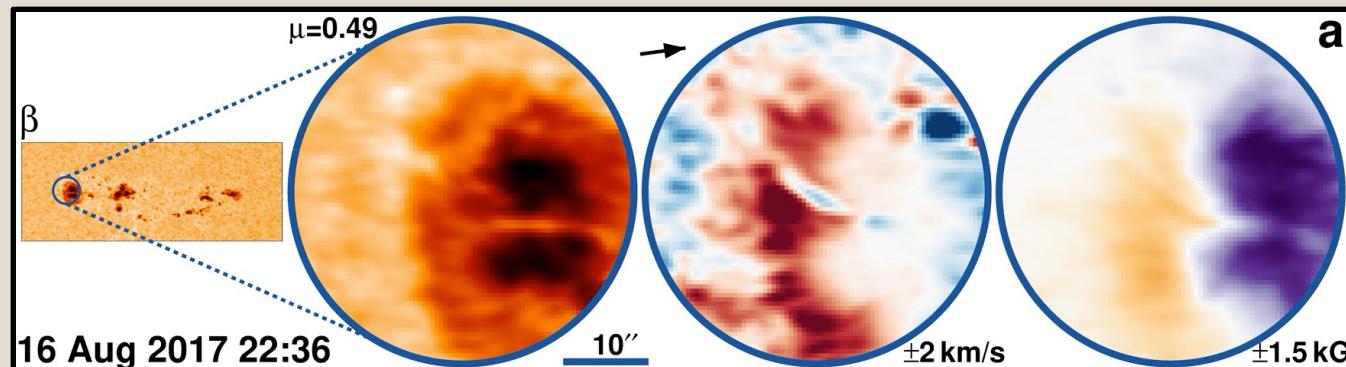




How common are counter Evershed flows?

Sebastián Castellanos Durán, Andreas Lagg, Sami Solanki

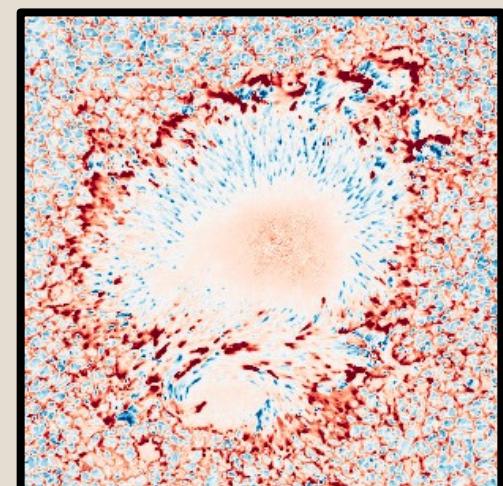
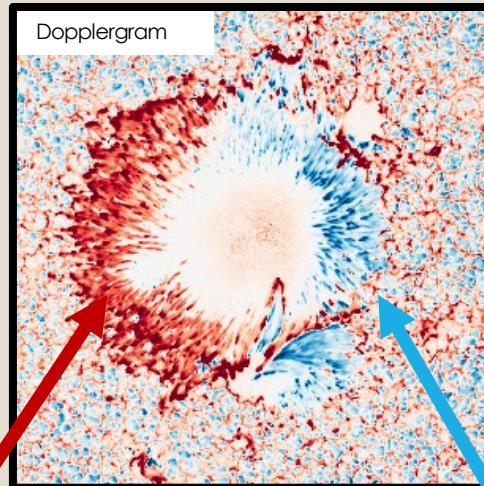
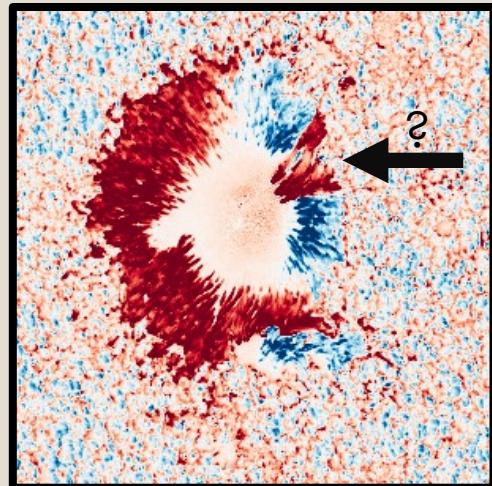
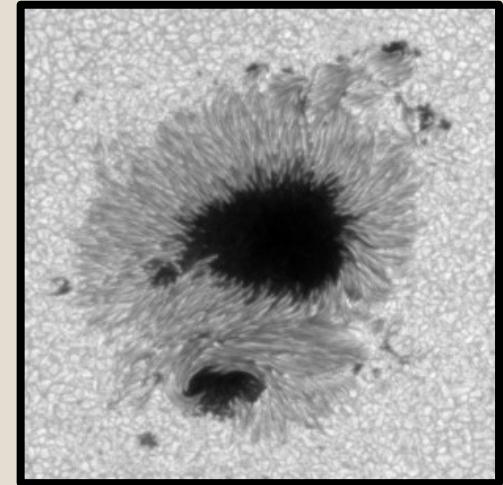
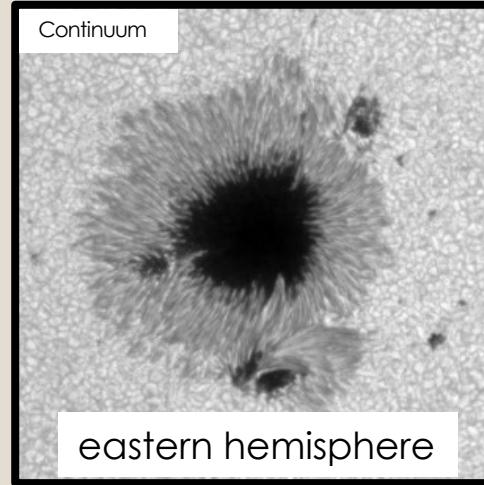
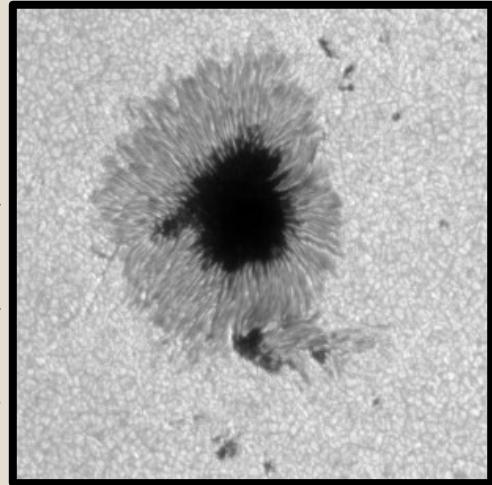
Max Planck Institute for Solar System Research
Göttingen, Germany



