

Europe and Space : the European Space Agency (ESA)

Chris de Cooker

Head of the ESA International Relations Department

Sofia, 13 January 2011

- **(Why) Space**
- **ESA**
- **ESA and Europe**
- **ESA cooperation with EU Member States**



- **Space as inspiration : education, outreach**
- **Space as innovation + strategic significance**
- **Space part of daily life :**
 - weather forecasting
 - air traffic control
 - communications and broadcasting
 - disasters (prevention and relief), etc
- **Space as tool for challenges of 21st century :**
 - environmental monitoring
 - management of natural resources
 - security and safety, etc.
- **“Space : a key asset for Europe to meet global challenges”**
- **Space as an economic driver**

The European Space Agency (ESA)

Convention signed in 1975, entry into force 1980

- **ESA was formed in 1975 as a successor to ELDO and ESRO.**
- **ESA has today eighteen Member States :**
Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Norway, the Netherlands, Portugal, Spain, Sweden, Switzerland, and the United Kingdom.

(Austria and Norway joined in 1987, Finland in 1995, Portugal in 2000, Greece and Luxemburg in 2005. The Czech Republic in 2008 and Romania will in 2011)
- **Two candidate Member States :**
Hungary, Romania
- **Relations with other EU Member States**
- **Canada**

“To provide for and promote, for exclusively peaceful purposes, cooperation among European states in space research and technology and their space applications.” [Article 2 of ESA Convention]

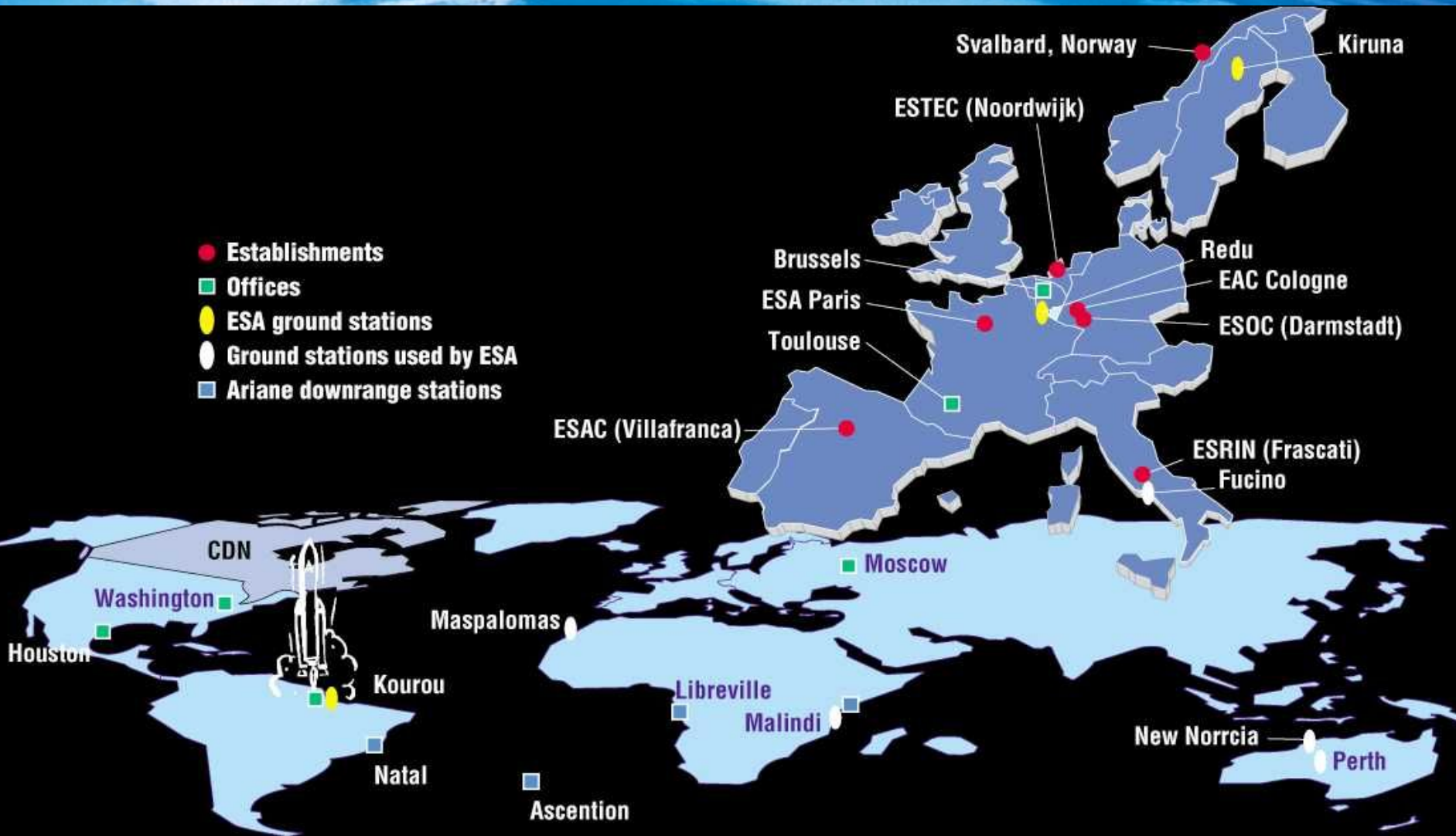
ESA is one of the few space agencies in the world to combine responsibility in all areas of space activity.

- Space science
- Human spaceflight
- Exploration
- Earth observation
- Launchers
- Navigation
- Telecommunications
- Technology
- Operations



ESA world locations

- Establishments
- Offices
- ESA ground stations
- Ground stations used by ESA
- Ariane downrange stations



COUNCIL

- **SCIENCE PROGRAMME COMMITTEE (SPC)**
- **ADMINISTRATIVE & FINANCE COMMITTEE (AFC)**
- **INDUSTRIAL POLICY COMMITTEE (IPC)**
- **INTERNATIONAL RELATIONS COMMITTEE (IRC)**
- **SECURITY COMMITTEE (SEC)**
- **SPACE SITUATIONAL AWARENESS COMMITTEE (SSA)**

PROGRAMME BOARDS

- COMMUNICATIONS
- EARTH OBSERVATION
- LAUNCHERS
- HUMAN SPACEFLIGHT, MICROGRAVITY AND EXPLORATION
- NAVIGATION

DIRECTOR GENERAL

ESA programmes : mandatory and

All Member States participate (on a GNP basis) in activities related to Space Science and in a common set of programmes (Mandatory programmes).

In addition, Member States choose their level of participation in Optional programmes.

Mandatory

- General Budget: Future studies, technological research, education, common investments (facilities, laboratories, basic infrastructure)
- Science: Solar System science, astronomy and fundamental physics

Optional

- Human spaceflight
- Telecommunications
- Earth observation
- Launchers
- Navigation
- Robotic exploration

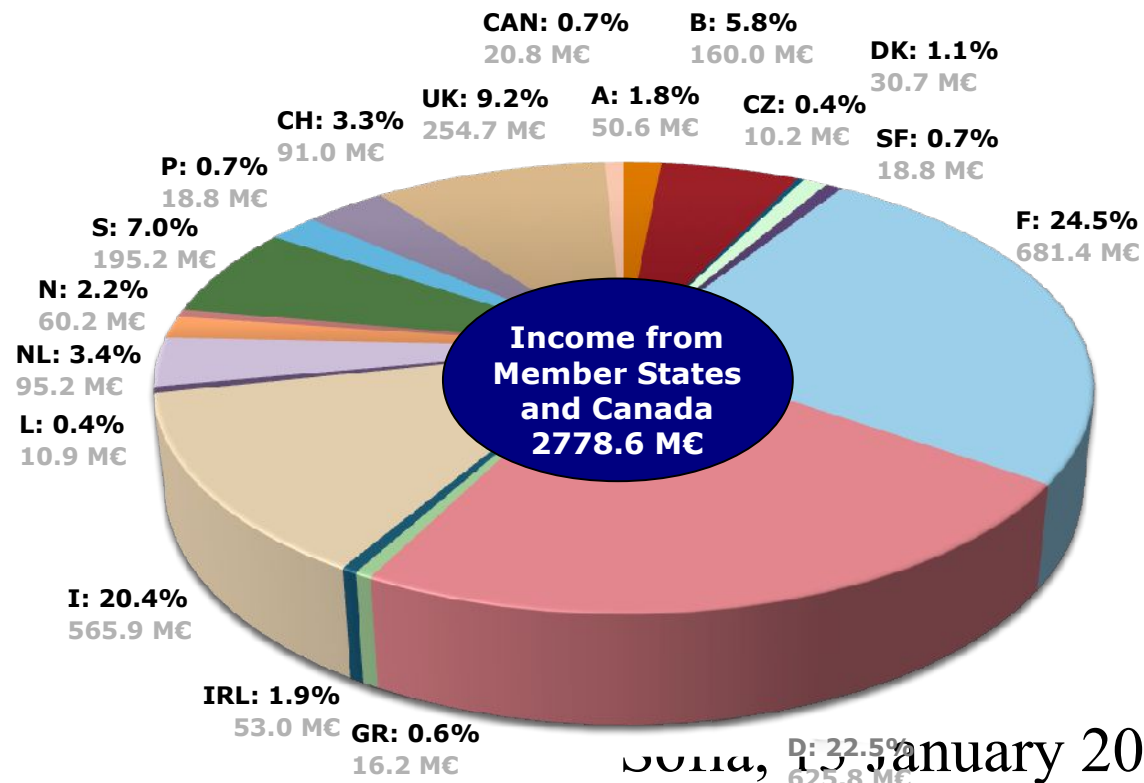
ESA Budget 2010 – almost 90% return to European industry

Income

Income from member states and Canada	2778.6 M€ (74.2%)
Income from projects with EU	754.8 M€ (20.2%)
Income from cooperating members	5.2 M€ (0.1%)
Other income	206.1 M€ (5.5%)
Total	3744.7 M€ (100%)

Expenditure

Earth Observation	684 M€ (18.3%)
Launchers	662 M€ (17.7%)
Science	610 M€ (16.3%)
Human Spaceflight	427 M€ (11.4%)
Telecom	358 M€ (9.6%)
Navigation	148 M€ (3.9%)
Technology	108 M€ (2.9%)
....	



