A LOFAR image of SS433 / W50

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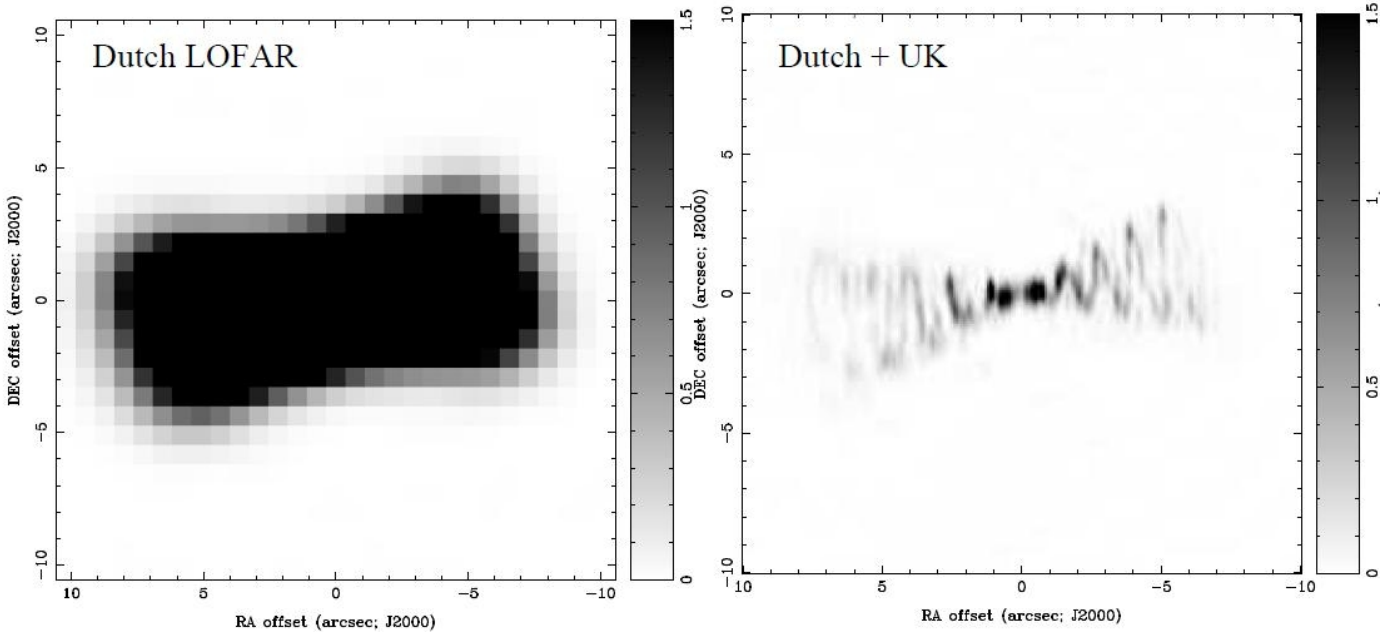
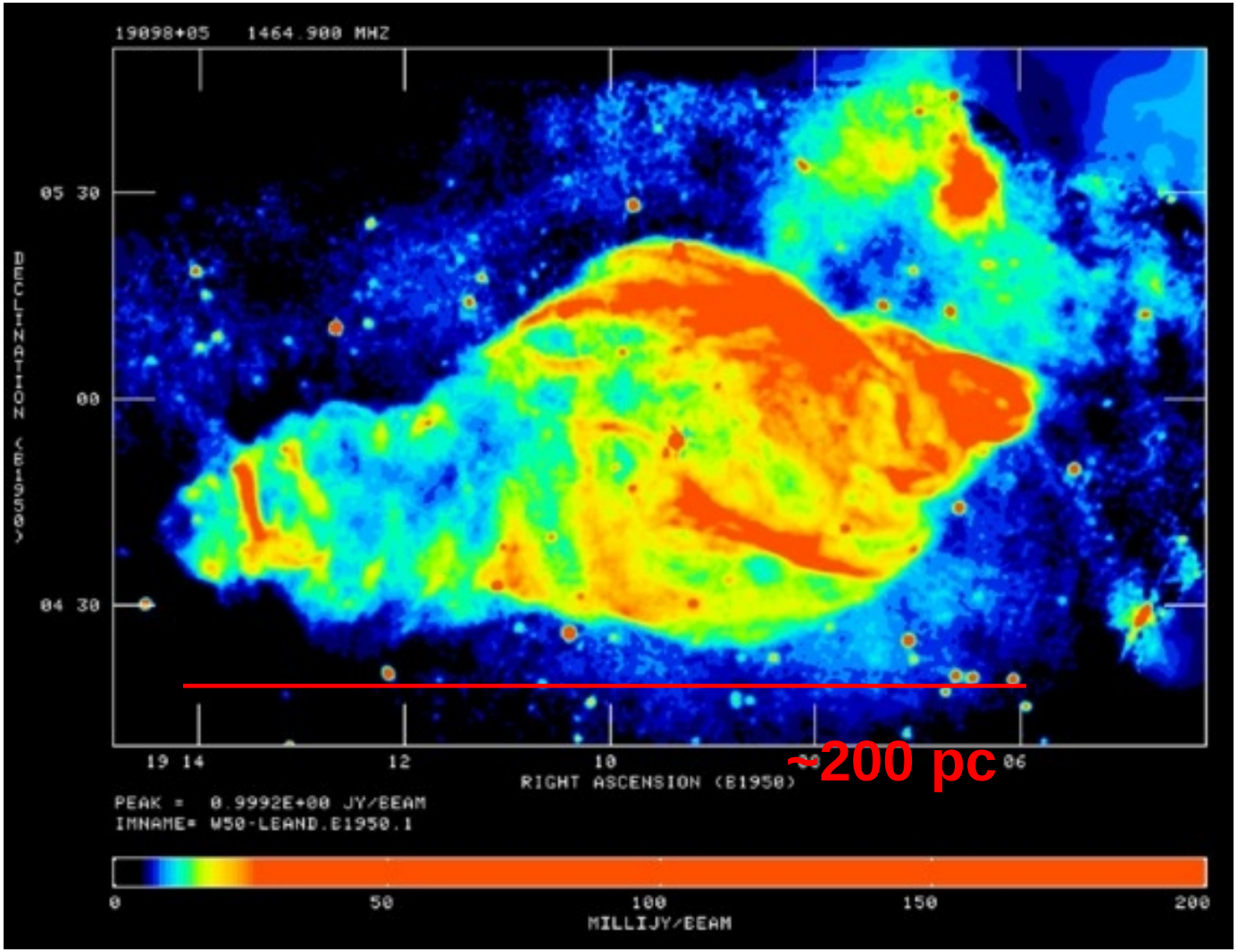
and the LOFAR Transients KSP

SS433 / W50

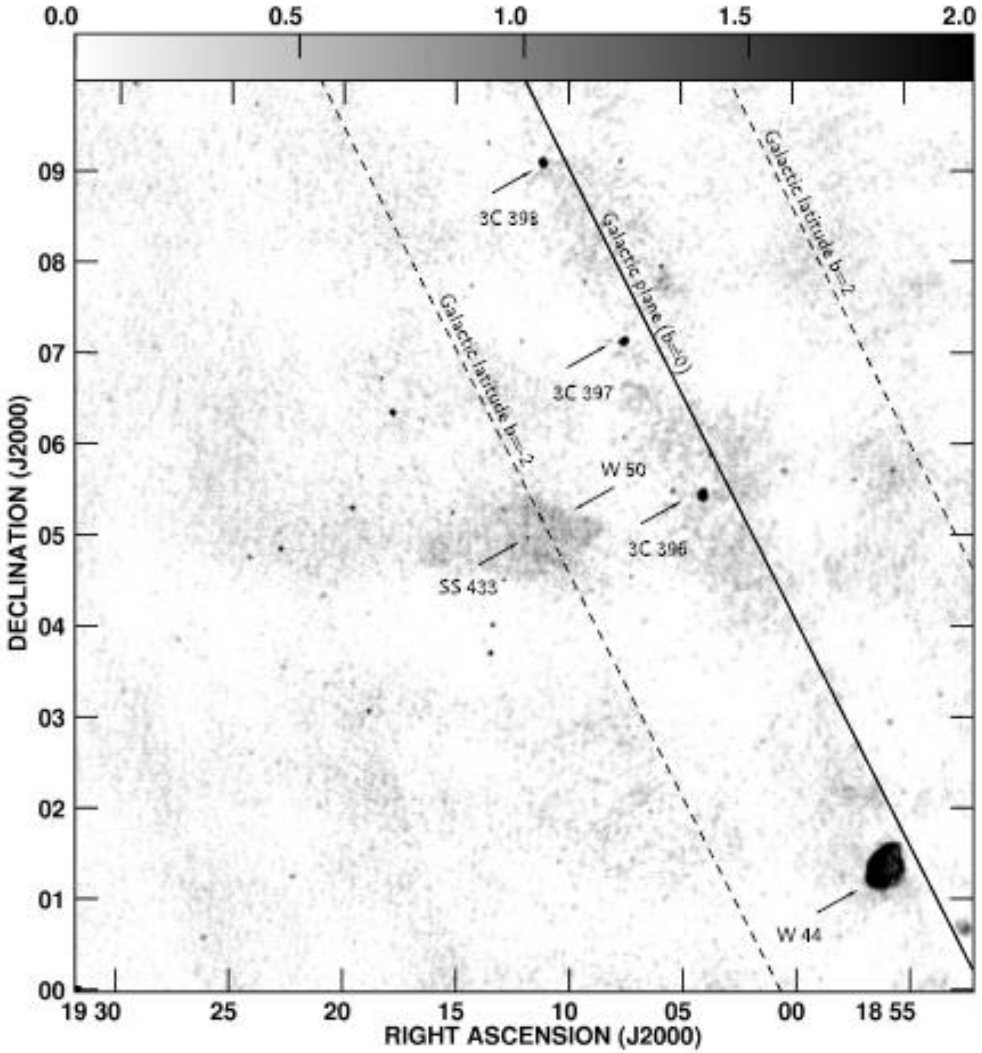
- Famous Galactic microquasar
- RA 19 11 49.57, Dec +04 58 57.9 (J2000)
- D = 5.5 kpc
- W50 nebula ~20 000 years old.
- Mildly-relativistic (v = 0.26c), precessing jets (precession period 162.5 days) from SS433 inflate ‘ear-like’ structures in W50.



