Istanbul Ahoy!

The ISPRS Congress Beckons - with Imaging to the Fore!

It doesn't seem all that long ago when we were busy warming up for the last ISPRS Congress held in Amsterdam. Now, four years later, we are getting ready for the next (20th) Congress which is being held in Istanbul, Turkey between 13th and 23rd July, 2004. The last four years have simply flown by, with lots of innovation and development, especially in the imaging field. Without doubt, much of the focus in the technical exhibition will be on these imagers, while, in the lecture sessions, we can expect to hear how they are being applied to a wide range of projects in the mapping, field and environmental sciences.

By Prof. Gordon Petrie

Figure 1. The Applanix Digital Sensor System (DSS) comprising a digital camera with an IMU mounted above it, together with a fully integrated POS-AV electronics package. (Source: Applanix)

Part I - Airborne Imaging

I.1 - Large-Format Digital Cameras & Scanners

It has been a long and rather tough four years for two of the stars of the last Congress held in Amsterdam - Z/I Imaging with its Digital Modular Camera (DMC) and Leica with its ADS40 pushbroom line scanner. At least part of the story is the change in status from the previous partnerships to single ownership. Thus Z/I Imaging, which was a partnership between Zeiss and Intergraph, is now wholly owned by Intergraph. Essentially the DMC was a Zeiss product developed in the factory in Oberkochen. With the buy-out by Intergraph, the development, assembly and testing of the camera has been shifted out of the Oberkochen factory to new premises in Aalen, Germany and Shannon, Ireland. Besides which, some of the key staff have not transferred to Z/I and have remained with Zeiss. In the case of Leica, which bought out its partner (BAE Systems) in LH Systems, the impact has been much less in the case of the ADS40 with all the development of the imager still being located in Heerbrugg in Switzerland. A much bigger impact on the company has been the loss of the SOCET SET software and digital photogrammetric workstations (DPWs) that have remained with BAE Systems. To replace this, Leica has developed its Photogrammetry Suite. Both of these ground-breaking DMC and ADS40 digital imagers have needed lots of additional time and money to ensure their full development. Thus both imagers are very expensive with comparatively few buyers up till now. According to the presentations made at the RSPSoc meeting held in Newcastle-upon-Tyne at the end of March, Z/I imaging have only delivered six DMC cameras with a seventh about to be shipped. Leica have delivered around ten examples of the ADS40. None the less, there is still intense interest in both of these imagers and one can expect to have reports on users' experiences with them to be given both in the Congress lecture sessions and on the companies' exhibition stands. However both companies now face competition in the area of large-format digital imagers in the shape of the Vexcel UltraCam D digital frame camera system that was announced during 2003. It is substantially lower in cost than its rivals. For most people, their first view of the UltraCam will be at the ISPRS Congress in Istanbul - though doubtless it will be shown beforehand at the ASPRS annual conference being held in Denver in May. Deliveries of the UltraCam are reported to have already started - which, if true, is a quite remarkable achievement.

I.2 Medium-Format Digital Cameras

The present cost of purchase of the large-format digital imaging systems is beyond the means of many of the smaller service providers. In the meantime, the results of the many developments of medium-format digital frame camera systems - typically with 4k x 4k formats - should be on view at Istanbul. Many of these utilize high-quality 6 x 6cm or 6 x 4.5cm film cameras as the basis of their systems with the film magazine replaced by a digital back that can generate colour images. The GeoTechnologies consultancy from the U.K. have already built and supplied a number of their MF-DMC cameras to an international clientele. This small group is not likely to be seen at Istanbul. However a major player that is certain to participate in the ISPRS Congress is Applanix from Canada, which is now part of the Trimble organization. The company has bought over the Emerge DSS project, which is based on the Contax 645 camera and a features a

