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The effect of AMR on the magnetized CME model in Icarus

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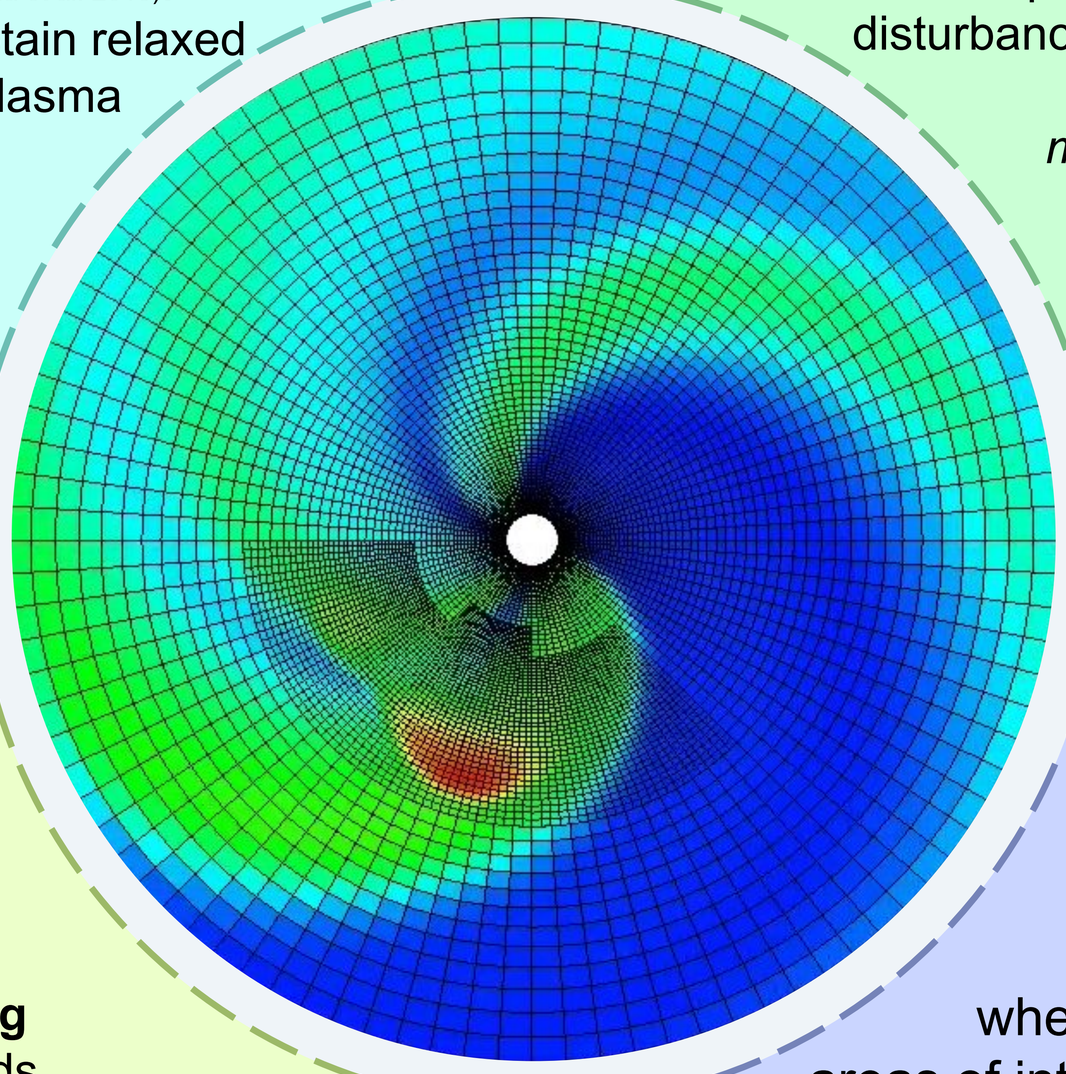
Icarus (Verbeke et al. 2022) is a new heliospheric tool implemented in MPI-AMRVAC (Xia et al. 2018). MHD equations are solved to obtain relaxed solar wind. Initial values of the plasma variables at the inner boundary (at 0.1AU) are taken from the coronal model. CMEs are superposed on top of the stationary solar wind.

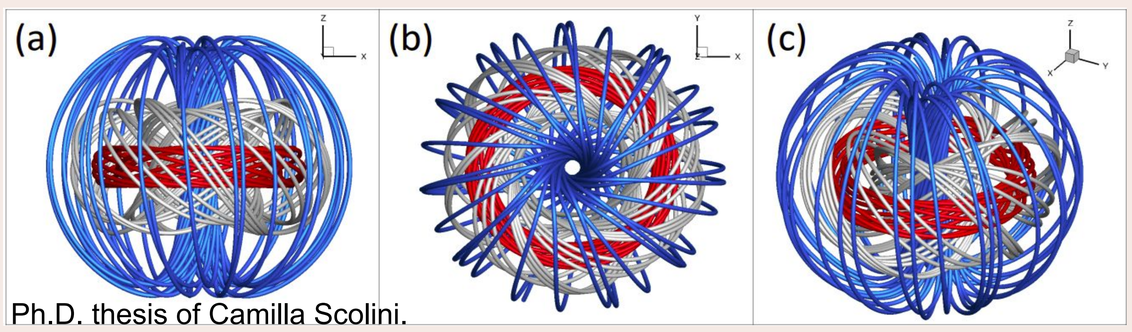
Coronal Mass Ejections (CMEs) are the main drivers of interplanetary shocks and space weather disturbances. Predicting the **arrival time** and **impact** of such CMEs enables the *mitigation of the damage* on various technological systems on Earth. In this study we model a magnetized CME - **a spheromak**. The magnetic field inside the spheromak is divergence- and force-free by definition. This study addresses the particular CME event on 12/07/2012.



