# Short-lived climate forcers (SLCF) in the IPCC WGIII AR6: Input to the TFI 3rd Expert Meeting

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# WGIII Context

- Trends and drivers
- Co-benefits and trade offs
- Impacts on emission scenarios
- Building sector: efficient cooling
- Transport: aviation and shipping

# Trends and drivers

Example of assessed SLCFs and their sources

- Aerosols, sulphur emissions or organic carbon (reduce forcing)
- Black carbon, carbon monoxide or non-methane organic compounds (NMVOC) (contribute to warming)
- These are co-emitted during combustion processes in power plants, cars, trucks, airplanes, but also during wildfires and household activities such as traditional cooking with open biomass burning.

# Trends and drivers

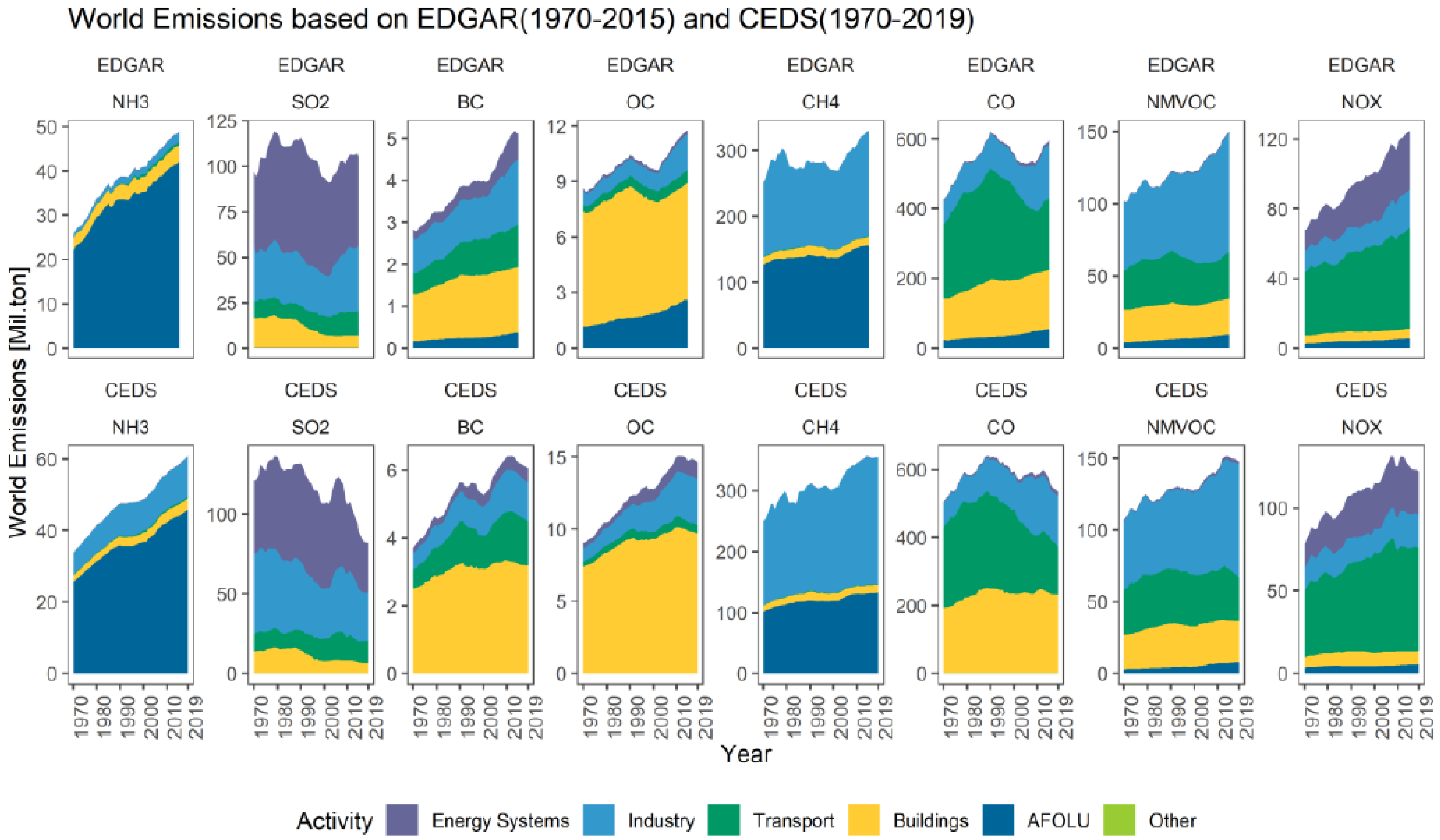



**Figure 2.8 Air pollution emissions in by major sectors from CEDS (1970-2019) and EDGAR (1970-2015) inventories**

Source: Crippa et al., 2019a, 2018; O'Rourke et al., 2020; McDuffie et al., 2020

- Conventional air pollutants that are subject to significant emission controls in many countries include: SO2, NOx, BC and CO.
- 2015-2019, global SO2 and NOx emissions have declined, mainly due to reductions in **energy systems**
- Also, reductions in BC and CO emissions appear to have occurred over the same period, but trends are less certain (poorly quantified traditional biofuel use).

