



Status of Certification Procedures for Quiet Supersonic Flight

Robbie Cowart – AIAA AVIATION 2019, Dallas, TX

June 19, 2019

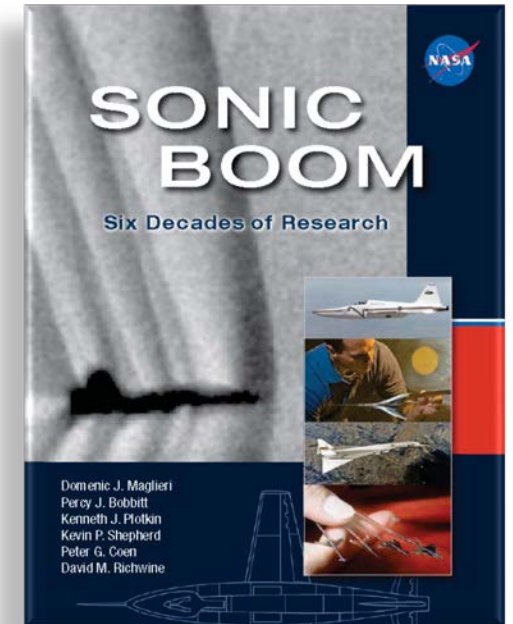
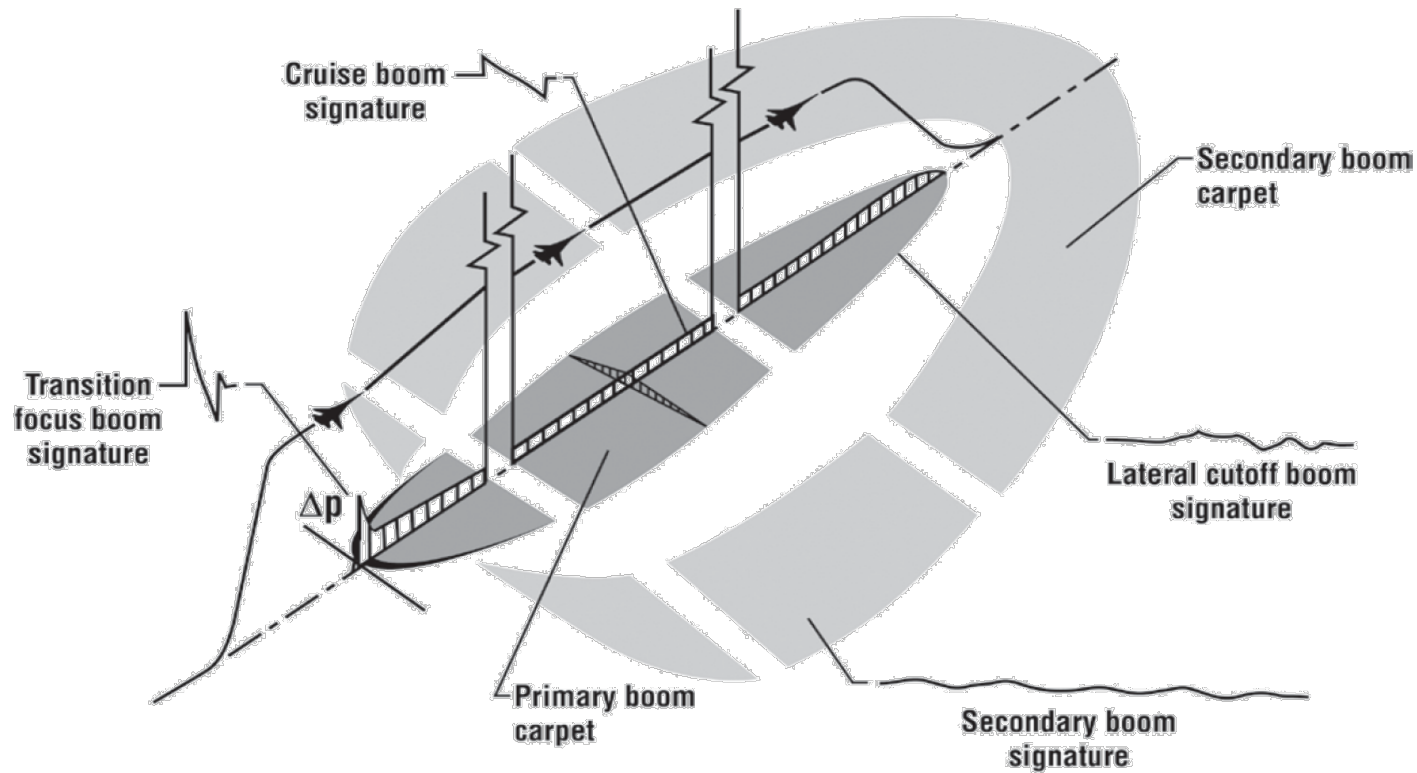
Noise Regulation for Supersonic Aircraft[†]

