

POLITÉCNICA

D4 - Review and validation of EUROCONTROL calculation of the adjustments of the 2004, 2005 and 2006 historical annual CO2 aviation emissions in the EU-27

The Innaxis Foundation & Research Institute

Polytechnic University of Madrid (UPM) - School of Aeronautical Engineering

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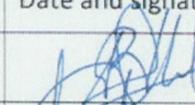
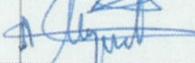
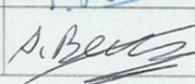
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1 INTRODUCTION

1.1 Purpose and scope

On 19 November 2008 the European Parliament and the Council of the European Union adopted Directive 2008/101/EC (hereafter referred to as "the Directive") amending Directive 2003/87/EC so as to include aviation activities in the European Union Emissions Trading Scheme (EU ETS).

On 30 December 2008, the European Community and the European Organisation for the Safety of Air Navigation (EUROCONTROL) concluded a cooperation agreement for the provision of support by EUROCONTROL to the European Commission for the inclusion of aviation in the EU ETS. One of the tasks for which EUROCONTROL is providing support is the estimation of "historical aviation CO₂ emissions". Historical aviation CO₂ emissions is to be understood as the average of the annual CO₂ emissions in the calendar years 2004, 2005 and 2006 from aircraft performing an aviation activity included in the EU ETS, and will serve as a basis to set the CO₂ emissions cap for aviation. Considering the financial implications of the total quantity of allowances to be allocated to the aviation sector, it is essential to ensure that the estimation of the historical aviation CO₂ emissions is of the highest possible quality.

EUROCONTROL has established a process for the estimation of the annual historical aviation CO₂ emissions in the EU-27 that consists of the following steps:

- a. establishment of a process for the estimation of the annual historical aviation CO₂ emissions in the EU-27 relying on the air traffic management information available in EUROCONTROL;
- b. calculation of the 2004, 2005, and 2006 annual historical aviation CO₂ emissions estimates based on the above process;
- c. collection of actual fuel burn information from volunteer aircraft operators (AOs);
- d. analysis of the fuel burn information and establishment of a methodology for reconciling the historical annual CO₂ aviation emissions estimates (phase b) relying on this actual fuel burn information;
- e. adjustment of the 2004, 2005, and 2006 annual historical aviation CO₂ emissions estimates based on the above reconciliation methodology for EU-27;
- f. establishment of a methodology for the reassessment, upon the extension of the EU ETS to other states, of the annual historical aviation CO₂ emissions.

The process established by EUROCONTROL within phase (a) has been reviewed in the technical report ref. INX-ETS-TR-09-01 "Report on the review of the process for the estimation of the historical annual CO₂ aviation emissions in line with the Directive prescriptions" and amended by EUROCONTROL according to the recommendations provided therein; and the correctness of the calculation of the 2004, 2005, and 2006 annual historical aviation CO₂ emissions estimates carried out in accordance with the resulting process (phase (b)) has been verified within report ref. INX-ETS-TR-09-02 "Report on the validation of the calculation of the 2004, 2005, and 2006 historical annual CO₂ aviation emissions estimates based on the process reviewed in D1".

However, the methodology used for these calculations, which is based on EUROCONTROL implementation of the ANCAT-3 methodology and on the air traffic data available at EUROCONTROL, is not able to account for certain factors that have an influence on the fuel consumed, hence on the CO₂ emissions. By using actual fuel burn data, it is possible to estimate the influence of these factors in order to adjust the theoretical calculations and therefore improve the accuracy of the assessment, thereby reducing the risk of underestimating or overestimating the total emissions for the 2004-2006 period.

With the aim to obtain the best possible estimate of historical CO₂ emissions, EUROCONTROL has requested actual fuel burn data from different aircraft operators (phase (c)). A methodology for adjusting the annual historical aviation CO₂ emissions estimates on the basis of the analysis of the actual fuel burn information (phase (d)) has been proposed in the technical report INX-ETS-TR-09-03 "Methodology for reconciling the historical annual CO₂ aviation emissions estimates based on the actual fuel burn information as provided to EUROCONTROL by volunteer aircraft operators".

