



# **MEXICAN GLACIERS**

## **INDICATORS OF TROPICAL CLIMATE IN MEXICO**

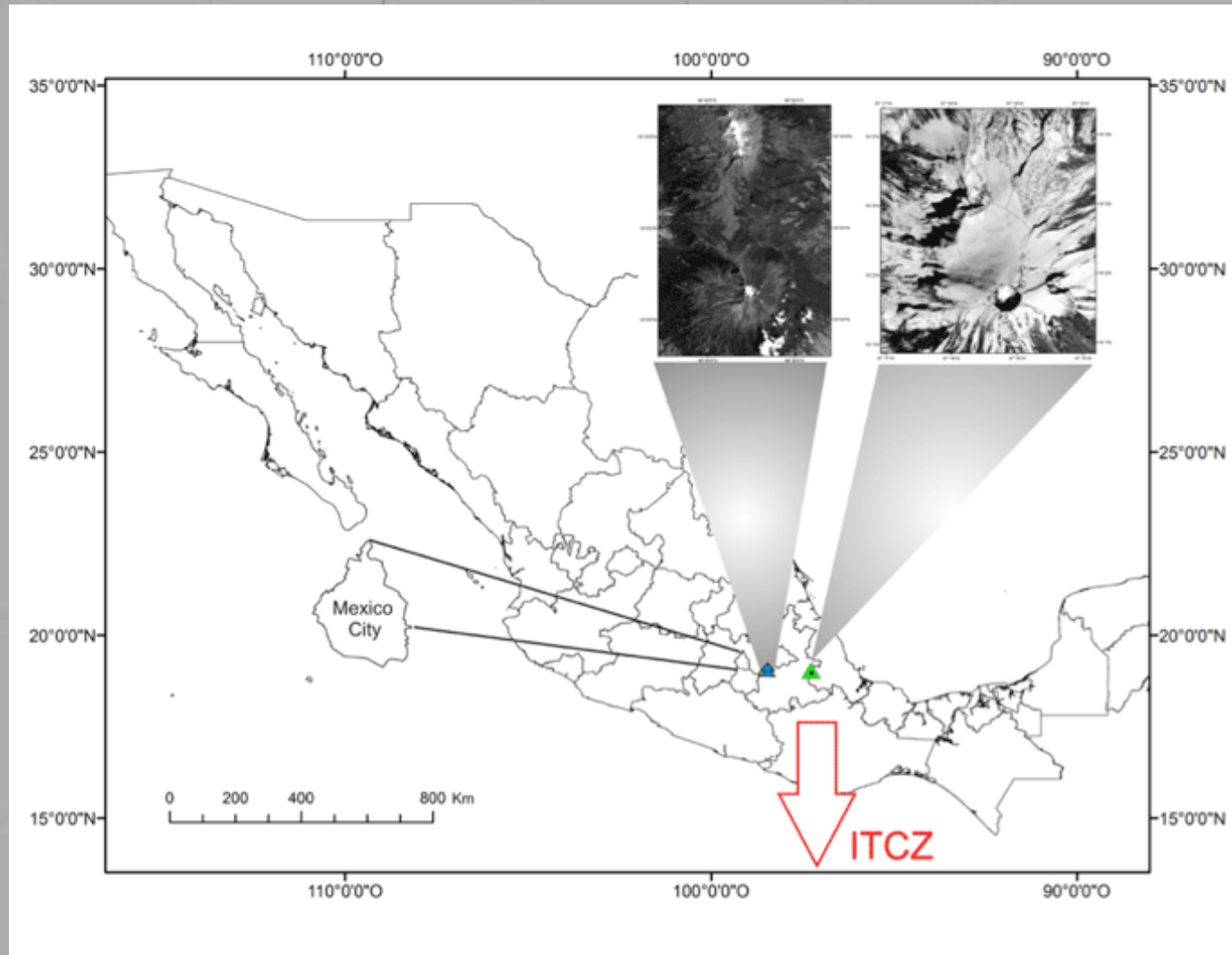
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**DR. HUGO DELGADO GRANADOS**

