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Atmospheric Measurement Techniques Discussions
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Interactive Comment

Interactive comment on "McClear: a new model estimating downwelling solar radiation at ground level in clear-sky conditions" *by* M. Lefèvre et al.

M. Lefèvre et al.

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General comment. We thank the reviewer for his comments. Answering them will make the text clearer and more precise.

General comments

COMMENT. The authors are presenting a new radiative transfer model (RTM) approach that is based in an existing RTM (libradtran) code. The idea is not something new but the approach includes some innovative features. In order to state that this approach is better than other models a more thorough discussion about advantages and disadvantages of this and other models have to be considered.

ANSWER. We will withdraw our claim that the McClear is better than the state-of-the art models (in abstract and conclusion). This is difficult to establish. One point is to compare the results of comparisons between models and BSRN data as we did between McClear and HelioClim-3v3. Another point is to perform a thorough analysis of advantages and disadvantages of one model compared to others. To that extent, one has to define a set of measures and criteria that may differ depending on the perception of the fitness-for-use of each model, and therefore on the typology of users.

COMMENT. Since we are talking about a cloudless sky model and the libradtran code, Eo values and solar angle dependent parameters are well known, all the weight on the quality of the model is related with other input parameter values such as AOD, WV e.t.c. The final comparison with the BSRN stations include uncertainty related with: a. Difference on the input atmospheric parameters as derived here with the real atmospheric parameters b. Deviations due to the ground based uncertainty (more pronounced in direct beam data and their absolute calibrations) c. Deviations due to the approach of fitting the libradtran outputs in a specific atmospheric case. It is essential to try to estimate and quantify separately these three sources of uncertainties.

ANSWER. We agree with the reviewer. We are not in a position to quantify precisely these sources of error. The uncertainty of MACC outputs and more generally of re-analyses for water vapour content and ozone have been documented by several articles, as for the aerosols. The BSRN data are reputed for their quality, so that we can take for granted that the relative uncertainty of the pyrheliometers is approximately 2%. (WMO #8, 7th Edition, 2008)) To the list of sources of uncertainties, we would add the influence of the difference in support of information: the pyranometers and pyrheliometers are pin-point measurements while MACC re-analyses are grid nodes. There is also the influence of the temporal and spatial interpolation of the MACC data, and indeed many others due to the several approximations made in the model. Each type of error may interact with others in a manner that may depend on several conditions. The only thing we can do for the time being is what we did. Further works are on their

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way that are dedicated to the analysis of the outcomes of McClear in more specific conditions, e.g. in case of large dust load, or in tropical zone.

COMMENT. Concerning the AOD data. For this cloudless sky model approach aerosol data play an important role in certain regions on earth. Mostly desert aerosols from Sahara, fires from the Amazon and urban pollution at China are the first ones that play the most important role in solar irradiance changes with no clouds, globally. In this comparison only limited data from such areas exist, here. Authors need to exhibit the performance of the model to such cases. Meaning isolating such aerosol cases from the sites within such areas.

ANSWER. We agree with the reviewer. As mentioned in our answer to the previous point, more specific studies are on track, especially for desert aerosols. Here, we have only a limited number of reliable data sets in BSRN in desertic areas: Sede Boqer and Alice Springs, and to a lesser extent Tamanrasset which is located on a rocky mountain. We do not have data in Amazonia. As for polluted areas in China, only Xianghe is available.

COMMENT. RMSE should increase with increasing solar zenith angle. Do you mean that relative RMSE is constant?

ANSWER. Actually, the RMSE has a tendency to decrease as the solar zenith angle increases. The following graphs exhibit the changes in RMSE with the solar zenithal angle for the global and the direct irradiance. It is only a tendency as one may note that the changes may be complex. The relative RMSE is not constant as shown in the following graphs (Figs 1 to 4).

COMMENT. Figures from more complex sites than the one chosen here could be useful to discuss the results.

ANSWER. The site of Payerne was initially selected because it is the origin of the BSRN network and is certainly one of the most known. Below are graphs for the

Xianghe station. They will be put in the revised version.

Other comments

COMMENT. P5 line 22 : Profiles of what quantity ?

ANSWER. This should be read as “vertical profile of temperature, pressure, density, and volume mixing ratio for gases as a function of altitude taken in the AFGL data sets (see section 3.2)”. This has been corrected in the revised version.

COMMENT. The Monte Carlo approach needs some clarifications.

