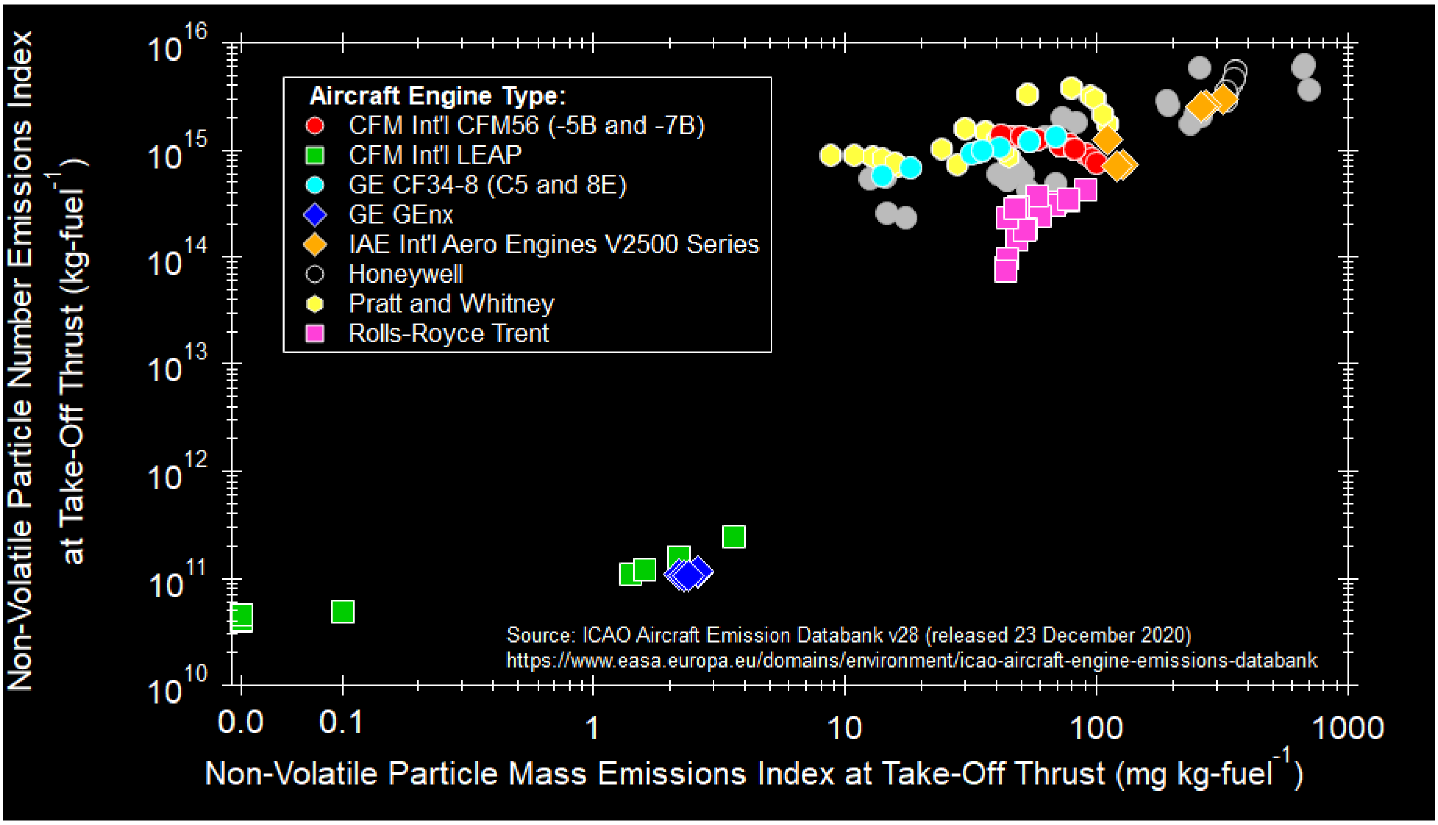
Twitter Thread by Rich Moore

Rich Moore
@richardhmoore

One exciting thing from over the holidays is that the Int'l Civil Aviation Organization (@ICAO) and aircraft engine manufacturers for the first time publicly released quantitative emissions indices for particle # and mass emitted per unit fuel burn! ■ 1/

https://t.co/zXuFN66SWe



Up until now, certification data for aircraft engine particle emissions have been reported in terms of a "smoke number", which is derived from the change in reflectance of a Whatman 4 filter after collecting 16.2 kg/m² exhaust. 2/