Based on Castellanos Durán et al (2021) A&A Letters, **651**, L1

The Evershed flow

Siu-Tapia et al (2017, 2019)



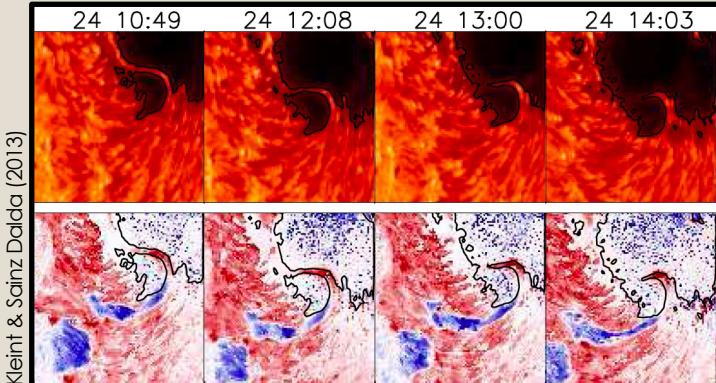
$\mu \sim 0.6$

Limb side=> redshifted

$\mu \sim 0.8$

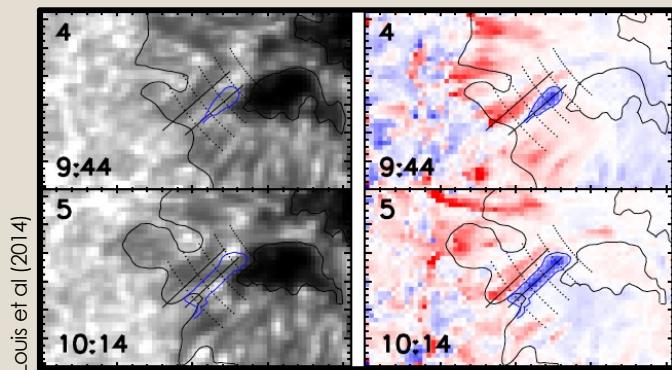
Center side=> Blueshifted

Counter Evershed flows (CEFs)

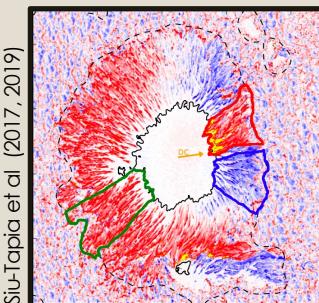


Described as:

→ "...unusual..."

