

Interactive comment on “Estimating surface fluxes over middle and upper streams of the Heihe River Basin with ASTER imagery” by W. Ma et al.

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General comments:

The subject of this paper is quite interesting and meets the scope of the HESS journal. However, the manuscript needs significantly major modifications and improvements before it can be published.

The authors didn't make clear what the objectives of this study are. Is it for the evaluation of SEBS algorithm applicable in an arid and cold environment? Is it for understanding of regional distribution of land surface fluxes over a heterogeneous arid/cold area? For either one of the purposes, the abstract and the introduction needed to be

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refined to reflect the objective of the paper by emphasizing the corresponding aspects.

The description on the ground measurements and satellite data are not sufficient. In general, the data quality in particular the quality of turbulent fluxes data and the procedures for the pre-processing of the turbulent flux measurements should be discussed before data are used.

Energy balance non-closure is a big issue in the experimental study of the near-surface layer of the atmospheric boundary layer. Before using the ground measurement for the validation, it is important to know how good the energy balance closure is for all the sites.

The authors didn't indicate which level of ASTER data were used. If they are higher level products, please indicate what they are. If the raw ASTER data (level 0 or 1) were used, please indicate how the atmospheric corrections were done for all the bands used in the study and what were the required information were needed for the corrections.

How many ASTER images were used in the study? There is an inconsistency in introducing ASTER data throughout the paper: in the abstract, it was said 'The ASTER data of 3 May and 4 June in 2008 was used'; in section 3 'Case studies and validation' it was mentioned that '4 scenes of ASTER data over the mid-to-upstream sections of the Heihe River Basin are used.'; while in the conclusion part, the authors said: 'Only three ASTER images are used in this study.'. Please clarify how many ASTER data were really used in this study.

Several variables appeared in the algorithm SEBS: for instance, roughness length, fractional vegetation cover, windspeed, air temperature and humidity etc without explaining how they were obtained. For instance, I would like to see the following descriptions and explanations: - How the roughness length was calculated at the regional scale? - How the fractional cover was determined from ASTER data? - How the meteorological variables (windspeed, air temperature and humidity) were obtained at the ASTER image

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scale?

As a scientific paper the analyses and discussions on the results are neither comprehensive nor sufficient. As indicated by the authors the study area was quite large and heterogeneous, the land surface properties are expected varying over different sites (Yingke, Huazhaizi, Guantan, Maliantan, A'rou, Binggou and Yakou), thereafter the parameterizations of some crucial variables may need careful treatment over completely different land cover types (from the mountainous forest in the cold upstream to the arid/semi-arid agricultural zone in the mid reach of the Heihe river). The authors didn't give sufficient descriptions on the land cover and vegetation conditions, however. Such information should be included to help understanding the dependence (or independence) of surface fluxes (both from observations and from estimate) on the land cover and vegetation types. Are these site all characterized as arid or cold climate? If there are mountainous areas in the study region, how the ground elevation affects the estimates of fluxes and radiation components? Is there any such consideration in the calculations and parameterizations?

The authors have given the ranges of all the estimated fluxes (page 4626, line 3-8), it would make the paper more solid if some detailed analysis in relation with the land surface properties and in different seasons could be given.

In the section 3 'Case studies and validation', the authors mentioned that the validation was done by comparing the estimations and the measurements of sensible and latent heat fluxes without any description on how the ground measurements were made and by what instruments. Seven stations were mentioned without any description of basic land surface properties and characteristics of turbulent/radiation fluxes at these sites. These information need to be given precisely and in detail. There was no quantitative discussion on the accuracy of the estimates of all the estimated fluxes.

The conclusions were not addressed adequately. See below for the specific comments. Concluding remarks should rely on the analyses and discussions of the results.

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Please make consistent and systematic analysis on the results to arrive at logical and convincing conclusions (including those bulleted points on Page 4625-4626). Once the objective and scientific questions of the paper are refined by the authors, they should also be reflected in the conclusions.

