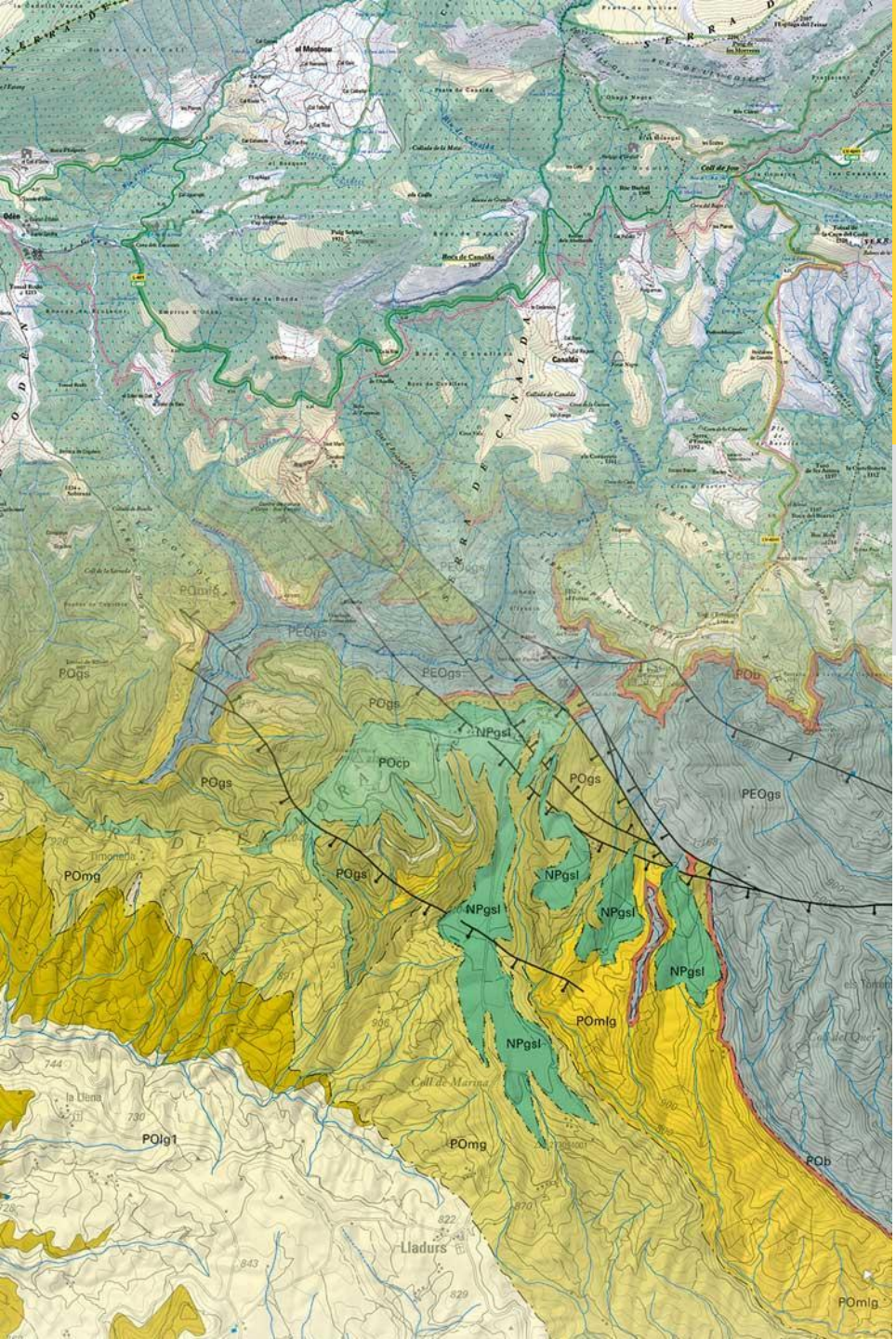


ICGC services provisioning to scientific & professional communities

Anna M. Baron

Geodesy Department

ICGC
Institut
Cartogràfic i Geològic
de Catalunya

Generalitat
de Catalunya

Outline

- The ICGC
  - Geodetic Infrastructure
- CatNet network
  - CatNet infrastructure and services
  - Network monitoring
  - International Activities
- Positioning services
  - Review
  - Activity Map and usage statistics
  - New formats for positioning services
  - New uses of the services

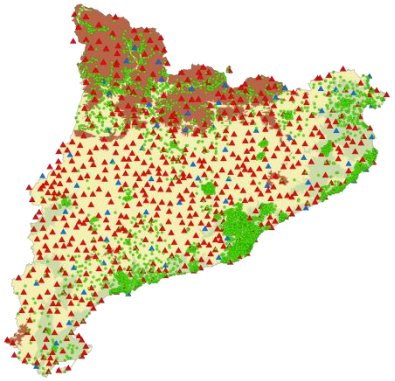
The ICGC

- The *Institut Cartografic i Geològic de Catalunya* (ICGC) is:
  - The Mapping Agency of Catalonia
  - Responsible for the production of all official cartography at any scale
  - Responsible for provide access to the official reference frame in Catalonia.

  - Mandate that is accomplished by SPGIC: Integrated Geodetic Positioning System in Catalonia.
    - Objective: To allow the positioning over Catalonia
    - Tools: Geodetic Networks
    - Resources: Geodetic Support elements

ICGC - SPGIC

PASSIVE NETWORK

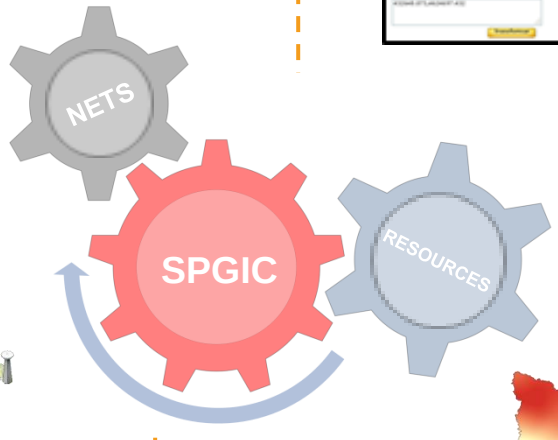


REFERENCE SYSTEMS

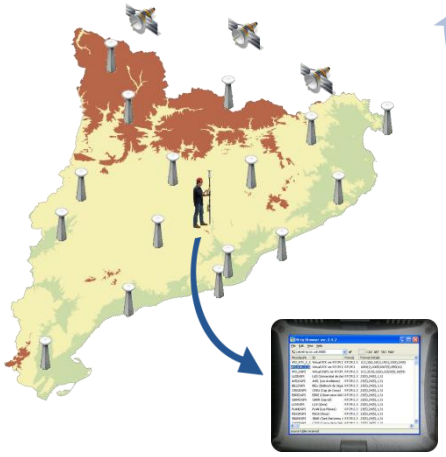
TECHNICAL GUIDES

CALCULATOR

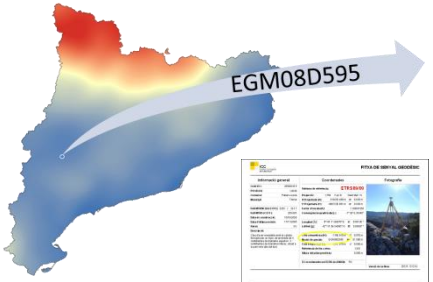
GEODETIC SHEETS

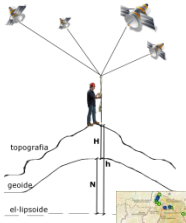


CATNET NETWORK



CATALAN GEOID





ICGC - SPGIC

- Geodetic Networks in Catalonia
  - Classical geodetic network

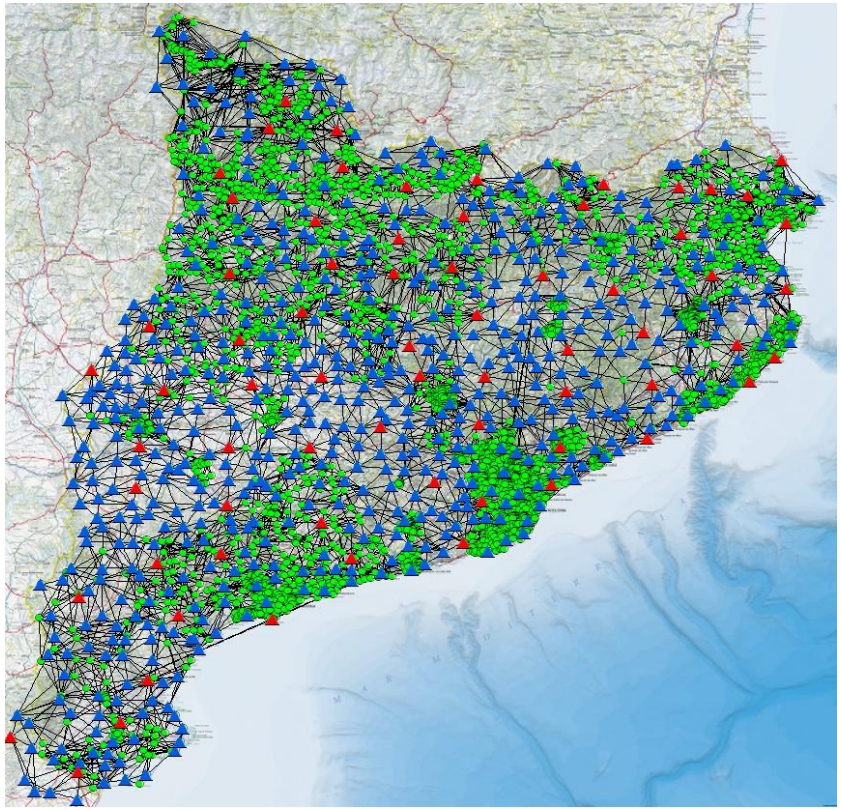
ICGC - SPGIC

- Geodetic Networks in Catalonia
  - Classical geodetic network
    - **3D network**

4302 Survey Marks

69	▲	**REGENTE Network**
681	▲	**ROI Network**
3621	●	**Utilitary Network (XU)**

Precision 4cm (1σ)



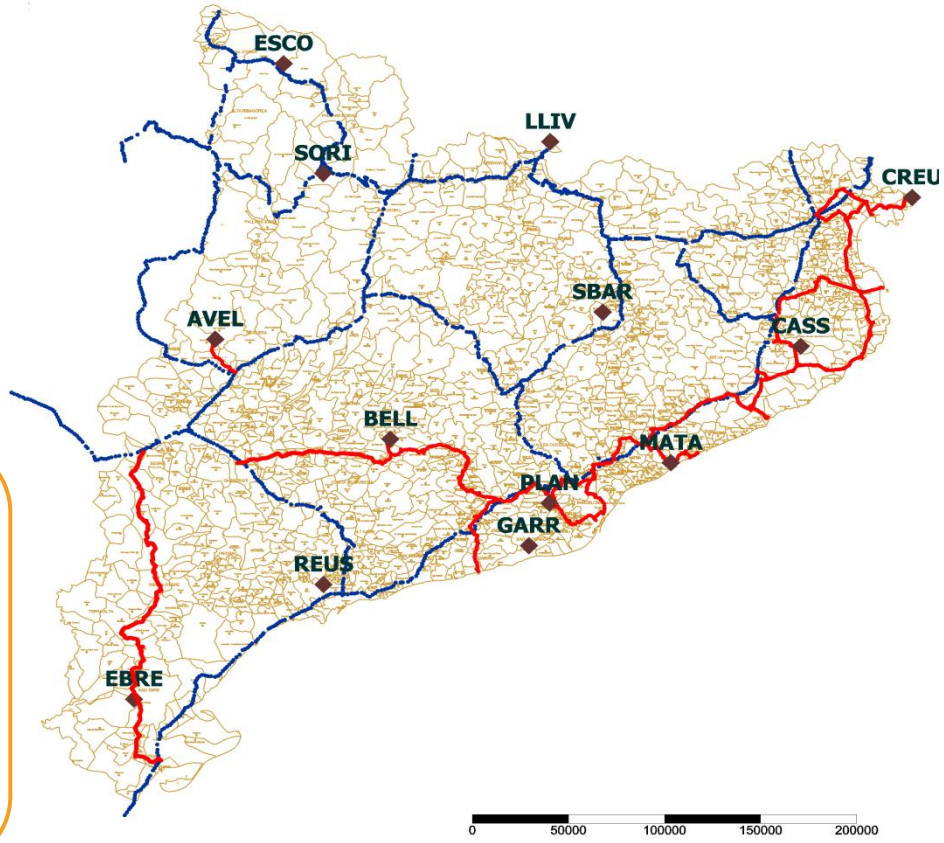
ICGC - SPGIC

- Geodetic Networks in Catalonia
  - Classical geodetic network
    - XU network
    - **XdA leveling network**

Total distance levelled: 2539 Km

- 1612 Km REDNAP
- 928 Km XdA

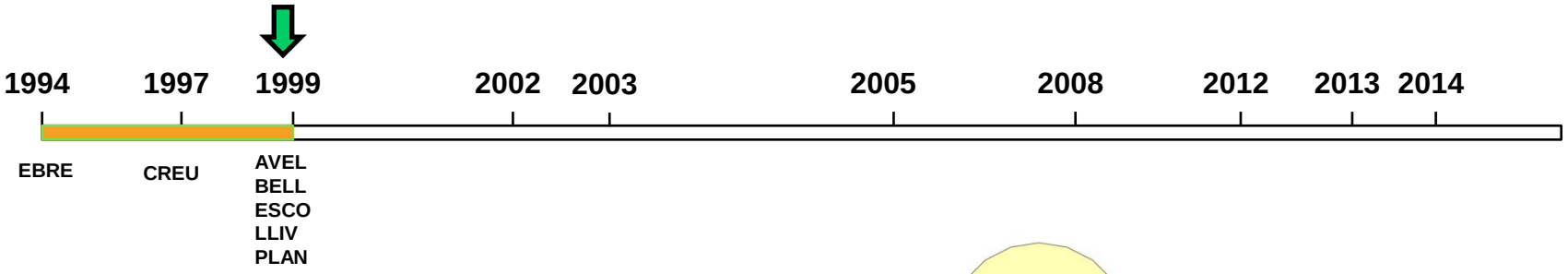
Ellipsoidal Height at 465 points in REDNAP

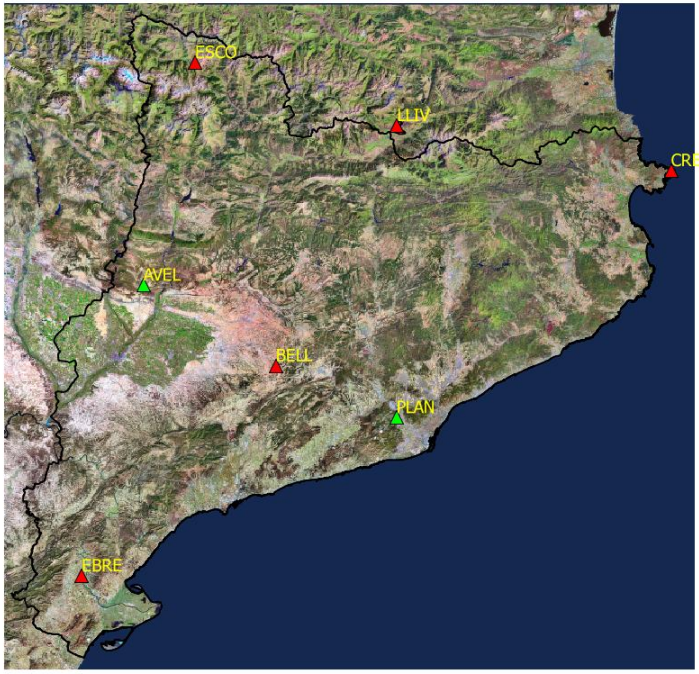


ICGC - SPGIC

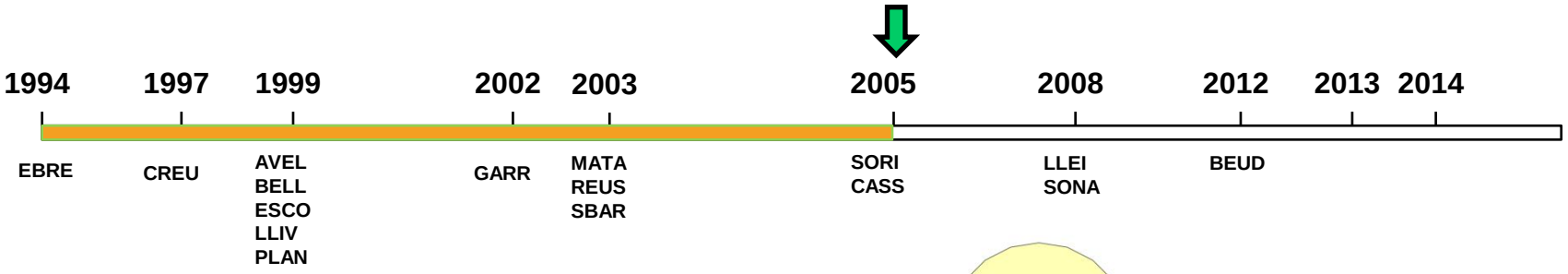
- Geodetic Networks in Catalonia
  - Classical geodetic network
    - XU network
    - XdA leveling network
  - **GNSS permanent network**

