Travel Impact Model (TIM)
ADVISORY COMMITTEE

TECHNICAL BRIEF

Travel Impact Model (TIM) Roadmap

Revised November 2024

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1. INTRODUCTION TO THE TIM

The Travel Impact Model (TIM) developed by Google is a transparent and continually improving emissions-estimation model. It is built on the most recent scientific research and is constructed from public and licensable datasets from third parties. The TIM was designed as a public service, to provide a reliable source from which to calculate and present the climate impact of individuals taking flights. Prominent travel companies such as Google, Skyscanner, Booking.com, Expedia, and Sabre have incorporated the TIM into their platforms to help customers identify and choose less-emitting flights.

Critical to the TIM's success and ongoing improvement is the Advisory Committee (AC). The AC is composed of world-leading experts on sustainability and aviation from industry, academia, government, and non-governmental organizations. The AC's primary contribution is independent supervision and guidance to ensure the model's precision, relevance, and compliance with the most up-to-date scientific standards. The AC's dedication to ensuring the TIM's accuracy and refinement is evident from this first two-year TIM operating plan, which focuses on expanding the dataset coverage and incorporating feedback from diverse stakeholders. This is a collaborative governance structure where the AC is the decision-making authority and is informed by the International Council on Clean Transportation (ICCT) and Google; Travalyst is the dissemination partner and guarantees that the TIM remains a continually improving tool to standardize emissions information across the aviation industry.

2. TIM PRINCIPLES

The following key principles are to ensure the TIM's effectiveness and reliability:

a. **Accurate** and validated with real-world data
b. **Precise** in distinguishing more- and less-emitting flights
c. **Comprehensive** in covering the full climate impacts of aviation
d. **Futureproof** across new technologies and aircraft designs
e. **Transparent** in methods, data sources, and assumptions
f. **Consistent** across airlines and industry stakeholders
g. **Accessible** and free to all users

These criteria are used to categorize recommended workstreams in the TIM operating plan.

3. TIM OPERATING PLAN

Table 1 shows the TIM operating plan as of November 2024. It includes the various workstreams, with their dependencies and time frames, and all aim to enhance the model's accuracy and scope.

Table 1. Current workstreams to refine the Travel Impact Model (TIM)

No.	Workstreams	Sub-workstream	Criteria	Status
1	Expand greenhouse gas (GHG) coverage	Kyoto gases	C. Comprehensive	Complete
		WTW accounting		
2	Integrate belly freight	Payload estimation	A. Accurate B. Precise	Agreed; in implementation
		Fuel burn apportionment	A. Accurate B. Precise	
3	Incorporate real-world operations		A. Accurate	Agreed; in implementation
4	Add data sources to user interface (UI) / Attribution		E. Transparent	Complete
5+6	Model validation and selection		A. Accurate F. Consistent	Agreed; in implementation
7	Boost modeling granularity	Itinerary-level payloads	A. Accurate B. Precise	In progress
		Aircraft empty weights		
		Degradation and OEM improvements		
8	Incorporate short-lived climate pollutants, notably contrails		C. Comprehensive	In progress
9	Credit sustainable aviation fuel (SAF) use		D. Futureproof	In progress
10	Incorporate zero-emission planes (hydrogen and electric)		D. Futureproof	Not started

Completed Active

4. DESCRIPTION OF WORKSTREAMS

Workstream 1: Expanding GHG coverage

Workstream 1 improved the comprehensiveness of the TIM and future-proofed it to capture future fuel and propulsion options. Previously, the model provided estimates of carbon dioxide (CO_2) only, and not all GHGs recognized by the United Nations Framework Convention on Climate Change. Furthermore, the TIM only covered direct combustion emissions, and not emissions associated with upstream fuel production. Under this workstream, the AC recommended that the TIM be revised to a CO_2-equivalent, well-to-wake emissions accounting basis, to cover all GHGs under the Kyoto Protocol and to prepare for the integration of sustainable aviation fuels (workstream 9) and zero-emission planes (workstream 10). This update was completed in October 2023.

Workstream 2: Belly cargo

Workstream 2 improved the estimation of passenger emissions from aircraft that carry both passengers and cargo ("belly cargo"). The AC agreed to apportion a share of the full flight CO_2 to belly cargo using a mass-based approach. As explained in the first Technical Brief from the second AC meeting (AC/2 -TB/1),[1] the AC recommends the use of a 50 kg per seat correction factor (to account for furnishings and service equipment) to normalize the carbon intensity of belly and dedicated cargo. The AC also agreed to use historical U.S. Department of Transportation T-100 data to estimate belly cargo weight on flights outside the United States. The use of alternative datasets with better data for non-U.S. flights, notably the ICAO DATA+ M2 dataset, will also be investigated in the future.

