OPTIMAP

Solar Activity Parametrisation for OPTIMAP

Volker Bothmer & OPTIMAP Team

ESWW11, 17-21 November 2014, Liége, Belgium

Introduction

OPTIMAP

- OPTIMAP = Operational Tool for Ionosphere Mapping and Prediction

- Project of German Space Situational Awareness Center aiming at providing advanced predictions of ionospheric VTEC conditions in near real-time up to several days in advance

Introduction

OPTIMAP

- Project partners:

German Space Situational Awareness Centre (WRLageZ), Uedem, Germany

Centre for Geoinformation of the German Armed Forces, (ZGeoBw), Euskirchen, Germany

German Geodetic Research Institute(DGFI), Munich, Germany - Center of Geodetic Earth System Research (CGE)

Georg-August-University Göttingen, Göttingen, Germany - Institute for Astrophysics

OPTIMAP

Ionospheric Key Parameters

Introduction

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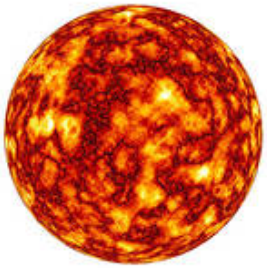
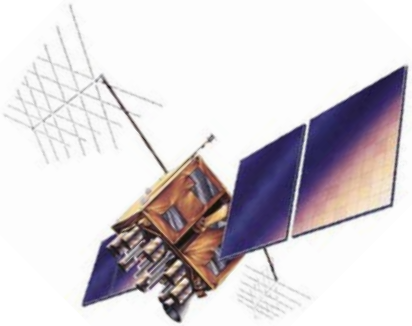


Solar Variability



Electromagnetic signals

Ionosphere

60 km – 1000 km

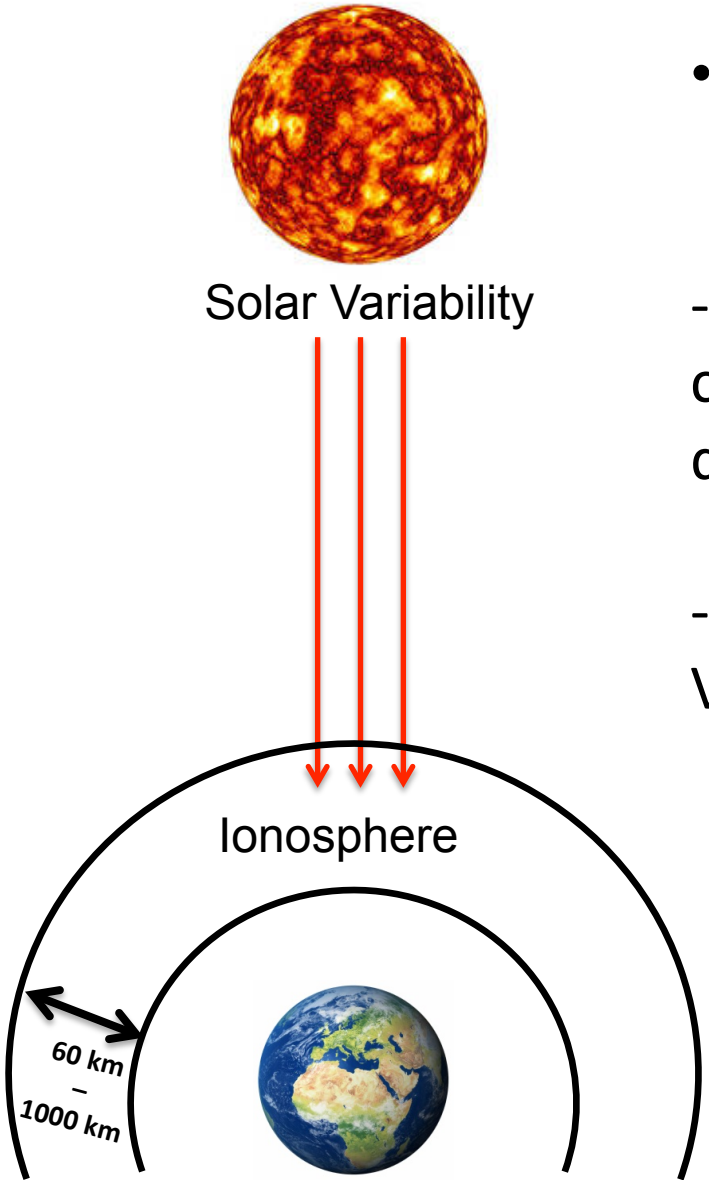
Signal disturbances in form of

frequency dependent diffraction

Troposphere

Ionosphere

Einführung



- Key Parameters characterising ionospheric conditions

- Electron density profile for characterising the vertical electron density distribution N↓e

