<Review>

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Implementation of Satellite Imagery Information System for Korean Meteorological Administration

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Abstract : Scattered satellite images were collected and converted from TDF to HDF as a standard format. We reviewed all the metadata on the images domestic and abroad and set up the metadata for the meteorological satellite images and naming rules in KMA. The satellite information search system that meteorological satellite images were in service with metadata for public and academic fields was implemented for quick search and download. This system will facilitate satellite images for various academic purposes beyond KMA and management functions of the system make routine workflow to manage satellite images in an ease and standardized way.

Key Words : Meteorological satellite archiving system, Metadata, Naming rule, Data conversion.

1. Introduction

1) Backgrounds

Meteorological satellite data have been collected and reserved for weather forecasting, but systematic management with archiving all the images in the past had not been introduced before 2005. In spite of requirement for satellite images in time for research purposes, it was not easy for scientists to obtain the exact images timely. Also the information of satellite is not limited to general cloud maps but applied to various thematic maps.

Images taken in a static orbit such as MTSAT-1R and FY-2C and Meteosat-5 have been received and NOAA images in polar orbits, as well. During monsoon seasons with frequent typhoon upcoming, satellite images tend to draw public interest and to be used by decision makers or disaster managers. It is necessary to understand the standardizing procedure to archive all the images as system integration jobs in order to provoke further usages of satellite images.

2) Study purpose

We aim to develop an archiving system with full database for metadata for each image, raw data sets, thumbnail images and related data to expand the usage of meteorological satellite data. For the efficient management, the metadata of the satellite images and naming rules should be set up. We designed the metadata and naming rules, which are based on International Standard 19115-2 working

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draft which defines the metadata of images and gridded data, with some changes considering the characteristics for meteorological images having high temporal resolution.

3) Methods

As HDF format was decided as a standard format, we converted raw data from TDF format, which depends on specific software such as Terra Scan to HDF format. In 2006, satellite images of forty-five terabytes were collected from various devices such as DLT and hard drivein many departments, even in other institutes and were rectified with the fixed boundary layer. Error removal process for image had been set up and preceded with advices of retired meteorological experts. A web-based system for management of satellite images and an Internet service system have been developed for the purpose of easy search and navigation schemes for general users.

Metadata and naming rules are designed and presented in workshops and modified on the basis of the interviews with meteorological officers.

2. SIIS Archiving Process

1) Material preparing step

We gathered more than 1.05 million sheets of satellite imagery taken polar orbit and Earth Observation Satellite like MODIS from Aqua and Terra satellite. We called this archiving system as SIIS (satellite image information system) which is composed of SIMS (satellite image management system) and SISS (satellite image search system).

2) The rectifying step

All the errors are checked out and rectified by both naked eyed inspection and shell programming for systematic errors. Shell programming is done by customizing TerraScan software.

3) The reproducing stage

All the raw data were drawn from the digital linear tape (DLT) and hard disks and the size of each satellite image were recorded. The lists of missing data were made and recollected from original

DB building

scope

contents	procedure	amounts
Data archiving for Polar-orbit data and rectification	∪ NOAA, FY1, Terra, Aqua images	1,050,607
	∪ Rectification with quality control	1,050,607
Reproducing missing data	∪ Recollection of raw data ∪ Binary file reproducing	14,371
Analyzing images For Clouds information	∪ GMS-5, GOES-9, MTSAT-1R ∪ Compensation and analysing images for cloud cover	80,575
Conversion data	∪ Selection of standard format ∪ Converting raw images into the standard format	184,337

Fig. 1. Work Scope of Archiving System.

producing agencies and other receiving centers in both domestic and abroad.

4) The cloud data producing

Rectified data were processed for estimating amounts of clouds for satellite images with geostationary orbits such as GMS-5, GOES-9 and MTSAT-1R. Cloud estimating was based in the shell programming on Terra Scan.

5) The format conversion and saving

All the raw image in TerraScan data (TDF) format were converted into Hierarchical Data Format (HDF) and saved under the new naming rules and with the metadata, which were set in technical notes.

3. Selection of standard format for KMA.

To expand the usage of satellite images from this archiving center, we investigated the format used by the other organizations to provide satellite images.

National Geographic Information Institute holds not only aerial photographs but also satellite images, which have been taken since 1966. All the scanned images can be provided to users on the request in the format of TIFF(Tagged Image File Format) and JPG. Internal format of NIX (National Image eXchange) is preferred as it is a standard of framework data for Korean Government. Korean Aerospace Research Institute and Korea Aerospace Industry Ltd. are in charge of distribution of KOMPSAT images; they provide the images in the format of HDF in principle but convert the images into TIFF on the request of users. Korean Ocean Research and Development Institute (KORDI) have all the images in the form of HDF and provide in both HDF and TIFF.

