THE ACTIVITIES AT THE PERMANENT IGS STATION UPAD OF THE UNIVERSITY OF PADOVA

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1. INTRODUCTION

The GPS station UPAD of the University of Padova operates since 1994 as a permanent installation in support of the IGS (International GPS Service for Geodynamics). The UPAD station serves the scientific and tutorial needs of the Department of Geology, Paleontology and Geophysics, as to the applications of GPS data to Earth Sciences, and of the Centro Interdipartimentale di Studi e Attivita' Spaziali (CISAS) 'G. Colombo', as to the applications of GPS techniques to Space Engineering, Space Communication and Navigation. The station (Figure 1) is located downtown Padova, on the roof of the University Main Building, near a Geodetic Dome formerly used for astrolabe observations (Figure 2) . The line of sight is unobstructed except on the northern side, because of the geodetic dome. However the orbital geometry of the GPS satellites is such that this obstruction is harmless.

2. STATION EQUIPMENT

The equipment consists of :

- TRIMBLE 4000SSE geodetic receiver 9+9 channels, L1/L2
- Geodetic antenna dual frequency with ground plane
- PC 386 Hewlett Packard RS25C running DOS 6.22
- Streamer Colorado for backup on magnetic cassette
- High speed modem
- Ethernet connection

Figure 1. The UPAD station

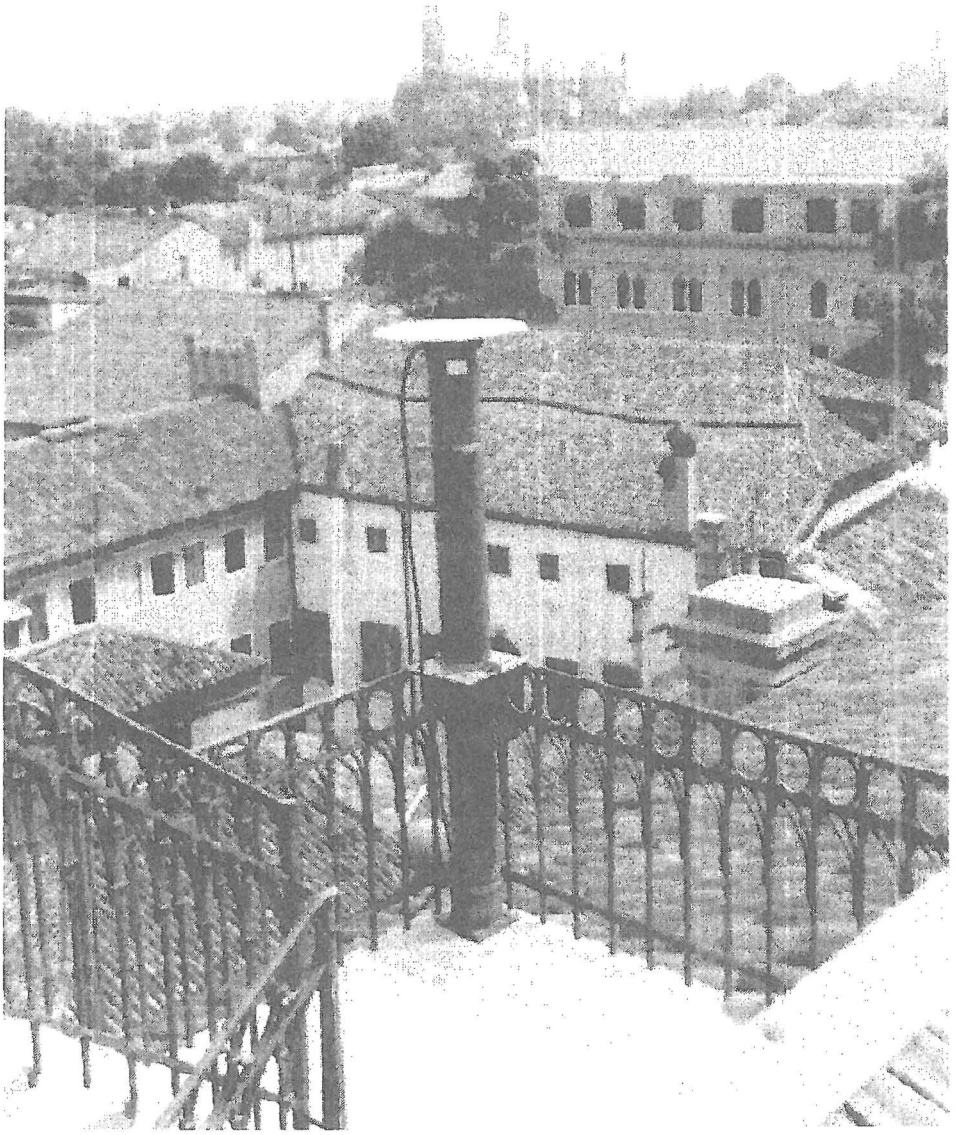

Figure 2. The antenna of the UPAD station

3. PROCEDURES

The station is designed to work unattended and autonomously, following a pre-programmed schedule on the PC and on the receiver. For IGS activities, data logging starts daily at 00:05 UTC and ends at 23:59 UTC, with a sampling time of 30 seconds. The data logging is done on the receiver both as a caution against blackouts (the receiver is provided with two batteries) and to keep the PC available during the day for offline work. At the end of a daily session a scheduler on the PC activates a batch procedure which does the following:

- connect via serial port to the GPS receiver, download the datafile and memory cleanup. This is done with the Trimble's TRIM4000 program driven by a binary command file.
