LBWG memo 29

Selfcal issues in 1600+434

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The field of 1600+434

1600+434 is one of the sources presented in Badole et al. (2021). It is a double source with a separation of just over an arcsecond; each component has a flux density of about 30 mJy at 150 MHz. The scientific purpose of the project is to measure the flux density ratio of the components. The source is a little too faint for successful amplitude selfcalibration, although the phases can be corrected. The nearest LBCS source, which was used for delay calibration and initial phase correction is 1559+4349, and which has a nominal flux density of about 3 Jy (most of which is likely visible on long baselines).

This memo reports pitfalls encountered during the calibration process which may be encountered in other projects, or in pipeline calibrations. All processing was performed in AIPS.

Procedure

1559+4349 was used for initial delay calibration, following failure to produce a successful delay calibration in the standard pipeline. A successful calibration was obtained with FRING using a 1-minute solution interval for both delay and phases, a S:N threshold of 2 for solutions, a delay window of 400 ns and a previously-made map from a previous iteration of the mapping procedure. Good solutions were obtained. However, the delay solutions required careful solution editing and clipping with SNSMO to eliminate points scattered up to 200 ns away, and smoothing due to the short solution interval needed to get simultaneous solutions for delay and phase.

A second calibration table was made using the FRING solution table, with an added round of amplitude and phase solutions with a 5-minute solution intervals in CALIB for baselines >40 kλ. Here an L1 solution needed to be used to avoid large numbers of failed solutions, and careful smoothing of both amplitude and phase was needed to avoid, in particular, discrepant points in amplitude. The amplitude solutions appeared to be good, and the calibrated data showed a lower level of amplitude variation with time. Smoothing was applied to keep only amplitude variations on timescales of greater than about 1 hour. Variations were generally within 50% with the exception of some antennas (e.g. DE604) with much bigger variations, up to a factor of 4-5.

Two datasets of 1600+434 were produced by transferring and applying the 1559+4349 solutions. One dataset had only the delay and phase solutions (dataset 1) and another was produced with the additional amplitude and phase solutions (dataset 2). Since the phase/delay solution had taken out the fast variations in phase with time and frequency, the data were averaged to 1 minute in time and 196-kHz channels.

Results

Each of these two 1600+434 datasets was imaged using `robust=0` with >40 kλ baselines. They were then phase selfcalibrated with a 10-minute solution interval and using one phase solution for the whole band (because of the faintness of 1600+434 there was not sufficient S:N on less than that), together with a model consisting of the clean components as far as the first negative (after merging with CCMRG. Images with the phase self-calibration were produced. Finally, an amplitude and phase selfcalibration with a 1-hour solution interval was attempted. These did not produce good maps, due to the lack of S:N even on long solution intervals.

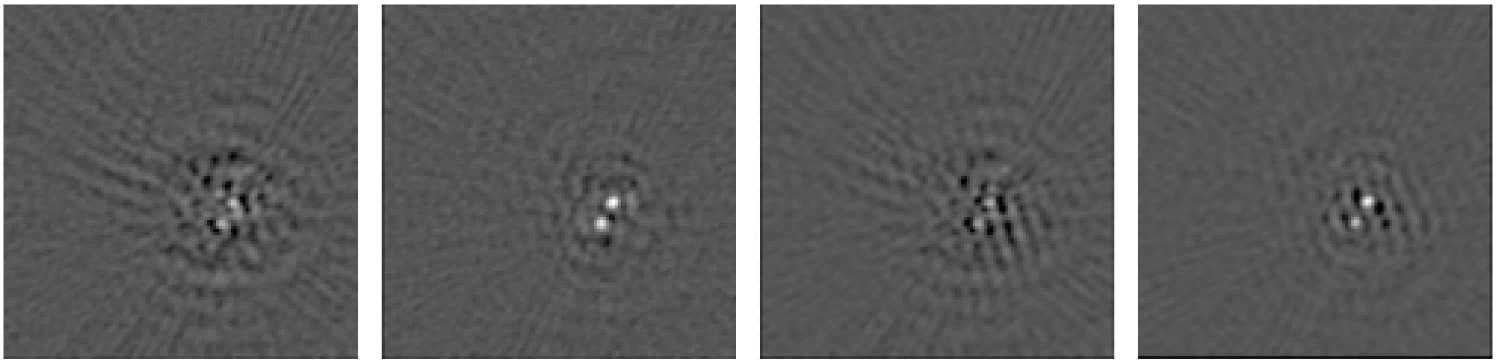

Figure 1: Maps. Left two: phase and delay solutions only transferred from phase calibrator, before and after phase selfcal on the target. Right two: as the left two, except with phase, delay and amplitude solutions transferred from the phase calibrator.

Fig. 1 shows the results, all on the same greyscale. The left two maps are those produced by transferring only the phase and delay solutions from the phase calibrator, with the first map made from the initial dataset and the second after one round of phase selfcal. The two on the right are the maps made with, in addition, amplitude solutions transferred from the phase calibrator.

These two sets of images differ in two ways: the flux ratio is 1.3 in the first set of images (the ratio claimed in the submitted version of the paper) and 1.9 in the second set. It is fairly obvious that there is a second difference: the second set has an obvious problem in the form of large negative bowls close to the main components.

Opinions

- On the narrow question of the paper, it is clear that the first set of images (flux ratio 1.3) are reliable and the others are not.
- The quality of the images is limited by residuals due to the amplitude calibration. Amplitude selfcal is impossible on the target, and highly problematic even on a relatively bright phase calibrator. Although the solutions look sensible, the result they give is clearly inferior.
- All calibrations - delay, phase and amplitude - are improved by scrutiny, removal of discrepant points and smoothing.
- Some relatively subtle differences in amplitude calibration produce very different quality of output image. This is worrying from the point of view of quality of images produced by pipelines.