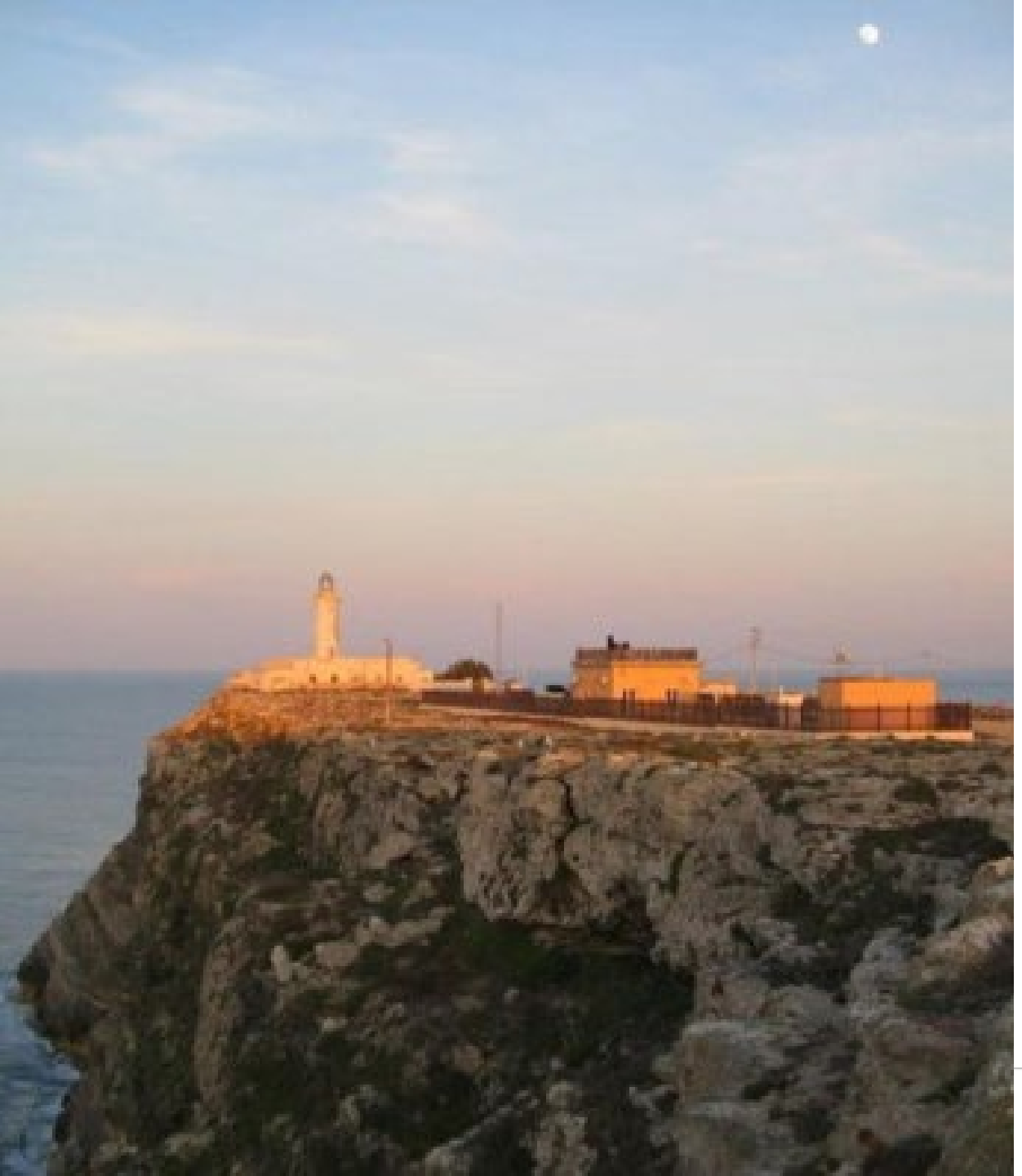
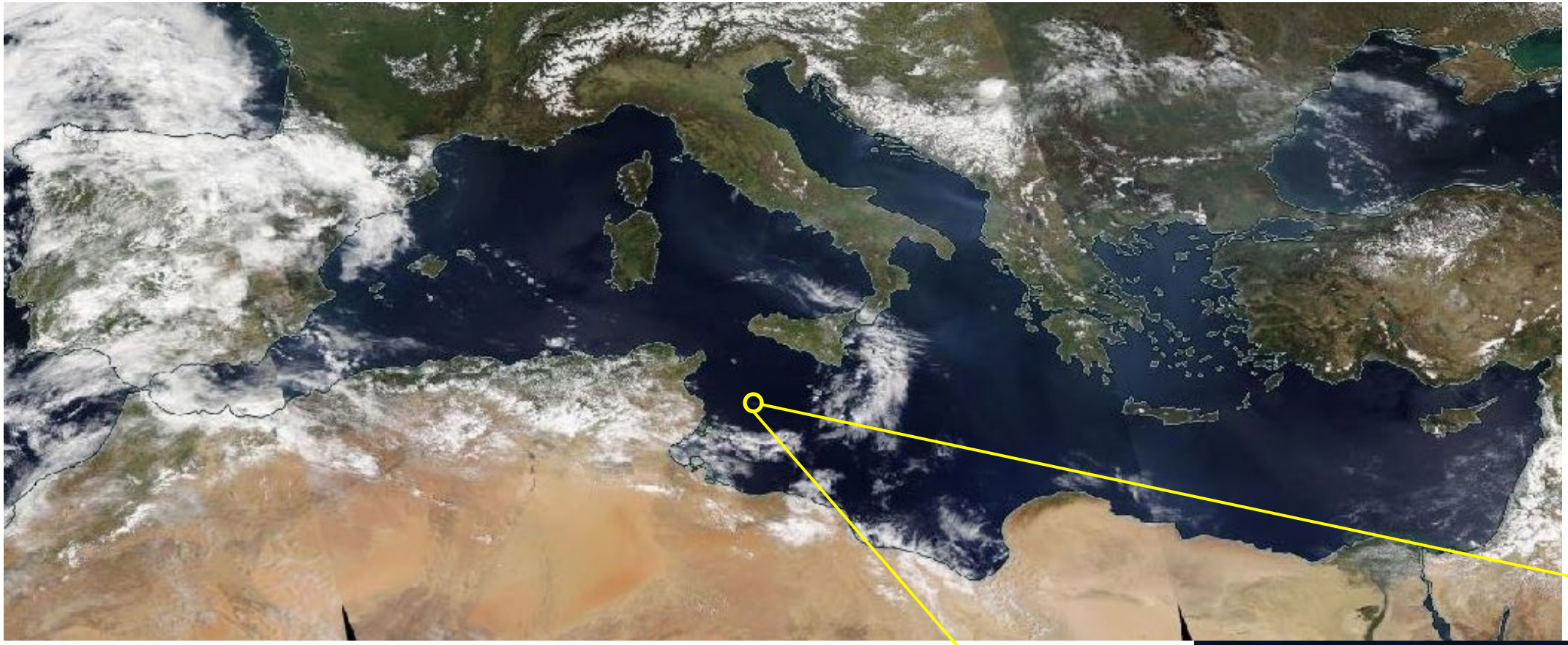


ACTRIS
CCRES

First 2 years of cloud characteristics at the ENEA Lampedusa Station for Climate Observation from Cloudnet retrievals

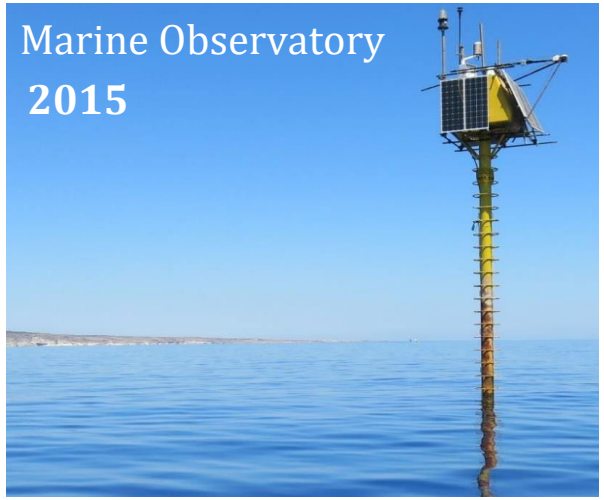
CCRES/CLU Spring Workshop, online, 1st and 2d of June 2026

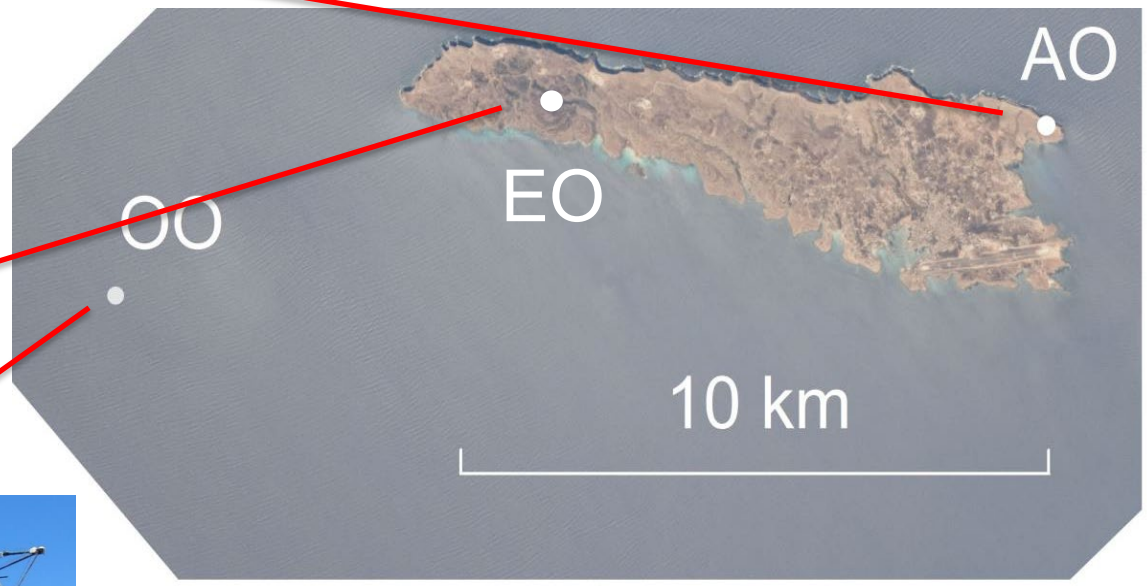
The ENEA Station for Climate Observation of Lampedusa a *remote observatory* in the center of the Mediterranean



- small size about 20 km^2
- flat max. height 130 m
- 130 and 210 km away from the Tunisian and Sicilian coasts
- far from significant anthropogenic emissions (around 5,800 inhabitants)

An Integrated Climate Observatory





Picture ISS 024-E-10246, Earth Science Remote Sensing Unit at NASA Johnson Space Center

ACTRIS cloud remote sensing observations and data availability

All instruments used in this study have been operational at the Lampedusa station since November 2023.

