Towards a climate neutral ATM

Scientific progress in FlyATM4E project

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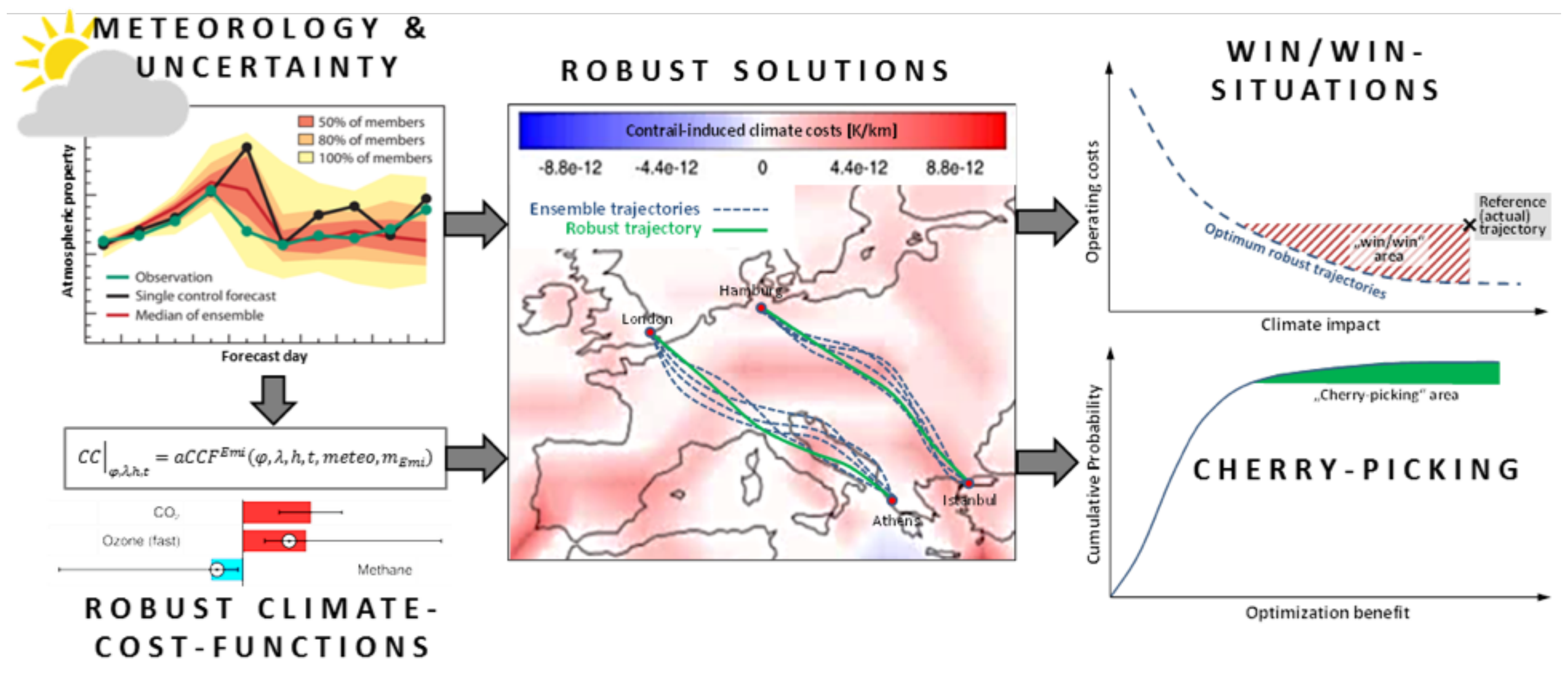
Concept

FlyATM4E will **develop a concept** to identify climate-optimised aircraft trajectories which enable a robust and eco-efficient reduction in aviation's climate impact.

