Testing of a Monitoring, Reporting & Verification (MRV) Scheme for the integration of non-CO_2 aviation effects into EU ETS

On behalf of the German Environment Agency
FKZ 3720 42 502 0
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K. Dahlmann[1] and M. Niklaß[2]

V. Grewe[1], F. Linke[2], S. Matthes[1], M. Plohr[3], J. Scheelhaase[4]

[1]DLR Institute of Atmospheric Physics
[2]DLR Air Transportation Systems
[3]DLR Institute of Propulsion Technology
[4]DLR Institute of Air Transport and Airport Research

Vote by the European Parliament on 8 June 2022 **for integrating non-CO_2 aviation emissions into EU ETS**

Amendment 11:

"[…] **non-CO_2 aviation emissions**, in line with the precautionary principal, **can no longer be ignored**. Union regulatory measures are needed to achieve reductions of emissions in line with the Paris Agreement. Therefore, **the Commission should set up a monitoring, reporting and verification scheme for non-CO_2 aviation emissions**.

Building on the results of this scheme the Commission should, no later than 31 Dec. 2026, based on an impact assessment, **submit a legislative proposal** containing mitigation measures for non-CO_2 emissions, by **expanding the scope of the EU ETS to cover such emissions.**

Until the adoption of a legislative proposal extending the scope of this Directive to cover non-CO_2 emissions, starting from 31 Dec. 2027, the **CO_2 emission factor** for emissions from aviation activities **shall be multiplied** by 1,8 **to account for non-CO_2 aviation emissions**, by 1,9 from 31 Dec. 2028 and by 2,0 from 31 Dec. 2029. […]"

Amendment 51:

"[…] The MRV scheme for non-CO2 emissions shall contain data on at least the following: a) fuel flow; b) mass of the aircraft; c) ambient humidity; d) latitude, longitude and altitude of the aircraft; e) average humidity and temperature; f) emission indices for CO2, H2O, sulphur dioxide (SO2) and NOx; g) CO2 equivalents per flights. […]"

https://www.europarl.europa.eu/doceo/document/TA-9-2022-0230_EN.pdf

Pilot Phase: Monitoring and reporting of non-CO_2 effects, but no monetary internalization.

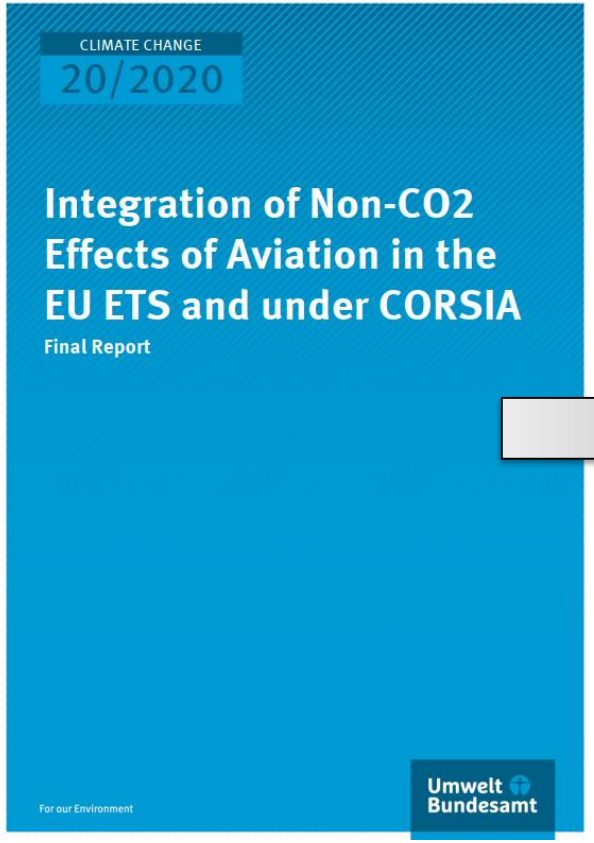
Until 31 Dec 2026: Legislative proposal how to integrate non-CO_2 effects in the EU ETS (Accounting).

Transition Phase (From 31 Dec 2027 until adoption of legislative proposal)**:** Constant multiplier for accounting non-CO_2 effects in the EU ETS.

Definition of data to be monitored and reported per flight.

Legislation proposal rejected by the Council of the EU (2nd legislative body formed by the 27 national ministers). **Compromise in progress.**

Overview of current project activities



Niklaß et al., 2020

AIRLINE PERSPECTIVE

Task 1

Monitoring & Reporting of non-CO_2 effects *(per individual flight)*

AUTHORITY PERSPECTIVE

Task 2

Verification of the reported CO_2 equivalents *(per individual flight)*

NOT APPLICABLE FOR MRV

Task 3

Development of an application for a simplified estimate of CO_2 equivalents per flights

NOT APPLICABLE FOR MRV

Task 4

Development of a concept for integrating the simplified CO2e application into TREMOD

