**Title**

Water surface heights in the upper Brahmaputra and Nam Co basin with ICESat-2

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**Abstract**

Due to climate change, glaciers are melting on the Tibetan Plateau. These glaciers are the water source for big rivers as the Brahmaputra which stream towards the most densely populated area on Earth. Previous studies indicated that water surface heights of lakes connected to the glaciers are increasing in the north of the Tibetan Plateau, while they are decreasing in the south. Current literature does not provide a clear answer on the reason why the north and the south are behaving differently. For determining why the south is behaving different than the north, the processes in the basin should be identified and distinguished. For addressing what all the processes in the basin are, the waterbodies in the upper Brahmaputra should be monitored and their relation to the processes and the other waterbodies should be determined. For determining this relation it is of importance to first determine the lake surface heights and river surface heights in this area. This research focusses on determining water surface heights in the upper Brahmaputra and Nam Co basin (located in south of the Tibetan Plateau) using remote sensing, which is the preferred method since waterbodies in this area are difficult to reach for in-situ measurements.
In this study, data of ICESat-2 is used for water surface height measurements. The laser satellite mission ICESat-2 has been launched in 2018 and makes use of three pairs of beams. Lake surface heights are determined by first computing the water surface heights per beam and finally per ICESat-2 passing. Several additional steps to determine the river surface heights are required due to the slope of rivers. Therefore, the passing beams are clustered, resulting in several locations in the river which can be further analysed. It is found that river surface heights are harder to determine due to the presence of bars and shorelines. Therefore, the method for determining the river surface heights should only be used for non-braiding rivers.
A precision for both lake surface heights and river surface heights of 0.1 meters is found. This research found that ICESat-2 can have a contribution for determining lake and river surface heights due to its relatively good precision, but also due to its high spatial resolution. The ground-track spacing of ICESat-2 is lower than other satellite missions, resulting that ICESat-2 passes the most amount of lakes and river locations. In total the water surface heights of 299 lakes and 127 river locations are determined. This small ground-track spacing is at the cost of the temporal resolution resulting in large time gaps in the timeseries of the lakes and river locations. Therefore, a seasonal variation and generic water surface height curve will be difficult to assess. It is possible that ICESat-2 will miss the moments with the extreme water surface heights resulting in a misconception of the water surface heights. But, over a longer time period it may be possible to fit a generic water surface height curve through the water surface heights of lakes larger than 10 km2 due to its higher amount of ICESat-2 passings.