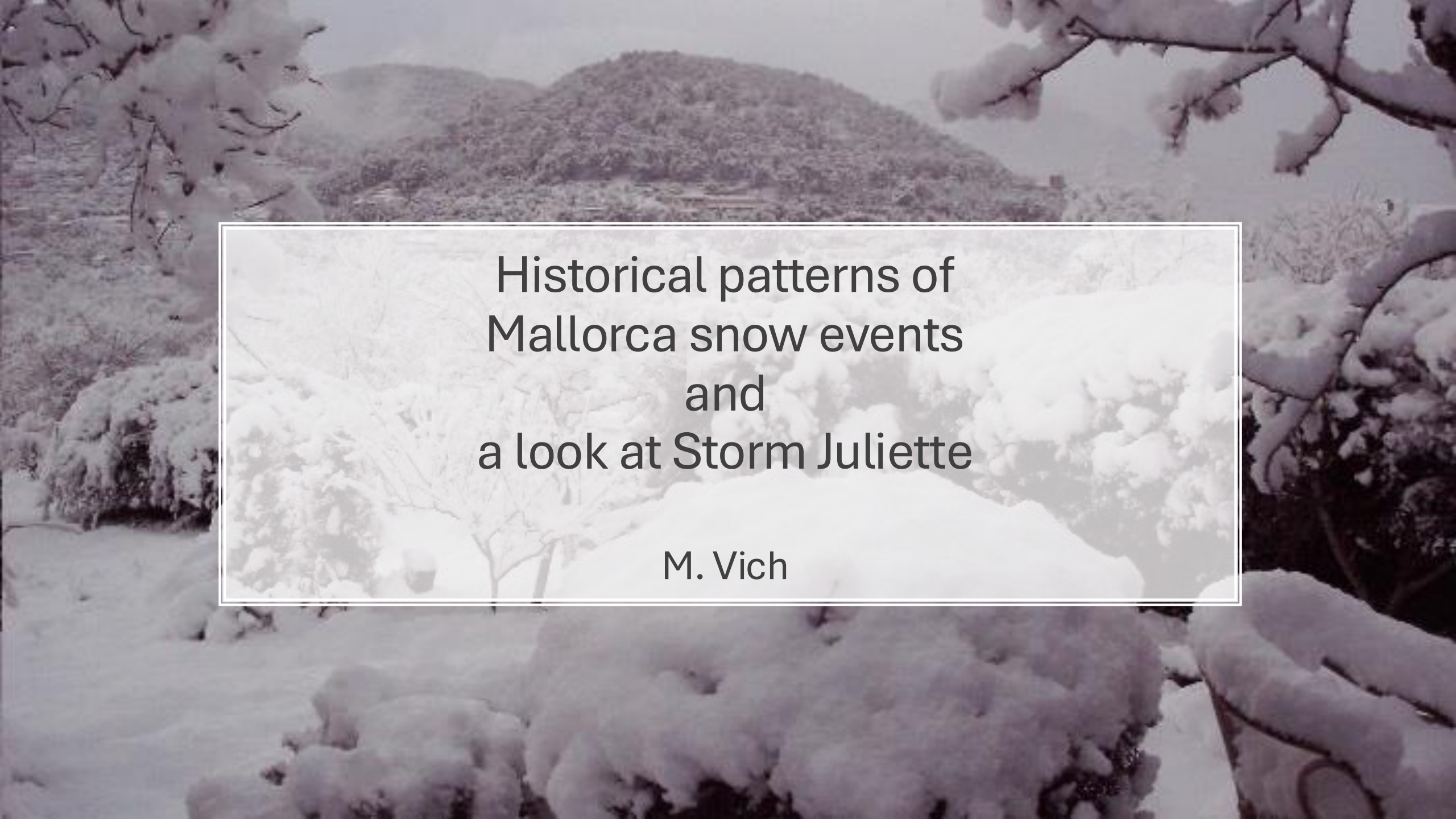


Historical patterns of Mallorca snow events and a look at Storm Juliette

M. Vich

Why Snow Events in Mallorca Matter

Capdepera en la gran nevada de 1956

Las calles de la localidad quedaron totalmente blancas.

La playa de Portocristo nevada en 2005 / **MIQUEL NICOLAU DURAN**

4 y 5 de febrero de 2012

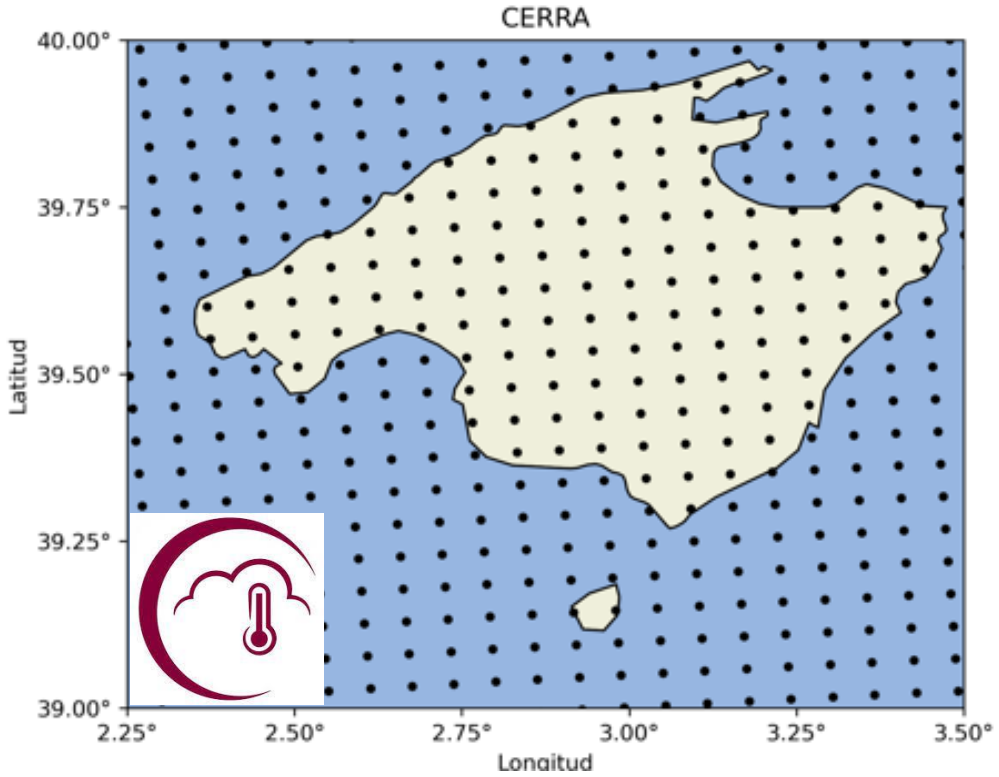
Historical Snowfall Patterns (1985–2020)

Data Source:

Reanalysis CERRA

(Copernicus European Regional Reanalysis)

- Resolution: 5.5 × 5.5 km
- Temporal: 3-hourly
- Period: Sept 1984 – June 2021



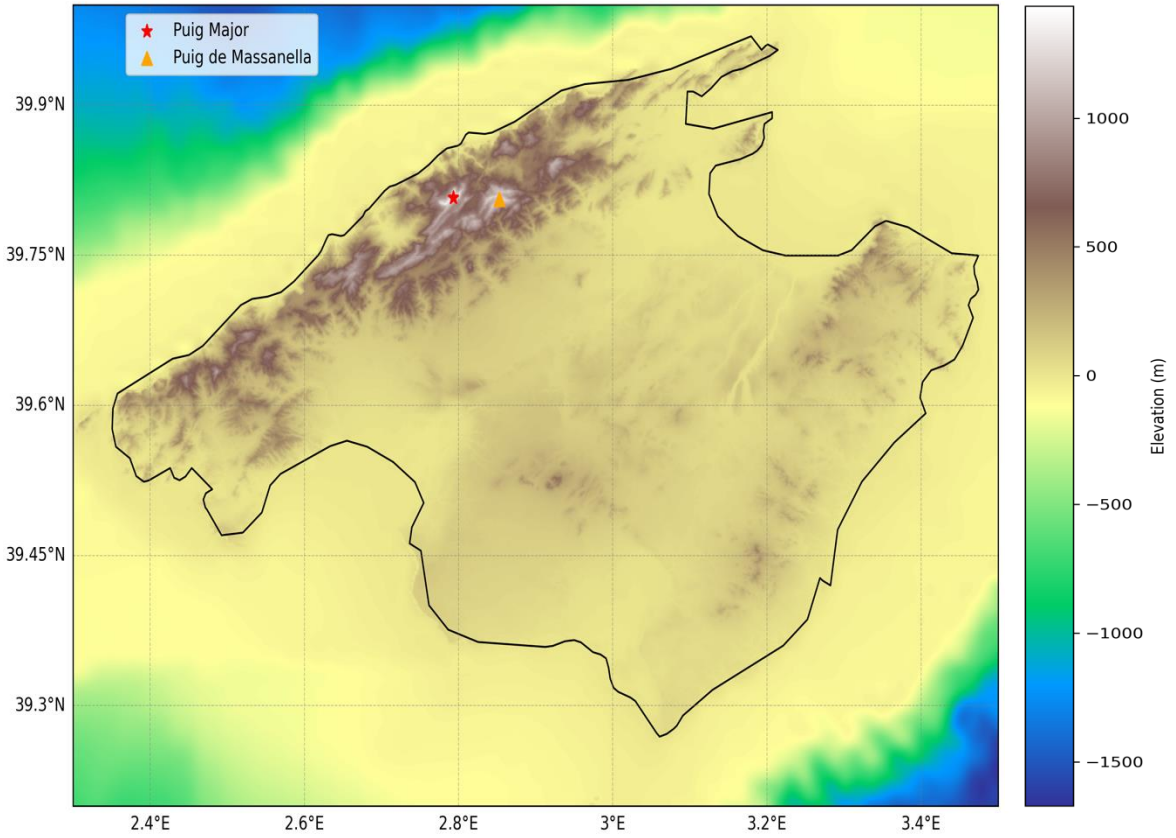
Snow Depth Estimation

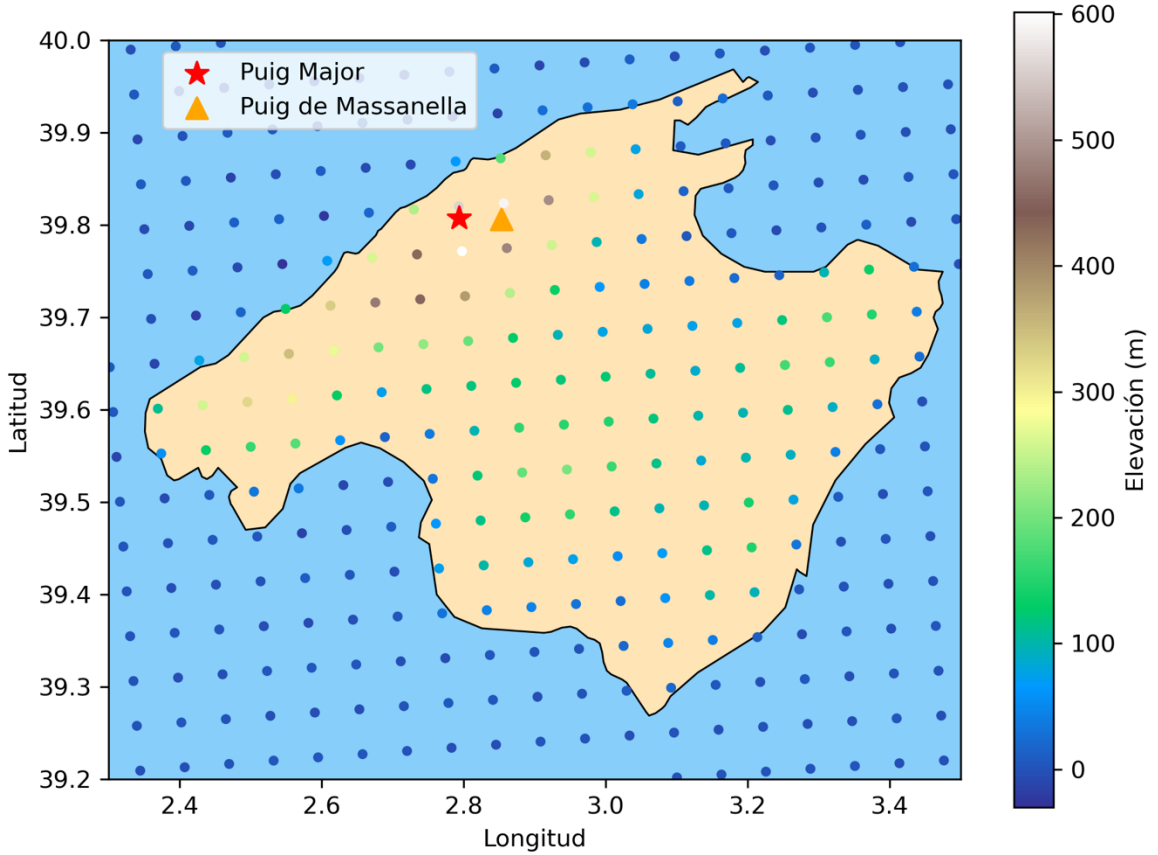
$$\text{Snow depth [cm]} = 100 \times \frac{\text{Snow Water Equivalent [kg m}^{-2}\text{]}}{\text{Snow Density [kg m}^{-3}\text{]}}$$

(Pomeroy & Gray, 1995)

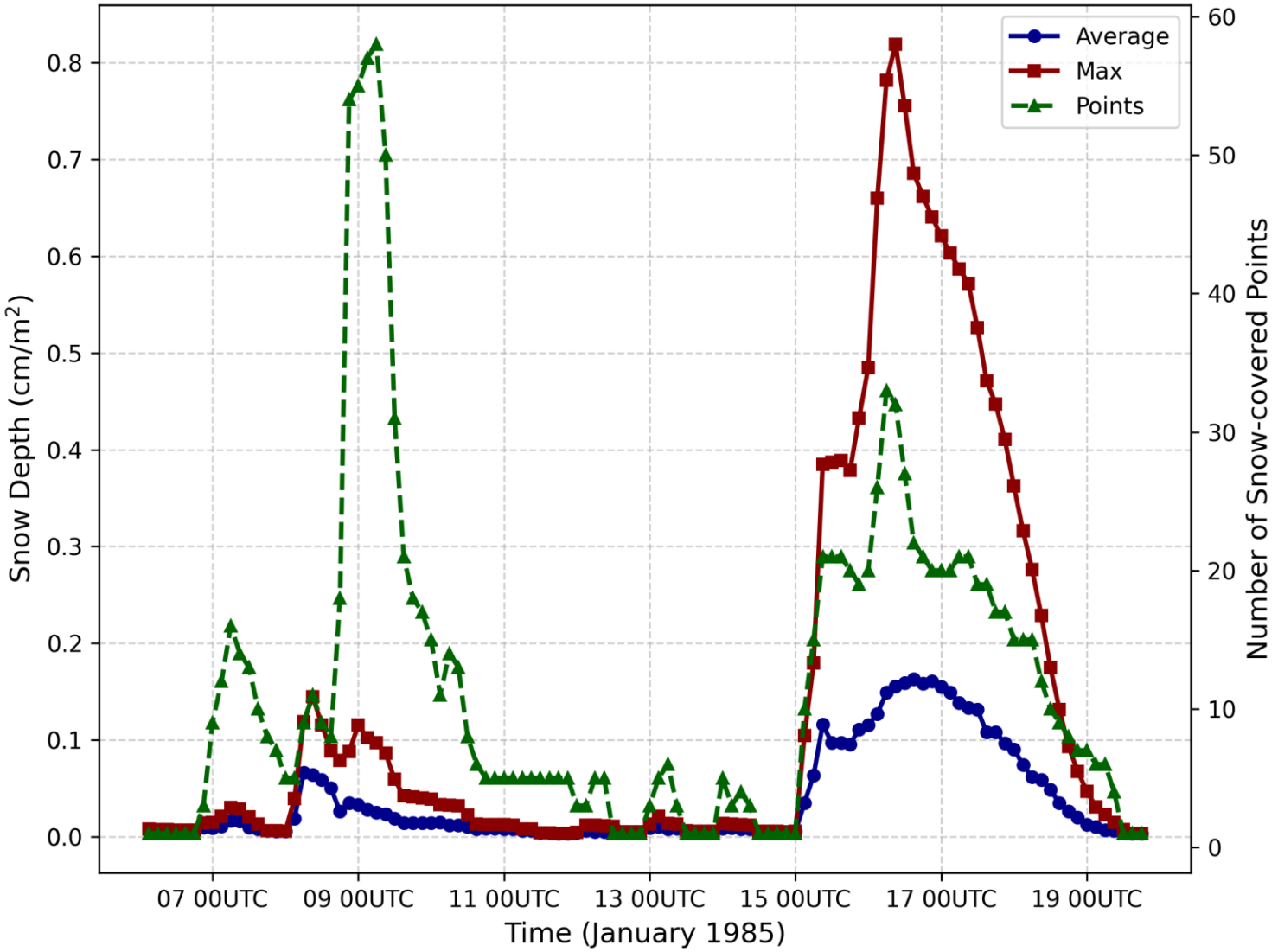
CERRA Dataset – Strengths and Limitations

- High temporal resolution, consistent dataset
- Underestimates snow depth due to coarse topography
- Serra de Tramuntana underrepresented in elevation





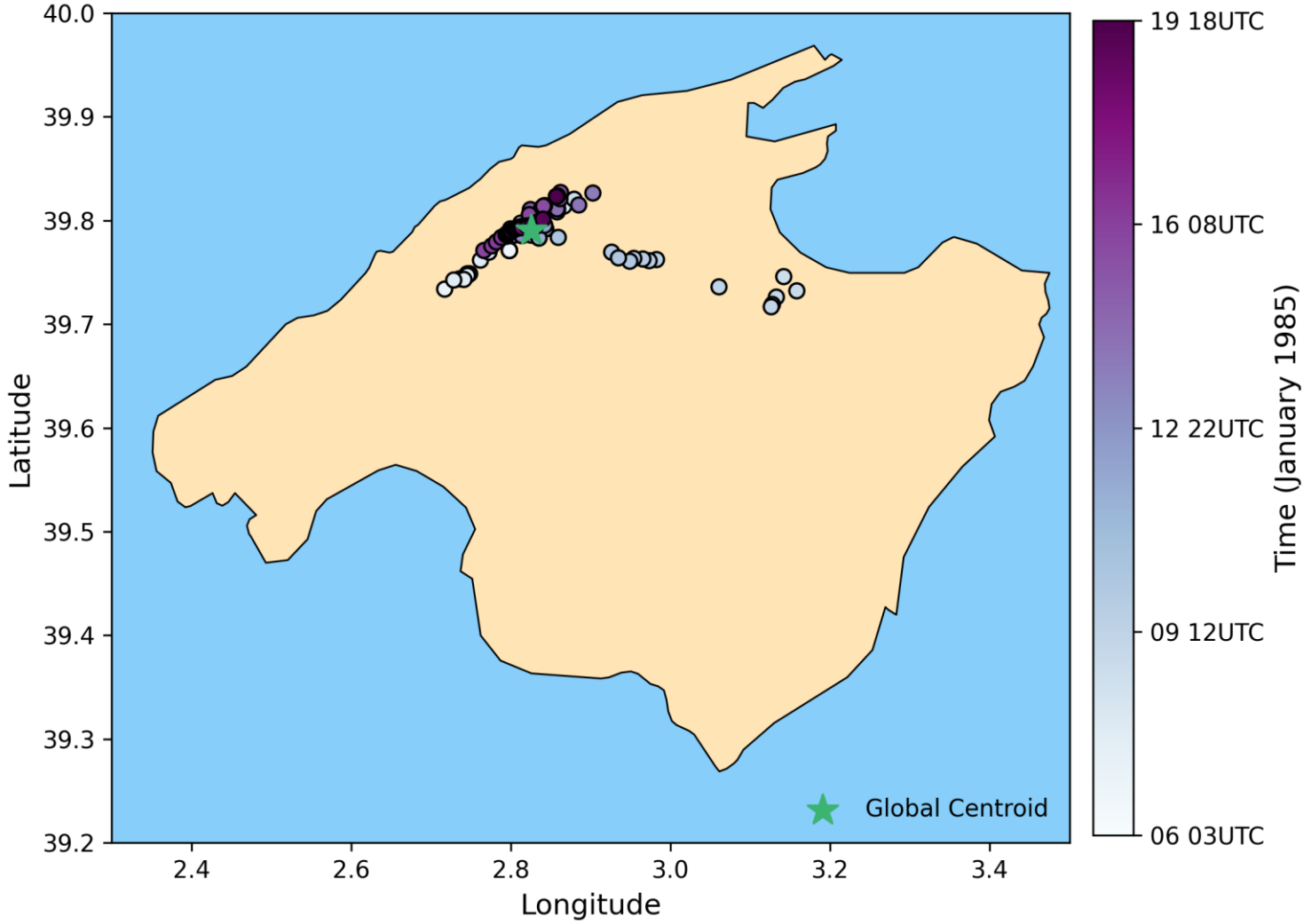
Methodology



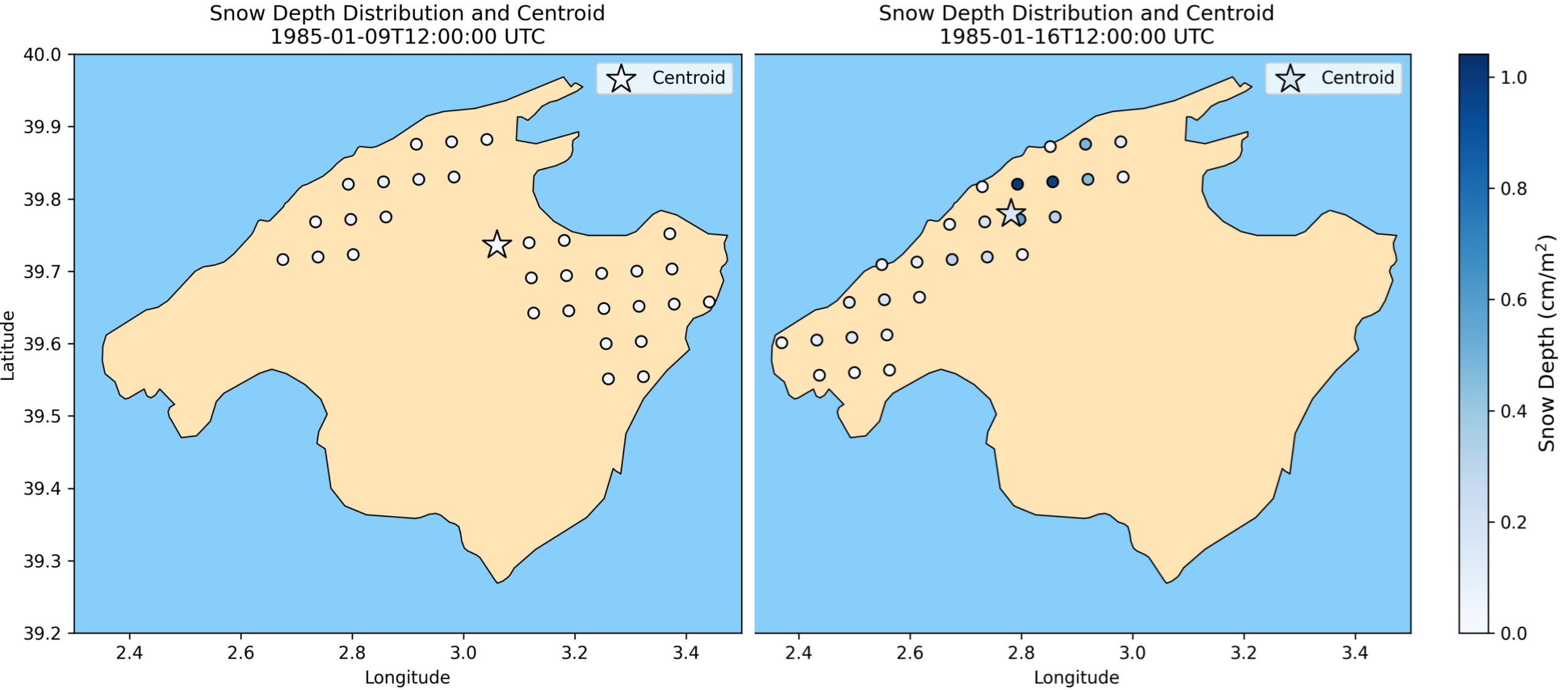
Methodology

- Identify snow events via centroid and snow depth analysis

- Metrics:
  - Event duration
  - Spatial dispersion
  - Affected area
  - Intensity (mean snow depth)

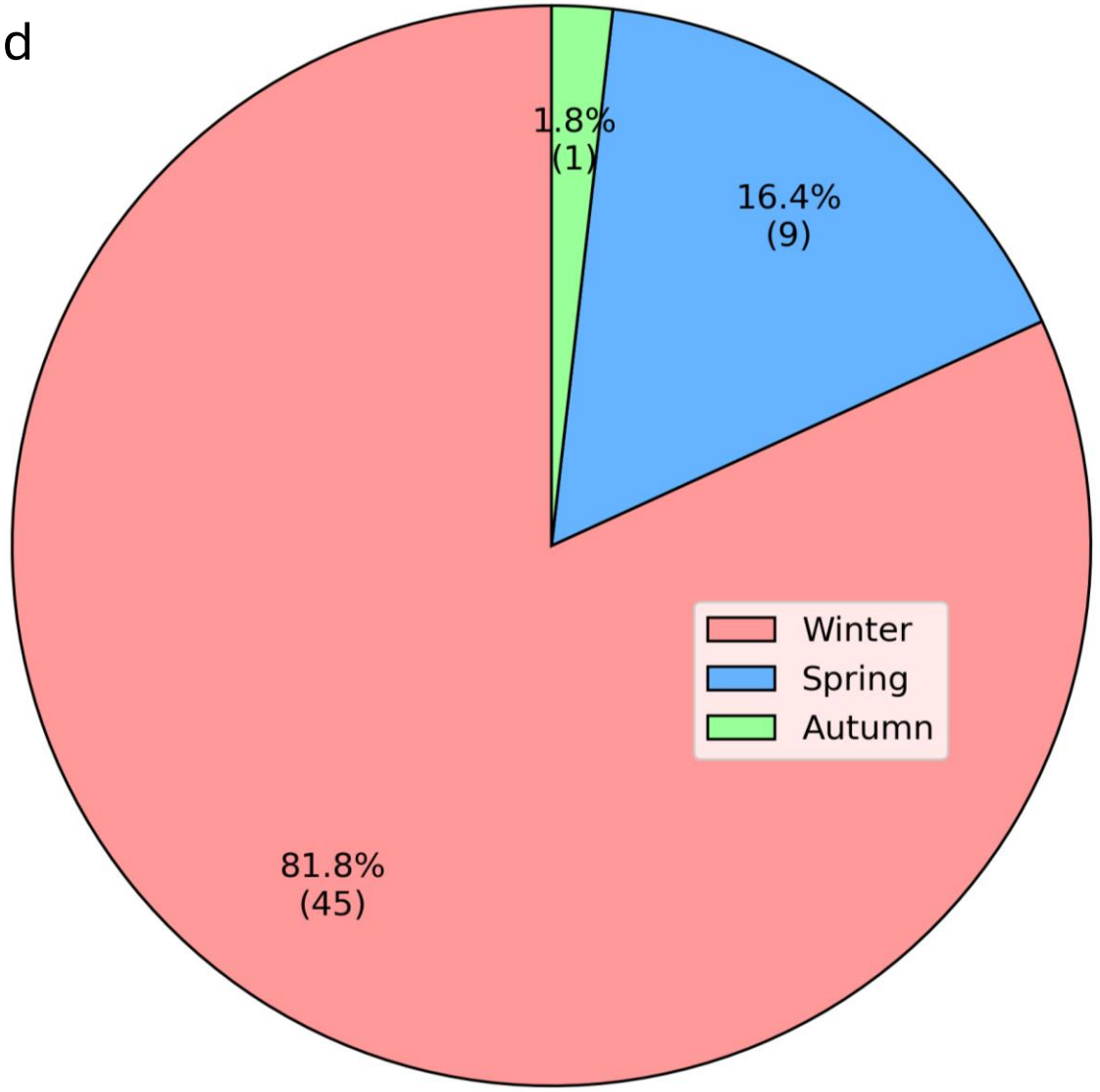


Methodology

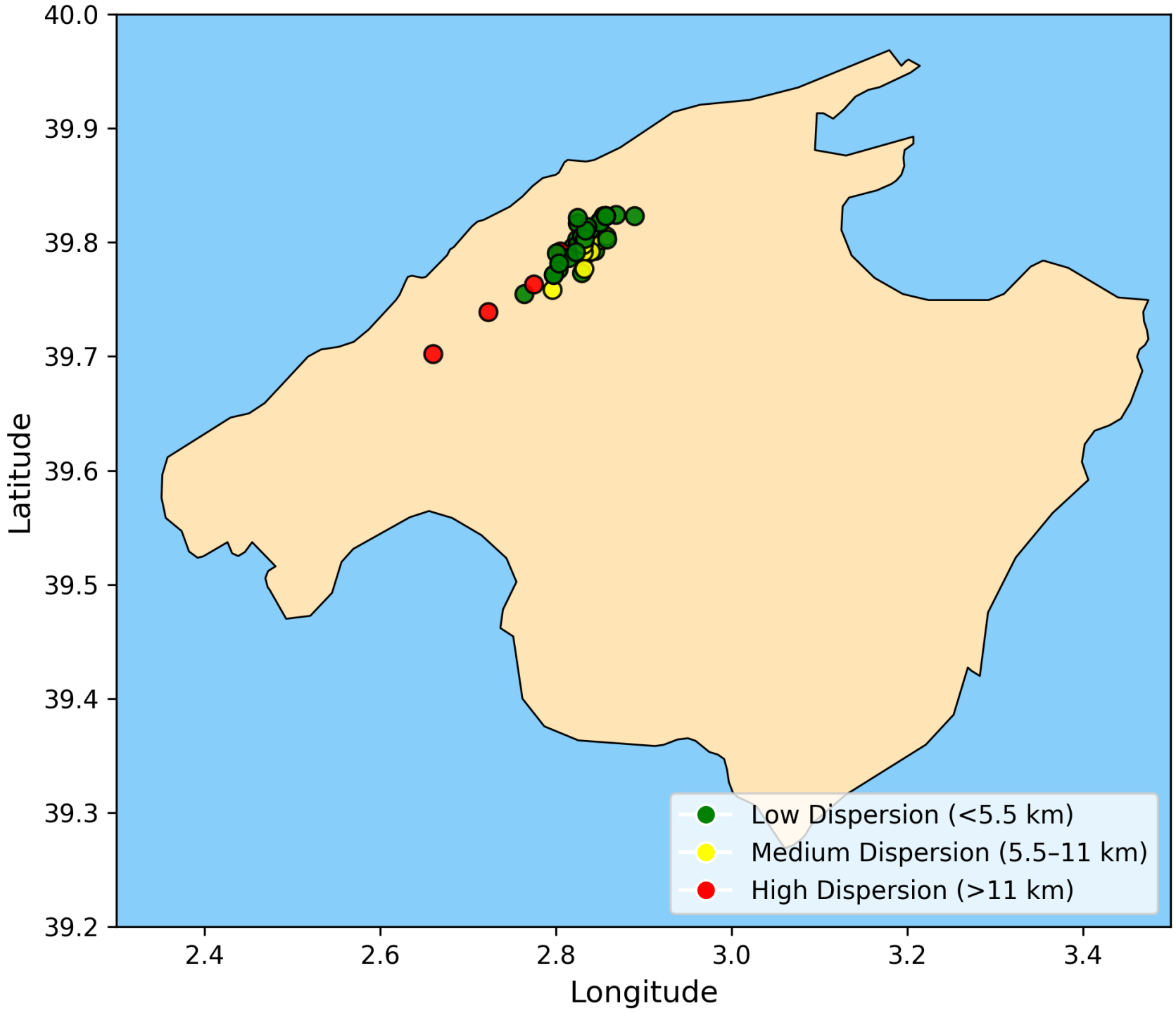


Results

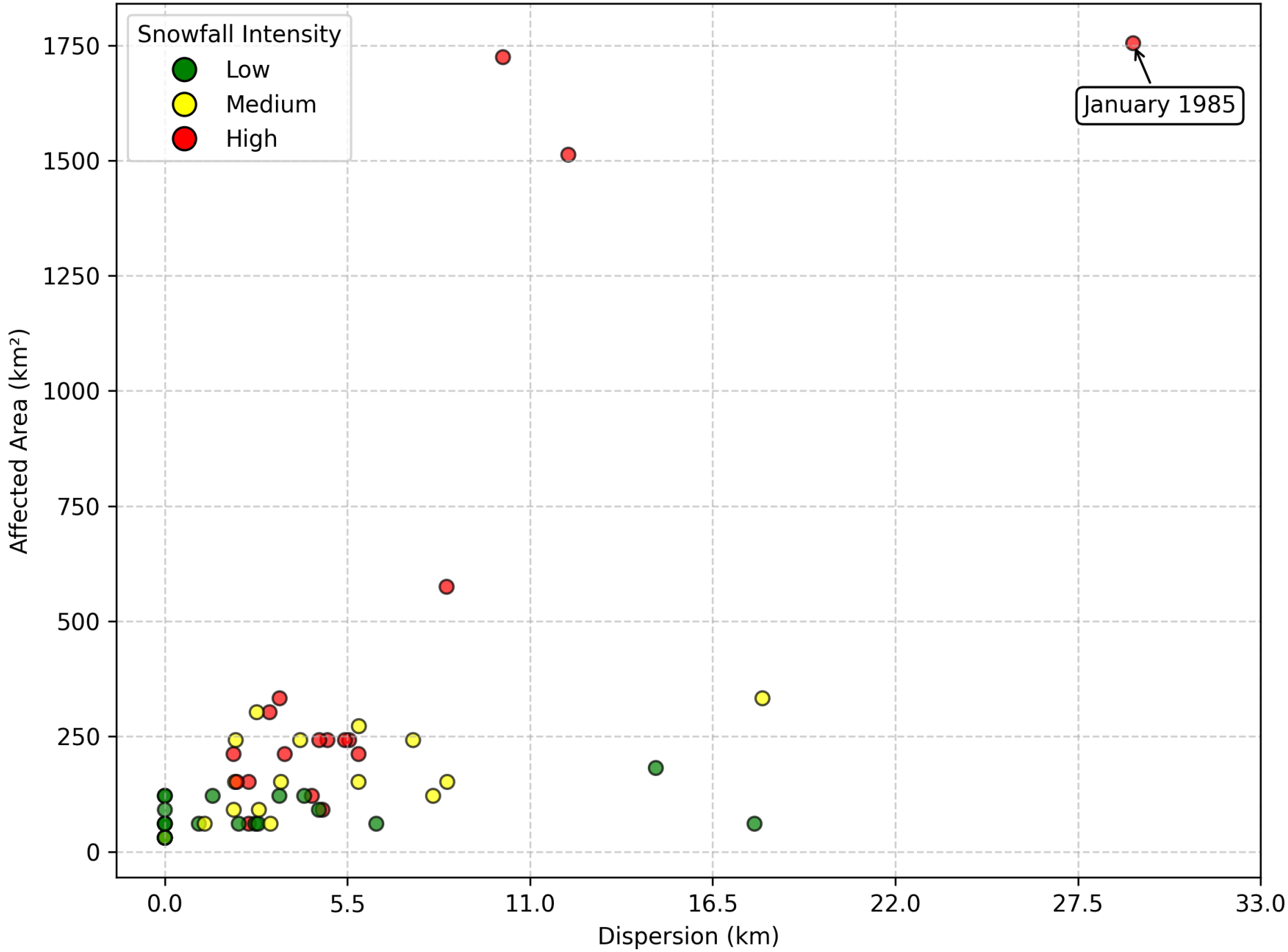
- **55 snowfall events** recorded over the study period
- Spanning **36 years**, from 1985 to 2020
- Averaging approximately **1.5 events per year:** typically, **1 to 2 events annually**



