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Newsletter

OF THE INSTITUT CARTOGRÀFIC DE CATALUNYA

Generalitat de Catalunya
Departament de Política Territorial
i Obres Públiques
Institut Cartogràfic de Catalunya

Information about the production, development and research projects
of the Institut Cartogràfic de Catalunya

Initiation of the DGPS (Differential GPS) service RASANT in Catalonia

The Institut Cartogràfic de Catalunya (ICC), the Direcció General de Transports (DGT) and the Centre de Telecomunicacions of the Generalitat de Catalunya (CTGC) have announced the launch of the RASANT (Radio Aided Satellite Navigation Technique) system for broadcasting the differential corrections of the Global Positioning System (GPS). By combining the signals of the GPS satellites and the signals of the RASANT system, co-ordinates of points can be obtained with relative accuracy of up to ± 1 m. The applications of this system are numerous. In particular, it enables the positioning of land transportation vehicles. In general, it enables the positioning of any element, be it static or moving on the territory.

RASANT is a system for broadcasting the differential corrections computed by the ICC at reference stations equipped with GPS receivers. The corrections are based on the standard RTCM SC-104 format and are sent through the Radio Data System (RDS) included in the signal of *Catalunya Música* in its transmissions. The reception conditions of the RDS signals are identical to those of the radio programme. The useful coverage corresponds to the coverage area receiving the stereo signal of *Catalunya Música* under normal conditions. This extends to approximately 90% of Catalonia and covers 95% of its population.

The signals of the GPS satellites can be used for absolute positioning and navigation –using a single receiver– with an accuracy of ± 50 m. In differential mode –using, additionally, the data of a reference receiver– accuracy of up to ± 1 m can be obtained, and with geodetic receivers of up to few millimetres. RASANT broadcasts data from the reference receivers by radio in the form of phase smoothed code differential corrections.

For an optimal use of the GPS, and in order to correctly represent the co-ordinates obtained in this way on maps, account should be taken of the differences between the WGS84 reference frame –that of the

GPS– and the ED50 frame –the one used in Spain. The differences between the ellipsoidal elevations –those obtained from the GPS– and the orthometric elevations –those that are shown on maps– should also be considered. The set of these differences is the geoid. To take full advantage of the GPS, data from the work receiver should be combined with data from a reference receiver –DGPS mode–, the datum transfer parameters between the WGS84 and ED50 reference frames, and the geoid.



These data, the parameters and geoid can be obtained free of charge from the ICC.

There have been three phases in the deployment of RASANT: a demonstration phase, an experimental phase and an operational phase. The demonstration phase began in December 1995 in the FM coverage area of the Collserola communications Tower, Barcelona. The quality of reception and the precision and accuracy of co-ordinate determination has been tested. The experimental phase will begin in autumn 1996, when the GPS reference station will be moved to its definitive location in Bellmunt de Segarra –at the Centre de Telecomunicacions i Enllaços of the CTGC– and the coverage area be extended to practically the whole territory. The operational phase will begin at a time yet to be specified in the course of 1997. The difference between the experimental phase and the operational phase is that during the latter, the service will have a higher reliability.

The RASANT system has been developed at the Geodesy and Cartography Agency of the Land Nordrhein-Westfalen (Germany) and has been adopted by the other German *Länder* and by the ICC itself. All these organisations promote the adoption of the RASANT as a European system for the broadcast of GPS differential corrections via FM RDS transmissions.

For more information about the RASANT service, please write to:

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Atles topogràfic de Catalunya 1:50 000

The *Atles topogràfic de Catalunya 1:50 000* is a joint publication of the Institut Cartogràfic de Catalunya (ICC) and Enciclopèdia Catalana SA. This work, published in 1995, is in three volumes of 31 x 22 cm each. In total, there are 328 pages of cartography produced in a regular cut with rectangles of 26 x 18 cm.

For the division into volumes, various criteria have been combined: presentation in similar thicknesses; regularity in the shape of the geographic areas represented, and the presentation, in each volume, of regions that are closely interrelated.

