Reducing Europe's Aviation Impact on Climate Change using enriched Air Traffic Forecasts and improved Efficiency Benchmarks

FABEC Research Workshop "Climate Change and the Role of Air Traffic Control"

Day 2 - 23 September 2021

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Agenda

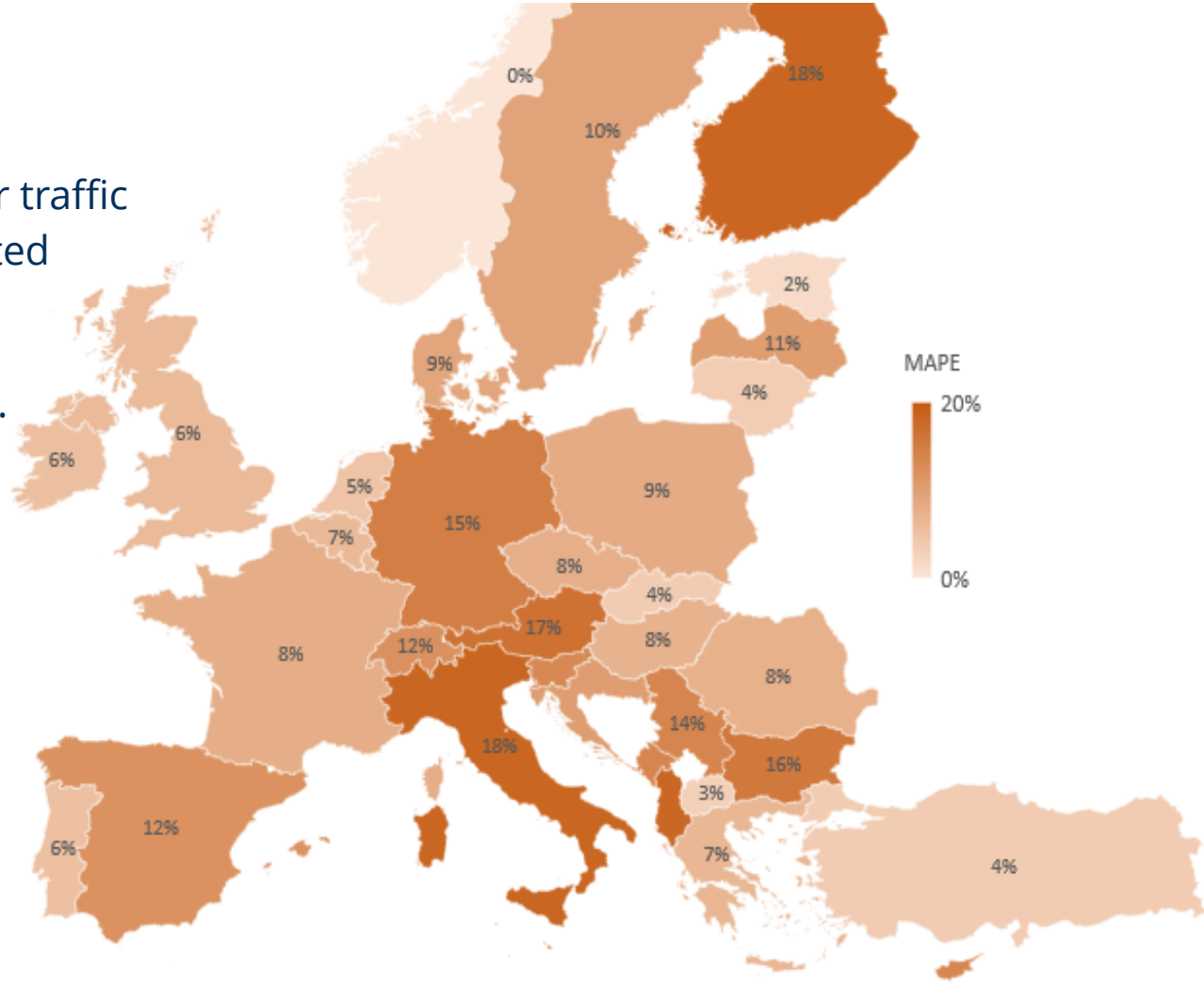
1. Motivation – Why we need enriched data?
2. Current Benchmarking – Is Horizontal Flight Efficiency enough?
3. Application – How ETAS using NEST can improve the process.
4. Results – How an alternative benchmarking can look like.
5. Conclusion – The benefits.

