Sodar Siting Considerations, Interference Sources, Installation, and Maintenance

Jerry H. Crescenti
U.S. Dept. Commerce / NOAA
Air Resources Laboratory
Field Research Division
Idaho Falls, Idaho

Introduction

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- Interference Sources - Noise
- Installation
- Maintenance

References

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Siting Considerations

- Representative location
- Site logistics
- Meteorology sensor collocation

Representative Location

- Acquire data to meet program objectives
- Homogeneous vs. complex terrain
- Complex terrain features may bias data

Site Logistics

- Accessible
- Safe and secure
- Level ground
- Sufficient drainage
- Clear of obstructions
- Adequate electric power
- Data communications link

Meteorology Sensor Collocation

- Data validation / verification
- Share site resources
  - shelter
  - power
  - personnel
- Integrated data sets

Interference Sources - Noise

- Can significantly degrade data quality
- Difficult to differentiate Doppler-shifted backscattered signal from noise
- Poor SNR increases variance
  - biases backscattered signal toward zero
- Need to avoid or minimize noise interference
- Classifications
  - active or passive
  - broadband or narrowband

Active Broadband Noise

- Wide range of frequencies
  - random or white noise
  - low frequencies
- Decreases SNR results in decreased range
- Diurnal, weekly, and/or seasonal patterns
- Examples
  - highway and road traffic
  - machinery, industrial facilities, and power plants
  - airplanes

Active Narrowband Noise

- Fixed-frequency
- Misinterpret as valid backscattered signal
  - erroneous wind values
- May saturate received signal
  - no valid wind values
- Coded pulse
- Examples
  - back-up beepers on trucks and forklifts
  - birds and insects

Combating Active Noise

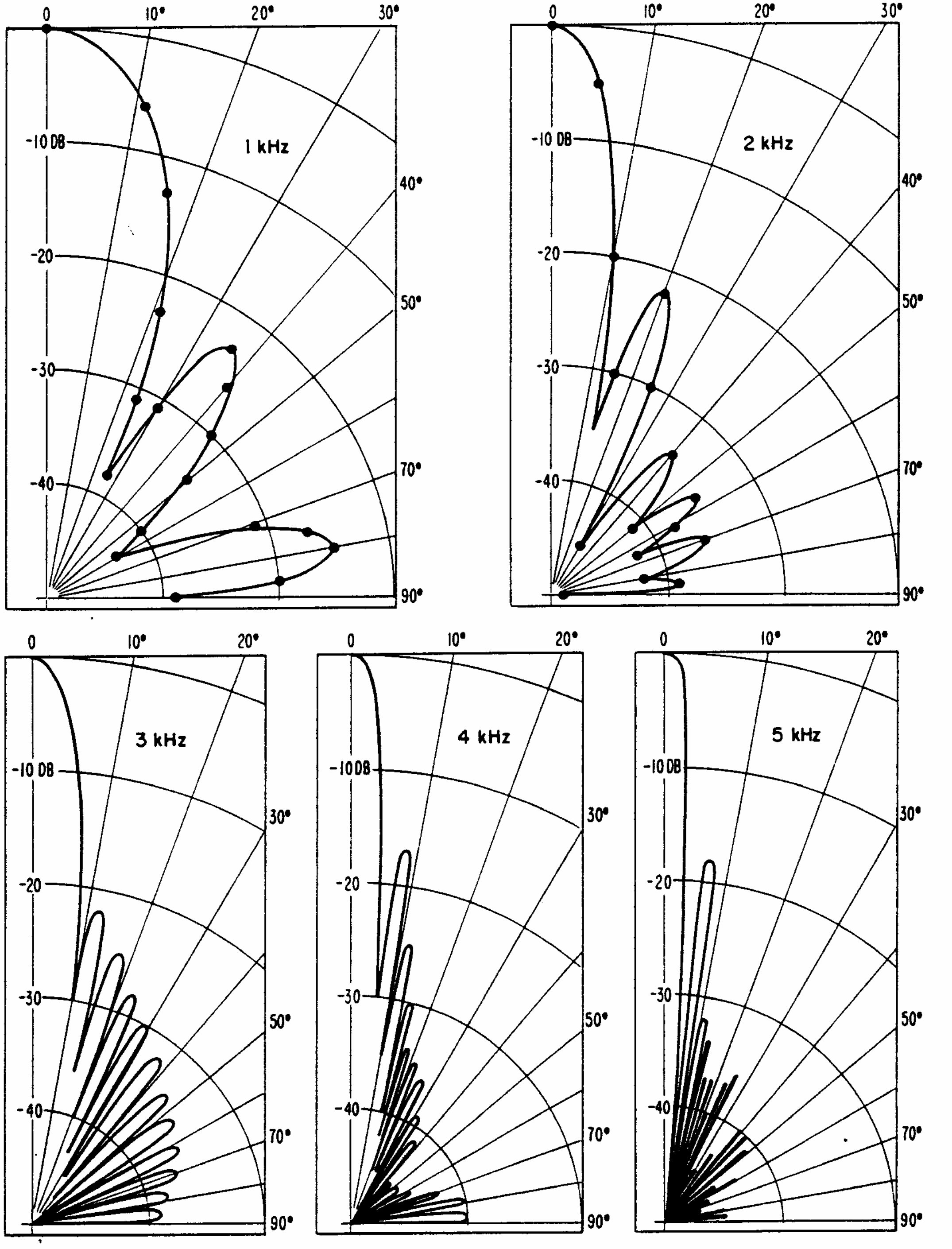
- Noise survey
  - diurnal and weekly patterns
- Qualitative
  - identification of noise sources
- Quantitative noise survey
  - noise level meter (< 50 to 60 dB)
  - spectral analysis software (Spectrogram)
- Conduct “listen-only” mode
- Change transmit frequency

