

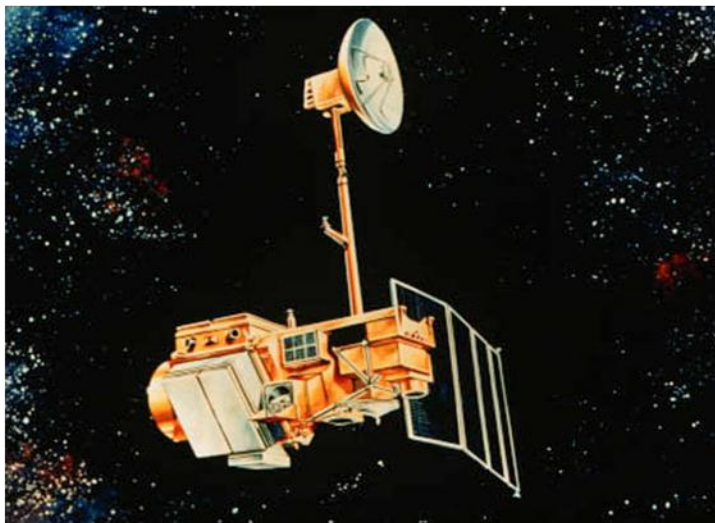
# “EARTH OBSERVATION AND SMALL SATELLITES: FROM DATA TO KNOWLEDGE“

Àrea d'Observació de la Terra (CS\_PCOT)  
Dr. Jordi Corbera  
[jordi.corbera@icgc.cat](mailto:jordi.corbera@icgc.cat)



# EARTH OBSERVATION: BACKGROUND

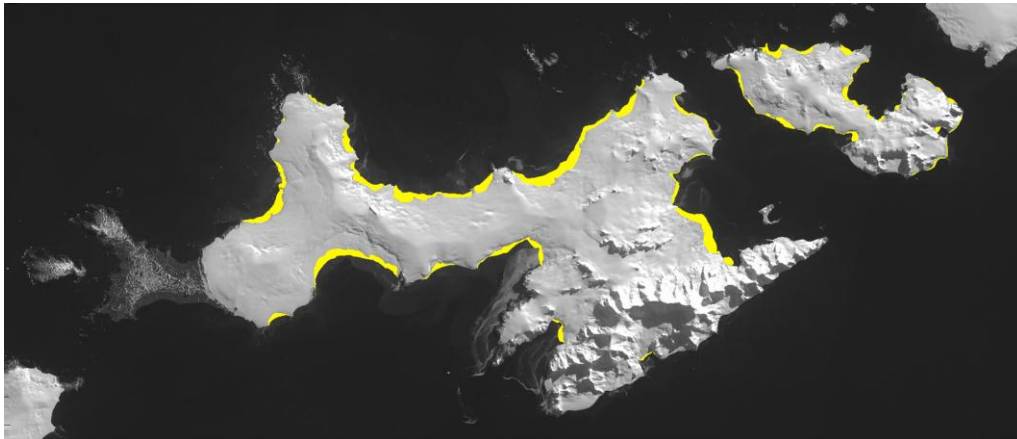
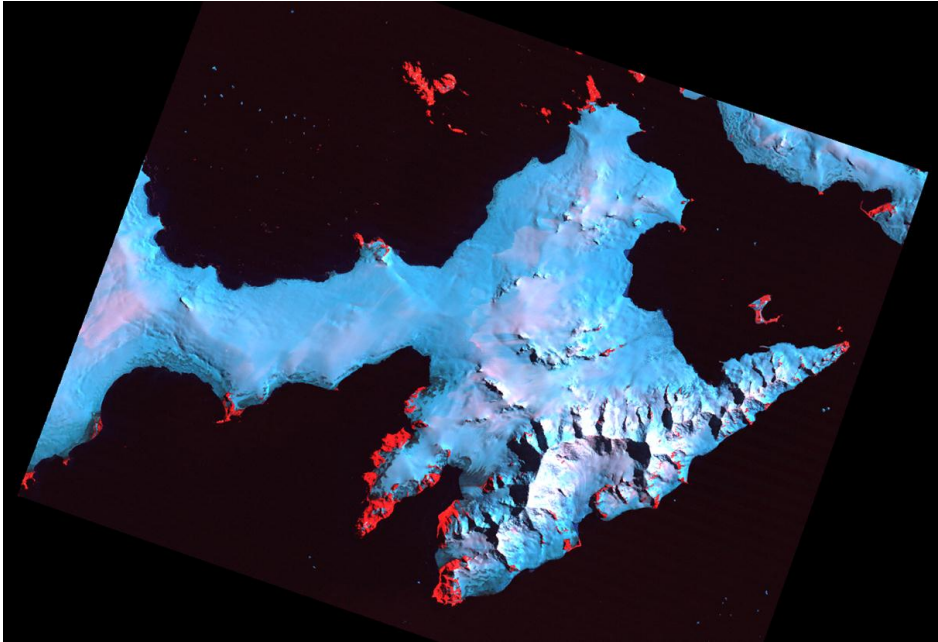
80' – 90'



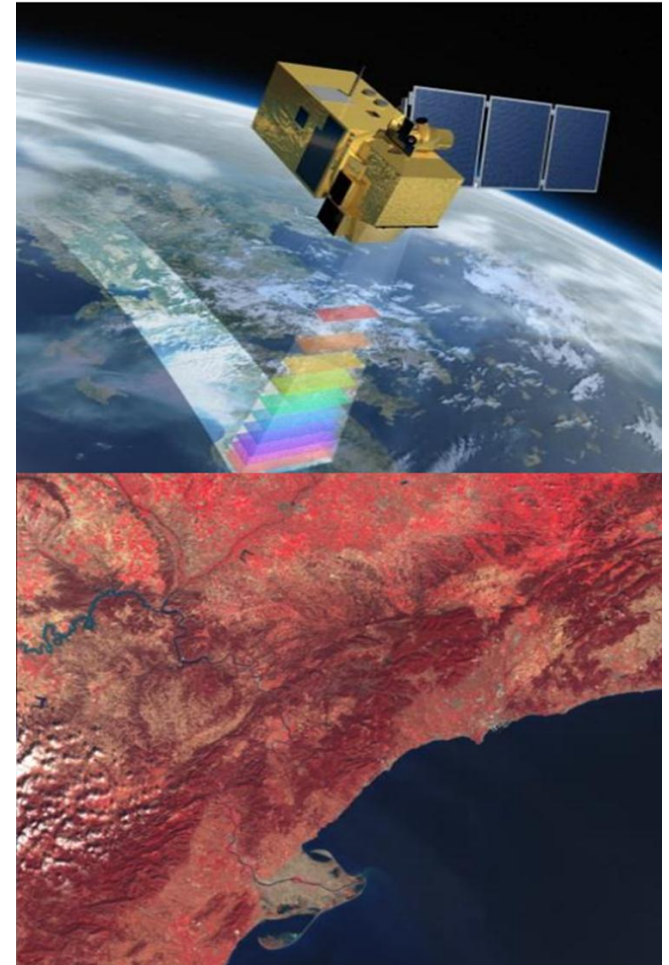
ACTUAL'



# EARTH OBSERVATION: BACKGROUND



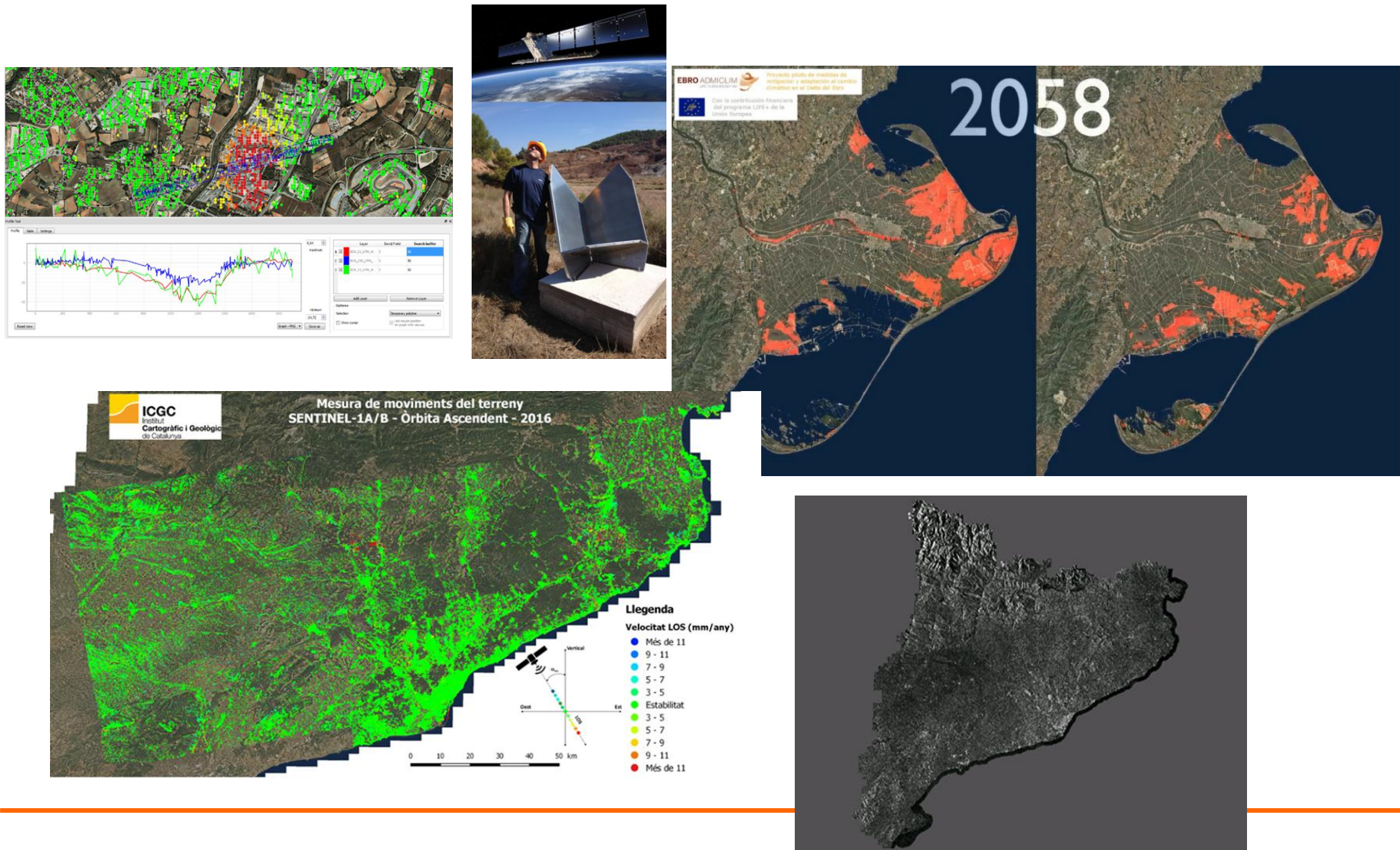
80' – 90'



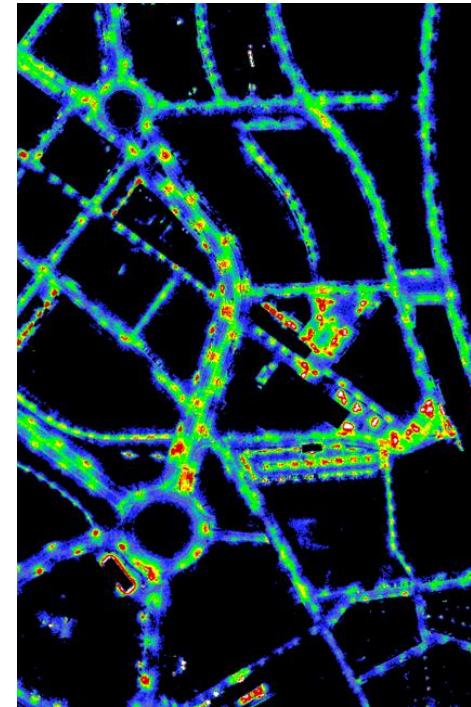
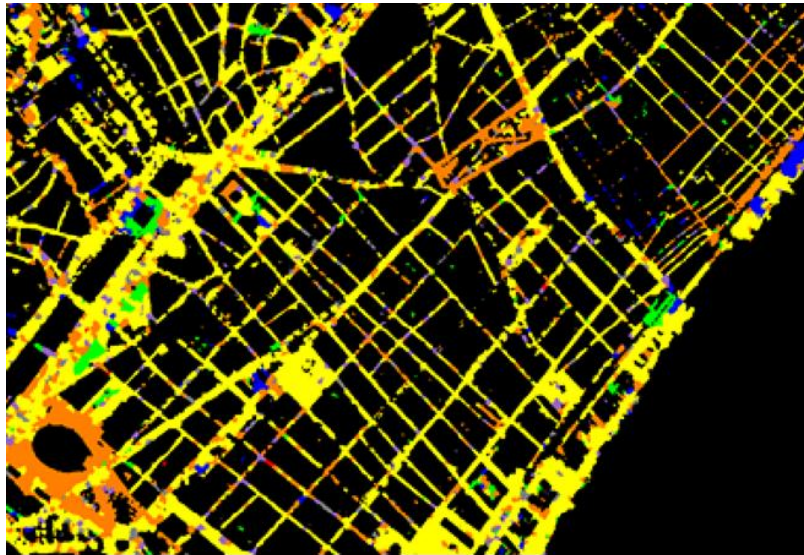
**ACTUAL'**

<https://earthengine.google.com/timelapse/#v=-62.6075,-60.41542,9.074,latLng&t=0.76>

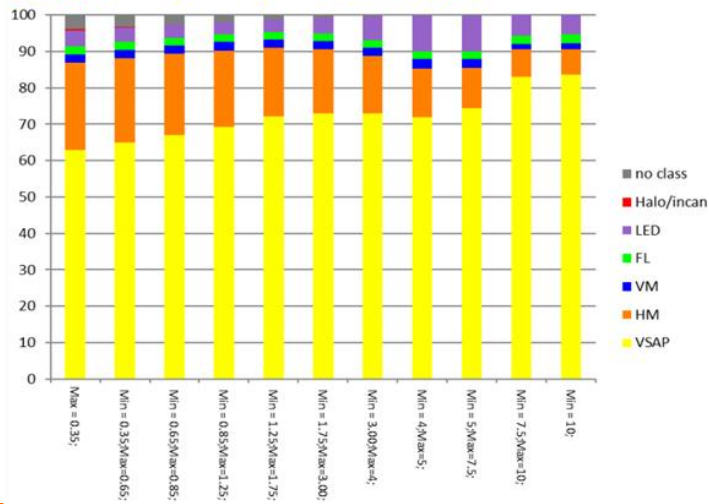
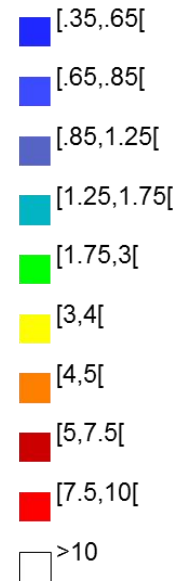
# EARTH OBSERVATION: PLATAFORM & USABILITY



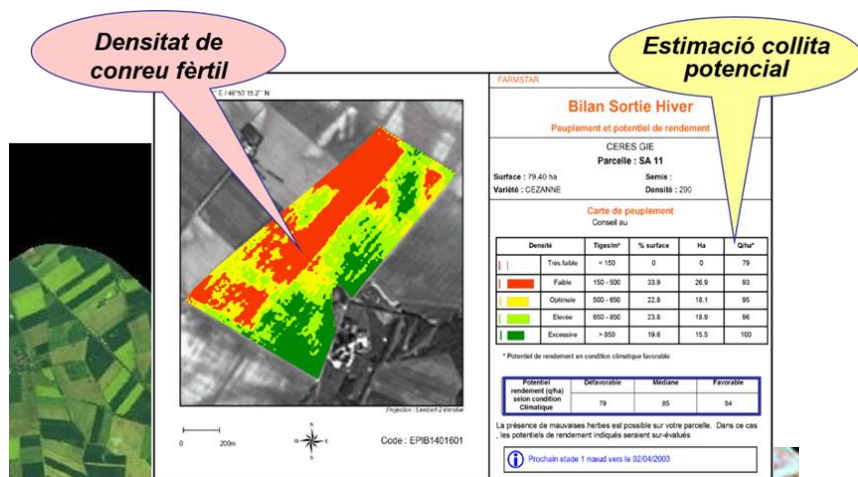
# EARTH OBSERVATION: PLATAFORM & USABILITY



