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Radiative forcing from light absorbing aerosols in snow and ice through catchment scale integrative hydrologic analysis.

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There is great interest regarding the magnitude of radiative forcing resulting from light absorbing impurities in snow and ice (LAISI), particularly black carbon. Hansen and Nazarenko (2004) triggered extensive research relating to the potential 'efficacy' of the effect and impact on the climate system. This work was followed closely by the implementation of LAISI radiative transfer calculations into several model studies. The work of Painter (2012) yields a new algorithm that provides a direct measure of radiative forcing in snow from MODIS and showed that the algorithm gives reasonable estimates over strongly polluted areas. However, direct observations of the impact are challenged due to the complex nature of snow as a medium, as identified by Warren (2013) when he asked, "Can black carbon in snow be detected by remote sensing?". We conducted extensive surveys over Greenland and Svalbard using airborne sensors aboard UAVs to provide an assessment of the accuracy of MODIS surface reflectance toward the measurement of direct impacts from black carbon events. Like Warren, we found the inherent variability of snow as a medium to greatly mask an observed impact of LAISI. In the southwestern US, the impact of dust on the hydrology of the region has been demonstrated in several studies. Therefore, our most recent efforts to quantify the impact of black carbon and LAISI in general on the climate have focused on utilizing the 'integrating' aspects of snowpacks at the catchment scale. In this work we present recent results that demonstrate how catchment scale hydrologic analysis can be used to quantify LAISI induced radiative forcing and validate remotely sensed measures. Our approach provides an assessment of the seasonal cycle of instantaneous at-surface clear sky radiative forcing from LAISI as predicted by model and satellite observations and the potential impact on water resources for a basin located at the southern slope of the Himalayas – a region sparse in observations which provides water resources for millions of people.

References

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