

Space Weather as a Global Challenge

**IMPC DLR Neustrelitz and
Expert Service Centre Ionospheric Weather (I-ESC)**

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Wissen für Morgen

German Aerospace Center - DLR Site Neustrelitz



Range measurements of radio waves at the “Versuchsfunkstelle Strelitz – VFSS” of the Telegraphen-Versuchsamt (TVA) Berlin (1913)

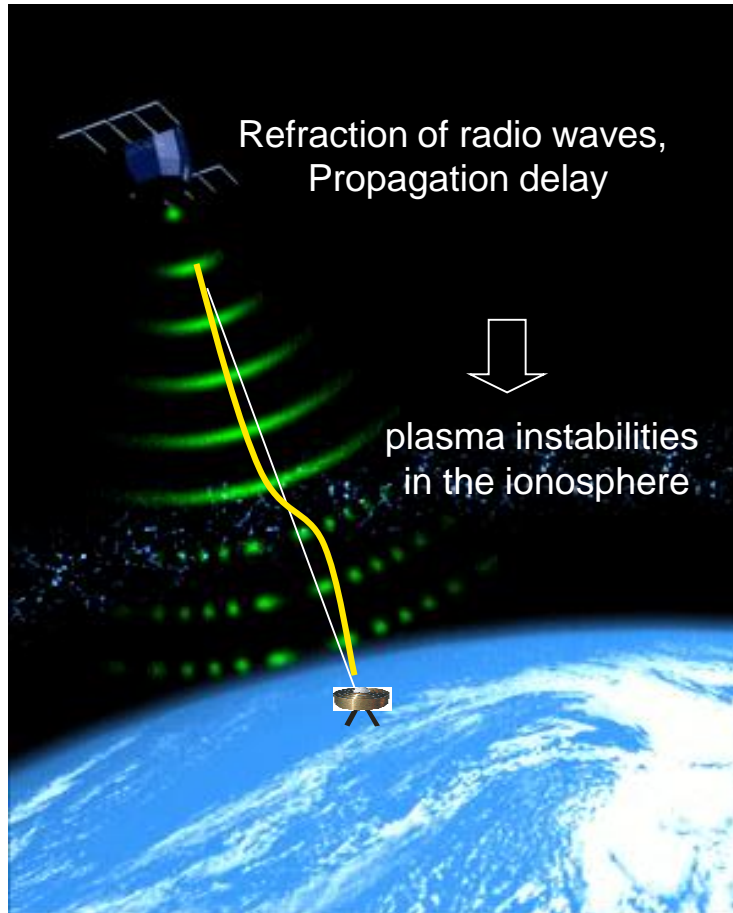


DLR Neustrelitz (Today)



Since 100 years research on the interaction of electromagnetic waves with the atmosphere/ionosphere at the site Neustrelitz.

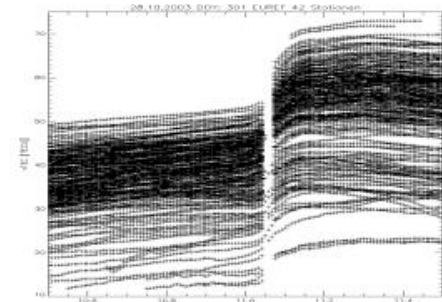
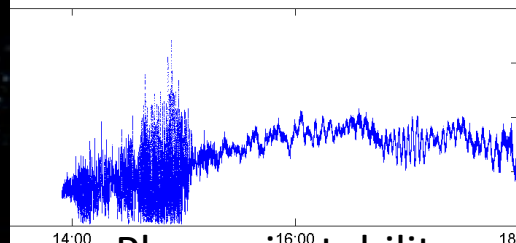
Background: Impact of ionospheric effects are a challenge for navigation, communication and earth observation services



The plasma of the ionosphere (TEC) causes a delay of the radio signals

→ *Pretending an excess in distance between the satellite and the measurement site*

