STAY GROUNDED

countering aviation – for a just transport system

Network Meeting - Fall 2020

THE REAL CLIMATE IMPACT OF AVIATION



HOW TO ZOOM

- 1. Rename your profile with your name and organization (click on participants and rename yourself)
- 2. Keep mic muted if you don't speak (use the chat function in case you experience difficulties during presentations)
- 3. Raise hands: Use the chat and make a star * if you want to speak
- 4. This meeting is being recorded and made available publicly the recording starts now.



AGENDA OF THE WEBINAR

- 1. Non-CO₂ impacts: What are the latest figures and what do they mean? Eric Lombard Rester sur Terre (SG France)
- 2. Mitigating the climate forcing of contrails. Marc Stettler Imperial College London
- 3. What should regulators do? Bill Hemmings - Aviation consultant (Rosetta advisory services Brussels)
- 4. Discussion



Non-CO₂ impacts of aviation What are they and how much is it?







- 1. Produced by the combustion of kerosene in reactors: 1 Gt/yr
- 2. Produced in upstream operations (Well to tank): 0.2 Gt/yr
- 3. Total contribution of aviation : 2.9% of all human-caused CO₂
- 4. Long-lived: accumulates in the atmosphere. Still 30% after 100 years





- 1. NOx (nitrogen oxides) are not greenhouse gases (not to be confused with nitrous oxide, N₂O, a powerful GHG).
- 2. But they react in the upper atmosphere and:
 - produce ozone (O₃), a GHG, lifespan = 1 mo (heating effect)
 - destroy methane (CH₄), a GHG, lifespan = 12 yr (cooling effect)
- 3. Overall heating effect



Contrails and contrail cirrus

 Water vapor + soot + cold / humidity → Contrails (ice crystals) Life-span = 1 h

- 2. Contrails sometimes \rightarrow Contrail cirrus. Life-span = 1 day
- 3. Contrail cirrus forcing dominates that of persistent linear contrails (90/10)
- 4. Cooling in the day, heating at night. Overall heating effect
- 5. Very few flights account for most of the energy forcing (2% of flights account for 80% of the EF in <u>Marc Stettler's study</u> in Japan).



Contribution of aviation to climate heating How much?

What are we talking about? Two ways of dealing with the question:

- 1. How much has aviation already contributed to the currently observed heating (about 1°C)?
- 2. How much do emissions of aviation contribute to additional heating caused by overall human ongoing activity (in a year for instance)?



1. Historical contribution of aviation

To date[#], the radiative forcing of aviation is responsible for 3.5% of the observed heating.

It is the result of:

- CO₂ accumulated since the beginning of aviation: $\frac{1}{3} = 1.2\%$
- Short-lived non-CO₂ that constantly appear and vanish, as long as there are planes in the sky: $\frac{2}{3} = 2.3\%$

[#] 2011 data (<u>Lee et al 2020</u>)



2. Contribution of aviation to the ongoing additional heating

Today[#], aviation emissions account for 5.9% of all human-caused additional heating.

It is the combination of:

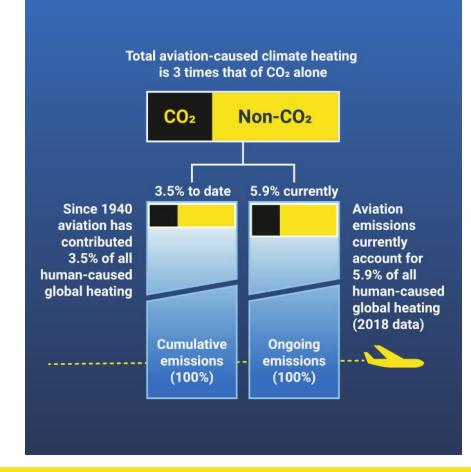
- CO₂ emissions from oil well through flights = 1 + 0.2 Gt CO₂/yr
- non-CO₂ emissions = 2.1 Gt CO₂e*/yr

Total: 3.3 Gt CO₂e*/yr (over 56.1 Gt CO₂e*/yr)

[#] 2018 data (Lee et al 2020)



Key figures





The past or the future?

"Aviation has already contributed **3.5%** to the currently **observed heating**", is what has been retained from Lee's recent article. It's the result of **past** air traffic.

