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Atmospheric rivers drive exceptional Saharan dust transport towards Europe and subsequent snow melt in the Alps.

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This study highlights the occurrence of atmospheric rivers (ARs) over northwest Africa towards Europe, which were accompanied by intense episodes of Saharan dust transport all the way to Scandinavia, in the winter season. Using a combination of observational and reanalysis data, we investigate two extreme dusty AR events in February 2021 and assess their impact on snow melt in the Alps. The warm, moist, and dusty air mass (spatially-averaged 2-meter temperature and water vapour mixing ratio anomalies of up to 8 K and 3 g kg⁻¹, and aerosol optical depths and dust loadings of up to 0.85 and 11 g m⁻², respectively) led to a 50% and 40% decrease in snow depth and surface albedo, respectively, in less than one month during the winter season. ARs over northwest Africa show increasing trends over the past 4 decades, with 78% of AR events associated with severe dust episodes over Europe.

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