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## **Browse Guidelines Document (BGD)**

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***CEOS***

***Working Group on Information Systems  
and Services***

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## **1. INTRODUCTION**

This document has been developed by the ad-hoc Browse Task Team in the Data Stewardship Interest Group (DSIG) of the Committee on Earth Observation Satellites (CEOS) [<http://www.ceos.org>] Working Group on Information Systems and Services (WGISS).

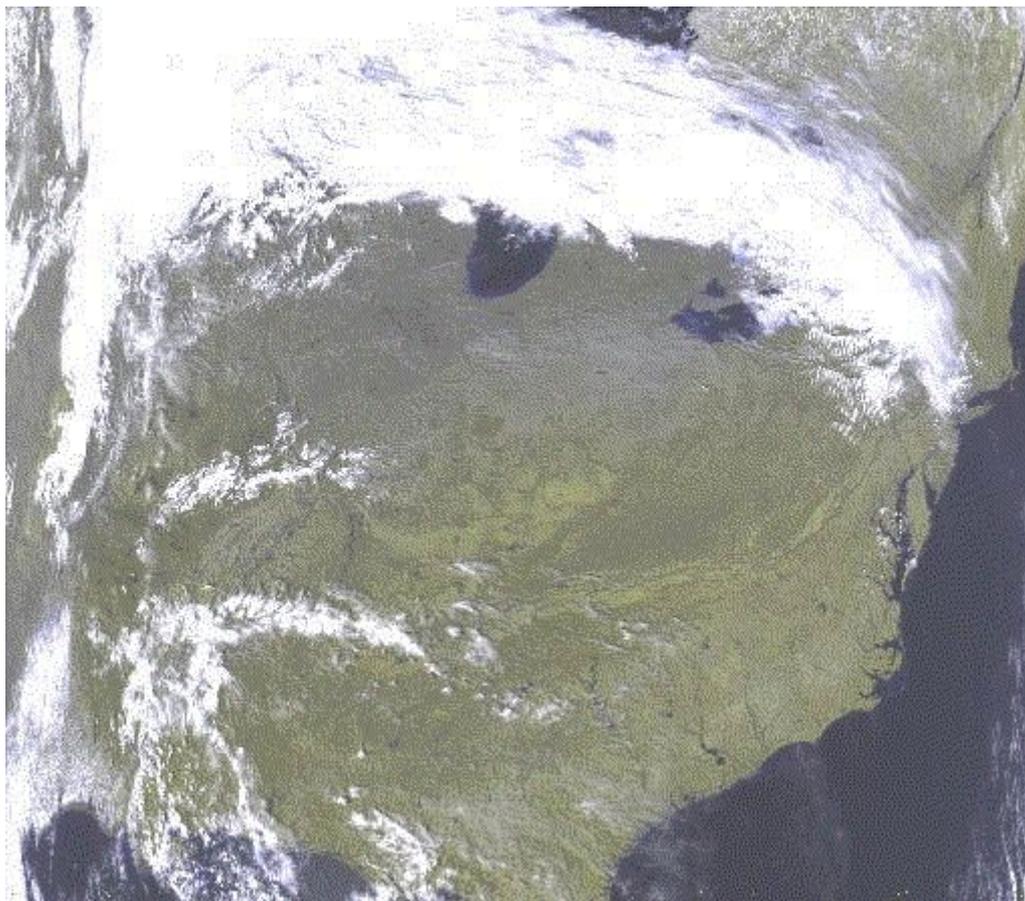
The purpose of this document is to provide information about browse data and recommendations for development of browse data systems. It is hoped that the information and recommendations provided will give the global change research community and other users of remote sensing information simpler and wider access to the wealth of data that is now available. This in turn will help to stimulate more data providers to make their information holdings available and encourage further development of global interoperable data systems. CEOS Working Groups and Subgroups are consensus organizations and the recommendations made within this document are non-binding.

### **1.1. Intended Audience**

This document is intended to assist data providers, including designers, developers and operators of Earth observation data systems to understand how a browse service might be made available to a wider audience.

### **1.2. Background Information and Scope of Document**

Data sets collected by Earth observation satellites are often quite large and it is impractical for data users to examine complete data sets. In addition, providing Earth observation data is growing as a commercial field and an increasing number of data providers require payment for data sets. Earth observation data holdings are typically managed in a catalogue that can be queried by users to determine its contents and locate data sets. A catalogue system allows a user to identify individual data sets that fulfill specific requirements identified by the user. Data providers often offer a browse service that allows the user to review the selected items usually at a reduced resolution. This enables users to establish whether the item is appropriate for the intended purpose. Figure 1-1 shows an example of a browse image for Advanced Very High Resolution Radiometer (AVHRR) instrument data archived by NOAA.



**Figure 1-1 Example of an AVHRR Browse Image**

Simple examples of the use of browse data might be:

- Does the data cover the desired area?
- Are the expected features present (e.g., an oil spill)?
- Is the data of adequate quality (e.g., is the feature masked by cloud cover)?

This document also attempts to explore the ways to make more use of browse than a role of a preview. Considering the evolving GIS and web mapping applications and standards supporting the technology, this document attempts to provide guidelines for satellite browse images to better serve GIS users or non-satellite data users, providing some tips for conventional browse to take on GIS-ready characteristics.

### 1.3. What is “Browse” ?

The role of browse is to provide users with visual aid in locating and determining the data they are after in their search process. To best support this role, the images tend to be reduced in spatial resolution and band representation, allowing large volumes of browse images to be generated quickly. Although geolocation information is usually provided, browse imagery is not always geolocated<sup>1</sup> (i.e. the basic raster transformed to geographic coordinates). In addition, not much attention is usually paid to the accuracy of geometric and radiometric corrections for the browse image.

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<sup>1</sup> Also referred to as georeferenced or georegistered.

However, this conventional connotation of browse has been changing and some data providers are starting to provide better-quality browse on a wider range of images than they used to. For example, for several years now, USGS has been offering full-resolution browse in Glovis, allowing users full interpretation at the search process. Most organizations would have this level of images available as dataset products not as browse images and this USGS’s ambitious step forward has blurred the line between browse and data products. USGS has done an extensive study on this subject, which is seen in the document “User Portal : Browse Evaluation”, and “Full Resolution Browse” [4]. Their other document “User Portal:Browse Evaluation” points out the need of expansion of browse definition to accommodate the evolving web mapping technologies and gives additional concept; “a visual entity that can also serve for mapping and interpretation”, and the full resolution browse, among others, supports the widened definition.

However, it would be contentious for other organizations to take the same path since it usually involves their data distribution policy and the need of resources to accommodate the change and it is solely at the discretion of data providers to determine the browse specification.