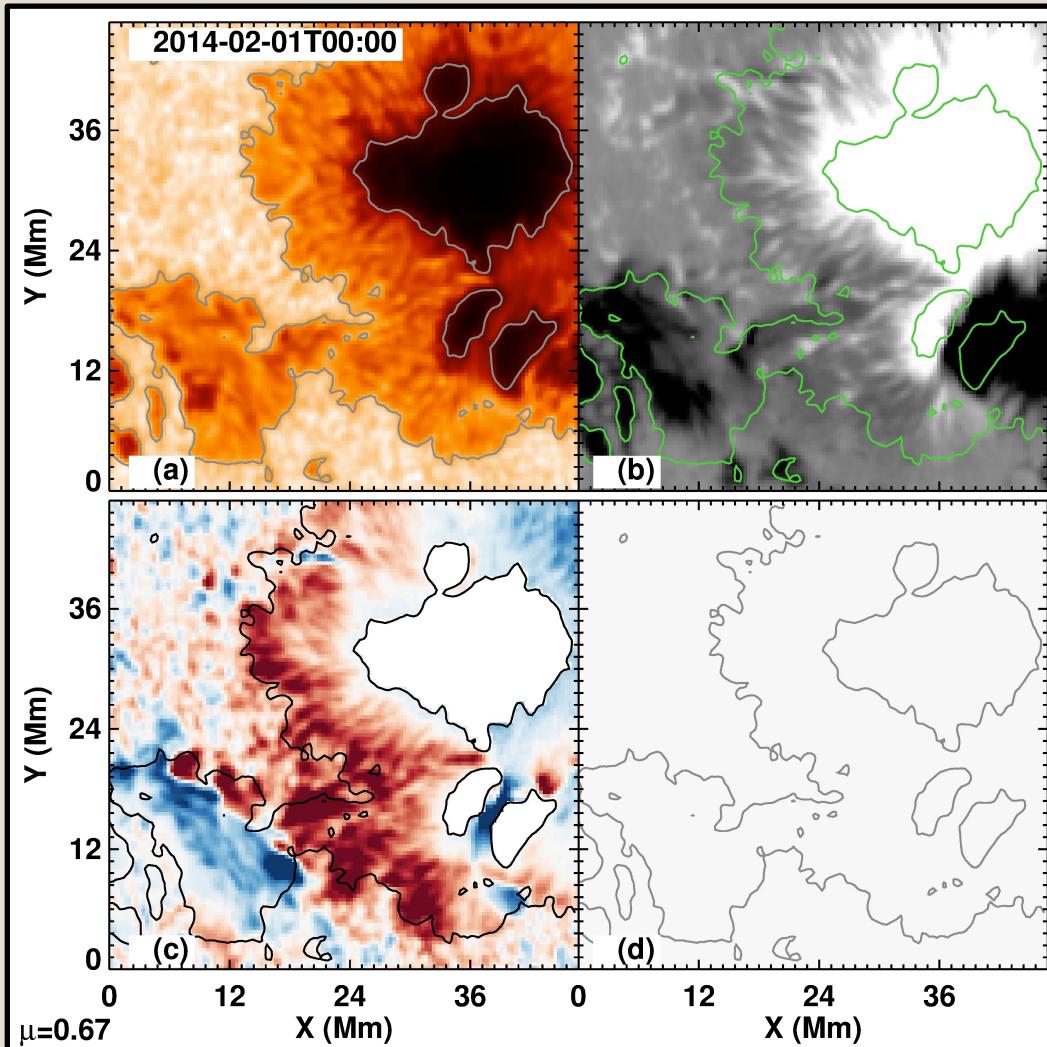


→ "...anomalous..."



→ "...atypical..."

