IPCC Emission Scenarios - Importance for Assessing Aviation Contributions to Climate Change

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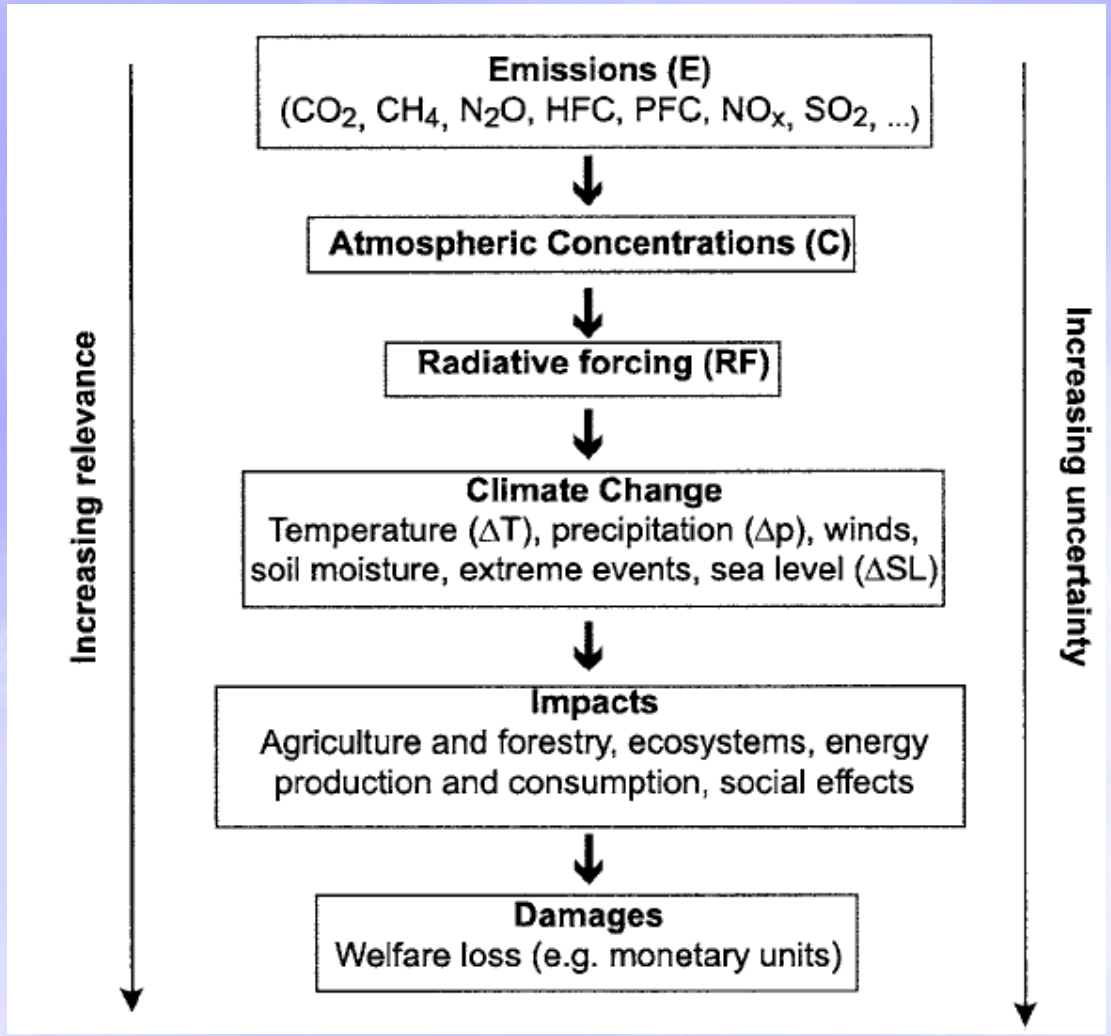
Chain of potential effects of emissions

- Emissions cause pos.& neg. forcings
- Impact of emissions from one source depend on emissions from other sources
- Emissions impact climate and air quality



(Fuglestvedt et al. 2005)

