

Why emissions from civil aviation matter: Climate Impact of Aviation

Volker Grewe

DLR-Institute for Atmospheric Physics

TU Delft, Chair for Climate Effects of Aviation

ECATS Vice-Chair



Knowledge for Tomorrow



Comparison of emission of CO₂ equivalents (TgCO₂/year) comprises CO₂, CH₄, NO₂, SF₆, HFCs, CFCs (without gases from the Montreal Protocol)

Country / Type	1990	2000	2010	2015	% Change 1990-2015	
Germany	1251	1043	942	902	-28%	↘
France	550	556	517	464	-16%	↘
Europe	5641	5151	4773	4307	-24%	↘
International Aviation	545	682	759	840 ²⁰¹⁴	+54%	↗

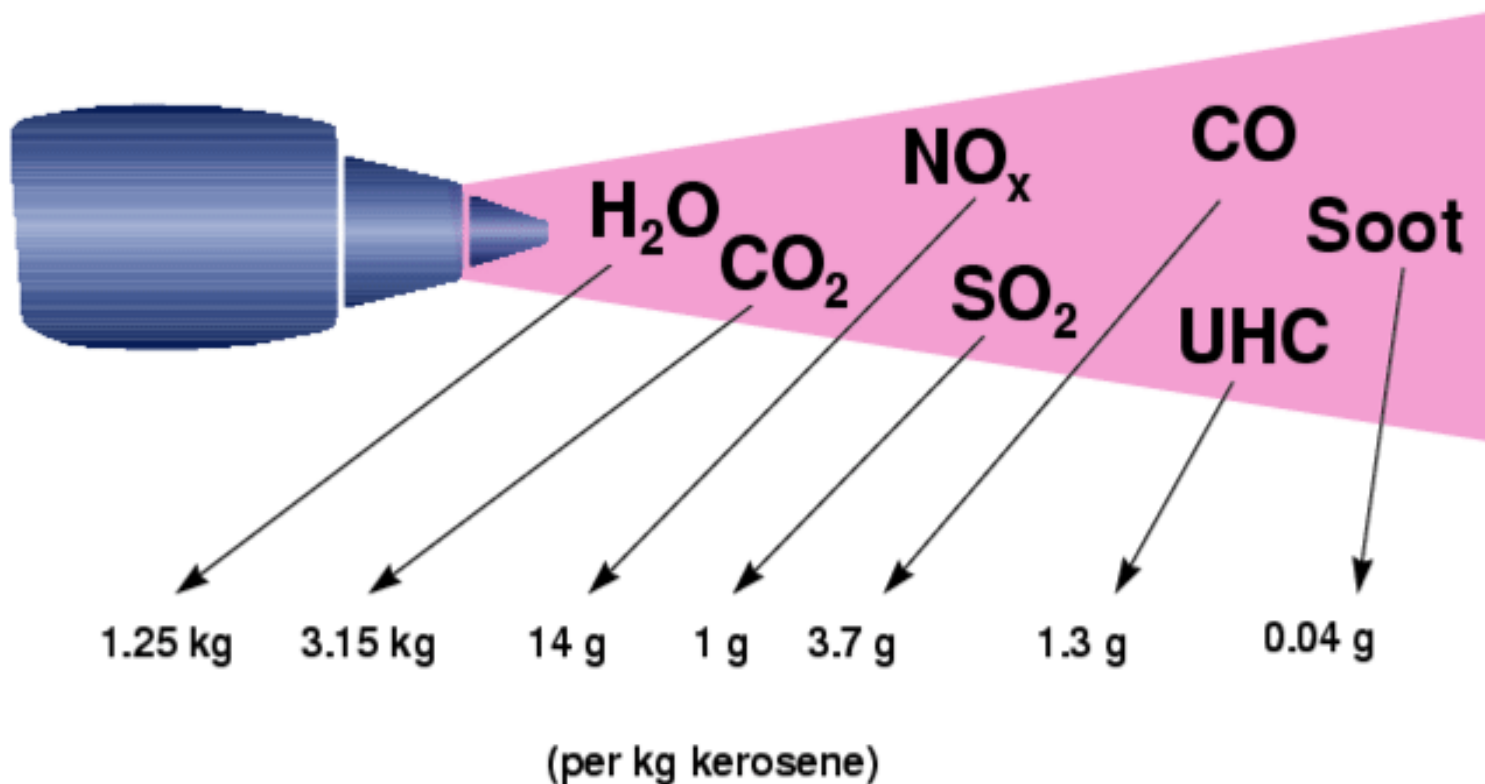
Data: unfccc.int
iea, 2016

- International Aviation
 - emits eq.CO₂ comparable to a large EU country
 - shows large increase in emissions



Air traffic emissions at cruise

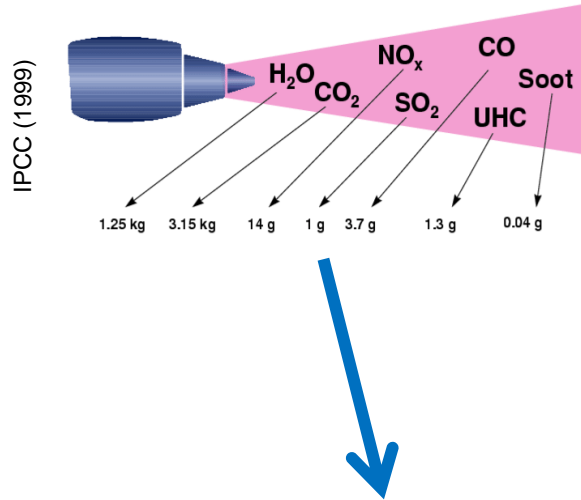
Combustion products • depending on operating conditions
• at cruise altitude



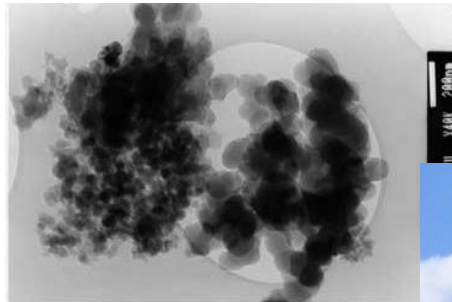
IPCC (1999)



