

# Operational contrail mitigation

8 Nov 2023

EUROCONTROL, Brussels

**Dr. Adam Durant**

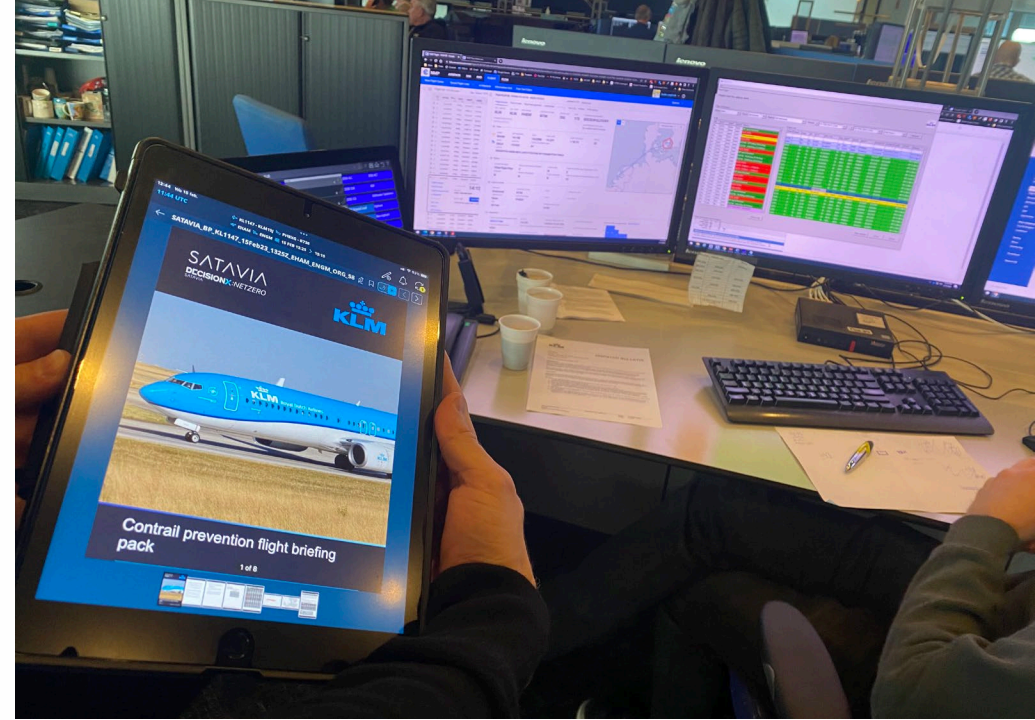
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Chief Executive Officer, SATAVIA

