

# Solar cycle variation in the properties of photospheric magnetic concentrations



Achuan Song<sup>1</sup> (acsong@mail.ustc.edu.cn), Quanhao Zhang<sup>1\*</sup> (Zhangqh@ustc.edu.cn), Yuming

Wang<sup>1</sup>, Rui Liu<sup>1</sup>, Jie Jiang<sup>2</sup>, Xiaolei Li<sup>1</sup>, Jiajia Liu<sup>1</sup>, Shaoyu Lv<sup>1</sup>, and Ruobing Zheng<sup>1</sup>

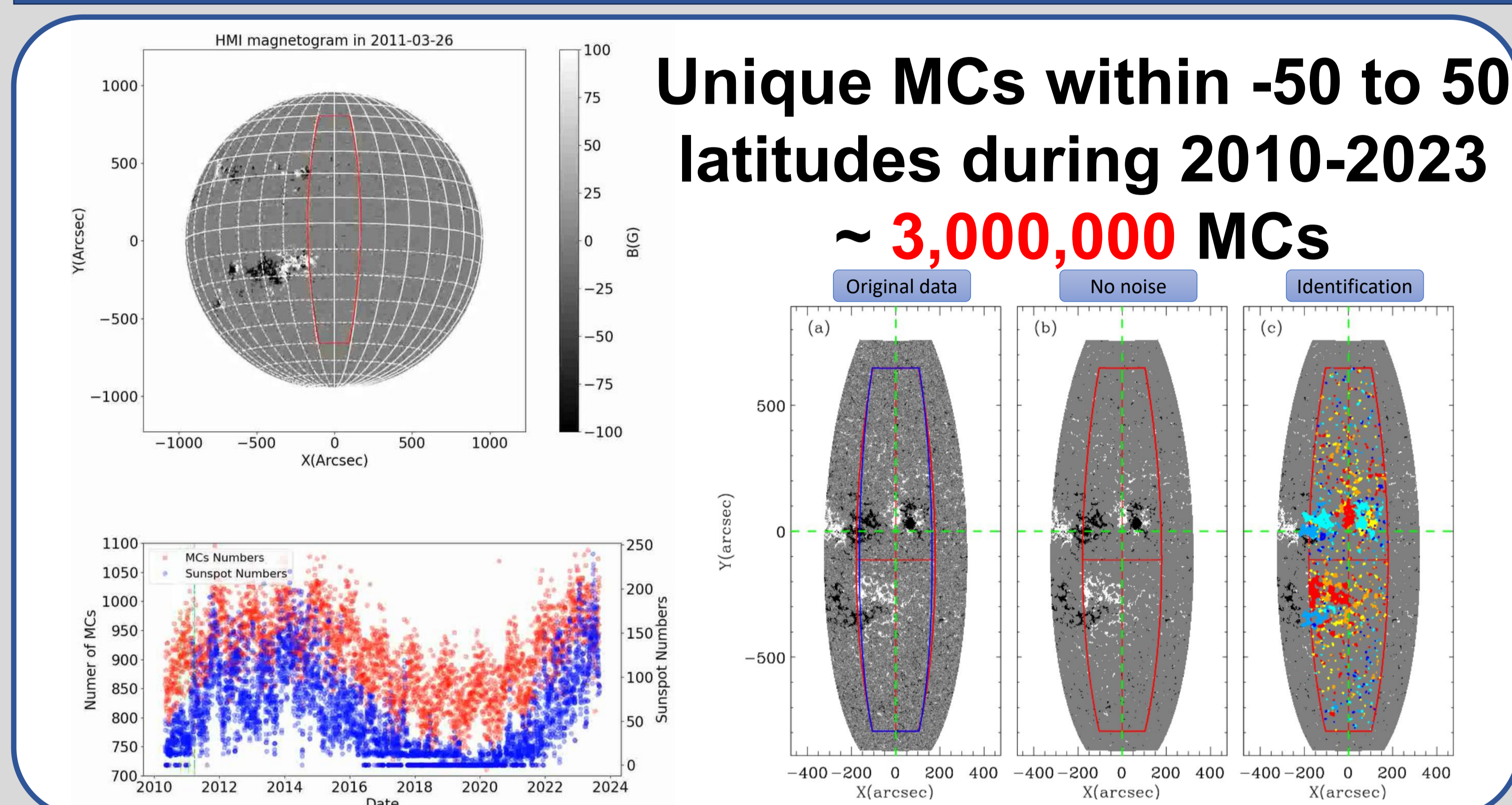
1. School of Earth and Space Sciences, University of Science and Technology of China

