

Noise statistics of PACS mappers

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Outline

- **Approach**
- **Blue band noise**
- **Red band noise**

Approach

Approach

Atlas is a wide, void field with essentially no emission except for a few scattered sources.

The output of the mappers for this field can be regarded as a sample of the spatial noise introduced by the mappers. Noise statistics can then be computed.

Atlas blue: 6500x6200 pixels

Atlas red: 3250x 3100 pixels

As a preliminary step a flag image, excluding the sources and the image border from the statistics, is constructed.

Next two slides show the blue and red Atlas tiles plus the flags.

Blue

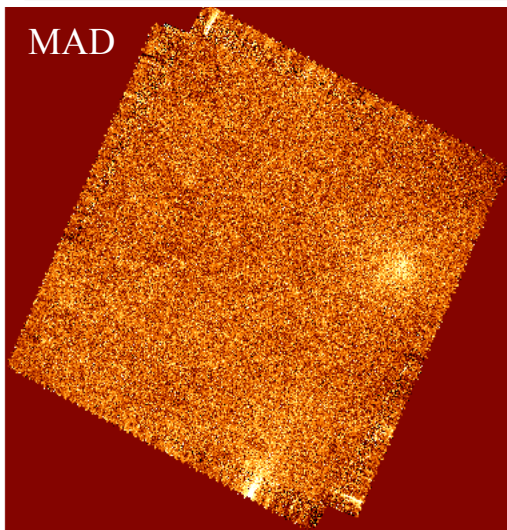
Madmap
Scanamorphos
Tamasis
Unimap

Red

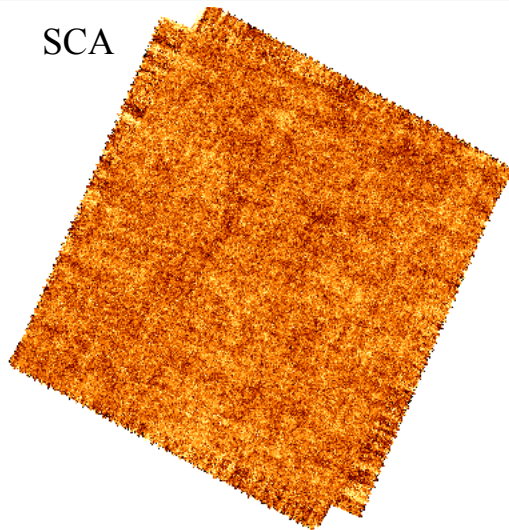
Madmap
Scanamorphos
Tamasis
Unimap
Sanepic

