Europska Unija
Ulaganje u budućnost
Projekt je sufinancirala Europska Unija iz Europskog socijalnog fonda

Validation of the CME Arrival Time and Geomagnetic forecast alerts under COMESEP

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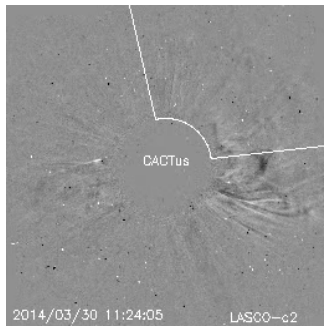
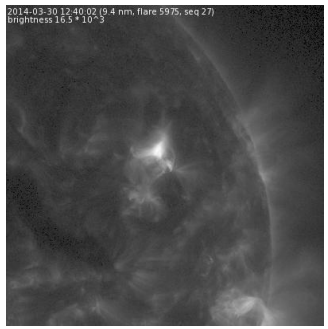
COronal Mass Ejections and Solar Energetic Particles (COMESEP)

= collaborative EU FP7 project (2011-2014)
AIM: produce a fully automatic alert system (runs since 2014)

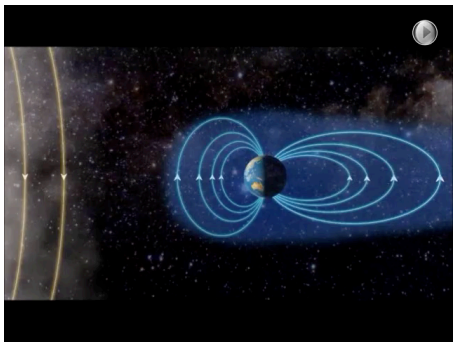




CME/flare detection

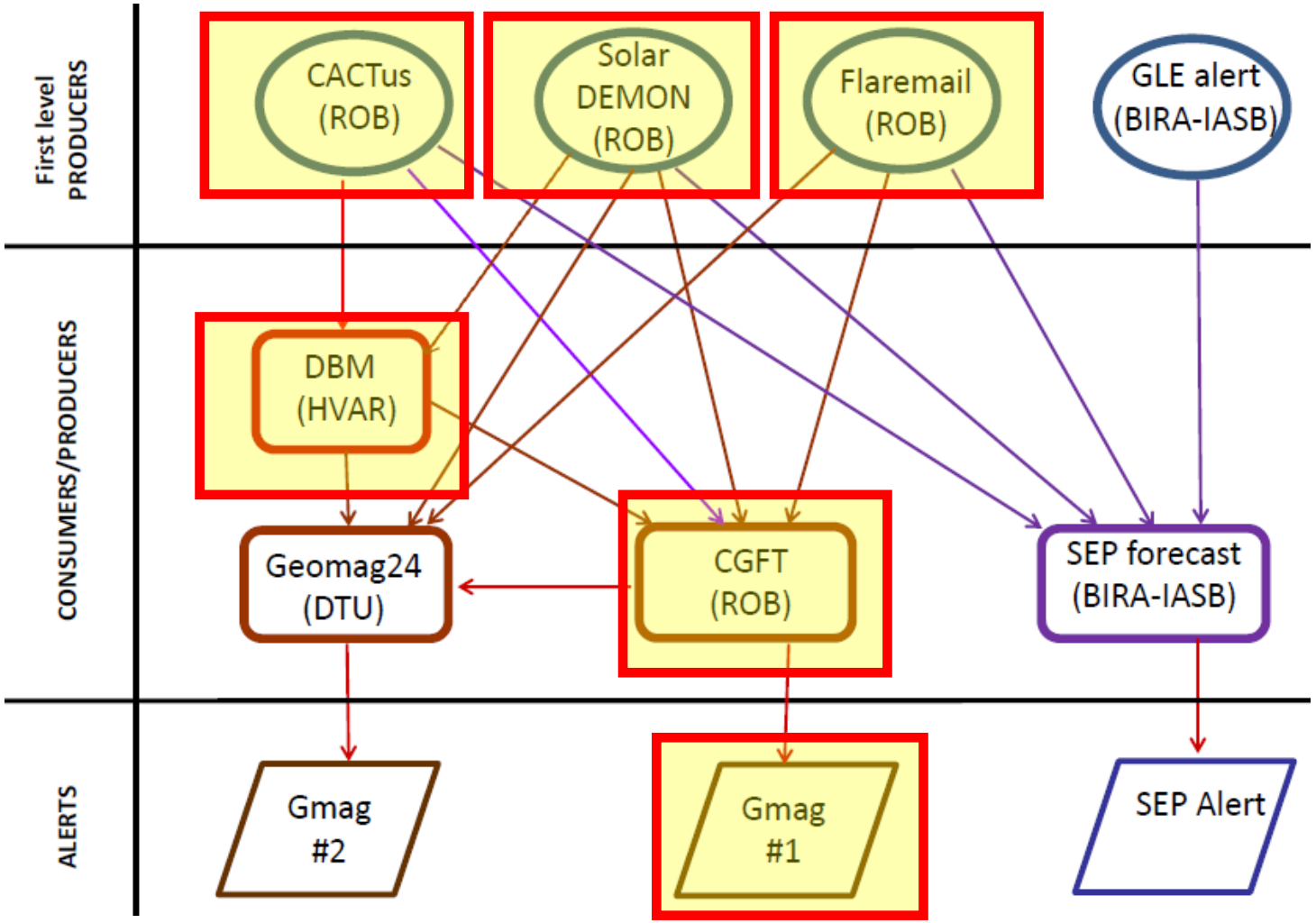
COMESEP

Forecast

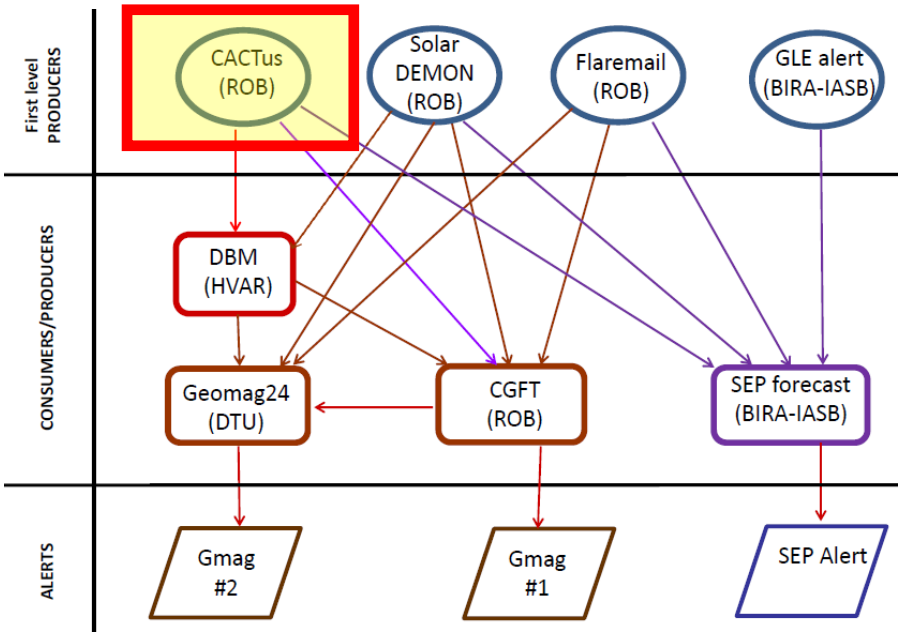


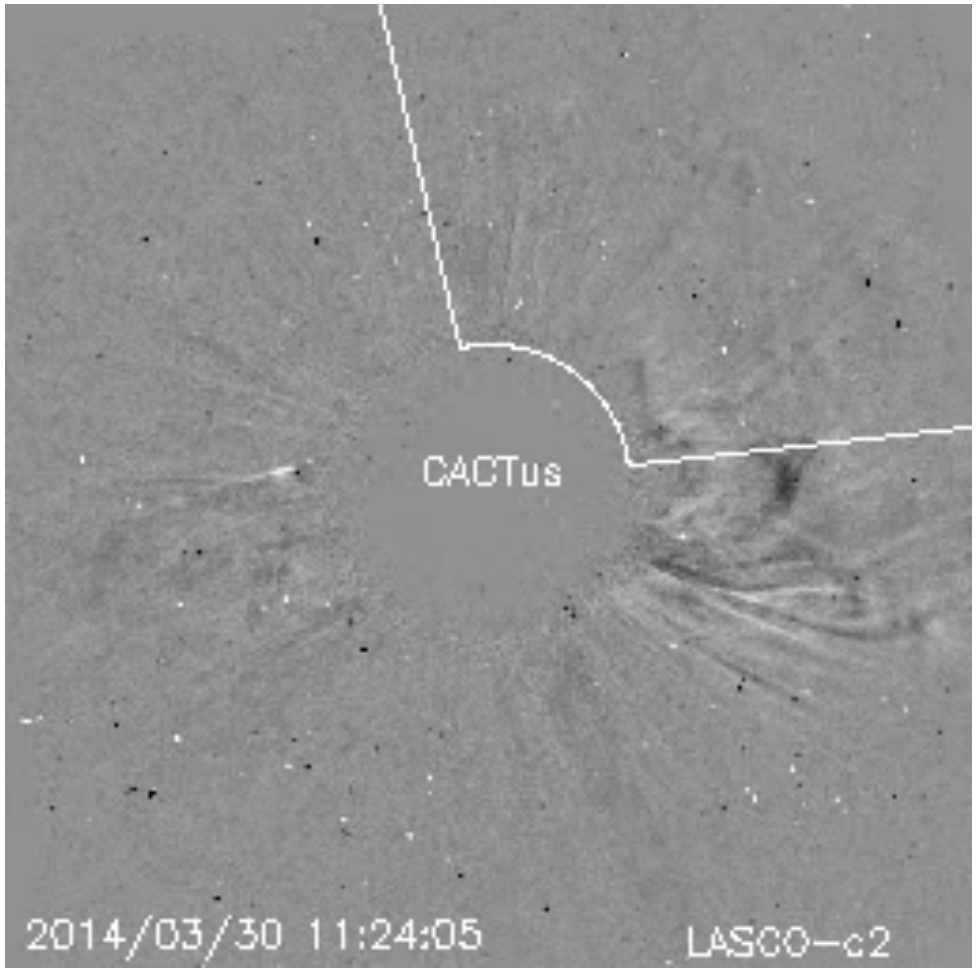
SEPs/geomagnetic storms

COMESEP ALERT SYSTEM



Computer Aided CME Tracking (CACTus)