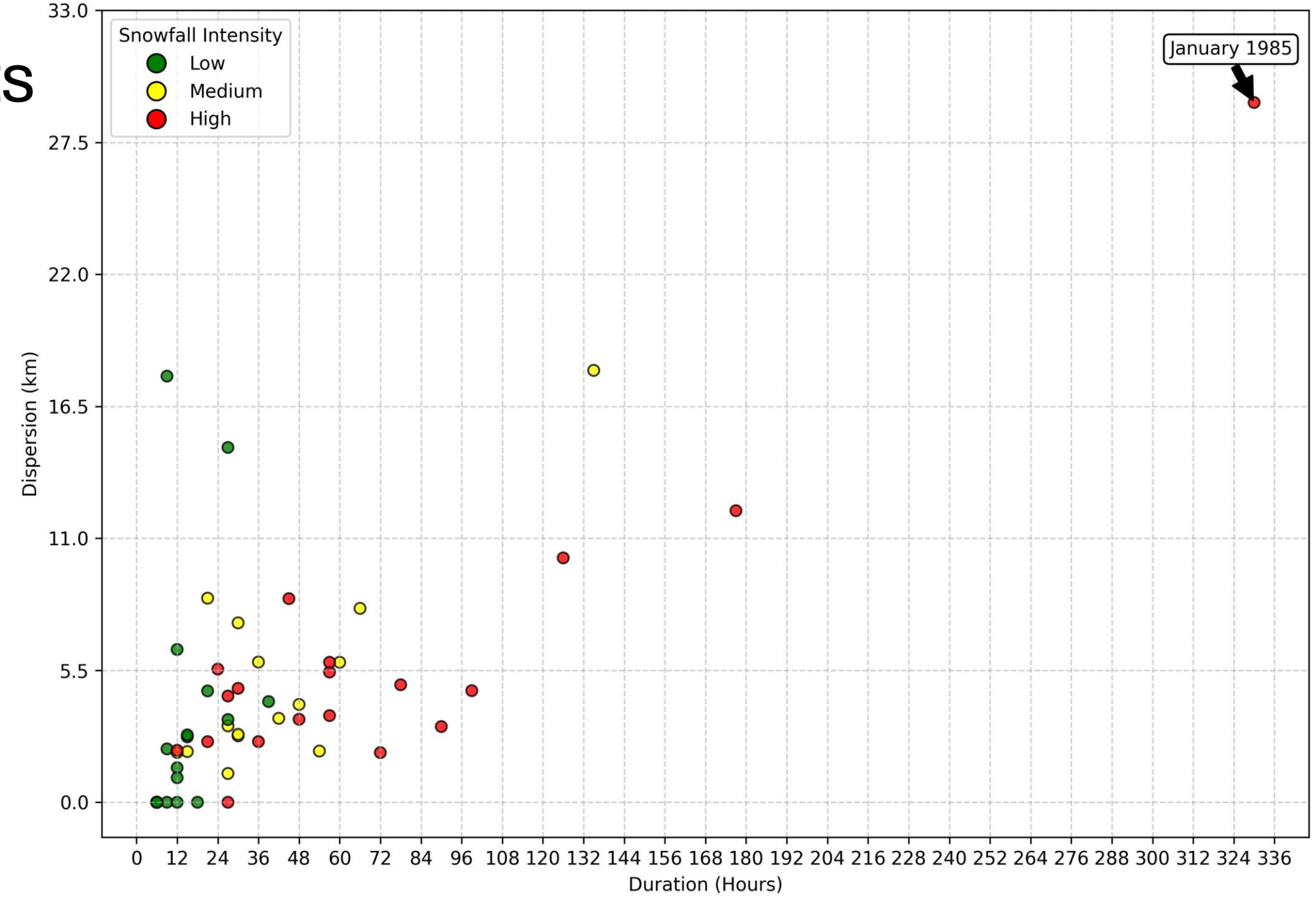
Results


40.0
39.9
39.8
39.7
39.6
39.5
39.4
39.3
39.2
Latitude
2.4
2.6
2.8
3.0
3.2
3.4
Longitude
Low Dispersion (<5.5 km)
Medium Dispersion (5.5–11 km)
High Dispersion (>11 km)

Results


Snowfall Intensity
Low
Medium
High
January 1985
Affected Area (km²)
1750
1500
1250
1000
750
500
250
0
0.0
5.5
11.0
16.5
22.0
27.5
33.0
Dispersion (km)

Results


Snowfall Intensity
Low
Medium
High
January 1985
Dispersion (km)
33.0
27.5
22.0
16.5
11.0
5.5
0.0
0 12 24 36 48 60 72 84 96 108 120 132 144 156 168 180 192 204 216 228 240 252 264 276 288 300 312 324 336
Duration (Hours)

Key Findings from Historical Analysis

❄️ **Snowfall is rare** in Mallorca and mostly occurs in **winter (>80%)**

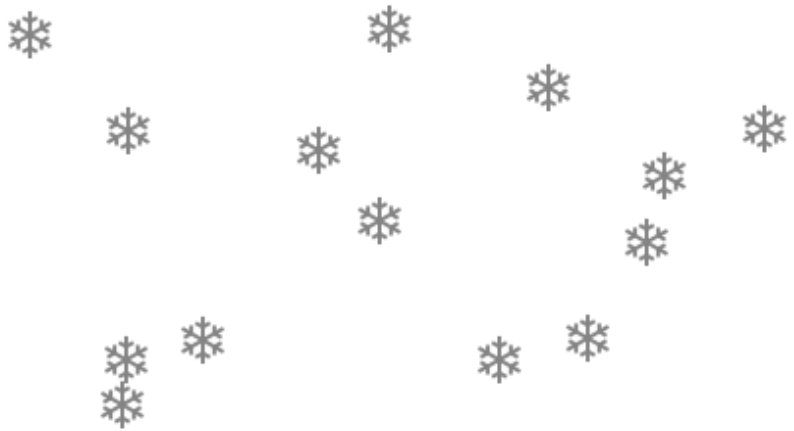
📅 **55 events identified (1985–2020)** — mostly **short**, **low-intensity**

📍 **January 1985** was the **strongest and widest event** (1,700 km^2)

🛰️ **CERRA** captures timing/spatial patterns, even if depth is underestimated

📉 **No trend** in frequency over 35 years

⛰️ All events cluster in **Serra de Tramuntana**



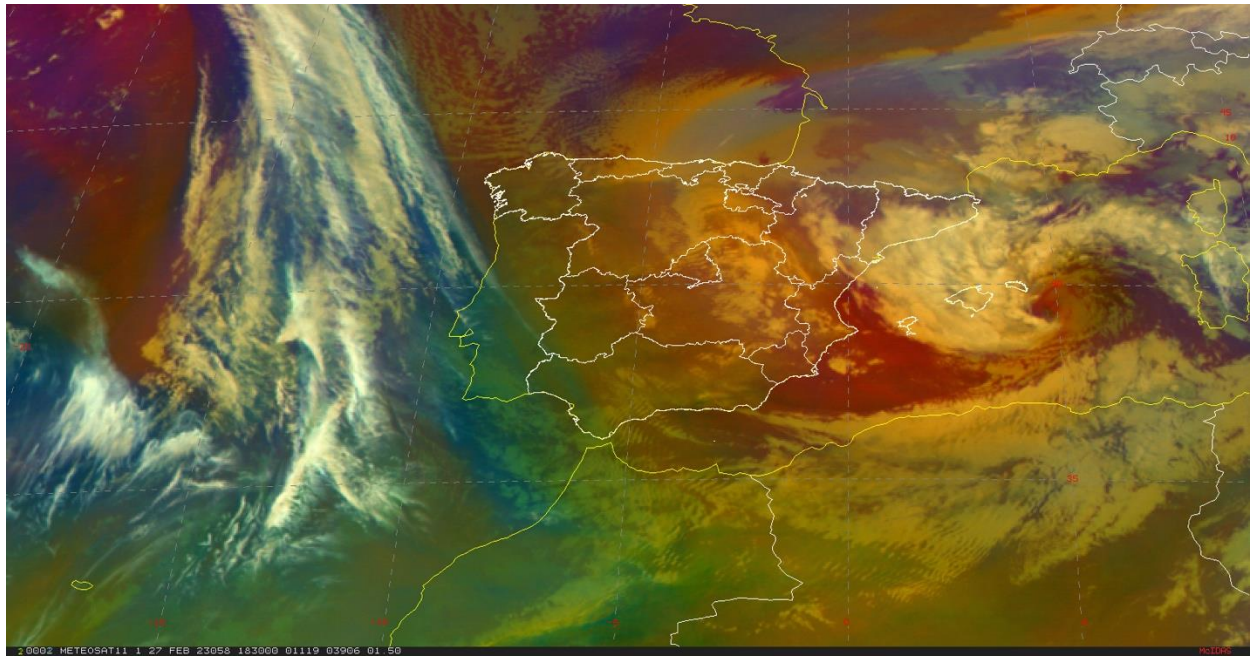
Historical Snowfall Patterns (1985–2020)

Storm Juliette (Feb 2023)

From long-term patterns ➜ to an extraordinary event

Juliette Storm: A brief description

AEMET - Storm Juliette Report - https://www.aemet.es/ca/conocermas/borrascas/2022-2023/estudios_e_impactos/juliette



RGB Airmass Satellite Image at 18 UTC on February 27, 2023

- **February 26**

  AEMET officially names **Borrasca Juliette** at 10:30 UTC due to the issuance of weather warnings.

- **Early February 27**

  A strong **Arctic cold air mass advects** into the Balearic Islands, leading to a significant drop in temperatures and widespread snowfall, particularly in Mallorca.

- **Late February 27**

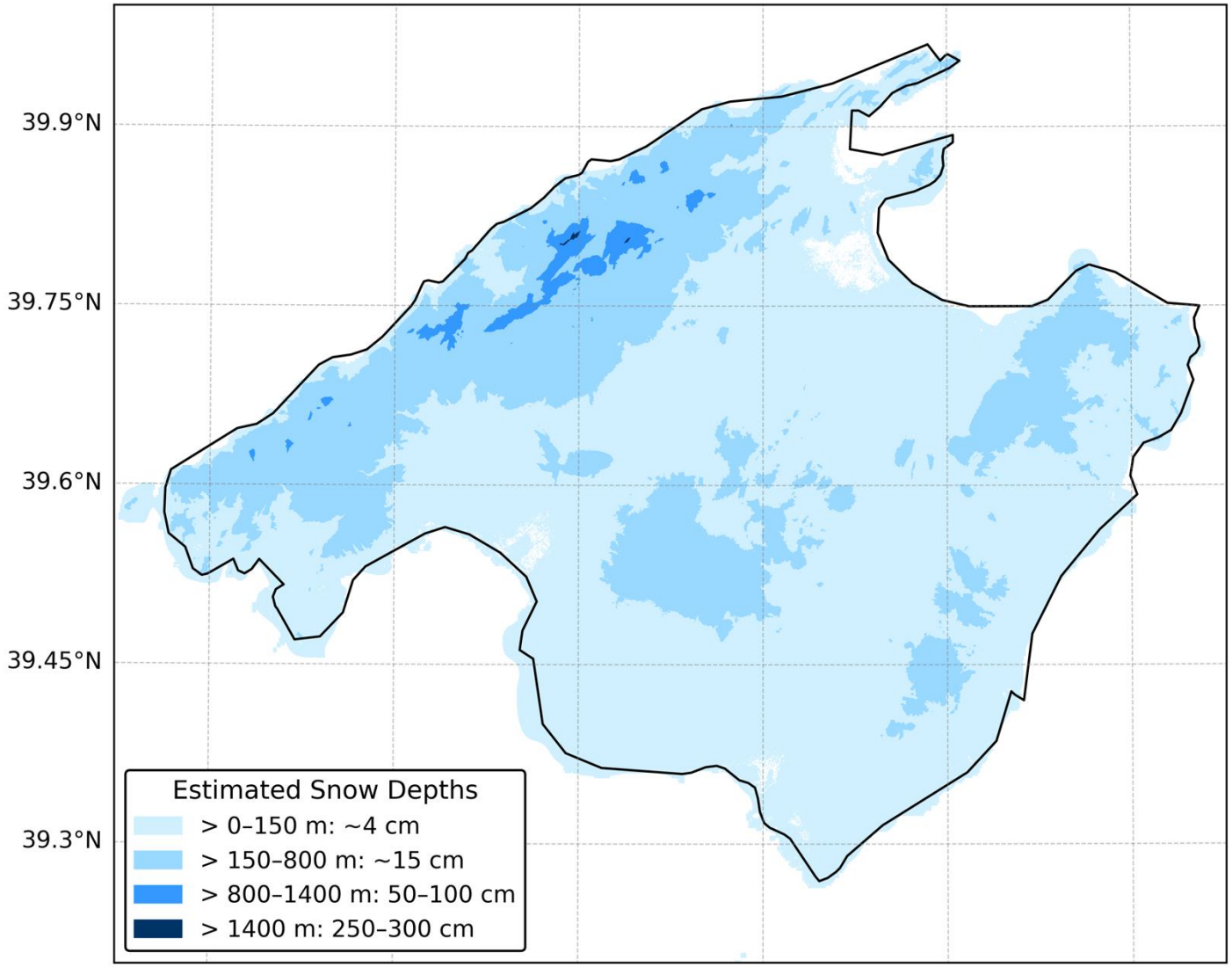
  The cold **advection** weakens as the cold core **stabilizes** over the western Mediterranean. Despite this, **snow levels continue to drop or remain lower than expected**.

- **February 28**

  Snowfall persists in the Balearic Islands, with notable accumulations, especially in the Serra de Tramuntana region of Mallorca.

Juliette Storm: A brief description

AEMET - Storm Juliette Report - https://www.aemet.es/ca/conocermas/borrascas/2022-2023/estudios_e_impactos/juliette



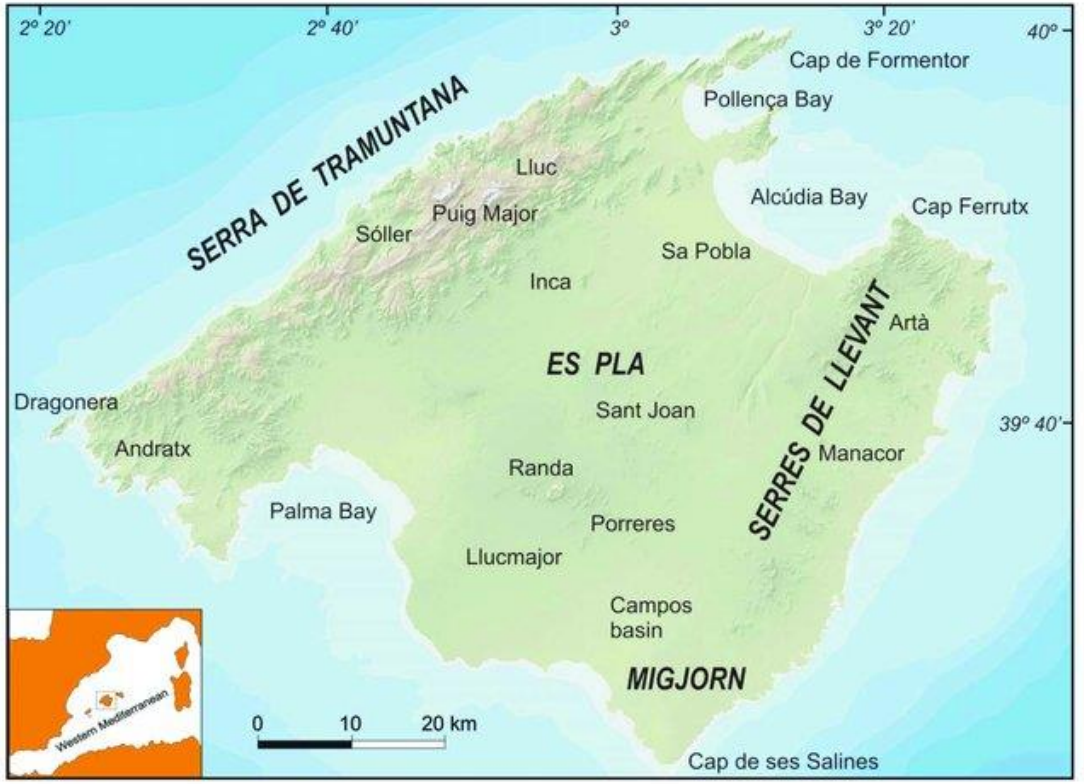


Figure 2 from Ginés et al. 2012.

Ginés, A., Ginés, J., Fornós, J. J., Bover, P., Gómez-Pujol, L., Gràcia, F., ... & Vicens, D. (2012). An introduction to the Quaternary of Mallorca. Monografies de la Societat d'Historia Natural de les Balears, 18(2).

Plaça Pax, Felanitx

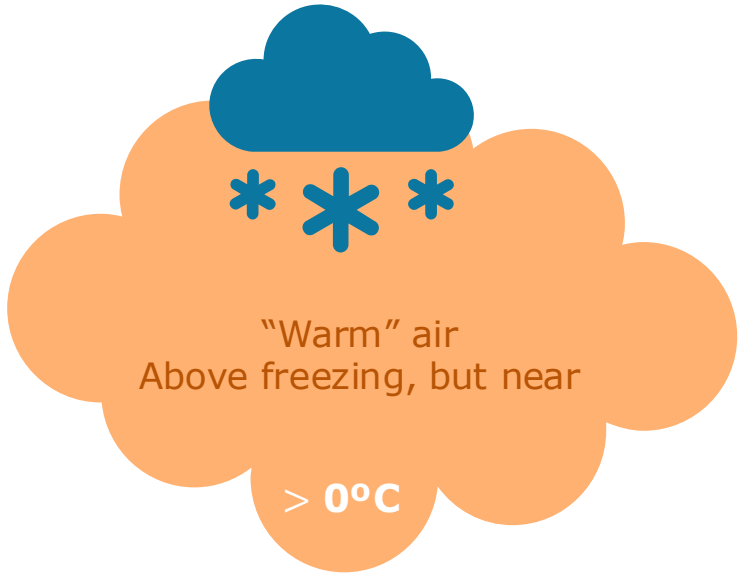
Santuari de Lluc

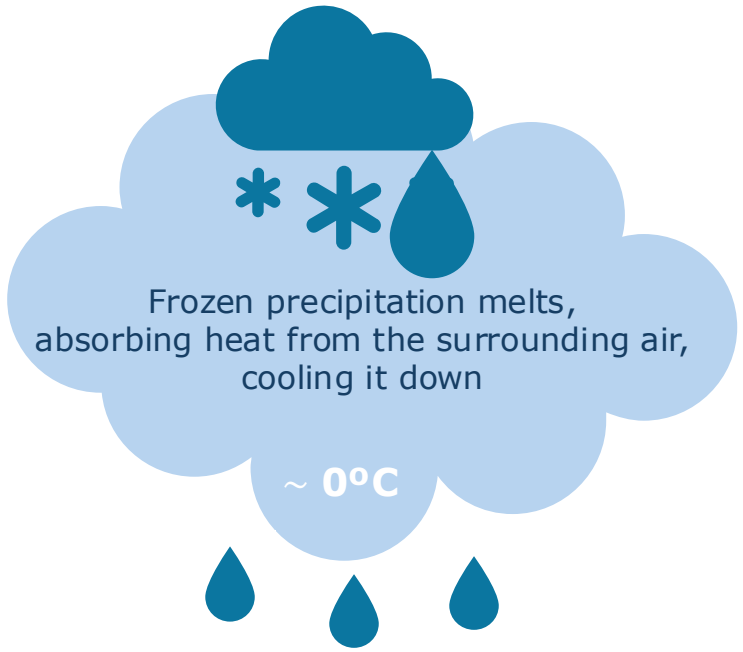
So why the unusually low snowfall level of Storm Juliette?

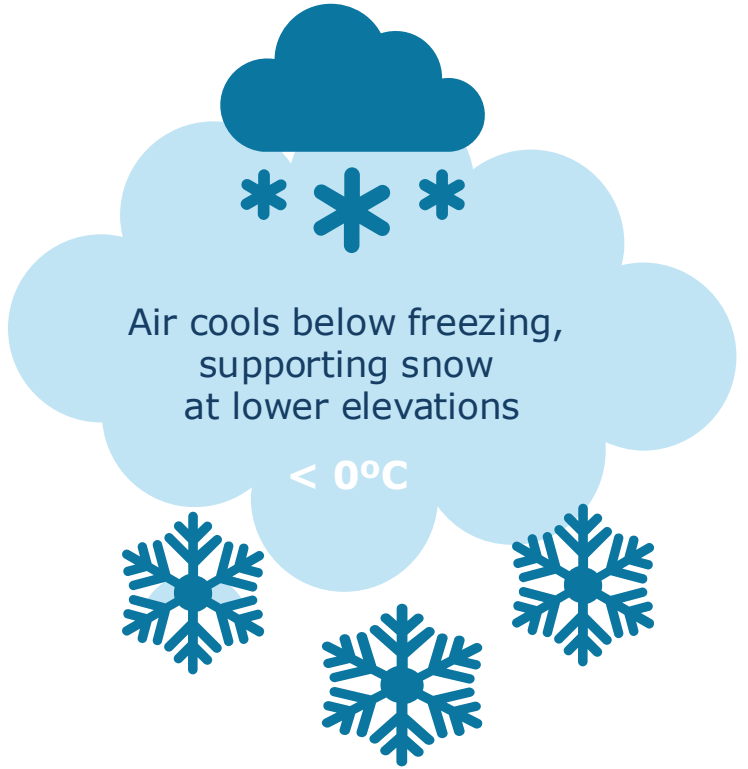
The Melting-induced cooling

a second-order process that becomes relevant when temperature advection is weak

keeps active as long as frozen precipitation encounters warmer air







Frozen precipitation
snowflakes, sleet, and ice pellets

all solid forms of precipitation formed in cold cloud layers

The *melting effect* occurs when frozen precipitation falls through a shallow layer of above-freezing air, melting (fully or partially), which absorbs heat from the surrounding air from the environment.

This cooling can lower temperatures to near or below 0°C, allowing a transition from rain back to snow, even without strong cold air advection.

This process can contribute to rapid drops in snowfall altitude during marginal-temperature winter storms.

This is sometimes called the 'melting effect cooling' (Kain et al., 2000).

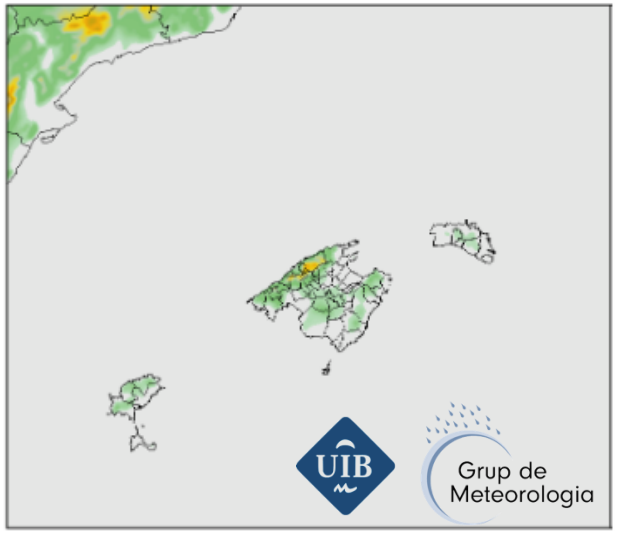
Numerical weather model output as an exploratory tool

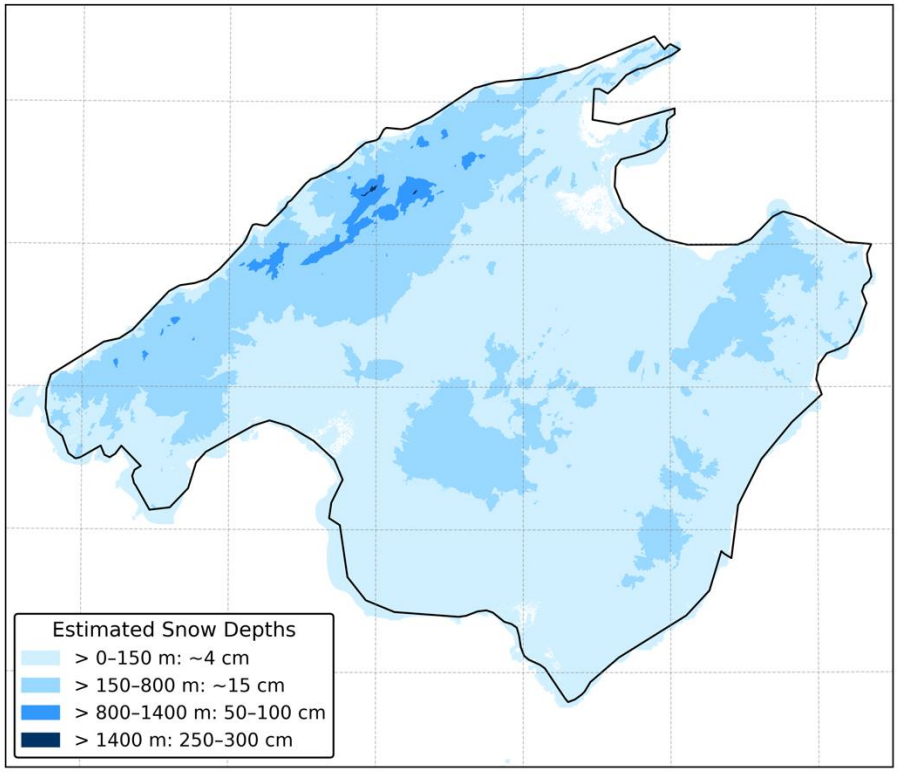
- TRAM model, a Triangle-based Regional Atmospheric Model, a nonhydrostatic fully compressible numerical model
- Operational SR domain, equivalent to 2 km horizontal resolution in squared grid.
- Kain-Fritsch 2 convective scheme
- Reisner 2 microphysics scheme
- Initialized with GFS generated on 26-02-2023 at 00 UTC and forced every 3 h with the same GFS run.
- Simulation started 26-02-2023 at 0900 UTC and ended at 01-03-2023 at 1200 UTC

TRAM / MeteoUIB

https://meteo.uib.es/tram/

SR (2 km)