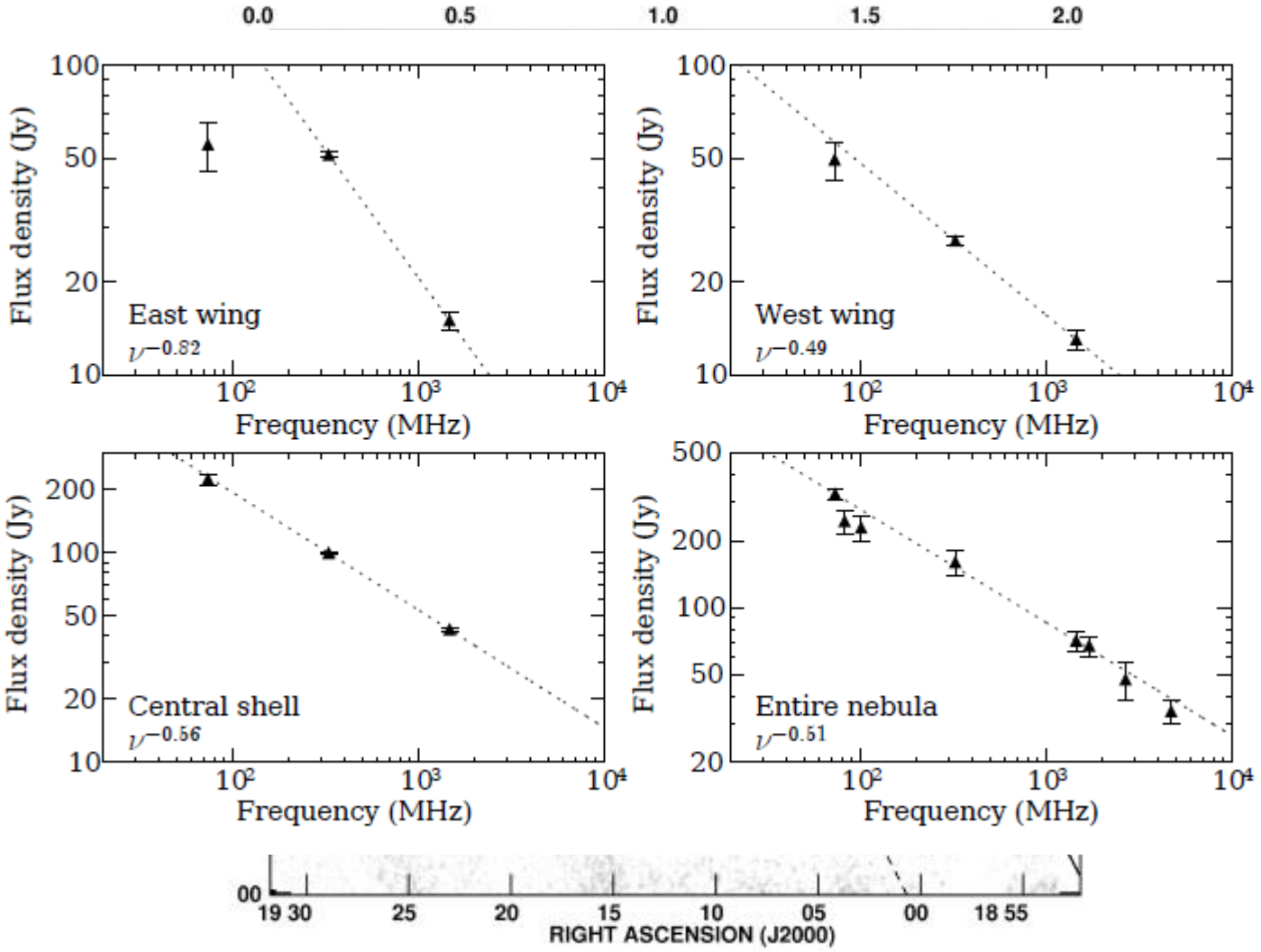
LOFAR simulations of central region (Cashman, Hill & Fender; LOFAR workshop 2007 April).



- VLA 1465 MHz map (Dubner et al., 1998, AJ, 116, 1842). Resolution 56 arcsec x 54 arcsec, rms 0.5 mJy/beam.
- See http://images.nrao.edu/object/index.php?id=266)



- VLA 74 MHz map (Miller-Jones et al., 2007, PoS(Dynamic2007)011). Resolution 108 arcsec x 93 arcsec, rms 192 mJy/beam.



