Methane emissions from the Arctic Ocean to the atmosphere (MOCA)

S. M. Platt[1], C. L. Myhre[1], B. Ferré[2], A. Silyakova[2], O. Hermansen[1], G. Allan[3], A. Stohl[1], I. Pisso[1], N. Schmidbauer[1], C. Percival[3], J. Pyle[4], J. Mienert[2]

1Department of Atmosphere and Climate, Norwegian Institute for Air Research, 2007 Kjeller, Norway

2CAGE – Centre for Arctic Gas Hydrate, Environment and Climate, Department of Geology, UiT the Arctic University of Norway, Dramsveien 201, 9037 Tromsø, Norway

4University of Cambridge, Department of Chemistry, Lensfield Road, CB2 1EW Cambridge, UK

The release of methane (CH_4) due to global warming from hydrate deposits under the seafloor is a potential climate tipping point and a major uncertainty in the global methane budget [IPCC 2013]. There may be up to 1200 Gt of CH_4 stored in hydrates under the rapidly warming Arctic Ocean [Biastoch et al 2011] and whether warming is leading to CH_4 release to the atmosphere in the region is unknown. To address this issue the Methane Emissions from Arctic Ocean to Atmosphere (MOCA) project was established: state-of-the-art oceanographic and atmospheric measurement techniques were applied over a large area of the Arctic including northern Norway, the Barents Sea, and areas of shallow water around Svalbard.

Figure 1: Measurement platforms. Left: the RV Helmer Hanssen, CH_4/ CO_2/ CO measurement (Picarro G4201), offline analysis of ^{13}C isotope and light hydrocarbons e-g- ethane/ propane, water column measurements of CH_4 and other variables. Middle: the Zeppelin Mountain Observatory (474 m), long term measurement of CH_4 and other trace gases. Right: Facility of airborne measurements (FAAM) flights, CH_4 measurements down to as low as ~15 m.

Conclusions

- We used a comprehensive array of measurement platforms to conduct one of the most extensive surveys of CH_4 release from ocean to atmosphere ever performed
- This unique array can be used to quantify, constrain and identify regional and local sources of CH_4
- CH_4 from ocean to atmosphere was not large during the time period of the campaign

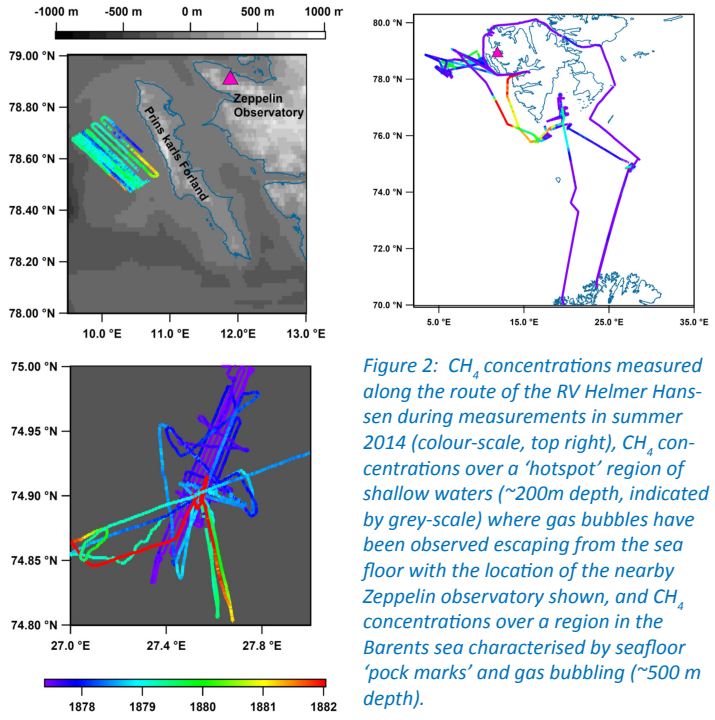

Figure 2: CH_4 concentrations measured along the route of the RV Helmer Hanssen during measurements in summer 2014 (colour-scale, top right), CH_4 concentrations over a 'hotspot' region of shallow waters (~200m depth, indicated by grey-scale) where gas bubbles have been observed escaping from the sea floor with the location of the nearby Zeppelin observatory shown, and CH_4 concentrations over a region in the Barents sea characterised by seafloor 'pock marks' and gas bubbling (~500 m depth).

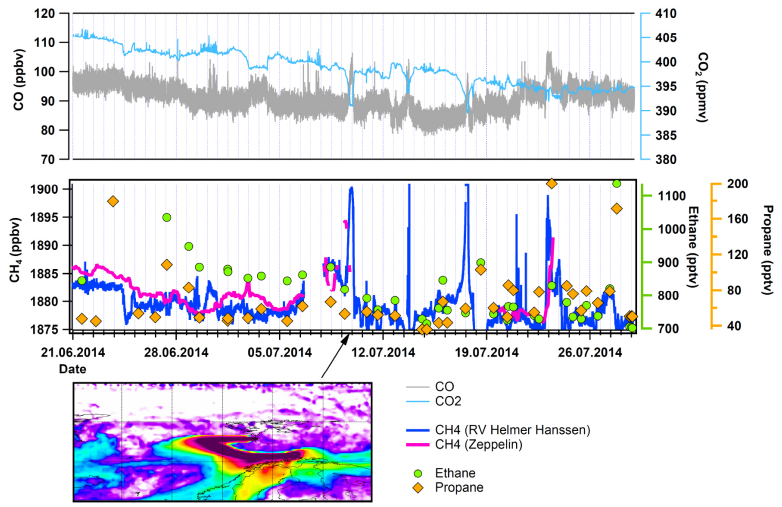

Figure 3: CO/ CO_2 concentrations measured aboard RV Helmer Hansen during the summer 2014 campaign (top), CH_4/ ethane/ propane measured aboard Helmer Hansen and CH_4 measured at the Zeppelin observatory during periods where the Helmer Hanssen was nearby. Information on all species can be combined together with FLEXPART sensitivity footrprints (e.g. bottom, darker=higher sensitivity) to provide an understanding of variations in CH4 during the campaign. For example for the period indicated by the arrow, FLEXPART indicates the air mass is likely influenced by Scandinavian/ Siberian wetlands, further evidenced by high CH_4 concentrations and low CO_2 and no increase in propane or ethane (typical anthropogenic pollutants). Large CH_4 spikes were not observed over hotpots, suggesting only small influences of oceanic methane release on atmospheric methane.

References

IPCC, 2013: Summary for Policymakers. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Biastoch, A. et al. Rising Arctic Ocean temperatures cause gas hydrate destabilization and ocean acidification. *Geophys. Res. Lett.* **38**, L08602, doi:10.1029/2011gl047222 (2011).

Acknowledgements

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