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A NOVEL COMPACT NO2 INSTRUMENT FOR HIGH-RESOLUTION AIR QUALITY REMOTE SENSING

Abstract

Remote sensing of NO2 and other atmospheric trace gases is rising in importance, owing to the effect on the environment and quality of life that human-made atmospheric constituents have. In the case of NO2, the air quality in densely populated areas is negatively affected. The scientific community is therefore calling for accurate global NO2 measurements with high spatial- and temporal resolution to better monitor NO2 sources and the Earth's NO2 cycle. The launch of TROPOMI in 2017 (ESA/Airbus DS Sentinel-5p instrument with major TNO contributions) has marked a key step in providing the scientific community with these insights thanks to a number of innovations in the field of optical space instrumentation.

The current paper introduces the design of the novel 'Compact NO2 spectrometer' dedicated to facilitating future global NO2 remote sensing. It aims at a significantly smaller instrument size while looking to retain key performance parameters as established by TROPOMI. The compact size will enable the instrument to be compatible with a multitude of different space platforms, therefore facilitating a future global coverage of daily NO2 measurements.

The design study was commissioned by the European Space Agency (ESA). An integrated development approach was used between TNO and the The Royal Netherlands Meteorological Institute (KNMI) to achieve a compact design that fulfils the requirements of the scientific community.

The present paper first outlines NO2 data use cases and the scientific requirements for state-of-the-art NO2 instruments. It then describes the design features of the 'Compact NO2 Spectrometer', such as the compact optical design, the use of free-form optics, an 'athermal' all aluminium approach, and novel approaches to data processing. The performance with respect to state-of-the-art space instruments (such as TROPOMI) in terms of achieving the required spectral resolution, spectral range and high signal-to-noise ratio is discussed. It is shown that a very fine spatial sampling (down to 0.5x0.5 km2) can be reached while still following a very compact low-mass low-volume design approach.