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Supplementary Material for

Inferring forms of glacier slip laws from estimates of ice-bed separation during glacier slip

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Introduction

Here we provide various figures that complement the main text. The figures show how slip-law form changes with different ice-flow directions (Fig. S1), an evaluation of the effects of different tapers on the slip-law forms (Fig. S2), a comparison of the different tapering methods on a DEM subsection (Fig. S3), a comparison between the Lliboutry and Kamb estimated slip laws (Fig. S4), photos from the Castleguard and Tsanfleuron proglacial areas (Fig. S5), and how domain size effects the slip-law forms (Fig. S6)

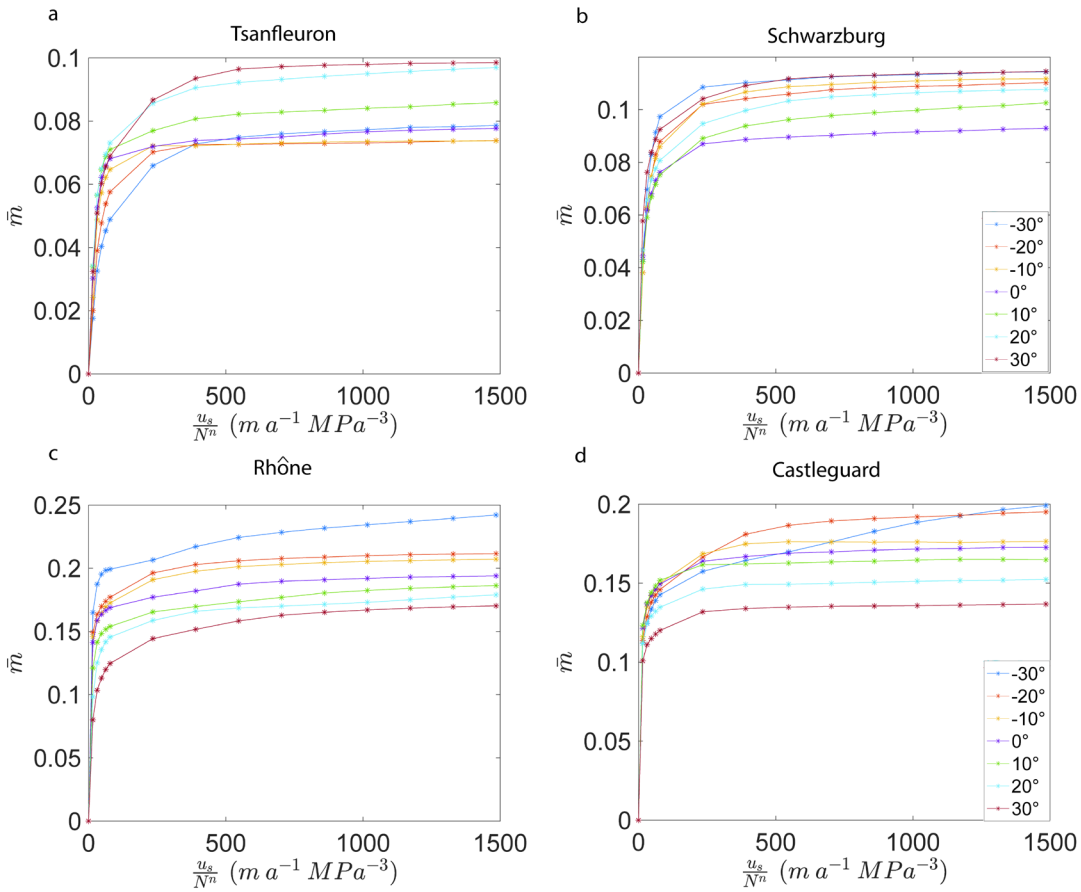

Fig. S1. Inferred slip-law forms centered from a single DEM section rotated in the counterclockwise (positive values) and clockwise (negative values) directions away from the most recent mean ice flow direction indicated by striations. Plots illustrate the insensitivity of slip-law form to this range of ice-flow direction.