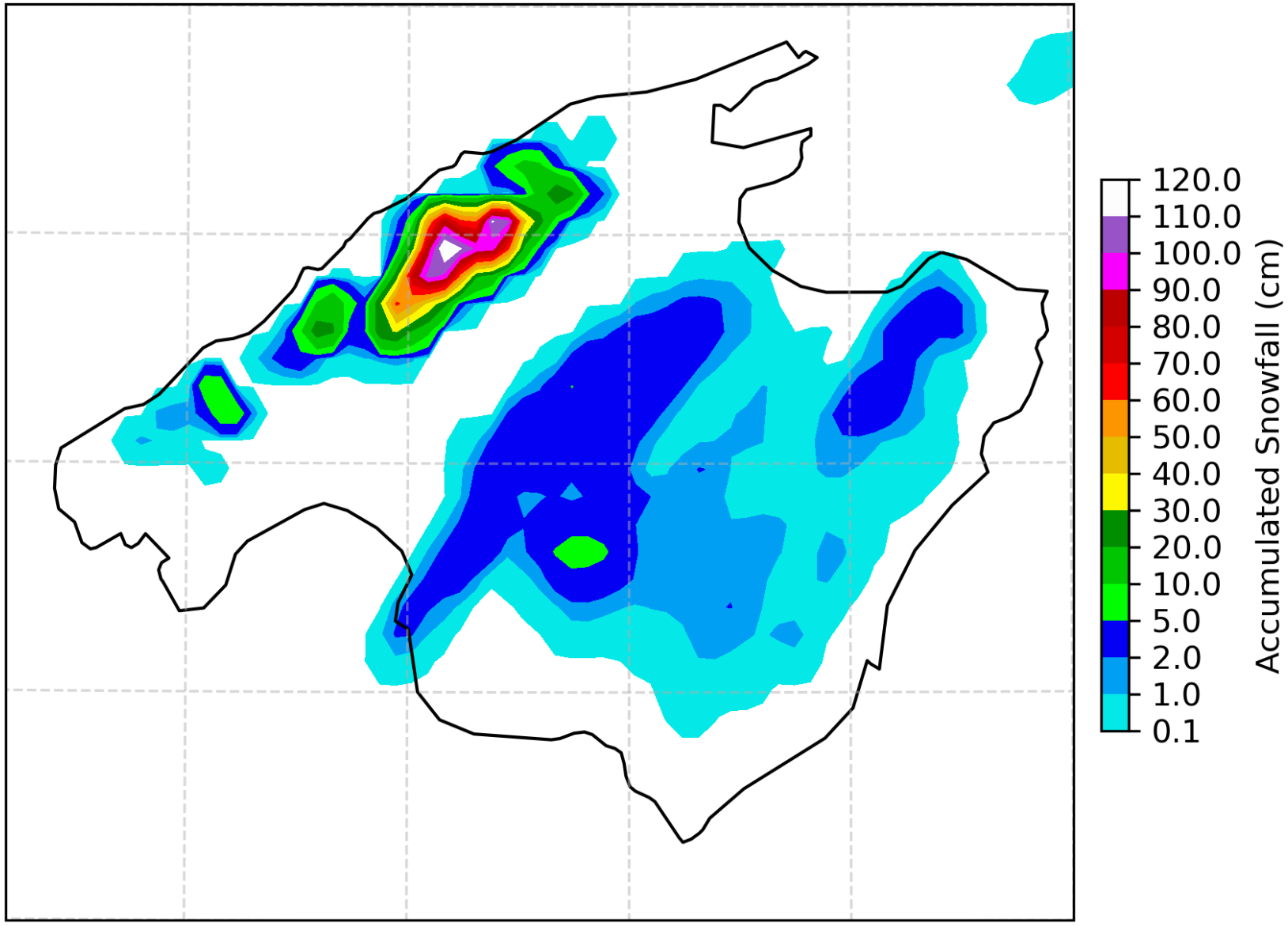


Snowflakes can turn into graupel

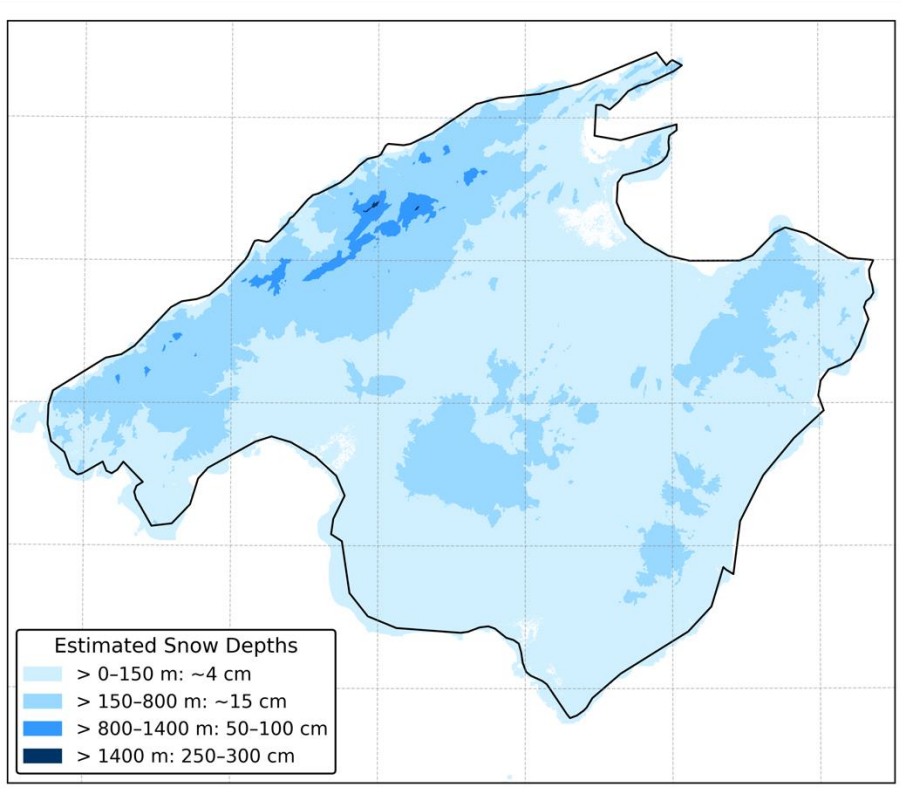
Almost graupel

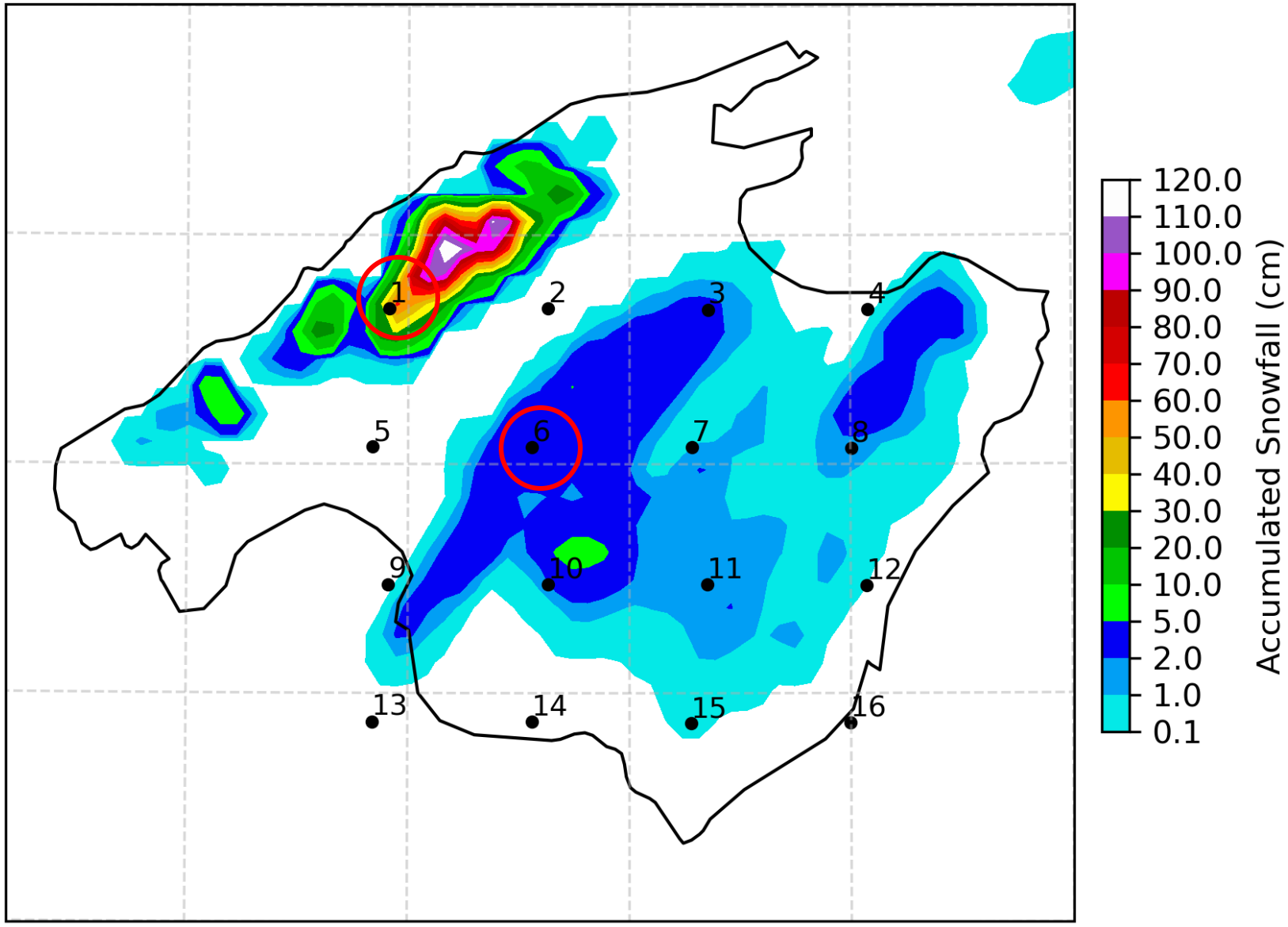
Graupel in shape of snowflake

https://en.wikipedia.org/wiki/Graupel

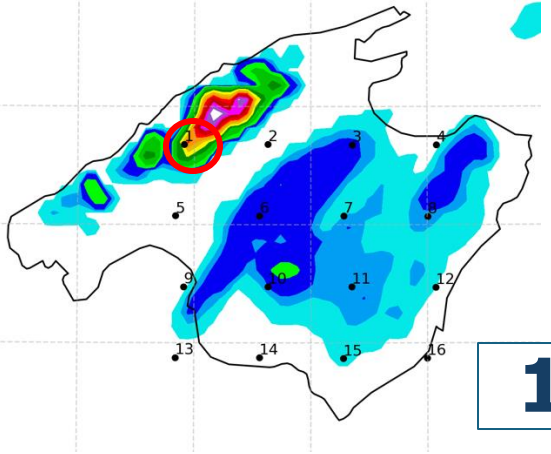


Accumulated snowfall from 09:00 UTC on February 26 to 12:00 UTC on March 1, 2023.





Accumulated snowfall from 09:00 UTC on February 26
to 12:00 UTC on March 1, 2023.



1

Location number: 1

Height (m)

1400
1200
1000
800
600
400
200

-1°C
0°C
1°C
2°C
3°C
4°C
5°C
Ground

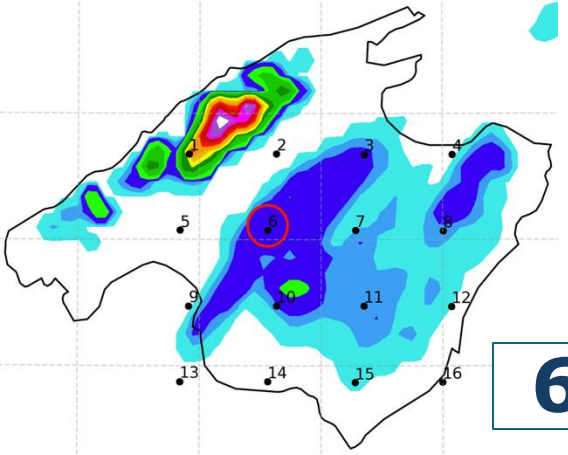
Snowfall (cm)

0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0

Instantaneous Snowfall (cm)

26-02 09:00
26-02 12:00
26-02 15:00
26-02 18:00
26-02 21:00
27-02 00:00
27-02 03:00
27-02 06:00
27-02 09:00
27-02 12:00
27-02 15:00
27-02 18:00
27-02 21:00
28-02 00:00
28-02 03:00
28-02 06:00
28-02 09:00
28-02 12:00
28-02 15:00
28-02 18:00
28-02 21:00
01-03 00:00
01-03 03:00
01-03 06:00
01-03 09:00
01-03 12:00

Time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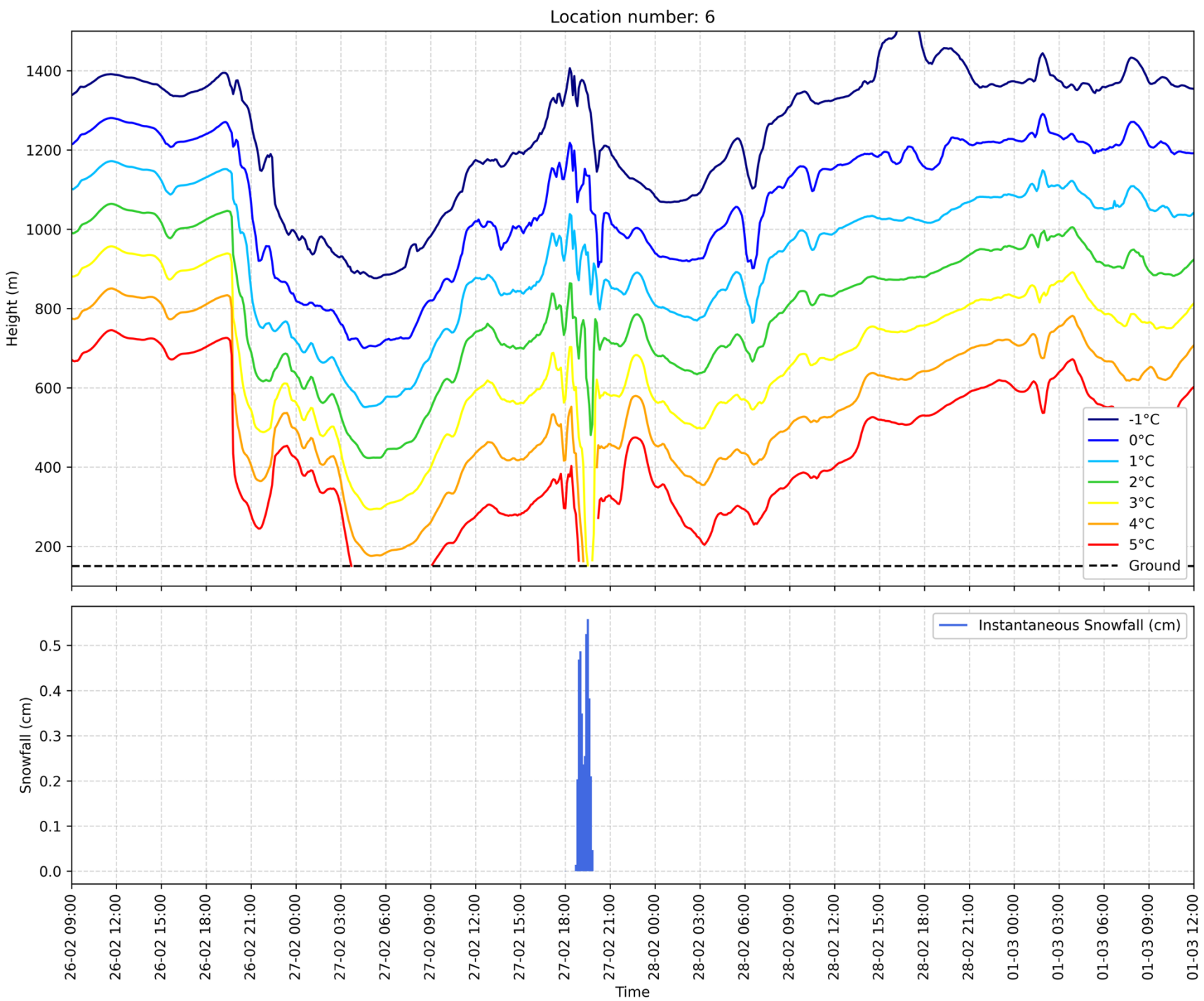
6


Location number: 6
Height (m)
1400
1200
1000
800
600
400
200
-1°C
0°C
1°C
2°C
3°C
4°C
5°C
Ground
Instantaneous Snowfall (cm)
Snowfall (cm)
0.5
0.4
0.3
0.2
0.1
0.0
26-02 09:00
26-02 12:00
26-02 15:00
26-02 18:00
26-02 21:00
27-02 00:00
27-02 03:00
27-02 06:00
27-02 09:00
27-02 12:00
27-02 15:00
27-02 18:00
27-02 21:00
28-02 00:00
28-02 03:00
28-02 06:00
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28-02 12:00
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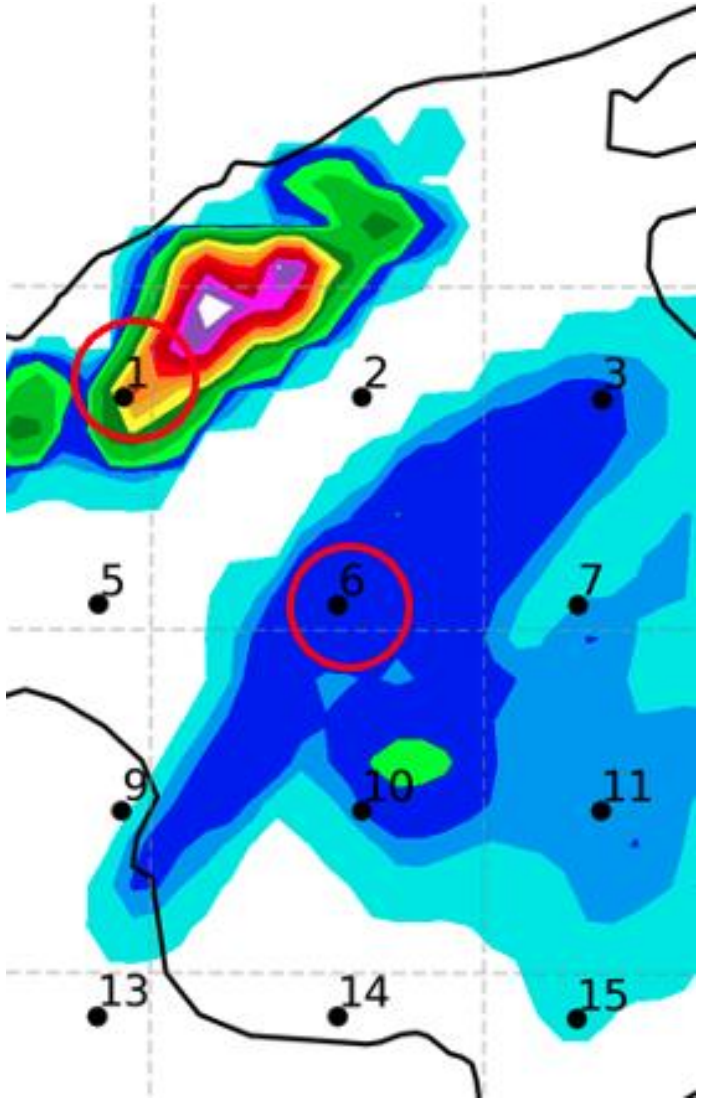
01-03 06:00
01-03 09:00
01-03 12:00
Time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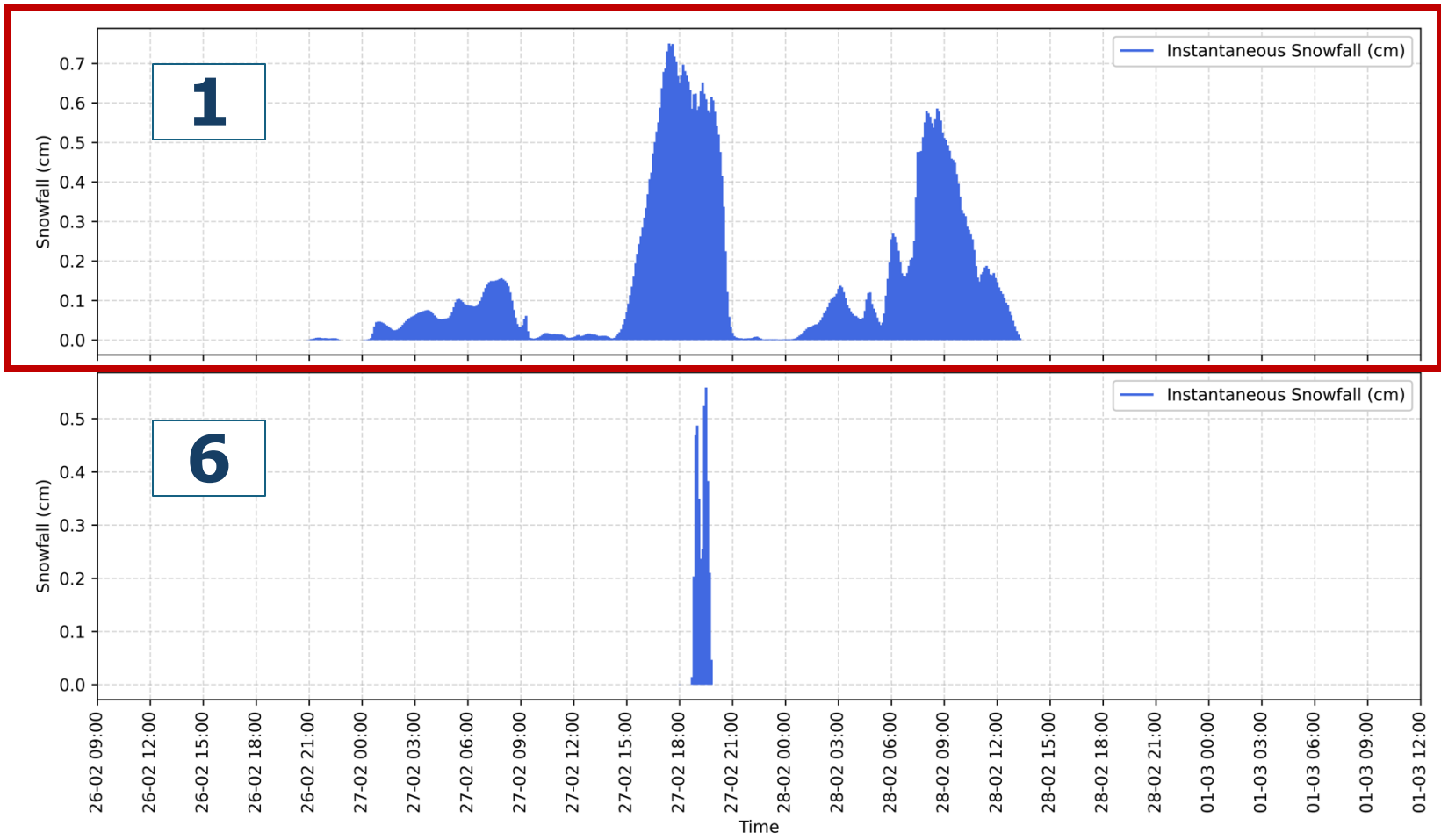
1
Instantaneous Snowfall (cm)
Snowfall (cm)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
6
Instantaneous Snowfall (cm)
Snowfall (cm)
0.0
0.1
0.2
0.3
0.4
0.5
26-02 09:00
26-02 12:00
26-02 15:00
26-02 18:00
26-02 21:00
27-02 00:00
27-02 03:00
27-02 06:00
27-02 09:00
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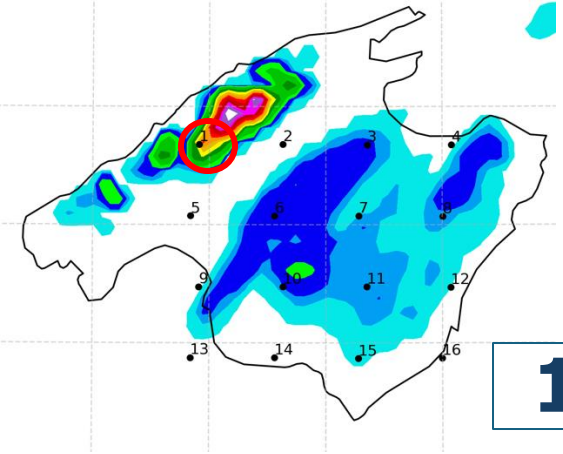
01-03 12:00
Time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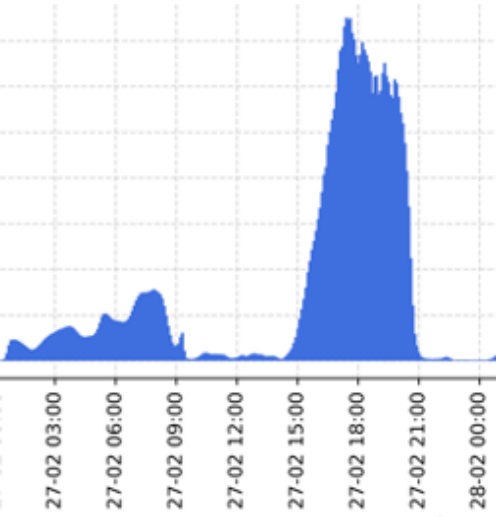
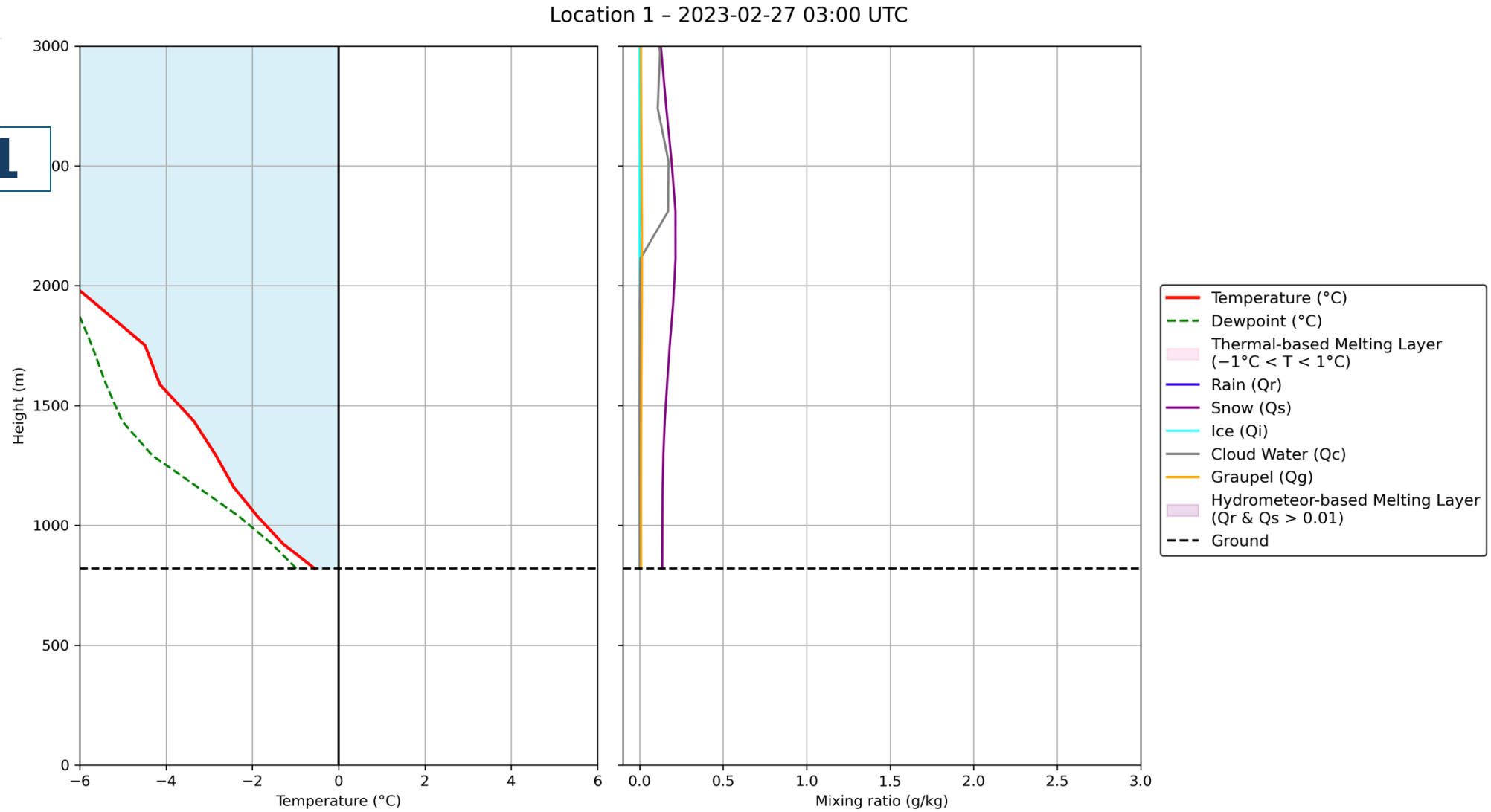
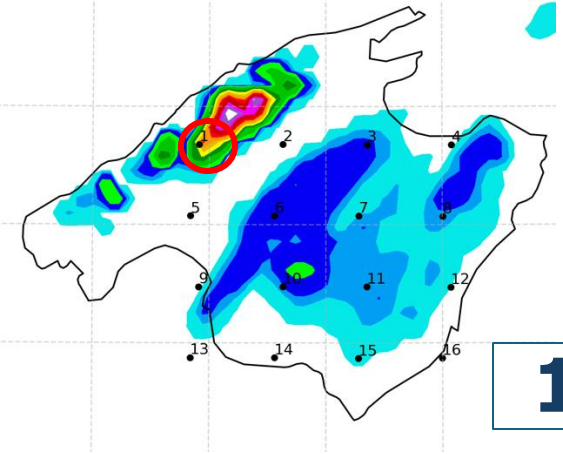
16

1

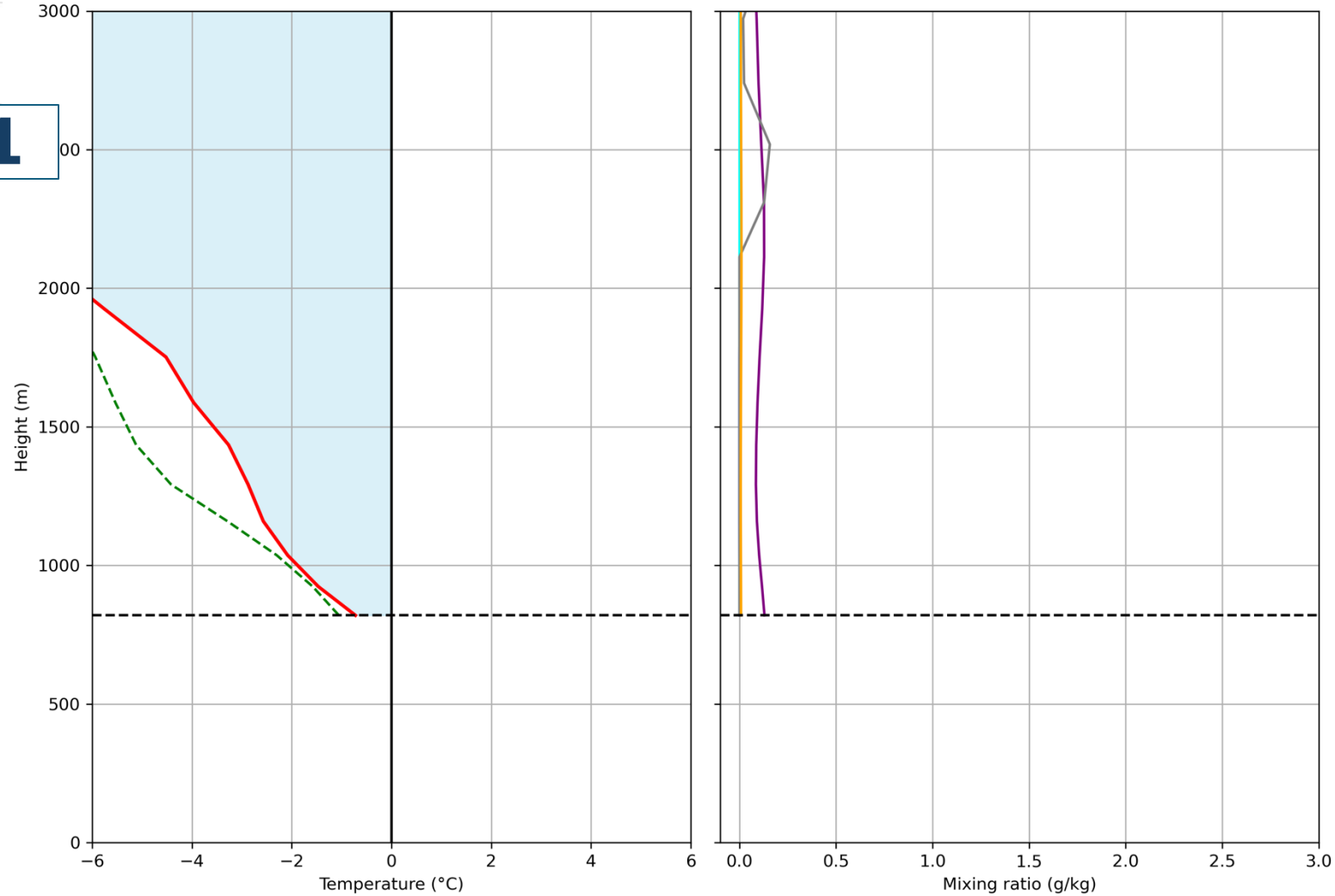

27-02 03:00
27-02 06:00
27-02 09:00
27-02 12:00
27-02 15:00
27-02 18:00
27-02 21:00
28-02 00:00

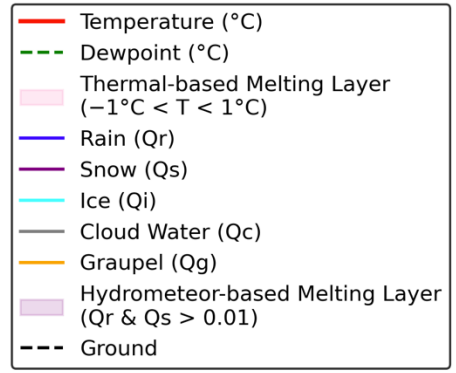

Location 1 – 2023-02-27 03:00 UTC
Height (m)
3000
2000
1500
1000
500
0
−6
−4
−2
0
2
4
6
Temperature (°C)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Mixing ratio (g/kg)
Temperature (°C)
Dewpoint (°C)
Thermal-based Melting Layer
(−1°C < T < 1°C)
Rain (Qr)
Snow (Qs)
Ice (Qi)
Cloud Water (Qc)
Graupel (Qg)
Hydrometeor-based Melting Layer
(Qr & Qs > 0.01)
Ground