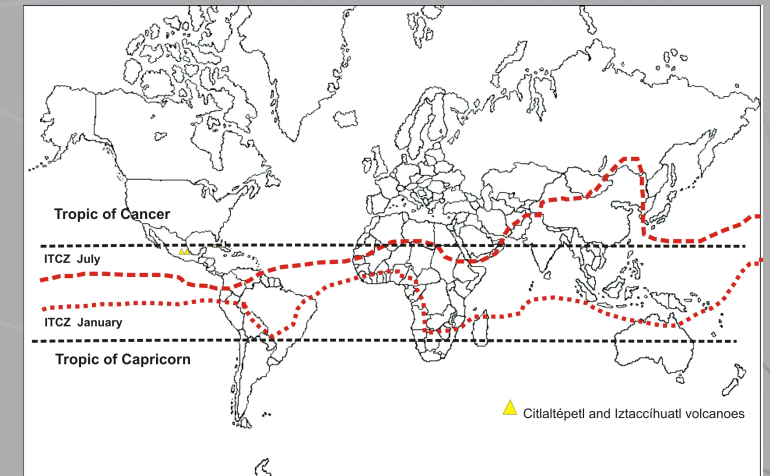
**OCTOBER 27, 2014**



# LOCATION OF THE MEXICAN GLACIERS



- The glaciers of Mexico are considered outside of the *Inter-tropical Convergence Zone (ITCZ)*, delimitation of the tropical climate.



- However, what is the climate regime of the cryosphere in Mexico, which define the presence, conservation and eventual extinction of our glaciers?

# MEXICAN GLACIERS ARE RETREATING AND DISAPPEARING

- Glaciers in Mexico have retreated a lot since the end of the Little Ice Age.

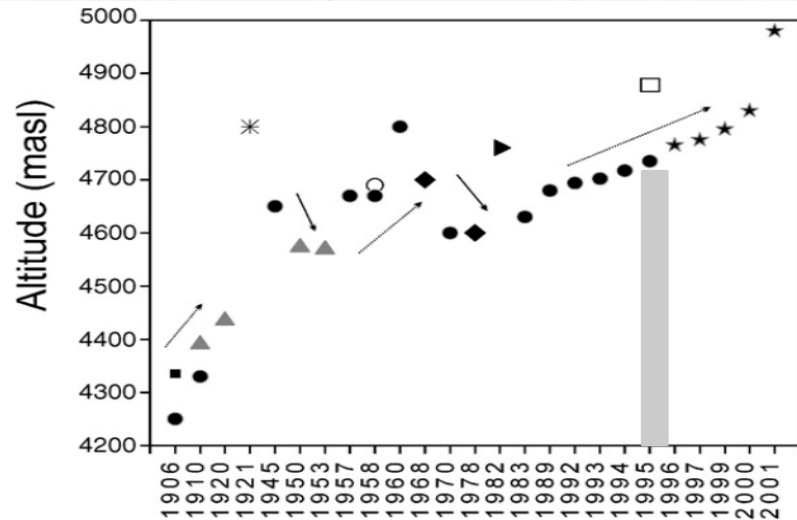
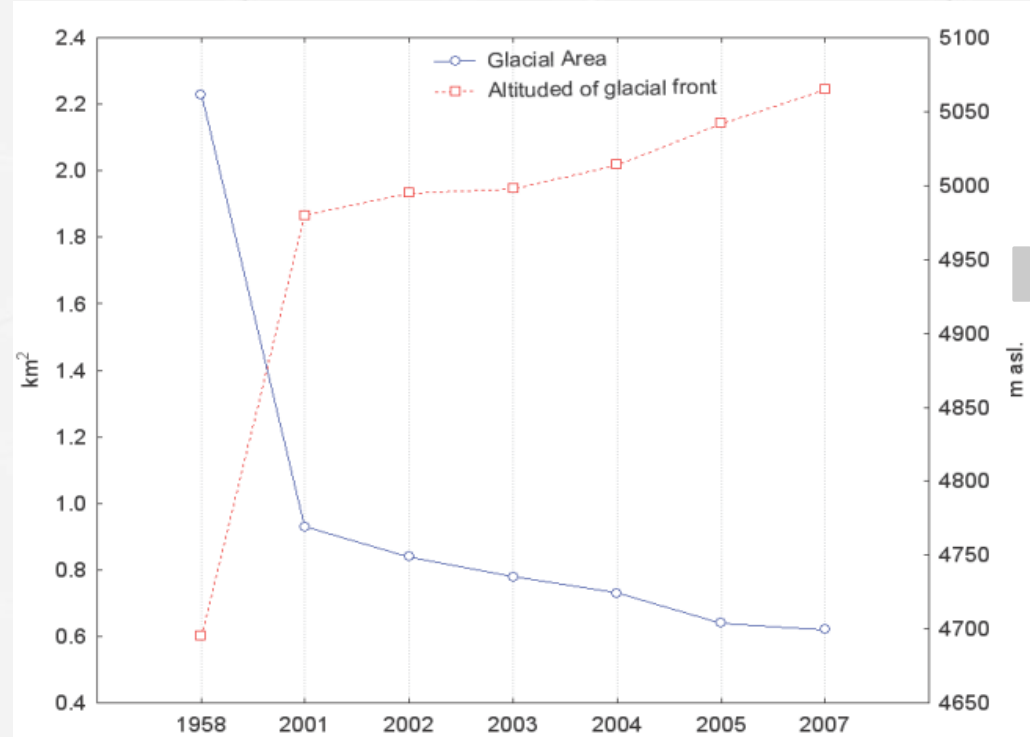


Fig. 3. Altitudinal evolution of Ventorrillo glacial front over the 20th century. Solid arrows indicate advance whereas dashed arrows indicate retreat. [■] - Anderson (1917); [\*] - Waitz (1921); [▲] - White (1954); [○] - Lorenzo (1964); [◆] - White (1981); [●] - Palacios (1996); [▶] - Delgado-Granados (1996); [□] - Delgado-Granados and Brugman (1996); [★] - present work.

