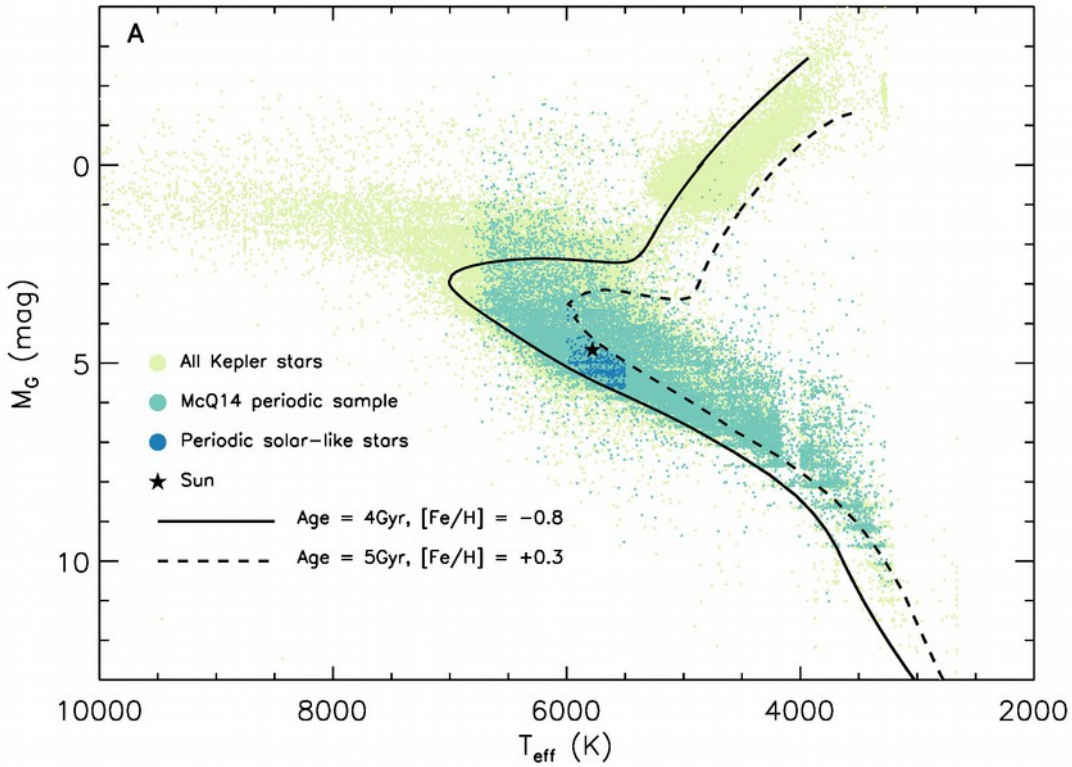
Why is the Sun less active than (some) other solar-like stars?

Travis Metcalfe (SSI)
Jen van Saders (U.Hawaii)

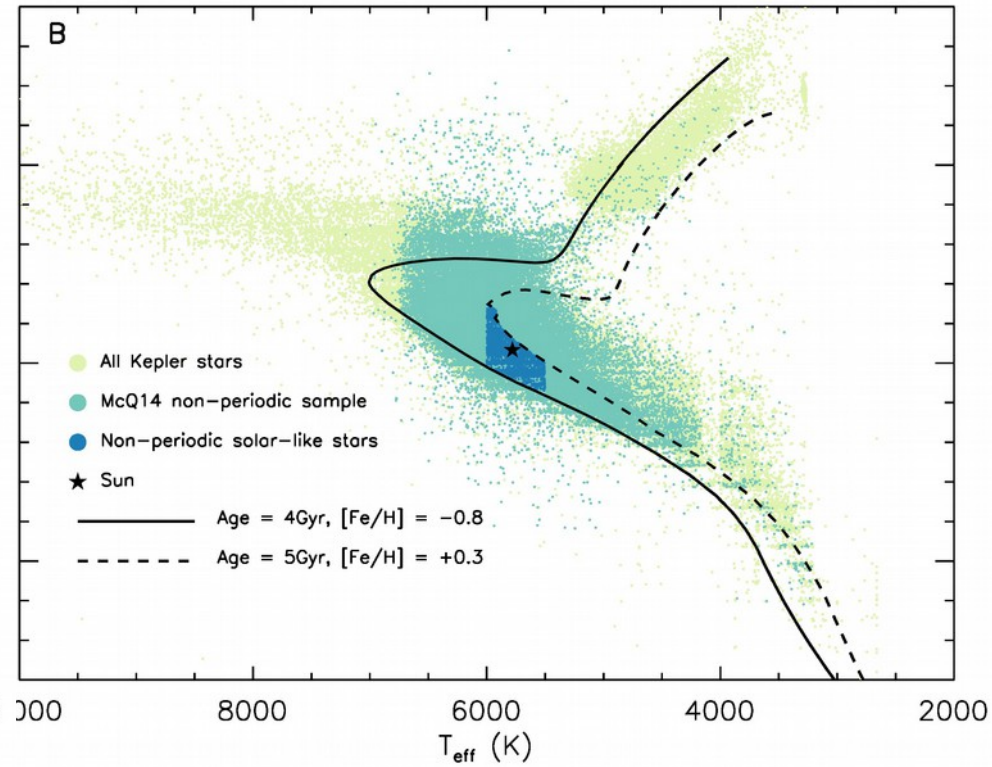
An analysis of stellar samples from Reinhold+ (2020, arXiv:2005.01401)

