

EGU24-17330, updated on 08 Oct 2024

<https://doi.org/10.5194/egusphere-egu24-17330>

EGU General Assembly 2024

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Inventory and kinematics of rock glaciers in Goikarla Rigyu, Tibetan Plateau

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Rock glaciers are periglacial landforms often observed above the timberline in alpine mountains. Their activity states can indicate the existence of permafrost. To help further explore the development and motion mechanisms of rock glaciers in semi-arid and humid transition regions, we used a manual visual interpretation of Google Earth Pro remote sensing imagery and a 7-year (2017-2023) InSAR time series analysis to provide a detailed rock glacier inventory of the Goikarla Rigyu area of the Tibetan Plateau (TP). Approximately 5057 rock glaciers were identified, covering a total area of ≈ 404.69 km². Rock glaciers are unevenly distributed in the study area from west to east, with 80 % of them concentrated in the central region, where climatic and topographic conditions are most favorable. Under the same ground temperature conditions, increases in precipitation are conducive to rock glaciers forming at lower altitudes. Indeed, the lower limit of rock glaciers' mean altitude decreased eastward with increasing precipitation. The LOS deformation velocities results showed that 71.3% (n=3608) of the rock glaciers were in the transitional state, including 58.4% (n=2954) of the rock glaciers with deformation rates in the range of 10-30 mm/year and 12.9% (n=654) of the rock glaciers with deformation rates in the range of 30-100 mm/year. And 28.7% (n=1449) of the rock glaciers were in the relict state. Analysis of mean annual air temperature and annual precipitation data for the period 2000-2022 in the region where the rock glaciers are located shows that the faster-moving rock glaciers are distributed in locations where the mean annual air temperature is warming significantly faster and the rate of decrease in annual precipitation is relatively low. By comparing the results of rock glacier activity discrimination based on different indicators, it is found that the method based on kinematic data is more applicable to the discrimination of transitional state rock glaciers in the region, especially for those rock glaciers whose surfaces have been covered by vegetation but are still in motion. This study contributes to the understanding of the complex response of rock glaciers to environmental and climate change in semi-arid and semi-humid climatic zones.