Can auroral activity have an effect on the upper-mesospheric temperature?

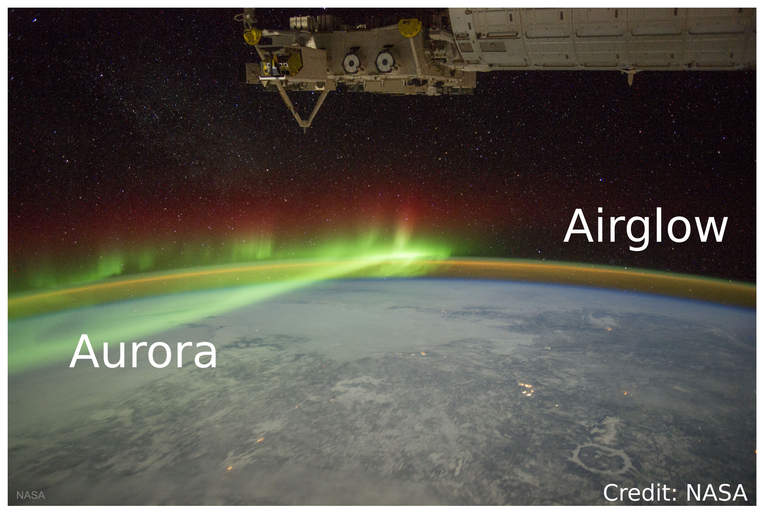
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Motivation

● Auroral electrons are not energetic enough to penetrate down into the mesosphere, yet a possible indirect effect of auroral activity on the upper mesospheric temperature (~87 km) remains unknown.
● A single event of enhanced temperature (ΔT = 10 K) after auroral activity was observed at Syowa Station, Antarctica [Suzuki et al. (2010)].



Airglow and Temperature

● Airglow describes the radiative relaxation of excited atoms or molecules in the middle and upper atmosphere. Excited hydroxyl molecules (OH*) are produced through chemical processes driven by solar radiation.
● We derive the rotational OH*(6-2) airglow temperature from the ratio of the P1(2) and P1(4) molecular rotation lines
● The OH*(6-2) emissions have wavelengths between 830 - 845 nm. Auroral emissions of atomic oxygen (845 nm) contaminate the airglow spectrum ➡ temperatures derived from airglow are only reliable during times of no aurora

Event study: 2021-11-30, Longyearbyen, Svalbard

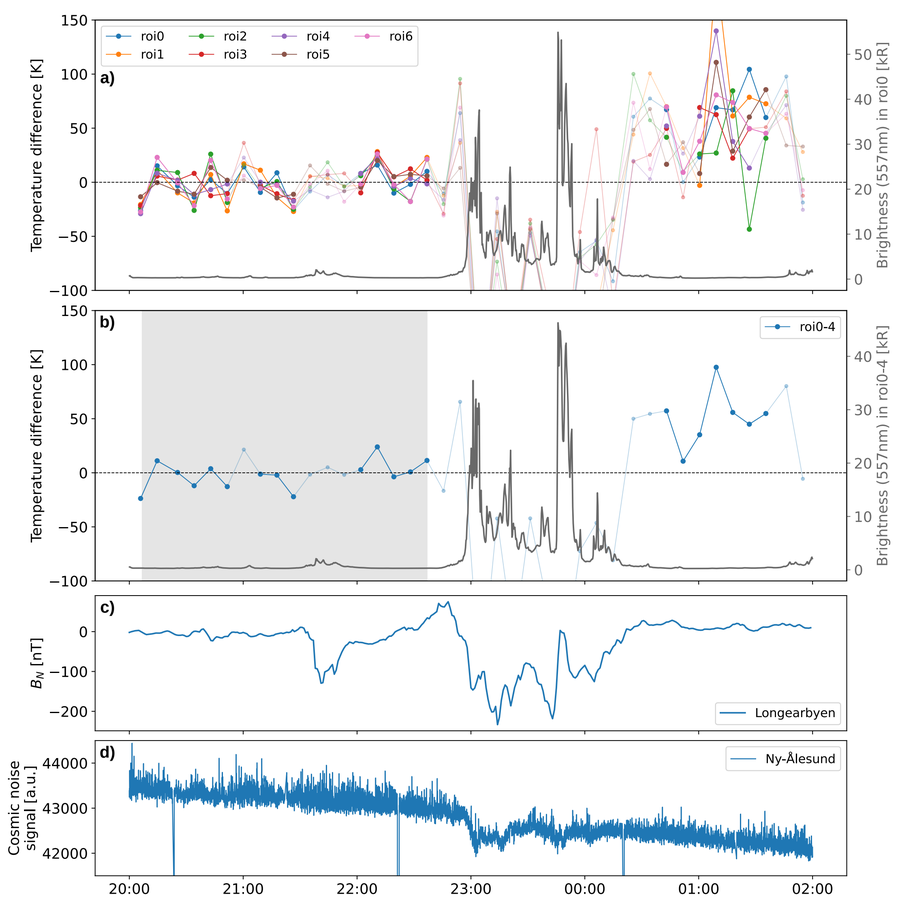


Fig. 1: a) Temperature difference from pre-aurora level in different regions of interest (see fig.2) derived from All-sky airglow imager data. Transparent points mark times of active aurora for each region; b) Same as a) but for regions 0-4 combined; c) North-component of the ground magnetic field measured in Longyearbyen, Svalbard; d) Cosmic noise signal from riometer (40 MHz) in Ny-Ålesund, Svalbard.

