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GREENER AIR TRAFFIC OPERATIONS

# The environmental impact assessment of greener trajectories

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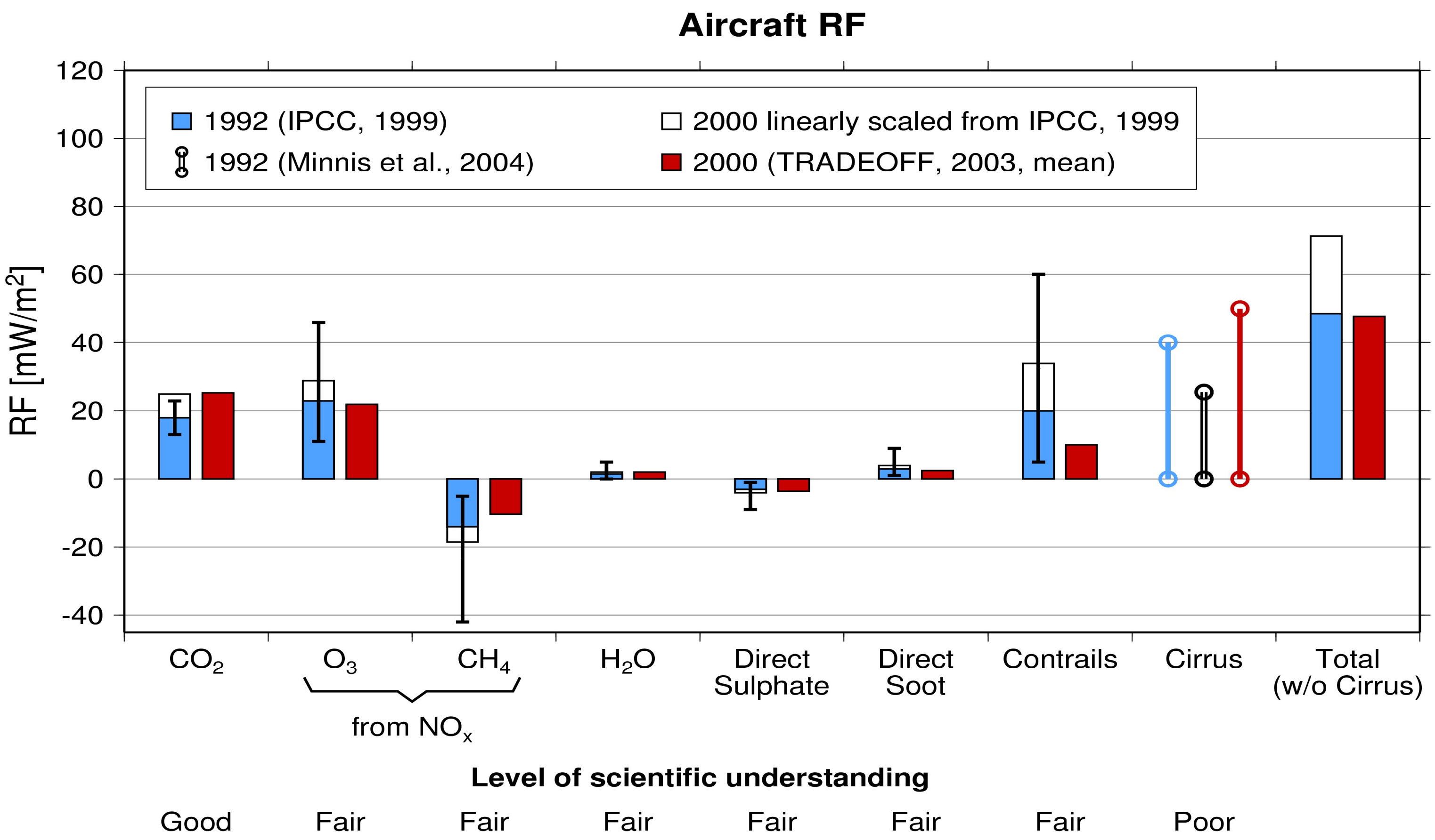
# Evaluation of environmental impact in GreAT: objectives

- The main objective is to evaluate the environmental impact of aviation pollutants such as $CO_2$ and NOx, on climate change.
- The main approaches include the establishment of common evaluation metrics, system and methodology.
- The fuel consumption and air pollutant emissions will be modelled and calculated.
- The tradeoffs between climate change impact and other environmental and performance indicators will also be studied.