**89% of the ESA Budget is returned to European industry -
Mainly for research and development**

Industrial policy

About 90% of ESA's budget is spent on contracts with European industry.

Industrial policy objectives:

- maintain and develop space technology,**
- improve the worldwide competitiveness of European industry,**
- encourage the development of an industrial structure appropriate to market requirements, making use of existing industrial potential of all Member States,**
- ensure that all Member States participate in an equitable manner corresponding to their financial contribution.**



Sofia, 13 January 2011

13

Europe as a global space player

- **Increased role for space in support of Europe**
- **Strategic importance of space for Europe to achieve its goals, both in Europe and in the world**
- **2 EU flagship programmes : Galileo and GMES**
- **The need for a European Space Policy**
- **Stronger cooperation between ESA, the EU and the Member States**
- **Commitment by 29 countries**
- **ESA as a partner**

EU and ESA

- Increasing cooperation => Framework Agreement entered into force on 28 May 2004. Space Councils. Joint Secretariat.
- On 22 May 2007, 29 Ministers (of ESA and EU) endorsed a European Space Policy, which had been prepared by the EC and the DG of ESA.
- Policy allows EU, ESA and their member States to increase coordination of their activities and programmes, and organise their respective roles relating to space, providing a more flexible framework to facilitate European investment in space activities.

**CONSOLIDATED VERSION OF THE TREATY ON THE FUNCTIONING OF
THE EUROPEAN UNION
(OJ C 115/47 of 9 May 2008)**

Article 4

1. The Union shall share competence with the Member States where the Treaties confer on it a competence which does not relate to the areas referred to in Articles 3 and 6.
 - [. . .].
3. In the areas of research, technological development and space, the Union shall have competence to carry out activities, in particular to define and implement programmes; however, the exercise of that competence shall not result in Member States being prevented from exercising theirs.
 - [...]

**CONSOLIDATED VERSION OF THE TREATY ON THE
FUNCTIONING OF THE EUROPEAN UNION
(OJ C 115/47 of 9 May 2008)**

TITLE XIX

**RESEARCH AND TECHNOLOGICAL DEVELOPMENT AND SPACE
[. . .].**

Article 189

1. To promote scientific and technical progress, industrial competitiveness and the implementation of its policies, the Union shall draw up a European space policy. To this end, it may promote joint initiatives, support research and technological development and coordinate the efforts needed for the exploration and exploitation of space.

2. To contribute to attaining the objectives referred to in paragraph 1, the European Parliament and the Council, acting in accordance with the ordinary legislative procedure, shall establish the necessary measures, which may take the form of a European space programme, excluding any harmonisation of the laws and regulations of the Member States.
3. The Union shall establish any appropriate relations with the European Space Agency.
4. This Article shall be without prejudice to the other provisions of this Title.

ESA cooperation with EU Member States

Cooperation in support of “Europe” : socio-economic and political considerations

Recent events

- New space programmes and activities, with significant involvement of the EU (Galileo, GMES);
- Recent enlargement of the EU. Further enlargement?
- European Space Policy adopted on 22 May 2007 by 29 states (members of EU and ESA);
- Request by 2005 ESA MC to “adapt ESA’s institutional framework for associating all interested European states in its space programmes with a view to reinforcing trans-European cohesion.”
- Lisbon Treaty;
- Restructuring of European space industry.

ESA and new(er) Member States of EU

Raison d'être

- **Need for ESA to involve in its activities those EU Member States that are not (or not yet) ESA Members.**
- **All of the countries concerned have expressed their interest to participate in ESA's activities. Some signed cooperation agreements even before joining the EU.**

ECS Agreement

- **ESA created the special status of European Cooperating State in March 2001.**
- **A new status granted to those EU Member States that wish to have closer relations with ESA and ultimately to accede to the ESA Convention.**
- **Duration of the Agreement: in principle five years.**
- **Previous Cooperation Agreement ceases to exist.**

Status

- **Hungary signed a Cooperation Agreement in 1991, which was renewed. It signed the ECS Agreement in April 2003. The current PECS runs until November 2008. Hungary has formally applied to become a member state. It has in the meantime be agreed to renew the ECS Agreement for another period in order to better prepare for membership.**
- **The Czech Republic signed a Cooperation Agreement in 1996, which was renewed. It signed the ECS Agreement in November 2003. The current PECS runs until November 2009. The Czech Republic and ESA signed the Accession Agreement on 8 July 2008, which entered into force on 12 November 2008.**

Status (cont'd)

- Romania signed a Cooperation Agreement in 1992, which was renewed. It signed the ECS Agreement in February 2006. The PECS was signed in February 2007. Romania has applied for membership and accession agreement will be signed on 20 January 2011.
- Poland signed a Cooperation Agreement in 1994, which was renewed. It signed the ECS Agreement in April 2007. The implementing PECS was signed on 28 April 2008.
- Estonia signed a Cooperation Agreement on 20 June 2007. It signed the ECS Agreement on 10 November 2009. PECS was signed on 22 September 2010.
- Slovenia signed a Cooperation Agreement on 9 June 2008. It signed the ECS Agreement on 22 January 2010. PECS was signed on 30 November 2010

Cooperation agreements with other Central and Eastern Europe, status

- **Latvia signed on 23 July 2009**
- **Cyprus signed on 27 August 2009**
- **Slovakia signed on 28 April 2010**
- **Lithuania signed on 7 October 2010**
- **Discussions ongoing with Bulgaria and Malta**

Enlargement

- **Ireland signed Convention on 31 December 1975, ratification was deposited on 10 December 1980, i.e. after entry into force;**
- **Austria started participation in some optional programmes in 1973 with specific agreements – no Framework Cooperation Agreement. Association Agreement signed in October 1979. Membership in December 1986;**
- **Norway started cooperation in Telecommunications programme in 1973. Specific agreements - no Framework Cooperation Agreement. Association agreement in April 1981. Membership in December 1986;**

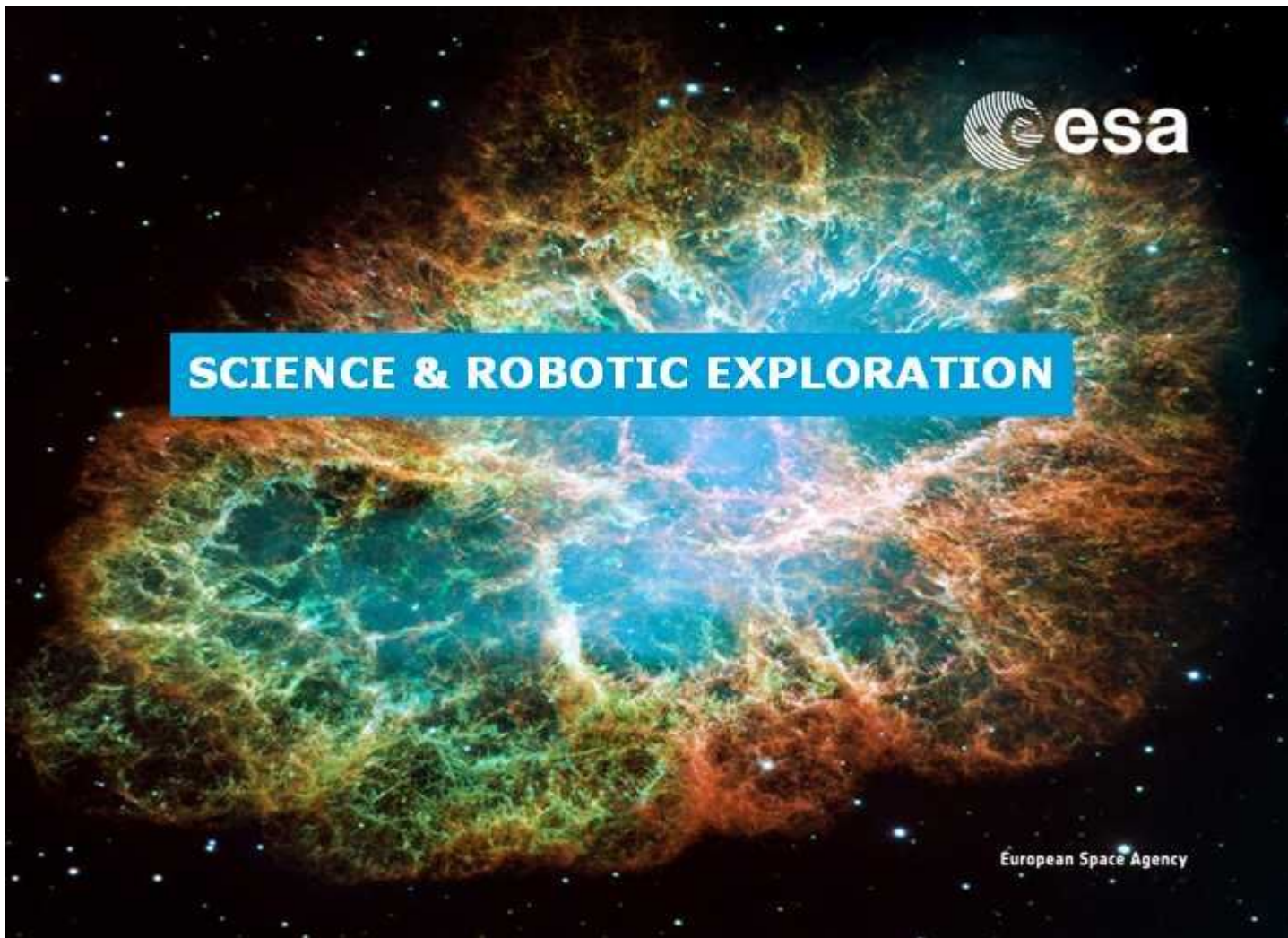
- **Finland started cooperation after the entry into force of the Convention. Association agreement was signed in September 1986. Membership in 1994;**
- **Portugal signed Framework Cooperation Agreement in July 1996. membership in 2000;**
- **Greece signed Framework Cooperation Agreement in January 2001. Membership in March 2005;**
- **Luxembourg participated in some optional programmes with specific agreements. Membership since June 2005;**
- **Czech Republic signed ECS agreement in 2003 and became an ESA member state on 12 November 2008.**
- **Romania signed a Cooperation Agreement in 1992, which was renewed. It signed the ECS Agreement in February 2006. The accession agreement will be signed on 20 January 2011.**

ANNEX

The image shows the cover of a report titled "ESA'S SPACE PROGRAMMES". The background is a deep blue gradient, with a large, dark, crescent moon in the upper right corner. A thin, light blue horizontal line is visible near the bottom of the image. The title "ESA'S SPACE PROGRAMMES" is written in white, bold, uppercase letters on a dark blue rectangular background in the upper left. In the bottom right corner, the text "European Space Agency" is written in a small, light blue font.