With that said, this guidelines document keeps the technical specification of browse image out of the definition of browse, and rather, keeps the definition small and simple as “Browse is an image that assists in the selection of datasets”.

Sometimes “preview” or “quicklook” is also used interchangeably in this context.

Browse functionality in general are summarized in Table 1-1 below:

**Table 1-1 Summary of Browse Functionality**

Browse function	Resolution	User type	Envisaged use
Viewing prior to ordering	partial	end user	check whether data is appropriate to the user's needs before placing an order
Identifying type and quality of data in a dataset (semi-guide)	full or partial	end user	for an inexperienced user (or user unfamiliar with the dataset) provides an overview of the characteristics of the dataset
Pre-processing check and selection of processing algorithms/parameters	full or partial	system operator	generates sample products from a subset of data prior to committing full resources to the processing task and enables evaluation of rival algorithms or algorithm parameters
Specification of processing parameters	full or partial	end user	interaction with a browse image allows the user to fine-tune the processing parameters to be applied to the associated data products
Reduced archiving and processing costs	full or partial	system operator	browse products can be used to support a policy of processing higher level products only on demand, thereby reducing archiving and routine processing overheads
GIS use	full or partial	end user or WMS enabled portal	browse images can be used as GIS raster layers.

In the context of a distributed system, however, some of these are likely to be mainly local requirements, such as the pre-processing check, which would normally be carried out only by system operators before

generating a processed data item at the processing center. In addition, the use of browse to provide an illustrative example of the type of product that has been identified may be regarded as a capability of a guide service rather than a browse service. For this reason, this document focuses on the most widely accepted understanding of the use of browse as a means of establishing whether a specific data item is appropriate to the user's needs before placing an order for the retrieval of the full resolution data product from the archive.

## 2. BROWSE PRODUCTS

Browsing in this context is part of a sequence of steps necessary for a user to evaluate individual data items from a data set. It is the interactive, visually oriented part of the resource searching and data quality assessment process, which aids in the selection or prioritizing of information. The activity itself is dependent on the user's interests and criteria at the time that he or she is browsing, thus making it difficult to optimize browsing in a general way.

### 2.1. Browse as a Decision Process

The act of browsing is in essence a complex interactive decision process that is dependent on both explicit and implicit evaluation criteria applied by the user. It can be viewed as a hierarchical decision process where the number of decision levels *possible* is dependent on the information content of the browse data and the number of decision levels *necessary* is dependent on the user's evaluation criteria. While a particular browse object may not have enough content to allow a user to definitively determine its relevance based on his or her search criteria, it needs to be emphasized that being able to qualify browse data even at a first level of the decision hierarchy can significantly reduce the amount of information that is classified as relevant. And, as a result, it significantly reduces the amount of information that the user must deal with.

### 2.2. Browse Types by Technical Characteristics

Technical characteristics of browse may vary according to what type of dataset the browse represents. In this sense, browse can be categorized into three types: browse representing high-to-moderate-resolution datasets from optical instruments, SAR instrument datasets, or geophysical-parameter datasets.

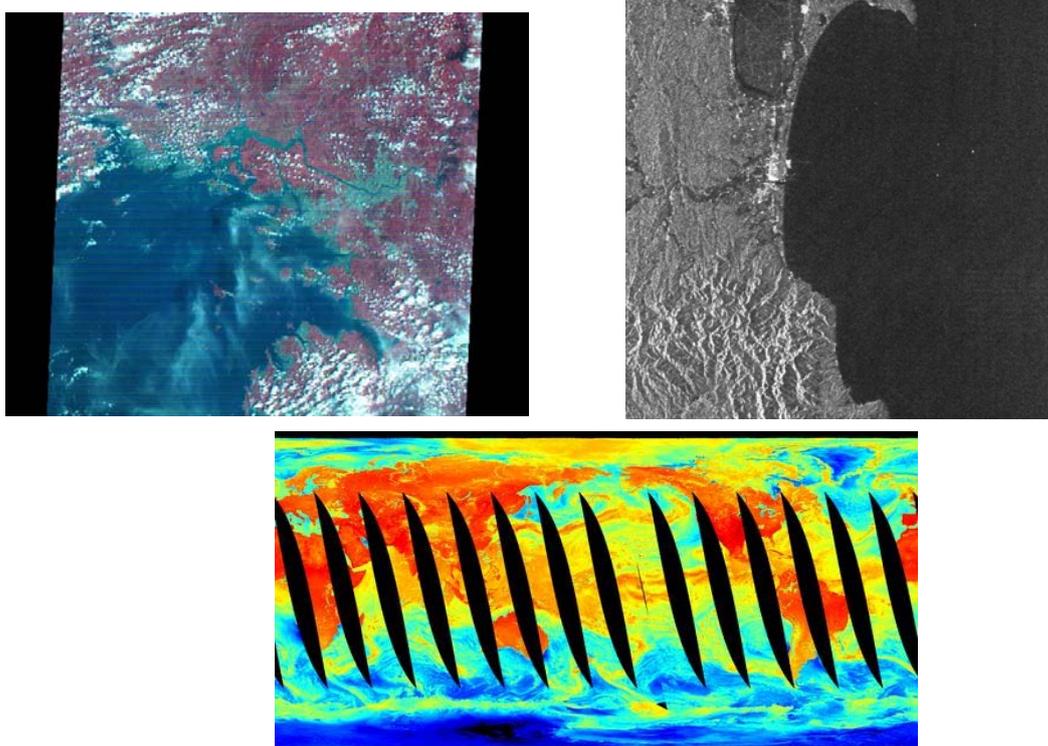
In the context of browse of land image with high-to-moderate resolution, users are usually looking at;

- does it contain the area I'm looking for ?
- does the cloud cover affect the area of my interest ?
- how well can the event be interpretable ?

The same would go for SAR dataset browse except for the cloud cover examination.

As for the browse of geophysical parameters datasets, users usually want to grasp tendency or intensity of a specific geophysical parameter, and judge whether to obtain the dataset product for his or her research. Usually, for level 3 or higher products, the spatial coverage is the entire globe.

Table 2-1 shows these characteristics.



**Figure 2-1 Example browse images : High-to-moderate-resolution browse from optical instruments (top-left), SAR browse (top-right) and Geophysical-parameter browse (bottom)**

**Table 2-1 Browse Types and Characteristics**

Type	What to be interpreted from browse	Geographical Extent	Image Resolution	Processing Level of Browse Source Dataset	Color Assignment	Need of Legend
High-to-Moderate Resolution datasets from optical instruments	Data Quality Cloud Cover Spatial coverage Event Appearance (e.g. Flood)	Small	High to Moderate	L1 or lower	Composite	No
SAR datasets	Data Quality Spatial coverage Event Appearance (e.g. Flood)	Small	High to Moderate	L1 or lower	Panchromatic, grey scale	No
Geophysical Parameters datasets	Spatial Coverage (*) Event Appearance (e.g. Heavy Rain etc.) intensity and distribution of the parameter	Large	Low	L2,3	Pseudo-color	Yes

\*applicable to Level 2 or lower dataset browse

It also needs to be taken into account that algorithm updates occur regularly for geophysical parameter datasets and this can lead to re-creation of browse.

