

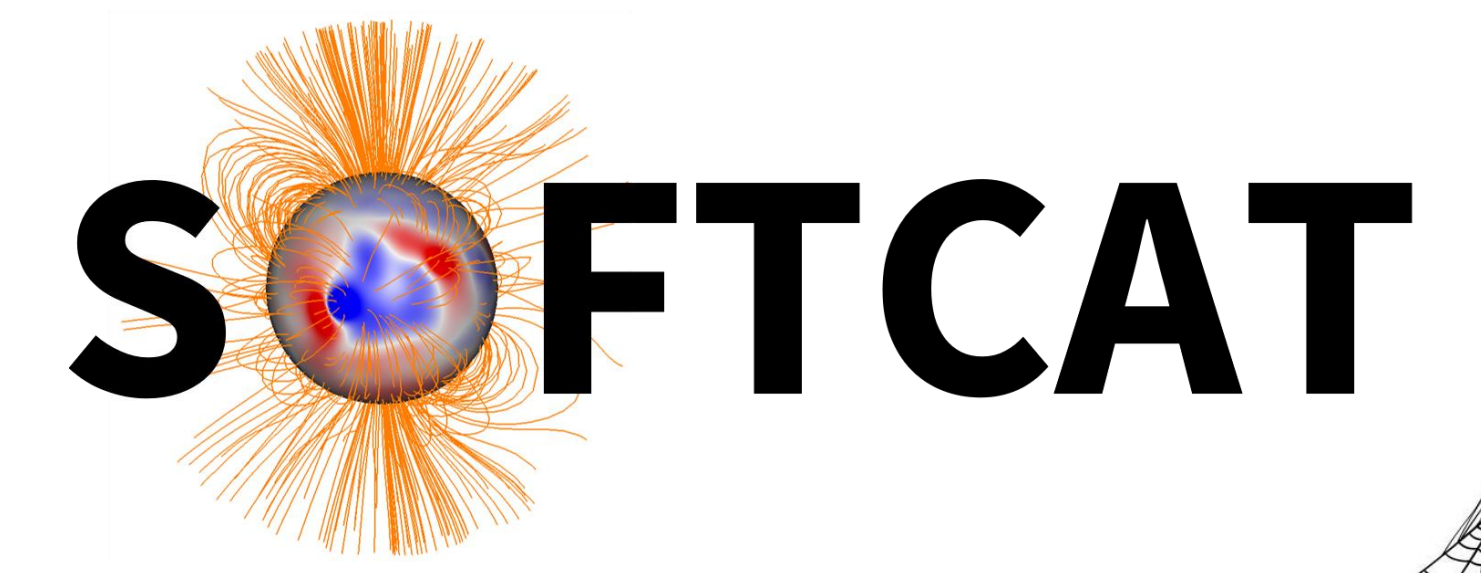
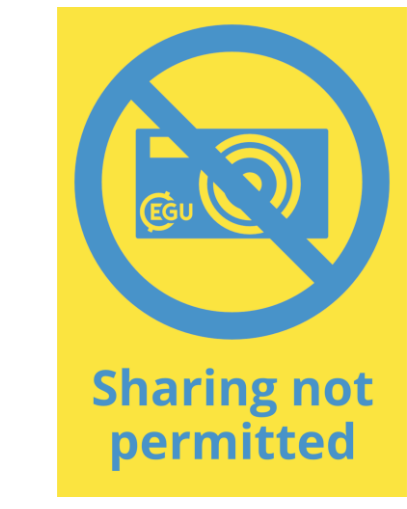
# PRELIMINARY STATISTICAL ANALYSIS OF MAGNETIC SWITCHBACKS DURING PARKER SOLAR PROBE ENCOUNTERS



Ezgi Gülay<sup>1</sup>, Eleanna Asvestari<sup>1</sup>, Thierry Dudok de Wit<sup>2,3</sup>

✉ ezgi.gulay@helsinki.fi

<sup>1</sup> Department of Physics, University of Helsinki, Helsinki, Finland  
<sup>2</sup> LPC2E, OSUC, University of Orléans, CNRS, CNES, Orléans, France  
<sup>3</sup> International Space Science Institute, Bern, Switzerland