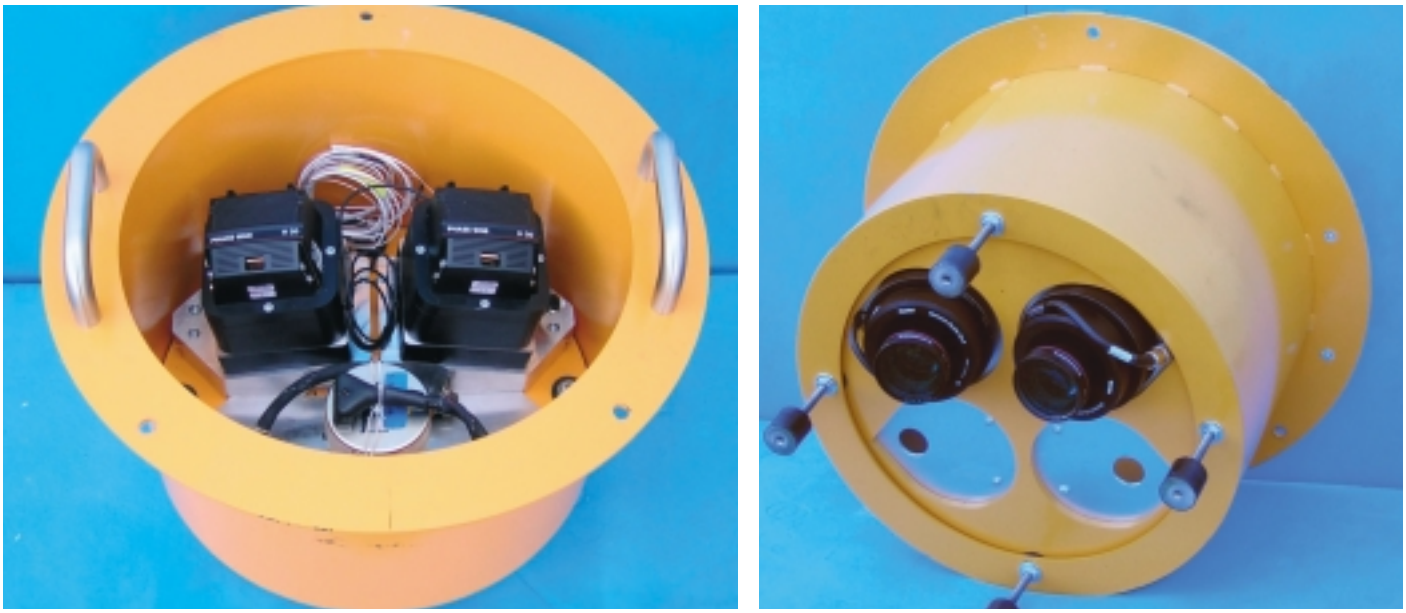

Figure 2. The DiMAC digital modular camera system with its cylindrical mount containing two camera modules, seen (a) from above; and (b) from below. (Source: AeroPhoto DiMAC)

MegaVision digital back. Applanix had developed the accompanying electronics package based on its POS/AV DGPS/IMU system and an embedded TrackAir flight management system. Now it has taken over the whole system, which is still quite expensive, but certainly much more affordable than the large-format systems. With the marketing muscle of Trimble behind it, the DSS camera promises to be a major force in the digital imaging business - notwithstanding the much smaller format and coverage. As stated at the Newcastle RSPSoc meeting at Newcastle, already 22 of these DSS cameras have been sold. Participants will be able to see the camera in the technical exhibition at the Congress. Another medium-format digital frame camera that has now been launched on the American market is that originally developed for in-house use by the EnerQuest mapping company based in Denver. Again it has a 4k x 4k format and is now equipped with a colour digital back. With the amalgamation of the EnerQuest and 3Di companies to form Spectrum Mapping, the decision has been taken to market and sell the camera to other mapping companies. Both EnerQuest and 3Di have used their digital cameras in conjunction with their airborne laser scanners (lidars) providing DEM data for the ortho-rectification of the frame images. I will be surprised if we do not hear more about this particular (camera/lidar) combination in the presented papers given at this Congress - not only from Spectrum, but from other suppliers. Another potentially serious rival to all of these digital cameras is the newly announced DiMAC (Digital Modular Aerial Camera). While this originates from the Belgian Cicade aerial mapping company based in Namur, a separate but associated company called Aerophoto-DiMAC has been set up in Luxembourg to develop and market the system. The DiMAC is based on a Rollei [?] camera body with a digital back provided by the Danish Phase One company. This is based on a Kodak True Colour CCD areal array with 5,440 x 4,080 pixels. In many respects, the DiMAC system has strong resemblances to the original modular concept of the Z/I Imaging DMC - in that it will be available with either one, two, three or four camera units that can be placed in a common cylindrical gyro-controlled mount. However, a major difference is that each of the component cameras generates a true colour image, whereas, with the DMC, each of the four cameras acquires a black-and-white (pan) image only - albeit with a somewhat larger format of 7k x 4k pixels. True or false-colour images can only be produced in the DMC using four additional multi-band cameras, each with a restricted 2k x 3k format. Furthermore Z/I Imaging has not been pursuing the original modular concept and has, till now, only been shipping the full DMC system with its twin four-coupled cameras. It will be most interesting to see and hear more about the DiMAC system which is scheduled to have its first major showing at the Istanbul Congress. If so, it will have plenty of attention!

