Standard Operating Procedures

CCRES Instrumentation for Satellite Cal/Val

Motivation for the SOPs: The EarthCare satellite to be launched in May 2024 will be equipped with a 94 GHz Cloud Radar (CPR) with global coverage. Due to the importance of this mission, the measurements of the CPR and its associated products must be studied and validated using different approaches.

In the case of ACTRIS, our infrastructure has a large number of cloud radars which cover several latitudes and climate zones. This fact, paired with ongoing efforts to calibrate and homogenize the measurements in our network, represent strong assets for EarthCare CalVal efforts.

The existing methods for the validation of satellite based cloud radars rely on the statistical comparison of a large number of homogeneous data taken during extended time periods. The **CCRES Instrumentation for Satellite Cal/Val** Standard Operating Procedures (SOPs) are the guidelines to build this dataset in the ACTRIS network, by **extending** the already existing SOPs for standard operation within ACTRIS. Hence, the **standard SOPs** also **remain valid and must be correctly implemented** since they help to maintain the correct functioning of the ACTRIS Data Centre.

Standard SOPs for the instruments associated with CCRES:

- **Doppler Cloud Radar (DCR)** SOP can be found **here**
- **Microwave Radiometer (MWR)** SOP can be found **here**
- **Doppler Lidars (DL)** SOP can be found **here**
- **Automatic low-power lidars and ceilometers (ALC)** SOP can be found **here**
- **Disdrometer** SOP can be found **here**

Additional requirements for the EarthCare CalVal

I. Site requirements

1	Operation area : environment surrounding the instrument	Open view within a cone of specified elevation angle from zenith (for wind scans).
2	Specific points of attention	● If scanning capabilities of the DCR and the MWR are used, be sure that there are no objects blocking the radar field of view when performing wind scans. ● An ALC has to operate continuously to enable an optimal preprocessing of the vertical reflectivity profiles retrieved by the DCR. ● Finally, local regulations for the use of the RF spectrum should be reviewed before installing an active instrument.
3	Comply with local Safety and Security Rules	The RF frequency commonly used in cloud radars (above 10 GHz) is absorbed at the skin surface, with very little of the energy penetrating into the underlying tissues. Exposure to RF fields above 10 GHz at power densities over 1000 W/m2 are known to produce adverse health effects, such as eye cataracts and skin burns. Commonly used cloud radars operate with a much lower power density (in the order of mW/m2), hence they should represent no danger. However, we recommend to check the recommendations given by the radar manufacturer, and the WHO: https://www.who.int/news-room/q-a-detail/radiation-radar

II. Additional DCR Operation modes Sat Cal/Val

1	Stability	Operate a Disdrometer in parallel so that the Ze-monitoring can be performed. Make sure the Disdrometer follows the CCRES SOPs
2	Operational modes	Different modes depending on the radars available at each site. **Non-scanning radar:** Leave vertical for the duration of the overpass (+/- 1:00 h centered around the overpass time). Choose settings that enable the observation of the complete troposphere at your site. **Scanning radar:** If a DCR is equipped with a scanning unit, one PPI “wind” scan has to be done every 30 Minutes. Scans should start N

		minutes after the full hour (e.g. N=15 min indicates that scans should run ‘15 and ‘45 past the full hour). . N for the identified sites that can do wind scans: ● Cabauw: N = 0 min ● Potenza : N = 15 min ● Granada: N = 15 min ● Jülich: N = 22 min ● Munich: N = 0 min ● Bucharest: N = 0 min The objective is to minimize the overlap between overpasses* and wind scans. *Definition of an overpass: time when the satellite enters a 200 km radius circle centered at a national facility.
3	Maintenance	Log radomes maintenance operations, change and report if you see they are damaged. Also log calibration of the instrument
4	Wind scans	A guide to program the wind scans on MIRA and RPG radars will be provided by CCRES before EarthCare launch.

III. Reminder MWR Operation modes Sat Cal/Val

1	Scanning modes	Performing Boundary Layer Scans every 15 Minutes is preferred. (Minimum requirement in MWR SOP is 30 min repetition rate). - If the site performs wind scans with the radar, synchronize starting time with the radar wind scans (sect. II.2). - Else, start at ‘05 after the full hour. The rest of the time operates at zenith pointing.
2	Ensure collection metadata and housekeeping data	write all data gaps, changes updates or irregularities in a log book
3	Maintenance	Log radomes maintenance operations, change and report if you see they are damaged. Also log calibration of the instrument

IV. Additional DL Operation modes Sat Cal/Val

1	additional operations	Following the standard Instrument CCRES SOP
2	Wind scans from Doppler Lidar	If the DL is equipped with a scanning unit, one PPI scan has to be done every 30 Minutes.

		- If the site performs wind scans with the radar, synchronize starting time with the radar wind scans (sect. II.2). - Else, perform scans at ‘05 and ‘35 after the full hour. Recommendations based on JOYCE experience: Doppler Lidar (HALO Photonics Doppler wind lidar): ●15° off zenith (75° elevation) ●10° azimuth steps ●126 sec for the whole 360° azimuth range

V. Reminder ALC operation modes Sat Cal/Val

1	Operation mode	**Automatic low-power lidars and ceilometers (ALCs)** must operate continuously, following the same guidelines of regular ACTRIS cloud remote sensing stations (SOP linked in the first page of this document). For the CalVal, ALCs are important because they enable the detection of supercooled water in ice clouds. If left unchecked, ice clouds with supercooled water can bias reflectivity comparisons between ground and spaceborne based radars due to uncorrected attenuation effects.

VI. Documentation

1	Synthesis of technical actions (e.g. on-line log book)	Document all changes made at the instruments (instrument has moved, replaced parts, etc), changes in the measurement procedure or settings, data gaps, **scanning patterns.**