Decibel Level Variation Related to Changes in Distance and Other Factors Affecting Propagation

Presentation to:

Airport Noise Abatement Committee

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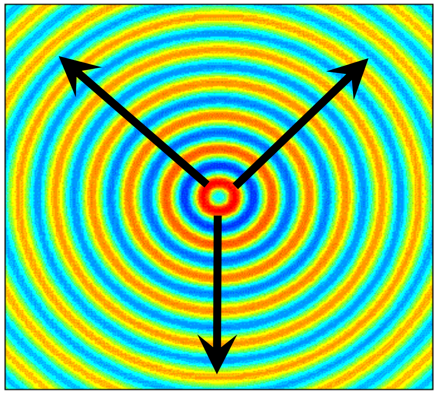
What affects sound propagation?

- **Distance from the source to the receiver**
- **Meteorological ("weather") conditions**
  - Humidity
  - Wind
  - Temperature
- **Ground effects**
  - Surface conditions
  - Barriers

What is “sound propagation”

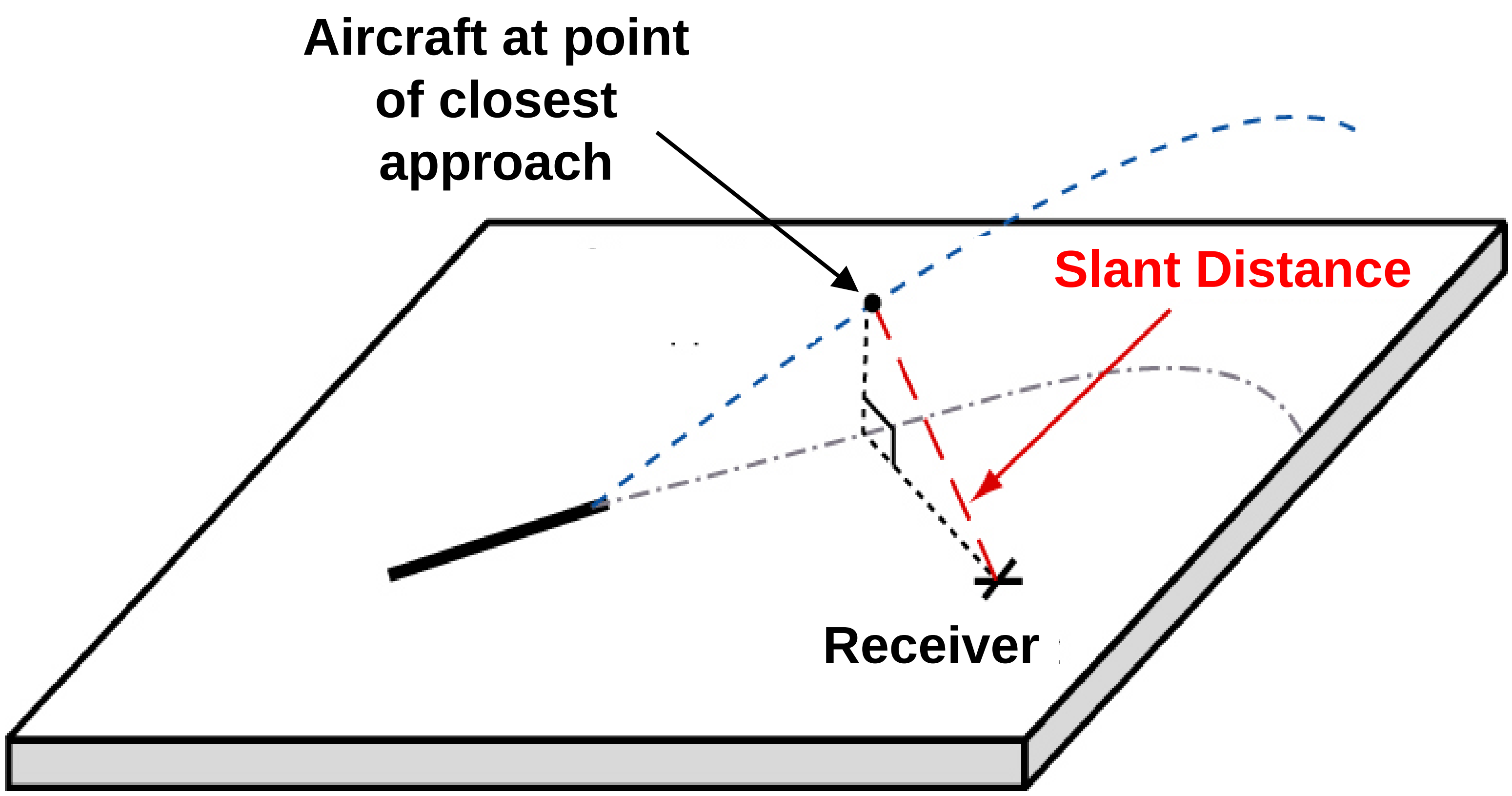
- The propagation of sound from a discrete (“point”) noise source can be compared to ripples on a pond when a rock is thrown into it.
- The ripples spread out uniformly in all directions, decreasing in amplitude as they move away.



