Glacier and Hydrological Changes of Monsoonal Temperate Glacier in Mt. Gongga and it's Environmental Implications

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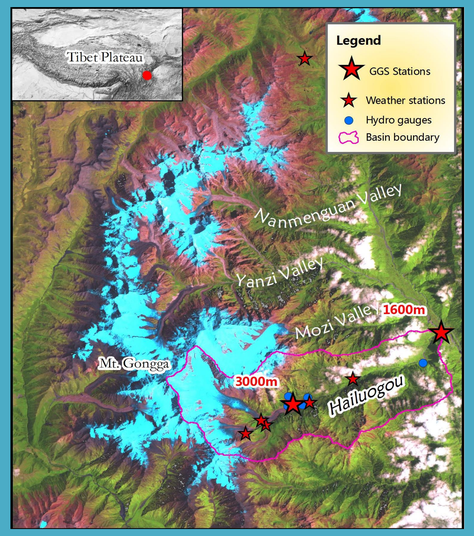
INTRODUCTION

Mt. Gongga is situated in the middle of Hengduan Mountain range, which is located on the Southeastern Tibet Plateau. Its summit has an elevation of 7556 m a.s.l.. Mt. Gongga Glacier has a total area of 255.1km^2 The largest Hailuogou Glacier has a length of 13.1 km and an area of 25.71 km^2. This benchmark site offers us the opportunity to study a maritime glacier system for which long-term, specific, although incomplete, information about the glaciology, meteorology, and hydrology is available. Cryosphere change here has not only impacted the hydrological processes and variation of glacial runoff, but also has driven remarkable dynamics of mountain surface processes and preglacial ecological environment.



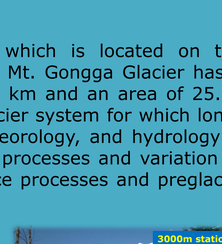
Mt. Gongga Station (GGS)

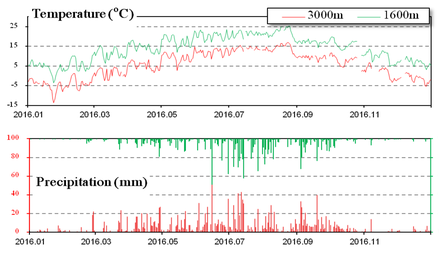
Since 1989, the GGS aims to:

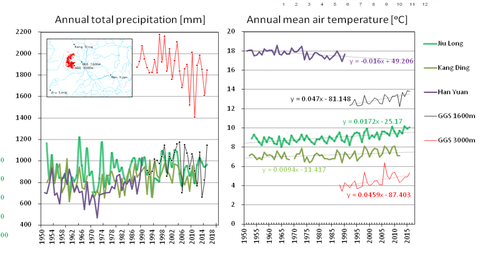
- Monitor climate changes and its impacts on alpine cryospheric, hydrological and biological systems;
- Recognize the mechanism of the construction and productivity formation and evolution of high alpine ecosystems;
- Understand the interaction mechanisms among cryosphere, biosphere and human activities;
- Provide scientific bases and key technologies to ensure the ecological security and regional sustainable development.

CLIMATE AND OBSERVED CHANGES

Local climate is characterized by the southeast monsoon in summer and westerly circulation in winter. The mean annual air temperature from 1988 to 2013 at the Mt. Gongga Station (GGS; 3000 m a.s.l.) is 4.4° C, and mean annual precipitation is 1.9 m. About 80% annual precipitation occurs during May–October and the precipitation peak occurs in July. Precipitation in the catchment increases with altitude. Runoff in the catchment shows a clear seasonal cycle, with the peak in August. About 80.2% of runoff occurs between May and October. Over the past 30 years, the Gongga Mountain region has experienced significant warming, together with the remarkable decreasing high-altitude precipitation due to weakened monsoon.

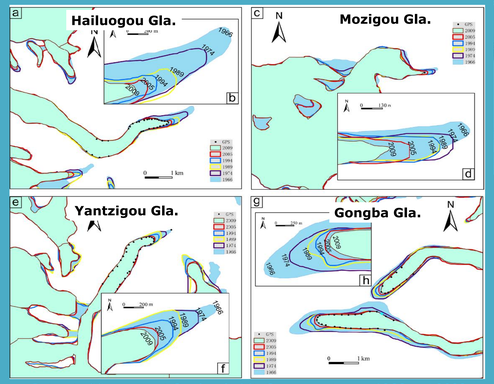




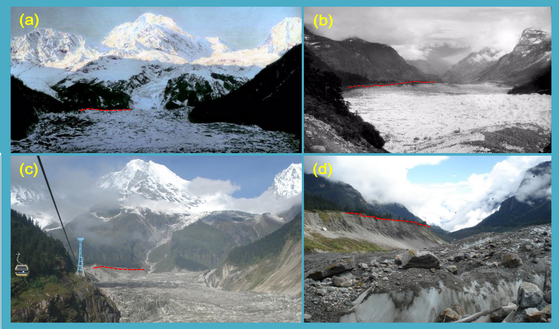


GLACIER CHANGES

Most glaciers in Mt. Gongga, SE Tibet, are physically belong to the type of monsoonal temperate, which generally with low altitude of ablation area and highly interacted with environments in their proglacial zones. Due to the strong influence of maritime climate and monsoon, temperate glaciers in Mt. Gongga are characterized with high level of mass balance, low altitude of terminals, strong surface ablation and fast ice flow speed.

