

Statistical study of prominence eruptions in the wide field of view of Solar Orbiter/EUI/FSI

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**STEREO Science Team
Meeting, 3-4 March 2025**

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Starting point: EUI eruption list

<https://www.sidc.be/EUI/solar-eruptions>

sidc.be/EUI/solar-eruptions

Royal Observatory of Belgium / Solar Influences Data Analysis Center

Extreme Ultraviolet Imager

About Data & Software **Solar Eruptions** Community

Solar Eruptions

Onset Time	Instrument	Principal Angle	Description of Event
2020-05-30 00:40:00 UTC	FSI 174	South-East	first CME observed by FSI
2020-06-17 14:00:00 UTC	FSI 174	South-East	Small eruption
2020-06-19 17:00:00 UTC	FSI 304	East	Small prominence eruption
2020-11-17 03:00:00 UTC	FSI 174	North-West	Nice eruption
2020-11-18 21:00:00 UTC	FSI 174	South-West	Nice eruption
2020-11-19 02:30:00 UTC	FSI 174	South-West	Eruption
2020-11-20 16:00:00 UTC	FSI 174	South-West	Small eruption

Event selection criteria:

- Events seen off-limb in EUI/FSI 304 Å
- Years: 2021, 2022
- Set of investigated events: 229 prominences

Measurements

Table of events

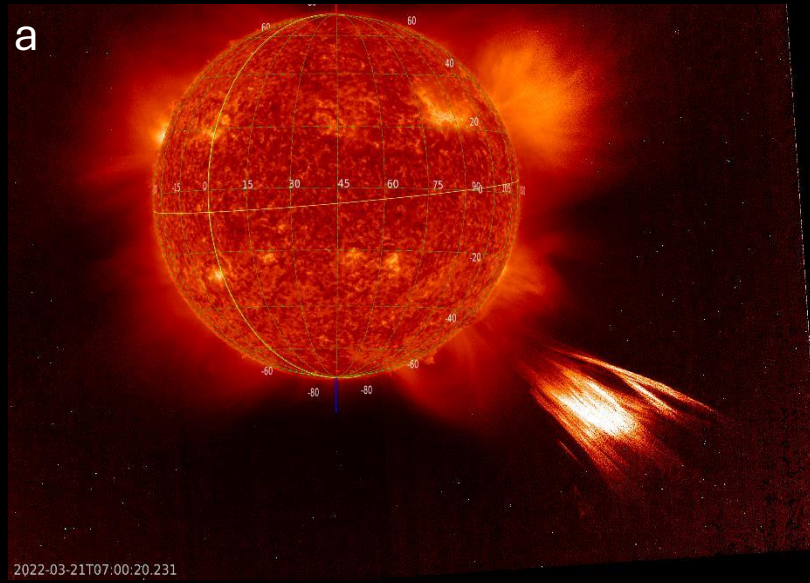
	FSI 174 (Y/N/ND) ND = No Data	FSI 304 (Y/N/ND)) ND = No Data	Compass_point from disk center (N,S,E,W)	Description of eruption, PE = prominence eruption	Time of Maximum height measurement	Reviewer 1 (BD, DS, DT, ED, LR, MM, MW)	maximum height of leading bright feature [Rs]	PA at maximum height of leading bright feature [deg]	PA leaving Limb [deg]	Reviewer 2 (BD, DS, DT, ED, LR, MM, MW)	maximum height of leading bright feature [Rs]	PA at maximum height of leading bright feature [deg]	PA leaving Limb [deg]	Reviewer 3 (BD, DS, DT, ED, LR, MM, MW)	maximum height of leading bright feature [Rs]	PA at maximum height of leading bright feature [deg]	PA leaving Limb [deg]
2021-02-21 2:00:00	Y	Y	North-West	Narrow PE, later detached from the Sun	2021-02-21 10:24:11	MM	1.56	294	316	MW	1.56	290	310	BD	1.57	295	316
2021-03-21 16:00:00	Y	Y	North-West	PE, from narrow to cloud(rain)-like. Downflows also observed.	2021-03-21 21:02:44	MM	1.56	298	310	MW	1.5	295	310	BD	1.56	298	310
2021-03-21 20:00:00	Y	Y	South-West	PE, narrow attached to the Sun, it detached later. Twisted. Downflow?	2021-03-22 01:32:44	MM	2.26	238	235	MW	2.3	240	236	BD	2.3	239	235
2021-04-22 21:00:00	Y	Y	North-West	Big PE, moving along a loop-like structure	2021-04-23 01:47:44	MM	1.66	269	310	MW	1.68	270	310	BD	1.69	272	310
2021-04-23 22:00:00	Y	Y	South-East	PE, starts as a loop and then one leg detaches and erupts	2021-04-24 0:32:44	MM	1.62	112	136	MW	1.63	110	135	BD	1.64	112	135
2021-04-24 4:00:00	Y	Y	South-East	PE, far in the FOV, twisted and then elongated structure	2021-04-24 7:25:14	MM	2.69	111	118	MW	2.69	230	115	BD	2.71	111	116
2021-04-25 8:00:00	Y	Y	South-West	PE, elongated, parallel with the limb	2021-04-25 12:32:44	MM	1.3	231	231	MW	1.3	230	230	BD	1.38	227	230
2021-04-25 10:10:00	Y	Y	East	PE, detached at one leg. A small one just before this one.	2021-04-25 13:25:14	MM	1.7	70	81	MW	1.7	80	80	BD	1.74	69	85
2021-09-04 17:30:00	Y	Y	South-East	PE, loop-like, one leg detaching later on	2021-09-04 18:41:44	MM	1.33	150	142	MW	1.35	151	150	BD	1.38	150	143

Avg Max height [Rs]	Avg PA at max height [deg]	Avg PA leaving limb	Approx deflectio n (Deg, use with care)	Obvious deflectio n (Y/N)	Reach edge of FOV of image? Y/N	Nearby Feature (AR, EqCH)	Nearby Fan/Stream er (Y/N)	Nearby Polar CH (Y/N)	Post flare loops (Y/N)	Associated flare/bright ening (Y/N)	Dimming (Y/N)	Wave 304 (Y/N)	Wave 174 (Y/N)	Case study (Y/N)	Approx Velocity (km/s, use with care)
1.563333333	293.00	314	21.00	Y	N	-	Y	Y	N	N	Y	N	N	N/Y	10.65554858
1.54	297.00	310	13.00	N	N	AR	N	Y	N	N	N	N	N	N/Y	16.85245541
2.286666667	239.00	235.3333	-3.67	Y	N	-	N	Y	N	N	N	N	N	N/Y	41.35263474
1.676666667	270.33	310	39.67	Y	N	-	Y	Y	N	N	N	N	Y	23.23835728	
1.63	111.33	135.3333	24.00	Y	N	-	N	N	N	N	N	N	N	N/Y	40.23581405
2.696666667	110.67	116.3333	5.67	N	N	-	N	N	N	N	N	N	N	N/Y	90.2063505
1.326666667	229.33	230.3333	1.00	N	N	AR	Y	Y	Y	N	N	N	N	N	9.636519188

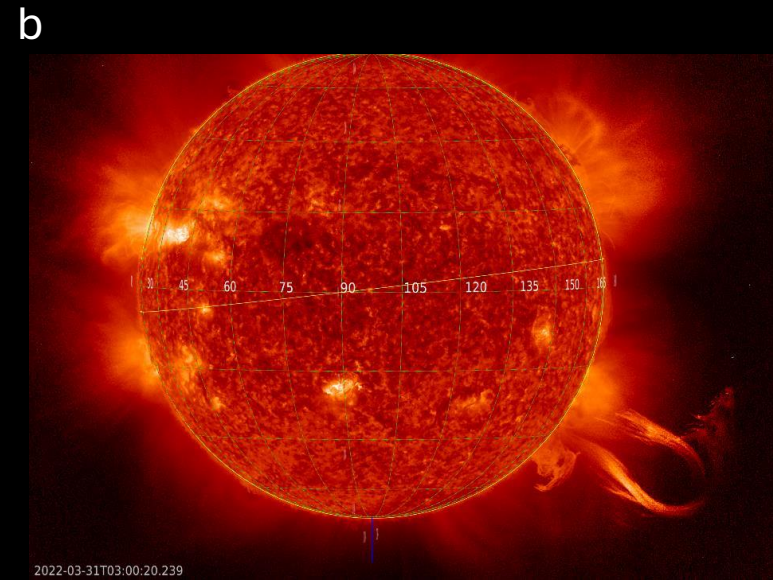
BD: Brenda Dorsch
DS: Daria Shukhobodskaja
DT: Dana Talpeanu
ED: Elke D'Huys
LR: Luciano Rodriguez
MM: Marilena Mierla
MW: Matt West

