



AIR CENTRE
ATLANTIC INTERNATIONAL RESEARCH CENTRE

Space: New Frontier for Business

32 Seminario RCTM
July 2022

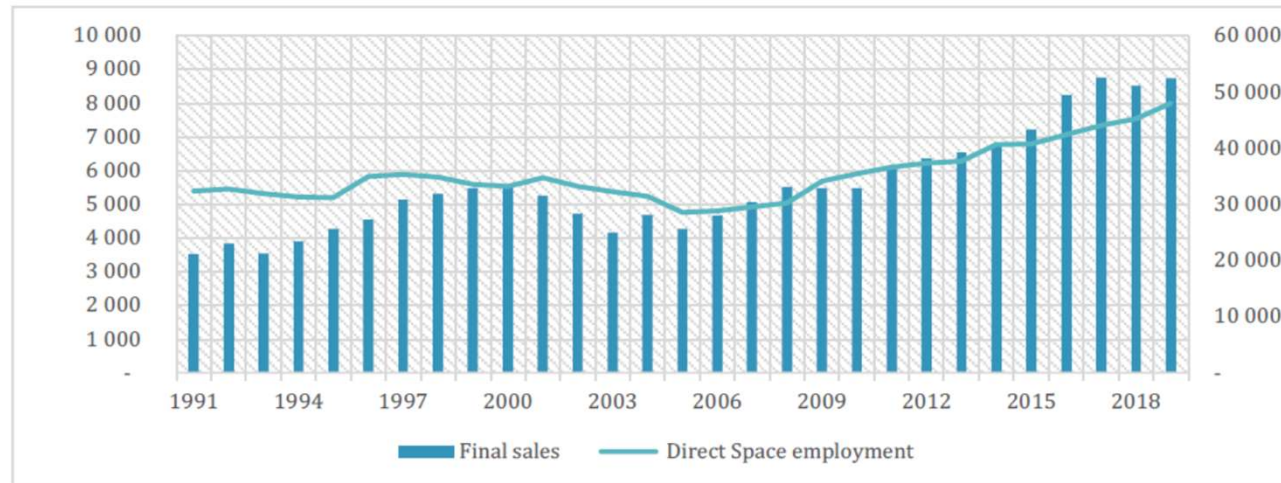


- **Analysis of Space Activities**
- **Institutional space**
- **Commercial Space**
- **Space Traffic Services**
- **Earth Observation Business**
 - **GEOSAT: EO Applications**
 - **Target Goals**
 - **Role of Government**
 - **Investment Options**
- **Conclusions**



- The space industry is a knowledge-intensive strategic sector, fundamental for the implementation of many public policies, supporting all economic sectors and essential in the daily life of citizens
- The space sector is also an engine of growth and job creation, studies by specialized consultants affirm that for every euro invested in space, a multiplying factor of 10 is generated in the country's economy
- The space sector has been very resilient to crisis like the current Covid-19 pandemia, with a continuous growth

European space industry sales and employment (M€, right & FTE, left)





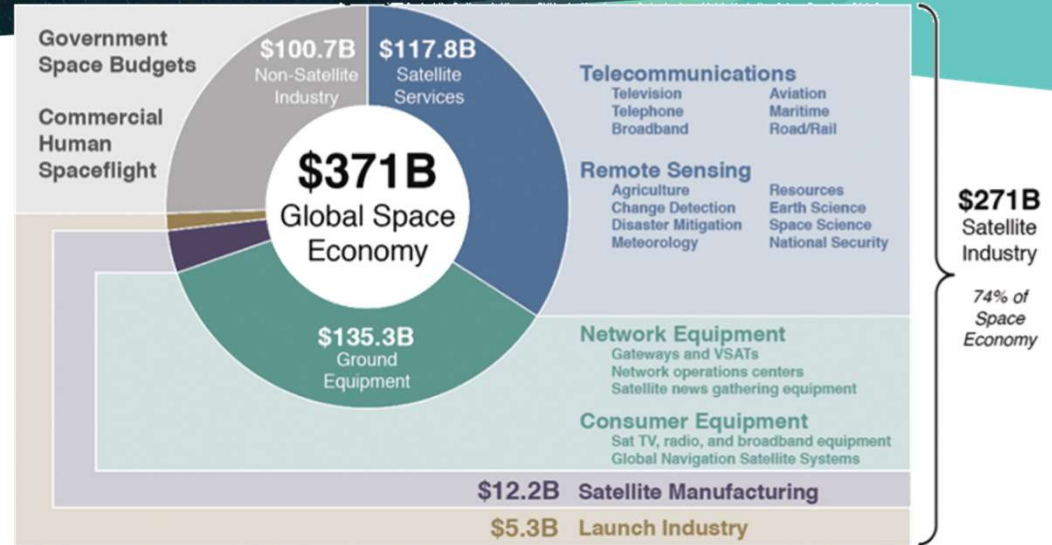
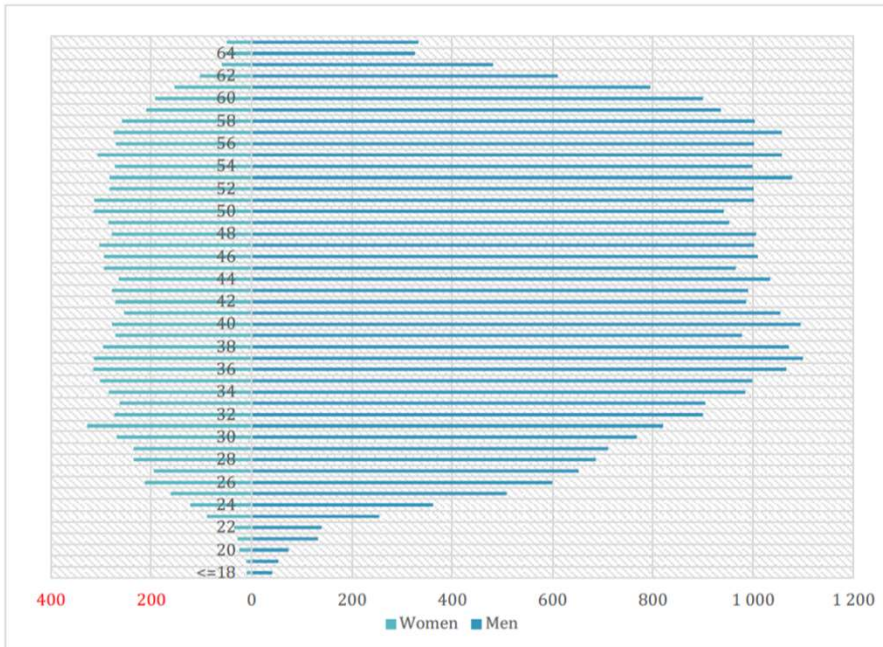
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SPACE INDUSTRY STATISTICS

Space industry employees' qualification and gender characteristics (Table)

Qualification profile	All	Men	Women
1. University (4-5 years and up)	57%	59%	53%
2. University (up to 3 years)	16%	17%	13%
3. Higher Vocational School	10%	10%	11%
4. Vocational School	8%	7%	13%
5. General School Only	5%	4%	7%
6. Apprenticeship	0%	0%	0%
Not available	3%	3%	3%

Space industry employees age pyramid



Fonte: Brycetek

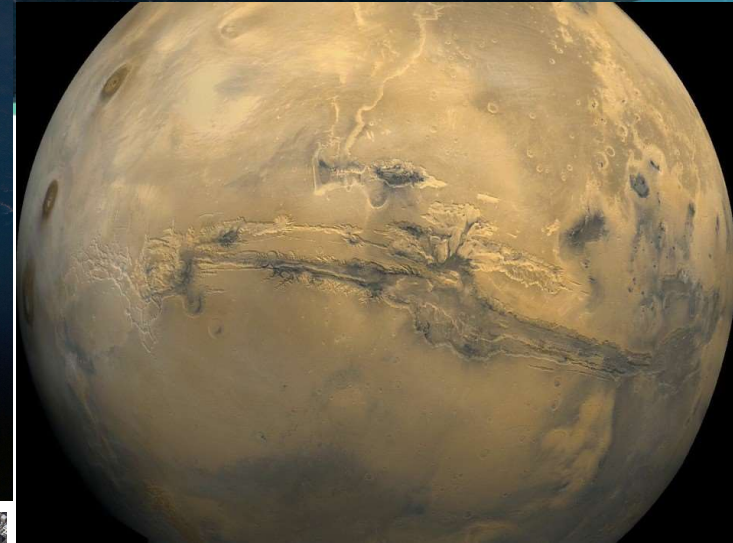
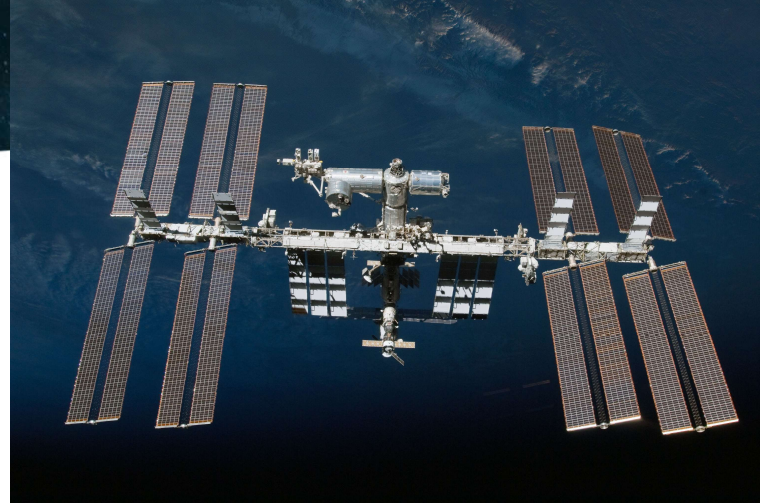


Fonte: Brycetek

SPACE INDUSTRY SEGMENTATION

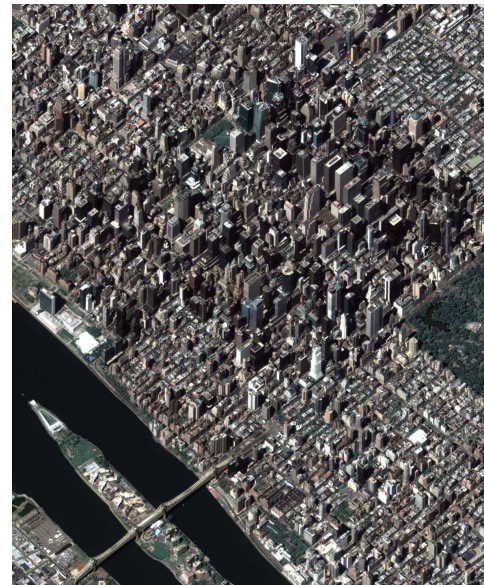
- **Institutional Space:**

- Scientific programs
- Interplanetary missions
- Manned flights

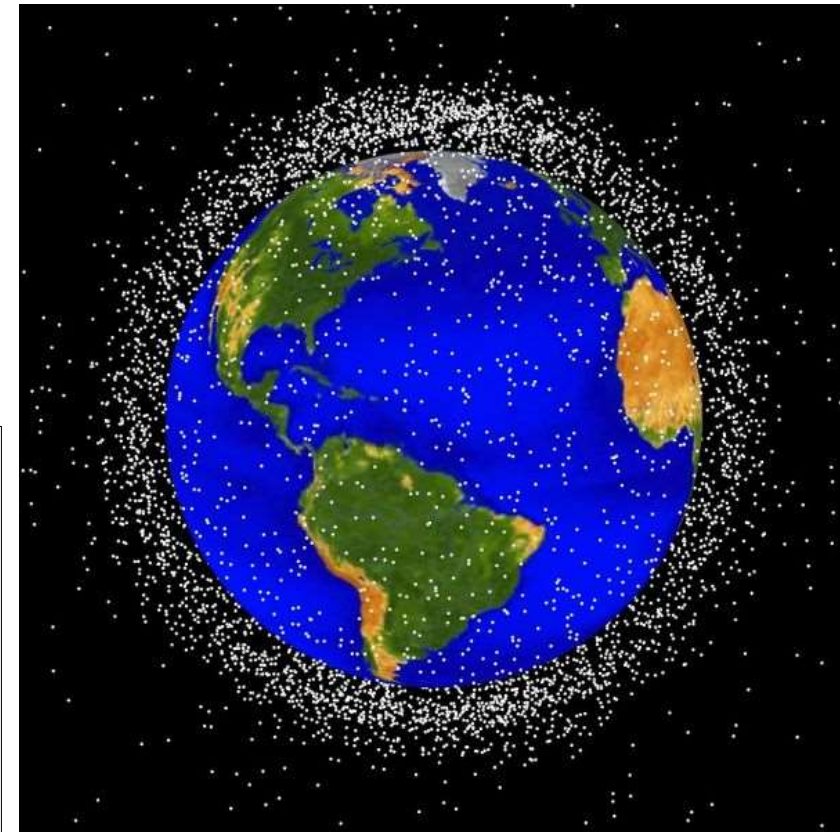
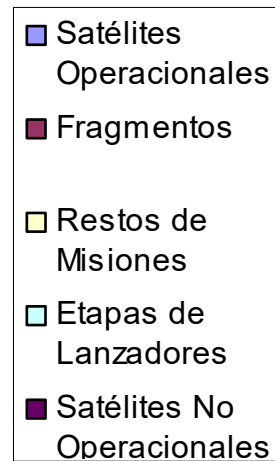
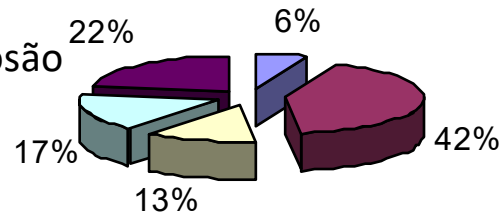


- **Commercial Space:**

- Telecommunications → mature, capital intensive
- Satellite Navigation → free open service, PRS
- Earth Observation → emerging, high potential !!
- Space Traffic Services → geographical location
- Launch Services → Santa Maria Spaceport
- Future commercial services:
 - Space Tourism → In the future Santa Maria
 - Asteroid Mining → too early

