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Local-scale atmospheric inversions to monitor CH_4 emissions from industrial sites using mobile and/or fixed-point measurements

Pramod Kumar[1], Grégoire Broquet[1], Christopher Caldow[1], Olivier Laurent[1], Camille Yver-Kwok[1], Ford Cropley[1], Bonaventure Fontanier[1], Adil Shah[1], Mathis Lozano[1], Sara Defratyka[1], Susan Gichuki[1], Thomas Lauvaux[1], Rodrigo Rivera[1], Guillaume Berthe[2], Frédéric Martin[2], Sonia Noirez[2], Olivier Duclaux[3], Catherine Juery[3], Caroline Bouchet[4], Philippe Ciais[1], and the TRACE team[*]

[1]Laboratoire des Sciences du Climat et de l'Environnement (LSCE/IPSL), CEA-CNRS-UVSQ, 91191 Gif-sur-Yvette, France, Gif-sur-Yvette, France (pramod.kumar@lsce.ipsl.fr)

[2]IFP Energies nouvelles-Géoscience, 92852 Rueil-Malmaison Cedex, France

[3]TOTAL Laboratoire Qualité de l'Air (LQA), 69360 Solaize Cedex, France

[4]SUEZ-Smart & Environmental Solutions, Parc de l'ile, 15-27 rue du Port, 92022 Nanterre Cedex, France

[*]A full list of authors appears at the end of the abstract

The efficient and precise monitoring (detection, localization, and quantification) of fugitive methane (CH_4) emissions is essential in preventing and mitigating greenhouse gas (GHG) emissions from oil and gas industrial facilities and landfills. Various strategies of mole fraction sampling within or in the vicinity of the sites and of atmospheric inversions have been developed for such a monitoring. Many studies have ensured the constant improvement of instrumentation, of measurement strategies and atmospheric inversion techniques.

In this context, we participated in two controlled-release experiments at the TOTAL Anomaly Detection Initiatives (TADI) test site (Lacq, France) in October 2018 and 2019, dedicated to evaluate the ability of different local-scale atmospheric measurement and inverse modeling systems to localize and quantify point sources. We also conducted a series of 18 campaigns to regularly quantify methane emissions from the active "Butte-Bellot" landfill (about 35 km south-east of Paris) since 2018. We developed and applied different inversion approaches to process mobile or fixed-point measurements, which, in both cases, rely on a Gaussian dispersion model to simulate the atmospheric plume from the potential source location or mole fraction sensitivity at the measurement time and location to emissions at the potential source locations.

The series of CH_4 and carbon dioxide (CO_2) controlled releases in TADI covered a wide range of release rates (~0.1 to 200 gCH_4/s and 0.2 to 200 gCO_2/s) and durations from 4 to 8 minutes (brief) to 25 to 75 minutes (longer). During the corresponding campaigns, we conducted both near-surface mobile and fixed-point (~2-4 m height) in situ atmospheric measurements based on Picarro CRDS, LGR (MGGA and UGGA), and LI-COR (LI-7810) instruments. Both inversions based on mobile measurements and those based on the fixed-point measurements provide estimates with a 20-30% average error for the CH_4 and CO_2 release rates, whatever the duration of the releases. The use of fixed-point measurements during long releases allow for a more precise localization of

sources with an average location error of ~8m.

The analysis of the CH_4 mobile measurements at the “Butte-Bellot” landfill reveals the difficulties in exploiting measurements close to such a site with diffuse emissions whose spatial distribution is difficult to characterize, heterogeneous and highly variable in time. The series of estimates of the total CH_4 emissions from the site based on remote mobile plume cross-sections, based on atmospheric inversions, are discussed.

This presentation will highlight positive perspectives opened by the proposed inversion approaches and by our results and discuss options for further improvements when processing both types of measurements.

TRACE team: Pramod Kumar1, Grégoire Broquet1, Christopher Caldow1, Olivier Laurent1, Camille Yver-Kwok1, Ford Cropley1, Bonaventure Fontanier1, Adil Shah1, Luc Lienhardt1, Mathis Lozano1, Sara Defratyka1, Susan Gichuki1, Thomas Lauvaux1, Rodrigo Rivera1, Guillaume Berthe2, Frédéric Martin2, Sonia Noirez2, Olivier Duclaux3, Catherine Juery3, Caroline Bouchet4, Michel Ramonet1, Philippe Ciais1