

CME ARRIVAL PREDICTION AND ITS DEPENDENCY ON MODEL PARAMETERS

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ELEvoHI („ELLipse Evolution model based on Heliospheric Imaging data“) utilizes time-elongation measurements from CMEs outside the field of view of coronagraphs using data from STEREO/HI.

—> This approach allows the **derivation of the CME kinematics from observations** when the drag-force is the dominant driving force.

—> ELEvoHI is **drag-based** and allows the CME to adjust its kinematics due to ambient solar wind speed (slow CMEs are accelerated, fast CMEs are decelerated)

More information on ELEvoHI can be found in

Assumptions of the ELEvoHI model: **T. Rollett et al. (2016)** and **T. Amerstorfer et al. (2018)**!

1. The CME frontal shape is **elliptical**
2. The **drag-parameter** is constant during propagation
3. The **background solar wind speed** is constant in space and time
4. The modeled **CME kinematics** stay consistent with **observations from HI**

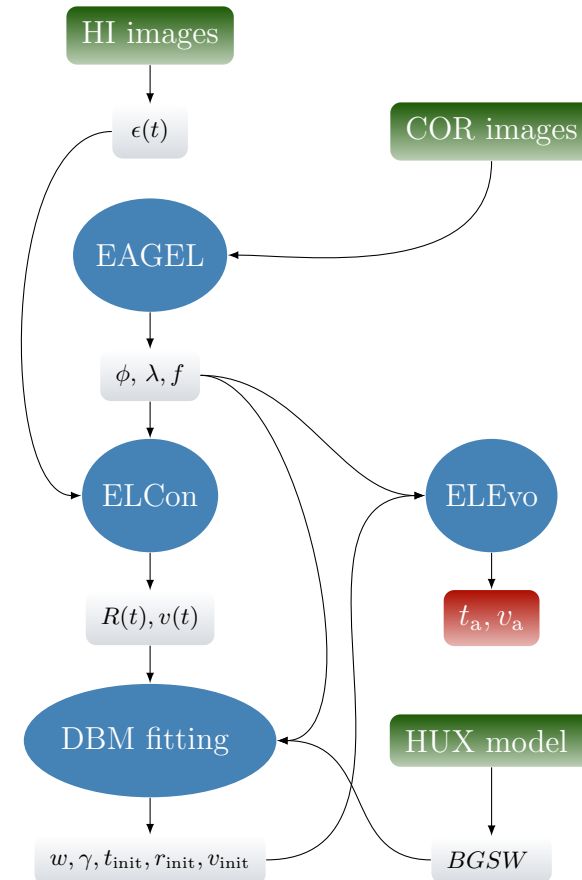
ELEvoHI is operated as an ensemble approach, where different runs are performed based on varying input parameters, related to frontal shape, propagation direction and background solar wind speed.

Currently under study:

- What are the sources of input parameters leading to the smallest prediction error?
 - > ambient solar wind
 - > CME frontal shape/direction
([this display](#))
- Is the elliptical CME front realistic? Is the prediction the same from two vantage points (ST-A vs ST-B)?
(display by J. Hinterreiter
<https://meetingorganizer.copernicus.org/EGU2020/EGU2020-7829.html>)
- How can we use near real-time ST-A beacon data for ELEvoHI?
(display by M. Bauer
<https://meetingorganizer.copernicus.org/EGU2020/EGU2020-5247.html>)

