



The impact of flight trajectories in aviation emissions: the GreAT project

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The GreAT project: Greener air traffic operations

MOTIVATION – Climate change

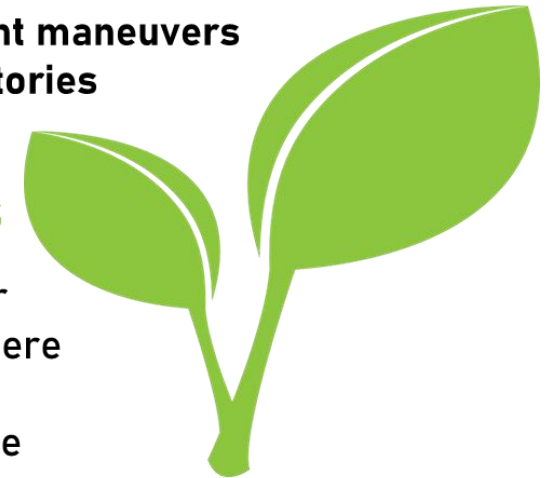


Mitigate the **causes**

- Use more efficient aircraft
- Use alternative fuels / propulsion
- **Use more efficient flight maneuvers along optimized trajectories**

Mitigate the **consequences**

- Actively remove CO₂ (and other gases) again from the atmosphere
- Influence thermal balance of the earth





The GreAT project: Greener air traffic operations



CHALLENGES

Investigation of new possibilities to **reduce gas emissions** of flight trajectories at local and global level



New concept to manage air traffic in a ,greener´ way, e.g. by using Trajectory Based Operations (**TBO**) and **adapted airspace design**



Determination of the potential to save gas emissions with **greener trajectories**

