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Interactive comment on "Frontal ablation and temporal variations in surface velocity of Livingston Island ice cap, Antarctica" *by* B. Osmanoglu et al.

Anonymous Referee #1

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The manuscript reports on the estimation of mass balance for an extensively ice covered island in the Antarctic Peninsula region, based mainly on information derived from observations by various Earth observation satellites, complemented by in situ measurements for limited areas. Considering the poor knowledge on mass balance of glaciers in the Antarctic periphery, it is certainly a valid goal trying to reduce this uncertainty. Unfortunately the available data base is rather inadequate for deriving accurate mass balance numbers for the ice body of Livingston Island, so that the impact of the work regarding uncertainties in mass balance of the Antarctic Peninsula region is rather limited.

There are three issues regarding the data base that significantly increase the uncer-

tainty of the mass balance estimates:

(i) A main deficiency is the lack of ice thickness data. Frontal ablation (primarily due to iceberg calving) is a main component of the mass balance of the island's glaciers. The authors infer the sliding parameter and flow law enhancement factor for the relation between surface velocity and ice thickness by deducing these parameters from available thickness data. The validity of this approach is questionable, as ice thickness data are available only for a very small part of Livingston Island. Accurate information on ice thickness at flux gates is essential to obtain good estimates for calving fluxes. Close to glacier fronts ice thickness fields are only available for the small Johnsons and Hurd glaciers which contribute very little to the island's frontal mass export (0.4 Mt/yr out of 509 Mt/yr for the whole island). It is questionable if the ice flow parameters determined for these glaciers are transferable to those glaciers which dominate the calving fluxes for Livingston Island and have much larger flux gates and coastlines. Even for the area where measured ice thickness data are available, the uncertainty of estimated ice thickness is high (Fig. 4), although the sliding and flow law enhancement parameters (Eq. 4) have been adjusted with this data set. For medium and fast moving glacier regions there is no obvious correlation between estimated and GPR-measured ice thickness, and for slow velocities the data points are widely scattered.

(ii) The uncertainties of the DEMs used for the analysis of mass balance, ice flow, etc. are very high, as deduced by comparison with ICESat data (RMSEs between 125 m and 368 m, depending on the DEM). Slope errors due to inaccuracies of DEMs propagate into ice thickness estimates. Merging the different DEM data sets is not a convincing strategy, as 3 of the DEM the data sets cover only part of the island. For sake of homogeneity it would be better to use the one of the better quality DEM (e.g. sharpened RAMP) which covers the whole island. Regarding the unusually high RMSE values for the various DEMs vs. ICESat, the procedures used for error assessment should be reported.

(iii) The uncertainties of the retrieved velocities need to be properly assessed and

specified for the different data sets. Significant variations in relative accuracy are to be expected, depending on sensor resolution, time span of an image pair, stability of features, and magnitude of ice velocity. The velocity data in Figure 6 show an overall trend for higher velocities in summer (to be expected for this glacier type), but the data seem to be quite noisy so that only for few of the glaciers the seasonal trends are statistically significant. In order to learn about the reliability of the velocities, error bars should be provided for the individual velocity data in Fig. 6. In addition, it would be of interest to relate the temporal variations to the mean velocities for each of the glaciers.

Figure 5, maps of surface velocity and ice thickness. The selected colour scale provides very little discrimination for the majority of the glacier area, being dominated by low values. (may possibly use a logarithmic scale).

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