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Observing System Simulation Experiment of CAIRT limb profiles focusing on UTLS composition

The Changing-Atmosphere Infra-Red Tomography Explorer (CAIRT) is a candidate for ESA's Earth Explorer 11. This mission has been proposed in order to achieve a step change in our understanding of the coupling of atmospheric circulation, composition and regional climate. The CAIRT concept proposes to perform limb infra-red tomography of the atmosphere from the troposphere to the lower thermosphere (about 5 to 115 km altitude) with a 400 km swath to provide a three-dimensional picture of atmospheric structure at unprecedented scales.
This contribution investigates the capability of CAIRT to analyse Upper Troposphere Lower Stratosphere (UTLS) composition using an Observing System Simulation Experiment (OSSE). In this effort, a reference atmosphere –the nature run in the OSSE terminology –is built based on the Copernicus Atmosphere Monitoring Services (CAMS) control run (horizontal resolution ~40 km and a vertical resolution ~500 m in the tropopause region) between October 2021 and March 2022 (5 months). The nature run is used to generate CAIRT level 2 (L2) profiles of ozone (O3), water vapour (H2O) and carbon monoxide (CO), along with a CAIRT orbit simulator and a simulator to account for CAIRT instrumental errors as well as vertical and along track smoothing. Simulated CAIRT L2 profiles are then assimilated by the Belgian Assimilation System for Chemical ObsErvations (BASCOE) to provide analyses of O3, H2O and CO –the assimilation run. In order to measure the added value of CAIRT data in the assimilation run, a BASCOE control run without CAIRT assimilation, is also done. We have also simulated and assimilated Aura Microwave Limb Sounder (MLS) O3, H2O and CO profiles in order to measure the added value of CAIRT against this instrument.

This study reveals that CAIRT (1) O3 profiles are able to constrain BASCOE down to 7 km of altitude, a few km lower (thus better) than MLS; (2) H2O profiles are able to constrain BASCOE down to the tropopause region, with a slightly better performance than MLS at high latitudes; and (3) CO profiles are able to constrain BASCOE in the UTLS region while MLS providing a much better constraint above 10 km.

Topic

Upcoming Earth observation limb and occultation instruments

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