

スバルバル諸島ニーオルスンにおける大気中酸素濃度連続観測 Continuous measurements of the atmospheric O₂/N₂ ratio at Ny-Ålesund, Svalbard

後藤 大輔^{1*}; 森本 真司²; 青木 周司²; 中澤 高清²; 村山 昌平³
GOTO, Daisuke^{1*}; MORIMOTO, Shinji²; AOKI, Shuji²; NAKAZAWA, Takakiyo²; MURAYAMA, Shohei³

¹ 国立極地研究所, ² 東北大学大学院理学研究科, ³ 産業技術総合研究所

¹National Institute of Polar Research, ²Graduate School of Science, Tohoku University, ³National Institute of Advanced Industrial Science and Technology

Simultaneous observations of atmospheric O₂ (defined as O₂/N₂ ratio) and CO₂ concentrations provide valuable information about the global carbon cycle. For a better understanding of the global carbon cycle, several laboratories have developed precise measurement systems for the O₂/N₂ ratio and carried out systematic observations since the early 1990s. To elucidate the variations of the atmospheric O₂/N₂ ratio in detail and to contribute to a better understanding of the role of Arctic region on the regional and global carbon cycle, we developed a continuous measurement system using a differential fuel-cell O₂ analyzer, and then initiated systematic observation at Ny-Ålesund, Svalbard in November 2012, which is the first continuous observation in the Arctic region. The system is equipped with NDIR analyzer to measure CO₂ concentration simultaneously. The analytical precisions of O₂/N₂ ratio and CO₂ are estimated to be ±1.4 per meg and ±0.03 ppmv, respectively. Here, we will present observational results of the first year.

The O₂/N₂ ratio observed at Ny-Ålesund shows a clear seasonal cycle with peak-to-peak amplitude of about 120 per meg, which reaches a minimum in late March to early April and a maximum in August. On the other hand, the CO₂ concentration varies seasonally in opposite phase with the O₂/N₂ ratio, showing the amplitude of 16 ppm. Short-term variations on time scales of several hours to several days are also clearly seen. In winter, it is often observed that the O₂/N₂ ratio sharply declines in a short time, accompanied by an increase in the CO₂ concentration, and the low values last for several hours or days. The O₂:CO₂ exchange ratio defined as the slope of a linear regression line between the measured values of O₂/N₂ ratio and CO₂ range between -1.6 and -1.5 ppm/ppm, which are close to the average O₂:CO₂ exchange ratio expected from fossil fuel burning in Europe. The results of backward trajectory analysis indicated that the air masses arrived at Ny-Ålesund during the periods when such short-term variations were observed passed near or over Scandinavian Peninsula. Therefore, such a decline in the O₂/N₂ ratio is ascribed to transport of urban air influenced by human activities in Europe. In spring to summer, irregular fluctuations of O₂/N₂ ratio are often observed. The amplitude of such fluctuations reaches 50-60 per meg (corresponding to about 10-13 ppm). Similar fluctuations of CO₂ are also found in opposite phase with O₂/N₂ ratio. However, their amplitudes are 5 ppmv at most. The comparison of backward trajectories of air parcels with the distributions of marine biotic net primary production suggests that such fluctuations of O₂/N₂ ratio are closely related to O₂ emission due to marine biological activity near Norwegian Sea.

キーワード: 大気中酸素濃度, 炭素循環, O₂:CO₂ 交換比, 大気-海洋間 O₂ フラックス
Keywords: atmospheric O₂, carbon cycle, O₂:CO₂ exchange ratio, air-sea O₂ flux