ASTRON

Netherlands Institute for Radio Astronomy

LOFAR

Simultaneous Nightside Interplanetary and Ionospheric Scintillation

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A recent MWA paper claimed to see night-side interplanetary scintillation (IPS) in imaging observations at a time cadence of 2s.

The usual time-scale for IPS is ~2s.

Naturally, this has caused some disquiet in the IPS community.

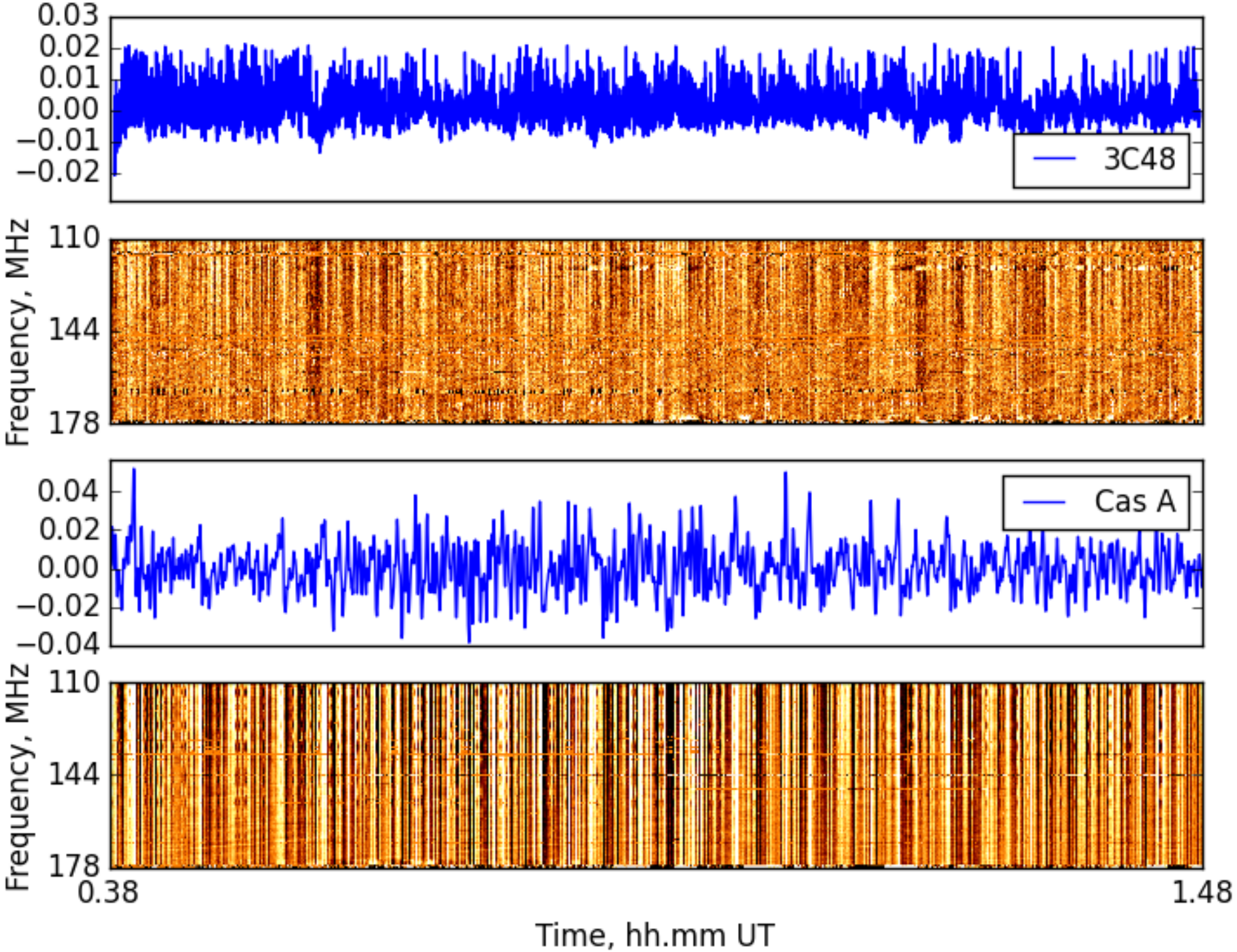
With LOFAR, we can check: can this be IPS? Or is it more likely to be ionospheric scintillation?

