

Activity nests as prolific flare factory: from solar minimum to maximum

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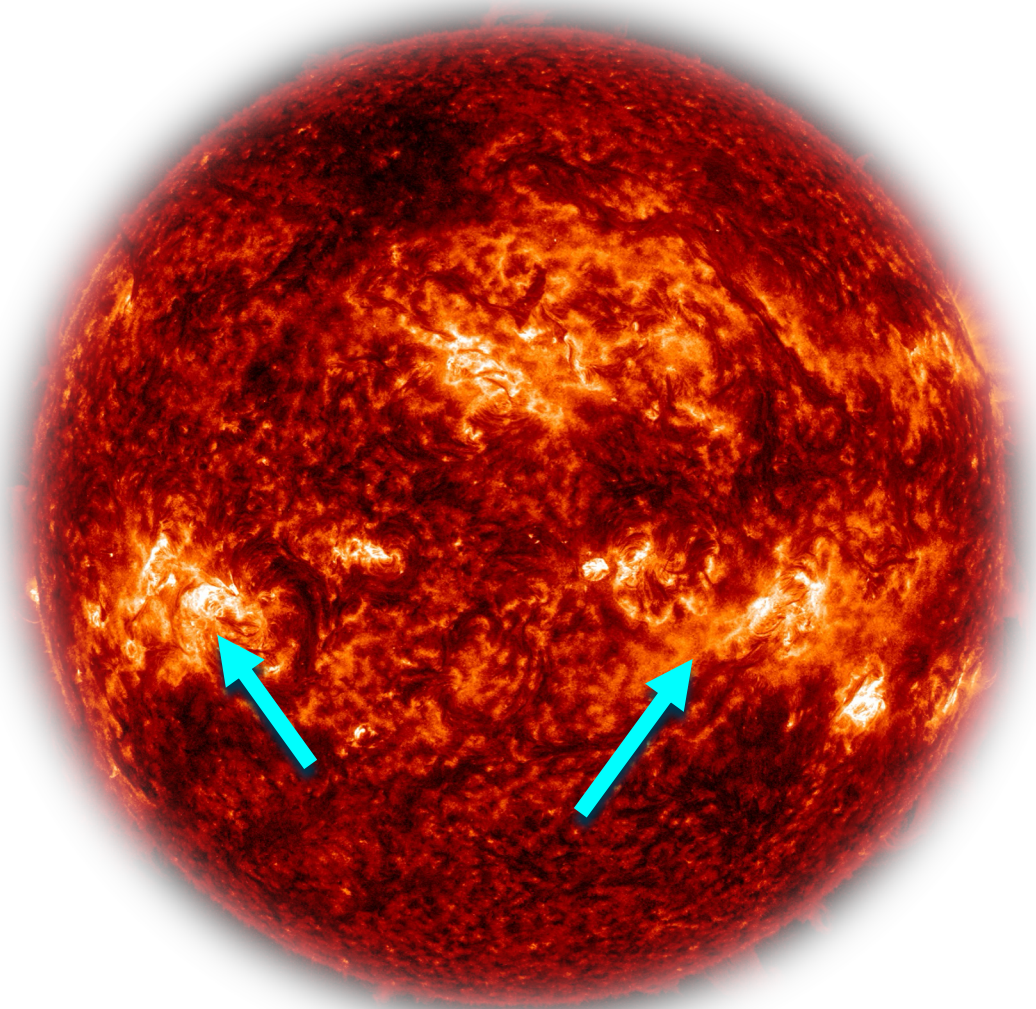
**STIX Meeting, Dublin
July 22-24 2026**

With **A. Finley, A. Blaise**, A.S. Brun, M. Janvier, E. Buchlin, B. Perri, R. Jarolim, D. Müller, A.S.H. To, H. Heklund



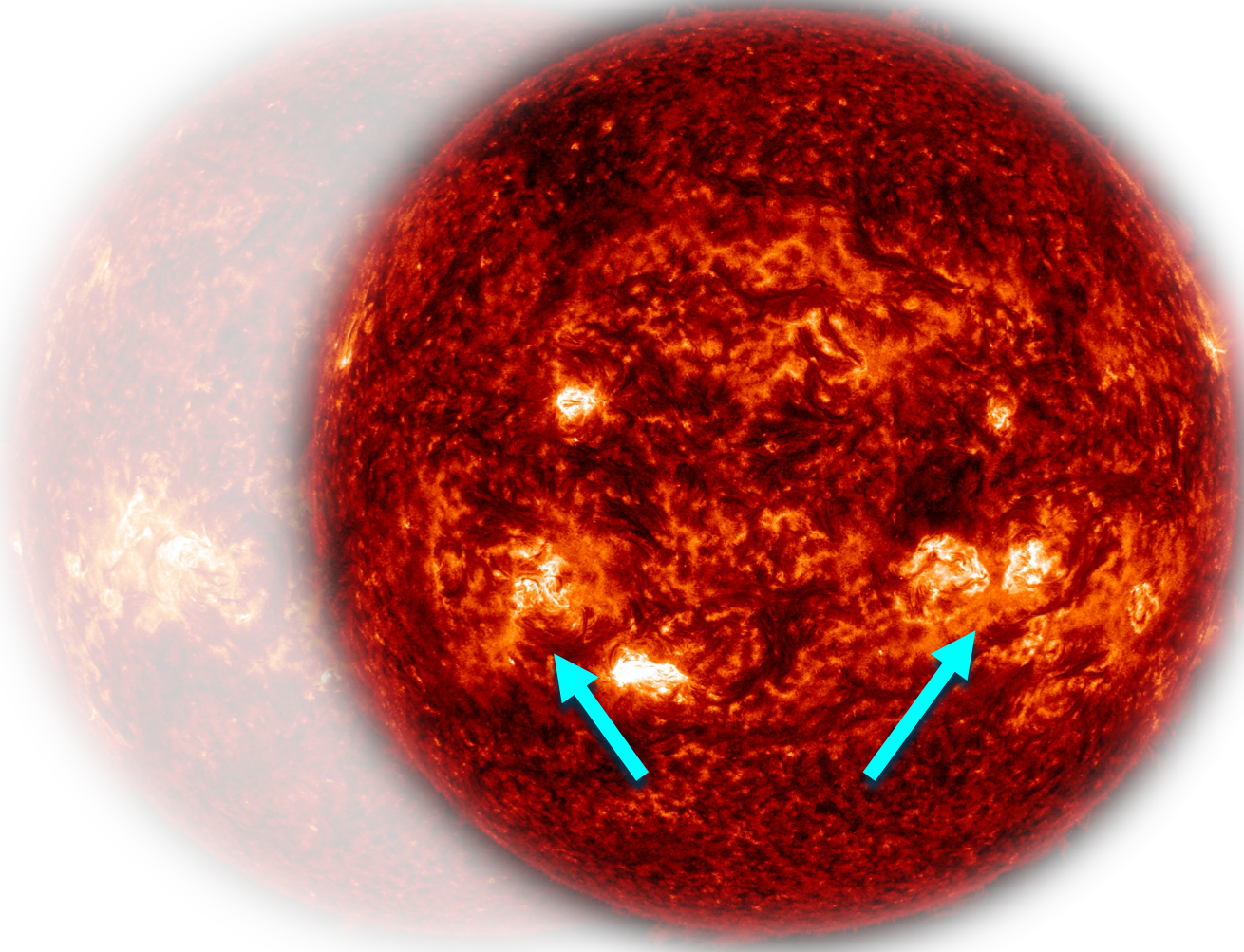
How to Define Active Longitudes/Nests on the Sun?