- Vertical total electron content / VTEC) derived through integration

$$VTEC = \int_{h_1}^{h_2} N_e(h)dh$$

Introduction

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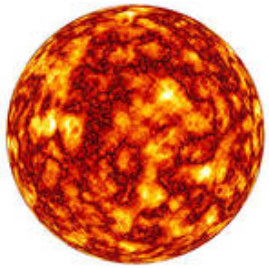


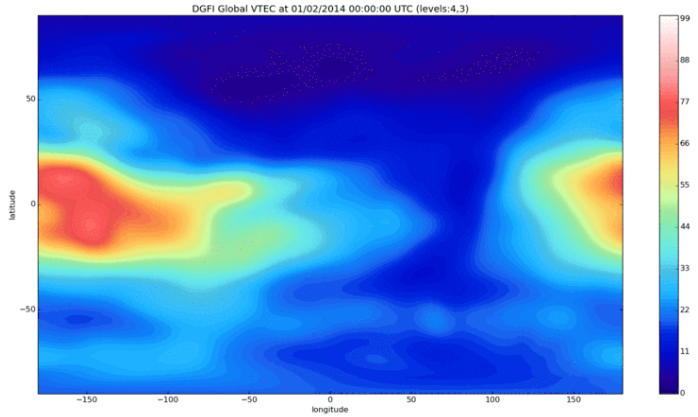
Solare Variability

Ionospheric Modelling

Ionosphere

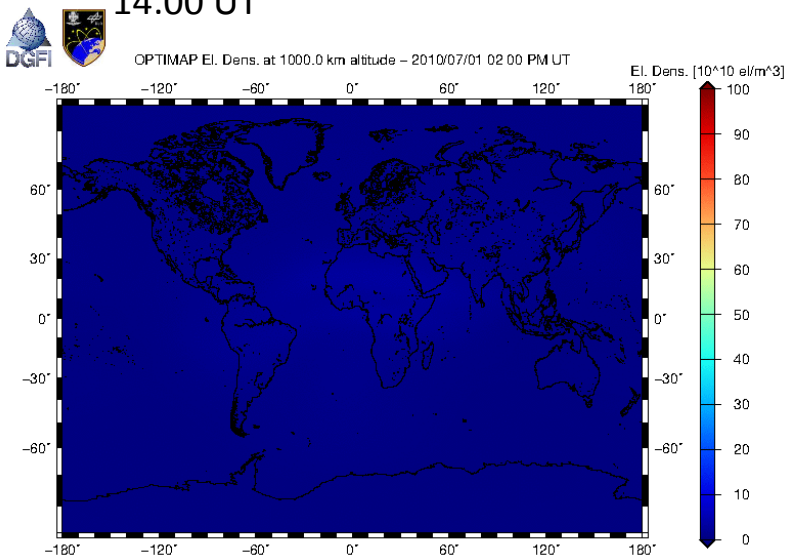
60 km – 1000 km

Variability of vertical total electron content as function of horizontal position and time



$$VTEC(\lambda, \varphi, t)$$

Electron density -Tomography as function of horizontal position and height between 100 and 1000 km at t = 14:00 UT



$$N_e(\lambda, \varphi, h)$$

OPTIMAP

Key solar activity data sets and scientific analysis methods used for OPTIMAP forecasts

OPTIMAP processed solar data

Satellite/Obs.	Instrument	Location	Object	Parameter	Cadence	Time series
-		Dominion Radio Astrophysical Observatory (NDAA)	Solar Flux	10.7cm Radio	tbd	18 Mon.
SDO	AIA	remote Sun @L1	Corona	EUV @ 193 A	tbd	18 Mon.
SDO	AIA	"	Chromosphere	EUV @ 304 A	tbd	18 Mon.
GOES15		Earth Orbit	Flare	Solar X-Ray Flux	1min	18 Mon.
SOHO	C2	remote Sun @ L1	CME	Vis., FOV 2-6 R_s	tbd	18 Mon.
	C3	remote Sun @ L1	CME	Vis., FOV 3.7-32 R_s	tbd	18 Mon.
STEREO A/B	COR2	remote Sun @ 1AU Orbit	CME	Vis., FOV 2-15 R_s	1-2 hrs after event detection	18 Mon.
			Integr. EM emission at radio wavelengths			18 Mon.
			Integr. EM emission at X-ray and at (E)UV wavelengths			18 Mon.
			Impact-Parameter of earth directed CMEs			18 Mon.
			Flare Impact-Parameter			18 Mon.