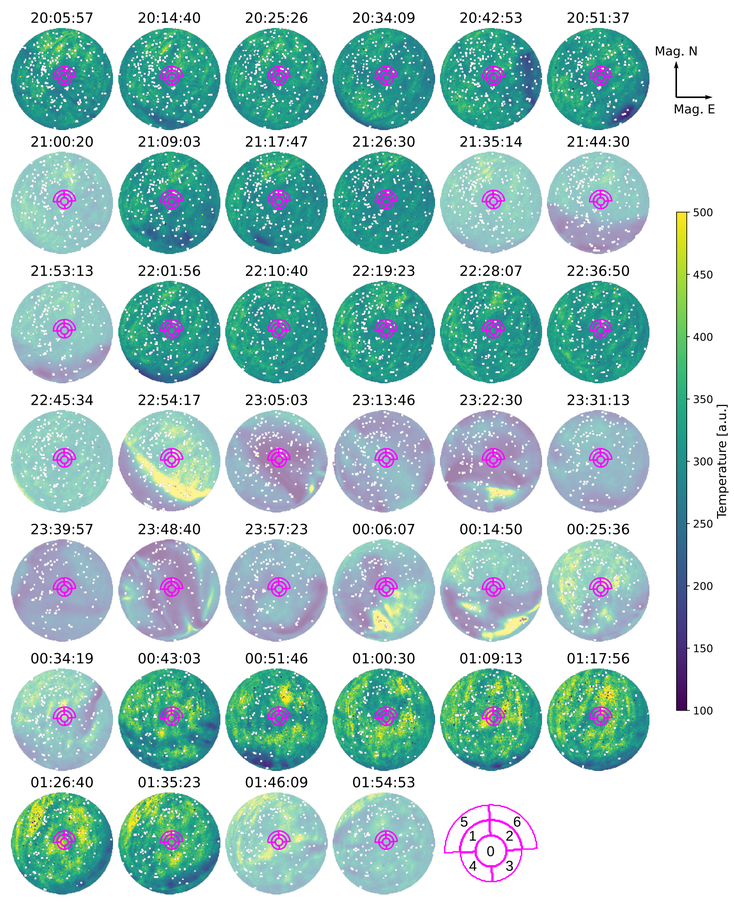


Fig. 2: Temperature maps derived from the All-sky airglow imager at Kjell Henriksen Observatory in Longyearbyen, Svalbard. Magenta lines mark regions of interest. Region labels are displayed in the bottom right panel. Transparent maps mark times of active aurora in the regions of interest 0-4.

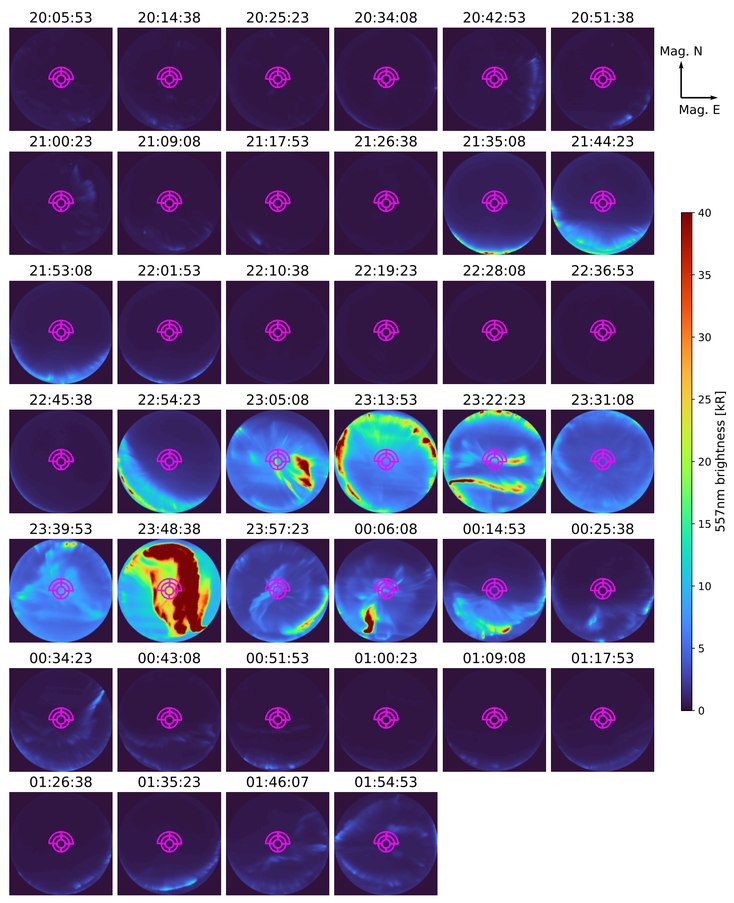


Fig. 3: Brightness of green auroral emissions (557 nm) from the All-sky imager at Kjell Henriksen Observatory in Longyearbyen, Svalbard. Magenta lines mark regions of interest (same as in fig. 2).

Key Observations:

● Increased temperature and temperature variability after auroral activity
● Decrease in cosmic noise signal ➡ particle precipitation into ionosphere D-region (60-90 km) during aurora event
● No solar particle event

Possible Mechanisms

- Gravity waves triggered by geomagn. activity
- Changes in mesospheric chemistry
- Particle heating/Joule heating
- **Other?**

Conclusion

● Enhanced upper mesospheric temperature (~87 km altitude) was observed after a time of prolonged auroral activity in Longyearbyen, Svalbard (75.24°N, geomagn. latitude).
● The effect persisted for at least 45 min following the end of auroral activity within the region of interest, with an average temperature increase of ~50 K compared to pre-auroral conditions.

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