The purpose of the present document is to verify that this reconciling methodology is correctly implemented by EUROCONTROL and thus validate the final figures for 2004, 2005, and 2006 annual historical aviation CO₂ emissions estimated by EUROCONTROL.

A systematic requirements verification has been carried out, in order to check that every sub-process/step contemplated in the reconciling methodology:

- is implemented through a specific function;
- is implemented in a manner that is consistent and does not conflict with the implementation of the rest of requirements;
- is implemented in such a way that the tool accesses the right data;
- is correctly implemented from the computation/mathematical requirements point of view.

Additionally, a verification test case has been run in parallel by EUROCONTROL and the Innaxis-UPM project team, in order to cross-check the obtained results and confirm the correctness of the calculations.

1.2 Structure of the document

The document is organised as follows:

- In section 2, requirements verification is carried out, in order to check every sub-process/step contemplated in the reconciling methodology is correctly implemented, and the results of the verification test case are presented.
- Section 3 summarises the conclusions of the verification process and provides a set of recommendations.

1.3 References

- [1] Directive 2008/101/EC of the European Parliament and of the Council of 19 November 2008 amending Directive 2003/87/EC so as to include aviation activities in the scheme for greenhouse gas emission allowance trading within the Community.
- [2] EUROCONTROL Price Enquiry No. 09-110224-E. Technical specification.
- [3] Review of the EUROCONTROL process for the estimation of the historical annual CO₂ aviation emissions in line with the Directive prescriptions. Innaxis-UPM. Ref. INX-ETS-TR-09-01.
- [4] Report on the verification of the calculation of the 2004, 2005 and 2006 historical annual CO₂ aviation emissions estimates based on the process reviewed in D1. Innaxis-UPM. Ref. INX-ETS-TR-09-02.
- [5] Methodology for reconciling the historical annual CO₂ aviation emissions estimates based on the actual fuel burn information as provided to EUROCONTROL by volunteer aircraft operators". Innaxis-UPM. Ref. INX-ETS-TR-09-03

- [6] ECAC. Recommendation ECAC/27-3 Methodology for emissions calculation.
- [7] EUROCONTROL. Calculation of Emissions by Selective Equivalencing (C.A.S.E.). Edition 1.0, 25 November 2003.

2. REVIEW OF EUROCONTROL IMPLEMENTATION OF THE RECONCILING METHODOLOGY

The following diagram illustrates the reconciling methodology, indicating with numbers (1 to 21) each one of the steps of the process.

