



Space Weather Application Center Ionosphere (SWACI) - requirements for improving products, services and modelling

Norbert Jakowski¹, Holger Maass¹ and Juergen Drescher²

German Aerospace Center

¹ Neustrelitz, Kalkhorstweg 53, Germany

² DLR Washington DC, 1776 I Street, NW, Suite 1000 Republic Place



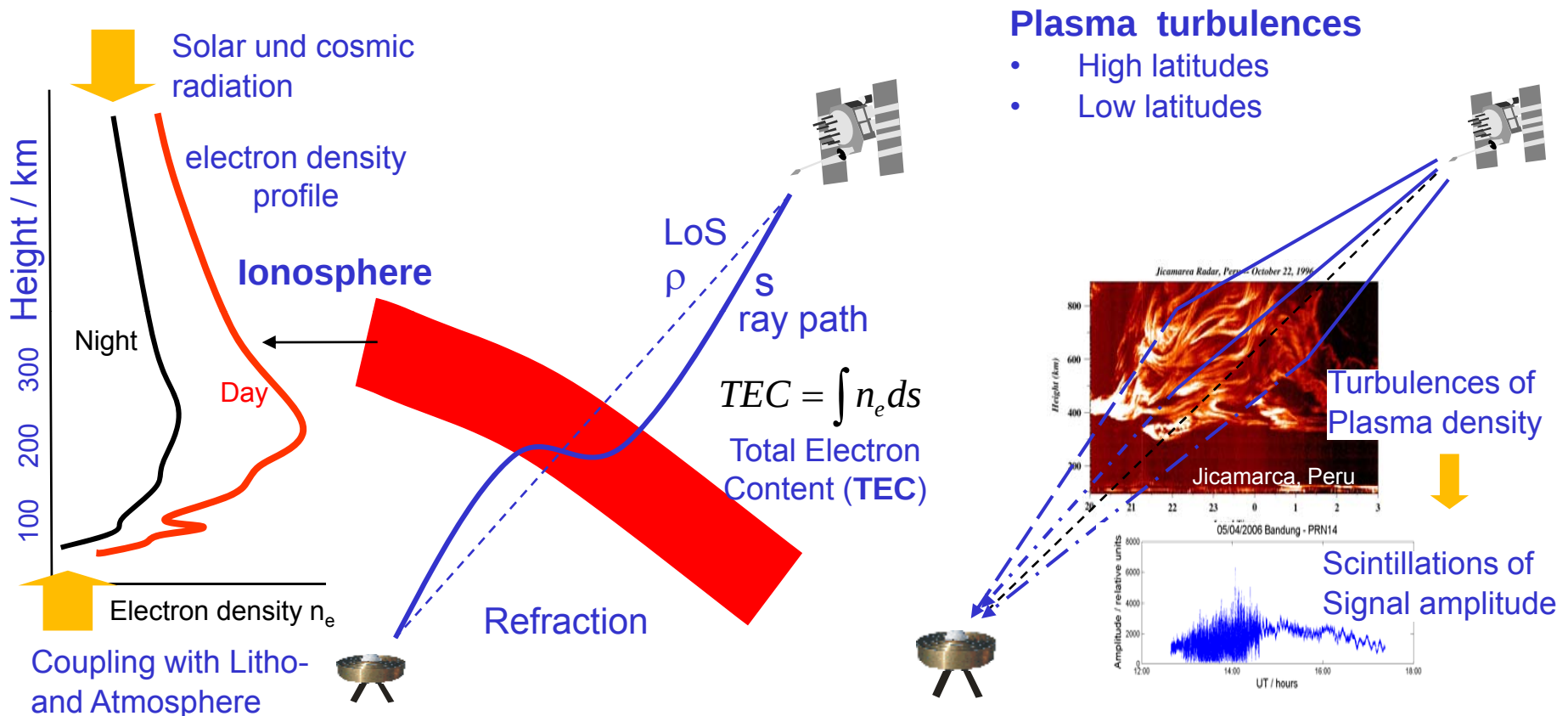
OUTLINE

- Introduction
- GNSS Monitoring of the ionosphere via SWACI
- Applications and their requirements
 - Precise positioning
 - Safety of Life
- Summary / conclusions

- Space weather refers to the conditions on the sun and in the solar wind, magnetosphere, **ionosphere**, and thermosphere that can influence the performance and reliability of space-borne and ground-based technological systems and can endanger human life or health. (Definition NSWP, USA, 1996)