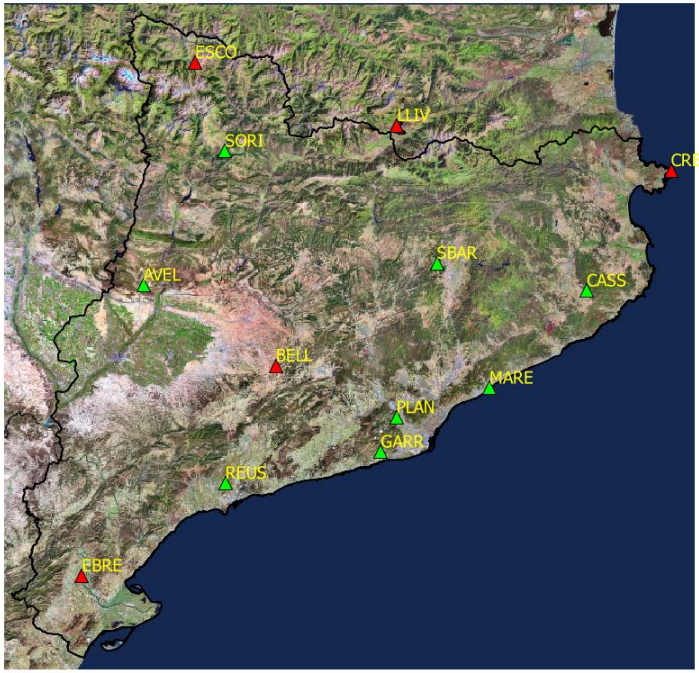
CATNET infrastructure

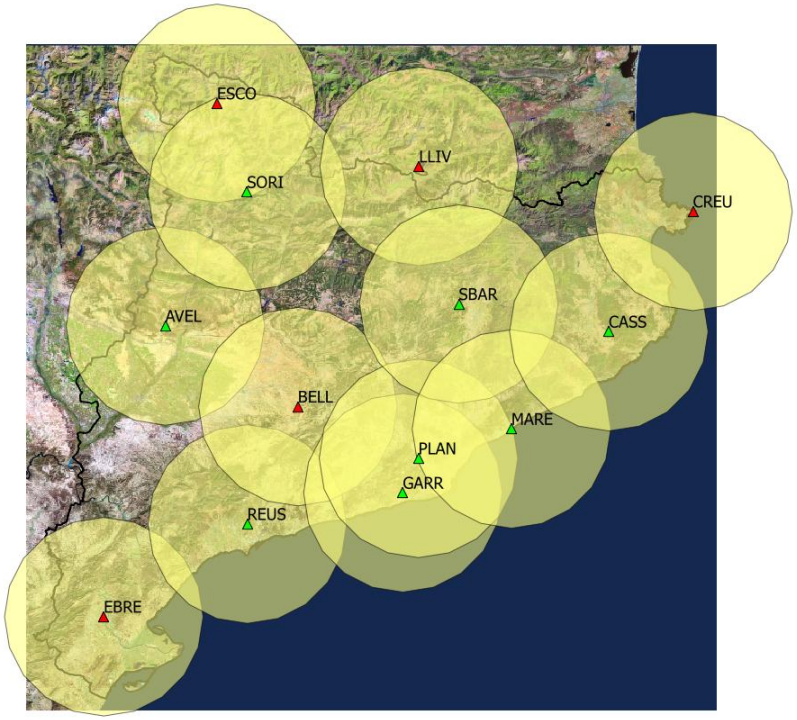




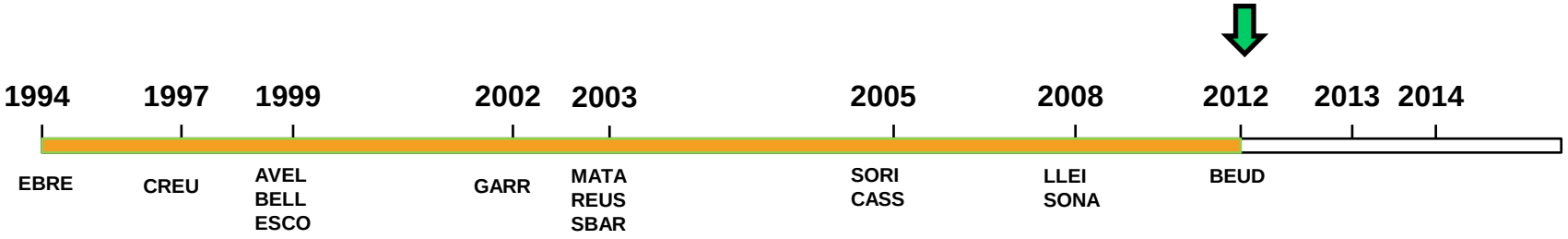
CATNET infrastructure

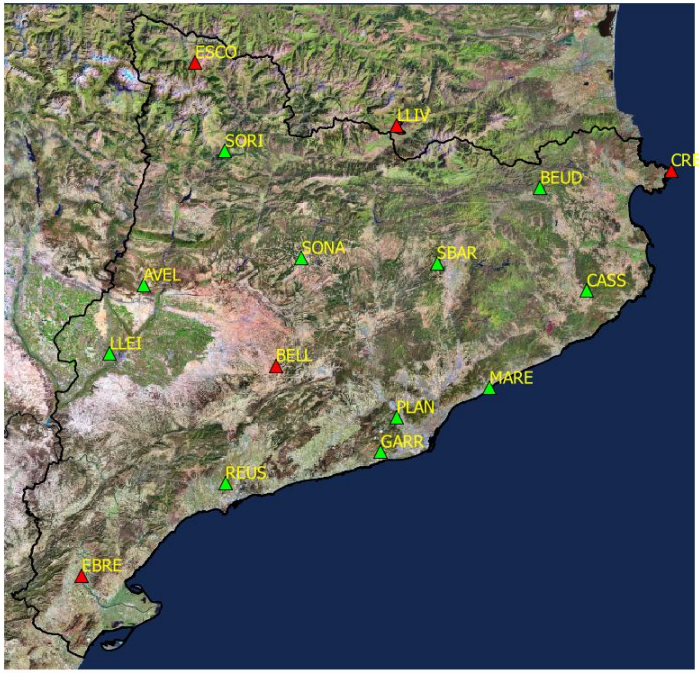


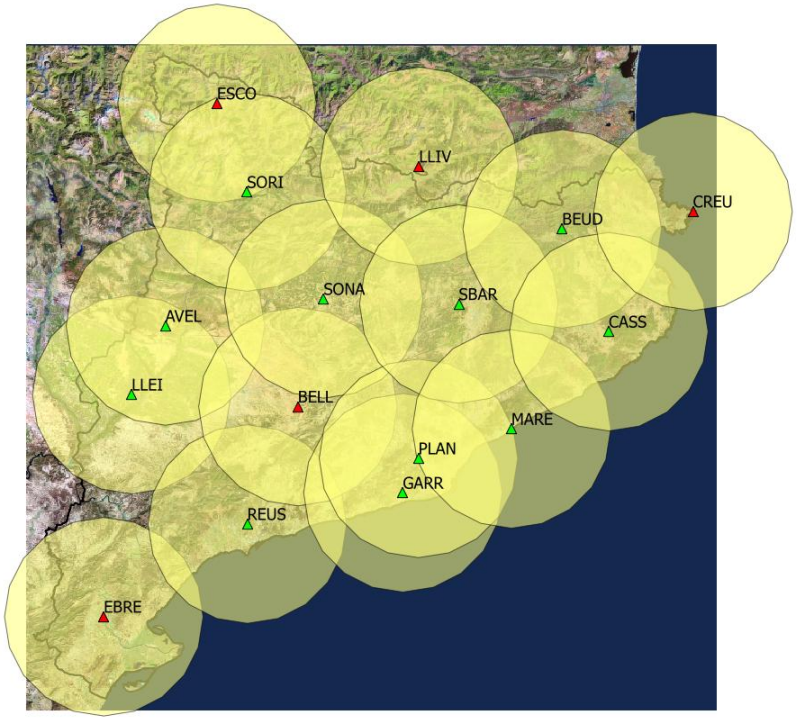




CATNET infrastructure

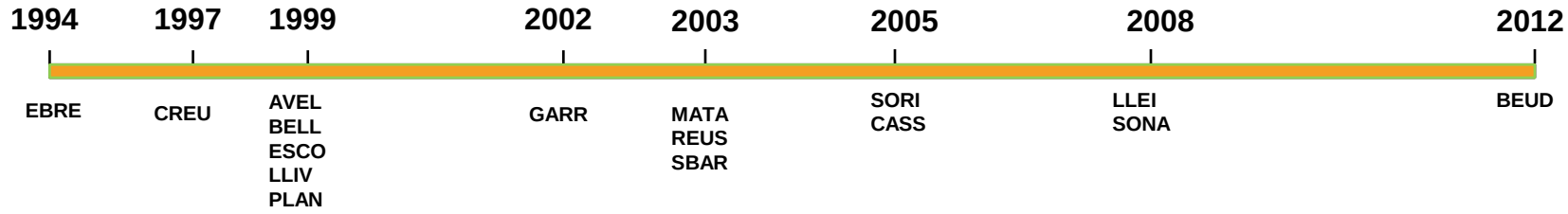




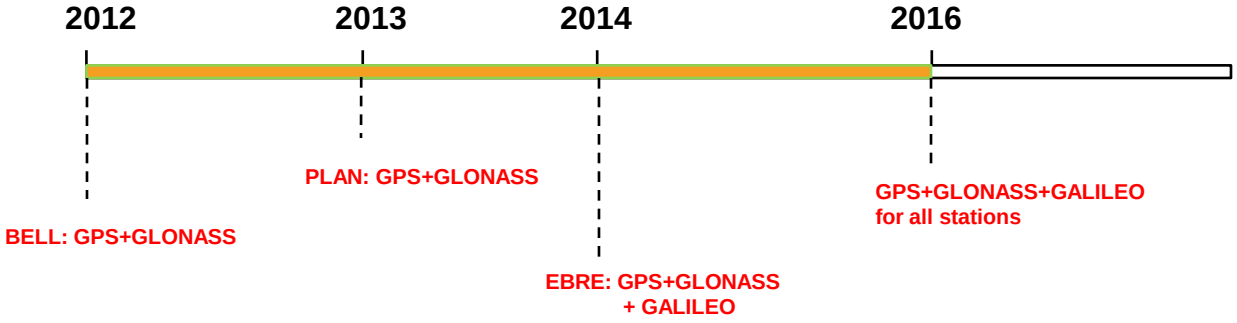


CATNET infrastructure

- CATNET Network deployment

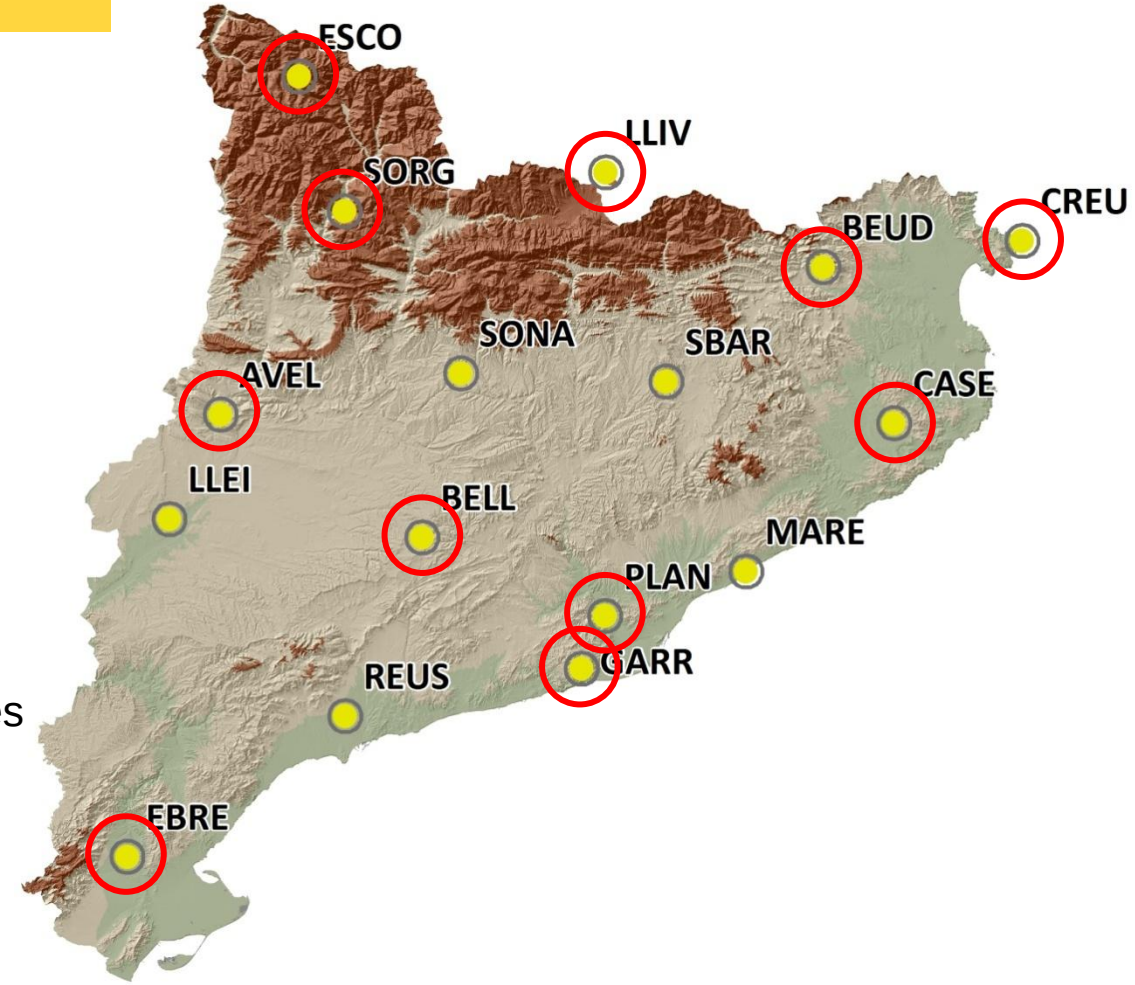


- GNSS capability



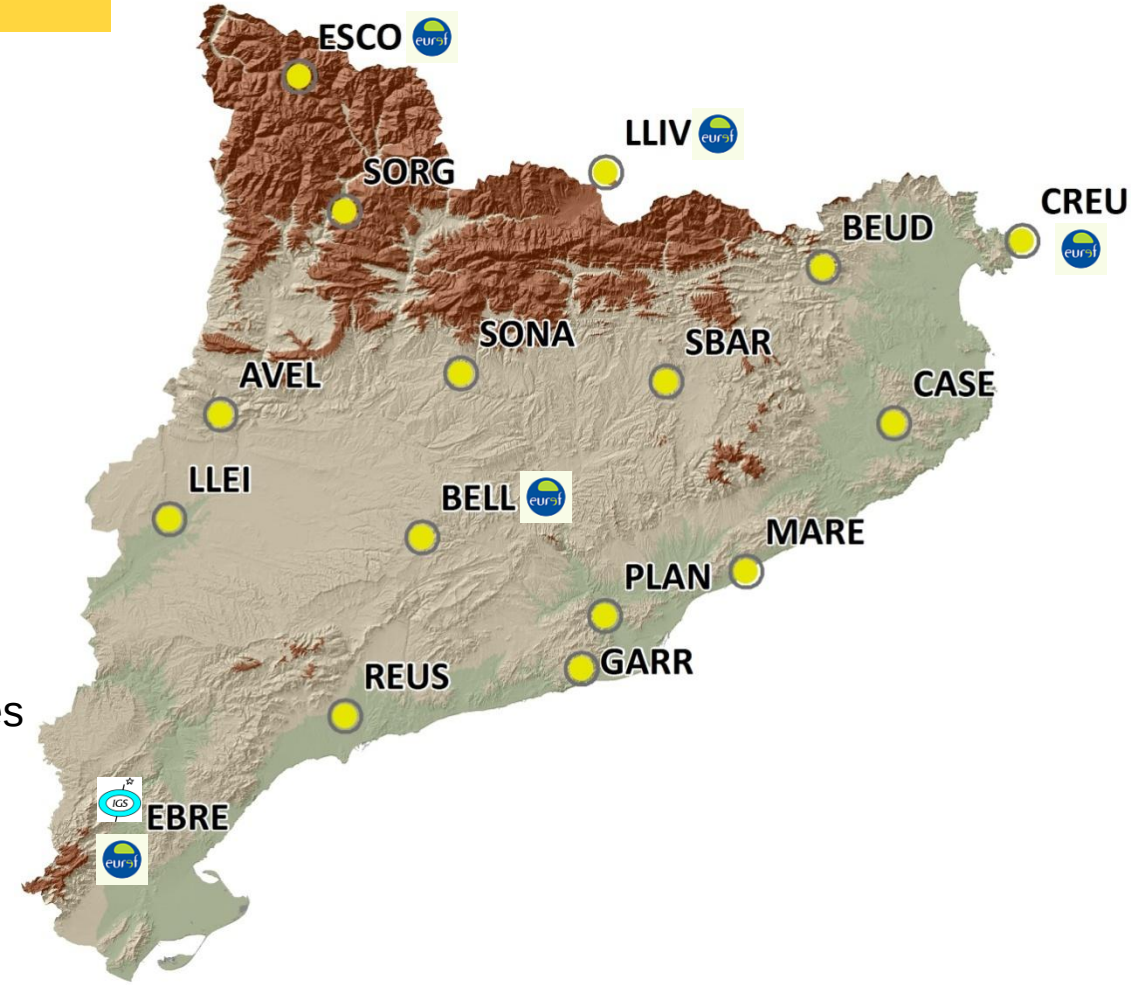
CATNET infrastructure

- 16 stations
  - 11 Geodynamic
    - EBRE
    - ESCO
    - LLIV
    - CREU
    - BELL
    - AVEL
    - SORG
    - CASE
    - PLAN
    - GARR
    - BEUD
  - 5 Densification for RTK services
    - LLEI
    - REUS
    - MARE
    - SONA
    - SBAR

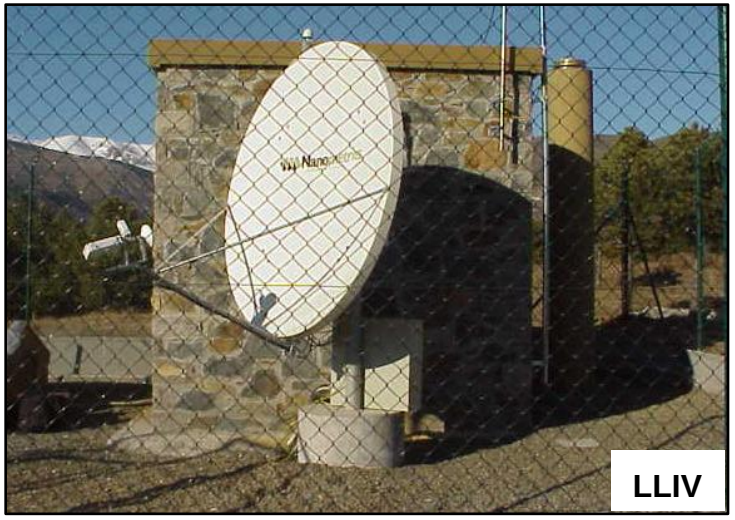


CATNET infrastructure

- 16 stations (5 EUREF & 1 IGS)
  - 11 Geodynamic
    - EBRE
    - ESCO
    - LLIV
    - CREU
    - BELL
    - AVEL
    - SORG
    - CASE
    - PLAN
    - GARR
    - BEUD
  - 5 Densification for RTK services
    - LLEI
    - REUS
    - MARE
    - SONA
    - SBAR



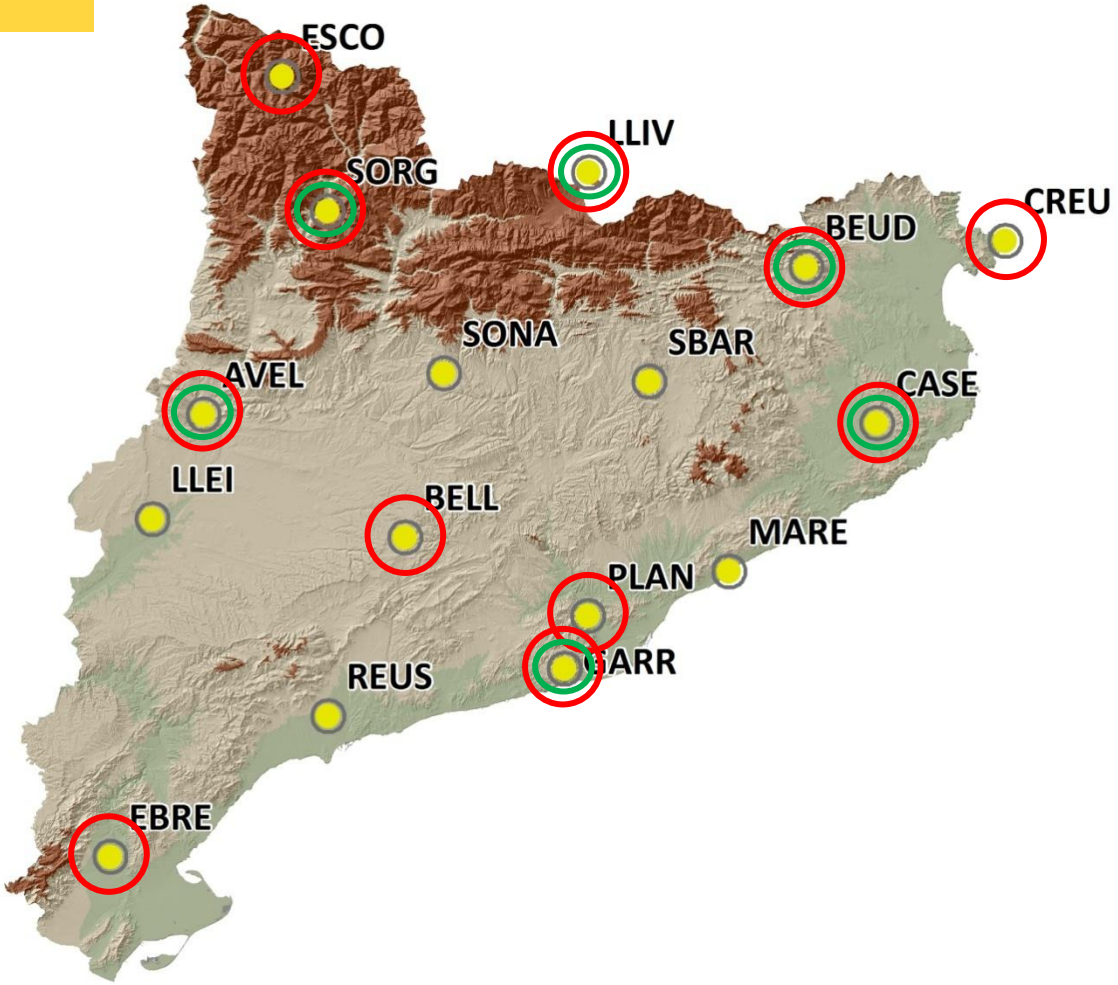
CATNET infrastructure



CATNET infrastructure

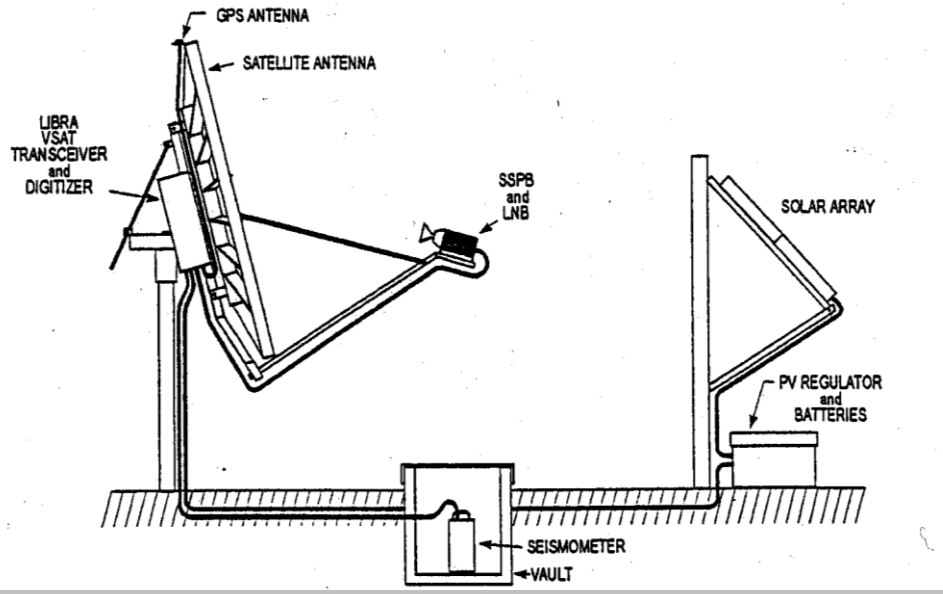
- 16 stations
  - 11 Geodynamic
  - 6 also seismic stations

