Gesellschaft für Luftverkehrsforschung

the safety maker in aviation

Fuel Efficiency in Air Transport:

The Enhanced Trajectory Analysis System (ETAS)

ETAS is a post-flight trajectory assessment tool. Historically, it has been developed in order to enable various kinds of performance benchmarking activities:

- per-flight fuel efficiency and emissions
- aircraft performance/deviation estimation
- continuous climb/descent operations
- cruise altitude and cost index selection
- trajectory-based noise mapping

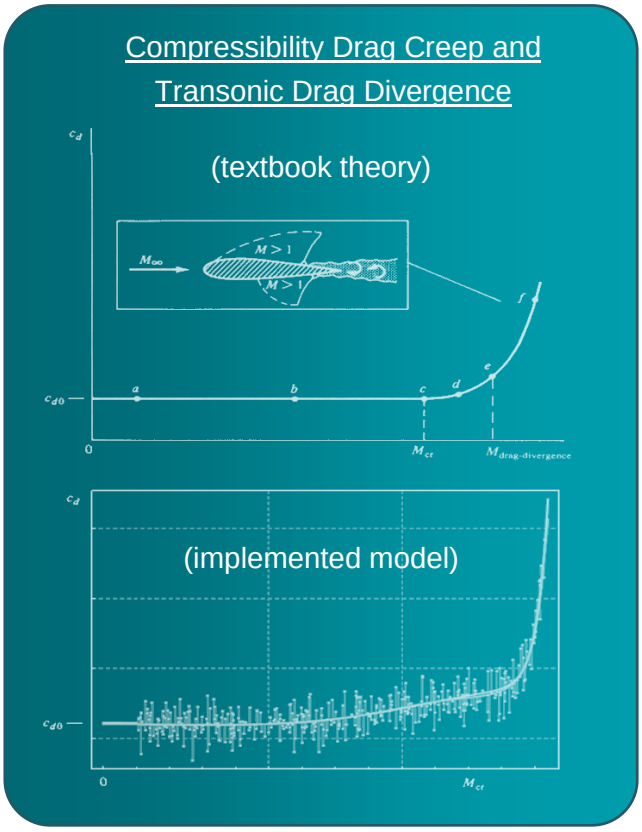
Though ETAS was first targeted to support ANSP, airports, and government organizations, ETAS can now, in its 3rd release, be re-configured to also precisely meet airlines' flight planning and inflight decision support needs:

- optimizing vertical profiles and routes
- dealing with meteorological uncertainties
- enhancing existing tools & solutions (flight planning, ops control, EFB)

