First of all, we would like to thank **Prof. Dr. Li Jia** for her careful work and her very useful suggestions. We will try to take advantage of her advice for improving the revised manuscript. For an easier comprehension, the comments of **Prof. Dr. Li Jia** are also reported. At the same time, the reply part uses the red typeface.

General comments:

Prof. Dr. Li Jia "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 refined to reflect the objective of the paper by emphasizing the corresponding aspects."

Answer: Thank you for your suggestions. "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?" Yes, It's right. I have refined it in the revised manuscript using red typeface.

Prof. Dr. Li Jia "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."

Answer: Thanks for your suggestions.

At first time, the data quality in particular the quality of turbulent fluxes data and the procedures for the pre-processing of the turbulent flux measurements were discussed. After we discussed, this parts were deleted. Because the aim of this paper is estimating surface fluxes over middle and upper streams of the Heihe River Basin with ASTER imagery, not the land surface data analysis.

Prof. Dr. Li Jia "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."

Answer: Yes, you are right.

As we know, in SEBS it is not mentioned the energy balance non-closure. Also I asked Prof. Su about this. Our aim is to evaluate the regional surface heat flux partially, next step we will prepare to validate energy balance closure for all the sites. We think it's a very scientific question.

Prof. Dr. Li Jia "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."

Answer: Thank you for your suggestions.

The level of ASTER data is L1B. I have refined it in the revised manuscript using red typeface.

Prof. Dr. Li Jia "How many ASTER images were used in the study? There is an inconsistence 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."

Answer: There are four scenes ASTER data were used in this study. I have changed it in the revised manuscript using red typeface.

Prof. Dr. Li Jia "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 scale?"

Answer: About the roughness length at the regional scale, we mainly used kB^{-1} to derive it. As we know the equation:

$$z_{0h} = z_{0m}/\exp(kB^{-1})$$

where B^{-1} is the inverse Stanton number. Here to estimate the kB^{-1} value, Su's way is proposed as follows:

$$kB^{-1} = \frac{kC_d}{4C_t \frac{u_*}{u(h)}(1-e^{-ne/2})} f_c^2 + 2f_c f_s \frac{k \cdot u_*/u(h) \cdot z_{0m}/h}{C_t^*} + kB_s^{-1} f_s^2$$

where f_c is the fractional canopy coverage and f_s is its complement. C_t is the heat transfer coefficient of the leaf. For most canopies and environmental conditions, C_t is bounded as $0.005N \leq C_t \leq 0.075N$ (N is number of sides of a leaf to participate in heat exchange). In detail we can see Bob Su's paper. Vegetation coverage can be derive from ASTER data directly. So the roughness length can also be derived.

In SEBS windows, we can direct input the meteorological variables (wind speed, air temperature and humidity) .

I have changed it in the revised manuscript using red typeface.

Prof. Dr. Li Jia "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?"

Answer: Thank you for your suggestions. I have refined it in the revised manuscript using red typeface.

Prof. Dr. Li Jia "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."

Answer: Thank you for your suggestions. I have refined it in the revised manuscript using red typeface.

Prof. Dr. Li Jia "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."

Answer: Thank you for your suggestions. I have refined it in the revised manuscript using red typeface.

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

Answer: Thank you for your suggestions. I have refined it in the revised manuscript using red typeface.

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

Answer: Thank you for your suggestions again. I have refined it in the revised manuscript using red typeface.

Specific comments:

Prof. Dr. Li Jia "Some specific comments are also given directly to the manuscript (see the supplement file)."

Answer: Thank you for your very useful comments. We had already made the corresponding revision. In the paper we marked using red typeface.

Prof. Dr. Li Jia "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."

Answer: NOAA/AVHRR (the National Oceanic and Atmospheric Administration/Advanced Very High Resolution Radiometer), GMS (Geostationary Meteorological Satellite) and Landsat-7 ETM (Enhanced Thematic Mappe).

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

Prof. Dr. Li Jia "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."

Answer: When using SEBS, firstly we resized the ASTER data. Then SEBS can be used in future analysis.

Thank you for your very useful comments. We had already made the corresponding revision. In the paper we marked using red typeface.

Prof. Dr. Li Jia "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."

Answer: The mission of WATER is to improve the observability, understanding, and predictability of hydrological and related ecological processes at catchmental scale, accumulate basic data for the development of ***watershed science*** and promote the applicability of quantitative remote sensing in watershed science studies (Li, 2008). This words were coming from Prof. Li Xin's paper ***(Li, X., Wang, J., Ma, M., et al., (2008), Simultaneous Remote Sensing and Ground based Experiment in the Heihe River Basin: Scientific Objectives and Experiment Design, Advances in Earth Science (in Chinese), 23, 897-914)***. Here our aim is to illustrate the status of WATER area.

Thank you for your very useful comments. We had already made the corresponding revision. In the paper we marked using red typeface.

Prof. Dr. Li Jia "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 'land surface variables' which is applicable to any land surface conditions (either with or without vegetation)."

