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Impact of Saharan mineral dust layers on cloud formation and cloud properties

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Mineral dust contributes strongly to the global aerosol load. The largest source region of mineral dust is the Sahara. But mineral dust cannot be treated as a regional phenomenon. Once lifted in the air, it can be transported thousands of kilometers over several days. The main transport pathway spans over the Atlantic Ocean from Africa towards the Caribbean; with its peak season during the summer months. But transatlantic dust transport can also happen during wintertime, however with less frequency. In addition, the dust particles can be transported northward over the Mediterranean and Europe. In rare events, it can even reach the Arctic region. All the way during transport the dust layer has an impact on the Earth's radiation budget, by direct interaction with the incoming and outgoing radiation by scattering and absorption, and by indirect interaction as dust can impact cloud formation and cloud properties.

To study long-range transported Saharan dust as well as the dust's impact on cloud formation and properties, airborne lidar measurements with the WALES lidar system onboard the German research aircraft HALO have been performed over the western sub-tropical North-Atlantic Ocean during NARVAL-II in August 2016 and EUREC4A in January/February 2020. We observed dust transport during the summertime in the clearly separated and well-defined Saharan Air Layer (SAL) as well as during wintertime, when dust transport happens at lower altitudes and the SAL is less separated. In addition, we were also able to capture an event of dust long-range transport into the Arctic during the HALO-(AC)3 campaign in spring 2022. From our measurements we could show, that small amount of water vapor embedded in the SAL has a strong impact on the atmospheric stability and thus also impacts the formation and properties of clouds during long-range transport. Additionally, dust particles are known to act as ice nuclei and with that lead to ice formation at different environmental conditions, changing the ice cloud's microphysical properties.

In our presentation we will give an overview of the performed WALES measurements. We use these measurements to study dust long-range transport and its impact on the atmospheric stability, cloud formation and cloud properties.