Project 41
Identification of noise acceptance onset for noise certification standards of supersonic airplanes

Motivation

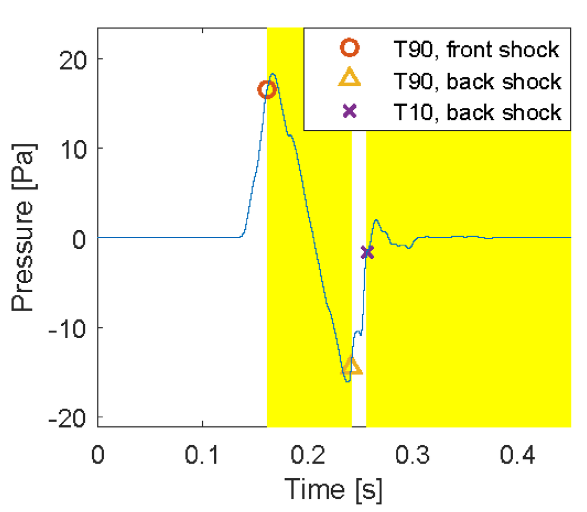
- Developing certification standards for low-boom noise

Objectives

- Continue development of turbulence removal methods for low-boom ground signatures
- Assess viability of different computational schemes for sonic boom propagation
- Support the development of international standards for low-boom supersonic flight

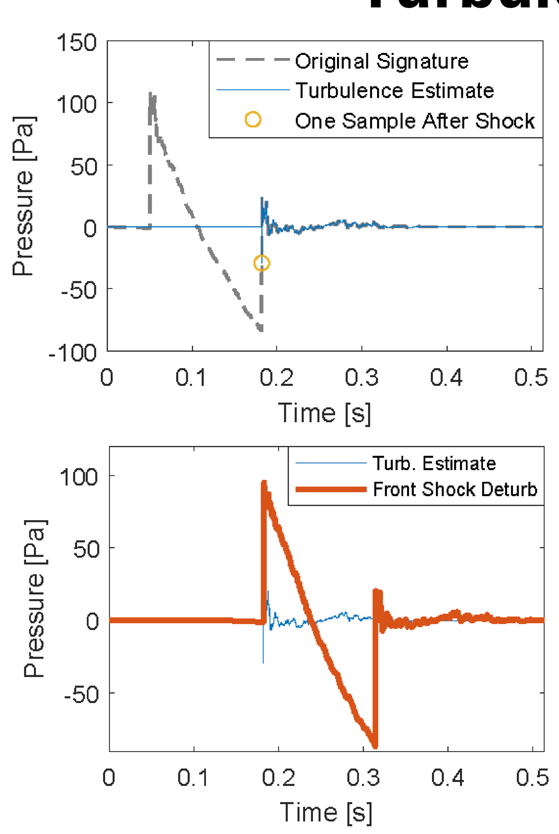
Removing Turbulence for Individual Signatures

Low-Pass Filtering



- Waveform is low-pass filtered around the shocks to retain shock features

Turbulence Subtraction

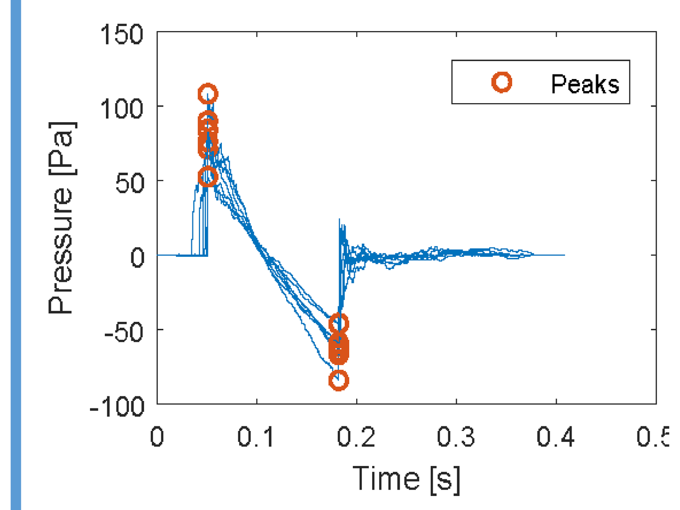


- Back shock behaves like a step function
- Any differences are subtracted off, giving a turbulence estimate
- Turbulence estimate is subtracted from front and back shocks
- Does not work for waveforms that are not N-waves

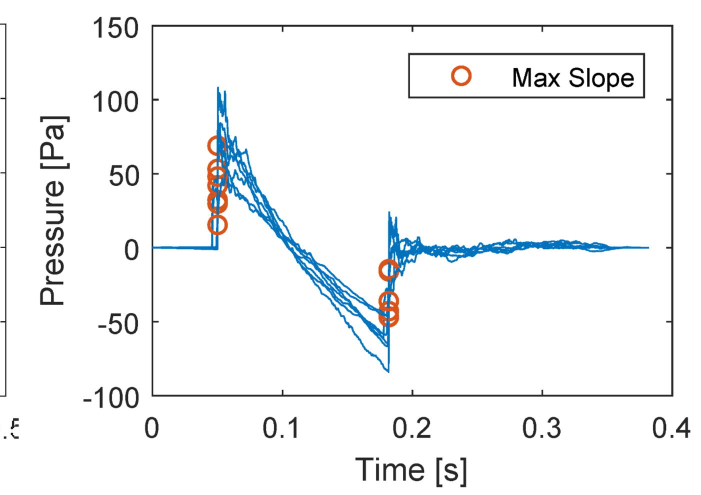
Removing Turbulence for Multiple Signatures