I.3 Small-Format Digital Cameras

One hears continually about small-format digital frame cameras being used for the acquisition of airborne imagery - usually over relatively small areas of terrain. By far the largest number of these cameras have been examples from the extensive Kodak DCS range. I will be surprised if we don't hear lots about their use from the papers being presented at the Congress, especially in the Commission VII programme that is mainly concerned with thematic applications. But participants should also look out for news about the Kodak DCS Pro 14n digital frame camera. With its CMOS areal array producing a 3k x 4.5k = 13.9 Megapixel image and its heavily discounted street price now down to the $3,000 to $5,000 price range, it seems sure to become important - since its areal array is only a little bit smaller than that of the medium-format cameras discussed above. It offers a relatively inexpensive way for companies and organizations to gain experience with digital cameras, digital image data acquisition and a wholly digital production flow line. Kodak will have a stand at the Exhibition. Let us hope that it will be displaying this DCS Pro 14n camera

Figure 3. The Kodak DCS Pro 14n digital frame camera. (Source: Kodak)

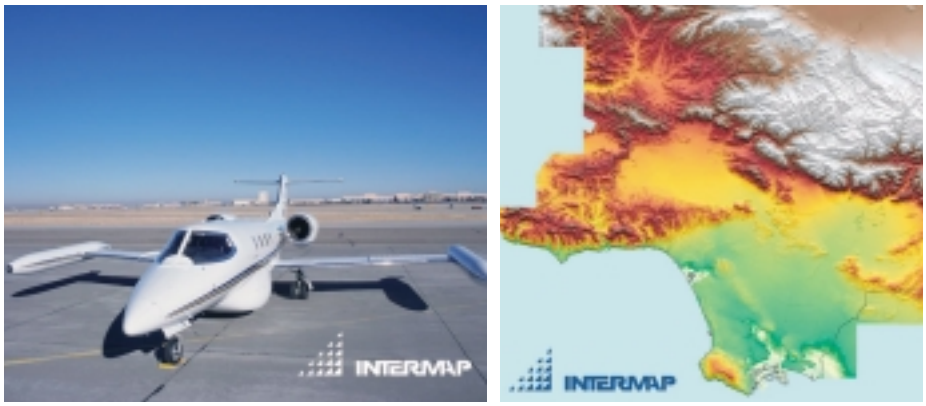

Figure 4. (a) The modified Learjet 36 aircraft that carries Intermap's STAR-3i interferometric SAR system. The bulge on the underside of the aircraft that houses the SAR antenna can clearly be seen.
(b) A shaded relief representation of Los Angeles County in California based on the elevation data collected using the STAR-3i interferometric SAR system. (Source: Intermap)

