

# Artificial Intelligence and Sustainable Aviation

Can Artificial Intelligence help Aviation address Environmental and Societal issues?

Aviation Sustainability Unit

EUROCONTROL

21 April 2023

# Sustainable Aviation





Aviation has an impact on the environment and society...

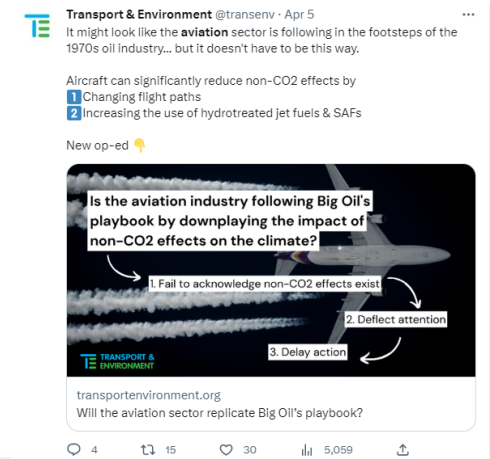
- Need to monitor and measure precisely these impacts (Noise, Pollution, Climate Change, ...)

... but environmental and societal issues also have an impact on aviation

- Need to measure and accurately predict environmental impacts on aviation
- Need to better understand public sentiment regarding the aviation industry's environmental and societal impacts



LOCAL CONCERNS		<b>Global Emissions</b> Contribution to Climate Change CO <sub>2</sub> , NO <sub>x</sub> , O <sub>3</sub> , Contrails, ...
		<b>Aircraft Noise (around airport &lt;=10000ft)</b> QoL, Sleep disturbance, Health effects, etc. Noise contours, Population exposed, ...
		<b>Airport Local Air Quality</b> Health effects (CO <sub>2</sub> ), CO, HC, NO <sub>x</sub> , SO <sub>x</sub> , PM, VOCs, ...
		<b>Third-Party risk</b>



# Artificial Intelligence: A Key Enabler for a Greener, Sustainable Aviation Future

- **Observational Data and Computer Vision** techniques can improve environmental impact assessments
- **Machine Learning** can help estimate the impact of climate change on ATM ... and the impact of aviation on environment
- **NLP and Information Retrieval** allow to better understand the public perception of aviation

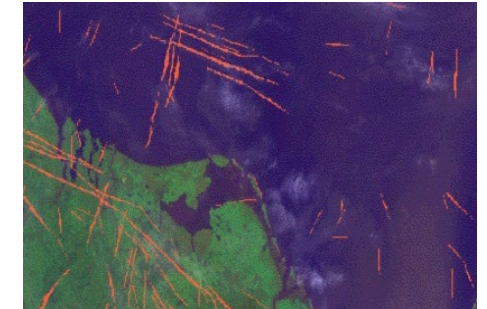


# Observational Data and Computer Vision

Observational techniques complement the computations provided by physical models

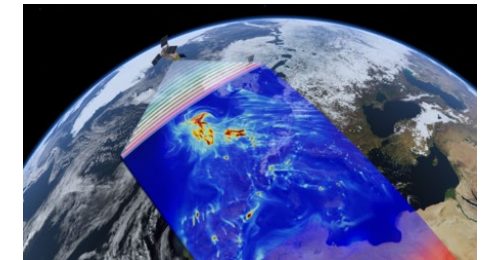
## ➤ Contrails Monitoring and Prediction

Monitor and predict contrail formation, and accurately measure climate impacts



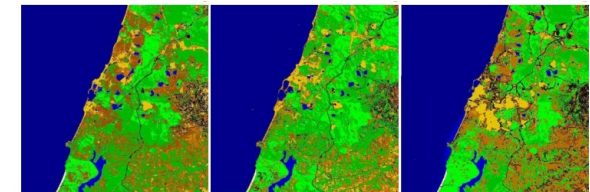
## ➤ Atmospheric observation of pollutants

Measure atmospheric concentrations of pollutants (CO<sub>2</sub>; NO<sub>x</sub>; SO<sub>x</sub> ...) and correlate observations with physical models