Observations

In November 2015, a couple of night-time observations of the excellent IPS source 3C48 were taken, using the remote stations.

Simultaneously, the core stations looked at Cas A.

Scintillation was seen.

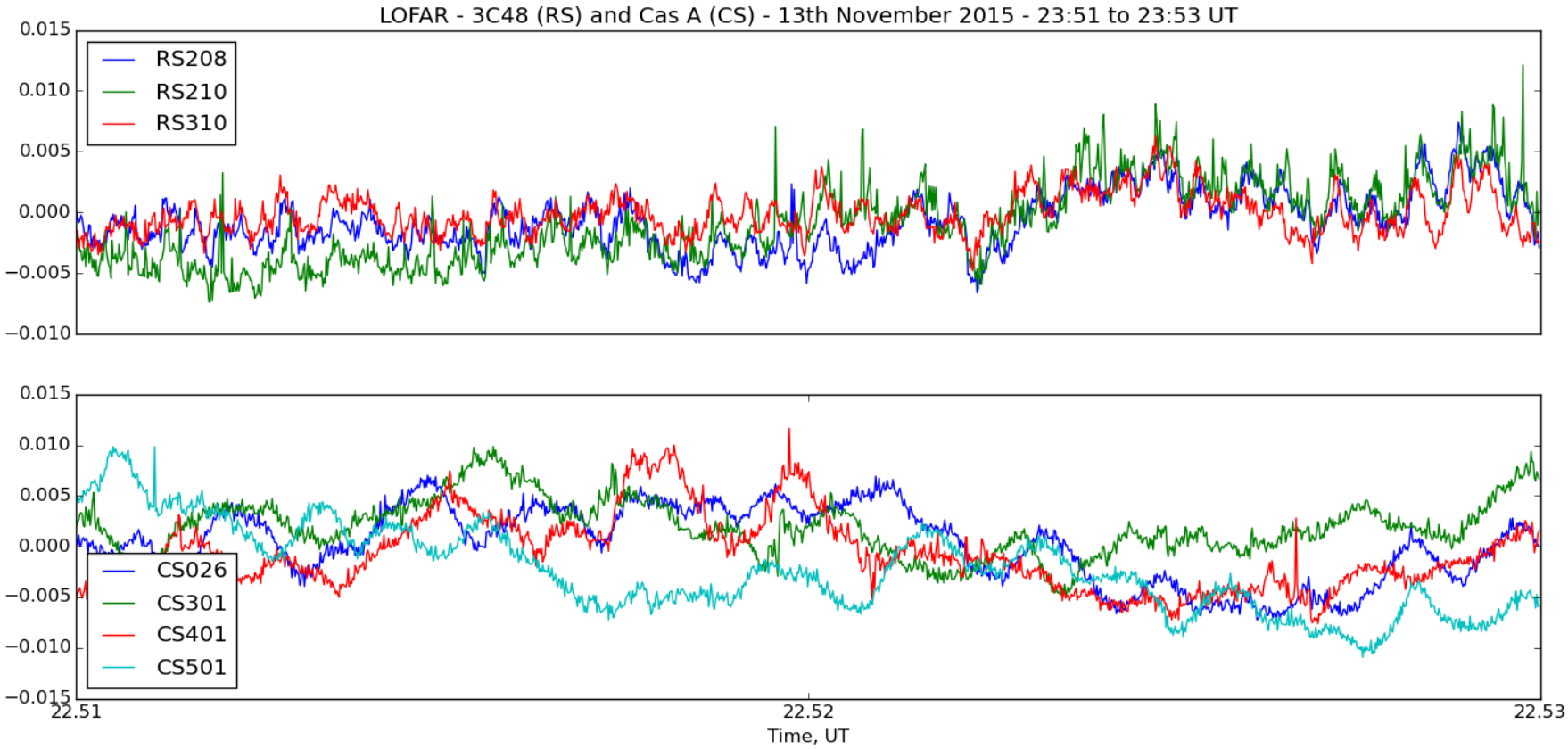

0.03
0.02
0.01
0.00
−0.01
−0.02
3C48
Frequency, MHz
110
144
178
0.04
0.02
0.00
−0.02
−0.04
Cas A
Frequency, MHz
110
144
178
0.38
1.48
Time, hh.mm UT

