Authors response to review of gmd-2020-442 by C.T. van Dalum

Reviewer comments are in black. Author response in blue and proposed changes in the manuscript in **bold blue** or in latex fonts.

I am glad to see that the authors have addressed most of the previously raised issues very thoroughly and the manuscript has improved considerably. There are still a few rather minor issues, most of them textual suggestions. After these issues are solved, the manuscript is ready for final publication in my opinion.

The authors are very thankful to Christiaan van Dalum for re-reviewing the manuscript and providing helpful comments. All the comments have been taken into account and a point-by-point response is provided below.

1. In the previous review, I wrote a few comments about the comparison of VALHALLA with SNOWBAL. Most issues are sufficiently resolved, but one important topic still remains. An important difference between SNOWBAL and VALHALLA, from my understanding, is that when implemented in a climate model, SNOWBAL is also able to provide solar radiation absorption for each subsurface snow layer on each model time step, thus allowing for internal heating. VALHALLA provides the total energy absorption of the snowpack with high accuracy, but if I am not mistaken, does not provide shortwave radiation absorption for each subsurface snow layer. Hence, a climate model is then unable to determine internal heating. In other words, the answer of the following question should help take away the confusion: 'When implemented in a climate model, does VALHALLA provide solar radiation absorption for every subsurface snow layer and on every time step?'. If the answer is yes, I think this should be mentioned in the manuscript. If the answer is no, then this should be mentioned in the comparison with SNOWBAL where the purpose of SNOWBAL is compared with VALHALLA.

In its current implementation, described in the paper, VAHLALLA doesn't directly provide access to the broadband absorbed energy in each layer, but it does provide the absorbed energy in each layer for each tie point. The step of the interpolation of the absorbed energy per snow layer has not been performed yet, but it should not be too complicated (analytical formulas from Kokhanavosky et al., can also be used for that). To make this point clearer we performed the following modifications in the manuscript:

Section 4.3 was modified as follows :

"The SNOWBAL coupling scheme from Van Dalum et al. (2019) described in the introduction of our study provides albedo calculation with an accuracy better than 0.01. Thanks to the physics of the snow radiative transfer model TARTES, SNOWBAL accurately calculates the vertical distribution of the absorbed energy in the different snow layers. **For** VALHALLA when using the method with TARTES or with any other multilayer radiative transfer model for snow (e.g. SNICAR, He et al., 2018)**, the vertical distribution of the absorbed energy is calculated for the tps but the vertical profile of broadband absorbed energy is not directly available. This would require further development of the method."**

2. P2 L35-38: Some citations would be useful here.

References to Gardner & Sharp, 2010; Munneke et al., 2011 were added :

"This is usually overcome in most global and regional climate models by computing broadband or narrowband albedo to estimate the energy budget at the snow and ice surfaces **(Gardner & Sharp, 2010 ; Munneke et al., 2011)."**

3. P5 L124: '… only on illumination …' à '… only on SZA …' Changed

4. P6 L153: '… or broadband irradiance irradiance …' à '… or broadband irradiance …'Changed

5. In Sect. 3.5, it is not immediately clear what is meant with 'constant spectral resolution', especially in P15 L293-294: '… obtained for varying constant spectral resolution.'.

Yes, we agree that it was not clear. This was changed as follows :

"\subsection{Comparison to calculations **with regular spectral resolution**}

In Fig. \ref{fig:6} we compared the broadband albedo bias obtained with the VALHALLA methods to the bias obtained for **spectral resolution varying from 2 to 100 nm**. The comparison was performed using the simulations from section \ref{subsec:numerical}. For **regular spectral resolution**, the absolute bias generally increases with the spectral steps and tends to be more negative. This means that the bias on the absorbed energy tends to be more positive when the spectral steps increase. We believe that for **low** spectral resolution, "

6. P15 L296: 'We believe that for large spectral resolution…'. This should be low resolution. Changed

7. P18 L334: 'The tps were taken into account in the method (30 tps), …'. I don't understand this.

The sentence was removed since it was confusing and the beginning of the paragraph was changed to:

"**The accuracy of the method is sensitive to the locations and to the number of tps.** "

8. P19 L366: 'ration' à 'radiation'Changed

The following sentences can be reformulated to improve readability:

1. P15 L289-290: '… is absorbing a large amount of energy, such as with an important LAPs concentration, the biases on…'.

The sentence was changed to : "**The biases on the spectral and broadband energy increase with the amount of energy absorbed by the snowpack**".

2. P15 L301-302: 'However, for the … at 20 nm resolution.'

"The **VALHALLA** method uses **30 wavelengths (30 tps) when the calculation at 20 nm resolution requires 184 wavelengths**. **Thus**, for the same bias on the broadband albedo, the **VALHALLA** method uses six times fewer bands than a calculation at 20 $\si{\nano\meter}$ resolution."