National Report of Portugal

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1. Introduction

The present report covers the activities of the Portuguese Institute of Cartography and Cadastre, IPCC, concerning the EUREF work, during the last twelve months. The following items will be focussed: National Permanent GPS Stations Network (ReNEP-GPS), National Geodetic Network (RGN), Vertical Deflection Points Network (RPDV), First Order Levelling Network (RNGAP) and Gravimetric Network (RNG).

2. National Permanent GPS Stations Network (ReNEP-GPS)

The development of the network has proceeded with the establishment of a set of three new stations and the up-grade of Cascais station (CASC). The new stations are located in Gaia (near Porto city, in North), in Lagos, Algarve, in South and the third one in Ponta Delgada, island of S. Miguel, in Açores archipelago. Each of these stations are near a tide gauge.

The configuration of the stations is as follows:

Leica CRS1000 receiver; Leica AT504 antenna; Paroscientific Met3 meteorological station; MC-CDU control station software.

For the time being we are collecting data at a 30 s rate, 24 h files

Cascais station belongs to the EUREF network since October 1998. The new stations will also be integrated in the EUREF network soon.

By the end of 1999 a public tender for the acquisition of the equipment for three more permanent stations was closed. These new stations will be delivered next August. The installation will take place during September 2000. These new GPS stations will be placed one in Madeira island, the others in Portugal mainland near the Spanish border.

For 2001 we intend to densify the network with three more stations: one in the center of Portugal mainland, a control station to be placed in the IPCC headquarters and the third station to the Açores, Central Group. The proposed configuration of the network for Portugal mainland is shown in fig. 1.

All the already established stations are connected to the National Geodetic Network (RGN).

There is a particular interest in the Açores station, since it is situated near (a few meters) the DORIS antenna, installed by IGN – France, and the place can be considered as belonging to the EUREF Permanent Network and is specially important for geodynamics.

3. National Geodetic Network (RGN)

After the GPS observation of the first order network, connected to the IBERIA95 réseaux, a campaign concerning the observation of the 2nd order was started in 1998. Actually circa 30% of the 900 2nd order trig points are already observed. The computations of these observations are being carried out with GPS Survey and GeoLab. Since this year we are using the GeoGenius software package and we intend to recompute all the data with it.

The following standards are used to observe the 2nd order network:

- 4 – 5 double frequency Trimble GPS receivers
- 2 h session
- 15 s epoch interval
- elevation mask 10°
- occupation of two first order points in each session

The preliminary computations have been finished in the end of 1999, and the results are better than 5 centimeters (at 95% of confidence level) for both planimetric coordinates and height.

Since 1994 IPCC is carrying out the reconnaissance and the material recovering of the classical geodetic network. This network comprises about 9000 trig points (mostly concrete pillars). Madeira archipelago network is already completely recovered. The Açores archipelago network is almost completed and 70% of Portugal mainland network is also already made. All the rebuilt pillars are observed with GPS and recomputed.

4. Vertical Deflection Points' Network (RPDV)

In the period 1975-1978 a network of about 130 stations was observed with a prismatic astrolabe. The results of the observations were used to compute a geoid model for Portugal.

In 1998 a project for the reobservation and densification of that network was started. The first step consisted in

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reobserving 25 stations with a more accurate device and precise method. The equipment used was the Zenithal Camera of ETH-Zürich.

Meanwhile, following a protocol of cooperation between IPCC and the ETH , the automatic ICARUS system has been put in operation. For improving the precision of the observations a TCA2003L theodolite was bought and the ICARUS communication software rewritten to that apparatus.

During the fall of 1999 took place an experimental campaign with ICARUS. Some 30 stations were observed in the central part of Portugal mainland, see figure 2. For each station two independent series of observations were performed. The r.m.s. of each series was bellow 0.2" for both coordinates (astronomical latitude and longitude). Quiet a few series were repeated in order to achieve this precision. In table 1 are listed the ICARUS observed values and the components of the deflections of the vertical in WGS84 (ITRF96 solution). The average time needed to perform a station observation (two series) was about two hours. In the beginning and at the end of the campaign the observers had determined their personal equation at the Astronomical Tapada Observatory, in Lisbon.

We intend to resume the ICARUS campaign as soon as possible, in order to duplicate the number of already existing VDP in Portugal mainland.