Sample selection

periodic



non-periodic

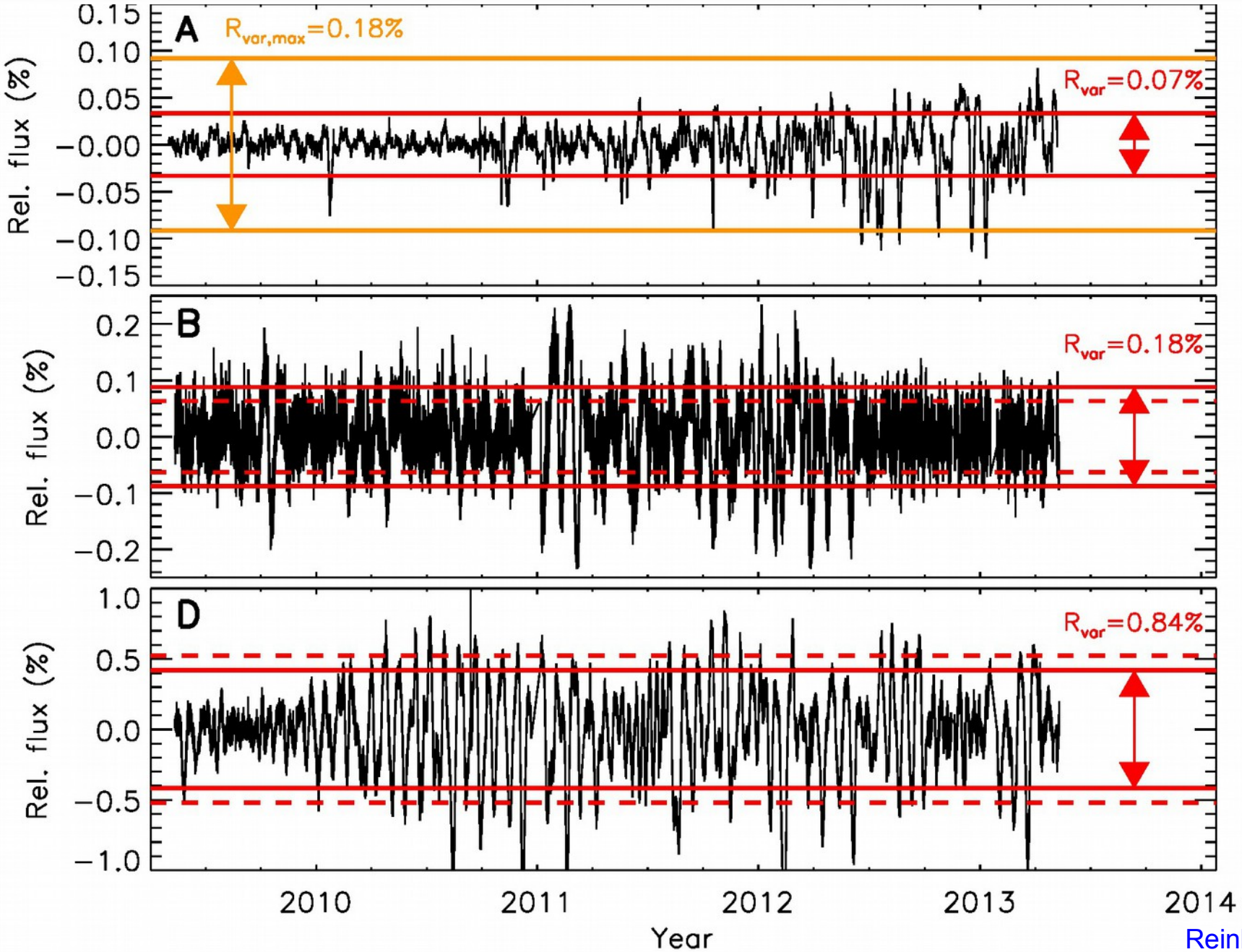


- 369 “solar-like” stars
- Rotation: 20-30 days
- 13% of composite sample

- 2529 “pseudo-solar” stars
- Rotation: not detected
- 87% of composite sample

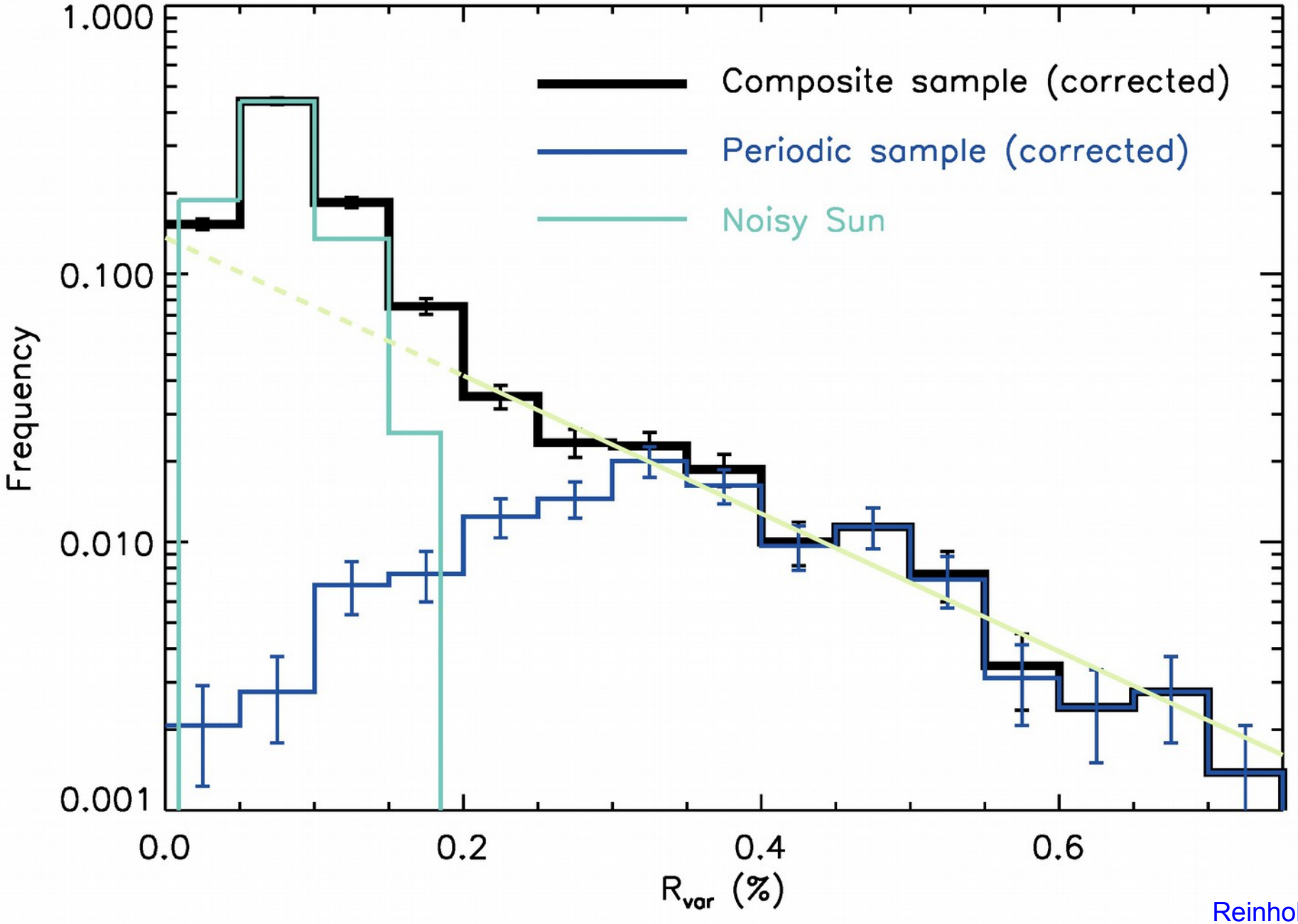
Reinhold+ (2020)

