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Qsat: A Mission Proposal for Profiling Water Vapour from Space

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In many important respects climate and weather rely heavily on the distribution of water vapour in the atmosphere. In terms of climate change, water vapour leads to the largest feedback, as it more than doubles the surface warming from atmospheric CO_2. In the tropics, lower tropospheric water vapour is the best predictor of vertical motion and precipitation, thus making it central for understanding tropical weather, the climate of the tropics, and tropical climate change, as well as cloud feedbacks. But also in the extra-tropics, the poleward transport of water vapour in the storm track regions, e.g., in the form of “atmospheric rivers”, which often accompany the rapid intensification of extra-tropical cyclones, is frequently associated with important weather events and extremes. Some of the questions related to the distribution of water vapour in the atmosphere, in particular in the upper troposphere, are longstanding and have been targeted by previous measurement systems, albeit not satisfactorily.

To make progress with regard to these open questions the authors proposed to ESA the idea for a future mission, Qsat, to globally measure profiles of tropospheric water vapour with high vertical resolution and low bias from a satellite in a lower Earth orbit. Using the differential absorption lidar (DIAL) technique in combination with a scanning microwave radiometer Qsat would resolve the distribution of water vapor, also in the lower troposphere, over a broad area. Its measurements would close a long-standing gap in the observing system and provide crucial new information for climate research and weather forecasting.

We will present the mission idea, the instrument concept and show simulations of the expected performance under various atmospheric conditions. Measurement examples from an airborne demonstrator for Qsat will be used to highlight the deficits of current global water vapour profiling and the possible benefits of Qsat.