- For aircraft the sound propagates in three dimensions; i.e., “spherical spreading.”

Source-to-receiver distance

- For aircraft, the three-dimensional source-to-receiver "slant distance" (sometimes called "slant range") is the critical dimension



Decibel changes with distance

- **When there are no obstacles and no reflectors (what acousticians call "free field" conditions)**
  - The instantaneous sound pressure level decreases by about 6 dB when the slant distance doubles
  - The instantaneous level decreases by about 3.5 dB when the slant distance increases by about 50%
  - A 40% distance increase reduces the level by about 3 dB
- **Recall from the "Noise 101" presentation**
  - In a normal day-to-day environment…
    - A 3 dB change is generally the threshold of detectability
    - A change of 6 dB is clearly perceptible
- ***Small changes in distance have a negligible effect***

FLL example

▪ For example, let's consider RMT 5

- Approximately 2,700' from 9R/27L extended centerline
- Aircraft on approach are about 200' high

Considering the change in distance only	
If the altitude changed by:	**Decibel level would change by approx.**
+100'	-0.03 dB
+500'	-0.26 dB
-100'	+0.02 dB

- The aircraft would have to be moved about 750' closer to the site to produce a noticeable (3 dB) change in level.

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Major meteorological effects

- Absorption of sound by air molecules
- Wind effects
- Temperature gradient affects

Atmospheric absorption of sound

- **Sound energy is converted to heat by "molecular absorption"**
  - Mostly affects higher frequencies
  - Varies with temperature, humidity and air pressure
- **Can add 1 to 3 dB +/- more attenuation over 1,000' to 3,000' distances, for typical Florida weather**
  - Humidity is particularly important
  - Effect diminishes with additional distance
- **Clouds, fog, and rain have no little or no effect by themselves, but often occur during wind and temperature conditions with significant effects**

Wind and temperature effects

- **Sound paths are bent (curved) up or down**
  - Most important when aircraft are on or near the ground relative of the receiver (elevation angle less than 30 degrees, or so)
- **Wind effects are fairly common sense**
  - Wind blowing from the source will tend to *reduce* attenuation
    - Sound levels *increase*
  - Wind blowing toward the source will tend to *increase* attenuation
    - Sound levels *decrease*

Wind and temperature effects

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- **Temperature effects are more complex**
  - Largely relate to changes in temperature with altitude
  - If temperature goes down with altitude (normal “lapse” conditions)
    - Sound attenuation *increases*
    - Sound levels *decrease* at the receiver
    - Most common on a sunny day
  - If temperature goes up with altitude (“inversion” conditions),
    - Sound attenuation *decreases*
    - Sound levels *increase* at the receiver
    - Most common in the evening or night after a sunny day

Ground effects

- **Sound propagation over the surface is affected by reflective and absorptive properties of the ground**
  - Only important when aircraft are on or near the surface (elevation angle less than 30 degrees, or so)
  - Soft ground can reduce levels by reducing reflections
  - Hard ground (including water) can increase sound levels by enhancing reflection
- **Obstacles can attenuate and/or reflect sound:**
  - Structures, walls, terrain
- **Thick forests**
  - To act as a barrier, obstacles must break the line-of-sight path from the source to receiver

Summary

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- **Considering the "spherical spreading of sound" only:**
  - Lmax is reduced by about 6 dB per doubling of distance
  - Lmax is reduced by about 3 dB with a 40% increase in distance
- **"Atmospheric absorption" can further reduce levels 1 to 3 dB over 1,000' to 3,000' distances, for typical Florida weather**
- **Wind and weather can increase or decrease these effects**
  - Wind blowing from the source to the receiver can increase levels
  - Wind blowing from the receiver to the source can decrease levels
  - Temperature inversions can increase sound levels
  - Fog, clouds, and rain have no significant independent effect
- **Questions?**