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Assimilation of tropospheric ozone from the IASI instrument using an Ensemble Kalman Filter coupled with the regional Chemical Transport Model (rCTM) CHIMERE

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During the last decade, many efforts have been made to set up accurate systems to monitor and forecast tropospheric ozone concentrations. Especially, data assimilation methods combining models and observations (mainly ground based measurements in the case of tropospheric ozone) have been applied for Air Quality (AQ) purposes. In parallel, new infrared sounders have been launched (IASI, TES). In the case of the IASI instrument (operational since 2006 aboard the low-orbit MetOp-A satellite), it's now established that ozone retrieval shows reliable concentrations in the free troposphere at daily scale [1]. Also, in spite of a lower sensitivity to surface ozone concentrations, it has been shown [2] that this instrument was able to detect photochemical episodes indicating a genuine potential to improve AQ model skills.
Here, we present the results of a one-month assimilation exercise (July 2007) made with a Local Ensemble Kalman Filter (EnKF) applied to the CHIMERE rCTM and using the partial tropospheric columns (0-6 km) retrieved from IASI radiances. The filter set-up will be briefly described (formulation of observation operator using the averaging kernels derived during the retrieval process, the model and the observation error, etc.). Results indicate a mean improvement with respect to IASI columns of 1.5 DU (30%) in terms of RMSE (compared to a reference run) and 2 DU (70%) for the bias. In this paper, we present the spatio-temporal distribution of the corrections, and particularly we evaluate the impact of this assimilation at the surface and in the free troposphere. Moreover, the improvement in ozone analysis is quantified using independent in situ measurements. Comparing simulated vertical profiles to sondes and/or aircraft profiles (MOZAIC), it is shown that in average, the profile after assimilation is in better agreement at 2-4 km altitude with in situ data. For the ground stations, we found an improvement in RMSE up to 2.5 ppb for 90% of background stations. Results from specific sensitivity test (ensemble size, local patch size, i.e. the number of the pixels used in analysis, etc.) demonstrating the robustness of the assimilation system will also be presented.

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[2] Eremenko, M., Dufour, G., Forêt, G., Keim, C., Orphal, J., Beekmann, M., Bergametti, G. & Flaud, J.-M.: Tropospheric ozone distributions over Europe during the heat wave in July 2007 observed from infrared nadir spectra recorded by IASI, Geophys. Res. Lett., 35, L1885, doi:10/1029/2008GL034803, 2008.