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Hydrology and Earth System Sciences Discussions

Interactive comment on "Estimating surface fluxes over the north Tibetan Plateau area with ASTER imagery" *by* W. Ma et al.

W. Ma et al.

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First of all, we would like to thank the Anonymous Referee #2 for your careful work and very useful suggestions. We will try to take advantage of your advice for improving the revised manuscript. For an easier comprehension, the comments of the R2 (Anonymous Referee #2) are also reported. At the same time, the reply part uses the red typeface.

R2: 1707/19ff: It sounds as this paragraph already states the data processing used for the actual study but I assume that this paragraph should only summarize the current state of the art. Please clarify.

Answer: Yes. You are right, this paragraph only summarizes the current state of the art.

In the paper we mentioned so many References in order to explain that remote sensing data can be used to derive the land surface parameters and surface heat fluxes.

R2: 1709/24ff: For a more complete overview of the techniques applied in this study, please shortly explain the technique mentioned for the retrieval of the land surface temperature as you have already did it for the other parameters of interest.

Answer: This part is a general introduction for how to derive the land surface heat fluxes. We have added the introduction of land surface temperature (Tsfc) using red typeface in the revised manuscript as follow: Hook (1992) evaluates a technique developed to extract emissivity information from multispectral thermal infrared data. The techniques are the assumed Channel 5 emittance model (reference channel model). They permit emissivity information to be derived from all five ASTER channels. The assumed Channel 5 emittance model only permits emissivity values to be derived from four of the five ASTER channels.

Other parameters are explained in the following parts.

R2: 1710/25: For the computation of longwave radiation fluxes you have to assume certain atmospheric conditions. Please specify what kind atmospheric profiles do you use?

Answer: Atmospheric model uses MOTRAN in this paper. Model atmosphere is midlatitude summer. Type of atmospheric path is slant path. Model of execution is thermal radiance. The others, such as temperature, pressure, water vapor, ozone, methane, nitrous oxide, carbon monoxide, other gas, altitude profile, are all in midlatitude summer. Aerosols model used rural-VIS=23km. Ground altitude above sea level is 4.5km. We have added in the revised manuscript.

R2: 1711/18ff: Please explain the the data base for the empirical retrieval of equation 4 (i.e. how many data pairs have been used, how have they been selected etc. and what was the general correlation between them?)

HESSD

5, S1700–S1708, 2008

Answer: Thank you for your very useful comments and suggestions. Eighteen data pairs have been used for the empirical retrieval of equation 4, and all the data was observed under the clear day. Then we derived equation 4 to determine regional soil heat flux.

R2: 1712/02ff: If I understand correctly, the area-wide distribution of the sensible heat flux is solely dependent on the satellite retrieved surface temperature (air temperature is linearily computed from the surface temperature). All other parameters of eq. 5 have been held constant over the entire research area. If this is correct please explicitly mention that, if not, please explain how e. g. the roughness length has been distributed in space. In addition, please shorthly discuss the retrieval of eq. 9 (i. e. data base, correlation etc.).

Answer: Prime formula of sensible flux is eq. 5. In this equation, aerodynamic resistance ra include many parameters, such as Von-Karman constant; friction velocity, reference height, zero-plane displacement height, the aerodynamic roughness, the excess resistance for heat transportation, the stability correction function for heat etc. The area-wide distribution of the sensible heat flux is NOT solely dependent on the satellite retrieved surface temperature, e.g. the roughness length in each pixel is derived from NDVI (Jia et al., 1999). Eq. 9, Ta(x,y)=0.7784Tsfc(x,y)+60.1706, is derived from AWS (Automatic Weather Stations) data.

R2: 1714/01ff: The validation of the retrieved datasets has some drawbacks. You do not mention the number of stations used for the comparison (i. e. how many pixel values of the ASTER images could have been compared etc.). Moreover, it is not clear to me if the station measurements are realy indepentend of the measurements used to derive the empirical functions in chapter 2. If they are not indepented, they are of no use for the validation and you have to select other ASTER scenes. In addition, you only mention mean deviations for all three images - are there differences of the agremment between the seasons? Although I do not understand why you haven’t included more ASTER datasets in the first place? Alternatively (if you had problems with the sta-

HESSD

5, S1700–S1708, 2008

Interactive Comment

tion measurements or something like that) you could have used precomputed MODIS product datasets and compare their data values to your ASTER products.

