Sustainable Skies Conference: Contrails in Focus

7-8 November 2023

EUROCONTROL's Brussels HQ

Angelo Riccio

This project has received funding from the SESAR Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 890898
https://create-project.eu/

Introduction and motivation

CREATE - Innovative Operations and climate and weather models to improve ATM resilience and reduce impacts

CREATE SOL-1:
Multi-scale multi-pollutant air quality system (AQS)

CREATE SOL-2:
Multi-aircraft environmentally-scored weather-resilient optimized 4D-trajectories in the flight execution phase

CREATE SOL-3:
CO2 and non-CO2 balanced Environmental Scores Module

Università degli Studi di Napoli Parthenope

ARIANET

FMI

CIRA
Italian Aerospace Research Centre

nlr

UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH

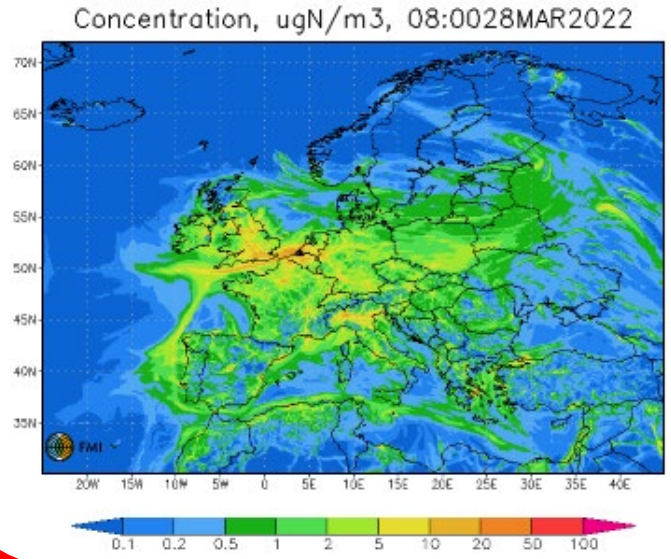
EUROCONTROL

CANSO

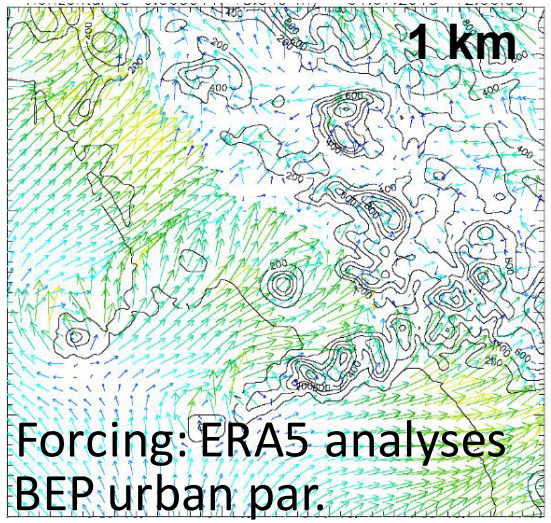
Background

- In the flight plan generation and optimization process it is aimed to find a trajectory which meets all ATM constraints but is environmentally friendly as well.
- The CREATE project proposes a solution (CREATE-SOL-3) which address both CO_2 and non-CO_2 effects during the en-route flight phase.
- The non-CO_2 effects include
  - H_2O emissions
  - NO_x emissions
  - Contrail formation
- The solution will be used to evaluate the “greenness” of aircraft 4D trajectories, which can be used in both strategic (before flight) as tactical (during flight) flight planning and optimisation.
- The solution should be a pragmatic KPI which can be used in trajectory replanning and optimisation from an ATM point of view.
  - Results to be acquired in a timely manner
  - The output of the calculations should be used in making trade-offs for flight trajectory selection
- The achieved TRL of the solution is TRL1.

Regional scale air quality (SILAM)

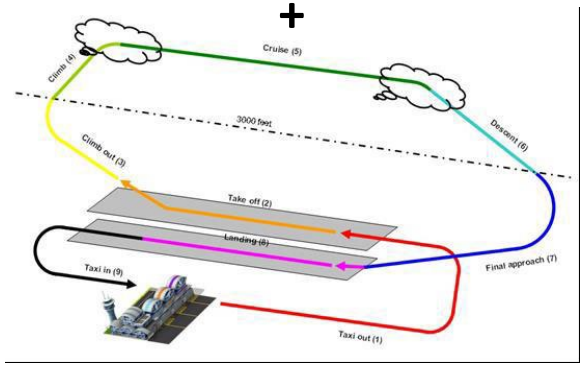


Urban scale meteorology (WRF)



