

Interactive comment on “A coupled remote sensing and the Surface Energy Balance with Topography Algorithm (SEBTA) to estimate actual evapotranspiration under complex terrain” by Z. Q. Gao et al.

Anonymous Referee #2

Received and published: 26 August 2010

1 General Comments

This paper introduces a method for estimation of evapotranspiration based on energy transfer equation and with inclusion of topographical parameters of terrain (e.g. slope, aspect) using MODIS images over a large area in Northeast of China. Inclusion of the topography parameters is mostly used for estimation of net radiation. In addition, the

C1985

authors used these parameters for adjustment of temperature difference. This paper has a good structure for presenting the research, however, there are some concerns regarding formulation of the methodology and validation of the results which are addressed in the “Specific Comments” section. Another important issue is the use of English grammar and appropriate use of technical words and phrases throughout the text. This paper is publishable if proper modifications applied to the text.

2 Specific Comments

Abstract

4877-line 7

What you mean by “limited” in “limited temporal and spatial scales”?

4877-line 9

What do you mean by complex terrain? Where the complexity of terrain addressed in the formulations given in the subsequent sections of the paper?

4877-line 14

Does this paper gives “Full account” for the dynamic impacts of complex terrain and changing land cover with some varying kinetic parameters over time? I guess it is better to use another appropriate word instead of “full” as still there are still unknown issues about effects of terrain on ET, especially in regard to advection and atmospheric turbulence.

4877-line 15

The phrase “in concert” replaced with more appropriate word.

4877-line 16

How the dynamic impact of terrain and land cover with roughness parameters are addressed “over time”? Where in this paper the effect of time is addressed in the formulation?

Introduction

4878-line 12

Soil evaporation is not negligible, especially when soil moisture content is relatively high

4878-line 14

Comparison or accompanying of soil moisture and evaporative power of the net radiation is not correct. They are basically different

4878-line 15

Portioning of R_n is not only dependent to the soil moisture, but also to the atmospheric turbulence.

4878-line 17

The statement in the first paragraph for relating ET with the sustainability and climate change is ill. Rephrasing is necessary.

4878-line 21

Point measurement of ET can be done by other methods as well. The basis for separation of the ET measurement methods at point scale must be given in a more appropriate way.

P4878-line 23

Eddy-covariance method is not just an energy balance method, as it works based on both energy and mass (water vapor) transfer.

C1987

P4879-line 2

The phrase “high precision” in ET estimation by remote sensing should be adjusted or proper references regarding this level of precision are cited.

P4879-line 3

This kind of categorization of the remote sensing ET methods is not good. Provided cited papers for this sentence have not a such a categorization.

4879-line 9

Surface radiation temperature replaced with “surface radiative temperature”

4879-line 13

“at first” is not correct English phrase

4879-line 17

Link of roughness length parameters with surface parameters in SEBS is not based on “similarity theory”. In SEBS, the similarity theory is rather used for estimation of sensible heat flux

4879-line 18

Replace “ET ratio” with “evaporative fraction”

4879-line 18

Please change the phrase “based on the SEBS”. SEBS includes a number of methods for different parameters. In exact words, in SEBS, after determination of the evaporative fraction, ET is determined by multiplying this fraction to the available energy ($R_n - G$)

4879-line 25

Replace “one and two layer model” with “two-source energy balance” or “dual-source energy balance”.

C1988

4879-line 26

Improve the wording in this sentence

4880-line 1

The sentence “They were in good agreement” should be included with the previous sentence with more coherent English grammar

4880-line 14

Why residual methods are the best?

4881-line 6

How “time period” is addressed in the formulation of SEBTA?

4881-line 7

Higher than what in “higher resolution”?

4881-line 10

Put “with” between “areas” and “complex”

2.1 The fundamental theory of the SEBTA

4881-line 20

Is the latent heat the driving factor of ET? The driving factors of ET are seems to be the available energy ($R_n - G$), the moisture availability of the soil, and the water content in the crops.

4881-line 20

The phrase “the closure in the energy balance equation can be confirmed” has no relation with the first part of the sentence.

4882-line 5

C1989

Do you mean aerodynamic “diffusion” theory or aerodynamic “turbulence” theory?

4883-line 14

The sensible heat flux is heat exchange between the surface and a level in the atmosphere not between surface and “atmospheric turbulence”

4883-line 21

What do you mean by “sample size”?

