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Variability in Central Asia seasonal snow cover during the MODIS period of record

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Snow melt in the Tien Shan of Central Asia accounts for a large portion of the seasonal water supply for millions of inhabitants. Studies based on in situ records suggest that maximum snow depth and snow duration in the Tien Shan has decreased, as has annual river flow at lower elevations, over the past 50 years. Although the need to monitor trends in winter snow accumulation has increased as this resource is threatened by climate change, the number of in situ measurements of snow depth has declined, forcing reliance on remote sensing methods.

In this talk we describe trends in seasonal snow cover for 8 individual hydrological basins in Central Asia, as well as for the Tien Shan as a whole, using operational products derived from the MODIS Terra instrument. Data from the Moderate-Resolution Imaging Spectroradiometer (MODIS) data, available since early 2000, have proven useful for a large variety of land, ocean and atmospheric applications. The MODIS standard snow-cover products, archived at the National Snow and Ice Data Center, are available in swath-based, daily, 8-day and monthly aggregations at a variety of spatial resolutions. Similar products are also available from the MODIS Aqua instrument launched in 2002. For this study the daily snow covered area (SCA) product at 500m resolution from Terra was used.

We defined a season as starting on day 227 (mid August) and running for 365 days. To fill in missing data an array consisting of only permanent ice, land and lakes was used to initialize a process whereby a snow map for each day was compared to one from the previous day. Where a value in the current day was cloudy or for some other reason

missing, the value from the previous day was substituted. In other words, persistence was used to fill in missing data. Percentage of snow cover in each basin was computed by dividing the number of snow pixels in a basin by the total number of land pixels, excluding water bodies. The timing and duration of SCA was computed by elevation band in each basin. In addition to computing statistics for the individual basins, results for the whole of the Tien Shan were derived using the 1500m contour encompassing the range.

Seven winter seasons were analyzed. For a given season the date of maximum snow coverage varies widely between basins but for the Tien Shan as a whole the period of peak coverage and the rate at which the total snow covered area declines is rather consistent for the 7 winters. However, the data show that the duration of maximum snow coverage in the Tien Shan has decreased and there is some suggestion that the date of melt onset is occurring earlier. Some basins have a large degree of the interannual variability in maximum snow cover, arising from variable wintertime circulation patters, while for others this variability is small. Our results demonstrate the utility of the MODIS snow cover product for input to snow runoff models.