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THE WATER VAPOUR EXPLORER MISSION – DEEPENING THE UNDERSTANDING OF THE UTLS THROUGH LIMB SOUNDING AND MID-INFRARED PASSIVE SPECTROMETRIC REMOTE SENSING MEASUREMENTS

Abstract

The stratosphere plays an essential role on Earth's water cycle. Tropical thunderstorms trigger the dynamics of the Upper Troposphere Lower Stratosphere (UTLS) region, as the mixing of air in this region causes variability of water vapour. This effect has a significant impact on the polar jet stream, and hence the North Atlantic Oscillation, which affect the water cycle and induce extreme weather events. Therefore, the scientific community has repeatedly claimed that deepening the understanding of UTLS coupling is critical to expanding our knowledge of atmospheric processes and enhancing the prediction of

extreme weather events. Because this region is highly stratified around the globe, observations with high vertical resolution would help to better constrain the current operational numerical weather predictions and climate models. The proposed WAter Vapour Explorer (WAVE) mission aims to monitor water vapour in the UTLS, as an indicator of the dynamics of this region. It entails a constellation with three small satellites of approximately 480 kg, located in sun-synchronous low Earth orbits at an altitude of 817 km. Thanks to a limb-sounding and cross-track scanning mid-infrared passive spectrometer (824 cm^{-1} to 829 cm^{-1}), it shall provide UTLS measurements with resolutions of 1 km and 25 km in the vertical and horizontal directions respectively. Furthermore, a potential synergy of WAVE and MetOp-NG satellites is identified, such that data fusion retrieval algorithms could expand these water vapour profiles to cover the range from the surface to the lower stratosphere. The satellite subsystems have been designed using commercial-off-the-self components to enhance their Technology Readiness Level, and the programmatic planning shall allow for space-borne operations as early as 2025. This Phase 0 mission concept was conceived by students at the Alpbach Summer School 2016, a nine-day design challenge devoted to "Satellite Observations of the Global Water Cycle". With a five-year nominal lifetime and enough consumables for ten years of operations, the WAVE mission constitutes a novel yet affordable remote sensing solution to enhance spatial and temporal resolution of water vapour measurements in the UTLS region, thus narrowing a critical scientific gap on the understanding of the water cycle.