Non-CO_2 MRV

Support for establishing a monitoring, reporting and verification system

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On behalf of the project consortium for DG CLIMA: *To70, DLR & AerLabs*

Workshop on Aviation Non-CO_2 Emissions, Brussels, 14/12/2023

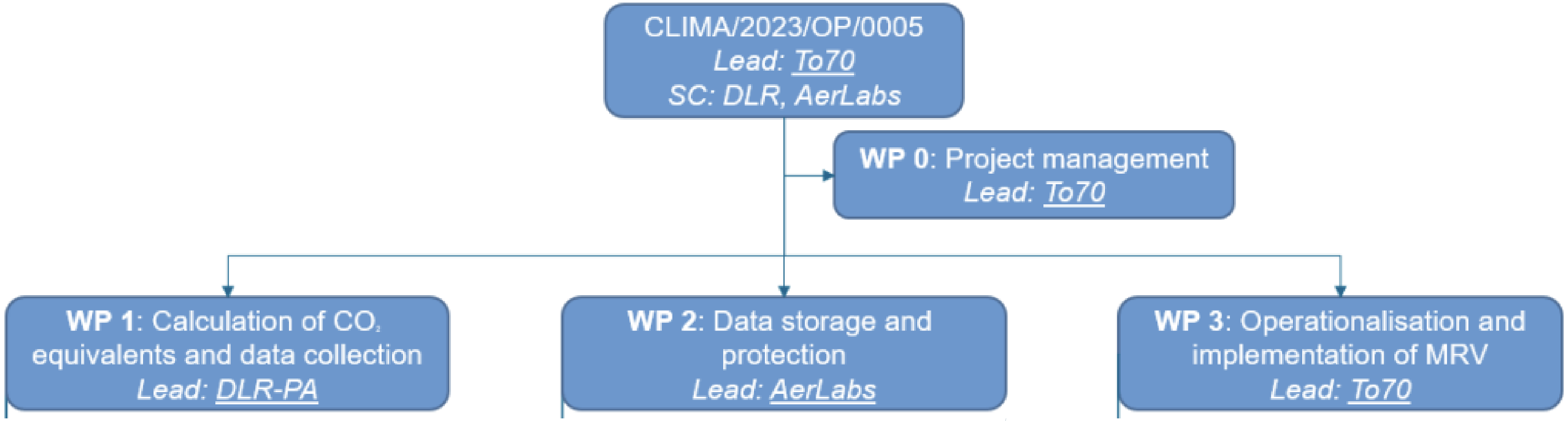
European Commission

Non-CO_2 MRV | Agenda

- MRV project objectives
- Planning
- Overview of work packages
- Preliminary WP 1 results
- Summary

Objective & structure of the non-CO_2 MRV project

- The European Commission has been given a mandate to create a monitoring, reporting and verification framework for non-CO_2 aviation effects
- Objective of tender CLIMA/2023/OP/0005 is to provide advice on data needs & develop an IT tool for data collection; provide an overview of models and metrics
- Project consortium: To70, DLR, AerLabs
  - Data advisory: Lufthansa, KLM, KNMI, DWD



Planning MRV

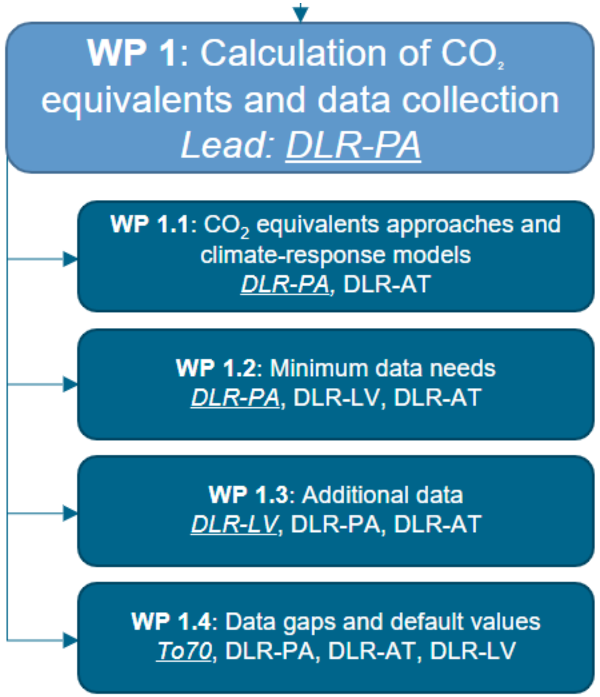
Preliminary report Internal	Public meeting External	Intermediary report Internal	IT solution and Operationalization	Finalisation of project
Nov. 2023	Dec. 1st 2023	Jan. 2024	2024 →	Dec. 2024
WP1			WP2, WP3	