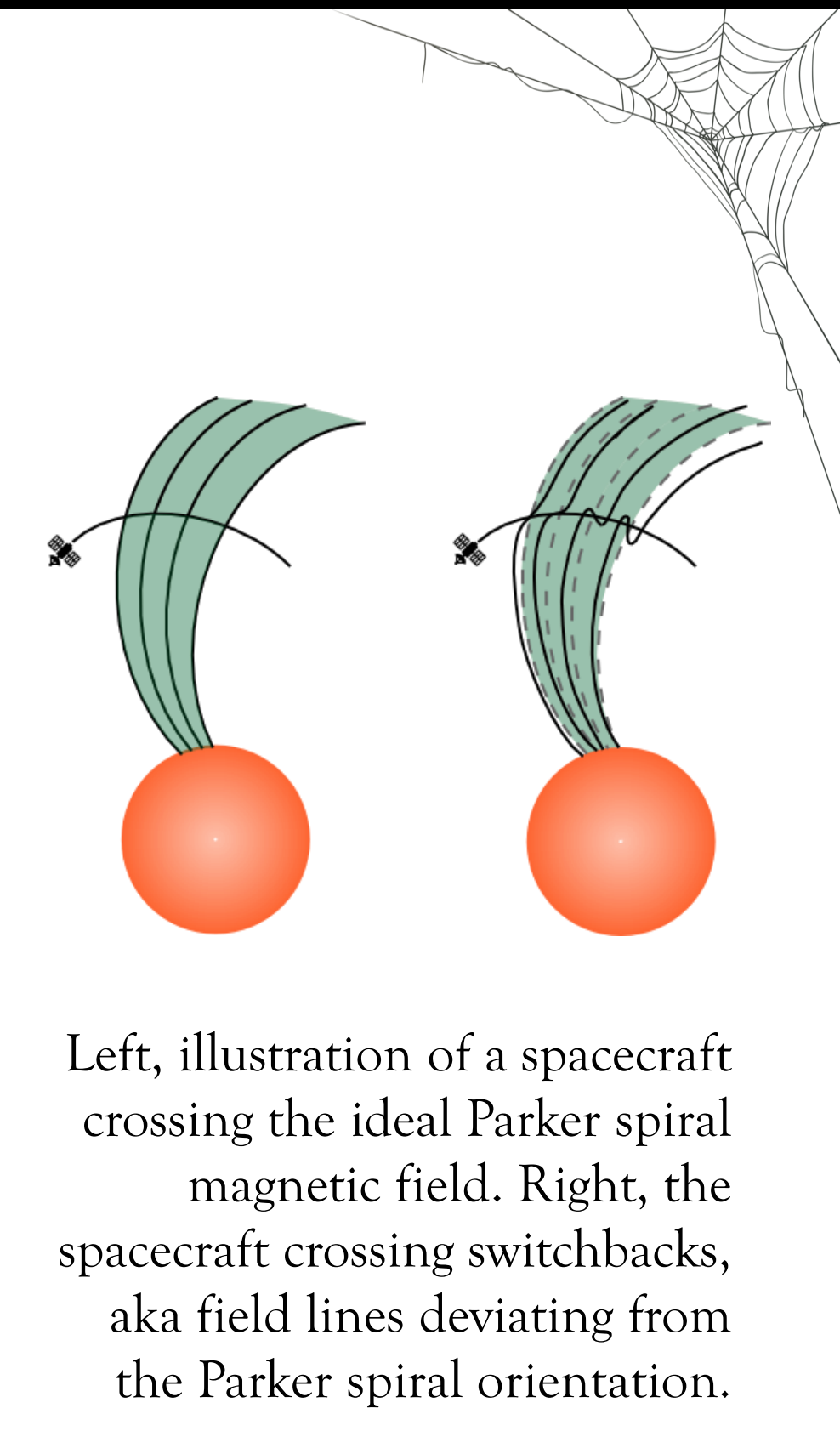
## INTRODUCTION

### Switchbacks

- Sharp Alfvénic deflections in the magnetic field lines
- Ubiquitous close to the Sun
- Relatively new, many unknowns

### Motivation

- Investigating the dependence of switchback occurrences to solar wind conditions
- Radial distance
- Solar wind speed
- Solar cycle



Left, illustration of a spacecraft crossing the ideal Parker spiral magnetic field. Right, the spacecraft crossing switchbacks, aka field lines deviating from the Parker spiral orientation.