What's important for the **future** is what we are doing now! And today (before Covid), aviation emissions account for **5.9%** of all human-caused **additional heating**. It's what we must all say!

Multiply CO₂ by 3 is valid for the past as well as for the present.



GWP*: a new approach for calculating CO₂ equivalent of short-lived species

Let's think of radiative forcing as blankets that keep the earth warm!

For short-lived blankets like contrail cirrus:

- if air traffic is constant, the thickness remains constant : there as many contrail cirrus being formed as disappearing
- If air traffic grows, the thickness of the blanket increases
- If air traffic decreases, the thickness decreases.

► Adding some CO₂eq. for contrail cirrus and other non-CO₂ emissions is only necessary if traffic grows.



Why use GWP* rather than GWP or GTP?

GWP* <u>first proposed for methane</u>, now extended to very short-lived emissions of aviation.

Using GWP*:

- preserves the link between emissions and warming/cooling of the atmosphere
- is less dependent on time horizon.

Aviation	GWP20	GWP50	GWP100	GWP*20-100	
Tot CO ₂ -e / CO ₂	4.0	2.3	1.7	3.0	(Multiplier)



GWP*: a change in the way of thinking

From: adding a non-CO₂ burden, proportional to CO₂ emissions, to every flight

To: adding a non-CO₂ burden, proportional to traffic growth, to aviation as a whole

Outcome:

- 1 Gt CO₂ for every 1 mW/m² incremental Effective radiative forcing (increased blanket thickness).
- For the last 18 years, average increase of non-CO₂ ERF = 2 mW/m²/yr
- non-CO₂ burden = 2.1 Gt CO₂-e*/yr

1 Gt CO₂ + 2.1 Gt CO₂-e* = 3.1 CO₂-e* (2018, without Well to Tank)



A new argument for degrowing aviation

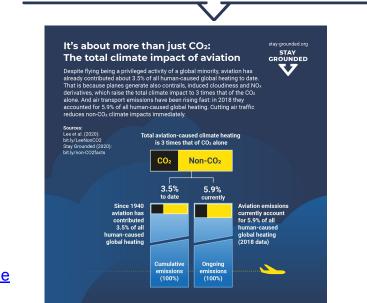
Degrowing aviation reduces the thickness of the non-CO₂ blanket

- It's equivalent to CO₂ negative emissions (withdrawing CO₂ from the atmosphere)
- It has an immediate effect

Potential : 67 Gt CO₂-e (about twice the emissions of aviation since 1940 or 1.6 times the annual worldwide emissions of CO₂)



IT'S ABOUT MORE THAN JUST CO2



Aviation's climate impact is 3x that of its CO2 alone
In 2018, it caused 5.9% of global emissions
Cutting air traffic reduces emissions immediately
Mitigation is possible, but resisted

 Account for CO2 AND non-CO2 emissions
 Take measures to reduce ALL impacts
 Apply operational and technological improvements

Keep air traffic low

FACT SHEET | OCTOBER 2020

It's about more than just CO₂

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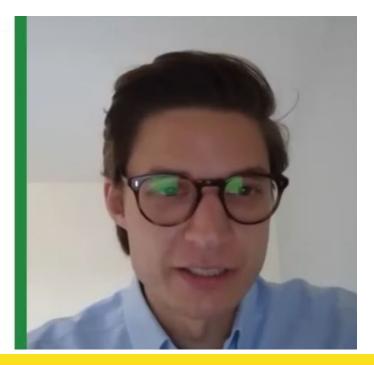
Mitigating the climate forcing of contrails

Imperial College London

Non-CO₂ impacts: mitigating the climate forcing of contrails

- Roger Teoh, Marc Stettler, Center for Transport Studies, Imperial College, London
- Ulrich Schumann, DLR (German Centre for Air and Space Travel)

Decarbonisation of Aviation 17th June 2020





Flight diversion over Japan: Key results

- 18% of flights forming contrails
- Maximum warming between 3 pm and 6 am. Cooling may occur in daytime
- 2.2% of flights generating 80% of the Energy forcing (EF)

Small change in flight altitude (+/- 2000 ft) of 1.7% of flights :

- Reduction of EFContrail: 59%
- Reduction of EFTotal: 36%
- CO₂ penalty: + 0.01% for the fleet



Mean 2006 net-contrail Radiative forcing from Aqua MODIS data

