Supplementary material:
Massive permafrost rock slide under warming polythermal glacier (Bliggspitze, Austria)

Felix Pfluger et al. 2024

1 Figures

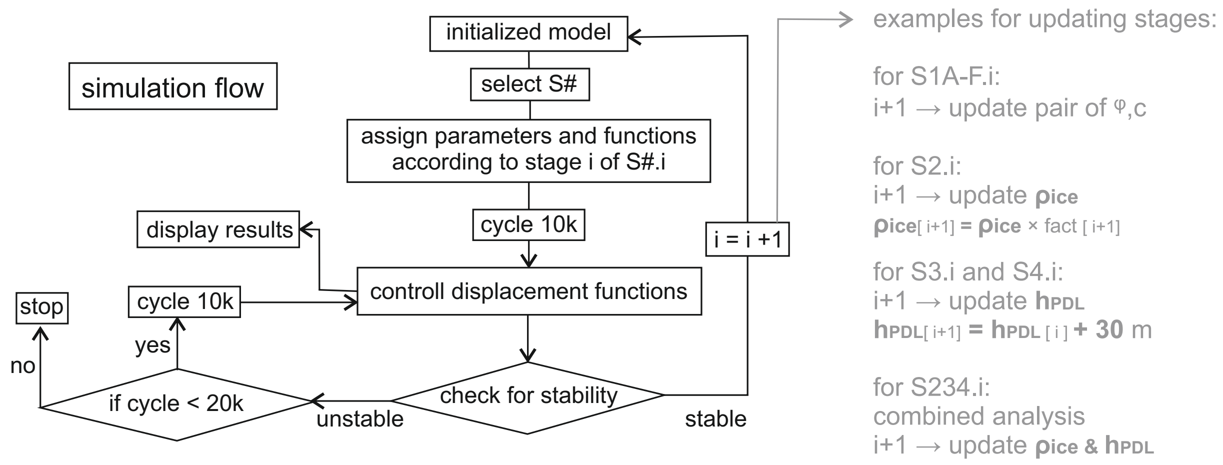

Figure S1. Flow chart for the simulation of stages according to the defined scenarios using the UDEC modeling framework.

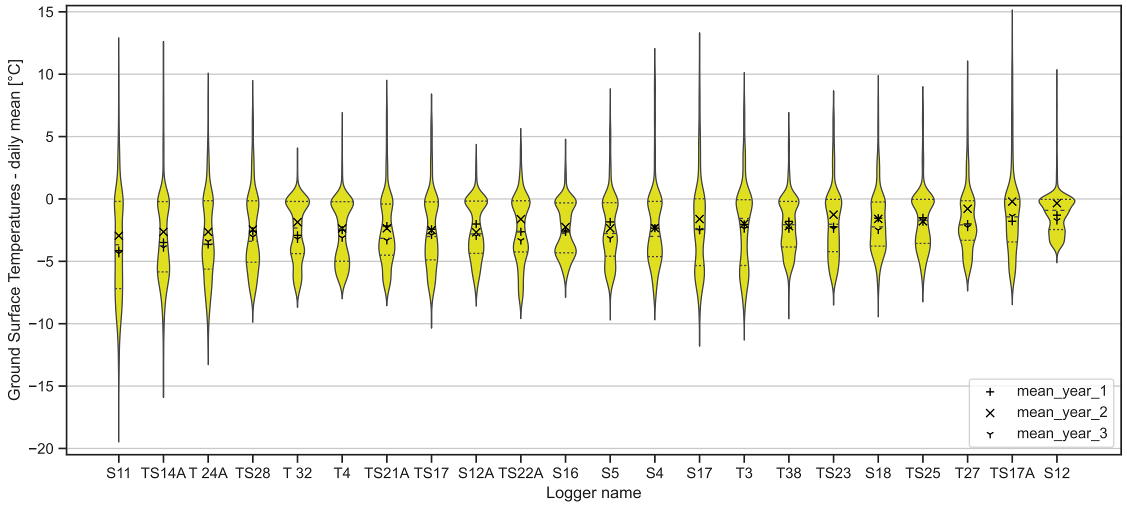

Figure S2. Violinshaped boxplots presenting distribution of mean daily GST values over full measurement interval from Sep-02-2013 to Aug-31-2013 for the 22 GST logger positions.

