Snow Cover changes in Central Asia derived from long term time series analysis of medium resolution remote sensing data

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Central Asia

Snow cover constitutes the main source of water for the Central Asian countries. Caused by a continental climate with most precipitation falling in winter months as snow, snowmelt runoff in spring contributes more than 60% to the available water resources. This runoff is essential for irrigation, agriculture, ground water replenishment, and hydropower generation. Because climate change is affecting the amount of snow as well as the snow cover duration, the runoff regime of the region might be affected as well. Thus it's important to analyse the occurring snow cover developments and trends – to quantify the effect of climate change on snow cover now and in the future. Medium resolution remote sensing sensors are a suitable data source for this task. They are available since the 1980s and offer daily observations with a resolution not lower than 1 km per pixel.

Data Sources and processing

For the years between 2000 and 2017, the MODIS daily snow cover products MOD10A1 and MYD10A1 are used as the basis for the calculation of the snow cover statistics. For years prior to 2000, AVHRR was selected as the primary data source. While the MODIS snow maps are available as thematic Level 3 products, the AVHRR data come as Level 1B and require additional pre-processing (see figure 1 for an overview of necessary tasks).

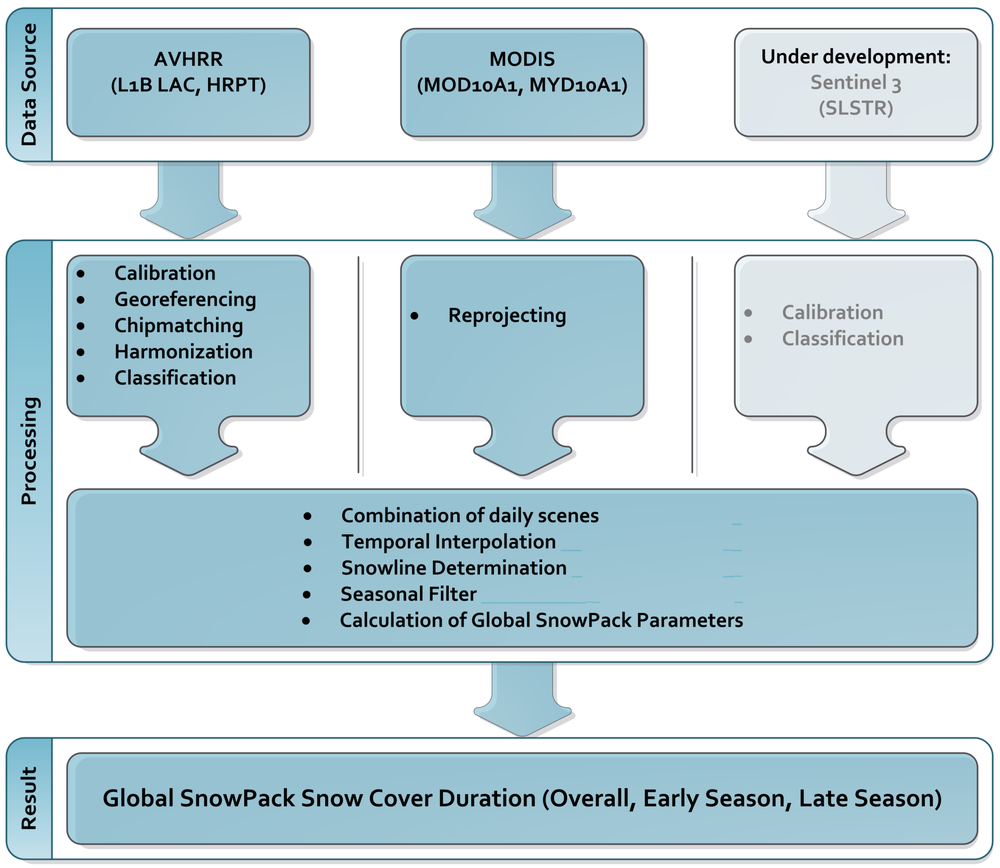

Fig. 1: Processing of AVHRR and MODIS snow maps

After pre-processing of AVHRR data both AVHRR and MODIS snow cover maps are post-processed to eliminate cloud covered pixels using four successive steps. After these steps have been performed the snow maps are completely cloud free and contain information about snow cover presence for each day of the time series. Snow cover parameters like duration, onset and melt of snow can now be calculated and statistically evaluated.