- Civil supersonic flight operations are prohibited over many parts of the world
 - 14CFR § 91.817 regulates flight speed for civil aircraft sonic boom
 - ICAO Assembly Resolution A39-1 Appendix G: Problem of Sonic Boom
- 14CFR § 36 Subpart B establishes landing & takeoff (LTO) noise requirements for transport category subsonic aircraft while Subpart D covers noise limits applicable for Concorde
 - Currently, there is no civil LTO noise regulation for new supersonic aircraft
- Two parts to consider for future supersonic capable aircraft
 - En Route Noise (sonic boom)
 - LTO Noise

[†] https://www.faa.gov/news/fact_sheets/news_story.cfm?newsId=22754

Supersonic En Route Noise

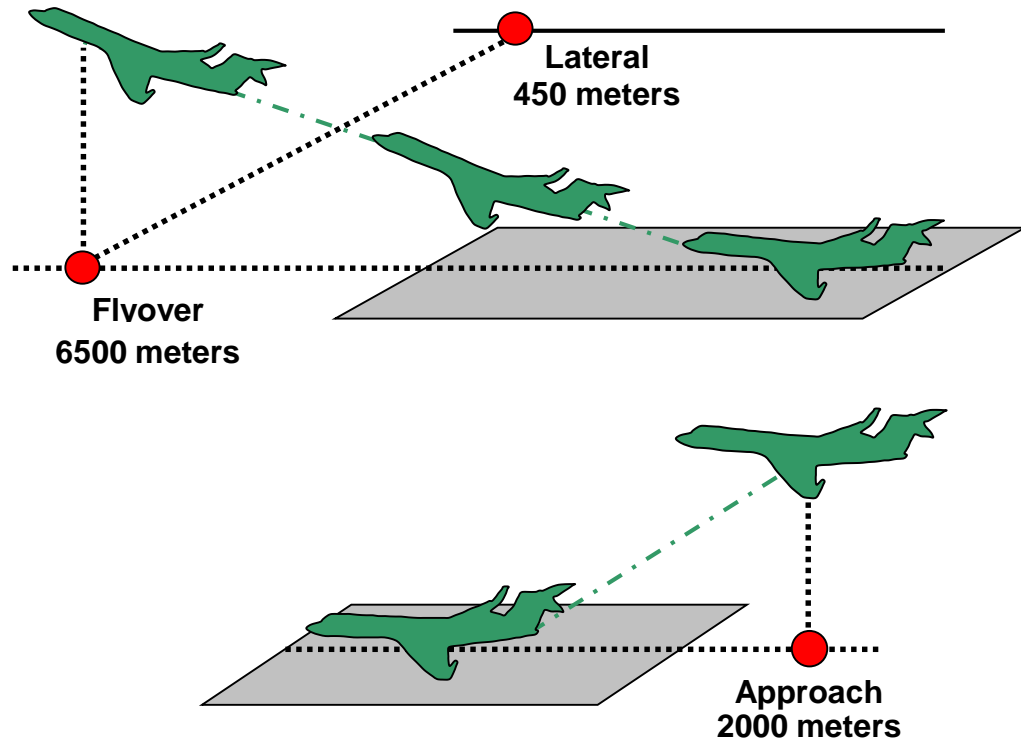
Ref. Figure 1.3
Maglieri, et. al. NASA-SP-2014-622



NASA-SP-2014-622
SONIC BOOM: Six Decades of Research
www.ntrs.nasa.gov

What Noise to Certify for Supersonic En Route Operations?

Aircraft Noise Certification (LTO Noise)



- Three (3) Measurement Points At Reference Conditions for LTO Noise
 - Takeoff Noise → Flyover & Lateral
 - Approach Noise
- Reference Atmospheric Conditions
- Effective Perceived Noise Level (EPNL)
 - Metric For Reporting Cert Level
- Test Day Measurements Corrected to Ref. Procedures and Ref. Day Conditions

En Route Noise: Need Reference Procedures, Reference Conditions, and Certification Metric

Potential Procedures...What Can We Do?

