CBERS-2

Joint China-Brazil Remote Sensing Satellites

The CBERS Programme, a co-operative Chinese-Brazilian Earth Resources Satellites Programme with versatile cameras, has realised a vast success of the Brazilian data distribution policy that is leveraging research and business in Earth observation. It is expected that in 2005 new ground stations around the world will be receiving CBERS images.

Since the launch of the first US Landsat-1, formerly called ERTS (Earth Resources Technology Satellite), back in 1972, the world never stopped to improve on remote sensing technologies and broaden the applications. Landsat-1 opened to the world new opportunities for observing the Earth from a completely new point of view. From space it became possible to investigate the Earth's resources and phenomena using images gathered at various wavelengths, spatial resolutions and temporal frequencies. The sequence of launching and availability of new satellite systems was marked with the introduction of new players in the remote sensing sector, such as India with its Indian Remote Sensing (IRS) satellites. More recently, after a long-term partnership, two countries – Brazil and China – built and launched two satellites for Earth observation.

Long-term Co-operation

The negotiations between Brazil and China for a long-term co-operation in Earth observation from space started back in 1988. The first phase of the programme was to build, launch and operate two technological remote sensing satellites, in which costs and operational responsibilities would be shared. The first satellite was launched October 1999 and operated until August 2003, almost two years longer than its original two-year planned life span. The second CBERS was launched 21st October 2003 from the Taiyuan launch site in Shanxi, China, by the Long Mach 4 vehicle. The CBERS Programme was the first co-operation in this field between two developing countries in the world. Many challenges had to be overcome in order for the programme to advance and culminate in the successful launches of the two satellites, such as language, different technological stages, distance between the two countries, logistical aspects, etc. The results obtained by CBERS-1 and -2 were considered an achievement so important by both countries that an agreement for the follow-up of the programme was signed. In addition, as the CBERS-3 is planned to be launched only in 2008, another agreement was signed between both countries for the launching of a CBERS-2B in 2006, to avoid an eventual lack of remote sensing data between the possible end of CBERS-2 and the launch and commissioning of CBERS-3.

CBERS-2

The satellite body size is 2.5 x 3.2 x 8.4 metres – including the solar panel deployed – with a weight of 1,575kg. The satellite has a three-axis stabilised platform in a sun-synchronous recurrent and frozen orbit at an altitude of 778 kilometres, with an inclination of 98.50. This means that at a given latitude all the images are gathered almost at the same local time. The local time at the descending node is 10:30 a.m. The repeating cycle is 26 days, which means that every 26 days the same area of the ground is imaged by the satellite cameras, except the poles. The satellite's energy supply can provide 1,100 watt. The satellite control centres are located in China and Brazil, which allows for constant monitoring and control of the satellite. At present there are four ground image-receiving stations for CBERS: Beijing, Wulumuqi and Nanning in China, and Cuiabá in Brazil. The satellite has an on-board tape recorder, which can record images from every part of the planet and transmit them to an available ground receiving station during the night pass.

CBERS-2 Payload

The main mission of the CBERS Programme is to contribute to a better understanding of our changing planet. This is accomplished by a set of cameras that continuously image the Earth in different optical spectral regions and at a variety of spatial and temporal resolutions. The pay-load of CBERS consists of a high-resolution imaging camera Charge-Coupled Device (CCD), an Infrared Scanner (IRMSS), a Wide-Field Imager (WFI), a Space Environment Monitoring (SEM) system, and a Data Collecting System (DCS). The CCD camera is a five-band push-broom device that operates in the blue, green, red, near infrared and panchromatic bands. Its manoeuvrable mirror can provide ±320 across-track viewing. This feature allows the acquisition of images out of the regular track of the satellite. This characteristic is important to monitor disasters or emergencies, such as flooding. Also, this feature can be used to acquire pairs of images from different viewing angles to compose stereo-pairs for cartographic purposes. Its Ground Instantaneous Field Of View (GIFOV) of 19.5 metres makes this camera an important instrument for thematic mapping purposes. It has been used for many different research and operational projects in Brazil and China, and even in some neighbouring countries for research purposes.

Other Instruments

The IRMSS is a scanner system with four spectral bands: two in the Short-Wave InfraRed (SWIR), one panchromatic, and one in the thermal infrared region. The first three bands are 77.8 metres GIFOV, while the thermal band is 156 metres. This camera is a complement for CCD cameras, as it covers the SWIR portion of the electromagnetic spectrum. The round features are central pivots for irrigation of agriculture fields. The third camera of the CBERS payload is the WFI, which is a push-broom system with GIFOV of 258 metres, and a large swath of 900 kilometres. This camera can visit some specific areas on the ground in less than five days. It presents a very good

compromise between spatial and temporal resolutions. It can be used together with other satellite systems to compose a global monitoring system. Its two spectral bands are specially located in order to compose some vegetation indexes such as the NDVI (Normalised Difference Vegetation Index).

CBERS-2 Data Distribution in Brazil

Brazil and China had agreed that a distribution policy inside their territories is defined by each of them. For third countries an agreement should be established, which is in the final stages. It is expected that by the end of 2005 at least three foreign ground stations will be ready to receive CBERS-2 data on a routine basis. In the Brazilian case, CBERS data is considered public domain. Accordingly, CBERS images will have to be used as much as possible by the public at a low cost. This implies that the CBERS-2 images can be downloaded free from the internet. The objective is to maximise the use of CBERS data in order to create a strong remote sensing sector that would involve academia and the private sector, in addition to the government. Especially for CBERS-2, a complete processing system was developed by the Brazilian government and private sector.

Data Work-flow

As soon as the CBERS-2 images are acquired by the Cuiabá ground receiving station in Brazil, they are sent to a central processing and distribution facility. After the cataloguing processes, the user can access and request the images in a user-friendly browsing system. Within a few minutes the images are available for downloading via ftp. In general, more than 80% of the requests are ready for download in less than 10 minutes. As a consequence of this Brazilian government policy of free distribution of CBERS-2 data on the internet for Brazilians, more than 6,000 users accessed the CBERS images within six months after the satellite commissioning phase. This huge mass of users comes from more than 2,500 institutions, including large companies, Non-Governmental Organisations (NGOs), people from academia, schools, consultants, government institutions, small business, farmers and others. More than 40,000 CBERS-2 images have been distributed since then. CBERS-2 applications involve many areas, including deforestation monitoring and mapping, environmental management and control, agriculture applications, such as crop monitoring and identification, coastal zone and reservoir monitoring, land-use mapping, tourism and other applications.

Programme Future

CBERS-2 is working well; however, as its life was not planned for a long stay in orbit, Brazil and China decided to build CBERS-2B, to be launched in October 2006. This satellite will be very similar to CBERS-2, except for the substitution of the IRMSS with a 2.5-metre spatial resolution panchromatic camera. The objective is to maintain the monitoring capabilities provided by CCD and WFI cameras, and to improve the mapping capability with the high-resolution camera for cartographic and measurement purposes. The pointing system and the recording capabilities of CBERS-2B will be improved. For CBERS-3 and -4, an improvement of the cameras is foreseen. The present configurations of the current CCD will be maintained and some WFI applications will be improved by an advanced camera with the same large swath, but with a 70-metre GIFOV, and 10-bit data quantisation IRMSS with a 40-metre GIFOV. In addition, a new camera will be introduced, with a 5-metre GIFOV in the panchromatic band and 10 metres in the multispectral mode.

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