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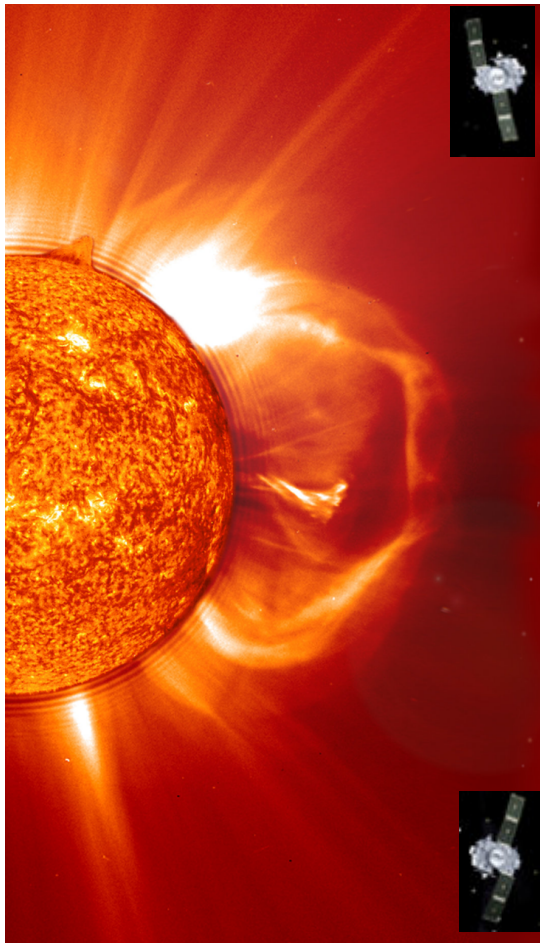
OPTIMAP processed solar wind data

OPTIMAP

Satellite	Instrument	Location	Object	Parameters	Cadence	Time series
ACE	SWEPAM	in-situ @ L1	Plasma	V,N,T	64sec	18 Mon.
ACE	MAG	in-situ @ L1	IMF	**B**, B_x, B_y, B_z	1sec	18 Mon.
				$V \bullet B_z$		18 Mon.
				ΔB		18 Mon.
				Solar wind classification (CMEs, HSS, SW, CIRs, SIRs, shocks)		18 Mon.

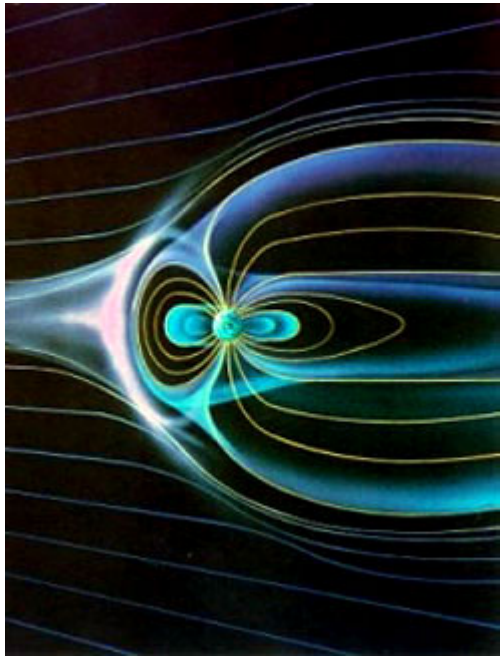
Analysis methods

STEREO satellites provide 3D-view



Which direction does the CME go? Will it miss?

ACE gives 15-30 mins premonition time



How fast is the CME? When will it arrive at Earth and with which -Bz ?

