Up, Up, and Away: Innovations in Advanced Air Mobility

Volpe Center's Role in Acoustics

Environmentally Responsible Integration | January 17, 2024

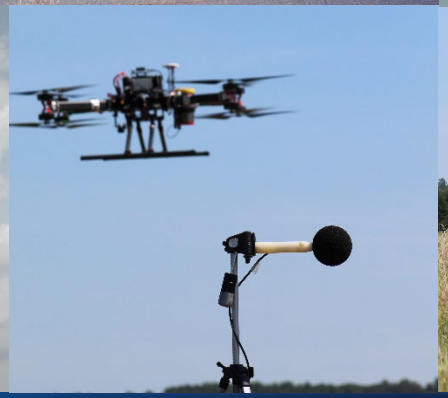
Christopher Roof

Discussion Outline

- Noise certification
- Noise modeling and the National Environmental Protection Act (NEPA)
- Volpe intra-governmental coordination and support
- Volpe technical support to AAM industry

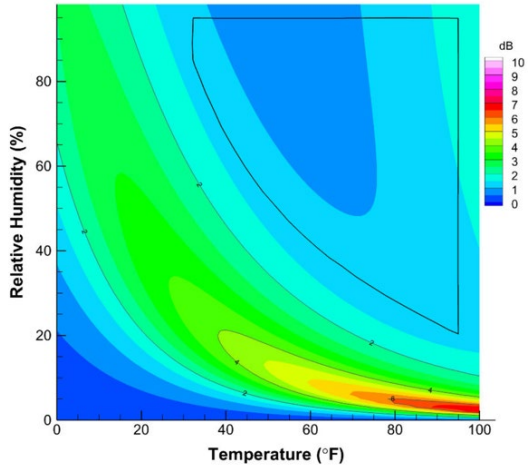
Volpe Aviation Noise Certification Support for Emerging Technologies

- 1970's: Concorde
- 1980's: Helicopter "Rainbow" reports, Unducted Fan
- 1990's: NOTAR (NO-TAil-Rotor), Tiltrotor
- 2000's: Small drones, spiroid winglets, UAM/AAM, GoFly



Noise Certification

- Decades-long history for traditional commercial aviation
- Separate processes for fixed-wing and rotorcraft
  - Also for small and large rotorcraft…
- Technical Issues: background noise, signal-to-noise ratio, ground effects, terrain and instrumentation…