ANSWER. We thank the reviewer to underline this point. Indeed, we forgot to mention that we were modelling the marginal distribution, and not the distribution of the properties themselves. The text is now:

“The optimization was done for each of the 10 inputs listed above. A Monte-Carlo technique is applied to randomly generate sets of inputs to libRadtran within the 10D-space, with the exception of the current parameter which is regularly sampled with a small step. The optical properties were selected by considering their observed marginal distribution. More precisely, the uniform distribution is chosen as a model for marginal probability for all parameters except aerosol optical thickness, Angstrom coefficient, and total column ozone. The chi-square law for aerosol optical thickness, the normal law for the Angstrom coefficient, and the beta law for total column ozone have been selected. The parameters of the laws are empirically determined from the analyses of the observations made in the AERONET network for aerosol properties and from meteorological satellite-based ozone products.”

COMMENT. P3373, L10-12: what exactly do you mean by the uniform law ?

ANSWER. The uniform distribution means that any value in the random selection has the same statistical weight.

COMMENT. Xianghe results are poor in terms of correlation and similar to other stations in other statistical parameters. How is this possible, is not shown or explained.

ANSWER. We thank the reviewer for this point. It turns out that the low correlation coefficient is due to the limited range of values taken by direct irradiance and the direct clearness index. See graphs above. One may compare to Payerne since the graphs are given in the submitted paper. The direct irradiance for Payerne ranges between 250 and 800 W m 2 while it ranges between 550 and 800 W m 2 for Xianghe. There is a large difference in dynamics from a statistical point of view which leads to a lower correlation coefficient. This is even more true for the clearness index for direct irradiance which is concentrated around 0.8 for Xianghe, and more expanded for Payerne: 0.55 to 0.7.

Interactive comment on Atmos. Meas. Tech. Discuss., 6, 3367, 2013.

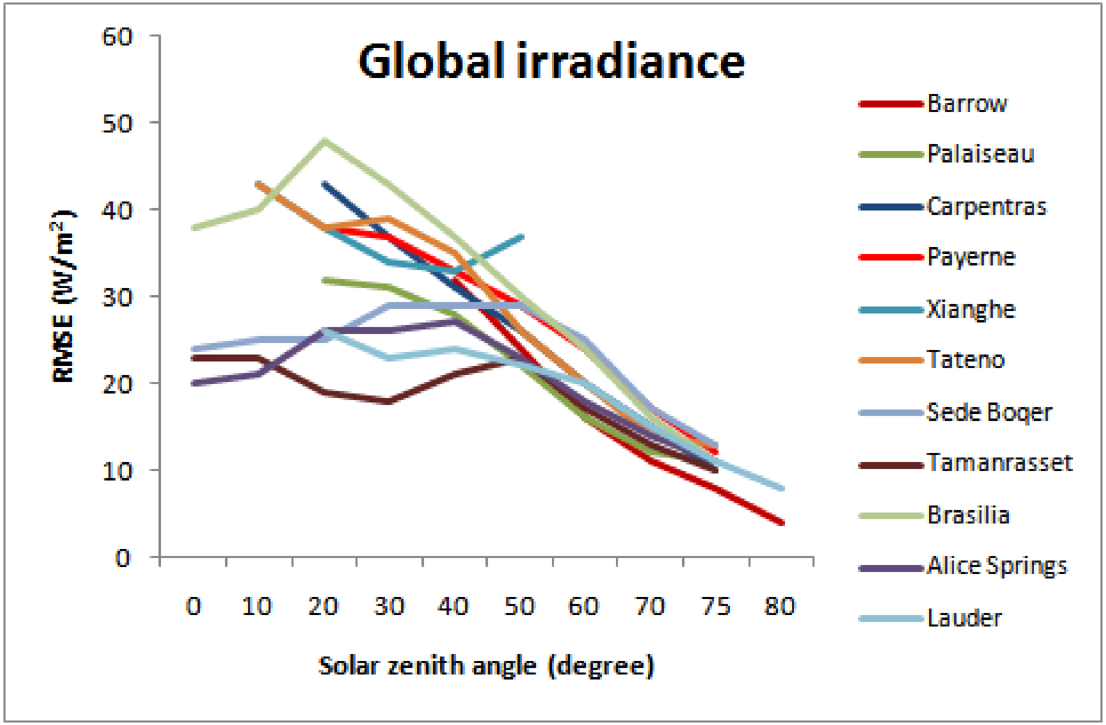

Fig. 1. RMSE as a function of the solar zenith angle for each station. Global irradiance

