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Snow model comparison to simulate snow depth evolution and sublimation at point scale in the semi-arid Andes of Chile

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S1 Albedo and fresh snow density parameterizations

Table S1.1: Fresh snow density parameterizations SNOWPACK

Lehning (old)	$\rho_{fs} = 70 + 30\,TA + 10\,TSS + 0.4\,RH + 30\,WS + 6\,TA\,TSS - 3\,TA\,WS - 0.5\,RH\,WS$
Lehning (new)	Lehning et al. (2002, eq. 2) with $\alpha = 90$
Zwart	Zwart (2007)
Bellaire	$\rho_{fs} = exp(3.946 + 0.07703\,TA + 0.0001701\,HH + 0.02222\log(WS) - 0.05371\,TA\log(WS))$ HH is the altitude above sea level
Pahaut	Vionnet et al. (2012, eq. 1)

Table S1.2: Albedo parameterizations SNOWPACK. The exact equations can be found in SNOWPACK's code.

Lehning (0)	Statistical model of surface snow albedo based on measurements from Weissfluhjoch study plot
Lehning (2)	Statistical model of surface snow albedo based on measurements from Weissfluhjoch study plot
Schmucki (GSZ)	Statistical model based on $S_{\downarrow}$ and $S_{\uparrow}$ at 4 Swiss stations and the grain size
Schmucki (OGZ)	Statistical model based on $S_{\downarrow}$ and $S_{\uparrow}$ at 4 Swiss stations and the optical equivalent grain size

Table S1.3: Fresh snow density parameterizations SnowModel

Default	Gascoin et al. (2013, eq. 1)
Lehning (old)	$\rho_{fs} = 70 + 30\,TA + 10\,TSS + 0.4\,RH + 30\,WS + 6\,TA\,TSS - 3\,TA\,WS - 0.5\,RH\,WS$ with $\rho_{fs} = 50$ if $\rho_{fs} < 50$ and $\rho_{fs} = 158.8$ if $\rho_{fs} > 158.8$
Lehning (new)	Lehning et al. (2002, eq. 2) with $\alpha = 90$ and $\rho_{fs} = 50$ if $\rho_{fs} < 50$ and $\rho_{fs} = 158.8$ if $\rho_{fs} > 158.8$

Table S1.4: Albedo parameterizations SnowModel

Default	$\alpha = 0.9$ for $TA < 0$ $\alpha = 0.6$ for $TA > 0$ $\alpha = 0.15$ for no snow
Time-evolution	Strack et al. (2004, eq. 3-4)

