

# The ECATS Global Aviation Impact Primer

ECATS-CIAP



# What is climate ?

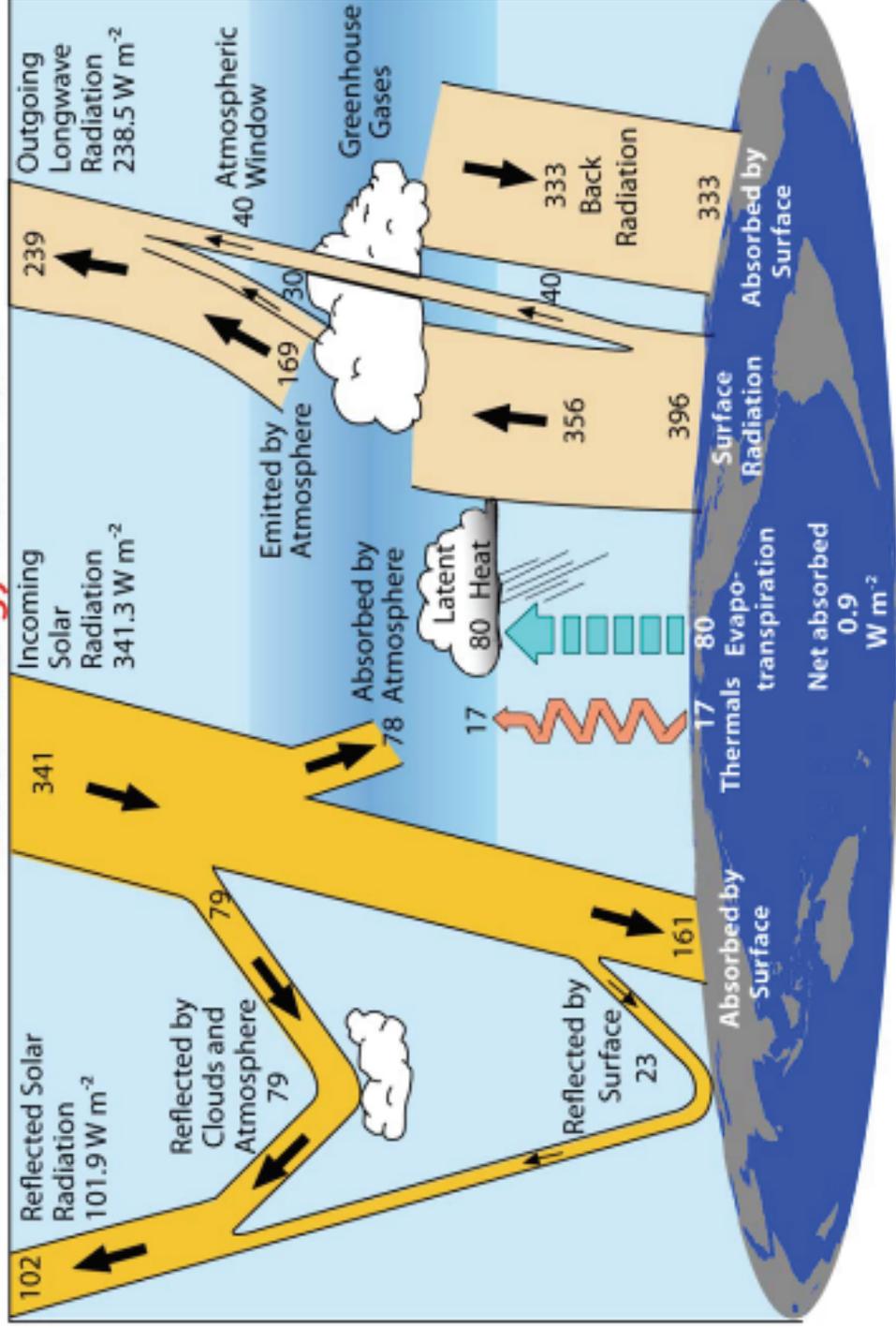
Climate is an expression for a dynamical equilibrium between energy reaching the Earth-Atmosphere System and energy leaving this system.

The carrier of this energy is electromagnetic radiation.

The energy input consists of solar radiation, mainly visible light.

The energy output consists of (1) reflected solar radiation and (2) thermal (infrared) radiation from the Earth-Atmosphere System.

# Global Energy Flows $W m^{-2}$



Trenberth et al., 2009: Earth's Annual Global Mean Energy Budget

# How can climate change ?

When either the input or the output of energy from the Earth-Atmosphere System changes, the balance between input and output is disturbed.

The system heats up when the input is larger than the output. It cools down when the input is smaller than the output. This change proceeds until a new equilibrium is established.

# What is the greenhouse effect?

The atmosphere contains mainly nitrogen (78%) and oxygen (21%). The remaining % is trace gases. These trace gases absorb the infrared thermal radiation of the Earth; they produce a natural greenhouse effect.