Analysis methods

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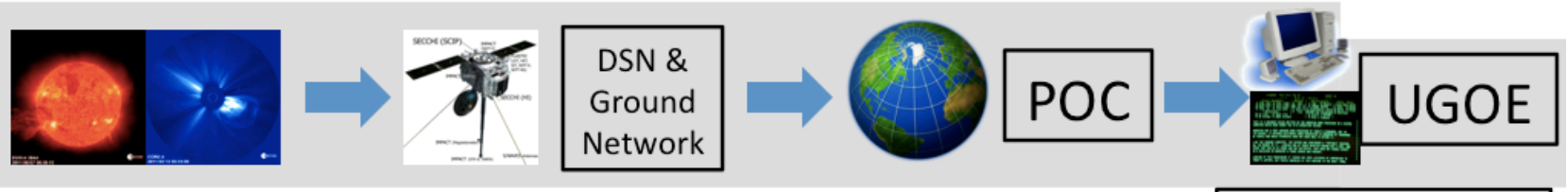
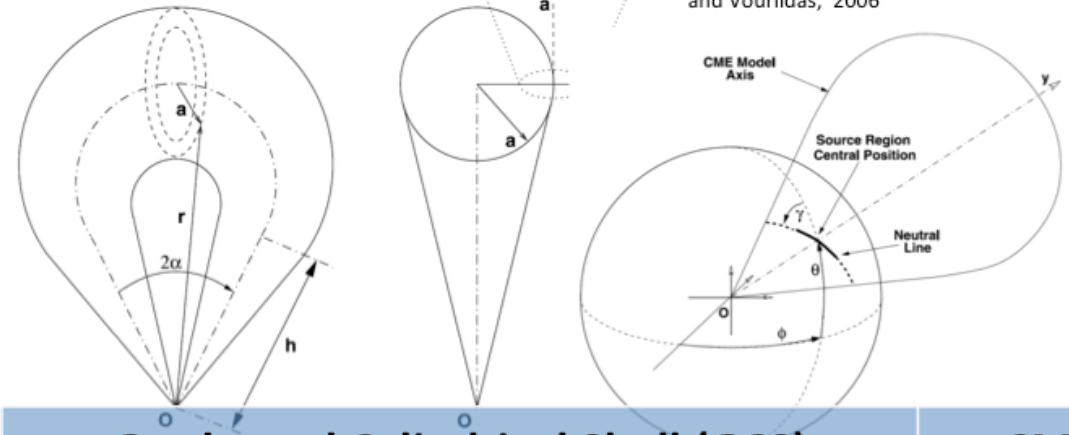
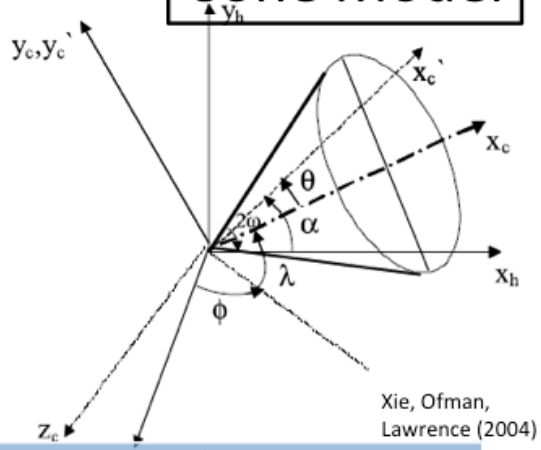


GCS Model



Cone Model



Graduated Cylindrical Shell (GCS)	CME Analysis Tool (CAT)
flux tube model ("croissant" like shape)	ice cream cone model
detailed parametrization (6 parameter)	geometry: 4 parameter, velocity
electron density distribution, ray-tracing code	multi-fit tool
main purpose: detailed 3-D CME analysis	main purpose: forecast of CMEs