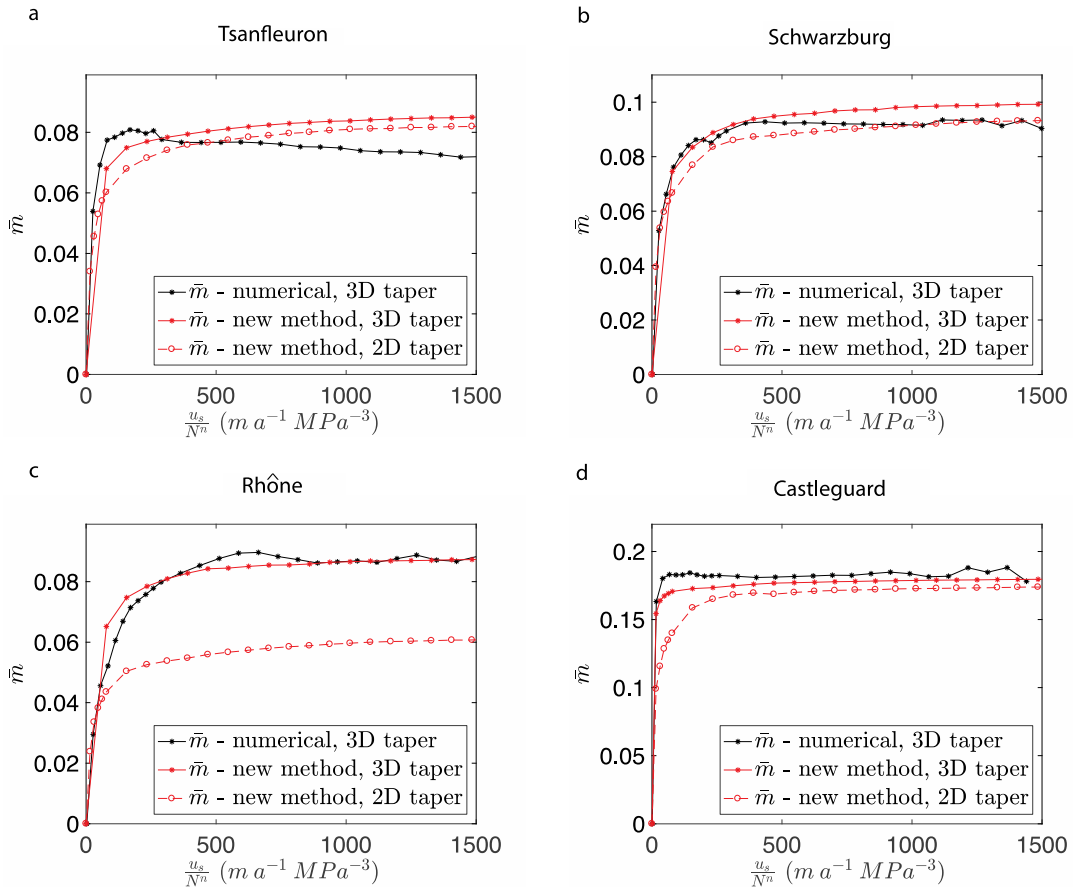

Fig. S2. Estimated average bed slope in contact with the ice, $\bar{m}$, as a function of scaled slip velocity from the full-Stokes modeling of basal cavities with the taper described in Helanow and others (2021) (numerical, 3D taper), the new method used herein for estimating cavity geometry with the taper described in Helanow and others (2021) (new method, 3D taper), and the new method with the Tukey cosine taper described in Text S1 (new method, 2D taper). The 'new method, 3D taper' plots are the same as the red lines in Fig. 5, whereas the 'new method, 2D taper' is the method used in Fig. 6. Results are for morphologically representative subsections of the (a) Tsanfleuron, (b) Schwarzburg, (c) Rhône, and (d) Castleguard proglacial areas. Note that although the magnitudes of $\bar{m}$ at Rhône estimated using the 2D taper method are small compared to that of the other two methods, the slip-law forms are similar. As we are concerned with only the form of the slip law, we find the 2D taper acceptable. The difference in $\bar{m}$ magnitudes for Rhône is

due to two prominent bumps near the up-glacier side of the DEM whose shape and amplitude change depending on the taper applied (Fig. S3).

