

ESCAPE OSSR onboarding: A CME database

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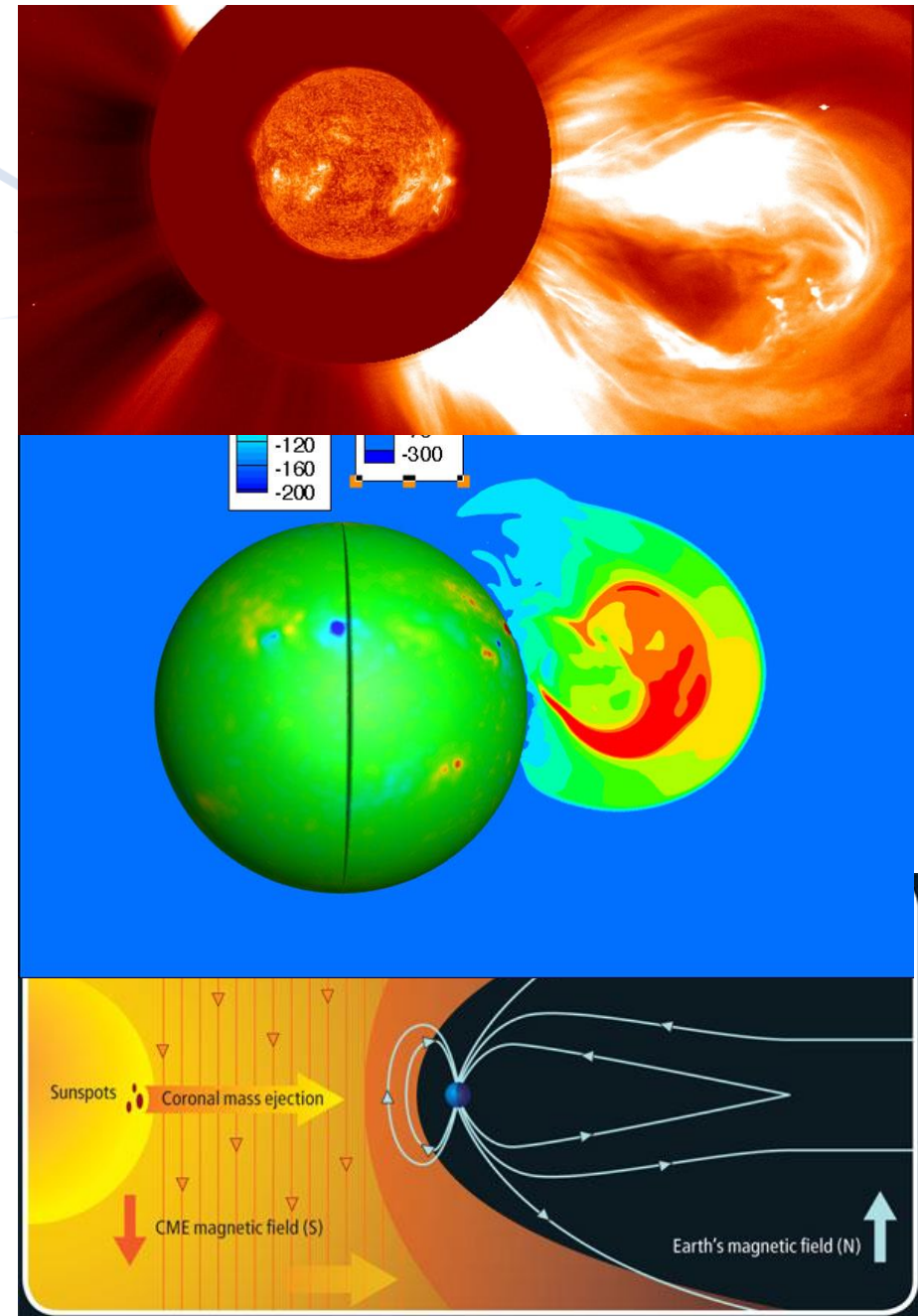
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Context

