Response to COMMENTS

Title: Variations in surface roughness of heterogeneous surfaces in the Nagqu area of the Tibetan Plateau

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We are thankful to the reviewers for their valuable comments on the paper. Below we provide the responses to the comments and questions raised. Modifications and improvements are incorporated in the revised manuscript as mentioned below for each of the comments. For easy visualization, the responses to the reviewers' comments in bold are provided below and changes in manuscript are also highlighted in RED color (Track Change).

Comments:

Thanks a lot for the effort to improve the manuscript. Nevertheless, this reviewer still find rooms to be improved further. Some comments as below for authors' considerations:

Anonymous Referee #1

1. English writing is still a problem, and not scientific enough. Please do putting efforts in polishing it to a professional level.

Response, We have modified the English writing again. See the revised draft for details

2. The response to "Anonymous Referee #1" (in terms of verification for d and average vegetation height) should be included in the revised manuscript.

Response, The magnitude of the zero plane displacement d is related to many factors, first of all it is related to the canopy height. In 1969, G. Stanhill had empirically obtained the relationship between the height of the high-stalk crop h and the height of zero-plane displacement d as:

$d=2/3h,$

In this study, BJ, NAMC and NPAM sites are located in the seasonal frozen soil area, and the vegetation is alpine grassland with small changes in vegetation height, ranging from 0 m in winter to 0.045 m in summer. h takes 0 in winter, 0.020 in spring, 0.0450 in summer, and 0.030 in autumn. Recalculate the roughness and change the following figures according to the newly calculated roughness. The new surface roughness is slightly larger than the old surface roughness, specifically 0.0003m in spring. Same in summer. 0.00008m larger in autumn, 0.0005m in winter (fig. 2 and fig.

6). After recalculation, the observed calculated value is closer to the retrieved value, and the maximum difference between the slopes of the new and old graphs is 0.012, the slope of new graph is closer to 1, and the correlation is higher, which proves that the remote sensing retrieved result is credible (fig.7).
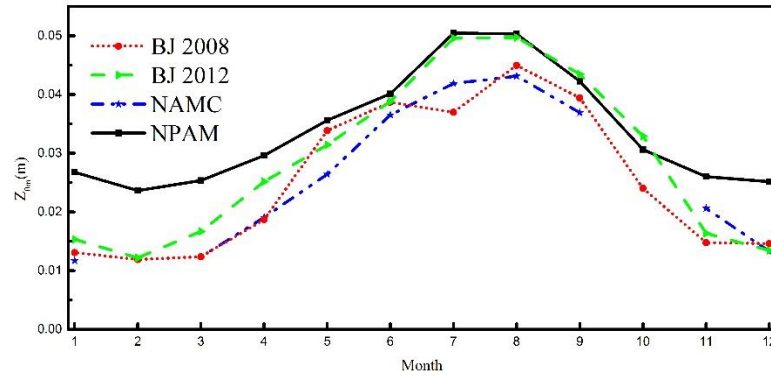

Fig. 2 Surface roughness length of different sites on the northern Tibetan Plateau. NPAM, NAMC, BJ2008, BJ2012 refers to the annual variation of the roughness lengths in 2012 at NPAM site, in 2010 at NAMC site, in 2008 and in 2012 at BJ site respectively.
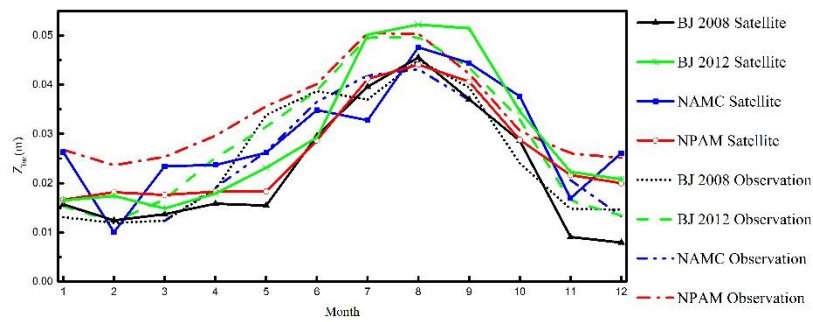

