Technical levers for contrails reduction

Nicolas Jeuland - Safran

7-8 November 2023

EUROCONTROL’s Brussels HQ

Aircraft / propulsion system technologies are key in the reduction of contrails formation

Emissions

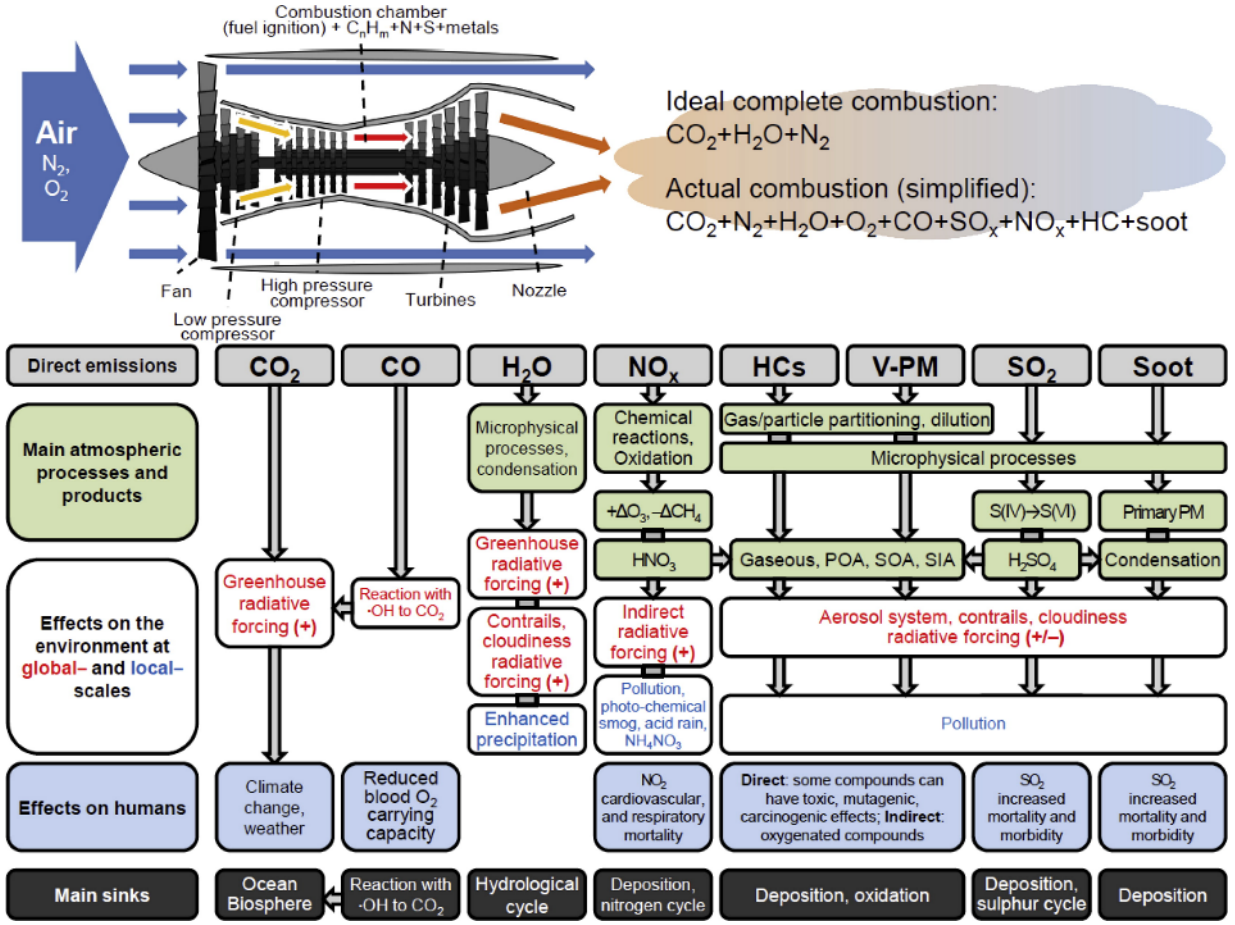
Engine geometry / configuration

Aircraft configuration

SAFRAN EUROCONTROL CANSO

Aircraft / propulsion system technologies are key in the reduction of contrails formation

