ASCENT Project 57

Support of Supersonic Aircraft En-route Noise Efforts in ICAO CAEP

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Cost Share Partners: Boom, Gulfstream

Objective:

- Research continues to support FAA in the development of technical standards for civil supersonic aircraft under the ICAO CAEP
  - Task 1: Efforts focus primarily in the area of en-route sonic boom noise assessment
  - Task 2: Testing capability of PCBoom software to model secondary sonic booms

Project Benefits:

- Predictive capabilities for sonic boom impacts
- Continued study of secondary sonic boom prediction
- Applicability of certain metrics
- Testing of signal processing methodologies for sonic boom signals
- Scheme assessment for sonic boom certification

Research Approach:

- Task 1: Simulate the effects of turbulence on shaped sonic boom within the atmospheric boundary layer
  - Propagate from cruise altitude to ABL with no-turbulence tool and ABL to ground with turbulence tool (involving both vector and scalar types)
- Task 2: Currently looking at prediction of secondary sonic boom for supersonic aircraft approaching U.S. coastlines, using flight conditions similar to Concorde.
- Task 3 (Volpe): Recover Concorde secondary boom signatures recorded by Volpe in 1979.

Major Accomplishments (to date):

- Using extended shaped boom input waveform file provided by NASA and tapers before and after propagation prevented artifacts before and after shocks
- Performed secondary sonic boom predictions for U.S. west coast for the first time

Future Work / Schedule:

- Determine sources of non-physical spiking in KZKFourier produced signatures
- Diagnose PCBoom secondary boom signal amplitude anomalies

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Turbulence Methodology

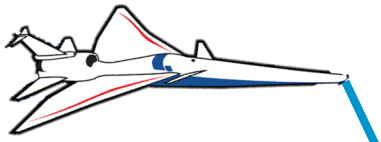
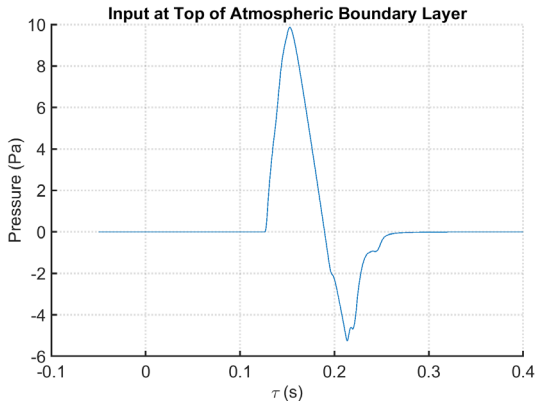


*Image courtesy of NASA

No Turbulence Tool: PCBoom 6.7.1.1

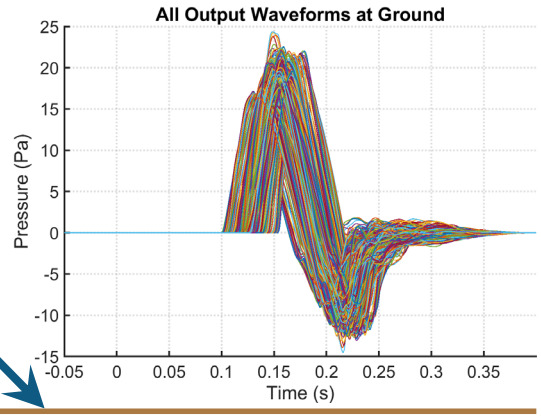
- Run from cruise altitude (54,000 ft) to top of ABL
- C609 shaped boom input waveform provided by NASA
- C609 models the NASA X-59 aircraft



Atmospheric Boundary Layer (ABL)
(268.2, 411.4, 1026.7 m)

Turbulence Tool: KZKFourier 2D2.4

- Applied 10% taper to KZKFourier input
- 10 random seeds to simulate turbulent atmospheres
- Considers both velocity and temperature fluctuations
- Run from top of ABL to ground altitude
- Applied 25% taper to KZKFourier output
- Output 100 ground pressure waveforms per turbulence condition



Ground

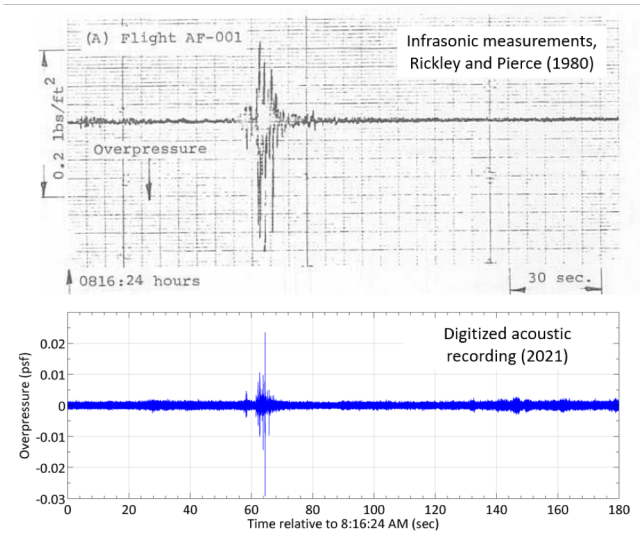
Use of New Database by WG1 PrSG

- Data provided to CAEP WG1 Procedures Subgroup for further analysis
  - Realistic perturbations of X-59 like (C609) sonic boom signatures
  - Use to prepare for analysis of actual X-59 ground signatures, heard by public
  - Assess applicability of en-route certification concepts and test for possible future use in standards
  - Trends seen in turbulent propagation simulations, consistent with previous work:

