# IPCC Special Report on Aviation & the Global Atmosphere (1999) - an historic perspective

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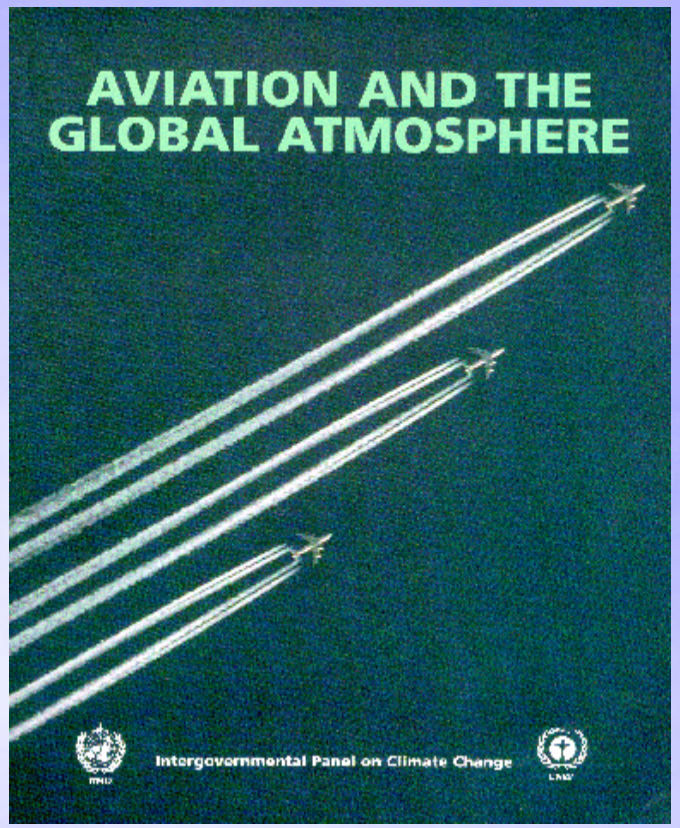
# The IPCC Special Report (1999)

