

Statistical study of sporadic sodium layer (SSL) in the polar lower thermosphere and upper mesosphere by using the Tromsø sodium LIDAR

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We will present statistical results about sporadic sodium layers (SSLs) appearing in the polar lower thermosphere/upper mesosphere during winter (November–January). The sodium LIDAR at Tromsø (69.6N, 19.2E) 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 2100 hours of temperature, sodium density, and wind data between October 2012 and March 2016. Analyzing these datasets, we have identified twenty-four SSL events over the four winter seasons, and have investigated characteristics of the SSLs.

We have addressed the following questions about SSLs: (1) in-situ generation or advection, (2) ionization of aurora is needed, (3) role of Es layers and temperature, and (4) local time dependence and advent height. Concerning (1), it is important to distinguish events if they were in-situ generated or just advected into the views of the LIDAR, since so far no proposed mechanisms can explain well the rapid increase of the sodium density found in the beginning of SSL events. Based on investigation of timings of detection at each beam direction, it is found that SSLs of the 10 events seemed to be in-situ generated, while those of 14 events were advected. Concerning (2), auroras would play an important role for generation of SSLs at high latitudes, but their role is not yet well understood. At Tromsø, several instruments monitor the aurora activity. These data showed that auroras appeared in 17 events. Concerning (3), existence of sporadic E layer would be important for generation (in particular, for providing sodium atoms), but its role is not well understood quantitatively. Concerning (4), local time dependence and height of advent of SSLs are also keys to understand generation mechanisms of SSLs, in particular relationship with tide, planetary, and gravity waves. Out of the 24 events, SSLs of 9 events appeared above 100 km before 21 UT, while SSLs of the 11 events showed up below 100 km after 21 UT.