Estimating degree-day factors based on energy flux components

Referee #3: Rijan Kayastha (Comments and Responses)

General Comments

This paper tries to do something new on the positive degree-day factor by analysing different previous research which is very good. It is good that the authors still agree that the conventional degree-day approach is still good to use where data are insufficient. I have found the paper deals with the shortwave radiation calculation in detail which is very good for data insufficient regions. But the others such as the need of using different degree-day factor for space and time has already been applied in many previous researches and need to mention in this study. I also like to comment on the symbol used for a degree-day factor; in the past papers degree-day factor is denoted by the letter "k or K" but nowadays DDF is being used. The authors should also think about this issue. About the use of the degree-day factor in a climate change study, if we consider all parameters which affect the degree-day factor and assign the degree-day factor accordingly, it will still give a good result. Authors should also think about it.

Dear Reviewer,

Thank you very much for your helpful comments and suggestions to improve the manuscript. We are very grateful for the manuscript summary. In the revised manuscript, we shall mention the related studies where the authors highlighted the need of using degree-day factors for space and time. We agree that in the past for denoting the degree-day factor symbol '*k*' (e.g. Braithwaite, (1995b) or '*a*' (Rango and Martinec, 1995)) has been used. But in this study we used '*DDF*' because '*k*' has been already mentioned for von Karman's constant. We agree that in climate change studies if we consider all the parameters affecting the degree-day factor, it will give good results. But in present study we have tried to highlight that how the degree-day factors might vary under climate change, keeping in view the data constraints. In our opinion, if comprehensive dataset is available then it would be appropriate to use energy balance models. Of course, it makes sense to estimate the influence of each effecting parameter on the *DDF*.

Keeping in view all of your comments and suggestion, we shall make numerous changes in the revised version of our manuscript. Below, we repeat each of your comment and our reply to them one by one. All responses are in blue font for clarity of reading.

Muhammad Fraz Ismail
On behalf of all the authors

Specific comments

Line 118: Need to mention the name of the country (Germany) after Ammergauer Alps.

We shall add the country name in the revised manuscript.

Line 260: It should be "The net longwave radiation flux …….

We shall update it in the revised manuscript.

Line 261: Equation (20) should be at line 264 instead of line 261 at present. The sentence does not look good at present.

In the revised manuscript we shall place equation at line 264.

Line 233: Need to use a different letter for a coefficient other than k. Because k is used as Von Karmann constant on line 310.

We agree and it will be replaced with 'k_{Rs}' in the revised manuscript.

Line 404: should be degree-day models instead of "degree-day factor models."

Thank you for your comment. We shall update it in the revised manuscript.

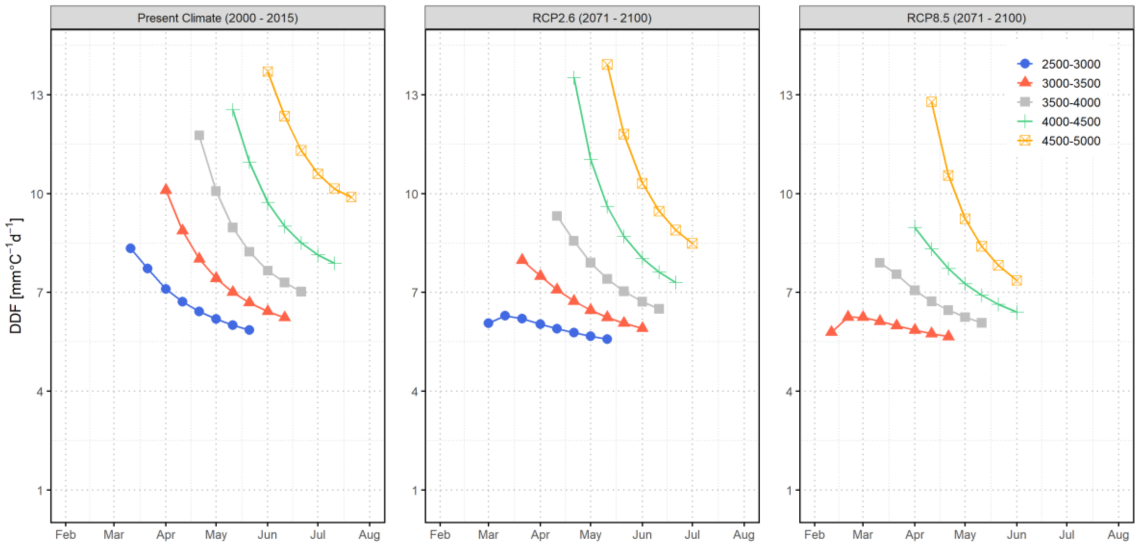
Line 461-463: The result stated in those lines "All of these models show the same tendency of linear increase by altitude, with the altitude factor being comparatively smaller under clear sky compared to overcast conditions" is to some extent is different from the results which we have received on a Glacier AX010 in Nepal (Kayastha et al., 2000).

