Climate risks from the return of supersonic aircraft

Regulators need to be aware of potential climate impact

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Summary

A number of companies have announced efforts to bring back commercial supersonic transport. In the resulting media coverage the extraordinarily negative environmental impact of these aircraft, especially the climate impact, is often overlooked. Such aircraft have extremely high fuel consumption demands and extreme non-CO2 climate effects, far above those of subsonic aircraft. Policy-makers should therefore be wary of facilitating the reintroduction of supersonic aircraft, and introduce measures to ensure that any potential reintroduction does not result in a net increase in civil aviation's climate impact compared to a 'no supersonic' scenario.

1. Introduction

To date, the only regular commercial supersonic aircraft in operation was the Concorde. During its nearly three decades in operation, it carried passengers across the Atlantic in half the time of subsonic aircraft. However it only ever got off the ground thanks to generous government support - costing an estimated US$2bn in current terms to develop, a bill met by French and UK taxpayers. Air France and British Airways were given the aircraft by these governments for free to operate, but as the aircraft burned 22 tons of a fuel an hour - twice that of a Boeing 747 carrying four times as many passengers - it always struggled to prove profitable for the airlines. So while the 2000 loss of Concorde flight 4590 led to the fleet's retirement soon after, the economics were always stacked against it. Russia attempted commercial supersonic aircraft in the 1970s with the Tupolev Tu-144, but that aircraft was retired after 55 passenger flights due to recurring safety issues.

2. The return of supersonic commercial flight?

A decade and a half later efforts are underway, particularly in the US, to bring back commercial supersonic aircraft. Several companies are working on designs, which are in their early stages, however it appears that they will aim to develop business jet aircraft or aircraft which will carry up to 50 passengers (versus the 100 on Concorde) and that will aim to operate more routes than Concorde's New York-London/Paris routes. It is unclear how viable these efforts are, however the various announcements have been extensively covered. Early testing of small demonstrator aircraft has even begun. Overlooked in this coverage is the environmental impact, particularly the climate impact, of such aircraft.

3. Environment issues

3.1. Noise

The noise impact from Concorde's sonic boom is well known. It further harmed Concorde's commercial viability, as governments in Europe, the US and elsewhere refused to permit it operations at supersonic speed over land. This excluded many routes for the aircraft, particularly harmed the Paris-New York route and precluded commercial operations to the Far East.

The supersonic aircraft currently under development are claimed to have a lower noise impact for landing and take-off. However while some new designs may indeed meet international noise standards for this portion of the flight, an important caveat is that these aircraft will carry will carry fewer passengers than their subsonic equivalent. As a result the amount of noise nuisance for a given amount of transport capacity will increase if supersonic aircraft replace subsonic operations at airports.

For the noise impact from inflight, the ‘sonic boom’ which is unique to supersonic aircraft, there are no international standards. However some states (including the US and some states in Europe) have banned overflights by such aircraft. While some of the designs for new supersonic claim a reduction on the noise impact of Concorde, they may still be potentially well above the noise impact of subsonic.

3.2. Climate

Along with concerns about noise pollution, the reintroduction of supersonic aircraft would result in an enormous increase in the aviation sector’s climate impact. The first problem is the fuel consumption: Concorde consumed twice as much fuel in order to carry four times fewer passengers than the Boeing 747. With subsonic aircraft having become increasingly fuel efficient since the time of Concorde, this gap will remain or widen, despite claims that the new supersonic aircraft will be more fuel efficient than Concorde was.

The second climate problem is caused by the much higher operating altitude needed to realise supersonic flight given the lower air density required. Flying at 55,000 feet, instead of the 30,000 for subsonic, they create substantially higher non-CO2 climate effects. These are the warming effects created by aviation emissions which are different from the CO2 effects and which are the result of aircraft flying at altitude. For subsonic aircraft they equal or even exceed the CO2 effects: flying even higher means those effects are worsened. For example at this altitude the non-CO2 effects mainly due to water vapour emitted have a longer lifespan than at lower altitudes.