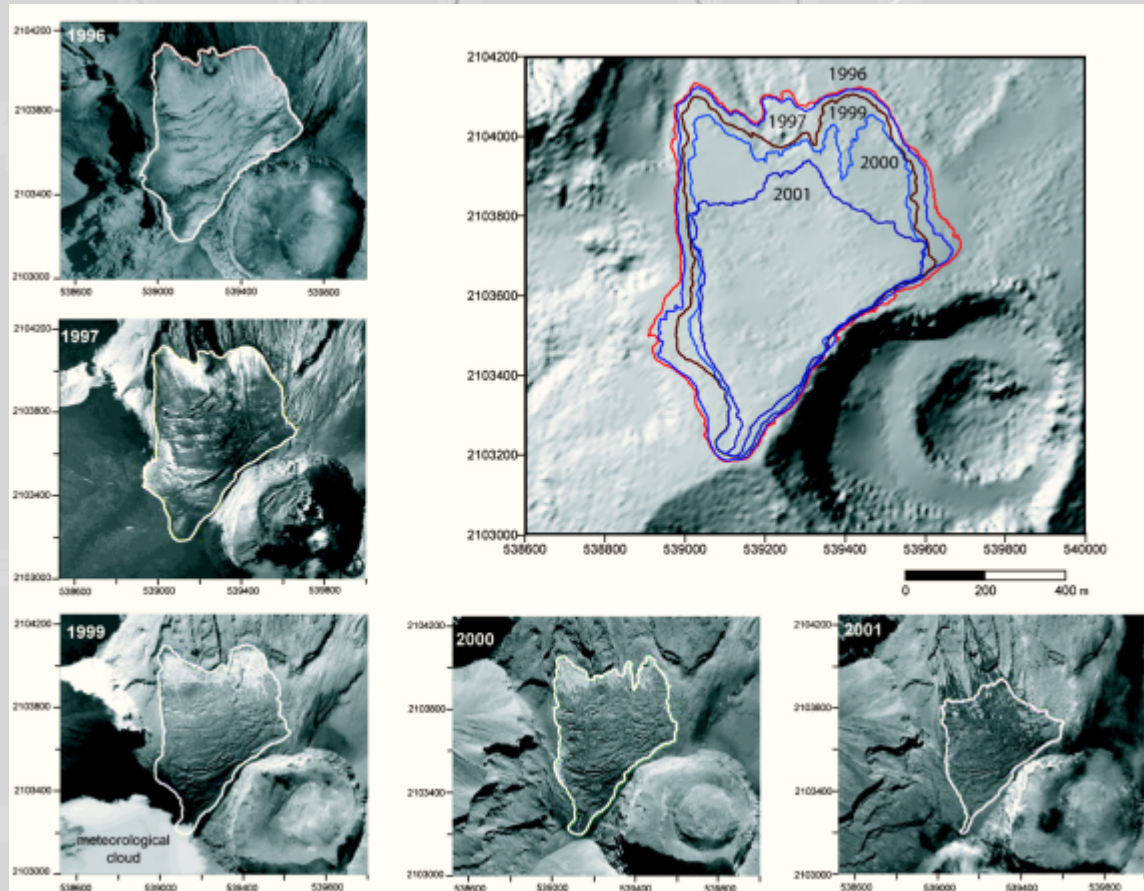


- Apparent advances or stationary phases of glacier front represent an excessive snow accumulation pattern while not increase the glacial extent by itself indicates a decrease of the snow line. These patterns could be associated with meteorological phenomena like “La Niña”.



