THE CRITICAL MISSING LINK FOR FORECASTING LONG-TERM SOLAR VARIABILITY

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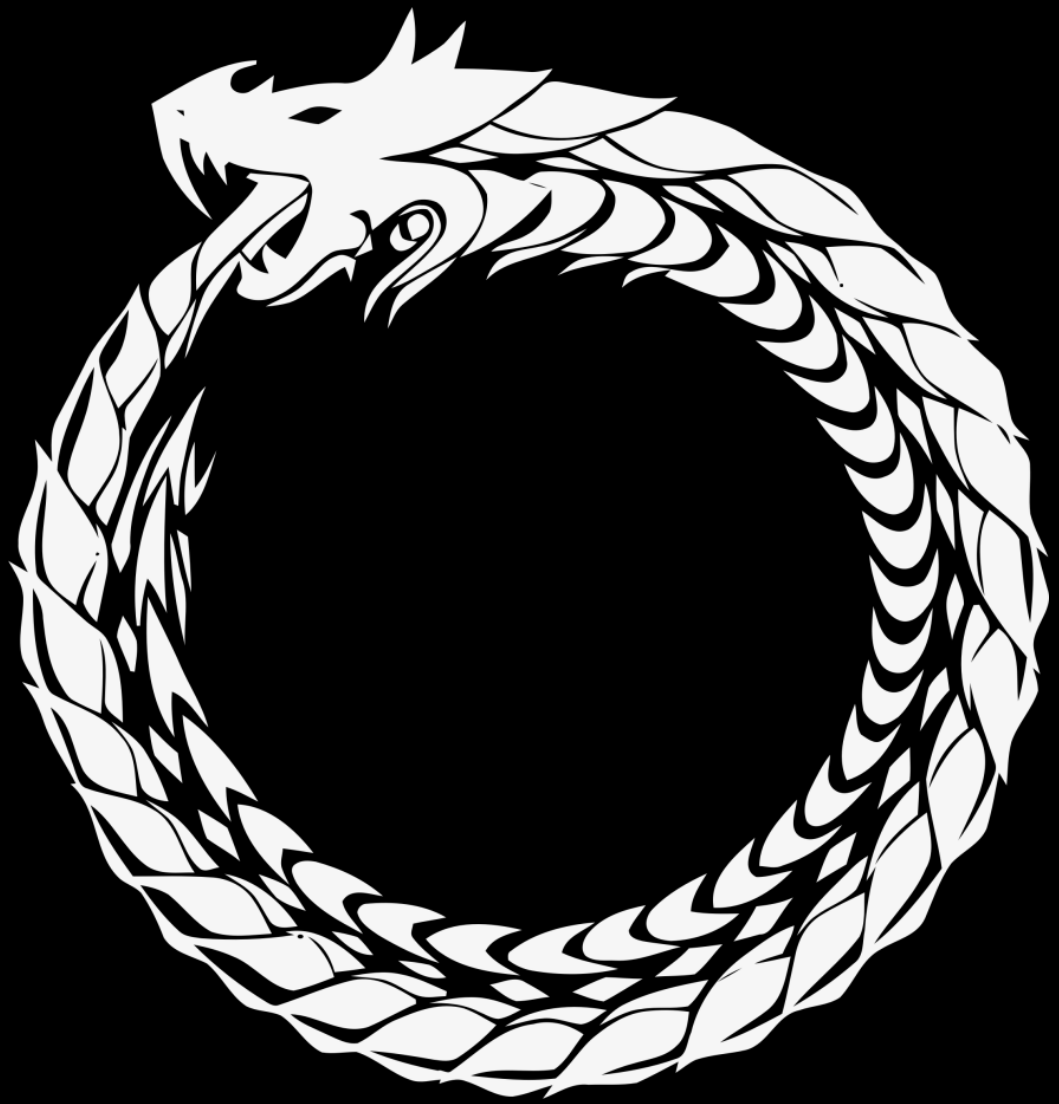
TAKE HOME MESSAGE

- The solar cycle propagates through the alternation of deterministic and stochastic phases.

- Predicting short term and long-term solar variability is like playing a game of chance that uses loaded dice (bipolar magnetic regions, BMRS).

- In order to increase our probability of success we need to understand as much as possible the way the dice are loaded.

- But for this, we need a homogeneous long-term BMR catalog.



HOW DOES THE SOLAR CYCLE OPERATE?