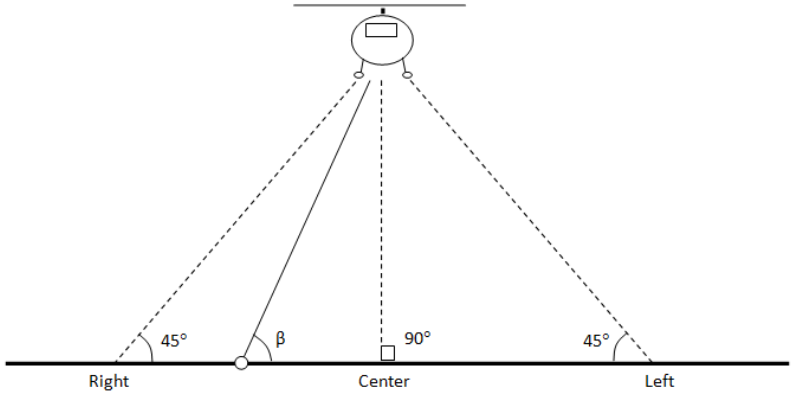


Document	Description	Application
FAA Part 36	Measurement requirements for aircraft noise certification	As a guide for standard measurement practices
ANSI/ASA S12.75 - 2012	Measurement methods for high performance military jet aircraft	As a guide for standard measurement practices
ICAO Doc 9501 AN/929	Environmental Technical Manual	As a guide for standard measurement practices
ANSI/ASA S1.26-2014	Methods for the Calculation of the Absorption of Sound by the Atmosphere	As a guide for standard measurement practices
NASA/TP-2020-5007433	Urban Air Mobility Noise: Current Practice, Gaps, and Recommendations	Documents the state of UAM noise measurements during UNWG formation
SAE ARP 4055	Ground-Plane Microphone Configuration for Propeller-Driven Light-Aircraft Noise Measurement	As a guide for microphone installation details
International Electrotechnical Commission International Standard 61265	Electroacoustics - Instruments for measurement of aircraft noise - Performance requirements for systems to measure sound pressure levels in noise certification of aircraft.	Standards for microphones
ICAO Annex 16 Vol. I, 8th Ed., Amend. 14 Attach. H. "Guidelines for Obtaining Helicopter Noise Data for Land-use Planning Purposes"	Guidance material for the use of noise certification data or supplementary test data for land-use planning purposes suitable for the prediction of helicopter noise exposure contours and to support the development of heliport noise abatement operational procedures.	Provides guidance on hover noise measurements, including microphone layouts and operations.
ICAO/CAEP 12 WG1 Proposal 61 Section 4 "Guidelines for Acquiring Helicopter Hover Noise Data"	Proposed revision to Annex 16, Vol I, Attachment H to provide guidelines on acquiring helicopter hover noise data to achieve sufficient commonality in measurement conditions and locations to permit comparability between different hover noise datasets.	This is pre-publication version of the Annex 16 Land-Use Planning Attachment H listed above

Source: DRAFT UAM Ground & Flight Test Measurement Protocol
URBAN AIR MOBILITY NOISE WORKING GROUP (UNWG) SUBGROUP 2

Noise Certification

- Novel technical issues
  - Wind speeds at the vehicle
  - Acoustic directivity controlled by individual rotor phase
- How treat Advanced Air Mobility noise certification?
  - Not legacy aviation OEMs
  - Rapidly evolving technologies
  - Fluid missions
  - “Transition” states
  - Metrics

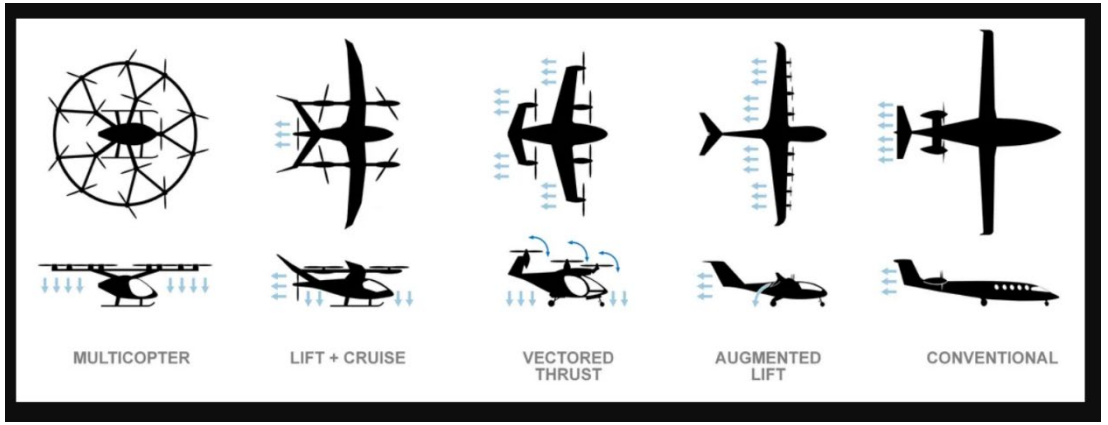


Source: FAA ASCENT Project 77
Penn State University

Volpe @ GoFly Competition https://goflyprize.com/
2020

Noise Characterization/Certification

- Collaboration
  - US Govt – FAA, NASA
  - Other Govt – EASA, UK CAA,…
  - Industry/other partners within ICAO
- US individual vehicle whitepaper process…
  - Certify vehicle under existing rules, if warranted
  - FAR Part 36 Appendix H/J for large/small rotorcraft, K for tiltrotor
  - Rule of Particular Applicability (RPA) using G3 issue paper
- International process in parallel



