Comparison Between Phase Velocity Spectra of Gravity Wave over Syowa and Davis, the Antarctic, using OH Airglow Imagers: Where Are Origins of Gravity Wave with High Phase Speed?

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Gravity waves (GWs) transport their momentum and energy from the lower atmosphere to the upper atmosphere and drive the general circulation, which significantly changes the temperature in the middle atmosphere [Fritts and Alexander, 2003]. Understanding this role quantitatively will improve the modern general circulation models [Alexander et al., 2010; Garcia et al., 2017]. However, spatial and temporal variations of GW characteristics (e.g., phase velocity) are poorly understood. In particular, it is necessary to understand the GWs over the polar night jet region since this region is one of the GW hot spots.
To understand those GWs, our group has observed the GWs over Syowa (69°S, 40°E) using various instruments (e.g., lidar, OH imager, and MF radar). We recently compared the GWs over Syowa and Davis (69°S, 79°E), which have similar terrain and meteorological conditions, to show their horizontal variation over the East Antarctic. We found, from the lidar temperature observations, that vertical profile of GW potential energy is similar between Syowa and Davis, except for a clear enhancement around 30-40 km over Davis [Kogure et al., 2017]. Horizontal propagation characteristics are more clearly observed by airglow imaging measurements of ~90 km altitude. The comparison of four imagers' results between April-May 2013 have indicated that the major propagation directions were westward at three stations (Syowa, McMurdo, Halley), but GWs at Davis seemed to propagate in all the directions, which was different from the other three. [Matsuda et al., 2017]. It seems like secondary GWs contributed to the spectra over Davis.
The goal of this study is to reveal what causes the difference in the mesospheric GW characteristic over Syowa and Davis. In this study, we will show the ground-based horizontal phase velocity spectrum at ~87 km altitude over the two stations derived from OH imagers in more detail. We analyzed the OH airglow imager data obtained for eight months (from March to October in 2016) over the two stations with M-transform [Matsuda et al., 2014]. This included only the data without clouds and aurora contaminations continuously for at least one hour. The numbers of nights with such data sets are 40 nights at Syowa and 55 nights at Davis. We compared the GW spectra in winter mean and their seasonal variations at both stations. The GW energies at both stations were larger in winter (May-August) than the energy in April-May and September. Regarding the comparison between both stations, the GW energy at Davis was larger in winter than that at Syowa, and both energies in April-May was comparable. The lager energy at Davis in winter is consistent with that secondary waves are more frequently generated over Davis than that over Syowa [Matsuda et al., 2017]. On the other hand, the energies in September at Davis was one-third times smaller than that at Syowa due to the earlier seasonal change. This difference was not caused by background wind filtering, but probably due to a lack of sources. We also compared GW events on the same nights. Clear sky and aurora free data were available at both stations on ten nights. Comparison of phase velocity spectrum obtained on the same night events showed very similar characteristics on only one night out of ten. On five nights, the spectra were quite different. On the other four nights, the spectral peaks with slow westward phase velocity (> 50 m/s) were commonly observed, but additional spectral peaks were found over Davis and not over Syowa. We investigated, using raytracing method, where the GWs over Davis with the common spectrum and additional spectrum on one of the four nights (29th Aug.), propagated from. This investigation suggested the common waves propagated from the right below each station. On the other hand, the additional waves propagated from the stratosphere over the sea. This presentation will show the results of OH imager observations and the raytracing results, and we will discuss what causes spatial and temporal variations of the GW characteristics.