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Research opportunities of climatic changes in Tajikistan

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The global climatic changes influence on natural environment and development of economy of all countries. At present, the world community pays much attention to the decision of this problem. However, only the participation of all countries in those researches can give the fast and effective results. Based on scientific data, having in our disposal, we are ready to join in the work on researches of climatic changes.

Introduction: The Data Set

An extensive network of hydrometeorological stations was created in Tajikistan for the last 70 years that passed after Soviet-German expedition to Pamir. Being available continuous records of meteorological data (pressure, air temperature, surface temperature, precipitation, humidity, wind, clouds, visibility, fog, thunderstorm, hail, snowstorm, haze) spanning 40-70 years from nearly 70 meteorological stations situated on the slopes of the mountains (300 - 4200 m a.s.l.) in the mountain districts of Tajikistan. Four stations made measurements of solar radiation and radiation balance. Unfortunately, many stations are closed now for financial reasons. At present only 36 stations are working. Nevertheless, it is necessary to check up quality of their work.

All meteorological stations in Tajikistan composed observation net of hydrometeorological service of USSR. Observation program, terms of measurements, equipment, analyze of results are standard for all stations in this net. Meteorologists according to standard instructions edited all errors, and data were sent to World Hydrometeorological Data Centers (Tashkent, Moscow). Long term climatic data until 1966 were published in climatic reference books. The data from the previous 60 years have been archived and are available (in the handbook and archive papers) for collaborative research.

All observations were made on the high mountain stations (down 4000 m a.s.l.). That is why the data are unique. There are long term observations on many stations, but not all of them are located in high mountains. Glacier Fedchenko (Gorbunova) station is on 4169 m a.s.l. It is the highest of the meteorological station in the world. The data were collected in ways that may be compared with other high mountain data. They are valuable, because they span a long period.

The first aim is to compare data from different mountain stations in different world

regions. It is more important to show that mountain stations have long-term records of climatic change in the air thickness of troposphere (to 4000 m a.s.l.). We attempted to show only examples of temperature and precipitation from four stations.

With the help of these data, we can investigate climate change over that period at high altitudes and, in particular, we can determine the vertical profiles of the long-term trends in mean temperature and precipitation.

Air Temperature

We analyzed the mean annual air temperature from 1929 to 1993 at four stations (those stations made measurements of solar radiation and radiation balance).

Analyze if those data shows that the temperature on low levels increased more than on high ones. For 100 years at the lowest station (Kurgan-Tube) the annual temperature trend increased to 1.9°C. On the highest station (Fedchenko glacier) the annual temperature trend increased to 0.7°C. So it is possible to make a conclusion, that at the bottom levels has taken place more substantial increase of temperature, than at the upper ones.

This vertical difference of the temperature increase leads to the increase of the vertical gradient of air temperature. The vertical temperature gradient increased to 3.3% per 70 years between levels one (426 m a.s.l.) and fore (4169 m a.s.l.). This rise reduces atmospheric stability and may be the reason of other dynamic and thermodynamic changes.

Precipitation

Mean annual precipitation also increased over the recording period. The rate of precipitation increase at the first level (426 m a.s.l.) is 4.6 mm/100 years and on the second (803 m a.s.l.) is 64.7 mm/100 years. There is 181.6 mm/100 years on the third level (2800 m a.s.l.) and on the highest (4169 m a.s.l.) one is 536.8 mm/100 years.

Thus, the increase of a vertical gradient of temperature and instability of atmosphere well proves to be true by increase of quantity of precipitation. It had been spoken about in 1998 on a workshop in Maratea (Italy) [1].

Dust Storms

The highest mountain ranges of Tyang-Syang and Pamiro-Alai form a curtain-like system in which there are voluminous orographic niches open to penetration of air masses from the southwest. Mountain ranges rise up to 5000 - 6000 m above the sea level in the eastern and northern parts of Central Asia. They form a barrier preventing these south-western air masses from penetrating any further. Those are

the usual conditions for the Tajikistan area.

There are no long-term aerosol observations in Tajikistan. There are aerosol samples only in single scientific experiments. In the meteorological stations only visibility were recorded. If visibility is lower than fixed limit, then it is recorded as "haze". The record shows how many day and how many hours per month the haze was. Those data also show aerosol pollution of air for the long time. Haze arises after dusty air came from dessert area of Central Asia.

Glaciers record aerosol in their levels of ice. But for such researches is necessary to get the ice core. Haze, which is lofted into the air by the dust storms, remains suspended there. After the episode itself and it is then transported to large distances by air streams through the lower troposphere. The vertical extent of the haze layer may reach 3-4 km. The dust particle number density at 1.5 m height may reach 8.4 per cm^3 [2]. Haze duration in the Pamir Mountains took place only 3-6 days/yr [3]. While the average duration of a haze episode does not exceed 40 hr/yr in the north, that same figure increases to 200-400 hr/yr in the Central Valley, and further increases to 500-600 hr/yr in the extreme south. The annual cumulative duration of haze in the Pamir varies from 4-8 to 30-40 hr/yr. It is possible that change of number of dust haze is connected with change of atmosphere circulation. But we need to research such connection.

Summary

Analysis of this unique data (which were taken only from four stations) allows us to make some conclusions about 20^{th} century climatic change in Tajikistan.

- There was a stabilizing trend of annual air temperature at all measurement levels until 4000 m a.s.l.
- The rate of air temperature increase decreased with altitude, so that the vertical gradient of air temperature increased over the measurement period.
- The temperature increase was greater in the cold part of the year than in the warm half-year.
- Analysis of data of annual precipitation confirms it. Precipitation increases in mountain areas more then in valleys.
- Precipitation increases in cold half-year more then in the warm half-year.
- Warming-up of climate in mountain regions can influence degradation of some Pamir's glaciers. At the same time, precipitation increase can influence accumulation of snow and ice in mountain glaciers. The correct estimation of balance of these reason is a key to the forecast of water balance in this region. We don't know what of those reasons is the main. So we should find the reason.

Based on what was said earlier we determine the aims for the realization of this proposal. First, it is necessary

- to study methods and ways of estimation of climatic change in different country;
- to have an access to data which are necessary for comparison and analyze of climatic conditions of different mountain regions;
- to study models of climatic change;
- to compare climatic conditions of Tajikistan with the other mountain regions of the world, to study climatic change in Tajikistan and connect it with global climatic change.

The examples of the analysis of climatic data that were mentioned above show, that we can investigate data of other stations by the same way. From our point of view, it will help to solve many problems connected with climate change and its consequences. But we require the support of western partners, to realize such analysis jointly.

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