Supersonic travel can therefore, per passenger, have a climate impact many times that of subsonic. Research suggests that even a small replacement of subsonic aircraft by supersonic aircraft could cause very significant increases of aviation’s climate impact. Lee et al. 2009 estimated that, if brought into the fleet, 500 supersonic aircraft would equal 10-17% of the overall radiative CO2 forcing of subsonic aircraft in 2050. One company behind the reintroduction of supersonic has stated that they are aiming for 1,000 deliveries. By comparison, manufacturers are predicting a total global fleet of 40,000 aircraft in 2036 (the furthest out they will provide estimates) (Boeing, 2017). Supersonic therefore risks providing only a small share of transport capacity, but an outsized climate impact. This increased climate impact would be on top of the estimated 300% increase in aviation emissions by 2050 predicted by the UN’s aviation agency, ICAO.

A further issue is airport capacity, as these new supersonic aircraft will carry perhaps one-quarter the number of passengers of regular subsonic aircraft (i.e. Boeing 737). Many major airports are or are becoming capacity strained, so these aircraft could potentially usurp valuable slots at constrained airports only to carry four times fewer passengers at multiple times the climate impacts.

4. Currently existing regulations

Standards to regulate supersonic aircraft lapsed in the years following Concorde cessation of operations. As a result there are currently no noise or CO2 standards for these aircraft. The recently agreed ICAO CO2 standard exempts supersonic aircraft. A NOx standard for landing and take-off, applicable to supersonic aircraft, does still exist at international level however this outdated standard is even weaker than the existing subsonic standard and is therefore inappropriate for current objectives. What does exist are bans on the use of these aircraft over certain areas, for example the US and some European countries have banned overflights of aircraft at supersonic speed.

A number of regulatory developments are underway to address this gap. The UN's International Civil Aviation Organisation (ICAO) recently agreed to step up work to develop LTO noise and a boom standard for supersonic with the aim to have any certification requirement take effect potentially in 2022. ICAO will consider whether to develop a CO_2 efficiency standard for supersonic since those aircraft are excluded from the CO_2 standard agreed in 2016. Discussions are also ongoing as to whether to apply a NO_x subsonic standard to supersonic aircraft.

Meanwhile late last year the EU concluded reforms to its European Aviation and Safety Agency (EASA) which gives that agency some scope to introduce environmental certification requirements for supersonic aircraft.

5. Recommendations

Any regulation of supersonic needs to be guided by all available evidence. This includes examining the potential environmental impacts - noise and air quality, but also supersonic's CO_2 and non-CO_2 climate impact. However a critical assessment should not just be limited to the environmental impact, but also question the social and economic benefits of such aircraft. At present, they will permit a limited number of people to fly faster between destinations - for example cutting a 5 ½ hour journey to 3 hours, excluding time at airports. For a significant increase in aviation's already considerable environmental impact, there are potentially only limited direct social or economic benefits.

Regulators also need to be bound by existing environmental and climate commitments. The 2016 ICAO Assembly Resolution commits to a 'public acceptability test' before the reintroduction of supersonic aircraft is permitted. While such a 'public acceptability test' is yet to be defined, it's reasonable to argue that at the very least, it means there should be no backsliding in standards - that new technology should not result in a worsening of civil aviation's environmental impact. States should also be bound by their commitments under the Paris Agreement, which includes a temperature goal of limiting an increase in global temperatures to 1.5°C. Given the expected climate impact of supersonic, it's difficult to see how its deployment can be reconciled with this target.

While there are opportunities at both international and regional level to regulate the reintroduction of supersonic aircraft, the aim of these regulations should be to ensure that any reintroduction does not result in an increase in environmental harm (noise, air quality and climate) compared to a no-supersonic aircraft scenario. This can be done, for example, by applying existing and future subsonic standards to supersonic aircraft. No reasoning has been proposed as to why supersonic should be exempt from these standards.

Further information

Andrew Murphy
Aviation Manager, Transport & Environment
andrew@transportenvironment.org
Tel: +32(0)4 85 00 1214