SOLAR CYCLE PROPAGATION

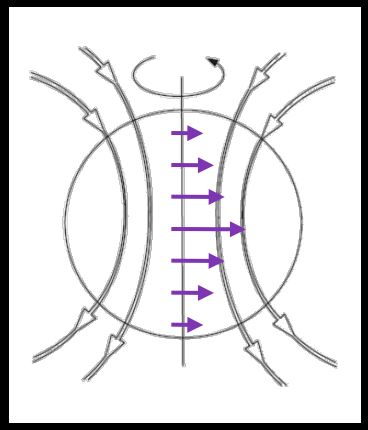
Poloidal

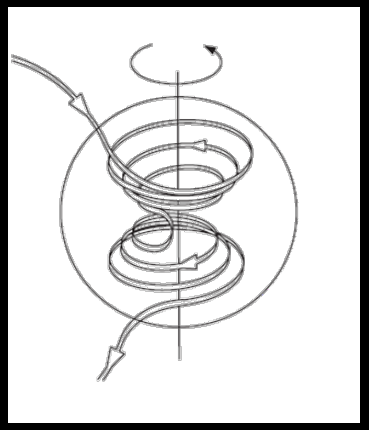
r - θ

Differential Rotation

Toroidal

ϕ





Credit: J. J. Love

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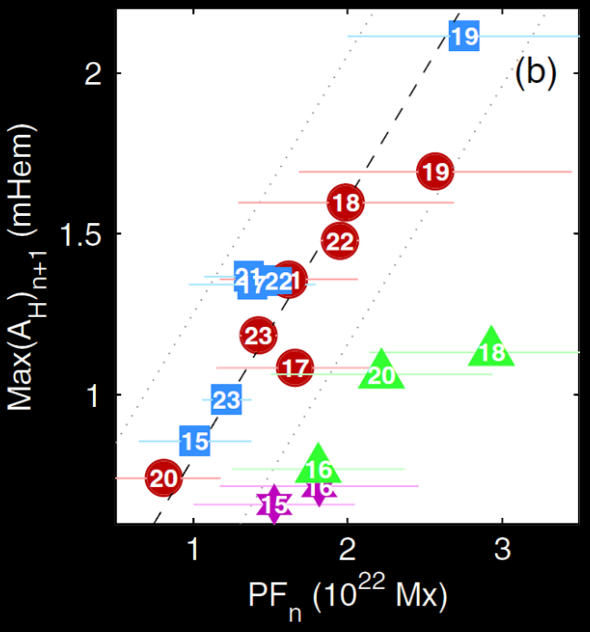
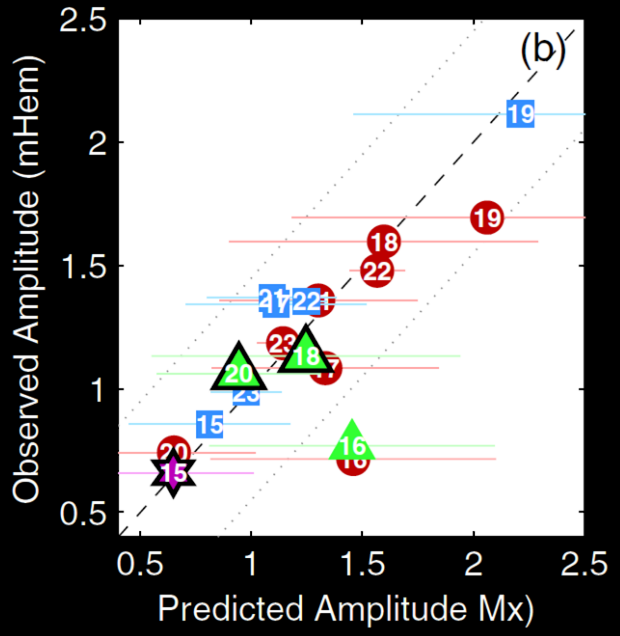
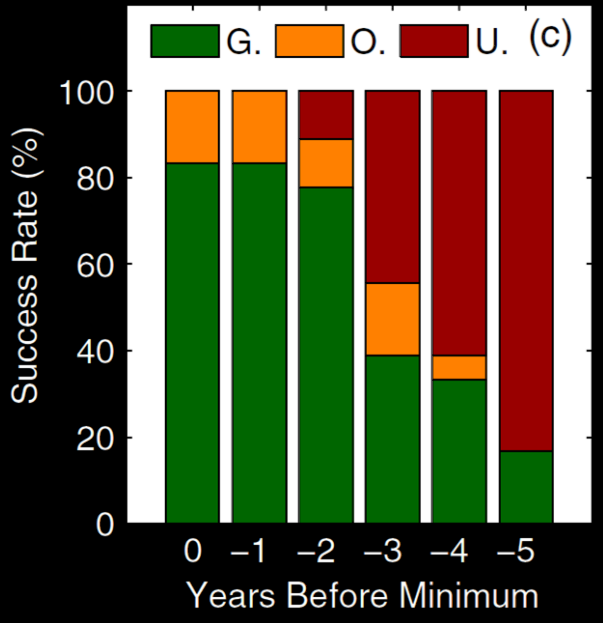
Muñoz-Jaramillo et al. (2013)







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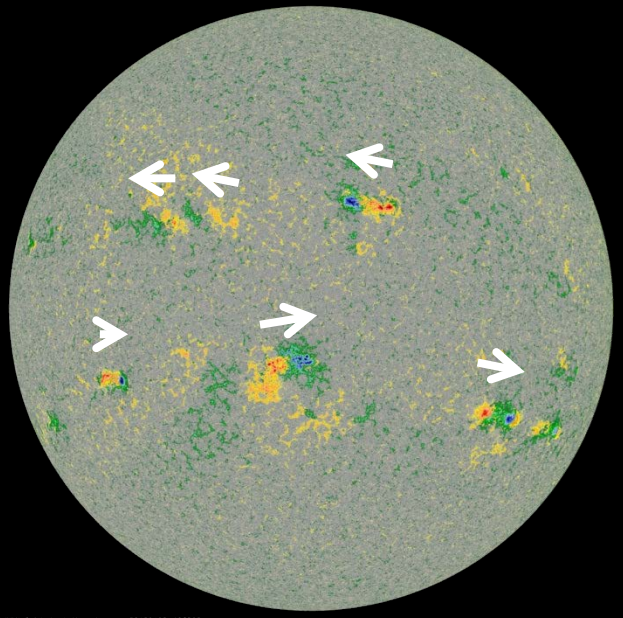
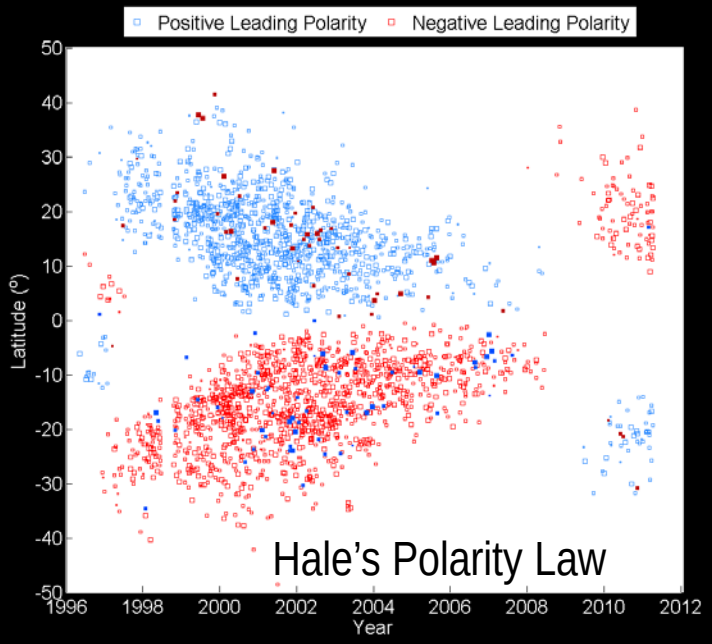
Emergence and Decay of Tilted Active Regions





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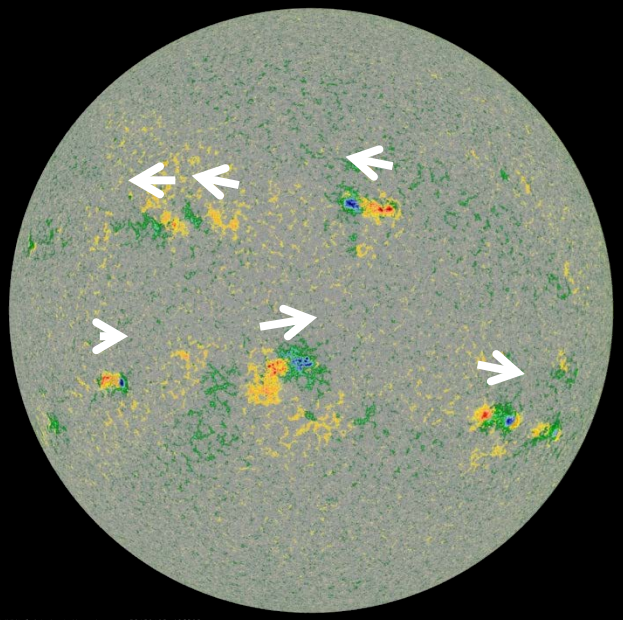

