Imaging NOTES

EARTH REMOTE SENSING FOR SECURITY ENERGY AND THE ENVIRONMENT

Fall 2008
Vol. 23 >> No. 3

RADAR

RADARSAT-2
TerraSAR-X

SPADAC's Information Warfare

News: RapidEye, ENVI, Socet GXP

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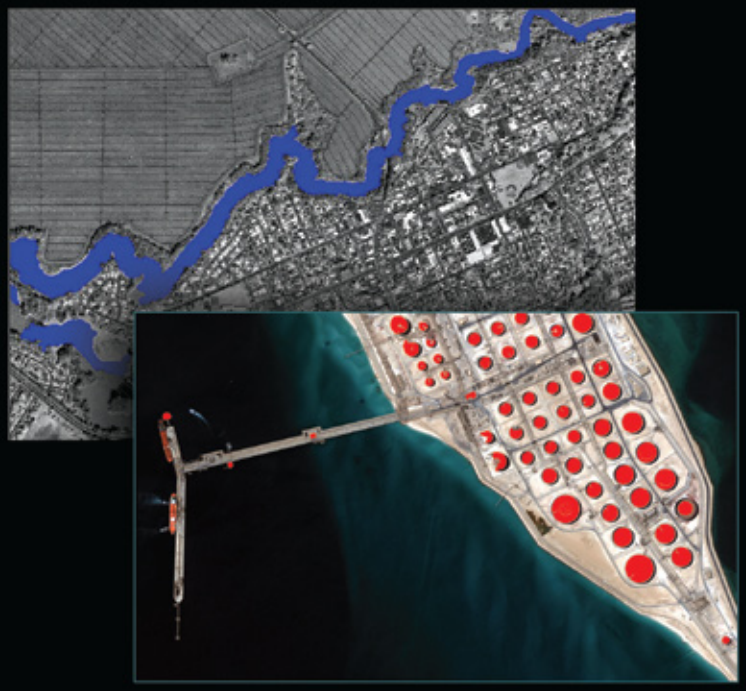

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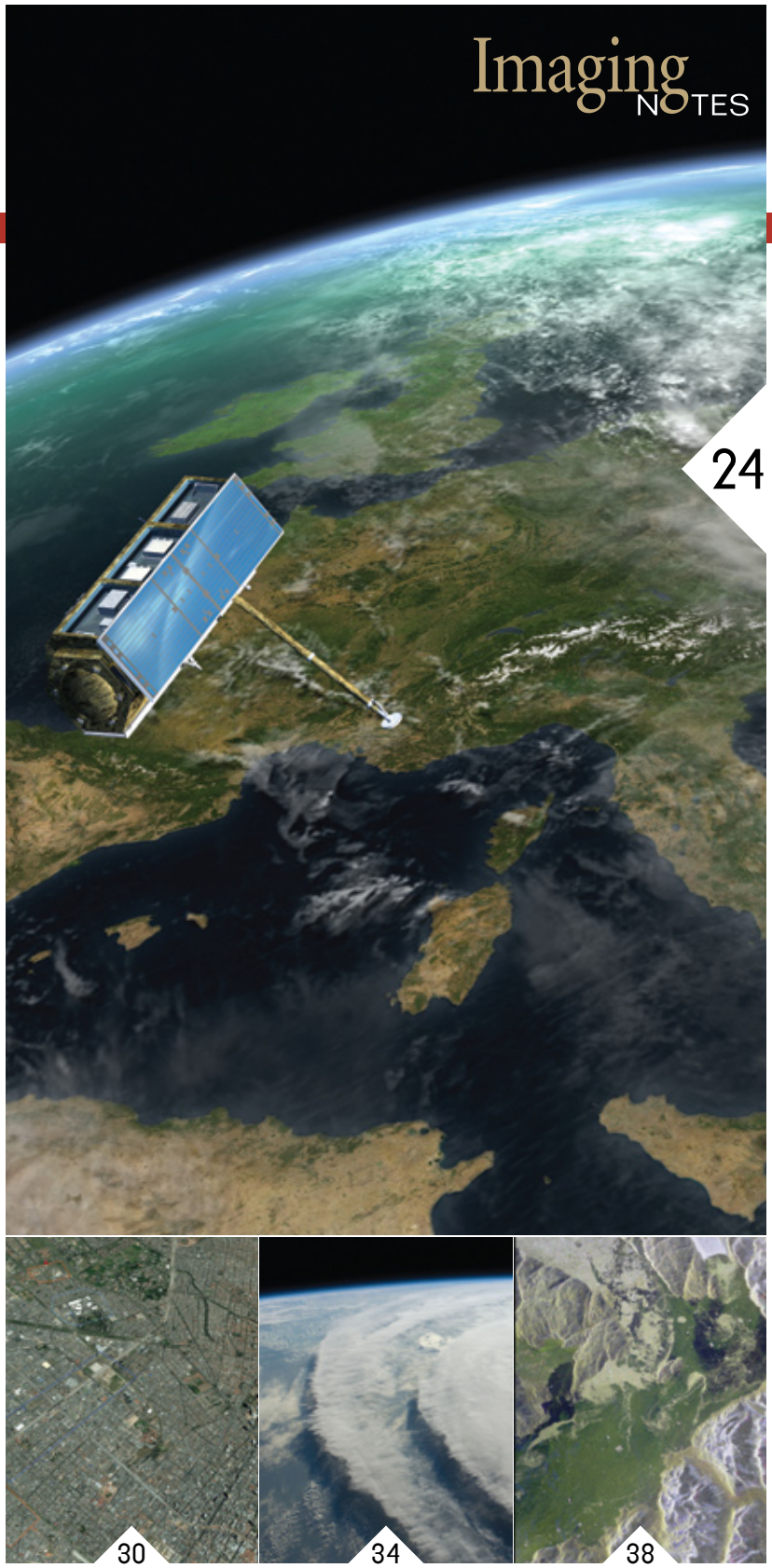

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Thunder Bay in Ontario, Canada

COVER IMAGE

Thunder Bay is located on the western edge of Lake Superior in Ontario, Canada. This color composite view was taken on March 3, 2008, by RADARSAT-2.

The left side of the front cover and much of the back cover show the white ice that has formed along the coast and in the water of Lake Superior. Temperatures across northeastern Minnesota, northern Wisconsin, and the Upper Peninsula of Michigan had been fairly cold during the first week of March 2008, with minimum temperatures ranging from -32° C to -36° C.

The RADARSAT-2 data was collected using ScanSAR Narrow B with dual polarization (Transmit: VV; Receive: VH). Red:VH; Green:VH; Blue:VV.

ScanSAR Narrow B is well suited to the detection and classification of ice and is used operationally to monitor ice formation and movement in the Great Lakes due to its large footprint (300 km in width) with good resolution (50m) and frequent revisit (1-2 days at this latitude).

Credit: RADARSAT-2 Data and Products © MacDonald, Dettwiler and Associates Ltd., 2008. All Rights Reserved. RADARSAT is an official mark of the Canadian Space Agency.

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OUR MISSION

Imaging Notes is the premier publication for commercial, government and academic remote sensing professionals around the world. It provides objective exclusive in-depth reporting that demonstrates how remote sensing technologies and spatial information illuminate the urgent interrelated issues of the environment, energy and security.

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GeoEye-1
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Markets Shifting Into Focus

Dear Readers,

When we talk with industry players at conferences and prepare our articles, we often get a very good snapshot of industry status and trends. Two trends are emerging that we have recently identified and have been covering:

- Imagery is now becoming more integrated into software, rather than serving only as a back-drop.
- Markets are shifting and coming into focus, after the entry of free Internet imagery into the marketplace rocked our world.

IMAGERY INTEGRATION

Regarding the first point, I had the honor of serving as moderator for the panel discussion at ESRI's first ever GIS and RS Summit, held prior to their User Conference this fall. Emerging from the discussion was this fact that imagery is finally coming into its own as a respected and valued layer of data, with software companies offering customers the capability to integrate imagery within GIS.

During the panel discussion, it was noted that Autodesk and others are incorporating imagery into their products as well. ITT VIS President/COO Richard Cooke stated that image processing must continue to evolve into the workflow in ways that maintain the scientific rigor, and in the future, interoperability will continue to improve.

In this issue, read about ENVI 4.5's seamless data exchange with ArcGIS Desktop (page 18) and BAE Systems' SOCET GXP v3.0 offering eXtreme Analyst, a merging of image analysis and geospatial analysis workflows (page 17). Two articles about this subject were published in our Summer issue, "Data Integration" and "Unlocking the Wealth of Imagery."

MARKETS SHIFTING INTO FOCUS

The discussion of shifting markets coming into focus is more complicated. For decades, GIS analysts in organizations needed rather expensive tools to do their jobs, and the demand for commercial imagery was increasing. A few years ago, Google Earth became the disruptive force in the marketplace, offering tools and imagery online, free of charge, completely changing the game.

As a result of Internet distribution of imagery, new markets are being formed that go beyond what we ever imagined. New market offerings include less expensive tools that don't require expert users, with applications across many types of businesses.

Our *Next-Gen Mapping* column has exposed our readers to new ways of thinking about and looking at the imaging/remote sensing market. Two years ago, we discussed in this column the different levels of users created by the introduction of Google Earth to the market: Legacy Users, ProAm Users, and Convergence Users. Over the last two years, we've seen these users evolve into three distinct markets for imagery and geospatial data:

- The Traditional Market of experts and GIS users;
- The Internet Mass Market of amateurs to professionals; and
- Emerging Business Users.

These markets are explored more deeply in *Next-Gen Mapping* on page 14.

Together, these markets are the LB(x) markets. LB(x), as coined by our *Next-Gen Mapping* columnists Natasha Léger and Craig Bachmann, refers to the location-based x-factor. Companies can now integrate location into their own strategic business plans, wherever they deem most valuable to get the greatest return – whether that is in manufacturing, distribution, or tracking of assets; that's the x-factor.

A LOCATION INTELLIGENCE SOURCE

Exploring these markets and tracking their evolution and growth require more attention than one column in *Imaging Notes* can provide. We expect these location intelligence markets to grow exponentially over the next few years. Therefore we will be launching a spin-off publication in 2009. We see a need for media that are the location intelligence sources for businesses that integrate geospatial intelligence with business intelligence.

IN THIS ISSUE

Fall is always a time when we gather at GeoInt and focus on defense and security issues. Thus, we bring stories on SPADAC's Information Warfare (page 30); RADAR technologies from TerraSAR-X (page 24) and RADARSAT-2 (page 38); and news from GeoEye-1, RapidEye, DigitalGlobe, BAE Systems, ITT, NJVC, SPADAC and USGIF in our new section called *News & Notes* (page 17). This new "news" section allows us to cover the exciting innovations of more companies in each issue.

In the area of milestones, Nancy Colleton honors NOAA Administrator Conrad Lautenbacher as he resigns, on page 46. We also congratulate NASA on its 50th Anniversary this October! The legacy of accomplishments is legendary, certainly; I only hope we can return our focus back towards Earth for the sake of humanity's future.

– Myrna James Yoo

The Game Continues to Change... and Ever More Quickly

POLICY WATCH

Over the past few years, the pace of change in the satellite remote sensing marketplace, broadly speaking, has really picked up. Many more satellites, carrying electro-optical or synthetic aperture radar (SAR) sensors, are in orbit, temporal and spatial resolutions have increased dramatically, and costs of medium resolution data have dropped precipitously. Further, as people become more familiar with the imagery and how to apply it to their needs, satellite systems are increasingly being tailored for specific uses.

When I first became involved in the world of satellite remote sensing in 1982, only one land remote sensing satellite routinely delivered imagery to customers—Landsat 4, providing high quality, 30-meter multispectral data. Two years later, the still-operating Landsat 5 followed. Customers were still called users in those days, as the notion that there might be a customer out there with specific data needs that could be satisfied by a steady stream of data from a commercial marketplace was still largely a dream to a few farsighted folks.

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Now, of course, 26 years later, the scene is quite different. Not only has available imagery dropped below the 1 meter mark in sharpness, but also data are sold commercially around the world, and numerous countries have launched their own parastatal systems for observing Earth's surface for a variety of public-good purposes. In fact, it is really hard to keep track of how many remote sensing satellites are in orbit at any one time. As soon as you think you have identified the lot, a new one with a unique capability is launched.

Did I say one? On August 29 this year, the German company RapidEye AG, based in Brandenberg, Germany, launched five 6.5-m resolution satellites together into the same orbital plane on one launch vehicle. Risky though it was, the launch and release into sun synchronous polar orbit was successful. As this issue went to press, RapidEye was still checking out its satellites, but if they operate successfully, the company's business model could well revolutionize the business of remote sensing.

In flying five identical satellites, RapidEye has provided the capability to revisit any site in the world once a day, vastly improving the temporal resolution of the system. That, combined with the 6.5-meter ground sample distance (GSD) of the sensors at nadir, provides a quantum jump in capability.

RapidEye has positioned itself as a service-oriented information provider. According to the company, you just need to give its experts your information needs and they will tailor information products to fit them. The resolution chosen is excellent for a wide variety of agriculture and resource management tasks, making it possible to keep up with short term changes in the environment below, a critical need for a wide variety of tasks. The company also envisions a demand for its tailored information in the utility, cartography, and government markets. If the prices are right, these products could just prove a market changer. See more in our News & Notes section on page 19.

As exciting as this development is, other recent Earth observation developments show just how fast this field is changing. For example, imagery from the moderate resolution China-Brazil CBERS-2B satellite (see *Imaging Notes*, Summer 2008) is now available for free to any country within reach of a CBERS-equipped ground station. Because the CBERS system has several ground stations around the globe, with more coming along, they cover millions of hectares.

Following Brazil and China's lead, the U.S. Geological Survey, which operates Landsats 5 and 7, is making data from these wide-field (185 km) U.S. satellites free for download from its Sioux Falls, South Dakota station. That's a far cry from the $4000 per scene that the U.S. used to charge for Landsat data when Landsat 5 was first orbited!

The private sector has shown that, with some relatively modest funding from government, it can deliver data and information services on a routine, sustainable basis. On September 6, the

Lake Merced, south of San Francisco, is shown in this 1-meter panchromatic image from OrbView-3 (re-scaled for best presentation). Launched in June 2003, OrbView-3 acquires 1-meter panchromatic and 4-meter multispectral imagery in an 8-kilometer-wide swath. OrbView-3 is owned by GeoEye, which launched their new satellite GeoEye-1 in September 2008. The first image from GeoEye-1 is published on page 19.

U.S. firm GeoEye, Inc., launched its latest commercial remote sensing satellite, GeoEye-1. Carrying a multispectral electro-optical sensor, GeoEye-1 will be able to resolve objects as small as 0.41 meters in panchromatic mode and 1.65 meters in multispectral mode. Because of U.S. security restrictions, GeoEye must resample any imagery better than 0.5 meters to the 0.5 meters allowed.

However, even with that restriction, this new satellite will offer a powerful combination to the imagery marketplace. DigitalGlobe, which launched its 0.5-meter panchromatic Worldview-1 satellite about a year ago, will launch a multispectral competitor to the GeoEye satellite next year.

Disaster monitoring has become one of the key uses for satellite data. Witness the SSTL-led Disaster Monitoring Constellation (DMC) that was placed in orbit a few years ago; five electro-optical multispectral satellites from countries as diverse as Algeria, China, Nigeria, Turkey and the United Kingdom make up this remarkable system.

This September, China launched another two similar satellites devoted primarily to observing natural disasters, especially monitoring the aftermath of earthquakes. By 2010, these will be part of a constellation of five similar satellites focused on disaster monitoring, something this earthquake-prone country needs. China plans to follow them next year with two SAR satellites, which will be part of a second five-member constellation. Together, China's constellations will provide some of the most powerful disaster monitoring capabilities in the world.

I expect this emphasis on using Earth observation satellite systems for human security applications (mostly public-good efforts) to increase over time. Yet, as I argued in the last issue, improvements in the supply side of Earth observations will not be successful unless the daunting issues of rapid information generation and delivery to the persons who need it are solved. A number of efforts, many begun by NGOs, have pointed the way to better use of the information, but large, public-good applications such as disaster response and resource management will need significant public sector involvement to be fully successful. ⋘

Political Footprints on the Planet

OBAMA AND McCAIN'S PLATFORMS TOO SIMILAR

A new administration will be upon us after the results are tallied for the November presidential elections. One way or another, the seating arrangements in the U.S. government will change, and a new set of political party affiliates will become entrenched for a four-year tour of duty at the helm of one of the world's most influential nations. In pondering this peaceful transfer of power, one of the U.S.A.'s most civilized behaviors, we might reflect on the impact of the 44th presidential election on the earth, and the current conditions and trajectories of that impact.

Those who are acute observers of the state of the planet will undoubtedly agree that regardless of who the victor is, the political footprint will be measurable and will affect us all. We might easily be distracted by economic chaos and Wall Street chicanery, or by military adventurism or by obdurate Russian leaders who appear to be singing "It's a rainy night in Georgia" while casting kerosene onto the international bonfire of vanities. However, the bottom line on preserving our biodiversity and coping with climate change remains paramount for our survival as a civilized species.

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The old axiom that all politics is local is an apt focus for the fact that all environmental impacts are also local to someone, albeit shared with the rest of us one way or another. Therefore, we might take the opportunity to look at the two major political parties and—with careful attention to objectivity and non-partisanship—differentiate which policies, as espoused by the campaign platforms and Web pages, will likely leave the greatest ecological footprints in the coming years.

ENERGY POLICY

Both parties' proclivities are to salve the citizens' fears of higher energy prices with a clever mix of more domestic oil drilling combined with increased nuclear energy, a minimum level of conservation, and investment into alternatives or renewables. While the McCain team has led the charge to "drill now," the Obama team has acquiesced to that strategy and also has offered the strategic oil reserve to further lower gas prices: blatant political pandering by both camps as they seek to protect the voting public from increased gasoline prices.

