Vertical motion of the neutral atmosphere in the winter polar MLT region using the sodium LIDAR at Tromsoe

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We will present characteristics of vertical motion above Tromsoe (69.6 deg. N, 19.2 deg. E) in the polar Mesosphere-Lower Thermosphere (MLT) between about 80 and 110 km, mainly based on sodium LIDAR data. Vertical motion of the neutral gases in the polar MLT is a peculiar issue, and its understanding is important in terms of substance transport as well as thermal structures. Observations of the vertical wind in the MLT region are rather difficult, because vertical velocities are generally thought to be about two orders smaller than horizontal wind velocities. For example, observations of vertical winds by radars (MF and meteor radars) are difficult. Thus, our understanding of the vertical motion in the polar MLT region is still limited. The sodium LIDAR operated at Tromsoe is capable of simultaneous measurements of wind velocities as well as neutral temperature with five directions with a good accuracy (about 1 m/s and 1 K, respectively). By using the LIDAR data (about 2200 hr data) obtained from October 2012 to March 2017 together with EISCAT, MF, and meteor radar data and auroral image data, we will discuss the characteristics of the vertical motion in the polar MLT.

We have analysed 77 nights of LIDAR data sets obtained under good conditions. Wave structures are almost always prominent in wind and temperature data sets. We have found several events where the vertical wind blew with strength of about 10 m/s. In the night of January 14, 2015, the upward vertical wind with an amplitude of 10 m/s was found between 92 and 101 km lasting for a few hours; the region of vertical wind appearance went down from 101 km to 92 km. During the night, the semidiurnal tide was strong with an amplitude of 100 m/s. This might suggest that strong vertical motion exists when such waves pass by the MLT region, but it seems like this event was not the case. In another event found in February 8, 2013, upward flows were observed between 94 and 96 km at the same time for 15 min, while no vertical flows were found at and above 97 km and at and below 93 km. Of particular interest in the both cases is that a sporadic sodium layer (SSL) appeared nearby the height region where the upward vertical wind was observed at the same time (in the case of January 14, 2015) or 15 min later (in the case of February 8, 2013). In this presentation, we will address what conditions are needed for the vertical motion occurrence. We will discuss possible relationships between strong vertical wind occurrence and advent of SSLs, aurora effects or atmospheric stabilities.