The effects of space weather on communication devices

Student: Sorena Azaripour
Student number: 140384848
Supervised by: Rajesh Tiwari

School of Electrical and Electronic Engineering, Newcastle University, UK.

Introduction:

The performance of many communication devices using global positioning system (GPS) signals on the Earth rely heavily on space weather. The Earths ionosphere has an ionised medium which during strong space weather has peak ionisation levels. When GPS signals pass through time-varying electron density irregularities in this part of the Earths atmosphere, the accuracy and the precision of data is lost due to severe signal refractions causing fluctuations in the phase and amplitude. As a result of this the communication devices can not function in a systematic way. In order to adjust and correct the fluctuation caused in amplitude and phase data from the European network station (EUREF) is picked up, analysed and observed.

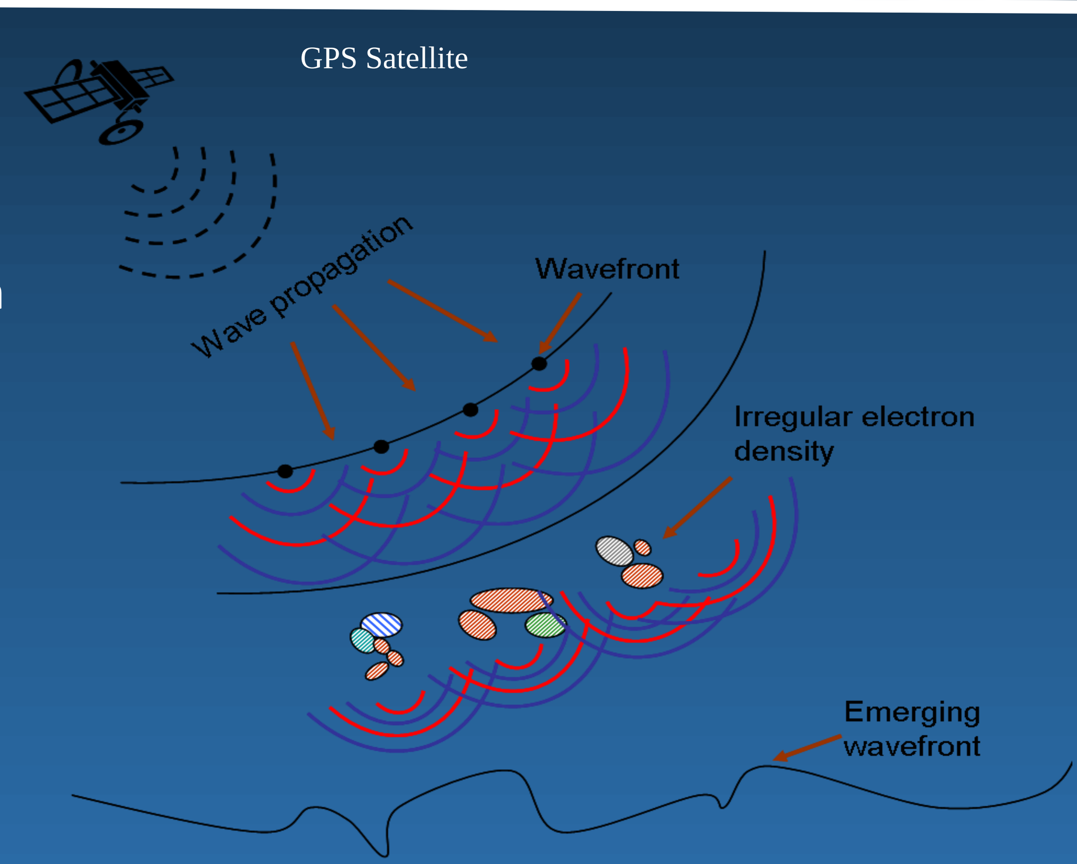

Figure 1: Representation of satellite signals hitting the ionosphere during strong space weather.

Aims:

- To develop understanding on the cause of fluctuations in signals affected by space weather.
- To observe and analyse data from the European network station (EUREF).
- To minimise the effects of space weather on devices using GPS signals.

Method:

- Collect raw data from EUREF.
- Unzip data files in order for the data to be used.
- Data is transformed from compact RINEX format into simplified RINEX.
- Data is analysed and observed.
- Data changed from mixed data into GPS.
- Data is run through an alarming index which presents measurements of the level of fluctuation on signals.

Rinex (Receiver independent exchange format) is a data interchange format that contributes to obtaining a more accurate result. The final result of an input satellite signal is its **speed**, **position** and other physical quantities.

In every observation 3 main quantities are defined:

1. Time - This is the receiver time of the received signal. The time it takes for the data to be transferred from the transmitter to the receiver.

2. Range - This is simply the distance between the satellite receiver and the satellite transmitter.

3. Phase - This is the measurement of carrier phase in whole cycles. This measures the number of whole cycles completed between the receiver and the transmitter.

Results:

After the collected data from EUREF is set to the correct format it is run through a developed alarm index called the Analogus phase index in which the measurement of fluctuations in the satellite signal is calculated and presented in a graph form.