Monthly vertical profiles derived from the Cloudnet retrieval are available from 24 November 2023 to 31 April 2026.

Two major data gaps are identified:

a) April–August 2025, due to maintenance of the radar depolarisation channel.

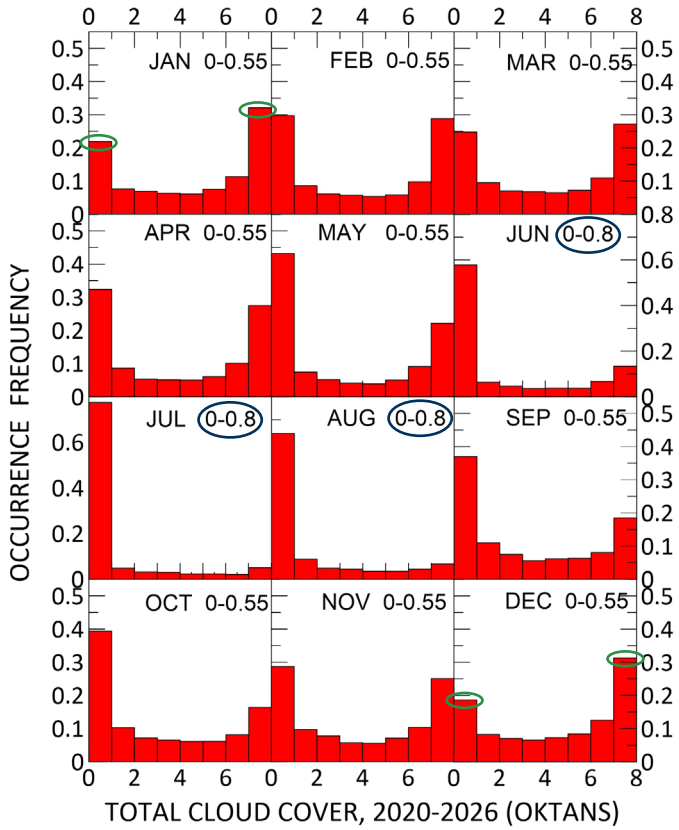
b) February–March 2026, associated with a malfunction of the radar thermal control system.

YEAR	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2023											20.7	**88.1**
2024	**93.4**	**95.4**	**99.9**	**96.6**	**97.9**	**99.9**	**91.2**	**90.3**	**94.7**	**87.7**	**96.7**	**95.7**
2025	**87.6**	**84.2**	**83.7**	20.6				**87.3**	**98.8**	**99.8**	**94.4**	**99.3**
2026	**99.1**	8.5	39.3	14.5								

Monthly percentage occurrence of cloud classes derived from Cloudnet retrieval

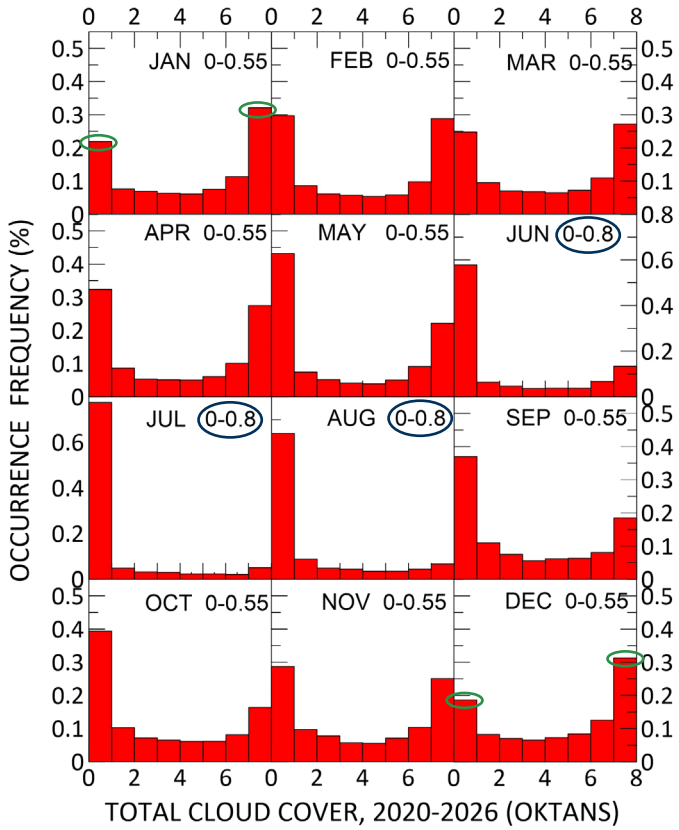
> 80% 1a labelling disdrometer calibration

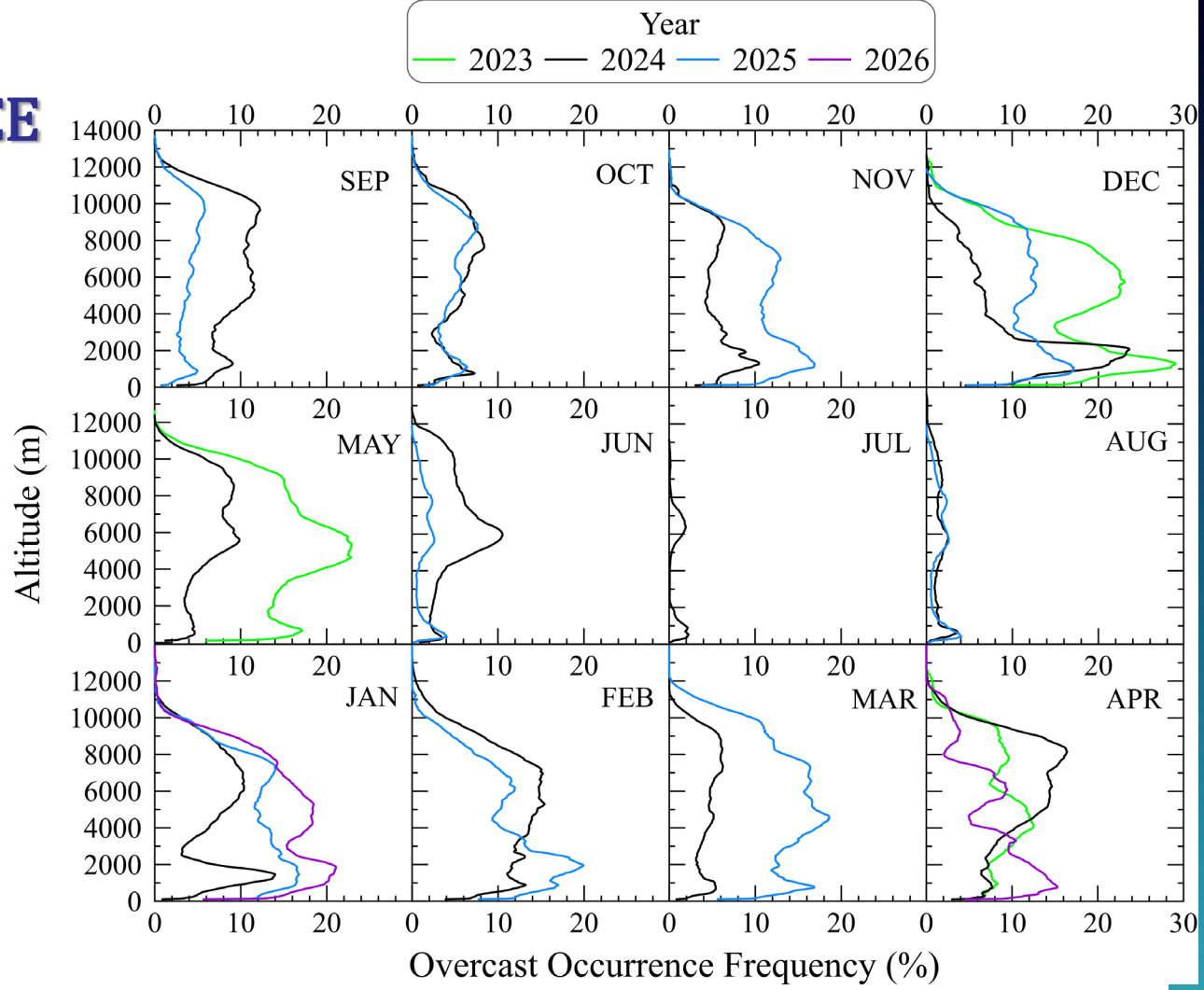
CLOUD COVER AND VERTICAL CLOUD OCCURRENCE



- The June–September period is shown using a different scale, reflecting the high occurrence of clear-sky conditions, which peak in July at values close to 80%.
- Overcast conditions exhibit a broader seasonal distribution, with mean values of about 30% between December and April.

