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Technical approaches for future active optical remote sensing
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Lidar is a unique active optical remote sensing technique, which can detect very small particles such as molecules, gas and particulate aerosols, clouds. Lidar can also measure range, wind speed, concentration of atmospheric constituents such as CO2, water vapor and so on. Communication Research Laboratory (CRL: former institute of NICT) proposed development of the space-borne coherent DWL as a candidate of the earth observation missions on the International Space Station (ISS)-Japanese Experimental Module (JEM) in 1997, which was called JEM-CDL. NICT started studies on feasibility of JEM-CDL under the support of the Phase II studies of the Ground Research Announcement of the National Space Development Agency (former institute of JAXA). NICT studied 2-μ m laser technologies for the JEM-CDL during 6 years from FY2000 to FY2005 and develop a 2-μ m laser with a high pulse-energy of 460 mJ operating at 10 Hz. NICT developed a 2-μ m conductively-cooled laser-diode-pumped single-frequency Q-switched solid-state laser as a second-generation laser system. NICT developed a ground-based 2-μ m coherent differential absorption and Doppler wind lidar for CO2 and wind measurements. DIfferential Absorption Lidar (DIAL) is more complicated than passive sensor, it has the potential advantage of measuring concentration of atmospheric constituents during nighttime. CO2 sources and sinks are located near the earth’s surface. Since 2-μ m spectral region has sensitivity close to the surface higher than 1.6-μ m spectral region, a 2-μ m integrated path differential absorption (IPDA) lidar is one of the promising space-borne active optical remote sensors. The coherent Doppler Wind Lidar (DWL) is also a complicated system but can measure Doppler wind speed with a high accuracy during daytime as well as nighttime. Although space-borne passive sensor needs scattering objects (water vapor, cloud), coherent DWL can provide a wind profile even clear sky condition. A combination of CO2 and wind measurements would facilitate better understandings of the carbon cycle on various temporal and spatial scales. Space-borne lidar can provide only profile data in a straight line. A synergy measurement of space-borne lidar and other technique would be important and valuable. NICT conducts studies on feasibility for a space-borne Doppler Wind lidar with JAXA, Tohoku University, the University of Tokyo, Meteorological Research Institute, and other institutes. NICT will start a new middle-term project in 2016. In this paper, we describe a future space-borne Doppler wind lidar and conceptual idea for carbon cycle lidar measurement.

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