Various morphologies observed

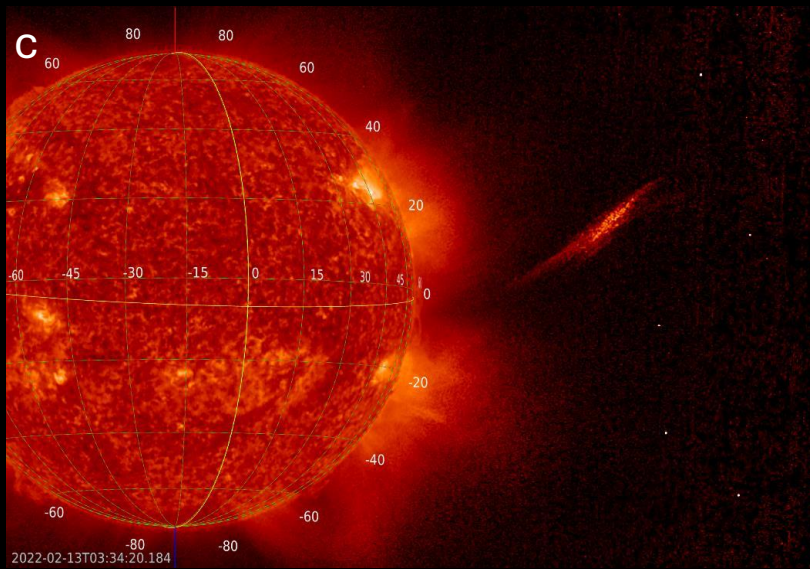
Fan



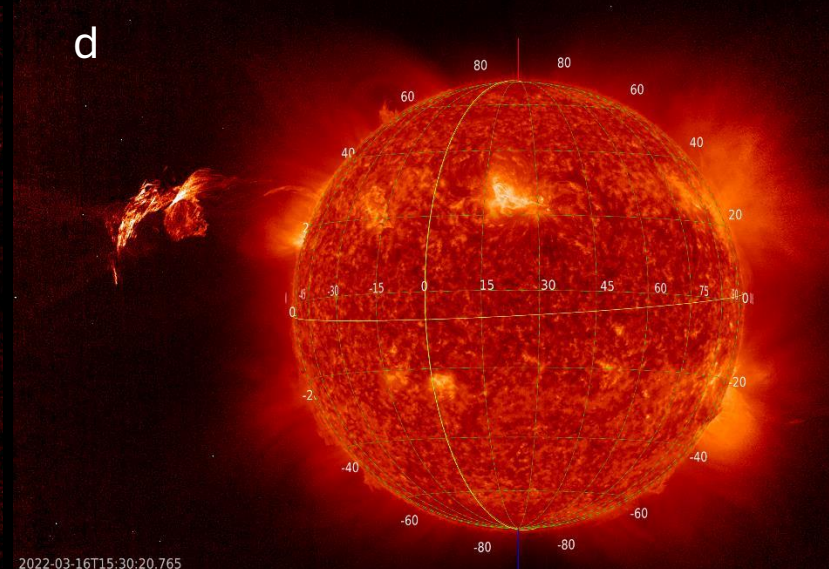
Loop



Jet

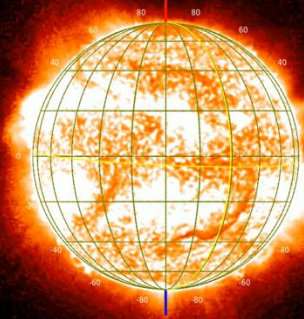


Twisted

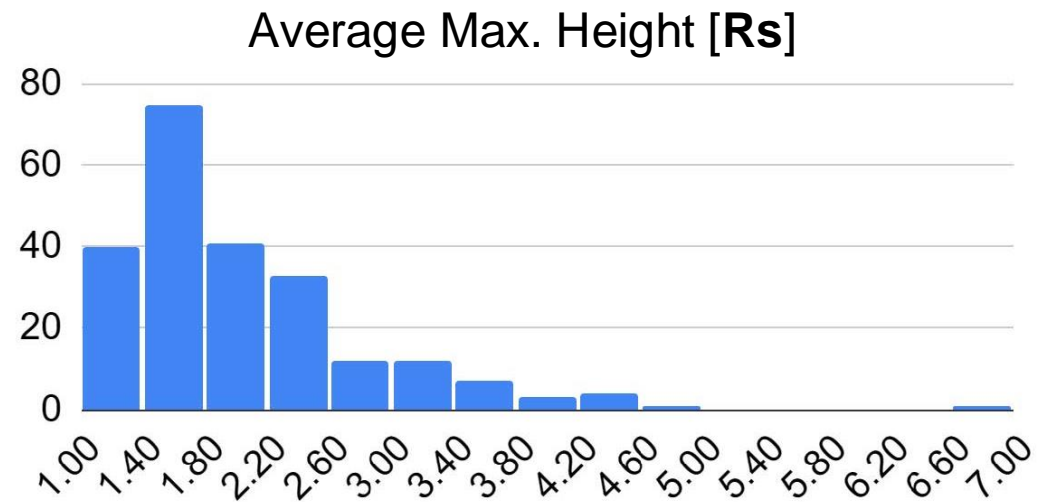


Changing morphology

Loop-like → Fan-like

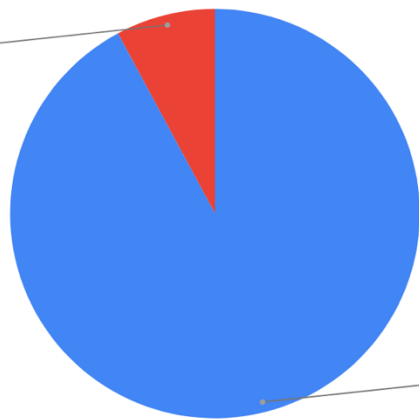


Maximum Height

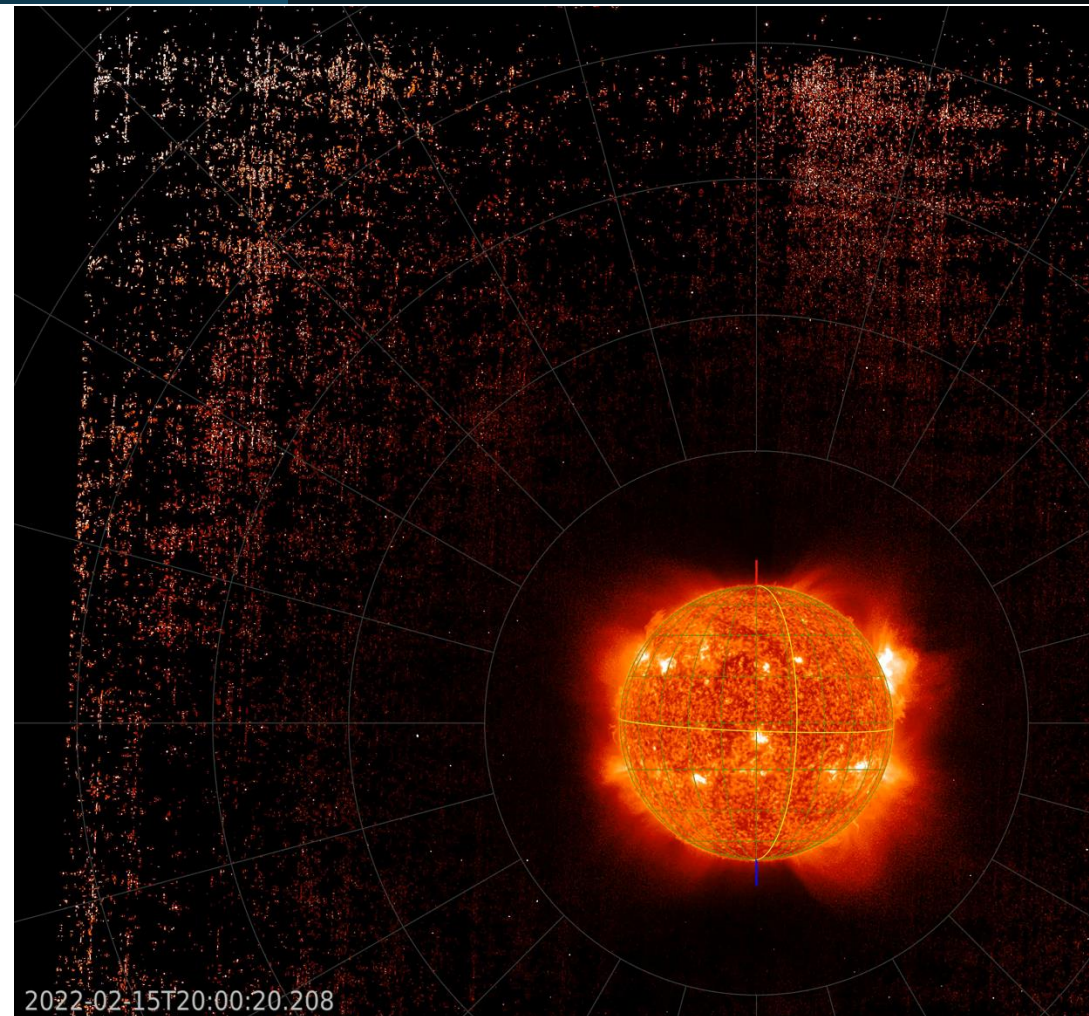


Reaches Edge FOV (Y/N)

Y
7.9%



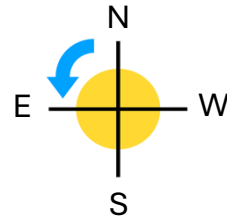
N
92.1%



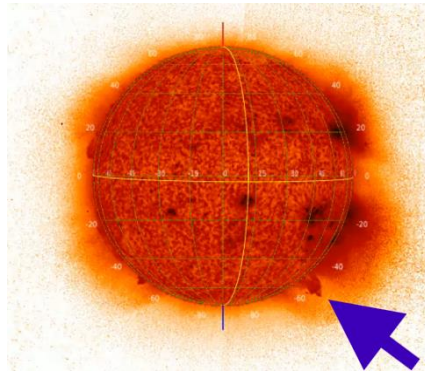
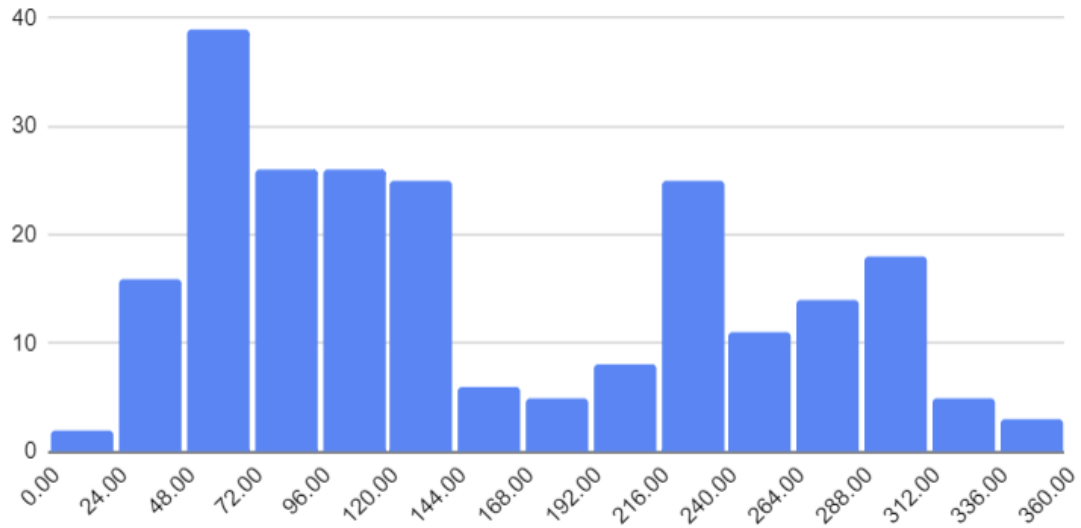
Furthest measured eruption:
2022-02-16, 6.82 R_{\odot} (Mierla et al., 2022)

