LONG BASELINE VECTOR DETERMINATIONS AND INTERCOMPARISONS

By East-Coast VLBI Group*
Presented by Curtis A. Knight

Haystack Observatory

The East Coast VLBI group has performed about 60 experiments over the last 10 years in the process of developing and exploiting advanced VLBI techniques. I will report on the most recent 14 experiments. About 2 years ago, we began a series of baseline measurements between the Haystack 37-m antenna, the OVRO 40-m antenna, and the Green Bank 43-m antenna (figure 1). Several technical improvements were made at the beginning of this series. The most significant of these was the introduction of wide bandwidth receivers so as to exploit the bandwidth synthesis technique more effectively. Phase calibration devices were used, as they had been in the past, to insure that the delay stability of the interferometer would be limited by the Hydrogen Maser frequency standards and not some other part of the receiver chain. The phase calibrators include a cable measurement system so that changes in the length of the cable between the Hydrogen Maser and the phase calibrator injection point can be compensated in the data processing. This cable compensation was not included in any of the data presented. The wideband receivers were in use at Haystack and OVRO from the beginning, but were used at Green Bank for only the last experiment.

Each of these experiments was of 1 or 2 days duration. Each day's work produced about 150 measurements of interferometric delay, and delay rate per baseline spread over about 10 radio sources. From these measurements, it is possible to estimate all three components of each baseline vector and all the source coordinates except the right ascension of one source, which must be fixed in order to define the origin of the right ascension coordinate. The baseline vector components are expressed in a "crust-fixed" coordinate system defined by the BIH circular D values for polar motion and AT-UT1 with McClure's formulation for diurnal polar motion and Dahlen's values for the Love numbers for the solid Earth tides, with tidal potentials calculated directly from the solar system geometry. (These models are discussed further in another paper.) Unfortunately, these models are not sufficiently accurate to permit an interpretation of a change in the angular position of the baseline vector in terms of a local motion of the Earth's crust. A variation of time in AT-UT1 of only 0.001 second of time is sufficient to change the equatorial components of the Haystack-OVRO baseline by 30 centimeters. This provides both a problem and an opportunity. The opportunity will be discussed in another paper, and I will avoid the problem by means of the observation that there is a quantity associated with the baseline vector that is independent of rotations – its length.

---

*East-Coast VLBI Group–Participating Organizations: Goddard Space Flight Center, Haystack Observatory, Massachusetts Institute of Technology, National Geodetic Survey, National Radio Astronomy Observatory.

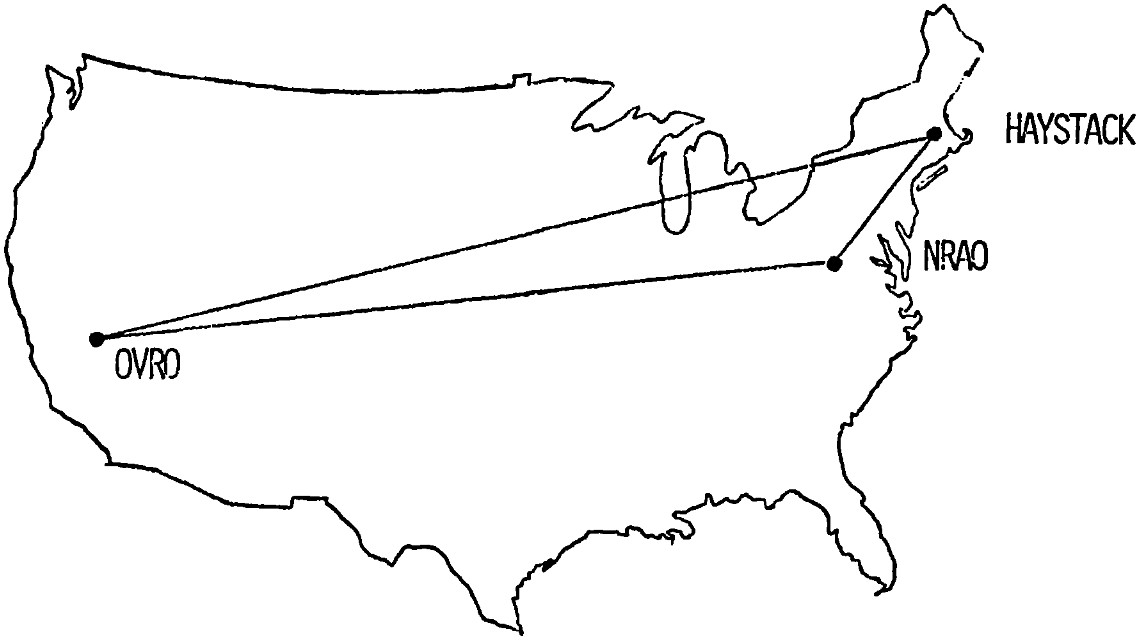

Figure 1.

Figure 2 displays preliminary, nearly independent determinations of the Haystack-OVRO baseline length obtained from data collected in 14 sessions of observations distributed over almost 2 years. These results are preliminary and not quite independent because, for example, the radio source coordinates were fixed at values determined from an average of those obtained from analysis of the data from each session of observations separately. When the source coordinates are allowed to vary in each baseline determination, the effect is to increase the scatter in baseline length by about 50 percent. This set of measurements is remarkable in that it demonstrates that for this period there has been no change in the baseline length of more than a few centimeters per year.

