Supplementary Material
Modeling the evolution of the Juneau Icefield using the Parallel Ice Sheet Model (PISM)

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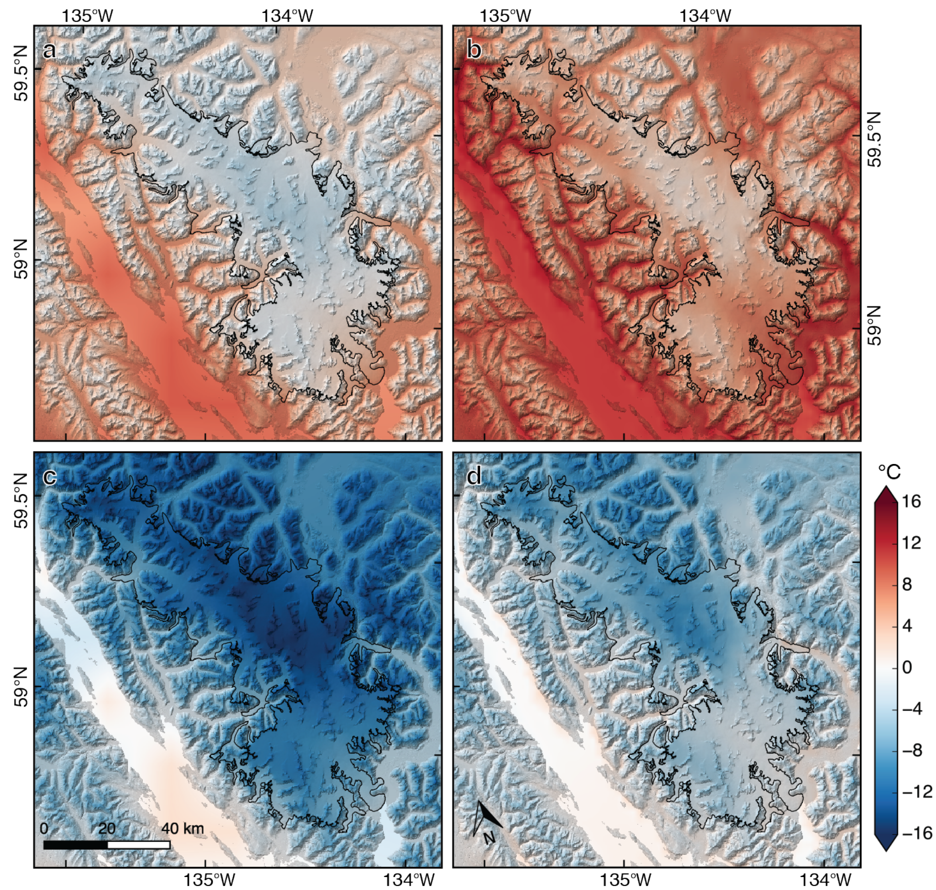

Figure S 1: Summer (April to September) and winter (October to March) 2 m air temperatures from WRF (a,c) and SNAP (b,d). Temperatures are averaged over 1971–2000, interpolated to the 300 m model grid, and adjusted to the SRTM topography using a lapse rate of $-5\,\mathrm{K\,km^{-1}}$, as in the experiments. The original resolution is 20 km for WRF and 2 km for SNAP. Especially at higher altitudes, WRF shows substantially lower temperatures than SNAP in both seasons. Black outline shows the present-day ice extent of the Juneau Icefield.

