Understanding instrument response using a linear system approach

Jiao Zhang

2013-06-13

Method

$$V_{ij}(\alpha = \omega t) = \int F(u_k) L_{ij}(u_k - u_0) \exp(i2\pi\alpha u_k) du_k$$

$$= \sum_{k=1} F(u_k) \underbrace{L_{ij}(u_k - u_0) \exp(i2\pi\alpha u_k)}_{A}$$

$$\begin{pmatrix} V_{ij}(\alpha_1 = \omega t_1) \\ \cdots \\ V_{ij}(\alpha_2 = \omega t_2) \\ \cdots \\ \cdots \\ V_{ij}(\alpha_n = \omega t_n) \end{pmatrix} = A \times \begin{pmatrix} F(u_1) \\ F(u_2) \\ \cdots \\ \cdots \\ F(u_n) \end{pmatrix} + \begin{pmatrix} \cdots \\ \cdots \\ n(i) \\ \cdots \\ \cdots \end{pmatrix}$$

A represent the instrument and sky mapping strategy.

$$A = USV^{-1}$$

SVD

Pseudo-inverse:

$$B = A^{-1} = VS^{-1}U^{-1}$$

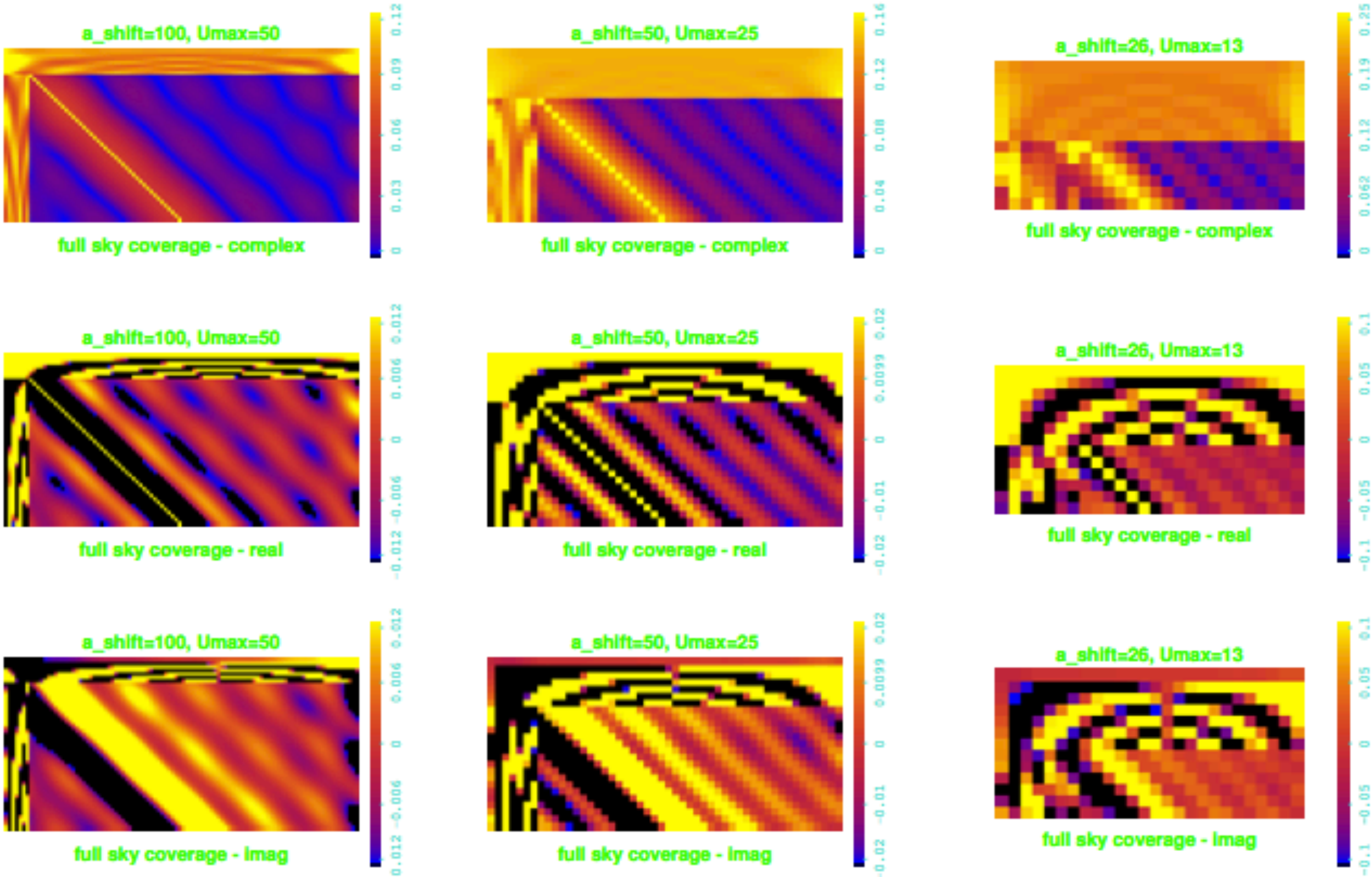
$$B' = VS'^{-1}U^{-1}$$

S is rectangular diagonal matrix with nonnegative real number on the diagonal.