## ➤ Land Use Planning & Sea Level Rise

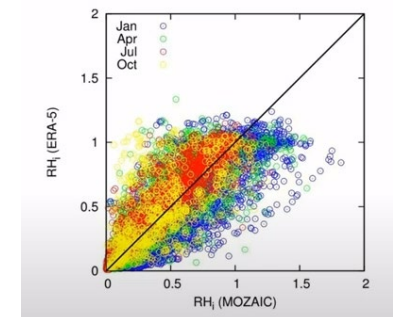
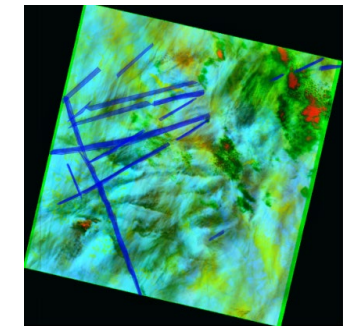
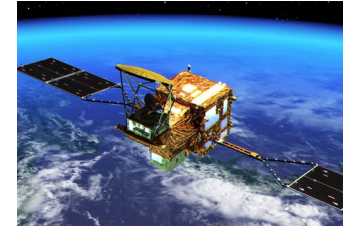
Monitor population living around airports and their exposure to noise levels and monitor and anticipate risks of extreme flooding events



# Computer Vision and Contrail Observations

**Detection and segmentation of contrails** on images will play an important role in ongoing contrail mitigation efforts

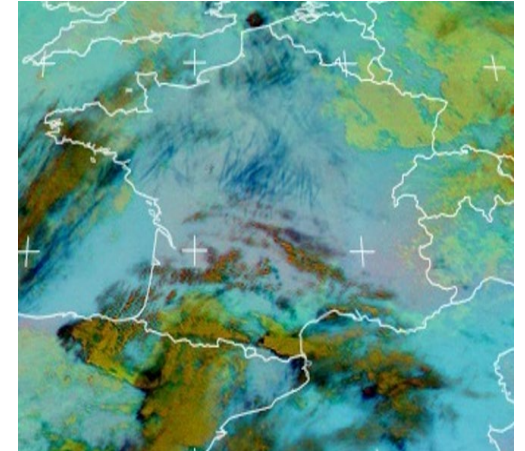
- **Monitor of contrails** and compute their environmental impact
- Map of observed contrails to actual flights.  
**Confirmation of the success of avoidance manoeuvres.**
- Improve **short-term contrail predictions** as physical models are too limited by weather forecasts





# The Difficulty of the Contrail Segmentation Task

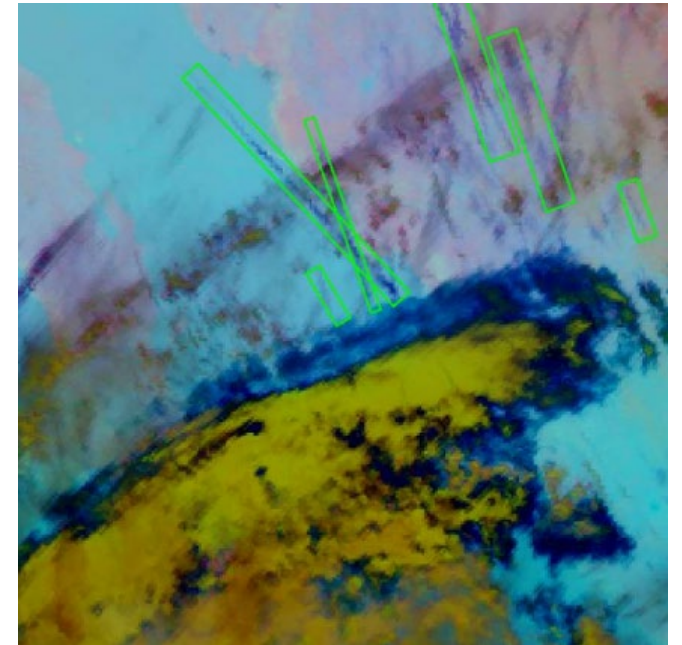
- The resolution of geostationary satellites (3-5 km/pixel) is coarse and leads to inaccuracies in detection results
- Ground based camera can be used as a benchmark to estimate the accuracy of satellite detection and better understand contrails formation
- Ongoing advances in Computer Vision (Fusion methods, Super-Resolution, ...) could improve the performances of segmentation models.