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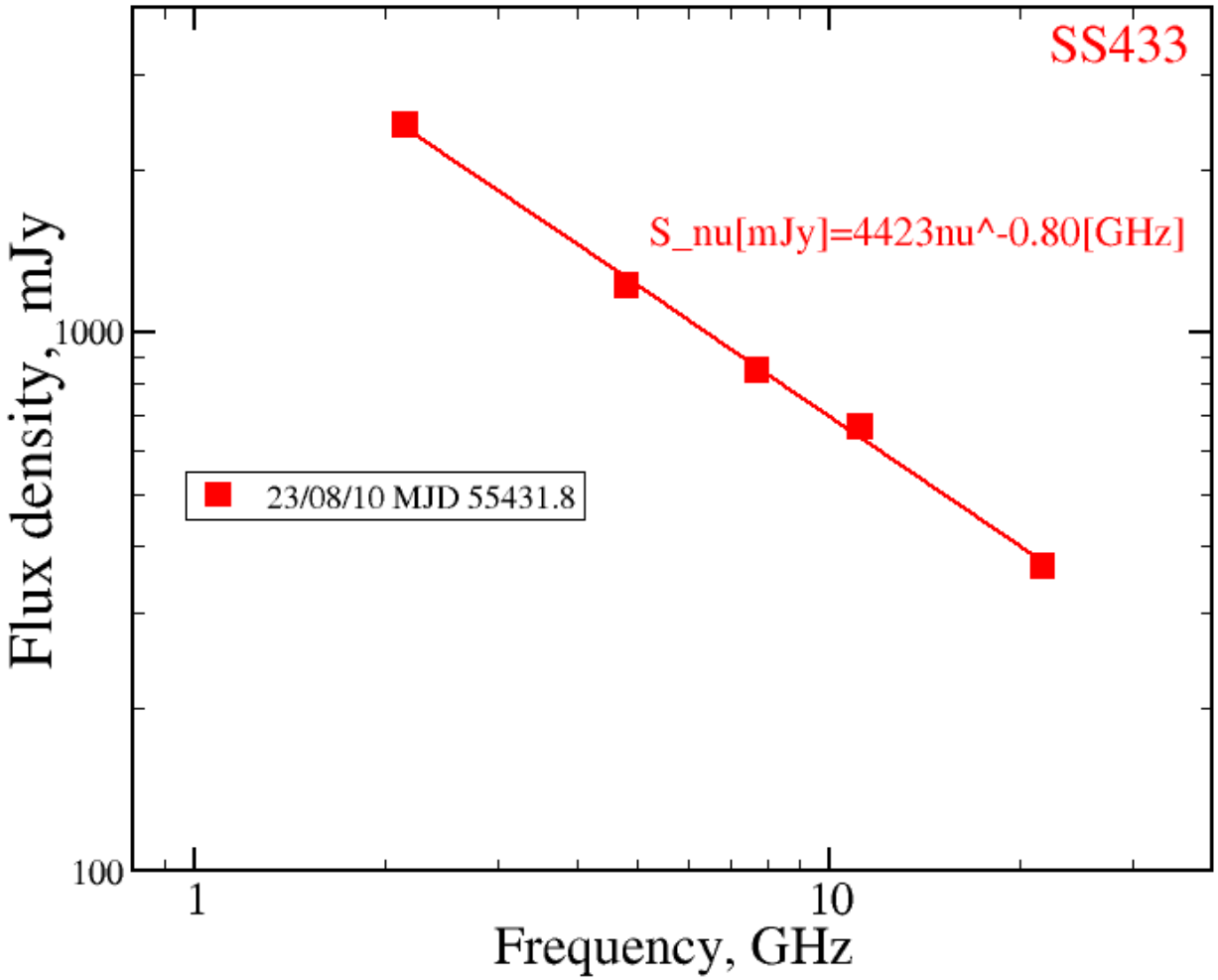
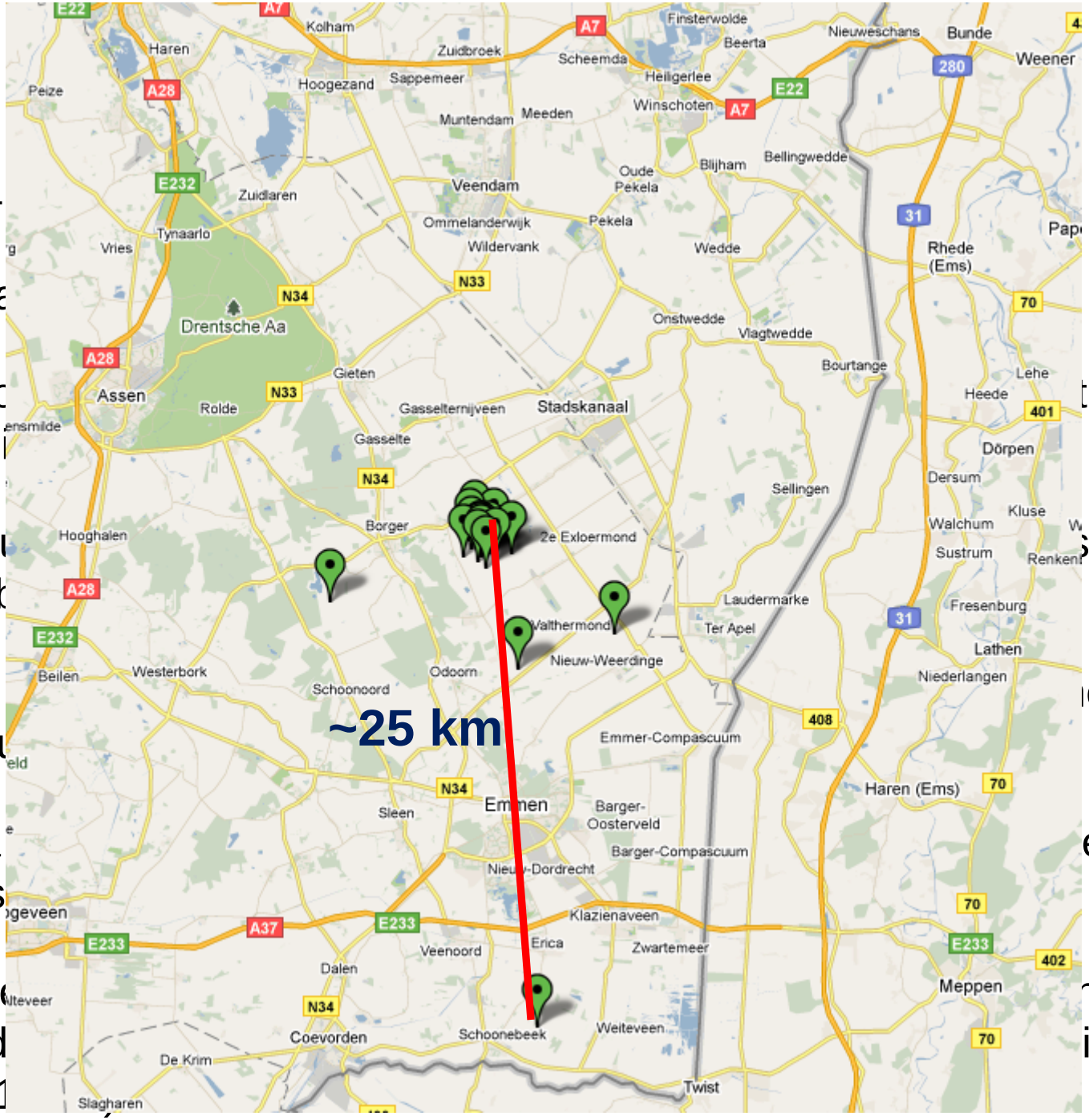


- Radio SED 2010 August 23 (http://cats.sao.ru/~satr/XB/SS433/SS433_sp_2010Aug23.png)
- ‘A very bright radio flare of SS433’ - ATel #2812 (Trushkin and Nizhelskij; SAO RAS)

A LOFAR image of SS433 / W50

- 2 x 4 hr runs (2010 August 25 & 26).
- UT range 18:23 – 22:23 in both cases.
- 15 core stations (each with 2 HBA ears) + 4 Dutch remote stations. Nominally 561 baselines.
- Frequency range 115-163 MHz; 248 subbands; 256 channels per subband.
- Raw data no longer exist for both runs; deleted from storage nodes to free up space.
- Data processed through an initial round of flagging and compression are still available on the LOFAR computing nodes.
- Processed data compressed in time and frequency; integration time per data point 5 s and only 1 channel per subband (channel width 183.1 kHz).

- 2 x 4
- UT ra
- 15 cc tions. Nomi
- Frequ s per sub-b
- Raw odes to free u
- Data ession are s
- Proc n time per d idth 183.1