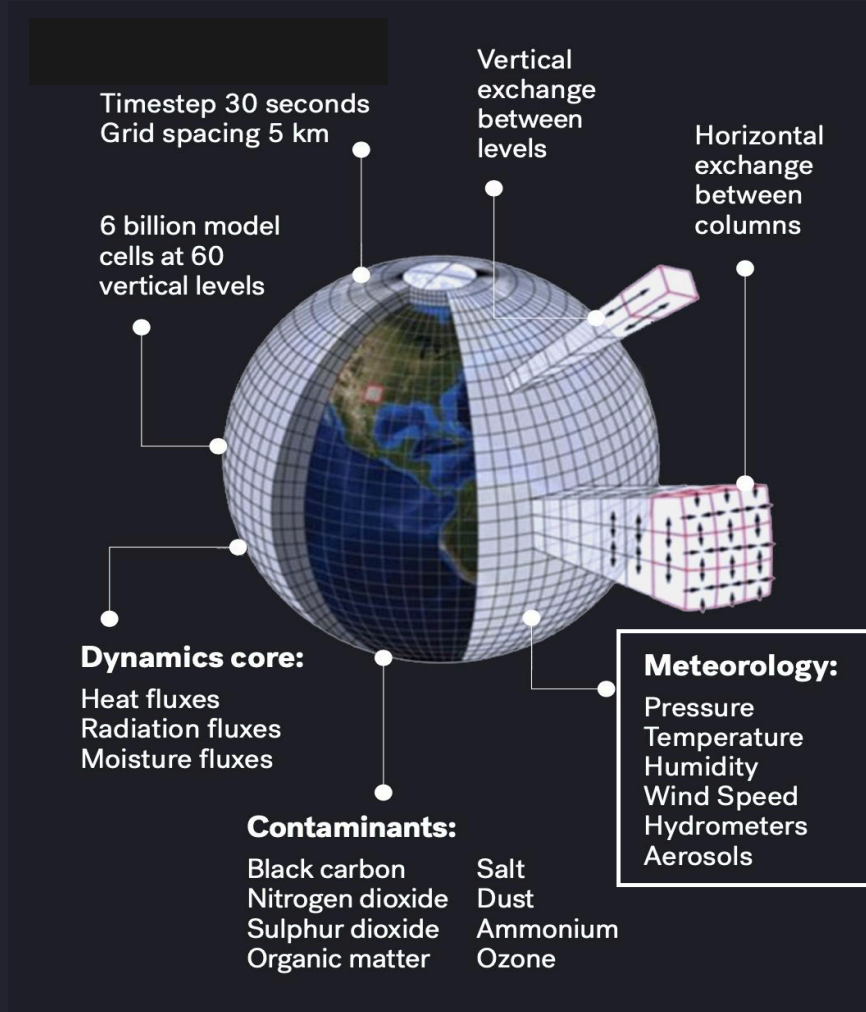


# CLIMATE OPTIMISED FLIGHT PLANNING

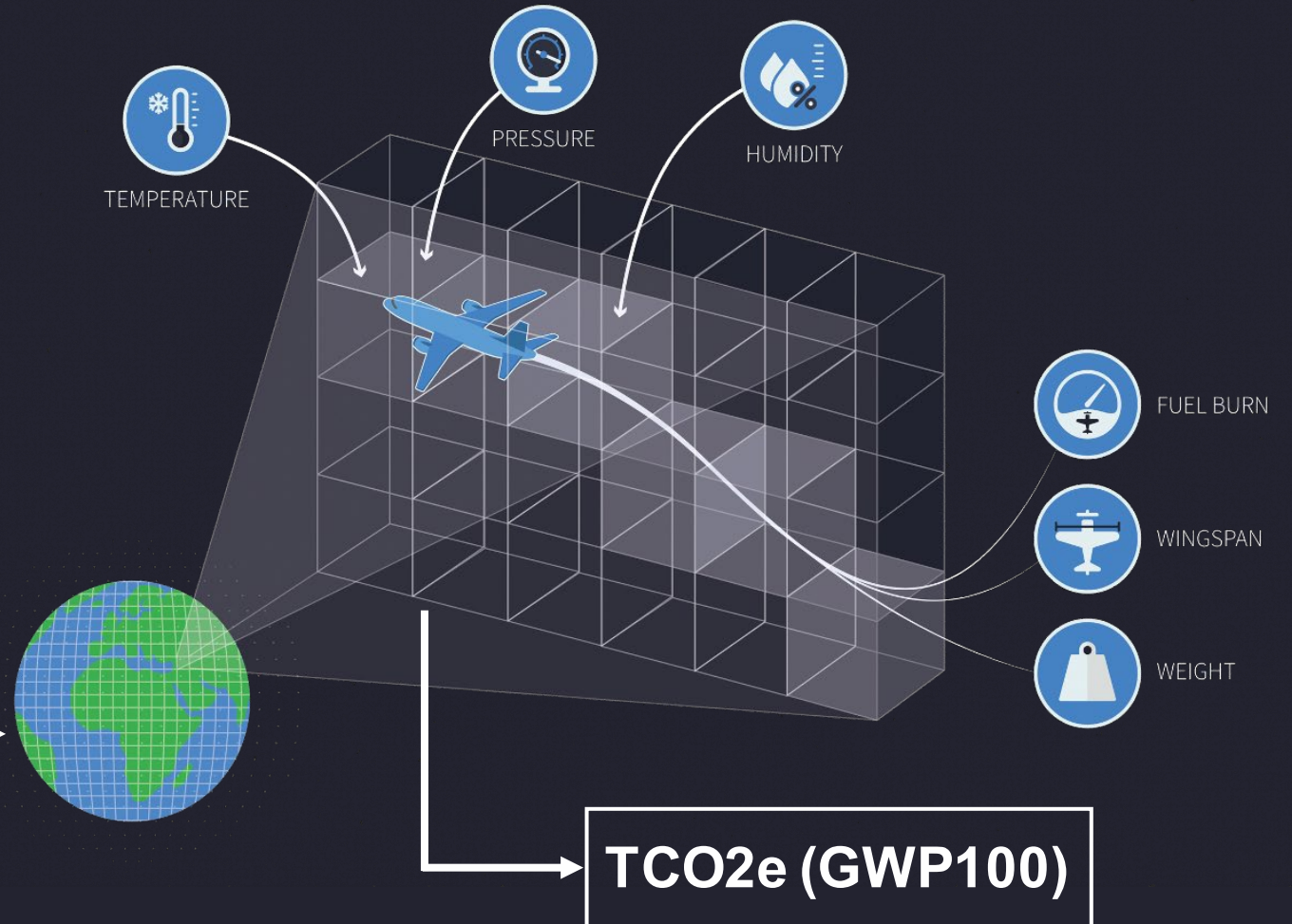
SATAVIA offers incentive-based contrail management to aircraft operators, enabled by smarter flight planning.



