ice cover on large lakes on a ca. weekly basis is also useful for improving numerical weather forecasting (e.g., lake-effect snowfall, thermal moderation effect) in cold regions.

For Climate Research Data Package (CDRP) V1.0, the LIC product is generated on a daily basis using MODIS data acquired from multiple Terra and Aqua satellite overpasses on each day as to maximize the number of cloud-free observations. The product, which covers a 20-year period (2000-2019), is first produced on a ca. 250-m grid (internal product) and then merged with the other lake thematic products on a common 1/120th degree grid. The primary input data source is the MODIS Terra/Aqua Atmospherically Corrected Surface Reflectance 5-Min L2 Swath (MOD09/MYD09), Collection 6 product. MODIS surface reflectance and brightness temperature bands are used in a threshold-based algorithm for feature retrieval (i.e. water, ice, or cloud classes). The surface reflectance bands are available at 250 m and 500 m resolutions. Brightness temperature bands are available in 1 km resolution. Geolocation is provided at 1 km resolution and is interpolated to 250 m. The second data source for LIC product generation is the maximum water extent observed in ESA CCI Land Cover (v4.0) at 150-m resolution. MOD09/MYD09 data from 17 lakes located in different regions of the Northern Hemisphere were selected for algorithm development and validation (Figure 1).

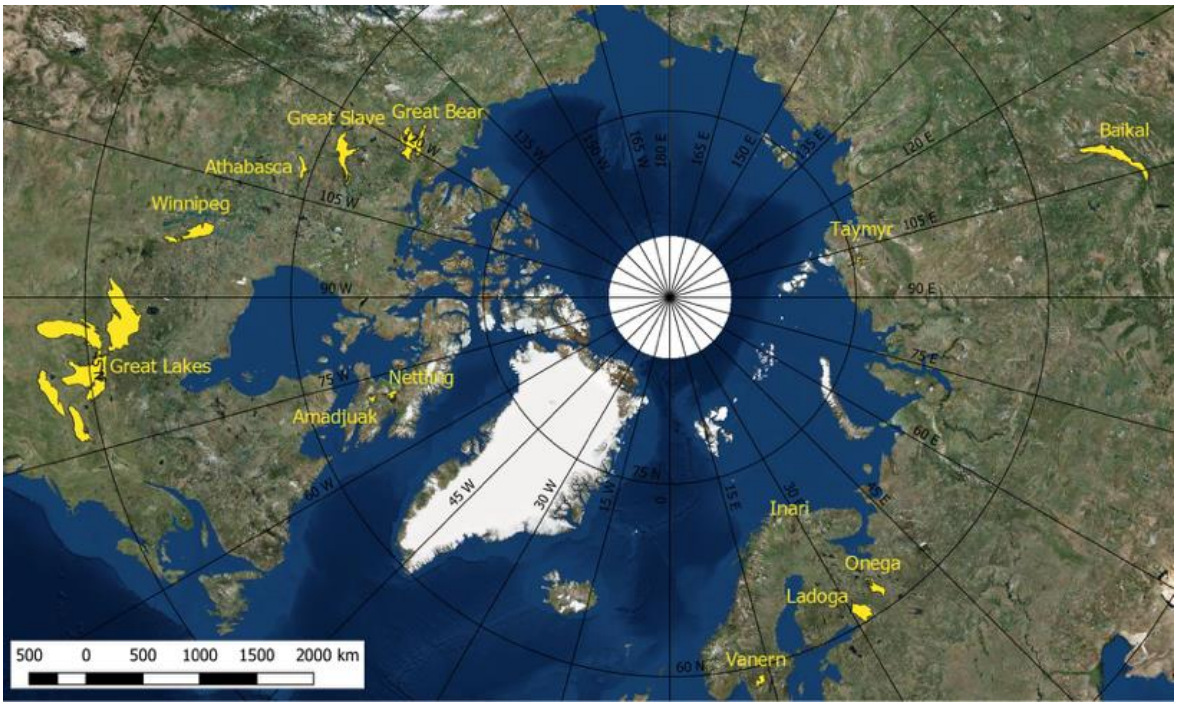

Figure 1 Geographical distribution of 17 lakes used for lake ice cover algorithm development and validation.