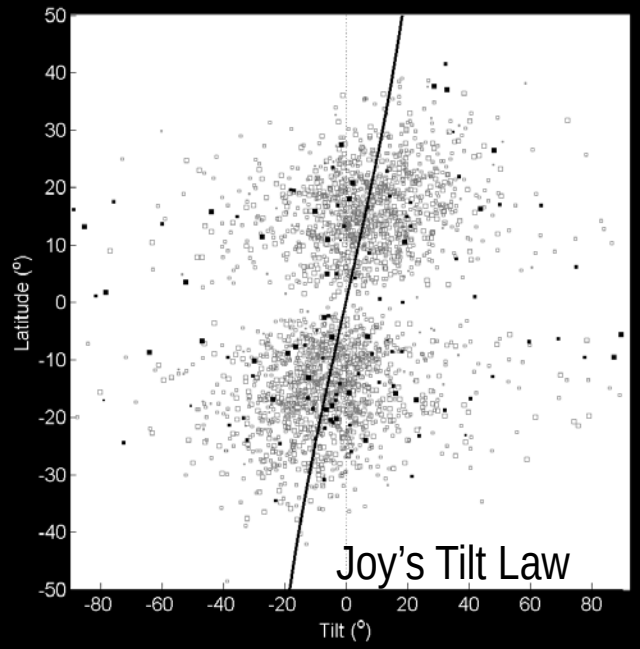

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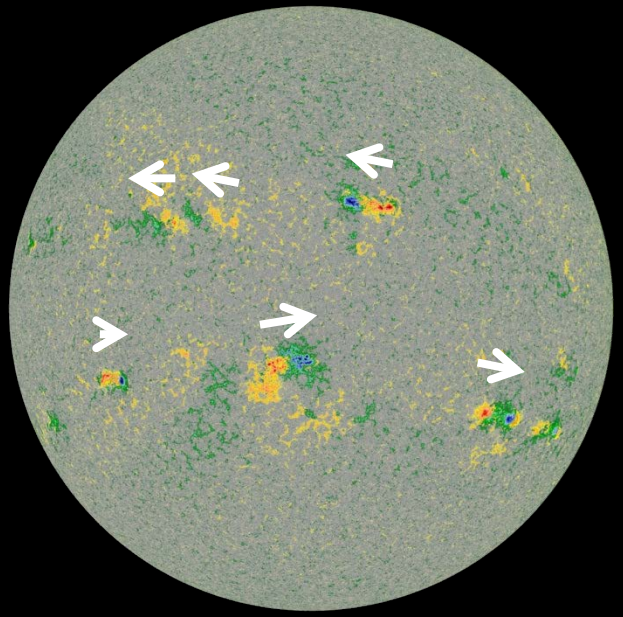

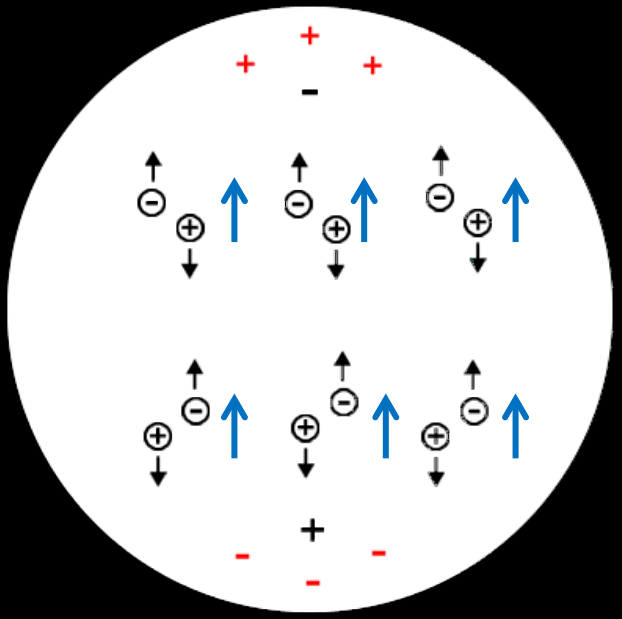

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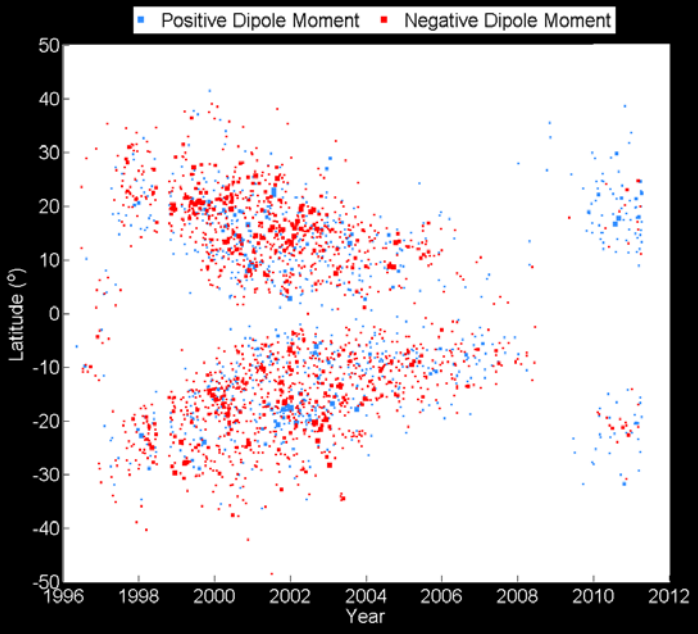
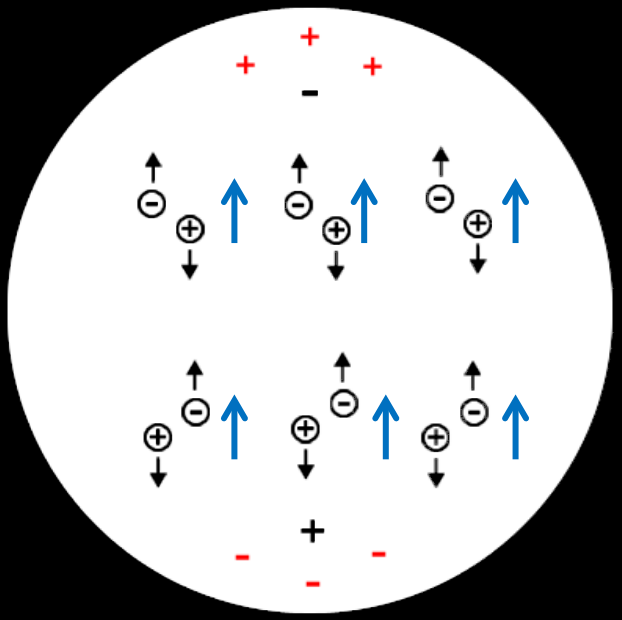
Emergence and decay of tilted bipolar magnetic Regions





