Forecast System Ionosphere

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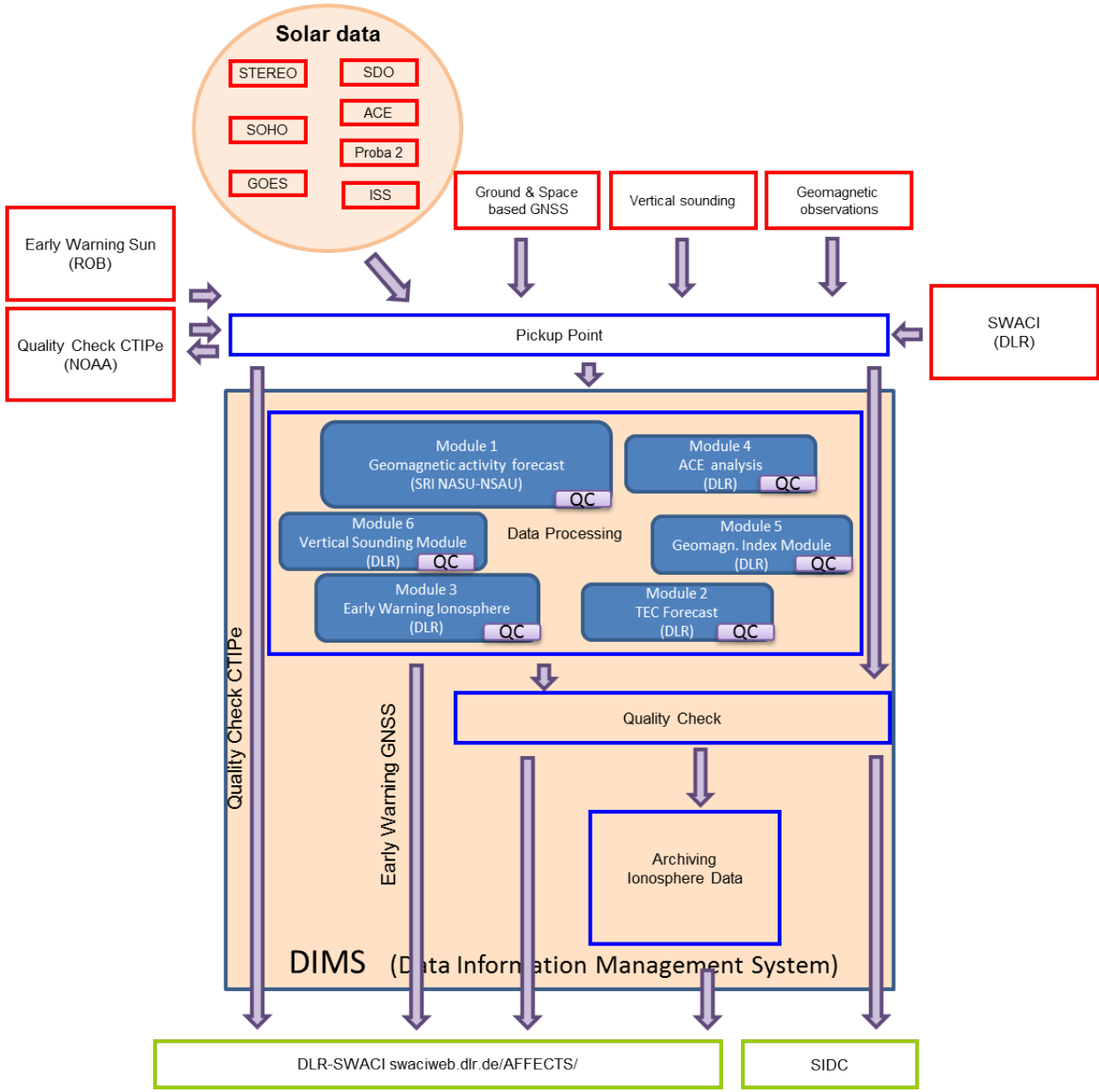
Forecast System Ionosphere

- processing system where forecast tools are networked in a proper way to generate the ionospheric forecast products
- the measurements are from the sun, geomagnetic field and ionosphere
- it uses the same principles as the SWACI system
- processing system is characterized by modular structure
- modules network within the processor frame
- modules run fully automated

