European Commission

Non-CO_2 MRV Consultation Meeting

Support for establishing a monitoring, reporting and verification system

01st December 2023

to70

DLR

AERLABS

Opening address

Polona Gregorin, Head of Unit DG Climate Action

Morning session

1. **Background on the non-CO2 MRV** *Dimitar Nikov, DG CLIMA*
2. **Description of consortium and project scope** *Vincent de Haes, To70*
3. **Elements of the MRV framework Project** *DLR, AerLabs, To70*

Background on the non-CO2 MRV

Setting the scene

Dimitar Nikov (DG CLIMA)

Scientific evidence on non-CO2 effects

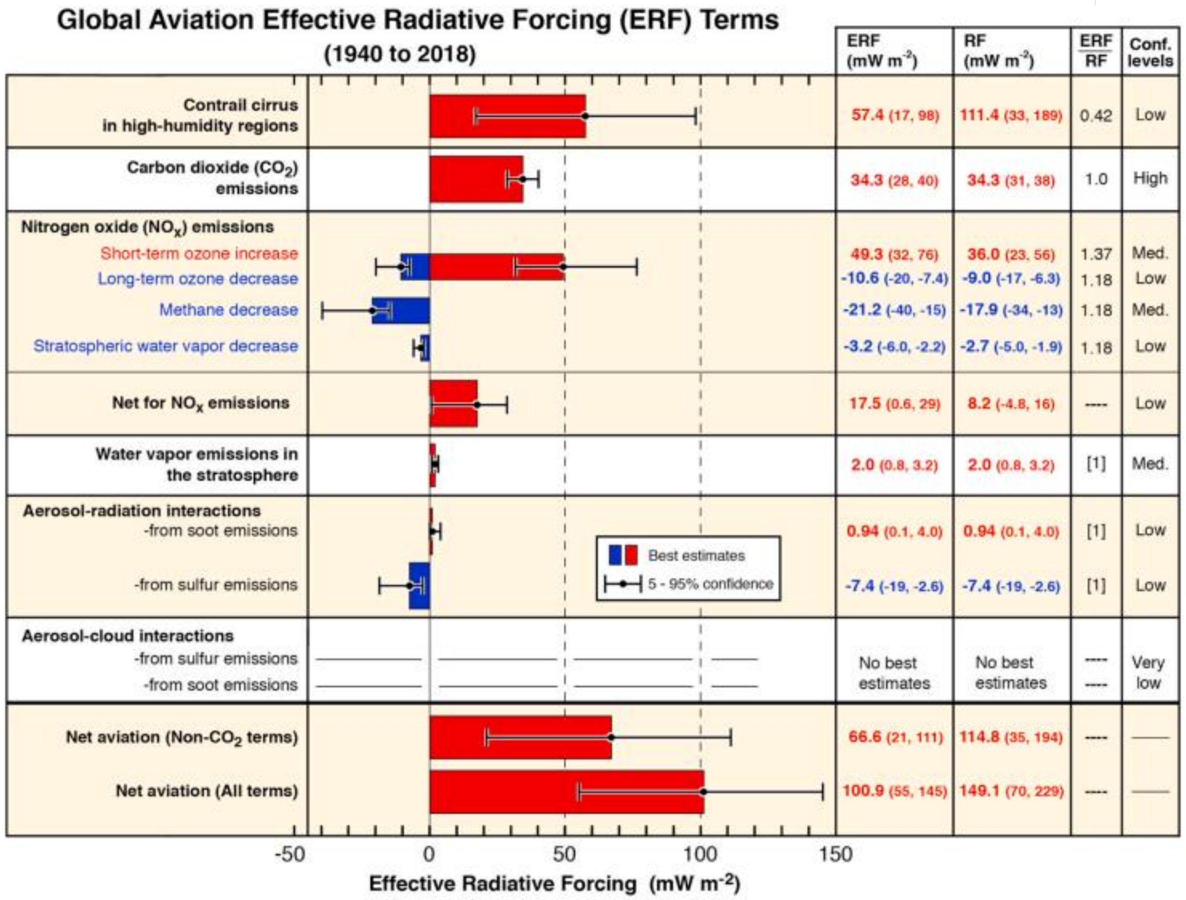


Fig. 1. D.S. Lee et al (2020), The contribution of global aviation to anthropogenic climate forcing for 2000 to 2018

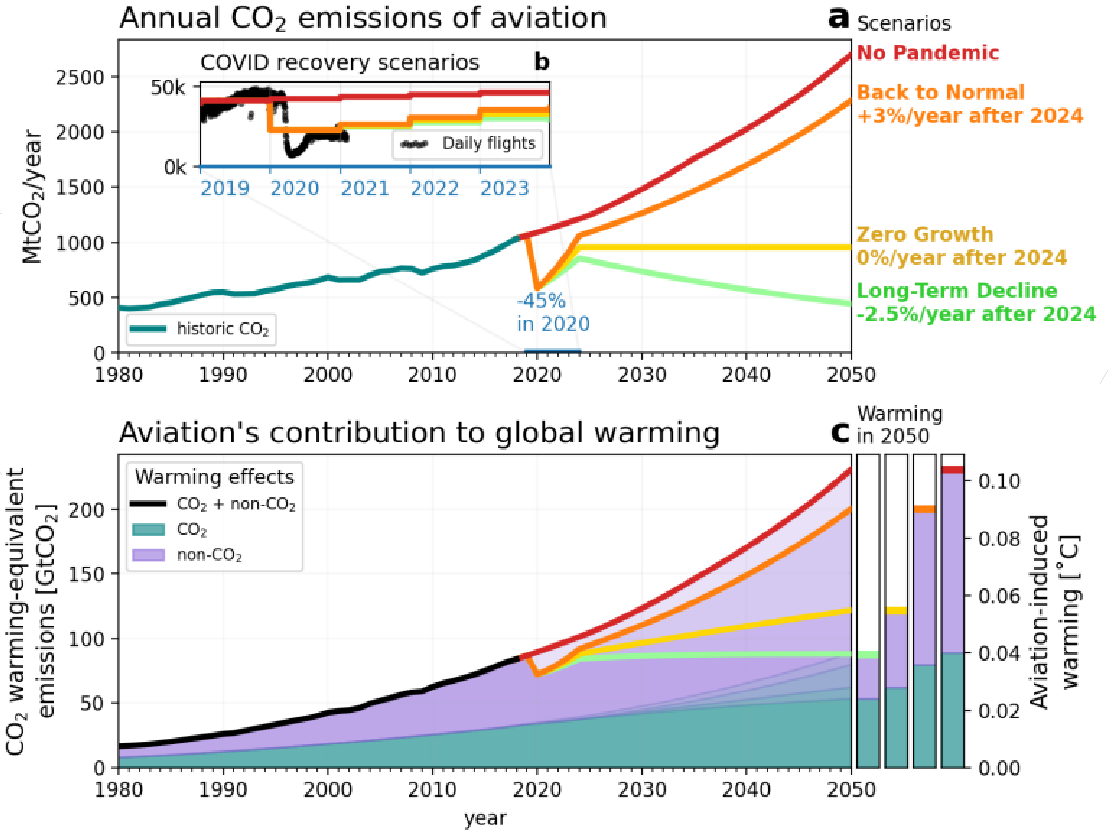


Fig. 2. Klöwer et al (2021), Quantifying aviation’s contribution to global warming

- IPCC (since 1999),
- Non-CO2 is not fixed share in time

Revision of the EU ETS – non-CO2 MRV

- **Art3 (v) : Definition of non-CO2 effects**
- **Art14.5 : MRV framework and further mandate**
  - **By 31 August 2024** – Implementing act including non-CO_2 effects in MRV framework (to contain, at a minimum, the 3D aircraft trajectory data available, ambient humidity, and temperature) enabling CO_2e per flight to be produced. The Commission shall ensure, subject to available resources, that tools are available to facilitate and, to the extent possible, automatise MRV in order to minimise any administrative burden.
  - **From 1 January 2025 –** MS shall ensure that each aircraft operator monitors and reports the non-CO_2 effects from each aircraft.
  - **From 2026** – EC will publish the results from the MRV framework once a year.
  - **By 31 December 2027** – based on the results of the MRV of non-CO2 aviation effects, the EC will submit a report and, if appropriate, a legislative proposal after having carried out an impact assessment to mitigate such effects by expanding the scope of the EU ETS to include non-CO_2 aviation effects.