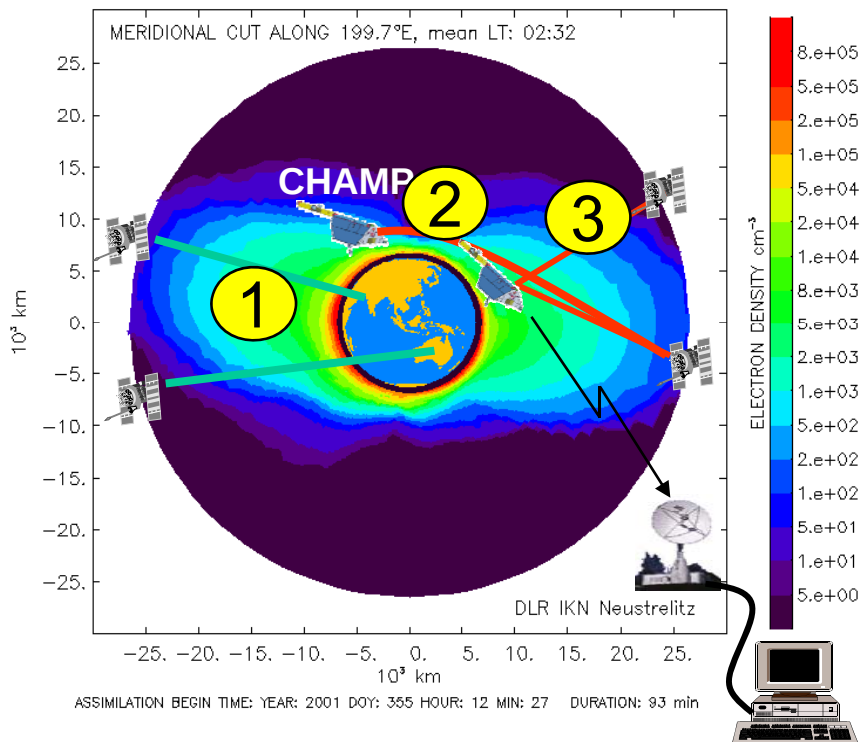
Radio wave propagation effects in the ionosphere



Ionosphere causes:

- Signal delay (range error in navigation is $\sim$ TEC)
- Fluctuations of signal strength (all radio systems)
- Faraday rotation (remote sensing, e.g. P- and L-Band radar)

GNSS based monitoring of the ionosphere via SWACI



Objective:

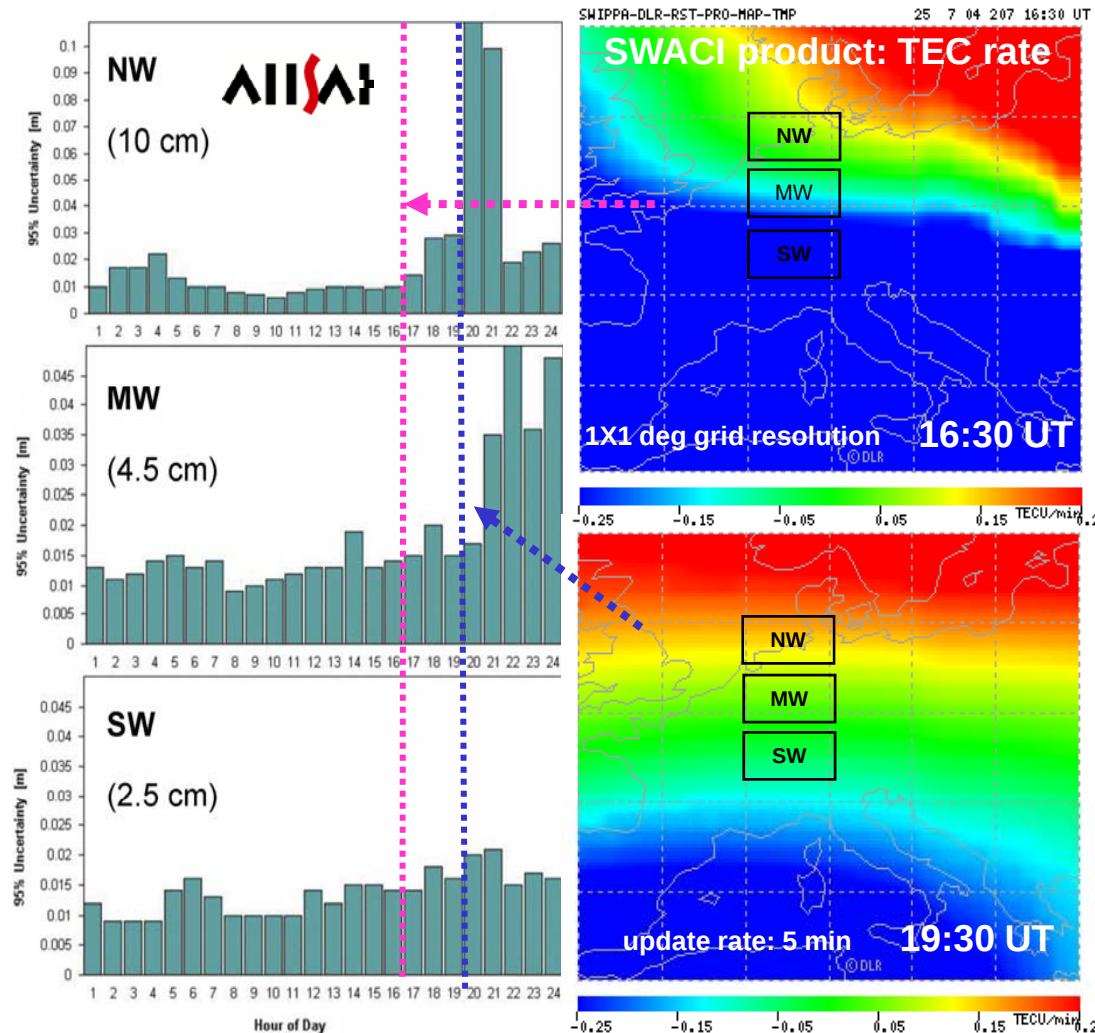
Establishment of an ionospheric weather service via the project **Space Weather Application Center Ionosphere (SWACI)** which is essentially supported by the state government of Mecklenburg-Vorpommern until end of 2010.

Permanent provision of ionospheric information and data by ground and spaced based monitoring of the temporal and spatial variability of the ionospheric plasma

SWACI (<http://swaciwed.dlr.de>)

