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## Modeling of non-radially propagating CMEs and forecasting their arrival time at Earth

We present the study of several halo CMEs that propagated non-radially and as a result, they impacted Earth as flank-encounters. We utilized the default-setup of EUHFORIA and the Cone model for the CMEs, in order to model the selected events. For the modeling input parameters we used a) the DONKI database and b) the GCS technique (Thernisien et. al 2006, 2009) for reconstructing the CMEs. Our study aims to better understand the importance of the direction of propagation in the input parameters of the Cone model and improve the modeled arrival time at Earth. We selected events that had strong non-radial velocity components so that we could see how important are the effects of the low coronal CME deflections for the final direction of propagation and the forecasting of the CME arrival at Earth.

Our results show that, when we use the input parameters from the GCS fitting, up to the height of 12 Solar radii, the modeled arrival time is very close to the observed one, with their difference being up to around 2 hours. On the contrary, when the DONKI data are used, the modeled arrival time is much further ( $\geq 10$ h) from the observed one. This is because at the height of the GCS fittings, the CMEs have experienced all the low corona deflections and they have taken their final direction of propagation.

We used two other methods, the type II radio bursts and the 2D-speed obtained from the coronagraph white light images to compare our modeling results.

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