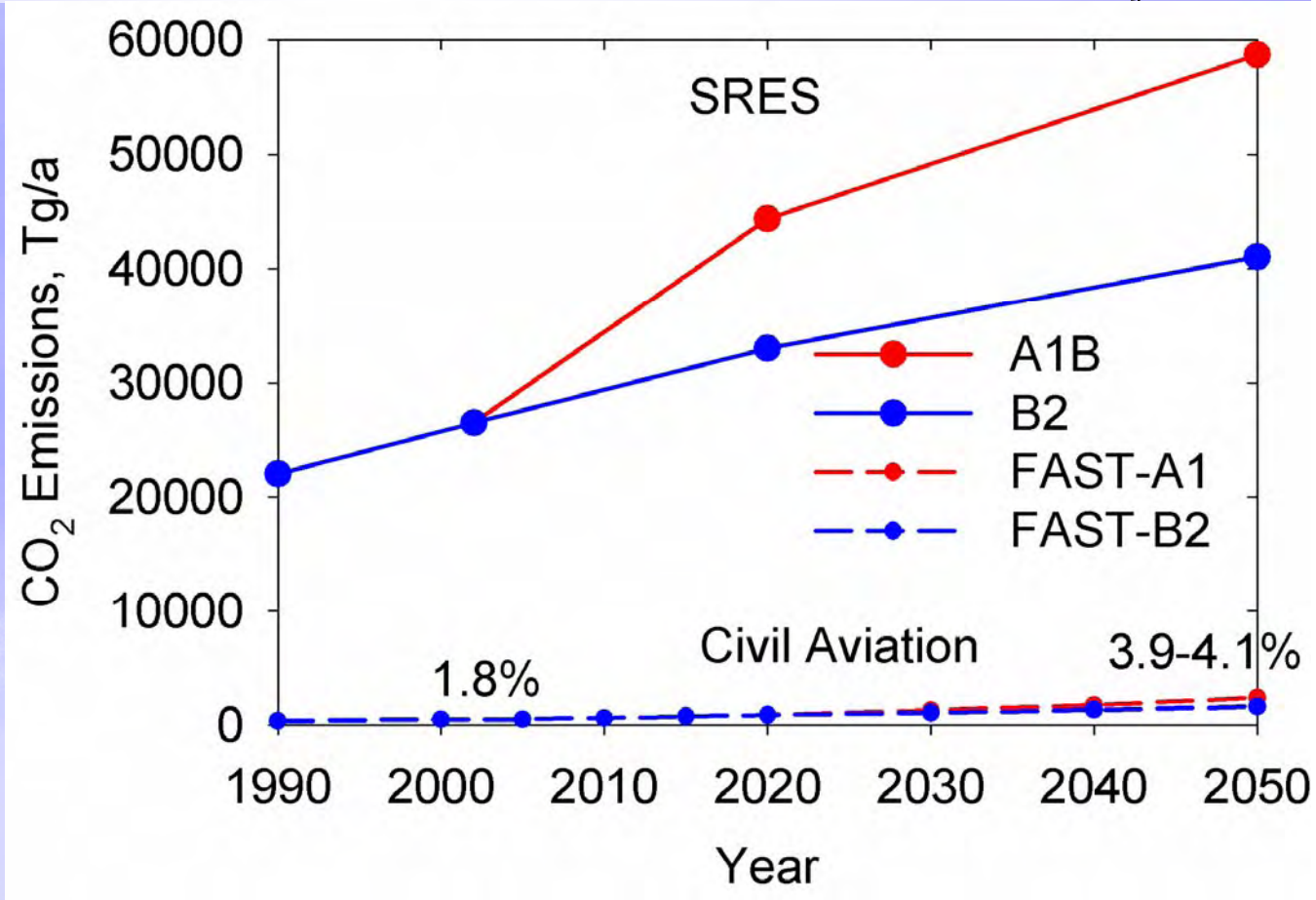
Characteristics of IPCC Scenarios

- Scenarios are alternative images of how the future might evolve
- Future emissions are determined by several driving forces:
  - demographic development
  - socio-economic development
  - technological change
  - environmental development
- Scenarios are the basis for climate change analysis
- A range of scenarios were developed - all should be considered equally sound.

(Details: IPCC - SRES, 2007)

