TECHNICAL NOTE
Airport Emissions Tracker Data

The International Council on Clean Transportation
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The data used for the airport emission tracker were derived from 2023 Spire Automatic Dependent Surveillance–Broadcast data and OAG data. Cruise fuel burn was modeled using EUROCONTROL's BADA3, while takeoff fuel burn and pollution emissions were modeled using the ICAO Aircraft Engine Emissions Databank. A more detailed methodology is provided in the following report:

Cruise fuel burn: Zheng, S., Mukhopadhaya, J., Benoit, J., Kumar, S. N., Rutherford, D., Rhode, D., & Sitompul, D. (2025, September 23). Aviation Vision 2050: The potential for climate-neutral growth. International Council on Clean Transportation. Retrieved from the International Council on Clean Transportation website: https://theicct.org/publication/aviation-vision-2050-sept25/

Landing and take-off pollution: Sitompul, D., & Rutherford, D. (2025). AIRLIFT: Aircraft Local Impact Footprint Tool [Dataset]. International Council on Clean Transportation. Retrieved from the International Council on Clean Transportation website: https://theicct.org/airlift-aircraft-local-impact-footprint-tool-nov25/

The airport emissions tracker contains information for the selected 1,300 largest global airports. This covers 83% of commercial passenger, 87% of commercial freighter, and 56% private jet flights globally.

Commercial passenger carbon dioxide (CO_2) represents the apportionment of total CO_2 emissions to passenger transport only, for flights operated by jet and turboprop aircraft.

Commercial freight carbon dioxide (CO_2) emissions represent the apportionment of total CO2 emissions to both freight carried on passenger aircraft ("belly freight") and freight carried on dedicated freighters.

Private jet carbon dioxide (CO_2) emissions represent total CO_2 emissions from private jets ranging from small aircraft (e.g., Cessna Citation Latitude or Embraer Phenom) to ultra-long-range aircraft (e.g., Boeing Business Jet or Airbus Corporate Jet).

Commercial passenger, freight, and private jet emissions of NOx, HC, CO, and $PM_{2.5}$ reflect only local emissions generated during the landing and take-off phase.

ABRIDGED METHODOLOGY

Cruise emissions

Flight trajectories, aircraft characteristics, and engine information are used to estimate fuel burn and cruise emissions for each flight. Aircraft performance during cruise at altitudes above 3,000 feet is modeled using BADA3[1], a EUROCONTROL performance model that provides aircraft-specific relationships for thrust, drag, fuel consumption, and flight behavior across different operating conditions. For aircraft not directly represented in the model, a similar aircraft type is assigned as a substitute based on weight, mission, and performance characteristics.

Before modeling, the flight data are cleaned and standardized so that each record can be matched consistently across trajectory, aircraft, and engine datasets. This includes harmonizing airport identifiers, aircraft types, airline identifiers, and engine references; removing duplicate or incomplete records; resolving missing or inconsistent aircraft-engine pairings; and assigning representative aircraft or engine matches where direct matches are unavailable. Additional adjustments are also made to ensure that flight trajectories, aircraft metadata, and emissions reference tables can be linked at the flight level. Where a direct match cannot be established, documented fallback procedures are used so that the flight can still be retained in the modeling inventory rather than excluded from the analysis.

The modeling uses the departure airport as the reference point for assigning flight activity and emissions. In other words, each flight's estimated fuel burn and emissions are attributed to the airport from which the flight departs. This provides a consistent basis for summarizing airport-level activity and comparing emissions across airports.

Cruise fuel burn modeled by BADA3 was used as the basis for estimating CO_2 equivalent (CO_2e) emissions. Total fuel consumed is multiplied by applying a constant well-to-wake (WTW) factor to determine CO_2e for cruise. The well-to-wake approach includes both upstream fuel-production emissions and direct in-flight combustion emissions. CO_2e is therefore calculated as:

$$CO_2e = WTW \times Fuel_{total}$$

where WTW = 3.8448 kg CO_2e / kg and $\text{Fuel}_{\text{total}}$ is total fuel burn during cruise. This means that CO_2e emissions increase in direct proportion to the amount of fuel consumed. Once cruise fuel burn has been estimated through the aircraft performance model, CO_2e can be derived directly and consistently across all flights using this constant factor.

Landing and take-off emission and pollution

To estimate air pollution from landing and takeoff (LTO) operations, the model uses several data sources depending on engine type and data availability. The main sources include the ICAO Aircraft Engine Emissions Databank[2] (EEDB), EUROCONTROL, EASA, and EPA guidance. The modeling follows a decision-tree approach, in which each engine is assigned the most specific available emissions source. For CO_2e emissions, we use a well-to-wake (WTW) fuel-burn approach, while for NOx, HC, CO, and $PM_{2.5}$, we use a tank-to-wake approach to calculate pollution generated from combustion during LTO.

For jet aircraft, LTO emissions are first matched directly to the ICAO Aircraft EEDB using engine identification. Where a direct match is not available, a set of fallback procedures is applied.

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[1] A. Nuic, *User Manual for the Base of Aircraft Data (BADA), Revision 3.7*, EEC Technical/Scientific Report No. 2009-003, EUROCONTROL Experimental Centre, 2009. https://www.eurocontrol.int/sites/default/files/library/003_BADA_3_7_User_manual.pdf

[2] European Union Aviation Safety Agency (EASA), ICAO Aircraft Engine Emissions Databank. https://www.easa.europa.eu/en/domains/environment/icao-aircraft-engine-emissions-databank

These fallback steps include matching to an engine from the same family, matching to an engine with a similar thrust range, and using Smoke Number–based estimation methods for engines that still lack $PM_{2.5}$ information. This stepwise approach allows the model to maintain broad coverage while keeping the emissions estimates as close as possible to actual engine characteristics.

For particulate pollution, the model combines non-volatile particulate matter with additional particulate components to estimate total $PM_{2.5}$. Time-in-mode (TIM) assumptions are applied across the four LTO phases—takeoff, climb, approach, and idle/taxi—using EPA assumptions. These assumptions are summarized in Table 1. We distinguish between commercial passenger and freighter TIM values and those used for private jets.

Table 1. *Time in mode based on operations*

Mode	**TIM for commercial passenger and freighter (minutes)**	**TIM for private jets (minutes)**
Take-off	0.7	0.4
Climb	2.2	0.5
Approach	4.0	1.6
Idle (Taxi)	26.0	13

For turboprop aircraft, the model uses the EASA emissions calculator with default ICAO values where available. Because turboprop coverage is less complete, constant fallback values are used for flights that cannot be directly matched. These fallback values are summarized in Table 2.

Table 2. Turboprop LTO emission fallback values

Engine type	**CO_2e LTO total mass (kg)**	**HC LTO total mass (g)**	**CO LTO total mass (g)**	**NOx LTO total mass (g)**	**$PM_{2.5}$ LTO emission (mg)**
Turboprop	465.16	77.11	12,759.54	72.57	43,674

Across both jet and turboprop aircraft, the final LTO emissions inventory relies first on the most specific available engine-level data and then applies documented fallback procedures where direct matches are not available. Carbon dioxide (CO_2e) emissions are calculated using the same equation as for cruise.

Finally, after calculating both the cruise and landing fuel burn we than categorize the flight operations and fuel burn were by flight distance:

- Short-Haul: Shorter than 1,500 km
- Medium-Haul: 1,500 to 4,000 km
- Long-Haul: Longer than 4,000 km

More detailed information of the modeling: https://theicct.github.io/JETSTREAM-doc/