Emissions

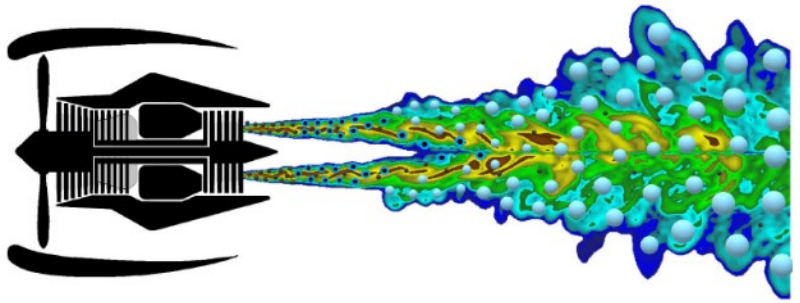


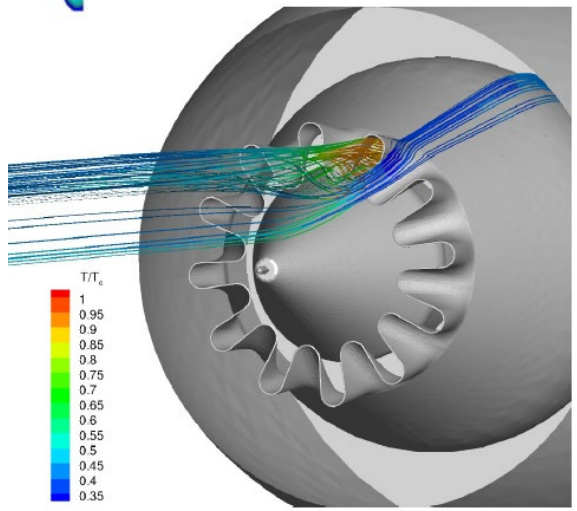
"Aircraft engine exhaust emissions and other airport-related contributions to ambient air pollution: A review"
Mauro Masiol, Roy M. Harrison, 2014

SAFRAN EUROCONTROL CANSO

Aircraft / propulsion system technologies are key in the reduction of contrails formation

Engine geometry / configuration



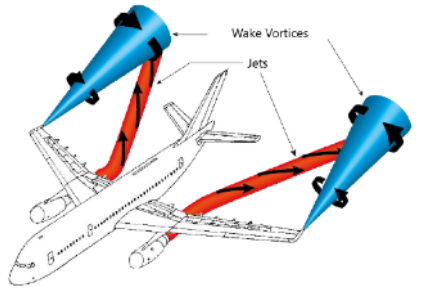


Adrien Misandeau, ETS Montreal

SAFRAN EUROCONTROL CANSO

Aircraft / propulsion system technologies are key in the reduction of contrails formation

Aircraft configuration

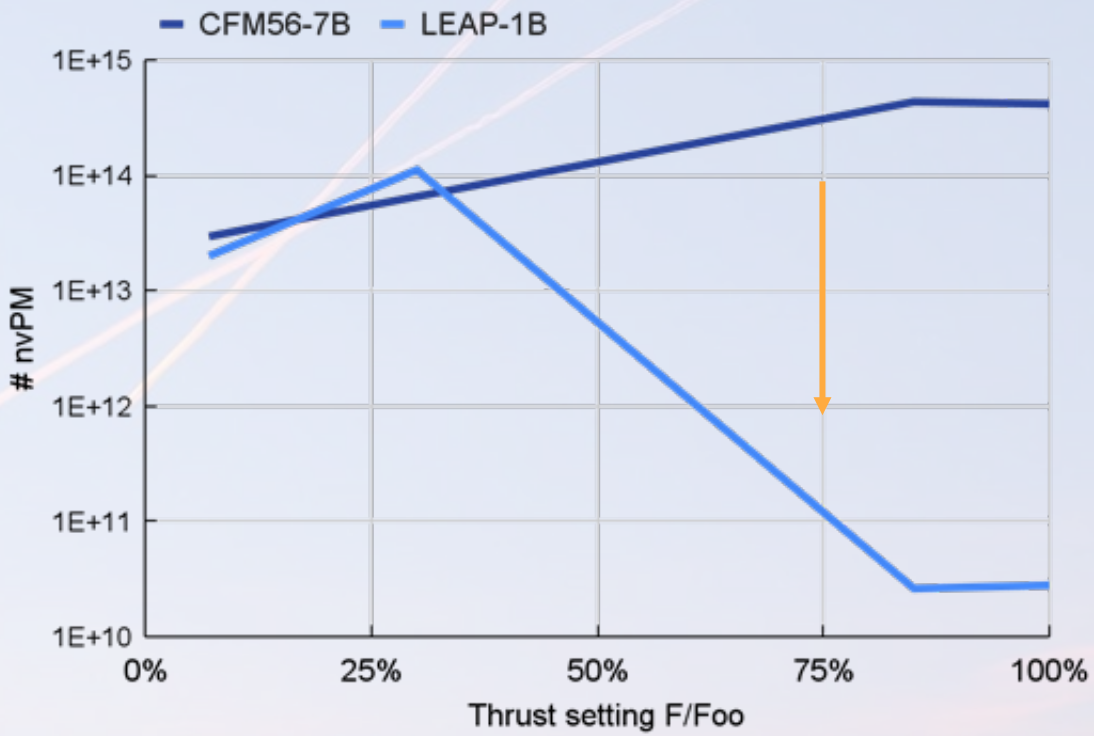


Simplified diagram describing the interaction of the wake vortex with the plume [Jean-Charles Khou thesis (2016)].

