

Helio4Cast - a real-time test environment to enhance space weather prediction at Earth

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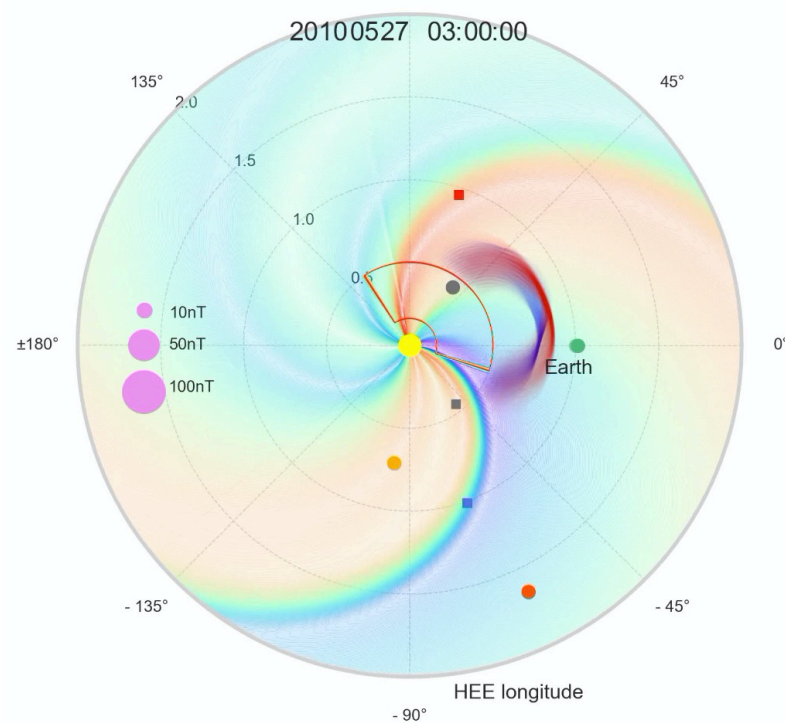
[@chrisoutofspace](https://twitter.com/chrisoutofspace)



FWF

Der Wissenschaftsfonds.

- With *Helio4Cast* we strive to bridge the gap between basic research and real-time space weather forecasts.
- Modeling of ICME flux ropes is done with our own semi empirical method (3DCORE), CME arrivals with ELEvoHI.
- Predictions of high-speed solar wind streams are based on quasi L5 data and solar wind modeling (THUX).
- We directly check how these fundamental results may enhance real-time space weather forecasts.
- Our focus is on a combination of numerical and empirical modeling, allowing to apply the similar simulations that we use for research also in a real-time setting due to fast computation of ensembles.

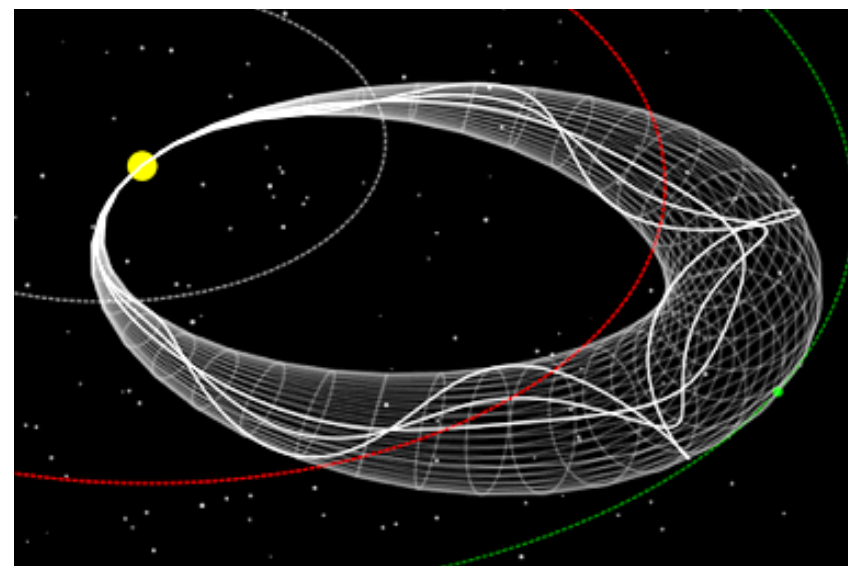


(1) THUX model with ensemble CME fronts from ELEvoHI

[Reiss et al. 2020, ApJ \(arxiv\)](#)

