



The potential of Sentinel-2 for investigating glaciers and related natural hazards

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Sentinel-2 (S2) features a number of characteristics that will improve mapping and monitoring of glaciers and related hazards, meaning the large swath width of 290km, the spatial resolution of 10-20m, and the repeat cycle of at least 10 days (higher towards the poles). In this study we perform a number of general tests on image radiometry and geometry as relevant to the glaciological image analysis. Based on commissioning-phase and ramp-up phase data, we find a geolocation accuracy of one pixel (at 10m) or better and co-registration accuracy between repeat scenes of around 1/3 pixel. Both error magnitudes are well acceptable for most glaciological applications. We also found patterns related to the mosaicking of the 12 detector sub-systems that form the full S2 swath. Also their magnitude will only matter in science-grade high-precision applications.

Cross-track offsets in orthorectified L1C data due to vertical errors in the DEM used have, however, to be observed. In particular at glacier tongues, DEMs will typically be outdated due to glacier shrinkage. For some examples in the Swiss Alps we found lateral offsets in S2 images of 30-40 m over such areas. For latitudes larger than 60 degree North (i.e. north of the SRTM coverage) we found geolocation bias patterns of the same order of magnitude all over the scenes, not only over glaciers. Geolocation biases in S2-derived products would for instance affect glacier outlines, especially when compared to other data such as Landsat, because of different orbit settings and use of other DEMs in the orthorectification process. This can be avoided to a large extent for glacier velocity measurements by relying on repeat data from the relative same orbit.

Through a number of case studies, we demonstrate and evaluate the capability of S2 for glaciological applications: Automatic multispectral glacier mapping based on S2 bands 4 (red) and 11 (SWIR) turns out to be very successful, among others due to the improved resolution compared to Landsat data. This improved resolution together with the high radiometric fidelity is also important for detecting and assessing glacier lakes and their changes over time. From S2 data it becomes possible to track velocities of smaller glaciers and even over seasonal scales, as we demonstrate for the European Alps, the Caucasus, New Zealand and Greenland. This opens up for the possibility of obtaining both summer and annual velocities from the same sensor.