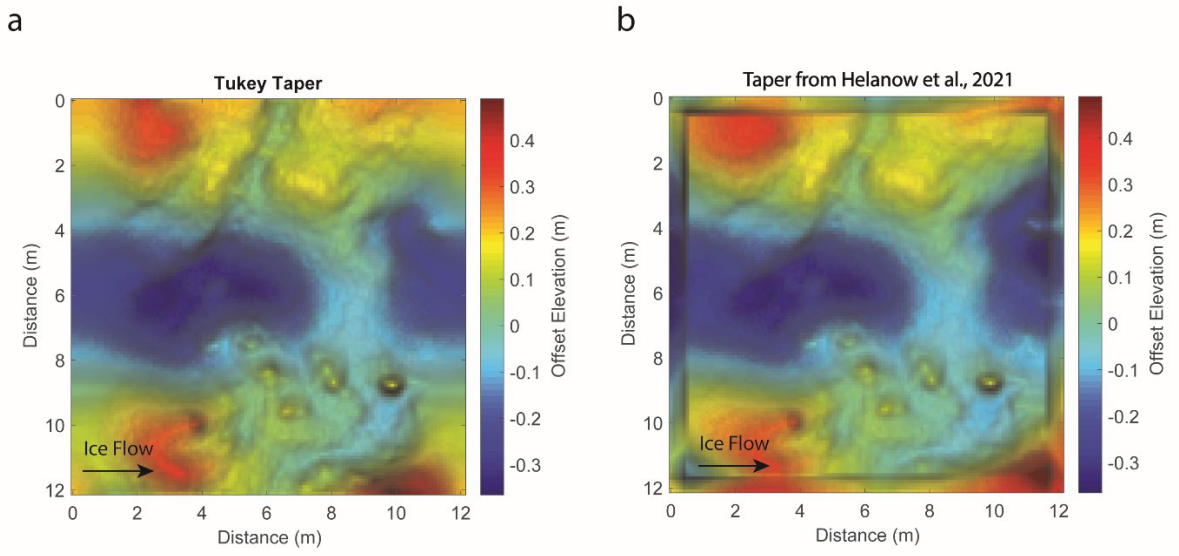

Fig. S3. Shaded relief maps of a) the Tukey taper used in this study and b) the taper implemented by Helanow and others (2021) applied to a morphologically representative subsection of the Rhône DEM.