Motivation – Why we need enriched data?

Recap Webinar „Forecast Quality“

Forecast Quality and Consequences

- Study shows limited forecast quality of European air traffic
  - Quality metrics show a majority of ANSPs affected by insufficient forecasts (MAPE > 10%).
  - Wide confidence intervals lead to significant resource and cost uncertainties (EU: 399 Mio €).
  - However, 66% of the predictions lie outside of the confidence interval.
- Under-estimation of demand over-loads the ATM system, increasing workload, delays, safety issues.
- Over-Estimation leads to over-provisioning, decreasing cost efficiency.
- Textbook case of quality vs. economy trade-off:
  - 4 KPAs: Capacity, Cost-efficiency, Safety and Environment



Current Benchmarking – Is Horizontal Flight Efficiency enough?

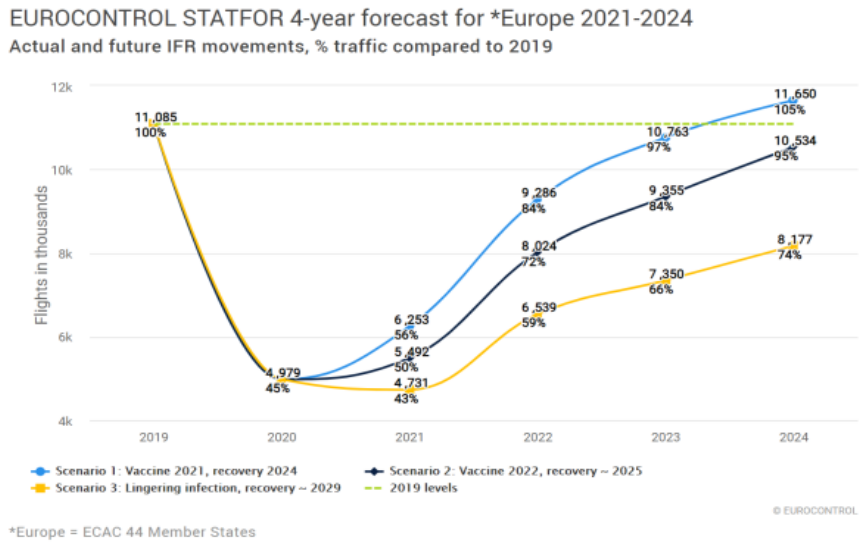
Key Performance Areas and Future Focus

Current Situation:

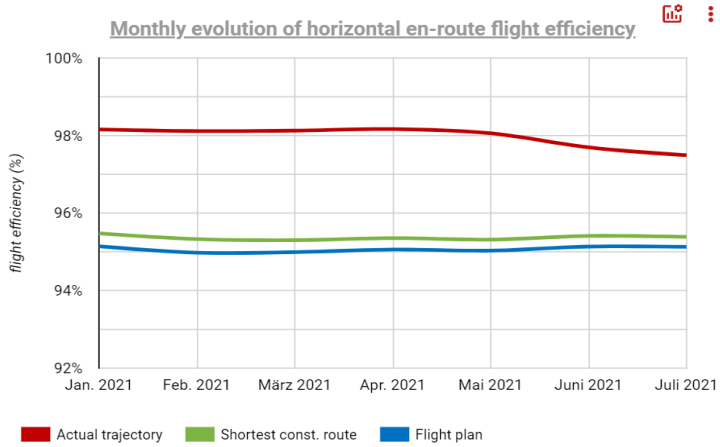
- 4 KPAs: Capacity, Cost-efficiency, Safety and Environment.
- Demand is hampered by COVID 19 – Even the „most optimistic“ estimations show that traffic will be on pre-COVID level in four years earliest.
- The focus of policy decision makers will shift more and more into environment (FFF etc.).
- Environment is yet only measured by Horizontal Flight Efficiency (HFE), which can refer to three data types:
  - Shortest constrained route (KES),
  - Last filed flight plan (KEP),
  - Actual Trajectory (KEA).
- Adding Vertical Flight Efficiency (VFE) is not straightforward, since ecologically friendly air transport must be measured in “3DE” following aerodynamics and thermodynamics

$$HFE_j = \frac{\sum L_{fjp} - \sum H_{fjp}}{\sum H_{fjp}}$$

L...flown distance
H...achieved distance
f...flight
j...airspace
p...portion of flight