Task 5

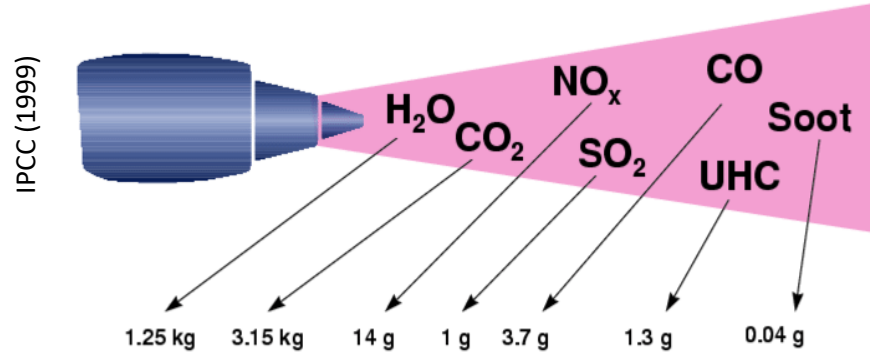
Review of the EASA-EC-Report

Testing of a MRV-Scheme of non-CO2 effects for EU ETS

Simplified estimation of the climate footprint of a flight

Review of the EASA-EC-Report

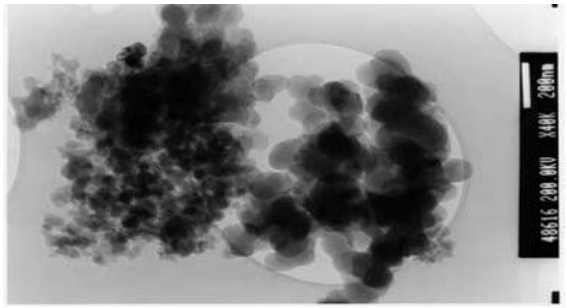
Climate Effects of Aviation Emissions



Direct greenhouse gases

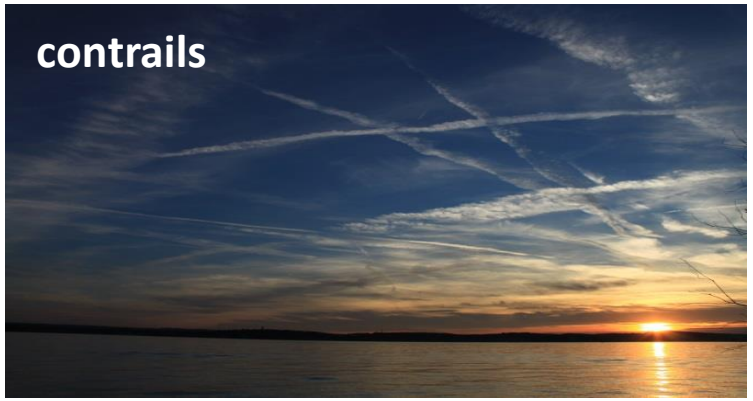
Indirect greenhouse gas chemistry

Direct aerosol effect

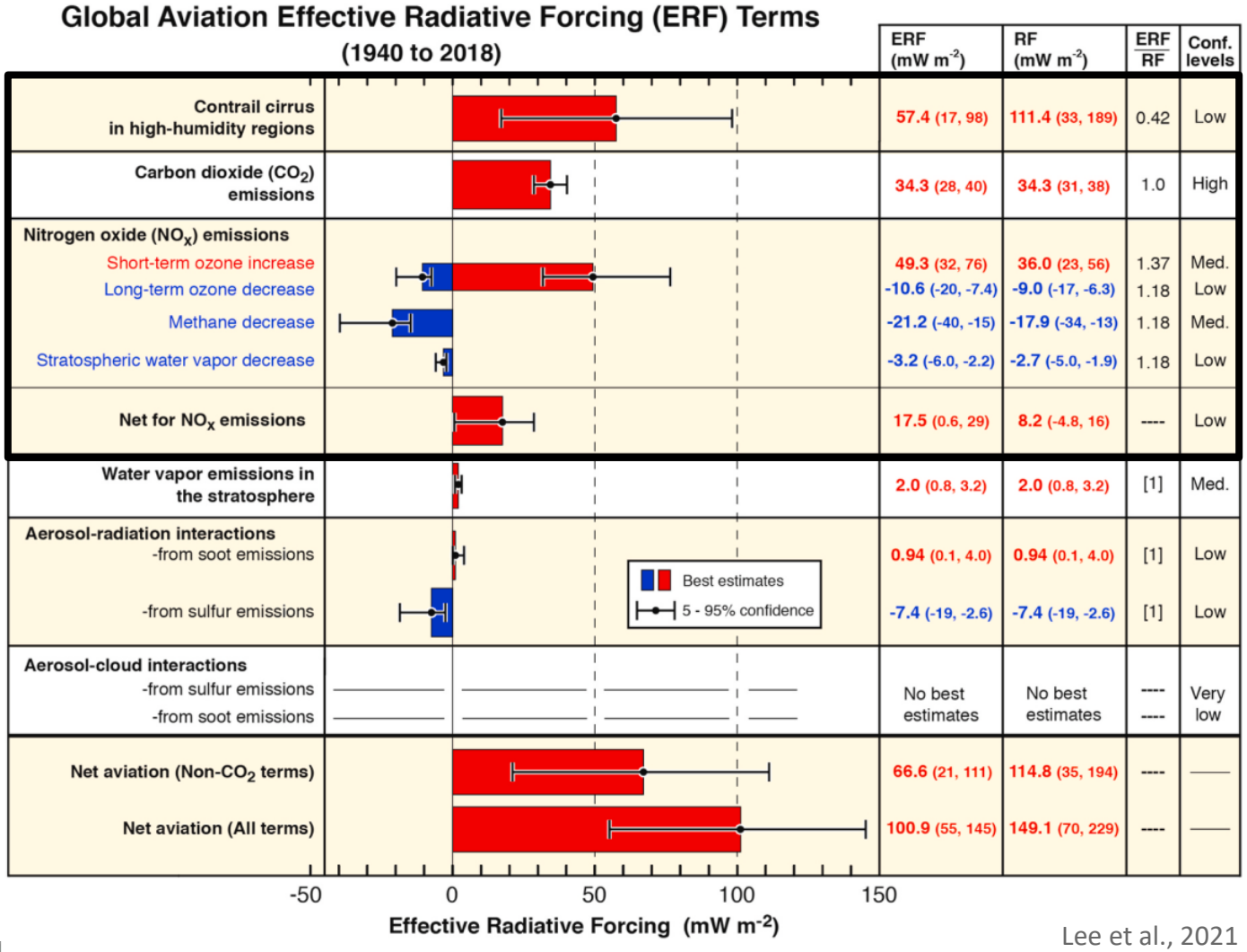


Popovicheva et al. (2004)

Aerosol effects on clouds

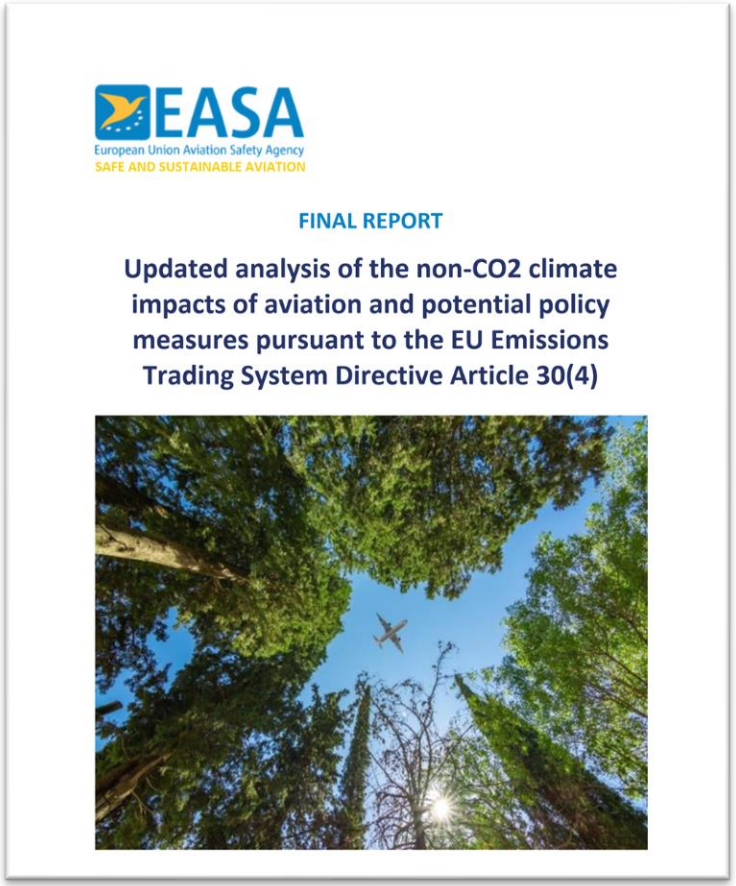


Effective Radiative Forcing in 2018 caused by historical air traffic emissions



Lee et al., 2021

CO_2, NO_x and contrails cirrus are major contributors to aviation ERF

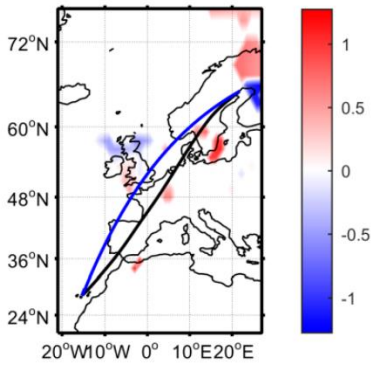


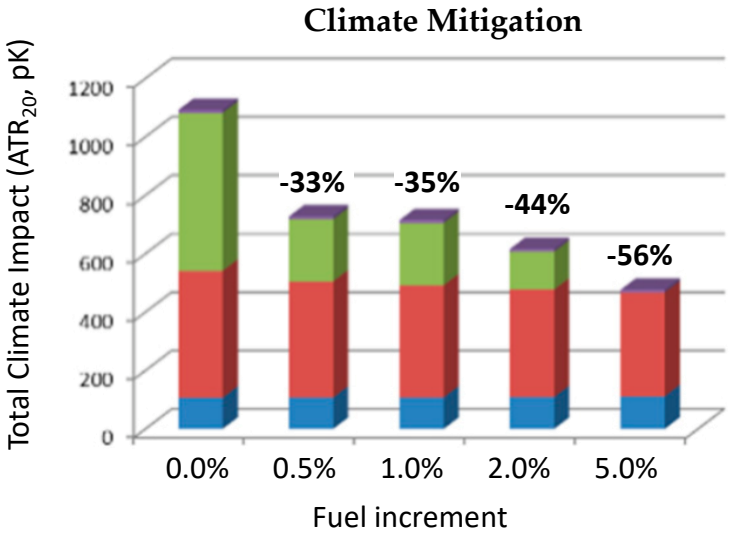
Individual contributions to total climate impact of alternative routings

