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Characterisation of the melting layer spatial variability in the Alps on polarimetric X-band radar scans

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Introduction

- Quantitative Precipitation Estimation (**QPE**) in the Alps is subject to many sources of error.

- Vertical profile (**VPR**) correction, is commonly applied to compensate for the lack of direct visibility with the radar.

- High altitude dual-polarization radars open up new possibilities to replace the **average identified VPR** with new correction techniques.

Objectives:

- Characterisation of the **vertical structure of polarimetric radar variables** from high-resolution observations in the alpine region.

- Analysis of the **spatio-temporal variability** of these **structures** and the **melting layer**.

- Research the relationship between radar variables measured at higher altitudes and **QPE at the ground level**.

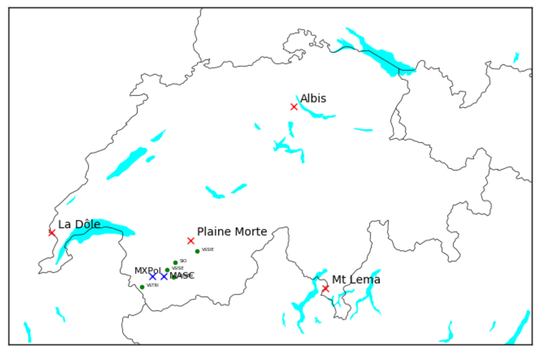

Fig. 1: MeteoSwiss operational C-band radars (red crosses) And study region with X-band radar (blue cross).

Melting Layer

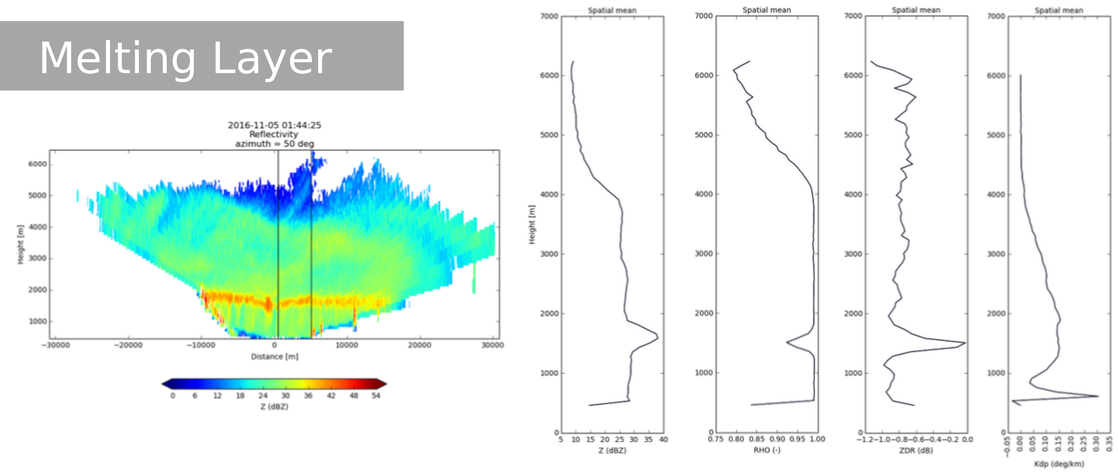

Fig. 2: Example of RHI scan for Reflectivity (left) and typical vertical profiles for polarimetric variables during The winter season in the Valais (Switzerland).

The **Melting layer** (ML) is:

- the transition region from solid to liquid precipitation and an important feature of **stratiform** precipitation
- often **assumed uniform in space and time** for QPE and VPR extraction
- in an **orographic context spatio-temporal variations of the ML** can be expected to to be **non-negligable**.

Methods

Measurement campaign in the **Valais** (Swiss Alps), Winter 2016-2017:

- from November 2016 to March 2017
- X-band Doppler dual polarization radar (**MXPol**)
- at the ground level (460 m asl) in the main valley
- close to the operational MeteoSwiss C-band radar
- 16 precipitation events
- over **250 hours** of precipitation
- a wide range of **meteological conditions**.

