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Climate change and aviation

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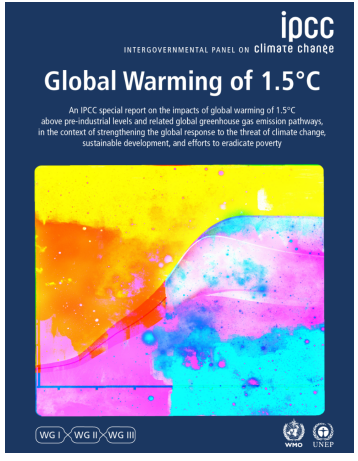
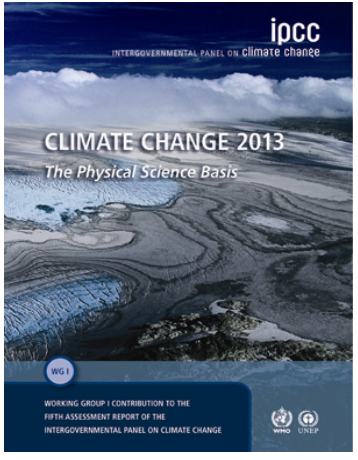
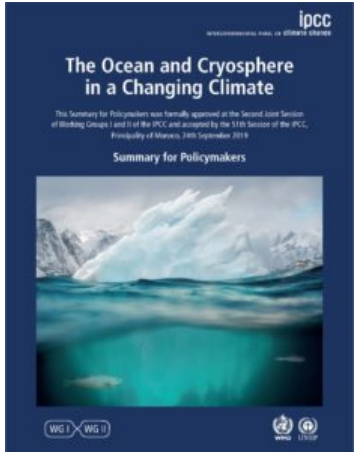
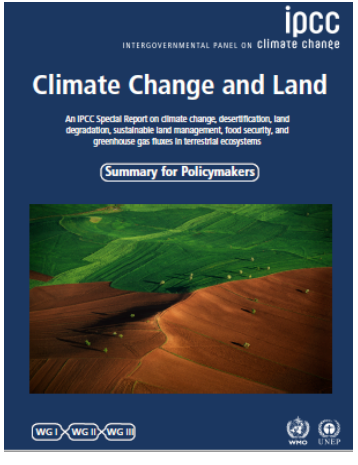
Climate change context

- Extensive recent background and advances
- A scientific reminder on CO_2
- Aviation and climate
- Challenges