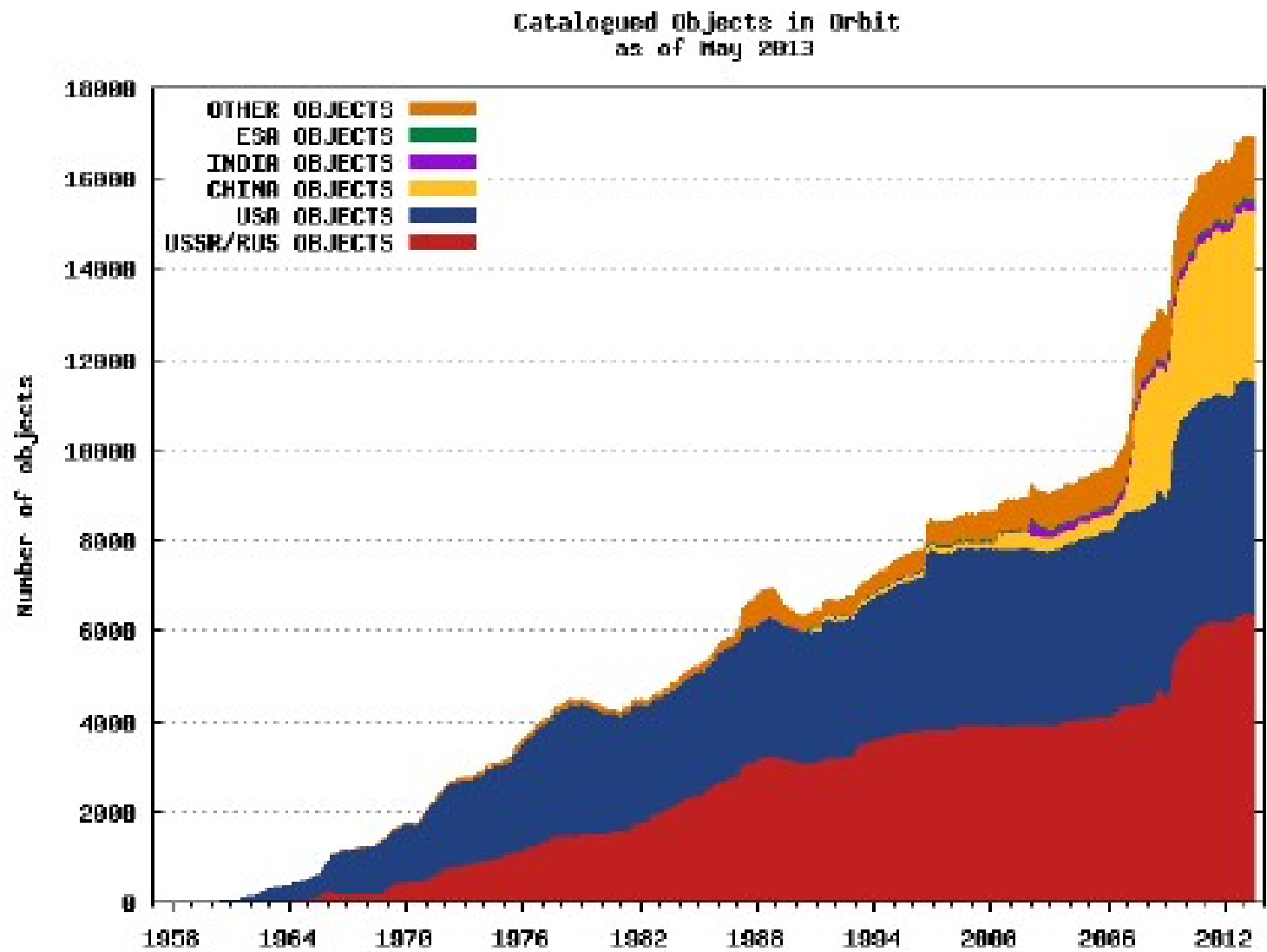


- Os detritos espaciais são constituídos por qualquer **objeto artificial na órbita da Terra que não esteja operacional e do qual não se espere uma recuperação razoável de sua funcionalidade original.**
- Dos cerca de 20.000 objetos catalogados, apenas 6% são satélites operacionais, o restante é um conjunto formado por:
 - Satélites não operacionais
 - Etapas de lançadores
 - Remanescentes de missões espaciais
 - Fragmentos de explosão



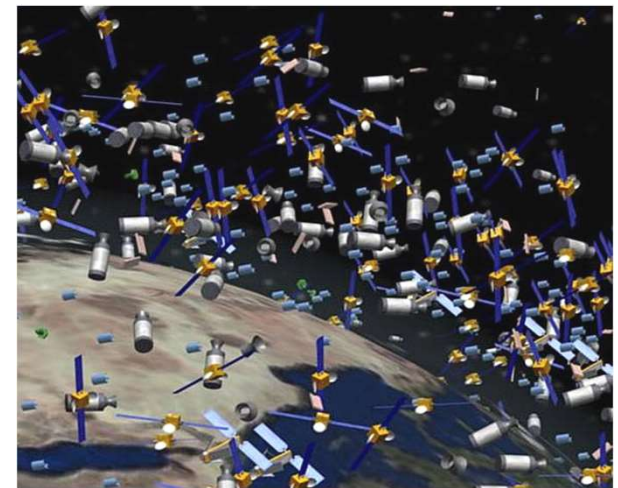
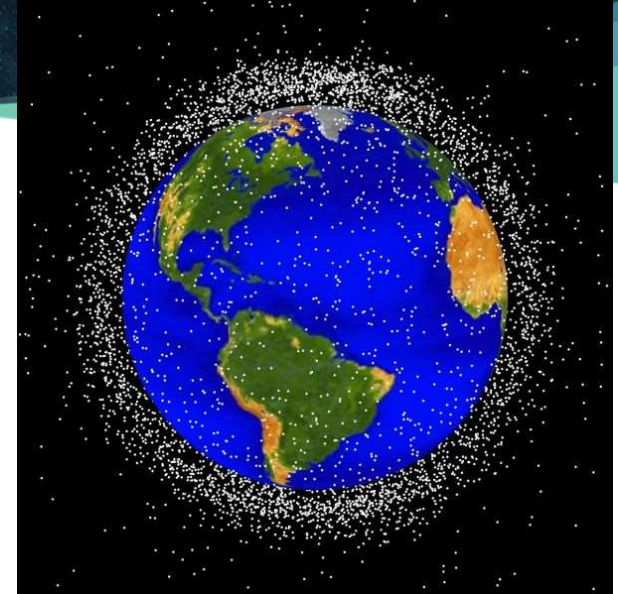


SPACE TRAFFIC SERVICES: Paises de origem



SPACE TRAFFIC SERVICES: RISCO DE COLISÃO

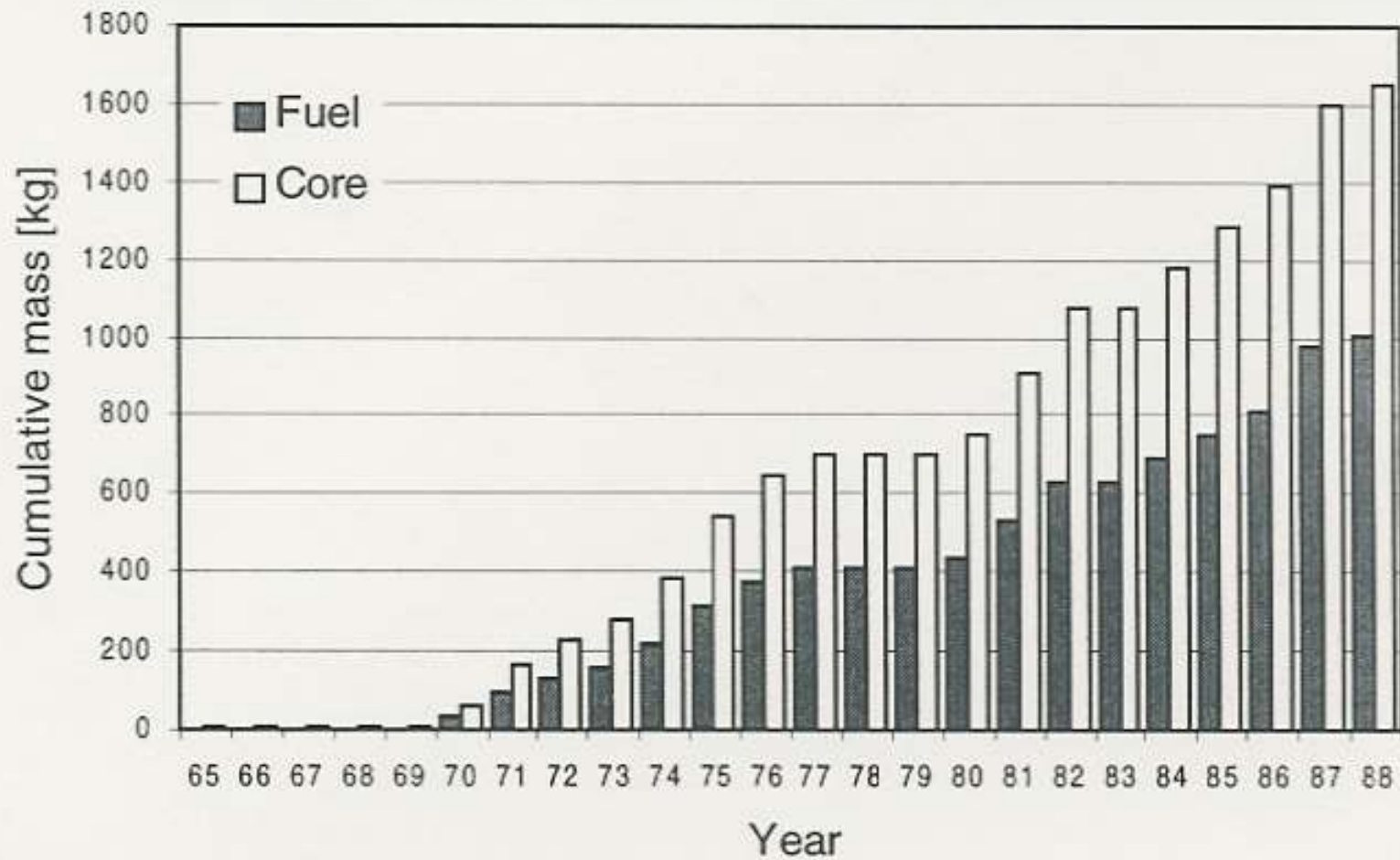
- Mesmo as colisões com pequenas partículas produzem consequências catastróficas devido à enorme energia cinética envolvida.
- Esses choques aumentam o problema, uma vez que inúmeras partículas são criadas.
- Para evitá-los, manobras de evasão são freqüentemente realizadas tanto em navios tripulados como o Shuttle ou em satélites terrestres (Geosat 1 e 2 a cada 10 meses).
- Várias colisões ocorreram até agora. O primeiro em 24 de julho de 1996, **Cerise**, um satélite francês colidiu com um fragmento de uma explosão anterior de um lançador Ariane. Após este incidente, o Cerise se dividiu em duas partes.
- Um dos mais graves foi um satélite americano da constelação de **Iridium** que se perdeu após uma colisão com os restos de uma missão russa.



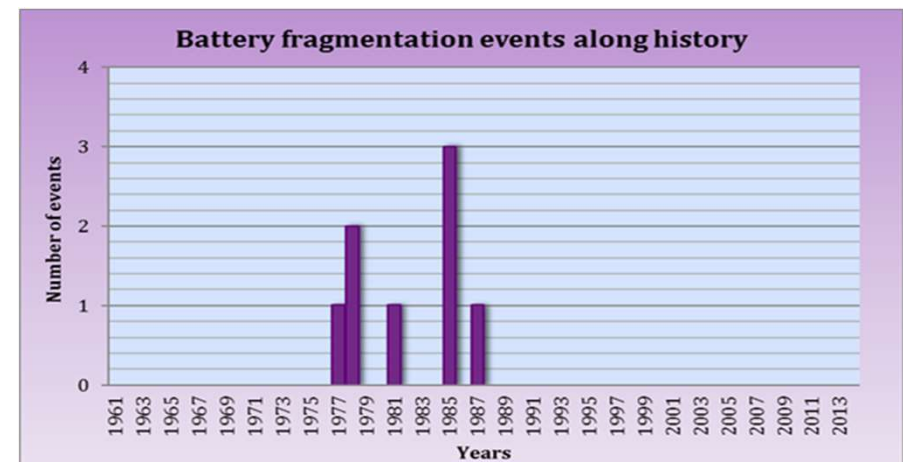
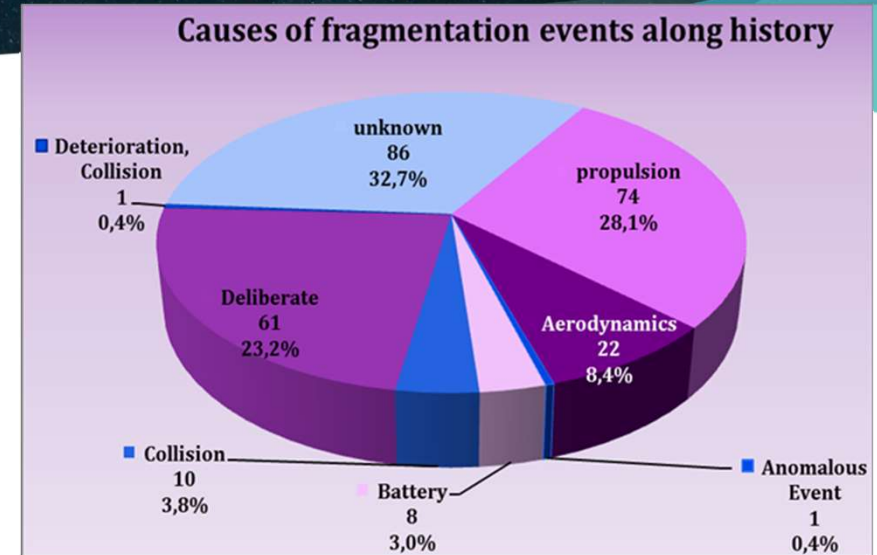
- A maioria dos objetos que entram na atmosfera se desintegra antes de chegar à superfície. A exceção a esta circunstância diz respeito a grandes estruturas (MIR, Skylab).
- Felizmente, uma grande parte da superfície da Terra é coberta pelo oceano, então a probabilidade de que o impacto na superfície seja na terra é menor (aproximadamente 3/4 do que cai no oceano).
- Essas reentradas oceânicas não constituem um perigo, a menos que o objeto envolva **carga nuclear**.
- Os continentes ocupam 30% da superfície da Terra, com apenas 1% ocupado por superfícies densamente povoadas, portanto o risco de causar ferimentos pessoais é muito baixo, a única vítima foi uma vaca em Cuba (lenda urbana)
- Várias reentradas ocorreram até o momento, as mais conhecidas são MIR (reentrada controlada), Skylab, Cosmos 954, ...