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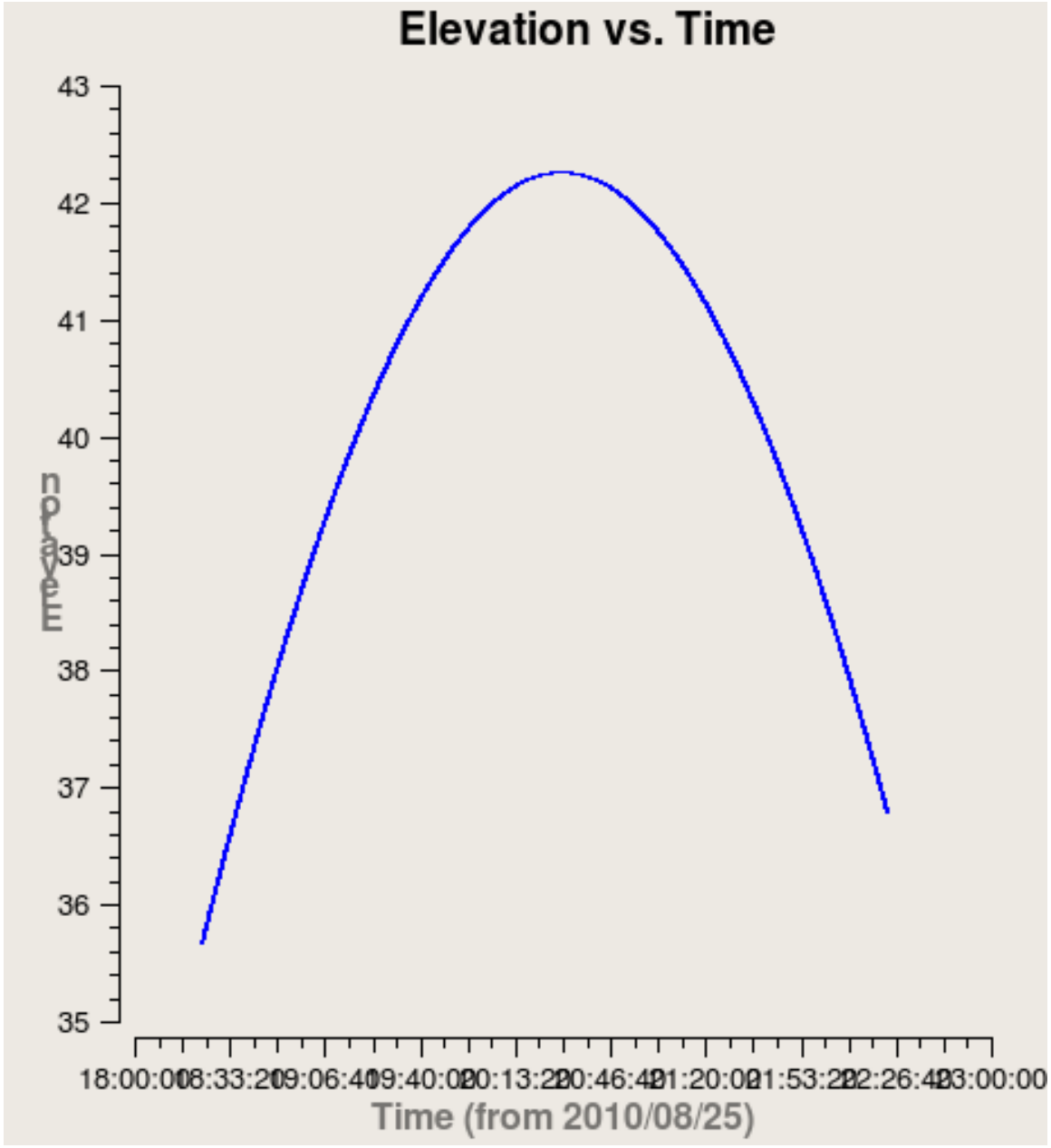
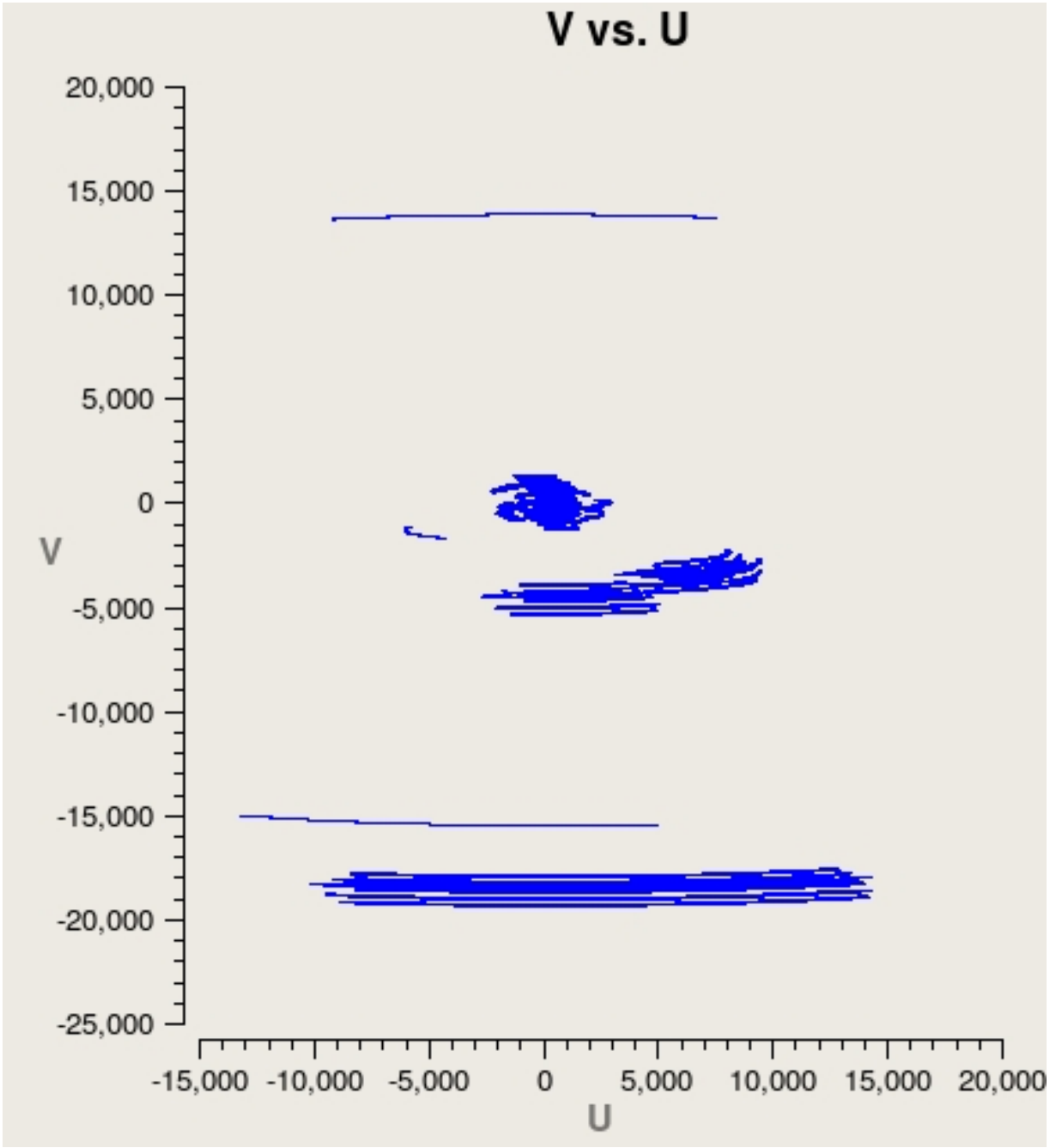
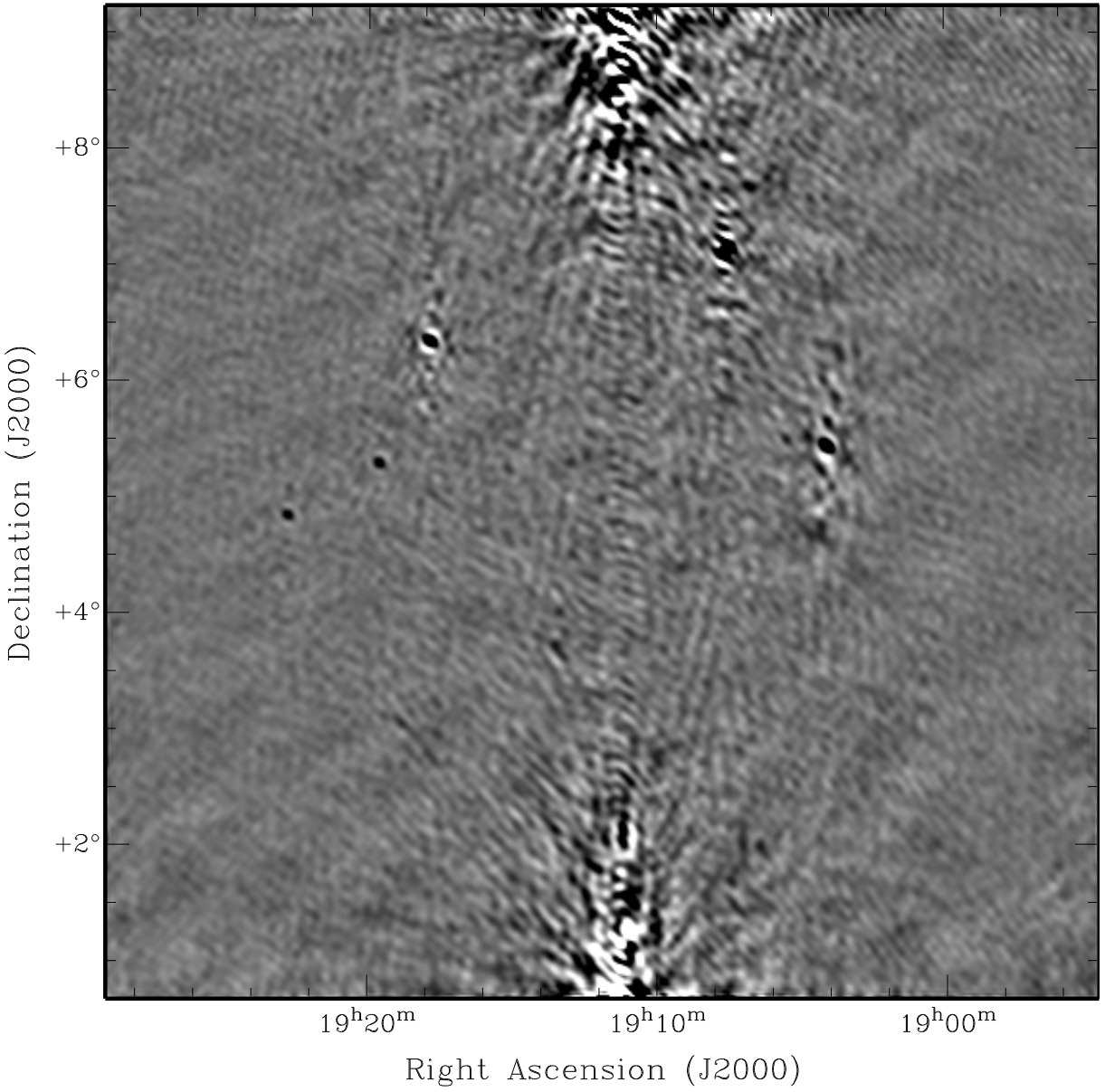