Range of variability



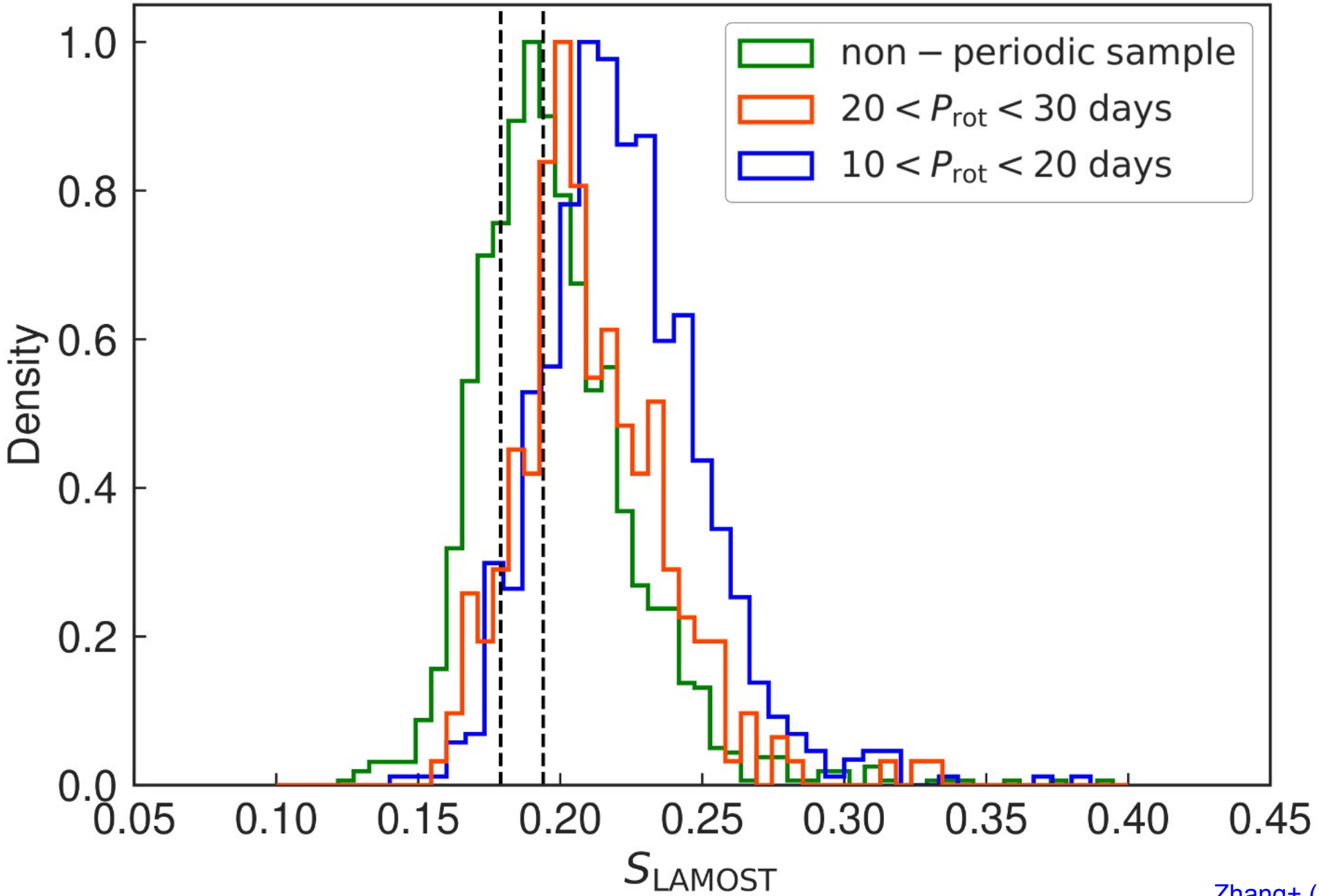
Reinhold+ (2020)

Variability distribution



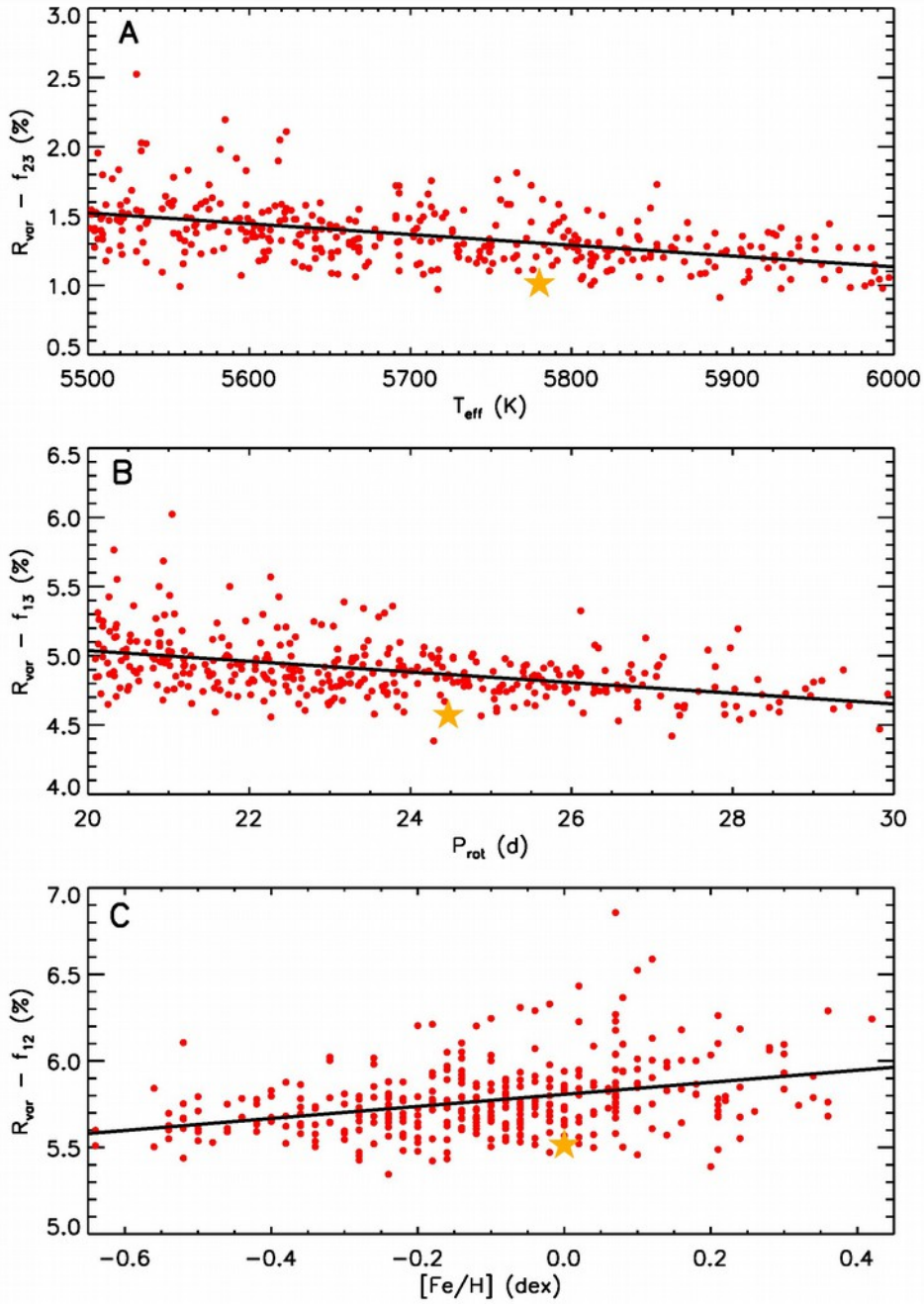
Reinhold+ (2020)

Activity distribution



Zhang+ (2020)