The content of the atlas is drawn from the ICC's base of numerical cartographic material at 1:50 000 scale and depicts the orography, hydrography, population, communications network, vegetation cover, administrative boundaries and other elements relating to Catalonia. The grid of the UTM projection at intervals of 1 km (2 cm on the map) and toponymic information are superimposed over this information.

The toponymic index contains approximately 60 000 entries for all three volumes. Each entry specifies the type of toponym, the region, the atlas page and the UTM co-ordinates of its position. Furthermore, each volume includes a short text on the presentation and arrangement of the atlas, and the flyleaves show how the volumes and pages of the atlas are distributed, and the legend, which allows to interpret all the symbols used in the atlas.

The *Atles topogràfic de Catalunya 1:50 000* is a publication that is easy to consult due to its size, its graphic reinforcement of the elements that make up the landscape (relief, vegetation cover, urban nuclei and communication routes) and its toponymic index. At the same time, it is a work of sufficient quality and cartographic precision to warrant use by specialists and professionals.

Thanks to its extensive distribution, with more than fifteen thousand collections of the first edition, this work has played a part in giving the citizens of Catalonia a cartographic perspective of their particular region to match that available to citizens of the most cartographically advanced countries.

Terra Alta project

On 29 March 1996, Regs de Catalunya SA (REGSA) commissioned the Institut Cartogràfic de Catalunya (ICC) to complete a photogrammetric flight at 1:5 000 scale and then to plot this digitally at 1:2 000 scale with coverage of land parcelling concentration of the irrigation system in Terra Alta. Additionally, the Terra Alta canal has been plotted from kilometre 40 to 86.5 with a bandwidth of 400 metres centred on the axis of the canal. Finally, a photogrammetric flight has also been made in black and white at 1:10 000 scale with 60% side overlap and 20% cross overlap.

The flight was made using kinematic GPS techniques, which made it possible to considerably reduce the number of ground control points. The total number of these was 74. The estimated accuracy of ground control was about 7 cm both in the horizontal and the vertical components.

The aerial triangulation was performed in 13 stages, with a total of 1 743 images and 74 ground control points. Point transfer between images and strips was carried out in the conventional way, by using at least 9 (von Grüber) points per image and transforming them to all adjacent images, both within the same strip and within adjacent strips.

The block triangulation adjustment was carried out with the in-house developed software system GeoTeX. GeoTeX includes a general photogrammetric, remote sensing and geodetic network adjustment program. In this particular project, the classical photogrammetric bundle self-calibrating model for the photogrammetric

observations and the drift-per-strip model for the GPS aerial control observations were applied.

The photogrammetric stereoplotting was performed on a digital photogrammetric stereo workstation. Images were digitalised on the Intergraph/Zeiss P1-1 scanner at 15 µm pixel size, thus yielding an approximate ground resolution of 7.5 cm.

The plotting process was completed on stereoscopic pairs formed by images with epipolar geometry. The epipolarising process uses the images' orientation parameters provided by the aerial triangulation block adjustment.

The epipolarised images are passed to the plotting stations from a server, either by network or by using an exabyte tape where the epipolarised images are stored. The digital photogrammetric stations have an internal disk of 2 Gb and a 27-inch monitor. Using appropriate stereovisualisation glasses and equipment the stereoscopic pairs can be photointerpreted and plotted with the help of the MicroStation graphic design system.

All the stereoscopic pairs plotted in DGN format are passed to the editing and quality control stations, where they receive the finishing touches and final checks before being transformed into map sheets. With respect to this project, it should be emphasised that all the apparent rural parcelisation is connected and its area can be directly measured.

It should be pointed out that in this project the area mapped at 1:2 000 scale is approximately 20 500 hectares.



Aerial control for aerial triangulations

Since 1994, the Institut Cartogràfic de Catalunya (ICC) has conducted all its aerial surveys collecting GPS (Global Positioning System) data for further use as aerial control. The advantage of aerial control lies in the considerable reduction of ground control points, leading to a great saving in economic terms and a reduction in the aerial triangulation time.