System architecture overview



Input data

Solar Wind Data	• ACE data
Ground & Spaced based GNSS	• TEC maps
Vertical Sounding	• SAO Files
Geomagnetic Observation	• indices
Early Warning	• Early Warning Message Sun
CTIPe	• TEC maps

Processing modules

Module 1: geomagnetic activity forecast (SRI NASU-NSAU)

- predicts the geomagnetic index Dst

Module 2: TEC forecast (DLR)

- predict TEC over Europe

Module 3: Early Warning Message (DLR)

- generates an early warning message which is primarily directed to users of GNSS systems

Module 4: ACE Analysis (DLR)

- applies preanalysis and correlations studies on ACE measurements in preparation for the TEC forecast module

Module 5: Geomagn. Index Module (DLR)

- Magnetometer measurements which are analyzed and prepared to be used for TEC forecast

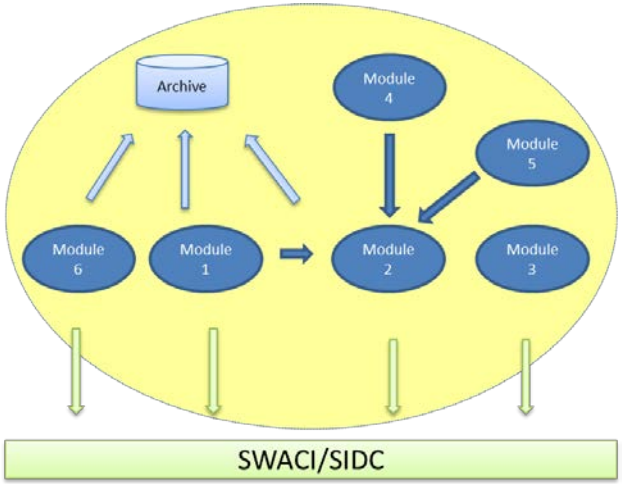
Module 6: Vertical Sounding Module (DLR)

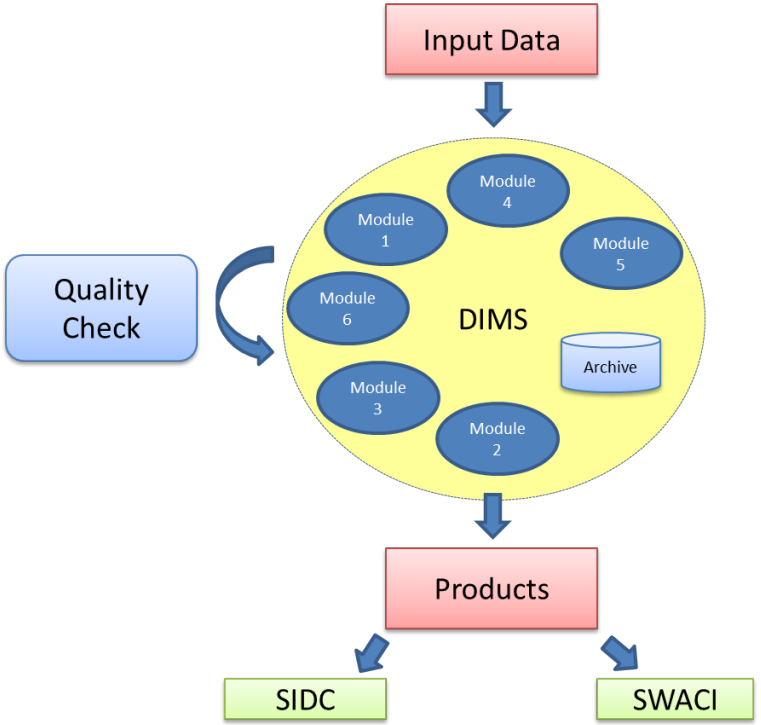
- slab thickness - calculated on the basis of vertical sounding data and TEC measurements

Product Generation Flow

DIMS – Data Information Management System

- offers comprehensive functionality for the management of large heterogeneous digital volume of data with spatial and temporal dimension.
- is designed for supporting the tasks required to handle Earth observation data provided via several satellite missions
- includes cataloging and long-term preservation