Emission Scenarios for CO_2 from all sources

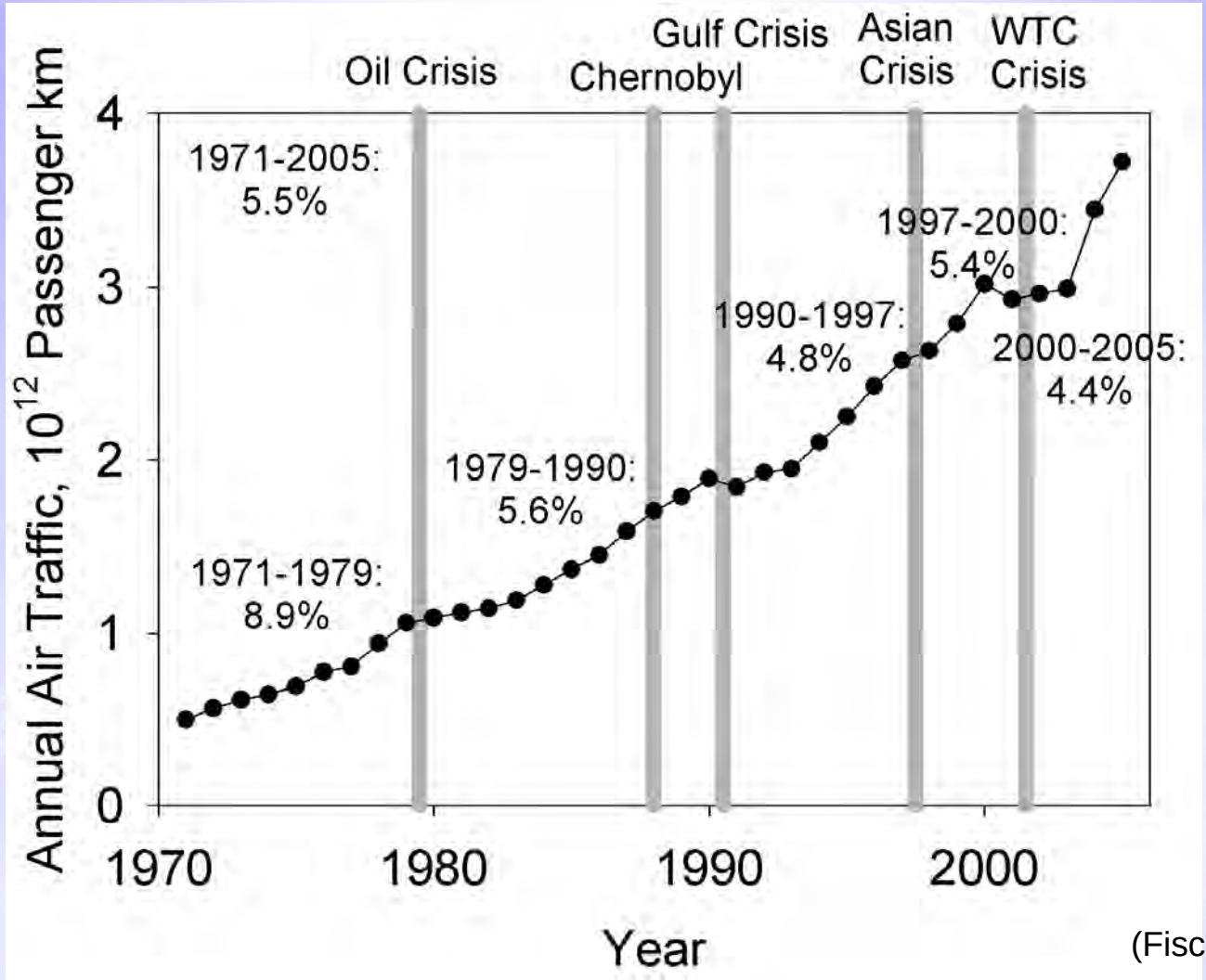
- A1B: rapid economic growth, balance across all sources, fast intro. of new technologies, strong globalisation
- B2: moderate economic growth, diverse technological change, more oriented towards environmental protection, focus on regional levels



Climate Impact of Aviation

- Global aviation contributes to climate change by emissions of carbon dioxide (CO_2), nitrogen oxides (NO_x), water vapour, particles, contrails and cirrus changes.
- Carbon dioxide is the most important greenhouse gas. Its effect is independent of the altitude at which the emission occurs.
- Nitrogen oxides from aviation at subsonic cruise altitudes enhance ozone formation and reduce methane; both are greenhouse gases.
- Water vapour and particles emitted at certain altitudes can induce contrails and cirrus cloud formation, likely enhancing the greenhouse effect.

Annual air traffic growth rates



(Fischer et al., 2007)