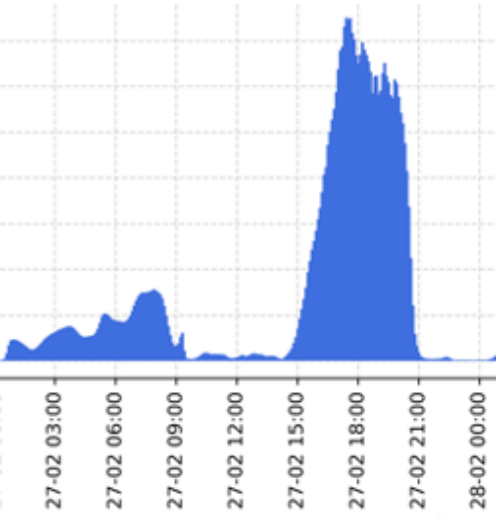


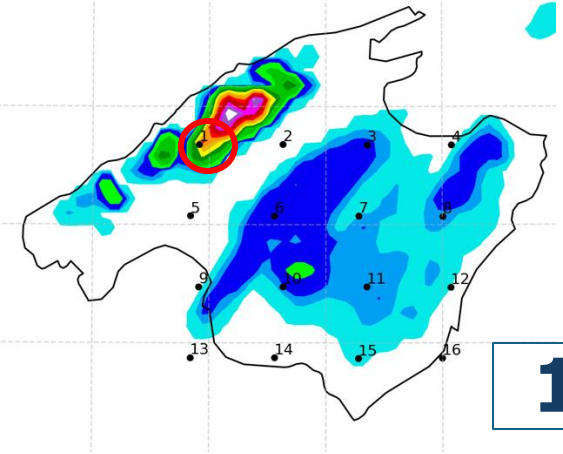
1

Location 1 – 2023-02-27 04:00 UTC





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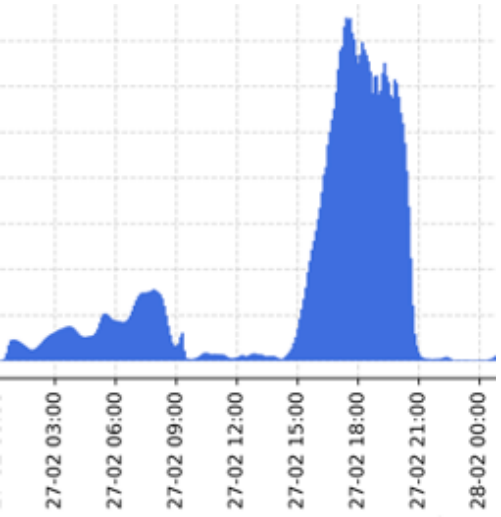
27-02 03:00
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27-02 21:00
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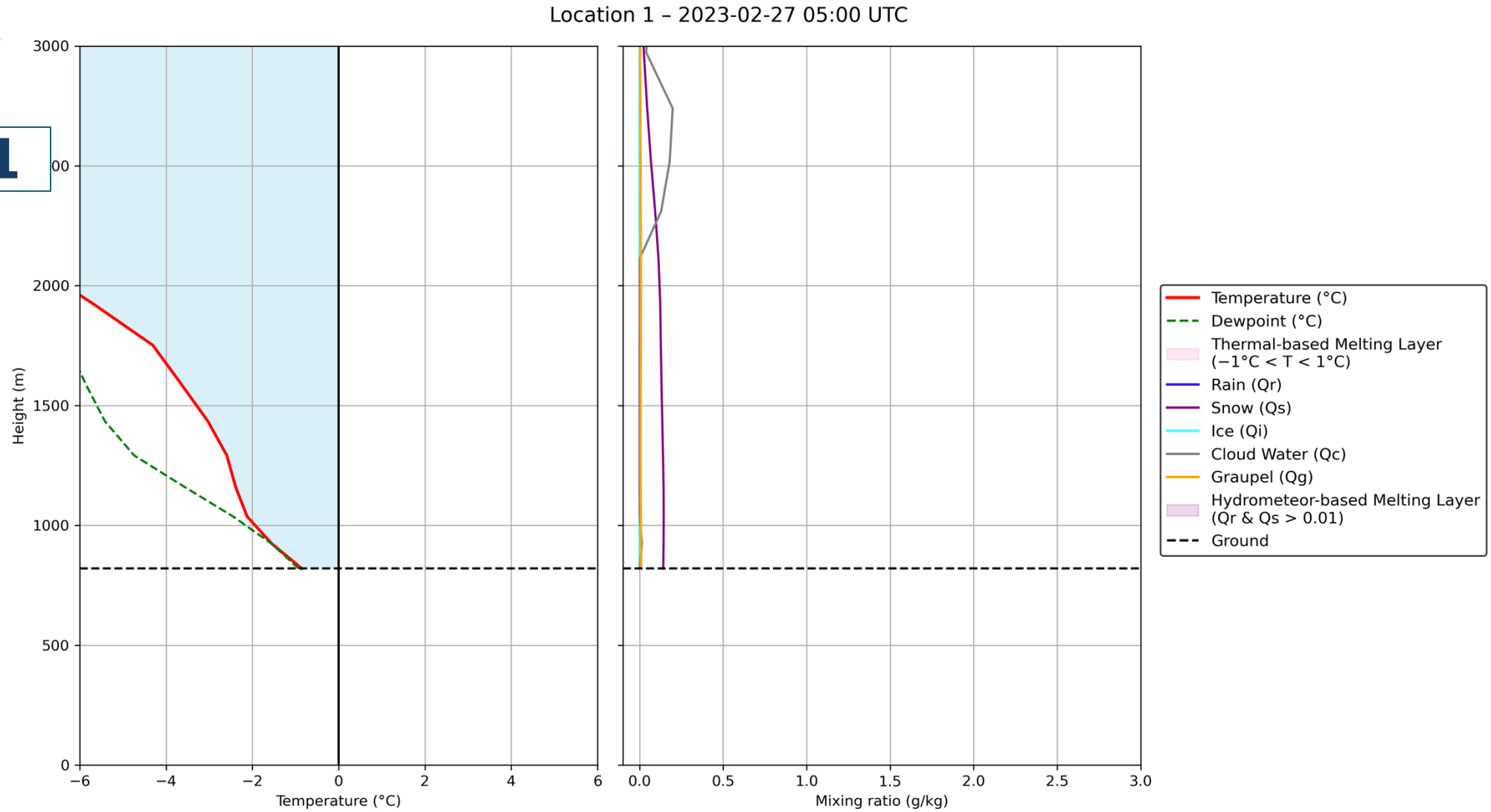
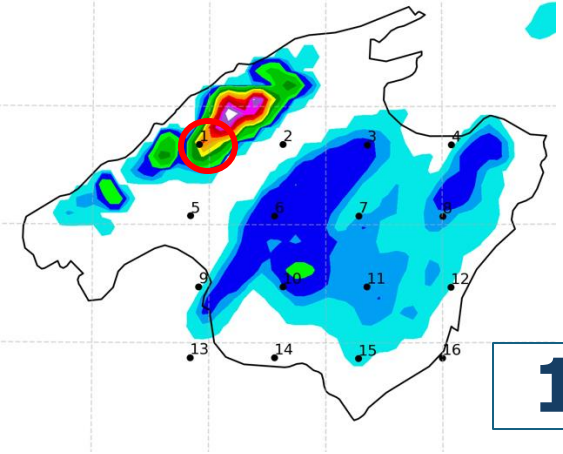

Location 1 – 2023-02-27 05:00 UTC
Height (m)
3000
2000
1500
1000
500
0
−6
−4
−2
0
2
4
6
Temperature (°C)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Mixing ratio (g/kg)
Temperature (°C)
Dewpoint (°C)
Thermal-based Melting Layer
(−1°C < T < 1°C)
Rain (Qr)
Snow (Qs)
Ice (Qi)
Cloud Water (Qc)
Graupel (Qg)
Hydrometeor-based Melting Layer
(Qr & Qs > 0.01)
Ground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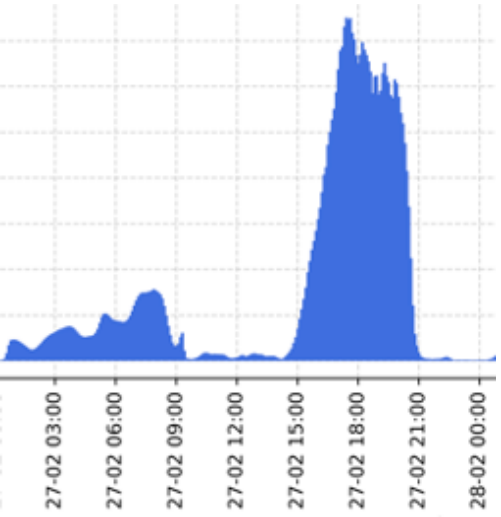
27-02 03:00
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27-02 18:00
27-02 21:00
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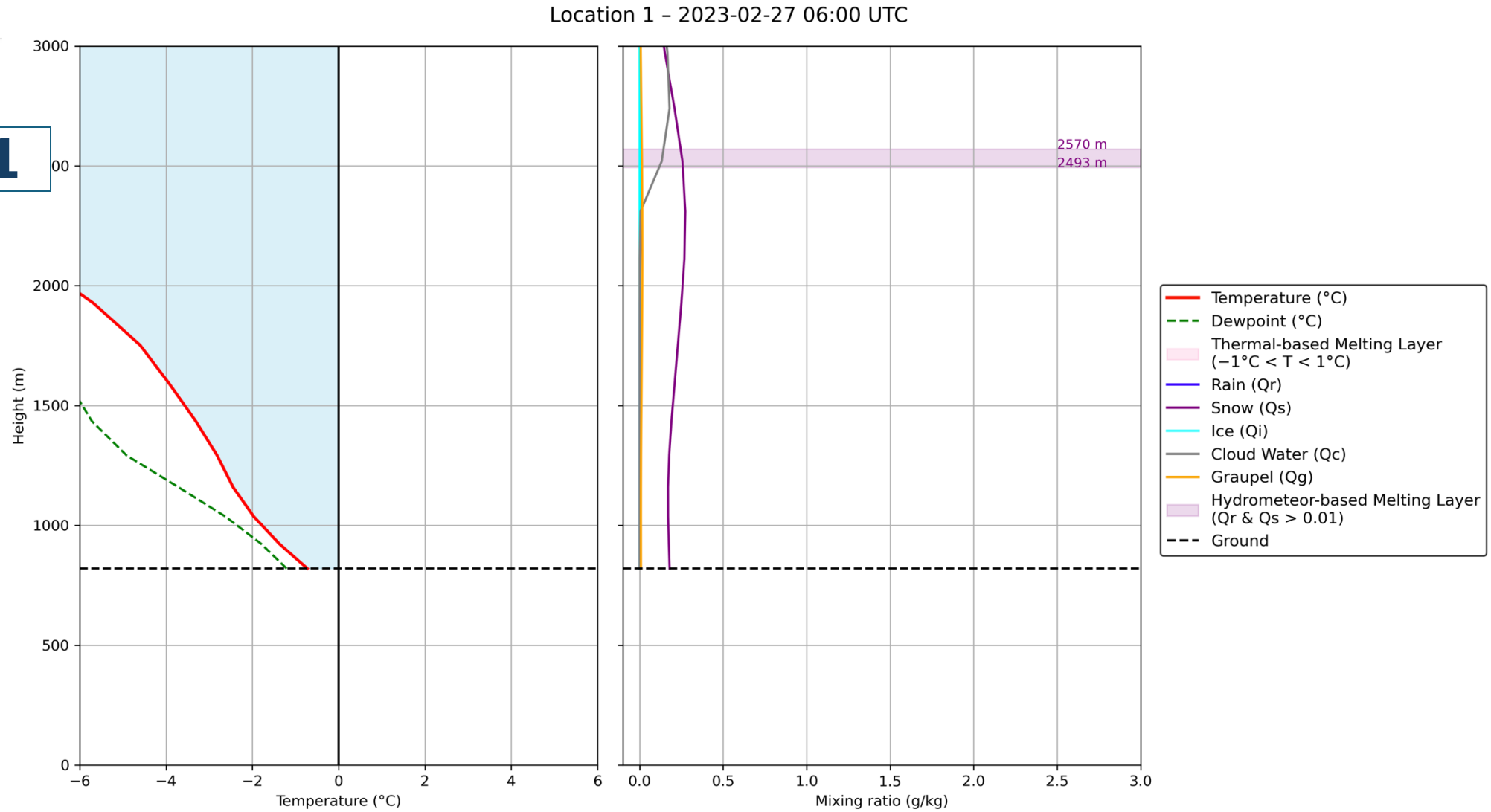
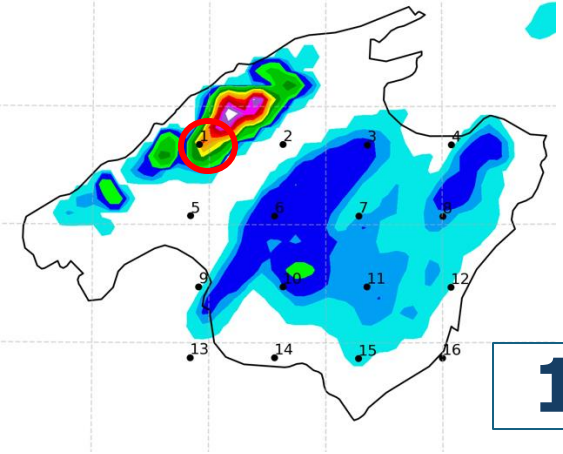

Location 1 – 2023-02-27 06:00 UTC
Height (m)
3000
2000
1500
1000
500
0
Temperature (°C)
−6
−4
−2
0
2
4
6
Mixing ratio (g/kg)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
2570 m
2493 m
Temperature (°C)
Dewpoint (°C)
Thermal-based Melting Layer
(−1°C < T < 1°C)
Rain (Qr)
Snow (Qs)
Ice (Qi)
Cloud Water (Qc)
Graupel (Qg)
Hydrometeor-based Melting Layer
(Qr & Qs > 0.01)
Ground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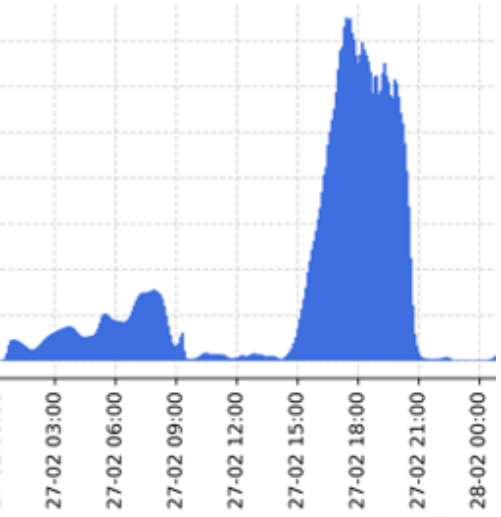
1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27-02 18:00
27-02 21:00
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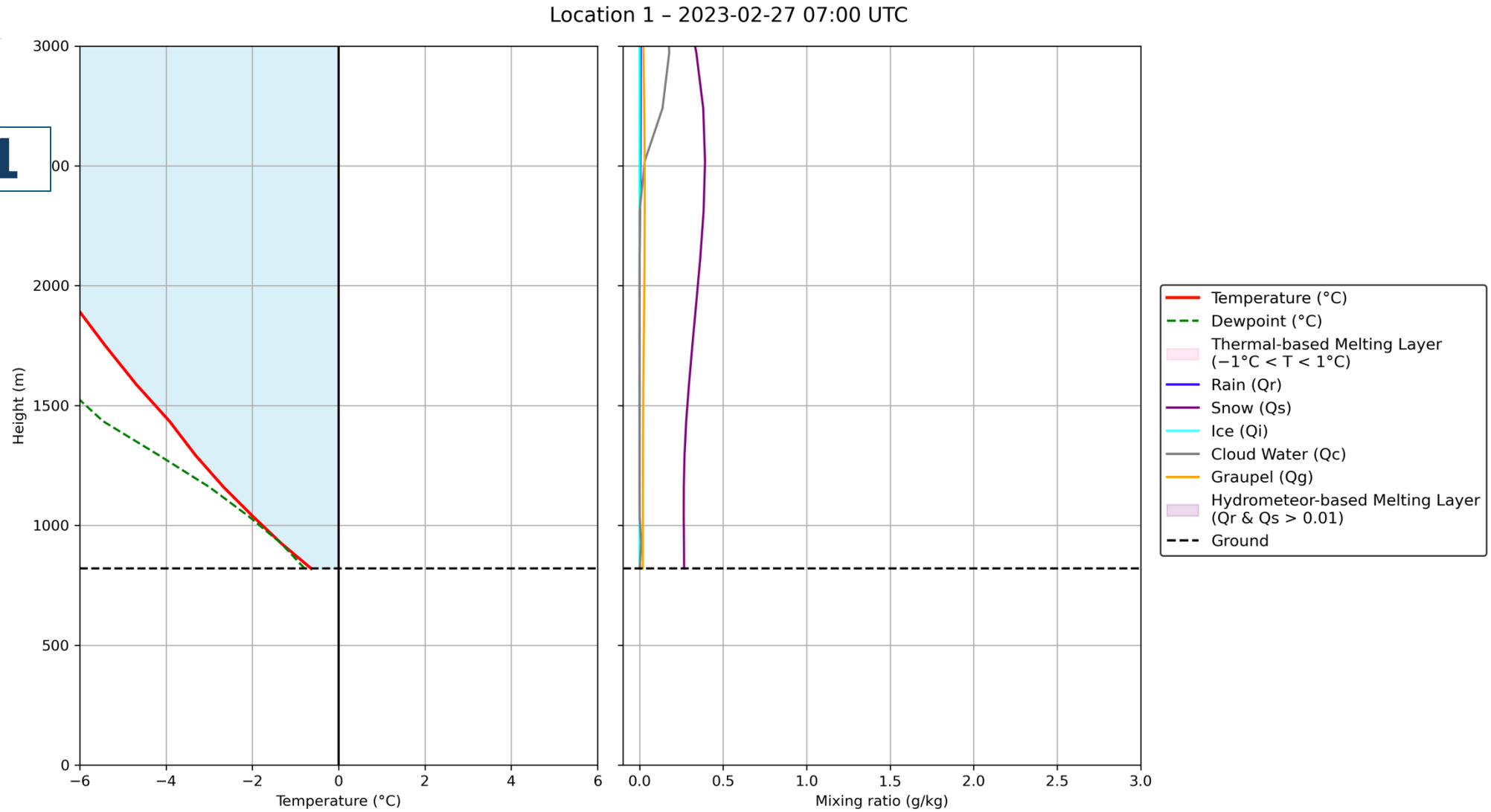
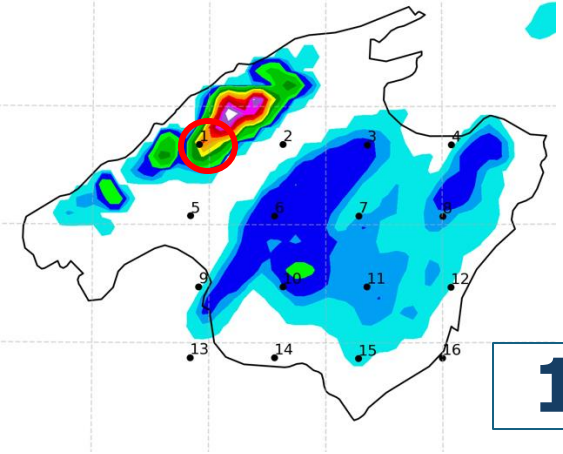

Location 1 – 2023-02-27 07:00 UTC
Height (m)
3000
2000
1500
1000
500
0
−6
−4
−2
0
2
4
6
Temperature (°C)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Mixing ratio (g/kg)
Temperature (°C)
Dewpoint (°C)
Thermal-based Melting Layer
(−1°C < T < 1°C)
Rain (Qr)
Snow (Qs)
Ice (Qi)
Cloud Water (Qc)
Graupel (Qg)
Hydrometeor-based Melting Layer
(Qr & Qs > 0.01)
Ground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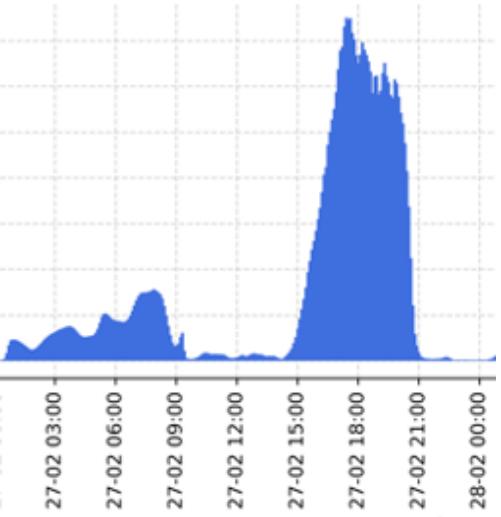
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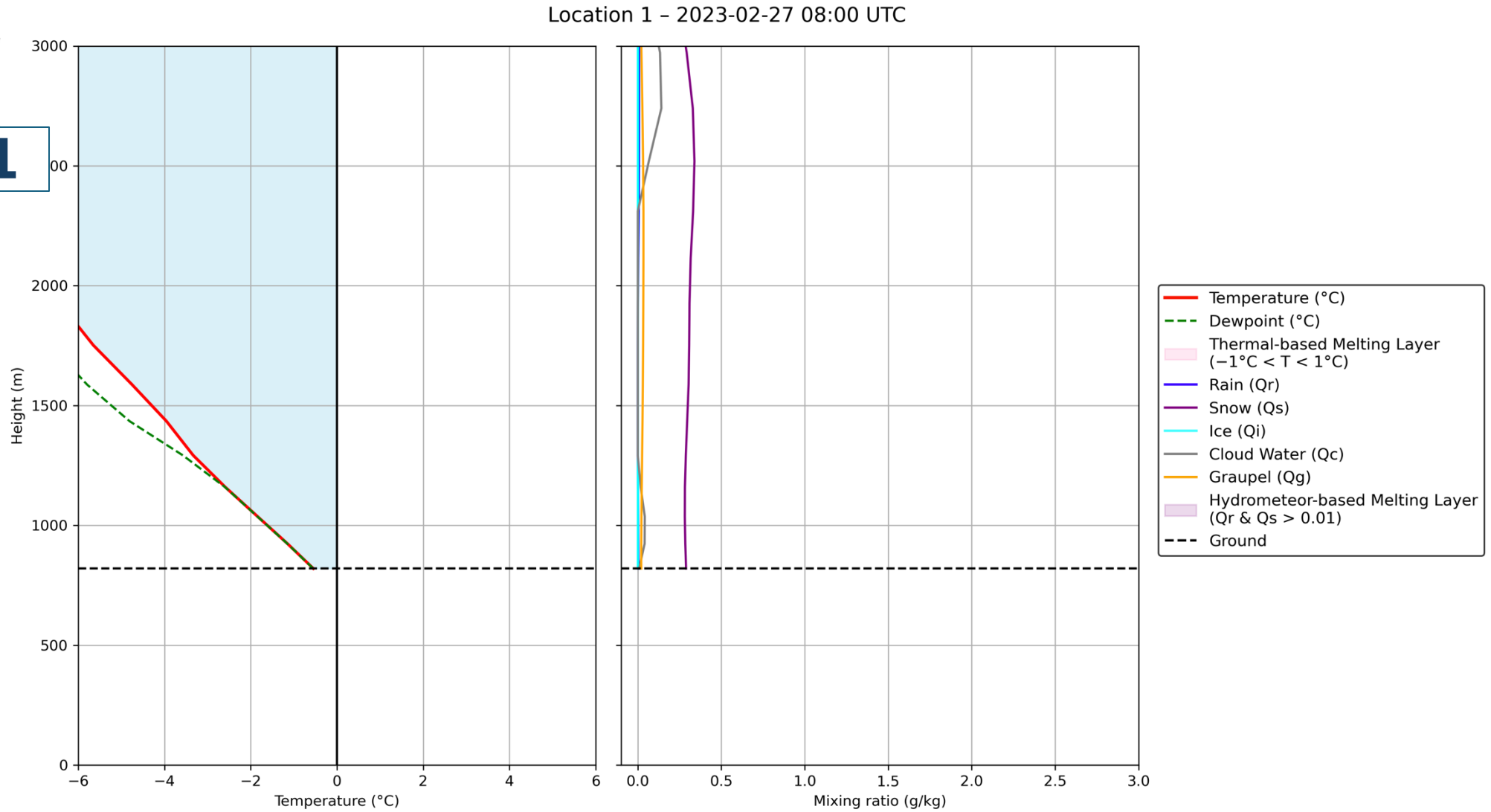
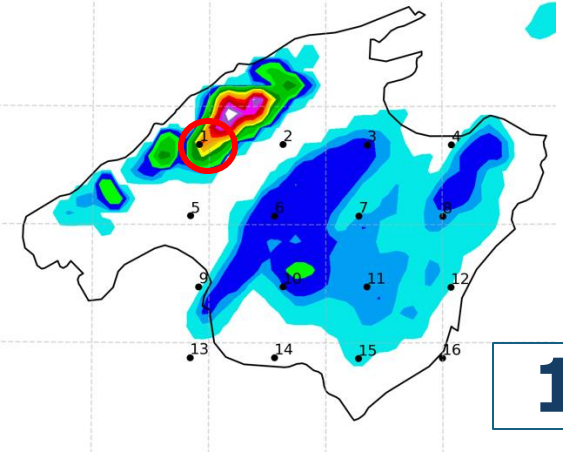
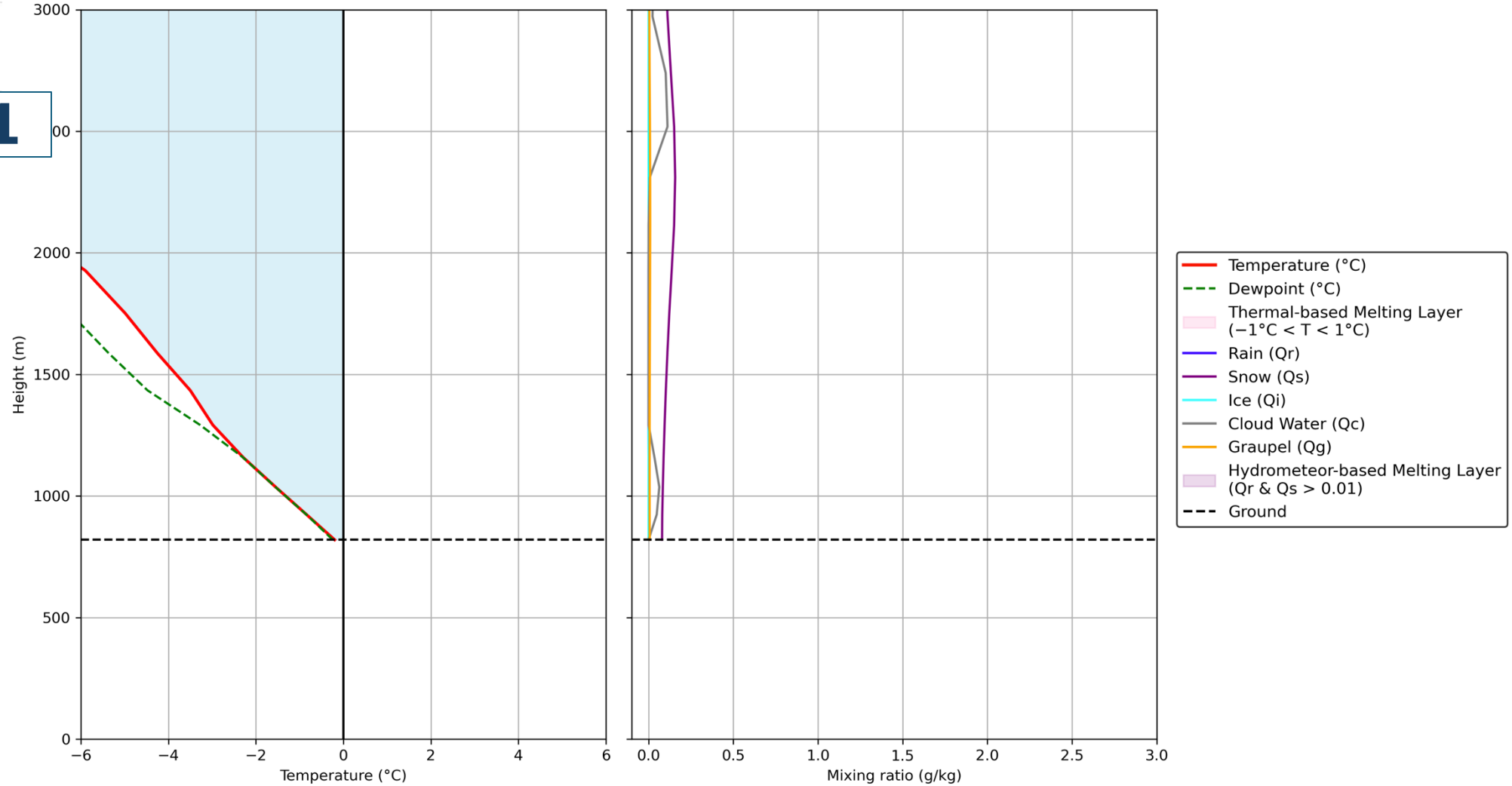
27-02 06:00
27-02 09:00
27-02 12:00
27-02 15:00
27-02 18:00
27-02 21:00
28-02 00:00

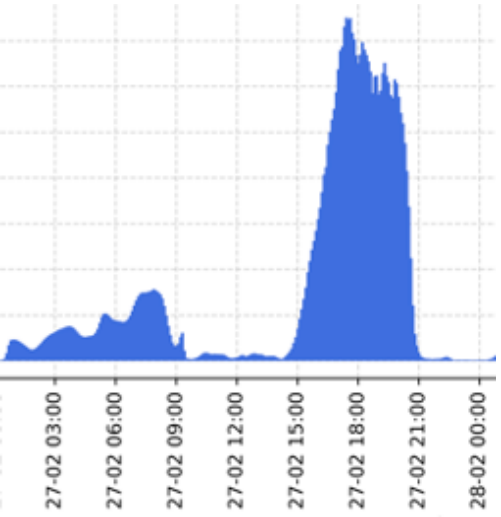

Location 1 – 2023-02-27 08:00 UTC
Height (m)
3000
2000
1500
1000
500
0
−6
−4
−2
0
2
4
6
Temperature (°C)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Mixing ratio (g/kg)
Temperature (°C)
Dewpoint (°C)
Thermal-based Melting Layer
(−1°C < T < 1°C)
Rain (Qr)
Snow (Qs)
Ice (Qi)
Cloud Water (Qc)
Graupel (Qg)
Hydrometeor-based Melting Layer
(Qr & Qs > 0.01)
Ground

