Biomass derived carbon key to western Himalayan Glacier melt

S.NIZAM[1], I.S.SEN[2], V. GALY[3], D. SELBY[4], VINOJ V[5], M. BIZMIZ[6], M.F. AZAM[7]

[1]IIT Kanpur; sarwar@iitk.ac.in
[2]IIT Kanpur; isen@iitk.ac.in
[3]WHOI, USA; vgaly@whoi.edu
[4]Durham University; david.selby@durham.ac.uk
[5] IIT Bhuabneswar: vinoj@iitbbs.ac.in
[6] University of South Carolina; mbizimis@geol.sc.edu
[7] IIT Indore; farooqazam@iiti.ac.in

One-sixth of the world population relies on glacier melt-water from the Hindu Kush Himalaya. Glacier melting rate is enhanced by additional heat absorption caused by increasing soot and dust on the glacier surface. The origin, concentrations, and spatial variability of the dust and soot on the glaciers are however poorly known. Here, we report on the source and origin of dust and soot on the glacier debris (cryoconite and moraine sediments) deposited on the ablation zone of Chhota Shigri Glacier (latitude 32.2° N, longitude 77.5° E, snout elevation 4050 m a.m.s.l.) in the Lahul-Spiti-valley of Himachal Pradesh, India. The source identification was done by coupling robust serial oxidation technique "Ramped Pyrolysis Oxidation (RPO)" analysis, ^{14}C, $\delta^{13}C$, $^{208}Pb/^{204}Pb$, $^{207}Pb/^{204}Pb$ and $^{206}Pb/^{204}Pb$, $^{187}Os/^{188}Os$, TOC, N, heavy metal concentrations with airmass trajectory modelling. To constrain the source end-members, atmospheric particulate matter (≤10 micron) were also collected in Harsil (latitude 31.1° N; longitude 78.7° E; elevation 2634 m a.m.s.l.), a remote village, Uttarakhand, India and Kanpur (latitude: 26.1° N; longitude: 80.2° E), an industrial city in the Indo-Gangetic plain. Harsil and Kanpur aerosols have distinct RPO thermograms and ^{14}C composition, and the glacier debris is similar to Harsil aerosols. The distribution of organic carbon activation energy (E_a), $\delta^{13}C$ and ^{14}C content (expressed in fraction modern, F_m) of evolved CO_2 suggests limited petrogenetic but no fossil fuel combustion inputs, and it points towards a biomass source. The $^{208}Pb/^{204}Pb$, $^{207}Pb/^{204}Pb$, $^{206}Pb/^{204}Pb$ and $^{187}Os/^{188}Os$ dataset further supports the absence of fossil fuel sources over Chhota Shigri Glacier. Our study therefore shows large spatial heterogeneity of anthropogenic combustion inputs on the Himalayan glaciers, so the anthropogenic impact on melting rates may have been overestimated.