5. First Order Levelling Network (RNGAP)

In 1999, the reobservation of the first order levelling network has reached 120 km in mainland. Simultaneously a new design for the levelling network of S. Miguel island in Açores archipelago was developed and some 100 km of this new network are observed in 1998 and 1999.

In Portugal mainland the computations and the analysis of the closed circuits were performed with very good results, see fig. 3. Next year it will be possible to adjust the entire network, based on the new sea level value for the Atlantic ocean in Cascais tide gauge, at 2000.

A study about the influence of the new predicted gravimetric values on the calculated geopotential heights was carried out. The adjustment in geopotential numbers will be performed as nodal point adjustment.

6. Gravimetric Network (RNG)

As stated in the previous report, the densification of the gravimetric network in Portugal mainland, with an average distance of about 5 km, finished in 1997. The results are being used for the edition of a map of isoanomalies and also for the computation of a geoid model. In 1999 were observed 292 new gravimetric stations along the levelled lines in 1998. These results will be included in the new edition of the isoanomalies map.

References

TORRES, J., PINTO, J., 1998 – *National Report of Portugal*, Proceedings of the EUREF Symposium held in Prague, Czech Republic, 2 – 5 June, 196-198.

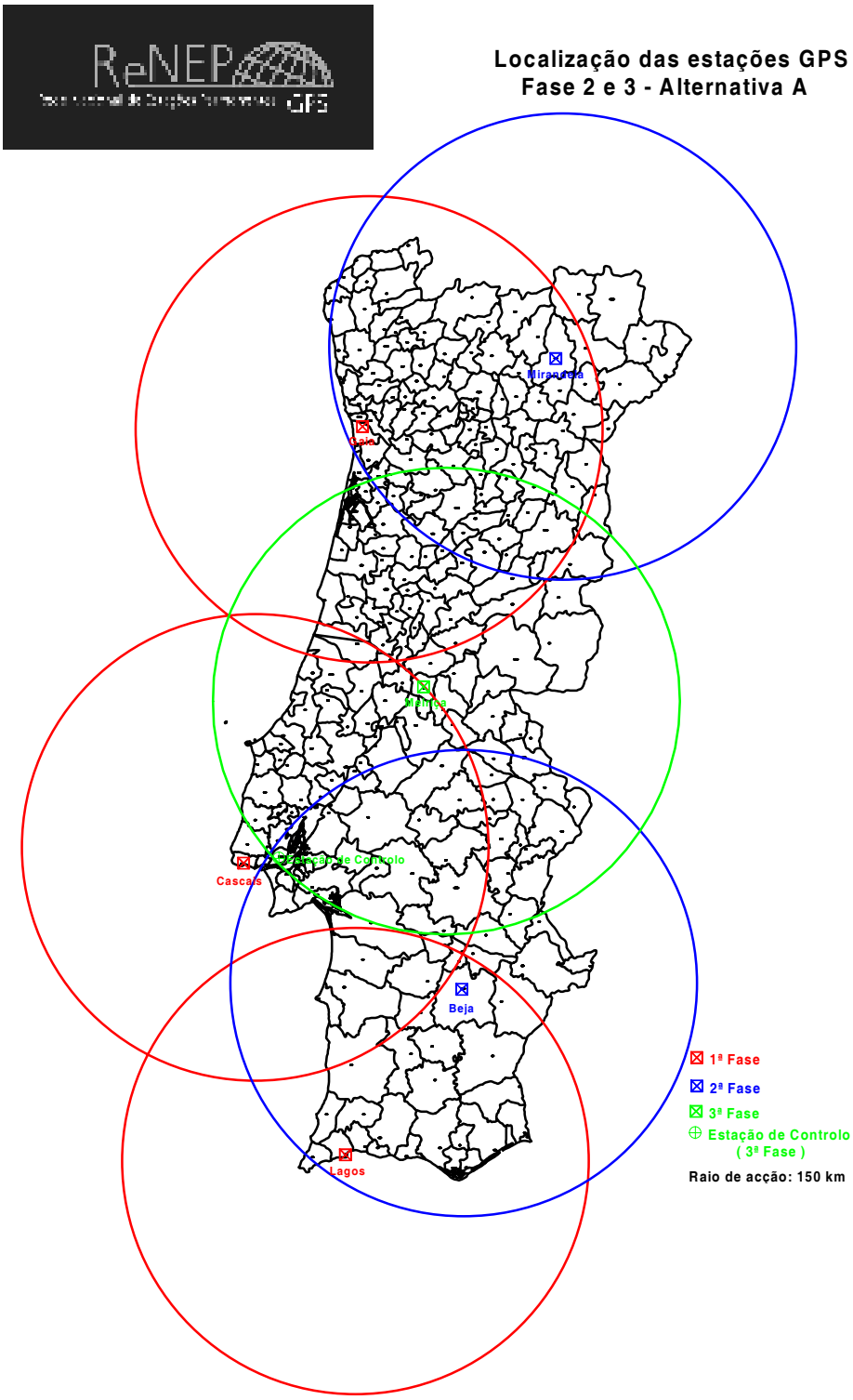

Fig. 1: Established and planned GPS permanent network in Portugal mainland

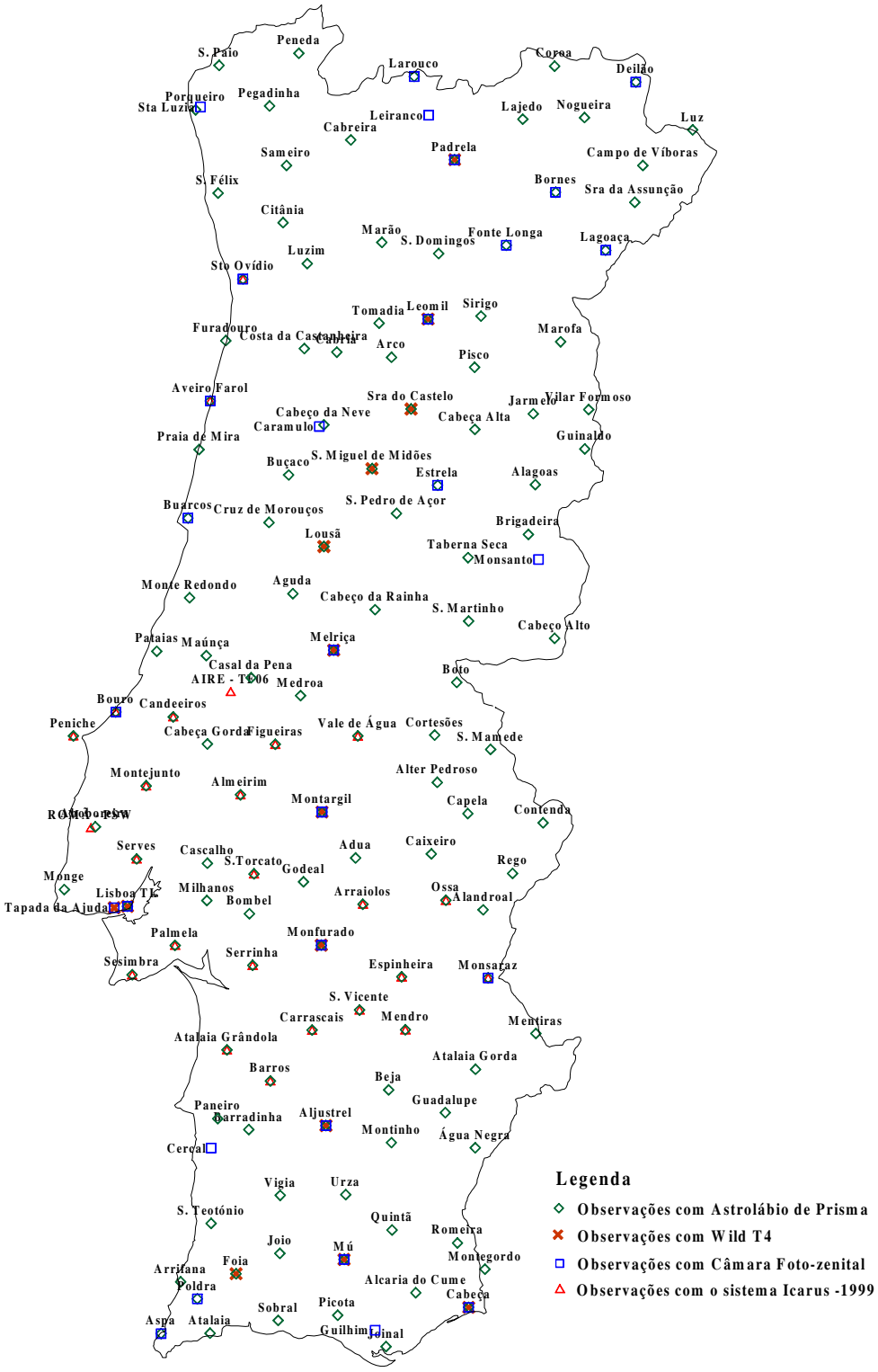

Fig. 2: Astronomical stations in Portugal mainland and ICARUS stations observed in 1999

