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Reducing emissions, contrails and climate impact from aviation – Highlights from recent aircraft campaigns
Global Effective Radiative Forcing from Aviation

Global Aviation Effective Radiative Forcing (ERF) Terms (1940 to 2018)

- **Contrail cirrus in high-humidity regions**: 57.4 mW m\(^{-2}\) (17, 98)
- **Carbon dioxide (CO\(_2\)) emissions**: 34.3 mW m\(^{-2}\) (28, 40)
- **Net for NO\(_x\) emissions**: 17.5 mW m\(^{-2}\) (0.8, 29)
- **Water vapor emissions in the stratosphere**: 2.0 mW m\(^{-2}\) (0.8, 3.2)
- **Aerosol-radiation interactions**:
  - From soot emissions: 0.04 mW m\(^{-2}\) (0.1, 4.0)
  - From sulfur emissions: -7.4 mW m\(^{-2}\) (-19, -2.6)
- **Aerosol-cloud interactions**:
  - From sulfur emissions: No best estimates
  - From soot emissions: No best estimates
- **Net aviation (Non-CO\(_2\) terms)**: 66.6 mW m\(^{-2}\) (21, 111)
- **Net aviation (All terms)**: 100.9 mW m\(^{-2}\) (55, 146)

**CO\(_2\)**: 34.3 mW m\(^{-2}\)

**NO\(_x\)**: 17.5 mW m\(^{-2}\)

**Contrail cirrus**: 57.4 mW m\(^{-2}\)

Lee et al., Atmos. Env., 2021
Reducing the climate impact from aviation

→ Aviation climate impact mitigation by alternative fuels – the fast chain
→ Lean combustion
→ Reduced emissions during COVID lockdown 2020, Contrail avoidance
Reduced soot emissions by biofuel blends

Moore et al., Nature, 2017

50% HEFA Biofuel

$D_g = 32.5 \pm 0.4 \text{ nm}$

$D_g = 28.0 \pm 0.5 \text{ nm}$
Climate impact and way forward

Efficient mitigation by alternative fuels

- 80% reduction in ice particle concentrations leads to 50% reduction in radiative forcing
- more pronounced in air traffic corridors
- Fast implementation in fueling system possible

Previous campaigns

- no 100% alternative fuel
- No aromatic composition < 8.5%
- No large engines
- Novel observations needed
Lean Combustion

→ Reduced NOx and soot emissions of staged lean combustors during LTO cycle

→ Flight tests show 35% reduction in EI NOx of new GEnx-2B PIP at cruise altitudes wrt CF6-50E.

What about soot and contrails at cruise?

→ Soot and contrail characteristics to be confirmed

→ Novel observations needed
CoViD Impact on airtraffic, contrail cover and climate

→ 80 % reduction in airtraffic in May 2020 in Europe
→ Strong reduction on contrail cirrus cover, optical thickness and radiative forcing

→ Contrail avoidance demonstrator projects
→ DLR, ATC Maastricht 2021
→ Greener by Design/DLR project

Schumann et al., 2020
Thank you!

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