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Direct methane and its stable isotope δ13C4 measurements over the Russian Arctic seas during ship campaigns in 2015-2018 and study of their sources and variability

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Methane (CH4) is an intriguing component of atmospheric air composition over the Arctic owing to its role as a possible climate feedback. Here we present the results of measurements of atmospheric methane concentration and its stable isotope ratio (δ13CCH4) in the Arctic seas of Russia during the cruises performed by scientist research vessels "Akademik Mstislav Keldysh" and "Akademik M.A. Lavrentiev" in 2015, 2016 and 2018. Most of data was obtained in September and October. Measurements of CH4 and δ13CCH4 as well as of CO_2 were made using a Cavity Ring Down Spectroscopy instrument from Picarro^{TM} (model G2132-i). The CH4 data were compared to available stationary observations in the Arctic region. Other trace gases (O_3, NO, NO_2, CO) were measured in parallel in 2016 and 2018. Orbital Infrared Atmospheric Sounding Interferometer (IASI) and Atmospheric InfraRed Sounder (AIRS) data for 2015-2018 are presented for comparison with direct in situ measurements.
Measurements revealed considerable variations of both CH4 and δ13CCH4 over the Arctic seas, which can be attributed to different sources. Model simulations and Keeling plot analyses showed that significant CH4 enhancement (up to 7% over the background level) in the Kara Sea was caused primarily by transport of wetland methane from the continent. The contribution from fossil fuel sources, especially near Yamal peninsula, was also high. High (up to 3,7 ppb) and short-lived peaks of CH4 in surface air were registered above the East Siberian Arctic Shelf (ESAS) on the almost uniform background and were uncorrelated with other trace gases. These peaks may be evidence of methane release to the atmosphere from marine seeps. Satellite data also confirm emissions from the ocean surface, mostly along shores in November. Nevertheless, further campaigns in combination with modeling and satellite data analyses are needed to estimate an importance of this source.