CLOUD COVER AND VERTICAL CLOUD OCCURRENCE





ACTRIS CCRES

Virtually no cloud July-Aug

Relative maximum

Low level Nov-Feb

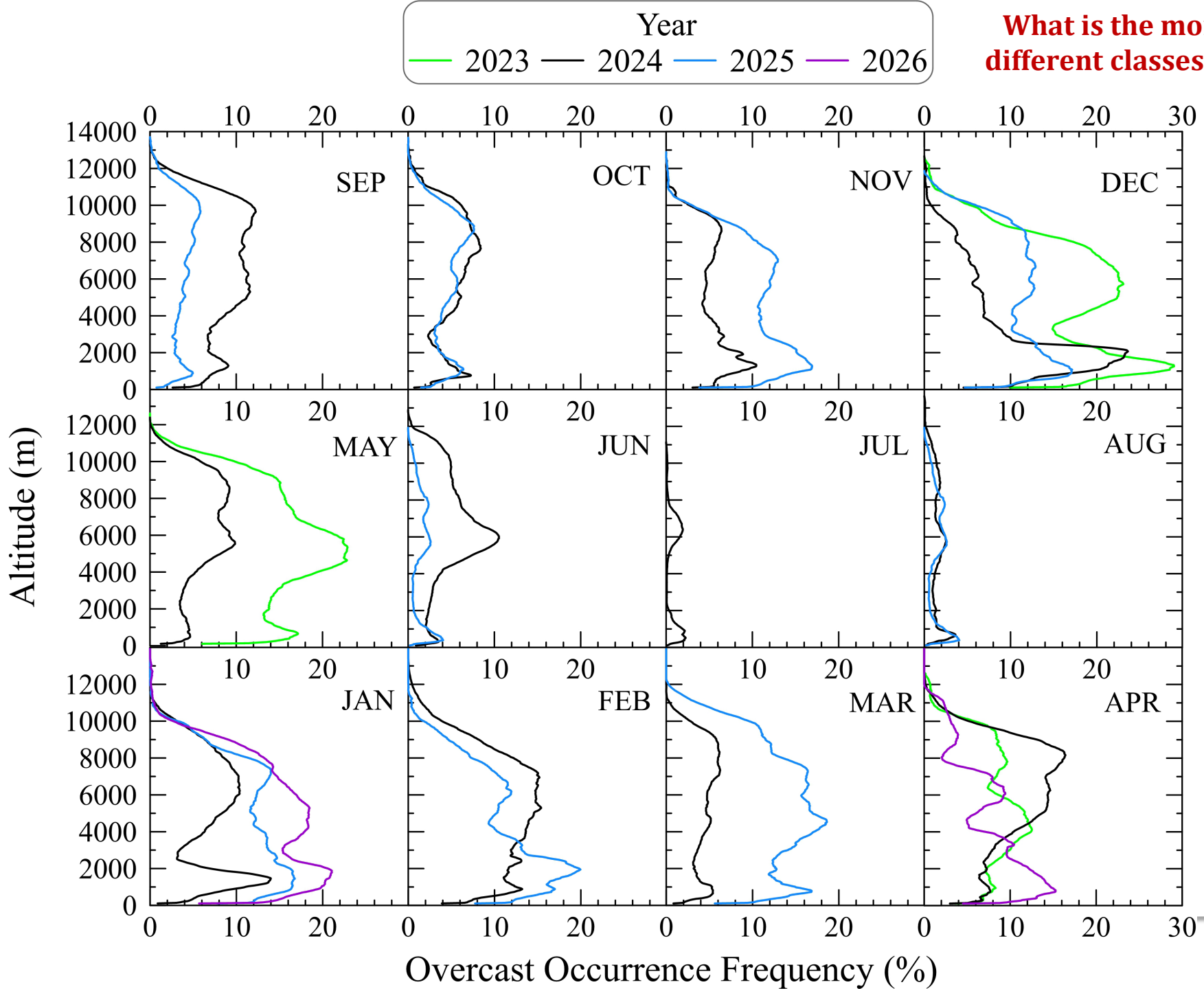
High level /

Max altitude ~ 13.000 m

- The June–September period is shown using a different scale, reflecting the high occurrence of clear-sky conditions, which peak in July at values close to 80%.
- Overcast conditions exhibit a broader seasonal distribution, with mean values of about 30% between December and April.
- Low-level clouds (below 2–3 km) strongly decrease from May to August, whereas a comparable reduction for clouds above 5 km is mainly limited to July–August.

Station for Climate Observations "Roberto Sarao" ENEA LAMPEDUSA

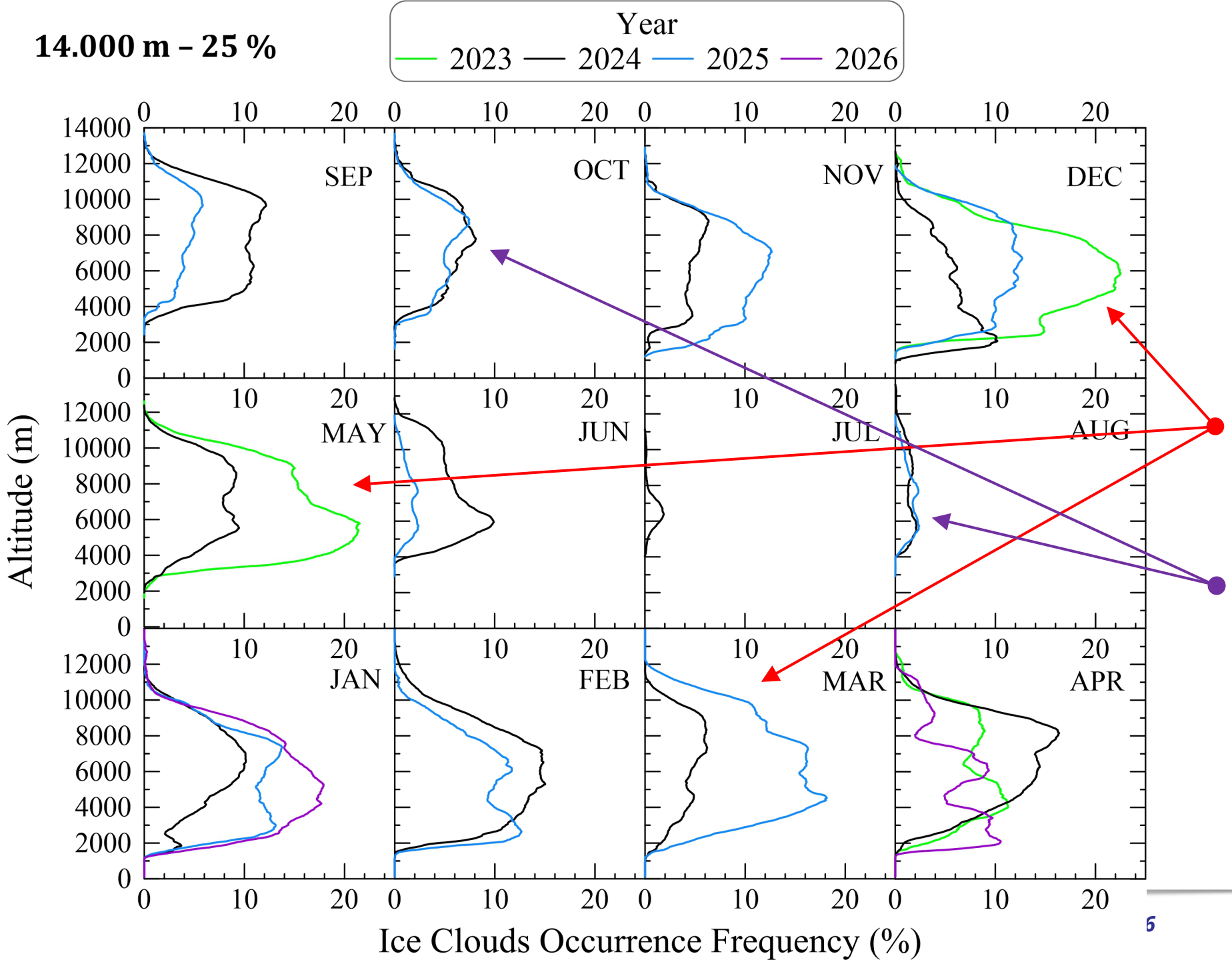
What is the monthly variability of the different classes predicted by Cloudnet?



CLOUDNET Classification	Classification used
Clear sky	
Aerosol particles, no cloud or precipitation	
Insects, no cloud or precipitation	
Aerosol coexisting with insects, no cloud or precipitation	
Ice particles	OVERCAST
Ice coexisting with supercooled liquid droplets	
Melting ice particles	
Cloud liquid droplets only	
Melting ice particles coexisting with cloud liquid droplets	
Drizzle or rain	
Drizzle or rain coexisting with cloud liquid droplets	

14.000 m – 30 %

14.000 m – 25 %



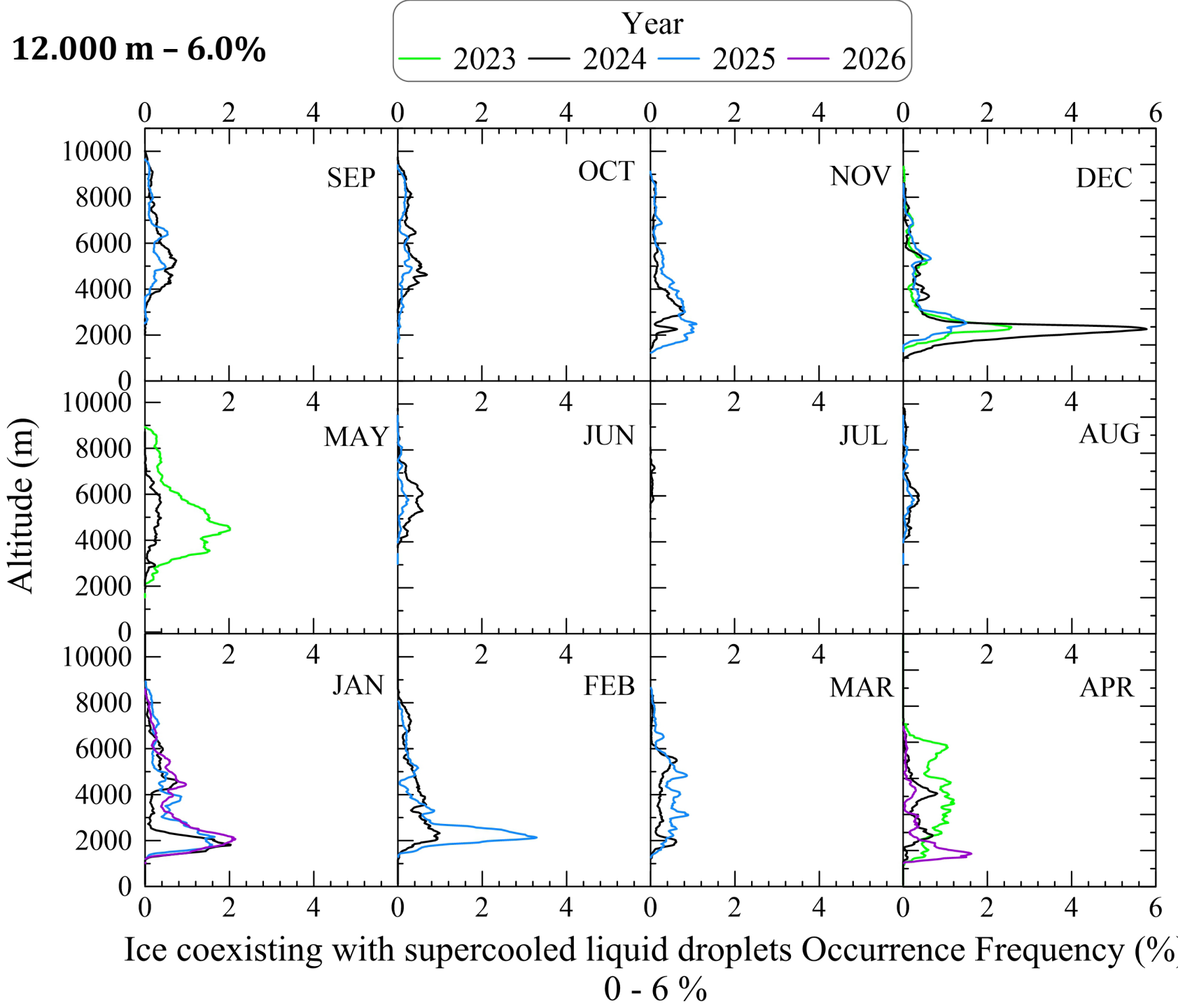
Ice Clouds

14.000 m – 25 %

Only a few months.
However, there are:

cases with large interannual variability

cases that are surprisingly similar



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Ice and supercooled droplets

12.000 m – 6.0%

Some low-level peaks in winter up to 5%, otherwise below 0.5%

Up to 10.000 m
August–September

May 2023 appears anomalous (HATPRO was missing, but it should be not required for classification)

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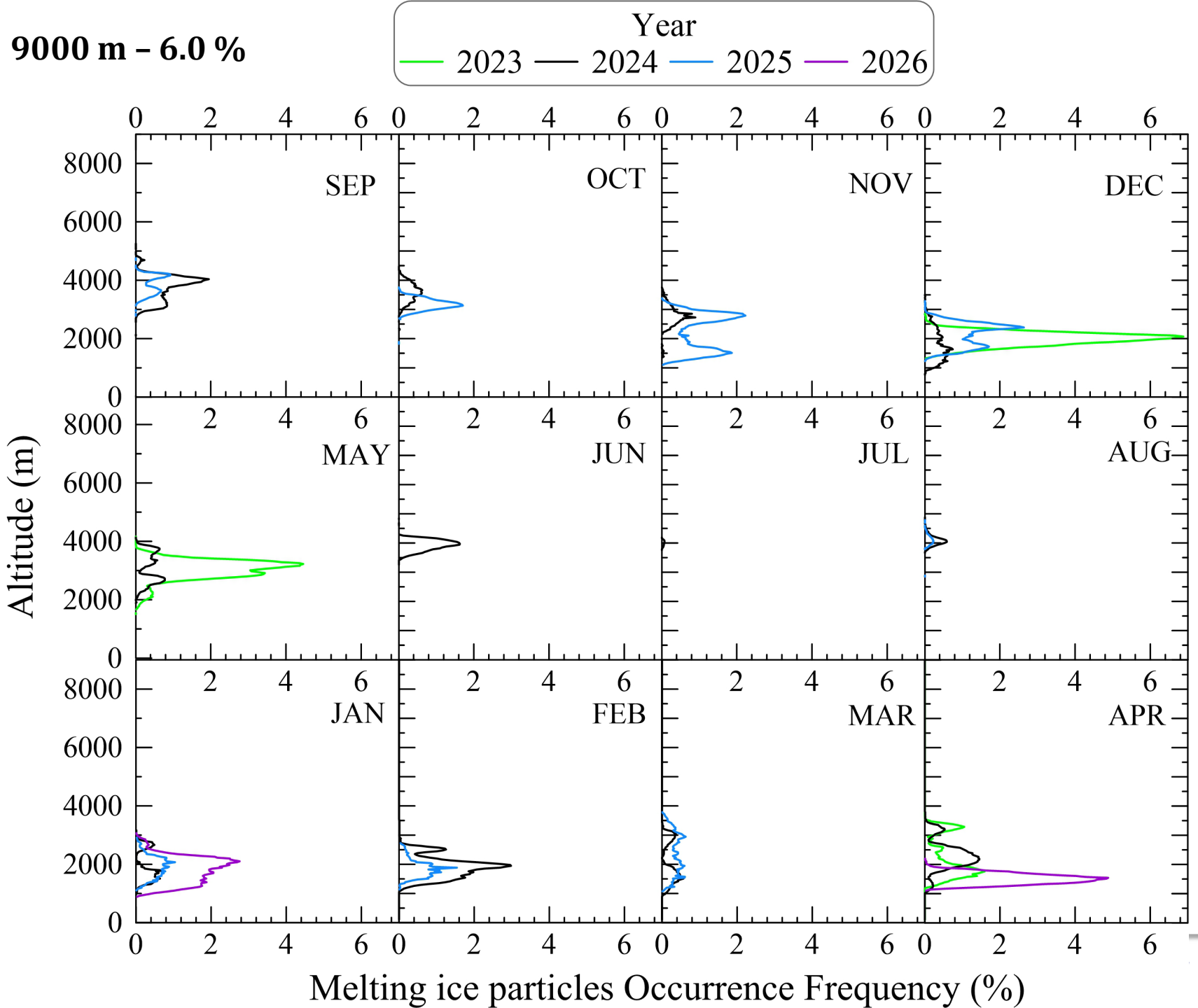
ENEA LAMPEDUSA