Source: EUROCONTROL / STATFOR



Source: EUROCONTROL

Application – How ETAS using NEST can improve the process.
Approach and Method

Scheme:

- To compute 3DE, we start using NEST generated input data, as standard input in today's forecast workflow through STATFOR.
- Aerodynamic/flight performance modeling through GfL's "Enhanced Trajectory Assessment System" (ETAS):
  - post-flight trajectory assessment tool.
  - developed to enable various kinds of performance benchmarking activities.
- ETAS to enrich forecast data to compute 3DE in three steps:
  1. First Loop: Building the performance ‚reference': using NEST KEP - last filed flight plan data. Ex-ante
  2. Second Loop: Assessing the ecological footprint: using NEST KEA - actual flight plan data. Ex-post.
  3. Computation of the environmental efficiency *3DE* and related cost:

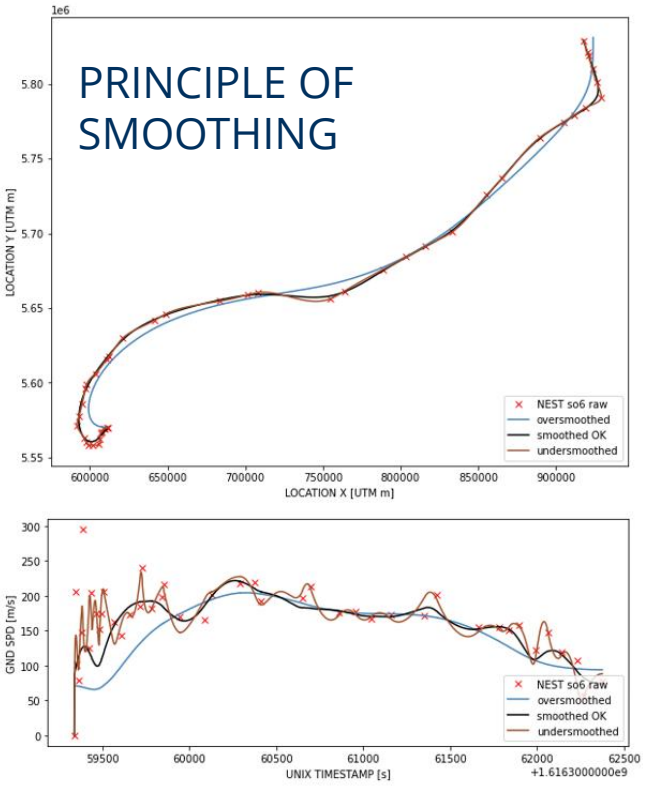
$$3DE_j = \frac{\sum KEA_{fjp}}{\sum KEP_{fjp}}$$

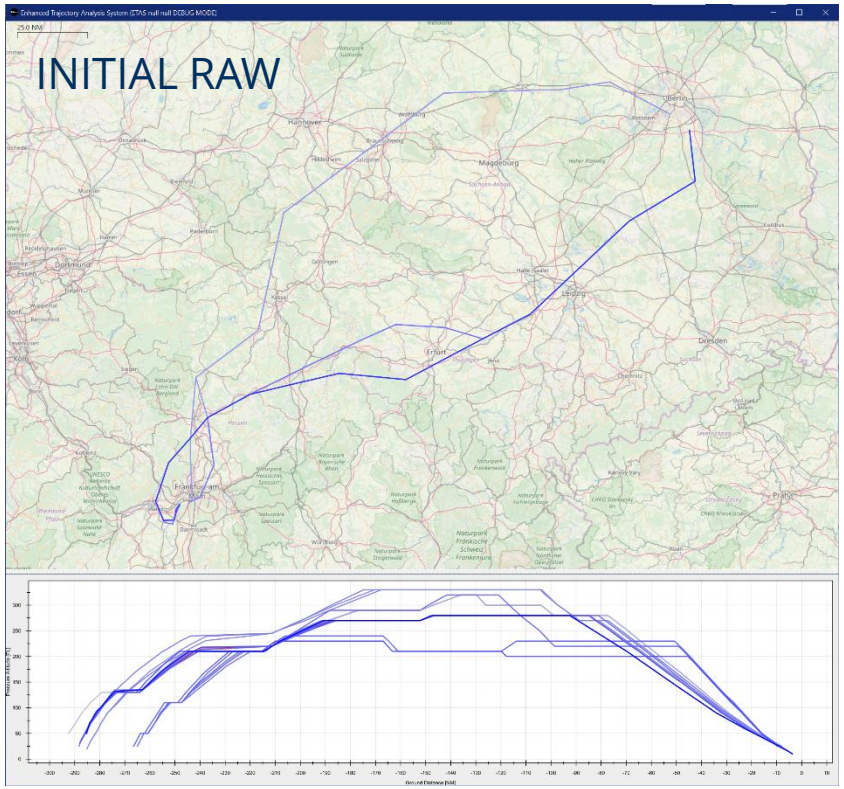
f...flight
j...airspace
p...portion of flight

