

Small-scale supersonic transport aircraft (S4TA): HISAC project

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Motivation

- Supersonic transport would facilitate long-range one day trips
- Market for small-scale aircraft
- Light aircraft with low boom shape could enable high speed even over land.
- Here: What is the potential climate impact?

The 3 HISAC Families

Common Requirements	Entry into Service	Ref PAX	Max. PAX	Subsonic Cruise	Max. Speed	Max. Alt.	Max. Range	Height Seating
	2015	8	19	0.95 MN	1.6 MN	FL410	4000 nm	1785 mm
Specific config.	Length [m]	Wing span [m]	MTO W [tons]	Fuel /MTO [%]	Max. Speed	L/D	Max Range	Number of engines
A - weight	36.8	18.5	51.1	53	1.6	7.00	4000 nm	3
B - range	41.6	24.0	60.5	53	1.6	7.45	5000 nm	2
C - boom	40.9	19.1	53.3	51	1.8	7.74	4000 nm	2

Overview on previous studies on supersonic transport

Main contributors: H₂O and CO₂
Large-Scale Supersonic Aircraft have a 6 time larger climate impact than subsonics.

Project	Concept	Full fleet	Cruise Alt. (km)	Number Aircraft	PAX	Speed [Mach]	Fuel [10 ⁶ kg/a]	RF [mW/m ²]
HSRP 1999	Boeing	2015	18-21	500	~300	2.4	82	-
IPCC 1999	Boeing	2050	17-20	1000	309	2.4	137	100
NASA 2002	Boeing	2015	15,17,19	500	10	<<2.4	1-4	-
SCENIC 2007	Airbus	2050	16-19	500	250	2.0	62	40
HISAC 2009	Dassault Alenia Sukhoi	2050	15-16	250	8	1.6-1.8	0.4	0.1

HISAC Emissions

Methodology:

- 4 flight trajectories representing regions from Pole to Tropics
- Calculation of emissions along flight trajectories
- Calculation of concentration changes and climate impact

Configuration	Mean flight altitude [kft]	Mean fuel Consumption [t]	Mean fleet fuel Consumption [Tg]	EINOx (LPP) [g(NO ₂)/kg(fuel)]
A	50.6	1.584	0.396	11.8
B	52.6	1.589	0.397	11.9
C	54.0	1.776	0.44	10.6
SCENIC	54-64	-	62.0	4.6

Atmospheric composition changes

Changes relative to background:
 Water vapour: 0.01 to 0.05 %
 Ozone layer: ~ -0.0005%

Contraails coverage:
 supersonics = contraails in the tropics
 Effect replaced subsonics = contraail avoidance

Contraails may form in the tropics!

Climate impact

Climate impact factor:
 Large Scale Aircraft: 6-14
 Small Scale Aircraft 3±0.4

Climate impact by 2100: -0.08 mK
 - 50% reduction of the climate impact by reducing non-CO₂ effects.
 = lower cruise altitude wrt SCENIC/IPCC

Summary

- Climate impact / ozone depletion of a fleet of S4TA are considerably smaller than for supersonic fleets considered previously for 3 reason:
 - (1) Smaller fleet size (Factor 2-4)
 - (2) Smaller aircraft = less fuel consumption (Factor ~40)
 - (3) Lower flight altitude = smaller Non-CO₂ effects (Factor ~5)
- Climate impact and ozone depletion of a S4TA fleet are larger than for respective subsonic fleet (Factor 3±0.4).

Outlook

Current and future 3D-emission estimates for small-scale aircraft needed. Direct intercomparison of climate impact of sub- and supersonic small-scale aircraft should be performed on the basis of those data.

References

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