4884-line 3

How dry and wet pixels are “always” present in satellite images? What about mixed pixel issues?

4884-line 7

What is “stable aerodynamic resistance”?

4884-line 10 and equation 7

As here you referred U_{200} to the wind speed at mixed layer, a logarithmic function can not be used. In the mixed layer the change of wind with elevation is not logarithmic and does not follow the Monin-Obukhov Similarity theory.

4884-line 15

Replace “dynamic roughness” with “roughness length for momentum transfer” as for z_{0m} (and for other parts of this paper)

4884-line 15

Why at 0.06 m height?

4884-line 20

How z_{0h} in SEBTA is determined?

C1990

4884-equation 9

Include d in the equation as $\frac{1}{u_*} = \frac{1}{k\bar{u}(z)} \ln \left(\frac{z-d}{z_{0m}} \right)$. Also refer to your figure 2 for correct equation

4885-line 1

Z is the height for wind speed measurement

4885-line 6

Explain how local advection effects addressed in equation 10, especially for the regions of image where irrigated vegetation is in vicinity of bare soil,?

4885-line 6

How a and b in equation 10 are determined?

4885-line 9

What do you mean by “effective heat fluxes”?

4885-line 10

Correct the equation in this line to: $LE_{wet} = R_{n,wet} - G_{wet}$

4885-line 13

Correct the equation in this line to: $LE_{wet} = R_{n,dry} - G_{dry}$

4885-line 14

Correct the equation in this line to: $dT_{dry} = (R_{n,dry} - G_{dry}) r_{ah,dry} / \rho_a c_p$

4885-line 20

How the values for k_{wet} are determined? Give reference

4886-line 5

C1991

Why the reference height is the average height of the region?

4886-line 5

How this adjustment done?

4886-line 8

Give reference for equation 14

4886-line 18

L is the Obukhov length

4886-line 20

In equation 20 for L , as stated in the original papers including SEBS paper, T_s should be replaced with θ_v (the virtual potential temperature), especially as your atmospheric reference level is at 200 meter in the mixed layer. Also, T_s in the land surface temperature. As L is for quantification of atmospheric stability, air temperature must be used, not land surface temperature.

4887-line 5

Modify to: Ψ_m and Ψ_h are integrated stability correction functions for momentum and heat transfer

4887-line 5

It seems that the level of observation for wind and air temperature are different (200 m for wind and 2 meter for air temperature). Please note that when using Monin-Obukhov Similarity theory functions, wind and air temperature must be in the same level.

4887-line 5

What are the formulas used to calculate Ψ_m and Ψ_h ?

4887-line 14

C1992

How equation 20 is formulated?

4887-line 15

Give reference for equation of λ

4888-line 4

24 hour ET ratio is not appropriate and is not equivalent to daily ET ratio as at night time this ratio is different and normally there is no transpiration by crops

2.2 The realization of complex terrain in the SEBTA

4888-line 22

Is SEBTA for only generation of the solar radiation?

4889-line 5

Here do you mean sunshine time or sunshine area?

4889-line 11

What do you mean by "time scale" here? Do you mean time step or interval?

4889-line 12

What are ω_{sr} , ω_{ss} and $\Delta\omega$ here? It should be expressed in the paper.

4889-line 21

Equation 25 is unclear. What is "SHADOW" in this formula?

4889-line 25

Define g_0 and g_i in equation 26

4890-line 2

Adjust the phrase "if the Sun can shine (or shade)" as Sun can not shade!

C1993

4890-line 5

It is obvious from this sentence that calculation of shading parameters is useful in better estimation of net radiation. However, in the subsequent sentence it is stated that this parameter is used for calculation of sensible heat flux. How this calculation done? Is this just for an adjustment on land surface temperature due to elevation change by equation 14? So, where did you account for full impacts of surface characteristics as you stated in line 12 of this page?

2.4 Dynamic determination of surface kinetic parameters in the SEBTA

4891-line 16

Refer to z_{0h} as another roughness parameter, as you later stated equation 29 for its estimation.

4891-line 22

Equations 27-29 are not in the cited reference (Sue et al. 1999)

4892-line 12

Change "others" to "other".

4892-line 19

Even with dynamic change of effective height based on MSAVI parameter, this is not the full use of available data for determination of roughness parameters, as still effects of atmospheric turbulence on roughness parameters are not included.