E. Bosman, J. Hinrichs

Analysis methods

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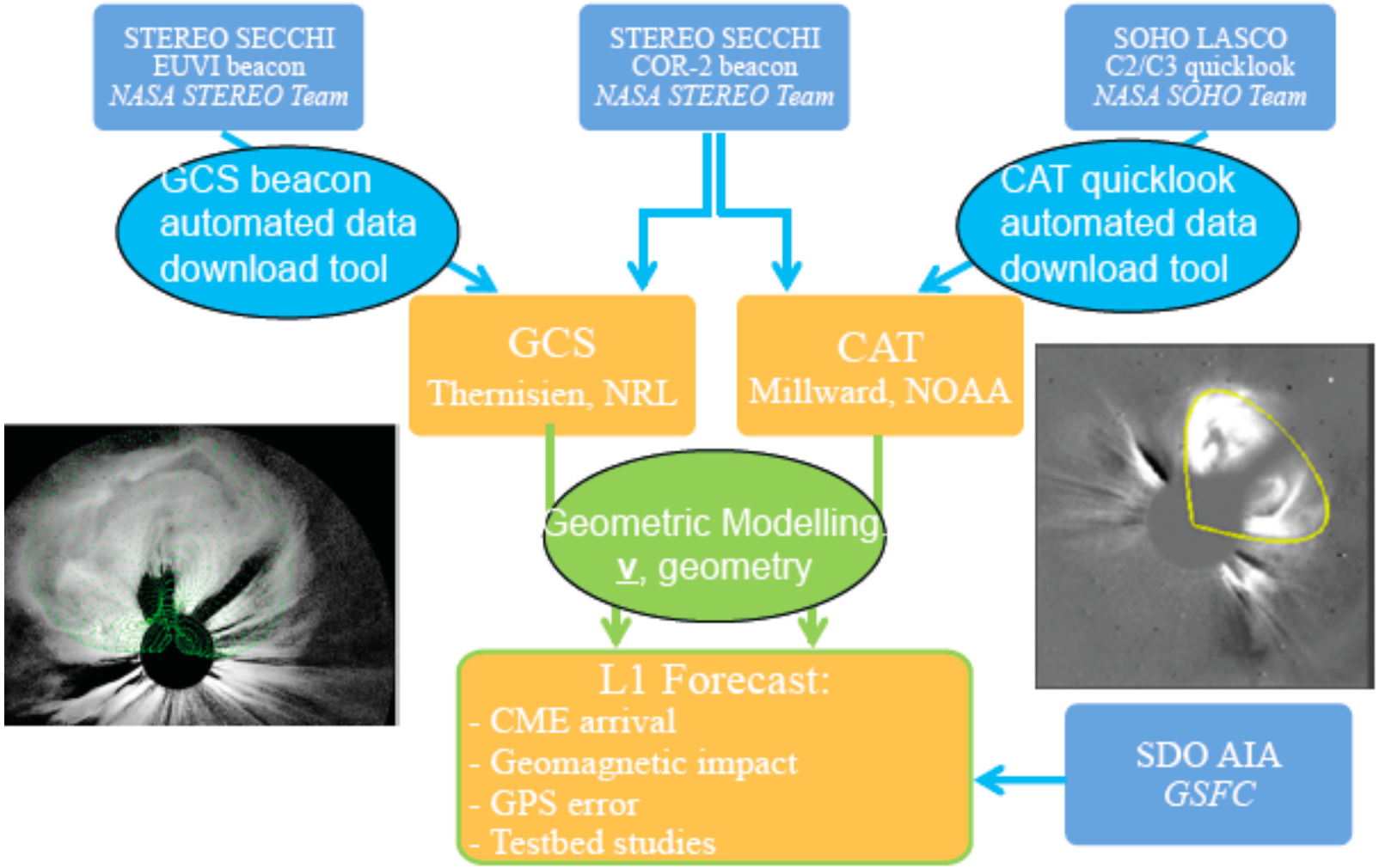
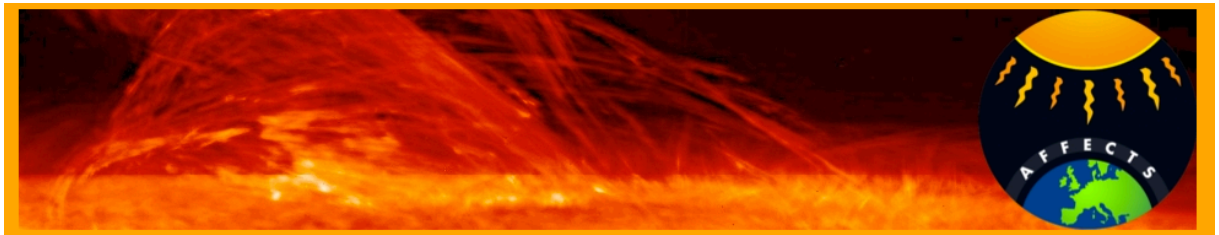