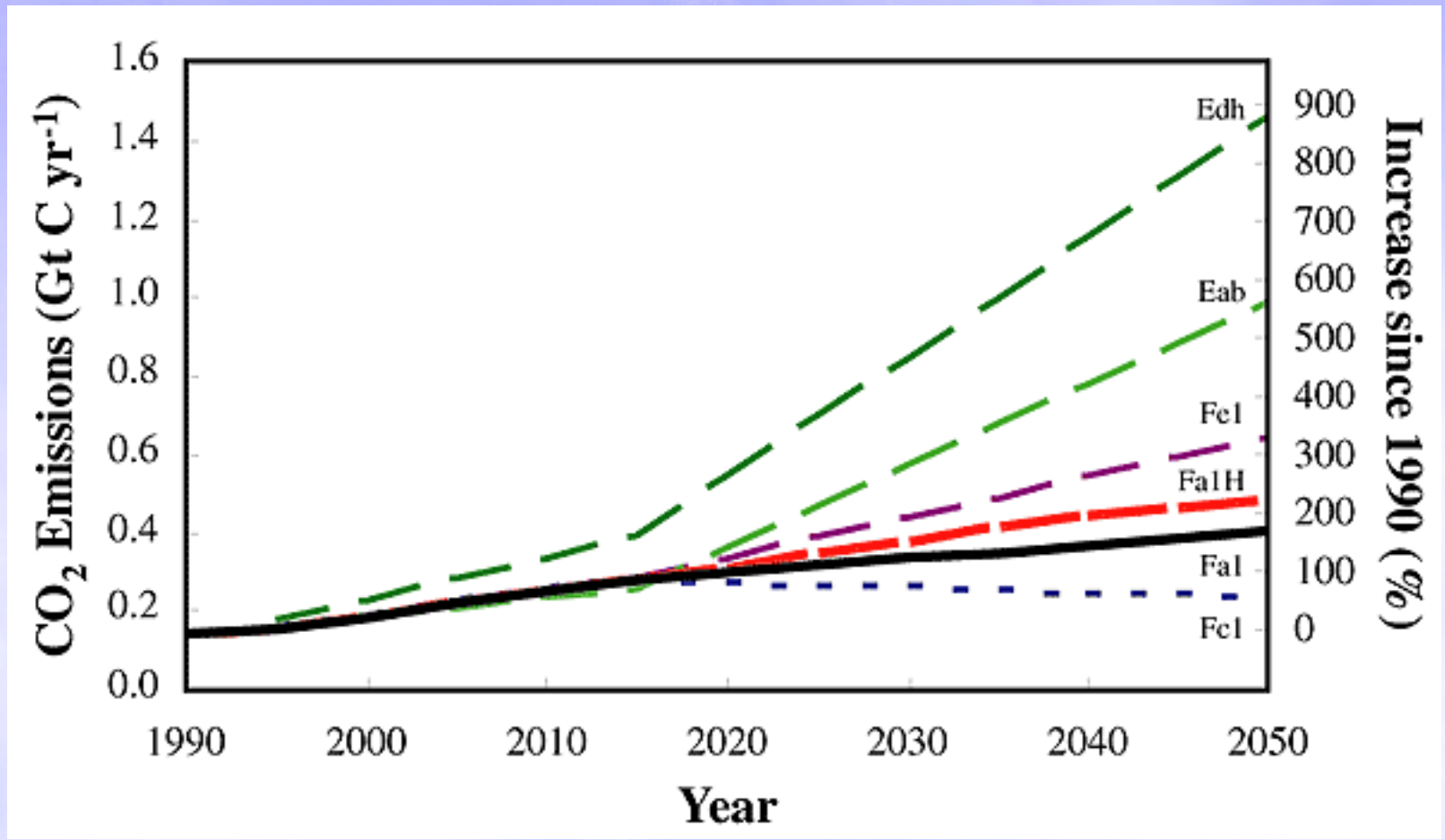



- International state-of-understanding of science, aviation technology and operations.
- Requested by ICAO to assist in decision and policy making.
- Developed aviation growth and technology scenarios to 2050 .
- Reviewed potential mitigation options
- Policy neutral

# Scope of the Report

- Aircraft emissions
  - $CO_2$, $H_2O$, HC, CO, particles, NOx , sulphur compounds
- Current and future changes
  - 1992, 2015 (forecasts), 2050 (scenarios)
- Impacts on
  - Climate and uv radiation
- Mitigation Options
  - Technology, Fuel and Operations, Regulatory, Market based
- No consideration of Local air quality impacts

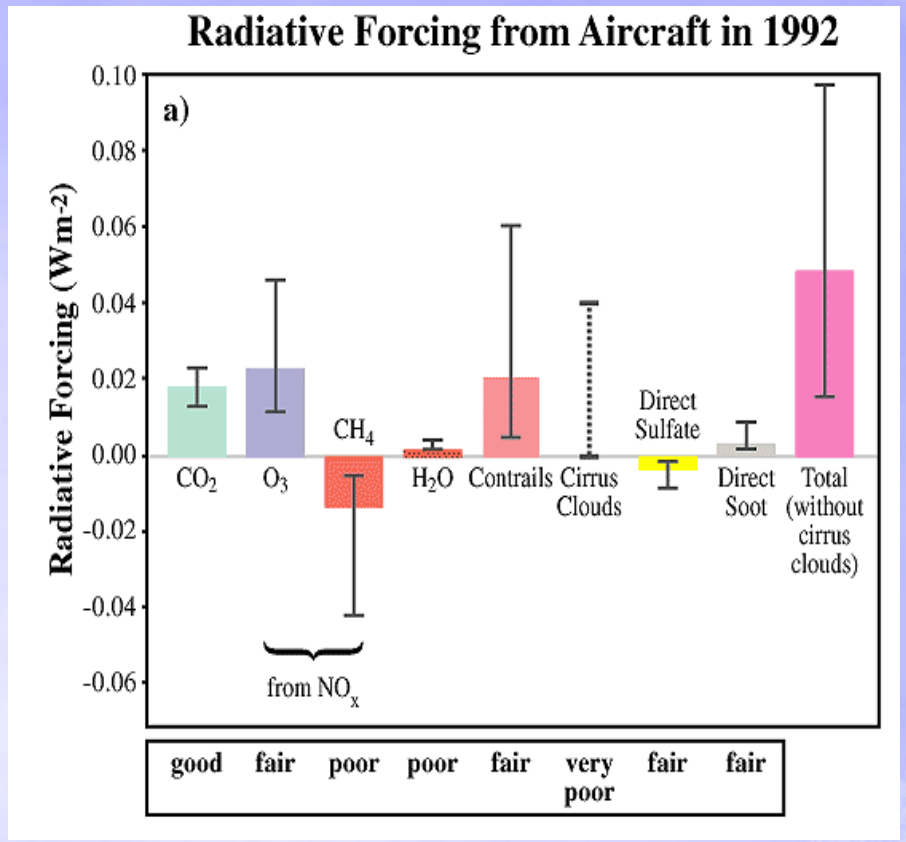
# Aviation Growth ($CO_2$)

