

# Depletion of mesospheric sodium during extended period of pulsating aurora

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In the last three decades, the impact of auroral particle precipitation on the neutral Na layer has been studied at high latitudes. Recently, we employed simultaneous observations by the sodium lidar and the European Incoherent Scatter (EISCAT) VHF radar at Tromsø, Norway (69.6°N, 19.2°E), to study the effect of auroral particle precipitation on Na density. Our simultaneous observations clearly showed an occurrence of Na density depletion during auroral ionization. The depletion around 100 km reached up to ~60% of the nightly mean Na density. However, it was still unclear which of the suggested mechanisms dominated the observed Na density depletion.

In this study, we quantitatively evaluated the Na density depletion due to charge transfer reactions between Na atoms and molecular ions produced by high-energy electron precipitation during a pulsating aurora (PsA). An extended period of PsA was captured by an all-sky camera at the EISCAT radar site during a 2-h interval from 00:00 to 02:00 UT on 25 January 2012. During this period, using the EISCAT VHF radar, we detected three intervals of intense ionization below 100 km that were probably caused by precipitation of high-energy electrons during the PsA. In these intervals, the sodium lidar at Tromsø observed characteristic depletion of Na density at altitudes between 97 and 100 km. These Na density depletions lasted for 8 min and represented 5-8% of the background Na layer. To examine the cause of this depletion, we modeled the depletion rate based on charge transfer reactions with  $\text{NO}^+$  and  $\text{O}_2^+$  while changing the  $R$  value which is defined as the ratio of  $\text{NO}^+$  to  $\text{O}_2^+$  densities, from 1 to 10. The correlation coefficients between observed and modeled Na density depletion calculated with typical value  $R=3$  for time intervals  $T_1$ ,  $T_2$ , and  $T_3$  were 0.66, 0.80 and 0.67.

The observed Na density depletion rates fall within the range of modeled depletion rate calculated with  $R$  from 1 to 10. This suggests that the charge transfer reactions triggered by

the auroral impact ionization at low altitudes is the predominant process responsible for Na density depletion during PsA intervals.

In this presentation, we will present about these results in detail and future plans for this study by using an upgrade in the data recording and laser control system for the Tromsø sodium lidar.