Statistical study of Sporadic Sodium Layer (SSL) observed at Tromsø

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Based on about 3000 hours of sodium density data obtained with the Tromsø sodium LIDAR over 7 year seasons between 2012 and 2018, we have identified about 40 events of Sporadic Sodium Layer (SSL) in the polar mesosphere and lower thermosphere (MLT) region. A SSL is a thin sodium layer (about 1-2 km) with high sodium density (usually factor of 2 or more higher than that of a normal layer), and its life time is about a few minutes to a few hours. We have investigated an occurrence rate of sporadic sodium layer (SSL) as well as necessary conditions for a SSL to form in the polar MLT region. SSLs appeared for shorter than 5 % of the overall observational time, indicating it is a rare event. Auroral electron precipitation as well as appearance of a sporadic E layer would be necessary conditions to form a SSL.

The sodium LIDAR at Tromsø (69.6 deg N, 19.2 deg E) has made simultaneous five directional (vertical position, plus 4 horizontal positions with zenith angle = 30 deg or 12.5 deg and azimuth = 0, 90, 180, 270 deg) observations, and has obtained about 3000 hours of temperature, sodium density, and wind data between October 2012 and February 2019. Analyzing the datasets with temporal and height resolutions of 3 min and 500 m, respectively, we have identified about 40 SSL events over the seven winter seasons. By utilizing five point observations, we have determined if a SSL was in-situ generated or was advected. Most SSLs show feature of advection (systematic and similar temporal variations of sodium density), indicating associated sharp rise of sodium density, whose mechanism has long been not understood, can be explained with an advection effect.

Observational results can be summarized as follows:
(1) most SSLs found are probably advected, (2) ionization of aurora would be a necessary condition, (3) sporadic E (Es) layers are almost always associated, (4) local time dependence of appearance of SSL is found, suggesting convectional electric field and semidiurnal tide would play an important role. We will address a generation mechanism of SSL.

Keywords: Sodium layer, Tromso, SSL, Es layer, Sodium LIDAR