Average Position Angle (PA)

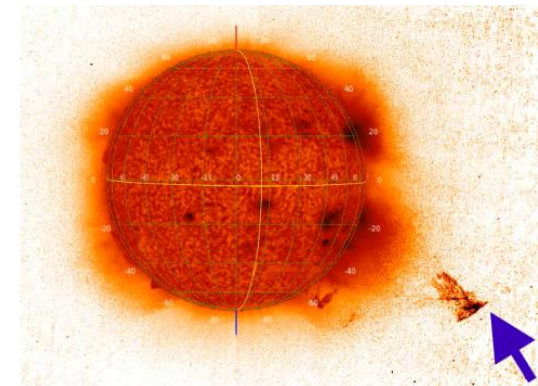
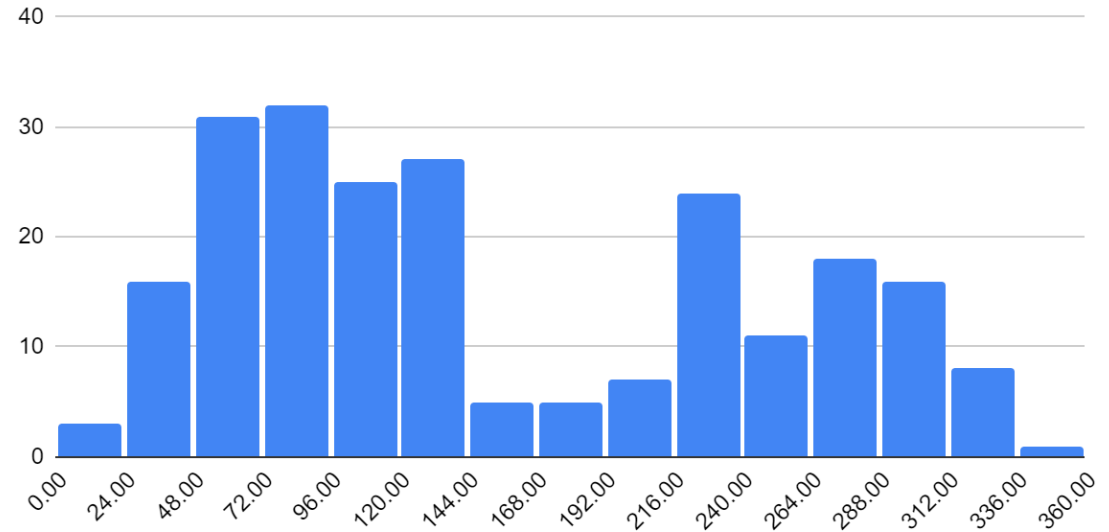
Statistics



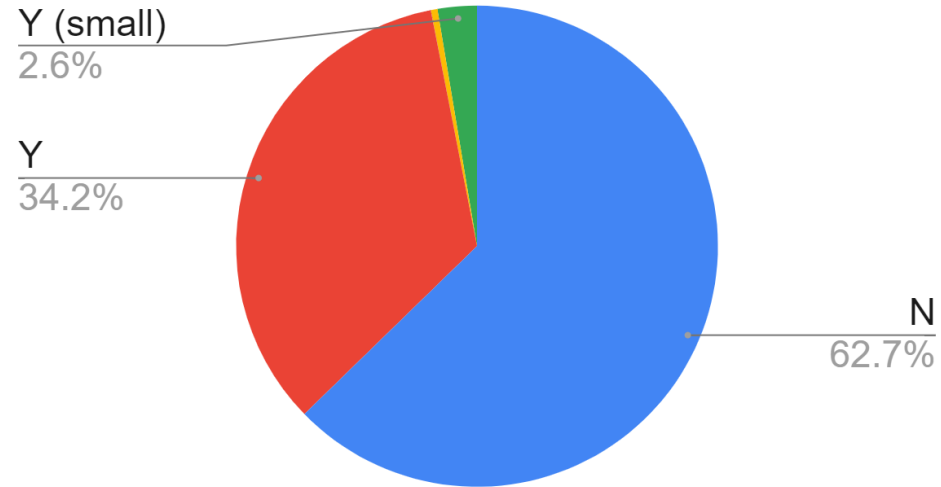
Average PA at limb



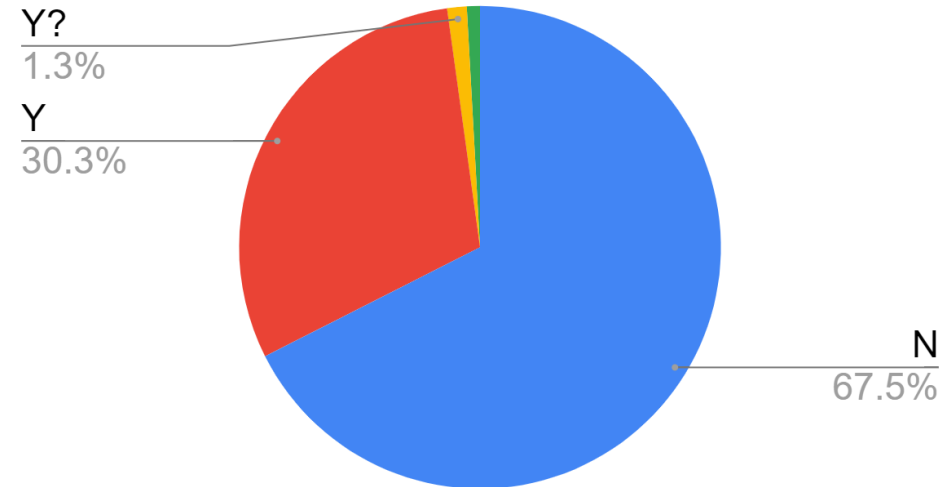
Average PA at Max. Height



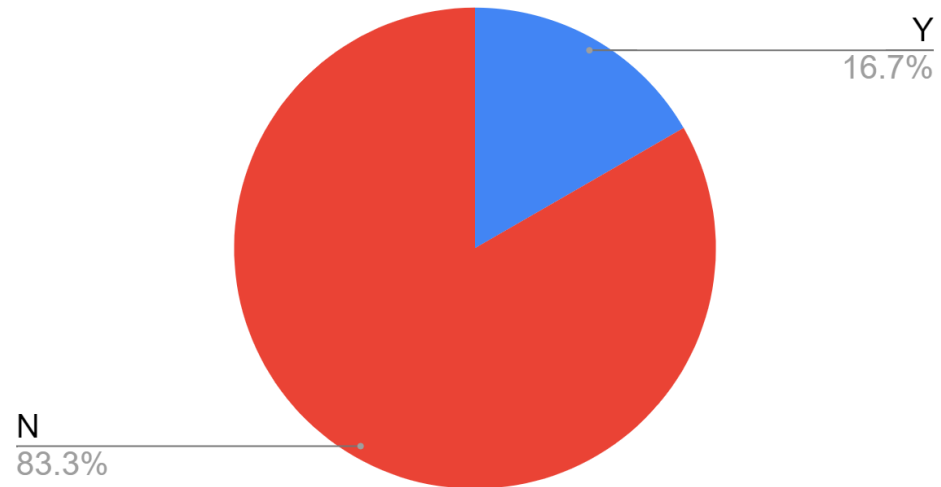
Associated Flares/Brightenings (Y/N)



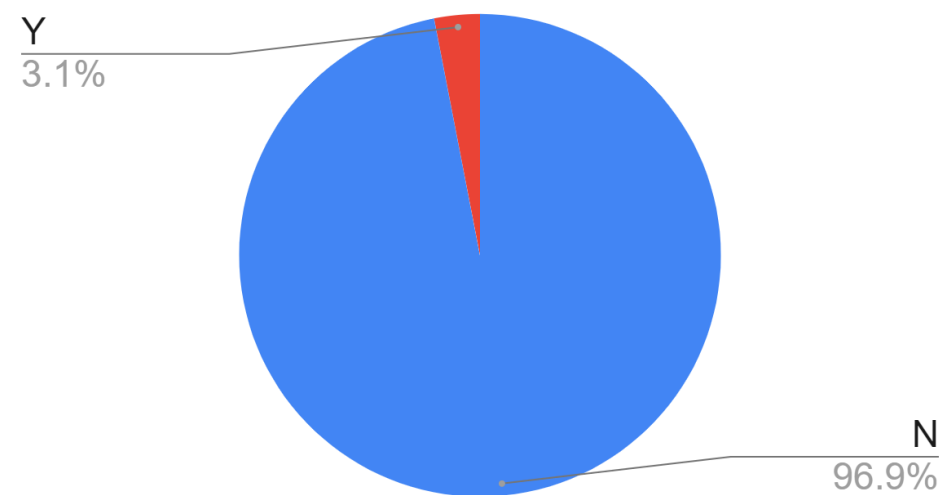
Post-flare Loops (Y/N)



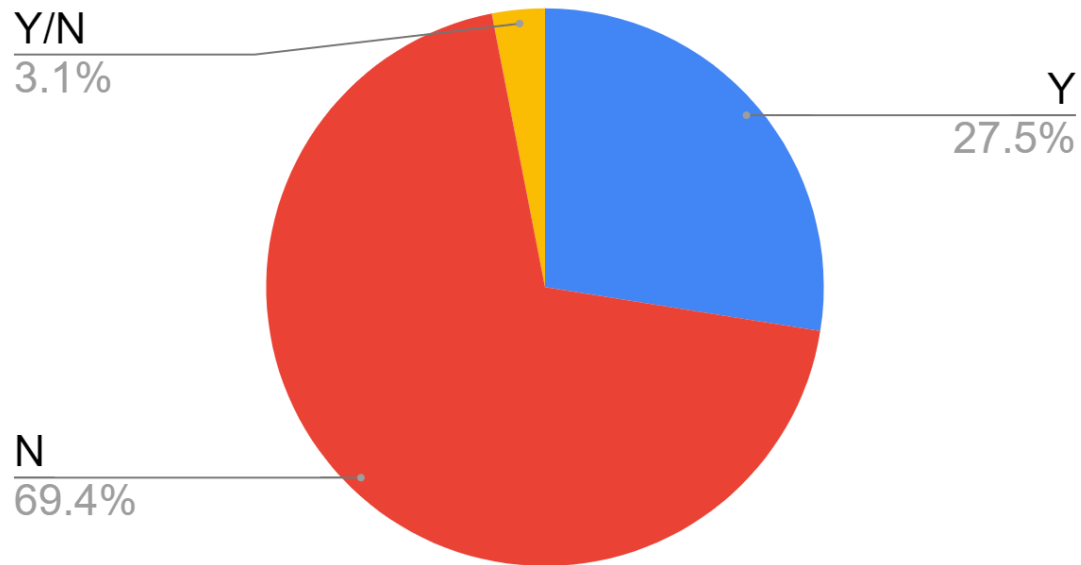
Dimming (Y/N)



