MIT Haystack Observatory Analysis Center

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Abstract

The contributions of Haystack Observatory to the analysis of geodetic VLBI data focus on improvement in the accuracy of the estimation of atmospheric delays and on the reduction of instrumental errors through analysis. In 2006 most of the effort was related to evaluating error sources for the proposed VLBI2010 system, including the impact of phase errors due to source structure.

1. Geodetic Research at the Haystack Observatory

The MIT Haystack Observatory is located approximately 50 km northwest of Boston, Massachusetts. Geodetic analysis activities are directed primarily towards improving the accuracy of geodetic VLBI results, especially through the reduction of errors due to the atmosphere and to instrumentation. This work, along with operation of the geodetic VLBI correlator and with support of operations at the Westford, GGAO, Fortaleza, and Kokee Park VLBI sites, is supported by NASA through a contract from the Goddard Space Flight Center.

2. Evaluation of Source Structure Phase Across a Wide Spanned Bandwidth

Since the anticipated observable for the next generation geodetic VLBI system is the phase delay, variations in phase due to changes in structure of the observed radio sources across the observed frequency range could be significant.

In order to investigate the magnitude of the problem, spectra were constructed for the Gaussian components of several sources based on the S-band and X-band models derived by Fey and Charlot [1].

Sources of varying complexity were selected in order to span the range of variation that might be encountered and to see how the variation depends on the Structure Index (SI) as derived by Charlot [2]. The modeled sources and their structure indices at S and X band are listed in the following table.

Table 1. Structure Indices (SI) for selected sources.

Source	**Structure Index**	
	S-band	X-band
0014+813	1	1
0113-118	2	3
0149+218	2	2
0202+149	2	2
0248+430	2	4

The complex visibilities are easily calculated for Gaussian component models. The phases as a function of frequency are shown in the figures for a baseline length of one Earth radius

for observations at several orientations relative to the projected baseline. The sources 0149+218 (Figure 1a) and 0202+149 (Figure 1b), even though having SI of 2 at both S and X, would not add significant errors to the phase delay for an observation at any orientation relative to the projected baseline. On the other hand the sources 0113-118 (Figure 2a) and 0248+430 (Figure 2b) would make phase connection across the band impossible without apriori structure information. For the source 0014+813, with SI of 1 at both S and X, the maximum phase is approximately 0.25 radians near 2.5 GHz. While this is not significant for the connection of phase, the error would be correlated with the effect of the ionosphere, which is another source of error that must be assessed.

