Comparisons of radiosonde water vapor measurements with ECMWF ERA-5 and contrails observations above Clermont-Ferrand (France)

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The cirrus clouds impact on the radiation budget of the Earth depends mainly of their optical thickness and altitude (Heymsfield et al., 2017). The contrails formed from aircraft emissions bring an additional impact to that of natural cirrus clouds (Kärcher, 2018). Their formation and potential evolution in cirrus clouds depend on the thermodynamical state of the atmosphere at fine scales, in particular of the saturation of water vapour with respect to ice. However, at their altitude of formation (~10 km), few reliable measurements of the water vapour are available.

In this study, we use observational data on the presence of crystals through their scattering observed by lidar and water vapor measurements using the Raman scattering technique (Fréville et al., 2015). Observations from standard meteorological balloon soundings (temperature, water vapor, and wind) (Dupont et al., 2020), as well as meteorological reanalyses (ECMWF), will be also analyzed to better characterize the overall context, considering finer vertical resolutions.

A first part of this study is to evaluate the quality of Modem M10 radiosondes humidity measurements available from the MeteoFrance network by comparison with ECMWF ERA-5 analysis. A second part of this study is to document contrails formation and evolution using a combination of instruments: an ADS-B recorder to identify aircraft type and position, a full sky camera to detect the presence of contrails and a collocated lidar to retrieve water vapour concentration profiles and macrophysical and optical properties of the contrail. The methodology and first results will be presented on a case study identified the 2nd of June 2023 above Clermont-Ferrand (France). Contrails have been observed when ECMWF ERA-5 relative humidity was around 115% and stay visible on the full-sky camera during more than 2 hours. This study is carried out in the framework of the European project BeCoM (Grant agreement ID: 101056885) whose main objective is to reduce the contrail radiative forcing.

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