

Upper tropospheric water vapor profiles derived from Raman lidar over France territories for contrail investigations

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Investigation of contrail formation has reactivated the requirement of accurate water vapor in the upper troposphere at cruise altitude. The French community has developed 4 Raman lidars with these capabilities from mid-latitude to tropics. Water vapor mixing ratio is proportional to the ratio of H₂O and N₂ Raman signals for the same altitude, so a calibration process is needed to give a physical meaning to this ratio. While for coaxial systems a calibration with independent measurement of the water vapor total column is pertinent, another method is required for non-coaxial systems.

A more universal external calibration method is adopted, using co-located ERA-5 hourly water vapor profiles that assimilate radiosondes in the lower troposphere. Hourly averaged integration periods of lidar WVMR, are compared with the corresponding ERA-5 re-analyses. Then, hourly calibration factors are used to estimate a full night calibration factor. Daily calibrations are inspected to detect any instrumental effect on the calibration coefficient. Final coefficients are then calculated for quasi stationary periods.

At some sites some other calibration methods including collocated radiosonde are applied, and are compared with our method.

This new developed software provides valuable information about the humidity content in the 7-11 km range, altitudes of a possible contrail formation, and will be used to force models and to better understand contrails formation and persistence. This investigation is part of European project BeCom, allowing a better view of the potential contribution of contrail in future air traffic regulation.