In figure 3, similar determinations of the Haystack-Green Bank baseline length are displayed. Measurements from older series of experiments have been included to extend the time spanned to almost 5 years. Note that the wideband receivers were used only in the last experiment. The limit on the rate of change in length of this baseline is also a few centimeters per year.

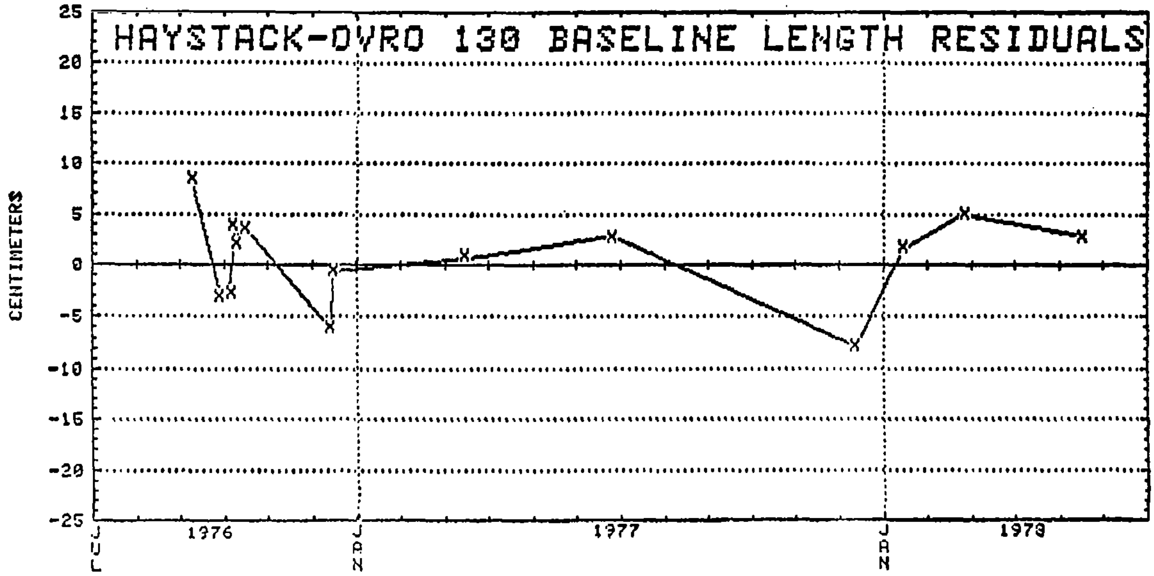

Figure 2.

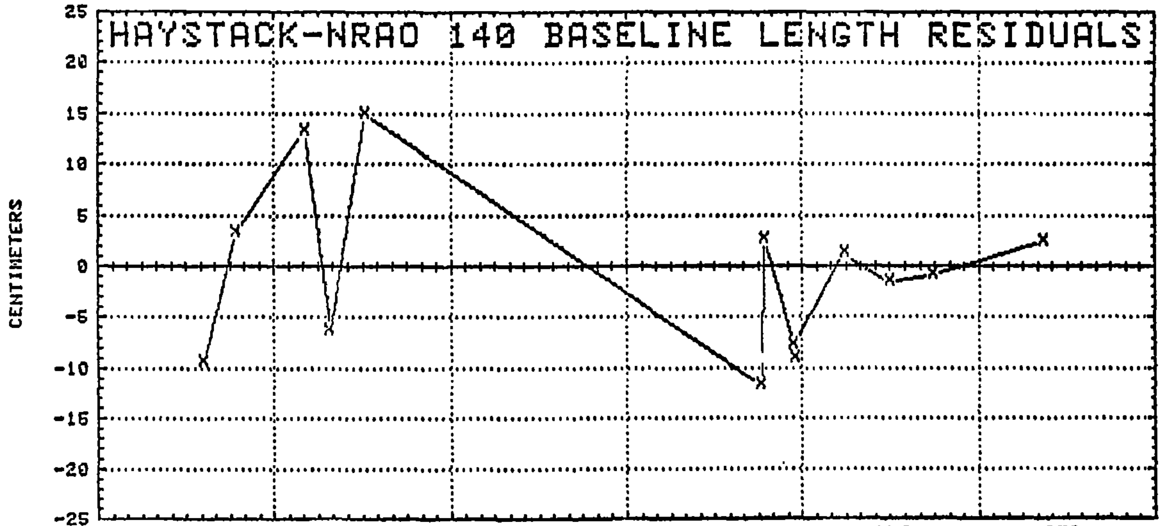

Figure 3.

How can we improve upon these results in the future? When deployed world-wide, the Mark-III VLBI system currently under development by the East-Coast VLBI group will provide the sensitivity to observe radio sources in all parts of the sky. This will eliminate the scheduling constraints associated with the Mark-I system, which could see relatively few sources. The multiplicity of baselines available will permit the observation of angular changes in one baseline relative to another, since the rotation of the Earth will be measured simultaneously with the baseline vectors to high accuracy. (This assumes that an adequate definition for 'crust-fixed' coordinates can be found in the age of centimeter level geodesy.) Water vapor line radiometers being developed at the Jet Propulsion Laboratory will, when placed at the Mark-III sites, permit the inference of the atmospheric delay in the line of sight to the radio sources. In short, we may look forward in the near future to a significant increase in the quantity and quality of geodetic measurements. Their interpretation should provide excitement for years to come.