Table 9-1

Operating characteristics of upper-air meteorological monitoring systems.

VARIABLES	RADIOSONDE	DOPPLER SODAR	BOUNDARY LAYER RADAR WIND PROFILER	RASS
Measured	• p, T, RH • Vector winds (WS, WD)	• Vector winds (WS, WD) • u,v,w wind components	• Vector winds (WS, WD) • u,v,w wind components	• Virtual temperature (T_v) • w wind component
Derived	• Altitude • Moisture variables (dewpoint, mixing ratio, vapor pressure, etc.) • Potential temperature • Inversion base, top • Mixing depth	• Mixing depth • Dispersion statistics (σ_θ, σ_w)	• Mixing depth	• Inversion base, top • Mixing depth

Table 9-1 (continued)

Operating characteristics of upper-air meteorological monitoring systems.

PERFORMANCE CHARACTERISTICS	RADIOSONDE	DOPPLER SODAR	BOUNDARY LAYER RADAR WIND PROFILER	RASS
Minimum Altitude	10-150 m	10-30 m	90-120 m	90-120 m
Maximum Altitude	5-15 km	0.2-2 km	1.5-4 km	0.5-1.5 km
Vertical Resolution	5-10 m (p, T, RH) 50-100 m (winds)	5-100 m	60-100 m	60-100 m
Temporal Resolution	Integration time 5 sec.-2 min. Resolution: intermittent (time between soundings 1.5-12 hr.)	Integration time: 11-60 min. Resolution: continuous	Integration time 15-60 min. Resolution: continuous	Integration time 5-10 min. Resolution: intermittent (time between profiles 5 min-1 hr.)

Table 9-1 (continued)

Operating characteristics of upper-air meteorological monitoring systems.

PERFORMANCE CHARACTERISTICS	RADIOSONDE	DOPPLER SODAR	BOUNDARY LAYER RADAR WIND PROFILER	RASS
Systematic Difference	p: ± 0.5 mb T: ± 0.2 °C RH: ± 10% U.V.: ± 0.5 to 1.0 ms^{-1}	WS: ± 0.2 to 1.0 ms^{-1} WD: ± 3-10°	WS: ± 1 ms^{-1} WD: ± 3-10°	± 1 °C
Comparability	p (as height): ± 24 m T: ± 0.6 °C T_d: ± 3.3 °C WS: ± 3.1 ms^{-1} WD: ± 5-18°	WS: ± 0.5 to 2.0 ms^{-1} WD: ± 5-30°	WS: ± 2 ms^{-1} WD: ± 30°	± 1.5 °C

Table 9-1 (continued)

Operating characteristics of upper-air meteorological monitoring systems.

OPERATIONAL ISSUES	RADIOSONDE	DOPPLER SODAR	BOUNDARY LAYER RADAR WIND PROFILER	RASS
Siting Requirements	• Requires relatively flat area approx. 30x30 m (allow sufficient space to launch balloon). • Absence of tall objects (trees, power lines, towers) that could snag weather balloon.	• Requires relatively flat area approx. 20x20 m (allow space for audit equipment, met tower). • Absence of active noise sources. • Absence of passive noise (clutter) targets. • No neighbors within about 100-500 m (depending on the sodar) who would be bothered by noise.	• Requires relatively flat area approx. 20x20 m (allow space for audit equipment, met tower). • Lack of radar clutter targets extending more than 5° above the horizon in antenna pointing directions; 15° otherwise.	• No neighbors within about 1000 m who would be bothered by noise.

Table 9-1 (continued)

Operating characteristics of upper-air meteorological monitoring systems.