ESA'S SPACE PROGRAMMES

European Space Agency



ESA'S REMARKABLE PIONEERS OF SCIENCE

- **Hipparcos** - most comprehensive star-mapper (1989-93)
- **IUE** - longest-living orbiting observatory (1978-96)
- **Giotto** - closest ever flyby of a comet nucleus (1986)
- **Ulysses** - first craft to fly over Sun's poles (1990-2008)
- **ISO** - first European infrared observatory (1995-98)
- **SMART-1** - first European mission to the Moon (2003-06)



MARS EXPRESS

FIRST EUROPEAN MISSION TO MARS (2003)

- Returning breathtaking high-resolution 3D images
- Finding water ice and traces of methane, possible conditions for life...
- First mission to probe beneath Martian surface



FIRST LANDING ON A WORLD IN THE OUTER SOLAR SYSTEM

In 2005, ESA's Huygens probe made the most distant landing ever, on Titan, the largest moon of Saturn (about 1 427 million km from the Sun).



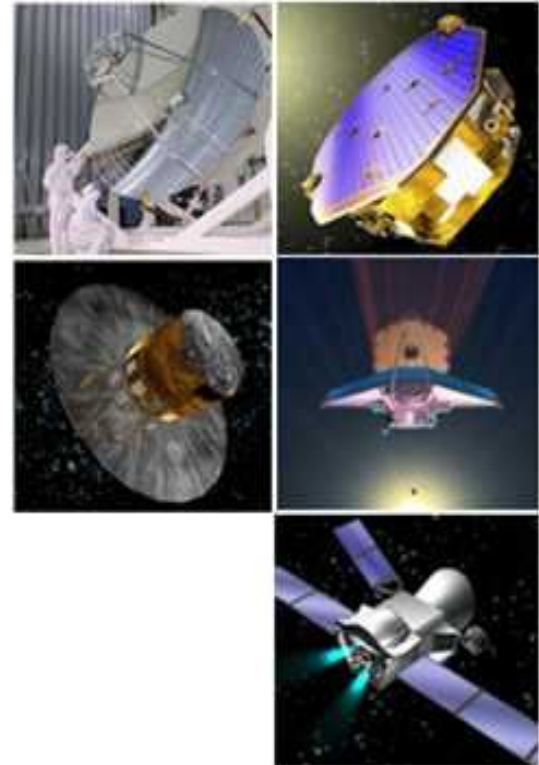
TODAY'S SCIENCE MISSIONS

Some of the missions now exploring our Solar System and helping us to understand our Universe

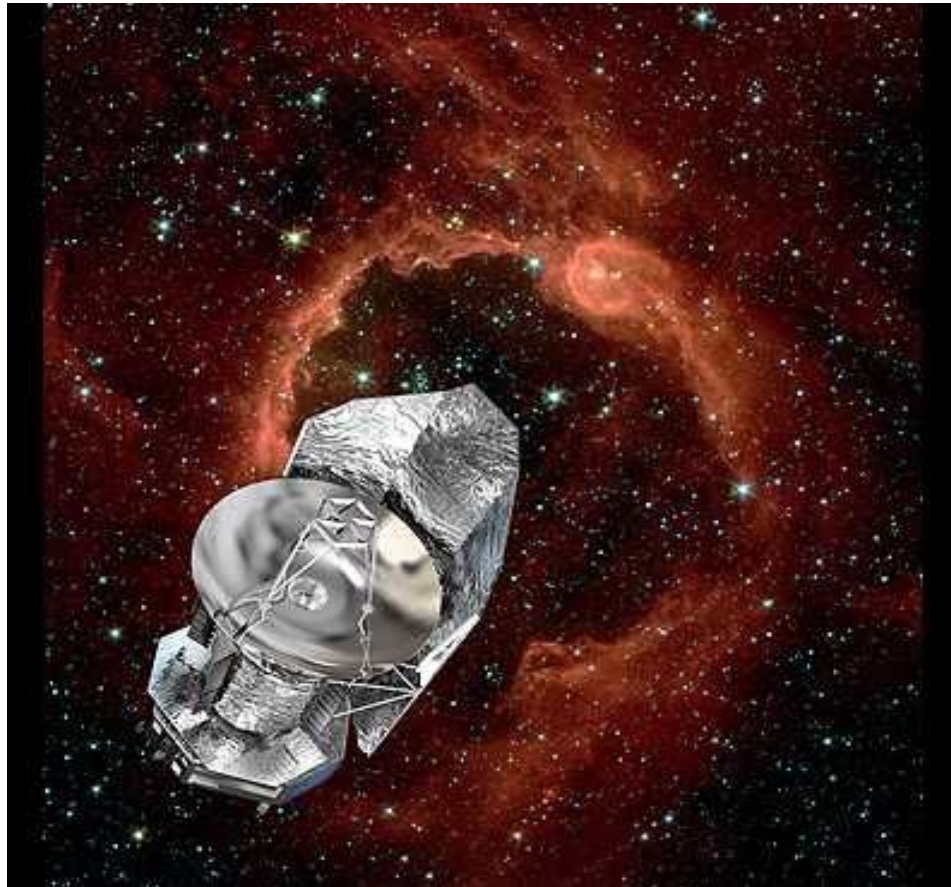
- Hubble (1990-)
- SOHO (1995-)
- XMM-Newton (1999-)
- Integral (2002-)
- Rosetta (2004-)
- Venus Express (2005-)

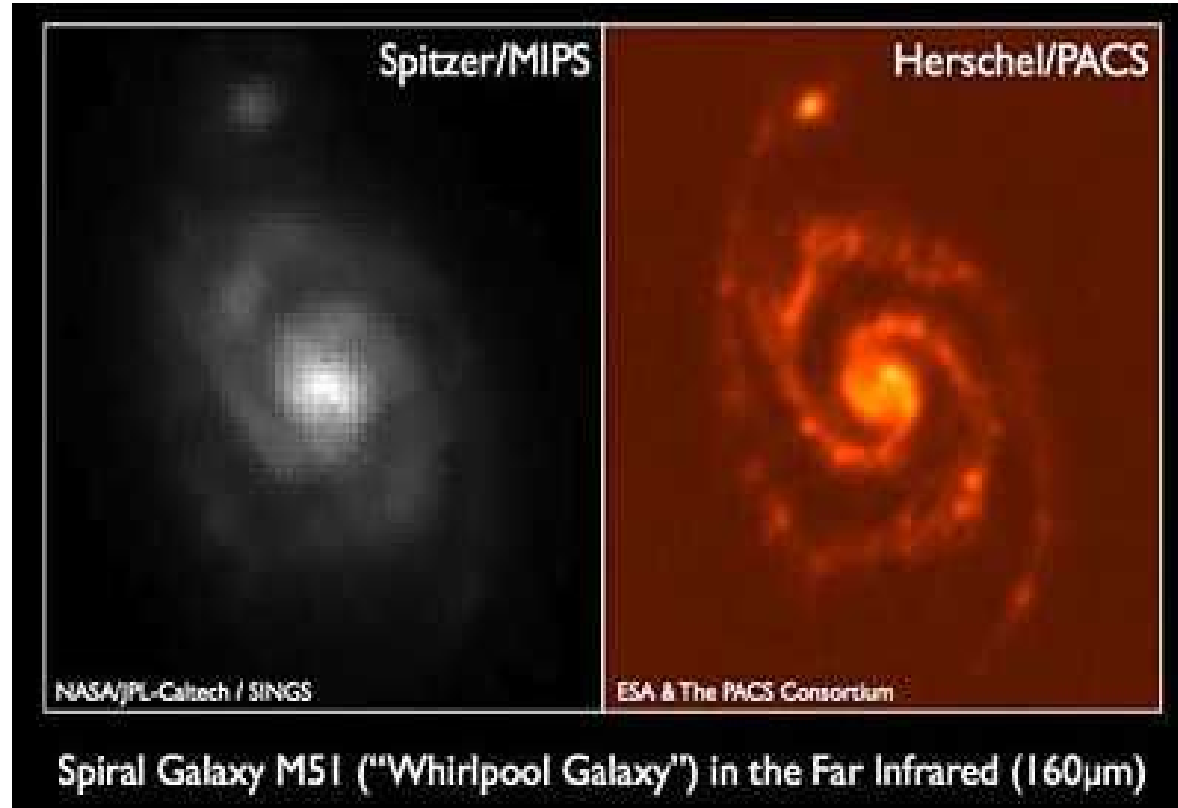


- **Herschel/Planck** - two missions studying different aspects of our cosmic origins (2009)
- **LISA Pathfinder** - testing technologies for gravity wave detection (2010)
- **Gaia** - mapping a thousand million stars in our galaxy (2011)
- **James Webb Space Telescope** - studying the very distant Universe (2013)
- **BepiColombo** - a satellite duo exploring Mercury (2013)



