



Contribution ID: 43

Type: Oral presentation

Black Carbon and Dust Deposition on South Cascade Glacier, Washington State, USA, Spanning 1840-2014: A Reconstruction of Fossil Fuel and Forest Fire Emissions, and Associated Snow Albedo Impacts

Monday 3 October 2022 11:20 (20 minutes)

Light absorbing particles (LAPs) include black carbon (BC) and mineral dust and are of interest due to their positive radiative forcing and contribution to albedo reductions and snow and glacier melt. This study documents historic BC and dust deposition as well as their effect on albedo on South Cascade Glacier (SCG) in Washington State (USA) through the analysis of a 158-m (139.5-m water equivalent [w.e.]) ice core extracted in 1994 and spanning the period 1840–1991, and three shallow ice cores collected in 2014. Peak BC deposition occurred between 1940 and 1960, when median BC concentrations were 16 times higher than background, likely dominated by domestic coal and forest fire emissions. Post 1960 BC concentrations decrease, followed by an increase from 1977 to 1991 due to melt consolidation and higher emissions. BC concentrations in the 2014 shallow cores remain elevated above background levels, and C14 analysis indicates that ~70% of the 2014 BC is from non-fossil fuels sources. Differences between the SCG record and BC emission inventories, as well as ice core records from other regions, highlight regional differences in the timing of anthropogenic and biomass BC emissions. Dust deposition on SCG is dominated by local sources and is variable throughout the record. Albedo reductions from LAP are dominated by dust deposition, except during high BC deposition events from forest fires and during 1940–1960 when BC and dust similarly contribute to albedo reductions.

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Track Classification: Pollution records