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## ***Interactive comment on “Modelling forest lines and forest distribution patterns with remote sensing data in a mountainous region of semi-arid Central Asia” by M. Klinge et al.***

**M. Klinge et al.**

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Received and published: 19 April 2015

Referee: The primary information that is lacking in this manuscript is methodological detail on the satellite classification process and reporting on the associated error. Since the actual forest area, as determined by satellite classification, is at the root of the entire analysis, the omission of error reporting is an oversight, since single date image classification is impossible without significant error. Answer: For checking the accuracy of the classification, we have performed a validation process by digitizing polygons of forest and none-forest area. These areas were identified by the air photos provided as basemaps “Imagery” and “Bing”. Although the basemaps served for both the clas-

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sification and validation, we of course used different polygons at different places. We have added a confusion matrix as table 1 to the manuscript and mentioned the effect of the producer's accuracy in the text.

Referee: How were the training data collected? Answer: The training area was manually digitized on the base of air photos, provided by ESRI's basemaps "Imagery" and "Bing". A 2nd control was done by checking the area in "google earth" and at least the polygons had to fit well to the Landsat Image.

Referee: Were the classes simply forest v. non-forest? Answer: Yes

Referee: What were the errors of omission and commission? Answer: For the determination of forest sites the error of omission is 11% and the error of commission is 0,5%. Around 6% of the forest area served for accuracy control. Further details are shown in the confusion matrix (new table 1).

Referee: What are the implications of these errors on the determination of forest distribution patterns/area? Answer: There can be an underestimation of forest area of up to 11%. This error depends on the spatial resolution of 30 x 30 m of the Landsat data and occurs predominately at the borders of the forest patches, where the classification depends on the quantity and density of trees in one pixel. For answering the questions described above, we have changed the 2nd paragraph in the chapter 3 Methods as followed: "The determination of the AFA in the investigation area was achieved based on a supervised maximum likelihood classification from multispectral satellite images (visible light and infrared channels) of Landsat 7/ETM+ of the 13th September 2000 (Fig. 3). Aerial photos provided as imagery and Bing basemaps by ESRI served for the detection of forest area reference sites for training and validation of the classifier. Two classes were built and manually digitised for the classification and validation process. One class represents the forest areas and the other class includes different kinds of no forest landscape. Depending on the ground resolution of 30 x 30 m one pixel covers the occurrence of several individual trees so that small clearings and aisles could

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have been disregarded. The confusion matrix in Table 1 shows a producer's accuracy of 89% for forest areas, where ~6% of the forest area were used for validation. This possible underestimation of the forest area of up to 11% mainly occurs at the borders of closed forest, where the classification depends on the quantity of trees inside of one Landsat pixel."

We have completely adapted the proposed changes concerning cosmetic correction in the following comments of the referee. Therefore, we here give only detailed statements, where further explanation is necessary.

Referee: Line 13: Unclear what is meant by "takes the same course." Changed to: While the actual lower forest limit increases from 1,600 m asl (above sea level) in the northwest to 2,600 m asl in the southeast, the upper forest limit rises in the same direction from 1,800 m asl to 2,900 m asl.

Referee: Lines 19-21: I agree that generally speaking the AFA is a minimum condition of the PFA, but there are notable exceptions to this rule, when the AFA is in fact greater than the PFA, due to forest management, forest encroachment, afforestation, etc. Changed to: This often makes it difficult to differentiate between natural factors and human impact on the distribution of timbered areas. In general, human activity has reduced the forest area since prehistorical times so that the actual forest area (AFA) pattern mostly represent the minimum of the potential environmental distribution range. However, due to the possibility of anthropogenic forest management and afforestation during the last centuries forests may occur at sites less favourable for natural tree growth.

Referee: Lines 8-9: Unclear the meaning of this sentence. Perhaps a word is missing? What is meant by "a transfer?" Changed to: However, to identify potential forest sites based on those definitions, the geologic and soil properties have to be comparable.