Objectives under the tender

- **Objective 1** – the contractor to provide advice on what data is necessary, on collecting, storing, and securing the monitored data, including on appropriate interfaces for collecting large amounts of data as well as, provide an IT solution. In case of data gaps, the MRV framework should enable the use of conservative default values.

- **Objective 2** – the contractor to provide an overview of models for MRV non-CO_2 effects to allow the calculation of non-CO2 equivalents per flight, and advice on how the MRV data can be included in these models.

Tender’s tasks

- Identify the **minimum** and **additional data** to be contained in the MRV
- Determine **data gaps** and **default values**
- Ensure **data collection, storage** and **protection (create IT tool)**
- Identify **CO_2 equivalent approaches** and **climate-response models**
- Ensure the **calculation** of **non-CO_2** for **different fuels**
- **Support** the **EC** in **further work** and **stakeholder engagement**

Deliverables

- **Inception report** – main areas of the work; approaches on the tasks; preliminary description of MRV elements.
- **Preliminary report –** shall contain the initial version of the scope and functioning of the MRV; minimum and additional data; data gaps and default values use; ways to calculate CO_2 equivalents; further work to operationalize the MRV; Concept note on stakeholder engagement (as output of the 1st Dec meeting).
- **Intermediary report** – containing the final version of the chapters in the preliminary report, plus an initial outline of the technical specifications of the IT solutions to collect, store, and protect data.
- **Final report** – containing the technical specifications of IT solution to collect, store, and monitor data; as well as an overview of the training on the MRV framework.
- **IT data tool + Trainings**

Description of consortium and project scope

Project overview

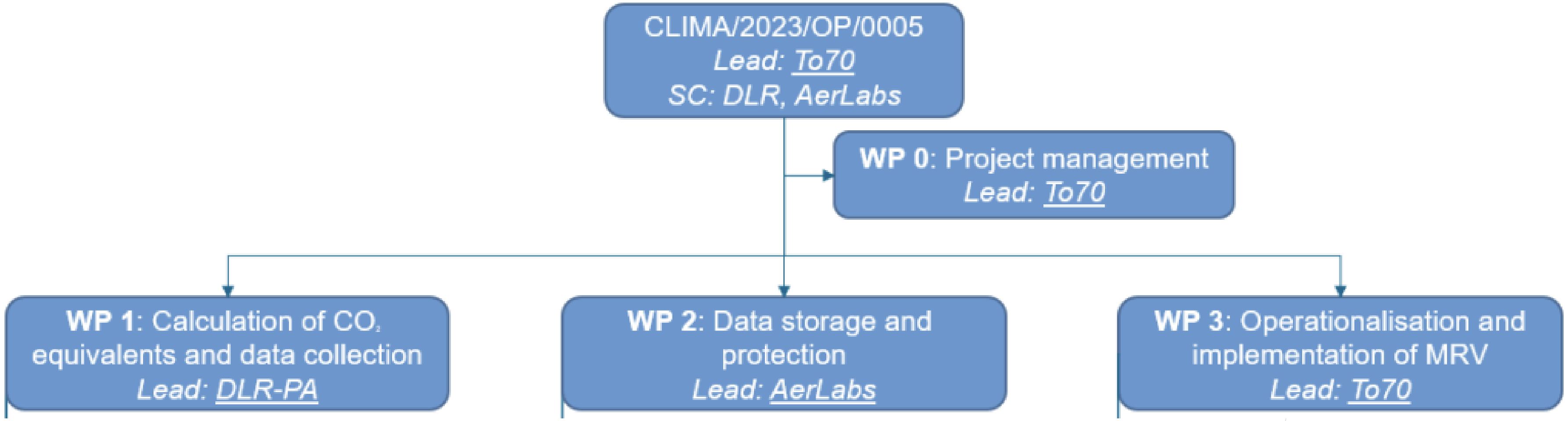
Vincent de Haes (To70)

Consortium

	to70	DLR	AERLABS
Expertise	Project management Aviation data gaps Operationalization	Non-CO2 models Climate metrics Aviation and Atmospheric data	Aviation data processing Aviation based IT tools Aviation data security
Team	Maarten Tielrooij Marson Jesus Eneko Rodriguez Vincent de Haes	Volker Grewe Roland Eichinger Liam Megill Alexander Lau Extensive support academic colleagues	Robert Koster Luis Natera Orozco Ian Brumby

Objective of the Non-CO_2 MRV

- WP1: Assess data required for suitable MRV, and potential data gaps.
- WP2: Understand how data can be stored and protected.
- WP3: Understand implications of MRV and connect with sector on potential operationalization.



Planning MRV - Update

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Delivered & presented *Nov. 23rd*

Open event in Brussels for all interested parties*

Preliminary report Internal	*Public meeting External*	*Intermediary report Internal*	*IT solution and Operationalization*	*Finalization of project*
Nov. 2023	Dec. 1st 2023	Jan. 2024	2024 →	Dec. 2024

WP1

WP2, WP3

Scope WP1

WP 1: Calculation of CO_2 equivalents and data collection
Lead: DLR-PA

- Understand use of climate metrics for aviation and provide **academically supported** advise most applicable metric.
- Understand the range of Non-CO_2 models and provide **academically supported** advise the most applicable model (s)
- Provide assessment of minimum and additional data needed for each model.
- Based on the models and metrics, provide **academically supported** advice on different approaches to apply models and metrics in an MRV.

Preliminary report Internal	*Public meeting External*	***Intermediary report Internal***	*IT solution and Operationalization*	*Finalization of project*
Nov. 2023	Dec. 1st 2023	**Jan. 2024**	2024 →	Dec. 2024
			WP2, WP3	

Scope WP2

WP 2: Data storage and protection
Lead: AerLabs

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- Setting up prototype of software platform to apply MRV, allowing for better understanding of:
  - Data needs for the MRV
  - Accuracy of output
  - Reporting constraints
  - Any other constraints
  - Basic tests with potential reporting partners

- Providing advice on data storage and protection

Preliminary report Internal	Public meeting External	Intermediary report Internal	**IT solution and Operationalization**	Finalization of project
Nov. 2023	Dec. 1st 2023	Jan. 2024	**2024 →**	Dec. 2024

WP1

WP2, WP3

Scope WP3

WP 3: Operationalisation and implementation of MRV
Lead: To70

- Assessing the implementation impact of MRV options on resources, regulatory burden, etc.
- Ensuring the sector is engaged with the MRV development
  - Public meeting
  - Workshops/meetings on MRV Q3 2024

Preliminary report Internal	Public meeting External	Intermediary report Internal	IT solution and Operationalization	Finalization of project
Nov. 2023	Dec. 1st 2023	Jan. 2024	2024 →	Dec. 2024

WP1

WP2, WP3

Elements of the MRV framework Project

Scientific architecture & data - Roland Eichinger (DLR)

Software architecture - Robert Koster (AerLabs)

Engagement with airspace users - Maarten Tielrooij (To70)

European Commission

Elements of the MRV framework Project

Scientific architecture & data - Roland Eichinger (DLR)

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Scientific architecture & data

Elements of the MRV framework Project

Project consortium: **to70**

DLR (German Aerospace Center)

