

Sonic Booms and Community Testing

NASA's role in enabling commercial supersonic overland flight



Alexandra Loubeau
NASA Langley Research Center

The National Academies of Sciences, Engineering, and Medicine
Fall Meeting of the Aeronautics and Space Engineering Board
October 14, 2020

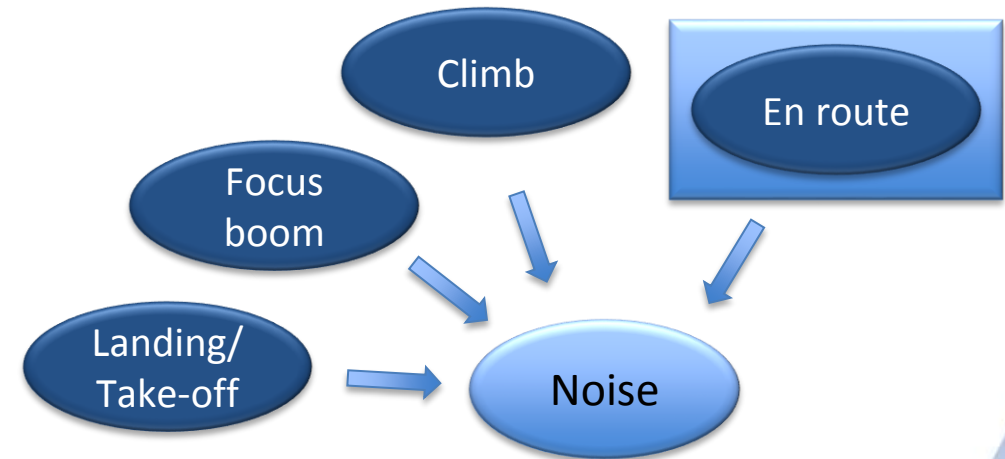
Civil Supersonic Flight



- Civil supersonic overland flight prohibited
- Recent advances to significantly reduce sonic boom noise
- Industry interest in lifting the ban

- **NASA is working with regulators to**

- Provide science-based assessment and data
- Enable development of a new noise standard
 - Noise metric, test procedures, noise limit



- **What are the payoffs if we are successful?**

- Replace current prohibition of civil supersonic overland flight with a noise-based standard for aircraft certification
- Open the door for development of a new generation of supersonic civil transport aircraft

