

# Wreckage of glaciers over central Qinghai-Tibet Plateau from multi-mission satellite data and its relationship with climate change

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**Abstract:** The variation of glaciers over Qinghai-Tibet plateau (QTP), as a response to climate change, has attracted wide interest in recent decades, for its significant impact on regional hydrological process and water supply in a large geographical area in Asia. The study presents area, thickness, and volume change of glaciers in Dongkemadi region in central QTP, based on a sequence of 12 Landsat images from 1976 to 2011 and multi-date laser altimetry data derived from ICESat over 2003-2008. The empirical area-volume scaling relationship was used to estimate volumetric changes of glaciers. The results show that the study glaciers have experienced a dramatic shrinkage from 1976 to 2011, with the glacial area reduced by 10.34% and volume reduced by 13.7%. The wreckage of glacier has been accelerated since 1990s and the rate of glacier loss has been stabilized at a linear rate of  $0.26 \text{ km}^2 \text{ a}^{-1}$  ( $0.29\% \text{ a}^{-1}$ ) since 1995. The elevation data reveal that the thinning was dominant over 2003-2008 with a linear rate of  $-0.56 \text{ m a}^{-1}$ . We show that the glacier changes are most strongly influenced by annual temperature, and the temperature in summer seasons (ablation season) exerts more control than that of winter temperature. As revealed by the relationship between atmospheric circulation patterns and glacier area/volume and local climate variables, the state of North Atlantic Oscillation (NAO) are found to have strong influence on glacier variation through impact on temperature and precipitation by modulation of westerlies, and El Niño Southern Oscillation (ENSO)

events are found to have inverse relation with local temperature variations through impact on Hadley cell. Expansion or decelerated shrinkage of glaciers observed in years 1986 and 2000 is supposed to be associated with the super ENSO events occurred in 1983 and 1998. It is worth note that the relationship between glacier variation in the central QTP and NAO and SOI is not always linear, and the mechanisms how the atmospheric circulations impact on regional climate variations over QTP need further research.

**Key words:** glacier, Qinghai-Tibet Plateau, climate change, North Atlantic Oscillation, El Niño Southern Oscillation