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Potential of future space instruments to detect NO_2 from ship emissions over European waters

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The importance of ship emissions for the marine boundary layer has long been recognized. One of the key species emitted is NO_x, the sum of NO and NO_2. In recent years, satellite observations have been used to identify the signature of tropospheric NO_2 from shipping emissions and to investigate their temporal variability and trends. However, current satellite NO_2 data products are limited by signal to noise ratio, spatial and temporal resolution, cloud and/or aerosol contamination, and the difficulty to separate shipping NO_2 from other sources of emissions, especially over Europe. Improvements on the first three of these points can be expected from future satellite instruments, in particular the Sentinel-5 Precursor (S-5P) and the Sentinel-4 (S4) missions that are planned to be launched during the current decade.

This study aims at quantitatively investigating the capability of future sensors to detect NO_2 from ship emissions over European waters. We focus more particularly on the East Mediterranean Sea, the Bay of Biscay and the North Sea areas, which are relatively polluted regions with significant contributions from dense ship traffic. A regional chemical transport model (CHIMERE) combined with a high-resolution emission inventory is used to generate NO_2 profile data with high spatial ($10\times10\text{km}^2$) and temporal (hourly) resolution. Based on these NO_2 data sets, pseudo-observations are generated for future sensors, as well as for OMI as a reference. These pseudo-observations are then compared to existing data records of OMI, and used to assess the potential of future sensors for identifying shipping emissions. The results show shipping NO_2 is possible to be detected by daily observations when integrating along ship tracks, even under unfavorable conditions.