Multisource data verification of a weather radar surface precipitation type product

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1. Introduction

Surveillance of snowfall events at low altitudes is critical in regions where these phenomena are not common, like in Southern Europe and the Mediterranean coastal regions. They can cause major problems of road safety and damage communications infrastructures that are not prepared for snow conditions. Therefore, it is important to know the surface precipitation type in order to provide valuable information to decision-makers in surveillance tasks. The Meteorological Service of Catalonia (SMC) implemented in 2006 a Surface Precipitation Type (SPT) product [1].

The main objective of this study is to provide a verification of the SPT product in Catalonia (NE Iberian Peninsula) using precipitation type observations from manifold sources. In addition, a comparison between Micro Rain Radar (MRR) and Parsivel disdrometer precipitation type classification for a specific location in the Pyrenees, La Cerdanya Valley. Both data is also compared against two different precipitation type discrimination methodologies.

2. Instrumentation

The SMC manages a network of four C-band single-polarization Doppler weather radars and a network of 183 automatic weather stations. A Parsivel disdrometer, a Radiometer and a MRR are also available.


Parsivel disdrometer


Radiometer


AWS

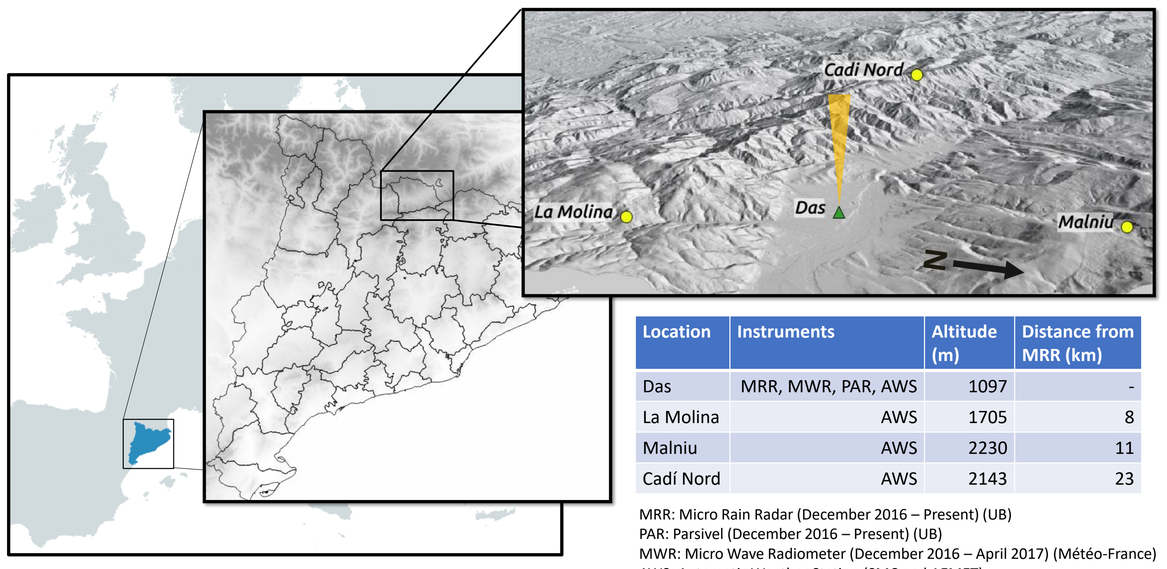

Weather radar


Micro Rain Radar

3. La Cerdanya Valley

It is a singular basin due to its orographic configuration which predisposes the formation of cold air pools, mountain gravity waves and enhanced precipitation.

For this reason, a wide variety of meteorological instruments are installed at La Cerdanya Valley.



Location	Instruments	Altitude (m)	Distance from MRR (km)
Das	MRR, MWR, PAR, AWS	1097	-
La Molina	AWS	1705	8
Malniu	AWS	2230	11
Cadí Nord	AWS	2143	23

MRR: Micro Rain Radar (December 2016 – Present) (UB)
PAR: Parsivel (December 2016 – Present) (UB)
MWR: Micro Wave Radiometer (December 2016 – April 2017) (Météo-France)
AWS: Automatic Weather Station (SMC and AEMET)

4. Rain or Snow

Two methodologies to discriminate precipitation type are considered:

- Koistinen and Saltikoff [2] (KS) approach provides an empirical formula (1) to calculate the probability of precipitation type.

