# Cryosphere Activities in Latin and South America

## Mexico

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**Summary**

This document briefly describes the recent glaciological activities after the first work in 1958. Also, this document emphasizes the importance of the study of the glaciers at this latitude, particularly because no international research programs have been developed in this area. These glaciers have not called much attention from the international community perhaps due to their size despite their vulnerability and uniqueness.

**Background**

The glaciers of Mexico are capping the top of the highest mountains of the country, they are roughly at 20ºN latitude, and they are the only ice masses at this latitude around the northern hemisphere. This fact makes Mexican glaciers very important tools for observing global changes in spite of their small size.

**First glaciological measurements in this area**

Glaciological research in Mexico started in late 1950s as part of the preparatory activities for the International Geophysical Year in 1958. This year a new glaciological section in Mexico was established. Prof. Jose Luis Lorenzo conducted glaciological research focused on the only glacial systems in Mexico at three highest mountains: Popocatépetl, Iztaccíhuatl and Citlaltépetl. At the time, all of them were considered as large glacial areas (> 1 $km^2$) whose contribution to the hydrological cycle was still unmeasured but not less important. More recently, after the extinction of Popocatépetl's glaciers, glaciers of Iztaccíhuatl and Citlaltépetl volcanoes have been monitored in order to determine the real factors involved on their existence, conservation and retreat. Currently, a research group at the Instituto de Geofísica of the University of México (UNAM) and other national institutions perform the glaciological studies in Mexico. Mass balance, energy interactions, rock glaciers and retraction of glaciers are some of the main topics of our interest.

**Sponsors of glaciological measurements in Mexico**

1. National Autonomous University of Mexico (UNAM). From 1958 – present.
2. National Council of Science and Technology (CONACyT). From 1999 to 2012.

**National and International Networks**

1. Working Group on Snow and Ice in Latin-America and the Caribbean (as part of the International Hydrological Program of UNESCO) now known as Regional Program of Snow and Ice in Latin -America and the Caribbean (as part of UNESCO)
2. World Glacier Monitoring Service – Switzerland.
3. Global Land Ice Measurements from Space (GLIMS – NSIDC)

**Which components of the cryosphere you measure (snow, glaciers, sea ice, etc.)**

1. Glacier monitoring from 1958 to present
    a. Glacier surface area
    b. Elevation of glacier front
    c. Thickness of ice
    d. Cartography and Inventories
2. Surface Energy balance from 2006 to 2009
3. Mass balance from 2001 to present
    a. Remote sensing techniques from SRTM and photogrammetric DEMs (2001-2006)
    b. Glaciological measurements: ablation stakes network (2012 to present)
4. Meteorological parameters (2006-2009)
5. Rock glaciers and permafrost (2014)

**Outlook for our site**

Citlaltépetl's glacier is the largest glacial area in Mexico (>0.6km$^2$). This is the reason why the recent environmental programs funded by UNAM and CONACyT can be extended until 2020. It is the interest of our scientific network to contribute as much as possible to the record the eventual glacier extinction on Citlaltépetl which is at 19°N where there are no more glaciers out of Mexico.

***1. How could CryoNet help meet your national, regional or global interests?***

Since the recent analysis implemented by the re-analysis meteorological data, it is necessary to compare this high altitude variability of the cryosphere in Mexico with other sites close to the 19°N or 19° S latitudes. Furthermore, these new analyses suggest the idea of a subtropical climate dominating the dynamics Mexican glaciers; then CryoNet will be useful to correlate data spatially and temporally in a close site to the currently evolving Intertropical Convergence Zone.

***2. What could you or your organization contribute to the implementation of CryoNet?***

a. Personnel trained for instrumenting and monitoring the network.
b. Personnel trained to analyze the signals and general data.
c. Personnel trained to maintain and acquire data at the high altitude.
d. Scientific infrastructure to process data.
e. Scientific team to interpret results.

3. **What do you see as the benefits of CryoNet: (e.g. for operational and research network operators, scientific and decision/policy making community, environmental monitoring and modelling, scientists, satellite data providers, etc.)?**
   a) Knowledge about these Mexican systems.
   b) More reliable and sustainable high altitude data.
   c) Scientific cooperation.
   d) Scientific interchanges.
   e) As an outlook: Information made available to policies and decision makers in order to monitor this hydrological source.
   f) Data availability

4. ***What do you see as existing gaps in cryospheric observations (e.g. thematic, spatial, temporal, availability, exchange, data policy, etc.) and how might CryoNet address these?***

Temporal observations of weather conditions over the Mexican glaciers have serious gaps, which make impossible to determine long-time climate variations on this region. Also, the spatial distribution of the national network meteorological stations is not enough and not so high in altitude to allow an analysis of these high altitude systems. Then, CryoNet could be an excellent opportunity to better support the actual networks and also to establish the basis for a new meteorological and glaciological research about Latin American ice masses, where many of them are at high altitude environments.

a) Spatio-temporal analyses

b) Data homogenization

c) International cooperation and interaction

d) Latin America mass balance and energy rate inventories.

5. ***Please prioritize CryoNet activities according your personal view (indicate HIGH/MEDIUM/LOW for each)***

Establishment of CryoNet network: **HIGH**

Standards, guidelines and training for observations: **HIGH**

Inter-comparison experiments (e.g. sensors, methods): **HIGH**

Cooperation with existing networks: **HIGH**

Data policy on archiving, accessibility and exchange: **HIGH**

Support national needs: **HIGH**