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Application of a methane carbon isotope analyzer for the investigation of δ^{13}C of methane emission measured by the automatic chamber method in an Arctic Tundra

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Methane emissions have been monitored by an automatic chamber method in Zackenberg valley, NE Greenland, since 2006 as a part of Greenland Ecosystem Monitoring (GEM) program. During most of the seasons the measurements were carried out from the time of snow melt (June-July) until freezing of the active layer (October-November). Several years of data, obtained by the same method, instrumentation and at exactly the same site, provided a unique opportunity for the analysis of interannual methane flux patterns and factors affecting their temporal variability.

The start of the growing season emissions was found to be closely related to a date of snow melt at the site. Despite a large between year variability of this date (sometimes more than a month), methane emission started within a few days after, and was increasing for the next about 30 days. After this peak of emission, it slowly decreased and stayed more or less constant or slightly decreasing during the rest of the growing season (Mastepanov et al., Biogeosciences, 2013). During the soil freezing, a second peak of methane emission was found (Mastepanov et al., Nature, 2008); its amplitude varied a lot between the years, from almost undetectable to comparable with total growing season emissions.

Analysis of the multiyear emission patterns (Mastepanov et al., Biogeosciences, 2013) led to hypotheses of different sources for the spring, summer and autumn methane emissions, and multiyear cycles of accumulation and release of these components to the atmosphere.

For the further investigation of this it was decided to complement the monitoring system with a methane carbon isotope analyzer (Los Gatos Research, USA). The instrument was installed during 2013 field season and was successfully operating until the end of the measurement campaign (27 October). Detecting both ^{12}C-CH_4 and ^{13}C-CH_4 concentrations in real time (0.5 Hz) during automatic chamber closure (15 min), the instrument was providing data for determination of δ^{13}C of the emitting methane (by a relation between ^{12}C-CH_4 and ^{13}C-CH_4 fluxes).

Unfortunately, the beginning of the season was missed due to a delay in the instrument shipment; the summer fluxes were lower than any of the 7 previous years due to an exceptional drought; the autumn burst was not detected due to both exceptionally slow soil freezing and a low soil methane content. However, the data obtained from the most productive chambers confirm the feasibility of the chosen method and give good expectations for the following field campaign 2014.