

THE CCRS QUICKLOOK SWATH BROWSER

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ABSTRACT

This paper presents the argument that there is an existing remote sensing data source that is being under-utilized in the form of browse data. This represents a large, on-line low-cost data source that could be used for scientific and non-scientific applications. In order to exploit this archive as an image source, a new user interface has been developed to query the browse imagery archive at CCRS that presents the imagery as a full swath containing all data collected in a satellite acquisition segment. Given easy access to this data, it can then be geocoded and combined to create continental or planetary scale mosaics and time-series. Some sample value-added image products derived from quicklook data are presented.

1 INTRODUCTION

While it is important for geomatics companies and commercial satellite operators to be profitable and serve their customers, it can be safely assumed that the general public will not pay current commercial rates for satellite remote sensing data and other geomatics data layers. Most freely available geomatics data sets consist of small-scale vector data or raster image mosaics of specific areas.

There exists a huge, and continuously growing, archive of low-resolution remote sensing image data that is readily accessible over the internet in the form of quicklook data from a variety of sensors. Quicklook data is produced primarily as a quality control tool for receiving station operators and as a catalogue image for users of the full resolution imagery products. It is currently viewed as a by-product of the image acquisition process with little intrinsic value. This paper presents the argument that quicklook data and value-added products derived from quicklook data are useful as imagery products in themselves.

To this end, a project was initiated at the Canada Centre for Remote Sensing (CCRS) to enable the exploitation of quicklook imagery as an image product. The objectives of this project are twofold:

- Provide a search and access mechanism to the browse imagery archive at CCRS that presents the quicklook data as image products.
- Demonstrate value-added products derived from quicklook imagery.

The target audience for this project is primarily the general public, however it is expected that scientific users, the education community and value-added service providers will also benefit from the outputs from this project. This market is distinct from the full-resolution imagery market and is potentially very large, and possibly uneducated in the field of remote sensing.

2 DATA CHARACTERISTICS

The advantages that quicklook data can offer are low cost, near real-time accessibility (subject to data policy restrictions), large quantities of archived data on-line and low data volumes, which implies rapid processing turnaround. The images are generally produced and recorded to disk during the acquisition process using real-time subsampling of the satellite downlink datastream. This means that the imagery can be viewed in real-time on a monitor at the receiving station as the data is transmitted to the earth. The data is available to be viewed remotely as soon as they can be transferred to a central database, although in practice a manual quality control or cloud cover assessment must be carried out beforehand.

The images are generally framed into roughly square scenes of approximately 500 pixels by 500 lines and radiometrically processed. Radiometric processing can include band selection, a linear contrast stretch or gamma function look-up table for viewing on computer monitors and image compression.

In scientific applications, the main disadvantages of using browse imagery are the low-resolution and the radiometric distortions due to compression and enhancement of the imagery. Low-resolution will always limit the information

content of the data to studying large scale features, since the information content is tied to the pixel resolution. It is possible for current and future quicklook processors to generate medium-resolution browse imagery that may alleviate this problem to some degree, however full-resolution imagery will always be required for studying features on the earth at a large-scale.

This does not mean that real information cannot be derived from low-resolution imagery. As an example, CCRS currently has an on-going operational program using outputs from the Geocomp-n system (Adair, 2000). This system produces vegetation indices, various radiation corrected products and forest fire masks for global change research, all of which use 1-km NOAA Advanced Very High Resolution Radiometer (AVHRR) data as input to measure continental scale forest health and carbon budgets. There are several other similar programs for studying global change research on a planetary scale (ESA, 2000; Goddard, 2000; USGS, 2000). Radarsat quicklook data should be useful for studying large-scale geological structures, in the same way that Magellan data of Venus was invaluable for studying the geology of Venus (Solomon, 1992). The imagery is useful in these cases only once it has been geocoded and assembled into a large area mosaic so that it may be tied to a particular location on the planet.

For some applications, loss of radiometric fidelity through lossy JPEG compression and radiometric enhancements may be acceptable. This includes the so-called "pretty picture" market, where an image is required for a poster, backdrop, background image layer in a GIS and so on. Again, it is possible for current and future quicklook processors to address scientific requirements by generating uncompressed imagery but with the resulting increased data volumes. In fact, such imagery is generally already produced in generating the browse images. It is this imagery which gets compressed and is only then transferred to the central database in order to minimize its impact on network bandwidth. It is anticipated that such imagery will be available in the future, perhaps through a privileged access mechanism or through e-commerce.