Ref. Figure 2.2
NASA-SP-2014-622

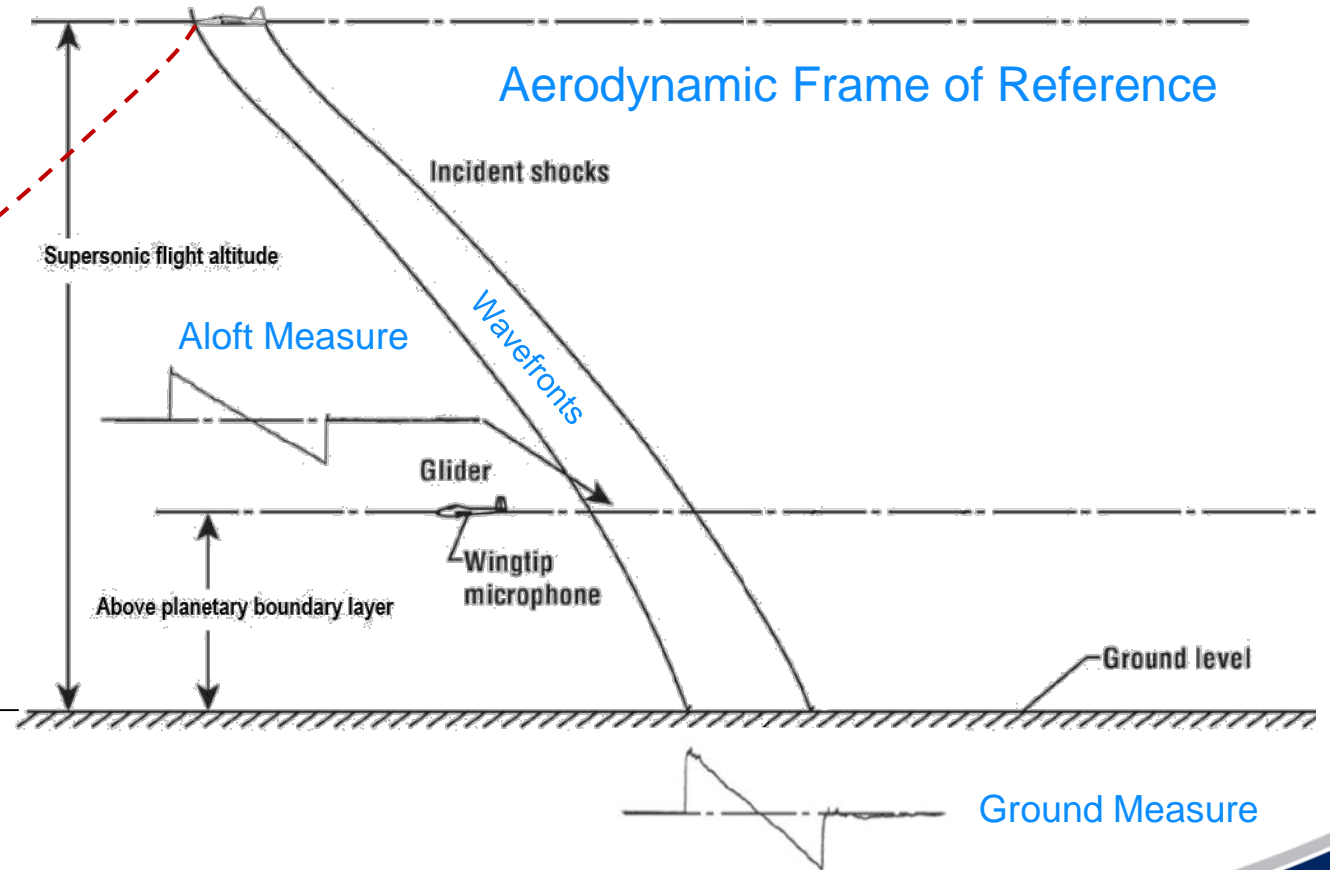
Acoustic Frame of Reference

Aerodynamic Frame of Reference