Tab. 1: Observed astronomical values with ICARUS and components of the deflections of the vertical

	Astronómicas - ICARUS (º ´ ´´)		WGS84 (º ´ ´´)		ξ "	η "
Estação	Latitude (N)	Longitude (W)	Latitude (N)	Longitude (W)	(φ Astro - φ WGS84)	(λ Astro - λ WGS) * cos φ
P1 - GeoBase	38 46 21,53	7 42 47,33	38 46 19,12	7 42 46,54	2,42	-0,62
P3 - GeoBase	**38 51 27,20**	**7 39 54,08**	**38 51 26,78**	**7 39 50,79**	**0,42**	**-2,57**
P5 - GeoBase	38 53 38,97	7 38 36,68	38 53 38,03	7 38 36,67	0,95	-0,01
ALMEIRIM	**39 08 29,89**	**8 35 14,27**	**39 08 32,07**	**8 35 11,92**	**-2,19**	**-1,83**
SERRINHA - PN/PE*	38 29 31,30	8 31 28,32	38 29 30,84	8 31 23,16	0,46	-4,04
MOTARGIL - TF02	**39 04 40,40**	**8 11 17,13**	**39 04 38,30**	**8 11 14,38**	**2,11**	**-2,14**
S. TORCATO - PE	38 50 26,42	8 31 14,07	38 50 26,07	8 31 08,56	0,36	-4,30
BARROS - PE	**38 03 03,12**	**8 26 10,68**	**38 03 04,90**	**8 26 08,16**	**-1,78**	**-1,99**
ATAL. GRÂNDOLA TF30	38 10 10,17	8 38 49,86	38 10 09,33	8 38 44,03	0,84	-4,59
MENDRO - TF31	**38 14 44,93**	**7 47 04,71**	**38 14 46,24**	**7 47 02,09**	**-1,32**	**-2,06**
S. VICENTE - PN	38 19 20,17	8 00 21,86	38 19 19,80	8 00 18,61	0,37	-2,55
STO. OVÍDIO	**41 06 29,59**	**8 35 16,64**	**41 06 28,51**	**8 35 13,96**	**1,08**	**-2,02**
AVEIRO FAROL	40 38 31,02	8 44 58,94	40 38 34,20	8 44 52,37	-3,19	-4,99
VALE DE ÁGUA	**39 21 57,53**	**8 00 43,74**	**39 22 01,40**	**8 00 41,05**	**-3,88**	**-2,08**
FIGUEIRAS	39 20 06,65	8 25 06,08	39 20 10,19	8 25 02,37	-3,55	-2,87
OSSA - TF29	**38 44 23,55**	**7 35 01,73**	**38 44 22,25**	**7 35 02,53**	**1,30**	**0,63**
ARRAIOLOS	38 43 36,28	7 59 20,01	38 43 32,53	7 59 17,26	3,75	-2,15
MONSARAZ	**38 26 31,47**	**7 22 52,16**	**38 26 32,54**	**7 22 53,72**	**-1,08**	**1,23**
ESPINHEIRA	38 26 54,41	7 48 04,02	38 26 53,80	7 48 03,15	0,61	-0,69
SESIMBRA	**38 27 03,63**	**9 06 28,83**	**38 27 10,08**	**9 06 24,40**	**-6,45**	**-3,47**
PALMELA	38 33 57,55	8 54 05,03	38 33 58,19	8 54 00,97	-0,65	-3,18
ROMÃ - PSW	**39 00 44,50**	**9 18 58,17**	**39 00 44,42**	**9 18 59,69**	**0,08**	**1,19**
SERVES - TF01	38 53 32,89	9 05 23,99	38 53 39,39	9 05 27,79	-6,51	2,96
AIRE - TF06	**39 32 05,01**	**8 38 11,65**	**39 32 08,87**	**8 38 11,75**	**-3,86**	**0,08**
CANDEEIROS	39 26 12,08	8 55 09,27	39 26 14,71	8 55 06,91	-2,64	-1,83
MONTEJUNTO - TF07	**39 10 19,77**	**9 02 52,11**	**39 10 24,16**	**9 02 54,75**	**-4,40**	**2,05**
PENICHE FAROL	39 21 44,66	9 24 33,25	39 21 38,09	9 24 28,12	6,58	-3,97
BOURO	**39 27 16,88**	**9 12 11,47**	**39 27 13,90**	**9 12 04,13**	**2,99**	**-5,67**
CARRASCAIS	38 14 42,36	8 14 15,27	38 14 44,97	8 14 05,23	-2,62	-7,89
MONFURADO - TF28	**38 34 07,62**	**8 11 29,26**	**38 34 08,93**	**8 11 23,80**	**-1,31**	**-4,27**
MELRIÇA - TF04	39 41 35,33	8 07 51,53	39 41 40,22	8 07 50,04	-4,90	-1,15

