Supplementary information

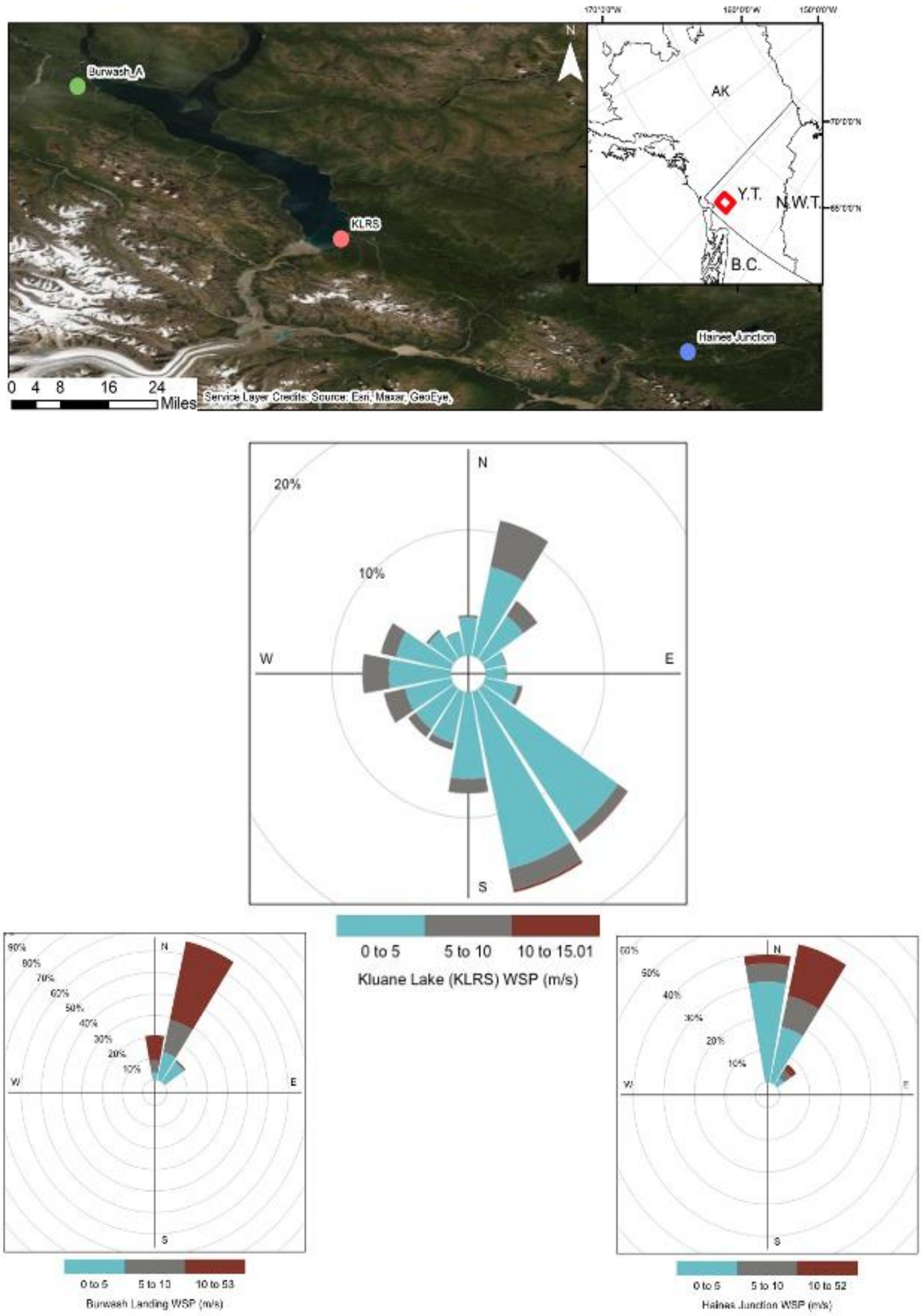

Figure S1. Winds roses from various valley locations for the whole of 2018. Lhù'ààn Mân has a much more complex wind regime than up (Burwash Landing) and down (Haines Junction) valley stations.