Trends

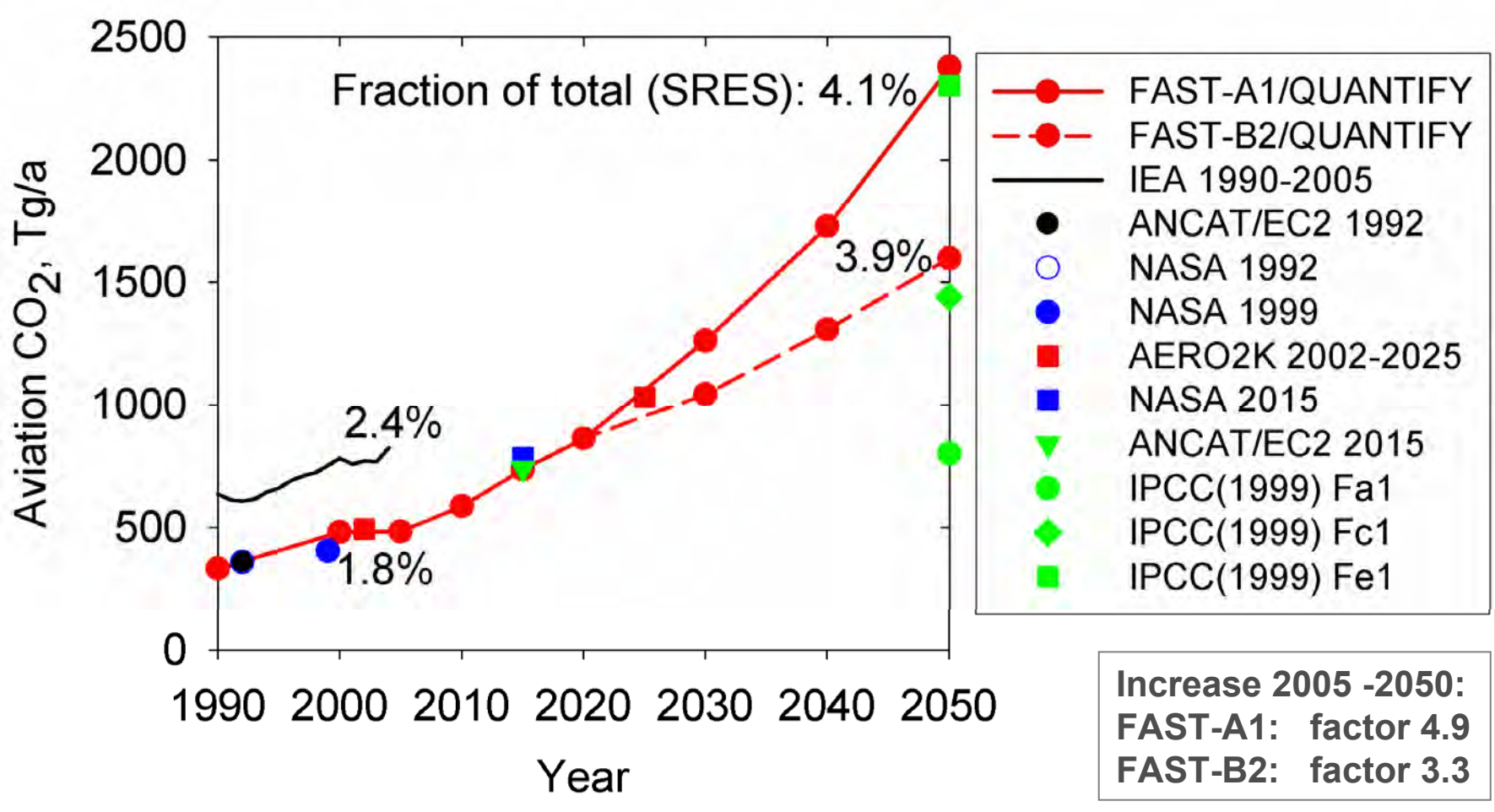
- Fuel consumption (CO_2-Emissions) in global aviation grew from 1990 – 2004 by

  2 to 3 % / year.
- The global emissions of nitrogen oxides from aviation grew by 4 to 5 % / year.
- For the near future, further growth of global fuel consumption and global emissions of CO_2 and NO_x by aviation is to be expected.

Scenarios of aviation emissions to 2050

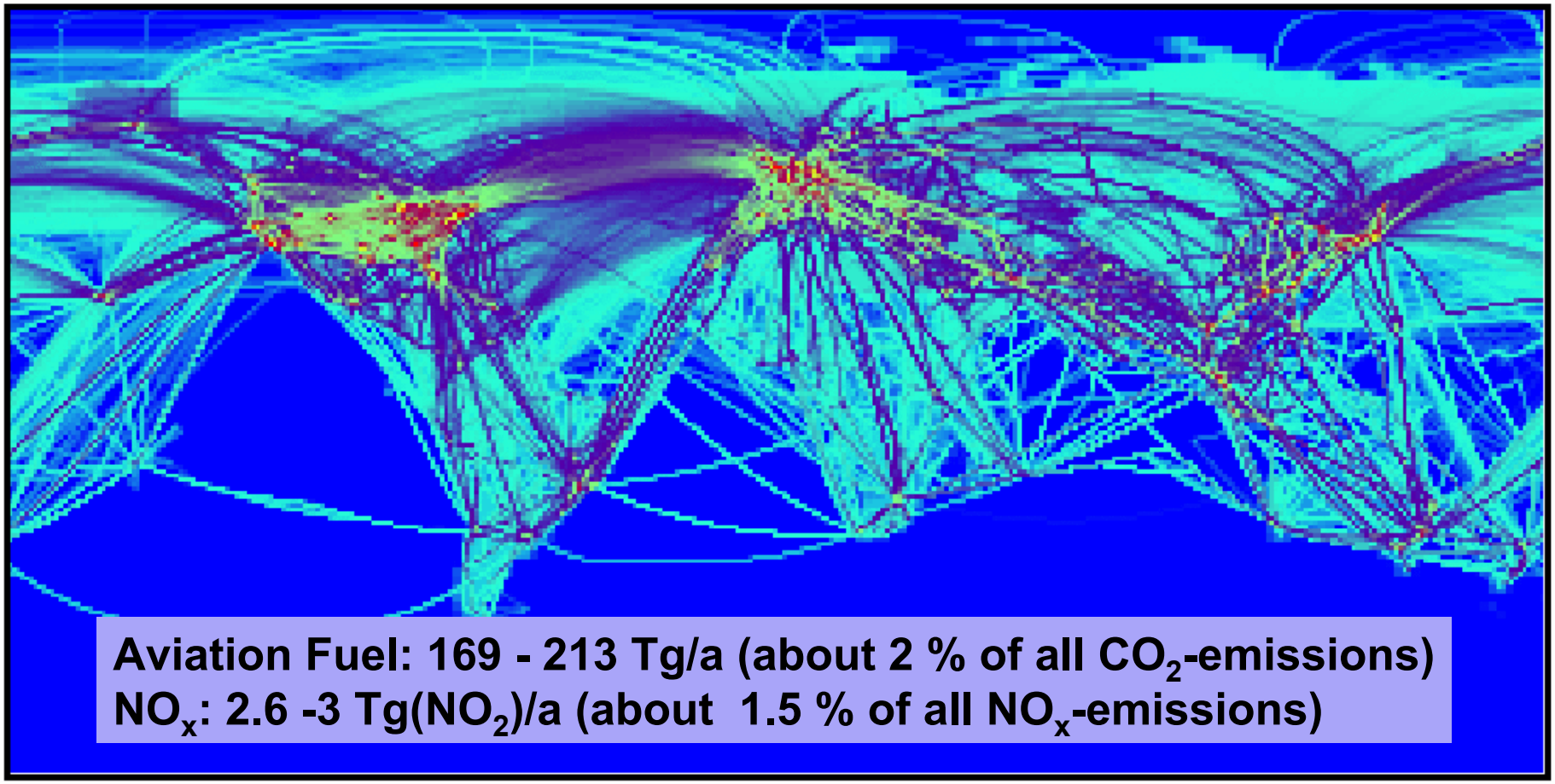
- IPCC (1999) based on GDP assumptions and ICAO air traffic statistics and forecasts
- FAST/QUANTIFY (European Project) based on GDP assumptions from IPCC-SRES and ICAO air traffic statistics and forecasts
- CONSAVE (European Project) based on GDP assumptions from IPCC-SRES and ICAO air traffic statistics and forecasts

