COMBINING VLBI AND GPS TO PRODUCE A NATIONAL CRUSTAL MOTION NETWORK IN THE UNITED STATES

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ABSTRACT. A National Crustal Motion Network for the United States using VLBI and GPS technologies is being developed. Implementation of both the VLBI and GPS components of the network is underway.

The many geophysical requirements for crustal motion monitoring in the United States result in the need for a National Crustal Motion Network (NCMN) consisting of hundreds of stations which are reobserved at varying intervals over extended time periods. Differential station positions must be determined with an accuracy of $\pm$ 1 to 3 cm. Fixed and mobile VLBI systems have demonstrated their ability to monitor crustal motion with the required accuracy. However, cost and logistical considerations prevent the use of mobile VLBI to establish and monitor the large number of stations constituting an NCMN. Comparisons of differential positions obtained during Global Positioning System (GPS) receivers with those obtained using mobile VLBI demonstrate that GPS results can provide equivalent accuracies of 1 to 2 cm over baselines up to about 500 km in length. Because a GPS measurement is about two orders of magnitude less expensive than a mobile VLBI measurement and logistically much simpler (hand portable equipment as compared to two large tractor-trailers for mobile VLBI), GPS will be used for establishing and monitoring most of the NCMN.

The replacement of mobile VLBI by GPS for measurements over shorter baselines heralds an era where VLBI will provide global and regional frameworks for the more detailed GPS measurements. The NCMN will use a regional VLBI reference frame consisting of about 30 VLBI sites. The remaining stations of the NCMN will be established using GPS geodetic receivers. These receivers will be referenced to the VLBI network through permanent co-location of GPS receivers at about 5 fixed VLBI sites in North America to provide GPS satellite orbit information in the VLBI reference frame and temporary occupation of fixed or mobile VLBI sites with GPS in the immediate vicinity of GPS observation campaigns while they are being carried out.

Implementation of the NCMN has begun. To the maximum extent possible

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the establishment of the NCMN is being carried out as a cooperative effort between NGS and other Federal agencies, state, and local agencies, and university groups. The fixed VLBI stations to be used in the regional VLBI network will consist of the three existing U.S. stations of the IRIS network, other existing stations at Mojave, Owens Valley, and Hat Creek, California, Maryland Point, Maryland and Green Bank, West Virginia, and the Very Long Baseline Array (VLBA) stations as they are implemented. Mobile VLBI sites wil consist of nine stations previously established as part of the NASA Crustal Dynamics Project (CDP) in California, Arizona, Nevada, Utah, and Colorado and stations established by the National Geodetic Survey (NGS) in the States of Washington, Texas, Oklahoma, Georgia, and Indiana during the 1986-87 time period specifically to support the NCMN. Permanent GPS stations for orbit determination are currently being operated at VLBI stations in Massachusetts, Texas, and California as a joint activity by NGS, the University of Texas and the Texas Department of Highways. NGS will begin operation of a permanent GPS station at its Richmond, Florida, VLBI site in August 1987.

In support of the NASA CDP, NGS currently operates its mobile VLBI systems to monitor a 15 station network in California and some five additional stations in the western United States. Mobile VLBI measurements over the California network have shown that movement across the San Andreas and associated fault systems is 3.5 to 4.5 cm/yr, less than the estimated long term North American-Pacific plate motion of 4.8 to 5.6 cm/yr. GPS measurements over the southern California mobile VLBI network were carried out by NGS in June 1986, and repeated in January 1987. These measurements demonstrated the ability of GPS to replace mobile VLBI over this network provided two to three stations continue to be monitored with mobile VLBI and represents the initiation of a transition from mobile VLBI to GPS monitoring over the next 2 to 3 years. In conjunction with other organizations additional GPS stations were established to densify the NCMN in southern California and extend it to the offshore islands. By the end of 1987 additional GPS activities to extend and densify the NCMN will include: (1) a 43 station GPS strain network reaching from the eastern slope of the Rocky Mountains to the Atlantic Ocean, (2) interconnection of the Hawaiian Islands, (3) repeated GPS occupations of VLBI sites in Alaska, (4) detailed GPS networks in the Imperial Valley of California, the Hegben Lake-Yellowstone area, the Anchorage area, Coastal Maine, the State of Tennessee, southern Arizona and the Houston-Galveston area of Texas, (5) a 20 to 30 station regional network in northern California and (6) a regional network in northwest Washington State.