

ESA Space Research in Action



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European Space Agency

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01/2007 - 1

ESA Member States



ESA, formed in 1975, has now 17 Member States

- Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Norway, the Netherlands, Portugal, Spain, Sweden, Switzerland and the United Kingdom.
- Hungary, the Czech Republic and Romania are European Cooperating States.
- Canada takes part in some projects under a cooperation agreement.

	D	B	F	I	NL	GB	DK	SP	S	CH	FL	A	N	FIN	P	GR	LUX
2005																	
2000	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1995	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1987	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1975	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1973	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
1962	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

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01/2007 - 2

The purpose of ESA



An inter-governmental organisation with a mission to provide and promote - for exclusively peaceful purposes - the exploitation of:

- Space science, research & technology
- Space applications.

ESA achieves this through:

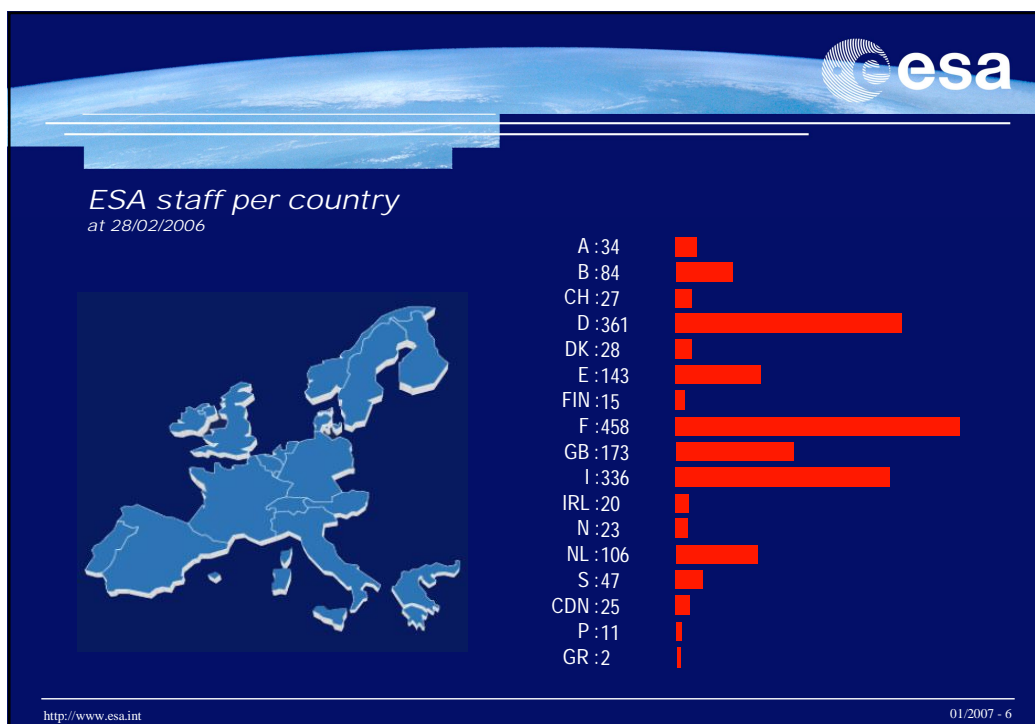
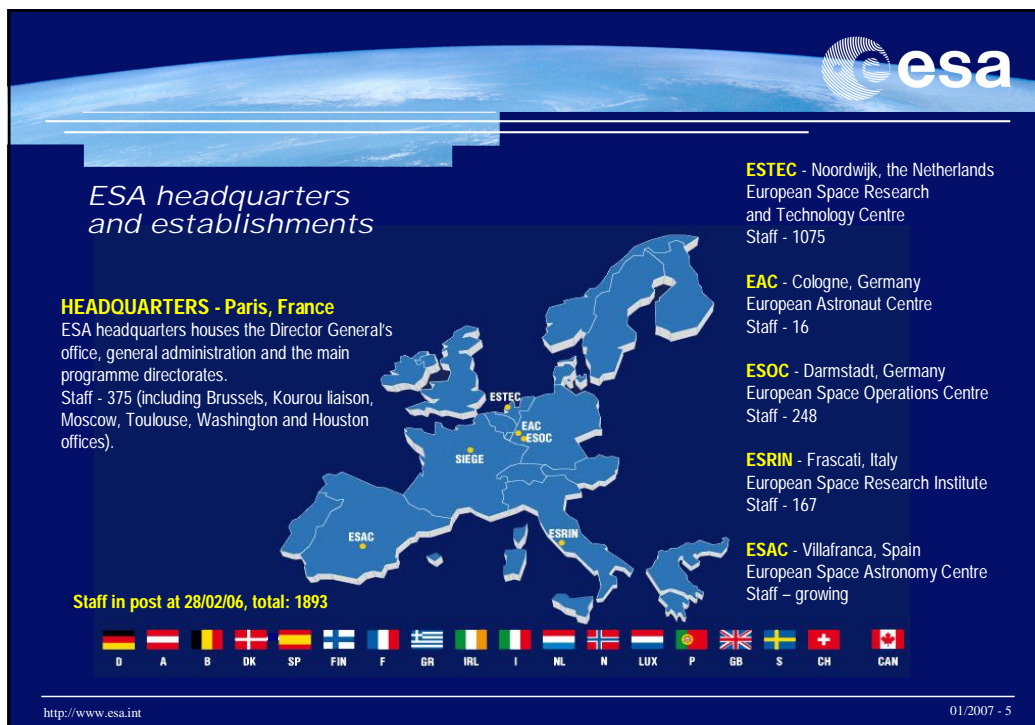
- Space activities and programmes
- Long term space policy
- A specific industrial policy
- Coordinating European with national space programmes.