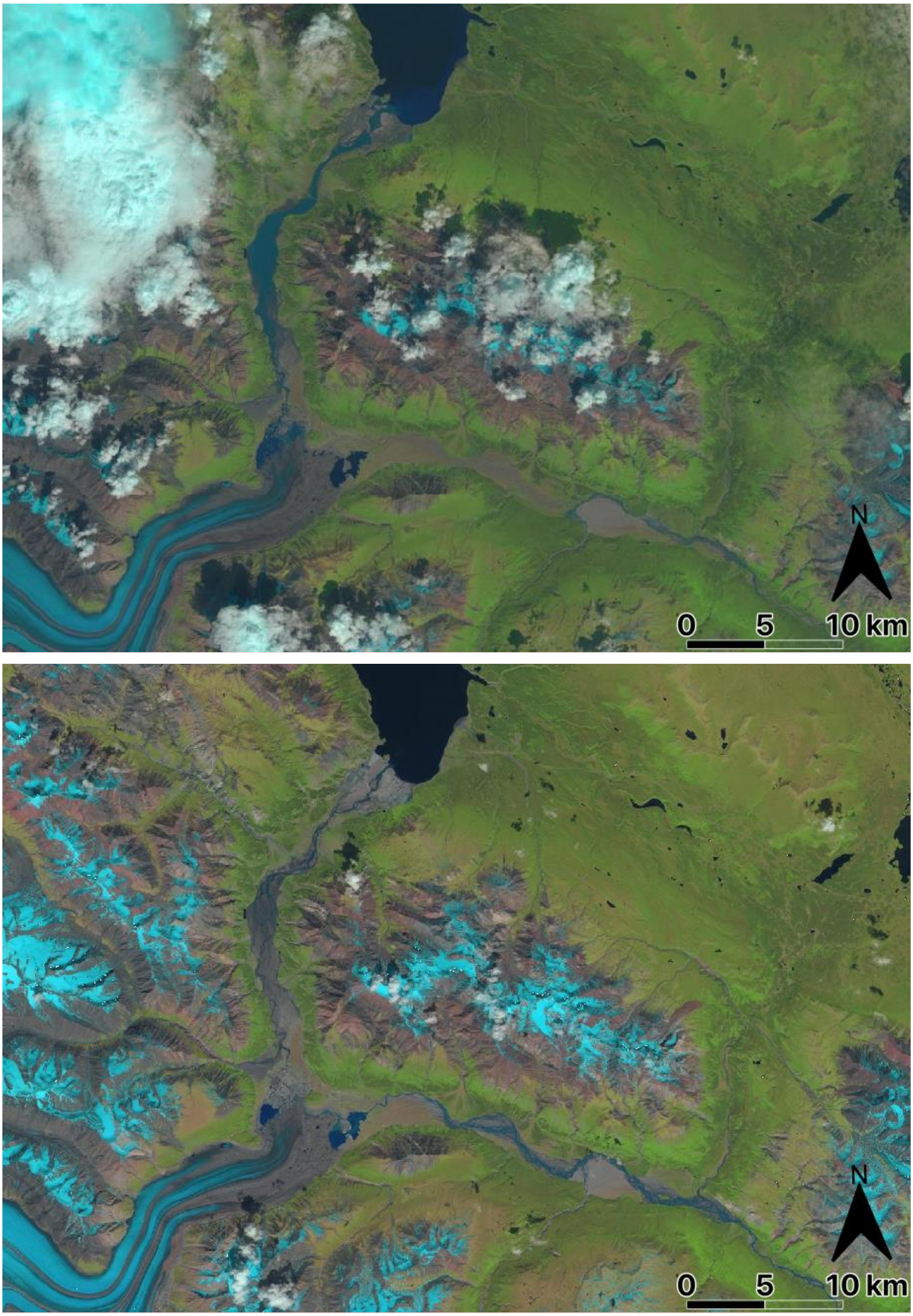

Figure S2. The changes in river flow after glacial retreat and subsequent diversion of the Á'áy Chù to the Kaskawulsh river. True colour Sentinel image on the left shows high flow in the northern flowing Á'áy Chù, and low flow in the estuary flowing Kaskawulsh river on 23/06/15. After the sudden draining of the

terminus lake in the spring of 2016 increased flow can be seen on the Kaskawulsh river on the image on the right, with reduced flow in the Á'áy Chù (taken on: 14/06/19).

S3. Implications of using Level 1.0 AERONET data

Precipitation is a good indicator of cloudiness and the size of water droplets in the cloud affect AOD. Figure S4 details monthly rainfall in 2018 at KLRS. Because of the peaks in precipitation and therefore cloudiness, peak months have an increased uncertainty in their AOD.