[Amerstorfer et al. 2018, Space Weather \(open access link\)](#)

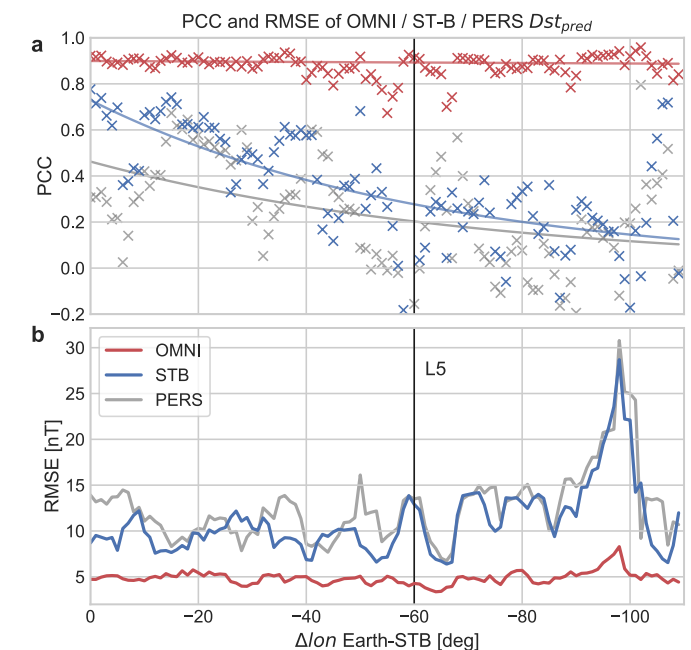
[Hinterreiter et al. 2020, in prep.](#)



(2) 3DCORE flux rope model

[Möstl et al. 2018, Space Weather \(arxiv\)](#)

[Weiss et al. 2020, in prep.](#)