ESA programmes

All Member States participate in activities related to space science and in a common set of programmes (mandatory programmes).

In addition, members chose the level of participation in optional programmes:

- Human spaceflight
- Microgravity research
- Earth observation
- Telecommunications
- Satellite navigation
- Launcher development.



ESA world locations

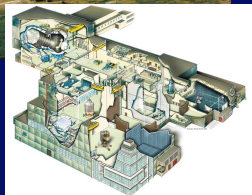


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01/2007 - 7

ESA-Noordwijk

(ESTEC, European Space Research and Technology Center), the Netherlands.



ESA's largest establishment.

Principal functions:

- Project management
- Future studies
- Space science
- Conception & management of ESA's space technology programme
- Spacecraft testing
- Provision of technical expertise & laboratory facilities.

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01/2007 - 8

ESA-Darmstadt

(ESOC, European Space Operations Centre), Germany.



Ensures the smooth working of spacecraft in orbit.

Principal functions:

- Operation of spacecraft
- Satellite control & payload operations
- Design & operation of ground facilities.

Operations Control Centre:

- Main control room
- Spacecraft dedicated control rooms
- Computer & engineering facilities
- Ground stations.

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01/2007 - 9

ESA-Frascati

(ESRIN, European Space Research Institute), Italy.



Principal functions:

- Acquisition, processing, archiving & distribution of remote sensing data from ERS-2, ENVISAT & other non-ESA satellites such as Landsat, NOAA-Tiros, MOS, JERS, etc.
- Management of ESA's non-operational data processing activities, including development and operation of information systems.



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01/2007 - 10

ESA-Villafranca

(ESAC, European Space Astronomy Centre), Spain.



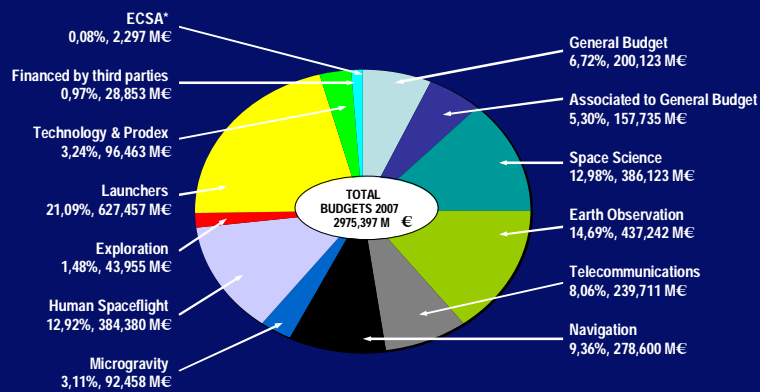
Support to astronomical research projects worldwide.

Principal functions:

- Ground stations to control and track satellites
- Provides vast satellite data archives
- Provides services to astronomical research projects worldwide.

