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Remotely-sensed and field-based observations of glacier change in the Annapurna-Manaslu region, Nepal

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Himalayan glaciers have shrunk rapidly during the past twenty years. Understanding the factors controlling these losses is vital for forecasting changes in water resources, as the Himalaya houses the headwaters of major river systems, with densely populated catchments downstream. However, our knowledge of Himalayan glaciers is comparatively limited, due to their high-altitude, remote location. This is particularly the case in the Annapurna-Manaslu region, which has received relatively little scientific attention to date. Here, we present initial findings from remotely sensed data analysis, and our first field campaign in October 2016. Feature tracking of Band 8 Landsat imagery demonstrates that velocities in the region reach a maximum of 70-100 m a-1 , which is somewhat faster than those reported in the Khumbu region (e.g. Quincey et al 2009). A number of glaciers have substantial stagnant ice tongues, and most are flowing faster in the upper ablation zone than in the lower sections. The most rapidly flowing glaciers are located in the south-east of the Annapurna-Manaslu region and tend to also be the largest. Interestingly, initial observations suggest that the debris-covered ablation zones in the south-east are flowing more rapidly than the smaller, clean-ice glaciers in the north of the region. Comparison of velocities between 2000-2001 and 2014-2015 suggests deceleration on some glacier tongues. In October 2016, we conducted fieldwork on Annapurna South Glacier, located at the foot of Annapurna I. Here, we collected a number of datasets, with the aim of assessing the relationship between surface elevation change, ice velocities and debris cover. These included: i) installing ablation stakes in areas with varying debris cover; ii) quantifying debris characteristics, using Wolman counting and by measuring thickness; iii) surveying the glacier surface, using a differential GPS; iv) monitoring ice cliff melting, using Structure from Motion and; v) measuring surface and sub-surface temperatures, using i-buttons. Initial results demonstrate large spatial variability in debris characteristics and thickness, which in turn appears to substantially influence melt rates. The surface topography is highly uneven and a number of ice cliffs are present, where melt rates appear to be much higher than in surrounding areas. Interestingly, we observed very few surface melt ponds or surface melt water, which we suggest maybe be due to the basal topography and/or debris characteristics, and aim to further investigate this during our 2017 fieldwork.