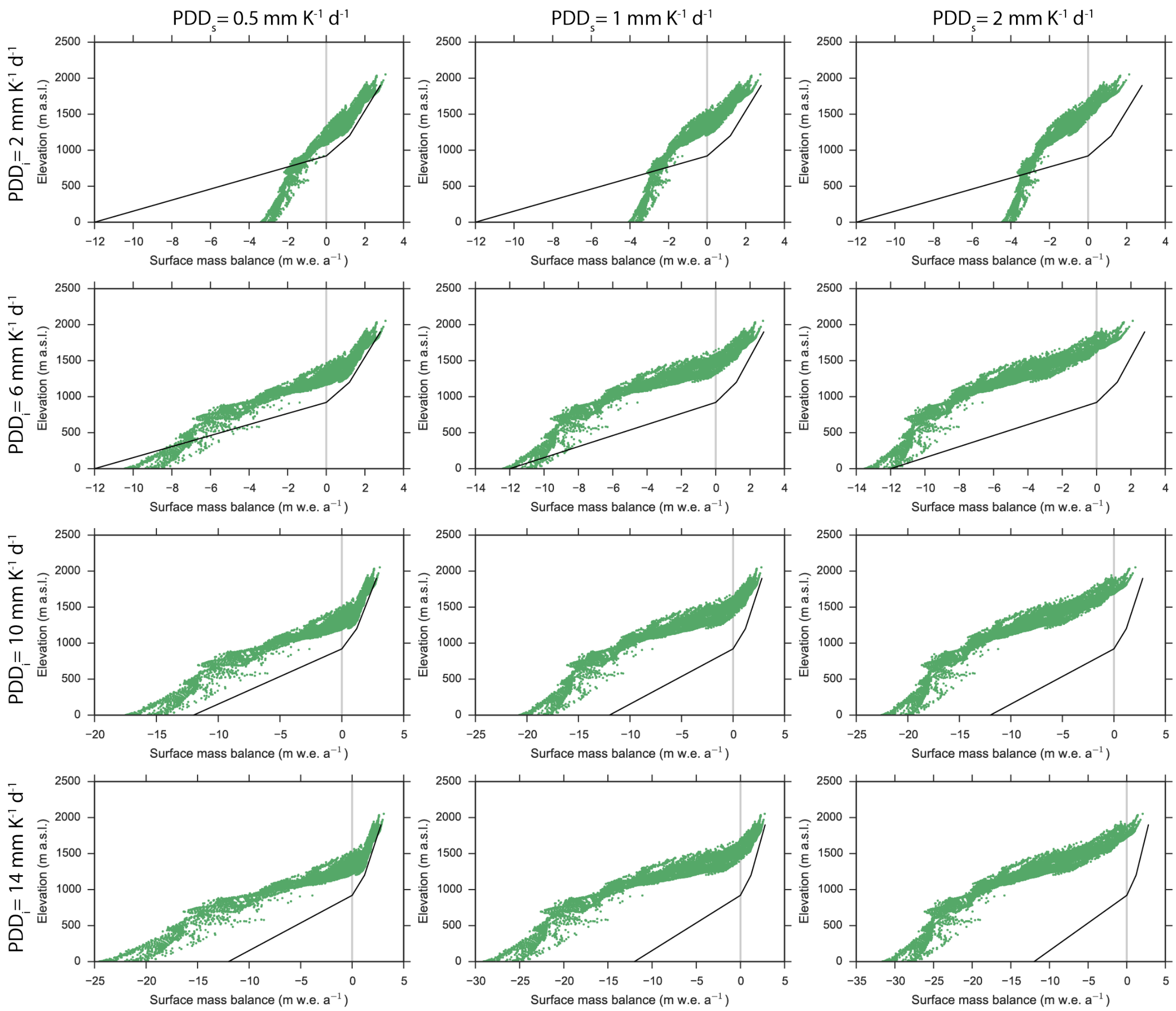

Figure S2 (a): Surface mass balance vs. surface elevation for Taku Glacier using the SNAP climate data set. The black line indicates the average profile derived from measurements between 1946 and 1986 (Pelto and Miller, 1990). Dots mark modeled surface balances of all Taku Glacier grid cells averaged over the period 1971–2000. We tested various PDD factors for snow ($\mathsf{PDD_s}$, columns) and ice ($\mathsf{PDD_i}$, rows). Even with a very wide range of PDD factors, no agreement could be achieved.