Elevation vs. Time
43
42
41
40
39
38
37
36
35
18:00:00
08:33:20
09:06:40
09:40:00
20:13:20
20:46:40
21:20:00
21:53:20
22:26:40
23:00:00
Time (from 2010/08/25)


V vs. U
20,000
15,000
10,000
5,000
0
-5,000
-10,000
-15,000
-20,000
-25,000
V
-15,000
-10,000
-5,000
0
5,000
10,000
15,000
20,000
U

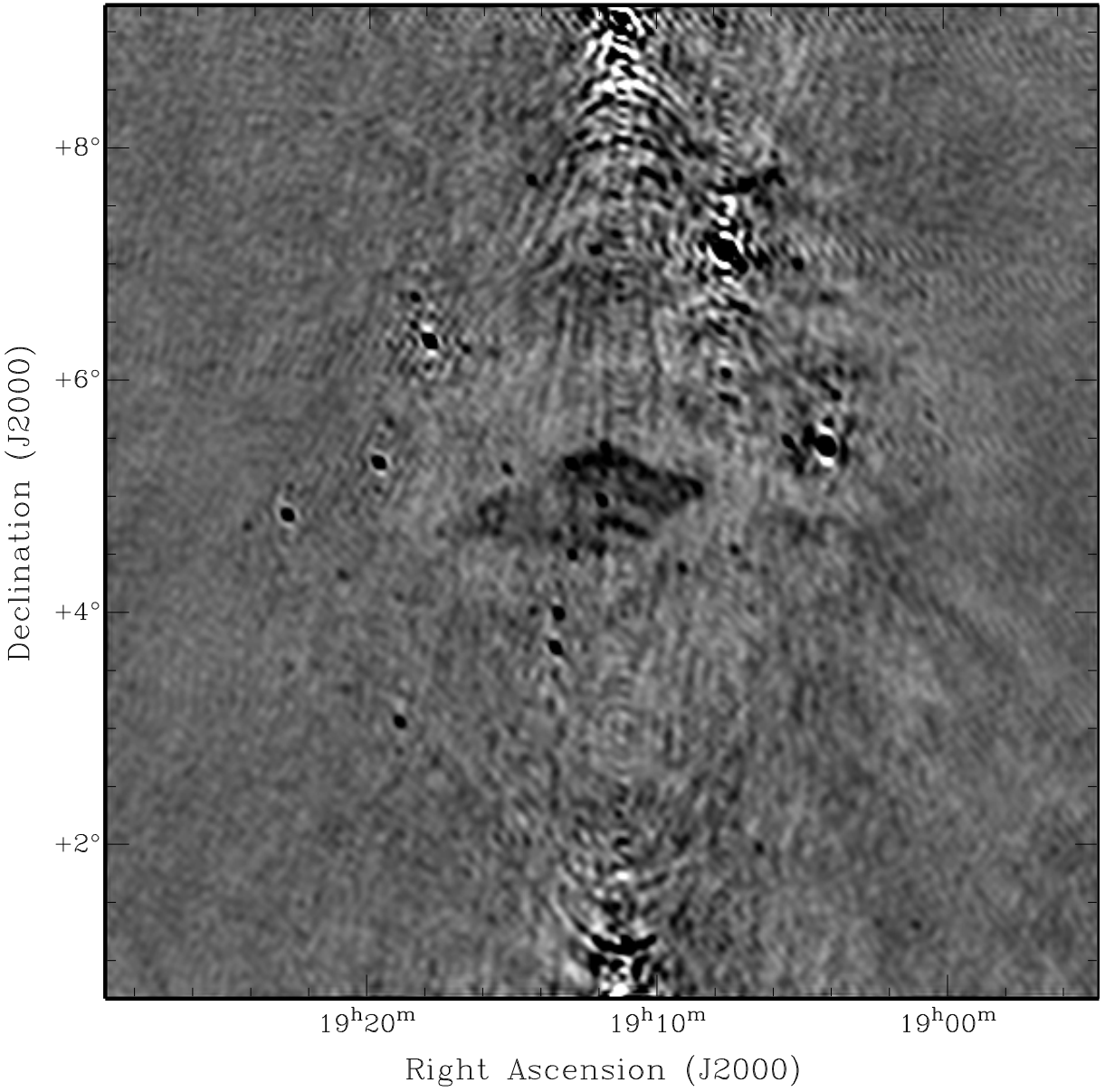
Data reduction

- Data processed through the LOFAR imaging pipeline.
- Initial compression and flagging with the New Default Pre-Processing Pipeline (NDPPP).
- Calibration carried out using BlackBoard Selfcal (BBS) and a (somewhat crude) sky model derived from VLSS and NVSS catalogues.
- Further flagging with NDPPP to remove bad calibration solutions.
- Images made for each sub-band with the ASKAP imager (cimager). These images can then be averaged together (but eventually we really want to combine sub-bands in the *uv* plane before imaging).
- Whole process can take many hours, especially if large images are required.

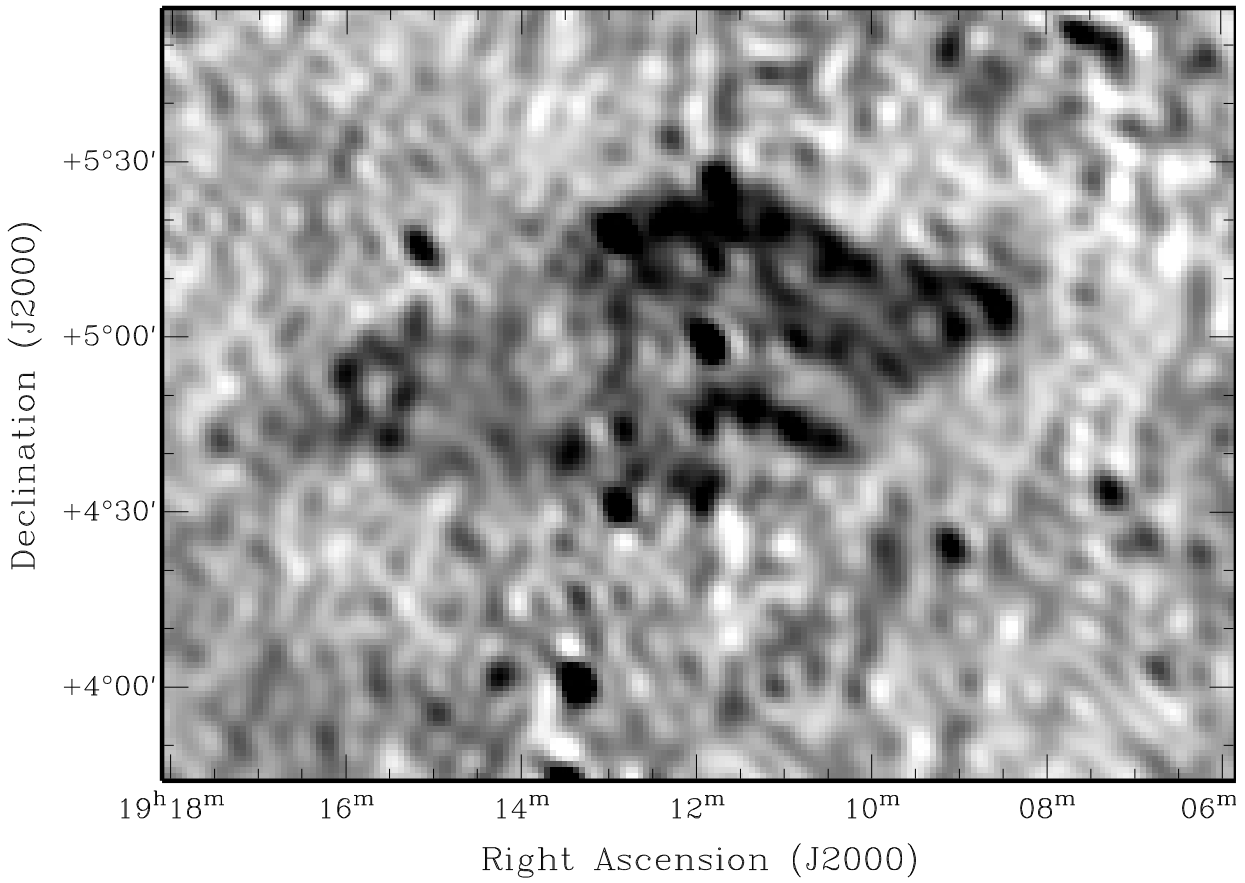


- L2010_20008 - averaged image from 219 sub-bands. Pixel size 60 arcsec, image 512 x 512 pixels. Robust weighting (r=0). Rms ~ 210 mJy/beam.