alongside its ubiquitous aerial camera and duplicating film materials. It would be interesting also to see and hear more about the applications of the images collected by the many multiple small-format (multi-band) cameras that are currently in use in the U.S.A. However this will depend to a certain extent on whether American practitioners attend in numbers - all of which is somewhat uncertain after the warnings about travel to Turkey that have been issued by several Western governments following the several terrorist bombings that took place in Istanbul at the end of last year (2003). Another important matter following on from the increasing use of digital cameras is the matter of their calibration. The well-known techniques based on the use of goniometers, collimators, grid plates and the recording of test patterns on photographic film or plates used that have been utilized for so long with large-format metric film cameras simply cannot be applied to digital cameras. It will be very important to hear at the Congress about the progress of the ASPRS and EuroSDR projects concerned with the development of techniques for the accurate calibration of digital cameras so that proper photogrammetric techniques can be applied to the resulting imagery. Unfortunately, so far, the need for this type of calibration has been ignored by many users of medium- and small-format digital imagery - especially those concerned mainly with thematic mapping.

I.4 Airborne SAR

The area of airborne SAR has shown a quite remarkable development and utilization over the last two or three years. The results should be in evidence both in the technical exhibition and in papers presented in the lecture sessions. At the forefront of this development has been the Intermap company, now headquartered in Denver in the U.S.A., although still with considerable facilities in its original home base in Canada. After the successful use of its STAR-3i interferometric SAR system on mapping projects in the cloud-covered tropical areas of Central America and the Caribbean, in 2002, Intermap then embarked on its NEXTMap Britain project. This resulted in the coverage of the whole of Great Britain with a DEM derived from interferometric SAR data. This has been used extensively both by the insurance industry (for flood risk assessment) and by GetMapping (to ortho-rectify its extensive photographic coverage of the country). Following on from this success, Intermap then initiated its NEXTMap Indonesia project. This has already covered much of the eastern part of that country, again a cloud-covered tropical area. Towards the end of 2003, Intermap then announced its NEXTMap USA project that aims to cover the whole of this vast country over a four-year period. To increase its capacity to undertake all these huge projects, Intermap has taken over the rival AeroSensing Radarsysteme company based in Munich, Germany as well as developing a new SAR-4 system in-house. The latest news about progress with these enormous projects will be a matter of great interest to many Congress participants.

Besides Intergraph with its AES system acquired via the AeroSensing Radarsysteme take-over, two other companies - EarthData (U.S.A.) with its GeoSAR and OrbiSat (Brazil) with its OrbiSAR - are operating dual-band (X- and P-band) airborne SARs. The longer wavelength P-band imagery provides penetration of vegetation cover, while the much shorter wavelength X-band imagery gives good surface reflections from the vegetation canopy, Without doubt, the results from projects undertaken with these dual-band imagers will be of considerable interest to many Congress participants.

I.5 Airborne Lidar

In parallel with airborne SAR, airborne laser scanning has enjoyed a spectacular growth in the four years since the last Congress in Amsterdam. However, unlike airborne SAR, which is still in the hands of two or three specialist companies, numerous commercial aerial mapping companies now act as lidar service providers - especially in the more highly developed countries of North America and Western Europe. The two principal builders of airborne laser scanners - Optech and Leica (formerly Azimuth) - appear to be doing well and both have booked stands in the technical exhibition when we will hope to see and hear more about their latest systems. It is interesting to note that IGI from Germany, previously best known for its CCNS flight management and navigation systems, will also have a stand in the technical exhibition. Hopefully this will provide Congress participants with the opportunity to see and hear more