$$p(snow) = 1 - \frac{1}{1+e^{(22-2.7T-0.2RH)}} \quad (1)$$

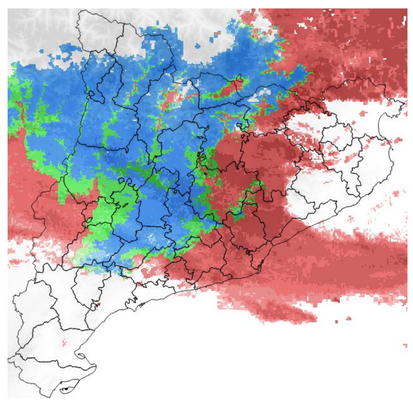
- A part of the USA National Mosaic and Multi-Sensor QPE System [3] (NMQ) classifies precipitation as snow if T < 2°C and T_w < 0 °C. Otherwise, precipitation is in from of rain.

Operational SPT product

Temperature and relative humidity analysis
From AWS network and a multivariate regression with anomaly correction, temperature an relative humidity fields are obtained for Catalonia.

Calculation of the probability of precipitation type
Using the temperature and relative humidity fields and equation (1) surface precipitation type field (SPT) estimates are calculated.

Merging with weather radar data
Surface precipitation type field is masked with weather radar precipitation field to obtain the SPT final product.



MRR precipitation type classification

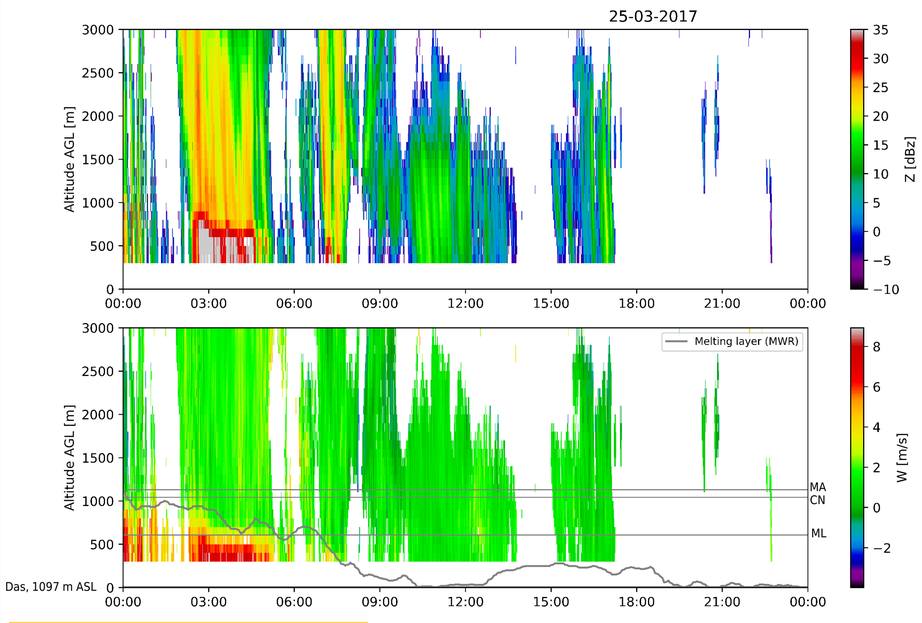
Precipitation is classified as snow or rain based on two parameters: melting layer height and Doppler velocity (W).

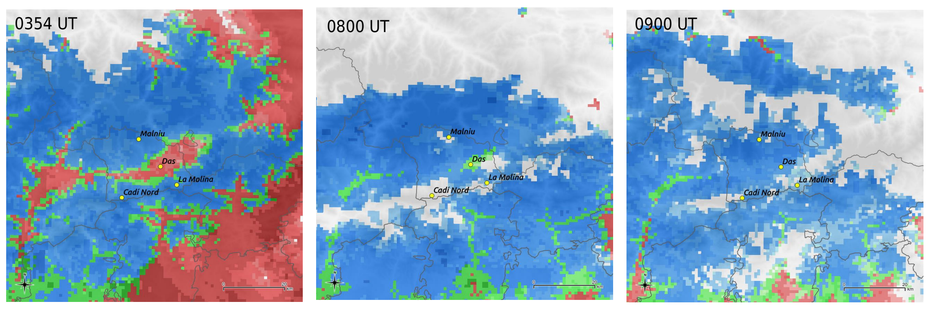
- Melting layer height calculation based on [4] approach
- If bin below melting layer, rain
- If bin above melting layer, snow
- If no melting layer:
  - Snow if W <= 2.8 m/s
  - Rain if W > 2.8 m/s

5. MRR verification

15 different episodes selected: snow, rain and mixed events. Three analysis are done:

- Precipitation type from MRR proposed algorithm against Parsivel disdrometer hydrometeor classification.
- Precipitation or No precipitation in AWS locations (La Molina, Malniu and Cadí Nord) against the bin of MRR data at the height of the stations.
- Precipitation type from MRR, and Parsivel disdrometer in Das, against estimations from KS and NMQ methods.