- Coronal Mass Ejection are expulsions of plasma and magnetic field from the Sun
- CME properties at launch are hard to measure
- CME properties during cruise in the Interplanetary Space are nearly impossible to measure
- We model their propagation
- We measure the effects of their transit at a few locations in the Heliosphere



How we built it

- We get info from
 - ICME database by Richardson&Cane (Unique handle + Chars at arrival)
 - SOHO-LASCO CDAW database (CME PoS position vs time close to lift-off)
 - Heliophysics Event Knowledgebase (features/events on the Sun to estimate CME source)
- Then we do:
 - 1) estimate CME source
 - 2) deproject CME front position
 - 3) evaluate CME chars at 20R_Sun
 - 4) associate CME propagation with a Solar Wind type
 - 5) Evaluate drag parameter and Solar Wind value for each ICME



The Database

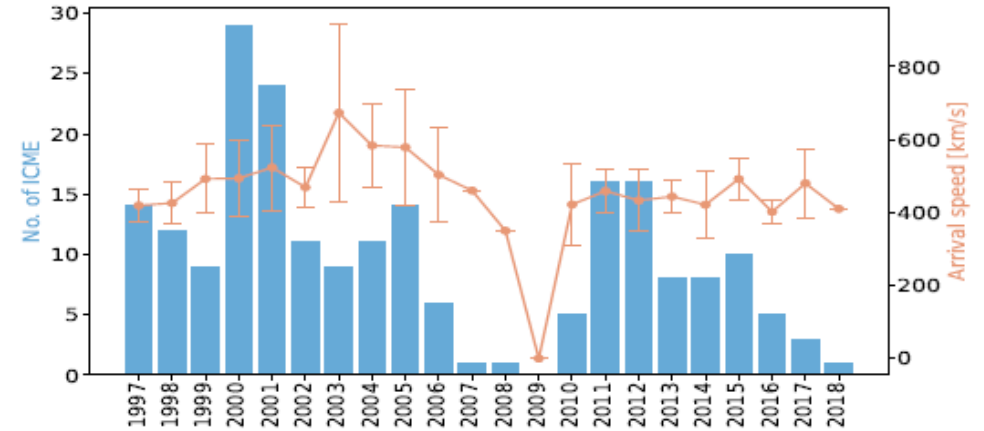
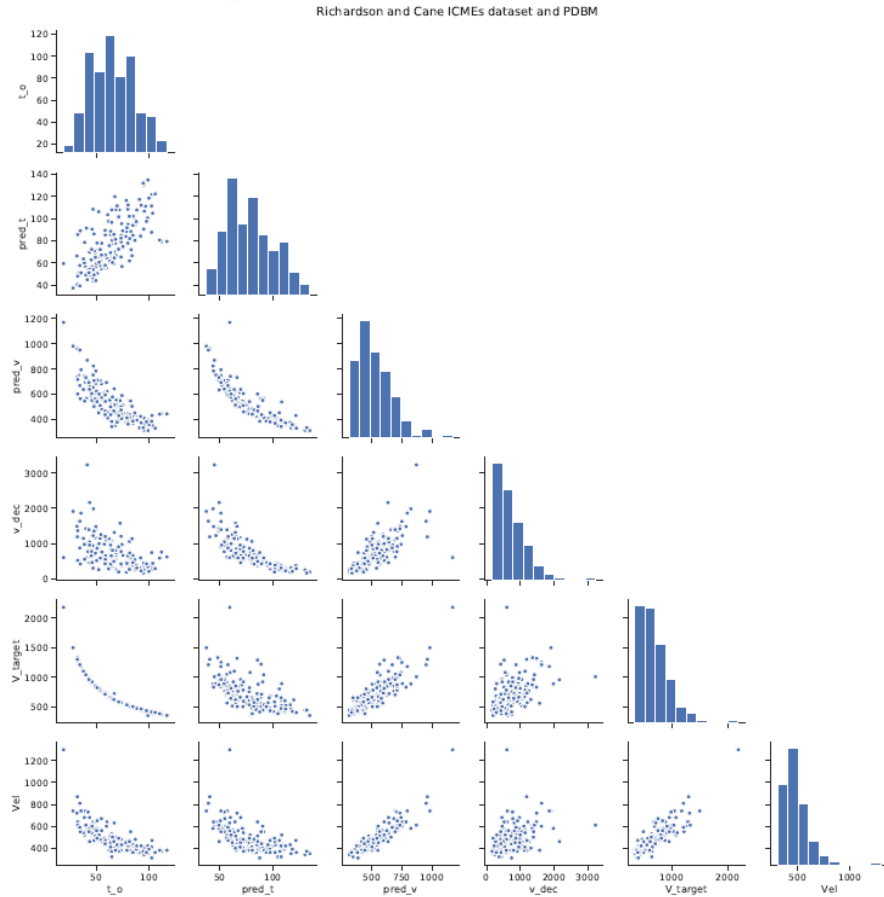
Table 1. Column description of the ICMEs data set created in this work.