PSM – Processing System Management

- Used inter alia for processor integration and systematic processing on demand
- responsible for computation and visualization of the data

Using Job Order File

- .xml file that a module has to read
- contains:
  - path information for input and output path
  - other needed processing parameter like date or processor name

```
<?xml version="1.0" encoding="UTF-8"?><Ipf_Job_Order>
 <Ipf_Conf>
  <Processor_Name>Scintillation</Processor_Name>
  <Version>prototype</Version>
                    …
  <Config_Files/>
  <Sensing_Time>
   <Start/>
   <Stop/>
  </Sensing_Time>
 </Ipf_Conf>
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  <Processing_Parameter>
   <Name>filename</Name>
   <Value>lcte100701.sct</Value>
  </Processing_Parameter>
                    …
 </Processing_Parameters>
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  <Ipf_Proc>
                    …
 <List_of_Inputs count="1">
     <Input>
      <File_Type>ScintillationSct</File_Type>
      <File_Name_Type>Directory</File_Name_Type>
      <File_Name>/home/swaci/inst/psm-scintillation-2/</File_Name>
     </Input>
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   <List_of_Outputs count="1">
    <Output>
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     <File_Name_Type>Directory</File_Name_Type>
     <File_Name>/home/swaci/inst/psm-scintillation-2/</File_Name>
    </Output>
   </List_of_Outputs>
  </Ipf_Proc>
 </List_of_Ipf_Procs>
</Ipf_Job_Order>
```

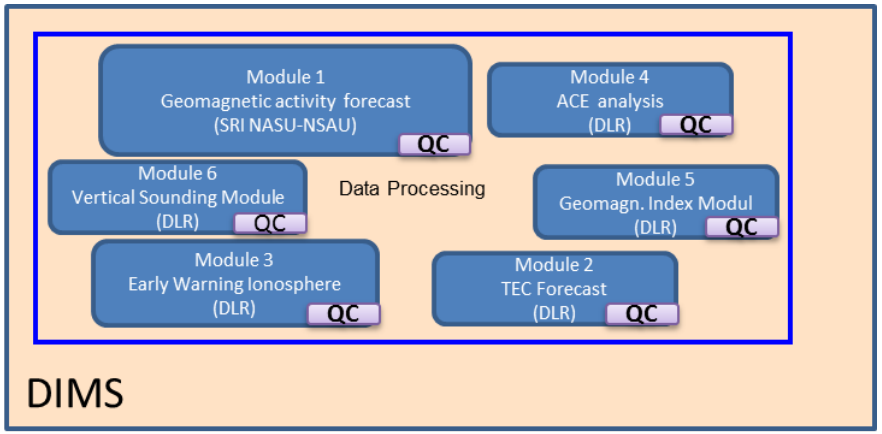
Meta data

Required:

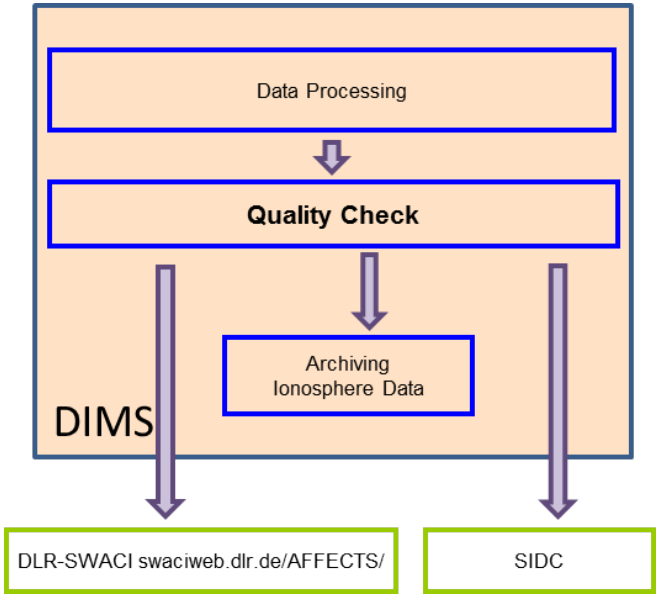
- **mission**
- **productname**
- **sensor**
- **stationName**
- **code**
- **project**
- **product_creation_time**
- **revision**
- **description**
- **contact_person**
- **startTime**
- **stopTime**
- **location**
- **Latitude_Start**
- **Latitude_End**
- **Longitude_Start**
- **Longitude_End**
- **format**
- **data_type**
- **Preprocessing_software_version**

