New flight procedures to reduce noise from aircraft departing and arriving at Boston Logan Airport

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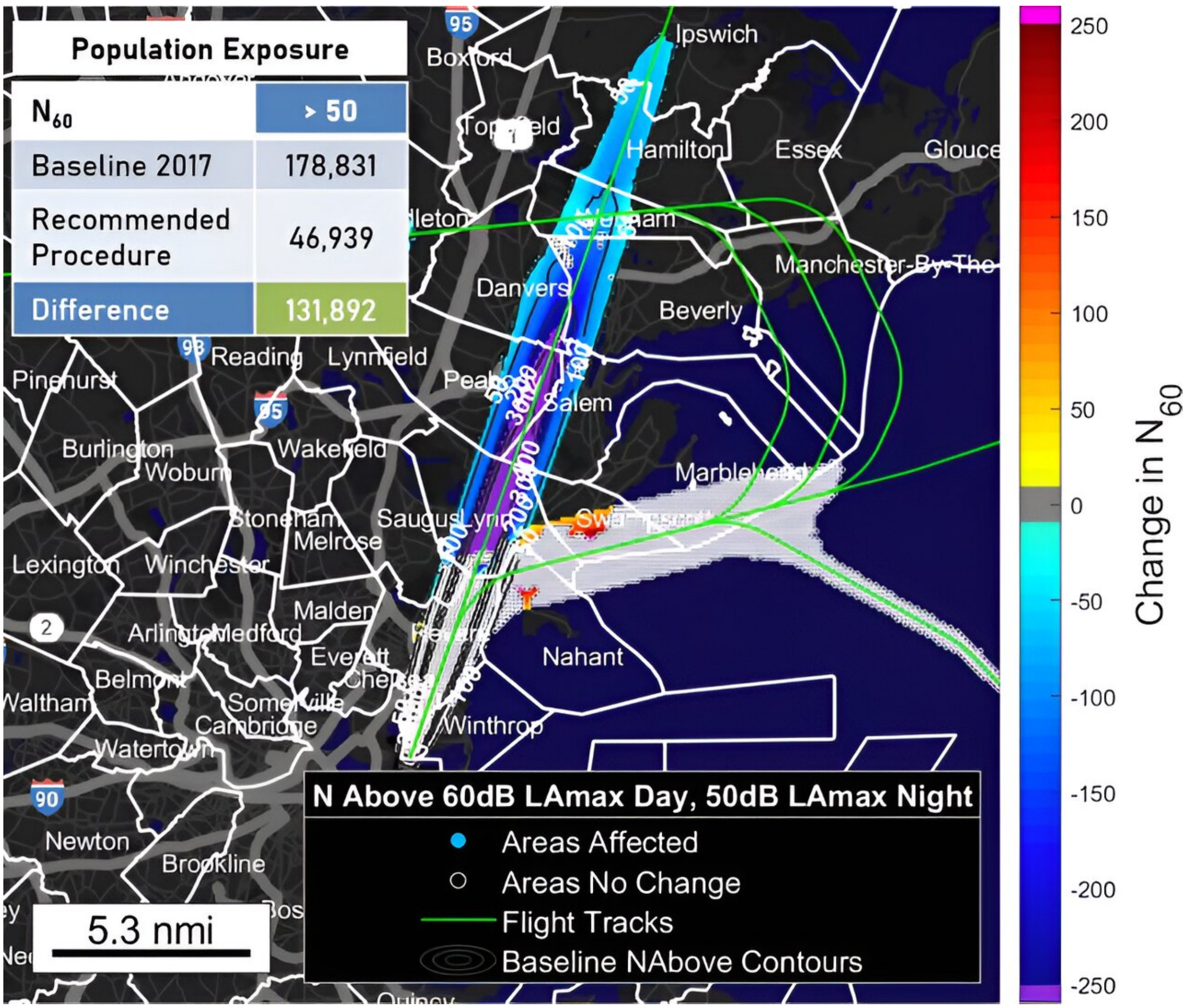

"Heat map" of the expected change in N_{60} for a new overwater approach procedure to runway 22L, which was implemented. Cooler colors represent areas that are expected to experience a lower number of overflights under the new procedure. Credit: ICAT

If you're a resident of Hull, Lynn, Salem, or other Massachusetts towns currently exposed to noise from aircraft approaching Boston Logan Airport, you may notice the skies getting a little quieter this year.

Over the last decade, improvements to aircraft navigation technology have allowed departing and arriving aircraft to follow highly precise routes in the sky. These new routes, known as Area Navigation (RNAV) flight procedures, were implemented at Boston Logan Airport between 2012 and 2013 and have allowed aircraft to navigate more efficiently and predictably in the airspace around Boston.

However, this shift to more precise navigation has had the side effect of concentrating aircraft trajectories over specific neighborhoods, leading to a perceived increase in aviation noise in affected communities. Complaints to the airport from those communities has increased correspondingly.