Aerlabs

Public Consultation Meeting on non-CO_2 Effects MRV

European Commission | DG CLIMA

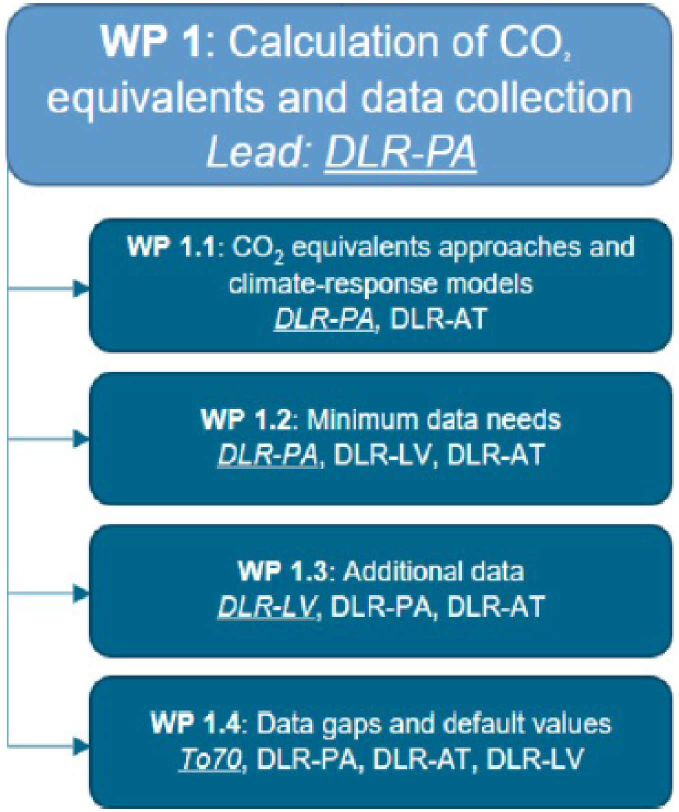
23 November 2023

Dr. Roland Eichinger
DLR – Institute for Atmospheric Physics

DLR

Scientific architecture & data – Outline

1) Introduction
2) CO_2 equivalent calculations (WP 1.1)
   - 2.1 Analysis of climate metrics
   - 2.2 Discussion of models
3) Minimum and additional data for models and MRV (WPs 1.2+1.3)
4) Data gaps and filling strategies (WP 1.4)
5) Uncertainties
6) Recommendation



PA: Atmospheric Physics

LV: Air traffic

AT: Propulsion technology

1) Introduction

To calculate CO2e, it has to be specified:

- **What is emitted to the atmosphere?**

  fuel and combustion process in aircraft engine

- **Where are these emissions executed?**

  routing system by 4-D trajectories

- **How does the atmosphere react to the emissions?**

  NO_x, contrails and H_2O affect climate on various temporal and spatious scales

Source: DLR

A CO_2 equivalent emission is the climate impact of any emitted climate species relative to the climate impact of one kg CO_2, for a given climate metric.

2.1) Climate Metrics (WP1.1)

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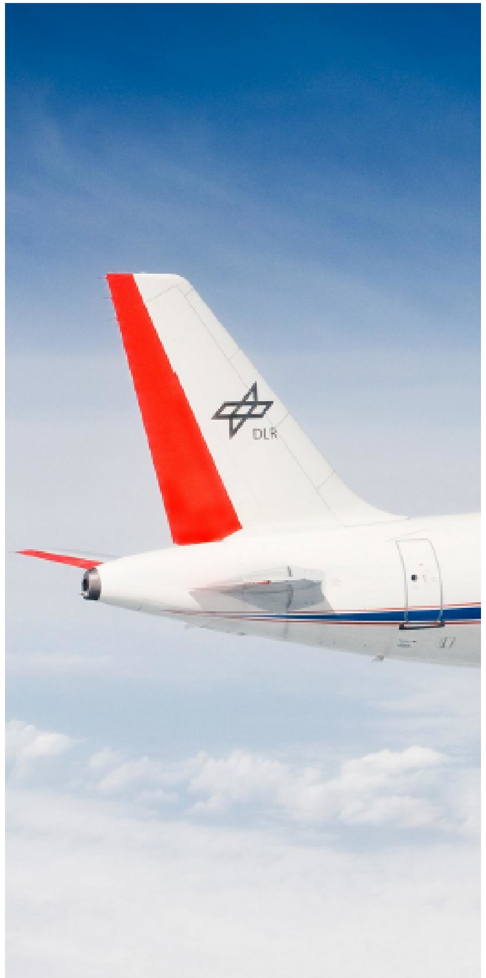
A climate metric used in the MRV framework should:

- be **transparent** and **simple** to use and comprehend, whilst remaining scientifically well grounded
- be **temporally stable**
- be appropriate for existing as well as future aircraft
- be **consistent** for a range of aviation emission scenarios
- be **compatible** with existing policy
- have temporal response of RF or temperature change as input



Source: DLR

Climate Metrics
and time horizon

- Radiative Forcing (RF)
- Global Warming Potential (GWP)
- GWP*
- Global Temperature-Change Potential (GTP)
- Average Temperature Response (ATR) / Integrated GTP (iGTP)

Considerations	RF	GWP	GWP*	GTP	ATR/iGTP
Transparent & simple	Low complexity	Less complex, but abstract concept	High complexity, abstract concept	Low complexity	Less complex
Temporal stability	Generally stable	Stable	Highly unstable	Generally stable	Stable
Compatibility with existing and future aircraft	Not compatible	Generally compatible, does not include efficacy	Generally compatible, does not include efficacy	Generally compatible, includes efficacy	Generally compatible, includes efficacy
Dependence on emission scenario	Strongly dependent on scenario	Generally independent of scenario	Independent of scenario, but sometimes surprising results	Dependent on scenario	Independent of scenario
Dependence on time horizon	Strong	Weak	Weak, but has a second time horizon	Strong	Weak

- General consideration of aviation climate impact → longer time horizons more appropriate
- Metrics most stable for time horizon of ~70 years

2.2) Models (WP1.1)

- **(open)AirClim** - DLR

  Climate response model to evaluate basic aircraft/engine configurations and general operational strategies

- **CoCIP-**pycontrails (Contrail Cirrus Prediction Tool) - DLR

  Lagrangian model to analyse contrail formation, life cycle and contrail climate effects for single flights or global air traffic

- **aCCFs** (algorithmic Climate Change Functions) - TU Delft/DLR

  4-D non-CO_2 effects for daily flight planning cost-efficiently implemented directly in NWP models

- **LinClim** – MMU

  Climate response model to assesses global radiative forcing and temperature impacts of all aviation non-CO_2 effects

- **OSCAR** – IIASA, ONERA, LSCE

  Compact Earth System model to compute climate response of global aviation emissions

- **LEEA** - Camebridge/Reading Univ., Airbus

  Simple response model to calculate climate impact of aircraft emissions

- **FaIR** – Oxford/Leeds Univ.

