Ionospheric scintillations over the polish LOFAR station PL610

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We present here the observations of ionospheric scintillations obtained with the polish station PL610 of the international LOFAR interferometer. A scintillation phenomenon occurs as a result of variations in the refractive index of the medium through which waves are traveling. In particular, the Earth's ionosphere is a strongly variable medium where high density gradients occur. Scintillation measurements may be successfully used to study the irregular structure of the Earth's ionosphere.

1 Introduction

The Polish station PL610 in Borówiec is a part of the LOFAR interferometer facility. Four days a week the station is used as the part of the international interferometer, during the remaining three days it operates in a local mode. A single LOFAR station consists of two sets of antennas: 96 LBA (low band antennas) operating for 10-90 MHz and 96 HBA (high band antennas) for 110-240 MHz frequency range. The signal from an individual antenna is sampled and digitized with frequency of 200 MHz, and can be formed into a beam pointed at target source. LOFAR gives the opportunity of directional observations (beam forming) which allows observing both distant and close radio sources such as the Sun or Jupiter, as well as studying certain regions of the medium in between.

2 Observations

Observations of two strong radio-sources (Cassiopea A and Cygnus A) were made using LBA antennas in the 8-30 MHz frequency range. The amplitude of signal was recorded with the frequency resolution of 195 kHz and 1 s time resolution. Signal requires normalization due to many factors including: the difference in antenna sensitivity depending on the frequency, changes in the signal level during the day, and the local radio interferences measured. For scintillation measurements, within every 5 minutes, the signal at each frequency is divided by the median value of the signal in the given channel.

3 Summary

Variations of the signal amplitude from Fig. 1 clearly show that the signal is significantly structured by the diffraction on the plasma irregularities. Clear diurnal changes in the observed pattern of the measured amplitude can be seen. The geometry of the observations is presented in Fig. 2. It should be noted that the sunrise

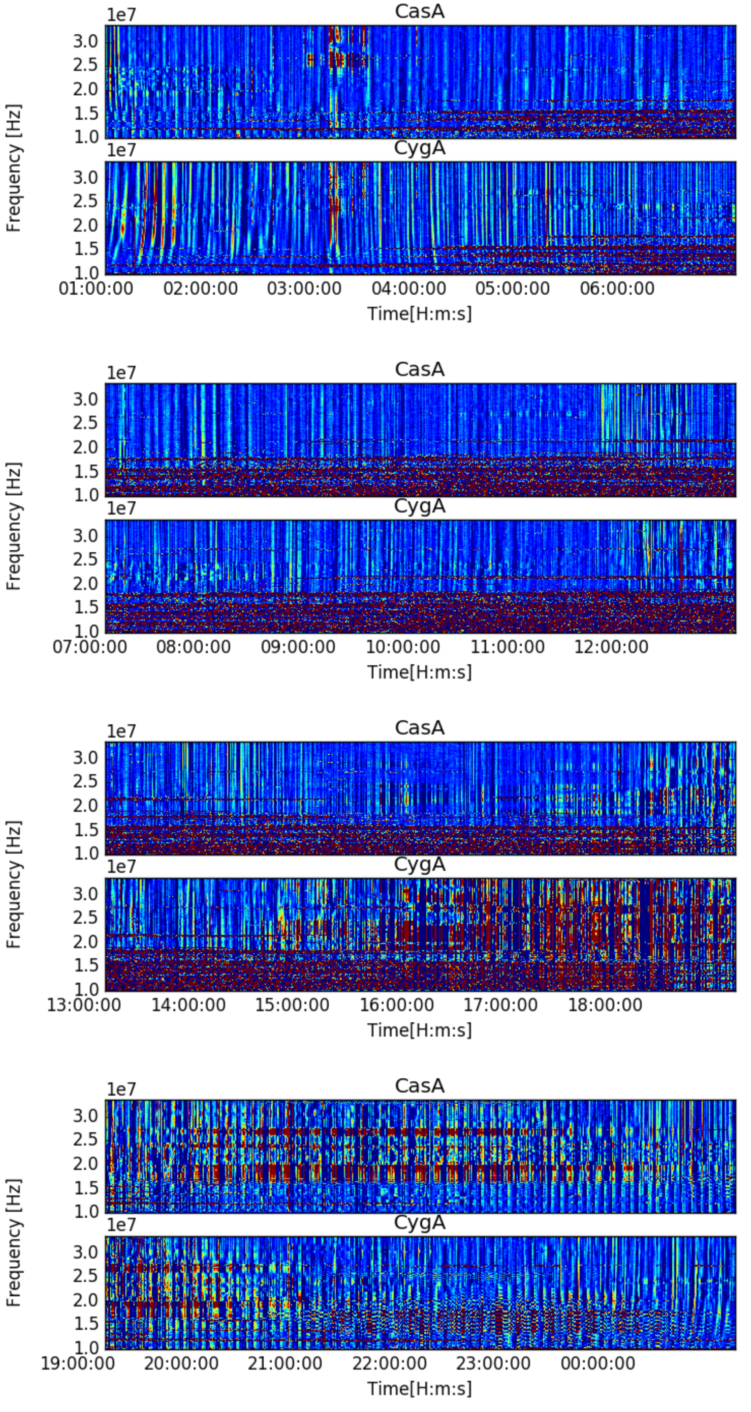

Fig. 1: Daily changes of measured signal amplitude from Casiopea A and Cygnus A. Single plot represents six hours of data. Color range is only illustrative and shows signal amplitude variation (weaker signal bluish and stronger reddish).

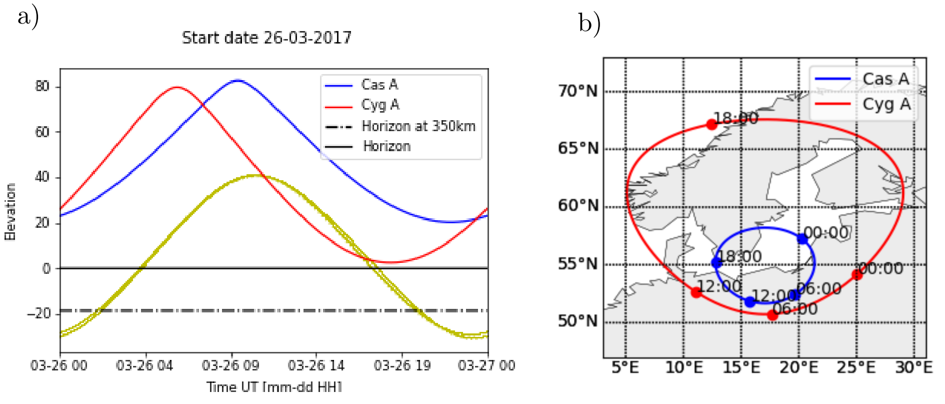

Fig. 2: a) The elevation of the radio sources, the Sun (yellow line) with marked positions of horizon is shown. b) Position of the pierce point for 350 km above surface for two radio sources.

occurs earlier at the altitude of 350 km (estimated altitude of maximum concentration of electrons) than at the ground level. This is because the location of the horizon at 350 km height is about 18 deg below the ground level horizon. The effect of the sunrise is particularly noticeable. At night and just after the sunrise, the structures are stronger and they follow each other with larger intervals. They also show dispersion – signals at different frequencies coming at different times.

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