*One SDO/AIA 304 image per
Carrington rotation*



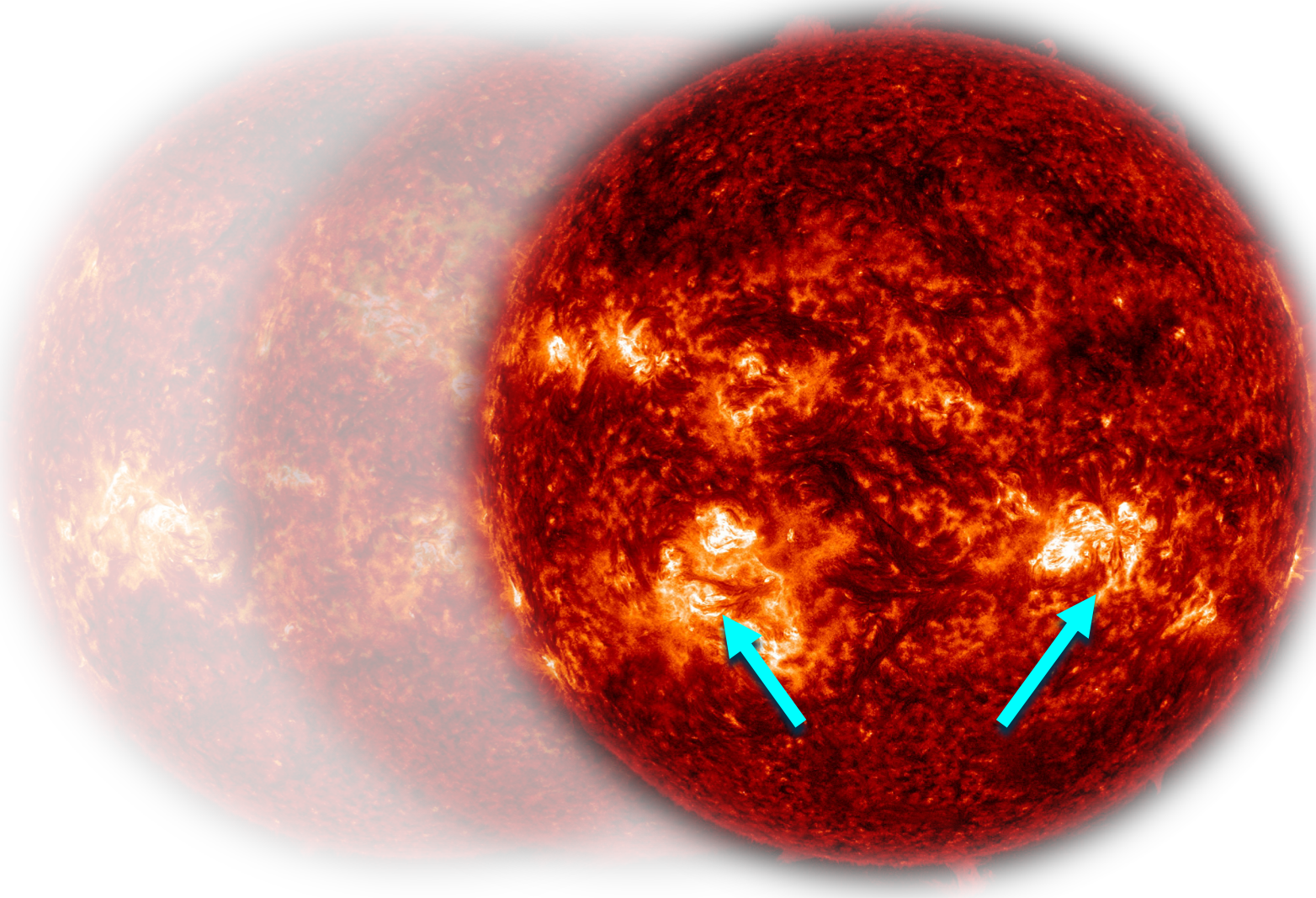
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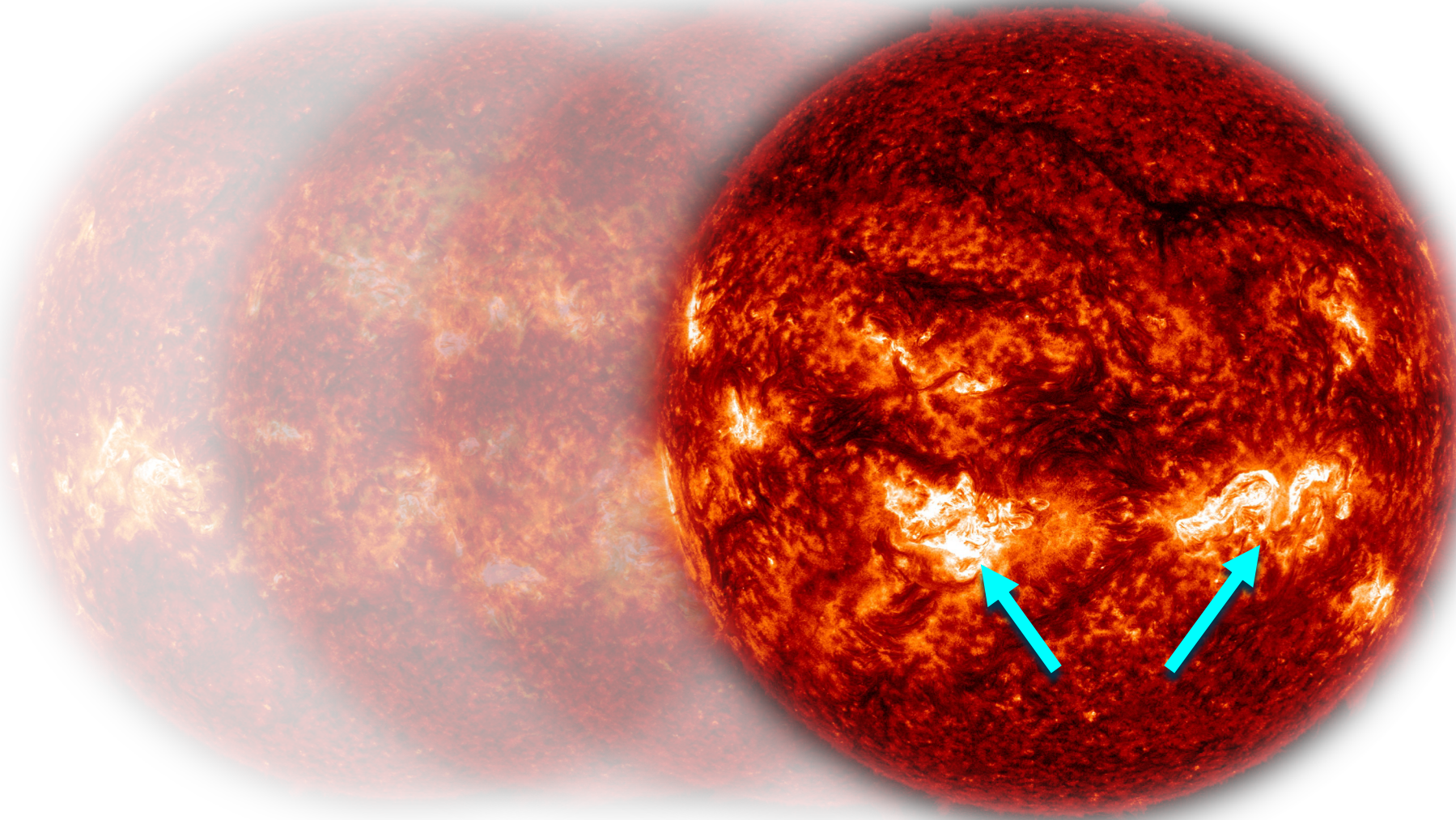
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