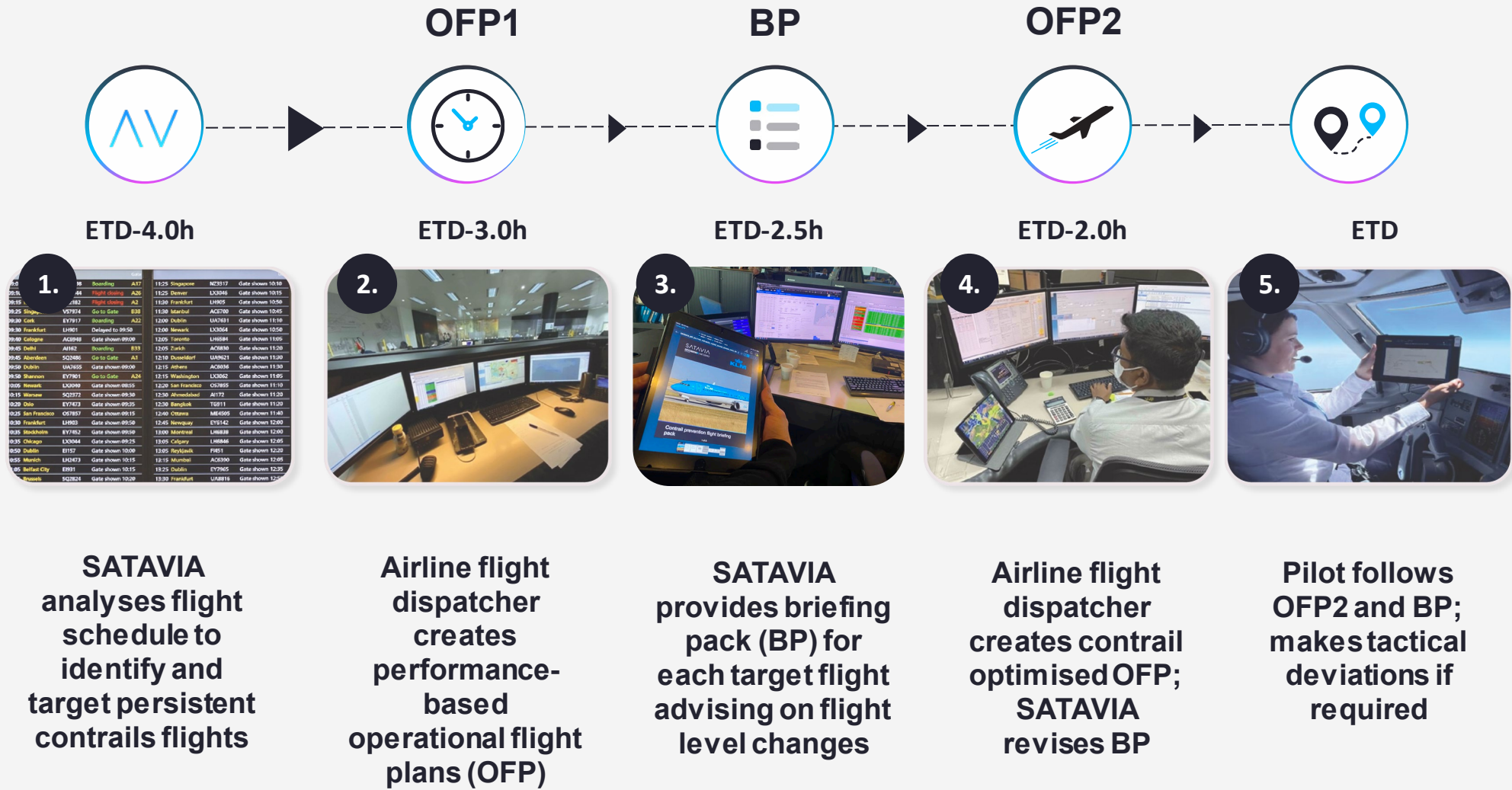
# 1. Numerical weather prediction model



# 2. Per-flight climate impact model



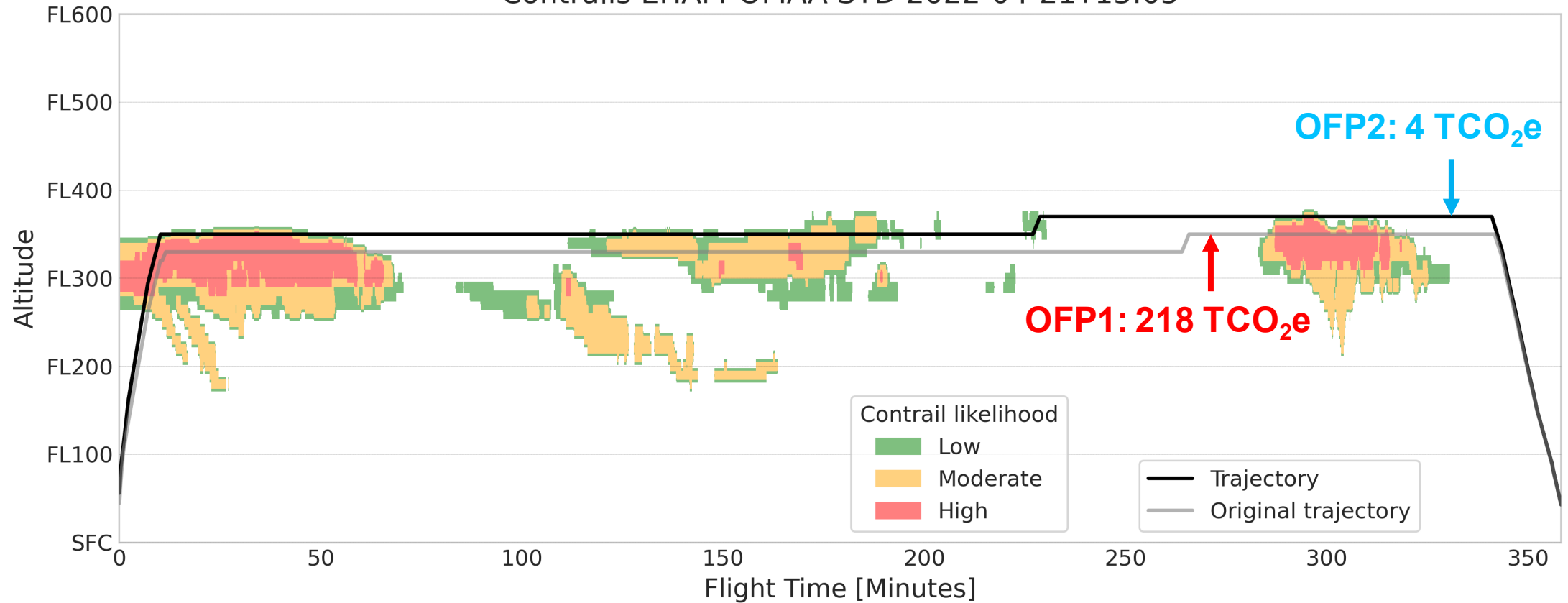
# Solution delivery timeline



# Example OFP optimisation



Contrails EHAM-OMAA STD 2022-04-21T13:05



## Operator trials to date

- First flight plans for contrails management using commercial flight planning software done by **Emirates** in March 2021
- First commercial flight doing contrails management with **Etihad** in October 2021
- 12 month trial with **Etihad** between Jan – Dec 2022
- Extended trial with **KLM and KLM Cityhopper** between Feb-Sep 2023
- **UK Space Agency / ESA ARTES** funding to run trials with operators running from Feb 2023 – Feb 2024 and has engaged with **11 airlines** to date reaching 15 airlines by end Nov 2023
- SATAVIA starts operational contrails management with **Etihad** from Jan 2024 (10 year contract)