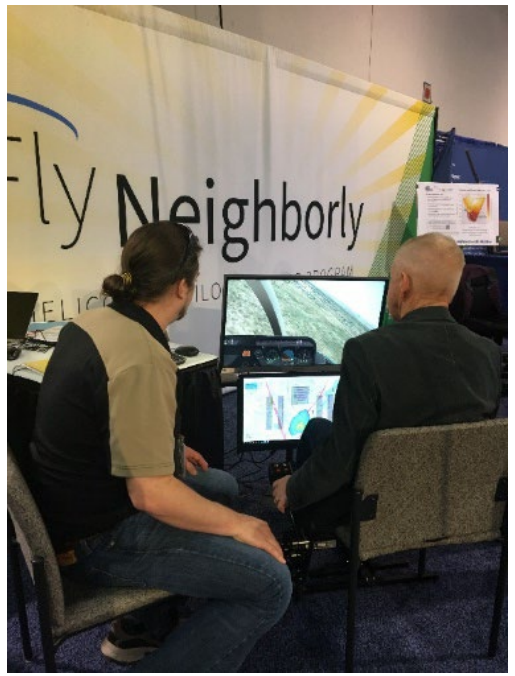
Source: "AAM Reality Index" https://aamrealityindex.com/aam-reality-index

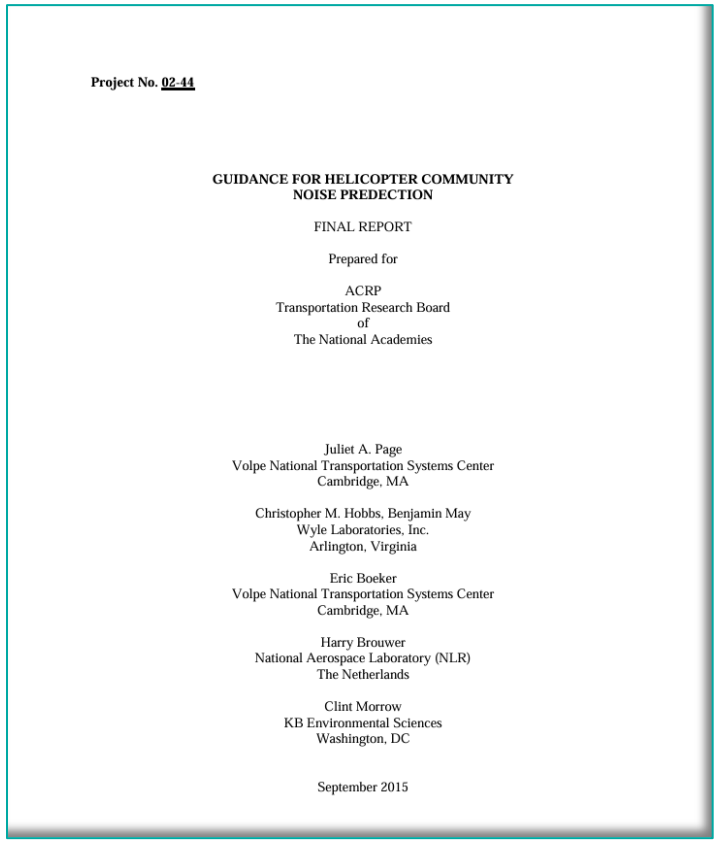
Noise Modeling and NEPA

FAA Advanced Air Mobility (AAM) Implementation Plan, Version 1.0:

> *"in order to determine whether compliance with NEPA is required, the FAA will need to identify whether there is/are a major federal action(s) triggering NEPA"*

- Noise
- Emissions
- Community engagement
- Construction impacts
- Environmental justice
- Wildlife





Project No. 02-44

GUIDANCE FOR HELICOPTER COMMUNITY NOISE PREDECTION

FINAL REPORT

Prepared for

ACRP
Transportation Research Board
of
The National Academies

Juliet A. Page
Volpe National Transportation Systems Center
Cambridge, MA

Christopher M. Hobbs, Benjamin May
Wyle Laboratories, Inc.
Arlington, Virginia

Eric Boeker
Volpe National Transportation Systems Center
Cambridge, MA

Harry Brouwer
National Aerospace Laboratory (NLR)
The Netherlands

Clint Morrow
KB Environmental Sciences
Washington, DC

September 2015

NEPA

- Noise Modeling
  - FAA's Aviation Environmental Design Tool (AEDT)
  - Volpe's Advanced Acoustic Model
  - eVTOL Simulation (MIT- ASCENT 84)
  - Probabilistic (UAS) Model (GTech- ASCENT 94)