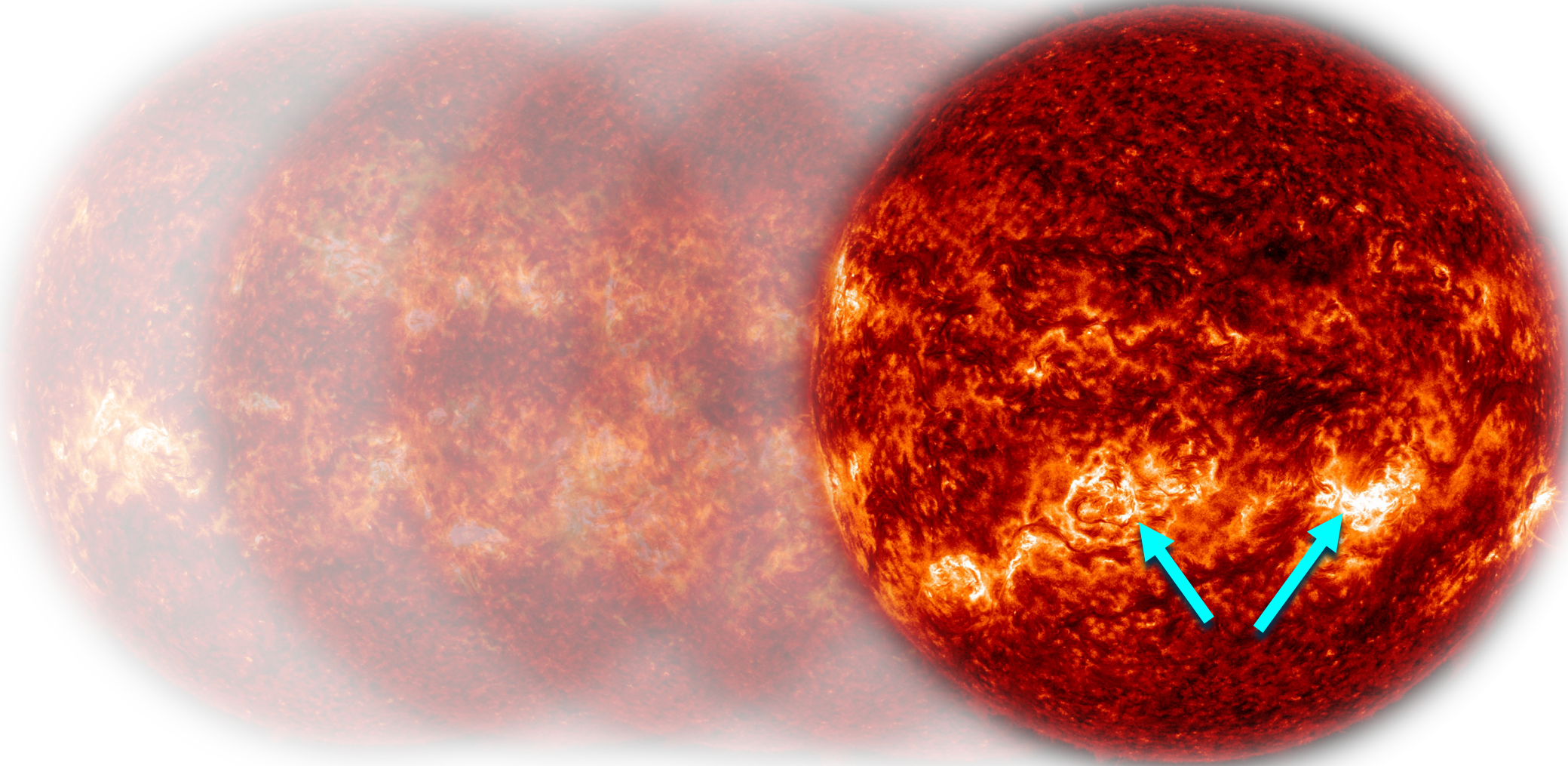
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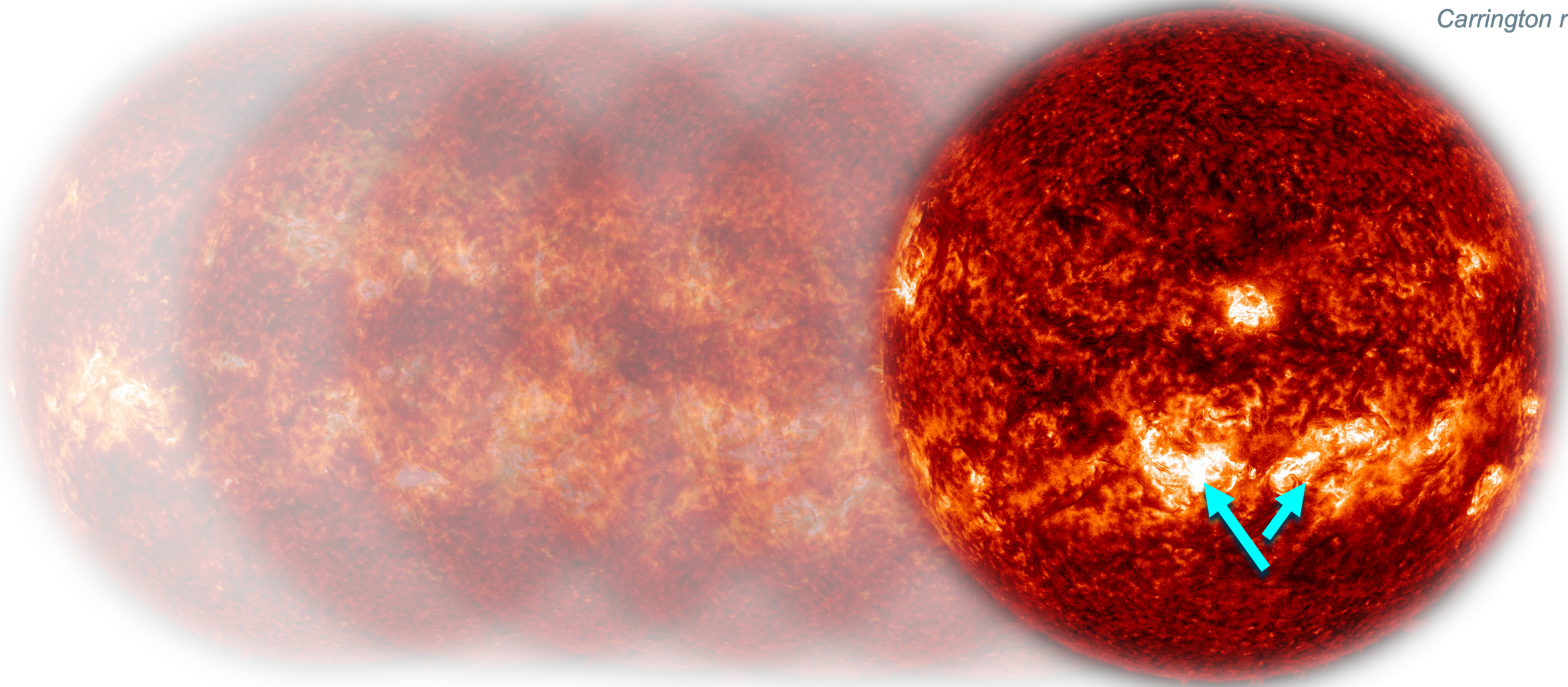
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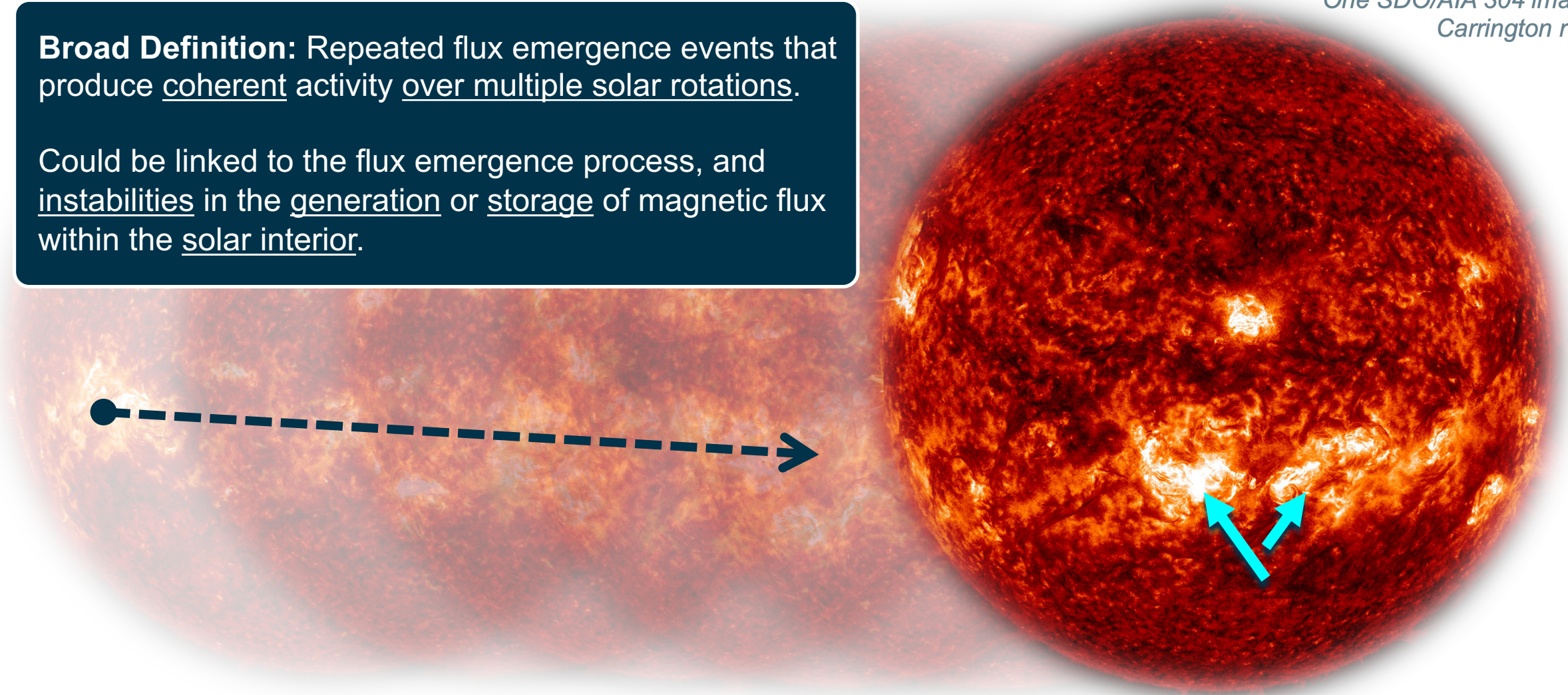


