

# Space Weather Impact on Precise Positioning Applications of GNSS (SWIPPA)

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# OUTLINE

**Motivation**

**DLR – IKN capabilities**

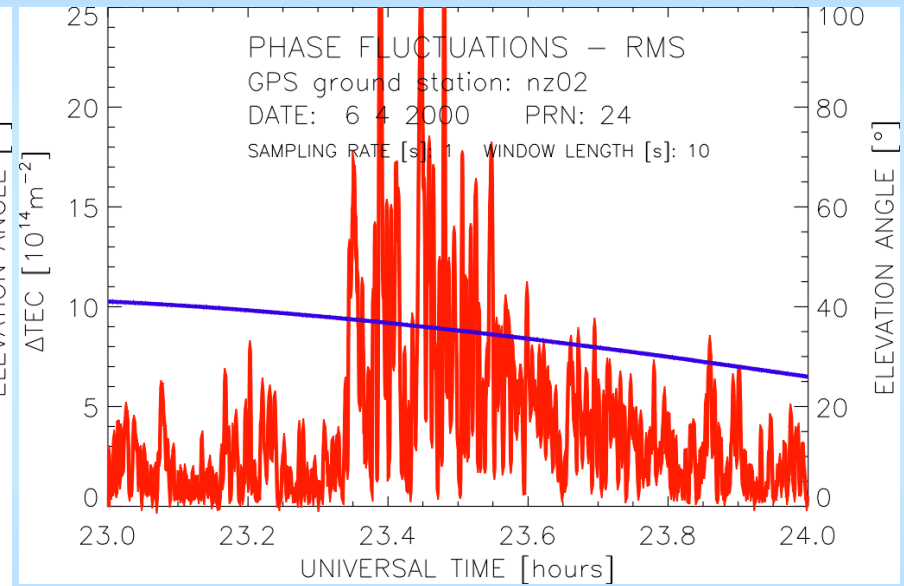
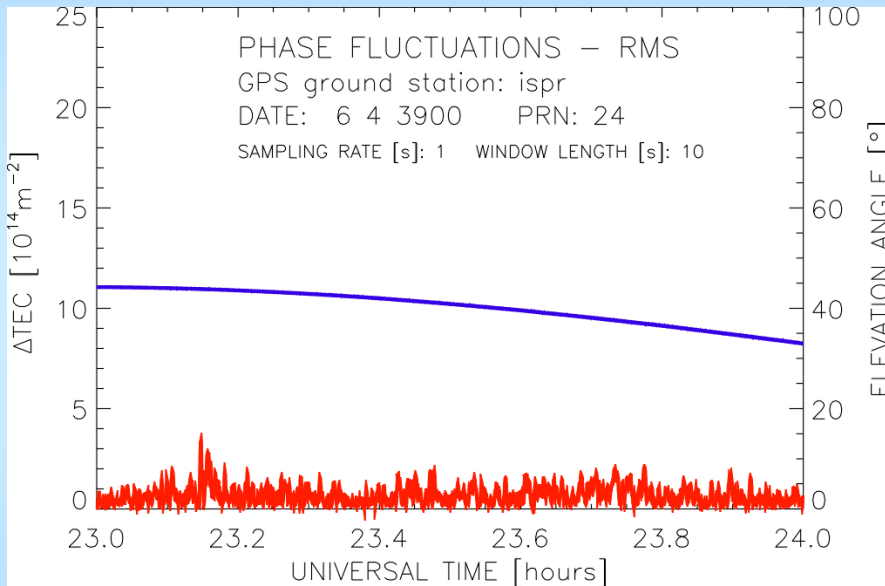
**Proposed solution**