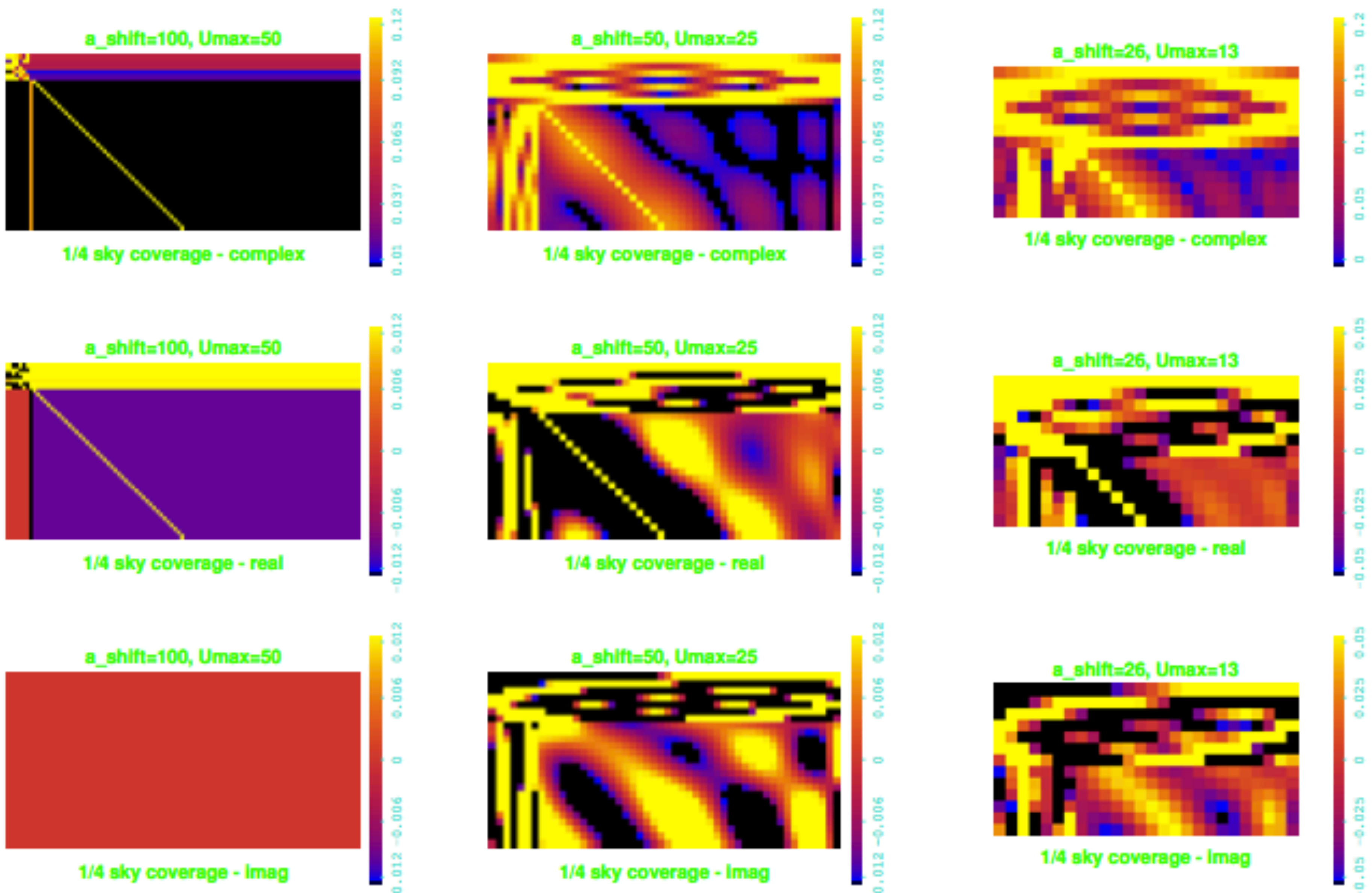
If the diagonal entries < threshold, we will put it to 0.

