Space Weather Impact on Precise Positioning Applications of GNSS

(SWIPPA)

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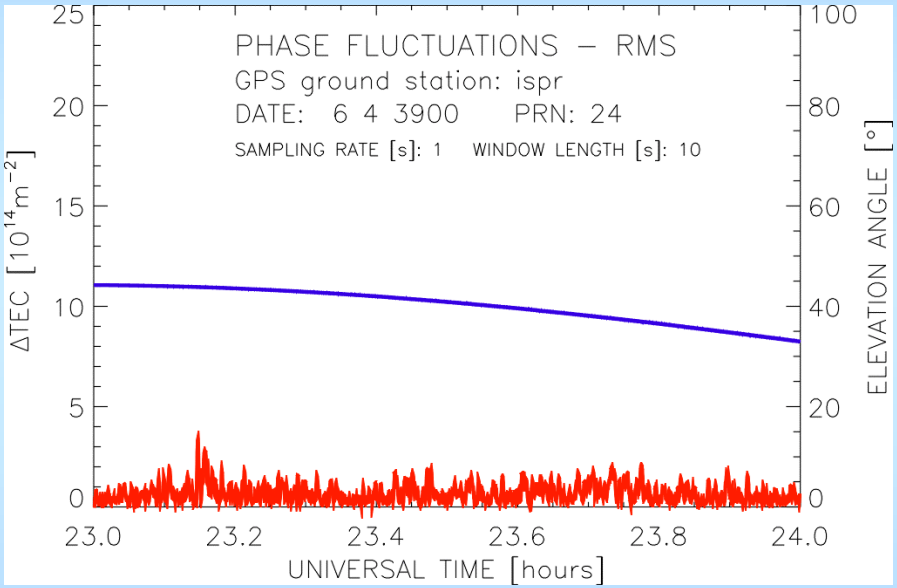
OUTLINE

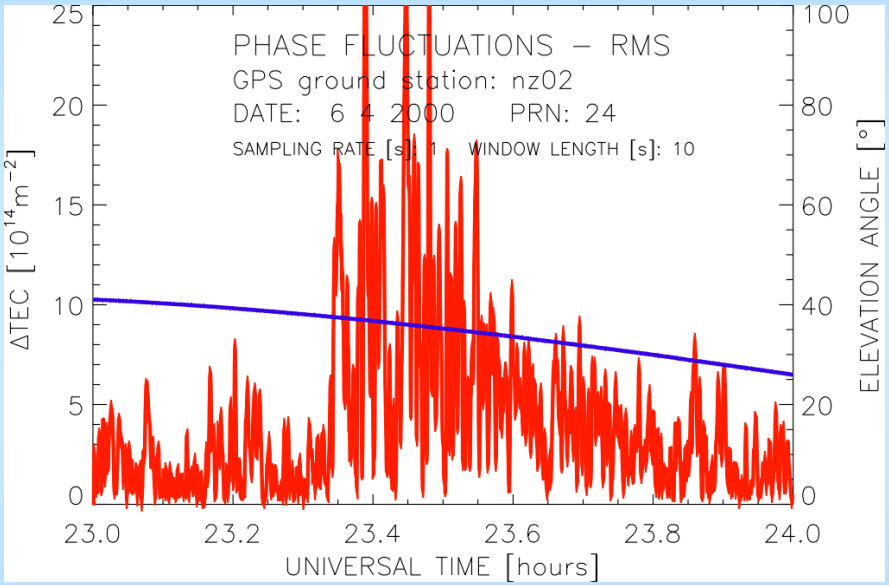
- Motivation
- DLR – IKN capabilities
- Proposed solution
- Project activities
- Summary