Today: Workshop on Aviation Non-CO_2 Emissions

WP 1 – Overview

Scope of work:

- Analyse **approaches, models and metrics** to calculate CO_2-equivalent emissions on a per-flight basis
- Identify **minimum and additional data** to be monitored, reported and verified
- Consider **data gaps** and recommend default values in case of missing or partially collected data



Preliminary report Internal	*Public meeting External*	***Intermediary report Internal***	*IT solution and Operationalization*	*Finalisation of project*
Nov. 2023	Dec. 1st 2023	**Jan. 2024**	2024 →	Dec. 2024
WP1			**WP2, WP3**	

WP 2 – Overview

Scope of work:

- Develop the user-friendly and **secure** IT solution that ensures the **collection and storage** of the monitored data.

Preliminary report Internal	Public meeting External	Intermediary report Internal	*IT solution and Operationalization*	Finalisation of project
Nov. 2023	Dec. 1st 2023	Jan. 2024	**2024 →**	Dec. 2024
WP1			**WP2**, WP3	

WP 3 – Overview

Scope of work:

- Preparing for the **operationalisation** of the MRV
- Analysis of **administrative and cost impact** of implementation
- Workshop(s) / training for sector to review MRV and provide feedback on integration of MRV

Preliminary report Internal	Public meeting External	Intermediary report Internal	IT solution and Operationalization	Finalisation of project
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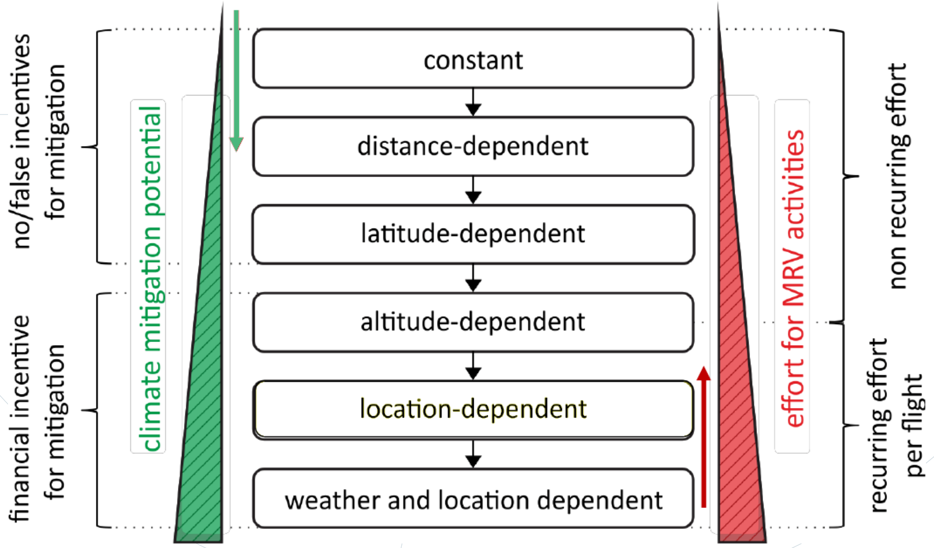
PRELIMINARY RESULTS WP 1

SAF contrail trials with Airbus A321 | Source: DLR

Calculating mission-based CO_2-eq emissions

- Larger climate mitigation potential possible with greater MRV effort



Niklaß et al. (2020)

