Anonymous Referee #2

This paper presents a modified version of the well known model SEBS. Two new features are presented: 1- a new kB-1 formulation for bare soil surfaces, which corrects a well documented overestimations of kB-1 by the original Brutsaert formulation (this aspect is, in the paper, secondary); 2- a method to account for topographical effects on radiation exchange. The new model algorithm is well documented and could be useful for applications in other mountainous regions. Both improvements are welcome, since in mountainous regions, bare soils are frequent and topographical effects prevent from using an average regional aerodynamical resistance and therefore methods based on the triangle method etc. Unfortunatly, the paper does not provide the comparison with performance values obtained at the same EC tower location with the original kB-1s formulation, nor does it build on enough data (one EC tower on what seems to be flat terrain) to evaluate the topographical module in a satisfying way. Some qualitative checking on several key elements (glacier for instance) allows to verify the realism of the new model. If the EC tower footprint at the 8 dates includes slanting terrain, please provide information on the slopes and azimuth angles of the pixels included in the footprint, as well as the performance of the original TSEB model that ignores topographical effects. Moreover, the climate forcing is spatialised from a single meteorological tower, which is not surprising in such a remote environment, and one could ask if alternative, even indirect, information could help solve the regionalisation issue for the climate forcing (regional climate model outputs , integrated moisture and temperature profile from atmospheric sounder etc, I’m not a specialist in the matter). In my view, the authors should concentrate on the improvement of the bare soil KB-1 evaluation rather than on the topographical module, by providing statistics of the original Zu (2002) model performances, and publish TESEBS in a journal such as Env. Modelling Software, or, alternate solution, provide a more comprehensive (even qualitative) assessment of the model performance in slanting terrain, the actual evaluation at regional scale being insufficient according to me.

Response:

In a paper that was just accepted by Journal of Applied meteorology and Climatology, Chen et al. (2012, JAMC), the new kB_1 has already been validated at four sites with different land covers on the Tibetan Plateau. We now listed the paper in the reference.

In the new version, the following table was added: to show comparison between TESEBS and SEBS in this study.

		TESEBS	SEBS
Sensible heat flux	**RMSE**	**31.1**	**34.6**
	MB	**-15.8**	**-21.7**
Latent heat flux	**RMSE**	**25.0**	**25.1**
	MB	**-6.8**	**-10.2**

From it, we can see that both RMSE and MB of sensible heat and latent heat flux show that TESEBS is better than SEBS. Compared to SEB (Su 2002), TESEBS has reduced mean bias about 5.9 Wm^{-2} and 3.4 Wm^{-2} for sensible heat flux and latent heat flux, respectively.

The slope and azimuth angles of the pixels around the EC tower are shown in the following figure 1. The terrain in the EC footprint is nearly flat. The EC flux tower is usually suggested to be setup on a flat surface. Otherwise the slope wind or other circulation can contaminate the quality of flux data. So it`s better to evaluate the satellite turbulent flux with measurement on horizontal and homogeneous place. For radiation evaluation, it is better to evaluate both on flat and inclined surface. The Landsat satellite pass time is around 10:30 am at local time. The sun hour angle is about 56 degree. From Fig. 2, it can be seen that solar diffuse radiation contributes 50 Wm^{-2} of a 350 Wm^{-2} solar radiation at the surface of the station. For the slopes facing the solar incoming direction, reflected solar radiation can be as high as 100 Wm^{-2}. This part of radiation has important meaning for the surface energy balance of snow and glaciers on the mountain slope, but these information in SEBS is not valid. All this remind us the importance of topography effects and have

to be considered in the model. This is a first step. Meanwhile, we are also looking for more observations over mountain area to evaluate the model.