**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

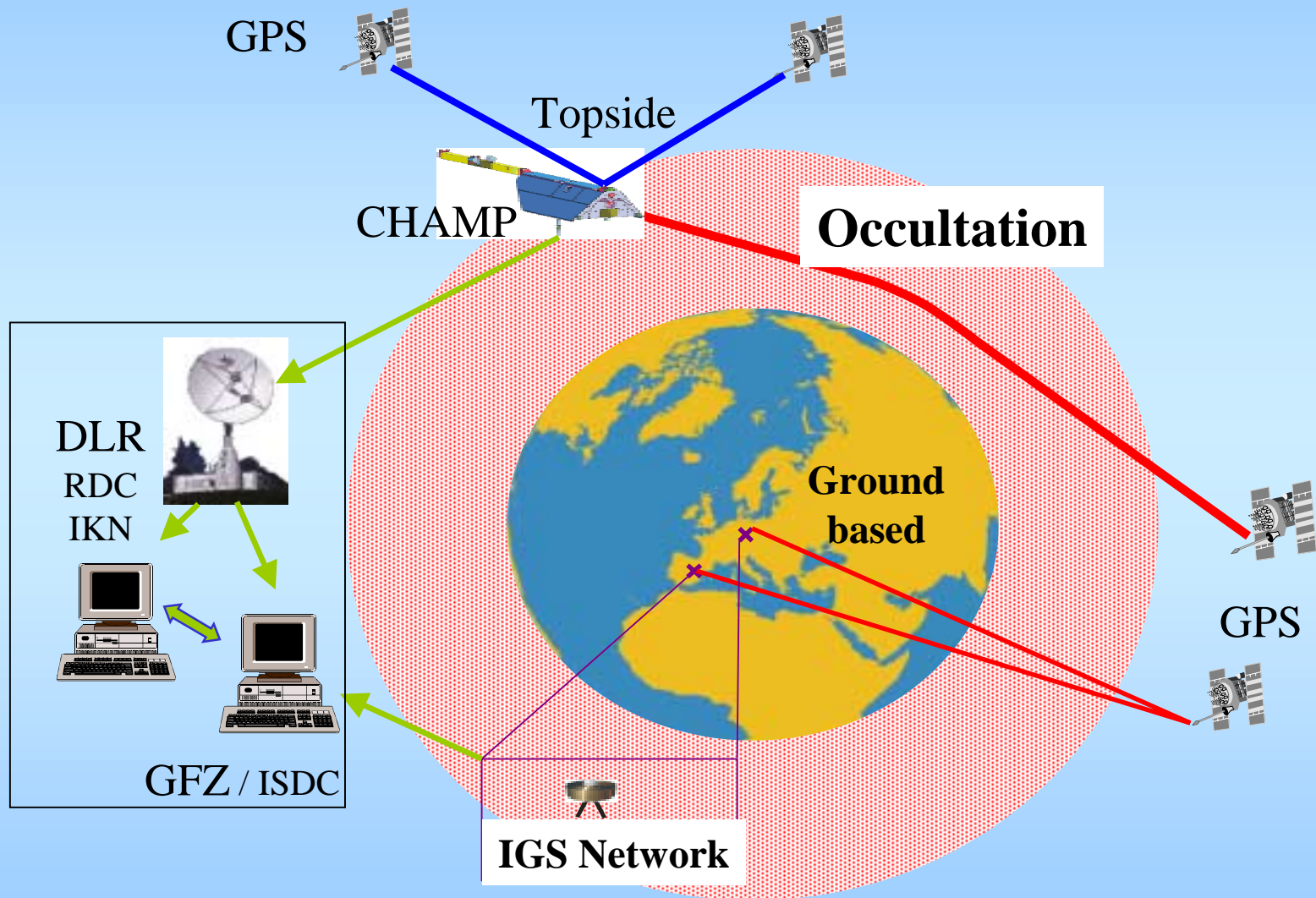
TEC =  $2 \times 10^{14} \text{m}^{-2}$   $\longleftrightarrow$  3.2 mm

