Large temperature and density perturbations in the lower thermosphere observed by S-310-30 rocket experiment

Junichi Kurihara[1], Koh-ichiro Oyama[2]

[1] Earth and Planetary Sci., Univ. of Tokyo, [2] ISAS

The vibrational temperature (Tv), the rotational temperature (Tr) and the number density of atmospheric N2 between 100-150 km were measured by a sounding rocket S-310-30, over Kagoshima, Japan at 10:30 UT on February 6, 2002. The main purpose of this rocket experiment is to study the dynamics and the thermal energy budget in the lower thermosphere by means of simultaneous temperature and density measurements. In the case of N2, Tv is predicted to exceed the kinetic temperature (Tk) above 100 km, because vibrational energy is supposed to be far from Local Thermal Equilibrium (LTE). On the other hand, Tr is expected to equal to Tk in the lower thermosphere. N2 density measurement is reasonable to estimate total atmospheric density since N2 is the main constituent up to 180 km.

We applied the Electron Beam Fluorescence (EBF) technique to in-situ measurement and obtained the spectra of N2+ 1st negative (1N) bands from 360 to 440 nm. Tv and Tr are determined by fitting the simulated spectrum to the observed spectrum, and the number density is deduced from the intensity of the spectrum. Aerodynamic effects on the measurement caused by the rocket flight are corrected quantitatively using Direct Simulation Monte Carlo (DSMC) method.

From the analysis of the results, wavelike structures with a vertical wavelength of about 50 km are found over both temperature and density profiles. The maximum deviations from MSISE-90 model reach 150 K in temperature and 50 % in number density at 115 km. While the observed temperature and density have such a large perturbations, these profiles show obvious anti-correlation and satisfy the hydrostatic law. Consistency between the measured parameters and implications of this large perturbation are discussed.