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LE FIGARO


LE FIGARO
Turquie: majorité absolue pour les islamistes

Un satellite européen pour prévoir les séismes

Goce sera lancé en mars 2008 pour mesurer les variations de la pesanteur terrestre. ***Page 8***

Un nouveau satellite européen pour mieux prévoir les séismes

ESPACE

Le satellite Goce va être bientôt lancé pour mesurer les infimes variations de la pesanteur terrestre, précieuses à connaître.

De notre envoyé spécial à Turin (Italie)

C'EST bien connu : on pèse moins lourd sur la Lune ou à bord de la Station spatiale internationale que sur Terre. Non que les régimes amincissants soient plus efficaces ici que là : la masse, autrement dit la quantité de matière dont tout corps est constitué, reste inchangée. Simplement, la gravitation, l'une des quatre forces fondamentales de l'Univers, mise en évidence par le physicien anglais Isaac Newton au XVII^{e} siècle, n'a pas la même valeur partout : nulle dans l'espace à partir de 100 km d'altitude, elle est six fois plus faible sur la Lune que sur Terre.

Plus surprenant encore : l'accélération de la pesanteur n'est pas non plus constante à la surface de notre planète. Certes, il s'agit de variations infimes, de l'ordre de 1 pour dix mille, autour de sa valeur moyenne (9,81 mètres par seconde au carré). Mais l'étude de ces « anomalies » gravitationnelles peut fournir une moisson d'informations aux scientifiques. Qu'il s'agisse d'étudier la structure interne de la Terre, et donc de mieux prévoir les séismes ou les éruptions volcaniques, de calculer le volume des calottes glaciaires, de surveiller les courants océaniques et leur influence sur le climat, ou encore d'évaluer les fluctuations du niveau de la mer.

Le satellite Goce de l'Agence spatiale européenne (ESA) fabriqué par le groupe franco-italien Thales Alenia Space, dans ses usines de Turin, avec le concours d'une quarantaine d'industriels de 13 pays d'Europe, sera capable justement de mesurer les variations du champ gravitationnel terrestre au millionième près et d'estimer avec une précision de 1 à 2 centimètres près la hauteur moyenne de la géoïde, autrement dit de l'océan au repos (sans les vagues). *« Les connaissances actuelles dans ce domaine sont incomplètes*, soulignait jeudi, devant la presse européenne, Danilo Muzi, responsable à l'ESA de ce projet lancé en janvier 2001 et dont le coût global est évalué à 300 millions d'euros. *Goce, l'un des satellites les plus complexes construits à ce jour, fournira pour la première fois et dans un délai rapide des données homogènes sur le champ gravitationnel à l'échelle de la planète entière. »*

Pour mener à bien sa mission prévue pour durer 20 mois, à 250 km en orbite autour de la Terre, l'engin de 1,1 tonne pour cinq mètres de long, en forme de torpille, est équipé d'un gradiomètre conçu par les ingénieurs de Thales Alenia Space à Cannes (France). Lequel est composé de six accéléromètres ultrasensibles disposés selon trois axes pour obtenir des mesures 3D. Autre particularité de Goce : son moteur à propulsion ionique lui permettra tout à la fois de corriger son altitude et de compenser automatiquement le freinage provoqué par la résistance des très rares particules atmosphériques présentes encore à ces hautes altitudes.

Lancement en mars 2008

Le mois prochain, Goce quittera définitivement Turin pour le centre technique de l'ESA (Estec) aux Pays-Bas afin d'y subir une ultime batterie de tests destinés à s'assurer qu'il supporte les conditions extrêmes qui règnent dans l'espace. Si tout se passe comme prévu, la mise en orbite devrait avoir lieu en mars 2008, au moyen d'une fusée russe Rockot, depuis la base de Plesetzk dans le nord-ouest de la Russie. En espérant que Goce ne subira pas le sort de Cryosat 1, un autre satellite de l'ESA destiné à mesurer l'épaisseur des glaces, détruit peu après son décollage, en octobre 2005, suite à une défaillance de ce missile militaire reconverti en lanceur civil. Mais les responsables de l'ESA se montrent confiants : *« les causes de l'accident ont été élucidées et les défauts corrigés »*, confie Danilo Muzi.

MARC MENNESSIER

LE TEMPS

Imprimer Retour

SOCIÉTÉ : Une Terre si subtilement attirante

Date de parution: Lundi 23 juillet 2007
Auteur: Olivier Dessibourg, Turin

ESPACE. Le satellite GOCE mesurera avec précision le champ de gravité terrestre, élément crucial dans les études d'océanographie, de climatologie ou de géophysique. Gros plan sur un engin qui modifiera la vision que les scientifiques ont de la Terre.

Une pomme qui lui tombe sur la tête. Selon la légende, c'est cet épisode qui aurait conduit Isaac Newton, en 1687, à déduire ses lois de la gravitation. Durant ses leçons de physique, chaque écolier apprend ainsi que tout corps choyant en direction du sol subit une accélération gravitationnelle appelée «g», qui vaut 9,81 m/s2. Cette valeur serait constante partout sur la Terre si celle-ci était une sphère parfaite. Or, à cause de sa rotation sur elle-même, notre planète ressemble plutôt à un ellipsoïde, ses pôles étant 21 km plus proches de son centre que l'équateur. Pire, les chaînes de montagnes et les abysses lui donnent carrément l'apparence d'un patatoïde. Sans parler de l'hétérogène distribution de la masse rocheuse dans ses entrailles. Si bien que le fameux «g» varie suivant l'endroit où l'on se trouve.

Grâce au satellite GOCE, les scientifiques de l'Agence spatiale européenne (ESA), dont la Suisse est membre, pourront bientôt établir une cartographie très détaillée du champ de gravité terrestre et de ses variations locales. La mise au point de l'appareil s'achève ces jours dans les «chambres blanches» de l'entreprise ThalesAleniaSpace, à Turin, où il a été présenté à la presse le 19 juillet. Grâce à cet outil, l'un des plus complexes jamais construits, les chercheurs espèrent faire des avancées déterminantes en océanographie, en climatologie, en géodésie ou en géophysique.

• Créer le géoïde

Le satellite a tout d'un engin d'espionnage, avec ses ailes sombres et ses menus ailerons. Qui sont en fait ses panneaux solaires: comme GOCE orbitera autour de la Terre à 250 km d'altitude seulement, où existe une atmosphère résiduelle, impossible de les déployer latéralement comme chez les autres satellites, car la résistance aérodynamique causerait un freinage marqué.

Sa mission: déterminer ce que les scientifiques appellent le géoïde. «Il s'agit de la surface virtuelle hypothétique de tous les points où la Terre exercerait la même force de gravité qu'au niveau moyen des océans», explique Danilo Muzi, chef du projet à l'ESA. Cette surface s'éloigne du sol réel au-dessus des zones où la densité de matière (roches, glaces, etc.) est grande, et donc où la gravité réelle est plus importante. En tenant compte des montagnes, ou des enfoncements de la croûte terrestre, ce géoïde prend ainsi l'aspect d'une Terre bosselée. Et Danilo Muzi d'imager encore: «Vu que la gravité est identique en tout point, une balle placée sur cette surface ne bougerait pas, même si l'on y voit des collines et des creux.» Un tel géoïde a déjà été esquissé par deux autres missions (CHAMP et GRACE). «Mais nous obtiendrons une précision inégalée. De l'ordre du centimètre sur une résolution géographique de 100 km. C'est crucial pour nombre d'applications.»

• Applications variées

La première est l'étude de la circulation océanique. «Avec les altimètres actuels embarqués à bord d'autres satellites, on mesure déjà précisément la surface des océans. Or les courants sont associés aux variations de niveau des eaux. Mais pour décrire ces courants très finement – avec une précision de vitesse de 10 cm/s –, il faut comparer ces niveaux à une valeur de référence. Cette valeur, ce sera le géoïde», explique Mark Drinkwater, scientifique à l'ESA. Ces travaux permettront aussi d'étudier les transports de chaleur dans l'océan, comme dans le Gulf Stream, ou de quantifier l'apport d'eau de fonte des banquises, et par là livreront des données précieuses aux climatologues.

De même, ce géoïde constituera un système de référence topographique unique à l'échelle planétaire pour toute mesure d'altimétrie, «comme celle du niveau de la mer, avec une précision d'un millimètre. Ce qui sera très utile à ceux qui doivent gérer crues et inondations, détaille Mark Drinkwater. Le géoïde démontrera aussi son intérêt lors de la construction d'un tunnel entre deux pays qui, avec le système actuel, peuvent avoir des références d'altitudes inégales.»

Autre domaine qui bénéficiera de GOCE: la géophysique. «Les mouvements tectoniques de la croûte et de convection dans le manteau terrestre dépendent de la densité des roches qui, elle, influence localement la gravité. Repérer les anomalies gravitationnelles permettra d'étudier la structure interne de la Terre, et par là les séismes ou les éruptions volcaniques. Et pourquoi pas de fournir des prévisions plus précises de ces phénomènes.»

• Instrument d'exception

Pour mesurer «g» et élaborer ce géoïde avec une précision inédite depuis l'espace, les scientifiques ont dû imaginer un dispositif avant-gardiste: un gradiomètre (lire ci-contre). Cet instrument ultrasensibles est

toutefois si capricieux qu'il ne livrera les données escomptées que si le satellite progresse de manière absolument régulière. Ce qui n'est de loin pas une sinécure dans cette très fine mais perceptible atmosphère. Pour compenser les minuscules frottements dans l'air induisant autant de changements de vitesse non désirés, les ingénieurs ont équipé l'engin d'un «compensateur de traînée en continu», capable de lui insuffler d'infinitésimales poussées si besoin.
«Ces poussées correspondent au minime coup de gaz que devrait donner un automobiliste roulant à 160 km/h lorsqu'une mouche s'écrase sur son pare-brise et le freine imperceptiblement. A bord de GOCE, c'est un moteur ionique révolutionnaire, fonctionnant au xénon, qui jouera ce rôle confinant à l'exploit», dit Rune Floberghagen, autre responsable du projet.
Enfin, pour corser les choses, la température intérieure devra être maintenue à 25°C, «à un dixième de millième de degré près, sous peine réduire notablement les performances», ajoute le scientifique. Quant à l'électronique de contrôle, produite par la firme bernoise Syderal, elle ne devra souffrir d'aucun défaut durant les 20 mois d'exploitation du satellite.
Bref, voilà autant de défis techniques inédits qui s'ajoutent à une autre première: GOCE doit lancer pour de bon la série des missions «Earth Explorer», avec lesquelles l'ESA souhaite détailler significativement nos connaissances de la planète bleue; le premier chapitre de ce programme devait être écrit par Croysat en 2005, mais ce satellite s'est désintégré au décollage.
Avant de partir vers les étoiles, ce joyau de technologie à 200 millions d'euros passera d'abord sur le banc de torture du centre d'essais de Noordwjik (Pays-Bas). Histoire de montrer qu'en mars 2008, il ne va pas souffrir du décollage à bord du lanceur Rockot depuis la base reculée de Plesetsk, en Russie. Et bien sûr qu'il restera à même de mesurer la gravité dans chaque situation.

Mesurer l'impact d'un flocon contre un pétrolier

Olivier Dessibourg

Pour mesurer avec une résolution prodigieuse, depuis l'espace, la force de gravité exercée localement par la Terre - autrement dit pour déterminer la fameuse accélération «g» avec laquelle tout corps tombe sur le sol - les scientifiques ont développé un instrument d'une sensibilité extrême, appelé gradiomètre. «Imaginez un flocon de neige pesant 0,2 gramme qui tombe sur un pétrolier d'un million de tonnes, explique Mark Drinkwater, scientifique de la mission à l'Agence spatiale européenne. Le gradiomètre de GOCE pourrait mesurer la force d'impact de ce flocon sur le tanker! Celle-là correspond à une fraction de 10000 milliardièmes de la valeur de «g». C'est exceptionnel!»
Le gradiomètre est un ensemble de six accéléromètres disposés par couple sur les trois axes orthogonaux de l'espace. Ces accéléromètres ne cachent rien d'autre en leur cœur qu'une «masse d'épreuve» possédant une certaine liberté de mouvement. «Lorsque le satellite avance sur certains éléments du relief, par exemple au-dessus de certaines montagnes très denses, ces six masses sont successivement plus ou moins attirées, sous l'effet d'une force de gravitation terrestre légèrement différente des endroits voisins», explique Mark Drinkwater. Les écarts par rapport à la position standard de ces masses d'épreuves sont alors mesurés, dans les trois directions, et permettent de déterminer une image en 3D de la gravité locale. Et cela avec une finesse époustouflante: «Nous parviendrons normalement à détecter la présence des plaques de banquises, mais aussi simplement de gros immeubles», s'extasie le chercheur.
Ce genre de gradiomètre, qui vole pour la première fois dans l'espace, a toutefois son talon d'Achille: pour être au maximum de ses capacités, il faut qu'il se trouve le plus près possible de la surface. GOCE orbitera donc à l'altitude minimale de 250 km, où existe déjà une atmosphère résiduelle qui le freinera. Les ingénieurs ont dès lors dû développer un moteur capable de compenser cette légère décélération et d'assurer une vitesse parfaitement constante, autre condition sine qua non du bon fonctionnement du gradiomètre.

CORRIERE DELLA SERA .it

22 luglio 2007

La missione impegna importanti scienziati e costa 300 milioni di euro

Goce, il satellite che guarda dentro la Terra

Il satellite dell'Esa, costruito in parte in Italia, partirà dalla Russia a marzo. Analizzerà la litosfera e il mantello superiore.

TORINO - Per la prima volta si potrà guardare dentro la Terra cogliendo processi oggi sconosciuti. Il metodo è particolare ma efficace e per metterlo a punto stanno lavorando da una quindicina d'anni. Principali protagonisti dell'impresa europea condotta dall'agenzia spaziale ESA, sono scienziati e tecnologi italiani. Tutto questo è concentrato nella missione «Goce» che partirà nel marzo dell'anno prossimo con un razzo russo Rockot dal poligono di Plesetsk, nel nord della Russia. Ma ora il satellite che materializzerà un grande balzo nella conoscenza del pianeta, e ormai completato, si sta preparando ad abbandonare la camera bianca di Thales Alenia Space di Torino dove è stato integrato per volare al centro Estec dell'ESA nei Paesi Bassi al fine di iniziare una serie di collaudi nei simulatori spaziali.

STRANA FORMA - Il satellite ha una forma strana, insolita perché assomiglia ad un aereo senza punta, con due pannelli solari tagliati come ali e due timoni. La ragione sta nel fatto che il veicolo volerà ad una quota molto bassa (250 chilometri) dove, la sia pur rarefatta atmosfera formata da sparse molecole, crea un ambiente nel quale il satellite deve volare quasi come un aeroplano appunto e quindi ali e timoni diventano in un certo senso «superfici di governo» del mezzo. Goce vola così basso perché deve misurare le variazioni di gravità della Terra costruendo una mappa di valori preziosi per diversi scopi. Per arrivare a questo, Goce dispone del più perfezionato gradiometro mai costruito che effettua misure con la precisione di un paio di centimetri e mostra aree con un dettaglio di un centinaio di chilometri mentre in passato si era intorno a 4-500 chilometri: quindi si vedranno cose prima impossibili da cogliere.

IL RILEVATORE DELLA GRAVITA' - Il gradiometro è formato da sei accelerometri distribuiti due su ognuno dei tre assi chiusi in contenitore a temperatura costante perché non devono subire alcun influsso il quale potrebbe alterare le loro valutazioni. E volando così basso dovranno, ad esempio, fare i conti con la resistenza all'avanzamento, cioè la frenatura aerodinamica causata dalle molecole. Per neutralizzarla Goce è dotato di un propulsore ionico che dieci volte al secondo genera un impulso variabile, cioè una spinta da 1 a 20 millinewton per annullare la resistenza. Quindi il propulsore funzionerà, di fatto, in continuazione per l'intera vita del satellite prevista in circa trenta mesi. Con certezza non si può sapere perché dipenderà da quanto combustibile Xenon utilizzerà. Ciò sarà conseguenza dalla variazione di densità dell'atmosfera la quale dipende da vari fattori a partire dall'attività del Sole che inviando verso la Terra particelle atomiche gonfia l'atmosfera in certi momenti rendendola più intensa.

CHE COSA FARA' – Goce misurando le anomalie gravitazionali rileverà le diverse densità della struttura della litosfera e del mantello superiore oltre alla distribuzione interna delle masse. Ad esempio depositi minerali e petroliferi o riserve d'acqua, possono essere scoperti da variazioni della gravità. Ma nello stesso tempo si possono realizzare modelli delle maree più precisi, conoscere meglio la circolazione delle correnti marine e costruire modelli tettonici per valutare con più precisione e mitigare il rischio sismico. Quindi, terremoti e attività vulcaniche, avranno in Goce un indagatore estremamente prezioso.

I PROTAGONISTI – Tecnologicamente Goce rappresenta una grande sfida vinta dai 70 ingegneri di Thales Alenia Space di Torino. «La nostra società guida l'impresa condotta a livello europeo – precisa il suo presidente Carlo Alberto Penazzi – coinvolgendo anche Eads e Onera, oltre a decine di altre società fornitrici di alta innovazione». In ESA, al centro Estec in Olanda, il programma è diretto dall'italiano Danilo Muzi mentre numerosi scienziati sono protagonisti sempre su scala europea: dal professor R.Rummel della Technical University di Monaco di Baviera al professor F.Sansò del Politecnico di Milano che lavora in collaborazione con il centro Altec di Torino. Costo della missione: 300 milioni di euro.

Giovanni Caprara

stampa | chiudi

Last Updated: Friday, 27 July 2007, 19:13 GMT 20:13 UK

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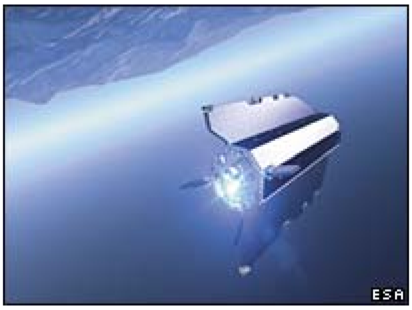
'Space arrow' to map Earth's tug

By Jonathan Amos
Science reporter, BBC News

A satellite that can measure tiny variations in the Earth's gravity field will be one of Europe's most challenging space missions to date.



Goce's gravity maps should achieve new levels of precision

OPEN Enlarge Image

Goce, due for launch next year, looks like a spyplane from a movie.

Its arrow shape, fins, and electric engine help keep the satellite stable as it flies through the wisps of air still present at an altitude of 260km.

Goce data will have many uses, probing hazardous volcanic regions and bringing new insight into ocean behaviour.

The latter, in particular, is a major driver for the mission.

By combining the gravity data with information about sea-surface height gathered by other spacecraft, scientists will be able to track the direction and speed of ocean currents.

"If we want to improve our climate models then we need to improve our knowledge of how the oceans move, and Goce will help us do that," mission scientist Dr Mark Drinkwater, from the European Space Agency (Esa), told BBC News.

Rock and no roll

Most people are taught at school that the acceleration due to gravity at the Earth's surface is 9.8m per second squared - but, in truth, this figure varies around the planet depending on the nature of the material underfoot.

> **We're smearing out the interpretation of the currents**
>
> Dr Mark Drinkwater, Esa

LISTEN **Goce's unique data**

The planet is far from a smooth sphere; the radius of the globe at the equator is about 20km longer than at the poles. This ellipsoid is then marked by tall mountain ranges and cut by deep ocean trenches.

The Earth's interior layers are also not composed of perfect shells of homogenous rock - some regions are thicker or denser.

Such factors will cause the gravitational force at the surface to deviate from place to place by very small but significant amounts.

The Gravity Field and Steady-State Ocean Circulation Explorer (Goce) will map these differences. This information will then be used to fashion what is, in essence, an idealised globe. Scientists call it the geoid.

It is a critical reference. The geoid defines the horizontal, tracing a surface on which, at any point, the pull of gravity would be perpendicular to it. Put a ball on this hypothetical surface and it will not roll - even though it appears to have slopes.

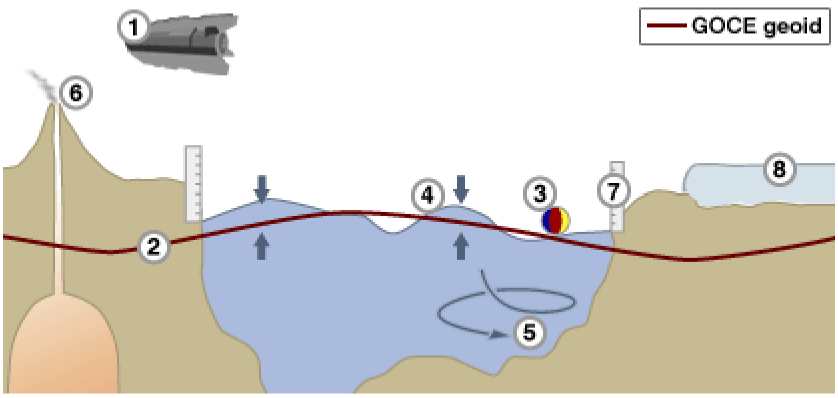
The geoid is of paramount interest to oceanographers who study the causes of the "hills" and "valleys" on the sea surface.

GRAVITY - A MOVING TARGET

The 'standard' acceleration due to gravity at the Earth's surface is 9.8m per second squared
In reality the figure varies from 9.78 (minimum) at the equator to 9.83 (maximum) at the poles

If local gravity differences are not creating these features, then other factors such as currents, winds and tides must be responsible.

With the help of the Goce geoid, scientists will be able to tease out these details with a precision and at a resolution not obtainable with current satellite technology.



1. Goce senses tiny variations in the pull of gravity over Earth
2. The data is used to construct an idealised surface, or geoid
3. It traces gravity of equal 'potential'; balls won't roll on its 'slopes'
4. It is the shape the oceans would take without winds and currents
5. So, comparing sea level and geoid data reveals ocean behaviour
6. Gravity changes can betray magma movements under volcanoes
7. A precise geoid underpins a universal height system for the world
8. Gravity data can also reveal how much mass is lost by ice sheets

"At the moment we can see structures down to the size of

150-200km," explained Dr Jakob Flury, formerly of the Technical University Munich, Germany, and now with the University of Texas at Austin, US.

"That's nice but the oceanographers want more detail. Goce will have spatial resolution which is finer, down to 80-100km. There are 'fronts' and currents in the oceans that are at width scales of 100km."

This will help scientists to characterise boundary currents, such as the Gulf Stream, which flow along the edges of deeply sloping continental shelves.

"The problem today is that we're losing detail as a consequence of the fact that our geoids have a very poor resolution," said Dr Drinkwater.

> **This is cruise control for a spacecraft, but at an unbelievable level of precision**
>
> Neil Wallace, QinetiQ

"We're smearing out the interpretation of the currents, and, as a result, we vastly underestimate the amount of water, heat and salt that's being transported around the ocean."

To make its gravity map, Goce will use a gradiometer. This unique instrument consists of three pairs of accelerometers that will sense the tiny variations in the tug of gravity over different parts of the Earth.

The instrument's performance is phenomenal: it will register accelerations that are less than one millionth of a millionth of the *g*-force we experience when standing on the Earth.

But to make the most of this sensitivity, Goce has to fly so low it will flirt with the top of the atmosphere; and that has proved to be a headache for the engineers because any buffeting on the spacecraft from air molecules will introduce noise into the data.

The "test masses" that make up the accelerometers must be kept in perfect free fall all the time to produce reliable readings. So, Goce uses an innovative drag-free propulsion system that throttles a special engine up and down to make compensations - to, in effect, fly the spacecraft around the test masses.

Qinetiq's engine assembly about to go into a vacuum test chamber

But again, the thrust levels required are tiny - a continuously variable force of anywhere between one and 20 milliNewtons during the science phase of the mission.

"This is cruise control for a spacecraft, but at an unbelievable level of precision," explained Neil Wallace from the UK technology company QinetiQ, which has built the engine.

"If you imagine you are driving your car down the motorway at 100mph (160km/h) and a mosquito hits the windscreen - the amount of deceleration your car experiences, that's what our engine has to compensate for."

The long and short

Goce is one of a growing number of spacecraft to employ an electric engine.

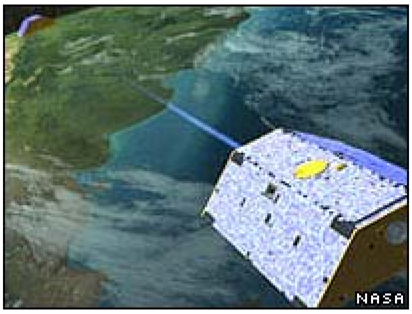
It draws power from solar panels stuck on one side of the satellite and uses this to charge xenon atoms which are then hurled out of nozzles on the rear of the tube-like body.

Goce will carry 40kg of xenon and this is the life-limiting factor on the mission.

Once all the xenon has been used up, the spacecraft will no longer be able to maintain fine control, and it will be allowed to fall back to Earth and burn up in the atmosphere.

Esa expects the mission to last 20 months - perhaps longer. Even this short period, though, should be sufficient to gain the high-quality data needed to produce the most detailed Earth geoid ever constructed.

And it will be a powerful complement to the work already being undertaken by the US-German Grace mission.



The existing Grace mission uses a pair of satellites

Mission weighs Africa's water
'Potato' Earth's deep secrets

Grace (Gravity Recovery and Climate Experiment) uses a pair of satellites to monitor how the gravity field changes over time - the evolving geoid.

It flies much higher - at about 500km - and as a consequence cannot match the resolution promised by Goce; but then the Grace twins are doing a different job.

"Grace is taking a movie and Goce is taking a high-resolution still", is the analogy used by Dr Michael Watkins, the Grace project scientist at the US space agency's Jet Propulsion Laboratory.

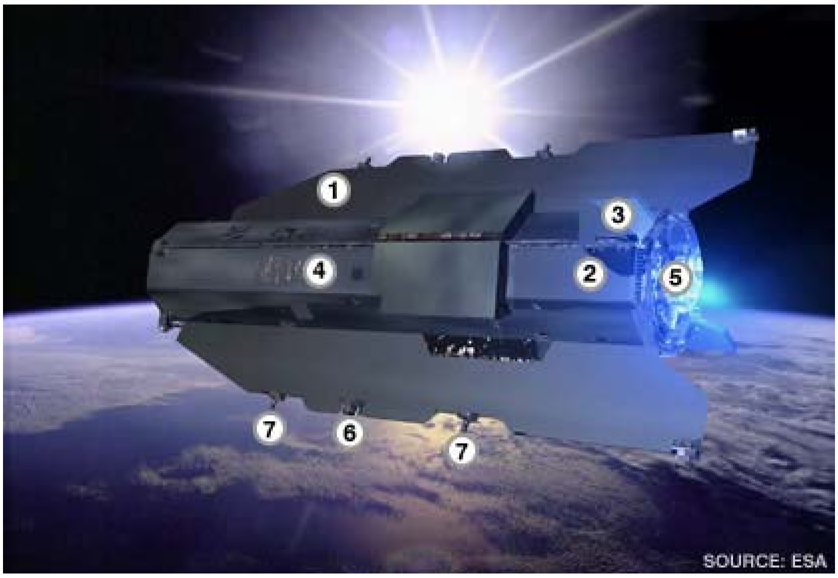
"The two missions use different ways to measure the gravity field, so they have different errors that are great to cross-calibrate," he told BBC News.

And increasingly science is about pulling together a broad range of datasets; the full picture only emerges when different perspectives and disciplines interweave.

To get a proper handle on sea level rise, for example, demands that ocean height measurements from satellites be combined with gravity and tide gauge readings and even GPS.

"It is the combinations of data which are the future," said Dr Drinkwater.

GRAVITY FIELD AND STEADY-STATE OCEAN CIRCULATION EXPLORER



1. The 1,100kg Goce is built from rigid materials and carries fixed solar wings. The gravity data must be clear of spacecraft 'noise'
2. Solar cells produce 1,300W and cover the Sun-facing side of Goce; the near side (as shown) radiates heat to keep it cool
3. The 5m-by-1m frame incorporates fins to stabilise the spacecraft as it flies through the residual air in the thermosphere
4. Goce's accelerometers measure accelerations that are as small as 1 part in 10,000,000,000,000 of the gravity experienced on Earth
5. The UK-built engine ejects xenon ions at velocities exceeding 40,000m/s; Goce's mission will end when the 40kg fuel tank empties
6. S Band antenna: Data downloads to the Kiruna (Sweden) ground station. Processing, archiving is done at Esa's centre in Frascati, Italy
7. GPS antennas: Precise postioning of Goce is required, but GPS data in itself can also provide some gravity field information

Jonathan.Amos-INTERNET@bbc.co.uk

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ABC

La ESA unificará el modelo para medir la **altura de las montañas**

ABC

MADRID. La Agencia Espacial Europea (ESA) zanjará la polémica surgida en 1999 sobre la verdadera altura del monte Everest, la cima de la Tierra. Hasta ese año, se consideraba oficialmente que dicha altura correspondía a 8.550 metros, pero el Instituto de Cartografía chino la fijó en 8.844,43, es decir, casi cinco metros menos de lo que se creía.

A comienzos de 2008, la ESA lanzará su programa Explorador del Campo Gravitatorio y de las Corrientes Oceánicas terrestres (GOCE, por sus siglas en inglés). Su misión será «mapear» la superficie del planeta con la mayor exactitud jamás alcanzada, así como unificar un modelo para establecer la altura exacta de las montañas, y al mismo tiempo cartografiar las corrientes marinas con la misma precisión.

Ambas tareas las llevará a cabo por medio de un dispositivo de medición del campo gravitatorio de la Tierra, distinto de unos puntos a otros a causa de la irregular distribución de materiales en el planeta. Según sus creadores, el programa GOCE marcará un antes y un después en el campo de la geodesia, y en el conocimiento de las circulaciones oceánicas y el nivel de los mares.

Más información sobre el programa:
http://www.esa.int/esaCP/SEMI9DWUP4F_index_0.html

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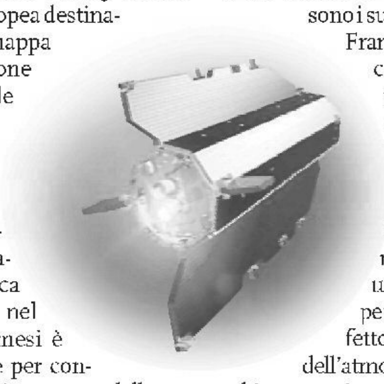
Il Sole 24 ORE

SATELLITE GOCE STUDIARE GLI EFFETTI SUL CLIMA

La mappa della gravità

Lo studio della gravità terrestre riparte da Torino. È qui, negli stabilimenti della Thales-Alenia Space che sono in corso gli ultimi ritocchi a Goce (Gravity field and steady state, ocean circulation explorer) il primo satellite del programma scientifico Living Planet dell'Agenzia spaziale europea destinato a realizzare la prima mappa mondiale ad alta risoluzione del campo gravitazionale del nostro Pianeta.



Lo sviluppo di Goce costa 200 milioni di euro dei quali 40 destinati direttamente alla franco-italiana Thales-Alenia (Thales 67%- Finmeccanica 33%) ed è cominciato nel 2001, ma negli ultimi mesi è avanzato a marce forzate per consentire di lanciarlo il prossimo marzo dalla base di Kourou, in Guyana, sfruttando così la bassa attività solare che riduce le variazioni di volume dell'atmosfera. Il satellite, un cilindro ottagonale lungo 5,3 metri e del peso di 1,1 tonnellate, è nato da un'idea italiana e per la prima volta porterà in orbita un gradiometro per la misura della forza di attrazione del nostro Pianeta. «Goce – spiega Fernando Sansò del Politecnico di Milano, che sovrintenderà l'analisi dei dati raccolti dagli strumenti – orbiterà intorno alla Terra per 20 mesi catturando tutte le variazioni gravitazionali terrestri per fornire i migliori dati finora raccolti sulla struttura e sulla dinamica interna della Terra, della circolazione marina e oceanica e della sua influenza sul clima». Il fiore all'occhiello di questo satellite sono i suoi strumenti sviluppati tra la Francia e l'Italia. «Oltre al sofisticato Gradiometro, per misurare il campo gravitazionale terrestre, Goce sarà dotato di un controllo orbitale e d'assetto "drag free" sviluppato a Torino – osserva Giuseppe Finocchiaro di Thales-Alenia che è capocommessa di una cordata di aziende – che permetterà di compensare l'effetto frenante delle molecole dell'atmosfera ancora presenti sull'orbita operativa». Si tratta di uno strumento essenziale perché Goce possa mantenere, quasi senza sobbalzi e deviazioni, un'orbita bassissima, ad appena circa 250 chilometri di altezza contro gli oltre 23mila previsti per quelli del sistema di posizionamento satellitare Galileo.

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http://guidoromeo.nova100.ilsole24ore.com/

www.esa.int/esaLP/
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FORSCHUNG AKTUELL

23.07.2007

GOCE soll ab 2008 das Schwerefeld der Erde unglaublich exakt vermessen. (Bild: esa.int)

Mit unglaublicher Empfindlichkeit

ESA-Satellit GOCE soll die Schwerkraft der Erde vermessen

Von Dirk Lorenzen

Astronomie. - Die Schwerkraft ist uns allen sicher die vertrauteste Kraft in der Natur - wir kennen sie aus schmerzvoller Erfahrung. Jeder Sturz, jedes zu Boden gegangene Glas, jedes zusammengebrochene Regal: Die Schwerkraft hat Schuld! Geophysiker wollen nun die Schwerkraft der Erde mit dem Satelliten GOCE so genau vermessen wie nie zuvor.

Wer zum Satelliten **GOCE** will, muss sich fast kleiden wie für eine Operation: Kittel an, Überschuhe, Haarhaube - nur der Mundschutz darf weg bleiben. Über Klebematten, die den letzten Staub von den Sohlen nehmen, geht es dann in die große Montagehalle von Thales Alenia Space am Stadtrand von Turin. Auf einer Arbeitsplattform ist GOCE zu sehen, sieben Meter lang, zwei Meter Durchmesser. Isaac Newton war der geniale Gedanke zur Formulierung der Schwerkraft beim Anblick eines vom Baum fallenden Apfels gekommen. Bei aller Hightech mit zahllosen Kabeln und aufwändigen Instrumenten ist Mark Drinkwater, GOCE-Projektwissenschaftler bei der Europäischen Raumfahrtagentur Esa, über 300 Jahre nach Newton im Prinzip nicht viel weiter:

Im Satelliten befinden sich zwei Testmassen, die etwa einen halben Meter voneinander entfernt sind und frei schweben. Während GOCE um die Erde kreist, spüren beide Massen die Schwerkraft der Erde etwas unterschiedlich. Die eine bemerkt eine Änderung etwas früher als die andere. Wir haben drei Paare von Testmassen und vermessen so dreidimensional, wie sich das Schwerefeld der Erde von Ort zu Ort etwas ändert.

Reichte bei Newton noch ein Apfel, so lässt Mark Drinkwater jetzt im GOCE-Satelliten sechs "Juwelen" um die Erde fallen: die Testmassen bestehen aus einer kostbaren Platin-Legierung. Wie stark die Schwerkraft an einem bestimmten Ort der Erde ist, hängt von der Menge und Dichte der Materie in der Umgebung ab: die Abplattung der Erde, Gebirge, Rohstoffvorkommen im Boden, die Gezeiten der Meere, ja sogar große Gebäude haben Einfluss darauf, wie stark wir die Schwerkraft spüren. GOCE soll nun erstmals das Schwerefeld der Erde vermessen - global und mit einer schier unglaublichen Empfindlichkeit:

Stellen Sie sich eine Schneeflocke vor, die auf einen Supertanker fällt. Dann spürt der Supertanker den "Einschlag" der Schneeflocke und fährt hinterher etwas langsamer weiter. Natürlich ist dieser Effekt winzig klein. Aber die Instrumente, die wir für GOCE bauen, sind so empfindlich, dass sie das Auftreffen der

Schneeflocke auf dem Tanker noch registrieren würden. Nur so bekommen wir wirklich ein umfassendes Bild des Schwerefeldes der Erde.

Dieses Beispiel illustriert, welche technische Hürden das GOCE-Team zu nehmen hatte. Manche Ingenieure räumen hinter vorgehaltener Hand ein, sie seien "fast wahnsinnig" geworden, welche Anforderungen bei GOCE zu erfüllen waren: Der Satellit besteht aus speziellen Kohlefasern, die sich praktisch nicht ausdehnen oder zusammenziehen, wenn der Satellit im heißen Sonnenlicht fliegt oder im kalten Erdschatten. An Bord gibt es keine beweglichen Teile. Jede Veränderung oder Erschütterung des Satelliten würde die Messungen unmöglich machen. Dabei setzt das Team um Mark Drinkwater in die GOCE-Daten große Erwartungen:

Das Schwerfeld liefert uns viele Informationen über die großräumigen Meeresströmungen und die Prozesse in der Erdkruste. Zudem vermessen wir die generelle Form der Erde auf etwa zwei Zentimeter genau. Diese Daten sind extrem wichtig, um Veränderungen im Klima besser zu erkennen und die Erde global zu vermessen. Zudem verstehen wir dann die Prozesse besser, die zu Vulkanen und Erdbeben führen.

GOCE wird nun noch einmal technisch auf Herz und Nieren geprüft. Im Frühjahr 2008 wird ihn dann eine Rockot-Rakete, eine ehemalige SS-19-Atomrakete, vom russischen Plesetsk aus in eine erstaunlich tiefe Umlaufbahn schießen: GOCE wird nur 250 Kilometer hoch die Erde umkreisen, gut 100 Kilometer tiefer als die Raumstation. Doch nur wenn er so tief fliegt, empfindet GOCE die Erde anziehend genug, um das Schwerefeld so extrem genau zu vermessen.

zurück . zum Seitenanfang

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Measuring sea level rise from space

By Mark Kinver
Science and nature reporter, BBC News

Meteorologists and climate modellers are eagerly awaiting the launch of a satellite that will be able to measure sea level rise to an unprecedented degree of precision.

Jason-2, scientists hope, will help shed light on the oceans' dynamics by measuring the topography - the "hills" and "valleys" - of the world's seas every 10 days.

The satellite's radar altimeter, Poseidon-3, is designed to measure the sea level height to within a few centimetres. It will do this from its orbit more than 1,300km above the Earth.

Data collected by Jason-2's instruments will help researchers develop more precise forecasts, improve hurricane path projections and reveal how climate change is affecting ocean currents.

"There is more to the dynamics of sea level rise than just a single, global rise," explained Mikael Rattenborg, director of operations for the European Organisation for the Exploitation of Meteorological Satellites (Eumetsat).

"Although we have seen, overall, global sea level rise, there are areas that have

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decreased for long periods, followed by an increase.

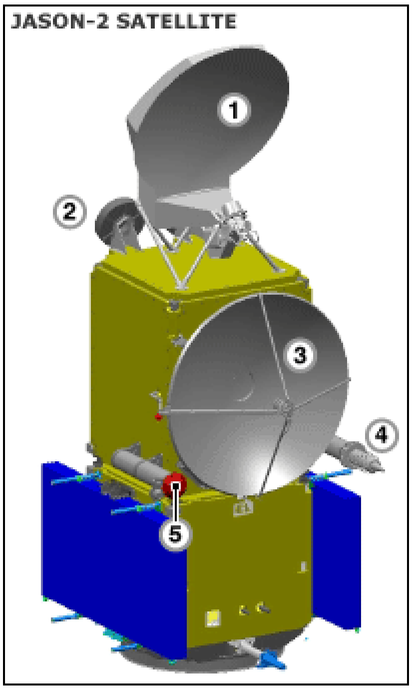
"We can only analyse the significance of regional variability of sea level rise if we have altimetry data available to us," he added. "Jason-2 will help us model and explain this evolution."

The satellite will be able to map 95% of the world's ice-free oceans every 10 days, something that would be impossible using survey vessels on the surface of the planet.

As well as observing variations in sea levels, Mr Rattenborg said the mission would also help researchers map seasonal and inter-annual ocean patterns, such as the Pacific's El Nino effect.

"This has a profound impact on the weather, not only in that region but globally. We can study this phenomenon in much greater detail with the altimetry data.

"All of these processes are coupled to climate analysis, which is the key reason why Eumetsat is interested in altimetry."



1. Advance Microwave Radiometer (AMR) - measures signal delay caused by water vapour
2. GPS antennas - ensures precise orbit path
3. Poseidon-3 altimeter- measures sea level
4. Doris antenna - tracking and positioning control
5. Laser Retroreflector Array (LRA) - tracks and calibrates measurements
Mass: 525kg (1,155lb)
Power generation: 511 watts
Height: 3m (9ft 8in)
Orbit: 1,338km (831 miles)

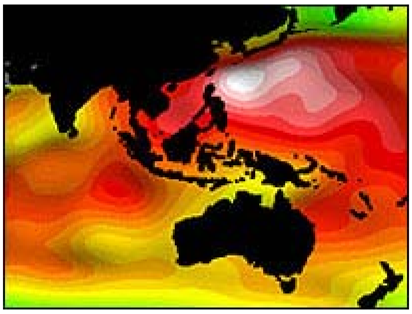
(Source: Eumetsat, Cnes, Nasa)

Storm tracking

Eumetsat operates and collects data from satellites on behalf of Europe's national meteorological agencies, such as the UK's Met Office, to compile forecasts and climate models.

Mr Rattenborg said the sea surface topography recorded by Poseidon-3 would also reveal tell-tale signs that would help predict the path and intensity of hurricanes.

He used Hurricane Katrina, which devastated the US Gulf coast in 2005, as an illustration.



"It passed over the Florida peninsula into the Gulf of Mexico as a strong hurricane (category three), but not an intense one.

Map showing sea level variations

OPEN Enlarge Image

"But suddenly, about 24 hours before it hit New Orleans, it developed into a category five hurricane.

"If you look at the sea surface temperature in the Gulf at the time Katrina passed over, it is fairly homogenous, so it does not explain why the system developed so rapidly."

Mr Rattenborg said the answer could be found in something called the Tropical Cyclone Heat Potential (TCHP).

"It is a measurement of the heat energy available in the deep layer of the ocean," he explained.

"Altimetry provides us with a measurement of this potential, because the (sea) surface topography reacts to the changes to the heat content beneath the ocean.

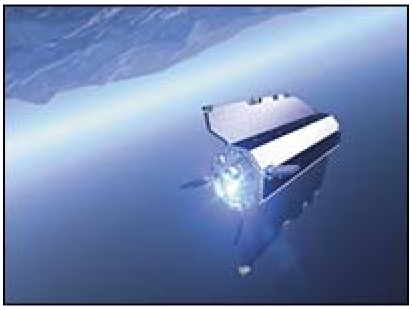
"In the area of the Gulf, south of New Orleans where Katrina passed, there was a sea-surface height anomaly, which corresponds to a very deep layer of very warm water.

"This clearly shows that by looking into the ocean, we can monitor the availability of heat energy."

But it is not only the thermal energy stored deep within the oceans that causes the variation in sea level, gravity also has an influence.

The subterranean geology is not uniform, some regions are more dense than others. This causes a subtle but significant shift in the Earth's gravitational force.

To measure the influence of gravity and its impact on ocean topography and currents, the European Space Agency (Esa) plans to launch an arrow-like satellite called the Gravity field and steady-state Ocean Circulation Explorer (Goce).


'Arrow' to map Earth's tug

"If we want to improve our climate models then we need to improve our knowledge of how the oceans move, and Goce will help us do that," mission scientist Dr Mark Drinkwater, from Esa, told BBC News.

By combining the data gathered by Goce and Jason-2, meteorologists and climate scientists will advance their understanding of the physical factors influencing the oceans and atmosphere.

Jason-2 is the latest addition to a series of satellites fitted with altimeters to map the sea surface.

The first, Topex/Poseidon, was launched in 1992 as an experiment to assess the effectiveness of high-accuracy altimeters to measure ocean dynamics from space.

Its success paved the way for the Jason-1/Poseidon-2 mission, launched in 2001.

Lessons learned from the previous missions have allowed the team building the Poseidon altimeter instrument for Jason-2 to improve its accuracy and reduce the margin of uncertainty to within 2.5cm.

All systems go

Because the satellite's orbit of 1,338km above the Earth's surface takes it through a harsh, radioactive environment, the craft's operational life is listed as five years.

Scientists involved in the project say Jason-1 is already using a number of back-up systems and it is only a matter of time before these fail, too; hence the need for Jason-2 to replace it.

As with the original Jason, this satellite and altimeter is being built by Thales Alenia Space in Cannes, France.

Jason-2 is on schedule for a June 2008 launch, say scientists

It forms the space segment of a mission called Ocean Surface Topography Mission (OSTM) - a joint initiative between the French space agency (Cnes), Nasa, and meteorological bodies Eumetsat and Noaa.

"This mission is dedicated to several objectives, including the precise, continuous and global measurement of the sea surface," said Pascale Ultre-Guerard, head of Cnes' Earth observation programme.

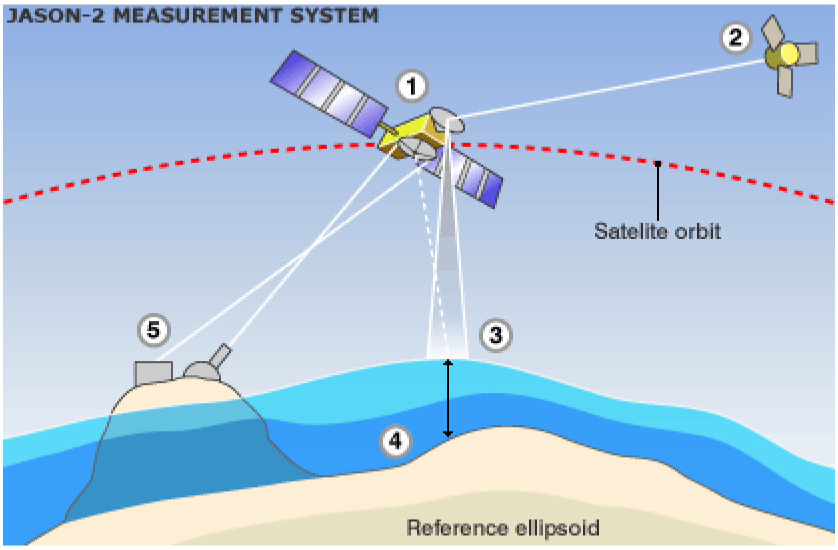
Thierry Huiban, Jason-2 project manager, said preparations were on schedule and the team was confident the satellite would be ready for its launch in June.

"We have completed the integration of the payload module with the [satellite's] platform.

"We are now carrying out tests to ensure the satellite qualifies for the space environment."

These tests include exposing the craft to the kinds of forces it will experience during its journey into space and while it is in orbit.

If all goes according to plan, Jason-2 is scheduled to be moved from southern France to its launch site at the Vandenberg Air Force Base, California, in February 2008, ahead of a June blast-off onboard a Delta II rocket.



1. Jason-2 satellite: From its 1,338km-high circular orbit, the craft maps 95% of the world's ice-free oceans' topography every 10 days
2, GPS satellites: The system is used to track Jason-2's position, ensuring very precise sea level height measurements
3. Sea height measurement via Poseidon-3 altimeter: The dual frequency radar signals are able to measure sea level height, wave height and surface wind speed
4. Sea surface topography: Variations in the height of the sea surface, when combined with measurements from other satellites and in-situ instruments, will allow scientists to improve weather and climate system models
5. Doppler Orbitography and Radiopositioning Integrated by Satellite (Doris) and laser ranging beacon: Ground stations ensure the precise positioning of Jason-2, which enables researchers to gather meaningful data from the satellite

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'Ferrari' of probes to check Earth gravity

Elegant satellite is the latest weapon in the fight against global warming

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Robin McKie, science editor
The Observer Sunday July 29 2007

Scientists unveiled a new weapon in the battle against global warming last week: a 16ft torpedo-shaped probe that will swoop over the atmosphere to measure Earth's gravity with unprecedented accuracy.

The Gravity and Ocean Circulation Explorer, or Goce, has been dubbed the Ferrari of space probes because of its elegant design and will be launched early next year on a Russian SS-19 missile. Scientists say its data on Earth's gravitational field will be vital in understanding how ocean currents react to the heating of our planet over the next few decades.

'Gravity is the force that drives the circulation of the oceans,' said Dr Mark Drinkwater, Goce's project scientist. 'Until we understand its exact role we cannot predict how the seas - and planet - will behave as the climate gets warmer. That is why Goce is being launched.'

Ocean currents take a third of all the heat that falls on equatorial regions and carries it to higher latitudes. One of the most important is the Gulf Stream, which scientists fear could soon be destroyed or diverted by melting Arctic ice. But they need to know all the gravitational effects that influence the stream's course across the Atlantic before they can make accurate predictions.

The problem is that Earth's gravity is not constant. The planet is flattened at the poles, for example, so gravity is stronger there, and weaker at the equator. Gas fields, mineral deposits, groundwater reservoirs and rock strata also produce variations in gravity. 'There are all sorts of wiggles and bumps in Earth's gravity field,' said Dr Chris Hughes, of the Proudman Oceanographic Laboratory in Liverpool. 'Each will influence ocean currents, which have a crucial role in moving heat around the world. If we are to understand how climate change is going to affect the planet, we have to have a precise picture of its gravity field.'

[redacted]

launch, has been put together by Thales Alenia Space Italia. And while most satellites are simply boxes with instruments bolted on, Goce is sleek and elegant; last week it was described by project manager Andrea Allasio as 'the Ferrari of space probes'. Covered with silver-blue solar cells, it must fly low because it could not measure Earth's gravity with sufficient accuracy in deep space. 'It has to get close to make its measurements,' said Professor Reiner Rummel, of Munich Technical University.

However, as Goce skims above the Earth at a height of 150 miles it will encounter drag from the outer edges of the atmosphere. To prevent it losing height, an ion rocket will be fired constantly to keep it in its correct orbit. Computers will send 10 messages a second to its engines to ensure the probe orbits at the right height. To measure Earth's gravity the probe will use GPS devices to plot its exact position and a gradiometer, a machine that can detect fluctuations of a million millionth in Earth's gravity. This data will be transmitted daily and used to build a model of Earth's shape that is accurate to within a centimetre, as well as putting together a highly accurate gravity map of the planet.

'Once we combine that data with observations of sea height and ocean current flow - information that is provided by other satellites - we will get a clear idea of what our oceans are doing,' added Hughes. 'Then we will get a better picture of how the seas are changing as the world heats up.'

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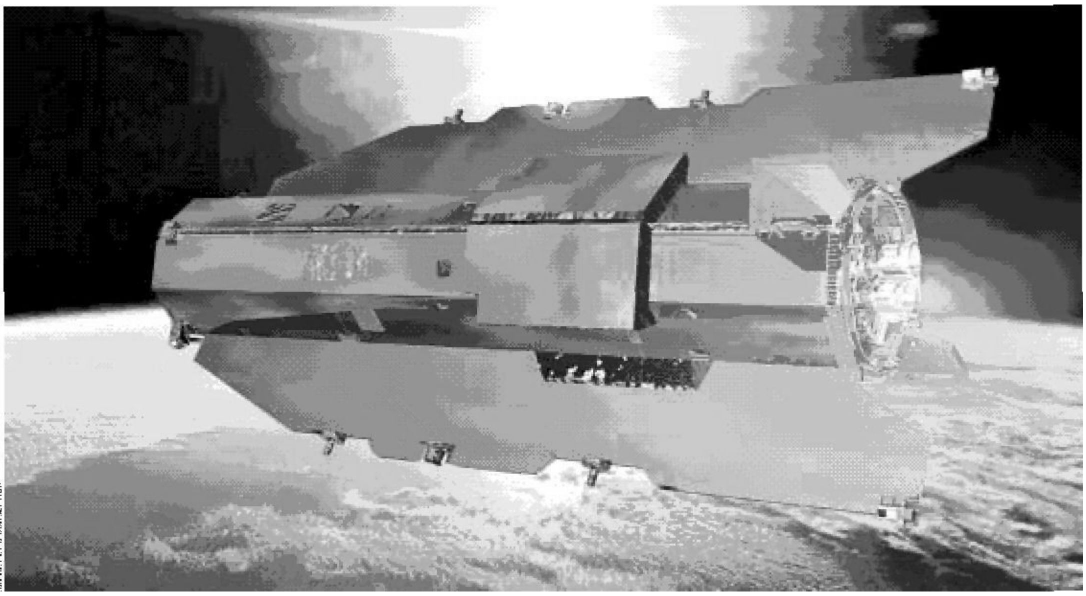


Keeping the Goce satellite (above) stable to permit sensitive gravity-field measurements while compensating for atmospheric drag at lower altitudes dictated the satellite's design. Goce uses small xenon-ion electric motors whose continuous pulses correct for drag.

ESA Struggles with "the Ferrari of Gravity Missions"

PETER B. de SELDING, TURIN, Italy

Europe's Goce gravity-field and ocean-circulation observation satellite is two years behind schedule following what designers agree were overly ambitious performance and schedule demands but is now on track for a March 2008 launch, Goce managers said.

The satellite, expected to weigh 1,100 kilograms at launch, is designed to operate from about 250 kilometers in altitude — the lowest orbit ever intentionally used by a European satellite — following its launch aboard a Russian Rockot launch vehicle operated by the German-Russian firm Eurockot Launch Vehicles GmbH.

Keeping the satellite still to permit sensitive gravity-field measurements while compensating for the considerable atmospheric drag at that altitude are part of a host of design challenges that Goce had to meet. The satellite has no moving parts, and will be powered by small xenon-ion electric motors whose continuous pulses will correct for drag.

In another concession to atmospheric drag, the satellite was designed to look more like a crude design for a space shuttle than a satellite. It is 5 meters long, just 1 meter in diameter, with rigid solar panels and tail fins that will help stabilize flight.

Goce is scheduled to leave prime contractor Thales Alenia Space Italy's production site here Aug. 20 for several months of testing at the Estec technology center in Noordwijk, Netherlands, operated by the satellite's owner, the European Space Agency (ESA).

Originally slated for a 2006 launch, Goce fell further and further behind schedule following steep design hurdles, notably for its accelerometers, designed by Onera, the French aerospace-research institute.

"We knew from the outset that the technical hurdles for this program were not benign," said Reinhold Zobl, head of ESA's Earth observation projects department. "But it's true we didn't expect this much of a delay. These accelerometers are beyond state of the art."

Mark Drinkwater, ESA's Goce project scientist, said Goce is "the Ferrari of gravity missions." The instruments, he said, have a sensitivity equivalent to being able to detect the force generated by a 200-milligram snowflake as it lands onto an oil tanker weighing 1 million metric tons.

Goce's gradiometer gravity-field instrument will rely on three pairs of accelerometers. ESA officials said the accelerometers are up to 100 times more sensitive than any previously flown in space.

Goce's contracting team was selected in early 2001. But as managers confronted successive scientific requirements, the program was slowed and the critical design review was not completed until July 2005.

In a series of presentations here at Goce prime contractor Thales Alenia Space Italy July 19, Goce program managers said that despite the delays, the total cost — satellite, launch and 20 months of

SPECIALE Il Satellite Goce

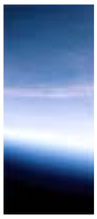
Satellite italiano da record

Consegnato all'Agenzia Spaziale Europea il satellite Goce, realizzato in Italia. Permetterà di conoscere i cambiamenti del clima attraverso la prima mappa della gravitazione terrestre

Il **satellite Goce**, acronimo inglese che sta per **esploratore del campo gravitazionale e della circolazione degli oceani**, è un gioiello di tecnologia ideato e realizzato da industrie e Università italiane preso in consegna dall'**Agenzia Spaziale Europea** (**Esa**) a Torino, per essere lanciato nel 2008 da un cosmodromo siberiano. Sarà l'unico satellite che, grazie a due innovativi motori a ioni, potrà mantenere un'orbita a bassa quota, di 250 chilometri, catturando ogni variazione gravitazionale terrestre. In tal modo, riuscirà a disegnare la prima mappa mondiale della gravitazione del nostro Pianeta. L'analisi fornirà accurati e completi dati sulla struttura interna della Terra, della circolazione su vasta scala delle acque marine e oceaniche e della loro influenza sul clima. Goce sarà d'aiuto, quindi, alla climatologia, migliorando le predizioni delle variazioni climatiche a lungo periodo e all'oceanografia, aumentando la conoscenza della dinamica globale della circolazione delle acque e del trasferimento di calore ad essa associata, fino a fornire informazioni per identificare zone a rischio sismico.

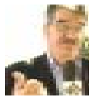
La cerimonia di consegna di Goce dall'industria italiana all'Esa si è svolta negli stabilimenti di Torino di Thales Alenia Space, responsabile del progetto di sviluppo, integrazione e prove del satellite. "Fra i contributi più importanti forniti dalla società all'intero progetto" ci dice **Carlo Alberto Penazzi**, amministratore delegato di **Thales Alenia Space** "troviamo il sofisticato Gradiometro che serve a misurare il campo gravitazionale terrestre, quindi il controllo orbitale per compensare l'effetto frenante delle molecole di atmosfera e una coppia di sofisticati ricevitori Gps con il computer di bordo". Anche l'Università italiana ha partecipato attivamente. Il **Politecnico di Milano** è stato responsabile del software di bordo, un "cervellone" che consentirà di raccogliere e di trasmettere costantemente i dati scientifici.

Goce è il primo satellite della serie **Earth Explorer Core Missions** del programma dell'Agenzia Spaziale Europea **Living Planet**, con l'obiettivo principale di conoscere più a fondo i lati nascosti del nostro mondo.

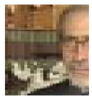


Il satellit

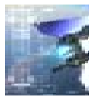
Multim



Politecnic
Servizio



amminist
Thales Al
di Giorgi



Link es

Sito Finm
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Giorgio Pacifici

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