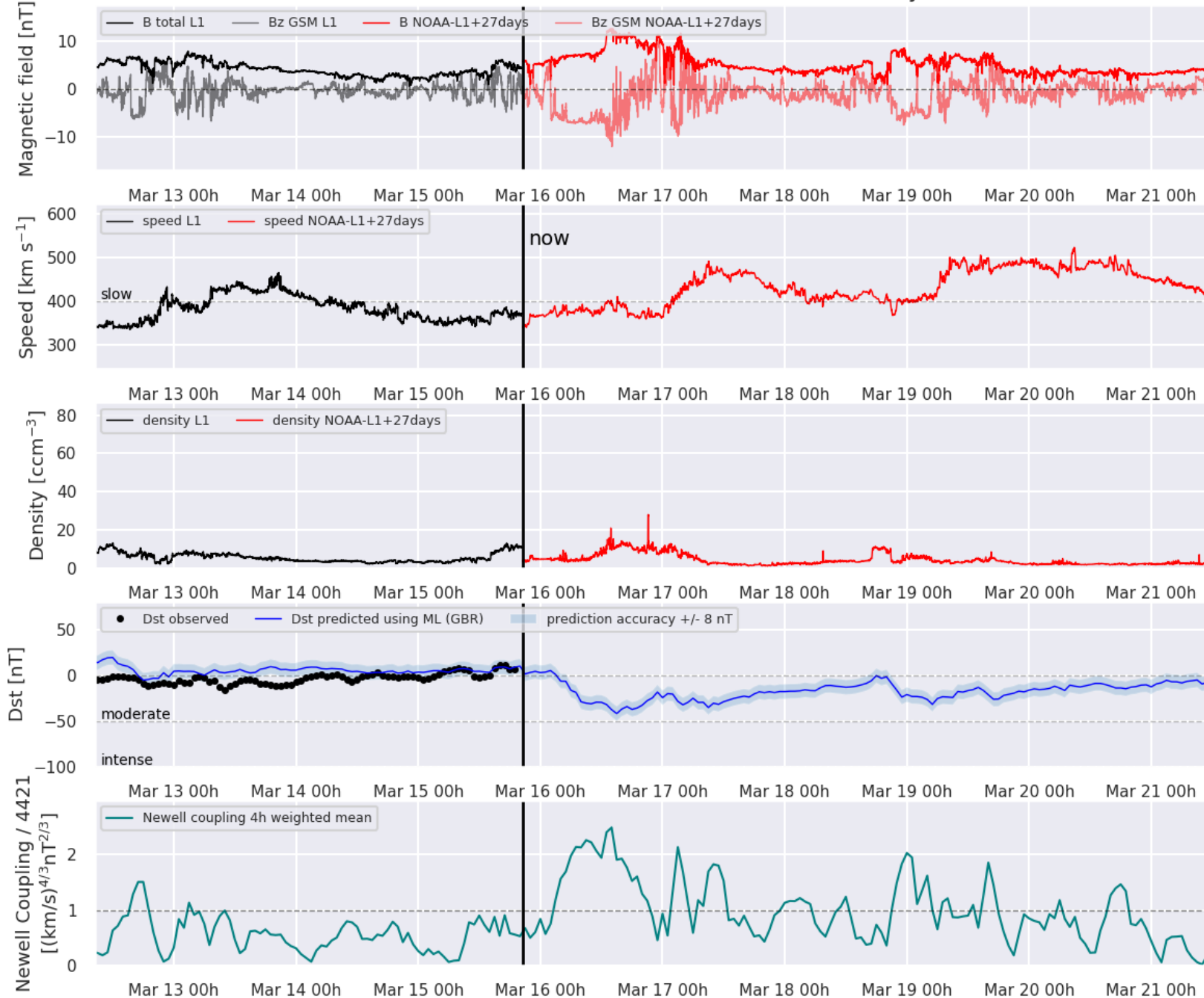


(3) Prediction of Dst for high speed streams with STEREO (quasi L5)

[Bailey et al. 2020 \(arxiv\), Space Weather, in press](#)

REAL TIME SOLAR WIND PREDICTION

L1 real time solar wind from NOAA SWPC for 2020-03-15 20:30 UT & 27-day SW-Recurrence Model (NOAA)



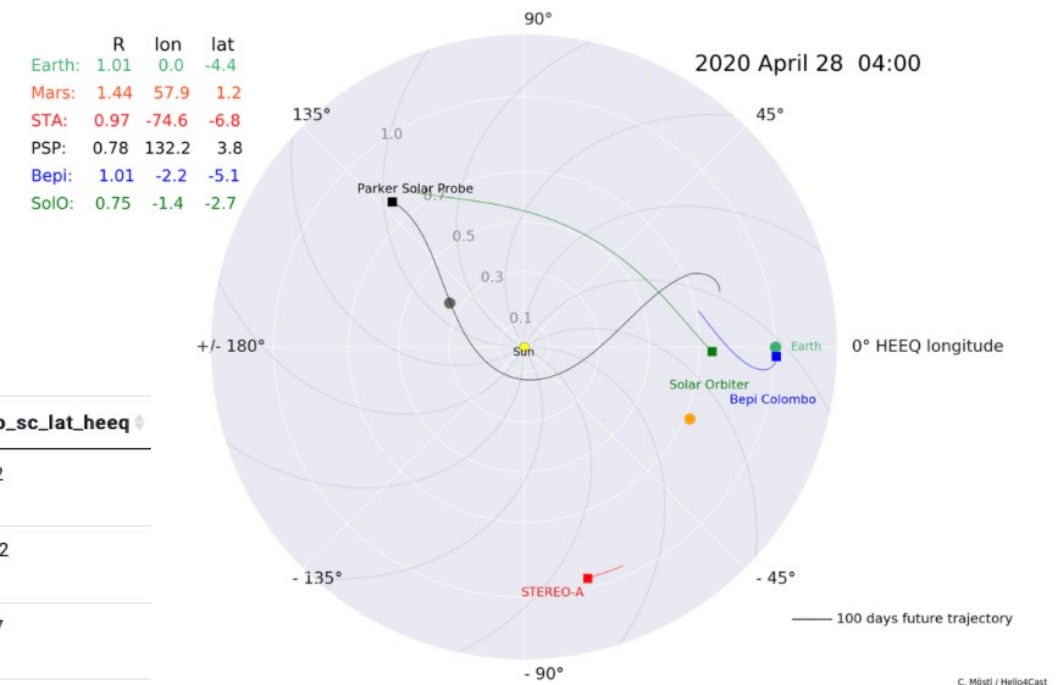
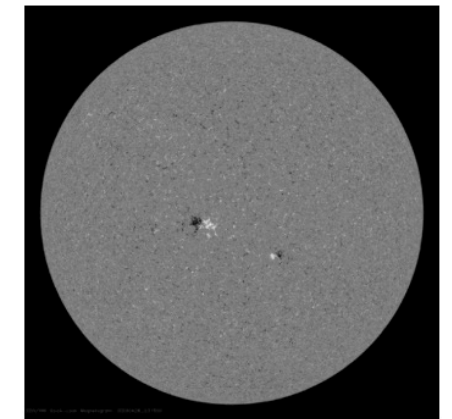
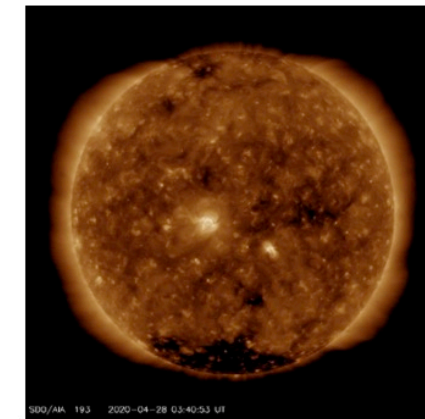
- Our real time solar wind prediction is called **PREDSTORM**.
- If data from **STEREO-A** is **not available**, a recurrence model with the NOAA L1 solar wind is used.
- A **Dst prediction** is included - for past times it is based on the observed solar wind. For future times, Dst is predicted depending on B, Bz, By, N, V with a new method using gradient based regression (GBR) on the [Temerin & Li \(2006\)](#) model.
- The Newell coupling function (bottom panel) is a 4h weighted mean, used as an input for the OVATION PRIME aurora model ([Newell et al. 2014](#)).
- A verification of this Dst prediction is shown by [Bailey et al. 2020, Space Weather, in press](#)

