Optical parametric devices for airborne and spaceborne lidar applications

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In recent years several airborne differential absorption lidar (DIAL) systems for the detection of atmospheric trace gases have been developed at DLR [1]. As their transmitters, various optical parametric oscillators (OPOs) and amplifiers (OPAs) have been deployed generating wavelengths from the ultraviolet to the mid-infrared range. Next to advantageous spectral properties, their high electrical-to-optical efficiency, ruggedness, and small volume are prerequisite for their successful deployment. In general, the fundamental or harmonics of Q-switched, diode-pumped Nd:YAG lasers serve as the pump. Past and current developments include OPO/OPA based lidar systems to measure ozone (O_3), water vapour (H_2O), carbon dioxide (CO_2), methane (CH_4), and mesospheric sodium (Na).

Ozone DIAL requires wavelengths in the range around 300 nm which is efficiently generated by sum frequency mixing of OPO radiation with the harmonics of the pump. For water vapour measurements the required wavelengths (~935 nm) can be directly generated by means of a 532-nm pumped OPO. However, the spectral requirements are stringent since the spectral width need to be close to the Fourier limit and the spectral purity is required to be high (>99.9%). This is achieved by applying the technique of injection seeding. While a spaceborne lidar mission to measure water vapour is put on hold, the German and French space agencies selected MERLIN as a satellite mission to measure atmospheric columns of methane being the second most important anthropogenic greenhouse gas after carbon dioxide. MERLIN whose launch is envisaged in 2019 will carry a near IR (1.6 µm) injection-seeded OPO.

To support the MERLIN and future greenhouse gas lidar missions, a demonstration system is being built at DLR that will be capable of simultaneously measuring both, CH_4 and CO_2 from an airborne platform. Considerable experience is drawn from a recent development of a helicopter-borne lidar system to detect leaks in natural gas transmission pipelines.

Reference

[1] A. Fix, “Tunable Light Sources for Lidar Applications” in: U. Schumann (ed.), Atmospheric Physics, Research Topics in Aerospace, Springer-Verlag Berlin Heidelberg 2012. ISBN: 978-3-642-30182-7 (Print) 978-3-642-30183-4 (Online) DOI: 10.1007/978-3-642-30183-4.