Fig. 6 Comparison of the surface roughness length by site observations and satellite remote sense retrieved data
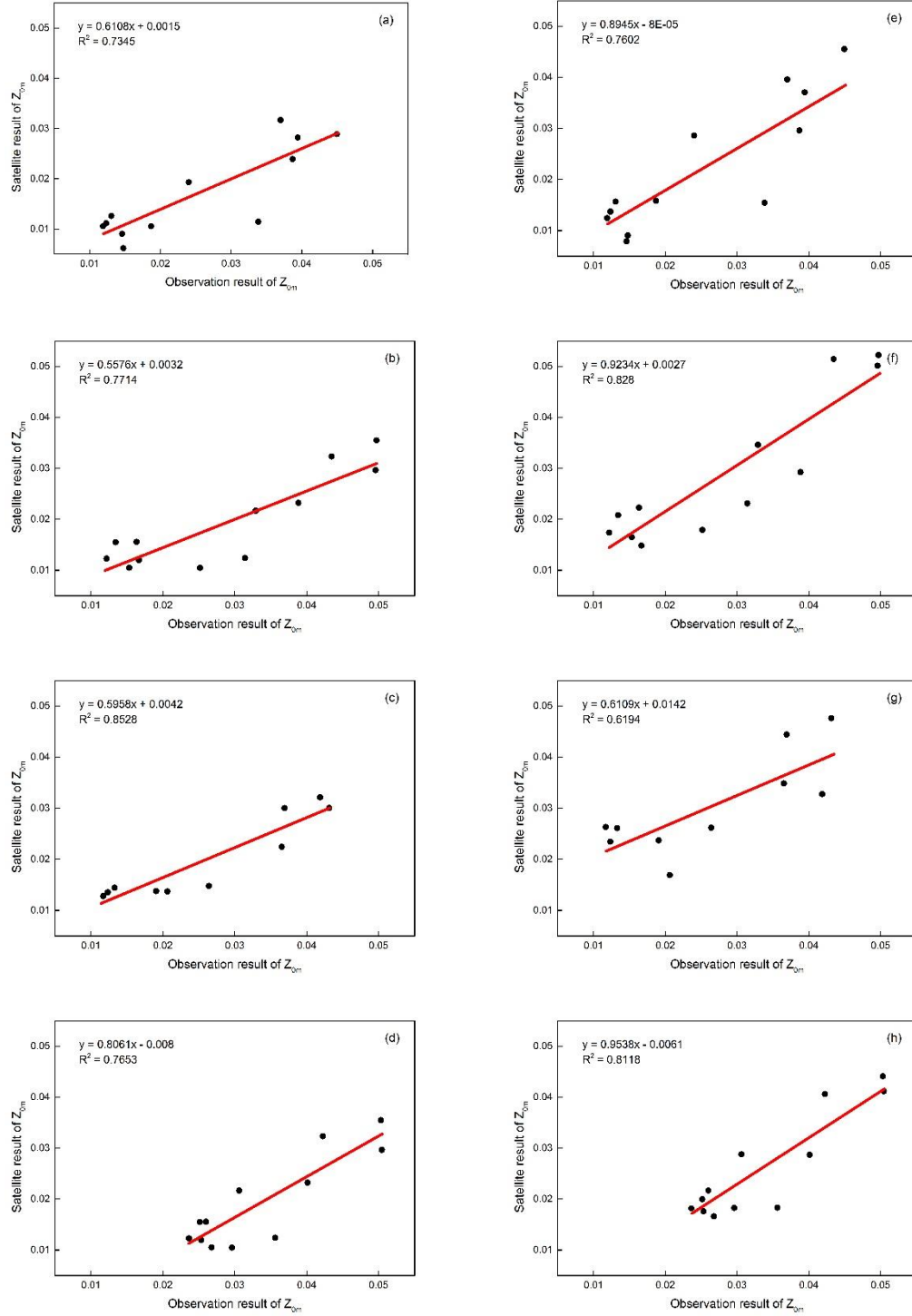
Fig. 7 Scatter plots of the retrieved and calculated surface roughness lengths at four sites

(a-d: scatter plot of the observation results and the average result of the underlying surface; e-h：

scatter plot of the observation and retrieved results; a, e: BJ station in 2008; b, f: BJ station in 2012;

c, g: NAMC station in 2010; and d, h: NPAM station in 2012)

3. in the section 5, this reviewer only see the evaluation of newly estimated surface roughness

for one site, using Noah-MP, while there are three stations. Please add the evaluation for the other two stations as well.

