Answers to the Reviewers' Comments

The quotations of the reviewer's comments are in italic.

Anonymous Referee #1

A two-layer surface energy balance parameterization scheme (TSEBPS) is proposed for the estimation of surface heat fluxes using thermal infrared (TIR) data over sparsely vegetated surface. It was also validated by using the two experimental data sets in this research. Some interesting results were gotten in this study and therefore the subject of the paper is worth to be published. However, the manuscript still has some shortages in current:

1. Page 6796, line 21 to 21, "At present, remote sensing. . . on the regional scale". You should give the references here.
Answer:
We have revised this part of the manuscript according to the reviewer's comment.

2. Page 6797, line 13 to line 18, you should give the references here when you review the single-source model.
Answer:
We have revised this part of the manuscript according to the reviewer's comment.

3. "auto-weather station (AWS)" in the manuscript should be "automatic weather station (AWS)", right?
Answer:
We have revised this part of the manuscript according to the reviewer's comment.

4. You should point out how to get all variables in the equations in your manuscript. I found some of them were missed in the manuscript.
Answer:
We have revised section 2.2 to give a clearer introduction for TSEBPS. This study is based on the theory of the classical two-layer model by Shuttleworth and Wallace (1985) and Shuttleworth and Gurney (1990), as well as the equations of resistances by Choudhury (1989) and Shuttleworth and Gurney (1990). The core of this paper is the new parameterization scheme but the model itself, and the details about the model itself may be found in the original paper or some other references. So only the necessary information about the two-layer model is given in the manuscript. On the other hand, we try to make it as clear as possible about the derivation of the parameterization method.

5. I think G in your equations is surface soil heat flux, right? Normally soil heat flux is been measured at the fixed depth under the surface, you should pointed out how to calculate it to the surface in your manuscript.
Answer:
We have revised this part in section 3 of the manuscript. G is the surface soil heat flux. The measured soil heat flux is the value at the 5cm under the surface for the all sites in this study, and was corrected to the surface by the method of integration using the gradient of soil temperature and the soil heat flux (referenced to, Liebethal, C., Huwe, B., Foken, T. Sensitivity analysis for two ground heat flux calculation approaches. Agricultural and Forest Meteorology, 2005, 132: 253-262.)

6. I think equation (8) is not correct over sparsely vegetated surface. I think there are some more components (eg. soil heat flux) in the right of the equation, right?
Answer:
Since equation (8) is the energy balance model for the foliage, there should not appear the term of soil heat flux. Actually, there are some other terms, such as the energy consumed in photosynthesis process, etc. These terms are very small compared to the sensible and latent heat fluxes, and usually can be neglected in

the equation. So equation (8) is correct.

Based on the comments above, I suggest that this manuscript should be accepted after the revising.

Anonymous Referee #2

The manuscript is a valuable contribution to the literature of surface energy balance.
Some general observations for improvements are listed below.

1. In all four case studies, the net radiation, soil heat fluxes should be presented in order to appreciate the magnitudes of the sensible and latent heat fluxes.
Answer:
We have revised section 4 according to the reviewer's comment. The average value of net radiation and soil heat flux for each site will be presented with the analysis of the model results.

2. The calculation of T0,wet in Eq. 24 is not explained but is necessary.
Answer:
We have revised section 2.2 according to the reviewer's comment. The calculation of T0,wet in Eq. 24 was mentioned briefly in the manuscript, and has been explained with more details in the revised manuscript.

3. The uncertainties of the measurements are mentioned in several places, but are not explicitly indicated for the different measurement methods for the four sites. This needs to be elaborated further site by site.
Answer:
We have revised section 4 according to the reviewer's comment.
The turbulent heat fluxes are measured by Bowen-ratio system in winter wheat sites and Eddy-covariance system in maize site. Both techniques are popular in surface heat fluxes experiments. Generally, it is assumed that EC method is better than the BR method because it measures air turbulence directly. However, the energy imbalance problem of EC data and the data processing methods are still under discussion in the scientific community. The error of BR method during sunrise and sunset moment is quite large and the use of data during that time is limited. In this study, EC data was processed to meet the energy balance with a Bowen-ratio method from reference (Twine et al., 2000), and the quality of BR data was also controlled during data processing. However, it is hard for the authors to compare the different measurement techniques based on the present datasets and give a conclusion about the uncertainties of the measurements in this study. Fortunately, some useful information can be found in the references that analyzed the variation of flux estimation by various micrometeorological techniques based on the datasets obtained in other experiment projects, such as Monsoon'90, FIFE, and ChinaFLUX (Norman et al., 1995, Twine et al., 2000, Massman et al., 2002, Yu et al., 2006). According to the references and other studies that compare model predicted flux with *in-situ* measurements (e.g., Timmermans, et al., 2007), uncertainties of fluxes are about 25~50 Wm^{-2} for H and LE measured by eddy covariance technique, and about 20% for LE measured by BR technique. The errors of the present model results are of similar magnitude with the uncertainties in the measurements.