Emission Scenarios for Aviation



Increase 2005 -2050:
FAST-A1: factor 4.9
FAST-B2: factor 3.3

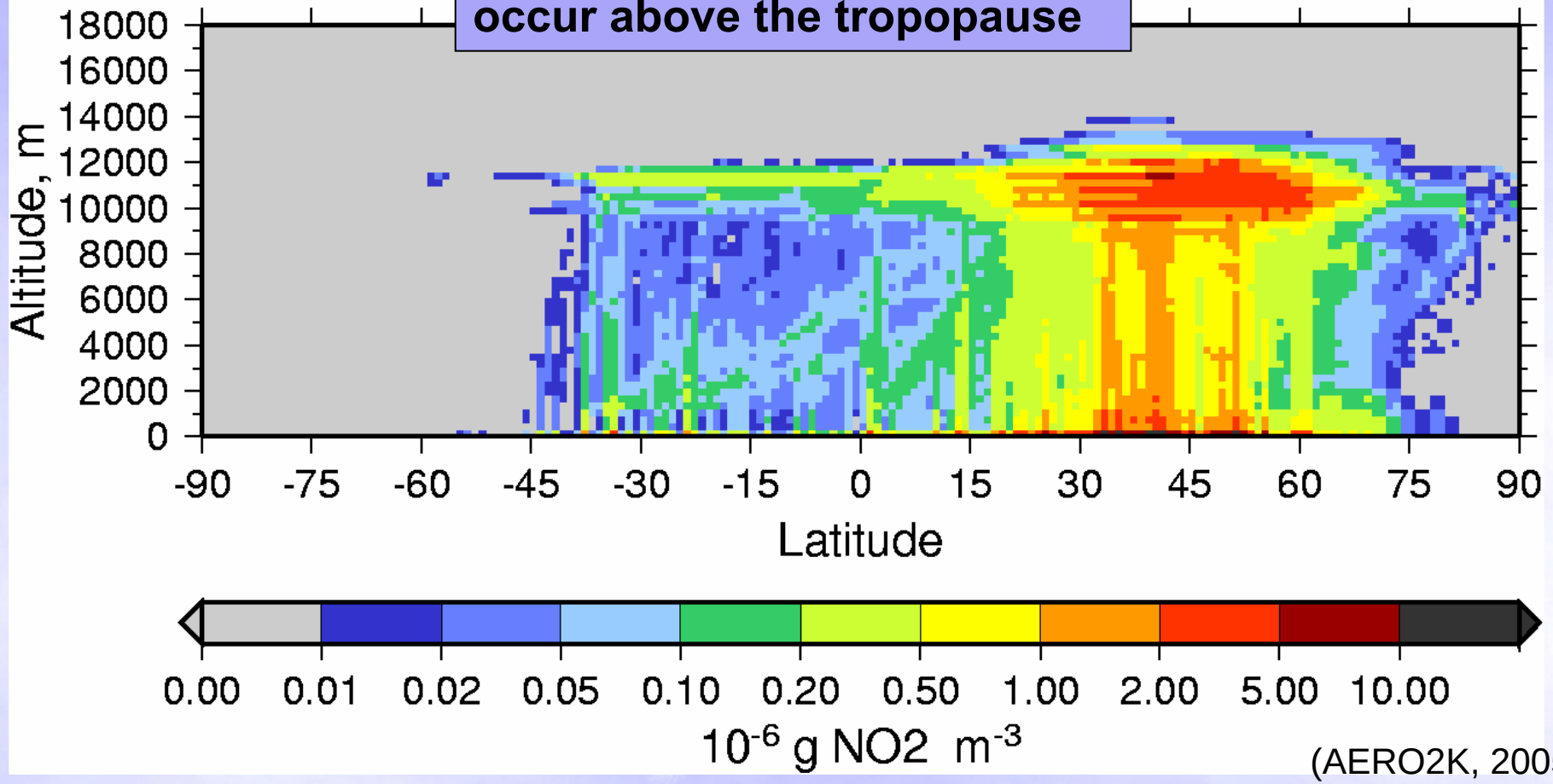
Global Distribution of Aviation Emissions