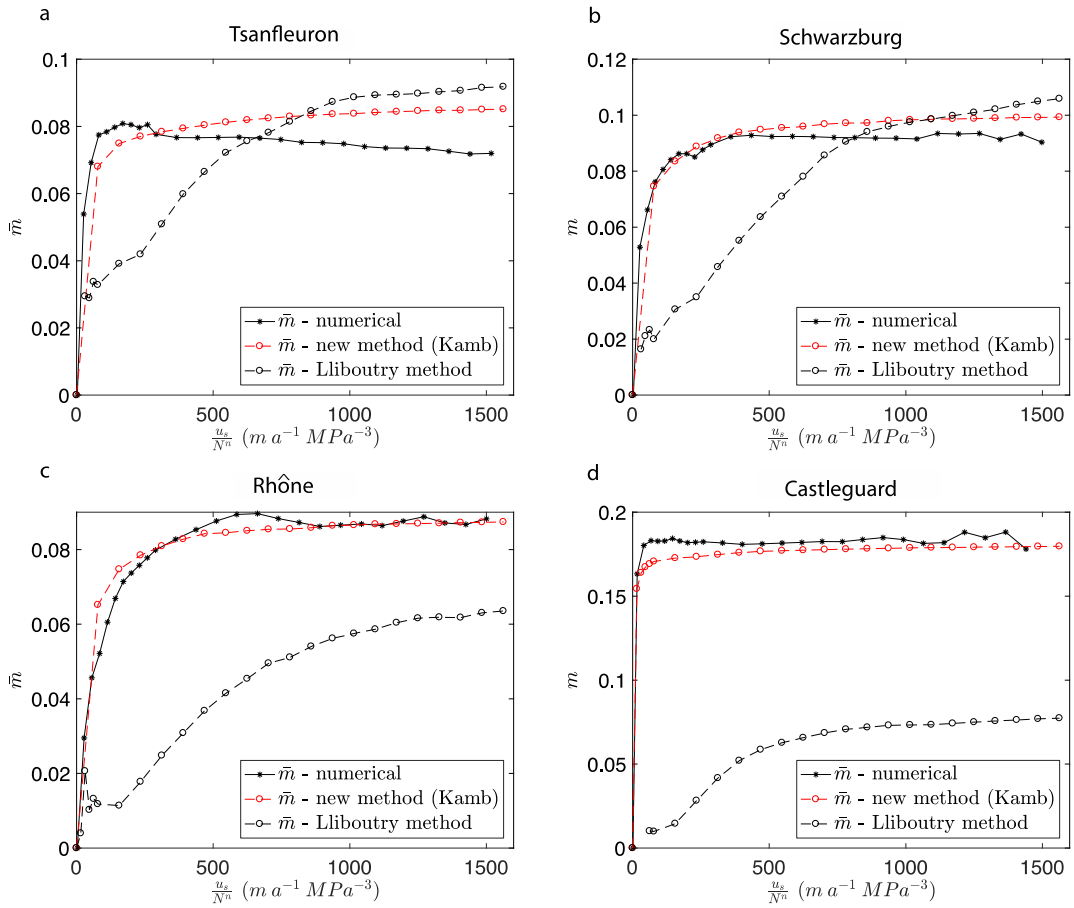

Fig. S4. Average bed slope in contact with the ice estimated using the numerical model (Helanow and others, 2021), Lliboutry's analytical model (Lliboutry, 1979), and the method herein that relies on Kamb's analytical model (Kamb, 1987). All models were run on the same DEM section with the same taper used by Helanow and others (2021). Results are for morphologically representative subsections of the (a) Tsanfleuron, (b) Schwarzburg, (c) Rhône, and (d) Castleguard proglacial areas.