Massman, W.J. and Lee, X.: Eddy covariance flux corrections and uncertainties in long term studies of carbon and energy exchanges, Agricultural and Forest Meteorology, 113, 121-144, 2002.
Norman, J. M., Kustas, W. P. and Humes, K. S.: Source approach for estimating soil and vegetation energy fluxes in observations of directional radiometric surface temperature, Agricultural and Forest Meteorology, 77, 263-293, 1995.
Timmermans, W., Kustas, W., Anderson, M. and French, A.: An intercomparison of the Surface Energy Balance Algorithm for Land (SEBAL) and the Two-Source Energy Balance (TSEB) modeling schemes, Remote Sensing of Environment, 108 (4), 369-384, 2007.
Twine, T.E., Kustas, W.P., Norman, J.M., Cook, D.R., Houser, P.R., Meyers, T.P., Prueger, J.H., Starks, P.J. and Wesely, M.L.: Correcting eddy-covariance flux underestimates over a grass land, Agricultural and Forest Meteorology, 103, 279-300, 2000.
Yu, G., Wen, X., Sun, X., Tanner, B. D., Lee X., and Chen, J.: Overview of ChinaFLUX and evaluation of its eddy covariance measurement, Agricultural and Forest Meteorology, 137, 125-137, 2006.

4. Data selection should be described in more detail - e.g. in Table 2 for NW3, 10 min data in 23 days would result in 3312 data points and not 230. Why and which data points are excluded?

Answer:
There are several reasons for the number of data points in Table 2.
1) The observation of TIR and heat fluxes was not continual during the experiment because of the malfunction of instruments and arrangement of the whole project especially for the winter wheat sites. For example for NW3, there is no TIR observation from April 5 through April 10, and April 16 through April 19. Since every data point needs both heat fluxes and TIR observation data, only small section of the dataset obtained during the experiment meet the requirement, especially for the dataset of winter wheat.
2) For TIR and heat fluxes data, the time interval may be different, and the data with higher frequency need to be averaged to keep consistency with other data. For example for NW3, the records of TIR data has 10 min interval, but 20 min average of heat fluxes were used in order to eliminate the system error of the Bowen-ratio observation. That resulted in the number of available data points reduced in half. For NW5, the 10 min average heat fluxes were computed from 5 min record of BR system, which is coincident with TIR data.
3) It is well known that the heat fluxes calculated from BR data at the transition time of sunrise and sunset can not give good results. A data processing procedure of BR measurements was used and all data points with unreasonable heat fluxes were excluded.
4) The data points include data from daytime and nighttime, but only the data during daytime when both sensible and latent heat fluxes are positive were used in order to make sure that all of the calculations give reasonable results.

Above procedure was used for all of the sites, including the maize site where the heat fluxes from EC system were recalculated with a Bowen-ratio method to make sure energy closure, and the results need quality control too.

5. It is suggested to have a copy editing of the manuscript because in several places some guesswork is needed to fully understand the meaning of some sentences.
Answer:
The manuscript is under editing by a friend who is engineer from native English speaking country.

More specific comments are given below.

Specific comments:
1. P3L7: Su et al., 2001 is missing in reference list.
Answer:
We have revised this part of the manuscript according to the reviewer's comment.

2. P9L5: 'SEBS (2002)' should be (->) 'SEBS (Su, 2002)'
Answer:
We have revised this part of the manuscript according to the reviewer's comment.

3. P10L8: 'saturate vapor pressure' -> 'saturation vapor pressure'
Answer:
We have revised this part of the manuscript according to the reviewer's comment.

4. P10L9: 'pychrome constant' -> 'psychrometric constant'
Answer:
We have revised this part of the manuscript according to the reviewer's comment.

5. P11L7: 'an interpolate method' -> 'an interpolation method'
Answer:
We have revised this part of the manuscript according to the reviewer's comment.

6. P25L28: A model study of kB−−1 −H -> kB−1 H
Answer:

We have revised this part of the manuscript according to the reviewer's comment.

7. P26L15: 'Verhoef, W.' -> 'Verhoef, A.'
Answer:
We have revised this part of the manuscript according to the reviewer's comment.

8. P37: wind information would be helpful also and should be added to the plots.
Answer:
We have revised figure 4 and relative paragraphs in section 4 according to the reviewer's comment.