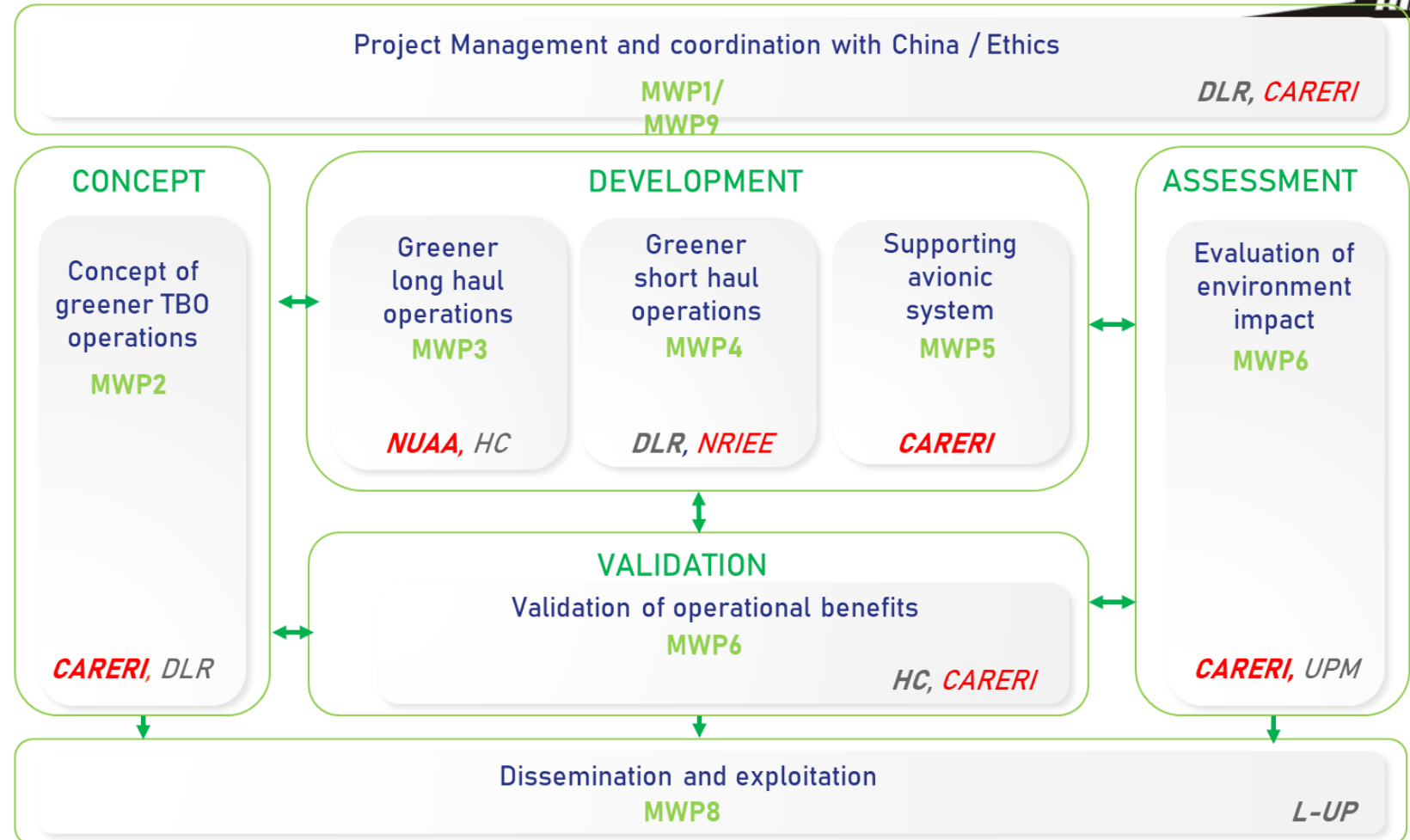


The GreAT project: Greener air traffic operations

GREAT PROJECT - Main Work Packages



<https://www.project-great.eu/>





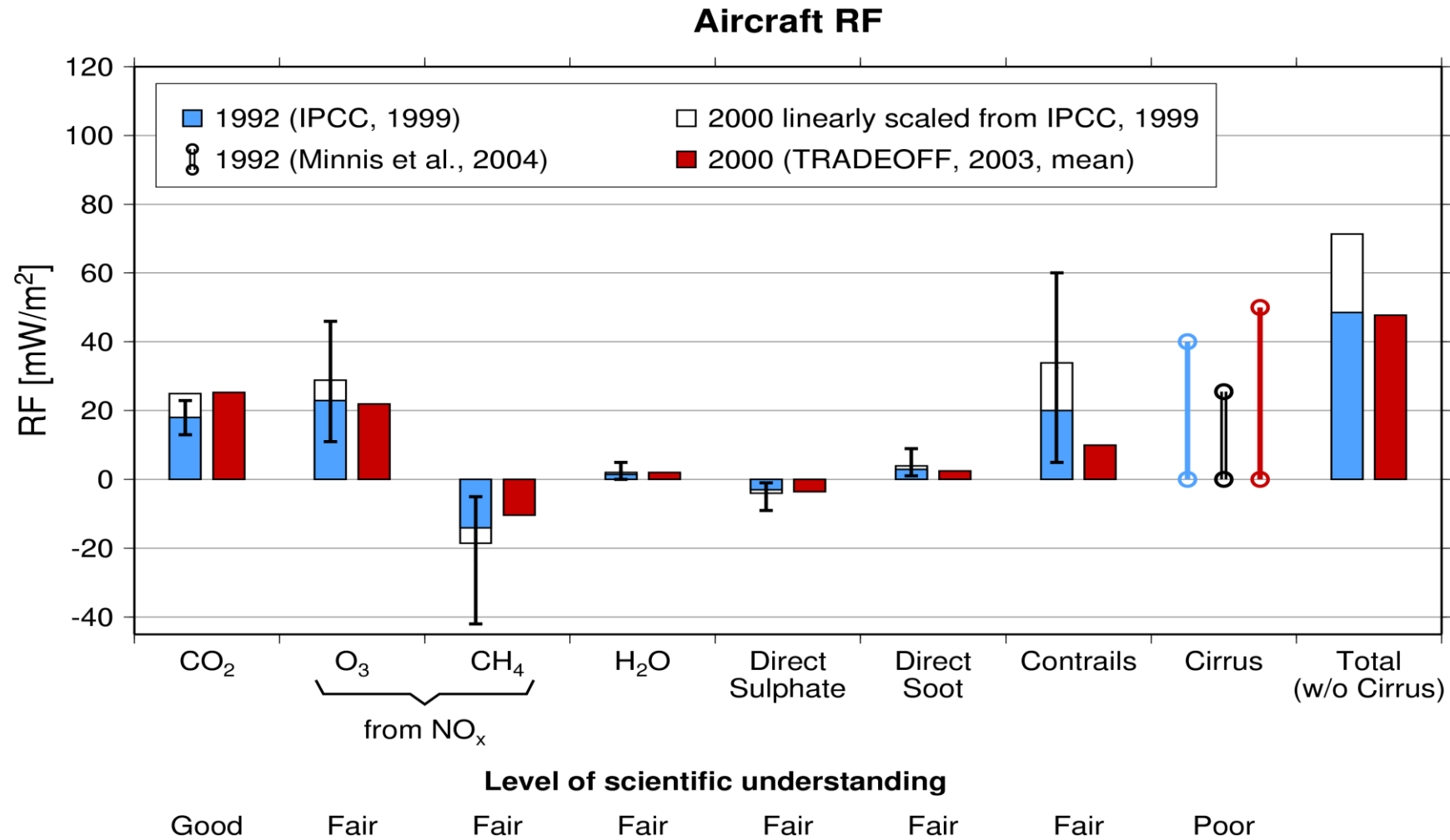
Evaluation of environmental impact in GreAT: objectives