Answer: Thank you very much for your nice comments and suggestions. We know that the ASTER coverage is 60 kmŒ60 km. As a result of the Tibetan weather and climate reason, it is very difficult to find the cloudless day for ASTER data. After our endeavor, we had found 3 scenes of ASTER data finally. It is a pity that only BJ station is inside the ASTER scene, other stations were not covered. But we are very happy to see, the remote sensing results and the land surface observation data have the very good consistence. At least an explanation of our parametrization plan is feasible in the Tibetan Plateau. We have the turbulent heat flux measurement and AWS in BJ station. We have used the land surface flux obtained from the AWS (automatic weather station) profile (gradient) data and have compared with the turbulent data. The result revealed that the surface flux derived from the profile data is credible. That is, we may use the profile data as the “ground truths”, using the ground truth to validate the remote sensing results is feasible. By the way, the observed profile data are obtained in the large-scale international cooperation experiment, the observed data are more credible, laying the foundation for the remote sensing validation. As already said we have selected only 3 scenes of ASTER data since more are very difficult, due to the fact that in Tibetan Plateau area, at noon, the convection intensifies, the cloud layer thickens, it becomes very difficult to find cloudless ASTER data. In Tibet Plateau area, the MODIS product is not very good, particularly the land surface temperature, the MODIS result is not suitable using directly in Tibetan Plateau area to understand local land surface processes due to the resolution. Therefore we use our parametrization method and ASTER data plan to calculate the land surface fluxes.

R2: 1716/20ff: Initialy you have rejected "low" resolution sensors like AVHRR and MODIS because of the heterogenety of the plateau. Now you propose to use them for the area wide distribution. In my opinion, MODIS would have been the first choice in the first place because of the nature of the task - 15 m area wide datasets for the

HESSD

5, S1700–S1708, 2008

entire plateau are generally not required by the majority of climatological and biological projects – and ASTER could be used for monitoring e. g. intensive plot areas of biological oriented projects. Nevertheless, you can easily aggregate the ASTER images to a 1 km scale, compute your analysis again and discuss the resulting (quantitative) differences between the 15 and 1000 m resolution data to get an initail estimate of the accuracy of MODIS datasets.

Answer: Thanks for your comments and suggestion. At first land surface fluxes have been calculated using the AVHRR data from our group in the Tibetan Plateau area, then used the TM data also to calculate the land surface fluxes. We found that the results of the AVHRR data and the TM data have resolution's problem due to they cannot reflect the land surface real condition. In order to make up this kind of insufficiency, we use the high resolution data (ASTER data) to have a look at the land surface flux of the slight change in Tibetan Plateau area. We discovered that the results of the land surface fluxes value derived from the ASTER data are very good. It is better to explain the land surface heterogeneity in Tibetan Plateau. Just like the reviewer said that MODIS is good in Tibetan Plateau, but as a result of the weather and climate reason, it is very difficult to find the cloudless scene in the day time in the monsoon period. If possible, we will calculate the land surface fluxes using MODIS data in Tibetan Plateau area for a longer time period which we hope sufficient cloudless scenes could be acquired. We thought that reviewer's suggestion is very good. Thanks again.

R2: 1706/26: Please replace "percent" by "percentage".

Answer: We had already made the corresponding revision. In the paper we marked using red typeface.

R2: 1707/15: Please change last sentence of paragraph; e. g.: "Since area-wide information on land-surface - atmosphere interaction parameters is required..."

Answer: We had already made the corresponding revision. In the paper we marked using red typeface.

HESSD

5, S1700–S1708, 2008

Interactive Comment

R2: 1707/25: Please change "emessivity e IS derived" to "emessivity e ARE derived".

Answer: Thanks. We have changed it in the revised manuscript. In the paper we marked using red typeface.

R2: 1708/14: Please replace "were rare" by "are rare".

Answer: We have changed it in the revised manuscript. In the paper we marked using red typeface.

R2: 1708/17ff: Please change second part of sentance; e. g.: "...1 km x 1 km and sub-pixel heterogeneity has been omitted."

Answer: We have changed it in the revised manuscript. In the paper we marked using red typeface.

R2: 1708/20: Please change last sentence; e. g.: "The aim of this research is to upscale in-situ point observations of land surface variables and land surface heat fluxes to the regional scale using high-resolution (15 m x 15 m) ASTER Data.