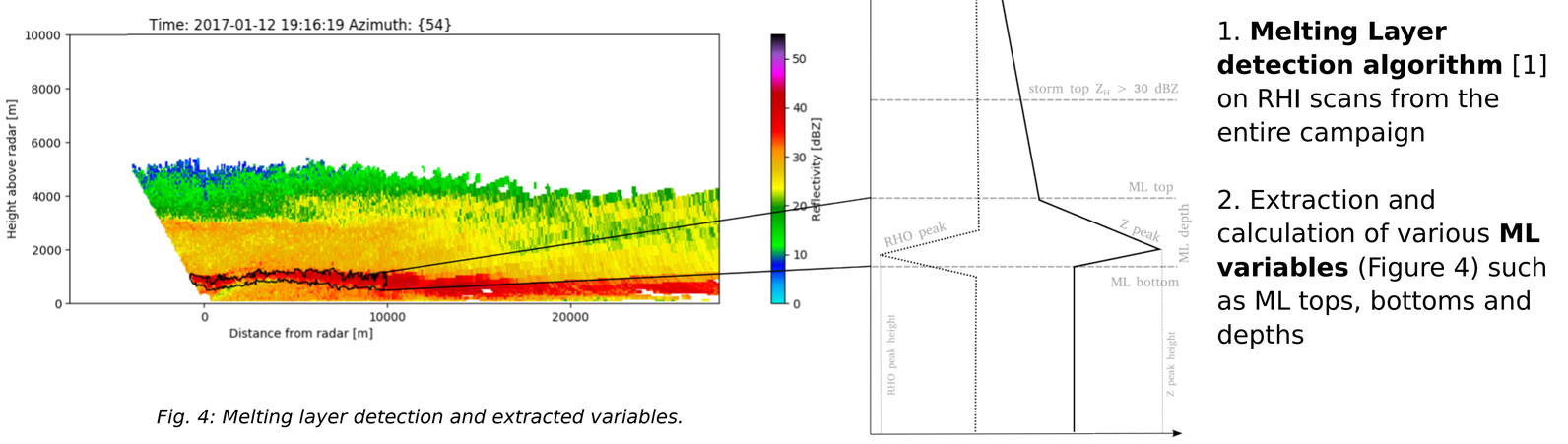

Fig. 4: Melting layer detection and extracted variables.

1. **Melting Layer detection algorithm** [1] on RHI scans from the entire campaign

2. Extraction and calculation of various **ML variables** (Figure 4) such as ML tops, bottoms and depths

Data

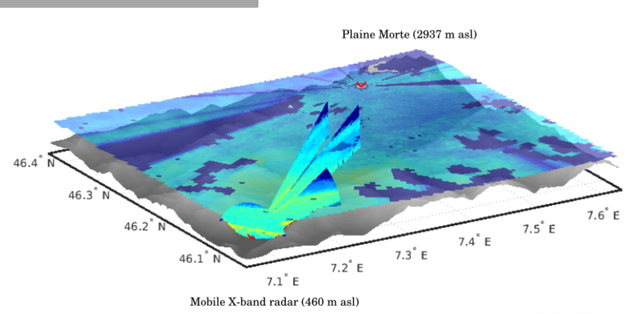

Fig. 3: Scan strategy for the Valais Winter 2016-2017 campaign.

3. The ML variables are subjected to a **simple Fourier transform** (Figure 5a)

4. The spectra are fitted with a **power law** (Figure 5b)

5. comparison of the power law **parameters** a and b of each fit

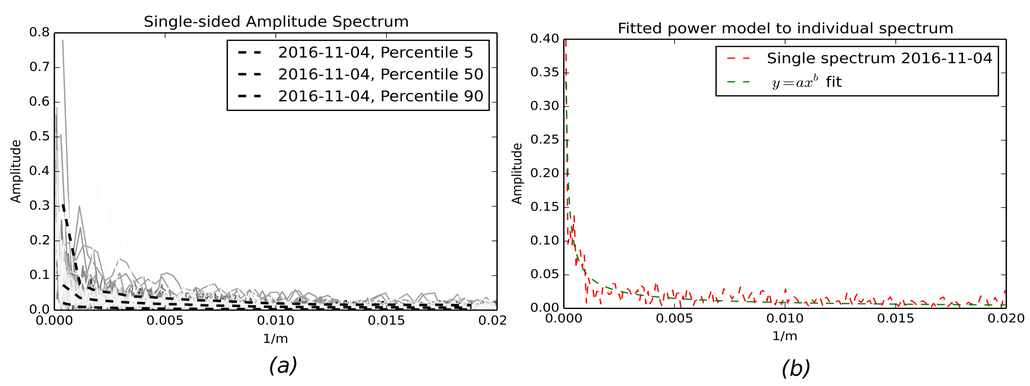

Fig. 5: Examples of single-sided amplitude spectra for one event (left), and the model fitted to a single spectrum (right).