- EBRE
- ESCO
- LLIV
- CREU
- BELL
- AVEL
- SORG
- CASE
- PLAN
- GARR
- BEUD



CATNET infrastructure

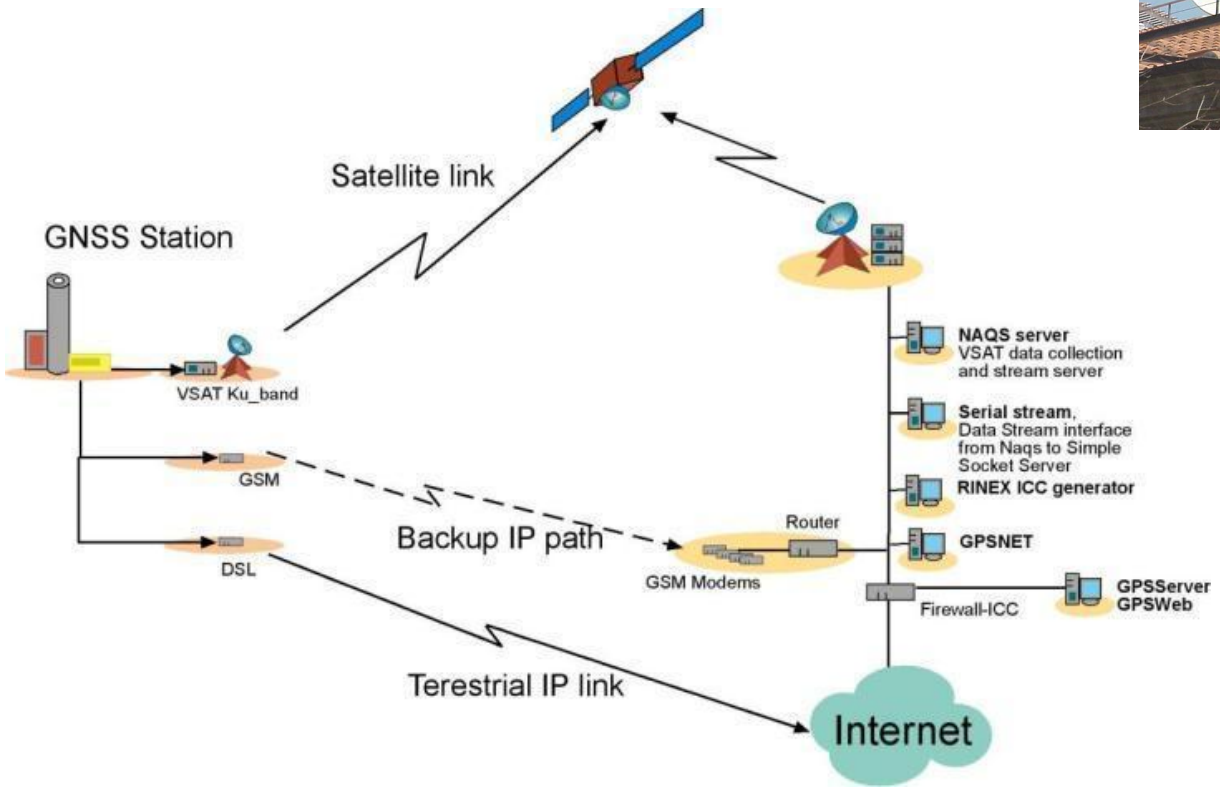
- Infrastructure at remote station:
  - GNSS Antenna/receiver
  - Seismic sensor
  - Communication devices (VSAT)



CATNET infrastructure

- HUB Site:

- Network communications:



Terrestrial data links

WIMAX:

Rural Internet

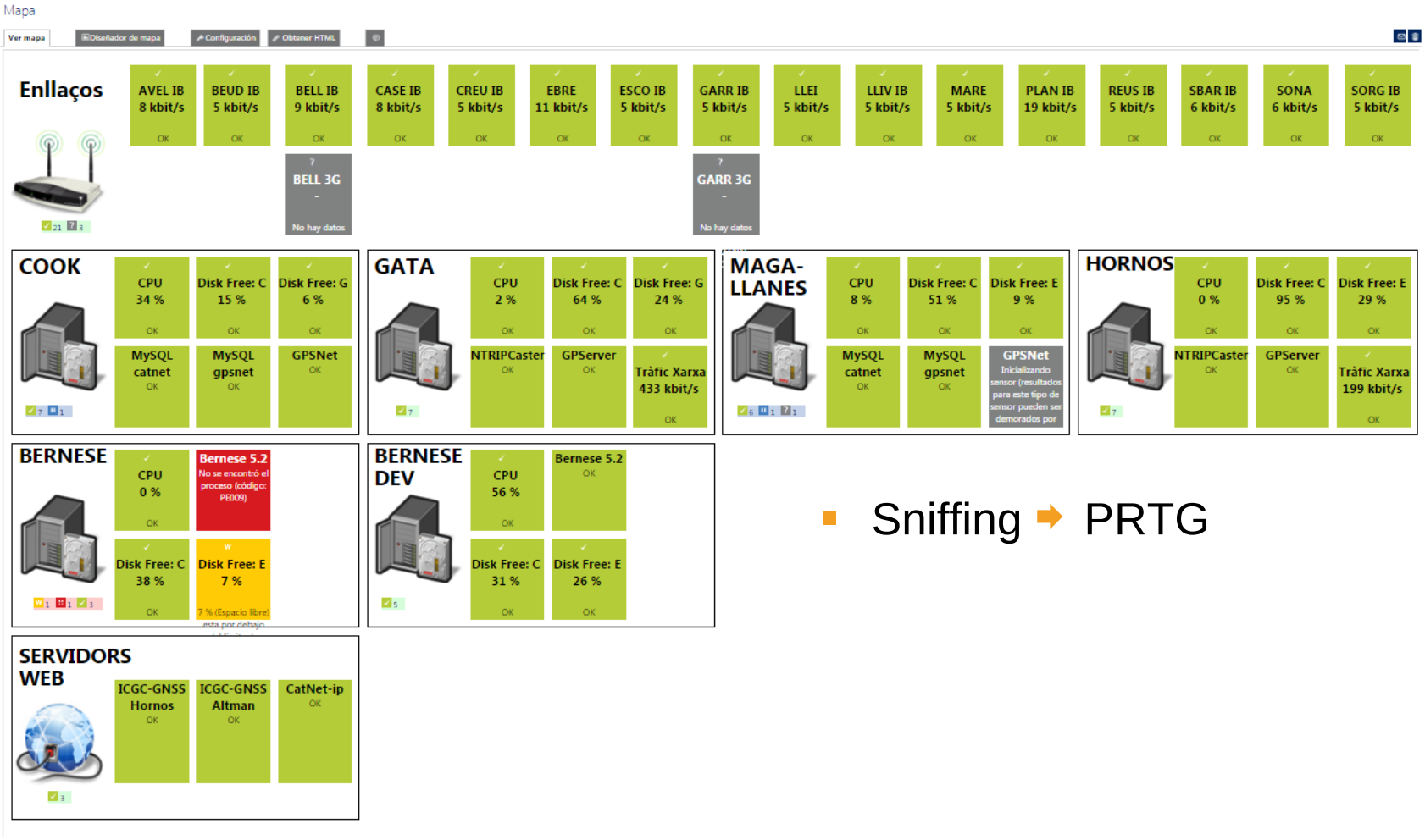
Radio Links for Data Services

256 KB - 4MB

Flexible Installation, low cost wrt satellite.

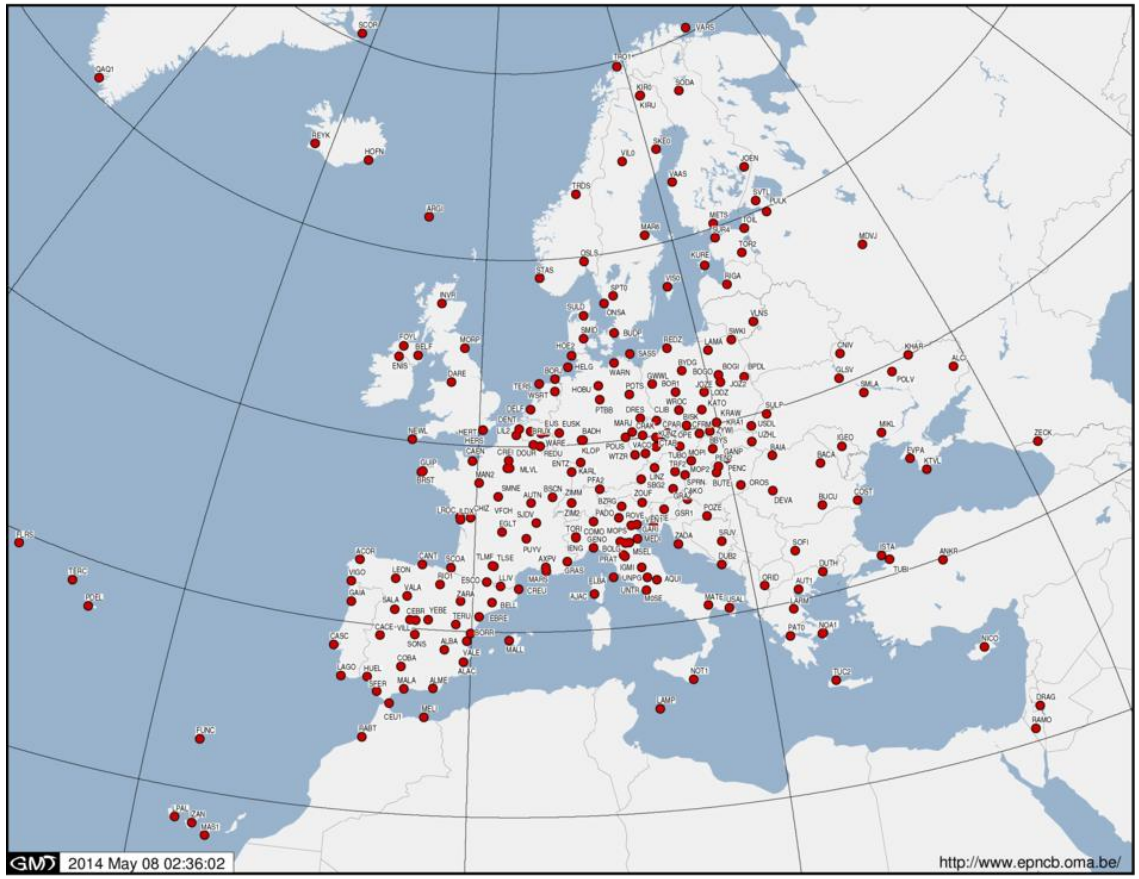
Line of sight required

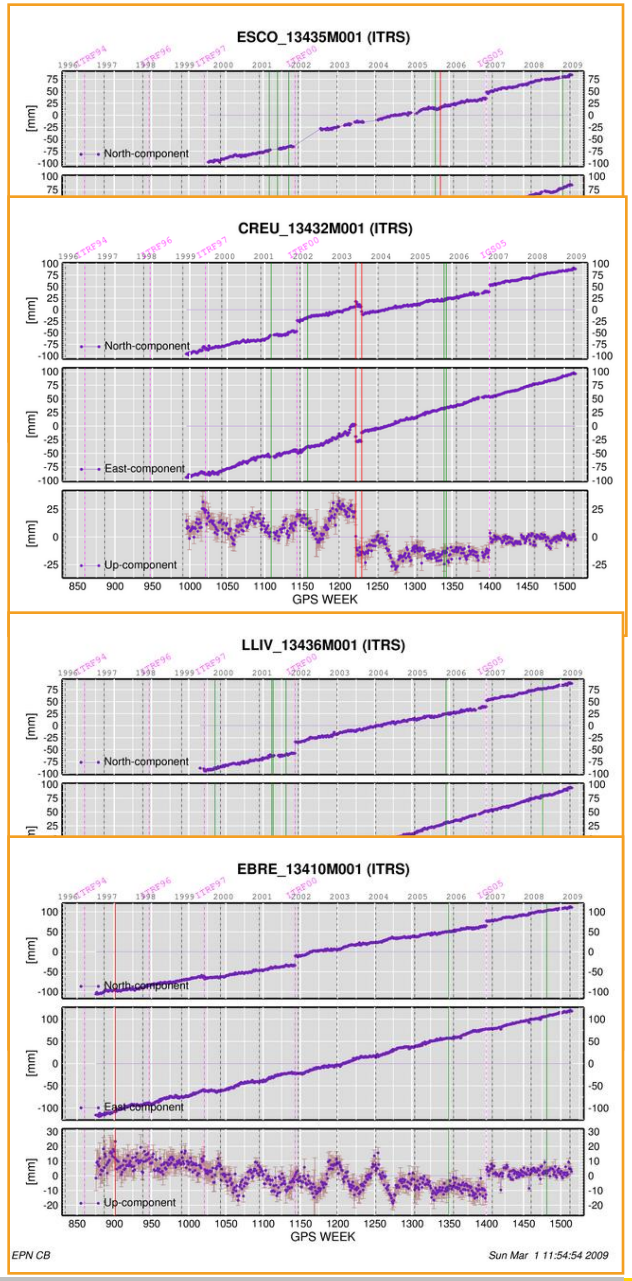
CATNET Network monitoring



- Sniffing ➡ PRTG

CATNET International activities: EUREF & IGS





ICGC in EUREF

- EUREF – IAG subcomission in charge of ETR89 maintenance. Access to ETRS89 is done through EPN (246 GNSS stations network).

- EPN is a densification of the IGS global network, used to maintain the ITRF reference frames.

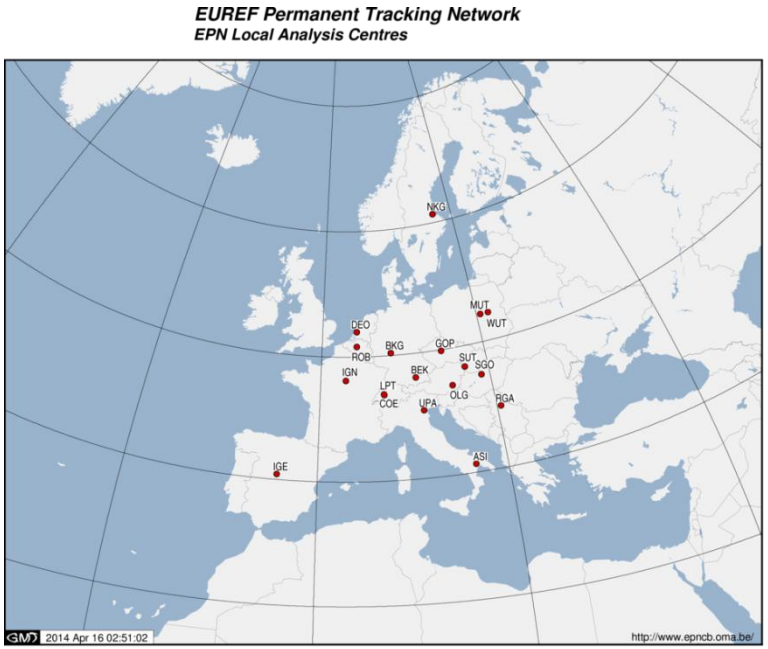
- These networks are also used for scientific application: land deformations, mean sea level, climatic changes, weather forecast…

EUREF Permanent Tracking Network

EUREF Permanent Tracking Network
Stations belonging to the IGS network

EUREF LAC & DAC

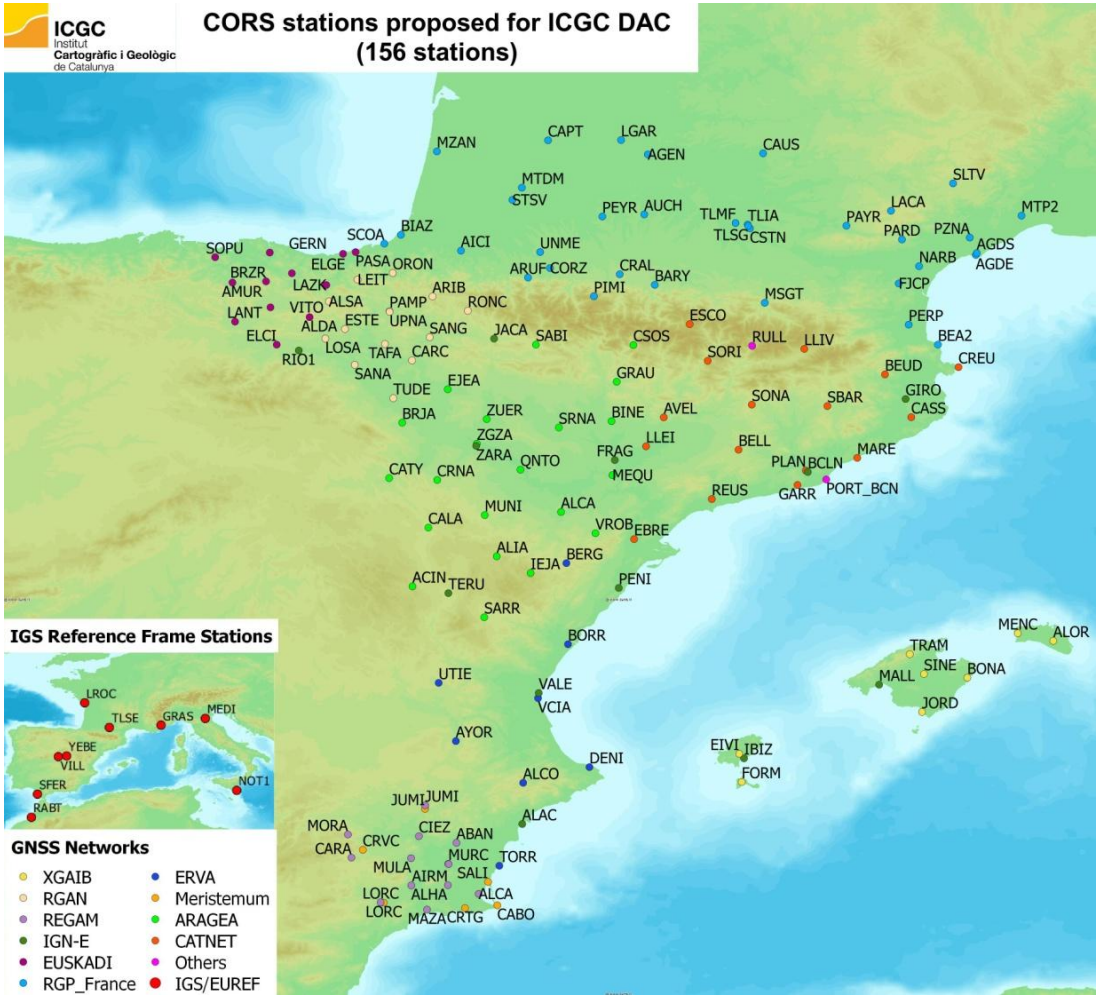
- What is a LAC?
  - LAC: Local Analysis Center
  - 17 currently working
  - Systematic data analysis
  - Daily computation of precise coordinates for all the stations (in 70-90 stations subnetworks)
  - Delivered to "EUREF Coordinator Centre", who computes the final and official coordinates.



- What is a DAC?
  - DAC: Dedicated Analysis Center
  - As a result of the reorganization of LACs, DACs are going to be focused in specific problems.
  - Computation and systematic data analysis for EPN and other stations.