Referee: Figure 1: Why was this detailed study area selected? Please provide some context for this study area selection? Text added: This closed mountain system was

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chosen for investigation because it provides excellent topographic preconditions to clearly indicate the lower and upper boundaries of forest distribution between the middle and central part of Asia. It is filling a gap of information about forest lines between regions of the Tien Shan mountains in the south and east, and the Altai mountains in the north (Fickert, 1998; Dai et al., 2013; Klinge et al., 2003).

Referee: Line 16: Unclear what a “planation surface” is. Perhaps there is a more common term for this? Answer: In geomorphology “planation surface” is a common known feature. However, in this study it is necessary to know that there is a flat surface building up the highest portions of the mountains. Therefore we changed the sentence as followed: The highest peak is the Nebesnaja reaching 3,652 m asl. A high mountain plateau in ~3,400 m asl is dropping southward, while the north facing slopes are cut steeply by Pleistocene cirques. Today, no glaciation but permafrost occurs in the uppermost areas.

Referee: Line 11: Change “Mai” to “May”; Unclear what is meant by “subordinate” in September. Does this mean that the precipitation minima occurs in Sept? Changed to: The precipitation maxima occur in May, June, and with minor secondary maximum in September.

Referee: How was the accuracy assessment conducted? Was there a formal sampling protocol/accuracy assessment of the Landsat classification based on imagery? If so, what were the results? Answer: This question was already answered in detail above. We added a table 1 with a confusion matrix and described the accuracy assessment in the manuscript.

Referee: Lines 8-9: If 99% of the frequency distribution of the elevation parameter was used to delineate PFA, why does Figure 4a (the top panel with elevation) not depict the light versus dark green? Answer: The 1% which is left is too small and cannot be shown clearly in the diagram. To make this point clearer, we have changed the caption of figure 4 as followed: Figure 4: Frequency distribution of relief parameters in

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relation to actual forest area AFA (for the diagrams aspect, slope gradient, and solar radiation input: dark green = standard deviation 95%, light green = marginal value range excluded from PFA delineation) and total study area (TSA, brown).

Referee: Results: Page 14678: Lines 12-14: I'm not sure that I follow the logic that the shallow left slope of the elevation parameter distribution is an indication of human impact. Wouldn't it be more plausible to suggest that a steep drop on the left side of this distribution would reflect something other than a biophysical driver? Answer: Human impact on forest reduction is less controlled by the parameter "elevation", it is more controlled by logistic approach of the nomads and woodcutters. At less accessible land like steep sloped places forest may occur while there is no potential forest around riverside and main paths of the nomads along the valleys. These are places which are subject to more grazing pressure by the livestock. In contrast, climate control is working in a more regional scale. Therefore this parameter, which has a strong influence on growth of large trees, is especially indictable by the sharp dependence on elevation limits. For a better explanation of this idea we added the following sentences to the results of the manuscript: Nomads and woodcutters approach to forest transformation by logistic problems of access in the relief, which reduces the pure signal of elevation in the data. Climate controls environmental conditions in a coarser regional scale and is creating sharper elevational boundaries. The curve of the parameter elevation has a shallow left and a steep right slope, which indicates human impact on forest distribution at the lower boundary. The lower forest lines start at 1,575 m asl and the upper forest lines exceed 2,900 m asl so that the maximal vertical distance of the forest limits for the entire investigation area is 1,325 m (Table 2).

Referee: Line 25: Not clear what is meant by the term "luv-side". Please clarify. Changed to: This is explaining the steep gradient of the upper forest line at the windward side of the mountain ridges.

Referee: Page 14682: Lines 16-17: The wording of this sentence implies that human impacts influence the elevation parameter. Clearly, this is not the case. Suggest

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rewording the sentence to imply that human impacts are most easily recognized by evaluation of the elevation parameter, or something along those lines. Answer: You are right, in that way the sentence is misleading. We have changed it as followed: Human impact is recognized by the evaluation of the parameter elevation.

Please also note the supplement to this comment:

<http://www.biogeosciences-discuss.net/11/C9295/2015/bgd-11-C9295-2015-supplement.pdf>

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Interactive comment on Biogeosciences Discuss., 11, 14667, 2014.

**BGD**

11, C9295–C9300, 2015

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