Climate impacts via non-CO₂ effects

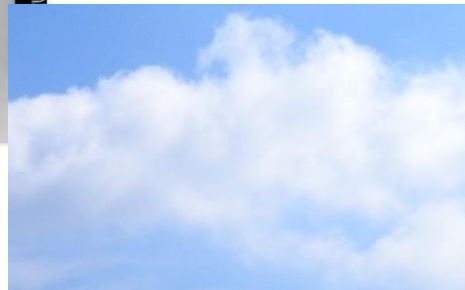


Air chemistry
ozone
methane

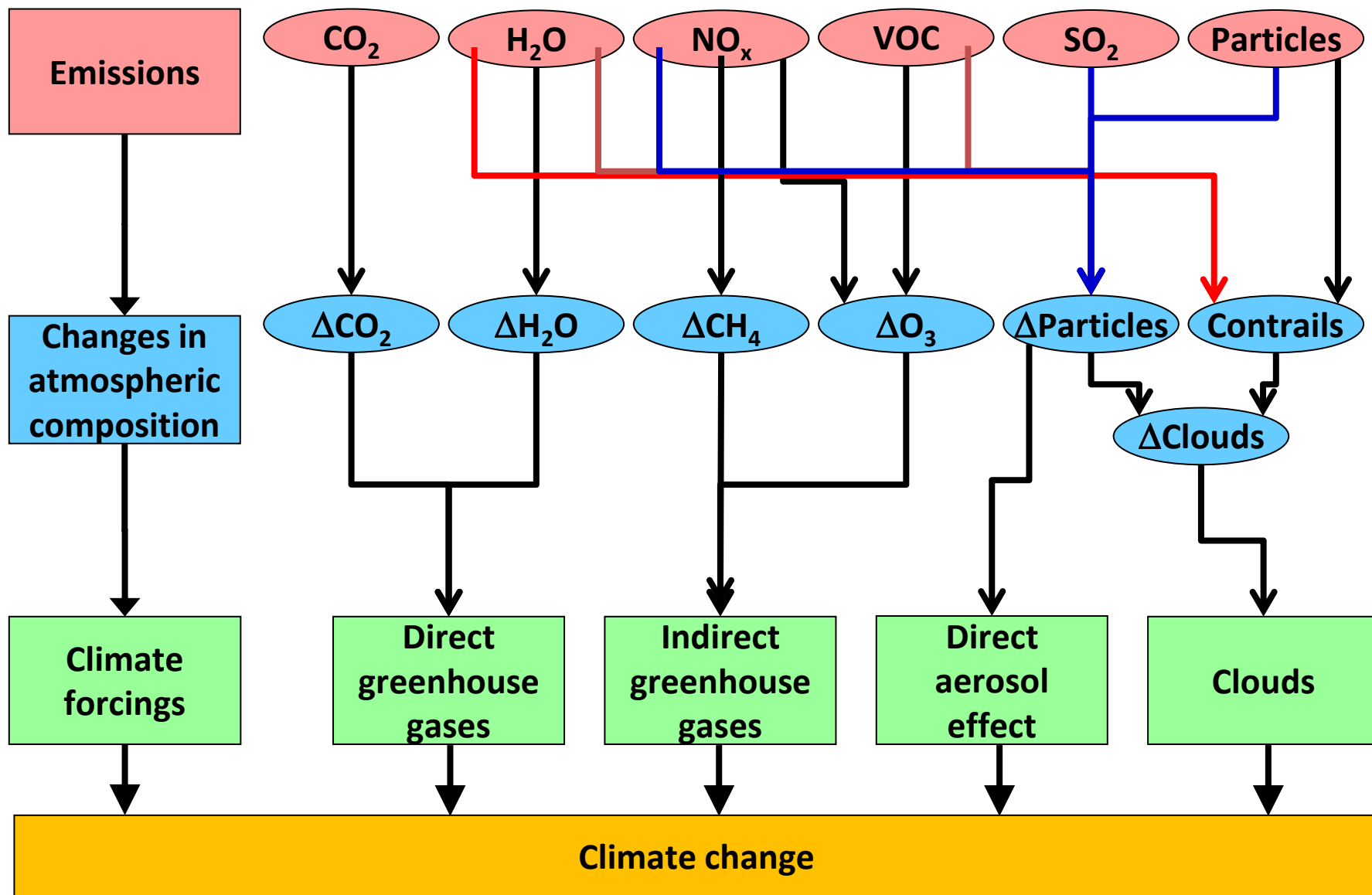


Popovicheva et al. (2004)

