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Improving Mark III Correlator Models After Correlation

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Abstract. Weak objects such as stars can only be mapped with VLBI using phase-referencing techniques. Phase-reference mapping is highly sensitive to imperfect interferometer delay models, and therefore cannot generally be performed on data from MKIII correlators for source separations of more than a few minutes of arc. An AIPS task has been developed to replace the correlator model in a UV data set with the VLBA correlator model (CALC 8.0). It is mainly intended for MKIII data which was read into AIPS via the task MK3IN, but can also be used to improve the precision of phase-reference mapping of VLBA data by correcting wrong apriori geometric information. A second task can replace the atmospheric model used in the correlator with measured values and an improved mapping function.

1. Introduction

Phase-reference mapping has become a standard mode of observation since the VLBA correlator became operational. This is due to the excellent geometric model applied in the correlation process which makes it possible to use the residual interferometer phases to make phase-reference maps with the help of standard AIPS tasks. Earlier attempts of phase-reference mapping using data from MKIII or even older correlator systems had to either use the total observables or fairly small source separations, and in both cases dedicated software to either subtract an improved geometric model from the data and/or to transfer the residual reference phase to the target data was required. As a consequence the process was difficult, time consuming and not available to a wider community.

The work being presented here was motivated by three different aspects of VLBI observing. Firstly, a significant number of observations are still correlated on MKIII correlators, e. g., nearly all EVN observations, and there is a strong interest to facilitate phase-reference mapping in a standard way with the EVN (and the Bonn MKIII correlator). Secondly, the VLBA correlator model can also be improved further, as two major disturbing effects—the varying delays introduced by both the atmosphere and the ionosphere—are only partially included (an altitude-dependent static model of the troposphere is used at correlation time, and no ionospheric correction is attempted). Thirdly, comparisons of astrometric results from several epochs require that the same correlator model is used, as differences in measured source separations might be dominated by systematic errors due to the different versions of the correlator model that were used. This may make it necessary to replace the correlator models for all epochs to make them the same.

2. Technical Realization

It is assumed that the antenna–based correlator model is correctly stored in the CL table of the UV data file. The time interval in the CL table should be sufficiently small so that the corrections to the UV data are sampled well enough. An appropriate CL table can be generated with INDXR (VLBA data) or MK3IN.

A new AIPS task PHREF is available to extract the correlator model from the CL table and replace it with the CALC model. This is reflected in a modified CL table which has new calibration phases, rates and delays. After applying the CL table to the UV data the residual delays, rates and phases are equivalent to those which would have been produced using the VLBA correlator model. Station and source coordinates, clock parameters and time information are supplied via an external text file.

A second task TROPO can insert an improved atmospheric model from measured temperature, pressure and humidity data. The required format of the atmospheric data is the one produced by the VLBA. A module for correcting the ionospheric delay contribution has not yet been realized. It is planned to use GPS measurements in a similar way to Ros et al. (these Proceedings, p. 389).

3. Tests

The new tasks were tested with a VLBA data set which was correlated with several offset apriori values of coordinates and time. Comparisons of this data corrected with PHREF to the properly correlated data set were used to verify the correctness of the PHREF and TROPO code (see fig. 1). PHREF also works correctly with MKIII data; tests were performed on data which was correlated on both the Bonn MKIII and the VLBA correlators.

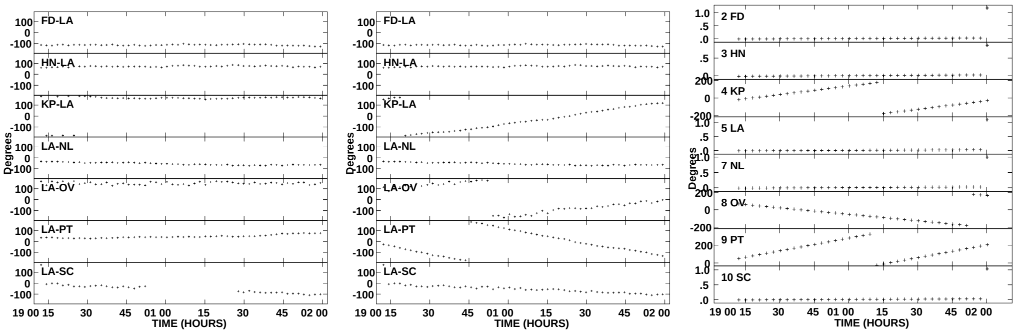

Figure 1. The left picture shows 2 minutes of the original test data set. The middle picture is the same data from a second correlation pass; stations KP, OV and PT were shifted a few meters. The picture on the right shows the calibration phases as estimated by PHREF. Applying them to the "false" data results in identical data to the original. The small deviations from zero calibration phase for the undisturbed antennas are due to numerical precision effects in the delay recalculation

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