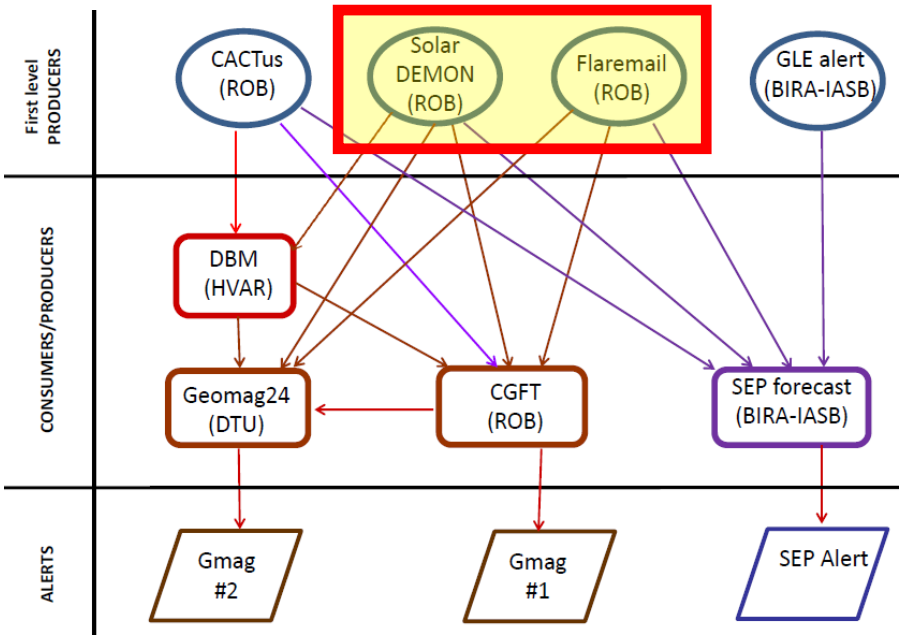


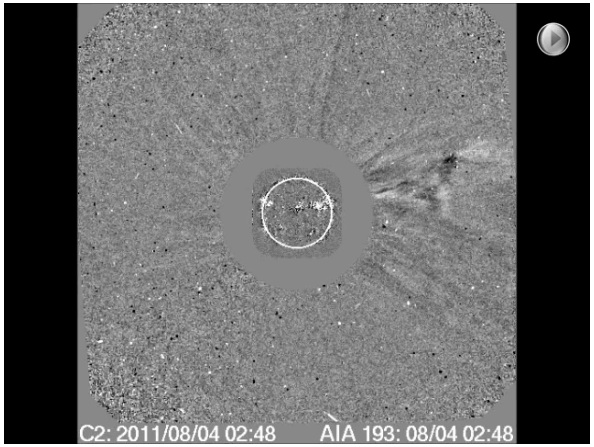
- Autonomously detects CMEs using SOHO/LASCO images

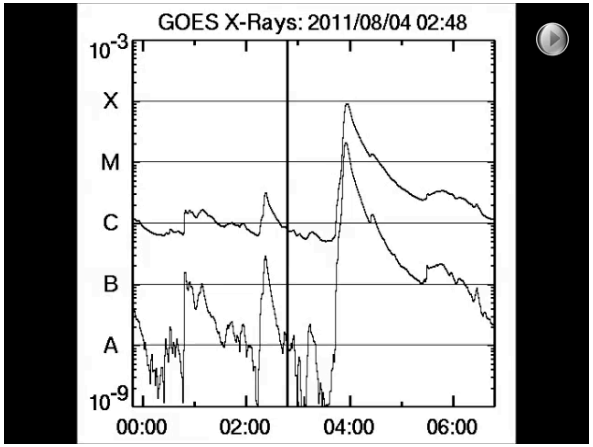
- Measures CME apparent width, w and plane-of-the-sky speed, v

