Science Article
Satellites & Sensors

This article reports on recent developments in Earth Observing satellites and sensors.

Meteosat-10

Europe's latest geostationary weather satellite, launched on 5 July, delivered its first image from its SEVIRI (Spinning Enhanced Visible and Infrared Imager) sensor on 13 August. The satellite is the third in a series of four satellites introduced in 2002. After the successful completion of in-orbit testing, on 12 December the MSG-3 satellite was declared ready to support the Meteosat operational services and renamed to Meteosat-10. Meteosat-10 is scheduled to become the prime operational satellite on 21 January after moving from 3.4º West to 0º East. Meteosat-9 will move to 9.5º East, and Meteosat-8 will move from 9.5º East to 3.5º East to become the backup for Meteosat-10. SEVIRI delivers weather coverage over Europe and Africa. It scans Earth’s surface and atmosphere every 15 minutes in 12 different wavelengths. SEVIRI has a best resolution of 1 kilometre in the visible bands, and 3 kilometres in the infrared.

The last of the series, MSG-4, is planned for launch in 2015.

Meanwhile, the European Space Agency and EUMETSAT have signed the agreement on the Meteosat Third Generation weather satellite system. The agreement determines the principles of cooperation between the two agencies when establishing the various components of the Meteosat Third Generation (MTG) system.

Kanopus-V-1 & BelKA-2

On 22 July, Roskosmos launched a Soyuz-FG/Fregat into polar orbit with a cluster of five small satellites. Kanopus-Vulkan-1 and BelKA-2 are Earth imaging satellites built by VNII Elektromekhaniki (VNIIEM), the former for Roscosmos and the latter for the Belorussian Academy of Sciences. The satellites carry 2-meter-resolution cameras.

Kanopus-V (a.k.a. Canopus-B) was designed for real-time monitoring of natural and man-made disasters and other emergency situations. It is an imaging satellite with a resolution of about 2.1 meter and a swath of 20 kilometre panchromatic, and a resolution of 10.5 meter and a swath of 41 kilometre of the 4-band multispectral camera. Resulting images would be used for cartography, agricultural planning and similar applications. VNIIEM advertised Kanopus-V as a complement to a larger Meteor-M spacecraft, which was built by the same company for large-scale observations of the Earth. A second satellite, Kanopus-V-2, will be constructed starting 2013.

Under an agreement with the Belarussian government, VNIIEM built a virtual copy of the Kanopus-V satellite, known as BKA, BelKA-2, or the Belarussian spacecraft. It was meant to be a replacement for the original Belarussian Earth-watching satellite, BelKA, which was lost in the botched launch of the Dnepr rocket in 2006. At the end of November 2012, Russian officials reported that they had been transferring control over to their colleagues in Belarus.

SPOT-6

On 9 September SPOT-6 was launched by an Indian PSLV rocket. It reached its final orbit on 22 September. In the mean time, its improved sensors have already been recording images.
Resolution is 1.5 metre panchromatic and 6 metre multispectral with a swath width of 60 metre at nadir. The architecture is similar to that of the Pleiades satellites (see below). SPOT-7 is due to launch early in 2014. SPOT-6 and SPOT-7 will be placed in the same orbit as the Pleiades satellites. Revisit time of SPOT-6 and SPOT-7 together is one day.

**Metop-B**

Metop-B was launched on 17 September. This is the second satellite in a series of three polar-orbiting meteorological satellites operated by EUMETSAT. The European Metop and American NOAA satellites carry a set of identical sensors: AVHRR/3 and the ATOVS suite consisting of AMSU-A, HIRS/4 and MHS. NOAA provides most of the joint instruments on board the satellites and EUMETSAT has developed and provides NOAA with the Microwave Humidity Sounder (MHS). In addition, the Metop satellites carry a set of European sensors, IASI, ASCAT, GOME-2 and GRAS, aimed at improving atmospheric soundings, as well as measuring atmospheric ozone and near-surface wind vectors over the ocean. The satellites are launched in five to six year intervals. The first Metop-A was launched in 2006. The third Metop-C satellite is scheduled for launch in 2017. With a satellite lifetime of more than 5 year the series is designed to provide continuity in satellite weather information.

**Miranda/VRSS-1**

China launched a CAST-2000 class remote sensing satellite on 29 September. The satellite, 'Venezuela Yaogan Weixing yi hao' (Venezuela Remote Sensing Satellite 1) was purchased by Venezuela and is named 'Miranda' after the independence leader 'Generalissimo' Francisco de Miranda (1750-1816). The satellite carries two high-resolution cameras and two medium resolution cameras. The high resolution cameras have a spatial resolution of 2.5 metre panchromatic and 10 metre multispectral. The medium resolution cameras have a spatial resolution of 16 metre. The satellite is designed to operate for a minimum of five years.

**Envisat**

On 11 October ESA denied the accusation that it had used the remaining fuel to continue Envisat’s mission instead of putting it in a disposal orbit. ESA said that "Envisat was planned and designed in 1987–1990, a time when space debris was not considered to be a serious problem and before the existence of mitigation guidelines, established by the UN in 2007 and adopted the next year by ESA for all of its projects." In 2010, ESA manoeuvred Envisat into a lower orbit, which allowed it to continue its observation. The fact that ESA extended the operational lifetime and did not put more effort into reserving fuel to prevent Envisat from becoming space debris in a low earth orbit has been severely criticized. Because of its huge size, Envisat is widely seen as a serious collision threat in this populated orbit.

For future satellite missions, ESA is investigating ways to deorbit used satellites in a controlled manner.
**Huanjing-1C**

China plans to launch eleven Huanjing satellites for disaster and environmental monitoring ('huanjing' is Chinese for 'environment'). Together, the satellites will be capable of multispectral (visible and infrared) and synthetic aperture radar imaging. The first two satellites, Huanjing-1A and Huanjing-1B, were launched on 6 September 2008.

Huanjing-1C was launched on 16 November 2012 on a Long March-2C rocket from the Taiyuan Satellite Launch Center. It is the first civilian Chinese remote sensing satellite to use a Synthetic Aperture Radar as imaging instrument. This particular S-band SAR was manufactured in Russia by NPO Mashinostroyenia. The SAR operates at 3.13 GHz (S-band) corresponding to a wavelength of 9.6 cm, and has a spatial resolution of 20 meters with a swath width of 100 km.

**Yaogan-16A, B & C**

Busy China launched another set of remote sensing satellites last year on 25 November. Yaogan (in full Yaogan Weixing, 'Remote Sensing Satellite') refers to a series of Chinese reconnaissance satellites launched in the early 21st century. This mission is similar to the Yaogan-9 mission, with three satellites flying in formation. Being similar to Yaogan-9, the triplet comprises an optical surveillance satellite, a synthetic aperture radar (SAR) satellite, and one that is possibly a signal intelligence satellite.

**Pleiades-1B**

Pleiades-1B was launched on 2 December. The satellite is a very-high-resolution dual-use satellite designed to provide optical imaging coverage for French and European defence ministries, institutions and civil users. It joins its twin, Pleiades-1A, which was launched on 17 December 2011. The panchromatic sensor has a resolution of 70 cm, whereas the 4-band multispectral sensor has a resolution of 2 metre. Swath width is 20 kilometre. It recorded its first images on 18 January.

**Göktürk-2**

On 18 December, Göktürk-2 was launched in China by a Long March 2D rocket. Göktürk is an optical reconnaissance satellite for the Turkish Defence Ministry. The satellite was built by the Turkish Aerospace Inc. and the TUBITAK research council. Its mission will have a dual civil and military purpose. This is the second Earth-observation satellite designed and manufactured in Turkey, following RASAT, which was launched in Russia on 17 August 2011. The satellite offers high-resolution images of 2.5 meter resolution panchromatic, and 10 metre (VNIR) and 20 metre (SWIR) multispectral. Swath width is 20 kilometre.

**Landsat 8**

Fourteen years after Landsat 7, Landsat 8 was finally launched on 11 February. Currently, the spacecraft is tested, its sensor devices are being slowly out-gassed and cooled. The first images are expected any time now. Operational production of image data is expected to start three months after launch.
The satellite carries two new pushbroom imaging devices, the Operational Land Imager (OLI) and the Thermal Infrared Sensor (TIRS). The OLI instrument provides 15-metre panchromatic and 30-metre multi-spectral spatial resolutions along a 185 km wide swath with a 16-day repeat cycle. In addition to the bands of the previous Landsats, OLI will have two new spectral bands, one in the deep blue for coastal applications and aerosols, and one shortwave-infrared band for cirrus cloud detection. Furthermore, Landsat 8 will deliver two thermal bands with a 100-meter resolution, covering the same area as the OLI sensor. With a 12-bit radiometric resolution the performance from OLI and the TIRS instrument will be substantially better than any of the previous Landsat sensors flown.

Earlier this year Landsat 5 was decommissioned after almost 29 years of loyal service. Its longevity earned it an official place in the Guinness Book of World Records as the longest operating Earth observation satellite. The workhorse Landsat 5 singlehandedly saved the Landsat program. The launch of Landsat 8 was long overdue as Landsat 6 failed to reach orbit in 1993 (now presumed taking pictures of the ocean floor), and Landsat 7 is already 14 years old, running out of fuel, and half blind due to a failing scan mirror correction device.

**Upcoming launches**

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Wim Bakker  
University of Twente / ITC  
The Netherlands  
w.h.bakker@utwente.nl