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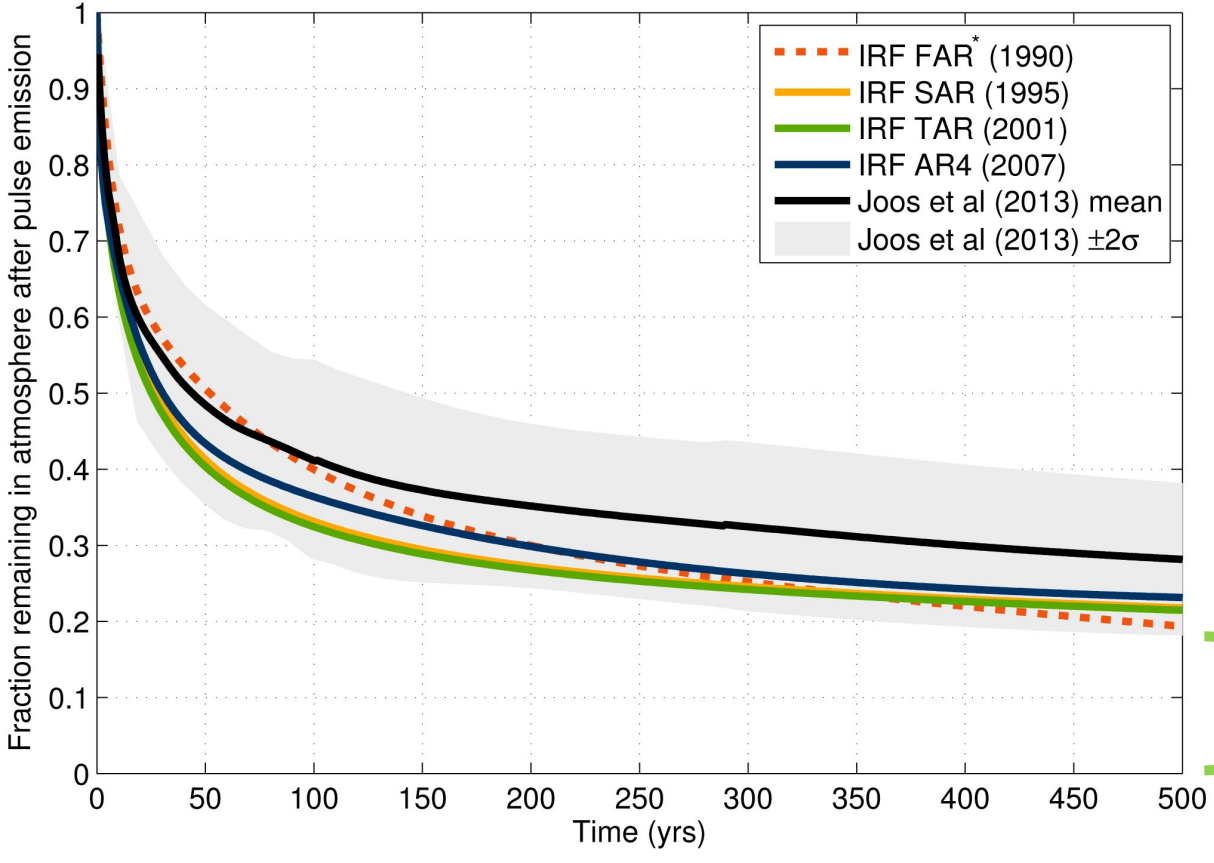
The importance of CO_2 – a scientific reminder



Looking at the decay of CO_2 emissions pulse

~ 50% removed within 30 years

~80% removed within a few centuries

~20% remains for many 1000s of years

Source: IPCC WG1, 2013, Chapter 8, Fig 8.SM.4, and IPCC WGI, 2007 Chapter 7

A scientific reminder of the metrics used

- 'Radiative Forcing' (RF, in watts per square metre) is used to quantify present-day impacts from current and (largely) historical emissions (in the case of long-lived greenhouse gases) as it has an approximately linear relationship with the equilibrium global mean surface temperature change (ΔT_s in Kelvin) since the onset of industrialization

$$\Delta T_s = \lambda \, RF$$

- Where λ is the climate sensitivity parameter in K $(Wm^{-2})^{-1}$
- Since IPCC AR5, the scientific community is now using the 'Effective Radiative Forcing' (ERF), since it accounts for fast feedbacks from e.g. clouds, aerosols better and has a better relationship with ΔT_s