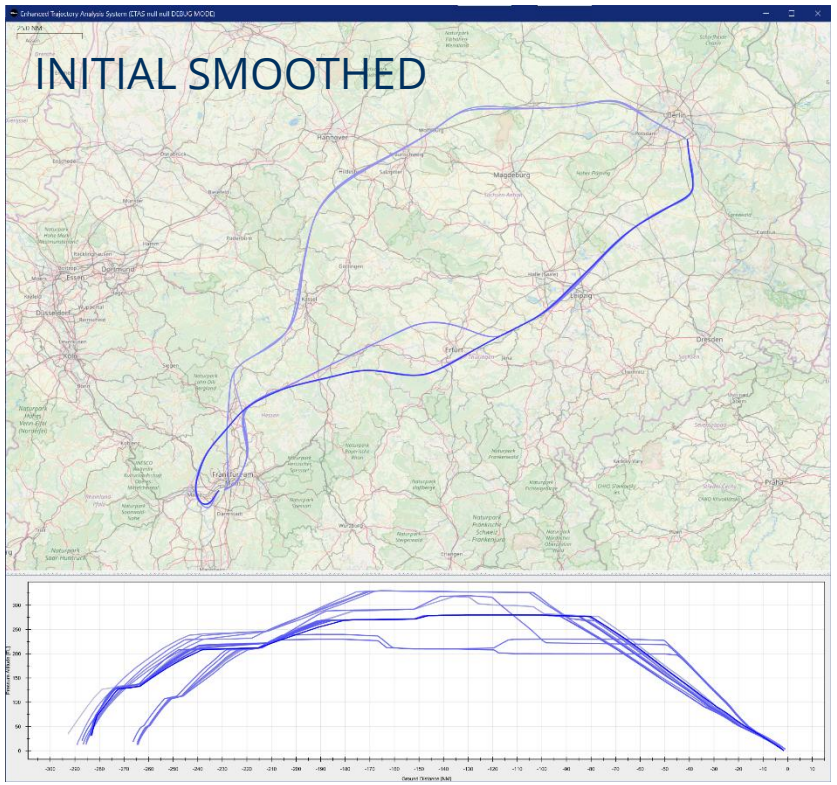
Source: GfL

Application – How ETAS using NEST can improve the process.