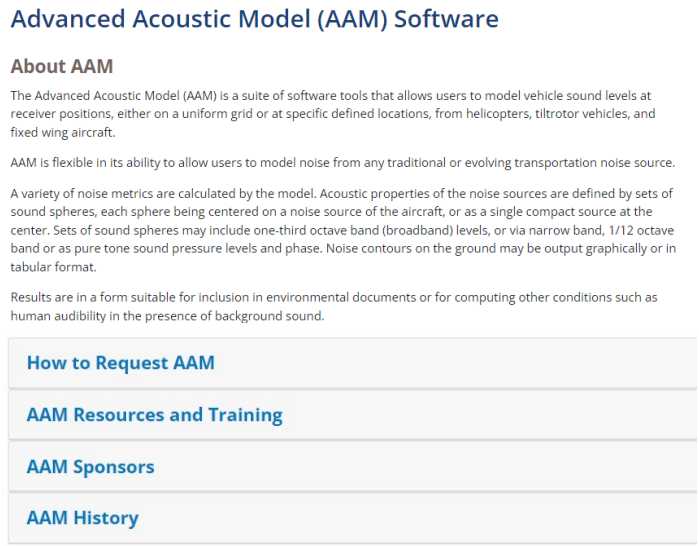
https://ascent.aero/

Aviation Environmental Design Tool (AEDT)

Version 3f

U.S. Department of Transportation
Federal Aviation Administration

https://aedt.faa.gov/3f_information.aspx



Advanced Acoustic Model (AAM) Software

About AAM

The Advanced Acoustic Model (AAM) is a suite of software tools that allows users to model vehicle sound levels at receiver positions, either on a uniform grid or at specific defined locations, from helicopters, tiltrotor vehicles, and fixed wing aircraft.

AAM is flexible in its ability to allow users to model noise from any traditional or evolving transportation noise source.

A variety of noise metrics are calculated by the model. Acoustic properties of the noise sources are defined by sets of sound spheres, each sphere being centered on a noise source of the aircraft, or as a single compact source at the center. Sets of sound spheres may include one-third octave band (broadband) levels, or via narrow band, 1/12 octave band or as pure tone sound pressure levels and phase. Noise contours on the ground may be output graphically or in tabular format.

Results are in a form suitable for inclusion in environmental documents or for computing other conditions such as human audibility in the presence of background sound.

How to Request AAM

AAM Resources and Training

AAM Sponsors

AAM History

https://www.volpe.dot.gov/AAM

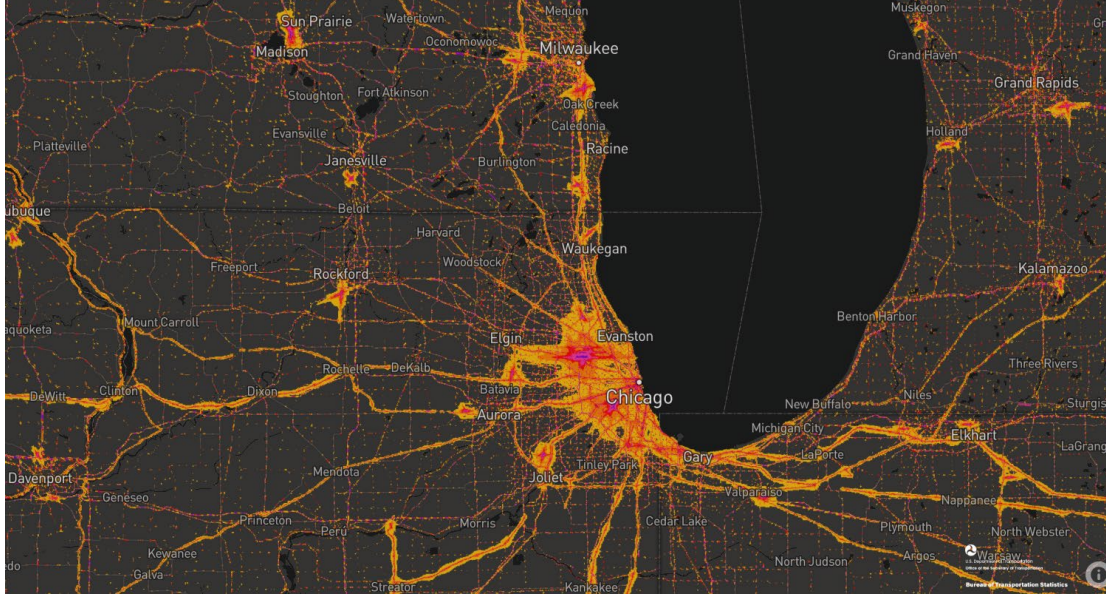
Intra-governmental coordination and support