# Aviation environmental impact



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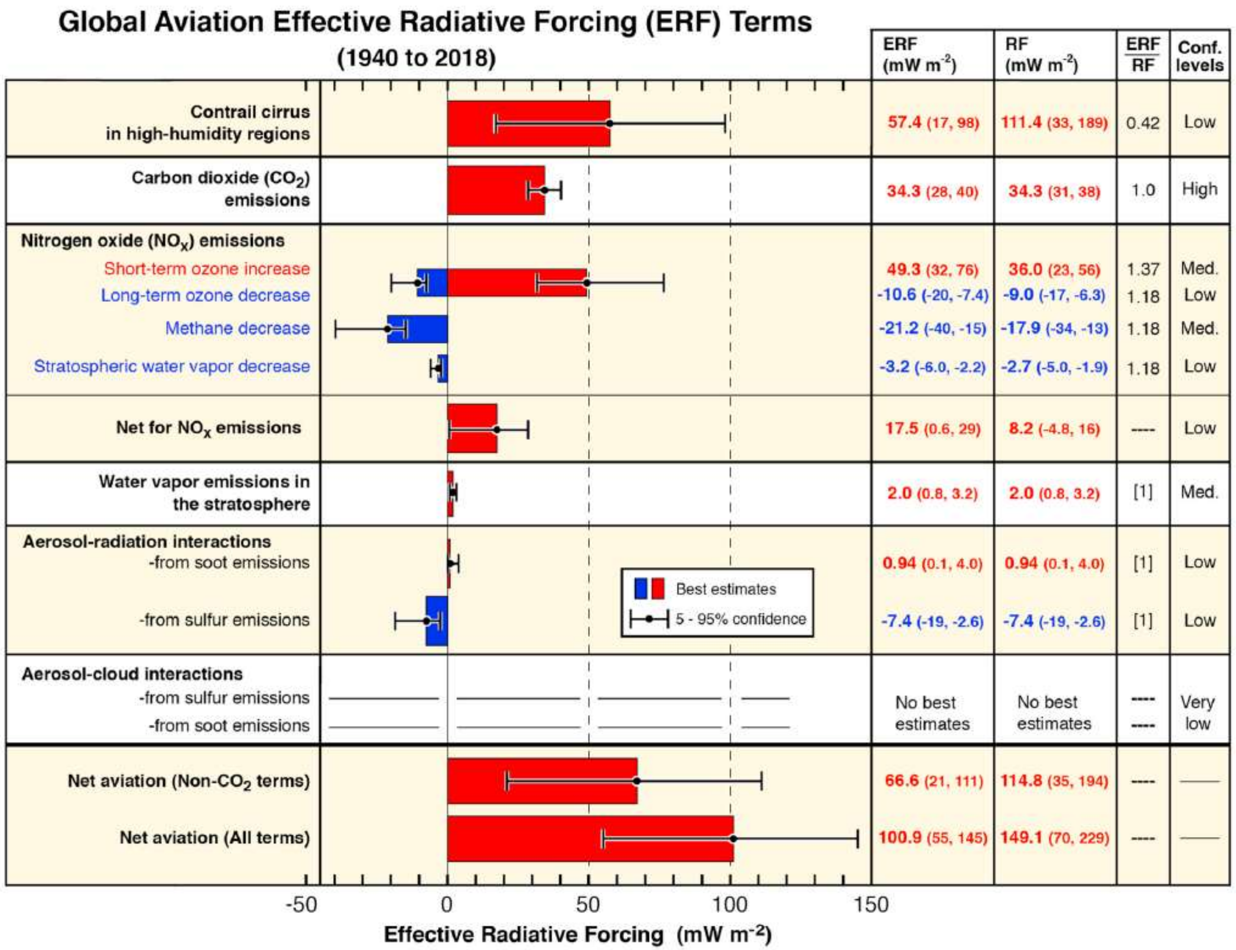

# Aviation environmental impact

| Metrics used | Content | Conversion factor (estimated value) |
| --- | --- | --- |
| Radiative Forcing (RF) | Instantaneous radiation effect due to previous and current emissions | 1 to 3[6] |
| Global Temperature Potential (GTP) | Temperature effect of a current emission pulse after x years | 20 years: 1 to 1.6<br>50 years: ~ 1.2<br>100 years: ~1.1 |
| Global Warming Potential (GWP) | Over the next x years integrated radiative forcing, which results from a current emission pulse | 20 years: ~ 4.5<br>50 years: ~ 3<br>100 years: ~ 2 |
| Equivalent Warming Potential (GWP*) | Global temperature change caused by changes in emissions of short-lived substances. | ~ 4[7] |

Sources: Lee et al. 2010; Fuglestvedt et al. 2010; Allen et al. 2018.