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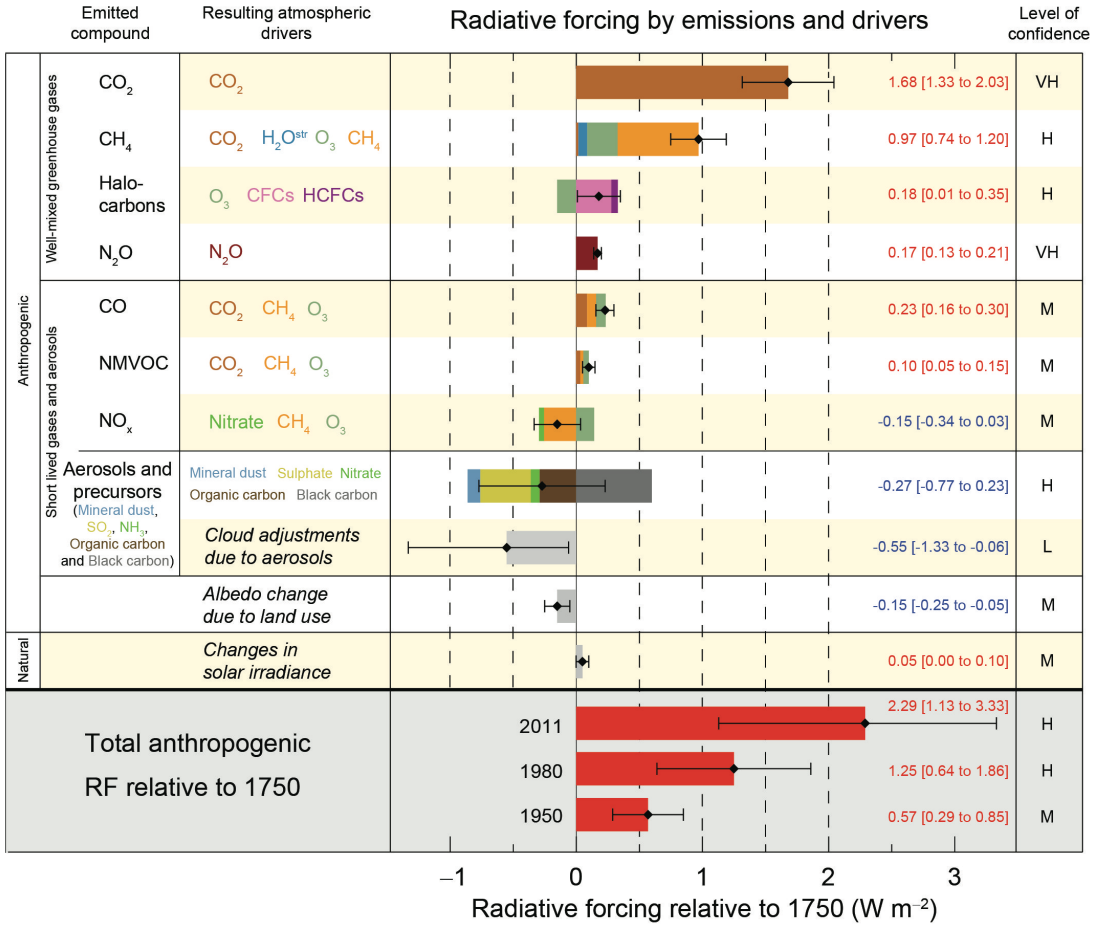