# A Data-Centric approach: Building a Contrail's Observation network

Providing **open curated/labelled datasets** of segmented contrails to the community is mandatory.

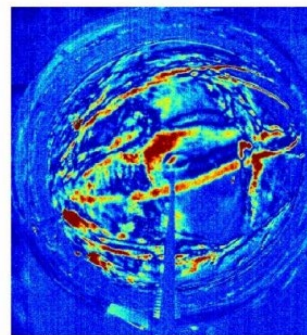
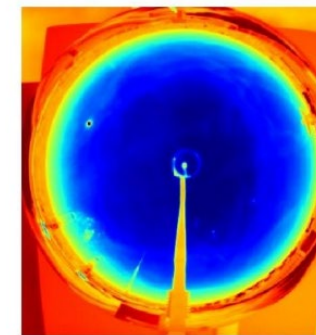
- Much of our effort this year will be devoted to **organizing several labelling campaigns**
  - ✓ Labelling images of **ground base camera images**
  - ✓ Labelling images of **high-resolution Satellite images** (MTG in Europe, Himawara in Asia)



# Ground Cameras at EUROCONTROL

EUROCONTROL has purchased a **ground-based camera system** (from REUNIWATT)

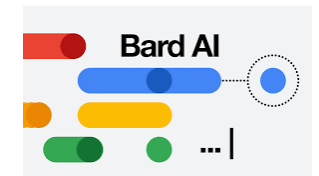
- A **hemispheric camera** in the **visible range**:
  - ✓ Daytime contrails are **easy to identify** (**Cooling effect**)
  - ✓ Wide-angle fish-eye lens monitors contrails over long-time scales
- A **hemispheric camera** in the **LWIR range**:
  - ✓ Contrails are also observed **at night** (**Warming effect**)
  - ✓ Efficient pre-processing to **enhance contrast in relevant spectral bands**
  - ✓ Calculations of the effective radiative forcing
- This composite system will serve as a benchmark and provide a better understanding of **the early stage** of persistent contrails formation





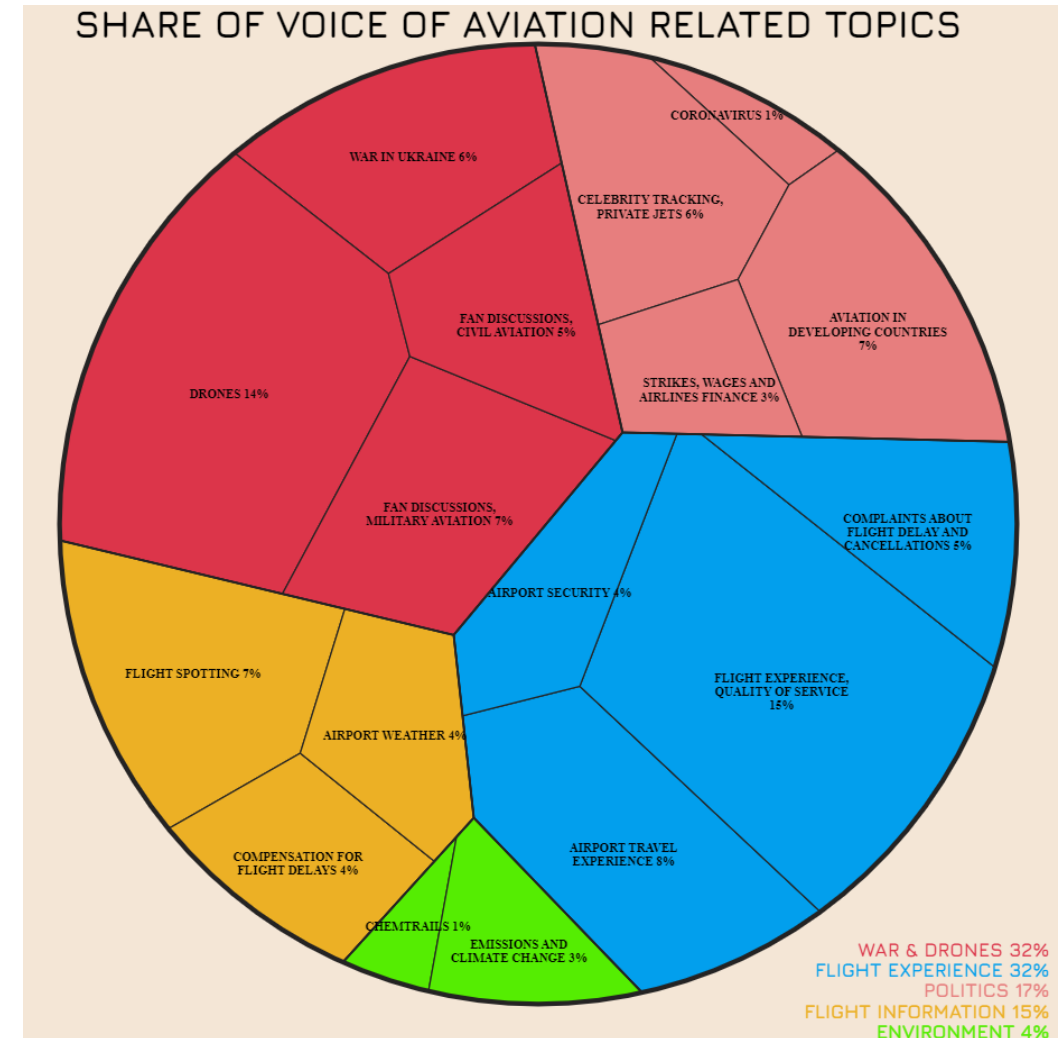
# Assessing the Societal Perception of Aviation