Name	Keyword	Description	Source
1 <i>LASCO start</i>	LASCO_Start	First CME appearance in LASCO C2/C3 coronagraphs	LASCO/CDAW
2 <i>Start date</i>	Start_Date	Start time of CME extrapolated at $20 R_{\odot}$	This work
3 <i>Arrival date</i>	Arrival_Date	Estimated arrival time of the ICME based primarily on plasma and magnetic field observations	R&C
4 <i>Plasma event dur.</i>	PE_duration	End of the ICME plasma signatures after 3 is recorded	R&C
5 <i>Arrival speed</i>	Arrival_v	(<i>km/s</i>) Mean solar wind speed during the period from 1 to 3	R&C
6 <i>Transit time</i>	Transit_time	(<i>hrs.</i>) Computed between 3 to 1	This work
7 <i>Trans. time error</i>	Transit_time_err	(<i>hrs.</i>) Error associated to the extrapolated start date (col. 3) of a CME	This work
8 <i>LASCO date</i>	LASCO_Date	Most likely CME associated with the ICME observed by LASCO	LASCO/CDAW
9 <i>LASCO speed</i>	LASCO_v	(<i>km/s</i>) Max. plane-of-sky (POS) CME speed along the angular width	LASCO/CDAW
10 <i>Principal angle</i>	LASCO_pa	(<i>deg.</i>) Counterclockwise (from solar North) angle of appearance into coronagraphs	LASCO/CDAW
11 <i>Angular width</i>	LASCO_da	(<i>deg.</i>) Angular expansion of CME into coronagraphs	LASCO/CDAW
12 <i>Halo</i>	LASCO_halo	If 15 is $> 270^{\circ}$ then 'FH' (full halo), if $> 180^{\circ}$ 'HH' (half halo), if $> 90^{\circ}$ 'PH' (partial halo), otherwise 'N'.	LASCO/CDAW
13 <i>De-proj. speed</i>	v_r	(<i>km/s</i>) De-projected CME velocity (from 7, see Sec.)	This work
14 <i>De-proj. speed error</i>	v_r_err	(<i>km/s</i>) Uncertainty of CME initial velocity 14	This work
15 <i>Theta source</i>	Theta	(<i>arcsec</i>) Longitude of the most likely source of CME	This work
16 <i>Phi source</i>	Phi	(<i>arcsec</i>) Co-latitude of the most likely source of CME	This work
17 <i>Source pos. error</i>	POS_source_err	(<i>deg.</i>) Uncertainty of the most likely CME source	This work
18 <i>POS source angle</i>	POS_source	(<i>deg.</i>) Principal angle of the most likely CME source	This work
19 <i>Relative width</i>	rel_wid	(<i>rad.</i>) De-projected width of CME	This work
20 <i>Mass</i>	Mass	(<i>g</i>) Estimated CME Mass (if provided)	LASCO/CDAW
21 <i>Solar wind type</i>	SW_type	Solar wind (slow, S, or fast, F) interacting with the ICME	This work
22 <i>Bz</i>	Bz	(<i>nT</i>) <i>z</i> -component of magnetic field at L1 and CME arrival time (col. 1)	R&C
23 <i>Dst</i>	DST	Geomagnetic Dst index recorded at CME arrival (col. 1)	R&C
24 <i>Stat. de-proj. speed</i>	v_r_stat	(<i>km/s</i>) Statistical de-projected CME speed, i.e. $v_r_stat = LASCO_v * 1.027 + 41.5$	Paouris et al.
25 <i>Acceleration</i>	Accel	(<i>m/s²</i>) Residual acceleration at last CME observation	This work
26 <i>Analytic sol. wind</i>	Analytic_w	(<i>km/s</i>) solar wind from DBM exact inversion	This work
27 <i>Analytic gamma</i>	Analytic_gamma	(<i>km⁻¹</i>) drag parameter, γ , from DBM exact inversion	This work

