

Climate change and aviation

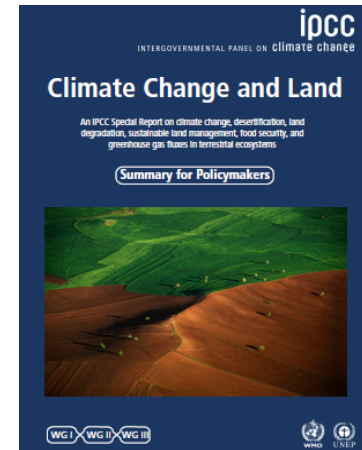
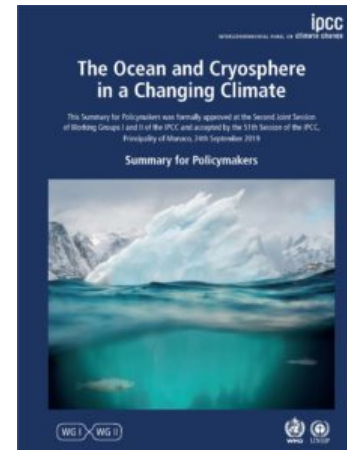
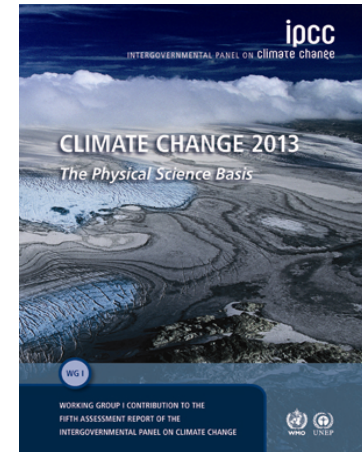
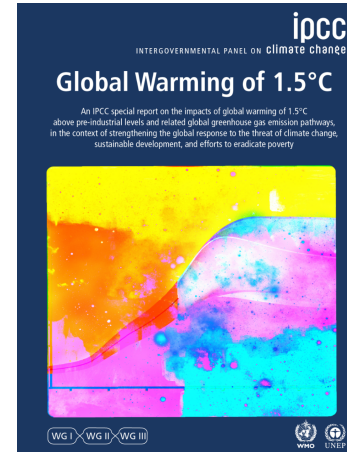
David S Lee, Manchester Metropolitan University, UK

David Fahey, NOAA Earth System Research Laboratories, USA

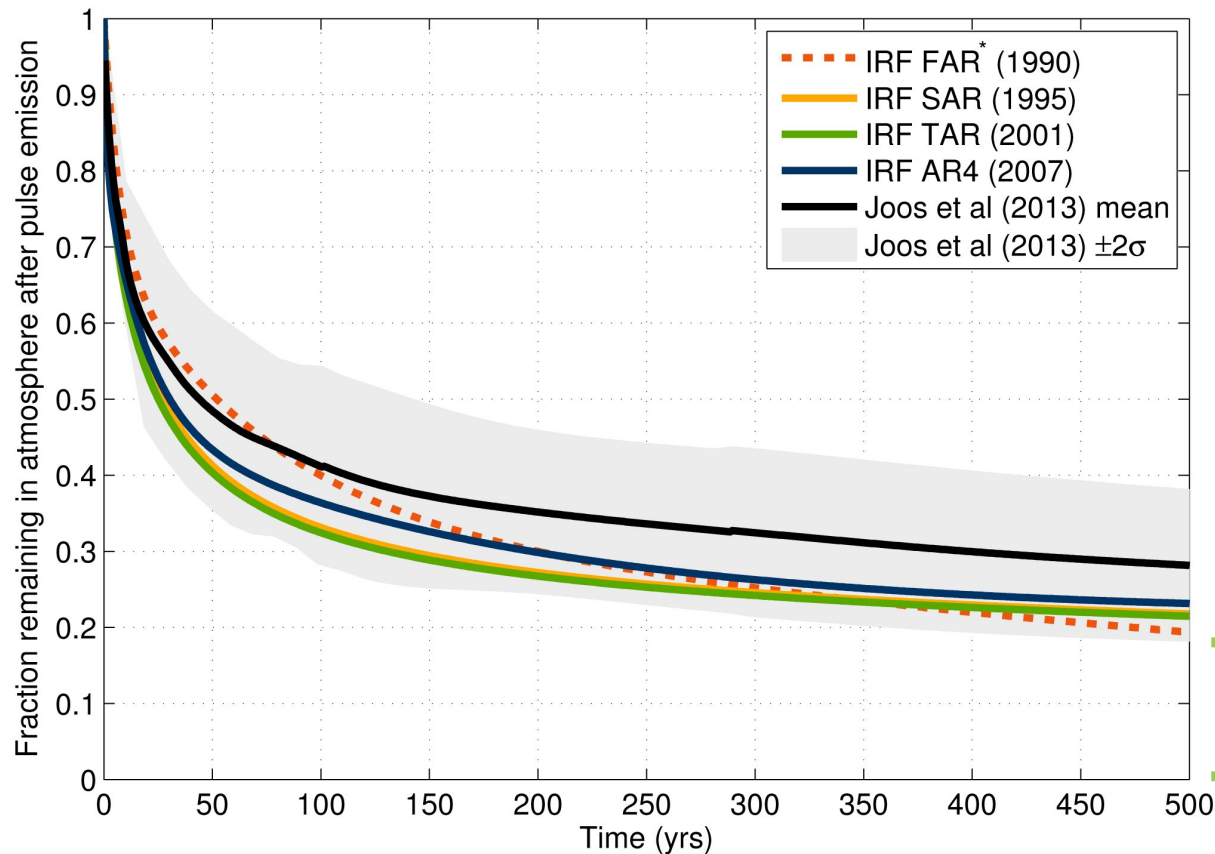
Jan S Fuglestvedt, CICERO and IPCC Vice Chair Working Group I, Norway

