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Radiative forcing by dust and black carbon in snow of High Mountain Asia: Implications for glaciers and water resources

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Snow and ice of High Mountain Asia provide critical freshwater supply to over a billion people and provide climate influence through higher albedo and lower thermal conductivity. High Mountain Asia holds the greatest amount of ice outside of Earth's polar region and as such has great potential to contribute to sea level rise. Snow cover and glaciers have been in general negative trend across the Anthropocene, yet there are large uncertainties in the scale of that retreat, the magnitude of the resulting contribution to sea-level rise, and in particular the causes. Our overarching science goal is to better understand the physical processes that are driving changes in High Mountain Asia snow and ice.

Here, we present analysis of our NASA remote sensing retrievals of radiative forcing by dust and black carbon in snow and ice from MODIS, VIIRS, and Landsat 8 in the study domain of the NASA High Mountain Asia program. We also evaluate the simulations of radiative forcing by impurities in snow from the Weather Research and Forecasting (WRF) model coupled with its chemistry component (Chem), the land surface scheme of the Community Land Model (CLM), and the snow, ice, and aerosol radiative transfer model SNICAR. The unique suite of remote sensing products are (1) the MODIS Snow Covered Area and Grain size (MODSCAG) from which we calculate fractional snow covered area and the spatial bulk surface snow grain size of that fractional cover, and (2) the MODIS Dust Radiative Forcing in Snow (MODDRFS) from which we calculate clear-sky radiative forcing by impurities in snow. The analysis will be cast in context of our understanding of at-surface radiative forcing by anomalies in greenhouse gases and give us insight into the controls on snow and glacier retreat.