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An evaluation of daily air temperature estimation on glacier surface in the Third Pole using MODIS LST data

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The Moderate Resolution Imaging Spectroradiometer (MODIS) land surface temperature (LST) data have been widely used for air temperature estimation in mountainous regions where the station measurements are sparse. The previous studies have mainly focused on the areas at the low elevations with meteorological station observations. However, the performance of MODIS LST on high-elevation glacierized areas was poorly known due to rough environment. In this study, we evaluated MODIS LST's application for daily air temperature estimation in glacierized areas based on ground measurements of four glaciers (Parlung Zangbo, Xiao Dongkemadi, Zhadang, Muztagh Ata) across the Tibetan Plateau (known as the Third Pole). The air temperature estimations from MODIS LST are also compared with the results from temperature lapse rate which has been applied extensively in mountainous basins. The comparisons between MODIS estimation and observed surface temperature indicate that MODIS nighttime LST with an average Root-Mean-Squared-Difference (RMSD) of 4.0 degrees Celsius, especially MODIS/Terra nighttime LST (mean RMSD of 3.3 degrees Celsius), is much more reliable than MODIS daytime LST data (mean RMSD of 8.0 degrees Celsius) on glacier surface. The large errors of MODIS daytime LST on glacier surface could be due to strong heterogeneity within pixels. The performances of MODIS nighttime LST on the estimations of daily mean (Tmean), minimum (Tmin) and maximum (Tmax) air temperatures with mean RMSDs of 3.3, 3.0 and 4.8 degrees Celsius respectively on glacier surface of the TP are all obviously better than those of MODIS daytime LST (mean RMSDs of 4.2, 4.7 and 5.7 degrees Celsius). For more accurate estimations of Tmean and Tmin in glacierized areas of the TP, MODIS nighttime LST (mean RMSDs of 3.8 and 3.5 degrees Celsius) can be a good alternative of temperature lapse rate (mean RMSDs of 5.4 and 5.0 degrees Celsius). This study provides the evaluation information for use of MODIS LST on glacier surface and can help alleviate the data-sparse problem of air temperature in glacierized areas of the Tibetan Plateau.