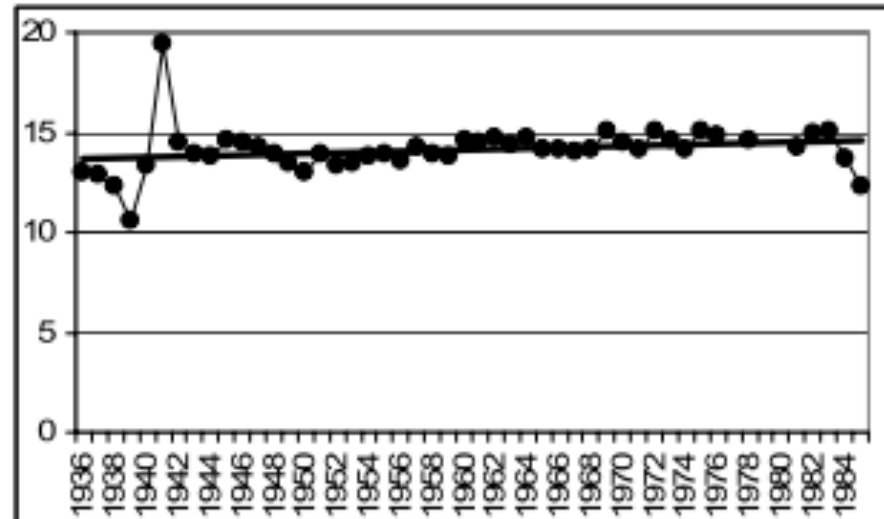
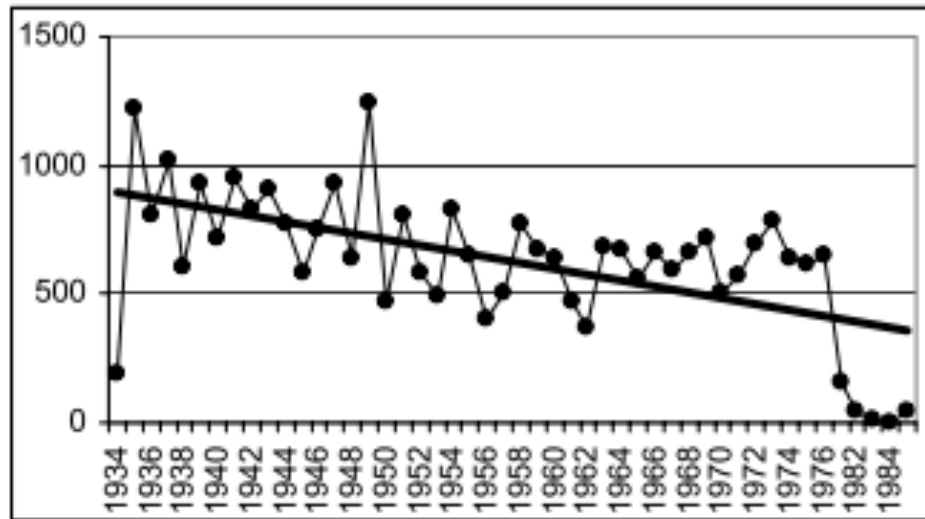
# OTHER FORCING PROCESSES DIFFERENT FROM CLIMATE

- At Popocatepetl volcano, eruptive activity since 1994 caused the extinction of its glaciers at the end of 2000. The volcanic effect masks the climatic influence of the glacial retreat.





# TEMPERATURE AND PRECIPITATION TRENDS



**Air temperature and precipitation anomalies from reanalysis data show the corresponding trends of increase and decrease over Iztaccíhuatl and Citlaltépetl volcanoes. These trends correspond with the current tendency of raising temperatures in the world.**



**THEN, PRECIPITATION IS ONE OF THE MAIN FACTORS INVOLVED INTO THE GLACIAL RETREAT (OR NOT) OF MEXICAN GLACIERS...**



**Landsat images of January 2010 showing the anomaly snow accumulation on the highest mountains in Mexico. From left to right: Nevado de Toluca, Popocatepetl-Iztaccíhuatl and Pico de Orizaba (Citlaltépetl).**

