

Forecasting the arrival of Coronal Mass Ejections: The Drag-Based Model



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THE MODEL

AIM: Prediction of ICME arrival

BASIC ASSUMPTION: Beyond ~20 solar radii the MHD “aerodynamic” drag caused by the interaction of ICME with solar wind, becomes the dominant force, so the equation of motion becomes:

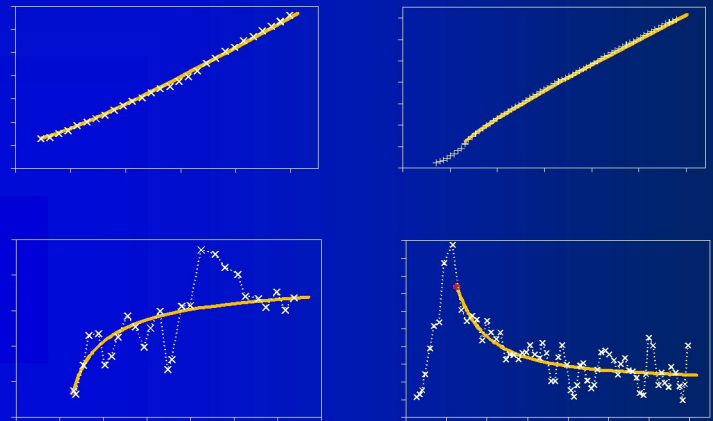
$$\ddot{\mathbf{r}} = -\gamma(\dot{\mathbf{r}} - \mathbf{w})|\dot{\mathbf{r}} - \mathbf{w}|.$$

CONSEQUENCE: fast ICMEs are decelerated, slow are accelerated ($\dot{\mathbf{r}} \rightarrow \mathbf{w}$).

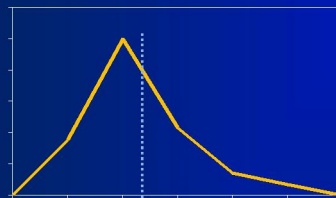
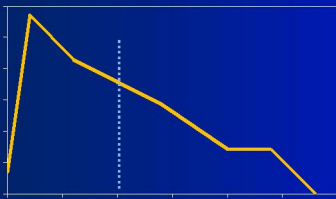
PARAMETERS: In the simplest form, we assume $\gamma, \mathbf{w} = \text{const}$. The drag parameter γ depends on characteristics of both ICME and solar wind – the drag is stronger for broader, low-mass ICMEs in a high-density (slow) solar wind.



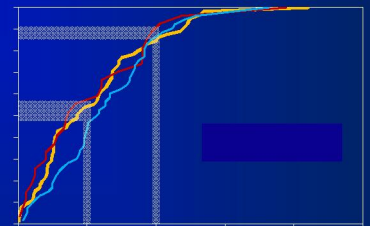
Running-difference images of the ICME take-off (LASCO/SoHO), providing the model input values $v_0(R_0, t_0)$.



Measurements taken from:
Liu et al. 2010, ApJ 722, 1762



Samples used:
Schwenn et al., 2005, AnnGeo, 26, 1033
Manoharan, 2006, SPh 235, 345



ONLINE FORECAST TOOL

<http://oh.geof.unizg.hr/CADBm/cadbm.php>

Input page:

Forecasting the Arrival of ICMEs at 1 AU:
The Drag-Based Model

Full description about the calculation method you can find here.

ICME take-off date: Sep 09 21:30 2011

CME (take-off) time: 233 h 00 min

R_0 - starting radial distance of CME (R_\odot): 200

v_0 - speed of CME at R_0 (km/s): 1000

γ - drag parameter (10^{-7} km^{-1}): 1

w - asymptotic solar wind speed (km/s): 900

Calculate | Reset

Output:
CME arrival date & time: 2011-09-11 13h:5min
Travel time: 63.28h
Transit speed at 214 R_\odot : 542 km/s

CONCLUSION

DBM offers predictions of the ICME arrival for >90% of events with an accuracy better than 24 h, and for >50% of events better than 12h.

ACKNOWLEDGMENT

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