A Comprehensive Dataset for Cryosphere Research in Central Asia

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Introduction
Seasonal snow and mountain glaciers are vital water resources for arid and semi-arid regions in Central Asia (CA). To quantify the future water resources change in CA requires the knowledge of current and past situation of its glaciers and seasonal snow cover. We present AsiaCryoWeb.org, as a comprehensive data set for cryosphere research in CA. It serves as a data portal for glaciological, snow cover, cryosphere and, and ice core data in Central Asia, as well as a platform for further research collaborations.

Research Area

We define the Central Asia as the geographic center of the Eurasian continent, between 30° N and 55° N latitudes and 50° E and 90° E longitudes (Fig. 1), with Caspian sea to the west and Altai mountains to the east, Western Siberia to the north and the Tien Shan, Pamir, Kupet Dag mountains to the south[1].

Glacier Database

Data and methods
1. Baseline glacier inventory (around 2000-2003) LANDSAT ASTER satellite images were used to generate glacier inventories for the Altai-Sayan, Tien Shan and Pamir.
SRTM DEM were used in orthocorrection of satellite images, and calculation of hypsometry statistics[3].

2. Historical glacier areas (1960-1970) Historical glacier areas were manually digitized from 2m Corona (1960s) and 6 - 9 m Hexagon (1970s) declassified satellite photographs. Overlapped images were co-registered for rigorous bundle adjustment and orthocorrection, with control points collected from GPS survey during field trip or picked up from modern high resolution imagery.

3. Recent glacier areas (2006 - 2008) High resolution ALOS/PRIISM imagery (10m resolution) was used to estimate glacier area in recent time.

Glacier Database Online

Complete glacier inventory data for Tien Shan, Pamir and Altai-Sayan, can be downloaded from AsiaCryoWeb.org.

Snow Cover Dataset

Data and methods
We collected all available AVHRR images (total number 91, 468) for Central Asia from 1980 to 2009 (Fig. 3), and all available MODIS Tierra 8-day snow cover product in 19 tiles (Fig. 4) from 2000 to 2009.

We identified snow pixels in each AVHRR image segments, then composed into daily snow cover data, which were further composed into 8-day maximum snow cover data. The daily and 8-day AVHRR snow cover were validated by comparison with ground snow survey data and MODIS data [4].

We used a series of spatial and temporal filters to fit cloudy pixels and gaps in 8-day AVHRR and MODIS snow cover (Fig. 5). The result were compared, and the AVHRR 8-day data were further adjusted according to the MODIS data.

Snow Cover Change in CA

We calculated Snow Cover Area Percentage (SCAP) for each 5km grid from eight-day snow cover data. The long term SCAP show the general distribution of snow cover in Central Asia (Fig. 5), which is basically relies on elevation (higher elevation, higher SCAP).

We examined the trend of snow cover change using Mann-Kendall’s test. Statistical significant SCAP change rate per decade were depicted in Fig. 6.

For high elevation mountain regions in Pamir and Tien Shan, there is significant decrease trend of snow cover extent. In Western Pamir, elevation between 3000 - 4000m, the SCAP change rate is -3.22% per decade, while in Eastern Pamir at the higher elevation area (> 4000m), the SCAP change rate is -4.68% per decade. In Western Tien Shan areas with elevation between 3000 - 4000m, the SCAP change rate is -4.38% per decade, while in Inner Tien Shan in the same elevation zone the value is -3.13% per decade. Decrease of snow cover extent in mountain regions might be caused by the increasing temperature, especially summer temperature in these regions.

At the same time, in northern Kazakh Steppe, there are large areas with significant strong increase of snow cover extent, which might be caused by the increasing winter precipitation.

Snow Cover Dataset Online

Eight-day cloudgap filled snow cover data derived from AVHRR and MODIS images in ERDAS IMAGINE format, as well as snow cover area percentage statistics in plain text format, were shared on AsiaCryoWeb.org, providing a continuous coverage from 1986 until now.

Meteorological Station

Data and methods
Meteorological station data from various sources have been collected, validated check, consistency checked, reformatted and combined together:
1. Central Asia Database, University of Idaho
2. Central Asia Temperature and Precipitation Data, NSIDC
3. Global Historical Climatology Network, NCDC
4. Meteorological Station Data in China

We identified exact location for each station via contacts with local collaborators and from high resolution GoogleEarth imagery. Stations with different name in different data sources were matched together based on location information, similarity of pronunciation of names, and similarity of actual records.

All records were rigorously checked automatically and manually for 1) typos; 2) physically impossible values; 3) missing / duplicated records. We also identified abnormal high or low values, and records that show an abrupt change. Data for one station from different sources were combined together by picking the values from the most trustworthy source.

All final data were saved in plain text format for easy manipulations and analysis.

Meteorological Station Data Online

Currently we collected monthly temperature and precipitation data for 412 stations (Fig. 1) in Central Asia from AsiaCryoWeb.org

Reference

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