



Seasonal and monthly variability of the daytime Mesospheric Echoes above Jicamarca

J. A. Florentino¹ and D. E. Scipión¹

¹ Instituto Geofísico del Perú

Abstract

The JULIA-MP mode from the Jicamarca Radio Observatory allows acquiring daytime echoes from the Mesosphere. More than 280 datasets have been collected and processed to obtain spectral parameters of the Mesospheric Echoes from August 2023 to December 2025. As described in previous works, they are highly intermittent in time and space. For the first time, a longer-term analysis was possible, and allowed us to characterize their behavior seasonally and monthly at different ranges. The PO% and SNR display a season and range preference for the analyzed period. Furthermore, it is possible to observe semi-annual oscillations at certain ranges.

1. Introduction

The JULIA-MP daytime mode of operation (7 to 18 LT) was conceived to study the 150 km echoes, although it was later noticed later that it could be useful to study the Mesosphere. Some of the relevant radar experiment specifications are listed in Table 1 [1]. From August 2023 to December 2025, approximately 280 days of valid data (days without gaps) have been collected. Although they are not evenly split, there are at least 10 days for each month (see Figure 1). This has allowed us to analyze the echoes' behavior monthly or seasonally.

Parameter	Specification
Inter-Pulse Period	1500 km (10 ms)
Transmission power (peak)	2 x 96 kW
Number of channels	2 (East and West)
Sampling rate	1.5 km (10 μ s)