## Classification



# EARTH OBSERVATION: PLATAFORM & USABILITY

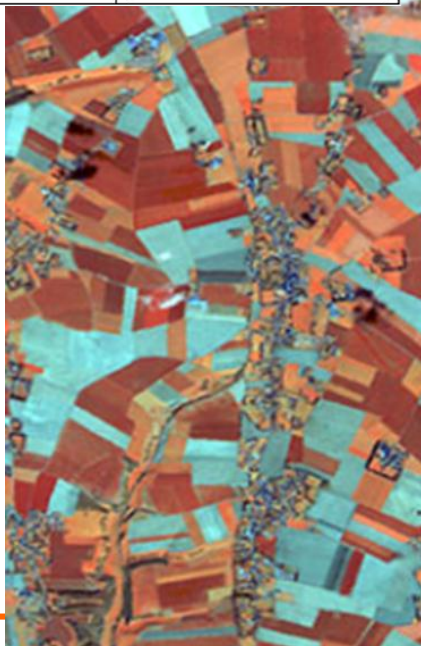


FUTUR AGRARI

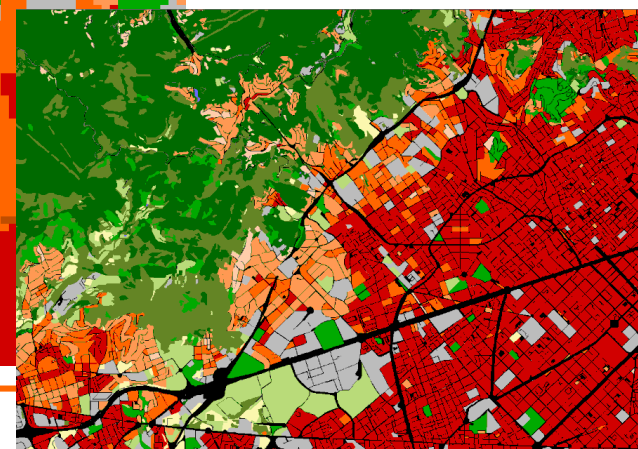
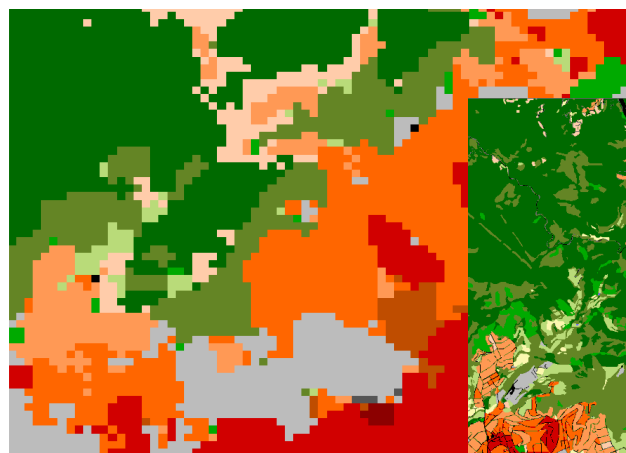
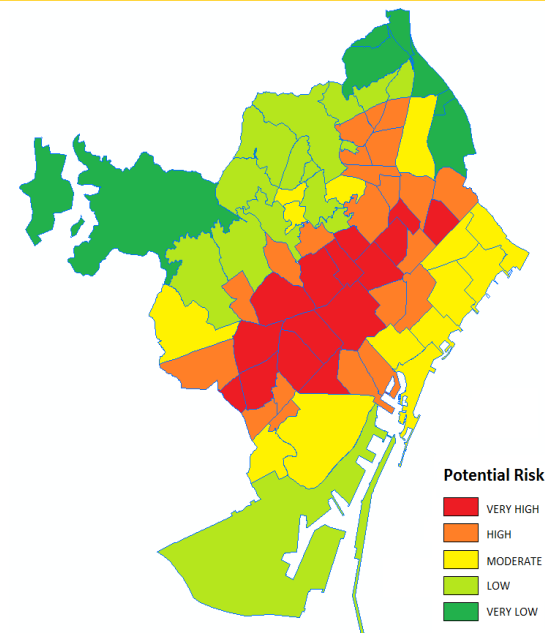
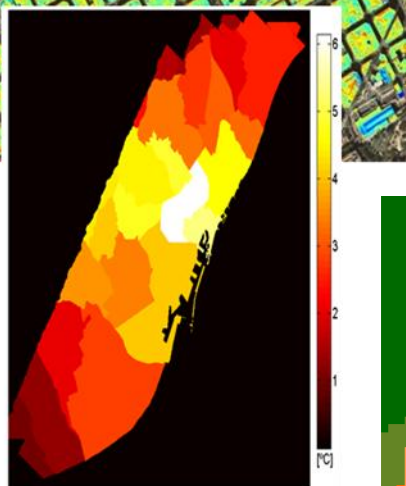
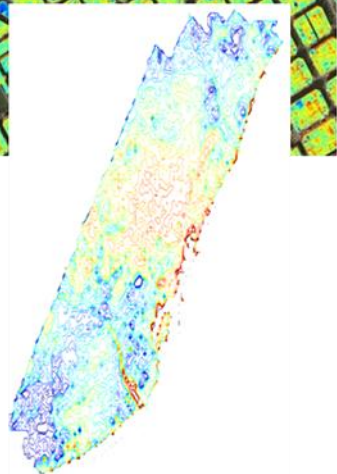
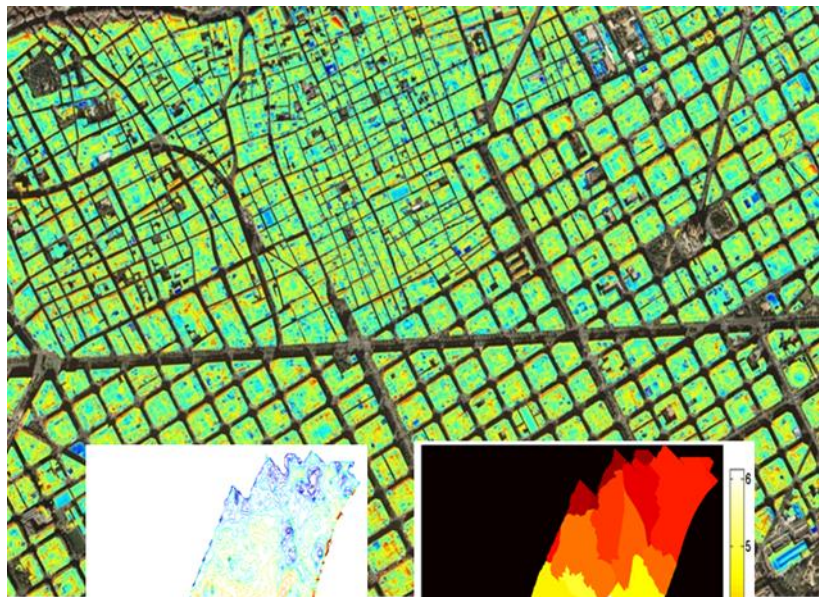


Coordination

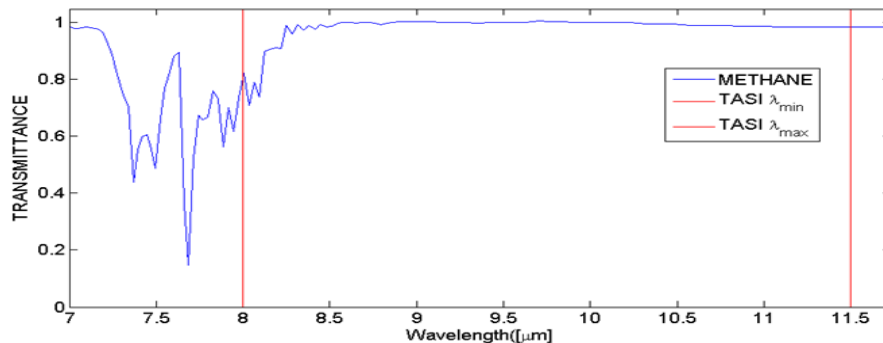
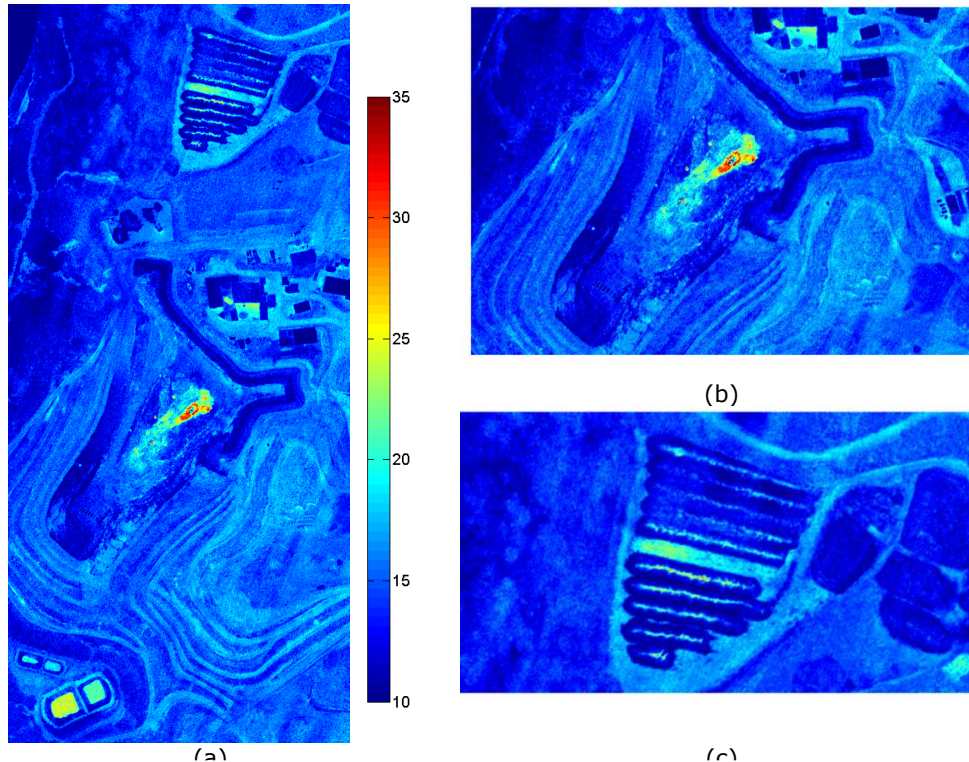
Generalitat de Catalunya  
Departament d'Agricultura, Ramaderia,  
Pesca, Alimentació i Medi Natural



# EARTH OBSERVATION: PLATAFORM & USABILITY



# EARTH OBSERVATION: PLATAFORM & USABILITY



| Overview                                       | Duo Pro R 640  | Duo Pro R 336    |
|--|--|------------------|
| Thermal Imager                                 | Uncooled VOx Microbolometer  |                  |
| Spectral Band                                  | 7.5 – 13.5 $\mu\text{m}$   |                  |
| Thermal Sensitivity                            | < 50 mK  |                  |
| Thermal Sensor Resolution Options              | 640 x 512  | 336 x 256        |
| Thermal Lens Options                           | 13 mm: 45° x 37°   | 9 mm: 35° x 27°  |
|  | 19 mm: 32° x 26°   | 13 mm: 25° x 19° |
|  | 25 mm: 25° x 20°   | 19 mm: 17° x 13° |
| Thermal Frame Rate                             | 30 Hz  |                  |
| Visible Sensor Resolution                      | 4000 x 3000  |                  |
| Visible Camera FOV's                           | 56° x 45°  | 56° x 45°        |
| <b>Radiometry</b>                              |  |                  |
| Measurement Accuracy                           | +/- 5 C or 5% of readings in the -25°C to +135°C range<br>+/- 20 C or 20% of readings in the -40°C to +550°C range |                  |
| <b>Physical Attributes</b>                     |  |                  |
| Size   | 85 x 81.3 x 68.5 mm<br>85 x 86.5 x 68.5 mm (640/25 mm lens only)   |                  |
| Weight   | 325 g<br>375 g (640-25 mm only)  | 325 g            |
| <b>Image Processing &amp; Display Controls</b> |  |                  |
| Imaging Modes                                  | IR-only, Vis-only, Picture-in-Picture (IR in Vis)  |                  |
| MSX Image Enhancement?                         | Yes  |                  |
| Multiple Color Palettes?                       | Yes – Adjustable in App and via PWM  |                  |
| <b>IMU Sensor</b>                              |  |                  |
| GPS?   | Yes (GPS, GLONASS)   |                  |
| Other Sensors                                  | Accelerometer, Gyroscope, Magnetometer, Barometer  |                  |
| <b>Interfaces</b>                              |  |                  |
| USB 3.0  | Power in, USB Mass Storage   |                  |
| 10-Pin Accessory Port                          | Power in, Analog Video Out, PWM, MAVLink   |                  |
| Micro-HDMI                                     | Digital Video Out  |                  |
| Input Voltage                                  | 5.5 - 26.0 VDC (10-pin JST Port)   |                  |
|  | 5.0 VDC (USB-C Port)   |                  |
| Power Dissipation (avg)                        | 10 W   | 10 W             |
| Remote Control?                                | Yes - PWM (3 channels), MAVLink  |                  |
| MAVLink interface?                             | Yes  |                  |
| Digital Video Output                           | 1080p60, 1080p30, 720p60   |                  |
| Mounting Features                              | 1/4"-20 TPI Tripod Mounts (qty 2, bottom surface)  |                  |
| <b>Environmental</b>                           |  |                  |
| Operating Temperature Range                    | -20°C to +50°C   |                  |
| Storage Temperature Range                      | -20°C to +60°C   |                  |
| Operational Altitude                           | +38,000 feet   |                  |

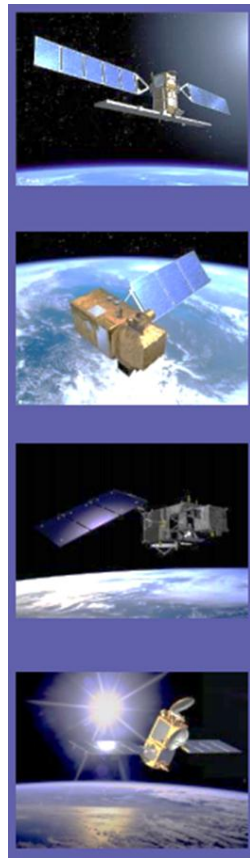


# EARTH OBSERVATION: COPERNICUS PROGRAM

**FULL, FREE AND OPEN ACCESS TO DATA**

- ATMOSPHERE MONITORING
- MARINE ENVIRONMENT MONITORING
- LAND MONITORING
- CLIMATE CHANGE
- EMERGENCY MANAGEMENT
- SECURITY

