MHD simulations in the Solar Terrestrial ObseRvations and Modeling Service (STORMS)

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ABSTRACT:

As part of the Solar Terrestrial ObseRvations and Modeling Service (STORMS), an important development axis is the production of heliospheric magnetohydrodynamic (MHD) simulations for monitoring and studying solar activity in the heliosphere and the near-Earth environment.
Starting from observations on the photosphere, 1D MHD model Multi-VP and 3D MHD model Heliocast give a physical and consistant description of the solar wind. The creation of synthetic imagery make it possible to compare the results with observations like coronagraph. A part of these simulations are available through the VSWMC Virtual Space Weather Modelling Center and can be coupled with other models (EUHFORIA). A « run on request » mode for users can help user in studying a particular event.

Figure 1: the welcome page of the STORMS website @ http://storms-service.irap.omp.eu/

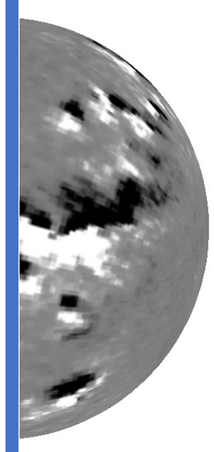
SWIFT pipeline

- **Magnetograms**

- Adapt/Gong : every hour
- Nso/Gong : every hour
- Wso : irregular

- **Simulations**

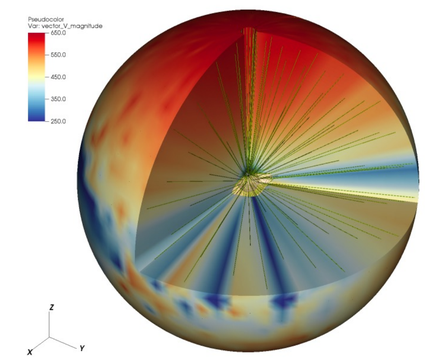
- Multi-Vp/PFSS launched daily to obtain continuous timeseries of density, velocity, magnetic field of solar wind at the sub-Earth point at R = 21 Rsun.
- Multi-Vp/PFSS launched weekly on a grid covering the entire sphere. 2D Map containing density, velocity, magnetic field of solar wind are build on the outer surface at R = 21 Rsun.



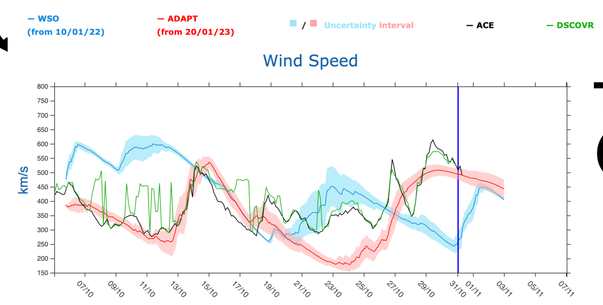
Magnetogram
R = Rsun

→ PFSS
Rss = 2-3 Rsun

→ Multi-VP
R = 21 Rsun



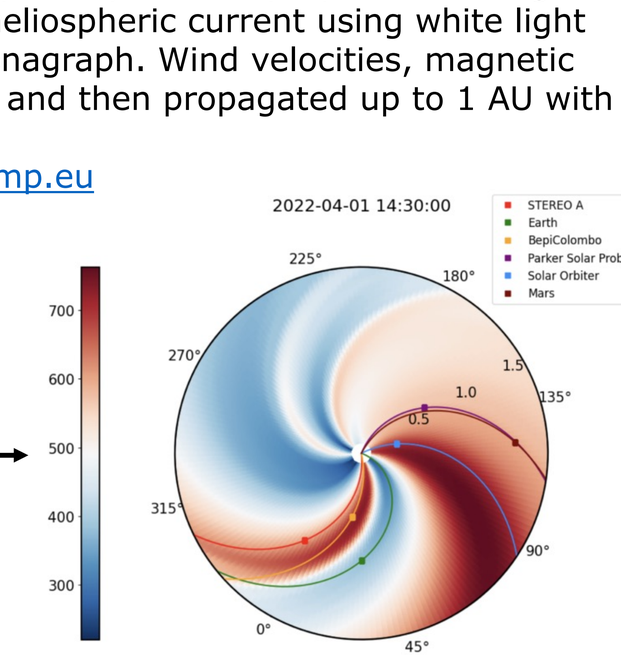
2D Map
3D Cube



Timeseries (ex: SWiFT)

- **Source surface and Adapt-realization optimisation (PFSS)**

Source surface height (rss) as well as 12 Adapt-realizations are optimized such that the corresponding Heliospheric Current Sheet (HCS) fits the White Light Streamer (SMB)



Virtual Space Weather Modelling Center (VSWMC)

- VSWMC users can request a simulation in our database. If this simulation does not exist, a simulation is launched on our infrastructure.

- **IRAP servers** : FORECAST 1/2/3/4 (680 threads), storage racks (METEO B1/B2 and FORECAST B1/B2.

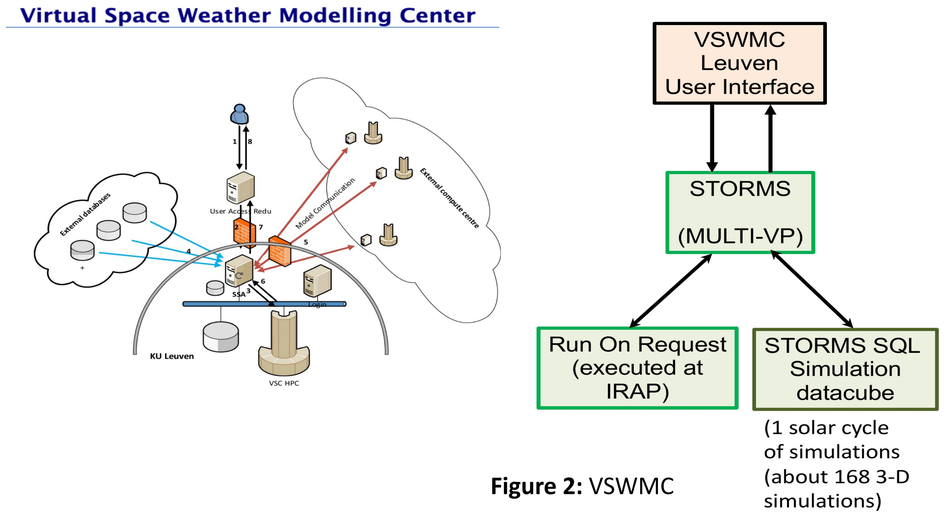


Figure 2: VSWMC

HELIOCAST

HelioCast is a novel method to derive empirically coronal properties through the identification and the localization of the heliospheric current using white light observations from the SOHO/LASCO coronagraph. Wind velocities, magnetic field, and densities are derived at 0.1 AU and then propagated up to 1 AU with a 3D MHD model.
Results run live at http://heliocast.irap.omp.eu

Initial conditions: WL image and Solar Maximum Brightness (SMB, top left), Angular distance from the SMB/HCS (top right), Radial velocity at 0.1 AU deduced from the SMB (bottom left), Radial magnetic field at 0.1 AU (bottom right)

Results: 3D MHD simulation propagating the initial conditions from 0.1 AU to 1.75AU

References:

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Conclusions:

✓More couplings are coming (Swift/Adapt, Heliocast/Best magnetogram)
✓Continuous integration and more storage
✓New server (GPU)
✓All is good