Budgets for 2007, Breakdown by programmes

APPROVED PROGRAMMES	: 2944,247 M€
PROGRAMMES FINANCED BY THIRD PARTIES	: 28,853 M€
EUROPEAN COOPERATING STATES AGREEMENT	: 2,297 M€
TOTAL BUDGETS FOR 2007	: 2975,397 M€

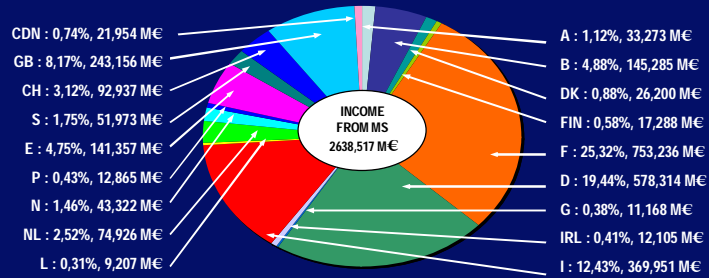


M€: Million of Euro

*ECSA : European cooperating states agreement

Budgets for 2007, Income

INCOME FROM MEMBERS STATES AND OTHER STATES : 2638,517 M€
OTHER INCOME : 336,880 M€
TOTAL BUDGETS FOR 2007 : 2975,397 M€

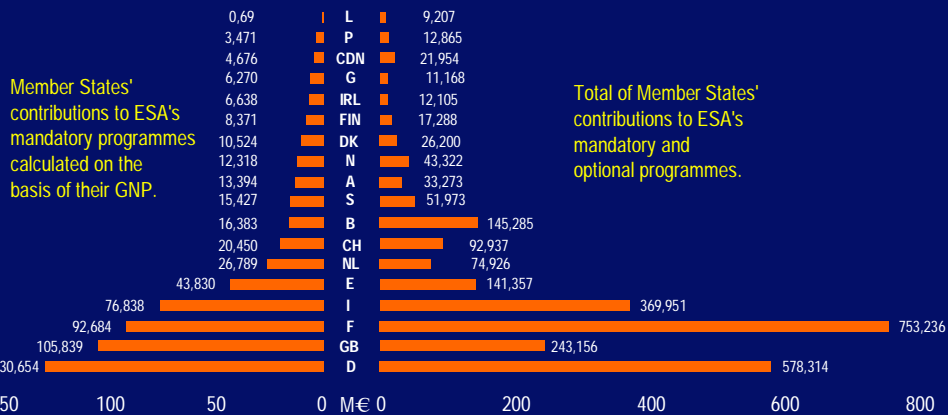


M€: Million of Euro
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01/2007 - 13

Comparison

Member States' mandatory contributions
with total mandatory and optional contributions
to ESA programmes.



M€: Million of Euro
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01/2007 - 14

Industrial policy



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

Industrial policy objectives:

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

The birth of commercial operators



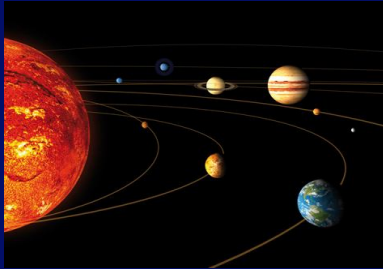
ESA is responsible for research and development of space projects.

- On completion of qualification, these projects are handed over to outside bodies for the production/exploitation phase.

Operational systems are transferred to new or specially established organisations:

- Launchers: ArianeSpace - launcher production phase and launch operations
- Telecommunications: Eutelsat & Inmarsat - international communications services via ECS/MARECS
- Meteorology: Eumetsat - Meteosat weather satellites
- Satellite Navigation: Galileo Joint Undertaking (with the E.U.).

Space Science



For over 30 years ESA's space science projects have shown the scientific benefits of multi-nation cooperation.

Areas covered by ESA:

- Space environment of the Earth
- Solar-terrestrial interaction
- Interplanetary medium
- Moon, planets and other objects
- Stars and the universe
- Fundamental Physics.

Science missions of today



First image of Titan's surface

ESA science missions currently contributing to our understanding of the universe:

- Ulysses (1990-...) - (with NASA) heliospheric studies
- Hubble Space Telescope (1990-...) - (with NASA) space observatory
- Soho (1995-...) - (with NASA) - Sun-Earth environment
- Cassini - Huygens (1997-2005-...) probe to Saturn and Titan
- Newton (XMM) (1999-...) - Multi Mirror mission
- Cluster 2 (2000-...) study of the Earth's magnetosphere
- Integral (2002-...) International Gamma-Ray Laboratory
- Mars Express (2003-...) mission to planet Mars
- SMART-1 (2003-2006) mission to the Moon
- Rosetta (2004-...) mission to comet Churyumov-Gerasimenko
- Venus Express (2005-...) mission to planet Venus.