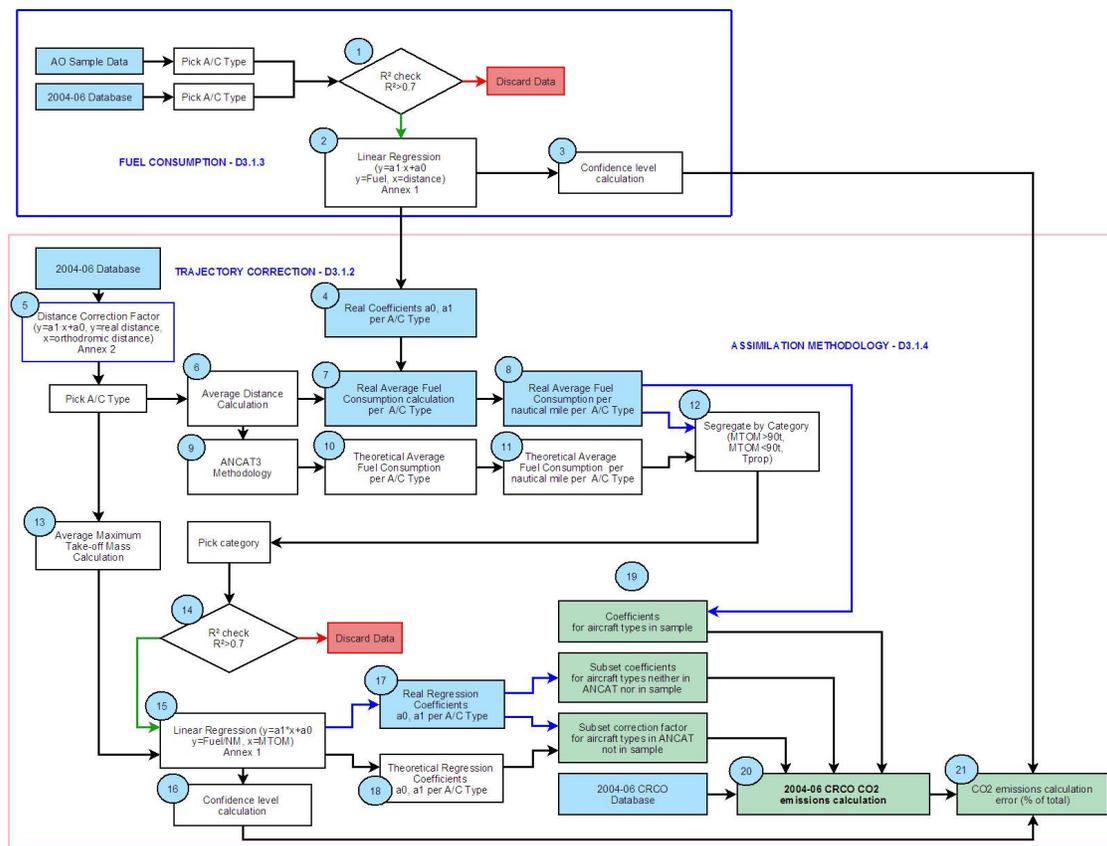


Figure 1. Reconciling methodology: flow chart

As with the methodology developed by EUROCONTROL, SQL is considered as a suitable computer language for the goal of this activity and brings enough clarity and quality to the process to be recommended as the computer language to be used.

The verification activity consisted in ensuring the reconciling methodology is followed properly, advising EUROCONTROL whenever any deviations were observed.

In particular, the verification activity consisted of the following steps:

- Checking that the implementation is correct in respect to the procedure.
- Checking that the SQL code implementation is correct.

The following table tracks each requirement of the Directive, identifies the steps in which such requirement has been implemented and indicates the outcome of the verification, both in terms of how the procedure is implemented and the result of the verification of the actual computer code:

Procedure Step	Description	Verified Procedure (see Figure)	Verified SQL code	Comments
1	Regression check			The minimum Regression coefficient was changed from 0.70 to 0.55
2	Linear regression			
3	Confidence level calculation			
4	Real Coefficients			
5	Distance Correction factor			
6	Average Distance Calculation			
7	Real data average fuel consumption			
8	Real data average fuel consumption per nautical mile, per aircraft type			
9	Application of ANCAT 3 Methodology			
10	Theoretical data average fuel consumption			
11	Theoretical data average fuel consumption per nautical mile, per aircraft type			
12	Category segregation of data			
13	Average Maximum take off mass calculation			
14	Regression Check			
15	Linear regression			
16	Confidence Level calculation			
17	Real regression coefficients			
18	Theoretical regression coefficients			
19	Coefficients			
20	CRCO CO ₂ emissions calculation			
21	CO ₂ emissions calculation error			

The methodology has been additionally checked by means of two test cases. First, EUROCONTROL have computed all steps of procedure for A340-300 and B737-200. In parallel, the project team has run the same calculations for the same aircraft types and results have been cross-checked. Both test cases were successfully passed.

3. VERIFICATION SUMMARY AND RECOMMENDATIONS

The Project Team has verified that:

- the methodology is implemented in a correct manner, and
- the computing facilities (hardware and software) are correctly used to achieve the goals of the methodology.

The Project Team has not found any nonconformity in the implementation of the methodology and therefore, the procedure is considered verified.

Two areas of potential improvement have been identified:

- EUROCONTROL has provided very detailed information about the computation process to be verified through technical meetings, presentations, access to their computing facilities as needed and direct access to the computer code. However, the Project team recommends EUROCONTROL to write and publish a technical document on the process followed to ensure all elements are correctly collected in a single document to be used for future reference in case any code modifications are needed.
- In case further modifications of the code were needed in the future (e.g. due to enlargement of ETS), a software configuration control process should be put in place to keep track of potential changes in a consistent manner.