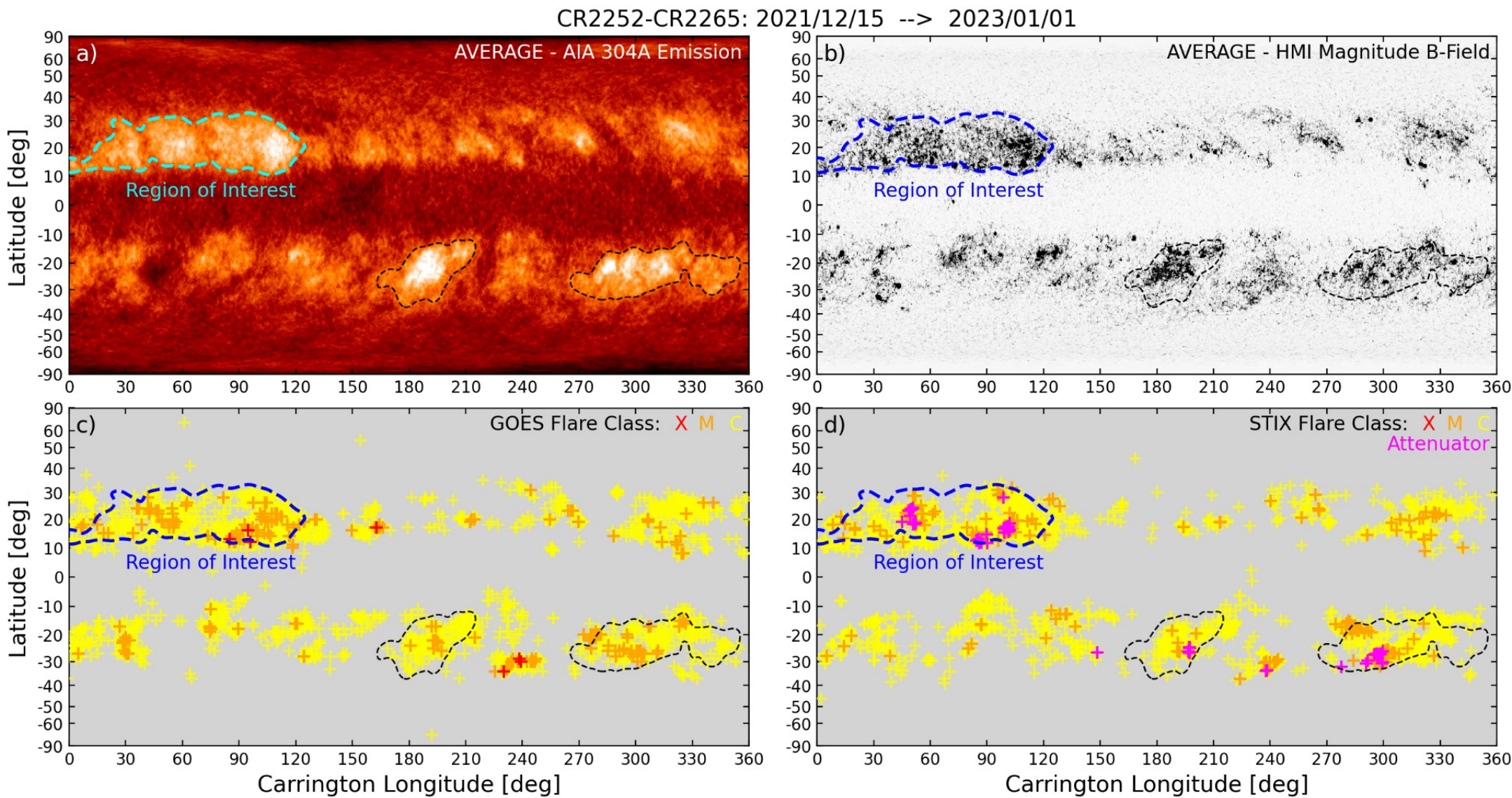
How to Define Active Longitudes/Nests on the Sun?

Broad Definition: Repeated flux emergence events that produce coherent activity over multiple solar rotations.

Could be linked to the flux emergence process, and instabilities in the generation or storage of magnetic flux within the solar interior.

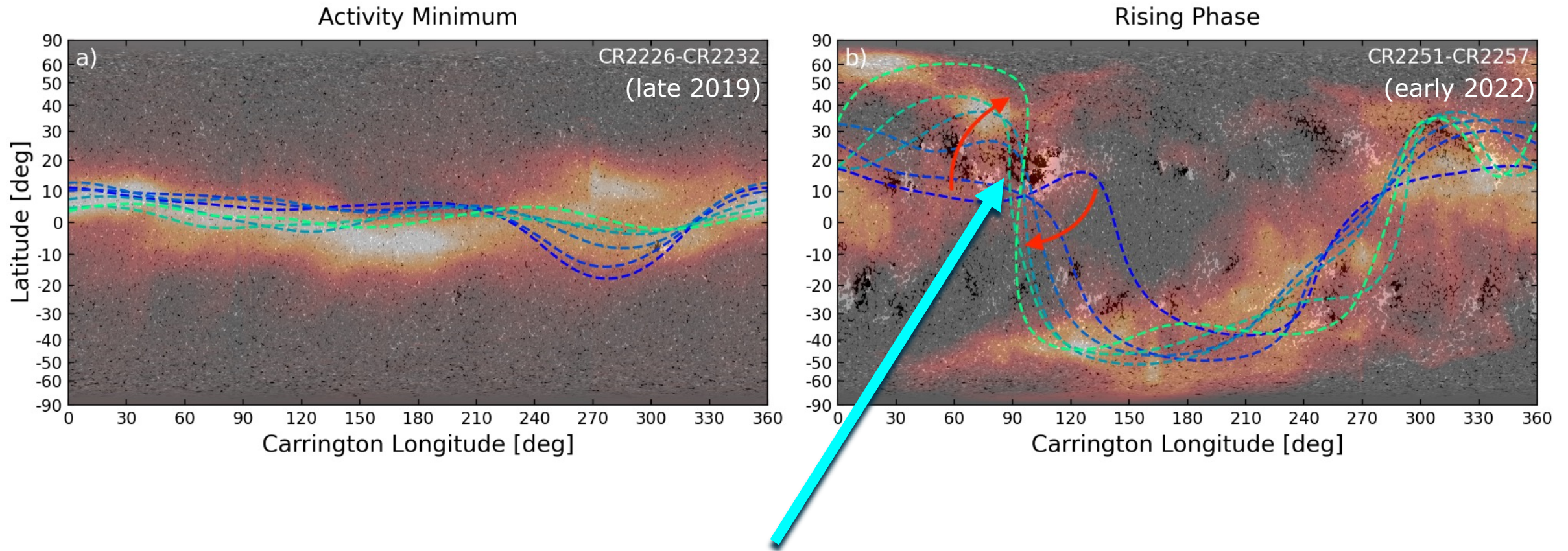
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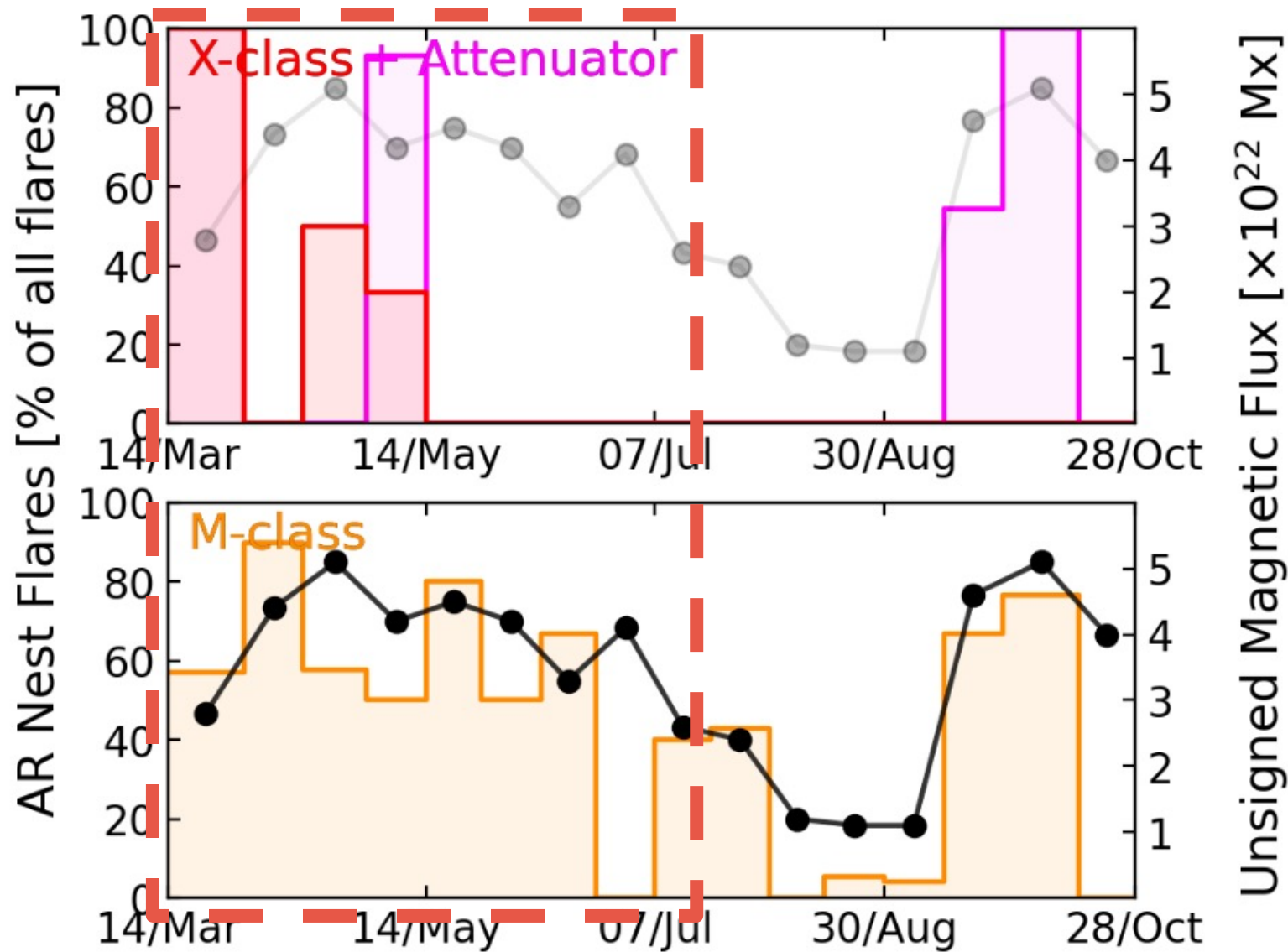
Active Nests anchor the heliospheric current sheet