Kalman-Smoothing of Data



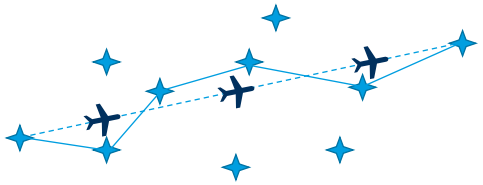




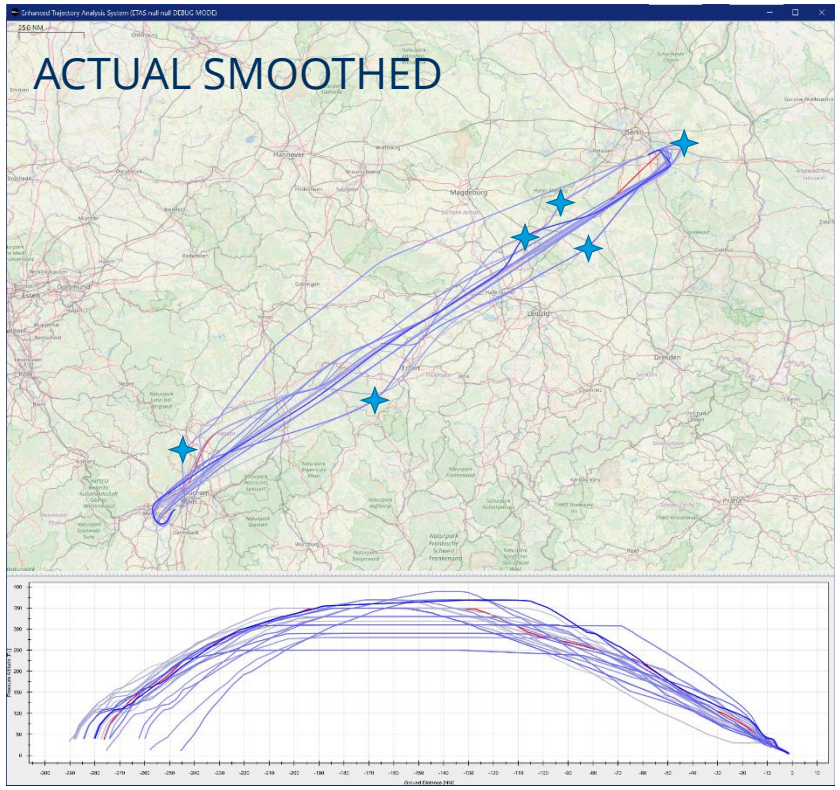
Application – How ETAS using NEST can improve the process.