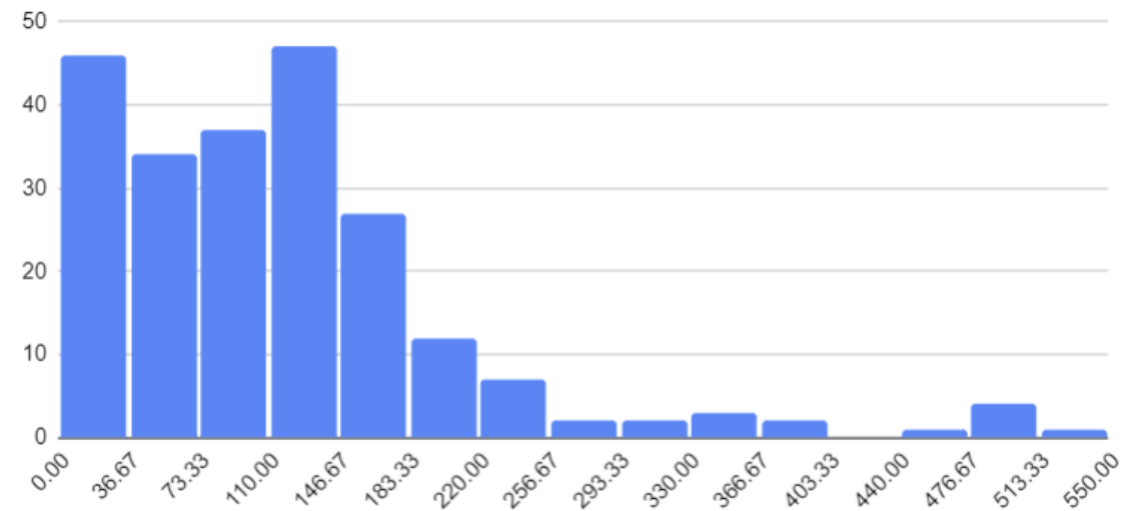
Wave 174



Obvious Deflection (Y/N)

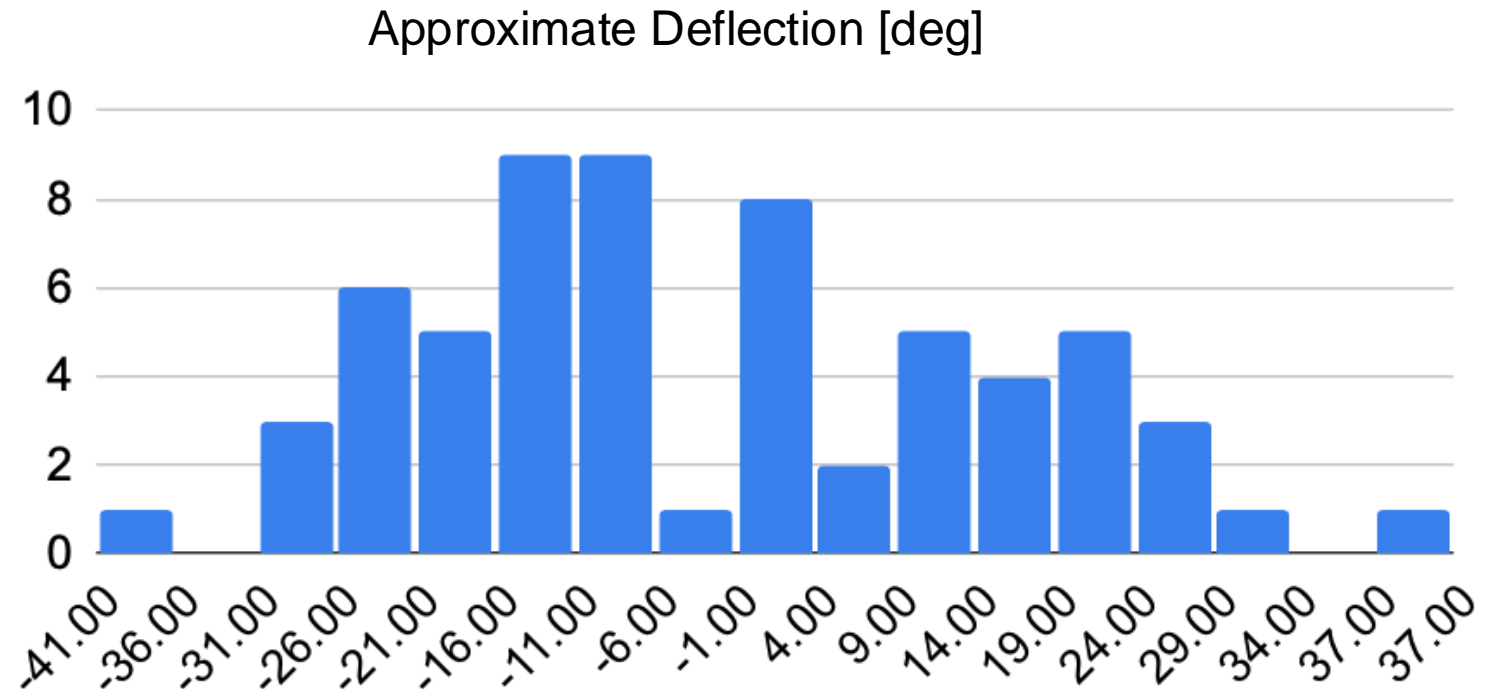
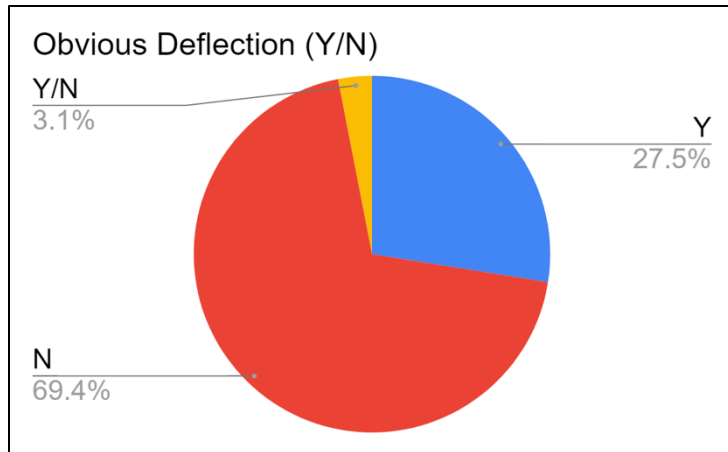


Approximate Velocity [km/s]

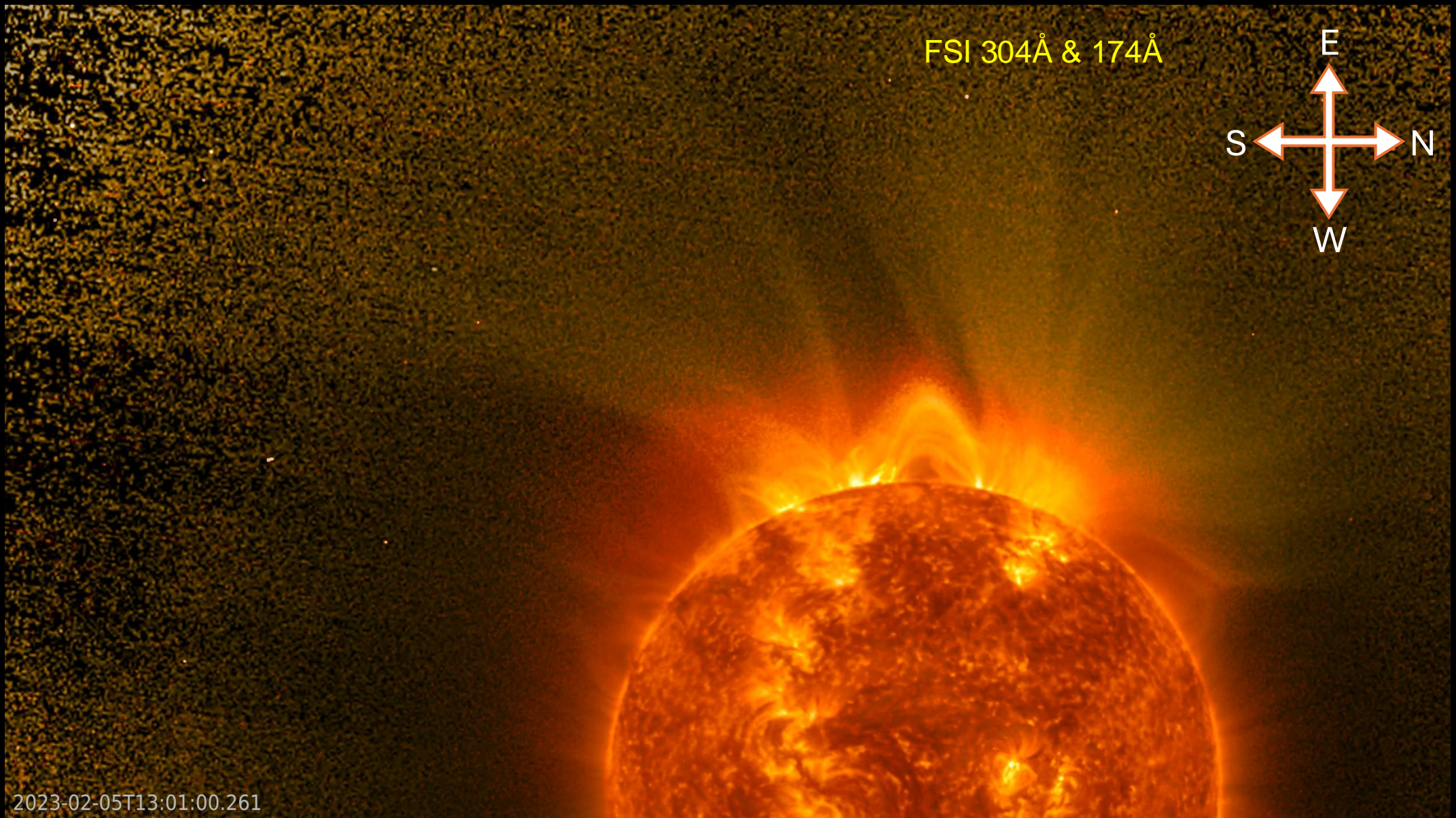


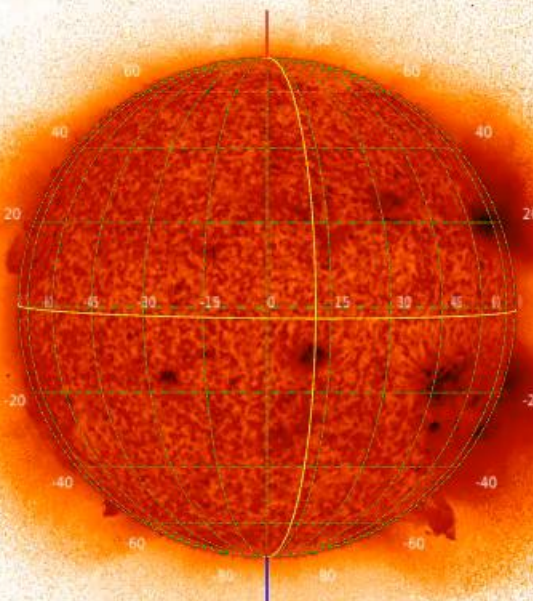
Estimated using the maximum height.

