# Current status of ground-based optical observations for short-wavelength infrared aurora and airglow emissions in Northern Europe

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Dayside aurora, polar patch, and airglow are the key phenomena for the understanding of the dayside magnetosphere, ionosphere, and neutral atmosphere coupling process. Those phenomena have been mainly monitored by active/passive radio remote sensing such as HF/VHF/UHF radar, LF wave receiver, and imaging riometer, but spatial and temporal resolutions by those measurements are basically not so good in comparison to optical measurements. Short-wavelength infrared (SWIR) wavelength is crucially important because lower sky irradiation by Rayleigh scattering may allow us to conduct ground-based optical observations even on the dayside. For investigations on geospace phenomena on the dayside and their generation process, we installed a Czerny-Turner type imaging spectrograph at Kiruna (67.85°N, 20.21°E) late August 2019, and we are currently developing a 2-D imaging spectrograph with a fast optical system and a narrow field-of-view (FOV).

The spectrograph at Kiruna, whose spectral range and that per pixel with a 600 /mm grating are 119 nm and 0.11 nm/pixel, respectively, focuses on continuous measurements of aurora ($N_2^+$ Meinel) and airglow (OH 3-1 band) spectrum around 1.5 microns. Although auroral emissions in this wavelength are thought to be not so strong compared to airglow, its detailed spectral feature and generation process are neither discussed nor fully understood. With regard to airglow, P1(2) and P1(4) emissions in OH 3-1 band allow us to estimate OH rotational temperature near the mesopause, which makes it possible to study roles of atmospheric waves in polar regions such as atmospheric gravity waves, planetary waves, solar thermal and lunar gravitational tides, Sudden Stratospheric Warming, and seasonal/year-to-year variability as well as artificial disturbances produced by rocket launches from Plesetsk.

Another spectrograph is designed for SWIR wavelength ranging from 1.09 to 1.25 microns that covers strong auroral emissions in $N_2^+$ Meinel band (1.1 microns) and $N_2$ 1st Positive band (1.2 microns). FOV and angular resolution are 55 degrees and 0.11 degrees per pixel, respectively. If a 30-microns slit is used, wavelength resolutions are 2230 and 5070, with two different gratings (950 /mm and 1500 /mm). The signal-to-noise ratio for 1 kR emissions can be expected to be larger than 1.0 in a few seconds exposure time. Therefore, we can investigate temporal variability of dayside phenomena such as dayside reconnection and pulsating auroras with sufficient sampling rates of a few seconds. This spectrograph will be installed at The Kjell Henriksen Observatory/The University Centre in Svalbard, Longyearbyen (78.21°N, 15.55°E). Taking advantage of its location, 24-hours continuous observations can be expected (solar zenith angle lager than 96 degrees) near the winter solstice. Additionally, collaborative studies with active/passive radio remote sensing such as EISCAT Svalbard radar and LF radio receiver will be done in the near future to evaluate spatial and temporal characteristics of dayside aurora.