The mesospheric sodium layer topside and bottomside extension

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The metal main layer is normally formed between about 80 km and 105 km in the mesosphere-lower thermosphere (MLT). In this talk, a large altitude range of a topside extension after sunset and a bottomside extension after sunrise of mesospheric sodium (Na) layer will be presented based on diurnal lidar observation of Na layer at a mid-latitude station, Beijing, China (40.5°N, 116°E).
The Na layer topside was frequently observed extending up to ˜120 km during the second half of the night in late April˜October though the Na density of these thermospheric extensions was often very small (<5% of the normal Na layer density). However, the bottomside extensions below 75 km were very rare, and all of them were observed during daytime in winter months, especially in December. Notably, a Na layer bottomside extension down to around 70 km with considerable Na density increase was observed in December, 2014.
Fig. 1(a) and (b) show Na density diurnal variations on 8˜10 September, 2014 and 11˜14 December, 2014, respectively. From Fig.1 (a) we can see that the Na layer topside extensions can be as high as 20˜30 km above the main layer and lasted for several hours from around midnight till near sunrise (˜7:00 LT). The peak Na density of the extensions were ˜100 atoms/cm^3. In Fig.1 (b), the Na layer bottomside was observed extending downward after sunrise and reached to around 70 km after midday on 14 December, 2014. During the daytime of the other two days (12 and 13 December), Na increase on the layer bottom can also be seen after sunrise, but the variation is less prominent than that on 14 December. Theoretical model studies suggested that ion-molecular chemistry dominate on the Na layer upper side above 95 km, while neutral chemistry play a more important role on the layer lower side below 90 km. The weaking of Na ionization and photochemistry can cause Na density building up after sunset in the E region and decrease Na during the day because of the reversing scheme, which may contribute to the topside extension during nighttime [Plane et al., 2015]. Photolysis of the principal reservoir $NaHCO_3$ together with the reaction of $NaHCO_3$ with atomic H whose rates are dramatically increased during the day are considered to be primarily responsible for the Na density increase on the layer bottomside after sunrise [Yuan et al., 2019]. However, the observed Na layer top side has much smaller diurnal variations in November-March, and the bottom side extension that down to 70-72 km were observed only in winter, especially in December. The different seasonal and diurnal variations of the Na layer top and bottom sides may imply the different chemistry and dynamic processes within them [Chu et al., 2011; Xue et al., 2013; Tsuda et al., 2015; Xun et al., 2019; Cai et al., 2019]. In addition, Höffner and Friedman [2004] suggested a direct influence of ablating meteoroids on the topside of the mesospheric metal layer based on observations of different metal layers. The roles of Na chemistry and dynamical process in the observed significant variations of the Na layer top and bottom sides will be investigated by making use of the mesospheric temperature measurement results from satellite observation and horizontal wind results from meteor radar, together with the ionospheric observational results from ionosonde.
Fig. 1. The Na density diurnal variations observed on (a) 8˜10 September, 2014 and (b) 11˜14 December, 2014. The rectangles in (a) and (b) denote the topside extensions and bottom side extension, respectively.

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Keywords: Sodium layer, Metal layer extension, Metal layer diurnal variation