Figure 2 shows an example of LIC products generated for low (winter 2011-2012) and high (winter 2013-2014) ice years. Validation of the LIC product and comparison with lake ice retrievals provided by NASA's MODIS Terra/Aqua Snow Cover products (MOD10/MYD10) have been performed via computation of confusion matrices built on independent statistical validation. Results show that the retrieval algorithm implemented for Lakes CCI outperforms NASA's Snowmap algorithm, attaining an overall accuracy (FU and BU periods combined) of 95.54% compared to 87.09%. Retrieval accuracies have been found to be more consistent between classes and also ice periods for the Lakes CCI LIC algorithm (BU: 14% and FU: 22% higher accuracy than NASA's Snowmap algorithm), in addition to better capturing the spatial distribution of cloud cover compared to the MODIS Snow Cover (MYD10/MOD10) products. Individual class accuracies are all above 90% (errors less than 10%) for LIC CDRP V1.0 (ice: 91.71%, water: 98.85%, cloud: 95.63%) which meet uncertainty requirements of 10% set by GCOS. Further assessment of the LIC product and its comparison with other products is planned leading to CDRP V2.0 by the broader user/modelling community.

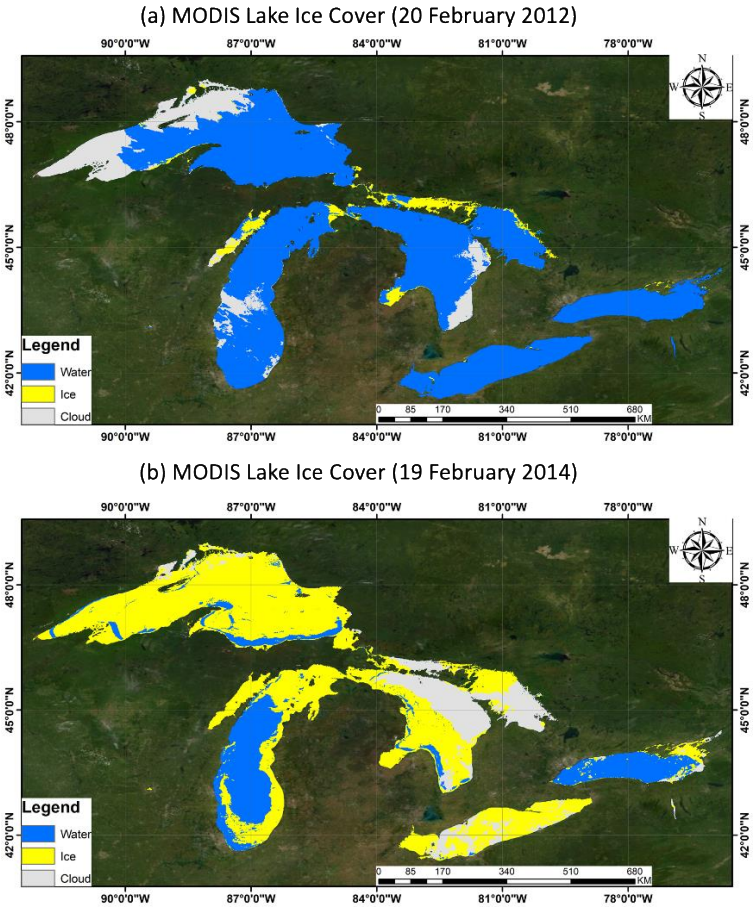

Figure 2 Examples of lake ice products of the Laurentian Great Lakes (Canada/USA) derived from MODIS Terra/Aqua for (a) a low ice year (20 February 2012) and (b) a high ice year (19 February 2014).

Given the importance of ice cover in lake-atmosphere interactions, the LIC ECV will be of interest to users who wish to: 1) examine short-term trends and interannual variability in ice cover globally (ca. 20 years); 2) investigate the impact of changing ice cover conditions on other variables covered in Lakes CCI, such as Lake Surface Water Temperature (LSWT); 3) conduct data assimilation experiments using state-of-the-art numerical weather prediction systems to demonstrate the impact of better consideration of LIC on, for example, improving predictions of lake-effect snowfall; and 4) evaluate lake models (e.g. FLake model) used as lake parameterization schemes in numerical weather prediction and climate models. Finally, from a socio-economic perspective, the LIC variable may also serve to examine the impact of changing ice conditions on winter transportation (shipping, ice roads) and food security (access to resources by northern communities via ice roads).

The first Lakes ECV Climate Research Data Package (CRDP V1.0)

The main characteristics of this data set are:

Spatial coverage:	250 lakes distributed globally (see map)
Spatial resolution:	1/120 degree global grid
Temporal resolution:	daily netCDF files containing all thematic variables including uncertainty
Temporal coverage:	From 1992 up to 2019.

Temporal coverage of each Lakes CCI thematic variable

Location of the 250 lakes included in the CRDP V1.0