



Better contrail mitigation through flight trajectory optimization (BeCoM)

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Trajectory optimization to mitigate the climate impact for persistent contrails



- Persistent contrail is formed in **limited regions** of the atmosphere, i.e., ice super-saturated regions (ISSRs, relative humidity w.r.t. ice >100%).
- Flight trajectories can be optimized to avoid ISSRs hence reducing the flight distance through ISSRs.

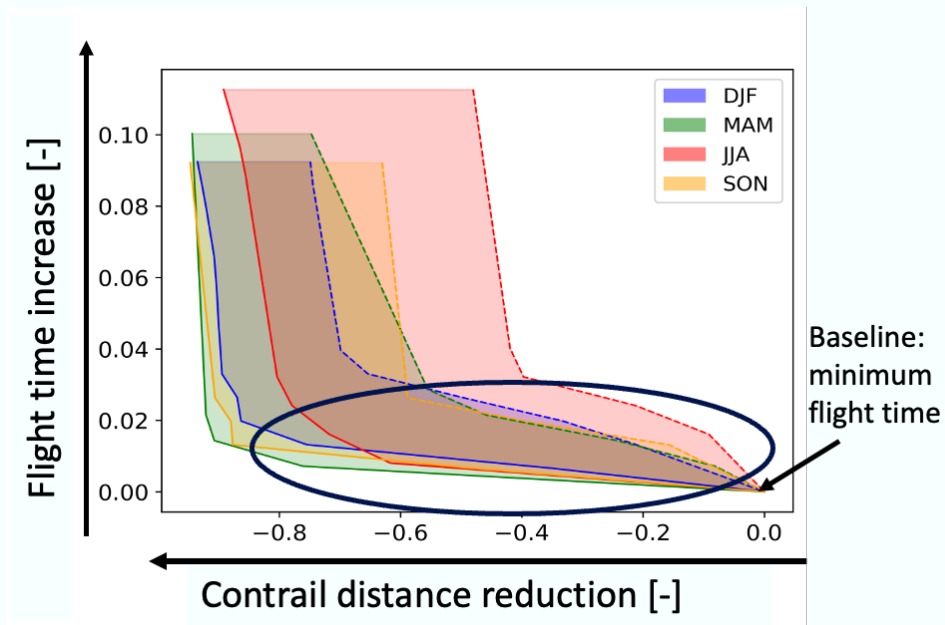


Figure: Examples of contrail avoidance over a year based on 103 transatlantic flights. (Yin et al, 2018)

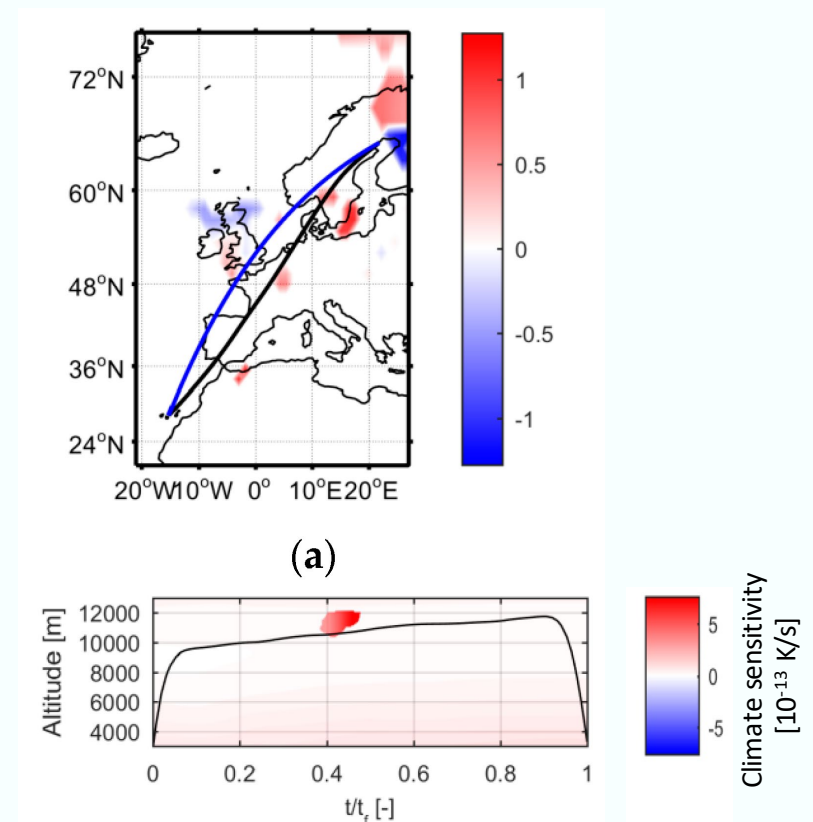


Figure: Example of optimized aircraft trajectory (Lulea-Gran Canaria, adapted from Fig. 1 in Matthes et al., 2020)