ELEVOHI MODEL SET-UP

The ELEvoHI Forecasting Scheme



HUX model: Riley & Lionello, 2011

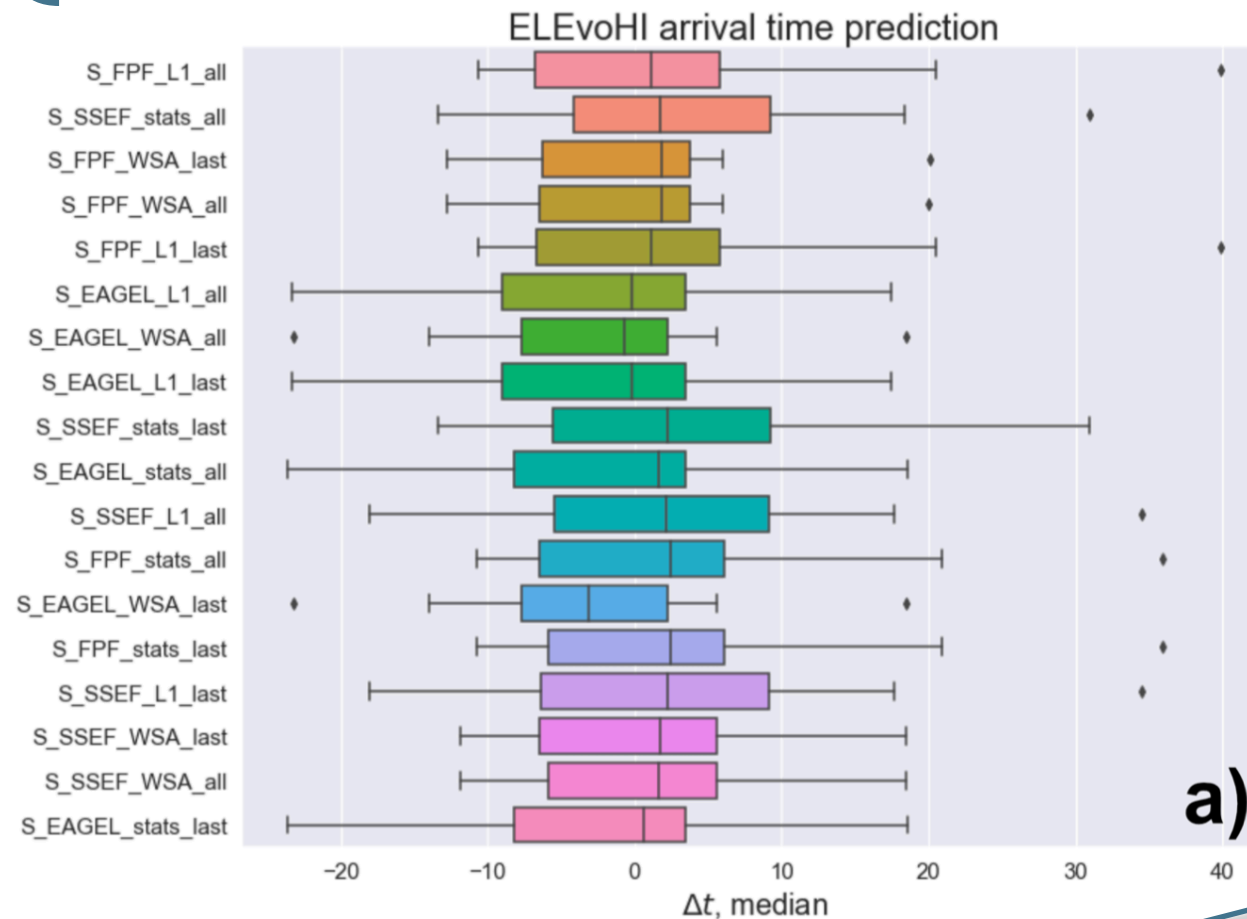
ELEVOHI MODEL SET-UP

- 15 well observed single CMEs
- 18 different model set-ups
 - **ambient solar wind**
 - WSA-HUX or
 - statistical (250 - 625 km/s) or
 - in situ data from L1,
 - **shape/direction**
 - EAGEL (GCS + ecliptic cut) or → outputs direction and half-width
 - fixed-phi fitting or
 - self-similar expansion, } half width assumed to be 30 - 50°
(easy and fast, no coronagraph data needed)
 - **definition of „best DBMfit“**
 - consider residuals of whole fit or
 - consider residuals of last three points fitted.

220 runs for each prediction
270 predictions for each event
→ 59400 runs in total

