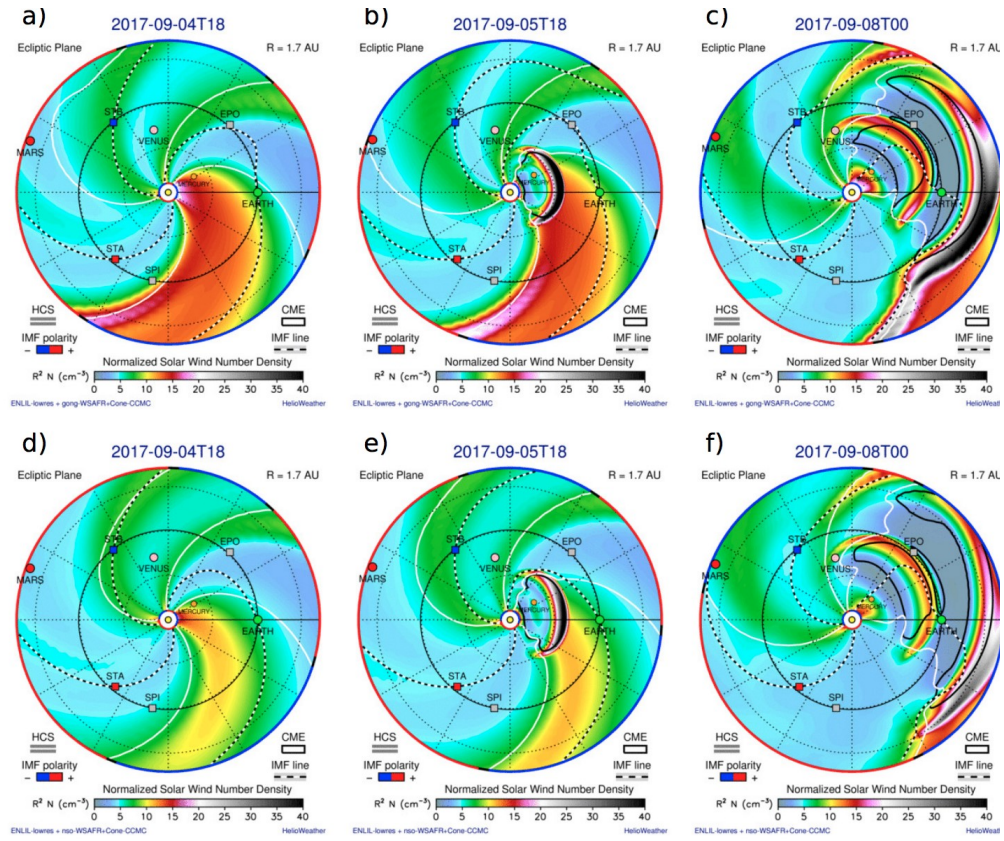
Round table discussion: forecasting

- **Needs (horizon, accuracy, lead time, …)**
- **What is required to achieve the needs, can they be achieved?**

Round table discussion: forecasting



Example of ENLIL simulations of coronal mass ejections into the solar system.

To improve forecasting:
-magnetic flux rope modeling (magnetic structure of the CME) will give Bz
-solar wind data assimilation

Multi-point observation:
now data from Solar Orbiter, Parker Probe, Beppi-Colombo, …
Not just Stereo, ACE, WIND, DSCOVR

Observing and Modeling Needs

Important limitations to predictions / have reliable or co

- Expensive vanta
  other planets, s
- Inaccessible reg
  through the cor
  flows in 3D.
- Detectible, but
  evolution, subsu

Important limitati
techniques

- Solar dynamo: fl
- Detection and ch
- Modeling of ene
  acceleration
- Modeling of field
- Propagation of e

NAS Space Weather Workshop, Solar Wind Panel — April 12, 2022

Major advance in observing polar fields and in tracking CMEs could come from polar view

