ON THE COMPUTATION OF GROUP DELAY CORRECTIONS CAUSED BY RADIO SOURCE STRUCTURE

J. Campbell, H. Schuh, G. Zeppenfeld
Geodetic Institute
University of Bonn
Nussallee 17
D-5300 Bonn

ABSTRACT: We developed a structure algorithm for the computation of phase- and group delay corrections to geodetic VLBI observations. For some of the sources, i.e. 3C454.3, 3C273B and 3C345 the corrections are in the range of several hundred picosecs of group delay.

1. INTRODUCTION AND CONCEPT

In geodetic VLBI one of the tacit assumptions is that the observed sources are pointlike objects serving as ideal benchmarks in a virtually perfect realisation of an inertial reference system. In reality however, the strongest of the compact radio sources which are used in geodetic VLBI are also among those displaying both complex structure and high variability. In a companion paper by Schalinski et al. it has been shown that it is possible to use the geodetic observations of the IRIS and CDP programs to map the structure as well as to monitor its temporal changes. Here we use typical hybrid mapping results to derive phase and group delay corrections for geodetic VLBI.

Our work is based on a detailed study by Thomas (1980) on source structure effects. Using the concept of "effective position" which is the position obtained for one particular observation when the structure effects vanish, THOMAS arrives at the position of the "centroid" as a weighted mean associated with all observations of a given source in a multiparameter baseline fit.This centroid is obtained if no source corrections are applied. If we consider to use a structure map, which describes the features of a source in terms of relative coordinates, we are free to choose a reference point for the structure corrections. There appear to be two alternatives:

a. if we choose the centroid as origin of our structure map, we can compute the delay corrections needed to modify our observations as if they were produced by a point source at the location of the centroid. The potfit rms will decrease, but the problem is not solved because the centroid changes its absolute position if the brightness distribution changes.

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b. if we choose a prominent feature (e.g. the brightest component) as origin and use the same procedure as above we obtain corrected observations which correspond to this component.

In view of what is known today about the physical nature of compact radio sources we may have hopes that features with a stable position in the absolute sense really exist (e.g. the core of a core-jet source).

2. PROCEDURE AND FIRST RESULTS

We have developed a software module STRUC which can be linked to our geodetic VLBI program BVSS and which contains a package of subprograms dealing with the different steps in the generation of structure corrections. At the first observation of a particular source STRUC loads the delta map (in a standardized format), transforms it to the desired new origin and performs an FFT to obtain the complex visibility function which is then saved on a temporary memory. In the observation loop the visibility function is read from this memory and after computing the baseline projections is interpolated to derive the phase and its derivatives with respect to the u-, v-coordinates, i.e. to frequency. Then the group delay corrections are formed and returned to the main program. The delay rate corrections are calculated by numerical differentiation. For first numerical tests we used the structure maps of 1803+784, 0212+735, 3C454.3 (see fig.1), 3C273B, 3C345 and applied the corrections to the CDP-experiment May, 5/6, 1983 (baseline Effelsberg-Haystack). The results show a significant influence on the residuals of the solution as well as on the geodetic parameters but more extensive testing is needed to establish the tendency of the effects.

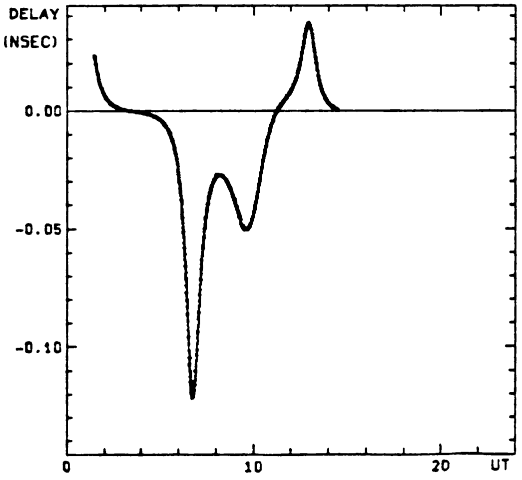

Fig.1. Group delay corrections for 3C454.3, Haystack-Effelsberg

In the future a combined package of source imaging and structure correction software will be included in regular geodetic VLBI-processing. Then, a reanalysis of the existing VLBI-databases solving for the position of the stationary component of each observed radio source will become a feasible task.

Ref.: Thomas, J.B. An Analysis of Source Structure Effects in Radio Interferometry Measurements. JPL Publ. 80-84,1980

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