



Lake level variations and water budget of ten greatest lakes in China using remotely sensed data (2003-2009)

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The lake level and water storages variations are important knowledge to water resources management, anthropogenic activities and climate change. In this study, the ten largest lakes with area of $\sim 1000 \text{ km}^2$ are monitored for their lake level and area derived from ICESat and Landsat data, respectively from 2003-2009. The ten lakes are located in three geographic regions, China, i.e. Lakes Selin Co, Nam Co and Qinghai in the Tibetan Plateau (TP); Lakes Dongting, Poyang, Taihu, Hongze and Xingkai in the eastern monsoon area; Lakes Bosten and Hulun in the arid and semi-arid area. The lake level and area of lakes Selin Co, Nam Co and Qinghai exhibit an obvious increase. The Lakes Dongting, Poyang, Taihu, Hongze show no obvious changes due to sparse ICESat data and seasonal variability, and Xingkai slight increase. The lakes Bosten and Hulun indicate an obvious decrease. The correlation coefficient between lake level and area of Lakes Bosten, Selin Co, Nam Co, Qinghai, Dongting, Poyang, Taihu, Hongze, Hulun, Xingkai is 0.85, 0.96, 0.83, 0.94, 0.37, 0.84, 0.71, 0.71, 0.94, and 0.76, respectively. Furthermore, the different lake stages are shown with boundary changes delineated from available ETM+/TM data at the end of each year. The ICESat elevation is validated with in situ water level observed at station Duchang of Poyang Lake, and yields a high correlation coefficient of 0.87. The in situ lake level of Poyang Lake shows a decrease change from 2003-2009 due to increased evaporation and decreased precipitation along with increased temperature. In addition, the operation of Three Gorges Dam altered the water exchange between the Yangtze River and Poyang Lake and resulted in more water outflow from lake to river during the wet season. The lakes in the TP indicate an increase of water level owing to glaciers retreating around the lake basins of Selin Co, Nam Co and Qinghai Lake. The lakes in the arid and semi-arid area such as Hulun Lake and Bosten Lake show a decrease variations because negative balance between precipitation and evaporation under warmer climate. Finally, the water budget is estimated using lake level and area change with coincide date. These results provide some quantitative information of ten greatest lakes changes in China and methods that remotely sensed data can be used as a powerful tool to monitor lake changes.