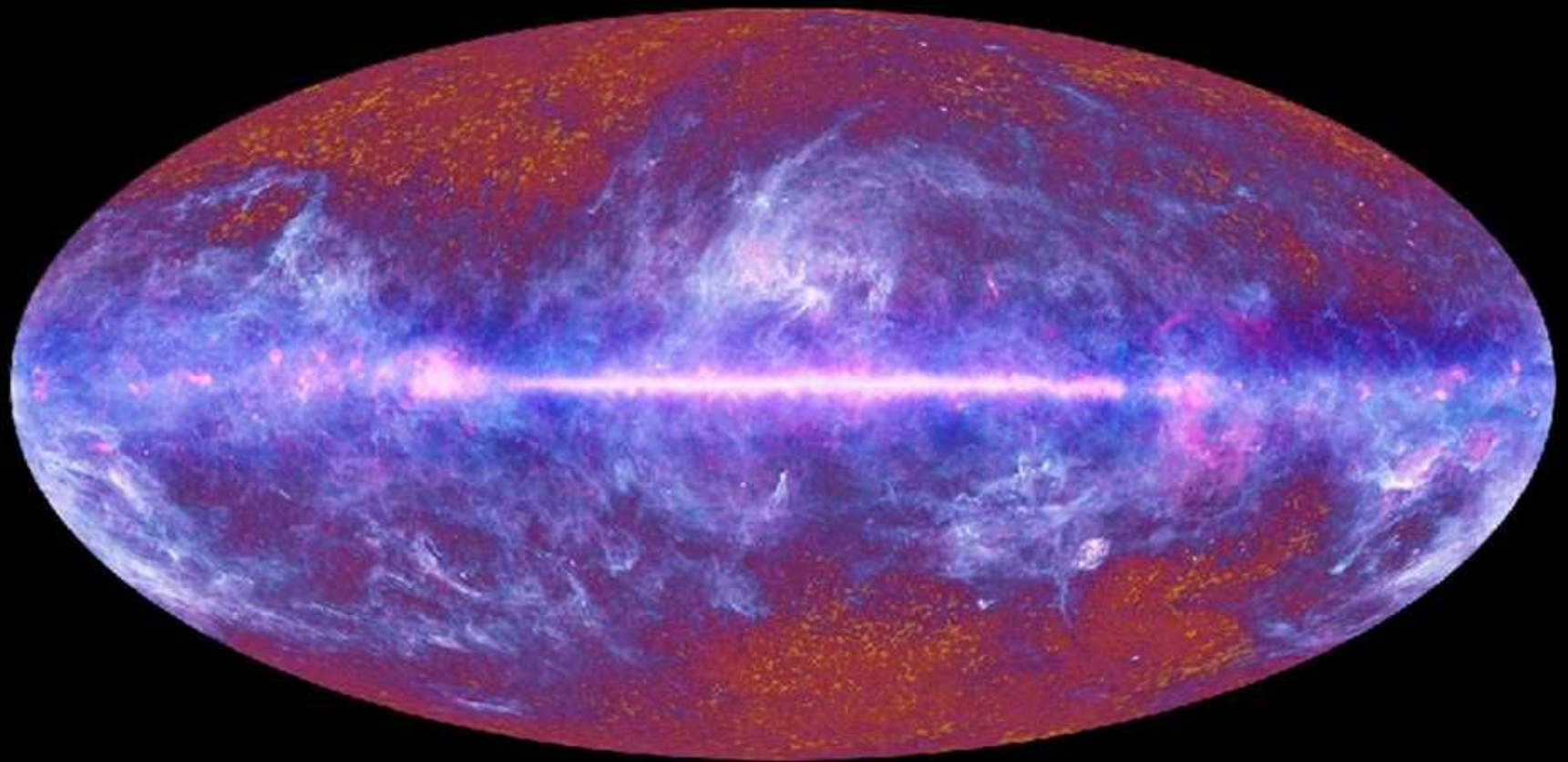
- **Herschel, the infrared observatory**





Planck, the coldest known object in space (-273,05 C)







LAUNCHERS

European Space Agency

Sofia, 13 January 2011

41

ESA's launchers guarantee European access to space.

Their development is an example of how space challenges European industry and provides precious expertise.

Ariane is one of the most successful launcher series in the world, soon to be complemented by Vega and Soyuz (first launch due in 2010).





COLUMBUS

7 February 2008 - Columbus launched on board Space Shuttle *Atlantis*. Now an integral part of the ISS, this is the first European laboratory dedicated to long-term experimentation in weightlessness.

ESA astronauts Hans Schlegel (D) and Léopold Eyharts (F) were essential team members on this assembly and commissioning mission.

Columbus offers unique opportunities for research in microgravity, adding value to science on Earth – as an extended part of ground-based research and industry infrastructures.



AUTOMATED TRANSFER VEHICLE (ATV)

A series of autonomous spaceships designed to resupply and reboost the ISS.

Each ATV carries up to 7.7 tonnes of cargo and fuel to the ISS. They then carry waste away from the ISS and burn up in the atmosphere in a controlled manner.

The first ATV, *Jules Verne*, was launched on 9 March 2008 by Ariane-5 from Europe's Spaceport in Kourou, French Guiana. On 3 April, it docked automatically with the ISS. At least another 4 ATVs are planned, one launched every 17 months.







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47

TELECOMMUNICATIONS



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48

1968 - Europe started to develop communications satellites, launching the **Orbital Test Satellite (OTS)** 10 years later. OTS was used for more than 13 years by ESA and Eutelsat.

Olympus, 1989 - this experimental satellite was the largest civilian telecommunications satellite in the world at the time of launch.

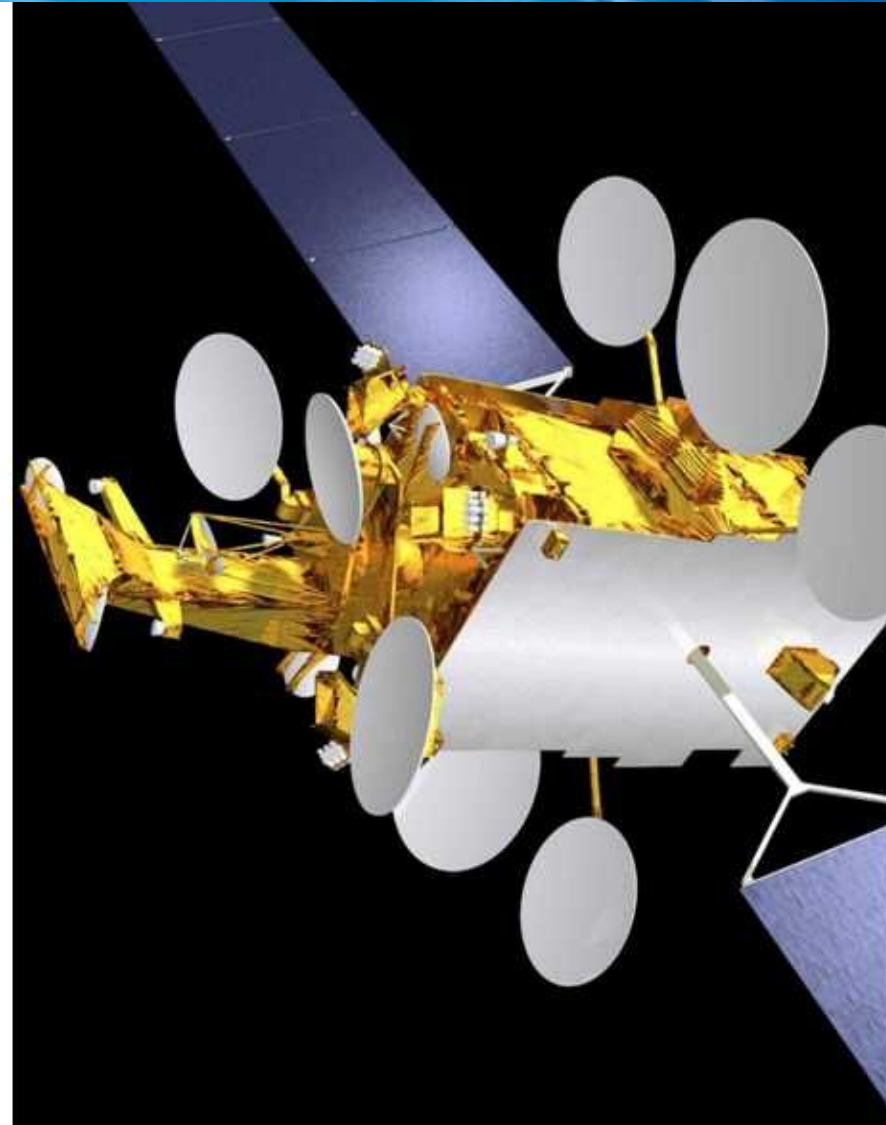
Artemis, 2001 - introducing a new era of telecommunication services to the world, with this latest multi-purpose telecommunications and technology demonstration satellite.



ARTES (Advanced Research on Telecommunication Satellites) – looking at innovative ways of developing and using communications technology.

Alphasat/Alphabus – Partnership (after competition) with a Telecom Operator to develop a high-power communications satellite by a joint industry team.

Small GEO – Partnership (after competition) with a Telecom Operator to develop a medium-size telecommunications satellite by a joint industry team.





NAVIGATION

European Space Agency

Sofia, 13 January 2011

51

Putting Europe at the forefront of this strategically and economically important sector, **Galileo** will provide a highly accurate, guaranteed global positioning service under civil control (www.esa.int/navigation).

Many applications include value-added services for transport by road, rail, air and sea, fisheries and agriculture, oil-prospecting, civil protection, building, public works and telecommunications.