Finley et al. 2025



Active Nests account for most large flares

Finley et al. 2025



The nest caused 40% of the total observed solar flares in 2022

In the near continuous monitoring window, it accounted for 50-70% of all solar flares

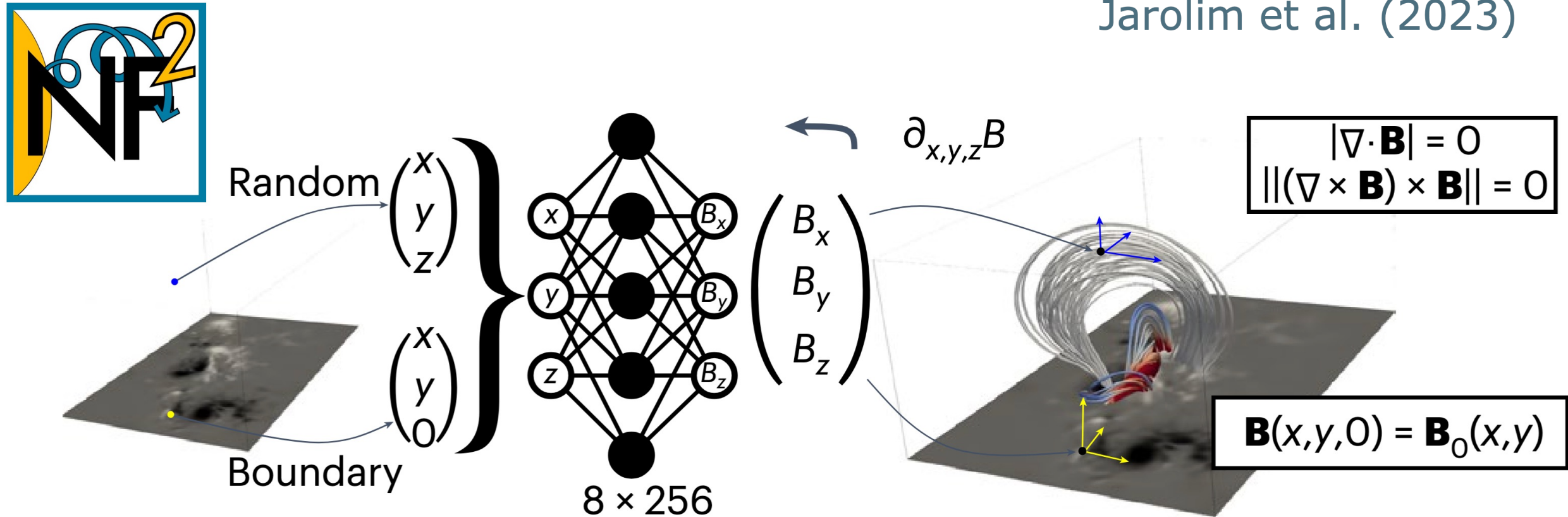
Number of 3D
extrapolations

Epoch	CR No.	SHARP No.	Obs. Start	Obs. End	Extra.
1	2254	8032	22-02-24 08:00	22-03-03 08:00	838
2	2255	8088	22-03-25 20:00	22-04-01 08:00	573
3	2256	8155	22-04-21 18:00	22-04-28 18:00	599
4	2257	8230	22-05-16 18:00	22-05-23 20:00	599
5	2258	8301	22-06-12 18:00	22-06-19 20:00	600
6	2259	8390	22-07-08 08:00	22-07-15 16:00	720

The extrapolations were performed only using HMI for now

NLFFF method: NF² Physics-Informed Neural Network (PINN)

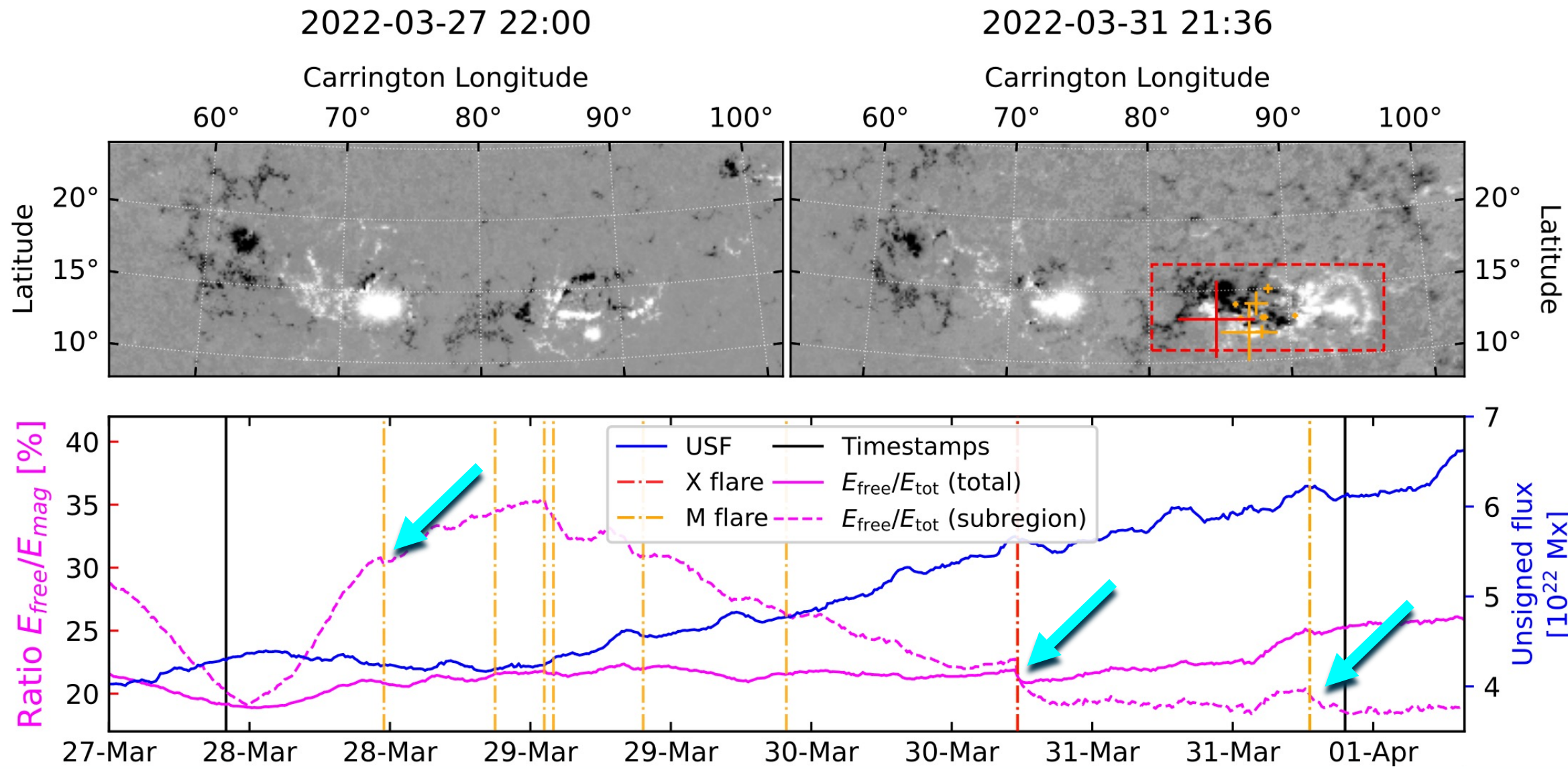
Jarolim et al. (2023)



We have tested and validated the method against the standard benchmark of de Rosa et al. (2015)

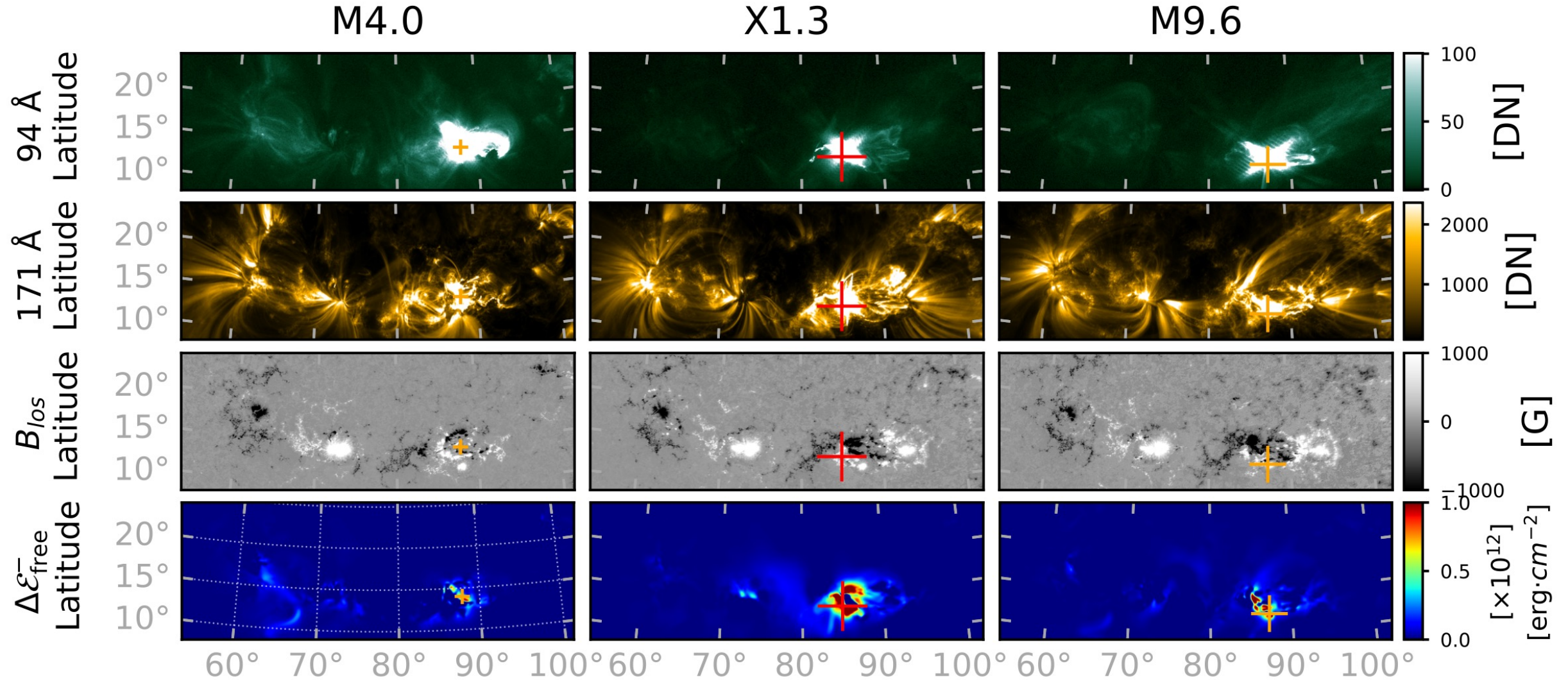
Extrapolation results for CR 2256 (epoch 2)