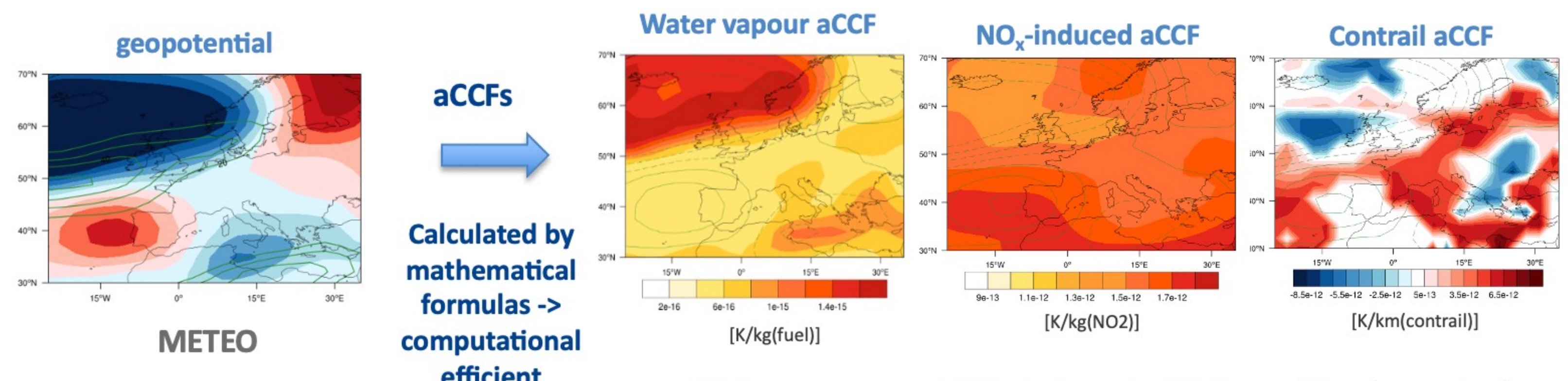
Climate optimization will take into account CO_2 and non-CO_2 effects, such as contrails and contrail-cirrus, water vapour, NO_x and particulate emissions.



Algorithmic Climate Change Functions (aCCFs)

- Algorithmic climate change functions (aCCFs) of non-CO_2 effects were developed to give the climate impact of aviation emissions at a specific location and time (over the North Atlantic).
- aCCFs can be calculated for contrail-cirrus, water vapour, NO_x-induced changes of ozone and methane
- aCCFs enable calculating climate impact based on meteorological parameters from numerical weather prediction data.
- aCCFs of non-CO_2 effects and their uncertainties provide environmental information to ATM / trajectory planning in order to avoid regions with high climate impact.