Italian emission inventory

\+

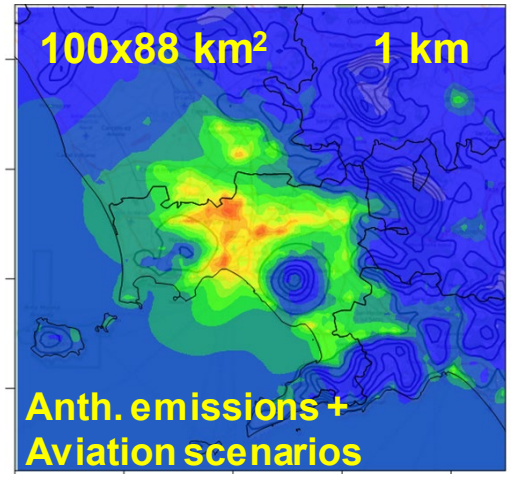


Aircraft+airport emissions

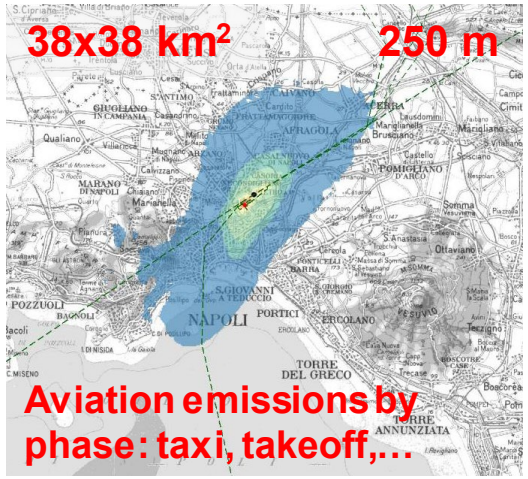
air quality

air quality

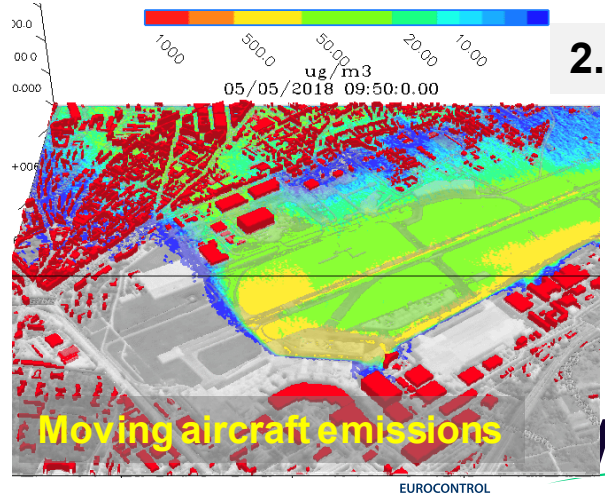
Urban scale CTM (FARM)



Local scale LPM (SPRAY)



Obstacle resolving LPM (PMSS)

