Seminar “Physics and Chemistry of the Atmosphere”,
Institute of Environmental Physics (IUP), Univ. Bremen
Date: 16-May-2025, 14:15
Place: Building NW1, Room S1360

Assessing anthropogenic CH4 emissions from aircraft – constraining landfill and open-cast coal mine emissions

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Along with carbon dioxide (CO2), methane (CH4) is a key driver of anthropogenic climate change. Reducing CH4 emissions is critical for short-term climate change mitigation. The main drivers of anthropogenic CH4 emissions are waste- and fossil fuel-related activities. They account for about half of the global anthropogenically emitted CH4. Atmospheric measurements of CH4 concentration gradients are a powerful tool to test inventory estimates, which are usually based on bottom-up methods.

In this paper we present two recent examples of elevated CH4 emissions from landfills near Madrid, Spain, and an open-cast coal mine in Queensland, Australia. Both targets are also clearly detectable in TROPOMI satellite XCH4 data and satellite data derived emission rates, which were questioned by facility operators for both areas. We use measurements from airborne passive imaging and airborne active greenhouse gas lidar instruments on board the same aircraft to identify emissions from the waste facilities. These are combined with validated modelled wind field data in a simple but fast cross-sectional flux

method to quantify their strength. Emission rates with up to 13 t/h at the time of the measurement flight for the study area from both techniques are in excellent agreement with each other and support the conclusion of under-reporting of the landfills from previous findings. A large proportion of the emissions are attributed to the active landfill sites. For the open-cast mine in Australia, passive airborne imaging data from one aircraft were combined with synchronously acquired in situ CH4 concentrations and wind field observations from a second aircraft. Emission rate estimates using the cross-sectional flux method, acquired on multiple days over 2 years, are by a factor of at least 3-5 higher than bottom-up based estimates and they agree with previous satellite-based estimates. Reasons for the large discrepancy between top-down and bottom-up estimates could be generalised emission factors for larger areas used in the inventory, which are not actually valid for specific mines.

These two examples illustrate how irregular but high precision measurements acquired during airborne campaigns can support emission estimates from satellite instruments and pinpoint CH4 sources. Furthermore, within certain limits, they can also support the verification of bottom-up methods.