Relative humidity (numerical weather prediction vs. measurements)



ERA-5 reanalysis vs. IAGOS in 2014

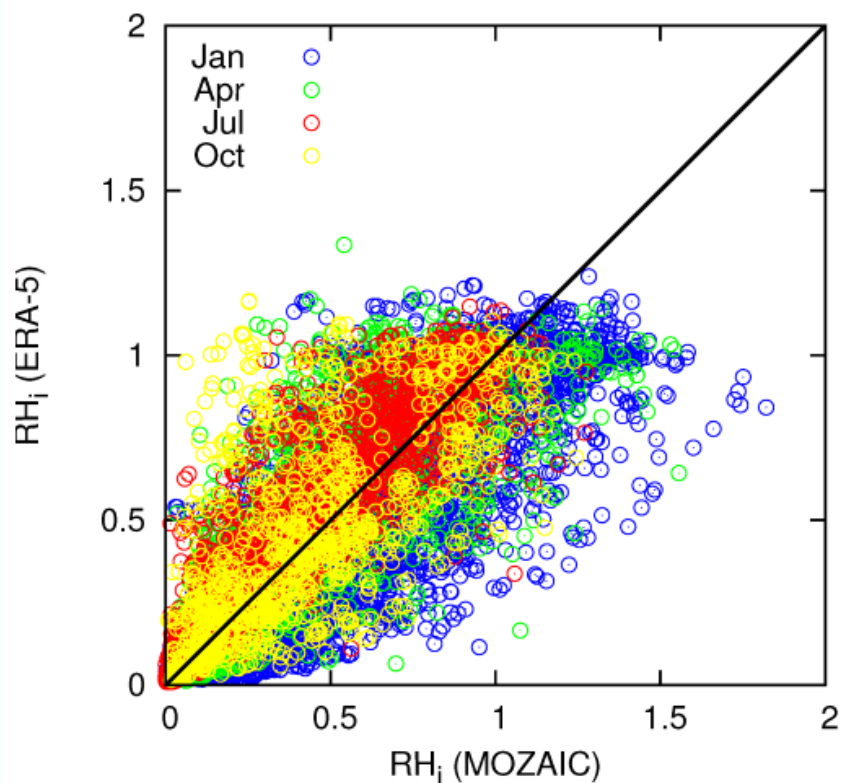
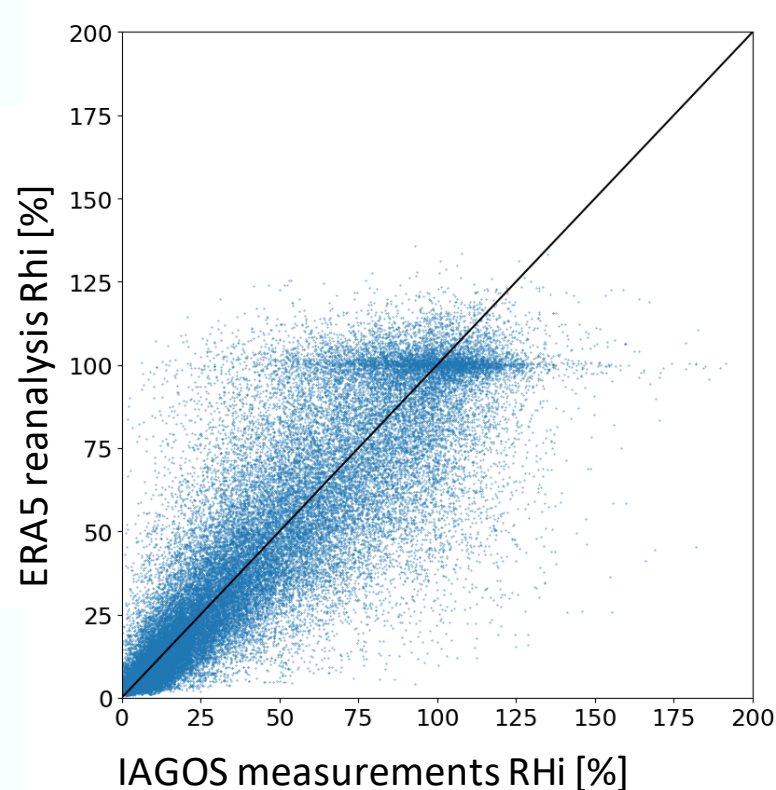


