



Early Warning for GNSS User

Presentation by Henrike Barkmann and Jens Berdermann





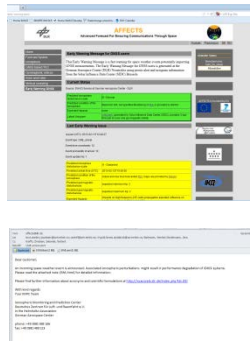
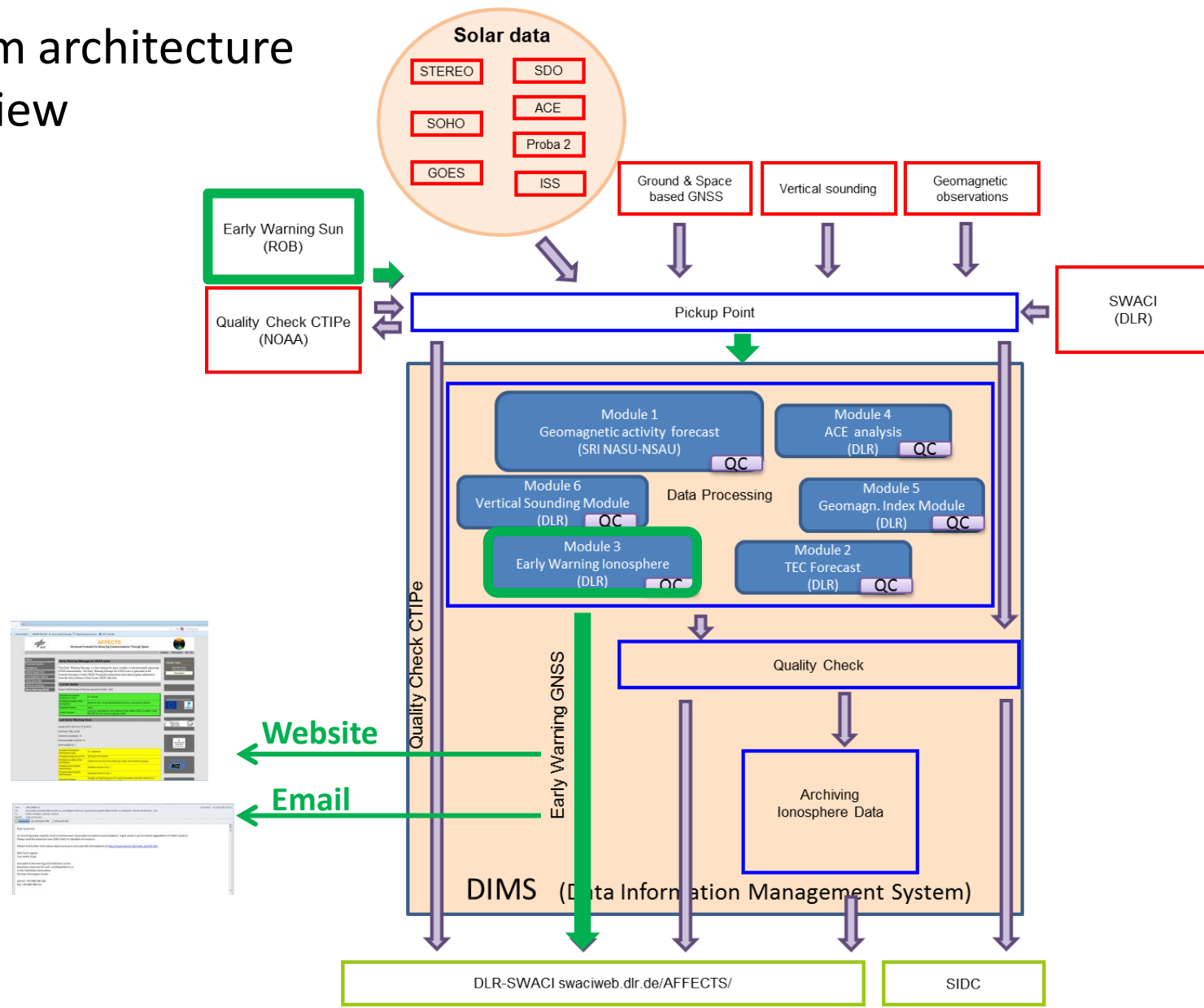
Early Warning for GNSS User – Part of the Forecast System Ionosphere