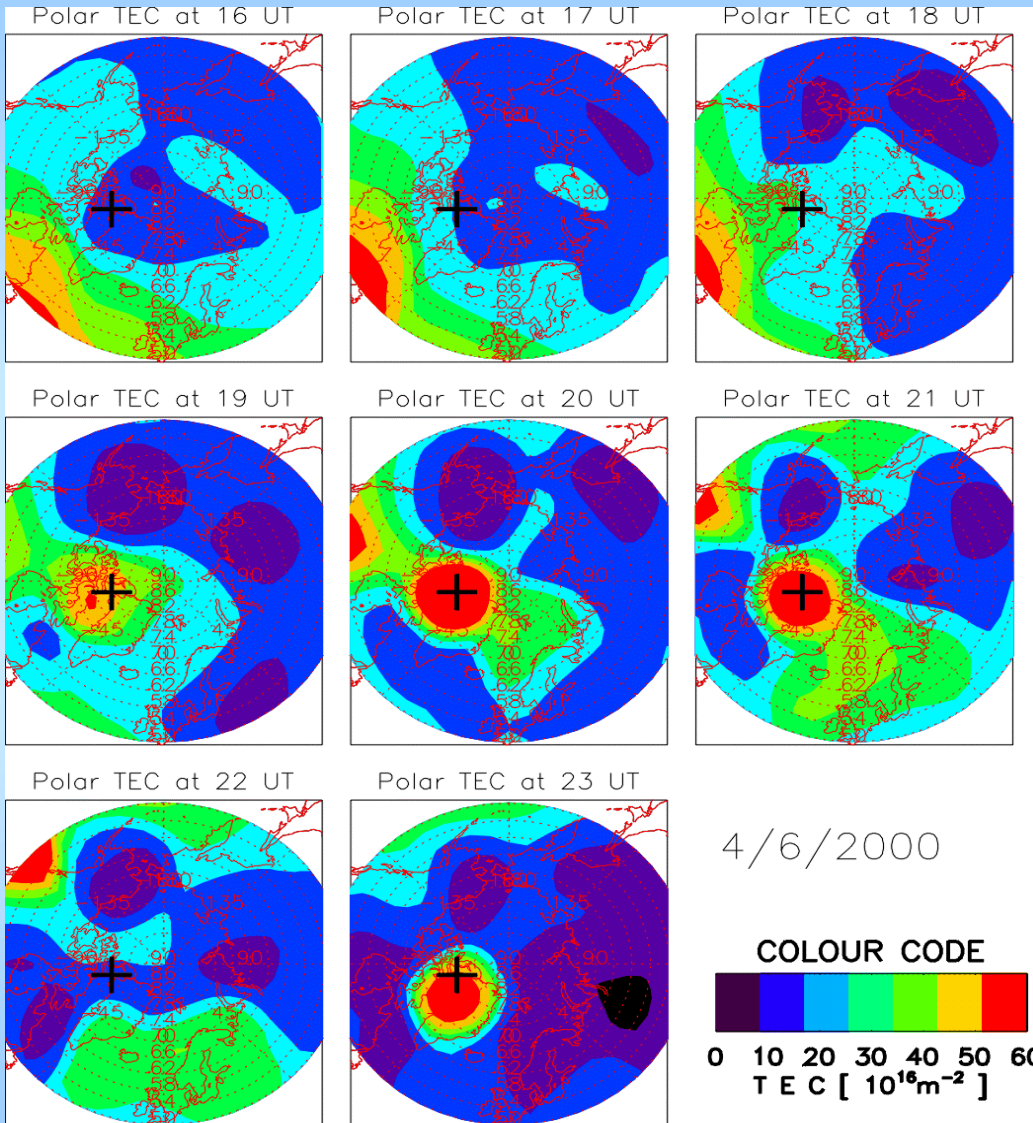
Perturbed noise level  $\rightarrow$  5 cm

