

## Observational evaluation of temperature/wind perturbations associated with small-scale AGWs : Horizontal propagation

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The Tromsø Na lidar, operated by Nagoya University, RIKEN, Shinshu University, and the University of Electro-Communications, has monitored wind and temperature structures associated with auroral activity in the high-latitude upper atmosphere since 2010. Although the observations are limited in the winter night (October to March), the lidar detected atmospheric wave signatures with an oscillation period of several hours and temperature change related to the wave propagation with high precision (less than 1K). Furthermore, this lidar started five-direction observation in October 2012: two elevation angles, 30 and 12.5 degrees of the oblique beams have been employed, which corresponds to horizontal distances of 58 and 22 km, respectively, between a pair of the two beams at the height of 100 km, and the observational setup can detect small-scale perturbations.

In this study, we tried identifying small-scale (less than 100 km) and short-period (less than 1 h) gravity waves using the Tromsø Na lidar. Gravity waves contribute significantly to the wind field and thermal balance in the mesosphere and lower thermosphere (MLT) region because they vertically transport horizontal momentum from the lower atmosphere. It is also pointed out that, in particular, smaller-scale and shorter-period waves tend to transport larger momentum. Small-scale gravity waves in the MLT region are mainly studied with airglow imaging measurements. However, the airglow measurements cannot directly observe temperature and wind perturbations, which are necessary for estimating the wave's momentum flux. Based on temperature and wind perturbations with the five-direction lidar, we quantitatively evaluate the dynamical effect of small-scale gravity waves propagating in the upper atmosphere.

In this presentation, we discussed the horizontal propagation direction of the observed wave signatures based on the phase delays in the five-direction lidar temperatures. For the waves on 20 January 2018, small-scale waves propagated northwestward (55° clockwise from north to east). This estimation was consistent with the result of 49° in the simultaneous 2-dimensional airglow images.

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