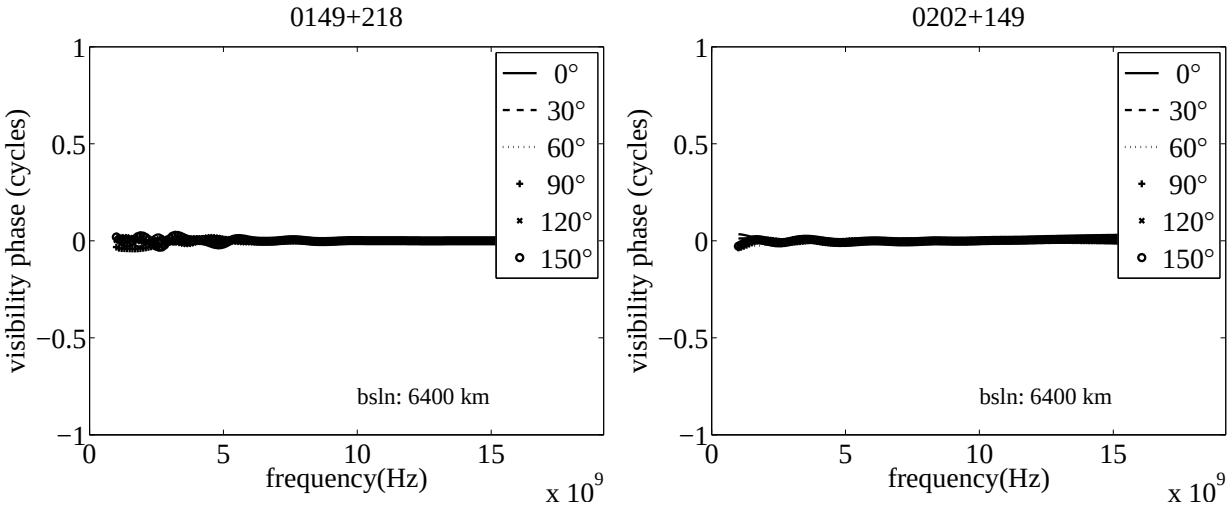

Figure 1. The source structure phase as a function of frequency and at six orientations relative to a baseline with length 6400 km for a) 0149+218 and b) 0202+149.

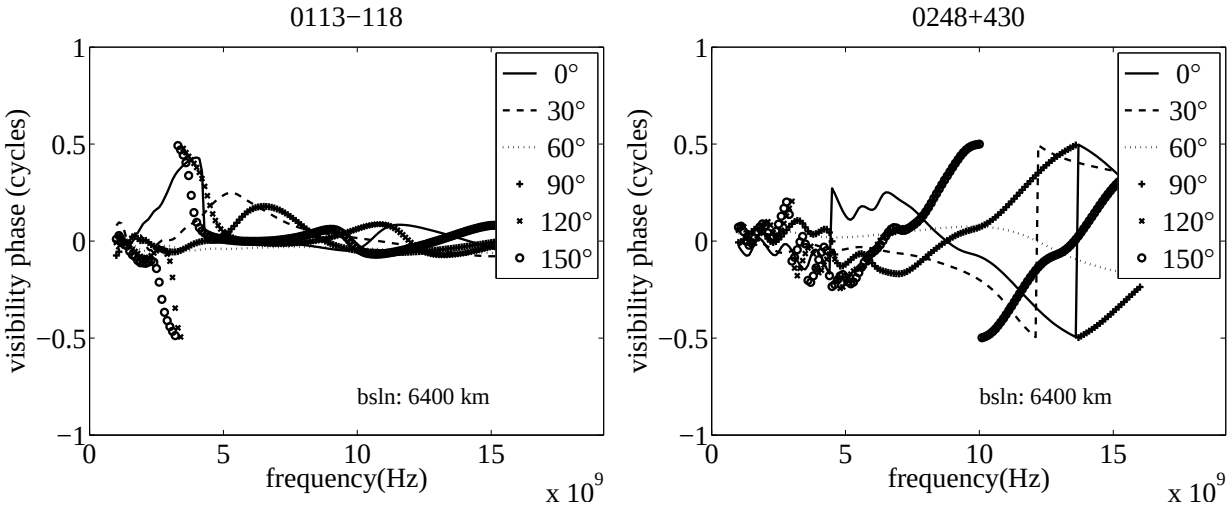

Figure 2. The source structure phase as a function of frequency and at six orientations relative to a baseline with length 6400 km for a) 0113-118 and b) 0248+430.

To the extent that these simplified models and this small sample represent the distribution of actual source structures, it appears that SI classes 1 and 2 may not produce large phase variations with frequency. Thus these sources may be acceptable for the geodetic observations. Of course a larger study is needed to see if the conclusion is supported when better statistics are established.

3. Outlook

In the upcoming year we will continue investigation of the potential improvements that can be obtained in the geodetic results by incorporating atmospheric effects as calculated from the MM5 Numerical Weather Model with a small horizontal grid spacing, as well as continuing the VLBI2010 simulations.

References

[1] Fey, A., and P. Charlot, VLBA Observation of radio reference frame sources. III. Astrometric suitability of an additional 225 sources, Ap. J. Supp. Series, 128:17-83, 2000 May.

[2] Charlot, P., 1990, Radio-source structure in astrometric and geodetic very long baseline interferometry, A.J., 99, 1309.