LOFAR ionospheric scintillation spectral measurements in mid-latitude region.

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EGU General Assembly 2022, Vienna

LOFAR and LOFAR PL610 Station

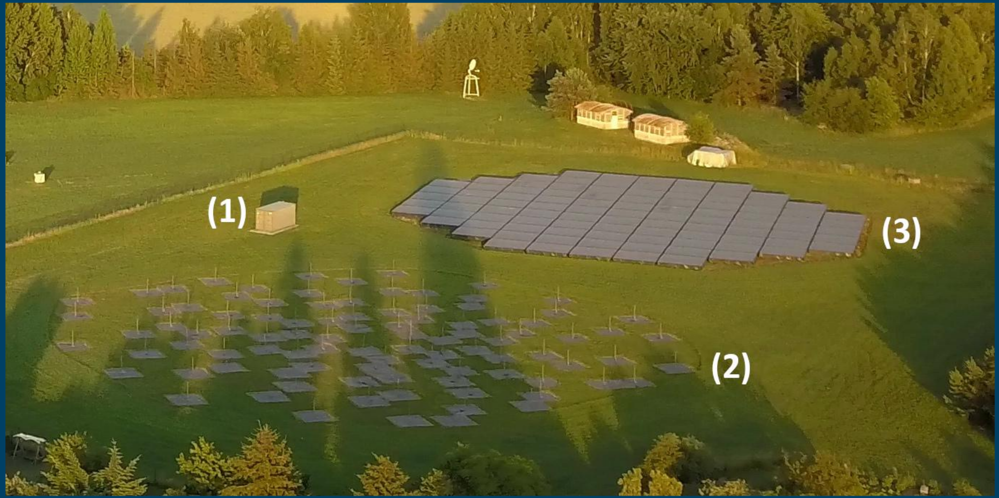
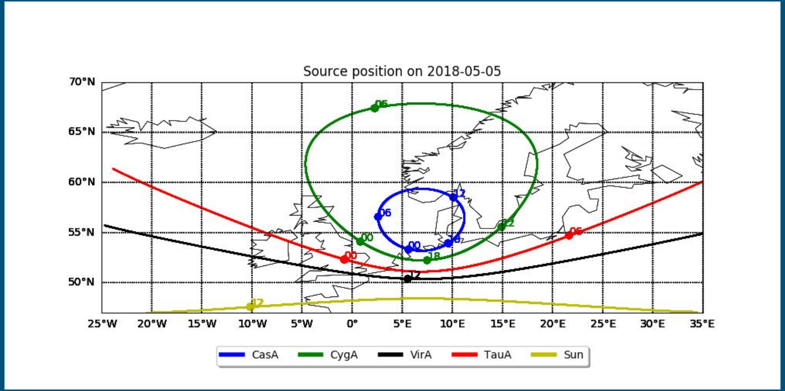


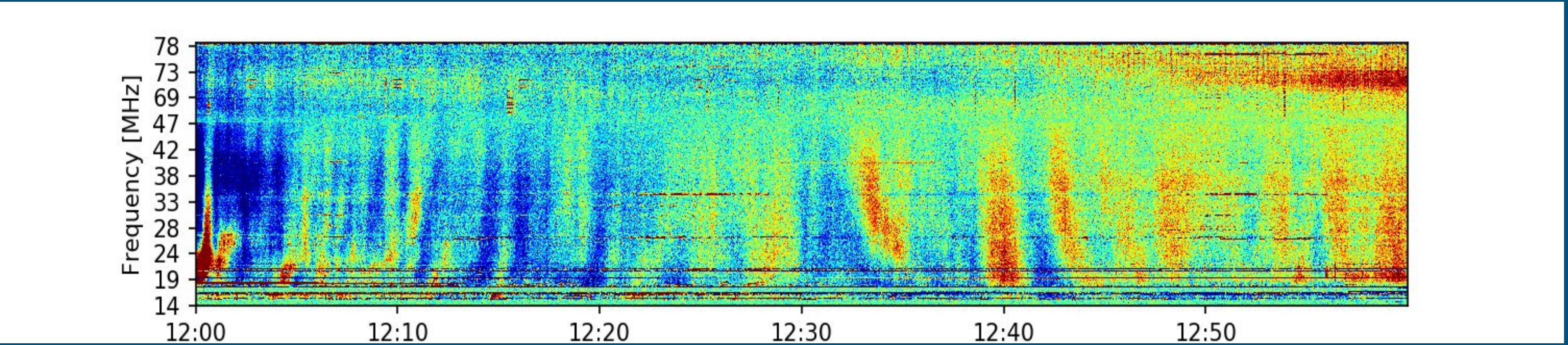
Fig. 2: LOFAR PL610 Station in Borówiec, Poland (52°16'32.7"N, 17° 04'25.5"E), owned by SRC PAS; (1) the container with electronic equipment, (2) LBA antennas, (3) HBA antennas.