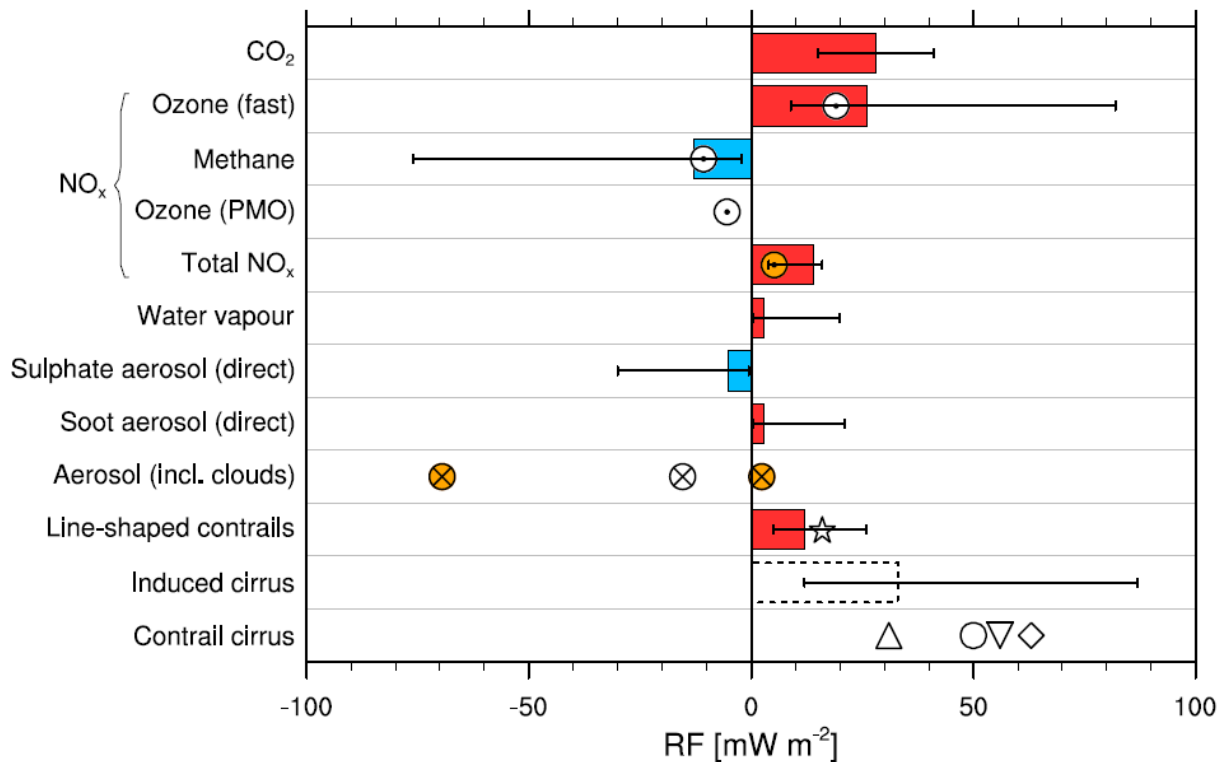
Aerosols
and effects on clouds



Atmospheric effects of aviation



Radiative Forcing in 2005 from historical aviation emission



Carbon Dioxide, NO_x emissions, and contrail cirrus are main contributors to aviation induced RF.