2. School of Space and Environment, Beihang University, Beijing, China

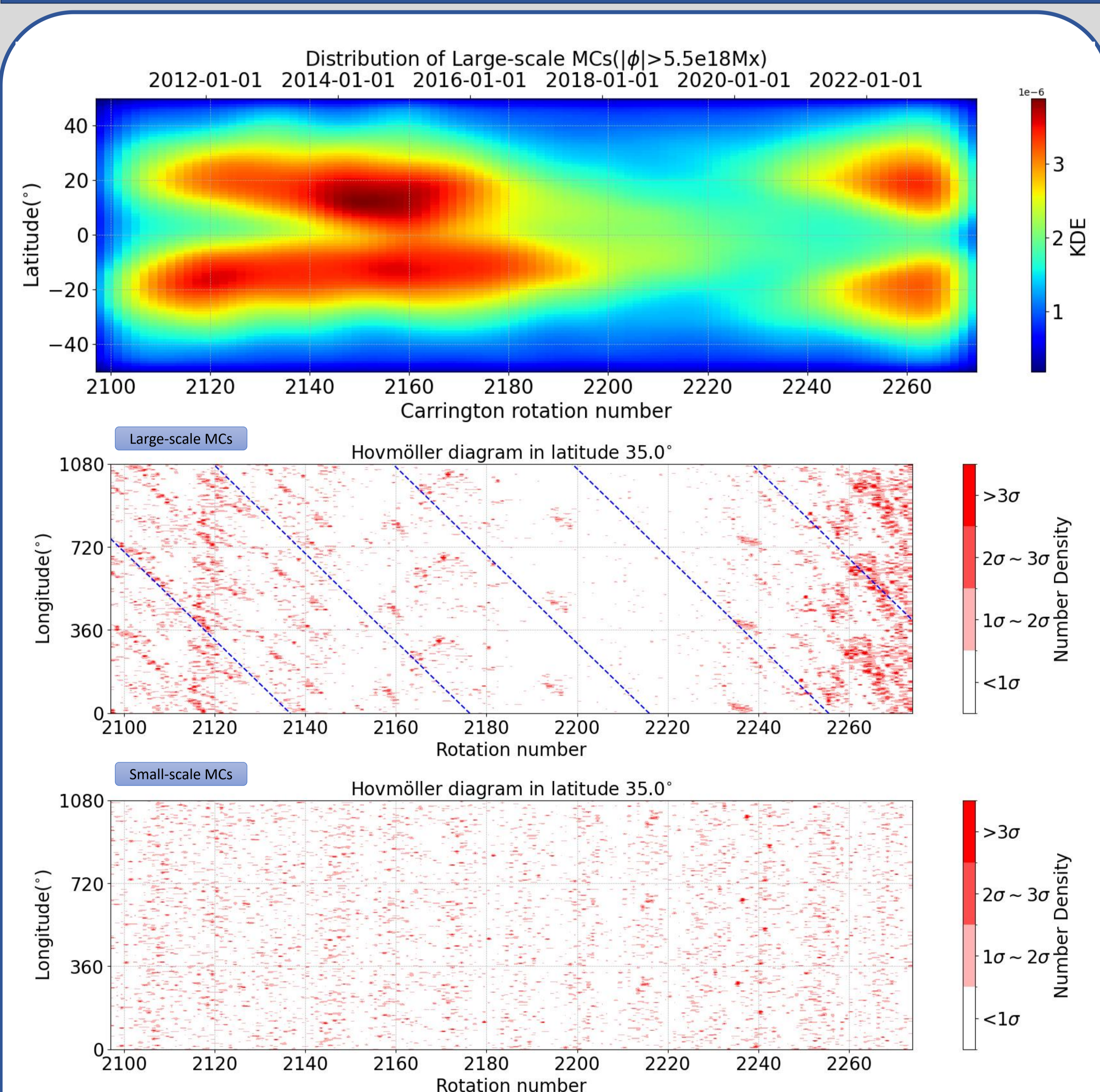
## Abstract

We investigate the statistics of characteristic physical parameters of magnetic concentrations (MCs) during a whole solar cycle by analyzing magnetograms from 2010 to 2023 observed by the Helioseismic and Magnetic Imager (HMI) on board the Solar Dynamics Observatory (SDO). We discover that MCs could be distinguished by two groups according to different power-law distributions of their physical parameters. The critical value for parameters are:  $\Phi_c = 5.5 \times 10^{18}$  Mx, scale  $L_c = 3.4$  Mm, and magnetic energy  $E_c = 2 \times 10^{21}$  J. We also notice that the active longitude (AL) revolve around the sun and persists over a long period. Our results suggest that small- and large-scale MCs could be generated by different physical mechanisms.