- Issues an alert when w>120 degrees

Solar DEMON and flaremail





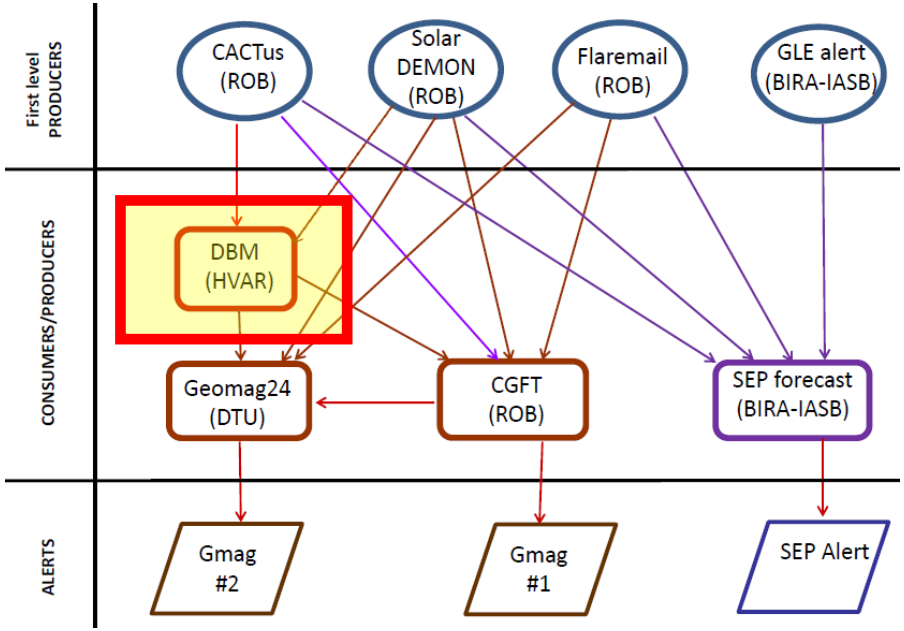


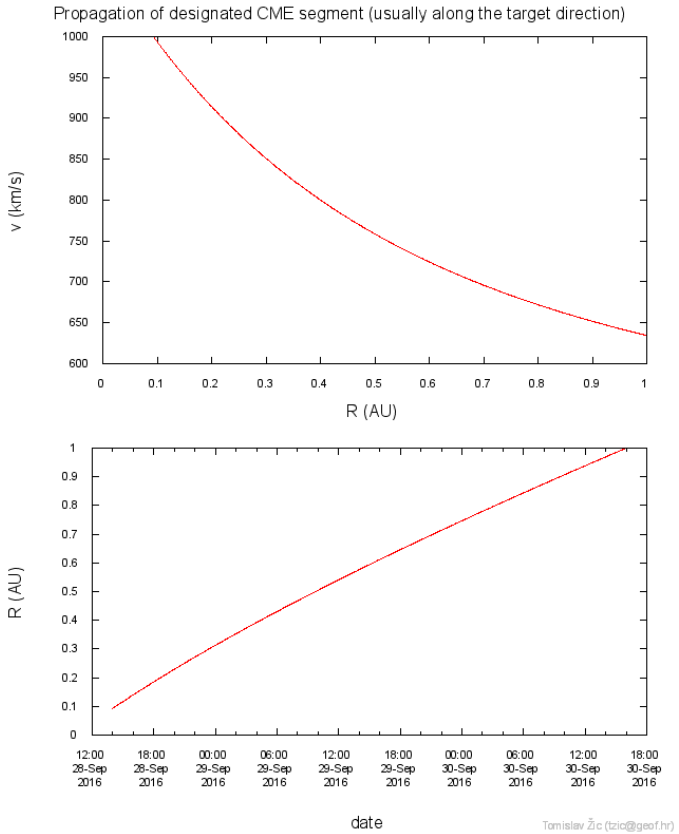
CMEs and flares associated based on spatial and temporal criteria (*Vršnak et al., 2005*)

The Solar Dimming and EUV wave Monitor (Solar DEMON)
- detects flares automatically and in real time using SDO/AIA data.

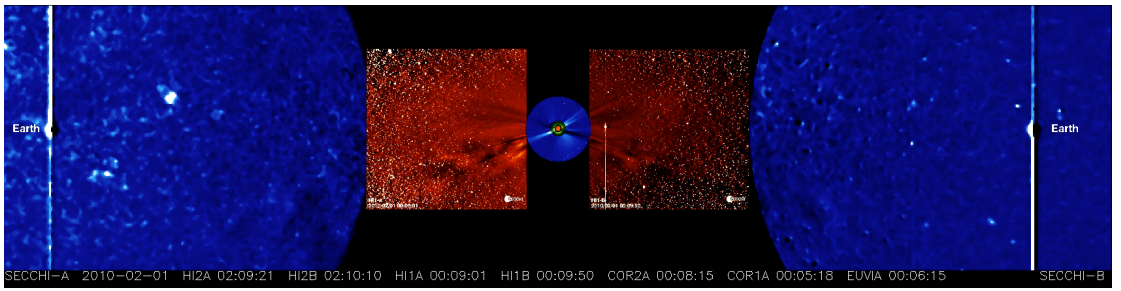
Flaremail
- issues an alert whenever an M- or X-class flare is detected in the GOES X-ray data

DRAG BASED MODEL (DBM)

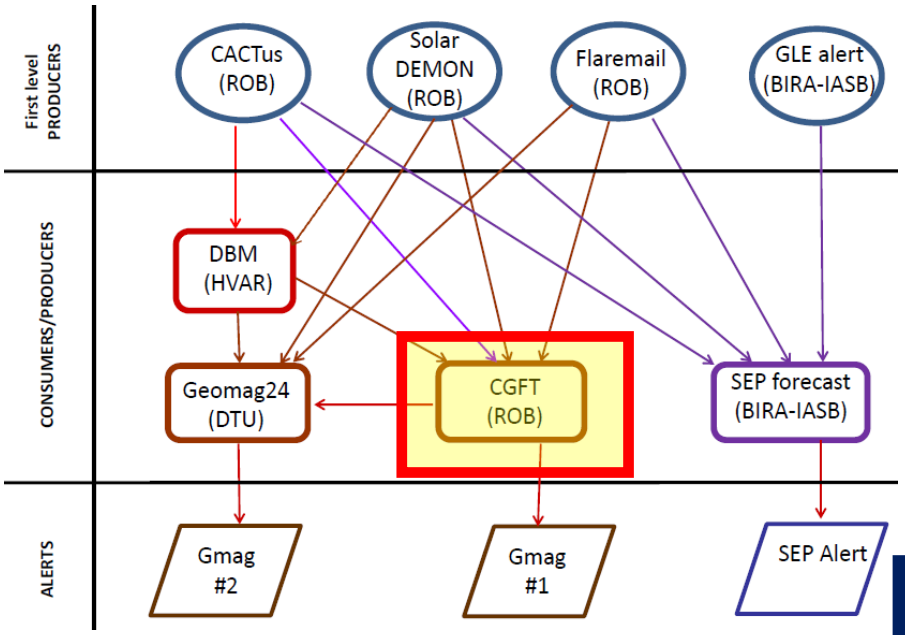




- assumes that MHD drag governs the propagation of CMEs in IP space
- Calculates ICME arrival time & speed