- Data conversion from Trimble binary to RINEX ASCII format, using the University of Bern programs TRRINEXO, TRRINEXN for observation and navigation data respectively.
- Data checking, by means of the program QC developed by UNAVCO:

  ✓ total number of acquired data
  ✓ percentage acquired/acquirable data
  ✓ number of edited data
  ✓ r.m.s. of the position differences between the QC values and the RINEX value
  ✓ r.m.s. (root mean square dispersion) of code multipath on L1 and L2, for all satellites
  ✓ total number of cycle slips on zero-difference data

✓receiver clock drift

- Compression of the RINEX files using the IGS program COMPRESS
- Compression of the raw Trimble binary files using the PKZIP program and backup on magnetic cassette
- Setup of DOS command file for file transfer via ftp to the Data Centers:

  ✓ GEODAF in Matera , of the Italian Space Agency : geodaf.mt.asi.it, subdirectory: GEOD/GPSD/RAW/

  ✓Graz Observatory, Austria: flubiw01.tu-graz.ac.at , subdirectory: cei/indata/rinex

  ✓University of Padova FTP public area: ipdunidx.unipd.it, subdirectory /pub/incoming/GPS-UPAD

- send data files via Internet/FTP to Data Centers

The above procedure requires approximately 15 minutes on the local PC. The remaining time is dedicated to offline operations. Of these the most important is the 'host mode', where a remote user logs on the local PC using modem connection, for interactive access to the receiver or just file transfer.

4. DATA STATISTICS

The statistics of the GPS data at UPAD are given in Figure 3. The basic features can be summarized as follows:

- data acquisition statistics: on average 99% of the acquirable data are acquired
- code multipath: on average <0.5 m on L1 and <0.7 m on L2. In 1995, low multipath periods are strongly correlated with periods when A/S (Anti Spoofing) was off
- number of cycle slips: < 100/day: higher number in 1995, when A/S was off
- clock drift: -4 msec/hour, implying a reset of 1 msec every 15 minutes. Marked seasonal component in summer, probably related to increase in room temperature