Predict Aloft Noise

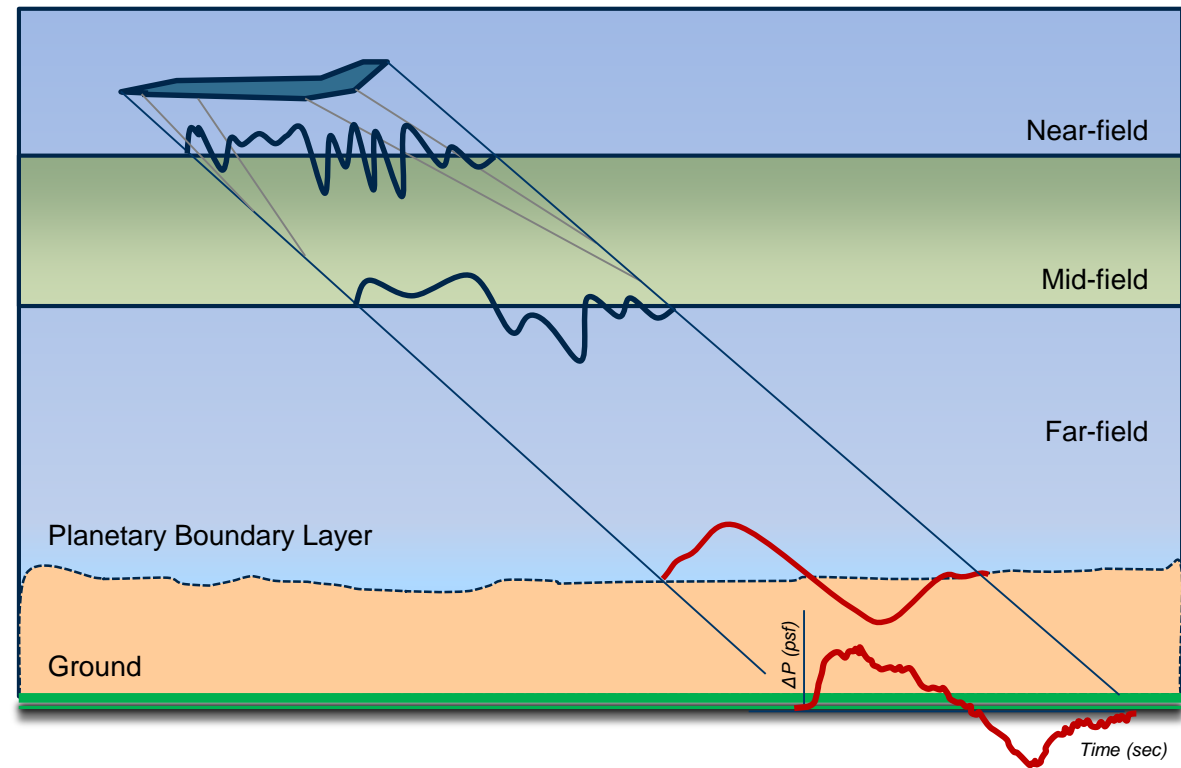
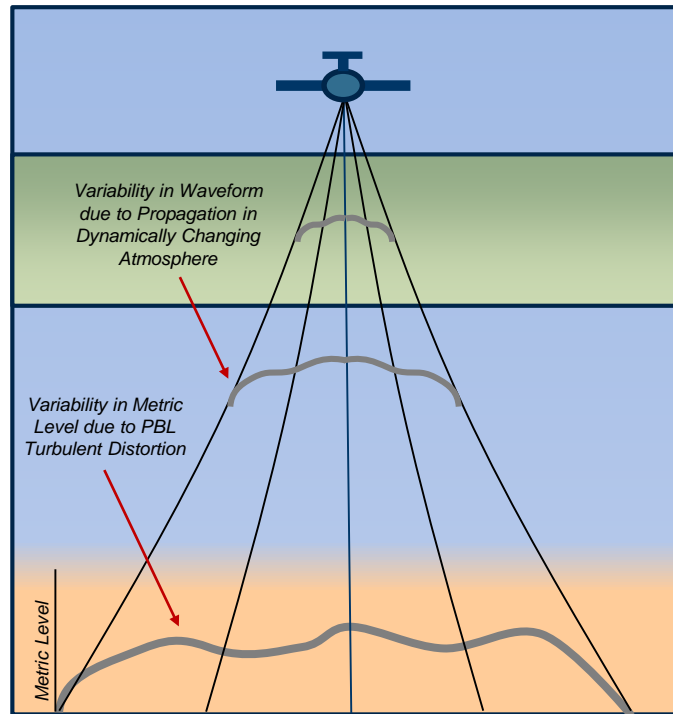
Ray Path