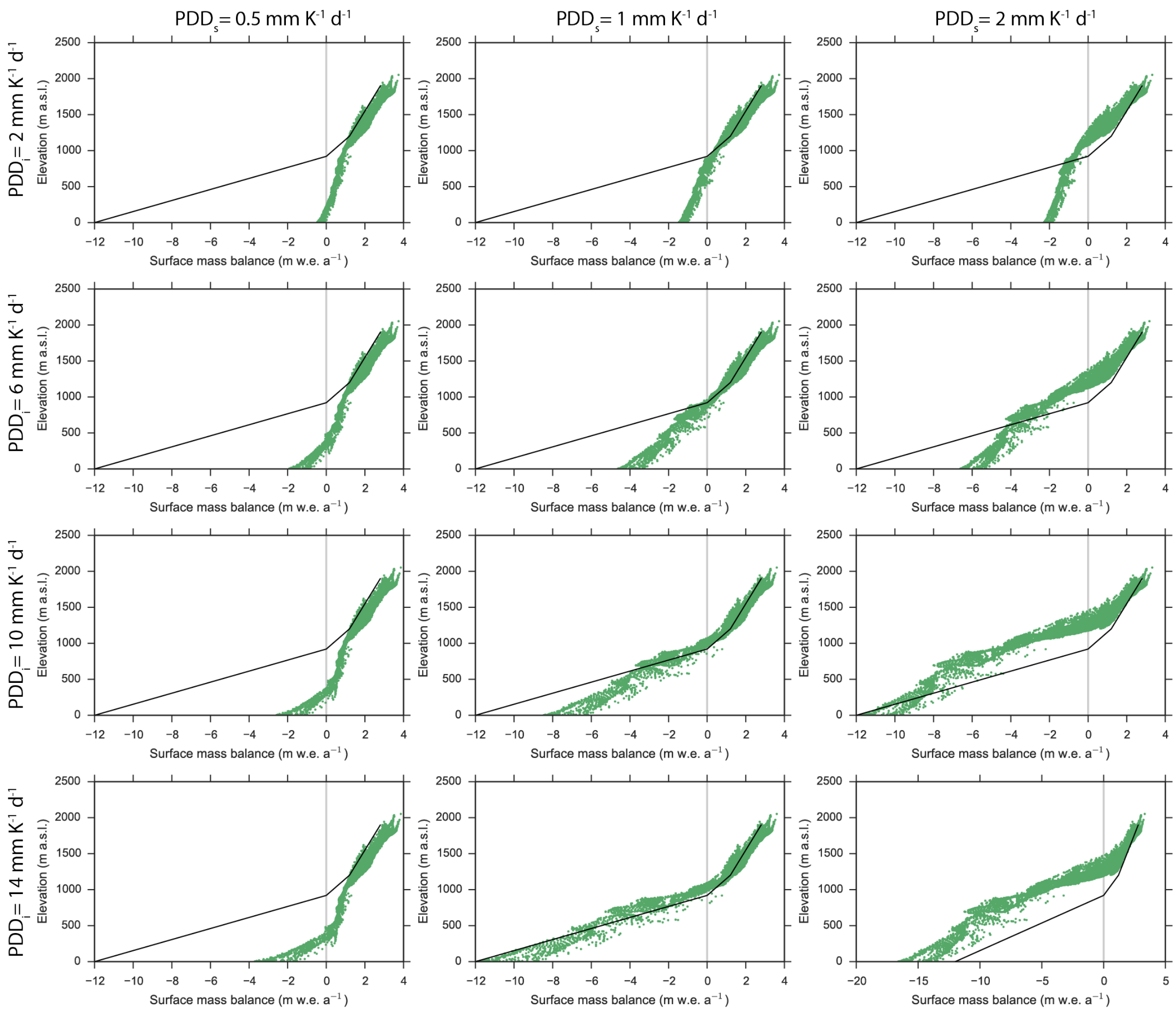

Figure S 2 (b): Surface mass balance vs. surface elevation for Taku Glacier. The model is forced with the SNAP data but temperatures are decreased by 2.5 K. See Figure S 2 (a) for further details. Reasonable agreement between model and observations could only be achieved with unrealistic PDD factors ($\mathsf{PDD}_\mathsf{s} = 1\,\mathrm{mm\,K^{-1}\,d^{-1}}$, $\mathsf{PDD}_\mathsf{i} = 14\,\mathrm{mm\,K^{-1}\,d^{-1}}$).

