Technology demonstration of space-borne differential absorption lidar (DIAL) for water vapor profiling

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Measurements of water vapor profiles are very important in the studies of atmospheric dynamics, clouds, aerosols and radiation. Water vapor is the predominant greenhouse gas and its vertical distributions are important in the global climate system. Water vapor data would lead to benefits in numerical weather prediction such as localized heavy rainfall event and typhoon forecasting. Passive remote sensing techniques from space provide global coverage of water vapor distribution lacking good vertical resolution, while lidar remote sensing techniques can provide water vapor distribution with high vertical resolution. The DIAL(Differential Absorption Lidar) technique is most available to perform high-resolution measurements of tropospheric water vapor distributions from space. Several researchers have proposed water vapor DIAL systems for spaceborne lidars, but have not been realized yet. We propose two-beam spaceborne water vapor DIAL with the OPA (Optical Parametric Amplifier) transmitter using 1350-nm absorption band. OPA system using QPM (Quasi Phase Matching) device is one path amplifier, therefore OPA is advantageous for space use because it has less restrictions than conventional phase matching OPO. An error simulation is performed assuming that the platform altitude is 250km (super low altitude satellite), the receiver diameter is 0.8m, the laser energy is 20mJ, and the repetition rate of the laser shot pair (on-off) is 500Hz. It is shown that less than 10% water vapor profile measurement relative error is possible between 0-2km altitudes with spatial resolutions of 200m vertically and 20km horizontally in East Asia in summer.

Keywords: water vapor, DIAL, space-borne lidar

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