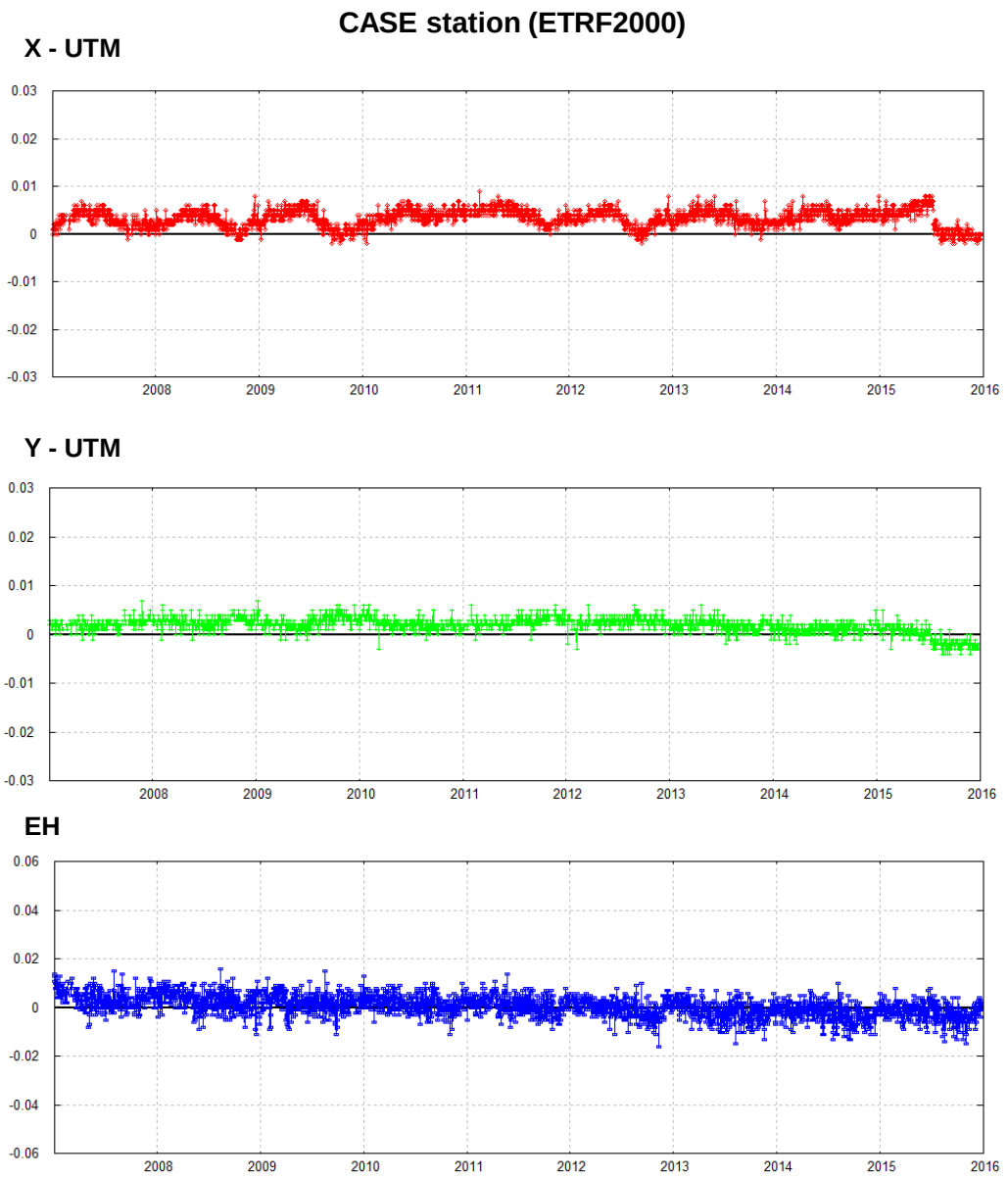
ICGC role as a DAC

- Daily process computation of 156 stations.
- Automatic procedures for downloading, computing and publishing the information.
- Fulfillment of international recommendations, coming from EUREF and IGS.
- Use of Bernese software for processing and different tools for results dissemination.



Reference frame monitoring

- Precise Geodetic applications:
  - Computation and monitoring of the reference frame
  - Testing new models (MF, loading tides)
- Maintenance monitoring
  - Hardware replacement
  - Trees pruning
  - FW updating



Reference frame monitoring

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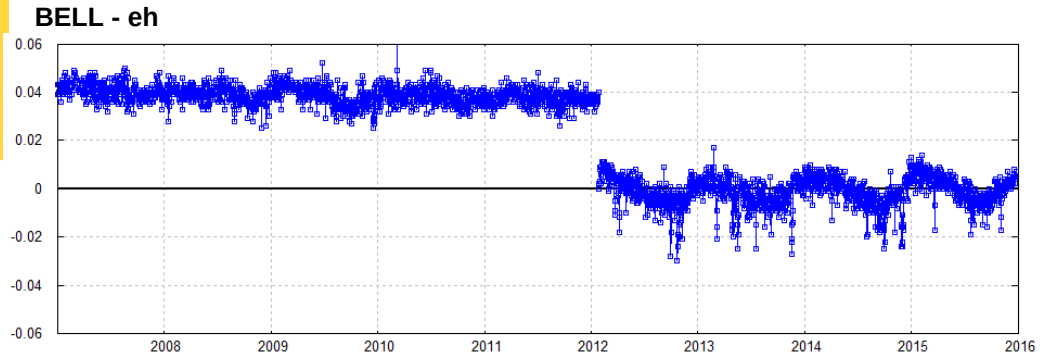
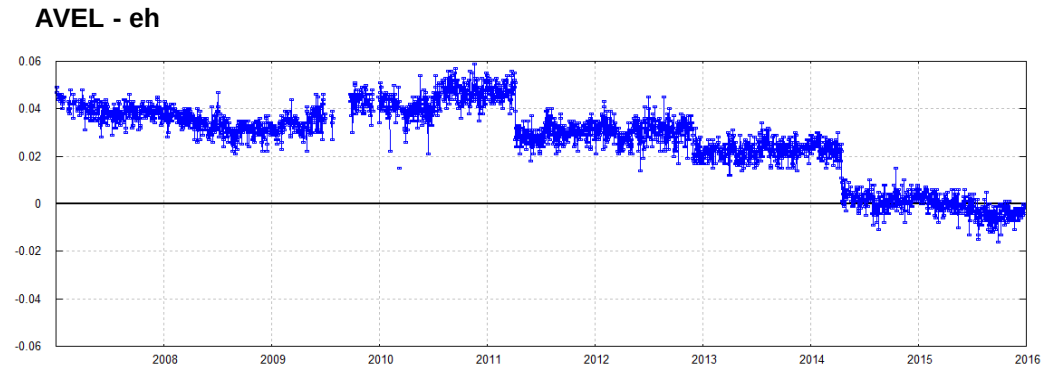
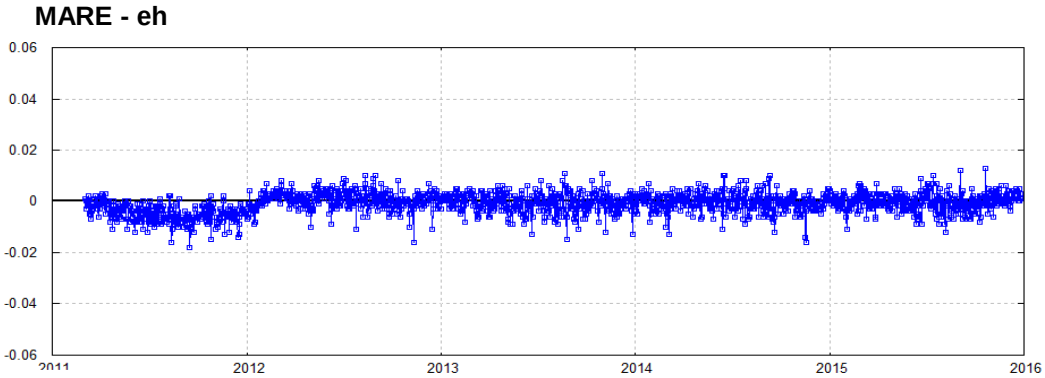
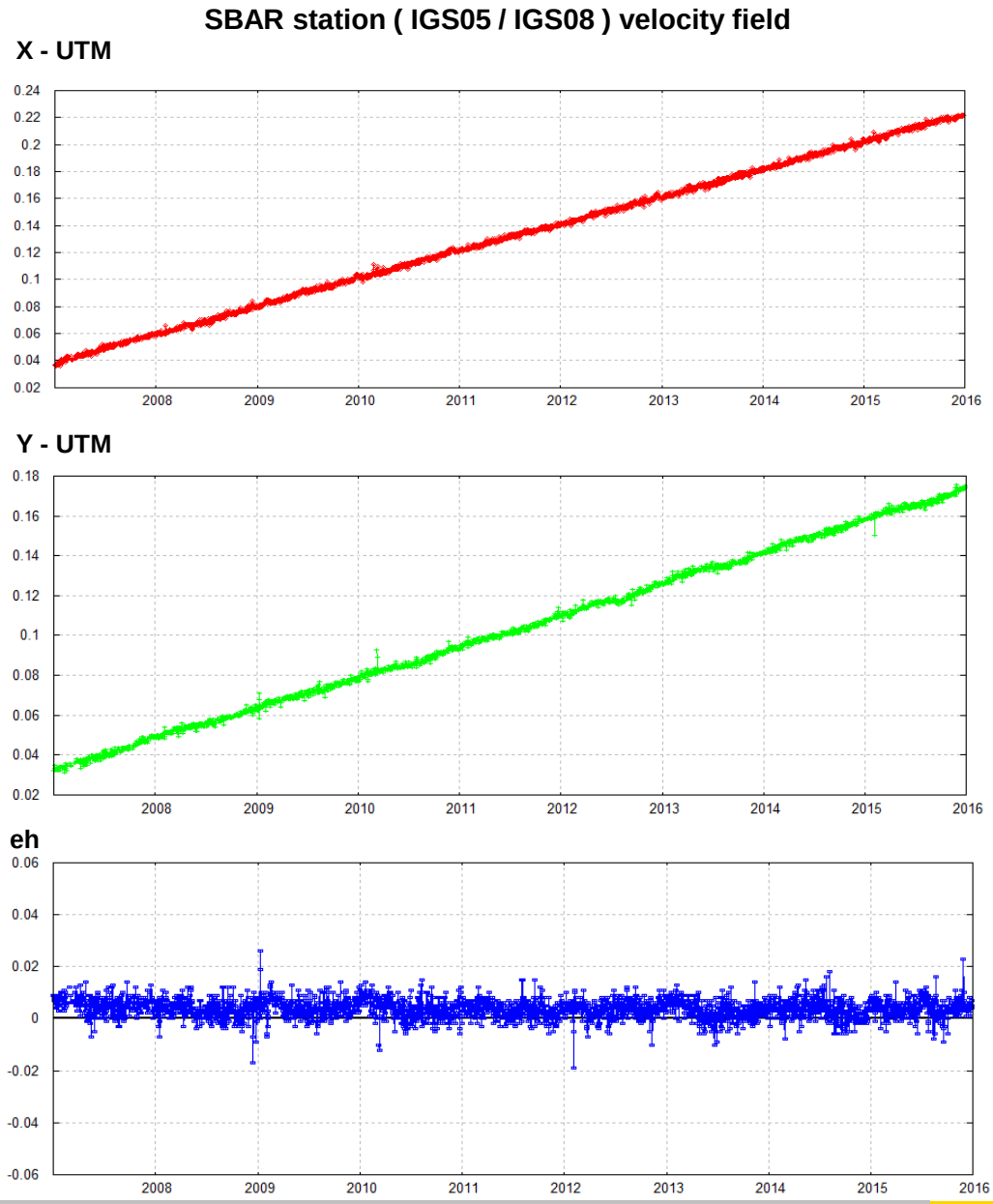






ICGC capabilities and services

- Capabilities as a DAC:
  - Calculation and monitoring of the TRF reference frames
  - Analysis of network coordinates stability
  - Computation of velocity fields (>2 years of data)
  - Monitoring of terrain deformation and tectonic movements
- New services coming:
  - High precision PPP services
  - GNSS stations Monitoring
  - Scientific and academic collaborations



Outline

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  - Activity Map and usage statistics
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ICGC positioning services

- Post-processing
  - **GeoFons**: RINEX files & tools aux data (geoid, coordinates, etc). FTP
  - **CatNet web**: RINEX files & tools (sat tracking, iono). HTTP

- Real Time

	Precision	Correction	Service
DGPS	1 m	Code	Direct
CODCAT	Submeter	Code	Interactive
RTKAT	4 cm plan. 6 cm altim.	Phase	Interactive

RTK service formats

TYPE OF OBSERVATION	FORMAT OF THE CORRECTIONS	MOUNTPOINT
RTK	RTCM 3.0	VRS_RTK_3_0
	RTCM 2.3	VRS_RTK_2_3
	CMR+	VRS_RTK_CMR
DGPS CODCAT	RTCM 2.3	VRS_DGPS