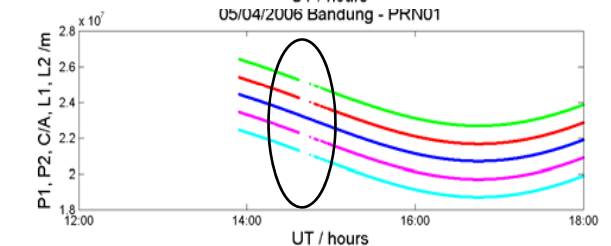
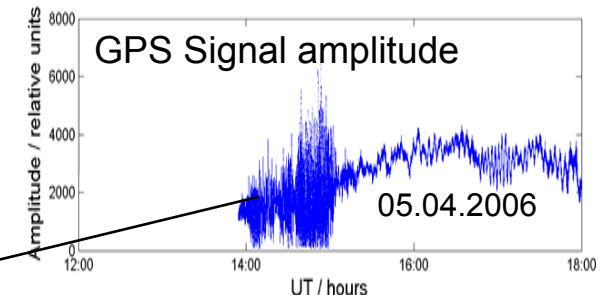
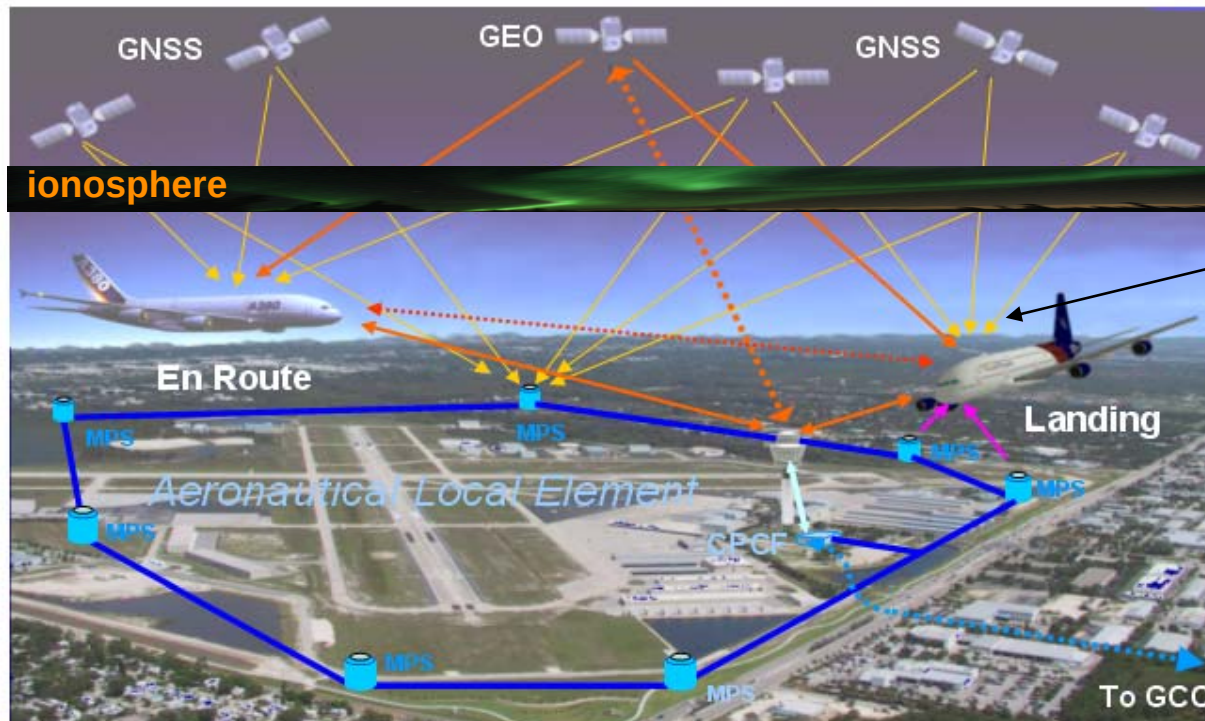
- ① Ground based GPS- and GLONASS- measurements (EUREF, IGS, SAPOS)
- ② GPS- Radio occultation measurements onboard CHAMP and GRACE
- ③ GPS- Navigation measurements onboard CHAMP (+GRACE)

Precise Positioning

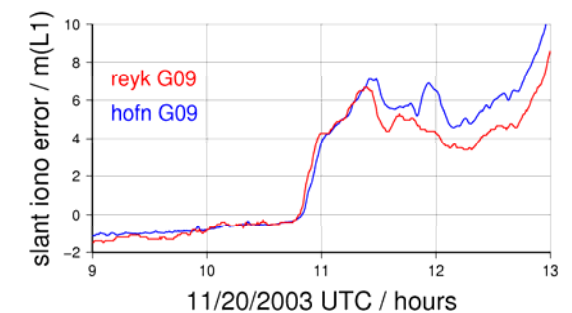


- Performance of GPS reference network degrades when ionospheric weather front approaches
- Main parameter to be monitored is the Total Electron Content (TEC)
- Requirements to improve precise positioning by a space weather service:
 - Temporal resolution of TEC monitoring: ≤ 5 min
 - Spatial resolution of TEC monitoring: ≤ 50 km
- Forecast up to 1-2 days ahead desired
- Continuity and integrity of signals are of less importance

Safety of Life (SoL)



GPS- loss of lock



Ionosphere- 'Threat model' required

GNSS-applications in the SoL sector require high
Integrity, Continuity and Availability of the GNSS signals

Operational detection and evaluation of ionospheric perturbations by ionospheric weather service that provides information and data on

- Ionospheric perturbation degree
- Direction, strength and speed of perturbation fronts
- Short term forecast of these quantities (10- 30 minutes ahead)



Summary and conclusions

- A Space weather - ionospheric data and information service (SWACI) is currently established at DLR Neustrelitz.
- The service will provide ground and space based ionospheric information derived from GNSS measurements (<http://swaciweb.dlr.de>).
- The envisaged data products are nowcast, forecast, alerts and also historical data on the ionospheric state and related space weather issues.
- To fulfil customers requirements, close contacts to users are needed.
- In case of GNSS users the requirements are quite different for GNSS applications in precise positioning and safety of life.
- Products and services which have been developed so far are helpful but don't fulfil all user needs.
- Improving the temporal and spatial resolution of data products as well as the reliability of forecasts and the technical service are permanent tasks.