- The main objective is to evaluate the environmental impact of aviation pollutants such as CO₂ and NO_x, 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 scientifically.
- By integrated validation via multiple data sources, the improvement of 4DT-based green operational technology on climate change will be evaluated.
- The tradeoffs between climate change impact and other environmental and performance indicators will also be studied.



Aviation environmental impact

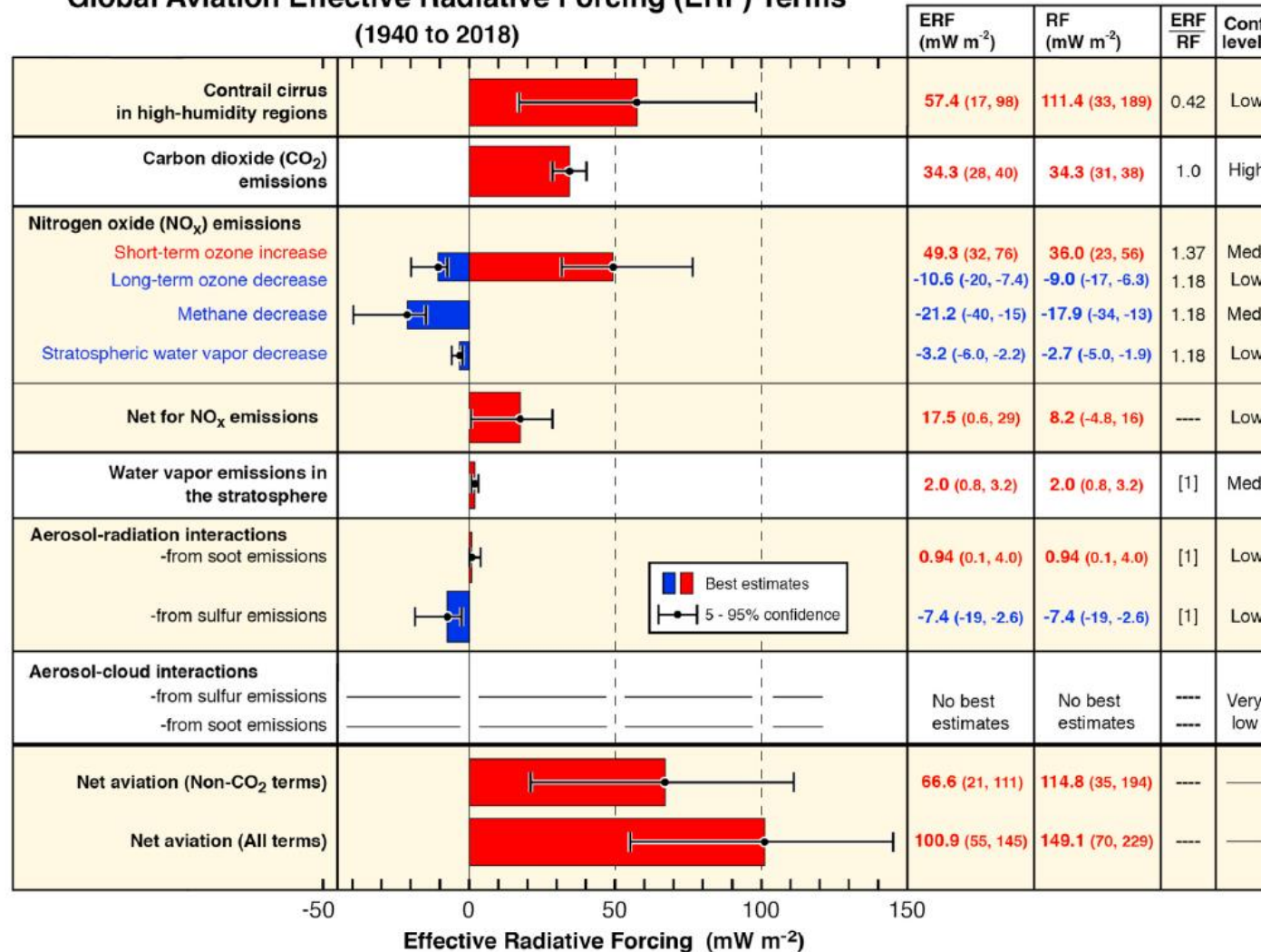




Aviation environmental impact



Global Aviation Effective Radiative Forcing (ERF) Terms
(1940 to 2018)





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 50 years: ~ 1.2 100 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 50 years: ~ 3 100 years: ~ 2