05/04/2006 Bandung - PRN01



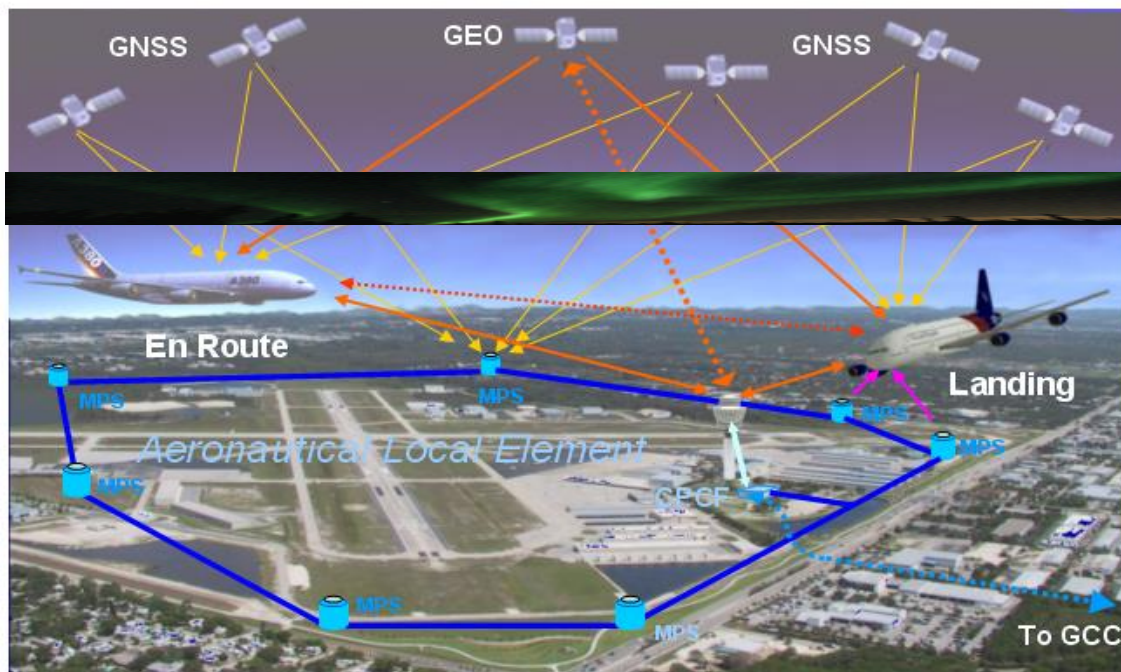
Plasma instability causes

- Signal strength fluctuations
- Defocussing of the signal

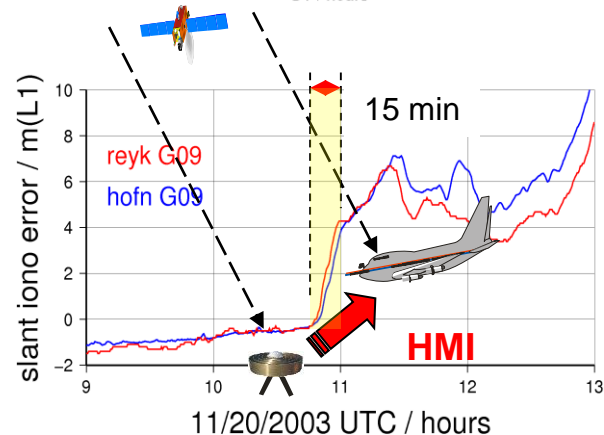
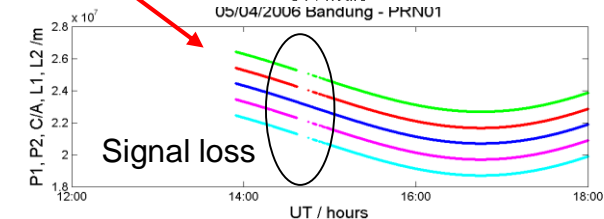
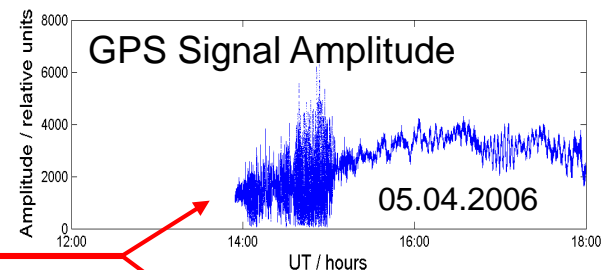
→ *Possible loss of the signal*



Ionospheric impact on Ground Based Augmentation Systems (GBAS) for GNSS guided aircraft landing



- Degradation of accuracy, integrity, availability and continuity of GNSS-signals possible.
- Ionospheric threat model needed.