Approach

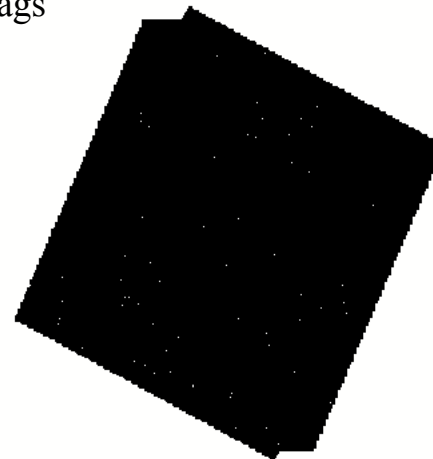
MAD



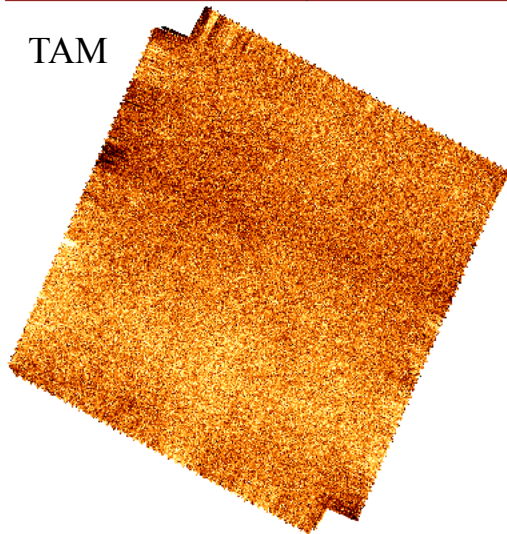
SCA



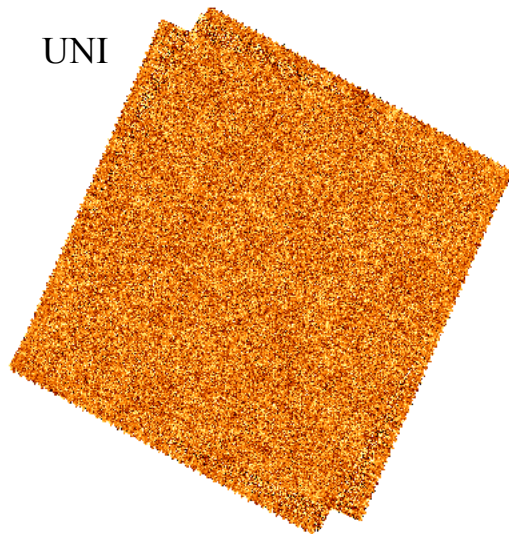
Flags



TAM



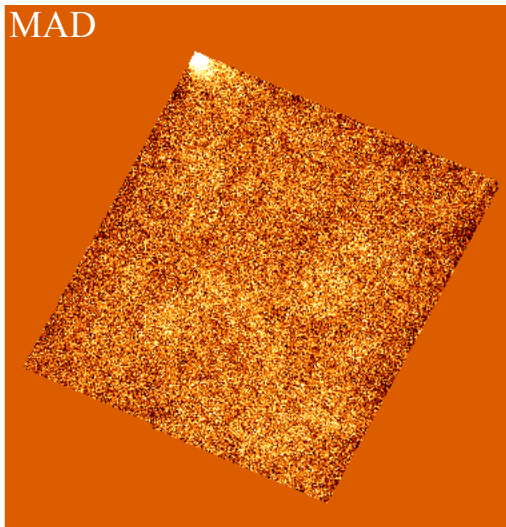
UNI



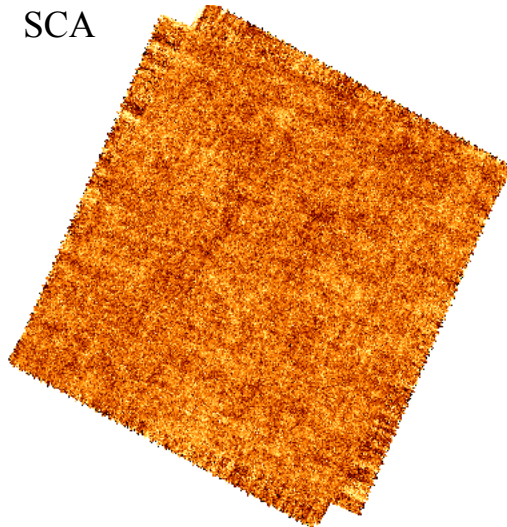
Blue

Approach

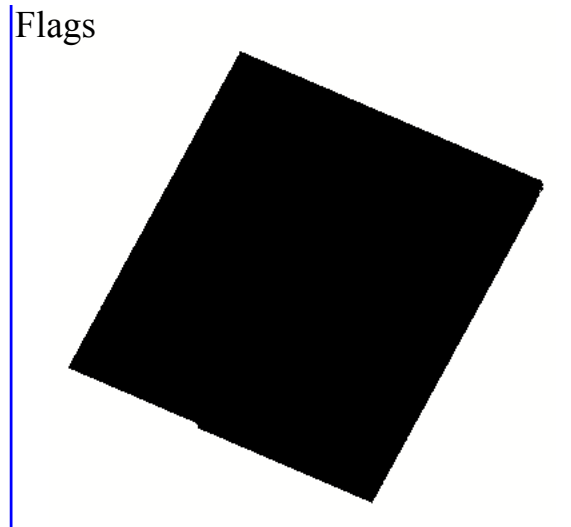
MAD



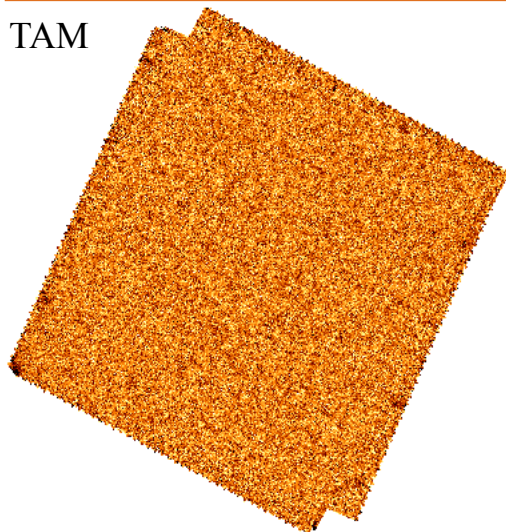
SCA



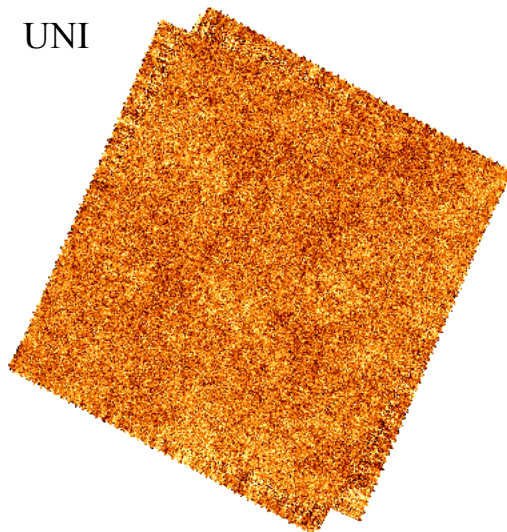
Flags



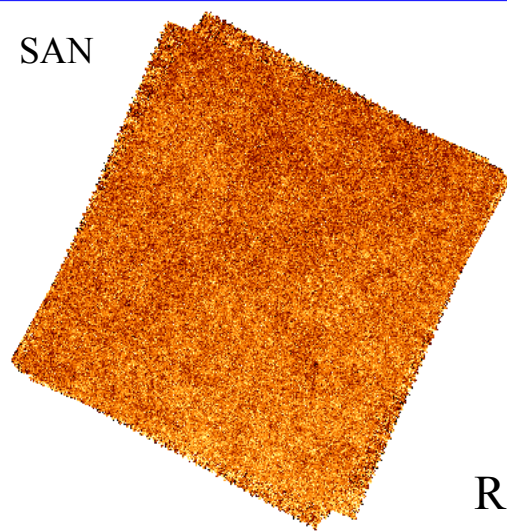
TAM



UNI

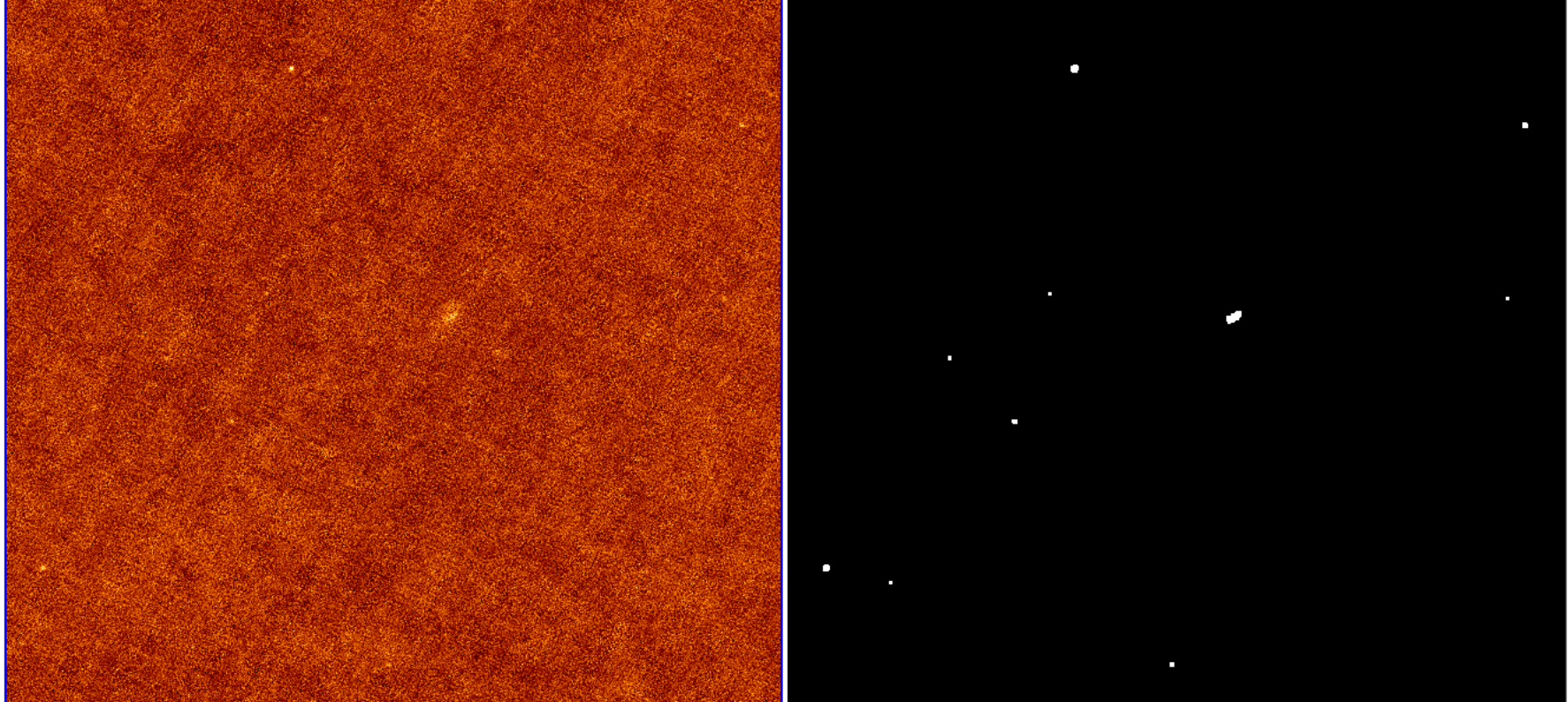


SAN



Red

Approach



Source flagging is done by integrating and thresholding.
Flags computed separately for each mapper and or-ed.