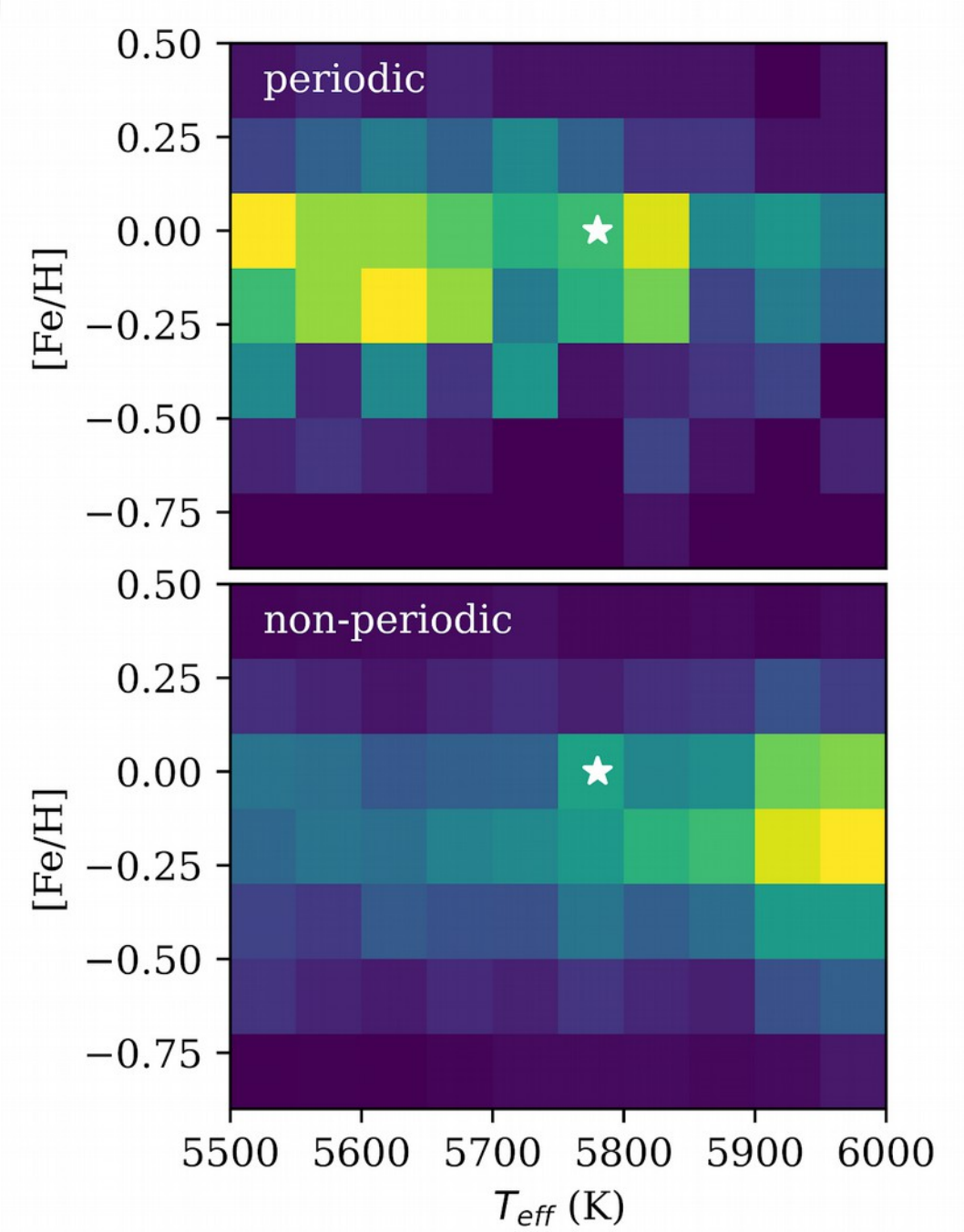
Multivariate linear regression



- Account for wide range of stellar properties with linear regression model
- Correct variability range to the value it would have if star had Sun's properties
- Dependencies on Teff, [Fe/H] and rotation period approximately removed

Reinhold+ (2020)

Sample bias: Teff and [Fe/H]



- Periodic stars typically cooler and slightly more metal-rich than average
- Non-periodic stars often hotter and metal-poor compared to the Sun
- Opposite biases in depth of convective envelope, important for activity!

Metcalfe & van Saders (submitted)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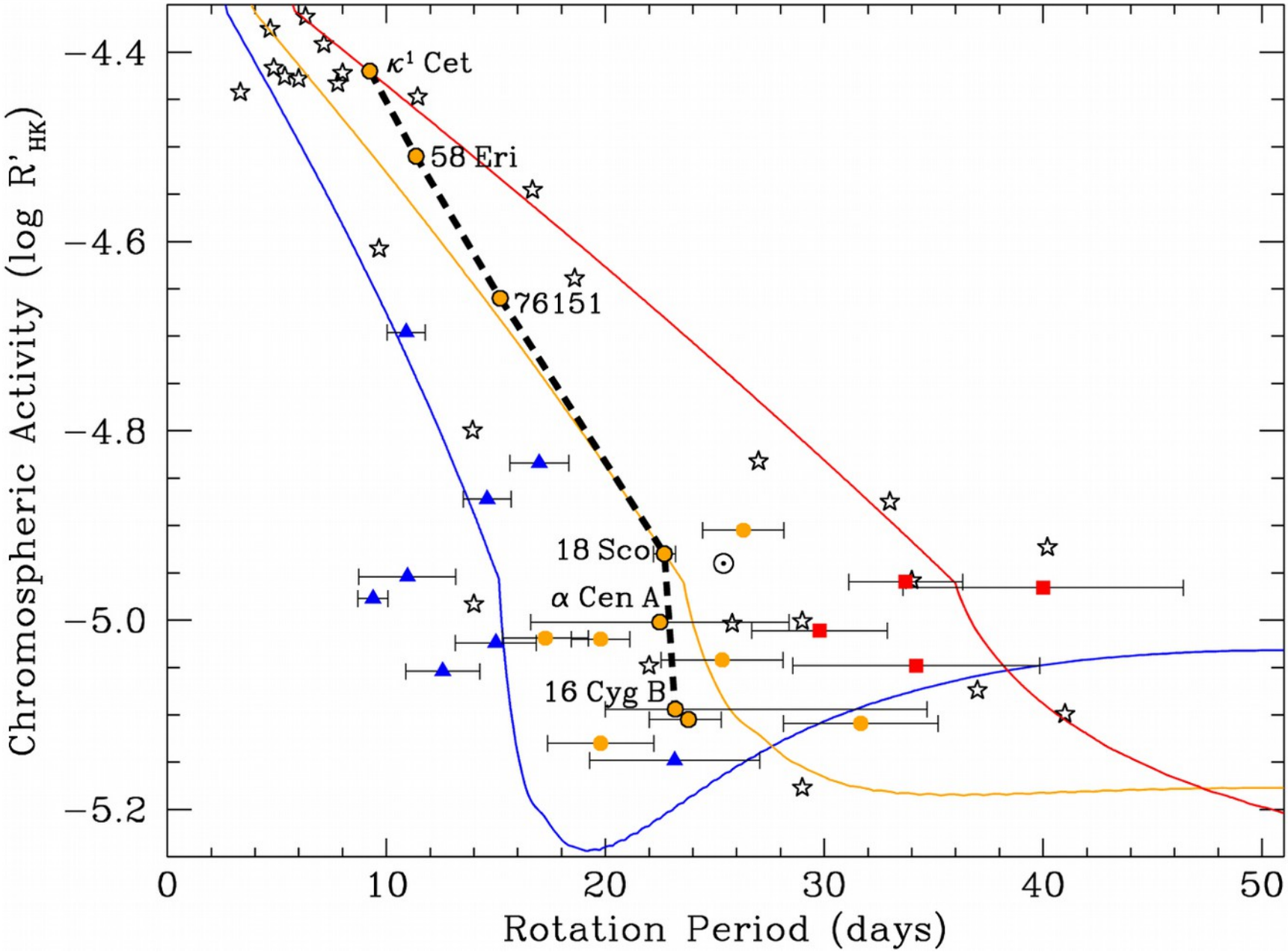
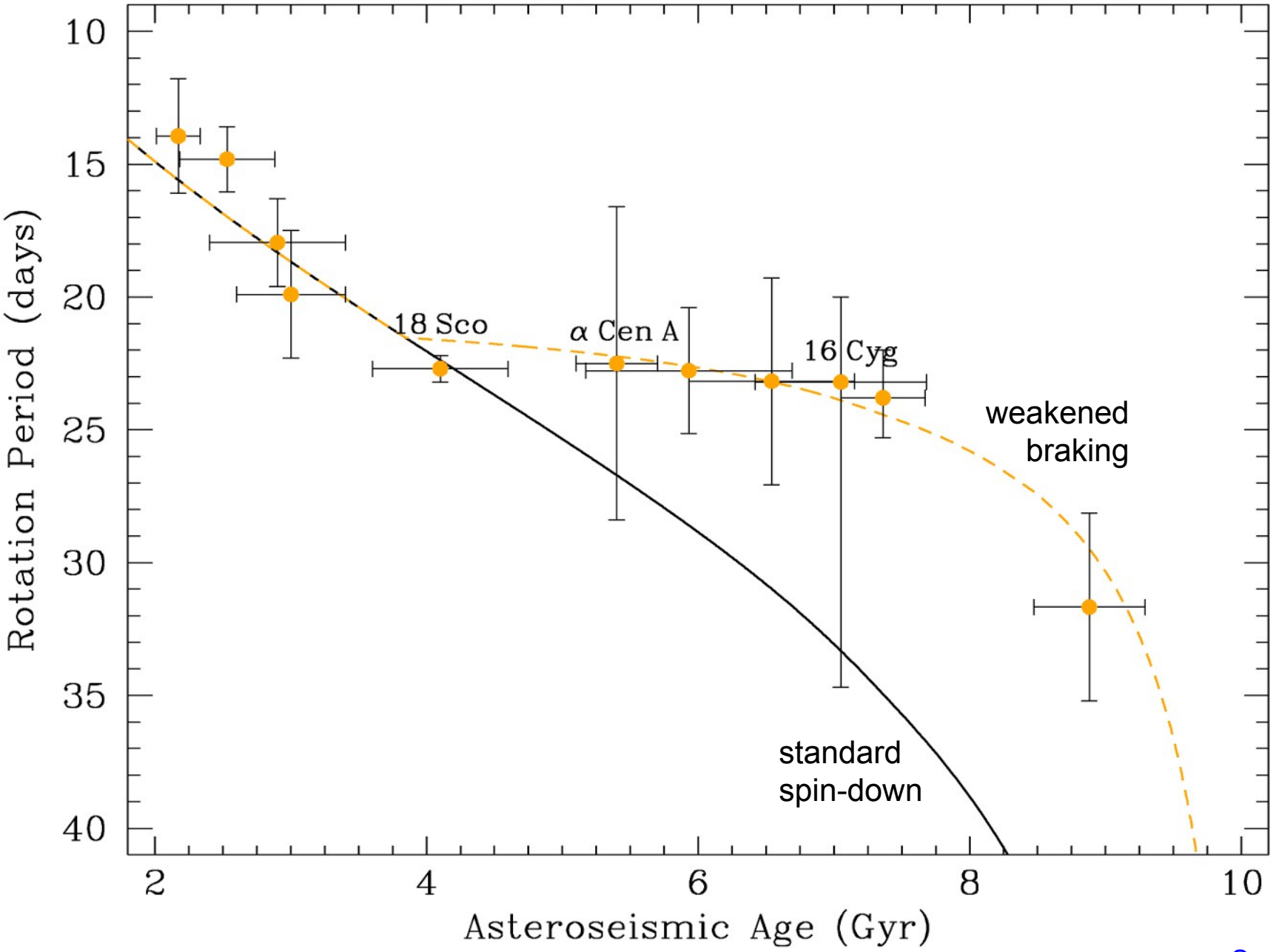
Rotation and activity decouple