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no responsibility or liability for the frequency of provision and accuracy of this forecast.
 not be liable for any losses and damages in connection with using the provided information.

<https://helioforecast.space>

Most material is preliminary but close to being finished, including current data, catalogs of ICMEs and SIRs, and our experimental real-time forecasts for the background solar wind (PREDSTORM), CMEs with HI (ElEvoHI), and aurora (OVATION Prime 2010).



Show 10 entries

Search:

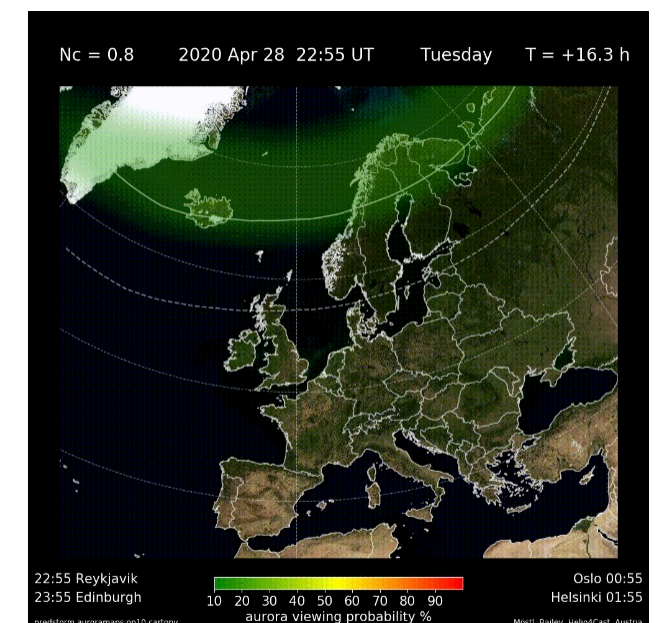
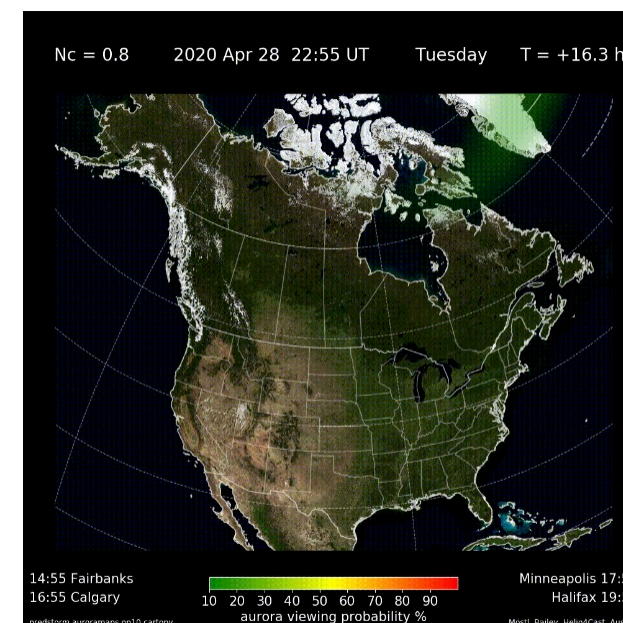
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0	ICME_PSP_MOESTL_20181030_01	PSP	2018-10-30 20:25	2018-10-30 20:25	2018-10-31 08:19	0.2645	24.92	0.12
1	ICME_PSP_MOESTL_20181111_01	PSP	2018-11-11 23:51	2018-11-11 23:51	2018-11-12 05:59	0.2545	178.55	-1.12
2	ICME_PSP_MOESTL_20190315_01	PSP	2019-03-15 09:00	2019-03-15 12:11	2019-03-15 17:49	0.5465	-161.32	3.17
3	ICME_PSP_MOESTL_20190324_01	PSP	2019-03-24 03:45	2019-03-24 03:45	2019-03-24 17:38	0.3858	-149.92	2.02
4	ICME_PSP_MOESTL_20190725_01	PSP	2019-07-25 08:13	2019-07-25 08:13	2019-07-25 23:06	0.7739		
5	ICME_PSP_MOESTL_20190731_01	PSP	2019-07-31 16:02	2019-07-31 16:02	2019-07-31 21:27	0.7076		
6	ICME_PSP_MOESTL_20190910_01	PSP	2019-09-10 10:39	2019-09-10 10:39	2019-09-10 13:41	0.3189		
7	ICME_PSP_MOESTL_20191013_01	PSP	2019-10-13 19:03	2019-10-13 22:47	2019-10-14 08:14	0.8077		
8	ICME_Wind_NASA_20070114_01	Wind	2007-01-14 11:31	2007-01-14 11:44	2007-01-15 07:45	0.9729		
9	ICME_Wind_NASA_20070115_01	Wind	2007-01-15 20:49	2007-01-15 20:49	2007-01-16 04:45	0.9731		

