Supplement of

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

Annelies Voordendag et al.

Correspondence to: Shelley MacDonell (shelley.macdonell@ceaza.cl) and Stef Lhermitte (s.lhermitte@tudelft.nl)

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## S1 Albedo and fresh snow density parameterizations

### Table S1.1: Fresh snow density parameterizations SNOWPACK

| Parameterization | Equation |
|------------------|----------|
| Lehning (old)    | $\rho_{fs} = 70 + 30TA + 10TSS + 0.4RH + 30WS + 6TATSS - 3TAW - 0.5RH \times WS$ |
| Lehning (new)    | Lehning et al. (2002, eq. 2) with $\alpha = 90$ |
| Zwart            | Zwart (2007) |
| Bellaire         | $\rho_{fs} = e^{3.946 + 0.07703TA + 0.0001701HH + 0.02222 \log(WS) - 0.05371TA \log(WS)}$ |
|                  | 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.

| Parameterization | Description |
|------------------|-------------|
| 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

| Parameterization | Equation |
|------------------|----------|
| Lehning (old)    | $\rho_{fs} = 70 + 30TA + 10TSS + 0.4RH + 30WS + 6TATSS - 3TAW - 0.5RH \times WS$ 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

| Parameterization | Equation |
|------------------|----------|
| 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) |
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 legend. 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.
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.
Table S4.1: **RMSE** of ensemble of parameterizations of SNOWPACK with $z_0 = 1$ 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 (old) | Lehning 1 | Schmucki GSZ | Schmucki OGS |
|---------------|-----------|--------------|--------------|
| 0.090         | 0.136     | 0.128        | 0.112        |
| 0.126         | 0.136     | 0.131        | 0.112        |
| 0.128         | 0.132     | 0.127        | 0.131        |
| 0.114         | 0.135     | 0.130        | 0.108        |
| 0.101         | 0.133     | 0.130        | 0.128        |

Table S4.2: **$R^2$** of ensemble of parameterizations of SNOWPACK with $z_0 = 1$ 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 (old) | Lehning 1 | Schmucki GSZ | Schmucki OGS |
|---------------|-----------|--------------|--------------|
| 0.856         | 0.436     | 0.507        | 0.569        |
| 0.652         | 0.502     | 0.585        | 0.789        |
| 0.645         | 0.465     | 0.642        | 0.602        |
| 0.766         | 0.478     | 0.564        | 0.813        |
| 0.832         | 0.484     | 0.547        | 0.585        |

Table S4.3: **RMSE** of ensemble of parameterizations of SNOWPACK with $z_0 = 1$ 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 (old) | Lehning 1 | Schmucki GSZ | Schmucki OGS |
|---------------|-----------|--------------|--------------|
| 0.121         | -         | 0.104        | 0.111        |
| 0.137         | -         | 0.106        | 0.108        |
| 0.127         | -         | 0.105        | 0.123        |
| 0.108         | -         | 0.106        | 0.106        |
| 0.129         | -         | 0.105        | 0.119        |

Table S4.4: **$R^2$** of ensemble of parameterizations of SNOWPACK with $z_0 = 1$ 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 (old) | Lehning 1 | Schmucki GSZ | Schmucki OGS |
|---------------|-----------|--------------|--------------|
| 0.694         | -         | 0.315        | 0.398        |
| 0.468         | -         | 0.424        | 0.455        |
| 0.434         | -         | 0.409        | 0.737        |
| 0.804         | -         | 0.401        | 0.450        |
| 0.452         | -         | 0.425        | 0.466        |
Table S4.5: RMSE of ensemble of parameterizations of SnowModel with $z_0 = 1$ 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 $z_0 = 1$ 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 $z_0 = 1$ 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 $z_0 = 1$ 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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