Use cross-correlation to establish the likely origin of the scintillation:

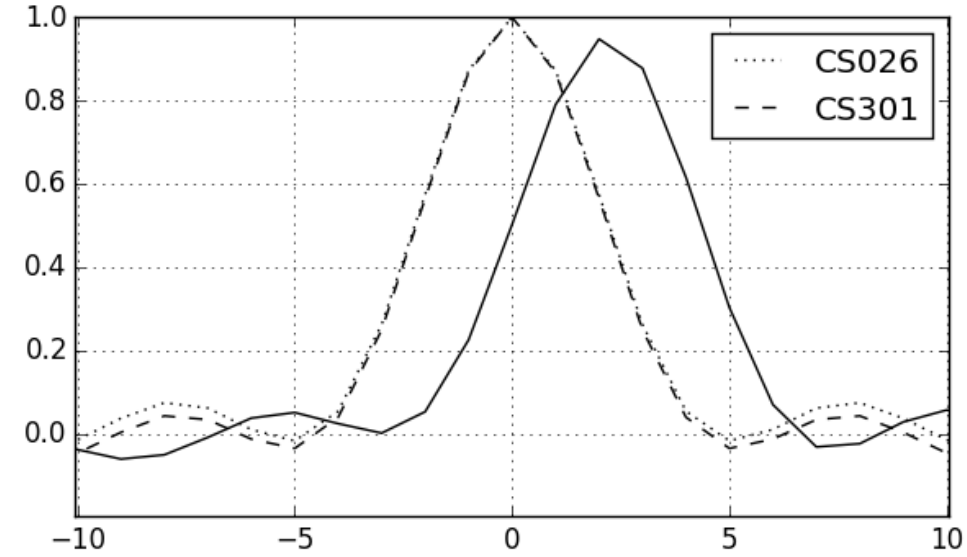
A time lag of several seconds is expected on core station baselines for ionospheric scintillation.

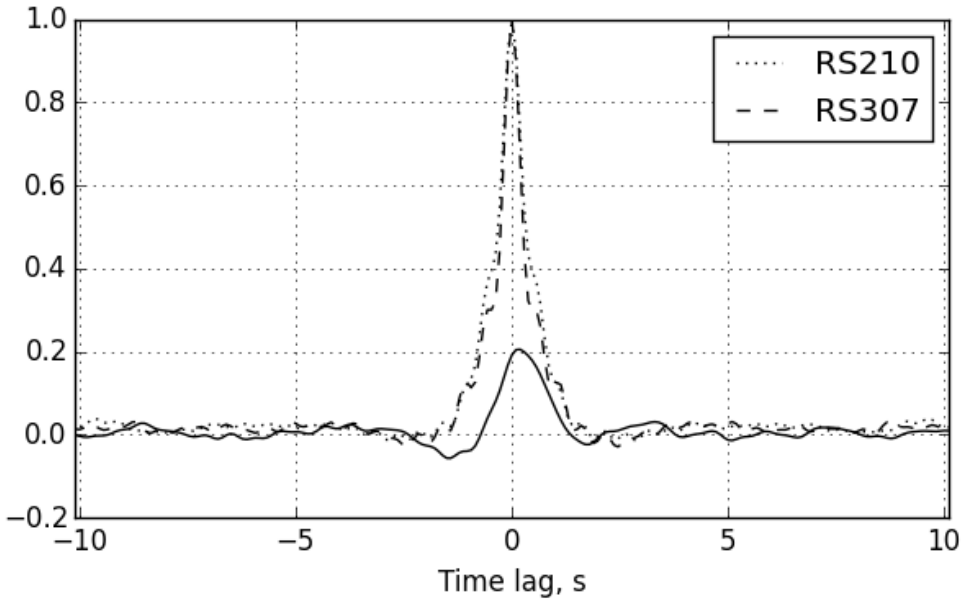
For IPS, remote station baselines should still see time lags <<1s.