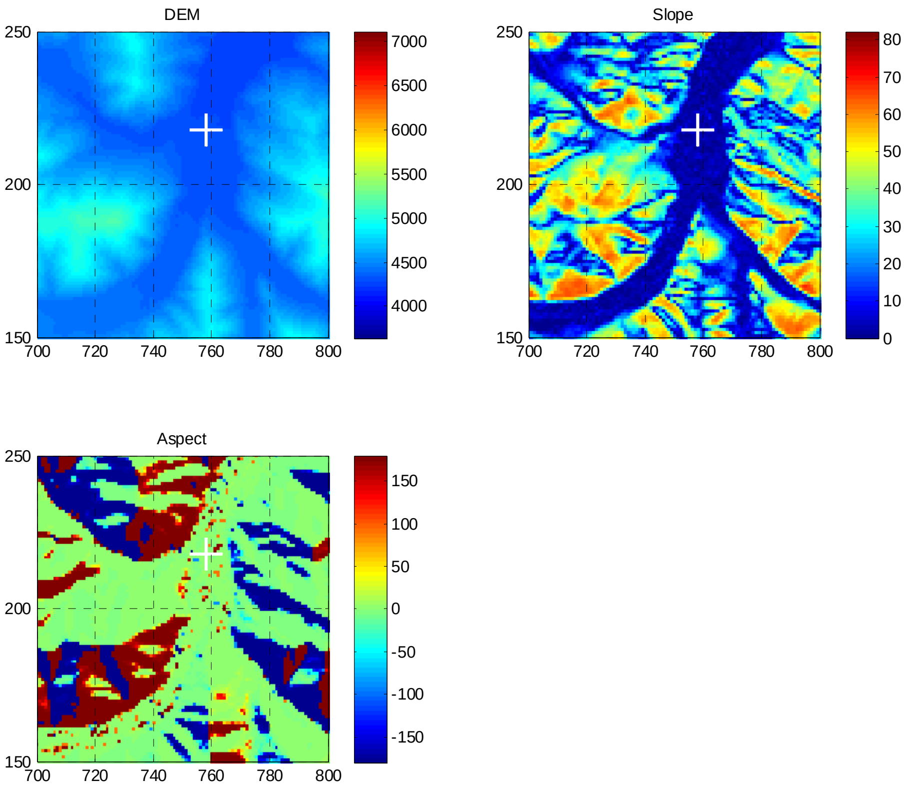

Fig. 1. The DEM (unit: m), slope (unit: degree, 0-90°) and aspect (unit: degree, change between -180 and 180 degree from North to West, South and North in anti-clock wise direction) information around the station.

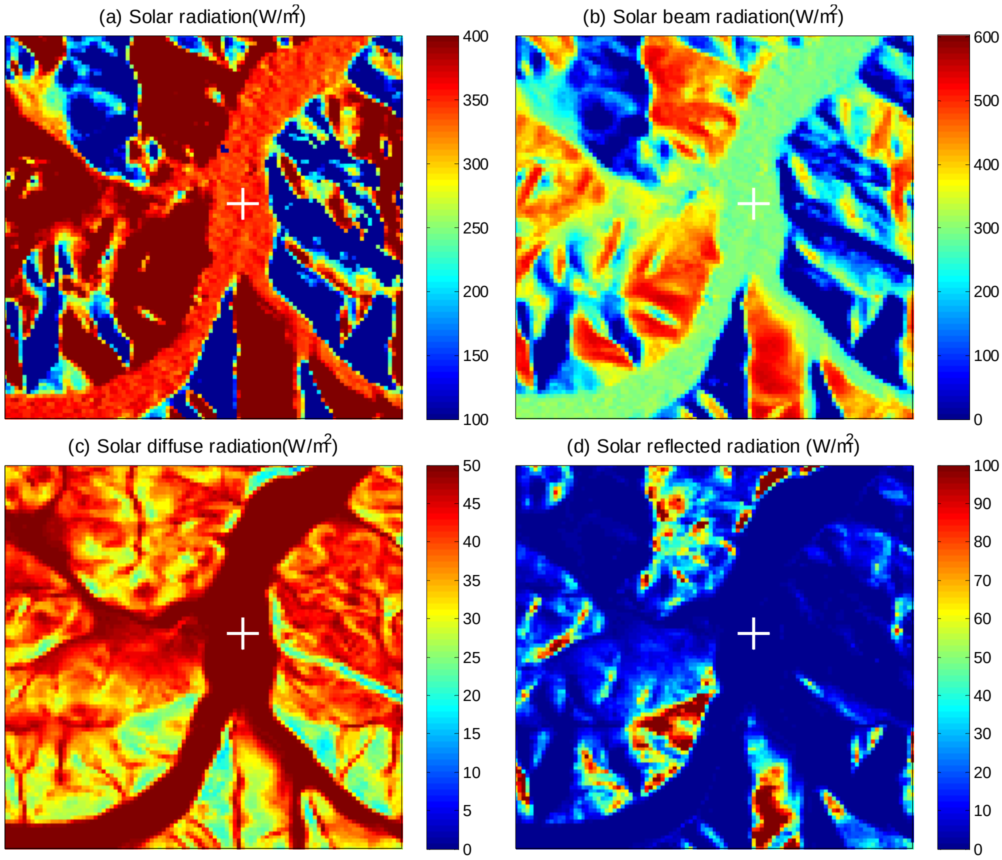

Fig. 2. Distribution of each surface solar radiation items around the station.

