

No Land Use 1850 CE

Revision of 1.11.16 by Andrew Sluyter.

By 1850 CE people inhabited and used, to one degree or another, all parts of Middle America except glaciated areas.

There are currently no glaciated areas in Middle America except for three volcanic peaks in Central Mexico that rise to over 5,000 m: Citlaltépetl (Pico de Orizaba), Popocatepetl, and Iztaccíhuatl. As measured in the mid-twentieth century, each peak had a small area covered by glaciers (ice and firn fields): Citlaltépetl, 950 ha; Popocatepetl, 72 ha; Iztaccíhuatl, 122 ha (White 2002). The total glaciated area was therefore 1,144 ha, or 11.44 km². White (2002) provides large-scale maps of the extent of that mid-twentieth-century glaciation for each of the three peaks. The maps show that the termini of the glaciers reached down to approximately 4,700 m at that time. Since the mid-twentieth century, those glaciers have been melting, retreating upslope, and decreasing in area (Ramirez Necoechea, Valenzuela Meraz, Hernandez Ramirez 2013). They might disappear entirely within a few decades.

The areas glaciated in 1850 CE are not easily derived from the published studies. Vázquez-Selem and Heine (2004) determined, on the basis of relict moraines, that the mean altitude of glacier termini for Iztaccíhuatl during the Ayoloco advance, which dates to the Little Ice Age (1300-1850 CE), to have been approximately 4,500 m, roughly 200 m lower than in the mid-twentieth century. During the warmer Holocene Climate Optimum (9,000-5,000 BP) and the Medieval Climate Optimum (950-1250 CE), the glaciers were likely much smaller, similar to their condition in the mid-twentieth century, with the termini at a mean elevation of about 4,700 m, or even smaller, as they are at present. In addition, during the Little Ice Age as well as during the Neoglacial (5,000-1,000 BP) that occurred between the Holocene Climate Optimum and the Medieval Climate Optimum, small glaciers might also have formed on lower peaks, in the 4,000-5,000 m range, such as La Malinche, Cerro Ajusco, and Nevado de Toluca (Vázquez-Selem and Heine 2004; White 2002). And many more peaks, of course, display evidence of glaciation during the ice ages of the Pleistocene epoch that preceded the Holocene during the Quaternary Period.

For the 1850 CE map, which falls during the Little Ice Age, the extent of glaciation is based on the following. Two peaks are well enough studied that maps of glaciation based on moraines and other features that date to that period are published. Vázquez-Selem and Heine (2004) provide a map of what they term Ayoloco advance for Iztaccíhuatl. Palacios and Vazquez-Selem (1996) provide a similar map for Citlaltépetl. They were scanned, georeferenced, and polygons of the glaciated areas were digitized. The area of the polygons is 613 ha for Citlaltépetl and 928 ha for Iztaccíhuatl. Since Popocatepetl lacks such studies another approach was used. It was assumed that since the glaciation on Iztaccíhuatl covered much of the peak above 4,500 m during the Little Ice Age, Popocatepetl would have been glaciated to a similar elevation. A polygon covering the area above 4,500 m was created from the elevation shapefile of a 1: 50,000 topographic map downloaded from www.inegi.org.mx: E14-B42, Huejotzingo, 2014. The 4,500 m contour was extracted and its area measured to be 1,081 ha, probably a gross overestimate of the glaciated area for the little Ice Age because glaciation depends on many other factors besides temperature and elevation, such as precipitation and slope, but it is the best estimate currently available. The polygons for Citlaltépetl, Iztaccíhuatl, and Popocatepetl are therefore all larger than the 500 ha threshold and were

added to the No land use 1500 CE map. Only glaciated areas with total areas equal to or greater than 500 ha (5 km²) were mapped for LandCover6k. An area of 500 ha is approximately 8% the size of the grid cells of 8,000 m by 8,000 m (64 km²/6,400 ha) used to judge the level of generalization appropriate for the project. So even an area of 500 ha, which, if a square, would have sides about 2.25 km (2,250 m) long, is not particularly significant and serves as an absolute lower threshold. Note that the polygons of perpetual snow (nieve_perpe50) for the 1:50,000 shapefiles that cover Citlaltépetl, Iztaccíhuatl, and Popocatepetl (E14-B46, Coscomatepec, 2014; E14-B42, Huejotzingo, 2014) grossly overestimate the glaciated areas, possibly because they derive from SPOT imagery of January 1, 2011, when snow would have covered those peaks far beyond the glaciated areas and resulted in misinterpretation.

In addition, I considered whether any other peaks might have supported significant areas (500 ha and larger) of glaciers during the Little Ice Age. To generate an estimate, I considered the two additional peaks, Nevado de Toluca and La Malinche, that have summits of at least 4,500 m, which the studies that do exist suggest was the mean elevation of the termini of glaciers during the Little Ice Age, compared to 4,700 m by the mid-twentieth century. I then estimated the areas above that elevation for each peak using the elevation shapefiles from the 1:50,000 topographic sheets for Nevado de Toluca (E14-A47, Volcán Nevado de Toluca, 2015) and La Malinche (E14-B43, Puebla, 2015). For La Malinche, with a summit at 4,503 m, the area above 4,500 m is so small that the shapefile has no contour line higher than 4,400 m, so I instead used that contour to delimit the polygon and found it had an area of only 1.5 ha. Nevado de Toluca also has a small area (82 h) above 4,500 m. Neither, consequently, could have had an area of glaciers anywhere close to 500 ha during the Holocene. Note that both those maps are also derived from SPOT imagery of January 1, 2011. The one for Nevado de Toluca has a large area of “perpetual snow” indicated, likely based on misinterpretation of winter snow. The one for La Malinche has no “perpetual snow” indicated.

Only the three polygons that reached the 500 ha threshold (Citlaltépetl, Popocatepetl, and Iztaccíhuatl) for Little Ice Age glaciation were therefore mapped as areas of no land use in 1850 CE.

Table 1. Glaciated areas during the Little Ice Age (1300-1850 CE).

Volcanic Peak	Period	Glaciated Area (ha)	Area ≥500 ha?	Source
Citlaltépetl	Little Ice Age	613	Yes	Palacios and Vazquez-Selem 1996
Popocatepetl	Little Ice Age	1,081	Yes	1:50,000, E14-B42, Huejotzingo, 2014
Iztaccíhuatl	Little Ice Age	928	Yes	Vázquez-Selem and Heine 2004
Nevado de Toluca	Little Ice Age	<82	No	1:50,000, E14-A47, Volcán Nevado de Toluca, 2015
La Malinche	Little Ice Age	<1.5	No	1:50,000 E14-B43, Puebla, 2015

References

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