Answer: Thank you for your very useful comments. We had already made the corresponding revision. In the paper we marked using red typeface. Here only the words 'land surface variables' in the paper.

Prof. Dr. Li Jia "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."

Answer: Thank you for your very useful comments. We had already made the corresponding revision. In the paper we marked using red typeface.

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

Answer: Thank you for your very useful comments. We had already made the corresponding revision. In the paper we marked using red typeface.

Prof. Dr. Li Jia "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 insitu point observations to regional scale, the above sentence should be re-written to reflect what was exactly done in this paper."

Answer: Thank you for your very useful comments and suggestions. We had already made the corresponding revision. In the paper we marked using red typeface.

Prof. Dr. Li Jia "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."

Answer: Thank you for your very useful comments. We had already made the corresponding revision. In the paper we marked using red typeface.

Prof. Dr. Li Jia "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:" '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.

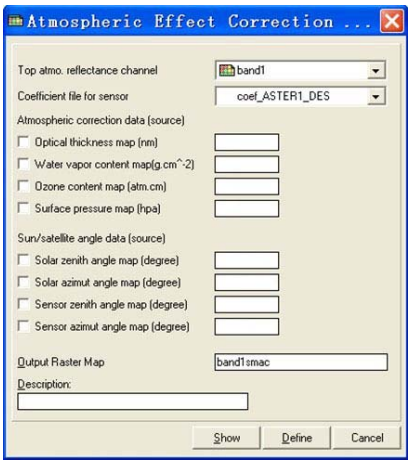
Answer: Thank you for your very useful comments.

The surface albedo is retrieved from narrowband-broadband conversion by Liang (Liang, 2001). The land surface temperature (T_{sfc}) is derived using a method developed by JIMENEZ-MUNOZ Juan C. (2006) from multispectral thermal infrared data. JIMENEZ-MUNOZ Juan C. (2006).

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

Prof. Dr. Li Jia "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?"

Answer: In SMAC, we can see



We can select the parameters in WATER area. Are they available at the regional scale? It is a very useful question! So we use land surface data to validate the remote sensing results. Maybe this is a way to derive the land surface heat fluxes.

Prof. Dr. Li Jia "Page 4623, line 14: 'Liang, 2001' , it should be Liang, 2000."

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

Prof. Dr. Li Jia "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."

Answer: Thank you for your very useful comments.

LST = btemp13 + a1* (btemp13 - btemp14) + a2* pow((btemp13-btemp14),2) + a0

+(a3 + a4* W)*(1-emissivity) + (a5 + a6*W)*dEmissivity .

where btemp13 and btemp14 are the brightness temperatures obtained from two TIR-channels 13 and 14 of ASTER data, emissivity is the mean emissivity, dEmissivity is the emissivity difference, and W is the atmospheric water-vapor content. This way come from JIMENEZ-MUNOZ Juan C. ***(JIMENEZ-MUNOZ Juan C., Sobrino, J., Gillespie, A., et al., (2006), Improved land surface emissivities over agricultural areas using ASTER NDVI, Remote Sensing of Environment, 103, 474–487).***

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

Prof. Dr. Li Jia "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."

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

Prof. Dr. Li Jia "Page 4624, line 11: The fractional vegetation cover is used in the calculation, how was it determined?"

Answer: Thanks. The fractional vegetation cover is used in the calculation and it was determined by vegetation coverage from ASTER data.

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

Prof. Dr. Li Jia "Page 4624, line 18: ' and the mean temperature, θ_0-θ_a,' Comments: It should be 'the difference of potential temperature between the land surface and the air'"

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

Prof. Dr. Li Jia "Page 4624, line 22 - 23: 'θ_0 is the surface shear stress,…' Comments: There is no such a variable τ_0 in Eq. 4 and 5."

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

Prof. Dr. Li Jia "Page 4625, line 10: About the referred paper (Ma, 2006): if you have used SEBS 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."

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

Prof. Dr. Li Jia "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."

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

Prof. Dr. Li Jia "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?"

Answer: Thanks again!

Albedo comes from Liang's way and LST from JIMENEZ-MUNOZ Juan C. The papers' authors said it's a best way to derive the parameters. So we only use it.

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

Prof. Dr. Li Jia "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."

Answer: Thank you for your suggestions. I have refined it in the revised manuscript using red typeface.

Prof. Dr. Li Jia "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."

Answer: Thank you for your suggestions. I have refined it in the revised manuscript using red typeface.

Prof. Dr. Li Jia "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?"

Answer: Here we want to illustrate the application of remote sensing. Thank you for your suggestions. I have refined it in the revised manuscript using red typeface.

Prof. Dr. Li Jia "Page 4627, line 12: 'This study implies the SEBS method is only applicable to clearsky 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."

Answer: Thank you for your suggestions. I have refined it in the revised manuscript using red typeface.

Prof. Dr. Li Jia "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."

Answer: Thank you for your suggestions and comments. I have refined it in the revised manuscript using red typeface.