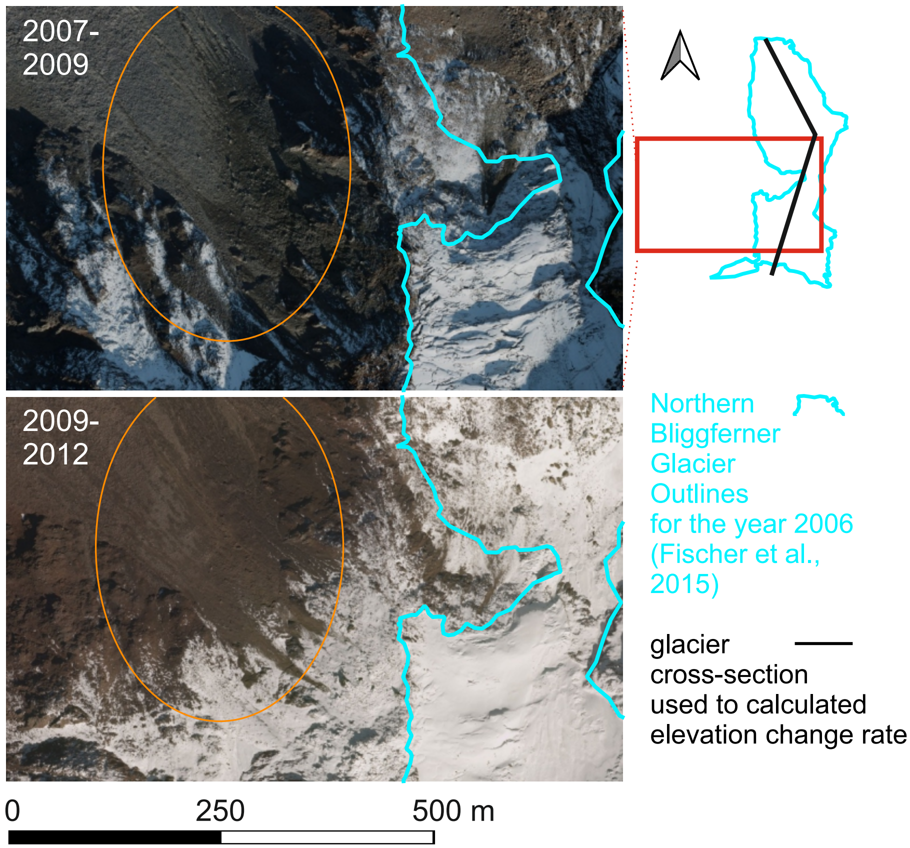

Figure S3. Wet areas in the west-facing slope below the Northern Bliggferner Glacier indicate ongoing debris flow activity in the years after 2007. Orthophotos provided by Land Tirol - data.tirol.gv.at.