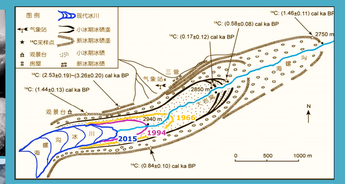


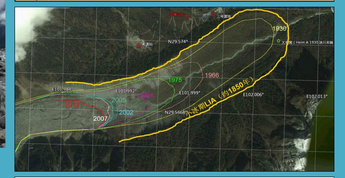
Retreat of four largest Glaciers in Mt. Gongga between 1966 and 2009

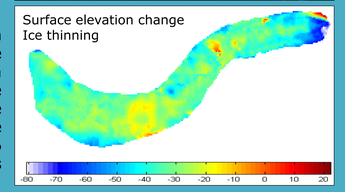


Changes of Hailuogou Glacier by comparing historical photographs between 1930 and 2013. a) and (b) were taken by Heim in 1930; (c) and (d) by Liu Qiao in 2013.

As a result of warming, the glaciers in Mt Gongga have been retreating considerably and losing mass during recent decades. The Hailuogou Glacier located on east slope of Mt. Gongga in Southeastern Tibet Plateau, has retreated more than 2 km since Little Ice Age (LIA). Mean terminal retreat rate is ~20m/a; surface area decreased by 3.5% (1966-2007). Between 1989-2008, surface elevation lowered by 33.9 ± 11.2m, with a mean rate of 1.8 ± 0.6 m/a. Glacier thinning is a major contribution to the mass loss comparing with area shrinkage.

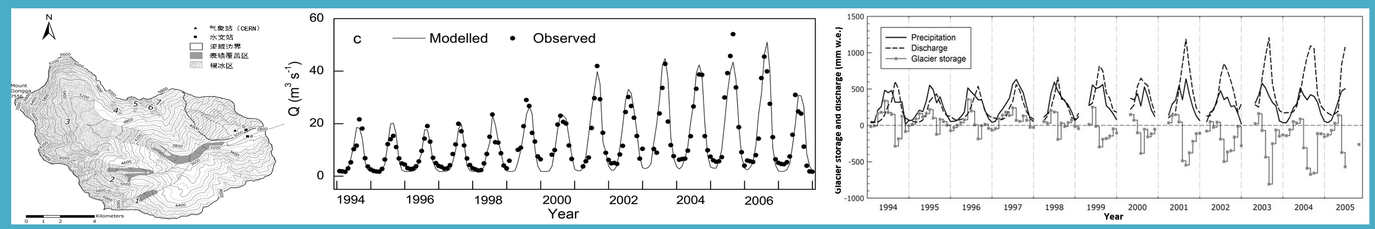






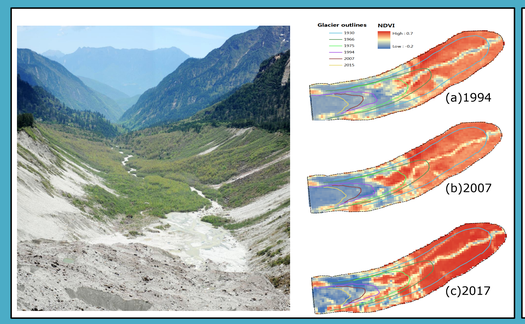
CATCHMENT HYDROLOGICAL RESPONSE

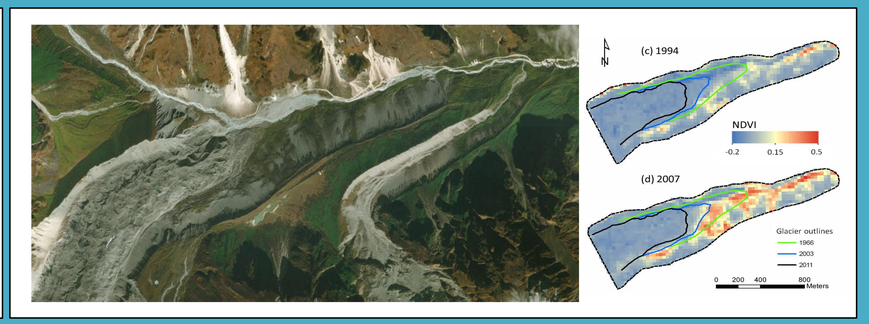
Observed and modeled runoff of the catchment showed a continuously increase trend from 1994 to 2007. These trends can be easily recognized from the total annual and summer (July-September) runoff variations. Annual discharge in HLG catchment shows a dramatic increase from 232.4×10^{6}m^3 (1994) to 684.5×10^{6}m^3 (2007). In particular, total discharge during the summer season (July-September) also exhibited a significantly increasing trend during 1994–2007.



VEGETATION PRIMARY SUCCESSION IN PREGLACIAL AREA

Normalized-difference vegetation index (NDVI) was calculated using Landsat TM/ETM images' reflected red and near-infrared band values. Changes of glacier terminal and preglacial vegetation for two typical glaciers (Hailuogou Glacier and Yantzigou Glacier) were presented below. The LIA preglacial zone (2980-2800 m) of Hailuogou Glacier (left), characterized by very fast primary succession due to local warm-wet hydrothermal conditions, possesses an integrated succession community from cold-adapted herbaceous to *Abies fabri* forest. Along the preglacial area of Yanzigou Glacier (right), frequent local debris and landslide have disturbed the establishment of vegetation.





REFERENCES

[1] Zhang G, et al. Quaternary International, 2015, 371: 49-57. [2] Pan B T, et al. The Cryosphere, 2012, 6: 1087-2012. [3] Zhang Y, et al. Journal of Hydrology, 2012, 444-445: 146-160. [4] Zhang Y, et al. Journal of Glaciology, 2010, 56(195): 65-74. [5] Liu Q et al. Journal of Glaciology, 2010, 56(196): 215-224.