(AERO2K, 2005)

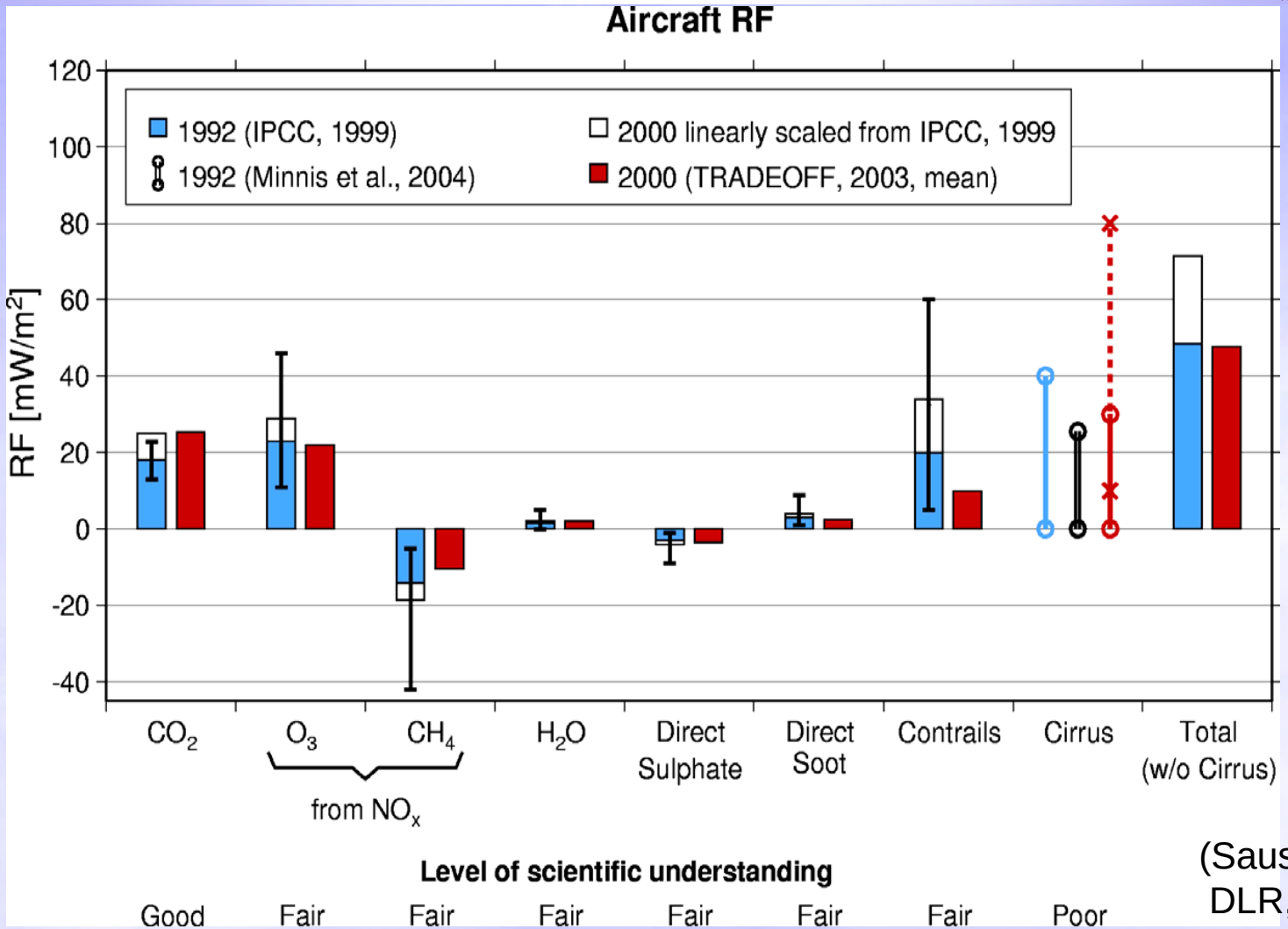
Vertical Distribution of Aircraft Emissions