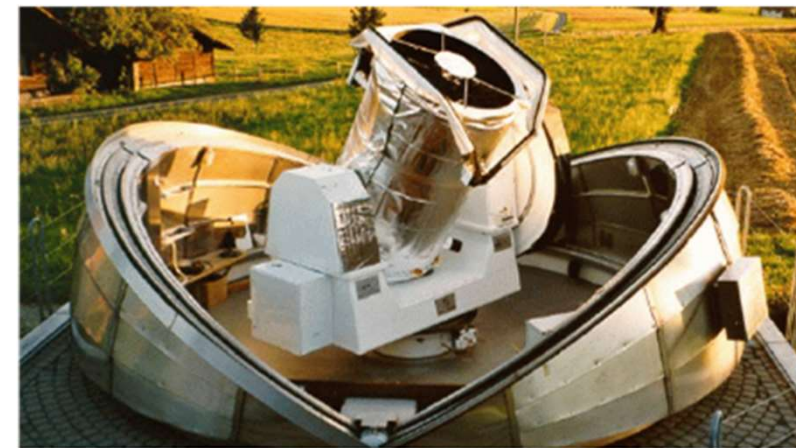
SPACE TRAFFIC SERVICES: RISCO DE REENTRADA (NUCLEAR)



- Aumenta o risco de colisão gerando fragmentos
- Detectável para peças grandes, mas também gera pequenas peças não detectáveis
- As recomendações para minimizar os detritos espaciais são cumpridas pelos integradores de satélites, produzindo uma diminuição notável na fragmentação no espaço
- O mais sério foi a fragmentação deliberada do satélite chinês Fenyung, gerando 2.500 fragmentos muito perigosos em um segundo.

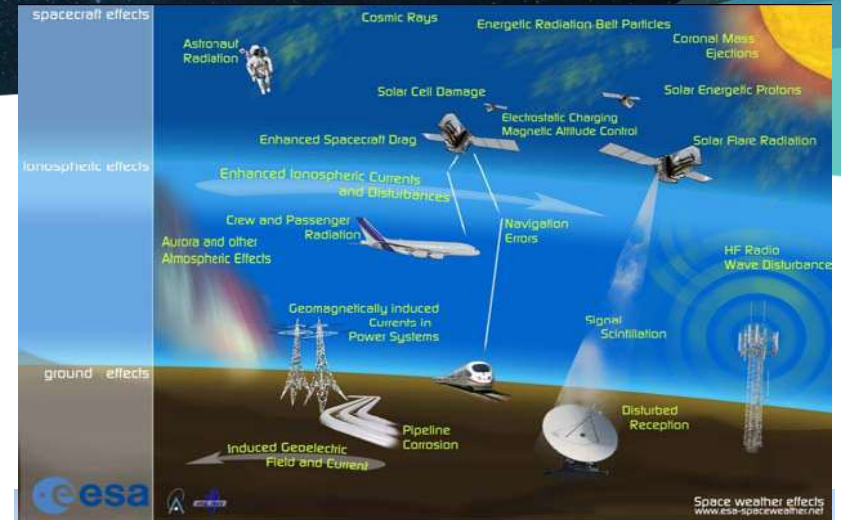


- **Reduzir** o número de objetos relacionados a cada missão
- **Passivação** de sistemas em órbita,
 - Diminuindo a pressão dos tanques de gás inerte
 - Eliminou o excesso de combustível no final da missão. Esse processo também pode ser usado para queimar o combustível em uma última manobra que retire o satélite de sua órbita.
- **Remover** os satélites das órbitas mais povoadas:
 - **Satélites orbitando em LEO**: sua altitude é reduzida até que sua vida útil seja inferior a **25 anos**. Um exemplo dessa manobra é a aplicada a um estágio do lançador Delta II, localizado a 900 km de altitude, que levaria centenas de anos para entrar. Após a manobra, essa etapa foi colocada em uma órbita de 200 km x 860 km, cuja reentrada ocorre em um ano.
 - **Re-orbitando satélites em GEO**: em uma órbita cemitério 300 km acima do cinturão de uso geoestacionário.



SPACE TRAFFIC SERVICES: Space Situational Awareness

- Um Sistema de Vigilância Espacial (**Space Situational Awareness ou SSA**) é de vital importância para garantir o uso futuro do espaço
- A Europa não possui sistema próprio e **depende dos dados fornecidos pelos EUA e pela Rússia**, o sistema SSA europeu encontra-se numa das fases preliminares de desenvolvimento.
- O sistema SSA europeu terá quatro domínios:
 - Detecção e rastreamento de objetos espaciais
 - Caracterização de objetos no espaço
 - Monitore o clima espacial
 - Monitore o risco de NEOs (asteróides e cometas)
- O sistema terá:
 - **Componentes no solo**: radares, telescópios e data centers
 - **Componentes no espaço** (satélites de observação)



SPACE TRAFFIC SERVICES: ESTÁGIOS DA VIGILÂNCIA DO ESPAÇO

Observación y detección

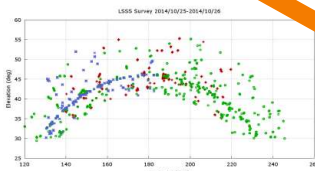
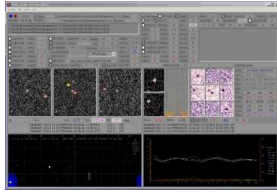
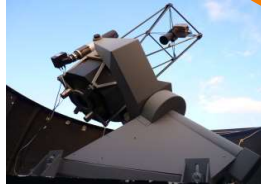
Seguimiento y caracterización

Determinación orbital, correlación e identificación

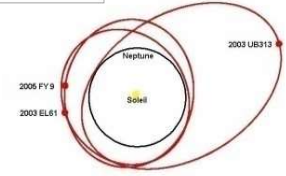
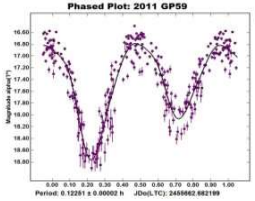
Catalogación

Determinación de riesgo

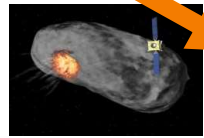
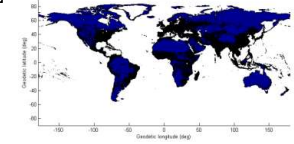
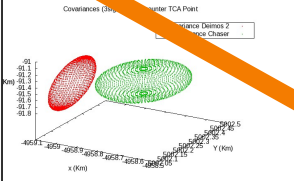
Mitigación



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00Q8137	08 26 9124.23	04 24 51	+00 08 40.4	V	18.4	V75
00Q8137	08 26 9669.23	04 24 02	+00 08 40.5	V	18.7	V75
00Q8137	08 26 9809.23	04 23 37	+00 08 30.5	V	18.7	V75
00Q8138	08 26 9863.00	23 38 02	+11 24 30.3	V	18.2	V75
00Q8138	08 27 0136.00	23 34 76	+12 33 50.2	V	18.9	V75
00Q8138	08 27 0206.00	23 34 46	+12 33 52.9	V	18.9	V75
00Q8139	08 27 0460.00	39 24 48	+11 00 00.0	V	18.4	V75
00Q8139	08 27 0809.00	39 24 24	+11 00 00.5	V	18.6	V75
00Q8139	08 27 0732.00	39 23 79	+11 00 09.2	V	18.4	V75
00Q8140	08 27 1346.02	39 27 33	+10 53 04.2	V	18.1	V75
00Q8140	08 27 1497.02	39 28 09	+10 53 10.9	V	18.2	V75
00Q8140	08 27 1824.02	39 28 31	+10 53 16.2	V	18.2	V75
00Q8141	08 27 1868.02	40 16 24	+11 37 05.4	V	18.5	V75
00Q8141	08 27 1808.02	40 16 00	+11 37 09.5	V	18.5	V75
00Q8141	08 27 18 52.02	40 17 03	+11 37 13.5	V	18.7	V75

