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Relative Abundances of Regional vs. Far Traveled Mineral Dust Deposited in the Alpine Zone of the Uinta Mountains, USA

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An active dust sampler deployed above treeline at an elevation of 3700 m in the Uinta Mountains (Utah, USA) is illuminating the relative importance of regional and remote sources of mineral dust. The wind regime at this location is strongly bimodal, either from the NNW (winter dominant) and SSE (summer dominant). The sampler uses solar-powered fans to pull air through a 7.5-cm diameter tube packed with glass beads. A wind-actuated switch allows the collection of separate samples for the two primary directions when windspeeds are in excess of 5 m/sec. Over the long term, each fan runs an average of $\sim$2 hr/day. The sampler is emptied twice in most years, yielding summer ($\sim$June-October) and winter ($\sim$October-June) seasonal samples. Results indicate that the dust concentration (measured as μg/hr of fan time) is greater in air approaching from the SSE. The magnitude of enrichment varies seasonally, with values $\sim$1.6x in the summer, and $>$3x during the winter season. In a collection that spanned a full 12-month interval (early July 2014—late June 2015) the enrichment was also $\sim$2x (192 vs. 105 μg/hr) indicating that southerly direction dominates on an annual basis. Grain size analysis with laser scattering after peroxidation reveals that samples from both directions have similar means of 15-20 μm. Samples from the SSE exhibit a more focused distribution with a variance of $\sim$300 μm^2 (s.d. 17 μm) compared with $\sim$1000 μm^2 for the NNW sample (s.d. 31 μm). Both samples exhibit similar abundances of very fine ($\sim$13%) and fine ($\sim$24%) silt. In contrast, clay is twice as abundant in the SSE sample, whereas fine and very fine sand are more abundant in the NNW sample. XRD analysis reveals that all samples contain quartz, illite, K-spar, plagioclase, and amphibole. One sample from the NNW also contains poorly ordered smectite. ICP-MS reveals that many trace elements are more common in samples from opposing wind directions. For instance, Zr and Hf are notably more abundant in samples from the NNW (North/South ratio $>$2.0) suggesting a regional source of zircon in that direction. In contrast Pb, Sr, Cu, Zn, and Li are all considerably more abundant in samples from the SSE (North/South ratio $<$0.6). Higher abundances of Li may reflect evaporation of Li-bearing brines as part of petroleum extraction efforts to the south of the mountains. Elevated Cu and Zn in the SSE samples may indicate wind deflation from mine tailings. Collectively these compositional differences in dust delivered from opposing wind directions indicate that regional dust sources contribute to the dust arriving in the Uinta Mountains.