Approach

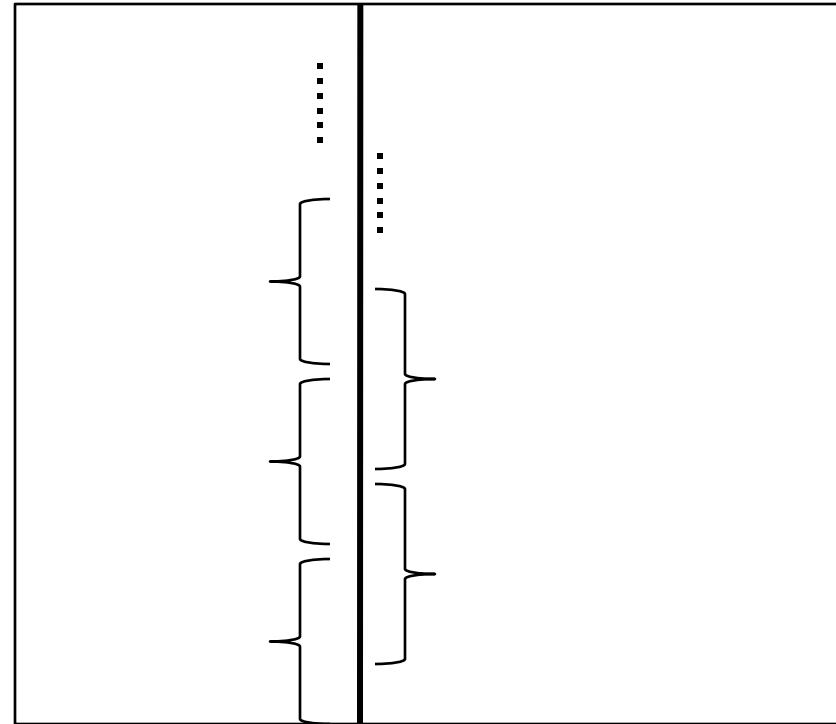
We compute the following statistics on the non flagged pixels

- Variance and distribution
- 1D noise spectrum
- 2D noise spectrum

Approach

1D spectrum is obtained as follows.

- We extract linear segments from all the columns of the image.
- If the segment is flag free we compute the spectrum (squared magnitude of DFT).
- Same is done for all image rows.
- We average all the spectra

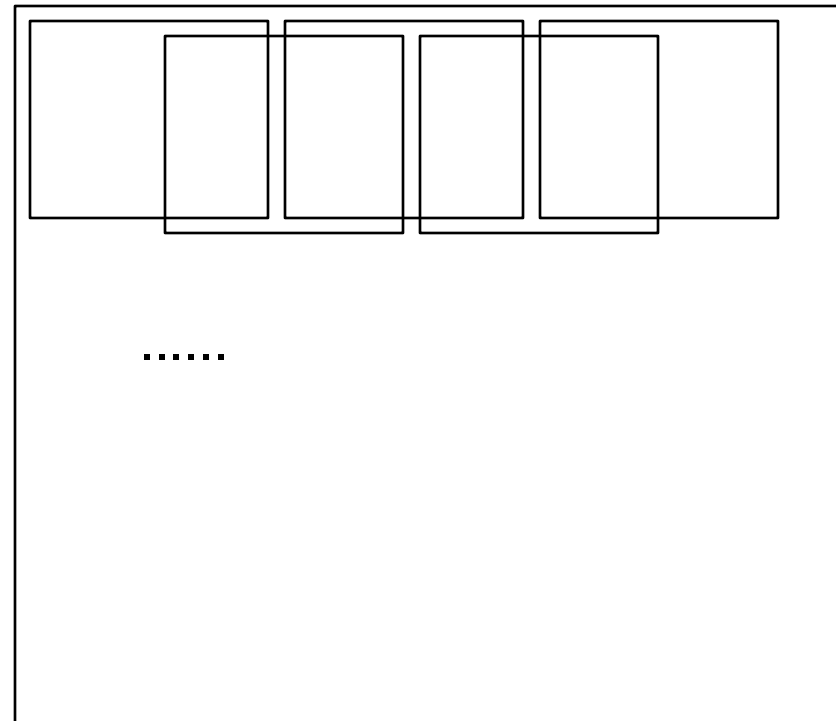


Note that the image offset only affects the DC of the spectrum.

Approach

2D spectrum is obtained as follows.

- We extract squared subimages from the image.
- If the subimage is flag free we compute the 2D spectrum (squared magnitude of 2D-DFT).
- We average all the spectra



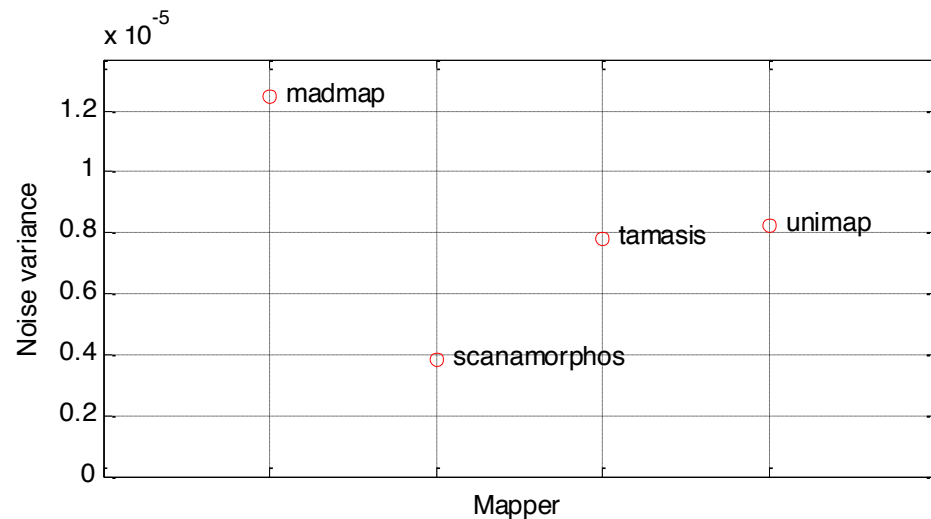
Note that the image offset only affects the DC of the 2D spectrum.

Blue data

Blue

We computed the variance of the blue map. We also report the SNR for NGC6334

mapper	var	var dB	SNR dB
madmap	1.24e-5	-49.05 dB	50.11 dB
scanamorphos	3.81e-6	-54.19 dB	55.26 dB
tamasis	7.78e-6	-51.09 dB	52.15 dB
unimap	8.20e-6	-50.86 dB	51.92 dB



Scanamorphos has lowest noise variance.