Level of Scientific Understanding (LoSU) varies between individual effects

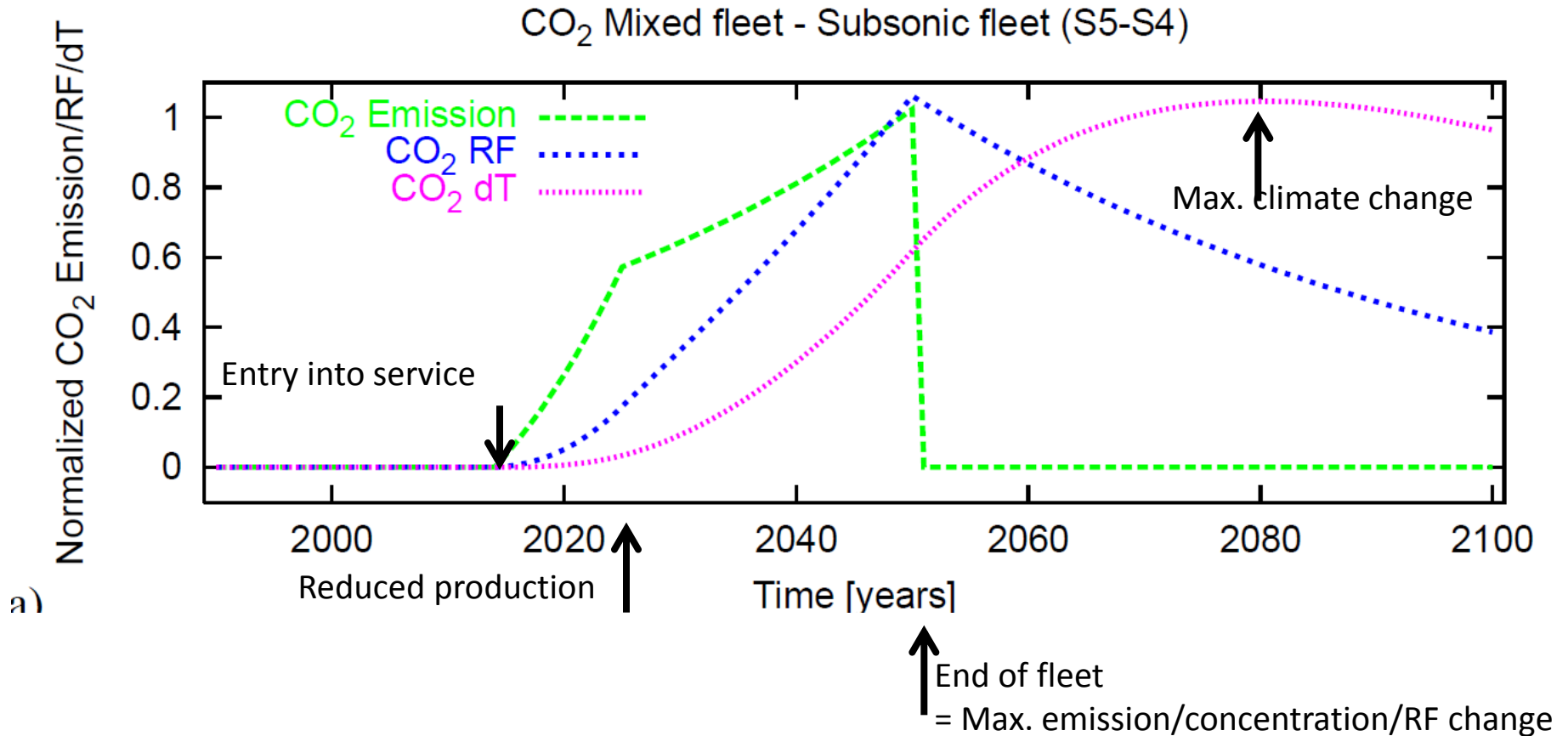
- ⊙ Søvde et al. (2014): EMAC, multi-model mean
- ⊗ Righi et al. (2013): reference case, parameter span
- ☆ Voigt et al. (2011)
- △ Burkhardt and Kärcher (2011)