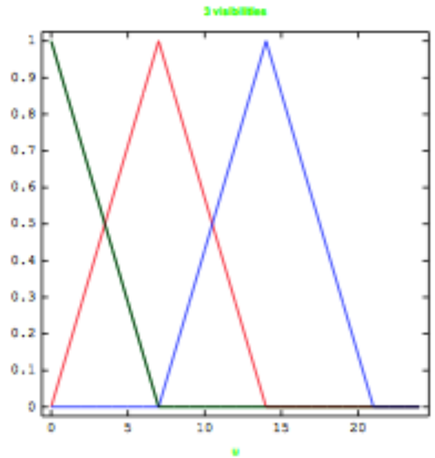
$$\begin{pmatrix} \cdots \\ \widetilde{F(u_i)} \\ \cdots \end{pmatrix} = B' \begin{pmatrix} \cdots \\ V_{ij}(\alpha_k) \\ \cdots \end{pmatrix} = B'A \begin{pmatrix} \cdots \\ F(u_i) \\ \cdots \end{pmatrix}$$

B’ Full sky rotation ----- Autocorrelation V_{11}



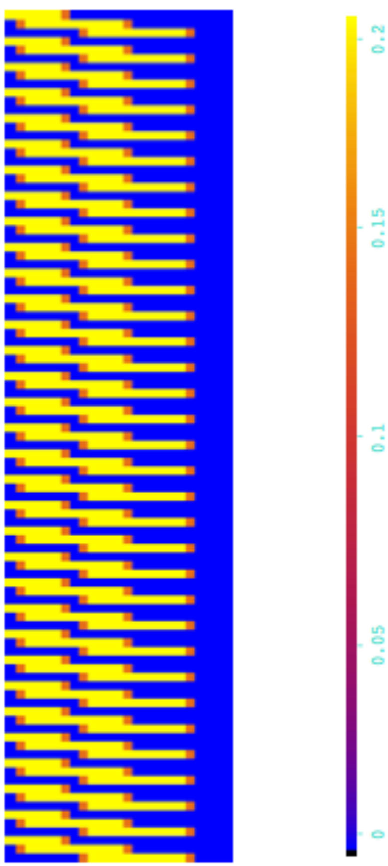
B’ a part of sky coverage like N-S direction

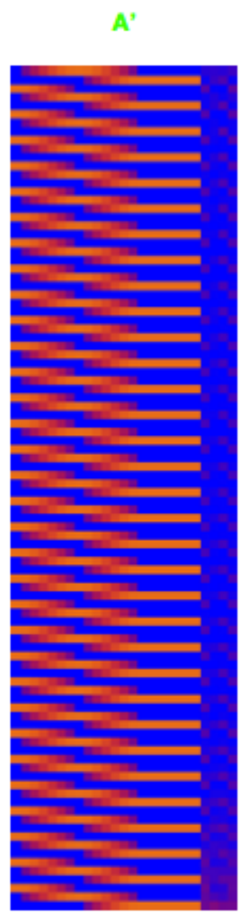




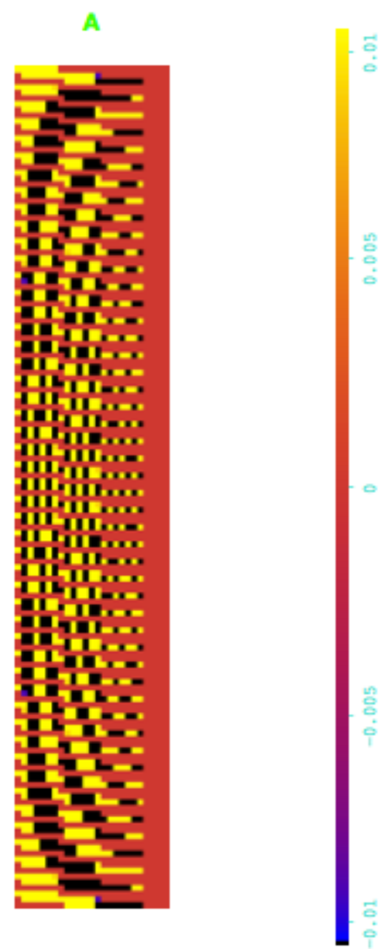
1D 3 visibilities: V_{11}, V_{12}, V_{13}

a_shift = 50, Umax = 25. A(150,25)