MOTIVATION

Variability of GPS carrier phase of PRN 24 at different sites

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





mean noise level

TEC= 2×10^{14}m^{-2} ⟺ 3.2 mm

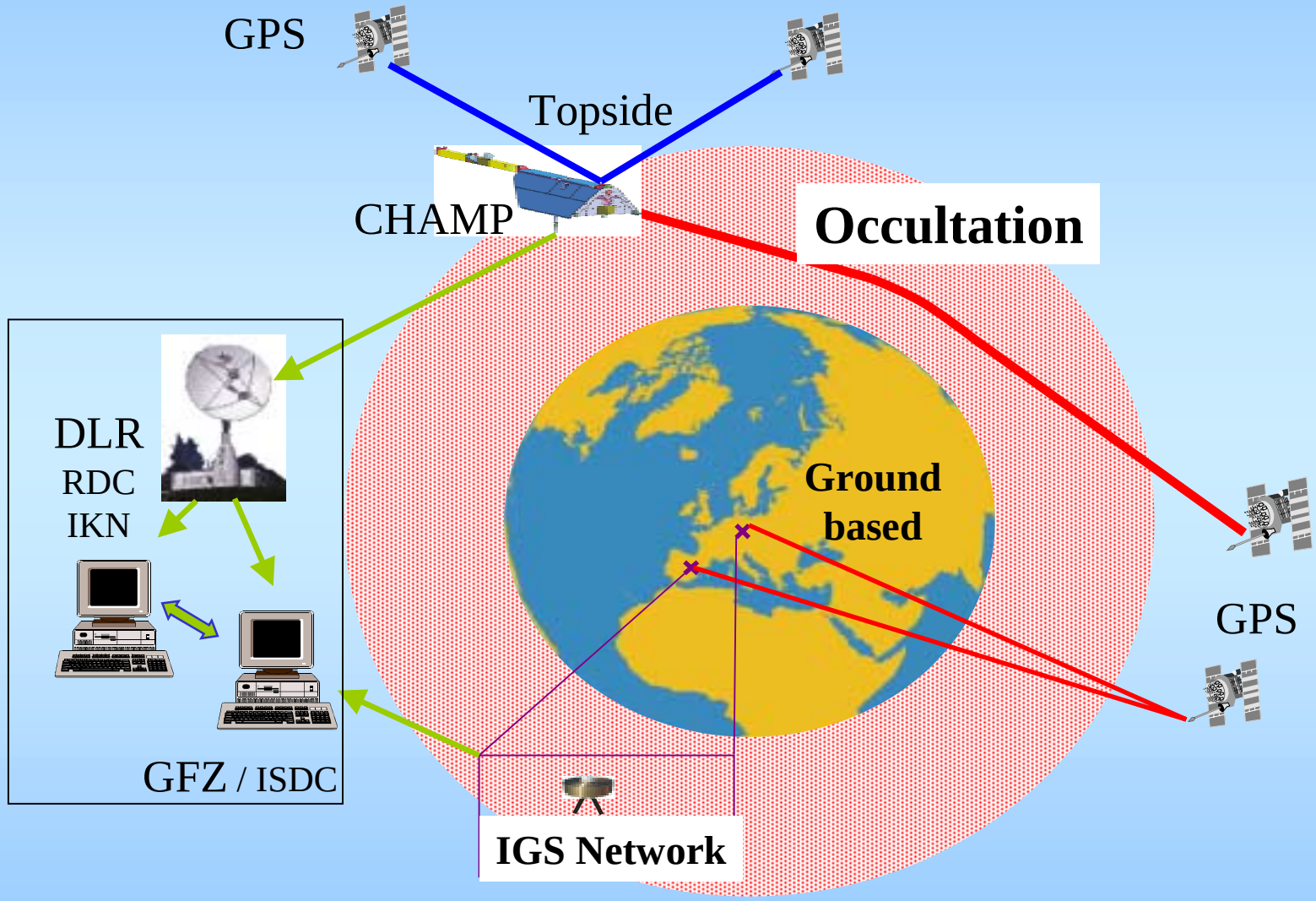
Perturbed noise level ⇨ 5 cm

problems in resolving wave length ambiguities