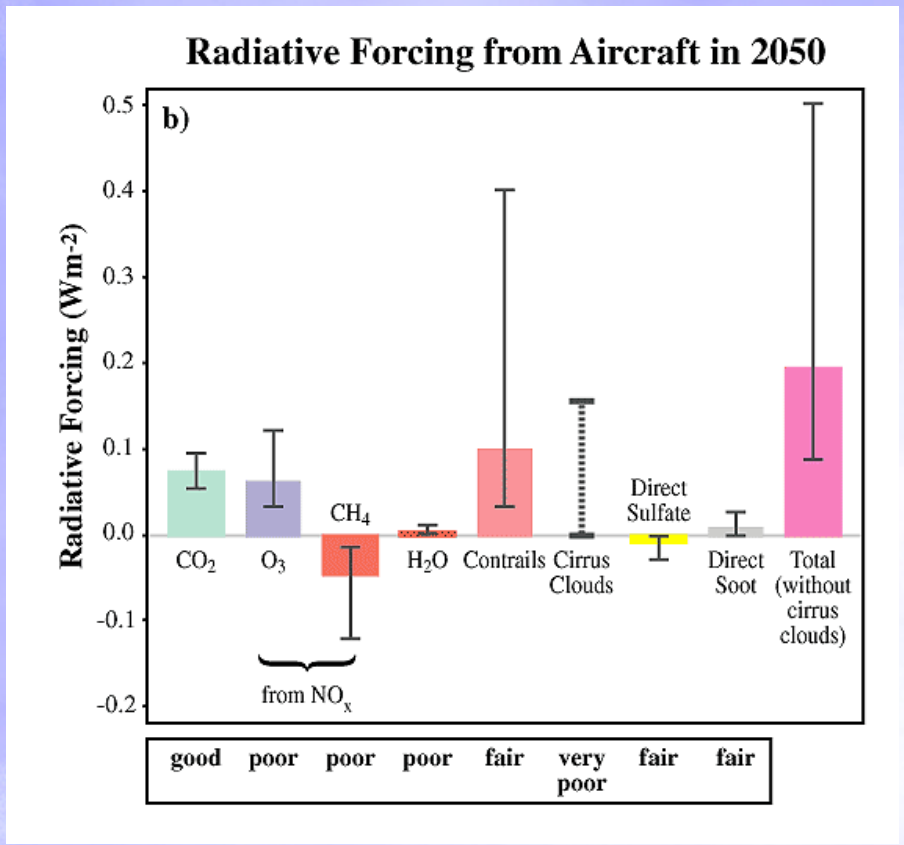


# Radiative Forcing (RF)

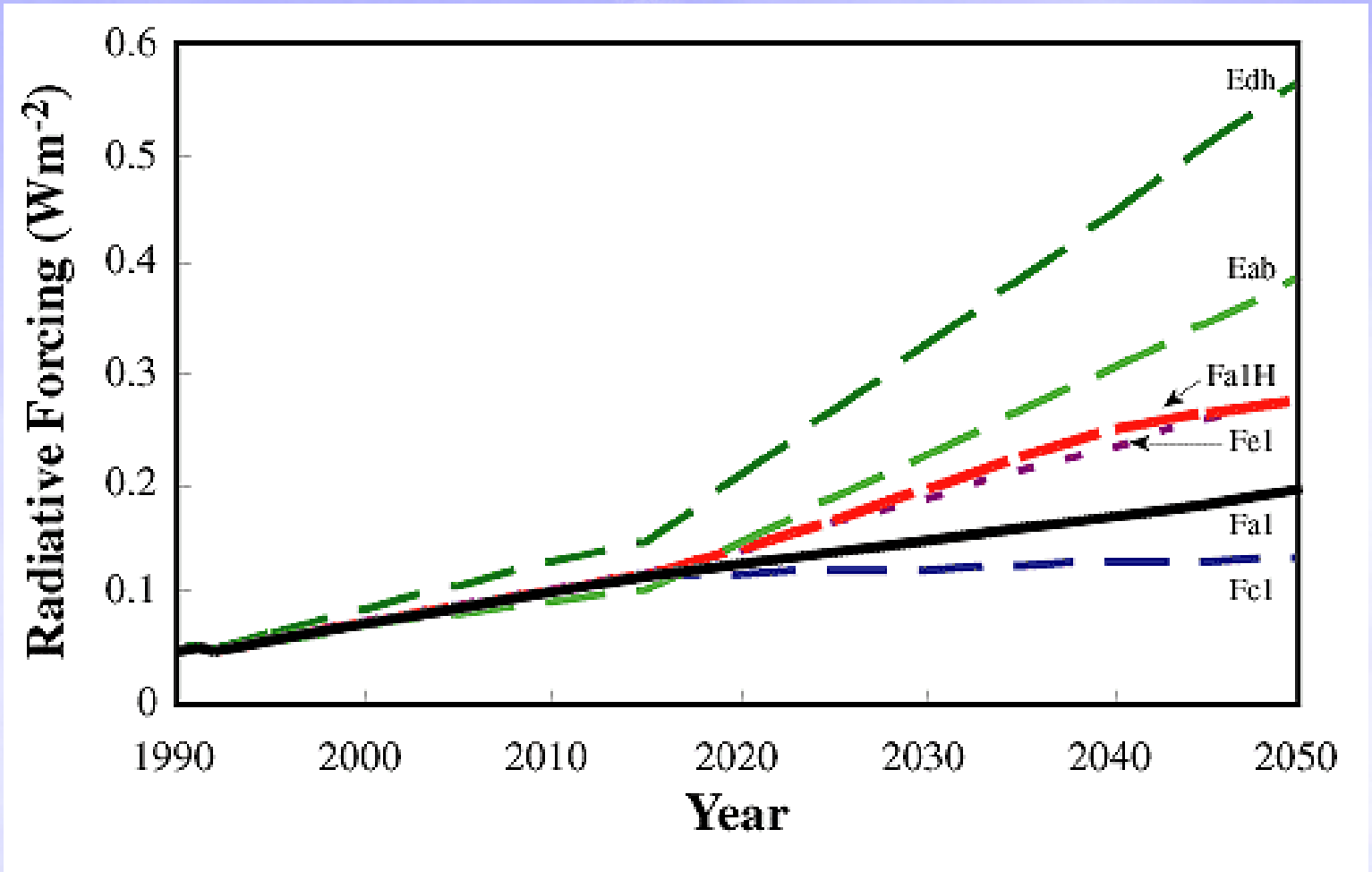
- RF is a measure of the importance of a potential climate change mechanism.
- It expresses the perturbation or change to the energy balance of the Earth-atmosphere system in watts per square metre ($Wm^{-2}$).
- Positive values of RF imply a net warming, while negative values imply cooling