problems in resolving wave length ambiguities

- 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





Polar TEC on  
**6 April 2000**

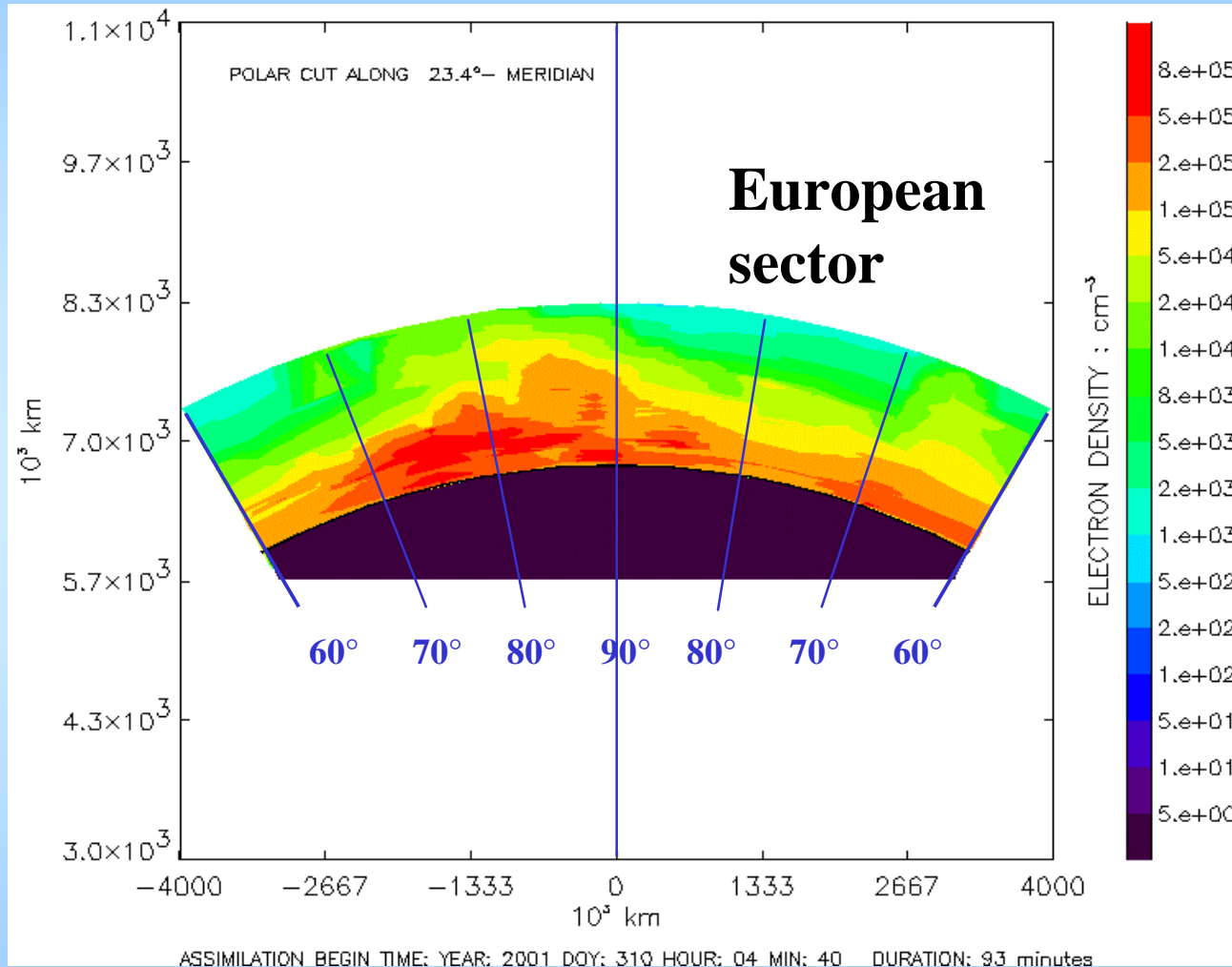
(lat > 50°N)

16 - 23 UT, hourly

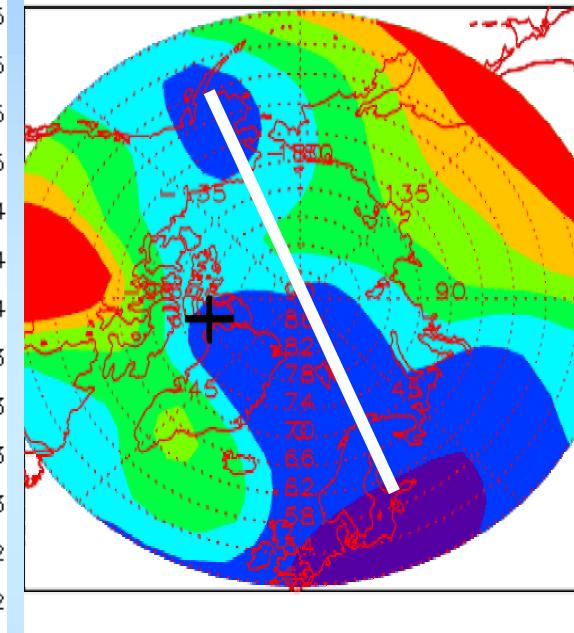
Provides key information  
on the onset phase of  
ionospheric storms