OPERATIONAL ISSUES	RADIOSONDE	DOPPLER SODAR	BOUNDARY LAYER RADAR WIND PROFILER	RASS
Siting Logistics	• Balloon inflation shelter (e.g., small shed, tent, etc.) • Small (e.g., 8x12 ft.) equipment shelter, tied down, lightning protection • Security fence • 110/220v, 30 amp power service (usually required for air conditioning) • Communications service for data telemetry, voice. • May require FAA approval for operations at airports. • Instrument set-up can be completed in less than a day.	• Small (e.g., 8x12 ft.) equipment shelter, tied down, lightning protection • Security fence • 110/220v, 30 amp power service (usually required for air conditioning) • Communications service for data telemetry, voice. • Site will require 1-2 days to establish once trailer, power, etc. installed.	• Small (e.g., 8x12 ft.) equipment shelter, tied down, lightning protection. • Security fence • 110/220v, 30 amp power service (usually required for air conditioning) • Communications service for data telemetry, voice. • Site will require 2-3 days to establish once trailer, power, etc. installed.	• Add-on to radar profiler or sodar. No special additional logistical requirements. • Approx. 0.5-1 day needed to install and get operational.
Licensing	N/A	N/A	FCC license required	FCC license required

Table 9-1 (continued)

Operating characteristics of upper-air meteorological monitoring systems.

OPERATIONAL ISSUES	RADIOSONDE	DOPPLER SODAR	BOUNDARY LAYER RADAR WIND PROFILER	RASS
Routine Operations	• Intermittent sampling; number of soundings varies with measurement objectives. Typically, one sounding per day near sunrise is a minimum sampling frequency; this will characterize the early morning stable boundary layer. Additional soundings are useful at mid-morning (ABL development), mid-to-late afternoon (full extent of daytime ABL), and at night (nocturnal ABL). • Requires expendables for each sounding (radiosonde, balloon, helium, parachute, light for night operations). • Manned operations; requires an operator for each sounding.	• Continuous sampling • Automated, unmanned • Daily checks of operational status via remote polling.	• Continuous sampling • Automated, unmanned • Daily checks of operational status via remote polling.	• Intermittent sampling every hour, or more often as needed. • Automated, unmanned • Daily checks of operational status via remote polling.

Table 9-1 (continued)

Operating characteristics of upper-air meteorological monitoring systems.

OPERATIONAL ISSUES	RADIOSONDE	DOPPLER SODAR	BOUNDARY LAYER RADAR WIND PROFILER	RASS
Maintenance	• Bi-weekly barometer calibration checks • Daily back-ups • Back-up tracking device (e.g., optical theodolite) useful in case primary tracking system fails.	• Routine bi-weekly site inspections, servicing • Monthly on-site backups • Snow, ice removal in winter • Manufacturer-recommended spare parts	• Routine bi-weekly site inspections, servicing • Monthly on-site backups • Snow, ice removal in winter • Manufacturer-recommended spare parts	• Routine bi-weekly site inspections, servicing (follow SOP) • Monthly on-site backups • Snow, ice removal in winter • Manufacturer-recommended spare parts
Ground Truth	• Barometric pressure • T, RH • Radio theodolite oriented to true north, level	• Antenna orientation relative to true north • Antenna level	• Antenna orientation relative to true north • Antenna level	• Acoustic sources level • Antenna level

Table 9-1 (continued)

Operating characteristics of upper-air meteorological monitoring systems.