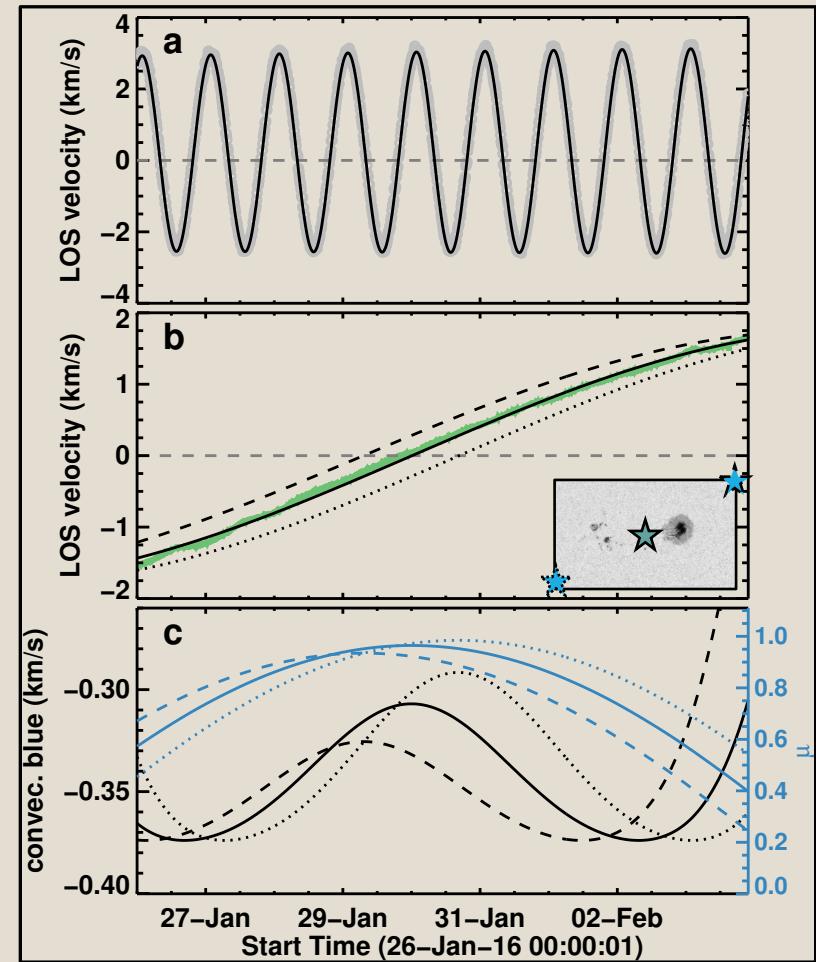
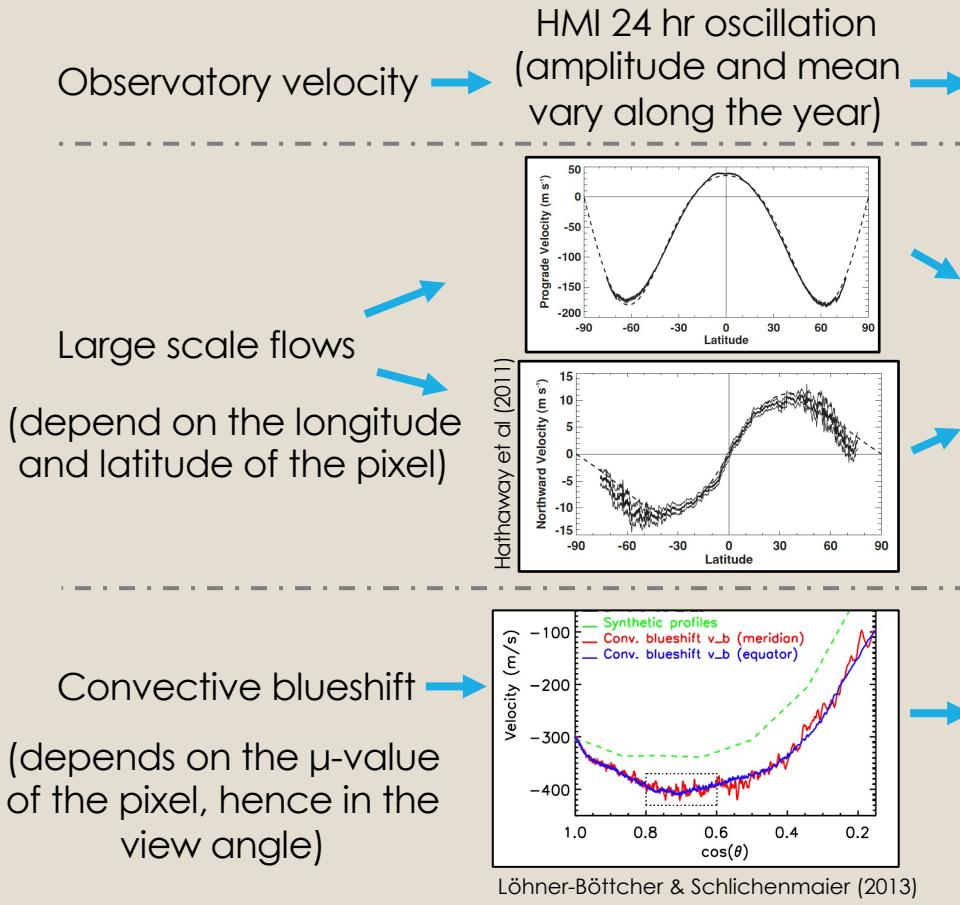
Counter Evershed flows (CEFs)



