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Insights into the seasonal dynamics of the lake-terminating glacier Fjallsjökull, south-east Iceland, inferred using ultra-high resolution repeat UAV imagery

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Proglacial lakes are becoming ubiquitous at the termini of many glaciers worldwide, leading to increased glacier mass loss and terminus retreat due to the influence such lakes are having upon ice dynamics. However, despite the highly dynamic nature and relative insensitivity to climate of many lake-terminating glaciers, an understanding of the key processes forcing their behaviour is lacking. As a result, it is difficult at present to accurately assess and predict the future response of these glaciers to continued warming. In addition, current methods of investigating lake-terminating glacier dynamics primarily involve the use of satellite remote sensing, which despite its clear importance in cryospheric studies does suffer from important limitations. A novel alternative is the use of repeat unmanned aerial vehicle (UAV) imagery, which can provide high resolution (cm-scale) imagery of the ice surface at varying spatial and temporal scales, depending on the needs of the researcher. As a result, this study utilised ultra-high resolution repeat UAV imagery to provide insights into the changing dynamics of Fjallsjökull, a lake-terminating glacier in southeast Iceland, over two periods during the 2019 summer melt season. The findings indicate that the overall dynamics of the glacier are controlled by the ~120 m deep subglacial channel under the study region, which is causing the glacier to flow faster as it enters deeper water, leading to increased ice acceleration, thinning and retreat. Such a correspondence between ice velocity and surface thinning suggests the implementation of the positive feedback mechanism “dynamic thinning” in this region of Fjallsjökull, with such heightened rates of surface thinning and frontal retreat continuing in future until the glacier recedes out of the subglacial channel into shallower water. Within this overall pattern, however, more localised, short-term changes in glacier dynamics are also observed which are likely to be forced primarily by subaqueous melting at the waterline, rather than being solely influenced by the basal topography. Although further work is required to add additional support to these findings, they clearly indicate the complex nature of the calving process and the dynamics of calving glaciers in general, highlighting the need for continued monitoring of lake-terminating glaciers at varying spatial and temporal scales.