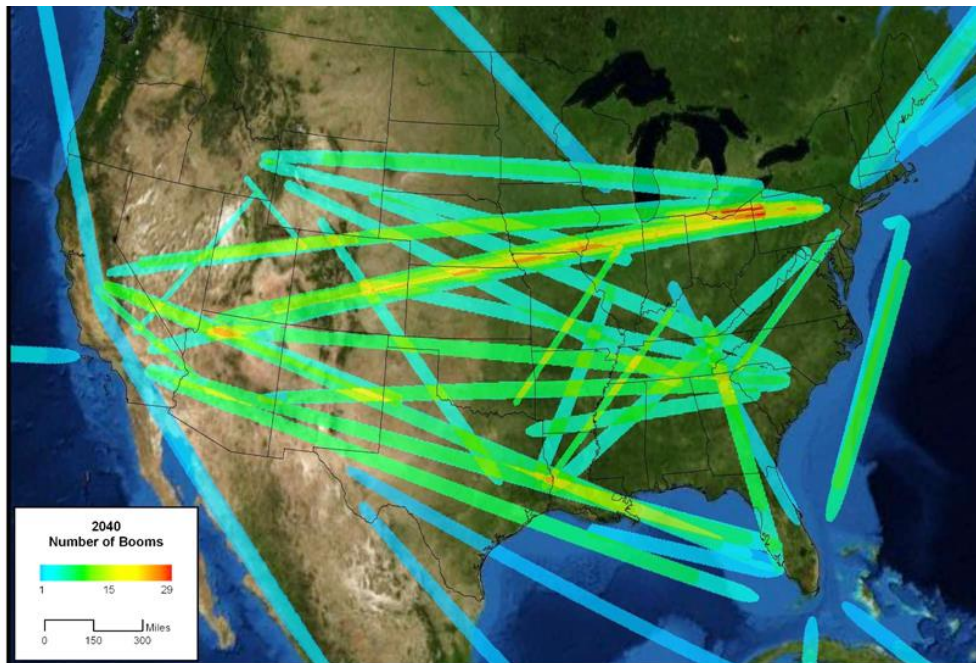
Sonic Boom Waveforms and Spectra



➤ Unique aspects of sonic booms

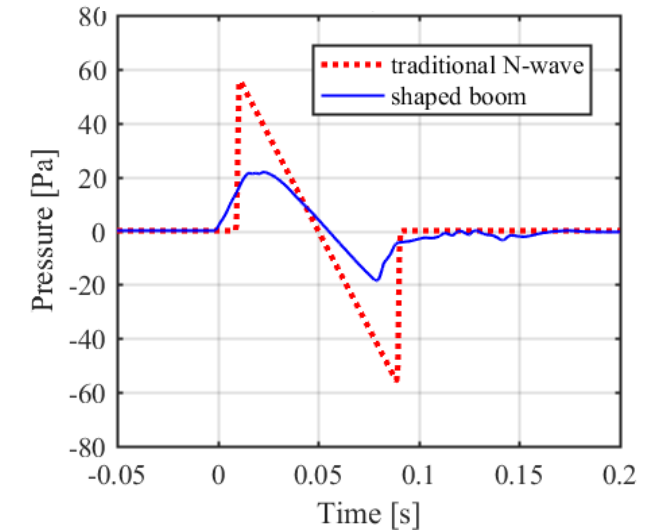
- Transient nature of sonic boom
- Low-frequency energy
- Created along entire supersonic path
- Cannot use the same methods/metrics as for subsonic aircraft