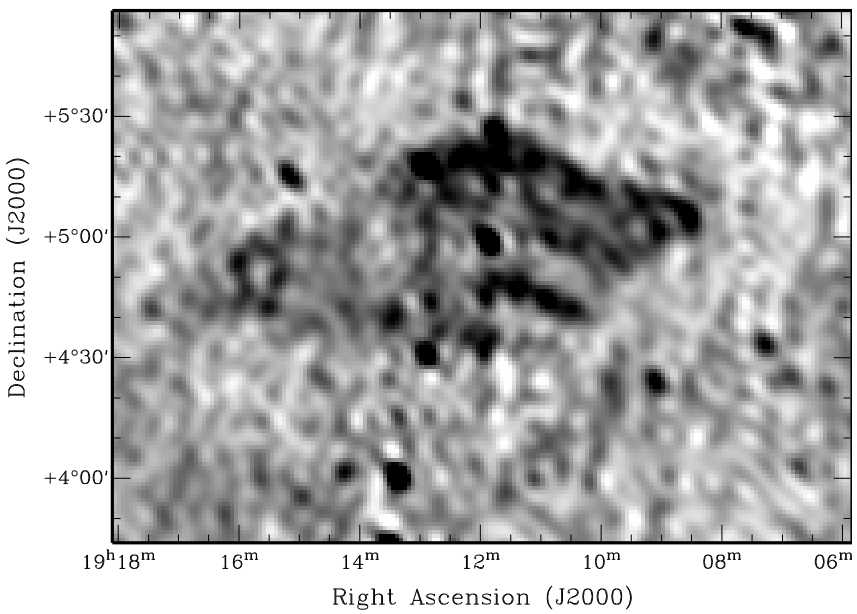
Note: SS433/W50 not included in sky model

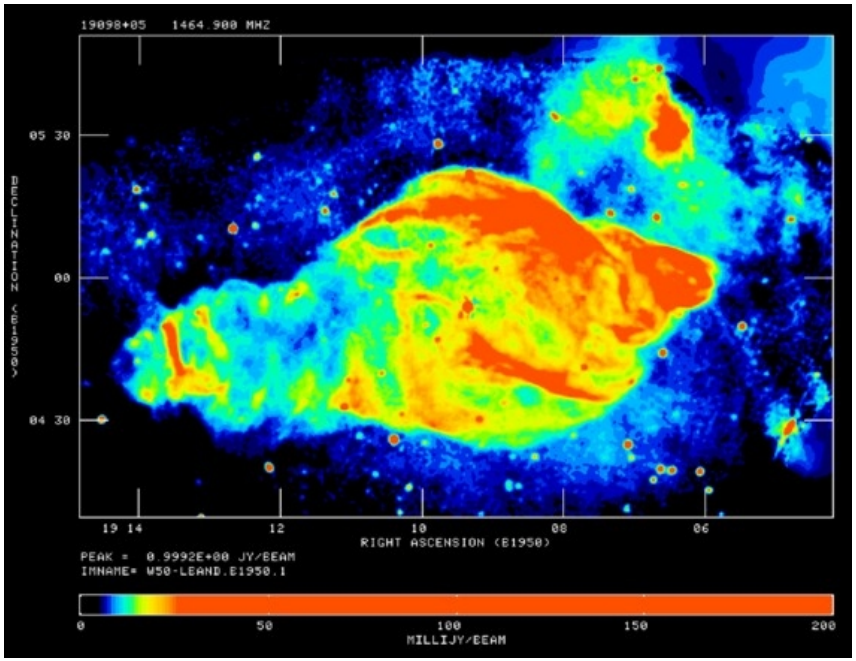


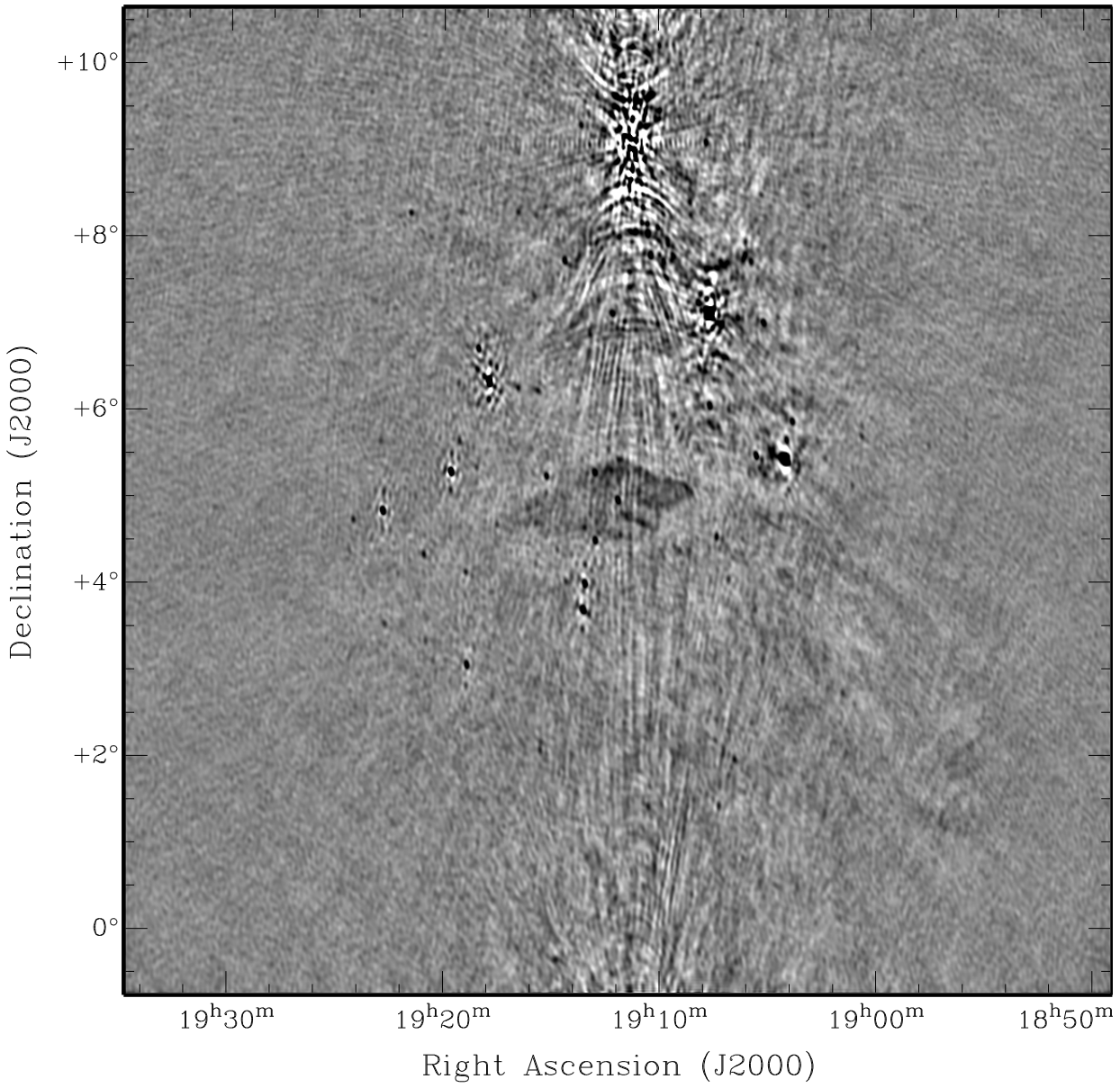
- L2010_09967 - averaged image from 246 sub-bands. Pixel size 60 arcsec, image 512 x 512 pixels. Robust weighting (r=0). Rms ~ 60 mJy/beam.