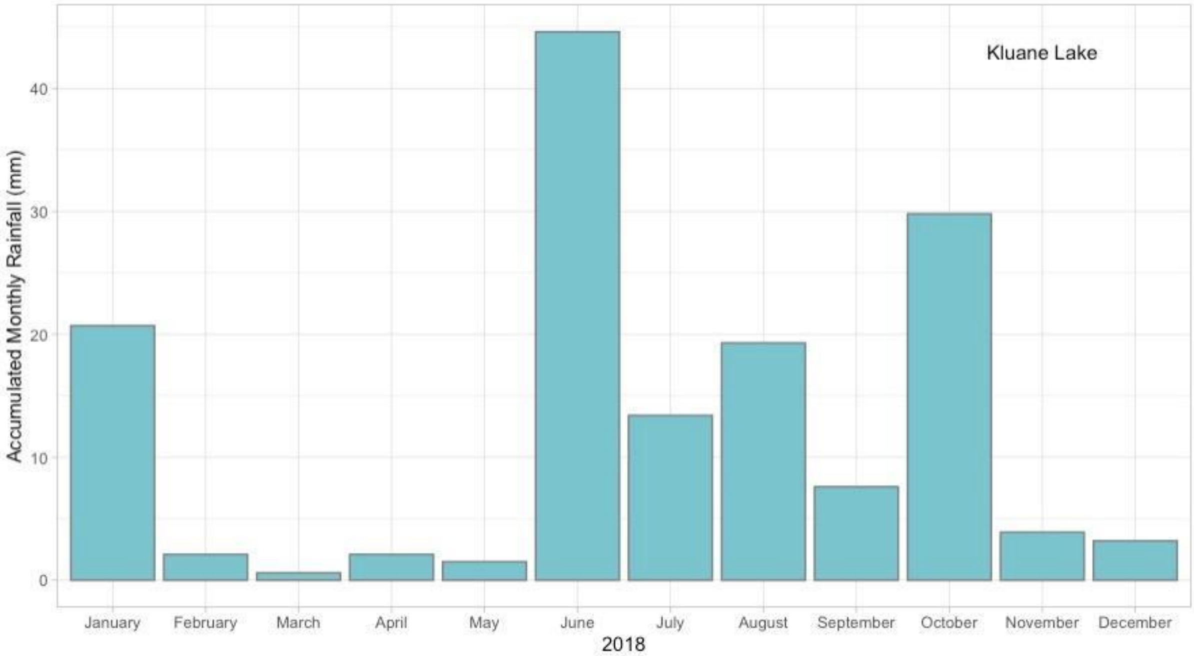

Figure S3. Monthly accumulated rainfall at KLRS in 2018.

S4. Linking DEDs to sources of dust

The high resolution of PlanetScope imagery (~3 m) provides great insight into the geomorphology of the delta, the detail of which allowed classifying sediment type extending beyond existing geomorphological classifications. If the geomorphology of the delta were mapped following the methods of Bullard et al. (2011) the whole study site would be low relief alluvial which is unarmoured and incised, but the high detail of PlanetScope imagery allows such fine scale sediment differences to be mapped. Figure S4 displays the geomorphology of the Á'áy Chù delta on the 24th May 2018, where multiple types of sediment can be identified. The high-water table is evidenced by the sporadic resurgence of stationary water. The PlanetScope imagery was combined with the oblique camera images to map the origin location of the dust plumes to identify areas where dust is seen to be actively entrained. Identifying dust origins is enhanced by a slight lag of one second between the NIR scan and the RGB PlanetScope scan; when the red and NIR bands are removed, dust is captured in motion at the site. These clear sky-differenced images, alongside the RGB images were then used to locate the origins of the dust plumes in the delta. When the geomorphological map (Figure S4) and dust plume origin map (Figure S4) are combined, the emissive areas and sediment type are established. The highest density of plume origins is located on the southern bank of the river in the medium and light sediment, close to areas of damp sediment. On the northern bank of the river sediment plume origins tend to be close to areas near standing water. Plume origins only occur in the central half of the delta. Strong katabatic winds are topographically channelled down the valley and provide the kinetic energy for MA to be entrained. Before the delta, the valley narrows (Figure S2) channelising the airflow and leaving the area exposed to the strongest of winds to be spatially restricted around the river, and the majority of dust plumes originate in this area.

