A system for airlines to monitor, report and verify non-CO_2 effects of aviation
A step-by-step guide for airlines

A new IT *Non-CO_2 aviation effects tracking system* (NEATS)

June 2024

Why is the Commission working on an MRV for non-CO_2 aviation effects?

It has long been known that aviation has a significant impact on the climate through its non-CO2 effects[1]. In accordance with the precautionary principle, the co-legislators have tasked the Commission with establishing a monitoring, reporting, and verifying (MRV) system for non-CO_2 aviation effects per flight.

What are the guiding principles of the non-CO_2 MRV?

The MRV system is based on the following principles:

a. **Flexibility**:
   i. Using available data provided by third-party sources and/or estimated through modules where relevant, rather than requiring data measured in-flight data.
   ii. IT tool allowing to automatise the entire MRV process, where other than the fuel properties (e.g., aromatic content), only aircraft properties (aircraft type, engine identifier and aircraft mass) are to be sourced by the Aircraft Operator (AO).
   iii. In case where no data is provided, default values to be used, maintaining the possibility of fully automatic MRV.
   iv. The IT tool is proposed as a menu, allowing the AO to use only what they need, where for instance one can use the emission-estimation module of the tool and the CO_{2e} calculation models, while another operator may choose to rely only on the modules estimating emissions but not on the CO_{2e} calculation model, etc.
   v. Multiple time horizons (20, 50, and 100 years) of the Global Warming Potential (GWP) metric, to express CO_{2e}, to avoid addressing impacts only from one temporal perspective and thus eliminate technology lock-in effects for the sector.
   vi. Small-emitters calculation with a simplified *climatological location-based model* approach.

b. **Data precision**:
   i. State-of-the-art open source models CoCIP[2] and aCCF[3] to compute CO_{2e} for non-CO_2 effects under the weather-based approach that is the default approach for the MRV, and open source version of AirClim[4] for the location-simplified approach for small emitters. Those models are widely tested for the purpose of measuring aviation non-CO_2. In addition, to

[1] Aviation and the Global Atmosphere — IPCC

[2] GMD - A contrail cirrus prediction model (copernicus.org)

[3] gmd-2022-220.pdf (copernicus.org)

[4] ACP - AirClim: an efficient tool for climate evaluation of aircraft technology (copernicus.org)

calculate fuel burn and emissions, respectfully Base of aircraft data (BADA)[5] and Boeing Fuel Flow method 2 (BFFM2)[6] modules, will be used.

What type of data is needed?

The following types of data are required to be fed into the new IT tool the EC is developing – *Non-CO_2 aviation effects tracking system* (NEATS). Most of this data can be automatically provided by the NEATS. See hereunder. NEATS will integrate the modules and models mentioned here above as well.

Data that can be automatically provided by NEATS:

a. **Flight information**
   i. Flight number,
   ii. Day and time of the flight,
   iii. Arrival and departure airport.

   The AO can choose to check and correct this data within NEATS for the given flights.

b. **Flight trajectory** – either the latest flight plan is filled out and sent before a flight takes place or a flown flight trajectory is provided, based on the approach used (weather-dependent and location-simplified approach respectively).
   i. Timestamp,
   ii. Latitude,
   iii. Longitude,
   iv. Altitude.

   This data will be provided by EUROCONTROL through NEATS. Operators will not need to collect the data themselves (unless they choose to).

c. **Weather data**
   i. Pressure,
   ii. Air temperature,
   iii. Humidity, etc (additional "enhanced" data is required for the weather dependent-approach: specific humidity/relative humidity over ice eastward and northward wind, vertical velocity, outgoing longwave radiation, etc).

   While for the basic weather data, pressure, air temperature and humidity, are required and calculated through an altitude-dependent correction within the NEATS' modules, for the weather-dependent approach more enhanced weather data is required. The latter will be automatically collected from the national weather services, and it will be processed through Numerical Weather Prediction[7] (NWP) modeling to obtain the final result. Operators will not need to collect the data themselves (unless they choose to and have the capabilities), instead, it will be provided as available data through NEATS.