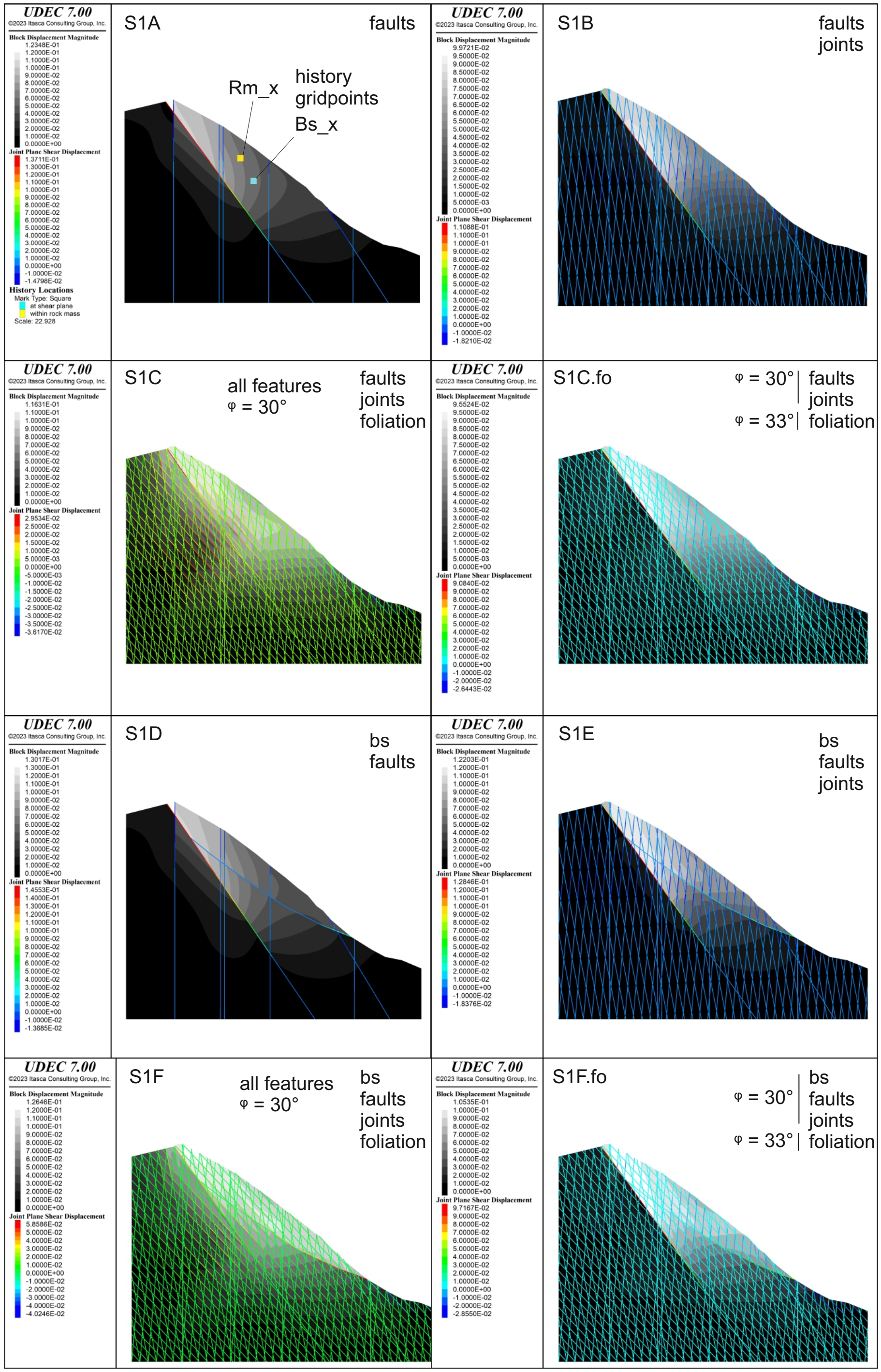

Figure S4. Scenario S1 as simulated with UDEC: State at the end of cycling for models with varying structural features A-F. Elastic blocks are parameterized according to Figure 3c. Shear parameters are kept constant at ($\phi = 30°, c = 0.1 MPa$) for every model run. For S1C.fo, S1F.fo we assigned $\delta\phi = +3°$ to foliation only, while other discontinuities kept the determined parameters.