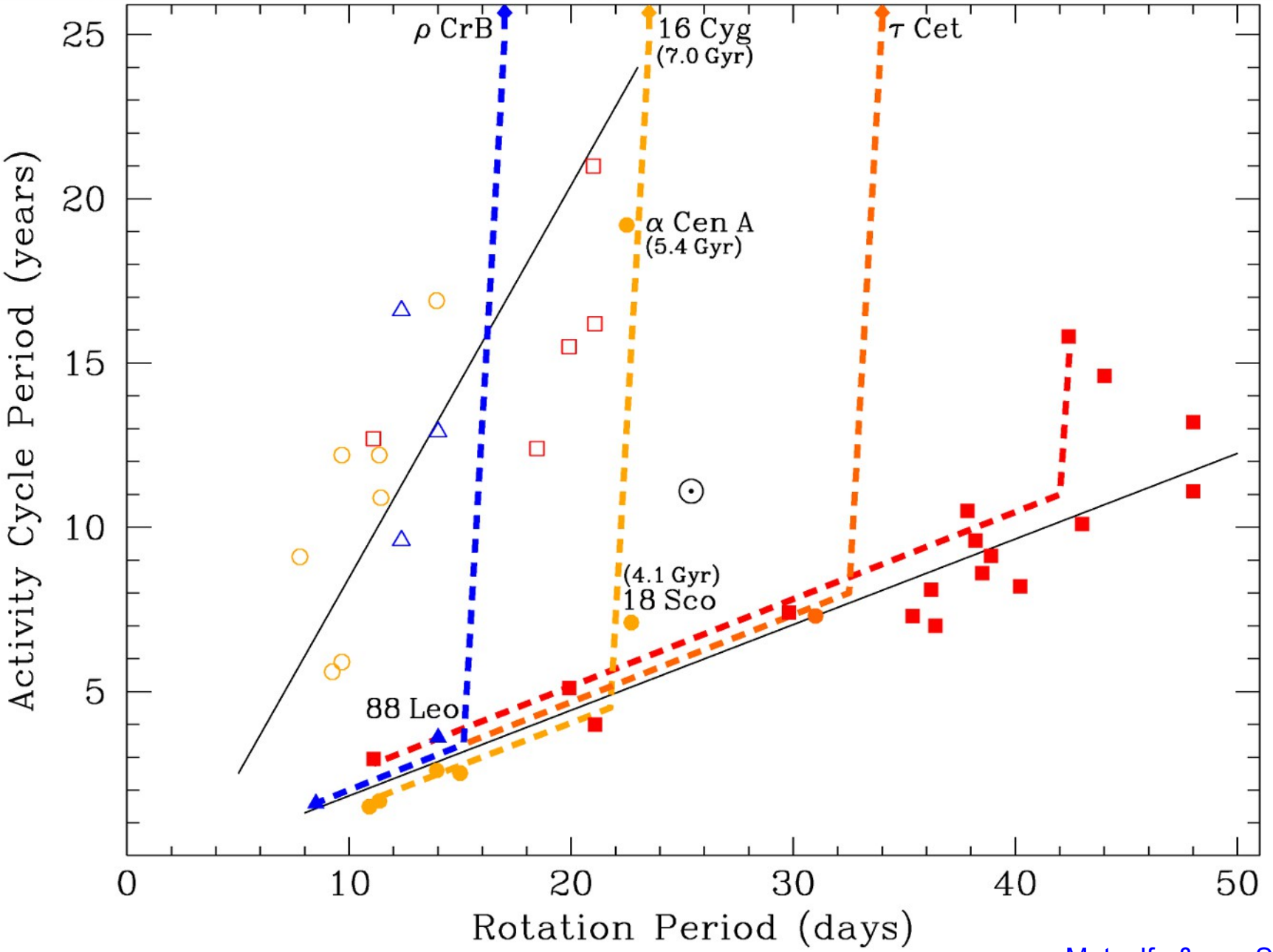
Metcalfe+ (2016)

