The ubiquitous nature of lubrication oil in aero gas turbine exhausts

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Civil aviation gas turbines utilize unique synthetic aeroderivative lubrication oils, formulated using polyol ester base stocks and various additives for oxidative stability over a wide temperature range. Airport field studies have revealed that lubrication oil is commonly present in organic PM emissions that are associated with emitted soot particles [1] and it was furthermore recently suggested that gas-phase oil molecules could even nucleate particles [2]. However, the dependence of emissions on engine state and technology are not well understood as well as the implications and fate of these emissions for ambient air quality and climate.

This presentation summarizes the highlights of the engine test cell measurements of the ongoing Aviation Plume PROPeRtIes AT point of Exposure (APPROPRIATE) project. Targeted measurements were performed in the exhausts of nine in service aircraft turbofans from two different manufacturers using an Extractive Electrospray Ionization ToF-MS (EESI-ToF-MS) an Aerosol MS (AMS), and a multi-orifice uniform deposition impactor (MOUDI). Aerosol chemical markers of used oil and commonly known oil components (e.g., tricresyl phosphate) were detected in the exhausts of all nine engines. An example for such an oil detection is show in Fig. 1 below which shows the mass defect analysis derived from the EESI-ToF-MS measurement of stock oil (left) and the exhaust of a PW4062A engine (right).

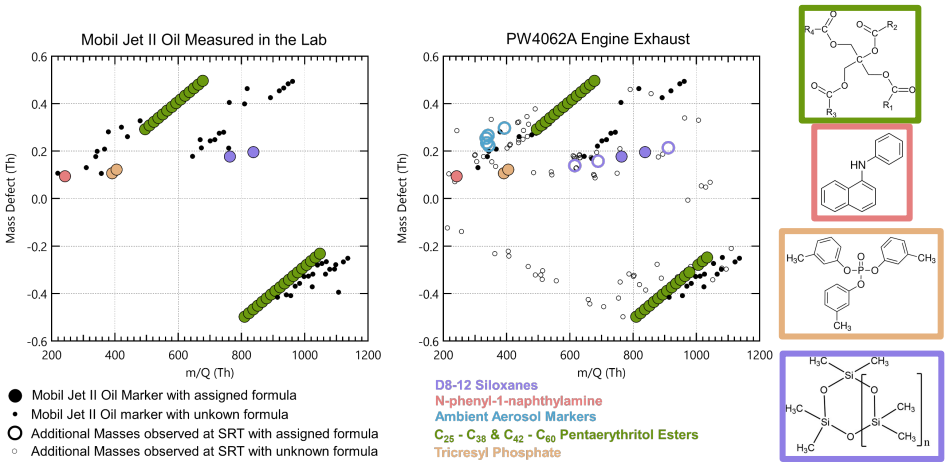

Fig 1 Example identification of jet engine lubrication oil shown as mass defect plots of stock oil (left) and PW4062 gas turbine engine exhaust (right) with their associated molecular structures (color panels on the right)

The thrust dependence and size dependent mixing state of the oil emitted will be further subject of the presentation in addition to the potential implications of this ubiquitous component of aero gas turbine exhaust.

[1] Yu et al., *Environ. Sci. Technol. 2012, 46, 17, 9630–9637*
[2] Ungeheuer et al., *Communications Earth & Environment 2022, 3 (1)*