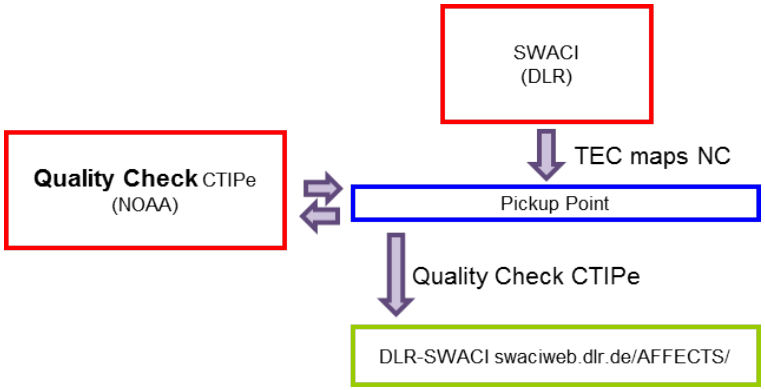
it is possible to expand the list for every module individual with other information

Quality Check

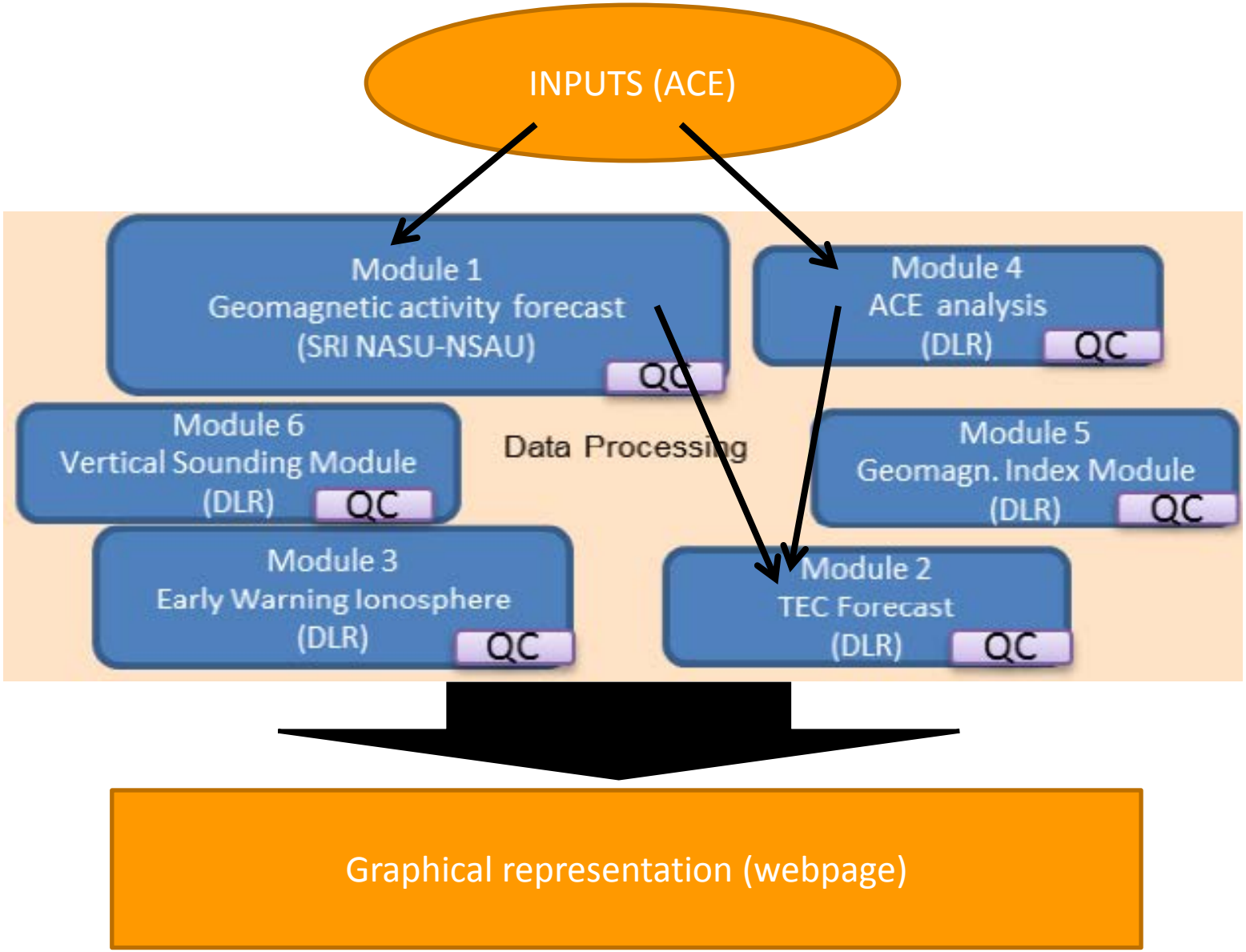


1. QC Modules
2. QC Data Management System
3. QC CTIPe





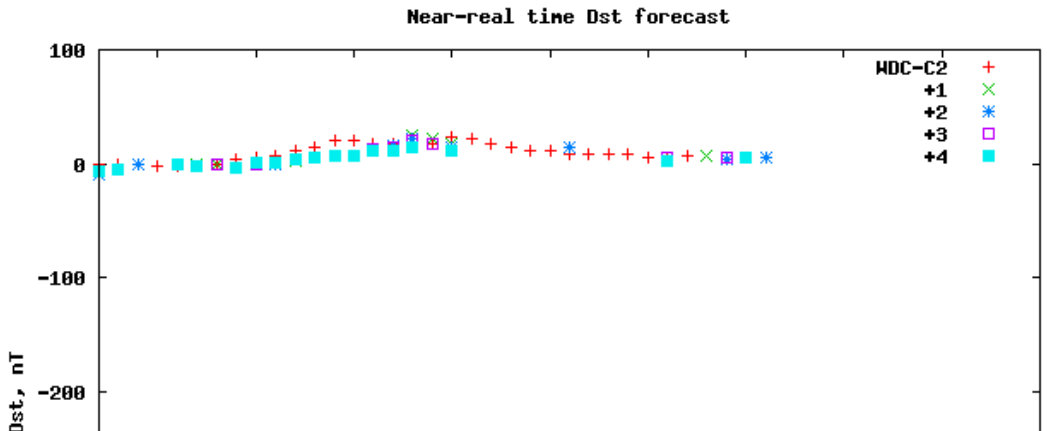
Dependencies within the FSI



Geomagnetic activity forecast

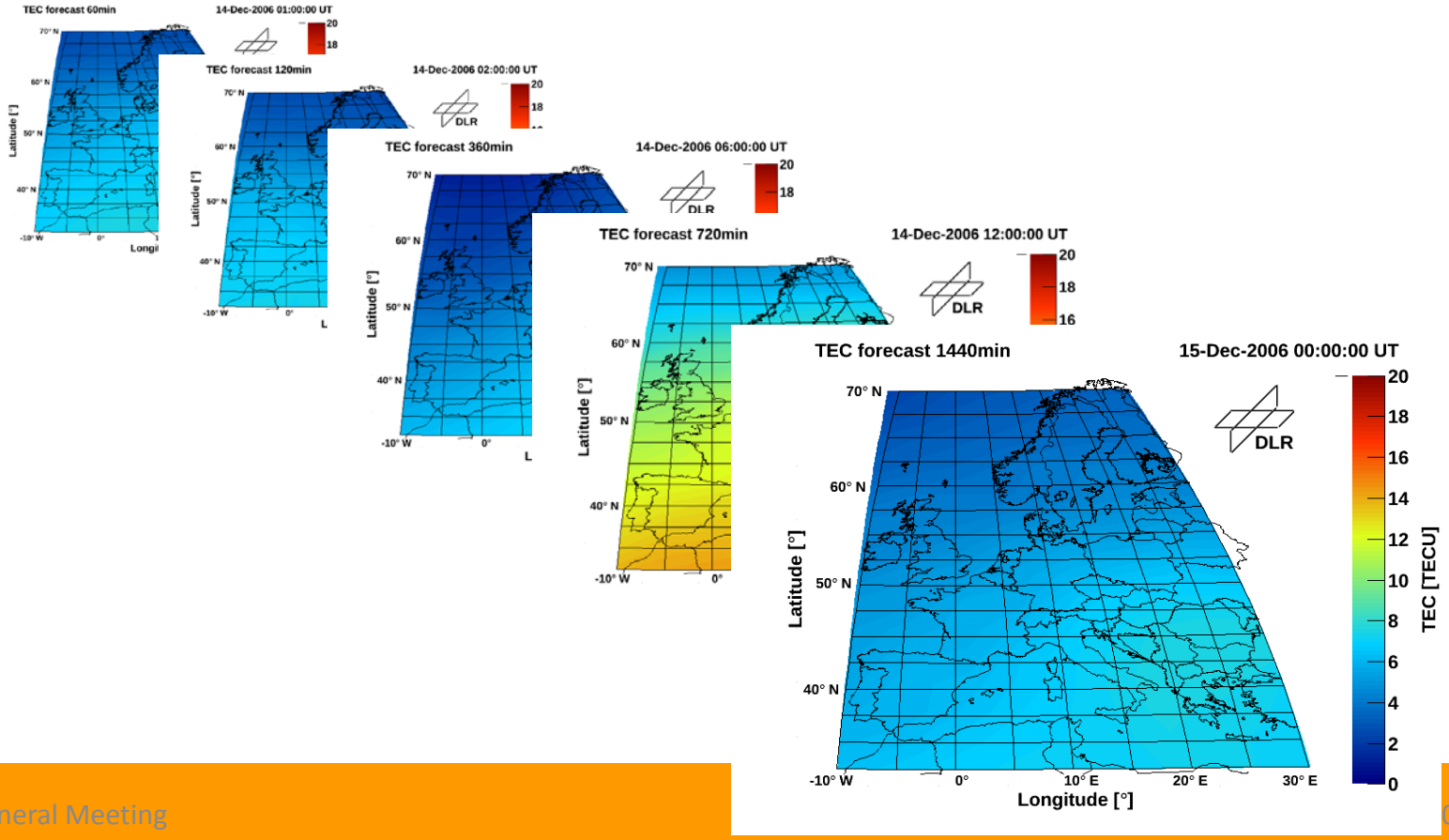
- Predicts the geomagnetic index Dst up tp 4 hours in advance
- Input: ACE data and previous Dst values
- Output: Dst forecast data file

HOY	HTND	YYYY	MM	DD	DOY	HH	Dst [nT]	FC+01H [nT]	FC+02H [nT]	FC+03H [nT]	FC+04H [nT]
653	476	2013	1	28	28	4	-15.	-13.	-15.	-12.	-13.
654	475	2013	1	28	28	5	-17.	-16.	-14.	9999.	-12.
655	474	2013	1	28	28	6	-17.	-17.	-16.	-15.	-15.
656	473	2013	1	28	28	7	-19.	-15.	-17.	-15.	-14.



TEC forecast

- Predicts TEC over Europe under perturbed conditions (24 hours in advance)
- Input: ACE data, geomagnetic forecast, …
- Output: TEC maps



Early Warning Message

- Generates an early warning message primarily directed to users of GNSS systems
- Input: Solar alerts disseminated by ROB (UGOE)
- Output: Warning mail, Webpage update

