Interactive comment on

"ESCIMO.spread – a spreadsheet-based point snow surface energy balance model to calculate hourly snow water equivalent and melt rates for historical and changing climate conditions"

by U. Strasser and T. Marke

Anonymous Referee #2

In this Paper the authors advertise an additional implementation of the most familiar 1-dimensional snow model ESCIMO. As the authors show, alternative versions have been implemented and published for more than a decade. Mostly, the algorithms were integrated in sophisticated hydrological models and coded in higher programming languages.

Now a simplified version of ESCIMO was realized as a spreadsheet, to be used with common office program packages like EXCEL. It has the advantage of an easy access to the software and understanding of the internal procedures by anybody. The transparency offers skillful users, to make their own changes to the model algorithms and parameters. Hence, the authors are right with their appraisal of their work as a useful tool for educational purposes. Concerning the convenience of the application in the field, I share the opinion of referee #1.

In contrast, the applicability of the tool to problems on global change depends more on the availability of an appropriate set of input data than on the model itself. The demonstrated example, based on a nontransparent and limited modification of temperature and precipitation input, equals more a sensitivity analysis of the model than an investigation of the evolution of the snow cover under a warmer climate. Hence, I recommend altering the caption of chapter 5 to something like "Sensitivity analysis of model results to modification of input data".

Overall the paper is generally understandable and the presented documentations of and examples are comprehensible. The description of the model theory in respect to energy balance is profound, but the description of the accumulation processes and the mass balance are superficial and need additional information.

The demonstrated errors in the input data series shows, that the model is obviously insensitive to such errors, and this should be commented in chapter 3.

If observational data of the SWE is available, the performance of the model runs can be rated or validated using three statistical criteria (*efficiency criteria*), which are more or less familiar. But although the authors show all calculation formulas, they fail to point out the difference and significance of the offered methods. In particular there are no references and explanations about the "index of agreement". The mentioned section of the text should be expanded.

The use of a spreadsheet seems to be appropriate for a bottom-of-the-line algorithm as the presented version of the ESCIMO snow model. There is no need for additional work on a user interface and the visual presentation of the results. But sophisticated expansions of the model require powerful programming techniques. The options of a spreadsheet are limited and cumbersome.

In detail I agree with the specific and technical comments of the anonymous referee #1. But there are further specific comments:

P628, line 3: better “at the snow surface” instead of “of the snow surface ”.

P 628, line 5: “The model makes use of … *incoming* short and long wave radiation”, because outgoing components will be calculated by the model

P630, line 14: In a strict sense Equation (1) is formulated for the snow *surface* (following the idea, that a surface is incapable to store energy…)

P630, line 19: A definition of the sign of the individual terms of equation (1) is missing: Here is a suggestion…”energy flux densities *directed to the surface are counted as positive* and are expressed…

P630, line25: As mentioned in table 1 *k* is a constant. It *depends* not really *on the value of air temperature*, but it can be assigned to two different values k1 and k2, classified by positive or negative air temperature

P631, line 5-9: The emitted long wave radiation is the sole exception of an explicit description of a component of the radiation balance. It would be helpful to declare the equation for the complete radiation balance to differentiate between the measured and calculated components.

P632, line 14: From the start at the end of the section which explains the model, nothing is mentioned about the component B of equation (1). In contrast, a constant value of 2.0 Wm^{-2} is given for B in Table 2. This should be explained.

P634, line 22: “are based on physical laws” : Which ones?

P636, eq. 10 and Line 18: if r would be the “correlation coefficient”, then $r^2 = R^2$ usually define the “coefficient of determination”. Why do the authors write $R^2=1-r^2$? Following common literature the equation should look like

$$R^2 = 1 - \frac{\sum_{i=1}^{n}(SWE_{obs}^{i} - SWE_{mod}^{i})^2}{\sum_{i=1}^{n}(SWE_{obs}^{i} - \overline{SWE}_{obs})^2}$$

Table 1:

Some of the given values and constants should be checked. In detail:

Recession factor -> better use *recession constant* k1…

The Function of the parameter “Threshold temperature for phase detection” is explained nowhere in the text!

As published in literature, the *emissivity of a snow* surface range from 0.96 to 0.99, depending on various properties, as like for instance surface roughness. Although the typical value of ε of a snow surface may be above 0.98, a value of 1.0 is definitely too large. In this case snow is considered as an ideal black body emitter.

What means the *specific heat of snow*? The given value equates to that of ice at 273.15K (0°C).

The given value of the specific heat of water is equivalent to a temperature of 20°C. At 5°C, as specified in table 1, a value of 4.20×10^3 $Jkg^{-1}K^{-1}$ is common.

Melting heat of ice also depends on temperature. Within the temperature range from -20°C to 0°C it increases from 2.889 to 3.337 Jkg^{-1}. The value, as stated, seems too high.

(referenz values are obtained from

Fischer, G (Editor) (1988) Landolt-Börnstein, Numerical data and functional relationships in science and technology, Group V: Geophysics and space research, Volume 4: Meteorology, Subvolume b: Physical and chemical properties of the air. Springer, Berlin, Heidelberg, 570pp.)