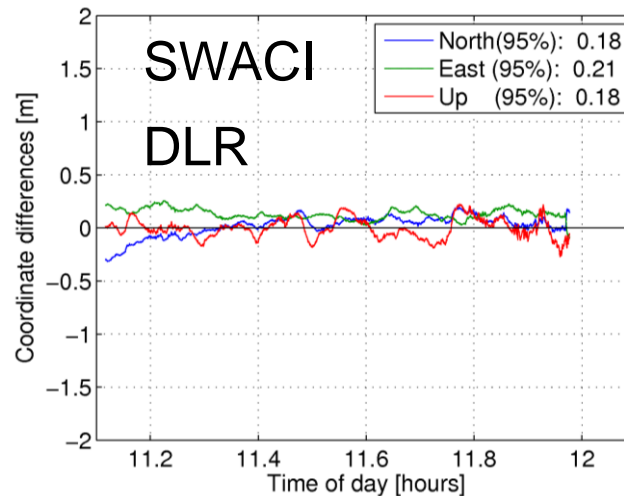
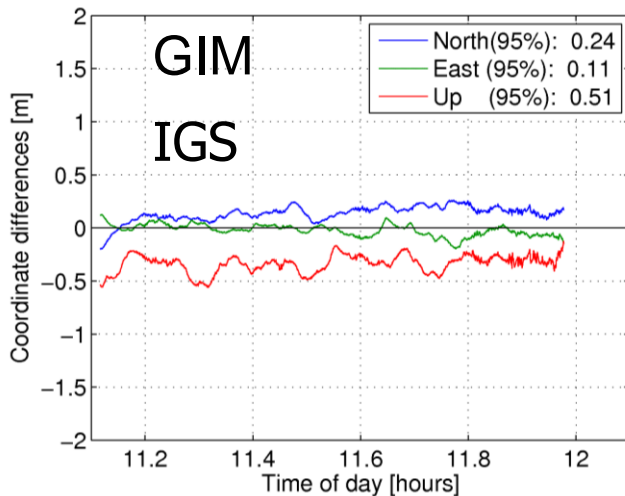
Ionospheric corrections using monitoring data



TEC data from DLR service SWACI have been used in a flight experiment at TU Delft in May 2005.

- Regional coverage
- High spatial and temporal resolution ($2.5^\circ \times 2.5^\circ$, 10 min)

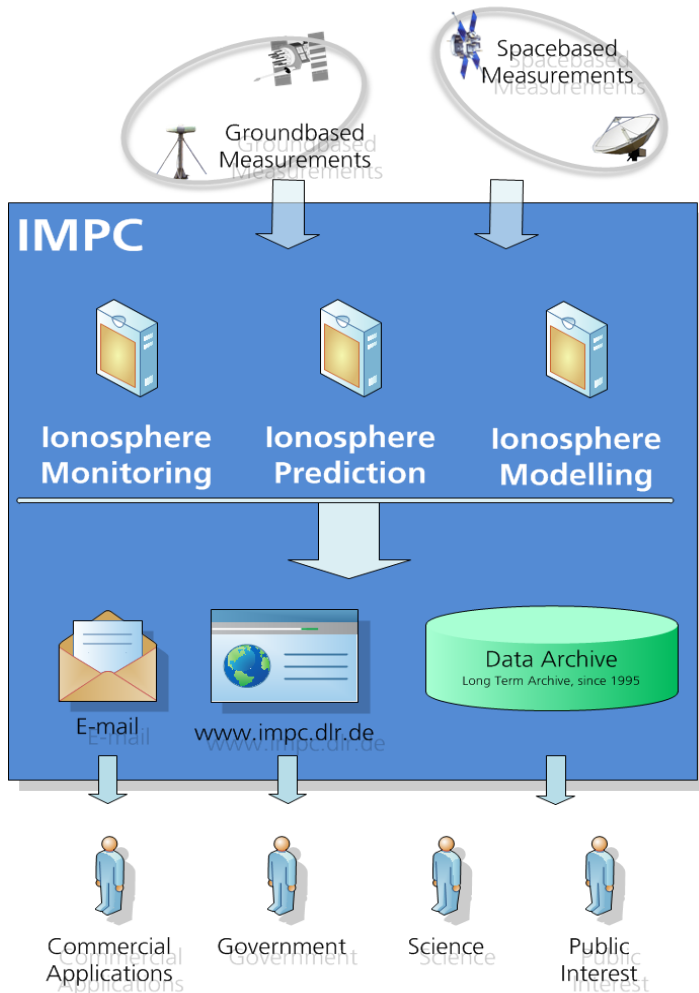
- Results:
 - Rather good in flight trial for vertical solution.
 - Could be improved if service covers a larger area.