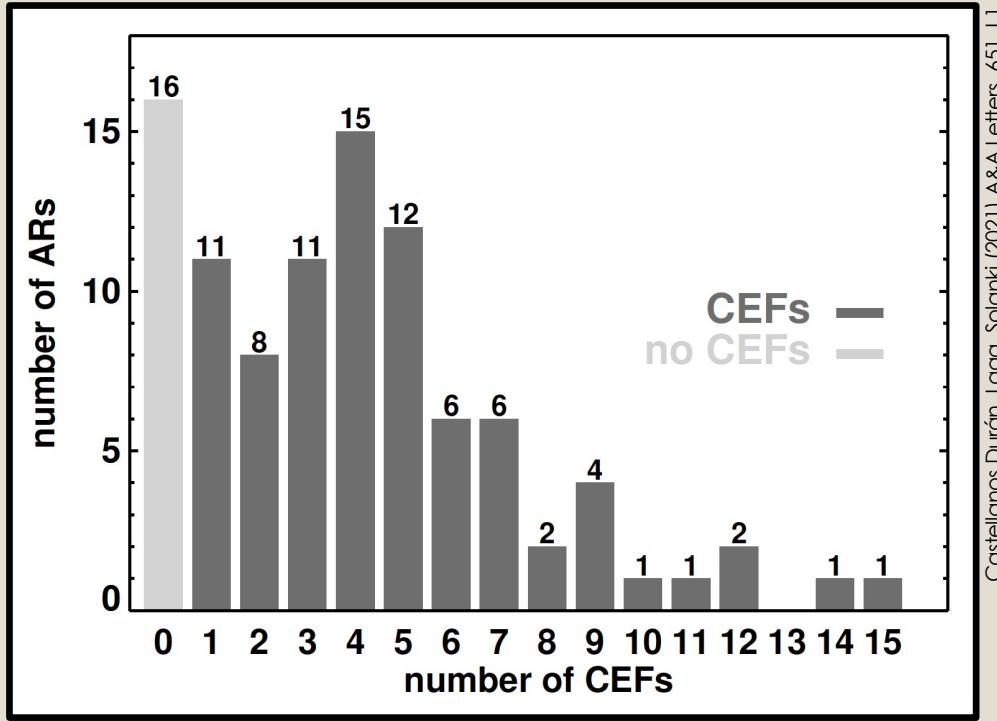
How rare are CEFs?

- Sample: 97 sunspot groups
- All types of sunspots groups from $\alpha \rightarrow \delta$
- Time appearance: 2011 – 2017
- Instrument: SDO/HMI
- Average observing time: 9.6 ± 1.4 days

LOS velocity calibration to HMI data



Total CEFs & complexity of the AR



Castellanos Durán, Lagg, Solanki (2021) A&A Letters, 651, L1

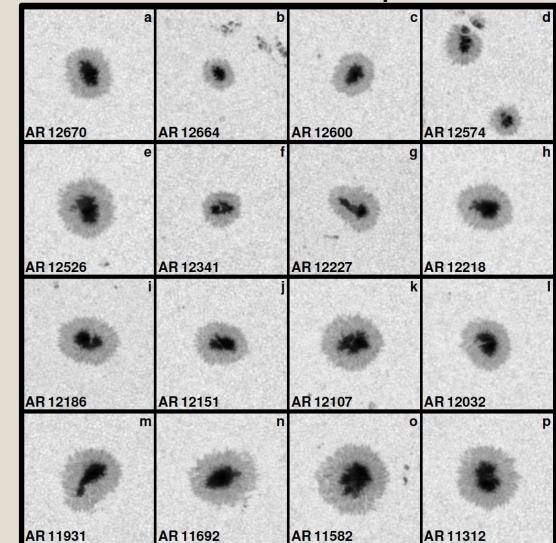
We found **384** CEFs in 83.5% of all ARs regardless of the magnetic complexity

6 CEFs were found per AR (median value).

ARs without CEFs share a similar roundish morphology and are all rather small, with a diameter smaller than 40 arcsec.

