

Interactive comment on “Measurements and modelling of snowmelt and turbulent heat fluxes over shrub tundra” by D. Bewley et al.

Anonymous Referee #1

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This paper reports new observational data on snowmelt, radiative, and sensible and latent heat fluxes taken during two snowmelt seasons over a tall shrub and a low shrub site. It also uses a dual-source energy balance model to assess the processes driving the melt process and to compare them between the different shrub tundra types. This is an important topic for understanding snowmelt processes in tundra regions, and one that is leading to new parameterizations in models. The paper is well written and the conclusions are supported by the data shown. I recommend the following minor revisions to improve the presentation of some methodological aspects and the clarity of the paper.

1. The abstract could be made more impactful and more attractive to a reader searching for the paper if you added some specific quantitative results. For example, when

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you say that the two shrub types differed, state by how much (in terms of days in snowmelt timing, heat flux magnitudes, etc.). When you discuss the model-data comparison, state when (seasonally or in relation to snowmelt timing) and by how much (percentage) they differed.

2. Intro. page 1006, lines 15-20: The Latin names of the shrub genera normally should be start with a capital letter (unless journal style differs).

3. Sec. 2.1, page 1009: Please add some information about the size of the shrub patches you measured. (And please see related comment below about the eddy covariance measurements.)

4. Sec. 2.2, page 1010: Did you measure only incident radiation? (If yes, please add "incident" here.) If that is true, how did you measure the albedo of the shrub patches? Sec. 3.2 mentions albedo measurements that were used to obtain the parameter values for the model. Please explain more clearly how and when albedo was measured. Finally, it is not clear if you had a net radiation measurement available during the snowmelt time series at the two sites—did you? If yes, this would be useful for evaluating the H and LE fluxes that were measured with eddy covariance system.

5. Sec. 2.4, page 1012: I understand that this is not a micrometeorological paper; however, you really need to provide a bit more information that would allow better interpretation of the flux measurements. If the flux measurements are explained in greater detail in another publication, please indicate that reference. Either way, please provide a few additional key details here. What was the measuring height at each site? Was the height referenced to the ground or to the top of the snow pack? Was the measuring height adjusted at all during snow melt? What was the approximate size of the shrub patches and what was the length of the shrub-covered fetch in the predominant wind direction? This information is important for interpreting whether the flux measurements are representative of the shrub site and whether the representativeness would have changed significantly during the snowmelt process. Where the snow is deep, the

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height of the tower above the reference surface (diminishing snow pack and eventually vegetation/ground) would be increasing with time—that would make the flux source area (footprint) grow in size. This effect would presumably be more important at the tall shrub site than the low shrub site, so it could contribute to measured differences between the two. The ideal way to assess this would be using a footprint model, but if the patch sizes are large (in relation to the instrument height), then this would be of less concern. Please provide enough information and explanation to help the reader interpret these issues.

Second, did you do any type of assessment of the reasonableness of the flux data? For example, were you able to compare the sum of $H + LE$ against R_{net} or do an approximate energy budget closure?

Finally, if they are not in another publication that can be referenced, please provide at least a brief basic description of key measurement and data processing methods for the flux measurements including issues such as: How/when were the KH2O and LI-7500 calibrated? How was it (and the radiometers and sonic) cleared of snow accumulation (if any) and cleared of frost? What was the separation distance between the sonic and the water vapor sensors, and did you apply a correction (e.g., Moore 1986) for the lateral separation? There is a known problem of sensor self-heating in the LI-7500 that is especially apparent in cold temperatures (see Burba et al. and others)—did you observe these effects and were any corrections applied? (Not necessarily required but it would be good to know if these effects were occurring during the measurements.) What sampling frequency was used and what averaging interval was used for calculating the fluxes? Were (which) coordinate rotations were performed? Were means or running means, etc. removed in calculating the fluxes? Were lag times between the sonic and the humidity sensors computed from the cross-correlations or fixed (or used at all)?

6. Sec. 3.1. The resistance terms are not clearly defined. Please define the resistance terms (verbally) when they are first used in Eqs. 2-5. The order of Eq. 6-8 is not the

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same as the resistances are presented in Eqs. 2-5...it would be clearer if you listed them in the same order. The r_{as} with the prime is not explained in Eq. 10.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 7, 1005, 2010.