From Observation to Application: An EarthCARE Contrail Dataset for Climate and Policy Support

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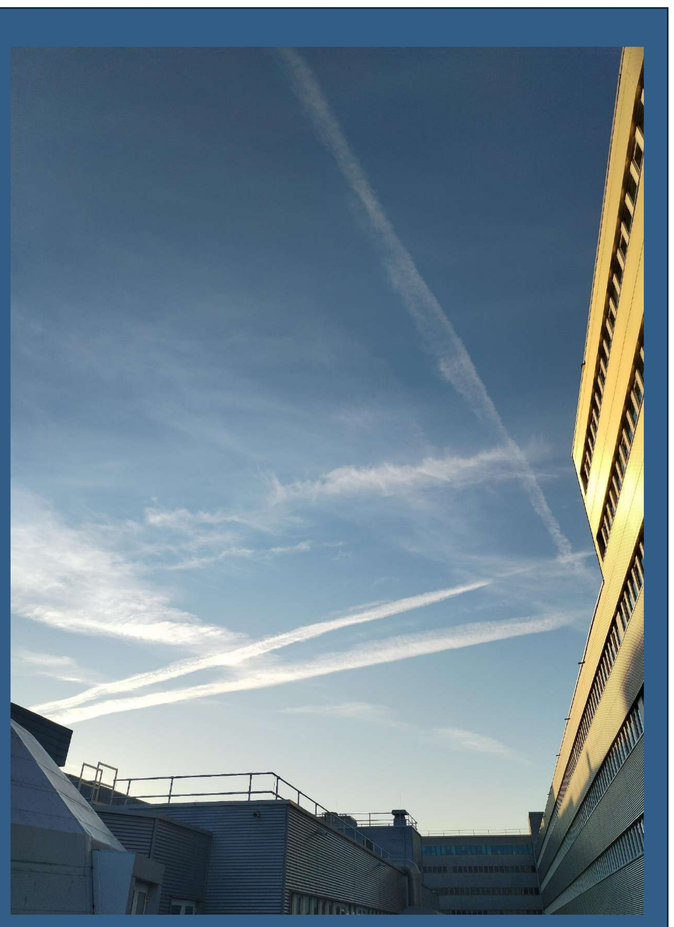
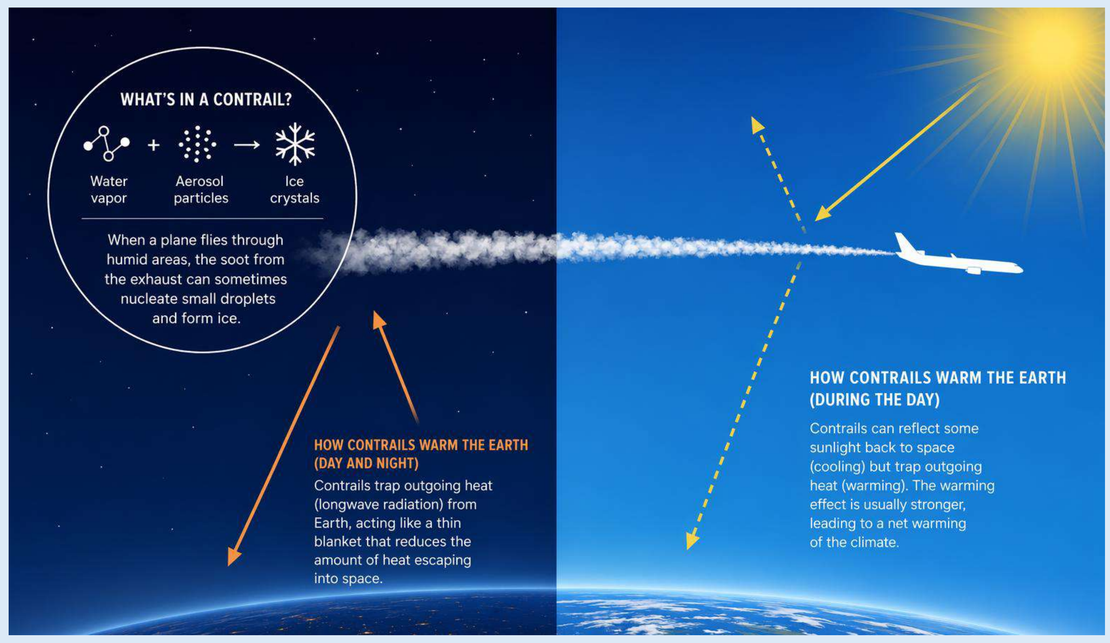
Why?

- Contrails are responsible for **>50% of aviation climate impact** [1]
- There is a need to understand under which conditions contrails lead to warming, when to cooling. [2]
- The European Union Emissions Trading Scheme integrates **non-CO2 climate impact of aircrafts** [3] → economic incentive to avoid contrail formation
- Contrail avoidance needs to have a **very high confidence** to be effective
- EarthCARE provides **state-of-the-art instruments** to assess the radiative impact and microphysics of contrails
- This project aims to build a database of contrails found in EarthCARE data