Post-processing format: RINEX 3.x

- The format can be adapted to new signals and constellations
- RINEX v3 is more readable (observables in a tabular pattern)

```
   R20   994   994   994   994   988   983   987   988   994PRN / # OF OBS
   R21  1043  1043  1034  1011  1036  1033  1027   992  1043PRN / # OF OBS
   R22   846   846   846   844   842   840   842   839   846PRN / # OF OBS
   R23   903   903   903   901   900   900   900   898   903PRN / # OF OBS
   R24   893   893   892   892   887   887   887   887   893PRN / # OF OBS
                                                            END OF HEADER
> 2014 04 05 00 00  0.0000000  0 20
C05  40295820.328 6  40295814.996 5  40295818.543 6                                                 209831042.901 6 170504963.624 5 162254735.771 6
C06  41244698.172 6  41244689.621 4  41244694.992 5                                                 214772020.392 6 174519839.723 4 166075349.147 5
C09  38734170.898 7  38734161.988 6  38734167.969 6                                                 201699055.998 7 163896983.913 6 155966528.865 6
G03  20946996.883 8  20947006.766 7                                                                                                 110077237.950 8  85774526.230 7
G15  25669975.273 6  25669986.117 3  25669985.254 5                                                                                 134896620.638 6 105114300.773 3 105114296.811 5
G16  20571983.578 8  20571992.254 7                                                                                                 108106512.455 8  84238895.568 7
G18  22086135.758 8  22086144.695 6                                                                                                 116063738.107 8  90439354.934 6
G19  22494398.633 8  22494406.426 6                                                                                                 118208896.659 8  92110874.031 6
G21  23209827.492 7  23209836.516 5                                                                                                 121968857.557 7  95040806.630 5
G22  21556030.281 8  21556037.977 7                                                                                                 113278121.136 8  88268746.376 7
G27  20682483.766 9  20682493.988 8  20682493.699 9  20682492.207 9                                                                 108687210.721 9  84691452.840 8  84691462.845 9  81162643.534 9
R03  23502309.133 6  23502306.910 6  23502315.500 6  23502316.227 6                                                                 125809005.042 6 125809406.060 6  97851840.261 6  97852073.257 6
R04  20923630.703 8  20923630.191 8  20923637.063 7  20923636.543 7                                                                 112044928.267 8 112045080.273 8  87146305.866 7  87146308.864 7
