The Cryosphere Discuss., 1, S275–S278, 2008
www.the-cryosphere-discuss.net/1/S275/2008/

The Cryosphere Discussions

Interactive comment on "Is snow sublimation important in the alpine water balance?" *by* U. Strasser et al.

Anonymous Referee #2

Received and published: 11 April 2008

General Comments

This is an interesting and generally well written paper which addresses the difficult problem of calculating snow sublimation over a large mountainous area with varied land cover types. The study brings together a lot of existing theory into a modelling environment and applies it to a case study in the 210 km2 Berchtesgaden National Park, Germany. Here, many of the necessary input data and boundary conditions (meteorological data, vegetation) are available in spatially distributed form at a relatively high level of detail. The key finding that sublimation represents a 'loss' of deposited snow of between 10-90% during the winter season, and is strongly dependent on the type of environment, e.g. forest, exposed summit ridge, valley bottom, etc., demonstrates that modelling sublimation in an alpine environment is more complex than suggested

by the paper title. Due to the need to interpolate meteorological data over large areas, representation of some physical processes is necessarily simplified, but otherwise the modelling effort is impressive. I recommend the paper be published after some important, but fairly straightforward changes are made, explained in more detail below. In summary: the first half of the paper is too long; too few details of the meteorological sensors and associated errors are given; and a more objective assessment of how realistic the calculated sublimation values are is needed.

Specific comments

The reader has to get through 17 pages of introduction and methods before getting to the really interesting part - the results. The introduction can be reduced by ~ a quarter by being less descriptive (save this for a review article?). The methods, while very thorough, can be reduced by at least the same margin by referring to published work for the more obvious and well established steps.

In contrast, there isn't enough information about the types of meteorological sensors or their situation (height, housing) to make an objective assessment of how measurement errors might affect the results. Stating manufacturer and model for every sensor would be too much detail, but instead please give some assessment of sensor quality, e.g are they WMO standard or otherwise? Were the air temperature sensors shielded, and artificially or naturally ventilated? If the latter, possible overestimation of air temperature above snow covers under light winds and sunny conditions needs to be considered. Similarly, how was the problem of overheating of thermistors measuring snow temperature treated? Or is this problem irrelevant due to the iterative method of finding snow surface temperature? Please state if so.

Equation 1 used to calculate the latent heat flux over a ground snow cover is a simple empirical formula that takes no account of the effect of stable stratification or variation in surface roughness on turbulent transfer. The implicit assumption (p. 314) that this is a safe approach over a long period, e.g. the winter season, is dependent on a balance

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between positive and negative errors, which may not be the case. If, for example, night time sublimation is most likely to occur under stably stratified conditions (p. 232, 24) there would be an overestimation of the latent heat flux and overestimation of sublimation. Similarly, is there any possibility of systematic errors due to spatial or temporal variations in surface roughness, e.g. the tendency for the snow surface to become rougher with time since deposition? These issues do not necessarily undermine the results, but should be considered in the discussion and evaluation of the results. At least 1 paragraph should be used to assess how realistic the modelled sublimation rates are, due to both the issues outlined here and other relevant factors.

Technical Corrections

The title is too general and should better reflect the content of the paper.

p. 305, l. 2, remove 'therefore'

p. 305, l. 9, 'cannot' is one word

p. 305, l. 20, remove 'our' as this is a general observation

p. 307, l. 5, and throughout the paper, when you say 'condensation' do you really mean (vapour to ice) sublimation? Condensation refers specifically to the vapour to water phase change (e.g. Oke, 1987, p. 28). Phase changes from vapour to ice, and the reverse are both sublimation. The confusion can be avoided by stating 'vapour to ice sublimation' or 'ice to vapour sublimation' as appropriate.

p. 310, l. 20, '...portion of the sky hemisphere...'

p. 316, l. 13, and p. 317, l. 9, full stop after the equations.

p. 318, l. 23, '... use of a modelled...'

p. 319, l. 6, check that h* is defined.

p. 322, l. 12, define the winter season (start/finish dates).

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p. 324, l. 5, suggest replacing 'formula' with 'approach'.

p. 325, l. 5, is it worth pointing out that, unlike snow to vapour sublimation, vapour to ice sublimation is not dependent on the presence of lying snow, so the pattern across the study area is much less variable.

p. 326, l. 18, replace 'at' with 'over'.

p. 326, l. 20, 'sublimates'.

p. 327, l. 22, replace 'only' with 'but'.

p. 327, l. 23, replace 'are' with 'is'.

p. 328. l. 7, is the study site topography really that extreme, or just typical of a high mountain environment?

Reference

Oke, T.R. Boundary Layer Climates 2nd Edition. 1987. Routledge.

Interactive comment on The Cryosphere Discuss., 1, 303, 2007.