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# Combined assimilation of IASI and MLS observations to constrain tropospheric and stratospheric ozone in a global chemical transport model

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Ozone acts as the main shield against UV radiation in the stratosphere, it contributes to the greenhouse effect in the troposphere and it is a major pollutant in the planetary boundary layer. In the last decades models and satellite observations reached a mature level, providing estimates of ozone with an accuracy of few percents in the stratosphere. On the other hand, tropospheric ozone still represents a challenge, because its signal is less detectable by space-borne sensors, its modelling depends on the knowledge of gaseous emissions at the surface, and stratosphere/troposphere exchanges might rapidly increase its abundance by several times. Moreover there is generally lack of in-situ observations of tropospheric ozone in many regions of the world. For these reasons the assimilation of satellite data into chemical transport models represents a promising technique to overcome limitations of both satellites and models. The objective of this study is to assess the value of vertically resolved observations from the Infrared Atmospheric Sounding Interferometer (IASI) and the Microwave Limb Sounder (MLS) to constrain both the tropospheric and stratospheric ozone profile in a global model. While ozone total columns and stratospheric profiles from UV and microwave sensors are nowadays routinely assimilated in operational models, still few studies have explored the assimilation of ozone products from IR sensors such as IASI, which provide better sensitivity in the troposphere.

We assimilate both MLS ozone profiles and IASI tropospheric (1000-225 hPa) ozone columns in the Météo France chemical transport model MOCAGE for 2008. The model predicts ozone concentrations on a 2x2 degree global grid and for 60 vertical levels, ranging from the surface up to 0.1 hPa. The assimilation is based on a 4D-VAR algorithm, employs a linear chemistry scheme and accounts for the satellite vertical sensitivity via the averaging kernels. The assimilation of the two products is first tested separately and a detailed validation with ozone-sondes data is carried out to better understand observational and model biases. Eventually, a 6 months assimilation experiment using both instruments is done and compared with sondes data, total ozone columns from the Ozone Monitoring Instrument (OMI) and a MOCAGE full chemistry model run. Several episodes of high free-troposphere ozone, as measured on a mountain observatory in US, are also examined in detail.

Results show that both satellite sensors provide useful and complementary information on the ozone profile, provided that some known biases are carefully accounted for. RMSE differences between the model run with data assimilation and sondes data decrease globally by 15-5% for UTLS (225-70 hPa) - TOC (1000-225 hPa) ozone columns respectively, with MLS providing the most effective correction. The best agreement with OMI total ozone columns is also obtained when both instruments are assimilated. Some issues probably related to unaccounted biases or incorrect assimilation parameters (background and observations error statistics) still prevent the accuracy of high latitudes tropospheric ozone to be improved.