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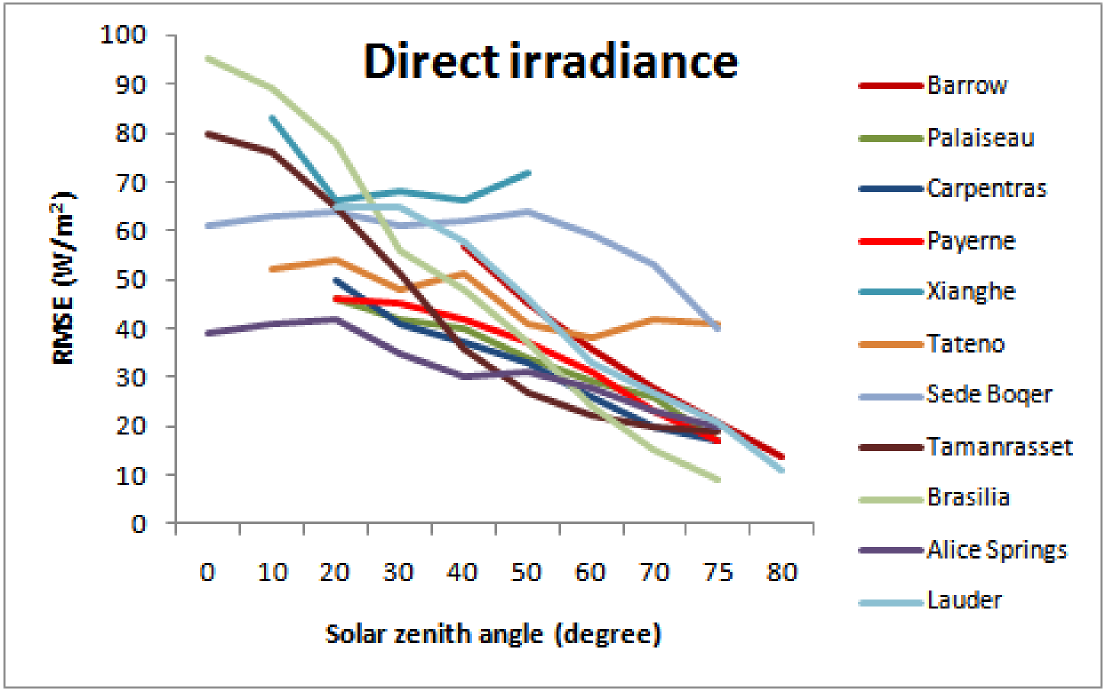

Fig. 2. RMSE as a function of the solar zenith angle for each station. Direct irradiance

