



First Experience in Operationally Monitoring and Assessing the Space Weather Impact on GNSS based Positioning

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SWIPPA

Space Weather Impact on Precise Positioning Applications



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- **AllSat GmbH Network + Services**, Hannover, Germany
- **IEEA** (Informatique, Electromagnetisme, Electronique, Analyse numerique), France
- **LVMV** (Land Surveying Office of Mecklenburg-Vorpommern), Schwerin, Germany
- **SENSYS** Sensorik & Systemtechnologie GmbH, Furstenwalde, Germany
- **FHNB** (University of Applied Sciences), Neubrandenburg, Germany
- **GFZ** (GeoForschungZentrum), Potsdam, Germany
- **SwissRe** (Swiss Reinsurance), Zurich, Switzerland

SWIPPA is a pilot project, jointly supported by the German Aerospace Centre (DLR) and the European Space Agency (ESA) via contract ESTEC-16952/02/NL/LvH.



The space weather can induce adverse effects on GNSS-based communication, navigation, and positioning applications. Permanent **ionosphere/space weather monitoring service should be established** and specific products, based on GNSS and space weather observations, should be generated and distributed to GNSS reference network operators in order to help them **deliver a more reliable, precise and secure positioning service** and to eventually reduce the operation, production, and other business costs. **Relevant information and support** to be regularly **exchanged** with SWENET (Space Weather European Network).

Objectives achieved by:

- Operational provision of GPS data
- Operational provision of ionospheric and space weather observations
- Pre-processing and calibration of GPS data
- Generation of TEC maps (and derivative products) over Europe
- Post-processing and analysis of ionospheric / space weather information
- Analysis of ionospheric / space weather effects
- Analysis of benefits for the service users

- Nowcast TEC maps
- Nowcast TEC spatial and temporal gradients
- Warning geophysical messages
- Forecast TEC maps
- Spatial mapping coverage – regional:

Mapping area:

Longitude: - 5° to + 25°E

Latitude: + 35° to + 60°N

Grid resolution (depending on the 'visibility' of GNSS satellites):

Longitude: 1° (best option)

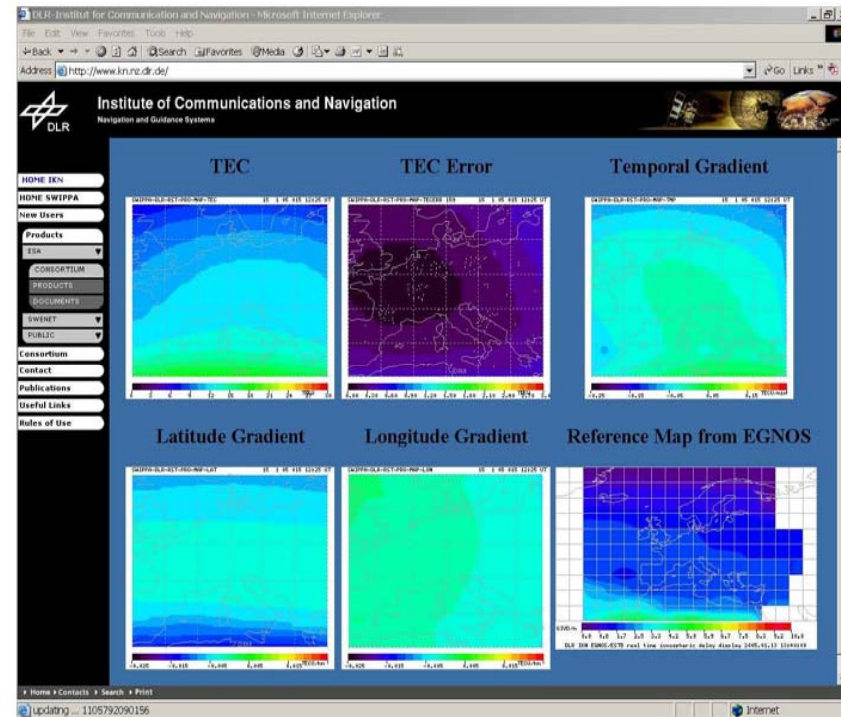
Latitude: 1° (best option)

