Interactive comment on "Quantifying ice loss in the eastern Himalayas since 1974 using declassified spy satellite imagery" by Joshua M. Maurer et al.

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Received and published: 23 May 2016

Using declassified spy satellite imagery (Hexagon and Corona) and recent ASTER imagery, Maurer et al calculate glacier mass changes for 21 glaciers in eastern Bhutan, from the 1974 to 2006. The methods and assumptions appear to be sufficient, errors in the analysis are well-documented, and the results are interesting and highly relevant. The paper is also well-referenced, very well-written, and essentially free from grammatical/structural/organizational errors.

Thank you for your helpful comments on the manuscript. We have addressed all of your concerns below, and feel they have improved the paper considerably.

Aside from the comments by the other reviewers (Pieczonka and Nuimura), I can only add a few general points that the authors might wish to address:

1) A very brief outline of the Hexagon/Corona pipeline (Maurer and Rupper, 2015) would be helpful.

A brief summary of the process is now included in section 2.1 on P4.

2) Why are only 21 glaciers studied? And what are the impacts of the 30% coverage threshold? Previous geodetic studies (e.g. Gardelle et al., 2013, Bolch et al., 2011) consider the entire glacierized area that is covered within a region. Using only 21 glaciers (and only those larger than 3 km2) and replacing potentially large missing areas with the regional mean for a specific glacier type and elevation band could result in biased regional estimates of glacier mass change that are not comparable to previous studies.

Unfortunately, low radiometric contrast, cloud cover, and spatially correlated noise/error in the DEMs prevent accurate calculation of changes for all glaciers in the region. While this does limit direct comparison to other previous studies (this among other things, such as different timespans covered), we feel these 21 large glaciers give a good regional picture of thickness changes over the 3 decade timespan. We have updated the discussion to more accurately reflect these facts in the paragraph starting on P6 L14.

We agree that replacing potentially large missing areas with regional means may result in biased regional estimates, and now include results using both the regional extrapolation method vs. assuming zero change for missing data (Table S3). Addition discussion of the observed impacts of extrapolation vs. assuming zero change is also included on P6 L3 and P9 L6.

3) How is the ELA defined in this study (it first appears on P10L29)? Strictly speaking, this is typically taken from surface mass balance measurements. While the elevation that divides geodetic mass gain and loss would be related to the ELA, I am not sure that it can be used as an ELA substitute (though I would be interested to hear otherwise).

The term “ELA” was being used too loosely here, and instead we substitute the term “glacier hypsometry.” Updated on P11 L20.

Specific comments:

P2L20: are these annual or seasonal streamflow contributions?

These are seasonal, their samples (from which their streamflow contributions were derived) were collected during September (post-monsoon). We have updated the text to make this important distinction clear.

The text has been updated on P2 L19.

P4L20: Define DN.

DN = Digital Numbers, these are simply the pixel values in Landsat and ASTER images before being converted to reflectance or radiance. Updated on P4 L28.

P10L25: What data support the conclusion that debris-covered glaciers melt at the same rate as clean-ice glaciers? If this is overall mass balance rates than it should be specified. Figure 4 clearly shows that melt rates at debris-covered glaciers are lower than those observed on clean ice glaciers for the same elevation band, and this is later referenced by the authors on P10L28.

We now clarify at the beginning of the section, that although elevation distributions of ice loss differ between clean-ice and debris-covered glacier groups, overall geodetic mass balance values are similar in magnitude. Updated on P11 L16.

P11L15: Debris cover will almost always get thinner moving up-glacier. The greater thinning rates observed at the transition between debris-covered and debris-free zones is due in part to enhanced melt rates under thin debris cover but also due to the simple fact that bare ice will melt at a faster rate than debris-covered ice at the same elevation. Modelling studies in the Khumbu region (Shea et al., 2015; Rowan et al., 2015) both indicate that debris-covered tongues will detach from their accumulation areas in the future, leading to greater future melt rates.

We now include this information and accompanying references in the text on P12 L12.