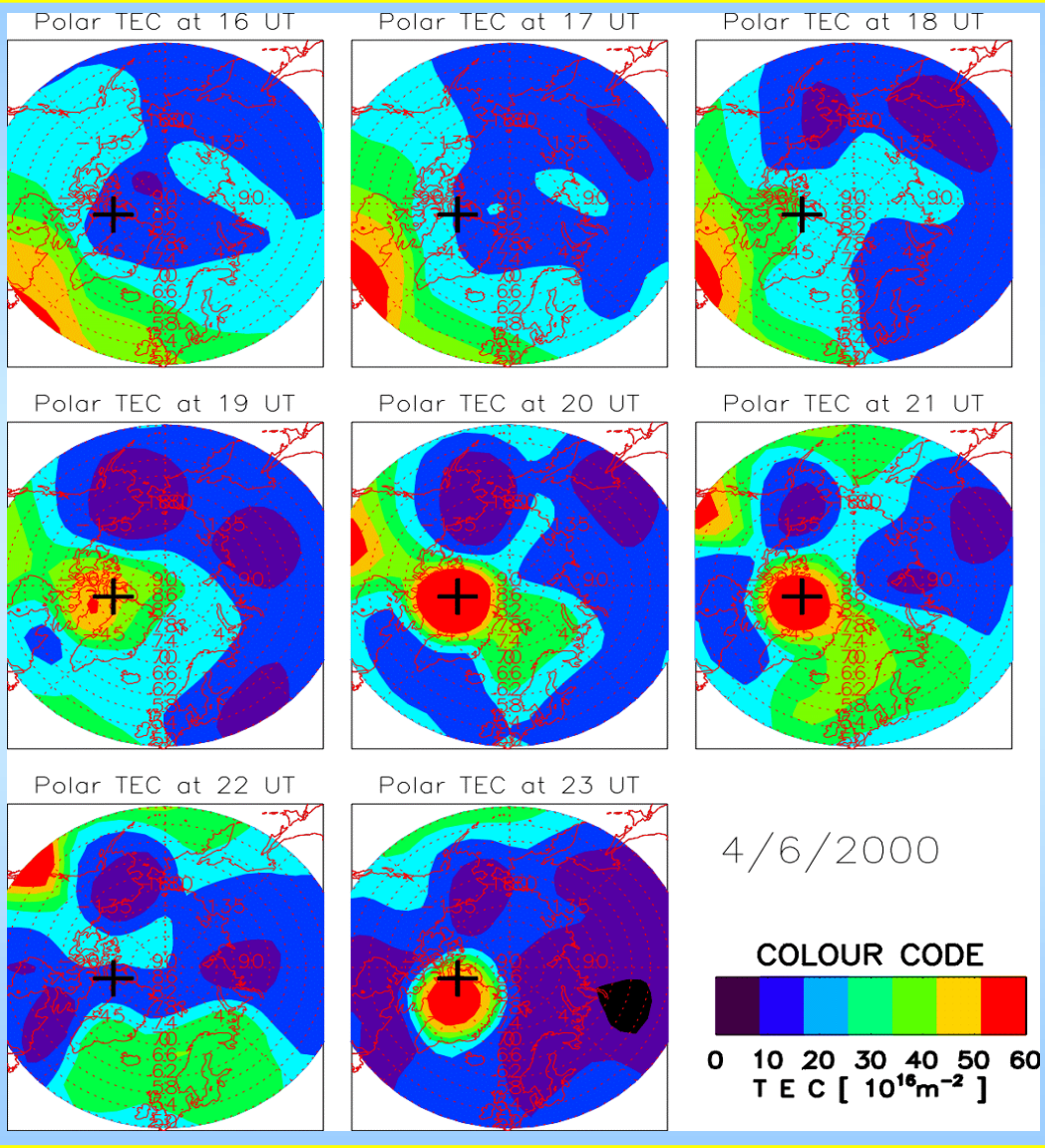
DLR - IKN CAPABILITIES

- Ground - based ionospheric monitoring by GNSS
  - Monitoring technique (TEC)
  - Large TEC data base (since 1995)
  - Near real-time processing
- Space - based ionospheric monitoring by GNSS
  - Ionospheric radio occultation
  - Topside ionosphere/plasmasphere sounding

