A Balloon-Borne Submillimeter-Wave Limb-Emission Sounder for Stratospheric Research

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A Balloon-Borne Superconducting Submillimeter-Wave Limb-Emission Sounder (BSMILES) was developed to measure vertical profiles of stratospheric minor constituents like ozone by detecting emission line spectra from these species. The flight experiments were conducted from the Pacific Coast of Japan. The observations were made by limb-sounding method which measures atmospheric limb. The limb-sounding method has advantages that it has high sensitivity by measuring long path length along the line-of-sight and high vertical resolution by scanning the observing beam in vertical direction. The wideband spectrometer enables to measure ozone and other molecules related to ozone destruction simultaneously.

The size of the gondola is 1.35mx1.35mx1.26m and the weight is 500kg. BSMILES carries a 300 mm diameter offset parabolic antenna, a liquid-helium-cooled superconducting low noise receiver (SIS mixer: Superconductor-Insulator-Superconductor mixer) at submillimeter wavelength, a three-axes fiber-optical gyroscope to measure attitude of the gondola, an acousto-optical spectrometer with 1GHz bandwidth and 1MHz resolution, a data handling system, and lithium batteries for power supply.

The balloon experiments were conducted on August 30, 2003 and September 7, 2004 at Sanriku Balloon Center (SBC) of Japan Aerospace Exploration Agency (JAXA) at the east coast of Japan. At the observation of 2003, the gondola was lifted by a balloon of 80,000m^3 in volume and reached an altitude of 33.8km after the gondola flew 200km eastward by westerly wind, then returned westward by the wind of opposite direction in the stratosphere. When the gondola approached Miyako-bay to about 40km, it dropped and splashed down in the Pacific Ocean by a parachute cutting the rope by the command from the ground and was retrieved by a boat and a helicopter. All the equipments were waterproofed and did not suffer serious damage from the shock of the splashdown. All systems operated properly during the observation and emission line spectra of ozone and chlorine monoxide were successfully measured and vertical profiles of these molecules were obtained. The ozone profile was in good agreement with that measured by an optical ozonesonde on September 13 at SBC.

At the observation of 2004, some systems were improved to increase the observing bandwidth and time efficiency. The BSMILES was launched at 6:31 a.m. local time by a balloon of 100,000m^3 in volume and reached an altitude of 35km. The system operated properly and O_3, H^35Cl, H^37Cl, HO_2, and O_3 isotopes were measured. An electrochemical concentration cell (ECC) ozonzonde was launched for simultaneous observation with BSMILES. Vertical profile of ozone was measured by an optical and an ECC oznozonde on September 4 and by an optical ozonzonde on September 5, 2004 at SBC.

This experiment will be useful for the development of the system and data analyzing software of JEM(Japanese Experiment Module)/SMILES(Superconducting Submillimeter-Wave Limb-Emission Sounder) on the ISS (International Space Station).