Daily maps:

[http://www.kn.nz.dlr.de/  
daily/tec-np](http://www.kn.nz.dlr.de/daily/tec-np)



Polar TEC at 5 UT

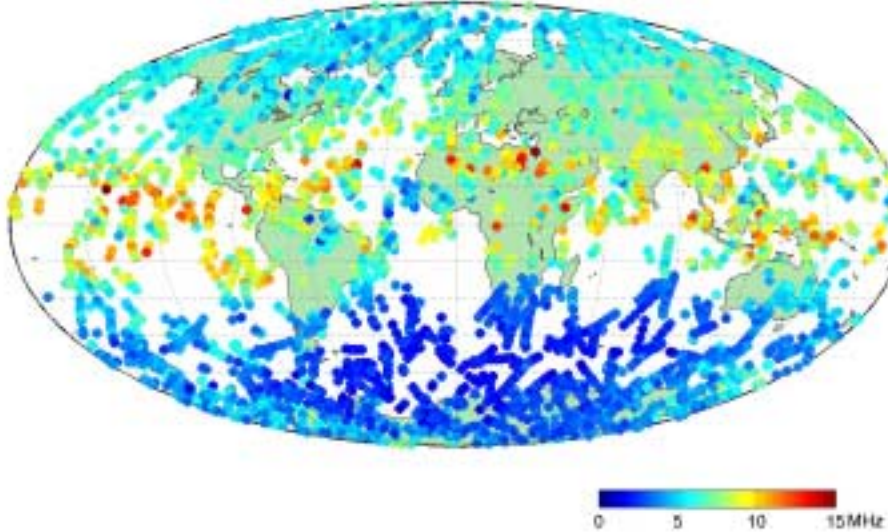


The electron density increase in the topside ionosphere near the pole over the Asian longitude sector (left) fits with the TEC map structure.

