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Shipboard measurements of atmospheric CH4, CO2 and CO mixing ratios during the MR12-E03 cruise of the R/V Mirai

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In order to investigate the potential sources of methane (CH_4) in the Arctic region, continuous measurements of the atmospheric CH_4 were carried out during a R/V Mirai Arctic Ocean cruise from September 3 to October 17, 2012. A cavity ring-down spectroscopy (CRDS) analyzer was used for the shipboard measurements of the atmospheric CH_4, carbon dioxide (CO_2) and carbon monoxide (CO). The analytical precisions evaluated from the measurements of the standard gases at a 24-hour interval during the cruise were 0.02 ppm, 0.3 ppb, and 0.9 ppb for the 5-min averages of CO_2, CH_4, and CO mixing ratios, respectively. When the wind blew from the relative direction of 200 +/- 20 degrees (rear left of the vessel), the contamination caused by its own exhaust fumes affected the CO_2 and CO mixing ratios with a tight correlation (Delta_CO/Delta_CO_2=3.8 ppb/ppm), while there was no significant influence from the exhaust fumes on the CH_4 mixing ratio. Such pollution events are easily distinguishable by the characteristics of the relative wind direction, the tight correlation of CO vs. CO_2, and large short-term (˜a few second) variability. The observed CH_4 mixing ratios showed larger variations with elevated peaks of several tens ppb in the Bering Strait, Chukchi Sea, and Arctic Ocean (65-75^{o}N, 155-175^{o}W) in comparison with in the western North Pacific. The largest CH_4 peaks of about 50 ppb were observed off the northern Alaskan cost. Since these CH_4 peaks were associated with similar CO_2 peaks but not with CO peaks, it is unlikely that the combustion processes or ocean were the sources of the elevated CH_4. The backward trajectory analysis suggests that the North Slope of Alaska is the most probable CH_4 source region. The simulated CH_4 variations based on an atmospheric transport model and given flux maps well capture the observed CH_4 variations, also suggesting that the most of elevated CH_4 were derived from the land sources.

Keywords: atmospheric CH4, the Arctic Ocean, cavity ring down spectroscopy analyzer (CRDS), shipboard measurements