# Trends and drivers

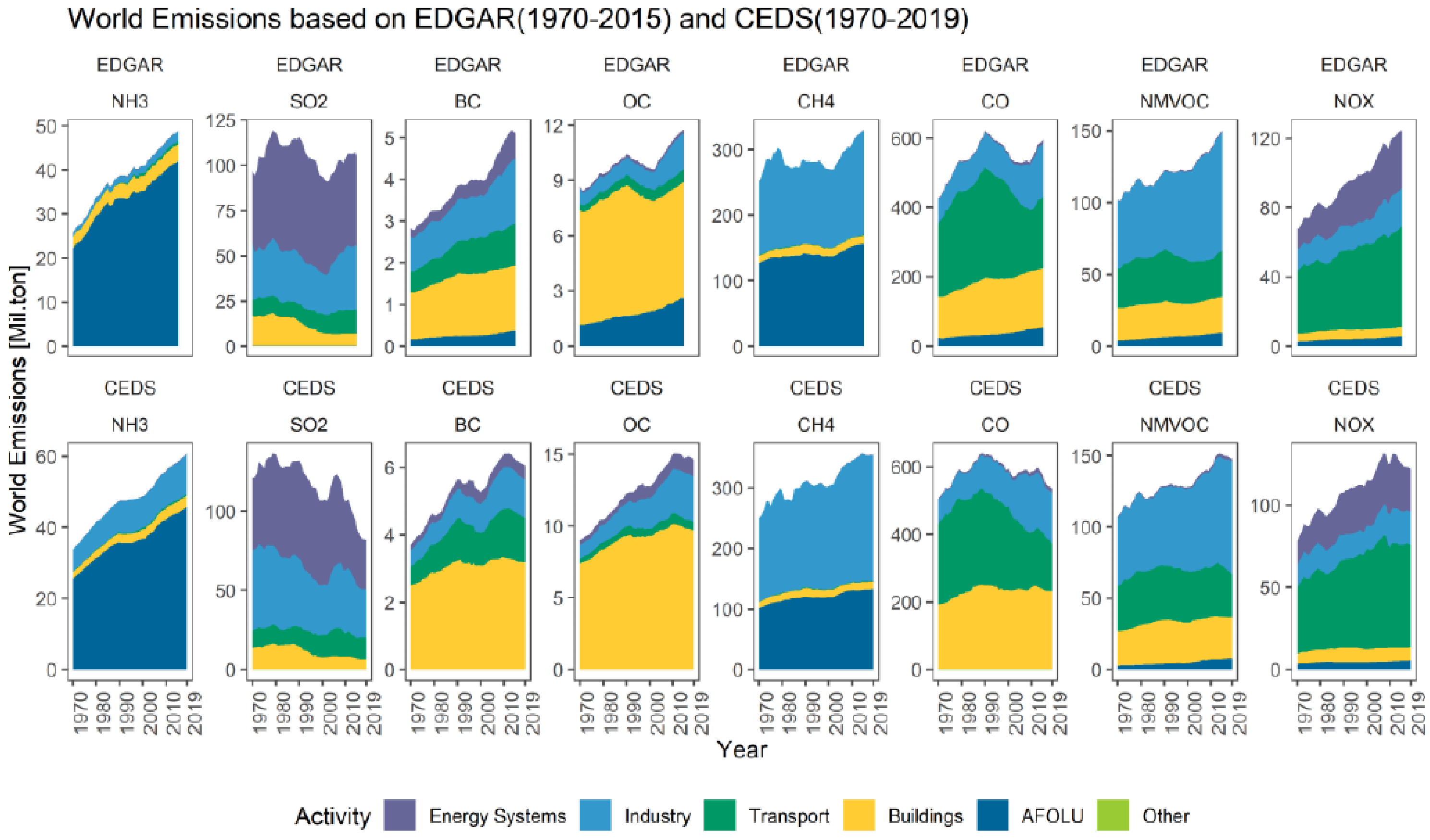



**Figure 2.8 Air pollution emissions in by major sectors from CEDS (1970-2019) and EDGAR (1970-2015) inventories**

Source: Crippa et al., 2019a, 2018; O'Rourke et al., 2020; McDuffie et al., 2020

- Emissions of CH4, OC and NMVOC have remained relatively stable in the past five years.
- OC and NMVOC may have plateaued, although there is additional uncertainty due to sources of NMVOCs that may be missing in current inventories

# Co-benefits and trade-offs

**Co-benefits**

SLCFs that contribute cooling: emission reduction thus leads to both air pollution and climate benefits.

- Reducing air-pollutants in the context of climate policies lead to substantial co-benefits of mitigation efforts
- Detrimental to human health, with estimates a total of 3.3 (1.6-4.8) million pre-mature deaths in 2010 from outdoor air pollution.

**Trade-offs**

SLCFs that contribute to warming: there is a possible trade-off

- As aerosol emissions are mostly associated with fossil fuel combustion, the benefits of reducing CO2 could, in the short term, be reduced as a result of lower aerosol cooling.

# Emission scenarios

- As these co-emissions have implications for net warming, they are also considered in long-term emission reduction scenarios as covered in the literature
- The smaller the residual Non-CO2 warming at the point of carbon neutrality, the larger the carbon budget.
- Deep SLCF emission reductions also increase the remaining carbon budget for a specific temperature goal
- Reducing SLCF emissions is critical to meet long-term climate goals and might help reduce the rate of climate change in the short term.
    - A strong reduction in methane emissions is the most critical component in Non-CO2 mitigation to keep the Paris climate goals in reach

# Building sector: efficient cooling

- **Synergies (HFCs)**: one possible synergy between SLCF and climate change mitigation is the simultaneous improvement in energy efficiency in refrigeration and air-conditioning equipment in the **building sector** during the hydrofluorocarbon (HFC) phase-down, as recognised in the Kigali Amendment to the Montreal Protocol.

- The Kigali Amendment and related national and regional regulations are projected to reduce future radiative forcing from HFCs by **about half** in 2050 compared to a scenario without any HFC controls, and to reduce future global average warming in 2100 from a baseline of 0.3-0.5°C to less than 0.1°C (WMO)

- Extensive replacement of high-global warming potential (GWP) HFCs with commercially available low-GWP alternatives in refrigeration and air-conditioning equipment.

