Statistical study on daytime sporadic sodium layers (SSLs) at Beijing, China (40.6°N, 116.2°E)

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A sodium (Na) lidar was successfully developed to permit full-diurnal-cycle observations of Na layer at Beijing, China (40.6°N, 116.2°E) in 2014. Statistical analysis of the parameters of daytime sporadic sodium layers (SSLs) was performed over lidar data between April, 2014 and December, 2016. The daytime SSLs occurrence had a maximum in May–June months, which is consistent with that of nocturnal SSLs above Beijing reported before (Jiao et al., 2015). Most daytime SSLs peaks tended to occur around early morning (7:00-8:00 LT) and afternoon (14:00-15:00 LT and 16:00-17:00 LT). The peak altitudes of daytime SSLs located at the altitude range of 91–105 km with an average altitude of 97 km, which was about 2 km higher than that of nocturnal SSLs (~95 km) at the same location reported in Jiao et al. (2015). Most of the daytime SSLs peak density was larger than that of the normal layer, furthermore, a SSL with very high peak densities (>30000 cm^{-3}), which was more than 15 times of the normal layer peak density, was observed. This strong SSL with downward motions was found to be accompanied by downward propagating sporadic E (Es) event with critical frequency (foEs) of more than 10 MHz. This suggests that Es contributes to the formation of this strong SSL although the electron density and Na^+ density estimated from the foEs are not enough to interpret the rapid Na atoms increase rate (roughly estimated to be ~4-5 $\times 10^{10}$ $m^{-2}s^{-1}$) and multi-directional Na lidar observation was not performed to evaluate the advection effect (Tsuda et al., 2015). The nocturnal SSLs above Beijing reported in Jiao et al. (2015) showed the time interval of Na density decreasing was often longer than that of increasing, however, in this study nearly half of the daytime SSLs showed faster decay. Such difference in temporal evolutions between daytime and nocturnal SSLs is likely due to the changing of photochemistry reactions which is greatly enhanced during daytime because of solar radiation. The observed daytime SSLs duration time were often less than 4 hours, notably, two SSLs lasted more than 10 hours were observed. The diurnal observations of SSLs provide valuable supports for the studies of Na layer behavior and evolution and formation mechanism of SSLs.

References

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