The inner and outer radial boundaries of the domain are **0.1AU** and **2AU** in spherical coordinates. Due to this big difference, the cells are **deformed** closer to the outer boundary. The length (Δr) of the cell remains constant and the width ($r*\Delta\theta$) increases. To fix this, radial **Grid Stretching** is applied to the grid which avoids the **elongation** of the cells by gradually increasing the cell size in the radial direction.

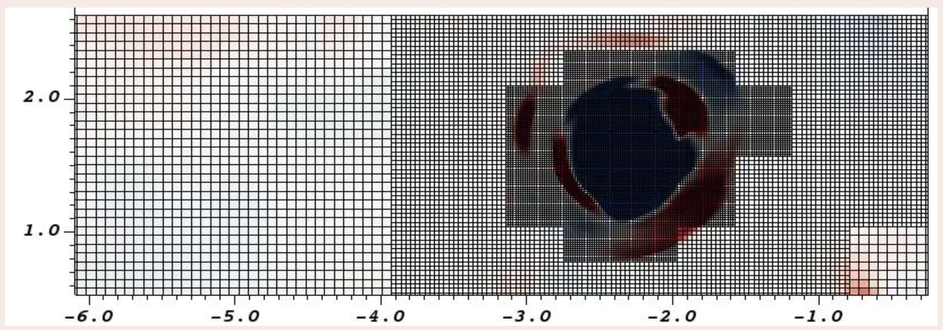
Solution **Adaptive Mesh Refinement (AMR)** ensures higher resolution in the domain where required. It results in refined areas of interest and saved computational resources and time.

Magnetic field components of a Linear Force-Free Spheromak

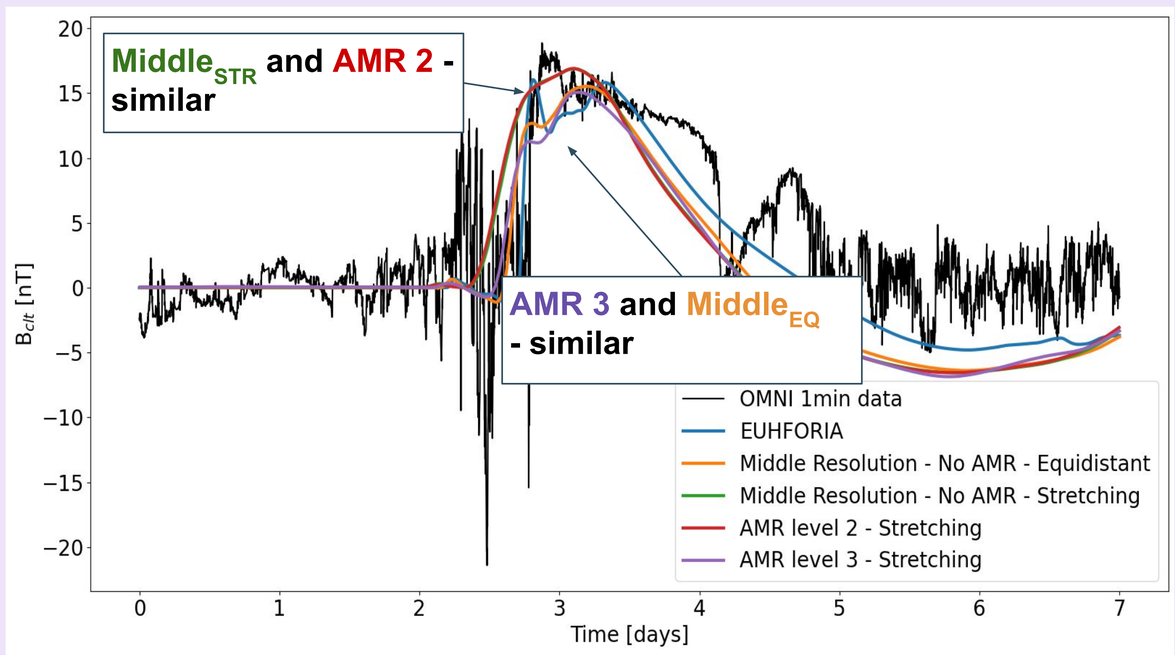


Ph.D. thesis of Camilla Scolini.

AMR level 3 at 1AU



B_z values at Earth



AMR 2	AMR 3
0h 14m	**0h 38m**

EUHFORIA	Icarus$_{EQUIDISTANT}$	Icarus$_{STRETCHED}$
18h 2m	**6h 9m**	**1h 3m**

Speed-up w.r. to EUHFORIA

AMR 2	AMR 3
77.3	**28.5**

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