

## Air–Sea CH<sub>4</sub> Flux in the Gas Plumes site from Eastern Margin of Japan Sea

\*青木 伸輔<sup>1</sup>、小宮 秀治郎<sup>2</sup>、登尾 浩助<sup>3</sup>、松本 良<sup>4</sup>

\*Shinsuke Aoki<sup>1</sup>, Shujiro Komiya<sup>2</sup>, Kosuke Noborio<sup>3</sup>, Ryo Matsumoto<sup>4</sup>

1. 明治大学大学院農学研究科、2. マックスプランク研究所、3. 明治大学農学部、4. 明治大学ガスハイドレート研究所

1. Graduate School of Agriculture, Meiji University, 2. Max Planck Institute for Biogeochemistry, 3. School of Agriculture, Meiji University, 4. Gas Hydrate Laboratory, Meiji University

Gas seeps have been observed at specific sites on continental slopes and gas hydrate stability fields. Gas seepage was also identified by the fishery echo sounder and multi-beam echo sounder as gas plume in echograms; gas plume represents their location where bubbles are released from the seafloor and rose throughout the water column. If seeped gas from the seafloor was emitted within the gas hydrate stability zone, the gas would react with seawater to form protective hydrate shells that enclose the bubble. This shield results in a decrease in a bubble dissolution rate to sea water, meaning an increase in the lifetime of bubbles as they rise through the water column. Therefore, the gas seeps from the seafloor may contribute to increases in atmospheric gas concentration in some cases. Our objectives were to investigate relationships between gas plume and atmospheric CH<sub>4</sub> concentration over the sea surface above gas hydrate / gas plume fields. We conducted continuous measurement of CH<sub>4</sub> concentration with meteorological information including wind speed and wind direction. We used the R/V Kaiyo-Maru No.1 and R/V Kaiyo-Maru No.7 (Kaiyo Engineering Co., Ltd., Japan) in 2014 and 2017, respectively. Concentration of atmospheric CH<sub>4</sub> was measured on the ship using a wave-length-scanned cavity ring-down spectrometer (WS-CRDS) (model G2201-I, Picarro Inc., USA). Air sample was collected from an air inlet deployed at the upper deck of the ship using an air pump placed in bridge. A conductivity-temperature-depth (CTD) was used for hydrographic measurements. Ship's location data were obtained with a nautical GPS. We detected increases in atmospheric CH<sub>4</sub> concentration close above gas plumes in 2014 and 2017. As CH<sub>4</sub> concentration anomalies were observed, the set-air gas flux tended to be large despite either emission or absorption by ocean. Our results suggest that the gas plume could contribute to increases in atmospheric CH<sub>4</sub> concentration, but further research is necessary to elucidate its mechanism. This study was conducted under the commission from AIST as a part of the methane hydrate research project funded by METI (the Ministry of Economy, Trade and Industry, Japan). We appreciate the support of the crew onboard R/V No.1 Kaiyo-maru and the crew onboard R/V No.7 Kaiyo-maru.

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