One Day Case Study of European Air Traffic on 18 December 2015

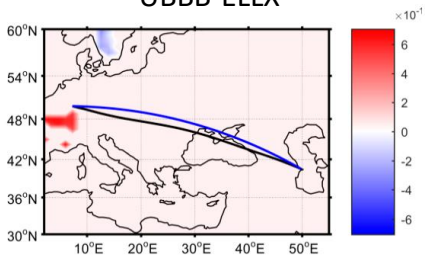
Matthes et al., 2020

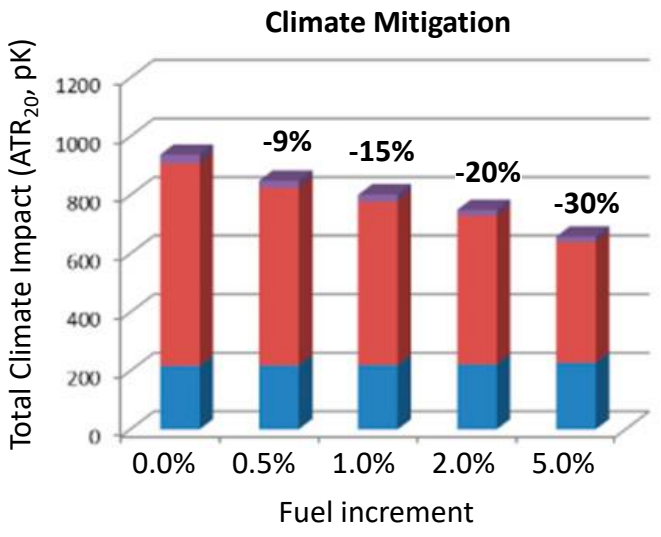
Example 1: Lulea – Gran Canaria (ESPA-GCLP)
Contrails-dominated climate impact





Example 2: Baku – Luxembourg (UBBB-ELLX)
NO_x-dominated climate impact (no contrails)





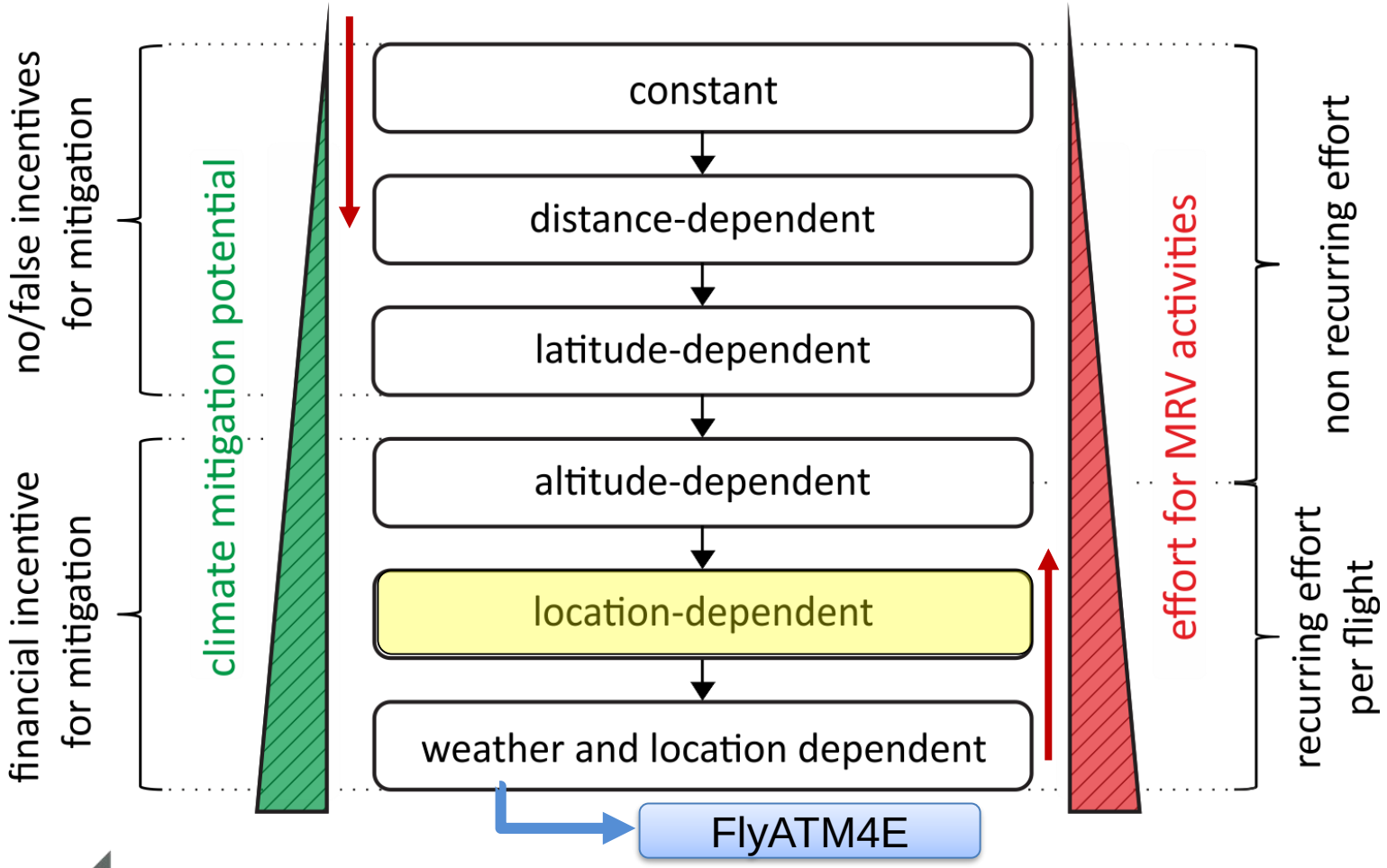
- **Climate-optimised routings can mitigate the total climate impact significantly**
- **The total climate impact of a flight can decrease despite increasing emissions** (e.g. -35% ATR_{20} for +1% fuel increase)
- **Climate-optimised routings might not be cost-optimal** (need for market-based / policy measures)

H_2O
AIC
NO_x
CO_2

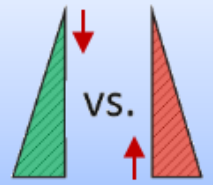
Results from ATM4E

Various options for integrating non-CO_2 effects of aviation into EU ETS

Integration based on CO_2 equivalents (CO2e)



Choosing a CO2e method is a trade-off between high climate mitigation incentives and low efforts for MRV activities.



Key criteria for selecting a CO2e method

- CO2e factors must provide an incentive for mitigating non-CO_2 effects
- CO2e factors should be easy to calculate, predictable and transparent

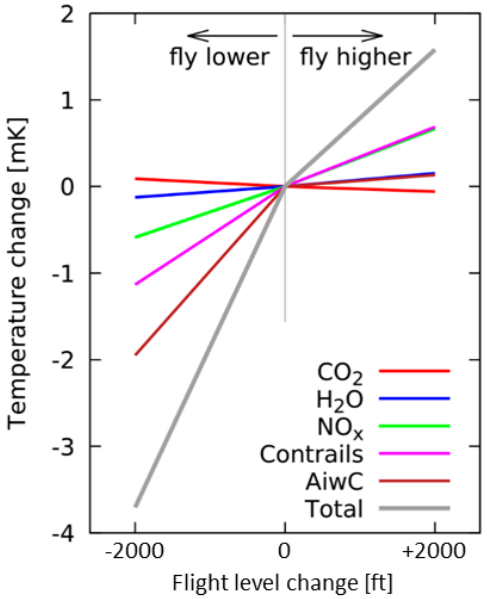
MRV: Monitoring, Reporting & Verification

Niklaß et al., 2020

Recommendation for CO_2 equivalent calculations, representing the non-CO_2 aviation effects

Not recommended

- **Simple CO2e factors** (constant, distance- or latitude-dependent)
  … further increase the focus on CO_2 reduction
  … might create false incentives *(incentive to fly higher rather than lower)*
  … "penalize" climate-optimised routings *(due to the increased fuel burn)*
  Potential applications: Estimation of the ecological footprint