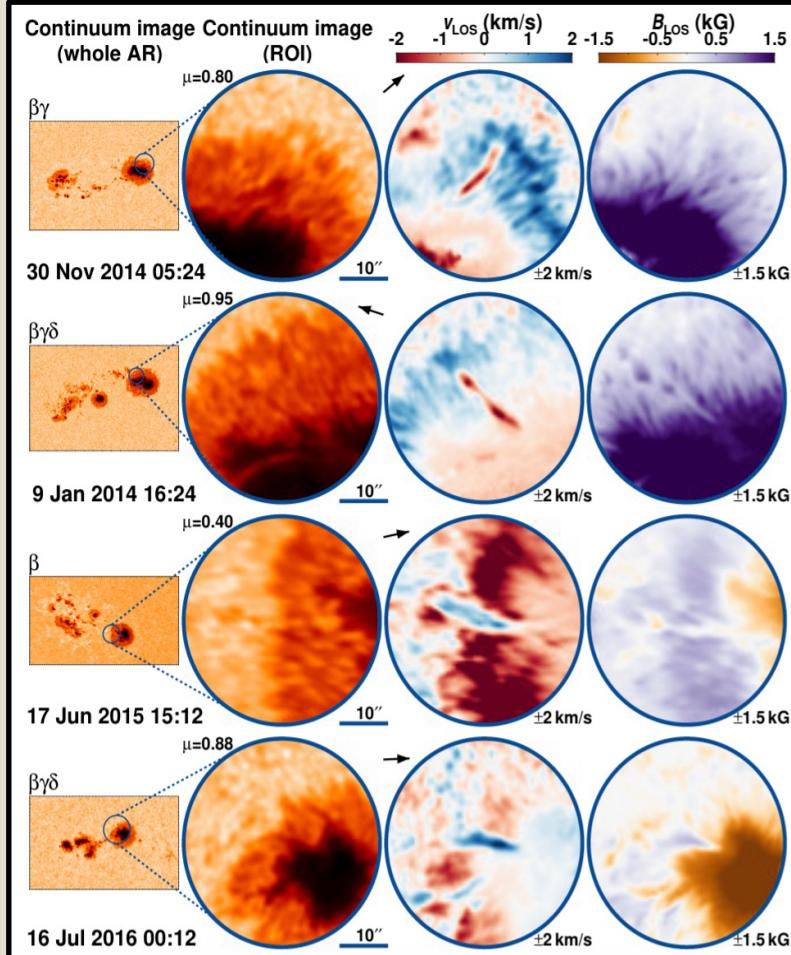


CEF-less sunspots

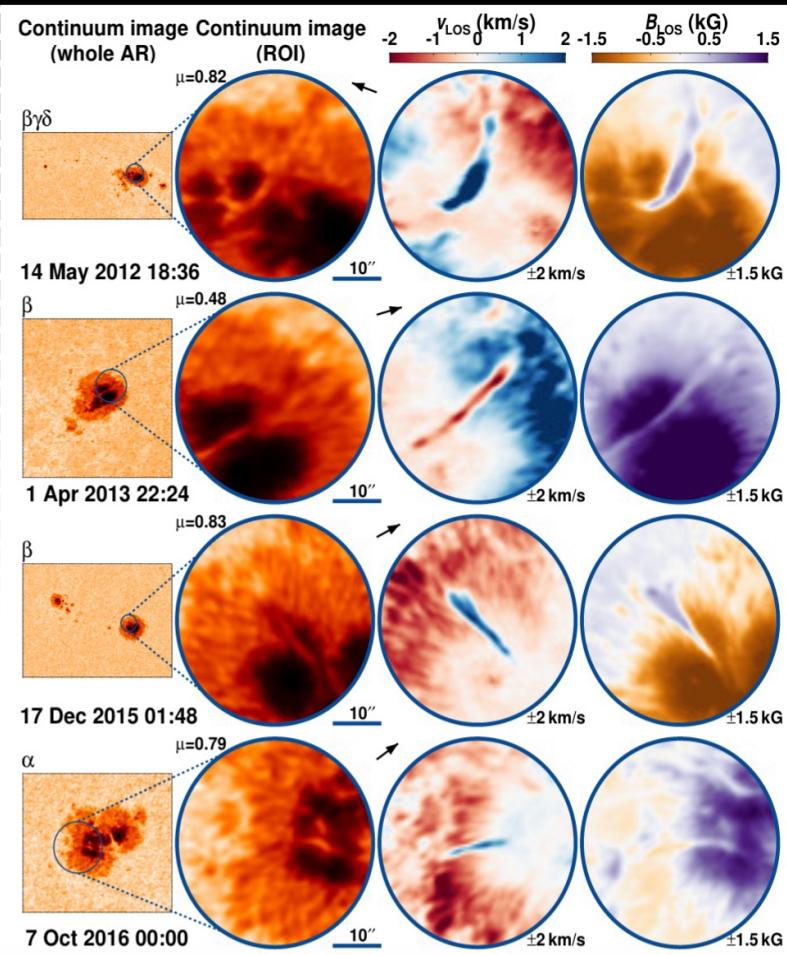


Two types of CEFS

Not associated with light bridges

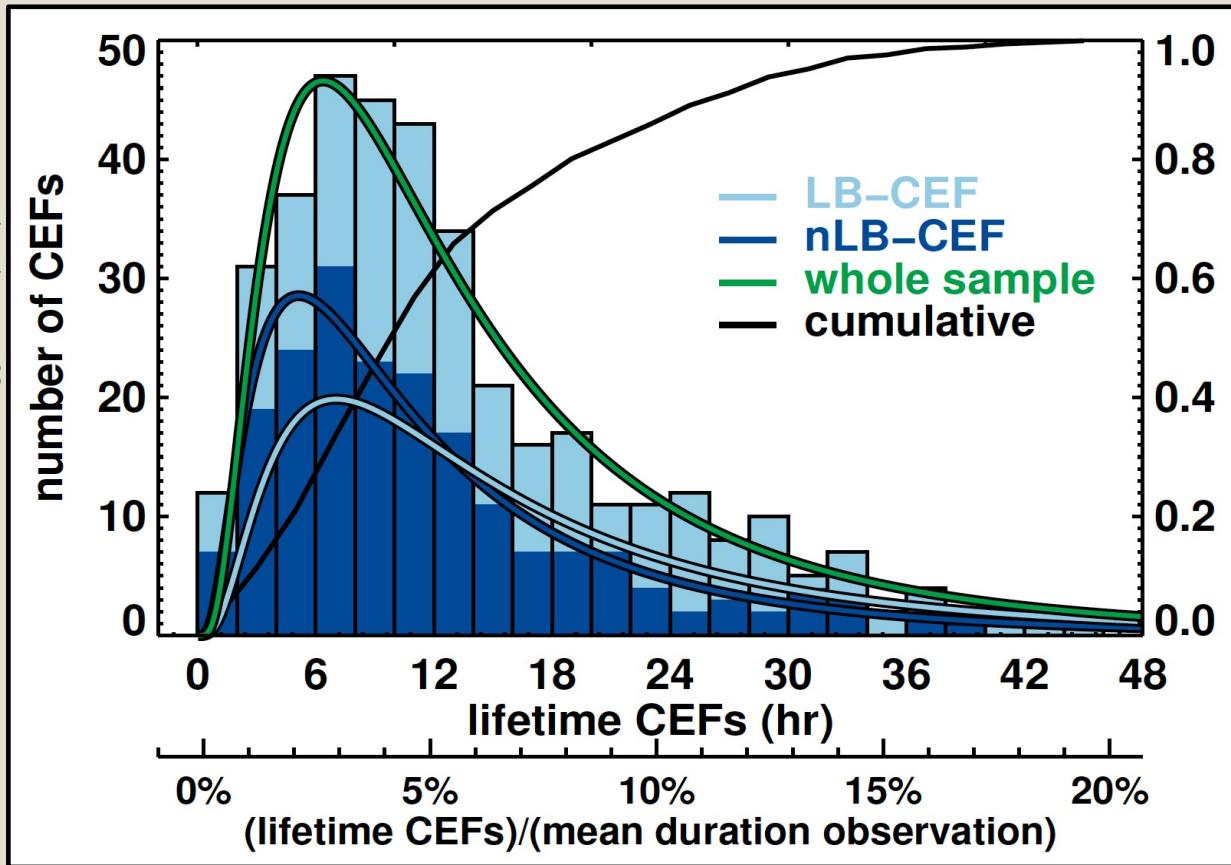


associated with light bridges



Both types of CEFs are almost equally common in our sample:
198 (51.6%) nLB-CEFs vs. 186 (48.4%) LB-CEFs.

Lifetimes CEFs

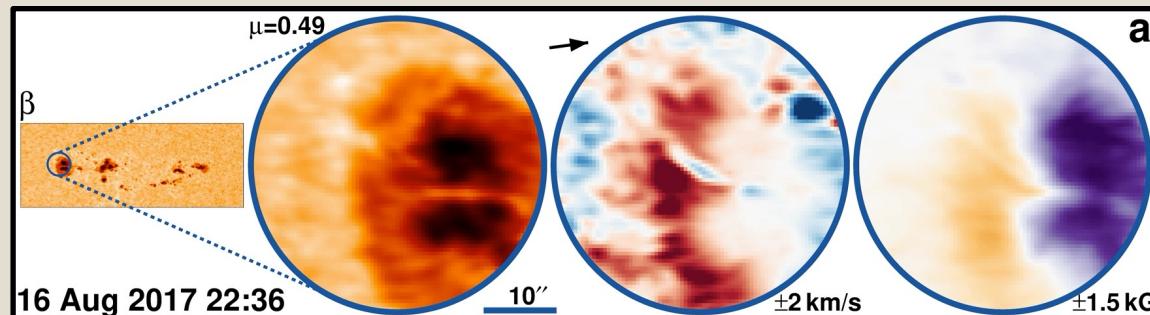


- Average lifetime of CEFs is 13.5 h
- Their lifetimes follow a log-normal distribution
- LB-CEFs have longer lifetimes of ~3.5 h