Calibrated Aircraft Performance Model

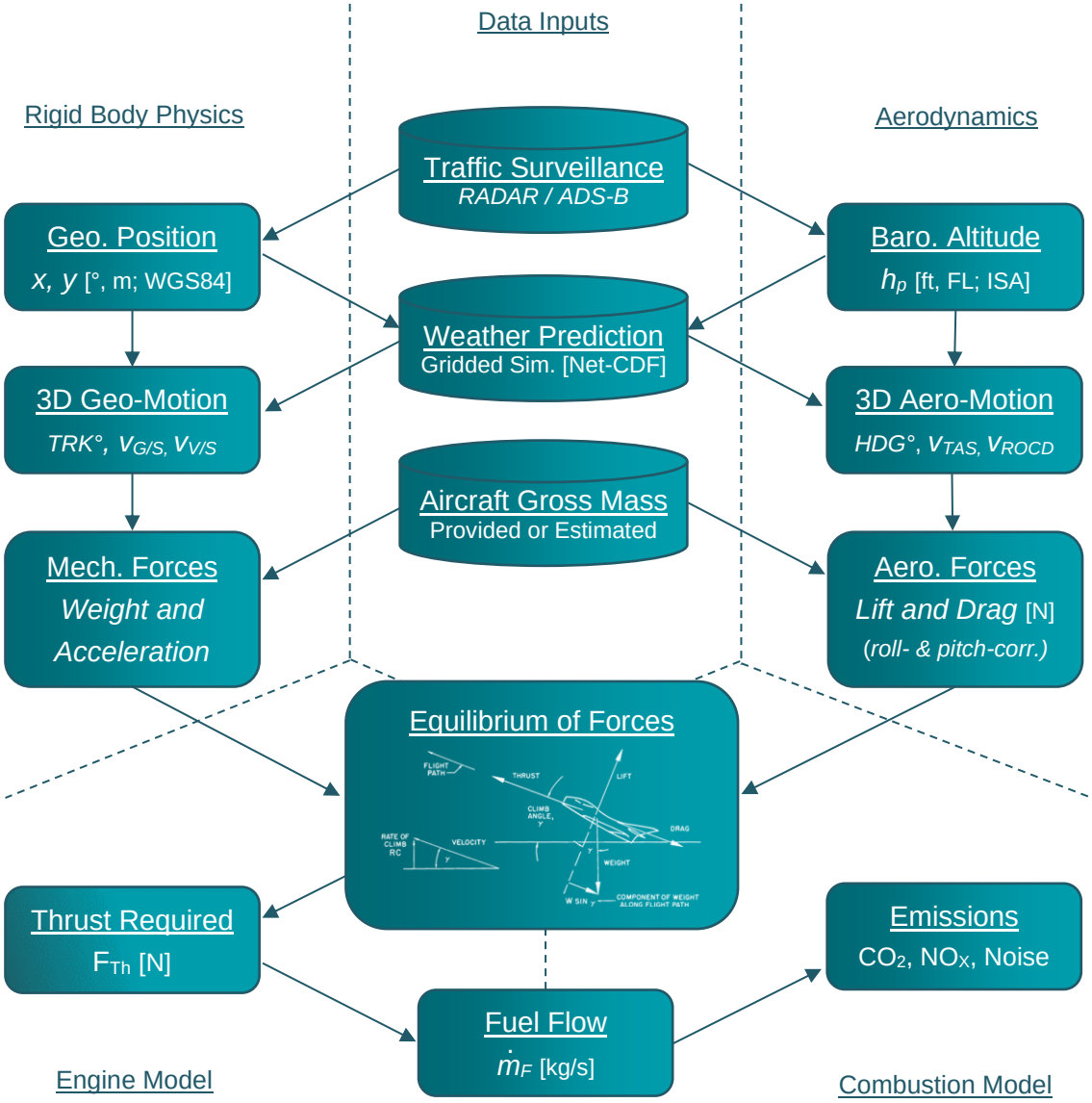
ETAS is not an aircraft design or performance engineering tool (like Airbus PEP, PET, OPT), but a cost-efficient solution for fuel efficiency assessment for ATM stakeholders. Aircraft performance is modeled using EUROCONTROL Base of Aircraft Data (BADA).

With Release 3.0, ETAS allows for adopting existing BADA models to reflect equipage details, such as retrofit winglets, or even individual aircraft performance levels. Likewise, completely new aircraft models can be introduced by means of calibration with customer-supplied flight data.



Depending on the required precision, the data requirement for aircraft performance model calibration ranges from tens to several hundreds of FDM flight cycles. The latest BADA aerodynamic model considers compressibility effects with a Mach-dependent drag model (see image above) on which we build our specific and highly effective model calibration representing at best those aircraft effectively operated by the customer taking into consideration potentially existing individual performance deviation factors.

A similar process for the turbofan jet engine model is currently under intensive development. Next to fuel flow, we aim at significantly improving the prediction of emissions.



Use of "Open" and Non-Confidential Data

From experience, we know that monitored flight data is highly sensitive due to legal and commercial concerns. Therefore, non-confidential air traffic surveillance data such as routinely collected noise mapping radar data or ADS-B data can be used as ETAS inputs. Similarly, weather data with crucial parameters such as local wind, temperature and pressure distributions can be obtained from local meteorology offices as numerical weather predictions. Increasingly, open-data initiatives have taken effect, making high-quality data sources more and more accessible.

As aircraft mass per flight operation is also commercially sensitive, a generic estimation method based on characteristic operational speeds has been designed and successfully tested. This robust method can further be enhanced with customer-supplied flight data or description of 'company' procedures. Likewise, non-clean configurations (flaps, landing gear) are estimated and considered in form of increased drag, and hence thrust requirements.

