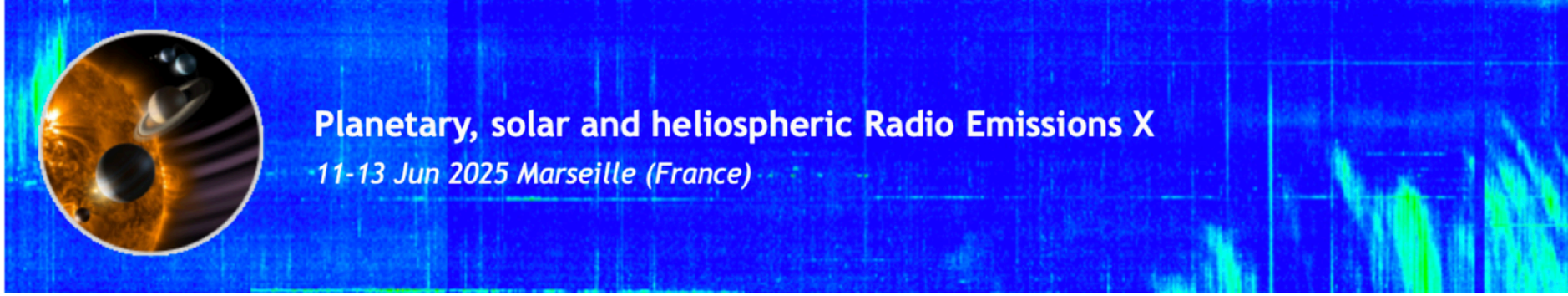
Exo-Solar Planetary Heliospheric Radio Emissions Stellar



Variation in Jovian Decametric radio emissions' characteristics due to Earth's declination changes

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Astronomy & Astrophysics

Effect of the Earth's declination variation on characteristics of Jovian decametric radio emissions

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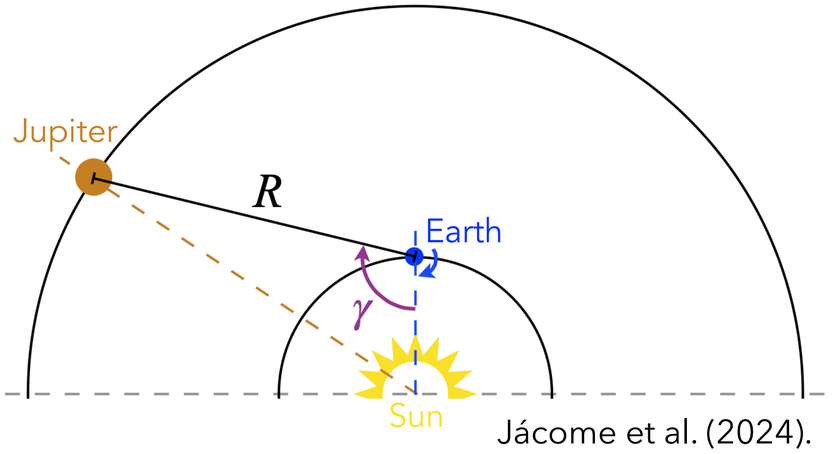
ABSTRACT

Context. The variation in the Jovicentric sub-latitude (declination, D_E) of a radio observer of Jupiter has long been known to affect the observation of Jupiter's decametric (DAM) radio emissions due to these emissions' anisotropic nature (through cyclotron maser instability beaming cones centered on Jovian magnetic field lines). The effect of the D_E variation, however, is still not clearly understood. For ground-based observations of Jupiter, the D_E variation, from −4° to +4°, occurs concomitantly with the cyclic variation in the distance to Jupiter, R, and Jupiter's elongation angle, γ, which also affect the emission observation. Those covariant effects must be removed, then, for an analysis of the pure effect of D_E.

- The aim of this study was to investigate the **pure effect of the Earth's declination (D_E) variation** on the maximum frequency (F_{Max}), duration (Δt), average Io phase (Φ_{Io}), and average longitude (CML) of Jovian DAM emissions observed with the Nançay Decameter Array (Routine/NDA), from 1990 to 2020.
- Earth's D_E relative to the Jovian coordinate system varies from −4° to +4°.
- The variation in the Earth-Jupiter distance, ***R***, and in Jupiter's elongation angle, γ, also affect the ground-based observations.



Jácome et al. (2024).