Madmap has the highest noise variance

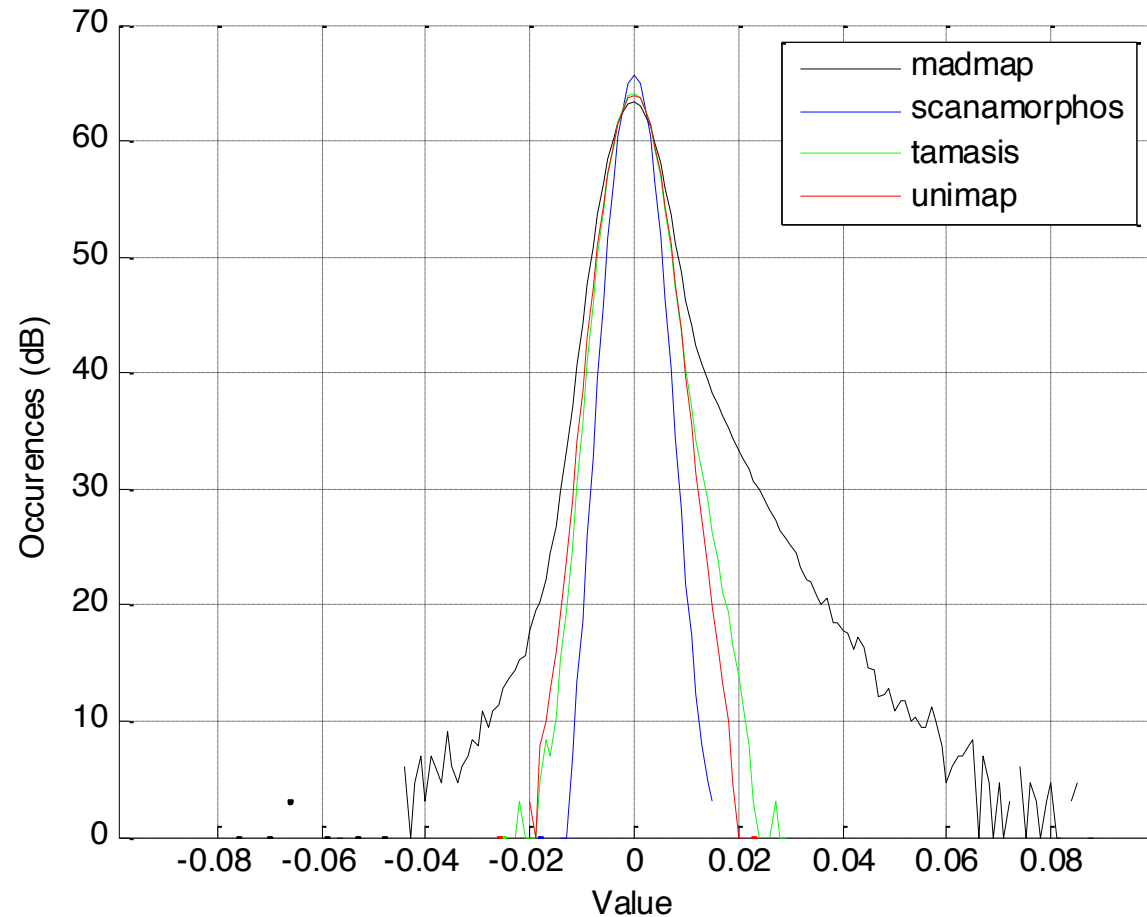
Blue

Distribution of the noise from the various mappers.

Offset is suppressed by setting the mean to zero.

Madmap has a wider distribution.

The other are similar with Scanamorphos yielding the narrowest.



Blue

1D noise spectrum.

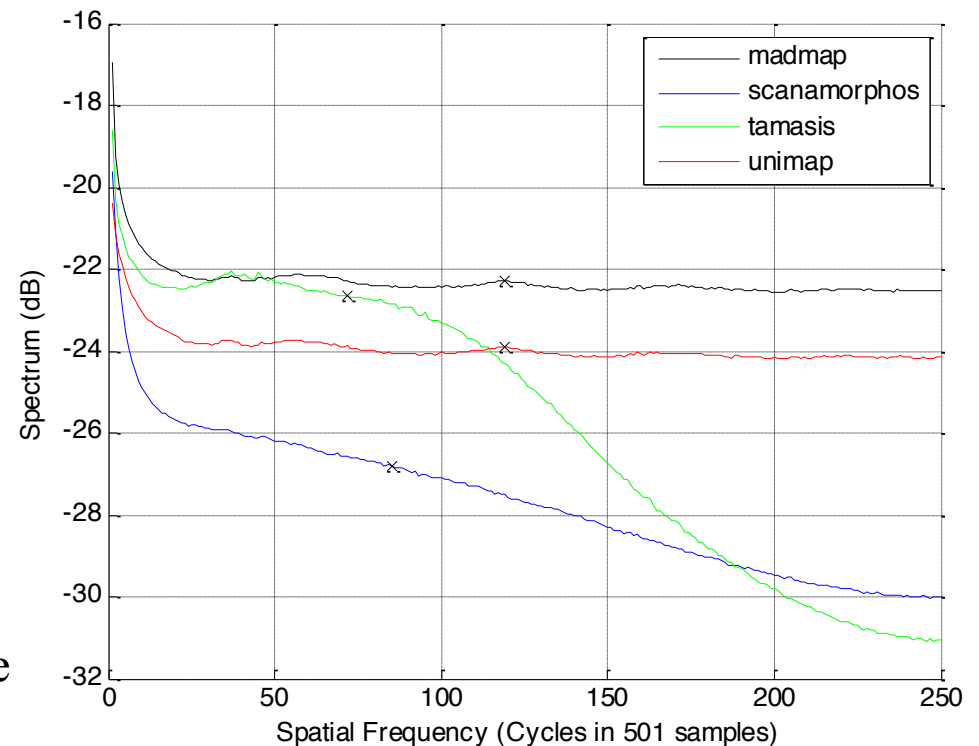
Segment length is 501 samples.

The X indicates the frequency with half power on the left and right.

All mappers peak at low frequencies.

In the other frequencies Madmap and Unimap yield essentially a flat spectrum.

Scanamorphos and Tamasis performance is frequency dependent. They perform extremely well at high frequencies. Their noise is concentrated at low frequencies.

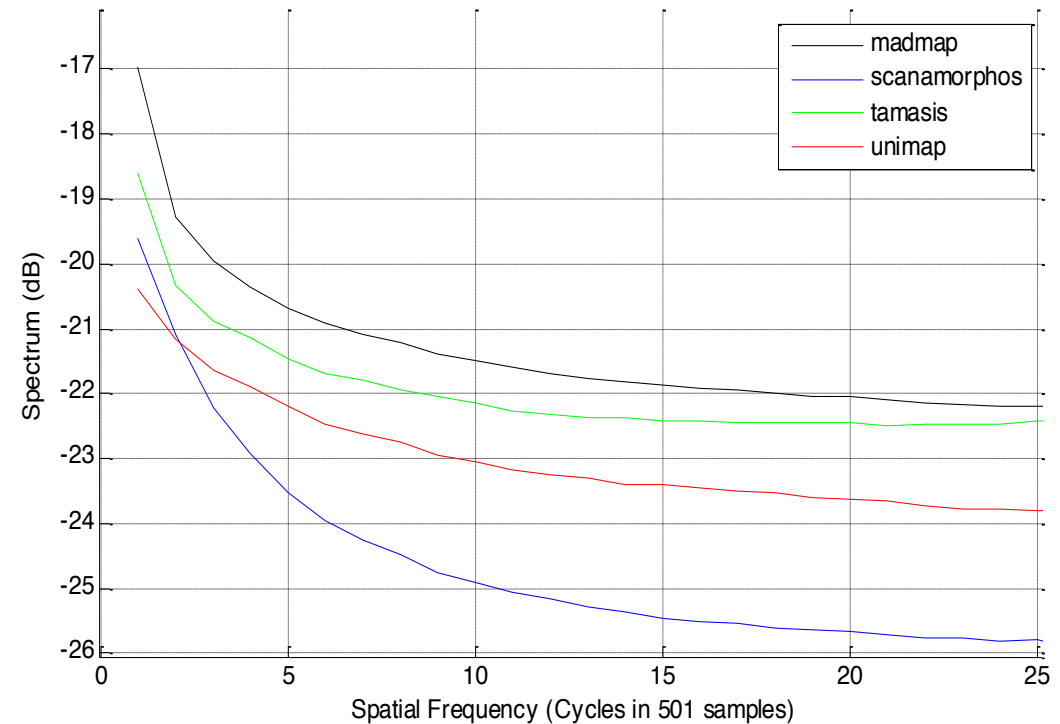


Blue

1D spectrum at low frequencies.

All the spectra raise at low frequencies, with different rates.

At the lowest frequency
Unimap is the less noisy
Madmap the more noisy.