[A.Q. Le et al., IAG Symposia, 133, Springer Berlin Heidelberg, pp 759-769. ISBN 978-3-540-85425-8 (2008)]



Ionospheric Monitoring and Prediction Center IMPC DLR Neustrelitz



- The Ionosphere Monitoring and Prediction Center (**IMPC**) of DLR provides a **near real-time information** and **data** service on the current state of the ionosphere, related forecasts and warnings.

- IMPC provides services for
 - Science
 - Governmental decisions
 - Commercial application
 - Public interest

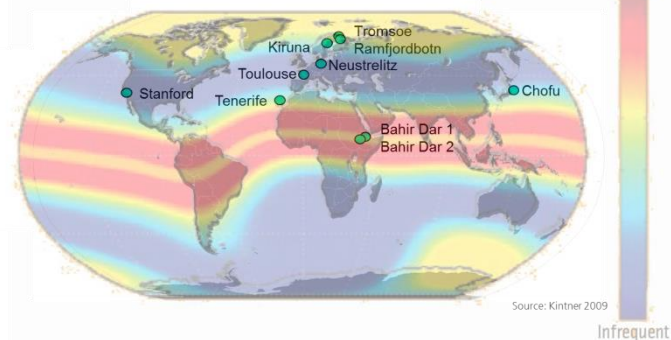
J. Berdermann, N. Jakowski, M.M. Hoque, N. Hlubek, K.D. Missling, M. Kriegel, C. Borries, V. Wilken, H. Barkmann, M. Tegler, Ionospheric Monitoring and Prediction Center (IMPC), Proceedings ION GNSS+, p. 14 – 21 (2014)



IMPC Facilities

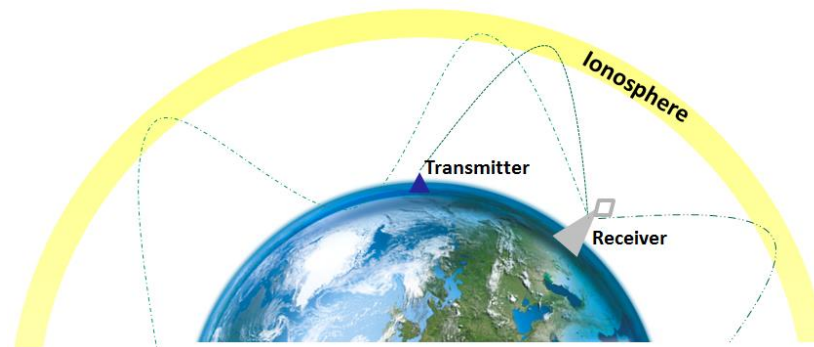
DLR operates an own high rate GPS receiver network for scintillation measurement from high latitudes to equatorial regions.