- Directed to customers of space based radio systems used in telecommunication, navigation/positioning and remote sensing
- informs customers and operators of GNSS on approaching space weather events
- GNSS customers and service providers will be aware of potential performance degradation of their systems
- Customers shall become prepared to undertake efforts to help mitigate the space weather impacts on the operated systems.
- Recently in its verification phase.
- Warning message is send automatically to external test users





System architecture overview





Early Warning by ROB


```
C:\Users\bark_he\AppData\Local\Temp\scp0622...

<?xml version="1.0" encoding="ASCII" ?>
<!-- id is for later reference -->
<!-- All dates and times in UT, in the ISO8601 standard -->
<!-- Time of the message -->
- <Message id="6" time="2013-02-07T16:20:36">
<!-- there can be 0 or 1 Alerts tags. Note that 0 tags means an empty message for the time being -->
- <Alerts>
<!-- there has to be at least 1 Alert tag -->
- <Alert>
- <Events>
<!-- there has to be at least 1 Event tag. updatenr = 0 => new event, updatenr > 0 update existing event. -->
- <Event id="5" updatenr="1" type="CME_arrival">
<!-- All dates and times in UT, in the ISO8601 standard -->
<!-- time is the expected arrival time of the CME at Earth -->
<!-- time_uncertainty is the uncertainty of the CME arrival time expressed in hours -->
<!-- min_estimated_peak_K is the minimal estimate of the peak of the local K index of Dourbes -->
<!-- max_estimated_peak_K is the maximal estimate of the peak of the local K index of Dourbes -->
<!-- probability of arrival is the probability that the CME reaches earth -->
<Arrival time="2013-02-08T12:00:00" time_uncertainty="12" min_estimated_peak_K="3" max_estimated_peak_K="4" probability_of_arrival="45" />
- <voe:VOEVENT xmlns:voe="http://www.ivoa.net/xml/VOEvent/v1.1" xmlns:lmsal="hhttp://www.lmsal.com/helio-informatics/lmsal-v1.0.xsd"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:schemaLocation="http://www.lmsal.com/helio-informatics/VOEvent-v1.1.xsd"
ivom="???" role="???" version="1.0">
- <Who>
<!-- Data pertaining to curation -->
<AuthorIVORN />
<Author>sidctech@oma.be</Author>
<!-- All dates and times in UT, in the ISO8601 standard -->
<!-- Time of the message; identical to time in message tag -->
<Author>2013-02-07T16:20:36</Author>
<!-- This ID is linked to the event, so update messages on the same event will have the same ID -->
<!-- Identical to id in the Event tag -->
<event_ID>5</event_ID>
<!-- Update number = 0 means it's the first message about this event; Update number = n means it's the nth update about this
event; identical to updatenr in the Event tag -->
<update_number>1</update_number>
<!-- identical to type in the Event tag -->
<event_type>CME_arrival</event_type>
</Who>
- <What>
<!-- Data about what was measured/observed. -->
- <Group name="CME_arrival_required">
<!-- Arrival time uncertainty is expressed in hours; identical to time_uncertainty in Arrival tag -->
<Param name="ARRIVAL_TIME_UNCERTAINTY" value="12" />
</Group>
- <Group name="CME_arrival_optional">
<!-- min_estimated_peak_K is the minimal estimate of the peak of the local K index of Dourbes; identical to
min_estimated_peak_K in Arrival tag -->
```






Website Early Warning GNSS



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Advanced Forecast For Ensuring Communications Through Space



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Early Warning Message for GNSS users

This Early Warning Message is a fast warning for space weather events potentially impacting GNSS measurements. The Early Warning Message for GNSS users is generated at the German Aerospace Center (DLR) Neustrelitz using presto alert and ursigram information from the Solar Influence Data Center (SIDC) Brussels.

Current Status

Source: SWACI Service at German Aerospace Center - DLR

issued (UTC): 2013-02-23T22:07:33

Event type: CME_arrival

Event time uncertainty: 12

Event probability of arrival: 65

Event update No: 0

| | |
|-----------------------------------------|---------------------------------------------------------------------------------------------------------------------|
| Predicted ionosphere disturbance scale: | I1 - Disturbed |
| Predicted arrival time (UTC): | 2013-02-27T20:03:00 |
| Predicted condition of the ionosphere | Actual and one hour forecasted TEC maps are provided by SWACI . |
| Predicted geomagnetic disturbances: | expected minimum Kp: 3 |
| Predicted geomagnetic disturbances: | expected maximum Kp: 5 |
| Expected Hazards | Impacts on high frequency (HF) radio propagation expected, influence on positioning and navigation is possible. |
| Influenced geographic area: | not specified |
| Associated halo CME: | http://www.sidc.oma.be/cactus/out/CME0047/CME.html |
| Associated Presto Message: | PRESTO FROM SIDC - RWC BELGIUM |