[5] Base of aircraft data (BADA) | EUROCONTROL

[6] "Fuel Flow Method2" for Estimating Aircraft Emissions (researchgate.net)

[7] 'Numerical Weather Prediction (NWP) model' refers to a computational system utilised in meteorology, comprising algorithms and mathematical formulations implemented in software, designed to simulate, and forecast atmospheric conditions over a defined spatial and temporal domain (spatial grid).

Data required directly from the AO:

d. Aircraft properties

i. Aircraft type,
ii. Engine UID,
iii. Aircraft mass (if not provided, take-off mass/ load factor).

Where no engine identifier or equivalent, is provided, **default values** per aircraft type, are used through NEATS. If the aircraft mass is not provided, the AO can simulate the aircraft mass by using the take-off mass. Subsequently, if neither the aircraft mass, nor the take-off mass are available, the load factor can be used to approximate the take-off mass. If no load factor is provided, a default value of 1 is used.

e. Fuel properties per flight – needed only in the weather-based approach (optional for the location-simplified one)

i. Aromatics content,
ii. Hydrogen to carbon ratio,
iii. Net calorific value.

If no flight fuel properties are provided, **default values** are used: the upper limits of Jet A-1 fuel according to the ASTM Standard Specification for Aviation Turbine Fuels, are assumed: (a) Aromatic content: 25% volume; (b) Sulphur: 0.3% mass; (c) Naphthalene: 3.0% volume.

f. (optional) Aircraft performance along the flight

i. Fuel flow,
ii. Engine efficiency

If the fuel flow is not provided from the flight data recorder equipment, the aircraft operator can use other means to derive the fuel flow, taking into account the thrust which depends on the aircraft's mass and true airspeed. Ultimately, this info is calculated through the engine identifier by NEATS (fuel burn module).

What if Aircraft Operator (AO) does not provide the required data?

In case the AO does not provide the data required from them, the MRV framework will be completed with default values as established by the MRR Regulation (draft Annex IIIa, Section 5 and Annex IIIb). The use of default values should avoid underestimating of CO_{2e} per flight compared to what can be obtained with monitored data.

What happens with the collected data?

The collected data is channeled via NEATS to the BADA and BFFM2 modules that feed into the open-source models (CoCIP; aCCF; AirClim). Based on the Global Warming Potential (GWP), these models provide the CO_{2e} for the range of time horizons of 20, 50, and 100 years.

Regarding fuel flow, BADA predicts the fuel consumption of a flight across all its phases, including climb, cruise, and descent, assuming standard aircraft operations.

For emission estimations, NEATS features the BFFM2 module, which calculates aircraft engine emissions of NOx, HC, and CO by correlating fuel flow rates with emissions generated during various flight phases. BFFM2 applies exhaust emission indices from the ICAO engine type certification, which are based on predefined reference conditions on the ground. BFFM2 estimates the corresponding emission indices during flight, assuming international standard atmospheric conditions, using correction factors to account for differences in temperature, pressure, and humidity.

What is the purpose of NEATS ?

NEATS will be available to Aircraft Operators (AO), accredited verifiers, and to competent authorities for the purpose of facilitating and, to the extent possible, automating the monitoring, reporting, and verification of non-CO_2 aviation effects.