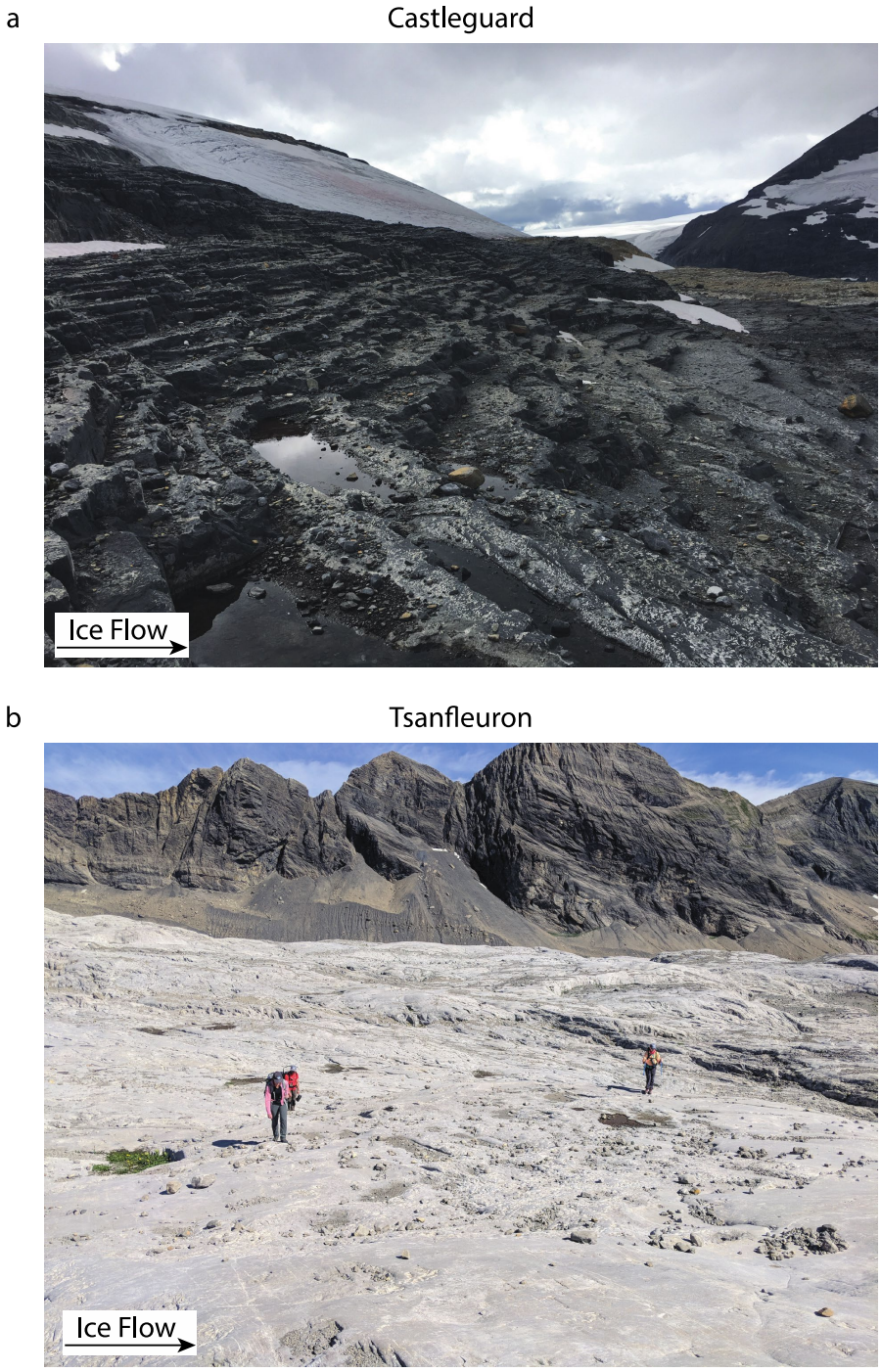

Fig. S5. Photos from the (a) Castleguard and (b) Tsanfleuron proglacial areas.

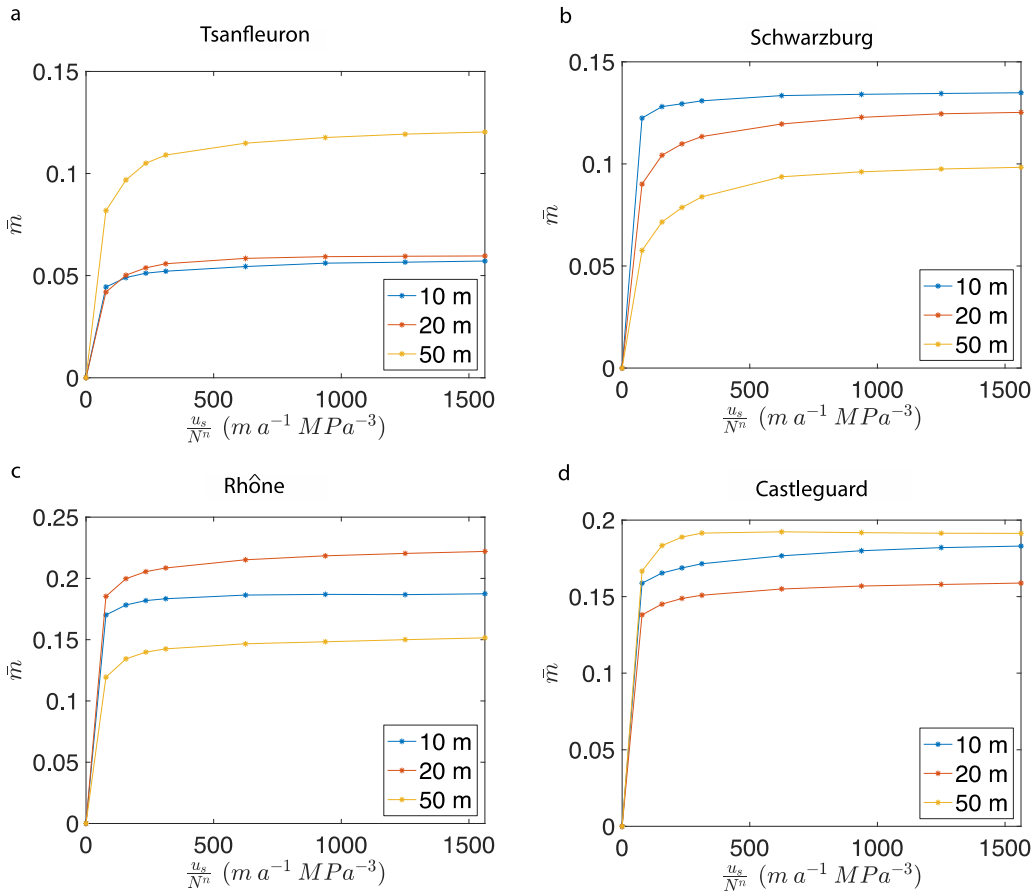

Fig. S6. Inferred slip-law forms centered on the same section of the DEM with variable domain sizes. Note that although the magnitudes of $\bar{m}$ are variable with domain size, the slip-law forms are similar.

References

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