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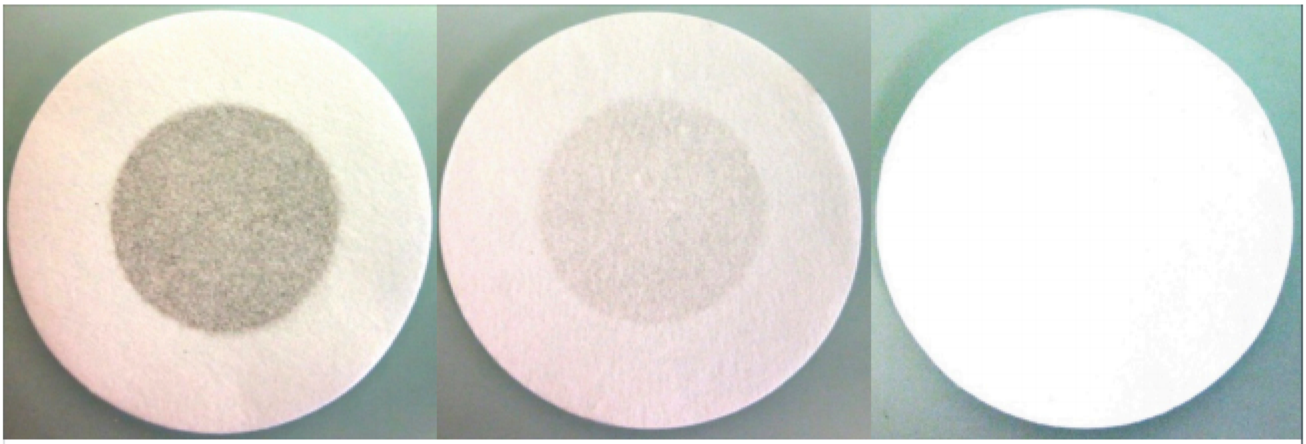