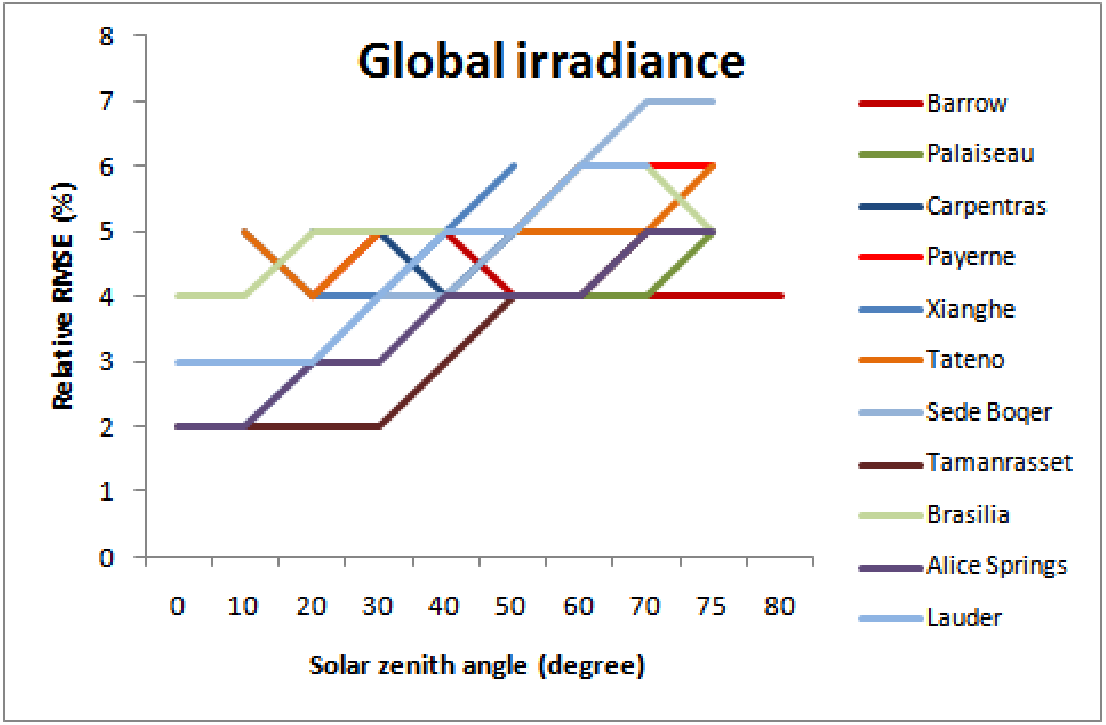

Fig. 3. Relative RMSE as a function of the solar zenith angle for each station. Global irradiance

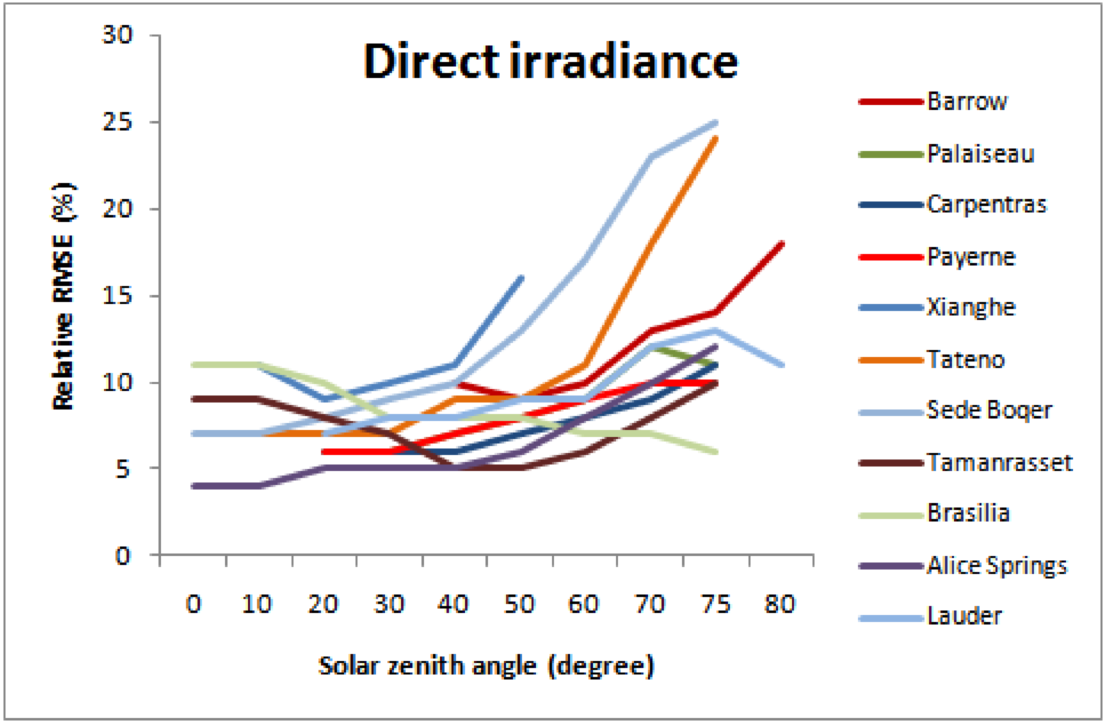

Fig. 4. Relative RMSE as a function of the solar zenith angle for each station. Direct irradiance