Capabilities – ground and space-based monitoring



Capabilities – polar cap monitoring



Polar TEC on

6 April 2000

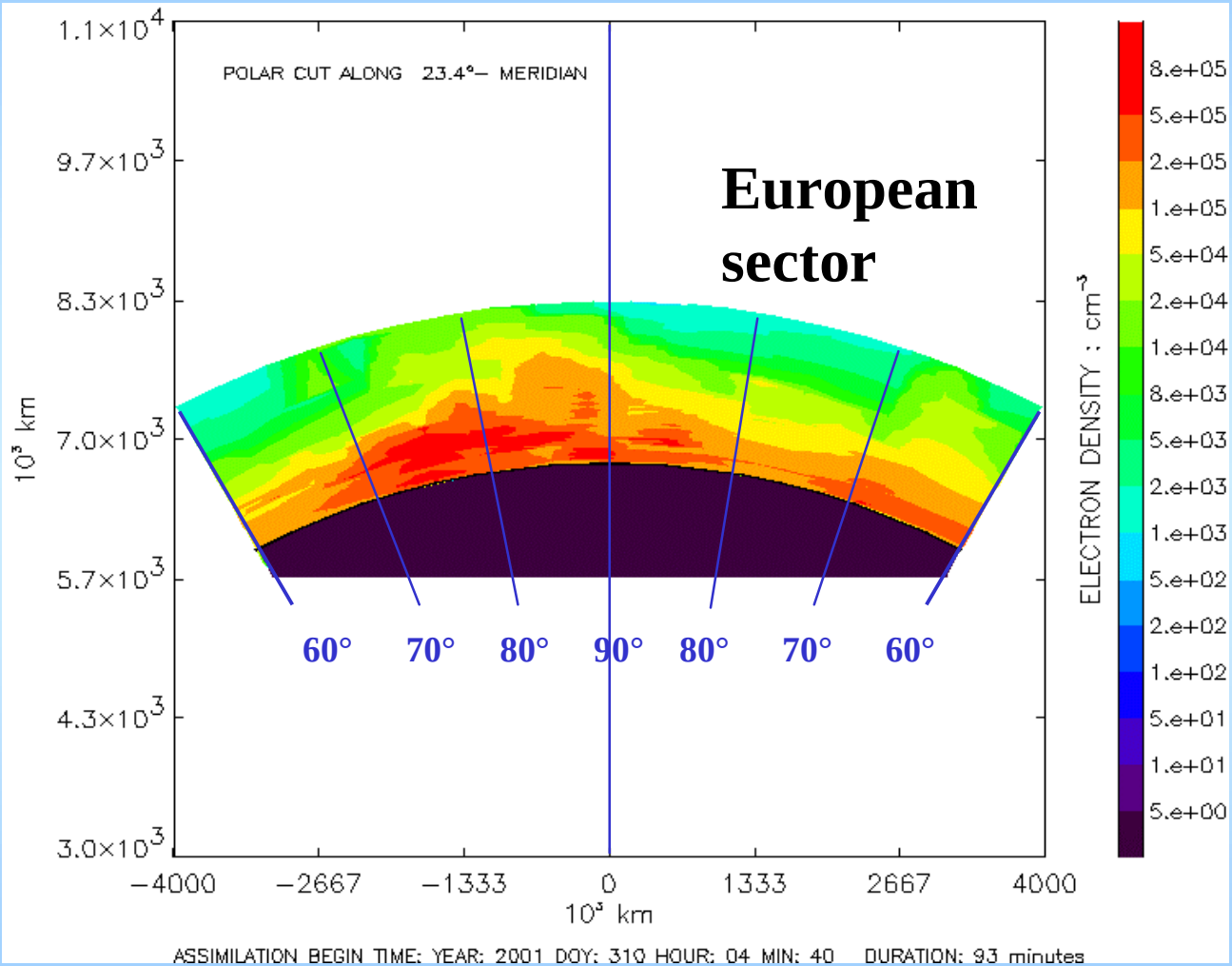
(lat > 50°N)

