

Double-Lidar airborne mission over Scandinavia for atmospheric transport assessment of methane and carbon dioxide

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In August 2021 took place in northern Scandinavia the MAGIC-2021 campaign, dedicated to the Monitoring of Atmospheric composition and Greenhouse gases through multi-Instruments Campaigns. Gathering 17 research teams from 7 countries, the campaign involved a large suite of instruments and payloads (ground-based, balloon-borne, and airborne). Among them, an original combination of two airborne lidars was deployed onboard the same aircraft (SAFIRE ATR42): on one side DLR's CHARM-F direct detection lidar for CH₄ and CO₂ measurement in IPDA mode (Integrated Path Differential Absorption), and on the other side ONERA's LIVE coherent lidar for range-resolved vertical wind vector profiles.

The scientific goal of this double-lidar experiment was to record greenhouse gas (GHG) concentration and wind data with very good temporal and spatial matching, so as to characterize GHG atmospheric transport and infer regional fluxes. Indeed, the boreal region is known to host significant sources of CH₄, either anthropogenic (gas and oil platforms) or natural (wetlands, peat bogs, lakes...). Moreover, high latitudes are generally considered to be a sink for atmospheric CO₂, but this effect could be strongly impacted by the rapid warming at these latitudes. However, due to the low population density and harsh environment, the boreal area is poorly covered by in-situ instrumentation. Therefore, airborne measurements appear as a preferred solution in these conditions.

The airborne campaign was based in Kiruna (Sweden), and lasted 10 days. Though it suffered from poor weather conditions, six flights were successfully completed by the ATR42 above northern Sweden, Finland, and Norway. CHARM-F and LIVE lidars operated nominally during those flights, collecting hours of data in various sky conditions (clear, haze, broken clouds...). The expected precision of CHARM-F and LIVE lidars were respectively around 0.3% for integrated columns of CH₄ and CO₂ (10 km-along track averaging) and 0.6 m/s for horizontal wind (2.5 km along-track averaging, for average aerosol load in France). The paper will detail the payload arrangement, and review CHARM-F and LIVE lidars main properties. The data processing work is currently in progress, but selected preliminary results of measured collocated GHG columns and wind profiles will be shown and discussed.