### 2.3. Role of Data Compression in Browse

Perhaps the most important factor influencing accuracy in browse data is the data size reduction biasing introduced during browse data generation. Data size reduction is accomplished through techniques such as subsampling (and/or wavelet type processing) and compression of original data granules. The different methodologies bias the accuracy of the browse data in different ways and therefore knowledge of which methodology has been used provides relevant information about what is being represented. For example, there are a number of ways that an 8km resolution browse data object could be derived from a 1km resolution data granule. You could apply an 8x8 box filter that provided the mean of the 64 data values within the box, or use the highest data value within an 8x8 region or simply extract the value of every 8th pixel from every 8th line. Each of these methods provides a different representative data value and applies a different statistical bias to the browse data.

In the case of data compression a different kind of biasing can be introduced. Data compression can be utilized to generate a browse data object directly from the original data granule or applied to an existing browse data object as a means of decreasing its storage requirements. When a specific browse data object is requested, the compressed version is retrieved and is either; delivered to the end user's system in the compressed state (to increase network transfer efficiency), or decompressed at the production site and then transferred to the end user. Both lossless, (e.g.; Huffman, Lempel-Ziv) and lossy (e.g.; JPEG) compression algorithms have been used to advantage for satellite image data compression. With lossless compression, the decompressed object is an exact replicate of the original. Lossless compression algorithms optimize data storage by cataloguing repeated sequences and creating an index of their location in the original object. For AVHRR image data, Lempel-Ziv compression provides typically 4-to-1 or 5-to-1 compression. In comparison, lossy compression algorithms are capable of much greater compression ratios and may allow the user to control how the data is compressed. Higher compression ratios are enabled by reducing the accuracy of various operations within the processing algorithm (discrete cosine transform, real to integer assignments), which have the result of mapping multiple data values from the original to a single data value in the decompressed object (e.g. values 22-32 from the original are mapped to 22 in the decompressed object). The tradeoff for higher compression ratios is that the decompressed object is not a replica of the original and it is difficult to infer how the biasing has modified the science data itself.

### 2.4. Browse Products in Comparison

Within CEOS, different member systems utilize different methodologies for generating browse data objects. Information on what methodology is being used and a description of how it is being implemented will provide the user with some measure of the browse data accuracy.

As an example of high-to-moderate-resolution type browse, table 2-2 shows a sampling of Landsat TM/ETM+ browse produced and held by CEOS member agencies. The full survey results are found in Appendix A.

**Table 2-2 Survey of Landsat TM/ETM+ Browse**

Agency	Browse Characteristics	Browse Online Access
JAXA	640x498x8bits image, composite 4,3,2 as RGB, subsampled 1:12.04 horizontal, 1:12.05 vertical; ascending band 6 and subsampled 1:3.01, non-geolocated, JPEG compression, metadata embedded in JPEG header	N/A
USGS	8141x7251 x8bits image, composite 5,4,3 as RGB, full-resolution, geolocated (North-up), JPEG compression, metadata embedded in JPEG header, ESRI world file, and GDAL XML	<a href="http://earthexplorer.usgs.gov">http://earthexplorer.usgs.gov</a>
NRSCC	512 x512x8bits image, composite 7,4,2 as RGB, 1:12 subsampled, non-geolocated, JPEG compression, metadata embedded in JPEG header	N/A
INPE	512 x512x8bits image, composite 5,4,3 as RGB, 1:12 subsampled, non-geolocated, JPEG compression	N/A
CCRS	950 x716x8bits image, composite 4,3,2 as RGB, geolocated(North-up), JPEG compression	<a href="http://ceocat.ccrs.nrcan.gc.ca/cdql/landsat5/track-XX/frame-YY/">http://ceocat.ccrs.nrcan.gc.ca/cdql/landsat5/track-XX/frame-YY/</a>

One of the remarkable points is that USGS produces full resolution browse for the entire LANDSAT products. Also, USGS and CCRS produces geolocated browse and making them online accessible while other agencies don't.

Similarly, table 2-3 is a sampling of geophysical parameter type browse.

**Table 2-3 Survey of Geophysical-parameter-type Browse**

Agency	Platform& Instrument	Dataset	Browse Characteristics	Browse Online Access
JAXA	Aqua AMSR-E	Level3 Soil Moisture	550x331x8bits image, global spatial extent, geolocated, JPEG compression	N/A
NASA	Aqua AMSR-E	Aqua AMSR-E Daily L3 Global Ascending/D escending.25 x.25 degree Ocean Grids	360X720x8bits image, global spatial extent, geolocated, JPEG compression, legend is embedded in the browse image, metadata embedded in JPEG header	<a href="ftp://n4ftl01u.ecs.nasa.gov/AMSA/AE_DyOcn.002">ftp://n4ftl01u.ecs.nasa.gov/AMSA/AE_DyOcn.002</a>
CCRS	Terra MODIS	MODIS Canada 10 day composite	2280x1920x24bits image, global spatial extent, subsampled 1:10, geolocated, TIF compression	N/A
ISRO	Ocesnat-2 Scatterometer	Winds, Sigma0	919x609x24bits image, global spatial extent, subsampled 1:2, geolocated, JPEG compression, metadata in text file, legend and base map is attached to the browse	<a href="http://www.nrsc.gov.in">www.nrsc.gov.in</a>
INPE	Terra(Aqua ) MODIS	MOD-09 Surface	512x512x8bits image, global spatial extent, subsampled 1:4, non-geolocated, JPEG compression, metadata	N/A

		Reflectance	embedded in JPEG header	
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While Table 2-2 and 2-3 are not a comprehensive survey of all browse products available, it does provide a sense of the wide array of browse data available and the various ways in which it can be produced.

## 2.5. Browse Access Policy and WGISS Browse Statement

The main purpose of browse is to make it easier for users to identify data products of interests. It is therefore recommended that all data providers provide open and free access to browse/preview/quicklook data. Even for commercial data providers, there can be little benefit in restricting access to browse data.

To further facilitate the open and free access, in December 2012, WGISS has conceived and agreed the following WGISS Browse Statement.

*The Committee on Earth Observation Satellite (CEOS) Working Group on Information Systems and Services (WGISS) endorses the concept of space agencies providing easy to access, geolocated browse/preview/quicklook images using community-accepted formats. These images should be at low to no cost to the user.*

### 3. BROWSE IMAGE TOWARDS GIS-READY

As seen in the Table 2-2 and 2-3, browse is created in a way that is in favor of the agency's (or relevant information system's) preference. However, it is essential to recognize across agencies that the use of browse images will be broadened with a hint of additional care in creating browse images. In this chapter, some of these features are described.

