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Airborne in-situ observations of natural methane emissions in Scandinavia during MAGIC 2021

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Wetlands in the high northern latitudes are a major, yet poorly known contributor to the global methane (CH_4) budget. In wetlands, peat bogs and lakes, CH_4 is produced by organic degradation processes. These natural emissions are affected by climate change though, e.g. by changing temperatures and permafrost thaw. A better understanding is essential also for discussing the human role in the budget of this important greenhouse gas and mitigation options.

However, the data coverage in the region is still thin: accessibility is limited, satellite sensors struggle with the high solar zenith angle, difficult surface and thermodynamic conditions, or clouds. Corresponding emission inventories and models differ significantly, in the distribution as well as in the amount of emissions. Based in Kiruna/Sweden, the French MAGIC initiative addressed these knowledge gaps by bringing together a multitude of instruments on three research aircraft (Safire ATR-42, BAS Twin Otter, DLR Cessna) and various other platforms for measurements in northern Scandinavia in August 2021.

Here we focus on airborne in-situ measurements with the DLR Cessna. The suite of instruments aboard the aircraft included a meteorological sensor package, a Picarro, and an Aerodyne QCLS, providing CH_4,CO_2, C_2H_6, $^{13}C(CH_4)$, temperature, H_2O, 3d-wind, all along the flight track.

The Cessna conducted 12 scientific flights in the region, which mostly targeted and scouted hotspots of CH_4 emissions indicated by wetland emission inventories. The flights were coordinated as often as possible with other airborne, ground-based and satellite platforms to allow for intercomparisons and for providing ground truth for remote sensing instruments. Estimating CH_4 emission fluxes is another major objective, which is challenging because of spatial and temporal heterogeneity of these area sources. To this end we tried a combination of different methods and flight patterns. We provide an overview of the measurements, discuss the different flight strategies and show first results of the analyses that are ongoing in the frame of the ESA MAGIC4AMPAC project.