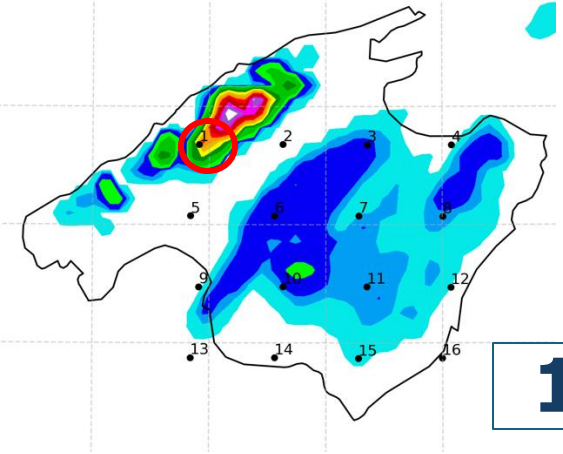


1

Location 1 – 2023-02-27 09:00 UTC



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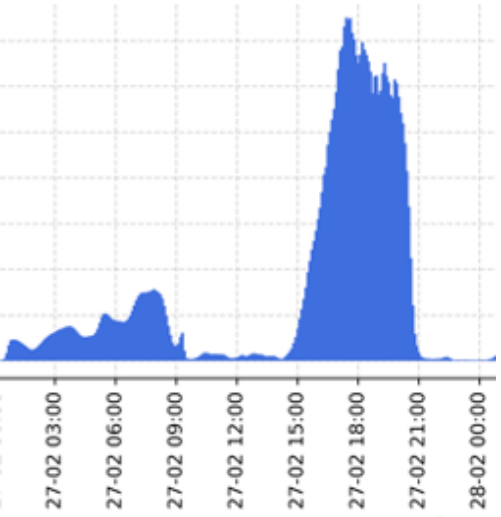
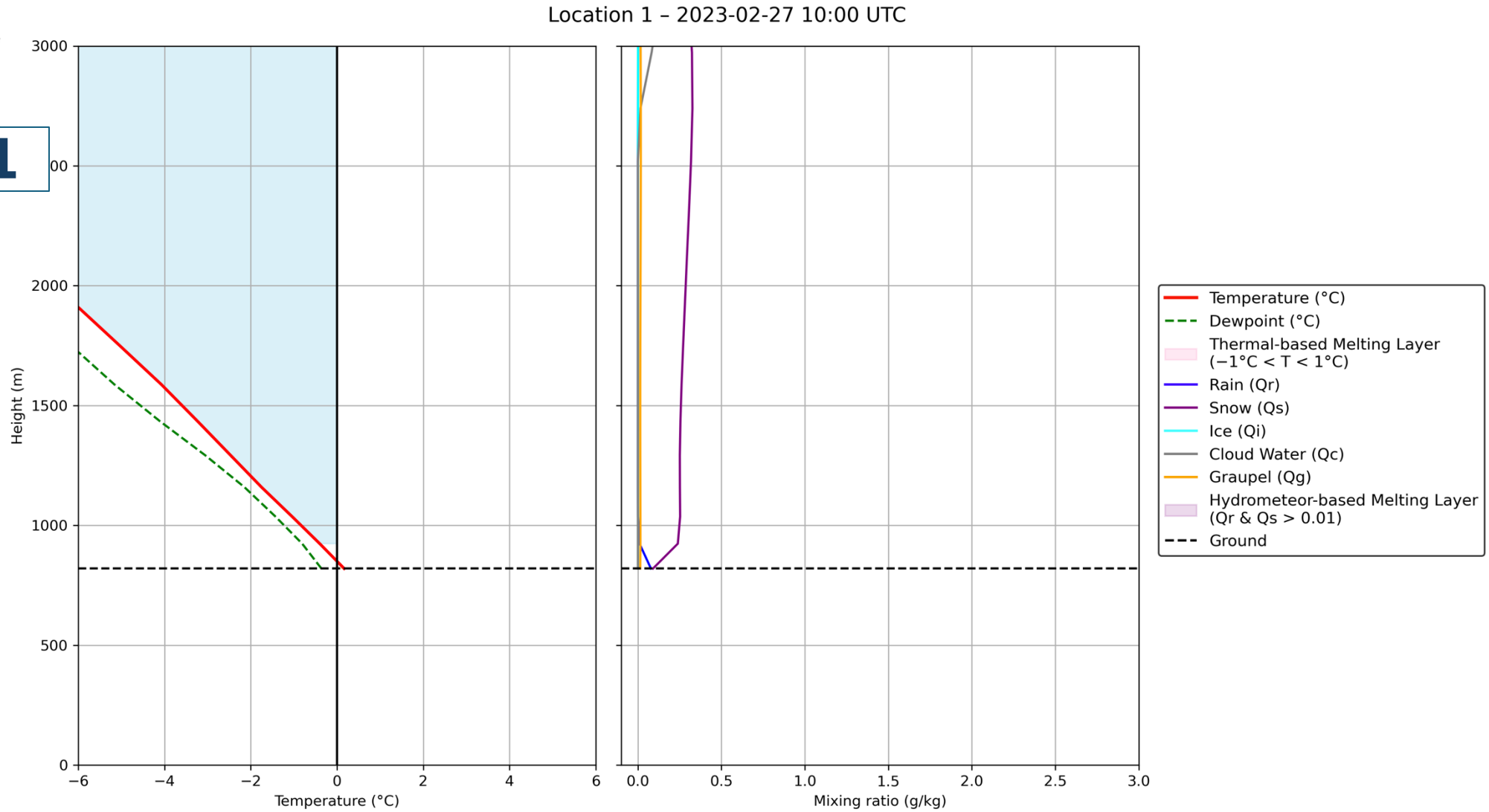
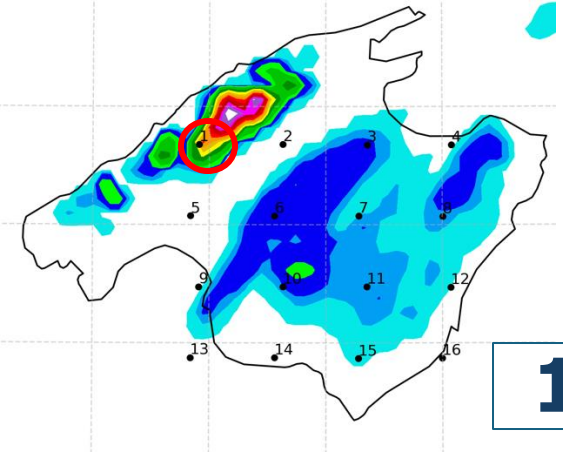
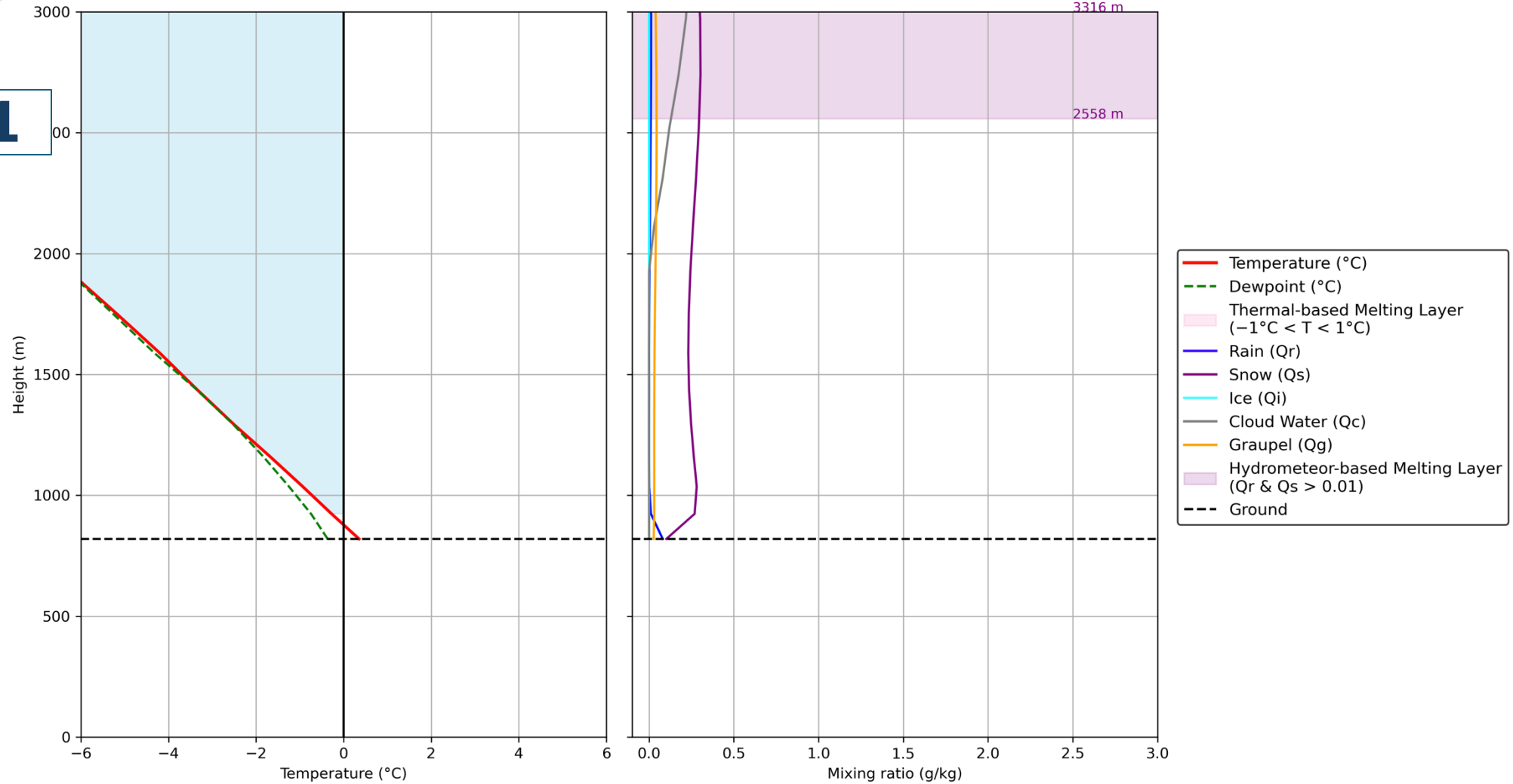

27-02 03:00
27-02 06:00
27-02 09:00
27-02 12:00
27-02 15:00
27-02 18:00
27-02 21:00
28-02 00:00

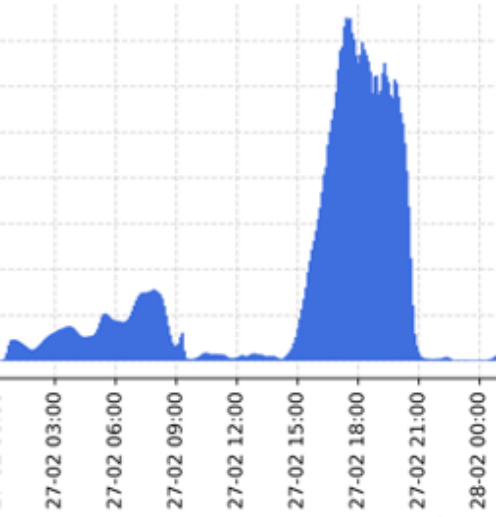

Location 1 – 2023-02-27 10:00 UTC
Height (m)
3000
2000
1500
1000
500
0
−6
−4
−2
0
2
4
6
Temperature (°C)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Mixing ratio (g/kg)
Temperature (°C)
Dewpoint (°C)
Thermal-based Melting Layer
(−1°C < T < 1°C)
Rain (Qr)
Snow (Qs)
Ice (Qi)
Cloud Water (Qc)
Graupel (Qg)
Hydrometeor-based Melting Layer
(Qr & Qs > 0.01)
Ground

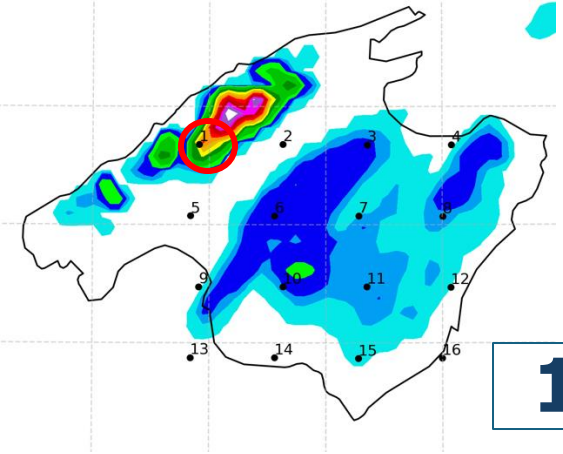


1

Location 1 – 2023-02-27 11:00 UTC



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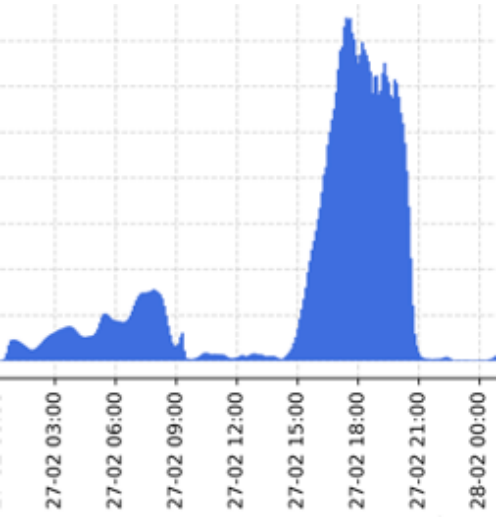
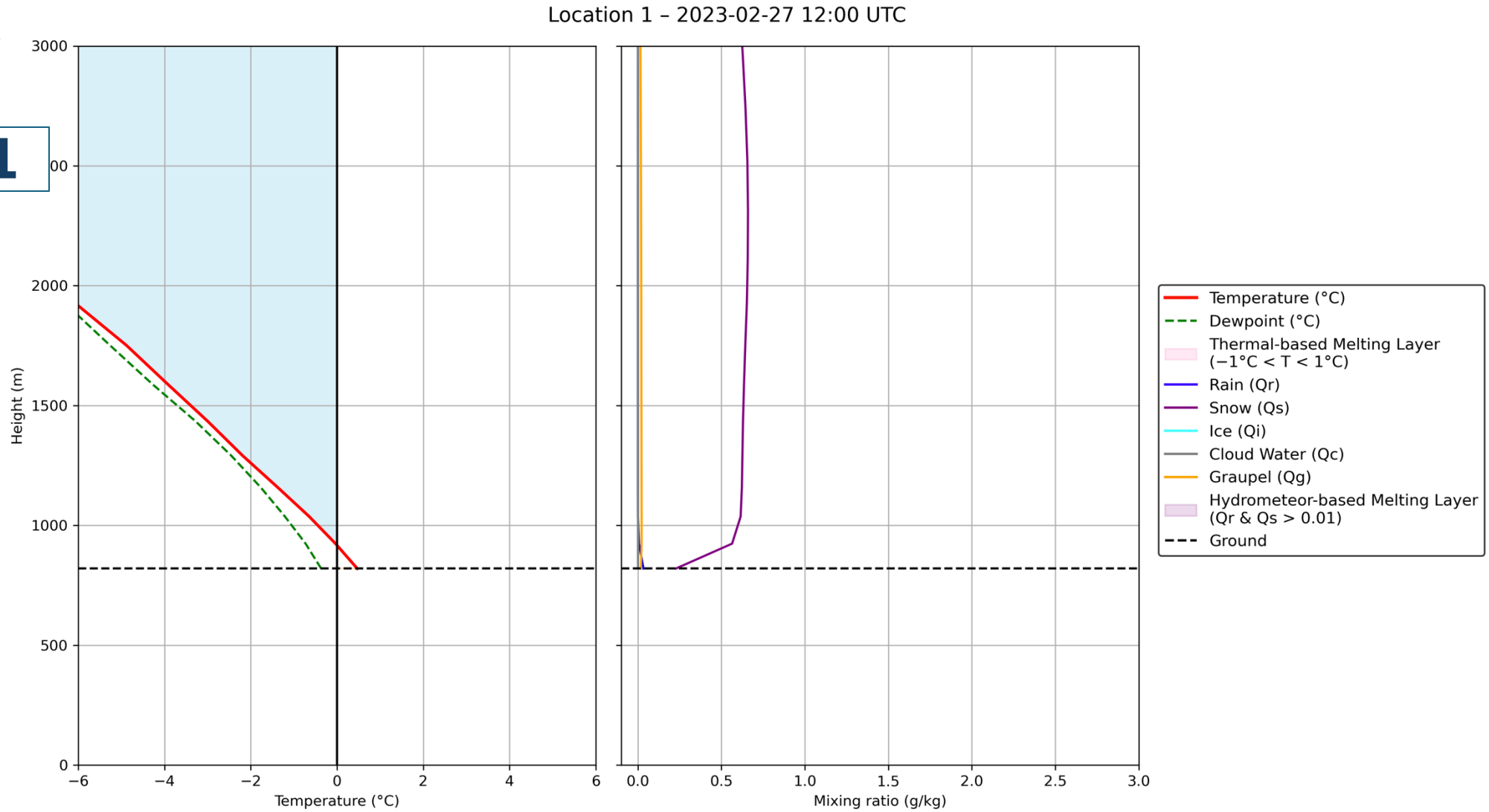
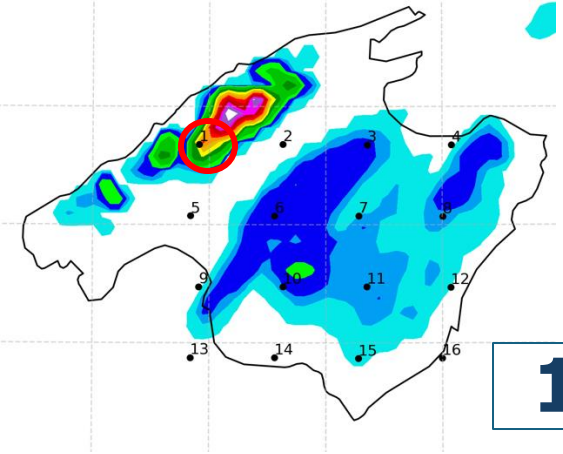

27-02 03:00
27-02 06:00
27-02 09:00
27-02 12:00
27-02 15:00
27-02 18:00
27-02 21:00
28-02 00:00


Location 1 – 2023-02-27 12:00 UTC
Height (m)
3000
2000
1500
1000
500
0
−6
−4
−2
0
2
4
6
Temperature (°C)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Mixing ratio (g/kg)
Temperature (°C)
Dewpoint (°C)
Thermal-based Melting Layer
(−1°C < T < 1°C)
Rain (Qr)
Snow (Qs)
Ice (Qi)
Cloud Water (Qc)
Graupel (Qg)
Hydrometeor-based Melting Layer
(Qr & Qs > 0.01)
Ground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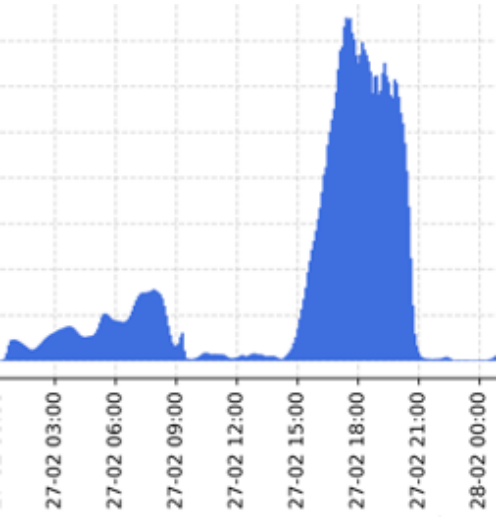
27-02 03:00
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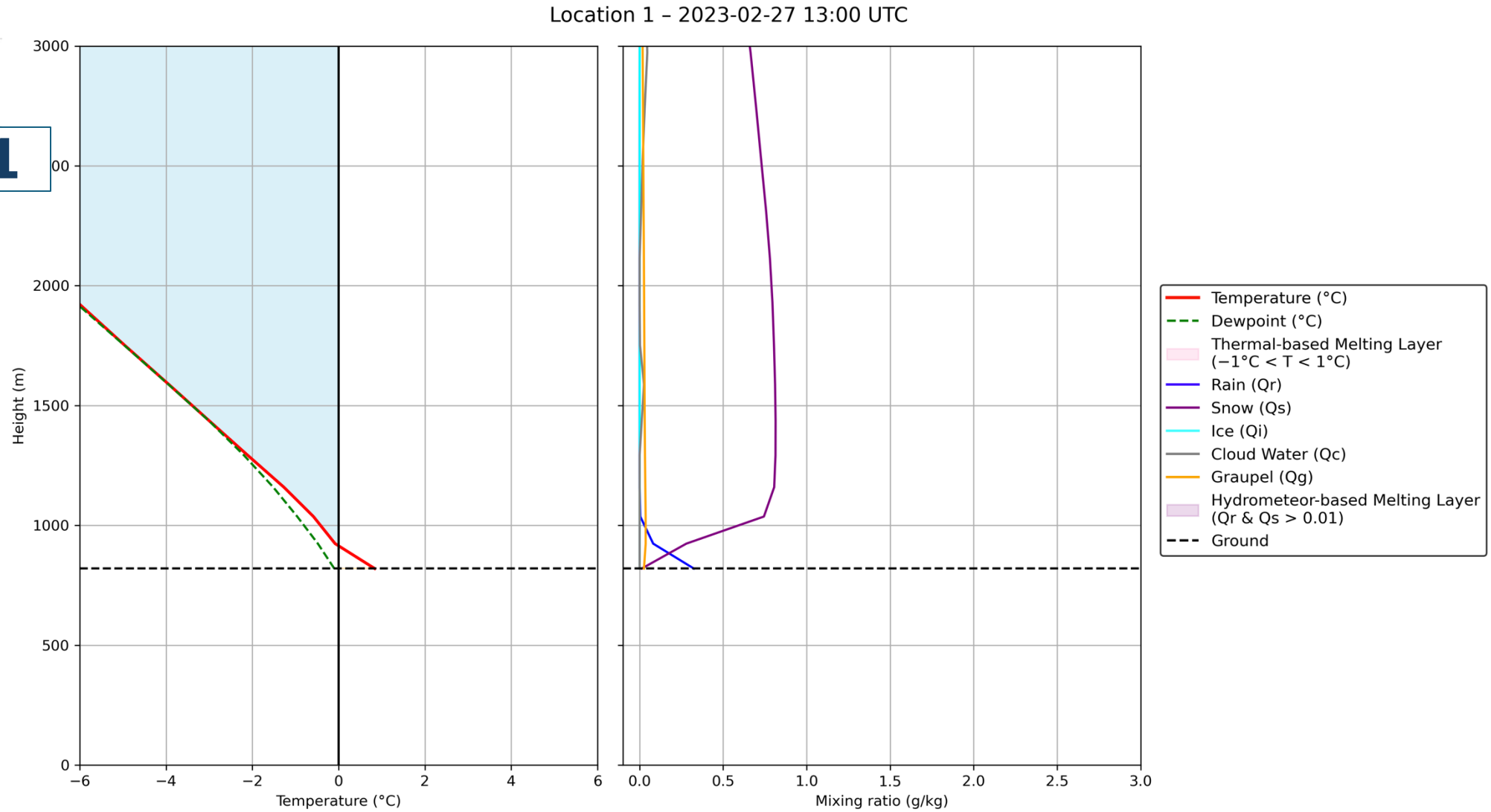
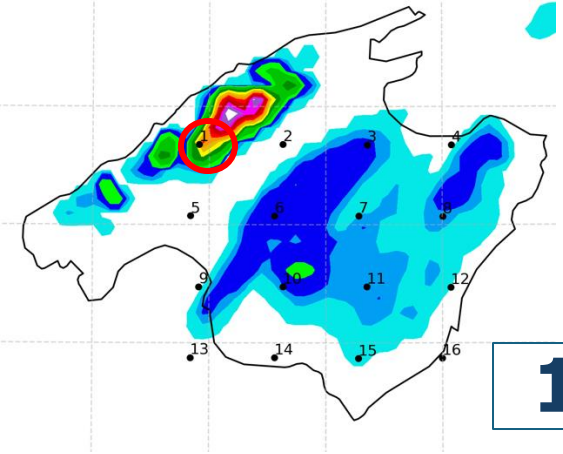
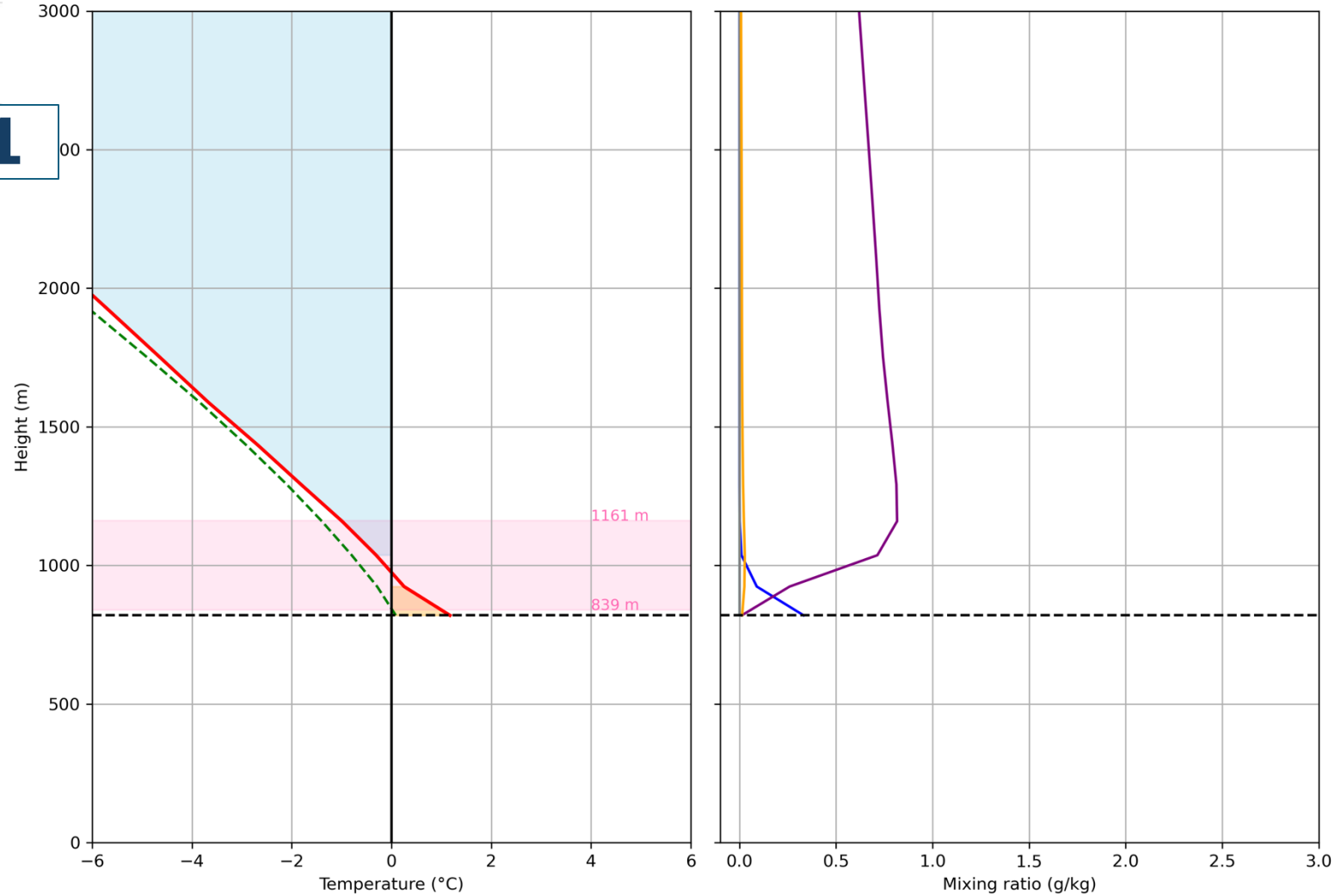
27-02 09:00
27-02 12:00
27-02 15:00
27-02 18:00
27-02 21:00
28-02 00:00

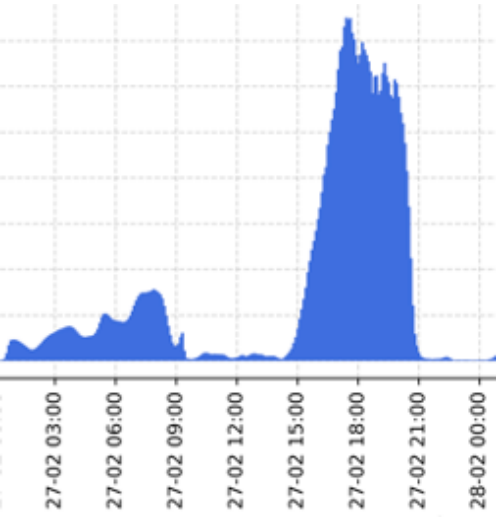

Location 1 – 2023-02-27 13:00 UTC
Height (m)
3000
2000
1500
1000
500
0
−6
−4
−2
0
2
4
6
Temperature (°C)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Mixing ratio (g/kg)
Temperature (°C)
Dewpoint (°C)
Thermal-based Melting Layer
(−1°C < T < 1°C)
Rain (Qr)
Snow (Qs)
Ice (Qi)
Cloud Water (Qc)
Graupel (Qg)
Hydrometeor-based Melting Layer
(Qr & Qs > 0.01)
Ground

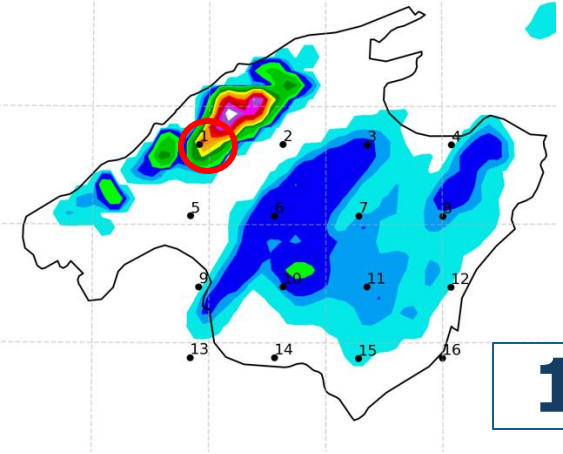


1

Location 1 – 2023-02-27 14:00 UTC

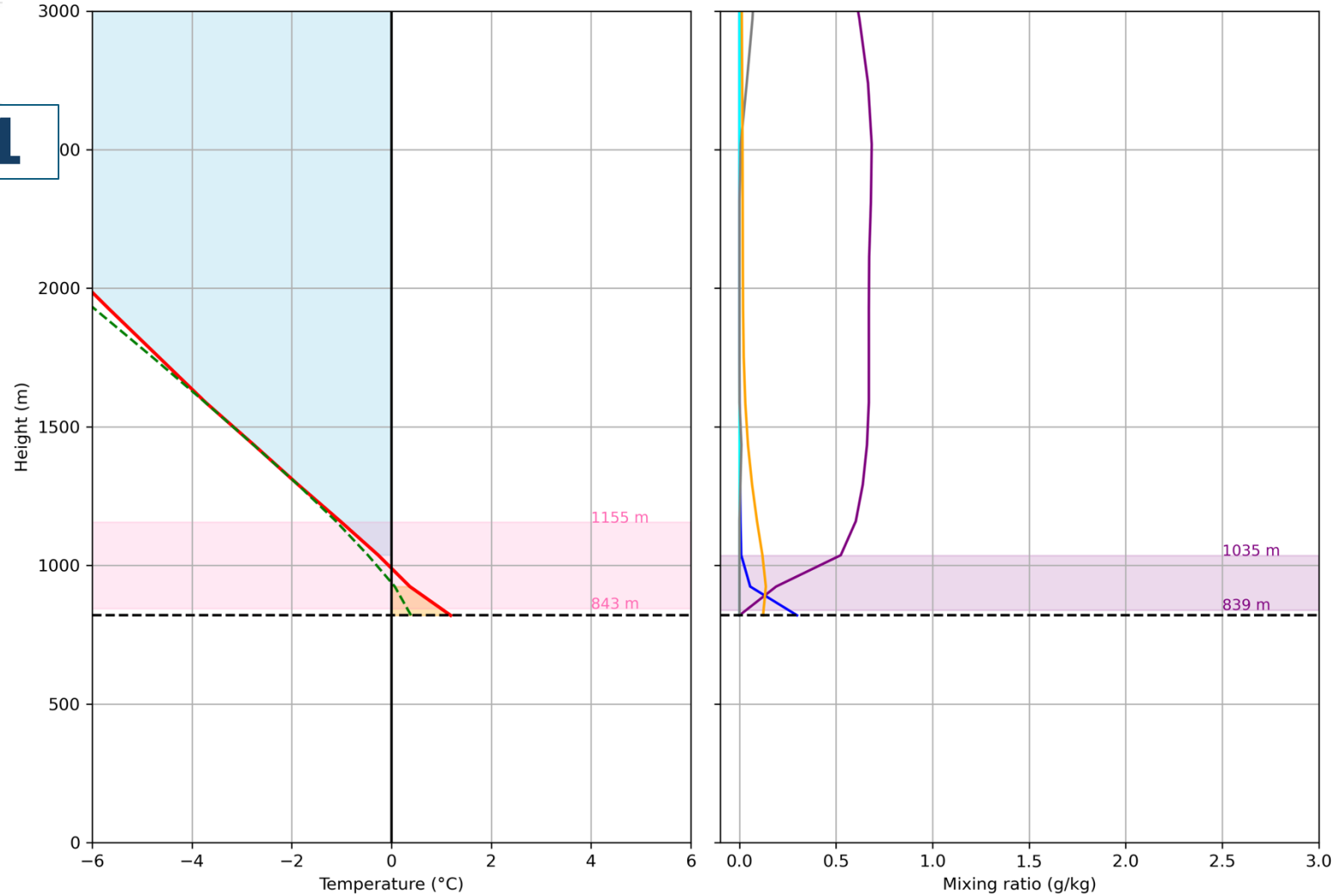


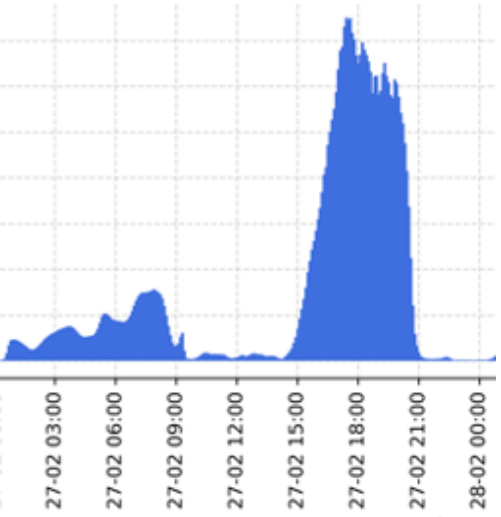


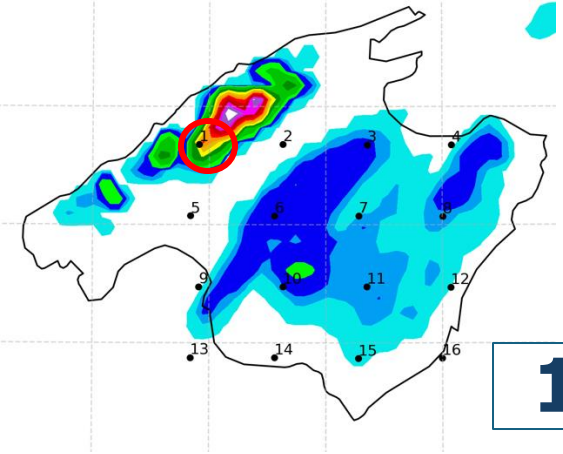


1

Location 1 – 2023-02-27 15:00 UTC



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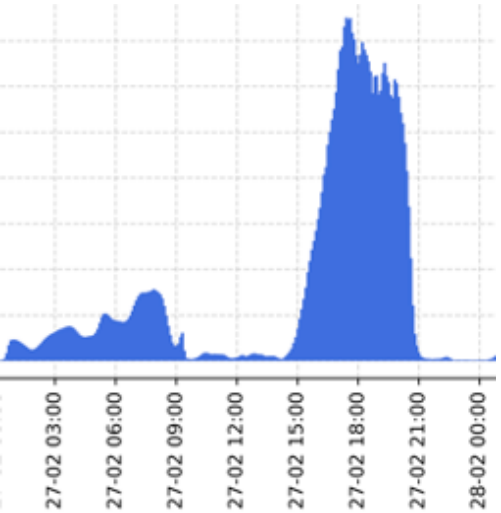
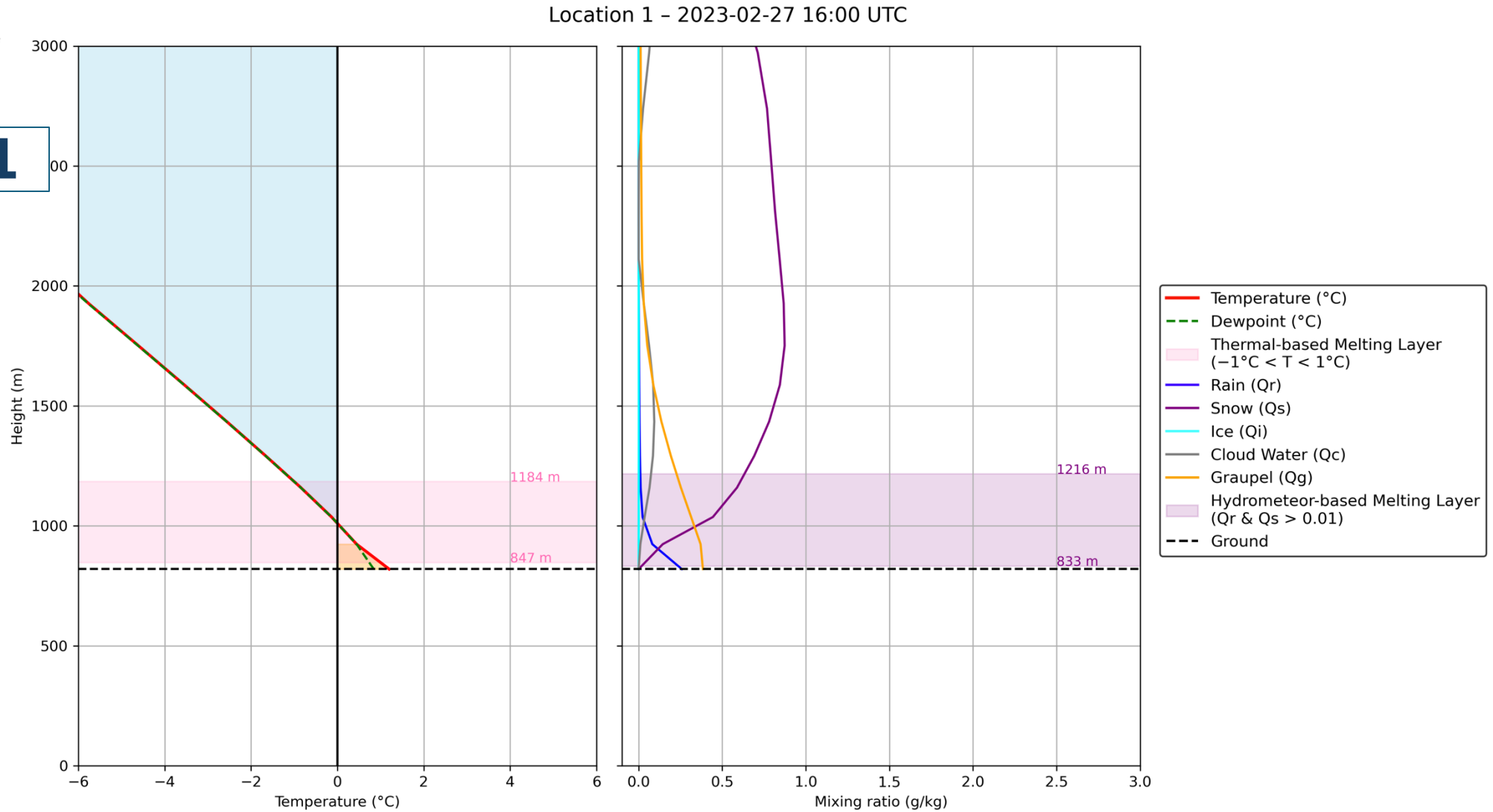