## Summary statistics (2022-2023)



### DECISIONX:NETZERO (Feb 2023 - Feb 2024)

**Aim:** To manage the non-CO<sub>2</sub> impact of aviation and verify avoided impact through aircraft operator demonstrations.



**11**

Airline operator trials



**>100**

Contrail optimised flights



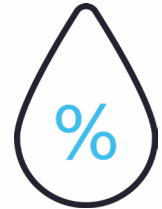
**52T**

Average CO<sub>2</sub>e savings per flight



**-36s**

Average flight time delta (seconds)



**0.1T**

Average CO<sub>2</sub> penalty per flight modified



# Factors impacting success of contrails management trials



In order of significance:

- Human factors – dispatch and flight deck
- Air traffic management – rules and on the day restrictions
- Aircraft performance
- Model uncertainty – flight targets and forecast uncertainty

# Validation: Model versus observation

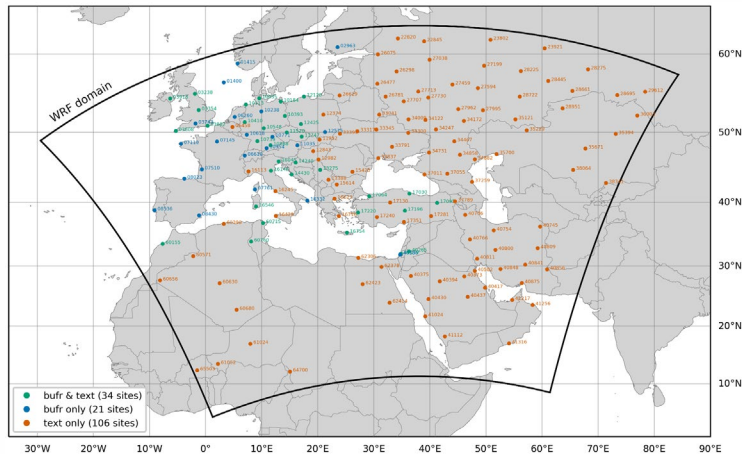
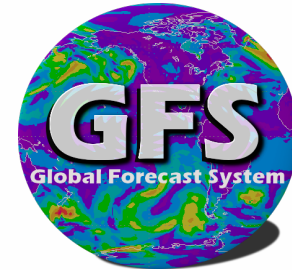
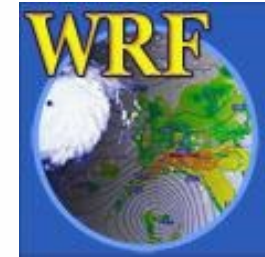
## Radiosonde in situ