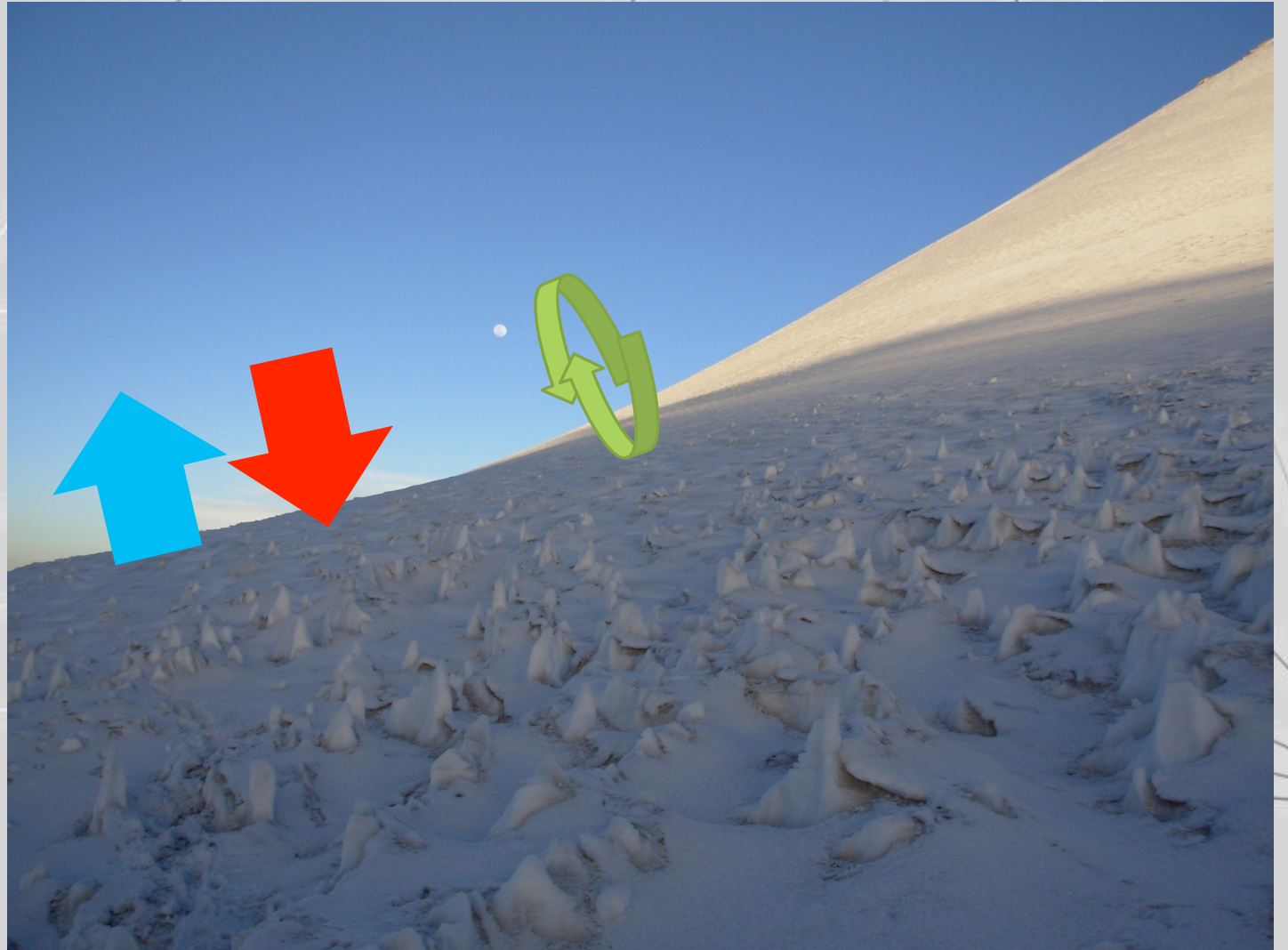






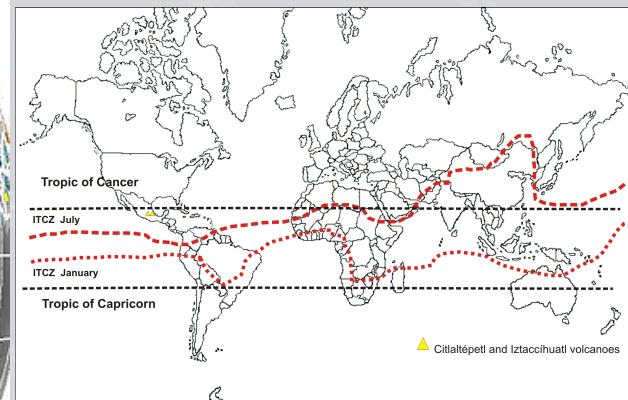