Aerial control is the subset of points of the aircraft's trajectory at the moments of image exposure. The aerial control points are geometrically related to image projection centres by previously observed eccentricity vectors. The aircraft's trajectory is defined here as the coordinates of a GPS antenna installed on top of the aircraft's fuselage. The trajectory coordinates are determined by combining phase and code GPS observations from the aircraft's GPS receiver and from the ICC's permanent GPS stations. All GPS receivers used are geodetic grade ones, thus allowing for high-precision relative positioning at the centimetre-decimetre level.

The core of the software suite used for the GPS computations is the SKIP (Static and Kinematic Positioning) program Inpho GmbH, based in Stuttgart, Germany.

Once the aerial control has been determined, it is introduced into the aerial triangulation adjustment. Aerial control makes ground control redundant, which can therefore be considerably reduced. This leads to great savings in costs and time. The accuracy of ground points and orientation parameters obtained in this way is comparable –if not superior– to the accuracy obtained by conventional aerial triangulation with ground control. The overall reliability of the procedure is improved as well. The block adjustment and other related ancillary computations are performed with the geodetic/photogrammetric software system GeoTeX, developed at the ICC.

The following table summarises the evolution of the number of oriented images, both conventionally and with GPS, over the last five years at the ICC.

A remarkable additional benefit of the introduction of GPS technology in aerial survey missions is the navigational capability at the ± 50 m accuracy level. Compared to the expensive and far less accurate systems previously used, GPS has revolutionised the way aerial survey navigation is performed. The ICC's aircraft are equipped with the GPS-based CCNS-4 (Computer Controlled Navigation System) made by the German company IGI mbH.

Year	Number of images		
	conventional	GPS	total
1991	5 176	-	5 176
1992	6 192	-	6 192
1993	6 035	-	6 035
1994	2 286	2 644	4 930
1995	1 363	7 461	8 824
Sep. 96	322	6 042	6 364
1996 *	483	9 063	9 546

* Total estimate for 1996

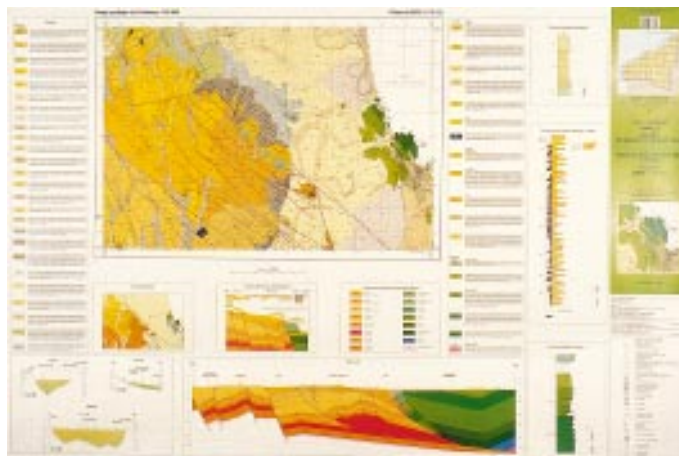
Mapa geològic de Catalunya 1:25 000. Beginning of the series

The Geological Survey of Catalonia of the Institut Cartogràfic de Catalunya (ICC) is undertaking several geological cartography projects that will be added to other cartographic products available (gravimetric map 1:500 000, 1987; geological map 1:250 000 and aeromagnetic map 1:250 000, 1989; map of hydrogeological areas, 1992, and geological cross-section of the central Pyrenees 1:200 000, 1992). In 1990, the initial drafts of the project to produce the *Mapa geològic de Catalunya 1:25 000* and geological cartography of Region I (metropolitan region of Barcelona) at 1:10 000 scale were drawn up.

The aims of the *Mapa geològic de Catalunya 1:25 000* series are to provide the public and private user with comprehensive homogeneous documents that are suitable to be used in national planning and in the planning of public works, and to make documents that can be used directly on site available to all users. The sheets published draw from the ICC's topographic material at 1:25 000 scale. Furthermore, since the

data is incorporated in a geographic information system, very specific thematic maps can be extracted.

The scale of the field work is 1:25 000, although in areas of poor outcrops or structurally complexes the scale of 1:10 000 is used.



The field work is being carried out following the usual methods of land survey and analysis of the data obtained. The Quaternary deposits are being studied from

both geological and geometric points of view. The study work is being carried out with the help of a PC-based computing system at a pilot stage, in which the field data that are introduced end up in a geographic information system. The ICC has taken full responsibility for the edition and publication of the maps using wholly digital methods.

