EGU2020-5057
https://doi.org/10.5194/egusphere-egu2020-5057
EGU General Assembly 2020

Satellite remote sensing of ice cliff migration

Bas Altena and Andreas Kääb
University of Oslo, Geosciences, Oslo, Norway (bas.altena@geo.uio.no)

Ablation patterns on debris-covered glaciers are highly complex and spatially variable, while accessibility is complicated due to steep topography and loose surface debris material. One of the main ablation components on debris-covered glaciers is ice melt on steep ice cliffs and associated cliff migration. When using measurement techniques that operate in absolute coordinates, a main challenge is to separate cliff retreat from the underlying ice movement. In-situ measurements are spatially limited, while giving highly detailed understanding of processes occurring on individual ice cliffs. Drones can extent such detailed measurements to a whole glacier tongue, but are still limited to a few glaciers and measurement times. Here we show how measurements of cliff migration rates towards a regional scale are possible with spaceborne optical instruments. For this study we focus on the Mt. Everest region, specifically the Khumbu Glacier and other glaciers in the surrounding. We use Venμs, a French-Israeli multi-spectral satellite, that provides images at high temporal resolution (a two day repeat), and at high spatial resolution (5m), at this spatial resolution it provides sufficient detail to investigate individual ice cliffs.

Migration of ice cliffs can have a dominant direction, but their shape evolves over time, complicating pattern matching. Similar challenges occur for velocity extraction of the underlying glacier ice, where the shadow casted by ice cliffs is a dominant feature on glacier imagery, thus instead of debris patterns, the velocity estimates have ice cliff migration patterns within. Hence, in order to reduce the interference between both processes we reduce the influence of shadow within the imagery and extract bulk glacier ice velocity. While specific ice cliff features are isolated and tracked. Thus different image tracking techniques are deployed, in order to distinguish one displacement from the other.

The ice-cliff migration can be separated from the general glacier velocity, which results in a regional estimate of ice cliff back wasting, and thus a proxy for clean ice mass-balance of debris-covered glaciers from space. Venμs is a demonstrator satellite, with a limited lifetime and acquisition strategy, but our automatic methodology is generic and can be transferred to, for example, the 10m imagery from Sentinel-2, making regional analysis feasible.