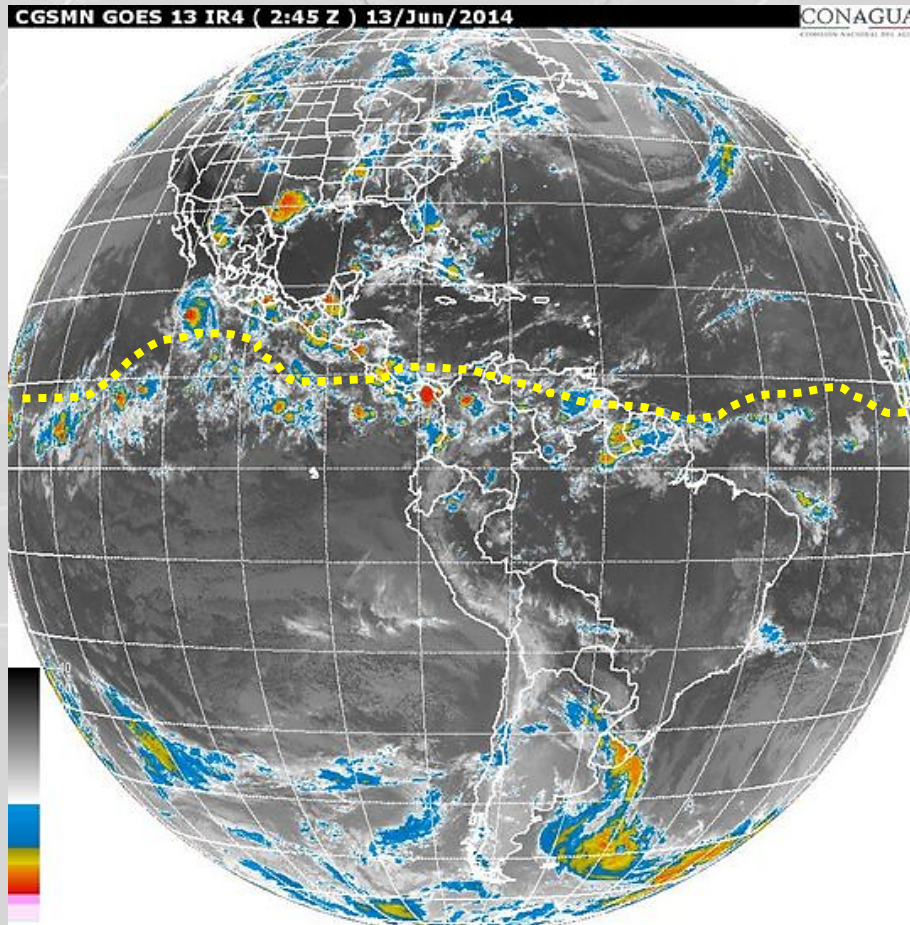
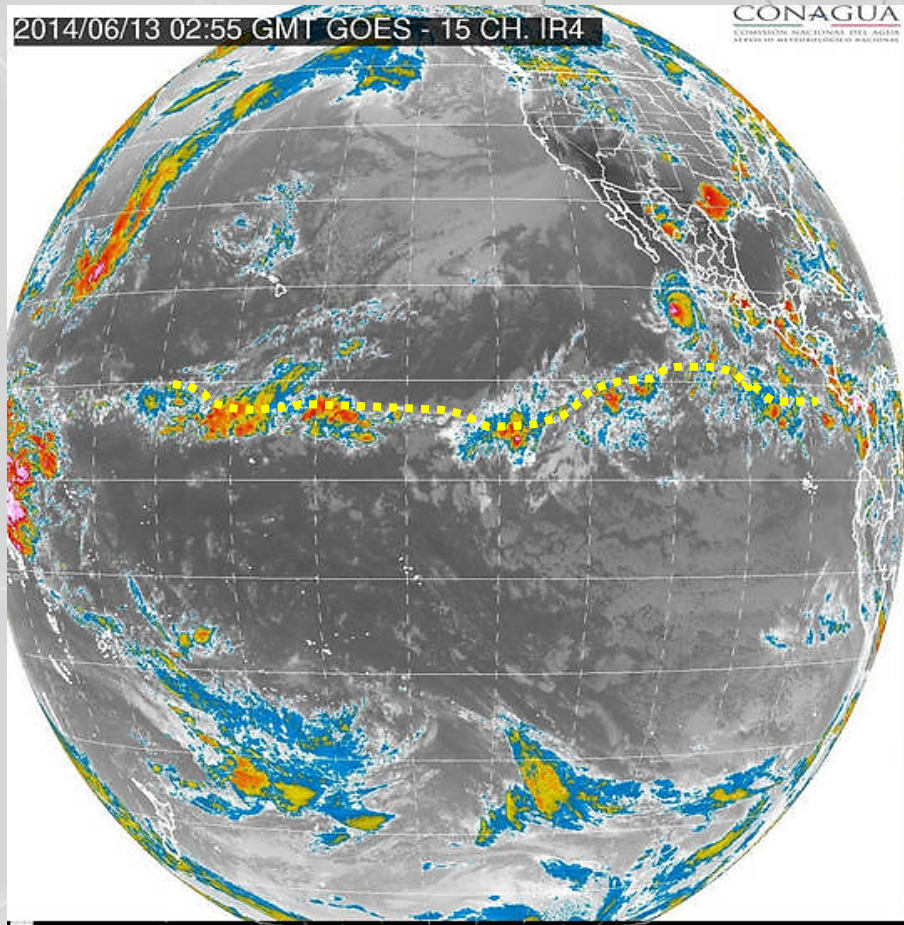
# OTHER FACTORS