Sediment in the Á'áy Chù delta is no longer being replenished by the yearly meltwater flooding of the delta due to the river diversion in 2016. This has dramatically changed the dynamics of MA emission at the site, and surface geomorphology gives a good indication into what surfaces are good emitters. Many of the emissive surfaces identified are located close to damp, dark-toned sediment or standing water bodies. These recently dried out sediments are newly available for entrainment. The recently dried sediment is eroded at a higher rate due to sediment around it that has already been deflated by winds which were unable to entrain the wet sediment. The majority of sediment is entrained from the darkest of surfaces. The darkness of the sediment can be used as a proxy for its moisture content (Mockford et al., 2018). The darker, wetter sediment is constantly being dried out by the wind, making sediment available for entertainment. This supports previous work from the site that confirms that the soil moisture is one of the main controlling factors on MA emission at the site (Nickling, 1978) and emphasises the need for high resolution work to be able predict emissions from the location.

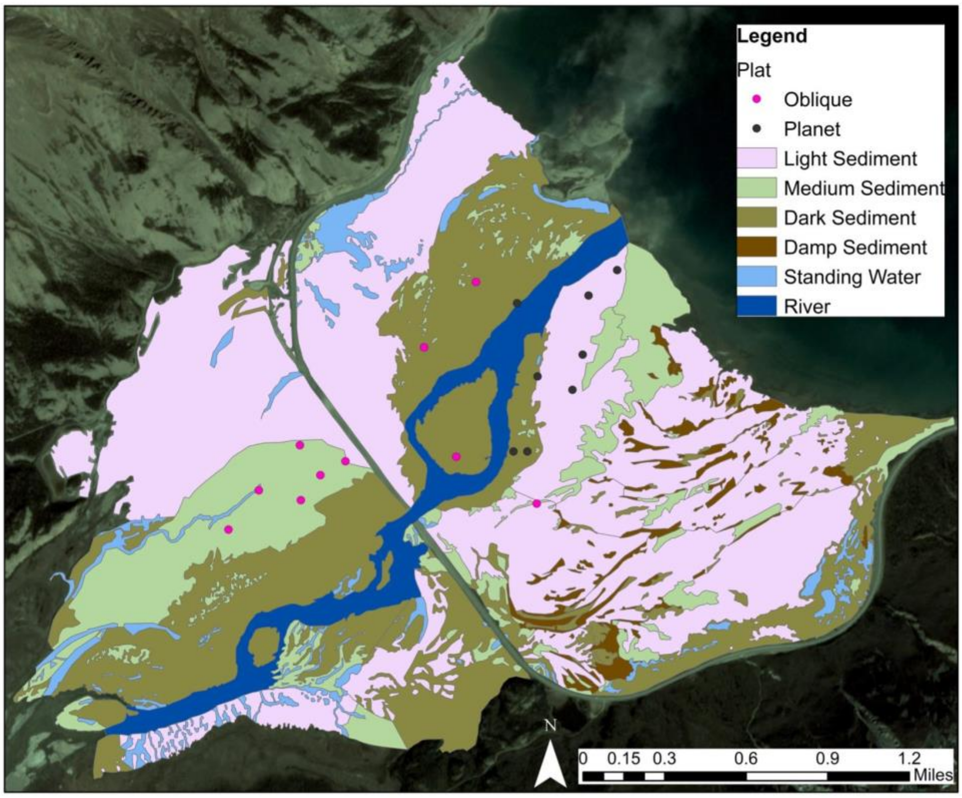

Figure S4 Distribution of different surface conditions on the Á'áy Chù delta on the 24th May 2018 and origins of dust plume on the delta. Geomorphological mapping is based on PlanetScope imagery for the day as well as the oblique camera images. Base imagery is from Planet imagery in June 2018.

Bibliography

Bullard, J. E., Harrison, S. P., Baddock, M. C., Drake, N., Gill, T. E., McTainsh, G., and Sun, Y.: Preferential dust sources: A geomorphological classification designed for use in global dust-cycle models, J. Geophys. Res. Earth Surf., 116, https://doi.org/10.1029/2011JF002061, 2011.

Mockford, T., Bullard, J. E., and Thorsteinsson, T.: The dynamic effects of sediment availability on the relationship between wind speed and dust concentration, Earth Surf. Process. Landforms, 43, 2484–2492, https://doi.org/10.1002/esp.4407, 2018.

Nickling, W. G.: Eolian Sediment Transport During Dust Storms: Slims River Valley, Yukon Territory., Can J Earth Sci, 15, 1069–1084, https://doi.org/10.1139/e78-114, 1978.