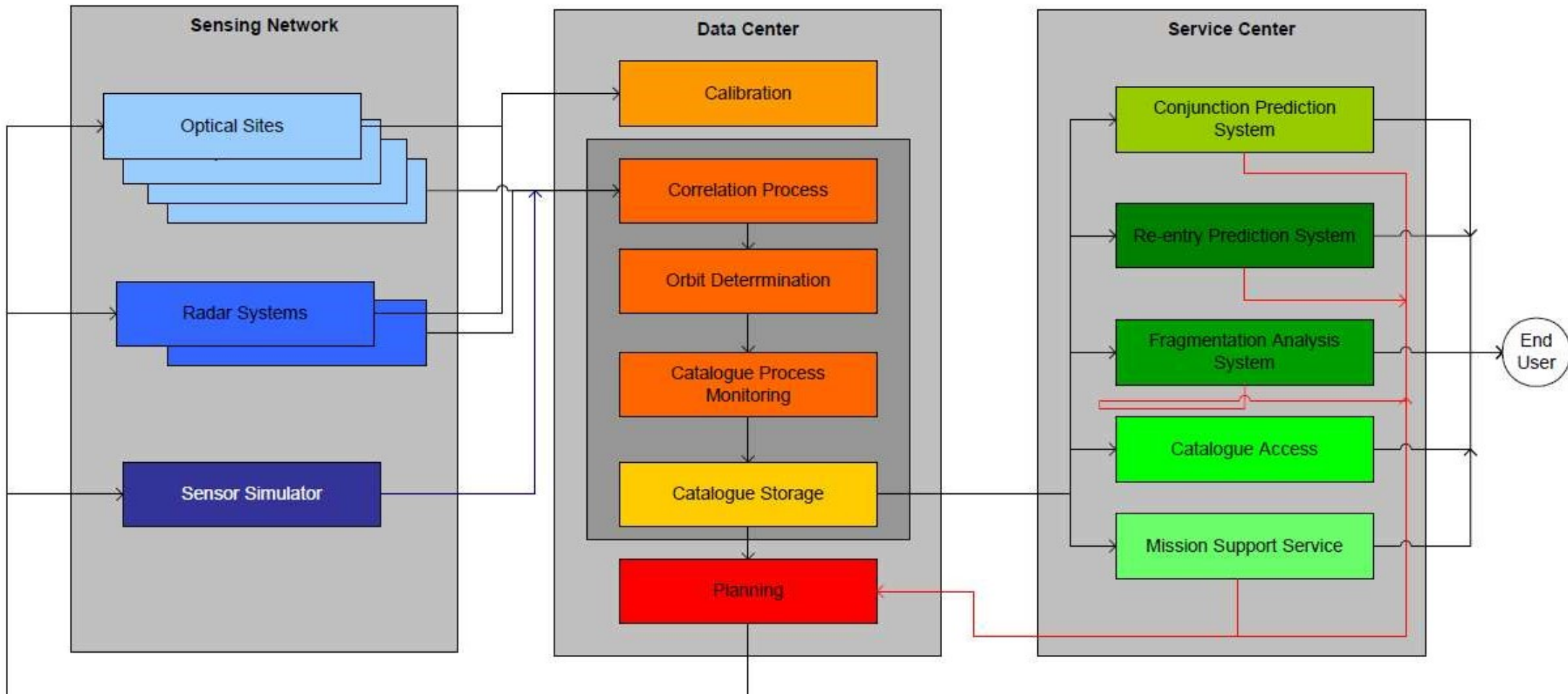


ID	RA	DEC	Mag	Filter	SNR	Class
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00Q8137	08 26 9669.23	04 24 02	+00 08 40.5	V	18.7	V75
00Q8137	08 26 9809.23	04 23 37	+00 08 30.5	V	18.7	V75
00Q8138	08 26 9863.00	23 38 02	+11 24 30.3	V	18.2	V75
00Q8138	08 27 0136.00	23 34 76	+12 33 50.2	V	18.9	V75
00Q8138	08 27 0206.00	23 34 46	+12 33 52.9	V	18.9	V75
00Q8139	08 27 0460.00	39 24 48	+11 00 00.0	V	18.4	V75
00Q8139	08 27 0809.00	39 24 24	+11 00 00.5	V	18.6	V75
00Q8139	08 27 0732.00	39 23 79	+11 00 09.2	V	18.4	V75
00Q8140	08 27 1346.02	39 27 33	+10 53 04.2	V	18.1	V75
00Q8140	08 27 1497.02	39 28 09	+10 53 10.9	V	18.2	V75
00Q8140	08 27 1824.02	39 28 31	+10 53 16.2	V	18.2	V75
00Q8141	08 27 1868.02	40 16 24	+11 37 05.4	V	18.5	V75
00Q8141	08 27 1808.02	40 16 00	+11 37 09.5	V	18.5	V75
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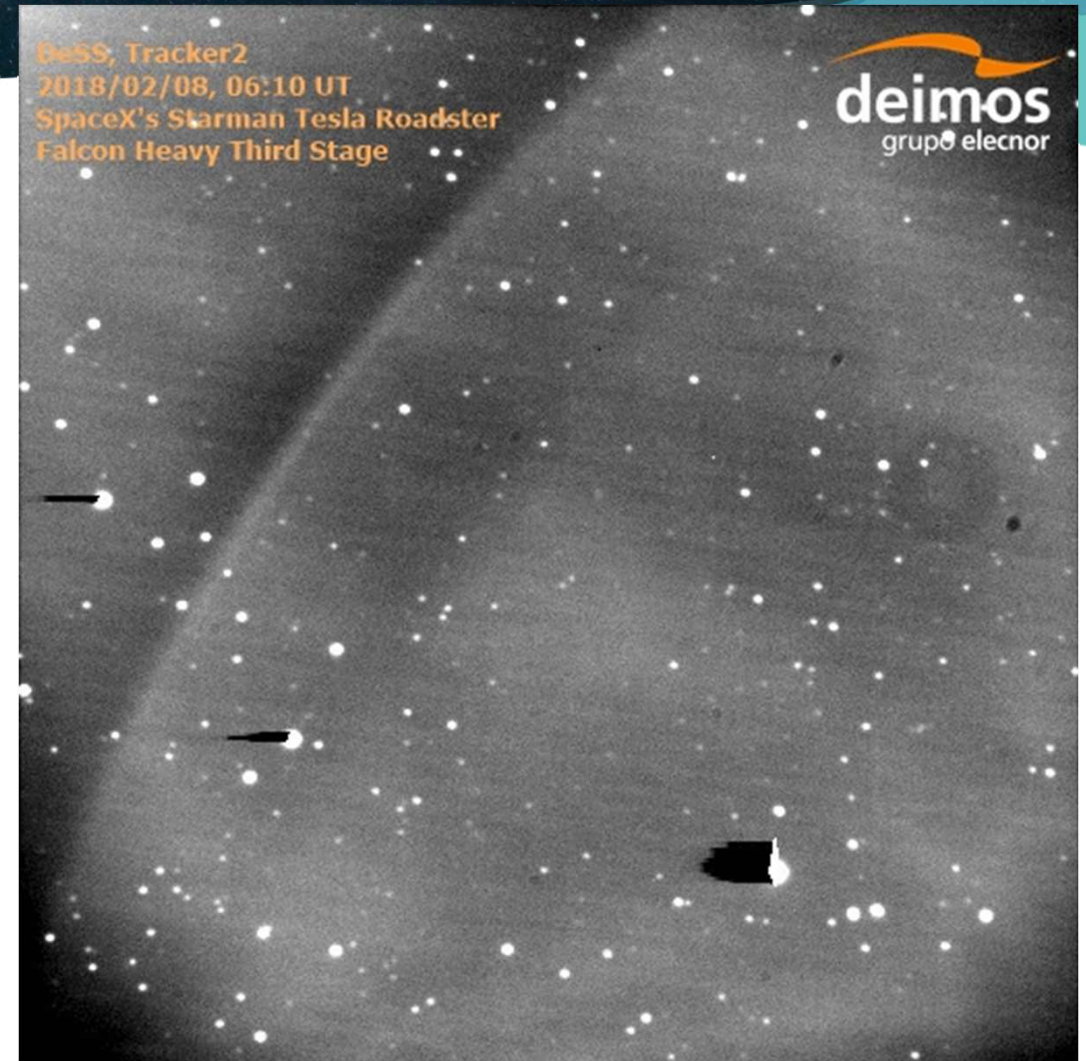
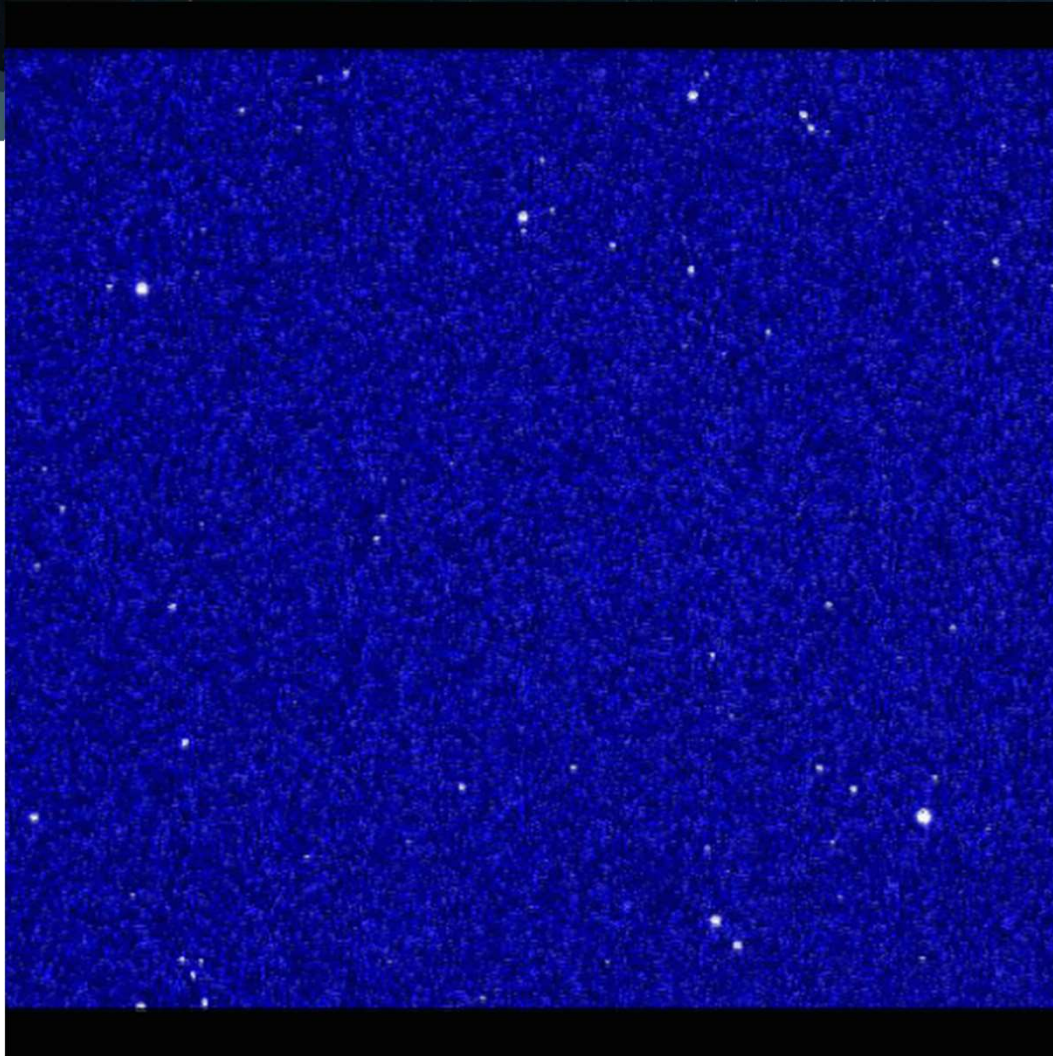


SPACE TRAFFIC SERVICES: ESTÁGIOS DA VIGILÂNCIA DO ESPAÇO



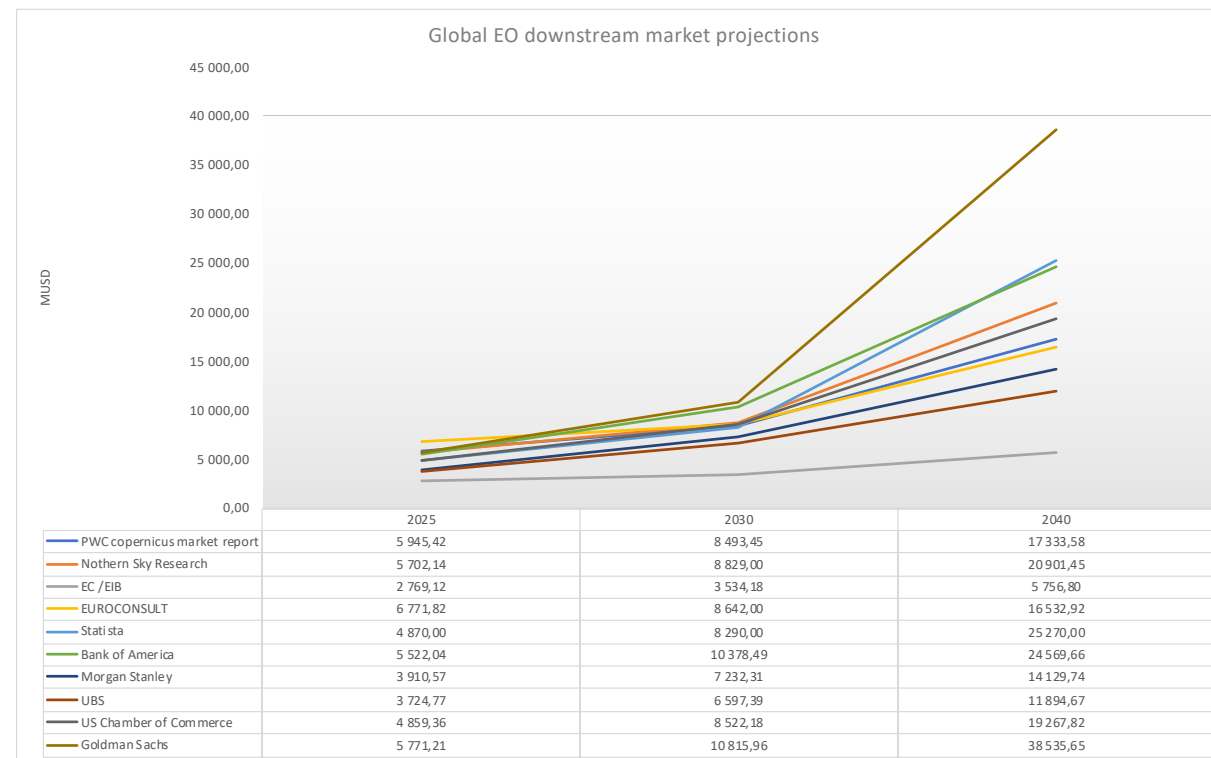


SPACE TRAFFIC SERVICES: OBJECT DETECTION



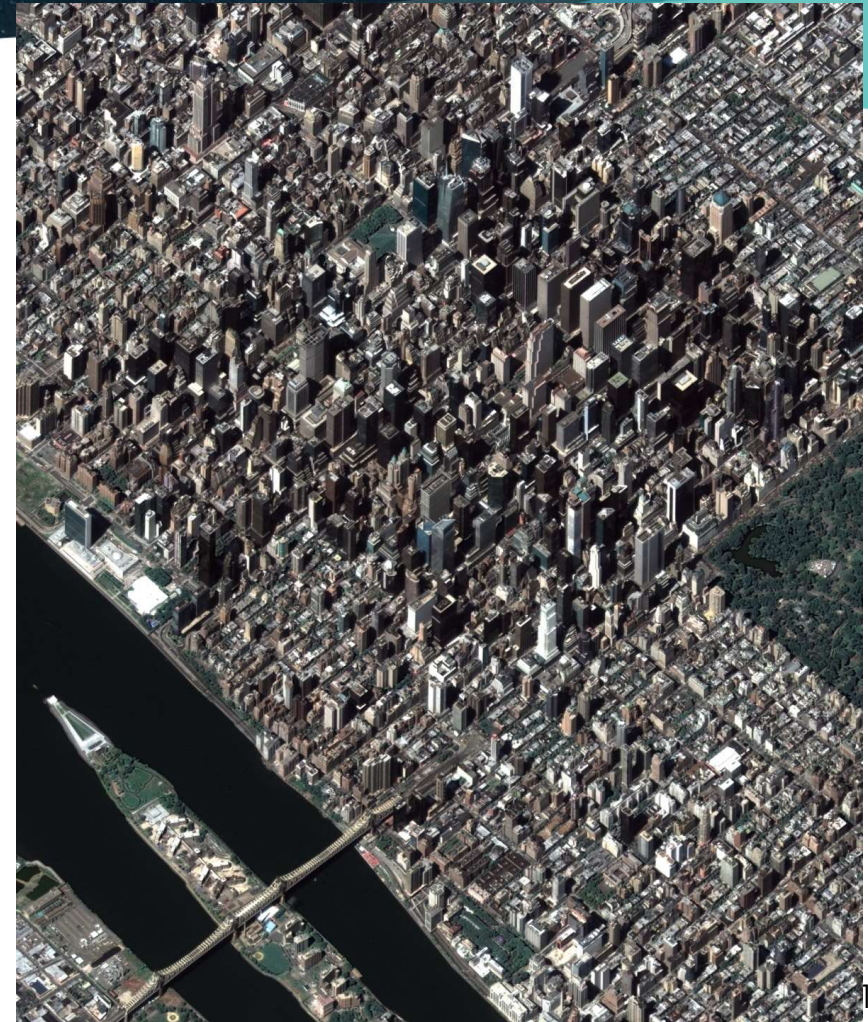
EARTH OBSERVATION: HIGH PRIORITY

- Investment in EO foster job creation in 3 different markets, the multiplication effect is amplified:
 - Upstream space market with space segment, ground segment and launch activities → space components manufacture
 - Downstream EO data sales segment → space operators market
 - Downstream EO added value products and services → ecosystem of value added companies (AI, Big Data, Machine Learning, ...)



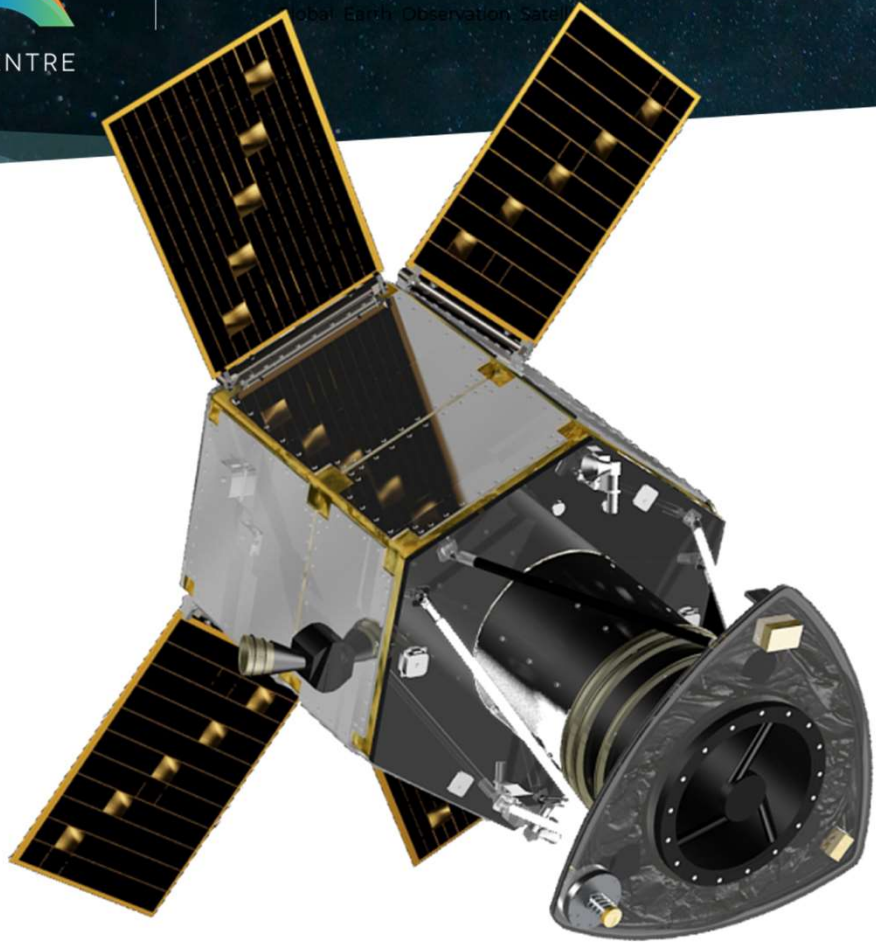
EARTH OBSERVATION: HIGH PRIORITY

- **EO products helps to solve the global challenges in line with the Green Deal EU strategy:**
 - **Climate change, environment monitoring, biodiversity protection**
 - **Optimization of agriculture, water and natural resources, forestry management, detect deforestation**
 - **Disaster monitoring (fires, flooding, tsunamis, earthquakes, volcanoes)**
 - **Urban monitoring, cadaster, cartography, air quality, smart cities**
 - **Defence applications: intelligence, border control, illegal traffic, security, safety and search and rescue**
 - **Oil and gas, energy, tourism, transport, utilities and civil emergency**



