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Constraints on oceanic methane emissions west of Svalbard from atmospheric in situ measurements and Lagrangian transport modeling

Ignacio Pisso (1), Cathrine Lund Myhre (1), Stephen Matthew Platt (1), Sabine Eckhardt (1), Ove Hermansen (1), Norbert Schmidbauer (1), Jurgen Mienert (2), Sunil Vadakkepuliyambatta (2), Stephane Bauguitte (3), Joseph Pitt (4), Grant Allen (4), Keith Bower (4), Sebastian O'Shea (4), Martin Gallagher (4,5), Carl Percival (4), John Pyle (5,6), Michelle Cain (5,6), and Andreas Stohl (1)

(1) NILU - Norwegian Institute for Air Research, Instituttveien 18, 2027 Kjeller, Norway, (2) CAGE - Centre for Arctic Gas Hydrate, Environment and Climate, Department of Geology, UiT-The Arctic University of Norway, Dramsveien 201, 9010 Tromsø, Norway , (3) FAAM, Natural Environment Research Council, Building 146, Cranfield, MK43 0AL, UK, (4) School of Earth, Atmospheric and Environmental Sciences, University of Manchester, Manchester, M13 9PL, UK , (5) National Centre for Atmospheric Science (NCAS), UK, (6) Department of Chemistry, University of Cambridge, Lensfield Road, Cambridge CB2 1EW, UK

Methane stored in seabed reservoirs such as methane hydrates can reach the atmosphere in the form of bubbles or dissolved in water. Hydrates could destabilize with rising temperature further increasing greenhouse gas emissions in a warming climate. To assess the impact of oceanic emissions from the area west of Svalbard, where methane hydrates are abundant, we used measurements collected with a research aircraft (FAAM) and a ship (Helmer Hansen) during the Summer 2014, and for Zeppelin Observatory for the full year. We present a model-supported analysis of the atmospheric CH4 mixing ratios measured by the different platforms. To address uncertainty about where CH4 emissions actually occur, we explored three scenarios: areas with known seeps, a hydrate stability model and an ocean depth criterion. We then used a budget analysis and a Lagrangian particle dispersion model to compare measurements taken upwind and downwind of the potential CH4 emission areas. We found small differences between the CH4 mixing ratios measured upwind and downwind of the potential emission areas during the campaign. By taking into account measurement and sampling uncertainties and by determining the sensitivity of the measured mixing ratios to potential oceanic emissions, we provide upper limits for the CH4 fluxes. The CH4 flux during the campaign was small, with an upper limit of 2.5 nmol / m s in the stability model scenario. The Zeppelin Observatory data for 2014 suggests CH4 fluxes from the Svalbard continental platform below 0.2 Tg/yr . All estimates are in the lower range of values previously reported.