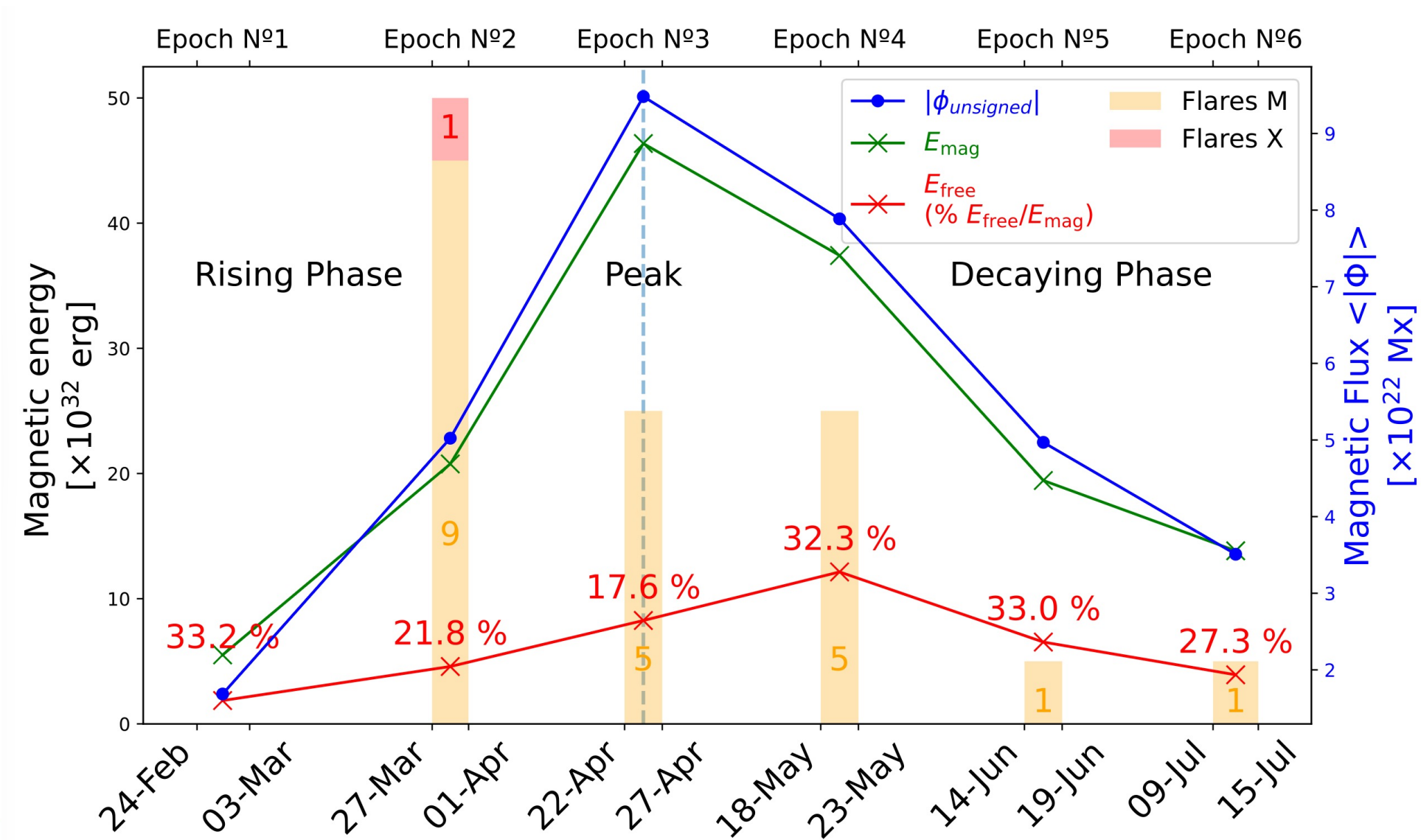
Blaise et al.,
Submitted to A&A

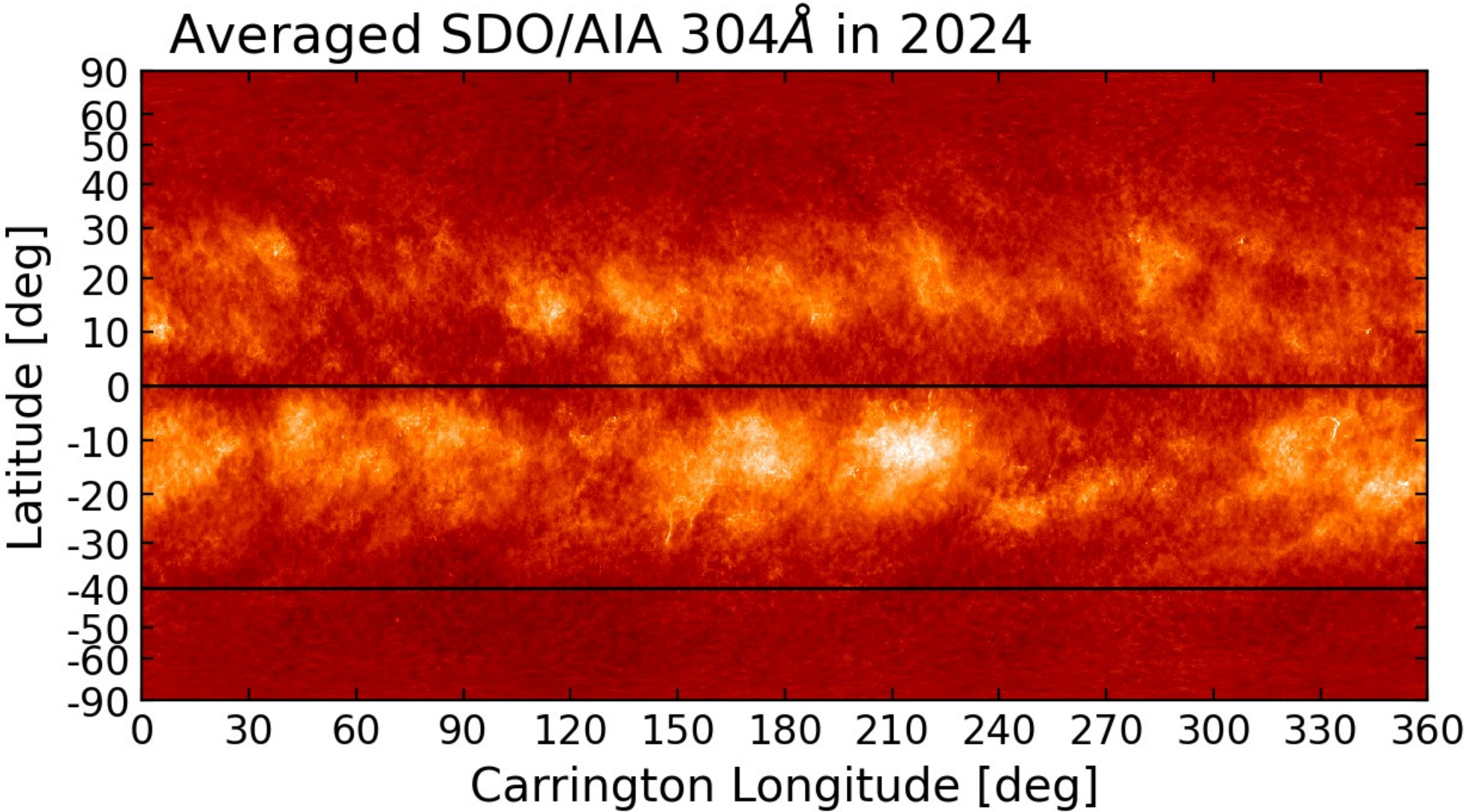


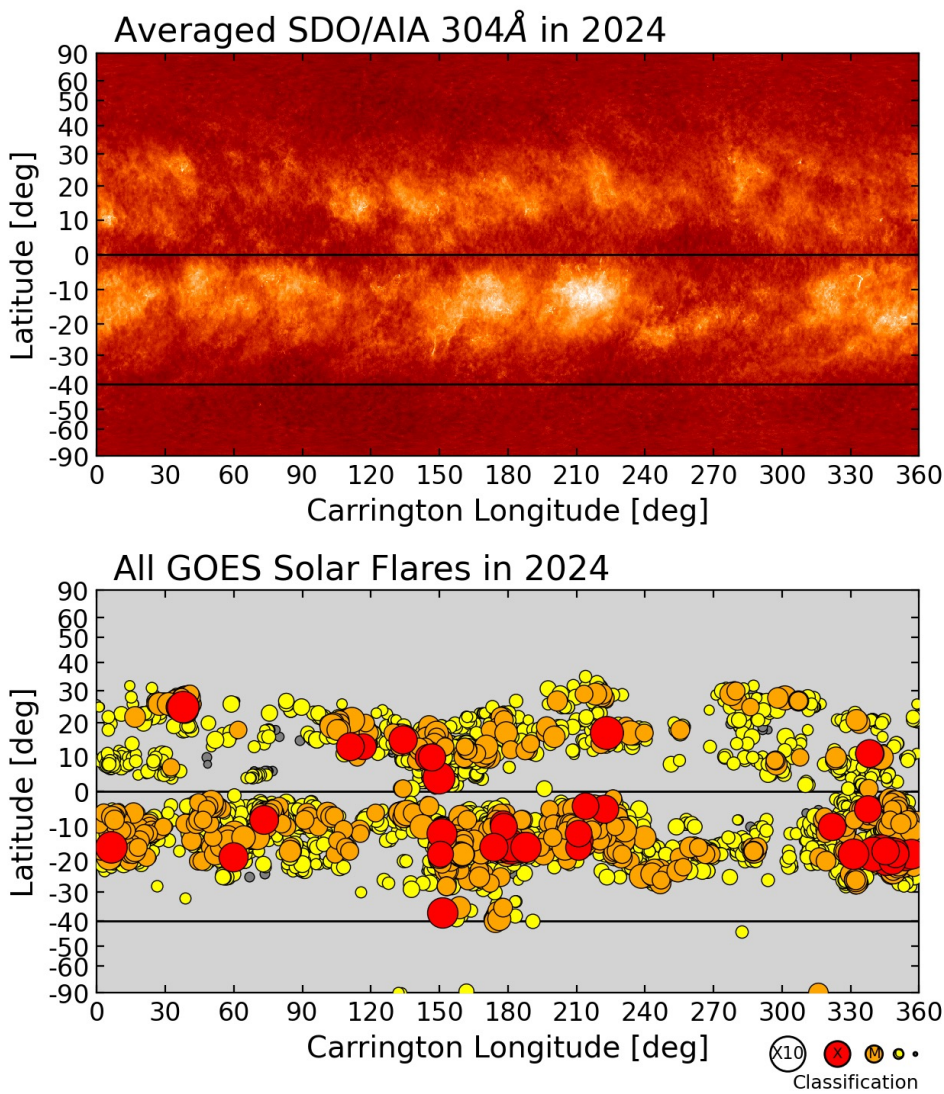
Extrapolation results for CR 2256

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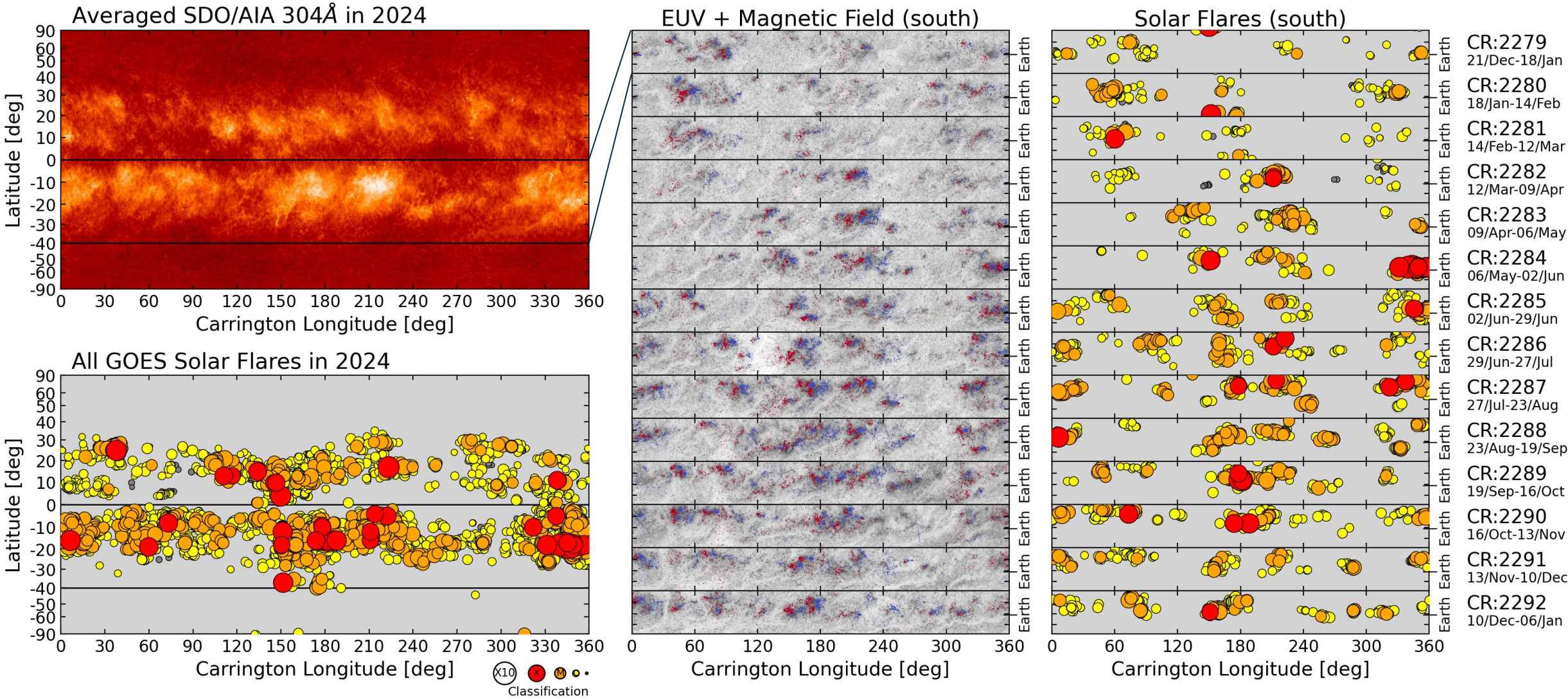