Monitoring

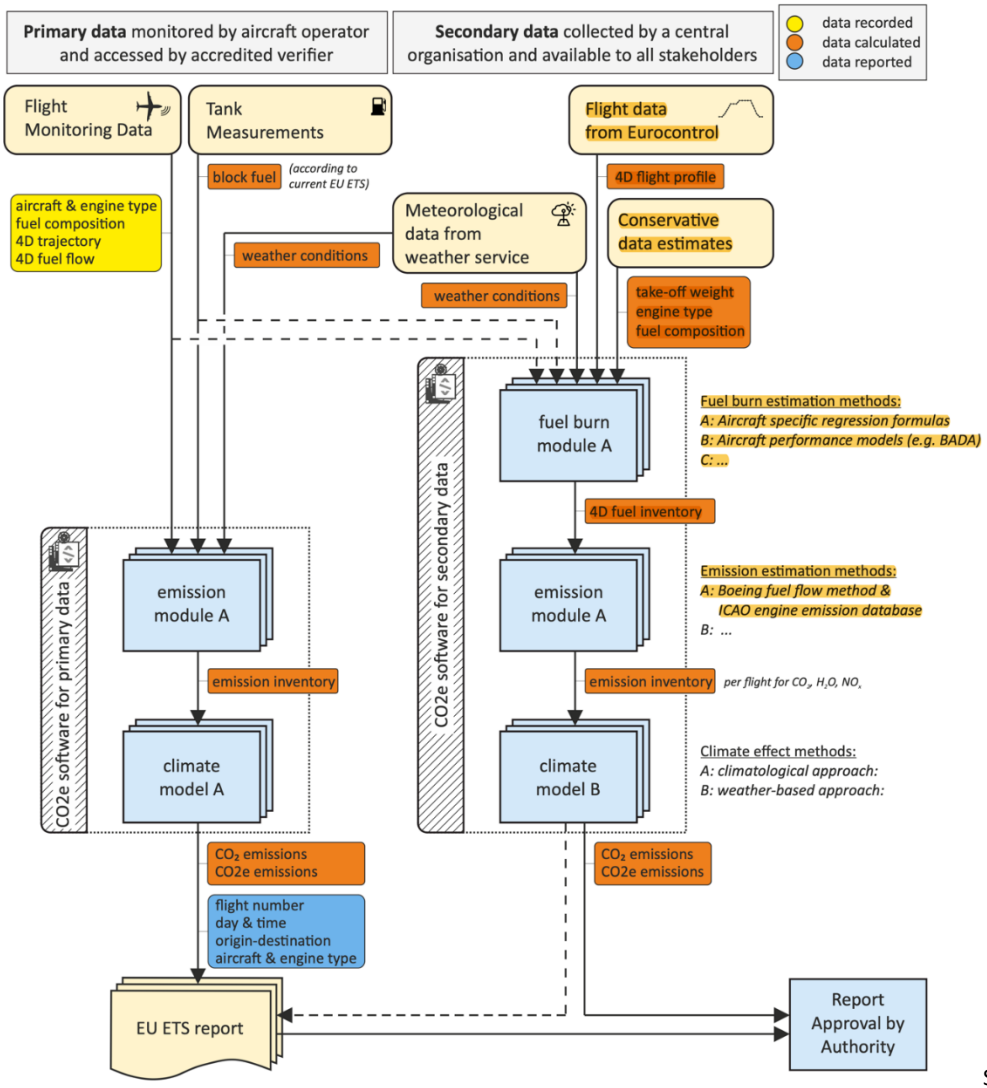
- NEATS streamlines the process as it incorporates directly or gives access to, available third-party collected flight trajectories and weather data allowing to minimize the AO's need to monitor fuel and aircraft properties.
- In addition to the data, NEATS incorporates the aforementioned modules and models, additionally providing a common reference Numerical Weather Prediction (NWP) model, where enhanced weather data is needed (for the weather-based approach). The use of the modules and models results in the calculation of CO_{2e} per flight as part of the monitored data.

Reporting

- At the end of each reporting year, NEATS will automatically generate an XML table containing data for each flight, including flight information, aircraft type, engine identifier, and CO_{2e} values expressed in GWP 20, 50, and 100. This process aims to minimize the administrative burden associated with the reporting phase and provides what is reported.

Verification

- The tool will provide verifiers and the competent authority with the ability to access and cross-check CO_{2e} data for each flight, while ensuring the protection of confidential information.



Source: To70, DLR, AerLabs

Indicative flowchart of the non-CO_2 MRV operational framework.

Steps to be undertaken by the Aircraft Operator to do the MRV:

1. Before starting the MRV - Internal to the Aircraft Operator (AO): Decide on the **approach** to undertake for the year to come (what modules, models to use; will measured data be provided, etc) and organise accordingly.

2. Before starting the MRV - Participate in trainings on filling the **monitoring plan** (MP) provided by the Commission. Fill in MP (common with CO_2) following a draft monitoring report template (to be made available by the Commission) and send the MP to competent authority for validation. If own/third-party tools are to be used for monitoring non-CO_2 they must first be approved by the Commission services, after which descriptions for the tools' technical specifications, workflow and monitoring flowchart must be added to the MP, before they can be used by the Aircraft Operator (AO). Finally, AO's should participate in trainings on undertaking the MRV provided by the NEATS system administrator.