Response, The simulated values of sensible heat fluxes at NAMC and NPAM sites (Fig.9 c, e) were significantly larger than the observation results, but the sensitivity experiment results were better than the control experiments results, while latent heat flux in the sensitivity experiment were greater than that in the control experiment and were close to the observation results at NPAM site (Fig. 9 f).
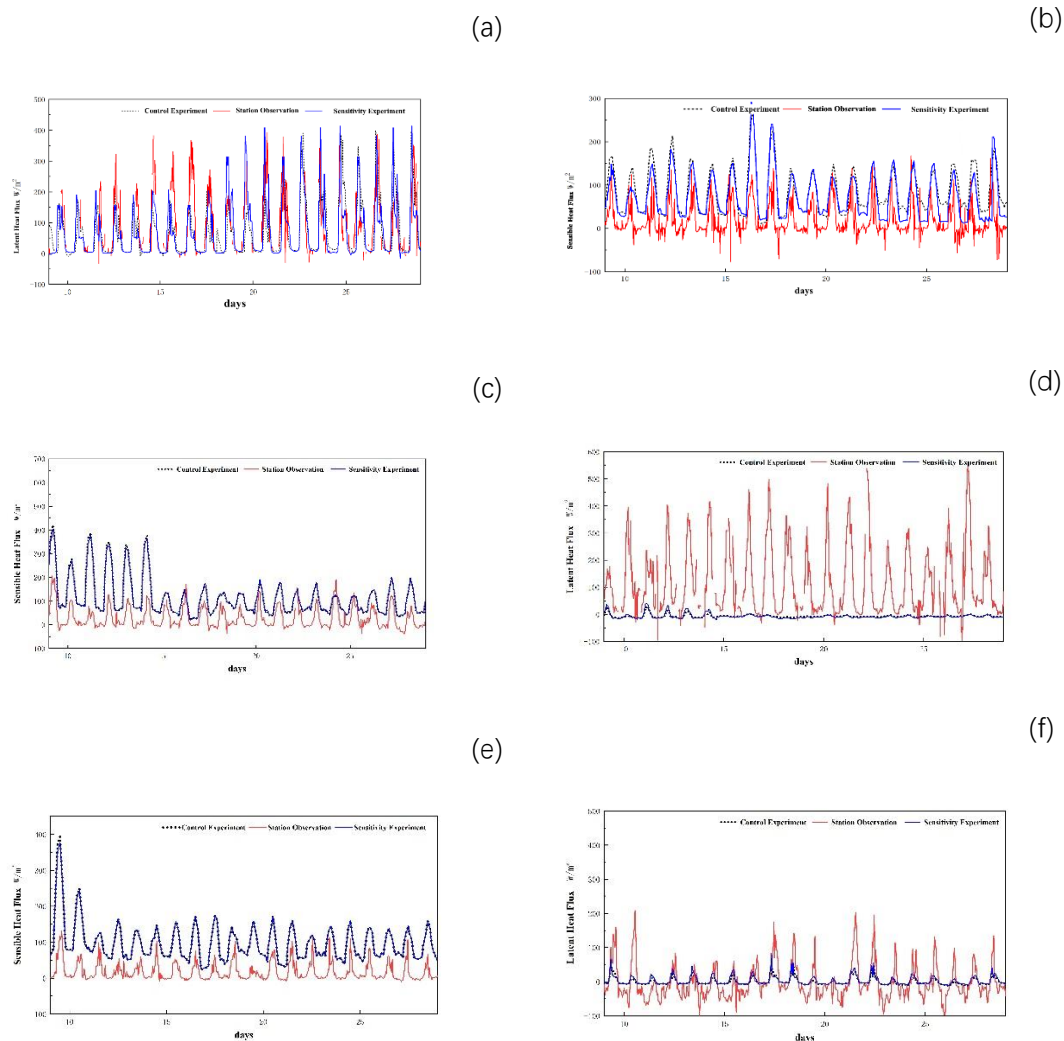
(a) (b)

(c) (d)

(e) (f)

Figure 9 Comparison of simulated and observed sensible heat flux (a, c, e) and latent heat flux (b, d, f) at BJ, NAMC, NPAM sites respectively.

There are some other comments, please see attached PDF.

Response, they were revised. see revised manuscript for details.

For example,

'Temporal and spatial variations of the surface aerodynamic roughness lengths (Z0m) in the Nagqu area of the northern Tibetan Plateau were analysed in 2008, 2010, and 2012 using MODIS satellite data and in-situ atmospheric turbulence observations. Surface aerodynamic roughness lengths were calculated from turbulent observations by a single height ultrasonic anemometer and retrieved by the Massman model.'

'These results are substituted into Noah-MP to replace the original parameter design numerical simulation experiment. After replacing the model surface roughness, the sensible heat flux and latent heat flux were simulated with a better diurnal dynamics.'

'Simulation and evaluation the impact of surface roughness on turbulent fluxes using Noah-MP model'

Anonymous Referee #2

Please see annotated manuscript for details.

The revision has incorporated my previous comments in going through a language editing, however the authors need to pay attention to the used terminologies and the meaning of different expressions.

1. **Massman retrieved model**

Response, it was revised 'retrieved by the Massman model'.

2. **the retrieved data values**

   Response, it was revised 'the retrieved values'.

3. **'replaces the original parameter and design**

   Response, it was revised 'to replace the original parameter and design'

4. **'has a better daily improvement effect.'**

   Response, it was revised 'were simulated with a better diurnal dynamics.'

5. **'inspiring'**

   Response, It was revised 'inducing'.

   And so on.

(c)

$y = 0.5958x + 0.0042$
$R^2 = 0.8528$

Satellite result of Z_{0m}

Observation result of Z_{0m}

(d)

$y = 0.8061x - 0.008$
$R^2 = 0.7653$

Satellite result of Z_{0m}

Observation result of Z_{0m}

(e) $y = 0.8945x - 8E\text{-}05$, $R^2 = 0.7602$

(f) $y = 0.9234x + 0.0027$, $R^2 = 0.828$

Satellite result of Z_{0m} versus Observation result of Z_{0m}

Figure showing scatter plots (g) and (h) of Satellite result of Z_{0m} versus Observation result of Z_{0m}.

Plot (g): $y = 0.6109x + 0.0142$, $R^2 = 0.6194$

Plot (h): $y = 0.9538x - 0.0061$, $R^2 = 0.8118$