R05  21817647.391 8  21817646.816 8  21817655.066 7  21817656.211 7                                                                 116628104.093 8 116628090.097 8  90710919.560 7  90710915.570 7
R09  23001468.352 6  23001466.566 6  23001479.426 5  23001479.172 5                                                                 122826580.061 6 122826565.079 6  95531829.812 5  95531826.820 5
R10  20919138.414 8  20919137.094 8  20919147.605 6  20919147.602 6                                                                 111510904.575 8 111510817.568 8  86730712.806 6  86730686.805 6
R11  22232016.078 7  22232014.793 7  22232023.176 6  22232023.379 5                                                                 118800903.098 7 118801073.150 7  92400933.765 6  92400945.781 5
R19  20581207.898 9  20581206.734 8  20581212.324 8  20581213.012 7                                                                 110095971.287 9 110095862.312 8  85630286.482 8  85630283.486 7
R20  20285360.414 8  20285359.844 7  20285368.332 8  20285368.500 8                                                                 108475151.202 8 108475018.199 7  84369529.934 8  84369527.940 8
R21  23381888.594 6  23381888.684 6  23381896.527 4  23381897.789 4                                                                 125121206.210 6 125121198.240 6  97316519.969 4  97316529.006 4
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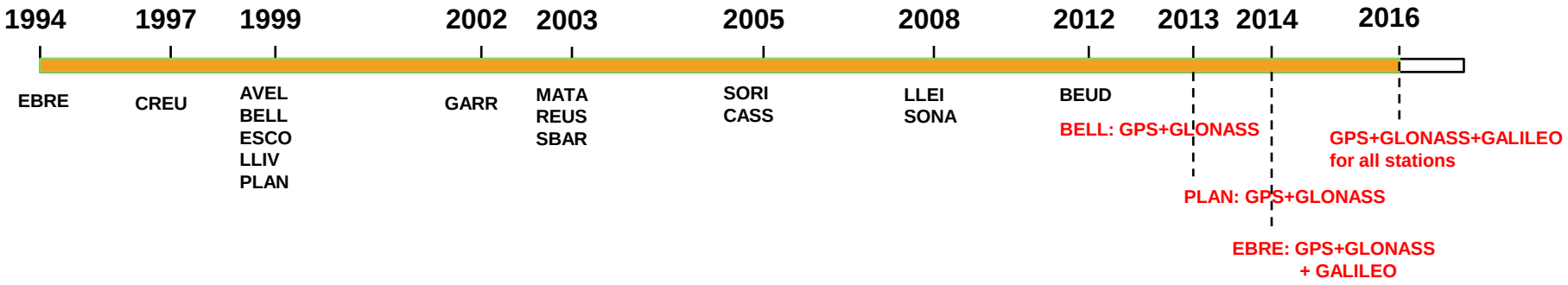
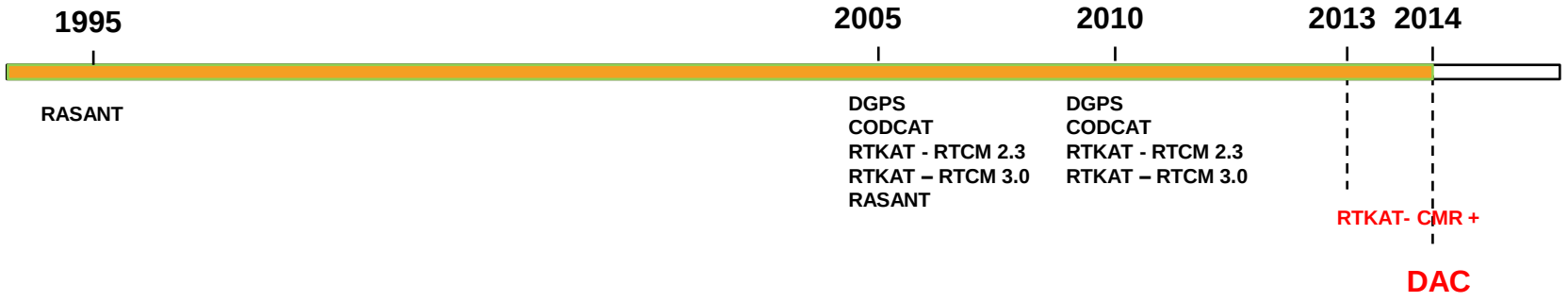
- GNSS industry gives support to the adoption of RINEX 3.0x

CATNET infrastructure

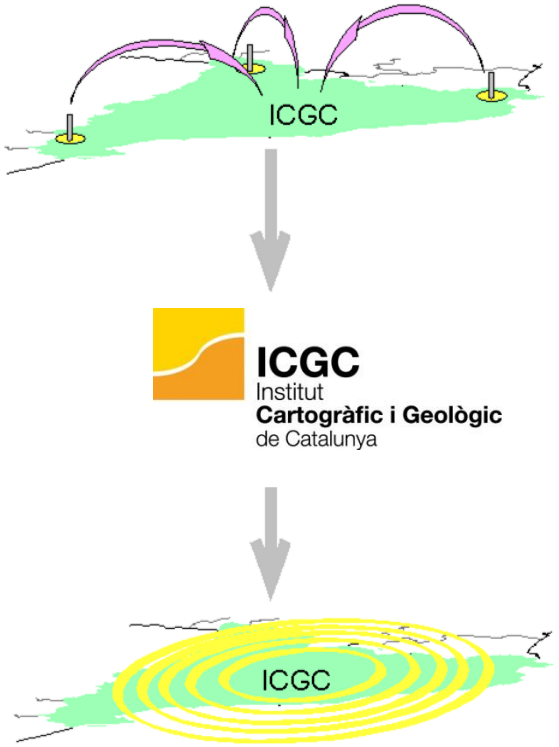
- CATNET Network deployment

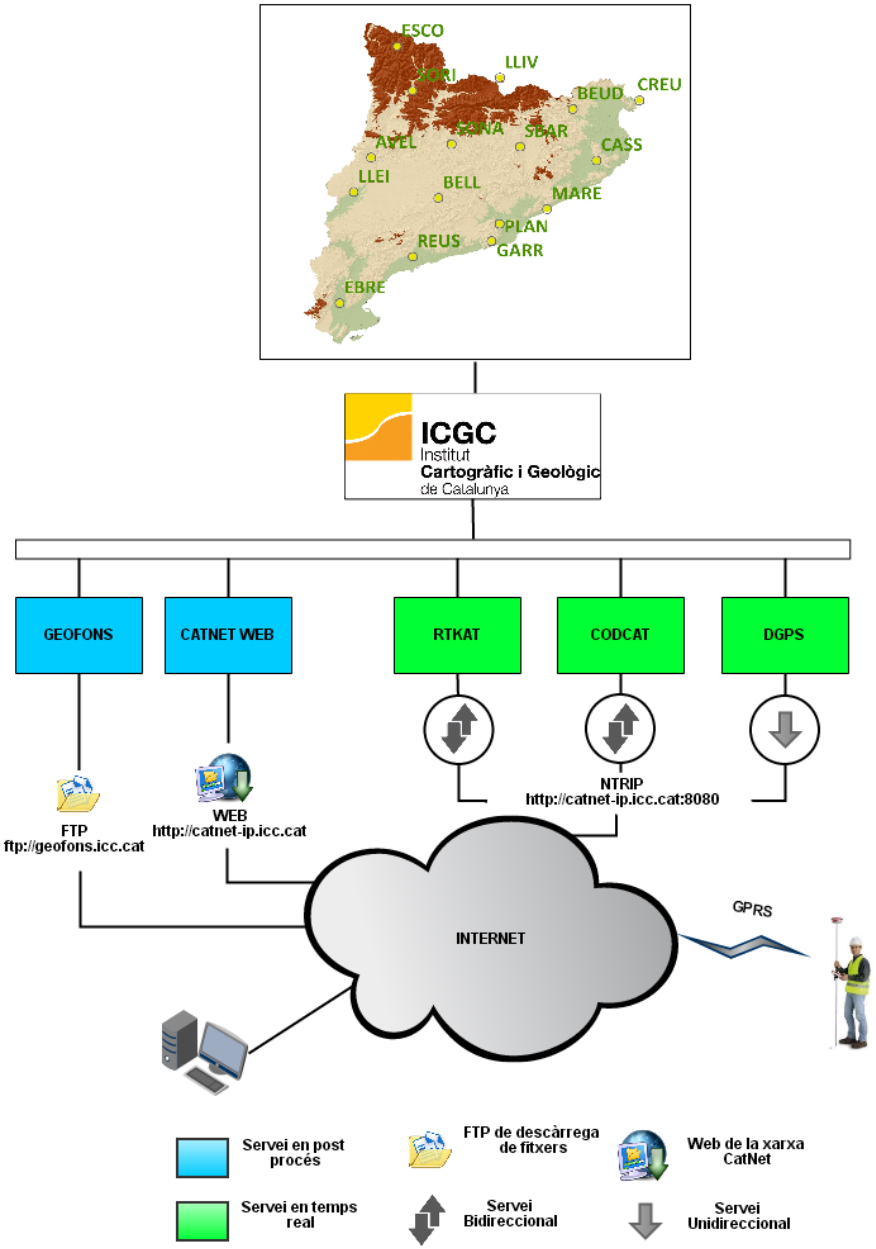


- Positioning services

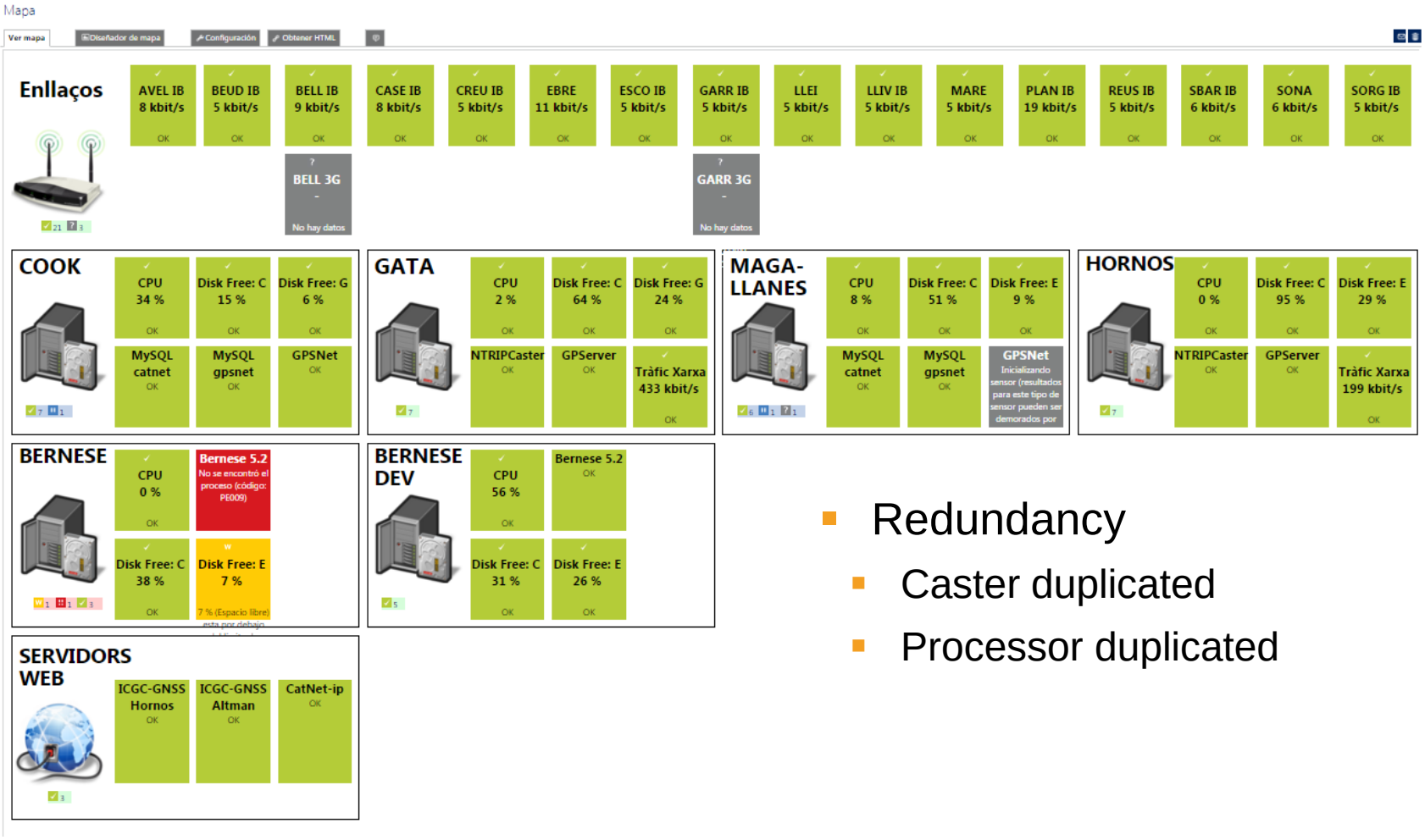


ICGC positioning services





CATNET Network monitoring



- Redundancy
  - Caster duplicated
  - Processor duplicated

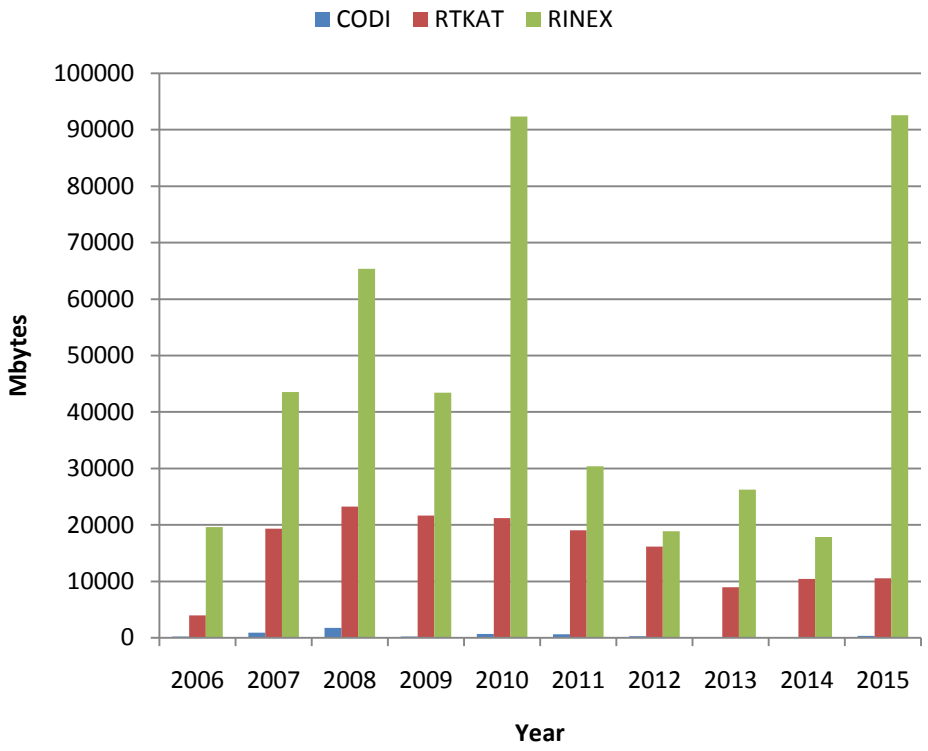
Activity map and usage statistics

Key Performance Indicators (PKI)

- Quantitative indicators:
  - Amount of data downloaded by user
  - Usage time of services by user
  - Number of active users of services
  - Number of new registered users

- Qualitative indicators :
  - Geographical distribution
  - Analysis of use regarding the soil type where take place the use of service

Data Volume



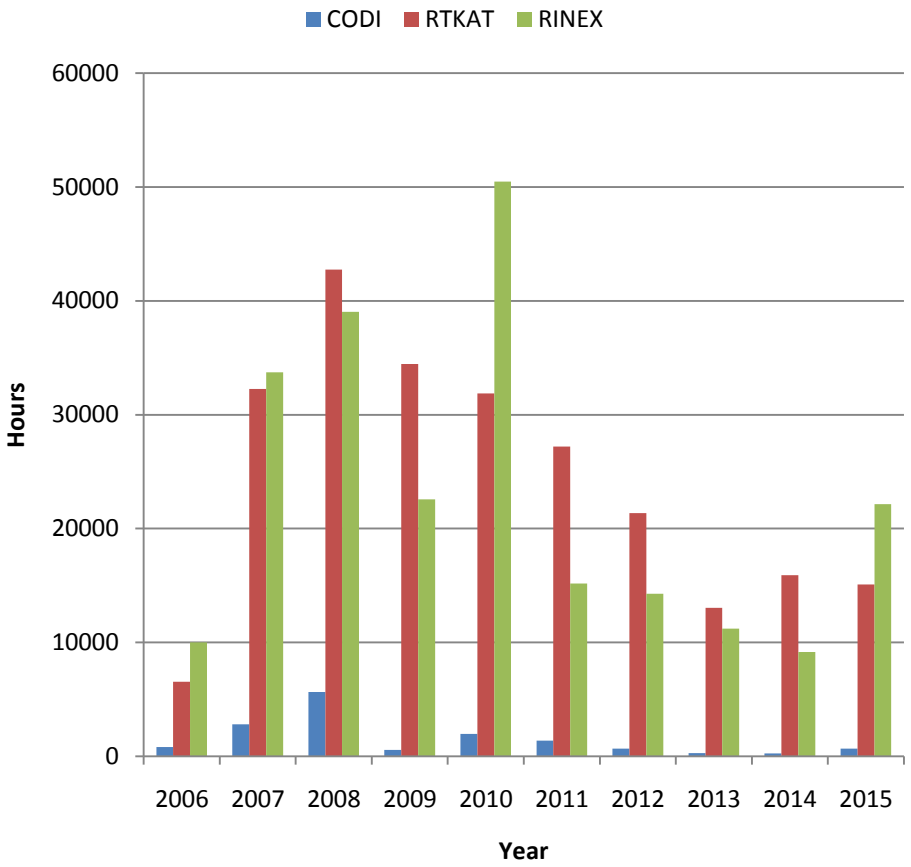
- Data Volume

Year	CODI (Mbytes)	RTKAT (Mbytes)	RINEX (Mbytes)
2006	220	3952	19638
2007	900	19319	43518
2008	1778	23259	65357
2009	236	21660	43431
2010	675	21177	92333
2011	601	19022	30397
2012	297	16168	18860
2013	138	8933	26230
2014	134	10432	17852
2015	319	10552	92581

- Variation respect previous year

Year	CODI (Δ%)	RTKAT (Δ%)	RINEX (Δ%)
2006			
