Continuous observation of atmospheric oxygen concentration onboard a cargo ship sailing between Japan and North America

Yu Hoshina1, Yasunori Tohjima1*, Kei-ichi Katsumata2, Toshinobu Machida2, and Shin-ichiro Nakaoka2

1 Center for Environmental Measurement and Analysis, National Institute for Environmental Studies, Tsukuba, 305-8506, Japan (tohjima@nies.go.jp)
2 Center for Global Environmental Research, National Institute for Environmental Studies, Tsukuba, 305-5806 Japan

In-situ observation of atmospheric oxygen (O2) and carbon dioxide (CO2) mixing ratios have been conducted in the North Pacific by using a cargo ship, New Century 2 (NC2), sailing between Japan and United State since December 2015. A fuel-cell type analyzer (Oxzilla-II) and a non-dispersive infrared analyzer (LI-840) are used for the measurements of the O2 and CO2, respectively. To detect their variations in the atmosphere, the flow rates of the air samples introduced into the analyzers and the outlet pressure are precisely controlled. We adopted the relatively low flow rates of the air samples of 10 cm³ min⁻¹, which sacrifice the precision and time resolution, mainly to reduce the consumption rate of the reference gases stored in high-pressure cylinders. The final precisions of the O2 and CO2 measurements when the system is set in the laboratory is 1 ppm for O2 (4 per meg for O2/N2 ratio) and 0.1 ppm for CO2. After the in-situ observation started onboard NC2, we found that the ship movement caused false wavy variations of O2 signal with the amplitude of more than several tens ppm and the period of about 20 seconds. Although we have not solved the problem at this stage, hourly averaging considerably suppressed the errors associated with the ship movement; comparison between the in-situ observation and flask sampling of air samples onboard NC2 shows that the averaged differences are −2.1±9.2 per meg and −0.02±0.33 ppm, respectively. The one-year data clearly show seasonal variations in the extensive North Pacific region.