GEOSat acquired the Business Units of Urthecast in Spain:

- Satellite GEOSAT-2 (12km swath @75cm) [former Deimos-2]
- Satellite GEOSAT-1 (625km swath @22m) [former Deimos-1]
- 10m Antenna in Boecillo, Valladolid, Spain
- Hardware for data storage, processing and delivery
- Software for Mission planning, Image processing and delivery
- Team of 46 people
- Facilities in Spain (Boecillo and Puertollano)
- Imagery Archive (6 billion km² mid res, 100 million km² very high res)



GEOSAT-2



GEOSAT-1



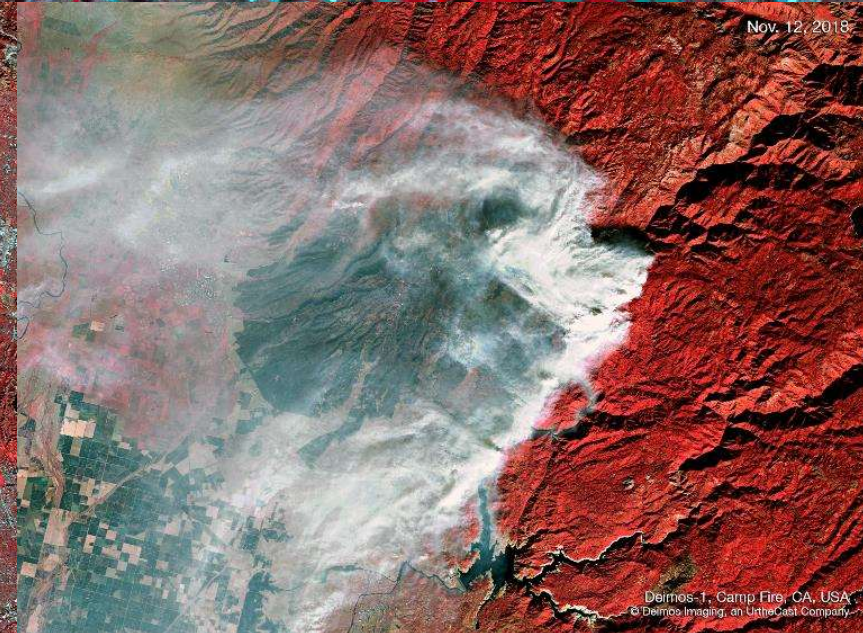
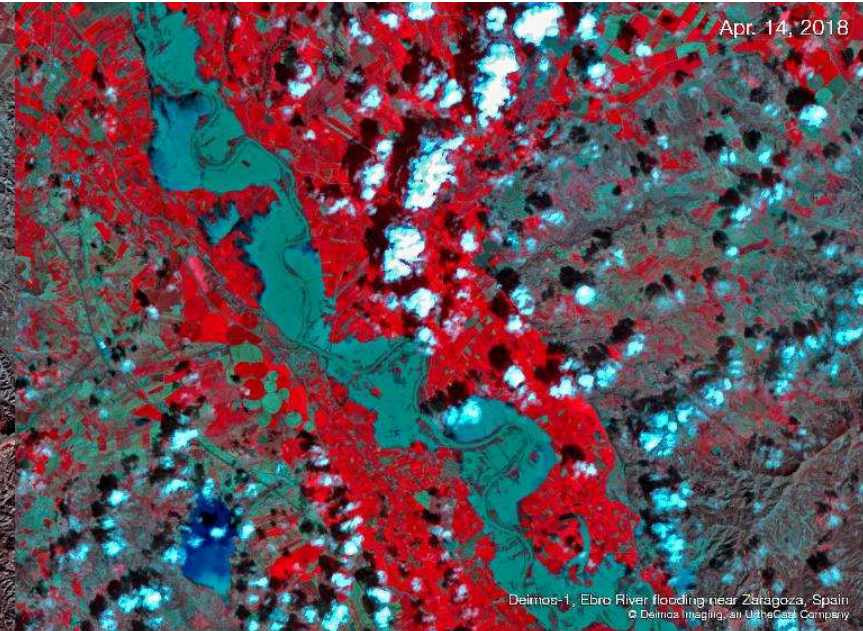
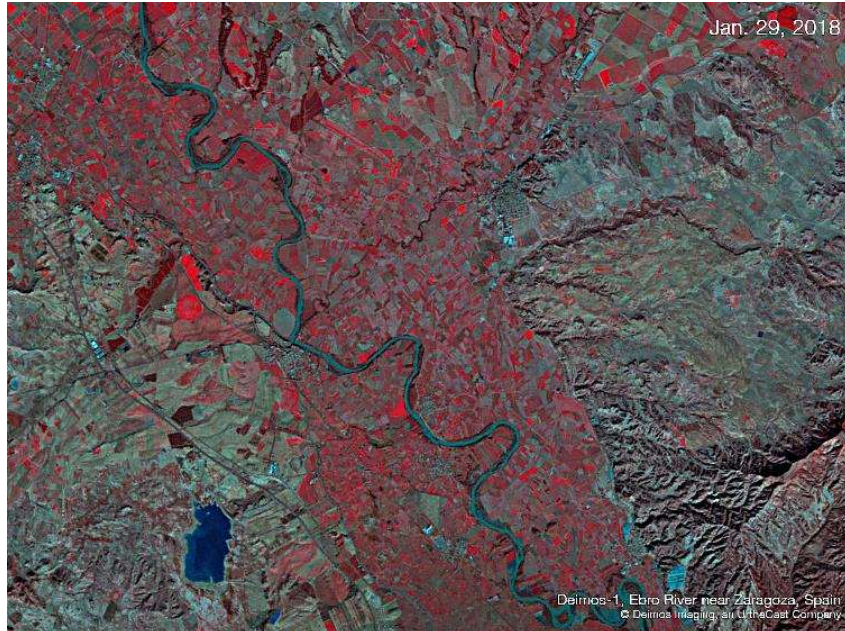
PRODUCTS: GEOSAT-1 Imagery

Wide coverage capability
(625km swath @ 20m)

Agriculture

Environmental management

Maritime traffic monitoring





PRODUCTS:
GEOSAT-2
Imagery

Very high res capability
(12km swath @ 75 cm)

Traffic monitoring

Land registry

Change detection

Homeland security

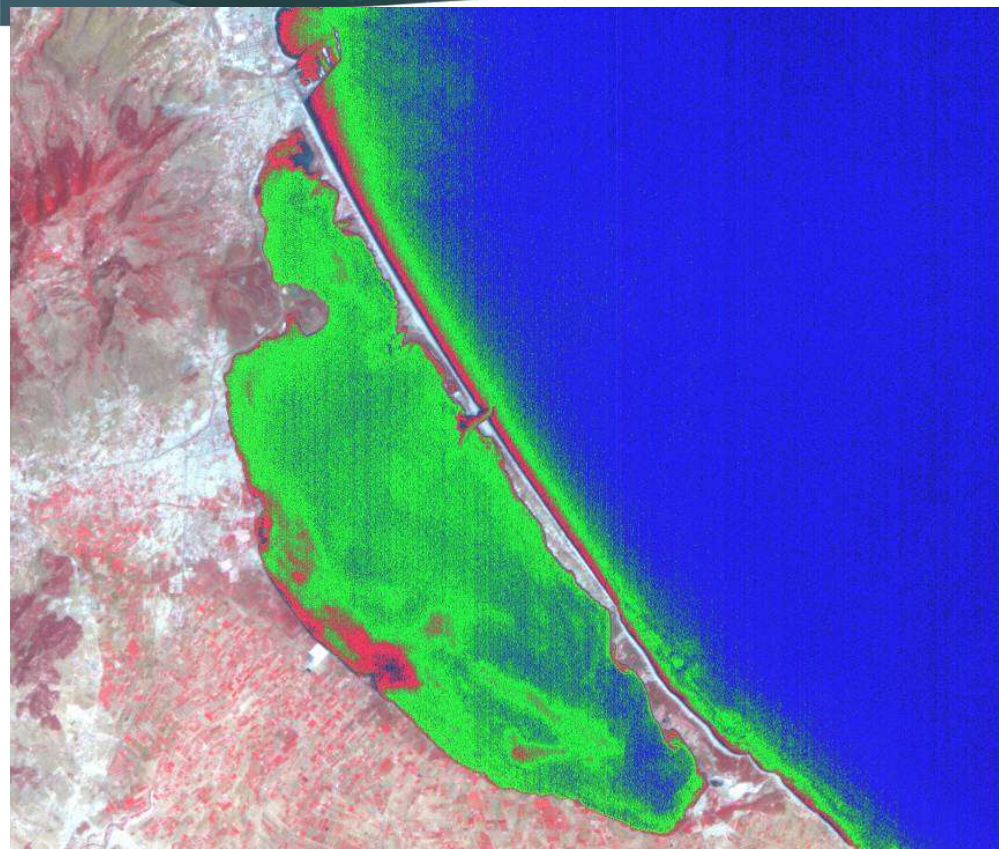


Deimos-2 Image, Daqing Oil Refinery, Heilongjiang, China, Apr. 01, 2017
© Deimos Imaging, an UrtheCast Company

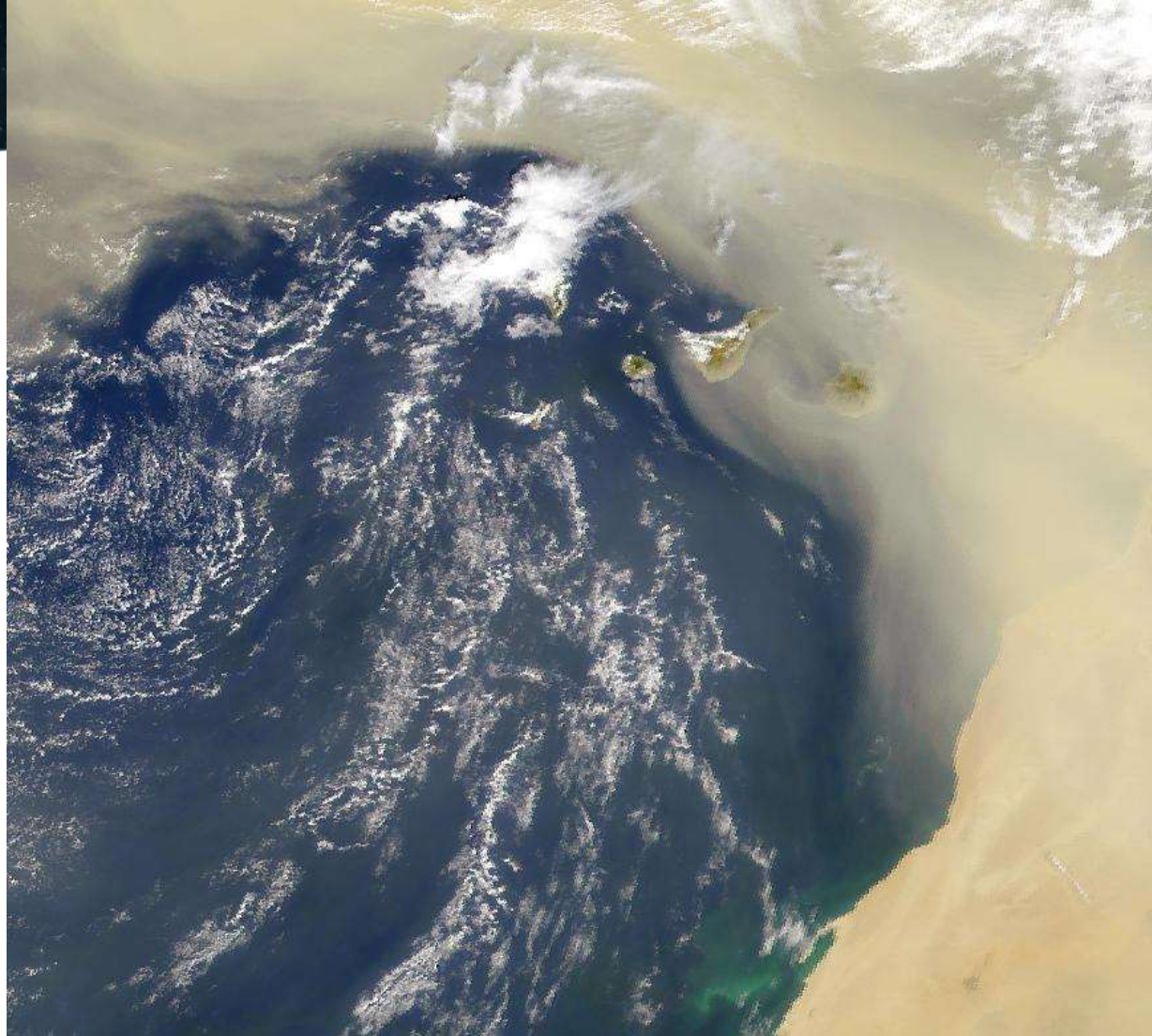
Deimos-2 Image, Port of Long Beach, CA, USA, Apr. 27, 2017
© Deimos Imaging, an UrtheCast Company