The oil industry's geophysicist, Dr. M. King Hubbert, calculated almost fifty years ago the fact that peak oil usage would impact the nation and world about right now. Experts increasingly accept the reality that we are heading on the down slope of this finite resource. Domestic oil drilling will not yield the results being claimed by both parties. We are running out of oil and the gas pump prices will continue to rise, while neither political candidate is willing to broadcast this new reality. Continued burning of oil will further damage our severely polluted atmosphere and exacerbate global warming. Neither campaign is willing to place this issue against the stark reality of citizens' behaviors and chart a 180-degree shift in national policy that would demonstrate real change and real international leadership. Pain at the pump will be a legacy until renewables alter the equation.

The other hot topic endorsed by both campaigns is clean-coal technology. This is neither cheap nor truly clean. Mountain-top removal is but one startling dimension of any ambitious coal energy policy. Solar, hydroelectric, tidal electric, wind, non-cereal biomass, and geothermal are requisite priorities for an energy policy that does not further damage the Earth.

GREENHOUSE GAS EMISSIONS AND CLIMATE CHANGE

Parity on the issue of climate change among the political campaigns is a given. Senator McCain has been a student of climate change science for over a decade and Senator Obama has been consistent in his aligned opinions. The two sides to the coin are (1) reduction of greenhouse gas emissions and (2) adaptation strategies for the impacts of global warming. Timely action on (1) may reduce the costly actions necessary for (2). Two quotes below highlight the critical nature of this issue and the stated urgency required to begin addressing our national and global challenges. Unfortunately, neither campaign appears ready to place the urgency of this issue front and center before the voting public, especially with our collective habit of watching feel-good news and entertainment.

"There is still time to avoid the worst impacts of climate change if strong collective action starts now."
– Stern Review, "The Economics of Climate Change," 2006.

"Humanity must act collectively and urgently to change course through leadership at all levels of society. There is no more time for delay."
– Sigma Xi and United Nations Foundation Report, "Confronting Climate Change: Avoiding the Unmanageable and Managing the Unavoidable," 2007.

"implement an economy-wide cap-and-trade program to reduce greenhouse gas emissions 80% by 2050." Neither campaign represents fast-track action.

Neither camp appears to embrace the concept of 'urgency' on this topic, and both are inclined to follow the cap-and-trade system that was used for acid rain reduction to protect sensitive lakes and

Neither campaign is willing to place this issue against the stark reality of citizens' behaviors and chart a 180-degree shift in national (energy) policy that would demonstrate **REAL CHANGE AND REAL INTERNATIONAL LEADERSHIP.** Pain at the pump will be a legacy until renewables alter the equation.

McCain's camp suggests that a "cap and trade system would encompass electric power, transportation fuels, commercial business, and industrial business – sectors responsible for just below 90 percent of all emissions. The cap and trade system would allow for the *gradual* reduction of emissions [emphasis added]." Their goal for 2050 is 60% below 1990 Levels (66% below 2005 levels).

Obama's camp suggests that they will historic statues. Urgency would imply the kind of attention that paramedics face when deciding whether to stop bleeding or assist breathing on an accident victim. And because all aspects of urgent action are intricately tied to economic, social, and environmental dimensions of governance and international trade, it is unlikely that any political actions will be categorized as urgent. Meanwhile, the victim still lies on the ground.

SPACE TECHNOLOGY PROGRAM

What emphasis is being placed on our capacity for Earth observation at a time of climate change, biodiversity loss, over-fishing, and other impacts? McCain's campaign offers to "ensure that space exploration is top priority and that the U.S. remains a leader," to "maintain infrastructure investments in Earth-monitoring satellites and support systems." Earth-monitoring satellites will compete with missions to the Moon and to Mars, as space exploration is top dog for these space enthusiasts. This does not bode well for Landsat data continuity missions.

Obama's campaign articulates a comprehensive space exploration agenda, but it too holds no safety net for the competition between space explorers and Earth monitors and is loaded in favor of space exploration. Perhaps star gazers for both parties should join the rest of us to look at what is happening beneath their feet. After 50 years, NASA and the nation should figure out that Mission to Planet Earth is still the best idea it has ever had.

A host of other areas could, and should, be examined to see if Spaceship Earth will receive the kind of care and maintenance it must have to successfully continue our journey through the cosmos. These areas include: green jobs, smart growth, transportation, international treaties (e.g., Law of the Sea and Kyoto), U.N. support, economics/trade, weapons sales, and population control. For everyone's benefit, let us hope that real change for the better does occur from the party that takes over leadership of the U.S. and that the winner accepts the challenge of saving the planet in an urgent and collaborative manner.

Nuages: Innovations in the Clouds

A NEW GEO MARKETPLACE

"Nuages" (Clouds) is Gypsy

Jazz guitarist Django Reinhardt's famous WWII song of peace, balance, and tranquility. It may not be the perfect soundtrack to support our exploration of the "disruptive" nature of "cloud computing." However, Django's timeless music has been an inspiration for many other artists in improvising and innovating new ways of looking at the world. Like Django, the new geo marketplace may be the source of inspiration and innovation for imagery/remote sensing (I/RS) products as the imagery value chain of data storage, processing, and distribution begins to incorporate cloud computing and create new information products and services.

According to the Wiki (we are talking "cloud computing" after all): Cloud computing is Internet-based ('cloud') development and use of computer technology ('computing'). The cloud is a metaphor for the Internet (based on how it is depicted in computer network diagrams) and is an abstraction for the complex infrastructure it conceals. It is a style of computing where IT-related capabilities are provided "as a service," allowing users to access technology-enabled services from the Internet ("in the cloud") without knowledge of, expertise with, or control over, the technology infrastructure that supports them.

According to the IEEE Computer Society, it "is a paradigm in which information is stored permanently in servers on the Internet and cached temporarily on clients that include desktops, entertainment centers, table computers, notebooks, wall computers, handhelds, etc." Cloud computing is a general concept that incorporates software as a service (SaaS), Web 2.0 and other recent, well-known technology trends, where the common theme is reliance on the Internet for satisfying the computing needs of the users.

Cloud computing is also known as utility computing and offers companies the opportunity to save money on technology infrastructure and reallocate resources to innovation and product development. How all this will change the way satellite I/RS data are stored, processed, and distributed is open to debate. It is clear, however, that "cloud computing" has the potential to disrupt the traditional value chain and enable innovation, not only in data, but in the information and applications that build value for a growing segment of end users.

Software as Services (SaaS) has had its detractors due to fears of loss of security, lack of performance control, and unknown liabilities. With Amazon's S3 web services and Apple's Mobile Me recent outages, dependence on the "cloud" doesn't seem to be pragmatic… until, of course, the cost savings associated with data storage, hardware, software applications, data processing and distribution, and an understanding of the real risk of "cloud computing" overcomes the fears and helps to transform businesses and organizations of all sizes and types.

THE NEW GEO VALUE CHAIN

Traditionally, I/RS data have been specified and delivered to expert users who "know" their applications. The value of the data was intrinsic to the mission of scientists, researchers, government analysts, and GIS users. Today, a growing segment of users represents less spatial data expertise, but a greater diversity of needs – and potentially a much greater set of requirements for data to become "information." Some believe

It is clear that "cloud computing" has the potential to **DISRUPT THE TRADITIONAL VALUE CHAIN AND ENABLE INNOVATION,** not only in data, but in the information and applications that build value for a growing segment of end users.

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I/RS MARKETS

Traditional Market: Experts and GIS Users	Internet Mass Market: Amateurs to Professionals	Emerging Business Users
Limited to government, compliance, asset management and resource planning	Advertising, Web 3.0 and geosearch, applications (widgets)	Location intelligence as a new place of information for competitive advantage; Integration into workflow
Mission specific, very detailed	Lowest common denominator	Information to drive top line growth; Improve opterations

Source: ITF Advisors

that this "greater set" can be handled by integrating the "silos of information" in the "cloud" – more about that below in the discussion of the new geo marketplace.

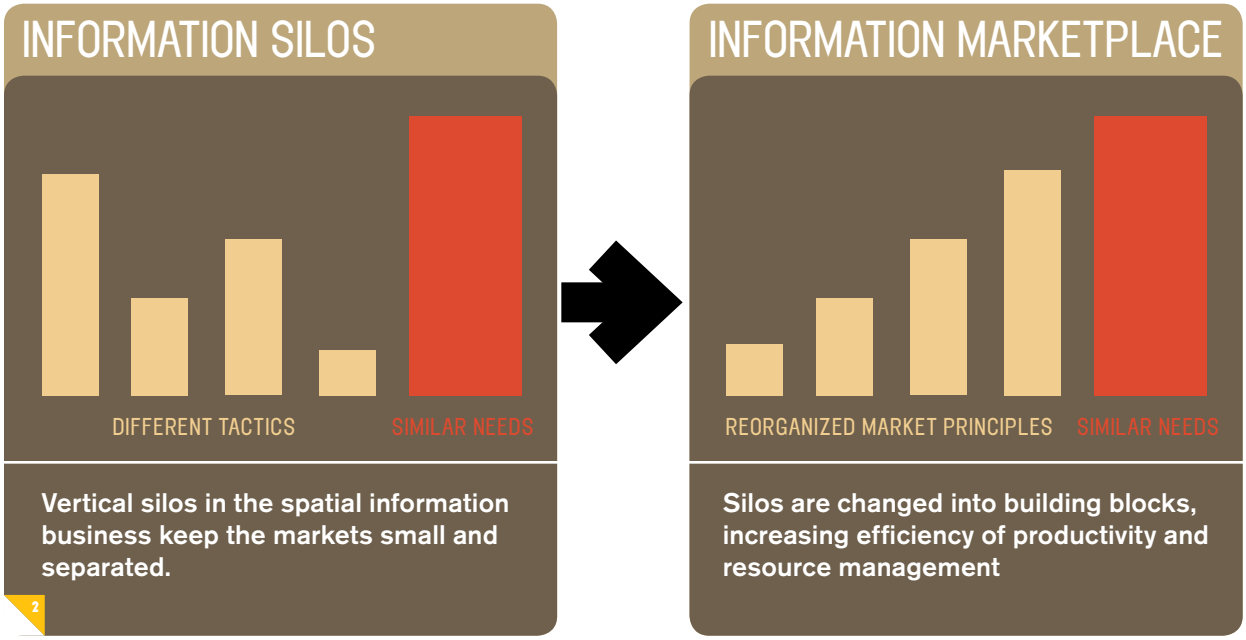
This diversity of users has created three distinct demand markets for I/RS: the traditional market of experts and GIS users, an Internet mass market of amateurs to professionals, and an emerging business users market which is still undefined. Therefore a new set of distribution cycles is emerging: "Data" and "Information."

The Data Cycle encompasses collection, processing, exploitation, and distribution that result in an image product. This image product is not viewed as "information" by many new users, but simply a backdrop that provides context for other data points. The Information Cycle includes the data, and must also be able to answer a "business value" question–to provide not only required data, but analysis, recommendations, and "answers" in formats that may be usable beyond GIS. The image/data becomes information when it is integrated with other data sets into a workflow and decision-making process. Some call this a mashup; others call it an information product.

Imagery distribution to date has focused on the Data Cycle, and the users of the data created the Information Cycle. The Data Cycle ran either directly to the end user or through resellers, to subject matter experts/consulting services and, most recently, to mass markets (via Google and Microsoft). This is the "raw data" distribution model.

An additional challenge is that the data were fragmented by industry vertical markets–for example, the "insurance" vertical did not contain the same specifications as the "agricultural" vertical.

In order to serve the growing segment of users who want Data + Information at lower costs with easy accessibility, the question for the marketplace is how "information value" will be developed before the end user ingests the content. In other words, the new users do not wish to invest in the Total Cost of Operations (TCO) to turn data into information (cost of data + cost of software application + cost of hardware to run the software + cost of training on the application + cost of manual analysis)–and they don't have to. See ***Figure 1***.



Source: WeoGeo

THE NEW GEO MARKETPLACE

Cloud computing and geospatial awareness create the opportunity for value-added/derivative imagery products to be developed, as well as for lower TCO for the new segment of users. These products may be as "lite" as presentation mashups or as "rich" as Hyperspectral Imaging. The ability to serve up both is a function of "outsourcing" the massive computation infrastructure in a cost-efficient, scalable environment.

Among the next-gen mapping suppliers innovating in cloud computing is WeoGeo. Imagine a place where the long tail qualities of geospatial interests, curiosity, and demand can find any geospatial product from a raw image product to a value-added image to geospatial art. WeoGeo is emulating the eBay model of frictionless transactions whereby a market of long tail users influences the value and liquidity of geospatial products.

WeoGeo was built to address two fundamental issues in growing the imagery market: 1) finding and acquiring high-volume/high-value mapping content and 2) fusing mapping content developed in industry verticals or "information silos" to create value-added geocontent. See ***Figure 2***.

The "cloud" helps solve the problems. According to CEO Paul Bissett, "The cloud allows organizations and businesses (especially small businesses) to find and acquire volumes of large image files and to process customized mapping content."

Putting massive computational infrastructure in the hands of the next-gen mapping users and suppliers will dramatically lower the cost of developing "information." As spatial imagery, remote sensing, and GIS finally get an infrastructure of the scale needed to put imaging products and services in the hands of the non-specialist, we see growth in the entire ecosystem. Data, hardware, software, support, and information suppliers will be able to tap into the three markets and build solutions that were previously restricted to large organization initiatives.

BACK TO THE CLOUDS

GIS and I/RS have always required a significantly greater computational infrastructure. Today, it appears that clouds on the horizon are not indicators of a rainy day for imaging; in fact, they may help create a much larger and diverse user base.

In many projects, "cloud cover" was a bad day for satellite imaging; however, "cloud computing" will enable a new value chain. Django Reinhardt, as jazz musicians tend to do, continued to take inspiration from the clouds innovating music that made him a legend. There appears to be a similar opportunity for satellite imaging. ≪

Experience the power of eXtreme Analysis (XA)

Image analysis (IA) and geospatial analysis (GA) workflows are becoming more integrated. Image analysts need the capability to extract accurate geospatial information, while geospatial analysts require additional analysis resources and increased ease of use. BAE Systems has listened to users who have been using multiple applications to complete their tasks; SOCET GXP was built to address these issues.

IA + GA = XA

The new SOCET GXP v3.0 release represents the convergence of IA and GA into one cohesive software package that reduces the dependency on multiple tools and increases usability: XA.

The eXtreme Analysis capabilities in SOCET GXP allow software users, from novice to expert, to experience the power of real-time image analysis, automated geospatial production, mapping, and 3D visualization in one product. XA is accomplished with an intuitive application that employs a ground coordinate system to record geospatial data, eliminating the need for manual registration. Automated, user-defined workflows characterize the application, eliminating excessive time spent on laborious tasks. The eXtreme Analyst has direct access to geospatial databases to store and retrieve features, a link to Google Earth for enhanced situational awareness, and the capability to create and distribute geospatial data products quickly. See ***Figure 1***. XA's have the best of both worlds—IA and GA integrated into a single application: SOCET GXP.

SOCET GXP AT-A-GLANCE

SOCET GXP is a geospatial-intelligence software package that uses imagery from commercial, satellite, and tactical sources to identify and analyze ground features faster and more efficiently. Operators can record measurements, analyze terrain, create 3D models with realistic geographic context, and monitor changes over time. Finished products generated from SOCET GXP include expansive maps, PowerPoint slides, geo-enabled PDF files with editable geographic attributes, and GIS data for future geospatial analysis.

SOCET GXP v3.0 allows operators to automatically measure, annotate, catalog, and retrieve ground features in a series of images to expedite geospatial analysis. With

FIGURE 1
SOCET GXP provides seamless integration and dynamic viewing and editing with Google Earth.

FIGURE 2
The Ortho On-the-Fly tool streamlines geospatial production while improving accuracy and reducing geometrical measurement errors associated with sensor and terrain modeling. It orthorectifies (stitches together) raw images in real time to produce a continuous, highly accurate image of an expansive area, allowing first responders and analysts in the field to view and analyze imagery without delay.

the click of a button, new functionality, such as automated triangulation and the Ortho On-the-Fly tool, can streamline geospatial production, while improving accuracy and reducing geometrical measurement errors associated with sensor and terrain modeling. See ***Figures 2-3***.

Additionally, imagery, terrain, vector, and mapping data are processed in their raw form within SOCET GXP whenever possible, a capability that simplifies workflows. The data can be used to build maps, develop transportation infrastructure, manage utilities and communications networks, coordinate operational missions, and designate troop maneuvers.

The software is used for applications as diverse as finding beach landing sites for combat troops, and helping to land the Mars Rover. See www.baesystems.com/gxp. ≪

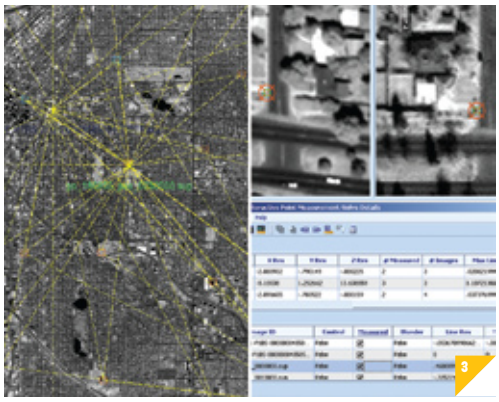
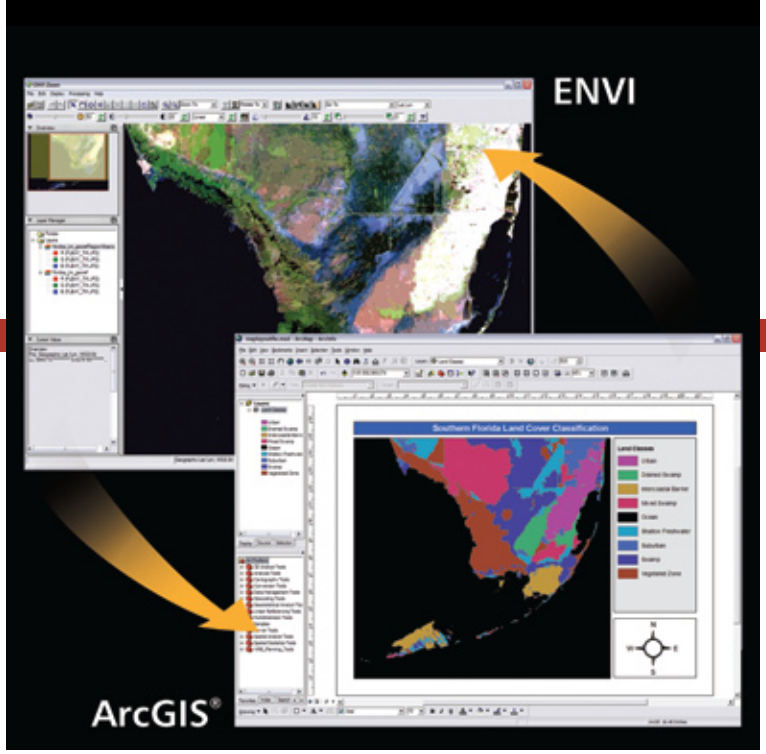


FIGURE 3
The automated triangulation process adjusts satellite or airborne sensor models to improve the accuracy of coordinates and measurements derived from imagery. It simplifies the triangulation process so that users who are not familiar with photogrammetry can be assured that all objects in an image, such as buildings, bridges, roads and other features, are represented accurately.



