Mountain precipitation phase identification from multiple datasets

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= Impact of Future Rain/snow transition height On Glacier mass balance

Context

Why is it so important to know the phase of precipitation?

- Fresh water resources distribution (snow/rain)
- Glacier mass balance modelling

How to estimate the precipitation phase?

- In-situ measurements
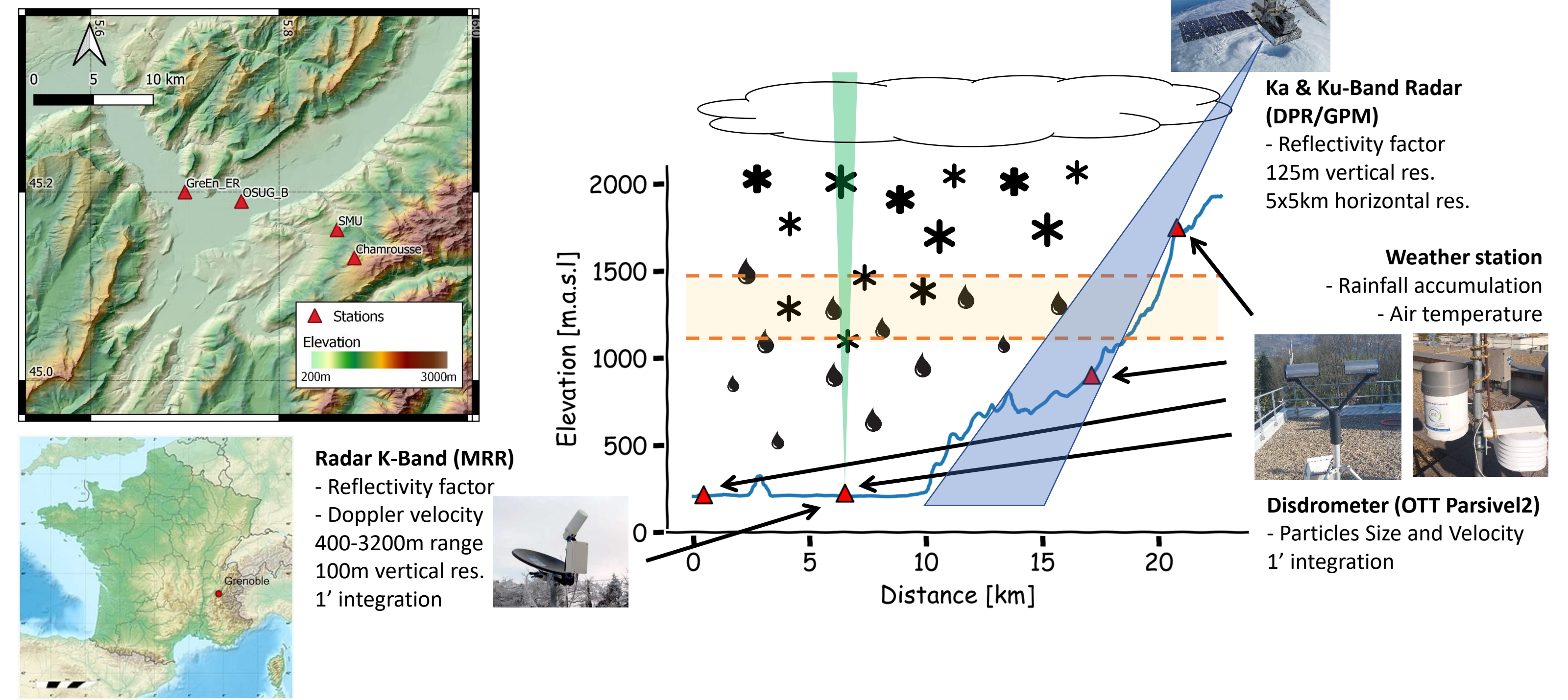- Remote sensing → Radars (spaceborne or ground-based)

Difficulties:

- Few recording instruments, remote areas
- Few assessments on satellite products, in particular in mountainous areas
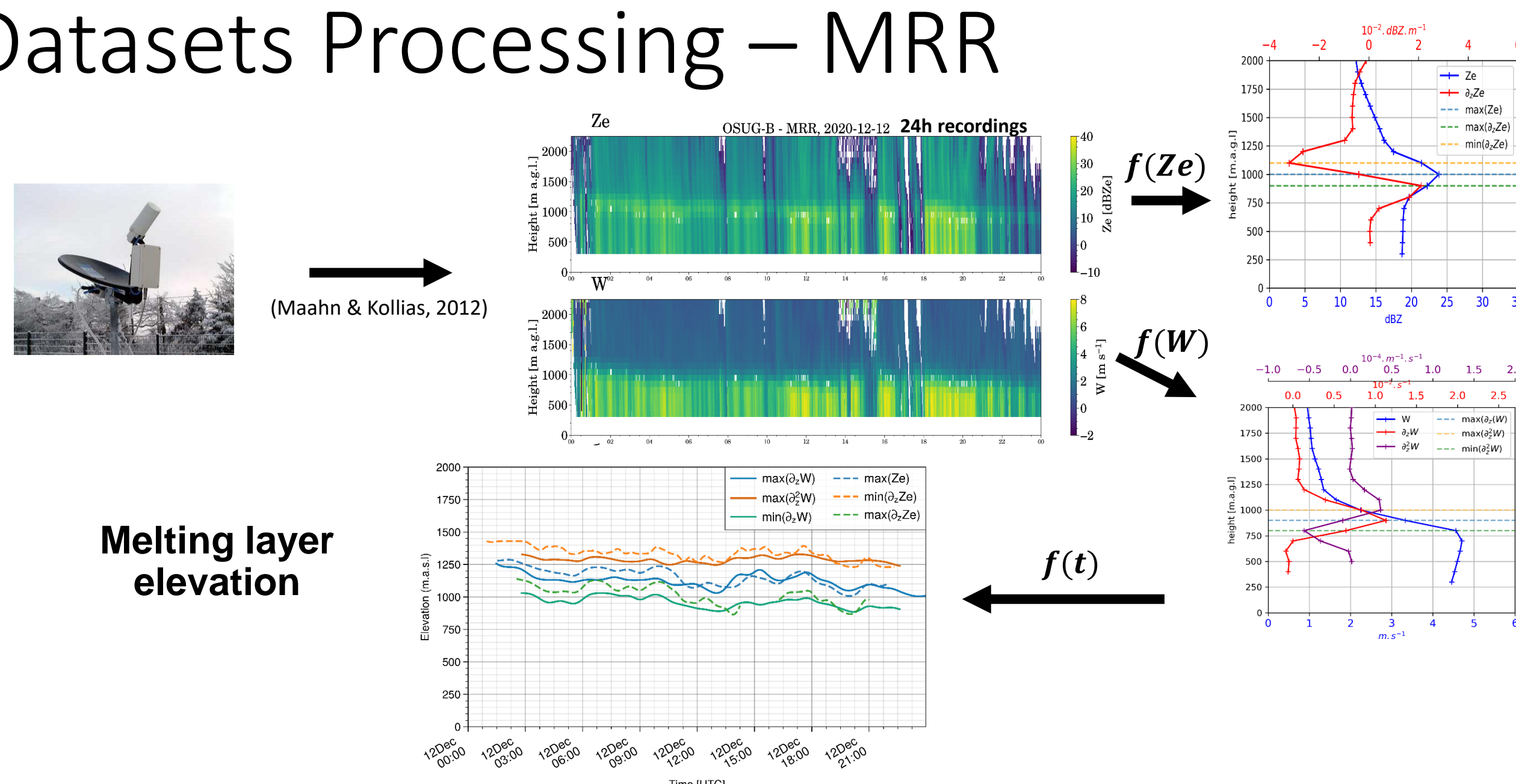- From point-scale to spatialized data