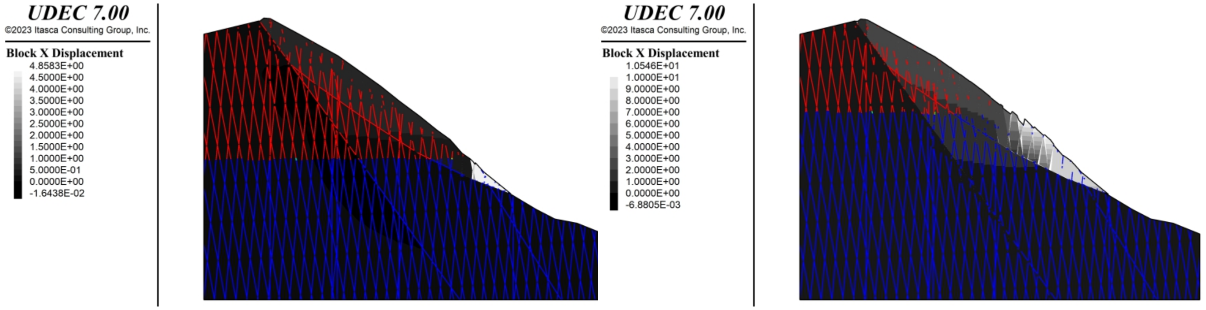

Figure S5. X-displacement of full model domain after cycling of two stages of the scenario S4. The elevation of the PDL (left image= 2900 $masl$, right=3000 $masl$) defines the peak ground water table (transition between red and blue discontinuities and delineated by the slope topography). Hydrostatic water pressure is applied to the blue coloured discontuinities according to the respective depth below water table. Parameter were assigned according to Figure 3c.

2 Tables

Table S1. Characterization of the rock mass by using the Geological Strength Index - parametrization (1). Intact rock properties (2) are tested in the laboratory. The material properties representing the rock mass (3) are derived from (1 & 2) to be subsequently assigned to the linear elastic blocks within the UDEC model. Specification for deriving parameters: 'estimated' values are derived from categorical relations or from given graphs. 'calculated' values are calculated according to the suggested formula.

Parameter	abbrev.	value	unit	source
(1) Geological Strength Index	GSI	35	-	estimated according to Hoek and Brown (2019)
Material constant intact rock	m_i	7	-	estimated acc. to Marinos and Hoek (2000)
Disturbance factor	D	0	-	acc. to Hoek and Brown (2019)
Material constants rock mass (m_b,s,a)	m_b	0.6869	-	calculated acc. to Hoek et al. (2002)
	s	0.0007	-	calc. acc. to Hoek et al. (2002)
	a	0.5159	-	calc. acc. to Hoek et al. (2002)
(2) Uniaxial Compressiv Strength	UCS	101	MPa	UCS test**, unfrozen, $\bar{x}, n = 5$
Young's modulous intact rock	E_i	39	GPa	UCS test**, unfrozen, $\bar{x}, n = 5$
(3) Young' modulous rock mass	E_{rm}	4.3	GPa	calc. acc. to Hoek et al. (2002)
Poisson ratio rock mass	ν_{rm}	0.38	-	estimated acc. to Vásárhelyi(2009)
Compressive modulous rock mass	K_{rm}	5.886*	GPa	calc. acc. to $K_{rm} = \frac{E_{rm}}{3(1-2\,\nu_{rm})}$
Shear modulous rock mass	G_{rm}	1.536*	GPa	calc. acc. to $G_{rm} = \frac{E_{rm}}{2(1+\nu_{rm})}$

*These values were rounded to $K_{rm} = 6\ GPa$ and $G_{rm} = 1.5\ GPa$ and assigned to the blocks for all UDEC simulations.

** UCS tests conducted according to recommendations of Mutschler (2004) under constant strain.

References

Hoek, E. and Brown, E. T.: The Hoek–Brown failure criterion and GSI – 2018 edition, Journal of Rock Mechanics and Geotechnical Engineering, 11, 445–463, https://doi.org/10.1016/j.jrmge.2018.08.001, 2019.

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Mutschler, T.: Neufassung der Empfehlung Nr. 1 des Arbeitskreises "Versuchstechnik Fels" der Deutschen Gesellschaft für Geotechnik e. V.: Einaxiale Druckversuche an zylindrischen Gesteinsprüfkörpern, Bautechnik, 81, 825–834, https://doi.org/10.1002/bate.200490194, 2004.

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