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Emergence and decay of
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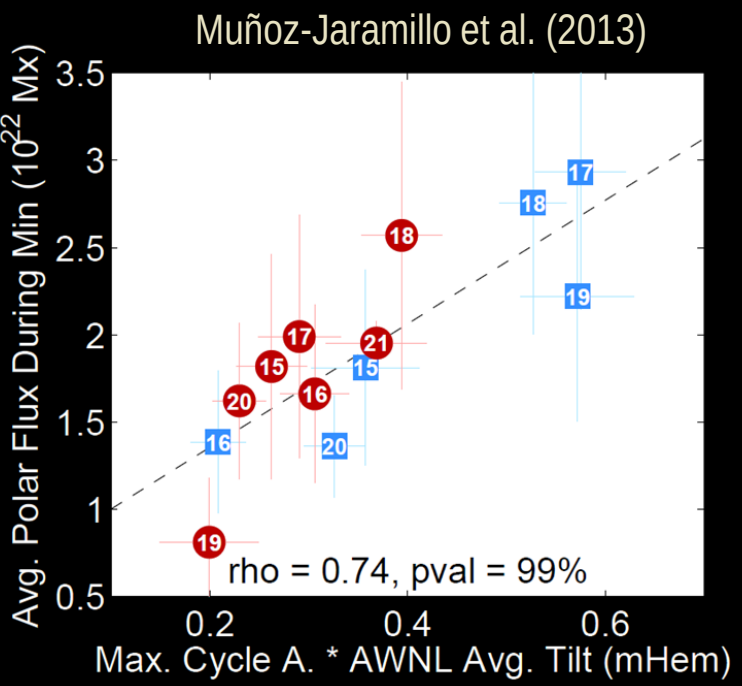
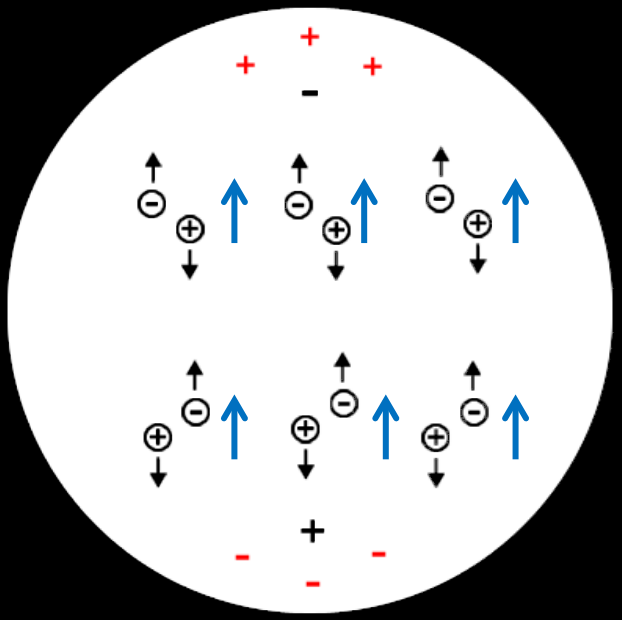
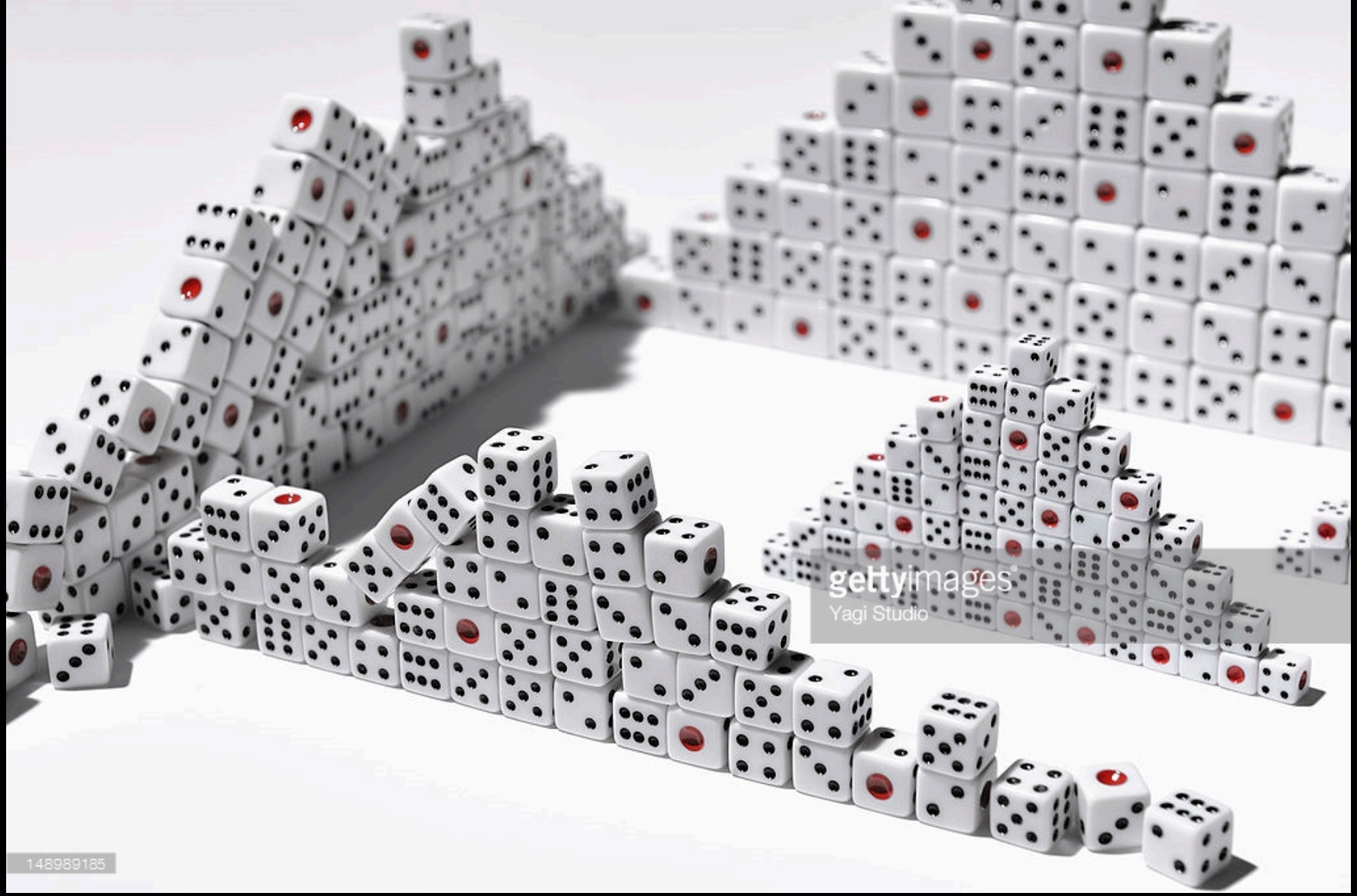
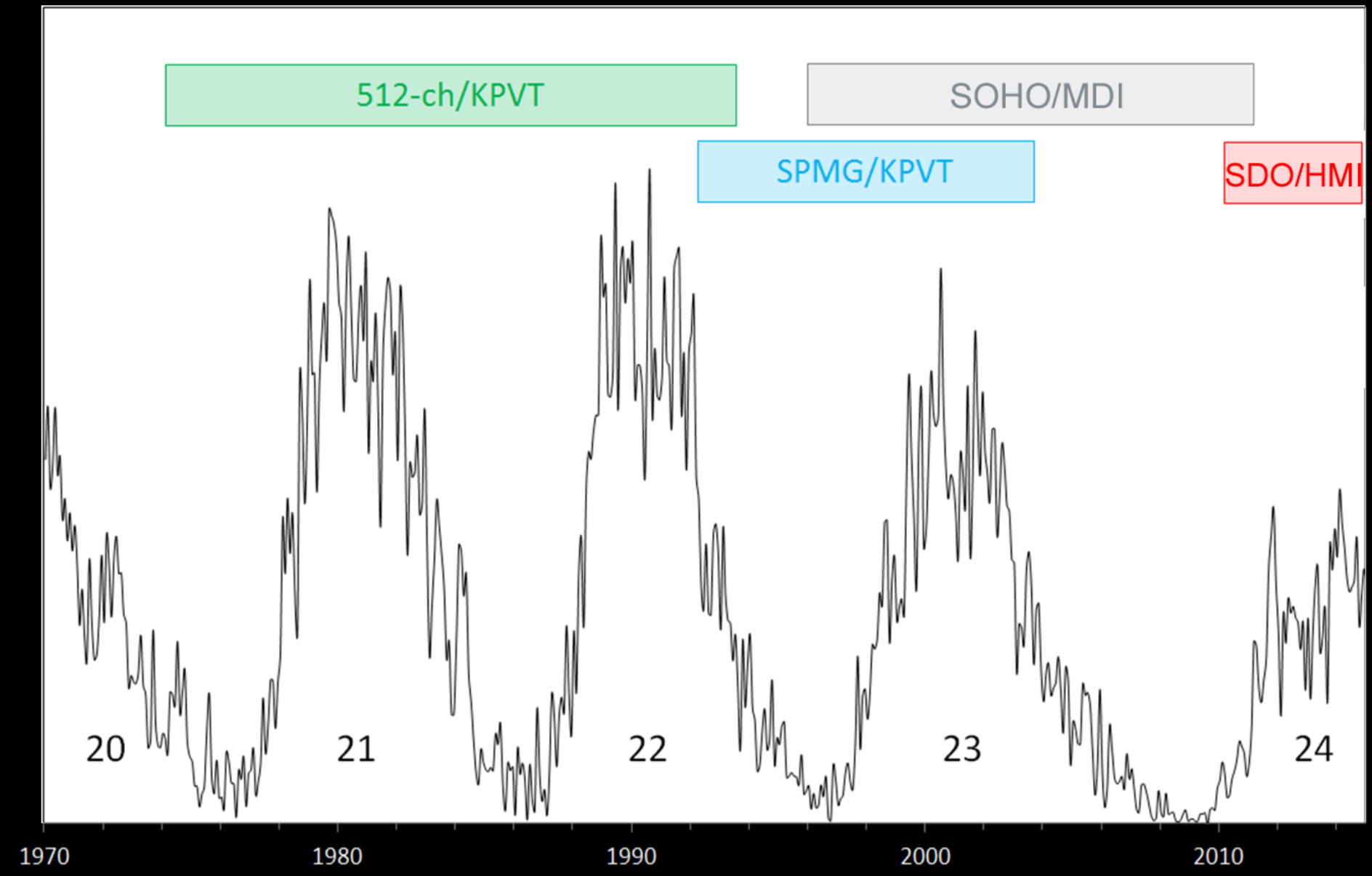