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Hubble



Ulysses



Cassini / Huygens



Cluster 2



Soho



Newton (XMM)

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01/2007 - 19

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Cosmic Vision



Rosetta



Venus Express



Mars Express

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01/2007 - 20

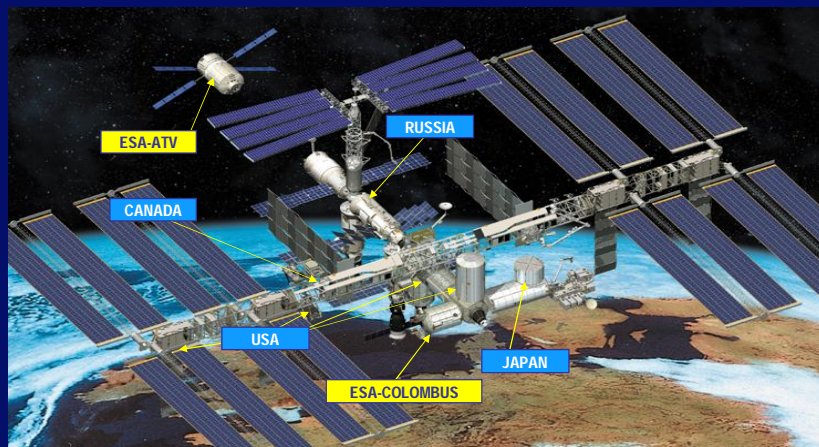
European astronauts



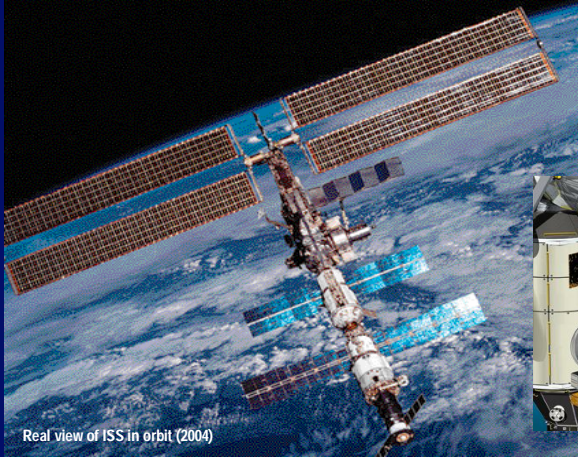
ESA astronauts:

- Jean-François Clervoy (France)
- Léopold Eyharts (France)
- Reinhold Ewald (Germany)
- Christer Fuglesang (Sweden)
- André Kuipers (Netherlands)
- Paolo Nespoli (Italy)
- Claude Nicollier (Switzerland)
- Thomas Reiter (Germany)
- Hans Schlegel (Germany)
- Gerhard Thiele (Germany)
- Roberto Vittori (Italy)
- Frank De Winne (Belgium).

The International Space Station

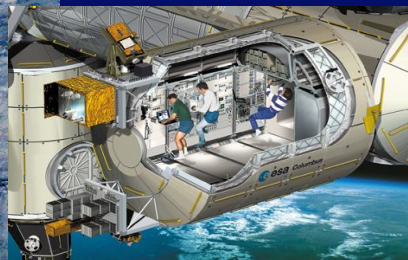


The International Space Station

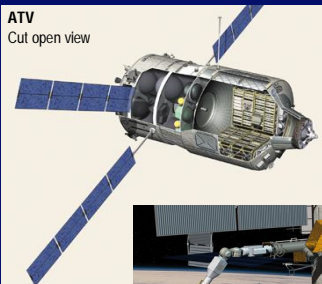


Real view of ISS in orbit (2004)

COLUMBUS LABORATORY artist' view



ATV
Cut open view



ISS
Artist' view with ATV docked

ERA
European Robotic Arm artist' view

Aurora: future human and robotic exploration.



In November 2001, The ESA Council approved the Aurora preparatory programme.