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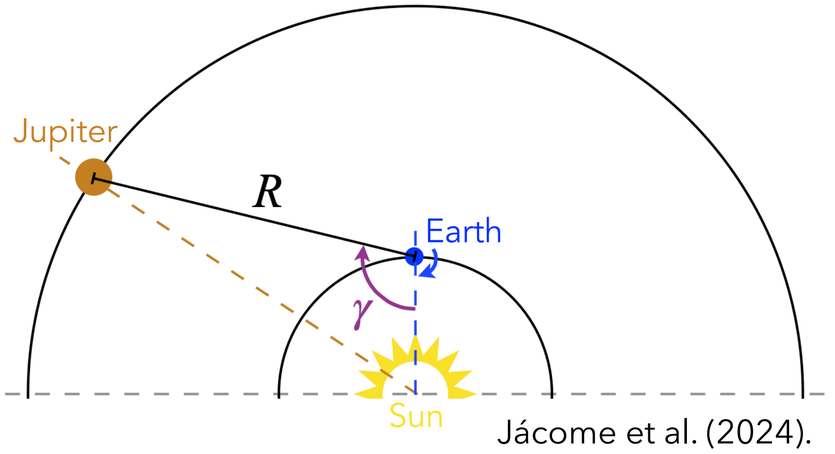
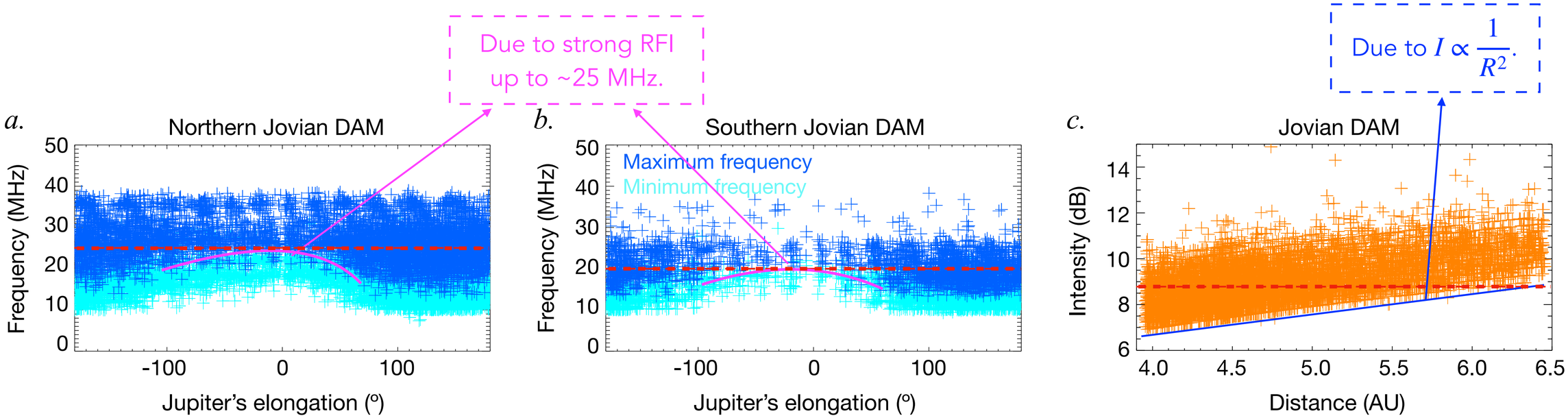
- The variation in the Earth-Jupiter distance, ***R***, and in Jupiter's elongation angle, γ, also affect the ground-based observations.

  - Intensity $\propto 1/R^2$
  - $\gamma \rightarrow 0°$: Jupiter is observed during daytime.
    - High ionospheric cutoff frequency (~15 MHz);
    - Strong RFI up to 25 MHz.
  - $\gamma \rightarrow \pm 180°$: Jupiter is observed during nighttime.
    - Low ionospheric cutoff frequency (~10 MHz);
    - Weaker RFI.



Jácome et al. (2024).

Data selection removing covariant effects



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- Maximum frequency thresholds: at 20 MHz (southern emissions) and at 25 MHz (northern emissions);
- Intensity threshold at 8.8 dB.

