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Advances in the development of a temperature and water vapor Raman lidar for observation of land-atmosphere interactions

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To understand the interaction and feedback between the terrestrial ecosystem and the atmosphere, rapid and spatially resolved vertical measurements of water vapor and temperature profiles are highly desirable. A unique ground-based Raman lidar system operating in the solar blind spectral region is developed with a four-telescopes array, collecting a nearly constant signal from 10 m to 500 m. To achieve the desired spatial (0.75 m) and temporal resolution (1 s) and measurements accuracy our lidar is equipped with a powerful laser (Nd:YAG) 266 nm with high pulse repetition rate (100 Hz) and short pulse duration ($<$3 ns). The overall efficiency of the lidar system is critical and the separation of the different spectral channels is done with the best possible transmission. The rotational-vibrational branches of Raman spectrum of water vapor (294.6 nm), nitrogen (283.6 nm) and oxygen (277.5 nm) molecules are separated in a polychromator, composed of four high purity fused silica prisms. A transmission of 83%, is obtained - this would be difficult to accomplish with narrow-band filters or diffraction gratings. The oxygen channel allows us to correct the backscattered signal for the tropospheric ozone absorption. The temperature measurement technique is based on measuring intensity ratio of lines in pure rotational Raman spectra of atmospheric nitrogen and oxygen molecules. Using a double stage diffraction grating polychromator we isolate from the lidar response the spectral lines which provide the shortest measurement time. The high dispersion needed for achieving this spectroscopic task is obtained by use of a matrix of two diffraction gratings in both stages of the polychromator. The complementary solutions - UV range, multi-telescopes array and high transmission polychromators - have led to a new generation instrument to

probe the interactions between land and the atmosphere.