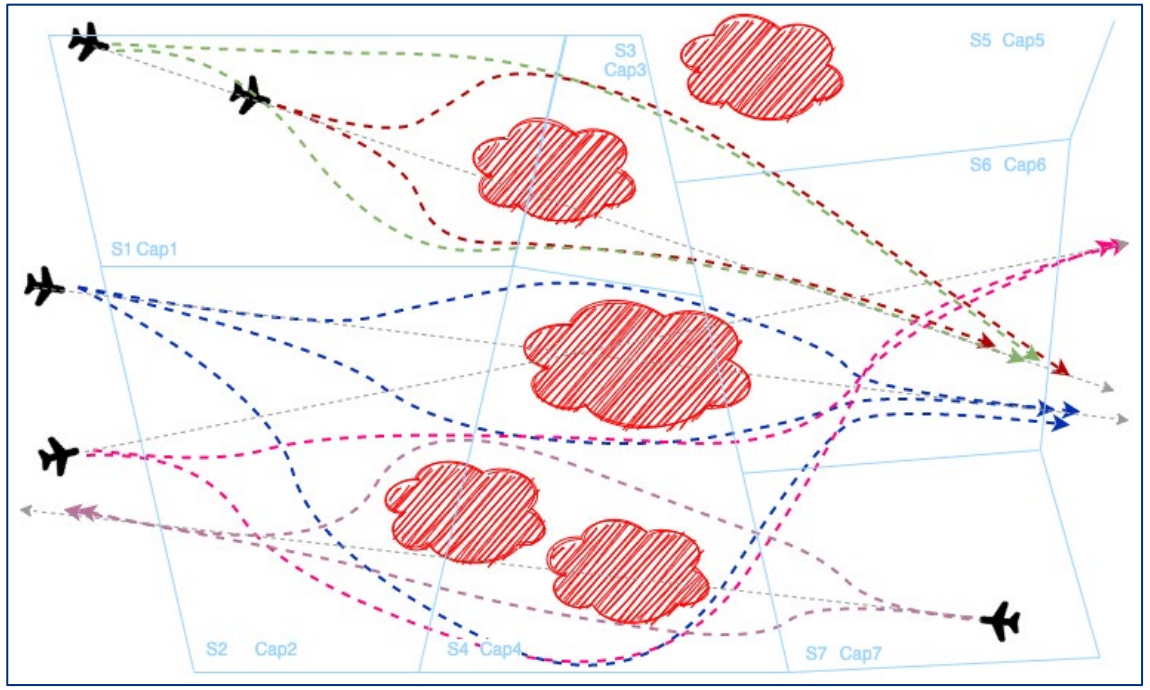


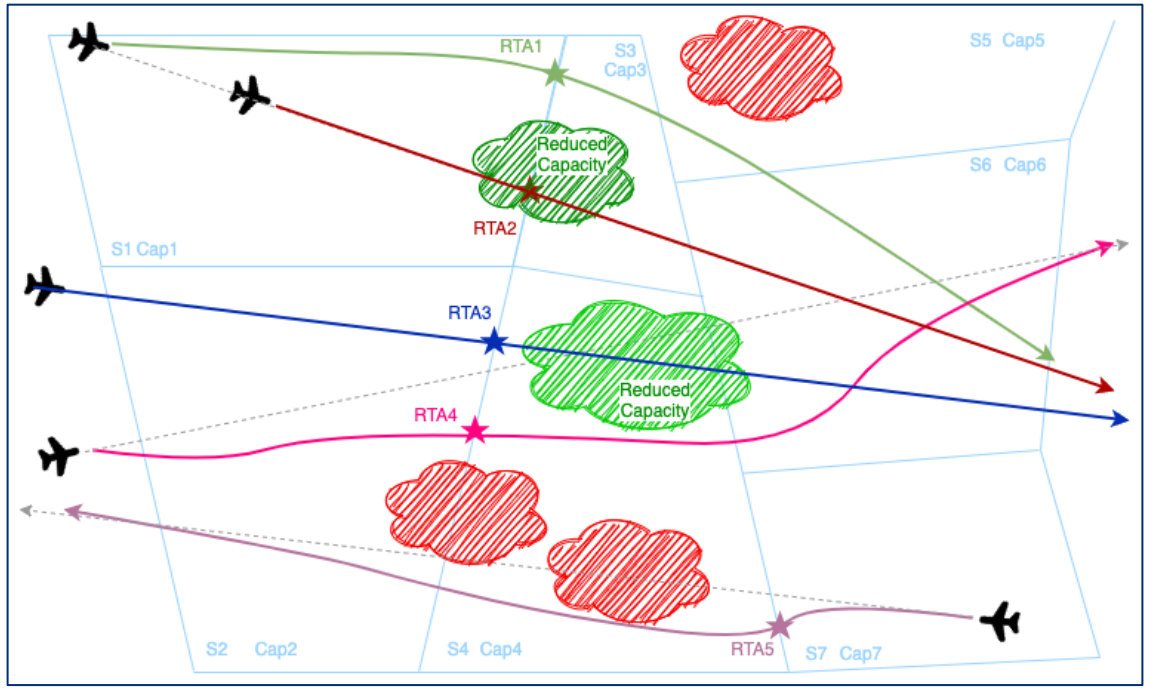
2.5x2 km²

5 m

EUROCONTROL

Concept of Operations





CREATE-SOL-3 was applied to North Atlantic use-case in simulation experiment, because this is where there is a large probability of large contrail sensitive area occurrence.