3 BROWSE IMAGERY DATA SOURCES

CCRS operates two satellite receiving stations: one in Prince Albert, Saskatchewan and the other in Cantley, Quebec. Quicklook imagery for all satellite data it receives has been produced since as early as 1983. Initially, the images were stored on microfilm and then in NTSC format on analog videodisk, and in digital format only since 1991 (Barkman, 1992). This represents a total data volume of digital products of 16 Gbytes, all accessible online. Browse data is generated and archived for the following satellites: Radarsat, Spot 1 through 4 (panchromatic and multiband HRV), Landsat 5 (MSS and TM), NOAA AVHRR 7 through 15. Landsat 7 ETM+ browse data generated at CCRS will be available in the spring of 2000. The breakdown of this data by satellite is given in Table 1 below.

Table 1 - CCRS digital browse statistics

Satellite	Quicklook imagery Date Range	Volume (Gbytes) As of 31/1/2000
NOAA AVHRR Satellites 6 to 15	July 1983 to present	1.9
Landsat 5	March 1991 to August 1999	3.9
Spot 1,2,3,4	April 1991 to present	7.9
Radarsat	April 1997 to present	2.4

There are many other similar resources offering low cost imagery on the Internet. A list of links to some of these sources will be available through the Swath Browser web page listed in section 4 below. There are numerous servers providing free vector data at a scale of 1:1 million and relatively few to provide raster imagery in the format described here. Most of these archives provide data for free, however user registration is required in some cases. One site of note is at the Centre for Remote Sensing and Processing in Singapore which describes a mosaic of South East Asia using ERS-1 and 2 browse imagery (Kwoh, 2000).

4 QUICKLOOK SWATH BROWSER

The main barrier to using quicklook data in real-world applications is the effort required to assemble enough data to make a useable image product, since each image covers a relatively small area on the ground. The current mechanism for viewing CCRS's archive of quicklook data is implemented as a scene-based catalogue (CCRS, 2000) that was designed for users ordering the full resolution image products.

An alternate user interface to the CEOCat database has been developed as a result of this project and can be found at the following URL:

<http://ceocat.ccrs.nrcan.gc.ca/quicklook>

This is a highly interactive, easy-to-use web interface for querying, selecting and downloading data from the CCRS browse imagery archive. It is supported under both Netscape 4 and MS Internet Explorer 4. Users must have JavaScript enabled in their browser. With JavaScript disabled, the user will still be able to perform searches and view the imagery, however certain interactive features of the web page are disabled, such as the overview map.

Key to this interface, is presenting the imagery to the user as a full swath that better represents the image acquisition process and provides large contiguous imagery datasets. Displaying the imagery as a full swath also gives the user better geographic context and it goes a long way to solve the problem of assembling large numbers of browse images to create a usable product.

An overview map is provided for locating the imagery on the earth. The user can zoom-in and out, select swaths and define the region of interest on this image with mouse clicks. The search interface allows searches based on geographic region of interest, dates, and various sensor parameters, such as satellite, imaging mode orbit number and cloud cover. Once the user executes the search, an outline of the resulting swaths are displayed on the overview map. The default search parameters are set such that if the user executes a search without modifying or entering any extra information, the resulting swaths will be the most recent acquisitions added to the database.

Also provided by the interface is a predefined collection of swaths in the "In the News" section. This list contains imagery from places around the world making recent headlines. Some examples of newsworthy events would be hurricanes, floods, earthquakes, wars, and so on.

The user can set various options such as the number of swath windows to be displayed at any one time, the maximum number of swaths to be returned for each sensor, a selection of overlays and so on.

The interface will eventually also allow for the gathering of auxiliary data inputs which cover the user's area of interest and user-selected swaths such as DCW vector data, DEM data from GTOPO30 and ephemeris. This will allow for further processing of the imagery by the user on his desktop. Metadata, or information about the data, will always be supplied since such information is essential for further processing of the imagery.

The interface relies on JavaScript for user interaction with the web page and for creating instances of various objects. As a result of this project, a reusable JavaScript GeoImage object has been created. This object gives access to geo-referencing information for geocoded images in JavaScript. It also allows for image overlays so that geocoded vector images may be superimposed on top of a base image layer. It is anticipated that the GeoImage object will conform to the specification of the Open GIS Consortium (OGC) for exchange and display of geographic images. Also, the swath itself is defined as a JavaScript object, although it's reusability is limited since it is defined for the requirements of this application.