Blue

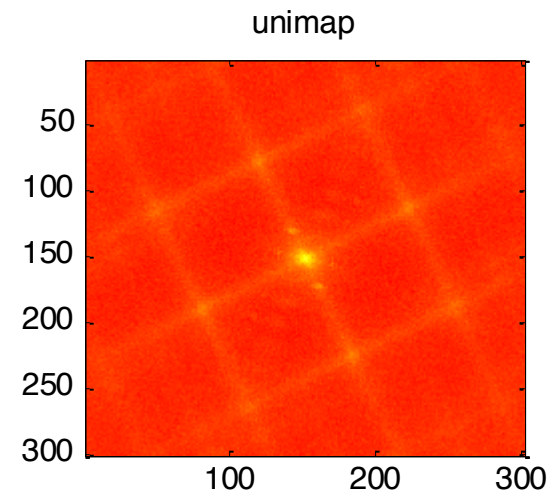
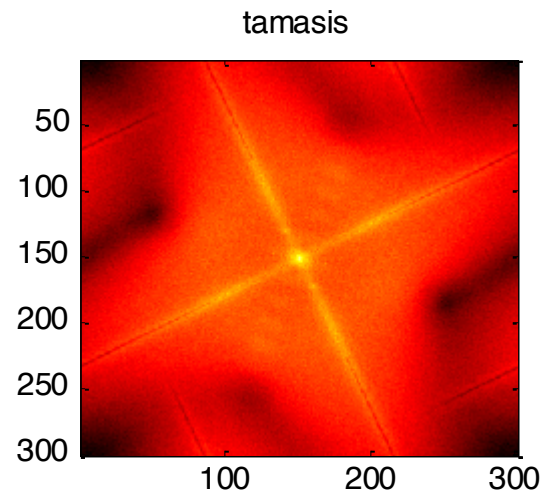
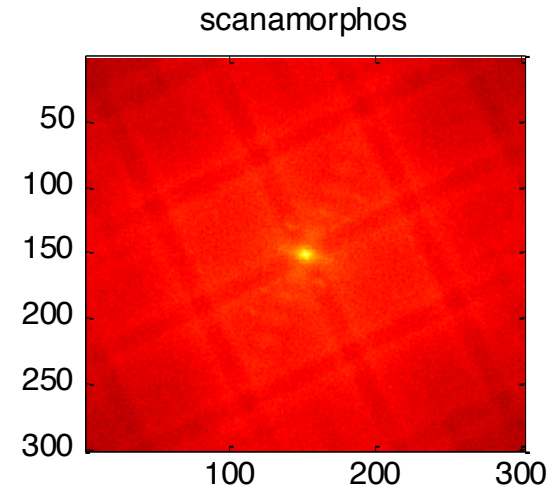
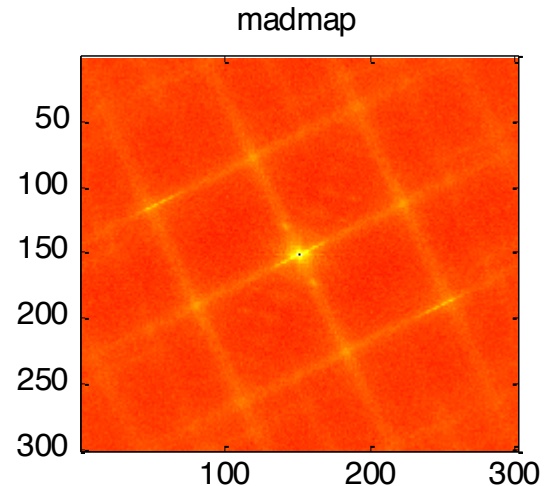
2D noise spectrum. Block size 301x301. DC (zeroed) at center.

The spectra are not isotropic (symmetrical).

This means that noise is dependent on the direction (in addition to frequency).

The scan directions have a clear impact. Stronger for Tamasis.

An additional (very faint) line is seen in the spectra.



Blue

Flat spectrum \Rightarrow White (not correlated) noise \Rightarrow 'Salt and pepper' noise

Non flat spectrum \Rightarrow Correlated noise \Rightarrow 'Orange peel' noise

Loosely speaking, from the 1D spectrum:

Unimap and Madmap close to white noise.

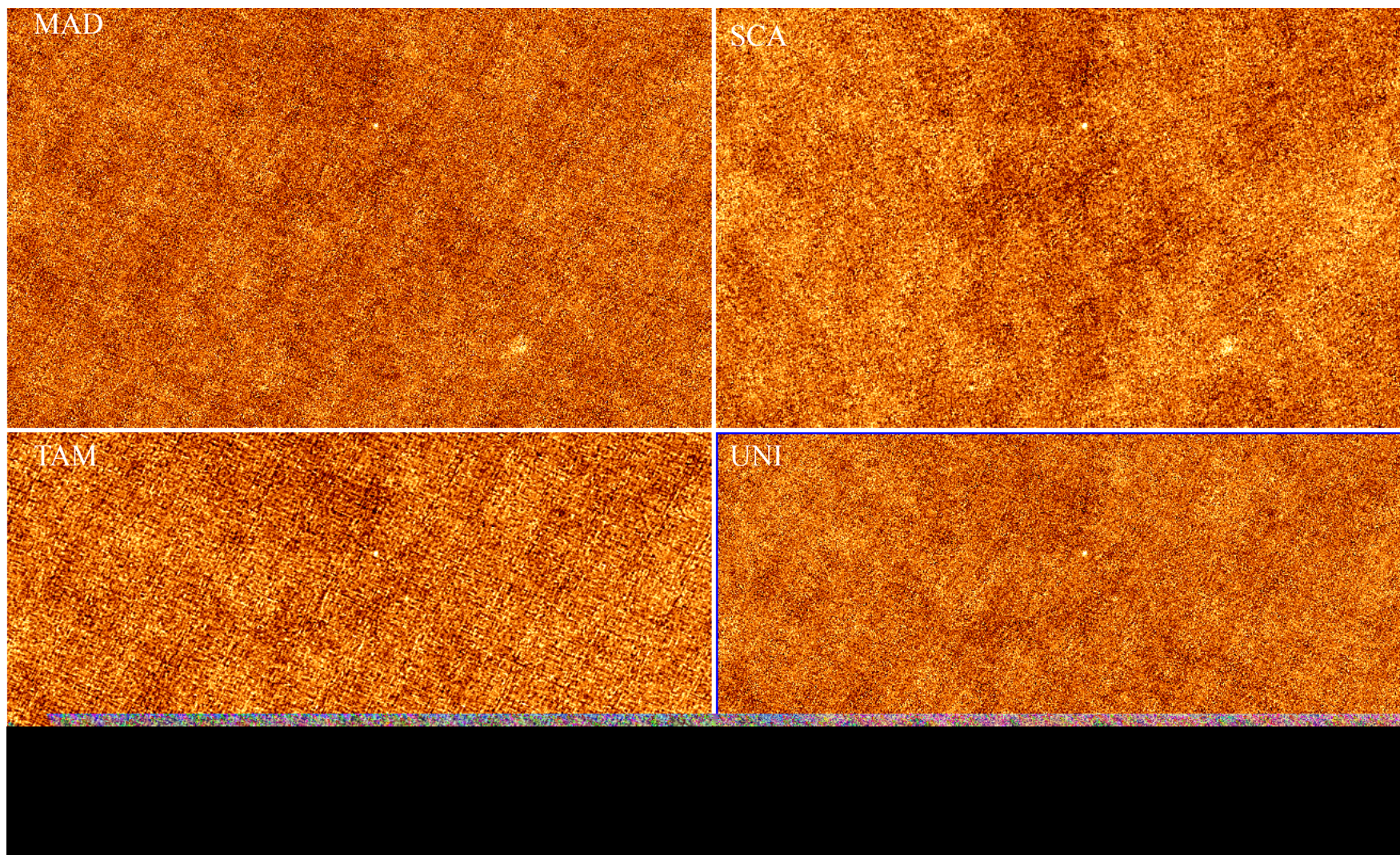
Tamasis and Scanamorphos introduce correlated noise.

From the 2D spectrum:

Tamasis has strong noise components along the scan directions.

Another direction is seen to have an impact.