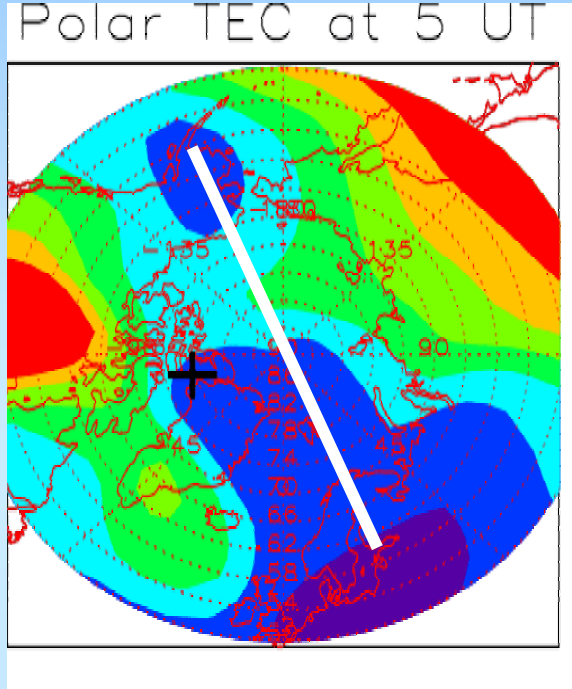
16 - 23 UT, hourly

Provides key information on the onset phase of ionospheric storms

Daily maps:
http://www.kn.nz.dlr.de/daily/tec-np

Capabilities – **GPS data assimilation**

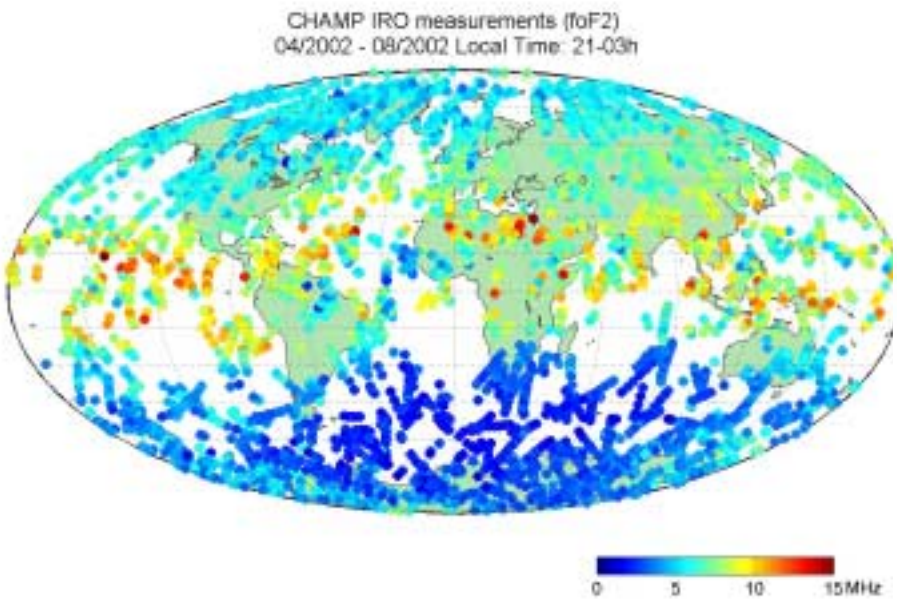


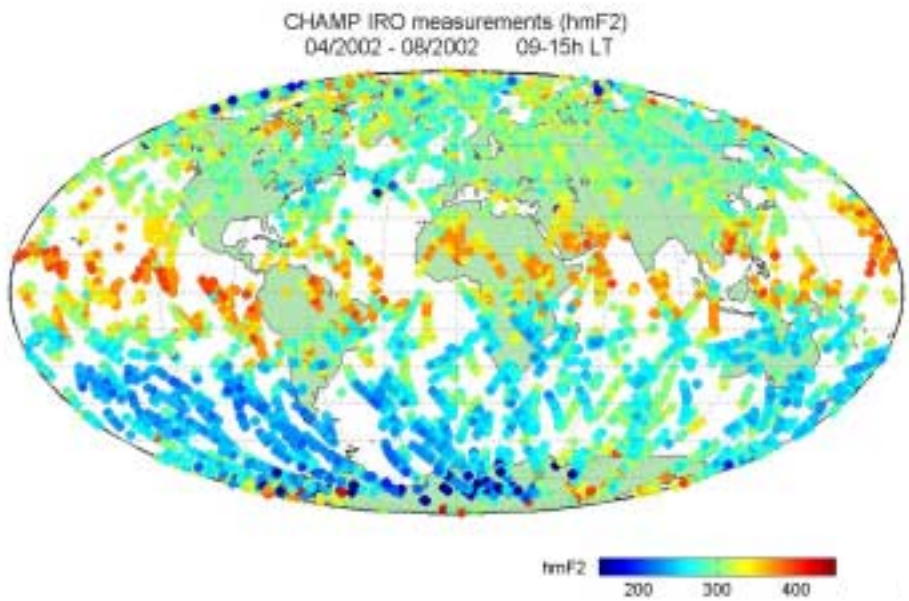


The electron density increase in the topside ionosphere near the pole over the Asian longitude sector (left) fits with the TEC map structure.

Capabilities – global coverage

Global foF2 distribution deduced from CHAMP/IRO measurements (April-August 2002)





F2 layer **critical frequencies** during 2002 Northern Summer, **night**-time

F2 layer **peak heights** during 2002 Northern Summer, **day**-time

IRO measurements on CHAMP provide actual information on the global state of the ionosphere