Scintillation Monitoring Network of DLR

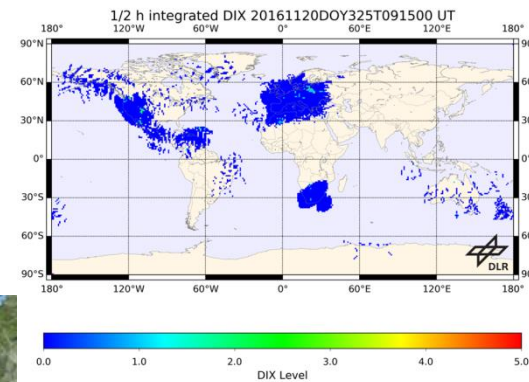
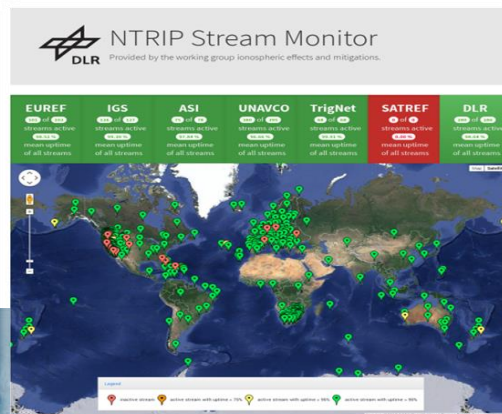
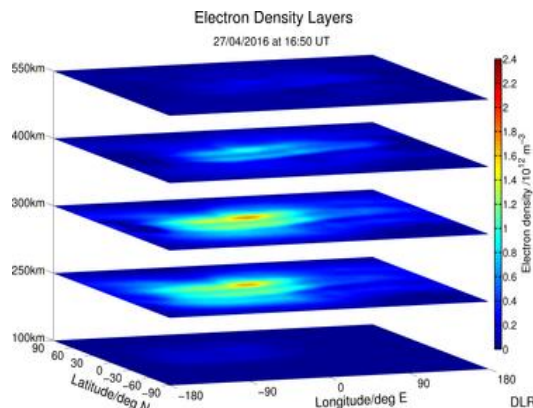
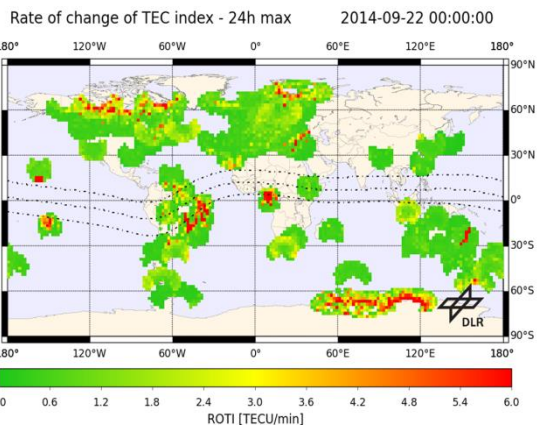
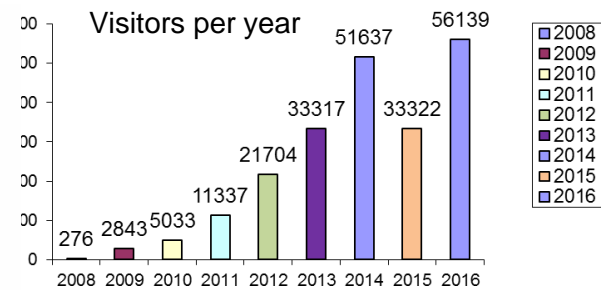
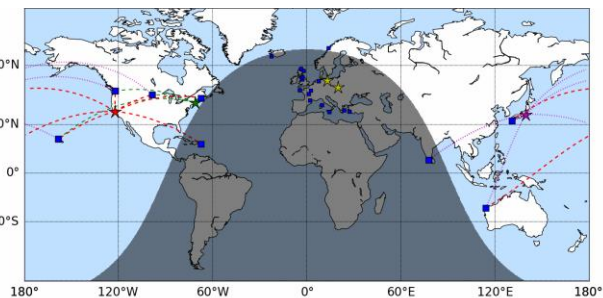
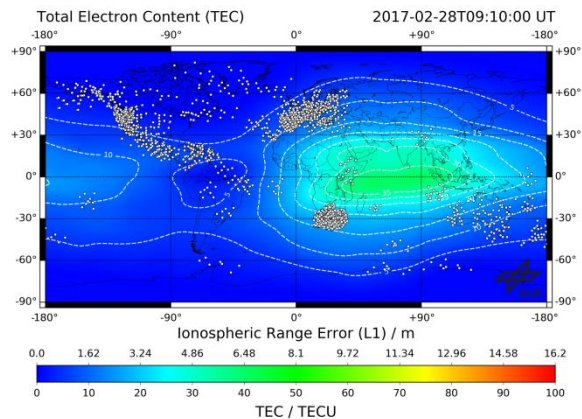