Predict Ground Noise

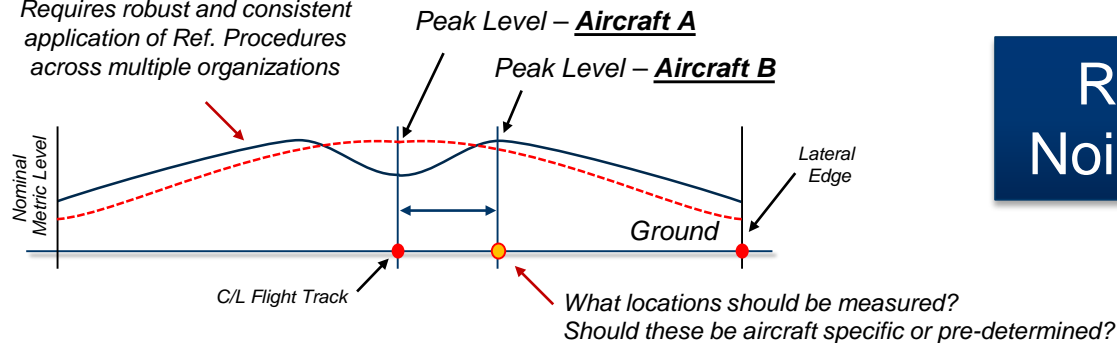


Measure and Predict Noise Levels

Supersonic En Route Noise Propagation Diagrams



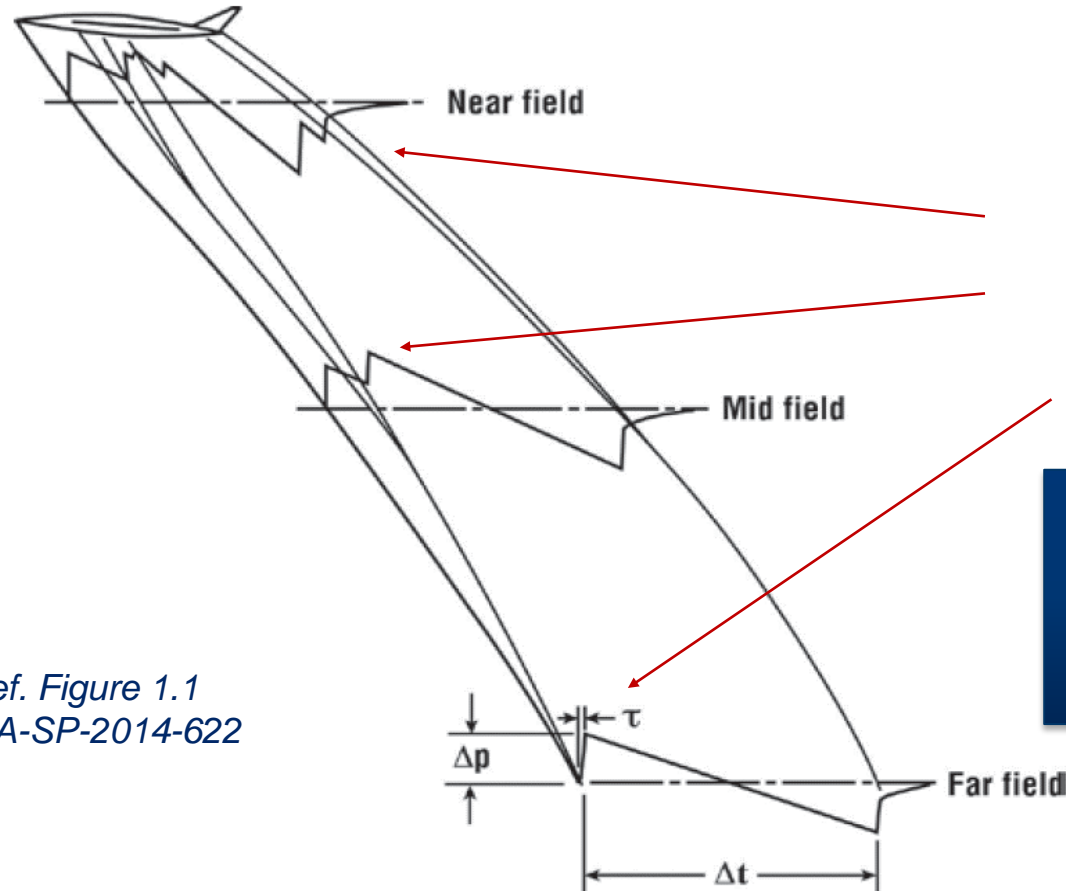
Requires robust and consistent application of Ref. Procedures across multiple organizations



Reference Procedure Must Characterize Noise Performance at Reference Conditions

How to Determine Noise Level at Reference Day Conditions?