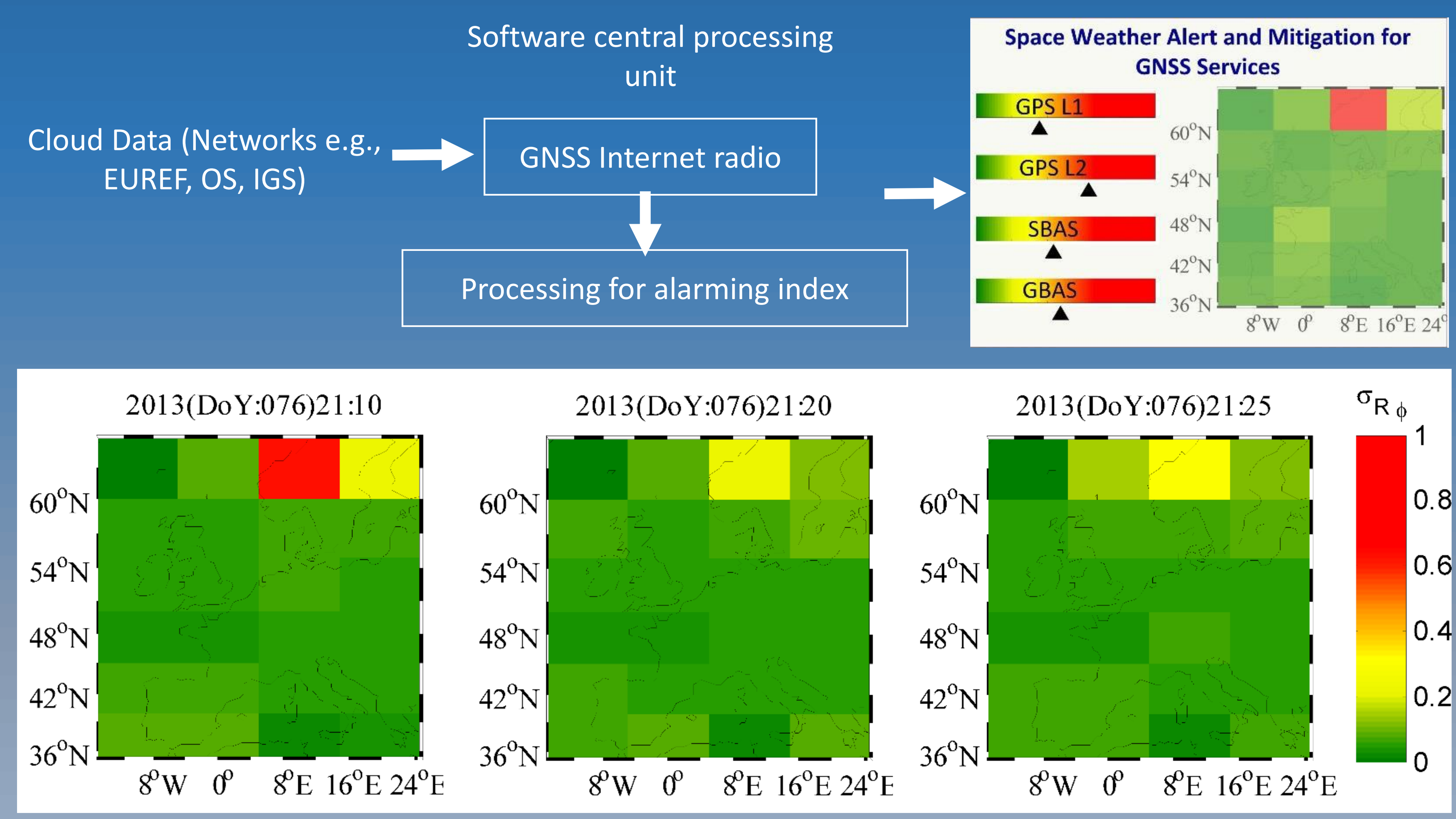

Figure 2: Comparison of measured data across Europe [1]

The graph above shows 3 different alarming indexes showing how much space weather has affected communication devices in different places in Europe during 2013.

- The measurement is labelled in different colours ranging from green to yellow to red scaled between 0-1.
- Starting at 0 in green. This is the *least* level of fluctuation caused on amplitude and phase of signals by space weather.
- At 1 *maximum* fluctuation in amplitude and phase is shown in red.
- Places that are in the area covered by red received the most fluctuated signals, some communication systems do not operate at this measure.

Conclusion:

The overall findings in this project revealed that fluctuations are greater closer to the north pole. However, there are developing technologies which minimise these effects from space by adjusting the refracted signal back to the original correct signal after it has passed through the ionosphere.

Acknowledgments and references:

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[1] -
R. Tiwari and H. J. Strangeways (2014), Regional alarming index for scintillation mitigation, *Space Weather*, 13, 72-85, doi:10.1002/2014SW001115.

Newcastle University