ENVI and ArcGIS users can now easily exchange data between the two applications via the geodatabase, including raw imagery, vector layers, and processed geospatial products.

ENVI Integrates Image Processing with GIS

In recent years, GIS professionals across industries such as urban planning, forestry, agriculture, and defense and intelligence have begun to realize the potential of geospatial imagery and the information it can provide. Information from imagery allows GIS professionals to make important decisions more quickly and greatly reduces the extensive fieldwork necessary to gather critical data.

Traditionally used as a simple backdrop to GIS to create visual context, geospatial imagery is now being used in GIS for countless applications. Common applications include finding similar features in an overall image scene, assessing damage from natural disasters, planning urban developments, and determining crop health in rural settings.

ENVI 4.5 (from ITT Visual Information Solutions, Boulder, Colo.) recently introduced new capabilities to facilitate the integration of imagery into existing GIS workflows. ENVI 4.5 provides seamless data exchange with ArcGIS Desktop from ESRI. Now GIS professionals using both ENVI and ArcGIS can easily exchange data between the applications and also generate maps using the full suite of map composition tools available in ArcGIS.

This innovative development is a significant advance in streamlining imagery and GIS workflows, a vast improvement over previous processes that required importing and exporting imagery among multiple software packages to achieve results. Now, GIS professionals have access to high performance image processing capabilities, allowing them to add rich geographic information to the geodatabase for a host of applications. See www.ittvis.com/ENVI. ≪

GeoEye-1 First Image: Kutztown University, Penn.

HIGHEST RESOLUTION IMAGERY IS HERE

On Saturday, Sept. 6, 2008, GeoEye-1 was launched from Vandenberg Air Force Base in California. The first color 0.5-meter image was taken on Oct. 7 while GeoEye-1 was moving north to south in a 423-mile-high (681 km) orbit over the eastern seaboard of the U.S. at a speed of 4.5 miles per second.

This first image was produced by fusing the satellite's panchromatic and multispectral data to produce a high-quality, true-color 0.5-meter resolution image. It captures what was in fact the very first location the satellite saw when the camera door opened.

GeoEye-1 was built by General Dynamics Advanced Information Systems in Gilbert, Ariz. The imaging system was built by ITT in Rochester, NY. ITT also built the imaging system for DigitalGlobe's WorldView-1 and is buildling it for GeoEye-2, slated for launch in 2011.

See www.geoeye.com. «

» *Kutztown University, located midway between Reading and Allentown, Penn., was literally the first image taken by GeoEye-1. The image shows the campus academic buildings, parking lots, roads, athletic fields and the track-and-field facility.*

RapidEye: Small Commercial Solution, Large Defense and Intelligence Capability

MDA develops and delivers operational small satellite solutions to address the operational needs of commercial and governmental customers at a lower price point, with manageable development risk. The company's operational small satellite approach aims to provide the economic benefits of small satellite technology with the programmatic rigor and data delivery capability of traditional space missions. This new generation of commercial satellites can provide the defense and intelligence communities with powerful broad area monitoring and surveillance capabilities, high revisit cycles, and lower costs.

The RapidEye mission was delivered on orbit, with associated ground infrastructure, under a firm, fixed price contract of less than $170M (Canadian dollars). MDA is the prime contractor for the RapidEye mission, responsible for the design and implementation of a turnkey system that includes space and ground segments, launch, on-orbit commissioning, calibration of the spacecraft constellation, and training and support to initial mission operations.

Late August 2008 saw the simultaneous launch of the five RapidEye satellites from a single launch vehicle into a sun-synchronous orbit at an altitude of approximately 630 kilometers. The satellites operate in a single

orbit plane, equally spaced and following each other approximately 19 minutes apart. On-orbit commissioning will take approximately four months before RapidEye AG assumes full commercial operation.

Each satellite weighs 156 kilograms and carries a five-spectral band push broom optical imager that provides a swath width on the ground of 78 kilometers at 6.5 meter ground sampling distance (at nadir; see See ***Figures 1-2.***) The imager's field of view can be oriented across track by rolling the spacecraft up to +/-25 degrees to provide the necessary coverage capability. Image data is stored in 48 gigabits of onboard mass memory storage before being transmitted to ground stations. Dual redundancy of key bus components ensures reliability and availability.

The RapidEye system can collect 4 million square kilometers of raw data per day and can generate more than 2.1 million square kilometers of orthorectified images per day from the raw data, to provide users with high-quality, timely imagery tailored to their specific intelligence needs. This high revisit cycle is relevant for warfighter support.

RapidEye satellites have a daily revisit capability anywhere on Earth, providing a rapid turn-around, from a customer request for information products, to digital delivery. The system has been designed to provide large area coverage, with frequent information updates from RapidEye AG. A very large data capacity enables the population and maintenance of an extensive database of information pertaining to large areas of interest, which directly supports intelligence work such as change detection.

MDA's RapidEye ground system is comprised of a dedicated Mission Control Center, a ground segment containing data processing, archiving facilities and a customer interface, commercial downlink sites, and an interface to the RapidEye AG product processing facility. The ground systems are designed to the same rigorous engineering standards and throughput levels as the headquarters systems MDA has delivered to DigitalGlobe, GeoEye, and RADARSAT-2, and the U.S. Air Force Eagle Vision transportable system.

RapidEye represents a powerful new geospatial intelligence gathering capability using MDA's operational small satellite solutions. It is a major new data source for global broad area change detection, and represents a significant technological leap in satellite capability at a considerably lower price point than previously thought possible.

See www.rapideye.de. Also see story on MDA's RADARSAT-2 on page 38.

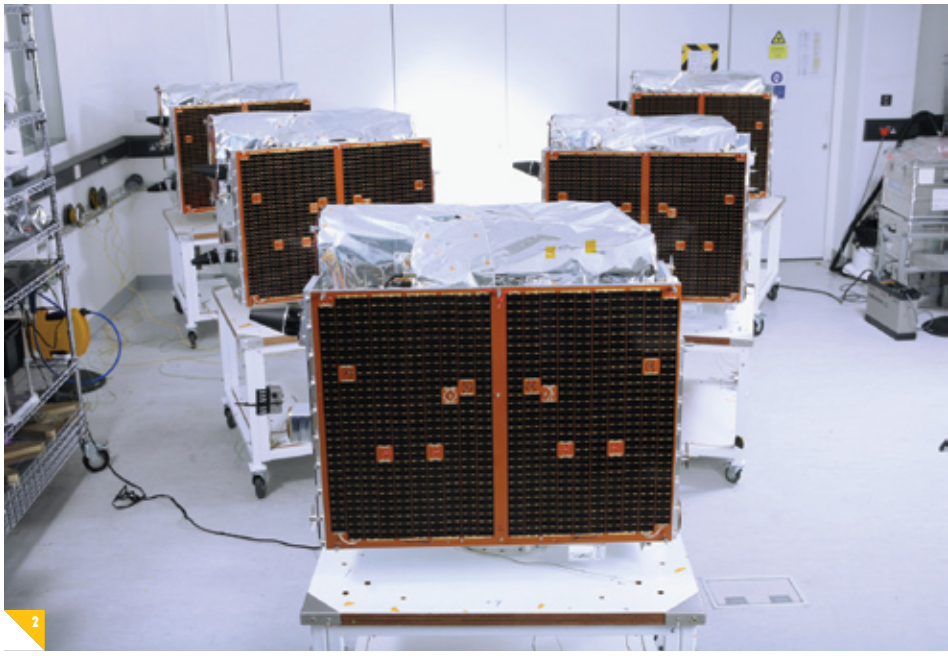


FIGURE 1
Rendering of RapidEye in orbit

FIGURE 2
RapidEye spacecraft prior to launch

SPADAC's EarthWhere Finding Home in More Defense and Civilian Organizations

SPADAC (McLean, Va.), a leading provider of spatially-enhanced technology solutions, has established new partnerships over the past several months with both defense and civilian government organizations through the sale of licenses for its EarthWhere product. Organizations now implementing EarthWhere include the National Geospatial-Intelligence Agency (NGA), Naval Air Systems Command (NAVAIR), Space and Naval Warfare Systems Command (SPAWAR), U.S. Department of State and U.S. Marine Corps.

EarthWhere is a spatial content management system that streamlines the organization, provisioning and disseminating disparate data for fast organization-wide access in required formats.

"SPADAC is eager to support both NAVAIR and the Marine Corps by helping both organizations to maximize the value of their spatial assets in a way that achieves substantial, long-term cost savings while simultaneously enhancing the quality of their systems," said Mark Dumas, founder and CEO of SPADAC.

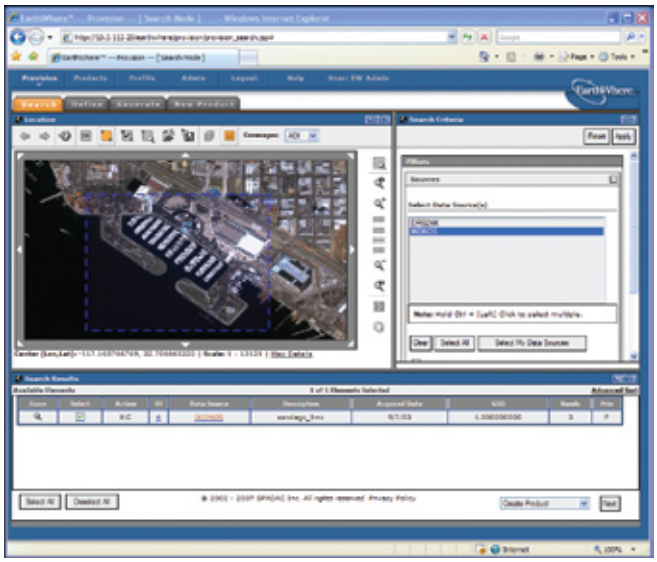
The recent release of EarthWhere 4.3 marks an important milestone for SPADAC. Since acquiring EarthWhere last year from SANZ, SPADAC has grown customer installations of the product by 79 percent while maintaining a 100 percent retention rate.

EarthWhere 4.3 features expanded support for a variety of input and sensor formats, an updated and more intuitive user interface, and the addition of new reporting capabilities. The software now automatically detects, catalogs and notifies users when new imagery is available on the system.

The three new sensor models that the 4.3 version supports include FORMOSAT, WorldView-1 and GeoEye-1. New file formats include NLAPS, NITF 2.1, TFRD, and DPPDB. More than 200 new HARN projections are now possible. Also, numerous enhancements have been made to ActiveIngest, which is a powerful cataloging engine that quickly and easily catalogs and ingests imagery data.

SPADAC has been recognized recently as a fast-growing private company nationally and in the greater Washington area. See www.spadac.com.

See also "Information Warfare" on page 30.



EarthWhere's "Zoom to Image" function allows users to zoom past the low resolution thumbnail of an image into higher resolution source data, bringing sharper, cleaner images of the areas of interest into focus.

DigitalGlobe Sets the 'Gold' Standard

This summer's Olympic Games marked several historic firsts. A total of 958 medals were awarded to athletes from 87 countries – the most medals and medal recipients in Olympic history. Michael Phelps won the most gold medals ever in a single Olympic Games. A lesser known first of the 2008 Summer Games was that NBC's broadcast marked the use of the highest-fidelity three-dimensional (3D) virtual representations of Beijing and the Olympic venues that have ever been created.

Satellite imagery provider DigitalGlobe teamed up with modeling- and simulation-service provider AEgis Technologies Group to equip NBC Universal with a 3D digital model of Beijing for worldwide broadcast and Web distribution during the Olympic Games.

The collaboration between AEgis' simulation technology and DigitalGlobe's satellite imagery library allowed virtual content databases to be rendered in just days. Viewers of NBC's broadcast experienced a virtual simulation of Beijing and the sensation of "flying" through the city from Olympic venue to venue. The debut of this

remarkable technology during the Olympics generated so much industry interest that DigitalGlobe and AEgis will introduce a new 3D satellite image-based product based on the collaborative technology later this year.

The Olympics imagery is just one example of DigitalGlobe's continuing commitment to exploring new ways to provide affordable solutions for imagery discovery and viewing. Key to this strategy is making high-resolution satellite imagery available via the Web.

At the August ESRI conference, DigitalGlobe launched *ImageConnect: Global*, an imagery subscription service that provides GIS professionals with instant online access to 30.5 million km^2 of premium imagery, with in-depth coverage of 36 countries worldwide. Through *ImageConnect: Global,* GIS professionals can quickly, easily and directly access high-resolution global imagery, much of which is not available through other Web services or commercial portals. Imagery content is constantly updated with new images collected from DigitalGlobe's sub-meter constellation of high-resolution satellites and aerial networks.

Any GIS professional who has experienced the frustration of not finding historical images and current views all in one place immediately understands the advantages of having both instantly available from a single source. With *ImageConnect: Global*, online imagery access for precision mapping, government programs and infrastructure projects is just one click away, enabling a constant flow of advanced imagery for integration into any ongoing project – instead of managing multiple imagery providers and data sources and their associated technical inconsistencies and cost inefficiencies. Extensive metadata, including acquisition date, resolution, accuracy and a worldfile, are also part of the *ImageConnect: Global* package, giving users the flexibility to select from a range of projections and image acquisition dates to customize their needs.

Demand of premium, highly accurate imagery is growing exponentially as more and more professional and government users and developers require real world perspective, in real time, to do their jobs. DigitalGlobe is meeting this challenge by continuing to provide premium satellite imagery in an accessible and affordable way to all businesses. See www.digitalglobe.com.

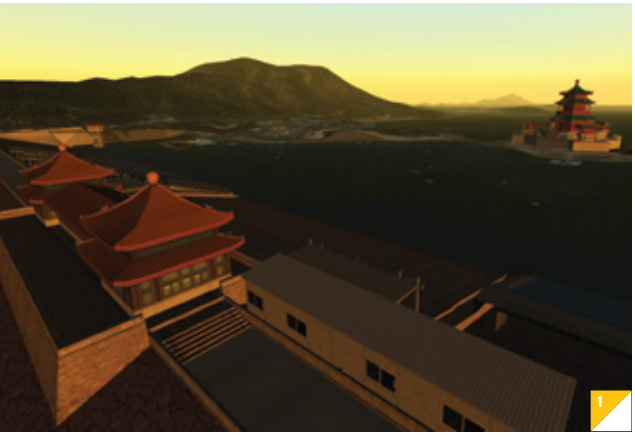


FIGURE 1
The Ming Tomb Reservoir (triathlon venue) is shown using fused product of DigitalGlobe imagery and AEgis 3D technology.

FIGURE 2
The Olympic Green is shown using DigitalGlobe imagery and AEgis 3D technology. The Olympic Stadium is in the foreground with the National Stadium (Bird's Nest) in the post-ground next to the Watercube. Behind that is the National Indoor Stadium, and behind that is the Convention Center.

NJVC Expanding HQ and Approved for GPO Schedule

Some call it growth. NJVC (Vienna, Va.) calls it transformation. In less than eight years, NJVC has grown from a small company with less than 30 employees to one of the largest information technology solutions providers supporting the U.S. Department of Defense (DoD), with a team that's more than 800 strong. Today, NJVC is preparing for further major expansions in new business and talent acquisition.

The company has welcomed several

USGIF Encourages Geospatial Intelligence Education

When the U.S. Department of Labor lists a technology as "high growth," it wouldn't be a stretch to conclude that the workforce in this sector is robust and expanding. That, however, is not necessarily the case in the geospatial intelligence arena.

In 2004, the United States Geospatial Intelligence Foundation, with the help of its membership, formed the USGIF Academy to help ensure a workforce of highly-qualified geospatial intelligence professionals. The Academy—through outreach to academia and academic institutions—supports lifelong learning and professional development in the skills and compet-encies associated with the geospatial intelligence profession and tradecraft.

One of the immediate concerns of the academy was to establish a Geospatial Intelligence Accreditation Program that would ensure colleges and universities are orienting students to a broad set of technical and critical thinking skills and knowledge relevant to entering and fostering a career in the geospatial intelligence profession.

Since that time, three national universities have received accreditation for their geospatial intelligence programs. University of Missouri at Columbia, Pennsylvania State University and George Mason University became the first schools to be accredited under USGIF's Geospatial Intelligence Accreditation and Certificate Program—the first and only program of its kind.

The Geospatial Intelligence Accreditation and Certificate Program complements a college degree, supports career development and provides professional recognition to the students in the form of a completion certificate. To gain accreditation, the schools applied to the USGIF Academy and were evaluated based on the criteria established by the foundation's review panel. The panel of leading experts from industry, government and academia spent more than a year establishing curriculum guidelines, accreditation standards and processes for the geospatial intelligence program.

Colleges and universities interested in creating a geospatial intelligence program or applying for accreditation are encouraged to submit applications. The USGIF Academy will review applications twice this year. Curriculum guidelines, requirements, applications and additional information are available on USGIF's website at www.usgif.org. «

new members to the NJVC management team at its headquarters. These key industry professionals include: Nick Aleyanis as senior vice president of engineering, formerly of BAE Systems; Paul Davis as chief technology officer, formerly of CSC; Vito DiNapoli as vice president of operations, formerly of CSC; Mary Jo Lampe as vice president of strategic marketing, formerly of Olive Group North America; and Darlene Connelly as general counsel, formerly of the President's Foreign Intelligence Advisory Board. The company recently promoted Jill Bruning to chief operating officer. Bruning, previously with CSC, joined NJVC in 2007 as information technology program manager.

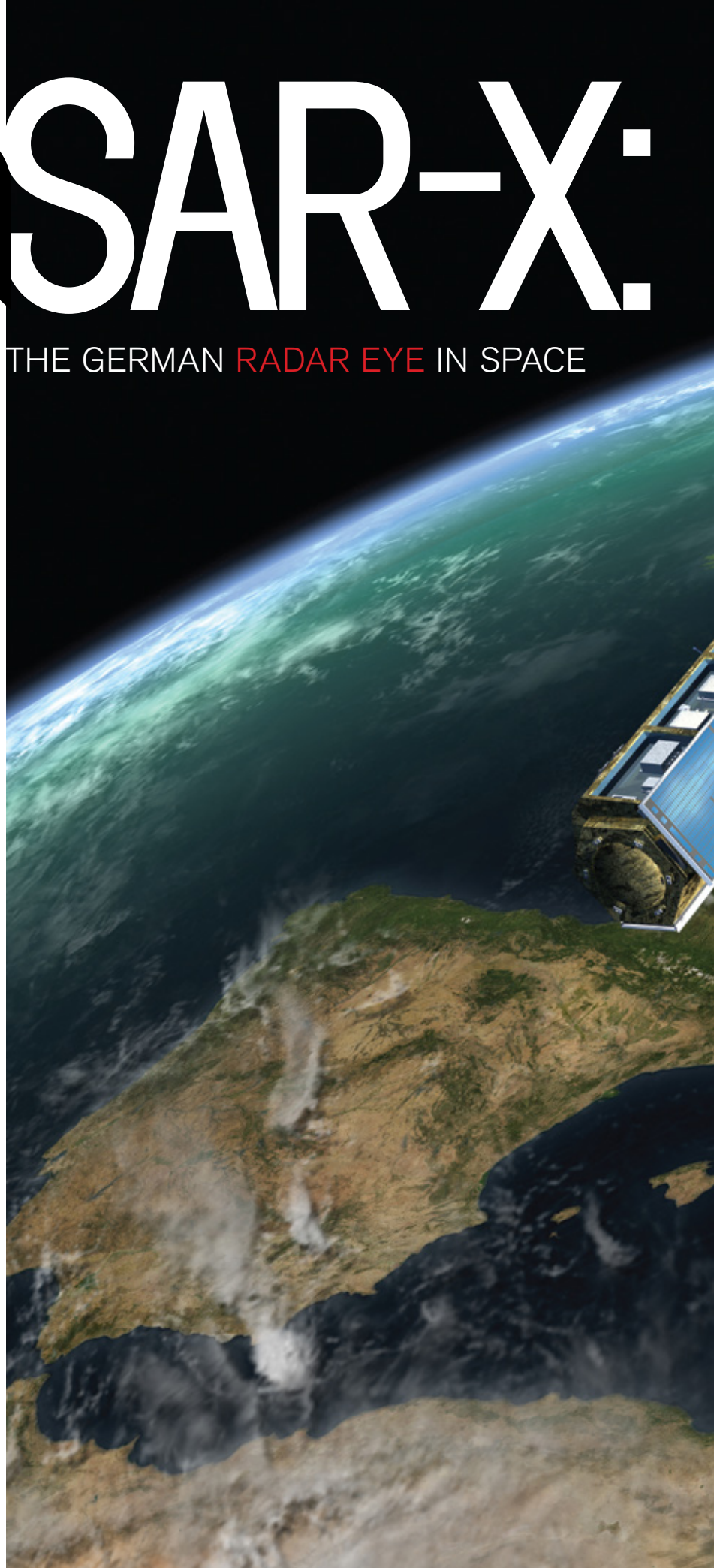
NJVC is actively seeking to recruit 100 individuals with clearances to support its current contract with the National Geospatial-Intelligence Agency (NGA) in the area of information technology, including Oracle and UNIX database administrator positions. More than 90 percent of NJVC current employees hold security clearances.

NJVC also just announced its approval as a vendor on the U.S. Government Printing Office (GPO) schedule. NJVC will provide printing services and published information in all forms, supporting and managing projects from books and pamphlets to maps, charts and posters, to CDs and DVDs.

Since its founding in 2000, NJVC has evolved into a leader within the government services industry, with annual revenues of approximately $400 million. Today, NJVC offers a full lifecycle of IT solutions to help solve the critical challenges of leading intelligence, defense and geospatial organizations with highly secure IT requirements, including its largest customer NGA. NJVC supports NGA's extensive technology needs by providing comprehensive IT infrastructure, secure communications, and IT support for the agency's locations around the world. See www.njvc-llc.com. «

TerraSAR-X:

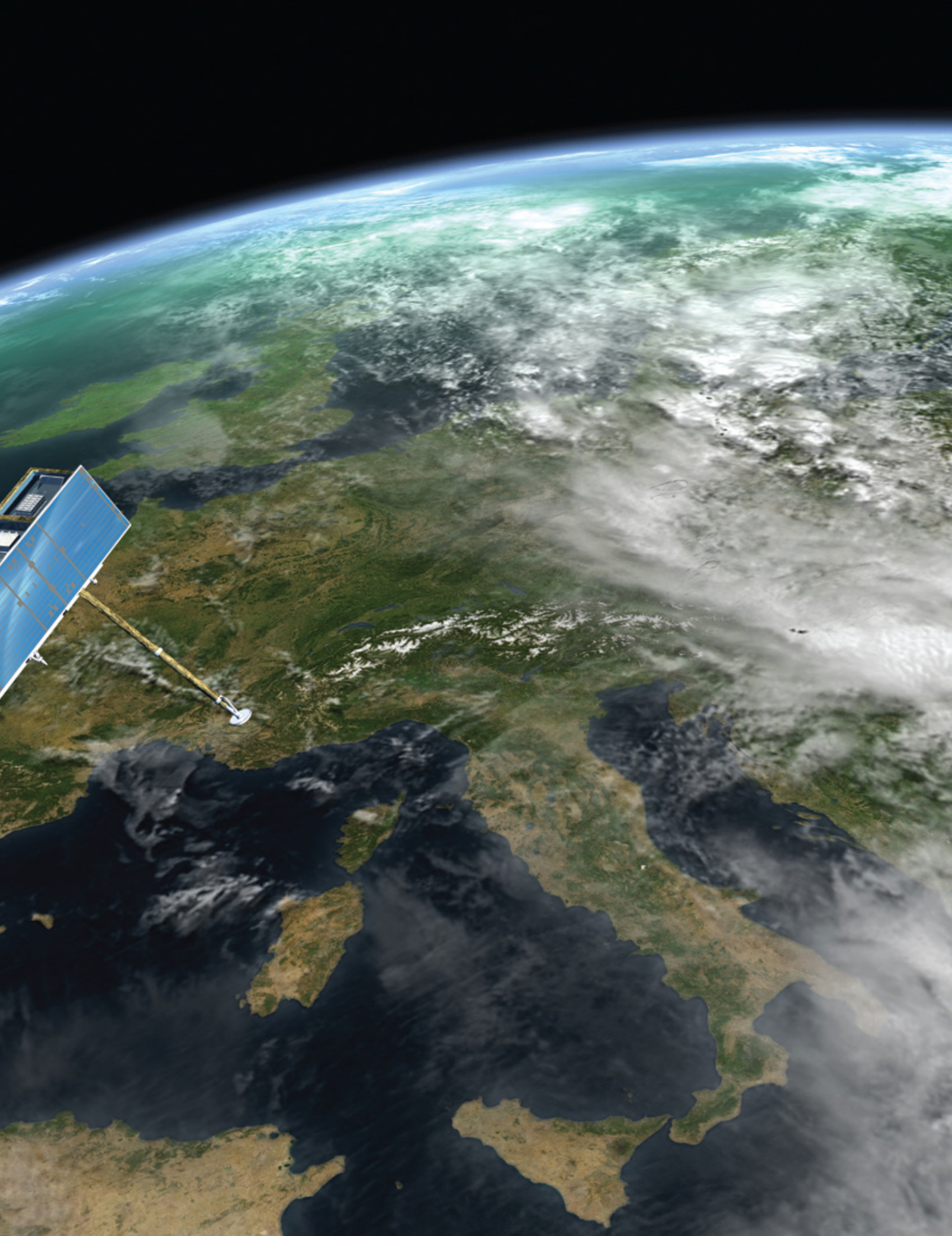
THE GERMAN RADAR EYE IN SPACE



TerraSAR-X is Germany's first national remote sensing satellite implemented in a public/private partnership between the German Aerospace Center (DLR) and Infoterra GmbH/EADS Astrium, with a significant financial participation from the industrial partner. This commercial radar satellite will acquire high-quality radar data for scientific observation of Earth, for disaster monitoring, and for geoinformation purposes for at least five years. At the same time, it is designed to satisfy the steadily growing demand of the private sector for earth remote sensing data in the commercial market.

TerraSAR-X (TSX) was launched in June 2007 on a Russian/Ukrainian DNEPR-1 launch vehicle from the Baikonur Cosmodrome in Kazakhstan. It delivered TerraSAR-X into a 514-km high, near-polar orbit. The orbit was selected so that the satellite flies in a sun-synchronous, dusk-dawn orbit. This means that the satellite moves along the day-night boundary of the earth and always presents the same face to the sun. While TerraSAR-X circles the earth, the satellite can take images of all regions of the earth with a resolution up to 1 meter in a spotlight mode, scanning Synthetic Aperture Radar (SAR) and strip-map manner, until after each 11 days

THOMAS FESKE, AGNÈS MELLOT,
DR. JÜRGEN DRESCHER
German Aerospace Center (DLR)
Washington, D.C.
www.dlr.de/tsx



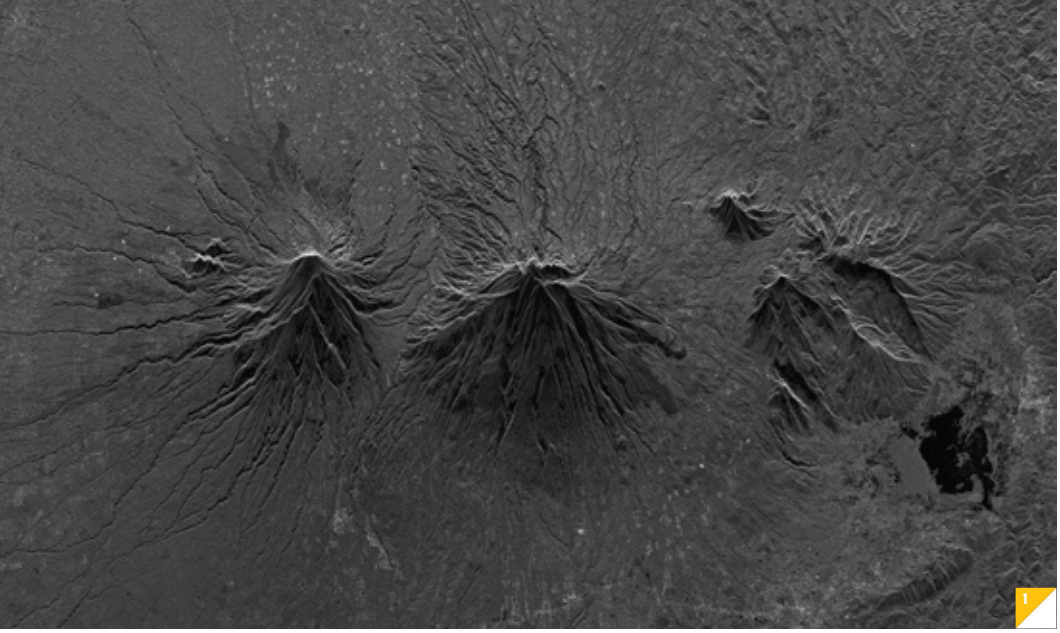


FIGURE 1

One of the most dangerous volcanoes of the world, the Merapi on Java in Indonesia: TerraSAR-X data are important bases for rapid mapping activities in the case of natural disasters.

FIGURE 2

Viedma Glacier in Patagonia: Remote sensing data provided by TerraSAR-X obtained from space complete Earth-based measurements, and are essential for monitoring the polar ice caps to analyze the effects of climate change.

it returns back to its original position and begins a new cycle. With different angles of view, each point of the earth can be targeted within two to four days.

The TerraSAR-X satellite is operated from the German Satellite Operation Center (GSOC) in Oberpfaffenhofen near Munich. The remote sensing data downlink is provided to the ground station at DLR Neustrelitz. A special law covering aspects of data security and the commercial distribution of high-resolution remote sensing data was put in place after negotiations on an intergovernmental level.

SCIENTIFIC UTILIZATION

In the 21st century, it is difficult to imagine our modern life without satellite services, whether the service is the daily weather report using meteorological satellites, the live transmission of an ongoing event from remote areas using modern communication satellites, or the navigation of airplanes, cars and ships on the world's oceans by means of global positioning system satellites.

These services that in recent times have become more and more part of our daily lives are possible thanks only to technologically advanced satellite missions operating in space combining remote sensing, navigation and communication services.

Sensor systems based in space are used for applications on science and earth observation, be they for research focusing on alterations of land surfaces, oceans, and the earth's atmosphere; for climate research; for the monitoring of disasters for geological investigations; or for many more uses. ***Figure 1*** reflects volcano activity in Indonesia, where an immediate observation can be vitally important.

Remote sensing data obtained from space thus complement and complete ground-based measurements. They are always essential if a global view of the earth is required, as is the case, for example, with weather monitoring or with investigation of the polar ice caps. ***Figure 2*** shows the Viedma Glacier in Patagonia.

With the new TerraSAR-X radar satellite, land masses of the earth, as well as ocean surfaces, are monitored and closely inspected. With increasing technical capabilities of these sensors, geoinformation data can be extracted from satellite images with ever more precision and with broad applications.

Because of one of the outstanding features of TerraSAR-X, the high spatial resolution that has been achieved with this civilian radar system will offer completely new perspectives for the monitoring of detailed ground infrastructures and resources. ***Figure 3*** is an example for land use classification on Mount Egmont in New Zealand. Examples are monitoring of vegetation and the separation of different plant species, as well as the precise analysis of urban environments in towns and villages. ***Figure 4*** shows copper surface mining in South America.

Radar technology provides velocity information of moving objects, and uses the Doppler shift effects in the signal analysis. So traffic monitoring on the ground is an additional feature and a useful tool, broadening the application spectrum of TSX. ***Figure 5*** demonstrates TerraSAR-X capabilities for detection and tracking of moving objects.

THE SATELLITE

With TerraSAR-X, a modern radar system is used for Earth remote sensing purposes. The technology of SAR is able to produce high-resolution images of the earth's surface, similar to photographic images. A SAR has a number of advantages compared with optical systems; for instance, radar is independent of any illumination by the sun. The measurements can be taken around the clock at any time of day or night under any weather conditions. This radar sensor technology is to a large extent independent of weather conditions such as cloud coverage. This attribute contributes significantly to the operation, application and reliability of the system, qualities that are increasingly requested by many users, since data are often required at a certain point in time regardless of weather or time of day.

With SAR, the earth's surface is "illuminated" with short pulses radiated

by a radar antenna. The radar pulse is reflected from the earth's surface, and the so-called radar echo is received by the antenna and recorded. In order to achieve a high spatial resolution, a technical trick is applied: The satellite with the SAR instrument moves at high velocity over the earth's surface. During the over flight, the echoes of many radiated radar pulses are summarized. The result is equivalent to a very large radar antenna (synthetic aperture), proportional to the distance the satellite traveled in this period of time. With this technique the spatial resolution is increased in the flight direction, since it depends upon the size of the antenna.

A SAR system like TerraSAR-X can be operated in different imaging modes, in order to achieve various results. The active antenna enables users to switch rapidly among different imaging methods:

1. **In the spotlight mode, the radar image records an area of 5 to 10 by 10 km size. In this manner a maximum resolution of up to one meter is achieved.**

2. **In the strip map mode, the satellite images a strip of 30 km width and a maximum length of 1,500 km. The resolution is three meters.**

3. **In the ScanSAR mode, a strip of 100 km width and 1,500 km maximum length is scanned with a resolution of 16 meters.**

The approximately 1.3-ton TerraSAR-X spacecraft is based on the EADS Astrium Flexbus concept and has an extensive heritage from the successful Challenging Mini-satellite Payload "CHAMP" and from Gravity Recovery and Climate Experiment "GRACE" missions. The 5-meter-long and 2.4-meter-wide satellite bus features a structure with a hexagonal cross-section. One of the six sides carries the 5-meter-long and 80-cm-wide radar antenna. The electronic boxes of the SAR instrument and the satellite bus are also fitted on the side faces of the structure, in just the same way as the satellite's solar generator, 5.25 square meters in size, which ensures the supply of energy by means of gallium arsenide solar cells.

The data recorded by the SAR instrument are transferred via a downlink antenna to the ground receiving station. The antenna is secured to a 3.3-meter-long mast in order to avoid interferences caused by the radar antenna. The mast is folded up during the launch and is extended only after positioning of the satellite into its orbit. It allows simultaneous acquisition of new data by the radar and transmission of previously stored data to the ground. The technology of the active, phase-controlled antenna enables a high flexibility and mission efficiency.

While in the case of a passive system, the whole radar antenna or even the satellite must be rotated in order to align the antenna onto the target area, the active antenna of TerraSAR-X can steer its radar pulses in a specific direction. The antenna is 4.8 meters long and 80 centimeters wide. The satellite is designed in a way that it can be installed, together with its antenna at its full size, on the launch vehicle. In this way, a complex unfolding mechanism can be avoided.

With radar instruments, various frequency ranges of the radar spectrum can be observed, the so-called bands. TerraSAR-X is operated in the X-band, which is lying at a frequency around 9.65 GHz, corresponding to a wavelength of about 3 cm.

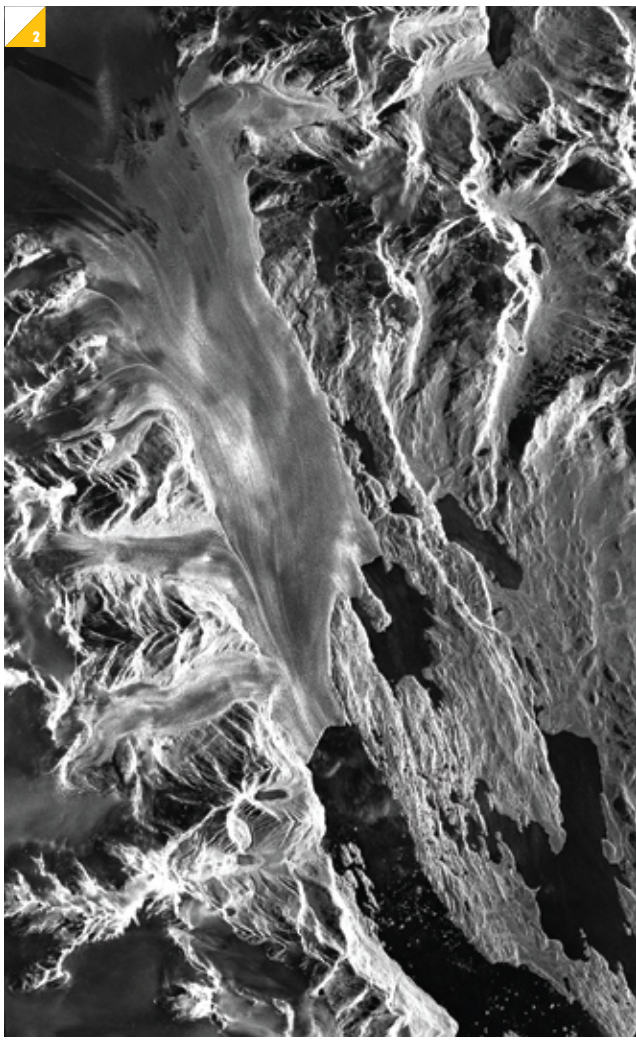
Thanks to the exact information concerning the contours of the earth—gained with the TerraSAR-X—scientists can, for example, predict along which routes the water will flow on the surface of our planet. By means of "virtual flooding" of the digital landscape on the computer, it is possible to simulate the effects of long duration rainfalls and to predict flooded areas and their effects on the environment.

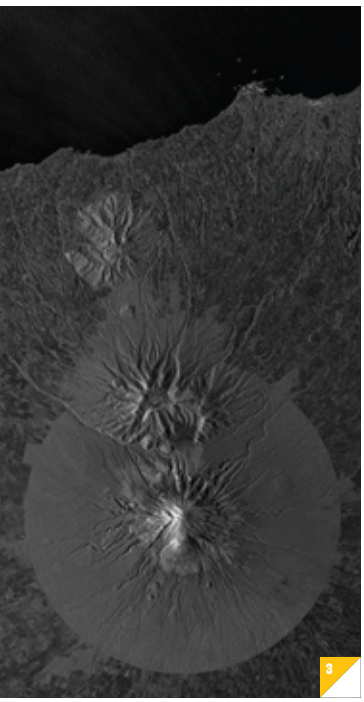
When exact height data is combined with information concerning the natural cover and the surface structures created by people, such as streets and buildings, construction companies are better able to plan power lines, oil pipelines, and also railway lines and bridges on the computer. Here the digital map replaces or supports the land surveyor on site.

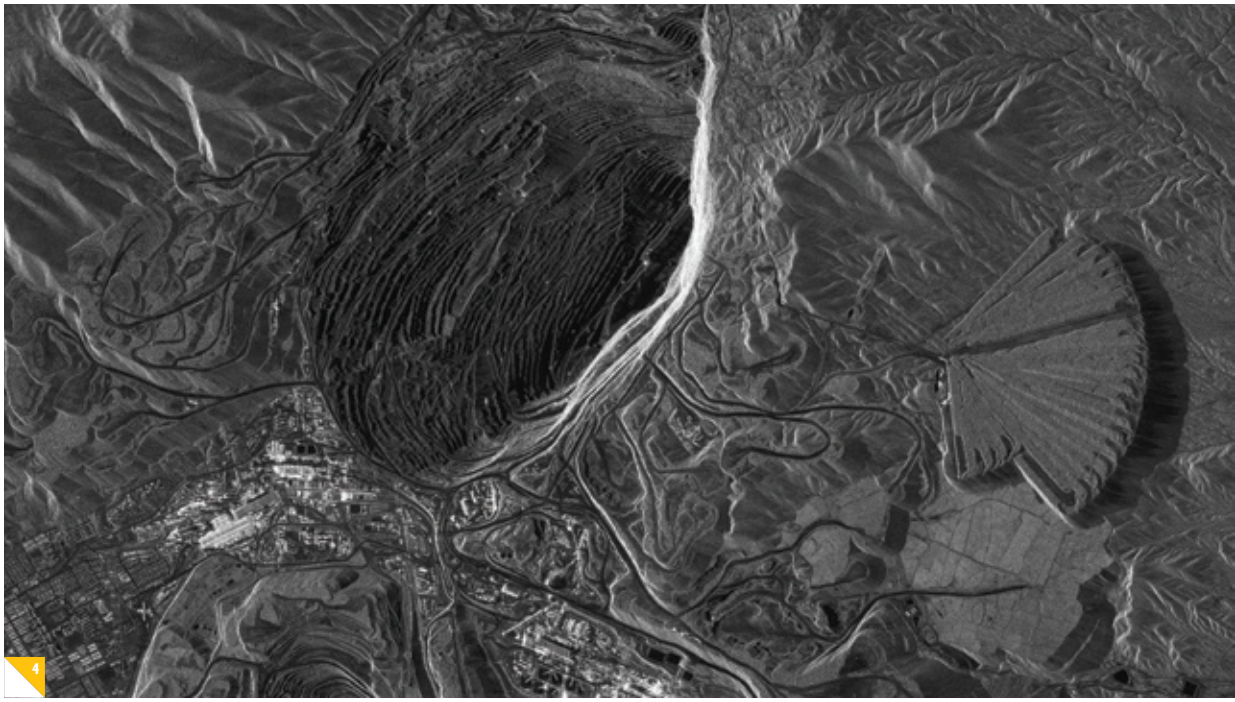
With the aid of a landscape model, mobile telephone companies can simulate the propagation of the radio waves and determine the optimum positions for their antenna masts. While still in the planning phase, it is possible to expose "radio holes" and remove them by careful positioning of the masts. By now, one year after the launch of TerraSAR-X, because of these technical possibilities there are many requests from private companies for the digital data.

PUBLIC/PRIVATE PARTNERSHIP

In the past, space projects have been almost exclusively financed by the state, due to their high costs and global mission objectives. With further technological







development, particular areas of space activities have also begun to interest the private market. Today remotely sensed Earth data and the information extracted from this data are also increasingly required for private-sector applications alongside scientific utilization. It is therefore the objective of the national Earth remote sensing program to transfer the extraction of this type of data in the long term to the private sector, and to open a self-supporting, sustainable area of business.

For TerraSAR-X, a cooperation agreement forms the basis of the collaboration between the state and the private sector. This agreement was signed on March 25, 2002, by the DLR space agency and EADS Astrium GmbH. DLR placed a contract for the development, assembly and launch of the satellite to EADS Astrium. The DLR research institutes are undertaking the development of the satellite operating system, as well as the ground segment for reception of the radar data and its processing, archiving, calibration and distribution. Moreover, DLR is responsible for the operation of the satellite over a period of five years.

Apart from the direct financial contribution to the project, EADS Astrium GmbH is obliged to develop a portfolio of innovative TerraSAR-X-based products and services and to establish a global distribution network. For this purpose, EADS Astrium founded its 100% subsidiary Infoterra GmbH in 2001. Infoterra's portfolio comprises data products, applications, and distribution partnerships.

COMMERCIAL UTILIZATION

These data products are of high interest on the free market. Infoterra offers TerraSAR-X data in different levels of refinement. They range from Basic Image Products (raw image data that can be acquired in different imaging modes, polarizations, and geometric projections according to clients' specifications) to Enhanced Image Products (orthorectified images or mosaics from several scenes) all the way to Geoinformation Products that contain significant information such as change detections.

The concept for the commercial exploitation of TerraSAR-X includes the marketing of so-called Direct Access Services. These provide TerraSAR-X imagery either for immediate use by an end user, the Direct Access Customer, or for further distribution in a specific region of the world by a Direct Access Partner.

Direct Access Customers and Direct Access Partners around the globe will operate their own ground stations and be able to receive the data directly from the spacecraft. Infoterra GmbH establishes its distribution headquarters in Germany and provides data, specific geo-information, and TerraSAR-X applications to clients worldwide.

LEGAL SITUATION: DATA SECURITY

In order to carry out the mission successfully, various facilities are required on Earth–the so-called ground segment. The satellite is controlled from the DLR ground station in Weilheim, near Oberpfaffenhofen. Both the command channel and the data transfer will be encrypted to prevent unauthorized access. DLR Neustrelitz provides the TSX-data downlink capabilities.

Data acquired by TerraSAR-X have a quality that, until recently, could be produced only by classified military satellites. These data are security-relevant. Effects of weapons or political threats can be substantially strengthened by these earth remote sensing data.

In German law there had been no regulations concerning distribution of data

or pictures of such quality. TerraSAR-X made a new law necessary. In addition, almost all efficient earth observing systems are dependent on U.S. construction units. The U.S. makes an export license for these construction units dependent on the fact that national regulations exist. Security interests must consider this when producing or distributing the earth remote sensing data.

Regulations of the new data security law in Germany are focused on examination of the distribution or accessibility of products of earth remote sensing data. This examination is necessary only if the data obtained from an earth remote sensing system were technically able to endanger the security interests of the Federal Republic of Germany. Great demands are made on operating with such high-quality earth remote sensing systems, demands that prevent satellites like the TerraSAR-X from being commanded by unauthorized entities and that protect important data from being inspected by unauthorized ones. For this reason, the administration of the earth remote sensing system must be approved and supervised.

The examination of the distribution or accessibility has to be arranged only in part by the provider of the data. By arranging this examination with sole responsibility, he could spread the data almost completely without official participation. Therefore, the provider of the data has to examine the data in connection with the concrete customer request, based on the possible endangerment of security interests. The examination takes place on the basis of specific criteria, which are given by the authority and which guarantee a fast, automated examination.

Relevant criteria are fourfold: the information content of the data; the person who inquires, as well as his customers; the requested target area; and the desired time. If the result of this examination is that no possibility of a security risk exists, then the data provider can distribute the data. Administrative proceedings are not necessary.

If the examination of the inquiry comes to the conclusion that security interests are possibly concerned, then the spread of data by the provider is subject to an official permission and certain limitations. The authority examines the inquiry and can permit it without change or can, in certain cases, limit the use and circulation of data of certain target areas, limit sending data to certain ground segments, limit permissible sensor operating mode or limit the quality of manufacturing of the data.

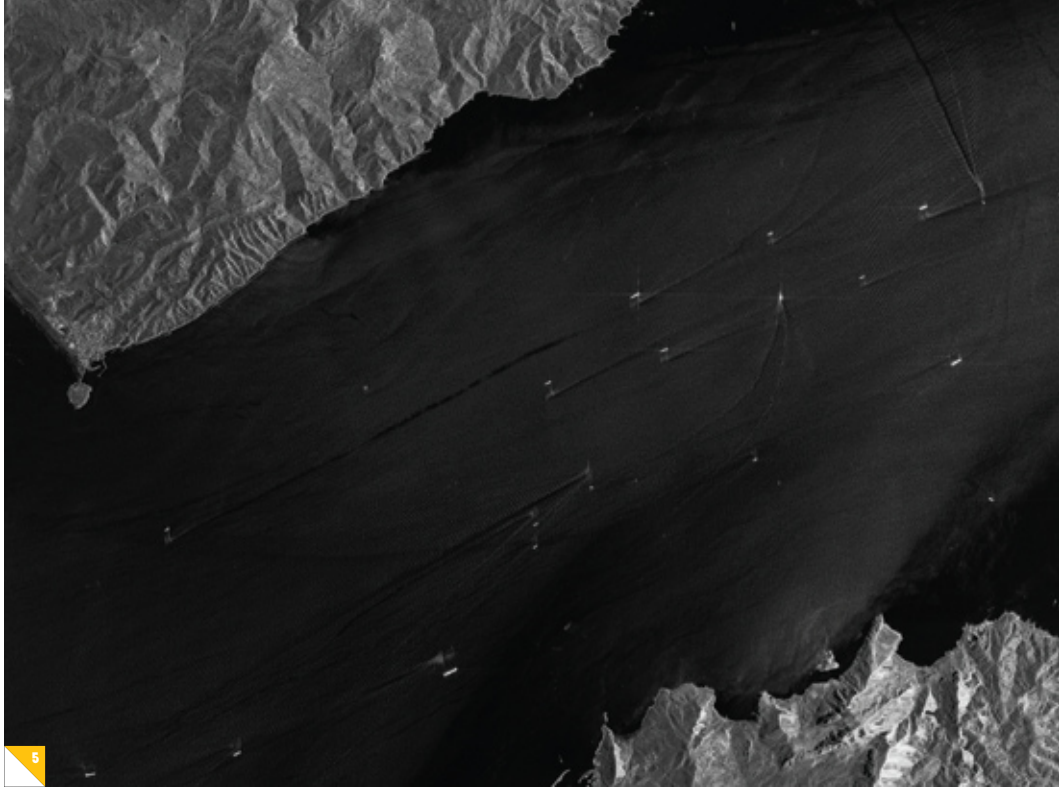


FIGURE 3
Tourist and agricultural land use on Mount Egmont in New Zealand: TerraSAR-X supports agricultural mapping services through multitemporal and multipolarization observations and facilitates large area assessments.

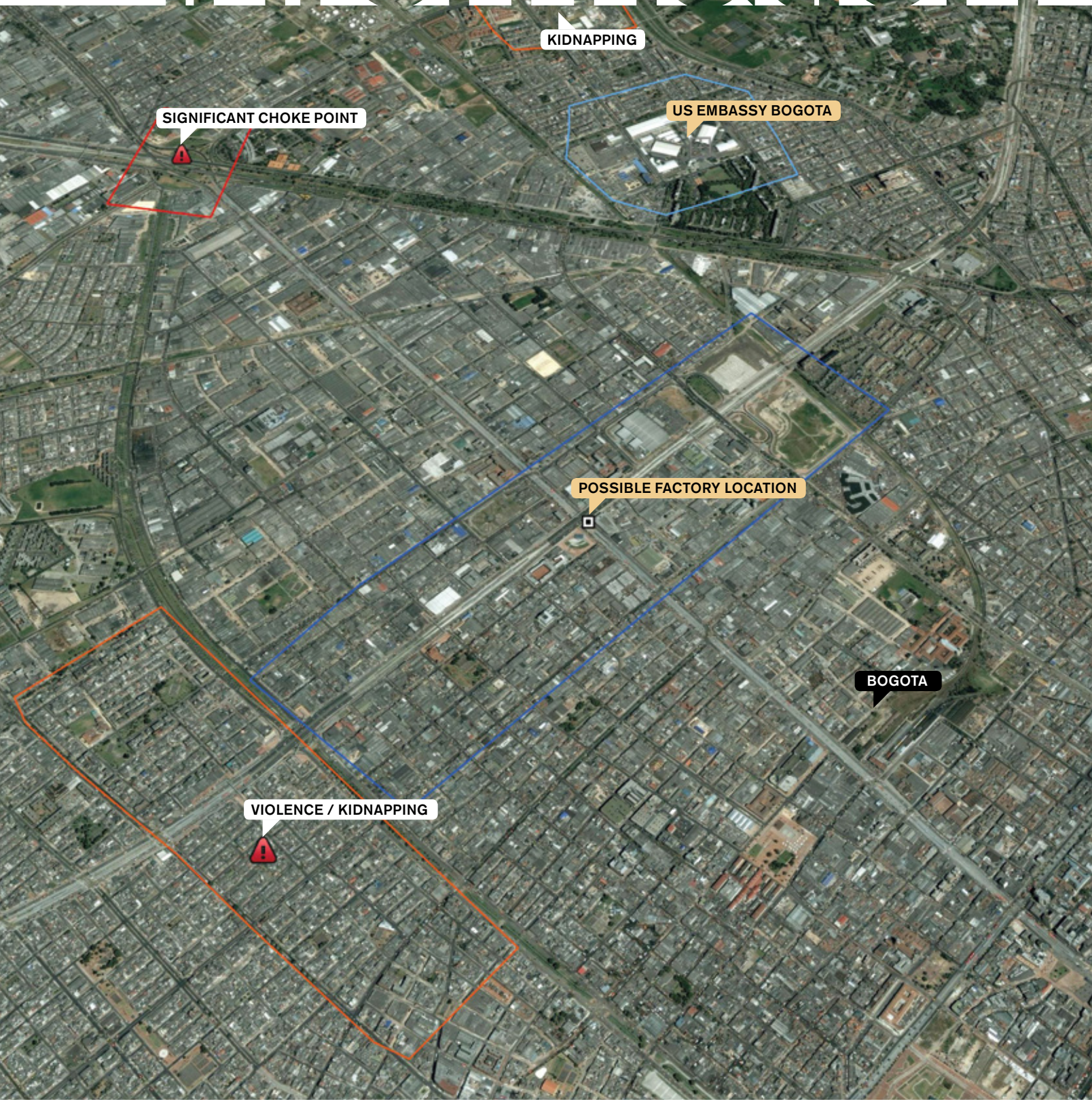
FIGURE 4
The biggest man-made hole, a copper surface mining operation in the center of the Atacama Desert on the west coast of South America: TerraSAR-X offers completely new perspectives for the monitoring of urban environments, as this example shows, observing long-term surface displacement.

FIGURE 5
The highly frequented Strait of Gibraltar in Spain: Along Track Interferometry allows, among other things, the detection of moving objects such as cars or ships.

THE FUTURE

Designers are already planning a follow-up system that will replace the satellite at the end of its operational life, anticipating that this follow-up system will be financed solely by the industry from the profits achieved with TerraSAR-X. The project, TerraSAR-X add-on for Digital Elevation Measurement, (TanDEM-X), is intended to generate a global digital elevation model of all terrestrial landmasses with an accuracy that has not yet been reached. This precision can be achieved by complementing TerraSAR-X with the additional TanDEM-X satellite of nearly the same design in a tandem orbit configuration. The two satellites will fly in a tight formation with only a few hundred meters of separation in approximately the same orbit. TanDEM-X is designed for a mission duration period of five years.

Information



Warfare

A MISSION-CRITICAL VITAL SEGMENT IN DEFENSE AND CIVILIAN INTELLIGENCE

On September 11, 2001, the world changed, altering the kind of warfare our country will be engaged in for many years to come.

While terrorism wasn't new to our nation, facing a "stateless" enemy capable of executing the largest attack on civilians within our borders dramatically altered our national priorities and our thinking on modern warfare needs. Suddenly, we were at war with an enemy that didn't have a capital, a flag, a province or even specific targets. The "game" had changed. The era of Information Warfare was born.

FIGURE 1

This image provides the base data representing a sample scenario in which viewers learn about the potential risks that may be encountered by building a factory (dark blue box) near our nation's embassy (light blue circle) in Bogota, Colombia. Critical data has been aggregated, filtered and analyzed to provider users with a greater understanding of not only the environment, but also relevant events that have occurred in the past such as kidnappings, bombings, violent crime and major traffic choke points.

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FIGHTING BACK WITH INFORMATION AND TECHNOLOGY

Industry responded to meet the demands of this new kind of warfare, developing technology that could be applied successfully to support military and intelligence communities, as well as federal civilian organizations, state governments and even commercial markets.

Different people and organizations have different descriptions of the growing area of Information Warfare. Some of them wrongly assume it's the version we most often see and hear about from Hollywood: scenarios that depict how the country might perform in response to a network attack on the Pentagon or on U.S. intelligence systems information technology infrastructure. But Information Warfare, in its broadest sense, is the fight against all hazards, man-made or natural, through the processing of all relevant, available information using technology that helps us prepare for, prevent and respond to the worst that man and nature can unfold.

DATA COLLECTION AND FUSION: KEYS TO COMBATING TERRORISM AND INSURGENCY

The individuals powering the war against us immerse themselves in the fabric of communities of the relatively good, and hide weapons behind curtains of innocent children, schools, hospitals and family homes. To combat an unseen enemy in this modern age, the keys are data collection and fusion.

Information Warfare uses data collection, fusion and distillation techniques to obtain accurate and timely information, thereby creating an advantage for the U.S. and its allies. Conduct of the war in Iraq provides a good example. Concrete knowledge is required in times when decisions are crucial, such as determining what house contains the bomb-making team that is intent on further destruction and loss of life.

In a civilian neighborhood where we can't afford to send soldiers or government law enforcement personnel to go blindly door to door—for both practical and political reasons—spatial information technology can play a critical role. The result is faster, actionable intelligence through predictive analytics. Reports and rumors and the analysis of social networks are distilled and fused to narrow down options.

NEW TECHNOLOGIES KEEP US ONE STEP AHEAD

In September, GeoEye sent up its satellite GeoEye-1, the world's highest resolution commercial Earth-imaging satellite. As more devices are developed and launched to listen, watch and communicate, and the frequency of collection increases, so does the quantity of data that requires distillation and analysis. For example, new technologies are now available that allow for data collection wirelessly, regardless of weather. The crucial role technology plays in the back-end management, distillation, assessment and analysis of this huge mass of relevant data is growing daily.

Conversely, the analytical capability and expertise of our nation is changing. A generation of intelligence analysts is beginning to leave their posts, with expertise built up during the Cold War. At the same time, the intelligence methods used are changing. The industry has moved away from Cold War types of analyses, and the technology and tools are becoming more complex.

Today, we have technologies that help analysts cut through the clutter, such as Signature Analyst, developed and released by SPADAC earlier this year. Signature Analyst is a decision support system that delivers enhanced objectivity by discerning subtle yet powerful and actionable insights, maximizing likelihood of success. Combining predictive analytics with spatial information, as well as human terrain and social networking elements, Signature Analyst delivers effective consequence modeling and improved confidence in decisions for a range of global operational and business challenges.

The goal of implementing these new technology systems is to stay ahead of the threat. It's about preventing another 9/11 disaster—being able to pre-empt and disrupt the plans of those with nefarious intent who would do us harm. It's about trying to get ahead of the curve. Information fusion and distillation make achieving that goal possible.

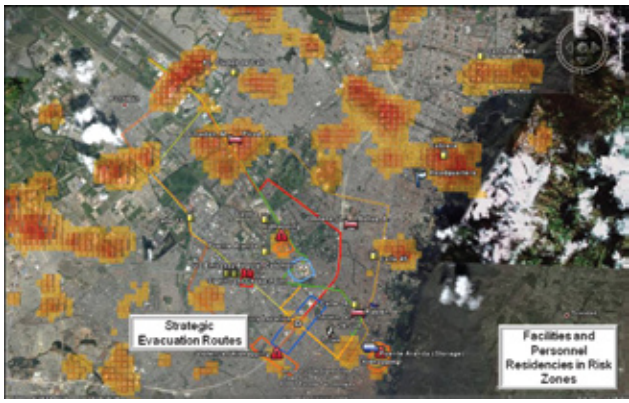

FIGURE 2

By analyzing a wide variety of multi-variate data sources, each with their own relationship to environment, predictive analytics systems can help teams better understand the tactics, techniques and procedures of adversaries to enhance situational awareness and mitigate risks of all kinds. For example, this sample map generated by SPADAC's Signature Analyst tool illuminates hotspot areas that are geospatially similar to locations where past events of interest have occurred, allowing decision-makers to better anticipate threats and respond accordingly.

INTELLIGENCE TO PREPARE AND RESPOND

Computer technology can be used not only to visualize, interpret and filter, but also to help prepare and react to occurrences.

Even for intelligence preparation for the environment, spatial intelligence technology can be used to develop relevant, effective operational and tactical plans to help visualize the battlefield and develop the course of action prior to ever leaving the briefing room. When preparing for the battlefield, whether it is a city block, mountain terrain or jungle, we can develop a 3D model of locations, identify

what could happen, determine distances for escape routes, identify speed limits, assess how quickly vehicles can move across any given terrain, and more. All these predictive analytics can help even a relatively small operation be more successful, particularly those involving discrete teams of the special operations community who depend on information to ensure relative superiority over their typically larger adversaries.

Of course, this technology is equally valuable in assessing various forms of risk for non-military applications. For example, if a commercial or governmental organization were considering building a factory in Bogota, Colombia, that organization would need to complete an analysis of personnel and asset protection risk, based on their chosen location (see ***Figures 1 and 2***). In this example scenario, to understand the potential threats, a wide variety of disparate data would be identified as relevant, correlated and ingested to provide decision makers with actionable intelligence on the status of risk. Data that might be included in such an analysis may include incidents of kidnappings, car bombings or other criminal activity in the surrounding area, potential choke points in roadways that would hinder escape routes, and other environmental factors.

EVOLVING NEEDS DICTATE INCREASED FUNDING

As the nature of armed conflict and administrations change, demand will continue for cutting-edge Information Warfare initiatives and programs in the intelligence arena, including geographic information service (GIS) requirements as part of the Information Warfare landscape. Tremendous opportunities for innovative technology companies will abound in this field. Beyond the battlefield, GIS and related technologies and solutions also bring great value to civilian and commercial applications.

As funding has grown in this niche, the solutions and technology supporting the Information Warfare era have continued to evolve. The critical nature of Information Warfare makes it relatively immune to funding reallocation. Even if we have an aggressive defense funding cut, the area of Information Warfare should continue to increase.

Unlike jeeps or tanks—hardware required to support the forward warfighter—Information Warfare technologies are capable of fighting adversarial networks. When the right solutions and tools are implemented to allow teams to apply resources more surgically, to better position troops and equipment, and to help increase overall safety, the ability to minimize the loss of life or injury can create a significant return on investment.

Currently, appropriations supporting this segment are hard to quantify because the services and solutions that support Information Warfare strategies run throughout a cross-section of the federal government's budget. While the overall segment is still very minor compared with overall defense and civilian total budgets, a ceiling in the future is unlikely.

WHAT THE FUTURE HOLDS

We've seen the efficiencies that result from predictive analytics tools, and we've been working to fill in the gaps. For example, we've been exploring solutions that are predictive in nature, such as location analysis and timeline analysis. We're also looking at unique solutions involving changes and patterns in time. Going forward, we will see those types of functions and technologies becoming more and more mature.

Technologies that can connect to databases to find non-obvious relationships are also becoming more and more valuable. As the quantity of information available to digest continues to build, computer technology will catch up. Already, the technology we're creating today is ingesting data in ways we couldn't have imagined 10 years ago.

For example, tools for collecting data are going to continue to increase in quantity and functionality. As a result, we'll likely see more collective device types, leading to more information we can cross-correlate for rapid non-obvious relationship discovery.

Also, there's a new generation of soldiers who are digitally friendly today. Let's face it: most soldiers have iPods in their flak jackets and laser i-sights on their weapons. More intelligence tools are being forward deployed every day, and that will continue, whether to soldiers in the field, to law enforcement in the city, or to safety workers during natural disasters.

Ultimately, therefore, the future technologies will be tools that can be used by smart users—a broader group of users that will include even the warfighters themselves. There still won't be any magic buttons you can press to solve all problems or answer all questions automatically. However, the tools will do more of the heavy lifting and filtering for the subject matter experts and analysts, enabling analytical success through faster, more efficient data processing, information location, and knowledge discovery. There is still no way to replace that human factor, but we'll take tools another step further, making them more user-friendly and creating new form factors (dashboard or GUI interfaces) that enable use of complex information technology with minimal training.

ASKING THE RIGHT QUESTIONS

The questions to be asked in developing future technologies for these tech-savvy individuals and groups will be more like these: "What do they need?" "How forward does it need to be?" "Which part of the solution needs to be done from D.C.?"

Opportunities for small businesses to play an important role to address certain deficiencies in existing systems and to come up with solutions will continue to be significant. SPADAC, for example, is working with an outstanding cadre of intelligence, defense, civilian, and commercial organizations to develop the most advanced tools available today. We look forward to continuing to help those and other organizations move the technologies and solutions within the Information Warfare segment further into the future. ≪

Weather + Climate
Communities Bring Transition Document to Next Administration

Hurricanes Gustav and Ike, like other natural disasters in recent years, demonstrated both the nation's progress and its shortcomings with regard to predicting, preparing for and responding to severe weather and a changing climate.

The track forecasts issued by the National Weather Service's National Hurricane Center for both Gustav and Ike were fairly consistent and, as it turned out, quite accurate. The result was adequate advance warning for those who would find themselves in the path of these storms.

On the other hand, meteorologists were much less confident in their predictions of storm intensity at landfall. Forecasts fluctuated from Category 1 (74-95 mph winds) to Category 4 (131-155 mph), which translated into significant swings in anticipated damage and overall impacts.

Coincidentally, these two devastating and deadly storms ravaged the Gulf Coast just weeks after the University Corporation for Atmospheric Research released its report, "Advice to the New Administration and Congress: Actions to Make our Nation Resilient to Severe Weather and Climate Change."

Developed by UCAR together with seven other organizations, the so-called "transition document" is intended to provide guidance to the next administration and Congress. Implementing the report's recommendations would cost an estimated $9.8 billion more than what the nation is currently planning to spend in five specific areas of concern:

1. OBSERVATIONS

"Fully fund the Earth observing system from satellite and ground-based instruments as recommended by the National Research Council," the report advises. "Observations from both space and the ground are key to monitoring climate and weather variables and developing climate and weather models. These observations will be essential in monitoring the progress and success of any carbon emission reduction initiative (e.g., cap-and-trade)."

The cited NRC recommendations are those included in its 2007 study, "Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond," ("The Decadal Study") which identified 17 satellite missions necessary over the next decade to ensure continuity of existing observations, and those expected in "Observing Weather and Climate From the Ground Up, A Nationwide Network of Networks," a study scheduled for an October release.

The transition document estimates the recommended satellite missions would cost almost $3.7 billion between 2010 and 2014, with cost estimates for the needed ground-based instruments yet to be determined.

John Snow, co-chair of the Weather Coalition, a group that advocates on behalf of the private, public and academic sectors of the weather community, emphasized the importance of observations during a media teleconference about the transition document.

"The first step in understanding the climate system is to really do a better job of observing both the atmosphere and the ocean," said Snow, who is also dean of the College of Geosciences at the University of Oklahoma and director of the Oklahoma Weather Center. "We have a good understanding, we think, of what needs to be measured. We have some idea of the technology needed to do it. But to deploy a global observing system of the scale that we need to make the observations is essential. We have to do that to be able to actually use the computers wisely."

Improved observations of the ocean are critical for better understanding and for predicting weather and climate, according to Robert Gagosian, president of the nonprofit Consortium for Ocean Leadership.

"Our ability to accurately predict the path and intensity of storms, so that communities can adequately prepare for these events, requires significant investment in ocean science, access to data though observatories, and computational infrastructure for modeling," Gagosian said. "The ocean is the missing piece of the climate equation. The ocean holds and transfers vast amounts of heat, carbon and water across the globe. Better understanding of these circulation patterns and sea-atmosphere exchange processes are essential for understanding and predicting global and regional climate systems."

The report recommends nearly $2.1 billion in ocean-observing initiatives between 2010 and 2014.

2. COMPUTING

"Greatly increase the computer power available for weather and climate research, predictions, and related applications," reads the transition document's second recommendation. "Current climate models do a reasonable job of providing useful information at the global level, but most climate change and severe weather impacts will be managed at local and regional levels (e.g., public health and safety, water and ecosystem management, energy production and use, food production, transportation services, recreation opportunities, military readiness)."

Most of today's computer models can only simulate climate changes on scales as small as around 100 kilometers, according to Snow.

"Right now we're dealing at resolutions of hundreds of kilometers, which really just barely resolves the Rocky Mountains. What we would really like to be able to do is run numerical models of the future climate at scales of tens of kilometers so we can pick up important terrain features and are able to see the level of detail so

FIGURE 1

Hurricane Ike in a photo from Sept. 10, 2008 that was downlinked by the crew of the International Space Station, flying 220 statute miles above Earth. The center of the hurricane was near 23.8 degrees north latitude and 85.3 degrees west longitude, moving 300 degrees at 7 nautical miles per hour. The sustained winds were 80 nautical miles per hour with gusts to 100 nautical miles per hour and forecast to intensify. Photo Credit: NASA.

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we can answer people's questions at the county and state level," he said.

The report notes that there are existing computers capable of resolving the desired level of detail, "but the climate community does not have enough access to them to meet the demand of modeling climate at these local and regional scales."

The report recommends more than $7.2 billion in upgrades to climate and weather supercomputing between 2010 and 2014, with the funding going to the nation's four primary climate modeling agencies—the National Science Foundation, NOAA, NASA and the Department of Energy.

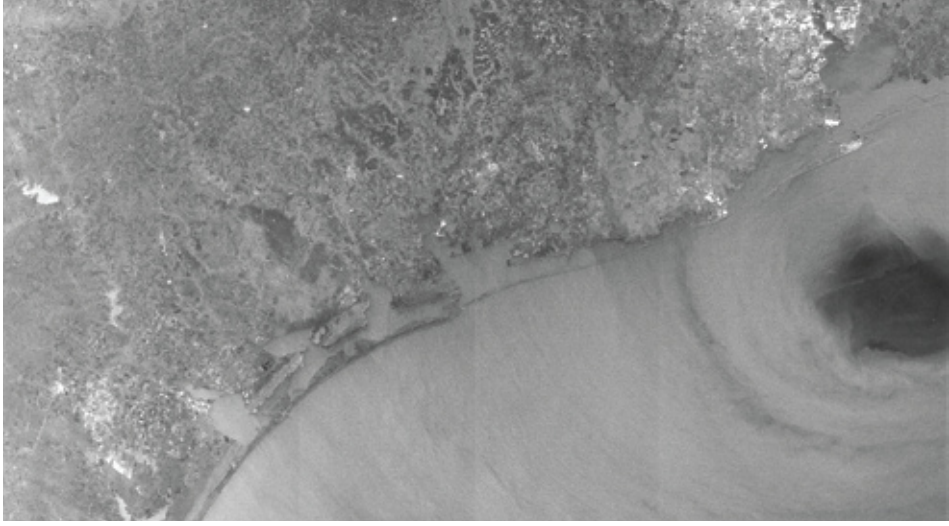

FIGURE 2

Satellite image of Hurricane Ike captured on Sept. 13, 2008 one hour prior to landfall in Galveston, Texas. Diameter of the eye is 75 km. Image courtesy of ESA, 2008, captured and processed by CSTARS/UNIVERSITY OF MIAMI under license from Eurimage.

3. RESEARCH AND MODELING

"Support a broad fundamental and applied research program in Earth sciences and related fields to advance present understanding of weather and climate and their impacts on society," reads the report's third recommendation. "We don't start from zero—the U.S. Global Change Research Program (USGCRP) and the Climate Change Science Program (CCSP) provide a substantial base of funding to work from."

The CCSP, an outgrowth of the USGCRP, coordinates research on climate and global change among 13 federal agencies. The base annual funding for the CCSP, expected to be around $1.9 billion in 2009, must be continued through 2014, the report recommends, and accompanied by approximately $2 billion in additional funding between 2010 and 2014 in order to improve knowledge of Earth's past and present climate, reduce uncertainty in climate projections, understand the impacts of climate change on natural and human systems, and explore abilities to manage risks and opportunities that climate change may bring about.

Jack Fellows, UCAR's vice president for corporate affairs, explains the importance of funding research and modeling activities. "Local and regional decision makers continue to move forward with climate-related planning with inadequate information and in the face of substantial climate feedback uncertainties that may prove very costly to civilization," Fellows said.

4. SOCIETAL RELEVANCE

The fourth recommendation states, "Support education, training, and communications efforts to use the observations, models, and application tools for the maximum benefit of society... We need to support programs that teach children at an early age to collect, analyze, and apply data to pressing environmental problems in a way that will help develop the next generation of environmental leaders. We also need to equip emergency managers and other public and private officials with the needed tools and information to make local and regional decisions."

Climate change is a particularly effective hook to attract young people to science and engineering, according to Nancy Colleton, executive director of the Alliance for Earth Observations, one of the report's sponsoring organizations.

"The topic of climate change is of great interest to students and has tremendous potential to draw them into science and engineering careers like never before," Colleton said. "This is a generation that is concerned and wants to do something about it."

5. LEADERSHIP AND MANAGEMENT

"Implement effective leadership, management, and evaluation approaches to ensure that these investments are done in the best interest of the nation. Strong, qualified leaders must be appointed to top policy positions," reads the report's fifth recommendation. "Most important, an experienced and knowledgeable leader coordinating the overall federal effort should report directly to the President."

Specific recommendations include revising the management structure of the CCSP, optimizing the role of the Office of Science and Technology Policy, creating an Earth system agency, and developing a comprehensive strategy to transition NASA research satellites into operational NOAA weather and climate satellites.

As part of the document's release, UCAR and the report's other sponsoring organizations are soliciting nominations for weather and climate leadership positions in the next administration, and plan to share the names of those nominated with the next administration.

On the international scale, the transition document urges the United States to remain involved in the Global Earth Observations System of Systems, an effort to integrate observations of the Earth collected by countries and organizations around the world. «

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RADARSAT-2

A VITAL NEW SOURCE OF GLOBAL GEOSPATIAL INTELLIGENCE

In December 2007, MacDonald, Dettwiler and Associates Ltd. (MDA) launched RADARSAT-2, which provides the world's most advanced commercially available C-band radar imagery. MDA is a key supplier of high-value conventional and operational small satellite missions for public and private customers around the world and innovative solutions for multiple geospatial intelligence applications. The company integrates commercial satellite data into defense and intelligence systems, from strategic command applications to in-theatre support for the warfighter.

The company's heritage as a space mission prime contractor has involved the development of several world firsts, including Anik-C, the first direct broadcast satellite; MSAT, the first mobile communications satellite; and RADARSAT-1, the first commercial remote sensing synthetic aperture radar (SAR) satellite. MDA also launched five small satellites, RapidEye, in August 2008. See story on page 19.

RADARSAT-2 is a multi-polarized commercial C-Band SAR satellite serving a follow-on mission to RADARSAT-1. RADARSAT-2 is a powerful tool for collecting global geospatial imagery through cloud cover and darkness. With more than 50 imaging modes, polarimetric options, and huge data volume collection capacity, the near-real-time mission is operationally scalable, with a ground segment that fits into the existing U.S. government infrastructure requirements. See ***Figure 1*** on page 40.

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The Canadian Space Agency and MDA developed a unique public-private partnership to create the RADARSAT-2 mission. MDA designed and built the satellite and ground segment and is responsible for the overall operation of the seven-year mission. The Space Agency's investment in the program will be recovered through the guaranteed delivery of data products for a wide range of Canadian government agencies.

RADARSAT-2 ensures the continuity of all RADARSAT-1 imaging modes. It has an extensive range of new features that improve resolution, polarization selection, tasking and data delivery. Significant improvements include a state-of-the-art phased array SAR antenna composed of hundreds of miniature transmit-receive modules. The antenna can be steered electronically over the full range of a swath and switched instantaneously between operating modes. See ***Figure 2*** on page 40.

RADARSAT-2 is an important new data source of global geospatial intelligence. It offers very specific capabilities, the advantages of multi-polarized SAR, and applications of its specialized image products for defense and intelligence communities.

POLARIMETRY: INCREASING THE DENSITY AND ACCURACY OF GEOSPATIAL INFORMATION

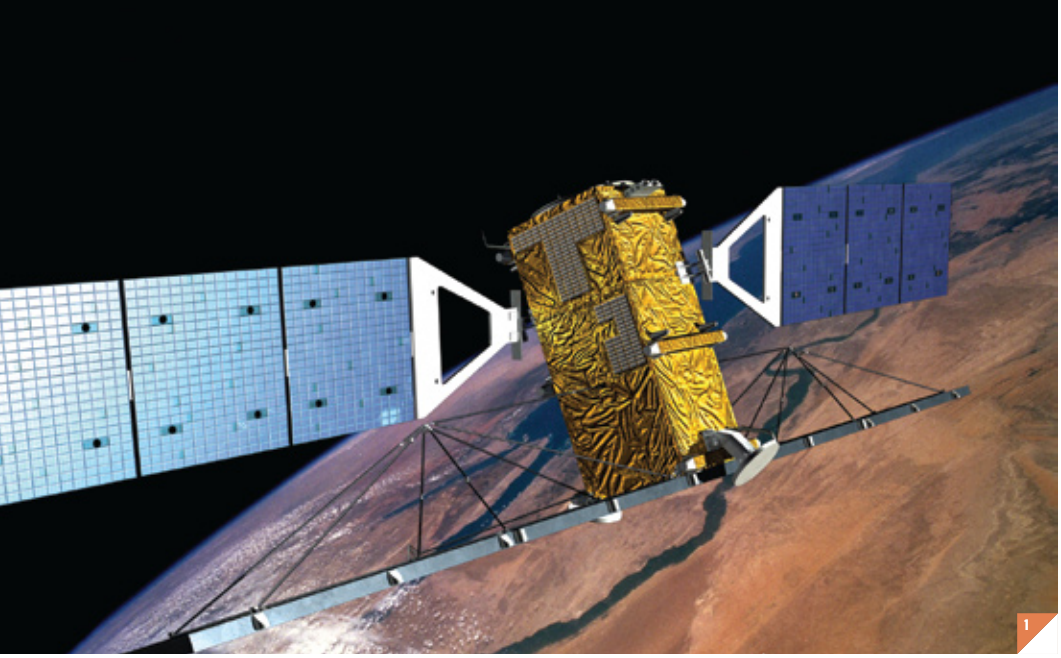
SAR polarization refers to the orientation of the radar beam relative to the Earth's surface. RADARSAT-2 can send and receive radar waves in both Horizontal (H) and Vertical (V) polarizations to produce co-polarized signals (HH and VV) and cross-polarized signals (HV and VH).

RADARSAT-2 is the first commercial high-resolution SAR satellite to offer quadrature polarization (Quad-Pol) capabilities, effectively four different polarization channels per image, to produce fully polarimetric datasets (HH, HV, VV and VH). Quad-Pol data retains both the amplitude and phase information of the radar waves, and the relative phase between the channels is also measured. RADARSAT-2 can image with Selective Polarization (HH and HV) or (VH and VV), Single Polarization (HH), Quad-Polarization (HH, VV,

FIGURE 3

The east coast of Greenland and the northern end of the Sermilik fjord are shown here from December 18, 2007, in the first RADARSAT-2 Standard Quad-Pol image, four days after launch. It is a composite of the three radar data channels (HH, VV, HV) displayed in a red-green-blue colour scheme. The scene is ~25km x 50km, with 25m nominal resolution.

The Fenrisgletscher glacier—a large, slow moving valley glacier that feeds into the Sermilik fjord—is visible in the upper right corner of the image. Glaciers in this area produce large volumes of icebergs that flow out to sea. In the fjord, variations in colour represent different types of sea ice and leads (open water). The use of polarimetric data greatly improves ice edge detection and the identification of ice types as well as increasing ice topography and structural information. The information provided can be used for ship navigation, and land/sea ice studies such as the position of glacier termini to support environmental monitoring.



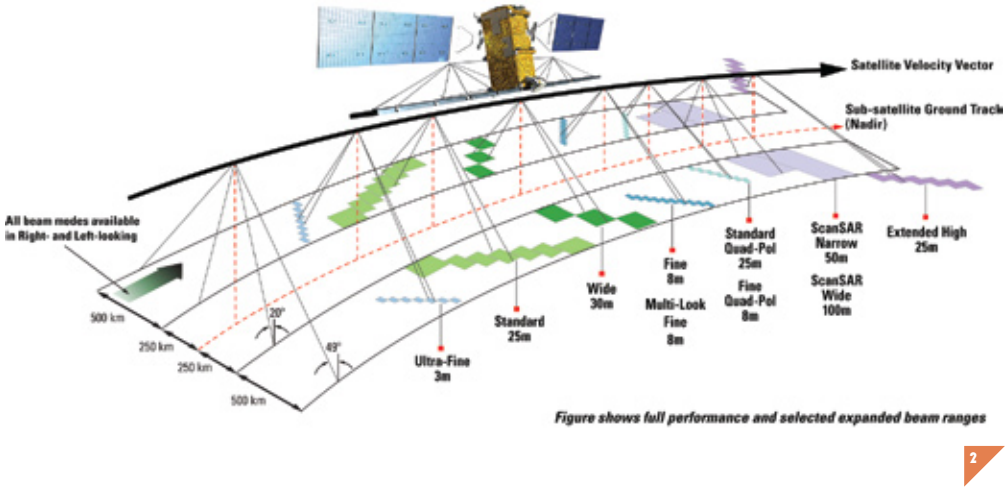


Figure shows full performance and selected expanded beam ranges

FIGURE 1
RADARSAT-2 was launched in December 2007.

FIGURE 2
RADARSAT-2 imaging modes and ground resolution

HV, VH), or Selective Single Polarization (HH, HV, VH, VV). ***Figure 3*** shows the first Standard Quad-Pol image from the satellite, four days after launch. The information in a Quad-Pol dataset greatly improves the ability to characterize physical properties of objects and to retrieve bio- or geophysical properties of the Earth's surface.

FASTER TASKING, MORE BEAM MODES

Improvements in tasking, collection, and dissemination make RADARSAT-2 a powerful surveillance tool. RADARSAT-1 tasking lead time for data acquisition was measured in days; with RADARSAT-2, it is measured in hours. Optimized space and ground systems focused on responsiveness to users places RADARSAT-2 at the forefront of commercial mission TCPED (Tasking, Collection, Processing, Exploitation and Dissemination) levels.

The left- and right-looking capability of the satellite increases its revisit time for Wide Area Surveillance, and the new high-resolution and polarimetric beam modes can provide an effective countermeasure to traditional denial and deception (D&D) techniques, such as camouflage or decoys.

ACTIONABLE GEOSPATIAL INTELLIGENCE FOR DEFENSE

RADARSAT-2 can play a vital role in multi-sensor surveillance programs for defense and intelligence applications. Its ability to perform regardless of weather conditions or time of day makes it a reliable source of geospatial intelligence for defense applications. Decision makers can receive actionable intelligence products within hours of downlink. The rapid revisit schedule and responsiveness to time-sensitive operations are also important.

The U.S. government has been using data from the RADARSAT family of satellites for 13 years. In that time, RADARSAT missions have established themselves as a trusted and proven source of powerful near-real-time surveillance products.

RADARSAT-2 is an exciting new source of geospatial intelligence for defense users. It offers a broad suite of applications, utility, and flexibility that can be readily integrated into existing U.S. government infrastructure. As the prime contractor for the mission ground segment and the supplier of the U.S. Air Force Eagle Vision transportable multi-satellite ground station, MDA can rapidly enable delivery of RADARSAT-2 imagery to all levels of the American defense and intelligence communities.

The recent successful completion of the U.S. Air Force/MDA space radar Tandem Mission Demonstration Program conclusively demonstrated RADARSAT-2's operational responsiveness, inter-operability, and warfighter utility for a broad range of Department of Defense and intelligence community users. During the first half of 2008, MDA provided roughly 5,000 RADARSAT-2 data products in support of a broad range of terrestrial and maritime applications across both the intelligence and warfighter communities. These included

PGM (Precision Guided Munitions) targeting, Indications and Warning, broad area Coherence Change Detection, and Maritime Domain Awareness.

ADVANCED GEOSPATIAL INTELLIGENCE PRODUCTS

RADARSAT-2 data can be delivered as raw imagery or as an Advanced Geospatial Intelligence (AGI) product. AGIs are derived from a single SAR image or multiple SAR images that can be single, dual, or quad-polarized, across the range of available resolutions. The information content of the image comes from computer-based algorithms that usually require some form of operator intervention. An AGI product may be considered as a tactical decision aid if the TCPED cycle occurs within hours. In contrast, if the TCPED cycle occurs within days, the AGI product would be a strategic decision aid.

An AGI product may entail quantitative information derived from the image or may be an annotated product containing end-user relevant features and targets. Examples of AGI products for selected defense and intelligence end users include:

- **Air Force:** Target product showing precise target locations; digital elevation models to support mission planning
- **Navy:** Ocean features product for operational oceanography
- **Army:** Terrain mobility product depicting land classes; coherence change detection or polarimetric change detection for situational awareness
- **Marine Corps:** Coastal-zone product to support amphibious operations

Expanding on these applications, here are several detailed examples of RADARSAT-2 utility:

Surface Moving Target Indicator

RADARSAT-2 has Surface Moving Target Indicator (SMTI) capability that uses along-track interferometry techniques to estimate the range-direction speed of moving objects. The SMTI information product indicates the estimated speed of detected targets in both terrestrial and maritime environments.

Open Ocean Surveillance

The Open Ocean Surveillance (OOS) value-added product is for ship detection, providing accurate estimates of ship length and direction. Ship class may also be estimated depending on the RADARSAT-2 image mode and resolution. Powerful algorithms automate the production of ship detection information products, requiring limited operator intervention. Rapid production and accuracy create domain awareness in support of naval operations.

Maritime Domain Awareness

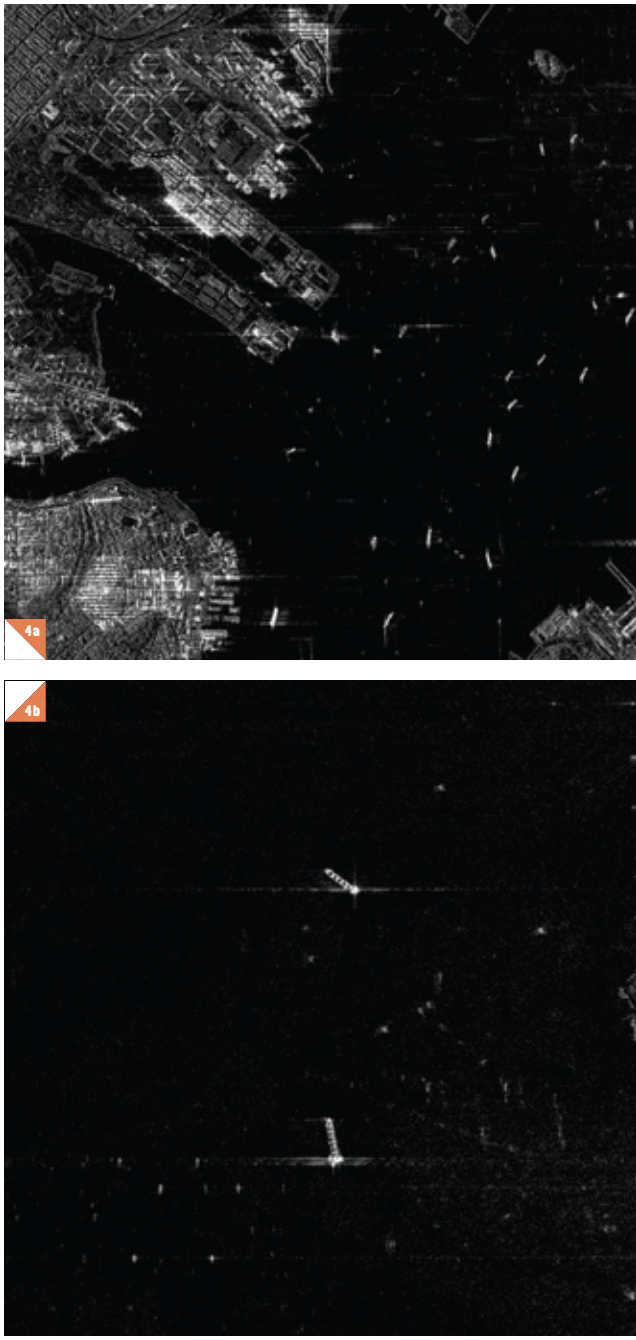
RADARSAT-2 data has significant potential to play a key role in support of international Maritime Domain Awareness. Drug transport corridors and illegal vessels typically transit open ocean, avoiding areas that are known to be regularly and accurately monitored by traditional methods and sensors. Detection and interdiction of illegal vessels relies heavily on a wide range of sensors and platforms used in an effort to track suspected targets from their point of origin to their destination.

SAR imagery from RADARSAT-1 has advanced the ability to monitor the world's oceans, particularly in the areas of ship detection, oil spill monitoring, and ocean wave surveillance, as it provides a direct measurement of the surface wave field.

The two basic approaches used for ship detection are detection of the wake signature, and detection of the ship target itself. RADARSAT-2 not only provides continuity to RADARSAT-1, but also offers specific improvements for ship detection applications such as the dual polarization modes that are available in all RADARSAT-2 beam modes.

This improvement expands on research done using RADARSAT-1 (C-HH) and ERS (C-VV) SAR data. Results showed that ship-sea contrast is higher for HH polarization, making RADARSAT-1 suitable for target detection. The results also demonstrated that VV

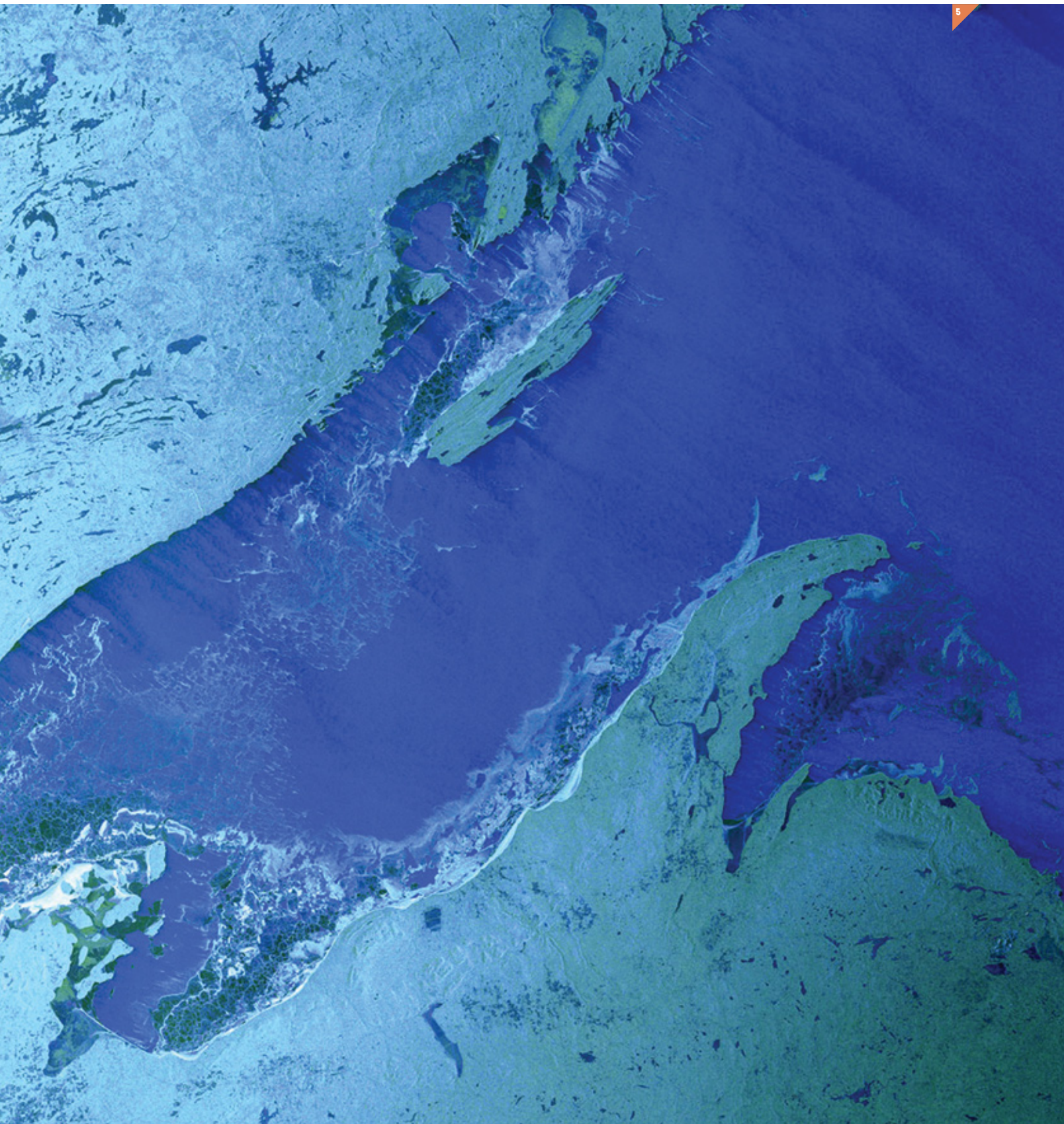
FIGURE 4
Ships in a busy port are readily detected and classified in this RADARSAT-2 image.



polarization provides more information about the sea state for improved detection of ship wakes.

RADARSAT-2's cross-polarized component (VH or HV) enables target detection at smaller incidence angles. The HH/HV combination provides optimized target detection over a greater range of incidence angles than RADARSAT-1, and the VV/VH combination provides both target detection (VH) and the ship wake analysis (VV).

RADARSAT-2's Ultra-Fine beam mode (3-m resolution) improves ship detection and, in combination with fully polarimetric (Quad-Pol) data, offers the potential for ship classification. ***Figure 4*** shows a port scene with ship detection and classification. Polarimetric data are not available on SCANSAR beam modes, which are best suited to ship tracking or to surveillance of regions with limited spatial extent such as small bays and harbors.



RADARSAT-2 complements existing shore-based radar and airborne approaches to monitoring for detecting ships, as well as existing homeland defense and law enforcement doctrine.

A multitude of unmanned aerial vehicles (UAVs), manned aircraft, and optical space sensors would be needed to cover the RADARSAT-2 satellite transit area. The Wide Area Surveillance coverage capability of RADARSAT-2 is an ideal complement to existing persistent surveillance programs employing conventional platforms and sensors. See ***Figure 5*** showing Wide Area Surveillance coverage of Thunder Bay.

Change Detection

RADARSAT-2 is well suited to collecting imagery for detailed change detection. Whether coherence, amplitude, or subsidence change detection, the millimeter elevation accuracy of RADARSAT-2 interferometry provides analysts with access to even the most subtle of environmental changes.

Land Target Detection and Classification

RADARSAT-2's active sensor and multiple beam modes are well suited to target detection and classification. Combined with the superior change detection capabilities and high revisit cycle, an unparalleled volume of current, accurate information of global activities is now accessible to defense and intelligence users.

GLOBAL HRTI-3 DEM POTENTIAL

SAR imagery has some significant advantages over conventional optical satellite imagery, because the active sensor can image in darkness and through heavy cloud cover. It is also well suited to rapidly collecting and deriving detailed terrain information on a global level for the creation of high-resolution digital elevation models (DEMs).

MDA has been working with the U.S. Air Force on a rigorous evaluation of RADARSAT-2 imagery for the purpose of creating a global DEM to HRTI-3. Previously thought to be little more than an objective for the future, the results have shown that a tandem mission combining RADARSAT-2 and a quick-to-launch clone satellite are more than capable of such a feat, with quality and accuracy levels far exceeding the current baseline SRTM (Shuttle Radar Topography Mission) dataset. See ***Figure 6*** for contrast between SRTM data and RADARSAT-2.

To date, MDA has supplied more than 5,000 RADARSAT-2 images to the U.S. Air Force, where it has been evaluated for interferometric potential (DEM creation), wide-area surveillance, change and target detection, intelligence, mapping, and subsidence. Results and user feedback have been very positive.

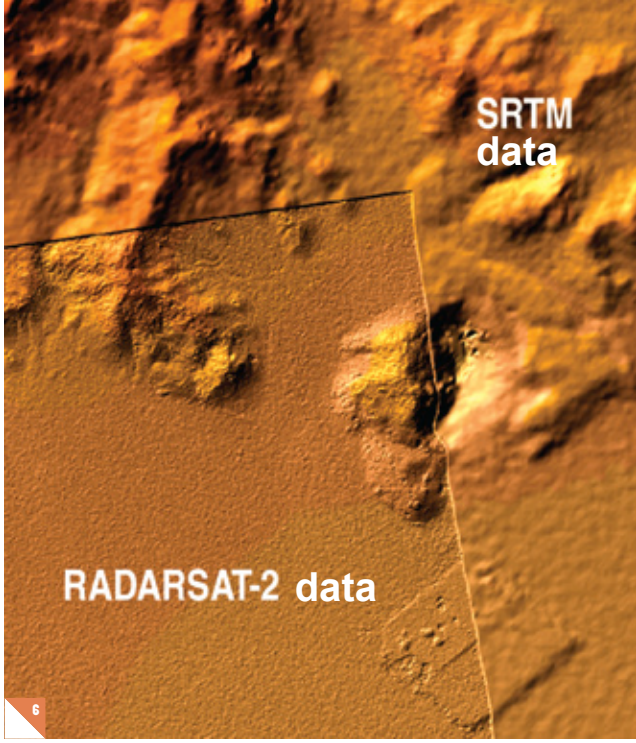


FIGURE 5

Thunder Bay, Ontario, Canada, RADARSAT-2 ScanSAR Narrow B with dual polarization (Transmit VV; Receive VH; R:VH G:VH B:VV), taken March 3, 2008.

Widespread ice that has formed on the western edge of Lake Superior can be seen in this colour composite view of the RADARSAT-2 data. ScanSAR Narrow B is well suited to the detection and classification of ice and is used operationally to monitor ice formation and movement in the great lakes due to its large footprint (300 km in width - can cover several hundreds of kms along track) with very good resolution (50m) and frequent revisit (1-2 days at this latitude).

This image also appears on the cover.

FIGURE 6

This image illustrates the difference between RADARSAT-2 and SRTM interferometry.

RADARSAT-2 was developed with input from operational defense users, and as a result, it has an exceptionally responsive TCPED cycle—a critical factor to consider when merging commercial imagery into defense and intelligence workflow. The mission's flexibility, access, capacity, and imaging capabilities point to the creation of a next-generation global DEM that raises the level of our ability to understand and model the entire planet in the digital domain.

RADARSAT-2 is the world's most advanced commercial SAR mission. It has been designed expressly for high-throughput operational geospatial intelligence users. Its staggering data collection capacity, flexible imaging modes, information-rich data, and unmatched TCPED cycle position it at the forefront of commercial satellite missions for modern defense and intelligence applications. MDA's space and ground segment experience, and its ongoing work to meet changing requirements of defense and intelligence communities, are advancing the level of sensors, algorithms, infrastructure, and applications for next-generation maritime surveillance, target detection, tracking, classification, and change detection.

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5 years geoint symposia

NOAA Administrator Conrad Lautenbacher confers with fellow co-chairs and national representatives during the first ad hoc meeting of the Group on Earth Observations, August 1, 2003.

At a time when we should be thanking him for all that he has done, **HE GRACIOUSLY ACKNOWLEDGES OTHERS AROUND HIM.**

(continued from page 46)

had become very clear that Lautenbacher–the former vice-admiral who had once played the banjo on Hootenanny–would be key to leading the U.S., as well as other nations, to implement GEOSS.

No one would argue that much work remains to be done to realize GEOSS. Data policy, gaps in measurements, quality assurance, interoperability issues, science and applications priorities, and the role of the private sector are all issues that remain to be more fully resolved within the GEOSS context.

In the U.S., it is not clear who will fill Lautenbacher's role, whether a new administration will support GEOSS, and whether appropriate funding will be made available to fast-track the U.S. contribution to GEOSS. However, the potential remains strong for what a system of systems could deliver to society to better manage the planet.

Not surprisingly, Lautenbacher in his September 23rd message recognized the summit and GEOSS as one of NOAA's accomplishments. As he describes it, the accomplishment was "The initiation of the first-ever Earth Observation Summit, which led to the formation of the Group on Earth Observations (GEO) and the commitment of 75 nations and 51 international organizations, to build a Global Earth Observation System of Systems (GEOSS), without which, among other things, it will be impossible to monitor the viability and progress of any worldwide agreement to reduce green house gasses and mitigate global warming."

The establishment of GEOSS is, in itself, a great achievement, and yet Lautenbacher's legacy as NOAA Administrator goes even further and "raises the bar" for future NOAA Administrators. It will be extremely important for the next NOAA Administrator to possess attributes similar to those that Lautenbacher brought to the position–including management of operational programs, an understanding of how we might leverage defense capabilities to benefit the civil sector, and awareness of the need to move quickly with technologies to respond to global change. These skills will be important in meeting NOAA's future mission needs, such as establishing a national climate service and fielding and deploying integrated systems needed in the future.

Frederick Nordlund, former Washington representative for European Space Agency, recently spoke with me and said how he regretted hearing of Lautenbacher's resignation. He stated, "I don't think we have ever seen a NOAA Administrator like Lautenbacher. Not only did he do so much for NOAA, he did so much for the world. We will miss him."

Well said, Frederick.

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A Few Words in Honor of NOAA's Departing Administrator

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Last week's announcement by NOAA Administrator Conrad Lautenbacher that he is resigning effective October 31, 2008, wasn't much of a surprise to many of us, as we have been expecting it. But what was surprising is that not two minutes after receiving the general NOAA announcement, Lautenbacher followed with a personal message thanking his colleagues for their support during his tenure as undersecretary of commerce for oceans and atmosphere. He wrote, "It has been an extreme pleasure and privilege to serve in this capacity and I am most grateful for your support and interest during these years."

This gesture was vintage Lautenbacher, and, having had the honor to work with him on various projects since 2003, I shouldn't have been surprised. He has traveled thousands of miles representing the U.S. abroad and has endured much difficulty in transforming and raising the visibility of NOAA during difficult political and economic times. At a time when we should be thanking him for all that he has done, he graciously acknowledges others around him.

That act represents my first impression of him—an impression that has remained consistent these many years—that he is a leader of solid integrity and a true civil servant. Lautenbacher never put himself first and always approached his work with the highest level of civility, dedication, and enthusiasm.

When the U.S. hosted the first Earth Observations Summit in 2003, those of us involved in planning the activity were eager to see how it would be received internationally. The U.S. had just invaded Iraq four months earlier and the summit was being called by an unpopular administration that wasn't known for its environmental culture, that was openly criticized for not signing onto Kyoto, and that rarely used the term "climate change."

The first Earth Observation Summit was very successful. It attracted 34 countries and resulted in a declaration to move forward with an ambitious multinational effort to connect the world's disparate Earth and environmental datasets, which today is known as the Global Earth Observations System of Systems (GEOSS). However, the first meeting of the ad hoc working group on Earth observations, which immediately followed the summit, didn't occur without its challenges. Many national representatives came to the meeting suspicious of U.S. intentions and concerned about possible ownership of the system the country proposed. In addition, because of the popularity of the meeting, there were many more participants than expected, which created problems with logistics and general entry to the meeting.

In this environment of uncertainty, early frustration, language barriers, and misunderstandings, I witnessed Lautenbacher's skills as a leader, diplomat, and statesman. He quickly greeted European colleagues, noting how good it was to have so many people want to be part of the ad hoc group; he personally welcomed numerous national representatives by shaking hands, thanking them for their participation, and continually emphasizing the importance of multinational partnership. He also deferred to his co-chairs from Japan and the European Commission to move deliberations forward, ensuring that the U.S. was not seen as monopolizing the discussions.

By the meeting's end, two things had happened: 1) the attendees had evolved into a cohesive working group, reaching agreement on how to proceed; and 2) it

(continued on page 45)

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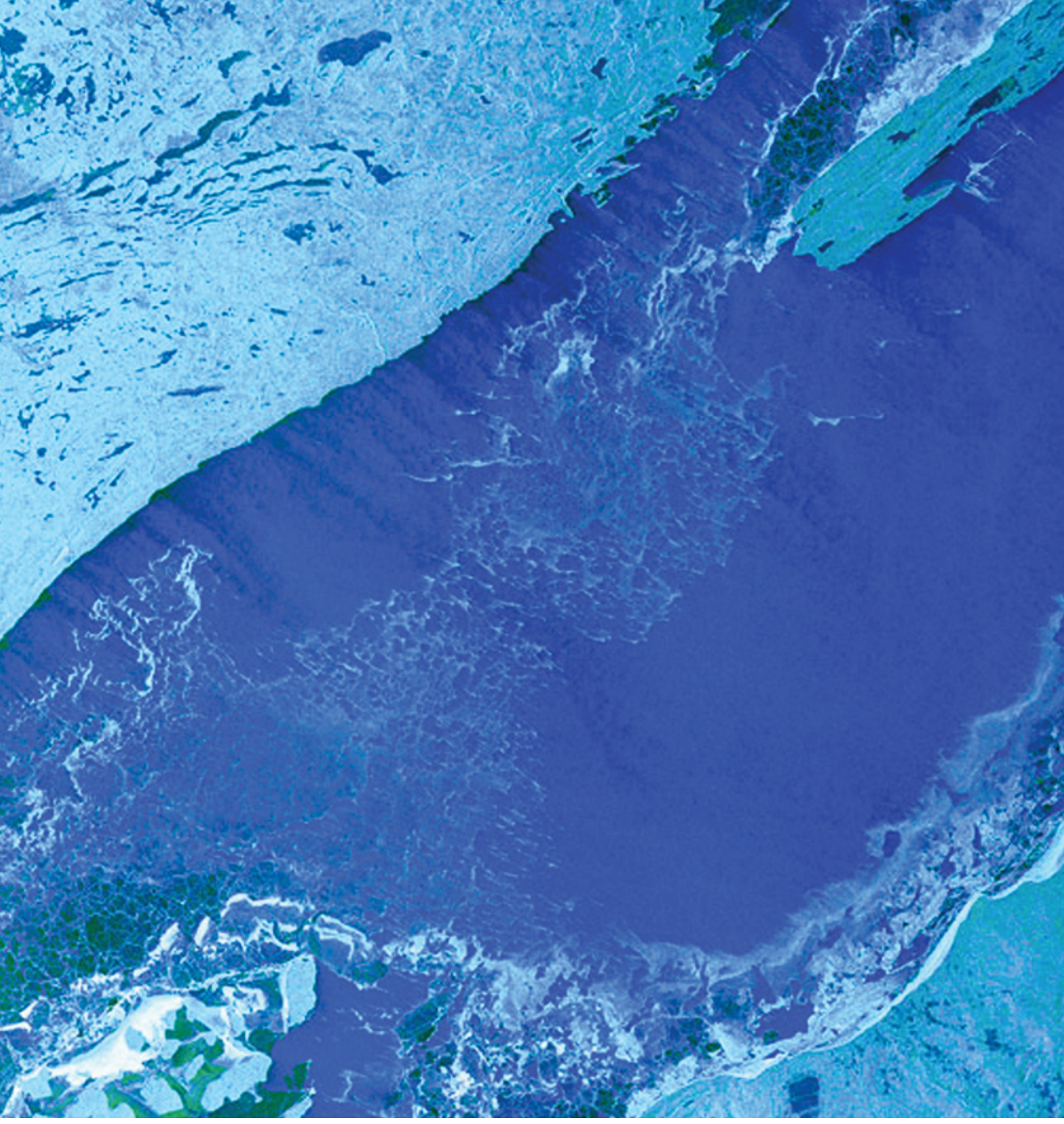

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