esa

climate change initiative

→ LAKES NEWSLETTER

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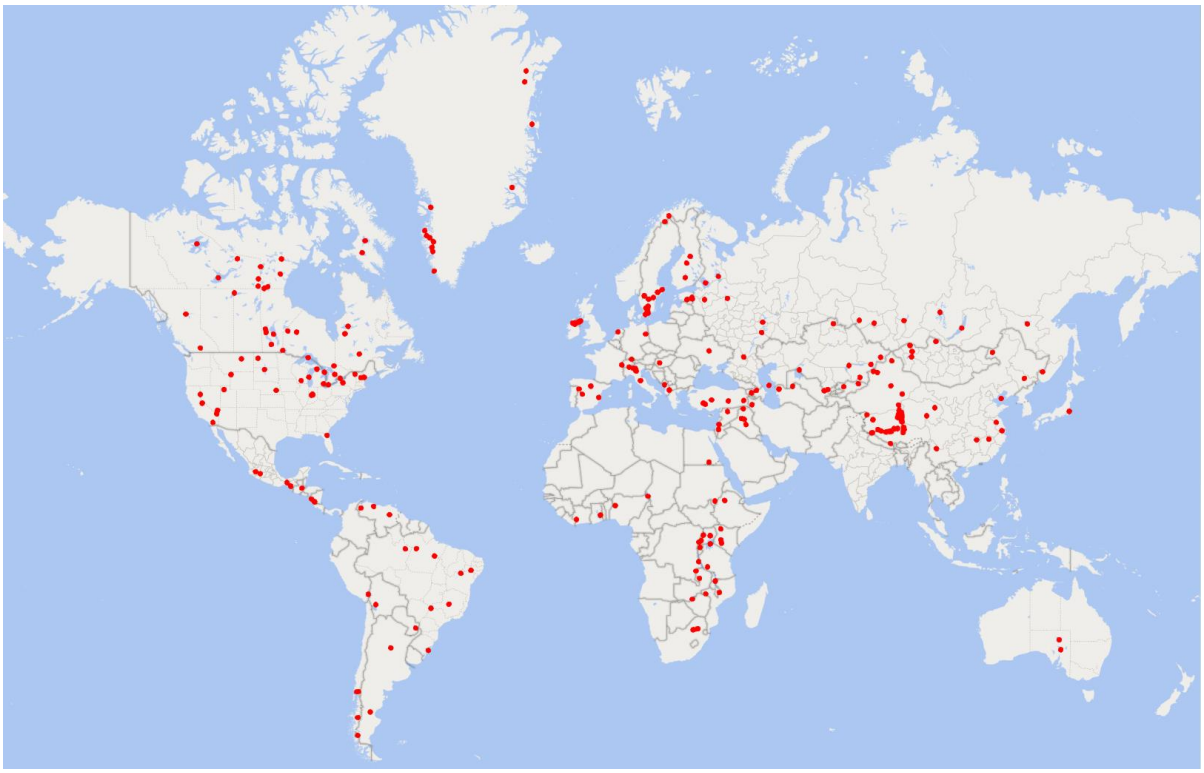
The lakes CCI project kicked off in Reading (UK) on the 14th of February 2019. The project aims to produce and validate a consistent dataset of the variables grouped under the Lakes Essential Climate Variables (ECV). It includes multiple variables: lake water level, extent, temperature, surface reflectance, and ice cover. The project falls under the broader umbrella of the Climate Change Initiative (CCI) of the European Space Agency (ESA) and will run for three years. Scientists from across Europe and Canada will exploit satellite data to create the largest and longest possible consistent and global climate data record for the lakes ECVs, relying on state-of-the-art methodologies and putting effort into further research to produce the highest possible quality data record to date. The first release of the lakes ECV dataset is expected in early 2020, for an initial set of over 200 lakes (see below).