Barcelona and its surrounding area (a radius of some 40 km) are being mapped at 1:10 000 scale, since, due to the high density of human activity, a particularly detailed base is needed for planning. This cartography, which requires a much denser field observation network, has, for the moment, been set aside for internal use with in specific projects.

The ICC is aware of the ambitious nature of this project, but, at the same time, there is systematic demand for the information that this series provides. To date, the following sheets have been published: 1994, 4 sheets; 1995, 7 sheets, and 9 sheets have been planned for 1996.

Cartocentro-I project

The Servicio Autónomo de Geografía y Cartografía Nacional of Venezuela, within the framework of the agreement established with the Institut Cartogràfic de Catalunya (ICC) for the transfer of advanced technology in the field of digital orthophotomap material, has produced the sheets of the orthophotomap series in colour on a scale of 1:25 000. These correspond to the Caracas NC-19-8 sheet on a scale of 1:250 000 covering an area of 1 162 500 hectares.

Cartocentro-I is a pilot project to produce digital orthophotomaps in colour, within the framework of a co-operative agreement signed by the Ministerio del Ambiente y de los Recursos Naturales Renovables and the Departament de Política Territorial i Obres Públiques of the Generalitat de Catalunya.

The driving force behind the updating of the basic cartography of this area was the Ministerio del Ambiente y de los Recursos Naturales Renovables, through the Servicio Autónomo de Geografía y Cartografía Nacional, following the realisation that there were significant variations, not only in the metropolitan area of the city of Caracas, but also in the outskirts of the city.

The powerful dynamic of uncontrolled growth in this area has had a considerable impact on natural resources, while there are insufficient public services and other social and economic problems. Due to this, and in order to establish a record of digital topographical data that could be incorporated into the databases of the Ministry and other institutions in the public and private

sector, the Servicio Autónomo de Geografía y Cartografía Nacional and the ICC have produced these orthophotomaps based on the digital infrastructure that already existed and also in accordance with a strict system of technical specifications that would, as a result, yield a uniform product.

The Cartocentro-I project was designed to provide photogrammetric coverage of the central and northern area of Venezuela, and, in particular, of Caracas and the surrounding area on a scale of 1:25 000. This product, which will enable the existing cartography to be quickly updated, will be of great use in applications relating to land registry, urban planning, localisation of services, land uses, monitoring of nature parks and hydric reserves, etc. The fact that it is a totally digital product will enable it to be incorporated as a basic element in geographic information systems under development in the Caracas area.



Products generated

- 93 sheets of the orthophotomap series in colour (1 000 copies printed of each of these),
- 12 CD-Roms, each of which includes 8 digital sheets of the orthophotomap series,
- specifications for the digital model of the series,
- specifications for the digital toponymy of the series, and
- database of digital models of the terrain of 45 x 45 metres.

Visit of DIGSA

On 26 July 1996, the directors of the geographic institutes of South America flew to Barcelona to discuss technical matters and to visit the facilities of the Institut Cartogràfic de Catalunya (ICC), taking advantage of meeting number 13 of DIGSA (*Directores de Institutos Geográficos de Sudamérica, España y Portugal*), which was held in Spain during that week.

Representatives of Argentina, Uruguay, Colombia, Peru, Ecuador, Bolivia, Brazil, Chile, Paraguay and Venezuela visited the ICC's new building, taking a particular interest in the activities currently being undertaken for Argentina, Bolivia and Venezuela.



Honorary mention

During the last congress of the *International Society for Photogrammetry and Remote Sensing* (ISPRS) held in Vienna, Austria, in July 1996, Doctor Ismael Colomina Fosch, Head of the Geodesy Service of the Institut Cartogràfic de Catalunya (ICC), received one of the President's honorary mentions for his 1992-1996 chairmanship of Working Group III.1 and for his preparation and organization of the *Integrated Sensor Orientation Workshop* held in Barcelona in September 1995. This mention comes as recognition of the work completed by the young Geodesy Service team and the ICC itself.



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