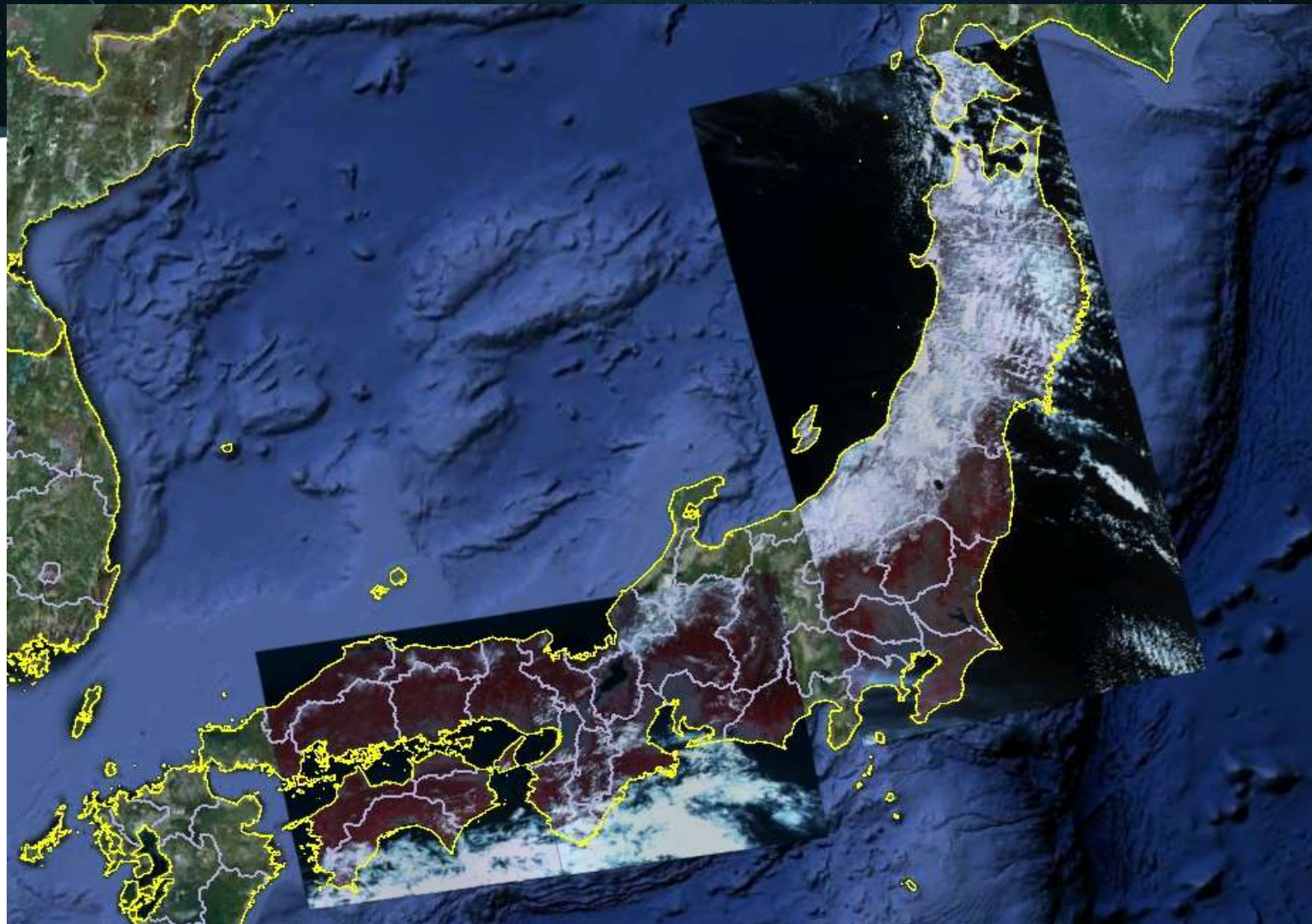
COASTAL POLLUTION CONTROL



COASTAL POLLUTION: AIR QUALITY CONTROL

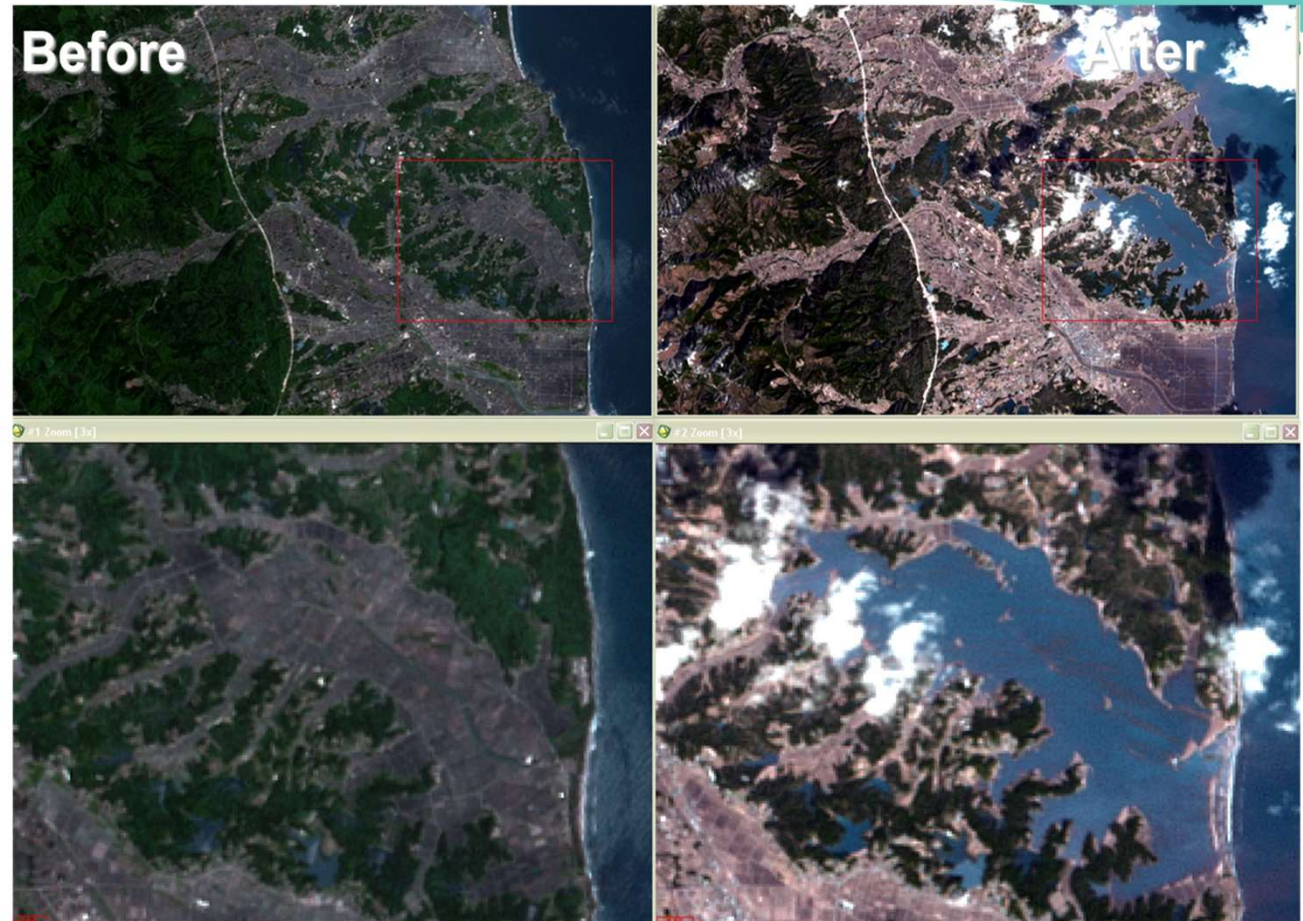


DISASTER MONITORING: TSUNAMI IN JAPAN (FUKUSIMA)

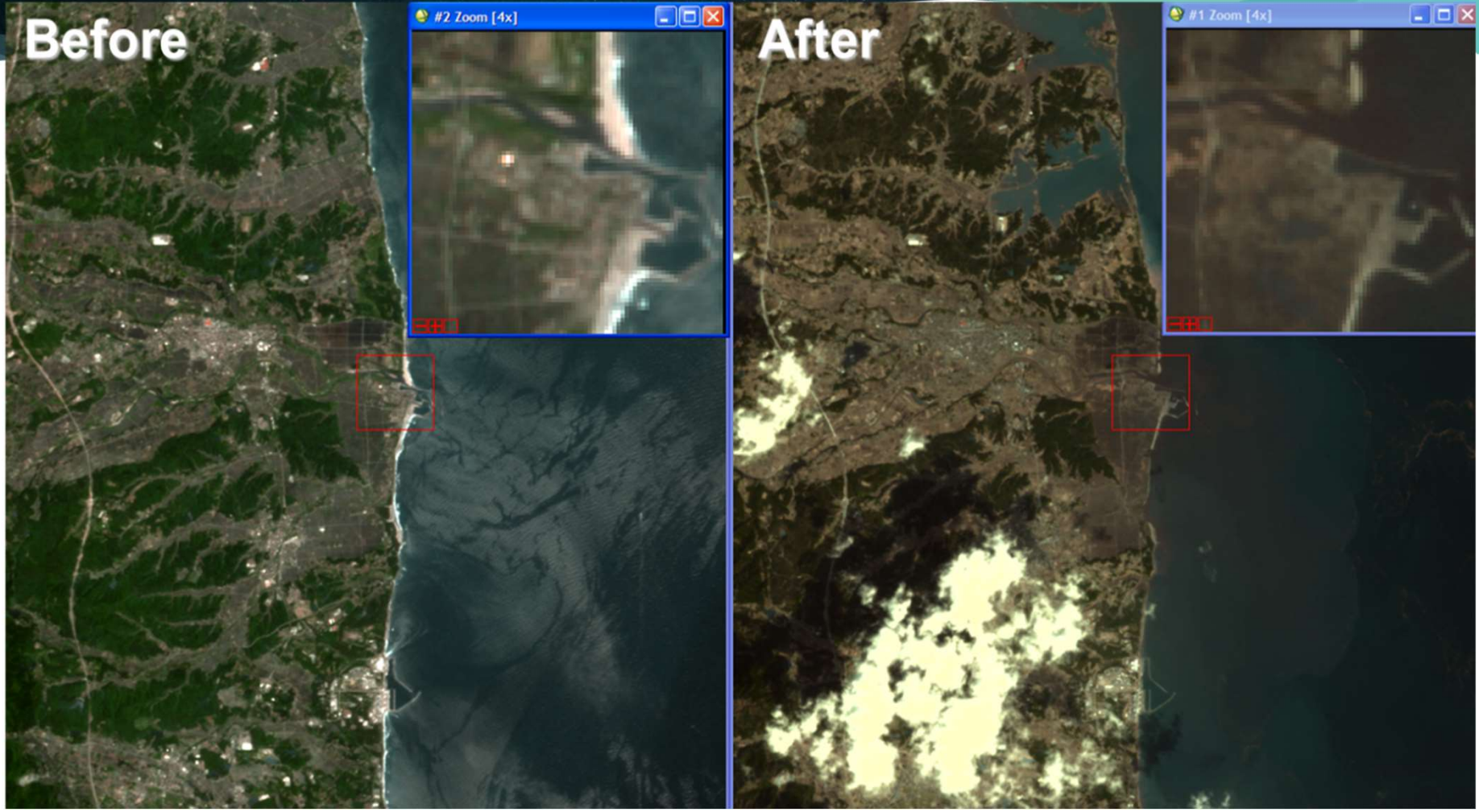


COAST NATURAL DISASTER MONITORING: TSUNAMI IN JAPAN

- **Satellite radar and optical imagery are also a valuable tool for mitigation of coast natural disasters**
- **Change detection algorithms provide a first alarm in case of large affected areas**
- **This image presents áreas of Japan before and after the tsunami, a quick analysis of infrastructures was done with above techniques**



DISASTER MONITORING: TSUNAMI IN JAPAN (FUKUSIMA)



COAST NATURAL DISASTERS: FLOODING (Katrina)





DISASTER MONITORING: VOLCANOS



deimosimaging
an urtheCast company



Calbuco volcano, Chile - 24 April 2015, DEIMOS-2 75cm Pansharpned Image

© DEIMOS Imaging, 2015

INTELIGENCE: KABUL AIRPORT (AUG 26)





