Review of "Satellite products of incoming solar and longwave radiations used for snowpack modelling in mountainous terrain"

General comment

This manuscript presents an interesting study on evaluating the usage of Meteosat Second Generation satellite derived solar and longwave radiation products in coarse-scale models. For this the radiation products were first compared to ground measurements in the French Alps and the Pyrenees as well as to forecast fields from the AROME model and analyses fields from the SAFRAN system. While the shortwave satellite radiation products showed lower errors with in situ measurements than modelled fields, a clear conclusion for the longwave satellite radiation products could not be drawn (differences around ground measurement uncertainties). Together with forecasts from AROME the satellite radiation products were then used to drive snowpack simulations using the snowpack model Crocus in the French Alps and the Pyrenees. An evaluation with measured snow depth revealed increased biases when using satellite-derived products.

Irradiances derived from the Satellite Application Facility on Land Surface Analysis (LSA SAF) are thoroughly evaluated over mountainous, snow-covered regions, at single points as well as analyzed spatially. The manuscript therefore presents a step towards assimilating high-resolution LSA SAF satellite irradiance products (3 km) over mountainous regions into models with grid cell sizes of only a few kilometers. Overall, the manuscript is well written and I suggest this manuscript to be published once the major comments and corrections listed below were addressed.

Major comments

My major comment or concern is about the used satellite-derived products which has an impact on the evaluation applied over mountainous regions. I might be wrong, but I could not find out if the satellite-derived products were corrected for topographical influences on radiation using digital elevation models which is however important.

For instance, spatial de-biasing in the shortwave radiation products needs to be conducted to reduce errors when applied over mountainous terrain. Meteosat Second Generation satellite-derived solar radiation was corrected before, see e.g. the HelioMont method (Stoeckli (2013), Castelli et al. (2014)).

Also, did you consider any topographic corrections for the downward longwave radiation product; I believe the algorithm suggested by Trigo et al. (2010) does not introduce limited sky view.

Please clarify and discuss both.

Specific comments

Line 102-104: What are you using the AROME forcing for? Please explain why you are using air temperature and relative humidity in 2m but wind and precipitation in 10m.

Line 120-122: How are the reanalyses interpolated at the exact station locations? Please clarify.

Line 151-152 and Line 160-161 : Please clarify the given target accuracy, i.e. citation. How was it derived ?

Line 170 : If possible, can you add the approximate or range of height of the "first operational atmospheric level" of AROME?

Section 2.2.4 "New DSLF product using AROME forecasts" : What is the reason that you first interpolate the AROME forecasts to the LSA SAF grid? Would it be possible to apply the algorithm directly on the AROME grid assuming the same cloud fraction in all AROME grid cells covered by the coarser LSA SAF grid cell? Maybe this way you could profit from the higher resolution temperature fields as the improvement between DSLF and DSLFnew is not that obvious based on Figure 3.

Line 182-183: I believe the statement that elevation is one of the most significant factors of surface radiation needs clarification. I guess this depends on scale, i.e. represented topographic complexity. There are also differences for shortwave and longwave radiation (as you also found (Figure 7)). Please discuss.

Line 230-233 : Did you evaluate the scenario : shortwave from DSSF and longwave from DSLF ? How do the results compare to those from your scenario c) ?

Line 242-243 : Why did you select a maximum elevation difference of 150 m between AROME grid cell elevation and station elevation for compiling a set of suitable snow depth measurements? In Line 185 you selected a maximum elevation difference of 300 m between AROME grid cell elevation and LSA SAF grid points. What are the reasons for the differing values? Please discuss.

Line 253-255: Please mention briefly which method you used to derive the terrain horizon, e.g. interval size or add a reference.

Line 255: Please specify why the horizon was not computed for Andorre and Envalira. Are those stations without topography in the surroundings?

Line 273: Can you add a similar table for the longwave measurements as Table 1 for the shortwave measurements? The table would give additional inside to the performance with regards to measurement uncertainties and altitude differences between model grid cell and station.

Technical comments

Line 40: Consider removing "were".

Figure 4: Please increase all labels and legend.

Line 295: Please rephrase : "Whatever the hour, AROME overestimates SW."

Figure 9: Please rephrase the last sentence in the caption.

Line 442 : Consider refering to Figure 2.

Line 446 : Consider refering to Figure 3.

Line 534-536 : Consider adding to "…due to a too strong altitudinal gradient. " that the gradient arises from the cold bias in AROME air temperatures.

References :

Stöckli, R. (2013). The HelioMont surface radiation processing. Scientific report MeteoSwiss, 93, MeteoSwiss: Federal Office of Meteorology and Climatology (123pp.)

Castelli et al. (2014). The HelioMont method for assessing solar irradiance over complex terrain: Validation and improvements. Remote Sensing of Envirnoment 152, 603-613.