Passive Noise

- Fixed-echo created when side lobes of acoustic pulse reflect off stationary objects
- Return same acoustic frequency
  - zero Doppler shift
  - wind values of 0 m s^{-1}
- Examples
  - buildings and towers
  - trees and transmission lines

Beam Pattern

- Gain pattern
  - vertical beam
  - unshielded
- Low-frequency
  - wide beam
  - wide lobes
- High-frequency
  - narrow beam
  - small lobes



Combating Passive Noise

- Construct obstacle vista table
- Tilt oblique beams away from objects
- Avoid objects taller than 15° above horizon

SENSOR DOCUMENTATION AND OBSTACLE VISTA TABLE

Date:	October 3, 2000	Site Name:	Raging Waters
Investigator:	Jerry H. Crescenti	Project:	VTMX / URBAN 2000
Instrument:	Doppler Sodar	Latitude:	40° 43' 55" N
Model:	Radian 600PA	Longitude:	111° 55 39" W
S/N:	00125	Elevation:	1291 m
Software Version:	3.0.031		
Vertical Angle:		Azimuth Angle:	
Beam 1:	0°	Beam 1:	—
Beam 2:	15°	Beam 2:	195°
Beam 3:	15°	Beam 3:	285°
Antenna Level:	0.2°	Leveling Tool:	Mitutoyo Pro 360 dig. level
Azimuth Reference:	15°	Azimuth Orientation Tool:	Garmin eTrex GPS
Frequency:	3000 Hz	Time Zone:	MDT
Averaging Interval:	15 min	UTC Difference:	-6 hr

Azimuth Angle (deg)	Obstacle Elevation (deg)	Obstacles / Distance	Other Notes
0	2	public restroom at 200 m	open dirt lot
30	2	residential homes at 500 m	open dirt lot
60	2	residential homes at 500 m	open dirt lot
90	15	water slides at 250 m	open dirt lot
120	5	tree at 100 m	open dirt lot
150	10	tree at 150 m	fence, shrubs, golf course
180	2	railroad tracks at 25 m	fence, shrubs, golf course
210	12	two trees at 50 m	fence, shrubs, golf course
240	10	cluster of trees at 60 m	open dirt lot
270	5	dumpster at 100 m	open dirt lot
300	10	cluster of trees at 100 m	open dirt lot
330	5	cluster trees at 200 m	open dirt lot

Other Noise Issues

- Strong wind
- Rain
- Insects in discrete dense layers
- Mice, birds, and insect infestations
- Algorithms identify and remove noise
  - various spectral techniques to isolate signal
  - listen for background noise
  - identify frequencies with zero Doppler-shift that are constant in time and space

Acoustic Shielding

- Anechoic shields serve two purposes:
  - reduce radiated side lobe acoustic energy
  - reduce received side lobe acoustic energy
- Phased-array vs. parabolic antennas
  - phase/amplitude-control create more defined beam
- Side lobes to consider:
  - 70° - 90°
  - ducting (refraction) under strong inversions

