

## Estimating snowline altitudes across High Mountain Asia for melt modeling: challenges in using remote sensing

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Separating snow, exposed glacier ice and debris cover on glacier surfaces are needed for inferring glacier snowline altitudes (SLAs), which are used as input for melt models. When estimated at the end of the ablation season, SLAs are also indicators of stable-state glacier equilibrium line altitudes (ELAs) and their changes over time. Within the framework of the Contribution to High Asia Runoff from Ice and Snow (CHARIS) project, we use remote sensing methodology to partition snow and ice on glacierized surfaces and to estimate runoff components through accumulation and ablation processes in five major river basins in high Asia: Ganges, Brahmaputra, Indus, Amu Darya and Syr Darya.

Here we illustrate the use of Landsat 8 Operational Land Imager (OLI) at 30m spatial resolution and Thermal Infrared Sensor (TIRS) imagery (90m) combined with Shuttle Radar Topography Mission (SRTM) terrain information (30 m) to estimate basin-wide glacier SLAs at monthly time scales for selected basins in the Ganges and the Indus. Standardized semi-automated band ratio algorithms and thresholds are implemented in a multi-criteria decision tree using python for multi-temporal image processing. Challenges in using remote sensing data for monthly snowline mapping in rugged glacierized terrain include the presence of deep shadows, clouds and seasonal snow at various times of the year. We use manual corrections, field-based snowline measurements and high resolution imagery for smaller subset areas to validate our estimates and to test their applicability to larger regional scales. Ultimately, with further testing and refinements, the methodology proposed can be applied to estimate year-to-year changes/trends in regional ELAs across various climate regimes, to identify years of low and heavy snowfall, to better parameterize ice and snow melt models or to aid interpretation of field-based hydrochemistry data acquired in sub-basins of the CHARIS region.