Last Early Warning Issue

issued (UTC): 2013-02-11T12:48:27

Event type: CME_arrival

Event time uncertainty: 12

Event probability of arrival: 10

Event update No: 1


| | |
|-----------------------------------------|-------------------------------------------------------------------------------------------------|
| Predicted ionosphere disturbance scale: | I1 - Disturbed |
| Predicted arrival time (UTC): | 2013-02-12T10:00:00 |
| Predicted condition of the ionosphere | Actual and one hour forecasted TEC maps are provided by SWACI . |

Aktueller Status



Benutzername:
bark_he_swaci

Abmelden


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Institut für Astrophysik Göttingen














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Current Status

Source: SWACI Service at German Aerospace Center - DLR

| | |
|-----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|
| Predicted ionosphere disturbance scale: | I0 - Normal |
| Predicted condition of the Ionosphere | Maximum DIX: not specified Monitoring of TEC is provided by SWACI. |
| Expected Hazards | none |
| Latest Ursigram | Ursigram , generated by Solar Influence Data Center (SIDC), provides 3-day-forecast of solar and geomagnetic activity. |

Last Early Warning Issue

issued (UTC): 2013-02-11T12:48:27

Event type: CME_arrival

Event time uncertainty: 12

Event probability of arrival: 10

Event update No: 1



| | |
|-----------------------------------------|----------------------------------------------------------------------------------------|
| Predicted ionosphere disturbance scale: | I1 - Disturbed |
| Predicted arrival time (UTC): | 2013-02-12T10:00:00 |
| Predicted condition of the Ionosphere | Actual and one hour forecasted TEC maps are provided by SWACI . |
| Predicted geomagnetic disturbances: | expected minimum Kp: 3 |
| Predicted geomagnetic disturbances: | expected maximum Kp: 3 |
| Expected Hazards | Impacts on high frequency (HF) radio propagation expected. Influence on |

Aktueller Status

Benutzername:
bark_he_swaci

Abmelden

AFFECTS is funded by EU





INSTITUT FÜR ASTROPHYSIK GÖTTINGEN

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★★★★★







Traffic lights color system

| Ionospheric Disturbance scale | Expected Hazards | Arrival Time | Influenced Area | Condition Ionosphere |
|-------------------------------|--------------------------------------------------------------------------------------------------------------|----------------------------------------------|-----------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|
| I0 | None | - | - | Ionosphere nominal |
| I1 | Impacts on high frequency (HF) radio propagation expected. Influence on positioning and navigation possible. | Arrival within a rough time period expected. | Rough information on influenced region (polar, mid-latitudes). | Ionosphere disturbed. |
| I2 | Strong impact on high frequency communication. Satellite navigation errors expected. | Detailed with reliable error estimation. | More detailed information on influenced regions (latitude dependent). | Ionosphere strongly disturbed with forecast information due to correlation analysis (ACE, Kp- dTEC). |





Green phase- I0:

- No early warning message (presto message) obtained
 - No space weather related hazards ahead
 - None or negligible disturbances of the ionosphere expected.
 - TEC rate stays nominal.
 - No interference or performance degradation for GNSS applications.
 - Low noise in communication related services.
- No GNSS warning mail is sent to registered users.

Yellow phase – I1:

- Earth related early warning message obtained from ROB (presto Mail and XML file)
- Space weather event with impact on GNSS users is ahead
- Infrequent single-event upsets and impacts on high frequency (HF) radio propagation are possible
- Influence on positioning and navigation at polar regions expected with decreasing impacts towards mid-latitudes.

Red phase – I2 (when more input is available):

- Earth related early warning message obtained from ROB (presto Mail and XML file)
- additional information (prediction for ACE, Kp-dTec correlation,...) .
- Information about expected strength and arrival time should have reliable error estimation.