Results, status of processing, and outlook

Figure 2 illustrates the mean snow cover duration between 2000 and 2017. ~120.000 MODIS data sets have been processed for this figure. A trend analysis including all years between 1986 and 2017 revealed that the overall snow cover duration is not changing significantly in most regions.

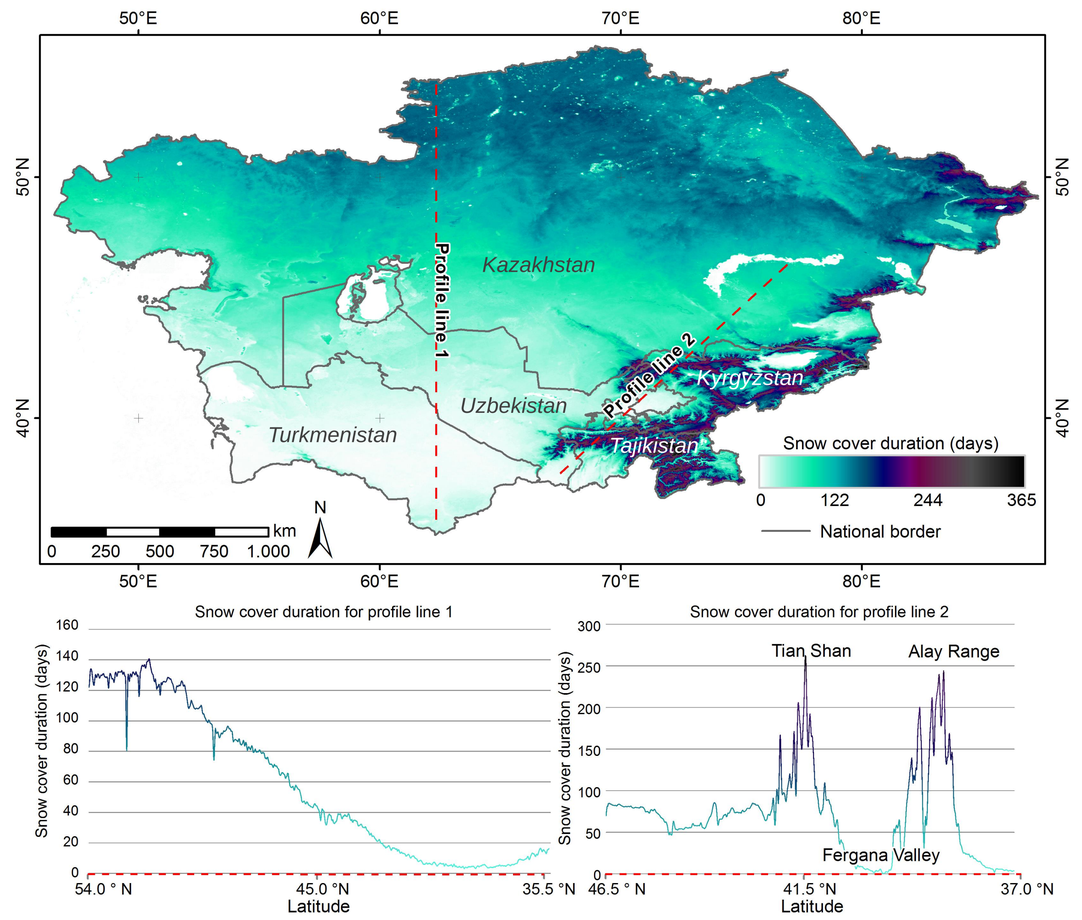

Fig. 2: Mean snow cover duration 2000 – 2017

What can be observed is in fact a shift to earlier snow cover onset as well as earlier snow cover melt which is most pronounced in northern Kazakhstan and the mountain regions in the south and southeast, as is illustrated in figure 3.