A joint effort between ESA and the EU, expected to generate and more than 100 000 highly qualified jobs in Europe.

GIOVE-A - first Galileo satellite, 2005

GIOVE-B - second, launched on 27 April 2008





PIONEERS IN EARTH OBSERVATION

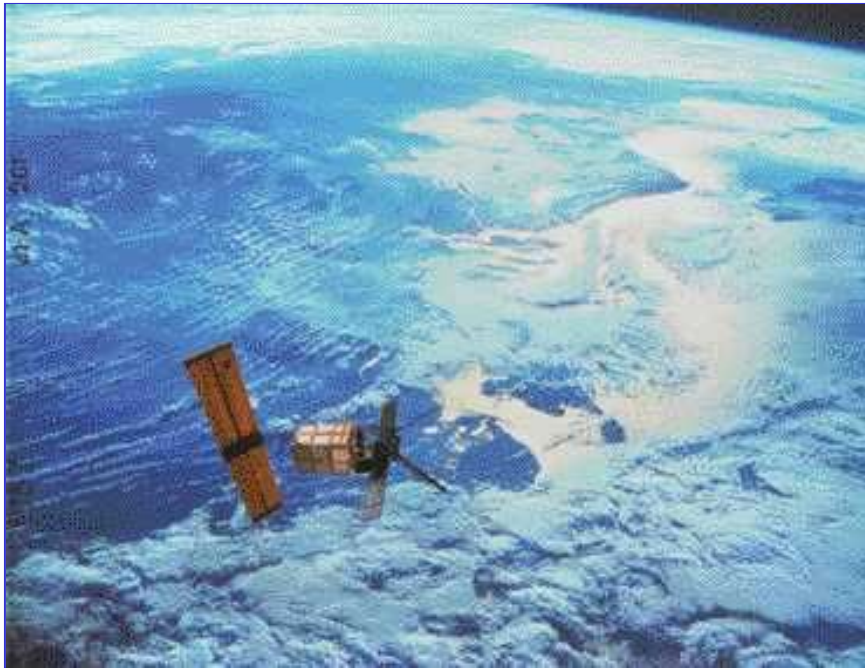
Meteosat, 1977 - ESA has been dedicated to observing Earth from space ever since the launch of its first meteorological mission.

ERS-1 (1991) and ERS-2 (1995) - providing a wealth of invaluable data about Earth, its climate and changing environment.

Envisat, 2002 - the largest Earth observation spacecraft ever built, it provides continuous monitoring of Earth's surface, atmosphere, oceans and ice caps.



A radar view of the Earth: ERS, ENVISAT



"LIVING PLANET" PROGRAMME

ESA's Living Planet Programme

comprises two main components:

- a science and research element (includes **Earth Explorer missions**),
- the **Earth Watch** element.

Earth Watch delivers Earth observation data for use in operational services, and includes the well-established meteorological missions with Eumetsat, and also new missions focusing on the environment and civil security under the **GMES** initiative.



EARTH EXPLORERS

These missions address critical and specific issues raised by the science community, while demonstrating the latest observing techniques.

They focus on the atmosphere, biosphere, hydrosphere, cryosphere and Earth's interior.

GOCE (March 2009)

SMOS (2009)

ADM-Aeolus (2009)

CryoSat-2 (2009)

Swarm (2010)

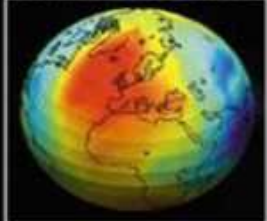
EarthCARE (2013)

A 7th Earth Explorer will be selected in 2009.

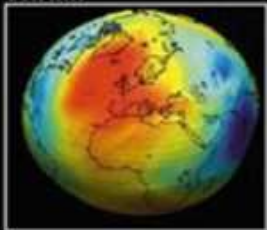


esa GOCE applications

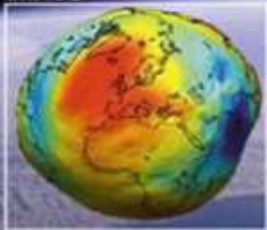
EARLY GRAVITY MODEL



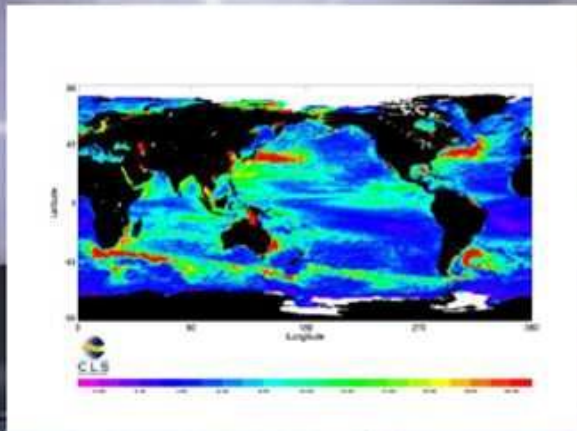
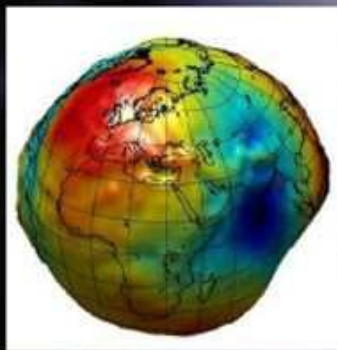
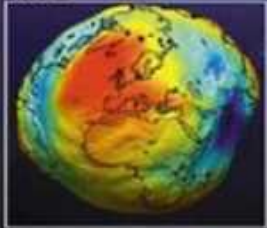
CHAMP



GRACE



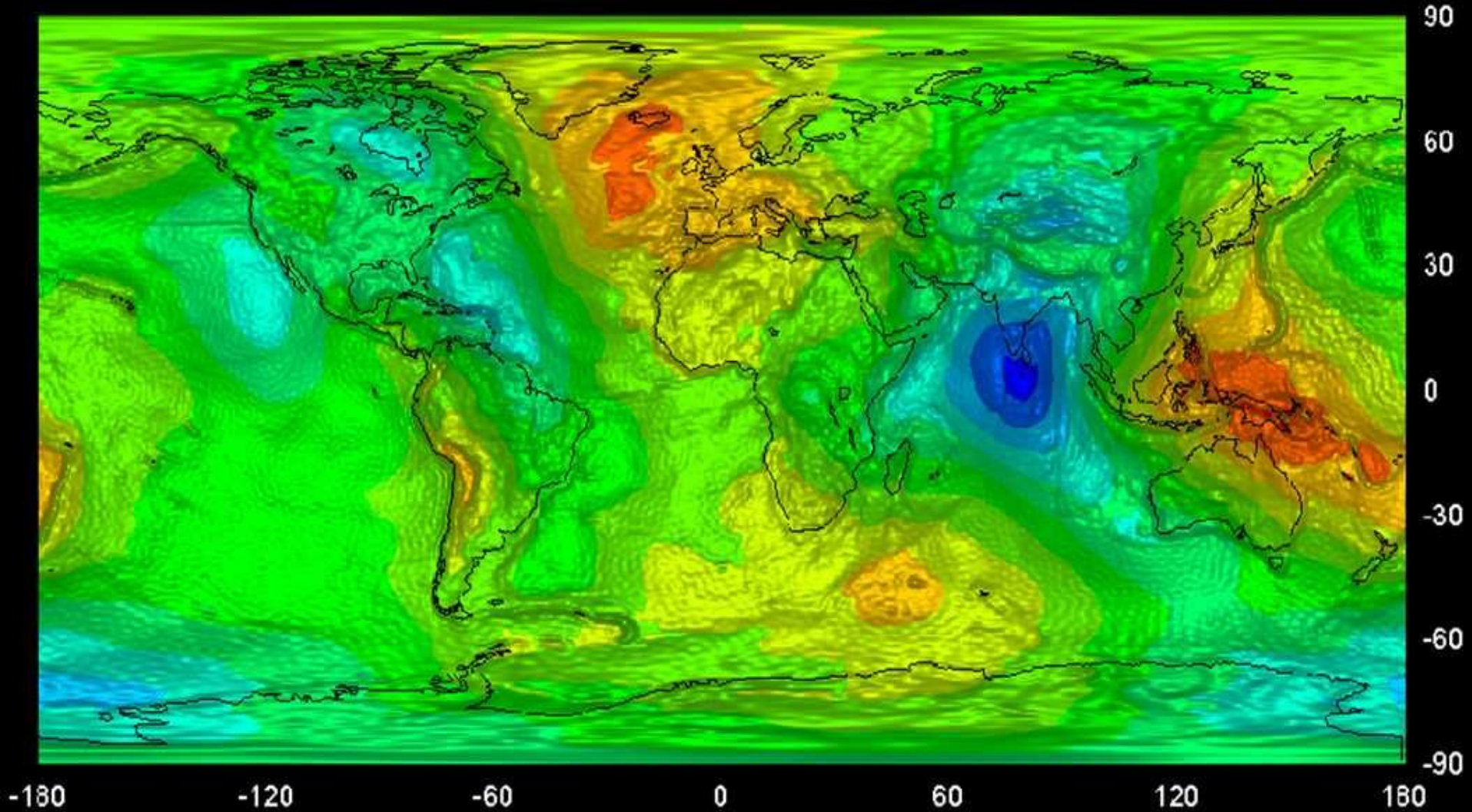
GOCE



Gravity field map and improved global geoid models

Improved understanding of ocean circulation and energy distribution

Global unification of height systems



**In space since Nov. 2009
-> calibration / validation
ongoing**

Applications:

- Improved models of global water cycle
- Monitoring and modelling of ocean circulation
- Improved management of water resources