27-02 03:00
27-02 06:00
27-02 09:00
27-02 12:00
27-02 15:00
27-02 18:00
27-02 21:00
28-02 00:00


Location 1 – 2023-02-27 16:00 UTC
Height (m)
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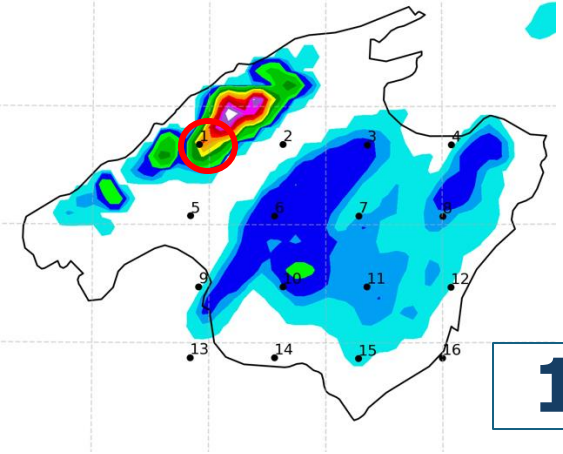
2000
1500
1000
500
0
1184 m
847 m
1216 m
833 m
−6
−4
−2
0
2
4
6
Temperature (°C)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Mixing ratio (g/kg)
Temperature (°C)
Dewpoint (°C)
Thermal-based Melting Layer
(−1°C < T < 1°C)
Rain (Qr)
Snow (Qs)
Ice (Qi)
Cloud Water (Qc)
Graupel (Qg)
Hydrometeor-based Melting Layer
(Qr & Qs > 0.01)
Ground



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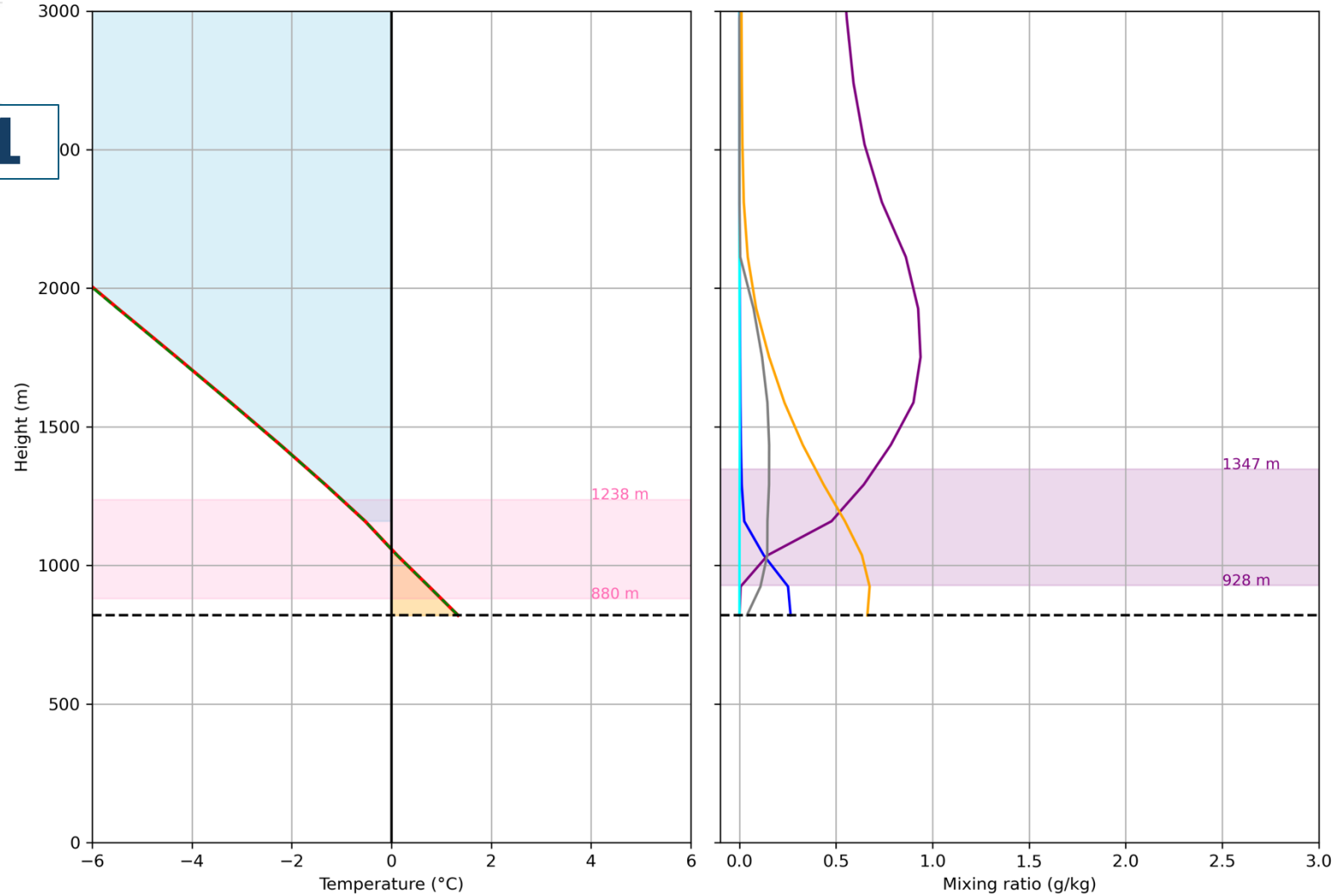
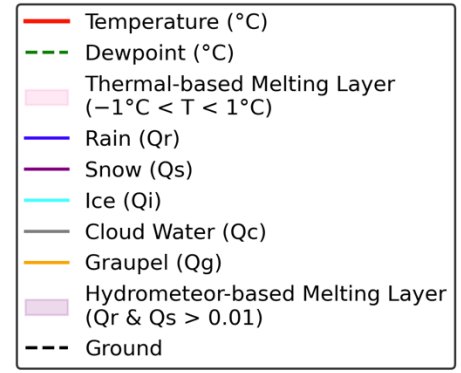
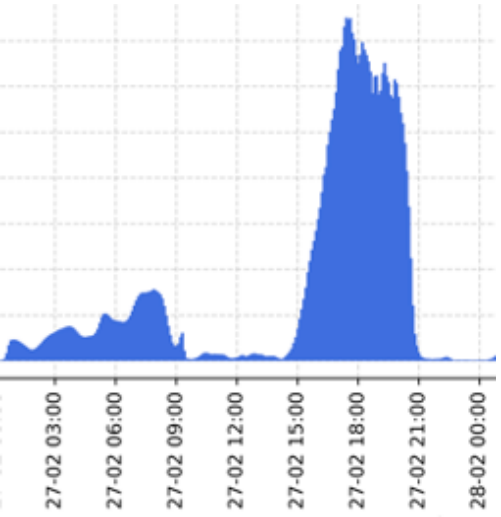
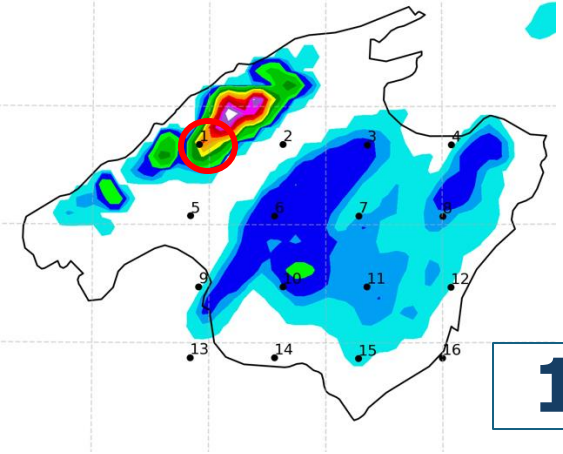
Location 1 – 2023-02-27 17:00 UTC





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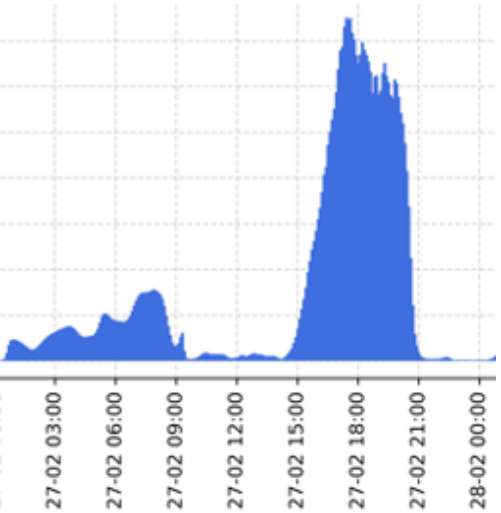
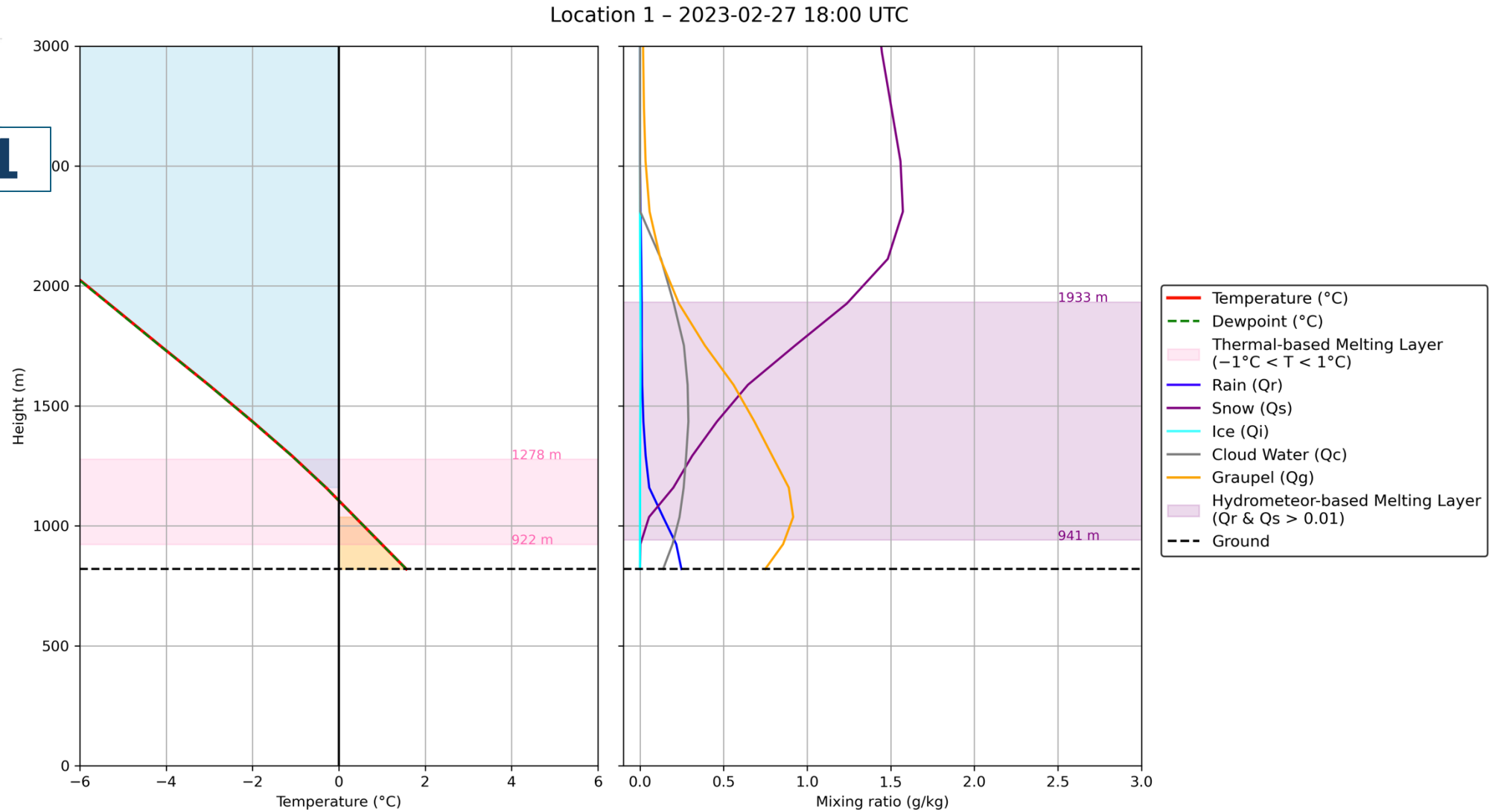

27-02 03:00
27-02 06:00
27-02 09:00
27-02 12:00
27-02 15:00
27-02 18:00
27-02 21:00
28-02 00:00


Location 1 – 2023-02-27 18:00 UTC
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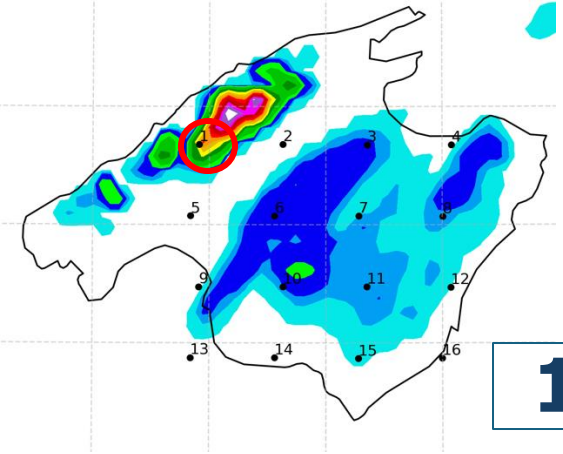
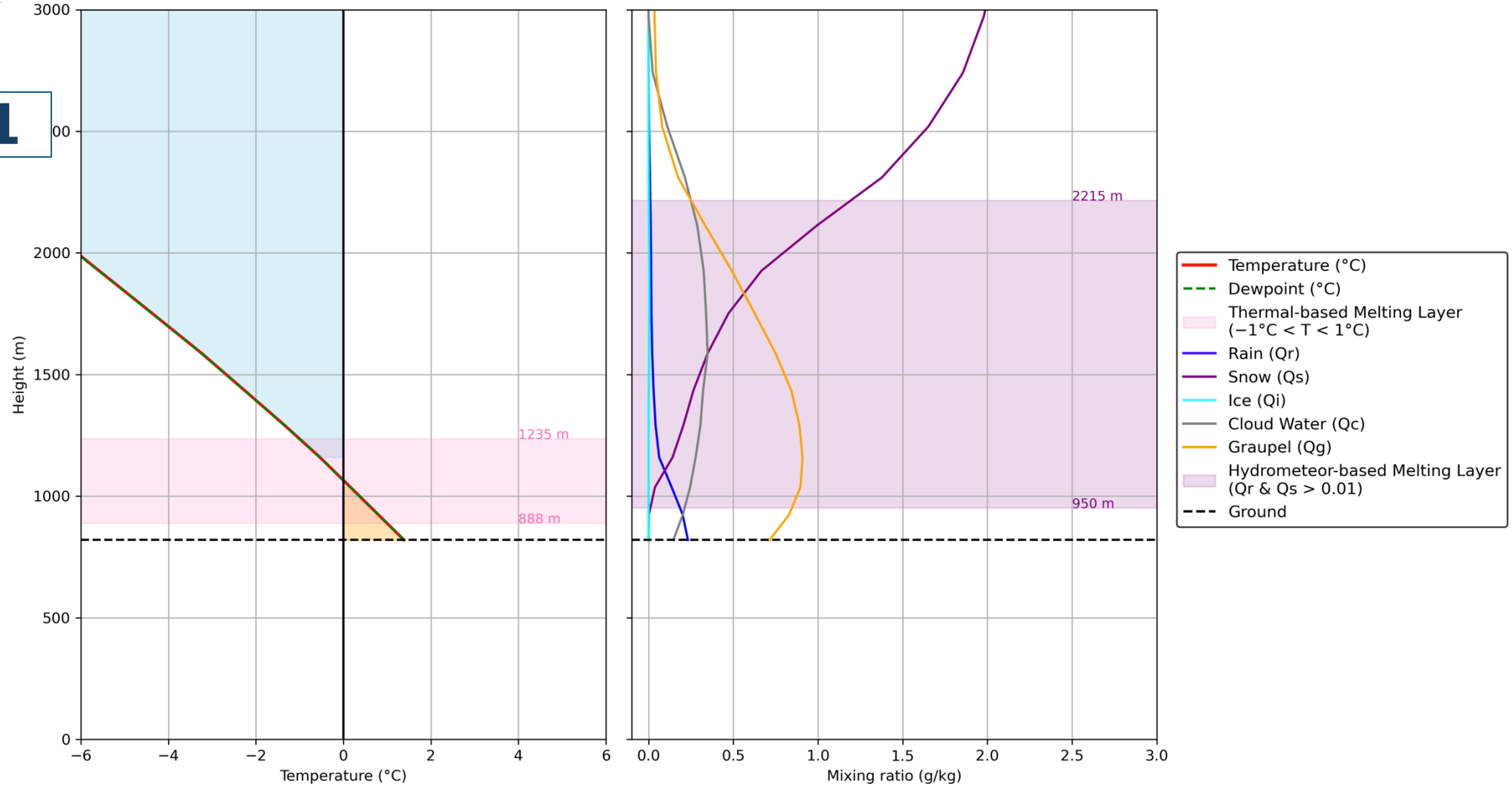
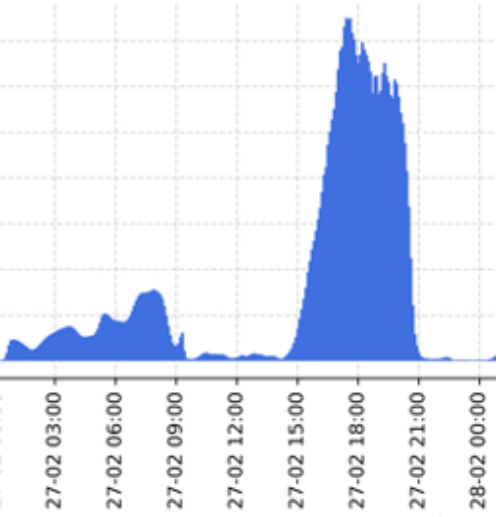
2000
1500
1000
500
0
1278 m
922 m
1933 m
941 m
−6
−4
−2
0
2
4
6
Temperature (°C)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Mixing ratio (g/kg)
Temperature (°C)
Dewpoint (°C)
Thermal-based Melting Layer
(−1°C < T < 1°C)
Rain (Qr)
Snow (Qs)
Ice (Qi)
Cloud Water (Qc)
Graupel (Qg)
Hydrometeor-based Melting Layer
(Qr & Qs > 0.01)
Ground