3 Case study

3.1 Study area

4893-line 13

Which method is used to estimate annual ET?

C1994

4893-line 14

What do you mean by “ample light and heat fluxes”?

4893-line 15

Give reference

3.2 Data collection and analysis

4893-line 21

Introduce the MODIS products you named here

4893-line 23

Did you use both daily and 8-day products of MODIS for land surface temperature (MOD11A1 and MOD11A2)?

4894-line 13

What is the temporal resolution of climate data used here? Why only one meteorological station used? Include some comments regarding the method of observations and equipments of this station.

4894-line 15

What do you mean here by “vectorized”? Is this vectorization applied to “all datasets” (even climate data)?

3.3 Model Validation

4894-line 19

Change “cover” to “covering”.

4894-line 20

As here SEBTA using energy balance approach and your observed ET are by a lysimeter-
C1995

ter using water balance approach, please give some comments and explanations regarding the differences of two method and the uncertainty of each method. What is the temporal resolution of lysimeter observations? How do you justify this with instantaneous ET from remote sensing?

Please give some description of the lysimeter site. What is the complexity of terrain for this site that SEBTA addressed? What is the distance between meteorological station used and this lysimeter? What are the average elevation at this site and the average elevation of the study area? What are a and b coefficients at this site? How air temperature justified for this site?

4. Results and discussion

4896-line 6

What is the bases for classification of “rough” and “moderate” terrains? Please give reference

4896-line 14

As in Figure 7a there is no couture line, how one can distinguee “distinct terraces on each 500 m”?

4897-line 23

Change “one” to “on”

4897-line 24

ET in any single time in any elevation is varying in maps. In other words, same elevations at any time have different ET. How did you prepare Figure 9 then?

As you have only one validation point in your study area, what is your assessment of the uncertainty of ET in Figures 8-12?

4.2 The impact of different patterns of LULC on ET estimation

C1996

Pages 4898 and 4899

What is the main conclusion of this analysis? What is your interpretation of the main results for this change of ET over land use? What is your assessment of the accuracy of these values?

4898-line 8

You can summarize this paragraph into a simple table. Try to summarize the text to prevent repeating of words

4899-line 1

Change “can be as biggest as”

4899-line 16

Where is the first hand for “on the other hand”?

4899-line 29

Southeast and Northeast must have first letter in capital. See also 4900-line 3

4900-line 1

A word must be missing between “and” and “regions”. This sentence is meaningless.

4.3 The impact of the inclusion of elevation, ..

4900-line 14

Change “water” to “water vapor”

4900-line 14

How you address the “full” introduction of DEM effects on water vapor and heat fluxes? Aren't there any term not included (e.g. advection terms due to topography) which is not included here? In my understanding, the only effects of DEM on ET addressed in this

C1997

paper is on calculation of net radiation and an adjustment on temperature difference.

4900-line 18

Although here you mentioned “1532 m” as the maximum height, the maximum elevation if Fig 11 is 1100 m.

4900-line 19

Where are “left” and “right” curves in Fig 11? I see you combined them to one graph

4901-line 2

What do you mean by “delineation of terrain effects”?

4901-line 8

Where is the source for extraction of values of Fig 12? What is the validation assessment of these values?

4.4 Final remarks

4901-line 24

Please note that in SEBS (Su, 2002), land use is considered by its kB^{-1} model for roughness parameters.

4902-line 10

How you proved the over-estimation of ET in the areas with higher elevations and larger shade slope? What are your validation data?

5. Conclusions

4902-line 3

What is “aerodynamic diffusion theory”?

4902-line 19

C1998

How you addressed “full account” of terrain on ET. Refer to my previous comments.

4903-line 4

What was your “consistency index”? Where is its definition?

4903-line 5

24 or 48? What are these 24 datasets of MODIS?

4903-line 6

What is your “differential analysis” here? What spatial scales you worked with? Isn’t it that your resolution for ET estimation is 1km based on MODIS thermal data? Also, what are your temporal scales? You only summarized data by averaging in seasonal time steps. Did you used remote sensing data with different temporal resolutions?

4903-line 9

What are your validation data for evaluation of ET change in different heights over different seasons?

Table 2:

This table does not exist in the cited reference (Liu et al., 2005), see page 4910.

Fig 1

Replace “Friction wind” with “wind friction velocity”

Fig 3

In vertical axis, state MSAVI as vegetation index, as stated in 4891-line 8