LOFAR stations, Credits: ASTRON

Scintillation measurements on PL610

- Simultaneous observation up to 4 directions,
- Four strongest radio sources (LOFAR A-Team sources) for scintillation observation purposes,
- 244 frequency channel for each direction,
- 100 samples per second.





Pipeline for S_4 processing

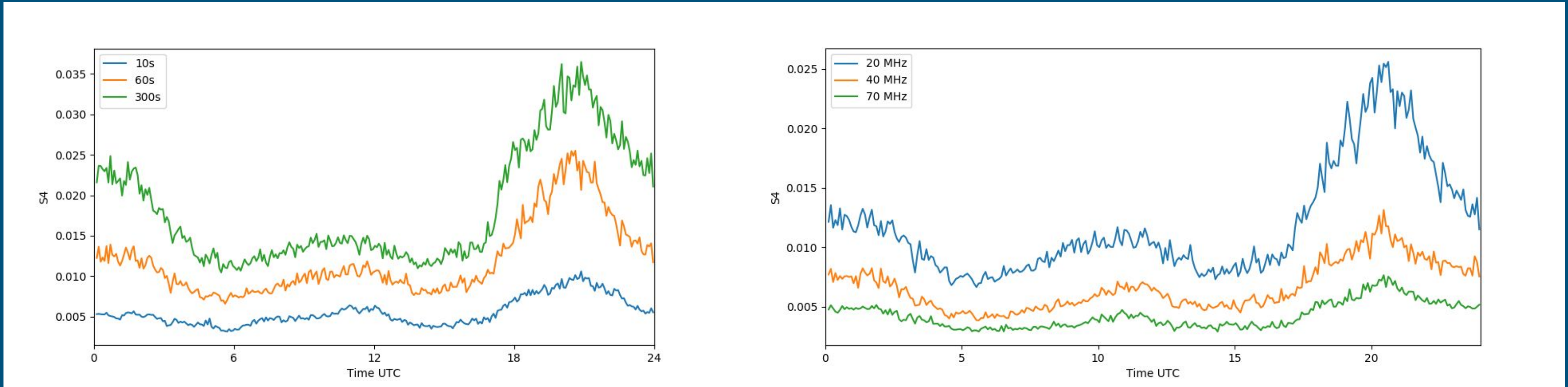


Fig. 11: S_4 index median for (left) different time span, (right) different subband depending on the time of a day.

- Automatic data filtration and S_4 index computation for all subbands and time spans,
- Computation of pierce point location, geomagnetic coordinates, local time, geomagnetic indices,
- Storing in database for simplified statistical analyses.

S_4 index measurements

Strong rise in S_4 index at approximately 4:00 pm UTC is related to the drop of value of Dst index during the main phase of the magnetic storm, followed by high scintillation activity at the start of recovery phase.

There seems to be no dependence on frequencies in the initial peak of the storm, then there is a decrease in the signal observed for low frequencies in the recovery phase.

The plot showing S_4 for different integration times, presents dependence on phase of the storm. At the beginning the dependence is minimal, then it drops down for the shortest integration times during recovery phase of the storm.