Preliminary results

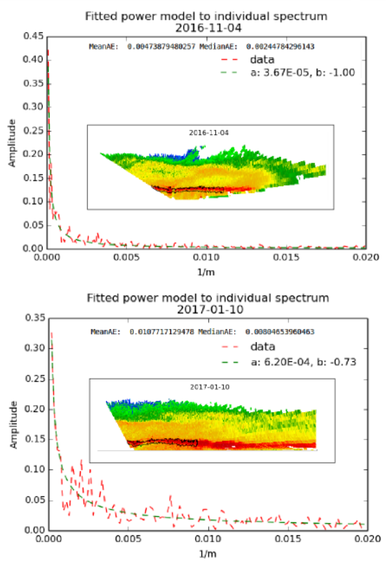

Fig. 6: Spectra and fits for an event with low spatial variability in the ML (top) and with high spatial variability in the ML (bottom).

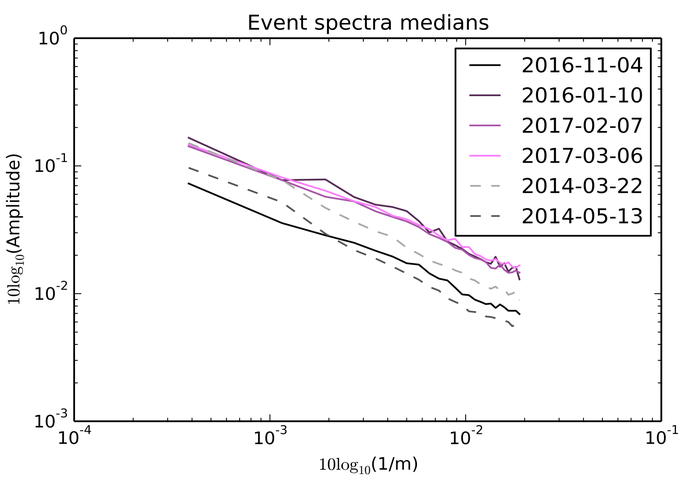

Fig. 7: Log-log plot of the event spectra medians; dashed lines represent events from a non-alpine measurement campaign.

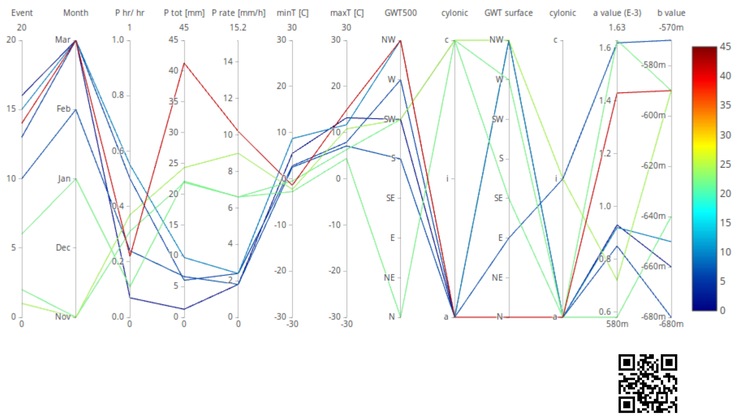

Fig. 8: Parallel coordinates plot for all analysed events from the Valais campaign with associated a and b values.

Conclusions

Preliminary results suggest that:

- **spatial variability** of ML variables can be distinguished with Fourier spectra (Figure 6)

- event spectra medians from the Valais campaign differ from non-alpine events, and **indicate variability at smaller spatial scales** (Figure 7)

- two **clusters of b values** van be observed for the Valais events (Figure 8).

References:

[1] Wolfensberger, D., Scipion, D. and Berne, A., 2016: Detection and characterization of the melting layer based on polarimetric radar scans. Quarterly Journal of the Royal Meteorological Society, 142, 108-124.