

Numerical process and sensitivity studies on dusty cirrus clouds

PI: Michael Weger

Dusty cirrus is a special cloud type linked to desert dust outbreaks in the midlatitudes. The cirrus shields emanating from the interaction of upper tropospheric dust with moisture are particularly extensive and often prevail for several days with correspondingly significant effects on near-surface shortwave radiation. The peculiar cloud properties, such as a small-scale pockmarked structure hinting at ongoing convection, sharply delineated cloud boundaries, and exceedingly low infrared brightness temperatures, distinguish this cloud type from other cirrus clouds not affected by mineral dust. While it is very likely that heterogeneous ice nucleation of mineral dust is at the root of these cloud properties (evidence comes from insitu and remote-sensing observations), we know yet little about the interaction details of mineral dust with cloud microphysics and radiation in a turbulent environment, and how this ultimately drives macroscale cloud evolution and properties.

Given this lack of understanding, it is not surprising that numerical weather prediction (NWP) models have issues in representing dusty cirrus clouds. Previous mesoscale modeling studies that explicitly considered dust emission and transport processes still underestimated cloud cover to a large extent, most likely, because of inadequate consideration of dust-cloud-radiation interactions at the subgrid scale.

In the framework of this project, a high-resolution numerical simulation strategy is pursued, which is capable of explicitly representing key subgrid-scale processes involved in dusty cirrus formation. Based on process and sensitivity studies with the NWP model ICON, the instability mechanism driving cirrus convection and its dependence on atmospheric and dust conditions is investigated. The results of this project will provide the basis for an improved parameterization of dusty cirrus clouds in mesoscale models.