- **Net Radiation on SEB**
- **Turbulent heat fluxes**
- **Annual variability of  $0^{\circ}\text{C}$  isotherm**
- **Trend of  $0^{\circ}\text{C}$  isotherm**
- **ELA Variation**
- **Others.....**





# IS ITCZ MOVING NORTHWARD?

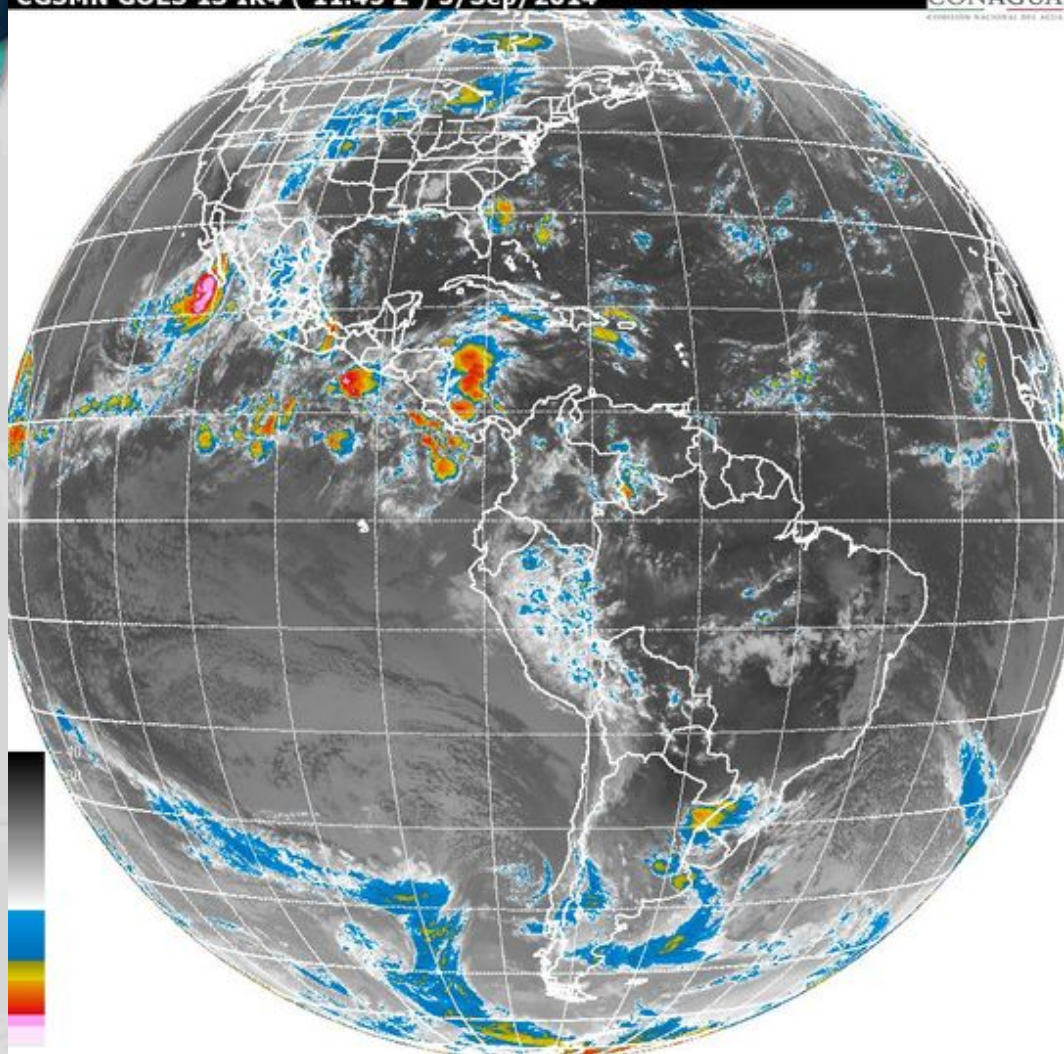


June, 2014



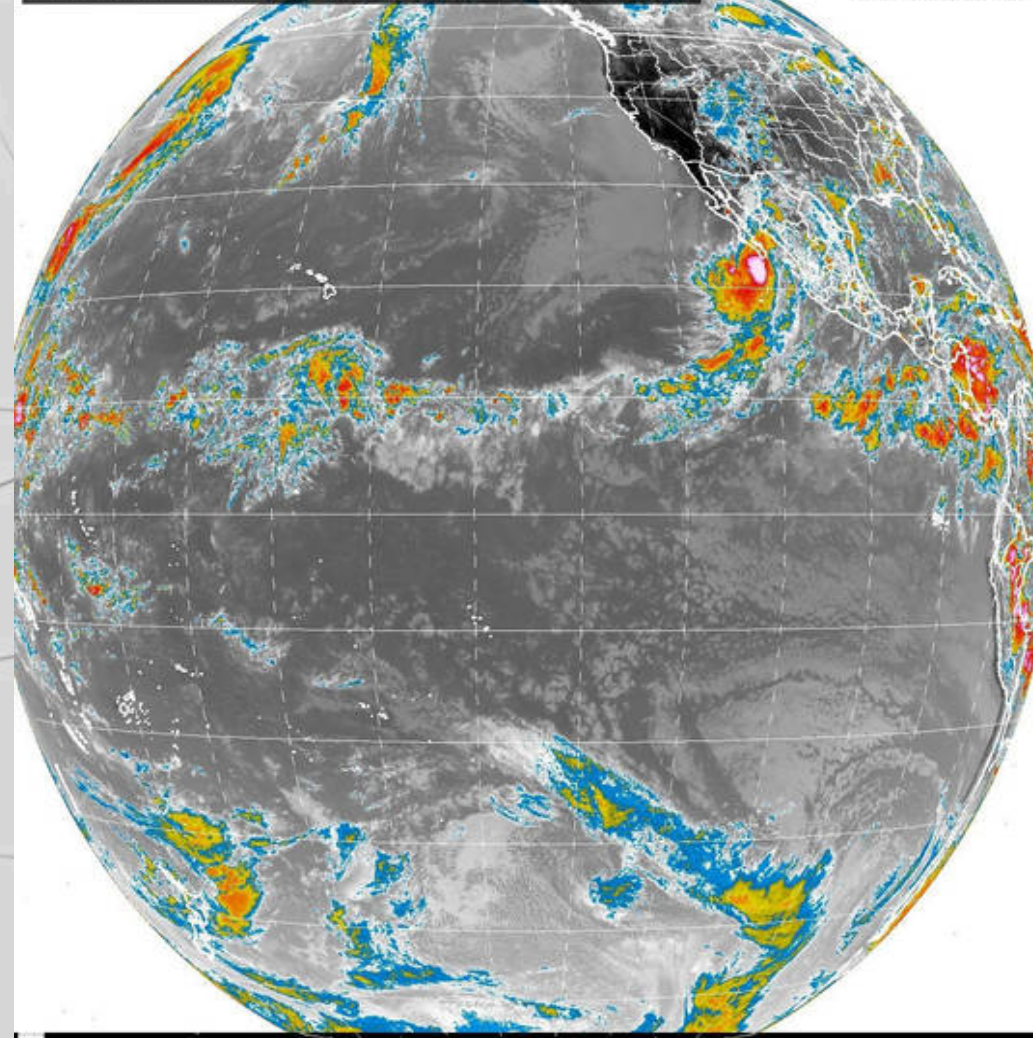
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September, 2014



# CONCLUSIONS ABOUT MEXICAN GLACIERS

- Mexican glaciers are retreating and eventually they will waste away.
- Glaciers like La Panza on Iztaccíhuatl volcano could rise their maximum altitud soon.
- A tropical atmosphere above the glaciers in Mexico could explain why these glaciers still exist and why those trends sometimes change, representing anomalous snow accumulation stages.
- Short-time observations about the surface energy fluxes on Pico de Orizaba's glacier show that even the geometry is completely different to that on tropical glaciers net radiation is one of the main components involved in the recent glacial retreat. However, the contribution of the turbulent heat fluxes is still in analysis.
- Penitents (Penitentes) are proof of the last conclusion.
- Northward displacement of the ITCZ is a good reason for new an better spatio-temporal analysisi of the weather conditions on high altitude Mexican glaciers.





## REFERENCES

- Cortés-Ramos, J., & Delgado-Granados, H. (2012). The recent retreat of Mexican glaciers on Citlaltépetl Volcano detected using ASTER data. *The Cryosphere Discussions*, 6(4), 3149-3176. doi: 10.5194/tcd-6-3149-2012
- Delgado-Granados, H., Julio Miranda, P., Huggel, C., Ortega del Valle, S., & Alatorre Ibarquengoitia, M. A. (2007). Chronicle of a death foretold: Extinction of the small-size tropical glaciers of Popocatépetl volcano (Mexico). *Global and Planetary Change*, 56(1–2), 13-22. doi: 10.1016/j.gloplacha.2006.07.010
- Julio-Miranda, P., Delgado-Granados, H., Huggel, C., & Käab, A. (2008). Impact of the eruptive activity on glacier evolution at Popocatépetl Volcano (México) during 1994–2004. *Journal of Volcanology and Geothermal Research*, 170(1–2), 86-98. doi:10.1016/j.jvolgeores.2007.09.011



THANK YOU