- Temporal coverage**

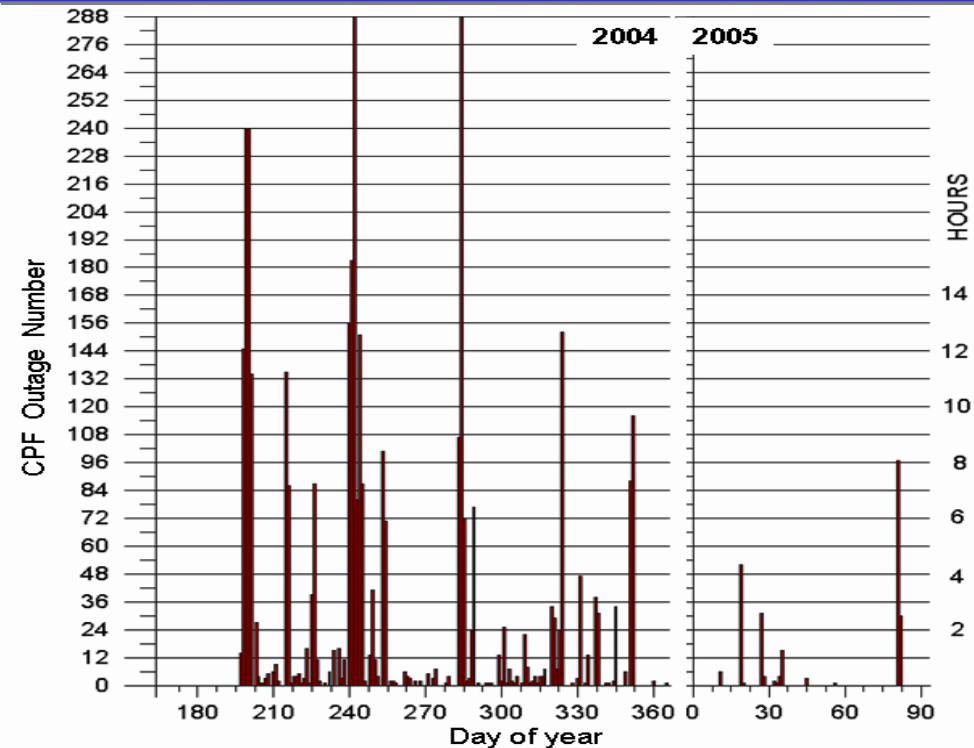
Availability: 24-hour service

Update rate: 15 min

Latency: 1 min



- **Service reliability.** The periods of service unavailability (planned or otherwise) decreased steadily during the project (see the figure).
- **Spatial and temporal resolution** particularly good, higher and better than originally requested by users.
- **Quality of forecast products** good, but can be further improved.
- The **service evaluation** was performed by consortium members and external users.
- Increased awareness of space weather - related problems.
- Improved likelihood of successful measurements and consequent processing. improved SAPOS-based imaging.
- About €1500 per day saved during each space weather event by avoiding repeated measurements/processing.
- About €250 per day per surveying team saved during each SpWe event by avoiding re-initialisation procedure(s) on the field.



- Further improve the spatial and temporal resolution of the nowcast service.
- Improve the quality of the short-term ionospheric forecast, diversify the forecast products.
- Utilise additional space-based measurements for plasmasphere reconstruction.
- Extend the current regional mapping towards local and global coverage.
- Develop novel techniques/products to be directly used in GNSS algorithms.
- Develop new improved service to address a larger set of professional GNSS users.

- **Experience gained** by the SWIPPA developers and users would help improving the services
- **New services** should address the needs/requirements of a wider GNSS user community
- **Forecast products needed by GNSS users:**
 - TEC disturbance, forecast needed from 3h to 24h in advance
(requires comprehensive fundamental research)
 - Scintillations local, forecast
(requires data processing on site)
- **Service operational costs (*estimated*):**

Service operation/upgrade:	1 person/year
Equipment maintenance (GNSS/IT equipment maintenance, data archiving, etc.):	1 person/year
- **Funding available** by the German State Government of Mecklenburg until the end of 2006 for the SWIPPA follow-on project SWACI