The transition to sustainable aviation fuels will lead to reduced contrail ice forming particle emissions

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1. What are contrails?

- Line-shaped ice clouds which form behind airplanes
- Form from water condensation on aviation particulate emissions
- Strong but uncertain warming effect

The intensity and lifetime are controlled by the number concentration and type of emitted particulates

Figure 1: Contrail-filled sky over East Dulwich 22/05/26.

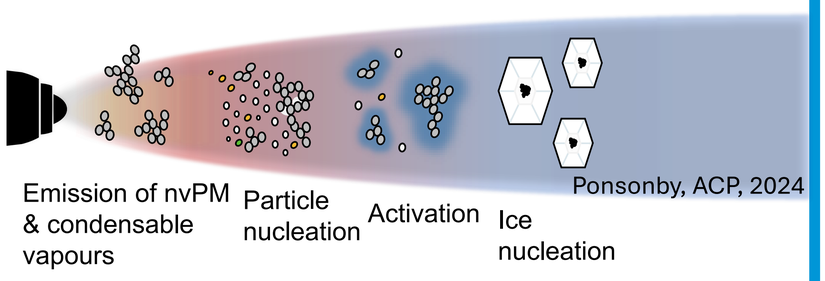
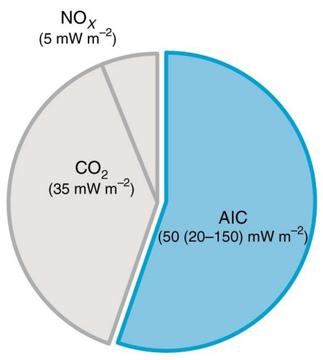


Figure 2: The steps involved in contrail formation.



Kärcher, Nature Commun. 2018

Figure 3: Aviation induced cirrus (contrails) accounted for ~2/3 of the radiative forcing due to aviation in 2018.

2. What is SAF?

- Sustainable Aviation Fuel
- Main IATA strategy towards net zero
- Policy targets drive SAF use (e.g. EU 6% by 2030)

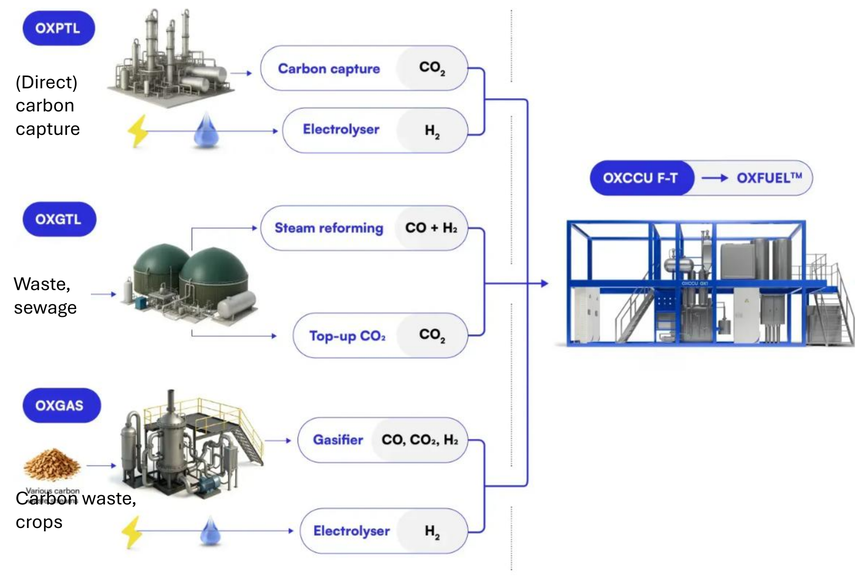


Figure 4: SAF can be synthesised from a variety of different feedstocks using different pathways. Adapted from OXCCU.