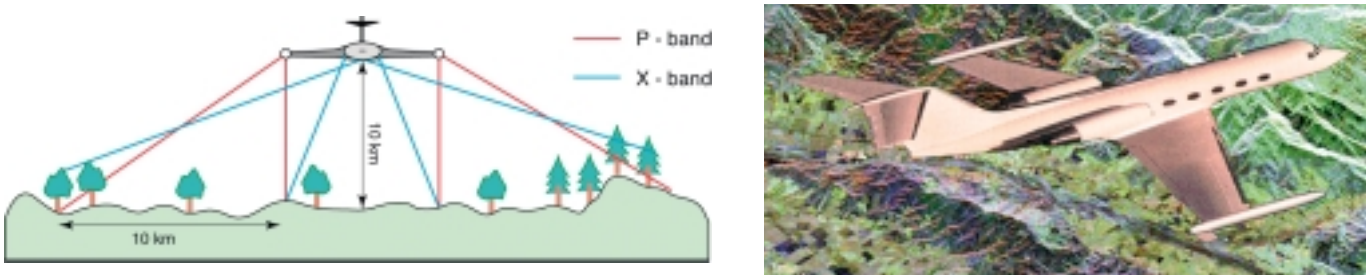

Figure 5. (a) Diagram showing the configuration of the GeoSAR dual-frequency (X- and P-band) airborne SAR system. (Original Source: EarthData: Re-drawn by Mike Shand)
(b) The Gulfstream jet aircraft from which the GeoSAR system is operated. The wing-tip pods carrying the P-band antennas can clearly be seen. (Source: EarthData)

Figure 6. (a) The Britten-Norman Islander aircraft of Precision Terrain Surveys Ltd.; the inset shows the lidar that has been installed in the aircraft. (b) A perspective view of the Needles, a prominent landmark at the west end of the Isle of Wight jutting into the English Channel, derived from airborne lidar data. (Source: Precision Terrain Surveys Ltd.)

about its recently announced LiteMapper airborne laser scanner, developed in collaboration with the well known GeoLas consultancy from Munich. I am also intrigued by the fact that a number of the airborne lidar service providers have constructed their own laser scanners in-house using largely off-the-shelf components. American examples are those from TerraPoint, Spectrum and Fugro-Chance; European examples are those built by TopoSys (Germany) and Precision Terrain Mapping (U.K.). It would be most interesting to learn more about this particular line of development - presumably these in-house developed systems are substantially lower in cost. As noted above, the combination of an airborne lidar to generate a DEM operated in combination with a medium-format digital frame camera to provide the associated ground imagery is becoming increasingly common.

Part II - Spaceborne Imaging

II.1 - Low Resolution Imagery

The activities of the two largest government space agencies - NASA and ESA - dominate this particular area, with an emphasis on them meeting the needs of the global environmental monitoring community - which appears to have established a dominating position regarding the space remote sensing programmes of both agencies. So NASA's Terra and Aqua satellites both have MODIS imagers, while ESA's Envisat has its MERIS and AATSR optical imagers - all generating optical imagery with ground pixel sizes in the range 250m to 1km. Undoubtedly we can expect to hear something about these activities, but, in truth, the global monitoring community tend to present their findings more to the meetings of IGARSS, ASPRS and the International Symposium on Remote Sensing of the Environment, rather than those of ISPRS. In this respect, one notices that neither NASA or ESA are listed in the preliminary list of exhibitors for the Istanbul Congress. It is unfortunate too that the Japanese ADEOS-2 satellite has failed after only ten months' operation. Coupled with the failure to launch the second pair of IGS high-resolution satellites, it has been a mostly disappointing period for the Japanese space remote sensing agencies with their long-standing commitment to global mapping. Given this steadfast commitment, it will be interesting to learn more about their future plans.

II.2 Medium Resolution Imagery

In many ways, this is an area where there have been many incidents of note - some of them negative. In particular, at the end of May 2003, the ETM+ imager on-board Landsat-7 started to malfunction through the failure of its scan line corrector (SLC) mechanism. This caused gaps and double imaging to appear on the ETM+ images. Attempts to remove these anomalies by incorporating data from other existing strips have not been a satisfactory solution. The whole situation has been made worse by NASA's refusal to accept the only bid (by Resource21) made for the Landsat Data Continuity Mission (LDCM). The result has been a major outcry from the large academic and scientific community involved with land cover and land use mapping and agricultural monitoring who are concerned at the resulting break in the Landsat data sets that stretch back to 1972. It will be interesting to hear more about the situation both at the ISPRS Congress and at the ASPRS annual conference that precedes it by a few weeks. On the positive side, there is the undoubted success of the Japanese built ASTER imager mounted on-board NASA's Terra satellite. In many ways (with its 15m ground pixel imagery), it is proving to be a substitute for the crippled Landsat-7 - with the additional benefit of providing stereo-cover that can be used both for interpretation purposes and DEM generation. Another perhaps unexpected success story in this area has been ESA's small PROBA satellite with its CHRIS hyperspectral imager which has produced lots of images that are proving valuable