DLR is a privileged partner of NOAA-SWPC and, as the only European member of the Real Time Solar Wind (RTSW) observation network, engaged in the data transfer and analysis of the Deep Space Climate Observatory (DSCOVR).

A Global Ionospheric Flare Detection System (GIFDS) has been established at DLR to measure sudden ionospheric disturbances (SIDs) in the D-layer Ionosphere caused by solar flares.



IMPC Products and Service

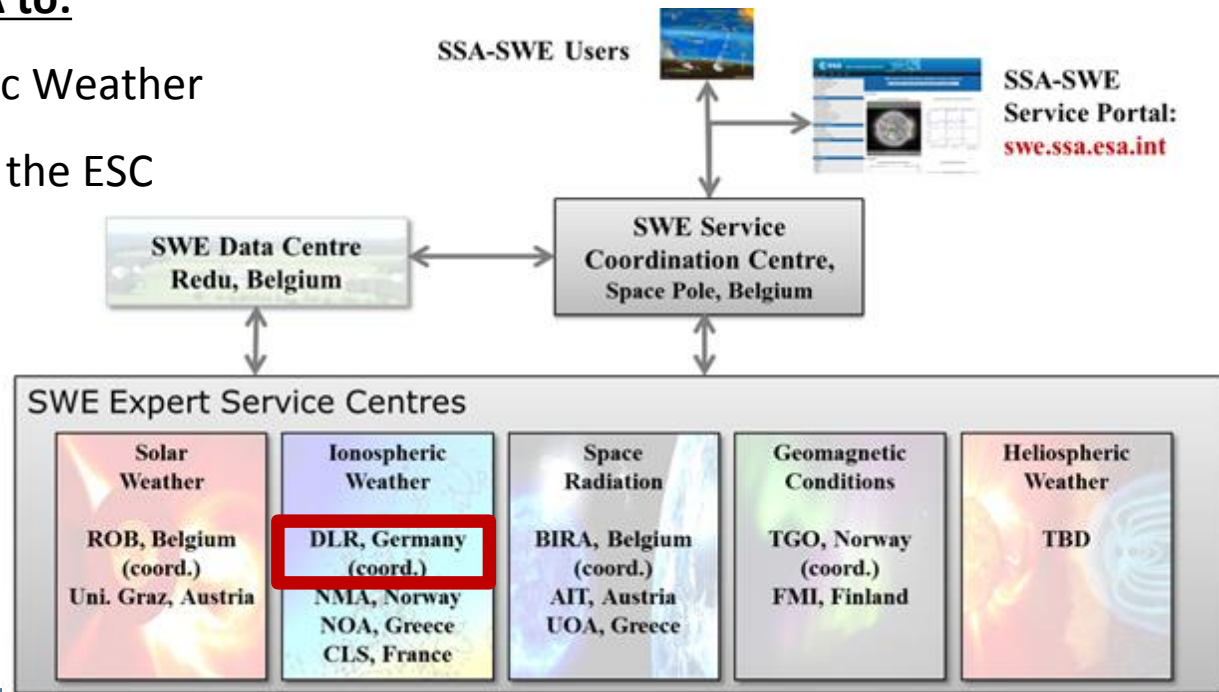


Service provision and coordination of the ESA SSA Expert Service Center „Ionospheric Weather“ (I-ESC)

The I-ESC provides, implements and supports the Ionospheric and upper Atmosphere Weather products and capabilities of the ESA SSA SWE network, including the observation, monitoring, interpretation, modelling and forecasting of Ionospheric and upper Atmosphere Weather conditions.