Source: IPCC WGI, 20013, SPM, Figure SPM.5

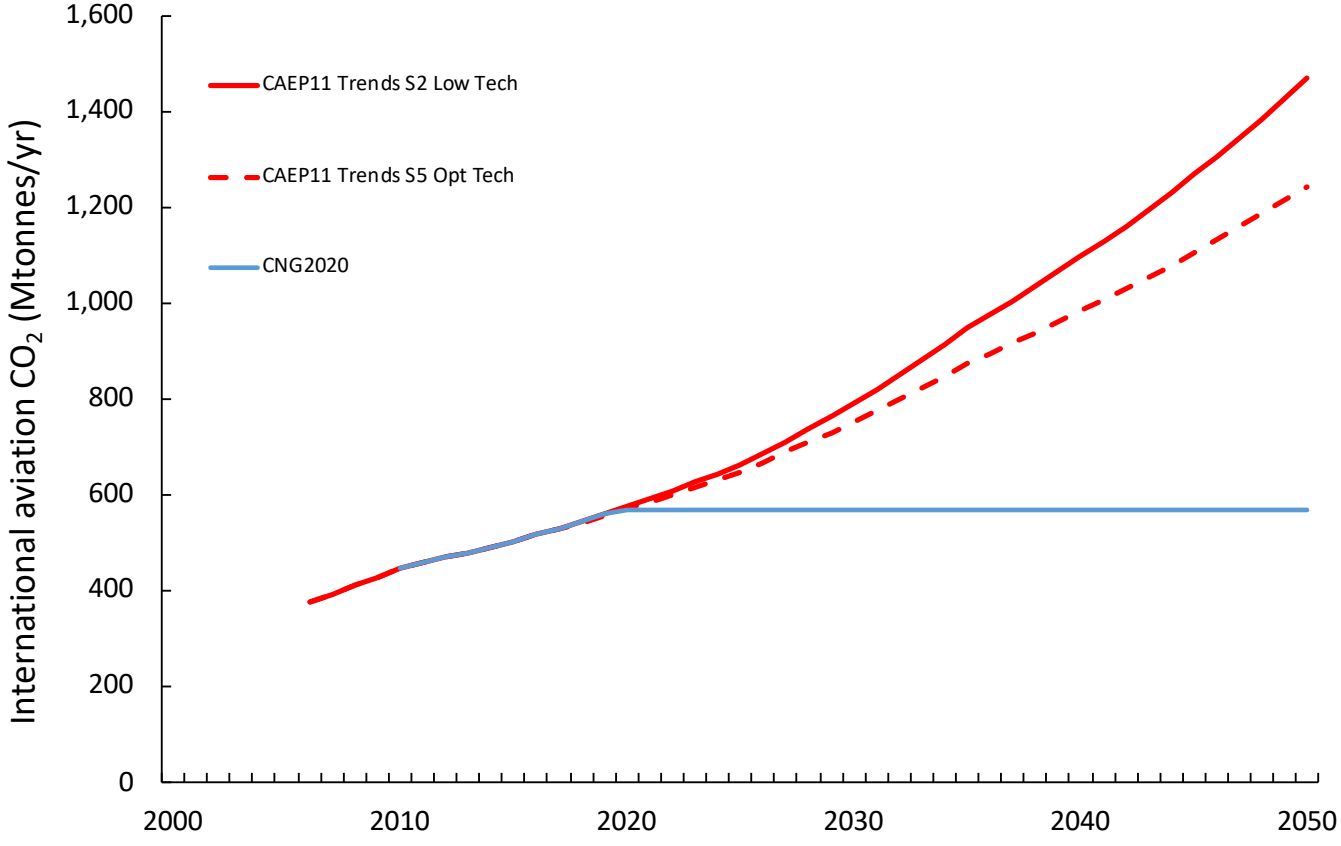
Aviation is more than CO_2

- The non-CO_2 impacts are ~65% of the present-day *Effective Radiative Forcing* from historical and current emissions
- They have larger uncertainties than CO_2 but
- Non-CO_2 impacts remain important