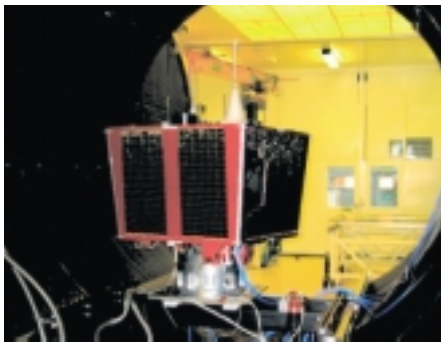

Figure 7. Bilsat, the Turkish remote sensing microsatellite built in cooperation with SSTL - being loaded into a test chamber at the Rutherford Appleton Laboratory (RAL) in the U.K. (Source: RAL)

Figure 8. An artist's impression of the new WorldView high-resolution satellite being constructed for DigitalGlobe. It is designed to produce imagery with 0.5m (pan) and 2.0m (multi-spectral) ground pixel [GSD] sizes respectively. (Source: DigitalGlobe)

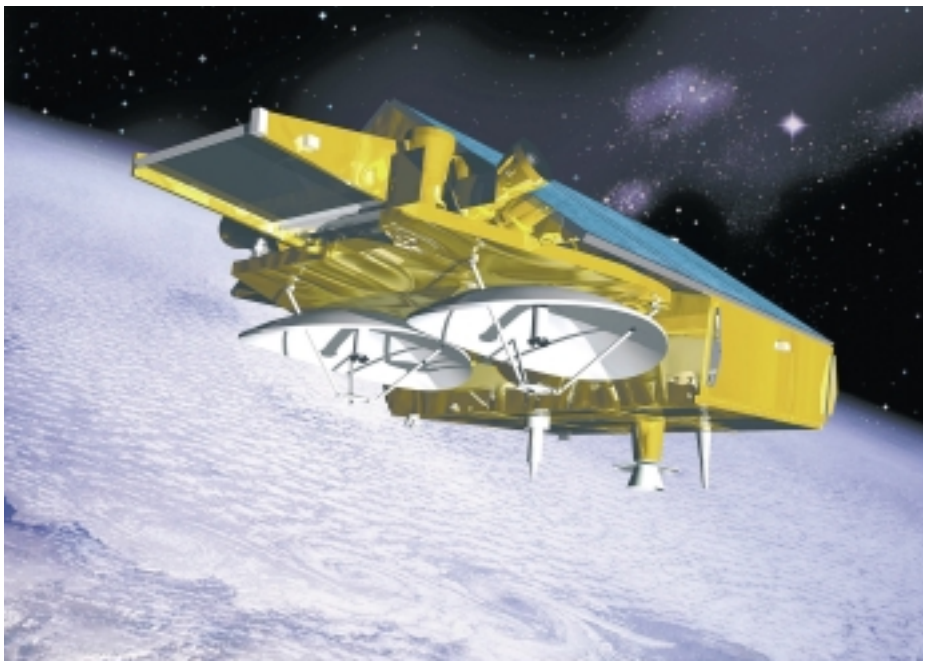

Figure 9. ESA's CryoSat equipped with the SIRAL instrument combining radar altimetry and SAR processing. It is designed to map the major ice sheets of the Earth and the associated areas of sea ice. (Source:Astrium)

to many field and environmental scientists - as indeed have those from the Hyperion hyperspectral imager operated on NASA's EO-1 satellite. Still on the positive side, is the imagery from the micro-satellites that have been launched by SSTL (UK) and its various partners from the developing world - Algeria (AlSat-1), Nigeria (NigeriaSat-1) and Turkey (Bilsat) - and the U.K. (UK-DMC) in the novel Disaster Monitoring Constellation (DMC). It seems certain that we will be hearing plenty about all this good news in presentations being made at the Congress.