→ Aim of the study:
Investigate selected precipitation events from several instruments (MRR, disdrometer, DPR/GPM) in the French Alps for precipitation phase identification
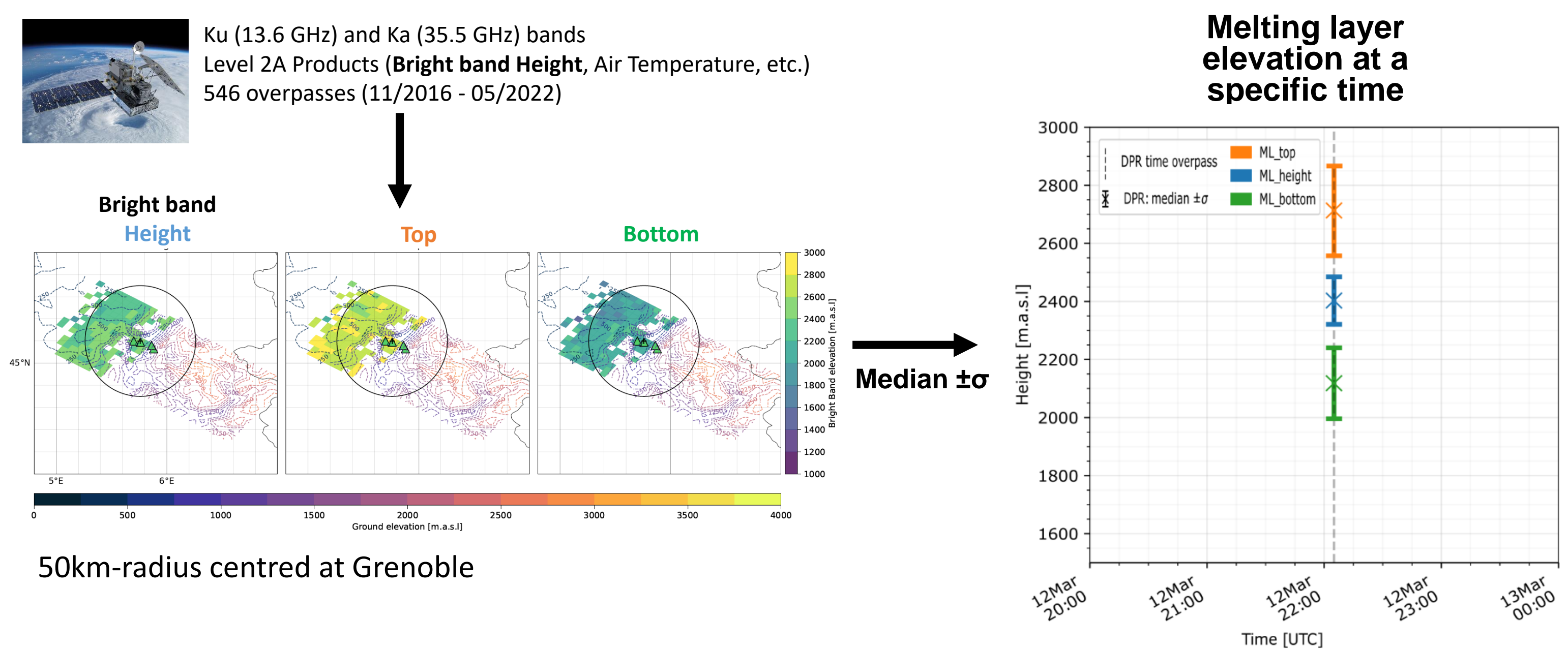
French Alps Datasets

Ka & Ku-Band Radar (DPR/GPM)
- Reflectivity factor
125m vertical res.
5x5km horizontal res.

Weather station
- Rainfall accumulation
- Air temperature

Disdrometer (OTT Parsivel2)
- Particles Size and Velocity
- 1' integration

Radar K-Band (MRR)
- Reflectivity factor
- Doppler velocity
400-3200m range
100m vertical res.
1' integration