Proposed solution – based on correlation between SW and TEC data

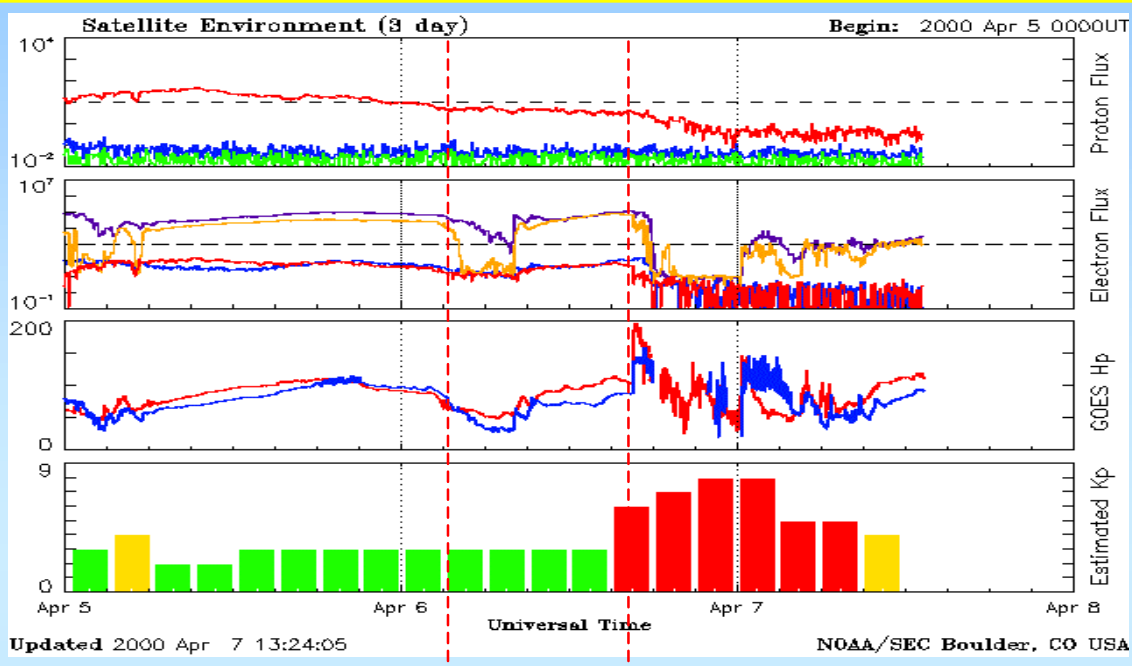
Comparison

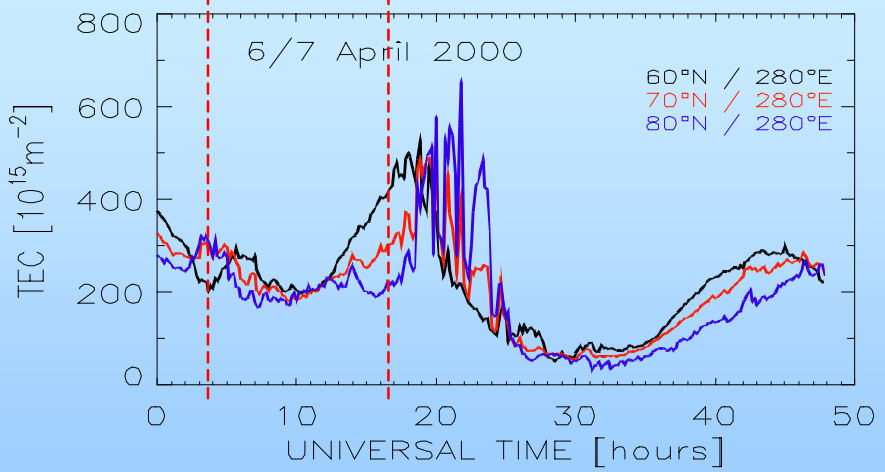
of the satellite-based **space environment observations** with