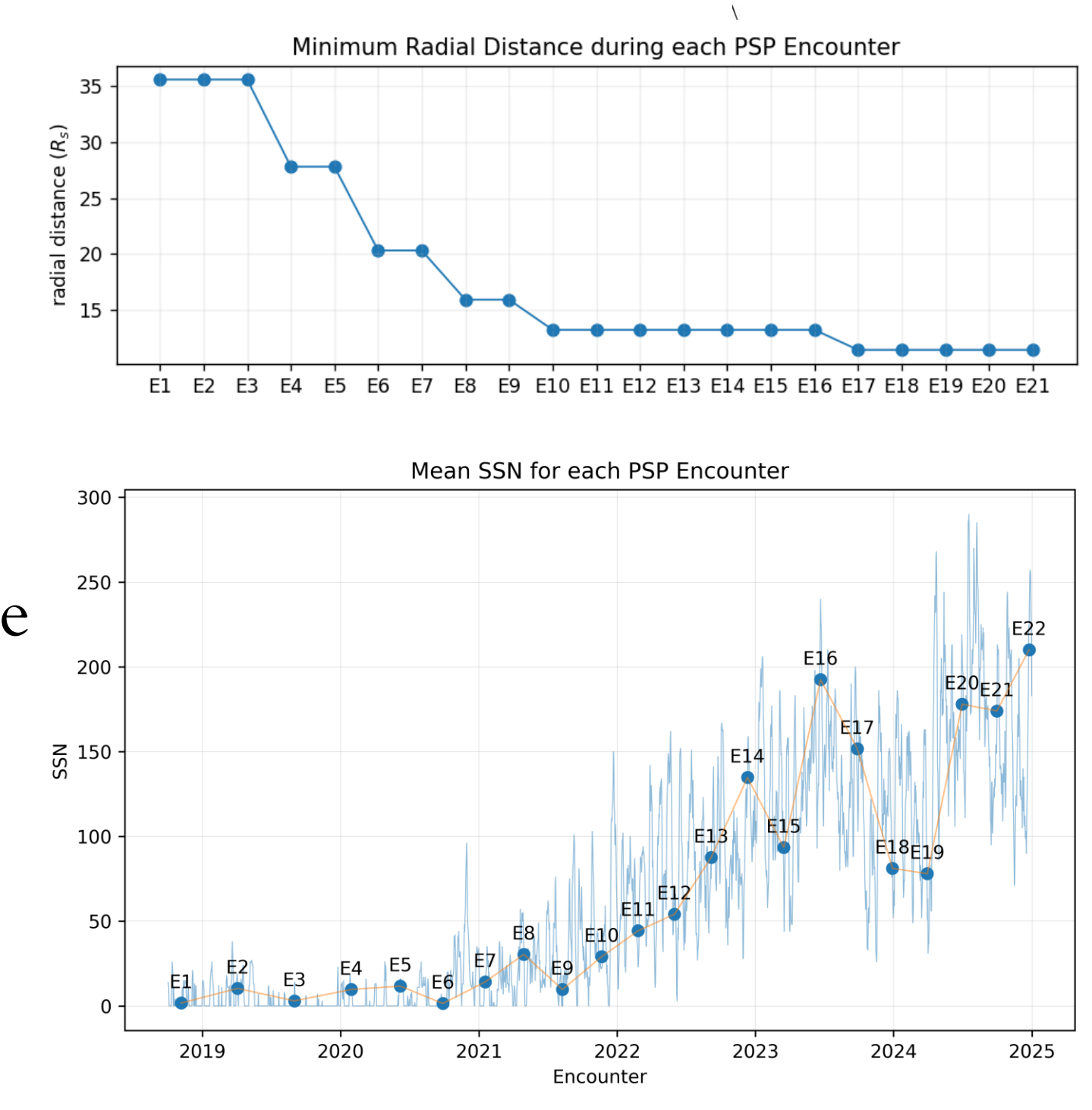
## DATA AND METHOD

### Parker Solar Probe (PSP)

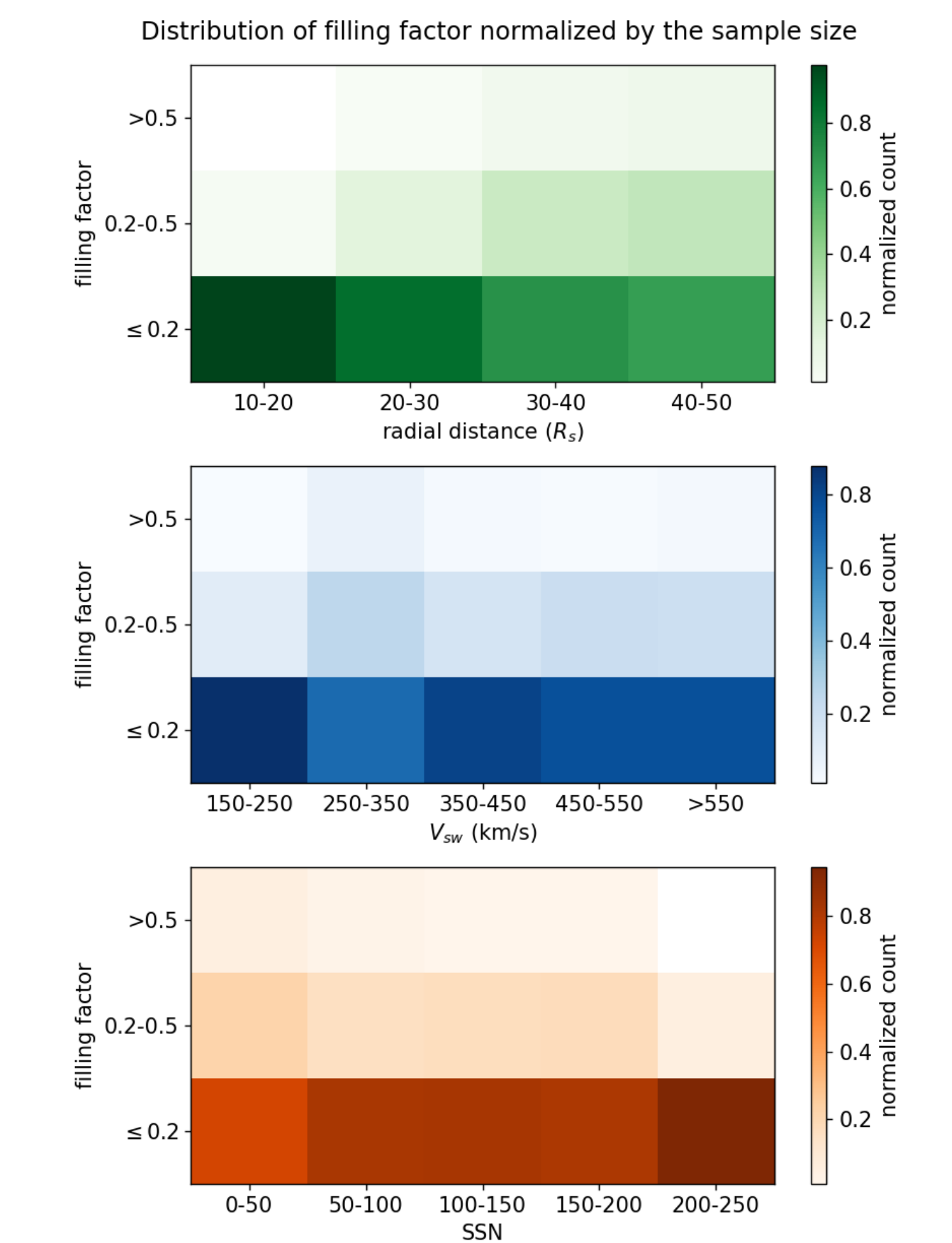
- Encounters 1-17 (2018-2024)
- Solar minimum and ascending phase
- 11  $R_s$  to 36  $R_s$

### Filling Factor

- Focusing on the fraction of time occupied by switchbacks instead of the occurrence rate
- Invariant to the spacecraft velocity and the expansion of corona
- Using statistical methods to disentangle the impact of different factors that are highly correlated