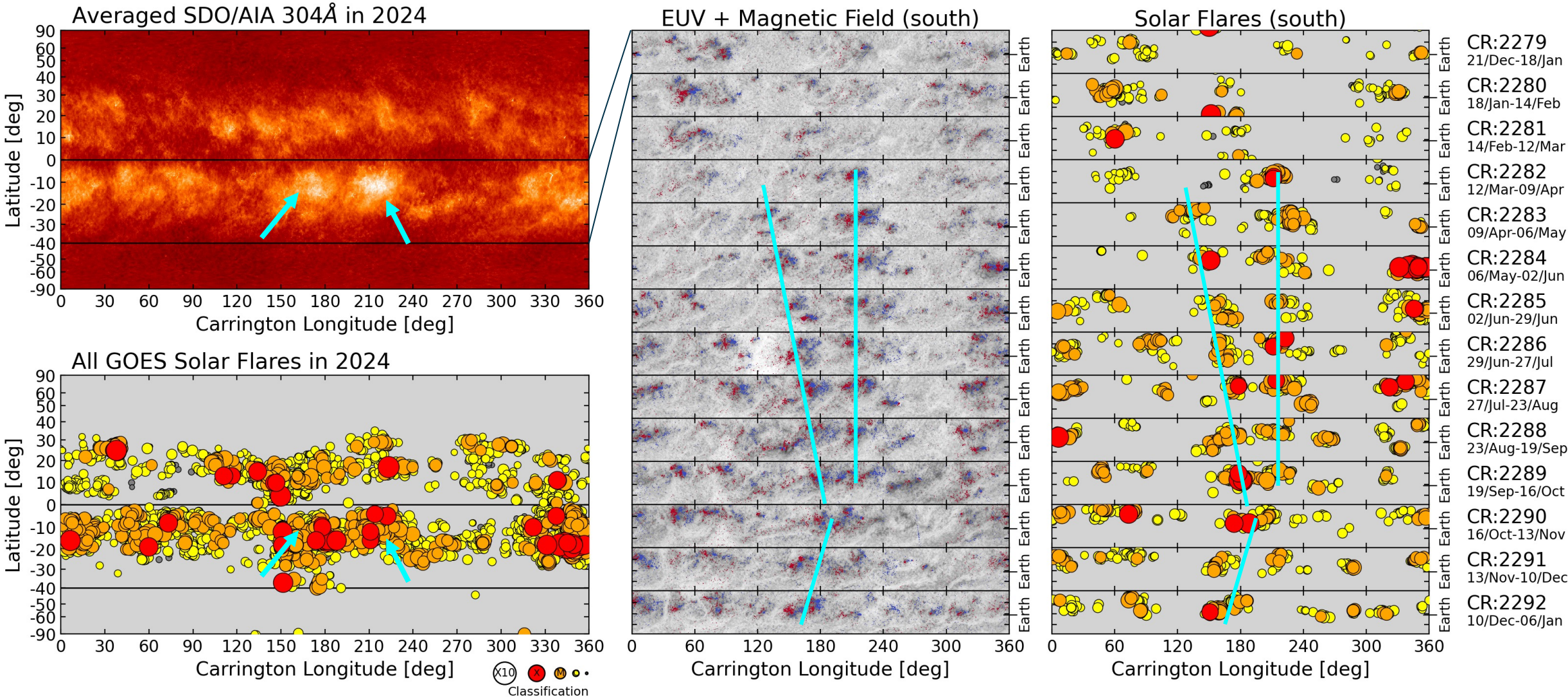
Solar Active Region Nesting in 2024

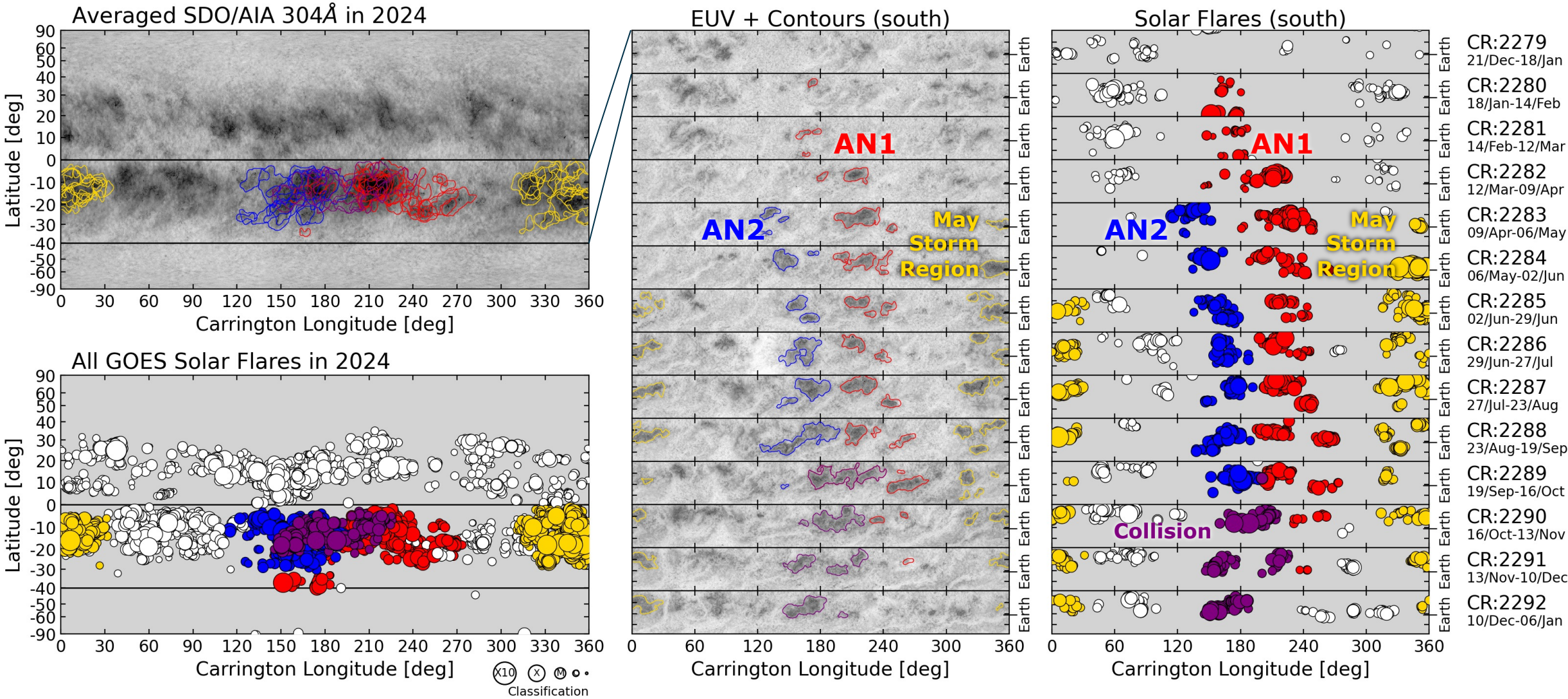
Finley et al.,
Submitted to A&A



Solar Active Region Nesting in 2024

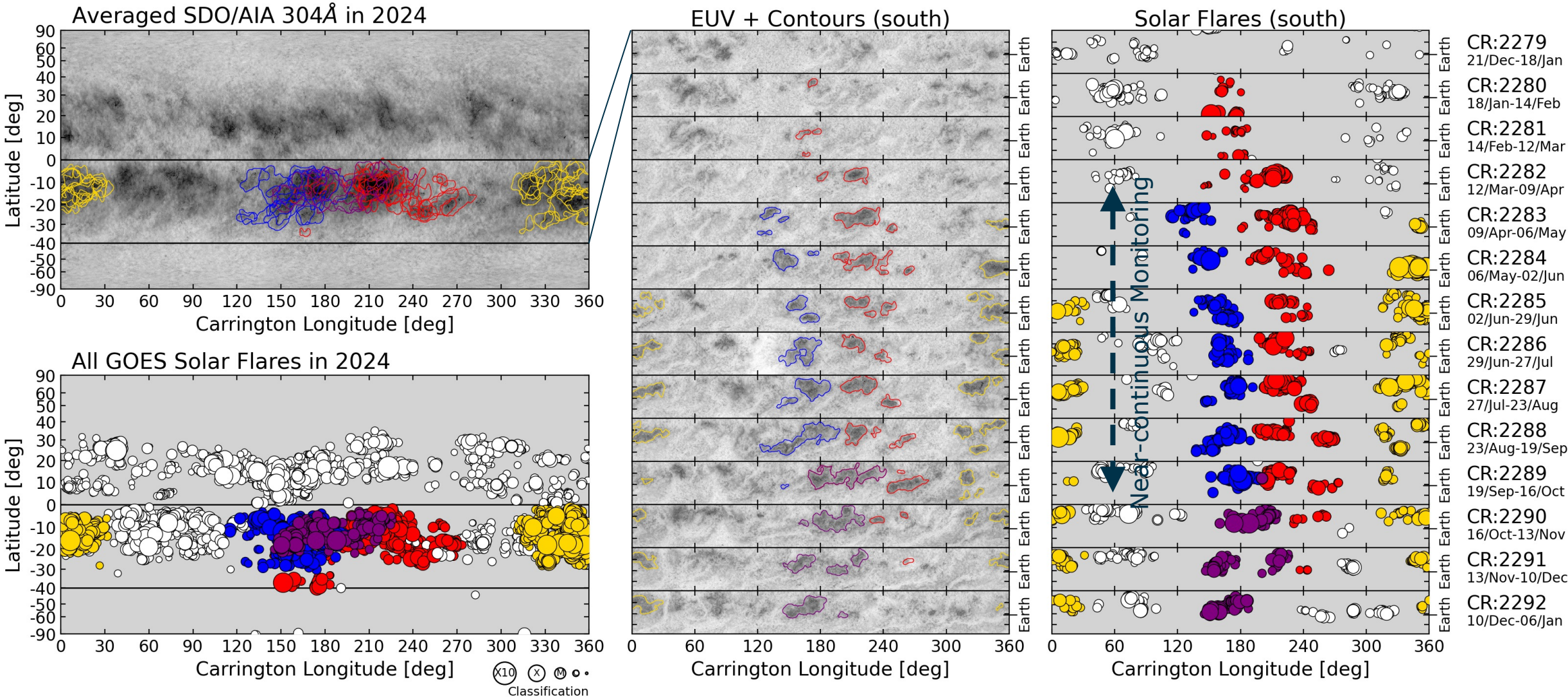
Finley et al.,
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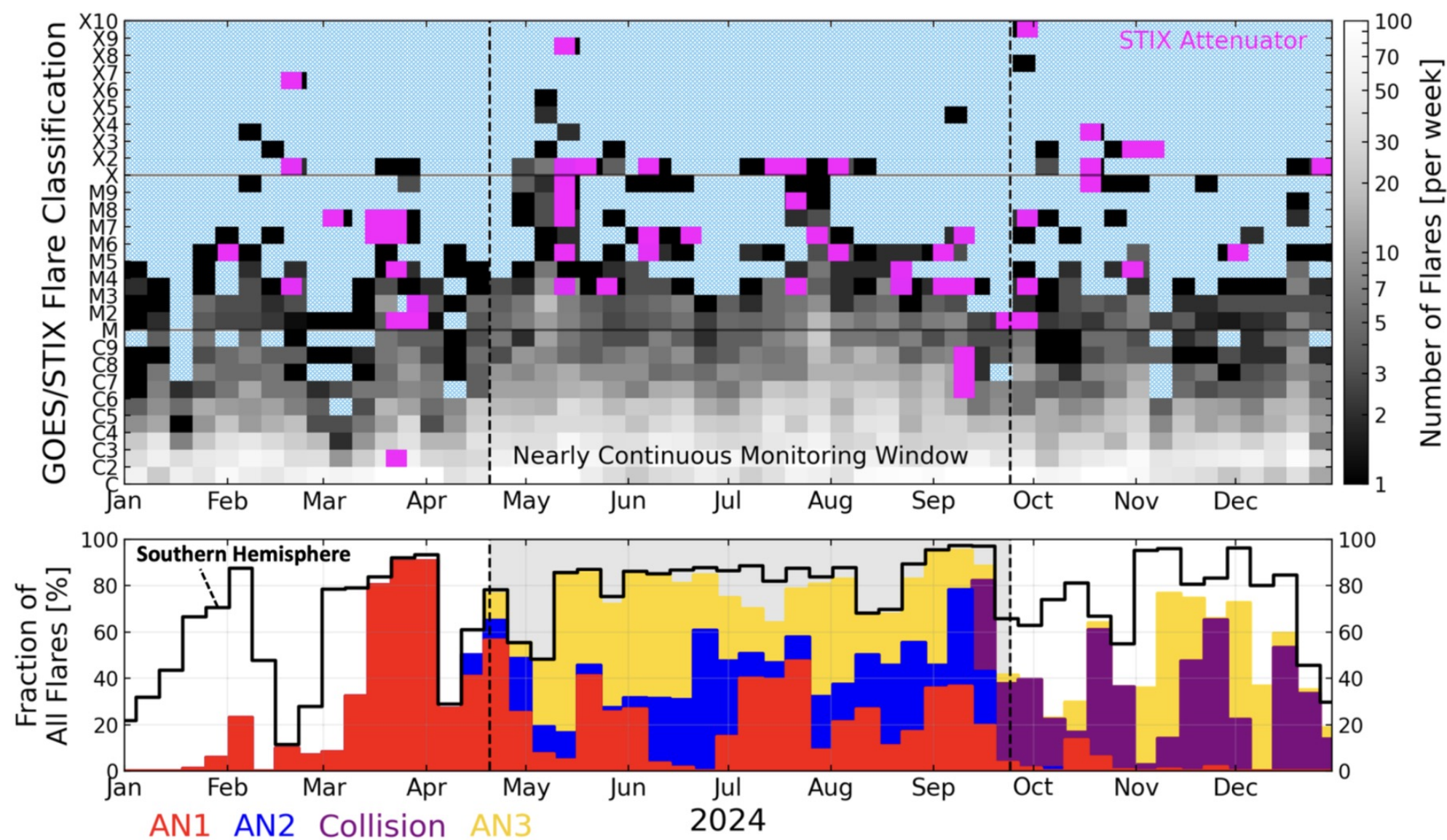
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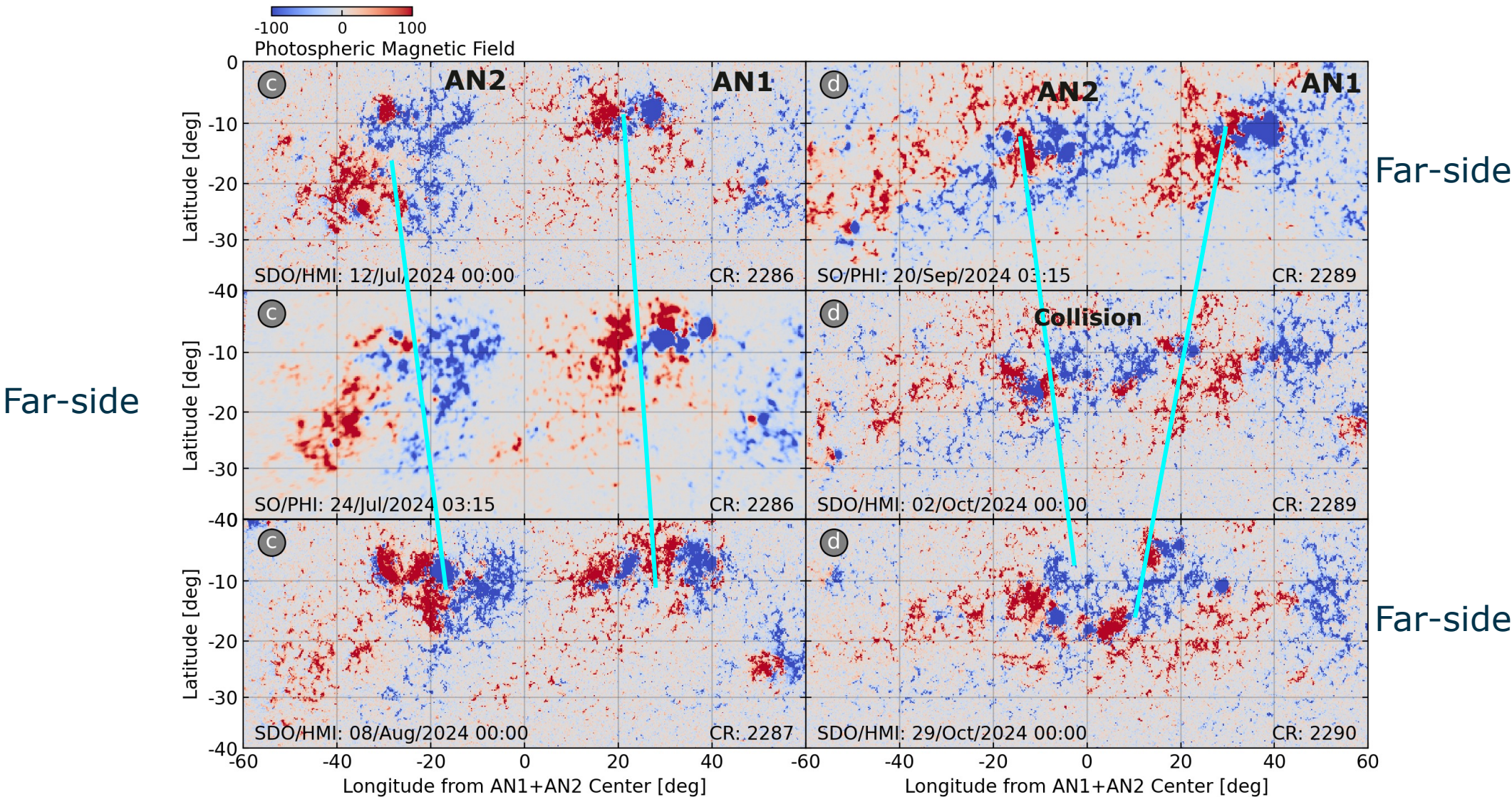
Finley et al.,
Submitted to A&A



