The Cryosphere

Supplement of

Enhancing the Representation of Glaciers and Ice Sheets in the ecLand Land-Surface Model: Impacts on Surface Energy Balance and Hydrology Across Scales

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Table S1: Summary of experimental setups for (a) PROMICE point-scale simulations and (b) global 2D simulations. See Sect. 2.4.1 for a detailed description of the experimental setups.

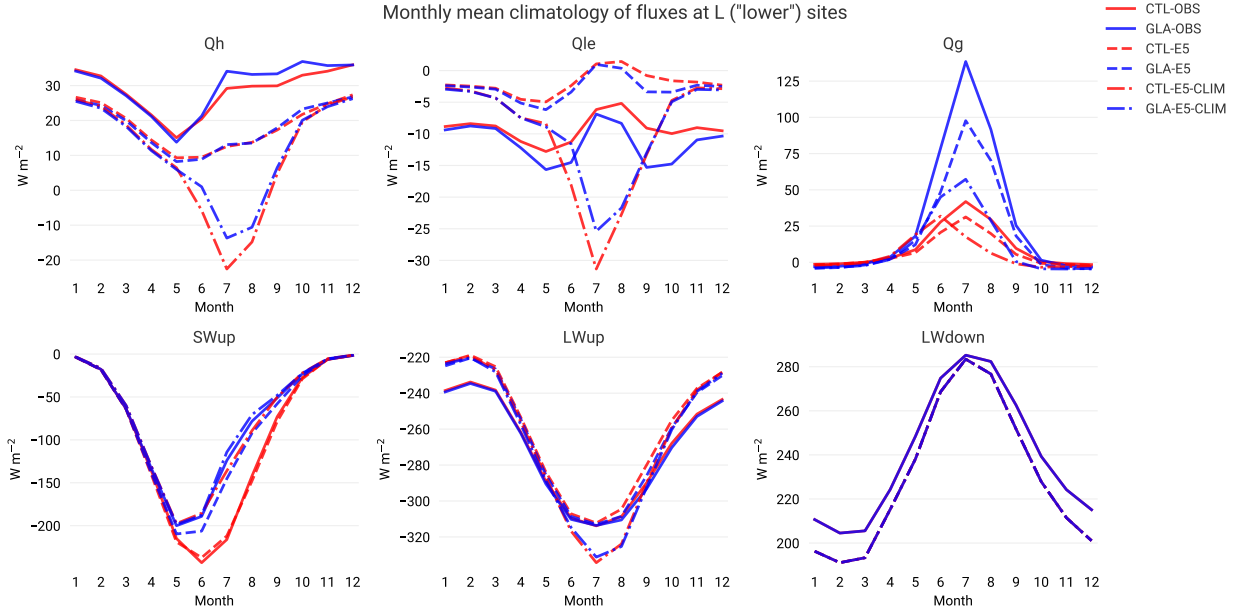| Label	Experiment setting	Forcing (Met. variables)	Glacier mask (f_{gl})	Horizontal resolution	Spin-up
(a) Point-scale (PROMICE sites)					
CTL-OBS	Baseline control	In situ (T, q, wind speed/dir, p_s, SW↓, LW↓); ERA5 solid+liquid precip.; ERA5 gap-fill	1.0	Point scale	Site period repeated until ≥30 yr, then final run
GLA-OBS	Glacier parameterisation	Same as CTL-OBS	1.0	Point scale	Same as CTL-OBS
CTL-E5	Baseline control	ERA5 (all variables)	1.0	Point scale	Same strategy as CTL-OBS
GLA-E5	Glacier parameterisation	ERA5 (all variables)	1.0	Point scale	Same strategy as CTL-OBS
CTL-E5-CLIM	Baseline control	ERA5 (all variables)	Nearest neighbour operational mask (9 km)	Point scale	Same strategy as CTL-OBS
GLA-E5-CLIM	Glacier parameterisation	ERA5 (all variables)	Nearest neighbour operational mask (9 km)	Point scale	Same strategy as CTL-OBS
(b) Global 2D simulations)					
CTL (global)	Baseline control	ERA5 conservatively regridded	Fractional mask (operational)	ecLand: ∼14 km (TCo799); CamaFlood: 15arcmin	20 yr (1970–1989) spin-up; analysis from 1990
GLA (global)	Glacier parameterisation	ERA5 conservatively regridded	Same (fractional, glacier tile)	ecLand: ∼14 km (TCo799); CamaFlood: 15arcmin	Same as CTL (global)