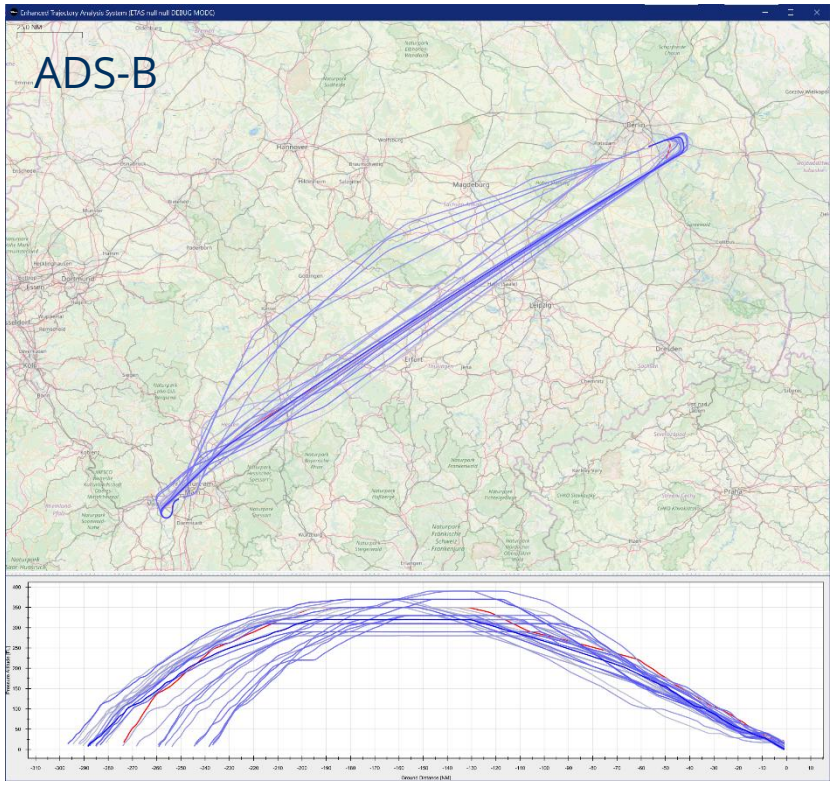
Flight plan updates, alias effects

PROBLEM OF NEAREST NEIGHBOR SELECTION



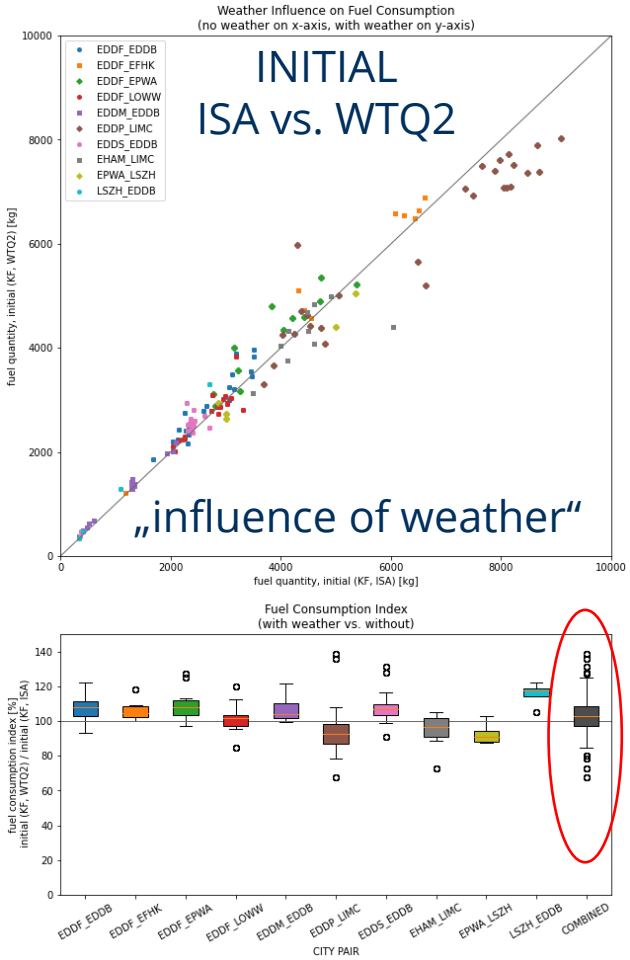
The actual flight plans are matched to fixed AIRAC cycle waypoints, using coarse update thresholds