Aligning and Averaging

By Peak

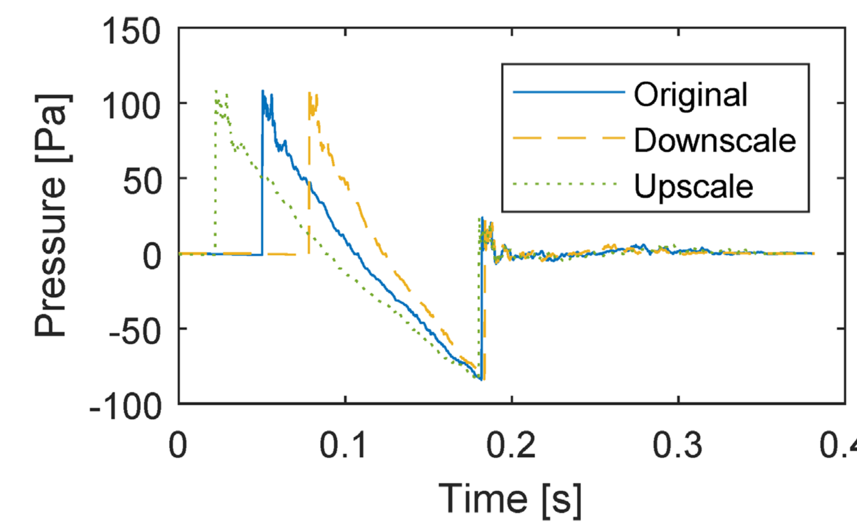


By Maximum Slope



- All signatures are time-stretched to have same duration as median-length waveform
- Signatures are then aligned by either the waveform peaks or points of maximum slope
- All signatures are then averaged into one composite signature

By Cross-Correlation



- Signatures are time-stretched based on different scaling factors and lags until maximum cross-correlation with a reference signature is achieved
- All signatures are then averaged into one composite signature

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Results and Discussion

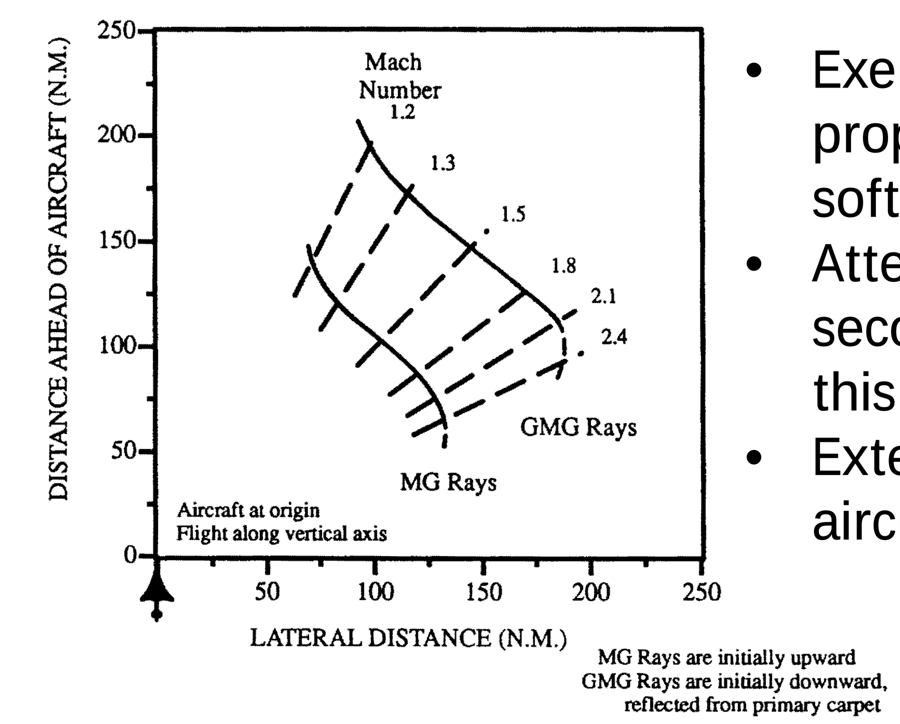
- Effectiveness of turbulence removal methods was determined by the closeness of the de-turbulized signatures to the original signatures.
- Signature similarity was evaluated with an objective metric (mean-square error) and several subjective metrics (Stevens Mark VII Perceived Level, ISBAP, ASEL, and BSEL)
- Individual low-pass filtering, group low-pass filtering, and averaging by maximum slope have the least variation across metrics

Next Steps

Task 1: En-route SARP Development

- Research audio fingerprinting methods as a further means for removing turbulence from boom and low-boom signatures
- Support scheme development exercise.
- Compare propagation outputs produced by different boom propagation softwares

Task 2: Secondary Sonic Boom Study



- Exercise a secondary sonic boom propagation module in the PCBoom software
- Attempt to reproduce Concorde secondary sonic boom predictions with this module
- Extend analysis to proposed supersonic aircraft

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FAA: Sandy Liu, Project Manager
Volpe: Juliet Page

Cost Share Partners:

Boom Supersonic: Eli Dourado
Gulfstream: Robbie Cowart, *et al.*

References:

[1] H. Poling, "Impact on weather and flight conditions on secondary booms," in 1995 NASA High Speed Research Program Sonic Boom Workshop, Vol. 1, NASA-CP-3335 (July 1996), pp. 136-150.
[2] D. J. Maglieri, P. J. Bobbitt, K. J. Plotkin, K. P. Shepherd, P. G. Coen, and D. M. Richwine, "Sonic boom: Six decades of research," p. 13, NASA Langley Research Center, Hampton, VA (2014).
[3] J. Xu and V.W.Sparrow, "Investigation of Deturbing Methods for Supersonic Aircraft Sonic Boom Certification," Manuscript in Preparation.

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