Time Series'

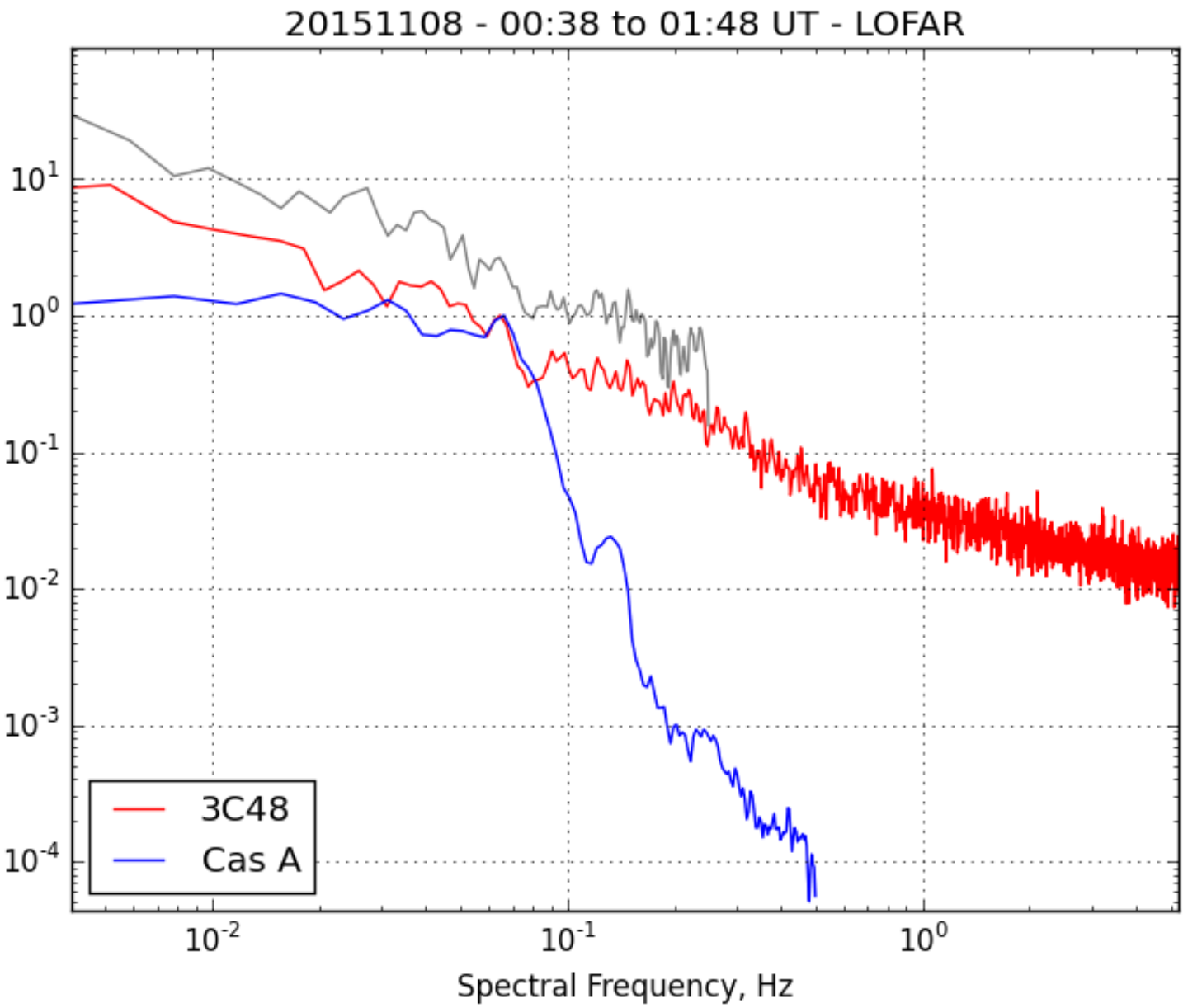

LOFAR - 3C48 (RS) and Cas A (CS) - 13th November 2015 - 23:51 to 23:53 UT
RS208
RS210
RS310
CS026
CS301
CS401
CS501
0.015
0.010
0.005
0.000
−0.005
−0.010
−0.015
22.51
22.52
22.53
Time, UT

