Unmanned atmospheric observation on the Antarctic continent: Development of automatic aerosol sampling system

K. Hara[1], N. Hirasawa[2], Y. Iizuka[3], H. Motoyama[2], M. Hayashi[1], M. Kobayashi[4]
[1]*Fukuoka Univ.,* [2]*NIPR,* [3] *Hokkaido Univ. ILTS, and* [4] *Polar observation system lab., CSE Inc.*

Atmospheric aerosol measurements have been carried out mostly at coastal stations in the Antarctic region, although measurements of atmospheric substances have been made even in inland area (South pole, Dome F, Dome C, and Kohnen Stations). For the better understanding of atmospheric cycles of minor substances in the Antarctic regions and their impact/relations, we need to make atmospheric measurements in the inland area of the Antarctica. However, scientific operation, particularlly wintering manned operation, in the inland area is realized by many logistic works such as construction, maintenance, and transport of fuels, building materials, and scientific instruments. Considering limitation of these logistics works and transports to inland areas under current condition, we need longer time to prepare logistic plan and the wintering manned operation in the inland station. Therefore, we consider altanative choice as “wintering unmanned operation” for atmospheric measurements. If automatic system is used for overwintering operation in the inland areas, we need smller scale of logistics works. This study aims to develop automatic aerosol sampling system (automatic aerosol sampler and enrgy-source) which can be operated in polar regions.

At first, we must consider specification and requirement of aerosol sampling on the Antarctic continent, because air pump and electric valves use the largest electricity. Minimum air sampling volume (ca. 20 m^3) is estimated for non-size segregated aerosol samplng from comparison with previous aerosol measurements at coastal and inlnd stations in the Antarctica (e.g., Hara et al., 2004; Weller and Wagenbach, 2007). Supposing weekly aerosol sampling, the required flow rate and power consumption of air pump and electric valves are a few – several L/min and 80-160 VA. These values are commensurate with the realistic size of automatic sampling system, although flow meter and computer neeed slightly additional power consumption.

Electricity is required for measurements and direct sampling of atmospheric aerosols. Because subject of this study is aerosols (i.e. atmospheric substances), electricity must be supplied from clean energy source. In contrast to auto weater station which whas been operated in the Antartic regions, larger electiricity is required for aerosol measurements and sampling because of operation of air pump. Weller and Wagenbach (2007) used automatic aerosol sampling system with solar panel, wind power-generator, and battery at Kohnen Station, Antarctica. Passive energy sources such as wind and solar powers, however, depends strongly on meterorological conditions. It is true that solar pannel is one of useful clean energy sources, but strong seasonal variation of solar radiation in higher latitudes, particularlly polar night, prevents stable power output from solar pannel. To operate air pump for aerosol sampling at larger flow rate, we must choose other clean energy source. Thus, we attempt to apply hybrid-power-generator system of alcohol fuel cell, wind power-generator, and battery in this study. This study composes (1) development of protptype of the hybrid-power-generator system and automaed-aerosol sampler, and (2) laboratory experiments, and (3) domestic field experiments.

References

Hara, K., Osada, K., Kido, M., Hayashi, M., Matsunaga, K., Iwasaka, Y., Yamanouchi, T., Hashida, G. and Fukatsu, T.: Chemistry of sea-salt particles and inorganic halogen species in Antarctic regions: Compositional differences between coastal and inland stations, Journal of Geophysical Research, 109(D20), doi:10.1029/2004JD004713, 2004.

Weller, R. and Wagenbach, D.: Year-round chemical aerosol records in continental Antarctica obtained by automatic samplings, Tellus, 59, 755–765, doi:10.1111/j.1600-0889.2007.00293.x, 2007.