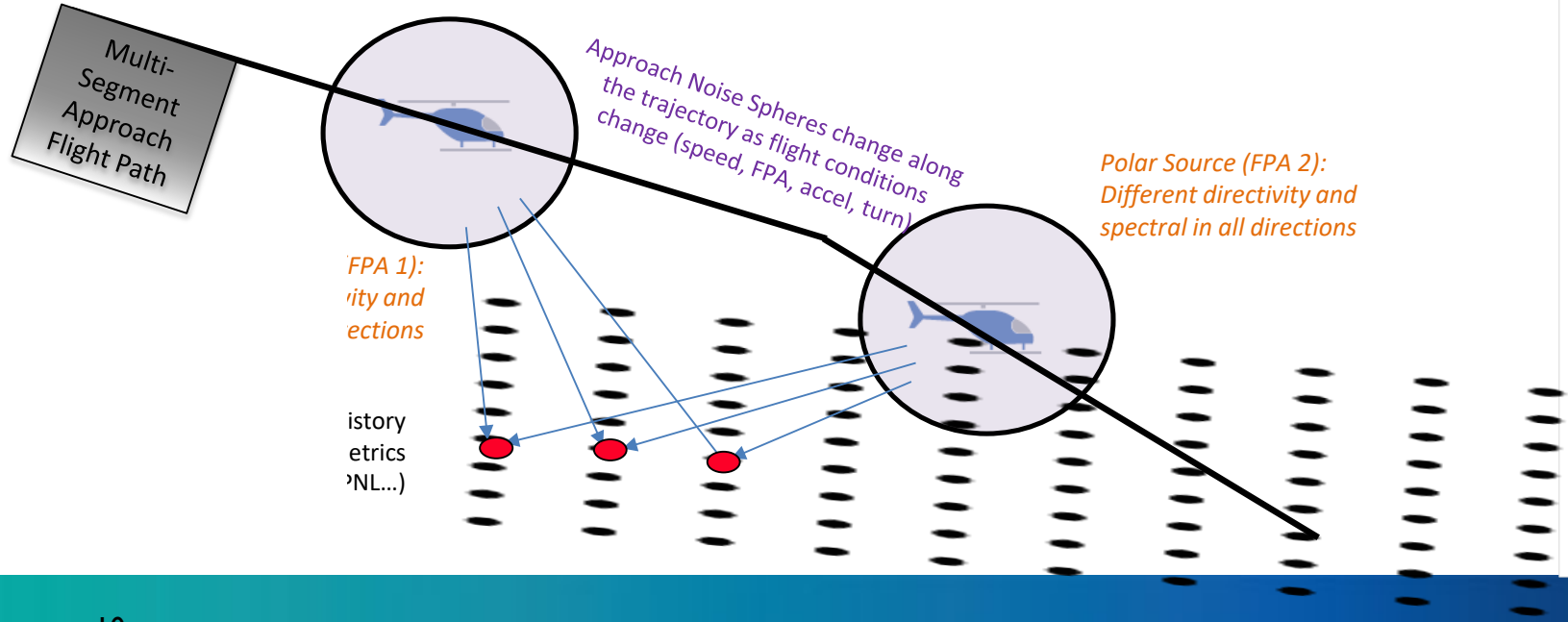
- FAA's Aviation Environmental Design Tool (AEDT)
  - NASA Ames
    - Model evaluation (AEDT, Advanced Acoustic Model, AirNoiseUAM)
      Source: InterNoise 2021: Rizzi, Page, Cheng
    - AEDT capabilities and limitations (EJ, vehicle characteristics)
  - NASA Langley
    - Unique approaches to modeling (rotorcraft vs. fixed-wing)
    - Profile modeling (fixed-point vs. procedural)
    - Operations handling (bulk operations)
    - Outreach and coordination
- Who do I call to make a complaint?
  - Airport-centric context for commercial aviation
  - Operations not focused on existing commercial airports?
    - Town hall, commercial entity, local police?