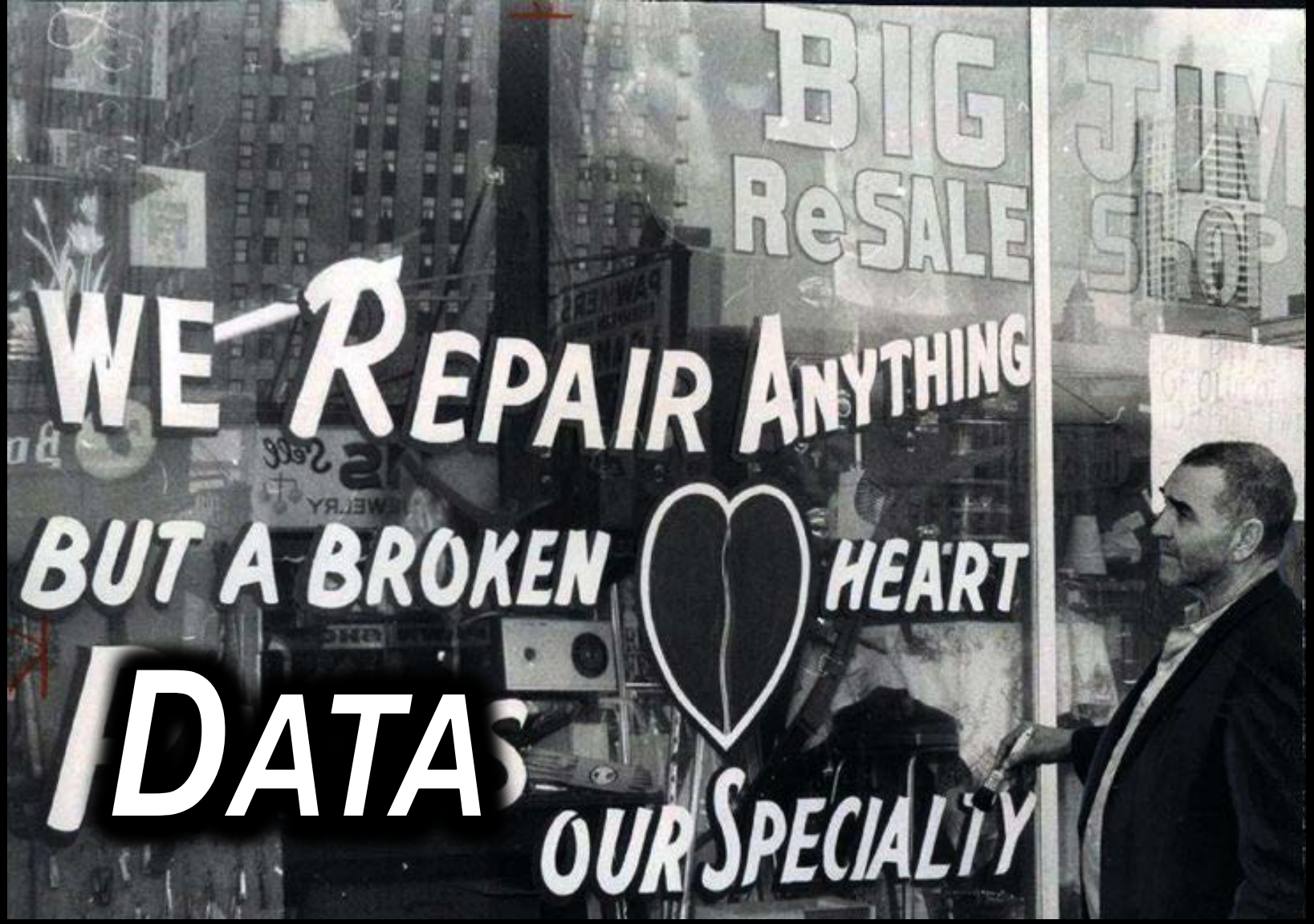


BMRs are the building blocks of the solar cycle.