Table 1. Radar experiment specifications

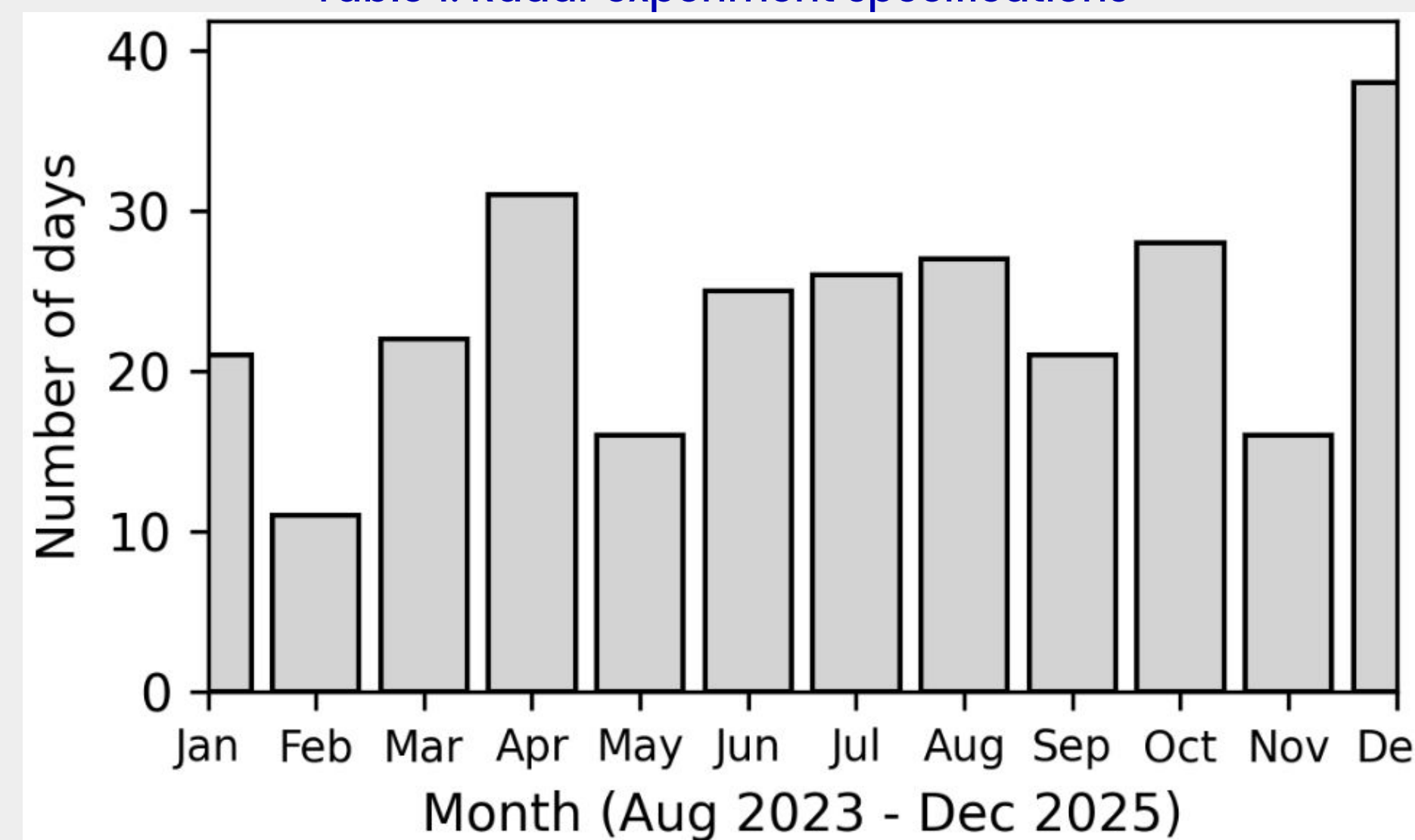


Figure 1. Monthly data coverage

2. Echoes processing and characteristics

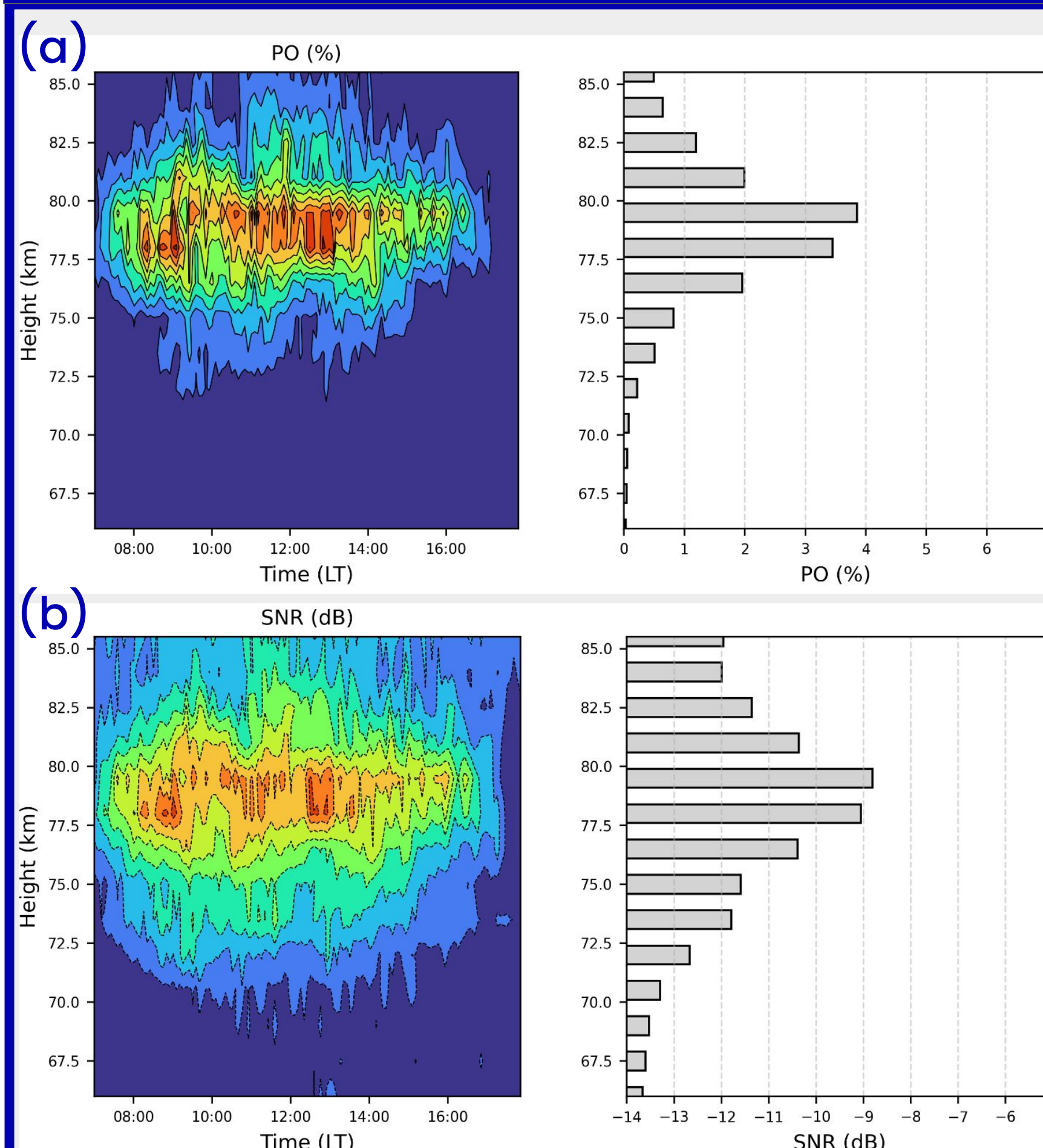


Figure 2. (a) Average daytime PO (%) and average by height (b) Average SNR (dB) and average by height

The spectral moments are obtained for both channels. After integrations and FFT operations, the resulting dwell-time is one minute. A -3 dB SNR threshold has been established to determine the occurrence of an echo. Temporal averages of 15 minutes were used to eliminate the echoes characteristic intermittence. The daytime Percentage of Occurrence (PO) and SNR averages for the period of study from both beams are shown in Figure 2. It can be noticed that most of the echoes occur between 75 and 80 km of height, and that the SNR displays a similar behavior. Echoes below 72 km are weak and seldom detected. The average by height of daytime PO and SNR has large variability (not shown in the figure).