  Reduced-complexity climate model to produce global temperature projections from emissions or forcing scenarios

Models

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- **AirClim** estimates impact of all non-CO_2 effects per flight on climatological basis
- **CoCiP** computes flight- and weather-based contrail effects in detail
- **aCCFs** calculates climate effect of all non-CO_2 effects on per flight basis with weather dependence
- **LinClim** predicts response of climatological aviation perturbation and monetary values of impacts
- **OSCAR** and **FaIR** are climate scenario models treating global emissions
- **LEEA** uses inventory of aircraft emissions to estimate climate effect

Criterium is fulfilled

++: fully

+: mostly

0: partly

-: mostly not

--: not at all

Model/ Requirement	(open) AirClim	CoCiP (pycontrails*)	aCCFs	LinClim	FAiR	OSCAR	LEEA
Scope of output	++	-	++	++	++	++	++
Weather dependency	--	++	++	--	--	--	--
Location dependency	++	++	++	--	--	--	0
Availability of required data	++	++	++	-	+	++	++
Transparency	+	++	++	-	++	++	-
Computational effort	++	0	++	++	+	++	++
Administrative effort	to be evaluated after specific use-case versions are generated						++
Fuel type consideration	+	++	+	?	--	--	--
Engine/aircraft type consideration	0	++	0	?	--	--	--

	Climate agent	AirClim OpenAirClim	CoCiP (pycontrails**)	aCCFs	LinClim*	FaIR	OSCAR	LEEA
Represented climate effects	Contrails	✓	✓	✓	✓	✓	✓	✓
	CO_2	✓		✓	✓	✓	✓	✓
	H_2O	✓		✓	✓	✓	✓	✓
	O_3	✓		✓	✓	✓	✓	✓
	PMO	✓		✓	✓	✓	✓	✓
	CH_4	✓		✓	✓	✓	✓	✓
Emission basis for generated	Contrails	AERO2K	Unit flight segment Single flight	Unit flight segment Single flight	N.A. Preprocessing required	Scaling with NO_x emisson	N.A. Preprocessing required	Aero2K emission enhance-ment per cruise altitude
	O_3 H_2O PMO CH_4	Unit Emissions	Flight segment emissions-	Unit Emissions	N.A. Preprocessing required	Unit Emissions	Unit Emissions	
Option for SAF/ fuel composition/ climate effect	Contrails	Scaling of particulate matter for contrail RF with blending ratio	SAF effects explicitly calculated from H content	-	-	-	-	-
Meteorological Parameters for flight resolved contrails implicit	Contrails	Potential coverage from probability for fulfilling SAC[1] and ISSR	Lifetime & climate impact explicitly calculated for contrail evolution, SAC	Fixed Lifetime, only T dependence, SAC	Climatologically prescribed	Climatologically prescribed	Climatology-based function	Line-shaped contrails, fixed
Chemistry	Radiation	Climatological relation	Locally dependent	Implicitly locally dependent	N.A.	Climatological relation	Climatological relation	Climatological relation
	Ozone	2D-Clim. ozone perturbation	-	4D ozone contri-bution		Linear function of CH_4, N_2O and ODSs		1D- Clim. ozone perturbation
	Methane***	Transient methane change	-	Transient methane change	Transient methane change	Transient methane change	Transient methane change by full methane cycle	Steady-state methane change

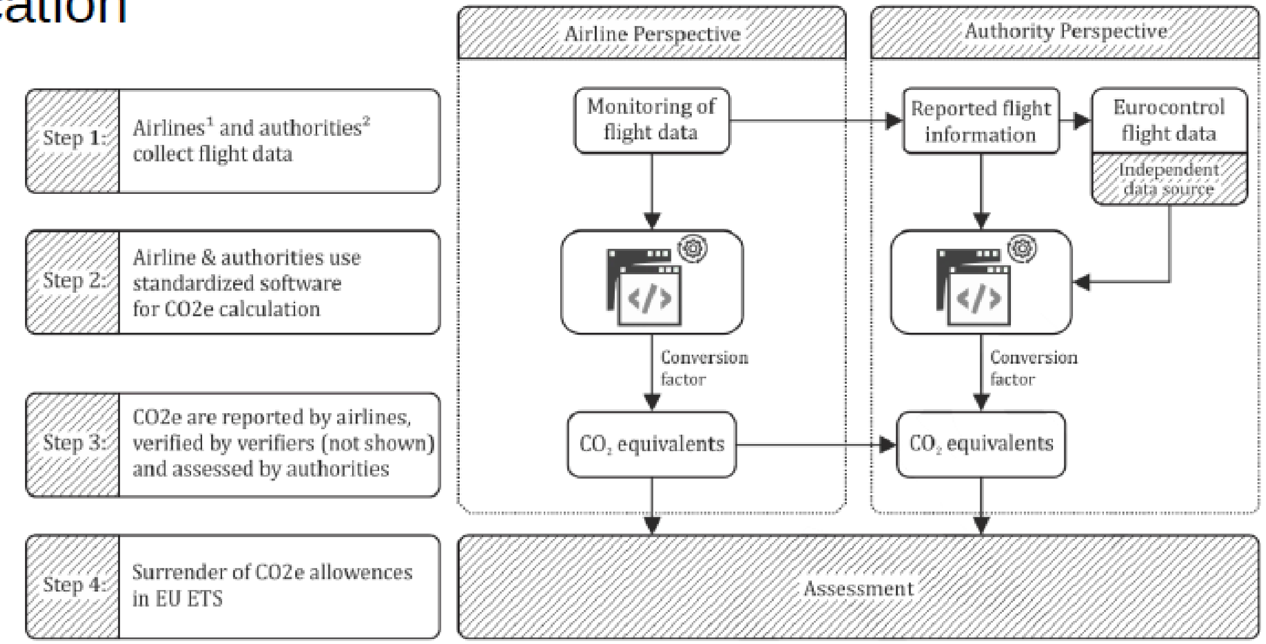
3) Minimum and additional data (WPs 1.2+1.3)

- Meteorological data (for weather-based approach) from weather sevices
- Flight data from aircraft operators
- Data collection should already be started during flight planning
- Data need should be reduced to a minimum to reduce effort for airlines and authority
- Two different storage systems with different data requirements might have to be established for monitoring and for verification

Project data stakeholders:

Weather sevices: DWD and KNMI

Aircraft operators: Lufthansa and KLM



Niklaß et al., 2020

Meteorological data

- Needed for weather-based approach
- Should be obtained from external sources
  → no reporting needed
- NWP model and forecast time has to be agreed upon in advance (operator and authority)

Blue: Minimum data

Light blue: Implicit minimum data

Green: Additional possible data

Input Data	Monitoring	Reporting	Verification
	Meteorological data		
Pressure*	✓		✓
Air temperature*	✓		✓
Specific humidity*	✓		✓
Relative humidity over ice	✓		✓
Eastward wind*	✓		✓
Northward wind*	✓		✓
Vertical velocity*	✓		✓
Specific cloud ice water content*	✓		✓
Geopotential*	✓		✓
Outgoing longwave radiation (OLR)	✓		✓
Reflected solar radiation (RSR)	✓		✓
Solar direct radiation (SDR)	✓		✓

Models/ Input data	Emissions Calculation Model	AirClim openAirClim	CoCiP (py-contrails)	aCCFs	FAiR	OSCAR	LEEA
		Meteorological data					
Pressure*			✓	✓			
Air temperature*	✓	✓	✓	✓	✓	✓	✓
Specific humidity*	✓	✓	✓	✓	✓	✓	✓
Relative humidity over ice				✓			
Eastward wind*			✓				
Northward wind*			✓				
Vertical velocity*			✓				
Specific cloud ice water content*			✓				
Geopotential*			✓	✓			
Outgoing longwave radiation (OLR)			✓	✓			
Reflected solar radiation (RSR)			✓				
Solar direct radiation (SDR)			✓	✓			

Flight data to run models

- Flight trajectory data and aircraft type are required
- Other flight data can optionally be used to improve accuracy
- Some data will be required to allow creation of particular incentives (Engine efficiency, fuel composition)

Blue: Minimum data to run model

Green: Additional possible data to enhance accuracy

Models/ Input data	Emissions Calculation Model	AirClim openAirClim	CoCiP (py-contrails)	aCCFs	FAiR	OSCAR	LEEA
		Flight trajectory					
Timestamp			✓	✓			
Latitude		✓	✓	✓	✓	✓	
Longitude		✓	✓	✓	✓	✓	
Altitude	✓	✓	✓	✓	✓	✓	✓
		Aircraft properties & performance					
Aircraft type	✓	✓	✓	✓	✓	✓	✓
True airspeed	✓		✓				
Engine UID	✓	✓	✓	✓	✓	✓	✓
Fuel flow	✓	✓	✓	✓	✓	✓	✓
Aircraft mass / Takeoff mass / Load factor**			✓				
Engine efficiency	✓	✓	✓	✓	✓	✓	✓
		Fuel properties & SAF					
Fuel type***	✓		✓				
SAF blending ratio	✓	✓	✓				

