SCIAMACHY - 10 years monitoring climate in space

28 February 2012

How has our ozone layer changed in the last 10 years? How do trace gases like nitrous oxides, carbon dioxide and methane influence our climate? How do environmental protection measures work? These were the questions that German researchers sought to address when, 10 years ago – on 28 February 2002, the European environmental satellite Envisat began its journey into space on one of the first Ariane 5 launchers.

On board the largest Earth observation satellite ever constructed was the German-Dutch-Belgian 'SCanning Imaging Absorption SpectroMeter for Atmospheric CartograpHY' – SCIAMACHY for short – about half of which was financed by the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR). The Institute of Environmental Physics at the University of Bremen is responsible for the scientific management of the project. The routine data acquired by SCIAMACHY is processed at the DLR site in Oberpfaffenhofen.

A map of the ozone layer

The main task of the SCIAMACHY spectrometer is to map the ozone layer and the development of the ozone hole, as well as to document the extent and effect of major environmentally harmful gases such as nitrogen dioxide, sulphur dioxide and methane. As part of Earth's atmosphere, the ozone layer, which is at an altitude of 15 to 50 kilometres (the lower stratosphere), protects the planet's surface from short-wave ultraviolet radiation. During the past 100 years, this protective shield has been disturbed by the introduction of man-made chemicals – particularly chlorofluorocarbons (CFCs). The result has been the ozone hole above the South Pole and depletion of ozone concentration in the ozone layer worldwide.

The concentrations of ozone-depleting chemicals in the stratosphere are decreasing as a result of their ban in the Montreal Protocol 25 years ago. But air streams are producing some surprising effects; for example, SCIAMACHY and its predecessor, GOME (Global Ozone Monitoring Experiment), were the first to observe an ozone hole above the North Pole. However, it only appeared twice during the whole observation period – in the winters of 1996/1997 and 2010/2011. Alongside ozone concentration, SCIAMACHY also records chlorine, bromine and nitrogen compounds, also directly involved in ozone depletion, globally.

How do environmental protection measures work?

SCIAMACHY data also shows that environmental protection measures really do work and can be observed by satellites. For example, nitrogen dioxide is a pollutant created during combustion processes – especially in power stations and road traffic. This oxidised form of nitrogen drives smog formation in urban conurbations; in high concentrations, it can damage the respiratory organs, particularly when combined with fine particulates. Using SCIAMACHY data, a German-US team of scientists was able to show that, between 1999 and 2006, levels of nitrogen dioxide pollution decreased by up to 35 percent in some US states as a result of the emission reduction measures implemented at three large coal-fired power stations. But the researchers were unable to observe any improvements in urban conurbations where the cause for nitrogen oxide pollution is mainly road traffic. An improvement in the air quality in large parts of Europe was observed, and attributed to environmental protection measures taken over the past 15 years.

Explosive economic growth – explosive environmental problems?

SCIAMACHY 'sees' a strong increase in nitrogen dioxide in countries and areas with rapidly growing economies – particularly China. But the concentrations of sulphur dioxide, which also

arises from the combustion of oil and coal, have shown a different trend. While nitrogen dioxide concentrations have started to rise again following a brief respite as a result of the 2008 economic crisis and the temporary measures introduced to clean the air for the Olympic Games in 2008, air pollution by sulphur dioxide has clearly been falling since 2007. That is because China is also becoming more environmentally aware – flue gas desulphurisation plants have been systematically introduced at coal-fired power stations.

Influence of carbon dioxide and methane on climate change

In addition, SCIAMACHY has been able to, for the first time, map the global distribution of the greenhouse gases carbon dioxide and methane from space . This helps researchers understand where the natural and industrial sources of these greenhouse gases are and how they influence climate change. Does a temperature rise in wetlands increase methane emissions, for example? The systematic observations with SCIAMACHY help to investigate these questions and devise countermeasures.