#### 3.1. Why the need of GIS-ready browse ?

Today, there exist much more GIS users including potential ones than those who are dealing with just satellite data. In most cases, GIS users in need of using satellite data would go through a number of steps prior to actually using it in their software. These steps include visiting a web site (eg. portal), search and order for data, and format conversion at the user site as needed. Users may also need to spend energy on working out band combination before finally obtaining their favorable raster image, such as RGB true color. And most importantly, they may know little about satellite data and a specialized and complicated format can scare off potential users.

Browse is usually created in a common image format and intended to be treated easily. It's becoming common for the browse to be more capable and interactive with the help of advances around the Internet technologies especially webGIS. WebGIS or web mapping applications make it much easier to provide, obtain and utilize images through standardized web service interfaces, providing more opportunity for satellite data to get more attention from wider community of users.

#### 3.2. WMS (OGC Web Map Service)

The way to make the most of GIS-ready images would be to serve them through web services. The most well known service for this would be OGC Web Map Service (WMS).

WMS is a specification of OGC web services that defines encodings of http GET and POST request to enable raster image acquisition over the internet.

WMS GetMap request, a WMS's operation for image acquisition, looks something like this.

```
http://example.wgiss.org/cgi-bin/wms?  
service=WMS&           ...service name  
version=1.3.0&         ...service version number  
request=GetMap&        ...operation name  
crs=crs:84&            ...coordinate reference system (projection)  
format=image/gif&      ...format  
width=750&             ...pixel number (row)  
height=750&            ...pixel number (column)  
bbox=-3000000,-3000000,3000000,3000000& ...bounding box  
transparent=true&      ...image transparency  
layers=city_1922,city_1950,city_2010    ...images to get (one or more)
```

As described in 2.3, browse of geophysical parameters usually needs associated legend to let users know the color scale and WMS supports interface for it as well.

Though the specification is applicable for satellite images, there is a complementary specification "WMS EO profile (OGC 07-063r1)", the OGC best practice document. This profile extends the core WMS specification and provides additional normatives dedicated to earth observation images.

The EO profile, to adjust EO images, supports these for WMS request:

- temporal parameter
- band identification
- bit mask image identification

There is also a specification called “WMTS”, Web Map Tiling Service specification (07-057r7), which should also be looked at when dealing with satellite images of large file size. A WMTS enabled server can serve tiles of spatially referenced data, enabling a WMTS client to mosaic the tiles obtained from the server and clip the set of tiles into a final image. This methodology benefits performance of client allowing for seamless and quick map appearance.

WMS server instances with satellite images can be searched at GCMD/IDN.

### 3.3. Recommendations for GIS-ready Browse Image

GIS software and webGIS related interface standards can handle data files in common image formats such as JPEG, PNG, GeoTIFF etc.

Though browse images are usually created in one of these formats, as seen in Table 2-1 and 2-2, there are still some extra criteria to be met. One important factor is to have the images geolocated<sup>2</sup> so that GIS software or web-mapping standard interface can consume and process the images correctly. Also they need to be map projected aligning with a well-known coordinate reference system.

Geolocating can be accomplished either by including geographic tags within the image file or having an associated file with geographic information. The USGS Browse Evaluation document [4] provides recommendations in this context. This Guidelines document shares some of them and add a few more recommendations to take account of the different browse types shown in table 2-1.

- URL accessible
- RGB True Color <sup>\*1</sup>
- Consistent stretches to allow for comparison of images <sup>\*1\*2</sup>
- Consistent color table to allow for comparison of images <sup>\*3</sup>
- Provision of color legend separately from image <sup>\*3</sup>
- Geolocated and map projected in one of the following formats:
  - JPEG 2000 with embedded GML Geographic tags
  - GeoTIFF with embedded Geographic tags
  - PNG with world file
  - JPEG with world file
  - Packaged within KML/KMZ format

[\*1] Applicable to High-to-Moderate resolution datasets browse from optical sensors

[\*2] Applicable to SAR datasets browse

[\*3] Applicable to geophysical parameters browse

In the context of color legends, there are practical cases that a legend is glued to the image. And often times, it also has coordinate axes, the title and some other descriptions embedded in the single image file. This would be of value when the browse is intended for stand-alone use, helping users interpret the image more correctly. It should not be the case, however, when it is a third-party web-mapping client application that reads the browse.

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<sup>2</sup> To specify every pixel in an image with lat/lon. The word “Georeference” is more commonly used but the meaning can be vague and different across agencies.

The possible discussion that may arise with regards to consistency of stretches or color table would be to what degree they should be consistent. Currently, there is no standard defining it that is applicable to all CEOS agencies. It is thus recommended, as an important first step, to maintain consistency within each agency (eg. consistent color table for precipitation). The standardization effort is considered to be a future option.

### 3.4. Browse in Catalog Web Service

The recommendations given in 3.3 include URL accessible browse. One benefit from this is that the browse can be used by web mapping applications.

But there is another important aspect to it, which is the association with catalog web service.

To facilitate the searching of distributed catalogues, CEOS WGISS is developing a protocol and associated service referred to as CWIC (WGISS Integrated Catalog). It provides a single, standards-based, web service (CSW) to the user community for searching the various partner systems and for obtaining results that lead directly to data granules. The CWIC search response includes an XML element (ISO-19115) that can contain the URL of online-accessible browse. This enables a CWIC-compatible client to access the associated browse along with the metadata. CWIC partners are encouraged to fill in this element. The URL can either be a direct link to the image file, or a WMS GetMap query.

### 3.5. Use scenarios

Once a browse image is aligned with the recommendations in 3.2, it is ready to be used in many ways. This subclause depicts some use cases of GIS-ready browse in satellite data information systems.

#### (1) Interactive browse in a portal

One example is to allow for more interactive browse at a web portal.

Shown in figure 3-1 is a search screen of USGS Earth Explorer, where a browse is overlaid on a base map. It allows users to see as many browse images overlaid in a map as they want, giving them much clear sense of spatial coverage of the scenes.