Figure S1: Mean annual climatology of modelled surface energy balance components at the *lower* sites, from ecLand CTL with in situ forcing (CTL-OBS), and with ERA5 forcing (CTL-ERA5) and with ERA5 forcing and ECMWF's operational glacier mask (CTL-ERA5-CLIM) and ecLand with the new glacier parameterisation (GLA-OBS, GLA-ERA5 and GLA-ERA5-CLIM for in situ, ERA5 forcing and ECMWF's operational glacier mask, respectively). Qh: sensible heat flux; Qle: latent heat flux; Qg: snow heat flux; SWup: reflected shortwave radiation; LWup: emitted longwave radiation; LWdown: incoming longwave radiation. Note the different y-axis scales for the different fluxes. See Sect. 2.4.1 of the main text and Table S1 for details on the different experiment setups
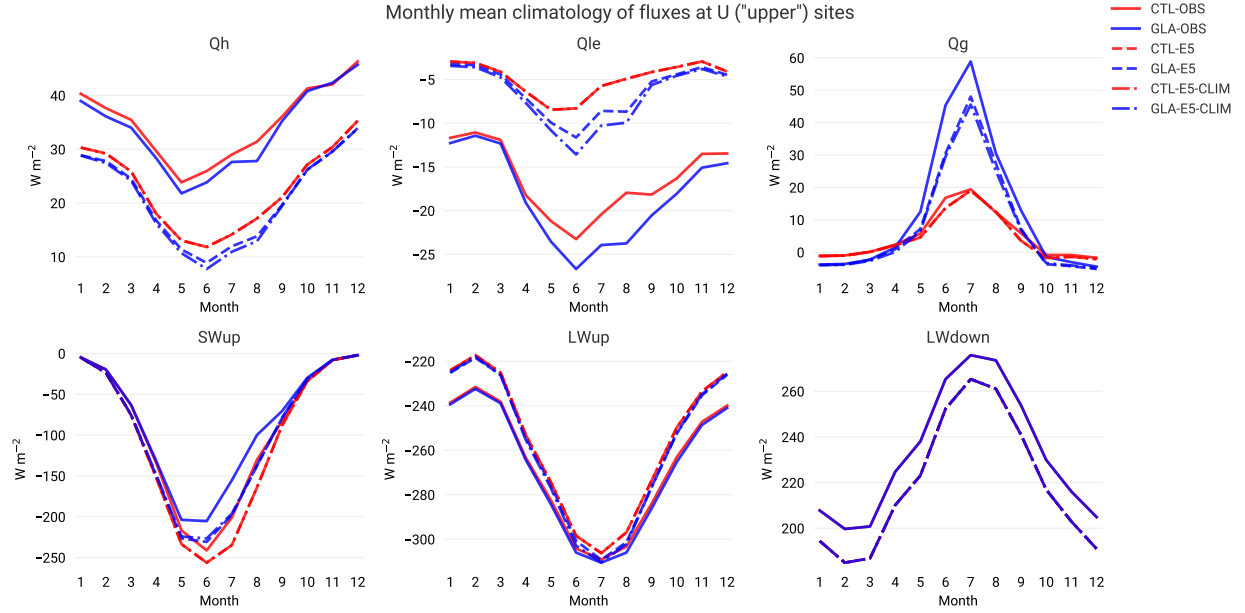
Figure S2: Mean annual climatology of modelled surface energy balance components at the *upper* sites, from ecLand CTL with in situ forcing (CTL-OBS), and with ERA5 forcing (CTL-ERA5) and with ERA5 forcing and ECMWF's operational glacier mask (CTL-ERA5-CLIM) and ecLand with the new glacier parameterisation (GLA-OBS, GLA-ERA5 and GLA-ERA5-CLIM for in situ, ERA5 forcing and ECMWF's operational glacier mask, respectively). Qh: sensible heat flux; Qle: latent heat flux; Qg: snow heat flux; SWup: reflected shortwave radiation; LWup: emitted longwave radiation; LWdown: incoming longwave radiation. Note the different y-axis scales for the different fluxes. See Sect. 2.4.1 of the main text and Table S1 for details on the different experiment setups