- The preparatory phase (2001-2005):
- During this period, work has been concentrated on the elaboration of a long term plan for exploration activities, and missions and technology definition studies.
 - automated guidance and navigation control
 - micro-avionics
 - data processing and communication
 - entry, descent and landing
 - crew and life support
 - in situ resource utilisation
 - power/generation, conditioning and storage
 - propulsion in space/transportation, robotics and mechanisms
 - structures and thermal control
 - instrument technology.

Aurora: future human and robotic exploration.



Artist's view of the ExoMars rover

The current Exploration Programme (Aurora) is divided into:

- Core programme: to establish the ability for Europe to participate in meaningful ways to the future global exploration initiatives.
 - Exploration roadmaps, scenarios and associated architecture studies
 - Mars Sample Return (MSR) preparation
 - Preparation of general robotic and human exploration technology
 - Awareness activities
- Exploration Missions: to provide for the development, launch and operation of selected exploration missions, starting with ExoMars.

The quest for information about the Earth



ESA has developed the Meteosat and MSG series of weather satellites, the environmental and climate research and monitoring satellites ERS-1 & 2 and Envisat, and prepares for the future with METOP, to provide tools for :

- Meteorology
- Environmental & climate monitoring
- Earth resource management & other applications.

Living Planet Programme: looking at the Earth in a different way.



The Living Planet Programme was created in consultation with key players such as:

- Europe's scientists
- Industry
- European Commission
- EUMETSAT and many others.

It comprises Earth Explorer and Earth Watch missions.

*GMES Space Component:
space infrastructure in support of
European policy priorities.*

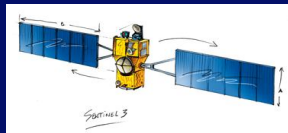
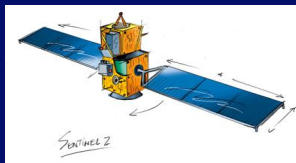
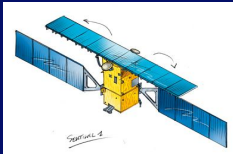
GMES (Global Monitoring for Environment and Security)
Joint endeavour led by ESA and the European Commission
to facilitate the acquisition and distribution of useful data
and information.

GMES space segment:

- Sentinel-1: Imaging radar mission (2011)
- Sentinel-2: Land monitoring mission (2011)
- Sentinel-3: Global ocean and land monitoring mission (2011)
- Sentinel-4/5: Atmospheric chemistry mission (tbd).

GMES ground segment:

- Provision of Earth observation data for GMES services
- Access to ESA, Eumetsat, national and third party missions.



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01/2007 - 29

*Telecommunications: a
commercial success.*

Telecommunications Satellites represent the largest
worldwide commercial space market.

Key areas of interest to ESA are:

- Fixed services
- Broadcasting
- Mobile communications
- Navigation
- Data relay
- Multimedia.



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01/2007 - 30

Satellite Navigation: Galileo



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01/2007 - 31

Europe's launchers fleet



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01/2007 - 32

Technology and Technology Transfer Programmes



Space is a major commercial opportunity for Europe. European space industry employs 40 000 people directly and 250 000 indirectly.

ESA manages more than 250 million euro in technology development contracts every year. ESA's Technology Programmes prepare Europe for the future and make industry more competitive.

ESA has set up a programme to stimulate the spin-off of space technologies. The Technology Transfer Programme makes European space technologies available for licensing or further development.

- Millions of euros in revenues for donors and receivers
- Hundreds of jobs created or saved
- New companies established
- Improved products and services on Earth.

Europe's first weather satellites



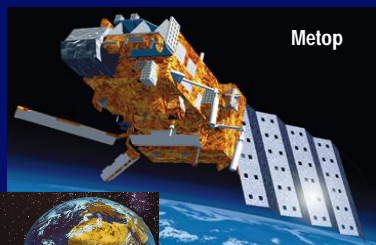
The first Meteosat was launched in 1977. Five more followed and the seventh was launched in 1997.

Placed in geostationary orbit they are designed to :

- Take pictures of the Earth every 30 minutes
- Distribute meteorology data
- Collect environmental data recorded by automatic ground stations.

Eumetsat owns and exploits the Meteosat satellites.