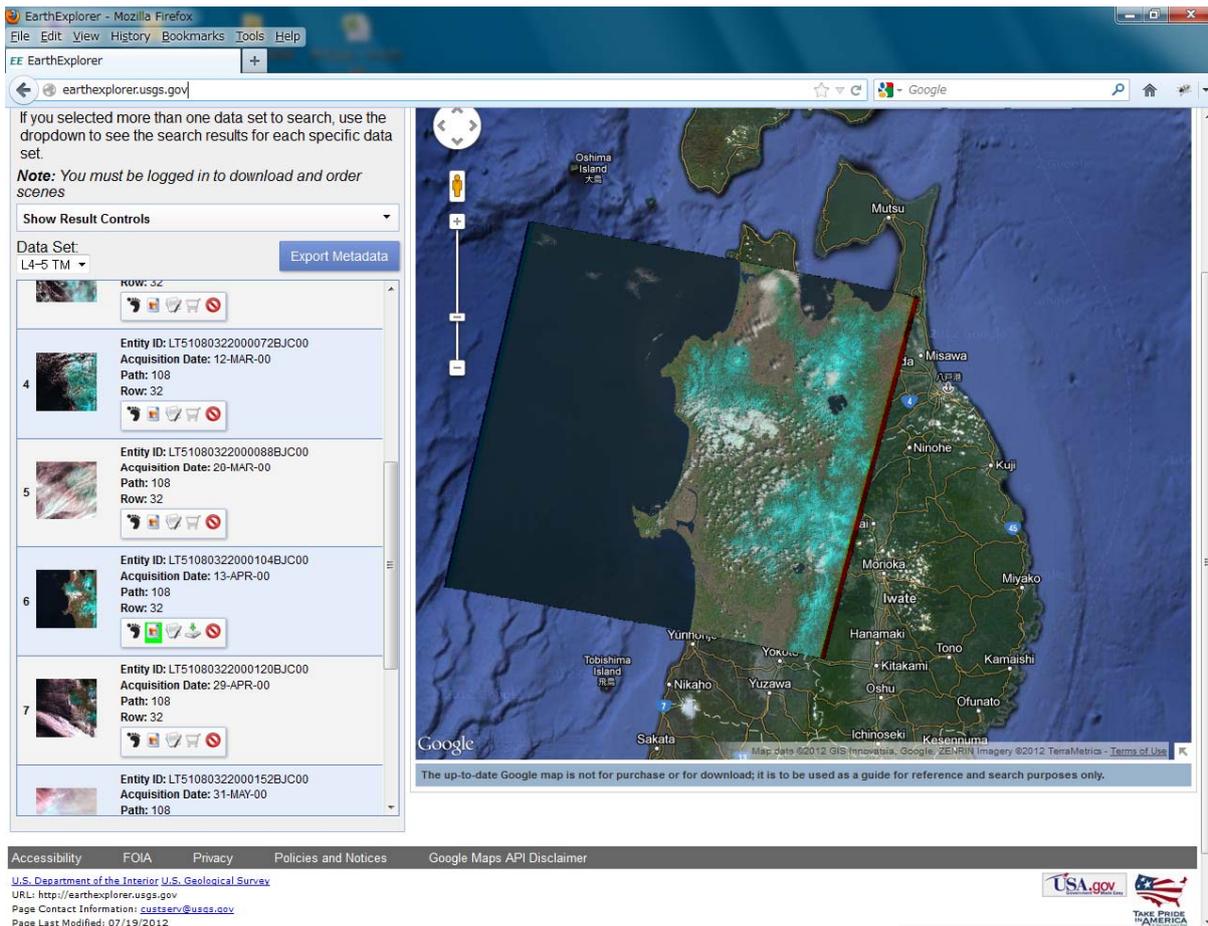


Figure 3-1 Browse Overlay in USGS Earth Explorer

Overlaying on a base map can also benefit when treating a browse with irregular scene coverage.

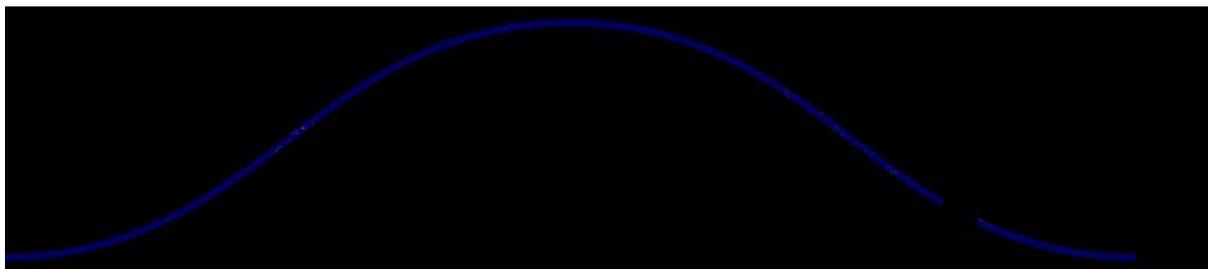


Figure 3-2 Browse of TRMM 2A25 (scene coverage=orbital path)

Fig.3-2 is a browse of TRMM 2A25 whose scene coverage is one orbital path.

In this case, the stand-alone browse wouldn't get across the coverage of the orbit path where the data is valid and thus the browse makes barely any sense to users. However, it will become of value once it's overlaid over a base map because not only does it give geographical reference, but a GIS/WMS client tools usually give the capability of zooming in and out retaining the relation to the base map underneath.

(2) NASA GIBS and NASA World View

NASA's Global Imagery Browse Services (GIBS) are a set of standard services to deliver global, full-resolution satellite imagery in a highly responsive manner. 50+ full resolution, global imagery products from NASA Earth Observing System satellites are available in near real-time (usually within 3 hours of observation). The browse images can be accessed by WMTS or Tiled Web Map Service (TWMS), an extension to the OGC Web Map Service (WMS) where only requests that match the exact geographic tile boundaries will be honored.

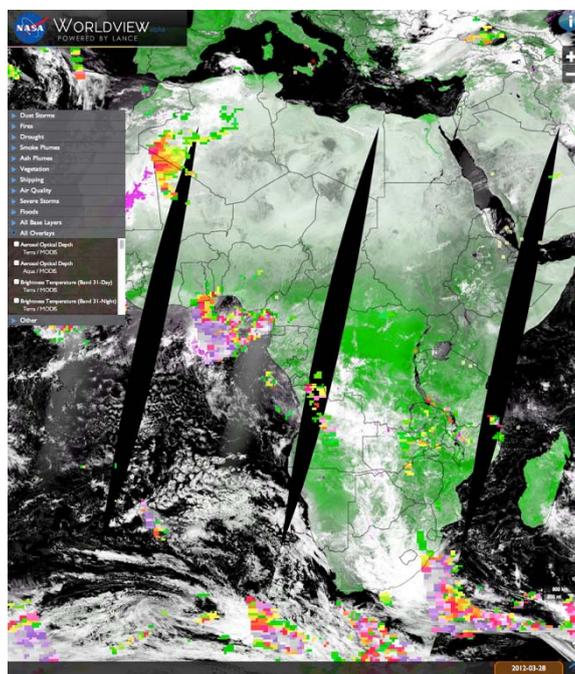


Figure 3-3 NASA World View

NASA World View is one of the clients that make use of GIBS and allow browse based search. It allows users to identify feature of their interest visually and go on to data retrieval.