Equivalent Warming Potential (GWP*)	Global temperature change caused by changes in emissions of short-lived substances.	~ 4 ⁷



Spatial and temporal distribution of aviation emissions



There is a significant difference between the effect on the climate change from CO₂ and non-CO₂ 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 CO₂ as a single magnitude in terms of climatic change impact, independently of the emission place and of the conditions of the surrounding air.



Spatial and temporal distribution of aviation emissions



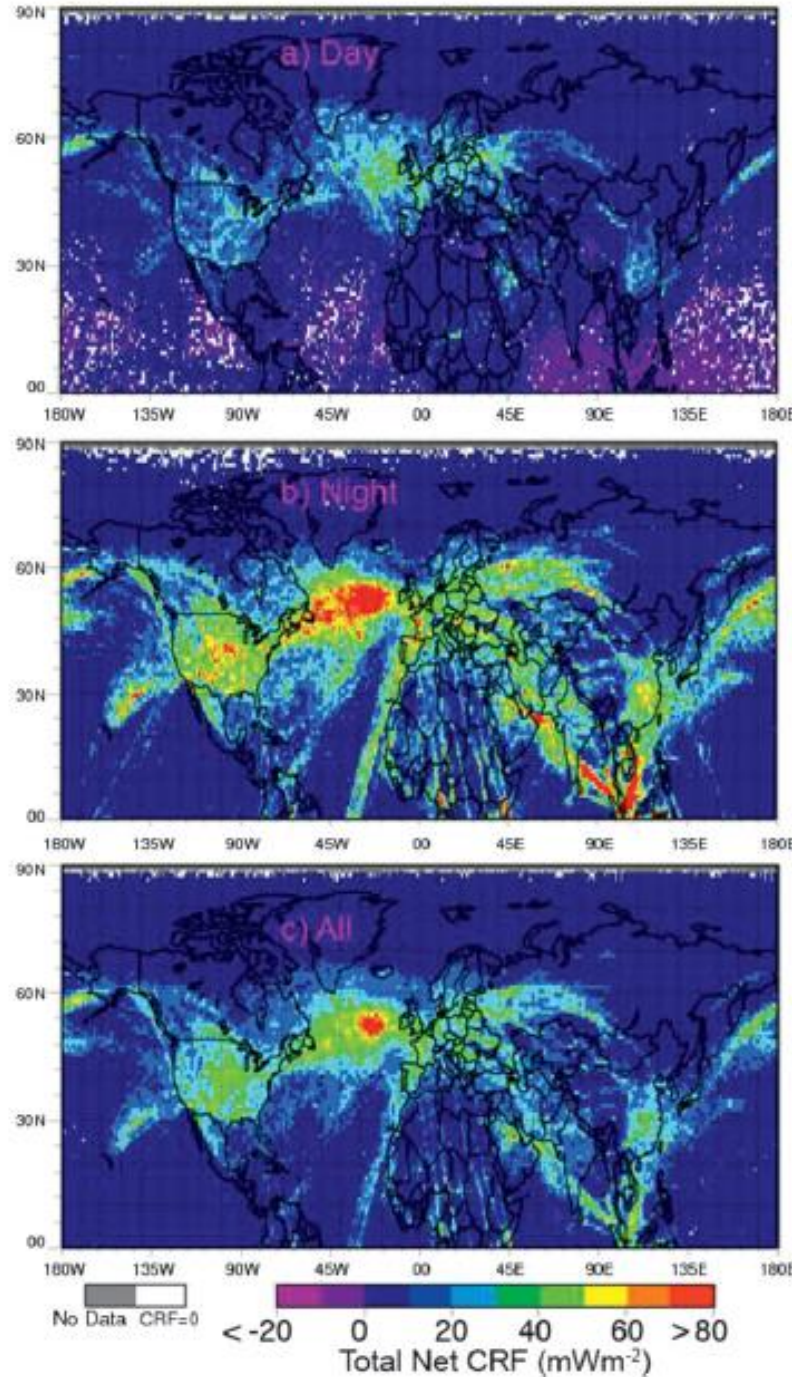
The **non-CO₂** have different and diverse characteristics, with much shorter average lives and stability depending on the chemical and meteorological conditions where they are emitted:

- 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 dis

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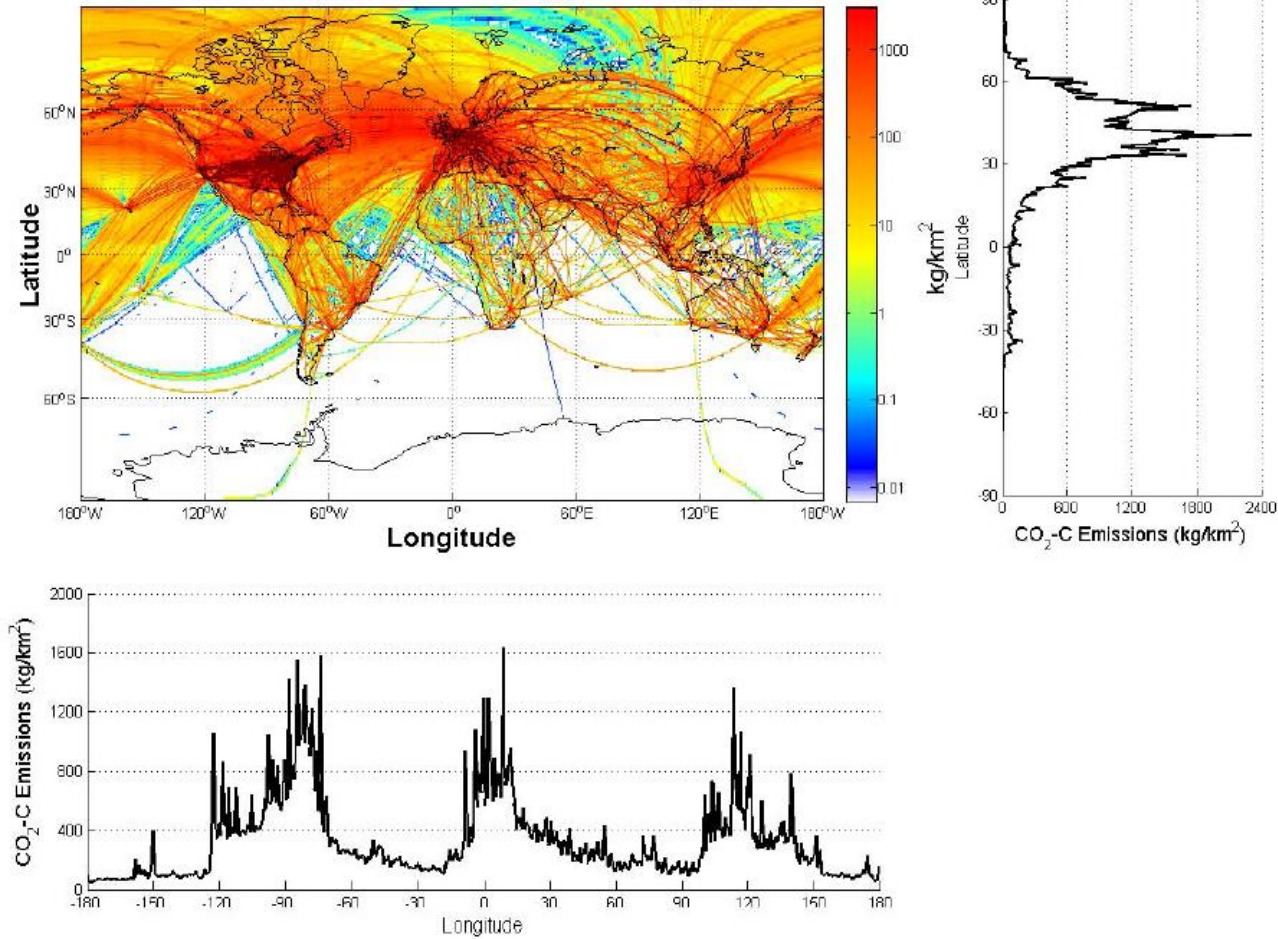