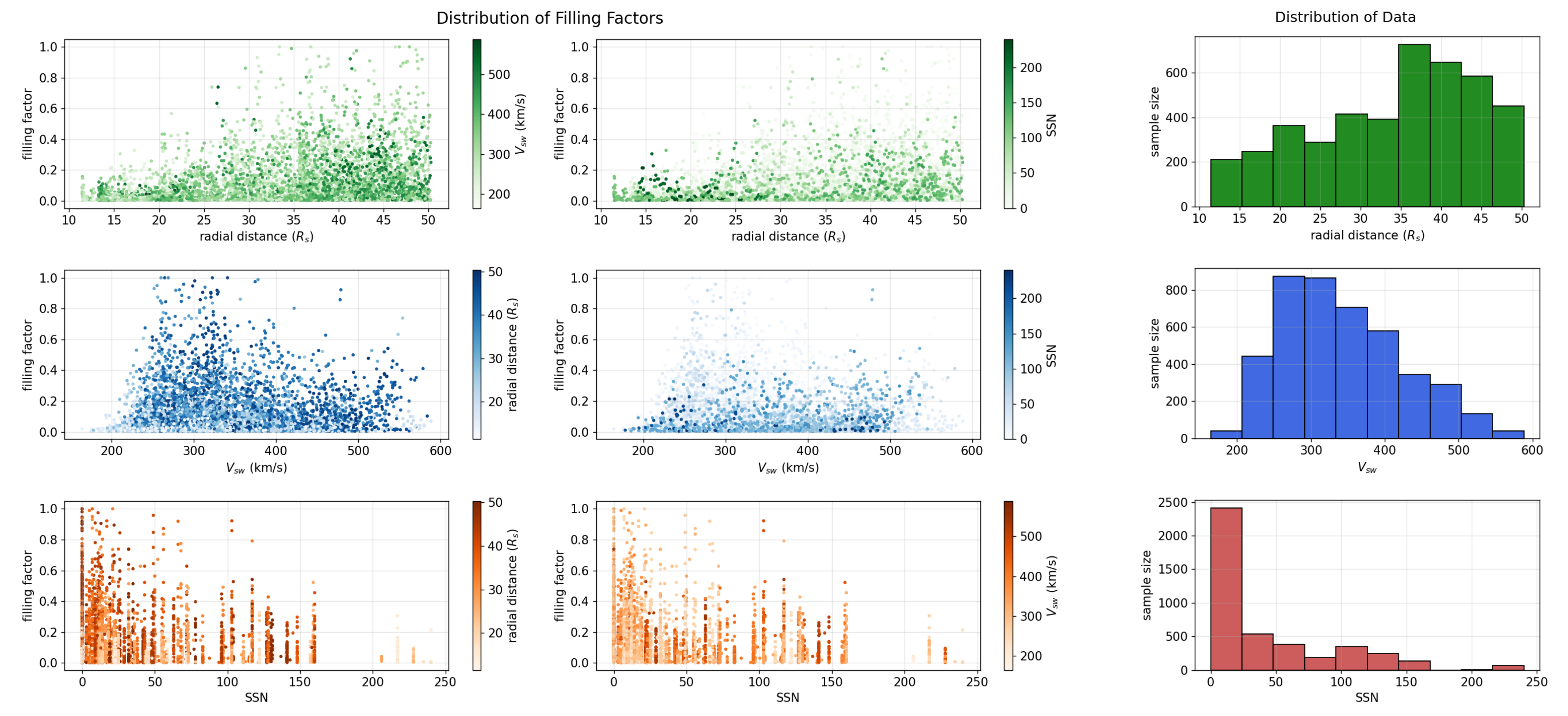
## CONCLUSIONS



## DISTRIBUTION OF DATA

Dependence of the individual filling factors show trend, yet the interpretation is compounded by the irregular distribution of data;

- No high filling factors below 25  $R_s$ , where it is dominated by high sunspot number (SSN)
- Highest filling factors at further distances with relatively slow solar wind and small SSN
- Yet, data is accumulated in further distances
- High filling factors are accumulated between 250-350 km/s where we see further distances and small SSN
- Yet, the data is accumulated between 250-350 km/s



- We introduce the **switchback filling factor** to investigate switchback occurrences.
- Switchback dependence on radial distance, solar wind speed and sunspot number are all considered together.
- The data is normalized based on the sample size to minimize the **observational biases**.
- High and low filling factor values show different trends.
- High filling factors are correlated with radial distance, and anticorrelated with sunspot number.
- Solar wind speed does not show a specific way of contribution when other variables are considered.

ACKNOWLEDGEMENTS: This work is part of the SOFTCAT project supported by the Research Council of Finland (grant number 355659).