DLR has been contracted by ESA to:

- Coordinate the ESC Ionospheric Weather
- Planning and Development of the ESC
- Data provision and service



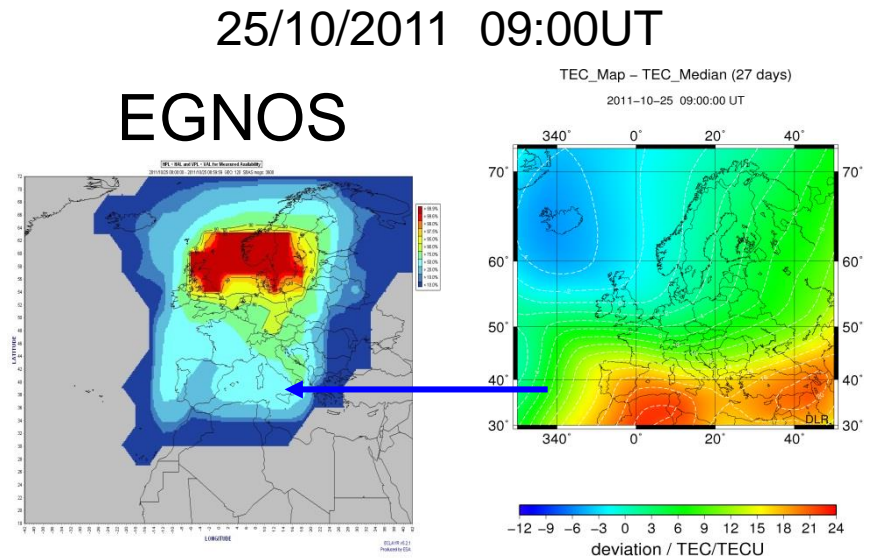
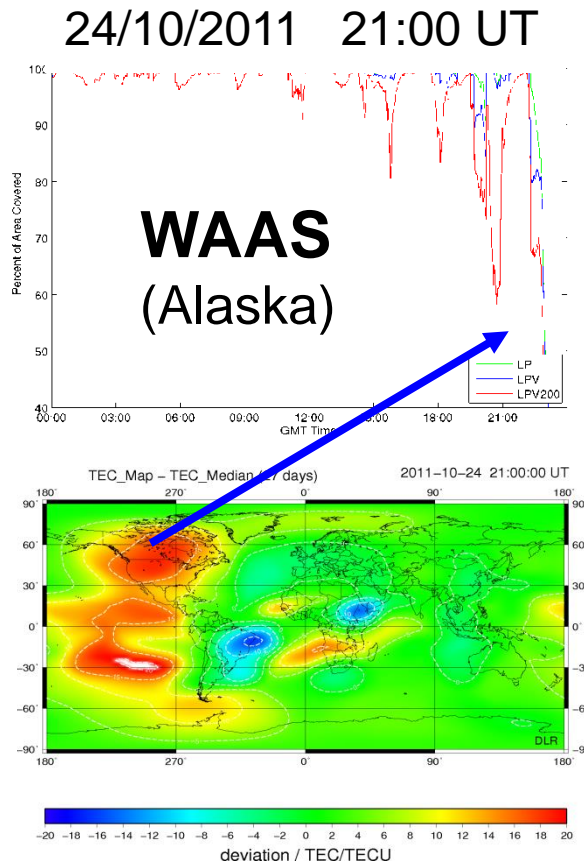
Ionosphere – Expert Service Center Mission Statement

Provide and develop **functionalities, capabilities and expertise in the domain of Ionosphere and upper Atmosphere** that are needed within the ESA SSA SWE network for demonstrating and assessing the influences of Space Weather informing and supporting end users through the provision of accurate, **reliable and timely products and (pre-)operational services**, tailored to their requirements.

The I-ESC thus provides, implements and supports the Ionospheric and upper Atmosphere Weather products and capabilities of the ESA SSA SWE network, including the **observation, monitoring, interpretation, modelling and forecasting of Ionospheric and upper Atmosphere Weather conditions**.