2007	309.1	388.8	121.6
2008	97.6	20.4	50.2
2009	-86.7	-6.9	-33.5
2010	186	-2.2	112.6
2011	-11	-10.2	-67.1
2012	-50.6	-15	-38
2013	-53.5	-44.7	39.1
2014	-2.9	16.8	-31.9
2015	131.8	1.2	418.6

Time of service



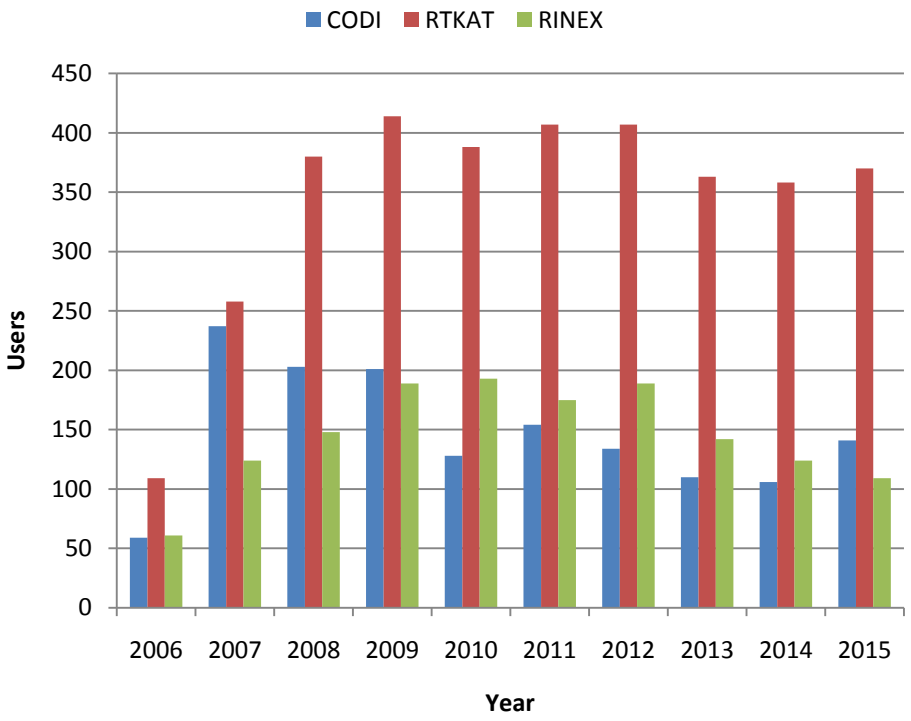
- Hours of service

Year	CODI (hours)	RTKAT (hours)	RINEX (hours)
2006	823	6559	9996
2007	2817	32272	33725
2008	5646	42744	39049
2009	571	34450	22580
2010	1961	31877	50487
2011	1382	27203	15168
2012	676	21350	14283
2013	292	13026	11201
2014	261	15911	9175
2015	684	15097	22150

- Variation respect previous year

Year	CODI (Δ%)	RTKAT (Δ%)	RINEX (Δ%)
2006			
2007	242.3	392	237.4
2008	100.4	32.4	15.8
2009	-89.9	-19.4	-42.2
2010	243.4	-7.5	123.6
2011	-29.5	-14.7	-70
2012	-51.1	-21.5	-5.8
2013	-56.8	-39	-21.6
2014	-10.6	22.1	-18.1
2015	162.1	-5.1	141.4

Active users



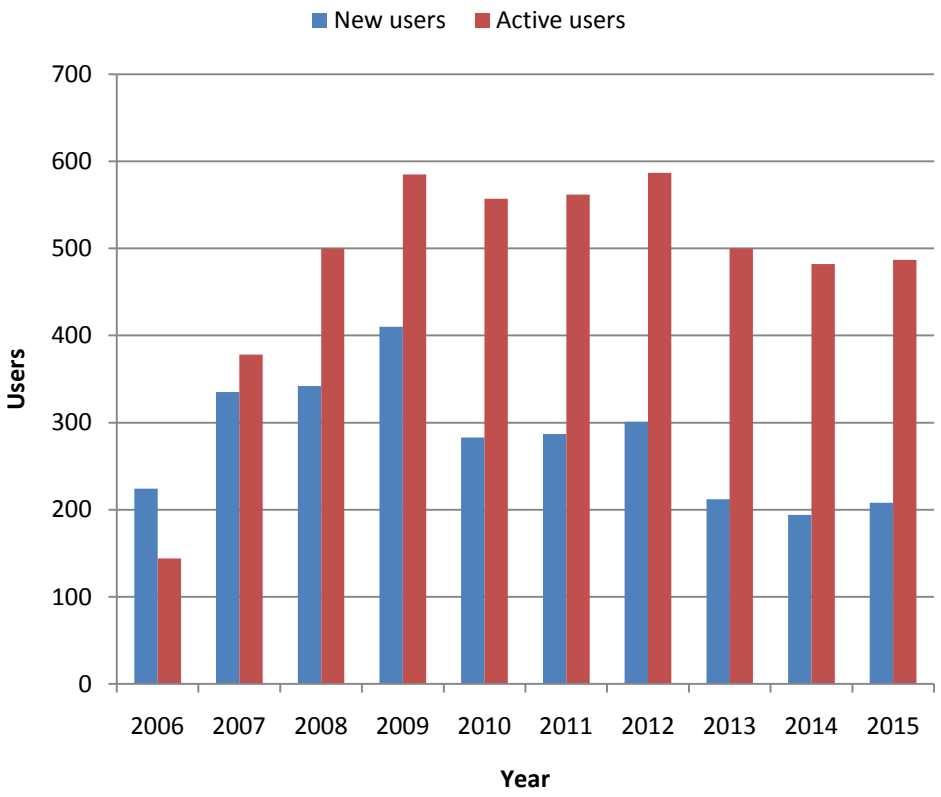
- Users per year

Year	CODI	RTKAT	RINEX
2006	59	109	61
2007	237	258	124
2008	203	380	148
2009	201	414	189
2010	128	388	193
2011	154	407	175
2012	134	407	189
2013	110	363	142
2014	106	358	124
2015	141	370	109

- Variation respect previous year

Year	CODI (Δ%)	RTKAT (Δ%)	RINEX (Δ%)
2006			
2007	301.7	136.7	103.3
2008	-14.3	47.3	19.4
2009	-1	8.9	27.7
2010	-36.3	-6.3	2.1
2011	20.3	4.9	-9.3
2012	-13	0.0	8.0
2013	-17.9	-10.8	-24.9
2014	-3.6	-1.4	-12.7
2015	33.0	3.4	-12.1

New registered users



- New registrations per year

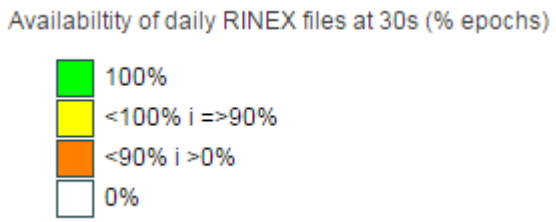
Year	New users	Active users
2006	224	144
2007	335	378
2008	342	500
2009	410	585
2010	283	557
2011	287	562
2012	301	587
2013	212	500
2014	194	482
2015	208	487

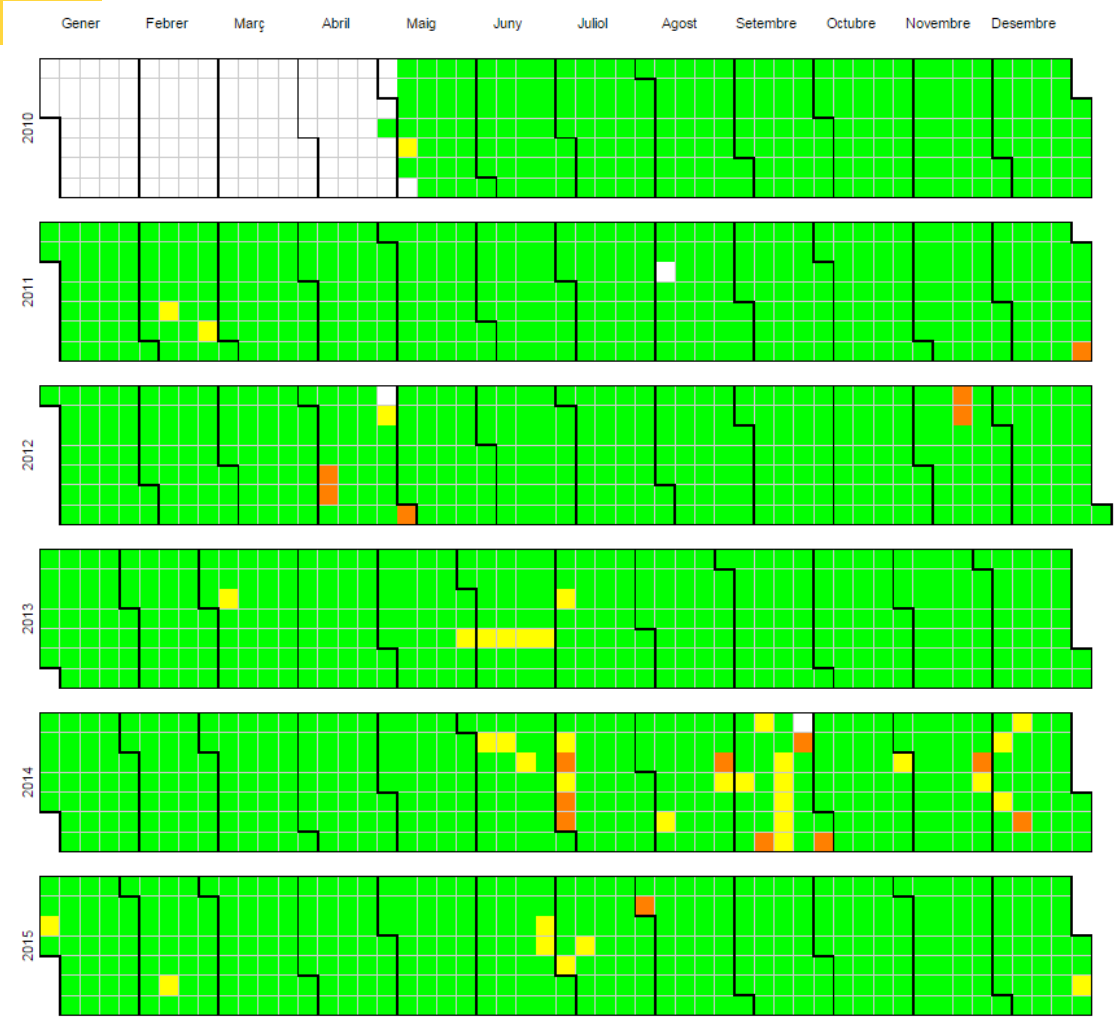
- Variation respect previous year

Year	New users (Δ%)	Active users (Δ%)
2006		
2007	49.6	162.5
2008	2.1	32.3
2009	19.9	17
2010	-31	-4.8
2011	1.4	0.9
2012	4.9	4.4
2013	-29.6	-14.8
2014	-8.5	-3.6
2015	7.2	1.0

Availability of RINEX files

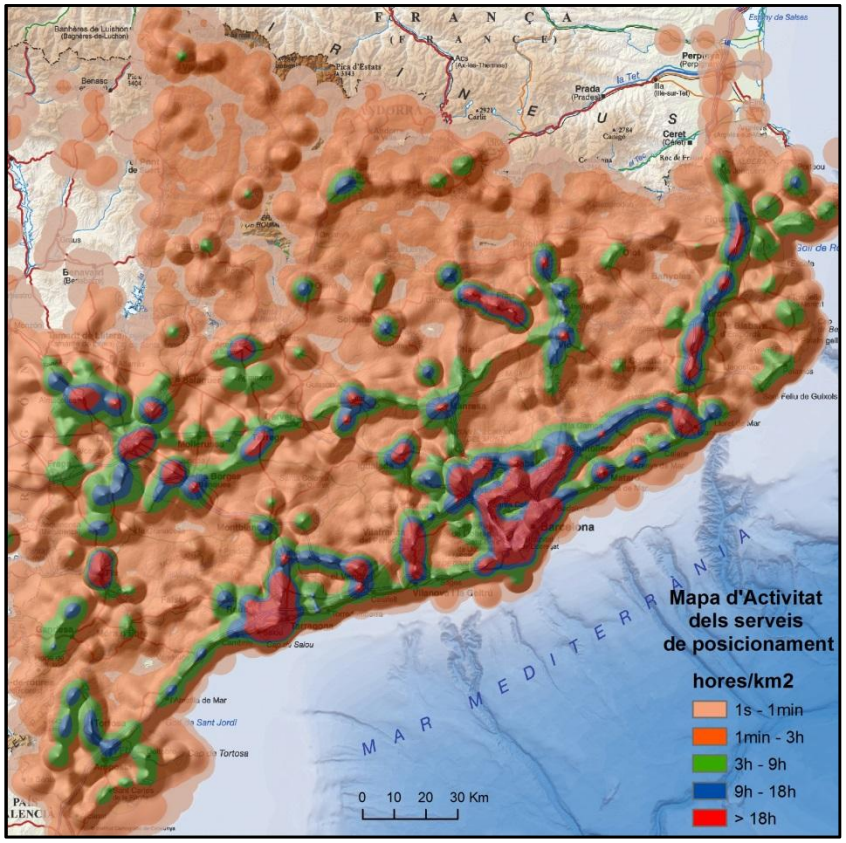
- Hourly Rinex at 1 second
- Daily Rinex at 30 seconds



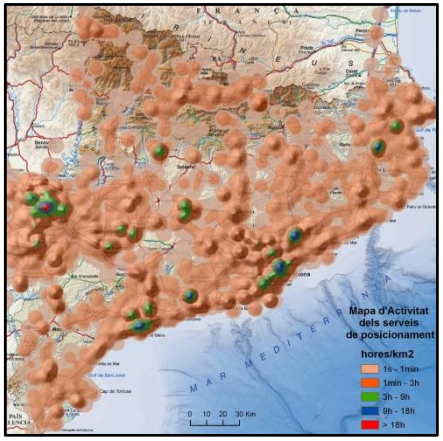


Activity map

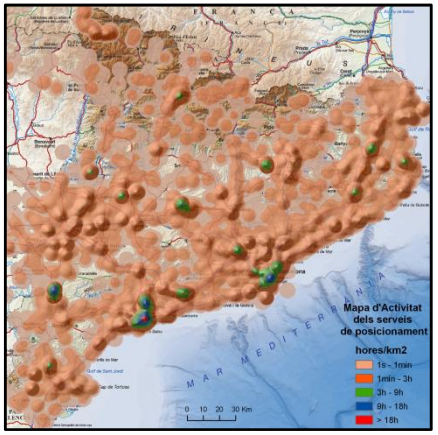
Activity for period 2009 - 2015



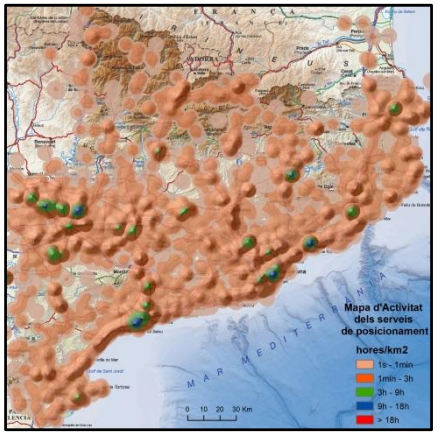
Activity 2014



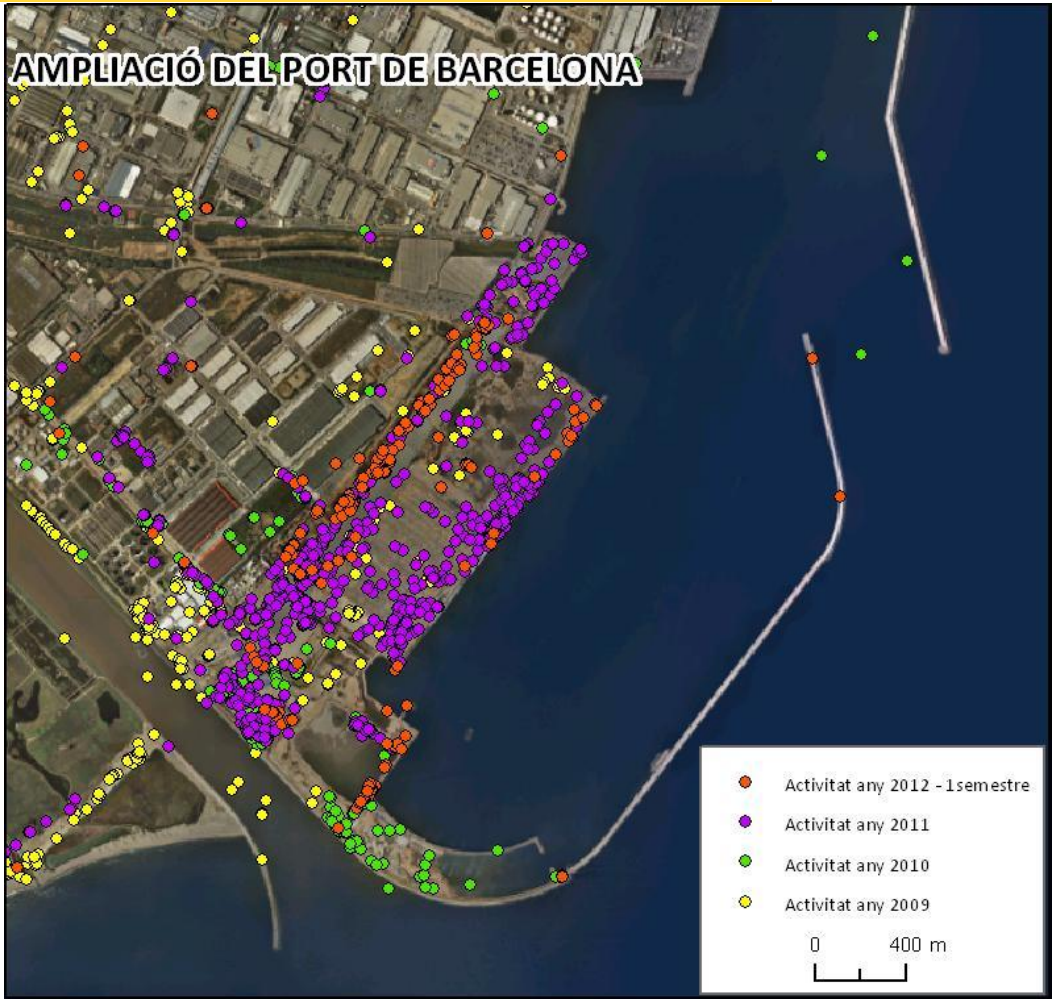
Activity 2013



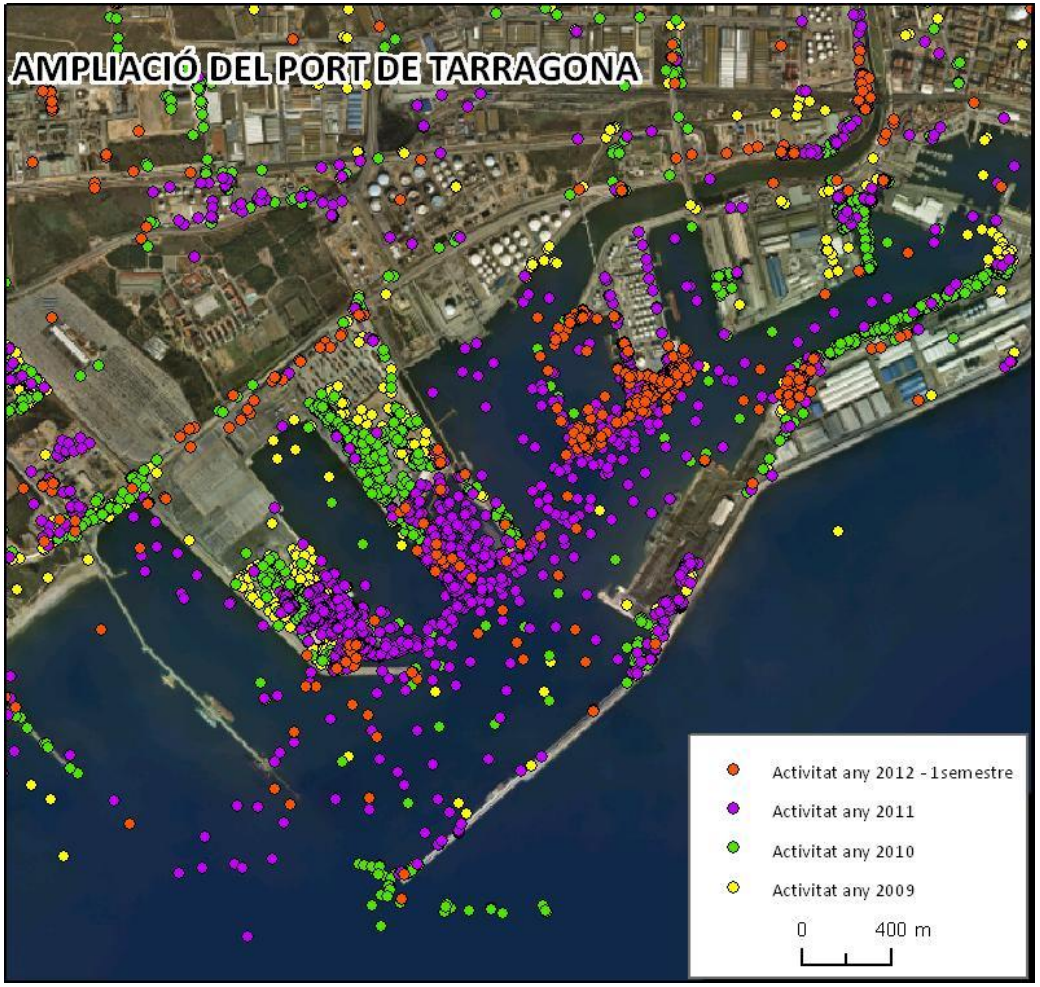
Activity 2015



Uses of the services: Harbours



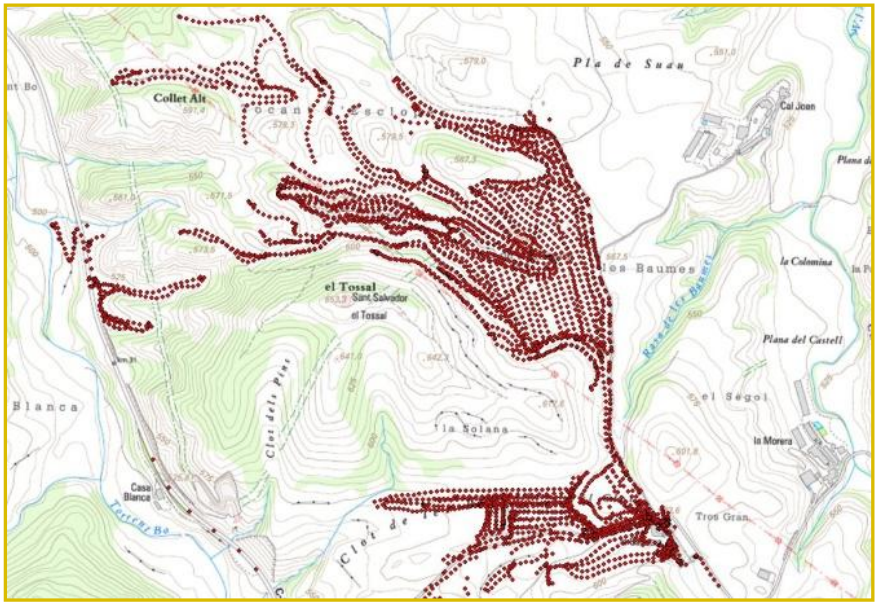
Harbour


AMPLIACIÓ DEL PORT DE TARRAGONA
Activitat any 2012 - 1semestre
Activitat any 2011
Activitat any 2010
Activitat any 2009
0
400 m


MAR MEDITERRANIA

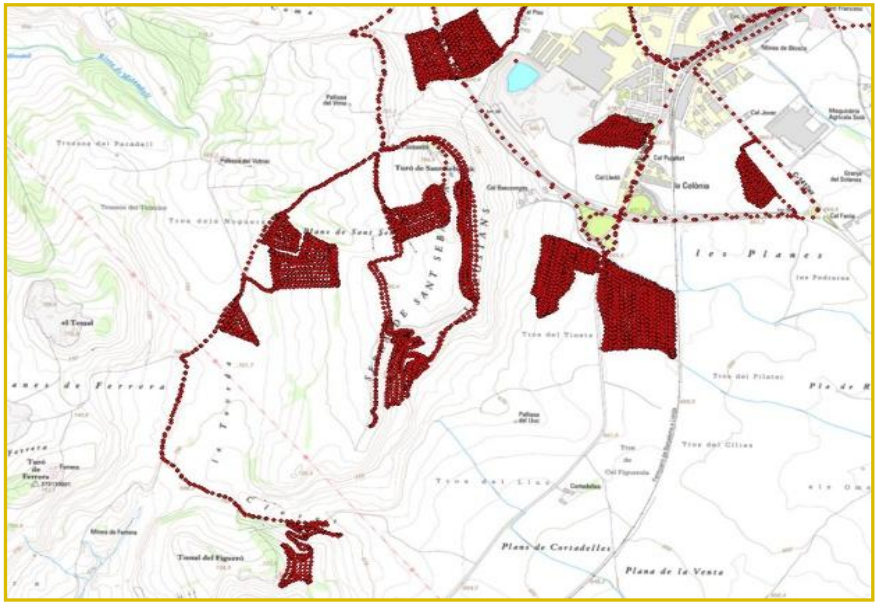
New uses of the services

- Precision farming



New uses of the services

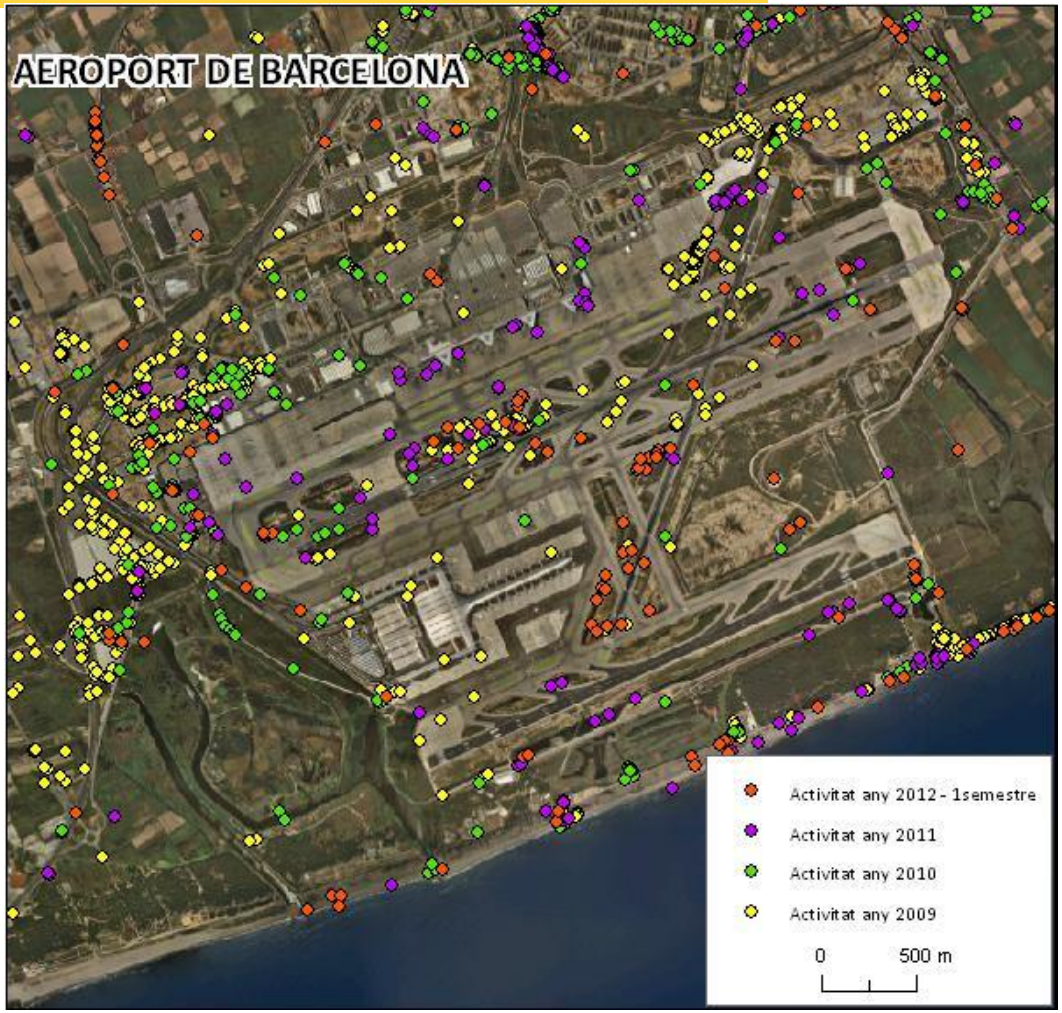
- Precision farming

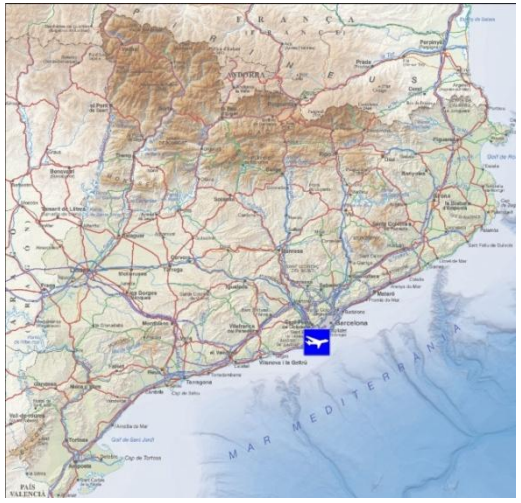


Civil works


Aeroport de Barcelona
Aeroport de Girona - Costa Brava