INTELIGENCE: AIR BASE





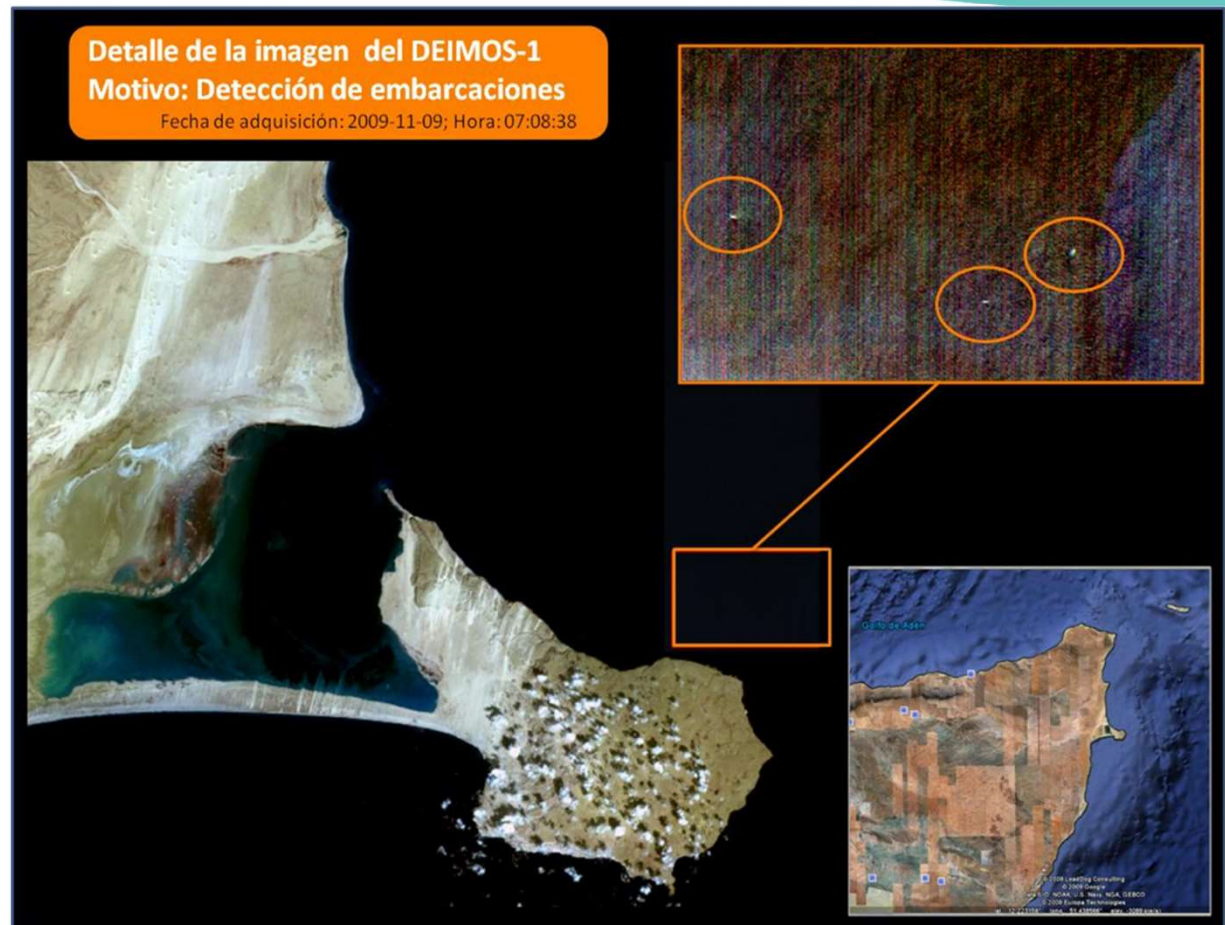
INTELIGENCE: AIR BASE



Davis-Monthan Air Force Base, Tucson, AZ, June 2014

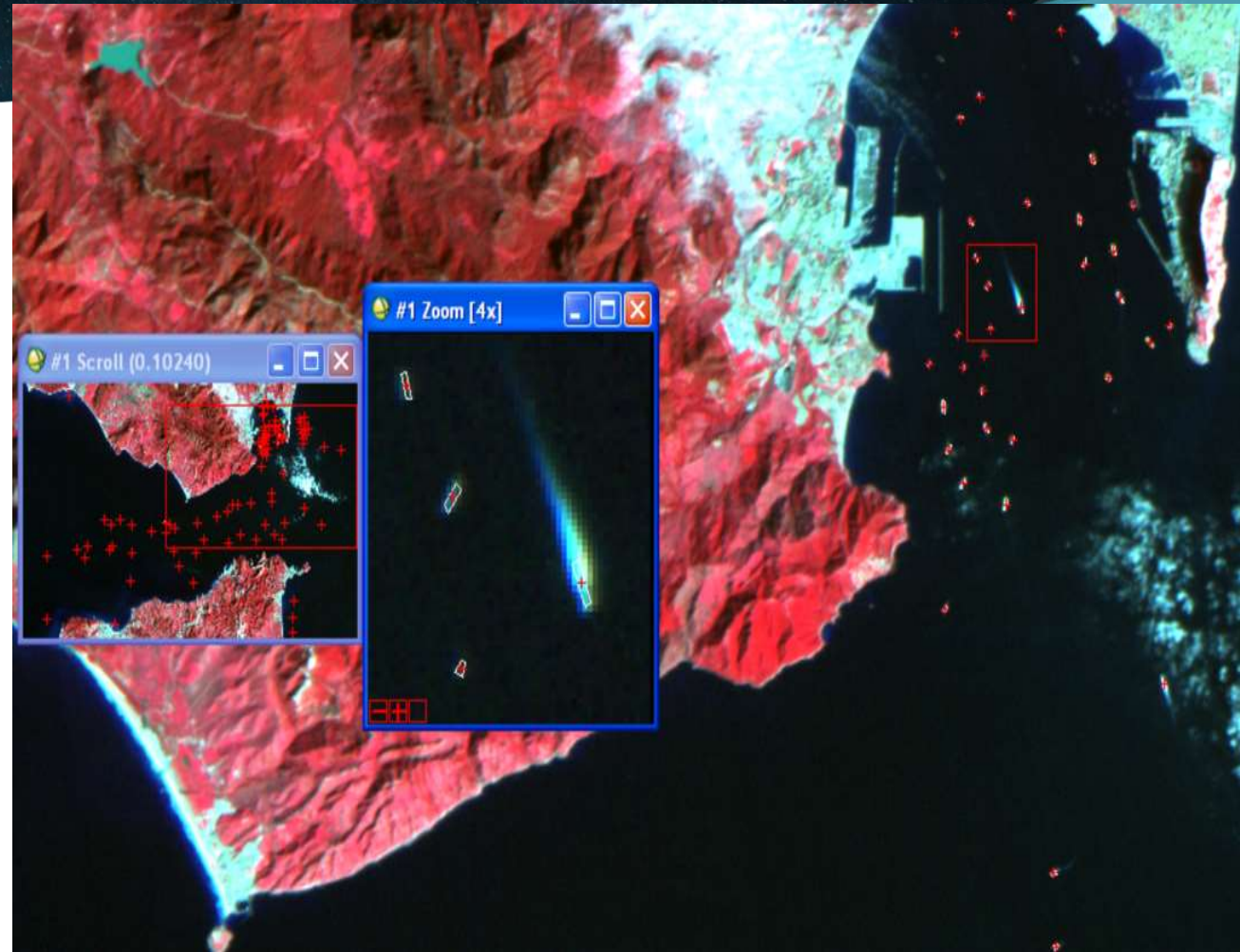
DEIMOS-2 imagery © DEIMOS Castilla La Mancha, 2014

- **Satellite and radar optical imagery are also used for coastal safety issues like fight against piracy**
- **The behaviour of the pirate boats can be identified thanks to Machine Learning techniques**
- **This image presents some pirates boats in the Indic Ocean waiting for vessels to attack**

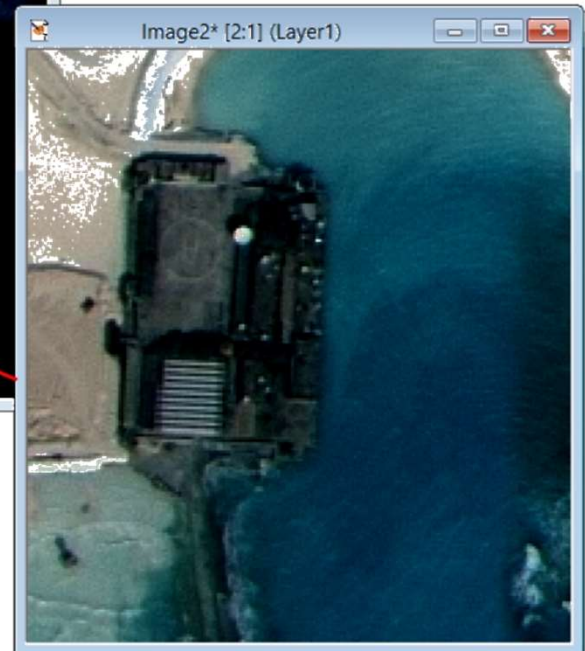


CONTROL OF ILLEGAL VESSEL TRAFFIC

- The combination of AIS + satellite optical or SAR data + AI algorithms allows the identification of illegal vessel traffic
- This image presents the maritime traffic on Gibraltar strait, AIS data is overlaid on satellite optical imagery, allowing to detect unidentified vessels suspicious of illegal immigration or narcotraffic



DETECT SUSPICIOUS OPERATIONS





DETECT SUSPICIOUS OPERATIONS



TERRORISM: BOKO HARAM CAMEROON



TERRORISM: BOKO HARAM CAMEROON



TERRORISM: BOKO HARAM CAMEROON

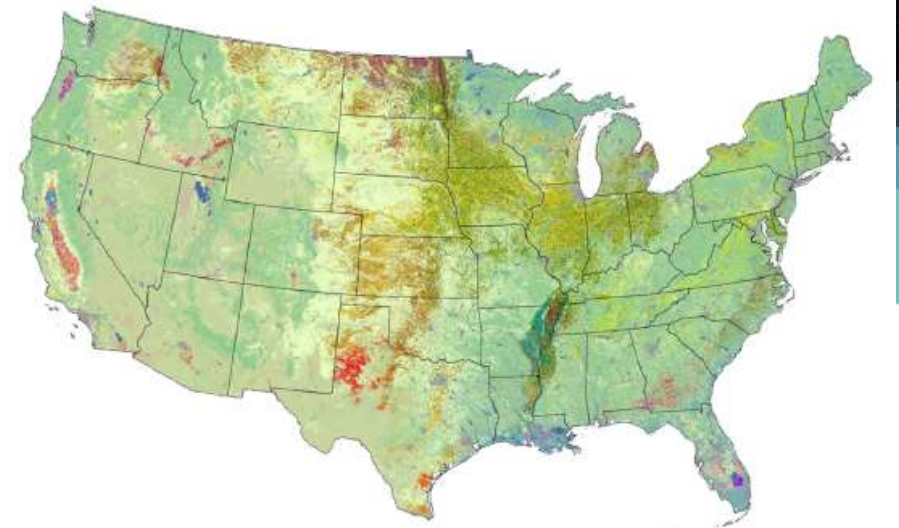
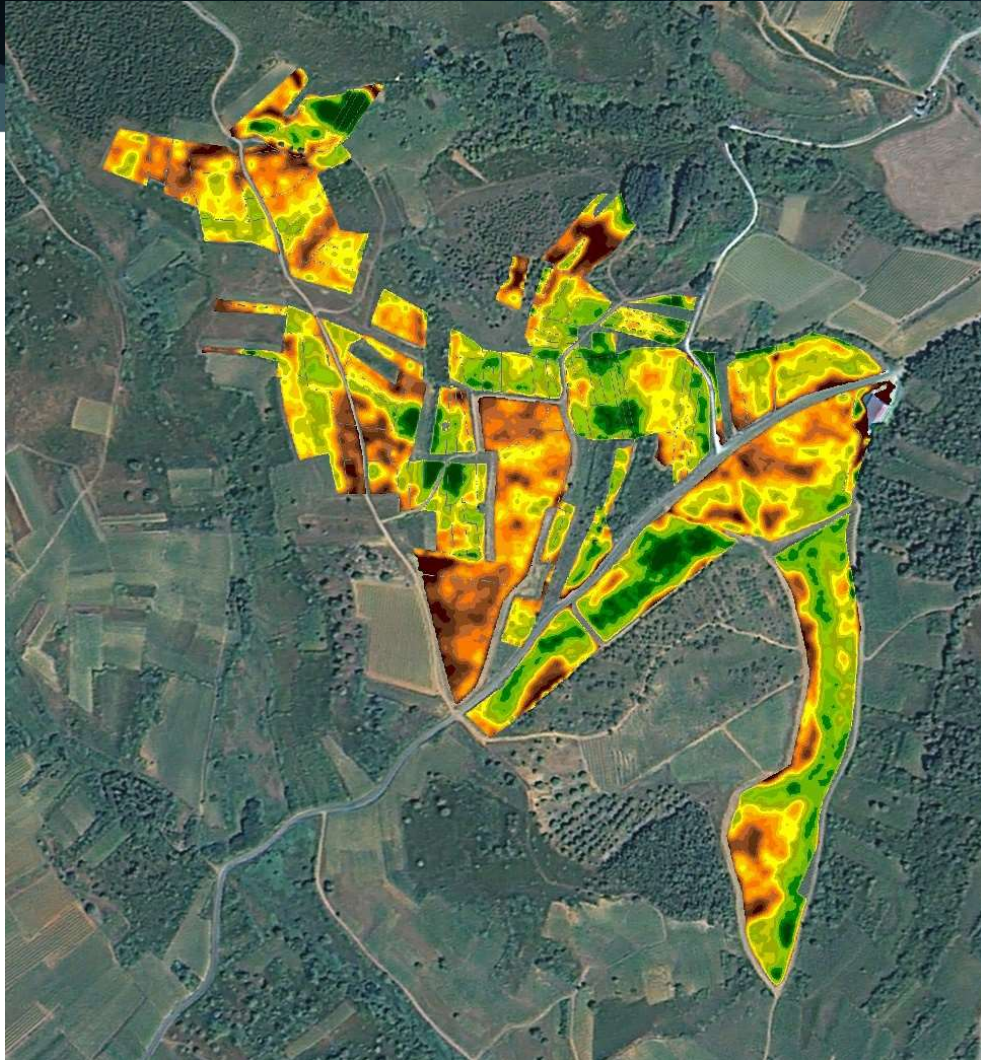


TERRORISM: BOKO HARAM CAMEROON



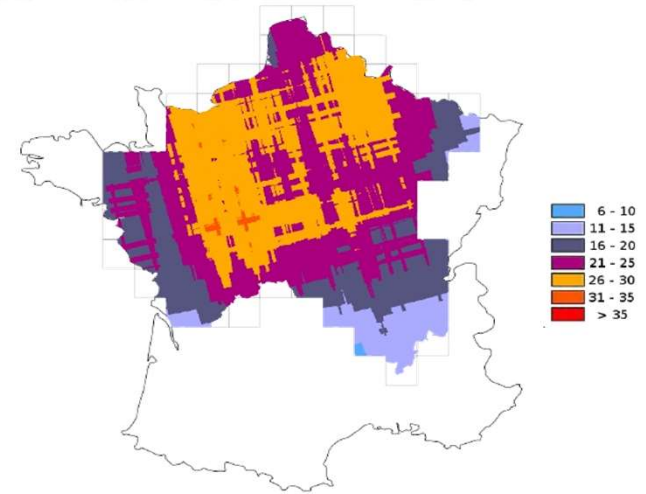


AGRICULTURE



Major Land Cover Categories

Agriculture	Non-Agriculture
Pasture/Grass	Woodland
Corn	Shrubland
Soybeans	Urban/Developed
All Wheat	Wetlands
Other Hay	Water
Fallow/Idle Cropland	Barren
Alfalfa	Perennial Ice/Snow
Cotton	
Other Crops	
Vegetables/Fruits/Nuts	
Sorghum	
Other Small Grains	
Rice	

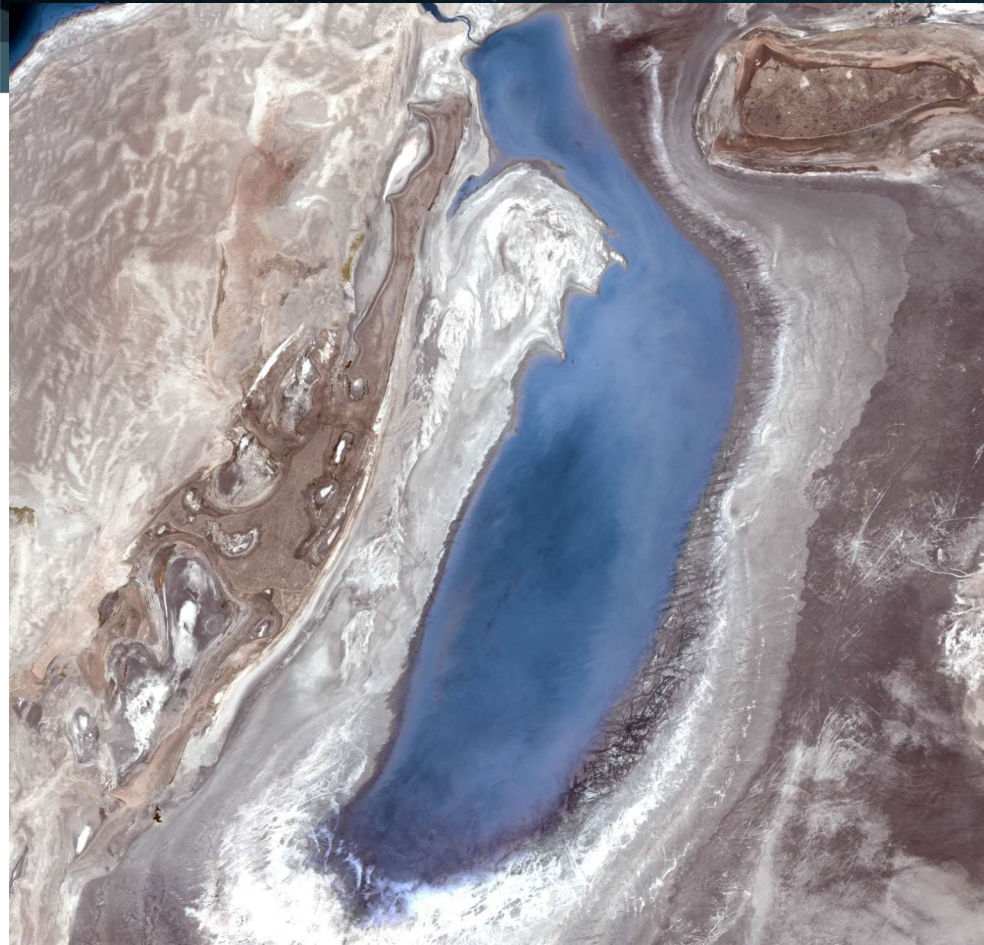


6 - 10
11 - 15
16 - 20
21 - 25
26 - 30
31 - 35
> 35

Number of times that every area has been captured within FARMSTAR 2013 campaign.

