

DLR ESA AllSat IONERMA SENSYS Swiss Re IEEA GFZ

## Current developments of 'Space Weather Impact on Precise Positioning Applications of GNSS'

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## OUTLINE

- Introduction to the Project
- Space Weather features in the ionosphere
- Radio scintillations
- SWIPPA data products
- Web presentation
- Summary

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## SW Service for precise positioning

Fixing time for positioning

Time to fix ambiguities as a function of local time (right axis) and number of available GPS and GLONASS satellites (left axis)

Ionosphere

Space-Weather Info

Corrections

Reference Station

SWIPPA Service Centre

Improved GPS service

Data Center

User

Improved measurements

~ 50 km

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## Space Weather Event on 6 April 2000

Electron and Proton flux measurements on GOES

Polar light observed in Potsdam (J. Rendel)

Voltagen on Gas pipelines of Ruhrgas

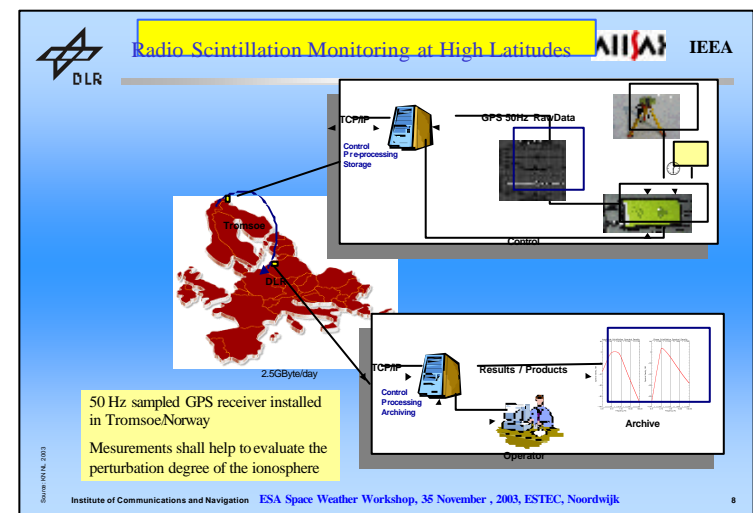
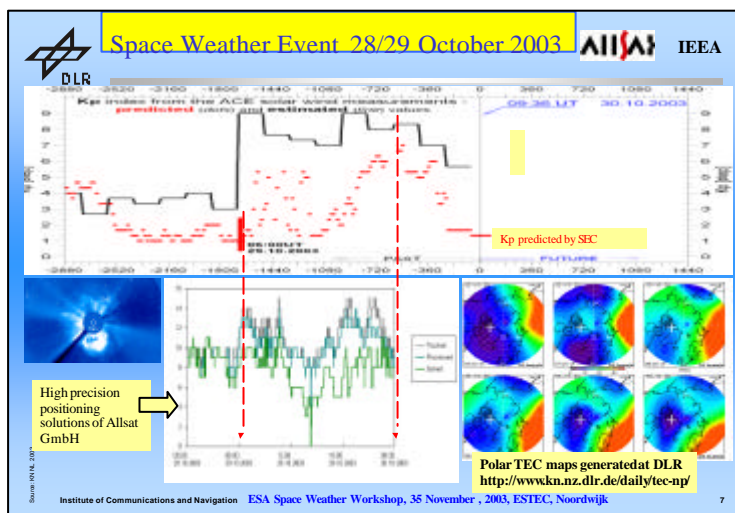
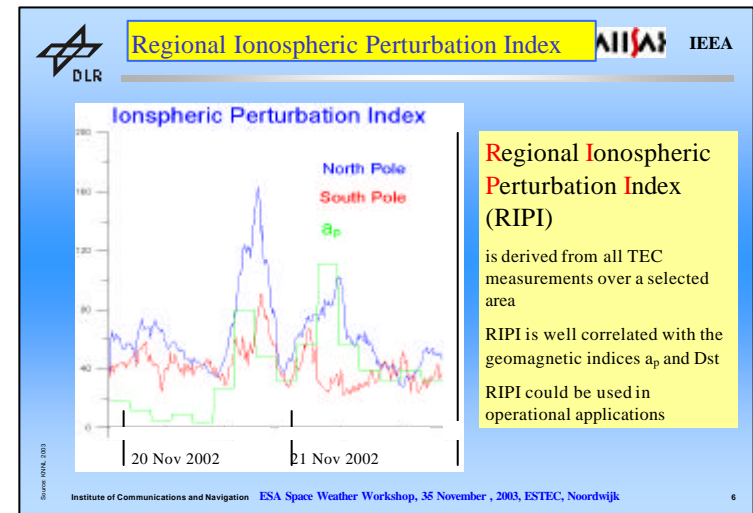
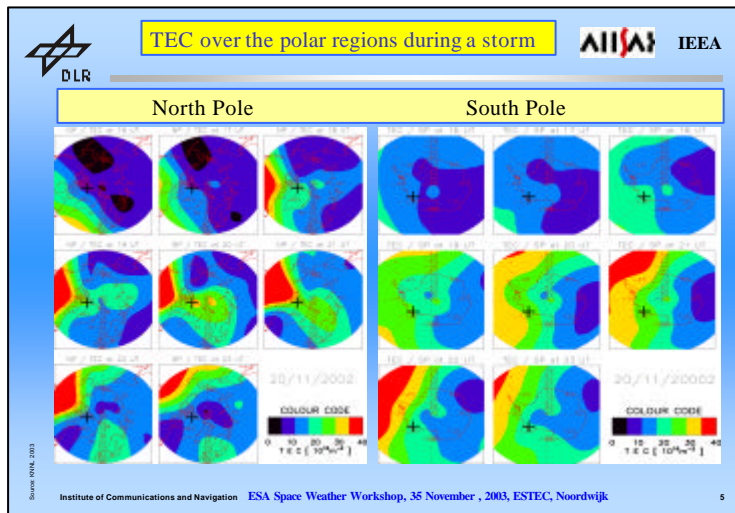
Perturbations of GPS-Measurements

Polar area and in Neustrelitz

0/7 April 2000

UNIVERSAL TIME [hours]

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**Loss of Lock Probability**

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The probability of intensity is Nakagami distributed.  
The loss of lock probability is the corresponding cumulative probability, given the threshold.

Scintillation Index  $S_4$

$$S_4^2 = \frac{\overline{(P-P)^2}}{\overline{P}^2}$$

Probability of loss of lock

Source: KINL, 2003

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**Simultaneous Fading - Satellites Locked Out**

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number of satellites locked out simultaneously  
sigma phi < 15°

16/MAR/2001

Number of satellites affected by scintillation

GISM Modeling

Measurements in Naha  
Matsunaga (ION meeting, 2002)

Source: KINL, 2003

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**GPS Differential Phase Fluctuation Map**

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Variability of TEC  
from  
GPS/GLONASS -  
Measurements

6 April 2000  
23 - 24 UT  
Sampling Rate: 1 Hz,  
10s window

SWIPPA Product

Source: KINL, 2003

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**GIVE map over Europe (ESTB)**

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GIVE/m

DLR IKM EGNOS/ESTB real time iono delay error display 2003.05.24 05:40:00

Grid Ionospheric Vertical Error (GIVE) in ESTB  
In DLR Neustrelitz continuously ESTB near real-time corrections are extracted by means of a GPS receiver capable of processing WAAS/EGNOS.

Source: KINL, 2003

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