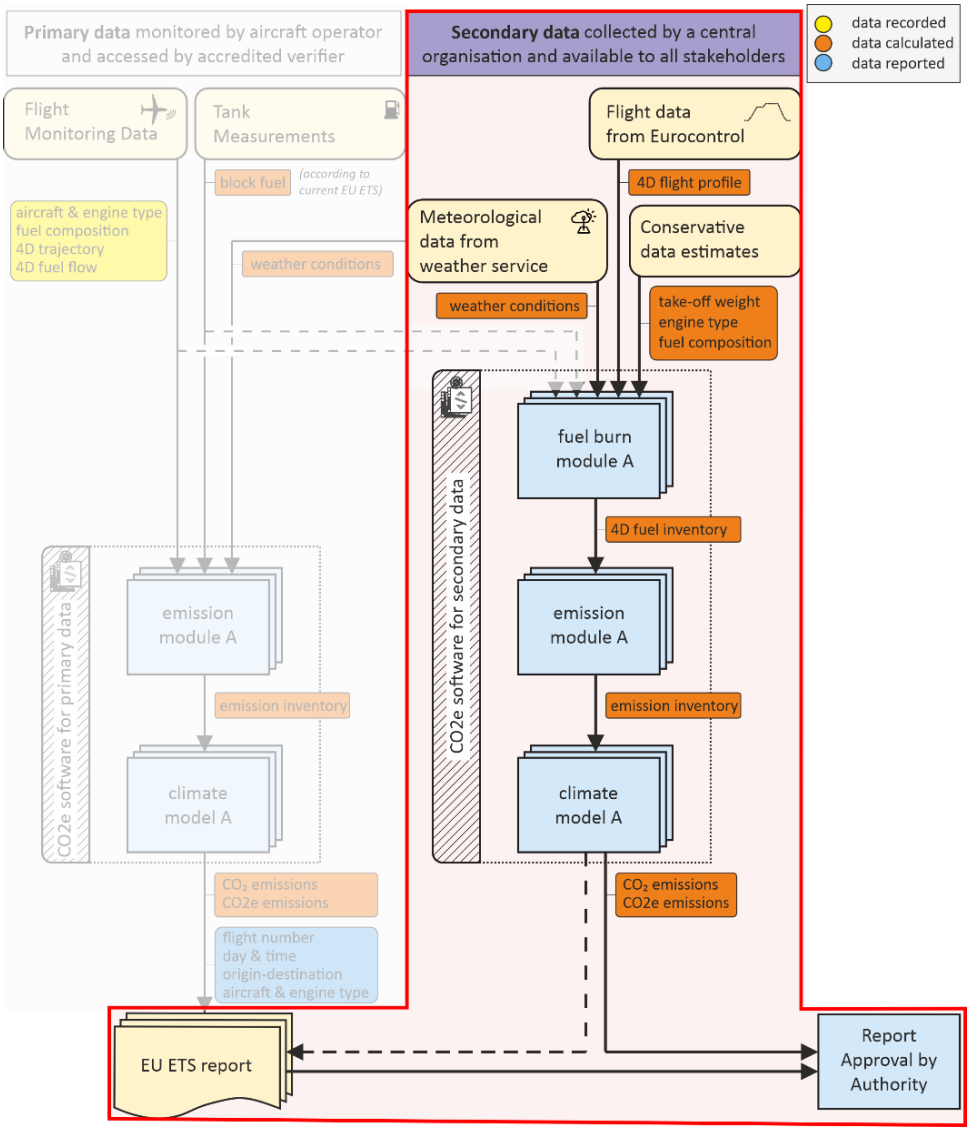
3. Start undertaking the **monitoring** according to the chosen approach and follow the MRV Guidance document to be made available by the Commission). If NEATS is unavailable, at minimum, collect the flight information (Flight number; Day and time of the flight; Arrival and departure airport) and aircraft properties (Aircraft type; Engine UID; Aircraft mass) per flight. Once NEATS is available, these will be provided for a CO_{2e} calculation. If NEATS is available, at minimum, the aircraft and fuel properties (Aromatics content; Hydrogen to carbon ratio, Net calorific value) are to be monitored per flight. All other data (flight trajectories, meteorological data, etc.) is provided by NEATS.

4. **Reporting** is facilitated by NEATS (data compiled by NEATS based on what is monitored).