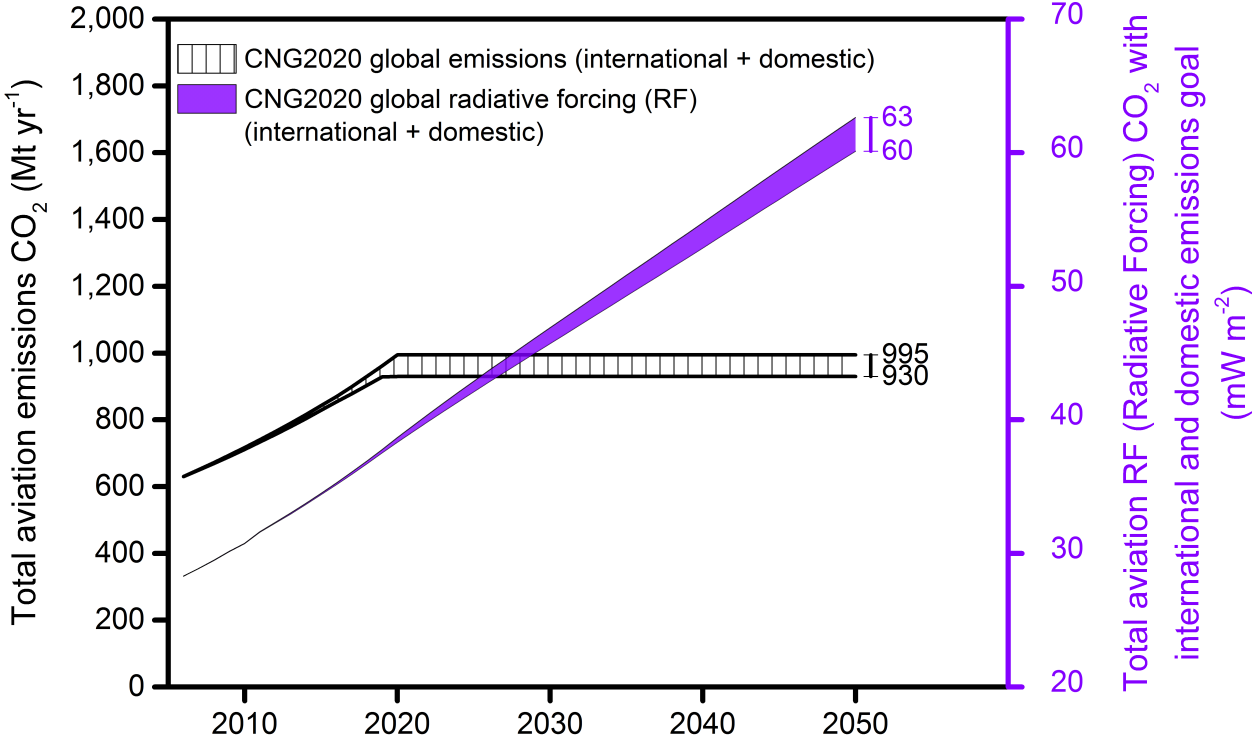
DRAFT – NOT FOR CIRCULATION

Source: Lee et al. (2020, under review)

International aviation CO_2 emissions



Why CO_2 is so difficult –scenario applying CNG2020 emissions of aviation CO_2



If the emissions stop increasing (stay constant in this case), the concentrations of CO_2 in the atmosphere continue to accumulate, and therefore the RF (and temperature response) continue to increase