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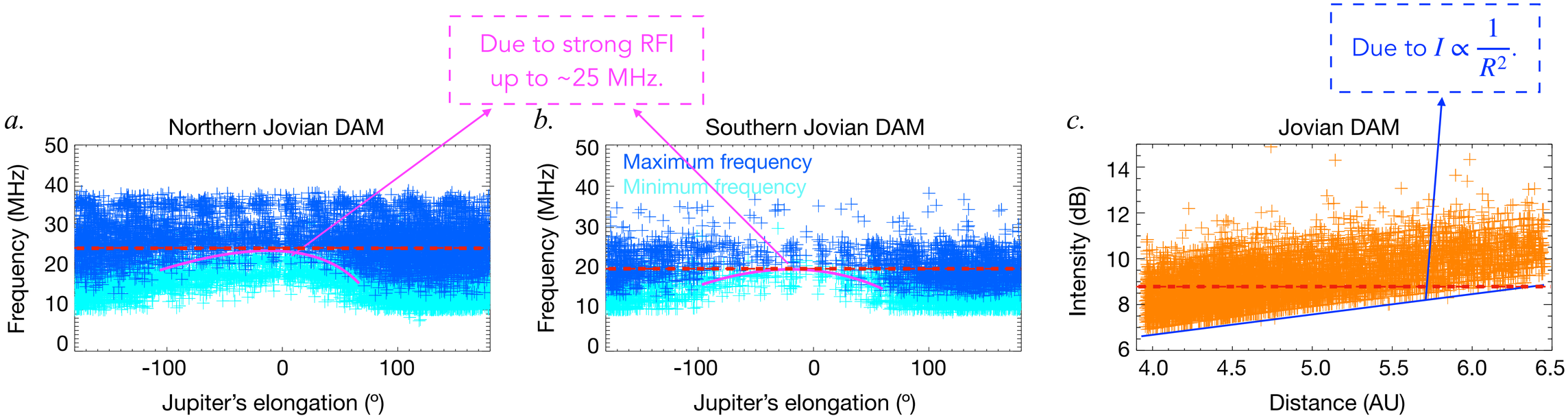
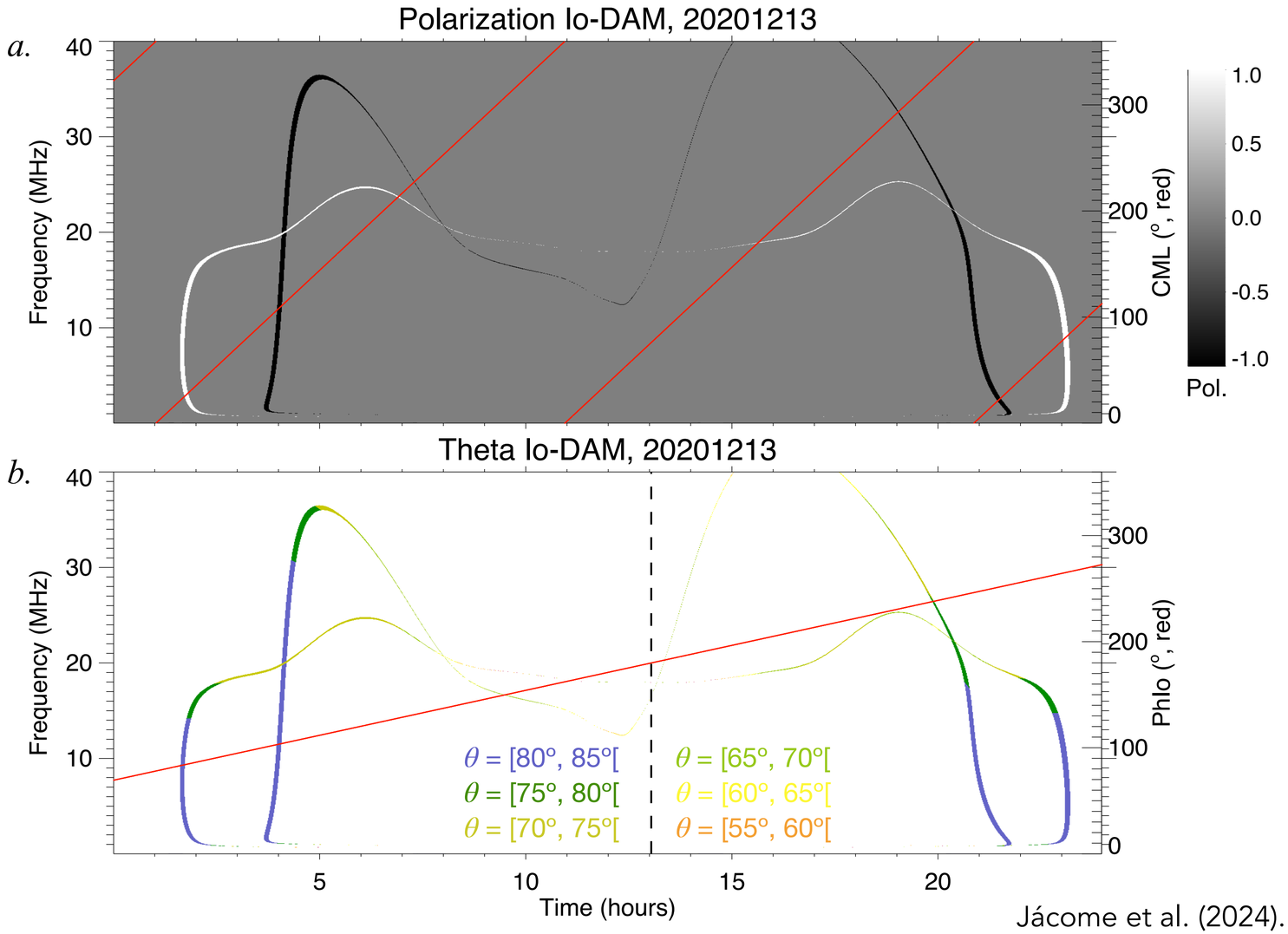


Jácome et al. (2024).

- Maximum frequency thresholds: at 20 MHz (southern emissions) and at 25 MHz (northern emissions);
- Intensity threshold at 8.8 dB.
- 3094 emissions were selected:
  - **1473 main Io-DAM emissions (Io-A, Io-B, Io-C, and Io-D).**

ExPRES simulations:

- 24-hour long;
- We applied the limitations of the NDA observation:
  - Start time and end time of the real observation;
  - Freq = [10 MHz : 40 MHz].