- What we can't do ...



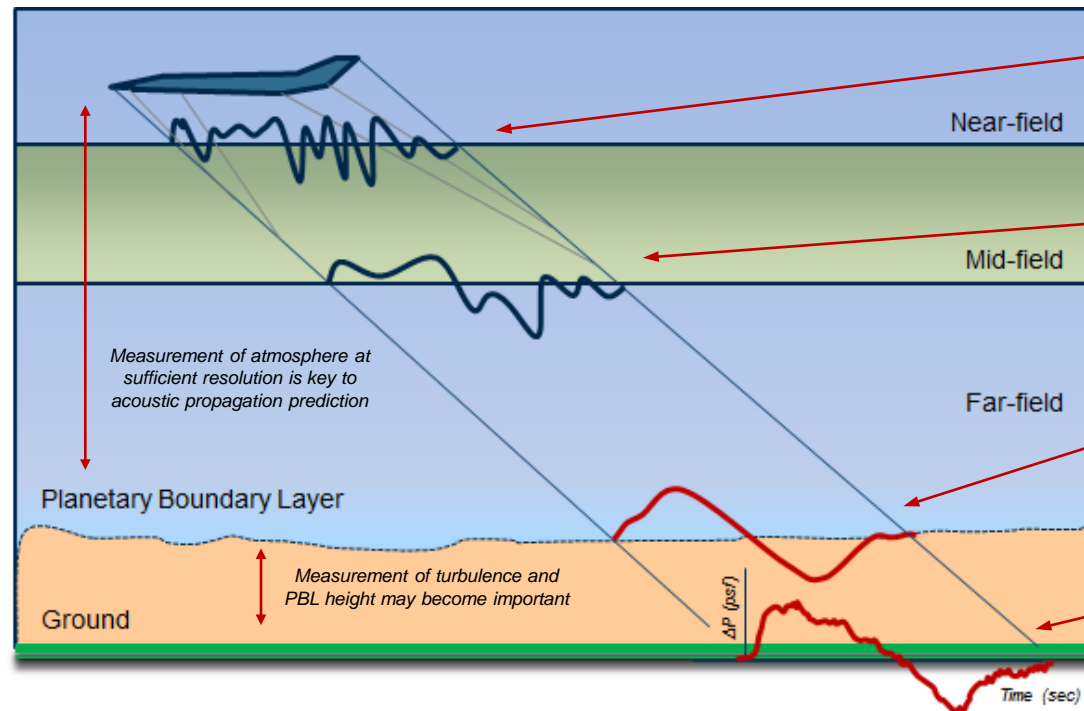
Ref. Figure 1.1
NASA-SP-2014-622

Nonlinear propagation

Noise source details are lost as shocks coalesce and merge into each other

Can't Analytically Back Out Noise Source From Ground Measurements

Some Other Potential Options



Validate Near-Field Source

- Wind tunnel testing of scaled model
- Near-field probing of aircraft at altitude

Validate Mid-Field Source

- Some optical measurement technique
- Ground-based advanced measurement (??)

Validate Source Above Planetary Boundary Layer (PBL)

