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## Study of cirrus cloud properties and occurrence over Europe during the COVID-19 based on the lidar measurements of CALIPSO

Qiang Li and Silke Groß

DLR, Institut für Physik der Atmosphäre, Wessling-Oberpfaffenhofen, Germany (qiang.li@dlr.de)

Cirrus clouds have a wide global coverage providing considerable radiative forcing on the Earth's climate system. Due to their inadequate representation in the global models, cirrus clouds can lead to large uncertainties in the climate prediction. To date, experimental and theoretical efforts have been widely carried out to study the anthropogenic effects such as aviation that may change the formation and microphysic and optical properties of cirrus clouds. Unfortunately, however, solid observational studies are still rare for us to draw any robust conclusion on anthropogenic influence on cirrus. During the COVID-19 pandemic the civil air traffic over Europe was significantly reduced. This unique situation provides a good opportunity to study the effect of air traffic on cirrus. In this work, based on the analysis of the CALIPSO measurements we present the changes of cirrus cloud properties and occurrence over Europe in March and April 2020 compared with the reference results in the previous years under normal conditions. The comparison shows that the cirrus cloud occurrence was reduced by about 30% with smaller cloud thicknesses found in April 2020. The average thickness of cirrus clouds was reduced to 1.18 km in April 2020 compared to a value of 1.40 km under normal conditions. In addition, the cirrus clouds measured in April 2020 possess smaller mean values of the particle linear depolarization ratio (PLDR) than the previous years at a high significance level, especially at colder temperatures ( $T < -50^{\circ}\text{C}$ ). The same exercises are extended to the observations over China and the United States. Besides the regional discrimination of cirrus clouds, we reach the final summary that cirrus clouds show significant changes in both March and April over Europe, no changes in both months over China, and significant changes only in April over the United States.