CME GEOMAGNETIC FORECAST TOOL (CGFT)



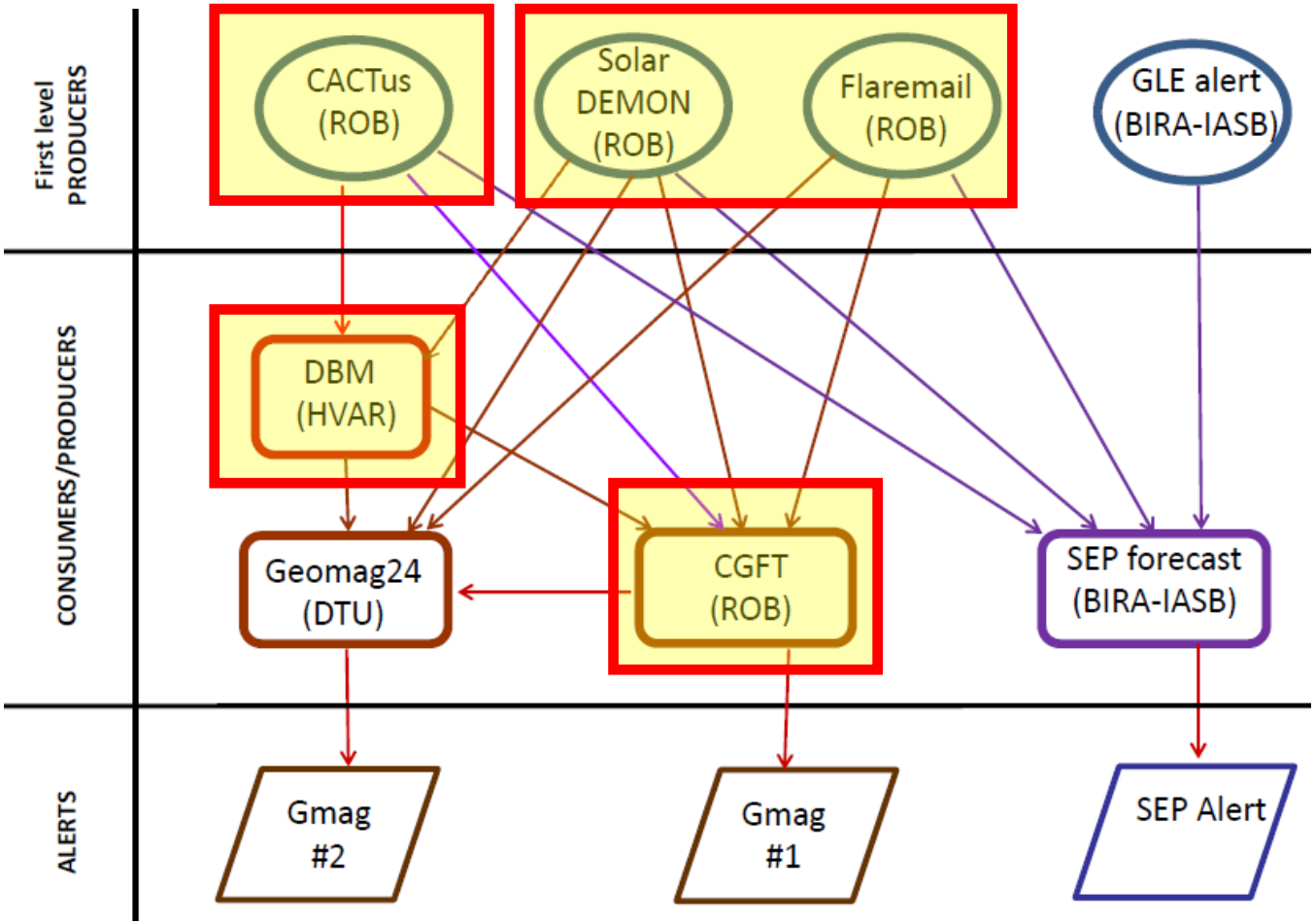
CGFT module 1

Estimates storm risk (4 possible ranges)

STORM LEVEL (|Dst|)	ARRIVAL PROBABILITY: very unlikely (0-10%)	unlikely (10-40%)	possible (40-70%)	likely (70-90%)	very likely (90-100%)
SEVERE (|Dst|>300)	MODERATE	HIGH	HIGH	HIGH	EXTREME
STRONG (|Dst|=200-300)	MODERATE	MODERATE	MODERATE	HIGH	HIGH
MODERATE (|Dst|=100-200)	LOW	MODERATE	MODERATE	MODERATE	HIGH
MINOR (|Dst|<100	LOW	LOW	LOW	MODERATE	MODERATE