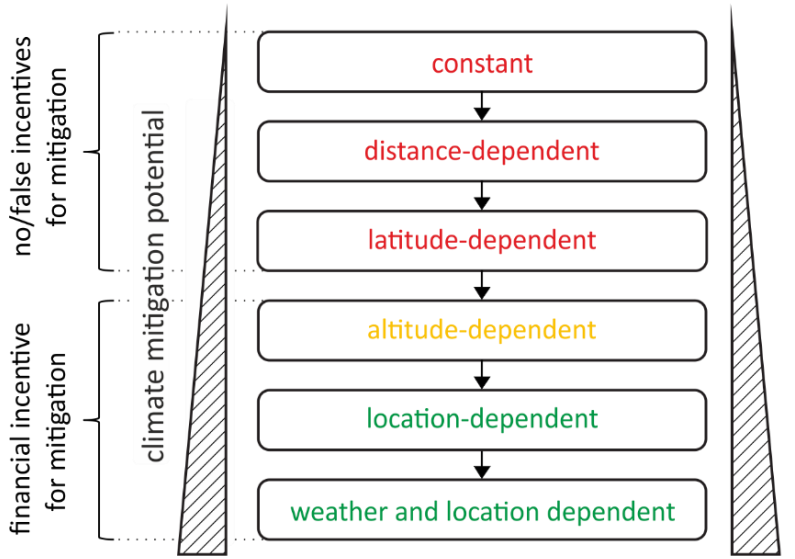


Matthes et al., 2021

Recommended

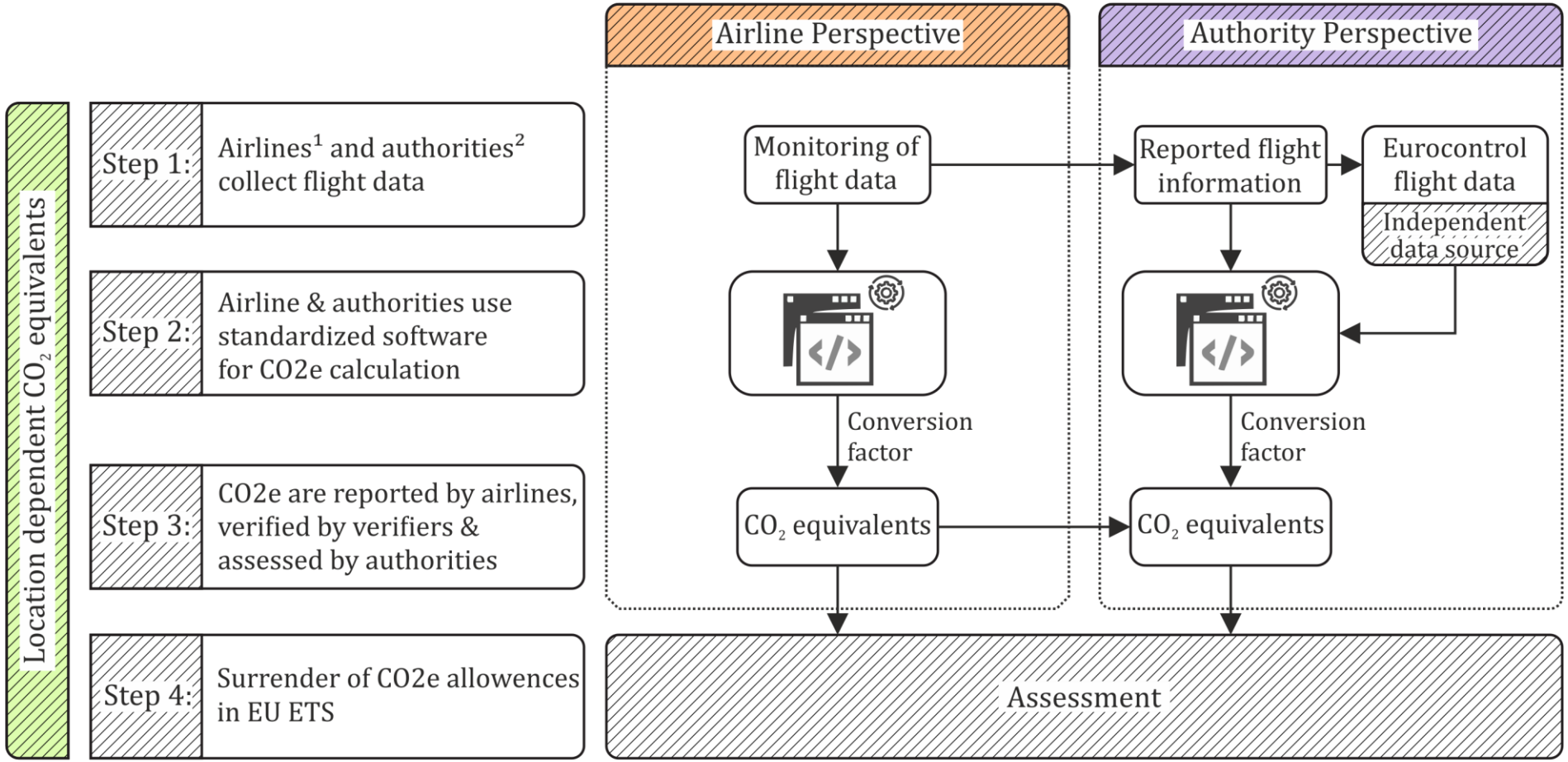
→ **More comprehensive CO2e factors** (altitude-, location- or weather-dependent) **needed to incentivize mitigation of non-CO_2 impacts**

- MRV effort could be reduced and transparency enhanced by using a public reference matrix with CO2e estimates for various
  … airport pairs and flight paths
  … aircraft and engine types
  … weather situations
- CO2e estimates must be assumed conservatively:
  Aircraft operators must not be better off with CO2e estimates



Niklaß et al., 2020

Task 1 & 2: Testing of all MRV steps for location-dependent CO2e factors

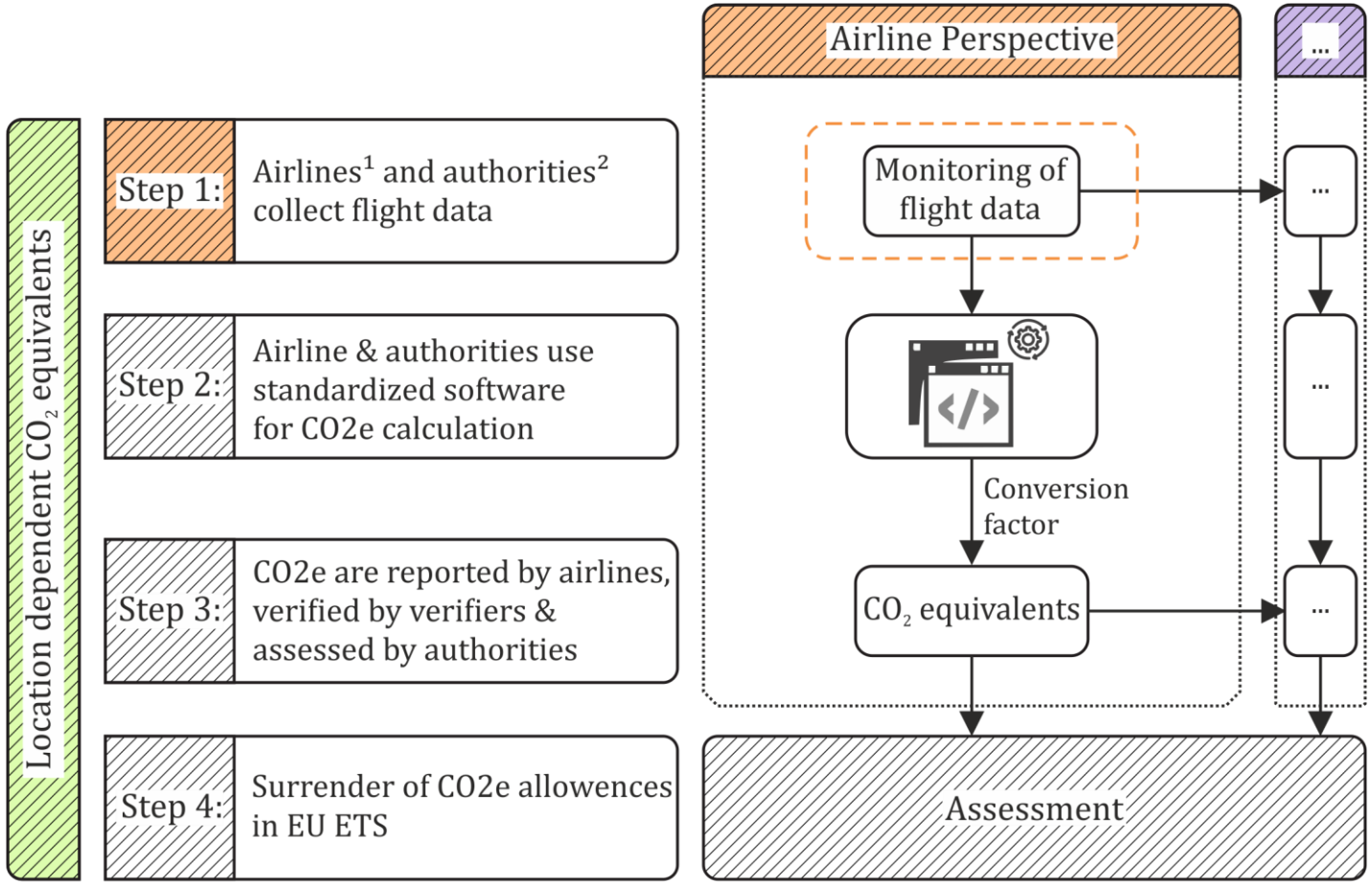


[1] Airlines collect flight data for all flights
[2] Authorities collect/request flight data for reported flights that should be assessed