In many cases the literature citations in the paper are not adequate and sometimes not correct (see below for some specific cases).

Specific comments:

Some specific comments are also given directly to the manuscript (see the supplement file).

Please give the full description of all the abbreviations used in the paper at the first place of their appearances. For instance: NOAA/AVHRR, GMS, NDVI, etc, then use the abbreviation only afterwards.

The authors have stated (page 4622, lines 11-13): '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 (15m×15 m) ASTER data.' However, the paper didn't discuss at all how to 'upscale in-situ point observations of land surface variables and land surface heat fluxes to the regional scale'. In addition, the thermal bands of ASTER sensor have the spatial resolution of 90m other than 15m. Please explain how the upscale was done. If the upscaling is not the main objective of the paper, it's better to remove or refine the statement mentioned above.

Page 4621, line 11 and 12: About the term of 'watershed science', please specify precisely what the relevant sector of science in this paper. Watershed science can be rather broad, it is too general to mention in this way.

Page 4621, line 17-18, 26-27: What is the difference between 'land surface variables' and 'vegetation variables'? If the authors are talking about in general the land surface, which is either bare soil or the mixture of soil-vegetation, I would suggest to use only

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'land surface variables' which is applicable to any land surface conditions (either with or without vegetation).

Page 4621, line 20 – 25: The cited literature should reflect the major and original development and algorithms for the land surface variables retrievals, other than those appeared in application cases. I would suggest the author to limit the list of references here to those precisely relevant to the land surface parameters retrievals.

Page 4622, line 11: It is not clear what your point is here. Landsat ETM has a spatial resolution much higher than 1km.

Page 4622, line 11-13: '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 (15m×15 m) ASTER data.' Comments: Besides it is not clear how the authors can upscale in-situ point observations of land surface variables and land surface heat fluxes to the regional scale, the Thermal Infrared Bands of ASTER (which is crucial for land surface fluxes estimates) have 90m × 90m resolution other than 15m×15 m. Please give precisely description at which spatial resolution the study was carried out. Unless the revised manuscript put some emphasize on the upscaling in-situ point observations to regional scale, the above sentence should be re-written to reflect what was exactly done in this paper.

Page 4622, line 16-17: 'The recent availability of high-resolution, multi-band imagery from the ASTER sensor has enabled us to estimate surface fluxes.'. Comments: The above statement gives one an impression that one can estimate surface fluxes only since ASTER observation is available. There are many studies using observations from earlier satellite missions. Please give a more adequate and precise description of problems to be dealt with in this study.

Page 4623: line 6-9: 'SEBS consists of: a set of tools for the determination of the land surface physical parameters, such as albedo, emissivity, temperature, vegetation coverage etc., from spectral reflectance and radiance measurements;...' line 11-12:

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'In this study, the Surface Energy Balance System (SEBS) retrieval algorithm is used for the ASTER data (Su, 2002).' Comments: SEBS as described in Su (2002) did not include the retrieval of surface parameters. Also, the retrievals depend on sensors used. Please give a precise description of models or algorithms used for retrievals of all the land surface parameters using ASTER data referred in this paper.

Page 4623, line 18-19: what kind of information or input will you need to do the calculation using SMAC? Are they available at the regional scale? If not how have you obtained these information?

Page 4623, line 14: 'Liang, 2001', it should be Liang, 2000.

Page 4623, Line 15 and 16: 'Juan (2006)', check at the first name of this author, also there are more than one authors in this paper, it should be xxxx et al (2006). In addition, this paper is on land surface emissivity other than about land surface temperature. Please give the description how the land surface temperature was derived from the ASTER data.

Page 4623, line 20-23: 'The sensible heat flux (H) is estimated from T_{sfc} , and regional latent heat flux (λE) is derived as the residual of the energy budget theorem (Liou, 2004; Ma, 2006) for land surface.'. Comments: These authors (Liou, 2004; Ma, 2006) are not those among the first ones who proposed such a method or concept. Citation should be given to the earliest or earlier studies.