3. The impact of SAF on contrail formation

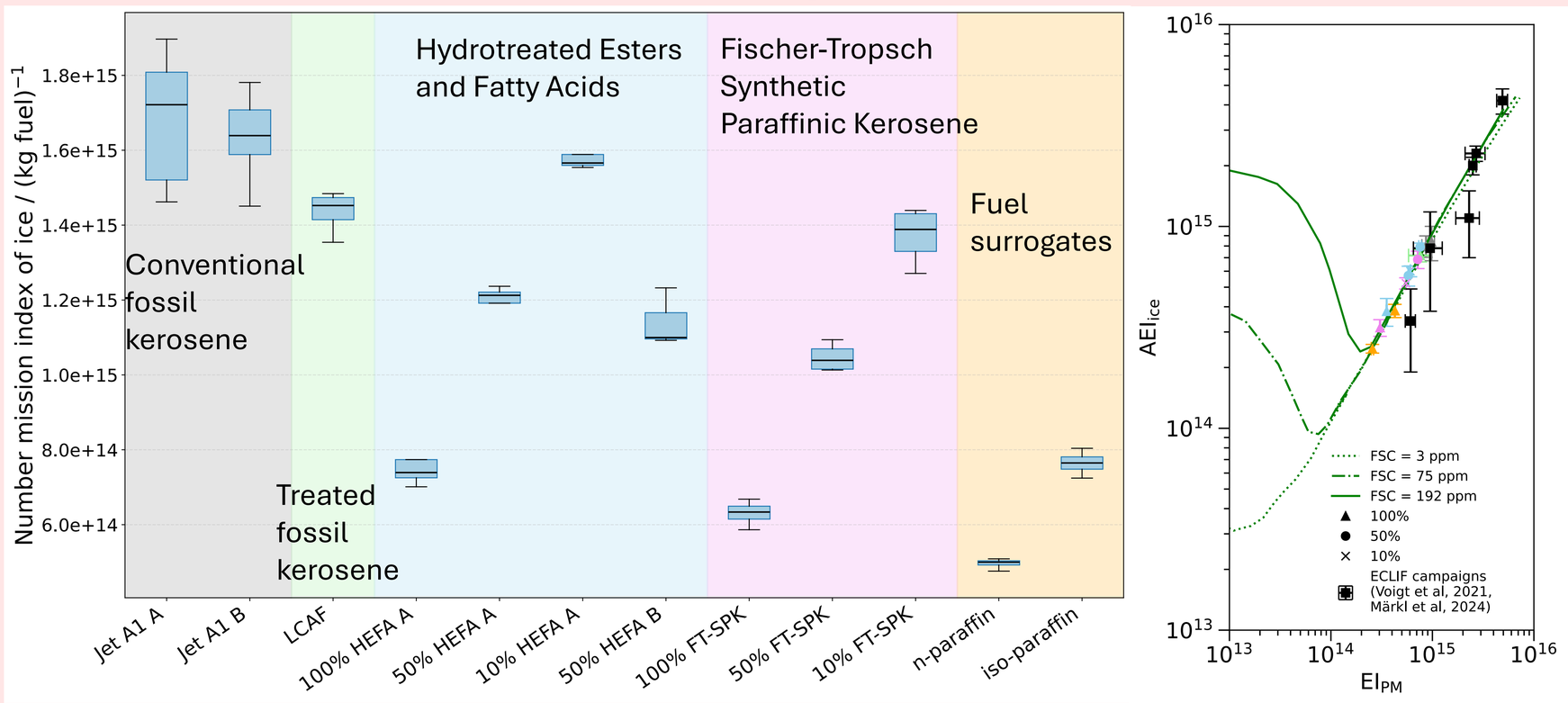


Figure 5: SAF significantly reduces the emission index of ice from a jet engine, even at low blend ratios.

- SAF can reduce the emission index of ice by two thirds
- Paraffinic fuel surrogates reduce this even further
- This could reduce contrail radiative forcing by ~40%
- The transition to SAF will lead to reduced contrail formation

- Still in the soot-rich regime with this engine

4. Methods

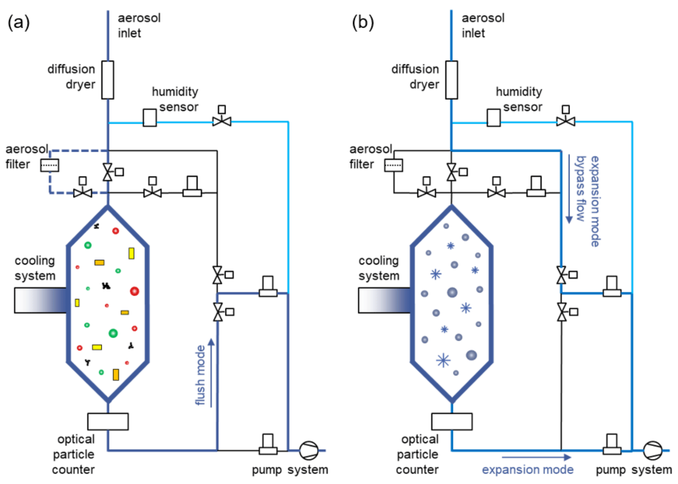


Figure 6: PINE cycle. a) the flush mode where the chamber is filled with the sample particles. b) the expansion mode where the chamber is sealed off and pumped, causing an expansion and the formation of hydrometeors.

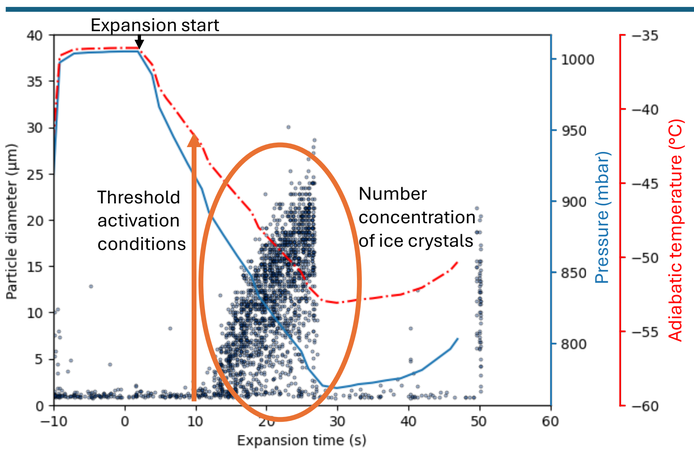
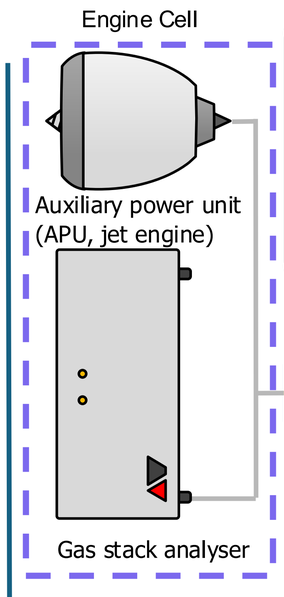


Figure 7: Data from a PINE cycle. The adiabatic temperature is calculated from the pressure, and each particle is sized. A cloud forms, and concentration of ice is measured, along with threshold activation conditions.



- APU gas turbine used to burn several different fuels
- Resulting emissions sampled into a suite of instruments, including the Portable Ice Nucleation Experiment (PINE)
- PINE: a cloud chamber where the contrail forming ability of emissions can be assessed

Figure 8: Above: Schematic of the experimental setup. Below: Photographs of the instruments. Left: the gas turbine auxiliary power unit (APU). Right: the particulate measurement instruments, including PINE.