P2-5 Development of the Airborne Water Vapor DIfferential Absorption Lidar (DIAL)

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Abstract For the future spaceborne water vapor DIAL system, an airborne DIfferential Absorption Lidar (DIAL) system is developed. An injection seeded triple pulse Ti:Sapphire laser is used for the transmitter and a LD pumped conductive cooled Nd:YLF laser is employed for the pump laser. These lasers are developed to verify possibility for a spaceborne water vapor DIAL in the near future. The entire system including the receiving telescope, receiving optics, APD detector and signal processing system are being developed. The system will be onboard the Beechcraft B200 aircraft and tested soon.

1. Introduction

Water vapor in the earth's atmosphere plays very important role in the global climate/weather system through such as the hydrological cycle, heat valance and formation of the cloud. Hence, it is very important to understand the global distribution of the water vapor.

Spaceborne water vapor differential absorption lidar (DIAL) technique is though to be one of the most effective method to measure the global water vapor distribution. The DIAL technique has much better vertical resolution compared with the other passive remote sensing techniques to measure water vapor profiles from space (Uchino et al., 1995, Nagasawa et al., 1995).

However, there are many problems to be solved before the water vapor DIAL will be onboard the satellite. We have designed and been developing an airborne water vapor DIAL system to lead the spaceborne water vapor DIAL. A compact, light weight and high efficiency conductive cooled laser system have been developed for the transmitter, a light and optically stable telescope, an efficient receiving optics and a signal processing system is under development (Shoji et al, 1999, Yanagisawa et al., 1999a, 1999b).

2. System Design

The system is designed to measure water vapor profiles with less than 10% error in the troposphere. Two on-line and one off-line wavelengths are used to extend the measurement range coverage. These three laser pulses are transmitted by a laser system to reduce the volume and weight of the system. Highly stabilized laser pulses of two on-line and one off-line are transmitted by a 1.2ms interval and repetition of the triple pulses is 50Hz. Details of the laser system are described in another paper. (Yanagisawa et al., 1999b) Transmitted laser pulses are precisely tuned to absorption-lines or non-absorption band are checked by a pair of photo-acoustic cells (PA cell). These tuning informations from the PA cell are feedbacked to the signal processing unit and the signal is not accumulated if the one or more laser pulse(s) of three pulses set is(are) badly tuned. Specifications of the DIAL system and the schematic diagram are shown in Table 1 and Fig. 1 respectively.

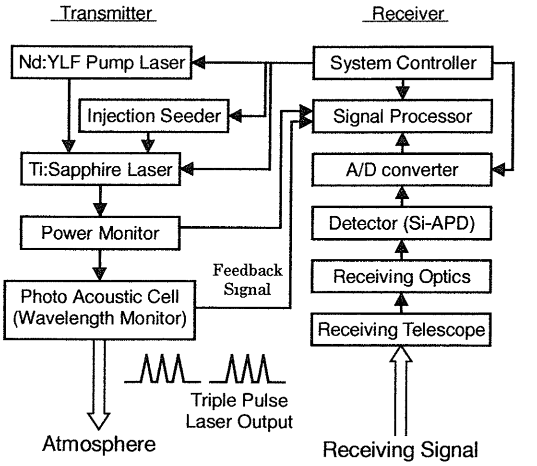

Fig. 1 Schematic diagram of the airborne water vapor DIAL

Table 1 Specifications of the airborne water vapor DIAL

Transmitter

Wavelength	~ 816 nm
Pulse Energy	15 mJ
Repetition	50Hz (3 pulses)
Wavelength Stability	< 0.06 pm (ON1,2) < 1 pm (OFF)
Spectral Width	< 0.045 pm
Beam Divergence	0.8 mrad
Optical Transmittance	88 %

Receiver

Telescope Diameter	20 cm
Field of View	1.6 mrad
Band Width	0.6 nm
Optical Transmittance	> 25%
Quantum Efficiency	85 %
NEP (APD Module)	2.5×10^{-14} W/Hz $^{1/2}$
A/D	12 bits
Sampling	533/267/133/66.7 ns

A sample of the error simulation is shown in Fig. 2. The flight level of the aircraft is assumed to be 7,000m. Combining with the two sets of on-off line wavelengths, the measurement can be done within 10% error in all altitude.

3. Summary

The laser system including the injection seeded triple pulse Ti:Sapphire laser and pumping Nd:YLF laser have been already developed. The system of an receiving optics, a signal processor and a control

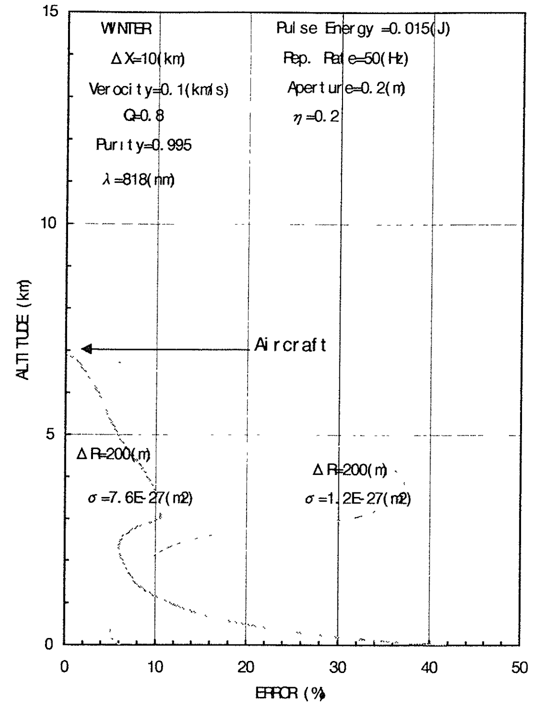

Fig. 2 Error simulation of the airborne water vapor DIAL

electronics are under development. Ground based and flight test will be executed soon.

Acknowledgments

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