- Method: Follow same feature and measure PA at limb – PA at max height.
- Applied only to cases with obvious deflections (63 events).



Deflection examples





Eruptions reaching $\geq 2 R_{\odot}$

Kinematics

Selection of subset of events to further study

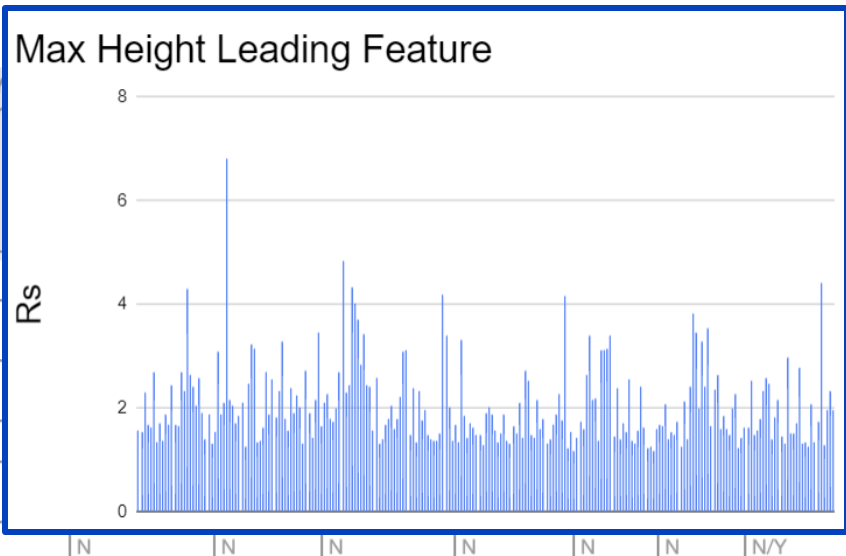
Criteria:

- max. height $\geq 2 R_{\odot}$
- &
- observed in more than a few frames.

94 events analysed

FSI 174 (Y/N/ND) ND = No Data	FSI 304 (Y/N/ND) ND = No Data	Compass_point from disk center (N,S,E,W)	Description of eruption, PE = prominence eruption	Time of Maximum height measurement	Reviewer 1 (BD, DS, DT, ED, LR, MM, MW)	maximum height of leading bright feature	PA at maximum height of leading bright	PA leaving Limb [deg]	Reviewer 2 (BD, DS, DT, ED, LR, MM, MW)	maximum height of leading bright feature [Rs]	PA at maximum height of leading bright feature [deg]	PA leaving Limb [deg]	Reviewer 3 (BD, DS, DT, ED, LR, MM, MW)	maximum height of leading bright feature [Rs]	PA at maximum height of leading bright feature [deg]	PA leaving Limb [deg]
2021-09-04 17:30:00	Y	Y	South-East	PE, loop-like, one leg detaching later on						1.35	151	150		1.38	150	143

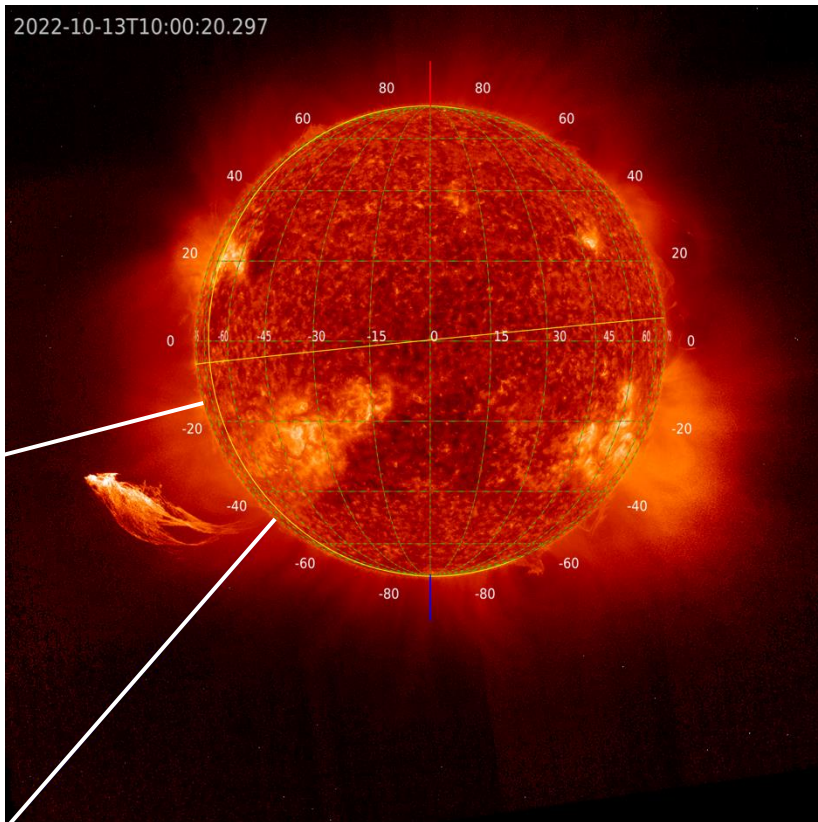
Avg Max height [Rs]	Avg PA at max height [deg]	Avg PA leaving limb	Approx deflection (Deg, use with care)	Obvious deflection (Y/N)	Reach edge of FOV of image? Y/N	Nearby Feature (AR, EqCH)	Nearby Fan/Str (Y/N)
1.563333333	293.00	314	21.00	Y	N	-	Y
1.54	297.00	310	13.00	N	N	AR	N
2.286666667	239.00	235.3333	-3.67	Y	N	-	N
1.676666667	270.33	310	39.67	Y	N	-	Y
1.63	111.33	135.3333	24.00	Y	N	-	N
2.696666667	110.67	116.3333	5.67	N	N	-	N



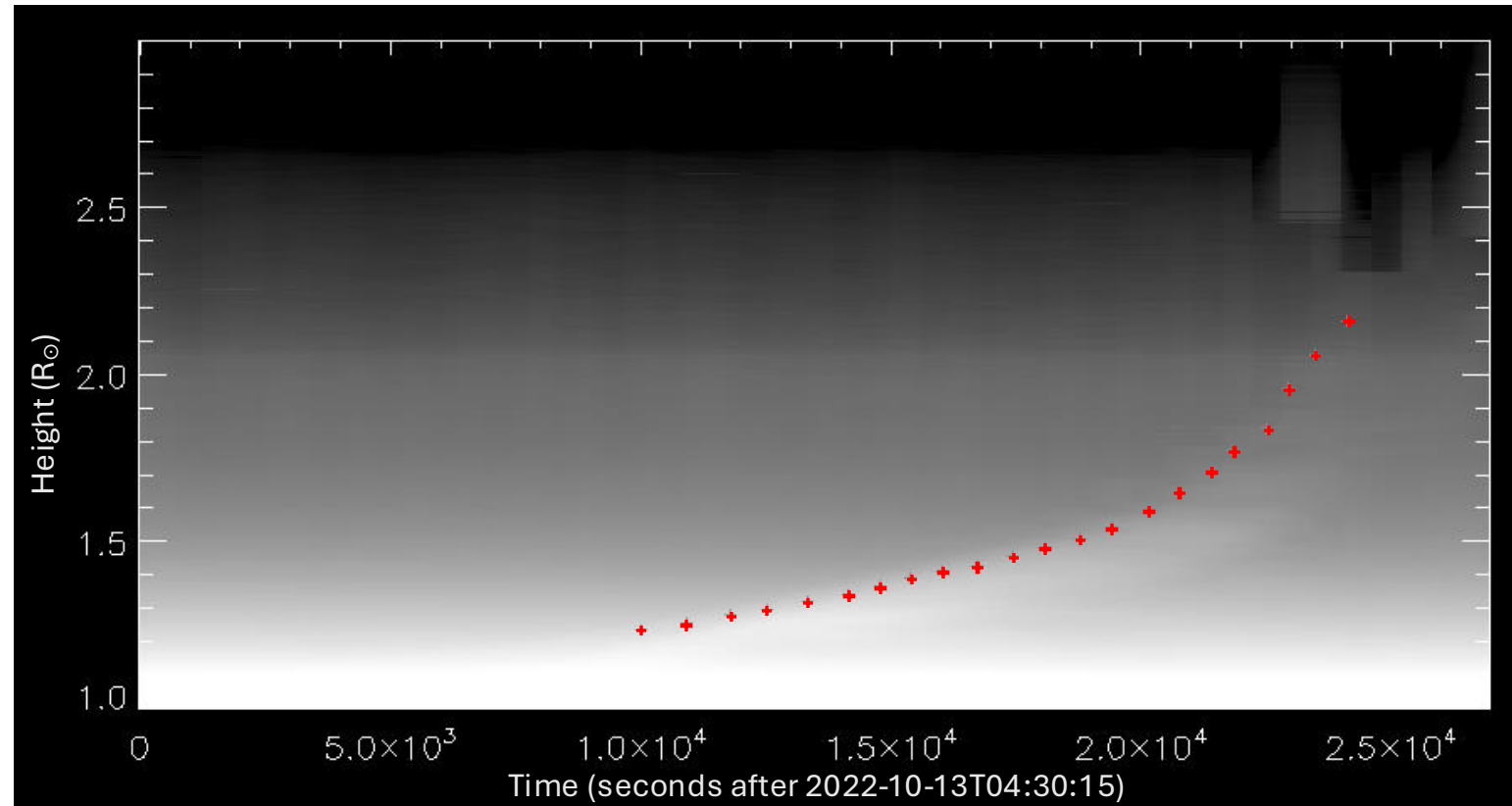
Approx Velocity (km/s, use with care)
10.65554858
16.85245541
41.35263474
23.23835728
40.23581405
90.2063505

- BD: Brenda Dorsch
- DS: Daria Shukhobodskaja
- DT: Dana Talpeanu
- ED: Elke D'Huys
- LR: Luciano Rodriguez
- MM: Marilena Mierla
- MW: Matt West

- Manual method: each eruption front is measured independently by 3 people 5 times.
- Software used: IDL/SolarSoft.



