Evaluating the impact of the CMIM satellite constellation on NWP using an OSSE framework

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ABSTRACT

Recent space technologies are currently paving the way for the advent of miniaturized remote sensing instruments onboard small satellites. Numerical Weather Prediction (NWP) increasingly relies on satellite observations and these small satellites could become an important part of the observing system in the upcoming decades. Constellation concepts are therefore being studied to complement existing programs. On that account, the Centre National d'Études Spatiales (CNES) is currently investigating the feasibility of a constellation of small sounders in partnership with the Centre National de Recherches Météorologiques (CNRM). This new program, which was given the name of CMIM (Constellation of MIni sounder for Meteorology), aims at complementing existing constellations and improving short and medium range NWP by 2030-2035. To achieve this, CMIM aims at densifying temperature and water vapor observations especially in the lower layers of the atmosphere by increasing revisits of Infra-Red (IR) and/or Micro-Wave (MW) instruments. CNRM and CNES with industrial support are currently evaluating the potential impact of CMIM by considering different scenarios: number of satellites, orbits, spectral bandwidth for the instruments,... To identify the optimal configuration in terms of performance, CNRM has selected the Observing System Simulation Experiment (OSSE) approach (Rivoire et al, 2024). In OSSE methodology, an initial long forecast with no data assimilation is computed. This Nature Run (NR), which uses the global ARPEGE model, serves as a reference. Next a simulation forecast samples the NR and adds calibrated noise to the data in order to generate a realistic set of observational data and replicate the observing system as foreseen in 2030-2035. Moreover, observational data are also simulated for the various CMIM constellation configurations. Finally all those observations are assimilated in a forecast using a 4D-Var system with a 6h update cycle. By comparing the quality of the forecast with and without the simulated CMIM observational data, both the impact on NWP and the optimal constellation configuration can be determined.