Datasets Processing – MRR

$f(Ze)$

$f(W)$

$f(t)$

Melting layer elevation
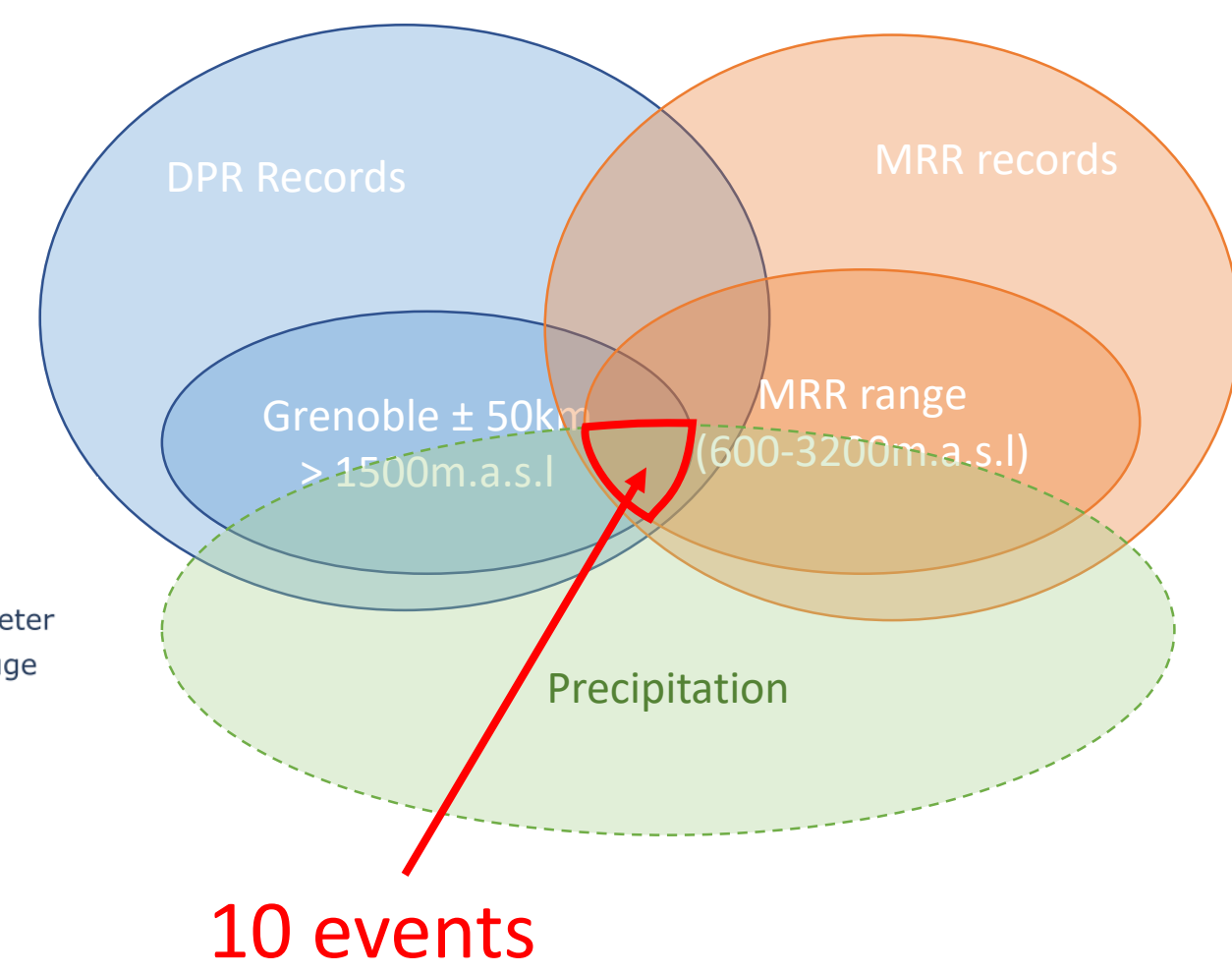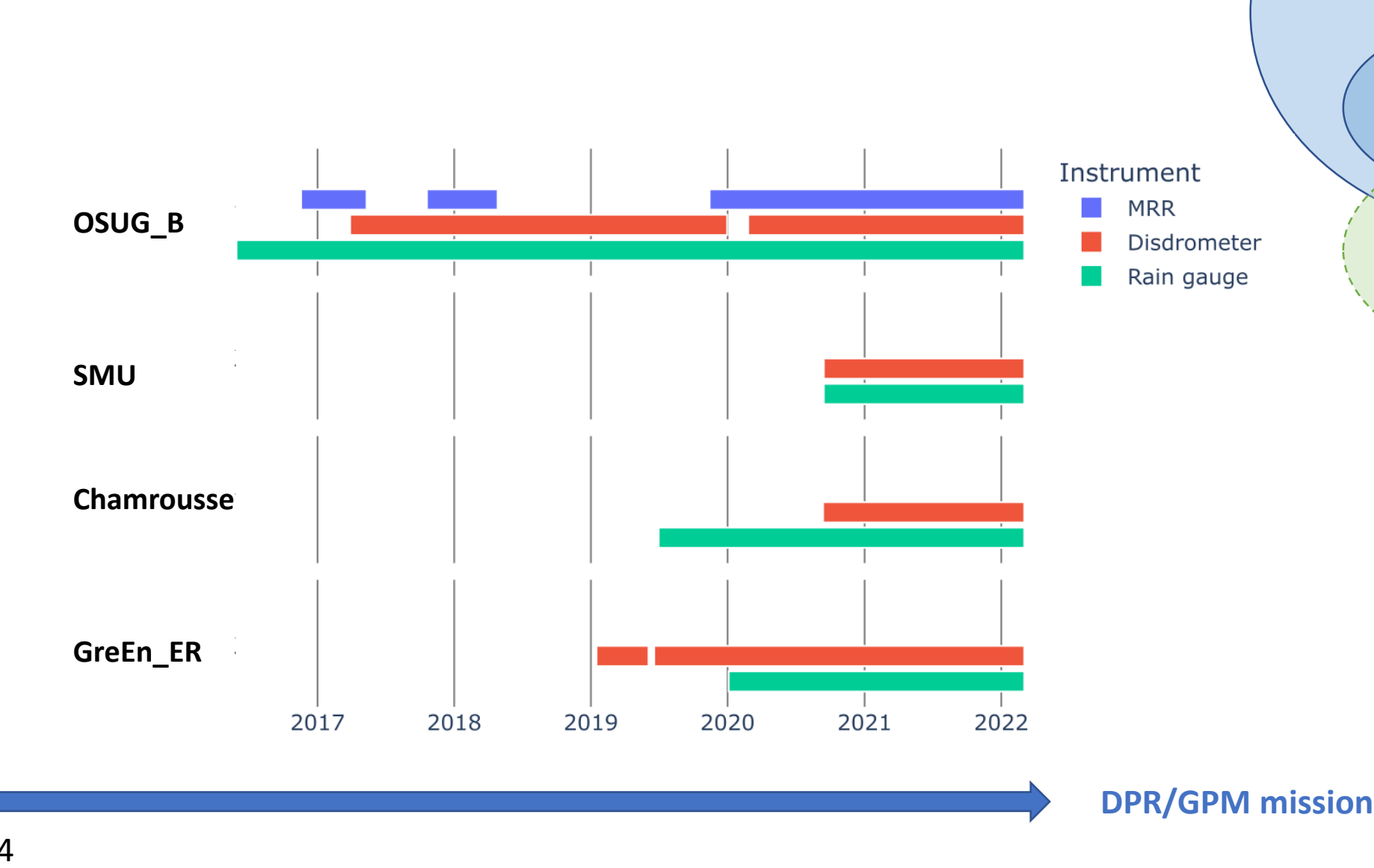
(Maahn & Kollias, 2012)