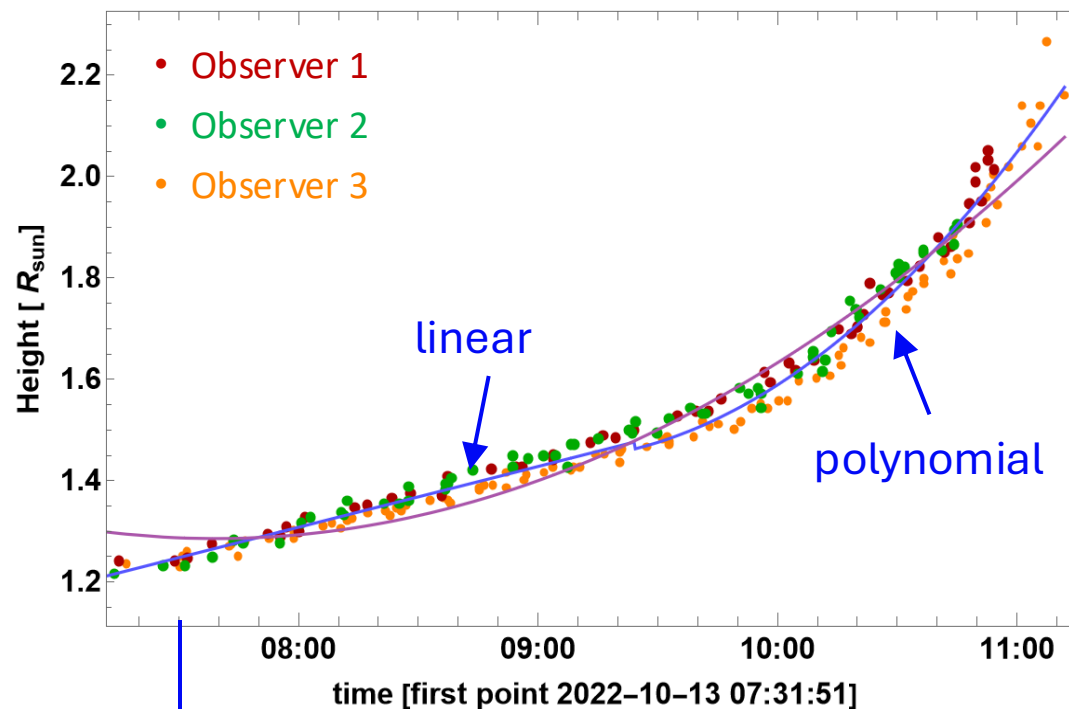
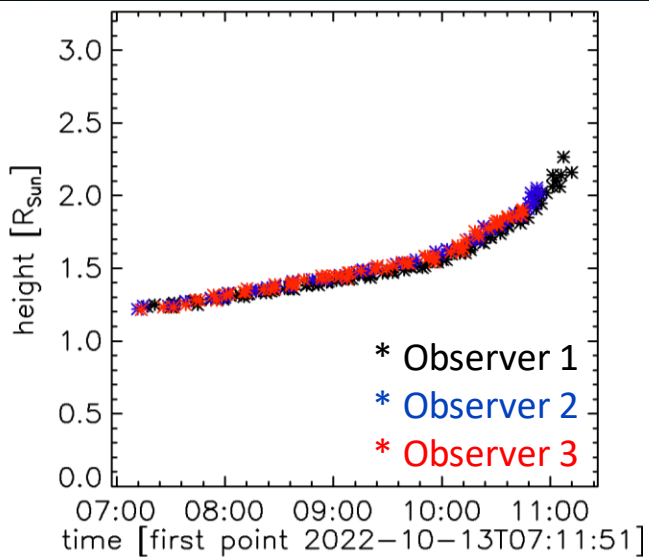
Example of an analysed eruption;
start time: 2022-10-13 04:30:00 UTC.



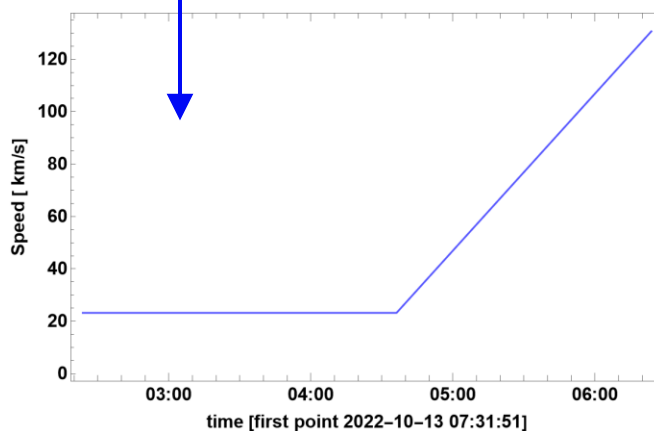
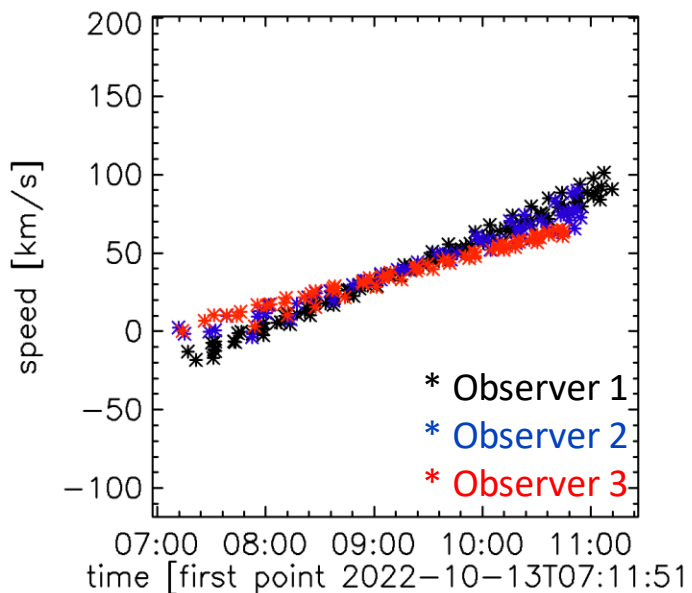
Track feature in time.

Speed and acceleration

Kinematics

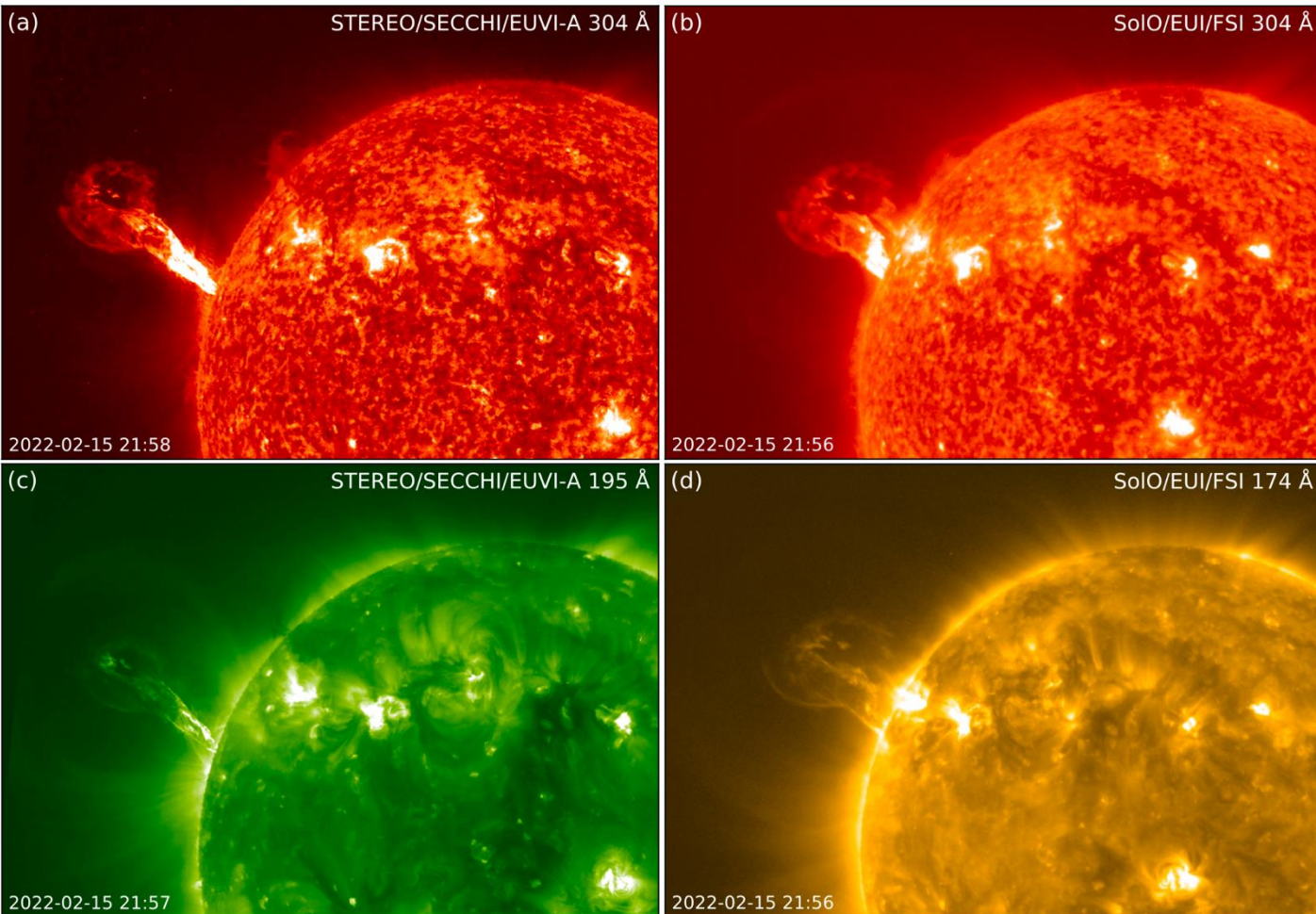


For most events we use a 2nd order polynomial profile.



