RC:

The reviewed paper is devoted to monitoring and mapping of the glacier extent and elevation changes from multi-temporal digital elevation models (DEMs). Main emphasis was put on determining the outlines of relatively small alpine valley glaciers, especially those having debris-covered margins. Generally interesting idea about different rates of elevation changes in debris-covered and debris-free parts of a glacier was offered as a “simple and robust way” to detecting and measuring the true extent and the overall area of alpine valley and rock glaciers. Comparatively low rate of elevation changes in debris-covered surroundings of visible glacier was proclaimed a reliable indicator for the existence of “dead ice” masked by debris.

A simplified technique based on differencing glacier elevation models was designed and tested using several asynchronous DEMs with different posting size resulted from airborne stereophotographic (1997) and laser scanning (2000s) surveys of three valley and one rock glaciers situated in the Ötztal and Stubai Alps, Austria. The roughness variation in the relief-shaded representation of DEMs (called “hillshades”) was devised as an additional indicator for delineating the glacier boundary in snow- and firn-covered accumulation areas. It was concluded that “the method is well suited for study areas where an accurate knowledge of glacier area and volume change is needed”.

Even if it might be the case for the study glaciers, which remains conjectural due to the lack of reported ground control and ground truth, the applicability of such indicators to modelling other glacial areas is doubtful. Apart from glacier-related processes, such as local decrease in albedo (stonefalls, dust, etc.), ice flow and deformation or crevassing, the surface lowering at glacier margins can originate from other, not necessarily glacier-related effects, e.g. weathering, wash-out, permafrost melting, denudation etc. The estimation of their potential and relative intensity is missing. Slope effects, both geometric and geophysical, also influence the data / DEM quality and the results of interpretation. The ice thickness decrease of 38 m along the eastern flank of the Hintereisferner snout (visible part in Fig. 6, a) might be related, at least partly, with an error due to strong slopes along and across the melt-water stream. Some shadowing impacts due to variable illumination might not be excluded. All such effects limit the applicability of the method proposed and should be treated in more detail.

The method (data- and work-flow) description and the accuracy/quality analysis should be given in more clear fashion. The robustness of the method proposed must be quantified. Automatic and manually performed procedures, e.g. visual analysis, should be delineated. The passage like “We set the glacier boundary directly by digitizing the strongest roughness change in the hillshades” is more or less clear, but I would like to know how the authors defined/quantified this strongest roughness change. Some corrective measures to avoid the propagation of gridding and interpolation errors at the stage of merging / subtracting multi-sensor DEMs with different posting / pixel size should be undertaken and described.

The methodological accuracy is given as ± 1% of the glacier area (in the abstract) and ± 1.5% of the glacier area (in the paper). The vertical accuracy of differential DEMs / glacier change models, the principal technical parameter limiting the methodical applicability, was not specified. There are other mistakes, misprints and omissions in the description of DEMs used in the study. The pixel size (cell size) of DEM 1997 was given as 5 m (in Figure 7), 10 m (on page 386) and 15 m (in Figure 10). What is correct? Apart from Table 1 specifying the point density of laser-scanning raw data there is no information provided about the posting / pixel size of LIDAR DEMs used. The interrelation between seasonal glacier changes and DEM data takes was not discussed. The planimetric (horizontal) accuracy of IKONOS image maps given as 17 m in the Ref. (Sharov & Etzold, 2007) is erroneously represented as vertical accuracy of 17 m in Fig. 10. There were no considerations and explanations given on the information contents / detailedness of the resultant dDEMs and maps. The quality control performed by “independent interpreters” is insufficient. It must be carried out and demonstrated by means of comparing with ground-truth / control data.

There were no substantial conclusions reached and the paper was not well structured. Its final part describing the “state of the art” (alternative techniques) should be given at the beginning of the paper. The method of differential radar interferometry could be added to the “state of the art description” as a good (cheaper!) alternative to optical methods / change models. Other geophysical methods (geodetic and stereophotogrammetric surveys in the field, radio-echo sounding, penetrating radar, seismic, drillings etc.) and geomorphological indicators providing additional ground truth should be mentioned as well. Figures 3 and 10, and maps in Figs 4, 6 and 8 including their legends and corresponding location diagrams must be corrected / improved. The caption for Fig. 5 is unclear. Figs. 11 through 14 can be omitted. Sentences like “in accumulation zones of glaciers, elevation changes are much smaller” should be referred to local conditions. There were paragraphs containing only one sentence. The manuscript must be checked by native speaker.

The inclusion of Reichenkar Rock Glacier situated far away from other study glaciers in the list of study areas had to be argued. It would be nice to see some data describing the local weather, related glacioclimatic parameters and their spatio-temporal changes. Typical rates of the ice-free surface lowering would be also instructive. My advice is: try to collect more evidence, both positive and negative, to better define the applicability and the performance of your technique in different glacial areas. My further questions might be related with the influence of lidar data / DEMs distortions and separate procedures of data processing.