When the trace gases increase, more thermal radiation is absorbed, that is, the greenhouse effect becomes stronger. This anthropogenic greenhouse effect leads to a warming of the Earth-Atmosphere System because the energy output is smaller than the input.

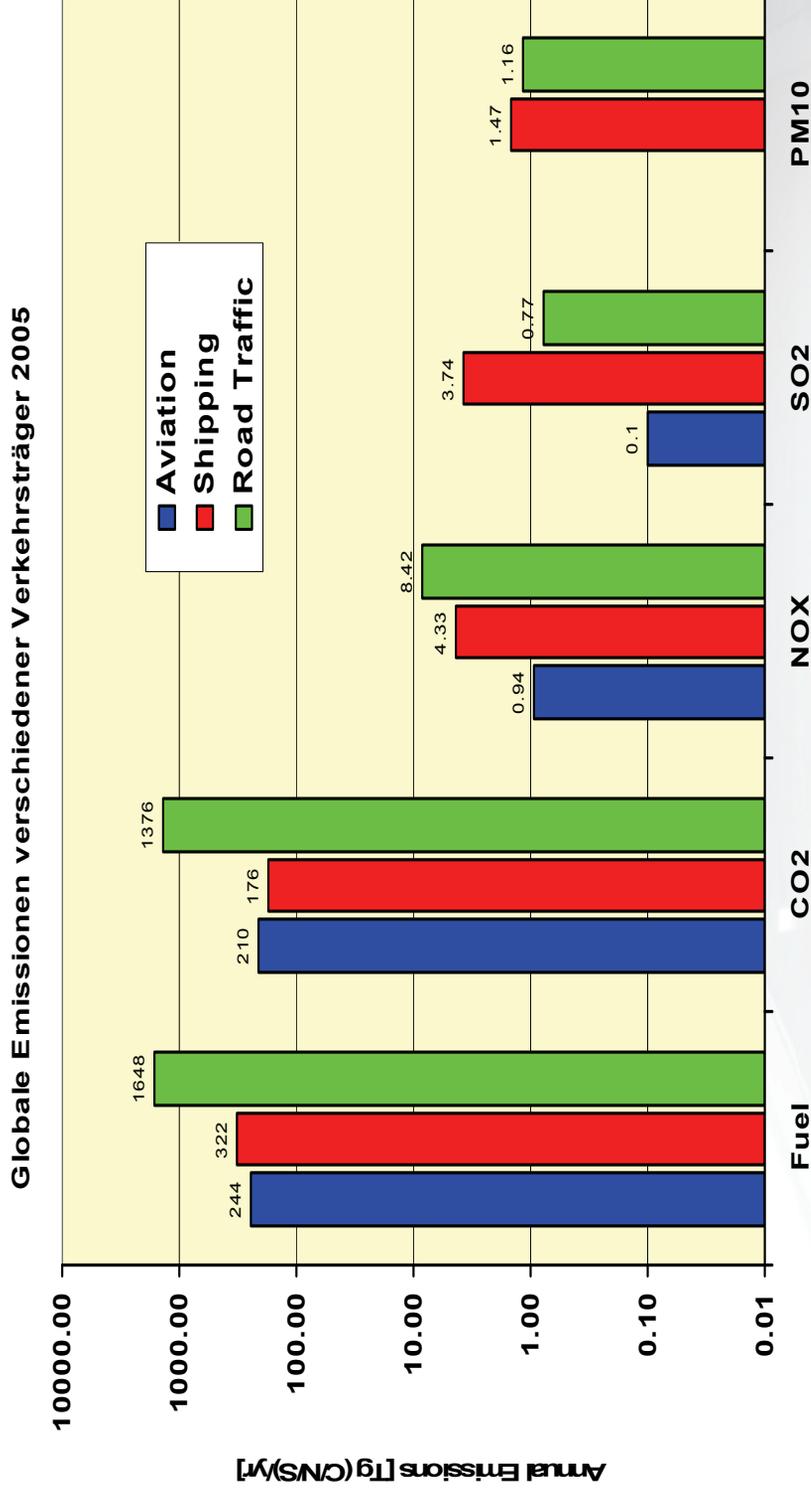
# Does aviation impact climate?

Yes! Aviation emits

- Radiatively active gases like CO<sub>2</sub>
- Gases which react in the atmosphere with other gases that are radiatively active (NO, NO<sub>2</sub>)
- Gases that lead to particles in the atmosphere (SO<sub>2</sub>) and soot particles

Aviation changes the atmospheric trace gas composition and amount and leads additionally to condensation trails and modification of natural clouds. Overall, it contributes to the greenhouse effect.

