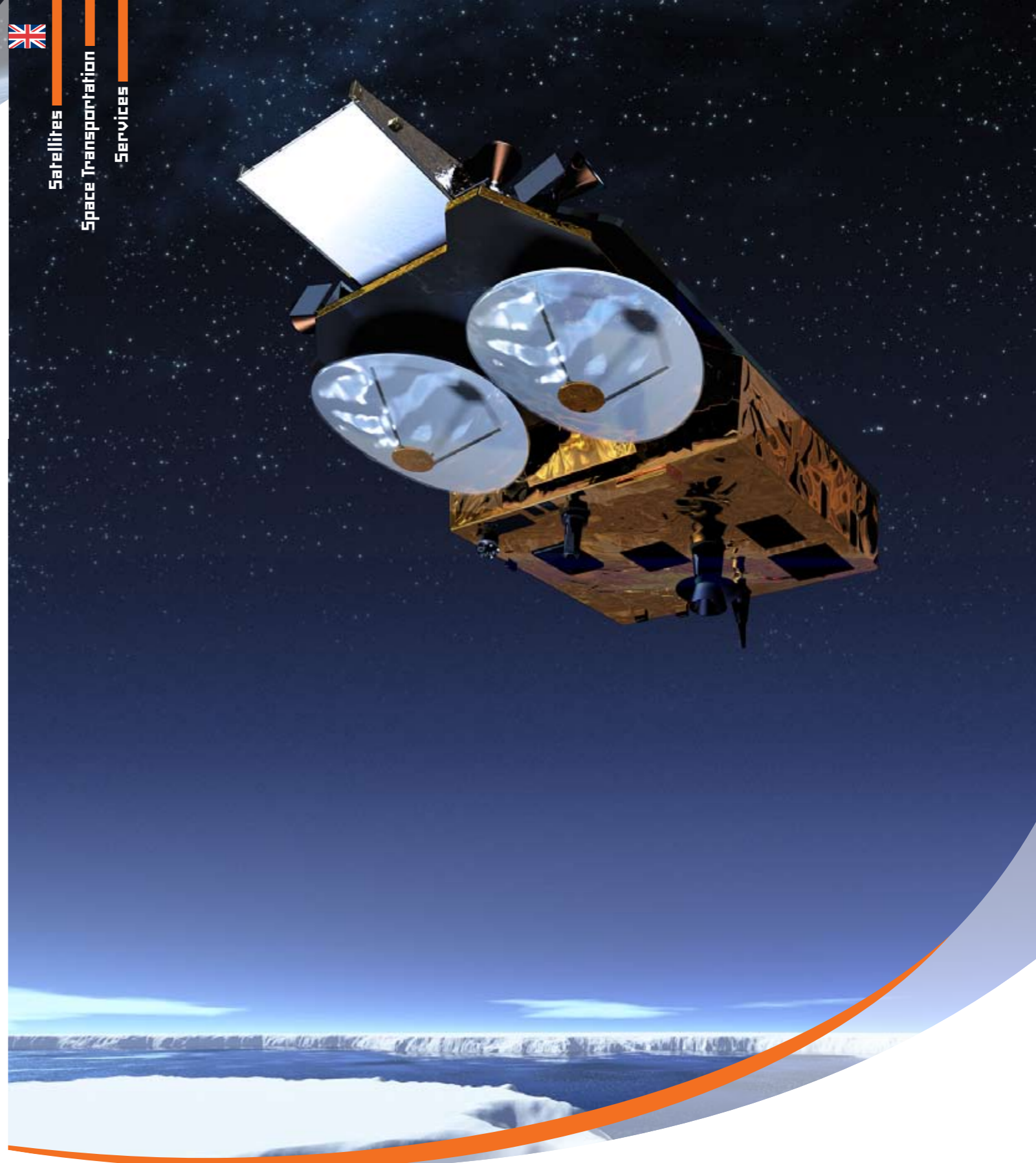




Astrium, a wholly owned subsidiary of EADS, is dedicated to providing civil and defence space systems and services. In 2008, Astrium had a turnover of 4.3 billion and more than 15,000 employees in France, Germany, the United Kingdom, Spain and the Netherlands. Its three main areas of activity are Astrium Space Transportation for launchers and orbital infrastructure, Astrium Satellites for spacecraft and ground segment and Astrium Services for the development and delivery of satellite services.