9000 m – 6.0 %



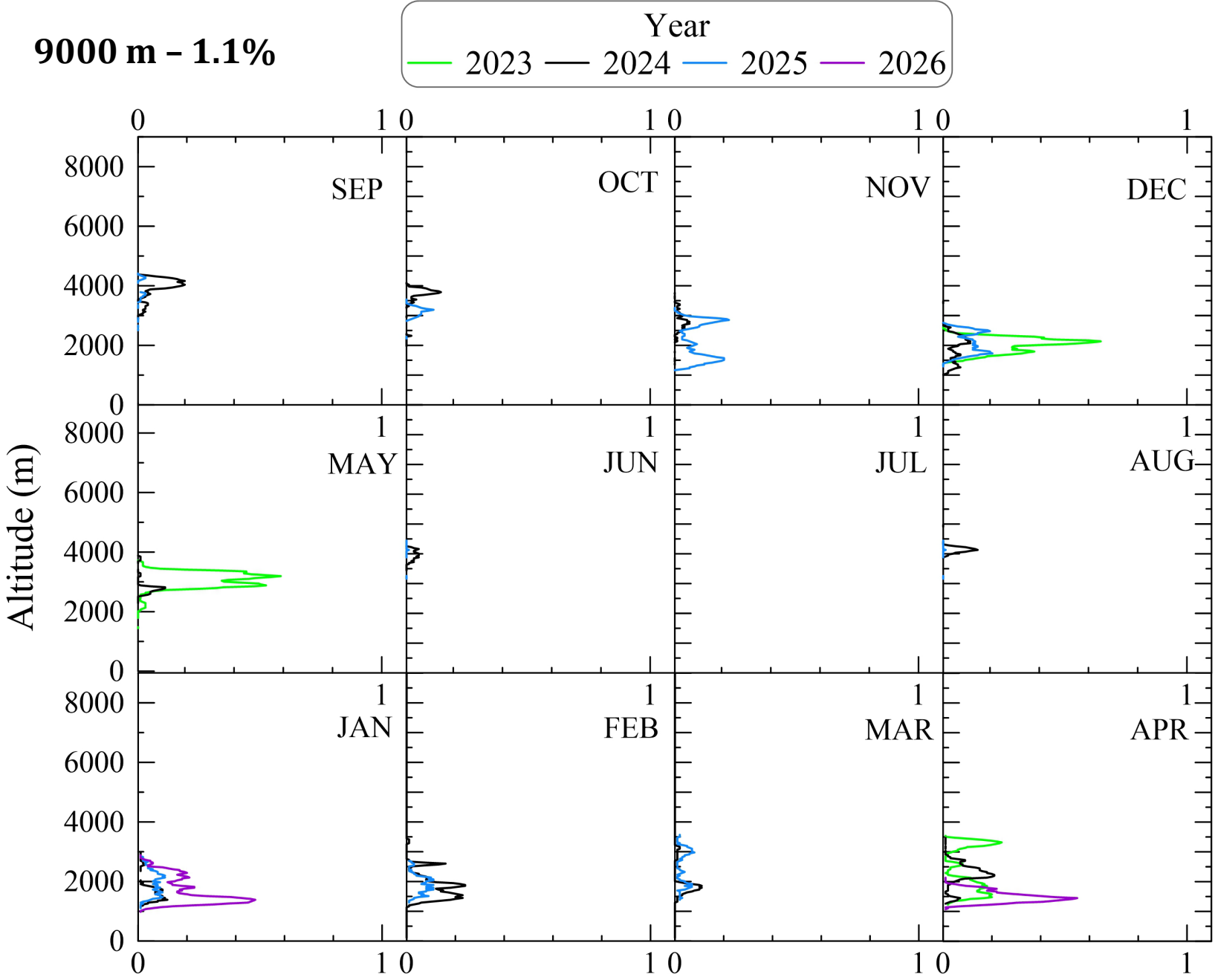
Melting Ice

9.000 m – 6.0%

Presence of some monthly peaks up to 6%

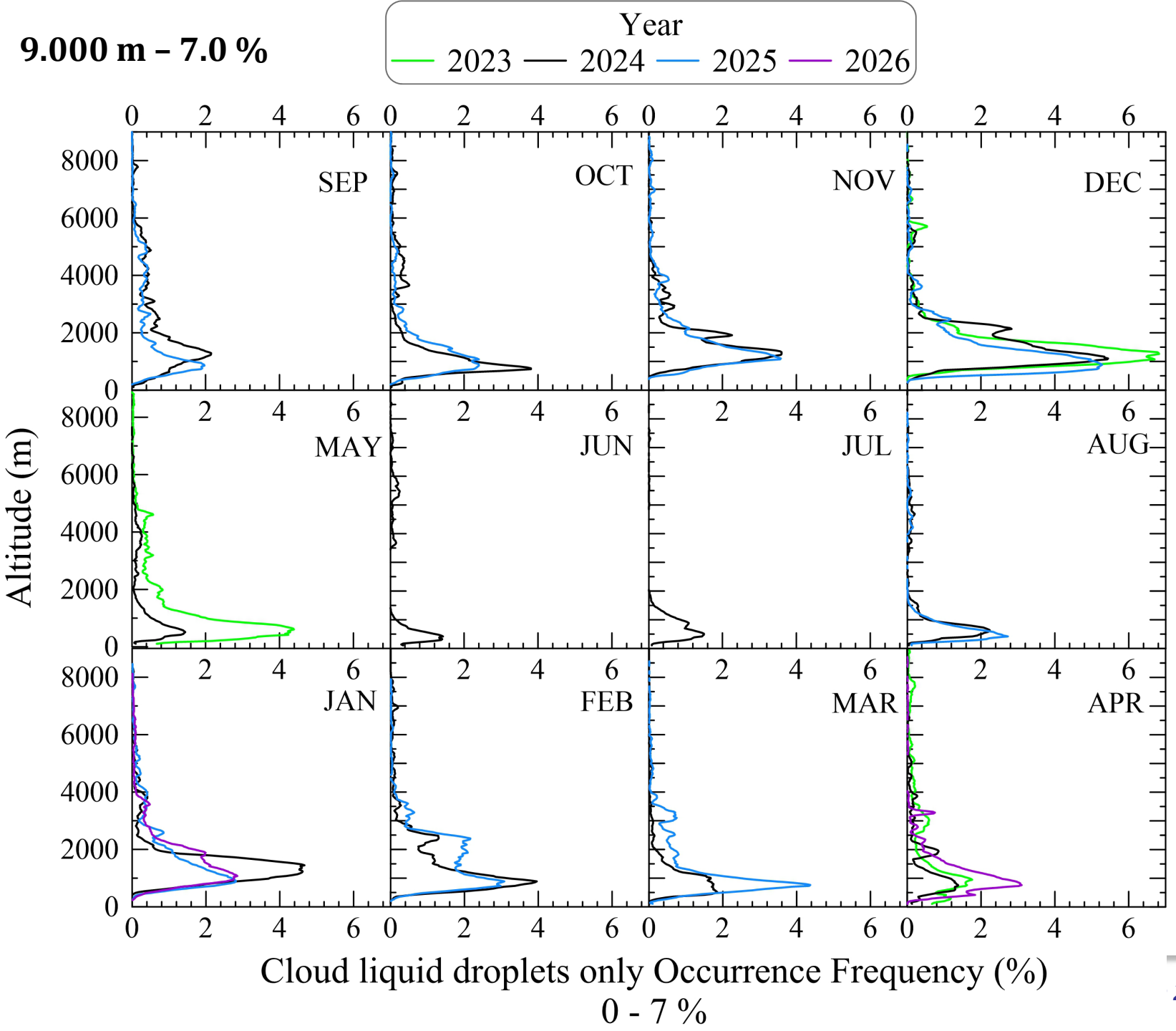
Expected interannual variability
Base height: 1,000–3,000 m
Top height: 3,000–4,500 m

9000 m – 1.1%



Melting ice and liquid droplets
9.000 m – 1.1%

As expected strong relation with Melting Ice, but almost negligible presence



Liquid droplets
9.000 m – 7.0 %

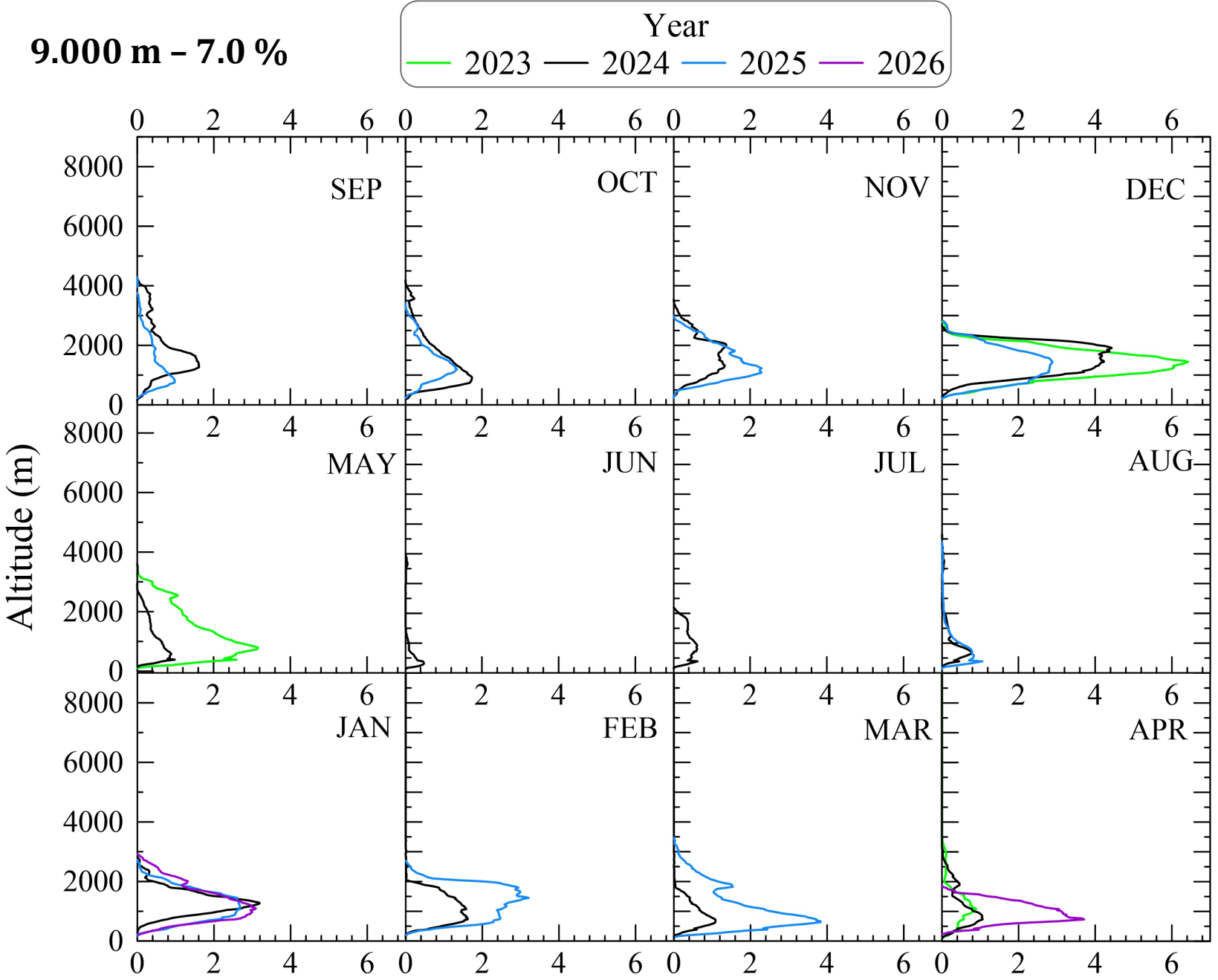
Annual variation of altitude and intensity of relative maximum