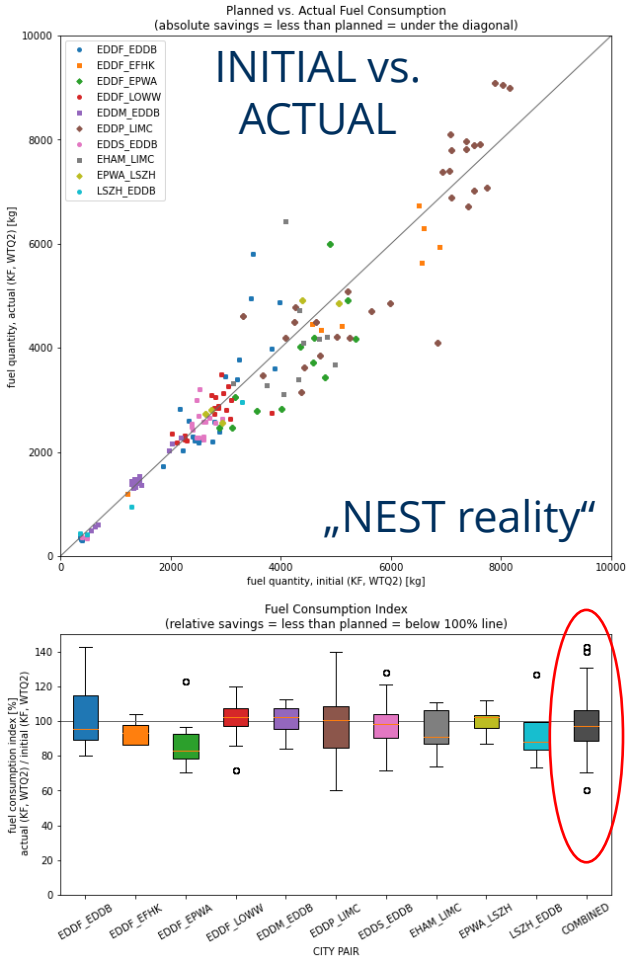


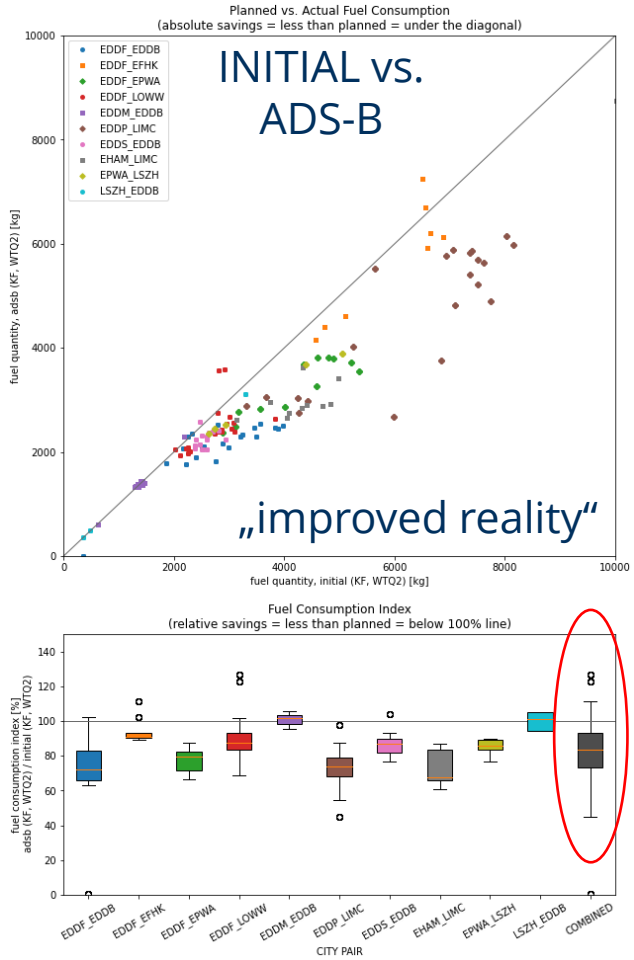


Results – How an alternative benchmarking may look like.

Fuel Consumption Index, our proposed 3DE KPI







Conclusion – The benefits.
Findings and Way Forward

1. The combined ecologic/economic ANSP efficiency can be improved by enriched forecasts.
2. Hypothesis: The environmental performance to become dominant in SES RP4 at latest.
3. Linking ETAS with EUROCONTROL's NEST forecast data provides adequate, sophisticated emissions prediction (split by sector, state / ANSP, and targeting a given forecast period)
4. The reference: We suggest enhancing the *initial flight* plan through Kalman filtering.
5. The benchmark: As second priority – to enhance *actual flight* plan with ADS-B data.
6. The 3DE metric integrates HFE, VFE and CI into one environmental performance measurement.
7. Use Case: During COVID, significant emission savings following 3DE (15% overall) due to low traffic
8. 3DE starts from city pairs, exhibiting interesting details. Allocation to FABs, States, ANSPs to comply with current ratings easy to manage, algorithms close to operationally ready.
9. More Use Cases to come – you're invited to join !

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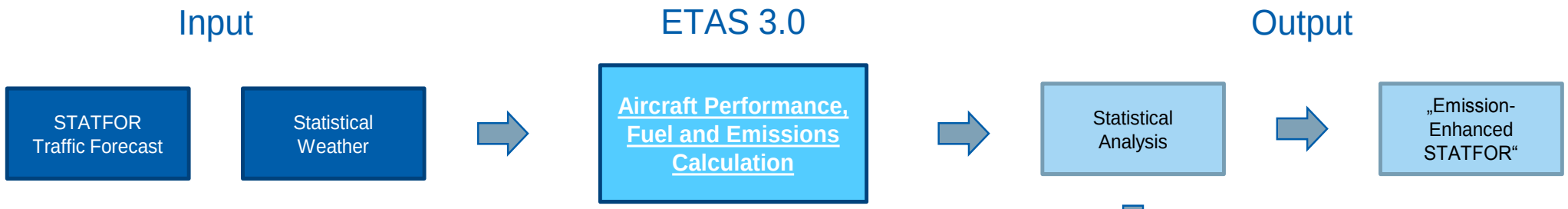
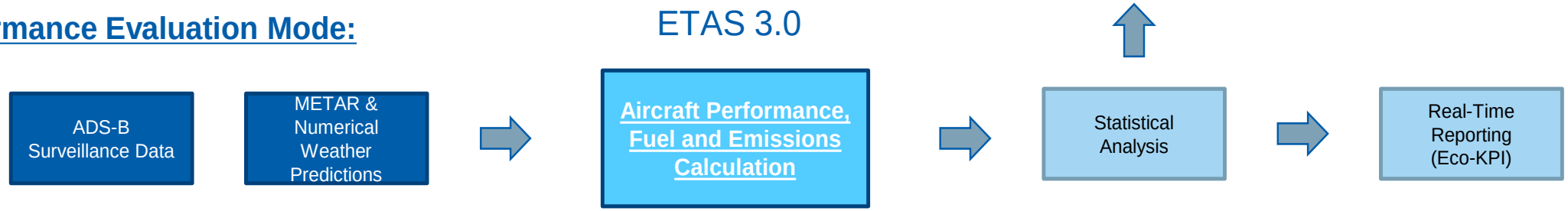
Appendix – ‘Emission-Enhanced STATFOR’