About 40 % of all emissions occur above the tropopause



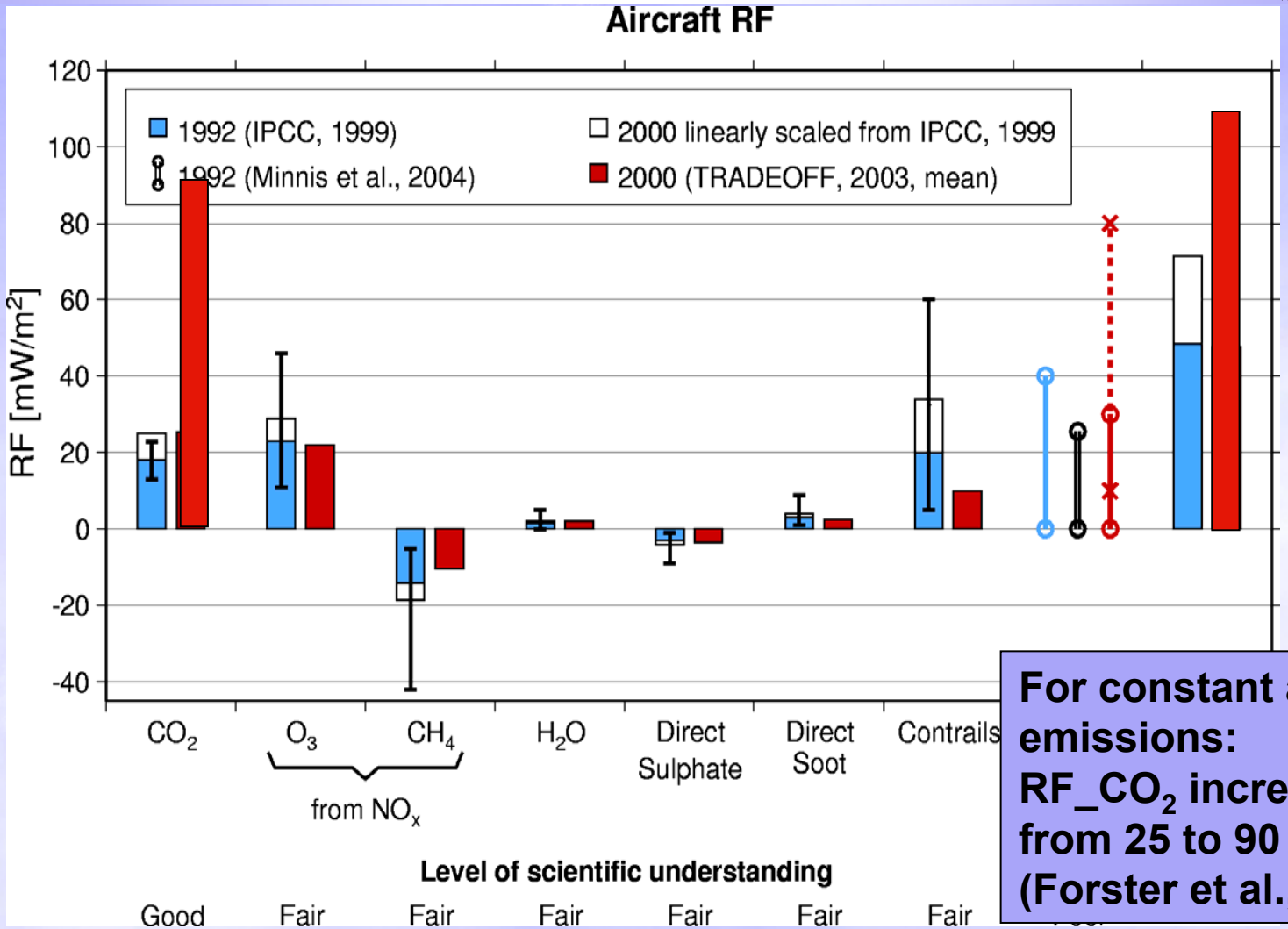
(AERO2K, 2005)