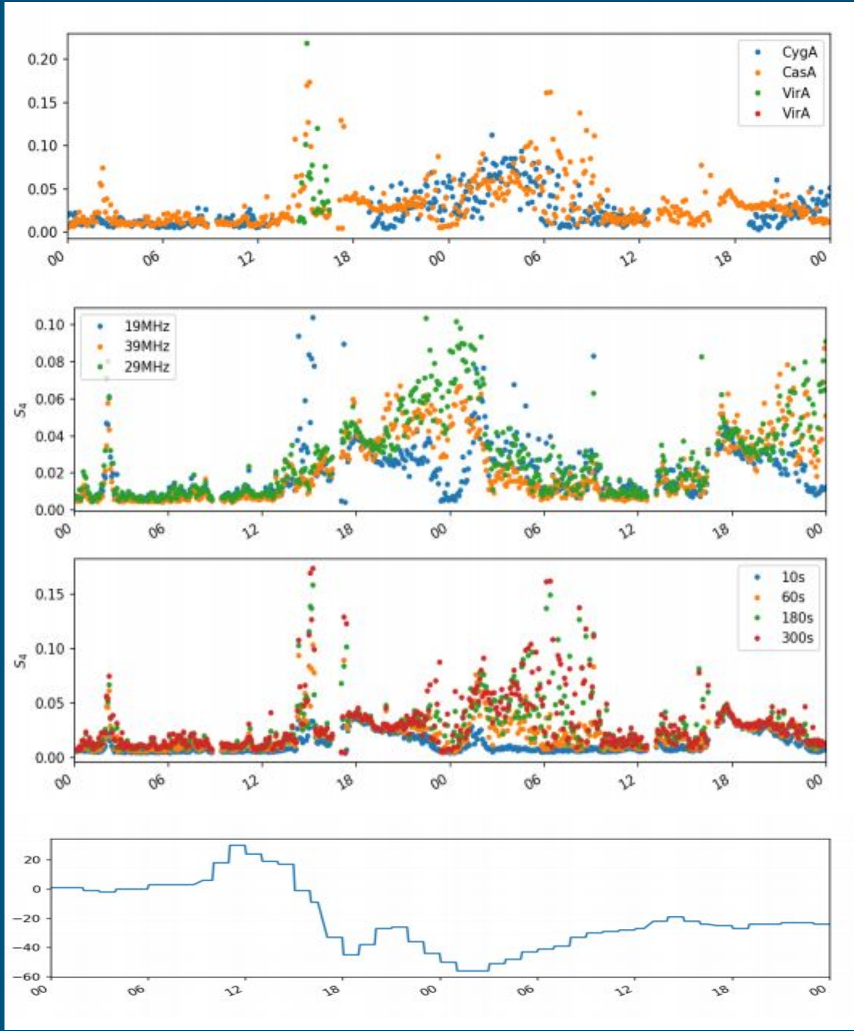
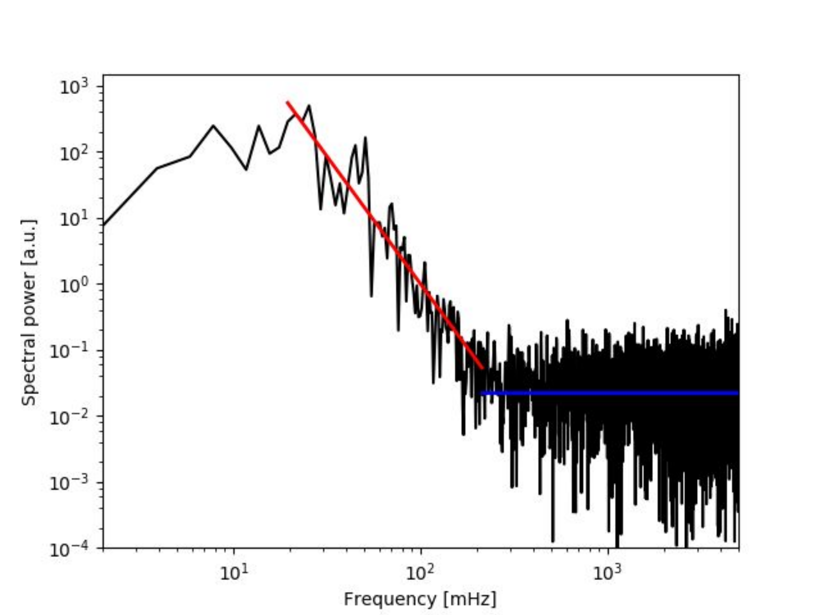


Fig. From top to the bottom: (1) The S_4 index for 20 MHz for available A-Team sources, (2) The dependence of S_4 index on observed frequencies for CasA, (3) The dependence of S_4 index on different integration times for CasA. (4) The Dst during the magnetic storm.

Fitting Spectral Index

- Estimating spectral slope directly related to ionospheric irregularities,
- Additional parameters can be fitted (noise level, fresnel frequency, scintillation spectral range, as well as parameters allowing estimation of the quality of the fit).



Conclusions

Spectra give the possibility to gain more information than just index s4 from processed signal. They also enable the evaluation of the signal quality and the elimination of unwanted signals.