1990
Visible fine smoke trail at take-off (actual smoke number filter measurement for illustration).

2014
Almost invisible smoke trail at take-off (actual smoke number filter measurement for illustration).

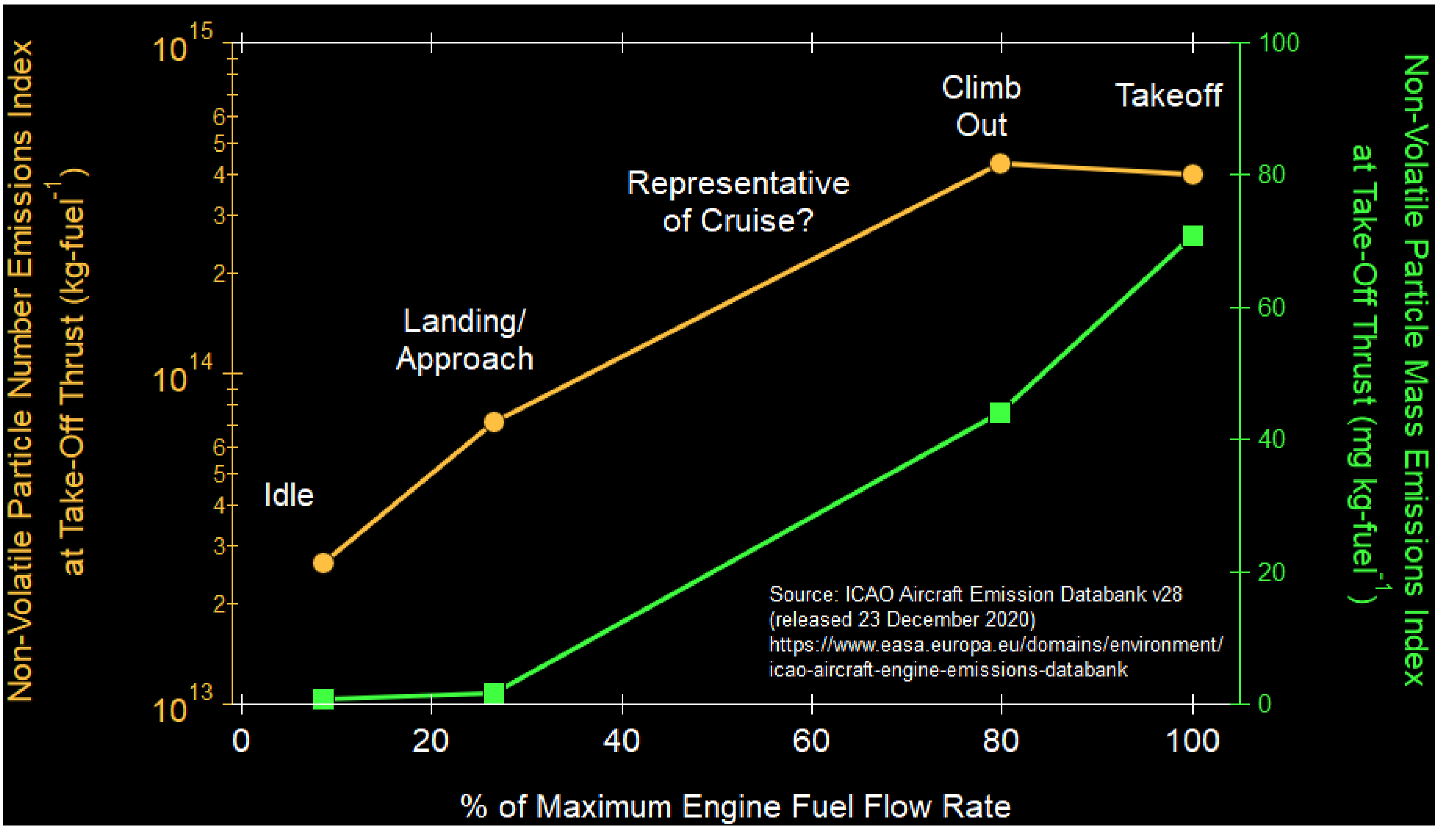
Beyond 2020
Barely detectable nvPM at take-off, technology currently used by one engine manufacturer in medium to large engines.

One challenge with the smoke number measurement is that the filter doesn't capture all of the particles -- especially small ones. Is the decrease in smoke number over time because we are trading a few large soot particles for many more smaller soot particles? 3/

While smoke numbers are not particularly helpful for quantitatively assessing particle emissions impacts on air quality & upper tropospheric composition, they have been a huge success in motivating the reduction of unsightly exhaust plumes! 4/

Photo credit: flickr/dsleeter_2000

The new EI data are much more useful for #AirQuality and #Climate modeling efforts seeking to understand the environmental impacts of aviation. Since they're collected at ground conditions, the data are most relevant to AQ, but maybe can be extrapolated to cruise conditions? 5/



Of course, we still need to understand how well the certification EIs capture real world, near-surface emissions impacted by fuels, engine maintenance, and human behavior (e.g., reduced thrust takeoffs). 6/