Aeroport de Lleida - Alguaire
Aeroport de Reus
Concentració parcel·lària - Castelldans
Concentració parcel·lària - Les Borges Blanques
Concentració parcel·lària - Verdú i Preixana
Pedrera d'en Jover
Planta solar termoelèctrica + biomassa - Termosolar Borges
Port de Barcelona
Port de Tarragona
Canal Segarra - Garrigues
Tram ITAM Tordera - Fogars de la Selva
Gaseoducte Martorell - Figueres
Autopista AP-7
Autovia Tarragona - Montblanc A-27
Condicionament de l'eix Vic - Gironella - C-154
Desdoblament C-31 Castell - Platja d'Aro - Palamós
Desdoblament de la C-13 (Lleida)
Eix Diagonal - C-15 i C-37
Eix Transversal - C-25
AVE
0
40 Km
C-154
C-25
C-13
AP-7
A-27
C-15 / C-37
C-31
Barcelona
Tarragona
MAR MEDITERRÀNIA
FRANÇA
ANDORRA

Airports


AEROPORT DE BARCELONA
Activitat any 2012 - 1semestre
Activitat any 2011
Activitat any 2010
Activitat any 2009
0
500 m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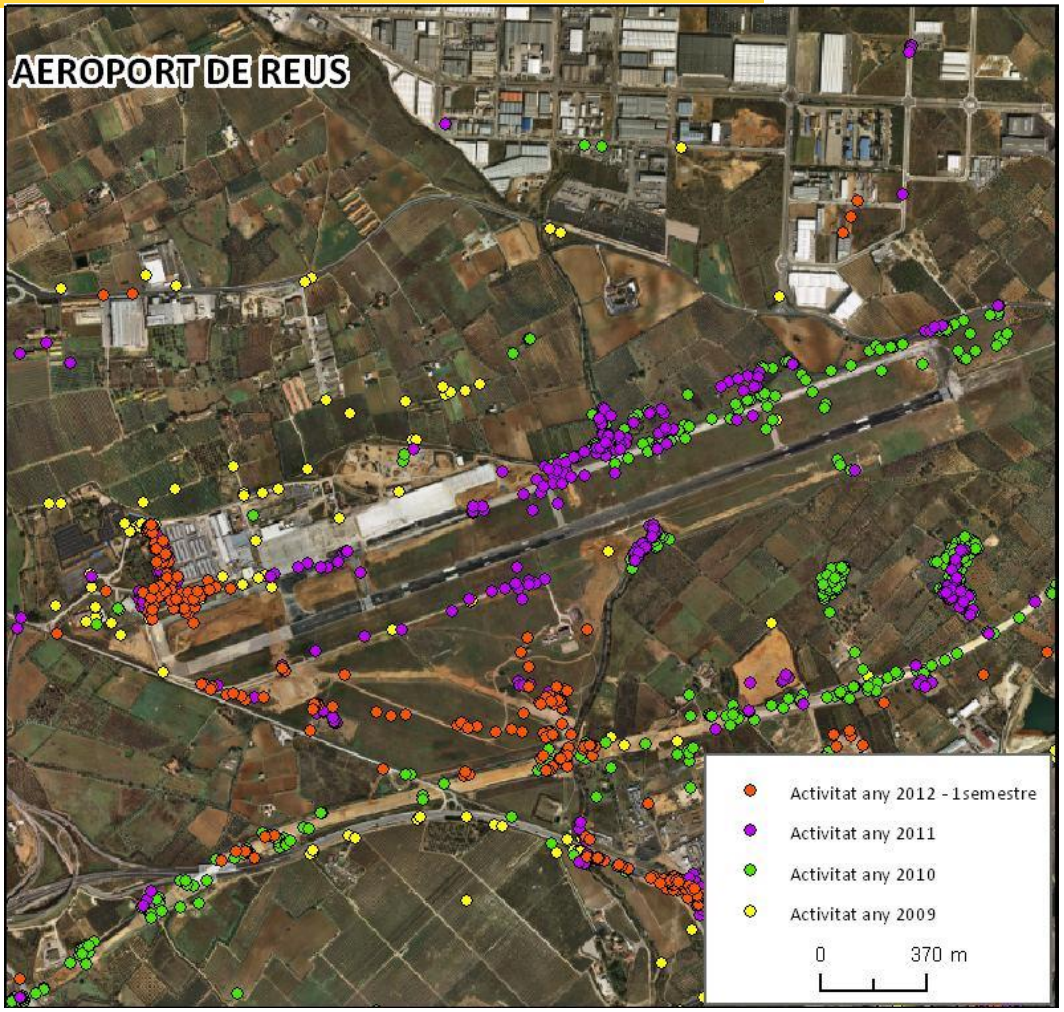
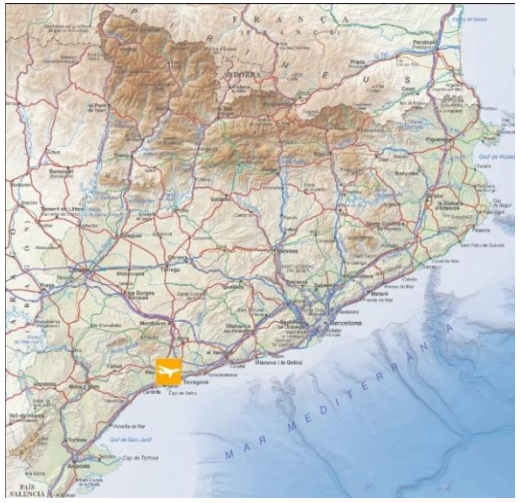
Airports


AEROPORT DE REUS
Activitat any 2012 - 1semestre
Activitat any 2011
Activitat any 2010
Activitat any 2009
0
370 m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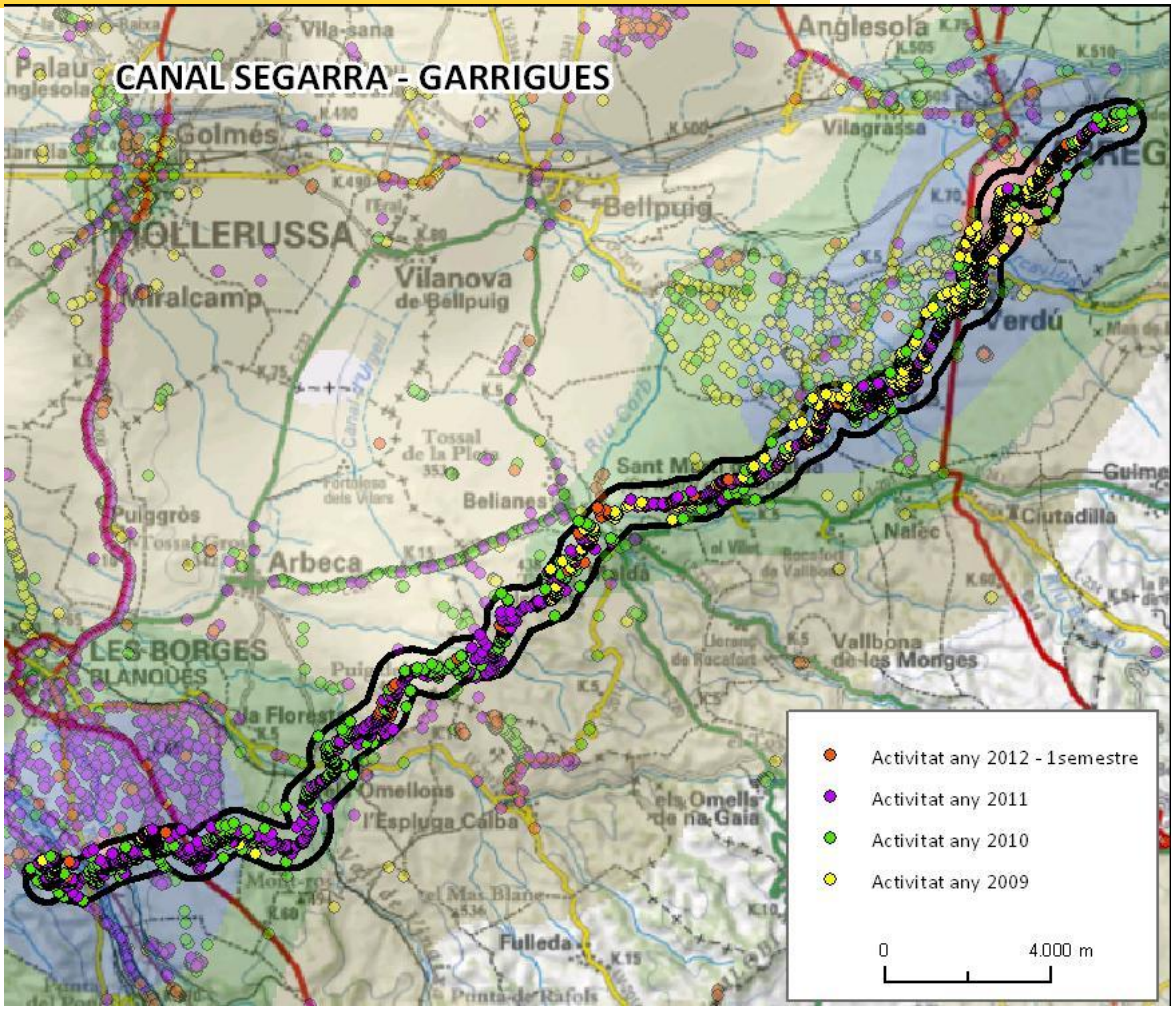
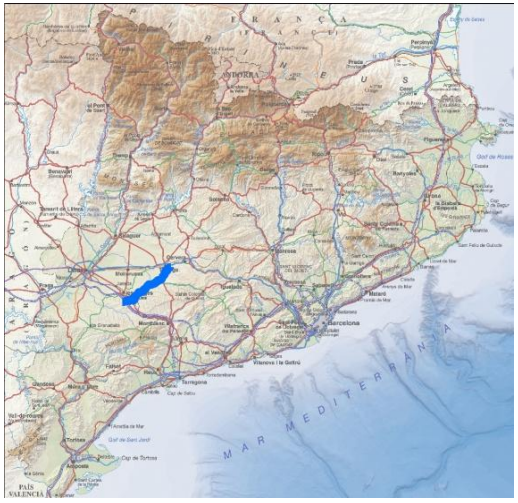
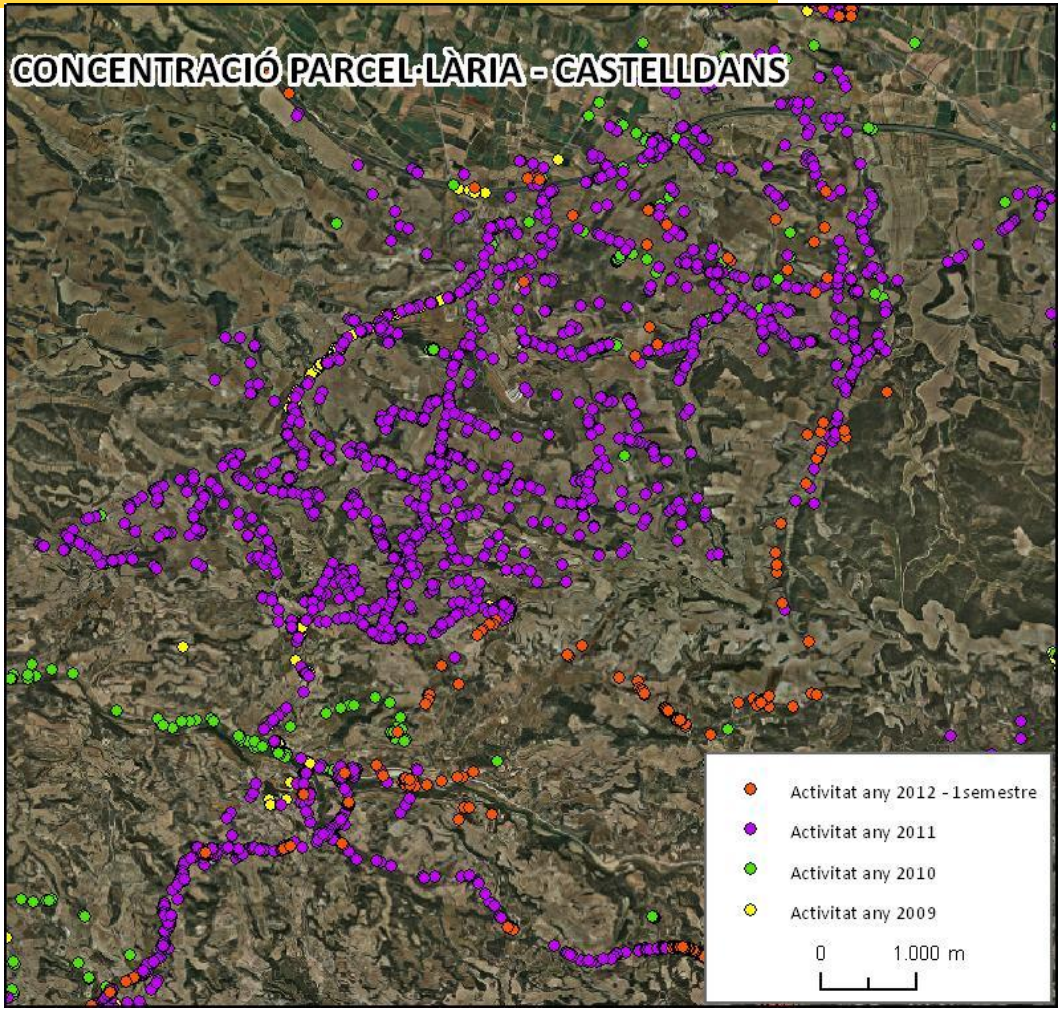
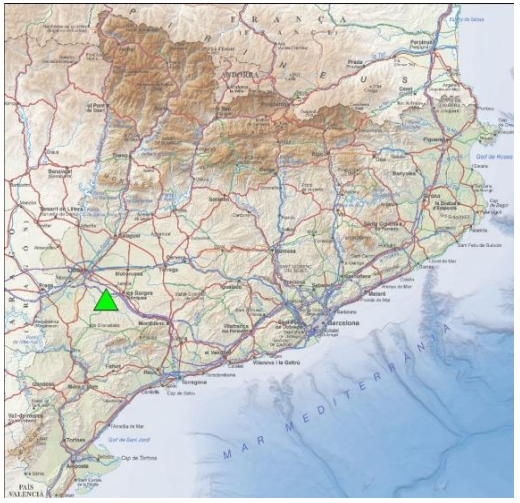
Water Infrastructures



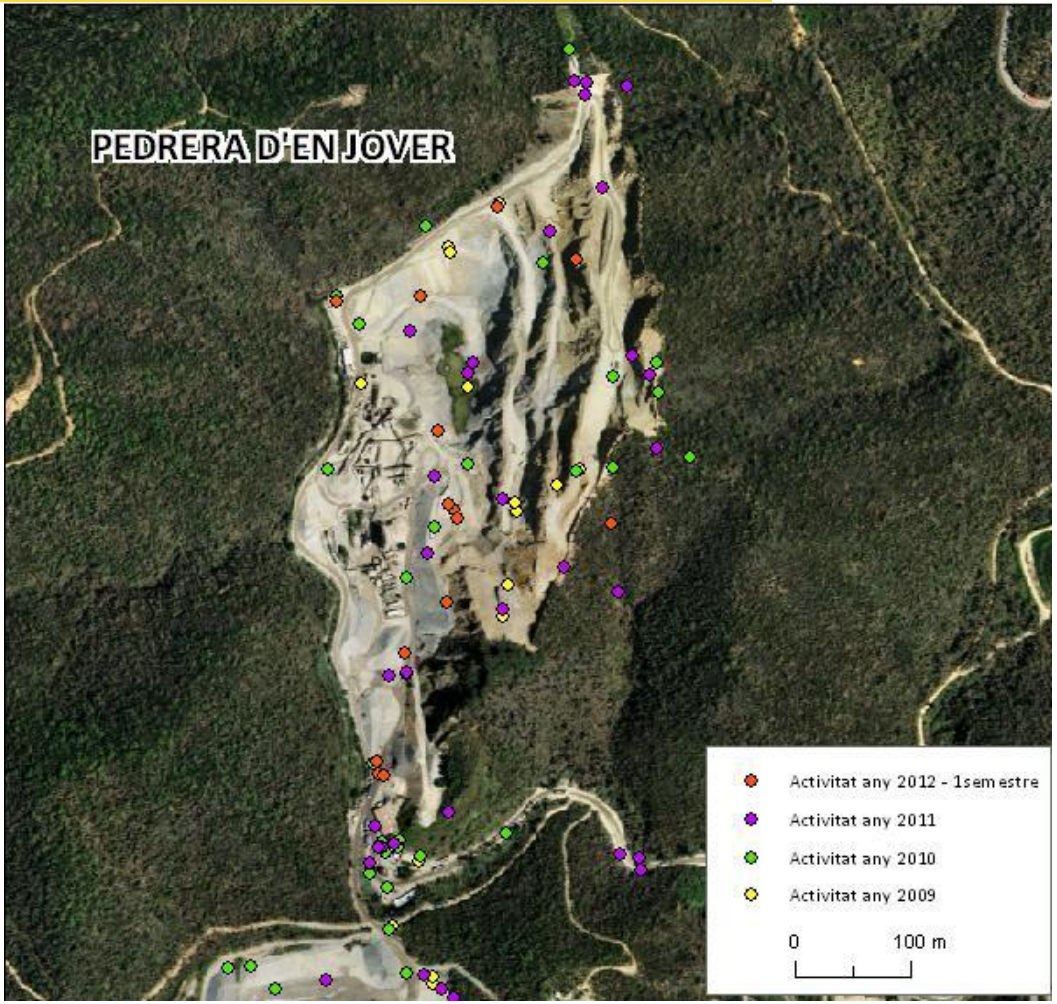


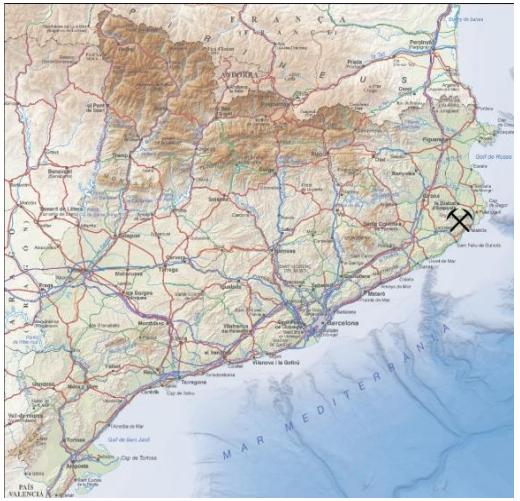
Agriculture delimitation



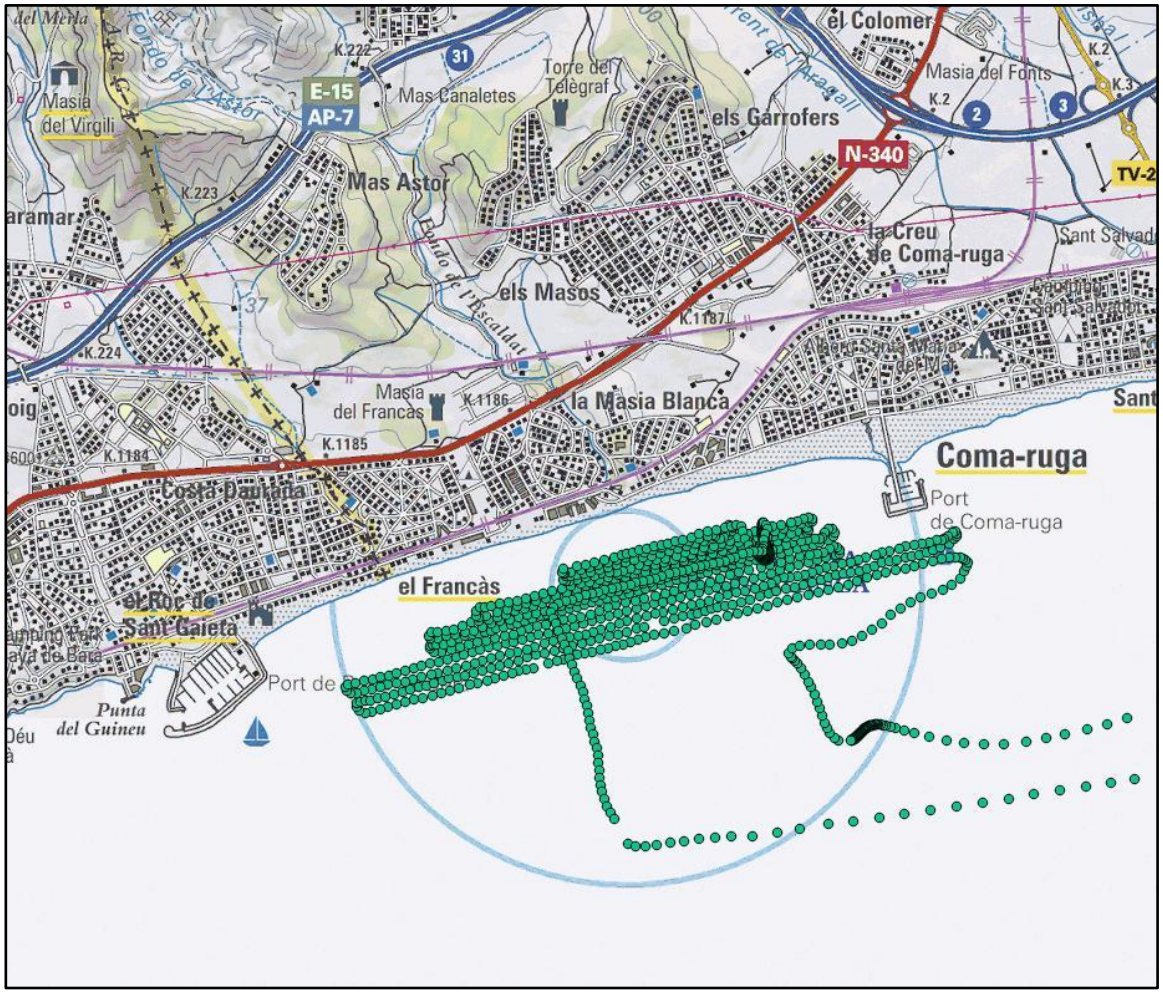


Extractive
Open mines



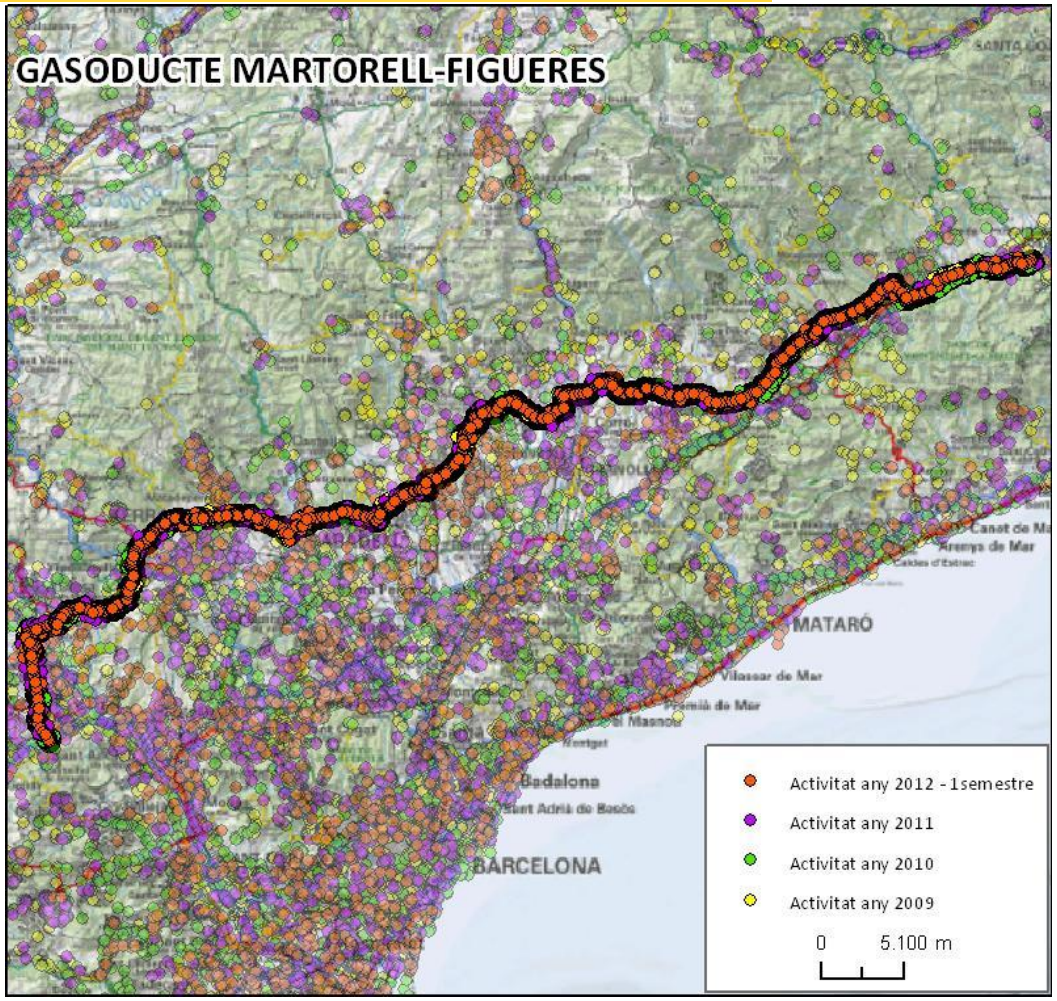


Batimetry

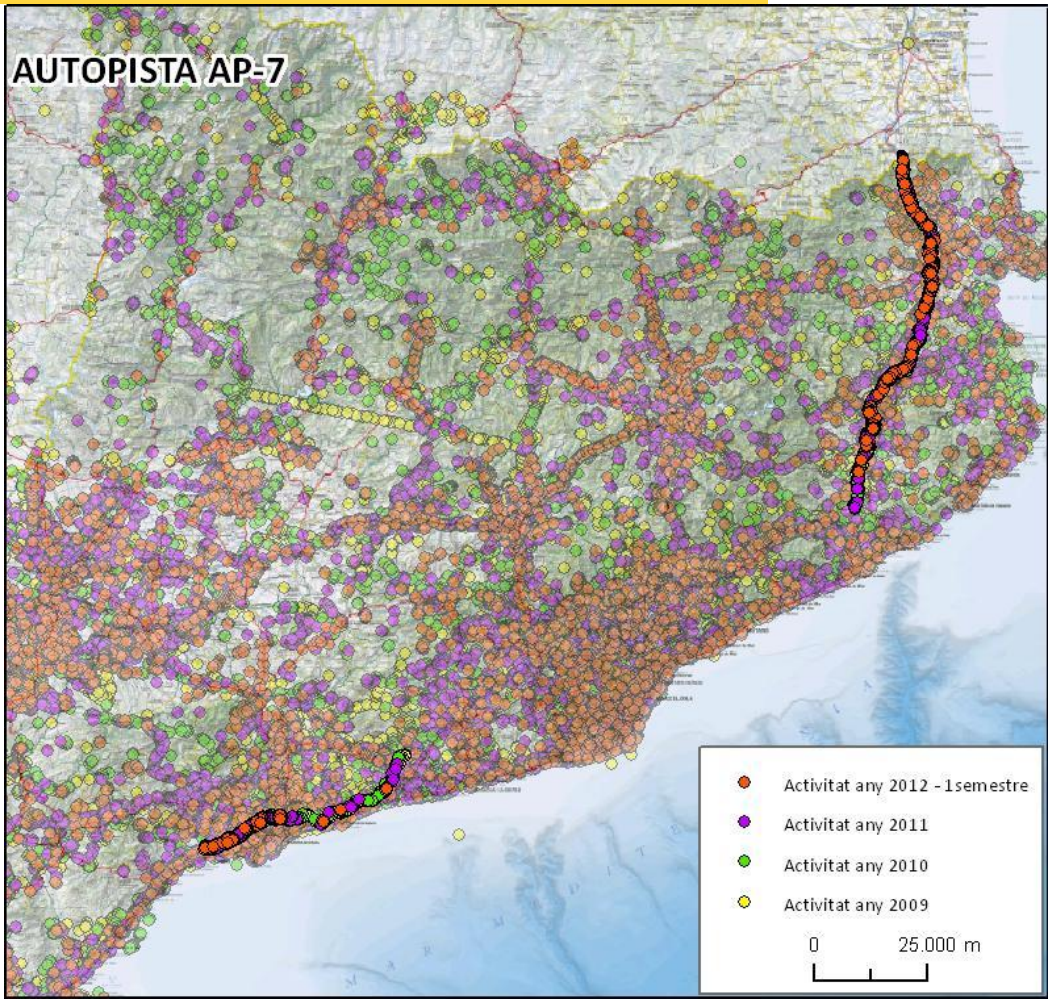

el Colomer
Masia del Fonts
Torre del Telègraf
Mas Canaletes
E-15
AP-7
els Garrofers
N-340
TV-2
Mas Astor
la Creu de Coma-ruga
Sant Salvad
els Masos
Masia del Virgili
Masia del Francàs
la Masia Blanca
Coma-ruga
Port de Coma-ruga
Costa Daurada
el Francàs
el Roc de Sant Gaieta
Port de
Punta del Guineu
K.222
K.223
K.224
K.1184
K.1185
K.1186
K.1187
K.2
K.3


Vielha
el Pont de Suert
Sort
la Seu d'Urgell
Puigcerdà
Tremp
Ripoll
Olot
Figueres
Berga
Solsona
Girona
Vic
Manresa
Cervera
Lleida
Mollerussa
Tàrrega
Igualada
Terrassa
Sabadell
Mataró
Barcelona
Montblanc
Valls
Vilafranca del Penedès
Vilanova i la Geltrú
Reus
Tarragona
Falset
Mora d'Ebre
Gandesa
Tortosa
Amposta
MAR MEDITERRANIA

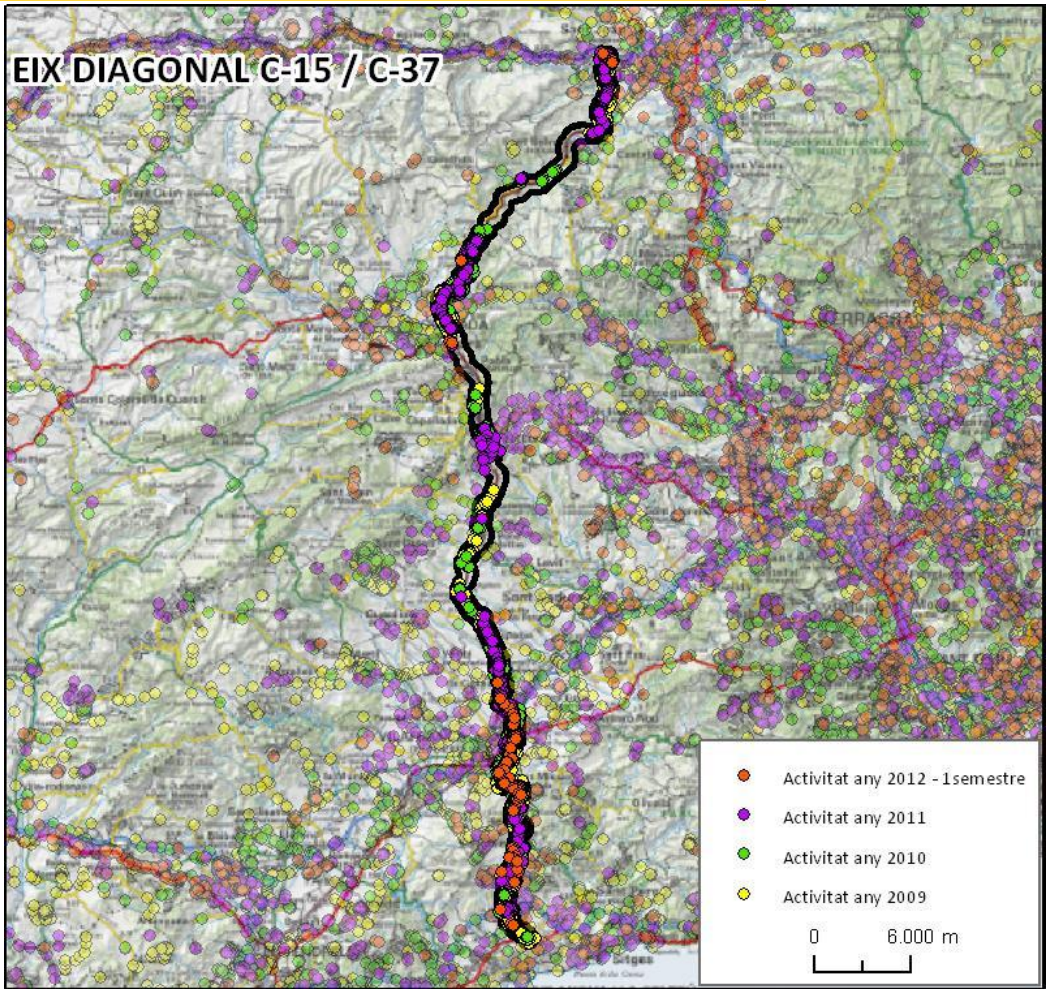
Gas Pipelines

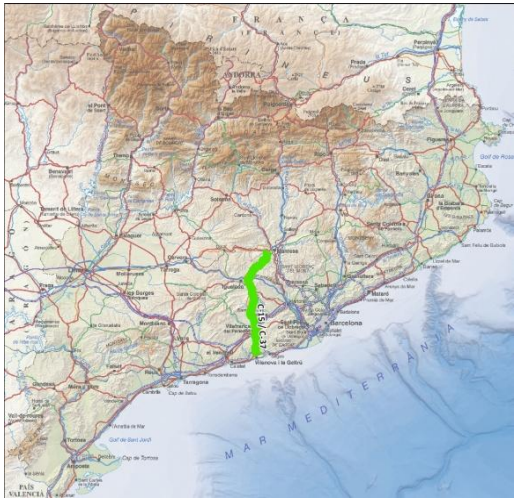


Highways

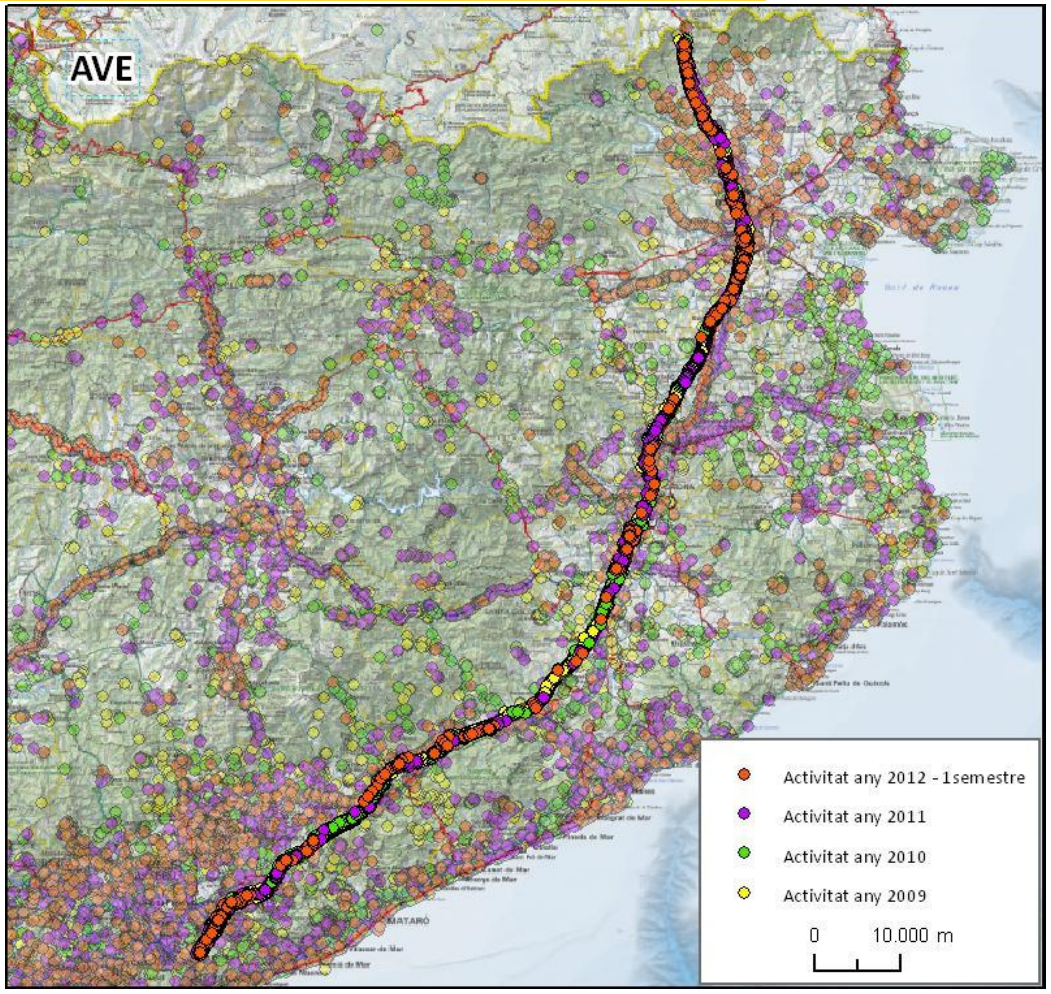

AUTOPISTA AP-7
Activitat any 2012 - 1semestre
Activitat any 2011
Activitat any 2010
Activitat any 2009
0
25.000 m

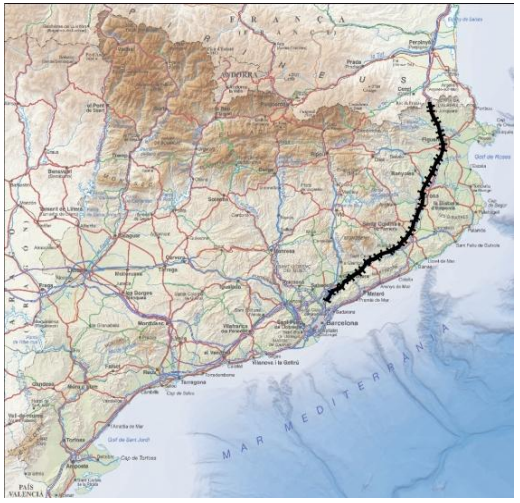
Regional roads





High Speed Trains





Thank you for your attention

Institut Cartogràfic i Geològic de Catalunya

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