AFFECTS Services

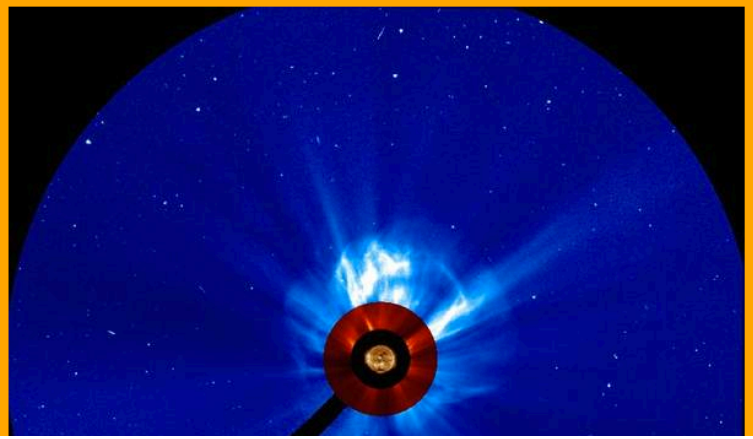


AFFECTS Solar Storm Warning

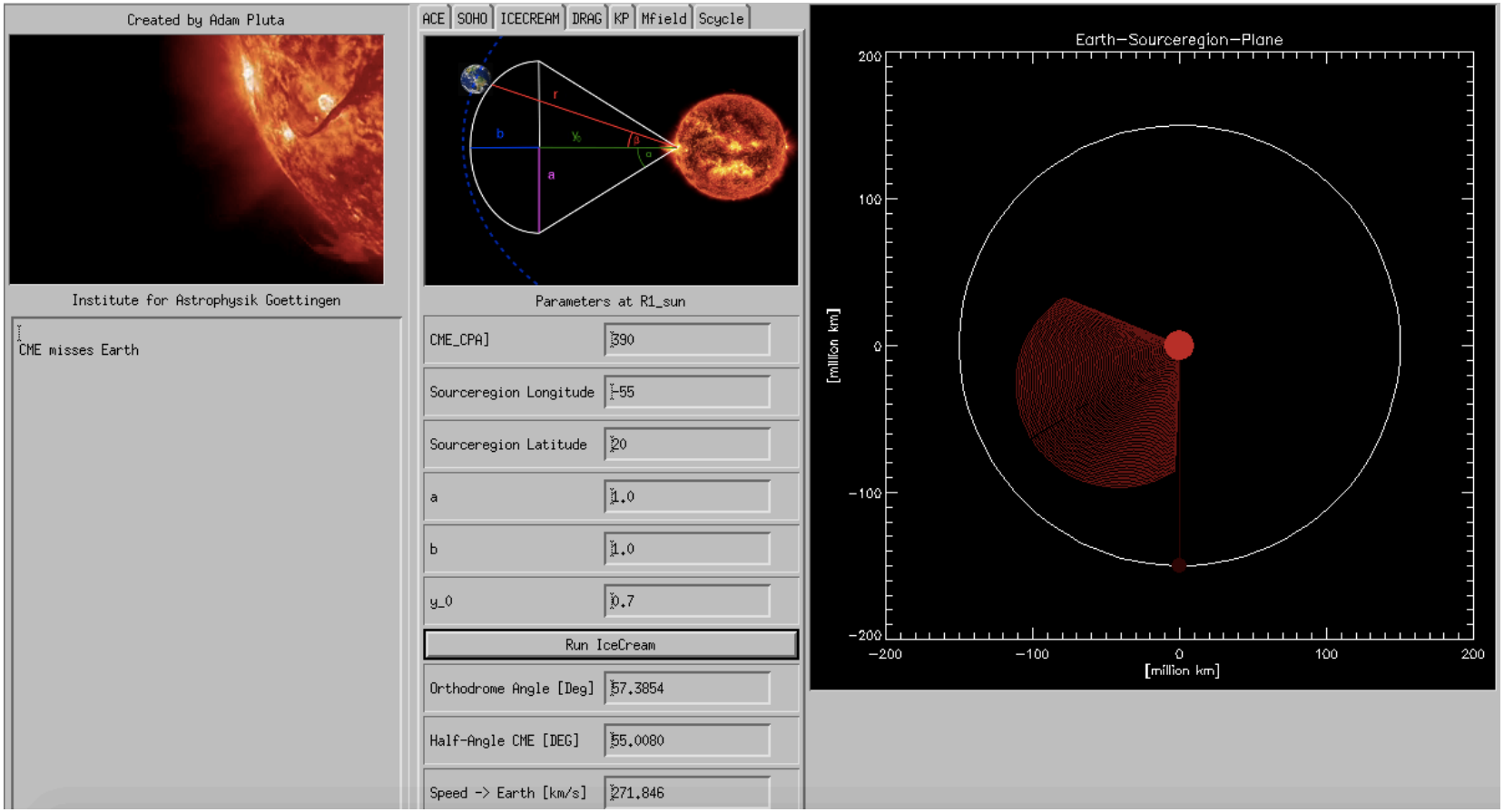
September 11, 2014

An X1.6 (R3) flare occurred disk centered at N14E05 on September 10, 2014 around 17:30 UT. The AFFECTS 3-D CME analysis yields an average propagation speed to earth of 1130 km/s. The arrival time at earth is calculated to 07:37 CET on September 12. Its speed in earth orbit is estimated to 941 km/s, the maximum Kp-value to 9. Based on the magnetic configuration of the CME, which is classified as a SEN flux rope type according to the Bothmer & Schwenn scheme, the main phase of the storm will be from 08 to 20 CET on September 12. Visibility of Aurora in central Europe is possible after sunset on September 12.

Please find more information about AFFECTS at www.affects-fp7.eu.