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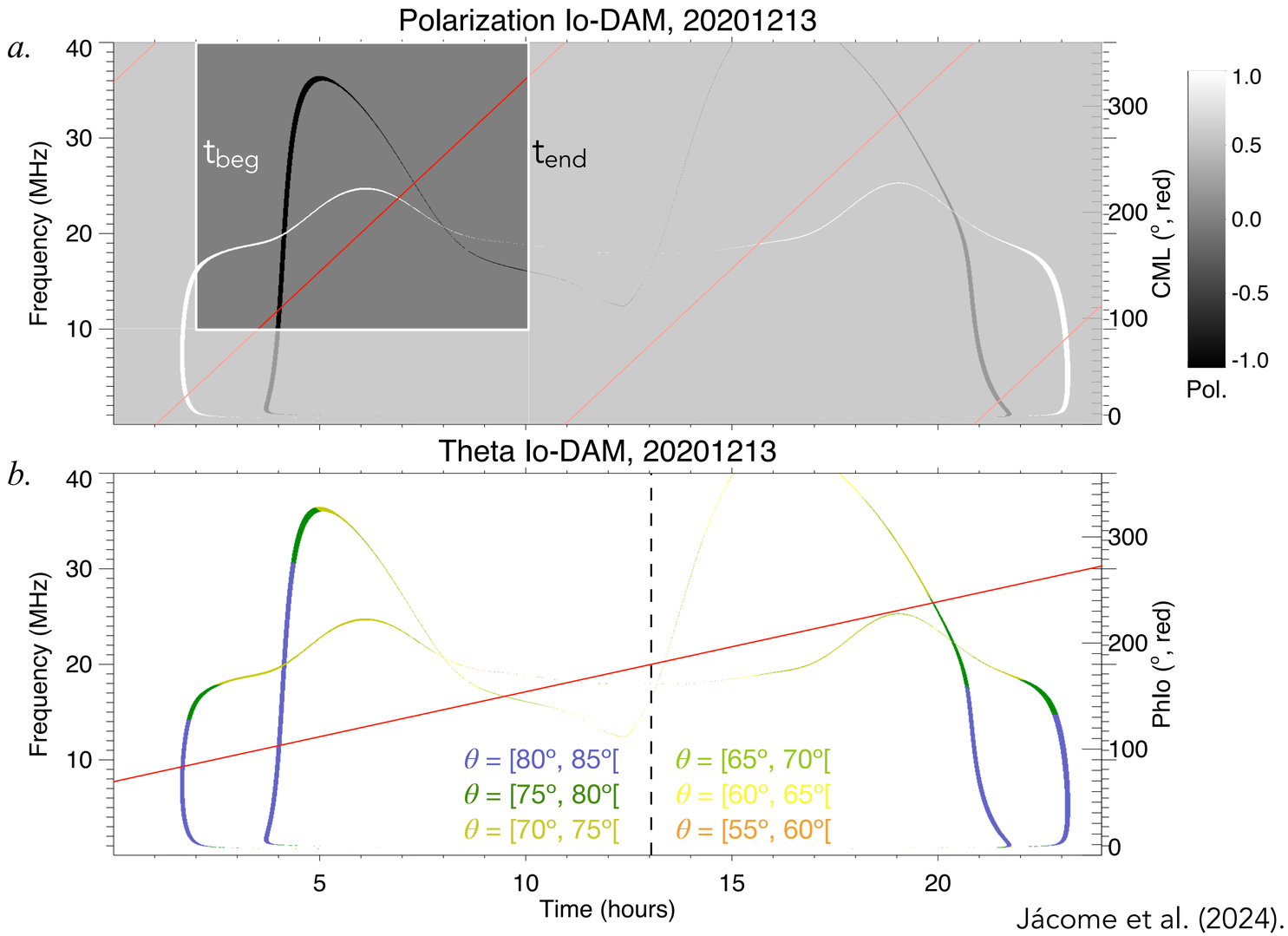


Jácome et al. (2024).

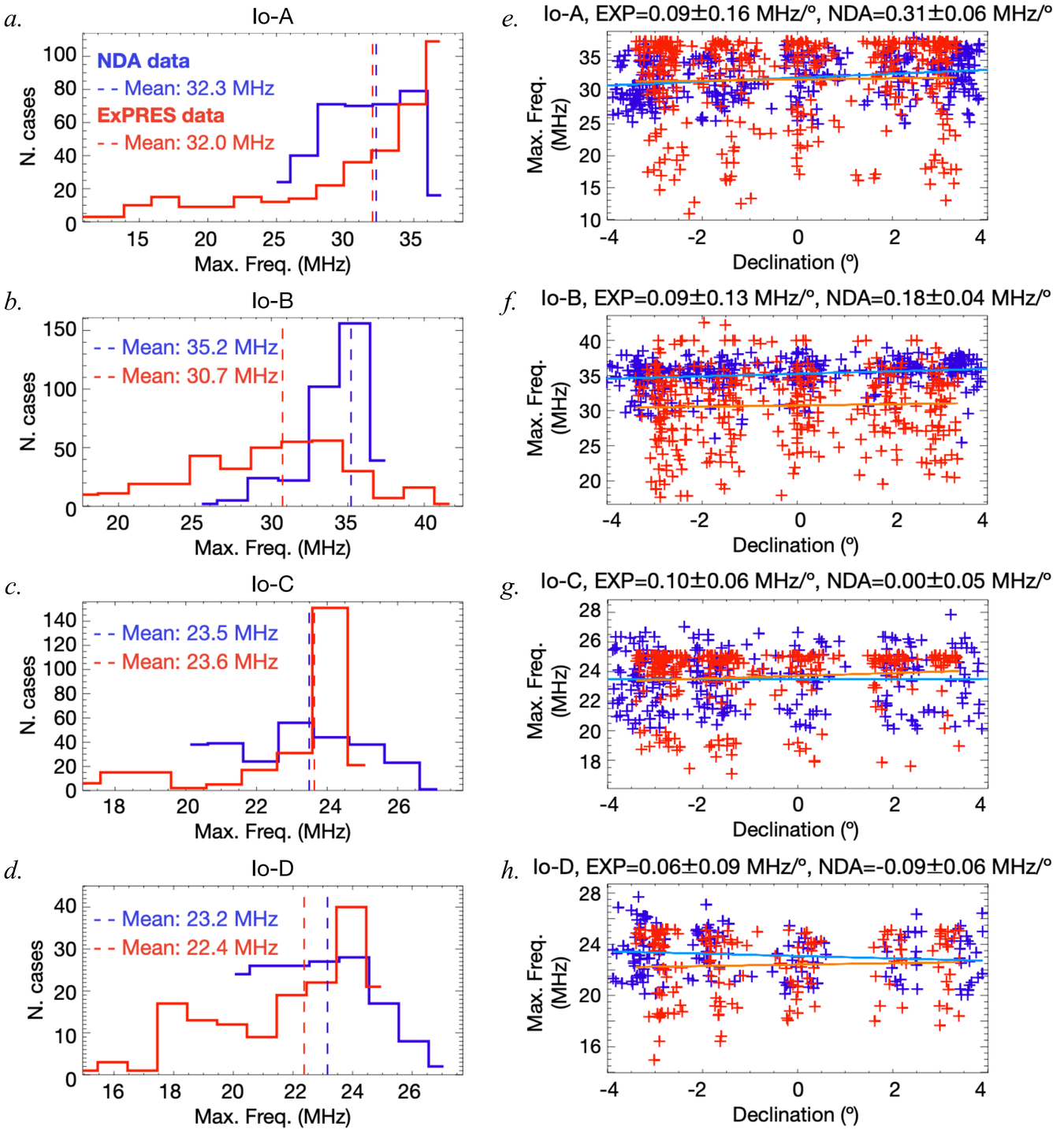
NDA vs. ExPRES emissions:

Maximum Frequency

Real data = NDA data

Modeled data = ExPRES data

Jácome et al. (2024).



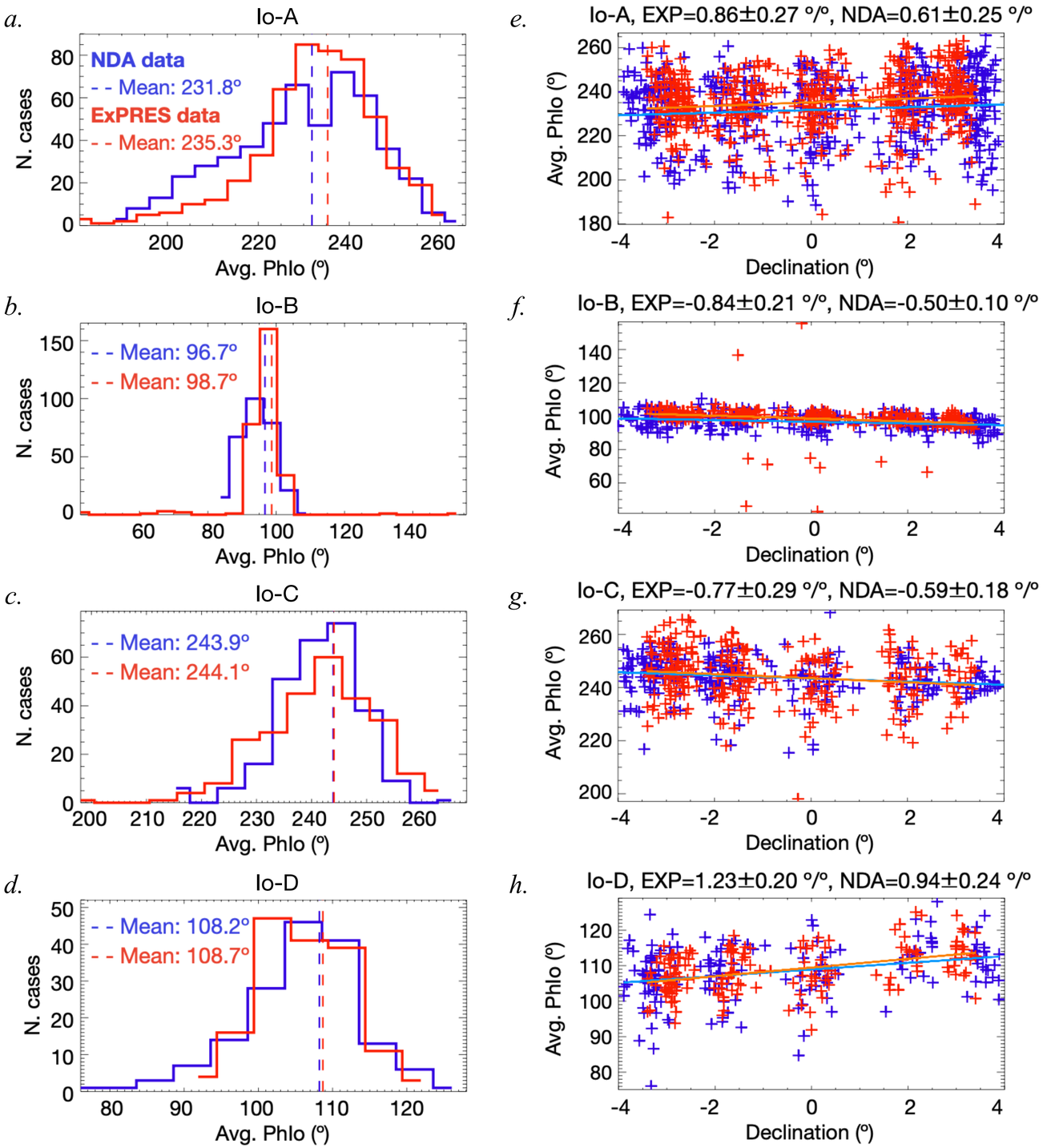
NDA vs. ExPRES emissions:

Average Io phase

Real data = NDA data

Modeled data = ExPRES data

Jácome et al. (2024).