# Spatial and temporal distribution of aviation emissions

There is a significant difference between the effect on the climate change from CO2 and non-$CO_2$ aviation emissions:

- Carbon dioxide is a very stable chemical substance and in the Earth's atmosphere conditions does not easily combine with other elements, achieving molecular lives around 100 years average.

- In addition, it has a high diffusion power in the different atmospheric layers and geographical regions, reaching homogeneous concentration levels very fast.

- All these properties allow to treat $CO_2$ as a single magnitude in terms of climatic change impact, independently of the emission place and of the conditions of the surrounding air.

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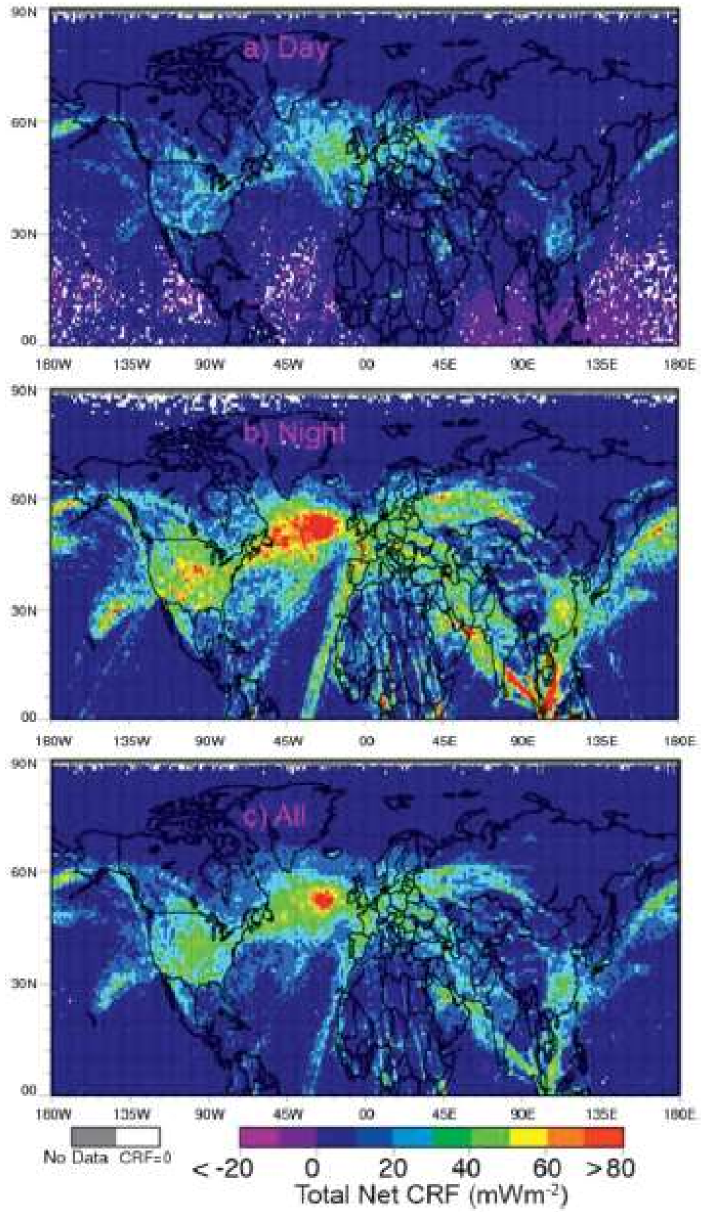
# Spatial and temporal distribution of aviation emissions

The non-$CO_2$ have different and diverse characteristics, with much shorter average lives and stability depending on the chemical and meteorological conditions where they are emitted:

- Many of them react with atmospheric components producing different types of substances.
- These chemical reactions may be strongly dependent on the emissions concentration.
- The geographical point of emission and the amount of concentration of each one of the substances have a relevant role in the resultant Effective Radiative Forcing
- The air space zones with the highest traffic (generally in the middle latitudes of the North Hemisphere) have different conditions than other less frequented areas and the months of the year with more flights get higher pollutant concentrations.