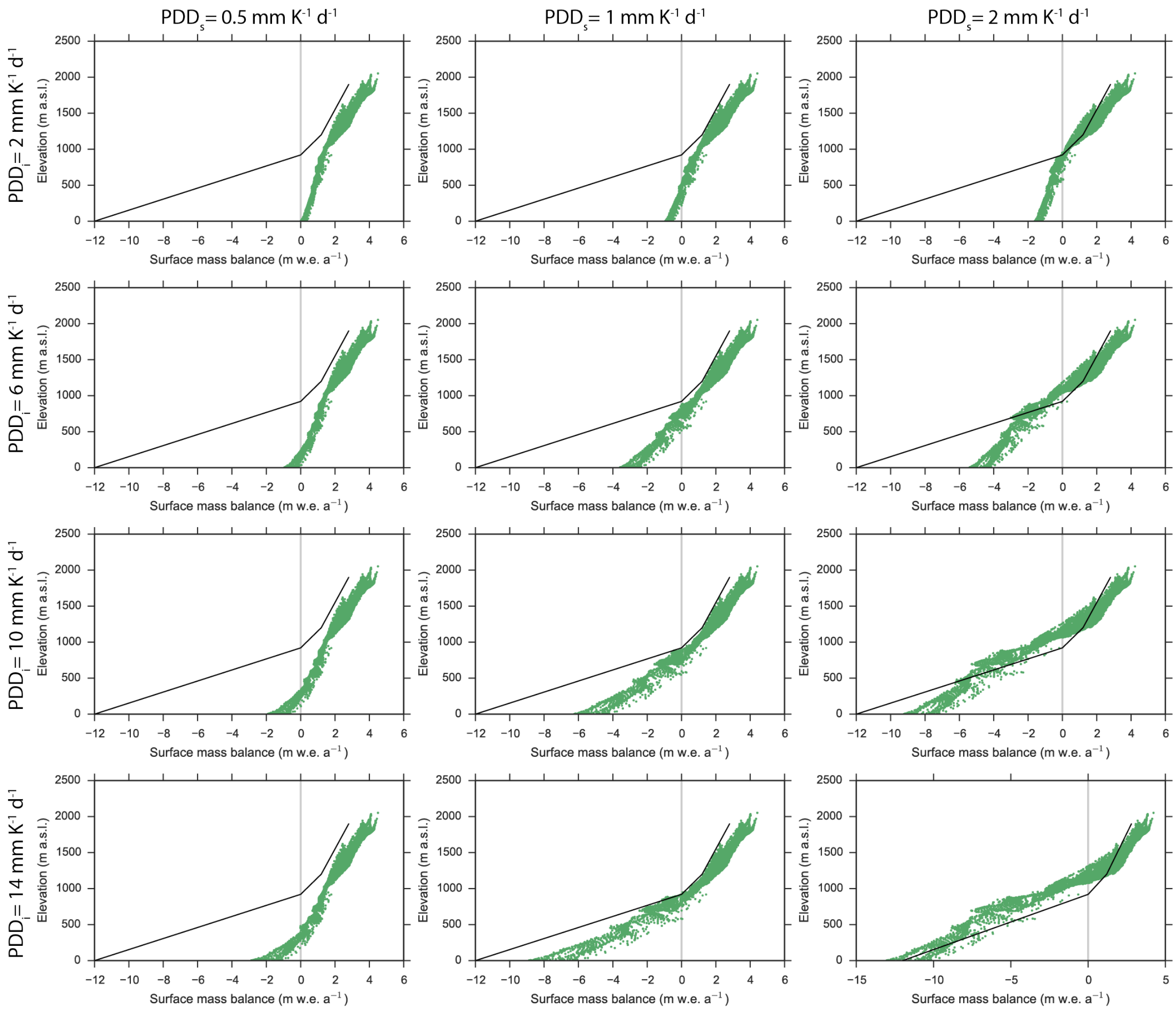

Figure S 2 (c): Surface mass balance vs. surface elevation for Taku Glacier. The model is forced with the SNAP data but temperatures are decreased by 5 K. See Figure S 2 (a) for further details. Reasonable agreement between model and observations could only be achieved with unrealistic PDD factors ($\mathrm{PDD_s} = 2\mathrm{mm\,K^{-1}\,d^{-1}}$, $\mathrm{PDD_i} = 14\,\mathrm{mm\,K^{-1}\,d^{-1}}$).

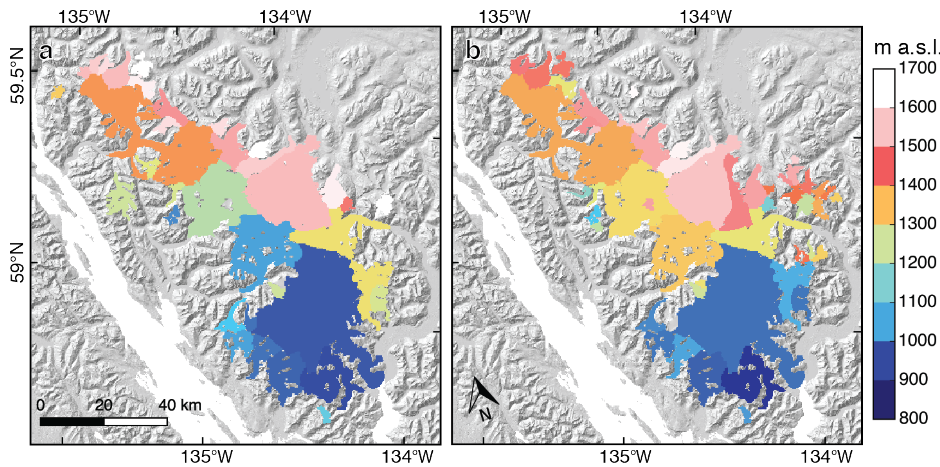

Figure S 3: (a) Modeled (reference run `REF`) and (b) observed median ELAs for individual glaciers of the Juneau Icefield. Modeled ELAs refer to years 1990–2019; observed ELAs span the period 1996–2014 and are only calculated for glaciers with at least 5 years of data. The time window for the model data is chosen as 30 year time window centered on the observation period. For each year the highest observed ELA in August or September was used. See Section 4.3 and Appendix A of the main text for details of the observations. The model is able to capture the basic spatial pattern with higher ELAs on the east side than on the west side, and lowest values in the region of Taku Glacier.