In this first newsletter we focus on the analysis performed for LWE (Lake Water Extent). The first step of our research aims to determine the best approach for retrieving this variable, using a combination of different datasets: radar altimetry that are used for the measurements of the LWL (Lake Water Level) variable, and a selection of satellite imagery (optical, radar) used to determine the *hypsometry*, which is the monotonic relationship between lake level and extent. An inverse method is used to determine the polynomial (second order) coefficients that allow LWE to be derived when LWL is known. The purpose of this work is to reduce the dependency on high resolution satellite imagery and the large computational effort needed to retrieve LWE directly from radar or optical imagery.

The teams in charge of this work are from Legos and Sertit (France), Norut (Norway) and Altamira (Spain). In these four laboratories, expertise in water mask determination has been developed and the objective is to select a short list of lakes where inter-comparison of the contours at different epochs is done with different algorithms and satellite images.

Three lakes have been selected in different regions with different morphological contexts. The Nam Co (Co means lake in Tibetan) which is a large lake (greater than 2000 km^2) located over the Tibetan Plateau (the second largest lake in Tibet), the Colhue-Huapi which is a lake with high spatial variability located in Argentina, and a narrow lake located in Norway, the Altevatnet

For each of these lakes, the first step in the analysis was to select a set of satellite optical images from Landsat and sentinel-2 series (done at Legos and Sertit) and of radar imagery (mainly Sentinel-1, done by at Norut and Altamira).

LWL for these three lakes have been retrieved in parallel: at Legos, long time series (from 1994 to 2019) were created for the Nam Co and Colhue Huapi lakes, using satellite radar and laser altimetry (Topex/Poseidon, ERS2, Jason-2, Jason-3, Envisat, Saral/Altika, Cryosat-2 and sentinel-3A). The time series are now online on the Hydroweb site (see http://hydroweb.theia-land.fr/hydroweb/view/L_namco, and http://hydroweb.theia-land.fr/hydroweb/view/L_huapi?lang=fr&basin=Chubut&lake=huapi) while for Altevatnet, a series of in situ data (2002 to 2018) have been provided by Norut.

Nam Co : 2017-12-01, Sentinel-2A L1C, False color

Inter-comparison has been performed at Legos using the first case study, Nam Co. Several datasets for LWE have been gathered and are now being compared. At Legos a series of around 15 images from Landsat, 5, 7 and 8 have been processed from 2000 to 2018. The idea is to observe a wide range of LWE and LWL to populate the hypsometry curve and to identify periods during which additional satellite images should be analysed.

In situ data collection for calibration and validation of the resultant algorithms requires significant effort, and we are grateful to have received a large data set from Dr G. Zhang from Institute of Tibetan Plateau Research, Chinese Academy of Sciences including a set of LWE variables, dating from the mid-nineties until 2014. It covers a wide range of variability in lake extent. Satellite images from Landsat 5 and 8, and sentinel-2A have also been processed at Sertit, and satellite radar imagery from sentinel-1 have been gathered (from the year 2018) and collected at Norut. The first results of this study are still very preliminary, but show good promise, allowing us to converge rapidly on a strategy for further satellite images processing in varying lake conditions. One of the obvious conclusions we can draw is that certain lakes which tend to be obscured by cloud cover in optical imagery, will require processing of radar imagery. At the same time, regions such as the Tibetan Plateau provided sufficient optical multispectral imagery (which are easier to process) to be used to determine the hypsometry of the lakes.

The first results of this inter-comparison are summarised below.

1. Using the Legos, Norut, Sertit, and G. Zhang datasets (altimetry and Landsat imageries) we have calculated the hypsometry polynomial coefficient of the Nam Co, considering a second order polynomial. The LWE/LWL vectors used to calculate the hypsometry are shown in Figure 1. The standard deviation is 6 km^2 for the LWE which is ~ 0.3% of the average extent of the lake.It falls within the GCOS requirements which is 5% of uncertainty for large lake such as the Namco.