A gradual evolution can be observed in some eruptions:

- slow rise,
- acceleration,
- propagation with constant speed.

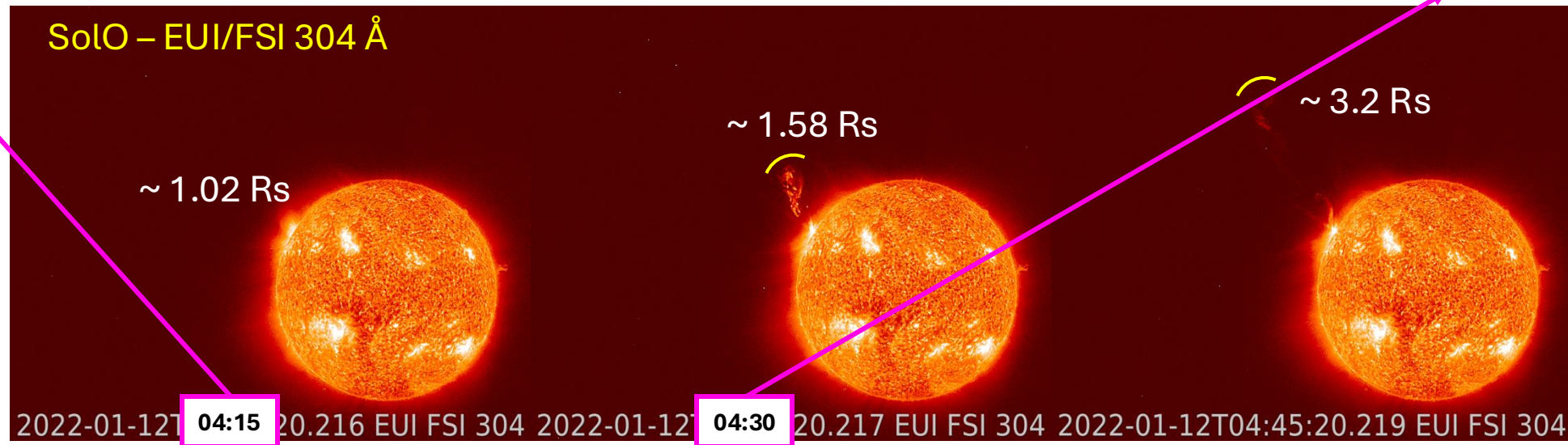
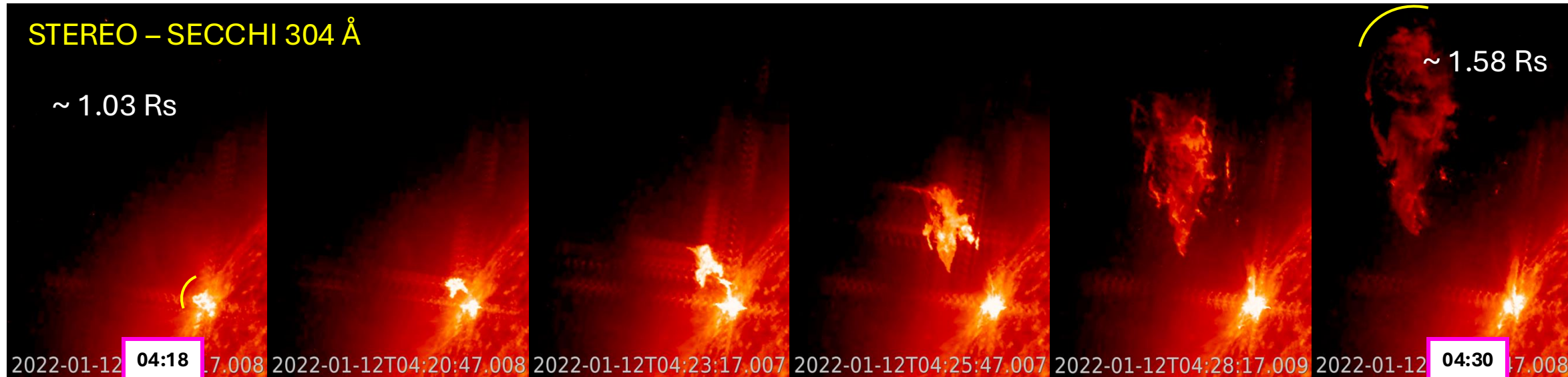


Mierla, et al., 2022.

- **Comprehensive** analysis of eruption dynamics.
- Crucial for **early-stage** assesment of kinematics.
- Enable **cross-validation**.
- **3D** reconstruccion.

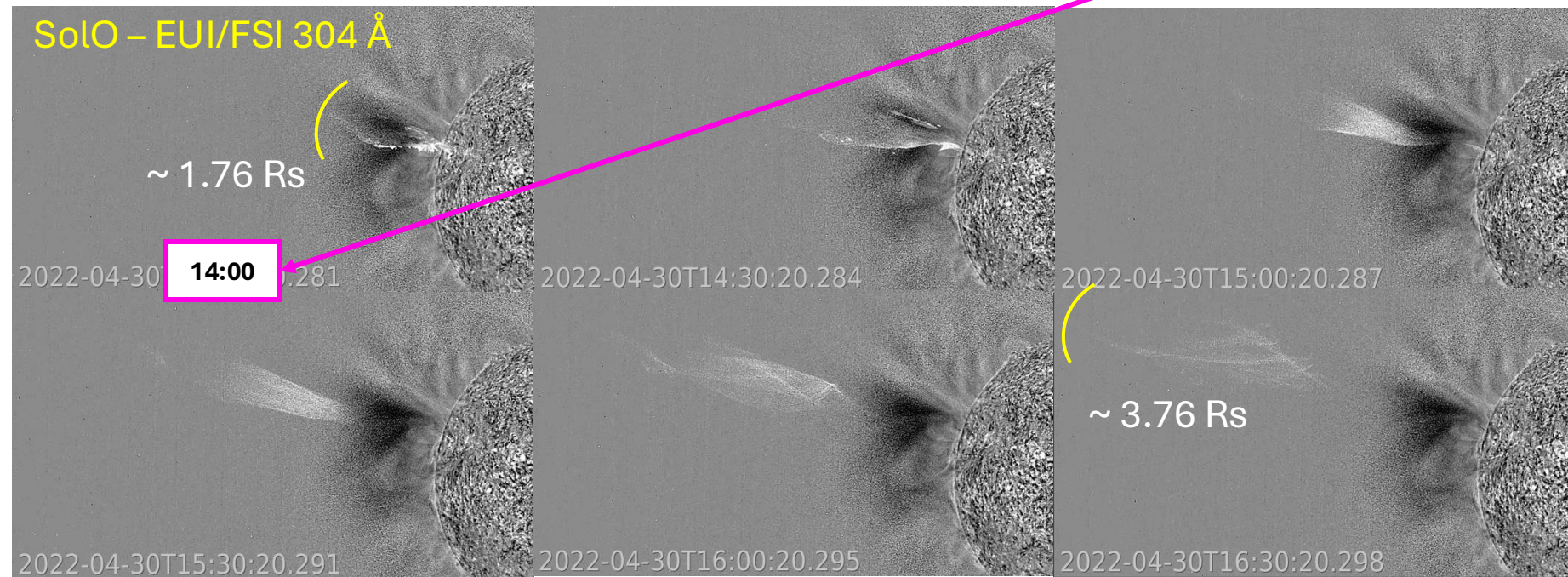
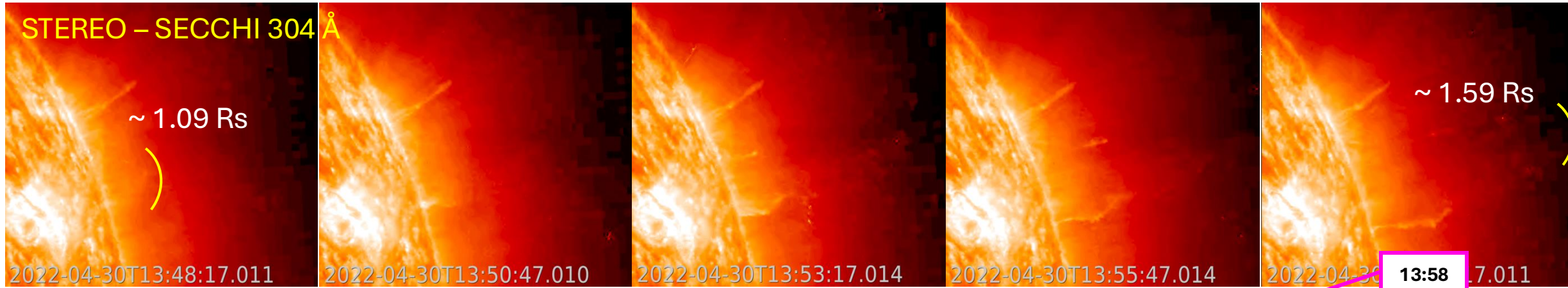
Multi-viewpoint observations

