The Design of UAV-borne Polarization Lidar for Supercooled Water Clouds Observation

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Supercooled water, as an important physical feature of cloud precipitation, is not only of great significance to the study of cloud phase state change, it also has important research value in weather modification, aviation flight safety and other fields. At present, the detection means for supercooled water is very limited, mainly using airborne in-situ sampling instrument and there is a lack of remote sensing detection equipment.

UAV technology changes fast with each passing day, and it has the characteristics of low cost, easy-to-use, safety and flexibility. The combination of lidar and UAV into atmospheric research has become a hot research topic. In this paper, an UAV-borne polarization lidar which can be used for supercooled water detection is introduced. The wavelength used for this lidar is 1064nm generated from Nd:YAG laser and a half wave plate is used for calibrating the depolarization ratio of the clouds, The lidar is installed on an UAV platform with a glass window on the roof. The laser pulse is transmitted up to the sky from the window and the clouds backscattering light goes through the window and is collected by the lidar telescope. Then, the collected light is split by a polarization prism into the parallel and perpendicular channels respectively and detected by APDs. Many physical characteristics of clouds such as phase states and particle shapes can be retrieved from depolarization profiles.

Aiming at UAV platform, research on environmental adaptability of this lidar has to be examined elaborately. According to the vibration characteristics of UAV platform, the finite element analysis (FEA) shows that the main structure of the lidar has good rigidity, and does not resonate with the fuselage, and meets the requirements of flight safety. Considering the flight performance of the UAV, the lidar should weigh no more than 5kg and be no higher than 20cm perpendicular to the mounting base . Because of the risk of cloud penetrating, waterproofness and air tightness are also essential. The lidar must work normally within the range of -40 to 40℃ and the estimated detection ranges are from 45m to 3km with the spatial resolution of 7.5m. The detailed overall structure of the UAV platform and the lidar configuration will be presented and discussed, as well as the results of the FEA.