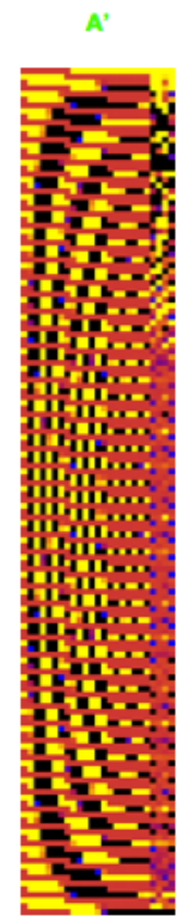




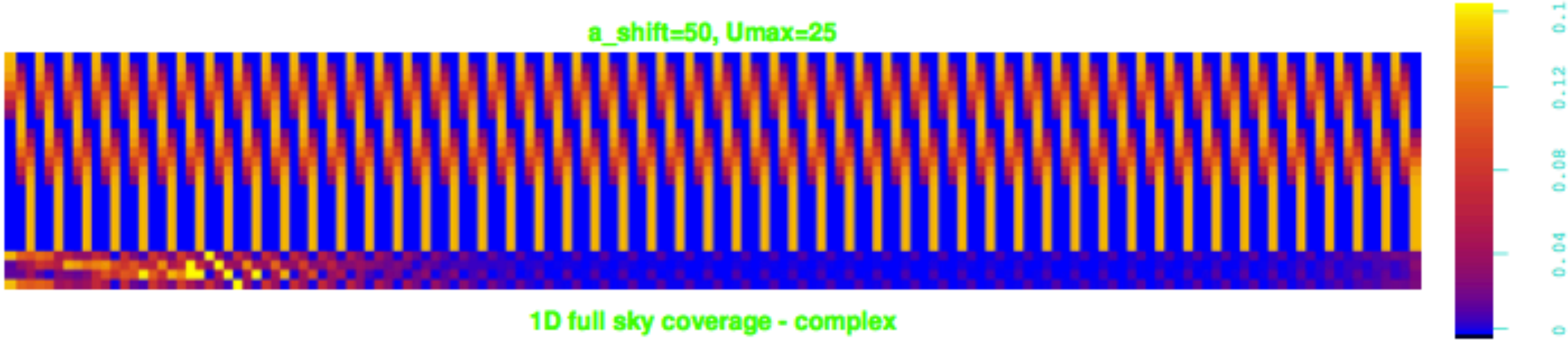
1D full sky coverage - complex

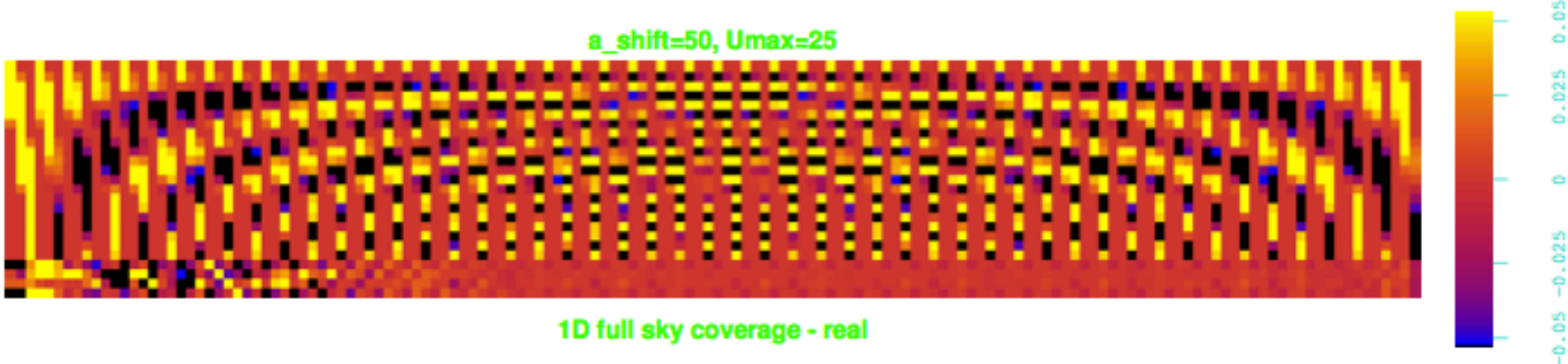


1D full sky coverage - real



1D full sky coverage - real


a_shift=50, Umax=25
1D full sky coverage - complex
0.16
0.12
0.08
0.04
0


a_shift=50, Umax=25
1D full sky coverage - real
0.05
0.025
0
−0.025
−0.05


a_shift=50, Umax=25
1D full sky coverage - imag
0.05
0.025
0
−0.025
−0.05