The problem is that there is no long-term BMR database

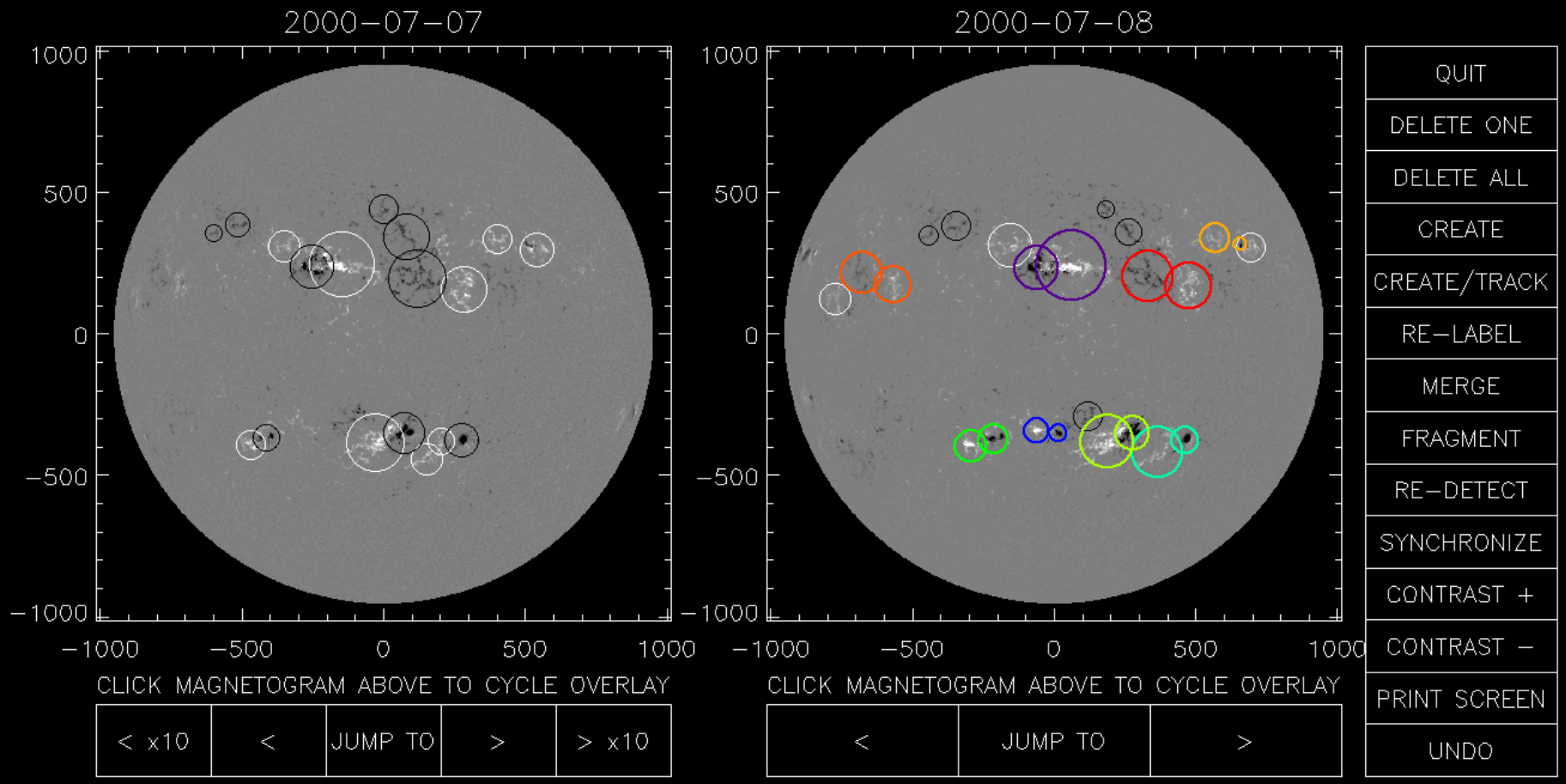


KPVT Data are underutilized because it has some outstanding problems



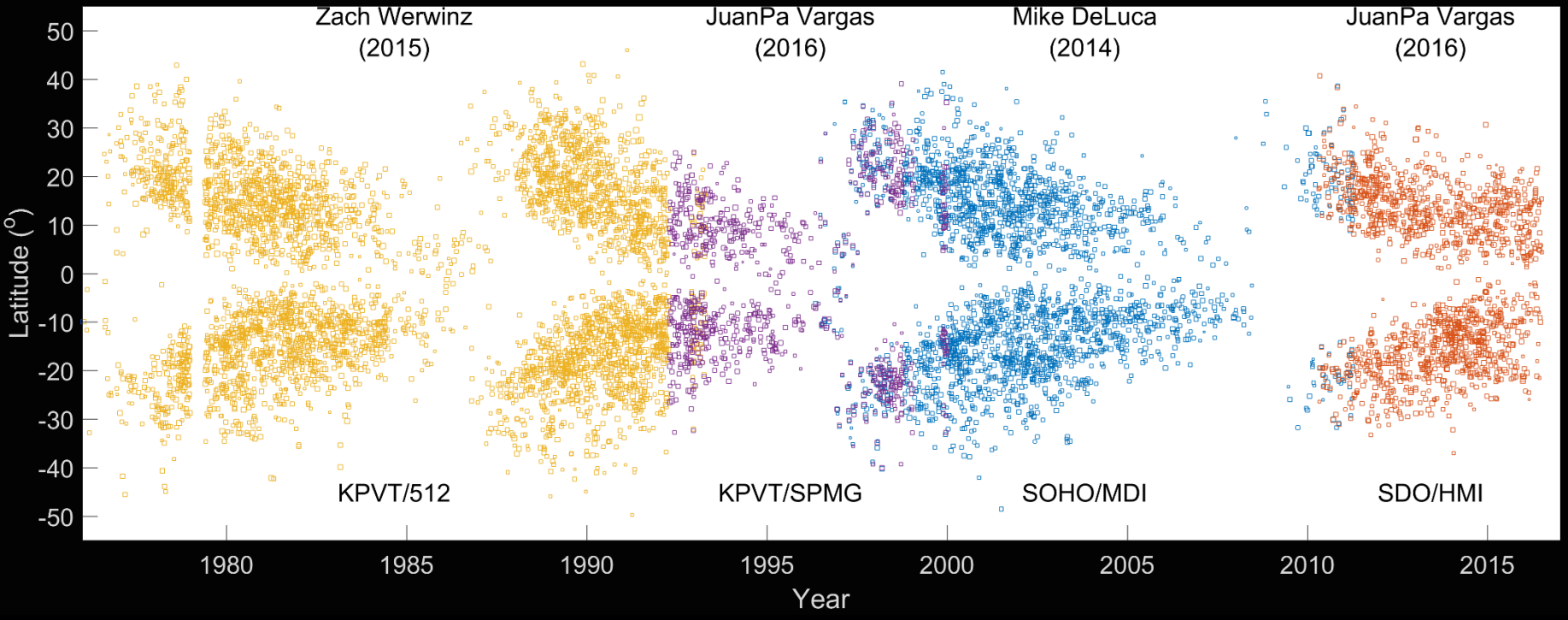
We have fixed nearly 6000 KPVT and SPMG magnetograms