Figure taken from Gierens, 2020

ERA-5 reanalysis vs. IAGOS in 2018



- The contrail persistence, i.e., relative humidity w.r.t. ice (RH_i) has a large spread between numerical weather predictions and measurements.

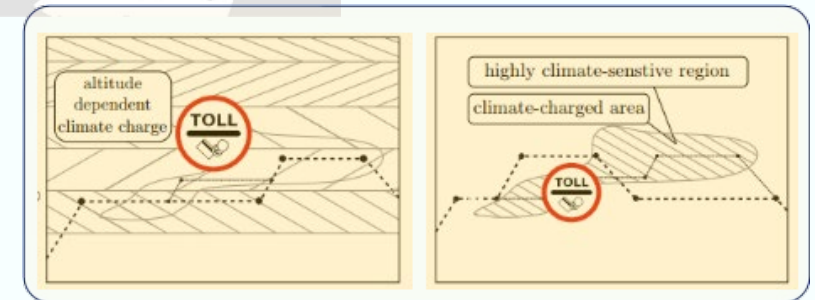
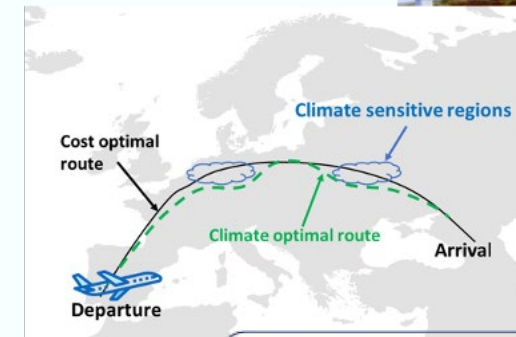
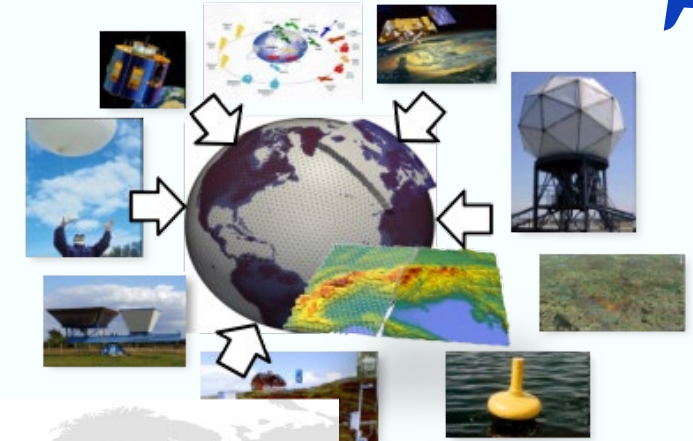
BeCoM goal and objectives

BeCoM aims to better predict persistent contrail by:

- O1: Operational and more accurate **humidity measurements** at the cruise level;
- O2: Enhancement of **the representation of Ice supersaturation** in NWP models;
- O3: Evaluation of the data and model predictions.

Hence, significantly reduce global mean contrail radiative forcing through:

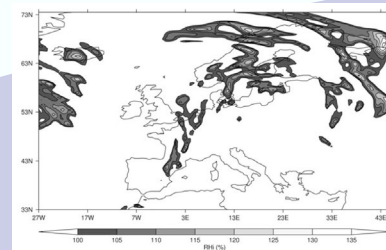
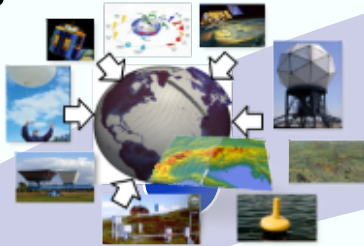
- O4: Flight trajectory optimization for **warming contrail avoidance**;
- O5: **Market-based measures for non-CO2 effects**.