5. Accredited Verifiers list will be published l at the end of 2025.

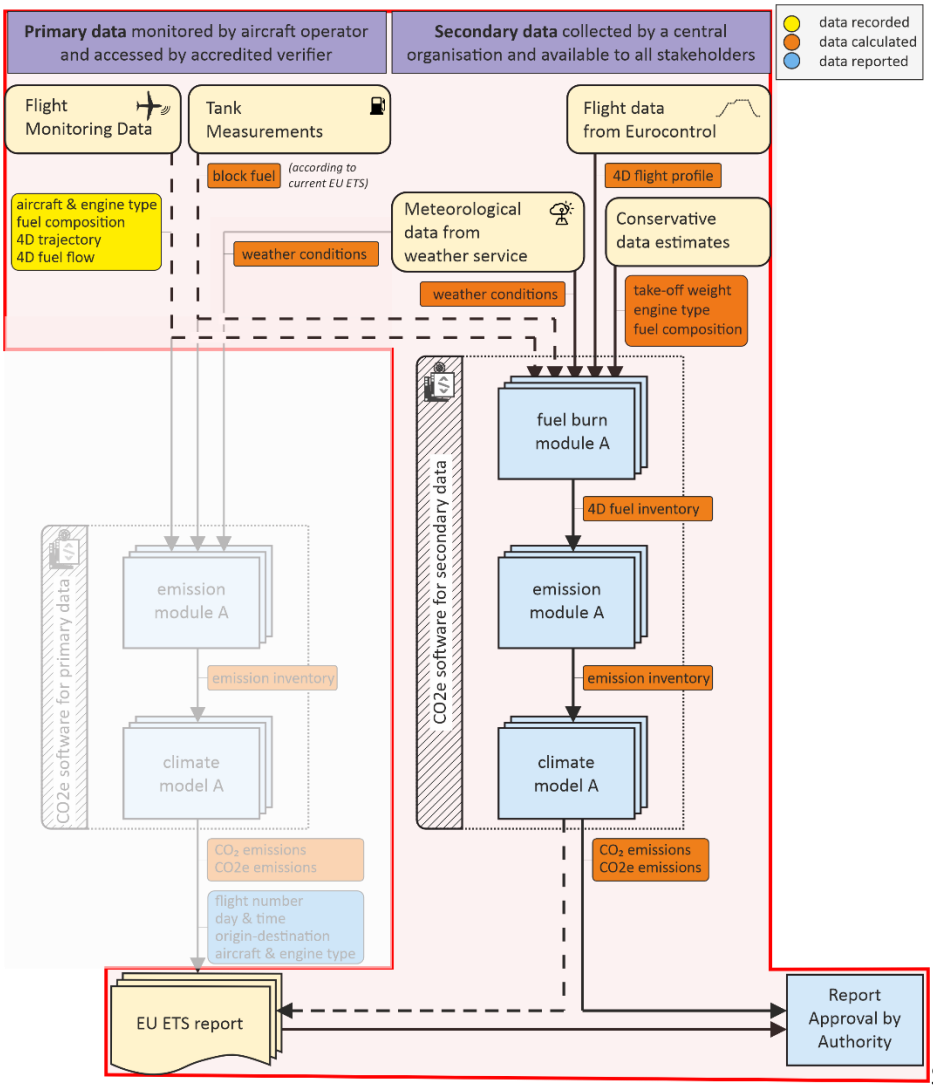
Examples of different configurations for application of the MRV by the AO:

1. With no manual data entry (default values for aircraft properties and fuel properties) and flight information only confirmed by AO in NEATS for the AO's given flights.