Showing 1 to 10 of 743 entries

Previous 1 2 3 4 5 ... 75 Next

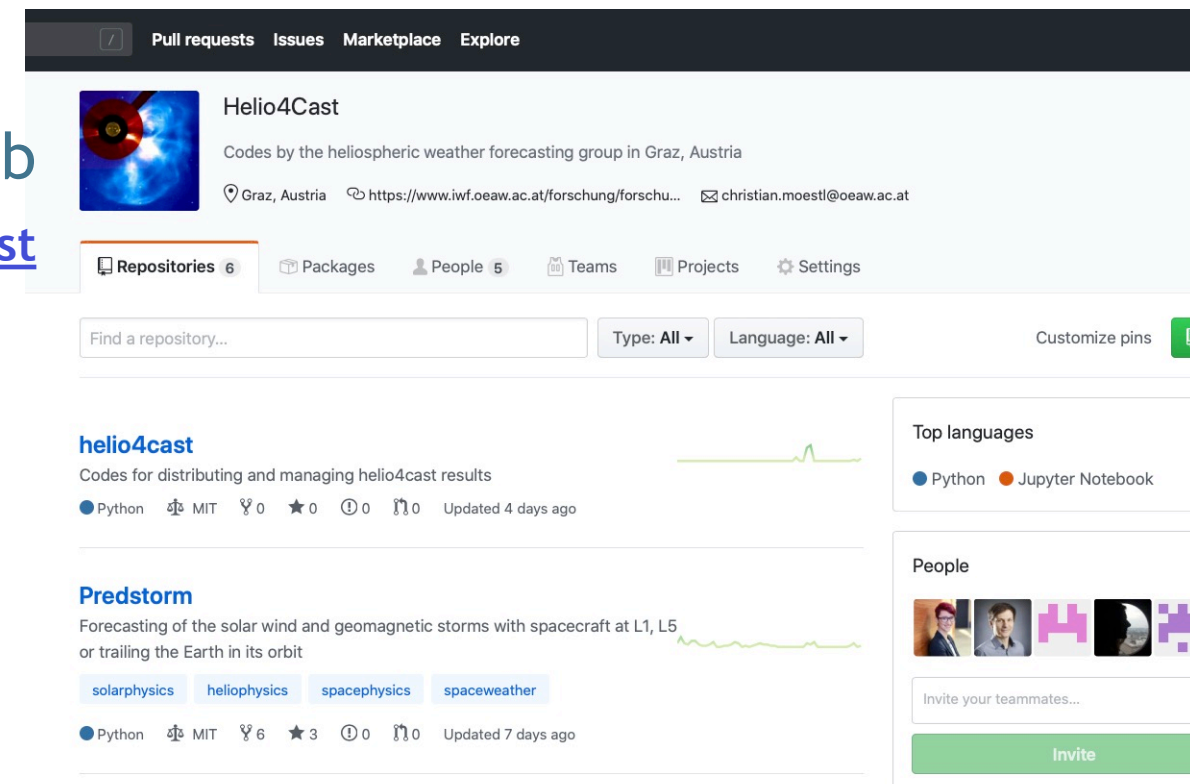
This catalog has been made by getting the 3 times of each ICME (shock or disturbance begin, magnetic obstacle start and end) from the individual catalogs below, and then calculating all parameters again consistently from the data by us.