Climate change context

- Extensive recent background and advances
- A scientific reminder on CO₂
- Aviation and climate
- Challenges



The importance of CO₂ – a scientific reminder



Looking at the decay
of CO₂ emissions
pulse

→ ~ 50% removed
within 30 years

→ ~80% removed within
a few centuries

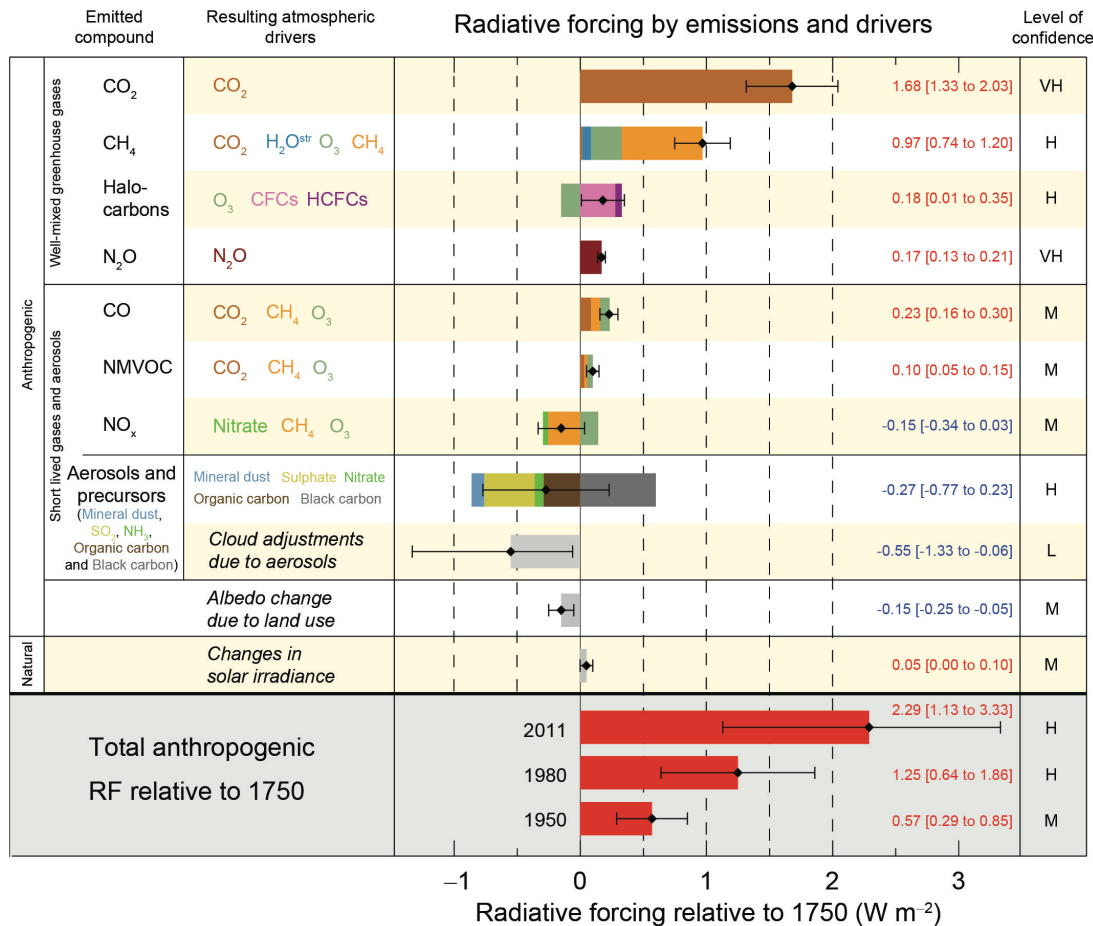
→ ~20% remains for
many 1000s of years

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

$$\Delta T_s = \lambda \text{ RF}$$

- Where λ is the climate sensitivity parameter in $\text{K (Wm}^{-2}\text{)}^{-1}$
- 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



