Standard Operating Procedures

Doppler lidar

This document describes the **Standard Operating Procedures (SOPs)** that must be applied to all Doppler lidars contributing measurements to the ACTRIS Cloud Remote Sensing Data Centre.

I. Site requirements

1	Operation area : environment surrounding the instrument	Open view within a cone of specified elevation angle from zenith necessary to obtain a wind profile, and preferably open view to horizon to enable low-elevation scans

II. Operation modes

1	Stability	Keep the instrument powered. This ensures permanent temperature stabilization.
2	Scanning modes	For scanning versions: perform VAD scans with sufficient beams for wind retrieval. Use VADs at two or more elevation angles to enable high resolution close to the surface. Continuous segments of vertical stare mode necessary for turbulent classification
3	Continuity	24/7
4	Ensure accurate system clock and location	Use UTC if possible (no changing with Summer Time), use ntpd or GPS reference
5	Ancillary measurements to be performed	Co-located ceilometer for an extended period to determine telescope focus function (if use of attenuated backscatter profile required)

III. Monitoring of system parameters

1	Instrument status dashboard(s) and (automatic) alert systems (applied on data and housekeeping data)	Store data at highest possible temporal resolution, noting that this may be impacted by sensitivity issues

2	Housekeeping data threshold and available variability	Same as above
3	Visual inspection of instrument (e.g. remotely controlled camera)	Store all standard raw data: signal and velocity, background measurements. Store spectra if possible.

IV. Data types and database connection

1	Temporal resolution of the data	Keep housekeeping data: background files, instrument internal temperature/humidity logs, system setup and scan schedule
2	Temporal resolution of the metadata	To be defined for each instrument manufacturer
3	Range resolution of the data	2D plots of background
4	Raw data and metadata flow (including housekeeping data) implementation to the data center	advised

V. Calibration

1	Retrieval of Calibration Parameters	• **Calibration parameters**: absolute calibration, background correction, telescope function and variability • **Absolute calibration**: - Doppler velocity and range calibration: hard target check - Attenuated backscatter: liquid cloud technique, after telescope focus determination. • **Background correction** performed during standard processing. • **Telescope function determination** by comparison with co-located ceilometer. Required every time telescope focus changed, or instrument modified/upgraded.
2	Characterization of measurement uncertainties	• **Doppler velocity uncertainty sources:** - Offset uncertainty assessed during instrument calibration and hard target. - Signal to noise ratio (including variation in laser power) • **Wind uncertainty sources:** - Pointing angle uncertainty - Doppler velocity uncertainty - Turbulent and inhomogeneity uncertainty • **Attenuated backscatter uncertainty sources**: - SNR uncertainty (including background correction uncertainty) - Telescope focus uncertainty - Cloud calibration method uncertainty

3	Calibration schedule (automatic and hands-on)	Automatic processing for SNR and velocity uncertainty. Cloud calibration updated every event. Telescope focus can be continuous or periodic depending on co-located ceilometer availability
4	Azimuth and elevation pointing accuracy	For scanning instruments (target and/or horizontal winds). Provide azimuthal correction from north. Ensure horizontal alignment of instrument.
5	Detecting systematic errors during instrument operation	● Hard target velocity calibration and pointing angle (target and/or horizontal winds). ● Monitor instrument stability (background, telescope focus, cloud calibration)

VI. Maintenance schedule

1	Preventive maintenance	Occasional cleaning of the telescope. Leosphere systems need regular change of dessicant to prevent lens fogging
2	Likely component replacements	Amplifiers can degrade - usually this is very rapid
3	Likely software issues, software upgrades	Version numbering crucial