A study of 8 hr and 6 hr atmospheric waves in the polar upper mesosphere and lower thermosphere above Tromsoe by using sodium LIDAR temperature and wind data

*Satonori Nozawa[1], Chiaki Morikawa[1], Takuo T. Tsuda[2], Takuya Kawahara[3], Norihito Saito[4], Satoshi Wada[4], Tetsuya Kawabata[1]

1. Institute for Space-Earth Environmental Research, Nagoya University, 2. Department of Communication Engineering and Informatics, The University of Electro-Communications, 3. Faculty of Engineering, Shinshu University, 4. RIKEN Center for Advanced Photonics, RIKEN

We have investigated relative importance of 8 hr and 6 hr atmospheric waves compared to the 12 hr wave (so-called semidiurnal tide) on the atmospheric wind dynamics as well as the atmospheric stability between 80 and 105 km above Tromsoe, Norway (69.6 deg N, 19.2 deg E). By using wind velocity and temperature data obtained by the sodium lidar at Tromsoe from October 2012 to December 2019, we have derived 12 hr, 8 hr, and 6 hr components using the Lomb-Scargle method. As far as we know, this is the first statistical study of those waves using temperature data in the polar Mesosphere and lower Thermosphere (MLT) region.

Short periodic tidal waves are less known than diurnal and semidiurnal tidal waves even though an amplitude of the 8 hr tide sometimes becomes comparable to that of diurnal tidal wave in the polar MLT region [Thayaparan, 1997; Younger et al., 2002]. Solar heating, and nonlinear interactions between diurnal and semidiurnal tides are thought to generate the 8 hour tide [Thayaparan, 1997; Akmaev, 2001; Younger et al., 2002; Moudden et al., 2013]. A modeling study by Smith [2001] showed the solar heating was a dominant source of generation of the 8 hr tide at high latitudes. Pancheva et al. [2021] using meteor radar wind data (1 hr/2 km resolutions) at Tromsoe showed that both the 8 hr and 6 hr tides had inter annual variability with a quasi-2-year-period, and vertical upward propagating of these waves had different wavelength according to season. The vertical wavelength of the 8 hr tide in November shows the longest among months, and is larger than 100 km.

We have derived 12 hr, 8 hr, and 6 hr components using 108 nightly wind and temperature data with their data length longer than 16 hours. Maximum amplitudes of the 8 hr component ranges from 10 m/s to 80 m/s with an average of 33 m/s, and ranges from 5 K to 33 K with an averaged of 11 K. The amplitude of 12 hr components are about 4 times larger than those of the 8 hr component in wind data, while in temperature data the amplitudes of the 8 hr component are comparable to those of the 12 hr component. The 6 hr component has amplitudes from 13 m/s to 96 m/s with an average of 40 m/s in wind data. In temperature data, it ranges from 5 K to 33 K with an average of 13 K. It is found that both the 8 hr and 6 hr components have smaller amplitudes than the 12 hr component in wind data, while they are comparable to those of 12 hr in temperature data. We have analyzed six long-data sets (data interval being 4 days or longer); we have derived 24 hr, 12 hr, 8 hr, and 6 hr components from the six long-data sets, and compared those each other. In wind data, the 12 hr amplitude is the strongest over the height region for most of time periods. The 24 hr component is the second strongest component, but the 8 hr component sometimes becomes stronger than the 24 hr component. The 6 hr component is less detected than the other 3 components, and the 6 hr amplitude is the smallest, suggesting the 6 hr tide has small amplitudes in wind data. In temperature data, amplitudes of 12 hr, 8 hr, and 6 hr do not show preference to each other, and those three components have similar amplitudes. Furthermore, we have made monthly

averaged data as functions of time and height, derived 12 hr, 8hr, and 6 hr components, and compared them each other. Based on these analysis results, we will discuss importance of 8 hr and 6 hr components on the wind dynamics and in the atmosphere stability in the polar MLT region.

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