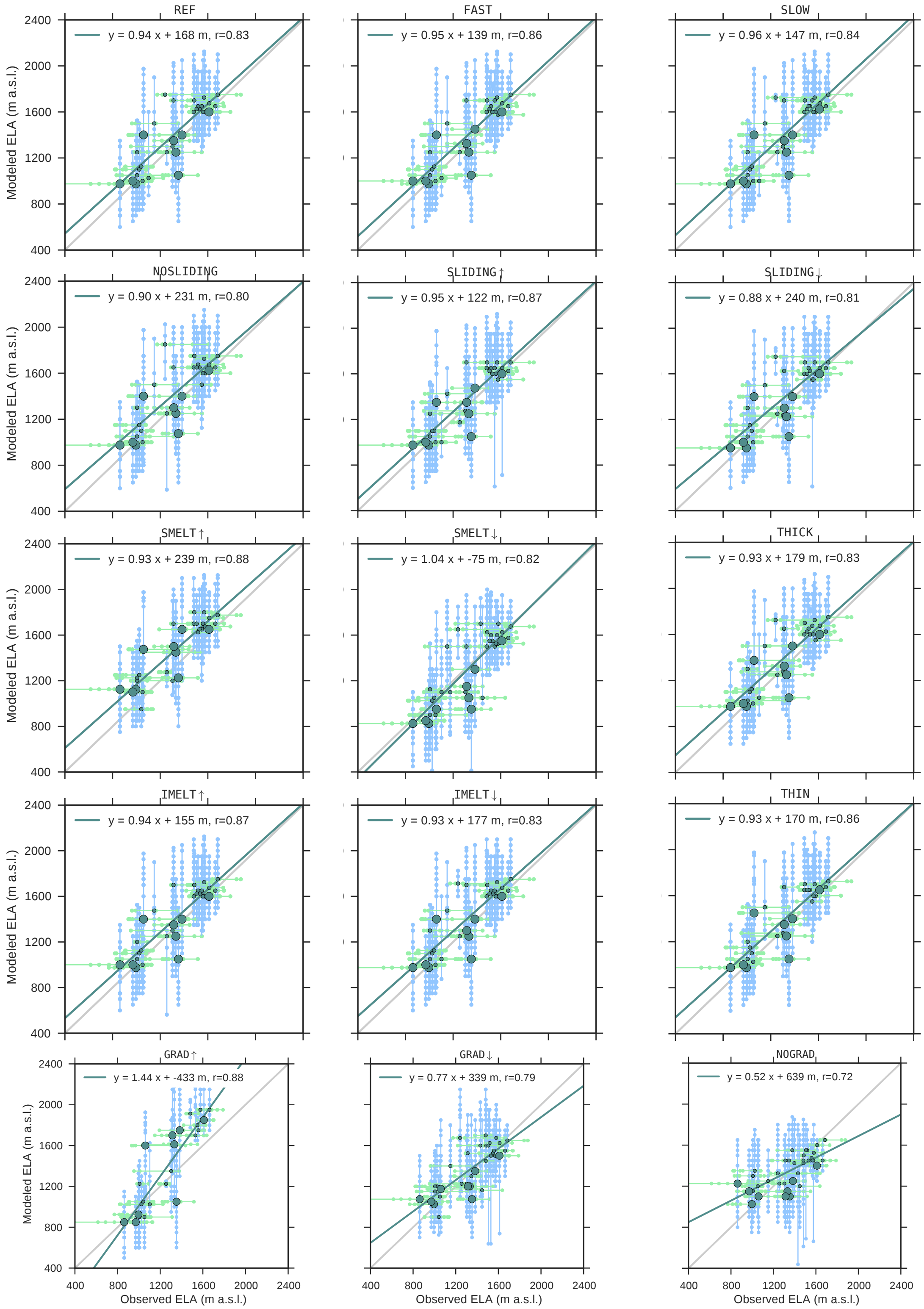

Figure S 4: Modeled annual equilibrium line altitudes (ELA) for the period 1990–2019 vs. observed ELAs for the period 1996–2014 for the Juneau Icefield for the reference run REF and all sensitivity experiments (Table 2 in the main text). The time window for the model data is chosen as 30 year time window centered on the observation period. Experiment names are given above the individual plots. Dark filled circles show the median of all available annual modeled and observed values for each glacier. Large dots mark glaciers $> 100\,\mathrm{km}^2$. Smaller circles mark smaller glaciers. Small dots connected by lines mark the ELAs for each individual year (green: observed; blue: modeled). Also shown are 1:1-line (light gray) and linear fit (dark line).