## Aircraft in situ



## Models



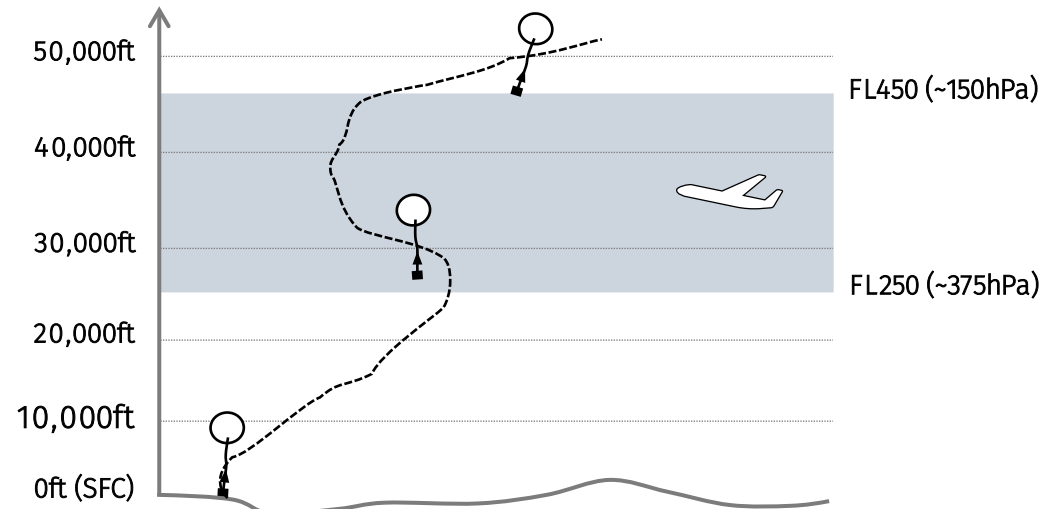


# Validation: Model versus observation



## High altitude focus

Data between FL250 and FL450 selectively analysed.