- Schumann and Graf (2013)
- ◇ Schumann et al. (2015)
- ▽ Bock and Burkhardt (2016)

Grewe et al. (2017)

Data are based on Lee et al (2009) with update from various more recent publications



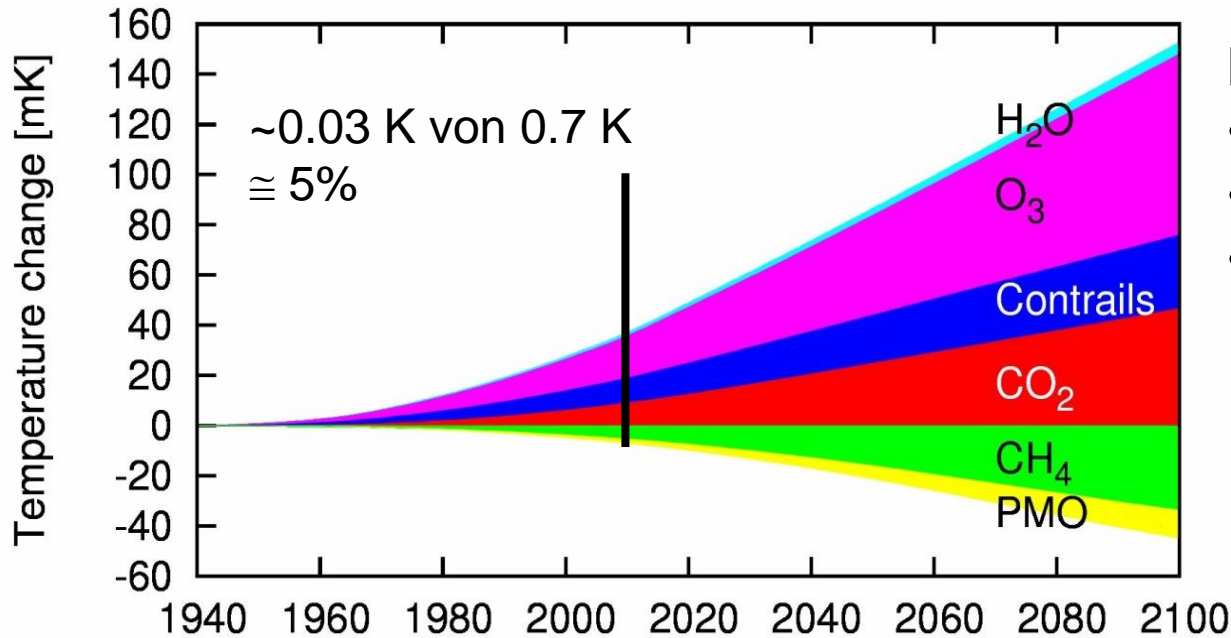
Difference between emissions, RF, and dT (Thought experiment)



