P2A.7 CLOUD MEASUREMENTS BY AIRBORNE W-BAND RADAR AND LIDAR ON JOINT APEX-E3/ECAV EXPERIMENT

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1. INTRODUCTION

Asian Atmospheric Particle Environmental Change Studies (APEX) project and EarthCARE (Earth Cloud, Aerosols, and Radiation Experiment) proposal validation (ECAV) team jointly conducted regional experiment in southwest Japan in March and April 2003. This experiment aims to understand the aerosol properties and their effects on the cloud system in east-Asia region, where various kinds of aerosols are transported in spring season. To this end, chemical characteristics, physical properties and radiation characteristics of cloud and aerosols are measured from aircraft, surface, and satellites.

In this experiment, a W-band cloud profiling radar developed by Communications Research Laboratory (CRL) and a UV Mie lidar developed by National Institute for Environmental Studies (NIES) were installed on Gulfstream-2 (G2) aircraft. Nadir-looking measurements by both radar and lidar over cloud top height provide vertical cloud structure and cloud physical property over broad area.

2. W-BAND RADAR AND UV MIE LIDAR

CRL W-band cloud profiling radar, called SPIDER, was developed in 1997. SPIDER is installed in a radar pod and attached to the body of G2. The peak transmitting power of an EIA power amp is 1.5 kW and the antenna diameter is 40 cm. SPIDER has functions of linear polarization measurement and Doppler measurement. NIES Mie lidar is installed in the inside of G2. UV (355nm) laser beam is emitted from a hole in the bottom of G2. A telescope of 120mm diameter is used for receiver, whose axis coincides with the laser beam. The parallel and perpendicular polarization return are measured by this system. The beam directions of the SPIDER and Mie lidar were fixed to the nadir. The standard range sampling interval is 82.5 m for SPIDER and 3.75 m for LIDAR. The flight information of G2 such as position, altitude, speed, pitch, roll etc. are recorded every 1 sec.

3. PRELIMINARY RESULTS

The base for aircraft was sited at Kagoshima airport during the APEX-E3/ECAV experiment. Three aircraft (G2, B200, C404) were used in this experiment. For G2 aircraft, ten flights were performed and the total observation time exceeds 21 hours. The flight paths of G2 are showed in Figure 1. Observation areas were mainly placed within the triangle that connect Kagoshima, Amami and Fukue. At Fukue and Amami, there were surface observation sites for radiation and aerosol measurements. Ground-based Mie lidars were installed at both sites and a W-band FMCW cloud radar was also installed at AMAMI site. Simultaneous observations with B200 and/or C404 were performed several times over the same flight path, where G2 flew several round trips at upper level and B200 and/or C404 flew at lower level.

Figure 2 shows an example of the cloud echo observed by the radar and lidar. Using the flight information, the ranges from the aircraft are converted to the heights from the ground. The off-nadir periods are shown as bars in the bottom. These periods correspond to tilting or banking of the aircraft. G2 left Kagoshima airport at 1235JST, reached Fukue at 1300 and flew over Amami at 1340. During 1400-1515JST, G2 made simultaneous observation with C404 along the line near 30.5 N. Middle level clouds around 5km are seen in both radar and lidar. However, lidar cannot detect echoes from cloud bottom because of strong attenuation around cloud top. Especially in aircraft turning time, cloud thickness observed by the lidar shows much thinner than that of the radar during off-nadir periods.

4. CONCLUDING REMARKS

We will try to get cloud physics parameters such as liquid water content, optical depth, by combining the radar and lidar data. It can be validated by in-situ measurement of cloud property using other aircraft sensors. This kind of validation is important for development of algorithm for satellite borne cloud radar/lidar such as proposed EarthCARE.