MRR precipitation type algorithm

MRR vs Parsivel*	POD	FAR	ETS
Precip./No precip.	0.90	0.15	0.62
Snow/No snow	0.78	0.31	0.49
Rain/No Rain	0.88	0.21	0.49

*21286 minutes of observations

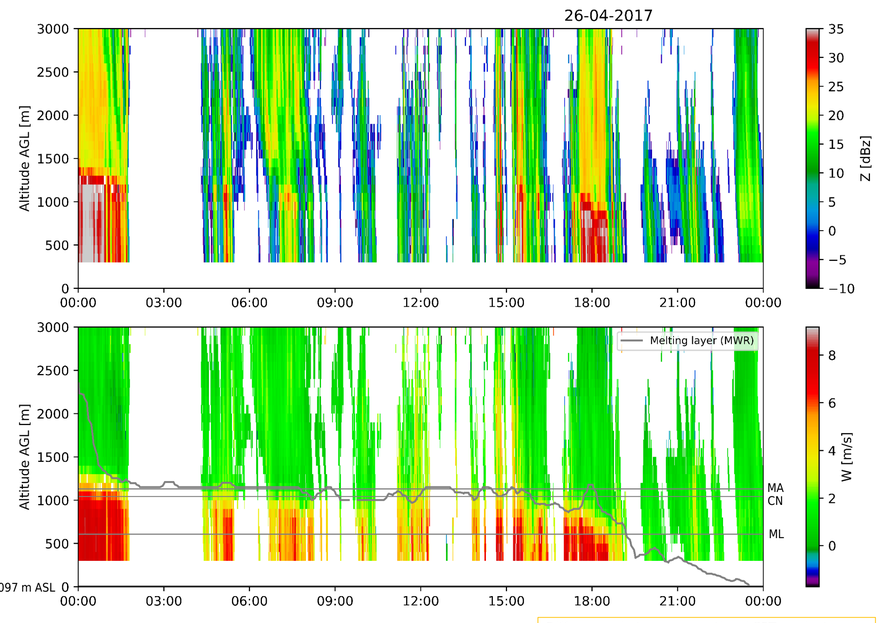
Micro Rain Radar horizontal agreement

MRR vs AWS**	POD	FAR	ETS
La Molina (ML)	0.84	0.35	0.30
Cadí Nord (CN)	0.91	0.34	0.31
Malniu (MA)	0.88	0.27	0.33

**734 groups of 30 minutes of observations for CN and MA, 534 for ML

Precipitation type classification*			POD	FAR	ETS
Das	Snow/No snow	MRR vs KS	0.82	0.14	0.54
		MRR vs NMQ	0.69	0.11	0.45
		PAR vs KS	0.92	0.10	0.70
		PAR vs NMQ	0.75	0.07	0.55
	Rain/No rain	MRR vs KS	0.88	0.15	0.54
		MRR vs NMQ	0.92	0.23	0.45
		PAR vs KS	0.91	0.07	0.70
		PAR vs NMQ	0.95	0.18	0.55
La Molina	Sn/No sn	MRR vs KS	0.94	0.23	0.44
		MRR vs NMQ	0.89	0.18	0.49
	Ra/No ra	MRR vs KS	0.66	0.10	0.44
		MRR vs NMQ	0.76	0.14	0.49

*441 groups of 30 minutes of observations for DA, 229 for ML



a) and b) are a time-height measurements of radar reflectivity and Doppler velocity from MRR, respectively. c) and d) include the representation of different precipitation type measurements (Parsivel, only for Das site) and estimates (MRR, KS, SPT and NMQ). KS and NMQ representations are independent of precipitation, therefore they are represented continuously. e) SPT product frames for The Cerdanya Valley area.

Future work

- Improving temperature and relative humidity interpolations through clustering to reduce differences between theoretical KS and the SPT product.
- Verification of all observational data gathered from different sources.
- Lay the foundations for a nowcasting SPT product.

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