# Annual emissions of aviation in 2005



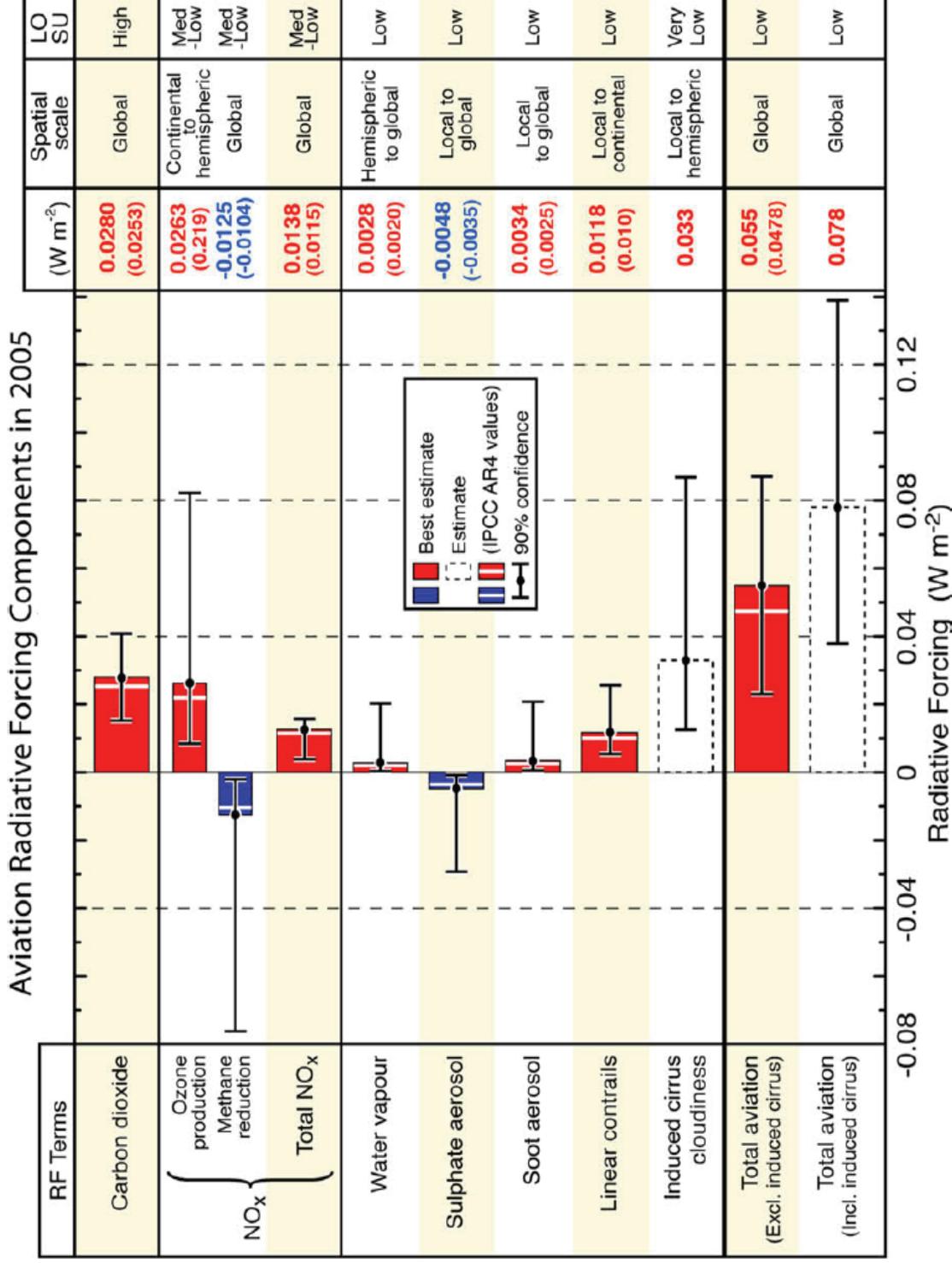
# What is particular about aviation?

Although world aviation consumes much less fuel than road traffic, and hence emits much less substances, aviation emits mainly in the upper troposphere and the lower stratosphere where background concentrations of species are low and residence times of pollutions are large.

Additionally aviation produces clouds (condensation trails) and affects natural clouds.

Therefore the greenhouse effect of aviation is proportionally larger than that of road traffic.

# Aviation component of the greenhouse effect



# Isn't the aviation contribution to the greenhouse effect minor?

The total anthropogenic greenhouse effect, measured in terms of the radiative forcing, is about  $1.6 \text{ W/m}^2$ . The current estimate of the aviation contribution is  $0.055 \text{ W/m}^2$ , i.e. 3-4% of the total anthropogenic effect.

In absolute numbers this is small. But aviation is a much smaller part of mankind's activities than this 3-4%, thus aviation is overrepresented in terms of greenhouse effect compared to mankind's activities.