Spin-down stalls near solar age



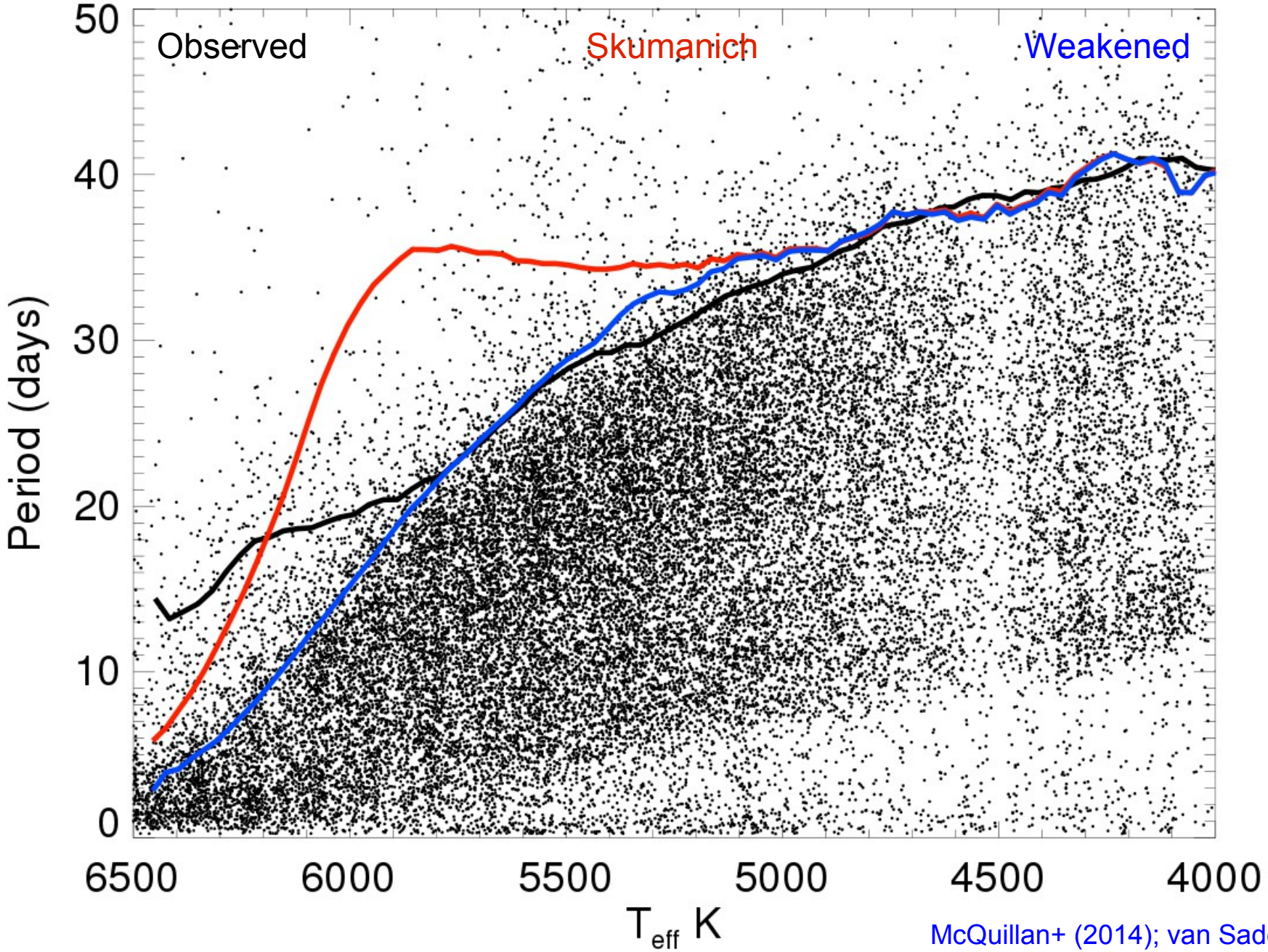
van Saders+ (2016)

Large-scale dynamo shuts down



Metcalfe & van Saders (2017)

Slow rotators missing or undetected

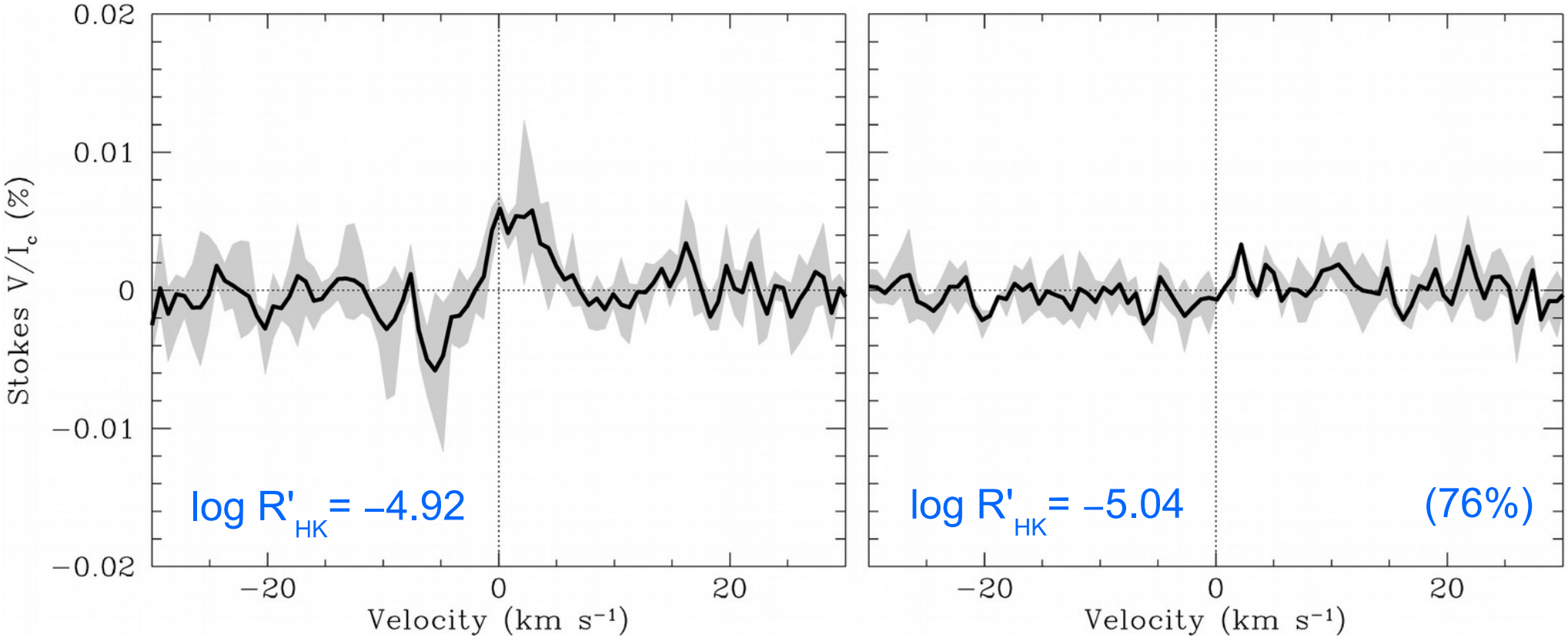


McQuillan+ (2014); van Saders+ (2019)