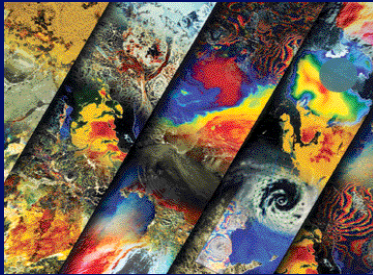
Cooperation with Eumetsat



ESA is cooperating with Eumetsat, the European Organization for the Exploitation of Meteorological Satellites on the development of two new series of meteorological satellites:

- MSG (Meteosat Second Generation): is a series of four geostationary meteorological satellites with improved performance with respect to the current Meteosat series. The first satellite was launched in August 2002, the second on 21 December 2005.
- METOP (Meteorological Operational Polar Orbiting Satellites): will be an European series of three polar orbiting spacecraft embarking a very comprehensive series of three meteorological payload provided by Europe and the USA. The first launch was on 19 October 2006.

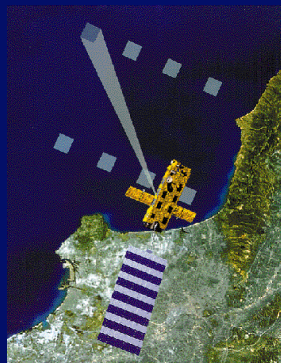
A radar view of the Earth: ERS, ENVISAT



The ERS (European Remote Sensing) satellites use radar instruments to survey the Earth's surface day & night and in all weather conditions.

- ERS-1, launched in 1991 ended its mission in March 2000.
- A second ERS satellite (ERS-2) was launched in 1995, with an additional ozone monitoring instrument (GOME). A constant flow of data from ERS-2 provides information on status and changes of:
 - Ocean currents, sea surface and ocean winds
 - Polar ice caps & ice movement
 - Atmospheric ozone.

ENVISAT: focusing on the environment.



ENVISAT is the most ambitious Earth observation satellite ever designed in Europe.

The 8 ton space craft was launched on Mars 2002 by an Ariane-5 into polar orbit at an altitude of 800 km.

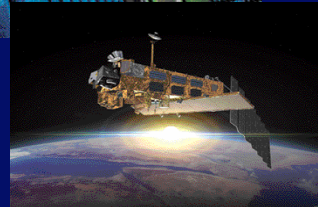
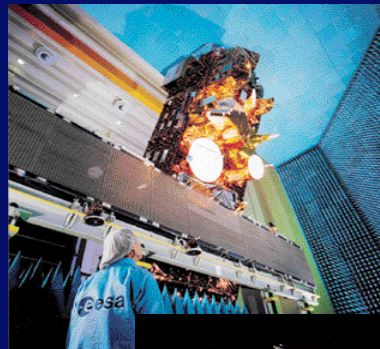
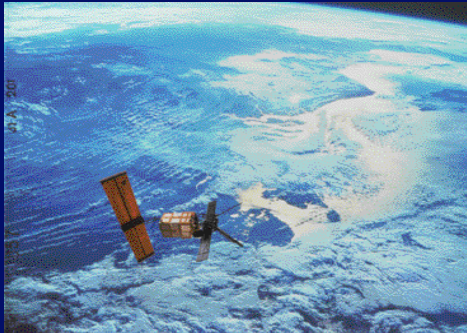
It carries a payload consisting of 10 instruments of advanced design, and provides:

- a smooth transition from the measurements taken by ERS-1 and ERS-2 (radar in particular)
- new data on marine biology land processed and atmospheric chemistry.

ENVISAT, along with ERS-2, provides a continuous supply of services to scientists and operational users over a period of more than 15 years in the field of:

- Crop inventories and forest management
- Tropical deforestation
- Biodiversity
- Natural disasters / damage assessment (flooding, forest fires, earthquakes, volcanic eruptions, etc.)
- Generation of digital terrain models (DTMs)
- Ozone layer / monitoring of ozone layer depletion and green house effect.

A radar view of the Earth: ERS, ENVISAT



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01/2007 - 39

Earth Explorer: to better understand the Earth.



Earth Explorer missions:

- Research oriented, focused on specific topics/techniques
- Provide regular flight opportunities

The approved missions:

Core missions

- GOCE: earth gravity field and geoid measurements (2007)
- ADM-Aeolus: wind speed vectors measurements (2008)
- EarthCARE: clouds, aerosols and radiation measurements, ESA-Japan joint mission (2012+).

Opportunity missions

- CRYOSAT-2: assessing the polar ice (2009)
- SMOS: soil moisture and ocean salinity (2007)
- SWARM: survey of geomagnetic field (2009).