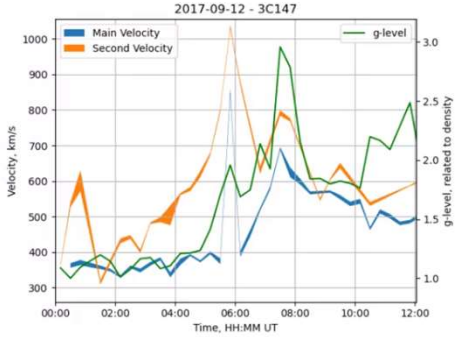
A polar OPS
Would enable
• Direct in-situ
magnetog
• OPS corona
with in-ecli

- Min practical
views of both
- Off-ecliptic im
evolution (HS
- Practical issu
s/c lifetimes,

Polar OPS mis

The Solar Wind

LOFAR 4SW

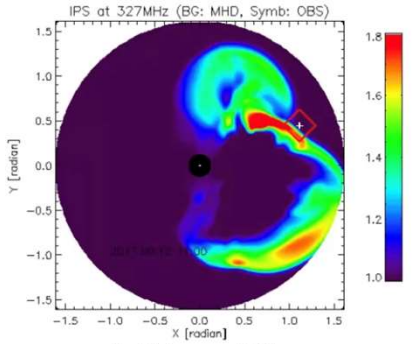


Fallows+, submitted, 2022

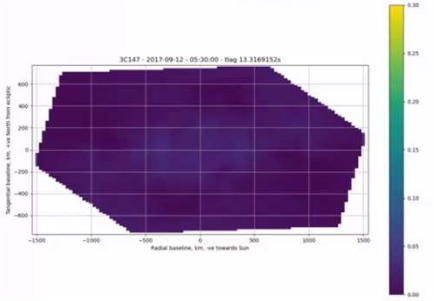
LOFAR can obtain detailed information on the solar wind and CME velocity, density, and turbulence, from long-duration observations.

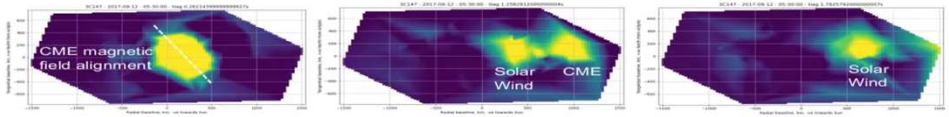
Left: Rise in velocity associated with a CME or shock front ahead of it, seen 2-hours ahead of an increase in density.

Right: Density enhancements seen by LOFAR (diamonds) plotted with those modelled using MHD.



