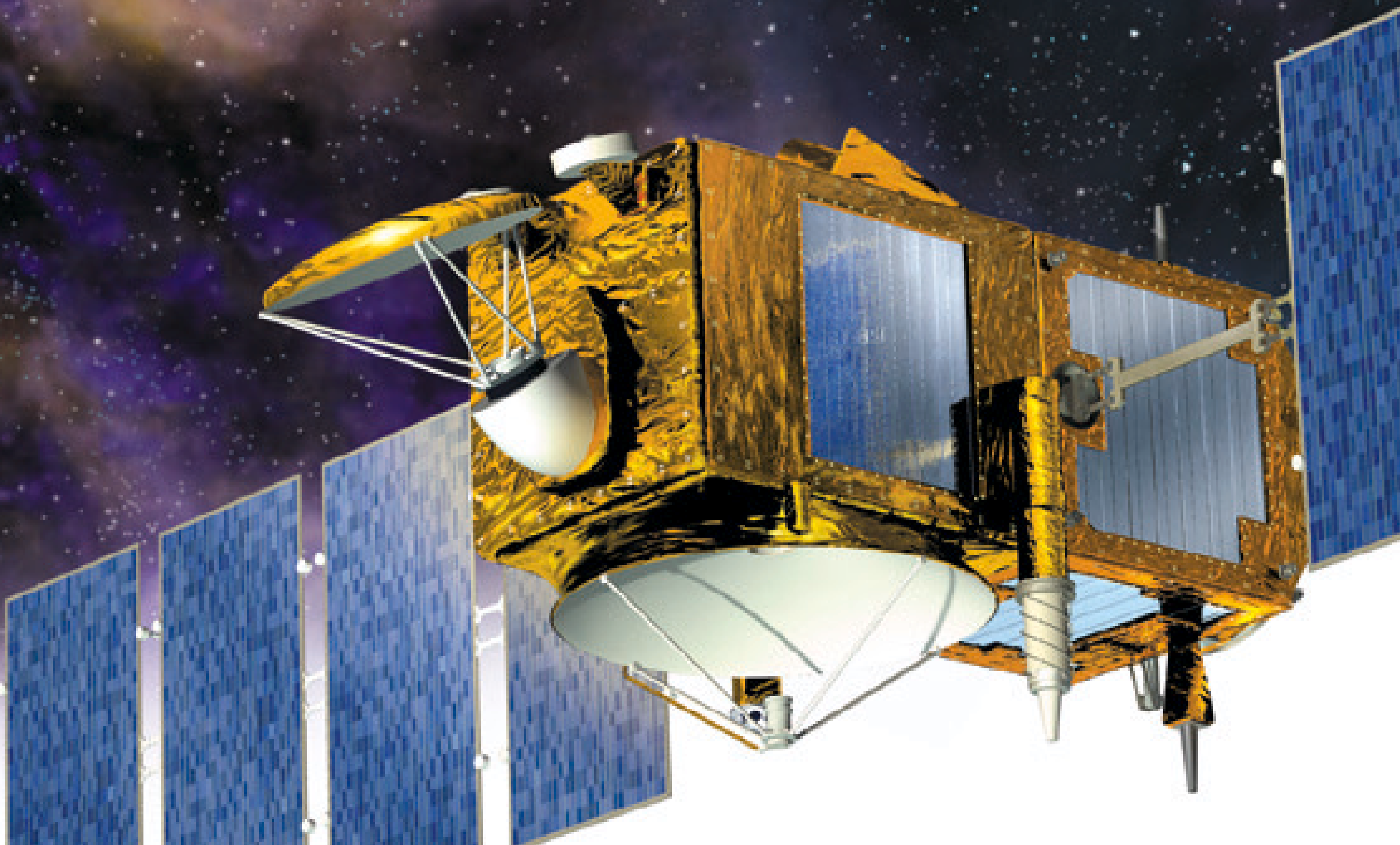
# Observing the oceans from space

# Jason-1 explores the seas



Is Earth getting warmer? What do the ocean currents hold in store for tomorrow? What are the underlying processes driving ocean movements? These are just some of the questions that Jason, the French/US spaceborne ocean-observing mission, is setting out to answer. The Jason series of satellites will sustain radar altimetry observations in the coming decades, providing continuous data on sea surface height (SSH) accurate to within a few centimetres all over the globe to tell us more about variations in surface and deep-water ocean circulation.

Designed to follow on from TOPEX/POSEIDON, Jason-1's instruments and data processing systems have drawn extensively on the lessons learned from its predecessor. Jason is a true ocean observatory that will supply SSH and sea-state measurements in near-real time to an international user community.

National Aeronautics and Space Administration
Jet Propulsion Laboratory

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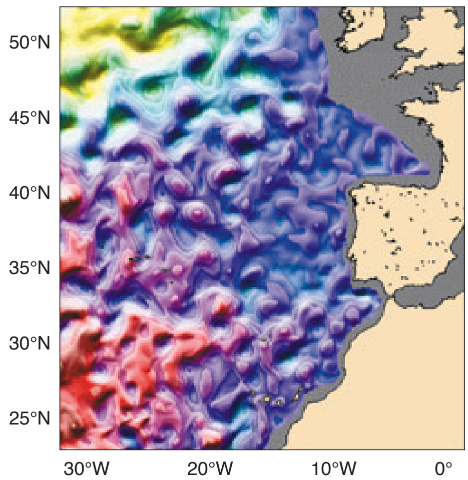
# An ocean observatory

The Jason mission is built around a series of satellites that will collect global data on a continuous basis for several decades. Jason-1 is the first cornerstone of a permanent ocean observatory designed to serve a broad spectrum of applications in Earth Sciences.

## Oceanography and ocean forecasting

Ocean variability is the central focus of the Jason mission. The satellite's orbit—identical to TOPEX/POSEIDON—has been defined to cover 90% of the world's ice-free oceans every ten days. Real-time data delivery will make it possible to issue ocean bulletins in much the same way as we do weather forecasts today.

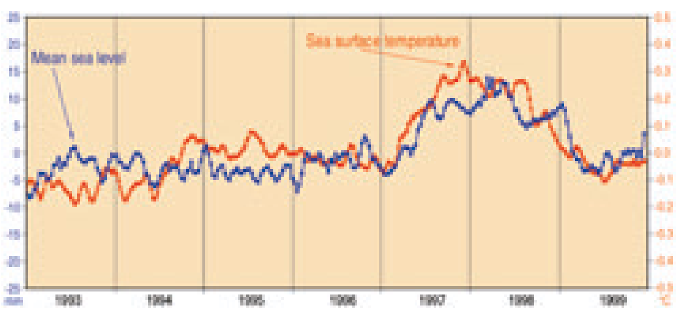



Forecasts of ocean circulation and its eddies

## Climatology and climate prediction

Altimetric data yield vital information for studying and predicting climate, in particular climatic phenomena such as El Niño. Jason-1's ability to measure mean sea level with millimetre accuracy will be a key asset for monitoring climate change.

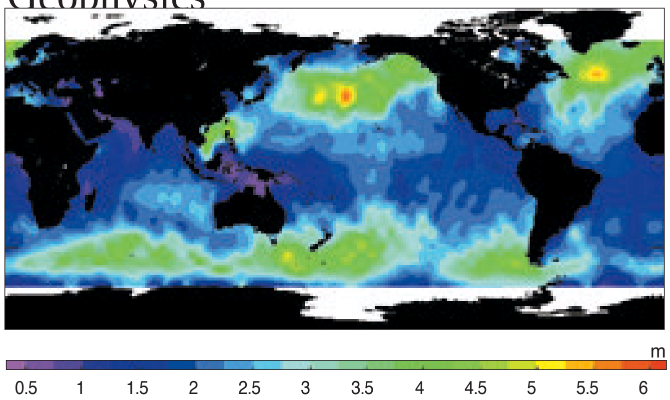
## Marine meteorology



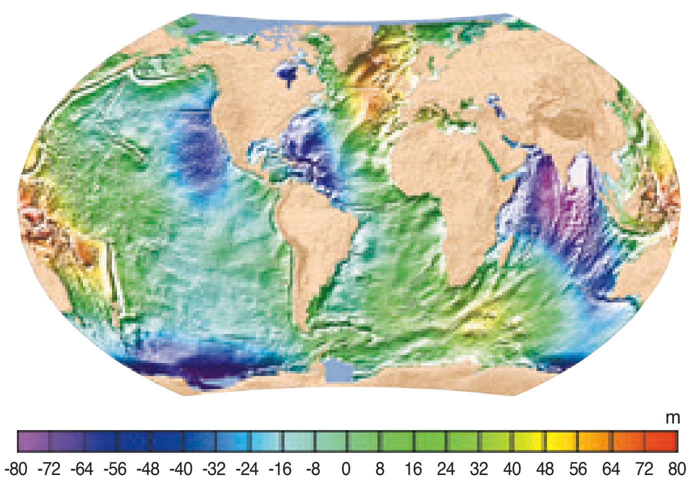

Global variations in mean sea level measured by TOPEX/POSEIDON

Jason-1 will deliver sea-state data (wave heights and wind speed) within three hours. This information will help us to better understand and predict weather conditions over the oceans.

## Geophysics




Wave heights measured by TOPEX/POSEIDON in December 1999




The mean sea surface shows how the Earth's gravity field affects the oceans.

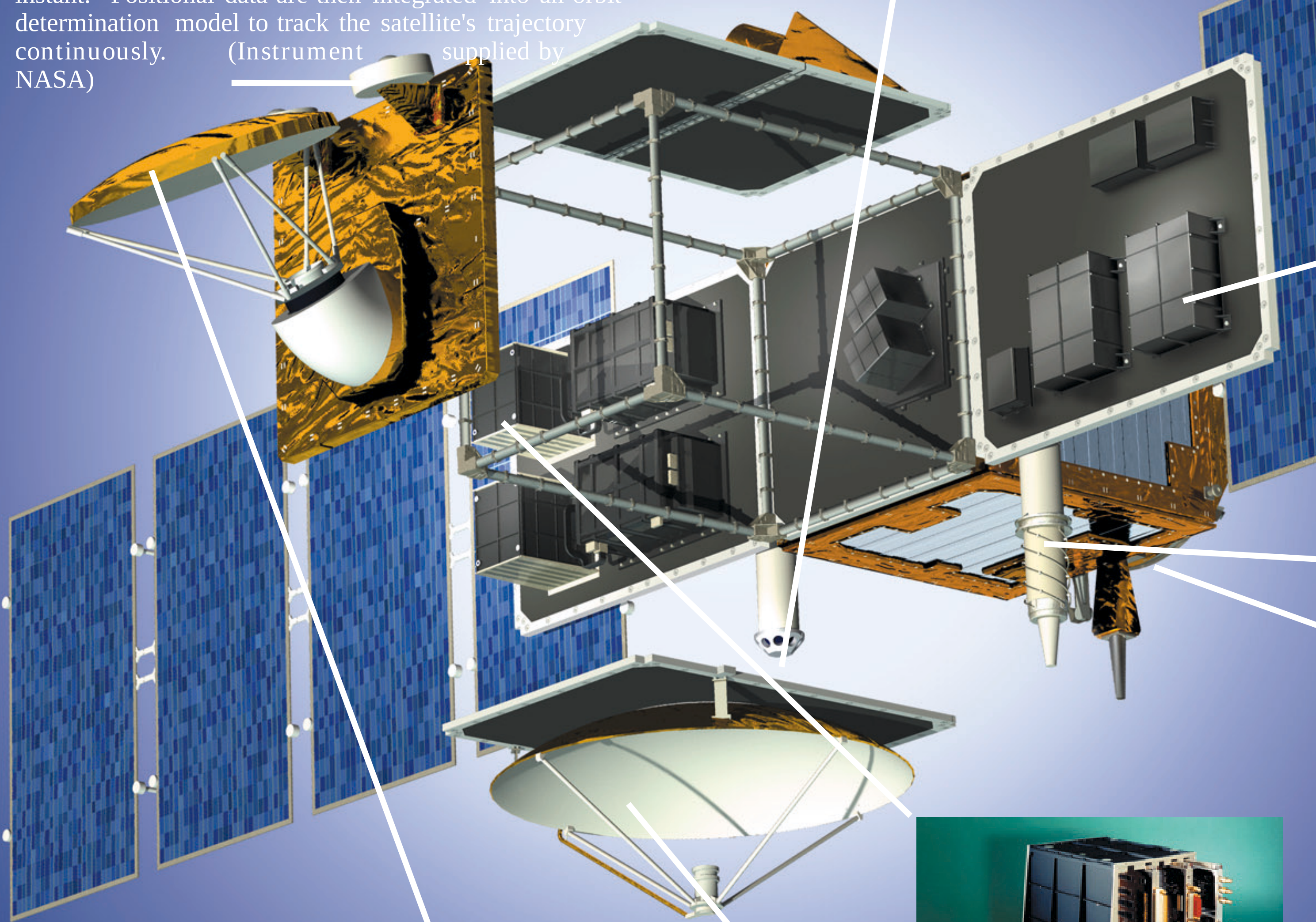
# The Jaso

## TRSR

The Turbo Rogue Space Receiver (TRSR) uses the Global Positioning System (GPS) to determine the satellite's position by triangulation, in the same way that GPS fixes are obtained on Earth. At least three GPS satellites determine the mobile's exact position at a given instant. Positional data are then integrated into an orbit determination model to track the satellite's trajectory continuously. (Instrument supplied by NASA)

## LRA

The Laser Retroreflector Array (LRA) provides a target for laser tracking measurements from the ground. By analysing the round-trip time of the laser beam, we can locate where the satellite is on its orbit. (Instrument supplied by NASA).



POSEIDON-2 altimeter processing unit (Alcatel) - Flight model.

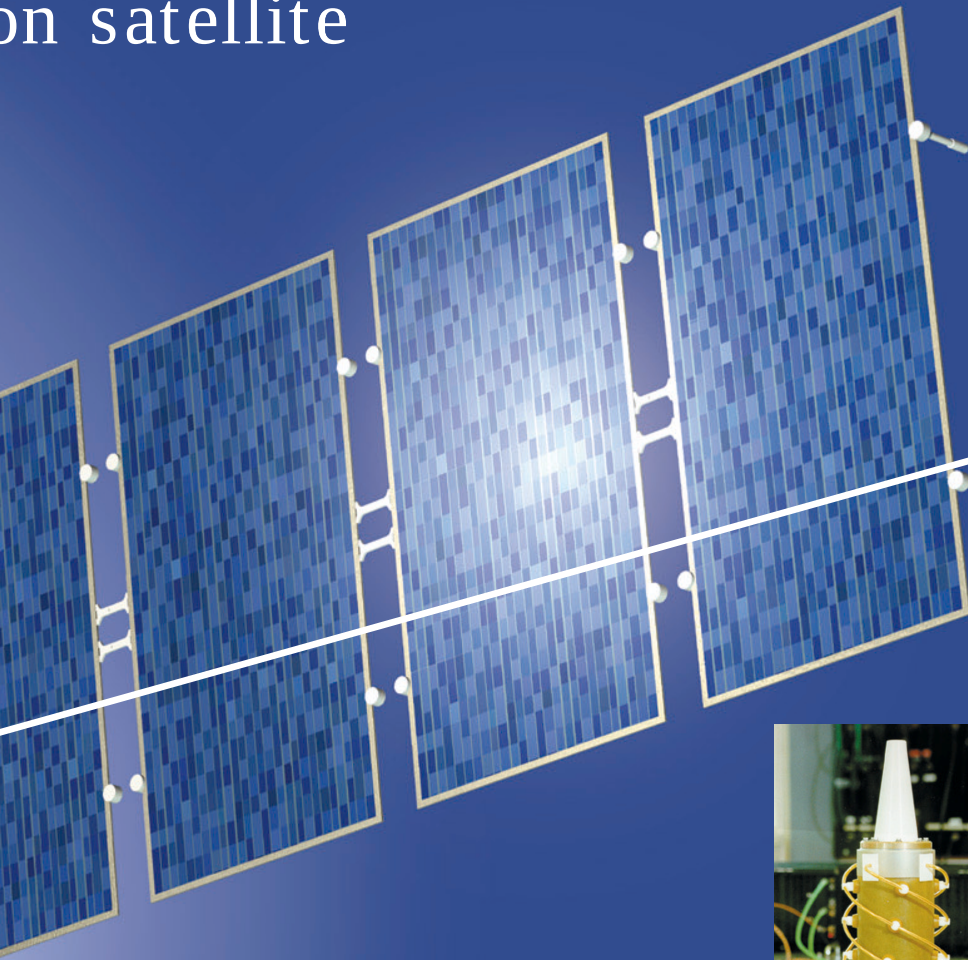
## JMR

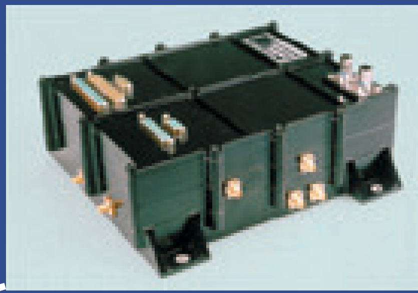
The Jason Microwave Radiometer (JMR) measures radiation from the surface at three frequencies (18, 21 and 37 GHz). Measurements acquired at each frequency are combined to determine atmospheric water vapour and liquid water content. Once the water content is known, we can determine the correction to be applied for radar signal path delays. (Instrument supplied by NASA).

Radiometer (NASA/JPL) - Engineering model during mechanical qualification test

Altimeter antenna (Alcatel) - Flight model in preparation for thermal and mechanical tests.

# on satellite

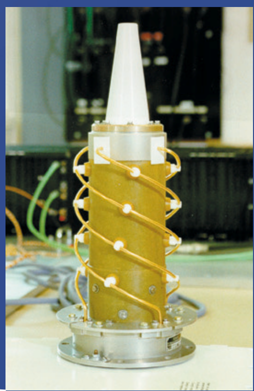




DORIS receiver (Thomson-Detexis) - Flight model.

## DORIS

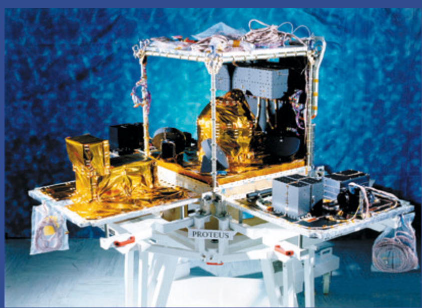
The DORIS system uses a ground network of 50 orbitography beacons around the globe, which send signals at two frequencies to a receiver on the satellite. The relative motion of the satellite generates a shift in the signal's frequency (called the Doppler shift) that is measured to derive the satellite's velocity. These data are then assimilated in orbit determination models to keep permanent track of the satellite's precise position (to within three centimetres) on its orbit. (Instrument supplied by CNES)



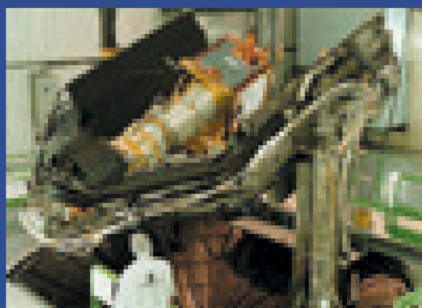
DORIS antenna (Starec) - Flight model.

## POSEIDON-2

POSEIDON-2 is the main instrument on the satellite. Derived from the experimental POSEIDON-1 altimeter on TOPEX/POSEIDON, it is a compact, low-power, low-mass instrument offering a high degree of reliability. POSEIDON-2 is a radar altimeter that emits pulses at two frequencies (13.6 and 5.3 GHz, the second frequency is used to determine electron content in the atmosphere) and analyses the return signal reflected by the surface. The signal round-trip time is estimated very precisely to calculate the range, after applying corrections. (Instrument supplied by CNES).



PROTEUS platform (Alcatel)
Integration of the thermal mock-up.



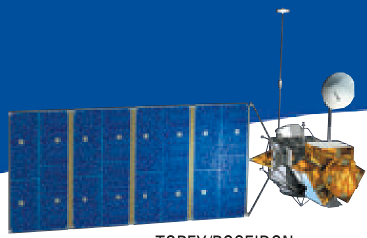
PROTEUS platform (Alcatel) - Preparation of the thermal mock-up for solar-vacuum test.

## PROTEUS

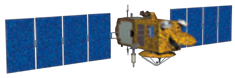
The PROTEUS bus is the basic module accommodating the housekeeping instruments required for the satellite to function, as well as the dedicated mission instruments.

PROTEUS adapts to different minisatellites, thus cutting mission design costs. (Supplied by CNES).

# The heritage of TOPEX/POSEIDON



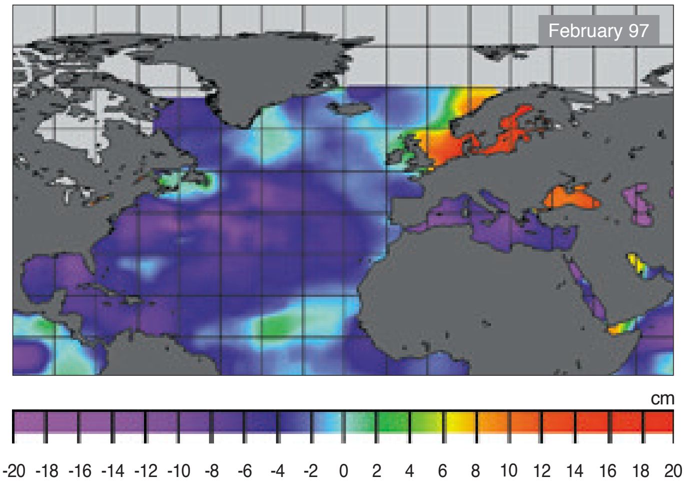
TOPEX/POSEIDON...



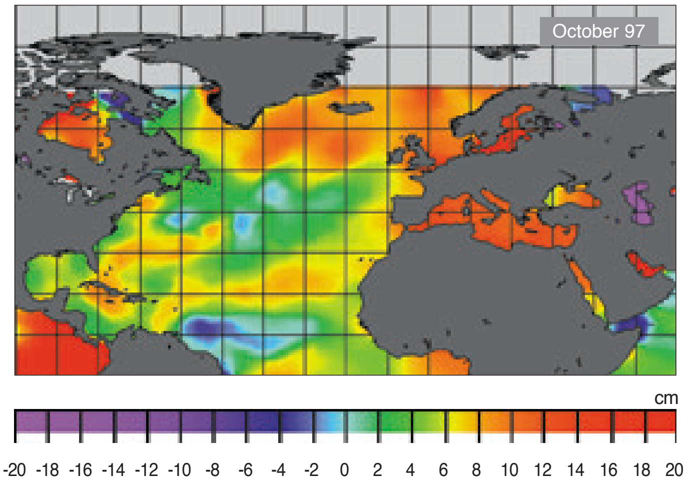
Jason-1

Since its launch in August 1992, TOPEX/POSEIDON has been charting the world's oceans every ten days. Data accurate to three centimetres at ocean basin scale have yielded a rich harvest of results, helping us to discover and further our understanding of many ocean phenomena, such as:

- Ocean circulation and variability,
- El Niño, particularly the 1997-98 episode,
- Low-amplitude phenomena (generating sea level variations of less than 10 centimetres),
- Seasonal ocean variations,
- Tides, now with an accuracy better than two centimetres.



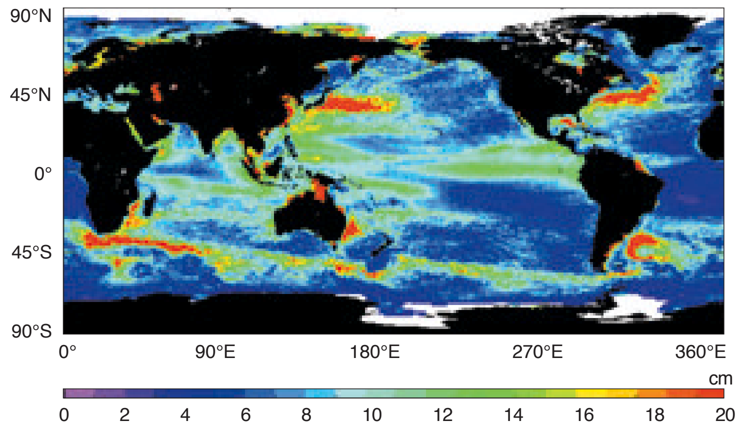

The oceans move in step with the seasons




Continuous series of measurements over ten years and more will soon allow us to observe new phenomena such as the Pacific and Atlantic Decadal Oscillations.

TOPEX/POSEIDON has also made operational ocean forecasting a reality, complementing such missions as ERS, and in the near future ENVISAT. These missions are wider in scope and geared less towards ocean measurements, but they are able to acquire a denser grid of measurements. This complementarity has proven a vital aid in improving our knowledge of:

- Mean sea surface variations,
- Eddies in ocean circulation spanning distances up to 100 kilometres,
- The geoid.




The most turbulent zones of the oceans, in red on this merged TOPEX/POSEIDON - ERS map, correspond to the movements and variations in intensity of major currents. The Antarctic Circumpolar Current, which flows in one of the most remote regions of the globe and can only really be observed and studied by satellite, is clearly visible. El Niño 1997-98, in green, also shows up in the Tropical Pacific.

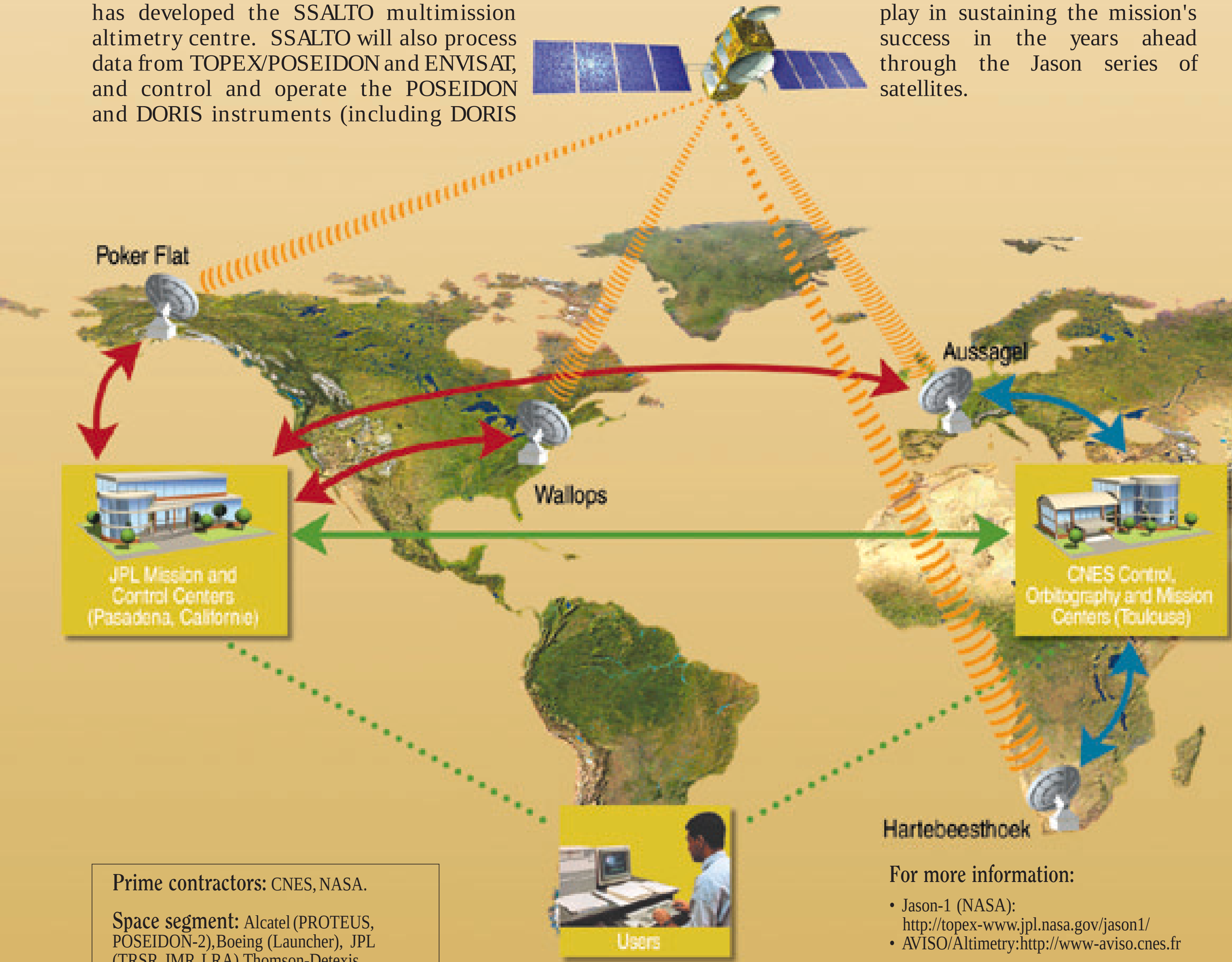
Jason-1 will follow on from TOPEX/POSEIDON and continue to provide data of the same quality, if not better. The PROTEUS multimission satellite bus and the heritage of the POSEIDON altimeter have significantly reduced mission development costs, laying the foundation for a series of operational satellites.

# Successful cooperation

Like TOPEX/POSEIDON before it, Jason-1 is the result of close international cooperation between space agencies, industry and data users working to accomplish a benchmark mission in terms of data quality and science and economic return.

From the moment the Jason-1 project began in September 1993 to the official memorandum of understanding in December 1996 and the satellite launch, cooperation between CNES and NASA has been the driving force behind its success. The two space agencies have combined their expertise in satellite design and operation, particularly for the ground segment—the nerve centre of the mission. NASA has responsibility for satellite control and the instruments it is supplying. To operate the satellite and process and exploit data, CNES has developed the SSALTO multimission altimetry centre. SSALTO will also process data from TOPEX/POSEIDON and ENVISAT, and control and operate the POSEIDON and DORIS instruments (including DORIS on the SPOT series of satellites).

The engineers and scientists making up the TOPEX/POSEIDON and Jason Science Working Teams (SWTs) have also worked closely together to enhance system performance. More than 400 teams from an ever-increasing number of nations worldwide are working with TOPEX/POSEIDON data. These teams are attracted by TOPEX/POSEIDON 's reliability and the broad palette of applications it serves. The user community thus has an important role to play in sustaining the mission's success in the years ahead through the Jason series of satellites.




**Prime contractors:** CNES, NASA.

**Space segment:** Alcatel (PROTEUS, POSEIDON-2), Boeing (Launcher), JPL (TRSR, JMR, LRA), Thomson-Detexis (DORIS).

**Ground segment:** CNES, JPL.

**For more information:**

- Jason-1 (NASA): http://topex-www.jpl.nasa.gov/jason1/
- AVISO/Altimetry: http://www-aviso.cnes.fr

**Sources:**

Alcatel, CLS, CNES, CNRS/LEGOS, JPL, NASA, SHOM, Starec, Thomson-Detexis.

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