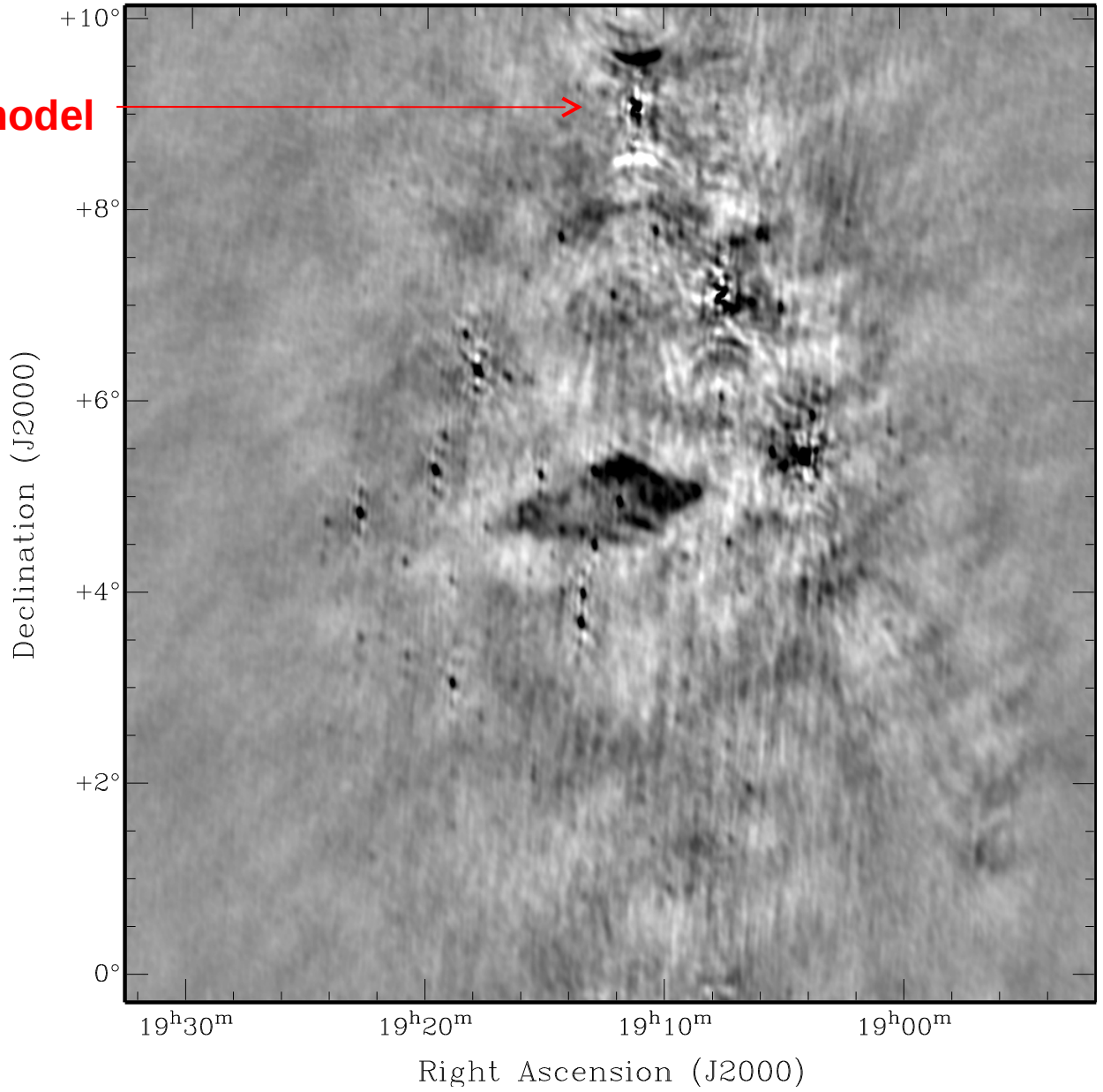
- SS433 peak flux density ~ 1.5 Jy/beam. Calibration solutions still somewhat questionable at this stage. Plenty of artefacts to clean up.


+5°30′
+5°00′
+4°30′
+4°00′
Declination (J2000)
19h18m
16m
14m
12m
10m
08m
06m
Right Ascension (J2000)

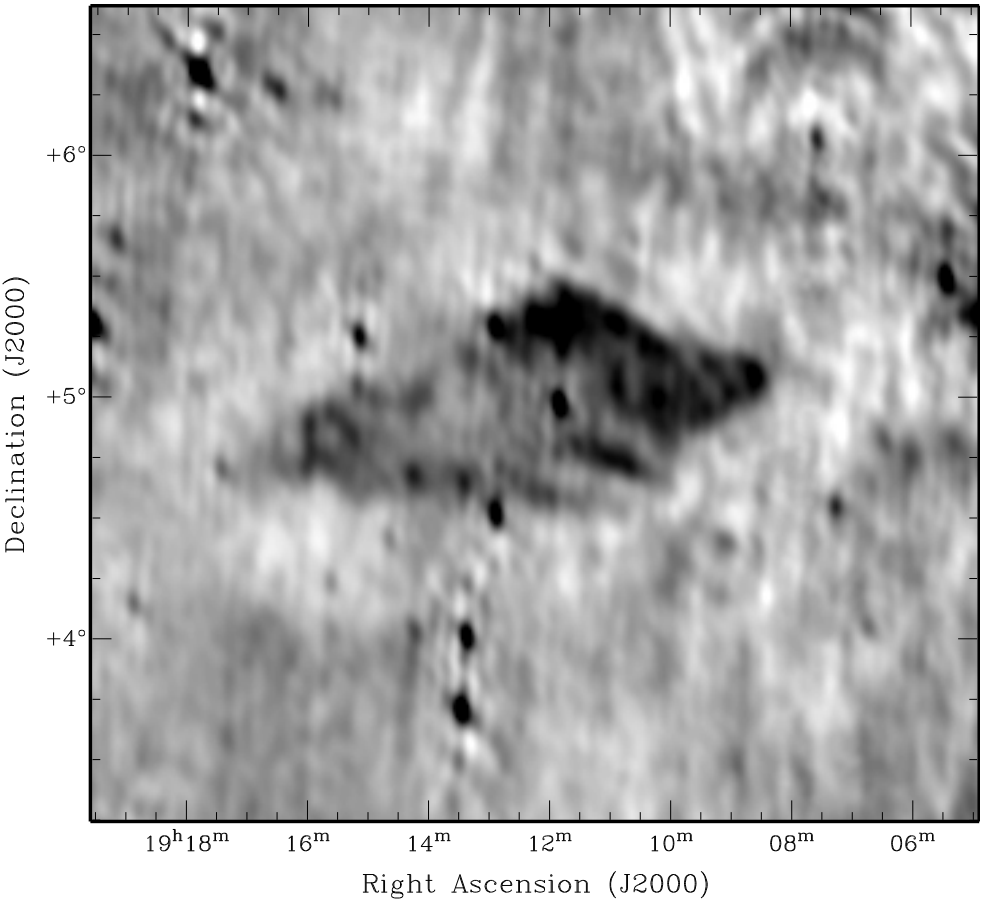

19098+05 1464.900 MHZ
05 30
00
04 30
DECLINATION (B1950)
19 14
12
10
08
06
RIGHT ASCENSION (B1950)
PEAK = 0.9992E+00 JY/BEAM
IMNAME= W50-LEAND.B1950.1
0
50
100
150
200
MILLIJY/BEAM

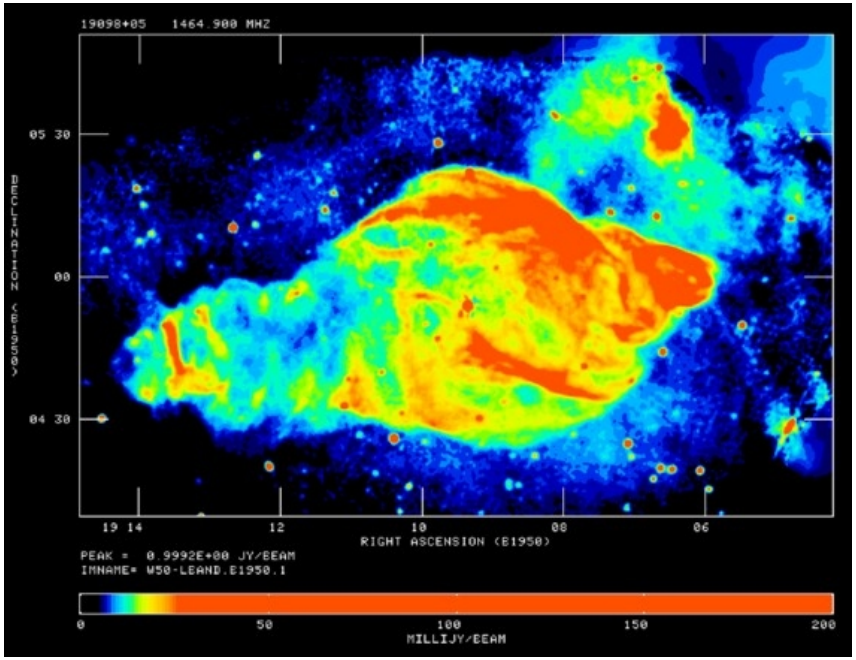


- L2010_09967 - averaged image from 242 sub-bands. Pixel size 40 arcsec, image 1024 x 1024 pixels. Robust weighting (r=0). Rms ~ 50 mJy/beam.

