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An elevated large-scale dust veil from the Taklimakan Desert: Intercontinental transport and three-dimensional structure as captured by CALIPSO and regional and global models

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Abstract. An intense dust storm occurred during 19–20 May 2007 over the Taklimakan Desert in northwestern China. Over the following days, the space-borne lidar CALIOP tracked an optically thin, highly elevated, horizontally extensive dust veil that was transported intercontinentally over eastern Asia, the Pacific Ocean, North America, and the Atlantic Ocean. A global aerosol transport model (SPRINTARS) simulated the dust veil quite well and provided a three-dimensional view of the intercontinental dust transport. The SPRINTARS simulation revealed that the dust veil traveled at 4–10 km altitudes with a thickness of 1–4 km along the isentropic surface between 310 and 340 K. The transport speed was about 1500 km/day. The estimated dust amount exported to the Pacific was 30.8 Gg, of which 65% was deposited in the Pacific and 18% was transported to the North Atlantic. These results imply that dust veils can fertilize open oceans, add to background dust, and affect the radiative budget at high altitudes through scattering and absorption.

The injection mechanism that lifts dust particles into the free atmosphere is important for understanding the formation of the dust veil and subsequent long-range transport. We used a regional dust transport model (RC4) to analyze the dust emission and injection over the source region. The RC4 analysis revealed that strong northeasterly surface winds associated with low pressures invaded the Taklimakan Desert through the eastern corridor. These winds then formed strong upslope wind along the high, steep mountainsides of the Tibetan Plateau and blew large amounts of dust into the air. The updraft lifted the dust particles farther into the upper troposphere (about 9 km above mean sea level, MSL), where westerlies are generally present. The unusual terrain surrounding the Taklimakan Desert played a key role in the injection of dust to the upper troposphere to form the dust veil.

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