Grewe and Stenke, 2008



Aviation's impact on global mean 2m-temperature



Main contributors :

- CO₂
- Contrails
- NO_x (O₃ and CH₄)

PMO=„Primary mode ozone“
Results from less CH₄
⇒ less HO₂ ⇒ less O₃ production

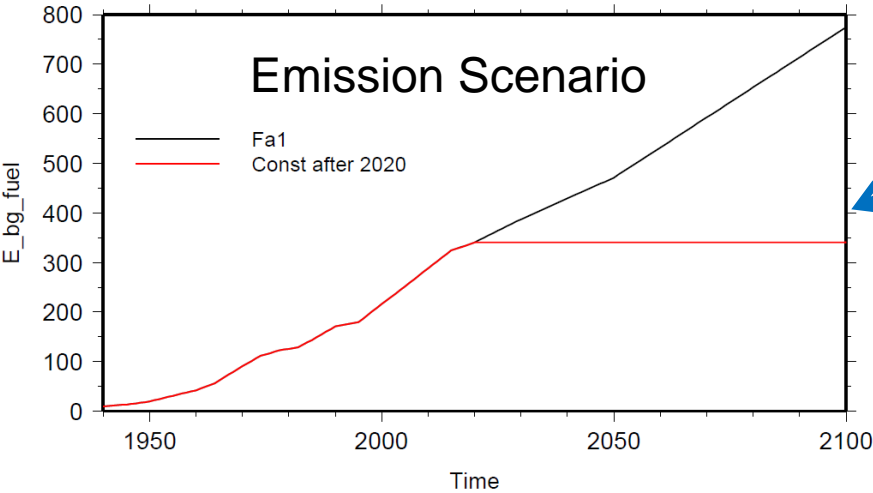
Air traffic contributes to climate change by roughly 5%.



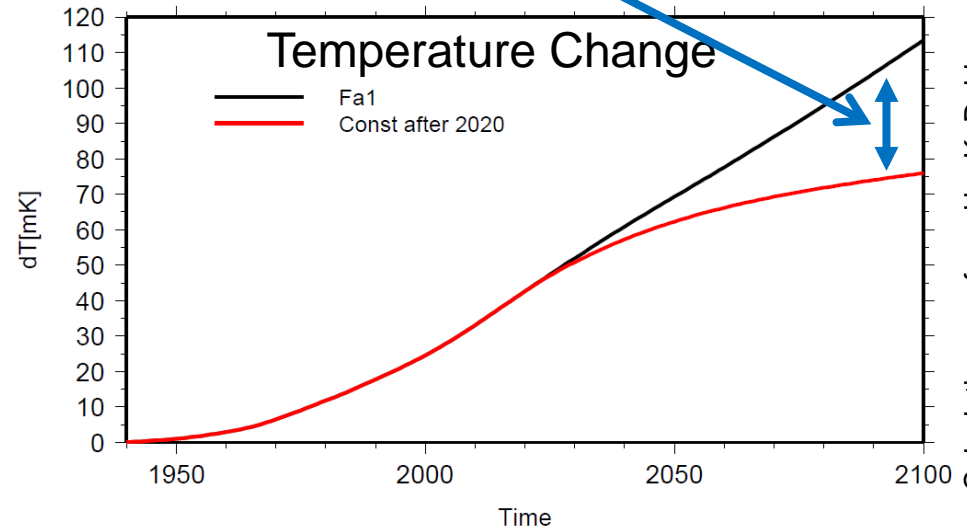
Comparison of a "Business-as-Usual" (FA1) with a "Constant Emission Scenario"