the polar **TEC- monitoring** data

on 6/7 April 2000 demonstrates

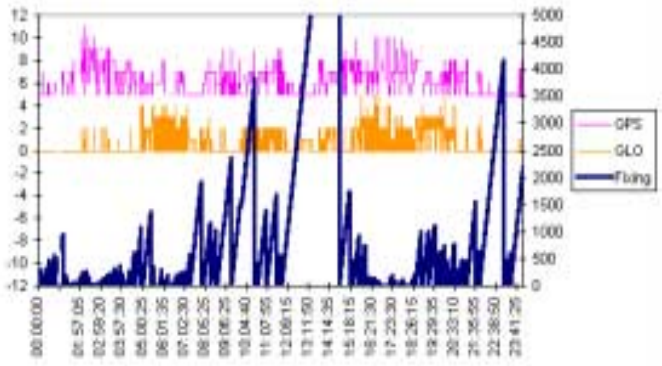
a **close correlation**





Proposed solution - Differential GPS for precise positioning at user level

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

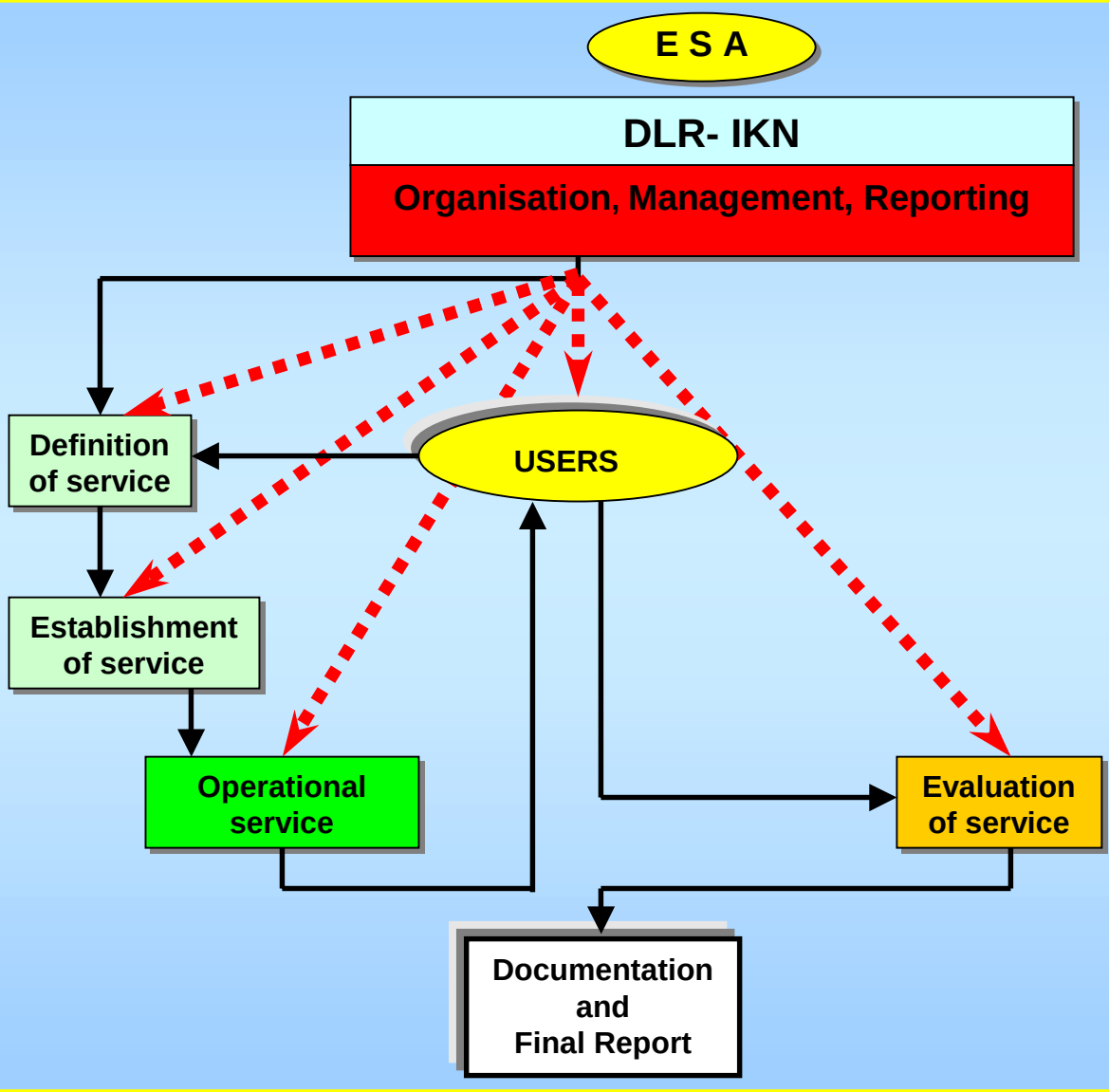
Data Center

~ 50 km

User

Improved measure ments

PROJECT ACTIVITIES



SWIPPA project contributes to the establishment of an European Space Weather Program by focusing on one specific task out of the many interdisciplinary tasks belonging to the space-weather issue: precise positioning. The project activities are seen as an integral part of an European Space Weather Network (SWENET) planned to be established within the Space-Weather pilot project. SWIPPA is to be executed in the following phases:

Phase1:

Service Definition and Establishment

Phase 2:

Service Operation

Phase 3:

Service Evaluation

SUMMARY

The project **focuses** on the concrete use of **space-weather information** in operational Global Positioning System (GPS) reference networks for **purposes of precise and reliable positioning**.

Several **data and service products** are offered to the designated users, research institutions, and general public. These products, based on information of the actual and predicted state of the ionosphere, will provide the users only with the **space- weather information they really need** for their tasks.

Present GPS and future GALILEO system customers will be provided with now-cast and fore-cast of the ionosphere state to **help them** to deliver secure and **precise positioning service** and to **reduce operation / production costs**.

The proposed **space-weather service will be thoroughly evaluated** and well-substantiated recommendations will be given to improve the service.