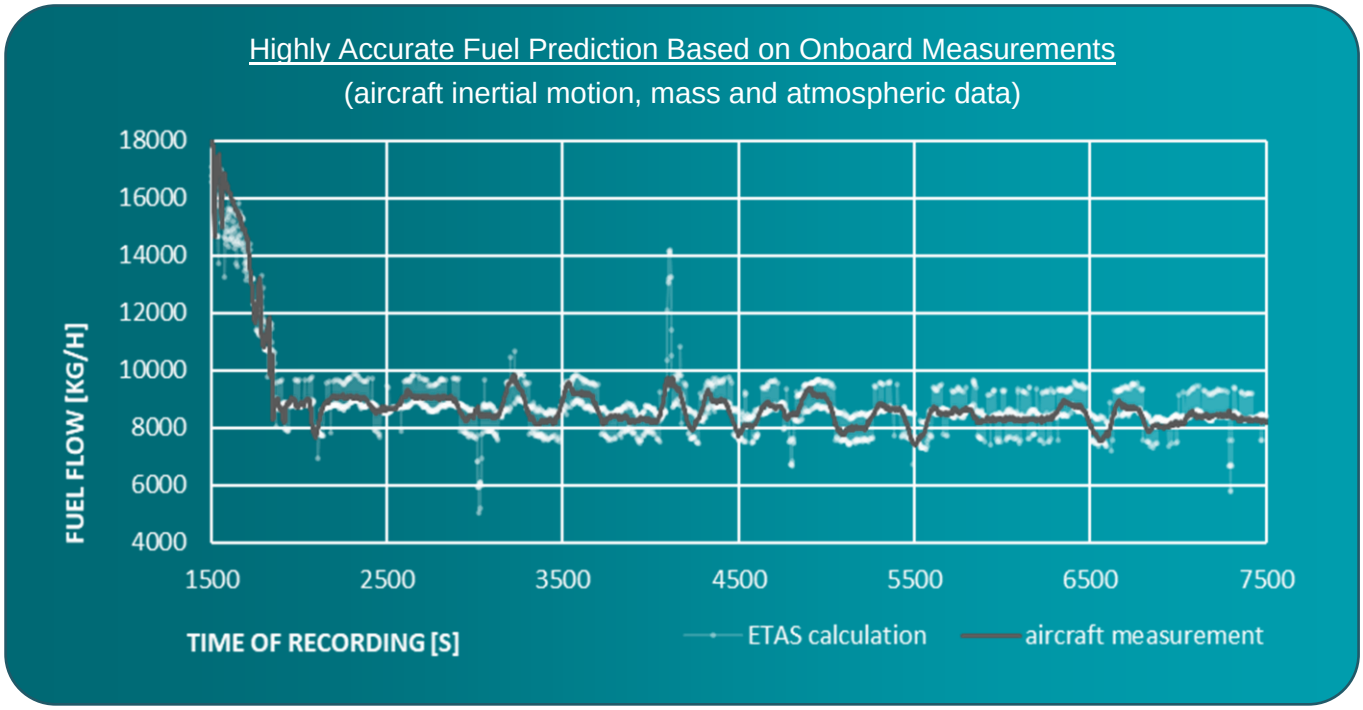
On the engine side, ETAS currently relies on BADA and ICAO Emissions DB, enhanced with EUROCONTROL findings for soot and the possibility to chain ETAS with ECAC Doc. 29 noise calculations (noise-power-distance, NPD).

Error-Minimizing Evaluation Sequence

The sequence of calculations, depicted in the upper chart, has been designed to maximize parallel processing and minimize error propagation. Noisy input data can be filtered and substituted with higher quality alternatives based on availability. The quality of models is stored per calculation as figure of merit to support post analysis and customer quality assurance programs.

Competitive Quality of Results

Compliant to the laws of mechanics and thermodynamics, the quality of ETAS results is largely dependent on input data accuracy, such as aircraft motion and mass. With good-quality input data, ETAS reaches extremely high precision, as shown below. ETAS was successfully introduced in 2016 to its launching customer DFS Deutsche Flugsicherung GmbH, managing the analyses for Deutsche Lufthansa, Condor, Hapag Lloyd and Germania.



For further information on your individual solution, please contact us directly by telephone or e-mail.

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John D. Anderson, "Fundamentals of Aerodynamics", Tata McGraw-Hill Education, 2010
Hugh H. "Harry" Hurt, "Aerodynamics for Naval Aviators", Naval Air Systems Command, 1960