# Spatial and tempo tion emissions

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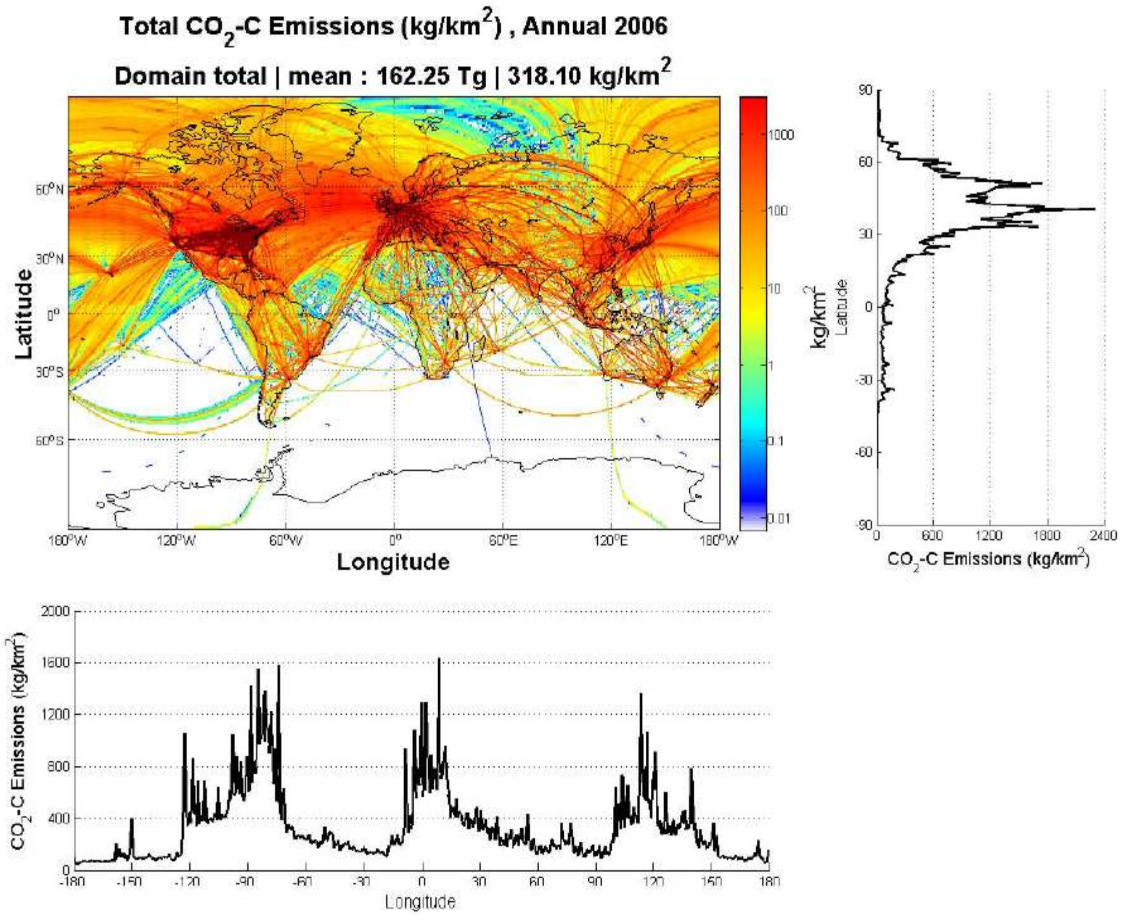
# Spatial and temporal distribution of aviation emissions