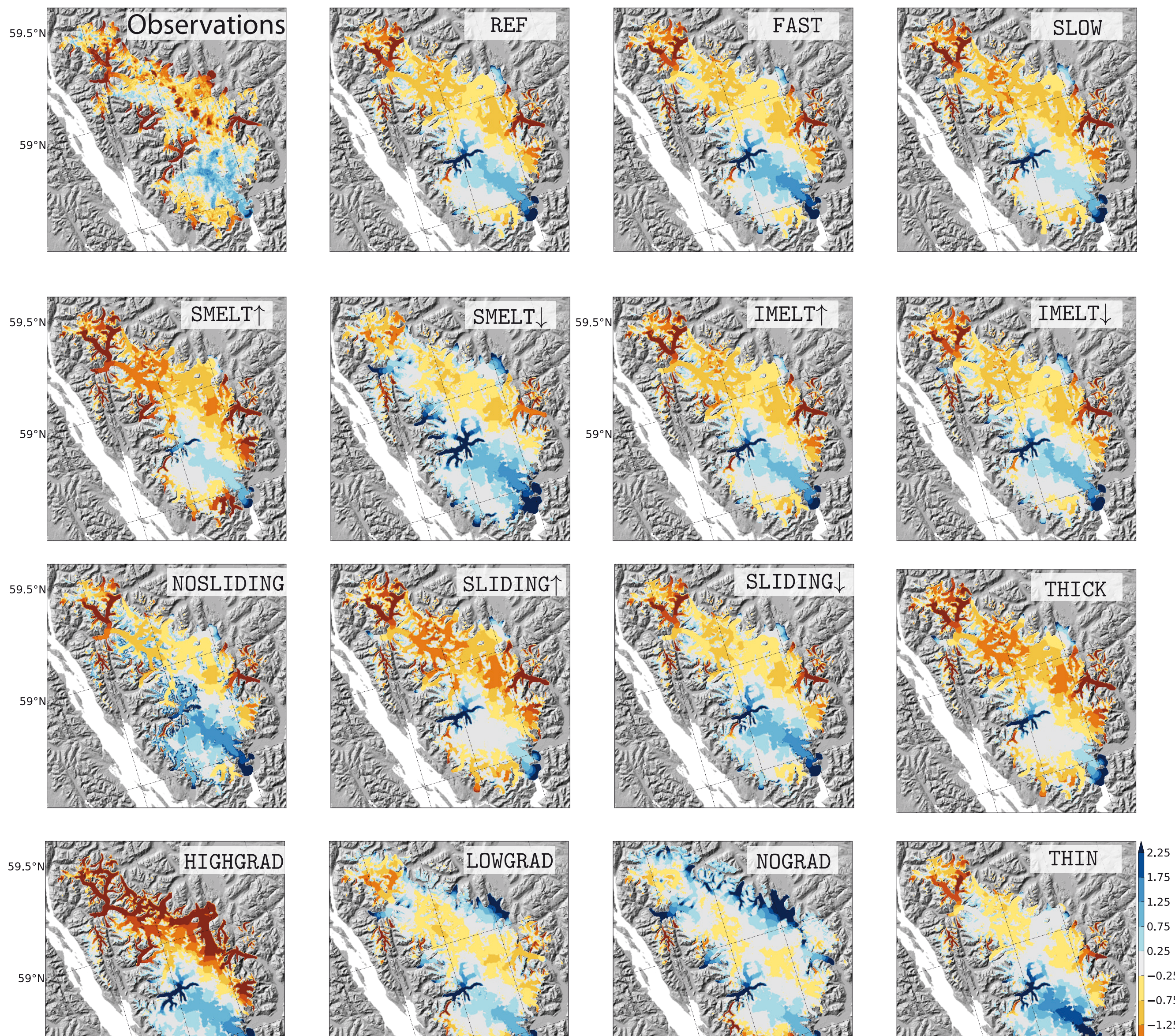

Figure S 5: Spatial pattern of observed and modeled mass balance rates averaged over the period 1971–2010 (in $\mathrm{m\,w.\,e.\,a^{-1}}$). The observed field is computed as a time-weighted mean of the observations from Larsen and others (2007) (75%) and Melkonian and others (2014) (25%), thus accounting for the different time coverage of the two data sets.

References

Larsen, C. F., R. J. Motyka, A. A. Arendt, K. A. Echelmeyer and P. E. Geissler, 2007. Glacier changes in southeast Alaska and northwest British Columbia and contribution to sea level rise, *J. Geophys. Res.*, **112**(F1), F01007. ISSN 0148-0227. doi: 10.1029/2006JF000586.

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Pelto, M. S. and M. M. Miller, 1990. Mass Balance of the Taku Glacier, Alaska from 1946 to 1986, *Northwest Sci.*, **64**(3), 121–130.