SAFRAN EUROCONTROL CANSO

Engine technology has evolved over time, resulting in lower solid particles emissions over time

	Engine	EIS	Combustion Technology
	**CFM56-7B**	1994	- Double Annular Combustor (DAC)
	**LEAP-1B**	2017	- Twin Annular Pre-mixing Swirler (TAPS II) combustor



Based on ICAO engine database

Sources: ICAO engine database, Safran, Estuaire

We looked at 6 months of real world 737 operations and substituted the aircraft type on identical flight profiles

Aircraft types	B737-800 (CFM56-7B) B737 MAX-8 (CFM LEAP)
Number of flights	645
Analysis duration	January to June 2023

Sources: Estuaire, ADS-B data

For this flight dataset, **current models** indicate significantly smaller contrail likelihood and lifetime for last generation engines

Contrail-specific values	CFM56 -7B	LEAP -1B	
Flight distance generating persistent contrails (%)	19.7%	17.2%	/2
Mean contrail age (min)	106	46	/35
Average energy forcing per flight distance (MJ/m)	132.5	3.7	

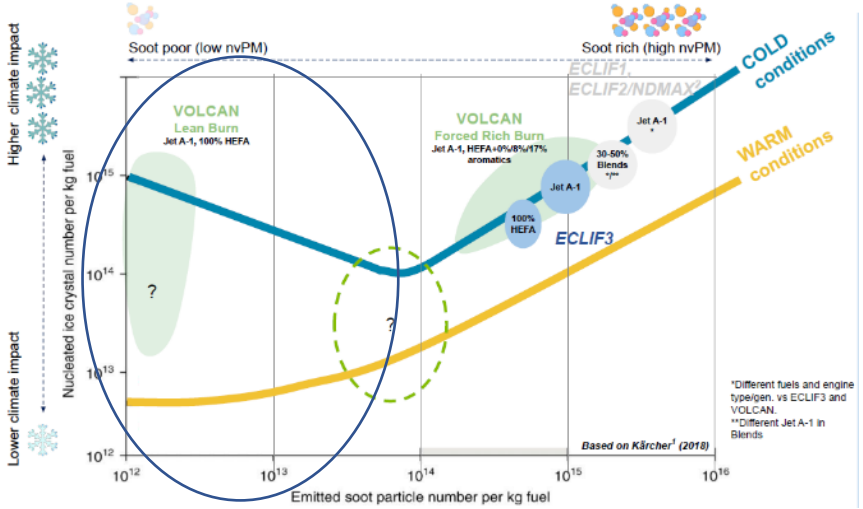
Sources: Estuaire based on COCIP model using ERA5 weather data

The accuracy of models is critical for future technologies development

Emissions

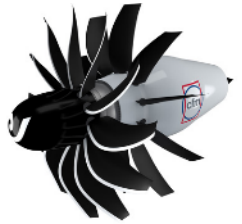
Engine geometry / configuration

Aircraft configuration



Impact of detailed engine / aircraft configuration not taken into account ➔ critical for new engine / aircraft configuration

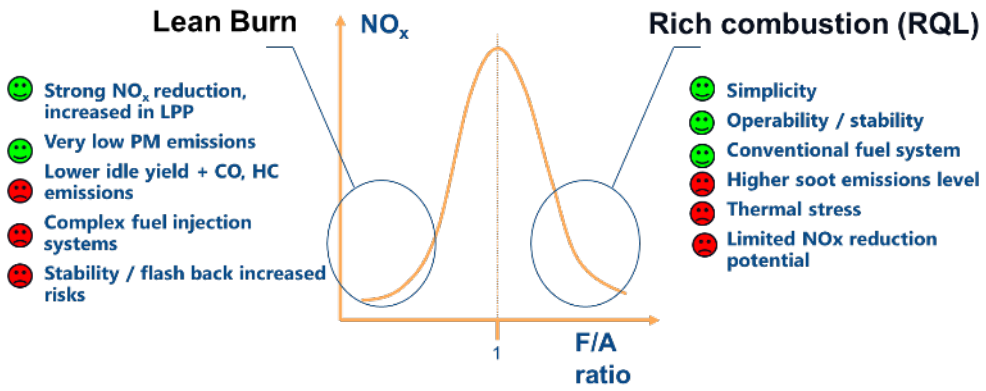
Behaviour at low PM emissions level not taken into account in current models ➔ could be a critical game changer (impact on combustion technology, synergy with SAF…)



SAFRAN EUROCONTROL CANSO

Conclusions

- Engine development is the result of compromises, taking into account multiple parameters :
  - Ground emissions / high altitude emissions
  - various emissions mitigation strategies
  - Emissions / noise / fuel consumption / operability…
  - Fuel composition (conventional vs SAF vs hydrogen)
  - Aircraft integration
- These engine developments need a clear and stable understanding and modelling of the complex chemical and physical phenomena. These models must be widely opened.
- Current models allow a preliminary evaluation, but are not sufficient to decide on these compromises
- R&T and international collaboration is more than ever critical :
  - Knowledge increase : Climaviation
  - Experimental : VOLCAN, Boeing Eco-Demonstrator
  - Numerical
- This topic is considered by OEM as critical and non-competitive, with a need for better coordination. A dedicated group has been created within CTO forum



AIRBUS DLR SAFRAN ONERA DASSAULT

SAFRAN EUROCONTROL CANSO