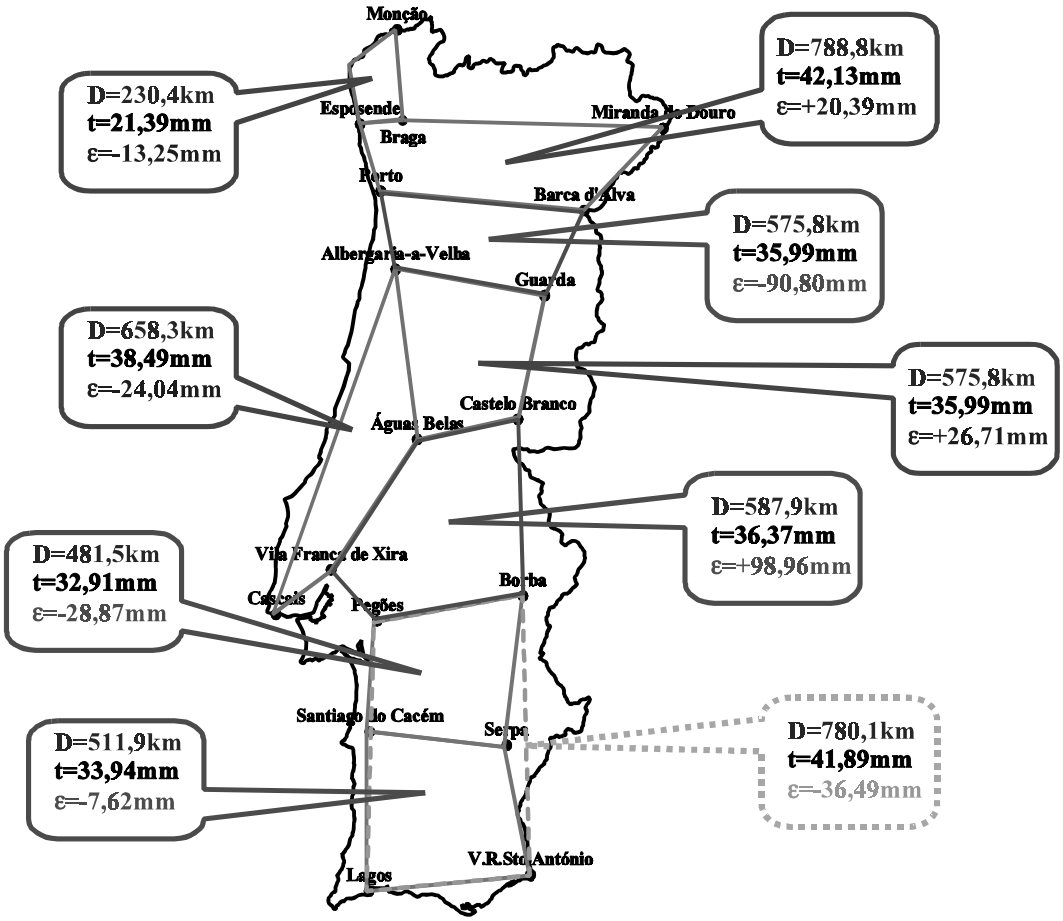

Fig. 3: Circuits closing errors of first order levelling network of Portugal Mainland.