Iwai+, in prep, 2022



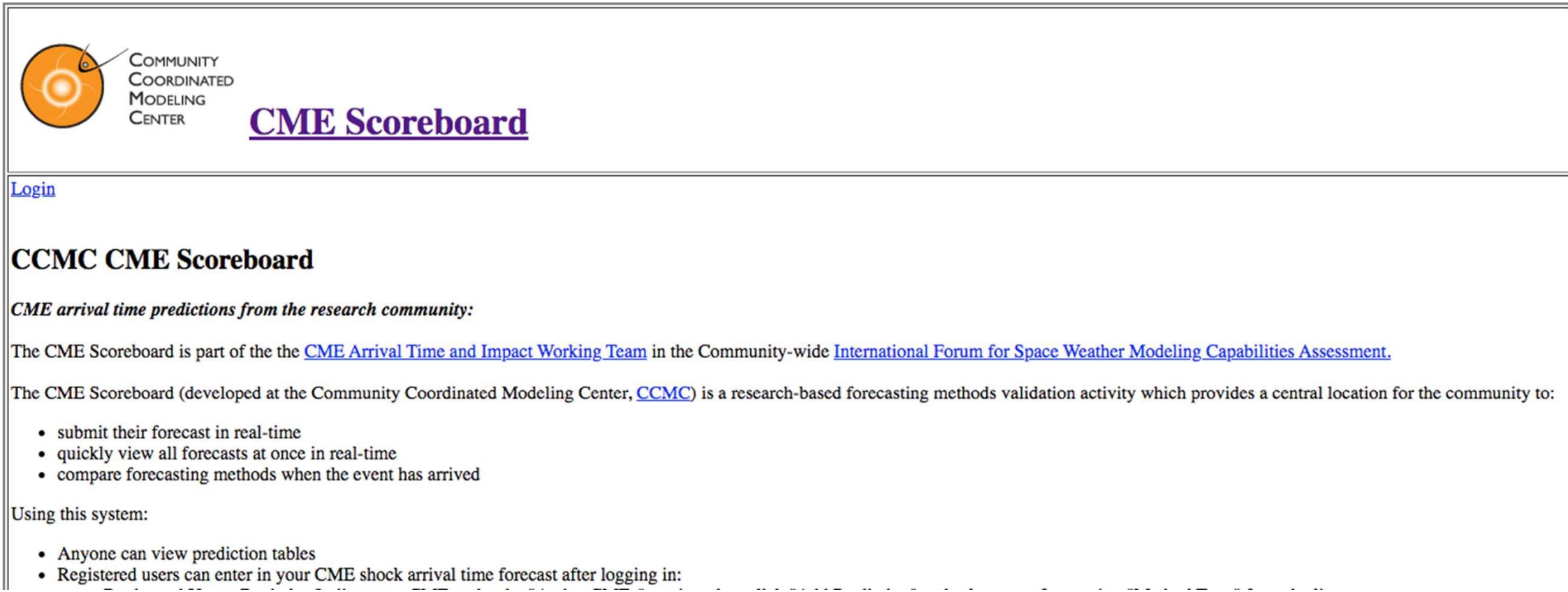


LOFAR imaging of the turbulent scintillation structure gives fundamental information on the small-scale structure within the solar wind and CMEs, complementing the large-scale structure seen in white-light observations.

LOFAR4SW — Richard Fallows

NASA/CCMC is setting up scoreboards to evaluate space weather models, for example for CMEs

But the IMF Bz scoreboard is not yet operational (geoeffectiveness)



COMMUNITY COORDINATED MODELING CENTER

CME Scoreboard

Login

CCMC CME Scoreboard

CME arrival time predictions from the research community:

The CME Scoreboard is part of the the CME Arrival Time and Impact Working Team in the Community-wide International Forum for Space Weather Modeling Capabilities Assessment.

The CME Scoreboard (developed at the Community Coordinated Modeling Center, CCMC) is a research-based forecasting methods validation activity which provides a central location for the community to:

- submit their forecast in real-time
- quickly view all forecasts at once in real-time
- compare forecasting methods when the event has arrived

Using this system:

- Anyone can view prediction tables
- Registered users can enter in your CME shock arrival time forecast after logging in:

CME: 2022-03-10T19:23:00-CME-001

Actual Shock Arrival Time: 2022-03-13T10:11Z

Observed Geomagnetic Storm Parameters:
Max Kp: 6.0
CME Note: Visible in the NW of STEREO A COR2 and as a halo in SOHO LASCO C2/C3. Associated with an eruption, dimming, and EUV wave SE of AR2962 (N12W12), best seen in SDO AIA 171/193 starting around 2022-03-10T18:42Z. Associated with below-threshold increase in greater than 10 MeV proton flux at GOES-P beginning 2022-03-10T23:15Z and below-threshold increase in 13-100 MeV proton flux at STEREO A IMPACT beginning 2022-03-11T01:00Z. | ARRIVAL NOTE UPDATE - from DONKI IPS entry (2022-03-13T06:35:00-IPS-001): Sudden jump in magnetic field amplitude reaching 20 nT as well as a jump in speed, density, and temperature. A subsequent rotation can be seen in the B-field components with a decrease in temperature indicating a flux rope passage. Bz mostly north during the flux rope passage starting around 2022-03-13T22:00Z.