Climate change from meteorological input data by using aCCFs



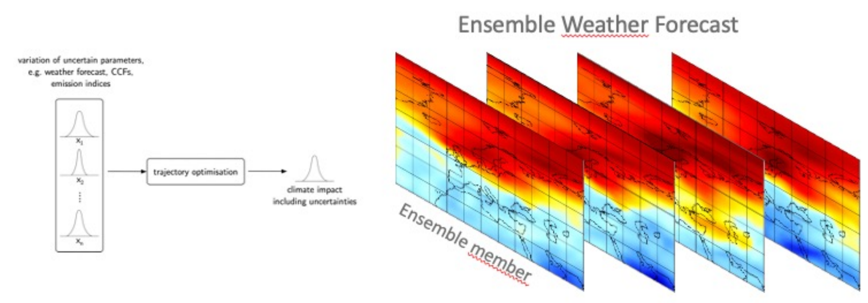
Matthes et al. 2017

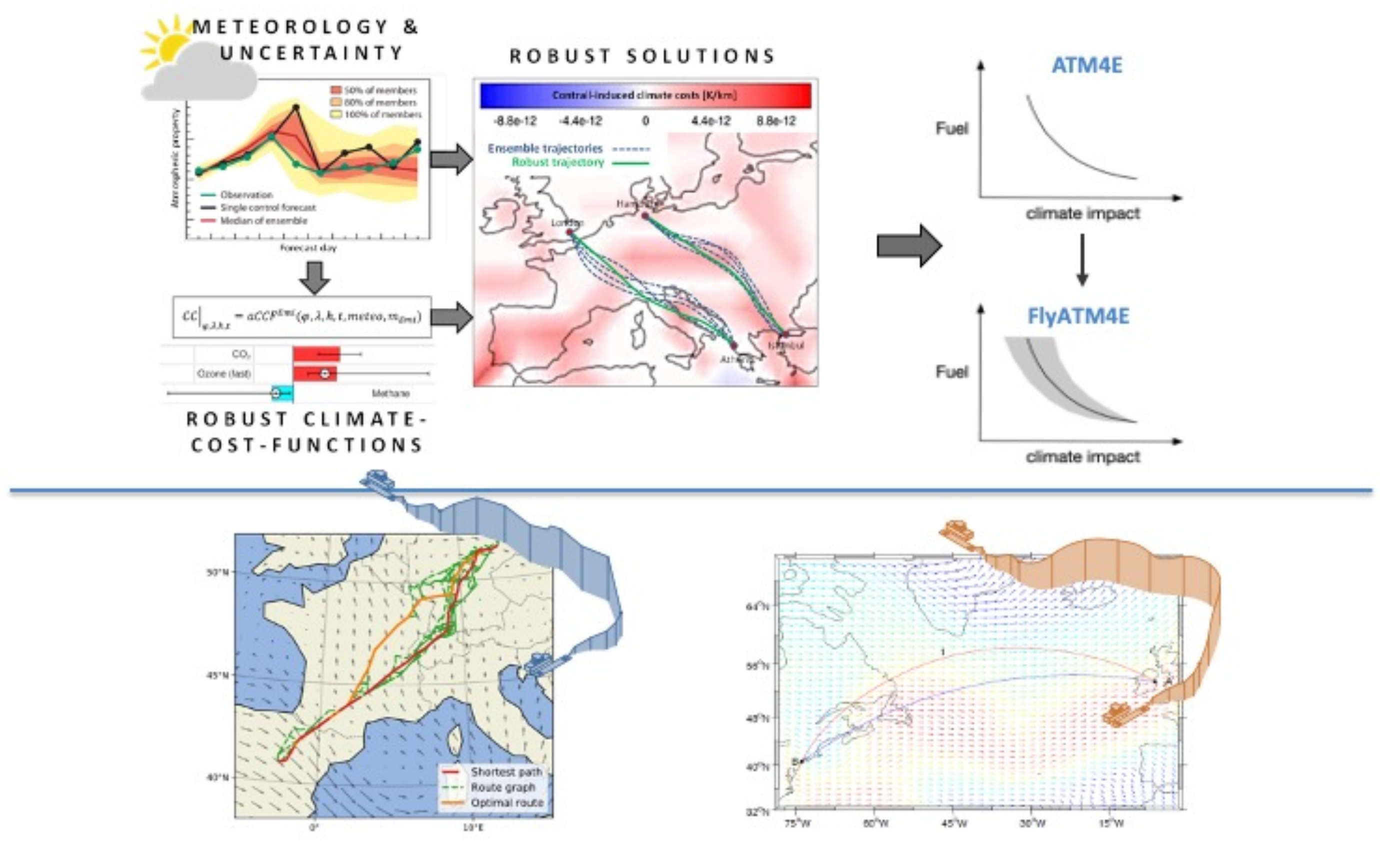
- Water vapour and NOx induced aCCF is positive (warming)
- Contrail (daytime) aCCF warming/cooling impact in areas where contrails can form

Robust Climate-Optimal Trajectories

Objectives:

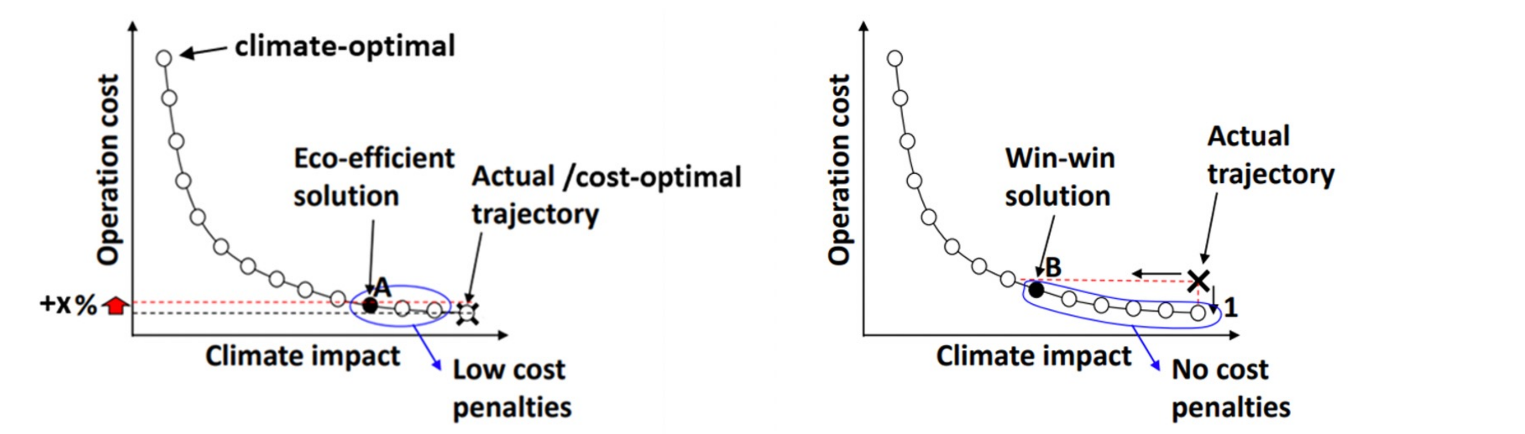
- **Establish a methodology** to consider uncertainties from MET data in trajectory optimisation and
- to **demonstrate** to investigate changes to estimated climate impact mitigation potential in adequate scenario





