1 Observation strategies

State-of-the-art microwave radiometers are designed for unattended continuous operation (24/7) with a high sampling rate (up to 1 second), only interrupted by regular calibration cycles. The observation strategy depends on the atmospheric variables which are in the main focus of the instrument user, and can include zenith observations, or elevation and azimut scan patterns.

1.1 Pointing and timing

The pointing strategy for passive microwave radiometers (MWR) is mainly determined by the user's preferences. For multi-purpose use of MWRs, a combination of zenith observations and scan patterns is useful, in order to derive integrated water vapour (IWV), cloud liquid water path (LWP), temperature profiles and horizontal inhomogeneities, with the disadvantages of regular breaks in the zenith timeseries and a low temporal resolution of the scans. If the deployment of the MWR is focused on a special parameter, the scan patterns should be chosen according to the recommendations below in order to obtain the best possible data.

In terms of zenith observations only, the high temporal resolution allows to observe the variability of liquid water clouds through the measurement of the LWP. Also, the IWV can be measured with high accuracy. However, for profiles of temperature, and humidity, additional elevation scanning considerably enhances the accuracy for layers below 1400 m above ground [Crewell and Löhnert, 2007]. Several MWRs are also equipped with an azimuth scanning possibility. With azimuth scans, the horizontal inhomogeneity of IWV and LWP can be determined. Azimuthal scans can either be performed under a constant elevation angle, e.g. 30° [Kneifel et al., 2008], or as a so-called full-sky scan with both azimuth and elevation scans [see e.g. Padmanabhan et al., 2009; Schween et al., 2011].

If the MWR is operated together with other complementary ground-based remote sensing instruments (such as millimeter cloud radars, Raman lidars, etc.), coordinated observation patterns will be useful.

1.2 Instruments performances

Nowadays, off-the-shelf commercial MWR are robust instruments providing continuous unattended operations and real time accurate atmospheric observations at ~1 min temporal resolution under nearly all-weather conditions. Commercial MWR units are usually offered with azimuth- and elevation-angle scanning capability. When properly calibrated, a MWR provides Tb with an absolute accuracy of ~0.3-0.5 K. Typical rms accuracy for derived products are:

- IWV ~ 1.0 mm (or kg/m2)
- LWP ~ 0.02 mm (or kg/m2)
- T(z) ~ 0.5 - 2.0 K (decreasing from surface up)
- WV(z) ~ 0.2 - 1.5 g/m3

Profiles of liquid water content (LWC) are also provided as a product by MWRP manufactures. It must be recognized that zenith MWRP observations alone contain not enough information to retrieve LWC profiles (Crewell et al. 2009); however, additional constraints, such as cloud infrared temperature, yield more information on cloud boundaries. The quality of LWC product by MWRP is probably sufficient for operational meteorology purposes.

The discussion above excludes water accumulation over the radome, which represents the major limitation under precipitation. If liquid or frozen water accumulate over the radome, all the retrieved products (even temperature) become not reliable because they are derived from obstructed observations. A number of solutions for mitigating precipitation effects are used in current MWR instruments, including rain sensor, hydrophobic coating, tangent blower, shutter, and side-view. These mitigation solutions effectively avoid water accumulation on the radome or mitigate its effect on the retrieved products in most of the cases. However, there are cases in which the mitigation solutions fail, as during intense rainfall or snowfall. Proper maintenance (cleaning and replacing) of the radome helps in reducing cases of precipitation mitigation failures.

Quality flags are usually adopted within the data stream to flag data during precipitation and/or with wet radome.

1.3 Data use impact

Examples of data use impact are described in the MWR networking activities and in the MWR data assimilation test

2 Existing ground-based systems

Currently there are several types of commercial and research MWR deployed worldwide.

2.1 Commercial systems

Commercial MWR units include, but are not limited to (in alphabetic order): Attex MTP-5, Radiometrics MP3000, RPG HATPRO.

2.2 Research systems

Research proto-types include, but are not limited to (in alphabetic order): ASMUWARA (Martin, 2002), GVR (Cadeddu et al., 2007), GSR (Cimini et al., 2007), MIAWARA (Bleisch et al., 2011).