Dipole magnetic field disappears

88 Leo: non-axisym. $\langle B \rangle_{ZDI}$~2.5 G

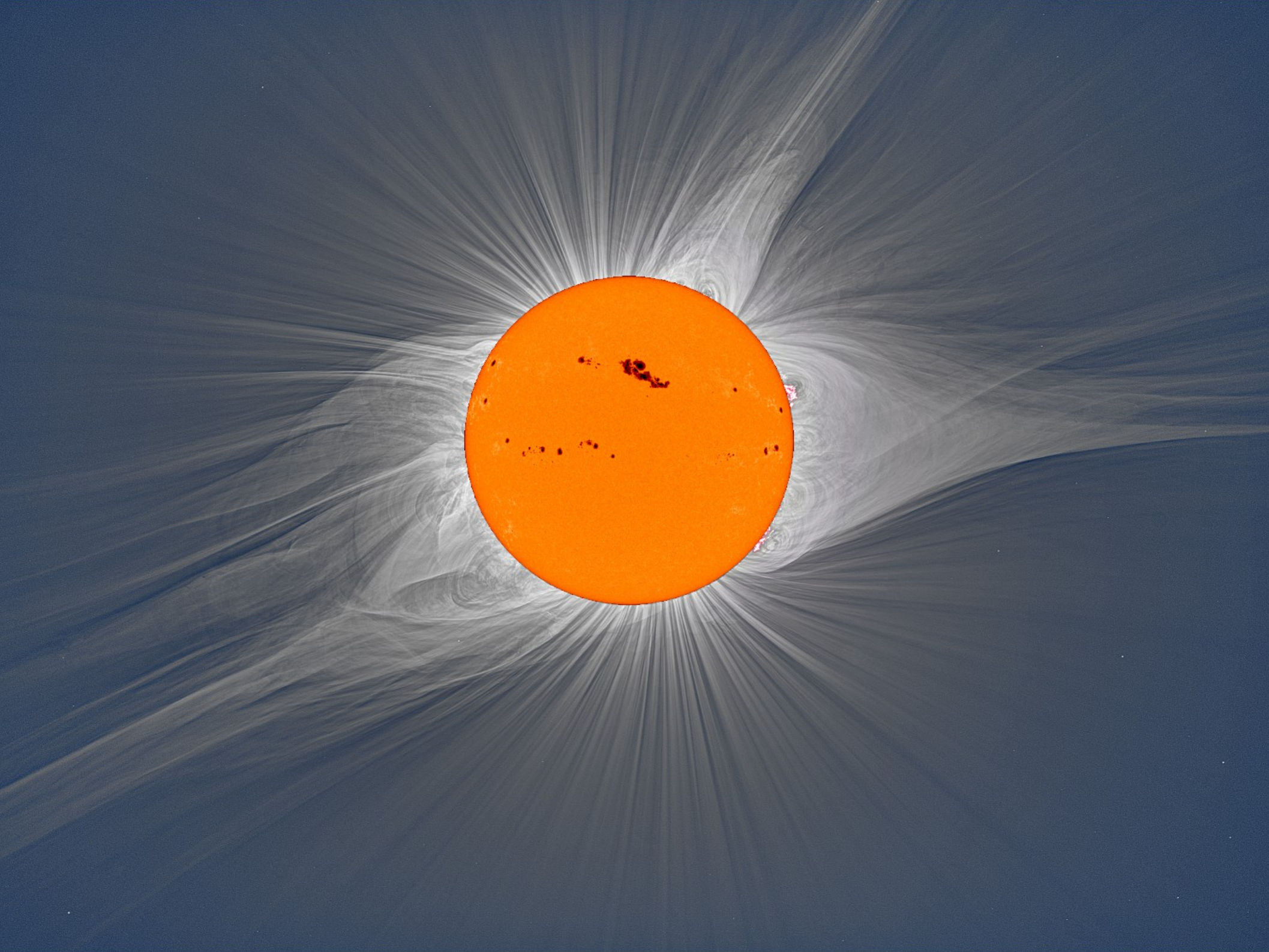
ρ CrB: $\langle B \rangle_d$< 20% $\langle B \rangle_q$< 53%



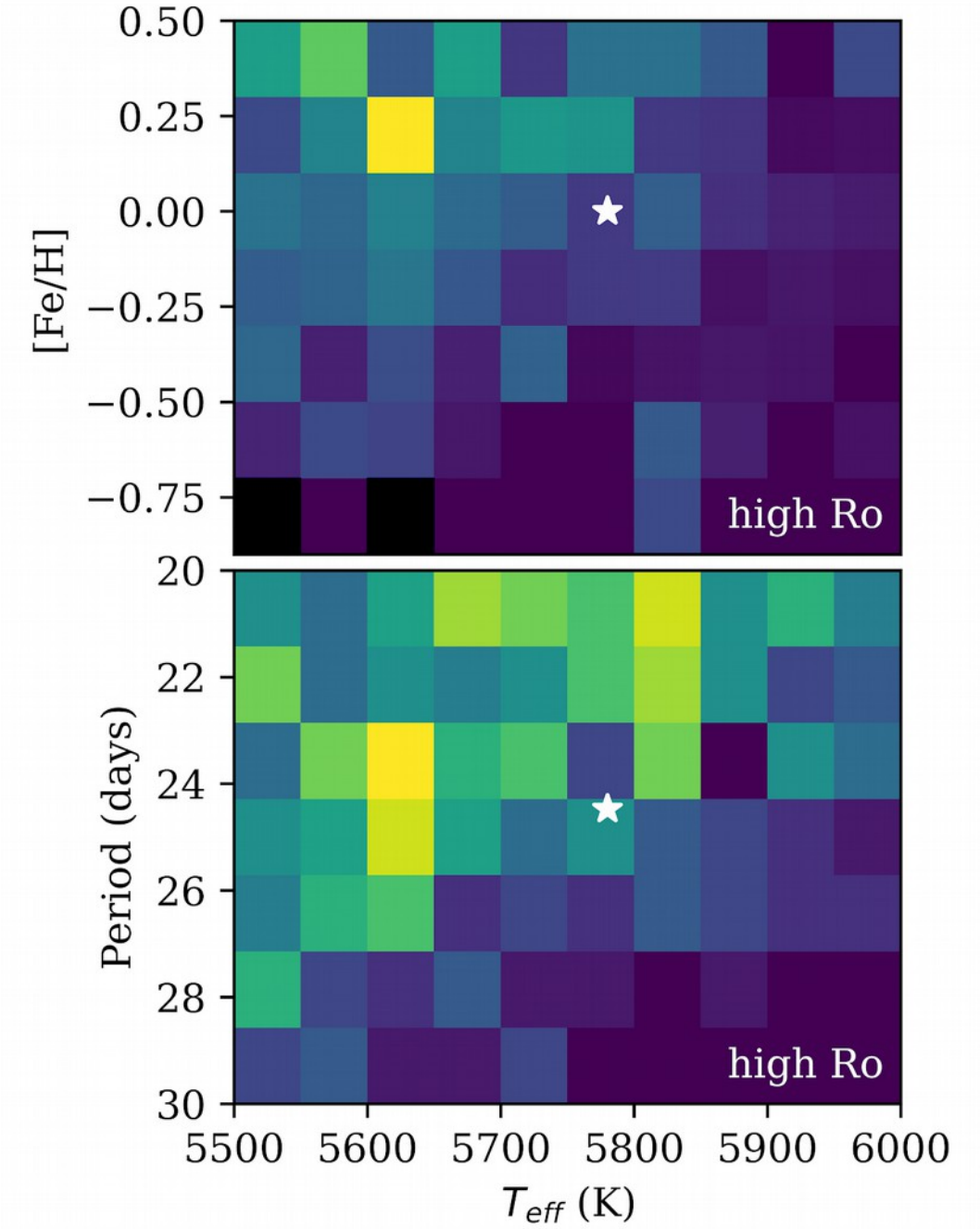
- Less evolved than Sun
- Activity cycle from MWO
- Field mostly dipole

- More evolved than Sun
- Flat activity from MWO
- Field mostly smaller-scale

Metcalfe+ (2019)