**opernicus**  
Europe's eyes on Earth

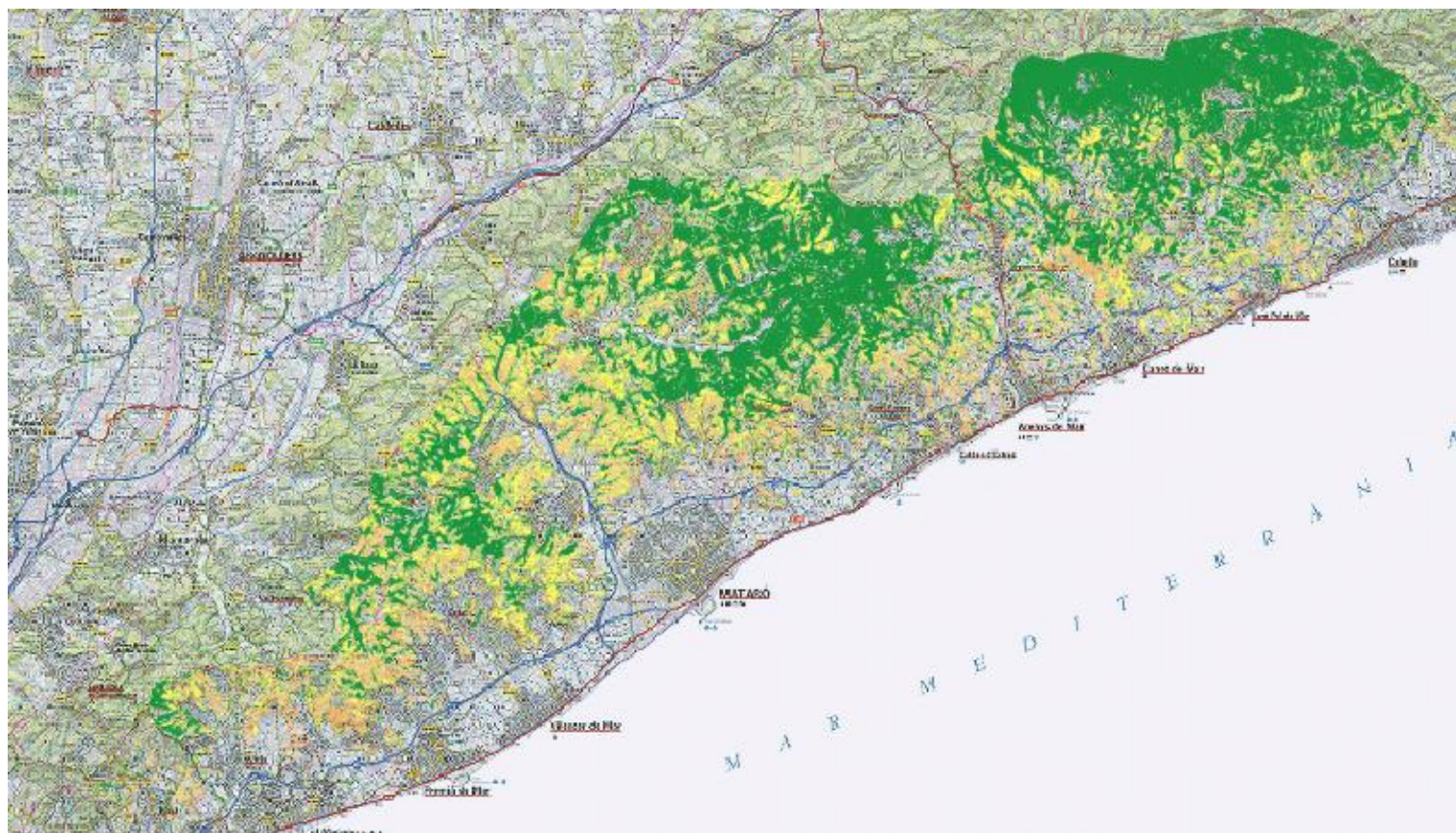


# EARTH OBSERVATION: COPERNICUS PROGRAM

Sentinel-2 02/08/2015

Sentinel-2 26/08/2016

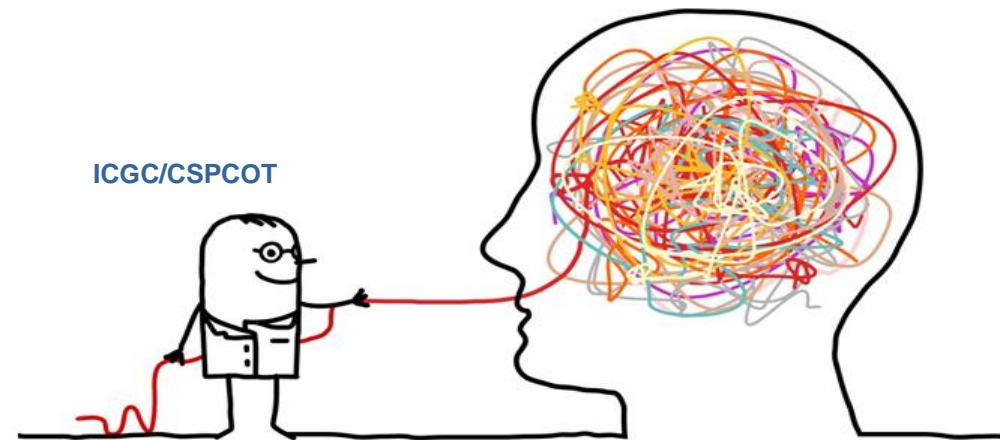
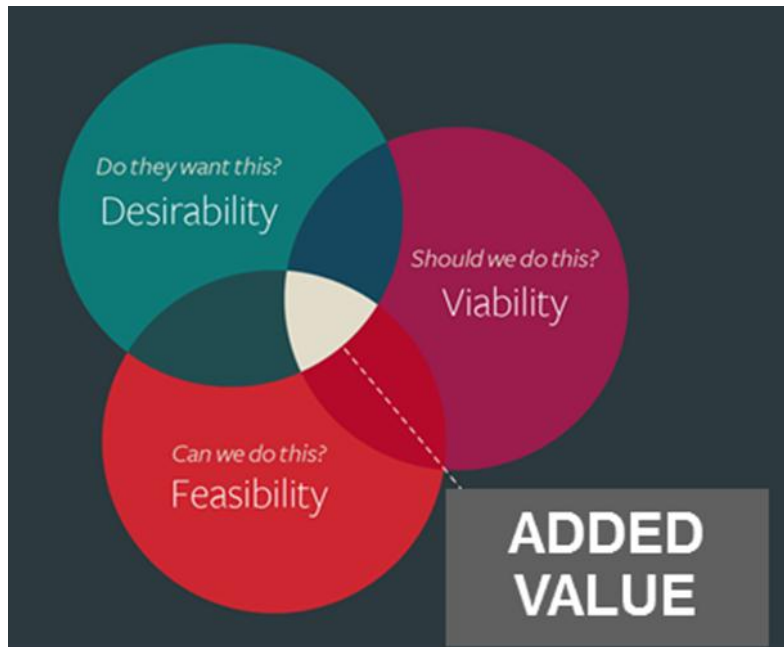
Mapa de decaïment 2015-2016



<https://www.diba.cat/web/incendis/altres-publicacions>

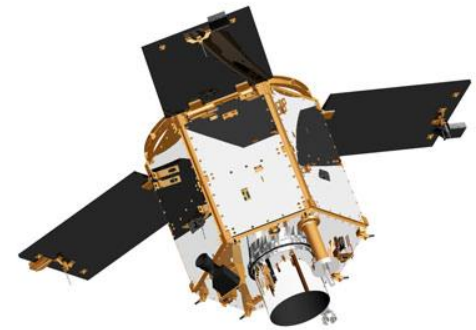
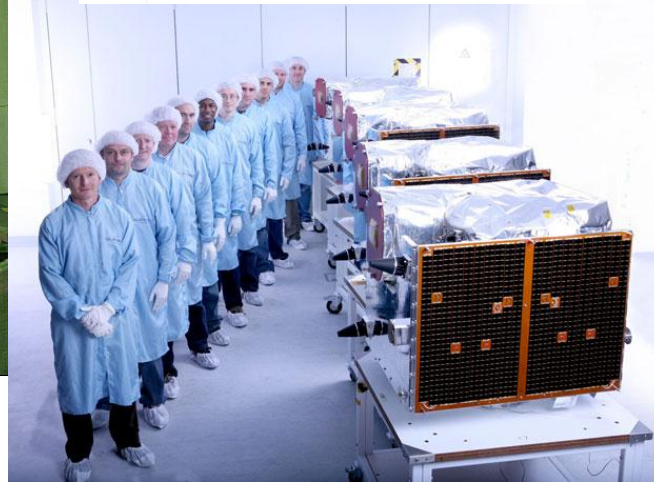
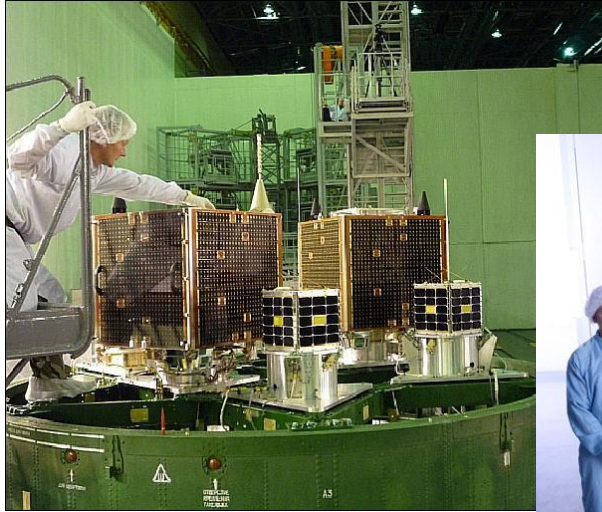
## WRAP UP

SCIENCE + TECHNOLOGY + REAL PROBLEMS TO BE SOLVED = ADDED VALUE



*“Imagination is the only weapon in the war against reality” – Lewis Carroll - Alice in Wonderland*

# SMALL SATELLITES: BACKGROUND



## SMALL SATELLITES: BACKGROUND

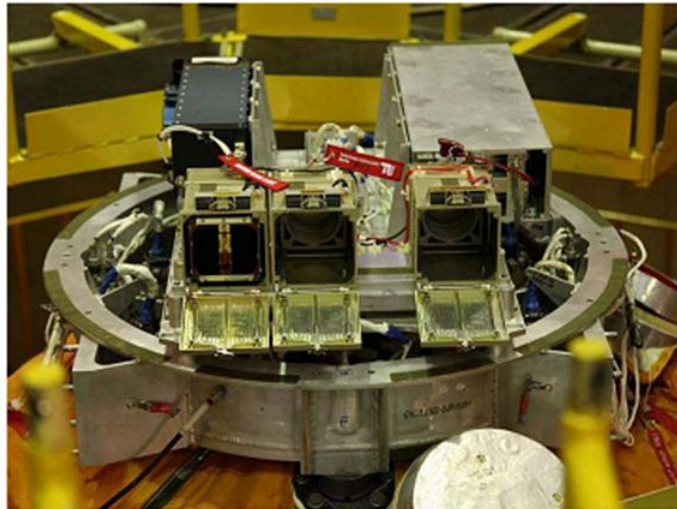
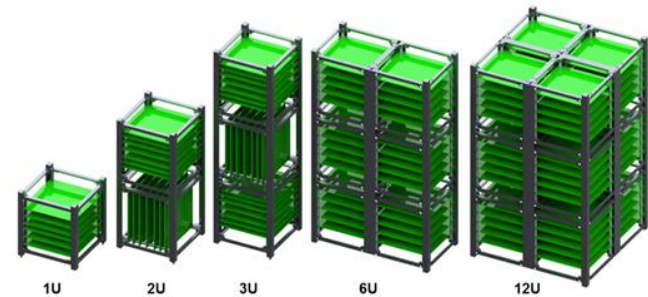


Table 1 Classification satellites by weight, power and cost

| Satellite class | Weight (dry), kg | Solar power, kW | Cost, mln. USD (about average) |
|-----------------|------------------|-----------------|--------------------------------|
| Pico            | <1               | < 0.05          | <0,4                           |
| Nano            | 1...10           | < 0.50          | 0,4...2                        |
| Micro           | 10...100         | < 1             | 4...8                          |
| Mini            | 100...500        | 1...2-          | 15...40                        |
| Small           | 500...1000       | 2...4           | 55...100                       |
| Medium          | 1000-2000        | 4...10          | 100...150                      |
| Large           | >2000            | >10             | >150                           |



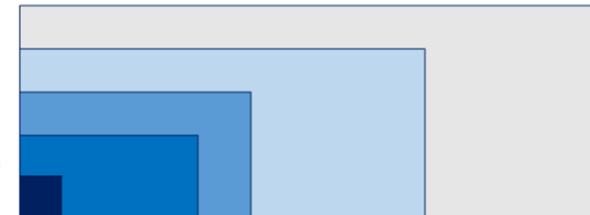
< 100 kg Microsat

< 50 kg Small Microsat

<24 kg Large Nanosat (12U CubeSat)

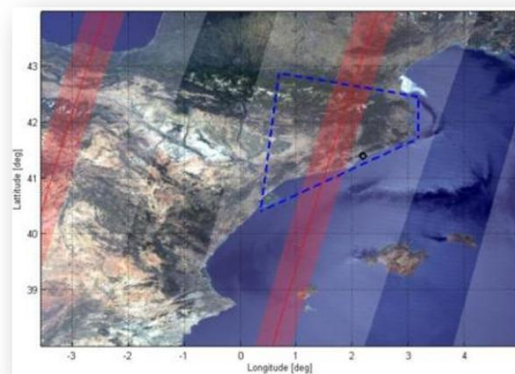
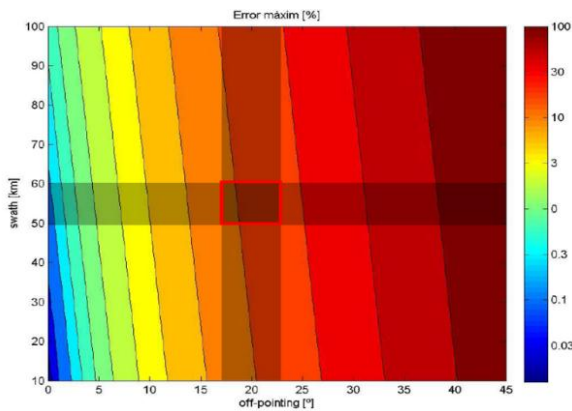
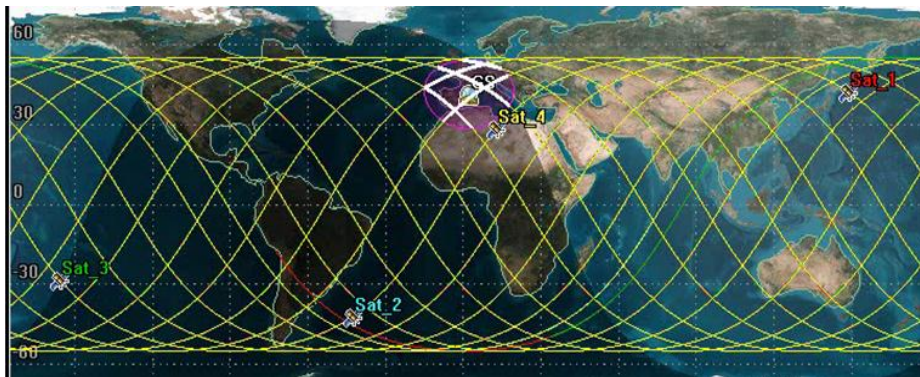
<10 kg Nanosat (6U CubeSat)

<1 kg Picosat (1U CubeSat)



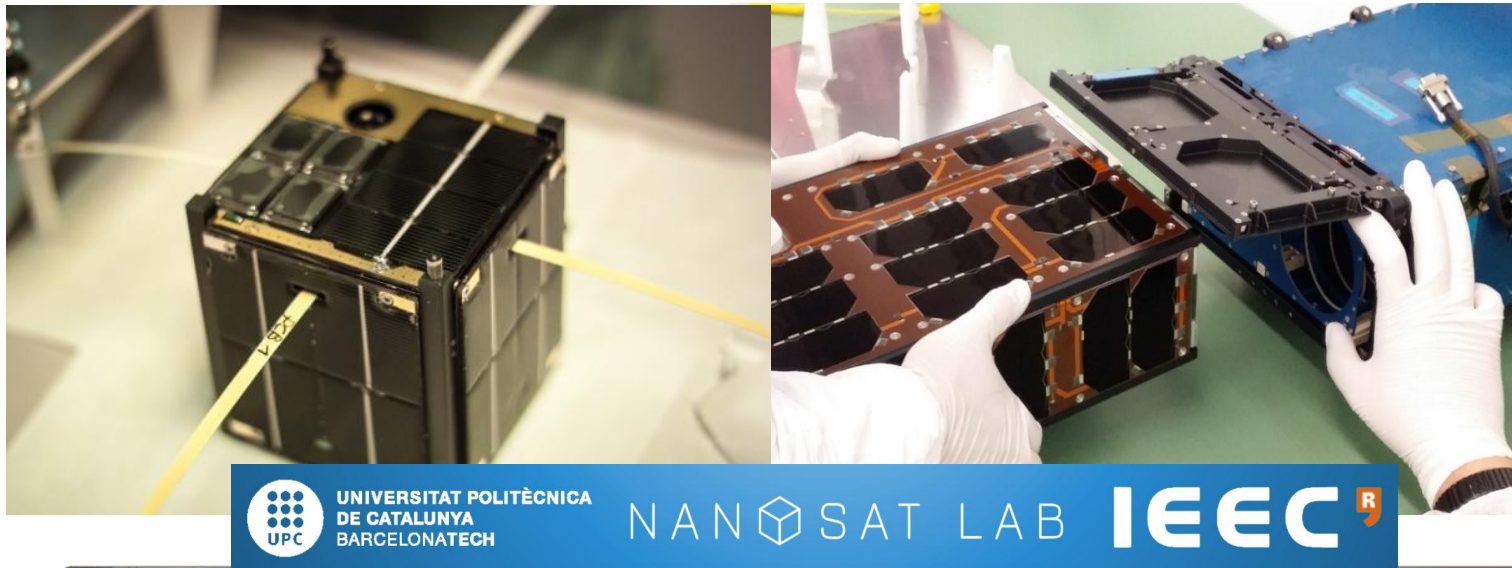
No és una qüestió tant sols de tamany ....

# SMALL SATELLITES: BACKGROUND



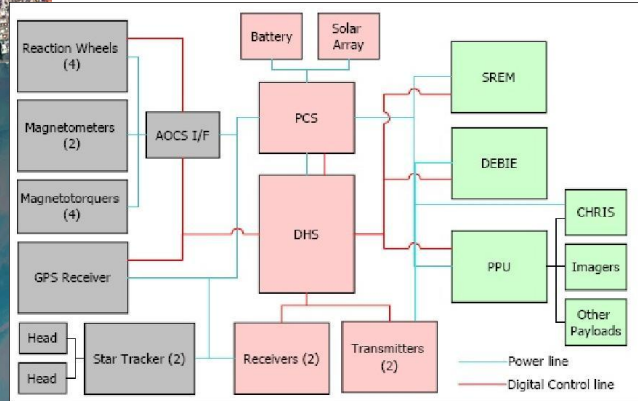
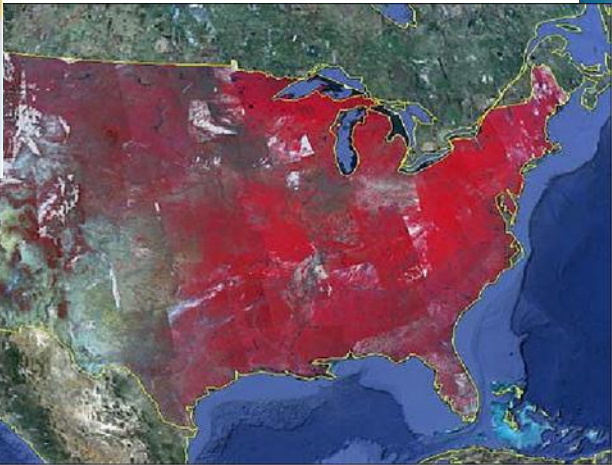
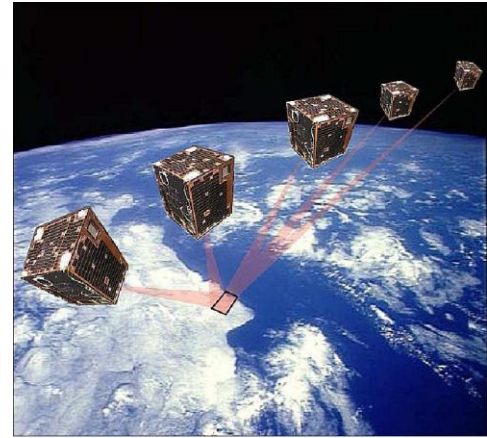
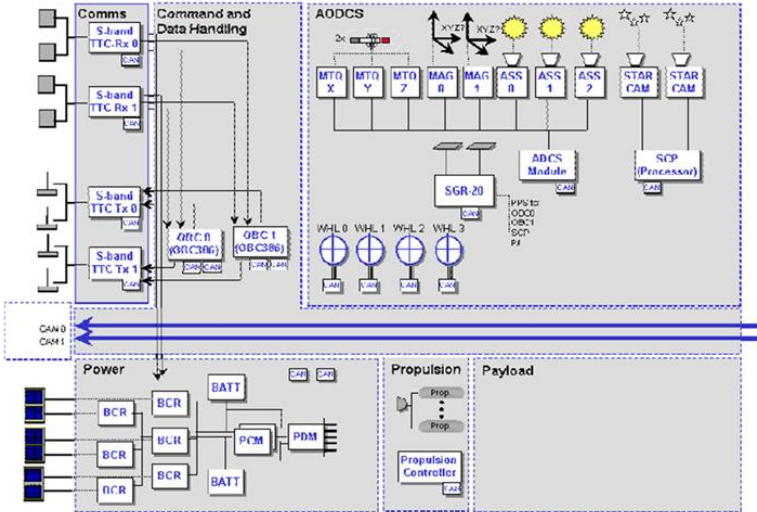
S'optimitza la capacitat de risc & innovació a l'espai per generar utilitat