Blue

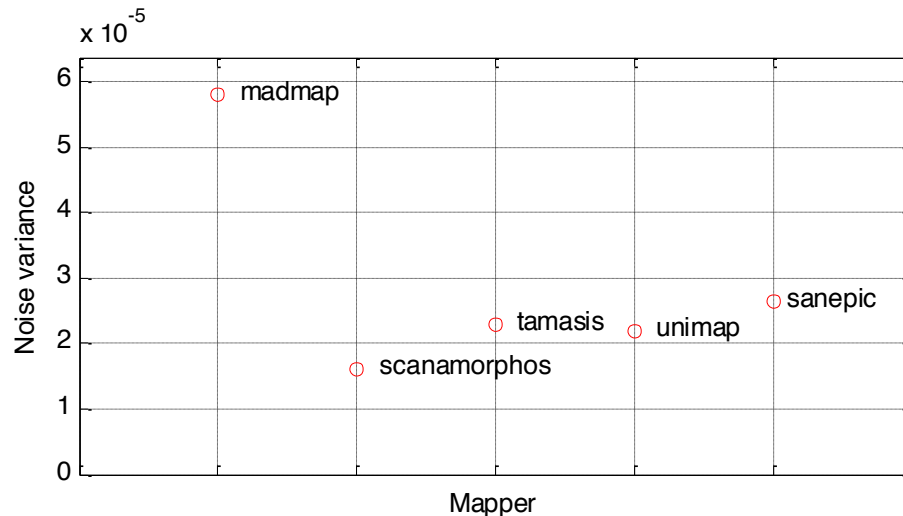


Red data

Red

We computed the variance of the red map. We also report the SNR for NGC6334

mapper	var	var dB	SNR dB
madmap	5.79e-5	-42.37 dB	52.82 dB
scanamorphos	1.60e-5	-47.95 dB	58.40 dB
tamasis	2.30e-5	-46.39 dB	56.84 dB
unimap	2.18e-5	-46.61 dB	57.06 dB
sanepic	2.64e-5	-45.78 dB	56.23 dB



Scanamorphos has lowest noise variance.

Madmap has the highest noise variance

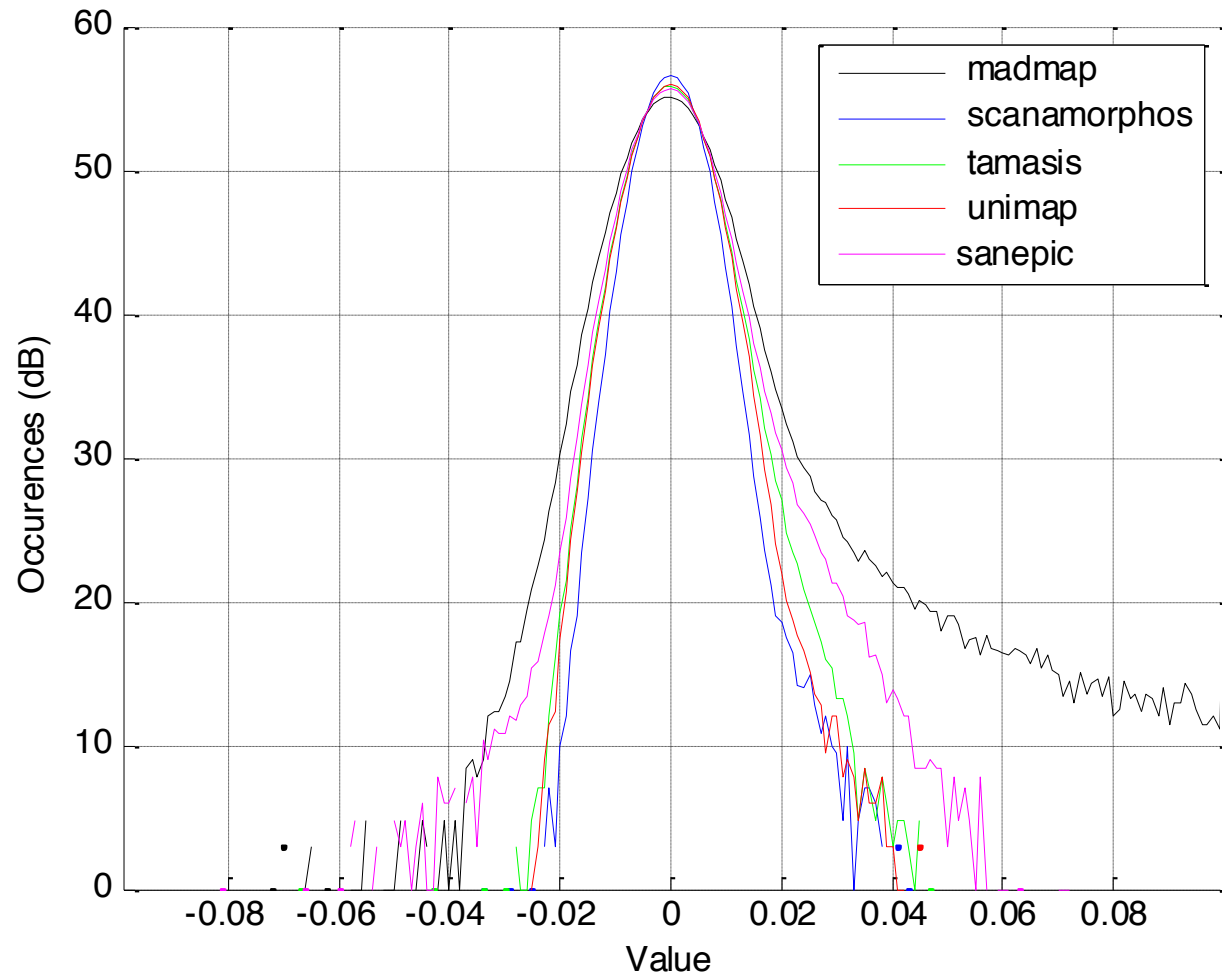
Red

Distribution of the noise from the variuos mappers.

Offset is suppressed by setting the mean to zero.

Madmap and Sanepic have a wider distribution.

Others are comparable.



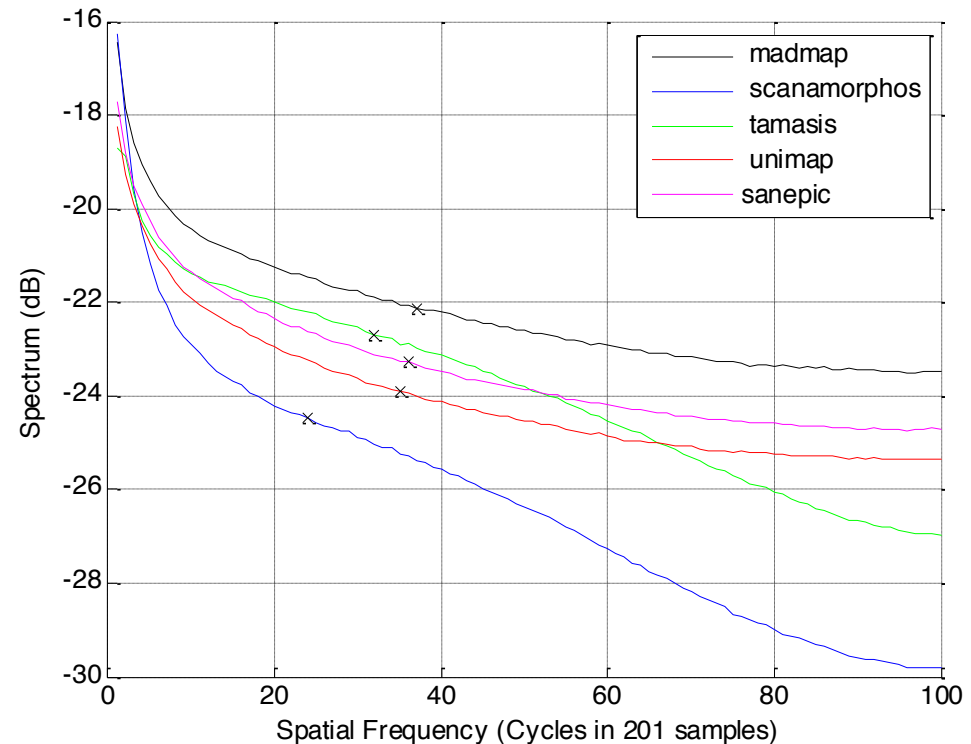
Red

1D noise spectrum. Segment length is 201 samples.