# Aviation RF in 1992 & 2050



# Total Radiative Forcing from subsonic aviation



# UV Effects

- Considering only subsonic aircraft
  - Small decrease in uv at the surface of the earth
- Including fleet of supersonic aircraft
  - Offsets the decrease due to subsonic aircraft
  - Overall effect is still a decrease

# Aircraft and Engine Technology Options

- Technology advances have substantially reduced most emissions per passenger-km. However, there is potential for further improvements
- Engine efficiency improvements reduce the specific fuel consumption and most types of emissions, but without advances in combustor technology, $NO_x$ emissions may also increase
- Any technological change may involve a balance across a range of environment impacts. For example:
  - carbon dioxide emissions, $NO_x$ emissions at ground level, $NO_x$ emissions at altitude, water vapour emissions, contrail - cirrus production and noise

# Fuel options

- There would not appear to be any practical alternatives to kerosene-based fuels for commercial jet aircraft for the next several decades

- Hydrogen fuel
  - may be viable in the long term, but would require new aircraft designs and new infrastructure for supply
  - would eliminate emissions of carbon dioxide from aircraft, but would increase those of water vapour

- Reducing sulphur content of kerosene will reduce $SO_x$ emissions and sulphate particle formation

# Operational Options

- Improvements in air traffic management (ATM) and other operational procedures could reduce aviation fuel burn by between 8 and 18%,
  - 6 – 12% from ATM improvements which are anticipated to be fully implemented in the next 20 years
  - A further 2-6% could come from improvements in other operational measures
- Improved operational efficiency may result in attracting additional air traffic

# Regulatory, Economic & Other Options

- Improvements in aircraft & engine technology and in efficiency of air traffic systems will not fully offset the effects from the projected growth of aviation
- Policy options to reduce emissions further include:
  - more stringent regulations
  - removal of specific subsidies and incentives
  - market-based options
  - voluntary agreements
  - research programmes
  - inter-modal substitution
- Most of these would lead to increased costs and fares

# Key areas of scientific uncertainty

- The influence of contrails and aerosols on cirrus clouds
- The role of $NO_x$ in changing ozone and methane concentrations
- The ability of aerosols to alter chemical processes
- The transport of atmospheric gases and particles in the upper troposphere/lower stratosphere
- The climate response to regional forcings and stratospheric perturbations

# Key socio-economic and technological issues

- Characterisation of demand for commercial aviation services
- Methods to assess external costs and the environmental benefits of regulatory and market-based options
- Assessment of the macroeconomic effects of emission reductions in the aviation industry that might result from mitigation measures
- Technological capabilities and operational practices to reduce emissions leading to the formation of contrails and increased cloudiness
- The understanding of the economic and environmental effects of meeting potential stabilisation scenarios (for atmospheric concentrations of greenhouses gases)

# The Report has …

- Acted as a catalyst for further focussed research and development activities
- Drawn together aviation specialists and atmospheric scientists

# The Report is…

- Unique in the integral involvement of technical experts from the aviation industry, alongside atmospheric scientists
- The most comprehensive assessment available of the effects of aviation on the global atmosphere
- The first IPCC report to consider a specific industrial subsector, though other equally deserve study
  - Available at www.ipcc.ch/pub/online.htm (IPCC special reports)

# Questions ?