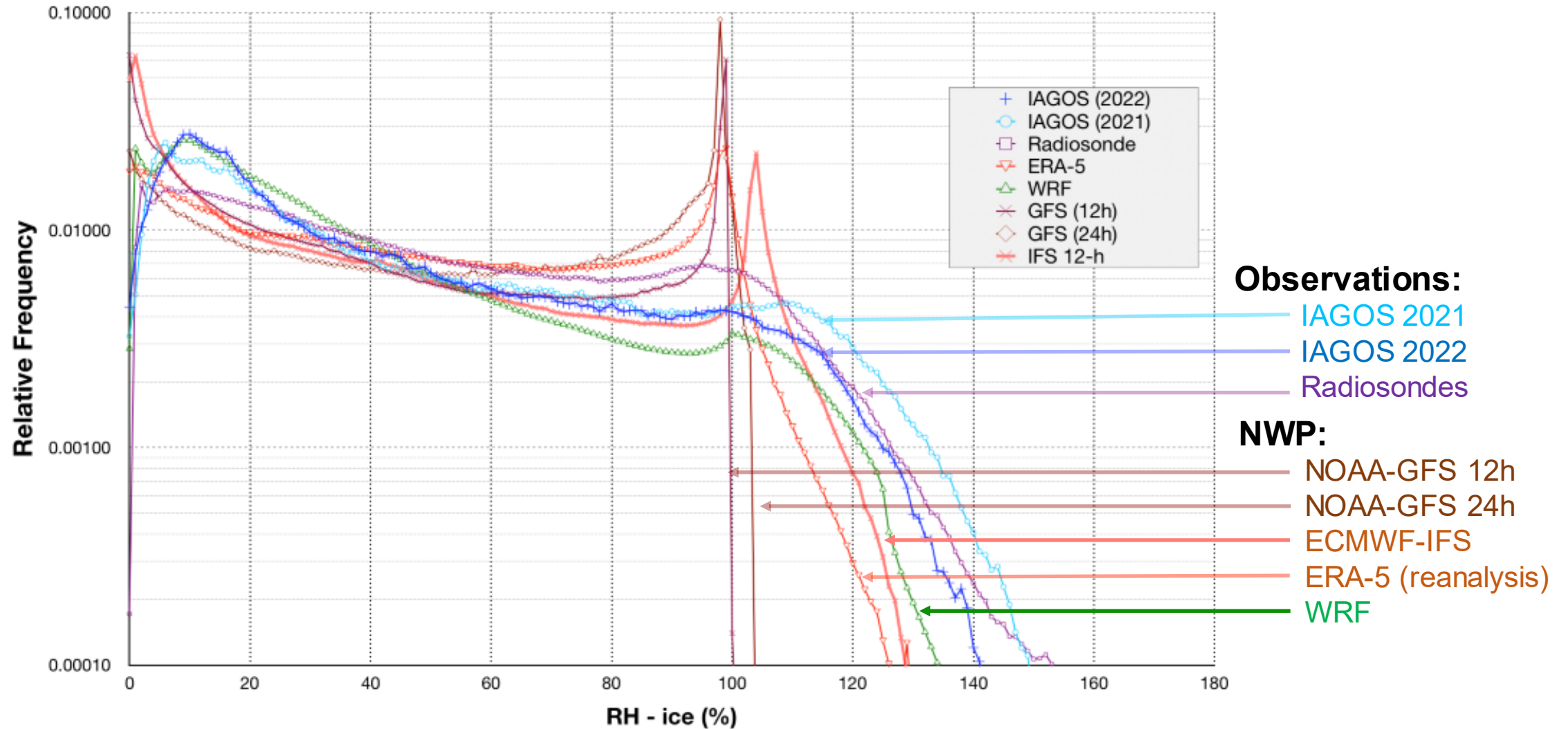


# Validation: Model versus observation



## Relative frequency of occurrence of RH-ice

IAGOS (2021; 253 flights; 1.76K obs, 2022; 383 flights; 1.85K obs)



# Validation: Model versus observation



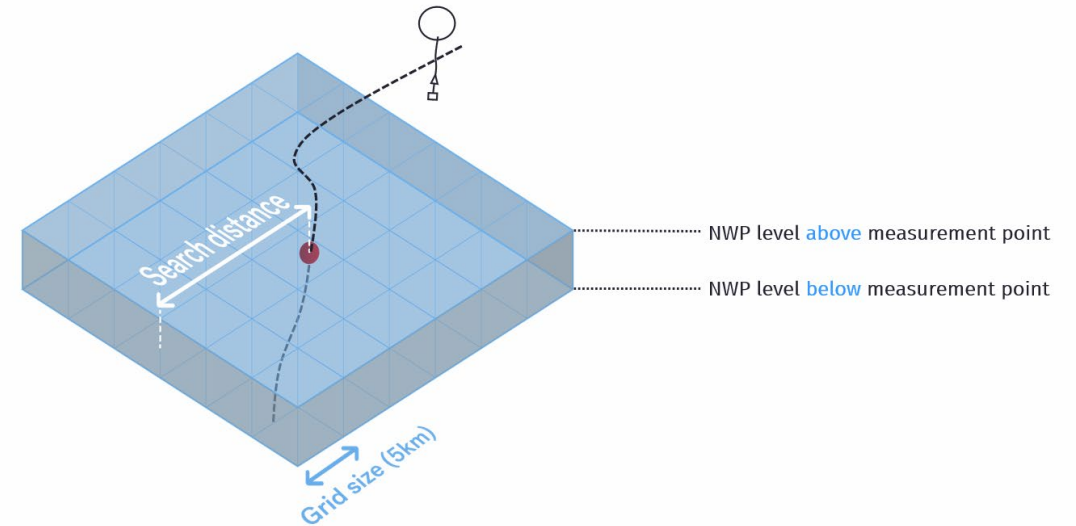
## F1 score contingency table

Describes how model data compare against the observational data; ranges from 0 (complete mismatch) to 1 (perfect match).

