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## ***Interactive comment on “The recent retreat of Mexican glaciers on Citlaltépetl Volcano detected using ASTER data” by J. Cortés-Ramos and H. Delgado-Granados***

**Anonymous Referee #2**

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**GENERAL COMMENTS** This is an interesting paper presenting the dramatic shrinkage of Glaciar Norte in Mexico between 1958 and 2007. It investigates the close relationship between glacial shrinkage and surface energy balance, determining the net radiation from ASTER satellite images and the energy fluxes from automatic weather stations. The scientific contribution is relevant taking into account the characteristics of the site and mainly the latitude (19°02' N). It should therefore be published but there are some points that need to be clear up before it can be published.

**ESPECIFIC COMMENTS**

2 Glaciers of Citlaltépetl Volcano It would be important to specify if there is any infor-

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mation concerning the position of the Equilibrium Line Altitude (ELA) for this region. This information may be important if we consider that the value may have an important role in the interpretation of results.

### 3.2 Glacier mapping using ASTER

P3155 L5-17 For the geometric correction of the ASTER images a SRTM Digital Elevation Model (90m resolution) was used. The horizontal Ground Control Points (GCP's) were obtained from panchromatic Landsat images (15m resolution) and 1:50000 scale maps. For this study the estimated horizontal error is  $\approx 40\text{m}$ . However it is not specified for this study if Digital Elevation Models were obtained from stereoscopic ASTER images (3N and 3B), in order to determine altitudinal position of the glacial front. If this is the case it would be important to specify what is the vertical error using this method. This is important taking into account that no elevation field measurements (DGPS) that have been undertaken. This may be relevant considering that the slopes of the study area are strong and that the base information for orthorectification incorporates an error source. The horizontal accuracy for SRTM model is  $\pm 15\text{m}$  and vertical accuracy is  $\pm 15\text{-}25\text{ m}$  (Toutin 2008).

P3155 L8 Six images from 2001-2007 were geometrically corrected for the analysis, however it is not specified in which periods and dates the satellite images were obtained. This information can be important to note in order to evaluate if the images could be comparable or not.

P3155 L20-23 “The visual analysis can use other elements present in the image as textures, footprints, sites and locations, which are more difficult to classify in digital form” Considering a visual analysis can also be very useful to use ASTER stereoscopic capabilities applying photogrammetric techniques in order to visualize and to identify relief characteristics.

3.3 Spatial distribution of the net radiation P3156 L24-25 If the accuracy of the method used is based on the geometric correction of images, it should be important again to

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take into account the comments section 3.2 (above).

#### 4.1 Areal changes of Glaciar Norte

P3159 L14-15 “Figure 2 shows the areal changes of the Glaciar Norte that extends, determined from ASTER images for 2001, 2003, 2005 and 2007.” While years are mentioned, there are no specified dates for each ASTER images. Again, this information has to be verified to establish whether the images can be compared with each.

P3159 L22 – P3160 L8 According to Table 1 in the period between 2001 and 2007 (ASTER), the height difference of glacial front position is 85m. By averaging an annual change, regardless of the period 2002-2003 (3m), the variation is about 20m. According the observations mentioned in 3.2, errors and vertical accuracies obtained from the SRTM model and Digital Elevation Models from ASTER images can be several meters. Under this consideration, how realistic is it to make a comparison between heights considering that they were not used Ground Control Points with DGPS for the calibration? It would be important to specify in greater detail how these heights were obtained and what are the details in their estimation.

#### 4.2 Surface: Distribution of net radiation

P3161 L19-20 “The net radiation values for 2007 are in agreement with the values measured on the same day of the year by the Glaciar AWS” Where can we see this relationship?

#### 5 Discussion

P3162 L1-2 In order to get a better estimate of the year of disappearance of the glacier, Is there some information on the thickness of the glacier and the rate of loss of thickness? It is recommended seeing (Ramirez et al. 2001).

P3162 L24 – P3163 L1; P3163 L28 –P3164 L8 The strong ablation on the glacier surface is located principally at zones of low altitudes where the temperature effects are more visible. However it would be important evaluate the influence of precipitation

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according to the direction origin. It is recommended to see for example (Soruco et al. 2009) showing the effect of mean altitude, exposure and source of precipitation.

P3163 L19-22, "The ablation processes occur along the year, however in this work is not possible to conclude if ablation is more prevalent in one season than another." The glacier retreat depends largely on the mass balance for the analyzed period. Therefore this can also be a relevant factor in terms of their accumulation and the Equilibrium Line Altitude (ELA) position. In small glaciers at lower altitudes, in certain years, the ELA can rise causing an imbalance in the glacier causing strong ablation (Vuille et al. 2008).

6 Conclusions P3165 L13-15 At this point is emphasized again the need to determine the ELA. Considering that studied glacier currently has an area less than 1 km<sup>2</sup> it can be very sensitive. In some years, depending on the position of the ELA, the glacier may experience an imbalance.

Figures Figure 1 can be improved. It is recommended to focus the upper figure in order to obtain a better balanced figure as a whole. It would be desirable also to show the current glacier contour to get a visual idea of surface change occurred. Figure 2 can probably be improved by maintaining a single reference window where the peak of the volcano is centered. It could be used for example the window of Figure e). It is recommended to standardize the position of the graphic scale of the figure a) with the rest of the figures. For the figure 2, the figure caption should specify the exact date of each image acquisition.

It is recommended as a complementary reference (Sicart et al. 2008)

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Soruco, A., C. Vincent, et al. (2009). "Glacier decline between 1963 and 2006 in the Cordillera Real, Bolivia." *Geophysical Research Letters* 36(L03502): 1-6.

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[Interactive comment on The Cryosphere Discuss., 6, 3149, 2012.](#)

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