Number of booms predicted in 2040

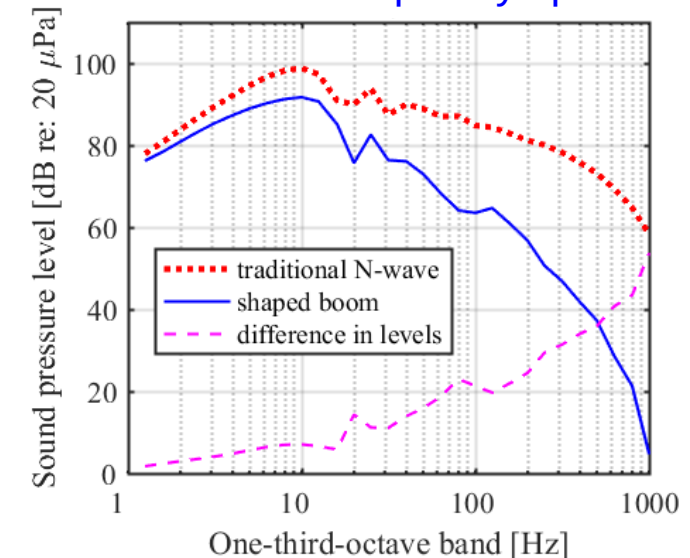


J. Rachami and J. Page. AIAA 2010-1385.

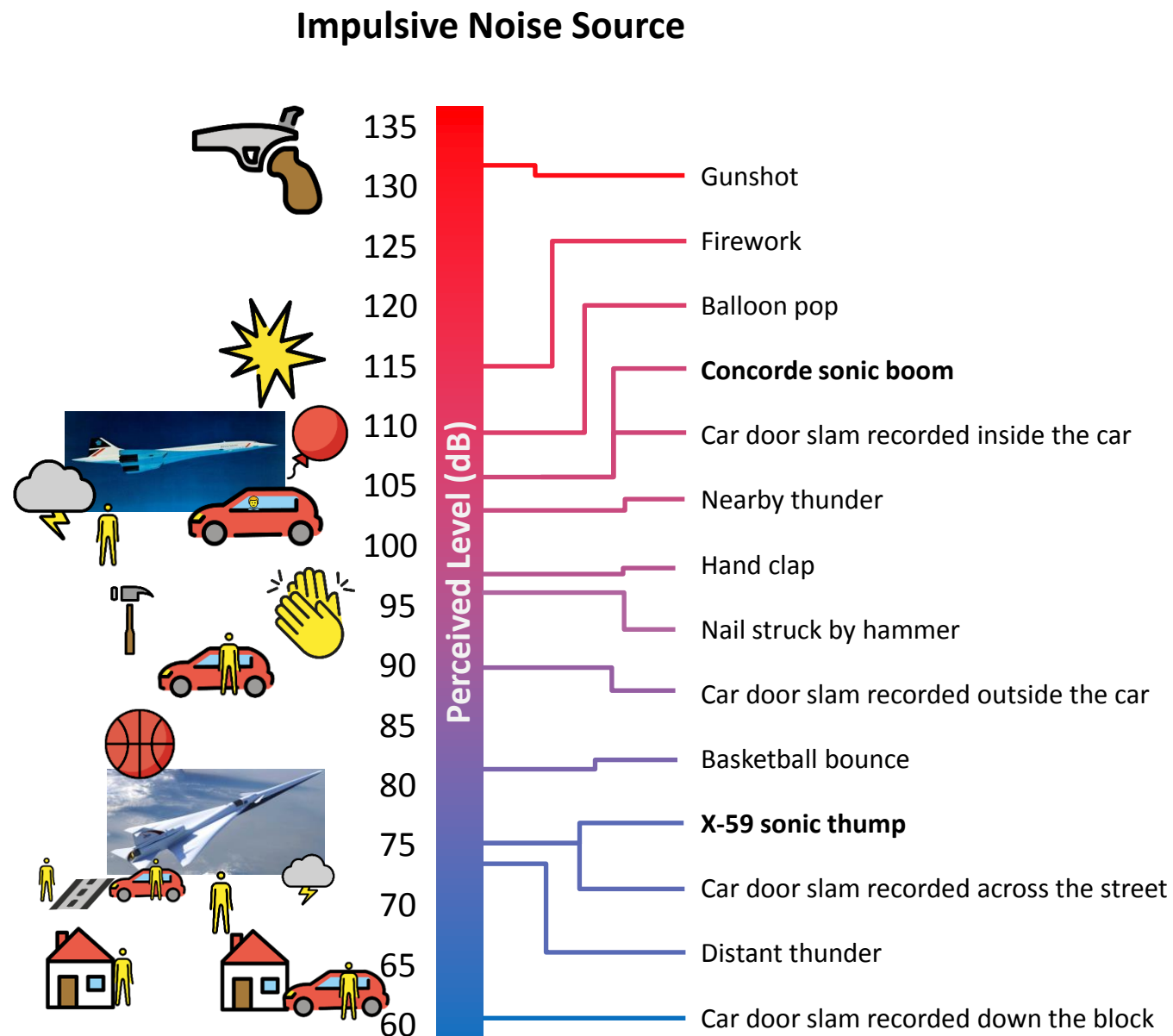
Example boom shapes



Variation in frequency spectra



“Thermometer” of Impulsive Noise Levels



Summary of Laboratory Testing



- **Sonic boom simulators have been used to investigate human annoyance to sonic booms in outdoor and indoor environments**
 - Pros: simulators allow control over environment, testing of variety of booms
 - Cons: setting not as realistic as at home, and only study single-event response
 - Most important factors studied separately
 - Results indicate that sonic booms with PL ~ 75 dB are much less annoying than conventional sonic booms
 - Annoyance levels to be confirmed with community testing

- **Full-scale vs. sub-scale aircraft**
 - For a given exterior PL, annoyance to sub-scale aircraft booms is not significantly different from that for full-scale aircraft booms
 - Confirmation that outdoor metrics can be used to evaluate supersonic aircraft designs, regardless of size
 - Results help justify relevance of X-59 demonstrator aircraft for use in community studies