A few hundred meters in June–July
Nov–Dec–Jan between 1,000-1,500 m

Stronger interaction with MBL in spring

Presence detected up to 7-8.000 m

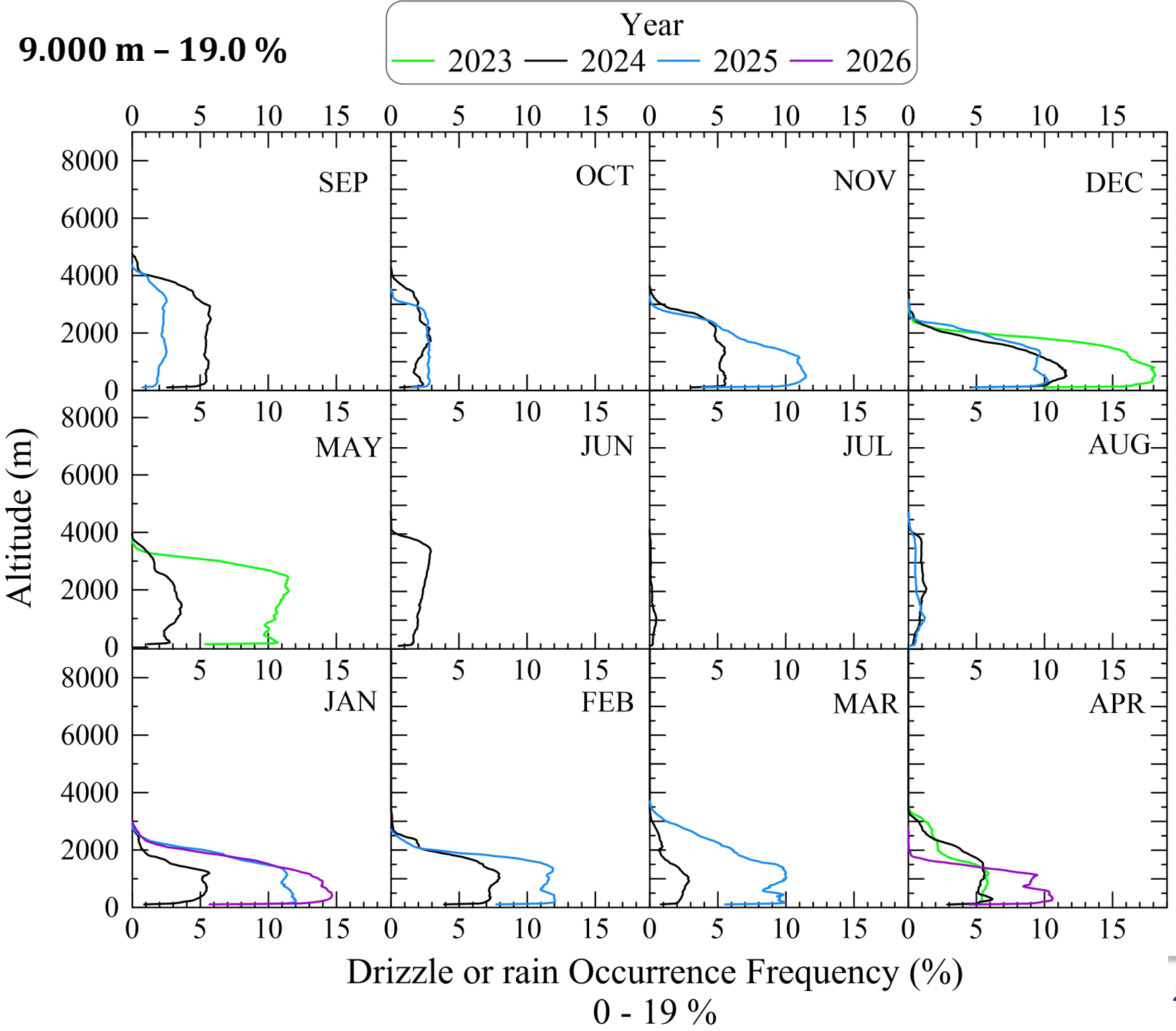
9.000 m – 7.0 %



Drizzle with liquid droplets
9.000 m – 7.0%

behavior and occurrence values
of the same order as liquid droplets

9.000 m – 19.0 %



Drizzle or rain
9.000 m – 19.0 %

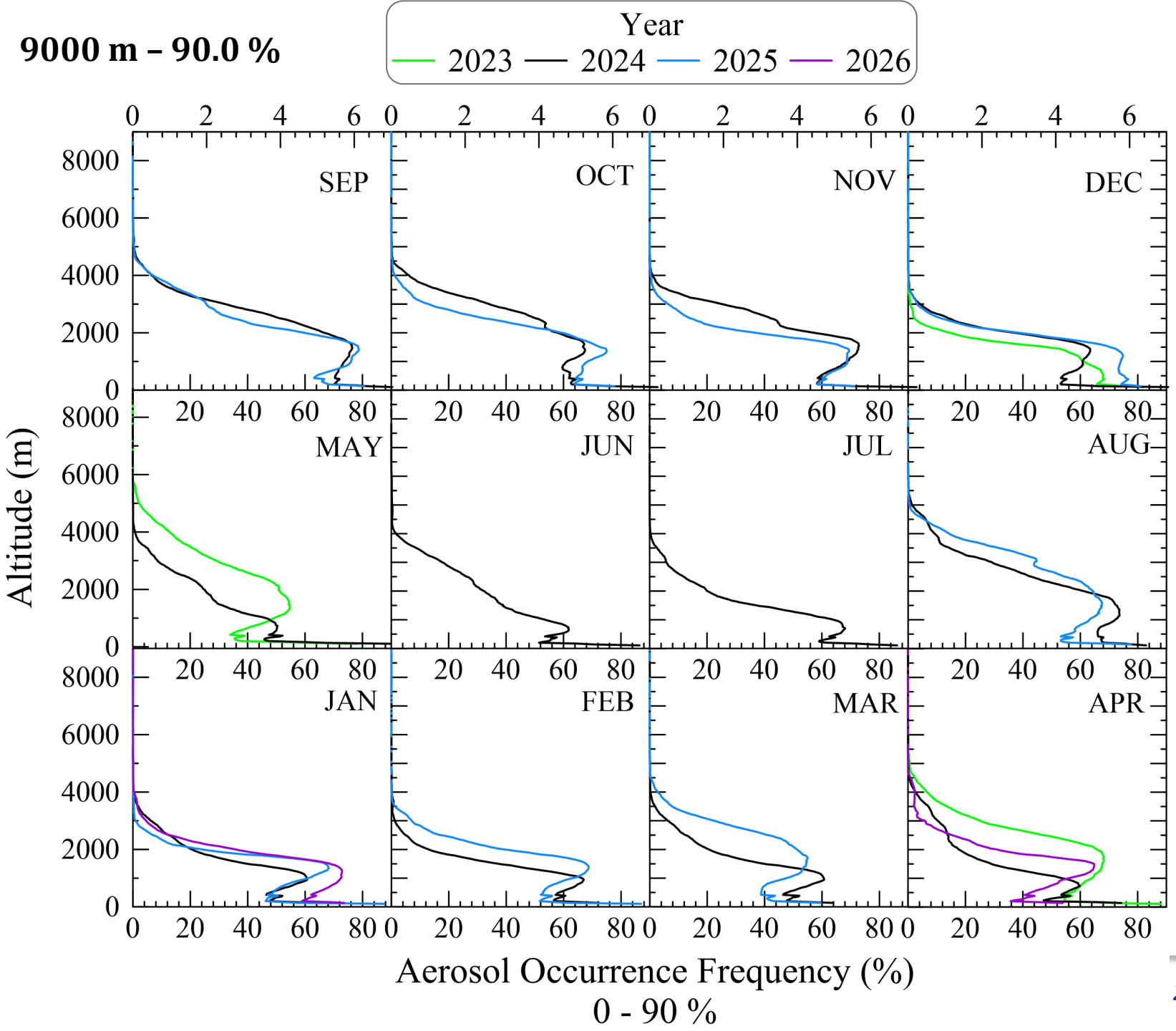
After ice particles,
it is the most frequent class!

Occurrence much higher than
cloud droplets

Annual cycle
with greater vertical extent in summer
up to 4000 m

Drizzle appears to be uniformly
distributed with height (as expected)

9000 m – 90.0 %



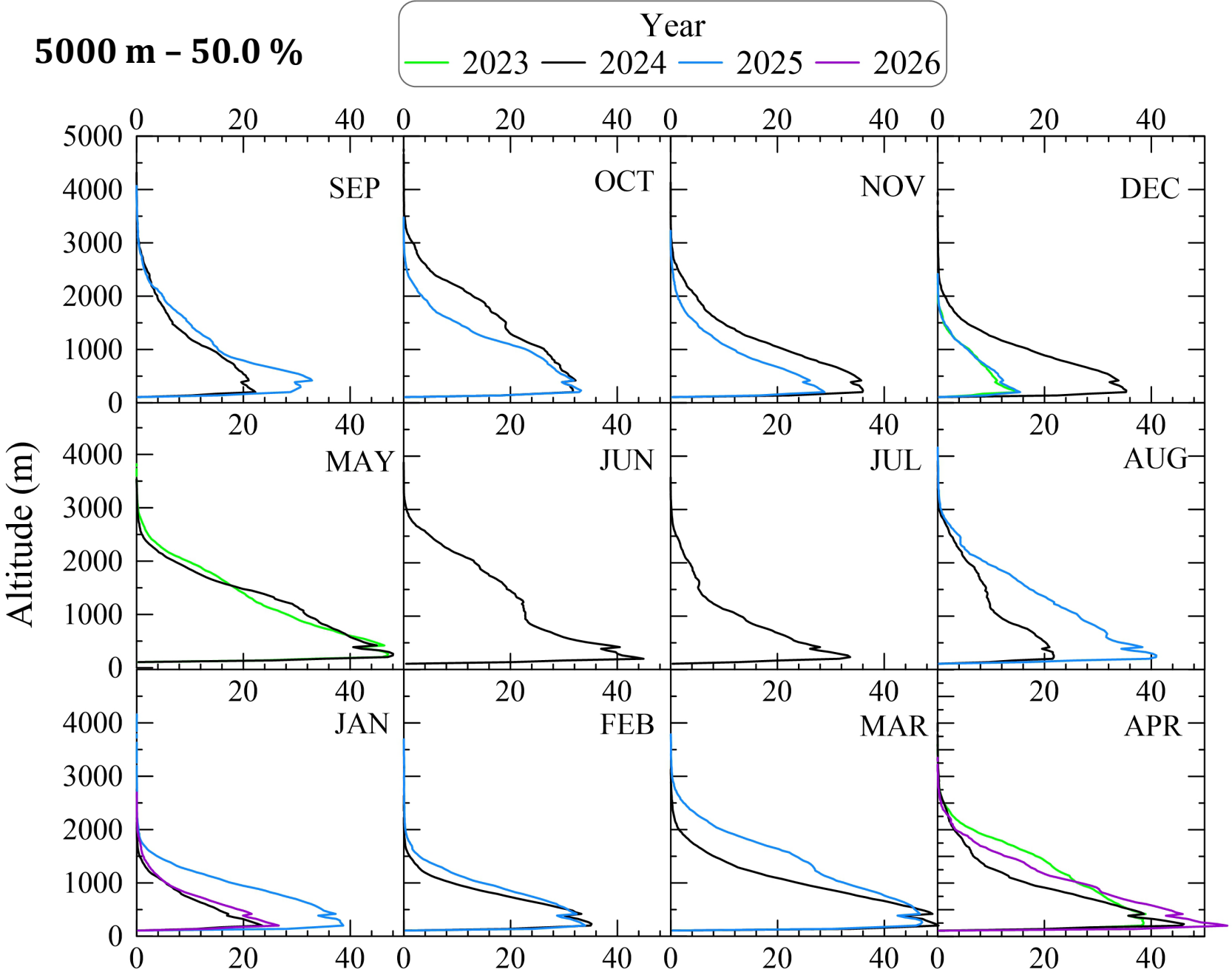
Aerosol
9000 m – 90.0 %

Outflow of desert dust up to 5500 m
also higher with a lidar

Overlap celiometer?