The sensors to be supported are Spot HRV, Landsat TM, MSS and ETM+, Radarsat and NOAA AVHRR. Spot, Landsat and NOAA data is available over North America. Radarsat data is available from around the world since Radarsat has an on-board tape recorder which gives it the ability to capture imagery at any time in its orbit and later downlink the signal once it is over a receiving station.

5 DEMONSTRATION PRODUCTS

5.1 Geocoded swaths

Given easy access to quicklook imagery, the usability of the data can be improved through geocoding. This would allow for vector overlays to be generated and viewed on top of the swath itself (without resampling any raster image layers), as well as allowing for the swath to be resampled to a user specified map projection. The data volumes involved are moderate and manageable with current technology and given the low volume of data, processing time is minimal.

Geocoding of the imagery can be accomplished either manually using ground control points, or systematically without operator intervention using on-board ephemeris or a historical database of ephemeris. At this point, the geographic accuracy that can be achieved using systematic ephemeris is unknown and is an area for further research. However, since the resolution of the imagery is low, the geographic accuracy requirements are not as high as is the case with full-resolution imagery.

A whole range of potential applications is then possible where a large number of swaths could be assembled into spatial mosaics or time series. In this case, radiometric balancing between swaths must be carried out; however software tools exist to do this task.

Some applications where geocoded browse data might be useful are large scale (continental/planetary) mosaicking, disaster response or cross-sensor fusion. Non-scientific applications include the so-called "pretty picture" market where imagery is required for presentations, newscasts, posters, and so on.

Some preliminary examples are shown below. In Figure 1, a mosaic of Yugoslavia using Radarsat browse imagery was created. In Figure 2, a mosaic of the Indonesian Island of Timor using Landsat 7 ETM+ browse imagery is shown. The Landsat 7 data set was provided by the Eros Data Center through CEOCat. These samples were geocoded manually using ground control points collected from the VMAP level 0 vector database and resampled using the OrthoEngine software product from PCI Geomatics.

Users also have access to the full historical archive of quicklook imagery. This enables time series' to be assembled to portray small-scale earth phenomena with a temporal dimension. This could involve simple "before and after" images to more complex multi-frame sequences. An example of a work in progress is shown in Figure 3 (the images are not yet geocoded). This example shows the formation of an ice sheet near the Antarctic Peninsula in February and March of the year 2000.

Further examples of value-added products derived from quicklook imagery will be accessible from the Quicklook Swath Browser web page, as they become available.

5.2 Web Mapping

An emerging trend on the Internet is web mapping, where users can create customized maps from various data layers. There are numerous web servers offering geo-referenced data. A number of web mapping companies have been recently created, for example MapQuest, Delorme, Vicinity, MapBlast and Expedia, which offer free or for-fee mapping services. Many of these services generate maps from vector based data sources but there are very few remote sensing data layer sources.

A major obstacle to creating maps from various sources in the past has been the interoperability between data sources. In order to bring some standardization to geographic data on the web and to make the various data sources interoperable, the OGC was created in 1994 (<http://www.opengis.org/>) and is comprised of many of the major players in the web mapping business. Its mandate is to develop advanced open systems standards and techniques in the area of geoprocessing and related information technologies. Once fully implemented a user would be able to select any combination of layers, both vector and raster, from any number of physically disparate map servers and combine the results to produce a map tailored to the user's particular requirements. This represents an important step forward in realizing the "Digital Earth" concept advanced by Al Gore (Gore, 1998).

Browse data has the potential for providing imagery layers in this scenario where it has the distinct advantage of low data volume given the current wide area network infrastructure where a large proportion of Internet users are using modem technology for access. It is intended that the geocoded swaths will be available through an OGC map server in the near future.

6 CONCLUSION

A new interface to access an existing and ever growing archive of remote sensing browse imagery has been presented. It is hoped that a wide range of users will now have convenient access to remote sensing imagery that they might not have had otherwise. The value of the imagery can be improved further through geocoding and mosaicking of the data. It is anticipated that new and innovative applications for the imagery will be discovered as the data reaches the broader public marketplace.

An area for future work is to arrange for access to higher spatial resolution and non-radiometrically enhanced browse imagery, when such imagery is available. The potential applications of this imagery in scientific applications are numerous. This may represent an important new market for satellite data providers to capitalize on.