In response, in 2016, the Federal Aviation Administration (FAA), Massport, and MIT began a three-way collaboration to identify potential modifications to the departure and arrival procedures at Boston Logan Airport that could mitigate the impacts of high flight track concentrations. Professor John Hansman and graduate students at the MIT International Center for Air Transportation (ICAT) led outreach to communities and technical development of potential procedure modifications.

Over a period of six years, ICAT investigated several technical solutions for mitigating aircraft noise. Following extensive collaboration with community groups and operational stakeholders, the research team submitted four new low-noise flight procedures to the FAA for implementation. Now being deployed in actual operations, these procedures are expected to reduce overflight noise for several communities and, in some cases, also reduce aircraft fuel burn.

Working with communities and aviation stakeholders

The study comprised two phases, or "blocks," of research. Block 1 procedures were characterized by clear predicted noise benefits, limited operational or technical barriers, and minimal equity concerns. Block 2 procedures were regarded as more complex due to potential technical barriers and equity challenges—instances in which one flight pattern might benefit one community at the expense of another.

Both phases of the study required extensive collaboration with communities, represented by the Massport Community Advisory Committee (MCAC), and operational stakeholders, which included experts from the FAA, air traffic controllers, and pilots from airlines. Public outreach meetings and meetings with the MCAC helped the ICAT team to identify community objectives and to receive feedback on procedure concepts. Further conversations with air traffic controllers at Boston Logan and airline pilots were also essential to identify and resolve operational issues and to confirm that concepts were technically feasible.

"Procedures were developed in collaboration with several stakeholder groups. In the end, the goal was to arrive at a set of procedures that achieved community noise-reduction objectives while satisfying technical constraints communicated by operational stakeholders," says Sandro Salgueiro, a postdoc at ICAT who contributed to the study.

Developing metrics to communicate noise impacts

As part of the work with community groups, the ICAT team developed new tools to communicate the expected noise impacts of proposed procedure changes. They developed two types of noise impact visualizations: one based on the change expected for a single flight, and another based on the change expected over one full peak day of operations.

A single-flight analysis compared 60-decibel contours for both current and proposed procedures, allowing the team to estimate the number of people who would be removed from this contour if the procedure were to change.

The full-day analysis used a different metric to communicate noise impacts. Because RNAV procedures tend to concentrate aircraft overflights, locations of noise complaints were found to correlate strongly with how often aircraft flew over those same locations. The ICAT team proposed a new metric that measured the number of daily overflights experienced per location that exceeded a noise level of 60 decibels, termed N_{60}. When assessing a procedure change, changes in N_{60} were illustrated as "heat maps" that communicated the expected areas of noise change along with the magnitude of the change.

"The N_{60} heat maps proved to be an effective way to communicate expected noise changes to communities, and community reception to our visualization tools was positive," adds Salgueiro.

New flight paths reduce noise exposure

Among several noise abatement concepts the ICAT team studied, they identified moving trajectories over water as the most effective noise abatement strategy that also satisfied operational stakeholder criteria for implementation.

Following reviews by operational stakeholders and deliberation by community groups, four ICAT-developed procedures were submitted to the FAA for implementation, two departure procedures and two approach procedures.

The new approach procedure to runway 33L, implemented in 2021, is now being flown regularly by large commercial aircraft. This procedure relies on a technology known as Required Navigation Performance (RNP) to guide aircraft on curved segments to the runway. A single-flight noise analysis of this procedure, shown above, estimated that 2,954 fewer people would be exposed to aircraft noise (above 60 decibels) when the new procedure is used in place of the conventional straight-in approach.

The new approach procedure to runway 22L, planned for initial use in 2024, similarly aims to replace the conventional straight-in approach with an over-water RNAV approach. A full-day analysis of this procedure estimated that 131,892 fewer people would be exposed to 50 or more daily overflights that exceed 60 decibels—a significant reduction.

"The two approach procedures that were implemented through this project represent significant advances towards making use of modern aircraft navigation capabilities to achieve more flexible routing that, in this case, provide significant noise benefits," explains Salgueiro. "I think this study sets a positive precedent that we are willing to innovate on how we design new procedures when there is a clear noise benefit to impacted communities."

Next steps

The ICAT researchers will continue to collaborate with the FAA and Massport by providing technical analysis to support the ongoing adoption of the new procedures. To encourage airlines to fly the new low-noise procedures, the team is now conducting analyses of fuel burn on the newly implemented procedures. So far, preliminary results suggest that, in addition to providing a noise reduction, the procedures may also provide fuel savings to airlines by cutting down on miles flown to the runway—a win-win scenario for both communities and airlines. With the support of Massport, the team is also analyzing data from a network of noise monitors installed around the airport. This will allow the team to measure and better understand the noise benefits achieved with the new flight procedures.

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