Aviation non-CO₂ effects and climate mitigation options

Volker Grewe <u>DLR-Institute for Atmospheric Physics</u> TU Delft, Chair for Climate Effects of Aviation ECATS WG-Lead Knowledge for Tomorrow



DLR.de • Chart 2 > Airneth Workshop 10/12/2019 > V. Grewe • Climate impact of aviation and mitigation options Aviation emission and climate impact



DLR.de • Chart 3 > Airneth Workshop 10/12/2019 > V. Grewe • Climate impact of aviation and mitigation options

Overview: Climate impact of aviation



How important are the aviation non-CO₂-effects?



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Time scales: Emission – RF – dT (Thought experiment)



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Climate mitigation options for aviation

- Technology Measures
 - New aircraft designs
 - Cruise altitude changes
 - Fuel efficiency
 - Emission reduction
 - Alternative fuels
- Operational Measures:
 - Avoidance of climate sensitive regions
 - Closure of airspace
 - Intermediate Stop Operations (
 - Formation filght
- Economical Measures
 - Market-Based Measures
 - Carbon off-setting





KIAD

Vashington Dulle

FL388 - 05:00 Day

Burkhardt et al. 2018

nate friendly, but conflicts

FL370: cheapest, but conflicts

FI 310: climate friendly, no con

Grewe et al. 2014

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ange

2



Both Directions

-10

-5

Grewe et al. 2017

Eastbound

-15

-20

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DLR-Project CATS: Climate Compatible Air Transport System Focus on a long-range aircraft



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CATS-optimisation approach

- Variation of initial cruise altitude and speed
- Optimal relation between costs and climate
- Definition of new design point
- Optimisation of the new aircraft for this new design point



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A330: Potential of a climate change reduction: CATS-results

Variation in speed an cruise altitude



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CATS Final results



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Different weather situations: Evolution of aircraft NO_x





Weather type #3 "Weak and tilted jet"

What happens if an aircraft emits NO_x at location A compared to location B?





DLR.de • Chart 13 > Airneth Workshop 10/12/2019 > V. Grewe • Climate impact of aviation and mitigation options **Evolution of O**₃ [ppt] following a NO_x pulse



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Avoiding climate sensitive regions: The approach



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Climatology based on 8 representative weather pattern





- Very flat Pareto-Front \Rightarrow Large benefits at low costs
- Win-Win situations exist, where a reduction in both, climate impact and fuel use, can be achieved due to inefficiencies in ATM. Grewe et al. (2017), Matthes et al. (2017)



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Why are non-CO₂-effects important to be considered in





North-Atlantic Flight routed





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Summary

- Enhanced knowledge on the processes related to aviation emissions.
- More than 50% of the climate impact from aviation due to non-CO₂ effects.
 - Aerosol impacts on clouds are uncertain
- Uncertainties remain, but may be better understood and can be employed to obtain robust solutions
- More mitigation studies, which include non-CO₂ effects.
 - Climate-sensitive areas could substantially reduce the climate impact of aviation at low cost increase.
 - CO₂ versus non-CO₂ trade-offs have to be solved
- Non-CO₂ effects play an important role and are not part of CORSIA, but may be included via equivalent CO₂ emissions or other means
- Combination of several options necessary: Alt. fuels + Tech + Operations