2026

5000 m – 50.0 %

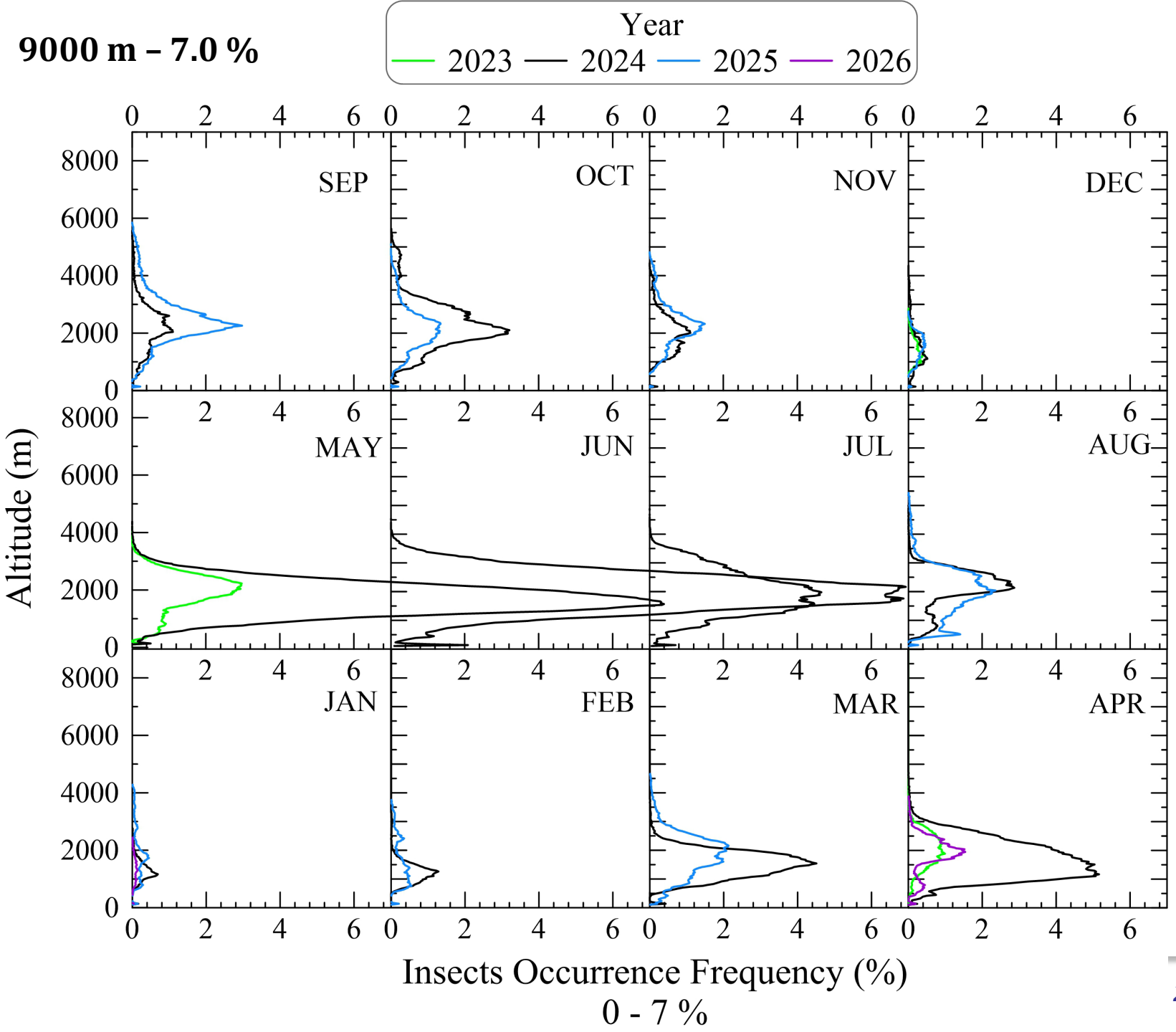


Aerosol coexisting with insects, no cloud or precipitation Occurrence Frequency (%)
0 - 50 %

Aerosol and insects
5,000 m – 50.0%

Maxima at very low altitudes
Possibly related to instrument overlap?

9000 m – 7.0 %

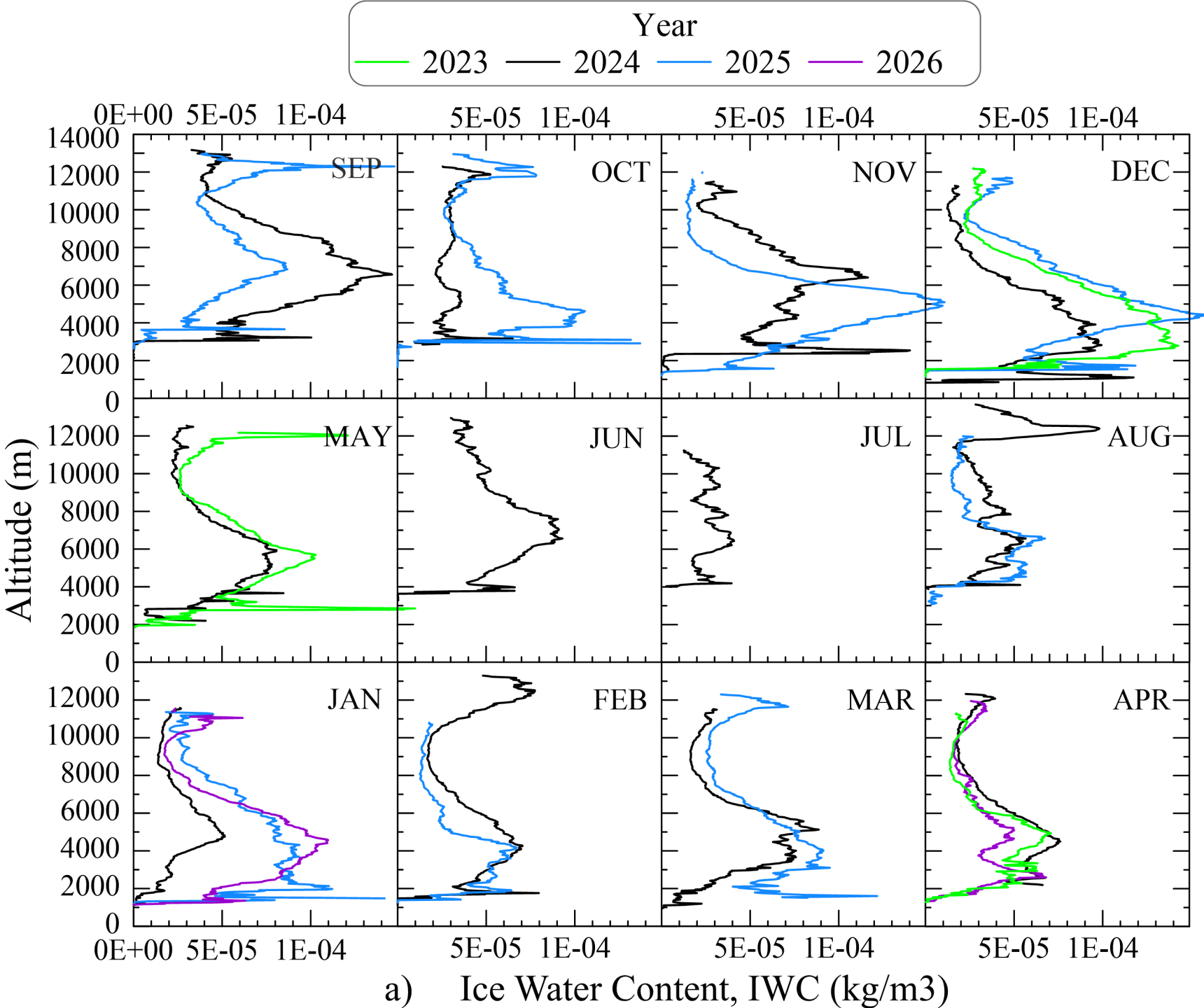


Insects
9,000 m – 7.0%

Much lower than the aerosol and insects class

Anomalous behavior in 2024?

Relative monthly maximum always above 1,000 m?

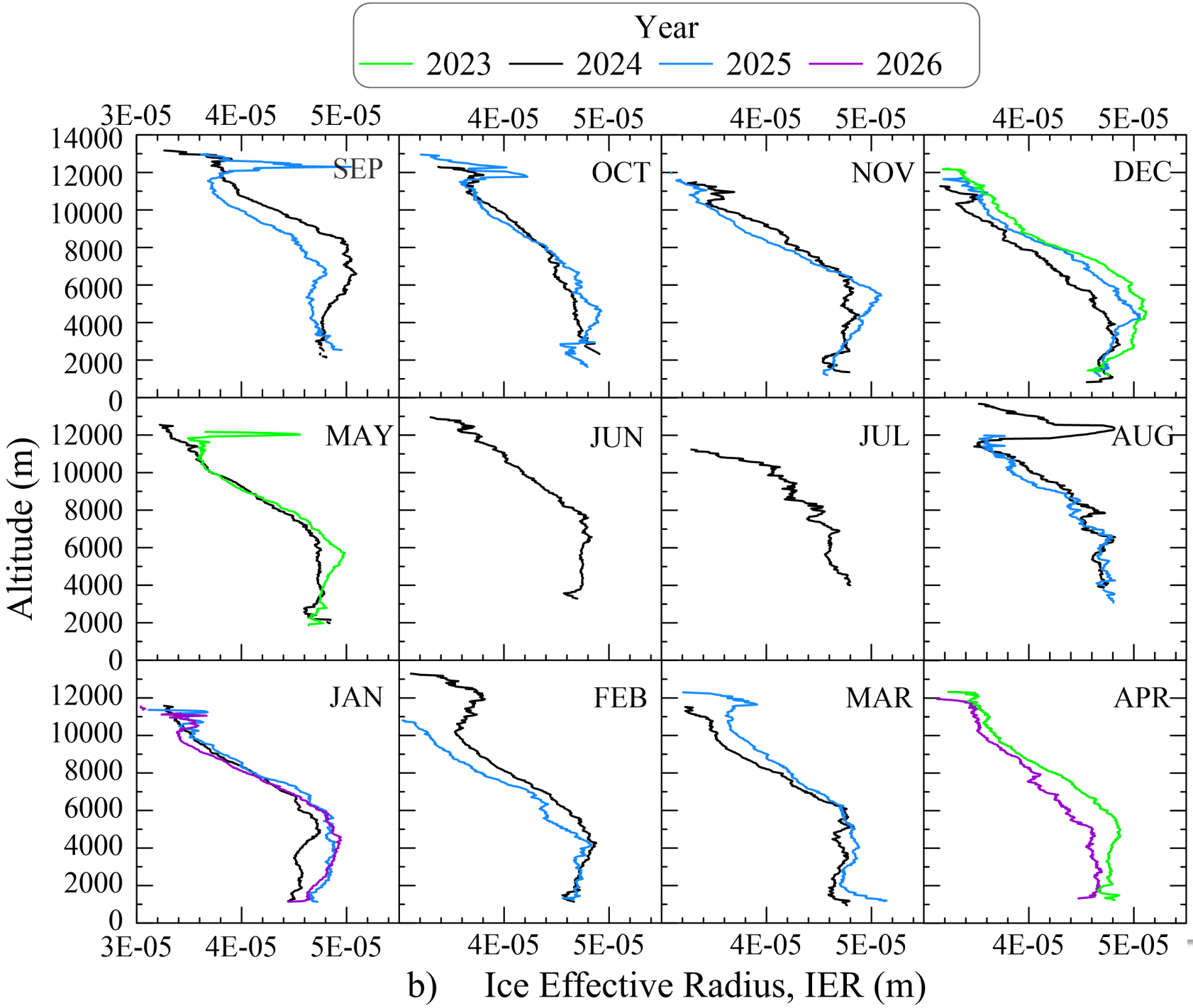


Ice Water Content

In several months, the altitude of ice clouds class maximum occurrence differs from that of maximum IWC.