"CORSA"-Scenario:

- Effective CO₂ emissions constant after 2020
- Non-CO₂ effects will follow fuel consumption
- Temperature change hence between FA1 and const. scenario



- Temperature increase even with constant emission
- Non-CO₂ effects unaffected from offsetting



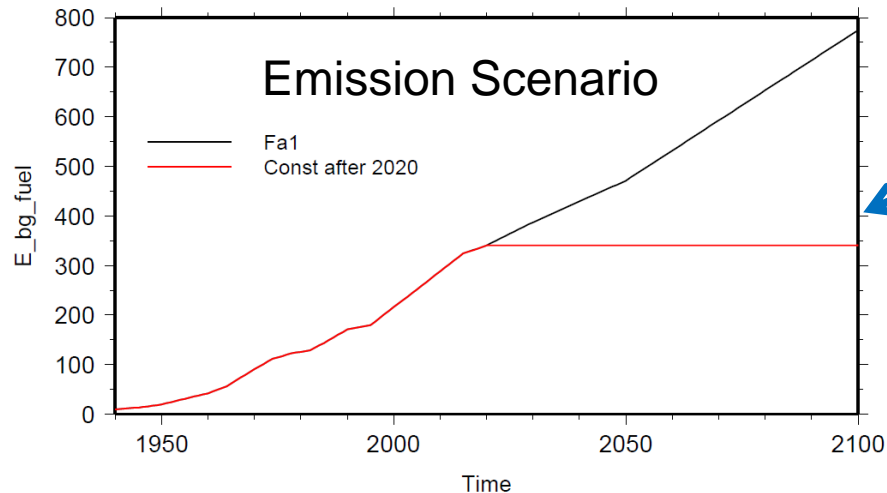
Calculations performed by K. Dahlmann, DLR, using AirClim



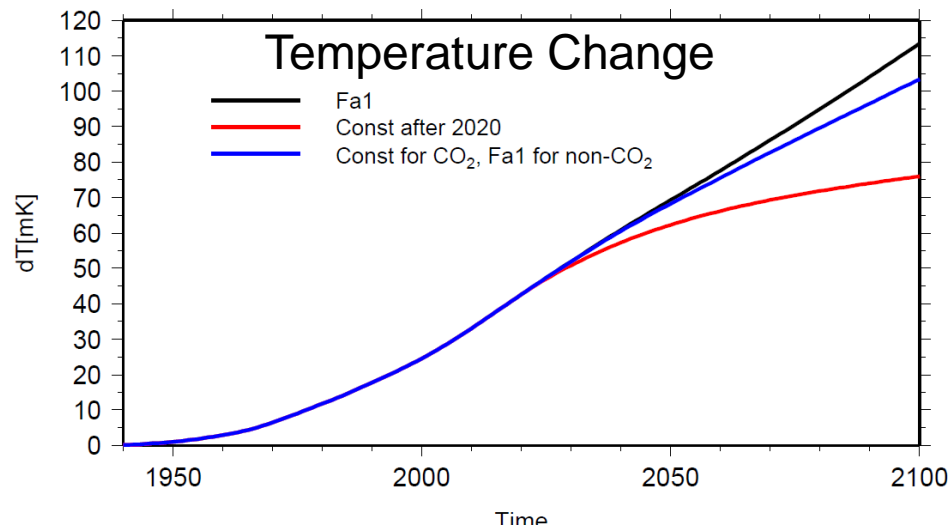
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Summary

- Aviation emits CO₂ in the order of a large European Country
- CO₂ emissions from aviation increase
- Non-CO₂ effects are large
- Roughly 5% of the anthropogenic warming is caused by aviation
- Constant emissions of CO₂ will still lead to temperature increases over decades
- Off-setting CO₂ is not affecting non-CO₂ effects





Thank you for your
attention