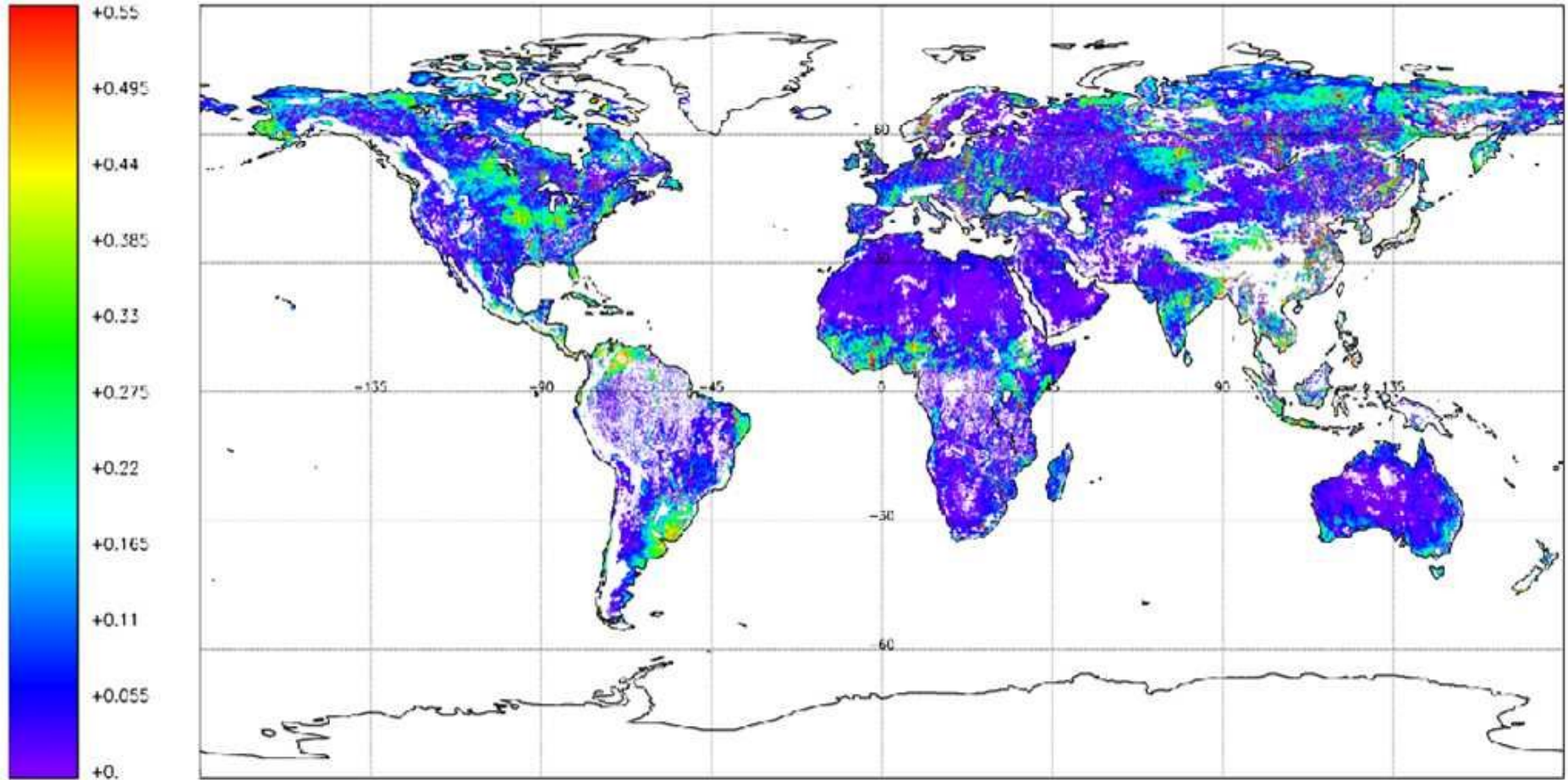




MIR_SMUDP2 - Soil_Moisture (m3m-3) - 20100620T001100 - 20100623T004816

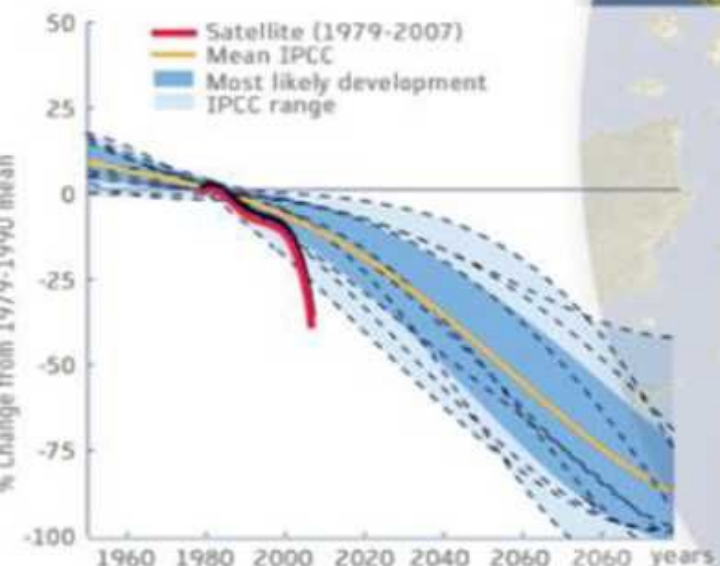
Cylindrical projection - 87 product(s) - Generated on 20100624T193111

Orbits: All - Fill value: -999.0

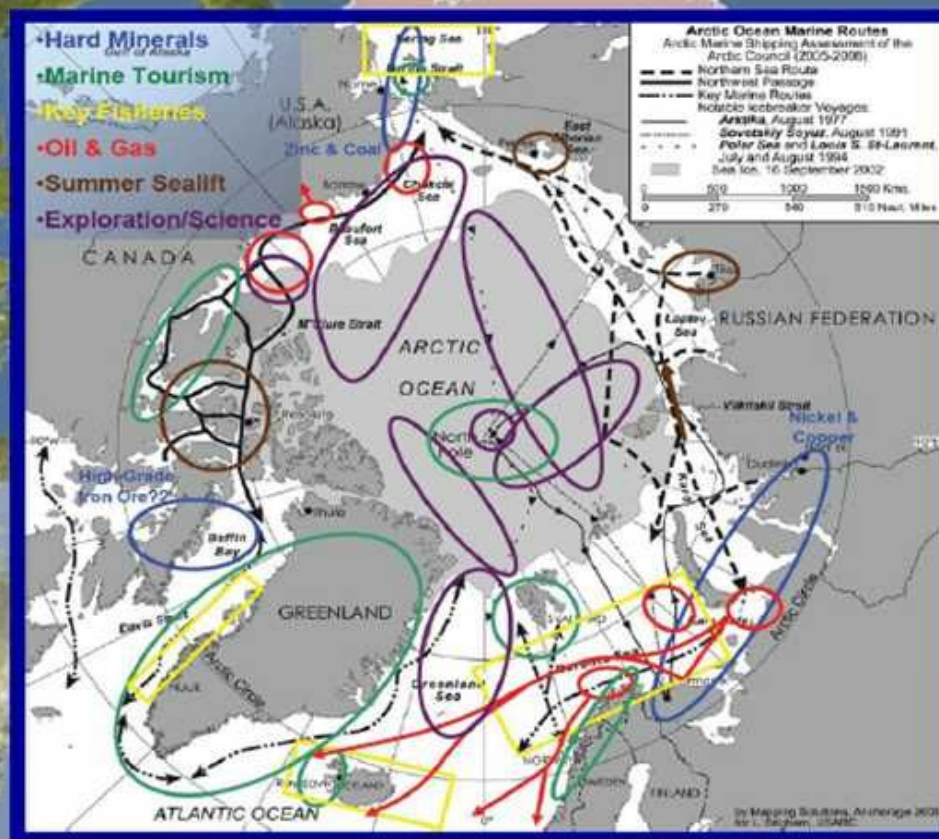


Cryosat-2

- Arctic sea-ice extent has shrunk by 2.7% per decade since 1978
- ESA's CryoSat mission shall lead to a better understanding of the role ice plays in the Earth system



Source: Asgeir Sorteberg, Bjeknes Centre for Climate Research and University Center at Svalbard



METEOROLOGICAL MISSIONS

'Living Planet' also includes the next generation of missions dedicated to weather and climate.

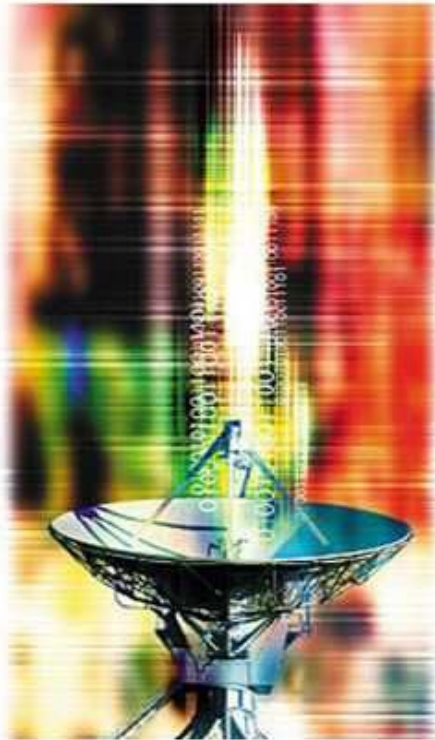
Meteosat Third Generation - will take over from Meteosat 11 in 2015, the last of four MSG (Meteosat Second Generation) satellites. MSG is a joint project between ESA and Eumetsat following the success of the first-generation Meteosat satellites.

MetOp - a series of three satellites to monitor climate and improve weather forecasting, the space segment of Eumetsat's Polar System (EPS).

MetOp-A (2006-) is Europe's first polar orbiting satellite dedicated to operational meteorology.