Niklaß et al., 2022

Task 1: Testing of all steps to be performed by an aircraft operator

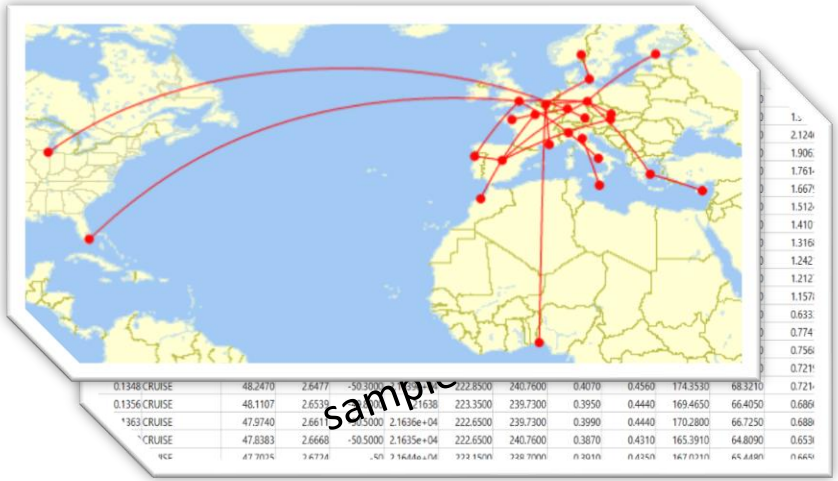
Airline perspective – Location-dependent CO2e factor



[1] Airlines collect flight data for all flights
[2] Authorities collect/request flight data for reported flights that should be assessed

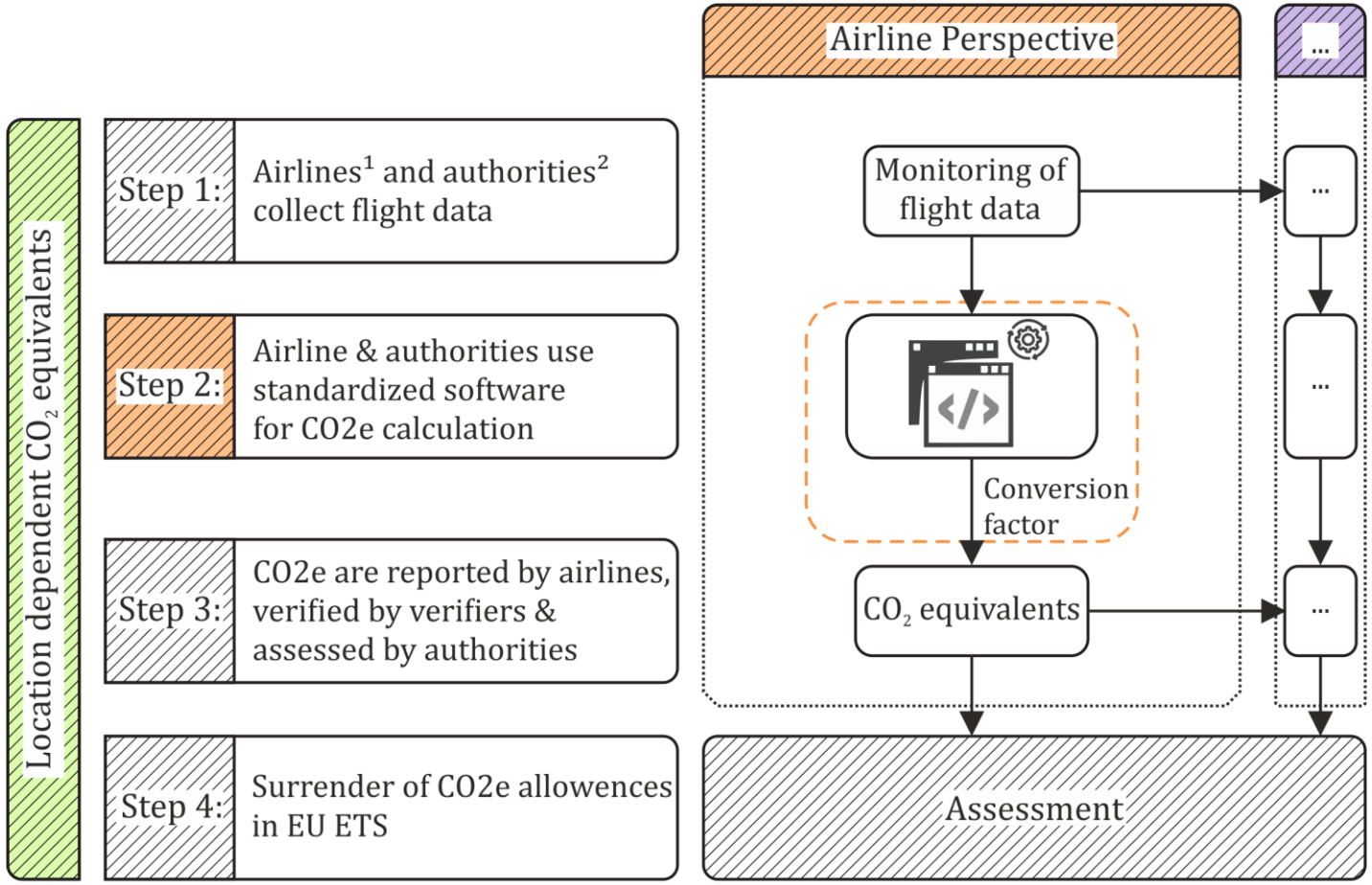
Monitoring of flight data:

- Data provided by European Air Transport Leipzig (EAT)
  - German cargo airline owned by Deutsche Post
  - Test based on flight and fuel data of 383 short and medium/long haul flights within Europe
- Data to be monitored per flight:
  - 4D position (time, lat, lon, alt)
  - Fuel flow
  - Aircraft mass
  - Ambient temperature



Task 1: Testing of all steps to be performed by an aircraft operator

Airline perspective – Location-dependent CO2e factor



[1] Airlines collect flight data for all flights
[2] Authorities collect/request flight data for reported flights that should be assessed