### (3) Exploiting Google Earth

Packaging a browse image into a KML (or KMZ – a zipped KML) file will allow the browse to be opened within the Google Earth Application. This has the advantage of making a great deal of additional context information available to the user.

## 3.6. Browse vs Product

Although the description and recommendations thus far in this chapter is about enabling browse ready for GIS use, some organizations would rather take a different path for serving GIS-ready images, i.e. as dataset products. This document does not intend to argue that browse is the only alternative for the source data of GIS-ready images. It is important to realize what is required for satellite data to become GIS friendly and how they can benefit wide range of users and applications.

## 4. BROWSE ATTRIBUTES

Table 4-1 provides a list of attributes that may be used to define or identify browse.

**Table 4-1 Browse Attribute Definitions**

Browse Attribute	Definition
Band	Information related to a band.
Band ID	Band Identifier.
Band Mode	Set of flags describing the status of activity of each band (active/present or not active/absent).
Bits per pixel	Number of bits of data for each pixel in the browse image.
Browse Compression	Description of the method used for compression of the browse data.
Browse Delivery Options	Description of the options in which browse data can be delivered on-line, e.g., the format and the size of the browse data.
Browse Format	Format of the browse data, e.g., GIF.
Browse ID	Identifier of browse data.
Browse Retrieval Option	Description of the browse retrieval options available for users, may be dependent on the user group they belong to.
Browse Service Options	A list of all the service options available for the browse data.
Cloud Cover	That portion of the sky cover which is attributed to clouds, usually measured in tenths of sky covered.
Data Quality	Evaluation of the usability and versatility of data.
File Size	Size of the browse image data file.
File Name	Name by which the file can be identified and retrieved.
Generation Method	Operations and processes by which an image is produced from source data.
Image Size	The size of an image stated in number of elements or in ground cover area.
Line Loss	A flag indicating loss of line(s) of data from an image, may also indicate the percentage of lines lost.
Number of lines	Number of lines of pixels in the browse image (typically in the vertical direction).
Number of Pixels	Number of pixels in one line of the browse image (typically in the horizontal direction).
Pixel Resolution	The ground area corresponding to one number of a digital image data set.
Platform	Support which carries the instrument(s)/sensor(s). A platform can be a spacecraft, a ground station or an aircraft.
Processing Date	Date when the browse image was generated.
Processing Level	Processing level information.
Sensor	Information related to the sensor such as name and sensor modes
Spatial Reference	Method by which location or coverage is designated (e.g., latitude and longitude).
Status	Online or Offline.
Subsample Ratio	The number of elements in the browse image divided by the number of elements in the source image.
Temporal Coverage	Time coverage for the data content.
Geospatial Coverage	Geospatial coverage for the data content.

Table 4-2 provides an example of the browse attributes in an operational system. In this case the attributes for Landsat TM browse held in JAXA information system, contained in the JPEG header.

**Table 4-2 Example of Browse Attributes**

Browse Attribute	Value
Browse ID	00110519990310108031
Band Assignment of Browse	432
Browse status	0 (Online)
Processing Date of Browse	19990311
Browse File Size (compressed)	119 kBytes
Browse File Size (uncompressed)	957 kBytes
Number of lines	498
Number of Pixels	640
Bits per pixel	8

In terms of WMS or GIS-ready, the attributes need to be present in any of the specific formats as stated in 3.3.

## **5. CONCLUSIONS**

This document has attempted to look at a variety of issues related to browse data production and cataloguing.

Based on the discussion throughout this document, the following are the recommendations for agencies to consider when choosing methods in generating browse products.

### **1. Browse Format for GIS-ready**

- 1) URL accessible
- 2) RGB True Color<sup>\*1</sup>
- 3) Consistent stretches to allow for comparison of images<sup>\*1\*2</sup>
- 4) Consistent color table to allow for comparison of images<sup>\*3</sup>
- 5) Provision of color legend separately from image<sup>\*3</sup>
- 6) Geolocated and map projectable image aligning with a well-known coordinate reference system (eg. WGS84)
- 7) File format to be in one of the following:
  - JPEG 2000 with embedded GML Geographic tags
  - GeoTIFF with embedded Geographic tags
  - PNG with world file
  - JPEG with world file
  - Packaged within KML/KMZ format

[\*1] Applicable to High-to-Moderate resolution datasets browse from optical sensors

[\*2] Applicable to SAR datasets browse

[\*3] Applicable to geophysical parameters browse

### **2. Browse in Catalog Web Service**

Individual browse product should be online and accessible through a direct URL or WMS GetMap (HTTP GET) request. The URL should appear in the search response of a catalog web service. (eg. CWIC)

3. All browse data should be open and freely available at no cost to the user (user registration may be required). Note this concept is officially supported in WGISS Browse Statement (see section 2.5).

4. A browse system should provide ancillary information useful to the user. The following set of browse specific attributes are recommended to be available. It is assumed that there is a link to the catalogue system which would provide additional data attributes (e.g., sensor type, instrument name, geolocation information, etc.).

- a. Subsampling scheme (e.g., every eighth pixel, every eighth row).
- b. Compression method (e.g., JPEG) and method specifics like quality level.
- c. Where appropriate – bands of data which were used to produce browse (e.g., AVHRR bands 2 and 4).

- d. Number of pixels and number of rows which compose the image (e.g., 350 pixels by 750 rows).
- e. Resolution of a pixel in the image (e.g., 20 m horizontal by 30 m vertical).

## **6. REFERENCES**

- [1] Full Resolution Browse (FRB) Recommendation Version 1.0 July 2010, USGS
- [2] Full Resolution Browse (FRB) Data Format Control Book (DFCB) Version 0.4 August 2009, USGS
- [3] The EDC's Past and Present Browse Strategies June 2004, USGS
- [4] LANDSAT Data Continuity Mission (LDCM) User Portal: Browse Evaluation Version 3.1 January 2008, USGS
- [5] OpenGIS® Web Map Server Implementation Specification, OGC® 06-042, 2006-03-15
- [6] OpenGIS® Web Map Services -Profile for EO Products, OGC 07-063r1, 2009-11-05
- [7] OpenGIS® Web Map Tile Service Implementation Standard, OGC 07-057r7, 2010-04-06

## **APPENDIX A - Results of Browse Survey**

This appendix contains the results of a 2012-2013 survey of CEOS agencies regarding the details of their production of browse products.