The in situ data that were used for the catalog, with a size of 8 GB in total, including extra data files with magnetic field components in RTN coordinates that are not used for producing the catalog, can be downloaded in python pickle format as recarrays from



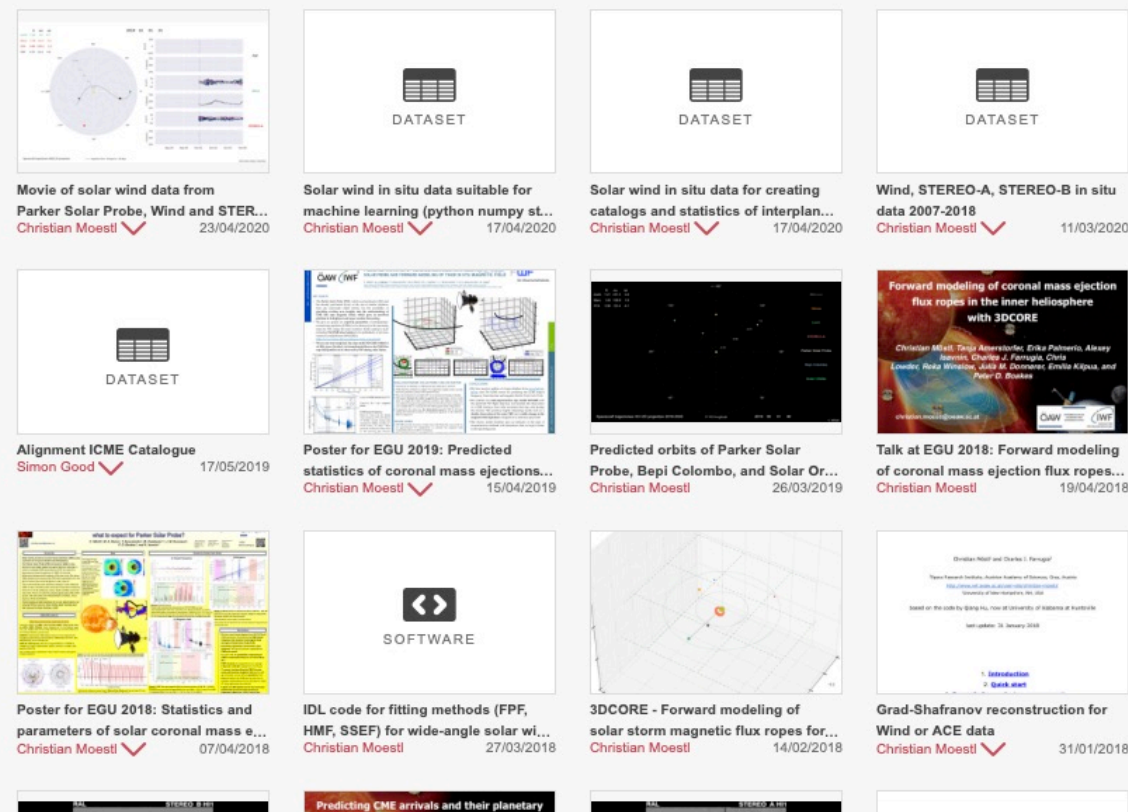
All our models will eventually be open source python packages (some are already open), all developed within our group, in order to be as reproducible as possible and to ease collaboration on codes.