ESM is used here,
each CT has an ESM score

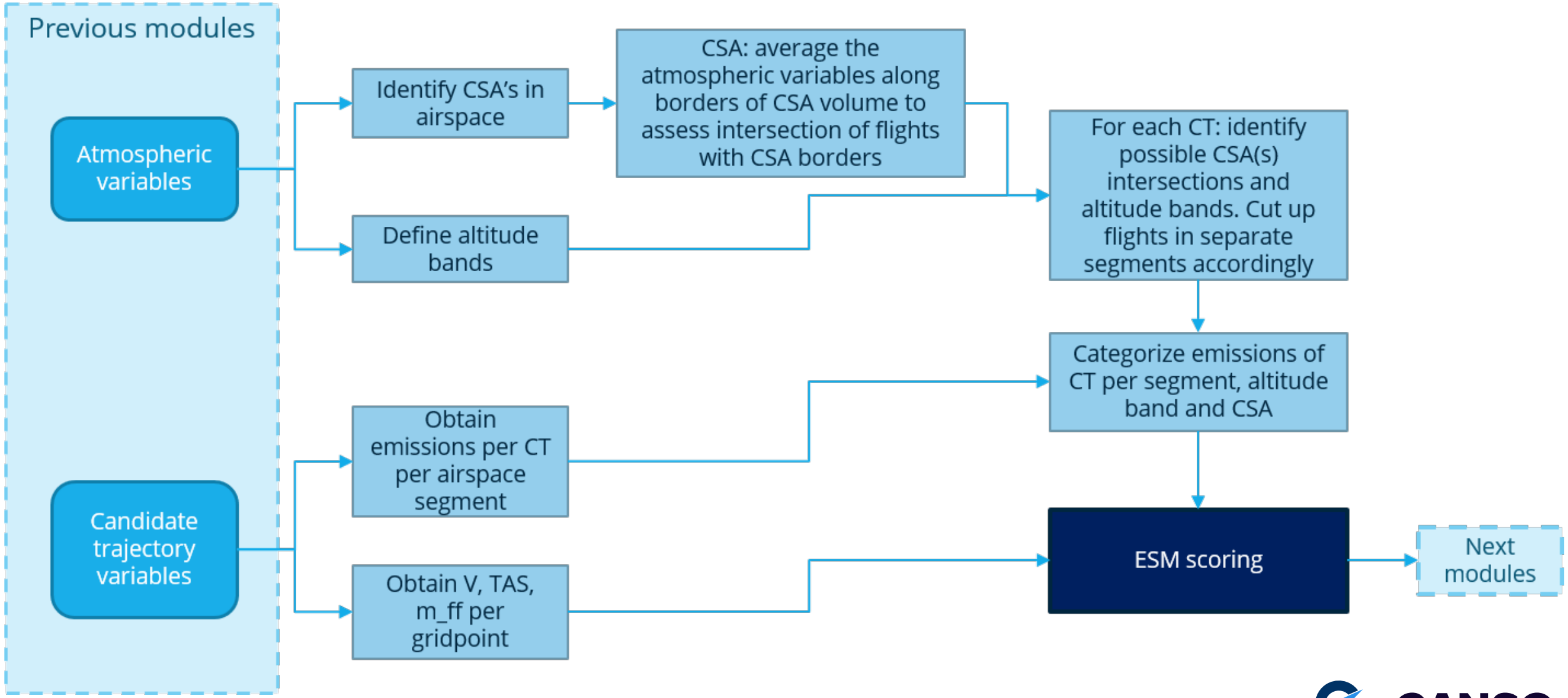
Solution concept

- **Non-CO_2 emissions** are dependent of location and time.
- **CO_2 emissions** are independent of location and time.