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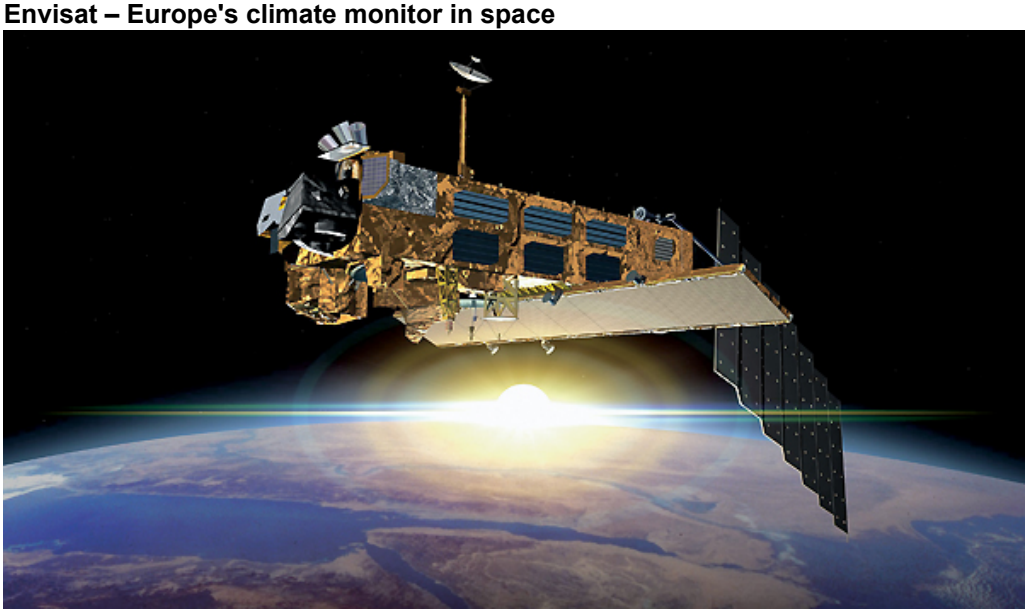
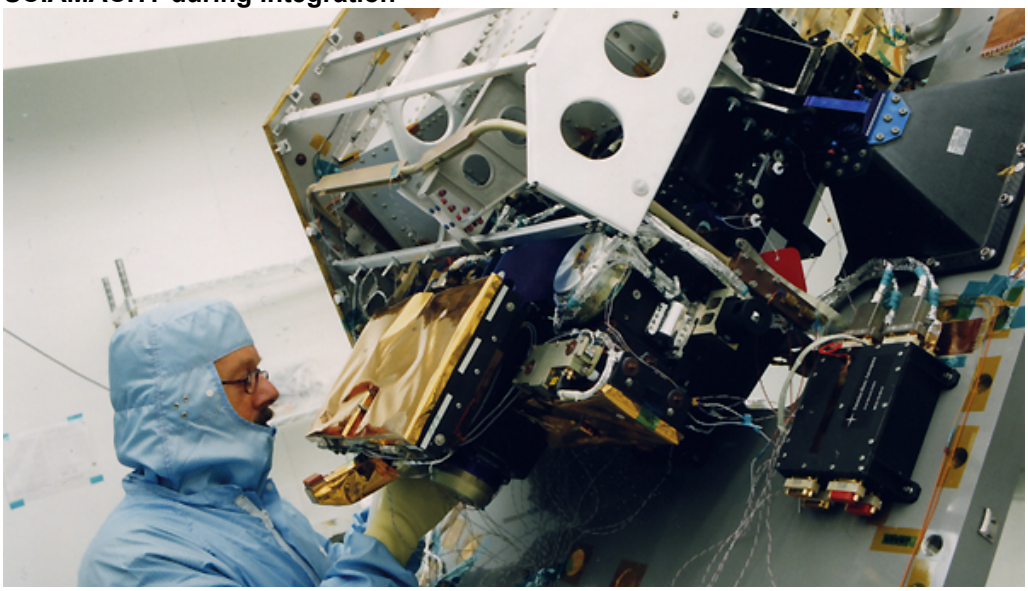
Envisat – Europe's climate monitor in space



Envisat is the largest Earth observation satellite ever built and was really only designed to operate for five years. Ten years later, its scientific instruments still work perfectly; one of them is SCIAMACHY.

Credit: ESA.

SCIAMACHY during integration



The German-Dutch-Belgian 'SCanning Imaging Absorption SpectroMeter for Atmospheric CartograpHY' – SCIAMACHY– during integration.

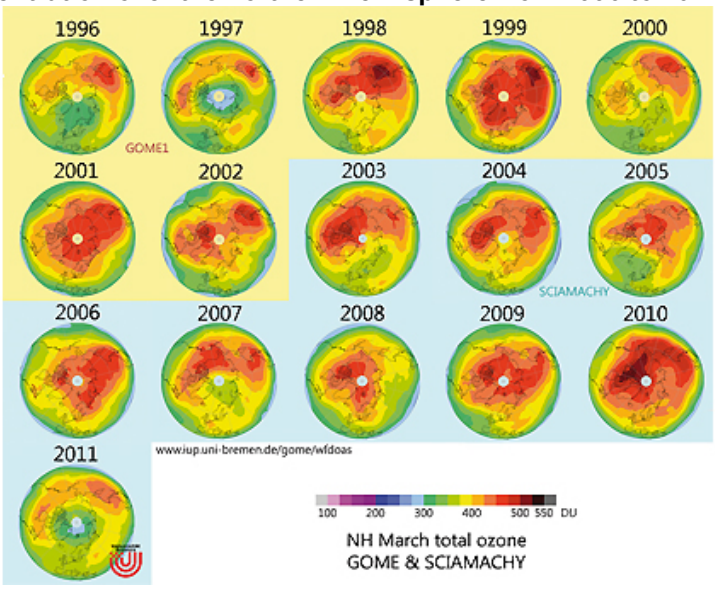
Credit: Dutch Space.

Envisat during thermal testing

Envisat was extensively tested in the Large Space Simulator at ESA's ESTEC facility. In this image, Envisat is being prepared for thermal testing.

Credit: ESA.

Ozone concentration over the northern hemisphere from 1996 to 2011



The ozone layer and the development of the ozone hole has been mapped continuously since 1996 by combining the data from SCIAMACHY with that of its predecessor sensor, GOME, on the ERS-2 satellite. An ozone hole was observed over the North Pole in the winters of 1996/1997 and 2010/2011.

Credit: IUP Bremen.

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