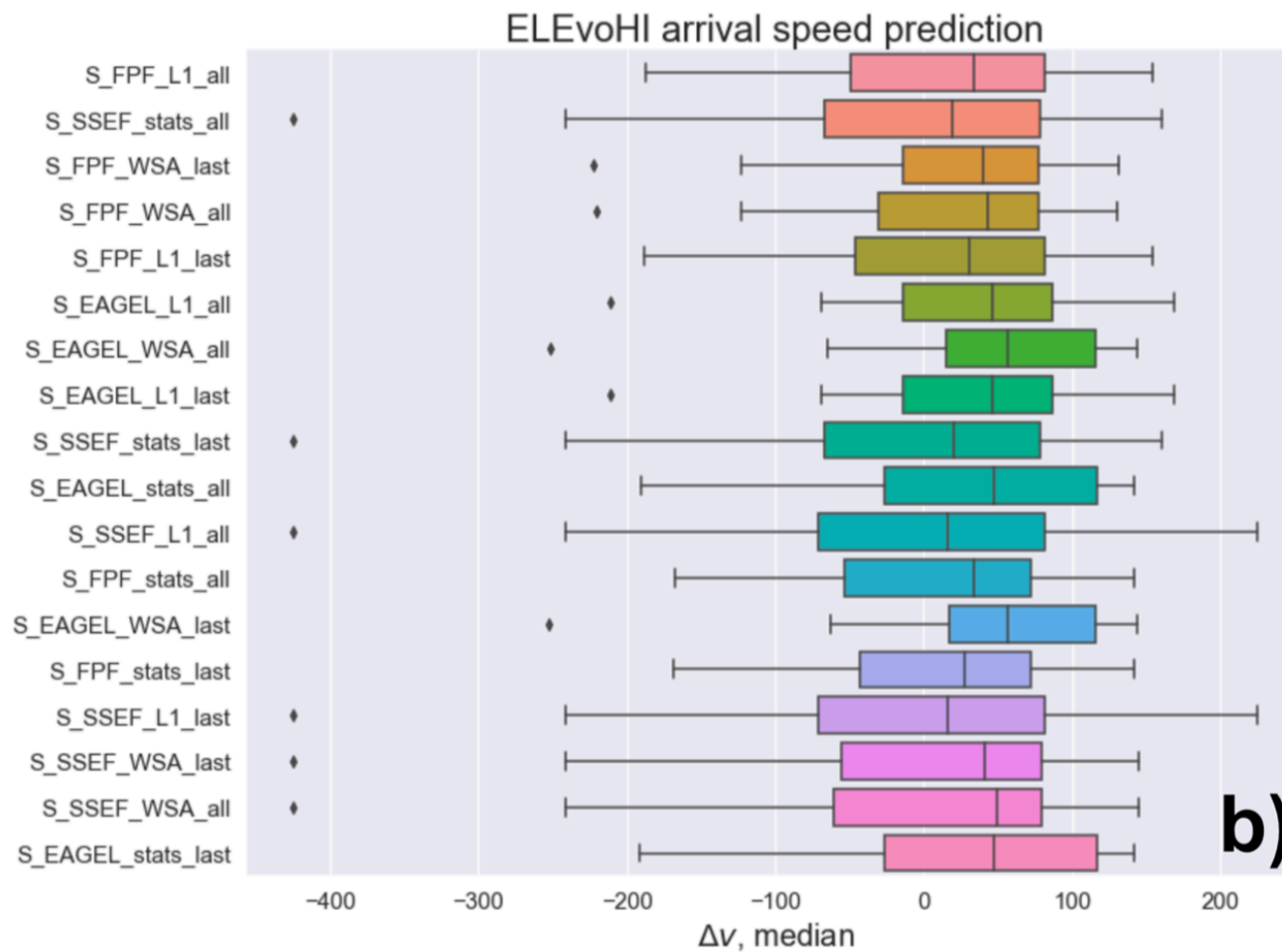
Every combination of these three input types was evaluated.

RESULTS



next slide

Figure 7. Overview of the prediction accuracy for every model set-up tested. Figure a) represents the prediction accuracy for the arrival time, figure b) for the arrival speed. The vertical lines within the boxes correspond to the median values, the boxes encompass the first and the third quartile, the whiskers correspond to 1.5 times the interquartile range, the diamonds represent outliers.



Our benchmark model, the **Fixed-Phi fitting method** (red dashed line), assumes **constant propagation speed** and that the same point of the CME is observed during propagation. It is the most basic approach of the HI models currently existing.

However, in this study, its prediction accuracy is comparable to ELEvoHI. This is the case because the list of CMEs predicted consists of only slow CMEs, for which the constant speed assumption is reasonable.

FPF: Rouillard, et al. (2008)