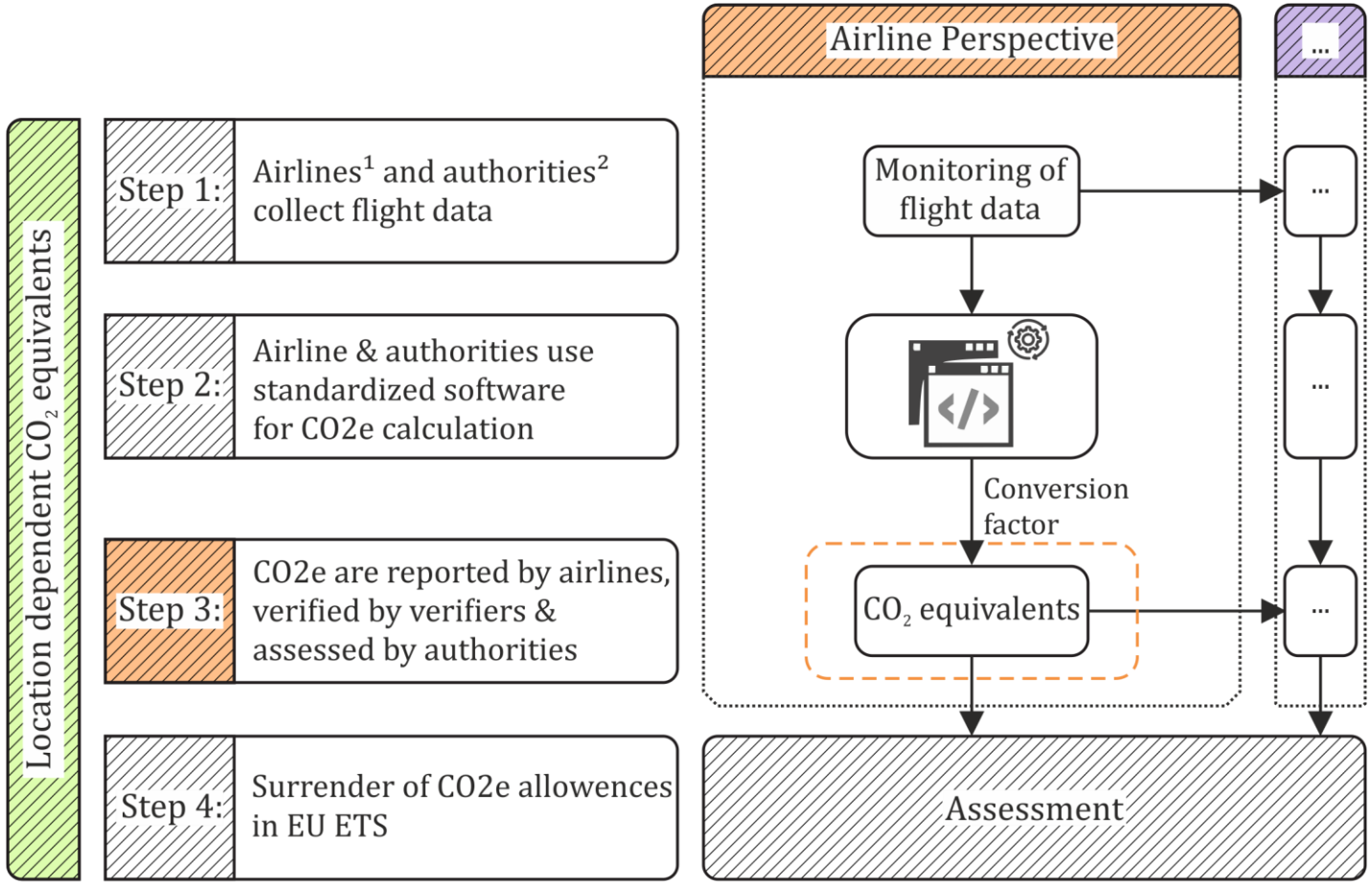
Automated CO2e calculation via software:

Data to be calculated by the aircraft operator per flight:

1. Emission indices for relevant species (CO_2, H_2O, NO_x) along the flown flight profile
   - EI NOx calculation procedure can be completely automated based on Boeing Fuel Flow Method 2
   - Data Source public available *(ICAO Engine Exhaust Emissions Databank; EDB)*
   - Required fuel flow data is directly recorded by operator
2. Calculation of CO2e per flight:
   - Climate-response calculation based on AirClim (climatological mean data)
   - Requires flight profile and emission inventory of CO_2, H_2O, NO_x
   - Procedure can be fully automated but no public version available
   - Open Source software of AirClim under development

Task 1: Testing of all steps to be performed by an aircraft operator

Airline perspective – Location-dependent CO2e factor



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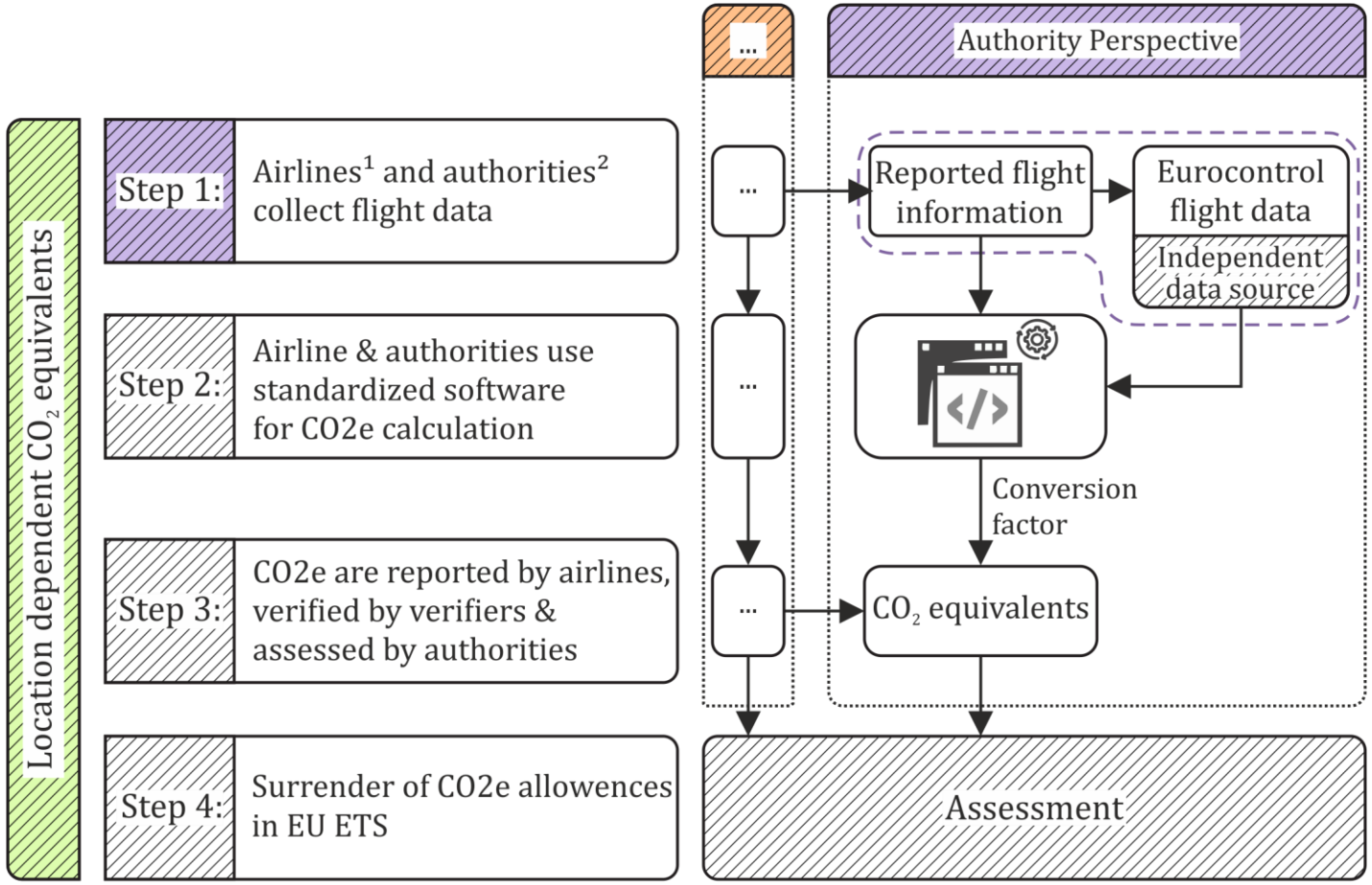
Reporting of CO2 equivalents

- What is the minimum data that must be reported to the authority per flight?
  - Origin and destination airport
  - Flight number (new)
  - Aircraft and engine type (new)
  - Fuel consumption
  - CO2 equivalents (new)
  - Take-off mass [optional]

- How can these steps be structured and automated?
- How to deal with data gaps? *(Monitoring)*
- What level of effort is required?
- Are there any legal issues?