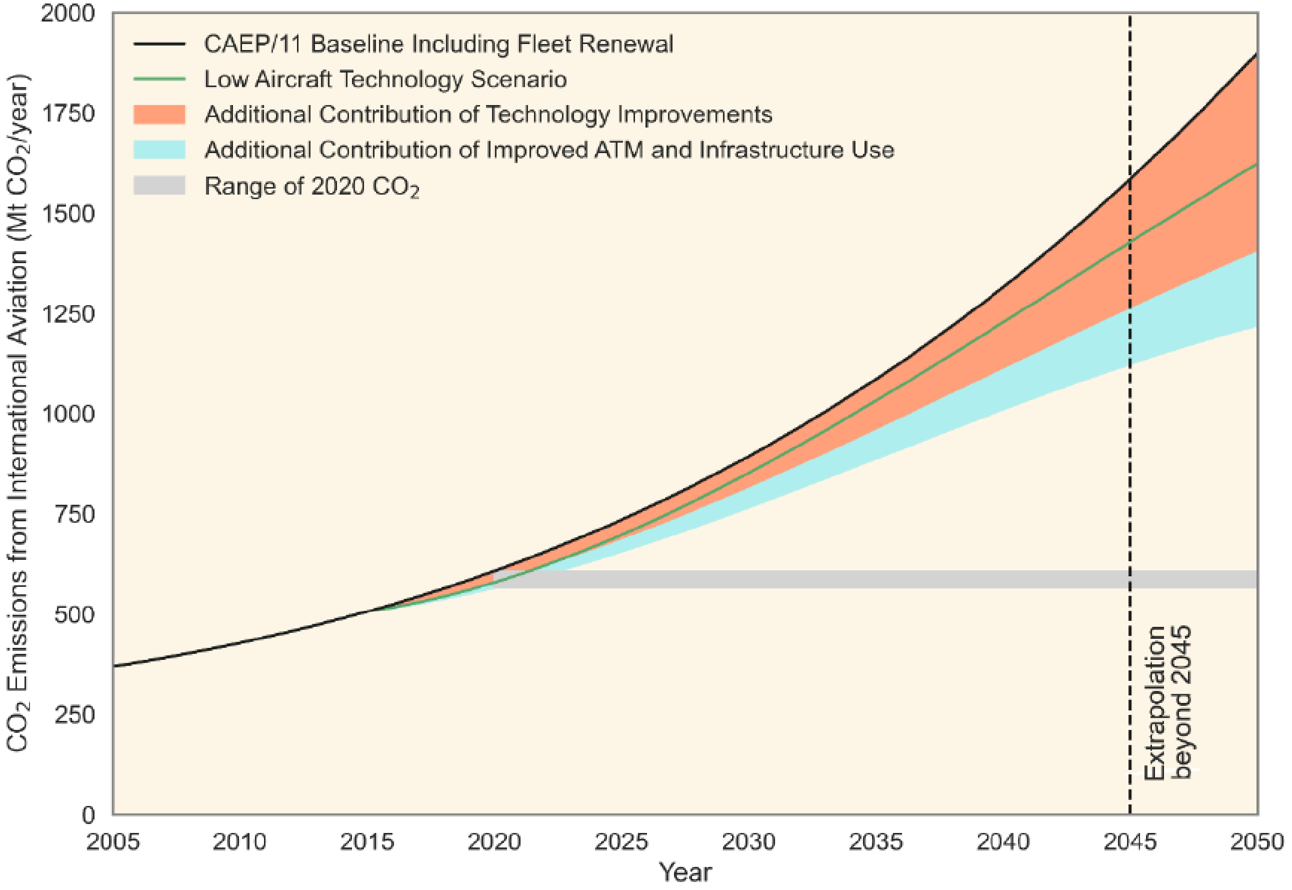
# Transport: aviation

- $CO_2$ mitigation of aviation to ‘net zero’ levels, requires fundamental shifts in technology, fuel types, or changes of behaviour or demand.
- In total, the net ERF from aviation’s non-$CO_2$ SLCFs is estimated to be approximately 66% of aviation’s current total forcing.

Mitigation options include:

- Technology options for engine and airframe
- Operational improvements for navigation
- Alternative biofuels, synthetic fuels, and liquid Hydrogen
- Technological and operational trade-offs between $CO_2$ and non-$CO_2$ effects
- Modal shift to High-Speed Rail
- Market-based offsetting measures

# Transport: aviation




**igure 10.11 Projections of international aviation emissions of $CO_2$. Data in Mt yr-1, to 2050, showing contributions of improved technology, and air traffic management and infrastructure to emissions reductions to 2050.**

Data from Fleming and de Lépinay (2019); projections made pre-COVID-19 global pandemic