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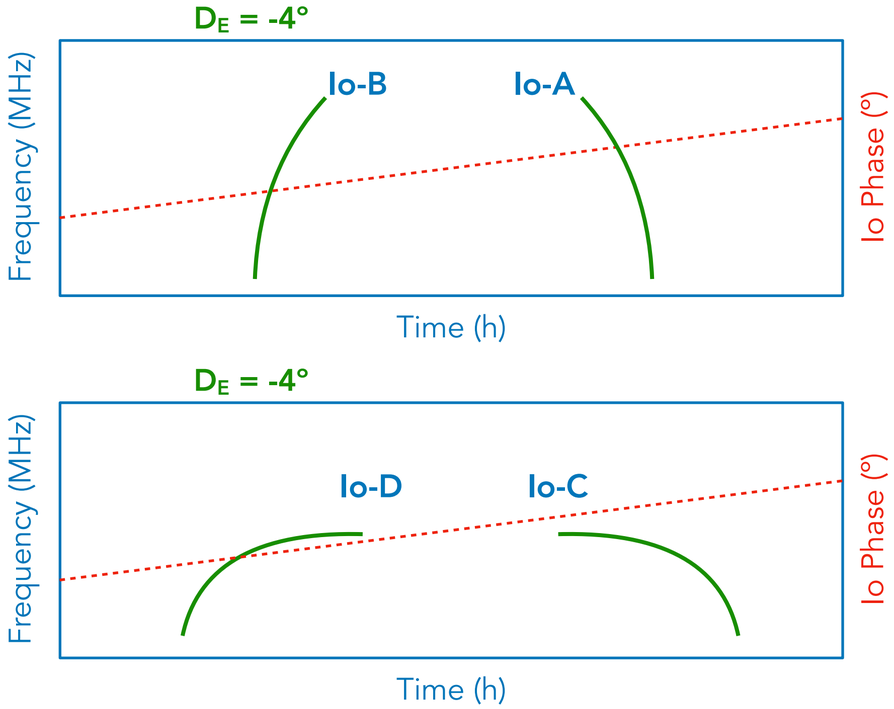
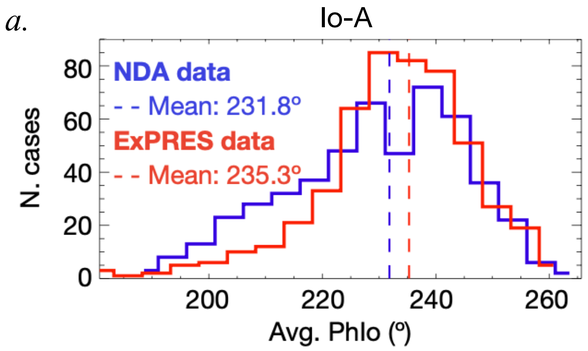
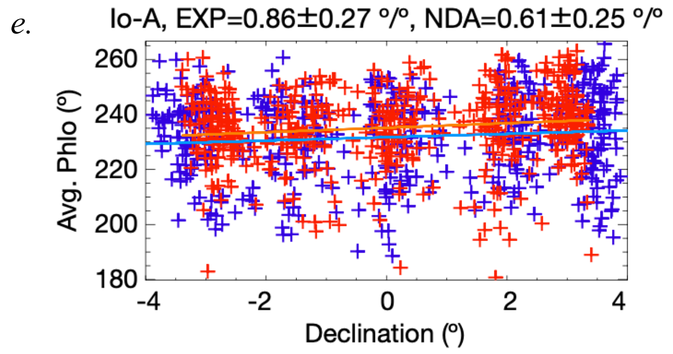
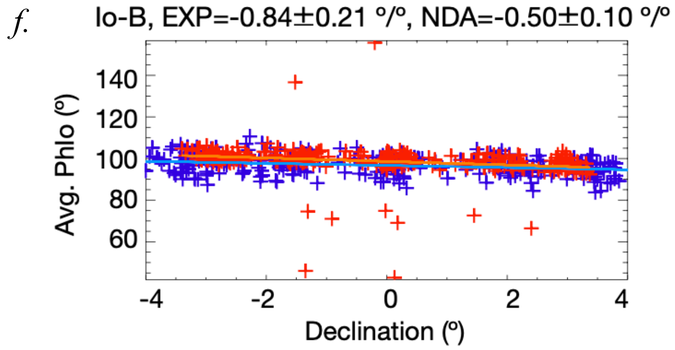
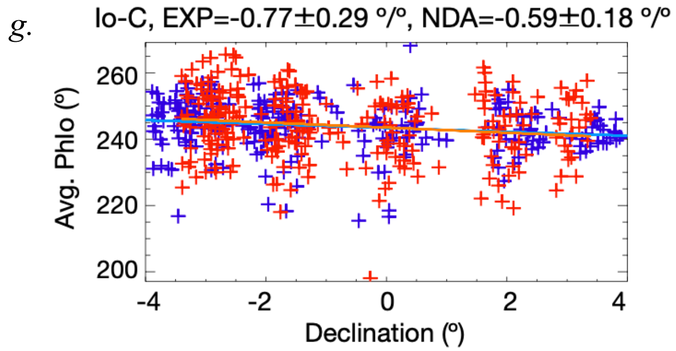
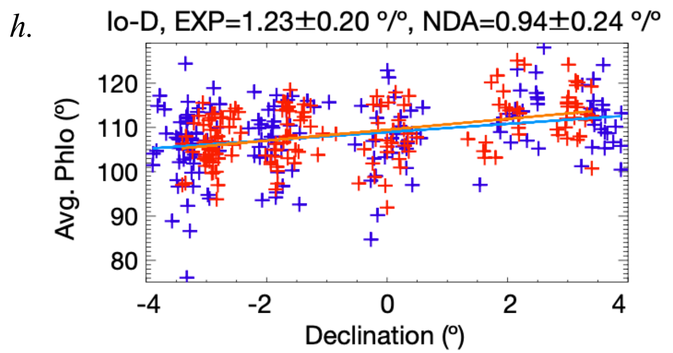