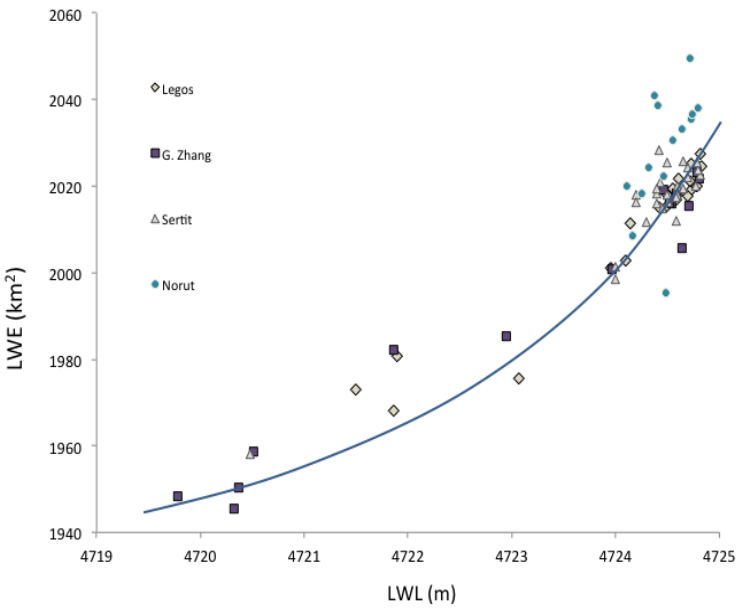


Figure 1: vectors (LWE/LWL) from G. Zhang, Legos and theorical hypsometry (second order polynomial)

2) LWE products from the different datasets (Norut, Sertit, Legos and G. Zhang) with the optical and radar imagery were also compared, with results shown in Figure 2. Thus far, the processing done at Legos, Sertit, and by G. Zhang show very high agreement. The radar imagery (Norut processing) present some slight disagreements with respect to the other satellite imageries, but with a dispersion of less than 1% of the total extent of the lake.

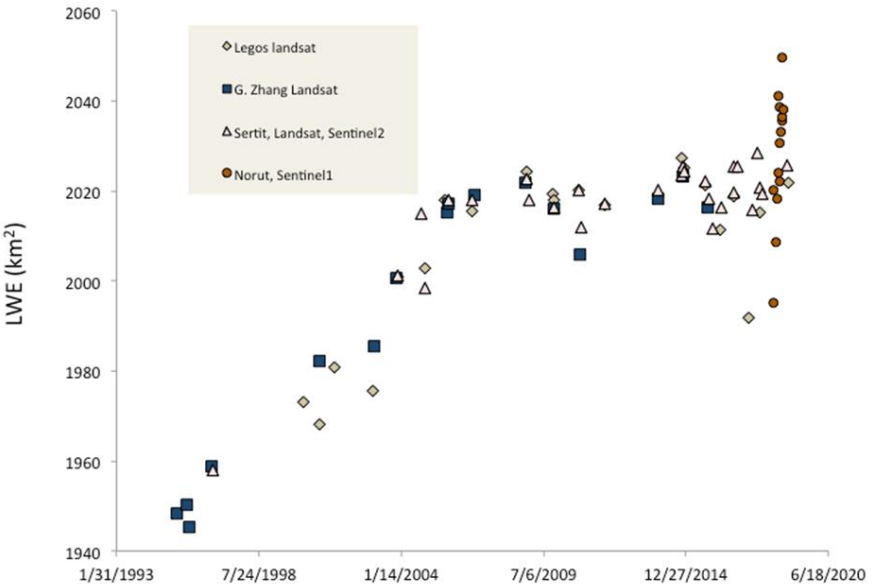


Figure 2: LWE time series from G. Zhang, Norut, Legos and Sertit.

The work planned in the next period is to conclude on the inter-comparison for the selected lakes and to subsequently define a strategy of LWE calculation based on multi-spectral optical and radar imagery with the most appropriate method depending on the type of lakes considered.