Global Monitoring for Environment and Security

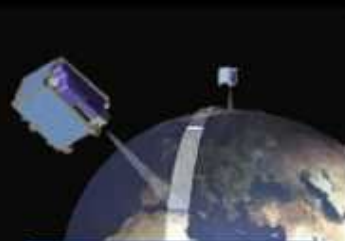


European **independence** in data sources
for environment and security monitoring
and
The European **contribution** to the Global
Earth Observation System of Systems
(GEOSS)

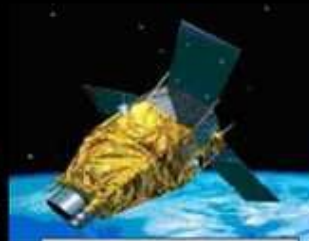
Joint Infrastructure: *National, EUMETSAT and Third Party Missions*



Terrasar-X



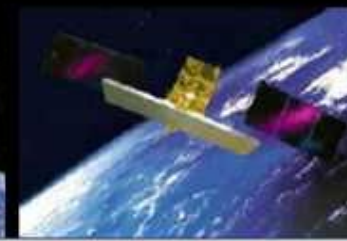
Rapideye



Pleiades



Jason-2



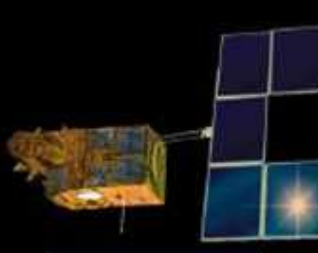
CosmoSkymed



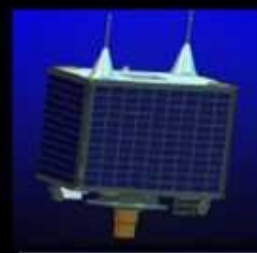
TopSat



Radarsat



SPOT

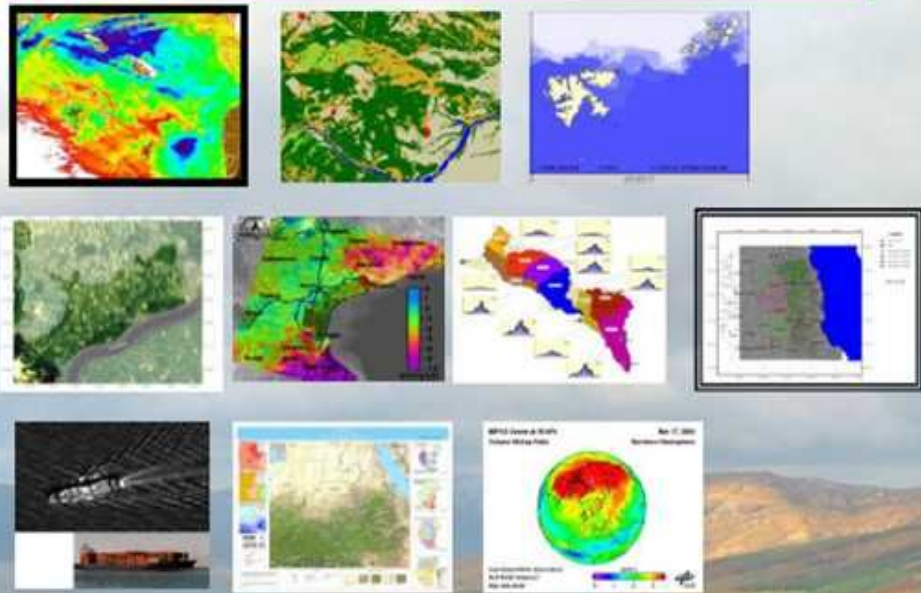


UK-DMC



METOP

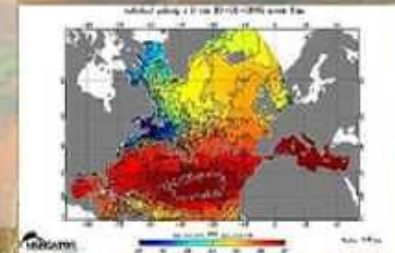
GMES Service Element



100 M€ by ESA MS
Period 2003-2008 (2009)
330+ user organisations
EC has invested another 100 M€

Fast Track Services

- Emergency Respond
- Land Monitoring
- Marine Services
- Atmosphere (Pilot)
- Security (Pilot)

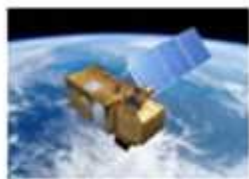




Sentinel 1 – SAR imaging

All weather, day/night applications, interferometry

2012, 2014+



Sentinel 2 – Multispectral imaging

Land applications: urban, forest, agriculture,..
Continuity of Landsat, SPOT

2013, 2014+



Sentinel 3 – Ocean and global land monitoring

Wide-swath ocean colour, vegetation, sea/land
surface temperature, altimetry

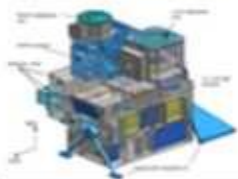
2013, 2014+



Sentinel 4 – Geostationary atmospheric

Atmospheric composition monitoring, trans-
boundary pollution

2018+



Sentinel 5 and Precursor – Low-orbit atmospheric

Atmospheric composition monitoring

2014, 2020



- **The rationale:**

to systematically generate and distribute long-term series of “**Essential Climate Variables**” (**ECV**) to meet needs of UNFCCC and IPCC, based on ESA archived EO data

- **The Output :**

- **ECV Records:** Quantifying the state of the Climate system to (a) advance our knowledge, and (b) support work of UNFCCC and IPCC for climate change mitigation and adaptation

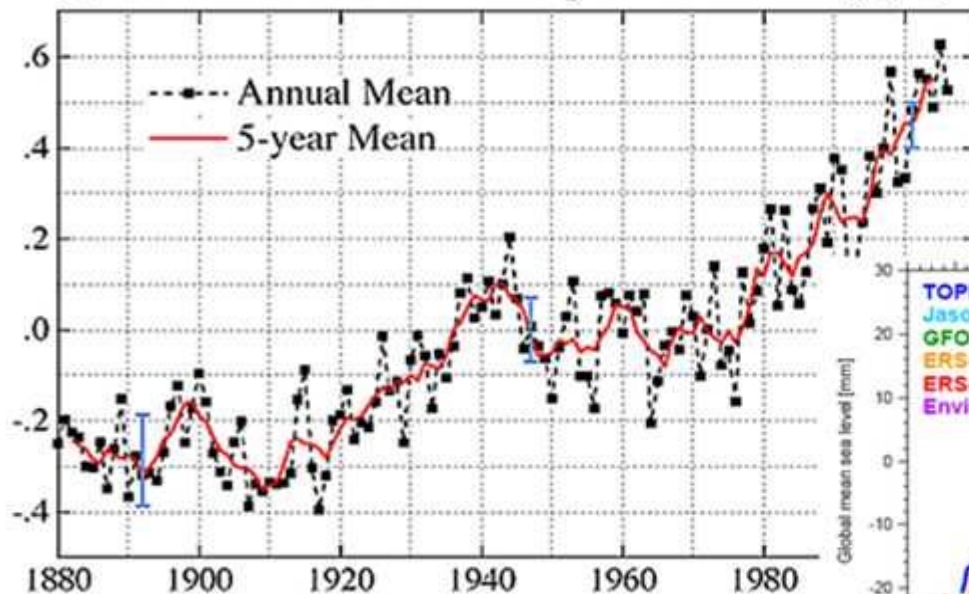
- **The Resources :**

- 6 years / 75 Million Euro

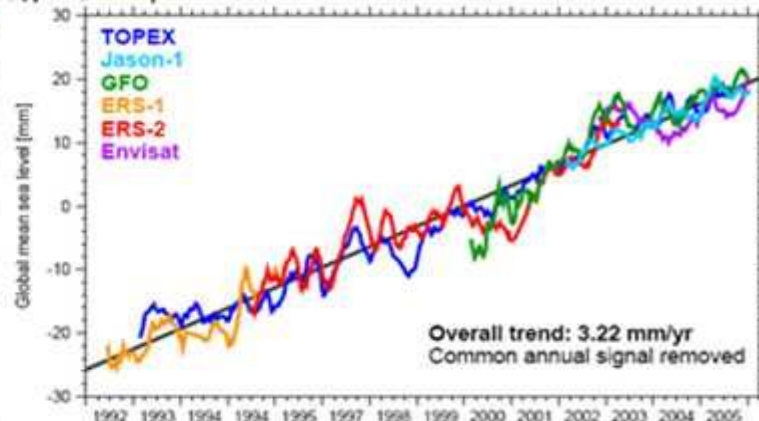
Increase of atmospheric temperature

(J. Hanson, R. Ruedy, M. Sato, K. Lo, NASA Goddard)

(a) Global-Mean Surface Temperature Anomaly ($^{\circ}\text{C}$)