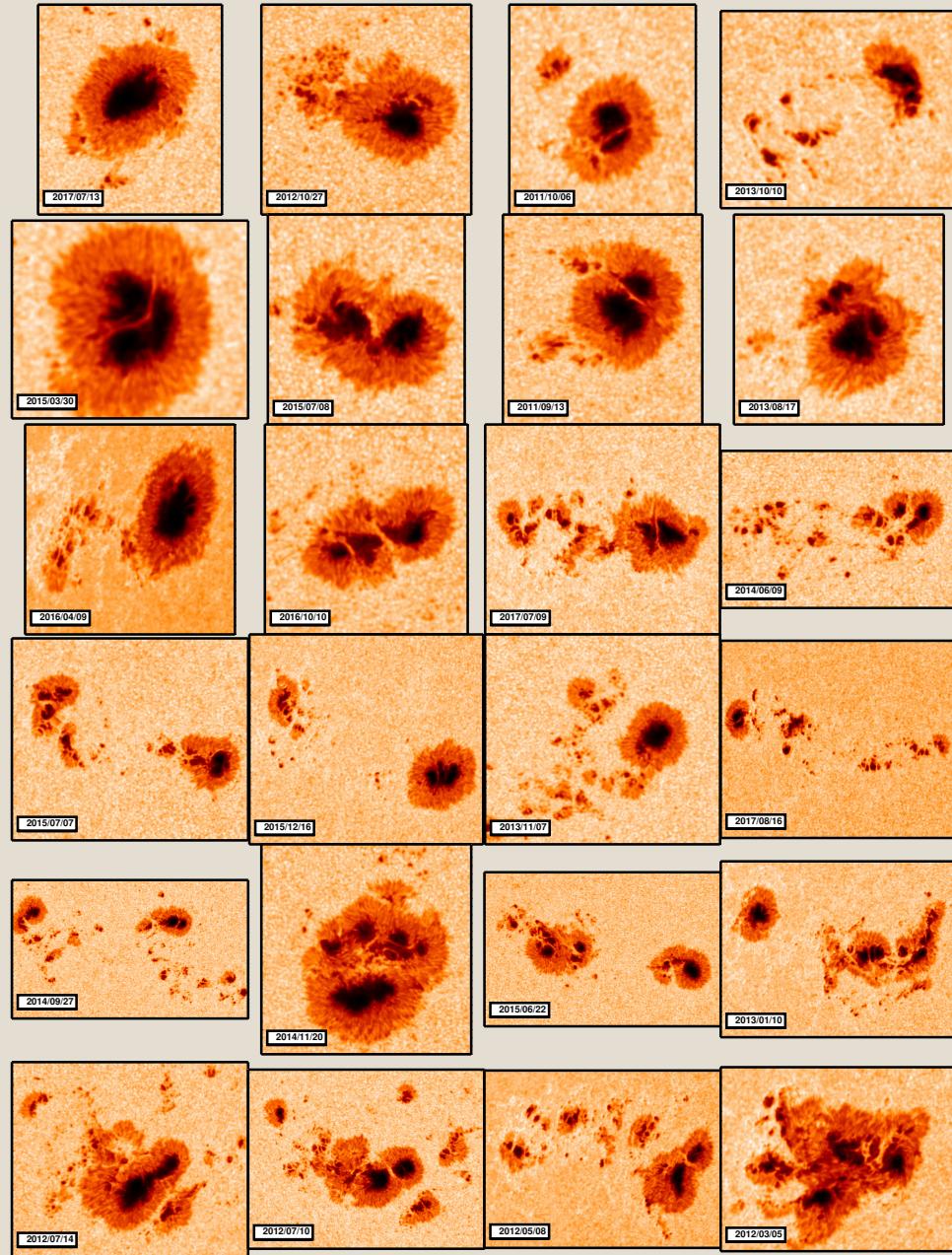
Take aways

- We found 384 counter Evershed flows(!)
- We found CEFs in **81 out of the 97** ARs studied between 2011 & 2017
 - CEF-less sunspots were very small
- There are **two types of CEFs** depending on the association with light bridges
 - **Both** types of CEFs are almost **equally common** in our sample
- The average lifetimes of CEF is 13.5 h

We needed to continuously track the ARs for, on average, **9.6 days** to detect **six** CEFs in an AR (median value). We expect to only see a CEF during **5.9%** of the total duration of the observation of an AR.



Examples of sunspots with CEFs observed by Hinode/SP



Hinode/SP observations