Satellite portrait of global plant growth will aid climate research

January 27 2006

ESA&acutes ten-instrument Envisat environmental satellite has been observing the Earth for more than three years. Picture by EADS Astrium. Credits: EADS Astrium

GLOBCARBON involves the development of a service to generate fully calibrated estimates of land products based on a variety of Earth Observation data, suitable for assimilation into sophisticated software simulations of the planet created by the global carbon modelling community.

The service is focused on the generation of various global estimates of aspects of terrestrial vegetation: the number, location and area of fire-affected land, known as Burnt Area Estimates (BAE), the area of green leaf exposed to incoming sunlight for photosynthesis, known as Leaf Area Index (LAI), the sunlight actually absorbed for photosynthesis, known as the Fraction of Absorbed Photosynthetically Active Radiation (fAPAR) and the Vegetation Growth Cycle (VGC).

To obtain these products, GLOBCARBON blends data from a total of five European satellite sensors: the VEGETATION instruments on SPOT-4 and SPOT-5, the Along Track Scanning Radiometer-2 (ATSR-2) on ERS-2, plus the Advanced Along Track Radiometer (AATSR) and Medium Resolution Imaging Spectrometer (MERIS) on Envisat.

At a 17 January GLOBCARBON progress meeting that took place at ESRIN, ESA's European Centre for Earth Observation, project partners and end-users heard that products for six complete years are now available, covering the whole of 1998 to 2003. A follow-on phase is planned to cover up to the end of 2007.

"GLOBCARBON is a multi-sensor, multi-year global service, and as such has been very challenging in scope," stated Geert Borstlap of VITO, the Belgium-based organisation leading the contract for ESA. "In processing terms we had about 45 terabytes of input data and 18 terabytes of output data, and within the process generated about one petabyte of intermediate data. We developed the necessary software and had about 25 computers and 25 terabytes of disks continuously running for one year from start to finish."

The processing algorithms used to render raw satellite data into final products have come from a number of authoritative sources: the International Geosphere-Biosphere Programme (IGBP); the European Commission's Joint Research Centre in Ispra, Italy (EC-JRC); the University of Toronto; the Centre d'Etudes Spatiales de la Biosphère (CESBIO) in Toulouse and the Laboratoire des Sciences du Climat et l'Environnement (LSCE) in Gif-Sur-Yvette as well as ESA's ESRIN centre in Frascati, Italy. Dr Stephen Plummer of IGBP oversees algorithm selection and interfaces with product users.

GLOBCARBON end users – charged with assessing and validating the products – comprise the Global Carbon Project (GCP) hosted in Canberra, Australia, the UK Centre for Terrestrial Carbon Dynamics (CTCD) in Sheffield, the Max Planck Institute for Meteorology (MPI-M) in Berlin, Germany and the Potsdam Institute for Climate Impact Research (PIK).

GLOBCARBON LAI results are also being checked with LAI products from CYCLOPES, another satellite-based service being developed through a project called Geoland, part of the European Commission's initial contribution to Global Monitoring to Environment and Security (GMES), a joint initiative with ESA to develop an independent environmental monitoring capability for Europe.

Researchers seeking to follow the carbon

Carbon's unique compound-forming properties underpin all life on Earth. They also mean this many-formed element is abundant not only in the biosphere but also in the geosphere, ocean and atmosphere, undergoing exchange – often rapidly – between them.

This movement of carbon through the different components of the Earth system is called the carbon cycle. Human activities have led the cycle to move out of balance, as fossil fuel burning and land clearances lead to increased atmospheric carbon levels driving global warming. This development may also have knock-on effects on the carbon cycle itself, in the uncertain responses of oceanic phytoplankton and land vegetation respond to rising temperatures.

Researchers have developed complex software models of carbon cycle processes to try and predict future changes, providing vital input for the Intergovernmental Panel on Climate Change (IPCC) and related groups assessing the potential impact of climate change. However any model is only as good as input data, and relevant data is lacking for certain aspects of the carbon cycle – especially land vegetation.

"GLOBCARBON is definitely a useful product for the carbon modelling community," explained Dr Tristan Quaife of CTCD. "Information about LAI is important because it gives us an ability to constrain the amount of green biomass available for photosynthesis and gas exchange through evapo-transpiration.

"These are probably the two key processes controlling carbon exchange with the atmosphere, so with better knowledge of LAI and its dynamics we have a better chance of estimating the primary productivity of an ecosystem.

"It is a similar story with vegetation growth cycle – or phenology. Improved information allows us to improve our knowledge of the length of time that leaves are out, influencing vegetation's ability to assimilate carbon from the atmosphere. That isn't well modelled at the moment because we don't fully understand what it is that makes a plant sprout its leaves, and consequently models aren't so accurate.

"Burnt area estimates are also useful because we don't fully understand global fire occurrence patterns either. We can map active fires from space, but what we are seeing there is only the part of the Earth that is combusted at that moment. To get a complete picture we need to record the full area burnt, which is useful for determining how much biomass has been removed from the Earth's surface and consequently how much carbon has been liberated into the atmosphere."

Source: ESA