- Instrumented aircraft or UAV
- Elevated instrumentation

Validate Ground Noise Level

- Traditional microphone measurements

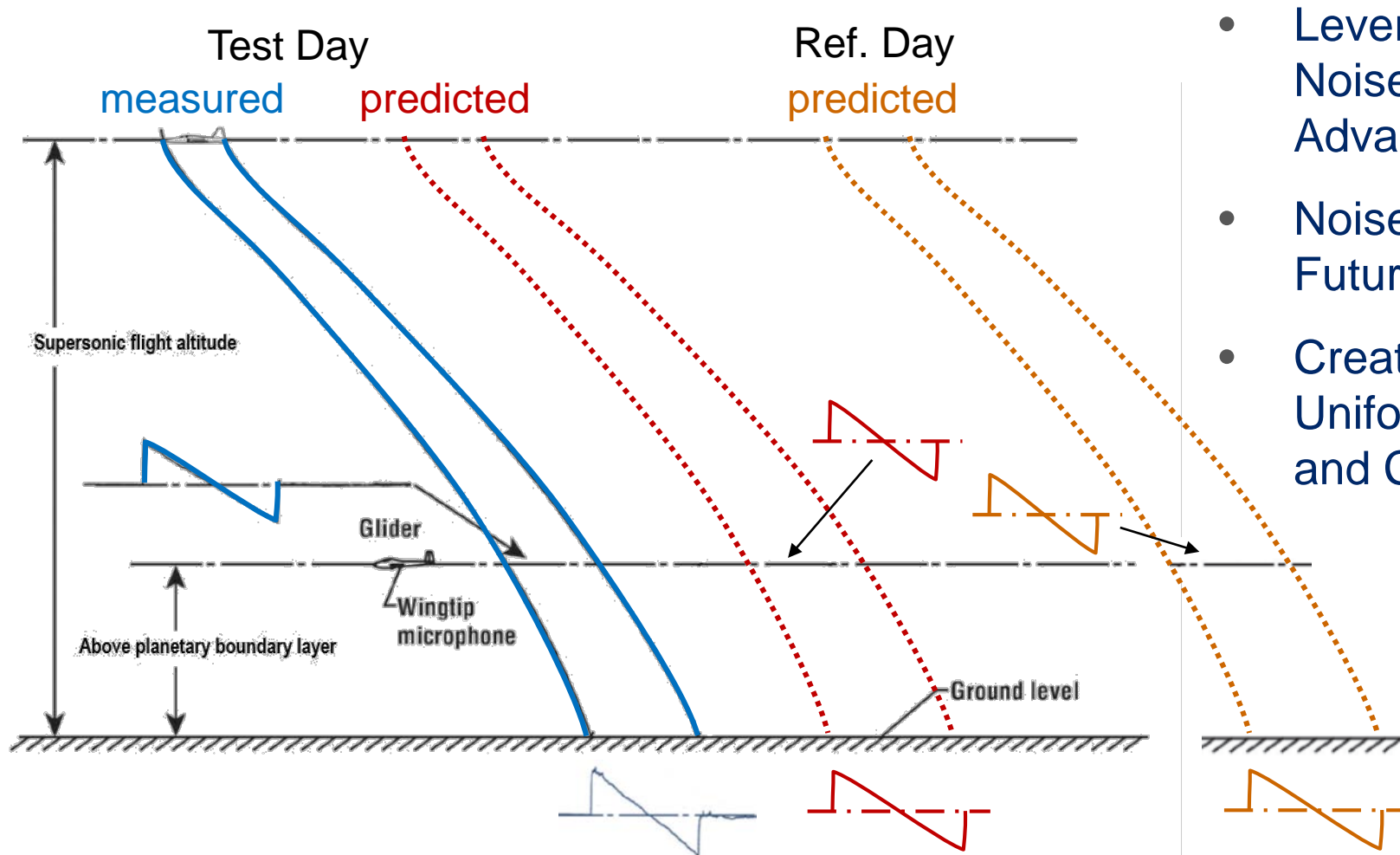
Consider Measurements to Define Noise Source

But there is variability of measured data due to many reasons ...

- Winds aloft from cruise altitude to ground level
- Quasi-steady flight conditions
- Atmospheric propagation through turbulence in PBL
- Long distance propagation (through dynamically changing atmospheric conditions)