## SMALL SATELLITES: BACKGROUND



S'optimitza la capacitat de risc & innovació a l'espai per traccionar coneixement

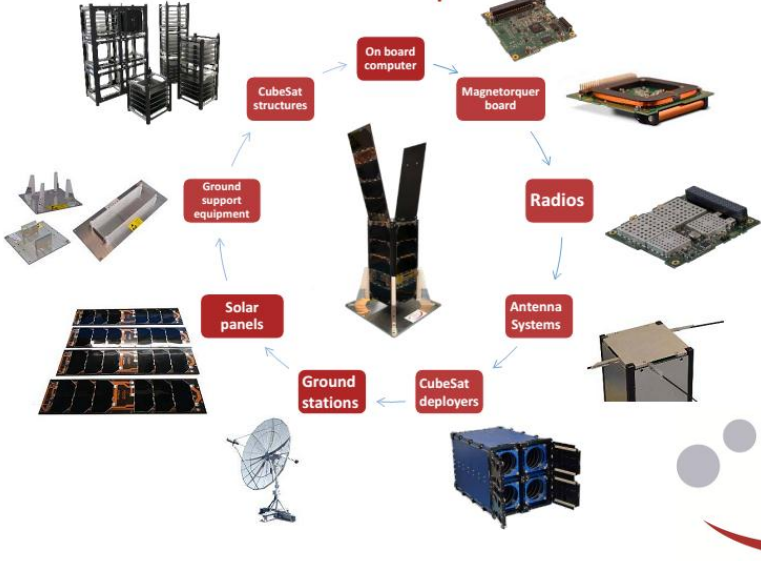
# SMALL SATELLITES: ARCHITECTURE





# SMALL SATELLITES: ARCHITECTURE

## Off-the-shelf standardized products



### CubeSatShop

PRODUCTS

One-stop webshop

- Antenna systems >
- Attitude actuators >
- Attitude sensors >
- Cameras & payloads >
- Command & data handling >
- Communication systems >
- CubeSat kits & buses >

Standardized products

### 12U Platform

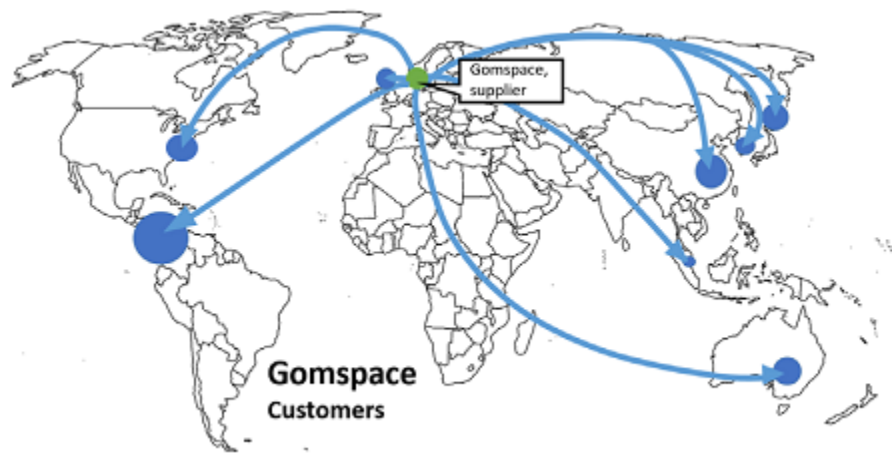
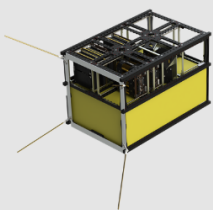
The illustration to the right is of a 12U configuration. Its design is based on the following selections:

- 12U Core Platform Package
- Fine ACS & ADS
- GPS
- S-band communication
- Deployable panel (not shown)

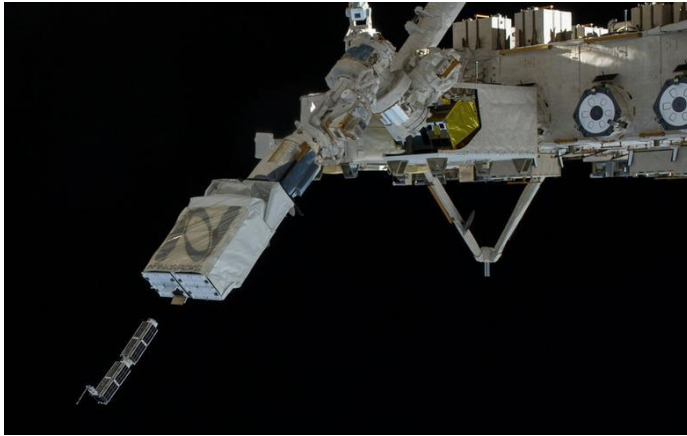
A 12U platform with this or a similar configuration can support many operational missions with demanding requirements e.g. Intensive communication or remote sensing types of missions.

The satellite provides the following key resources to these payloads:

- Payload volume: 8U+
- Average available power for payloads: 6W (no deployable panels), 18W (1 dep. panel) & 30W (2 dep. panels)
- Pointing performance: 1-2 degrees
- Downlink per day: 2 GB (1 ground station, SSO orbit)



# SMALL SATELLITES: WINDOW OF OPPORTUNITY



**28 CUBESATS FROM THE INTERNATIONAL SPACE STATION**

**QB50-ISS**

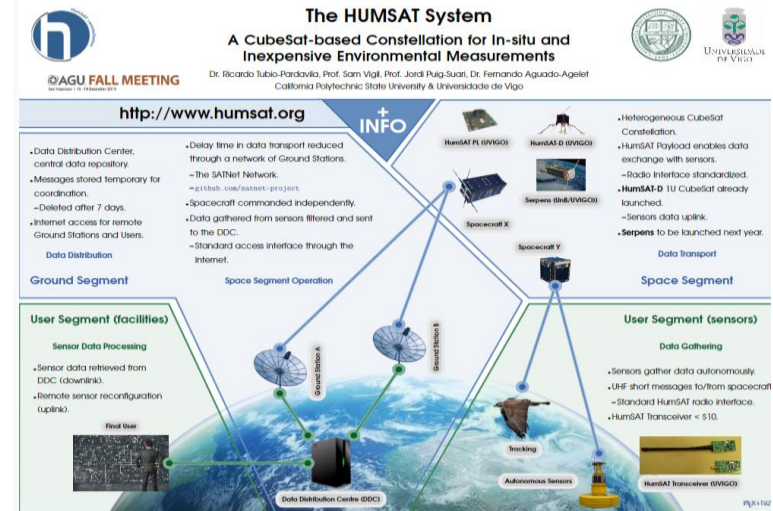
- 28 CubeSats
- Altitude 415km
- Inclination 51.6deg
- Launch on 16<sup>th</sup> March 2017
- Atlas-V Rocket from Cape Canaveral (USA)

**8 CUBESATS ON THE PSLV INDIAN ROCKET**

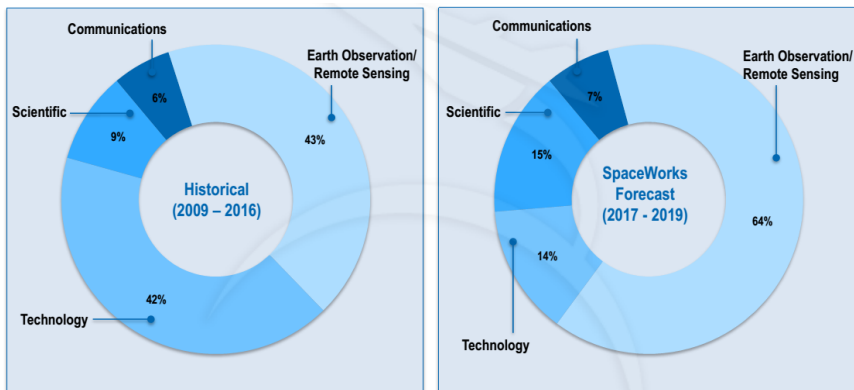
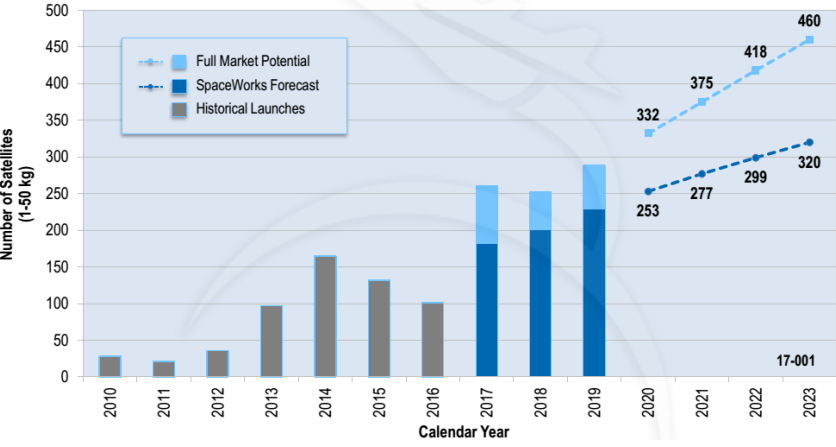
**QB50-PL**

- 8 CubeSats
- Altitude 500km
- Sun Synchronous Orbit 97.1deg
- Part of the Science Campaign
- Launch on 21<sup>st</sup> April 2017
- PSLV Rocket from Satish Dhawan Space Centre

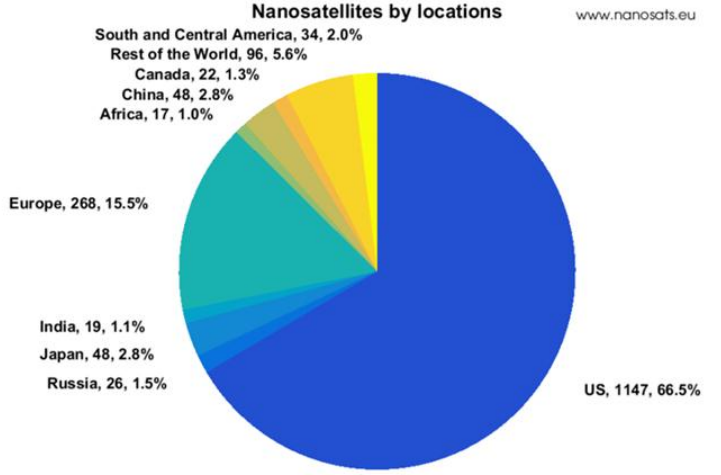
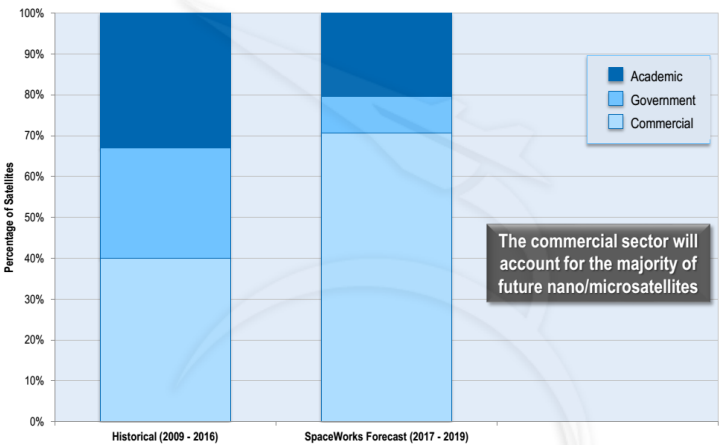
- **Xatcobeo (Dieste)**
  - University of Vigo, 1U, 2012-02-13, Vega, Space Technology, System Design & Verification. Deployment of a standard based 1U CubeSAT in the space, together with a ground segment. Two payloads: a software defined reconfigurable radio (SRAD) and a system for measuring the amount of ionizing radiation (RDS). There is also an experimental solar panel deployment system (PDM). Reentry 2013-08-31.
- **HumSat-D**
  - University of Vigo, 1U, 2013-11-21, Dnepr, Space Technology, Satellite-based system for connecting a set of users with a network of worldwide distributed sensors which they have previously deployed. Educational objectives.
- **OPTOS (Optical Nanosatellite)**
  - National Institute of Aerospace Technology, 3U, 2013-11-21, Dnepr, Space Science, System Design & Verification, Demonstrate new technologies. Distributed OBDH (On-Board Data Handling).
- **3CAT2**
  - Univ.Politécnica de Catalunya & IEEC, 6U, 2016-08-15, Long March 2D, Space Activity, Perform ocean altimetry by means of Global Navigation Satellite Systems Reflectometry (GNSS-R).
- **Qbit0**
  - Polytechnics University of Madrid, 2U, 2017-04-18, Atlas V, QB50, ISS, Space Science. The main objective is to operate its primary payload: the Ion and Neutral Mass Spectrometer (INMS).



# SMALL SATELLITES: WINDOW OF OPPORTUNITY



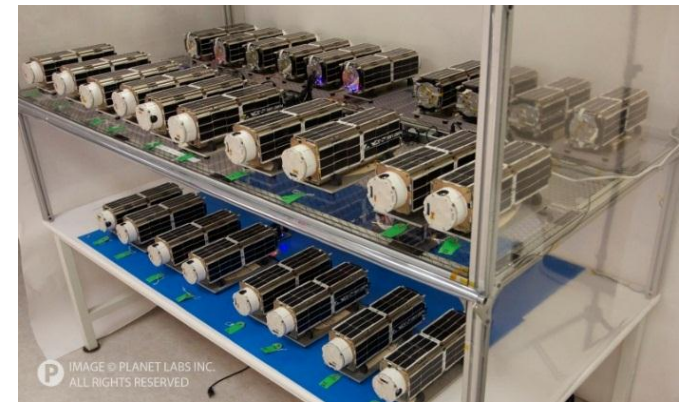
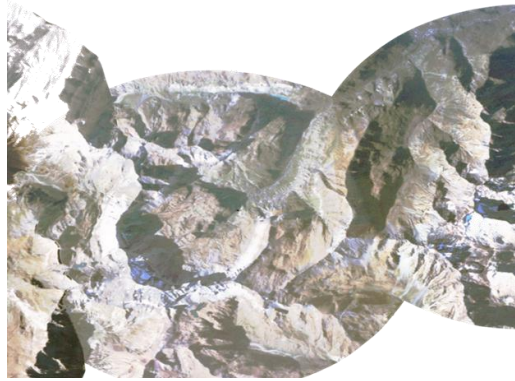
## Nano/Microsatellite Trends by Sector (1 - 50 kg)



La nova economia de l'espai, del technology push al market pull ...

## SMALL SATELLITES: WINDOW OF OPPORTUNITY

Planet Labs Inc. és una companyia privada amb base a San Francisco, CA (EUA). Aquesta companyia dissenya i fabrica satèl·lits de 3-U (d'aproximadament 5 Kg de pes). El Juliol del 2015 Planet Labs va adquirir BlackBridge. Per tant, ha incorporat l'arxiu i els satèl·lits operacionals de *RapidEye*. Els *Doves* porten una càmera RGB matricial (a 2017 + NIR), basada en una CCD comercial que proporciona un GSD entre 3 i 5 metres.




