Time and height variability of Fe-layer in the Mesosphere and the Lower Thermosphere region at Syowa Station, Antarctica (69.0˚S, 39.6˚E) based on a resonance scattering lidar measurements in two winter seasons

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The National Institute of Polar Research (NIPR) is leading a prioritized project of the Antarctic research observations. One of the sub-projects is entitled the global environmental change revealed through the Antarctic middle and upper atmosphere. Profiling dynamical parameters such as temperature and wind, as well as minor constituents is the key component of observations in this project, together with a long-term observation using existent various instruments at Syowa, Antarctica (69.0˚S, 39.6˚E). As a part of the sub-project, we developed a new resonance lidar system with multiple wavelengths. The lidar transmitter is based on injection-seeded, pulsed alexandrite laser for 768-788 nm (fundamental wavelengths) and a second- harmonic generation (SHG) unit for 384-394 nm (second harmonic wavelengths). The laser wavelengths can be tuned into the resonance wavelengths by a wavemeter that is calibrated and validated using a wavelength- stabilized He-Ne laser and a potassium vapor cell for doppler-free spectroscopy.

This lidar has capabilities to measure density variations of minor constituents such as atomic iron (Fe, 386 nm), atomic potassium (K, 770 nm), calcium ion (Ca^+, 393 nm), and nitrogen molecular ion (N_2^+, 390, 391 nm) and temperature profiles in the mesosphere and lower thermosphere (MLT) region. It can also estimate temperature profiles from the upper Stratosphere to the lower mesosphere using signals of Rayleigh scattering. The lidar system installed at the Syowa Station by the 58th Japan Antarctic Research Expedition (JARE 58) in January 2017, and then its observation has been continued by October 2018.

In this presentation, we are going to report initial results focusing on Fe atom and temperature variability in MLT region. In the two seasons, Fe measurements have been carried out for a total of 59 nights (653 hours). Preliminary analysis demonstrated that the seasonal variability of Fe atom abundance from February to October, which has a peak and a secondary peak at May and September respectively, is well agreed to those in preceding studies. In addition to seasonal variations, Fe atom response to energetic particles forcing due to magnetic storms and substorms will be analyzed in detail and discussed. Since Syowa station is located under aurora oval in the southern hemisphere, chemical reactions and electromagnetic dynamics are important for understanding of short-term variations on Fe density as well as wave forcing driven by atmospheric gravity waves.

Keywords: Mesosphere and Lower Themosphere, Metallic atom layer, Energetic particle forcing , Resonance scattering lidar

