Geophysical Research Abstracts
Vol. 18, EGU2016-9059, 2016
EGU General Assembly 2016

Central Asian supra-glacier snow melt enhanced by anthropogenic black carbon

Julia Schmale (1,2), Mark Flanner (3), Shichang Kang (4,5), Michael Sprenger (6), Daniel Farinotti (7), Qianggong Zhang (4,5), Junming Guo (4,5), Yang Li (4,5), Mark Lawrence (2), and Margit Schwikowski (1)

(1) Paul Scherrer Institute, Villigen, Switzerland (julia.schmale@psi.ch), (2) Institute for Advanced Sustainability Studies, Potsdam, Germany, (3) Universtiy of Michigan, Ann Arbor, USA, (4) State Key Laboratory of Cryospheric Science, Beijing, China, (5) Chinese Academy of Science Center for Excellence in Tibetian Plateau Earth Sciences, Beijing, China, (6) Swiss Federal Institute of Technology, Zurich, Switzerland, (7) Federal Institute of Forest, Snow and Landscape Research, Birmensdorf, Switzerland

In Central Asia, more than 60 % of the population depends on water stored in glaciers and mountain snow. Densely populated areas near lower-lying mountain ranges are particularly vulnerable and a recent study showed that the region might lose 50 % of its glacier mass by 2050. While temperature, precipitation and dynamic processes are key drivers of glacial change, deposition of light absorbing impurities such as mineral dust and black carbon can lead to accelerated melting through surface albedo reduction. Here, we discuss the origin of deposited mineral dust and black carbon and their impacts on albedo change and snow melt.

218 snow samples were taken on 4 glaciers, Abramov (Pamir), Suek, Glacier No. 354 and Golubin (Tien Shan), representing deposition between summer 2012 and 2014. They were analyzed for elemental carbon, mineral dust and iron among other parameters. We find the elemental carbon concentration to be at the higher end of the range reported for neighboring mountain ranges between 70 and 502 ng g-1 (interquartile range).

To investigate the origin of the snow impurities, we used a Lagrangian particle dispersion model, LAGRANTO. Back trajectory ensembles of 40 members with varied starting points to capture the meteorological spread were released every 6 hours for the covered period at all sites. “Footprints” were calculated and combined with emission inventories to estimate the relative contribution of anthropogenic and natural BC to deposited aerosol on the glaciers. We find that more than 94 % of BC is of anthropogenic origin and the major source region is Central Asia followed by the Middle East.

Further exploring the implications of mineral dust and BC deposition, we calculate the snow albedo reduction with the Snow-Ice-Aerosol-Radiative model (SNICAR). Even though mineral dust concentrations were up to a factor of 50 higher than BC concentrations, BC dominates the albedo reduction. Using these results we calculate the snow melt induced by anthropogenic BC and find that it is responsible for about 5 % additional snow melt relative to clean snow conditions. For the glaciated area in Kyrgyzstan, the resulting additional melted water volume corresponds to about 60 % of the annual municipal water consumption.

We conclude that a stringent air quality mitigation policy would benefit the region’s water resource management.