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Performance assessment of future thermal infrared geostationary instruments to monitor air quality

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Air quality (AQ) has a recognized onerous impact on human health and the environment, and then on society. It is more and more clear that constantly and efficiently monitoring AQ from space is a valuable step forward towards a more thorough comprehension of pollution processes that can have a relevant impact on the biosphere. In recent years, important progresses in this field have been made, e.g., reliable observations of several pollutants have been obtained, proving the feasibility of monitoring atmospheric composition from space. In this sense, low Earth orbit (LEO) thermal infrared (TIR) space-borne instruments are widely regarded as a useful tool to observe targeted AQ parameters like tropospheric ozone concentrations [1]. However, limitations remain with the current observation systems in particular to observe ozone in the lowermost troposphere (LmT) with a spatial and temporal resolution relevant for monitoring pollution processes at the regional scale. Indeed, LEO instruments are not well adapted to monitor small scale and short term phenomena, owing to their unsatisfactory revisit time. From this point of view, a more satisfactory concept might be based on geostationary (GEO) platforms. Current and planned GEO missions are mainly tailored on meteorological parameters retrieval and do not have sufficient spectral resolutions and signal to noise ratios (SNR) to infer information on trace gases in the LmT. New satellite missions are currently proposed that can partly overcome these limitations.

Here we present a group of simulation exercises and sensitivity analyses to set-up future TIR GEO missions adapted to monitor and forecast AQ over Europe, and to evaluate their technical requirements. At this aim, we have developed a general simulator to produce pseudo-observations for different platform/instrument configurations. The core of this simulator is the KOPRA radiative transfer model, including the KOPRAfit inversion module [2]. Note that to assess the impact of the different instruments on the analyses and forecasts of AQ by means of models, our simulator can be coupled with the chemistry and transport model CHIMERE to conduct observing system simulation experiments (OSSEs). Using our simulator, we have produced pseudo-observations for targeted sensors including some potential and planned future GEO instruments like MTG-IRS and MAGEAQ. In order to achieve the best performances that can be obtained from TIR instruments, we applied an altitude-dependent Tikhonov-Philips retrieval algorithm optimized to maximize the information retrieved from the lower troposphere. This algorithm has already demonstrated powerful performances to retrieve lower tropospheric ozone and to detect pollution events [1]. Finally, a detailed analysis of the pseudo-observations has allowed quantifying the added-value brought by the MAGEAQ TIR instrument to resolve LmT geographical patterns and temporal trends of ozone. The results are critically discussed.

REFERENCE

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