Flight data for MRV

- Aircraft type, flight information and engine UID are necessary for monitoring and reporting
- Flight trajectory data should be obtained from independent sources (EUROCONTROL)
- Certain data can be estimated to some degree (fuel flow), but will have to be filled conservatively if not available (→ WP1.4)

Input Data	Monitoring	Reporting	Verification
		Flight information	
Flight number	✓	✓	✓
Day and time	✓	✓	✓
Arrival and Departure Airport	✓	✓	✓
		Flight trajectory	
Timestamp	✓		✓
Latitude	✓		✓
Longitude	✓		✓
Altitude	✓		✓
		Aircraft properties	
Aircraft type	✓	✓	✓
Engine UID	✓	✓	✓
Aircraft mass / Take-off-mass / Load factor**	✓	✓	✓
		Aircraft performance (along flight)	
Fuel flow	✓	✓	✓
Aircraft Performance Model	✓		✓
True airspeed	✓	✓	✓
Engine efficiency	✓	✓	✓
		Fuel properties	
Fuel type***	✓	✓	✓
SAF blending ratio	✓	✓	✓

Blue: Minimum data to establish MRV

Green: Additional possible data to expand possibilities and enhance accuracy

DLR

4) Data gaps (WP 1.4)

Fill missing data with conservative values
→ Conservative values must not lead to lower CO2e than those obtained for similar flights under similar conditions

- **Fuel Flow**:
  1) recorded by the operator
  2) modelled by the operator during flight planning
  3) modelled using 3rd party models

     Various possibilities (Boenig (2) FFM, DLR FFM, P3T3)

     Other data such as aircraft mass, or true airspeed might be needed

- **Engine Type**:
  1) Engine UID provided by operator
  2) Most conservative default engine from list for specific aircraft (ICAO Engine Databank)

- **Fuel properties:**
  1) Fuel service provider or airport service (ReFuelEU)
  2) Assume Jet-A1

5) Uncertainties

- Humidity (low quality of forecasts in UTLS)
- Models (internal variability, assumptions for optimisation)
- Contrails (locality, life time, deformation, warming/cooling)
- Fuel composition and new technologies
- Emissions (distribution, combustion process)
- Other atmospheric processes (transport of NO_x, effect of soot on natural clouds, …)

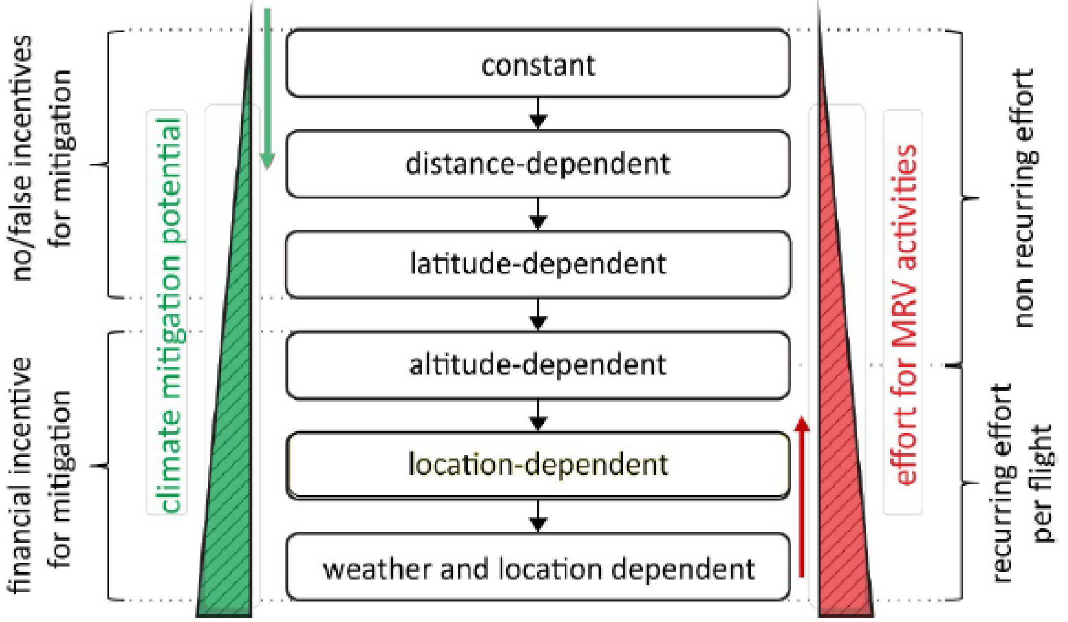
Uncertainties are inherent and will remain, but shall not prevent MRV implementation

They need to be addressed by appropriate validation and verification as well as by risk assessments to foster understanding of their risks and impacts

MRV needs to be open for new findings and uncertainties gradually reduced

6) Recommendation:

Two options
to calculate flight mission-based
CO2e for aircraft operators



Niklaß et al. 2020

- **Minimum effort solution:**

  Climatological approach with minimum data needs (likely attractive for smaller airlines)

  - **CONS**: Mitigation possibilities reduced to general options in operations (e.g. flying lower, ISO) and measures in aircraft design, propulsion technologies, use of SAF

  - **PROS**: Modelling and data effort for MRV low

- **Full potential solution:**

  Weather-based approach (likely attractive for airlines with more capacities)

  - **CONS**: Data and model processing efforts higher

  - **PROS**: More possibilities for incentives through detailed flight routing options (allowing to avoid negative climate impacts of cirrus and NO_x effects)

6) Recommendation:

Two options
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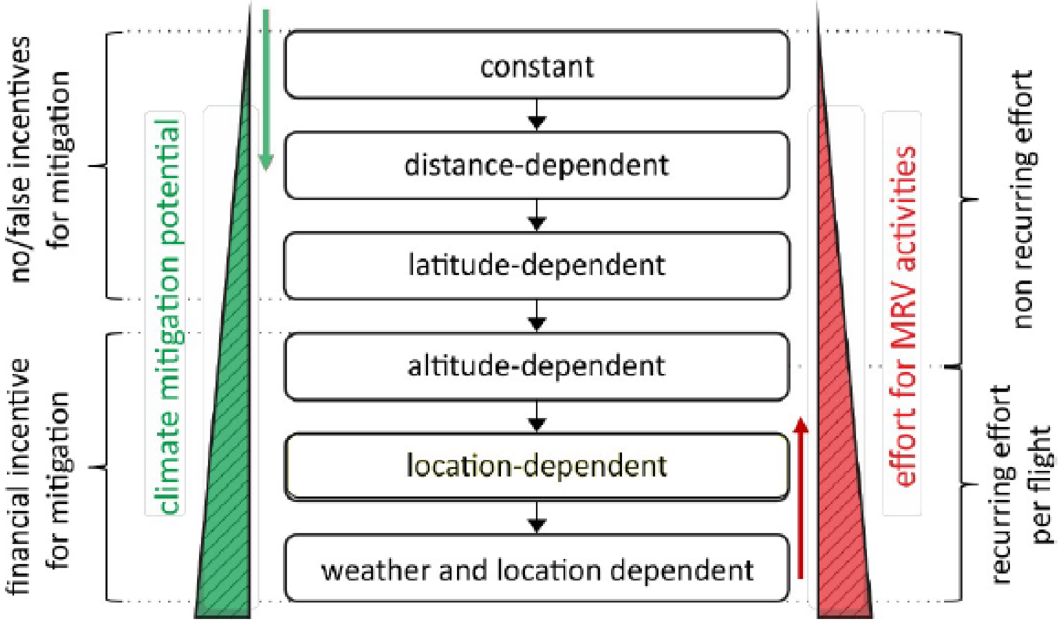

