Standard Operating Procedures

Microwave radiometer

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

I. Site requirements

1	Operation area : environment surrounding the instrument	Open view to horizon, preferably in northern direction to perform elevation scans.
2	Specific points of attention	Easy access for site visits (esp. for liquid nitrogen calibrations and radome exchange) is required
3	Comply with local Safety and Security Rules	Respect safety regulations when handling liquid nitrogen

II. Operation modes

1	Stability	Keep instrument always on power. This ensures permanent temperature stabilization.
2	Scanning modes	Standard operation: Vertical pointing Perform at least one elevation (boundary layer) scan every 30 minutes (HATPRO: > 100 seconds integration time). Optional azimuth scanning possible
3	Continuity	24/7
4	Ensure accurate system clock and location	most instruments ensure accurate time and location by attached GPS receiver (UTC time!)
5	Ancillary measurements to be performed	Weather station, Video camera, Infrared pyrometer
6	Recommendations to maximize good working order of the instrument	A device to dry the radome after precipitation events is highly recommended to maximize uptime.

III. Monitoring of system parameters

1	Instrument status dashboard(s) and (automatic) alert systems (applied on data and housekeeping data)	Keep all housekeeping data and check them regularly. Take warning messages from the instrument software seriously.
2	Housekeeping data threshold and available variability	To be defined for each instrument type
3	Web sites to access QLs	Brightness temperature time series
4	Visual inspection of instrument (e.g. remotely controlled camera)	**advised**
5	Routine on-site control	Radome cleaning (1x per week)

IV. Data types and database connection

1	Temporal resolution of the data	Store data with 1 second temporal resolution (or highest possible)
2	Temporal resolution of the metadata	Same as above
3	Range resolution of the data	not applicable
4	Raw data and metadata flow (including housekeeping data) implementation to the data center	Store all raw data (voltages, brightness temperatures, calibration data) HATPRO: BRT, BLB, HKD, IRT, MET, LV0, (SPC), LOG-files Radiometrics: LV0, LV1

V. Calibration

1	Retrieval of Calibration Parameters	● Absolute Calibration with Liquid Nitrogen (every 6 months), only during dry weather conditions (RH preferably < 70%) to reduce condensation on cold target ● Relative Calibration including - Hot load (gain) calibration (every 5-10 minutes) - Noise diode calibration (recommended only for certain instrument types) ● Relative calibration schedule depending on instrument type ● Sky tipping calibration not recommended as a standard calibration method, except for sites with low water vapor and difficult access (e.g. polar or alpine regions)

2	Characterization of measurement uncertainties	● **HATPRO:** Covariance calculation relative to running mean of HL-temperature. 1 hour HL-view with gain calibration every 5 minutes > difference to running mean of HL-temp (20 seconds). variable 14x14x2 (correlation/covariance matrix) > should be performed after every LN2 calibration > will be implemented in Software ● **Radiometrics:** Calculation of 12x12(TP/WVP 3000)/22x22 (MP-3000 A) correlation and covariance matrix of the difference between calculated and measured HL-temperature
3	Calibration schedule (automatic and hands-on)	● absolute calibration with liquid nitrogen every 6 months ● relative calibrations are automatically performed in the routine observations program
4	Azimuth and elevation pointing accuracy	Ensure horizontal adjustment of instrument. for azimuth scanning instruments, make sure to provide north position relative to the instrument
5	Detecting systematic errors during instrument operation	- Spectral consistency check of measured brightness temperatures - Monitoring of instrument stability (receiver temperature) - Check brightness temperatures on liquid nitrogen before performing absolute calibration

VI. Maintenance schedule

1	Preventive maintenance	**CHANGE MATERIAL**: Radome: every 6 months to 2 years, depending on site. The quality of the hydrophobic coating can be checked by pouring some water on it. If the water is not blown away, a radome change is necessary
2	Likely component replacements	
3	Likely software issues, software upgrades	software version numbering crucial