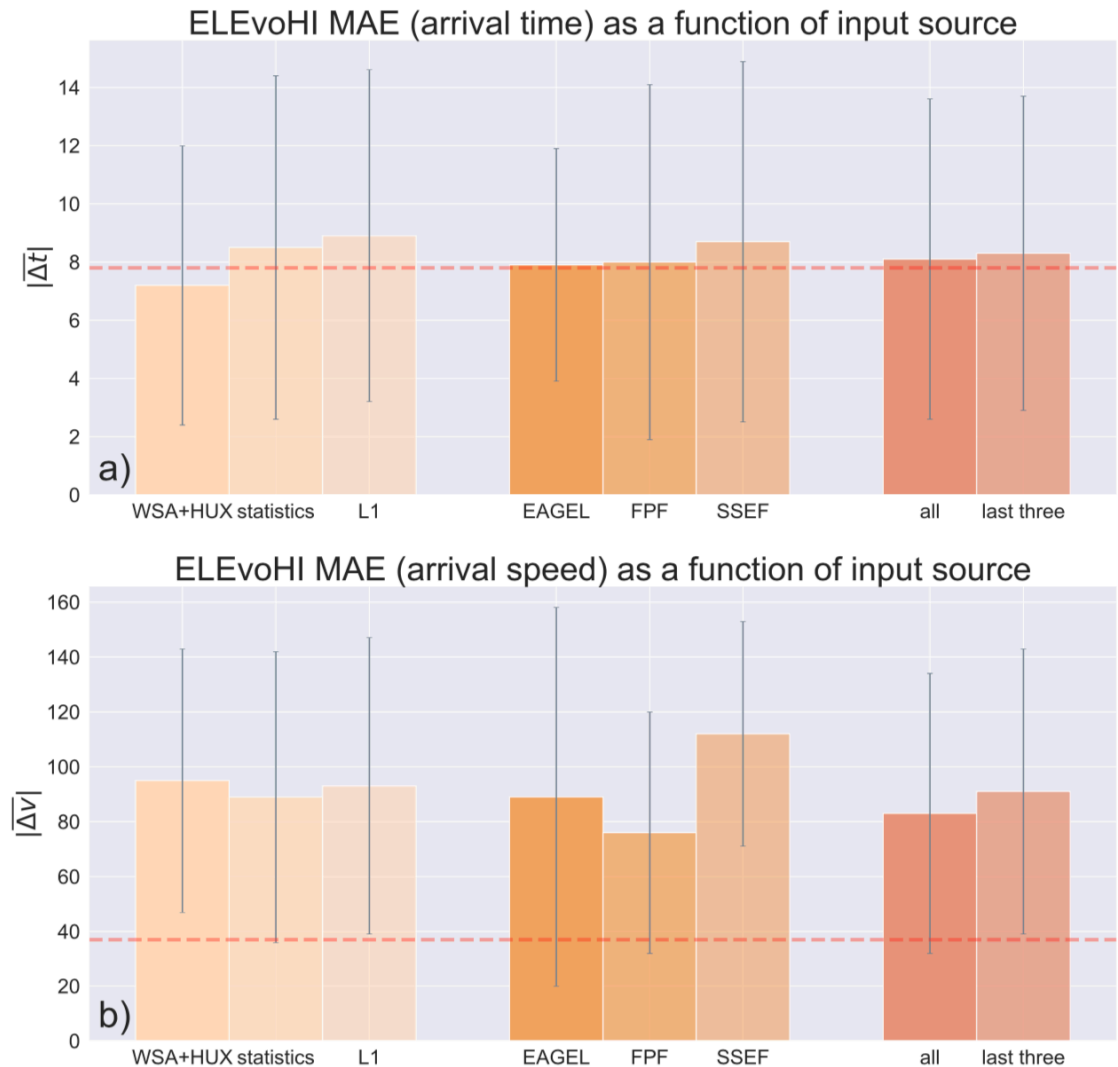


Figure 6. ELEvoHI MAE of arrival a) time b) and speed prediction corresponding to each input parameter. The left bars correspond to the background solar wind input, the middle bars correspond to the different sources of CME frontal shape and propagation direction, the right bars show the outcome corresponding to the way of defining the best DBM fit. The horizontal dashed lines represent the MAE of the benchmark model, FPF.

CONCLUSION

The most accurate prediction using ELEvoHI is possible when:

- **modeled background solar wind** (e.g. from HUX model) is used as input (although we only input an average and constant value!) and
- information on the CME frontal shape and direction comes from coronagraphs (GCS fitting + intersection with the ecliptic).

The model set-up with the highest accuracy reaches a mean absolute error (MAE) of ~7 hours.

This result suggests that an L5 mission carrying Heliospheric Imagers could indeed improve CME arrival predictions compared to predictions based on coronagraphs.

These results are soon going to be submitted to AGU Space Weather special section “Heliophysics and Space Weather Studies from the Sun-Earth Lagrange Points”. ([T. Amerstorfer et al., 2020](#))

THANK YOU
FOR YOUR
ATTENTION!

FWF

Der Wissenschaftsfonds.

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