1. LANDSAT TM/ETM+

Satellite/Instrument/Dataset	JAXA	CCRS	INPE	NRSCC	USGS
Dataset name	1) LANDSAT/TM/ETM+ (fixed)	1) LANDSAT/TM/ETM+ (fixed)	1) LANDSAT/TM/ETM+ (fixed)	1) LANDSAT/TM/ETM+ (fixed)	1) LANDSAT/TM/ETM+ (fixed)
Browse Image Characteristics	2) 640 X 498 (TM)	2) 850 X 750 (ETM+), 950 X 716 (TM)	2) 512 x 512	2) 512 x variable	2) 814x7251
Resolution (col x row)	3) 8	3) 8	3) 8	3) 8	3) 8
Subsampling rate	4) 1:12	4) systematic decimation(pixel skip)	4) 1:12	4) 1:13	4) 1:01
File format	5) JPEG	5) JPEG	5) JPEG	5) JPEG	5) JPEG
Band combination picked for browse	6) 4, 3, 2	6) 4, 3, 2	6) 4, 3, 2	6) 4, 3, 2	6) 4, 3, 2
Format of browse attribute	7) embedded in JPEG header	7) relational database schema	7) Unknown	7) embedded in JPEG header	7) JPEG header, ESRI world file, GDAL_XML
Georeferenced (geolocated) ?	8) No	8) systemically geocoded	8) No	8) Yes	8) Yes
Image orientation	9) satellite heading	9) North Up	9) satellite heading	9) satellite heading (Not north-up)	9) North-up
Processing level of data used for browse generation	10) Raw (Quick look)	10) L1B (TM), L1G ( ETM+)	10) radiometric equalization, sync loss interpolation, corners geolocation	10) FRED	10) L1
Routine production or per-order (on-demand) production	11) routine production	11) routine production	11) routine production	11) routine production	11) routine production
Purpose of browse generation (name as many)	12) to help users find data of interest in our portal	12) to help users find data of interest in our portal	12) help users to find data of interest	12) to help users find data of interest in our portal	12) cloud cover and quality assessment; determination of coverage extent
Availability of public online access and its methodology (eg.WMS)	13) No	13) No	13) no	13) No	13) JPEG files can be downloaded from the Earth Explorer web site
Online access URL (if applicable)	14) N/A	14) ETM+ : <a href="http://eoecat.ccrs.nrcan.gc.ca/cdjl/landsat7/rack-XXX/frame-YYY/">http://eoecat.ccrs.nrcan.gc.ca/cdjl/landsat7/rack-XXX/frame-YYY/</a> TM : <a href="http://eoecat.ccrs.nrcan.gc.ca/cdjl/landsat5/rack-XX/frame-YY/">http://eoecat.ccrs.nrcan.gc.ca/cdjl/landsat5/rack-XX/frame-YY/</a>	14) <a href="http://www.dpi.inpe.br/CDSR">www.dpi.inpe.br/CDSR</a>	14) <a href="http://cs.nrscc.gc.ca/">http://cs.nrscc.gc.ca/</a>	14) <a href="http://earthexplorer.usgs.gov">http://earthexplorer.usgs.gov</a>

2. Geophysical parameter product with global scene coverage<sup>1</sup>

Satellite/Instrument	JAXA	CCRS	INPE	ISRO	ISRO
Dataset name	1) Aqua AMSR-E	1) Terra (EOS AM) / MODIS	1) Terra or Aqua/MODIS	1) Oceansat-2 Scatterometer	1) Kalpana-1/VHRR
Browse Image Characteristics	2) Level3 Soil Moisture	2) MODIS Canada 10 day composite	2) MODIS Surface Reflectance	2) Winds Sigma0	2) CLM Rainfall, UTM, LST, QPE, SST, WWW, 650 x 900
Resolution (col x row)	3) 550 x 331	3) 2280 x 1920	3) 512x512 Browse Quicklook, 128x128 Thumbnail quicklook	3) 919x669	3) 650 x 900
Subsampling rate	4) 8	4) 8	4) 24	4) 8	4) 24
File format	5) JPEG	5) TIF	5) 1, 4	5) JPEG	5) JPEG
Specific band width picked for browse (if applicable)	6) n/a	6) na	6) n/a	6) For Geophysical Products Derived Products are displayed and not individual bands	6) For Geophysical Products Derived Products are displayed and not individual bands
Reason for picking the specific band width	7) n/a	7) na	7) n/a	7) n/a	7) n/a
For browse creation (reasoned when #7 is availability of legend of browse and its format of browse attribute)	8) n/a	8) No	8) embedded in JPEG header	8) overlaid over image as well as available as metadata text file	8) overlaid over image as well as available as metadata text file
Georeferenced (geolocated) ?	9) n/a	9) relational database schema	9) No	9) Yes	9) Yes
Dataset used for browse generation	10) Level3 Soil Moisture	10) MODIS TOA radiance, georeferenced and composited	10) MOD-09 Surface Reflectance	10) OSCAT	10) Level-2 and Level-3
Routine production or per-order (on-demand) production	11) routine production	11) routine production	11) routine	11) routine production	11) routine production
Purpose of browse generation (name as many)	12) to help users find data of interest in our portal	12) to help users find data of interest	12) browses scenes from the repository and check quality control	12) Overview of product to end user, which can help in selection for download	12) Overview of product to end user, which can help in selection for download
Availability of public online access and its methodology (eg.WMS)	13) no	13) Not yet	13) no	13) Web portal	13) Web portal
Online access URL (if applicable)	14) n/a	14) None	14) <a href="http://www.dpi.inpe.br/cdsr">www.dpi.inpe.br/cdsr</a>	14) <a href="http://www.nrscc.gc.ca/">www.nrscc.gc.ca/</a>	14) <a href="http://www.mosdac.gov.in">www.mosdac.gov.in</a>

