ISSI team: Understanding our capabilities in observing and modelling Coronal Mass Ejections

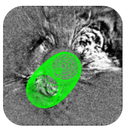
https://www.issibern.ch/teams/understandcormasseject/index.php/team-members/

Introduction

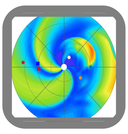
When determining input parameters for CME propagation models, it is common procedure to derive kinematic parameters from remote-sensing data. The resulting parameters can be used as inputs for the CME propagation models to obtain an arrival prediction time of the CME for example at Earth. However, when using the GCS modelling to obtain the needed parameters for simulations, different geometric structures and also different parts of the CME structure can be fitted. These aspects, together with the fact that 3D reconstructions strongly depend on the subjectivity and judgement of the scientist performing them, may lead to uncertainties in the fitted parameters. Up to now, no large study has tried to map these uncertainties and to evaluate how they affect the modelling of CMEs.

CME modeling chain

- CME observed at Sun's surface and in coronagraphs.



- A CME model is fitted to observations.
- Certain assumptions on CME geometry apply.
- Limitations due to projection effects.
- Limitations due to data gap or quality.
- **Uncertainties due to human fitting.**



- CME propagation model
- Assumptions on geometry, density, magnetic field,… of CME
- Assumptions about background solar wind

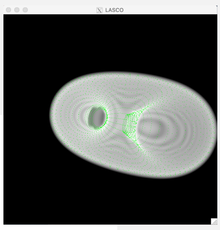
Final result: arrival time and impact

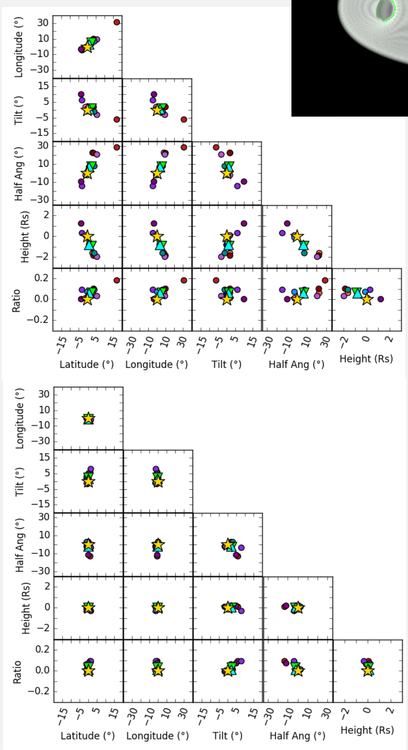
Start at basics: Human fitter

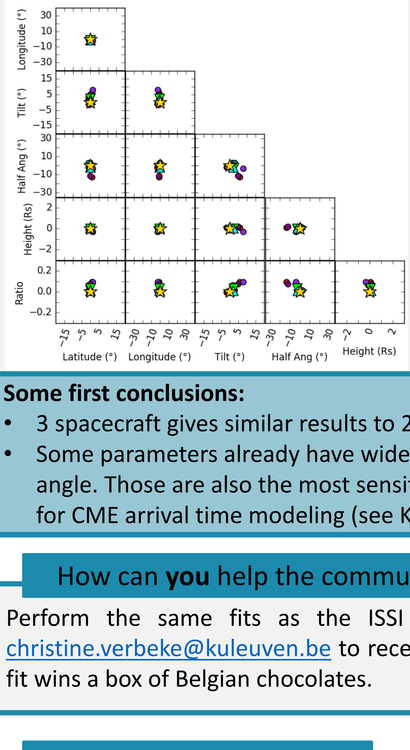
What? Uncertainty due to fitter.
How? Fit synthetic white light images of GCS model. We consider 1, 2 or 3 space crafts and different separation angles (60 (L5), 90 and 120 degrees).
Why? We know the exact GCS model parameters so we can compare.

Selection of results

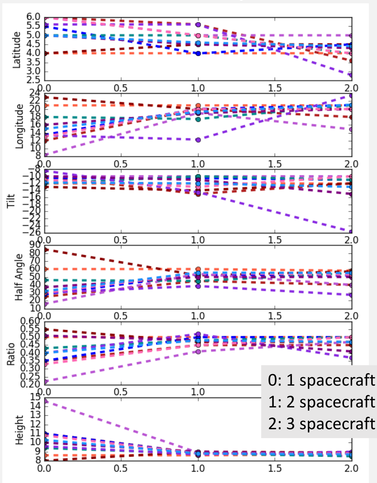
Top: LASCO only
Bottom: LASCO +STA (90 deg)



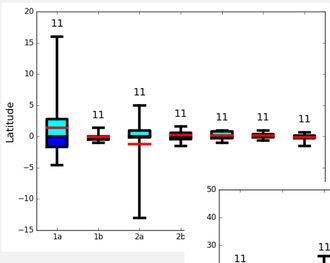




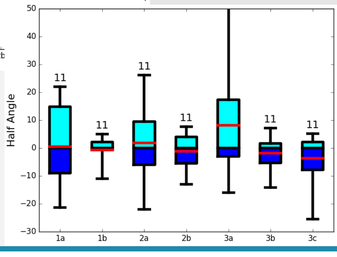
Change in GCS model parameters due to number of spacecraft



Box plots for different fits



X-axis information:
- Number : different spacecraft angles
- Letter: amount of spacecraft.
- Y-axis: deviation of fit from real GCS model parameter



Some first conclusions:
- 3 spacecraft gives similar results to 2 spacecraft.
- Some parameters already have wide spread e.g. half angle. Those are also the most sensitive parameters for CME arrival time modeling (see Kay et al., 2019).

How can **you** help the community?

Perform the same fits as the ISSI team to increase our final statistics! Contact christine.verbeke@kuleuven.be to receive your fitting files. The person closest to the real fit wins a box of Belgian chocolates.

What else are we doing?

- Fittings white light images of a simulation run of erupted CME. This is a more realistic case but with CME parameters that we can determine from the simulation for comparison.
- Determining difference between GCS model fittings by one fitter by using different processed images (Base difference, running difference, …).
- The ISSI team members have fitted 23 **BLIND** CME events. We hope this will help us advance in determining uncertainties as well as provide a benchmark for CME arrival time modeling (see https://www.issibern.ch/teams/understandcormasseject/).
- Perform ensemble simulations with different propagations models using the GCS fits and check impact on CME arrival performance

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