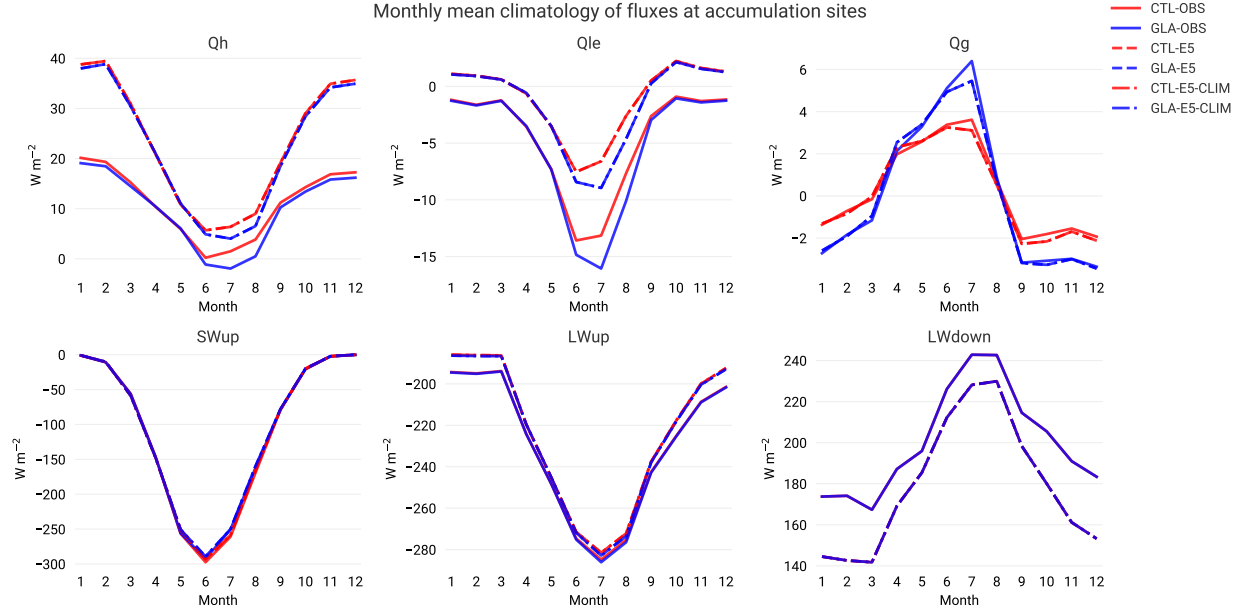
Figure S3: Mean annual climatology of modelled surface energy balance components at the *accumulation* sites, from ecLand CTL with in situ forcing (CTL-OBS), and with ERA5 forcing (CTL-ERA5) and with ERA5 forcing and ECMWF's operational glacier mask (CTL-ERA5-CLIM) and ecLand with the new glacier parameterisation (GLA-OBS, GLA-ERA5 and GLA-ERA5-CLIM for in situ, ERA5 forcing and ECMWF's operational glacier mask, respectively). Qh: sensible heat flux; Qle: latent heat flux; Qg: snow heat flux; SWup: reflected shortwave radiation; LWup: emitted longwave radiation; LWdown: incoming longwave radiation. Note the different y-axis scales for the different fluxes. See Sect. 2.4.1 of the main text and Table S1 for details on the different experiment setups
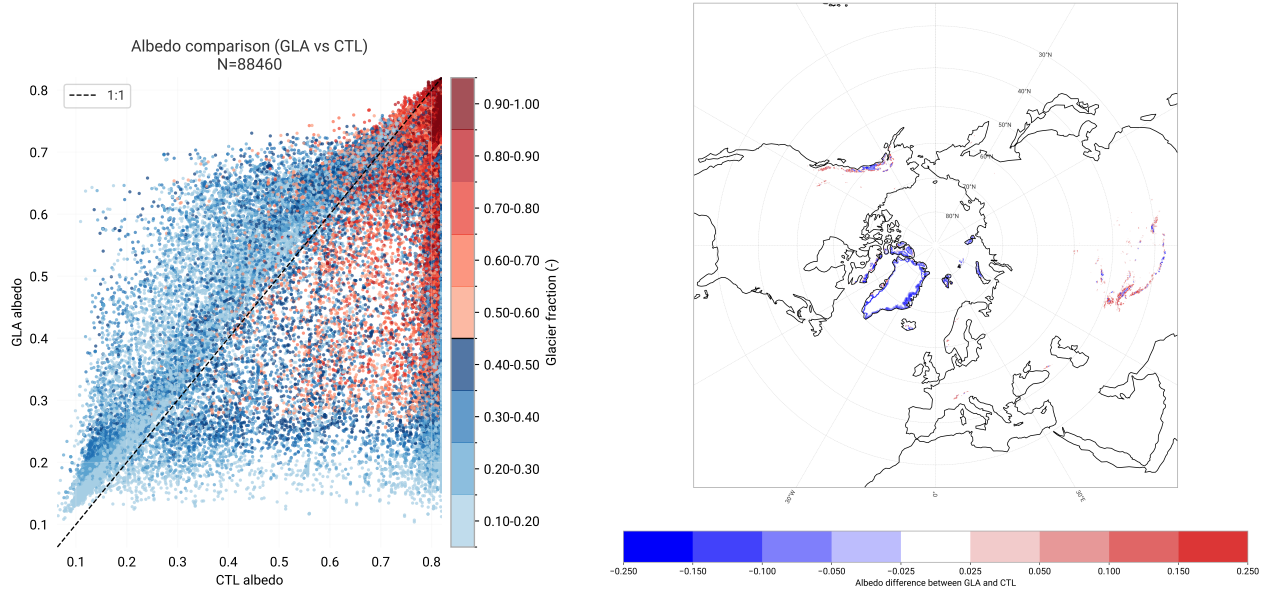

Figure S4: Left: Scatter plot of the daily and grid-box averaged surface albedo for CTL (x-axis) and GLA (y-axis) experiments, for grid points with a non-zero fraction of ice in a grid cell, for the June to August months from 2000 to 2019. Each point indicate The 1:1 line is shown in black. Right: Composite surface albedo differences between GLA and CTL experiments, for the June to August months between 2000 and 2019.

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