Geophysical Research Abstracts
Vol. 14, EGU2012-6679, 2012
EGU General Assembly 2012

Meteorological controls on glacier mass balance in Central Asia

A. Rasmussen
University of Washington, Earth and Space Sciences, Seattle, WA, United States (lar@ess.washington.edu)

Precipitation and upper-air temperatures are two variables that have been shown to exert a strong influence on glacier mass balance. The covariance of precipitation and temperature controls glacier accumulation, and temperature is the principal control on ablation. Calibrating these relations in the case of glaciers in Asia is severely handicapped by the extreme lack of surface mass balance measurements there.

U. S. National Centers for Environmental Prediction and U. S. National Center for Atmospheric Research (NCEP-NCAR) Reanalysis gives values of meteorological variables at many levels in the atmosphere at integer multiples of 2.5 degrees in both latitude and longitude spanning the globe. It also provides many variables at the surface, including precipitation, at a similar but different array of gridpoints. The database has the advantages that it has daily or better temporal resolution since January 1948, is free from missing values, and is maintained as an integral part of an ongoing major scientific enterprise.

Spatial variation over 60-100E, 25-50N of the mean 1948-2010 winter (Oct-Apr) and summer (May-Sep) precipitation shows winter maximum in the western part of Central Asis, summer maximum in the eastern part. Temporal variation over that period is shown at selected points, as is that in temperature.

According to published geodetic determinations, the mean annual mass balance at seven glaciers in Nepal declined from -0.18 m w.e. (water equivalent meters) in 1971-2002 to -0.82 m w.e. in 2003-2007. Between those two periods, there was only a 4% increase in the number of positive degree days at 5000 m, but there was a 23% decrease in precipitation. Whereas warming appeared to have slight effect in this case compared with drying, at several other glaciers the response to temperature was much stronger.

Upper-air temperatures at nearby NCEP-NCAR gridpoints were used with a degree-day model of annual variation of summer surface balance, B_s. At six glaciers between 71 and 87E at about 40N and two at 87E, 50N model error ranged between 0.18 and 0.34 m w.e., which is comparable to observational accuracy. These glaciers include two each in Kyrgyzistan, Kazakastan, China, and Russia. Sensitivity dB_s/dT to +1C temperature change ranges between 0.2 and 0.5 m w.e.

Long term changes in precipitation correlated positively between the two ends of the Himalaya, but those in temperature correlated negatively. In the upper Indus basin, annual precipitation declined about 20% between 1949-1954 and 1955-1970 and then about 40% between 1955-1970 and 1971-2010. Near Mt Everest, it declined 20% both between 1949-1956 and 1957-1991 and between 1957-1991 and 1992-2010. The number of annual 5000-m positive degree days increased about 15% in the east between 1948-1978 and 1979-2010 but decreased by the same amount in the west between those periods.