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

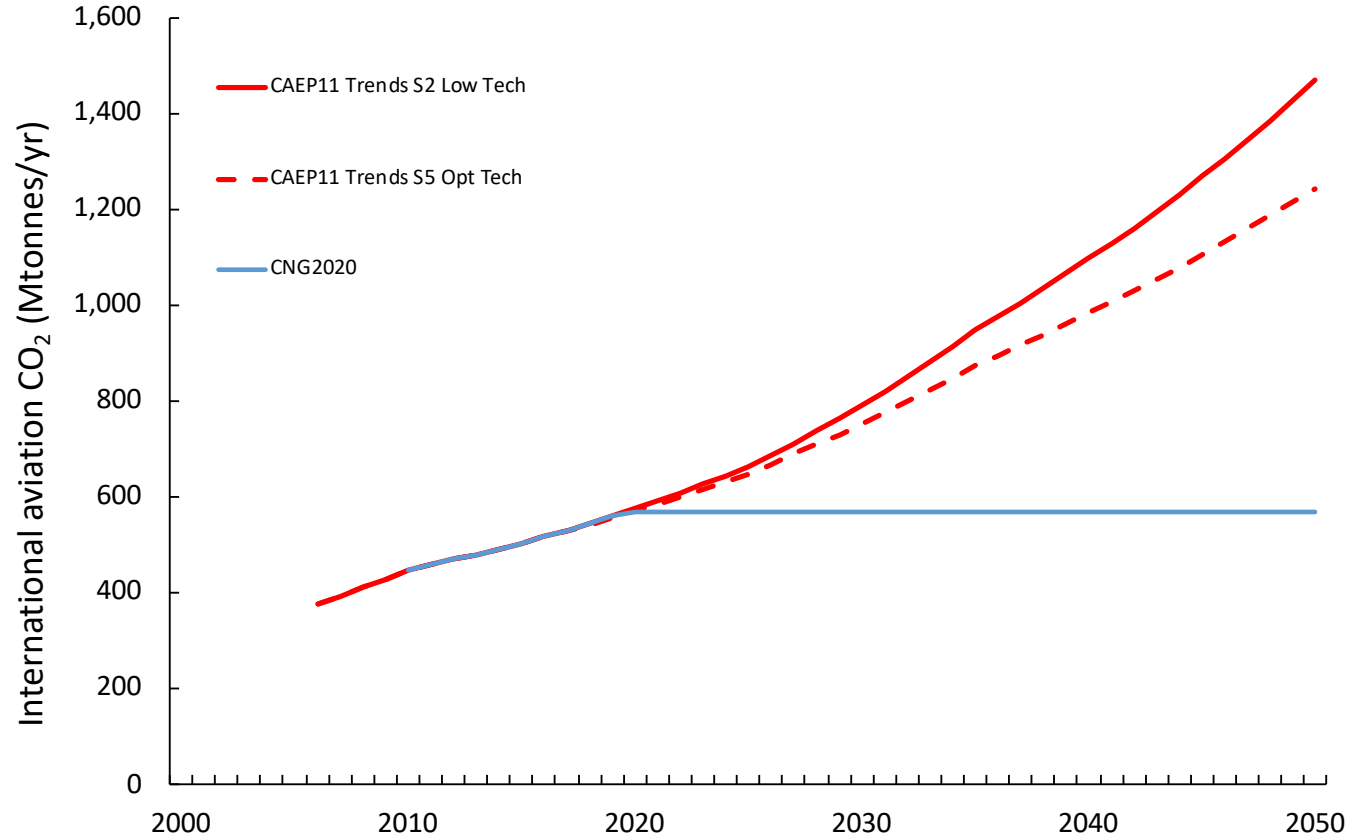
Aviation is more than CO₂

DRAFT – NOT FOR CIRCULATION

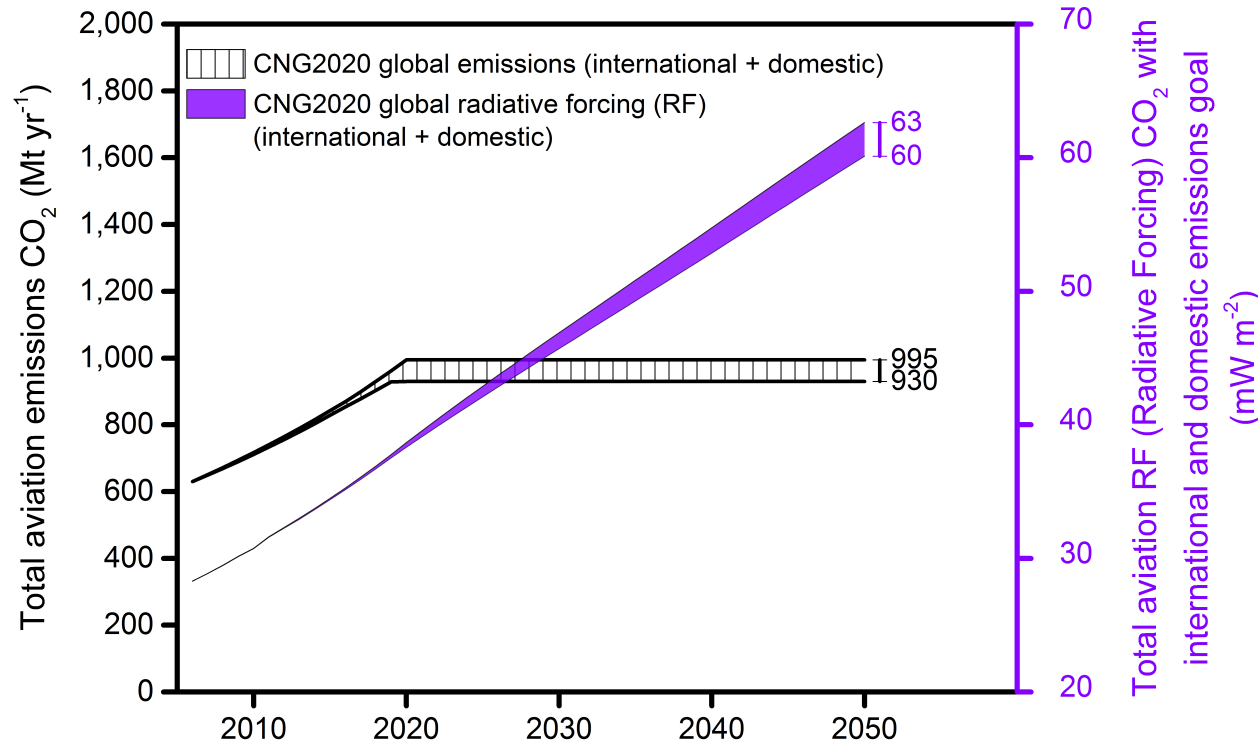
- The non-CO₂ impacts are ~65% of the present-day *Effective Radiative Forcing* from historical and current emissions
- They have larger uncertainties than CO₂ but
- Non-CO₂ impacts remain important

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International aviation CO₂ emissions