Estimates RISK LEVEL based on the RISK MATRIX

When risk level is higher than low issues alert



1. Triggered by DBM alert

2. Takes input from CACTus (and Solar DEMON and flaremail if available)

3. Calculates Risk level

4. Issues alert

COMESEP alerts in 2014

Total number of CMEs in 2014 (CACTus cat

Number of CMEs with w>120 (CACTus cat

Total number of issued CGFT alerts: 72

Number of Dst<-100 nT events: 3 (all are forecasted)

Number of CGFT alerts with medium risk: 65

Number of CGFT alerts with high risk: 7

STORM LEVEL (|Dst|)						
	SEVERE (|Dst|>300)	MODERATE	HIGH	HIGH	HIGH	EXTREME
	STRONG (|Dst|=200-300)	MODERATE	MODERATE	MODERATE	HIGH	HIGH
	MODERATE (|Dst|=100-200)	LOW	MODERATE	MODERATE	MODERATE	HIGH
	MINOR (|Dst|<100	LOW	LOW	LOW	MODERATE	MODERATE
ARRIVAL PROBABILITY		very unlikely (0-10%)	unlikely (10-40%)	possible (40-70%)	likely (70-90%)	very likely (90-100%)

Many low storm risk events were marked as medium risk because of arrival probability!

Number of CGFT alerts with Dst>-100 nT: 47

Number of CGFT alerts with -200nT<Dst<-100 nT: 0

Number of CGFT alerts with -300nT<Dst<-200 nT: 23

Number of CGFT alerts with Dst<-400 nT: 2

Using COMESEP tools with human intervention

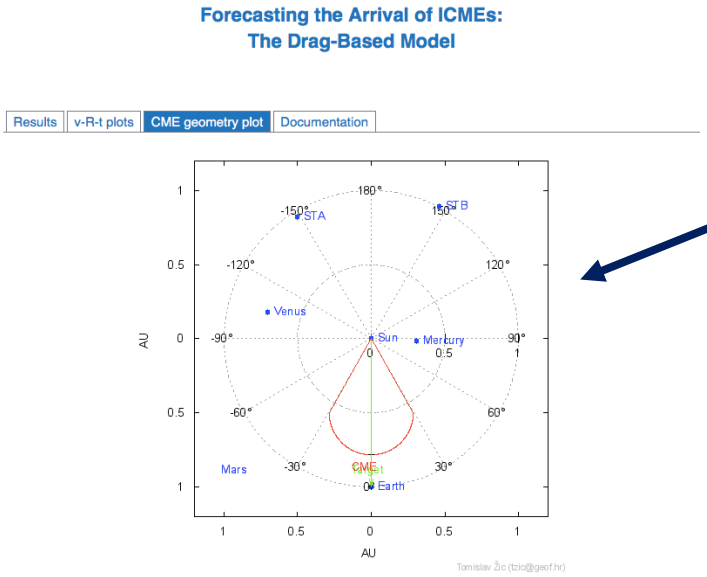
STEP 1: OBSERVERS CROSS-CHECK

Checking LASCO, SDO and GOES; CME/flare association; using STEREO to discard backsided events

STEP 2: USING RECENT VERSIONS OF TOOLS

Recent versions of tools are not automatically implemented in the COMESEP system

Available on-line as self-standing tools:

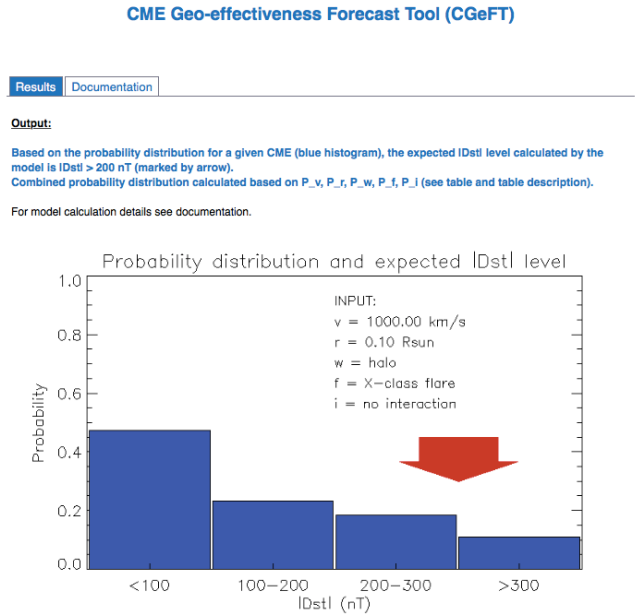


Advanced DBM

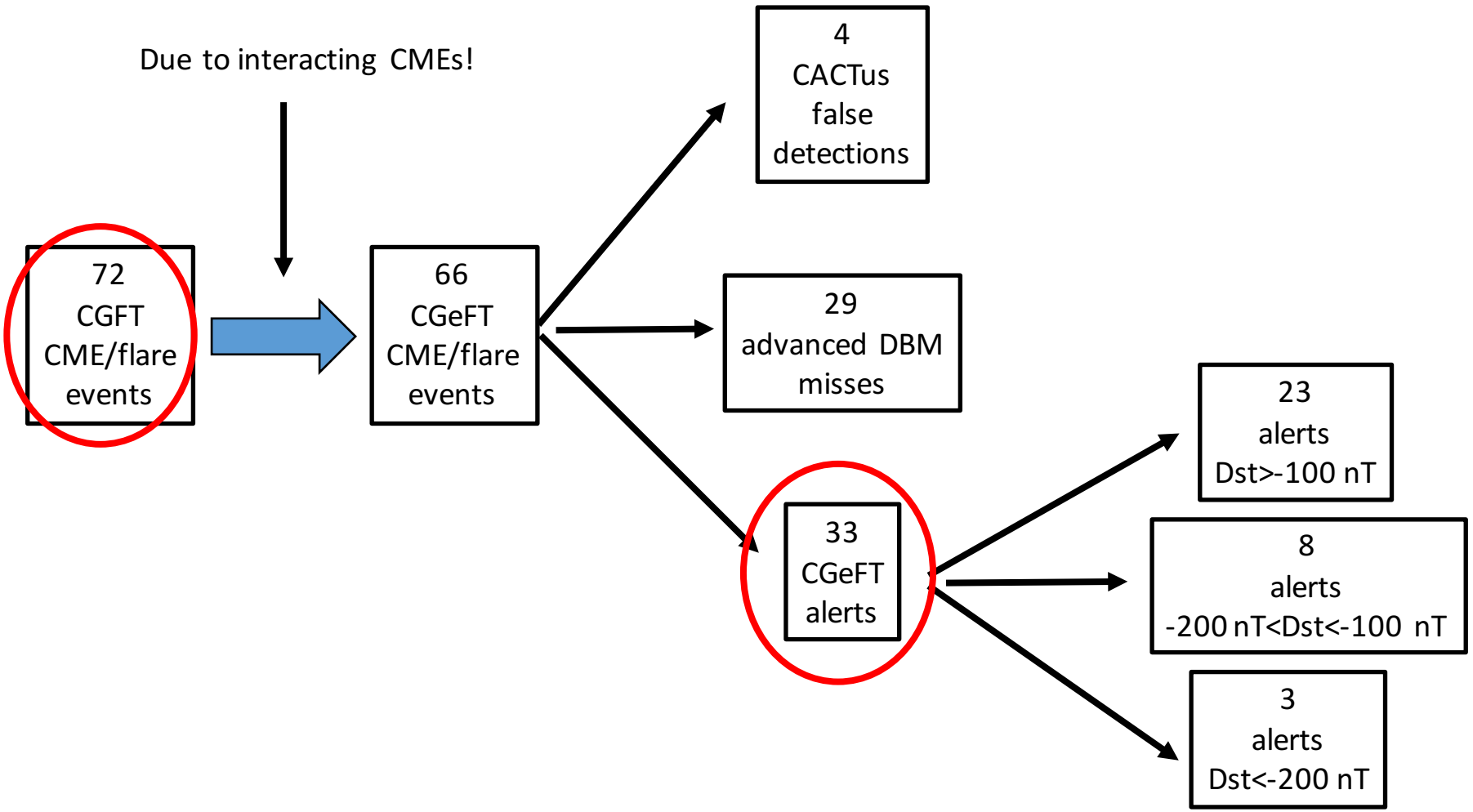
&

Advanced CGFT module 1
(CGeFT)