Actually, figure 4 is showing the relative increase in the altitude factor depending upon sky conditions (i.e. for clear sky K_T = 0.75 and under overcast condition K_T = 0.25). For the same elevation difference, the absolute change in clear sky is greater compared to overcast condition. We agree that we shall clarify this point in the revised manuscript.

Figure 10 shows that the degree-day factor at higher altitudes is higher in a comparative clear sky (in June) compared to July and August (peak monsoon season with a highly overcast period in Nepal). We assumed that due to the overcast situation, air temp does not change much and hence degree-day factors too do not change much. Why in the present study is the altitude factor comparatively smaller under the clear sky?

In Figure 10, we have tried to show the expected changes in the degree-day factors based on projected climate change (i.e. in this case temperature change). In this particular case, we have kept sky conditions as constant (i.e. clear sky). In addition, we have not applied any altitude factor in this specific case like we have done in figure 9 (b). But if we apply the clearness altitude factor then it would change the results as shown in the following figure. If sky conditions are changed then of course it will also alter the degree-day factor.

We agree that July and August are the peak monsoon season in this region with a highly overcast periods, so it will definitely impact the degree-day factors. We think that your comment here about the altitude factor is related to figure 4 which has been answered in the previous question.



Line 639 -640: This statement “Under overcast conditions, however, the DDF is virtually stable ranging from 4.4 to 4.5 mm °C-1 d-1 in the same period” is in agreement with what was shown in Figure 10 in Kayastha et al. (2000).

Thank you for your comment. We shall add the necessary citation in the revised manuscript.

Line 760-761: The message of this statement “Therefore, and as pointed out by many researchers, the DDF cannot be considered a constant model parameter. Rather, its spatial and temporal variability must be taken into account ….” Has already been implemented in Kayastha et al. (2020; Table 3) in which we have used two sets of degree-day factors; lower degree-day factor at lower altitudes (lower than 5000 m) and higher degree-day factor for higher altitudes (above 5000 m). Also, monthly degree-day factors are used to incorporate the seasonality of degree-day factors.

Thank you for your comment and necessary clarification. We shall add the important citation in the revised manuscript. We agree that it is important to consider the spatial and temporal variation in the degree-day factors.

References:

Kayastha, R. B., Ageta, Y. & Nakawo, M. (2000). Positive degree-day factors for ablation on glaciers in the Nepalese Himalayas: case study on Glacier AX010 in Shorong Himal, Nepal. Bulletin of Glaciological Research, 17, 1-10.

Kayastha, R. B. & Kayastha, R. (2020). Glacio-Hydrological Degree-Day Model (GDM) Useful for the Himalayan River Basins. In: Dimri A., Bookhagen B., Stoffel M., Yasunari T. (eds) Himalayan Weather and Climate and their Impact on the Environment. Springer, Cham, Doi: 10.1007/978-3-030-29684-1_19.

We shall add the important references in the introduction section as well.

References:

- Rango, Albert and Jaroslav Martinec. “Revisiting the Degree-Day Method for Snowmelt Computations.” Journal of The American Water Resources Association 31 (1995): 657-669.
- Braithwaite, R. J. 1995b. Positive degree-day factors for ablation on the Greenland ice sheet studied by energy-balance modelling. J. Glaciol, 41(137), 153–160.