Rayleigh/Raman lidar observations of gravity wave activity in the middle atmosphere over Syowa Station (69°S, 40°E), Antarctic.

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1.Background

1. High latitude (~60°S) is a hot spot of gravity wave (GW) activity.
2. Detailed Potential energy of GWs (Ep) profiles are useful, but radiosondes (e.g., Pfenninger et al. [1999]; Yoshiki and Sato [2000]) and Rayleigh lidars (e.g., Yamashita et al. [2009]; Alexander et al. [2011]) have limited height range (Rayleigh lidar: 30-70 km, Radiosonde: ~30 km).
3. We used improved Rayleigh/Raman lidar to estimate Ep profiles between 15 and 70 km at Syowa (69°S, 40°E).

2.Rayleigh/Raman(RR) lidar observation

<table>
<thead>
<tr>
<th>Location</th>
<th>Syowa Station (69°S, 40°E)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laser</td>
<td>Nd:YAG (355 nm, 6W)</td>
</tr>
<tr>
<td>Telescope</td>
<td>Nasmyth-Cassegrain (Diameter:82 cm)</td>
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<tr>
<td>Resolution*</td>
<td>Height : 900 m / Temporal : 1 hour</td>
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<tr>
<td>Height Range</td>
<td>15-70 km (cf., Rayleigh lidar:30-70 km)</td>
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*Original resolution: height resolution 15m / temporal resolution 1 min.

Number of nights of data available

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<tr>
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<td>1</td>
<td>12</td>
<td>1</td>
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<td>4</td>
<td>9</td>
<td>10</td>
<td>13</td>
<td>7</td>
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<td>13</td>
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<td>10</td>
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<tr>
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3.How to calculate potential energy of GWs

Potential energy of GWs (Ep) was estimated with vertical wavelength between 1.8 and 16 km from the temperature.

4.Result & Discussion

4.1 Features of Ep over Syowa

1. Above 30 km, Ep increases with a mean scale height of 11.3 km.
2. Above 30 km, Ep is larger in winter than in spring & fall (e.g., Alexander et al. [2011]).
3. Ep locally maximizes around 20 km and minimizes around 25 km.
4. Ep in Oct. 2012 is smaller and larger than these in the other years at 35-60 km and at 20-35 km, respectively.

Comparison with zonal wind (MERRA)

Comparison of Ep profiles in winter

5. Additional analysis

We also estimated Ep in 2014-15, and the Ep significantly enhanced in Aug. 2014.

Day-to-day variation of Ep at 50 km

The enhancement could be due to the PNJ (polar night jet). cf., other observation showed no enhancement (Ep = 46 J/kg at 50 km). Why? Unbalance was smaller?

5.1 Additional analysis

We also estimated Ep in 2014-15, and the Ep significantly enhanced in Aug. 2014.

Day-to-day variation of Ep at 50 km

6. Summary

1. Potential energy of gravity waves (Ep) over Syowa (69°S, 40°E) was extracted from the temperature observed by the RR lidar.
2. Ep increased with a mean scale height of 11.3 km above 30 km, and significant enhancement (~200%) was found at 20 km.
3. In spring, decent of u <0 m/s altitude modulated Ep profile around 35 km.
4. A scale height of Ep at Syowa between 30 and 40 km was larger than that at Davis (1500 km distance), and vice versa above 40 km.
5. The Ep over Syowa in Aug. 2014 was significantly enhanced, This coincided with approach of strong PNJ to Syowa.

How is the mechanism? 1. emission of GWs form PNJ ? or 2. favored propagation within the positive shear?