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Interactive comment on "A simple model for local scale sensible and latent heat advection contributions to snowmelt" *by* P. Harder et al.

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This is an interesting study combining some classical modelling approaches with modern measurements of advection over patchy snow and highlighting the role of latent heat fluxes. I just think that there are some errors that need to be corrected before publication. As they differ from previously published results, it would also be interesting to see an example of the snow patch images and power laws fitted to patch number and size data.

page 1, line 18 "advection of dry air" would be a more physically appealing description than "negative latent heat advection fluxes".

page 2, line 21 It is not correct to say that advection of LE_A from ponded meltwater is

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not represented in any model; the Liston (1995) model advects moisture and assumes that the snow-free patches are saturated.

page 3, line 15 It seems unlikely that “Initial melt is dominated by energy advecting from emerging snow-free patches”, which initially only provide a small source area.

page 3, line 17 “energy entrained by air movement across isolated snow-free patches” is not completely advected to surrounding snow if the snow surface is aerodynamically decoupled from the warmed air as observed by Mott et al. (doi:10.1175/JHM-D-17-0074.1).

page 4, line 20 Coefficient a is not dimensionless.

page 4, line 27 If heat and moisture are advected by the same mechanisms (presumably the justification for assuming the same parametrizations of a and b), what is the justification for using different stability parameters?

page 4, line 30 A pedantic point, but humidity is a property of air; “surface humidity” is not a meaningful quantity, and what is intended here is humidity in the microlayer where exchange between the surface and the air occurs.

page 5, line 1 “surface water vapor pressure”

page 5, line 5 “_soil” should be subscript

page 5, line 25 The derivation of Equation (25) is opaque. Trying to reproduce it, I arrived at the equivalent but more compact expression

$$S_{ret} = \frac{1}{\pi}\sin(\pi F) - F\cos(\pi F) \qquad (1)$$

page 6, line 3 More informatively, Equation (10) is a closed form fit to the parametric SCA curve produced by homogeneous melt of a log-normal SWE distribution.

page 6, line 13 A more intuitive way to write Equation (11) would be

$$F(A_p) = \left(\frac{A_p}{A_{\min}}\right)^{-D_k/2} \tag{2}$$

page 6, line 17 Hack's law relates stream length to basin area. Granger et al. (2002) attribute the use of Equation (12) relating linear dimension and area to Rignon et al. (1996).

page 6, line 25 The integrand in Equation (13) should be written as either $F(A_p)dA_p$ or $F(x)dx$, but the equation is incorrect anyway. Probability is given by an integral of a probability density function, which $F(A_p)$ is not; $1 - F(A_p)$ is a cumulative distribution function, the derivative of which would be a probability density function. I think that the intended equation is

$$p(A_{pi}) = F(A_{pi-1}) - F(A_{pi}) \tag{3}$$

page 8, line 24 Table 2

page 10, line 3 It would be useful to state that H_A and LE_A are estimated by Harder at al. (2017) from vertical temperature and humidity profiles.

page 11, line 21 No justification is given here for the statement “It is evident that SLHAM can quantify the key advection behaviours”.

page 12, line 4 Because three figures with normalized time axes have already been presented, the normalization needs to be explained before this.

Figure 4 D_k, as defined by Equation (11), should be positive.

Table 1 A in the parameterizations for b should be W

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