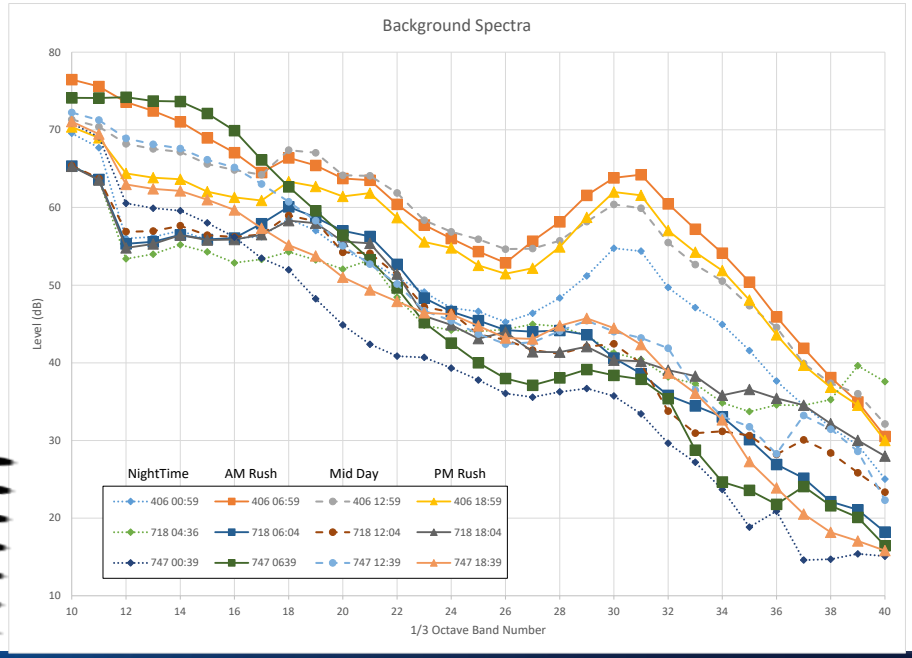
Volpe Support for Industry

- Audibility (d-Prime) analysis
  - Advanced Acoustic Model
  - Multiple ambient environments
    - Leveraged BTS National Transportation Noise Map

      https://maps.dot.gov/BTS/NationalTransportationNoiseMap/
- Noise Model Improvements
  - 1/12 octave band capabilities