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

Event type: CME_arrival

Event time uncertainty: 12

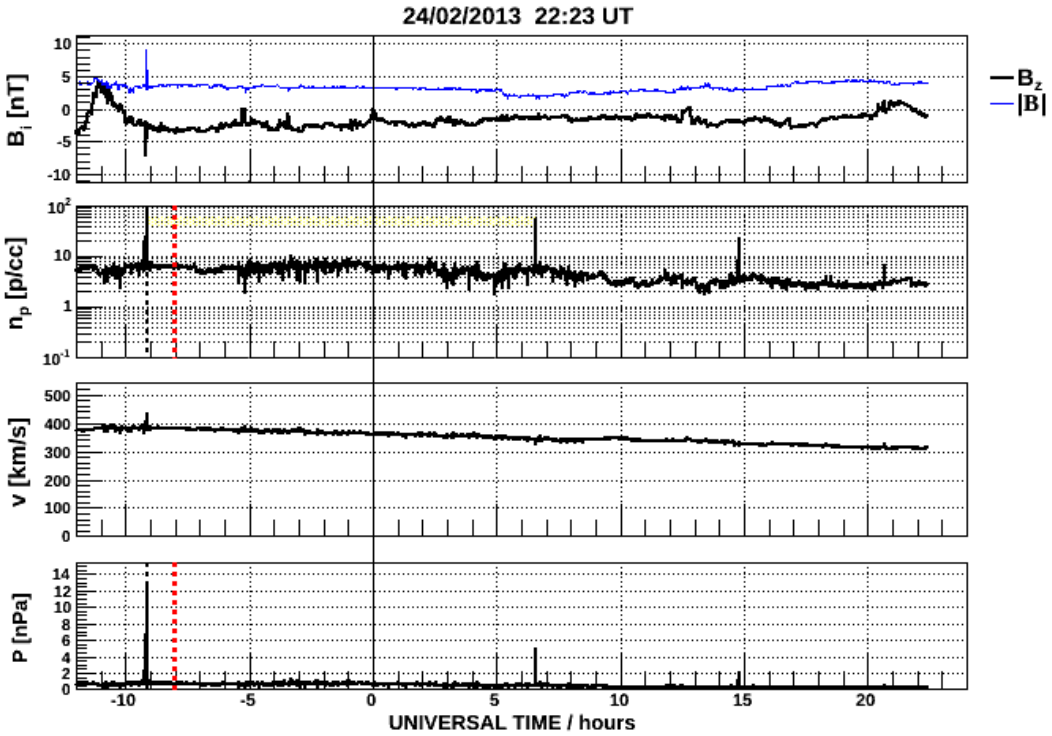
Event probability of arrival: 65

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

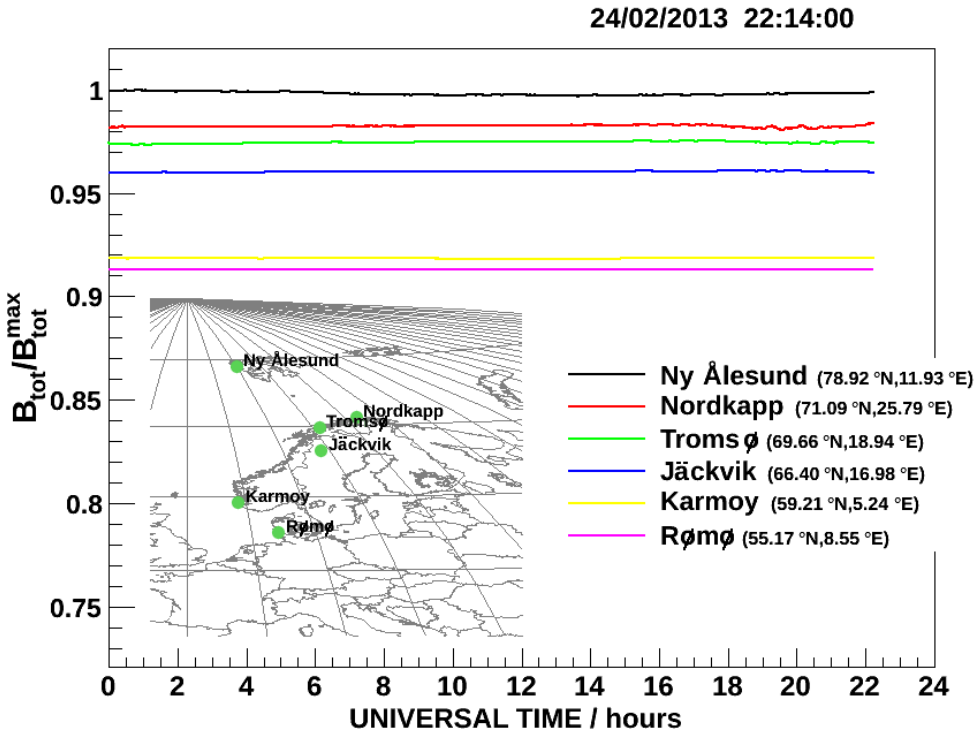
ACE Analysis

- Pre-analysis and correlation studies on ACE measurements
- Input: ACE data
- Output: data file, plot



