CORHITCAT Description

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CORHITCAT is a catalog of COR2 CMEs with the addition of a predicted arrival of each CME to a spacecraft (and its corresponding validation by cross-checking these predictions with an ICME catalog).

More in detail, CORHITCAT takes the input parameters from the Göttingen COR2 CME catalog (KINCAT):

https://www.helcats-fp7.eu/catalogues/wp3_kincat.html

and applies the method of Rodriguez et al. 2011 to see if, based on the GCS fits (with parameters available in KINCAT), a CME should arrive to L1 or to the any of the two STEREO spacecraft.
In order to validate these predictions, they are compared to real ICME arrivals, by using the ICMECAT catalog. To do so, we take the time when the ICME arrived to the spacecraft and propagate the ICME back to 15 Rs. The ICME propagates with a constant speed equal with the ICME speed. If the time at 15 Rs matches with the CME time from KINCAT within a 12 hours time window, we will call that a good hit (i.e. the CME-ICME are the same event).

Method description
To get the Graduated Cylindrical Shell (GCS) parameters, the geometrical model of Thernisien et al. 2006, 2009 is used in KINCAT. The model aims to reproduce the large scale structure of flux rope-like CMEs. It consists of a tubular section forming the main body of the structure attached to two cones that correspond to the "legs" of the CME. Only the surface of the CME is modeled, there is no rendering of its internal structure.
The model is applied to CMEs observed by SOHO/LASCO and STEREO/COR data. The following parameters are derived:
- outer shell height
- the CME direction of propagation in longitude and latitude (Φ and θ, respectively),
- the cross section of the CME legs (a),
- the tilt angle around the axis of symmetry (γ) and
- the half angle between the legs (α).

From the parameters provided by the model, one can then calculate the half angular width of CMEs in latitude and longitude, using the following formulas (Rodriguez et al. 2011):

$$\theta_w = \arcsin\left(\sin\alpha\sin\gamma\right)+\beta$$

$$\Phi_w = \arcsin\left(\frac{\sin\alpha\cos\gamma}{\cos\theta_w}\right) + \beta$$

where:
- β is the angular width of the CME legs cross section ($\beta = \arctan(\kappa)$, with $\kappa = a/r$),
- r represents the distance from the center of the Sun to the edge of the shell,
- Φ_w and θ_w represent the angular width of the CME in longitude and latitude, respectively.

Then, by knowing the location of the different spacecraft (latitude and longitude) one can infer whether a CME should be detected at one or more of them.

Catalog description

- 1st column: Event number (from KINCAT)
- 2nd column: date and time of the last image in COR2 with full visibility of the CME, in the format yyyy-mm-ddThh:mm (from KINCAT)
- 3rd column: predicted hit on STEREO–B (0 or 1)
- 4th column: predicted hit on Earth (0 or 1)
- 5th column: predicted hit on STEREO–A (0 or 1)
- 6th column: longitude at which the CME propagates (from KINCAT),
- 7th column: CME angular width in longitude,
- 8th column: difference in longitude between the CME edge and L1,
- 9th column: latitude at which the CME propagates (from KINCAT),
- 10th column: CME angular width in latitude,
- 11th column: Earth latitude,
- 12th column: difference in latitude between the CME edge and L1,
- 13th column: the associated ICME (using ICMECAT_ID from ICMECAT),
- 14th column: time of the propagated-back ICME at 15 Rs
- 15th column: time difference between the real CME (from KINCAT) and propagated-back ICME
- 16th column: validation of predicted hit on STEREO-B (0 or 1)
- 17th column: validation of predicted hit on Earth (0 or 1)
- 18th column: validation of predicted hit on STEREO-A (0 or 1)

Column 3-5: 0 means that the method predicts no hit, while 1 means that the method predicts a hit.
Column 16-18: 0 means that no associated CME was found, while 1 means that an associated CME was observed either by STEREO-B, Wind or STEREO-A.

References:
Rodriguez, L., Mierla, M., Zhukov, A.N., West, M., Kilpua, E., Linking Remote-Sensing and In Situ Observations of Coronal Mass Ejections Using STEREO, Sol. Phys. 270, 561 – 573, 2011.

Thernisien, A.F.R., Howard, R.A., Vourlidas, A., Modeling of flux rope coronal mass ejections. Astrophys. J. 652, 763 – 773, 2006.

Thernisien, A., Vourlidas, A., Howard, R.A., Forward modelling of coronal mass ejections using STEREO-SECCHI data, Solar Phys. 256, 111., 2009.