Thicker Atmospheric Boundary Layer → ▪ Lower mean levels ▪ Larger SDs

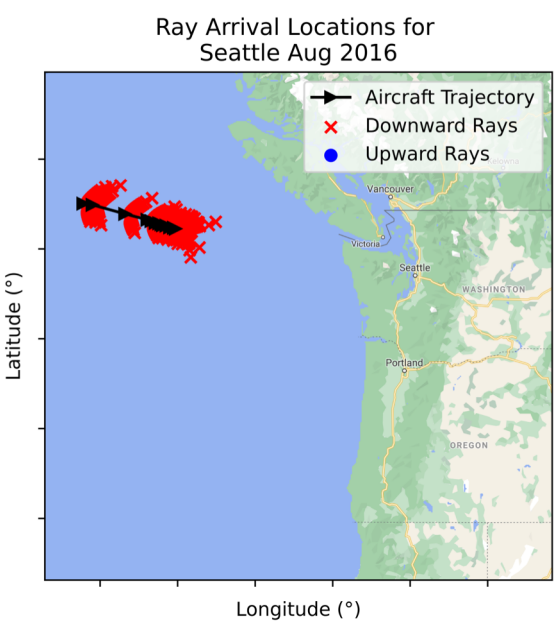
Recovery of Volpe Measurements of Concorde Secondary Sonic Booms from 1979

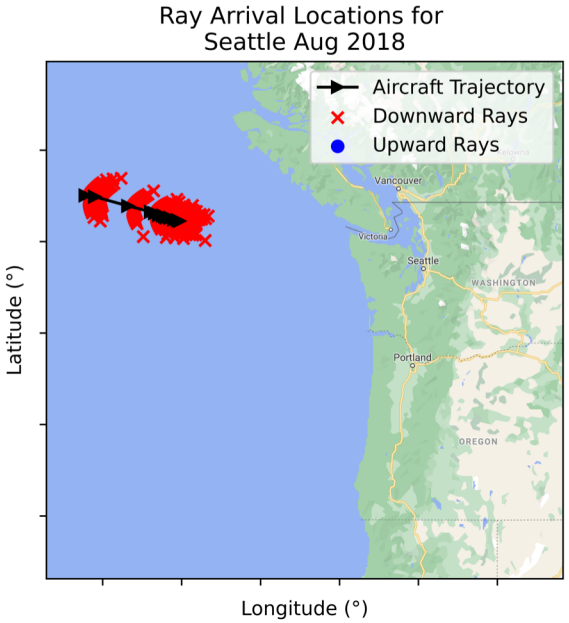
- Volpe able to read audio recordings so far
  - now working on actual infrasonic data tapes
  - we are hopeful



Seattle Approach Summer 2016/2018

- An approach from Tokyo into Seattle was modeled
  - Used Concorde as the aircraft
- Average Monthly weather data from CFSv2* was used
- Summer months were generally consistent from one year to the next
- Consistent with previous LAX results for summer months

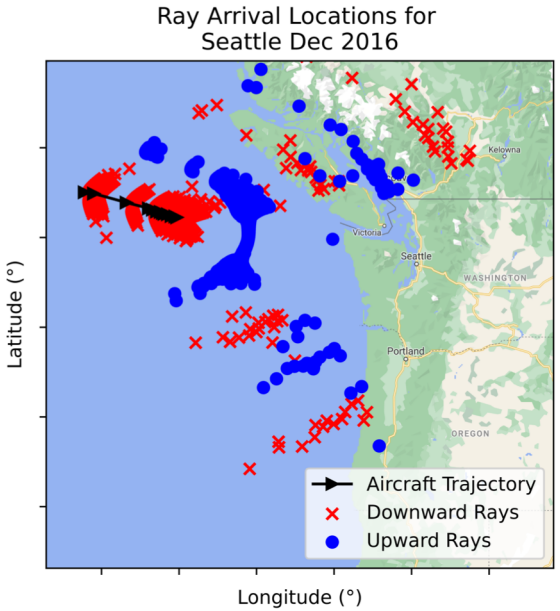


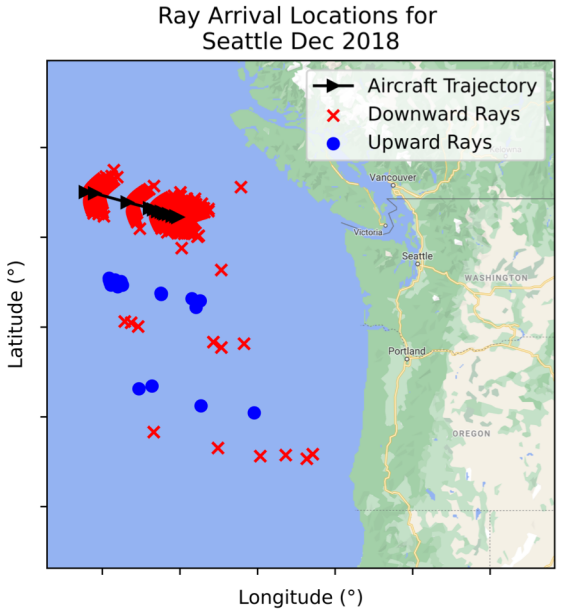


*Saha, S., *et al.* (2011). "NCEP climate forecast system version 2 (cfsv2) 6-hourly products," https://doi.org/10.5065/D61C1TXF.

Seattle Approach Winter 2016/2018

- Winter months were less consistent from one year to the next
  - Secondary booms were present in all winter months
- Consistent with previous LAX results for summer months





Expected Secondary Sonic Boom Arrivals			
	East Coast**	Europe**	West Coast
Summer	Yes	No	No
Winter	No	Yes	Yes

** previously observed from Concorde flights