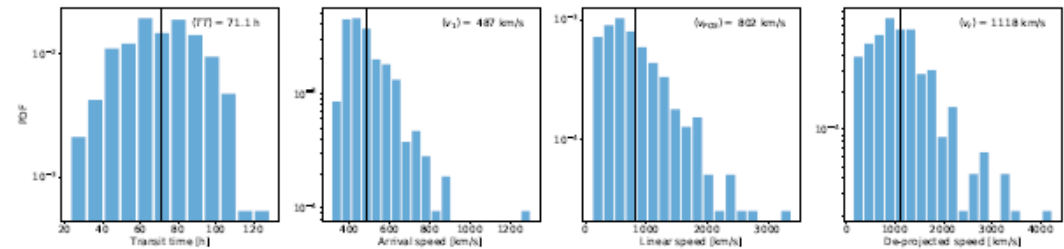
217 ICME Entries



A quick-look to the Database



Distribution of the selected ICME in our data set along the past 20 years. The orange line represents the average SoA of ICMEs for each year, the error bar represents the relative standard deviation.

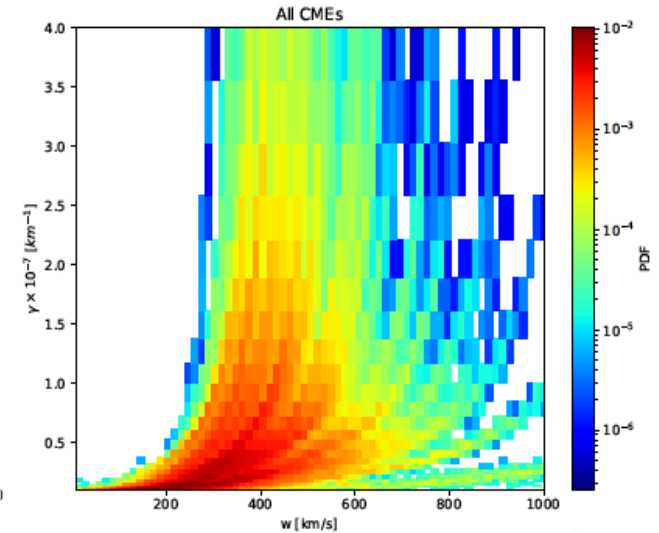
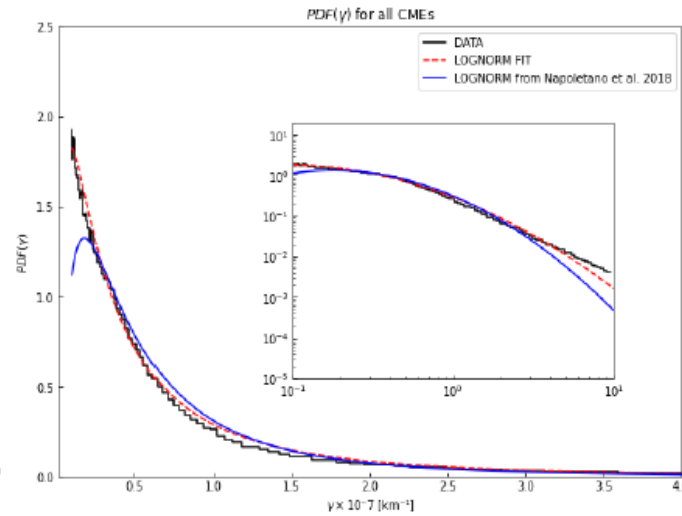
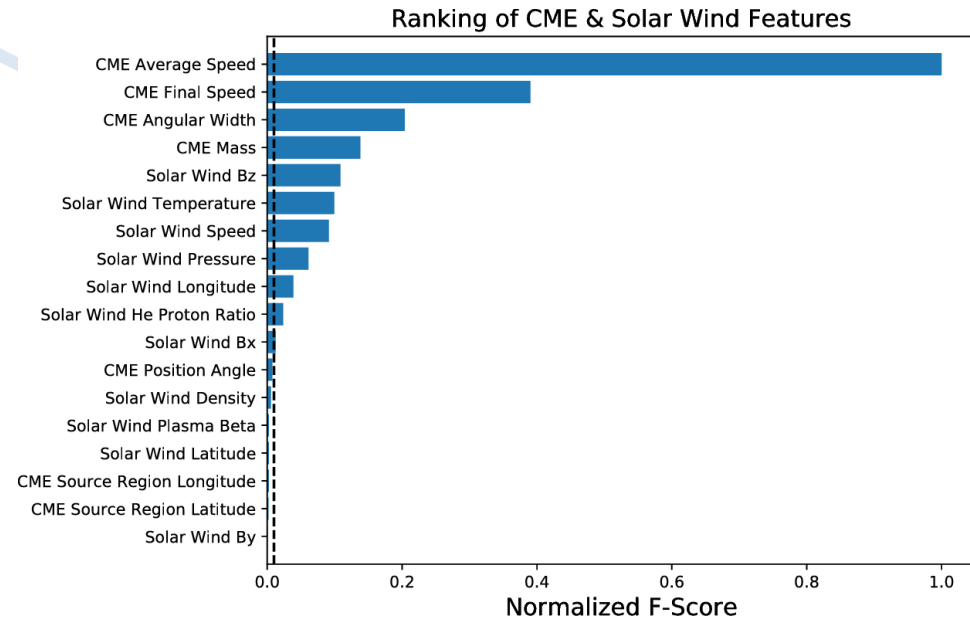
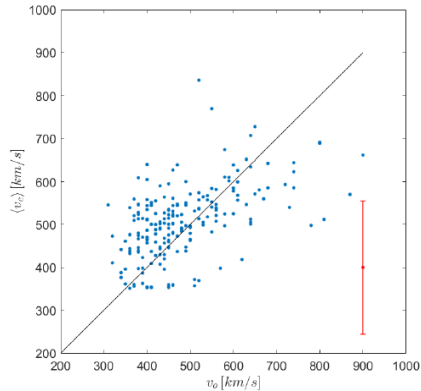
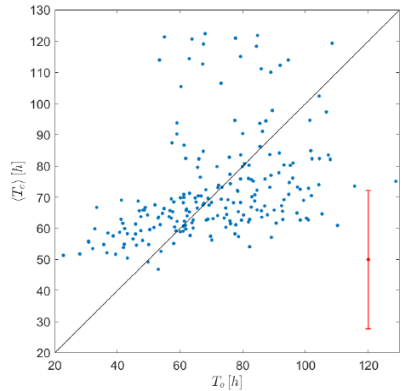


(From left to right) Probability distribution of the ICME ToA, SoA, linear plane-of-sky lift-off speed and de-projected lift-off speed obtained with from whole ICME data set. In every panel, the vertical dashed line (black) is the average value, also reported within each panel.



Use cases

- How would a typical use case for the data look like?
- Are there already plans to implement the use case?



PDFs for (left column) and the joint distributions (right column) obtained from the inversions of the ICMEs in the database. The lognormal function (blue line) used in Paper I is also plotted for comparison. In each panel, the inset shows the same plot on a log-log scale for an extended range.



How it is now?

- In which way is the data/service currently offered?
 - ICME_dataset_V3.0.csv
- Which interfaces/software are needed?
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- Is there already metadata offered with the service?
 - Add quicklook programs to go with the database?
- Is it registered in any platforms like zenodo?
 - NO
- We need:
 - Versioning, Referencing