Niklaß et al. 2020

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Thank you for your attention

Elements of the MRV framework Project

Software architecture - Robert Koster (AerLabs)

Software Architecture

Non-CO2 MRV IT Platform – DG Clima

Date 01-12-2023

By Robert Koster (CEO)

Prepared for:

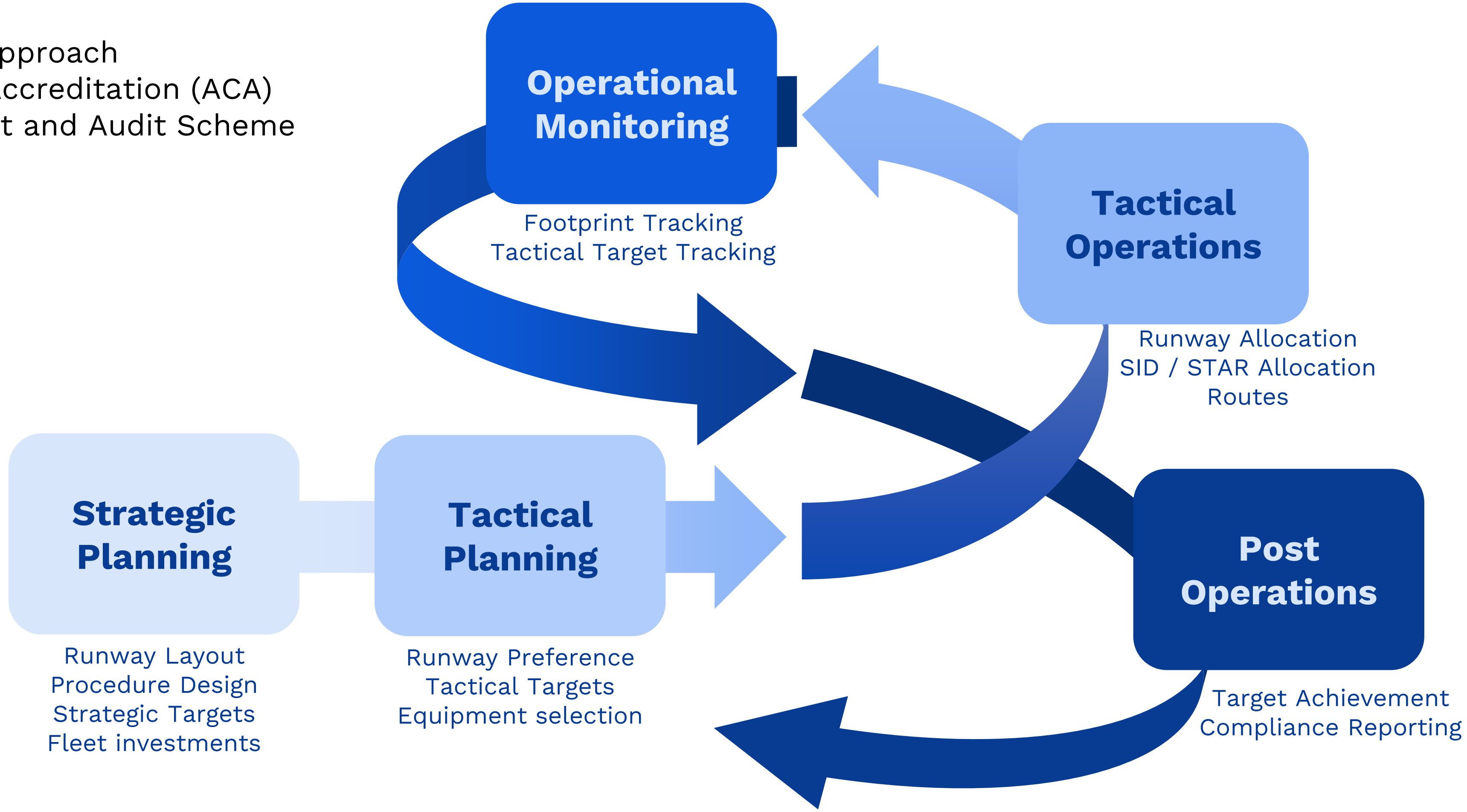
Public consultation meeting

About AerLabs

- Netherlands based aviation technology company
- Mission to reduce the environmental footprint of aviation across the world **moving towards a net zero future**
- Provide **Echo software platform** and services to enable the aviation industry to use data to reduce their noise and emissions impact
- Founding member of TU Delft's Aerospace Innovation Hub

Approach to environmental management

Compatible with:
- ICAO balanced approach
- Airport Carbon Accreditation (ACA)
- Eco-Management and Audit Scheme (EMAS)
- ISO 14001
- SBTi
- etc.



Our Four Pillars

Foundational to achieve Net Zero

Services to manage & reduce noise and emissions

Agnostic to local sensors

API based platform to integrate with your existing sensors & data sources

Stakeholder Engagement

An end to end service from planning to near real time monitoring & prediction

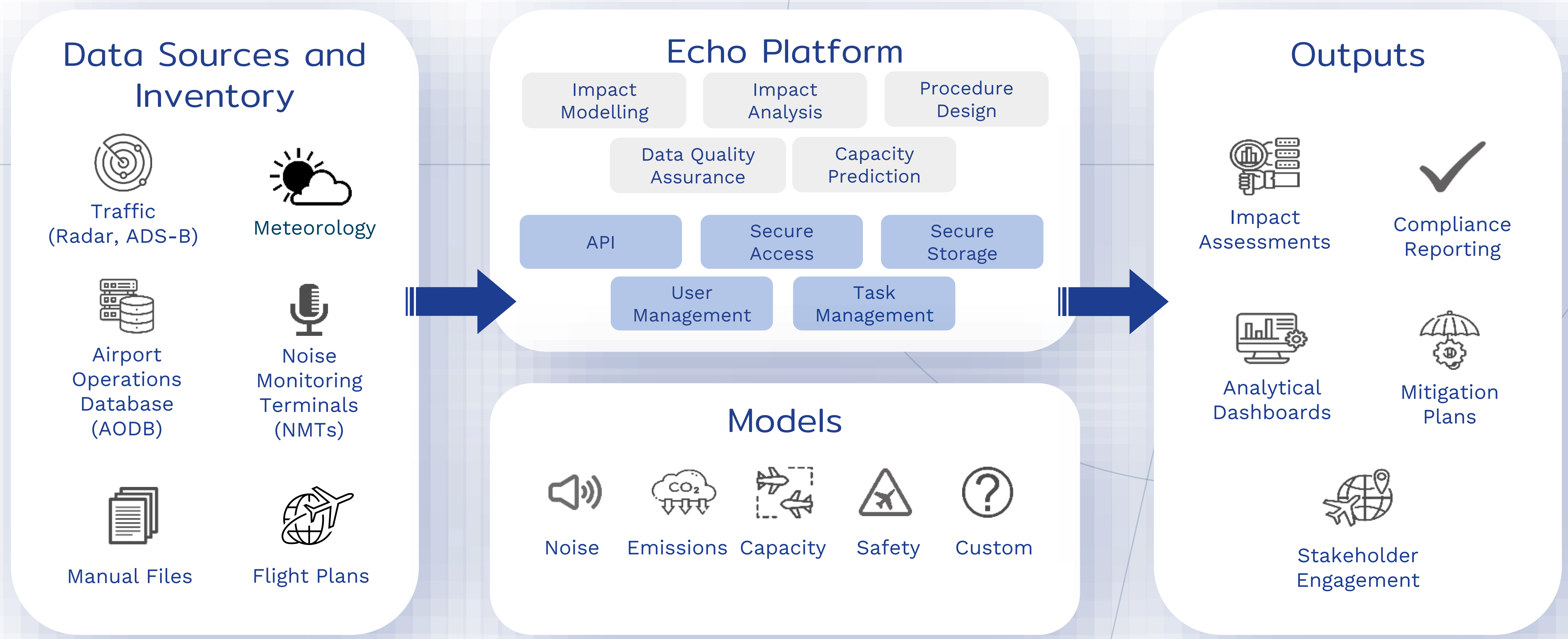
Automating Compliance Reporting

Simplifying EMAS, ISO 14001, EU directive 2015/996 & others

Areas of attention for MRV IT platform

- Ensure **data quality** and validation
- Minimise **administrative burden**
- Address data **privacy and security**
- Enable data **governance**
- Prepare for **operationalisation**

