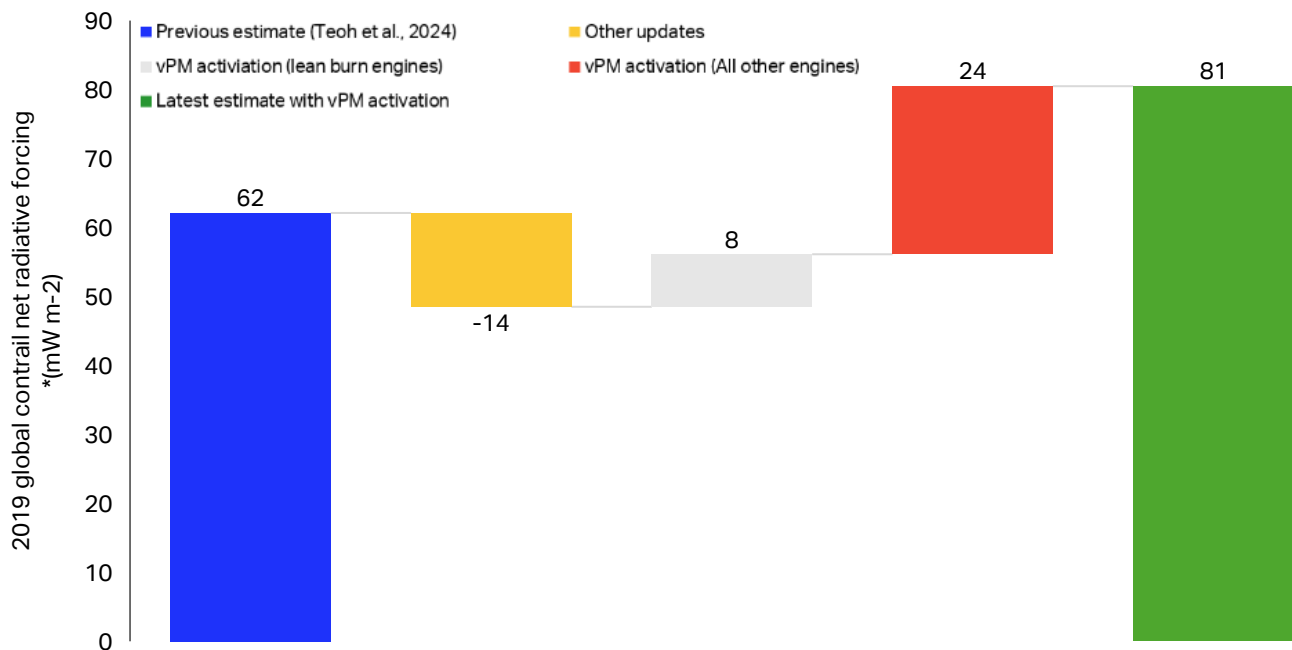


The impact of vPM on contrail-cirrus radiative forcing

Impact of model updates on contrail radiative forcing



Source: Teoh et al. (2025) in preparation
 *mW/m² = milliwatts per meter squared

- Contrails are known to have a global net warming climate impact. Aircraft gas turbine engines emit a mixture of particulate matter, including both non-volatile (nvPM) and volatile particulate matter (vPM), which contribute to the formation of contrails. Until recently, models estimating the climate impact of contrails only considered the role of nvPM, or soot. However, with newer aircraft engine technologies such as lean burn combustors (and alternative fuels) that decrease nvPM emissions, the role of vPM (i.e., sulphuric acid, jet lubrication oil vapors) in contrail formation becomes more important ([IATA in Depth](#)).
- Lean-burn engines are used for instance on the A320neo, Boeing 737 MAX, and Boeing 787 families and they made up 20% of the global annual distance flown in 2024 ([Teoh et al., 2025](#)). As this share continues to increase, the role of vPM in contrail formation is rising too. Recent research puts the radiative forcing (RF), accounting for both nvPM and vPM, at around 80 mW m⁻² (with an uncertainty range of ± 20 mW m⁻²), up from the 2019 estimate of 62.1 (mW m⁻²) (Teoh et al., 2025). In addition to the impact of lean-burn engines with low nvPM emissions, there is also a contribution to this higher RF from conventional engines in colder conditions where vPM can play a role in contrail formation.
- On-going research conducted through experimental and flight campaigns is indispensable to collect data that will help improve our understanding of these microphysical processes. Only data can enhance the accuracy and representation of contrail formation in models – work that sorely needs to be expanded.