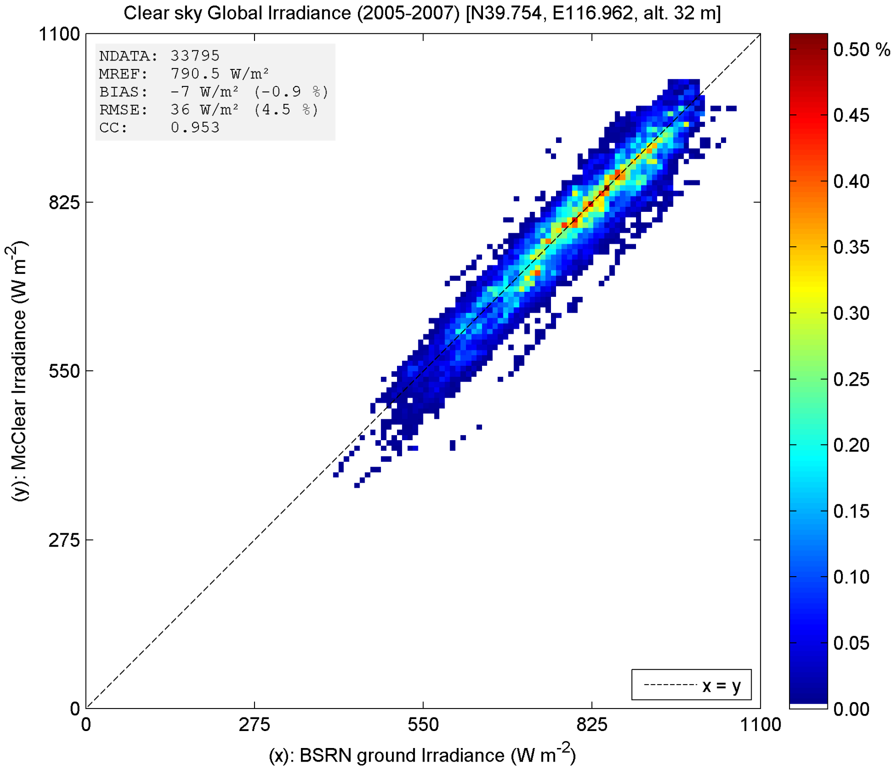

Fig. 5. Scatter density plot between BSRN 1 min clear-sky data and McClear. Xianghe. Global irradiance on horizontal surface.

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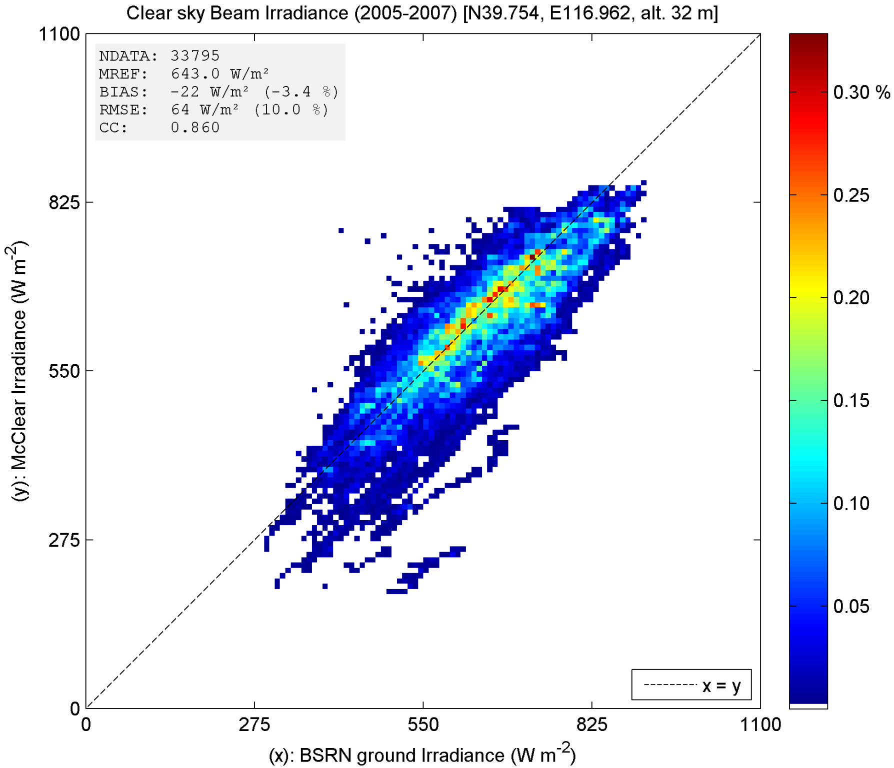

Fig. 6. Scatter density plot between BSRN 1 min clear-sky data and McClear. Xianghe. Direct irradiance on horizontal surface.