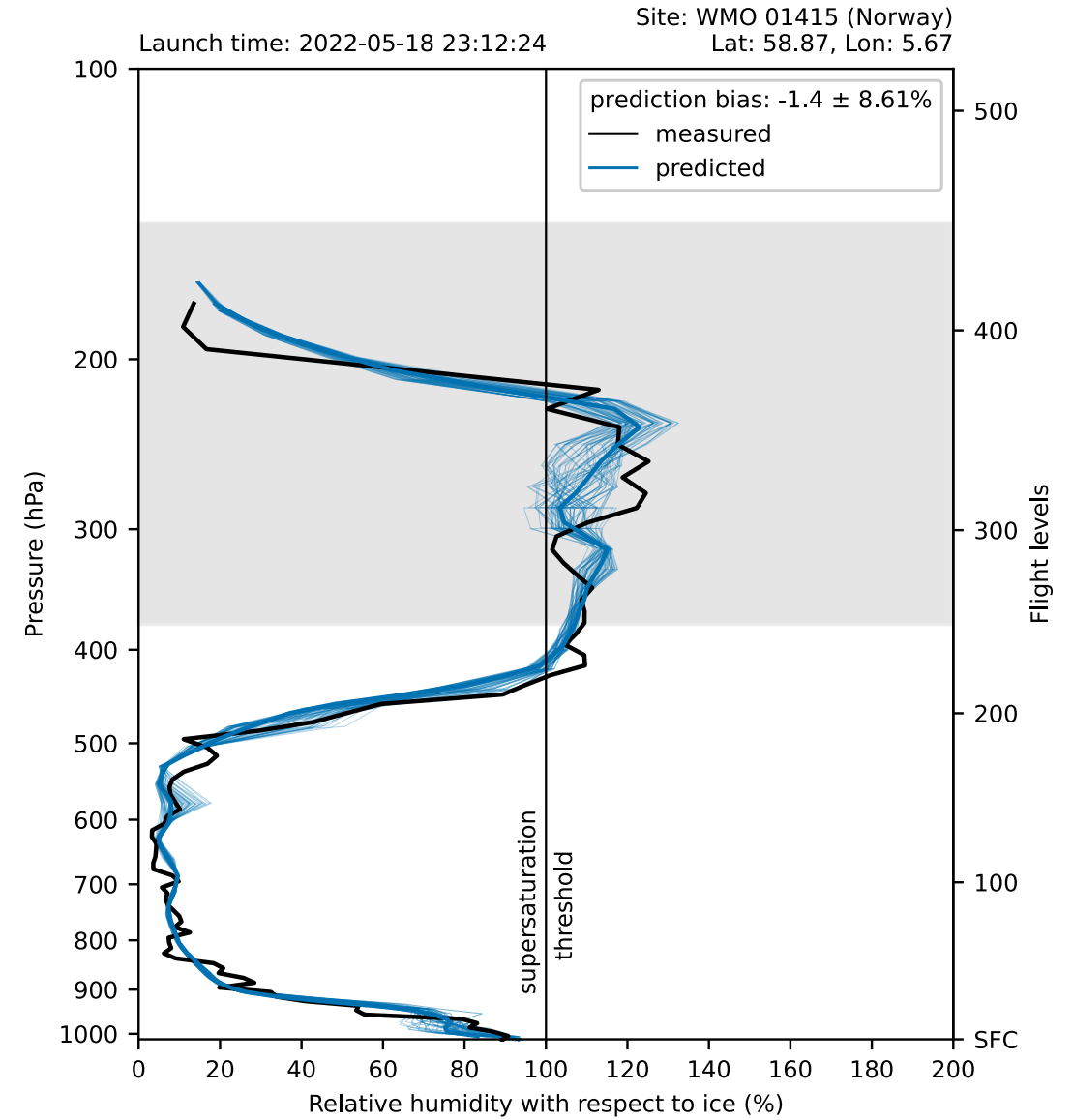
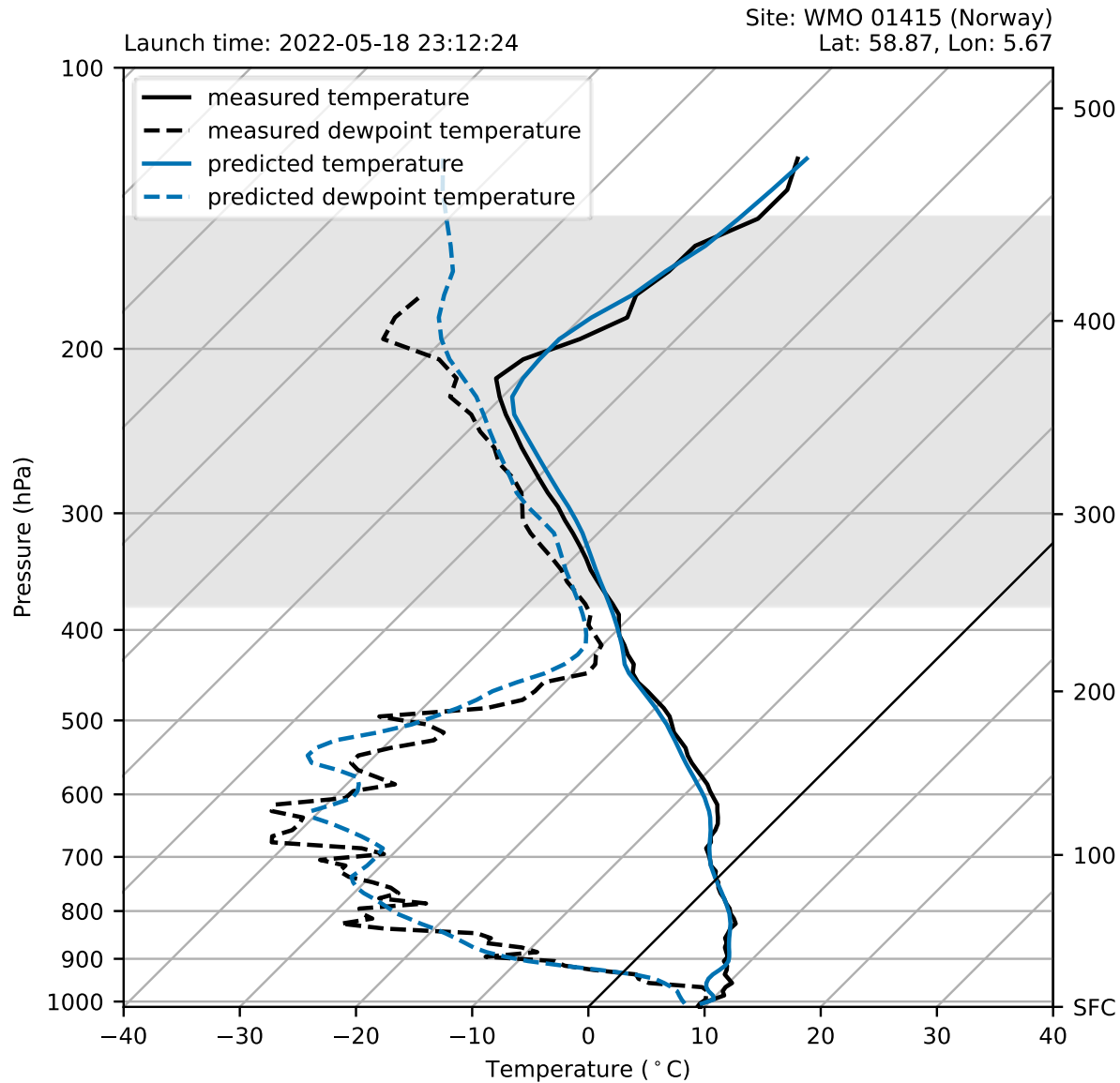
		Observations	
		Yes	No
Model	RH-ice > X %	Yes	No
	Yes	True Positives (TP)	False Positives (FP)
	No	False Negatives (FN)	True Negatives (TN)