II.3 High Resolution Imagery

Since the present author has just completed a world-wide survey of high-resolution imagery from space that has appeared in the last three issues of GeoInformatics, there is not a great deal to add about this area in this preview of the Istanbul Congress. As the survey showed, much of the activity in this area is concerned with national security issues and intelligence gathering. These matters are not likely to get much of an airing at the Congress in Istanbul. With regard to the three American commercial operators of the IKONOS, QuickBird and OrbView-3 satellites, both Space Imaging and OrbView-3 have suffered well-documented financial losses. Whereas DigitalGlobe appears to be in a rather stronger position - especially since it has also been successful in NIMA's NextView competition to build higher-resolution satellites. Its planned WorldView satellite will generate pan imagery with 0.5m ground pixel (GSD) and multi-spectral imagery with 2.0m GSD. No doubt there will be lots of papers and examples of civilian use of the present high-resolution imagery - including interesting presentations about the plan and height accuracies that can be achieved using different photogrammetric approaches and algorithms with this imagery. However all three companies are really heavily reliant on the national security and intelligence market. This can be seen from the activities of the two local Space Imaging affiliates - Inta Space Turk and Space Imaging Middle East (SIME) - both of which will have stands in the Congress technical exhibition and whose anchor customers are the Turkish and U.A.E. armed forces respectively. Needless to say, both ground stations have been kept frantically busy during the recent and still on-going hostilities in Iraq and Afghanistan. The strong military orientation of much of Space Imaging's activity (and that of its two commercial rivals) is simply reinforced by the news of the latest Space Imaging ground station being built in Poland with the Polish Ministry of Defence as the anchor customer. Moving slightly down the resolution scale, one comes to the SPOT satellites. The imagery from the two older SPOT satellites (-2 and -4) with their 10m (pan) and 20m (multi-spectral) ground pixel sizes suffered quite badly from the competition offered by the Landsat-7 imagery which, although it had a somewhat lower ground resolution (10m v. 15m for pan images), had a much greater

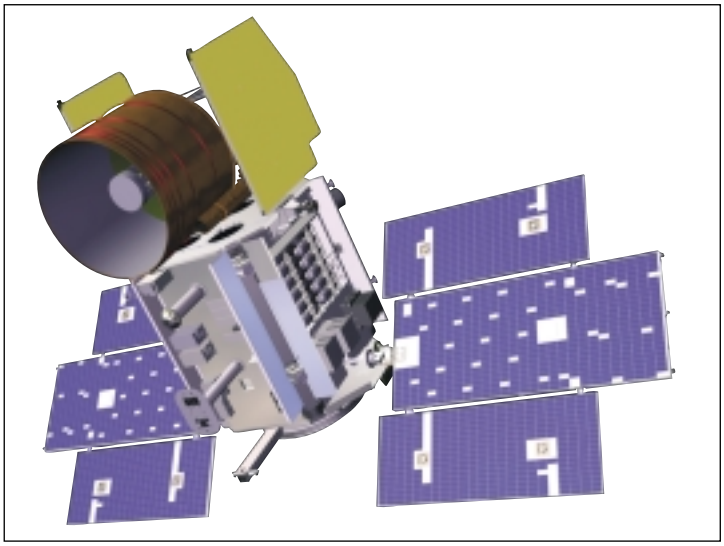

Figure 10. NASA's ICESat with its GLAS (Geoscience Laser Altimeter System) which is currently in operation to measure the surface elevations of the ice sheets covering Antarctica and Greenland. (Source: NASA/GSFC)

ground coverage - 185 x 185km v. 60 x 60km (a nine times area advantage!) - and a substantially lower price. Now we have SPOT-5 with its 5m pan ground pixel images (giving 2.5 to 3m ground pixel when operated in its Supermode) while still retaining its 60 x 60km area coverage. It will be interesting to see and hear how this imagery is being applied. A further matter of considerable interest to photogrammetrists will be the results of the accuracy tests of the HRS stereo-imagery being conducted under the aegis of EuroSDR - since normally this image data is not available, only the DEM data generated by SPOT Image. Similarly both the photogrammetric and the remote sensing groups attending the Congress will be interested to get news of the applications and the results of using the images from the Indian IRS-P6 Resourcesat that was launched in October last year (2003).