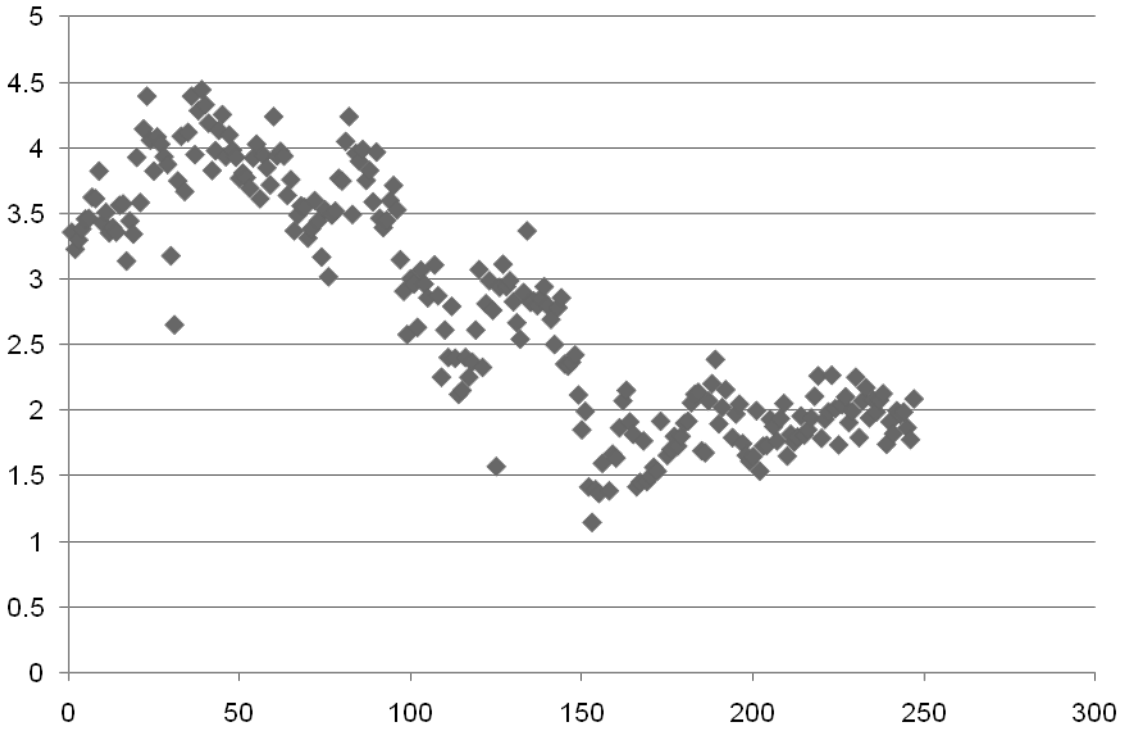


- L2010_09967 - averaged image from 243 sub-bands. Pixel size 40 arcsec, image 1024 x 1024 pixels. Robust weighting (r=1). Rms ~ 40 mJy/beam.


+6°
+5°
+4°
Declination (J2000)
19h18m
16m
14m
12m
10m
08m
06m
Right Ascension (J2000)


19098+05 1464.900 MHZ
05 30
00
04 30
DECLINATION (B1950)
19 14
12
10
08
06
RIGHT ASCENSION (B1950)
PEAK = 0.9992E+00 JY/BEAM
IMNAME= W50-LEAND.B1950.1
0
50
100
150
200
MILLIJY/BEAM

Peak Flux Density (Jy/beam)



Channel Number

- 1919+0518 – flux should be 3.7 Jy at ~150 MHz

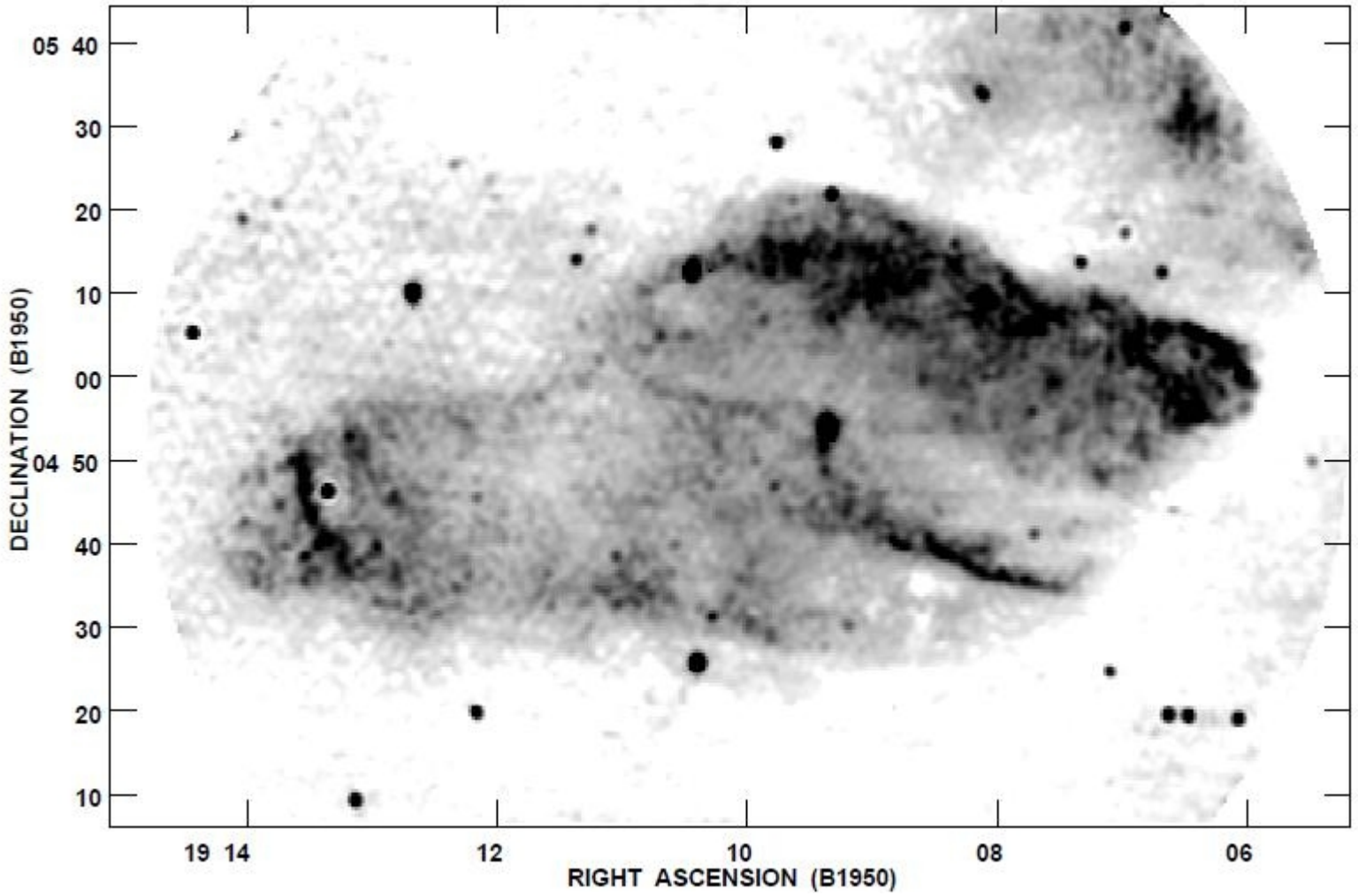
Current and future work

- Refine sky model using e.g. the Miller-Jones et al. (2007) VLA maps. Use higher-resolution data for 3C sources?

- Implement self-calibration. Can do this at the moment with CASA . Can CLEAN components from the cimager be similarly used to produce an updated sky model? What about constrained CLEANing?

- Apply directional gains. At the moment the best way to do this is to subtract all the sources in the sky model except the one you want to apply the gains to (but what happens if you model a source with several components?). Also need to apply station beam model.

- Two new 2 hr runs from 2011 April 10/11 (improved station-level calibration). But imaging pipeline not working at the moment...



- VLA 327.5 MHz map (Dubner et al., 1998, AJ, 116, 1842). Resolution 64 arcsec x 60 arcsec, rms 5 mJy/beam.