Alert via Email

Von: affects@dlr.de
An: knut.stanley.jacobsen@kartverket.no; sa...@kartverket.no; Yngvild.linnea.andalsvik@kartverket.no
Cc: Kraftt, Christian; Jakowski, Norbert
Betreff: CME arrival alert

Nachrichte: EWI.html (2 KB), EWI.xml (1 KB)

Dear customer,

An incoming space weather event is announced. Associated ionospheric perturbations are expected. Please read the attached note (EWI.html) for detailed information.

Please find further information about acronyms and scientific formulations at <http://www.swaciweb.dlr.de/daten-und-produkte/public/tec/tec-eu/>.

With kind regards
Your IMPC Team

Ionospheric Monitoring and Prediction Center
Deutsches Zentrum für Luft- und Raumfahrt e.V.
in the Helmholtz-Association
German Aerospace Center

phone: +49 3981 480 106
fax: +49 3981 480 123

C:\Users\bark_he\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.Outlook\LGH7H - Microsoft Internet Explorer b

C:\Users\bark_he\AppData\Local\Microsoft\Windows\Temporary Internet Files\Content.Outlook\LGH7HNKE\EWI.html

issued (UTC): 2013-02-10T00:36:49

Event type: CME_arrival

Event time uncertainty: 12

Event probability of arrival: 10

Event update No: 0

Predicted ionosphere disturbance scale: I1 - Disturbed

Predicted arrival time (UTC): 2013-02-12T10:00:00

Predicted condition of the Ionosphere: Actual and one hour forecasted TEC maps are provided by [SWACI](http://www.swaciweb.dlr.de/daten-und-produkte/public/tec/tec-eu/).

Predicted geomagnetic disturbances: expected minimum Kp: 3

Predicted geomagnetic disturbances: expected maximum Kp: 4

Expected Hazards: Impacts on high frequency (HF) radio propagation expected. Influence on positioning and navigation is possible.

Influenced geographic area: not specified

Associated halo CME: <http://www.sidc.oma.be/cactus/out/CME0047/CME.html>

Associated Presto Message: [PRESTO FROM SIDC - RWC BELGIUM](http://sidc.be/html/SWAPP/presto_test/presto/2012/presto195_realpresto.txt)

C:\Users\bark_he\Desktop\EWI.xml - Microsoft Internet Explorer bereitgestellt von T-Systems SFR

C:\Users\bark_he\Desktop\EWI.xml

```
<?xml version="1.0" encoding="UTF-8" ?>
<cme_alert>
  <issued>2013-02-10T00:36:49</issued>
  <eventType>CME_arrival</eventType>
  <eventUncertainty>12</eventUncertainty>
  <eventProbabilityOfArrival>10</eventProbabilityOfArrival>
  <eventUpdateNo>0</eventUpdateNo>
  <predictedIonosphereDisturbanceScale>I1 - Disturbed</predictedIonosphereDisturbanceScale>
  <predictedArrivalTime>2013-02-12T10:00:00</predictedArrivalTime>
  <predictedConditionOfTheIonosphere>Maximum DIX: not specified - Monitoring of TEC is provided by SWACI: http://swaciweb.dlr.de/daten-und-produkte/public/tec/tec-eu/ .</predictedConditionOfTheIonosphere>
  <predictedGeomagneticDisturbancesMin>expected maximum Kp: 4</predictedGeomagneticDisturbancesMin>
  <predictedGeomagneticDisturbancesMax>expected minimum Kp: 3</predictedGeomagneticDisturbancesMax>
  <expectedHazards>Impacts on high frequency (HF) radio propagation expected. Influence on positioning and navigation is possible.</expectedHazards>
  <influencedGeographicArea>not specified</influencedGeographicArea>
  <associatedHaloCME>http://www.sidc.oma.be/cactus/out/CME0047/CME.html</associatedHaloCME>
  <associatedPrestoMessage>http://sidc.be/html/SWAPP/presto_test/presto/2012/presto195_realpresto.txt</associatedPrestoMessage>
</cme_alert>
```





Email: Early Warning GNSS Message

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Early Warning GNSS Message

Please enter your e-mail address for subscription.

Your E-mail Address:

Aktueller Status

Benutzername:
bark_he_swad

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Early Warning GNSS Message

Please enter your e-mail address for unsubscrition.

Your E-mail Address:

Aktueller Status

Benutzername:
bark_he_swad

AFFECTS is funded by EU



Testuser:

- Kartverket - Norwegian Mapping Authority
- AXIO-NET
- DLR Neustrelitz





Future work

- Red phase settings
- Subscription user interface
- Ionosphere Information Enhancement





Thanks for your attention!

Contact:

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