Satellites

Space Transportation

Services

CRYOSAT-2

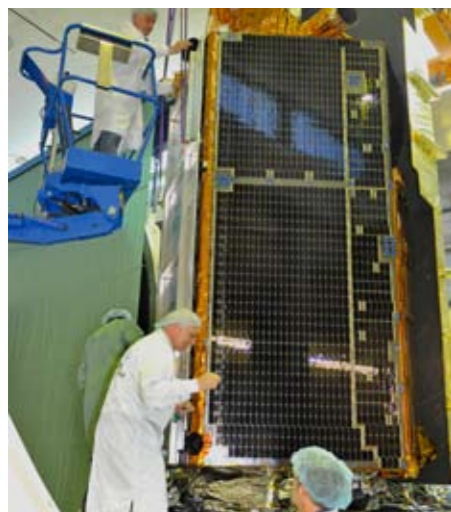
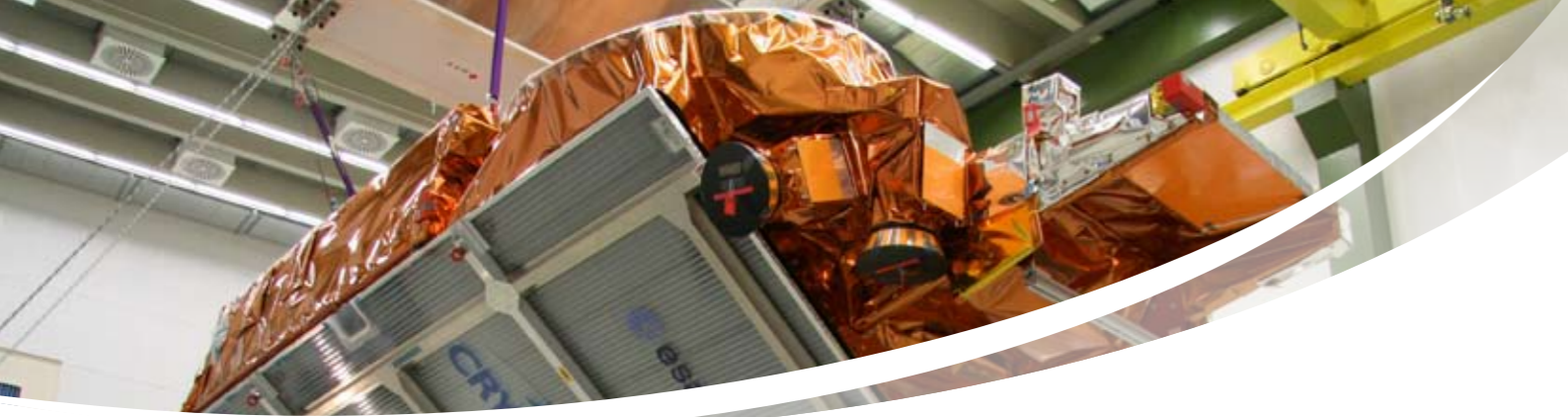


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Cryosat-2

Cryosat-2 is a three-year mission for accurate prediction and observation of the ice masses at the poles, and particularly of their rate of change. This is done by radar altimeter measurements of the distance between the Earth's surface, both sea level and freeboard ice elevation, and the satellite to give a subsequent calculation of the thickness of the polar ice sheets and floating sea ice.

Observations from Cryosat-2 will determine whether or not our ice masses are thinning due to global warming and determine the contribution that the Antarctic and Greenland ice sheets are making to an average global rise in sea level.

Background

Cryosat is an Opportunity mission in the European Space Agency's Earth Explorer Programme, a family of 6 missions that will monitor our environment. Astrium is prime contractor of 4 of the missions, and has a significant contribution to the other two. The GOCE satellite was launched on 17th March 2009, SMOS was launched on 2nd November 2009, Swarm and Aeolus will launch in 2011 and EarthCARE in 2013.

The first Cryosat spacecraft was destroyed in a launch failure in 2005. The mission was considered as important for understanding the influence of changing ice masses for the climatic processes so a rebuild with some modifications was agreed in early 2006.

Astrium's Role

The Cryosat programme builds on Astrium's heritage from the ERS radar satellites and the Earth Observation satellites Envisat, MetOp, Champ, & Grace.

As prime contractor for the Cryosat mission, Astrium was responsible for the design and build of the satellite, leading a consortium of 30 firms from Europe, USA and Russia on behalf of ESA.

Astrium integrated the satellite platform and was also responsible for the integration of all instruments. In addition Astrium built the Mass Memory and Formatting Unit (MMFU) and the Power Control and Distribution Unit (PCDU) which was built in a joint team together with Patria in Finland.

