Geophysical Research Abstracts
Vol. 20, EGU2018-12243-1, 2018
EGU General Assembly 2018

Advancing methods for water quality studies of Arctic rivers with remote sensing and ground-based measurements. Case study of the George river basin (Nunavik, Canada)

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The continental hydrological cycle of Arctic regions is one of the least understood components of the earth's climate system. Fundamental knowledge from the fields of meteorology and hydrology at high latitudes are needed to address our lack of knowledge about the impacts of climate change at multiple spatial scales (i.e. from local to global). In particular, considerable advances in optical sensors technology (high spatial and temporal resolution) now able us to track anthropogenic impact on the Arctic/Subarctic environments and changes in the physical properties of its components at broad spatial scales. Here, we propose a case study of remote sensing application to continental hydrology to: (i) estimate the quality of inland waters, and (ii) track their temporal evolution, by means of in situ measurements. This study is part of a participatory Program (OHMi/Nunavik) including Québec / France partnership and in collaboration with the Inuit community of Kangiqsualujjuaq (Aquabio/Imalirijiit project).
The study area is located in Nunavik, northern Québec (Canada), and concerns the George River catchment (565 km length, 41 700 km^2). The local study site (N 58° 10'/ W 65° 50') is situated at the south of the easternmost Inuit village of Nunavik, Kangiqsualujjuaq (Ungava Bay); about 100 km to the west of the Torngat Mountains and the Labrador border. The objective consists to constraint and adjust spectral indices given by literature concerning water properties (i.e. chlorophyll-a, transparency) to the specific case of arctic rivers, characterized by a high quality level. Spectral indices derived from visible and infra-red wavelengths provide relations that can be used to estimate water properties. However, ground-based measurements are necessary to assess the relevance of new equations adjusted for arctic/subarctic river basins. For the calibration step, field campaigns to measure water quality were conducted during summers 2016 and 2017 along a 35 km stretch of the river, with simultaneous remote sensing acquisition (Landsat-8, Sentinel-2).). Laboratory analyses of in situ measurements characterize the George River waters as oligotrophic (neutral pH, very low chlorophyll-a concentration (max = 1 to 2 μg/L). For remote sensing data, a specific model integrating a large panel of spectral bands (El Alem) is developed and compared to the referenced literature (Shafique, Baban, Torbik). The calibrated models are thereafter validated using the cross-validation technique. Coefficients of determination indicate both the challenge and potential of remote sensing for assessing inland water quality in arctic environments.