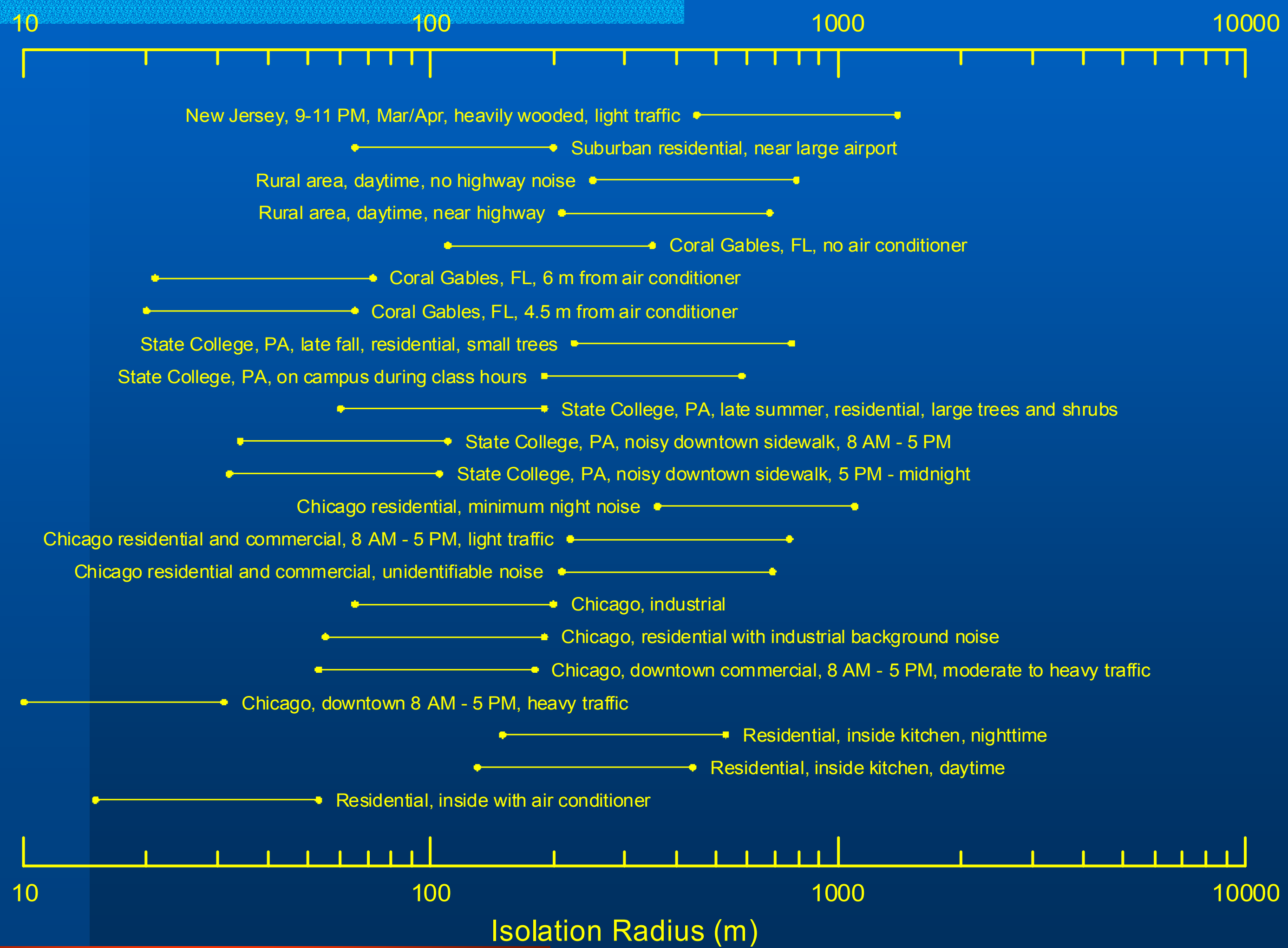
Acoustic Shielding

- Materials
  - straw / hay bales
  - plywood with sand or lead filling
  - fiberglass
  - 5-cm thick acoustically absorbing foam
- Geometry
  - cylindrical
  - hexagonal
  - rectangular
- When all else fails: pit / bunker

Isolation Radius (R_i)

- Minimum distance that must separate a sodar from its nearest environmental inhabitant
- Quieter environments have large R_i
- Noisier environments have small R_i
- Low-frequency sodars have large R_i
- High-frequency sodars have small R_i
- Minimum R_i: 500 - 1000 m
- Check local ordinances

Isolation Radius



Installation

- Time and personnel
  - one to two days
  - one to two persons
- Tools
  - digital level
  - GPS and/or transit
  - hearing protection
- Antenna placement
  - firm ground or concrete pad
  - tie-downs / anchor points

Installation

- Antenna orientation
  - level antenna to within ± 0.5°
  - azimuth angle to within ± 2°
- Site documentation
  - latitude, longitude, elevation
  - 360° panoramic photo vista
  - photos of sodar, shelter, and other equipment
  - site diagram
  - vista table
  - log book

Maintenance

- Site and shelter
  - Security and new obstructions
  - Air conditioner and heater
- Computer and data acquisition system
  - blown fuses and power supplies
  - bad components
  - diagnostic routines
  - disk space
  - routine data backup
  - clock

Maintenance

- Antenna orientation
  - level and alignment
- Antenna electronics
  - cables and connectors
  - acoustic transceivers
- Antenna and acoustic shield integrity
  - cables and guy wires
  - acoustic foam lining
  - water, snow, ice, dust, sand, and other debris
  - animal infestation