After system integration Astrium performed the functional and performance tests proving that the mission requirements can be achieved and the system is robust for the mission life time. During the environmental test campaign the Astrium team checked that the satellite can survive the severe conditions of launch and space environment.

Engineering Challenges

Non-sun-synchronous orbit

Cryosat has a high inclination orbit of 92° in order to get the best visibility of higher latitudes (>72°) and sufficient cross-overs up to the polar regions.

The orbit is not sun-synchronous so the direction from which sunlight falls on the satellite is constantly changing. The operation of the SIRAL instrument demands that its antennas point towards the Earth's surface within a few tenths of a degree. This means that rotating the satellite to face the sun is out of question. To achieve a low cost mission the number of mechanisms had to be minimised. The satellite geometry was arranged such that the solar panels are rigidly fixed to the satellite body, forming a 'roof' with a carefully optimised angle, to provide adequate power under all orbital conditions and still fit within the launch vehicle.

Instrument antenna design

Any distortion in the support of the antennas will cause errors to creep into the calculated angle of arrival and the elevation of the surface. To stay within the permitted error limits for the mission, such distortions have to be less than 30 arcseconds: approximately the same as the size of a football seen from two kilometres away. This represented a significant challenge, given Cryosat's unusual orbit – one that was met by designing the antenna support structure to be intrinsically stable and providing auxiliary attitude measurement sensors directly mounted onto this structure.

Customer	European Space Agency
Mission	Determine fluctuations in the mass of the Earth's major land and marine ice fields
Orbit	Low Earth-orbit, non-Sun-synchronous <ul style="list-style-type: none"> Altitude: 724km Inclination: 92°
Spacecraft	<ul style="list-style-type: none"> Aluminium-sandwich structure with two gallium arsenide body-mounted solar arrays, nominally delivering 800W each 78Ah Lithium ion battery Pointing error: < 0,1° Stability < 0,001°/s
Payload	<ul style="list-style-type: none"> SIRAL (SAR Interferometric Radar Altimeter) DORIS (Doppler Orbitography and Radiopositioning Integrated by Satellite) LRR (Laser Retro Reflector)
Features	Power: 400W (nominal) - 800W peak
Launch Mass	720kg
Dimensions	4.6m long, 2.34m wide
Launch Date	Spring 2010
Mission Duration	Six months of commissioning followed by a three-year operational mission
Astrium Responsibilities	<ul style="list-style-type: none"> Prime Contractor Spacecraft Integration and Testing MMFU (Mass Memory and Formatting Unit) PCDU (Power Conditioning and Distribution Unit)

Cryosat Science

There are two types of polar ice: ice on ocean and ice on the land.

These two forms of ice play different roles in our climate and they also pose different challenges when trying to measure them from space.

Sea ice is generally up to a few metres thick. Cryosat-2 will acquire precise measurements of the thickness of floating sea ice so that annual variations can be detected. Sea ice influences regional temperature and the circulation of ocean currents.

Ice sheets that blanket Antarctica and Greenland are several kilometres thick. Instead of measuring these vast thicknesses, the height of the surface will be measured accurately enough to detect small changes across the mission lifetime. It is the growth and shrinkage of these ice masses that have a direct influence on sea level.

Why is this important?

Polar ice helps to maintain the stability of Earth's climate system in a number of ways.

Due to its colour, ice reflects around 80% of the incoming solar radiation. If the ice cover were to decrease, less solar radiation would be reflected away from the Earth's surface and the atmosphere would absorb more heat.

Sea ice insulates the comparatively warm ocean waters from the cold polar atmosphere. It is so effective as an insulator that, without it, the overlying air temperature would increase by between 20 – 40°C during winter. If the ice sheets covering the polar ocean start to melt, then the ocean water will absorb a greater proportion of solar energy, causing further melting and creating a positive feedback loop.

When the ice forms during the winter it increases the salinity & density of the oceans, causing the surface water to sink. This creates a pump where the colder waters of the Polar Regions form deep currents to the equator and the warmer surface equatorial waters travel towards the poles. The major current is called the Gulf Stream and gives the northern Atlantic countries a warmer climate.

The polar ice also has an effect on the sea levels. The ice sheets covering Antarctica and Greenland amount to about 28 million cubic kilometres, which means that the sea level is about 65 metres lower than it otherwise would be. Although the central regions of polar ice are stable, melting significant amounts will cause a rise in our sea levels.