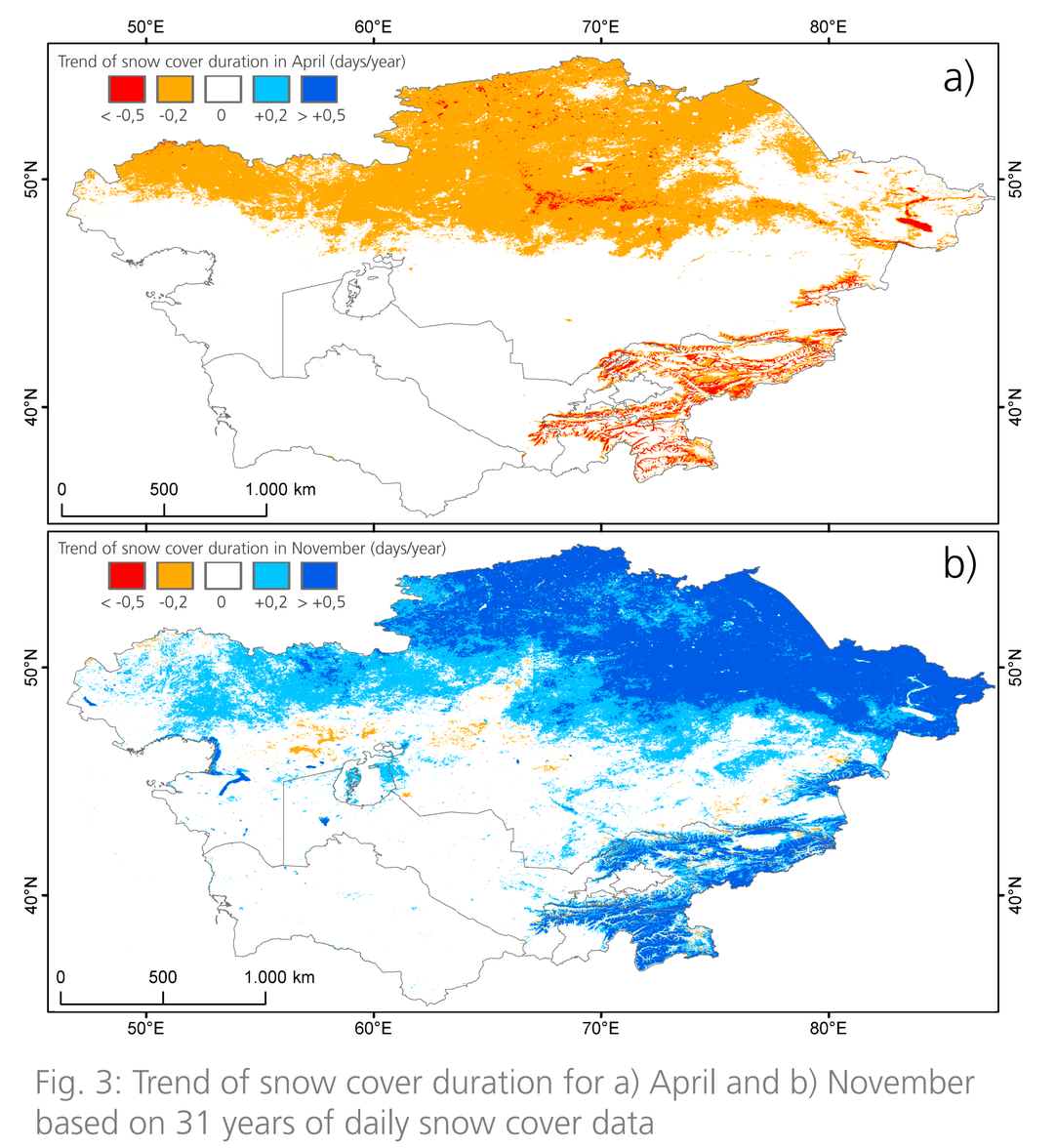

Fig. 3: Trend of snow cover duration for a) April and b) November based on 31 years of daily snow cover data

The identified trend could lead to severe alterations of the runoff regime of Amu Darya and Syr Darya rivers, which originate in the southeastern mountains and run into Aral Sea.

References

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