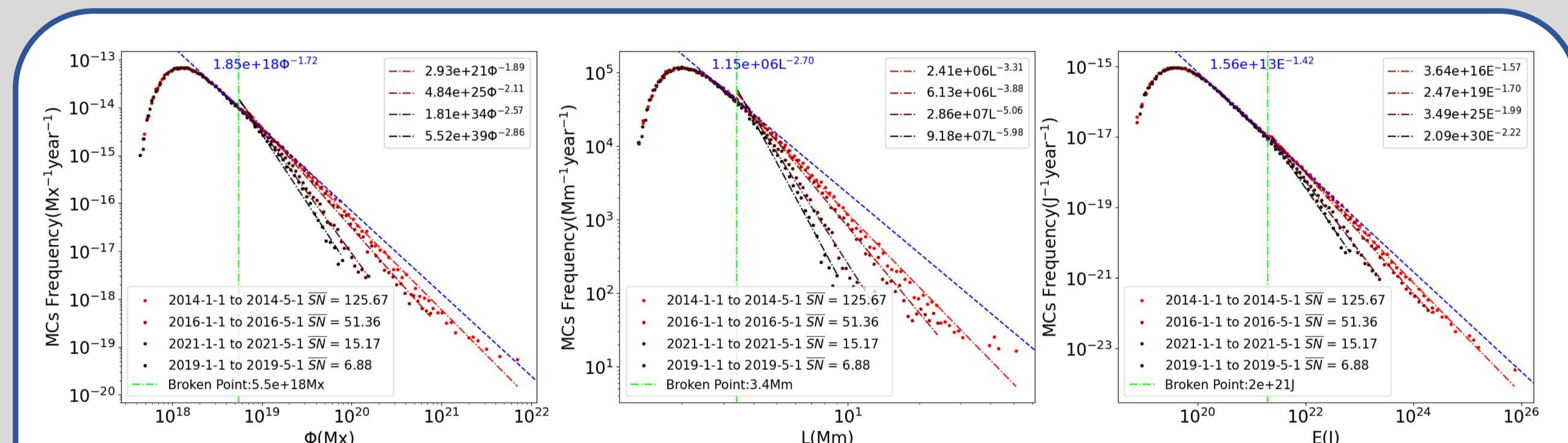
## 1. Data: MCs during 2010-2023



## 4. Temporal and spatial distribution of MCs



## 2. Distribution: Broken log-log linear



Borken point:

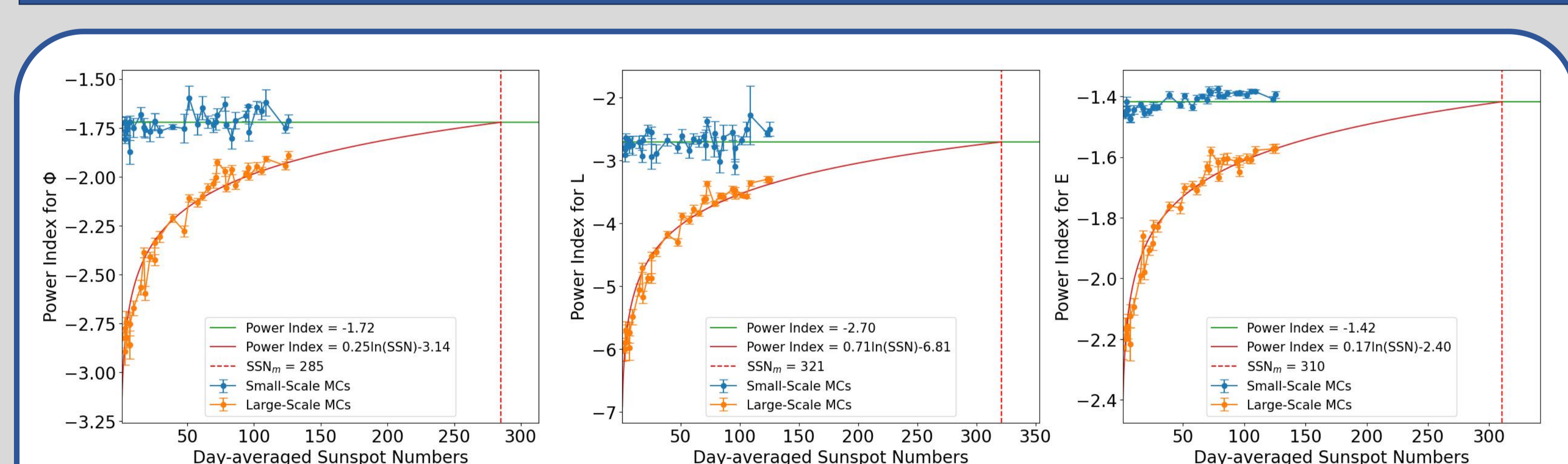
$$\Phi_c = 5.5 \times 10^{18} \text{ Mx} \quad L_c = 3.4 \text{ Mm} \quad E_c = 2 \times 10^{21} \text{ J}$$