### PLANET'S CONSTELLATION

|                              |   |  |
|------------------------------|---|--|
| <b>5</b> RapidEye Satellites | <b>140+</b> Dove Satellites<br>Build 13 PlanetScope | <b>7</b> SkySat Satellites               |
|                              |   | <b>6</b> More to be launched in 2017     |
|                              |   | <b>21</b> In Final Planned Constellation |

## SMALL SATELLITES: WINDOW OF OPPORTUNITY



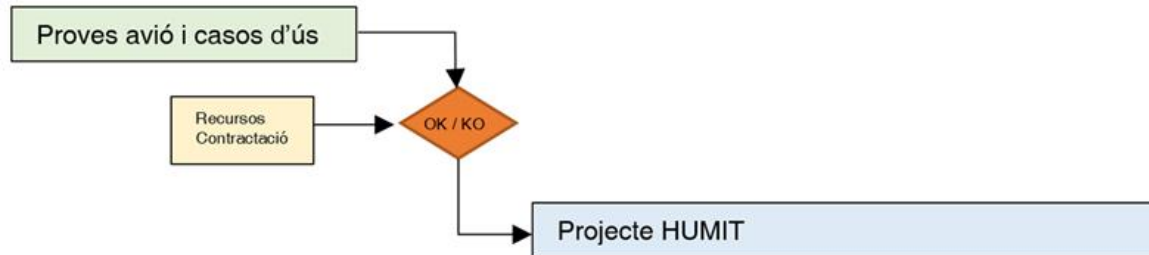
**ICEYE (Finland)** plans to later launch a constellation of 18 satellites in order to provide revisit times of several hours. Spacenews August-2017



| ALEPH 1 - PAYLOADS                          | Panchromatic                            | Multispectral   | Hyperspectral  | Thermal Infrared             |
|---|---|---|--|------------------------------|
| Ground Sampling Distance                    | 1m                                      | 1m  | 30m  | 90m                          |
| Swath                                       | 5km                                     | 5km   | 150km  | 92km                         |
| Spectral Bands                              | 400-900nm                               | 400-690nm<br>400-510nm<br>510-580nm<br>580-690nm<br>750-900nm | 400-900nm<br>up to 600<br>spectral bands<br>5nm FWHM | 8µm-14µm<br>0.01K resolution |
| Modulation Transfer Function at the Nyquist | > 15.00%                                |   |  |                              |
| Dynamic Range                               | 54dB raw / 66dB HDR                     |   |  |                              |
| Signal-to-Noise Ratio                       | 43dB                                    |   |  |                              |
| Boresight                                   | 25 deg                                  |   |  |                              |
| High Definition Video                       | 720p, 1080p, 4K, in every spectral band |   |  |                              |

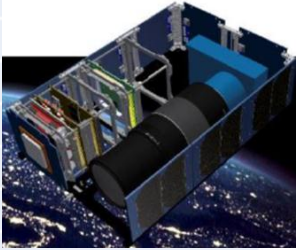
**SATELLOGIC (Argentina-Uruguay-USA-Israel-Barcelona)**

# SMALL SATELLITES: HUMIT MISSION STATEMENT



# Humit

## CATALONIA: CHALLENGE APPROACH

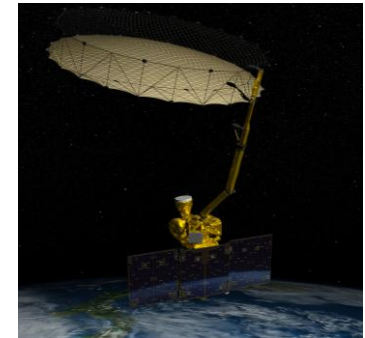
|                        |                    | PETIT SATÈL.LIT<br>HUMIT   |
|------------------------|--------------------|--|
|                        | Aeroportada        |  |
| <u>in – situ/terra</u> |                    |  |
| Molt alta resolució    | Alta Resolució (m) | Mitja resolució (Dm)   |
| <b>CONCA TREMP</b>     | <b>TRANSECTES</b>  | <b>TERRITORIS</b>  |

TERRITORIAL CHALLENGE:  
land cover change  
and soil moisture



INTERNACIONAL  
APPROACH

SMAP, COPERNICUS, SMOS...



# SMALL SATELLITES: HUMIT MISSION STATEMENT



## EXEMPLE OPCIÓ A (1detector):

$GSD = 200 \text{ m} / f = 9.6 \text{ mm} / \text{SWATH} = 280 \text{ Km}$

RGB ó

Narrow Bands (CWL):

680 nm (NDVI Red)

700 nm (Red Edge)

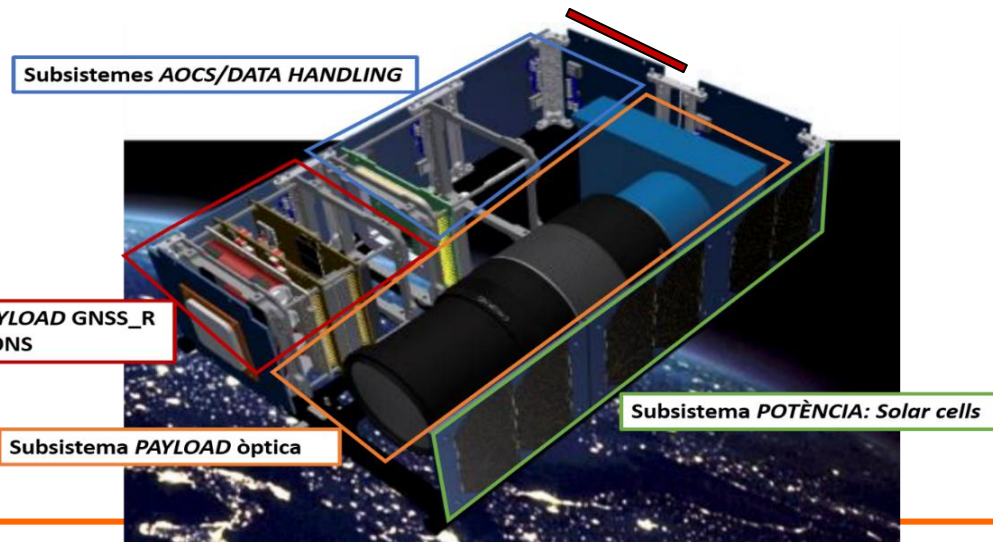
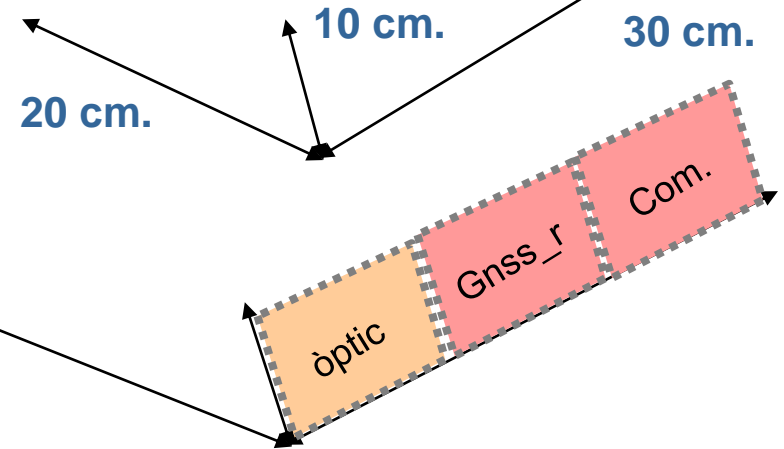
800 nm (NDVI NIR) (each 20 nm wide)

## OPCIÓ B (2 detectors):

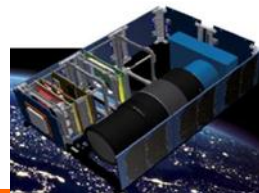
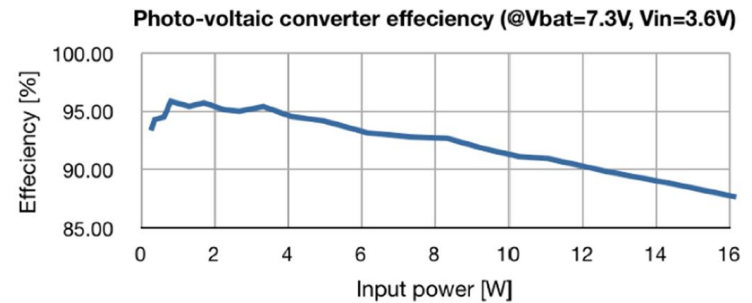
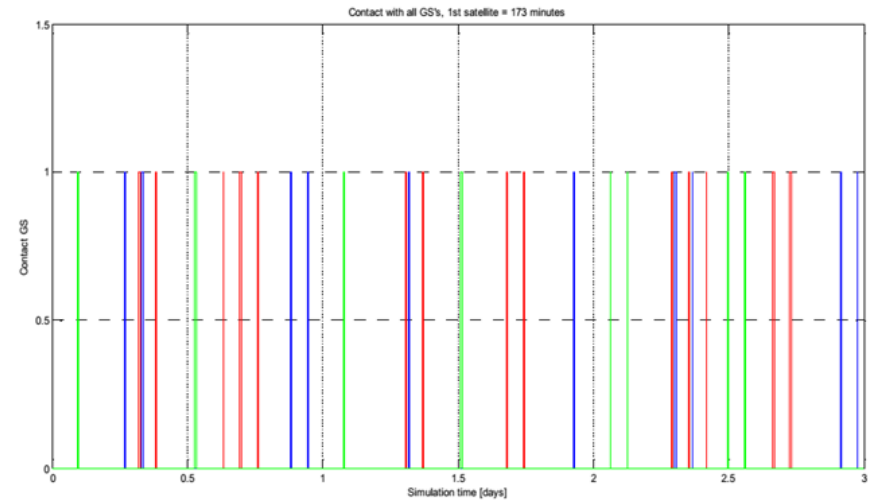
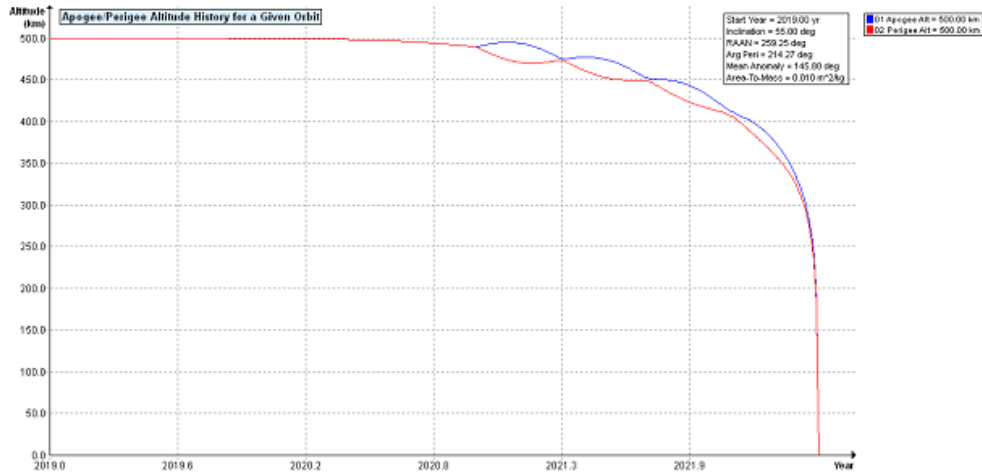
$GSD < 30 \text{ m} / f = 70 \text{ mm} / \text{SWATH} = 60 \text{ Km}$

RGB (400-700nm) + NIR (750-900)

Pes aprox.: 10-12 kg

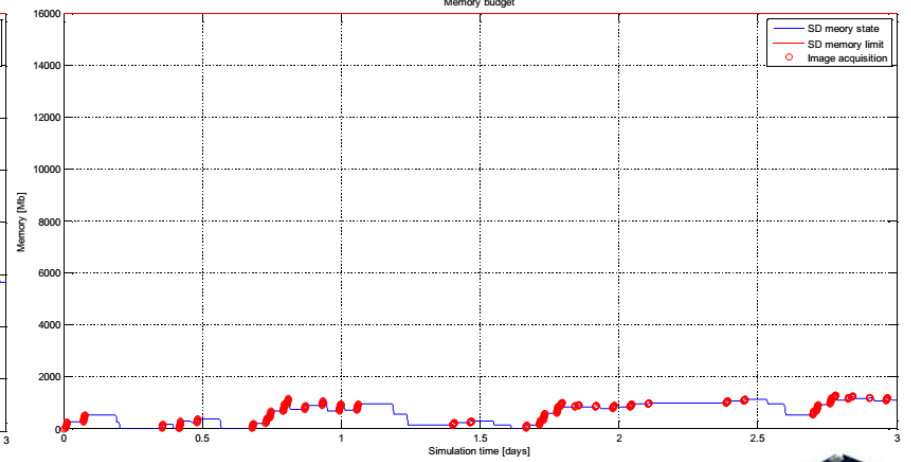
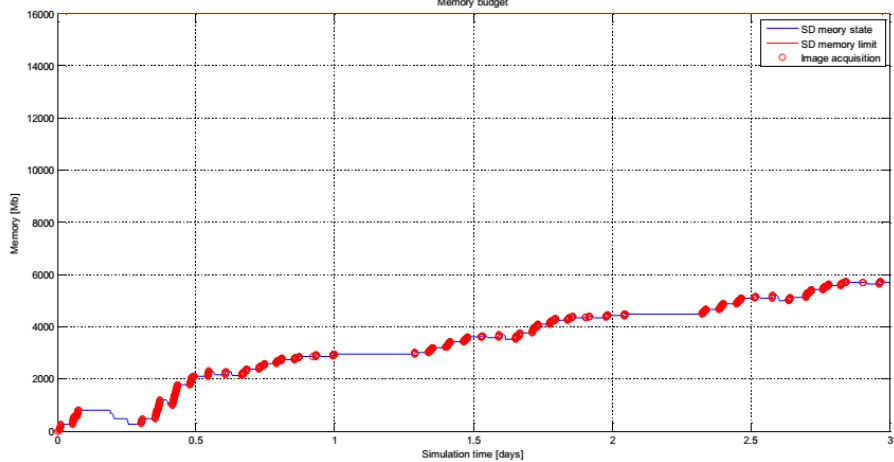
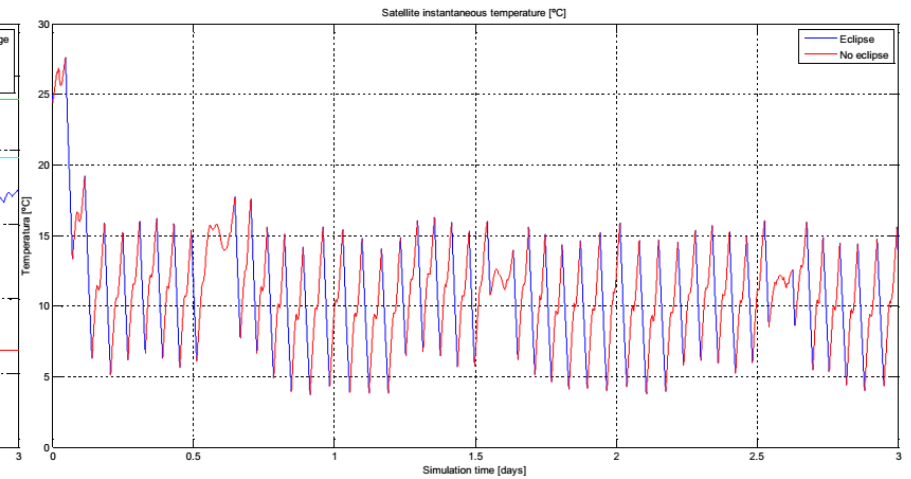
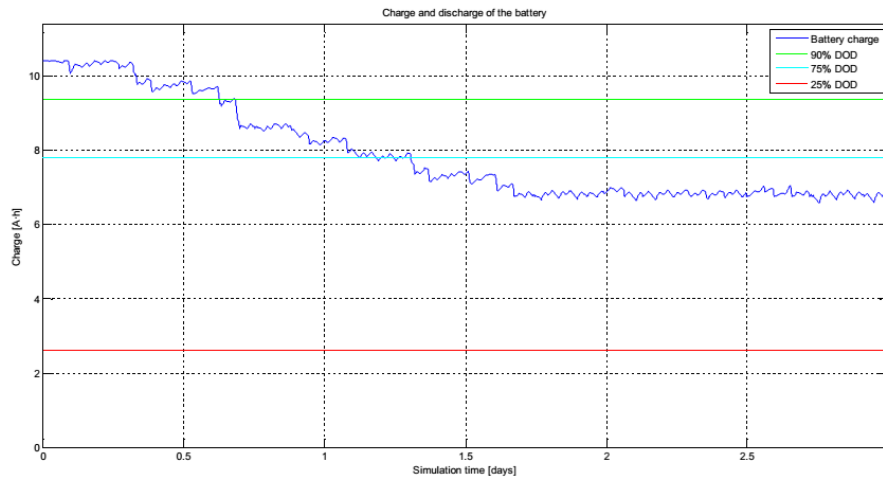


# SMALL SATELLITES: HUMIT MISSION STATEMENT

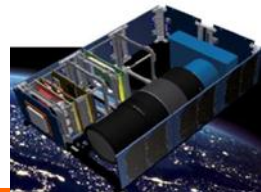




# SMALL SATELLITES: HUMIT MISSION STATEMENT

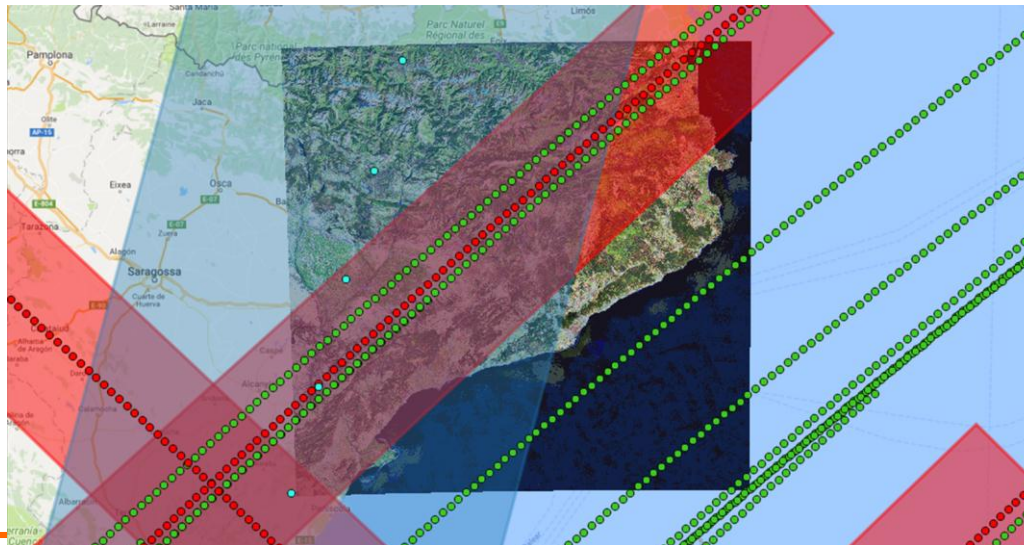


<https://www.instamaps.cat/geocatweb/mapa.html?businessid=ba5e3a685606b89883f13cf54e0d2b8c#no-back-button>