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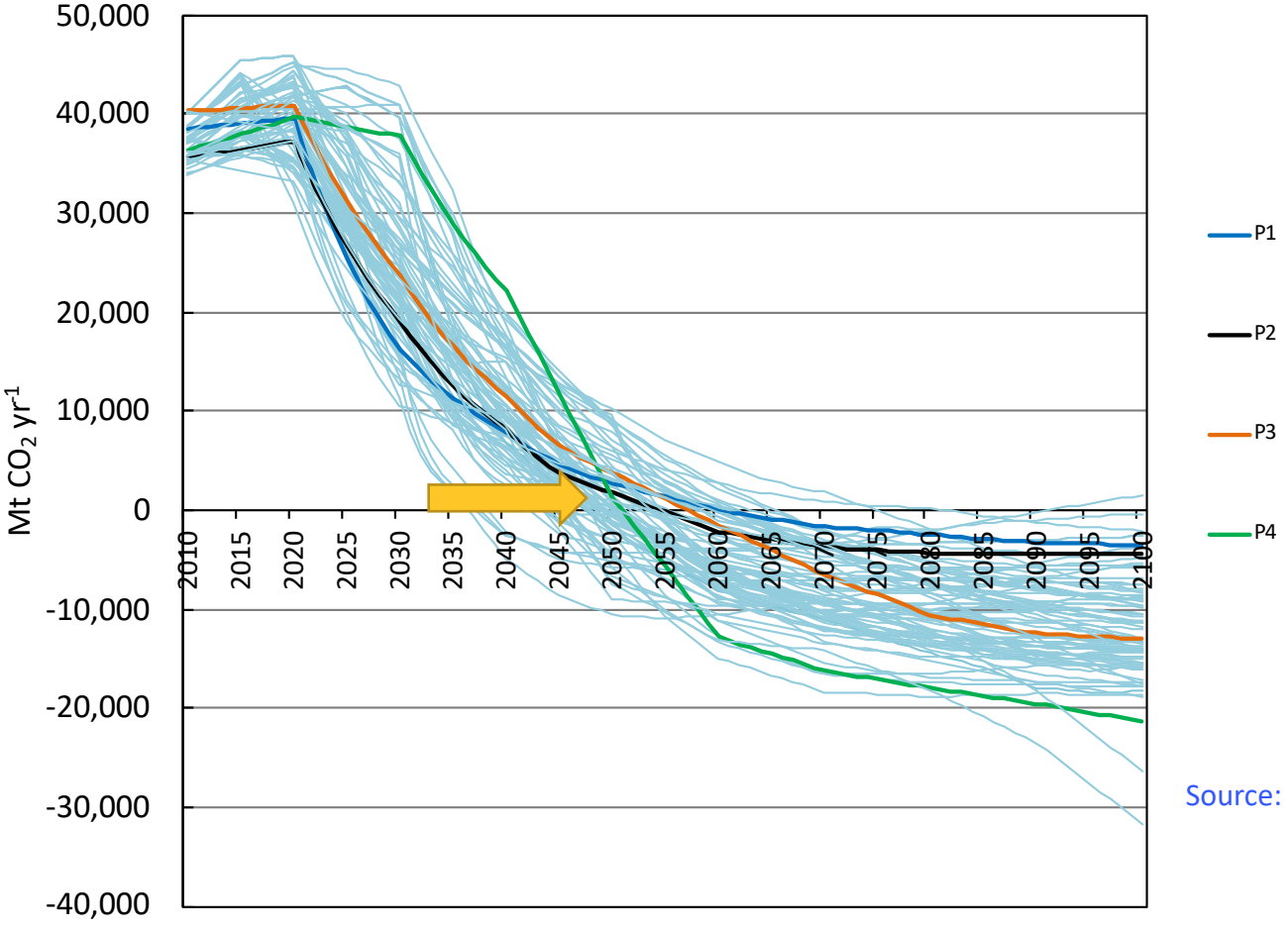
IPCC 1.5 degrees CO_2 emission data



Continued aviation CO_2 emissions to 2050 will be inconsistent with 1.5 degree emission

Scenarios P1 – P4 are illustrative pathways, see IPCC SR1.5 SPM for summary

Source: IPCC SR1.5 WGI re-drawn

Ongoing and potential future mitigation measures

Measures	CO_2	Change in non-CO_2
CORSIA	✔	✘
CO_2 Airplane Standard	✔	✔(if fuel ↓; small ↓ NO_x, if ≈ EI), potentially small ↑ in contrails
Operational improvements	✔	✔(if fuel ↓; small ↓ NO_x, if ≈ EI)
Lower C footprint biofuels	✔	✔ reduced aromatics, S in fuel: decreased contrails, decreased direct negative RF from S aerosol, unknown changes in aerosol – cloud interactions.
Carbon neutral synthetic fuels	✔	

Summary

- Achieving CNG2020 for international aviation CO_2 emissions will still result in a continued increase in RF (and temperature contribution)
- Aviation has additional non-CO_2 emissions, adding to the sector's RF and temperature contribution
- To meet Paris Agreement goals (Article 2a, 4) and net zero emissions by 2050*, continued CO_2 emissions from international aviation are problematic

* IPCC SR1.5 SPM C1 "*In model pathways with no or limited overshoot of 1.5ºC, global net anthropogenic CO_2 emissions decline by about 45% from 2010 levels by 2030 (40–60% interquartile range), reaching net zero around 2050 (2045–2055 interquartile range)*"