Leipzig/Halle: https://t.co/ITMszAGSej

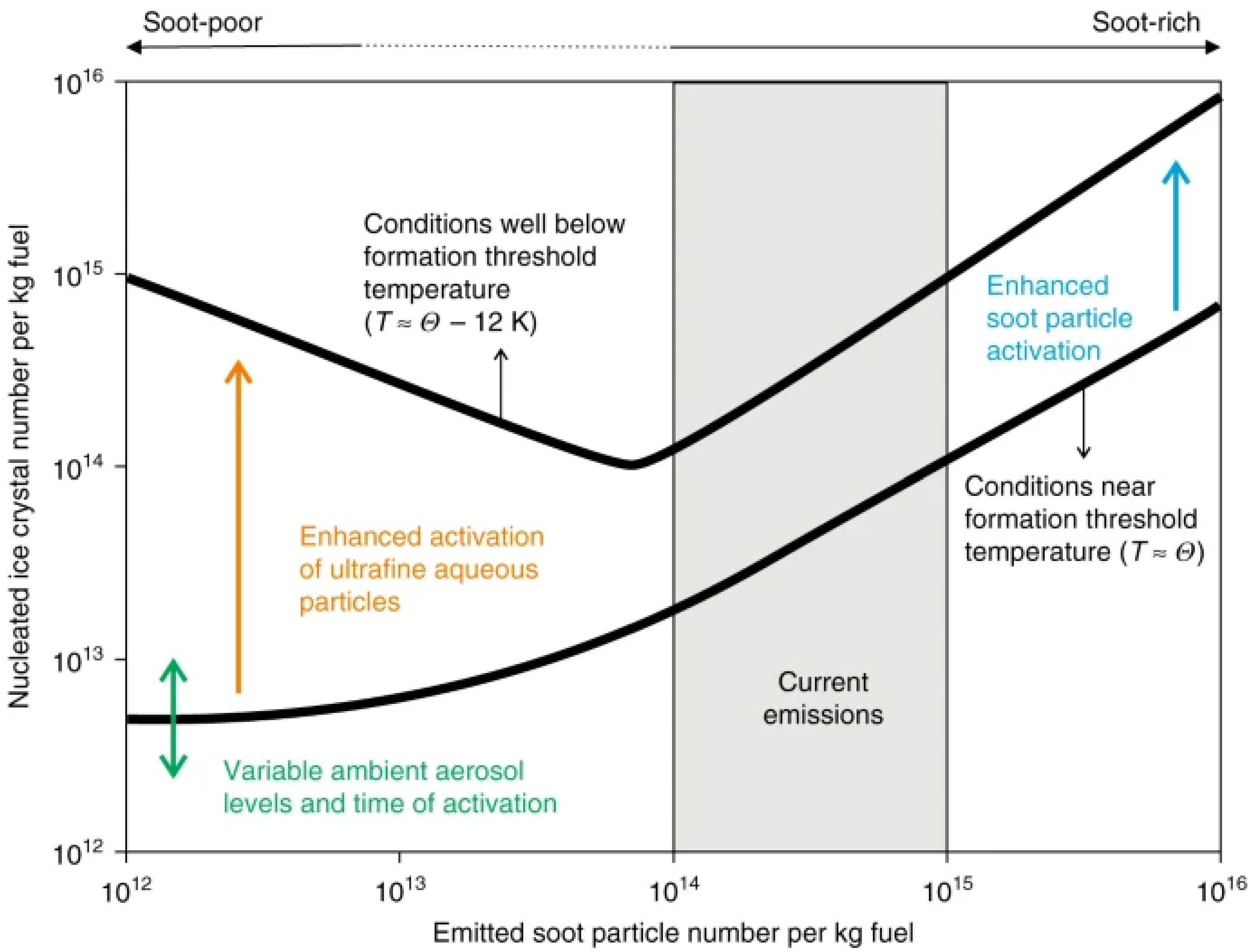
LAX: https://t.co/fSADIkoXEw

We also know that "spreading contrails and the cirrus clouds that evolve from them -- collectively known as contrail cirrus -- have a greater radiative forcing today than all aviation CO2 emissions since the first powered airplane flight" - B. Kärcher 7/

https://t.co/zLXnWyDCwc

If we can reduce engine soot particle emissions at cruise enough to fall below the soot-rich emissions regime (threshold ~ 10^{13} to 10¹■ per kg fuel) then that would translate into a reduction in climate-altering, aviation-induced cloudiness. 8/

https://t.co/Pi22W6Gw4Y



There are a number of promising approaches for meeting these targets in the short term including the use of sustainable, bio-based jet fuels as well as introduction of lean-burning combustion technologies. 9/

https://t.co/FSZWr27Tmg

Models of contrail formation and persistence provide the key to targeting these efforts when the economics might not make sense for widespread adoption of advanced (& expensive) biofuels. We can focus on large "contrail outbreaks" to have big impact! 10/

https://t.co/j3SmQwl0yy

The new ICAO aircraft engine particle emissions data released on Dec. 23rd are fertile ground for understanding how changes in engine technology (particularly advanced, lean-burning combustors) will impact the environment both near the ground and high above! 11/11

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