# SMALL SATELLITES: HUMIT MISSION STATEMENT

| DURADA DE LA SIMULACIÓ [dies] | ESTIMACIONS PERCENTATGES COBERTURA TERRITORI: CATALUNYA (32108 Km <sup>2</sup> )<br>[%] / RESOLUCIÓ = 300 m -SENSOR GNSS_R |       |                      |       | DURADA DE LA SIMULACIÓ [dies] | ESTIMACIONS PERCENTATGES COBERTURA TERRITORI: CATALUNYA (32108 Km <sup>2</sup> )<br>[%] / RESOLUCIÓ = 30 m - SENSOR ÒPTIC |                      |
|-------------------------------|--|-------|----------------------|-------|-------------------------------|---|----------------------|
|                               | INCLINACIÓ 55°   |       | INCLINACIÓ 98° (SSO) |       |                               | INCLINACIÓ 55°  | INCLINACIÓ 98° (SSO) |
|                               | MIN  | MAX   | MIN                  | MAX   |                               |   |                      |
| 1                             | 1,95   | 1,95  | 0,16                 | 1,14  | 1                             | 14,77   | 8,47                 |
| 5                             | 1,95   | 1,95  | 0,43                 | 2,29  | 5                             | 14,77   | 16,95                |
| 10                            | 2,31   | 4,71  | 0,83                 | 2,86  | 10                            | 35,76   | 21,18                |
| 15                            | 2,68   | 7,81  | 1,18                 | 4,95  | 15                            | 59,24   | 36,69                |
| 20                            | 3,54   | 10,63 | 1,79                 | 6,67  | 20                            | 80,68   | 49,40                |
| 25                            | 3,54   | 13,28 | 2,08                 | 8,19  | 25                            | 100,79  | 60,66                |
| 30                            | 4,76   | 16,21 | 2,45                 | 10,3  | 30                            | 123,02  | 76,25                |
| 60                            | 7,13   | 30,28 | 5,03                 | 19,83 | 60                            | 229,77  | 146,83               |
| 90                            | 9,49   | 45,72 | 7,54                 | 28,78 | 90                            | 346,92  | 213,17               |
| 120                           | 11,87  | 59,97 | 10,05                | 38,51 | 120                           | 455,08  | 285,18               |
| 150                           | 14,24  | 75,21 | 12,56                | 48,05 | 150                           | 570,72  | 355,84               |



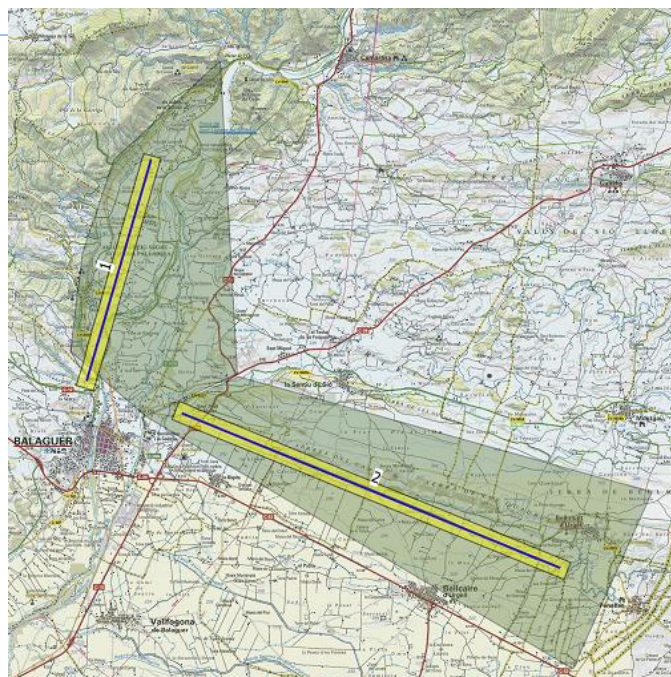
# SMALL SATELLITES: HUMIT MISSION STATEMENT

*Detecció pèrdues infraestructures d'aigua*

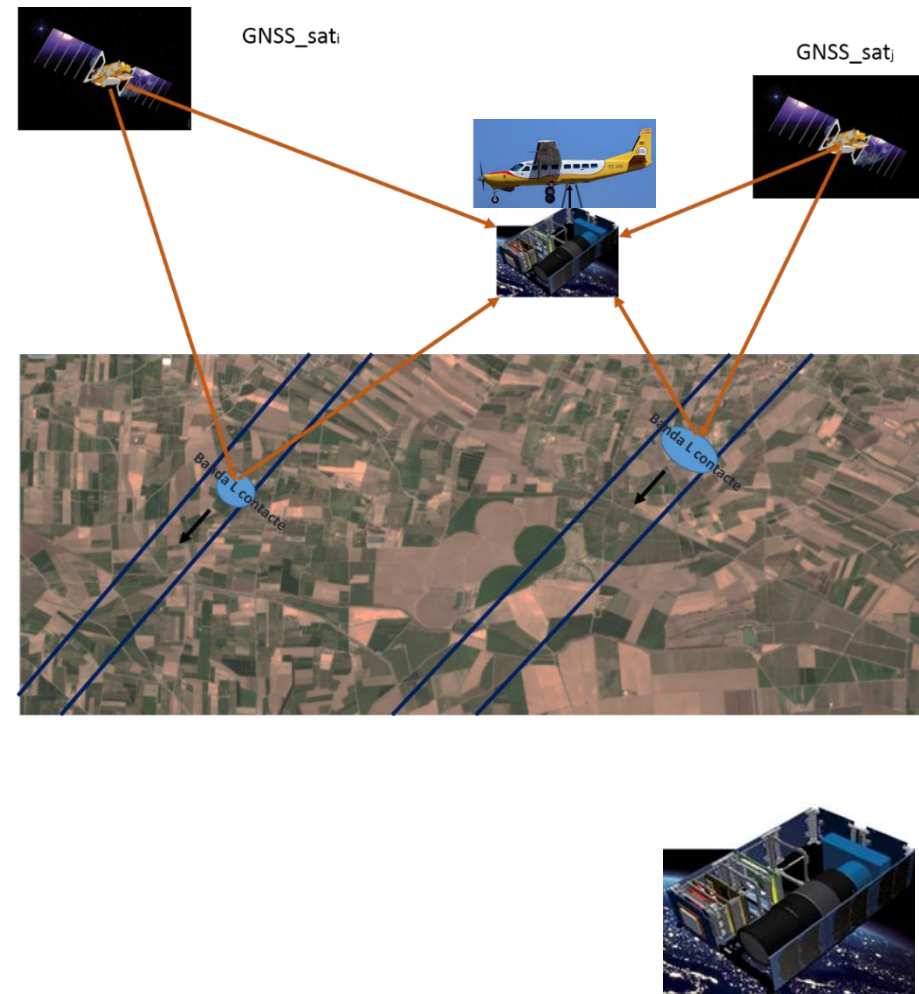
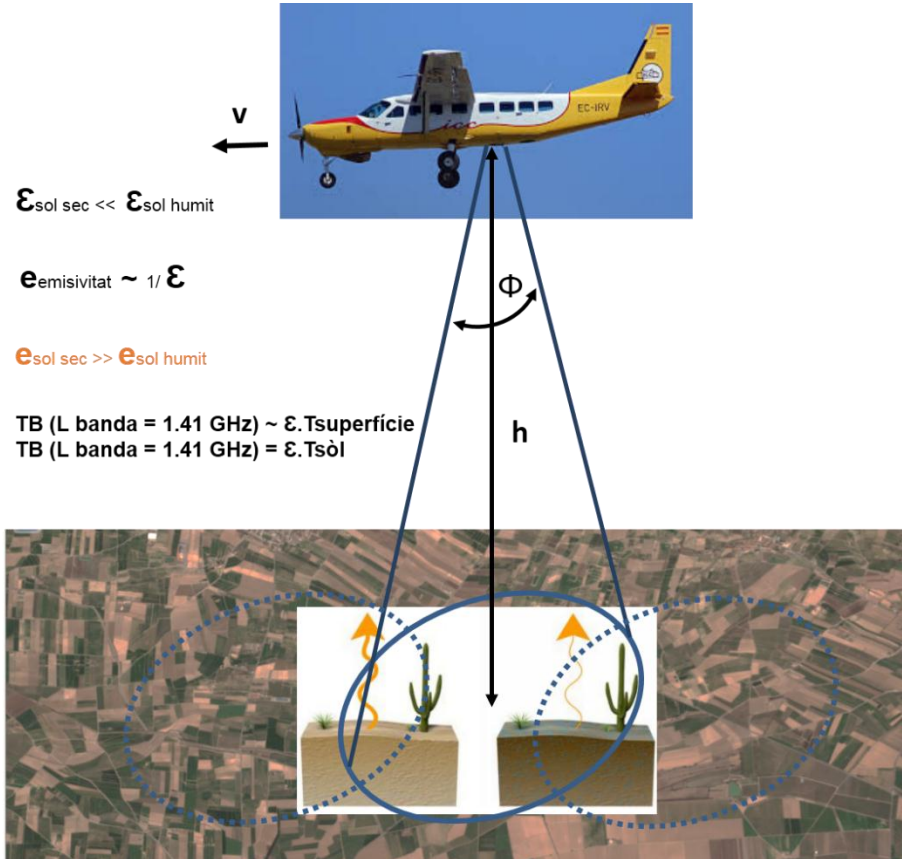
*Identificació/monitorització de l'ús del recurs hídric*

*Recuperació humitat: agricultura precisió*

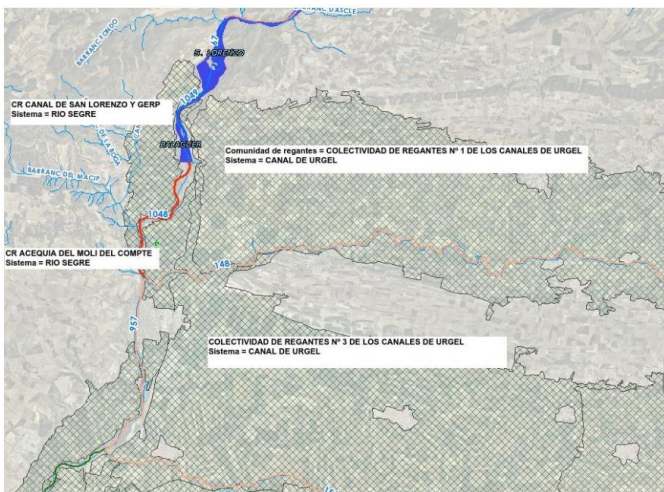
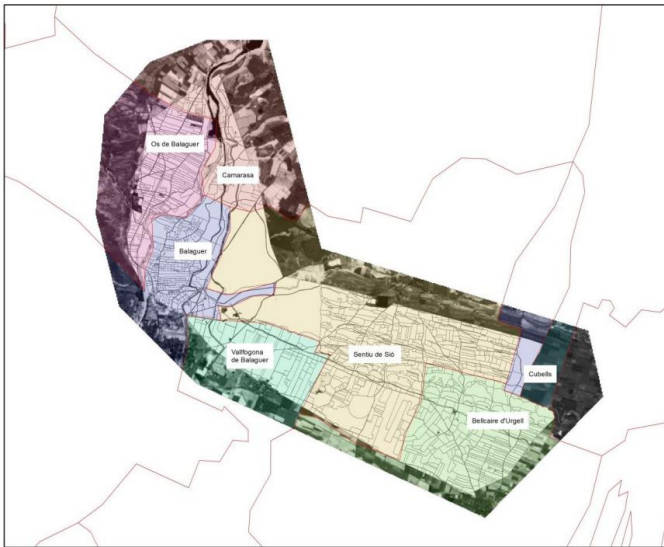
|                                |   |   |  |
|--------------------------------|---|---|--|
| <i>Descriptor</i>              | Fer a partir de la fusió de dades VNIR (NDVI), tèrmic (temperatura de superfície) i radiòmetre (Temperatura de brillantor/humitat) un <i>downscaling</i> per recuperar valors d'humitat amb GSD de pocs metres per veure potencials pèrdues o deficiències estructurals en infraestructures de transport recurs aigua | Fer a partir de la fusió de dades VNIR (NDVI), tèrmic (temperatura de superfície) i radiòmetre (Temperatura de brillantor/humitat) un <i>downscaling</i> per recuperar valors d'humitat amb GSD de pocs metres per potencial identificació camps de regadiu/seca, pous il·legals, ús/abús recurs hídric (aquífers). | Fer a partir de la fusió de dades VNIR (NDVI), tèrmic (temperatura de superfície) i radiòmetre (Temperatura de brillantor/humitat) un <i>downscaling</i> per recuperar valors d'humitat amb GSD de pocs metres, això com estendre els observables a NDVI, estres hídric etc per dissenyar el valor afegit en termes de productivitat/qualitat. |
| <i>Proposta</i>                | Vol demostrador sensor microones ARIEL amb AISA I TASI sobre el canal Segarra Garrigues en zones prèviament analitzades com a candidates amb potencials problemes estructurals i/o amb camps de conreus regadiu/seca  | Vol demostrador ARIEL amb AISA I TASI sobre el canal Segarra Garrigues en zones prèviament analitzades com a candidates amb potencials problemes estructurals i amb camps de conreus regadiu/seca   | Vol demostrador amb ARIEL amb AISA I TASI, sobre la zona de la Conca de Tremp, on hi ha (ICGC) xarxa mesura humitat i conreus potencialment d'interès per a donar valor afegit amb la recuperació d'humitat (vinyes, oliveres, llenyosos ...)  |
| <i>Gestió/ Coordinació</i>     | ICGC/BALAMIS  | ICGC/BALAMIS  | ICGC/BALAMIS   |
| <i>Proveïdor de tecnologia</i> | ICGC/BALAMIS  | ICGC/BALAMIS  | ICGC/BALAMIS   |



# SMALL SATELLITES: HUMIT MISSION STATEMENT



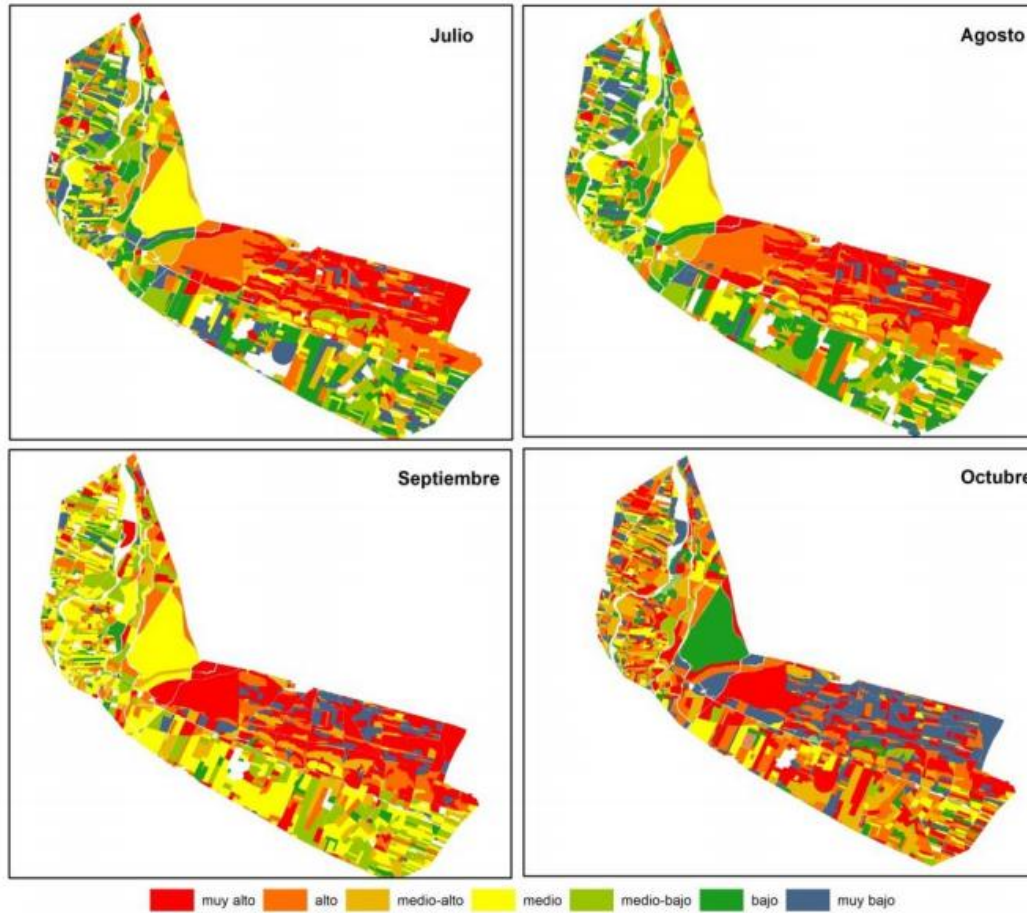
# SMALL SATELLITES: HUMIT MISSION STATEMENT



