Integration of air mass trajectory models and Pb isotope data to trace the long-range transport of atmospheric dust in India

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Determining the sources and pathways of airborne particulate matter is a difficult problem, and it is particularly challenging in India due to the strong influence of local sources. Possible source area (PSA) of aerosols is often examined by using back trajectory models. Other powerful tool for understanding the PSA of aerosols is radioisotope systems, such as U-Th-Pb, Rb-Sr and Lu-Hf because the isotope ratios remains unaltered during different surficial processes. In this study, we report a high-resolution (bi-weekly) trace element concentrations and $^{208}Pb/^{204}Pb$, $^{207}Pb/^{204}Pb$ and $^{206}Pb/^{204}Pb$ data of aerosols (PM_{10} fraction) collected over Harshil, a small remotely located village located at an elevation of 2600 m above MSL in the Himalayan Mountains. In addition to dust sampling, high resolution (~15min interval) meteorological data such as temperature, humidity, precipitation, wind speed, wind direction was obtained from Automatic Weather Station (AWS) that was installed at the site. Aerosol loading data showed that the average concentration of aerosol varies from 80 $\mu g/m^3$ during the summers to 11 $\mu g/m^3$ during the rainy and winter season. $^{208}Pb/^{204}Pb$, $^{207}Pb/^{204}Pb$ and $^{206}Pb/^{204}Pb$ and the trace elements mass fractions also showed significant variability. This variability is also seen in the meteorological data from the AWS. The site experiences diverse meteorological condition and have distinctly different wind pattern causing this extreme temporal variability. Harshil PM_{10} aerosol samples had elevated mass fractions of Pb, Cd, Zn, As and Cu. For example, Pb concentration in the aerosol samples varies between **3-57µg/g**. Trace element can be used to delineate natural versus anthropogenic sources. For example, the average Pb/Cu ratio of UCC is 0.8, while the aerosols in Harshil have much higher Pb/Cu ratios (**~1.02**). To a first order, this implies an anthropogenic origin for Pb. The anthropogenic origin of Pb is further confirmed by the Pb isotope ratio data. The high resolution Pb ratio isotope data presented in this study helped us to better understand the long-range transport of atmospheric dust in India.