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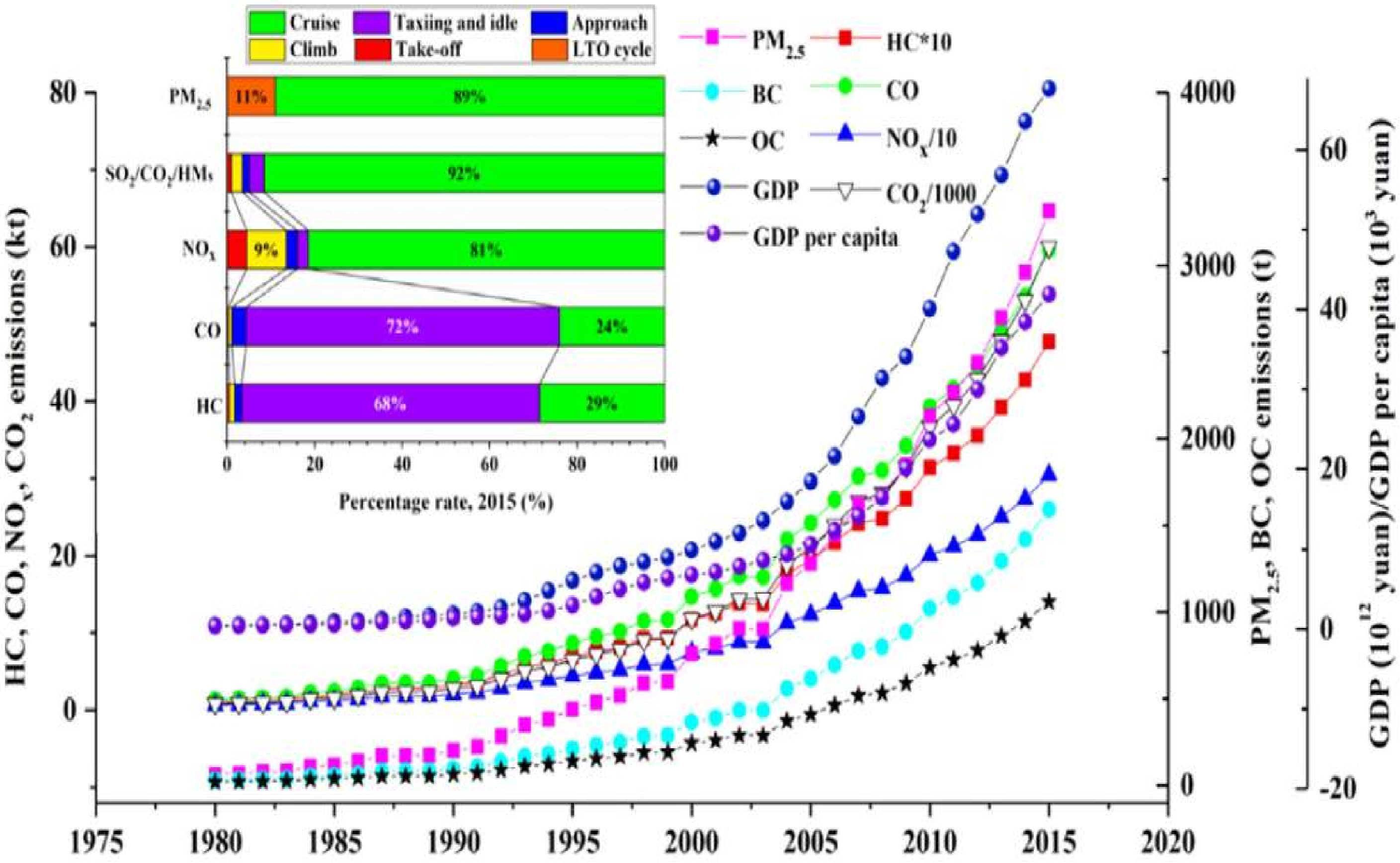
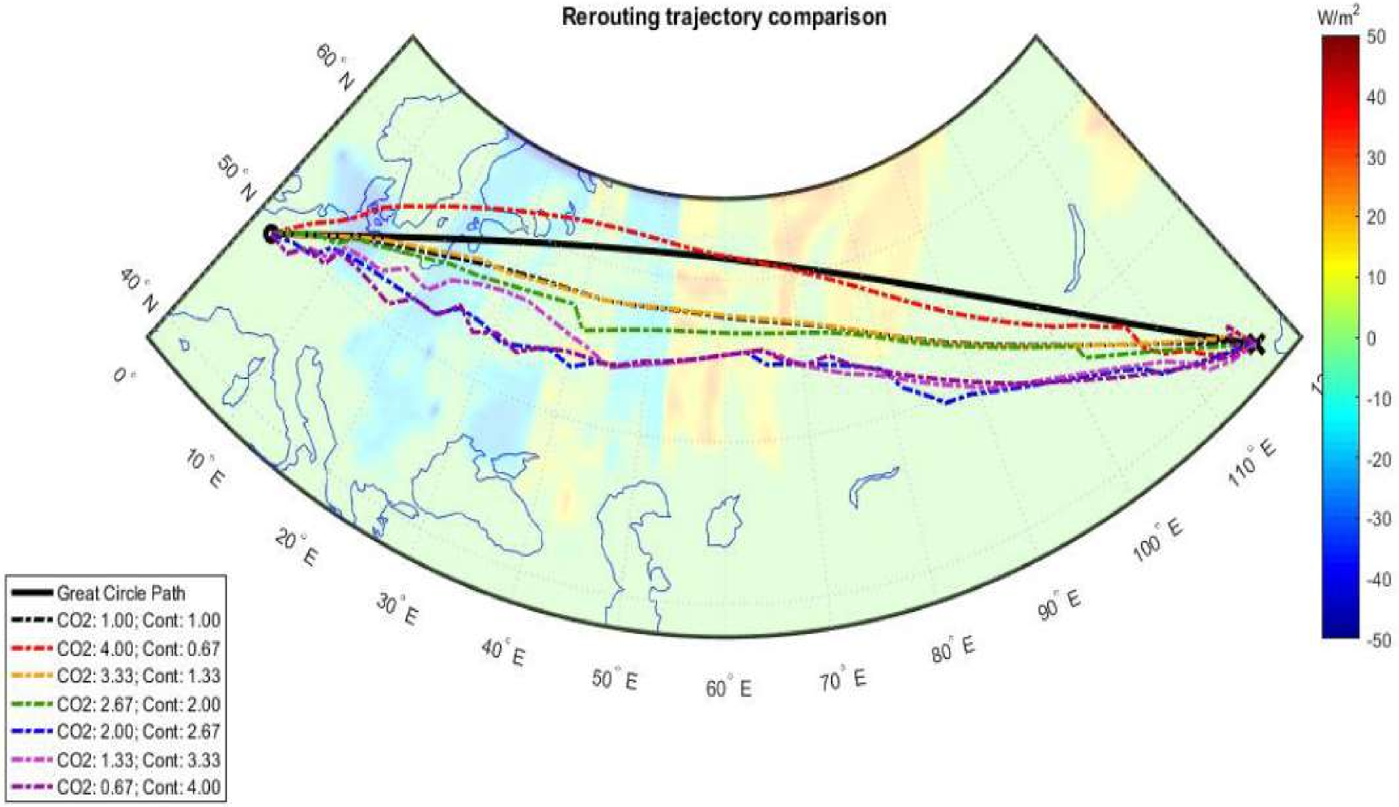
# Spatial and temporal distribution of aviation emissions