Satellite/Instrument	NASA	Aqua/AMSR-E	Terra/MODIS	Aqua/MODIS	Aura/TES
Dataset name	1) Aqua AMSR-E	1) Aqua AMSR-E Daily L3 Global	1) Terra MODIS Land Surface Temperature/Emissivity Daily L3 Global 0.05 Degree Climate Modeling Grid	1) MODIS/Aqua Snow Cover Daily L3 Global 0.05Deg CMG, Version 5	1) Aura TES L3 Atmospheric Temperatures Daily Gridded
Browse Image Characteristics	2) 360x720	2) 720x720	2) 720x720	2) 720x360	2) 180x360
Resolution (col x row)	3) 8	3) 8	3) 24	3) 24	3) 8
Subsampling rate	4) 1:2 (col), 1:2 (row)	4) 1:0 (col), 1:1 (row)	4) 1:1 (col), 1:1 (row)	4) 1:1 (col), 1:1 (row)	4) 2:1 (col), 4:1 (row)
File format	5) JPEG	5) JPEG	5) JPEG	5) JPEG	5) JPEG
Specific band width picked for browse (if applicable)	6) n/a	6) n/a	6) n/a	6) n/a	6) n/a
Reason for picking the specific band width	7) n/a	7) n/a	7) n/a	7) n/a	7) n/a
For browse creation (reasoned when #7 is availability of legend of browse and its format of browse attribute)	8) The legend is embedded in the browse image	8) The legend is embedded in the browse image	8) The legend is embedded in the browse image	8) The legend is embedded in the browse image	8) The legend is embedded in the browse image
Georeferenced (geolocated) ?	9) embedded in JPEG header	9) embedded in JPEG header	9) Embedded in JPEG header	9) embedded in JPEG header	9) embedded in JPEG header
Dataset used for browse generation	10) Aqua AMSR-E Daily L3 Global Ascending/Descending 25x25 degree Ocean Grids	10) AMSR-E/Aqua Monthly L3 5x5 deg Rainfall Accumulations	10) Terra MODIS Land Surface Temperature/Emissivity Daily L3 Global 0.05 Degree Climate Modeling Grid	10) MODIS/Aqua Snow Cover Daily L3 Global 0.05Deg CMG, Version 5	10) Aura TES L3 Atmospheric Temperatures Daily Gridded
Routine production or per-order (on-demand) production	11) routine production	11) routine production	11) routine production	11) routine production	11) routine production
Purpose of browse generation (name as many)	12) To help users find data of interest	12) To help users find data of interest	12) To help users find data of interest	12) To help users find data of interest	12) To help users find data of interest
Availability of public online access and its methodology (eg.WMS)	13) FTP	13) FTP	13) FTP	13) FTP	13) FTP
Online access URL (if applicable)	14) <a href="http://4f0101u.ecs.nasa.gov/AMSA/AE_DyC002">http://4f0101u.ecs.nasa.gov/AMSA/AE_DyC002</a>	14) <a href="http://4f0101u.ecs.nasa.gov/AMSA/AE_RnGd002">http://4f0101u.ecs.nasa.gov/AMSA/AE_RnGd002</a>	14) <a href="http://4f0101u.ecs.nasa.gov/MOLT/MOD11C1.005/">http://4f0101u.ecs.nasa.gov/MOLT/MOD11C1.005/</a>	14) <a href="http://4f0101u.ecs.nasa.gov/MOSAMYD10C1005/">http://4f0101u.ecs.nasa.gov/MOSAMYD10C1005/</a>	14) <a href="http://4f0101u.ecs.nasa.gov/TEST/LS3ATD.003">http://4f0101u.ecs.nasa.gov/TEST/LS3ATD.003</a>

<sup>1</sup> (eg) Level 3 or higher of AMSR-E, TRMM, AIRS etc. dataset

3. Others

Satellite/Instrument/Dataset	ISRO	ISRO	NRSCC	NRSCC	NRSCC	NRSCC	NRSCC	NRSCC
Dataset name	1) Oceansat-2/OCM	1) Kalpana-1/VHRR	1) SPOT1/2/4/5 Panchromatic & Multi-spectral	1) IRS-P6/LISS4/LISS3/4AWIFS	1) HJ1A/1B CCD	1) Radarsat1/Radarsat2 SAR	1) Envisat ASAR	1) BJT
Browse Image Characteristics	2) 466 x 502	2) Indian Remote Sensing Satellites (IRS), with Panchromatic, Thermal, and Multi-spectral	2) 700 x 800	2) 512x512	2) 512x512	2) 1024 x variable	2) 512 x variable	2) 512x512
Resolution (col x row)	3) 24	3) 24	3) 24	3) 8	3) 8	3) 8	3) 8	3) 8
Subsampling rate	4) 1.08	4) 1.08	4) 1.08	4) Panchromatic1:1.2 & Multi-spectral 1:6	4) LISS4 1:14 LISS3 1:12 AWIFS 1:34	4) 1:16 from 1:3 to 1:49	4) 1:5, 1:6.5	4) Panchromatic1:1.2 & Multi-spectral 1:20
File format	5) JPEG	5) JPEG	5) JPEG	5) JPEG	5) JPEG	5) JPEG	5) JPEG	5) JPEG
Band combination picked for browse	6) 6, 5, 3	6) individual bands	6) 8, 2, 1	6) 8, 2, 1	6) 8, 2, 1	6) n/a	6) embedded in JPEG header	6) n/a
Format of browse attribute	7) Available as Metadata (Text file)	7) Available as Metadata (Text file) as well as embedded in the jpeg	7) embedded in JPEG header	7) embedded in JPEG header	7) embedded in JPEG header	7) embedded in JPEG header	7) embedded in JPEG header	7) embedded in JPEG header
Georeferenced (geolocated) ?	8) No	8) Yes	8) No	8) No	8) YES	8) No	8) No	8) No
Image orientation	9) Satellite Heading	9) North	9) satellite heading (Not north-up)	9) satellite heading (Not north-up)	9) north-up	9) satellite heading (Not north-up)	9) satellite heading (Not north-up)	9) satellite heading (Not north-up)
Processing level of data used for browse generation	10) RAW data browse chips are generated soon after real time acquisition	10) Level-1	10) FRED	10) FRED	10) level2	10) FRED	10) raw (before L0)	10) raw (before L0)
Routine production or per-order (on-demand) production	11) routine production	11) routine production	11) routine production	11) routine production	11) routine production	11) routine production	11) routine production	11) routine production
Purpose of browse generation (name as many)	12) Product Ordering	12) Visualization of cloud systems and for product ordering	12) to help users find data of interest in our portal	12) to help users find data of interest in our portal	12) to help users find data of interest in our portal	12) to help users find data of interest in our portal	12) to help users find data of interest in our portal	12) to help users find data of interest in our portal
Availability of public online access and its methodology (eg.WMS)	13) Through a Web portal	13) Through a Web portal	13) No	13) No	13) No	13) No	13) No	13) No
Online access URL (if applicable)	14) <a href="http://www.mosdac.gov.in/registration">www.mosdac.gov.in/registration</a>	14) <a href="http://www.mosdac.gov.in/registration">www.mosdac.gov.in/registration</a>	14) <a href="http://cs.nrscc.gc.ca/">http://cs.nrscc.gc.ca/</a>	14) <a href="http://cs.nrscc.gc.ca/">http://cs.nrscc.gc.ca/</a>	14) <a href="http://218.247.138.98/rel01n.jsp">http://218.247.138.98/rel01n.jsp</a>	14) <a href="http://cs.nrscc.gc.ca/">http://cs.nrscc.gc.ca/</a>	14) <a href="http://cs.nrscc.gc.ca/">http://cs.nrscc.gc.ca/</a>	14) <a href="http://www.bhit.com/en/frame/login.asp">http://www.bhit.com/en/frame/login.asp</a>