All mappers peak at low frequencies.

For all mappers, noise power is frequency dependent.

Scanamorphos is the best performer at high frequencies.

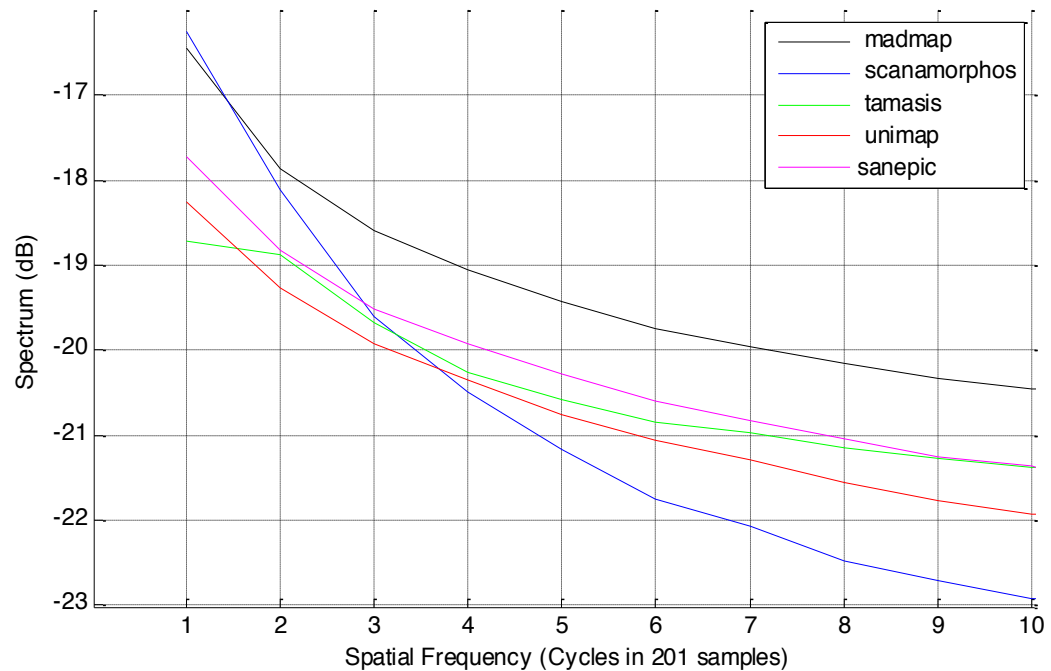


Red

1D spectrum at low frequencies.

All the spectra raise at low frequencies.

At the lowest frequency
Tamasis is the less noisy and
Scanamorphos the more noisy.



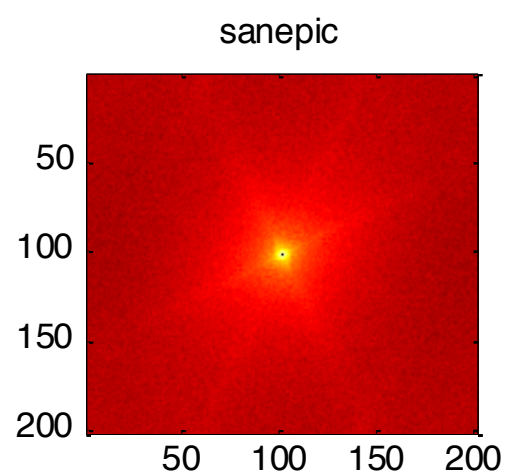
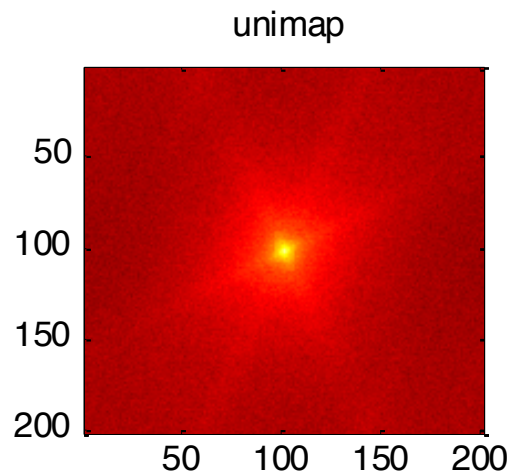
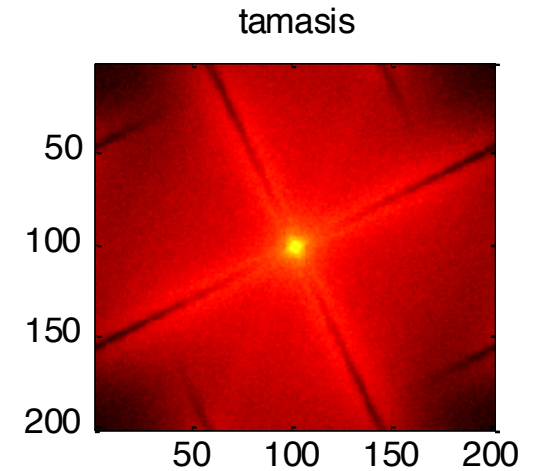
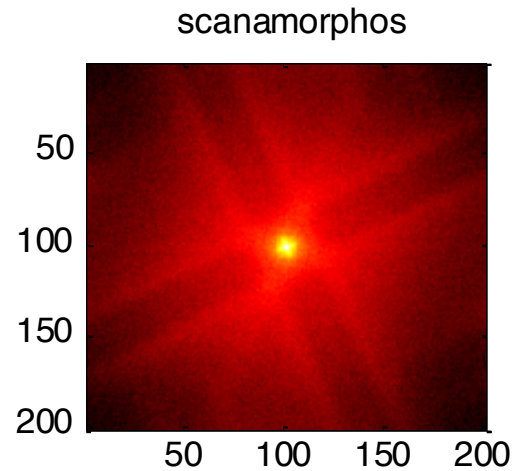
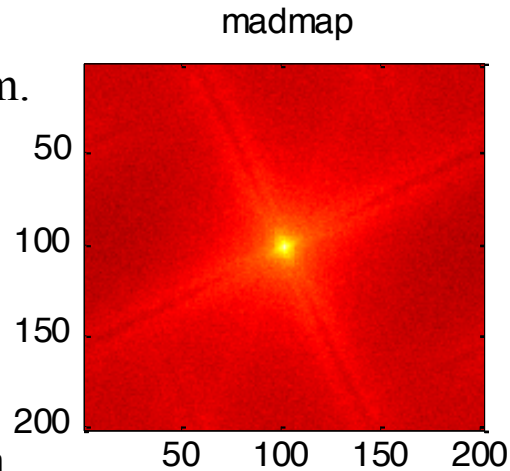
Red

2D noise spectrum.

Spectra not isotropic.

The scan directions have a clear impact.

Additional faint line is seen.



Red

Differences are less marked than in the blue band.

From 1D spectrum:

All mappers introduce correlated noise.

Unimap, Sanepic, Tamasis and Madmap have similar level of correlation.