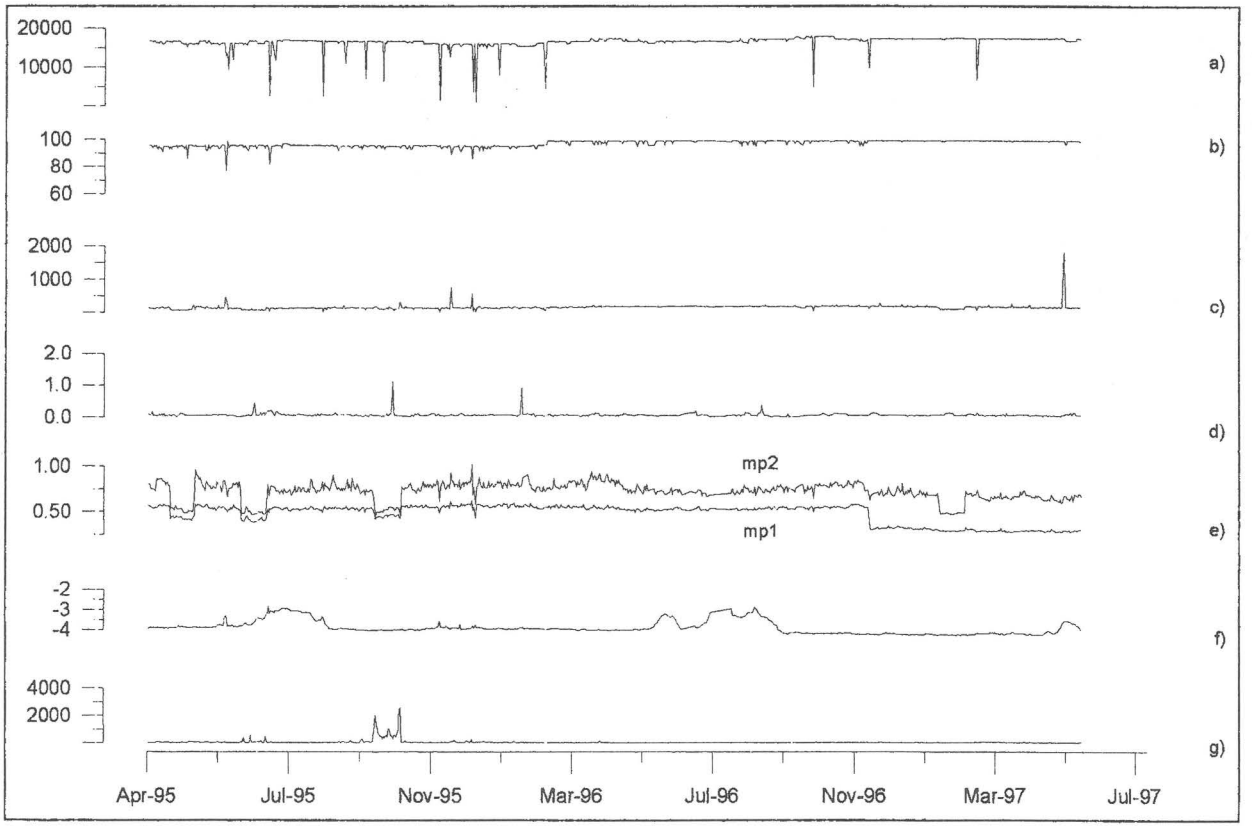

Figure 3. Data statistics of UPAD from April 1995 to June1997: a) number of acquired data; b) % of acquired/acquirable data; c) number of edited data; d) QC-RINEX position difference (km); d) code multipath on L1 (mp1) and L2 (mp2) (meters); f) clock drift (msec/hour); g) number of cycle slips on undifferenced data.

5. SCIENCE AND APPLICATIONS

5.1 CRUSTAL DEFORMATION IN THE EASTERN ALPS

A number of Austrian, French and Italian permanent GPS stations have joined in a network comprising the Eastern Alps, dedicated to the measurements of relative displacements (Figure 4). The computation of the baselines is based on the BERNESE Program Vers. 4.0 of the Astronomical Institute of the University of Berne. The processing scheme is based on the following steps:

- create directory structure appropriate for the campaign of day nnn
- upload from Data Centers compressed RINEX files for day nnn and store into the appropriate directory area
- upload from Center for Orbit Determination in Europe (CODE) precise ephemeris file, satellite clock file, ionospheric file, updated ERP file, satellite problem file and store into the appropriate directory area(s)
- setup BERNESE's -N, -I, -F files as appropriate for the campaign
- run in batch mode the basic modules of BERNESE
- on a weekly basis, combine daily free-network solutions
- archive weekly solutions in SINEX format
- generate updated plot files of changes in baseline length and station coordinates