Spatial distribution of aviation emissions



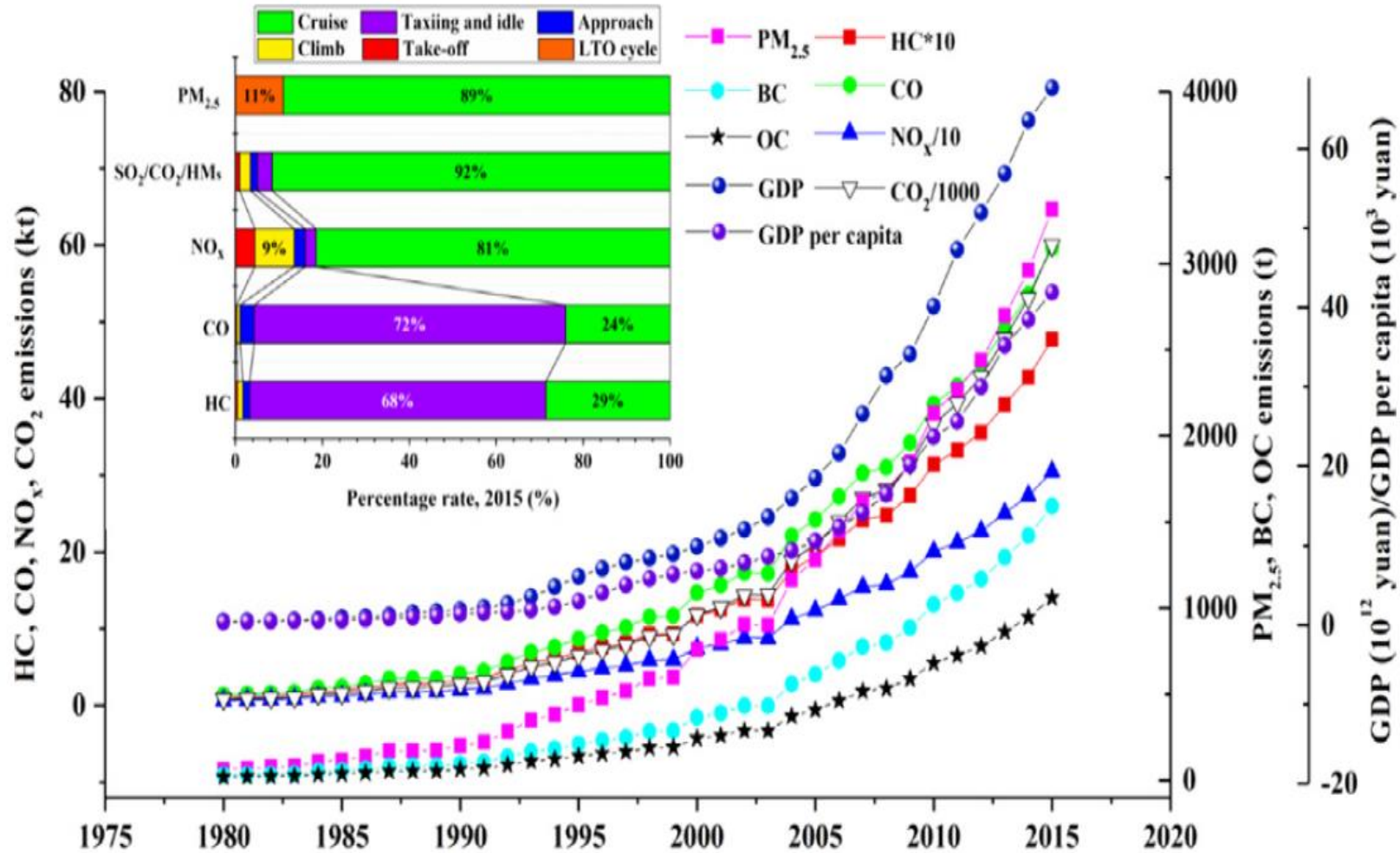
Total CO₂-C Emissions (kg/km²) , Annual 2006