S2 Idealised set up

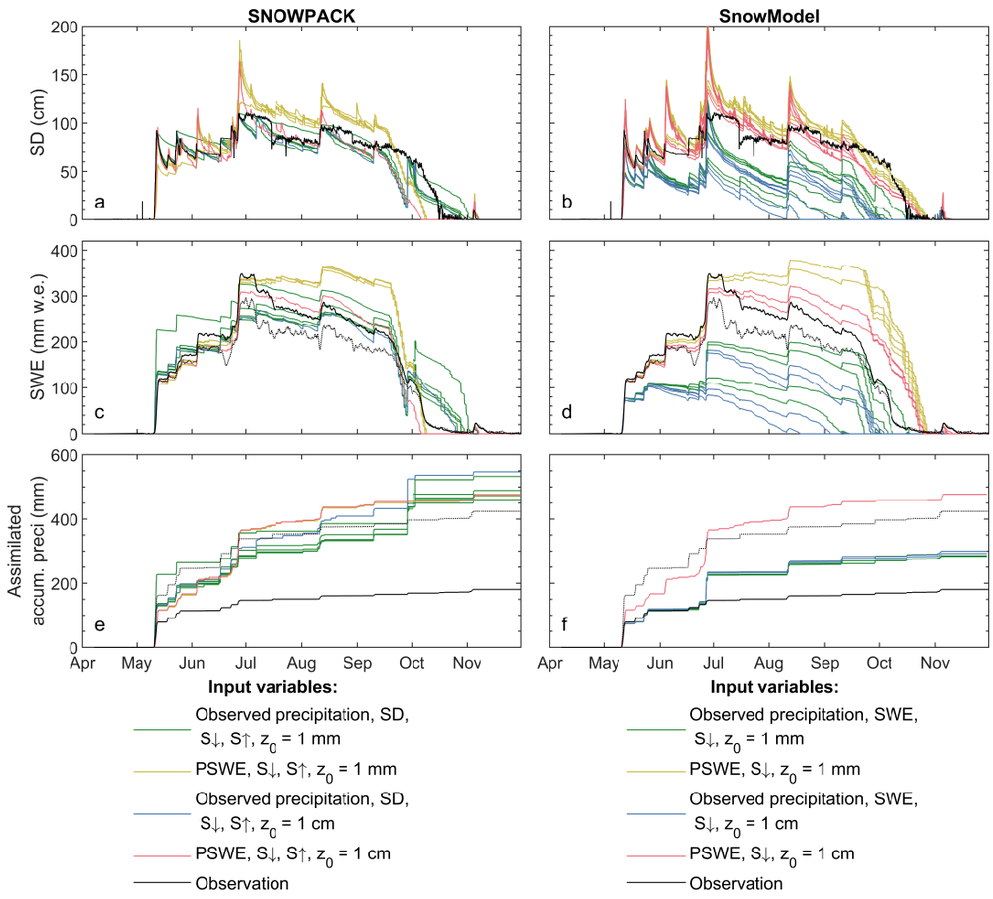

Figure S2.1: a-b) SD, c-d) SWE and e-f) the cumulative assimilated precipitation for SNOWPACK (a,c,e) and SnowModel (b,d,f) and observations (black). The different forcing parameters are given in the legenda. The simulations with SNOWPACK for every different input set were done with five different fresh snow density parameters and the simulations with SnowModel for every input set were done with six combinations out of three fresh snow density and two albedo parameterizations. PSWE is equal for z_0 is 1 mm and 1 cm and thus only the red line is visible in e-f). The solid (dotted) line in c-d) indicates the more (less) reliable SWE measurement from potassium (thallium) rays.

S3 Precipitation corrections

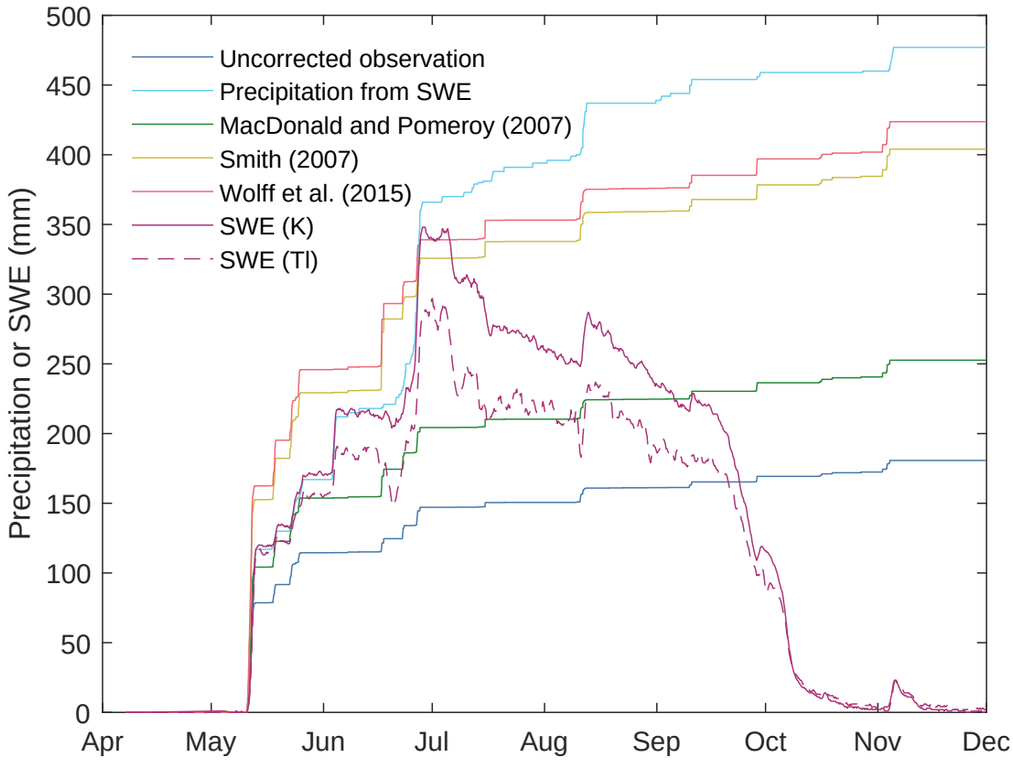

Figure S3.1: Observed cumulative precipitation, precipitation corrected from SWE (PSWE) and precipitation corrections (MacDonald and Pomeroy, 2007; Smith, 2007; Wolff et al., 2015). The two SWE observations with potassium (K, solid line) and thallium (Tl, dotted line) gamma rays are also given.

S4 Statistics of model calibrations

Table S4.1: *RMSE* of ensemble of parameterizations of SNOWPACK with $z_0 = 1\,\text{cm}$. *Lehning 0*, *Lehning 1*, *Schmucki GSZ* and *Schmucki OGS* are the albedo parameterizations as named in the model and *Lehning (old)*, *Lehning (new)*, *Bellaire*, *Zwart* and *Pahaut* are the fresh snow density parameterizations. The ensemble chosen as reference is given in bold.