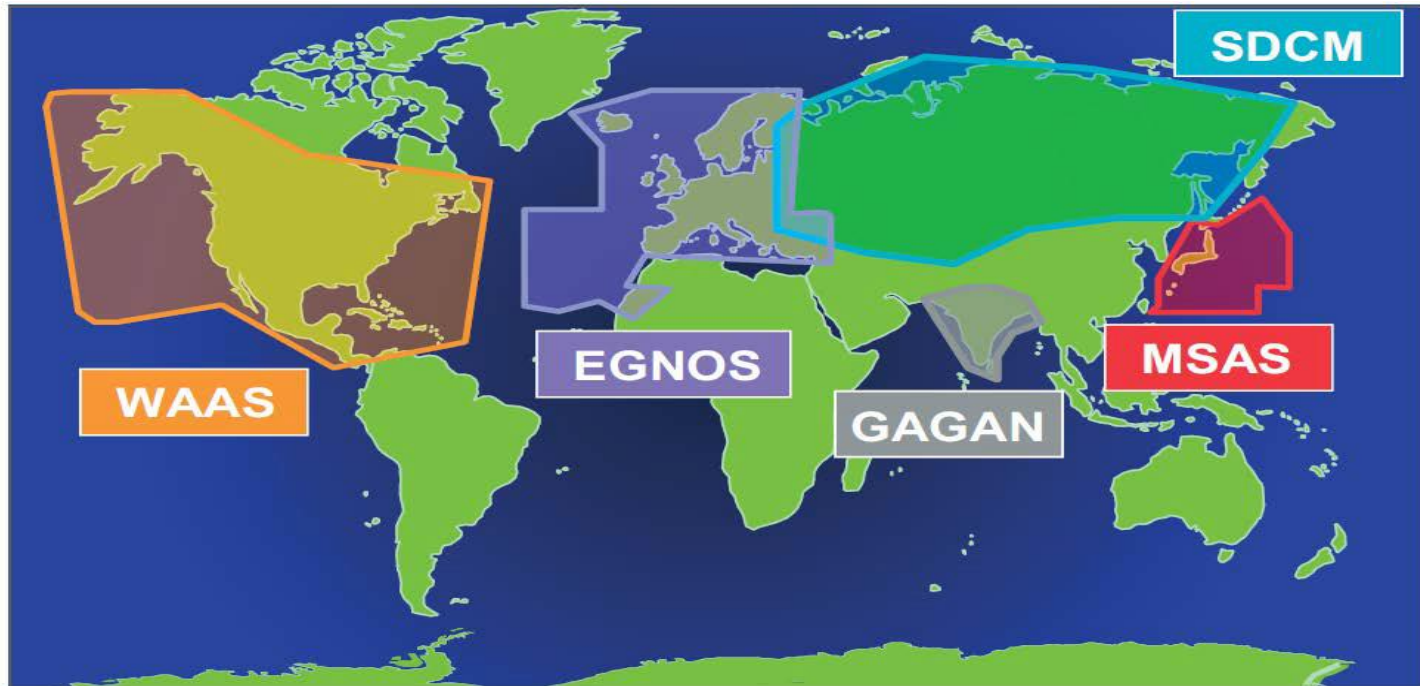
Ionospheric impact on augmentation systems WAAS and EGNOS on 24/25 October 2011



Performance of space based augmentation systems such as WAAS und EGNOS is strongly affected by ionospheric perturbations during ionospheric storms.



Satellite Based Augmentation Systems (SBAS)



- WAAS (US): Wide Area Augmentation System; since 2003 operational
- EGNOS (Europe): European Geostationary Overlay System; since 2009 operational
- MSAS (Japan): Multi-functional Satellite Augmentation System; since 2007 operational
- GAGAN (India): GPS Aided Geo Augmented Navigation
- SDCM (Russia): System of Differential Correction and Monitoring

Source: ESA



Education and Public Outreach

Raising the public awareness

Annual Space Weather Summer School



Joint Space Weather Camp between DLR (D), UA Huntsville (USA) and SANSA (ZA) with contributions from national and international experts.

National Space Weather Workshop 2015



Experts from industry, government bodies and authorities discussed about extreme events in space weather. Preparation of a national strategy for handling space weather threats in Germany.



Thank You

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