



## **Climate Impact on the Cryosphere Changes and Aridity in Pamir**

Elena Aizen, Vladimir Aizen, and Hang Zhou  
University of Idaho, Geography, Moscow, United States

We analysed the modern impact of climate change on the aridity, seasonal snow cover, and glacier dynamics at the Pamir mountains (Amu Dar'ya River basin) using data of meteorological and glaciological observation from 1945 to 2016 and remote sensing data between 1970 and 2016.

The maximum air temperature changes were observed in the Western Pamir below 1000m, minimum in Central and Eastern Pamir above 4000m. The difference between the means of the annual air temperatures for the two periods of 1977-2016 and 1945-1976 in Pamir is two times lower than in all of central Asia. The difference in annual precipitation for the two periods in Pamir is more than twice larger than the difference over central Asia. The positive difference in annual precipitation increases with an increase in elevation. The largest positive difference is observed in the winter, in the Western Pamir. The main climatic features that distinguish Pamir from other central Asian regions are the major contributions of moisture in the winter-spring while summer precipitations are minimal. There are insignificant increases in air temperatures and in annual precipitation between 1977 and 2016, compared to the period from 1945 to 1976. We did not find significant changes in aridity during two considered periods in Pamir. The coupling between large-scale atmospheric patterns and modifications of regional precipitation revealed the intensified influence of Arctic Oscillations and the loss of influence of the Pacific North American mode, which caused an increase of the winter precipitation between 1977 and 2016. The weakened impact of North Atlantic modes caused the decrease of spring precipitation in all of Pamir's regions.

Analysis of AVHRR and MODIS satellite images from 1986 to 2016 revealed the highest snow cover duration (over 240 days of perennial snow cover) above 3000m with a maximum at Central Pamir. Low elevations at Western Pamir and Eastern Pamir have less than 30 days of snow cover duration. Areas above 3000m show decreasing snow cover durations (-1.59 days/year) while the Pamir-Altai and Western Pamir ridges exhibit increases in snow cover duration (1.24 days/year).

Analysis of high resolution satellite images (KH-9, Landsat ETM+, SRTM DEM, ALOS PRISM, Quick Bird and SPOT) between 1970 and 2016 demonstrated that Pamir glacier area has decreased on average by 5% or 615km<sup>2</sup>. The glacier area changed in Pamir mainly due to the recession and disappearance of small- sized glaciers with areas between 0.5 and 2.0km<sup>2</sup>. The medium- sized glaciers, from 2.1 to 10.0km<sup>2</sup>, and particularly large glaciers with areas more than 100km<sup>2</sup> in Central Pamir changed only by 2-3%. The largest glacier area changes (up to 10%) appeared in the northwestern and southwestern Pamir. There are 35 glaciers in Central Pamir that have been observed to be increasing in area between 1970 and 2016. The changes in the volumes of the glaciers are more significant rather than changes in glacier areas, up to 15%.