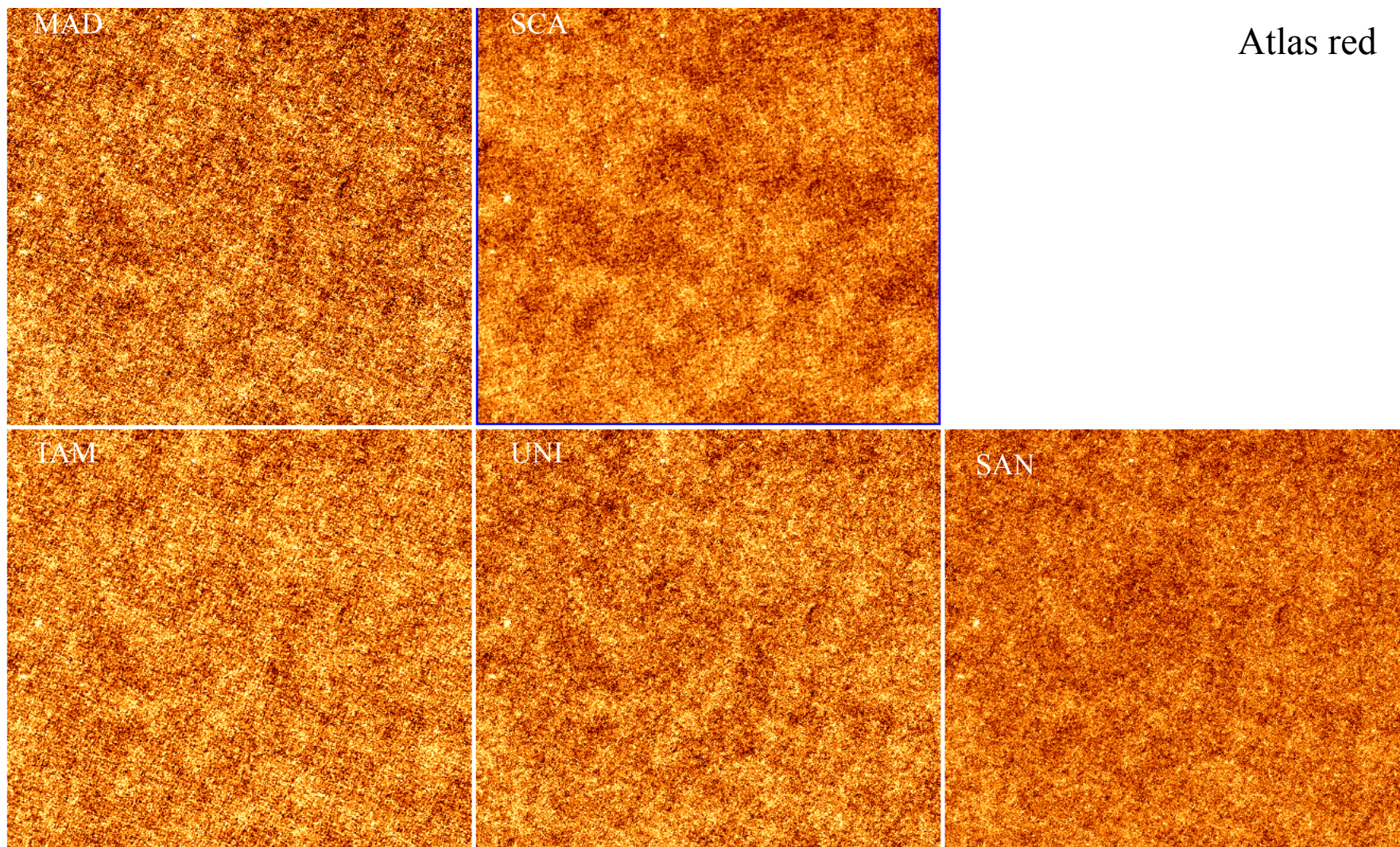
Correlation is stronger for Scanamorphos.

From 2D spectrum:

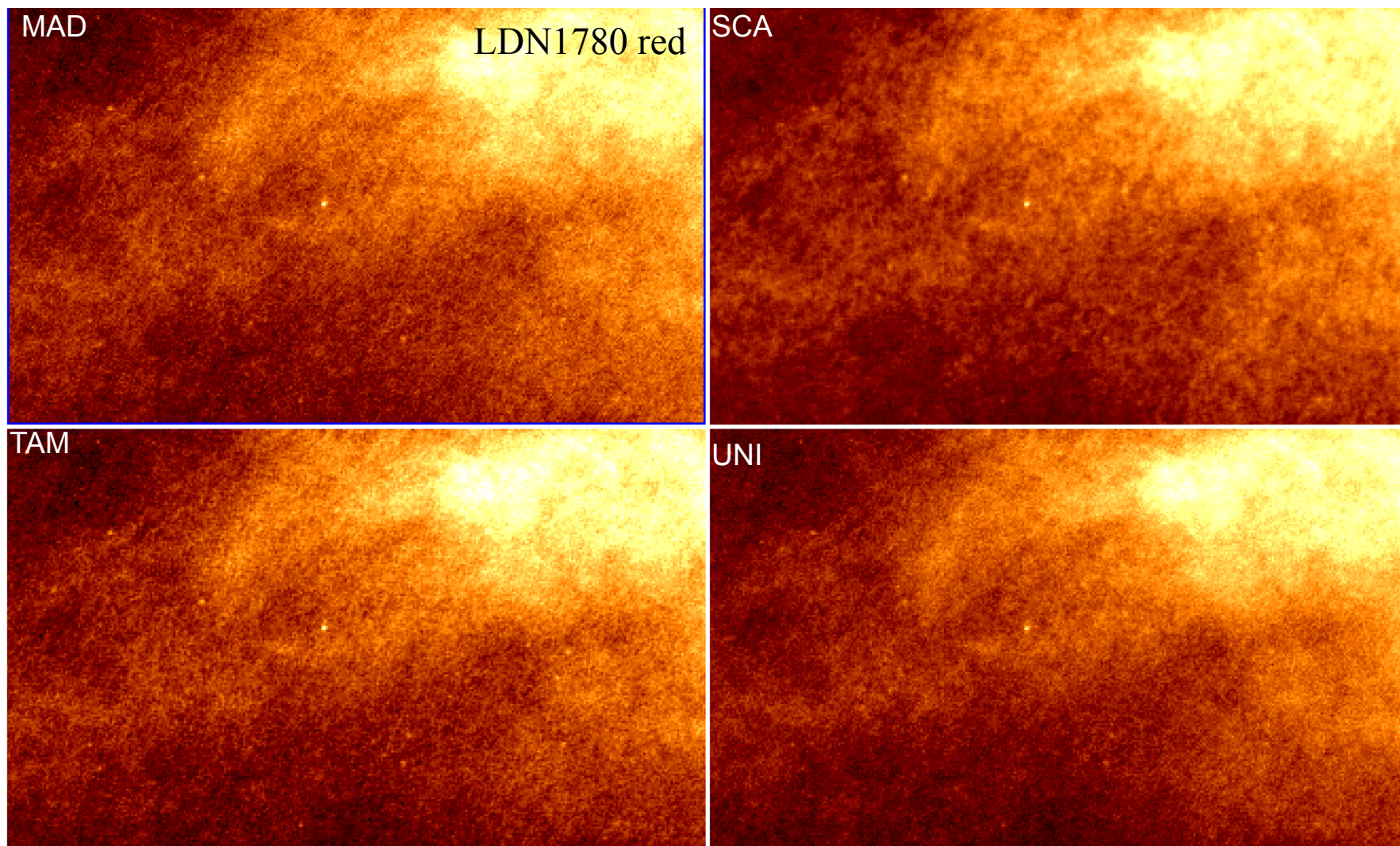
Unimap and Sanepic essentially isotropic.

Sacamorphos and Tamasis not isotropic.

Red



Red



Thanks

The workshop was a big opportunity to gain expertise and a strong push to improve Unimap.

Sincere thanks to Roberta, Babar and all the mappers/experts.