Still Need Noise Levels at Reference Conditions

Considerations for Reference Test Procedures

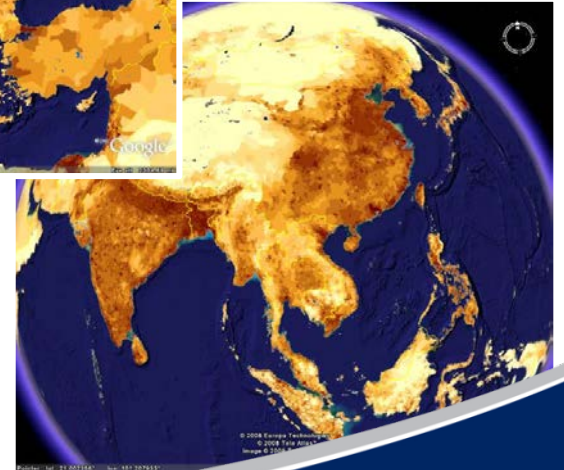
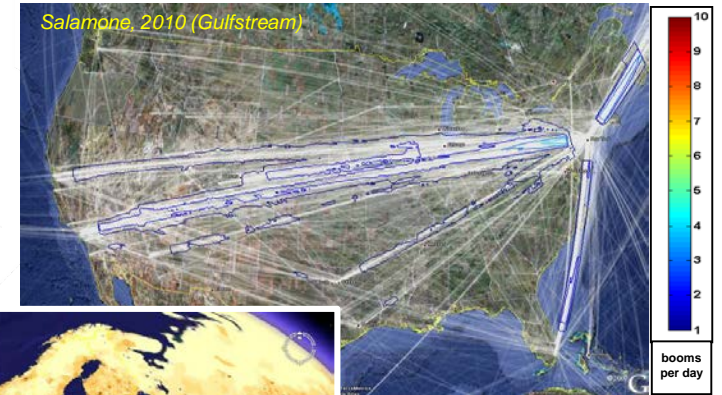
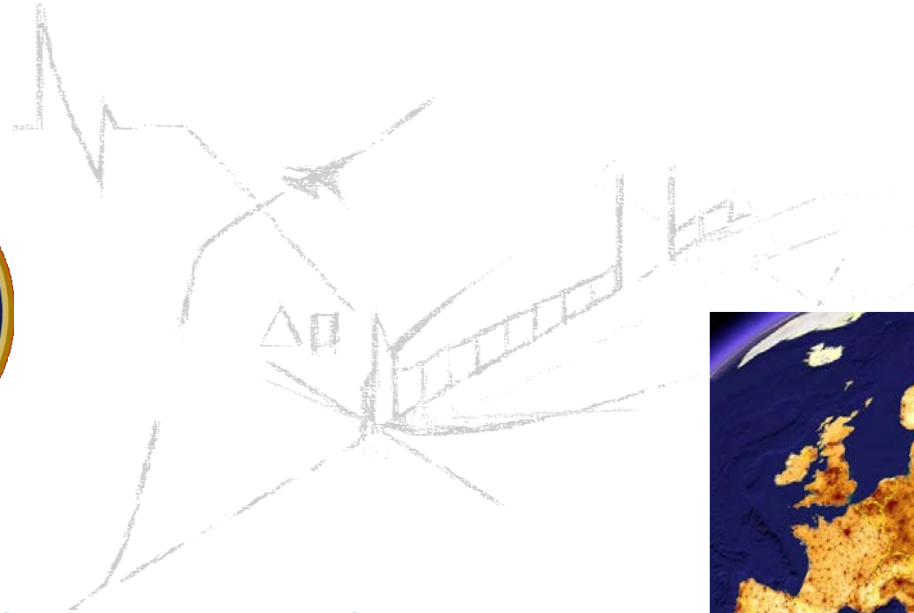


- Leverage Strengths Of Traditional Noise Measurements Along With Advanced Computational Methods
- Noise Predictions Could Be Used In Future En Route Noise Certification[‡]
- Create Robust Steps Which Can Be Uniformly Implemented By OEMs and Civil Aviation Authorities

Deviates Slightly From Traditional Aircraft Noise Certification

[‡] Note: AIAA 3rd SBPW to be held in Jan. 2020 @ SciTech

Road to Updating 14 CFR § 91.817 Civil Sonic Boom



- International Civil Aviation Organization Committee on Aviation Environmental Protection (ICAO / CAEP)
- Monitoring sonic boom research & advising on international rule-making for overland supersonic flight
- Progress toward 'Supersonic En Route Noise Standard'

Summary

- Flight Operations At Cruise Speeds Above Mach 1 Prohibited In Many Countries Worldwide
- International Regulations Needed For Future Supersonic Aircraft
- Certification Methodologies and Reference Test Procedures Being Explored For Supersonic En Route Noise By Experts In The Field
- Advanced Computational Capabilities, CFD Prediction Tools, And Sonic Boom Propagation Predictions May Have Role In Future Noise Regulation

A low-angle, close-up shot of a white Gulfstream aircraft fuselage against a clear blue sky. The Gulfstream logo, a stylized 'G' inside a circle, is positioned above the word 'Gulfstream' in a dark blue serif font. A large, oval-shaped window is visible on the right side of the fuselage.


Gulfstream

Questions ??