Github

<https://github.com/helioforecast>


The screenshot shows the Github profile for 'Helio4Cast'. The profile header includes the repository name 'Helio4Cast', a description 'Codes by the heliospheric weather forecasting group in Graz, Austria', and contact information for Christian Moestl. Below the header, there are tabs for 'Repositories' (6), 'Packages', 'People' (5), 'Teams', 'Projects', and 'Settings'. A search bar and filters for 'Type: All' and 'Language: All' are present. The main content area lists two repositories: 'helio4cast' and 'Predstorm'. 'helio4cast' is described as 'Codes for distributing and managing helio4cast results' and is a Python package with 0 stars and 0 forks, updated 4 days ago. 'Predstorm' is described as 'Forecasting of the solar wind and geomagnetic storms with spacecraft at L1, L5 or trailing the Earth in its orbit' and is a Python package with 3 stars and 6 forks, updated 7 days ago. On the right side, there are sections for 'Top languages' (Python, Jupyter Notebook) and 'People' (a list of team members with an 'Invite' button).

Christian Moestl's public data



The screenshot shows a grid of 12 public data items from Christian Moestl on Figshare. The items are arranged in three rows and four columns. Each item has a thumbnail image, a title, and a date. The items include: 'Movie of solar wind data from Parker Solar Probe, Wind and STEREO-A, STEREO-B in situ data 2007-2018' (23/04/2020), 'Solar wind in situ data suitable for machine learning (python numpy st...)' (17/04/2020), 'Solar wind in situ data for creating catalogs and statistics of interplan...' (17/04/2020), 'Wind, STEREO-A, STEREO-B in situ data 2007-2018' (11/03/2020), 'Alignment ICME Catalogue' (17/05/2019), 'Poster for EGU 2019: Predicted statistics of coronal mass ejections...' (15/04/2019), 'Predicted orbits of Parker Solar Probe, Bepi Colombo, and Solar Or...' (26/03/2019), 'Forward modeling of coronal mass ejection flux ropes in the inner heliosphere with 3DCORE' (19/04/2018), 'Talk at EGU 2018: Forward modeling of coronal mass ejection flux ropes...' (19/04/2018), 'Poster for EGU 2018: Statistics and parameters of solar coronal mass e...' (07/04/2018), 'IDL code for fitting methods (FPF, HMF, SSEF) for wide-angle solar wi...' (27/03/2018), '3DCORE - Forward modeling of solar storm magnetic flux ropes for...' (14/02/2018), and 'Grad-Shafranov reconstruction for Wind or ACE data' (31/01/2018).