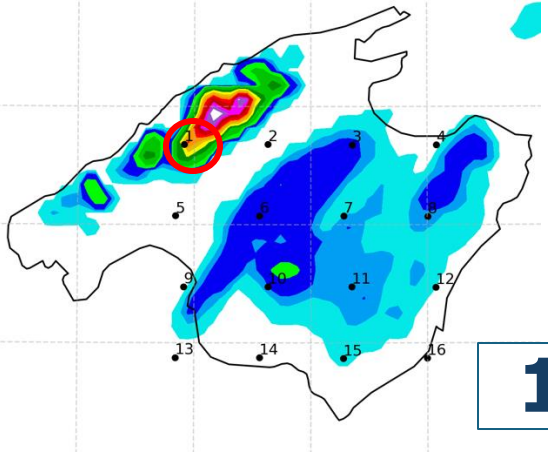


1

Location 1 – 2023-02-27 19:00 UTC

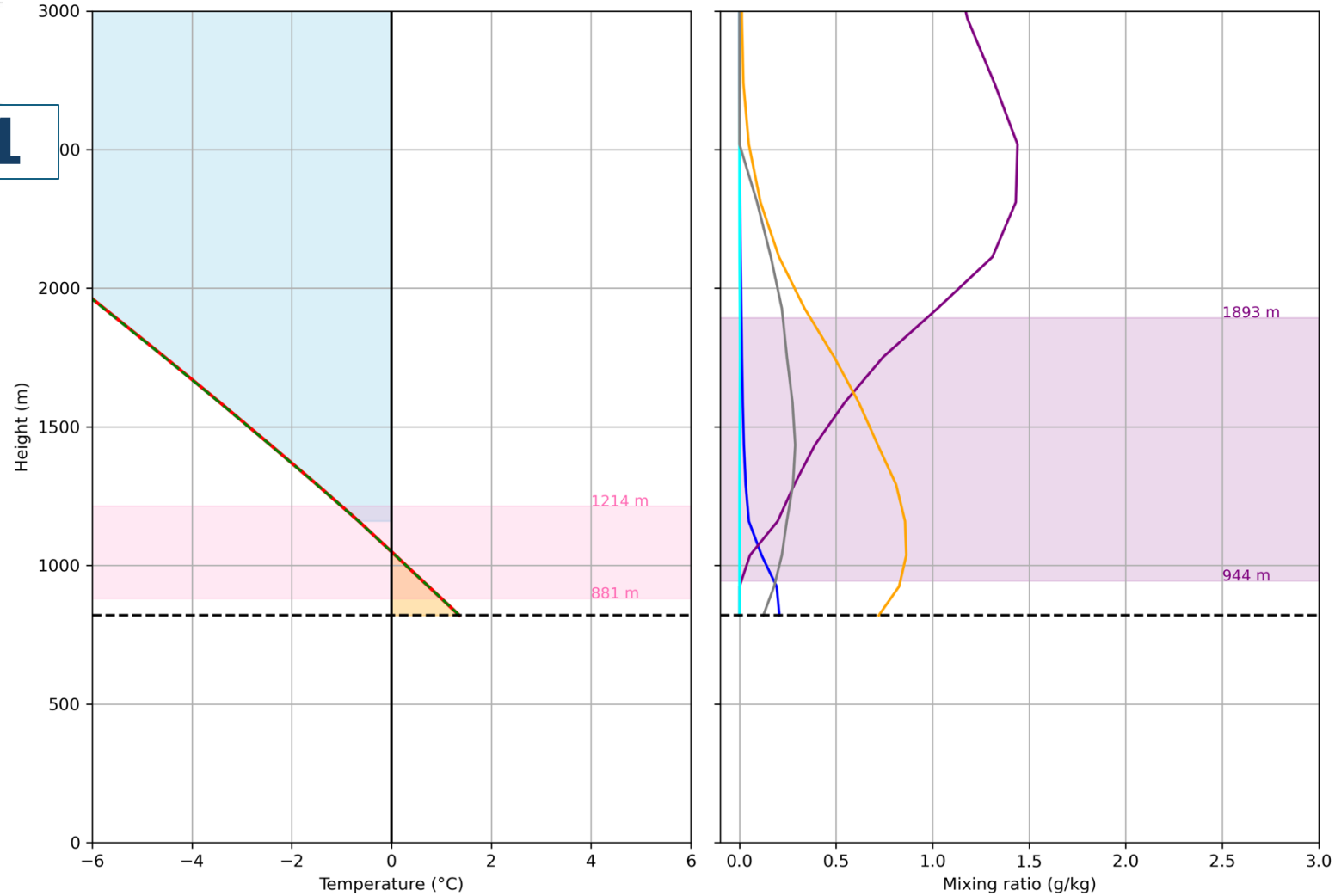


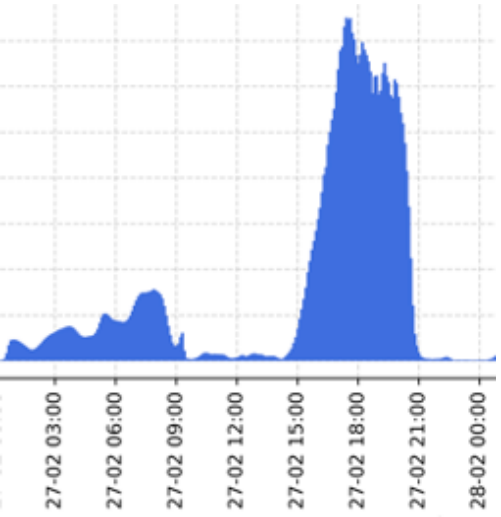


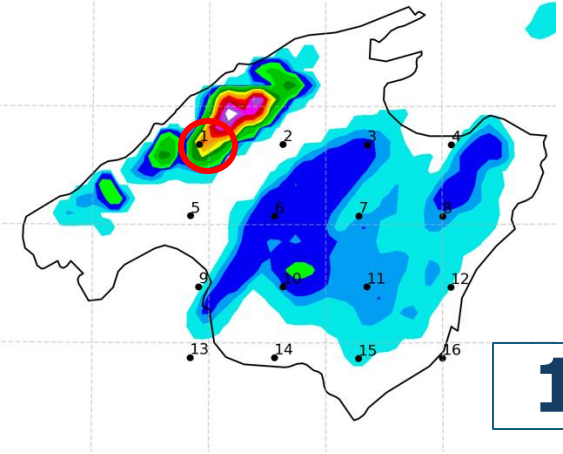


1

Location 1 – 2023-02-27 20:00 UTC

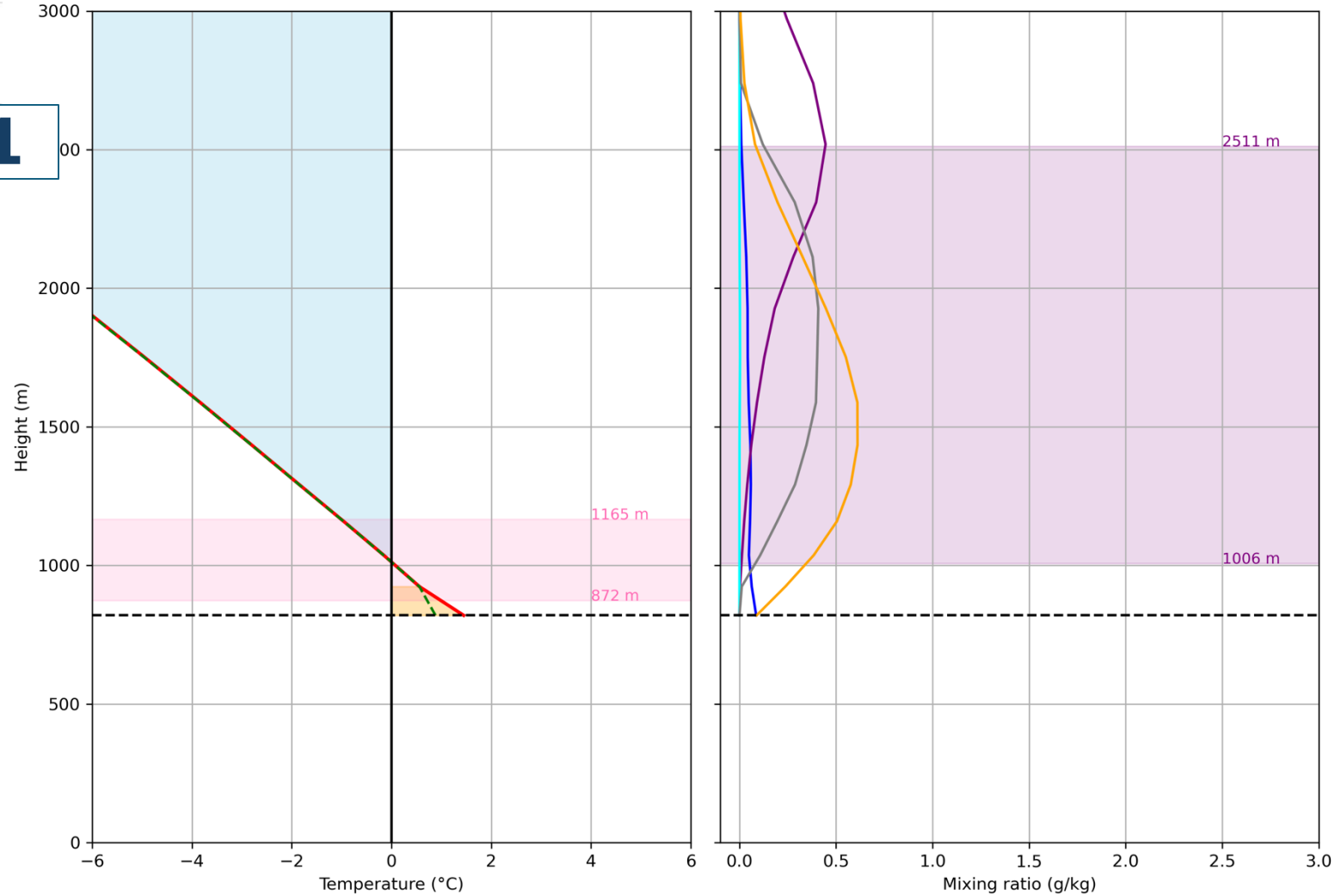


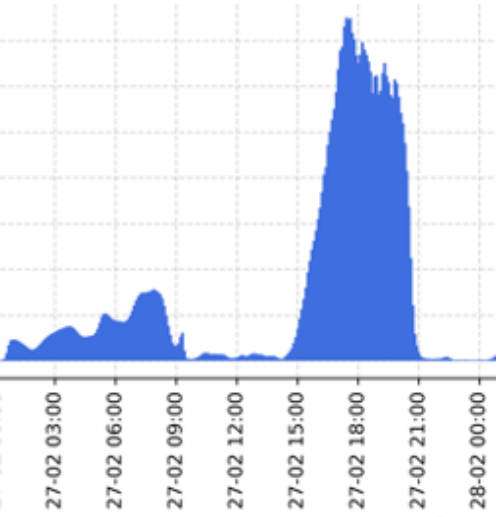


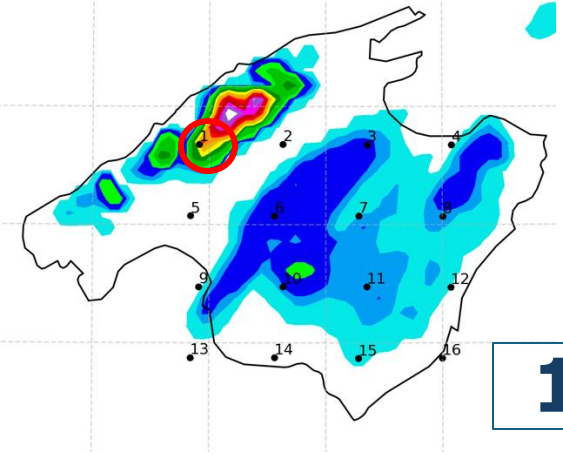


1

Location 1 – 2023-02-27 21:00 UTC

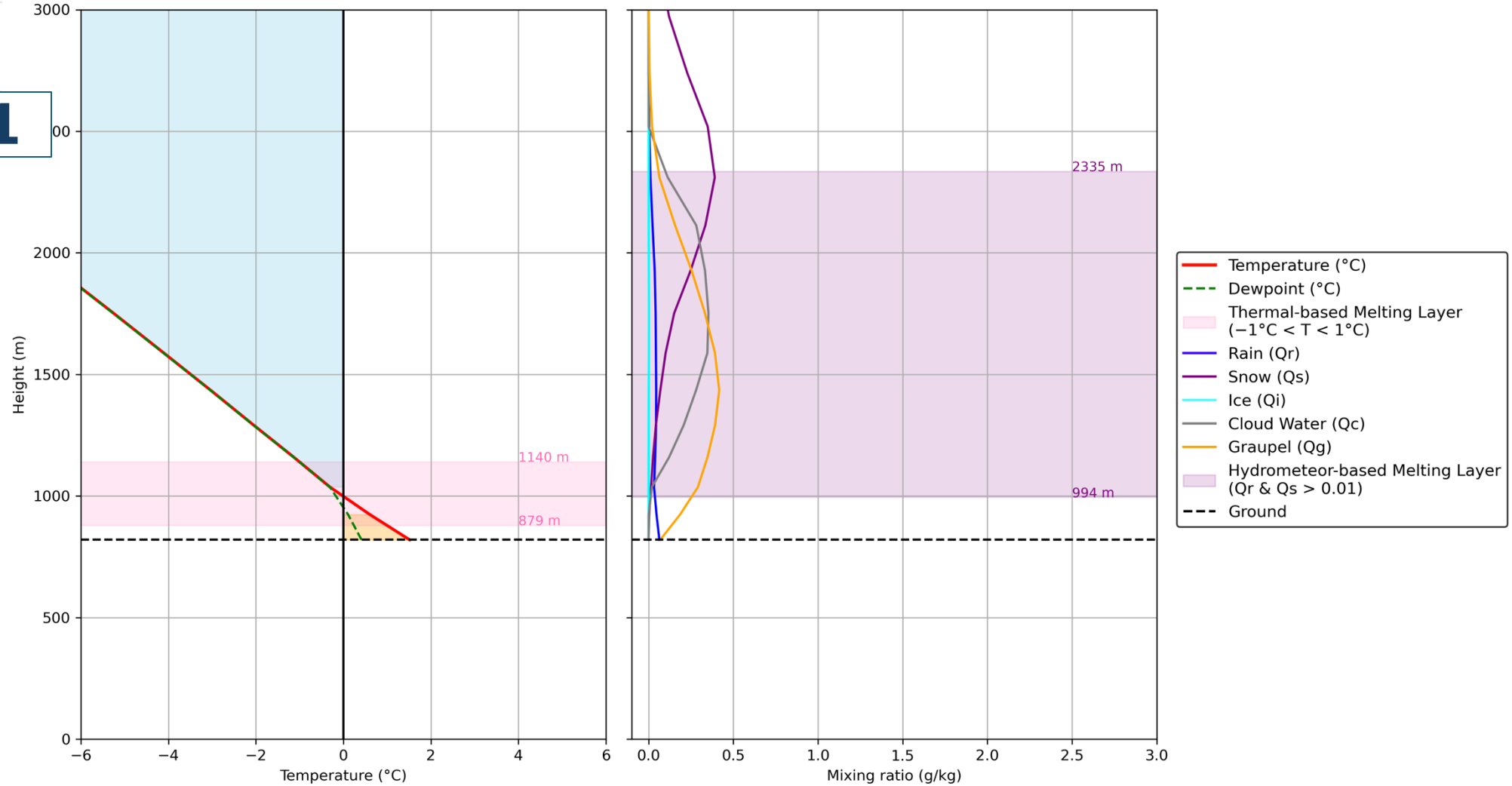


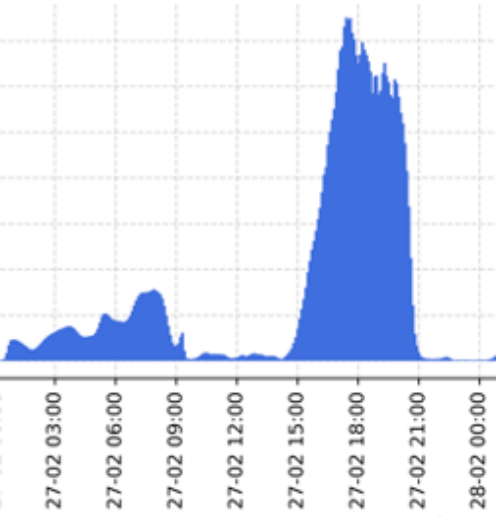


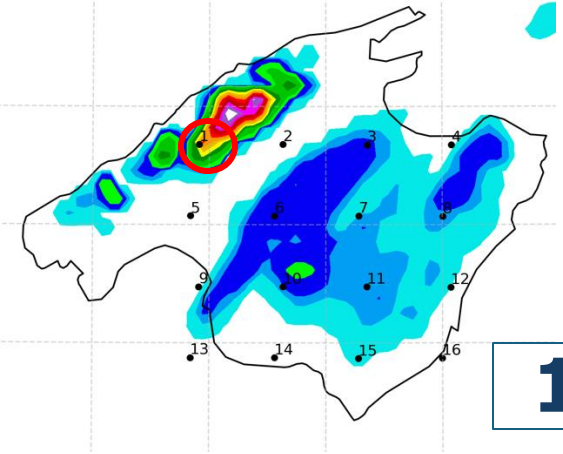


1

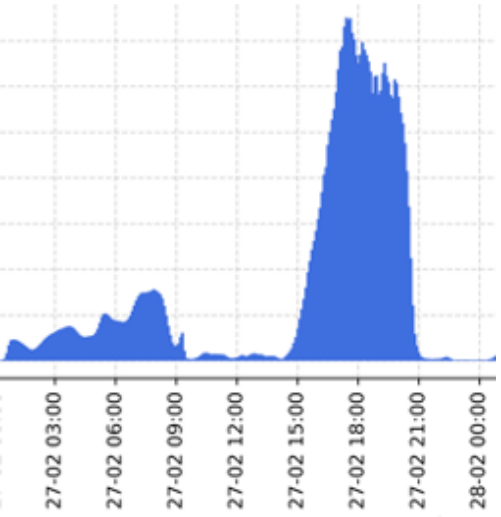
Location 1 – 2023-02-27 22:00 UTC

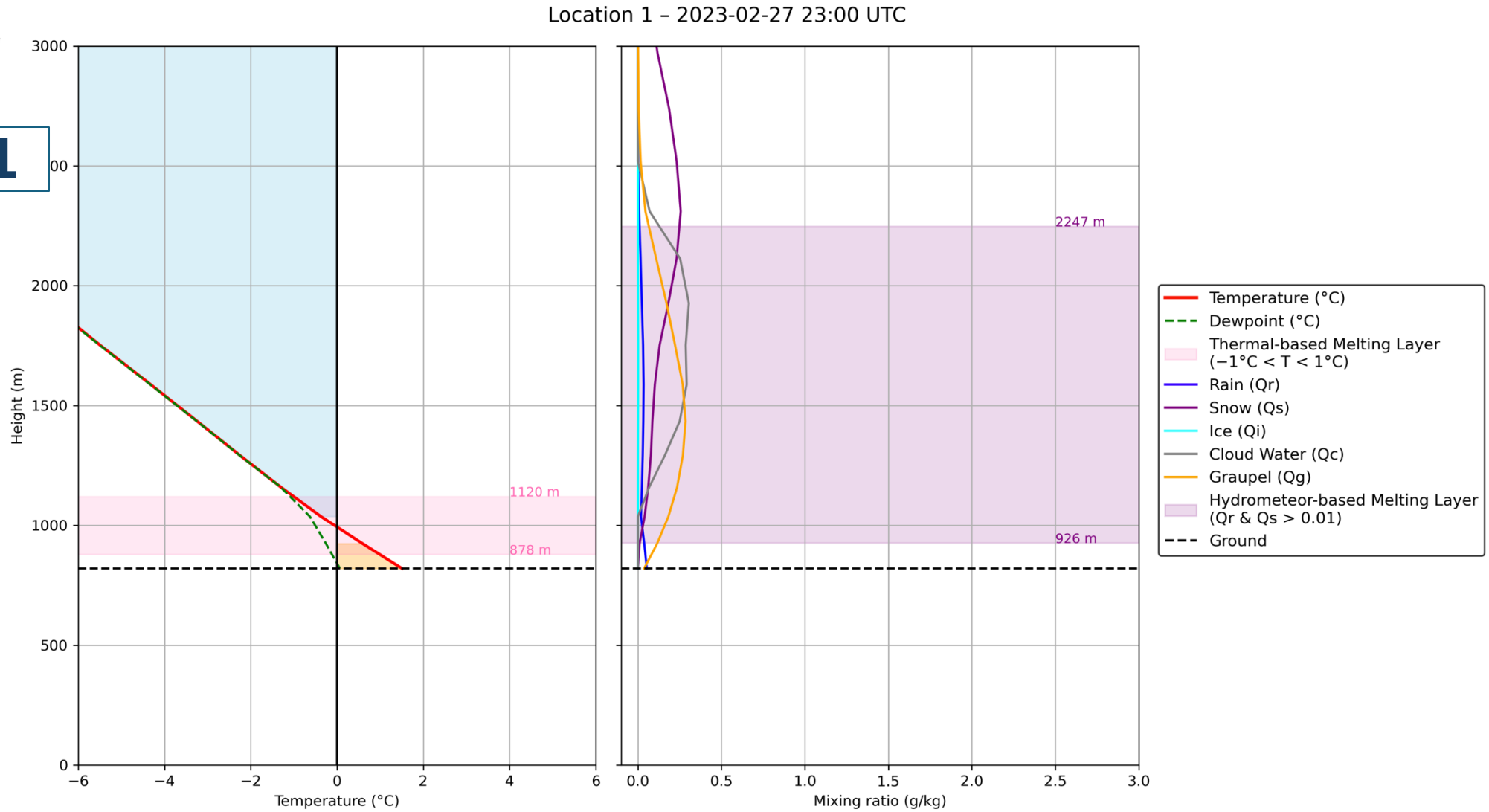


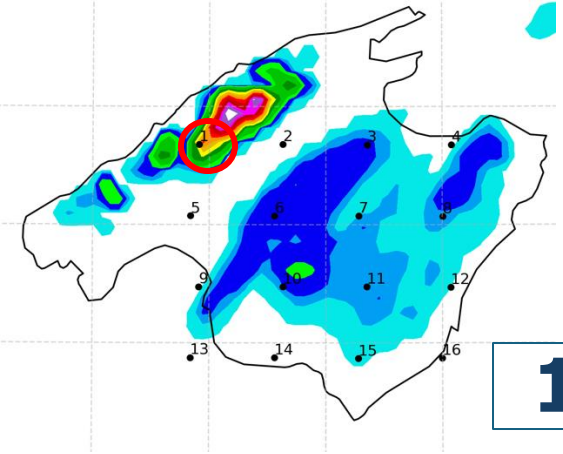



1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16

1


27-02 03:00
27-02 06:00
27-02 09:00
27-02 12:00
27-02 15:00
27-02 18:00
27-02 21:00
28-02 00:00


Location 1 – 2023-02-27 23:00 UTC
Height (m)
3000
2000
1500
1000
500
0
1120 m
878 m
2247 m
926 m
−6
−4
−2
0
2
4
6
Temperature (°C)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Mixing ratio (g/kg)
Temperature (°C)
Dewpoint (°C)
Thermal-based Melting Layer
(−1°C < T < 1°C)
Rain (Qr)
Snow (Qs)
Ice (Qi)
Cloud Water (Qc)
Graupel (Qg)
Hydrometeor-based Melting Layer
(Qr & Qs > 0.01)
Ground


1
2
3
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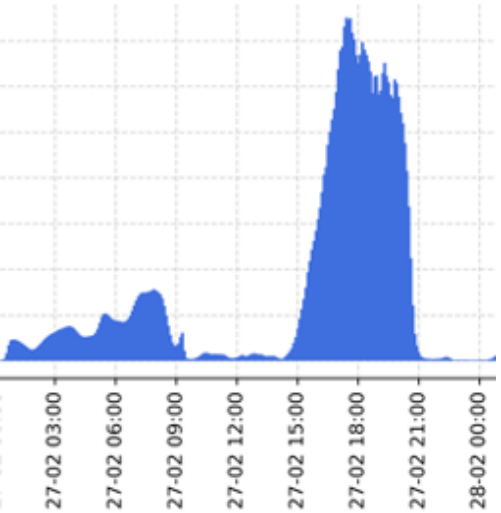
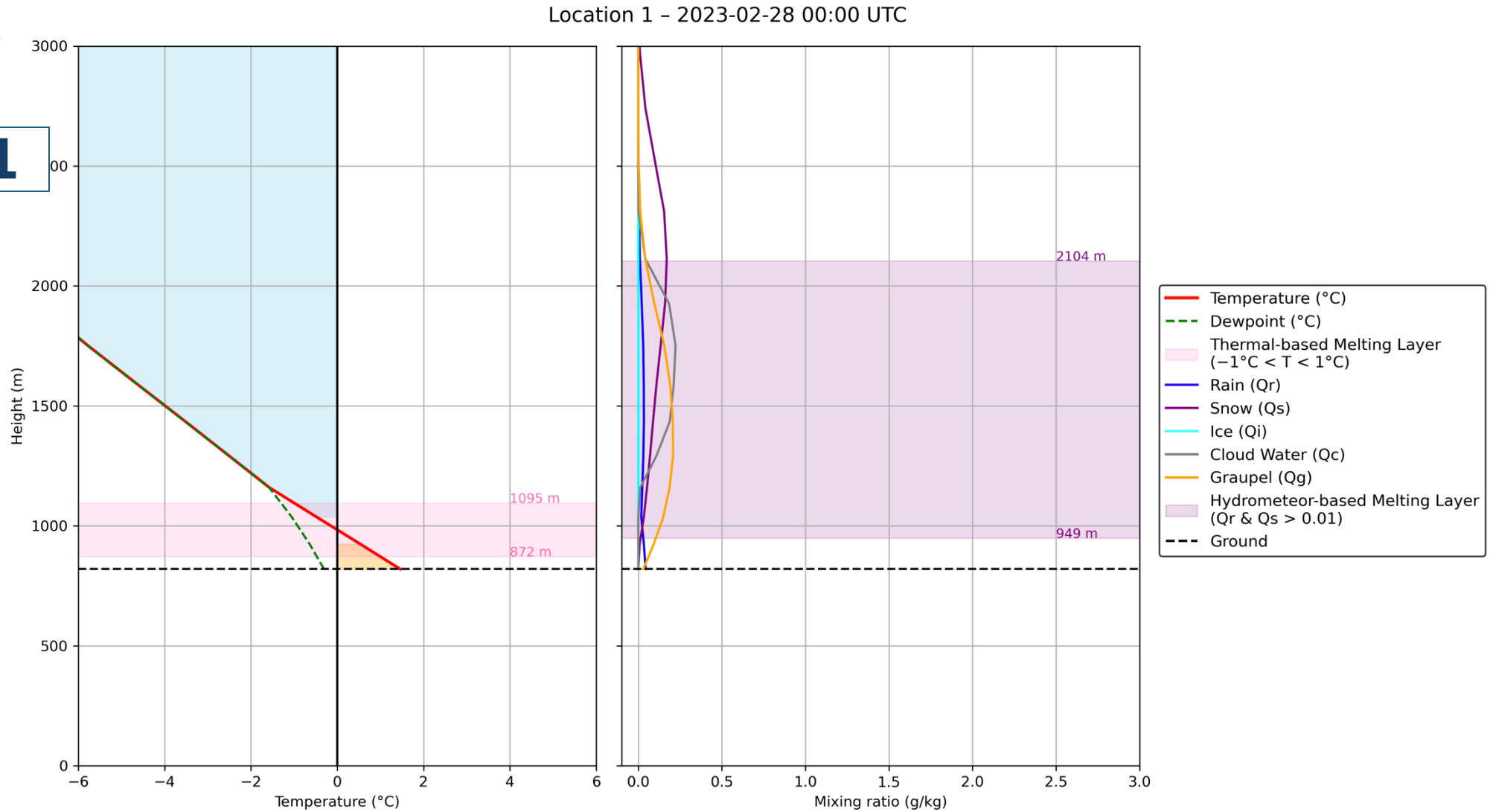
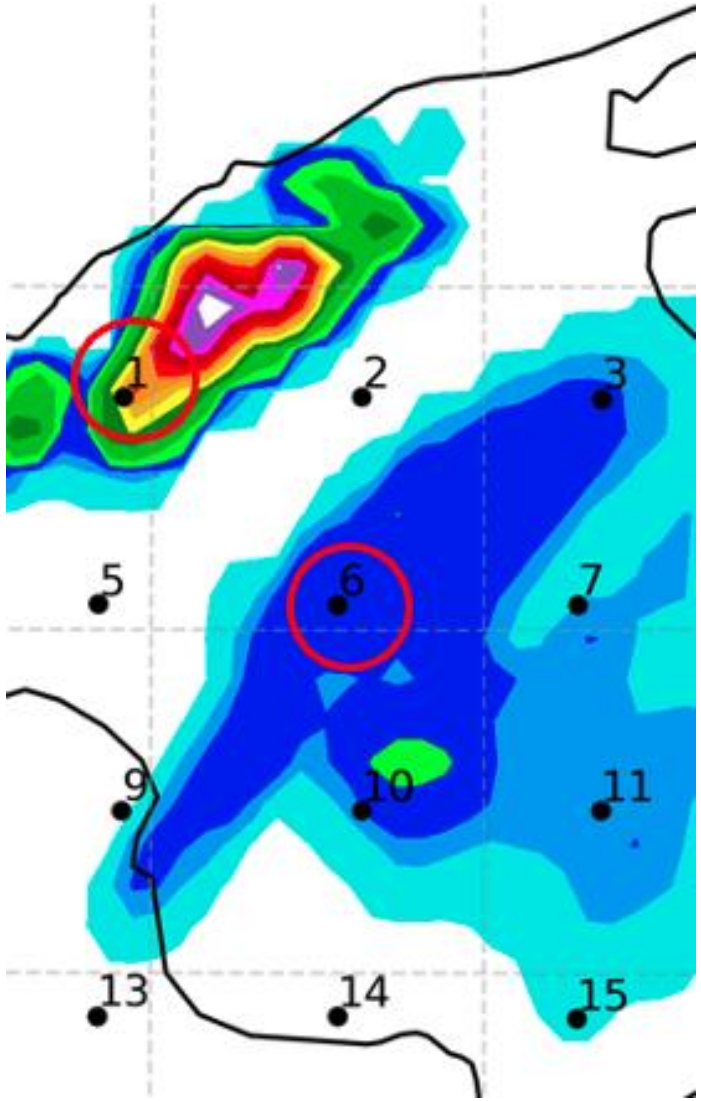
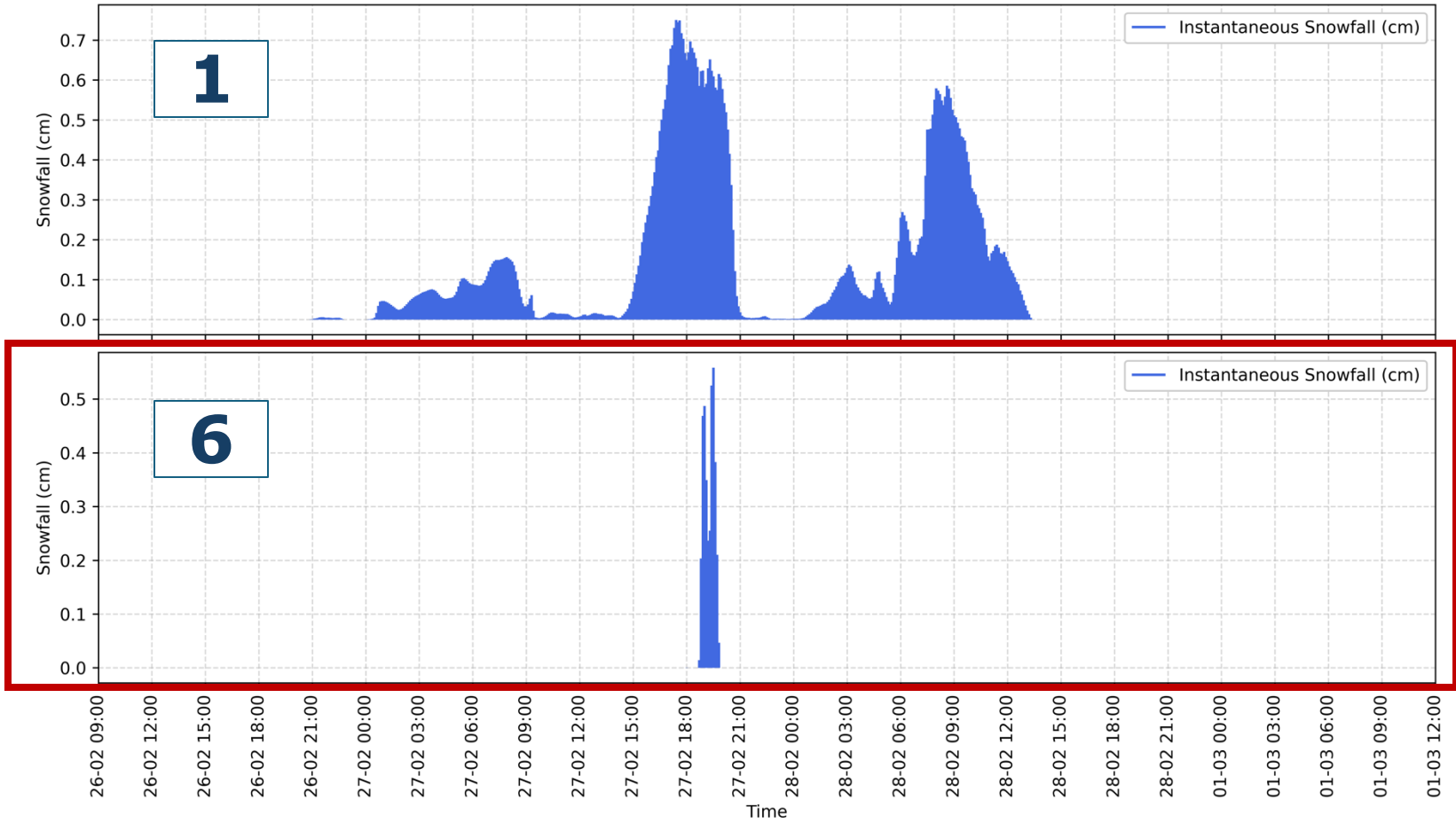
15
16

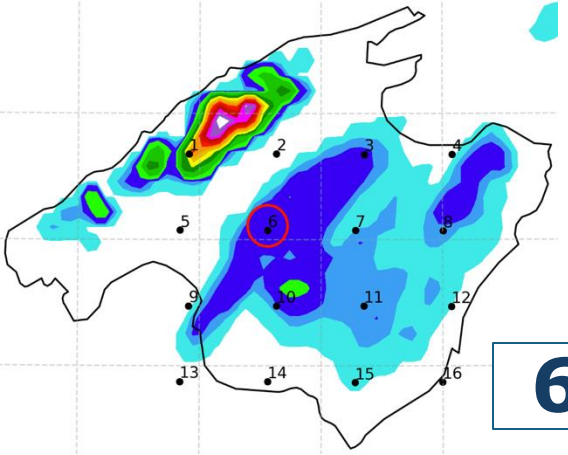
1


27-02 03:00
27-02 06:00
27-02 09:00
27-02 12:00
27-02 15:00
27-02 18:00
27-02 21:00
28-02 00:00


Location 1 – 2023-02-28 00:00 UTC
Height (m)
3000
2000
1500
1000
500
0
1095 m
872 m
2104 m
949 m
−6
−4
−2
0
2
4
6
Temperature (°C)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Mixing ratio (g/kg)
Temperature (°C)
Dewpoint (°C)
Thermal-based Melting Layer
(−1°C < T < 1°C)
Rain (Qr)
Snow (Qs)
Ice (Qi)
Cloud Water (Qc)
Graupel (Qg)
Hydrometeor-based Melting Layer
(Qr & Qs > 0.01)
Ground

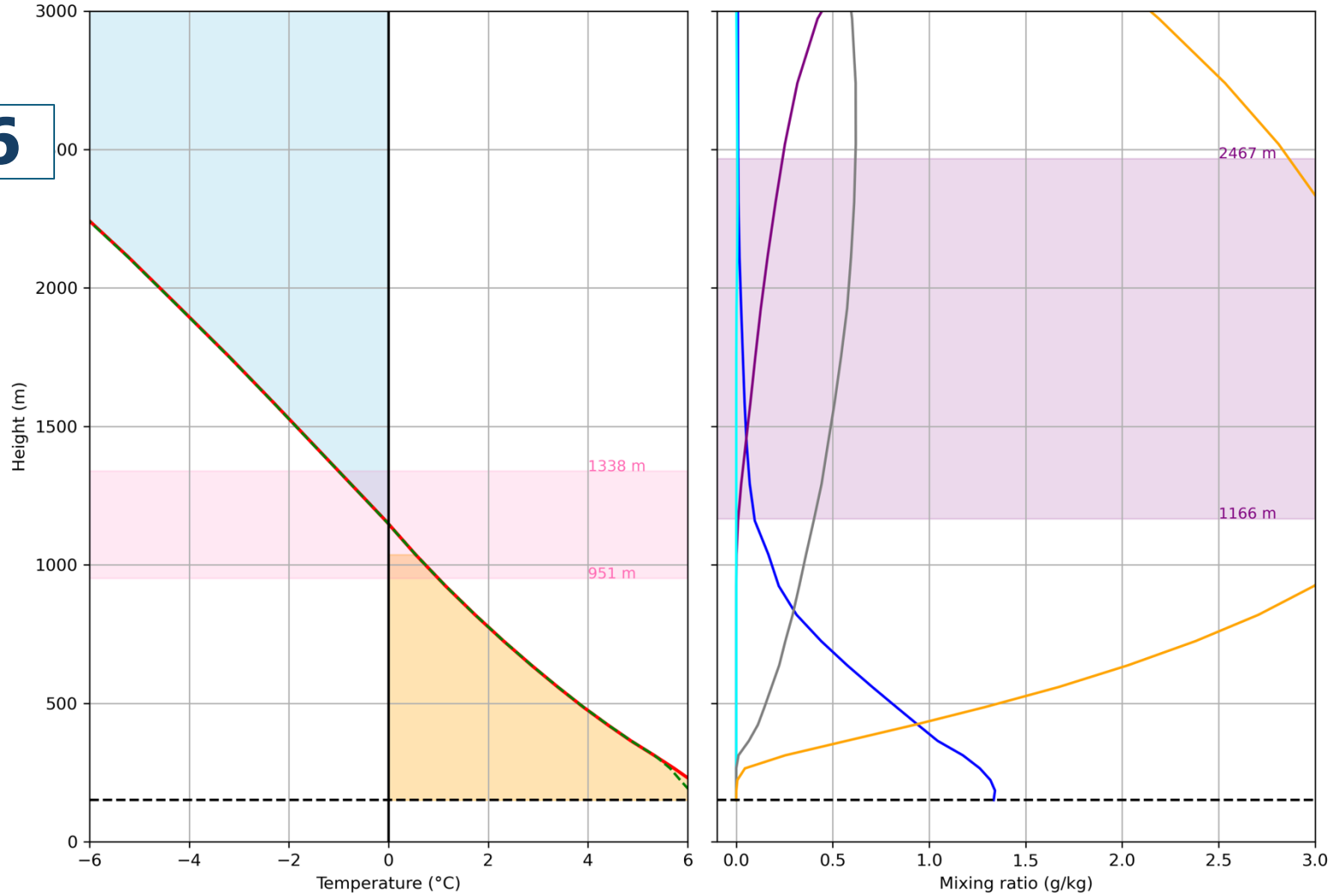

1
2
3
5
6
7
9
10
11
13
14
15

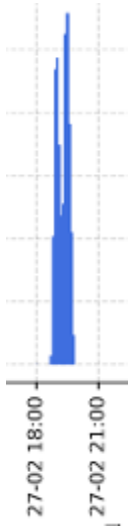

1
Instantaneous Snowfall (cm)
Snowfall (cm)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
6
Instantaneous Snowfall (cm)
Snowfall (cm)
0.0
0.1
0.2
0.3
0.4
0.5
26-02 09:00
26-02 12:00
26-02 15:00
26-02 18:00
26-02 21:00
27-02 00:00
27-02 03:00
27-02 06:00
27-02 09:00
27-02 12:00
27-02 15:00
27-02 18:00
27-02 21:00
28-02 00:00
28-02 03:00
28-02 06:00
28-02 09:00
28-02 12:00
28-02 15:00
28-02 18:00
28-02 21:00
01-03 00:00
01-03 03:00
01-03 06:00
01-03 09:00
01-03 12:00
Time

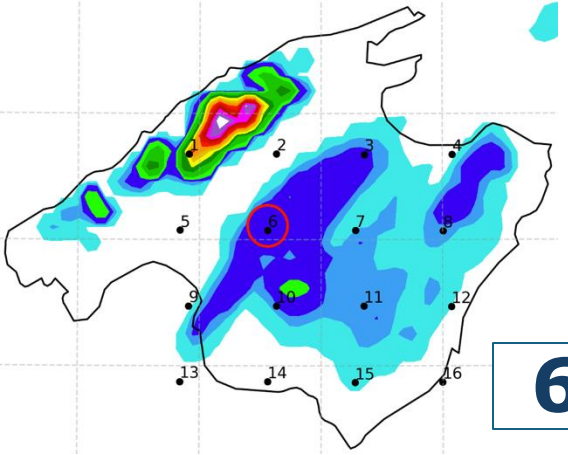


6

Location 6 – 2023-02-27 18:30 UTC






1
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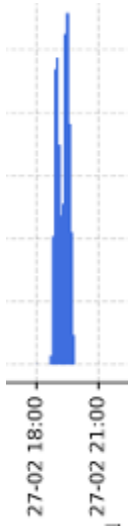
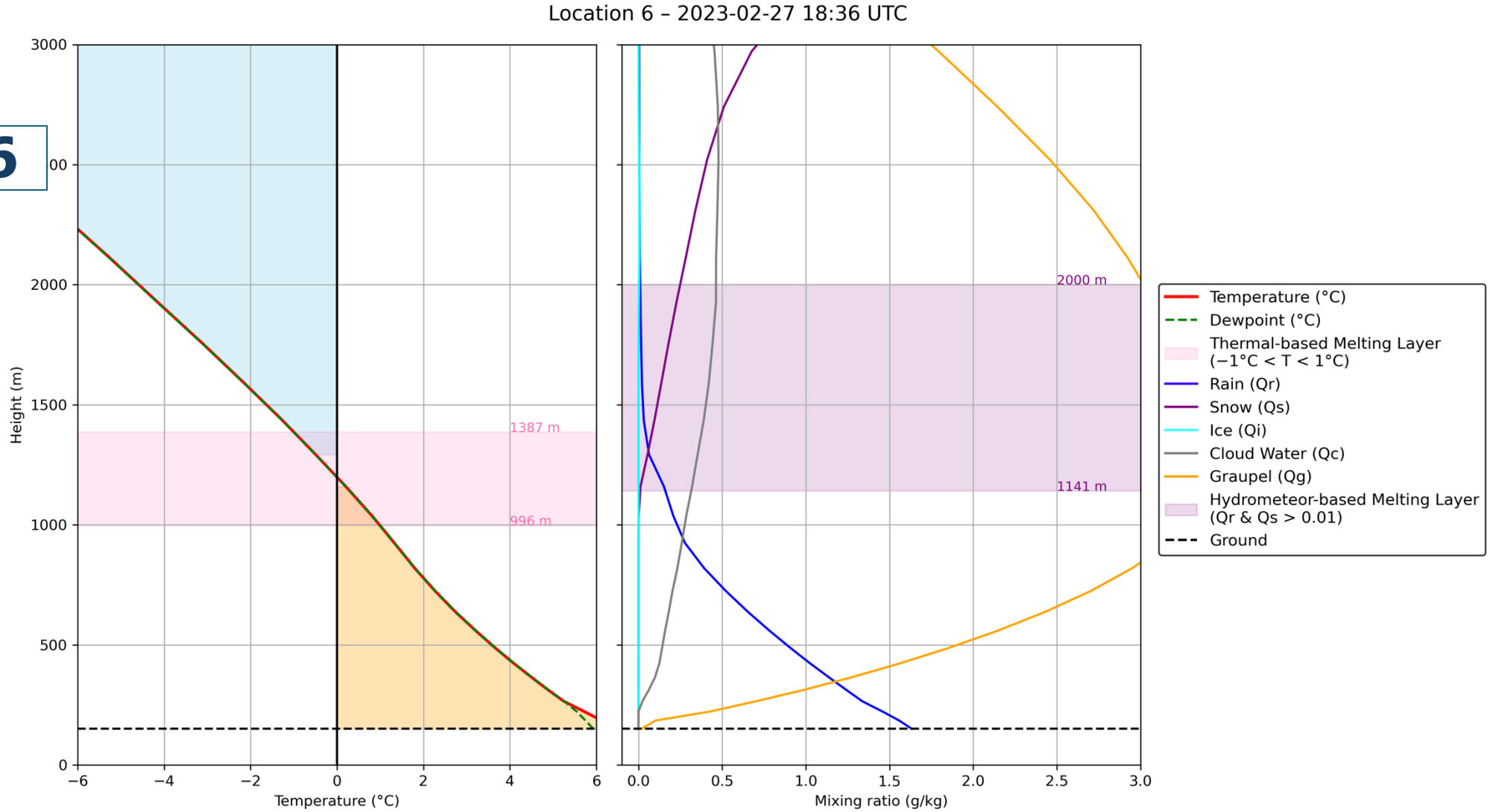
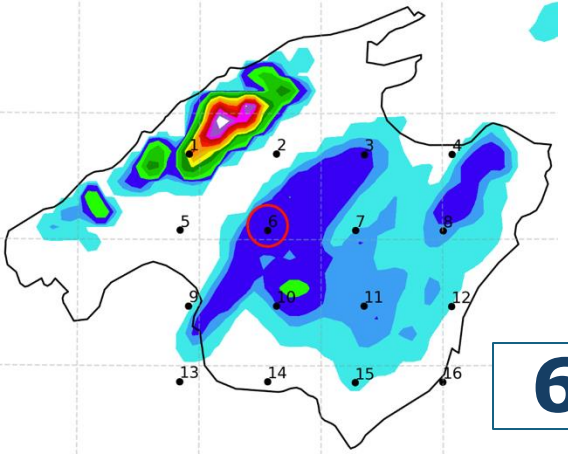
6
7
8
9
10
11
12
13
14
15
16

