CHAIN AGGREGATE PARTICLES IN UPPER-TROPOSPHERIC CLOUDS

Elongated chain-like aggregates comprised of ice crystals and frozen droplets have been observed in cirrus cloud anvils produced by electrified, summertime thunderstorms. Ice crystal chain aggregates have mainly been found in tropical and sub-tropical convection induced cirrus anvils, while frozen droplet chain aggregates have mainly been observed in mid-latitude continental convection induced cirrus anvils. Cloud chamber experiments have also been able to generate ice crystal chain aggregates while applying strong electric fields (> 60 kV m^{-1}) to environments with ice crystal concentrations between 3.0 x 10^6 – 4.0 x 10^6 m^{-3} and over a range of temperatures. While it is believed that electric fields are important for chain aggregate formation, exactly where and how the chain aggregation process occurs within thunderstorms is not well understood, which inhibits inclusion in cloud models. Not having chain aggregates in models causes inaccuracies to cloud radiative transfer properties. Furthermore, chain aggregates are important to consider for supersonic flight. During the CapeEx19 field campaign in the summer of 2019 near Melbourne, Florida, the North Dakota Citation II Research Aircraft utilized state-of-the-art instrumentation and sampled through cirrus anvils over multiple days in order to gain a better understanding into the chain aggregation process. Results from the case study on the 3 August 2019 flight during CapeEx19 suggests that chain aggregation may be occurring in multiple regions of the thunderstorm as well as it's induced cirrus anvil. In-situ electric field observations in the cirrus anvil region during the 3 August 2019 flight are seldom as high as to the electric field strengths utilized in the cloud chamber experiments to generate ice crystal chain aggregates. There has been no observations of chain aggregates in wintertime storms until the recent Investigation of Microphysics and Precipitation for Atlantic Coast-Threatening Snowstorms (IMPACTS) campaign during the winter of 2022 over the northeast CONUS via aircraft where chain aggregates comprised of ice crystals were observed in the upper levels of nor'easters on multiple research flights. An analysis is performed to investigate the presence of chain aggregates in upper-level clouds for summertime and wintertime storms to provide insight into the necessary conditions that aid in chain aggregation.