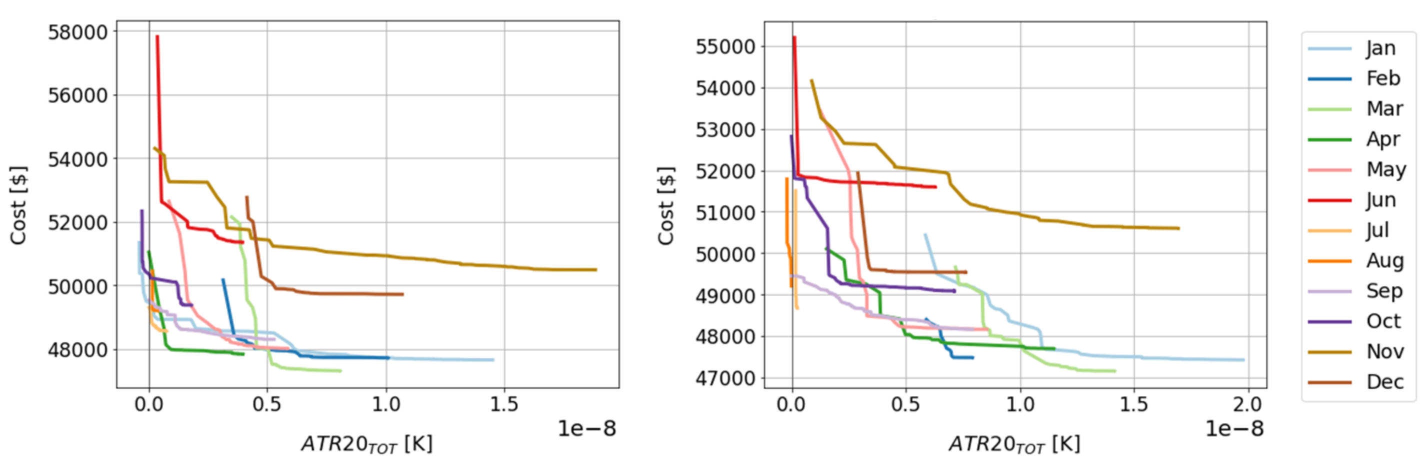
Eco-Efficient Trajectories

Objective: identify trajectories allowing a substantial reduction in climate impact, while:(a) leaving the cost nearly unchanged or (b) reducing the cost with respect to the actual trajectory.



(a) Lower climate impact, cost nearly unchanged. (b) Lower cost and climate impact.

Method: conduct annual/multi-annual simulations using an air traffic simulator (AirTraf) coupled with the Atmospheric Chemistry Model EMAC considering two objectives of climate impact (provided by algorithmic climate change functions (aCCFs)) and cost.



- **Figure**: collection of Pareto fronts for a flight from New York to Paris, under several atmospheric patterns throughout the year 2016 (every first day of the month).
- **Optimization objectives: (1) cost** (function of fuel use and fight time) **and (2) climate impact** ($ATR20_{TOT}$ = Total Average Temperature Response in a time horizon of 20 years, including effects from emissions of CO_2, NO_x, H_2O, and contrails).
- **First results:** higher potential to identify eco-efficient trajectories in non-summer months.

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Project Information

FlyATM4E

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