Ref: Khanal, A. K., Delrieu, G., Cazenave, F., & Boudevillain, B. (2019). Radar remote sensing of precipitation in high mountains: Detection and characterization of melting layer in the Grenoble valley, French Alps. Atmosphere, 10(12), 784.

Datasets Processing – DPR

Ku (13.6 GHz) and Ka (35.5 GHz) bands
Level 2A Products (**Bright band Height**, Air Temperature, etc.)
546 overpasses (11/2016 – 05/2022)

Bright band   Height   Top   Bottom

50km-radius centred at Grenoble

Median ±σ

Melting layer elevation at a specific time

Datasets availability

DPR Records

MRR records

Grenoble ± 50km
> 1500m.a.s.l.

MRR range
(600-3200 m.a.s.l)

Precipitation

10 events

Results – MRR vs. DPR

There are quite few events over the considered period for which both:
1) stratiform precipitation is observed at the same time as the passage of the DPR over the Grenoble region
2) all instruments are available at the same time
3) The melting layer is located between ~ 1500m and 3200m

→ On the 10 events corresponding to these conditions : Good consistency between DPR and MRR for both precipitation phase identification methods (Reflectivity and Velocity)

RMSE= 102m
r = 0.96
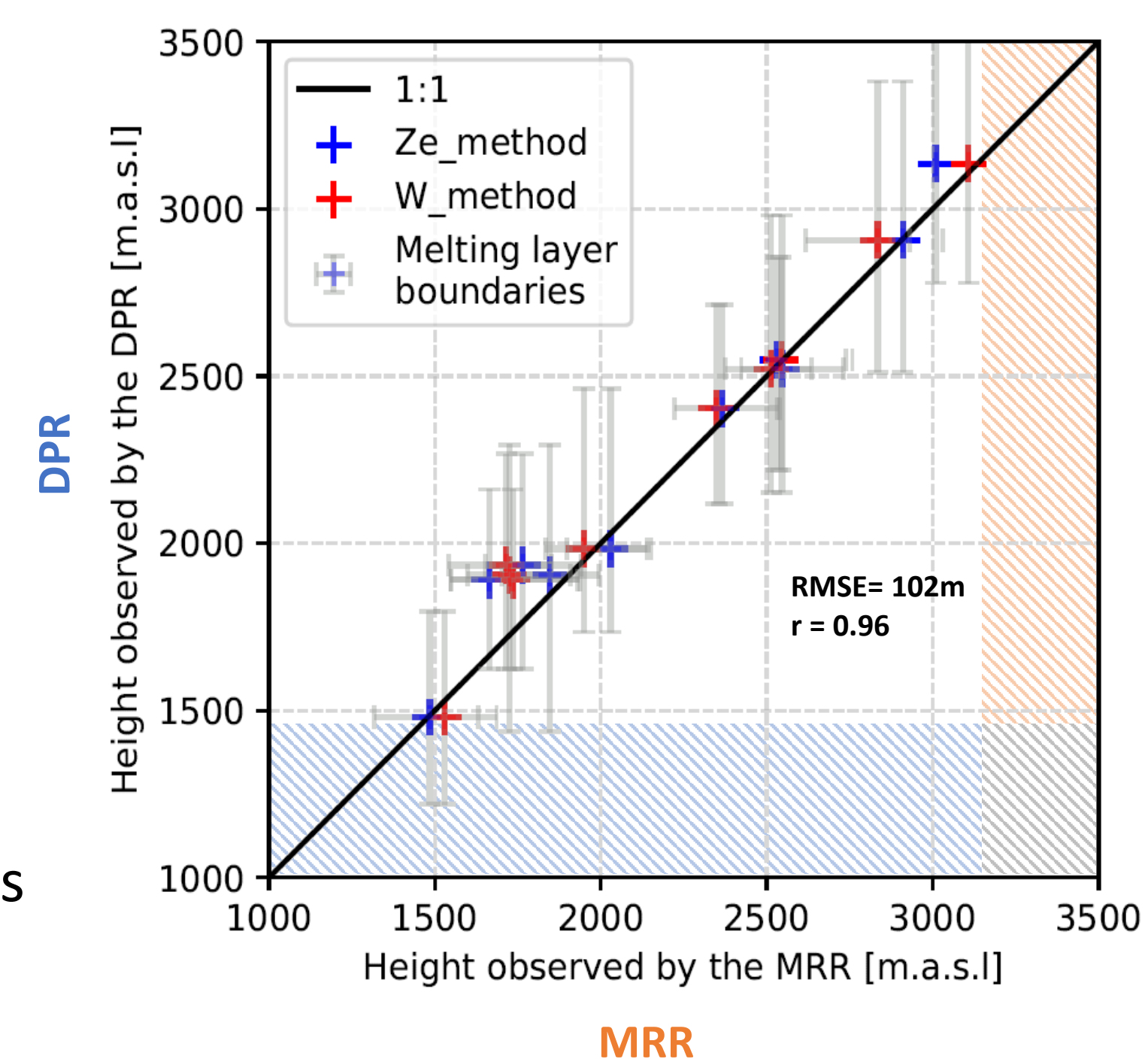
Datasets Processing – Parsivel