Cross-correlation Functions

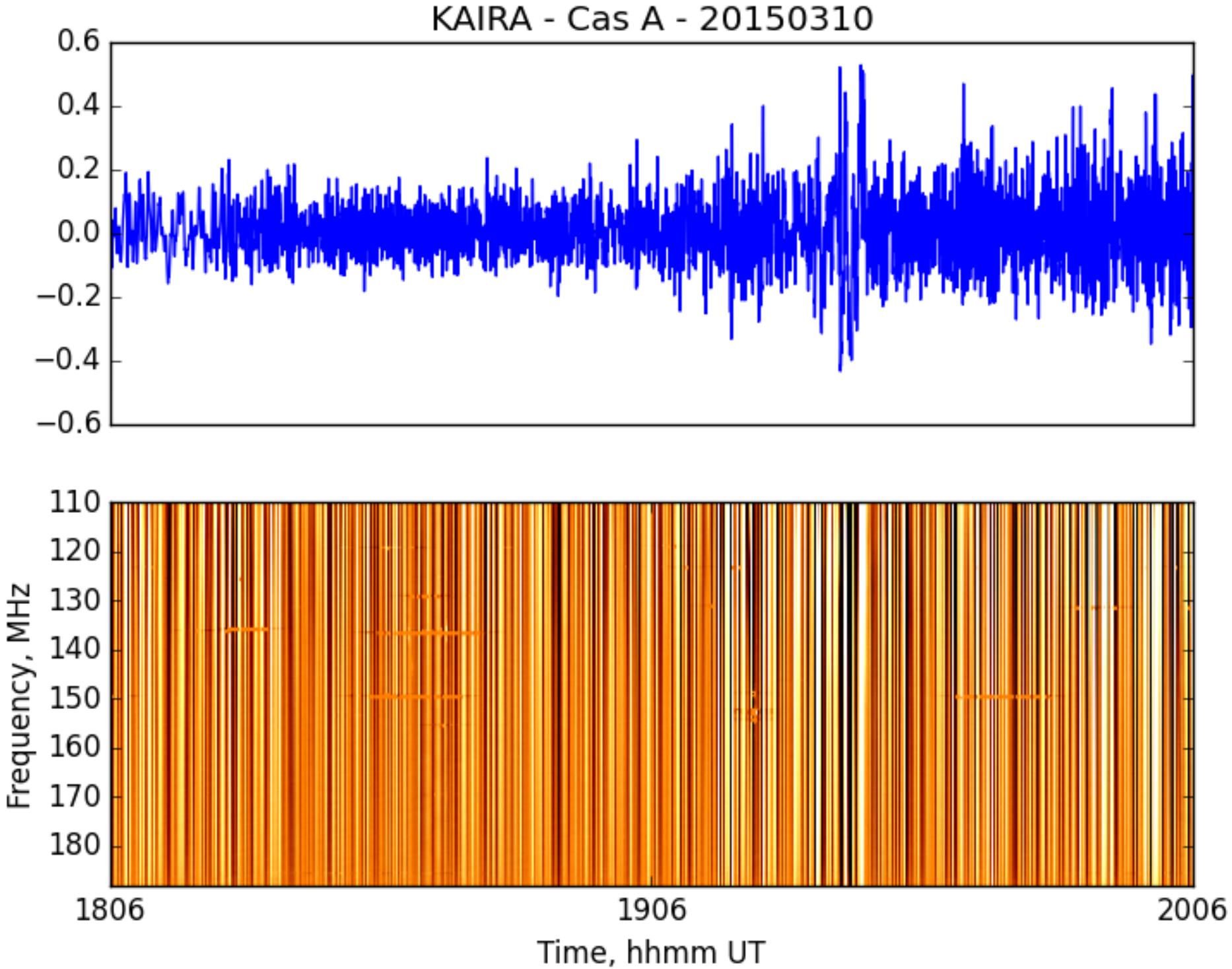


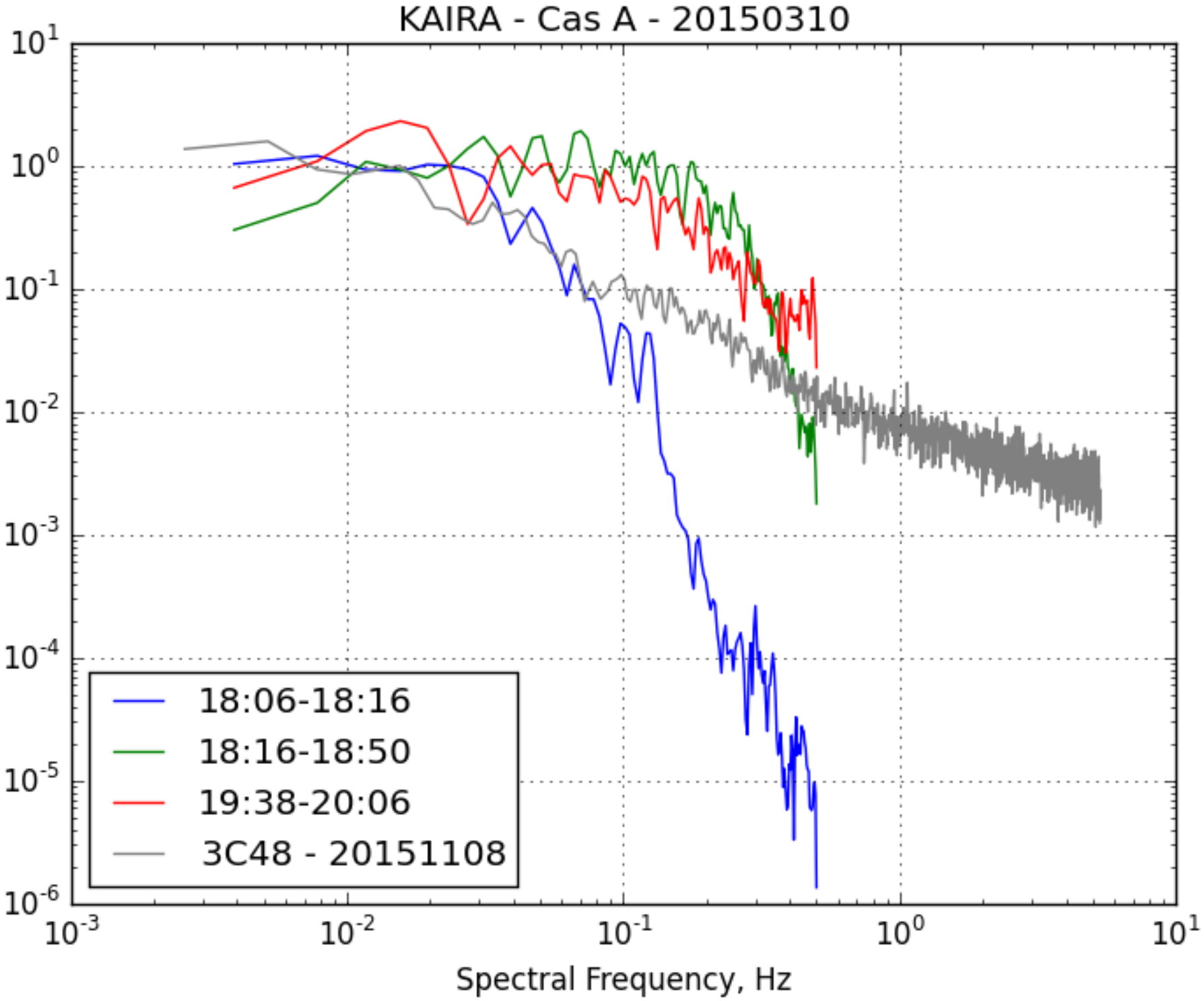


Power Spectra



In this example, the power spectra appear distinguishable. But is there ever an occasion when ionospheric and interplanetary scintillation could be confused?


KAIRA - Cas A - 20150310
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6
110
120
130
140
150
160
170
180
Frequency, MHz
1806
1906
2006
Time, hhmm UT


KAIRA - Cas A - 20150310
10^{1}
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-3}
10^{-2}
10^{-1}
10^{0}
10^{1}
Spectral Frequency, Hz
18:06-18:16
18:16-18:50
19:38-20:06
3C48 - 20151108

So yes. There can be occasions when scintillation from both media could be confused. But under what circumstances?

That is a more substantial question and the study is only just beginning.

Fallows et al., in prep, 2016