Page 4624, line 11: The fractional vegetation cover is used in the calculation, how was it determined?

Page 4624, line 18: 'and the mean temperature, $\theta_0 - \theta_a$ ', Comments: It should be 'the difference of potential temperature between the land surface and the air'

Page 4624, line 22 - 23: ' τ_0 is the surface shear stress,...' Comments: There is no such a variable τ_0 in Eq. 4 and 5.

Page 4625, line 10: About the referred paper (Ma, 2006): if you have used SEBS

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algorithm for all the fluxes calculations, the citation should be given to the paper that SEBS was proposed originally. Please use correct citations for all the papers/literature throughout the whole manuscript.

In Fig.4, there were 7 experimental sites mentioned in the figure caption, while only the results using part of the data (net radiation from 6 sites, results for soil heat flux, sensible and latent heat fluxes from 4 sites) were shown in the figure. Please in the revised manuscript clarify how many sites there were and explain why only data from fewer numbers of sites were used in the validation.

Page 4626, line 9-11: 'The derived net radiation flux over the study area is very close to the field measurement. It is the result of the improvement on surface albedo and surface temperature.' Comments: How the surface albedo and surface temperature were improved? What were the references to compare with for the improvement?

Page 4626, line 12-14: 'The regional soil heat flux derived from the relationship between soil heat flux and net radiation flux is suitable for heterogeneous land surface of the WATER area, because the relationship itself was derived from the same area.' Comments: The authors have simply taken the equation and coefficients directly from Su (2002) for the soil heat flux calculation, so the relationship is not derived from the same area. Please give a fair and precise statement on your conclusions.

Page 4626, line 15-20: 'The derived regional sensible heat flux and latent heat flux at the validation sites in the WATER area is in good agreement with field measurements (Fig. 4). 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 sensible heat flux and latent heat flux can be used over the upper streams of the Heihe River Basin area.' Comments: Explain how the atmospheric boundary layer processes have been considered in more detail in your methodology. Latent heat flux was estimated as the residual, so in deed there was no parameterization for latent heat. Please give precise description all the time.

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Page 4627, line 3-11: 'Only three ASTER images are used in this study. To obtain more accurate regional land surface fluxes (daily to seasonal variations) over a larger area (the Heihe River Basin), more field observations (ABL tower and 5 radiation measurement system, radiosonde system, turbulent fluxes measured by eddy correlation technique, soil moisture and soil temperature measurement system, etc.) and other satellite sensors such as MODIS (Moderate Resolution Imaging Spectroradiometer) and NOAA (National Oceanic and Atmospheric Administration)/AVHRR (Advanced Very High Resolution Radiometer) with more frequent temporal coverage have to be used.' Comments: What is the inherent relation between 'more accurate regional land surface fluxes over a large area' and the more field observations? And what is the relation with the need of other satellite sensors?

Page 4627, line 12: 'This study implies the SEBS method is only applicable to clear-sky days. ...' Comments: This is not correct. SEBS, as an algorithm of estimating land surface turbulent fluxes, can also be used for cloudy days if the land surface parameters can be derived from the satellite observations somehow.

Page 4627, line 15 – 20: 'SEBS has been developed to estimate atmospheric turbulent fluxes using satellite earth observation data, in combination with meteorological data from a proper reference height given by either in-situ measurements for application to a point, and radiosonde or meteorological forecasts for application at larger scales. On the basis of these experimental validations, SEBS can be used to estimate turbulent heat fluxes at different scales with acceptable accuracy.' Comments: there was no analysis neither any discussion or results to show that 'SEBS can be used to estimate turbulent heat fluxes at different scales' in this paper. The validation done in the study was only for the ASTER pixel scale, say a sole scale.

Please also note the Supplement to this comment.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 6, 4619, 2009.

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