We recommend two solutions:

1. Minimum effort: Climatological approach

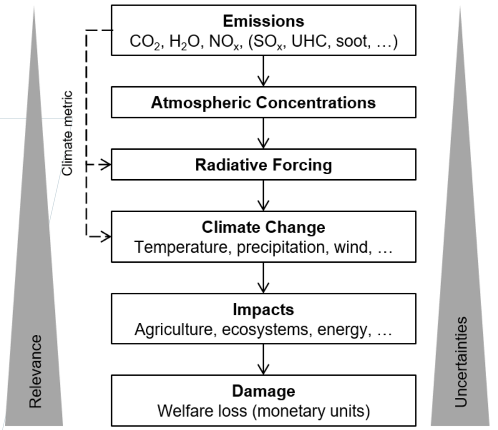
- **PROs**: Low modelling and data effort
- **CONs**: Mitigation possibilities reduced to general options in operations and changes in aircraft & propulsion design, general SAF use
- Likely attractive for smaller airlines

2. Full potential: Weather-based approach

- **PROs**: More incentive possibilities through flight routing options, targeted SAF use
- **CONs**: Higher modelling and data effort
- Suggested for airlines with more capacity

Climate Metrics

- Each climate metric has its own purpose and merits. The choice of climate metric is a **compromise**, but independent of the approach
- We find that integrated climate metrics with large time horizons (>70 yrs) are most appropriate, e.g. GWP_{100} or ATR_{100} (incl. efficacy)



Fuglestvedt et al. (2003)

The choice of climate metric does not have to be controversial!

Different time horizons possible, and we can understand the consequences of choosing a given metric.

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

Models

Each model has its own purpose and merits – the choice of model depends on the approach chosen.

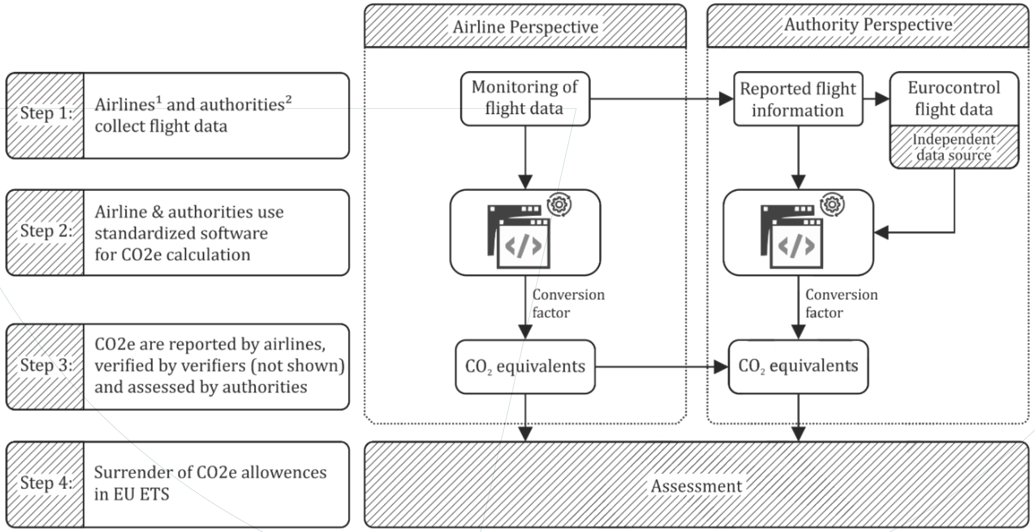
- **aCCFs** – TU Delft & DLR
  Calculates climate impact of all non-CO_2 effects on per-flight basis with weather dependence, direct implementation in NWP models
- **AirClim** (& OpenAirClim) – DLR
  Climate response model, estimates climate impact of all non-CO_2 effects on a yearly-mean climatological basis
- **CoCiP** (& pycontrails – open-source & integrated with other models) – DLR, Breakthrough Energy
  Lagrangian contrail life cycle model for the calculation of contrail climate impact of single flights & global air traffic
- **FaIR** – Oxford/Leeds Univ.
  Reduced-complexity climate model, produces global temperature projections from emissions or forcing scenarios
- **LEEA** – Cambridge/Reading Univ., Airbus
  Simple response model for climate impact of aviation emissions
- **LinClim** – MMU
  Climate response model predicting climatological response of aviation perturbation and monetary values of impacts
- **OSCAR** – IIASA, ONERA, LSCE
  Compact Earth System Model to calculate the response of global aviation emissions

