An approach to derive snow lines from MODIS data on the Tibetan Plateau, its analysis and climatic forcings

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The unique location of the Tibetan Plateau, the direct influence on the hydrological cycle and their apparent particular sensitivity to anthropogenic Global Change leave the glaciers on the Tibetan Plateau and the estimation of their future dynamic response to climate change as a challenging research field. However, within the remote areas of the Tibetan Plateau over large areas no measured glaciological as well as meteorological and hydrological data are available so that new methods on variations in energy and mass balance components of glaciers are necessary for a better understanding of atmosphere-cryosphere couplings. The shift of the equilibrium line altitude of a glacier can be used as an indication of mass balance variations. As a proxy for the equilibrium line altitude of the glaciers the end-of-summer snowline is used.

We investigate by means of remote sensing migration of the snow line in several mountain ranges distributed along an east west transect between the Nyainqentanglha Range in the east and the Gurla Mandhata mountain in the southwest of the Tibetan Plateau, including also the Purogangri Ice Cap on the central Plateau. This spatial range is chosen in order to account for varying influences of the monsoons and westerlies.

The snow line is derived from Moderate-resolution Imaging Spectroradiometer (MODIS) satellite imagery. We use datasets of the daily MODIS snow product and Level 1 data over a one-decade period to infer intra- and inter-annual snow altitude line variability and to derive regional equilibrium line altitudes according to an approach similar to [1]. The results are in good agreement with [2] and validated in detail by mapping snow lines within false colour visualizations of Landsat Satellite Thematic Mapper images with high spatial resolution. Further we investigate and present linking between snow line and the general atmospheric circulation.

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[1] Shea, J. M., Menounos, B., Moore, R. D., and Tennant, C.: An approach to derive regional snow lines and glacier mass change from MODIS imagery, western North America, The Cryosphere, 7, 667-680, doi:10.5194/tc-7-667-2013, 2013.
[2] Yao, T., Thompson, L., Yang, W., Yu, W., Gao, Y., Guo, X., Yang, X., Duan, K., Zhao, H., Xu, B., Pu, J., Lu, A., Xiang, Y., Kattel, D. B., and Joswiak, D.: Different glacier status with atmospheric circulations in Tibetan Plateau and surroundings, Nat. Clim. Change, 2, 663–667, 2012.

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