Domain total | mean : 162.25 Tg | 318.10 kg/km²



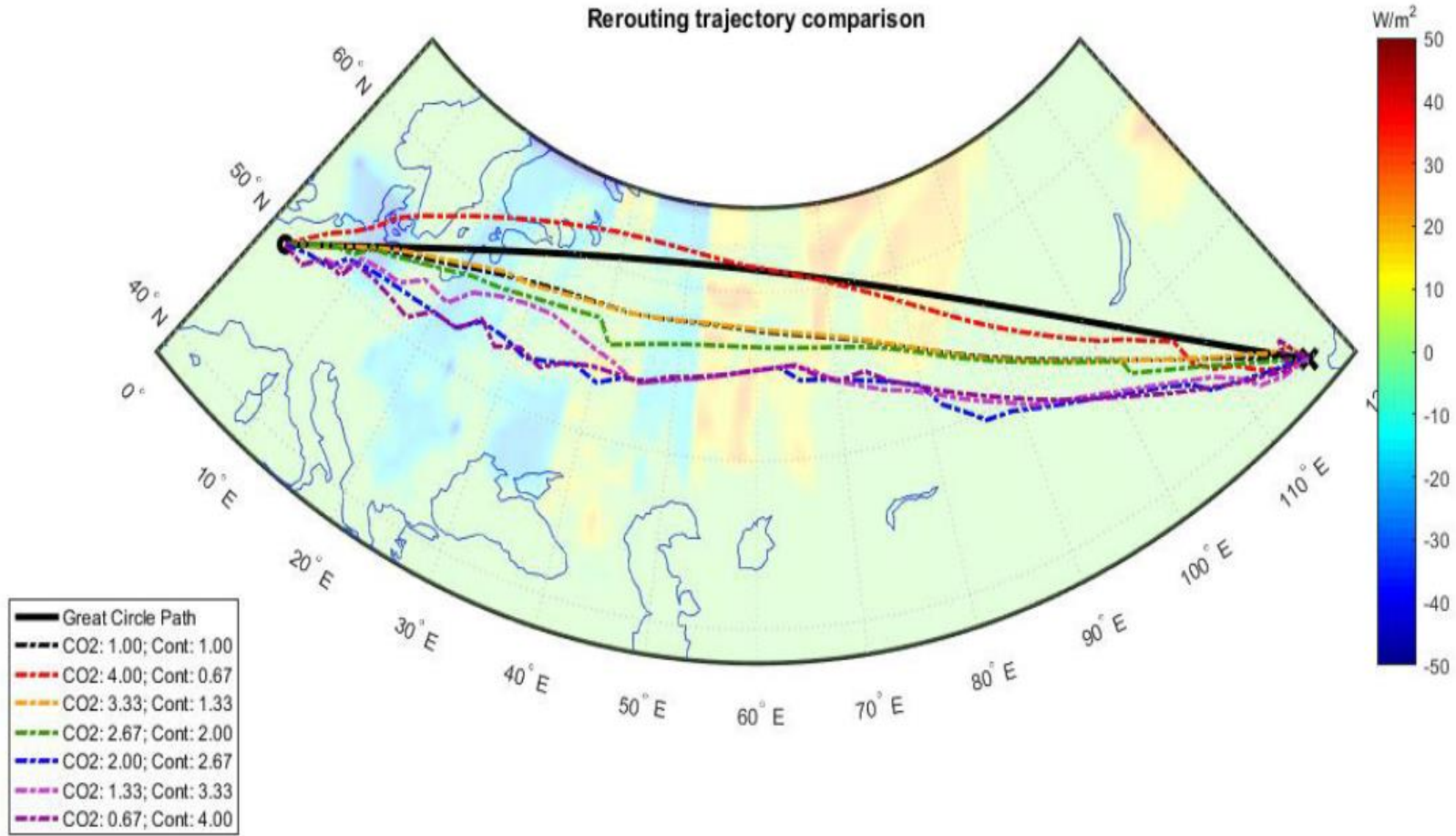


Spatial distribution of aviation emissions





Spatial 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.



Conclusions



- The future evolution of air transport emissions has received a lot of attention with respect to CO₂ but there are very few studies covering in detail the rest of contaminants, where there is still a relatively high level of scientific uncertainty.
- In the majority of the cases, the effect of all non-CO₂ pollutants on climate change is grouped in a coefficient to multiply the CO₂ effect.
- There is potential to reduce the overall environmental impact by optimizing trajectories
- Current ATM concepts need to be worked out.



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.