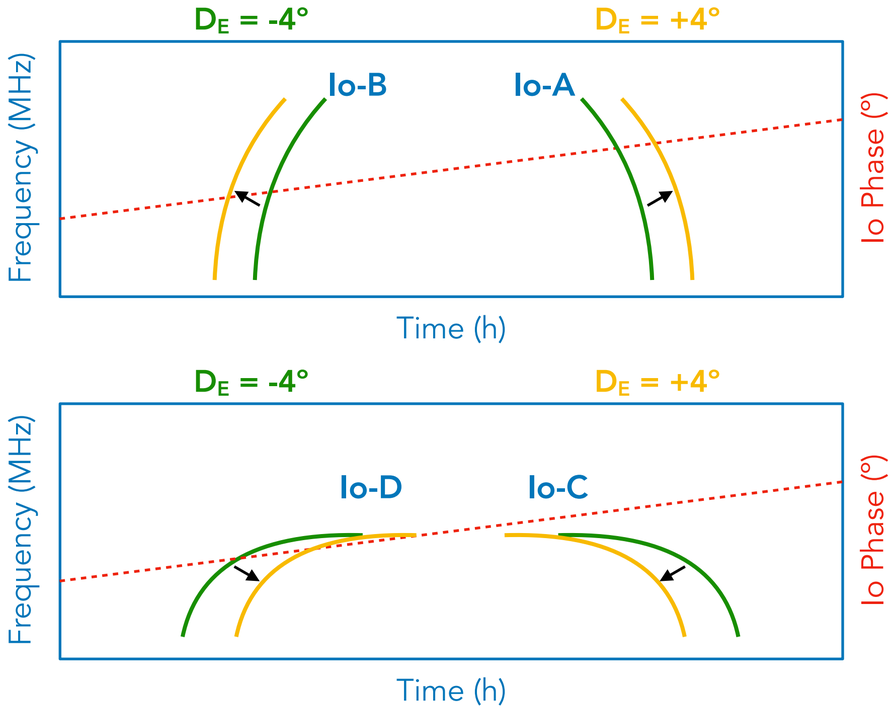
NDA vs. ExPRES emissions:

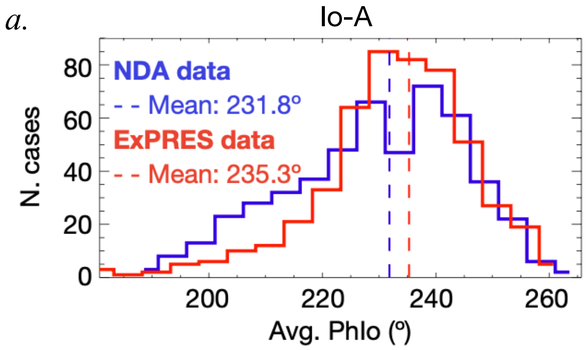
Average Io phase

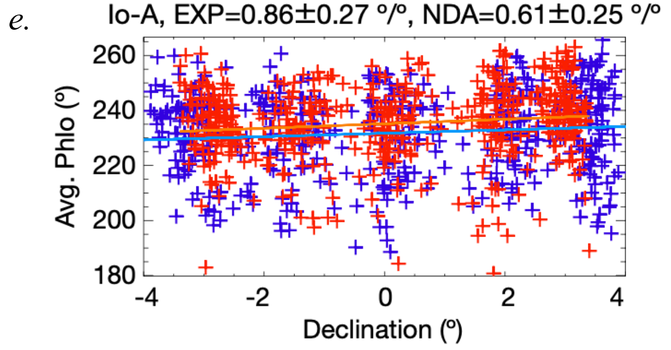
Real data = NDA data

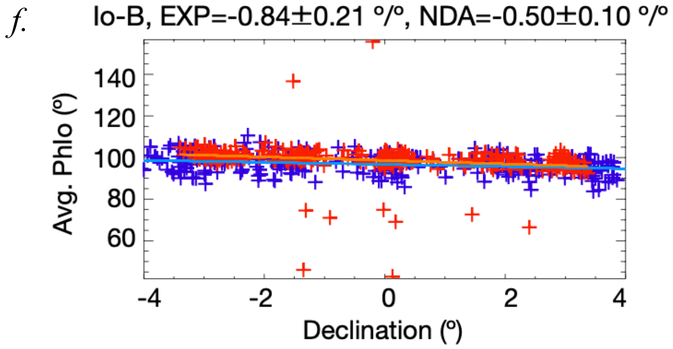
Modeled data = ExPRES data

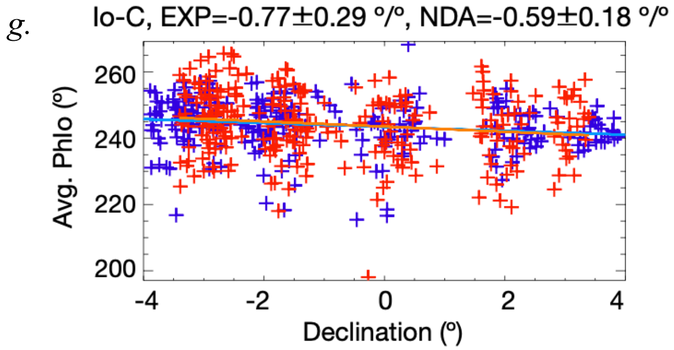
Jácome et al. (2024).

