#ArchitectingAviation

Towards green aviation: integrating environmental impacts mitigation in aircraft development

Enabling fast and data-efficient Life Cycle Assessment (LCA) integration into aircraft design through an innovative prediction methodology

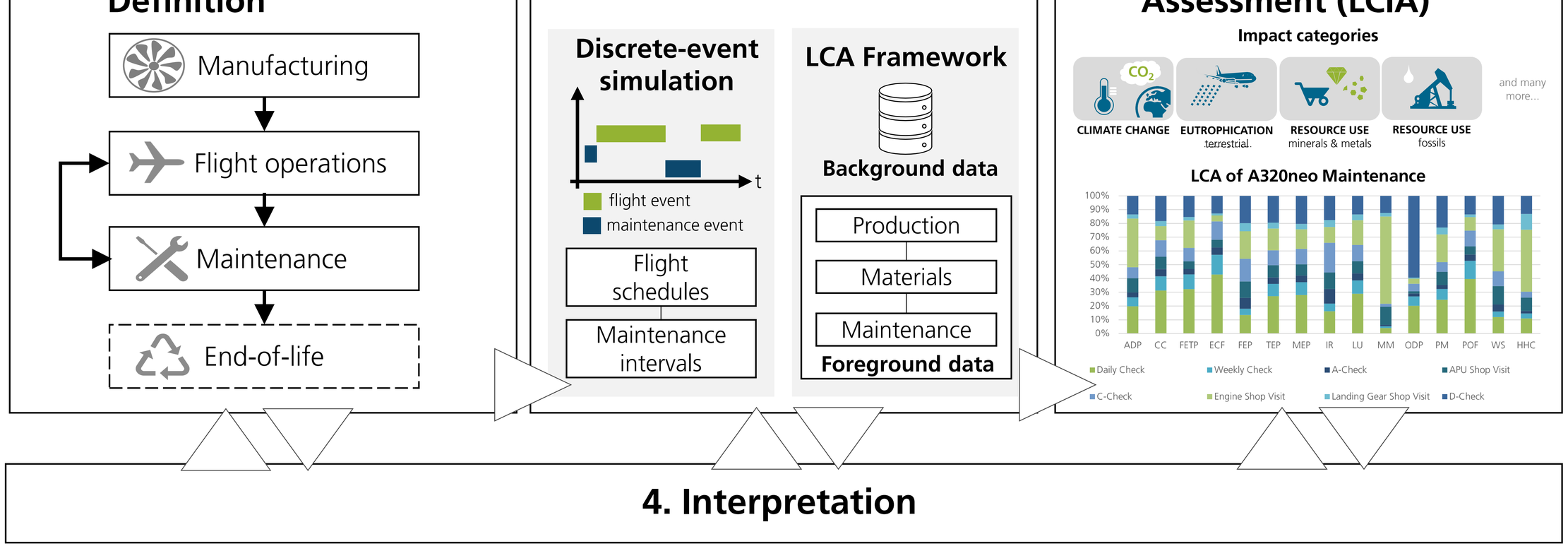

Figure 1: LCA begins with the goal and scope definition, considering aircraft manufacturing, flight operations, and maintenance. Next, we develop inventories to accurately represent each life cycle stage and integrate the LCA framework with a discrete-event simulation. Then, the impact assessment translates inventory results into measurable environmental impacts across 16 distinct categories. The interpretation step runs concurrently, providing insights and recommendations for informed decision-making.

Environmental assessment in aviation

Life Cycle Assessment (LCA) studies are usually hindered by the time-intensive data collection during the LCI step. In aviation, representative datasets are necessary for meaningful results due to sector-specific data requirements [1]. We present a high-level LCA methodology to enable faster assessments with less input data, focusing on the identification of key parameters that significantly influence environmental outcomes.

The proposed approach begins with a detailed LCA of different aircraft designs (e.g., regional, narrow-body, and wide-body).

This requires the creation of extensive LCIs, including manufacturing processes, aviation materials, maintenance activities and average flight times.

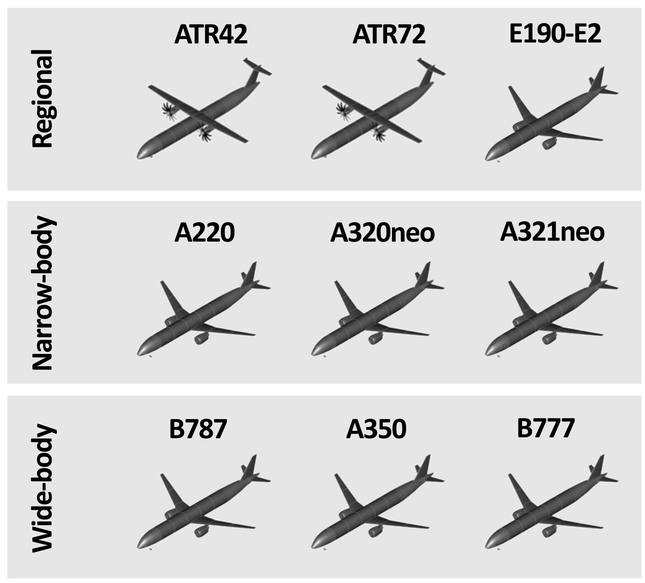

Figure 2: detailed LCA of the baseline aircraft is the foundation for high-level LCA regression models.