Model/ Requirement	(open) AirClim	CoCiP (pycont rails*)	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	?	--	--	--

Minimum and additional data (WP 1.2 & WP 1.3)

Data required:

- Flight emissions/emission indices
- Meteorological data from weather services (for weather-based approach)
- Flight data from aircraft operators, authorities & services, e.g. EUROCONTROL



Niklaß et al. (2020)

Considerations:

- Data needs should be **kept to a minimum**, while assuring required accuracy of results
- Two different storage systems with different data requirements may be required for monitoring and verification

Minimum and additional data (WP 1.2 & WP 1.3)

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

Flight data

- Aircraft type, flight information and engine UID are required. Other flight data can optionally be used to improve accuracy of the models
- Flight trajectory data should be obtained **from independent sources**, e.g. EUROCONTROL, to limit MRV effort
- Additional data will be required to allow for certain incentives (e.g. engine efficiency, fuel composition)
- Some data can be estimated to some degree (e.g. fuel flow), otherwise must be **conservatively assumed** (→ WP 1.4)

Data gaps (WP 1.4)

Missing data must be filled with conservative values. These must not lead to lower CO_2-eq emissions than if real values were used

Examples:

Fuel Flow

1. Recorded by the operator
2. Modelled by the operator during flight planning
3. Modelled using 3rd party models, (e.g. P3T3, DLR FFM)

Other data such as aircraft mass or TAS may be needed

Engine Type

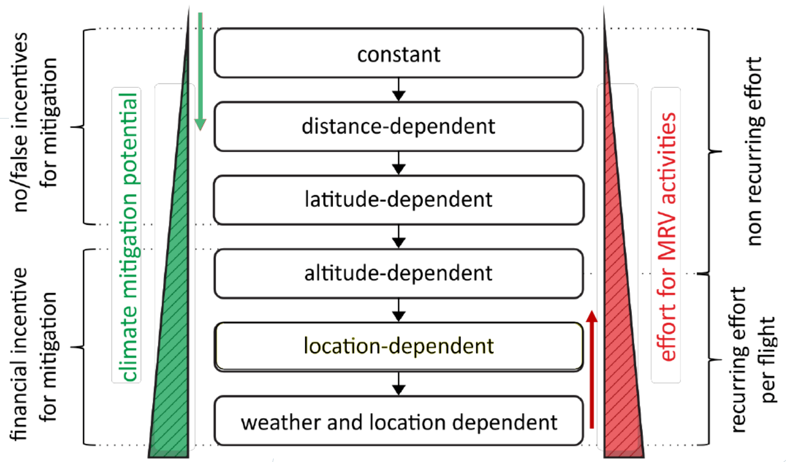
1. Engine UID provided by operator
2. Most conservative default engine from list for specific aircraft (ICAO Engine Database)

Fuel Properties

1. Fuel service provider or airport service (ReFuelEU)
2. Assume Jet-A1

Summary

- We recommend **both** a minimum effort (climatological) and a full potential (weather-based) approach
  - The full potential approach requires larger modelling and data effort, but provides more possibilities for incentives through detailed flight routing options, e.g. contrail and NO_x avoidance
  - The suitability and accuracy of the model depends on the approach chosen and the data available
  - Data gaps need to be filled conservatively and are being inspected in further work



Niklaß et al. (2020)

- Uncertainties are inherent and will remain, but should not prevent MRV implementation – research can continue concurrently
- The MRV needs to be open for new scientific research and understanding

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THANK YOU

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