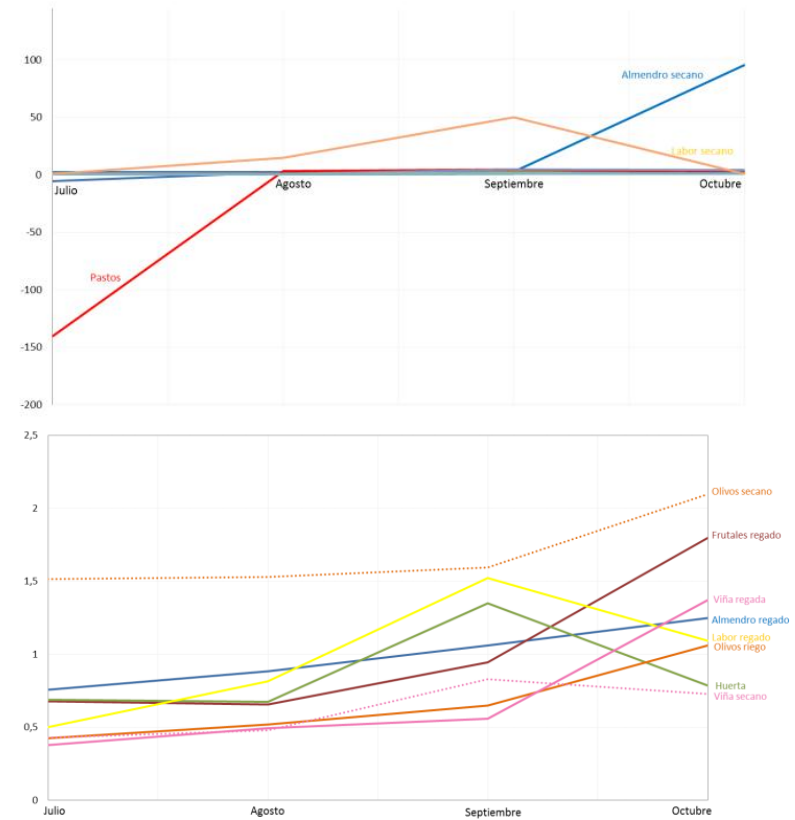
## AGRONOMIC TEST SITES INFORMATION



# SMALL SATELLITES: HUMIT MISSION STATEMENT



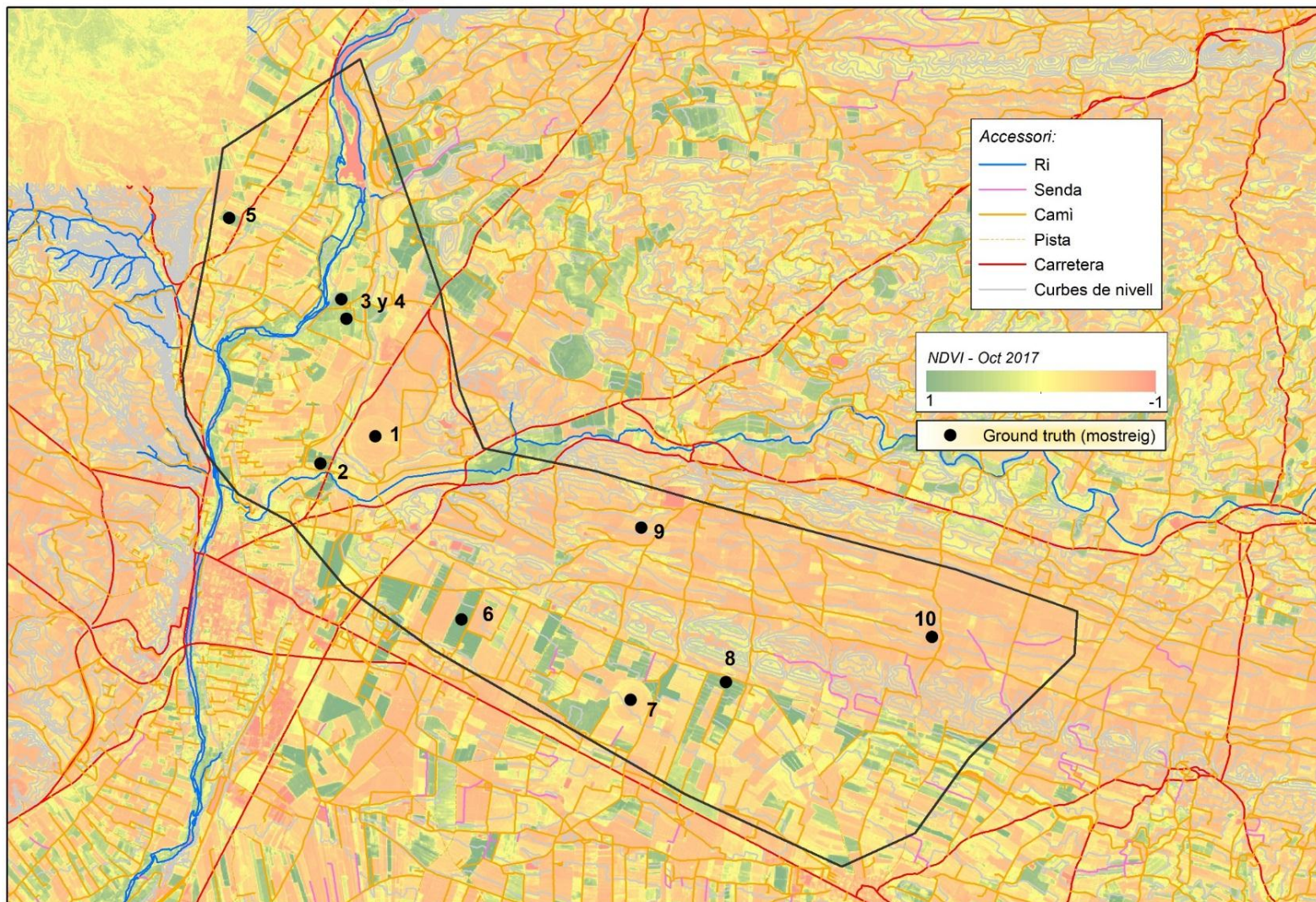
## Drought temporal variability



# SMALL SATELLITES: HUMIT MISSION STATEMENT

## HUMIT TEST SITES PROPOSSAL

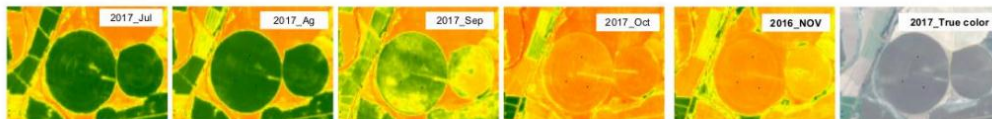
*DISSENY VOLS HUMIT- Zona Balaguer*



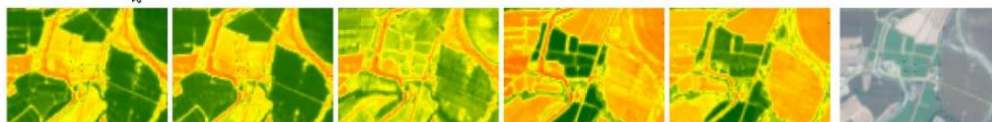
# SMALL SATELLITES: HUMIT MISSION STATEMENT

## Evolution SENTINEL 2 test sites

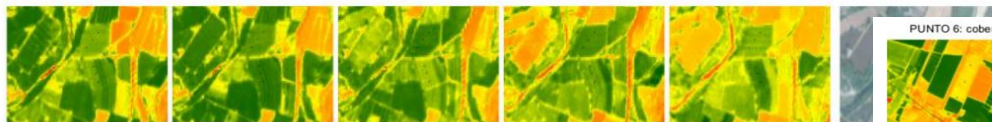
PUNTO 1: cobertura nula



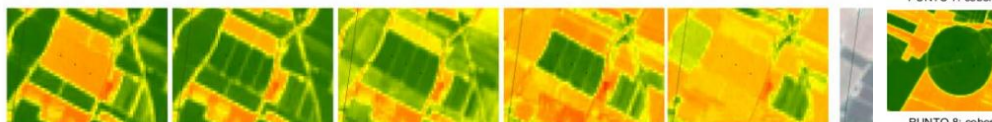
PUNTO 2: cobertura alta



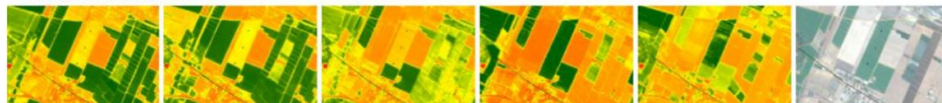
PUNTO 3 y 4: cobertura media



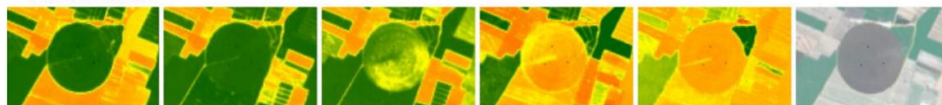
PUNTO 5: cobertura alta



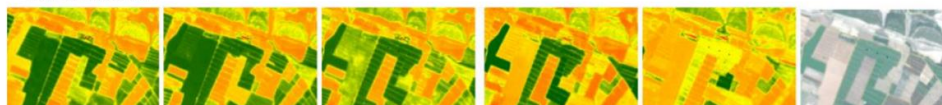
PUNTO 6: cobertura media



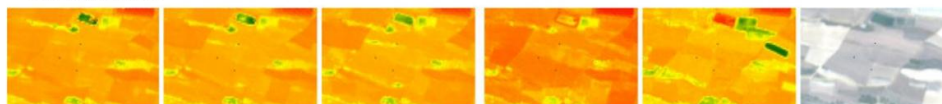
PUNTO 7: cobertura nula



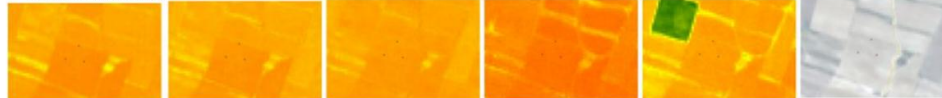
PUNTO 8: cobertura alta



PUNTO 9: cobertura nula

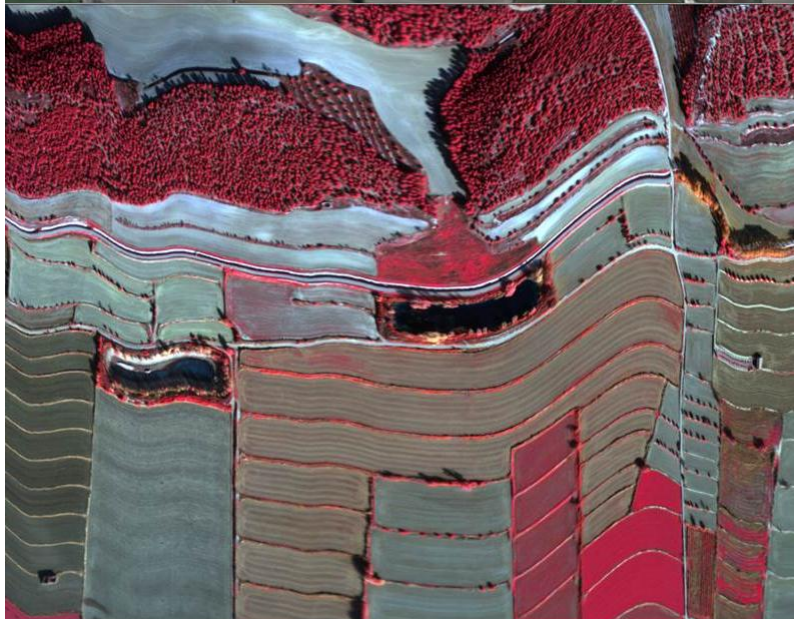


PUNTO 10: cobertura nula





# SMALL SATELLITES: HUMIT MISSION STATEMENT

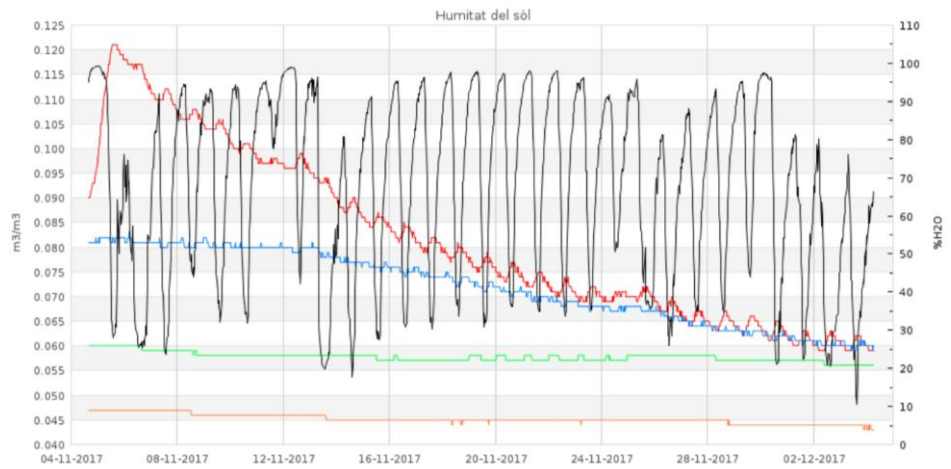
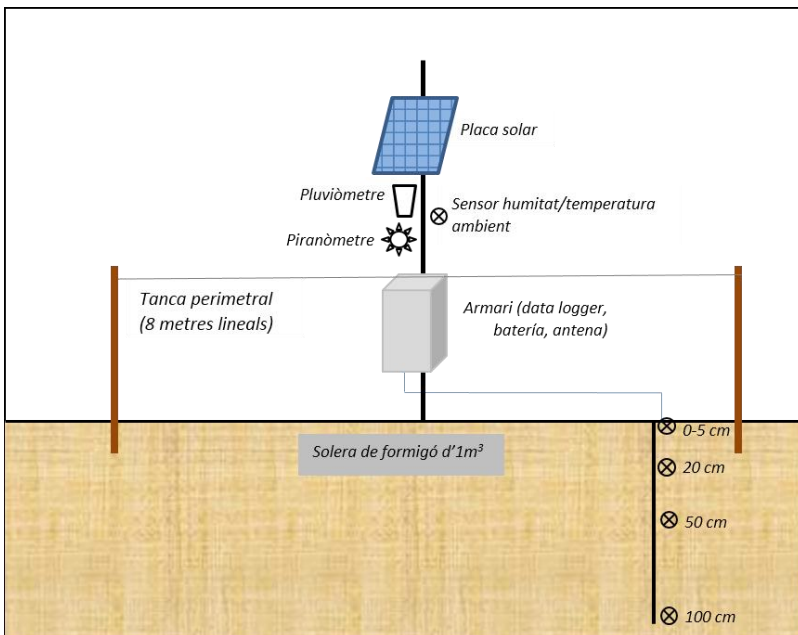
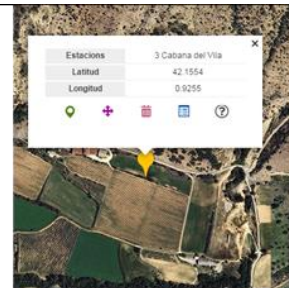


| NOM    | TEXT          | LATITUD  | LONGITUD | ETRS89_X  | ETRS89_Y   |
|--------|---------------|----------|----------|-----------|------------|
| HUMIT7 | MESURA_HUMIT7 | 41.77904 | 0.87004  | 322988.20 | 4627436.42 |
| HUMIT8 | MESURA_HUMIT8 | 41.78150 | 0.88425  | 324175.91 | 4627680.40 |

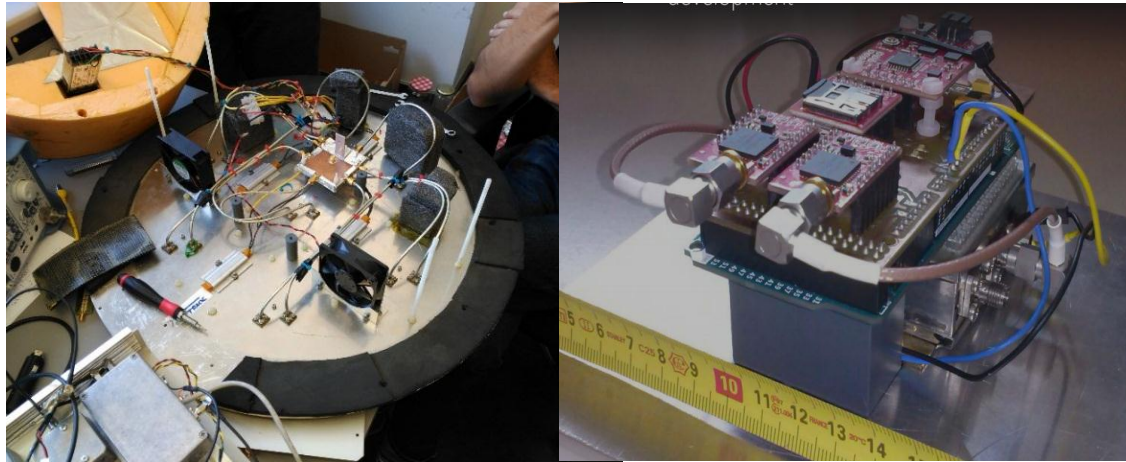
## SMALL SATELLITES: HUMIT MISSION STATEMENT