# Transport: aviation

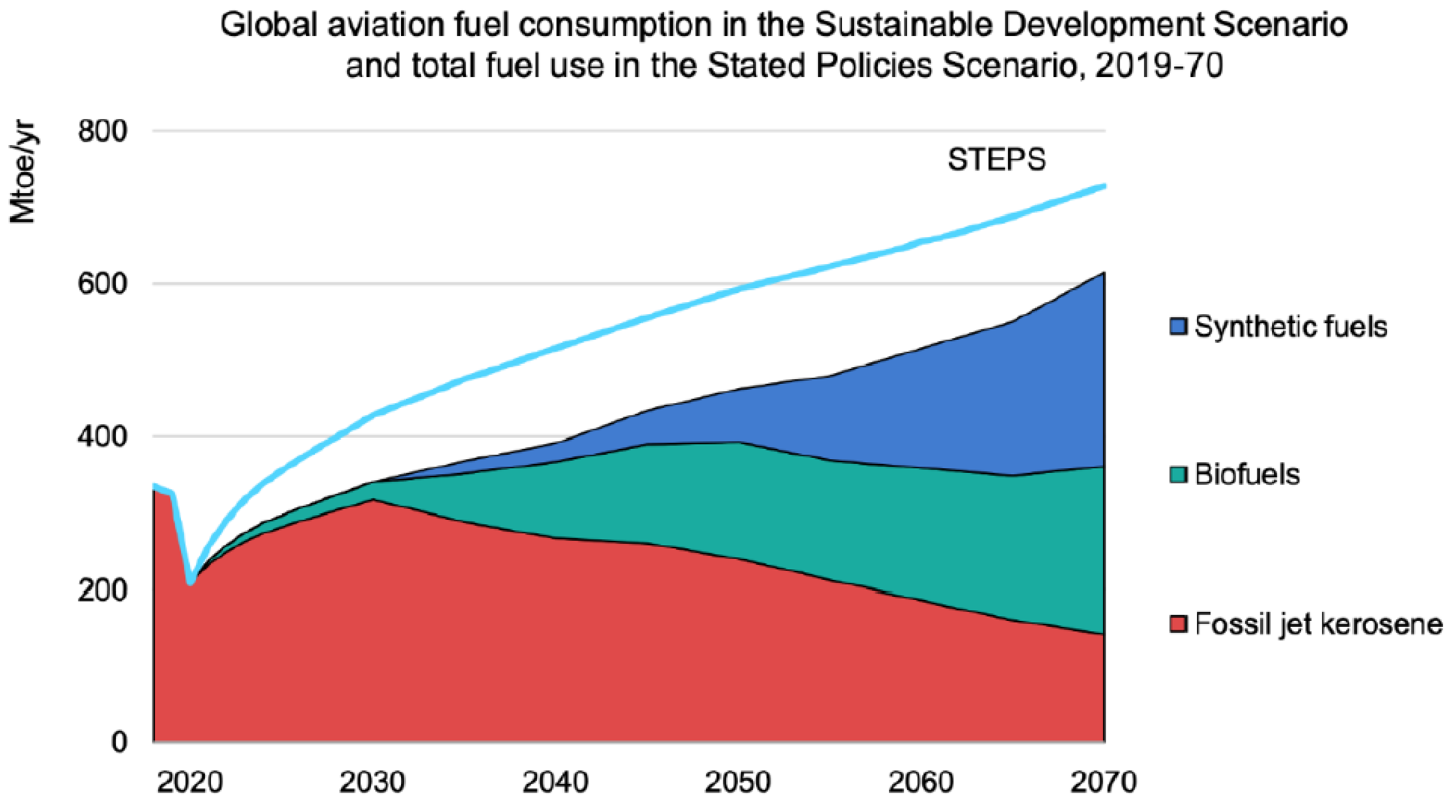



**Figure 10.12 The International Energy Agency's scenario of future aviation fuel consumption for the States Policies Scenario ('STEPS') and composition of the Sustainable Development Scenario**
(from (IEA 2021b))

# Transport: Shipping

- Emissions of SLCF from shipping not only affects the climate, but also the environment, air quality, and human health. Maritime transport has been shown to be a major contributor to coastal air quality degradation
- Furthermore, increases in sulphur deposition on the oceans has also been shown to increase the flux of CO2 from the oceans to the atmosphere

Mitigation

- Pollution control is implemented to varying degrees in the modelling of the SSP scenarios; for example, SSPs 1 and 5 assume that increasing concern for health and the environment result in more stringent air pollution policies than today.
- There is a downward trend in SO2 and NOx emissions from shipping in all the SSPs, in compliance with regulations.

# Thank you

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