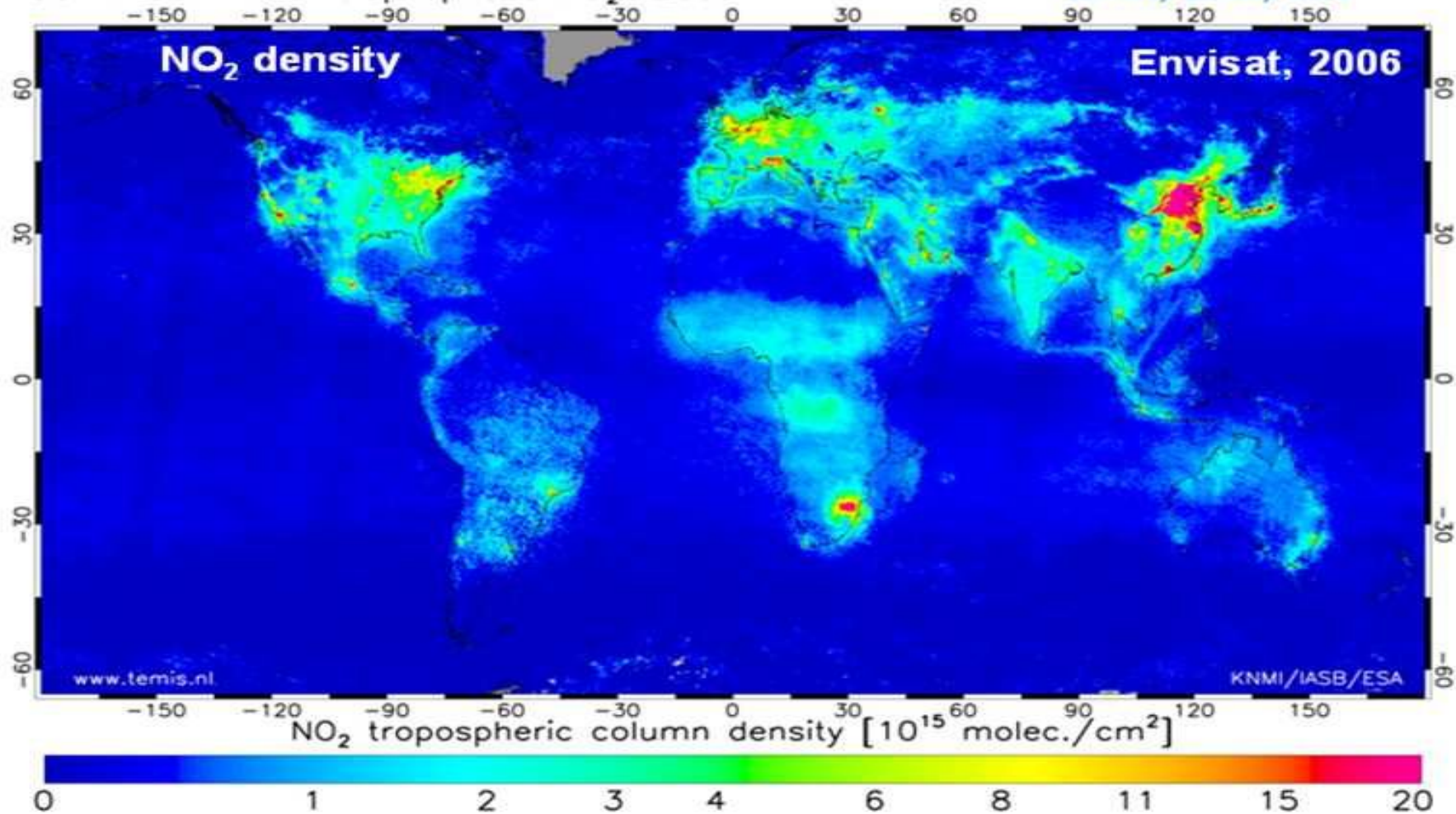
Sea level rise from satellite data 1992 – 2006



Courtesy of Remko Scharroo, Altimetrics LLC, New Hampshire, USA, 2006

SCIAMACHY mean tropospheric NO₂ 2006

KNMI/IASB/ESA



The International Charter on Space and Major Disasters

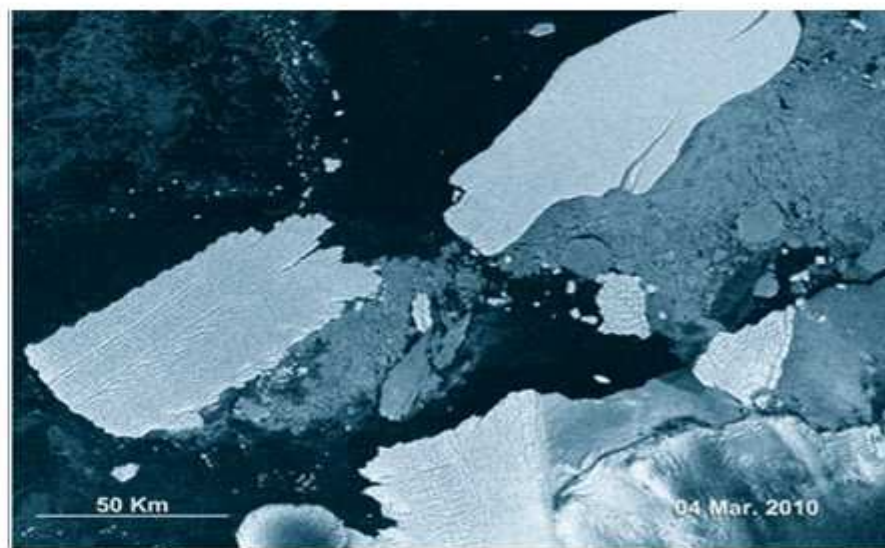
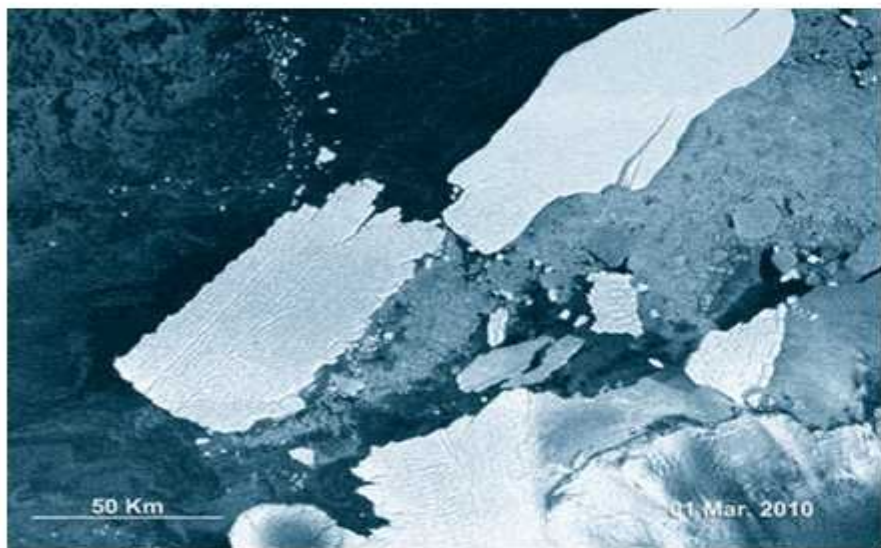
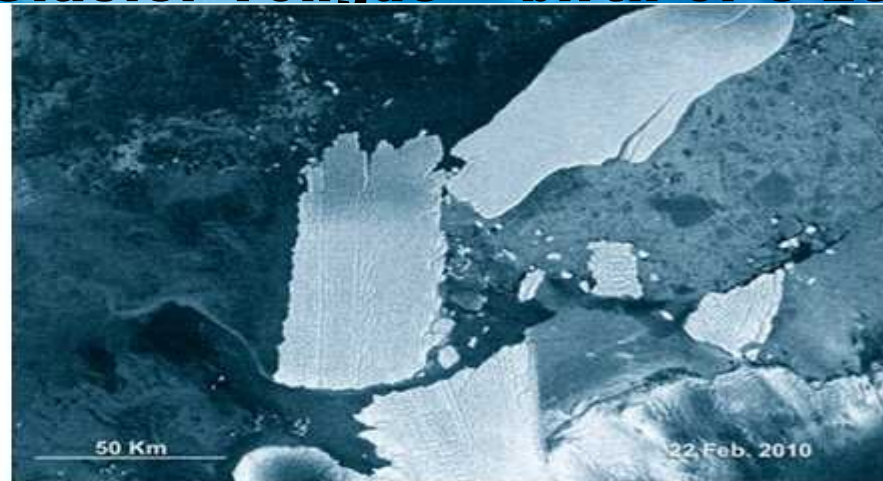
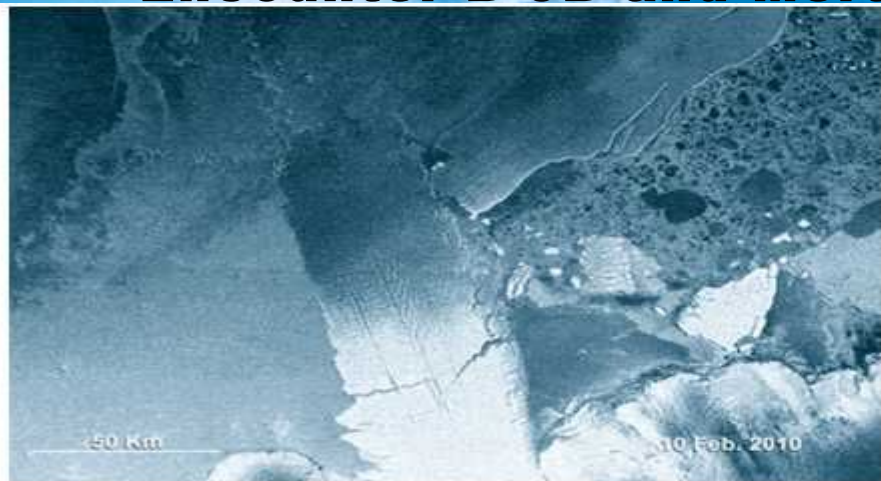
- > Data acquisition in case of natural or human-made disasters
- > Data delivery to civil protection agencies, emergency & rescue services

Examples of activations:

- Bam Earthquake 2003
- Darfur Crisis 2004
- Tsunami Catastrophe 2004/2005
- Hurricane Katrina 2005
- Sichuan earthquake 2008
- Hurricanes Gustav, Ike 2008
- Haiti earthquake 2010



Encounter B-9B and Mertz Glacier Tongue = birth of C-28



ESA'S 'CATALYST' ROLE

ESA is responsible for R&D of space projects. On completion of qualification, they are handed to outside entities for production and exploitation. Most of these entities emanated from ESA.

Meteorology: Eumetsat

Navigation: Galileo (with EU)

Launch services: Arianespace

Telecomms: Eutelsat and Inmarsat



Thank you !!

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