We use a human supervised automatic detection code to detect and characterize BMRs



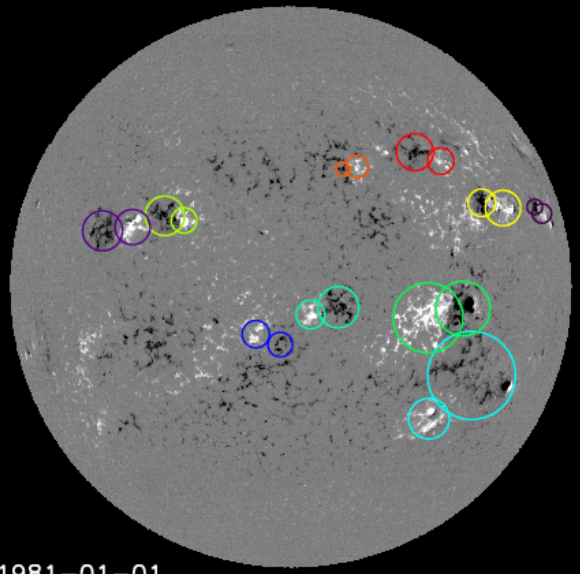
A human observer corrects pairing and labeling errors. Only about 5% of bipolar magnetic regions needs intervention.

Current Status



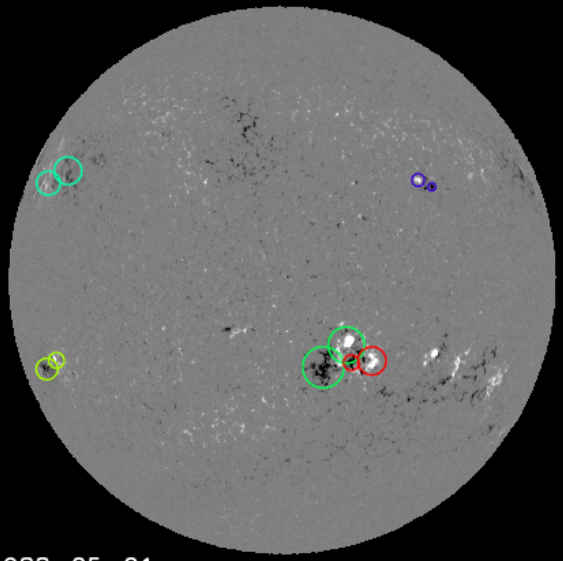
KPVT-512, KPVT-SPMG, SOHO/MDI, SDO/HMI done (6,885 unique objects detected and tracked).