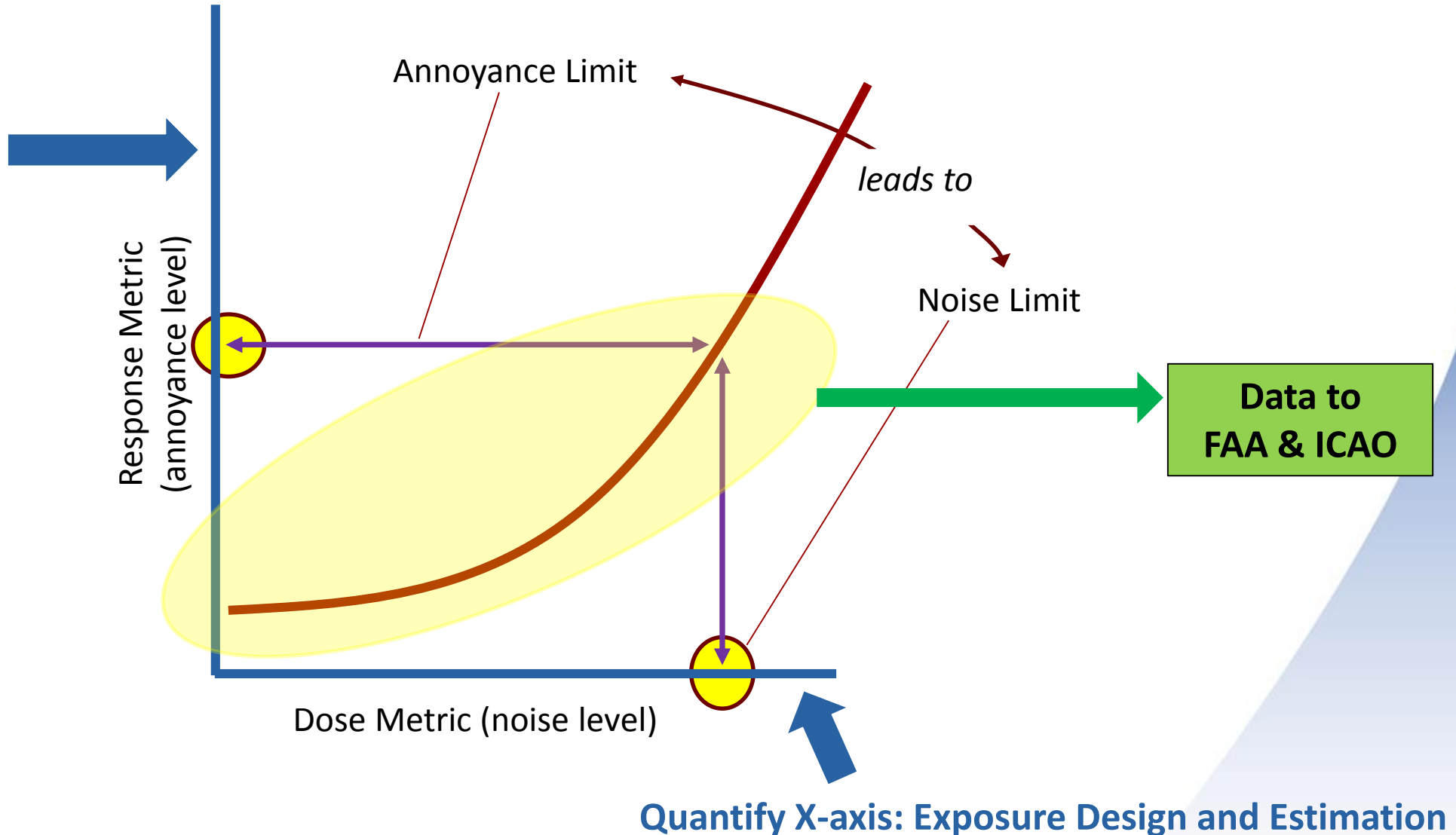
NASA Interior Effects Room



Dose – Response Characterization



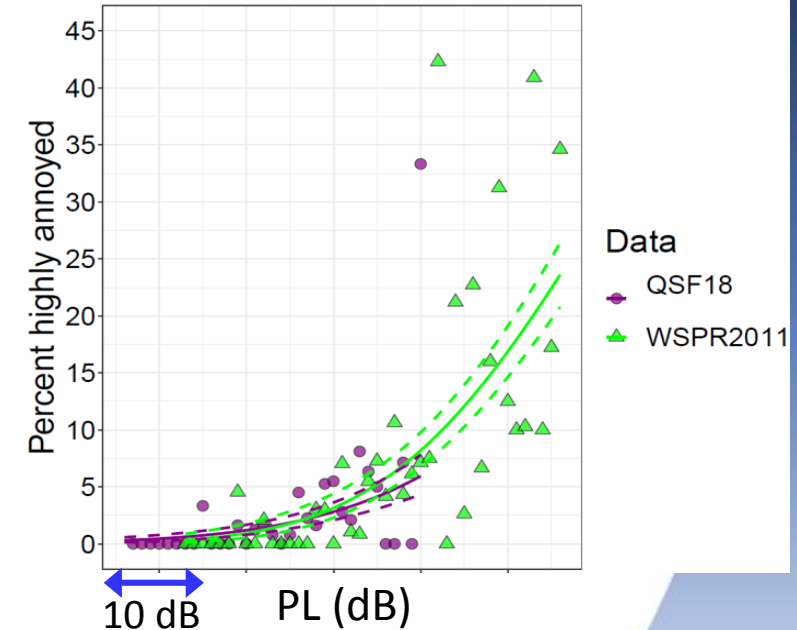
Quantify Y-axis:
Community Survey
Design/Analysis



Low Boom Community Response Testing



- **Build on prior community tests**
- **Small community study (WSPR2011)**
 - Added realism, but participants generally had regular exposure to sonic booms
 - Aircraft generated sounds over a small area
 - 50-100 test participants
- **Larger community risk-reduction study (QSF18)**
 - First test of community response in a “non-experienced community” since 1980s
 - Aircraft generated sounds over a moderate area
 - 500 survey participants, thousands of others exposed to sounds
- **Next step: fully realistic community overflights exposing large areas and varied populations**



J. Lee et al. J. Acoust. Soc. Am., 147:2222, 2020.



Conduct overflight tests with the X-59 in multiple representative U.S. communities

Next Steps



- **NASA is supporting the development of a new noise-based rule for supersonic flight**
- **X-59 community testing**
 - Key data will be gathered on public perception of quiet supersonic flights in several cities across U.S.
 - In preparation, further refinements of models and methods are being pursued
 - NASA invites international feedback on testing plans