Task 2: Testing of all steps to be performed by an authority

Authority perspective – Location-dependent CO2e factor



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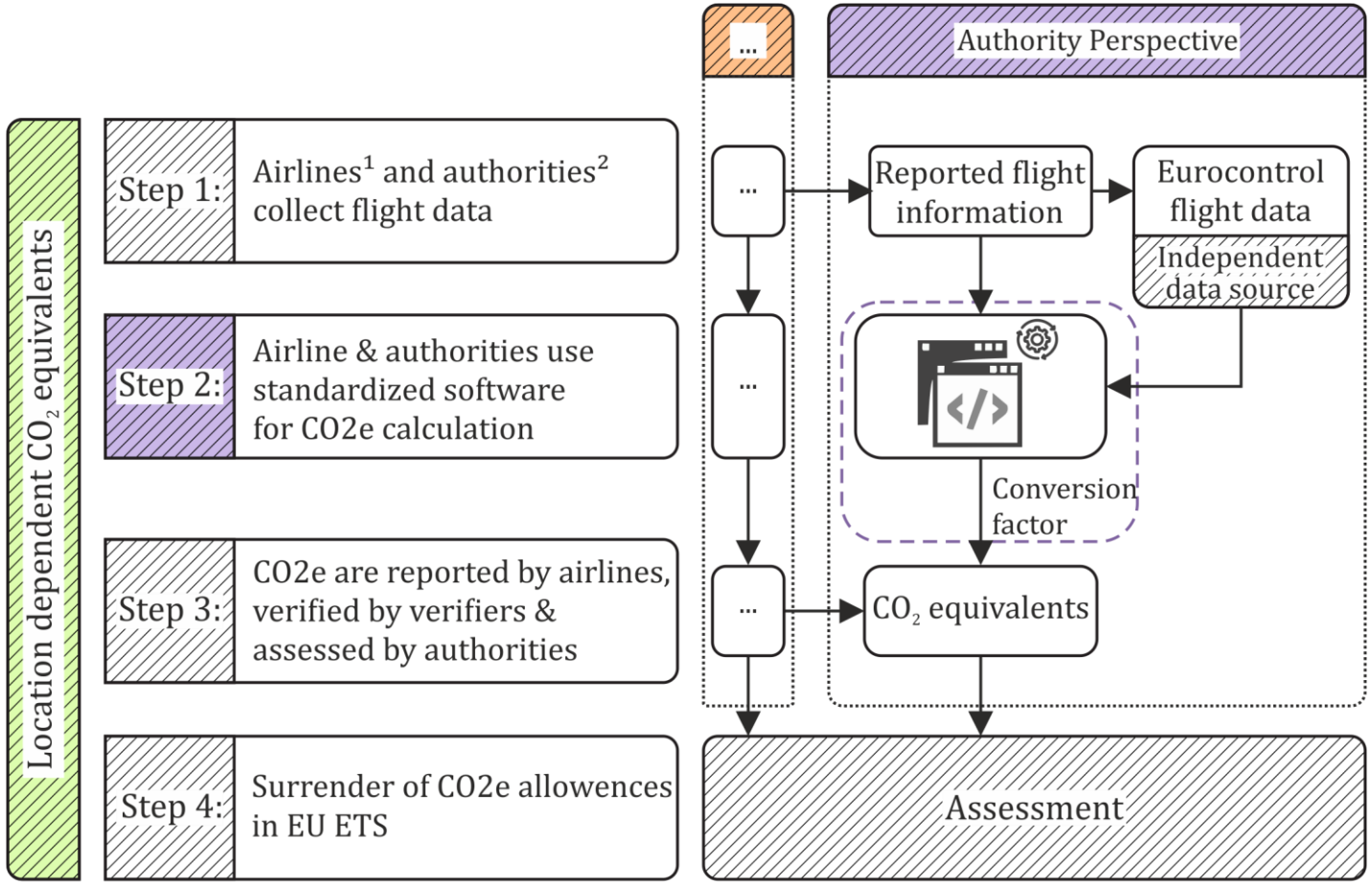
Collecting/requesting of flight data:

- Reported flight information
  - Origin and destination airport
  - Flight number (new)
  - Aircraft and engine type (new)
  - Fuel consumption
  - CO2 equivalents (new)
  - Take-off mass [optional]
- Query of relevant flight plan data
  (here: Eurocontrol DDR2 m3 data, if available)
  - 4D position (time, lat, lon, alt)

Task 2: Testing of all steps to be performed by an authority

Authority perspective – Location-dependent CO2e factor



[1] Airlines collect flight data for all flights
[2] Authorities collect/request flight data for reported flights that should be assessed

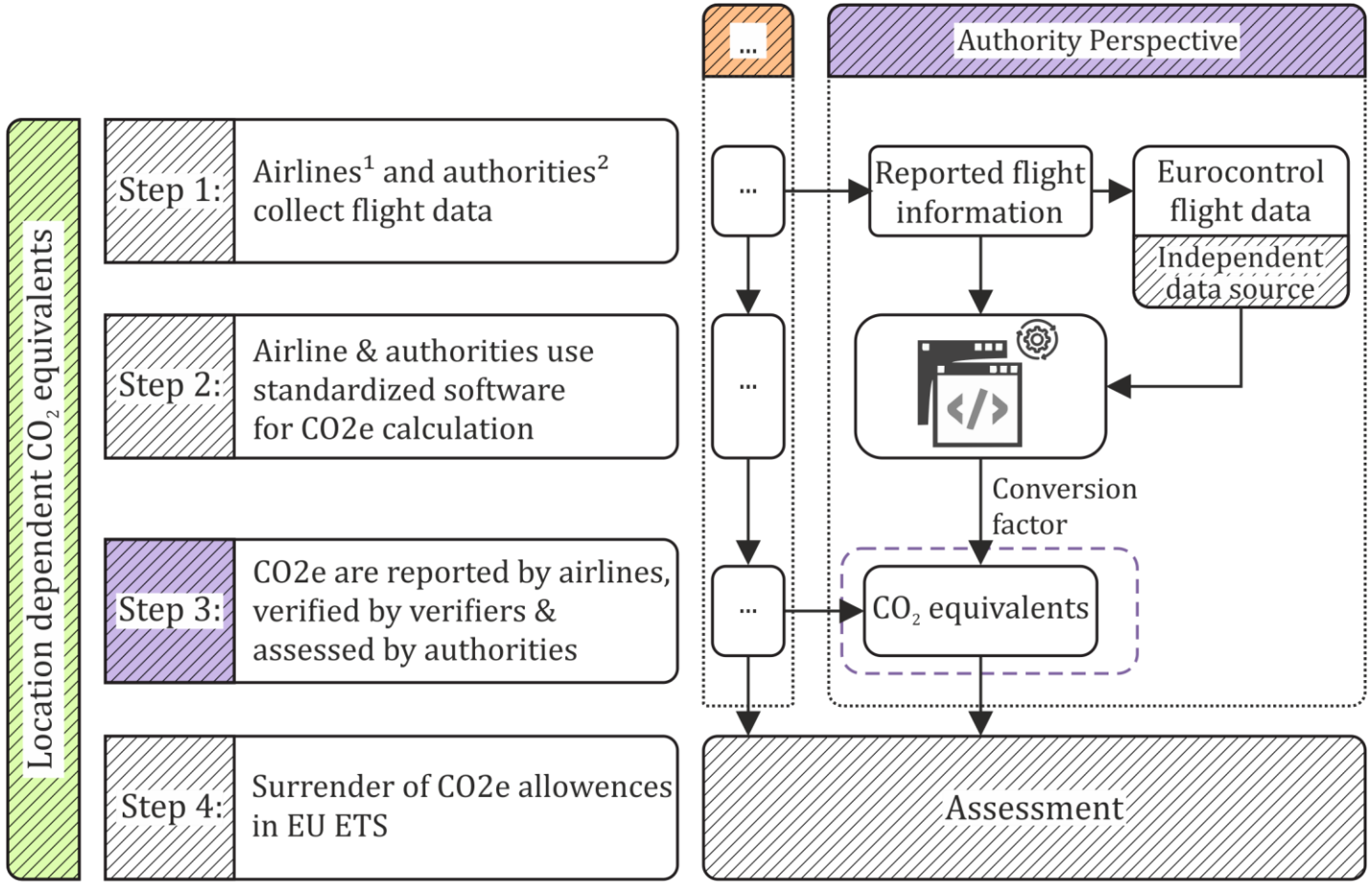
Automated CO2e calculation via software:

Data to be calculated by the authority per flight:

1. Query and processing of 4D flight trajectory data from Eurocontrol
2. (Simplified) fuel flow estimation along the trajectory
   - Calculation performed with varying simplifications (incl./excl. wind data, detailed A/C performance vs. regressions, etc.)
   - Automation depending on the procedure
3. Emission indices estimation for relevant species (CO_2, H_2O, NO_x) along the flown flight profile (Identical to Task 1)
4. Projection of aircraft emissions along the trajectory
5. Calculation of CO2e per flight (Identical to Task 1)
   Here: Climate-response calculation based on AirClim