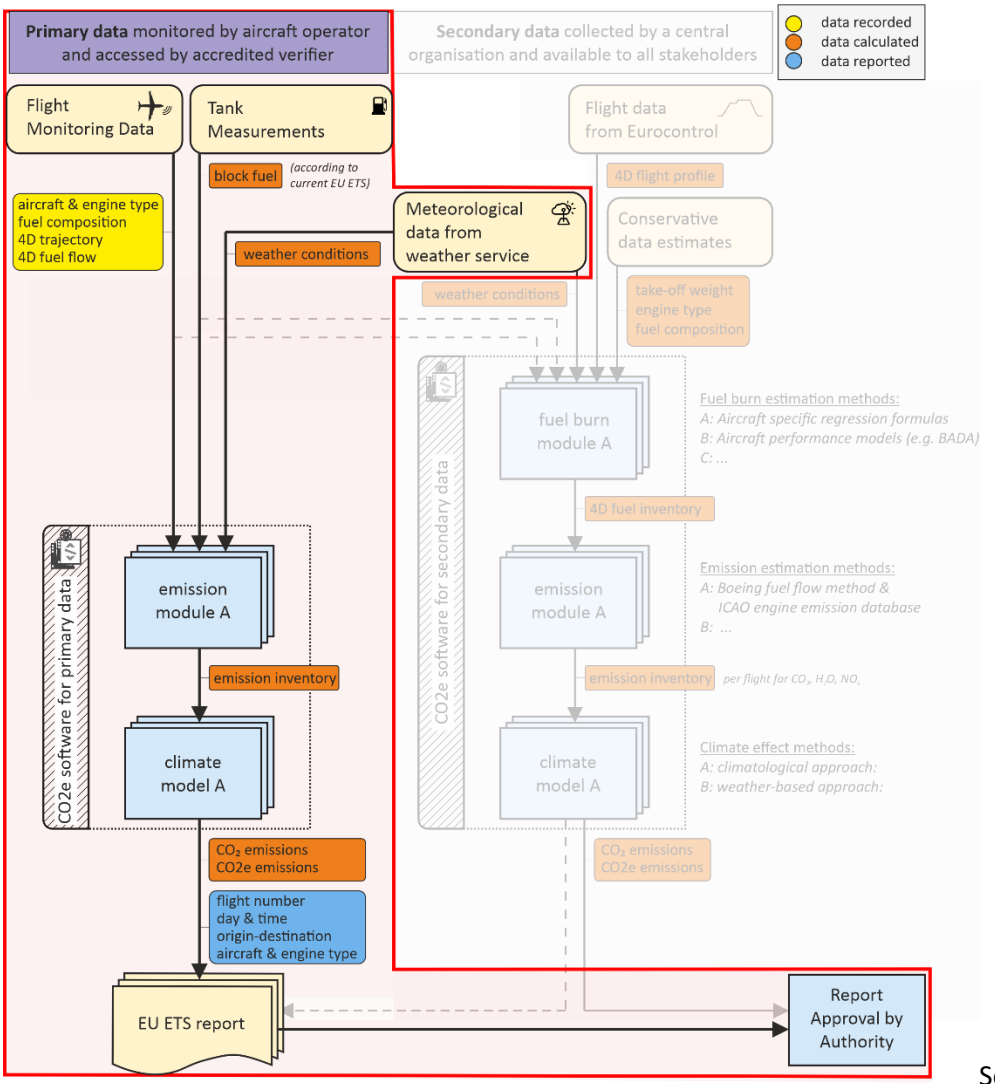
Source: DLR

2. If the minimum data identified for collection by the AO (aircraft and fuel properties) is available, different combinations exist, depending on what primary (measured) data could be added by the AO.



Source : DLR

3. With maximum measured data and own tools (modules, models) to calculate CO_2e.


Primary data monitored by aircraft operator and accessed by accredited verifier
Secondary data collected by a central organisation and available to all stakeholders
data recorded
data calculated
data reported
Flight Monitoring Data
Tank Measurements
Flight data from Eurocontrol
block fuel
(according to current EU ETS)
4D flight profile
aircraft & engine type
fuel composition
4D trajectory
4D fuel flow
Meteorological data from weather service
Conservative data estimates
weather conditions
weather conditions
take-off weight
engine type
fuel composition
fuel burn module A
Fuel burn estimation methods:
A: Aircraft specific regression formulas
B: Aircraft performance models (e.g. BADA)
C: ...
4D fuel inventory
CO2e software for secondary data
CO2e software for primary data
emission module A
emission module A
Emission estimation methods:
A: Boeing fuel flow method &
ICAO engine emission database
B: ...
emission inventory
emission inventory
per flight for CO2, H2O, NOx
climate model A
climate model A
Climate effect methods:
A: climatological approach:
B: weather-based approach:
CO2 emissions
CO2e emissions
CO2 emissions
CO2e emissions
flight number
day & time
origin-destination
aircraft & engine type
EU ETS report
Report Approval by Authority

Source : DLR