Unfortunately, there is no other station that has long term turbulent and radiation flux measurements around this area. Setting up surface energy balance measurement on the Mt. Everest is very costly and difficult. This limits the model to have a full evaluation as the reviewer suggested. There are no solar beam, diffuse, and reflected radiation measurements at our station, which makes it difficult to evaluate these three variables. Nevertheless, the radiation model was developed by one co-author, which has already been validated in several studies for different regions worldwide, including the Tibetan Plateau, such as:

Gueymard, C. A., 2003: Direct Solar Transmittance And Irradiance Predictions With Broadband Models. Part I: Detailed Theoretical Performance Assessment, Solar Energy, 74 (5), 355-379.

Gueymard, C. A., 2003: Direct Solar Transmittance And Irradiance Predictions With Broadband Models. Part II: Validation With High-Quality Measurements, Solar Energy, 74 (5), 381-395.

Madkour, M.A., M. El-Metwally and A.B. Hamed, 2006: Comparative study on different models for estimation of direct normal irradiance (DNI) over Egypt atmosphere, Renewable Energy, 31(3), 361-382.

Yang K, He J, Tang W, Qin J, Cheng CCK (2010) On downward shortwave and longwave radiations over high altitude regions: Observation and modeling in the Tibetan Plateau. Agricultural and Forest Meteorology 150: 38-46.

So we think it is feasible to use this model for the Tibetan Plateau.

Here, the meteorological forcing was spatialised from a meteorological tower, meanwhile it can also be adopted from other weather forecast models. The forcing dataset can also be interpolated from NCEP, ERA-Interim, or other reanalysis data after considering topographical effect.

ETM sensor has a failure of the Scan Line Corrector and clouds often occur over the mountain area, and both limit the availability of scenes in clear sky condition. When the satellite data is selected, the meteorological dataset is also needed to check whether it has observation at the satellite passing over time. All these make the available data for the evaluation become limited.

Detailed comments:

P10426L23: "Time series.... local scale": isn’t it the core of the paper ? why isn’t it shown here ?

Response: These contents are presented in the aforementioned paper (i.e. Chen et al., 2012, JAMC), which is just accepted.

http://journals.ametsoc.org/doi/abs/10.1175/JAMC-D-12-056.1

These results are not the core of this paper and also were not shown here. We added reference Chen et al. 2012 following the content ‘Time series.... local scale’.

Chen X., Su, Z., Ma, Y. M., Yang, K., Wen, J., Zhang Y., 2012, An Improvement of Roughness Height Parameterization of the Surface Energy Balance System (SEBS) over the Tibetan Plateau, Journal of Applied Meteorology and Climatology (accepted). URL: http://journals.ametsoc.org/doi/abs/10.1175/JAMC-D-12-056.1?journalCode=apme

P10416L9: "transport" > "exchange"; L10: reference/background info for Angstrom-Prescott model ?

Response: We prefer to 'transfer'. From equations 3-6, we can see this model is based on solar radiative transfer theory.

The reference is added following Angstrom-Prescott model (Prescott, 1940).

J.A. Prescott, Evaporation from a water surface in relation to solar radiation, Trans R Soc Sci Aust, 64 (1940), pp. 114–125

P10425L16: is z set to the boundary layer height in Eq. 12 ?

Response: No, z is air temperature measurement height, which is said that "θ_a is the potential air temperature at height z."

P10426L6: I don't get why the terrain is "complex": the tower is located on a flat bare soil (fig 1) which covers many Landsat pixels; moreover, with a height of 3.5 meter, the footprint covers at most several (1-10 maybe ?) landsat pixels. Couldn't you use other albedo products ? (ASTER ?)

Response: 'Due to the complexity of the terrain,' was removed. In order to make the model easier for the users, here we only introduced thermal, visible band of Landsat. ASTER albedo can also be one choice, but it may make extra burden for users to combine different sensors together.

Figures 3 and 4: units are missing

Response: The captions of Fig. 3 and 4 were revised with unit information.

Figure 5: geographical info. (scale) is missing.

Response: The geographical information of figure 5-7 is the same as bottom-left picture of figure 1. So in the caption of 5-7, we add the sentence: ’The geographical information is the same as bottom-left picture of figure 1.’.

Figure 6 caption: cross is not a line.

Response: ‘the cross line is the location of the station’ is revised to ‘the cross shows the location of the station’.

Ps. The revised manuscript was also uploaded.