Task 2: Testing of all steps to be performed by an authority

Authority perspective – Location-dependent CO2e factor

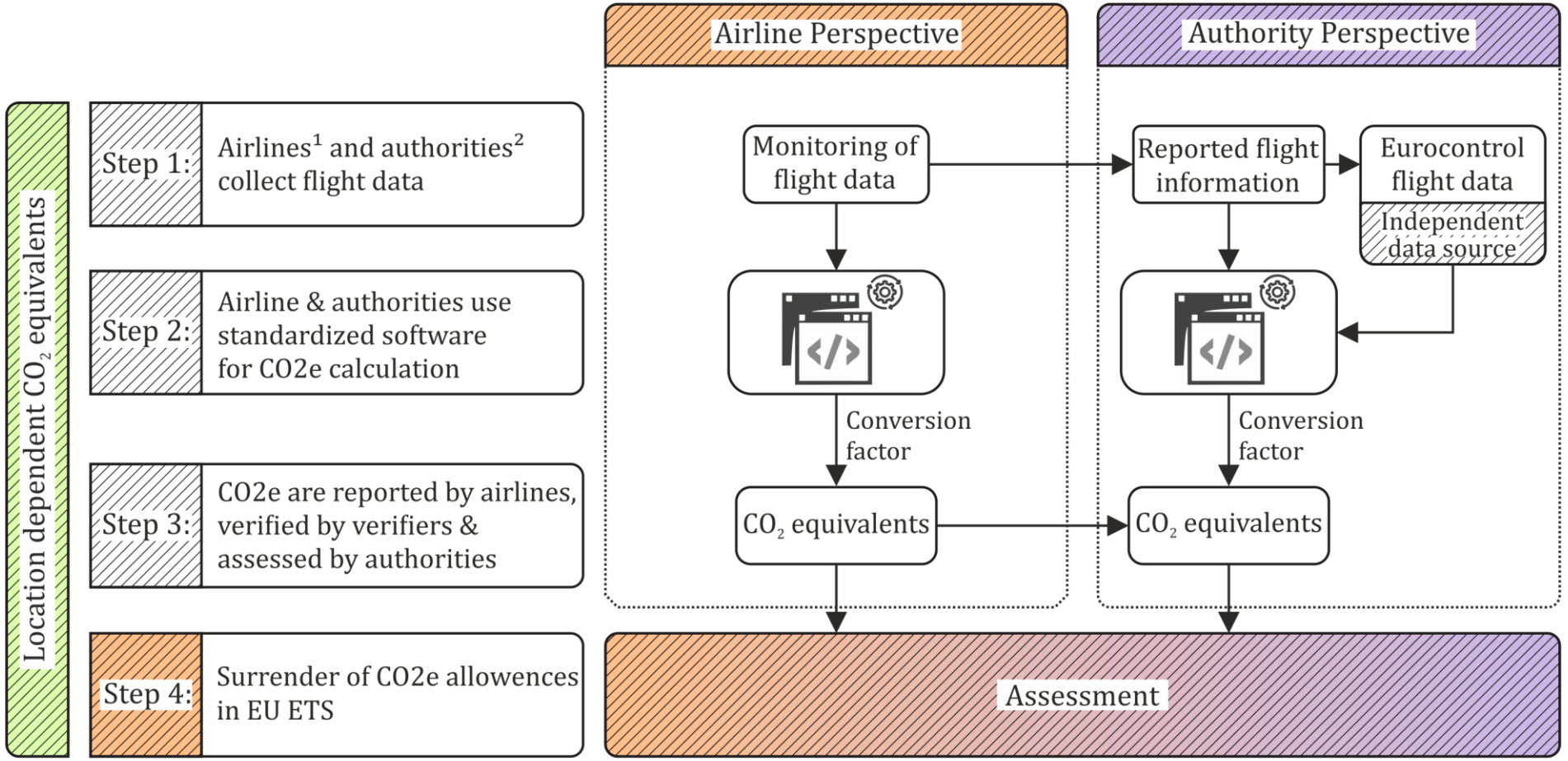


[1] Airlines collect flight data for all flights
[2] Authorities collect/request flight data for reported flights that should be assessed

Assessment of reported CO2e:

- How accurate is the verification process?
- What level of effort is required?
- How can these activities be structured and automated?
- Are there any legal issues?

Step 4: Surrender of CO2e allowances in EU ETS



[1] Airlines collect flight data for all flights
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Niklaß et al., 2022

Next step:

Analyses of …

(1) actual cost impacts on airlines and

(2) resulting impacts on competition

which are outside the scope of current project.

Feasibility of the implementation of non-CO_2 aviation effects in policy measures

Today

Operational feasibility currently been shown

CO_2 Equivalents

Atmospheric Uncertainties

Possible now

Risk assessment
Select policy measures and test pilot projects
Identify requirements and show-stopper

Today + ~1 years

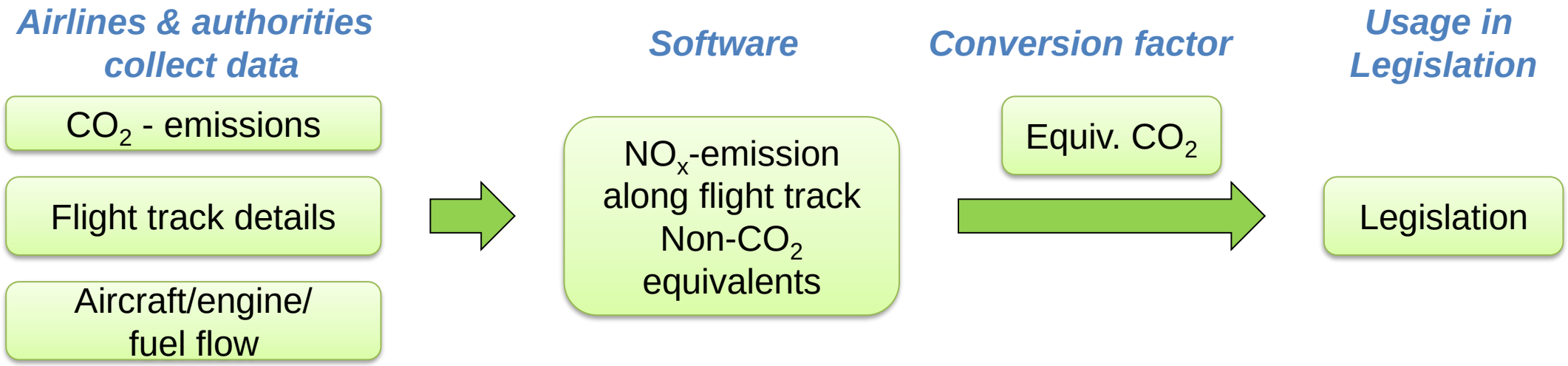
Operational feasibility

Final selection

Today + XX years

Policy measures
CO_2 Equivalents

Roadmap: Some possible steps forward



1. **Uncertainties:** Make use of uncertainties in calculation of equivalent CO_2
2. **Transition:** Stepwise implementation of CO2e accounting (20%, 40%, 60%, … at different years)
3. **Inclusion of uncertainties:** CO2e accouting for confidence intervals for each species individually (e.g. only 20%, 40%, 60%, 80% depending on uncertainties)
4. **Planning reliability:** No surprises (e.g. based on weather forecast or hindcast)

Summary

Aviation climate effects

- CO_2 and non-CO_2 effects are important contributors to aviation's climate impact and should be covered by the EU ETS (vote by the European Parliament on 8 June 2022)
- The understanding of non-CO_2 effects has been largely increased
- The nature of non-CO_2 effects, i.e. the dependency on meteorology largely limits reduction in uncertainties

Requirements for non-CO_2 calculation methods

- Should provide incentives for actually reducing non-CO_2 effects
  - not a constant factor, but depending on e.g. technology and operations
  - not simply adding costs, but providing the possibility to reduce climate impact and cost of operation

Policy measures and inclusion of non-CO_2 effects by CO_2e calculations

- Several calculation methods for non-CO_2 effects are in principle available, which differ in the degree of detail and are subject to uncertainties related to atmospheric science.
- Effort for operationalization is strongly dependent on the chosen CO_2e approach
- Risk assessment is required to better understand the impact of uncertainties on the calculation of non-CO_2 effects and thereby on the potential of setting wrong incentives
- Operational feasibility currently tested. Monitoring, reporting and verification of non-CO_2 emissions seems to be technically possible.
- Promising measures could be selected now, the economic impact analysed and pilot projects conducted