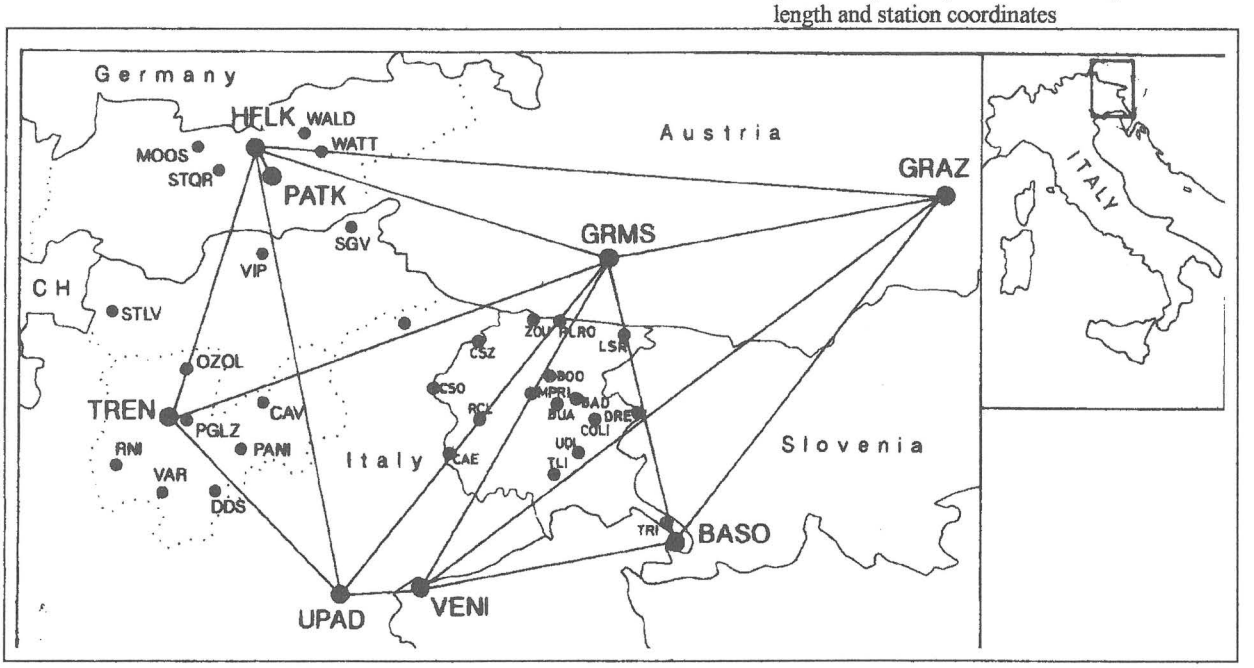

Figure 4. GPS and seismic network in the Eastern Alps

5.2 SUPPORT TO POSITIONING AND NAVIGATION

The UPAD station routinely supports post-processed positioning of mobile units. UPAD data can be downloaded via modem or FTP and combined with user data files to reconstruct trajectories in differental mode. Our software DDGPS employs double differences of pseudoranges smoothed with L1 carrier phase, and decimetric accuracies have been demonstrated, if at least 5 satellites are simultaneously tracked. The UPAD coordinates are known in the ITRF system and relative to local trigonometric verteces. Thus the coordinates of the mobile unit can be represented either in the ITRF reference system on the WGS84 ellipsoid, or in a local datum' on the ED50 ellipsoid oriented consistently with the national cartography:

Coordinates of UPAD

- in the local datum (Gauss Boaga planimetric System):

  UTM East (m) 1725243.94 m
  UTM Nord (m) 5032183.60 m

- in the national reference system (Roma M. Mario: ϕ =41°55'25".51N; λ= 12°27'08".40E)

  ϕ 45°24'21".83
  ω 0°34'30".96

- in WGS84 reference system:

ϕ	45°24'24".18
λ	11°52'40".55
h (ellipsoidic)	86.01 m

- orthometric height of ground marker
  39.822 m
- Gravity at marker
  9.80649121 m/sec^2

The most important applications and products are:

- production of vectors of 3-D coordinates, in support to GIS (Geographic Information Systems) applications
- positioning of aircraft for geo-referentiation of the focal center of the camera in aerial-photogrammetric flights
- precision computation of coordinates of landmarks occupied in static mode with a GPS receiver
- integration of vector data (arrays of coordinates of surveyied sites) and raster/vector maps

6. UPGRADES

Transition to the TRIMBLE 4000 SSi receiver and chocke ring antenna is scheduled in July 1997. Similarly the operational procedures will be managed by Trimble's URS (Universal Reference Station) software under OS/2 Warp 4.0 operating system.

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