Characteristics of mesosphere echoes over Antarctica obtained using PANSY and MF radars

*Masaki Tsutsumi[1,4], Kaoru Sato[2], Toru Sato[3], Takuji Nakamura[1,4], Koji Nishimura[1,4], Yoshihiro Tomikawa[1,4], Masashi Kohma[2]

1.National Institute of Polar Research, 2.1.Department of Earth and Planetary Science, Graduate School of Science, The University of Tokyo, 3.Department of Communications and Computer Engineering Graduate School of Informatics, Kyoto University, 4.The Graduate University for Advanced Studies

In the polar region characteristic radar echoes are observed from the mesosphere by using a VHF system. The nature of the echoes is distinctively different between summer and winter and those echoes are called Polar Mesosphere Summer Echoes (PMSEs) and Polar Mesosphere Winter Echoes (PMWEs), respectively. Since the PMSEs are usually very strong and can be easily measured with a small radar system, their nature is relatively well understood. On the other hand PMWEs are much weaker and they are still only poorly understood.
The PANSY radar (47MHz) at Syowa station (69S) is the only large aperture atmospheric radar in the Antarctic, and can continuously survey the dynamics of the middle atmosphere with high time and height resolutions [Sato et al., 2014]. Nishiyama et al [2014] reported the first study of PMWEs using PANSY radar and showed a seasonal and local time dependence of these echoes.
An MF radar system (2.4MHz) is co-located at Syowa, and has been operating for mesosphere and lower thermosphere observations. Although the MF radar has only a much poorer height resolution and is incapable of vertical wind measurement, it can almost continuously measure mesosphere day and night.
In this study the nature of the mesosphere echoes, mainly PMWEs, are being studied using the two radars based on the observation made in 2015. These radars are operated using largely different radio frequencies and can provide complementary information with each other such as wind velocities and also echo scattering mechanisms.
Horizontal wind velocities have been compared between the two radars with a great care mostly in the MF radar winds in order to avoid possible biases inherent in the correlation analysis technique employed for the MF radar wind measurement. A careful analysis has shown that the horizontal wind velocities agree well between the two systems with a high correlation coefficient around 0.8 throughout the height region of 65-85km.
Aspect sensitivities estimated using the MF radar data indicate that the winter time MF echoes in the lower mesosphere are more isotropic in winter than in summer, suggesting that the winter echoes are scattered by isotropic turbulences. A candidate that generates such isotropic structures is thought to be gravity waves, whose activity in the Antarctic mesosphere is maximized in winter [Dowdy et al., 2007; Yasui et al., 2016]. The height region of the low aspect sensitivity mostly corresponds to that of PMWEs, and this further suggests a possible connection between PMWEs and gravity wave activity. Aspect sensitivities based on the PANSY data are also to be analyzed and presented.

Keywords: Antarctic, PMWEs, MST radar, atmospheric gravity waves