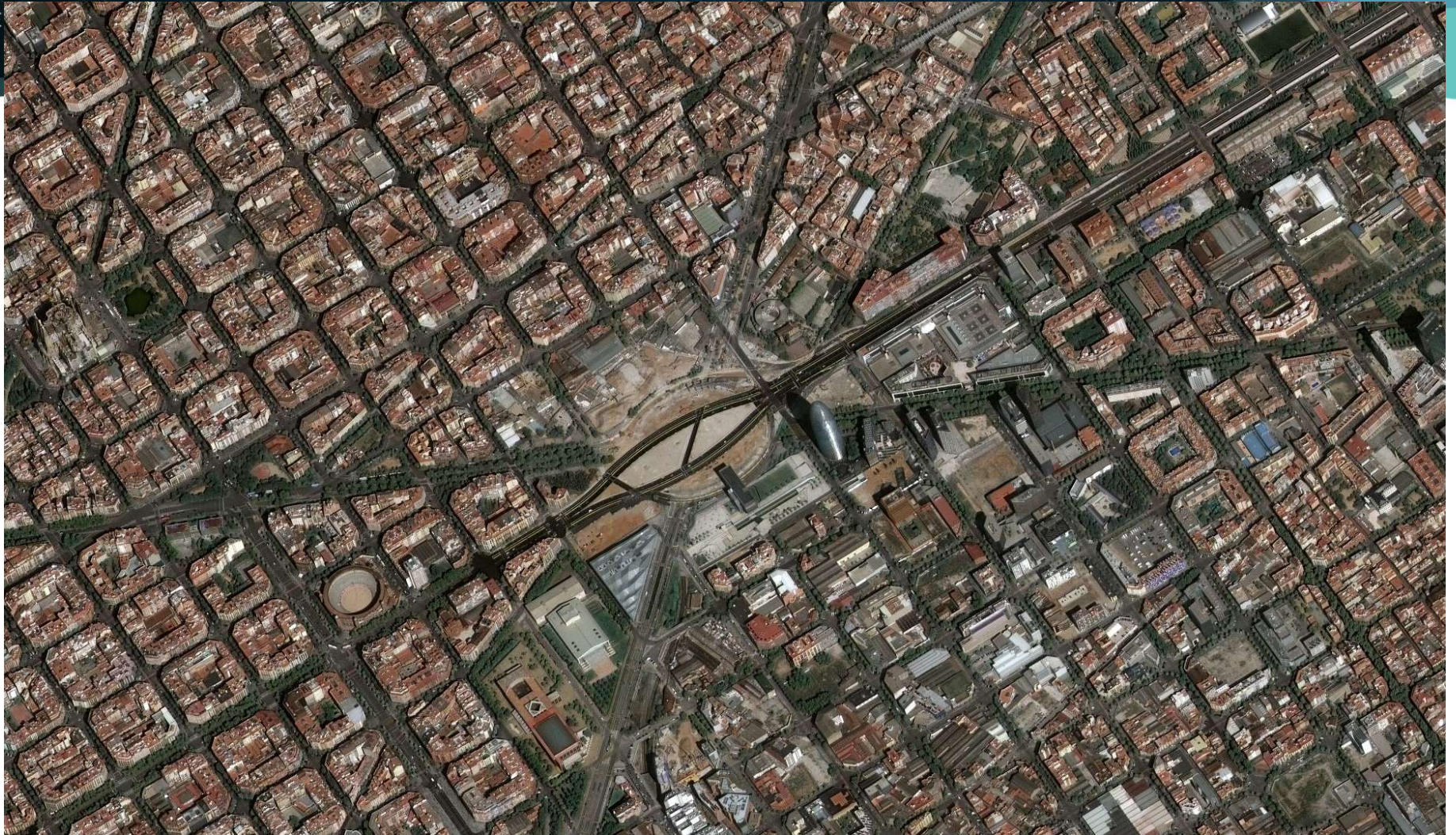


CLIMATE CHANGE, DEFORESTATION





URBANISM, CARTOGRAPHY, CADASTER



URBANISM, CARTOGRAPHY, CADASTER



FLOODING EBRO RIVER: BEFORE AND AFTER



FLOODING EBRO RIVER: BEFORE AND AFTER





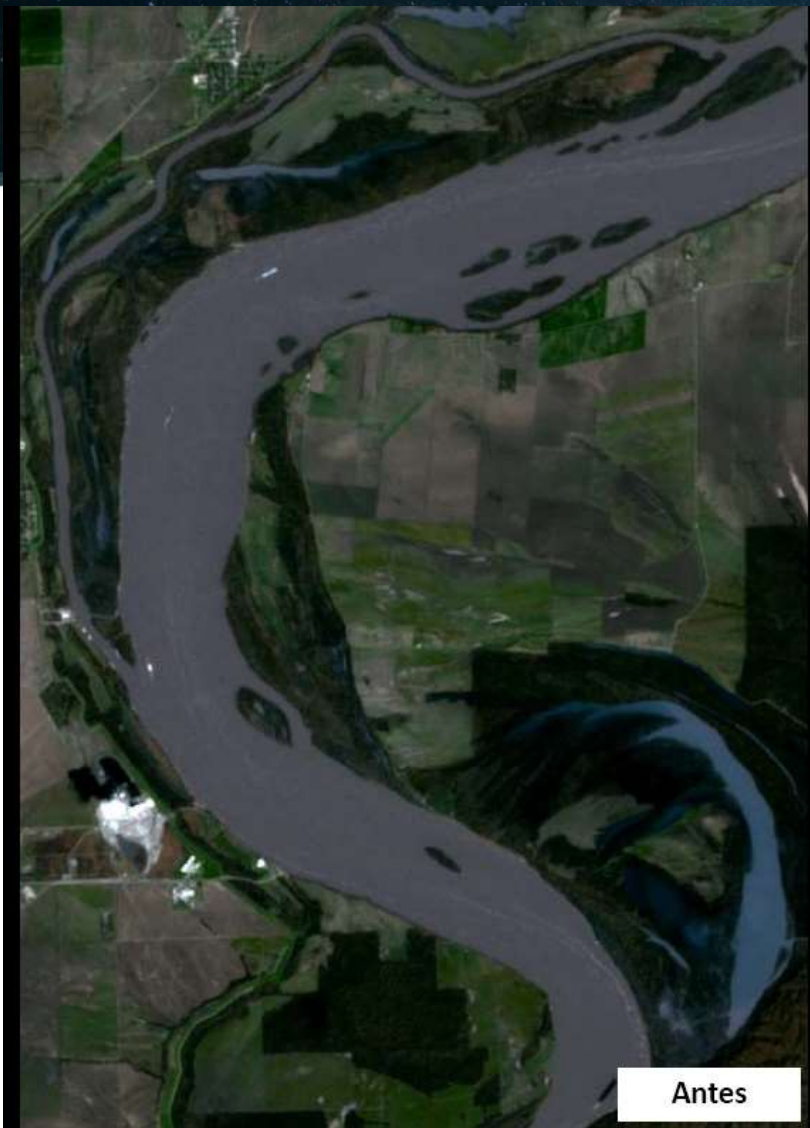
FLOODING EBRO RIVER: BEFORE AND AFTER



GERMANY FLOODING 2021



USA FLOODING



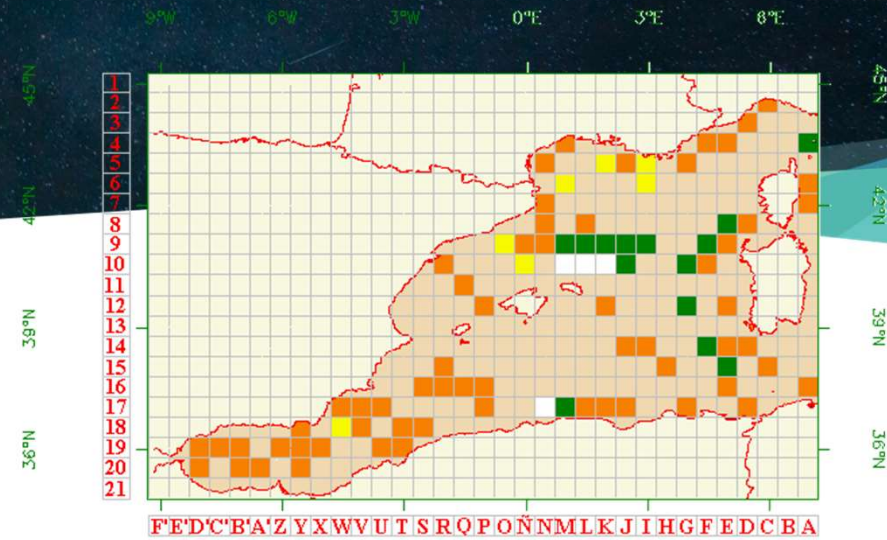
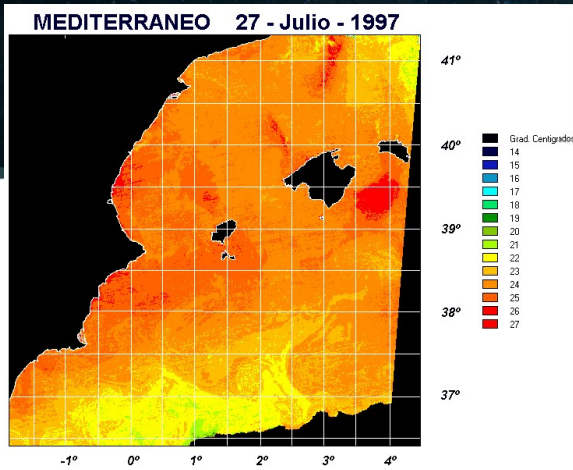




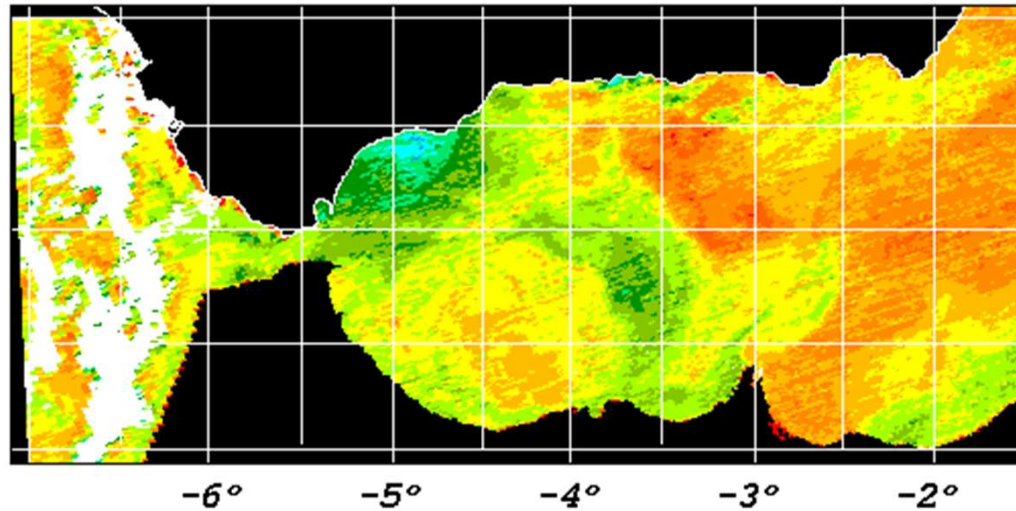
GEOSAT 1, Fire in Avila, Spain



FISH SUPPORT



ALBORAN 08 - Agosto - 1997





GEOSAT

GEOSTRATEGIC ANALYSIS



TARGET GOALS



- **The development of Earth Observation systems should target to the following goals:**
 - **Creation in Portugal of prime system integrator – operator which complete the space value chain**
 - **Generates a unique opportunity for the development of an ecosystem of small companies and startups that produce value-added services**
 - **Positions Portugal as key player in the Atlantic and fosters international collaboration with AIR partners**
 - **Generation of high qualified jobs in the different lines of the value chain and return of investment**

- The actions needed to promote the EO space industry are:
 - Foster use of EO satellite data in public institutions (cadaster, forest inventories, disaster management, water resources management, agricultural insurance)
 - Implementation of agile “Innovation Public Procurement” mechanisms
 - Support potential private users by giving facilities to access loan or tax advantages
 - Open privileged access to venture capital or capital risk for startups or small companies in the EO industry
 - Stimulate new vocations in this technical domain and increase the number of graduates in the applicable sciences



POTENTIAL SOURCES OF FUNDING



- **Different funding sources can be envisaged for the development of EO system industries in Portugal:**
 - **Recovery Plan, the PRR is one of the most suitable mechanisms, but it is not the only one**
 - **Private investment from the Portuguese space industry**
 - **Private investment from foreign space industries with strategic agreements**
 - **Private investments from Venture Capital or specialized Technological Investment Funds**
 - **Support from other R&D funding mechanisms like ESA, Horizon Europe or PT2030**
 - **The European Investment Bank (EIB)**

- After more than 60 years of space exploration, space is now the new frontier of business
- The traditional satellite telecommunications sector is now extended with new business like space tourism or asteroid mining
- Space Traffic Services emerge like a new commercial sector due to the congestion of space debris
- Earth Observation is the most attractive new space sector as it includes three markets and provides unique data to solve global challenges aligned with the EU Green Deal
- In this context, the development of EO systems is a very attractive project to promote the Portuguese industry at the level of system prime for the first time while providing valuable data for the space-climate-ocean interactions and fostering international collaboration