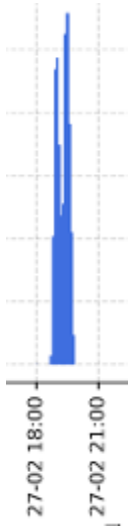
6

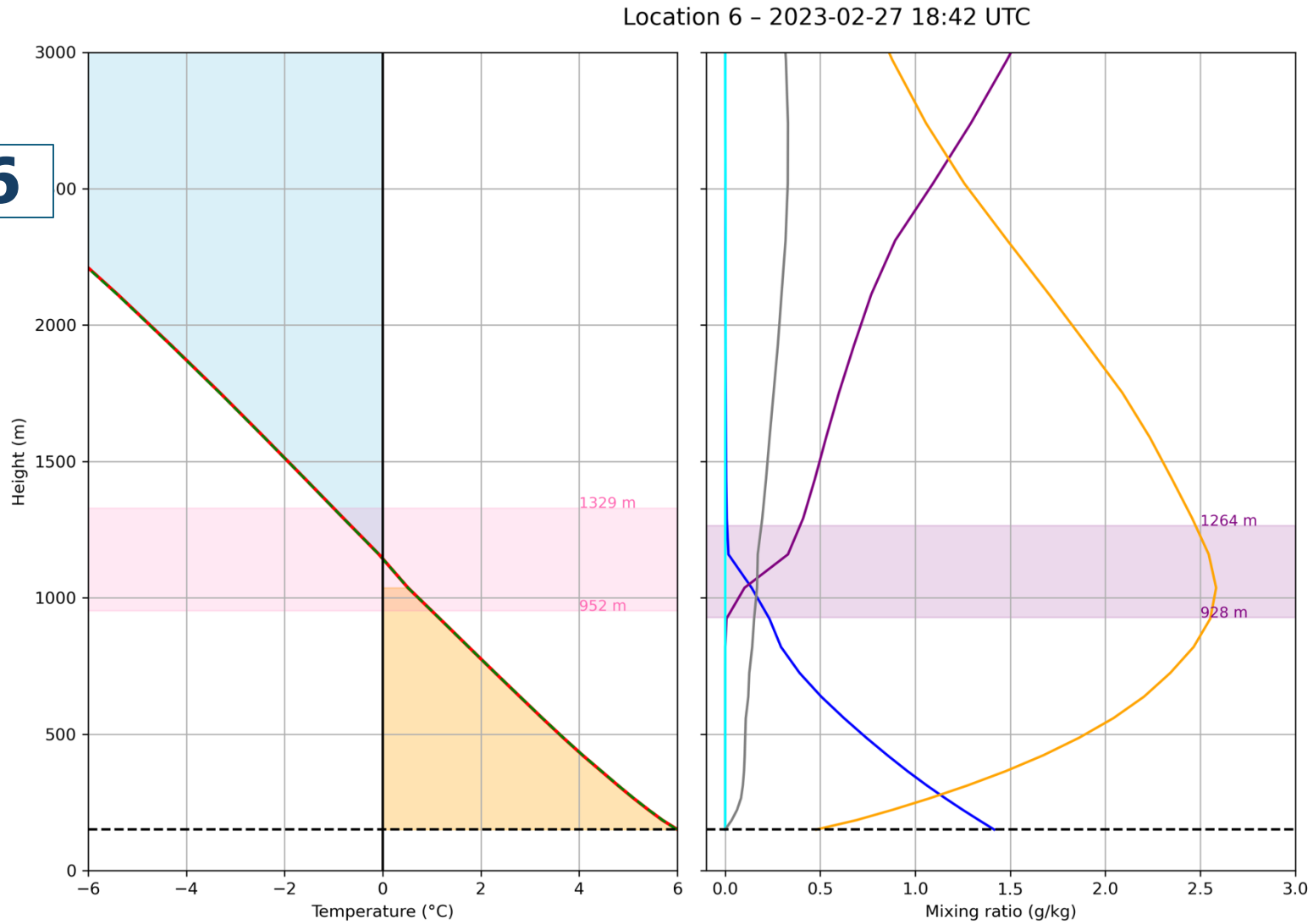

27-02 18:00
27-02 21:00

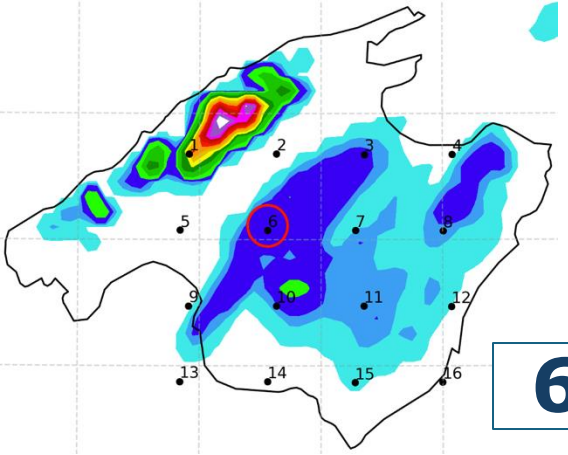

Location 6 – 2023-02-27 18:36 UTC
Height (m)
Temperature (°C)
Mixing ratio (g/kg)
1387 m
996 m
2000 m
1141 m
Temperature (°C)
Dewpoint (°C)
Thermal-based Melting Layer (−1°C < T < 1°C)
Rain (Qr)
Snow (Qs)
Ice (Qi)
Cloud Water (Qc)
Graupel (Qg)
Hydrometeor-based Melting Layer (Qr & Qs > 0.01)
Ground


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16

6


27-02 18:00
27-02 21:00


Location 6 – 2023-02-27 18:42 UTC
Height (m)
Temperature (°C)
Mixing ratio (g/kg)
1329 m
952 m
1264 m
928 m
Temperature (°C)
Dewpoint (°C)
Thermal-based Melting Layer (−1°C < T < 1°C)
Rain (Qr)
Snow (Qs)
Ice (Qi)
Cloud Water (Qc)
Graupel (Qg)
Hydrometeor-based Melting Layer (Qr & Qs > 0.01)
Ground


1
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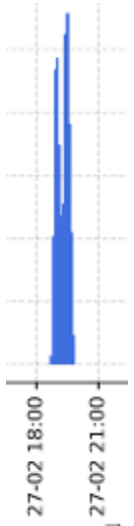
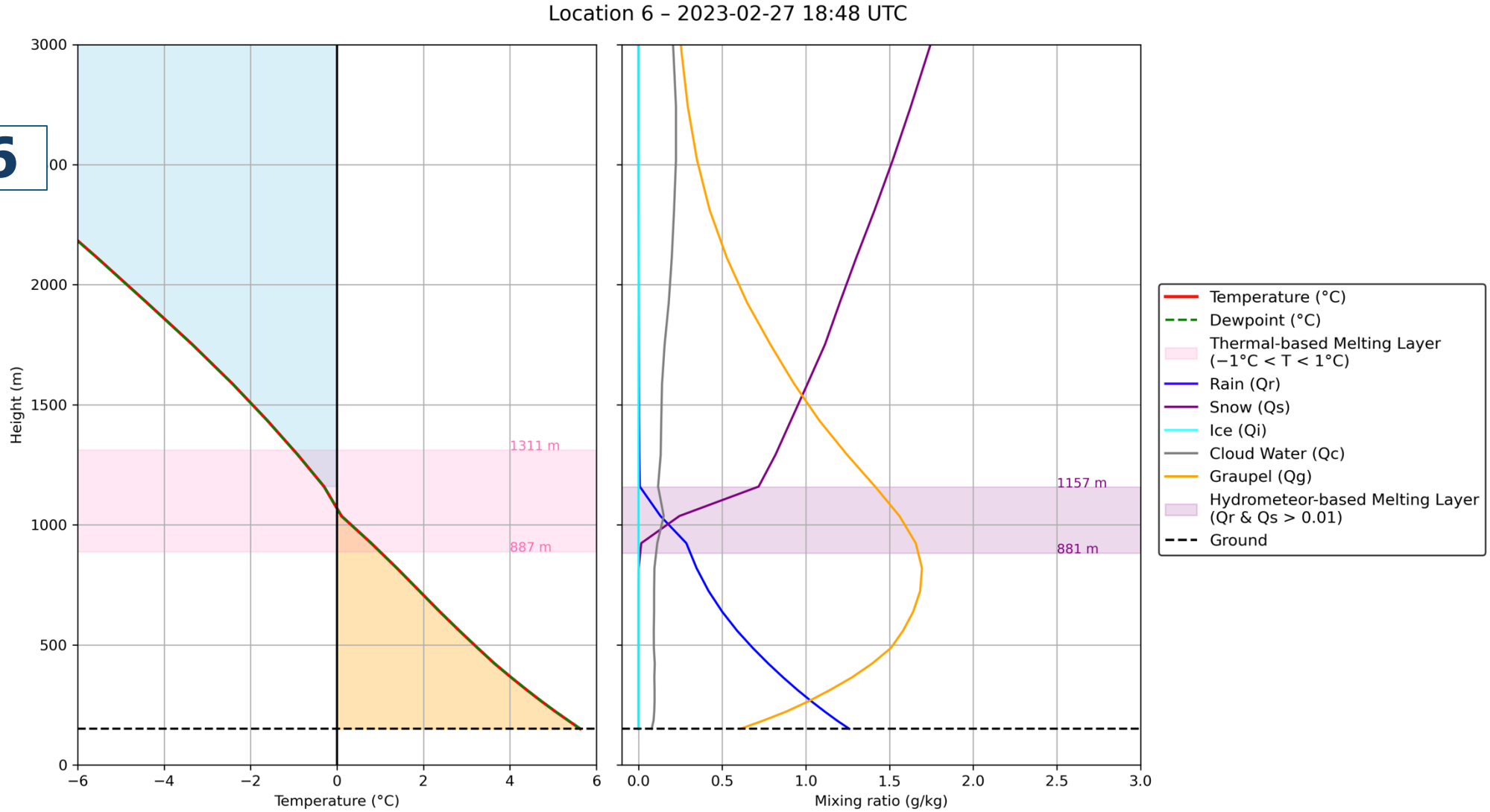
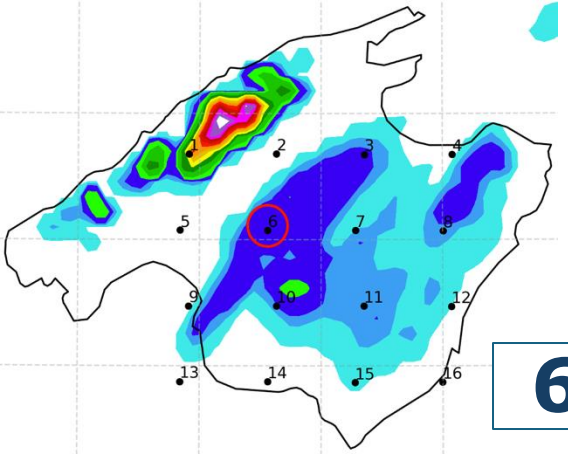
3
4
5
6
7
8
9
10
11
12
13
14
15
16

6


27-02 18:00
27-02 21:00


Location 6 – 2023-02-27 18:48 UTC
Height (m)
3000
2000
1500
1000
500
0
1311 m
887 m
1157 m
881 m
−6
−4
−2
0
2
4
6
Temperature (°C)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Mixing ratio (g/kg)
Temperature (°C)
Dewpoint (°C)
Thermal-based Melting Layer
(−1°C < T < 1°C)
Rain (Qr)
Snow (Qs)
Ice (Qi)
Cloud Water (Qc)
Graupel (Qg)
Hydrometeor-based Melting Layer
(Qr & Qs > 0.01)
Ground


1
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5
6
7
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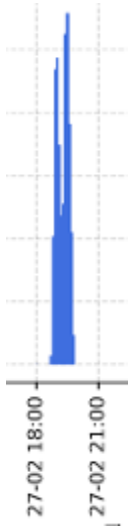
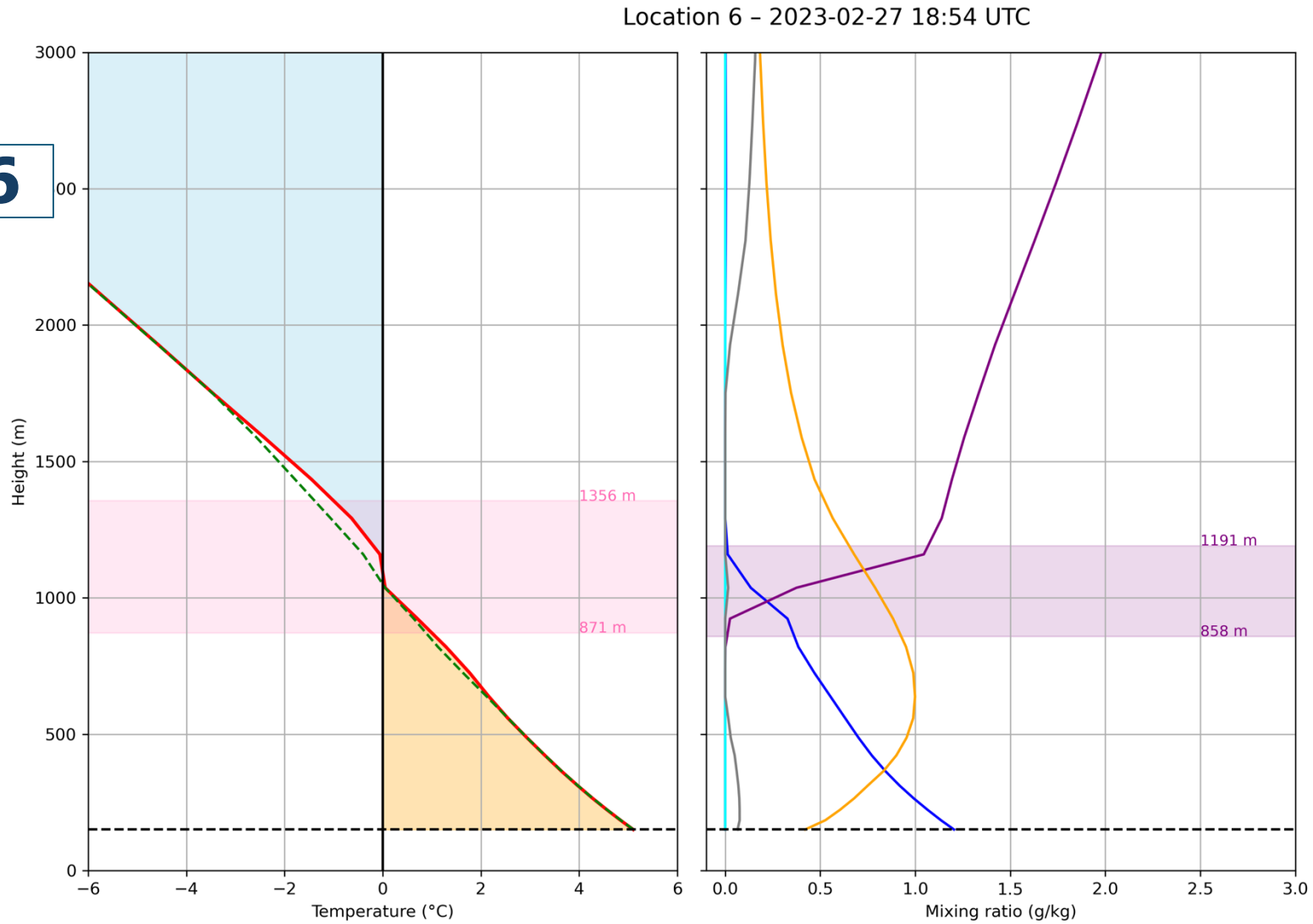
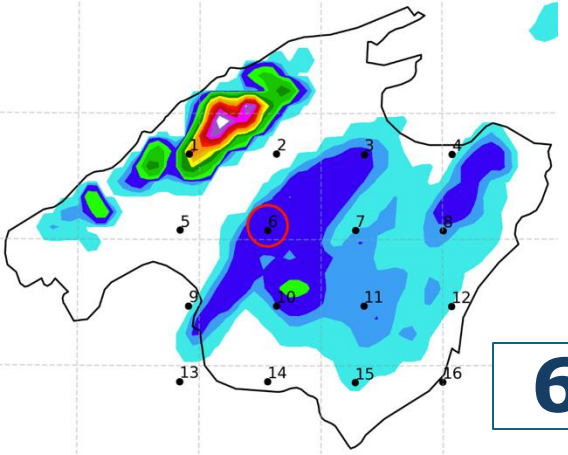
11
12
13
14
15
16

6


27-02 18:00
27-02 21:00


Location 6 – 2023-02-27 18:54 UTC
Height (m)
Temperature (°C)
Mixing ratio (g/kg)
1356 m
871 m
1191 m
858 m
Temperature (°C)
Dewpoint (°C)
Thermal-based Melting Layer (−1°C < T < 1°C)
Rain (Qr)
Snow (Qs)
Ice (Qi)
Cloud Water (Qc)
Graupel (Qg)
Hydrometeor-based Melting Layer (Qr & Qs > 0.01)
Ground


1
2
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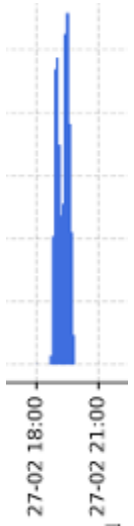
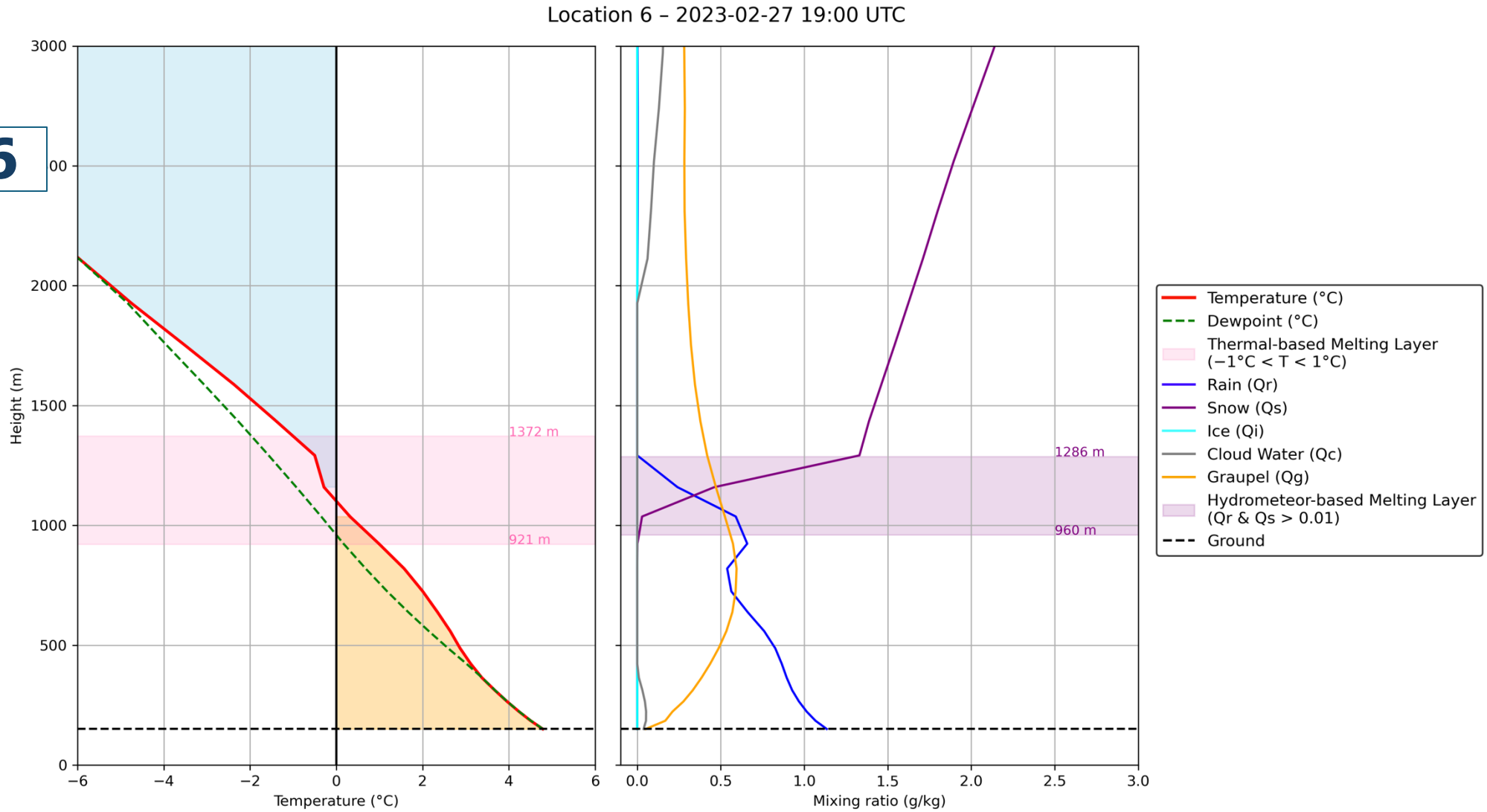
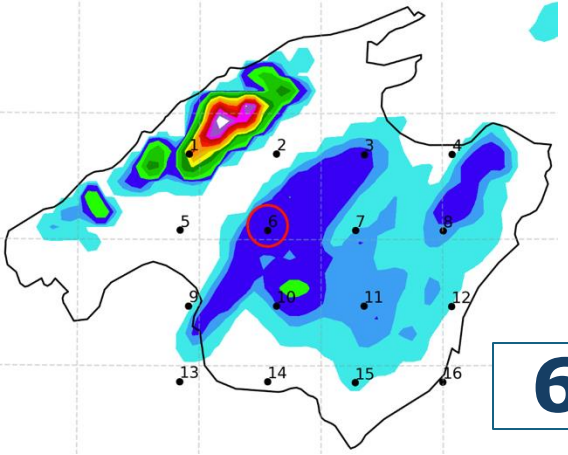
5
6
7
8
9
10
11
12
13
14
15
16

6

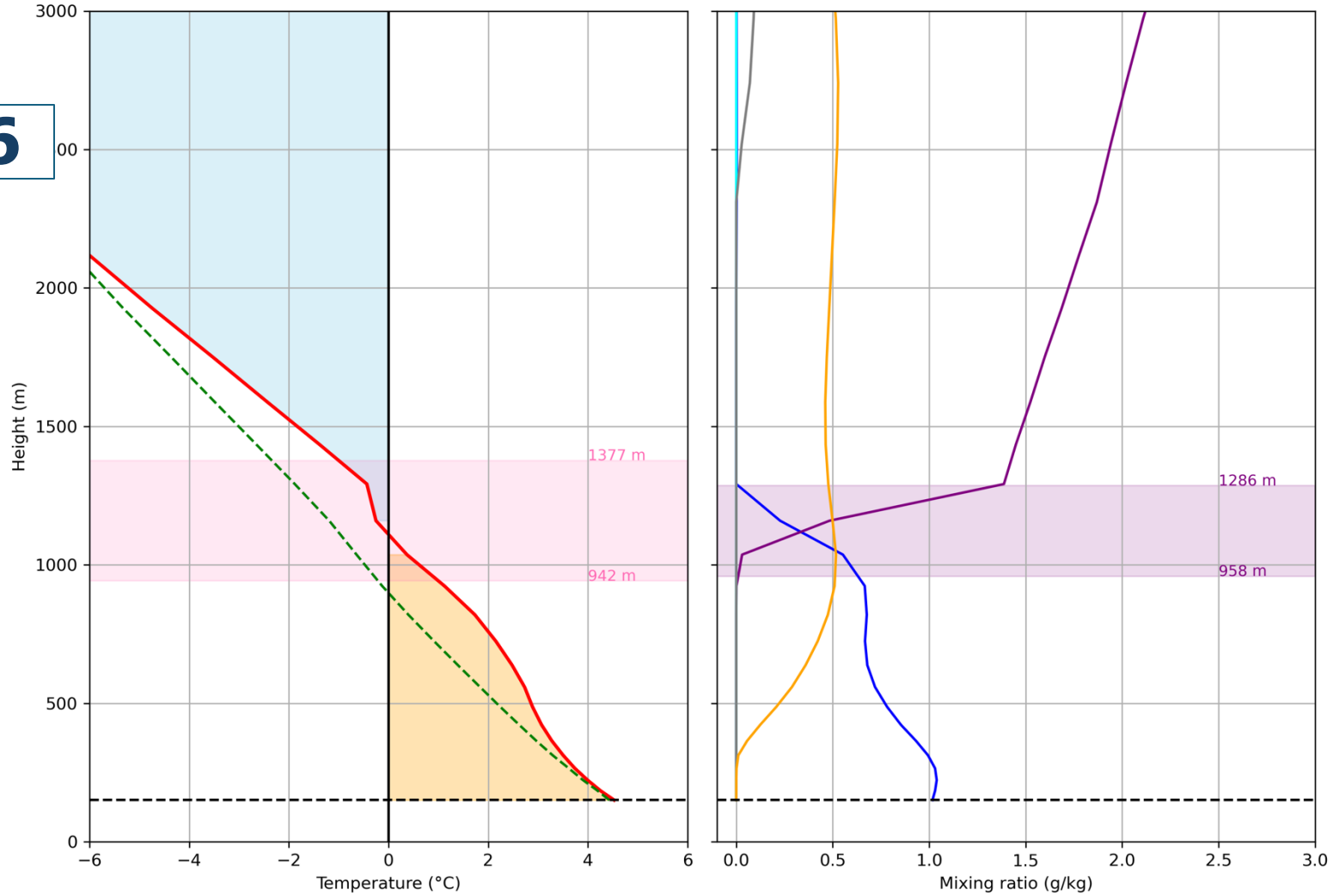

27-02 18:00
27-02 21:00

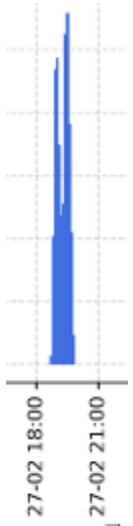

Location 6 – 2023-02-27 19:00 UTC
Height (m)
Temperature (°C)
Mixing ratio (g/kg)
1372 m
921 m
1286 m
960 m
Temperature (°C)
Dewpoint (°C)
Thermal-based Melting Layer (−1°C < T < 1°C)
Rain (Qr)
Snow (Qs)
Ice (Qi)
Cloud Water (Qc)
Graupel (Qg)
Hydrometeor-based Melting Layer (Qr & Qs > 0.01)
Ground

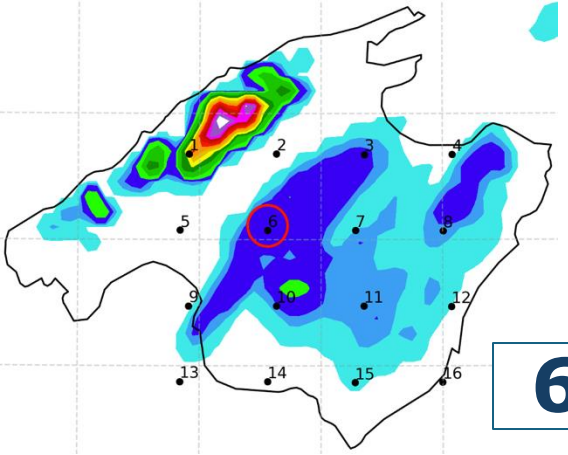


6

Location 6 – 2023-02-27 19:06 UTC

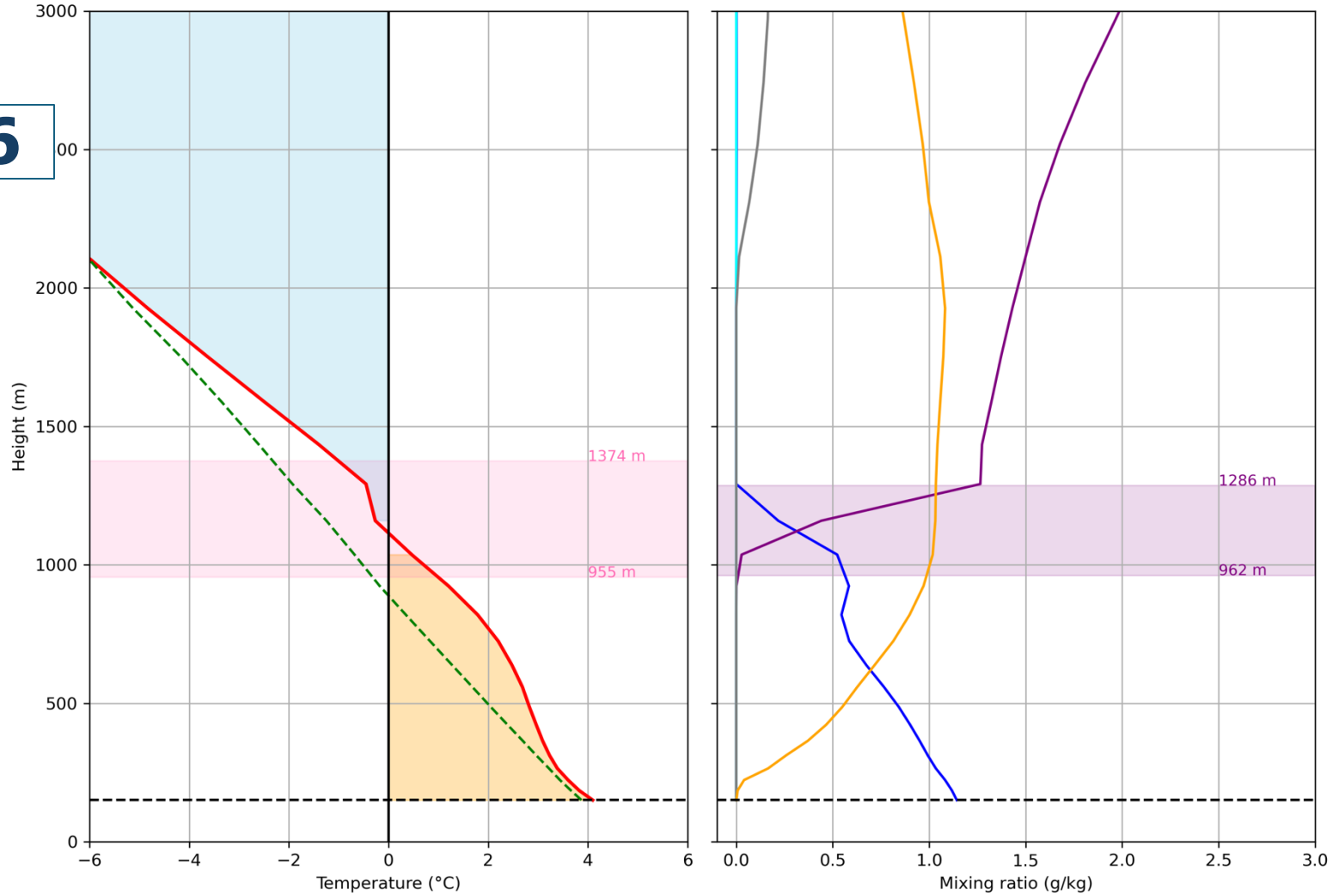


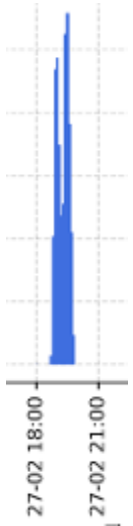




6

Location 6 – 2023-02-27 19:12 UTC





Key Findings from Juliette Storm

- **Storm Juliette** brought unusually low snow levels to Mallorca, with snow reaching sea level.
- While **cold advection** was initially strong, it **weakened** as the storm stabilized — yet snowfall **intensified at low levels**.
- Model diagnostics suggest **melting-induced cooling** contributed to further **snow-level descent**.
- **Graupel** played a relevant role by surviving near-0 °C layers more easily than fluffy snow.
- These findings highlight the **value** of accounting for **local cooling processes and mixed-phase precipitation** in short-range forecasts over maritime regions.

Final Thoughts

- Historical snow is rare but regionally consistent
- Juliette was an outlier event explained by local processes
- Modeling + physical insight are key to understanding future snow risks

Morning view of La Seu in Mallorca on February 5, 2012, at 9:00 a.m. | Photo: Teresa Ayuga

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