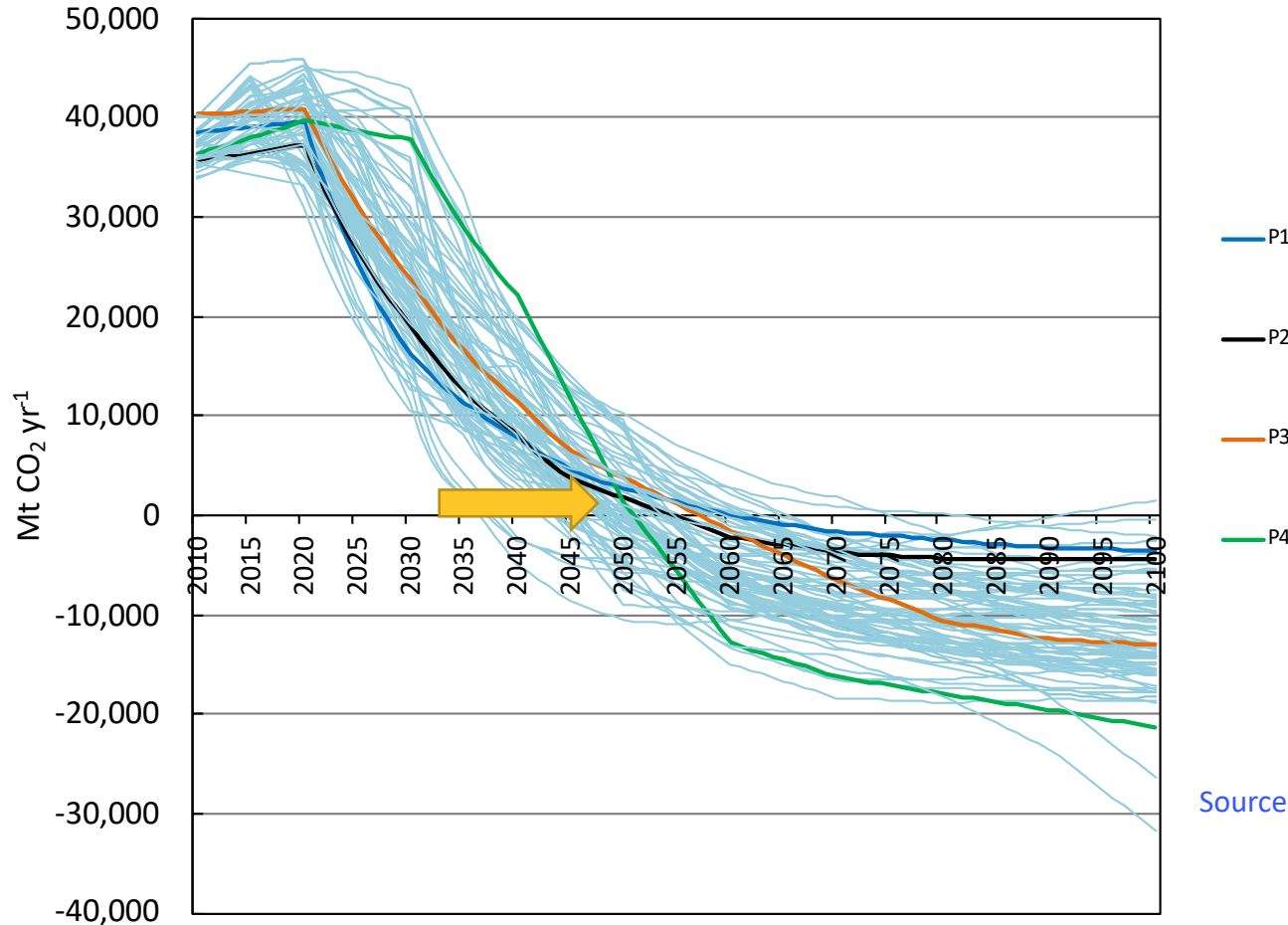


Why CO₂ is so difficult –scenario applying CNG2020 emissions of aviation CO₂



If the emissions stop increasing (stay constant in this case), the concentrations of CO₂ in the atmosphere continue to accumulate, and therefore the RF (and temperature response) continue to increase

IPCC 1.5 degrees CO₂ emission data



Continued aviation
CO₂ 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 CO₂ emissions will still result in a continued increase in RF (and temperature contribution)
- Aviation has additional non-CO₂ 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 CO₂ emissions from international aviation are problematic

* IPCC SR1.5 SPM C1 *"In model pathways with no or limited overshoot of 1.5°C, global net anthropogenic CO₂ emissions decline by about 45% from 2010 levels by 2030 (40–60% interquartile range), reaching net zero around 2050 (2045–2055 interquartile range)"*