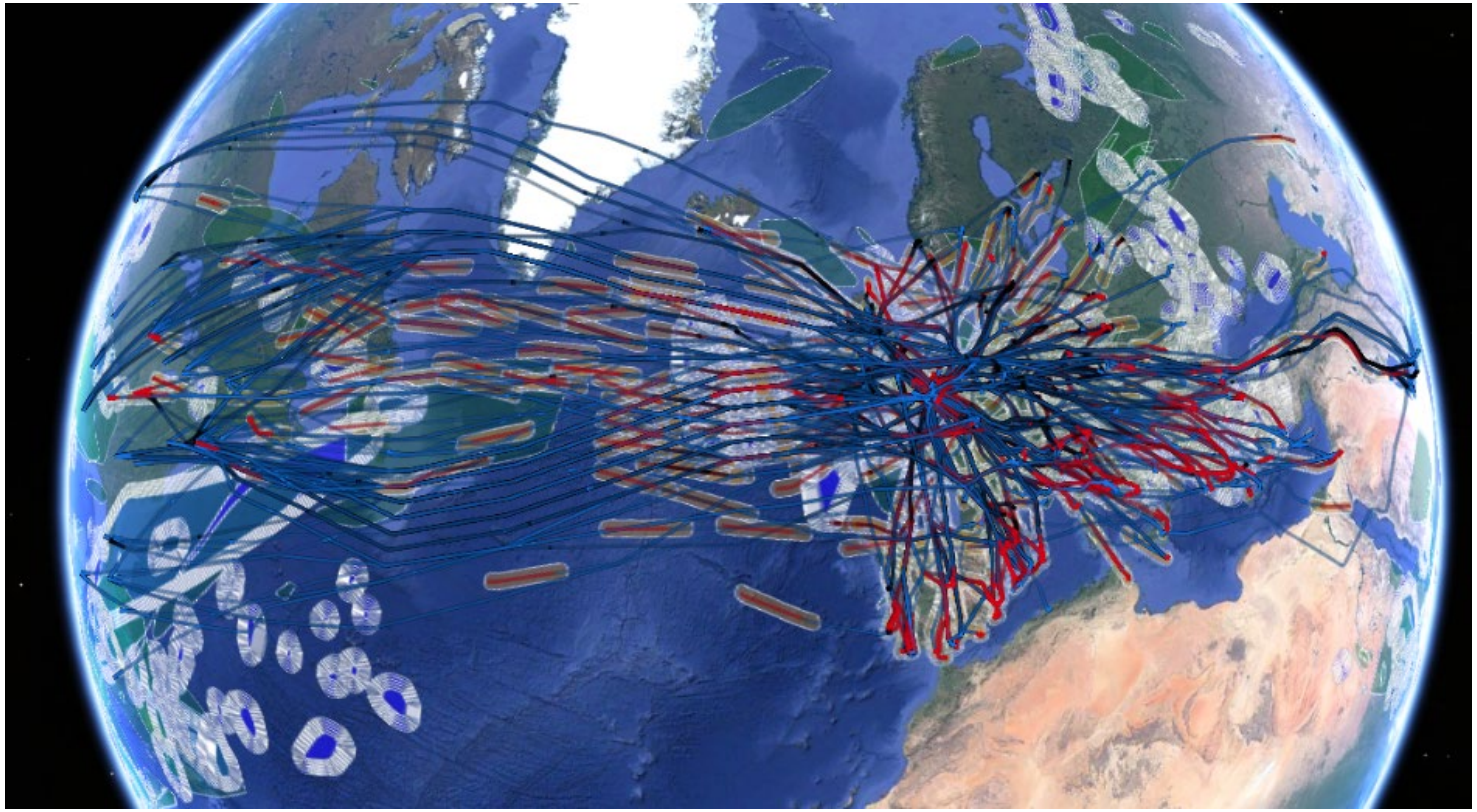
- The Environmental Scoring Module (ESM) assigns scores to each candidate trajectory (CT).
- ESM logic;
  - **CO_2** is linearly related to the total emitted amount per flight and therefore compared to other CTs
  - **NO_x and H_2O** emissions impact are related to altitude.
  - **Contrail formation** probability and impact are related to Climate Sensitive Areas (CSA)* and interference with other Candidate Trajectories.

*The current scope only considers Contrail Formation Region (CFR) to be relevant for the definition of CSAs

