Onboard observations of atmospheric CO_2 and CH_4 during Arctic cuises in 2012-2015

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We present distribution of the atmospheric CO_2 and CH_4 mixing ratios observed on board a R/V Mirai during 4 Arctic cruises: MR12-E03 (Sep. 3-Oct. 17, 2012), MR13-06 (Aug. 28-Oct. 17, 2013), MR14-05 (Aug. 31-Oct.10, 2014), MR15-03(Aug. 23-Oct. 5, 2015). The on-board measurements of the atmospheric CH_4, carbon dioxide (CO_2) and carbon monoxide (CO) were carried out by using a cavity ring-down spectroscopy (CRDS) analyser (Picarro, G2401). The estimated analytical precisions were evaluated to be about 0.02 ppm (CO_2), 0.3 ppb (CH_4), and 1 ppb (CO) for the 5-min averages. The observed results generally show not only latitudinal gradients between mid- and high-latitudes but also shot-term variations. Especially, CH_4 often show relatively elevated mixing ratios of several tens ppb in the Bering Strait, Chukchi Sea, and off the northern Alaskan coast. Since these elevated CH_4 peaks were generally associated with similar CO_2 peaks but not with CO peaks, it's unlikely that the ocean or combustion processes were the sources of the elevated CH_4. Backward trajectories of air masses along the cruise tracks are computed to examine the origins of the transported air masses. These trajectory analyses indicate that the elevated CH_4 are associated with the air mass transport from Alaska or East Siberia, especially North Slope of Alaska. CH_4 variations simulated by an atmospheric transport model and reported CH_4 flux maps fairly well capture the observed CH_4 variations, suggesting that the most of elevated CH_4 were derived from the land sources. However, there are significant differences in the amplitudes of the elevations between the simulations and observations, suggesting that the observed CH_4 spatiotemporal variations could be used to improve the CH_4 emissions from the Arctic regions.