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Continuous methane measurement using 9-tower network over Siberia

Motoki Sasakawa^{1*}, Kou Shimoyama², Toshinobu Machida¹, Noritsugu Tsuda³, Hiroshi Suto⁴, Mikhail Arshinov⁵, Denis Davidov⁵, Alexander Fofonov⁵, Oleg Krasnov⁵, Tazu Saeki¹, Yuji Koyama¹, Shamil Maksyutov¹

¹NIES, ²Hokkaido University, ³Global Environmental Forum, ⁴Japan Aerospace Exploration Agency,

⁵Institute of Atmospheric Optics of SB

Continuous measurements of CH₄ mixing ratio have been carried out with a tower network in Siberia in order to study the spatial and temporal variations of CH₄ in the forest, steppe, and wetland regions and estimate the distribution of the flux over this huge area where only few atmospheric investigations were made. The network consists of 9 towers located at Berezhovka (BRZ; 56°09'N, 84°20'E) since 2002, at Karasev (KRS; 58°15'N, 82°25'E) and Igrim (IGR; 63°11'N, 64°25'E) since 2004, at Demyanskoe (DEM; 59°47'N, 70°52'E), Noyabrsk (NOY; 63°26'N, 75°47'E) and Yakutsk (YAK; 62°50'N, 129°21'E) since 2005, at Savvushka (SVV; 51°20'N, 82°08'E) since 2006, at Azovo (AZV; 54°42'N, 73°02'E) since 2007, and at Vaganovo (VGN; 54°30'N, 62°19'E) since 2008. Air samples taken at two heights (5-85 m) on each tower are analyzed with a SnO₂ semiconductor sensor after passing through a line with a glass water trap, a Nafion membrane drier and a magnesium perchlorate.

Clear diurnal CH₄ variations were observed particularly during summer (from June to August) due to height change of mixed layer. Daytime CH₄ concentrations (13:00-17:00GLT) exhibited rise in summer and winter at almost all sites and higher concentrations and bigger deviations at the northern sites surrounded by extensive wetland regions. Daytime CH₄ mean of over 2000 ppb was observed at some tower sites at the same periods of several days in winter, which was associated with weather condition. High atmospheric pressure making low boundary layer caused the CH₄ accumulation in sub-continental scale during winter. The number of high daytime mean (> 2000 ppb) was the most in the summer of 2007 when temperature and precipitation rate were the highest in the five years (2004-2008) over West Siberia, which suggests that high CH₄ events observed in 2007 were mainly attributed to the emission from wetlands. However, influence of biomass burning also should be considered since many hot spots were detected over West Siberia by MODIS on satellites in the summer of 2007. Daytime mean CH₄ concentrations over Siberia generally displayed higher than CH₄ values reported from flask sampling at NOAA coastal sites located in the same latitude. Our coupled Eulerian-Lagrangian transport model reproduced this difference and seasonal variation with double maxima. In summer, it also reproduced day-to-day variations and clarified that CH₄ emitted from wetlands predominantly contributed to CH₄ variation. Source category calculations revealed that the major contributor to day-to-day variation changed from wetlands during summer to fossil fuel during winter.

Extremely high CH₄ plume of several ppm orders in several hours were sometimes observed from specific directions at towers of NOY and DEM where natural gas pipelines exist in several km. These results suggest that the tower network detected CH₄ leakage from the pipelines.

Reference

Sasakawa, M., K. Shimoyama, T. Machida, N. Tsuda, H. Suto, M. Arshinov, D. Davidov, A. Fofonov, O. Krasnov, T. Saeki, Y. Koyama, and S. Maksyutov (2010) Continuous Measurement of Methane Concentration using 9-tower Network over Siberia, submitted to Tellus B.

Keywords: methane, tower observation, Siberia, taiga, wetland, biomass burning