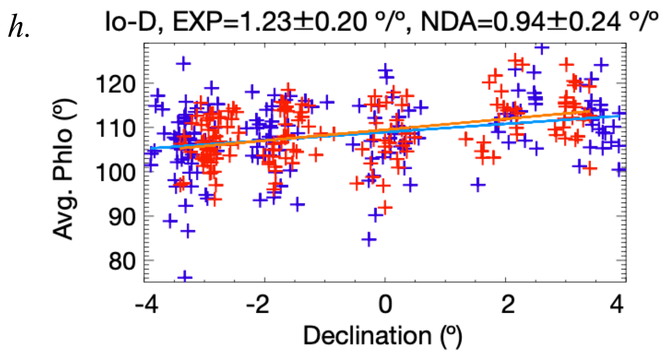












NDA vs. ExPRES emissions:

Average Longitude

Real data = NDA data

Modeled data = ExPRES data

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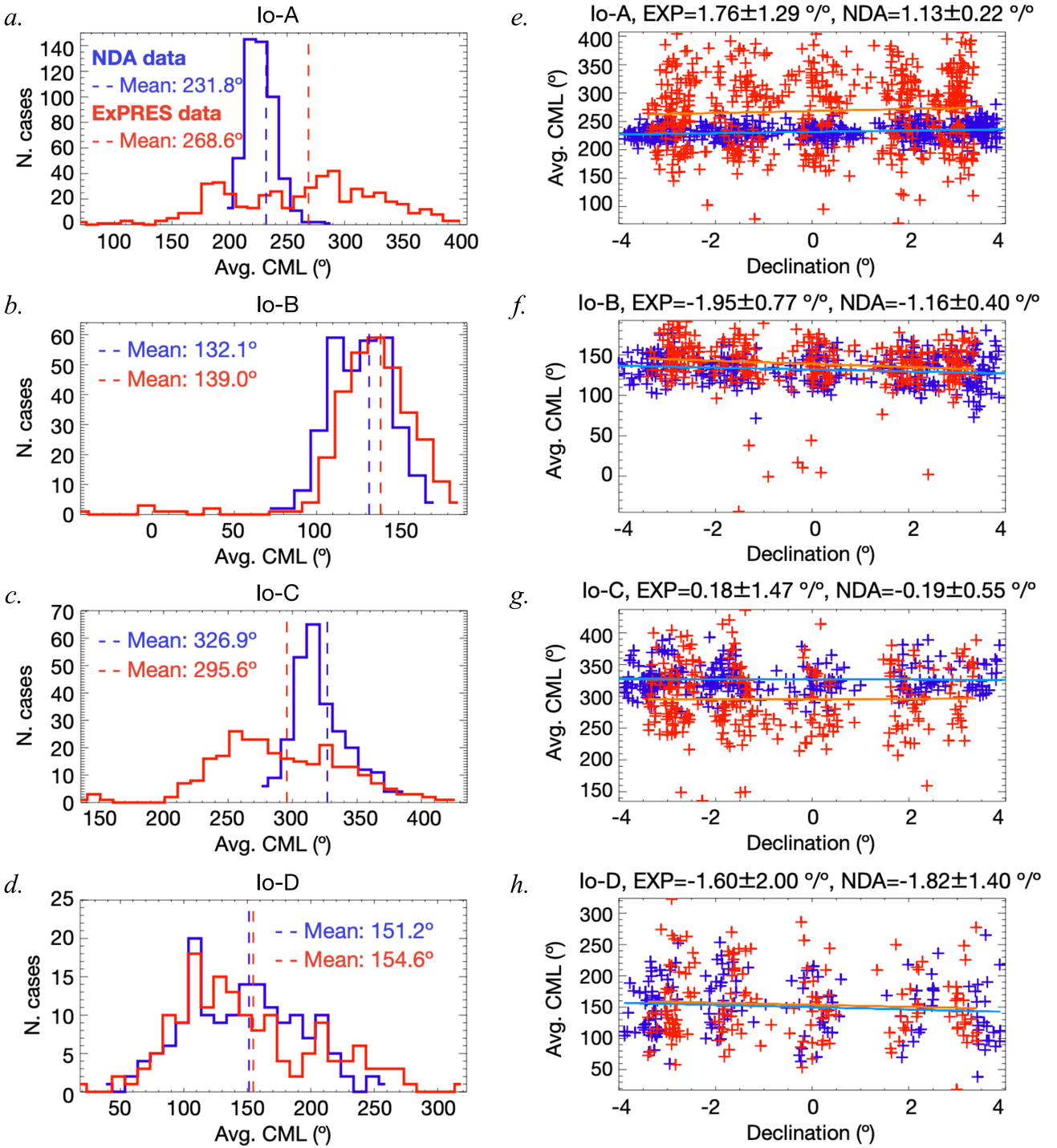

Conclusions

- We have proposed a selection of the emissions for the analysis of the pure effect of D_E.
- Our thresholds were defined at 20 MHz and 25 MHz for the maximum frequency of the southern and northern emissions, respectively, and at 8.8 dB for all the Jovian DAM emissions observed with the Routine/NDA.
- The observable effect of D_E variation is small.
- Io-DAM emissions are more clearly affected by the D_E variation on their average Io phase and average longitude, but F_{max} seems to be also affected, mainly that of the northern emissions (Io-A and Io-B).
- It has been also shown that ExPRES can simulate Io-DAM emissions consistently, as well as their variation with D_E.

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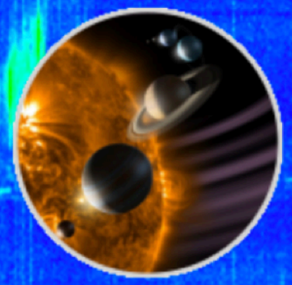

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