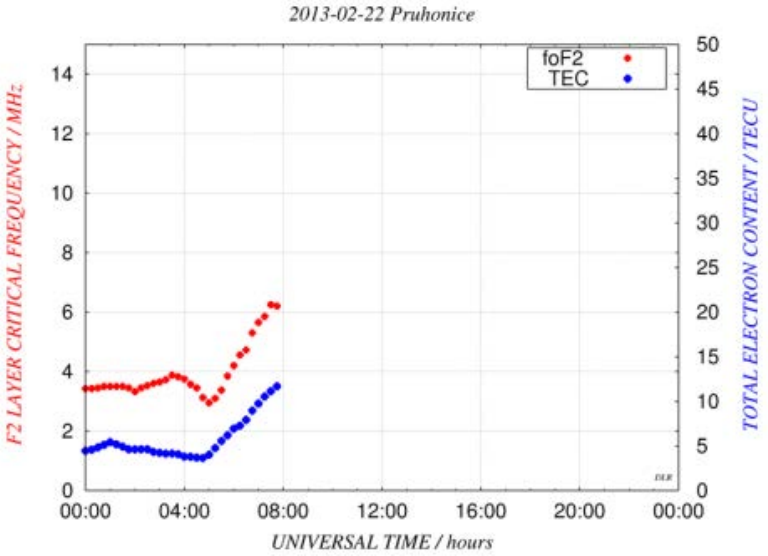
Geomagnetic Index Module

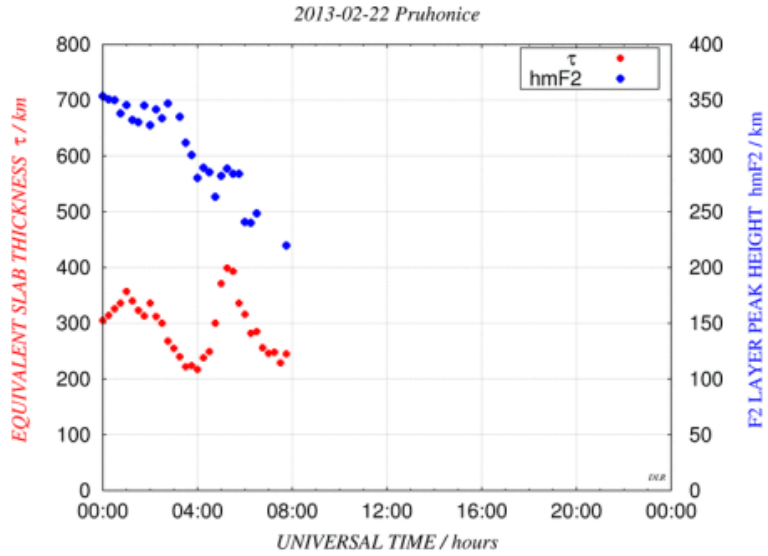
- Magnetometer measurements which are provided by UoT are analysed and processed
- Input: Measurements at different latitudes
- Output: plot



Vertical sounding

- Generates equivalent slab thickness profiles
- Input: TEC and Ionosonde data
- Output: plot





Pruhonice (49.1°N, 14.1°E)
Vertical Sounding Data supplied by Ionospheric observatory Pruhonice of the Institute of Atmospheric Physics ASCR

- Is a measure of the width of the shape of the vertical electron density profile of the ionosphere
- Defined by the ratio of the total electron content (TEC) and the peak electron density of the local ionosphere

Thanks for your attention!

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The research leading to these results has received funding from the European Commission's Seventh Framework Programme (FP7/2007-2013) under the grant agreement n° 263506 (AFFECTS project, www.affects-fp7.eu).