Overall, IWC profiles typically exhibit two maxima: one between 5 and 7 km, depending on season, and another around 11 km, possibly linked to intense convective events.

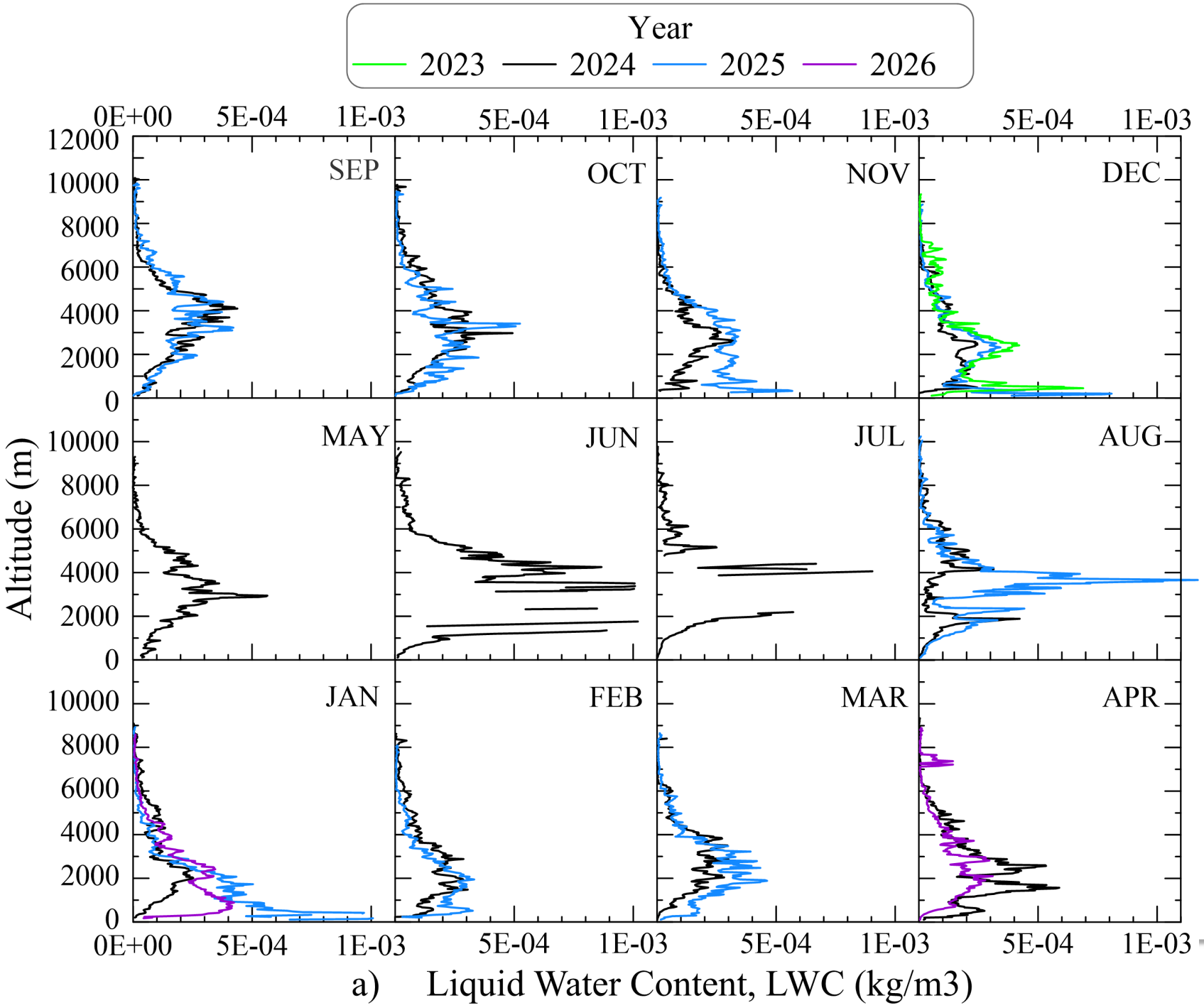
Nov.-Dec. maximum
up to ~1,5 10^{-4} kg/m^3



Mean Ice Effective Radius

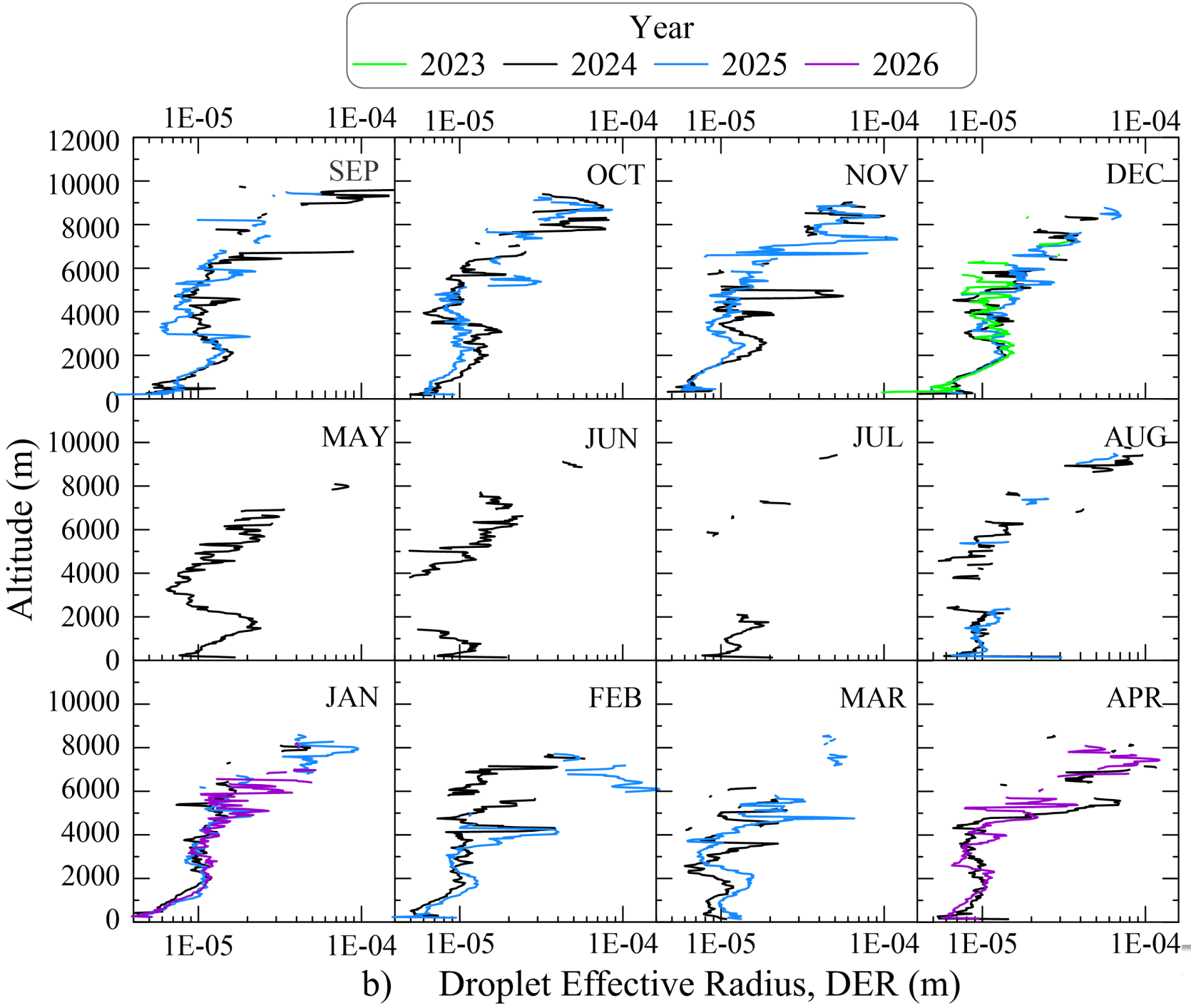
Values remain nearly constant (45–50 µm) up to about 5–7 km and then gradually decrease to ~35 µm.

Higher IER values above 10 km in Aug. 2024 and Sep. 2025 are likely associated with single events.



Liquid water content

LWC typically peaks at $2–3 \times 10^{-4}$ kg m^{-3} between 2- 4 km, with interannual variability.



Droplet Effective Radius

the largest variability and is displayed on a logarithmic scale.

A relative DER maximum often occurs at 2–3 km, at altitude lower than the corresponding LWC peak.

Increases with height from ~5–6 µm near the surface to 30–40 µm above 7 km, especially in Autumn, when Mediterranean convection is enhanced.

SUMMARY

The vertical cloud occurrence exhibits a pronounced annual cycle, with minimum values in July and August, when both liquid and ice cloud occurrence remains below 3 %. During winter and spring, the occurrence of ice clouds reaches its maximum, with values ranging between 16 % and 22 %.

Liquid cloud occurrence shows a more pronounced seasonal cycle compared to ice clouds, with maximum values of about 10 % at approximately 1000 m in December, and minimum values in summer. During spring and summer, both the altitude and magnitude of maximum occurrence decrease substantially, reaching values of approximately 3 % at altitudes around 400–500 m, indicating a stronger coupling of liquid clouds with the marine boundary layer.

The vertical distributions of IWC and IER exhibit maxima above 10 km that are not in phase with the occurrence maxima of ice clouds, likely due to the strong influence of a limited number of intense convective events.

The LWC and DER profiles highlight distinct behaviours between pure liquid and mixed-phase clouds. In particular, DER values above ~4000 m are often significantly elevated, likely due to the strong influence of ice particles, probably leading to overestimation under mixed-phase conditions.

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giandomenico.pace@enea.it

Thank you !