5. ACKNOWLEDGEMENTS

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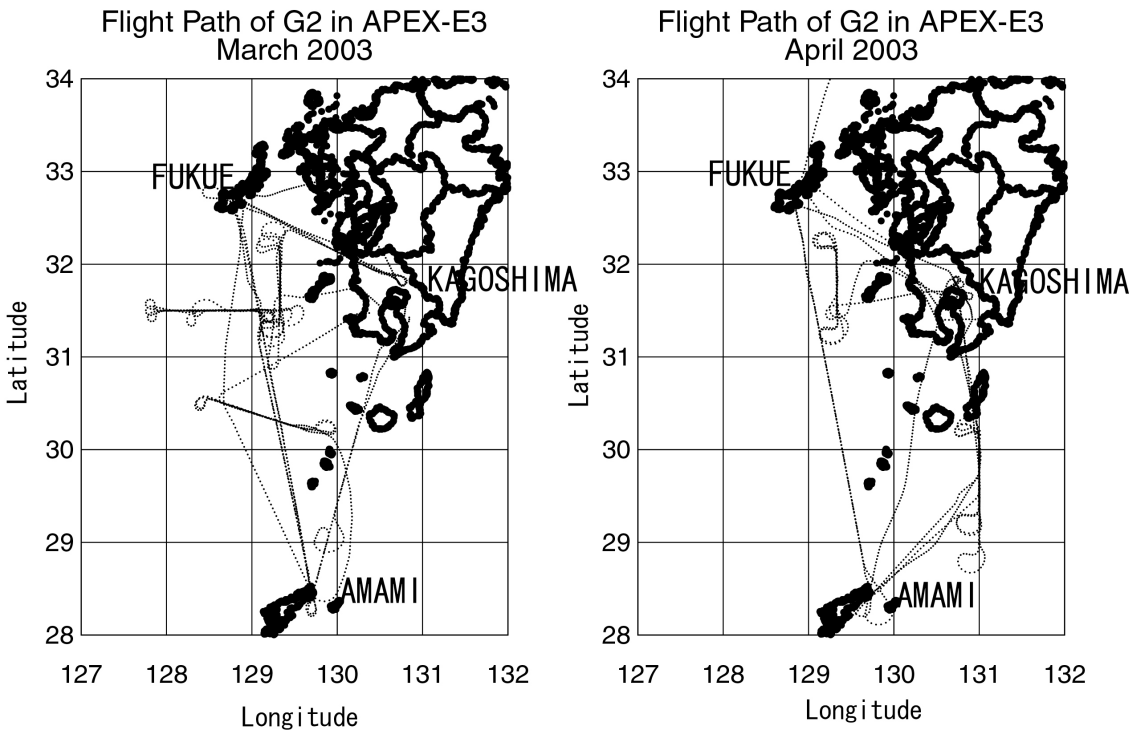

Fig.1 Flight path of Gulfstream 2 in March and April

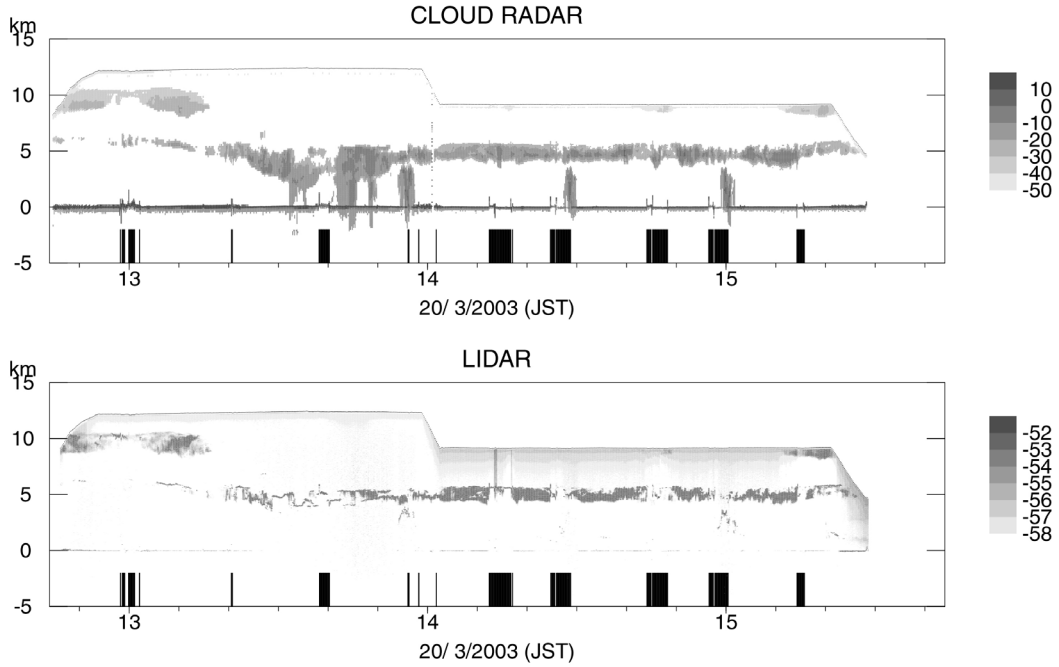

Fig.2 Time–height sections of cloud echoes observed by airborne W-band radar and lidar on March 20, 2003. Upper figure shows radar reflectivity in dBZ and lower figure shows lidar's return signal in dB. Bars in the bottom show periods when the radar and lidar beams were pointed to the off-nadir.