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01/2007 - 40

Earth Watch:
to initiate a long term monitoring of
the Earth.

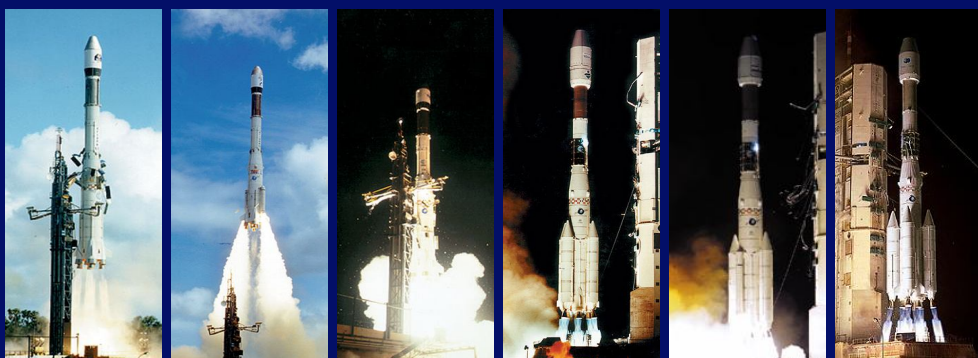


Earth Watch missions.

- Preparing operational missions
- Service oriented
- Guaranteeing data continuity
- Developed in partnership with European or national institutions.

Earth Watch includes meteorological missions with Eumetsat and also new missions focussing on the environment and civil security under GMES (Global Monitoring for Environment and Security).

Ariane success story



1st AR1:
L01, 1979


1st AR2:
V10, 1984

1st AR3:
V20, 1987


1st AR4:
V22, 1988

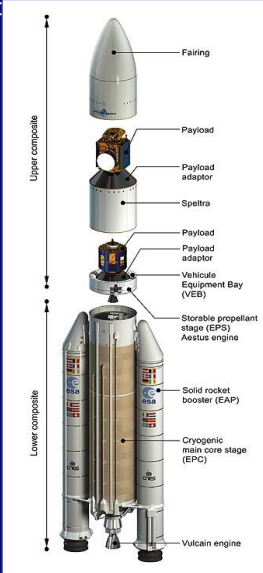
100^e AR4:
V134, 2000

Last AR4:
V159, 2003



*Ariane 5:
architecture.*





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01/2007 - 43



*Ariane 5:
architecture.*



SOLID PROPELLANT STAGE

EAP



VEHICLE EQUIPMENT BAY



FAIRING



STORABLE PROPELLANT STAGE



MAIN CRYOGENIC STAGE

EPC



VULCAIN ENGINE



SPELTRA



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01/2007 - 44



Europe's spaceport

(CSG, Guiana Space Centre).




Location:

- French Guiana, South America.

Sites:

- ELA (Ensemble de Lancement Ariane) - Ariane 5
- ELV (Ensemble de Lancement Vega) - Vega (2008)
- ELS (Ensemble de Lancement Soyuz) - Soyuz (2008)

Launch capacity:

- 8 Ar5 per year from ELA
- 4 Vega per year from ELV
- 4 Soyuz per year from ELS

Advantages:

- Payload mass gain for geostationary satellites because of proximity to the equator
- Launch to polar and geostationary orbits without overfly of populated areas.

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01/2007 - 45



Technology and Technology Transfer Programmes



Solar car Nuna



Green car speed record

ESA's technology transfer has successfully transferred over 200 space technologies to new sectors:

- Car and trucks
- Energy and power
- Engineering
- Environment and resources management
- Fitness and sport
- Health and medicine
- Leisure and lifestyle
- Safety and security
- Textiles.

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01/2007 - 46

Earth Change Challenges

- Humans & Knowledge-based Society
 - Research, Exploration, capacity building, education, data sharing
- Climate and Earth Change
 - Oceans, atmosphere, ice, vegetation, CO₂, Ozone, T,
 - Monitoring Anthroposphere, Pollution, Species loss?
 - Disasters, floods (1 bln), droughts (1.9), Earthquakes (0.1), Landslides (0.9 bln of people affected)
- Understanding and preserving water cycle
 - 1.2 bln people without clean water, 2.9 with no sanitation
 - Global water watch programme + services & policies