# Spatial and temporal distribution of aviation emissions



# Temporal distribution of aviation emissions

The temporal distribution of emissions depends on several elements, most of them related with the air transport demand in the different regions:

- Summer and holiday seasons attract more passengers. In the North Hemisphere, (with 90% of commercial traffic), the June-September period, with a peak mid-July to mid-August. In addition, there are some additional worldwide festivities like Christmas and some local ones like Chinese New Year, Thanksgiving in the USA, Eastern in some parts of Europe, that create additional demand.

- During the week, Monday and Friday have more traffic in business markets and Friday to Sundays for holiday places.

- During the day, passenger traffic has peaks in early morning and mid evening, while most freight moves at night. This schedule is different in Europe and North America, where there is little passenger movement at night (many airports close), than in Asia, with much more flights in those hours.

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# Conclusions

- The future evolution of air transport emissions has received a lot of attention with respect to $CO_2$ but there are very few studies covering in detail the rest of contaminants, where there is still a relatively high level of scientific incertitude.

- In the majority of the cases, the effect of all non-$CO_2$ pollutants on climate change is grouped in a coefficient to multiply the $CO_2$ effect.

- There is potential to reduce the overall environmental impact by optimizing trajectories

- Current ATM concepts need to be worked out.

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# Next steps in GreAT

**Development of an evaluation methodology for environmental impact**

- Environmental impact assessment indicator
- Environmental impact assessment index system

**Environmental Impact Assessment (EIA) of greener air traffic operation**

- Calculation of aircraft fuel consumption and carbon emissions
- Calculation of other climate change relevant emissions
- Environmental impact assessment of greener long and short haul operation approaches

**Discussion of the tradeoffs between environmental impact and performance indicators**

- Correlation Analysis of Airport/Terminal Operation Performance and Environmental Impact
- Correlation Analysis of ACC/Route Operation Performance and Environmental Impact

# Time for questions

This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement No 875154 GreAT.