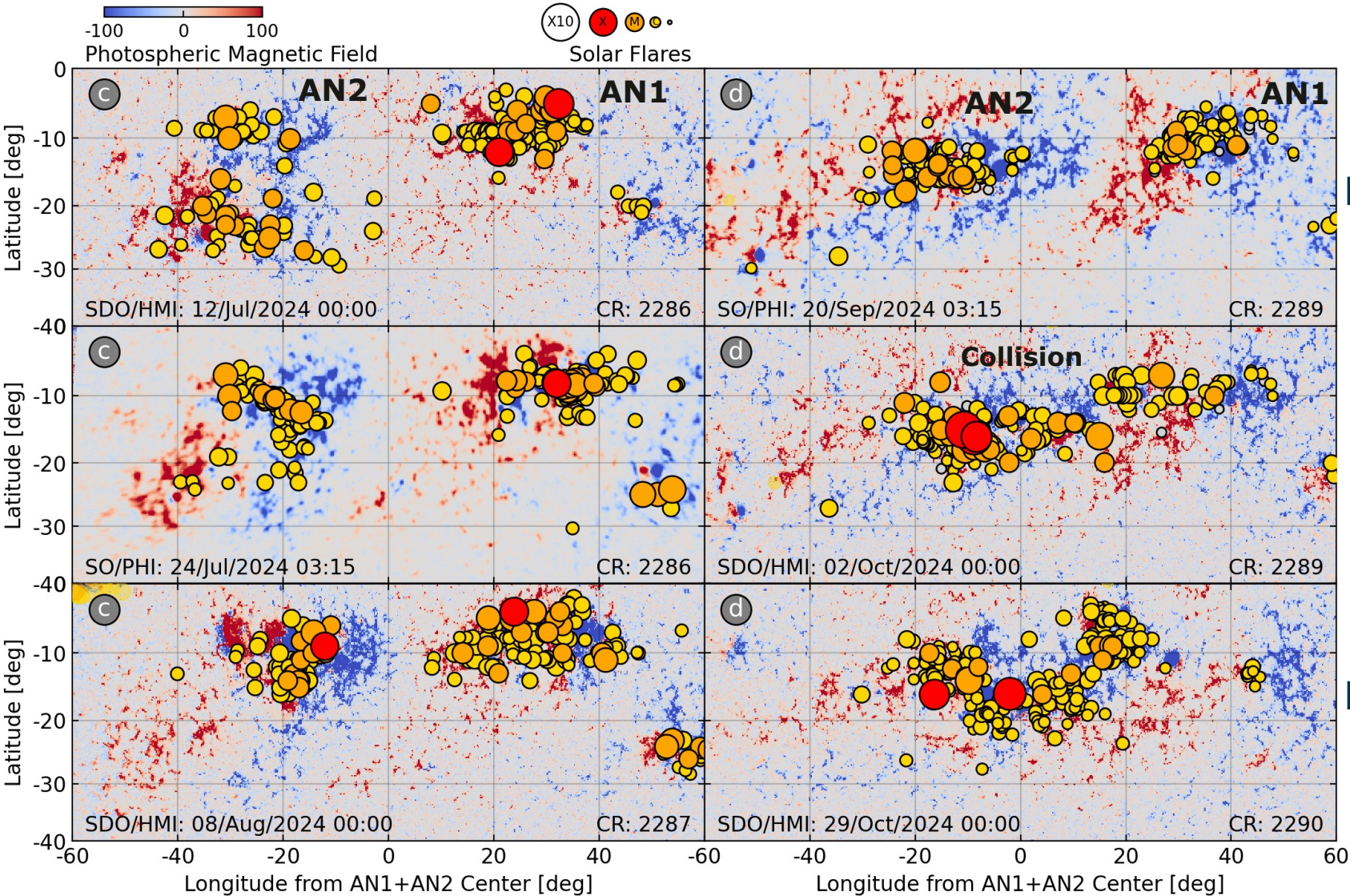
All Solar Flares Observed in 2024

Finley et al.,
Submitted to A&A





Far-side



Far-side

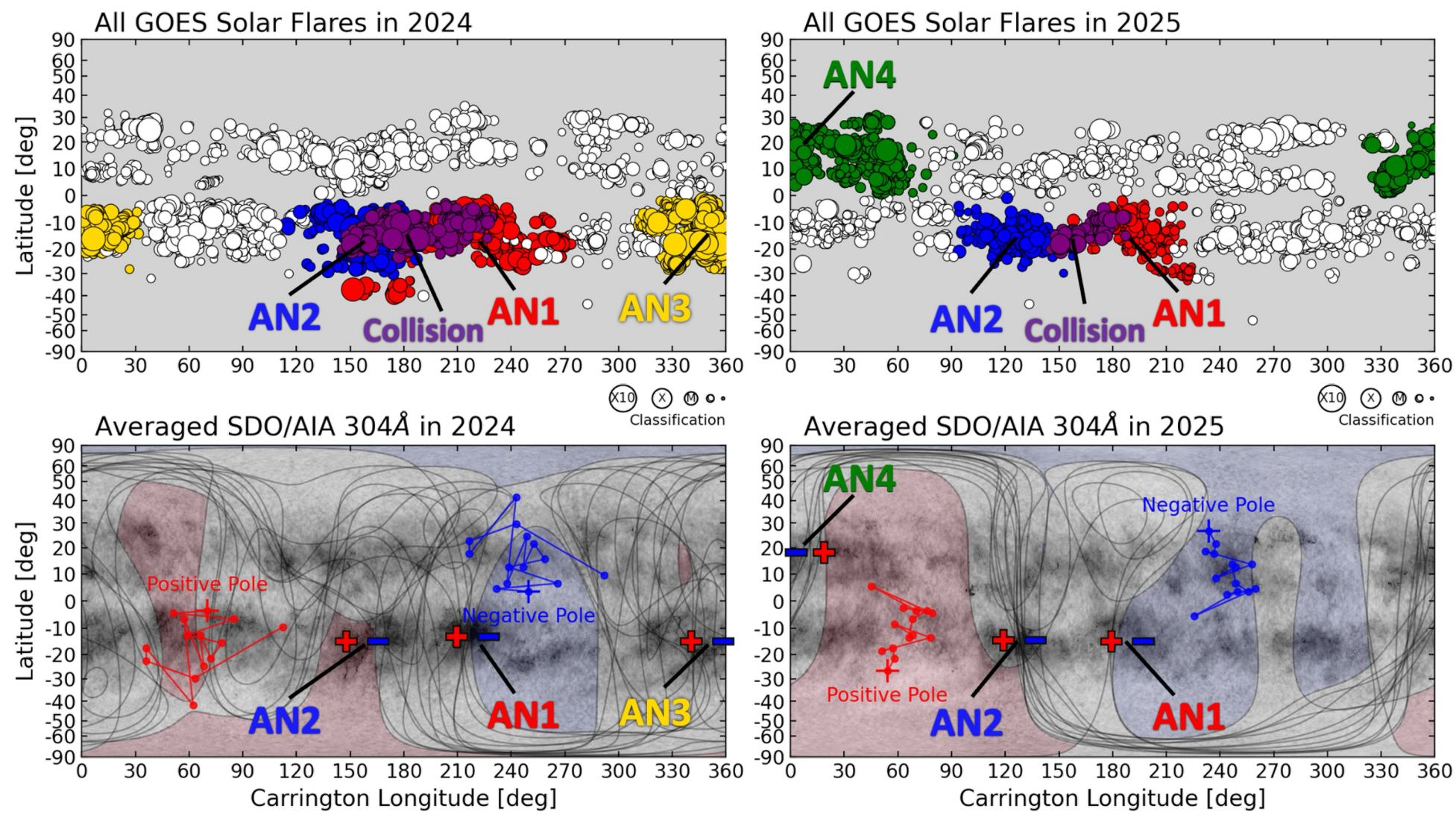
Far-side

Finley et al.,
Submitted to A&A



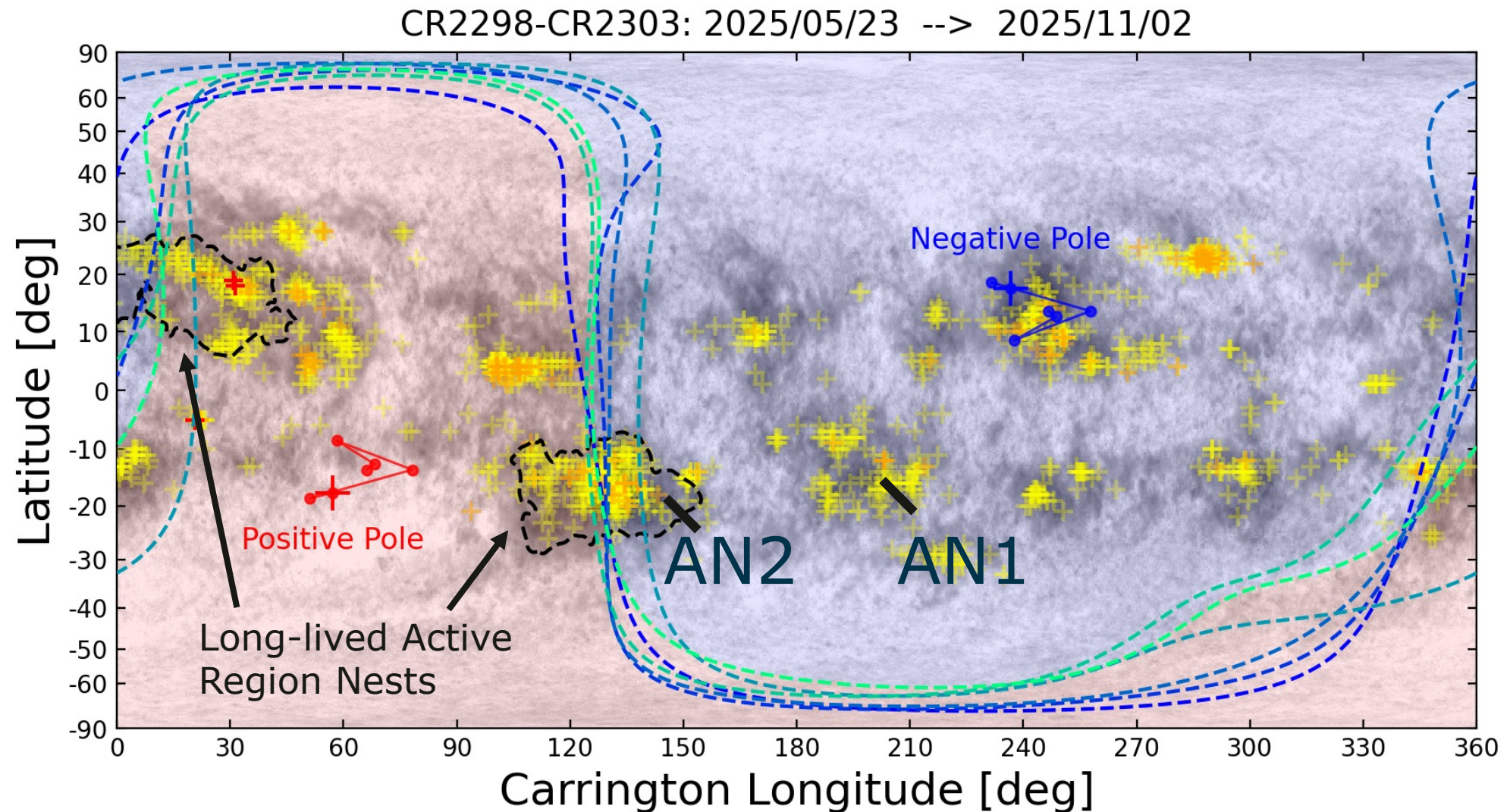
Flip-flopping of Solar Activity in 2025

Finley et al.,
Submitted to A&A



Heliospheric Magnetic Field, May-November 2025

Finley et al.,
Submitted to A&A



Conclusions

Nesting plays a key role in shaping solar activity and the Sun's large-scale magnetic field (**Finley et al. 2025**).

With the help of efficient extrapolation tools (like NF²), we can now attempt to assess the evolution of the (magnetic) energetics over yearly timescale (**Blaise et al., submitted to A&A**)

Leveraging multiple viewpoints to have almost constant time-coverage for the extrapolations is possible but remains to be done

The importance of nesting remains true solar maximum (**Finley et al., submitted to A&A**).

Let's build tools that exploit nesting for short-medium term forecasting!