- What are the **main aviation-related topics** mentioned on the **internet, research work and social networks** (ex: **Twitter**)? Are **environmental issues** a growing topics of interest?
- The Classical (Pre-ChatGPT) **NLP framework** for exploring large text corpora is **tedious**:
  - ✓ Clustering a data sample to discover topics
  - ✓ Validating/Re-defining topics with experts
  - ✓ Launching a labelling campaign
  - ✓ Building a supervised algorithm
- **Natural Language Processing advances** allow to explore large text corpora more efficiently



# Finding Topics with latest Language Models

- The results presented here are preliminary and based on a sample dataset (December 2022)
- Latest embeddings generation (ex: OpenAI GPT) lead to cleaner clusters (topics)
- LLMs engines and automatic prompting allow to interpret those clusters automatically
- Share of Voice for each topics (cluster) is then easily computed



# Building your own EnvironementGPT

## ImpactGPT

This webapp allows you to ask questions about IMPACT

Ask your question

Can I define my own ANP data?

SUMMIT YOUR QUESTION

To define your own ANP data, follow these steps:

1. Create and upload a complete user-defined ANP database:
  - Select the "choose a version" value of the Standard version list (default value)
  - Upload a complete user-defined ANP version
2. Modify an existing ANP database:
  - If an ANP database version is already selected, you can modify it by uploading your own set of ANP files.
  - You are not required to upload all ANP database files, only the files with new or updated data are required.
3. Update a user-defined ANP version:
  - Click on the button in the User-defined data section in the ANP Data panel.
  - A separate browser tab will open, providing ANP input file details.
  - Use the file browser to select and upload the zip archive file that contains the appropriate ANP files.
  - Click on the "Start Upload" button to begin the process.
4. Manage user-defined ANP versions:
  - A local version of the ANP database will be created and selected for the study, used for processing CID and noise impact assessment.



IMPACT User Guide

IMPACT release: 3.36

Doc Version: 1.0

### 3.6.5.1.1 Upload and use a complete user-defined ANP database

If you do not select an ANP database version, you can define your own complete ANP database and upload it. Then the study ANP database corresponds to your uploaded one.



You can use your own ANP version without using any data from a reference version by successively:

- Selecting the "choose a version" value of the Standard version list (default value)
- Uploading a complete user-defined ANP version