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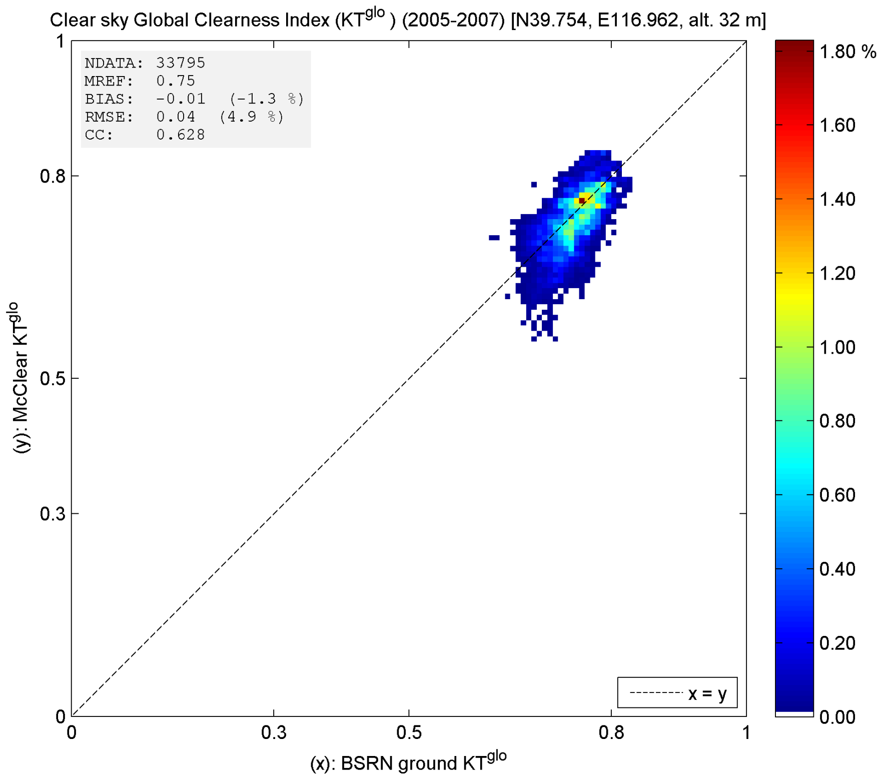

Fig. 7. Scatter density plot between BSRN 1 min clear-sky data and McClear. Xianghe. Global clearness index KT.

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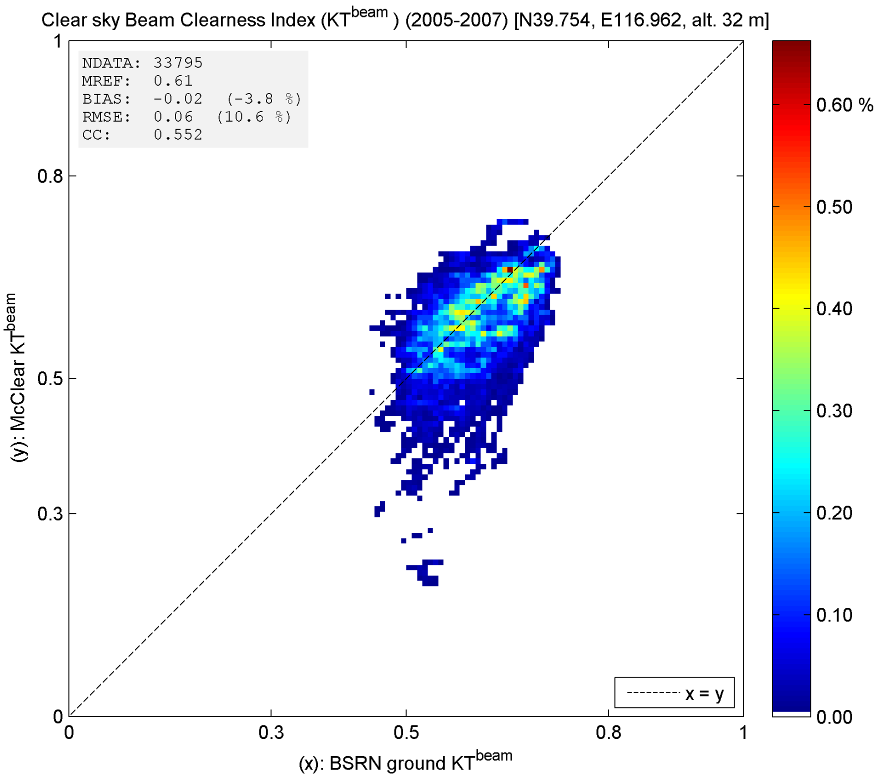

Fig. 8. Scatter density plot between BSRN 1 min clear-sky data and McClear. Xianghe. Direct clearness index KT.

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