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Understanding ICESat derived lake level changes of about 150 Tibetan lakes between 2003 and 2009

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The Tibetan plateau contains approximately five hundred lakes with an area of over one square kilometer. Observations of changes in the water level of these lakes could be an important indicator of trends in the water balance of the Tibetan plateau. In situ measurements however are not available for most lakes, while traditional radar remote sensing by e.g. Topex/Poseidon is hampered by a too large footprint to sample the many relatively small lakes. In addition, spatial patterns in the temporal trends of lake levels would provide information towards understanding the dominant hydrological process in the different lakes watershed.

Between 2003 and 2009 the Geoscience Laser Altimeter System (GLAS) on board of the Ice, Cloud and land Elevation satellite (ICESat) obtained world-wide elevation profiles during 18 one-month campaigns. Using the GLAS data it is possible to obtain lake levels at decimeter accuracy. An individual GLAS shot with a geolocation accuracy in the order of 5m has a diameter of about 70m which makes it suitable to sample small lakes. The GLAS system only obtained elevations along-track profiles below the satellite at an along-track sampling distance of 175m. The (across-track) distance between orbits is 73 km over Tibet. In each of the 18 campaigns the tracks are approximately repeated, although shifts between repeated tracks in the order of a few hundred meter are common.

Available GLAS data of all campaigns over the Tibetan lakes is selected using the MODIS lake mask combined with Landsat data for control. From the elevations available at each lake a mean lake level is determined per campaign, after removing outliers by fitting a horizontal line to observations using RANSAC. As a result, lake level variations between 2003 and 2009 of about 150 lakes were obtained. For these lakes, an analysis of both seasonal and inter annual water level trends is made. As for each lake also the approximate area is known from the lake mask, lake level changes can be directly converted to volumes of gained or lost water. As an example, the Yandrok Lake has on average lost 250 million liter of water per year in the period considered, while the Siling Lake gained most volume, more than 1 billion liter of water per year.

The sampled lakes are subdivided by watershed. For example, 105 of the sampled lakes belong to the inner Tibetan plateau, 18 to the Yangtze and 11 to the Yellow river basin. To increase understanding of the observed trends, the lakes will be further characterized according to their origin (e.g. glacier-fed), possible run-off (closed basin) and connectedness (series of lakes in one basin). Such analysis is expected to give, for the first time, a clear insight in the potential of using remotely sensed lake levels for the analysis of the water balance of the Tibetan plateau and of its sub-regional features.