II.4 Spaceborne SAR

At the moment, this is not a particularly active area - though the future is very bright. Over the last two to three years, only the ASAR mounted on Envisat has entered service. It operates in C-band and has a wide range of resolution modes, ranging from 30m (in spotlight mode), through 150m (in wide swath mode) to 1km (in global monitoring mode). Obviously these values fit in well with ESA's global monitoring objectives. However for the rest, it is a matter of being patient until the long-delayed Radarsat-2 flight finally gets off the ground and the fleet of European high-resolution satellites currently being built for the SAR-Lupe, TerraSAR-X and COSMO-SkyMed programmes are actually launched from 2005 onwards. CryoSat with its innovative SIRAL (SAR Interferometer & Radar Altimeter) instrument combining radar altimetry with SAR processing is also in the final stages of preparation for launch later this year (2004). Once all of these satellites have been launched, the whole situation regarding spaceborne SAR imagery will be transformed - but not in time for the Istanbul Congress!

II.5 Spaceborne Lidar

Although space lidar instruments were operated from the Space Shuttle by NASA in the mid-1990s, this are has been inactive till very recently. Furthermore the Vegetation Canopy Lidar (VC) mission was cancelled in 2001 arising from doubts about its instrument package. However, in 2003, NASA overcame its doubts and successfully launched its ICESat equipped with the GLAS (Geoscience Laser Altimeter System) to measure the surface elevations of the large ice sheets of the Earth such as those covering Antarctica and Greenland. It will be interesting to hear about the progress of this most interesting mission, hopefully at the forthcoming Congress.

Part III – Photogrammetry

During the ISPRS Congresses held throughout the 20th Century, the main attention in the technical exhibition was given almost invariably to the photogrammetric instrumentation - with most participants eager to see the latest generation of stereo-plotting instruments. In the background in a supporting role were the imagers - the large-format aerial film cameras from Wild (later Leica) and Zeiss (later Z/I Imaging) that only changed slowly from Congress to Congress. How things have changed over the last few years! Now the rapidly evolving digital imagers - cameras, scanners, SARs and lidars - hold centre stage, while the fascinating photogrammetric instruments have almost completely disappeared. They have been replaced by digital photogrammetric workstations (DPWs) that - even though they offer much greater performance and flexibility - don't have the same glamour or fascination. In this respect, the DPWs just look like any other computer workstation, except that they have a stereo-viewing capability. But however mundane they look, they still form an important element of the technical exhibition since they form the backbone of the substantial world-wide aerial mapping industry. Nowadays the changes and new developments in DPWs lie solely in the software and are not reflected in hardware. Furthermore most changes are small and incremental, rather than fundamental. Certainly we will see the products from the three largest photogrammetric system suppliers - Z/I Imaging (ImageStation), BAE Systems (SOCET SET) and Leica (Photogrammetry Suite) - since all three have already booked stands in the technical exhibition. So have several of the principal image processing system suppliers (Leica/ERDAS, PCI Geomatics and Definiens). Also present will be the second tier of DPW suppliers - DVP-GS, KLT and DAT/EM - from North America, though not, it seems, Boeing Autometric or ISM. From Western Europe, we will, of course, have Inpho (Germany) and Stora Enso (Finland), together with a newcomer - Digi 21 - from Spain. In recent years, the ISPRS Congress exhibition has also offered participants the chance to see the photogrammetric systems developed in Eastern Europe and Russia that were, for so long, excluded during the Cold War. On this occasion in Istanbul, among the exhibitors, we are promised GeoSystems (Ukraine), Racurs (Russia) and TopoL (Czech Republic). It will be very interesting indeed to see their current range of products.

Conclusion

As ever, we look forward eagerly to the Congress and its technical exhibition.

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