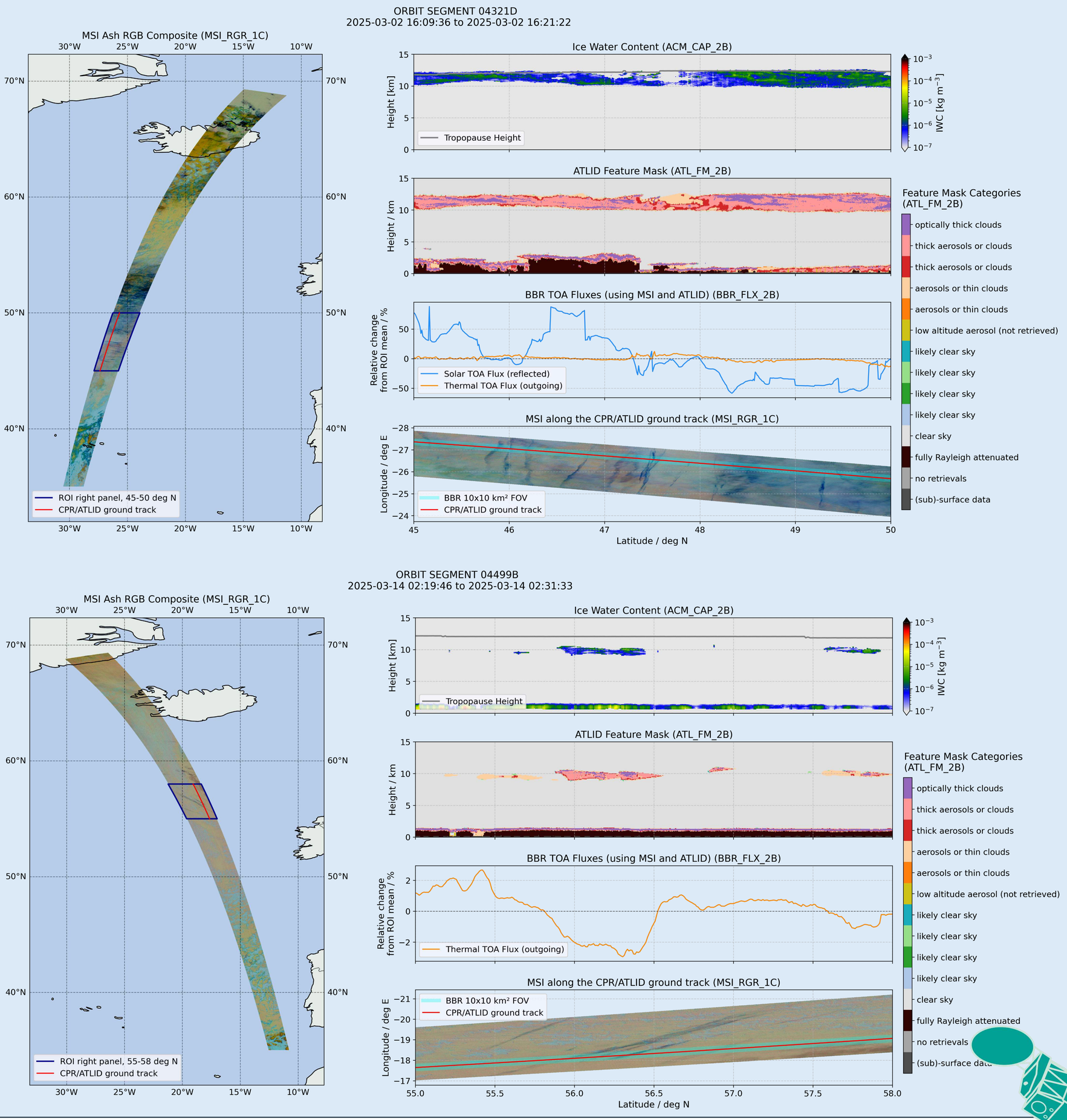
Contrails over ESTEC in Noordwijk at sunset

Radiative effects of contrails



1) reduction in outgoing longwave radiation both at day and night (→ net warming effect on Earth's radiative balance during the night) [1, 2]
2) reflect more shortwave radiation during the day (→ net warming, cooling, or no radiative effect during the day) [1, 2]

Contrails across different EarthCARE products



MSI Ash RGB

Combination of channels according to the EUMETSAT Ash recipe [4]. Through this combination of the thermal channels of MSI (TIR1, TIR2, TIR3), contrails appear as long, dark stripes in the MSI frames [2].

$$R = TIR3 - TIR2$$
$$G = TIR2 - TIR1$$
$$B = TIR2$$

Band	$\lambda[\mu m]$	$\Delta\lambda[\mu m]$
TIR1	8.8	0.9
TIR2	10.8	0.9
TIR3	12.0	0.9

Summary

- Case study for March 2025, western Europe and north-east Atlantic
- Here, we found a reduction of 2% in outgoing longwave radiation at night in BBR data
- Visible in ice water content (IWC) and ATLID feature class as thick aerosols or clouds at around 10 km (typical flight attitude)
- Creating a dataset of single contrails to better understand radiative effects
- Fully automated pipeline to produce a dataset with overview plots of contrails for a specific period and region

References

[1] Ortiz, I., García-Heras Carretero, J., Jafarimoghaddam, A. and Soler, M. (2025). Robust Evaluation of Neural Networks Trained on the OpenContrails Dataset. DOI: 10.1109/TGRS.2025.3629628.

[2] Dimitropoulou, E., de Buyl, P. and Clerbaux, N. (2026). Satellite-based estimation of high-altitude ice cloud radiative forcing derived through a Rapid Contrail-RF Estimation Approach. DOI: 10.5194/amt-19-437-2026.

[3] https://climate.ec.europa.eu/eu-action/transport-decarbonisation/reducing-emissions-aviation_en

[4] EUMETSAT Compilation of RGB Recipes https://eumetrain.org/sites/default/files/ 2025-11/RGB_recipes.pdf

This work is a collaboration with the E-contrail-2 project