Echo Platform



The Echo Platform is a cloud-based environmental management solution with the flexibility to support complex data analysis using custom models and bespoke data integration

MRV IT Platform Benefits

Automation of monitoring & reporting

Protects commercially sensitive data

Minimises the administrative burden

Thanks!

Don't hesitate to reach out

Robert Koster
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Awards and recognitions

Environment Category Winner

SUSTAINABLE AERO LAB

The Next Generation of Sustainable Aviation

Interactive Flight Path & Aircraft Noise Impact Tool

linkedin.com/company/aerlabs/

Elements of the MRV framework Project

Engagement with airspace users - Maarten Tielrooij (To70)

Work Package 3

- Making sure that the MRV works

- 3.1: Further work
  - Assess foreseeable costs of operating the MRV
  - Determine further work for implementing the IT solution

- 3.2: Stakeholder consultation
  - Evaluate the MRV system with stakeholders

Costs of the MRV

- Costs
  - Implementation
  - Operation

- Rough assessment
  - Discussions with stakeholders
  - Learning from similar concepts (UBA MRV)

Engagement

- Evaluate
  - operation of the MRV System
  - <u>not</u> results of the MRV calculation

- Subjects
  - Interfaces
  - Process
  - Data availability

Engagement

- Input from stakeholders (this session)
  - Data availability
  - Applicability across airlines

- Demonstrate IT solution in a workshop (summer 2024)
  - Interfaces
  - Process

- Collate feedback into future work

Opportunity for questions

Join at
slido.com
#3898 916

Lunch break

Afternoon session

1. **Presentation MET data availability**
   - *Björn Beckmann, DWD*

2. **Expert panellists**
   - *Volker Grewe, DLR*
   - *Maarten Tielrooij, To70*
   - *Robert Koster, AerLabs*
   - *Gerben Broekema, To70*

Availability MET data / Climate relevant MET data

MET data - Björn Beckmann (DWD)

Consulting meeting on non-CO_2 effects MRV

Availability MET data / Climate relevant MET data

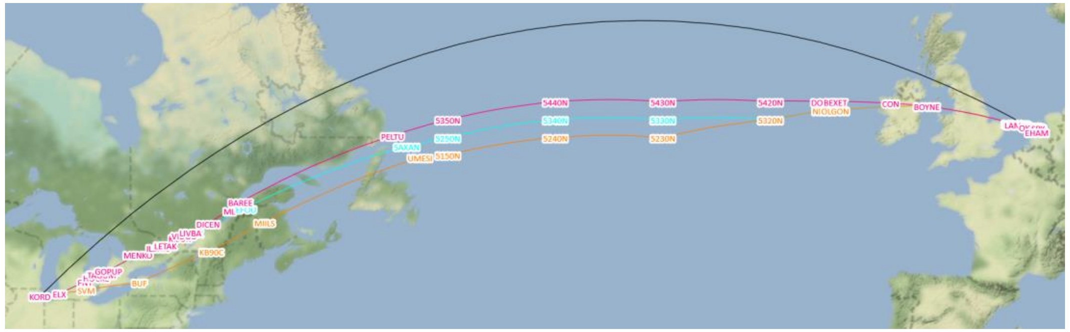
Dr. Björn Beckmann
German National Meteorological Service (DWD)
Department for Customer Services and Development
Aviation Customer Service

1st December 2023

MET forecast data for flight planning and air space monitoring

- Provision of MET forecast parameters from Numerical Weather Prediction (NWP) models, like wind, air temperature, air pressure
  - World Aviation Weather Forecast (WAWFOR) dataset by DWD:
    - Update: 4 times daily: 00, 06, 12, 18 UTC
    - Forecast time +48 h,
    - Forecast steps +1h,
    - Output for 00, 06, 12, 18 UTC are analysis
    - Output between FL50 and FL675
    - WAWFOR global: 13 km grid resolution,
    - WAWFOR EU section: 6,5 km grid resolution