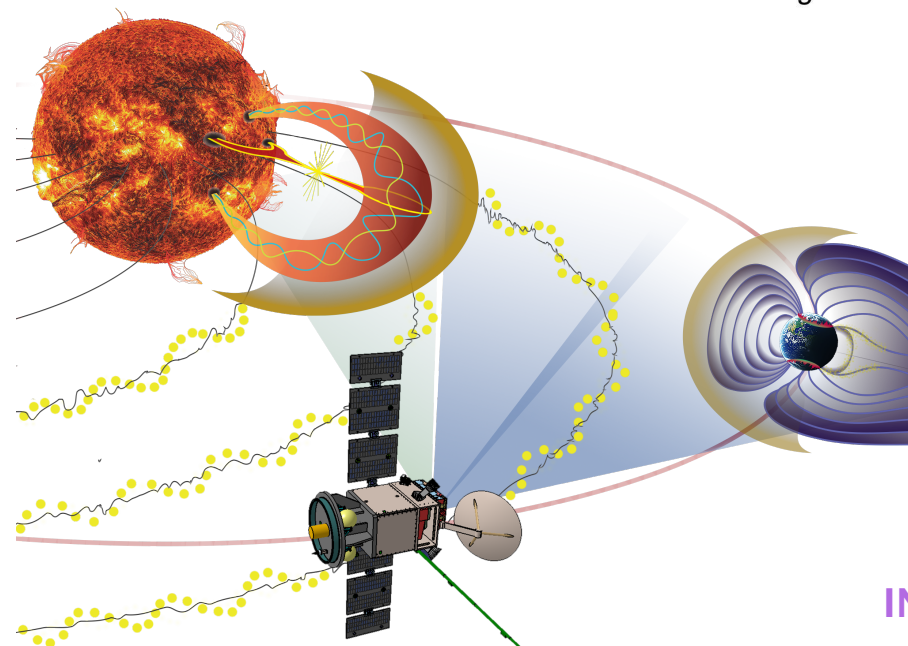
Figshare

https://figshare.com/authors/Christian_Moestl/3695146

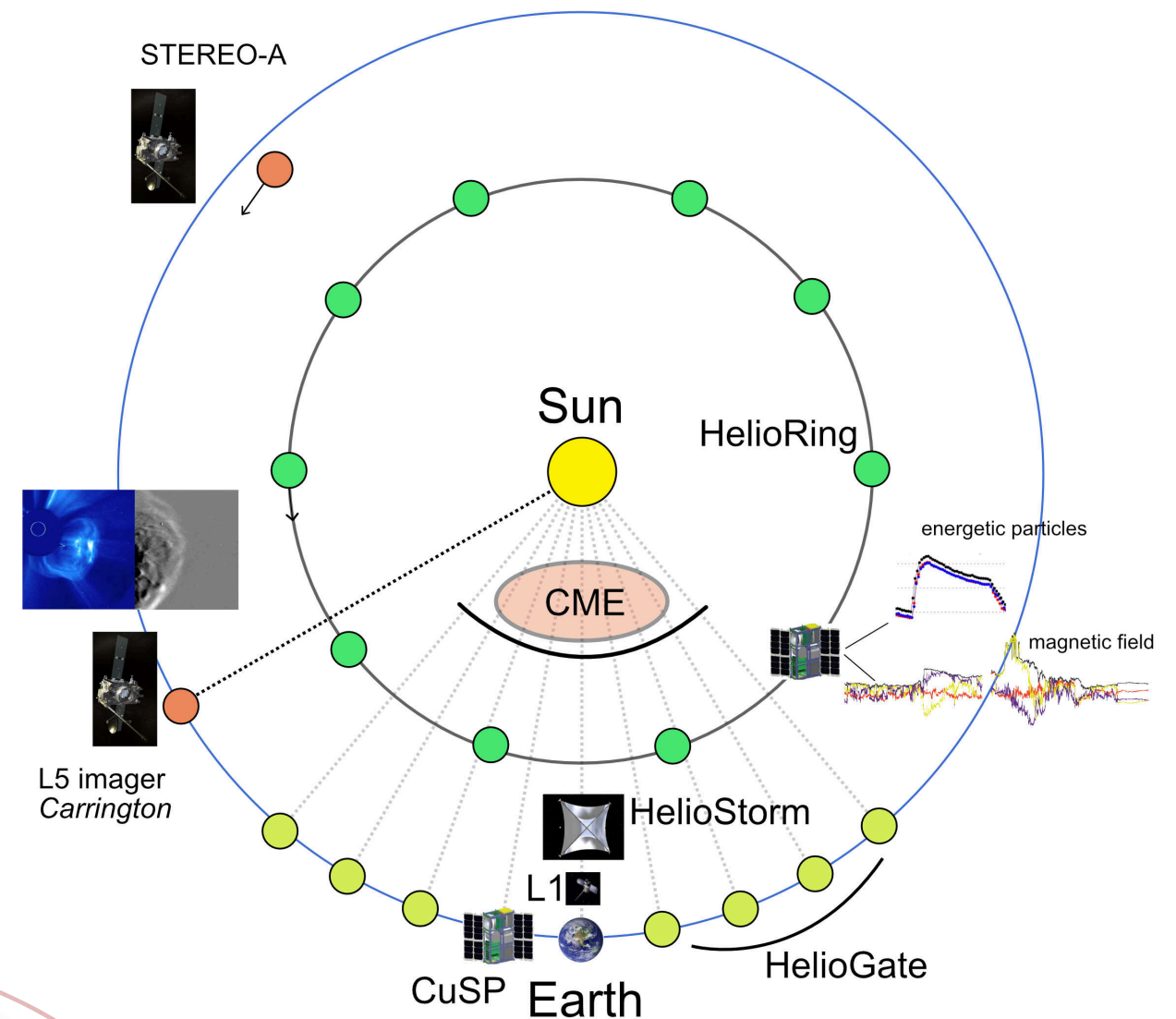
Please get in touch with us (e.g. christian.moestl@oeaw.ac.at) if you want to use these materials for your own work or contribute to our codes.

FUTURE WORK

- Study *Solar Orbiter*, *Parker Solar Probe*, *CuSP*, *BepiColombo* **CME lineups with 3DCORE**
- Real time modeling of the background wind and CME flux ropes optimized with **machine learning**
- Coupling to models of **geomagnetically induced currents**
- Check how different **interplanetary CubeSat** concepts would enhance the predictions
- Lay the groundwork for solar wind prediction based on data from a **mission to the L5 point**



Space Weather interplanetary CubeSat mission concepts



6/2016 C. Möstl, SRI Graz, Austria

INSTANT: Lavraud, Liu et al. 2016