CREATE SOL3: ESM logic

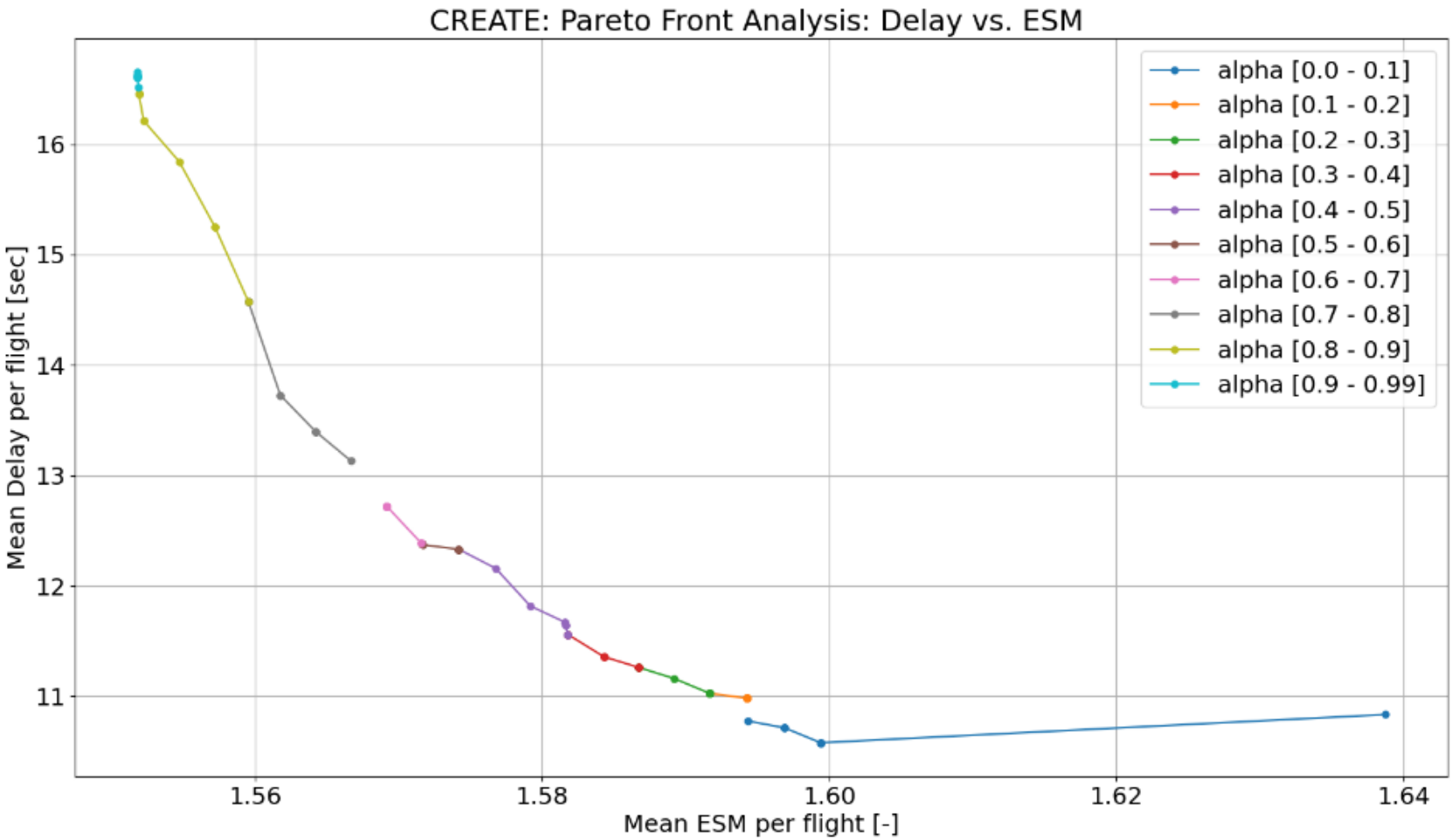


Fast-Time Simulation exercise



- No-fly zones (thunderstorms) (blue), contrail zones (green) and all baseline flights (blue lines) with their related look-ahead time area (red lines)
- Simulation scenario based on historical flight tracks of 27 July 2018
- 1308 flights were applicable for the trajectory optimisation

Results



Higher *alphas*:

- Lower ESM score, leading to "greener" flights.
- Higher extra operating cost per flight.

Lower *alphas*:

- Lower extra operating cost, leading to cost-effective flights.
- Higher ESM score, leading to higher-environmental-impact solutions.

Publications

- Middel J., Sutopo K., Heesbeen B., Verbeek R., van den Dungen N.H.M., Sáez R., Prats X. and Riccio A., "CO_2 and non-CO_2 balanced Environmental Scores Module for flight performance evaluation and optimisation", presented during the 12th EASN conference in Barcelona 2022; published in June 2023 Journal of Physics Conference Series 2526(1):012013, https://iopscience.iop.org/article/10.1088/1742-6596/2526/1/012013

- van den Dungen N.H.M., Sutopo K., Prats X., Di Vito V. and Riccio A., "Multi-aircraft environmentally-scored weather-resilient optimised 4D-trajectories", 2021 FABEC research workshop: Climate Change and the Role of Air Traffic Control (Vilnius, Lithuania)

- Bucchignani,E.; Zollo,A.L.; Montesarchio, M. Analysis of Expected Climate Extreme Variability with Regional Climate Simulations over Napoli Capodichino Airport: A Contribution to a Climate Risk Assessment Framework. Earth 2021, Volume 2, 980–996. 2021