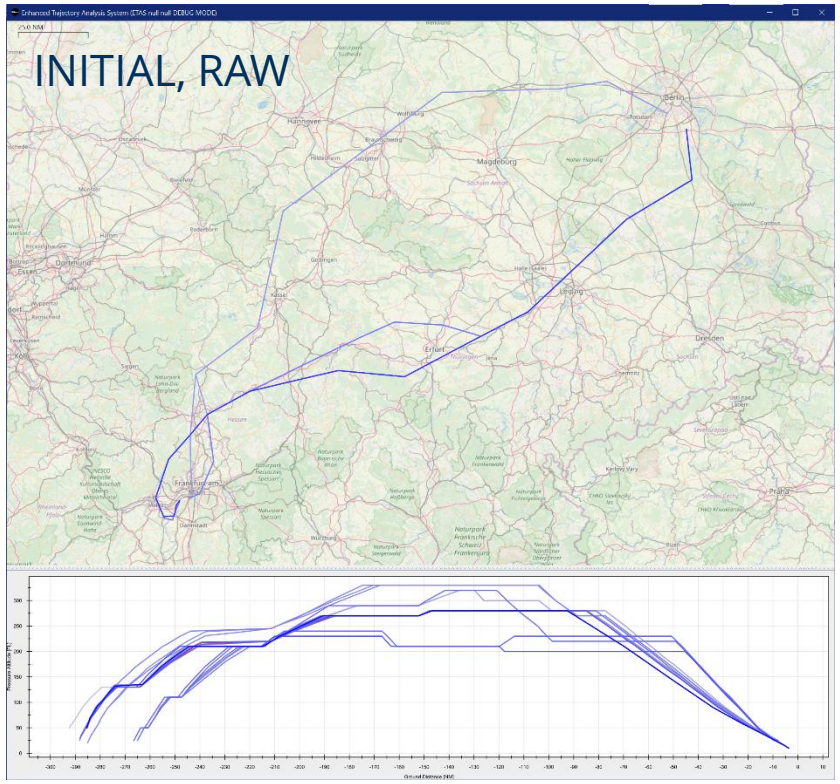
Prediction / Baseline Mode:

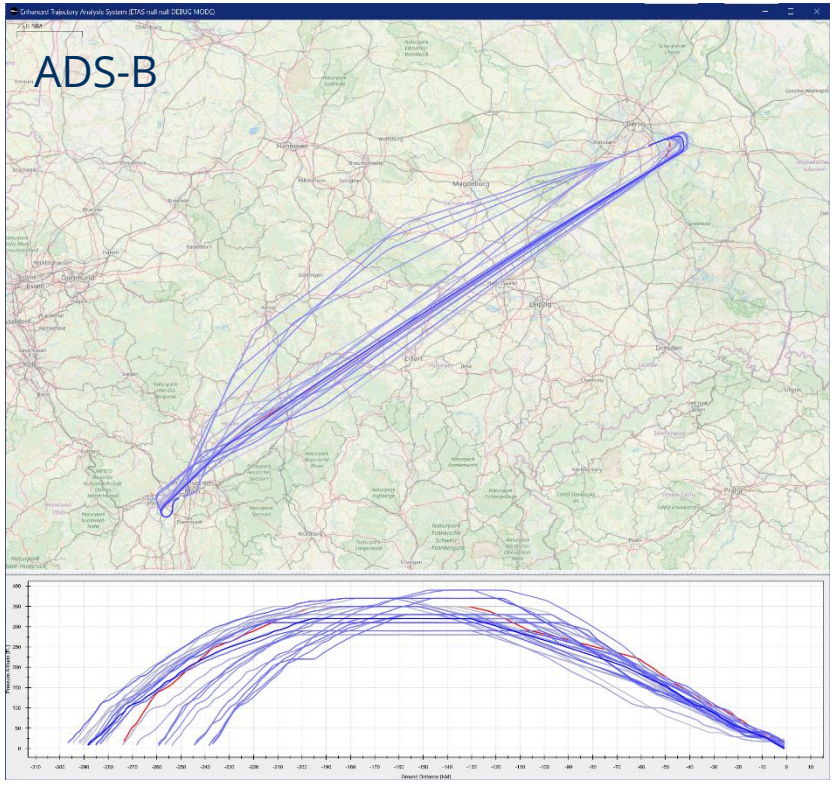


Performance Evaluation Mode:



Appendix – Savings potentials
Frankfurt–Berlin





Appendix – Savings potentials

Leipzig–Milano