BeCoM scope to improve ice supersaturation prediction



Assimilation of observational data and direct camera images using **artificial intelligence**



Measurements to be considered:

- LIDAR
- Radiosondes
- IAGOS



Operational and more accurate measurements of humidity & characterization

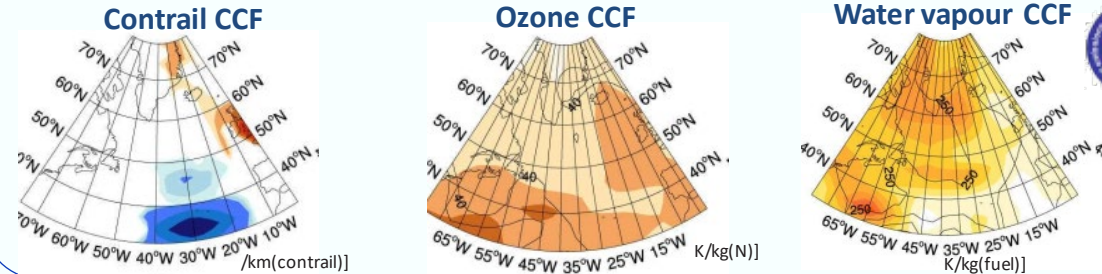
Better representation of ice supersaturation in NWP model

Sperber and Gierens, EGU sphere [preprint], 2023.

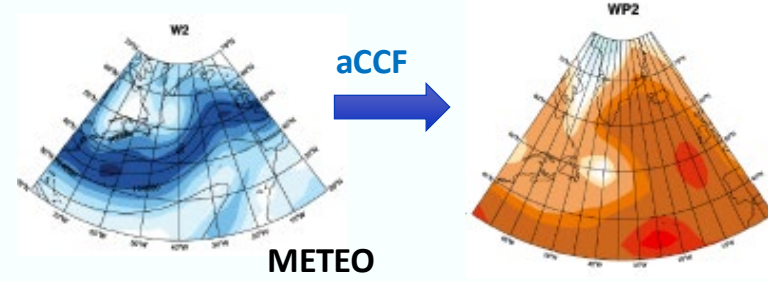
Cost-based flight trajectory optimization including non-CO₂ effects



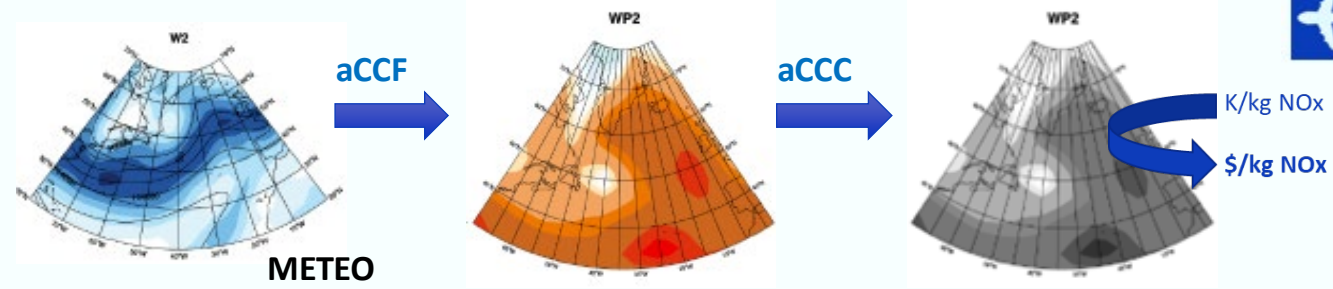
Climate Change Functions = four dimensional functions (space & time)



Algorithmic Climate Change Functions



Algorithmic Cost Functions for Climate Change



- Elaboration of a monetarization logic
- Elaboration of a methodology for integrating existing non-CO₂ uncertainties
- Calculation of robust algorithmic climate cost functions for climate change (aCCC)

BeCoM Consortium



Project coordination
WP4 lead
climate- optimized trajectory
calculation for contrail
avoidance.



WP3 Lead

- AI algorithms for contrail detection and data of assimilation process
- Climate-optimized trajectory calculation



WP1 lead
operational, new
measurements of
humidity and
characterization



WP6 lead
Communication and
dissemination



WP2 lead
Weather model and
data assimilation to
enhance the prediction
of super-saturation
fields in NWP.



Communication and
dissemination



W5 lead

- Conceptualization of non-CO₂ climate policy for flight planning;
- Ice cloud microphysics conceptualization to improve forecasts of ice-supersaturated regions in NWP.



Thank you for your attention



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