Radiative Forcing until 2000 from Global Aviation



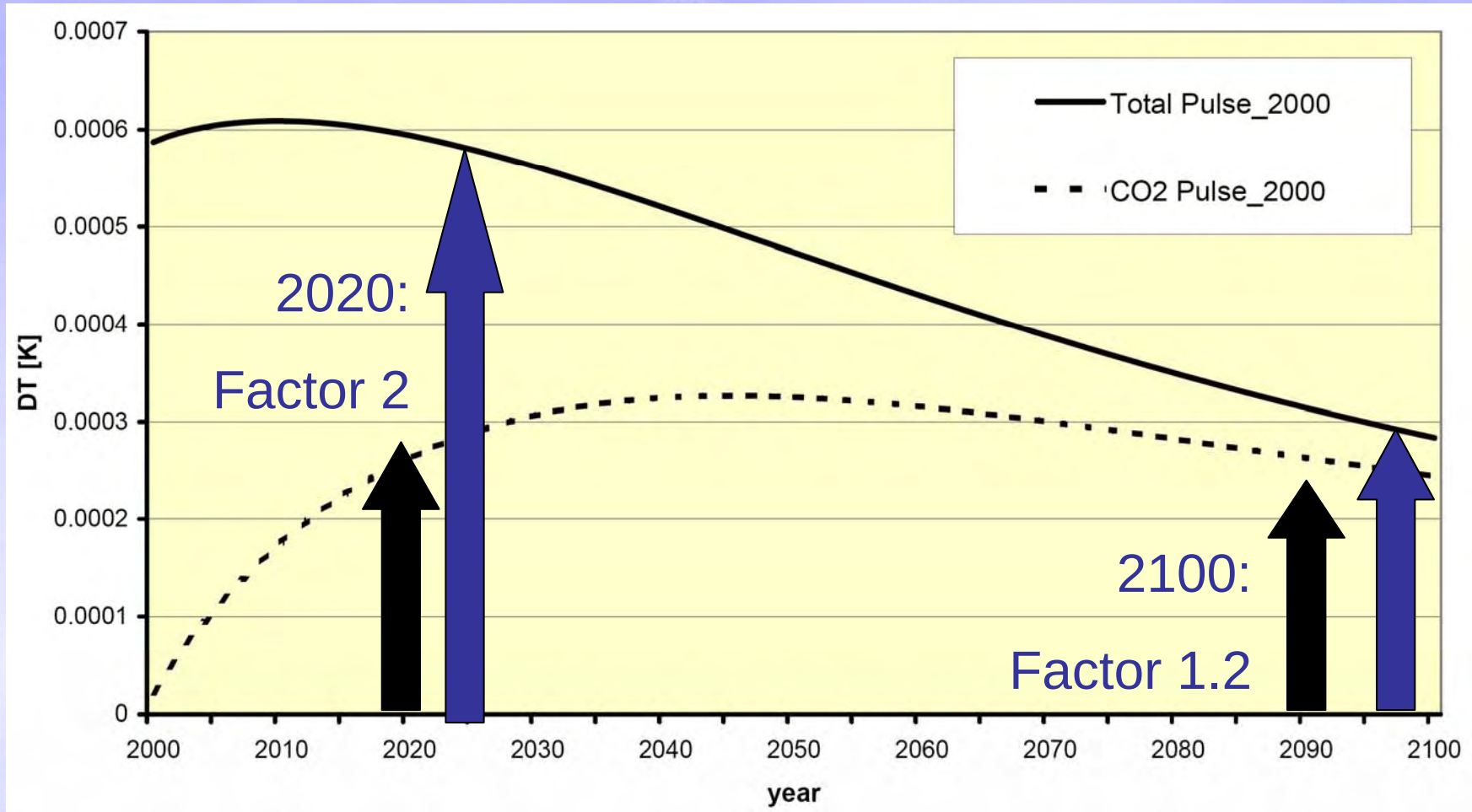
(Sausen et al., DLR, 2005)

Radiative Forcing until 2100 from Global Aviation



For constant aviation emissions: RF_CO_2 increases from 25 to 90 mW m^{-2} (Forster et al., 2006)

Temp. response from an annual pulse of aviation emissions



(Sausen et al., DLR)

Climate Forcing by Aviation (RF, ΔT)

Total RF / CO_2 RF: is not a constant factor

- The ratio of warming by aviation CO_2, ozone and contrails compared to warming by CO_2 alone depends on the scenario and time period considered.
- In the long term, warming induced by aviation CO_2 is largest.
- At short terms, warming by aviation NO_x and contrails is larger than that by aviation CO_2.

Conclusions

- Limiting global warming requires reductions in greenhouse gas emissions
- The relative contribution of aviation to global climate change depends on past emissions and emission scenarios
- The aviation share in CO_2 emissions is presently about 2 %
- The aviation share in radiative forcing is presently 2-8%
- Scenarios of civil aviation CO_2 emissions in 2050 show an increase by factors 3.3 - 5
- The relative importance of short-lived (NO_x, contrails) and long-lived (CO_2) emissions depends on choice of timescale
- If aviation emissions continue to grow while other emissions get reduced, the relative importance of aviation contributions grows.
- ICAO need to be involved in further developments of IPCC scenarios