Answer: We have changed it in the revised manuscript. In the paper we marked using red typeface.

R2: 1709/06: Please insert "includes A variety".

Answer: We have changed it in the revised manuscript. In the paper we marked using red typeface.

R2: 1710/03ff: Please delete "evaluates" and modify sentence; e. g.: "Hook developed a land surface...".

Answer: We have changed it in the revised manuscript. In the paper we marked using red typeface.

R2: 1710/14: Please modify sentence; e. g.: "represents the shortwave (...) and L(...) the longwave (...) radiation...".

HESSD

5, S1700–S1708, 2008

Interactive Comment

Answer: We have changed it in the revised manuscript. In the paper we marked using red typeface.

R2: 1710/22: Please modify sentence; e. g.: "where ai(...) are the correspondent ASTER band surface reflections."

Answer: We have changed it in the revised manuscript. In the paper we marked using red typeface.

R2: 1710/25: Please modify sentence; e. g.: "is derived directly from MODTRAN (Ma...)".

Answer: We have modified it in the revised manuscript. In the paper we marked using red typeface.

R2: 1713/05: Please change sentence to "functions ... ARE written as ...".

Answer: We have changed it in the revised manuscript. In the paper we marked using red typeface.

R2: 1714/14: Chapter 2.2.4 is only one sencente. I suggest to include this in chapter 2.2.3 and rename it to "Sensible and latent heat flux".

Answer: In order to make it very clear to the reader we write the manuscript in this way, we thought that the independent part coming out to be well. In this way the reader will understand our purpose very quickly. How do you think?

R2: 1714/07: The content of the sentence ("The derived land surface...") is repeated in the next sentence again. Please mention it only once.

Answer: Many thanks. We have checked this sentence and deleted it.

R2: 1714/11: Please explain the meaning of "BJ".

Answer: In the international cooperation experiment, selecting the observation point is very important. In this time, the "BJ" land surface is quite smooth. It is suitable to

HESSD

5, S1700–S1708, 2008

perform the boundary layer experiment. But what is the name called? There has a village nearby BJ, their village head is called BUJIAO. Therefore we take first letter B and J. It is BJ station. Also the station name of BJ has obtained international scientists unanimous approval. We have explained. In the paper we marked using red typeface.

R2: 1715/10: Please change the sentence; e. g.: "The reason is that the predominant land cover around the lake is composed by desertificated grass which was dry at the time of the measurement."

Answer: We have changed it in the revised manuscript. In the paper we marked using red typeface.

R2: 1715/17: Please modify sentence; e. g.: "The reason is that most OF the land surface...".

Answer: We have changed it in the revised manuscript. In the paper we marked using red typeface.

R2: 1715/25: Please clarify the meaning - do you mean that the good agreement is partly because of the fact that the station has already been used to derive the empirical relationship between the soil heat flux and the satellite datasets?

Answer: Thank you for your comments. We believed that the parametrization of soil heat flux is feasible in Tibetan Plateau area. That is, we gave a parametrization methodology using in Tibetan area. This is our goal.

R2: 1715/xx: Please generally include "the" before "validation site".

Answer:Thanks. We have added the "the" before "validation site".

R2: 1716/02ff: Please modify sentence; e. g.: "This is due to the fact that atmospheric boundary layer processes have been considered in more detail in our methodology and the proposed parameterization for ... can be used over ..."

Answer: We have changed it in the revised manuscript. In the paper we marked using

HESSD

5, S1700–S1708, 2008

red typeface.

R2: 1716/11: Please delete "the" before "field observations".

Answer: We have deleted it in the revised manuscript. In the paper we marked using red typeface.

R2: 1716/13: Please modify sentence; e. g.: "The retrieval of regional...".

Answer: We have modified the sentence in the revised manuscript. In the paper we marked using red typeface.

R2: 1716/16: Please delete "at a specific time of specific day".

Answer: We have deleted it in the revised manuscript.. In the paper we marked using red typeface.

R2: 1716/17: Please modify sentence; e. g.: "To obtaion more accurate regional land surface fluxes (dayly to seasonal variations) over a larger area (Tibetan Plateau), more field..."

Answer: We have modified the sentence in the revised manuscript. In the paper we marked using red typeface.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 5, 1705, 2008.

HESSD

5, S1700–S1708, 2008

Interactive Comment