## Neighbourhood approach

Compare each measurement point with all NWP grid points within search distance.



# Validation: Model versus observation



# Validation: Model versus observation



ISSR

non-ISSR

WRF	Horizontal search area (km x km)	RHI <sub>obs</sub> cutoff (%)	RHI <sub>model</sub> cutoff (%)	F1-score	TP (%)	FP (%)	FN (%)	TN (%)
interpolated	0	100	100	0.43	5.9	8.0	7.0	79.1
ring-1 (8 pts)	5 x 5	100	100	0.54	7.2	6.6	5.6	80.5
ring-2 (32 pts)	15 x 15	100	100	0.58	8.2	7.1	4.6	80.0
ring-3 (72 pts)	30 x 30	100	100	0.61	8.9	7.3	4.0	79.7

- ~13% of all data between FL250 and FL450 indicate ISSR conditions
- WRF achieves F1 score ~0.6 at RH100% cutoff
- Accounting for measurement error of 5% improves this to F1 score 0.67 at RH95% cutoff (data not shown)
- F1 score is sensitive to “unbalanced” datasets, e.g., in which true positives are small compared to true negatives
- Model performs well doing prediction of **non-ISSR** regions and achieves >0.9

- **NWP skill is adequate to do contrails management today**
- **Fuel burn penalties across over 100 flights with 11 different operators have averaged ~0.1 TCO<sub>2</sub> per flight**, while short haul flights have tended to generate a negative fuel burn penalty; this only applies to 5% of scheduled flights
- Every successful deviation offers **~50 TCO<sub>2</sub>e avoided impact**, which means **even with a non-perfect F1 score, the benefits of doing contrails management vastly outweigh not doing it** and therefore a **successful climate mitigation can be guaranteed**
- Most of the negative impact on success criteria are related to **human factors or external issues** which can be resolved by **software automation and improved ATM**

# Gold Standard Accreditation status

## Gold Standard approves aircraft contrails methodology concept

Originally published on [SATAVIA's website](#)

***Gold Standard provides approval of SATAVIA methodology concept to deliver credits for mitigating climate warming caused by aircraft clouds, pioneering a new global market focused on short-lived climate forcers***

- SATAVIA has pioneered aircraft contrail management since 2021, tackling a climate challenge accounting for up to 2.4 billion tonnes of carbon dioxide equivalent (CO<sub>2</sub>e) impact each year.
- Approved for progression by Gold Standard (GS), SATAVIA's contrail management methodology will enable issuance of provisional Certified Mitigation Outcome Units (CMOUs) for non-CO<sub>2</sub> aviation emissions avoided via contrail management activity, with in-sector rules-based usage e.g., against declared non-CO<sub>2</sub> emissions inventories.
- SATAVIA aims to achieve full GS Approved Methodology status by late 2023, positioning CMOUs as incentives for aircraft operators to undertake contrail management and accelerate progress towards lower climate impact flying.

Gold Standard®



Gold Standard: accreditation complete in H1 2024

Gold Standard, 4 Aug 2023 <https://www.goldstandard.org/blog-item/gold-standard-approves-aircraft-contrails-methodology-concept>