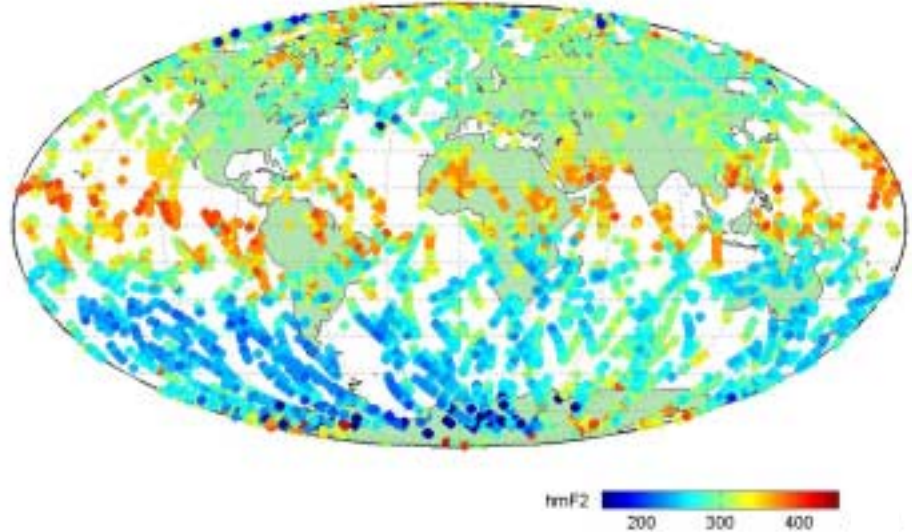
# Capabilities – global coverage

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

CHAMP IRO measurements (foF2)  
04/2002 - 08/2002 Local Time: 21-03h



CHAMP IRO measurements (hmF2)  
04/2002 - 08/2002 09-15h LT

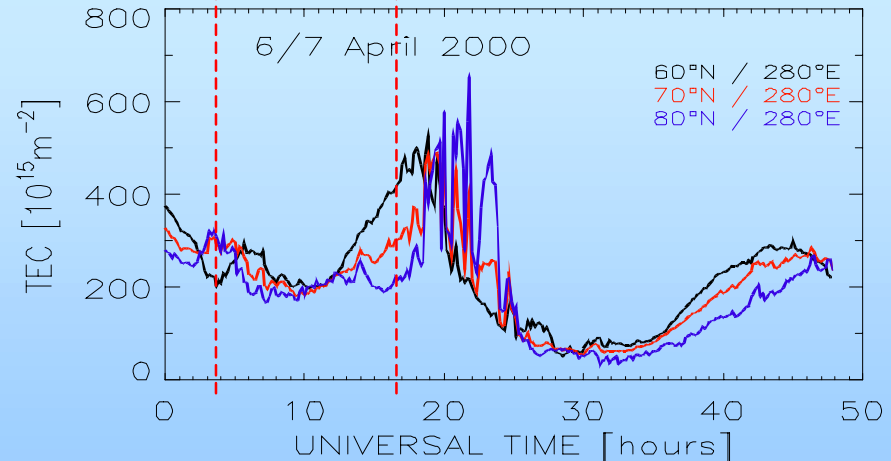
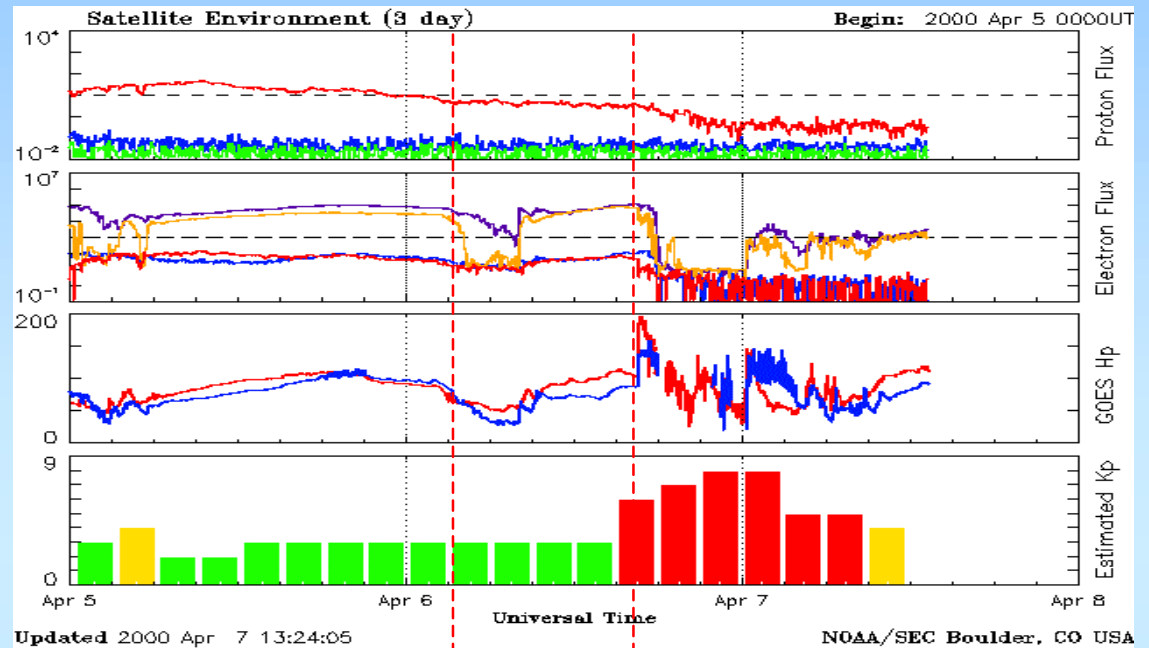


F2 layer **critical frequencies** during  
2002 Northern Summer, **night-time**

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

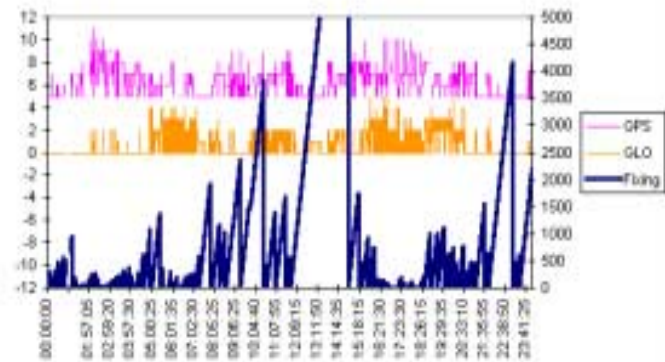
**IRO measurements on CHAMP provide actual information  
on the global state of the ionosphere**