Cycle 21



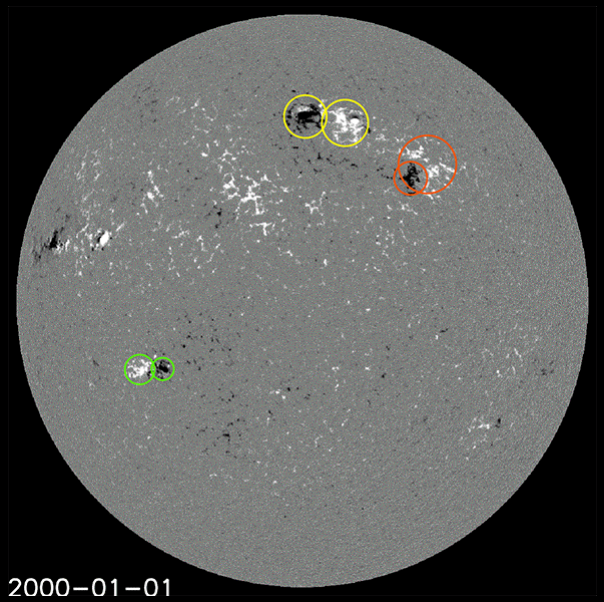
1981-01-01

Cycle 22



1988-05-01

Cycle 23



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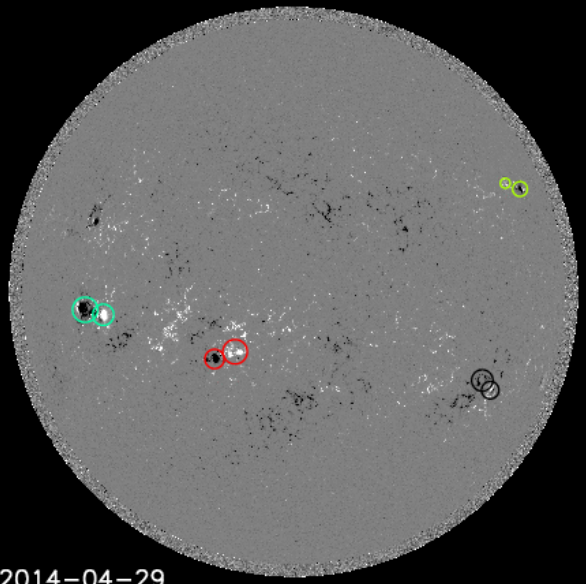
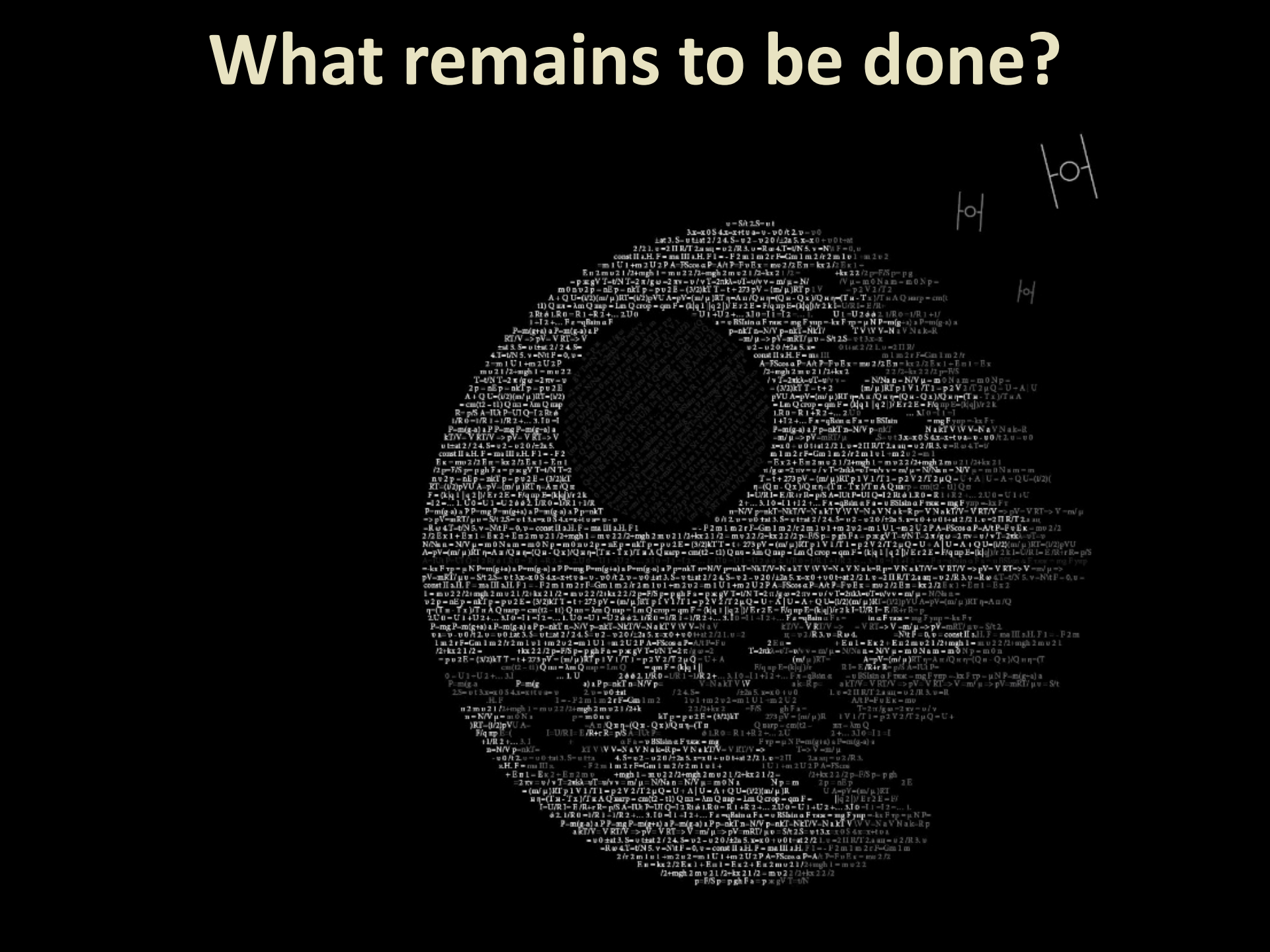
Cycle 24



2014-04-29

What remains to be done?



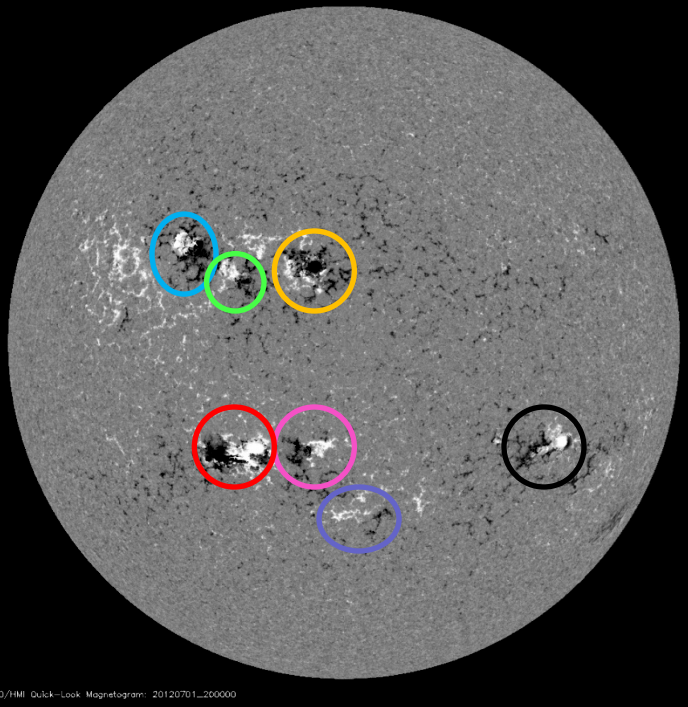
What remains to be done?

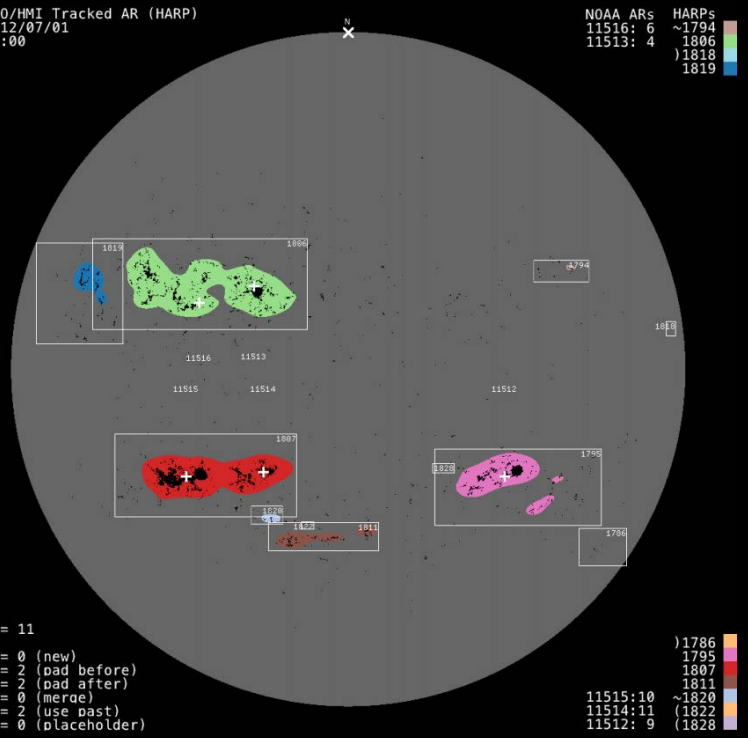
- We are doing a terrific job at cross calibrating magnetograms belonging to different instruments.
- We are going to focus bigly on identifying BMR returns and NOAA catalog matches.
- We would like to integrate our database and methodology to the NOAA catalog. It would be amazing!
- We are going to share these data all over the place so that together we can fulfill their tremendous potential.

It’s gonna be a yuuge success!


MAKE FORECASTING GREAT AGAIN

Active Regions (ARs) vs. Bipolar Magnetic Regions (BMRs)





- Bipolar Magnetic Region: Photospheric signature of an emergent flux-tube, originating inside the convection zone.
- Active Region: Magnetically connected region from which space weather events originate.