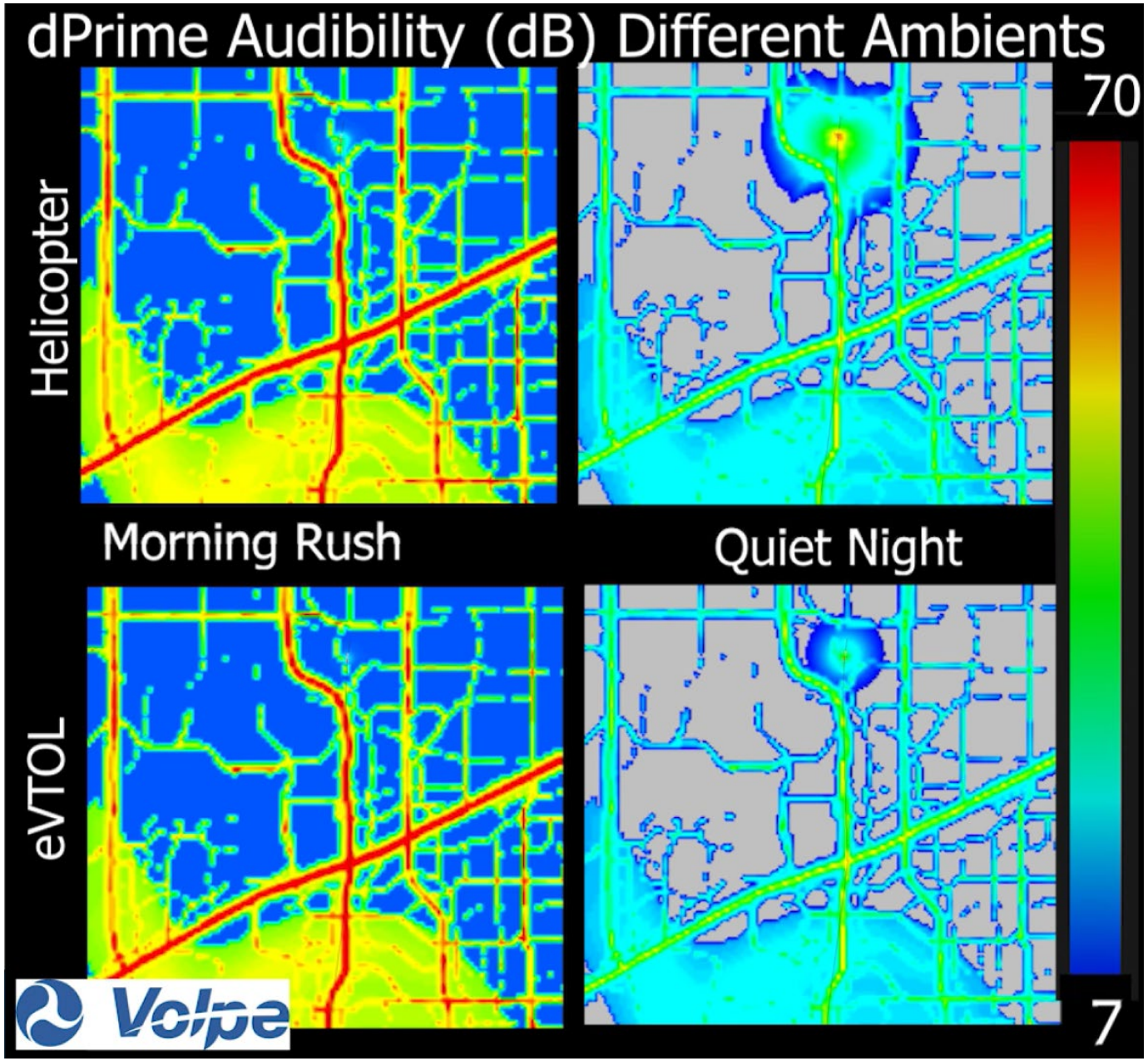






U.S. Department of Transportation Volpe Center

Volpe Support for Industry



Thank you for your time!

Volpe Acknowledgements

- Eric Boeker
- Chris Cutler-Wood
- Dr. Robert Downs
- Gregg Fleming
- Dr. Aaron Hastings
- Bradley Nicholas
- Juliet Paige (BRRC)
- Amanda Rapoza
- David Read
- David Senzig (FAA)
- Ted Thrasher (Mitre)
- Sarasina Tuchen (HASS COE)

Useful References

- NASA/FAA UAM Noise Working Group (UNWG) - https://ntrs.nasa.gov/citations/20220008095
- Quiet Drones Symposium - https://www.quietdrones.org/
- Federal Aviation Administration, FAA Order 1050.1F Environmental Impacts: Policies and Procedures, July 2015
- Federal Aviation Administration Advanced Air Mobility (AAM) Implementation Plan
- Lee, Cynthia, et al., Aviation Environmental Design Tool (AEDT) Technical Manual Version 3e, Report No. DOT-VNTSC-FAA-22-04, Washington, D.C.: Federal Aviation Administration, May 2022
- Lee, Cynthia, et al., Aviation Environmental Design Tool (AEDT) User Manual Version 3e, Report No. DOT- DOT-VNTSC-FAA-22-03, Washington, D.C.: Federal Aviation Administration, May 2022
- Nicholas, B., Thrasher, T., & Tuchen, S., Software Scoping Document for Integration of Urban Air Mobility Vehicles into the Federal Aviation Administration's Aviation Environmental Design Tool, DOT-VNTSC-NASA-21-01, U.S. Department of Transportation John A. Volpe National Transportation Systems Center, September 2021
- Rizzi, Stephen A., et al. Urban Air Mobility Noise: Current Practice, Gaps, and Recommendations, NASA/TP–2020-5007433, National Aeronautics and Space Administration, October 2020

Questions?

Christopher J. Roof

Chief, Environmental Measurement and Modeling
U.S. DOT Volpe Center

617.494.6344
Christopher.Roof@dot.gov

www.volpe.dot.gov

www.volpe.dot.gov/our-work/policy-planning-and-environment/environmental-measurement-and-modeling