3. Seasonal and monthly variability

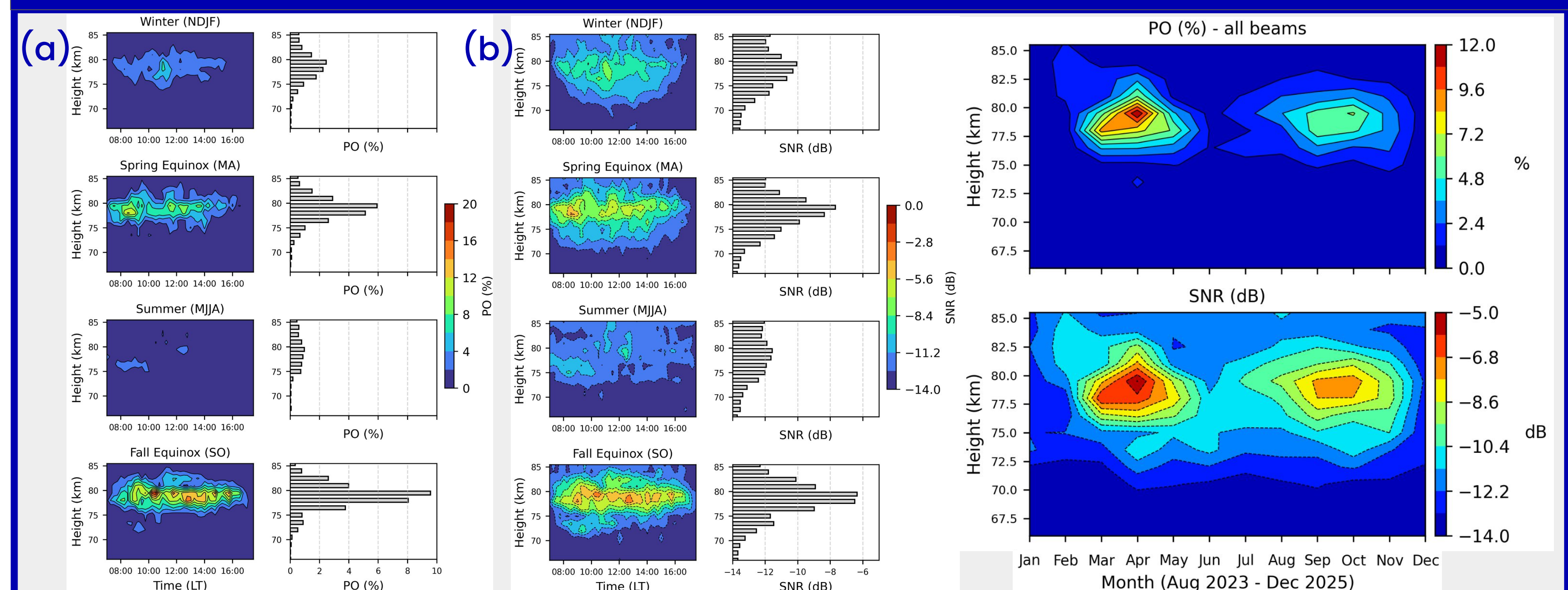


Figure 3. Seasonal average daytime: (a) PO (%) and average by height, and (b) Average SNR (dB) and average by height

Figure 4. Monthly average of the PO (%) and SNR (dB) from all the available data

As Figure 3 shows, mesospheric echoes occur more frequently, are more intense, are centered roughly at the same height, and are more present from around 8 to 15-16 LT during the equinoxes. Instead, during winter, they occur less, becoming 3 to 4 dBs weaker with respect to the equinoxes, and although they are still centered at the same height, they are confined between 10 and 12 LT. In summer instead, they almost disappear, and only a small percentage can be found between 8 and 10 LT just above 75 km. In terms of monthly behavior, Figure 4 shows higher PO (%) and SNR in March and April, and September and October, for heights between 75 and 82.5 km. The semi-annual oscillations (SAO) at those heights are clearly noticeable, and this has been numerically verified by calculating the RMS error when performing a least-squares fit.

4. Conclusions and future work

- ✓ The echoes mostly occur during the equinoxes and are very weak in winter.
- ✓ There are noticeable SAO behaviors in PO (%) and SNR.
- Design a better experiment configuration (power and resolution) to study the correlation between SNR and spectral width, and to make a further analysis to determine the origin of the echoes.
- Keep the continuous acquisition and processing of the data to make longer-term analysis, and study annual trends.

5. Acknowledgments

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6. References

- [1] Flores, R., et. al. (2026). Monitoring the Equatorial Ionosphere With the Upgraded Unattended Mode at Jicamarca. *Journal of Geophysical Research: Space Physics*, 131