Study on variation of neutral temperature in the polar MLT region using a sodium LIDAR at Tromsø

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In October 2010, we started measurements of atmospheric temperature in the polar mesosphere/lower thermosphere (MLT) region using a sodium LIDAR installed at Ramjordmoen, Tromsø (69.6°N, 19.2°E), where the EISCAT radars have been operated for a few decades. Understanding of mechanism causing neutral temperature variations in the polar MLT region is of vital importance for understanding atmospheric coupling process between lower and upper atmosphere on the earth as well as the Magnetosphere-Ionosphere-Thermosphere coupling process. The new sodium LIDAR provided temperature data with time resolution of 10 min during the 1st season between October 2010 and March 2011. During the 1st season, we succeeded in obtaining neutral temperature data for about 256 hours in total. At first, in this talk, we present an overview of observations of the 1st season. Major results are as follows: for two nights, October 5-6, 2010 and November 14, 2010, we succeeded in obtaining simultaneous observational data sets with the EISCAT UHF radar. During the interval, the electric field values were relatively small. We compared neutral temperature values from the LIDAR with the ion temperature values from the EISCAT between 95 and 105 km. In general, there is found in fairly good agreement. We have obtained 10 sets of temperature data sets with duration of 7 hours or longer, and analyzed them in terms of gravity waves and semidiurnal tide. We captured a mode change of the semidiurnal tide for the night of February 23, 2011 between 80 and 110 km. On October 29, 2010, we observed clear temporal variations of the temperature between 80 and 100 km. Results of the detailed analysis of this event will be presented in another talk by Takahashi et al. We found sporadic sodium layer (SSL) at 92–98 km between 2000 and 2330 UT (2100–2430 LT) on January 11, 2011. The sodium LIDAR measurement with 5-sec time-resolution reveals the details of dramatic sodium-density increase as well as short-period wavelike structure in the SSL.

At second, we will talk about our current LIDAR system. In September 2011, we significantly upgraded the LIDAR system for conducting simultaneous five beam measurements of temperature together with wind velocity. We made the following improvement of the system: (1) reinforcement of the laser output, (2) reduction of loss of the laser output before transmitting towards the sky, (3) restructure of the AO unit to improve seeder control and calibration of the laser wavelength, (4) reduction of background noise level of receivers by installation of 1 nm filters and iris masks, (5) equipping of FOV viewer of each telescope to monitor the direction, (6) improvement of observation software. Figure shows comparison of LIDAR data (vertical direction) of 5-sec integration between two datasets obtained on October 5, 2010 (black line: about 1.7 W output, 3 nm filter without iris mask) and September 24, 2011 (blue line: about 2.3 W output, 1 nm filter with iris mask). After the improvement was made, we started 5-beam observations on September 21, 2011. At last, we will present preliminary results from 5 beam observations from the beginning to up to date.

In this talk, we will present (1) overview of 2010 season results, (2) the current LIDAR system, (3) new results from 5-beam observations.

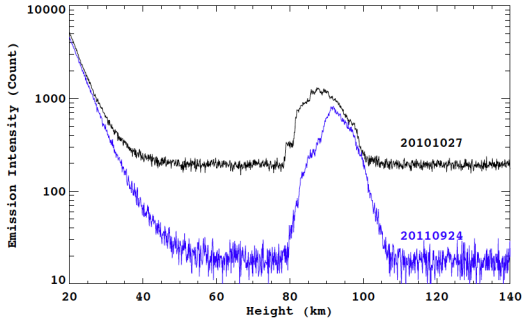

Figure: Comparison of LIDAR data (vertical direction) between October 27, 2010 (black) and September 24, 2011 (blue). Integration time is 5-sec.