Workstream 3: Real-world operations

Workstream 3 aimed to improve the accuracy of the TIM by calibrating it to real-world operations. Like many aviation emission models, TIM (v1.9.1) currently underestimates fuel use and CO_2 emissions by about 8% (weighted mean error) because it assumes that flights operate on great-circle distances and because its fuel burn algorithm, EEA 2019, does not account for inefficiencies from wind, weather, and airport congestion. Under this workstream, the AC approved the use of a distance correction factor that accounts for inefficiencies due to indirect routing. This will make the TIM more accurate to real-world operations. When combined with the update of the EEA fuel burn algorithm described in workstream 5/6, this revision will cut the model's average underestimation of fuel burn in half, from 8% to 4%.

1 ICCT, *Rationale for the Apportionment of Emissions to Belly Cargo* (2023), https://travelimpactmodel.org/static/media/belly_cargo_apportionment_rationale_vf.b4b6262bef3038a9a91b.pdf.

Workstream 4: Data/attribution

As part of its commitment to transparency, the AC recommended clarifying data sources and the calculation methodology as summarized on the TIM website and GitHub page. This update was completed in September 2023.

Workstream 5/6: Base fuel burn model validation/selection

Workstream 5/6 aimed to enhance the model's transparency by implementing a reproducible validation methodology and to improve its accuracy to real-world flight fuel burn. In the January 2024 meeting (AC/3), the AC members approved a validation methodology for the TIM. That will be used to assess how close the TIM fuel burn calculations are to the real-world fuel burn estimates and to evaluate how future changes are improving the model.

Following this decision, the existing fuel burn algorithm, EEA 2019, was compared with five alternative fuel burn model algorithms: ICEC, OpenAP, Poll-Schumann, Piano, and EEA 2023. Based on AC/5-TB/1, in June 2024, the AC recommended updating the TIM base fuel burn model from EEA 2019 to EEA 2023 to improve its accuracy.

Workstream 7: Increasing fuel burn model granularity

Following completion of the work to make the TIM more representative of real-world operations (workstream 3) and to update its fuel burn algorithm (workstream 5/6), the AC intends to further improve the accuracy and precision of the model by investigating second-order fuel burn effects. These may include variations in estimated operating empty weight by aircraft type and carrier, degradation in fuel efficiency as an aircraft/aircraft engine is used in service, variations in fuel efficiency due to engine variants for a given aircraft type, and the impacts of airport congestion and altitude. The AC is aiming to develop recommendations to correct these effects by 2025 and these improvements will be reflected in the updated version(s) of the TIM.

Workstream 8: Short-lived climate pollutants

This workstream aims to better represent the total climate impact of aviation by providing consumers with, in addition to CO_2 emissions, scientifically supported information about the warming impact from the short-lived climate pollutants (SLCPs) generated by their flight choices. The warming impact of these SLCPs, notably contrails and cruise nitrogen oxides (NO_x), are not currently included in the TIM's calculations. At the June 2024 meeting (AC/5), four different methodologies were analyzed to incorporate the impact of contrails in these estimations. After careful evaluation, the AC recommended classifying itineraries based on broad ranges of potential contrail warming. Future work is anticipated through AC/7 to define appropriate buckets and consider the seasonal probabilities. Additional work is also needed to develop recommendations for cruise NO_x.

Workstream 9: Sustainable aviation fuel (SAF) accounting

Currently, almost all (99.8%) of aviation energy use is provided by fossil fuels. As governments have committed to the Paris Agreement, airlines and jet fuel providers are working to develop alternative aviation fuels, often referred to as sustainable aviation fuel (SAF), that can be used in today's aircraft and engines. As some SAFs can provide significant (50%+) reductions in life-cycle GHGs compared with fossil fuels, it will be important to reflect those savings in the TIM as they scale. This workstream will clarify SAF accounting rules under the TIM, including which life-cycle accounting methods will be applied and how to allocate SAFs to individual tickets. That work must account for voluntary (corporate and consumer purchases) and mandatory (SAF mandate) efforts already in place.

Workstream 10: Zero-emission plane accounting

In parallel to the work on SAFs, aircraft manufacturers including Airbus, ZeroAvia, and Eviation are developing new aircraft types fueled by hydrogen or electricity that emit no GHGs during operation. This workstream will clarify the accounting rules for future zero-emission planes, with two key focuses: (1) accurately characterizing upstream emissions associated with fuel production and (2) clarifying the contrail impacts of hydrogen planes, which will emit minimal particulate matter but more water vapor than aircraft powered by fossil fuels.