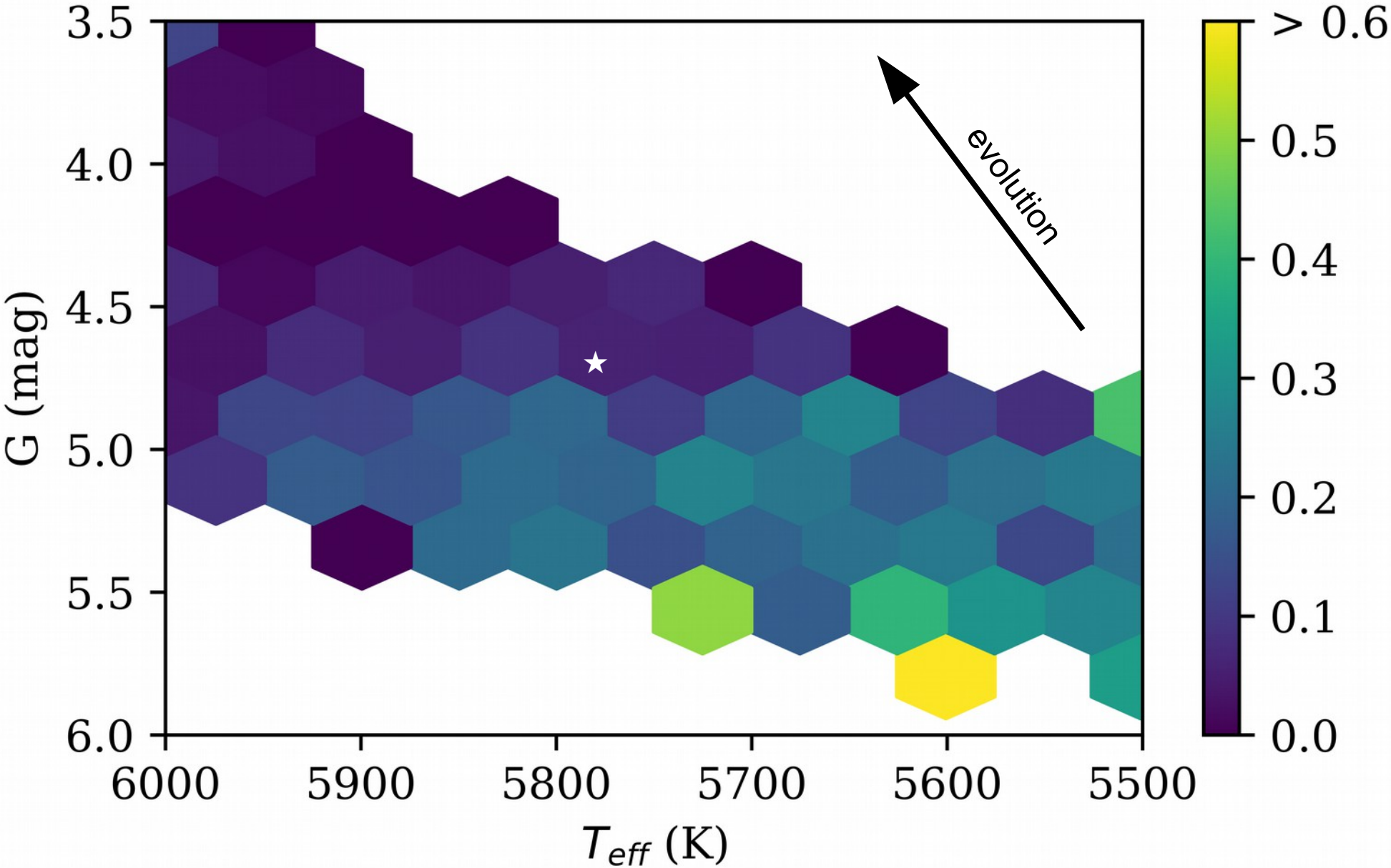
Sample bias: Rossby number



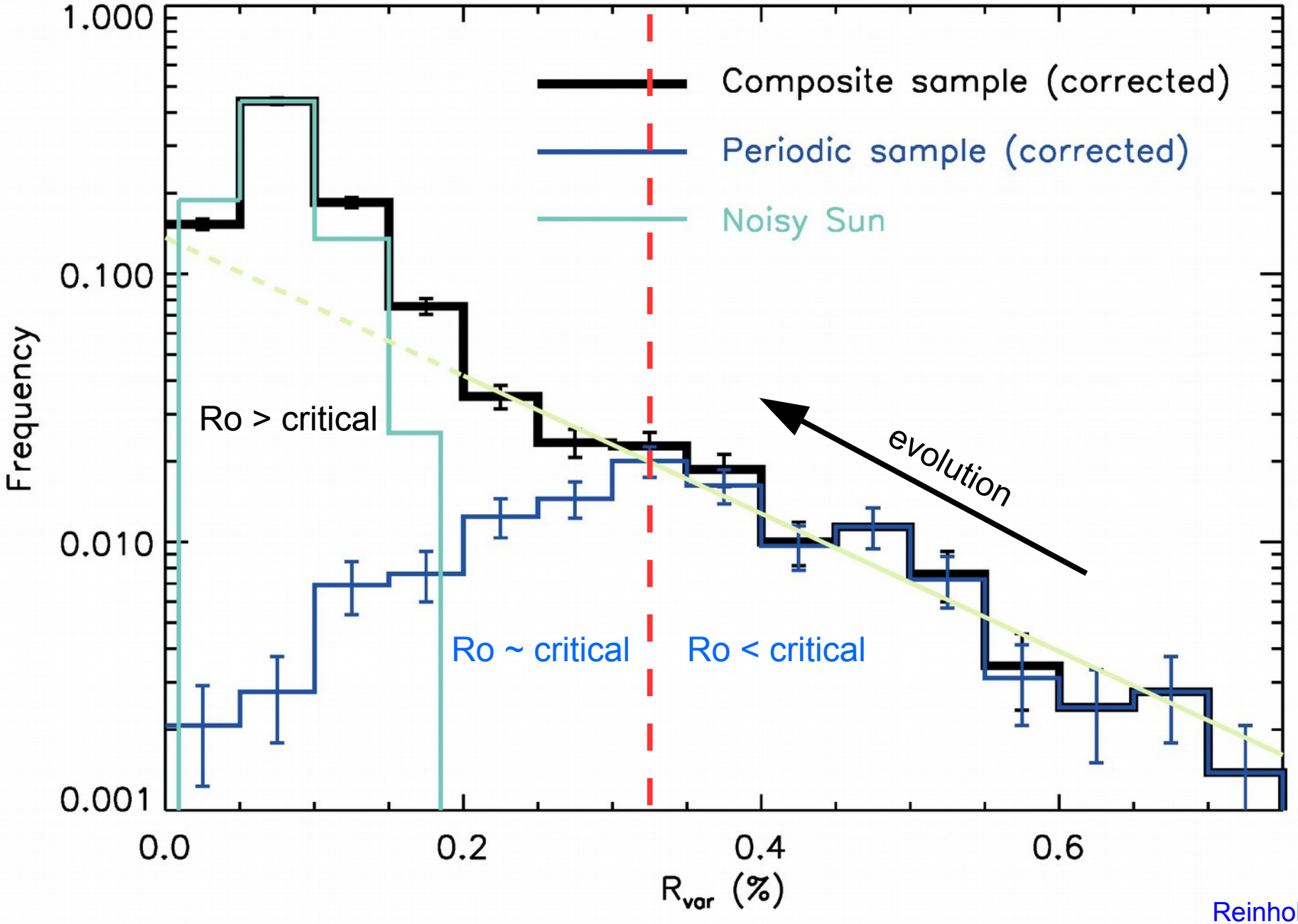
- Bins with detected rotation and observed periods are biased toward lower Ro
- Scatter from large errors on both Teff (150-200 K) and [Fe/H] (0.15-0.30 dex)
- Alternative interpretation would not be expected to show dependence on Ro

Metcalfe & van Saders (submitted)

Sample bias: evolutionary phase



Interpretation: magnetic evolution



Reinhold+ (2020)