http://oh.geof.unizg.hr/



Using COMESEP tools with human intervention

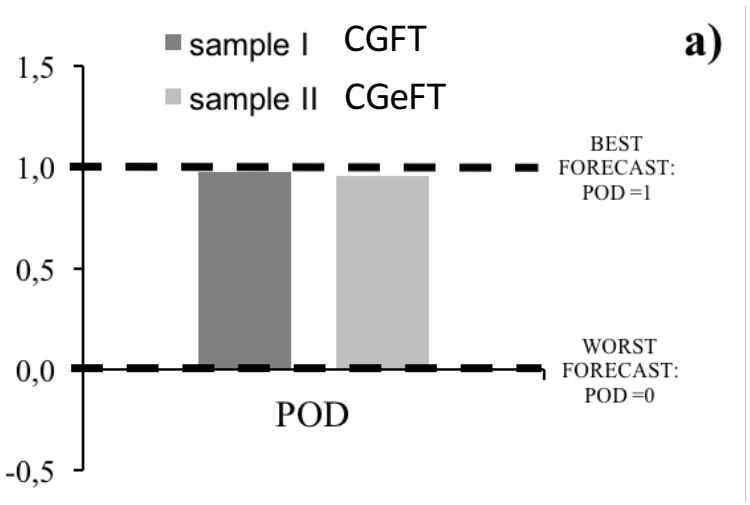


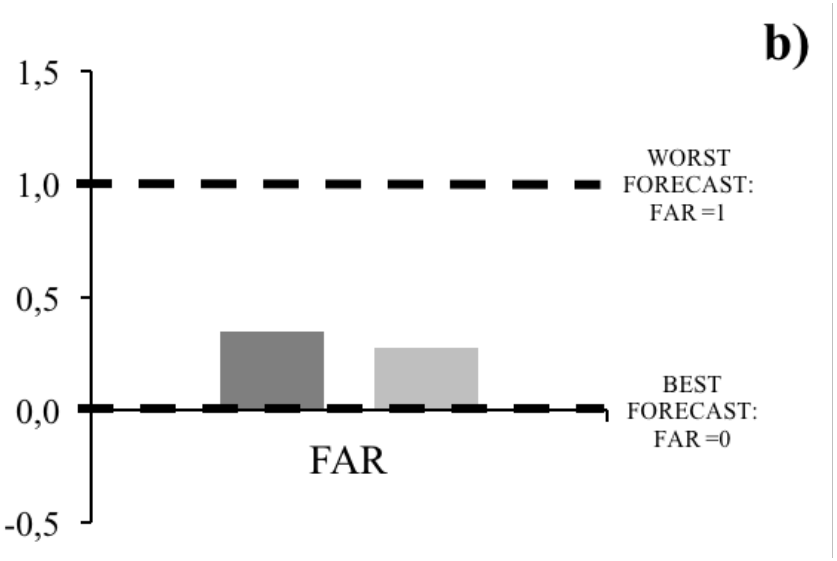
EVALUATION

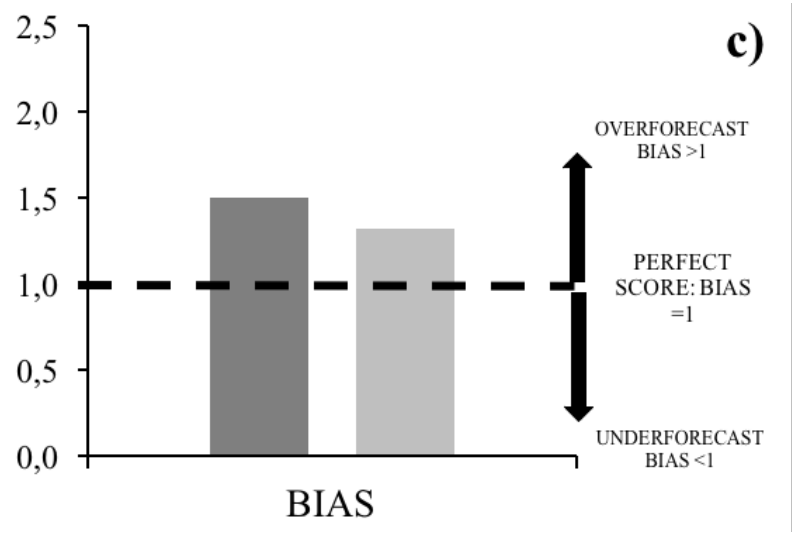
		OBSERVATION	
		YES	**NO**
FORECAST	**YES**	**HITS**=CMEs whose geomagnetic storm level was correctly forecasted CGFT – 47 CGeFT – 23	**FALSE ALARMS**=CMEs which were forecasted to produce storm stronger than observed CGFT – 25 CGeFT – 10
	NO	**MISS**=CMEs which were not forecasted and produced storm OR were forecasted to produce weaker storm than observed CGFT – 1 CGeFT – 1	**CORRECT REJECTION**=number of CMEs with w>120 which were not forecasted AND did not produce storm (Dst<100) CGFT- 26 CGeFT – 65

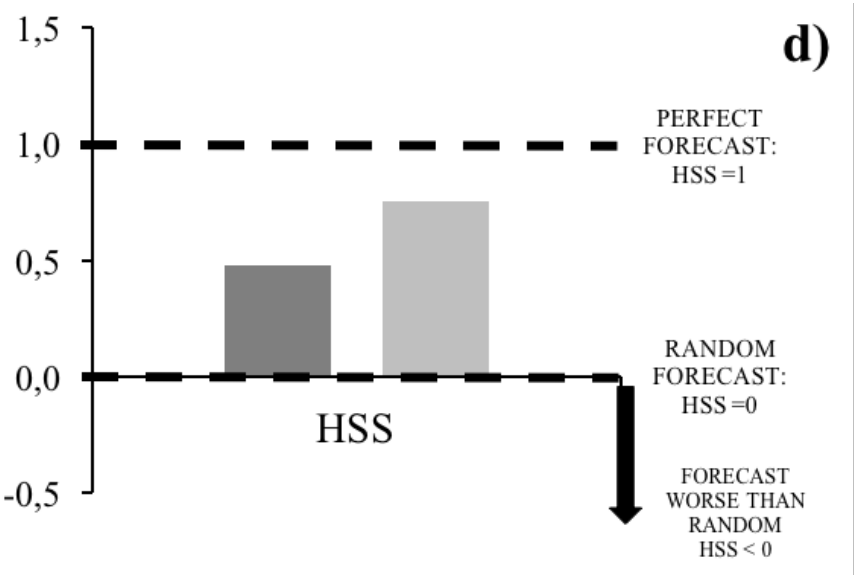
- Contingency table -

Evaluation results









Summary

ADVANTAGES:

Fully automatic, no human intervention

System is made of interrelated tools – easy to add, upgrade…

Large number of correct rejections,
System predicts well whether there will be a storm

DRAWBACKS:

Fully automatic, no human (observers) intervention

…but this is not done

… but predictability of actual storm level is questionable (only 3 storms out of which only 1 hit!)

CONCLUSIONS:

human intervention leads to better forecast

Improved automatic system is needed for future spaceweather applications

Thank you for your attention!