Predicted Shock Arrival Time	Difference (hrs)	Confidence (%)	Submitted On	Lead Time (hrs)	Predicted Geomagnetic Storm Parameter(s)	Method	Submitted By	
2022-03-13T09:11Z (-7.5h, +9.2h)	-1.00	97.0	2022-03-11T18:23Z	39.80	Max Kp Range: 5.0 - 7.0	Ensemble WSA-ENLIL + Cone (NASA M2M)	Robert Loper (M2M Office)	Detail
2022-03-13T11:35Z (-7.0h, +7.0h)	1.40	----	2022-03-11T13:48Z	44.38	Max Kp Range: 5.0 - 8.0	WSA-ENLIL + Cone (NASA M2M)	Robert Loper (M2M Office)	Detail
2022-03-13T11:51Z	1.67	----	2022-03-11T14:30Z	43.68	Max Kp Range: 4.0 - 5.0	SARM	Marlon Nunez (UMA)	Detail
2022-03-13T08:01Z	-2.17	----	2022-03-13T01:56Z	8.25	----	SPM2	Xinhua Zhao (NSSC CAS)	Detail
2022-03-13T12:36Z	2.42	----	2022-03-13T01:55Z	8.27	----	SPM	Xinhua Zhao (NSSC CAS)	Detail
2022-03-13T15:59Z (-7.0h, +7.0h)	5.80	----	2022-03-11T07:00Z	51.18	----	EAM (Effective Acceleration Model)	Evangelos Paouris (UoA)	Detail
2022-03-13T16:24Z	6.22	81.75	---	---	Max Kp Range: 4.42857 - 6.57143	Average of all Methods	Auto Generated (CCMC)	Detail
2022-03-13T16:38Z (-9.0h, +9.0h)	6.45	----	2022-03-11T07:00Z	51.18	----	EAM (Effective Acceleration Model)	Evangelos Paouris (UoA)	Detail
2022-03-13T18:00Z (-12.0h, +12.0h)	7.82	80.0	2022-03-11T15:29Z	42.70	Max Kp Range: 4.0 - 7.0	Other (SIDC)	Robert Loper (M2M Office)	Detail
2022-03-13T21:00Z (-7.0h, +7.0h)	10.82	----	2022-03-11T04:00Z	54.18	----	WSA-ENLIL + Cone (NOAA/SWPC)	Robert Loper (M2M Office)	Detail
2022-03-13T23:00Z (-6.0h, +6.0h)	12.82	80.0	2022-03-11T06:30Z	51.68	Max Kp Range: 4.0 - 6.0	WSA-ENLIL + Cone (Met Office)	Met Office (Met Office)	Detail
2022-03-14T00:00Z (-12.0h, +12.0h)	13.82	----	2022-03-11T06:00Z	52.18	Max Kp Range: 4.0 - 6.0	WSA-ENLIL + Cone (BoM)	Duty Forecaster (ASFC)	Detail
2022-03-14T01:00Z	14.82	70.0	2022-03-11T14:20Z	43.85	Max Kp Range: 5.0 - 7.0	Cone+HAF (SEPC, NSSC, CAS)	Jingjing Wang (NSSC SEPC)	Detail

CCMC CME Scoreboard

Example for one minor storm

CME arrival time predictions from the researc community:

The CME Scoreboard is part of the the CME A val Time and Impact Working Team in the Community-wide International Forum for Space Weather Modeling Capabilities Assessment.

The CME Scoreboard (developed at the Comm ity Coordinated Modeling Center, CCMC) is a research-based forecasting methods validation activity which provides a central location for the community to:

- submit their forecast in real-time
- quickly view all forecasts at once in real- e
- compare forecasting methods when the ev t has arrived

Using this system:

- Anyone can view prediction tables
- Registered users can enter in your CME shock arrival time forecast after logging in: