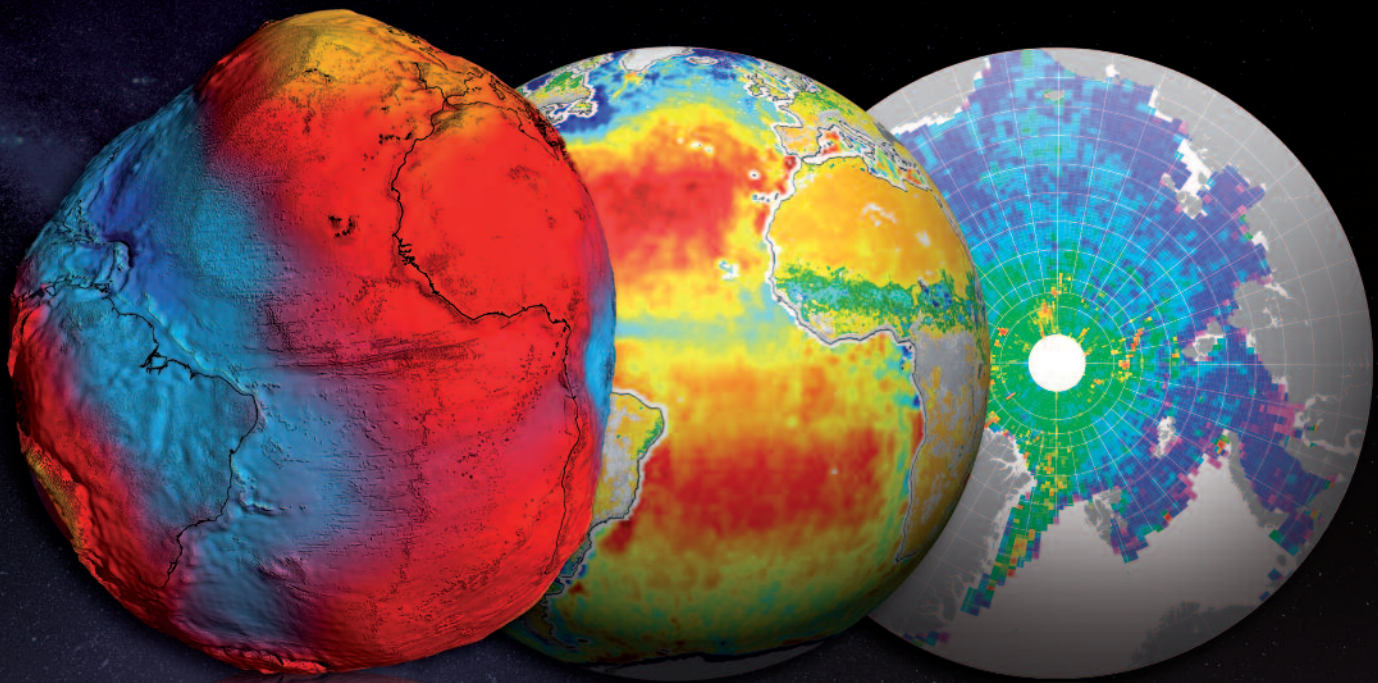
esa

earth explorers

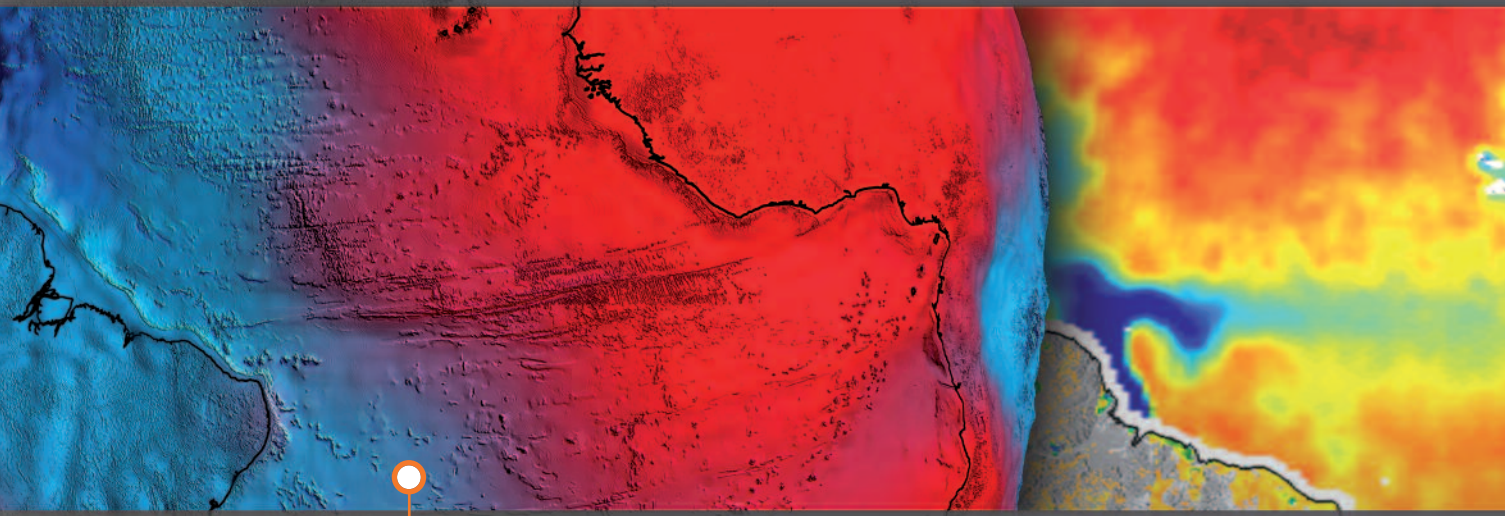
→ NEW VIEWS OF DYNAMIC EARTH



European Space Agency

→ SURPASSING EXPECTATIONS

Delivering a wealth of new information about our planet and forging state-of-the-art technologies, ESA's first three Earth Explorers – GOCE, SMOS and CryoSat – have been hailed as remarkable successes. These versatile satellite missions have surpassed expectations with a range of interesting and complementary results beyond their original goals.



→ UNRIVALLED PRECISION

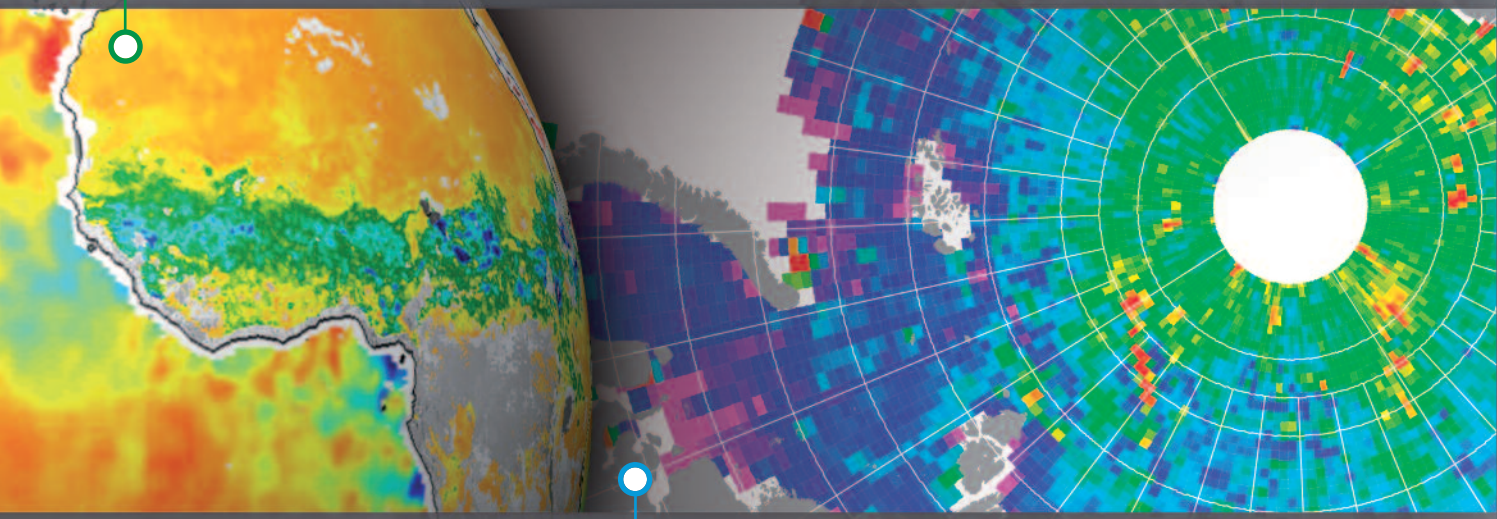
Carrying the first 3D gravity gradiometer in space and orbiting lower than any other Earth observation satellite, GOCE measured Earth's gravity with unprecedented accuracy, resulting in the most accurate 'geoid' ever produced. The geoid is a virtual surface of a global ocean shaped only by gravity.

goce

smos

→ NOVEL CONCEPT

SMOS uses an innovative technique of capturing images of 'brightness temperature'. These images correspond to radiation emitted from Earth's surface to produce global maps of soil moisture and ocean salinity for a clearer understanding of the water cycle.



→ COOL TECHNOLOGY

Reaching higher latitudes than earlier missions and carrying a sophisticated radar altimeter, CryoSat has provided new evidence of Earth's changing polar ice. This information is allowing us to understand how this remote and fragile component of the Earth system is so intrinsically linked to the climate.

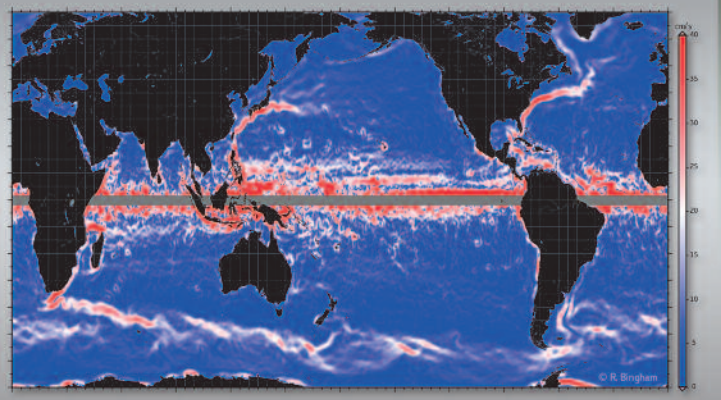
cryosat

“The new model of Earth’s geoid from GOCE has enabled ocean currents to be accurately mapped, globally and in unprecedented detail. Measurements from GOCE will allow scientists to better understand the complex relationship between ocean circulation and climate and how this may evolve as Earth continues to warm.”

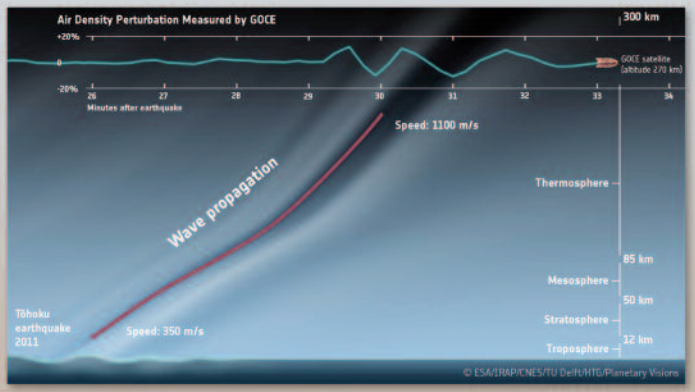
Rory Bingham, *University of Bristol, UK*

→ ESA’S GRAVITY MISSION

GOCE’s new geoid is leading to a better knowledge of ocean circulation, sea level, ice dynamics and Earth’s interior, along with the ability to measure heights across the globe more accurately. For instance, it is being used to help map ocean currents to understand how they moderate the climate by redistributing vast quantities of heat around the planet. GOCE’s precision data have also resolved an age-old debate, showing that the height of the sea decreases along the Atlantic coast from Florida to Canada.



GOCE is revealing ocean currents in unprecedented detail.



GOCE ‘felt’ the earthquake that struck Japan in 2011.

Feeling Earth move

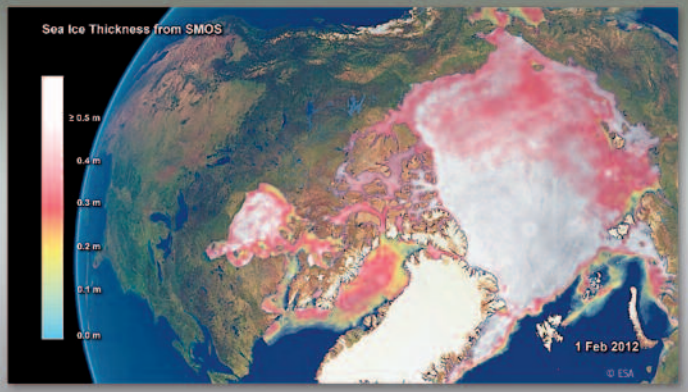
Orbiting at an extraordinarily low altitude, GOCE’s ion engine compensated for air drag by generating carefully calculated thrust. While this ensured a stable orbit, values of vertical winds and atmospheric density can be gained from the thruster and accelerometer data. In a surprising discovery, these data revealed that GOCE detected sound waves from the massive earthquake that hit Japan in 2011. Moreover, the innovative design of the GOCE satellite is set to pave the way for future low-orbiting satellites.

“SMOS is providing the first ever direct global measurements of soil moisture from space, paving the way for major benefits in weather prediction. Beyond this unique contribution, we anticipate additional benefits from the excellent SMOS data for a wide variety of applications such as ocean assimilation and modelling, sea-ice monitoring and, potentially, hurricane forecasting.”

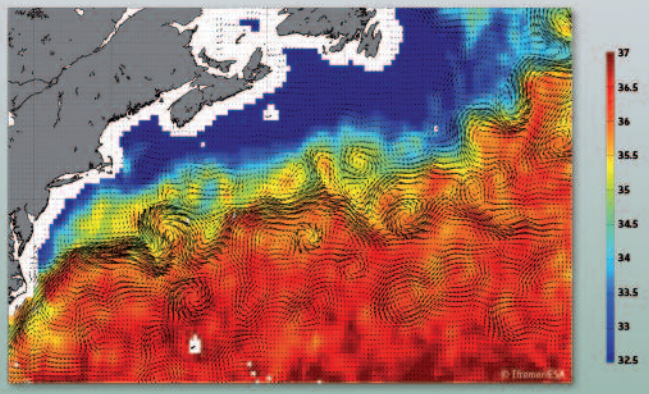
Jean-Noël Thépaut, *European Centre for Medium-Range Weather Forecasts, UK*

→ ESA'S WATER MISSION

As well as mapping soil moisture and ocean salinity to understand more about the water cycle and showing potential for improving weather forecasts, SMOS can be used to monitor sea ice. Radiation emitted by the ice allows SMOS to 'see' through the surface, yielding ice-thickness measurements down to 50 cm – mainly the thinner and younger ice at the edge of the Arctic Ocean. This information complements CryoSat's results.



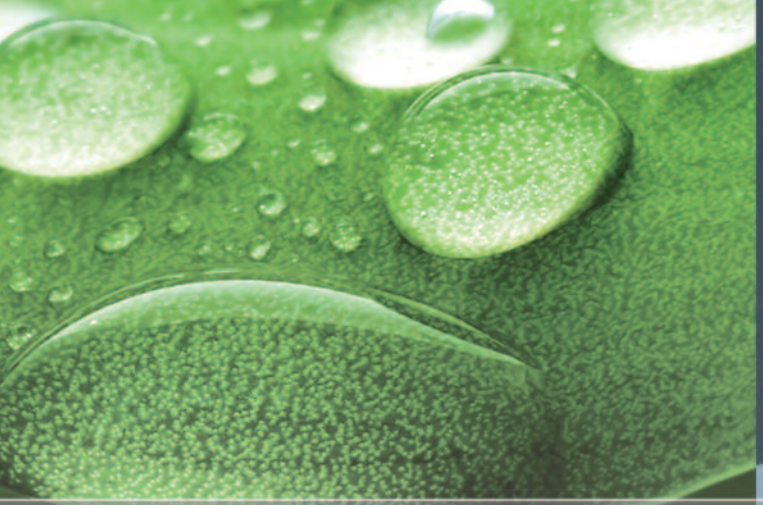
The versatile SMOS mission provides information on thin sea-ice.



Shedding new light on ocean currents.

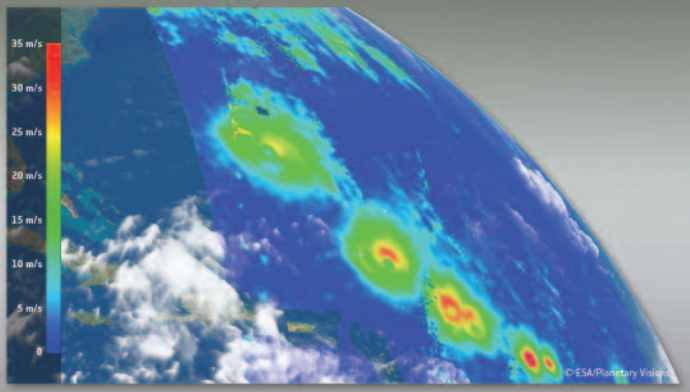
Eye on eddies

Salinity data are leading to a better knowledge of ocean circulation by providing insight into how salt is exchanged across current boundaries. For example, SMOS has shown that the warm, salty water carried north by the Gulf Stream converges with colder, less-salty water transported southward along the east coast of North America by the Labrador Current. SMOS can monitor eddies that pinch off, forming parcels of warm and salty water in the Labrador Current, and colder, fresher water in the Gulf Stream.



“CryoSat has already painted a remarkably detailed picture of how Earth’s polar ice is changing. The mission has provided the most extensive maps of Arctic sea-ice thinning to date, we have discovered craters in Antarctica that formed when lakes buried beneath the ice flooded, and we now have the first glimpse of how the polar oceans are changing between the ice floes and as they retreat.”

Andrew Shepherd, University of Leeds, UK



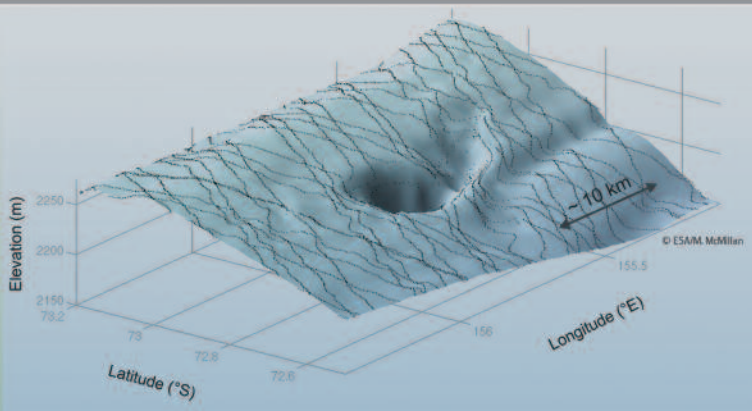
Winds under Hurricane Igor from SMOS.

→ ESA’S ICE MISSION

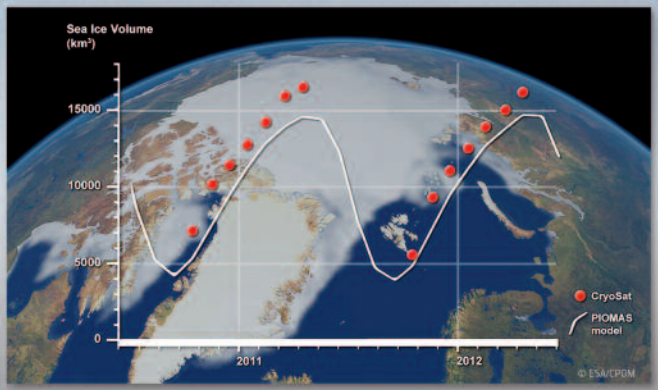
For several decades, satellites have witnessed a downward trend in the coverage of sea ice in the Arctic. Information from CryoSat has revealed, for the first time, that this loss of coverage is accompanied by a substantial decline in ice volume, which is a more accurate indicator of changes taking place. Coupled with NASA’s ICESat, CryoSat has shown that since 2008 the Arctic has lost about 4300 cubic km of ice during the autumn and 1500 cubic km in the winter.

Hurricane hunter

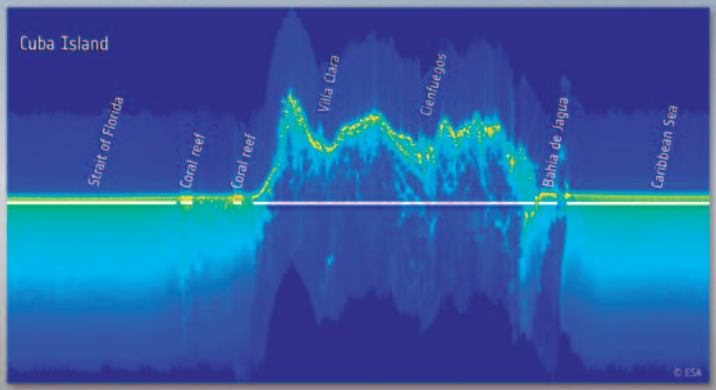
Since SMOS has the ability to see through clouds and its view is little affected by rain, it can provide reliable estimates of surface-wind speeds under intense storms. Strong winds over oceans whip up waves, which in turn affect the microwave radiation emitted from the surface. Although strong storms make it difficult to measure salinity, the changes in emitted radiation can be linked directly to the strength of the wind over the sea.



3D view of Antarctic ice crater using CryoSat data.



Changes in sea ice volume in winter from 2010 to 2012.



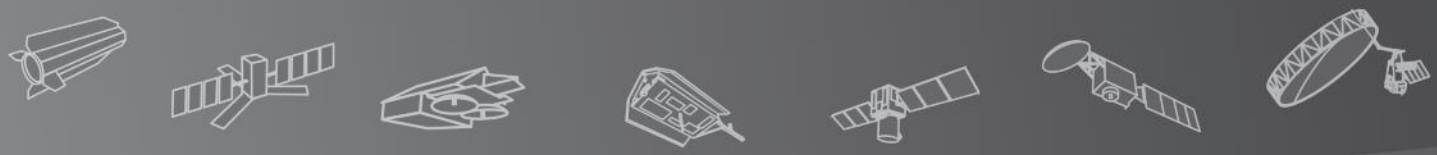
CryoSat readings over Cuba.

Antarctic flood

CryoSat has provided evidence of a huge flood under the Antarctic ice sheet. New measurements combined with older data from ICESat were used to map a large crater that formed as the overlying ice sank to fill the gap left by lake water that drained away. The map revealed that about six cubic km of water had escaped from under the ice, probably straight into the ocean, between 2007 and 2008.

Over land and under sea

CryoSat's sensitive radar altimeter also measures sea level and waves. Taking this a step further, scientists have discovered that CryoSat can potentially map coastal waters, and shows even greater capabilities to profile land surfaces and inland water targets such as small lakes, rivers and their intricate tributaries. In addition, since the height of the ocean surface reflects the shape of the ocean floor owing to gravitational pull, CryoSat's high spatial resolution measurements are set to revolutionise our understanding of water depth in deep oceans.



Understanding our changing Earth

Developed in response to pressing scientific challenges, ESA's series of Earth Explorer satellites offer new observational capabilities to understand different aspects of Earth and the impact human activity is having on natural processes.

The first of these novel missions, GOCE, mapped variations in gravity with unrivalled precision. This extraordinary satellite more than doubled its planned life in orbit and its data continue to be used far beyond their original scope. SMOS and CryoSat are providing new information on soil moisture and ocean salinity, and ice, respectively. By delivering a range of unexpected results, they too have surpassed expectations.

Swarm, launched at the end of 2013, is poised to continue in the same vein. Under development, ADM-Aeolus, EarthCARE and Biomass will advance our knowledge even more.

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