Comparison  
of the satellite-based  
space environment  
observations  
with  
the polar  
**TEC- monitoring**  
data  
on 6/7 April 2000  
demonstrates  
**a close correlation**

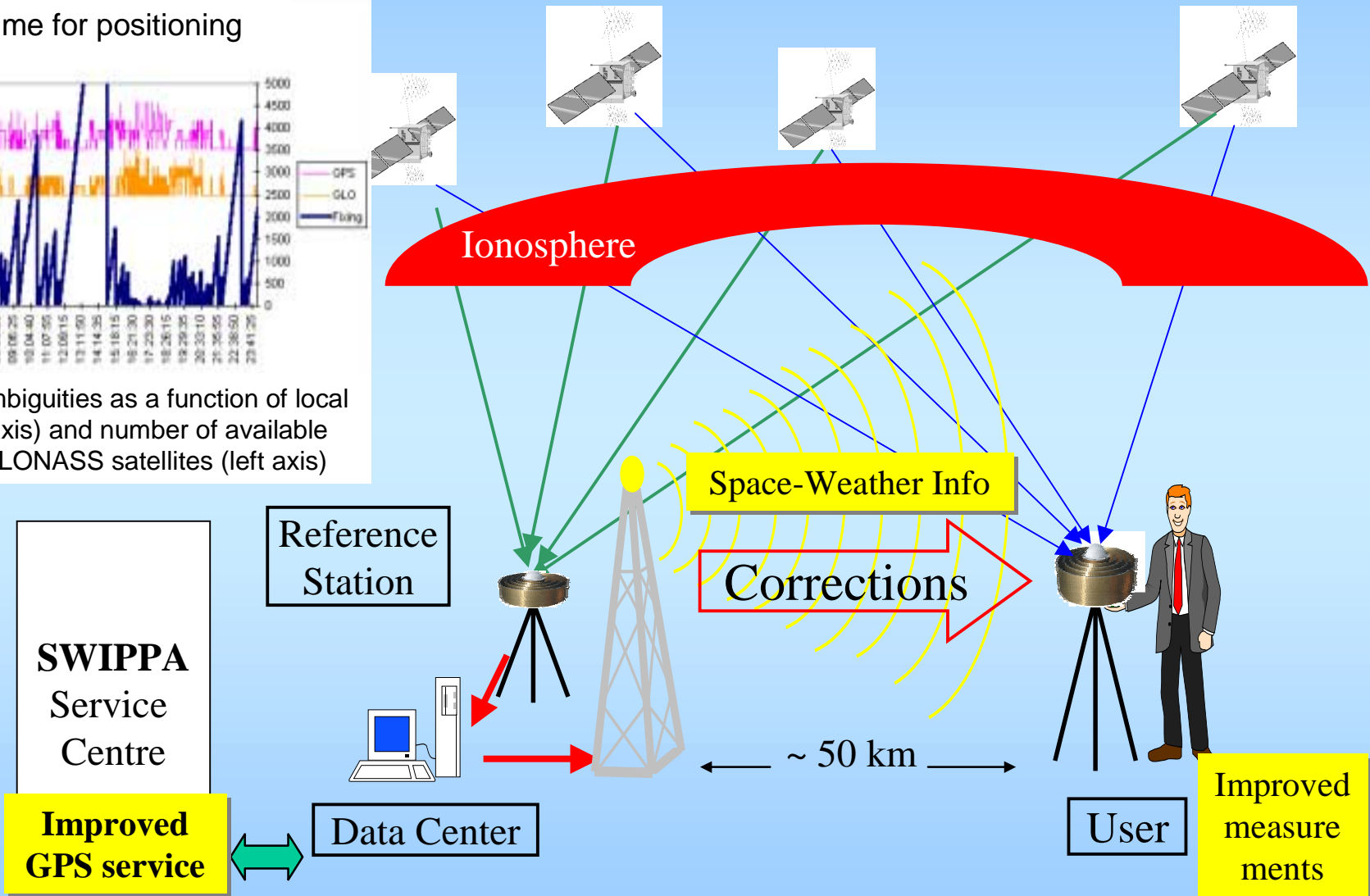


# Proposed solution - Differential GPS for precise