# SMALL SATELLITES: HUMIT MISSION STATEMENT

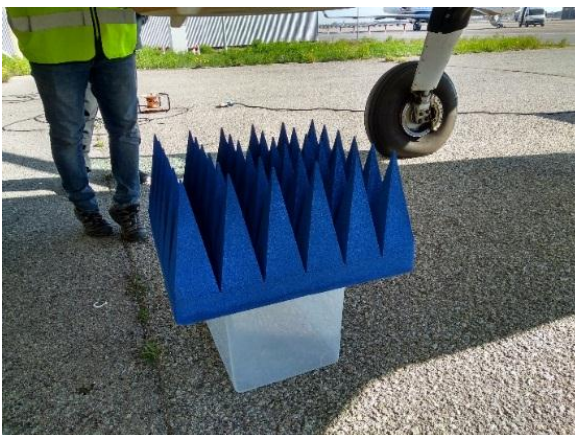
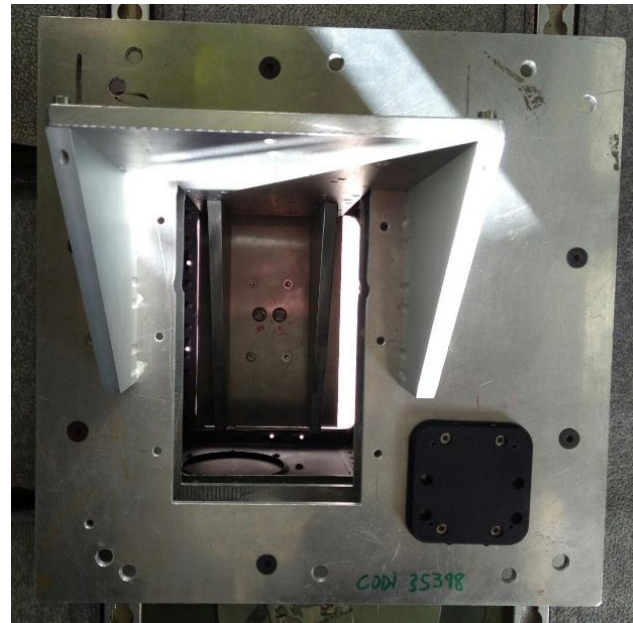
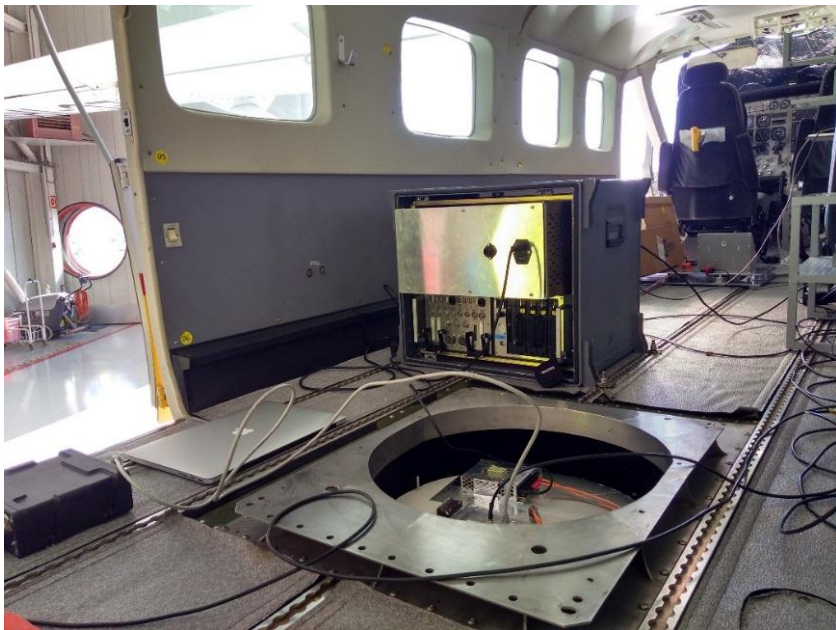


# SMALL SATELLITES: HUMIT MISSION STATEMENT

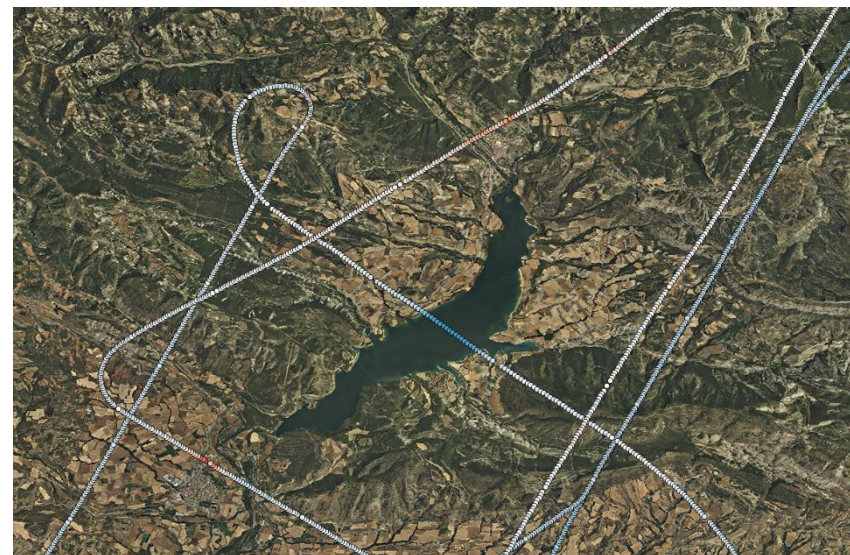
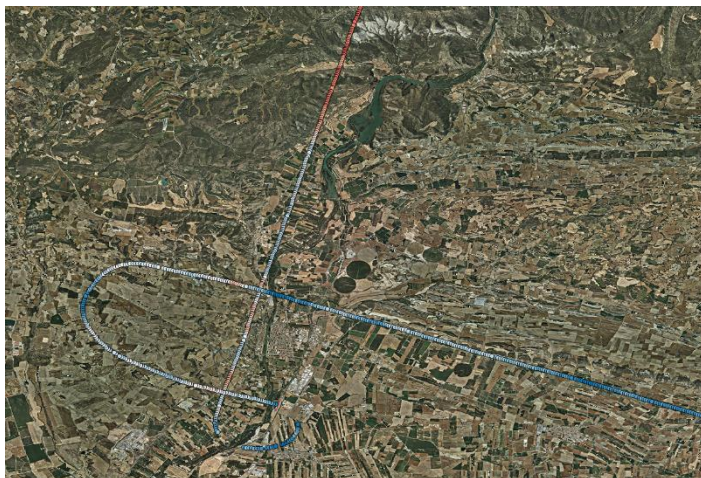


Fusion of earth observation data with optical hyperspectral and passive sensors in microwave band - L (radiometer and GNSS\_R)

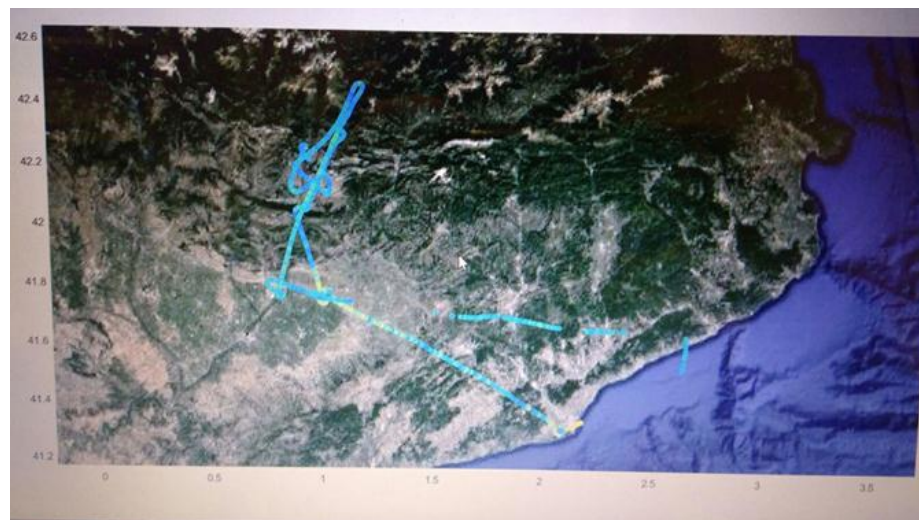
## SMALL SATELLITES: HUMIT MISSION STATEMENT



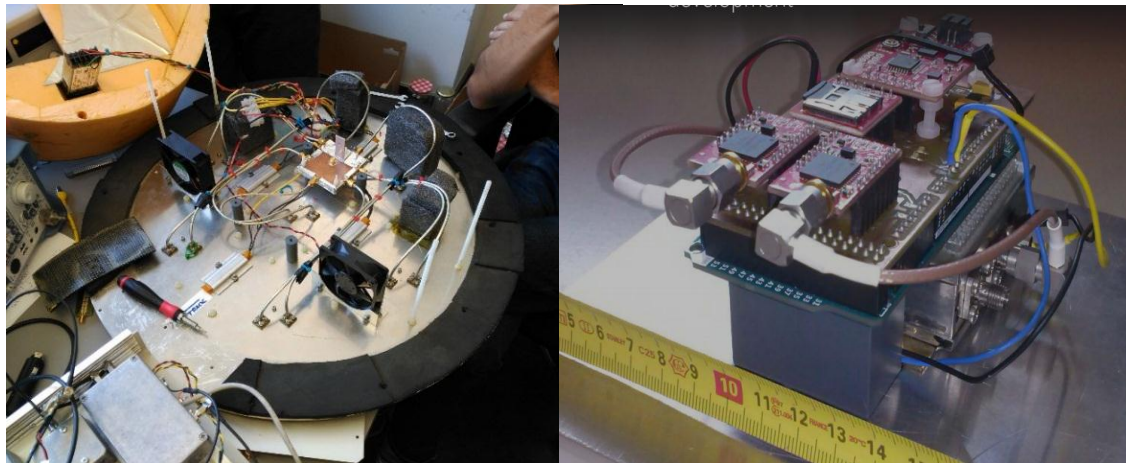
# SMALL SATELLITES: HUMIT MISSION STATEMENT



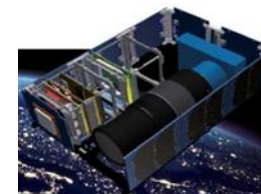
| Ref    | Densitat aparent | Humitat 55°C (%) | Humitat 105°C (%) | Textura estimada      | % argila (perfils "pròxims") |
|--------|------------------|------------------|-------------------|-----------------------|------------------------------|
| H-01/1 | 133,67           | 7,57             | 8,02              |                       |                              |
| H-01/2 | 145,25           | 6,46             | 6,91              |                       |                              |
| H-01/3 | 150,09           | 6,96             | 7,41              | Franca/Francoarenosa  | 16-25%                       |
| H-02/1 | 147,81           | 14,90            | 15,40             |                       |                              |
| H-02/2 | 147,44           | 14,22            | 14,72             |                       |                              |
| H-02/3 | 160,25           | 14,80            | 15,30             | Francollimosa         | 25%                          |
| H-03/1 | 118,99           | 32,44            | 33,55             |                       |                              |
| H-03/2 | 115,82           | 33,73            | 34,85             |                       |                              |
| H-03/3 | 139,61           | 28,06            | 29,17             | Francollimosa         | 15-17%                       |
| H-04/1 | 132,46           | 19,90            | 20,66             |                       |                              |
| H-04/2 | 136,95           | 23,73            | 24,49             |                       |                              |
| H-04/3 | 142,28           | 24,36            | 25,12             | Francollimosa         | 15-17%                       |
| H-05/1 | 127,60           | 23,31            | 24,06             |                       |                              |
| H-05/2 | 132,10           | 22,46            | 23,20             |                       |                              |
| H-05/3 | 128,36           | 24,44            | 25,18             | Francoargil-lollimosa | 30-35%                       |
| H-06/1 | 166,16           | 11,77            | 12,18             |                       |                              |
| H-06/2 | 135,50           | 12,04            | 12,45             |                       |                              |
| H-06/3 | 150,66           | 12,68            | 13,09             | Franca/Francollimosa  | 20%                          |
| H-07/1 | 139,36           | 18,18            | 18,64             |                       |                              |
| H-07/2 | 121,31           | 17,33            | 17,78             |                       |                              |
| H-07/3 | 136,84           | 20,64            | 21,09             | Franca/Francollimosa  | 17-21%                       |
| H-08/1 | 152,75           | 11,10            | 11,43             |                       |                              |
| H-08/2 | 131,53           | 11,35            | 11,68             |                       |                              |
| H-08/3 | 143,93           | 10,99            | 11,32             | Franca/Francollimosa  | -                            |
| H-09/1 | 131,94           | 12,32            | 12,69             |                       |                              |
| H-09/2 | 146,78           | 11,69            | 12,06             |                       |                              |
| H-09/3 | 131,56           | 11,91            | 12,28             | Francollimosa         | 17-22%                       |
| H-10/1 | 119,37           | 14,20            | 15,30             |                       |                              |
| H-10/2 | 127,92           | 11,60            | 12,70             |                       |                              |
| H-10/3 | 128,36           | 15,10            | 16,20             | Francollimosa         | 20%                          |



## HUMIT: MAD



Fusion of earth observation data with optical hyperspectral and passive sensors in microwave band - L (radiometer and GNSS\_R)



## FINAL REMARKS (1/2)

- Small satellites will not replace large satellites (multisensor and useful life time), it's not about platforms but the problems to be solved
- Small satellites represent accelerating access to space and associated competencies
- Small satellites represent a new paradigm in the feasibility / viability trade-off
- The small satellites will increasingly be oriented to commercial applications in earth observation. New jump from 6th to 12th and minisats to microsats
- The small satellites will have an approximation every more professionalized, also in the public sector and especially for earth science
- Small satellites represent the approach to "overcome" the great border of the temporary / reactivity resolution: constellation

**It's not a question about the platform , it's about usability**

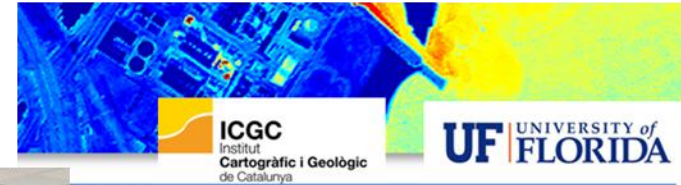
**THANKS FOR YOUR ATTENTION**



FINAL REMARKS (2/2)

EARTH OBSERVATION FROM DATA TO KNOWLEDGE TRANSFER !!!!!

màster en  
geoinformació



| EFFORT   | SUBJECTS  |
|--|---|
| 20% of EOS<br>attended learning<br>% assisted learning | <b>New trends and challenges on urban Earth Observation</b><br>EO_1: Principles of Earth observation on Urban Areas |
| attended learning<br>% assisted learning               | EO_2: Technical and operational design Earth Observation on urban areas   |
| 20% of EOS<br>attended learning<br>% assisted learning | <b>Earth Observation Added Value chain</b><br>AD_1: From data to information products and services                  |
| attended learning<br>% assisted learning               | AD_2: Direct and indirect impacts and benefits  |
| 35% of EOS<br>attended learning<br>% assisted learning | <b>Building Earth Observation Applications</b><br>AP_1: Surveillance: Critical Infrastructures and risk monitoring  |
| attended learning<br>% assisted learning               | AP_2: Climate and Health  |
| attended learning<br>% assisted learning               | AP_3: Thermal behavior and energy   |
| attended learning<br>% assisted learning               | AP_4: Change detection and growth   |
| 25% of EOS<br>attended learning<br>% assisted learning | <b>Mission analysis and Design</b><br>MAD_1: Problems to be solved: technical and operational approach              |
| 40% attended learning<br>60% assisted learning         | MAD_2: Added value chain architecture and potential benefits  |
| 40% attended learning<br>60% assisted learning         | MAD_3: Implementation plan and identification of end users  |

**Second Barcelona Techno Week**  
Course on nanosatellites

Institute of Cosmos Sciences, Barcelona  
From 10th to 14th July 2017

Presentation Program Registration Information Organizing Committee Course lecturers Social activities Previous Editions

**Course on nanosatellites**

The second ICCUB technowork will be devoted to the emerging field of nanosatellites. It will be an intensive 5-day "bootcamp" providing a comprehensive introduction to the basic concepts of nanosatellite design and construction.

- Keynotes, courses and workshops
- Hands-on participation (nanosatellite and presentation)
- Poster session (from 10am to 6pm daily)

**Initiative** **Collaboration**

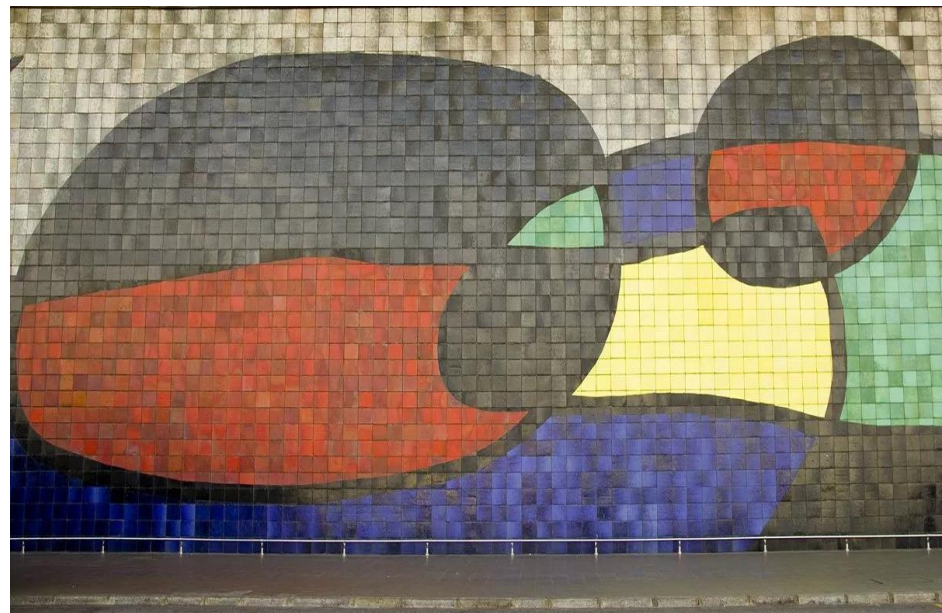
ICCUB Institut Cartogràfic i Geològic de Catalunya  
UNIVERSITAT DE BARCELONA  
IEEC Institut d'Enginyeria de Catalunya  
ICGC Institut Cartogràfic i Geològic de Catalunya



# **MOLTES GRÀCIES PER LA SEVA ATENCIÓ**



***ICGC, 2012  
False Color VNIR, sensor CASI550***



***Joan Miro, 1968  
Mural Aeroport de Barcelona***