The aircraft life cycle (production, flight operations and maintenance) is modelled using an in-house discrete-event simulation tool based on flight and maintenance schedules [2].

The results of the LCA midpoint impact categories, such as climate change and resource use, are then used as basis for regression models and represent the dependent variables.

The most relevant independent variables, either aircraft design (e.g. wing span or aircraft weight) or operational parameters (e.g. flight hours or cycles), are then identified and their relevance is quantified. These results serve as input for ALICIA dashboard.

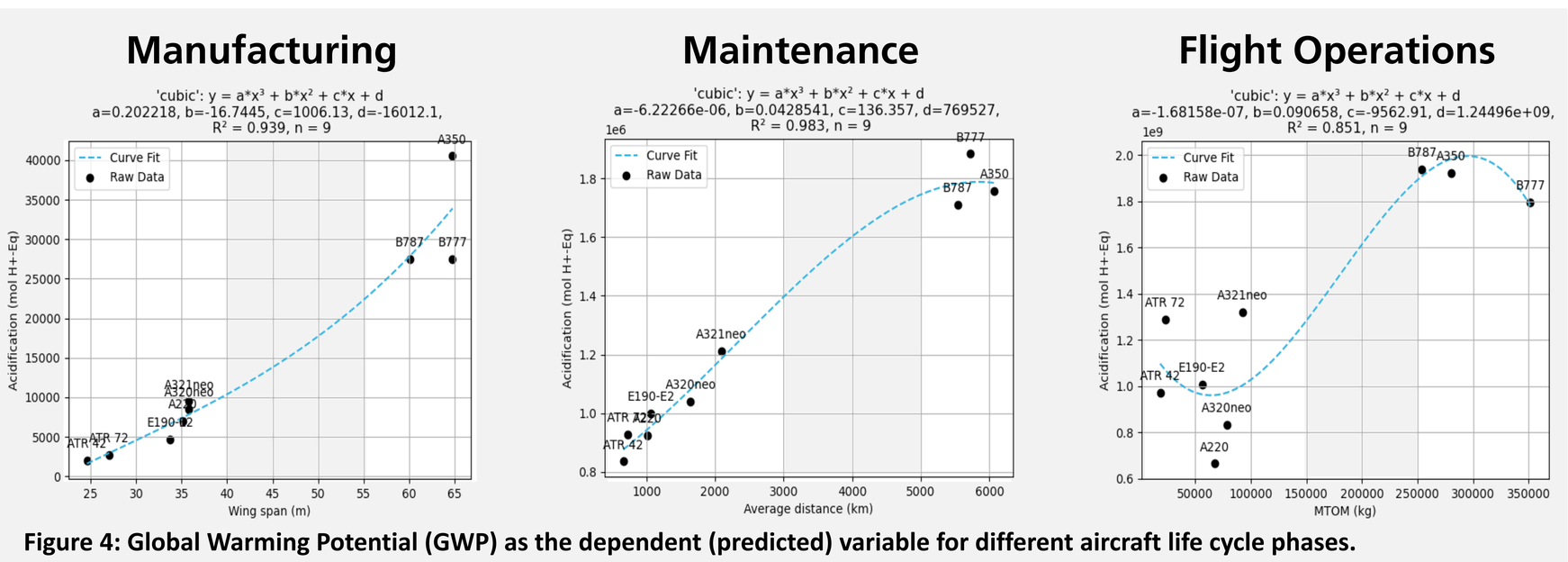

Figure 4: Global Warming Potential (GWP) as the dependent (predicted) variable for different aircraft life cycle phases.

Environmentally driven aircraft design

Our methodology aims to support the design of new aircraft, representing an innovative driver and establishing industrial ecology as a pillar of future developments in aviation.

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References

[1] Albano, et al. (2024). Life cycle inventories for aviation: Background data, shortcomings, and improvements. Journal of Cleaner Engineering and Technology. doi.org/10.1016/j.clet.2024.100813

[2] Pohya, et al. (2021). A modular framework for the life cycle based evaluation of aircraft technologies, maintenance strategies, and operational decision making using discrete event simulation. Aerospace. doi.org/10.3390/aerospace8070187