Design and first results of the new fourth generation Swiss radar network

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MeteoSwiss is presently renewing and extending its operational C-band weather radar network. The renewal is a unique opportunity to revisit the strategy for quantitative precipitation measurement and nowcasting and explore new solutions from science and technology. Measuring precipitation at ground in an operational manner is one of the most demanding tasks of a weather radar network, especially in a mountainous region such as the European Alps. It imposes high requirements on many aspects of the entire system design. This goes from optimum siting, rapid volumetric scanning, offline and online hardware calibration, high hardware stability, automatic hardware monitoring and remote control, to meticulous quality control and physically-based polarimetric-radar-measurements-aloft-to-precipitation-rate-at-the-ground transformation techniques. In the Alps particular attention must be given to visibility, ground clutter issues and hydrometeor phase.

The Swiss weather radars are replaced by state-of-the-art polarimetric Doppler radars with fully digital receiver technology with receiver-over-elevation design. Three new systems are already in operation. In order to improve radar coverage in the inner-alpine regions two new radars are being built on mountain tops, one of which is already running in test phase.

Key elements of the adopted strategy are:

- Central processing: sending raw polar data to the central server allows sophisticated data processing.

- Processing chains: four parallel data processing chains are employed, one for operations and three for development and deployment.

- Precipitation rate: QPE algorithms are revised and extended to polarimetry and new radar sites at 2900 m.a.s.l.

- Integration with raingauges: radar and raingauge data are merged using a space-time cokriging-with-external-drift technique specifically developed for 24/7 unsupervised processing.

- Time-to-customer: all base products are ready for dissemination within 60 seconds after completion of a volume scan. This is a prerequisite for thunderstorm, flash flood and debris flow warnings.

- Dual-polarisation: polarimetric information helps to improve elimination of clutter, identification of the hydrometeor phase and correction for signal attenuation.

- Linear Depolarization Ratio (LDR): LDR is not measured to avoid the use of a mechanical switch prone to failures

- Update rate: the antenna scans a full volume of 20 elevation sweeps every 5 minutes. All base products are updated every 2.5 minutes using an interleaved scan strategy, which allows to capture rapid development of flash-flood generating storms.

- Sampling geometry: short pulses of 500 ns help to limit the impact of ground clutter. The new scan strategy includes oversampling at low angles to improve QPE in the Alps.

- Calibration is based on a number of independent concepts: a) offline calibration of hardware components in the factory, after installation and during periodic maintenance, b) automatic calibration of the receiver channels with a noise source every 5 minutes, c) automatic monitoring of receiver sensitivity and differential reflectivity using sun and drizzle signals, d) verification of single and dual-polarization characteristics using external receiver and transponder systems.

- Receiver-over-elevation design: by mounting the receiver on the back of the reflector we gain several dB in sensitivity and avoid the use of a dual-polarisation rotary joint prone to failures.

The paper presents the design of and first experience with the new fourth generation Swiss weather radar network and gives an overview of ongoing research activities along the whole chain from hardware monitoring, signal processing, and polarimetry in the Alps to QPE and nowcasting.