LBWG memo 5

Chessboard imaging

Sean Mooney, 2018.06.15

The field of view for a LOFAR pointing is smaller when the international stations are included. This is because it is necessary to significantly average the dataset in time and frequency to get the data down to a reasonable size. Averaging the data causes smearing though, and you lose information beyond the pointing centre. This effectively limits your field of view. Therefore, it is not possible to make one high-resolution map of the entire wide-field LOFAR pointing. When it comes to imaging the sources in the wide field, we are left with two options.

1. **Averaging around individual sources** – Firstly, we could find how many sources in the wide field are worth imaging. We could then copy the dataset and phase-shift to the first source, placing it at the centre of the field. Then we could average in frequency and time to reduce the size of the dataset. This will smear out the sources far from the central source. We could then make a high-resolution image of this source. We then repeat this for each of the sources in the field we want to image. In a sense, we are making high-resolution images of the interesting patches of the sky. We could stitch these images together then using the low-resolution wide-field image to fill in the gaps. This is sometimes referred to as hybrid mapping. MaaijkeGer scripts can be used for the hybrid mapping.

2. The second option is to chessbaord the field. This means that, instead of imaging select regions of the field with high-resolution, we image the entire field by making many smaller high-resolution images and stitching them together. One advantage of this method is that is allows us to potentially make new discoveries as we will be imaging everywhere, even parts of the sky that are supposedly uninteresting. To do the chessboarding, a copy of the data is made and this is phase-shifted to position a predefined coordinate at the centre. Then we average around this point. This is repeated for other predefined coordinates, to cover the pointing as shown in Fig. 1. This shows two options of chessboarding, where we shift and average to different numbers of points. The 19/17 scheme (top) is more efficient than the 7/7 scheme (bottom), and is the most optimal from a number of tests by Neal Jackson.

The chessboarding option is the preferred option of the two presented since chessboarding schemes can produce substantially averaged datasets, out of which individual sources can be mapped (or further datasets cut out). A script to do the chessboarding is now in the pipeline, included in the Generic Pipeline format as a Python plugin.

In the final version of the pipeline, we plan to have a switch in the parset so that the user can toggle between the two options, depending on their science needs.

There is a point up to which averaging around individual targets (option 1) is more efficient than chessboarding the field (option 2). For example, if you only want to image one source, obviously option 1 is the better choice. There are $\sim$150 targets $>$60 mJy in a LoTSS field, so this is the break-even level above which chessboarding is more efficient.[1]

Question – Are the core stations kept throughout this process or are they ditched?

[1] In a LoTSS field there are $\sim$10 sources $\geq$1 Jy, $\sim$100 $\geq$0.1 Jy, and $\sim$1000 $\geq$3 mJy.

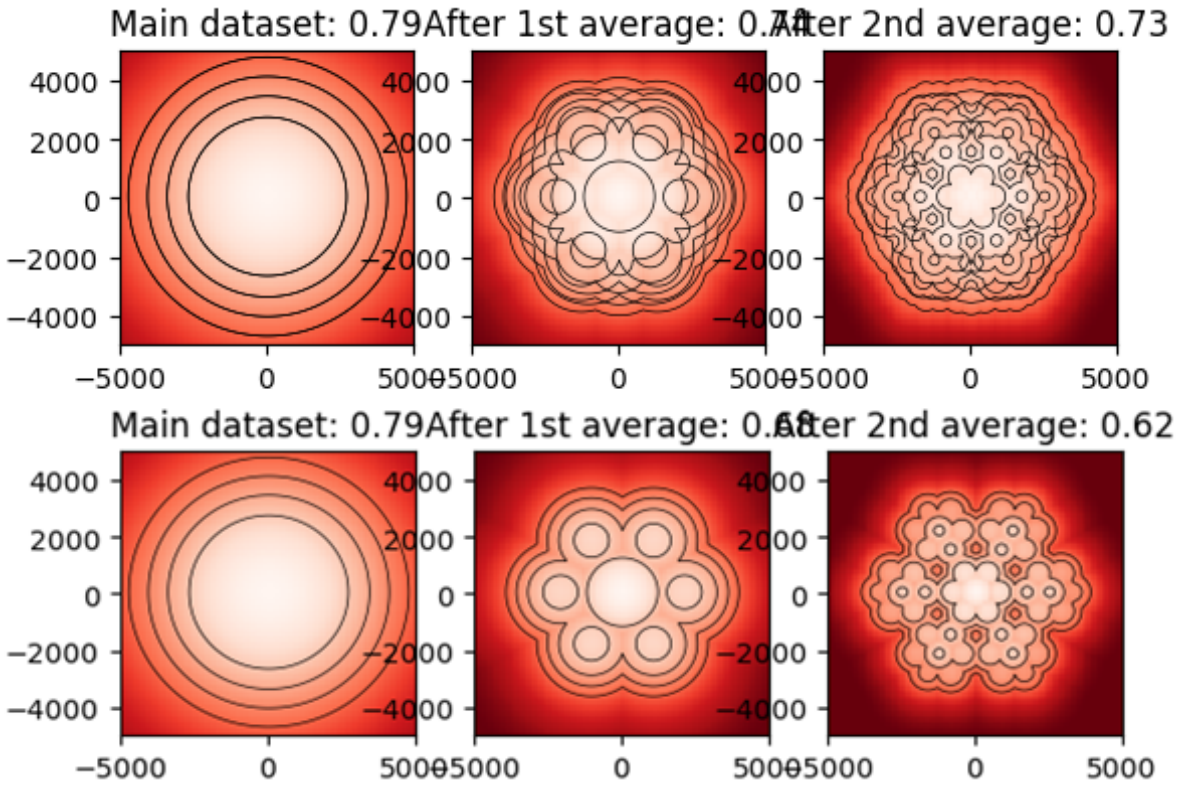

Figure 1: Demonstration of the chessboarding technique for two different configurations. The scale and the numbers are smearing factors. Each averaging step is by a factor 2, so the original 16 chsb and 1,s data (50 Gbsb) goes to 4 chsb and 4,s data (4 Gbsb). The top option is preferable as the bottom option leaves many regions of the map smeared.