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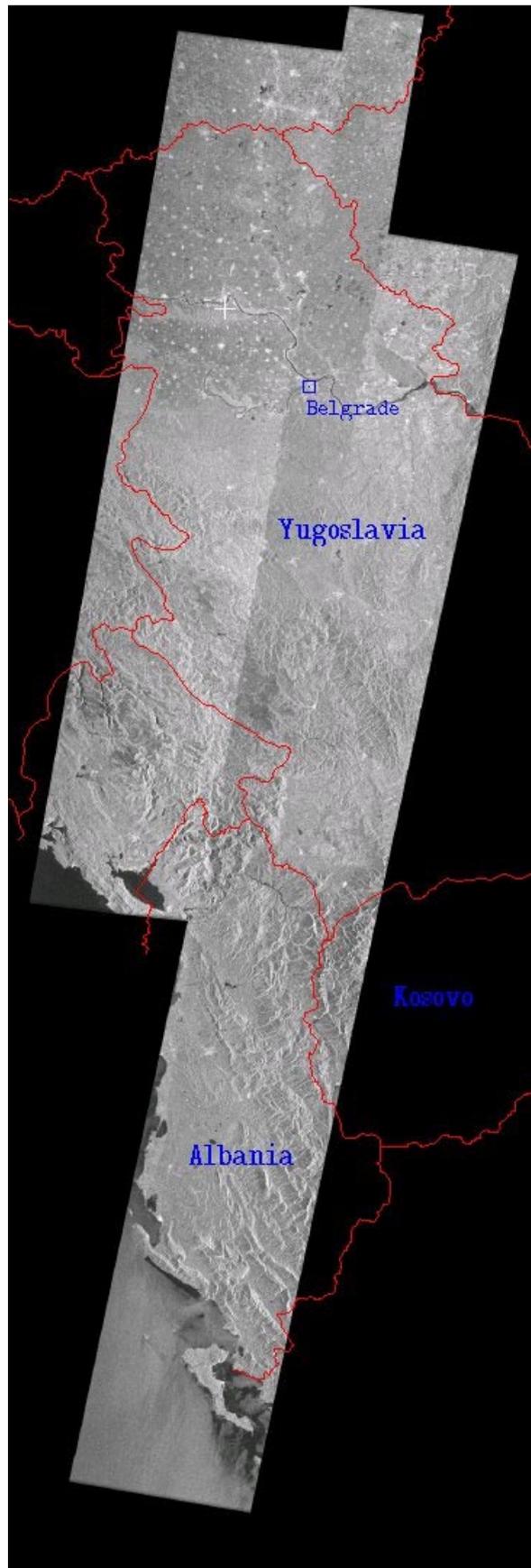