	Lehning 0	Lehning 1	Schmucki GSZ	Schmucki OGS
Lehning (old)	**0.090**	0.136	0.128	0.132
Lehning (new)	0.126	0.136	0.131	0.112
Bellaire	0.128	0.132	0.127	0.131
Zwart	0.114	0.135	0.130	0.108
Pahaut	0.101	0.133	0.130	0.128

Table S4.2: R^2 of ensemble of parameterizations of SNOWPACK with $z_0 = 1\,\text{cm}$. *Lehning 0*, *Lehning 1*, *Schmucki GSZ* and *Schmucki OGS* are the albedo parameterizations as named in the model and *Lehning (old)*, *Lehning (new)*, *Bellaire*, *Zwart* and *Pahaut* are the fresh snow density parameterizations. The ensemble chosen as reference is given in bold.

	Lehning 0	Lehning 1	Schmucki GSZ	Schmucki OGS
Lehning (old)	**0.856**	0.436	0.507	0.569
Lehning (new)	0.652	0.502	0.585	0.789
Bellaire	0.645	0.465	0.642	0.602
Zwart	0.766	0.478	0.564	0.813
Pahaut	0.832	0.484	0.547	0.585

Table S4.3: *RMSE* of ensemble of parameterizations of SNOWPACK with $z_0 = 1\,\text{mm}$. *Lehning 0*, *Lehning 1*, *Schmucki GSZ* and *Schmucki OGS* are the albedo parameterizations as named in the model and *Lehning (old)*, *Lehning (new)*, *Bellaire*, *Zwart* and *Pahaut* are the fresh snow density parameterizations.

	Lehning 0	Lehning 1	Schmucki GSZ	Schmucki OGS
Lehning (old)	0.121	-	0.104	0.111
Lehning (new)	0.137	-	0.106	0.108
Bellaire	0.127	-	0.105	0.123
Zwart	0.108	-	0.106	0.106
Pahaut	0.129	-	0.105	0.119

Table S4.4: R^2 of ensemble of parameterizations of SNOWPACK with $z_0 = 1\,\text{mm}$. *Lehning 0*, *Lehning 1*, *Schmucki GSZ* and *Schmucki OGS* are the albedo parameterizations as named in the model and *Lehning (old)*, *Lehning (new)*, *Bellaire*, *Zwart* and *Pahaut* are the fresh snow density parameterizations.

	Lehning 0	Lehning 1	Schmucki GSZ	Schmucki OGS
Lehning (old)	0.694	-	0.315	0.398
Lehning (new)	0.468	-	0.424	0.455
Bellaire	0.434	-	0.409	0.737
Zwart	0.804	-	0.401	0.450
Pahaut	0.452	-	0.425	0.466

Table S4.5: *RMSE* of ensemble of parameterizations of SnowModel with $z_0 = 1\,\mathrm{cm}$. *Default* and *Strack (Strack et al., 2004)* are the albedo parameterizations as named in the model and *Default*, *Lehning (old)* and *Lehning (new)* are the fresh snow density parameterizations. The ensemble chosen as reference is given in bold.

	Default	Strack
Default	0.185	**0.150**
Lehning (old)	0.185	0.150
Lehning (new)	0.185	0.150

Table S4.6: R^2 of ensemble of parameterizations of SnowModel with $z_0 = 1\,\mathrm{cm}$. *Default* and *Strack (Strack et al., 2004)* are the albedo parameterizations as named in the model and *Default*, *Lehning (old)* and *Lehning (new)* are the fresh snow density parameterizations. The ensemble chosen as reference is given in bold.

	Default	Strack
Default	0.585	**0.600**
Lehning (old)	0.584	0.595
Lehning (new)	0.583	0.599

Table S4.7: *RMSE* of ensemble of parameterizations of SnowModel with $z_0 = 1\,\mathrm{mm}$. *Default* and *Strack (Strack et al., 2004)* are the albedo parameterizations as named in the model and *Default*, *Lehning (old)* and *Lehning (new)* are the fresh snow density parameterizations.

	Default	Strack
Default	0.187	0.147
Lehning (old)	0.195	0.148
Lehning (new)	0.188	0.147

Table S4.8: R^2 of ensemble of parameterizations of SnowModel with $z_0 = 1\,\mathrm{mm}$. *Default* and *Strack (Strack et al., 2004)* are the albedo parameterizations as named in the model and *Default*, *Lehning (old)* and *Lehning (new)* are the fresh snow density parameterizations.

	Default	Strack
Default	0.558	0.541
Lehning (old)	0.539	0.560
Lehning (new)	0.545	0.540

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