Small-scale MCs unchanged in solar cycle

Large-scale MCs modulated by solar cycle

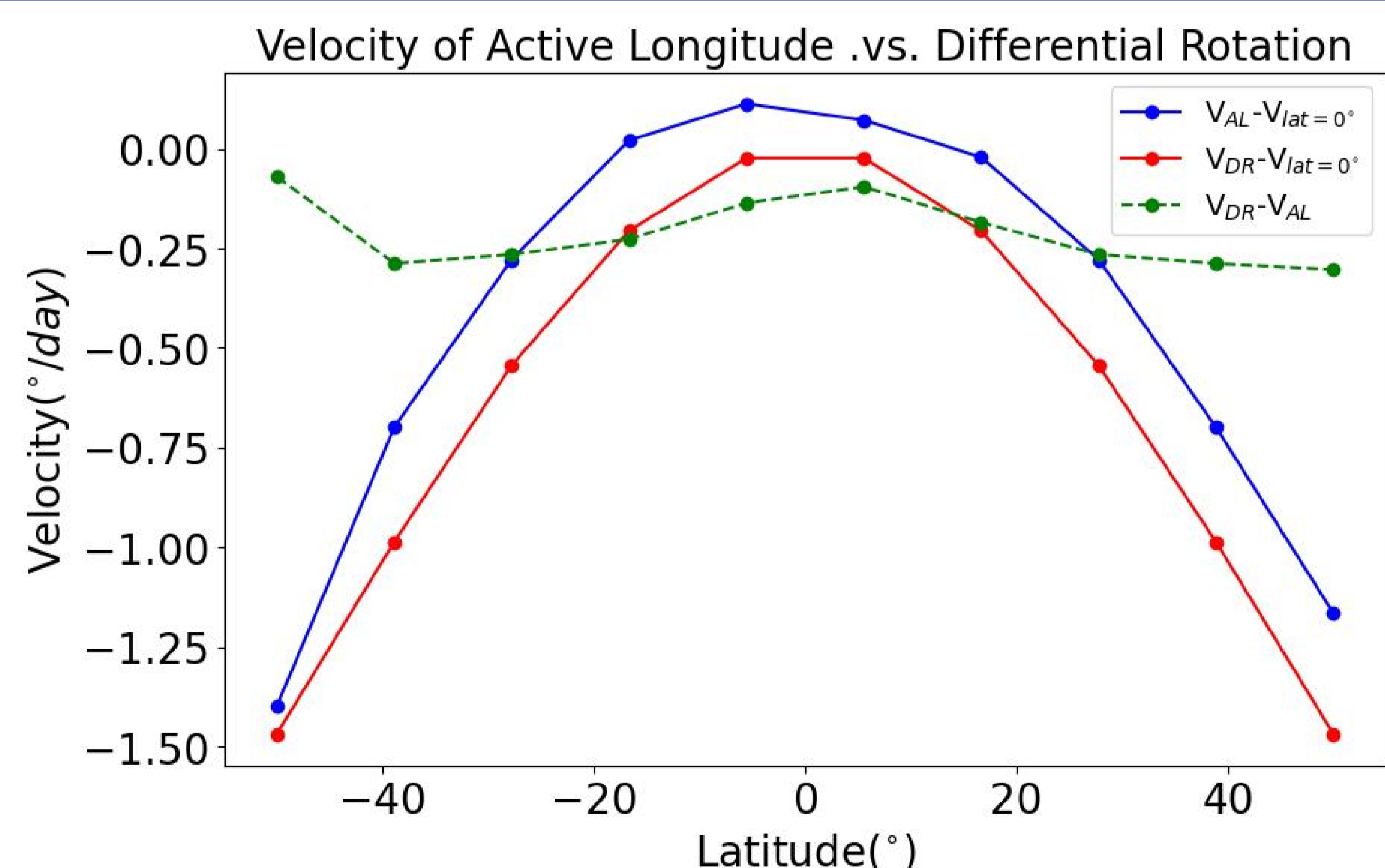
AL (large-scale MCs) has a global drift

## 3. Power index .vs. Solar cycle



Small and large-scale MCs satisfy consistent distribution when sunspot numbers reach  $\sim 300$

## 5. Revolve speeds of AL in latitude



Stable Active Longitude

## Conclusions

1. Small and large-scale MCs relate differently to the solar cycle
2. Active Longitude revolve around the sun for a long period

## Main References

1. Song, A., Zhang, Q., Wang, Y., et al. 2024, A&A, 682, A87
2. Parnell, C. E., DeForest, C. E., Hagenaar, H. J., et al. 2009, ApJ, 698, 75