OPERATIONAL ISSUES	RADIOSONDE	DOPPLER SODAR	BOUNDARY LAYER RADAR WIND PROFILER	RASS
QA	• Acceptance test • Standard operating procedure (SOP) • Routine comparison with 10 m tower data • Annual system audit • Annual performance audit of ground truth instruments (e.g., barometer).	• Acceptance test • Standard operating procedure (SOP) • Routine comparison with 10 m tower data • Annual system audit • Annual intercomparison using complementary upper-air system.	• Acceptance test • Standard operating procedure (SOP) • Routine comparison with 10 m tower data • Annual system audit • Annual intercomparison using complementary upper-air system.	• Acceptance test • Standard operating procedure (SOP) • Routine comparison with 10 m tower data • Annual system audit • Annual intercomparison using complementary upper-air system.
Training	• Operators trained to perform soundings; usually requires a few days of classroom and on-site training. • Final data review should be performed by a meteorologist familiar with the instrument systems used.	• Site technicians trained to service equipment; usually requires 1-2 days of on-site training. • Data processing technician trained to poll site, retrieve data, review operational status, troubleshoot problems. • Final data review should be performed by a meteorologist familiar with the instrument systems used.	• Site technicians trained to service equipment; usually requires 1-2 days of on-site training. • Data processing technician trained to poll site, retrieve data, review operational status, troubleshoot problems. • Final data review should be performed by a meteorologist familiar with the instrument systems used.	• Site technicians trained to service equipment; usually requires 1-2 days of on-site training. • Data processing technician trained to poll site, retrieve data, review operational status, troubleshoot problems. • Final data review should be performed by a meteorologist familiar with the instrument systems used.

Table 9-1 (continued)

Operating characteristics of upper-air meteorological monitoring systems.

OPERATIONAL ISSUES	RADIOSONDE	DOPPLER SODAR	BOUNDARY LAYER RADAR WIND PROFILER	RASS
Data Processing	• Reduce data on-site, ensure proper operations. • Bring final data to at least Level 1 QC validation (see text). • 100 Kb - 1 Mb/sounding	• Use vertical velocity correction (see text). • Bring final data to at least Level 1 QC validation (see text). • 100 Kb/day	• Use vertical velocity correction (see text). • Bring final data to at least Level 1 QC validation (see text). • 150 Kb-1 Mb /day	• Use vertical velocity correction (see text). • Bring final data to at least Level 1 QC validation (see text). • 20 Kb/day

Table 9-1 (continued)

Operating characteristics of upper-air meteorological monitoring systems.

STRENGTHS	RADIOSONDE	DOPPLER SODAR	BOUNDARY LAYER RADAR WIND PROFILER	RASS
	• *In situ* measurements • Deep profiles, high data recovery rates to extended altitudes. • Measures atmospheric moisture • Data compatible with global upper-air network.	• Samples lower parts of ABL • Continuous • Smaller sample volumes (finer vertical resolution). • Fixed reference frame • Useful in complex terrain to measure winds at plume heights.	• Samples through full extent of ABL • Continuous • Data recovery not affected by high wind speeds. • Performance improves with increasing RH. • Fixed reference frame	• Provides high time resolution of temperature profiles in ABL. • Measures T_v • Fixed reference frame

Table 9-1 (continued)

Operating characteristics of upper-air meteorological monitoring systems.

LIMITATIONS	RADIOSONDE	DOPPLER SODAR	BOUNDARY LAYER RADAR WIND PROFILER	RASS
	• Not continuous • Manned operations • Lowest altitude at which good winds are reported can be 200-300 m above ground level depending on tracking system, signal strength, operator training. • Balloon drifts with wind, producing moving reference frame for measurements. • Wet bulb not as reliable as carbon hygristor for measuring frost point. • Launching problematic during thunderstorms. • Subject to icing. • LORAN radio navigation system being discontinued.	• Altitude coverage may not extend through full depth of daytime ABL. • Altitude coverage may be limited at night due to nocturnal inversion. • Interference from active noise sources. • Interference from precipitation. • High wind speeds reduce altitude coverage. • Performance degrades (lower altitude coverage) with low RH. • Nuisance effects from transmitted noise. • Multiple component statistics such as σ_θ not reliable.	• Interference from precipitation. • Interference from migrating birds. • Lowest altitude sampled ~100 m above ground level. • May be subject to ground clutter. • Larger sample volumes (coarser vertical resolution). • Performance degrades (lower altitude coverage) at low RH.	• T_v may need to be converted to T. • Nuisance effects from transmitted noise. • Altitude coverage may not extend through full depth of daytime ABL. • Error sources exist that can produce biases on the order of 0.5-1° C, which may be corrected during post-processing.