Italy INAF Analysis Center

Monia Negusini, Pierguido Sarti

Abstract This report summarizes the activity of the Italian INAF VLBI Analysis Center. Our Analysis Center is located in Bologna, Italy and belongs to the Institute of Radio Astronomy (IRA), which is part of the National Institute of Astrophysics (INAF). The IRA runs the observatories of Medicina and Noto, where two 32-m twin VLBI AZ-EL telescopes are located. This report contains the AC's VLBI data analysis activities and illustrates the local surveys carried out in 2014 at IRA observatories.

1 Current Status and Activity

The activities related to local ties between different geodetic systems located at the observatories were carried out in 2014. At the Medicina and Noto sites, the local values of the Deflection of the Vertical (DoV) were determined using two different methods: a combination of GPS and geometric leveling on one side and gravity residuals on the other. The combination of Global Navigation Satellite System (GNSS) techniques, mostly GPS, and geometric leveling can be adopted for the computation and/or validation of geoid undulation, models, and DoV values. Additional methods that can be successfully employed to determine local DoV values are e.g. astro-geodetic measurements with total stations or zenith cameras.

During the surveys carried out in March 2014 at Medicina and in July 2014 at Noto, we employed GPS and high precision spirit (geometric) leveling to compute local geoid undulation over the areas surrounding the radio astronomy observatories. At site Medicina, two crews measured along the $L \approx 4.8$ km loop in one day, using one Trimble DiNi12 and one Leica DNA03 digital level ($\sigma = 0.3$ mm/km), and two pairs of 2-m invar rods. In spite of the challenging road conditions, the leveling survey was a real success, with leveling errors on every line well below the $2\sqrt{L}$ tolerance and a global misclosure of 0.9 mm over the $L \approx 4.8$ km loop.

At Noto where only one measuring crew was available, two full working days were necessary to complete the back and forth observations along the lines, using the Leica DNA03 digital level and the 2-m invar rods. Due to local specific limitations, no feasible roads/paths were identified to connect the **N** and **E** endpoints of the lines, and no closed loop was realized. The total length of the lines resulted in $L \approx 2.4$ km, with a maximum misclosure of 0.6 mm on a 600 m line, i.e. $\approx 1/3$ of the $2\sqrt{L}$ tolerance. The geometric leveling data were analyzed with STAR*LEV.

Eight hour GPS observations were performed close to the endpoints of the leveling lines, employing Trimble 5700 receivers and LEIAT 504 Choke Ring antennas. The GPS data analysis was performed with `Bernese V5.2` software, processing L1 carrier only using CODE troposhere parameters and global ionospheric maps. All models were expressed in IGS08 and the coordinates of MEDI (DOMES #12711M003), and NOT1 (DOMES #12717M004) were kept fixed to the ITRF2008 values at the relevant epochs: $(2014:107)$ and $(2014:207)$, respectively.

In addition, the *remove-restore* technique used for the computation of the gravimetric geoid undulation could also be implemented to estimate the DoV and to define its ξ and η DoV components.

Istituto di Radioastronomia INAF, Bologna

INAF Analysis Center

IVS 2014 Annual Report

Starting from the gravity residuals computed for the estimate of the Italian quasi-geoid *ITALGEO05*, the residual vertical deflection components were obtained using the Fast Collocation approach. The restore phase was performed adding the long-wavelength component in the term of deflection of the vertical and the high frequency due to the topography to the residual values of ξ and η.

The DoV results will be published in a paper currently under preparation.

2 Data Analysis and Results

The IRA began analyzing VLBI geodetic databases in 1989, using a CALC/SOLVE package on the HP1000 at the Medicina station. In subsequent years, the same software was installed first on an HP360 workstation and later on an HP715/50 workstation. In more recent years, two HP785/B2600 workstations and an HP282 workstation were used. In 2007, a new Linux workstation was set up for the migration of all the VLBI data analysis, and Mark 5 Calc/Solve was installed. During 2014, our Analysis Center had an internal problem, and we did not participate regularly in IVS activities. But we continued to update the catalog, and we installed and tested the latest release of CALC/SOLVE and the new geodetic software *vSolve*.

3 Outlook

In 2015, we will contribute again to IVS activities and submit INAF tropospheric parameters regularly to the IVS Data Center. We will also produce an updated long term geodetic solution.