Kinematics



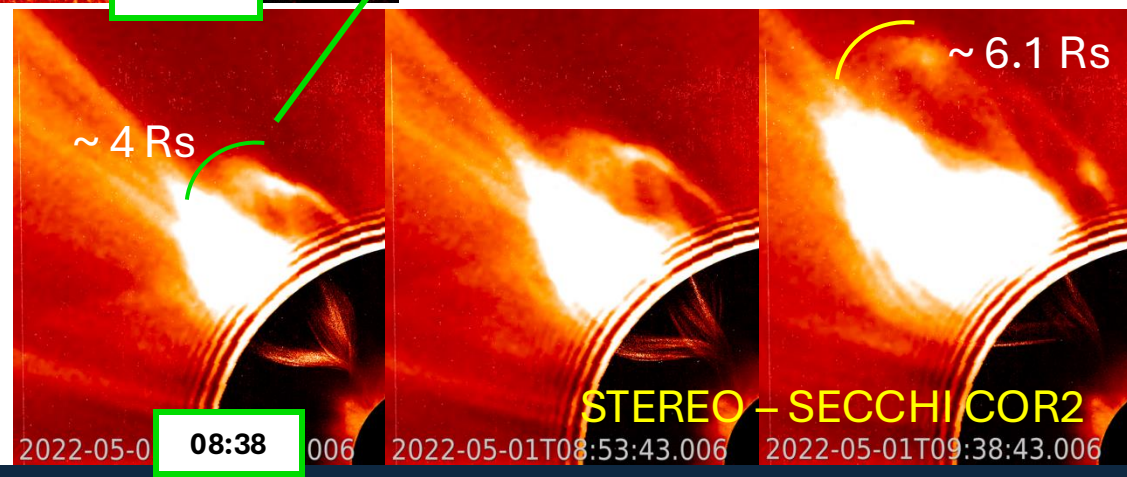
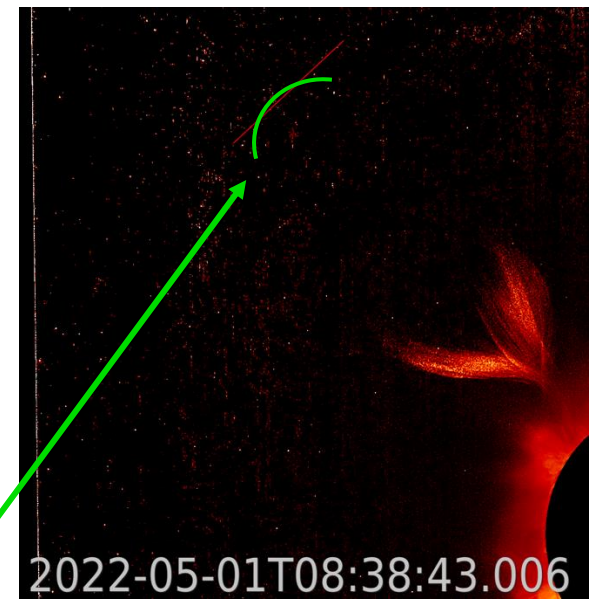
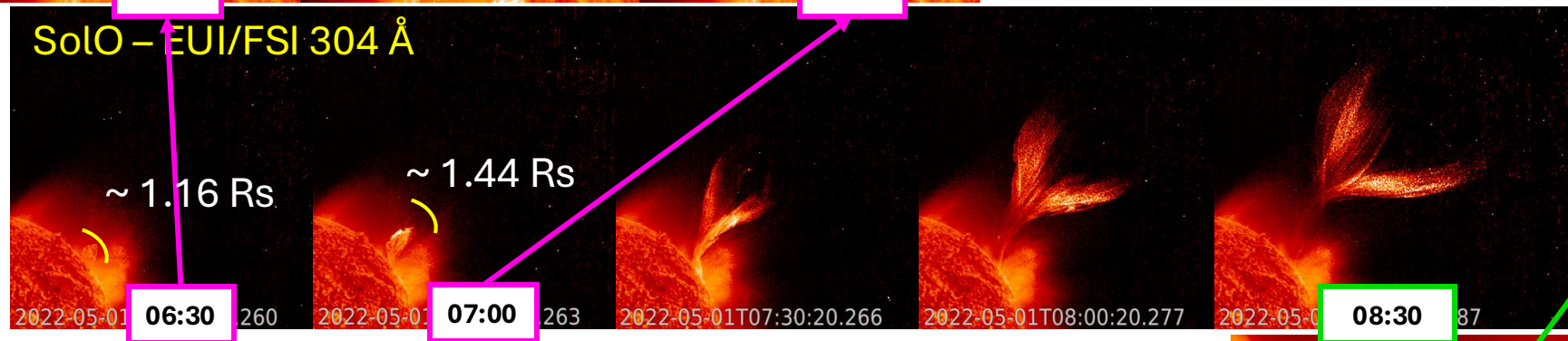
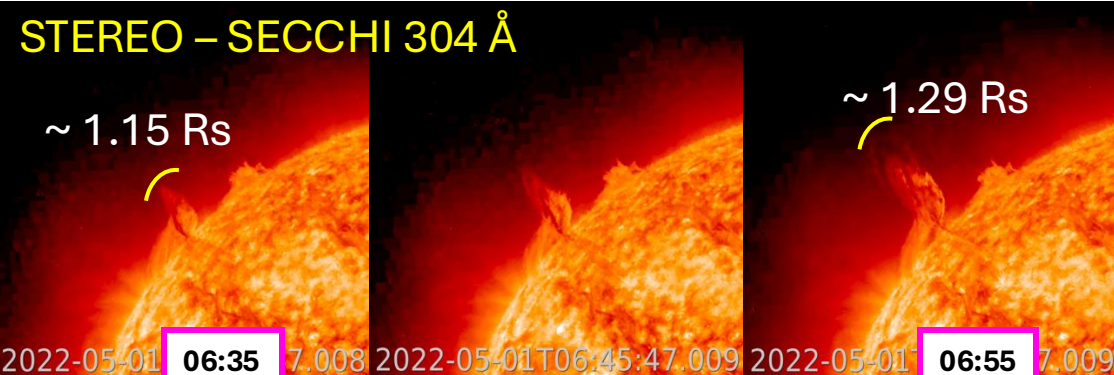
Multi-viewpoint observations

Kinematics



Multi-viewpoint observations

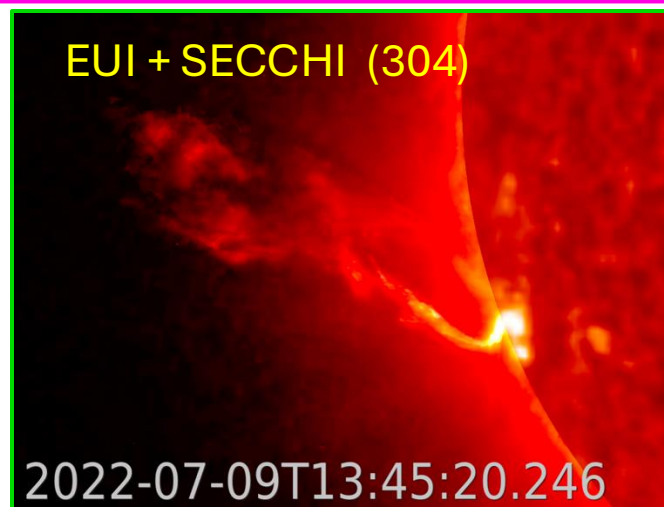
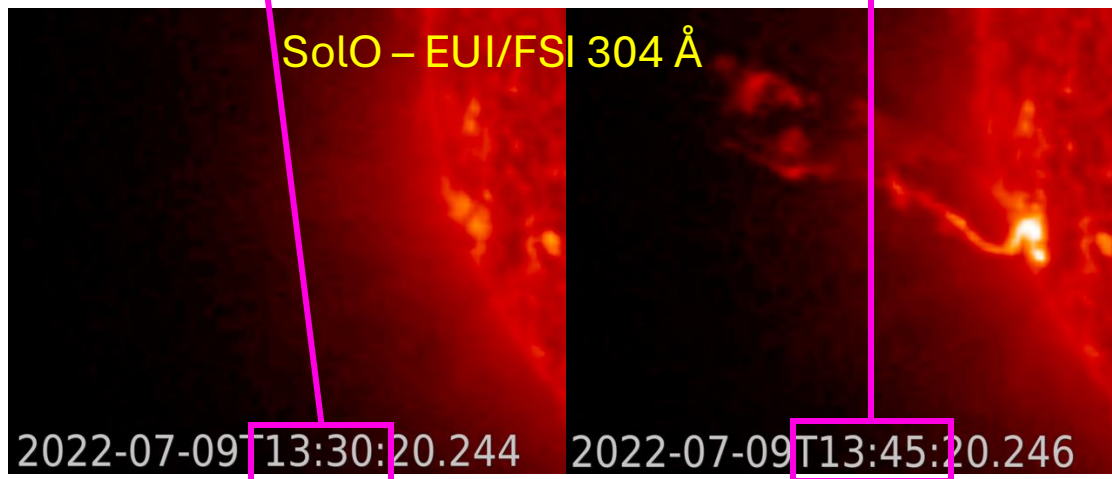
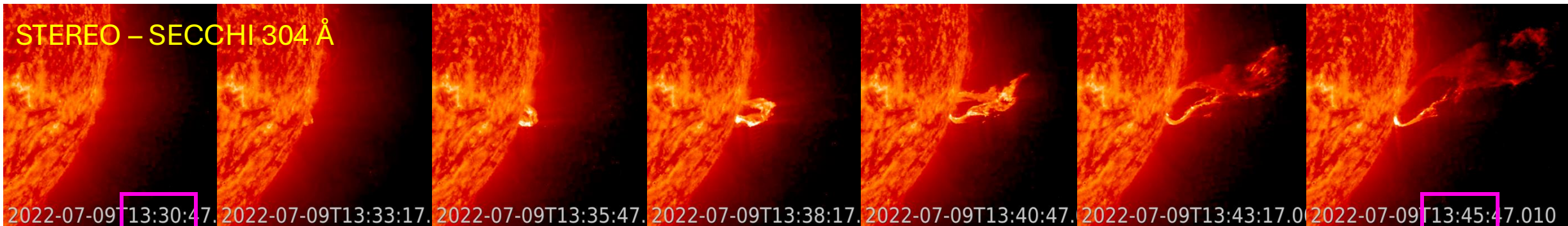
Kinematics



Combine different instruments to follow & reconstruct the eruption.

Multi-viewpoint observations

Kinematics



Summary & next steps

- Ongoing study of **prominence eruptions** observed by **EUI/FSI**.
- We identified different **morphologies**: *fan, loop, jet & twisted*.
- We examined the **deflection** in well-defined cases.
- We analysed the **kinematics**. We fit a 2nd order **polynomial profile** for many cases. Some eruptions presented different phases for which both **linear & polynomial** functions were combined.

Future work:

- The use of coronagraphs and EUV imaging, e.g. from **STEREO**, can help complete the kinematic analysis and enables detailed 3D reconstruction of eruptions.
- Selection of **case studies** for detailed analysis.