Particles Size and Velocity
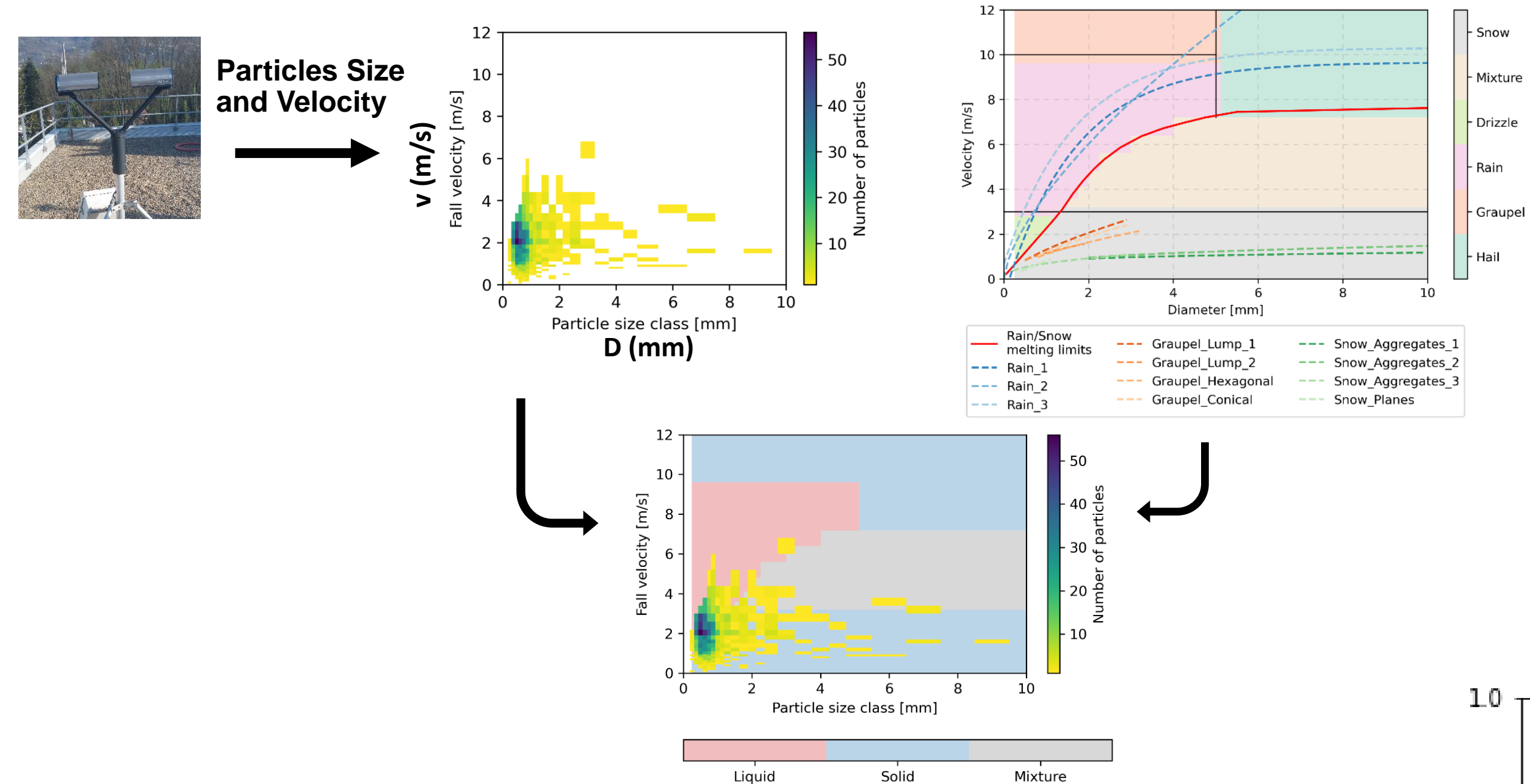
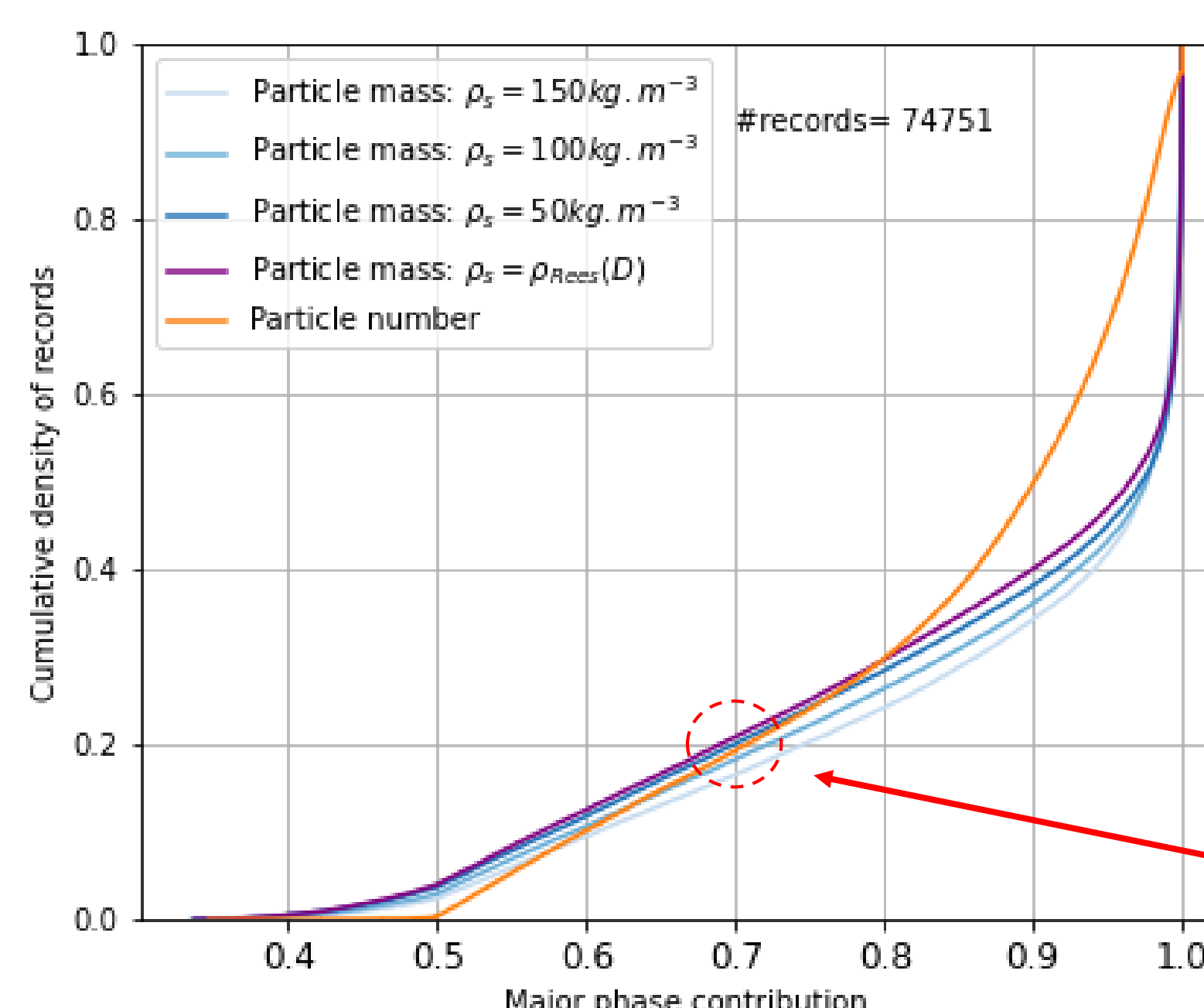## Extended study about phase identification with Parsivel

Manufacturer Classification
(**major phase** during 1' time step provided by the Parsivel)
vs.
Experimental classification
(Details about particles **phase ratio** during the same 1' time step from raw spectra)

Based on 13-months records in Chamrousse

For instance, 20% of the time the major phase represents less than 70% of the total

Conclusions

- Good consistency about the melting layer limits identified by MRR and DPR in the French Alps region
- But very few available cases for a robust analysis!

- A "reverse engineering" additional study about precipitation phase estimation from Parsivels which gives an idea of the share of the majority phase in the mixed precipitation.

Perspectives

- More existing datasets to explore (Sentinel-2, etc.)
- Other regions to study and datasets to investigate, e.g. MRR data from Andes (area concerned by the IFROG project, GlacioClim observatory) and LaMP (Univ. Clermont Auvergne)

Illustration on one case study in 2021