Flight trajectory planning
Source: LH Systems

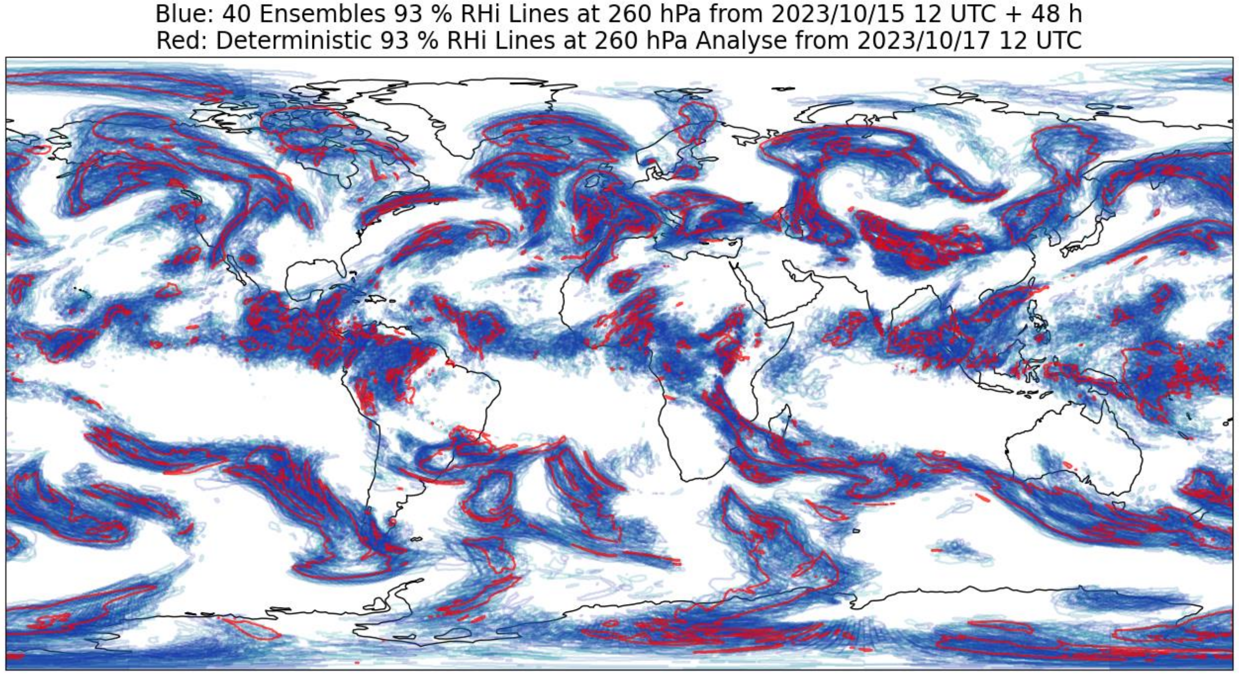


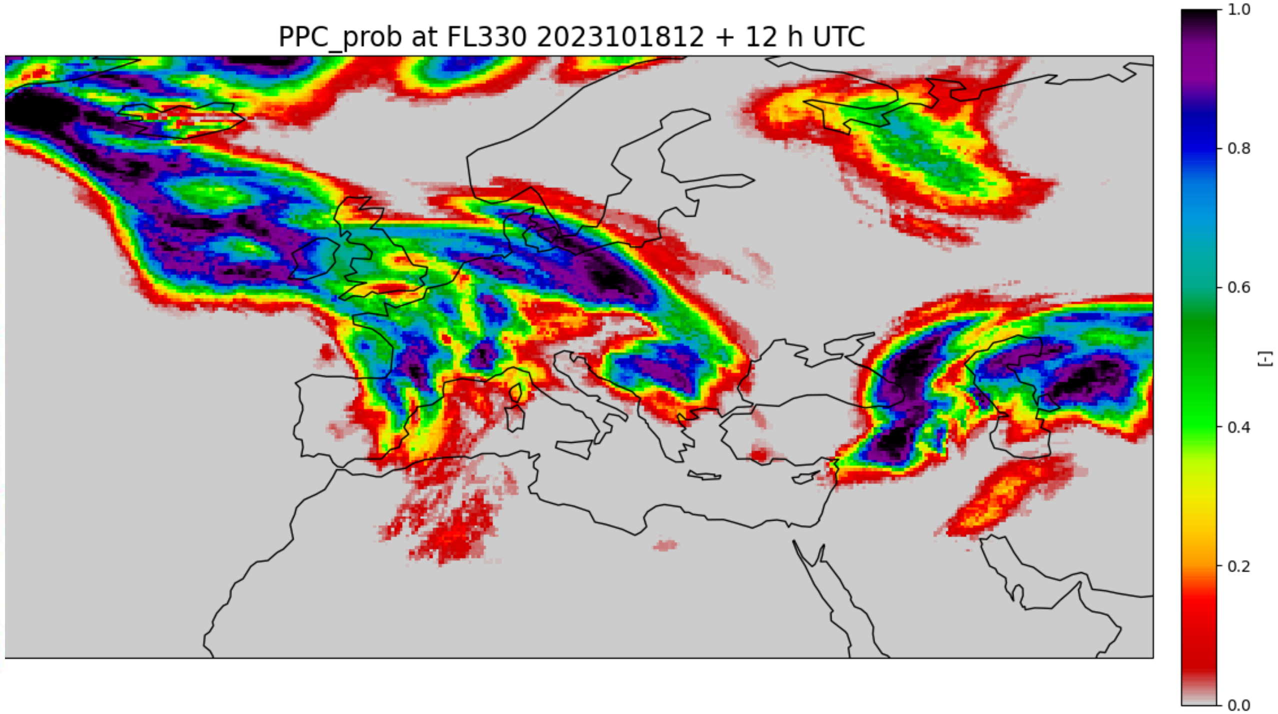
Additional MET data set for climate optimised flying

At DWD a data set with climate relevant parameters is under development in addition to WAWFOR, it contains (in collaboration with project LuFo D-KULT / DLR):

- Potential Persistent Contrail (PPC) binary and as probability: *Schmidt-Appleman criterion and **saturation of humidity***
- Output postprocessing climate change impact due to contrails
- Output climate change impact due to further non-CO_2 effects
  - NO_x, H_2O
  - CO_2 as reference value

Uncertainty in prediction of humidity and Potential Persistent Contrail





Relative humidity at 260 hPa > 93%: model analysis in red and 40 ensemble-member forecast +48 h in blue

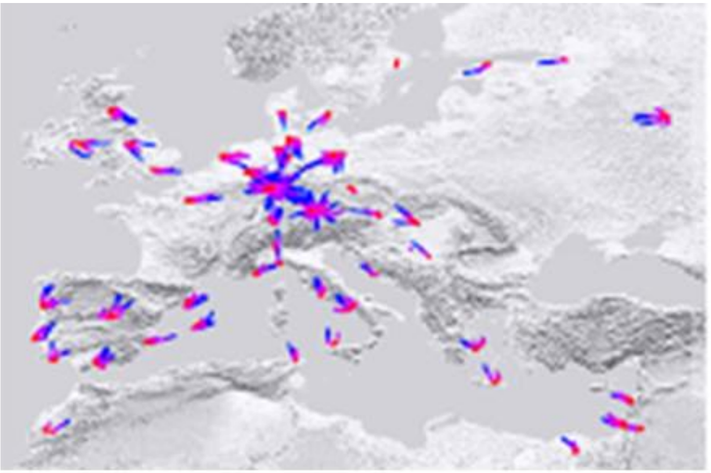
Humidity forecast uncertainty could be shown.

Source: DWD/R. Engelhardt

PPC probability based on 40 Ensembles +12h forecast at FL 330, *shows areas of greater predictive uncertainty in some cases, highlighted in red, yellow and green.*

Operational airborne humidity observations to improve forecast

- **WMO AMDAR** – Aircraft Meteorological Data Relay
- Data collection of humidity observations only during descent and ascent due to transmission costs from the aircraft to the ground
- Project LuFo MEFKON: Extension of AMDAR data collection on cruise level of 9 Lufthansa aircrafts over Europe
- **Assimilation of data into NWP: Benefit on humidity forecast**



AMDAR water vapor observations 30 Sep – 06 Oct 2019

- **UK Met Office:** Implementation of FLYHT WVSS-II water vapor sensors on 13 aircrafts – Embraer 145 – of Loganair Airline
- Observations and data transfer also planned at cruise level

Source: Met. Technology Int. 09/2023

Summary climate relevant MET data (1)

- Predictions of climate-relevant MET parameters are required for climate optimized flight trajectory planning and air space monitoring.
- Parameters could be provided by Numerical Weather Prediction and Postprocessing approaches.
- Persistent contrails have the greatest contribution to non-CO_2 effects. Persistent contrails can form in ice supersaturation regions (ISSR). An important meteorological input parameter for ISSR / PPC is relative humidity.
- However, the description of relative humidity through the analysis and predictions of NWP models is subject to relatively large uncertainties.
- To achieve maximum aviation user acceptance for air spaces which are already heavily congested, the PPC areas need to be localized as far as possible in terms of time and space.
- To improve humidity forecasts, the integration of airborne humidity observations into the data assimilation is particularly important. Therefore, it is necessary to extend operational data collection to cruising altitude and equip more aircraft with sensors. Currently over Europe, AMDAR data is only collected by a small number of 9 Lufthansa aircrafts during ascent and descent due to transmission costs from the aircraft to the ground.

Summary climate relevant MET data (2)

- The future satellite generation Meteosat Third Generation is also expected to provide added value with regard to NWP data assimilation for humidity, e.g. through LIDAR-supported measurements. Nevertheless, the importance of airborne observations is still recognized.
- The improved NWP based relative humidity analysis and forecasts could also be used for verification purposed for MRV system.
- For example, the European AMDAR program – EUMETNET Aircraft based Observation Programme E-ABO – could be expanded for collection of additional humidity observations.
- As the climate protection would be the main beneficiary and other application areas are likely to benefit of such an expansion of humidity data collection at cruising level, an alternative solution to the MET Service Providers should be discussed in terms of funding.
- An exchange between European Commission and EUMETNET is therefore recommended with regard to expansion and financing.

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Expert panel Data availability

Volker Grewe, DLR - MRV data expert

Maarten Tielrooij, To70 - MRV data gaps expert

Robert Koster, AerLabs - MRV data processing expert

Gerben Broekema, Broekema Aviation - Operational expert

Questions Data availability

Join at
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Coffee break

European Commission

Expert panel Data Flow

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DLR

AERLABS

European Commission

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Closing remarks

Polona Gregorin, Head of Unit DG Climate Action