positioning at user level

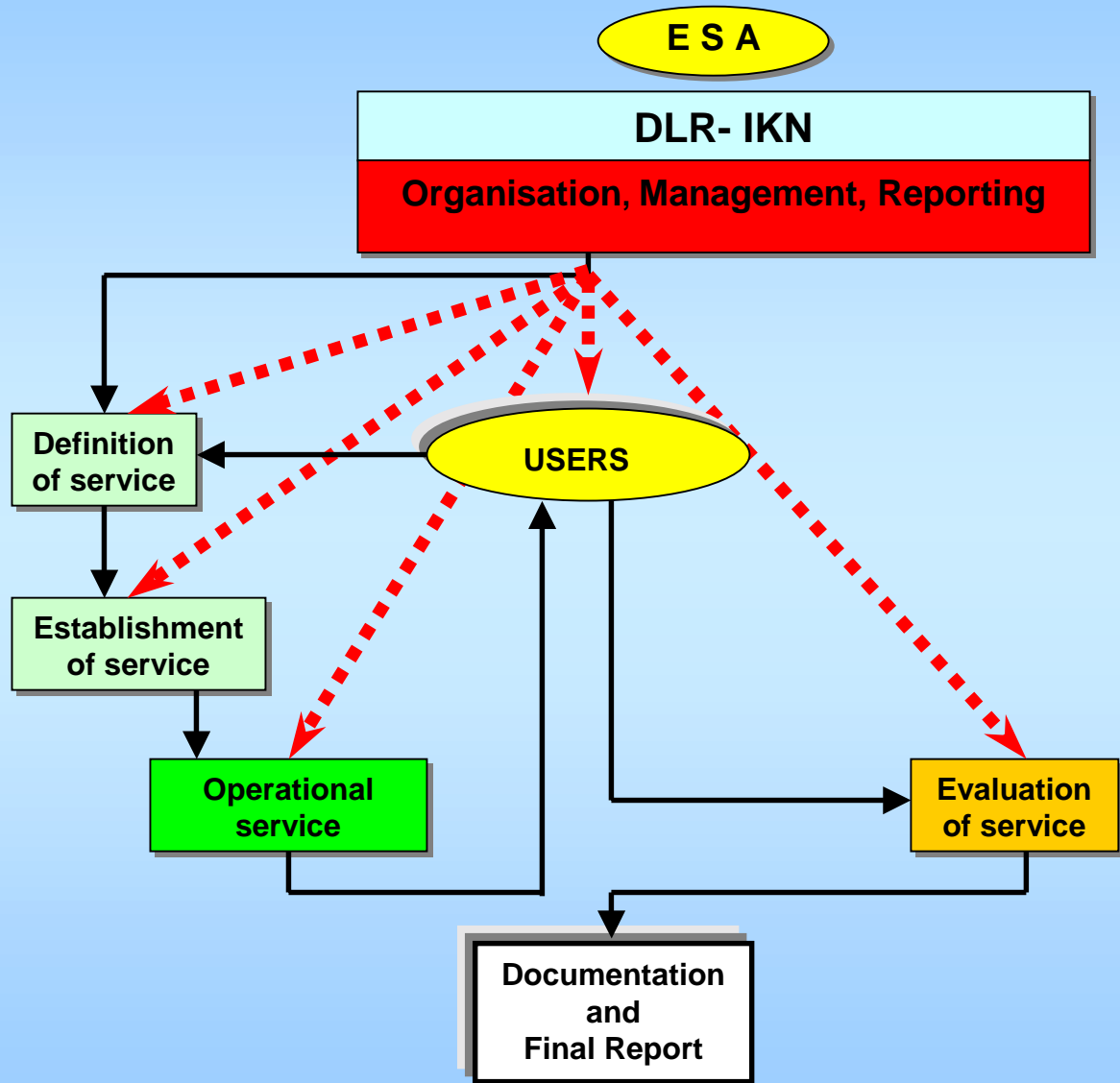
Fixing time for positioning



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



# 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:

- Phase 1:**  
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.