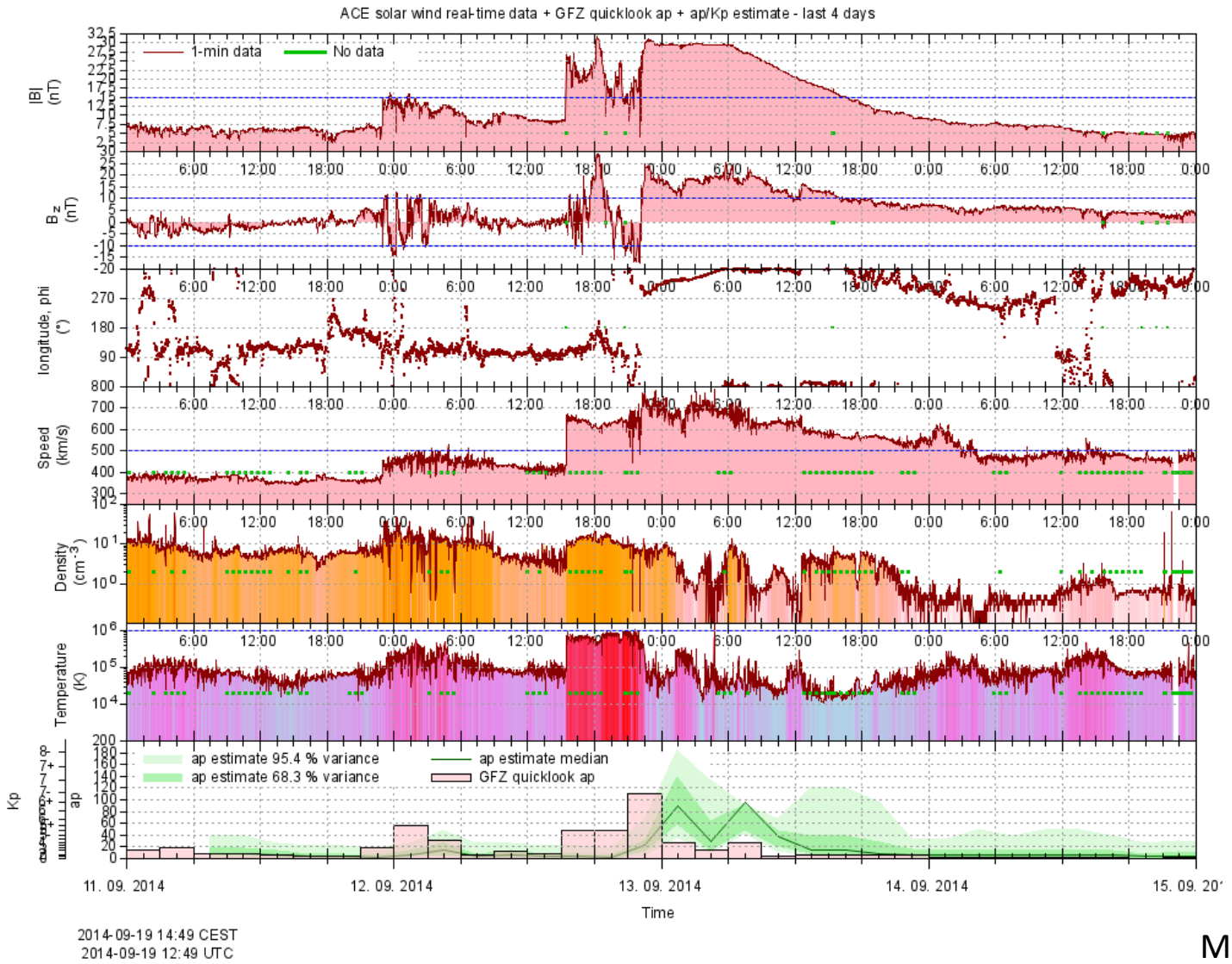


Input for Forecast



A. Pluta

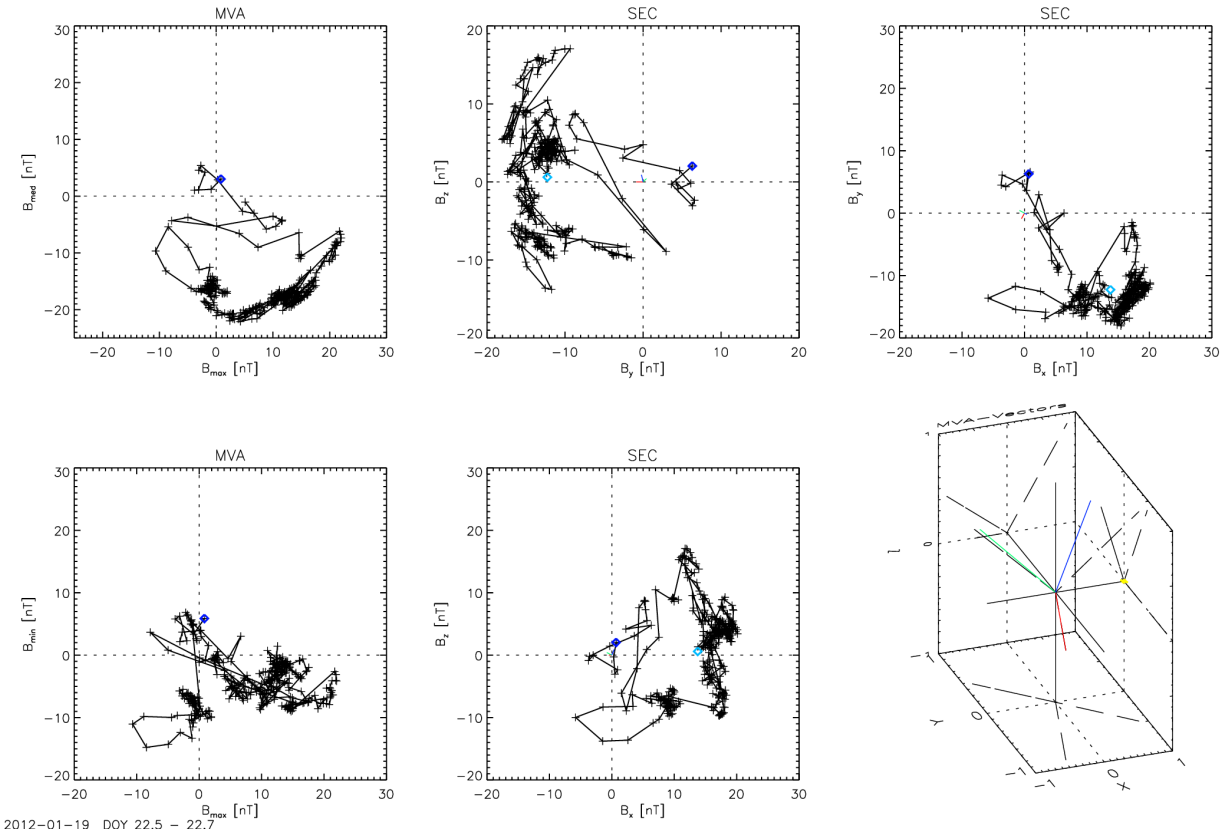
L1 solar wind measurements



M. Venzmer

Analysis methods

- Minimum variance analysis of in-situ data (M. Venzmer)



Summary and Outlook

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