Figure 1 - Radarsat mosaic of Yugoslavia with vector overlay

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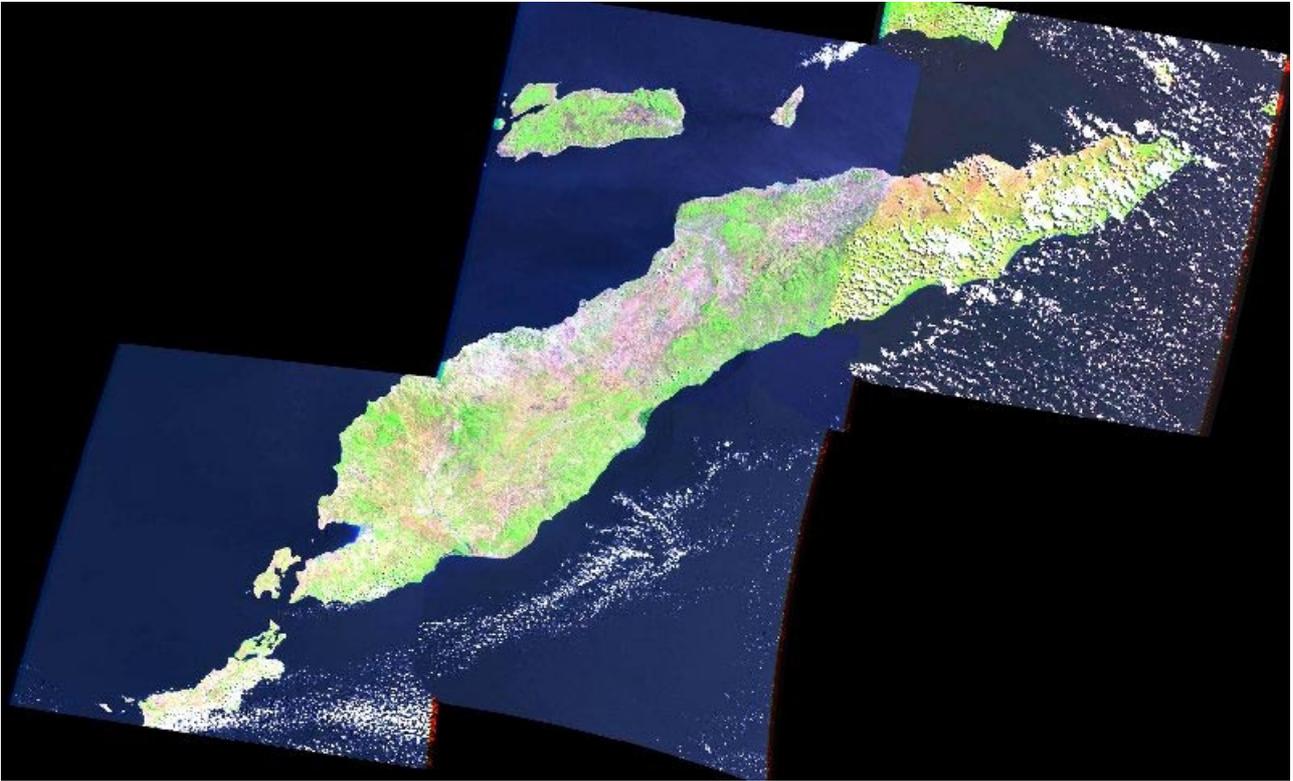


Figure 2 - Landsat 7 mosaic of Timor Indonesia, browse imagery from EDC

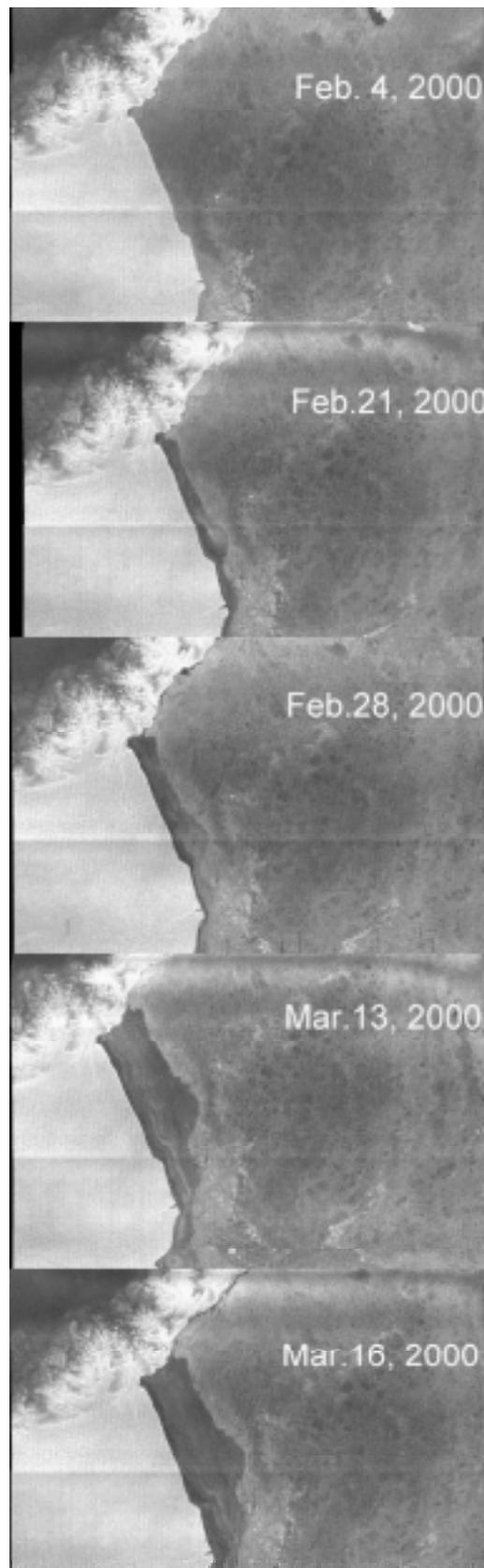


Figure 3 - Radarsat time series showing ice formation near the Antarctic Peninsula

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