Before the archiving process in 2006, most raw images were saved in the format of TDF, which are developed by TerraScan, the most popular software. We interviewed inner group of meteorological scientists in depth and outer general groups who may be potential user of meteorological satellite images. The former preferred HDF format, as it is easy to manipulate them with software language like IDL (interface data language) and the metadata of images

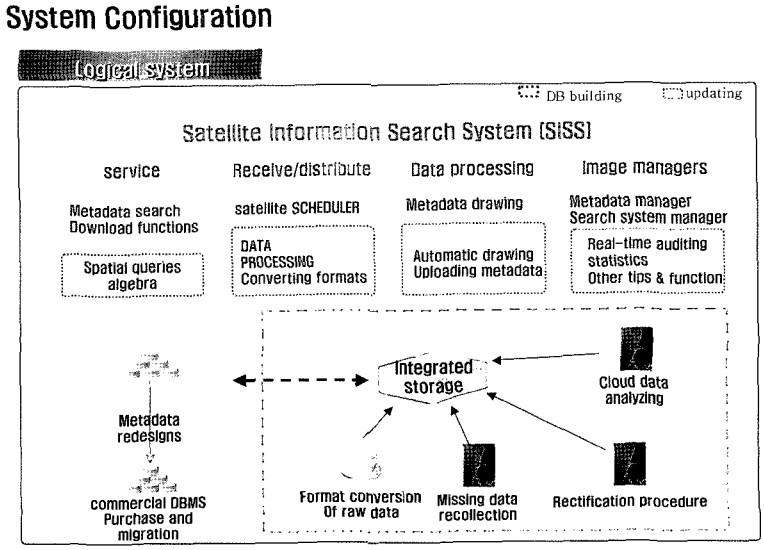

Fig. 2. System Configuration.

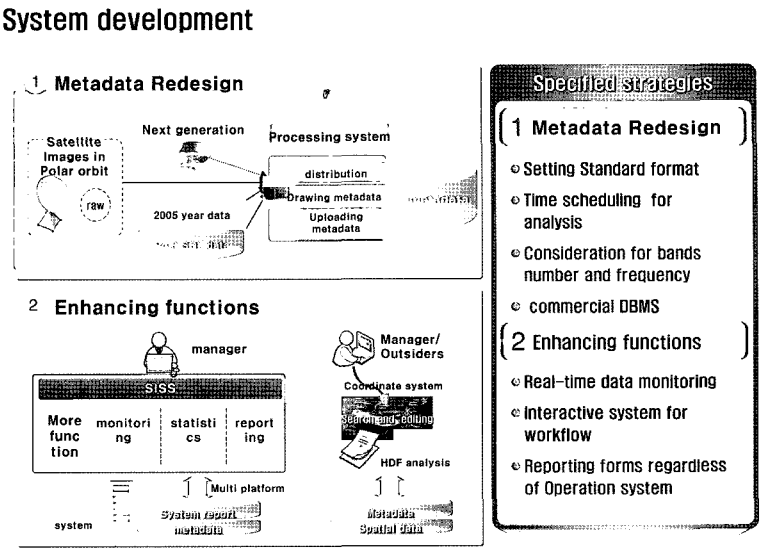

Fig. 3. System development and Strategies.

can be saved within the format together. GEOTIFF format is not familiar to meteorological scientists, although one of the standard formats of satellite images in International Standard and Open Geospatial Consortium is GEOTIFF.

The latter group showed preference of GEOTIFF, as interoperability of images and software availability for GEOTIFF format exceed HDF. Another reason is that it is easy to overlap images with the other geographic information for further analyses.

We made a decision of HDF as standard format for the raw images in KMA. The first reason is the frequent receiving of meteorological satellite images. Forty-eight images for a satellite are received a day it is necessary for the conversion process from TDF to HDF and from HDF and TIFF. It does not seem that KMA has enough budget for the maintenance of the process in near future. The second reason is that we could not find the best method to save the extra metadata for the angles of observation for each pixel in the format of GEOTIFF. That means HDF is good for reserve all the metadata within the format. The last reason is the archiving process will have to continue in the format with the least effort to change shell programs, which had been developed for the images in HDF and TDF.

To overcome the shortcomings of HDF format, we will provide a tip for shareware to users who prefer GEOTIFF format.

4. Decision of Metadata

Metadata are composed of subgroups of basic information, raw data, binary data, projection information, propagation information, process information, and management information image data. The standard metadata in the number of ISO 19115-2 working draft has ten packages in it (shown as Fig 4), which has been discussed more than four years. But this standard gives more general gridded data including satellite images; the special characteristics of meteorological satellite images are not fully covered. So the profile standard of ISO 19115-2 working draft are prepared.

The first groups of metadata is about the basic

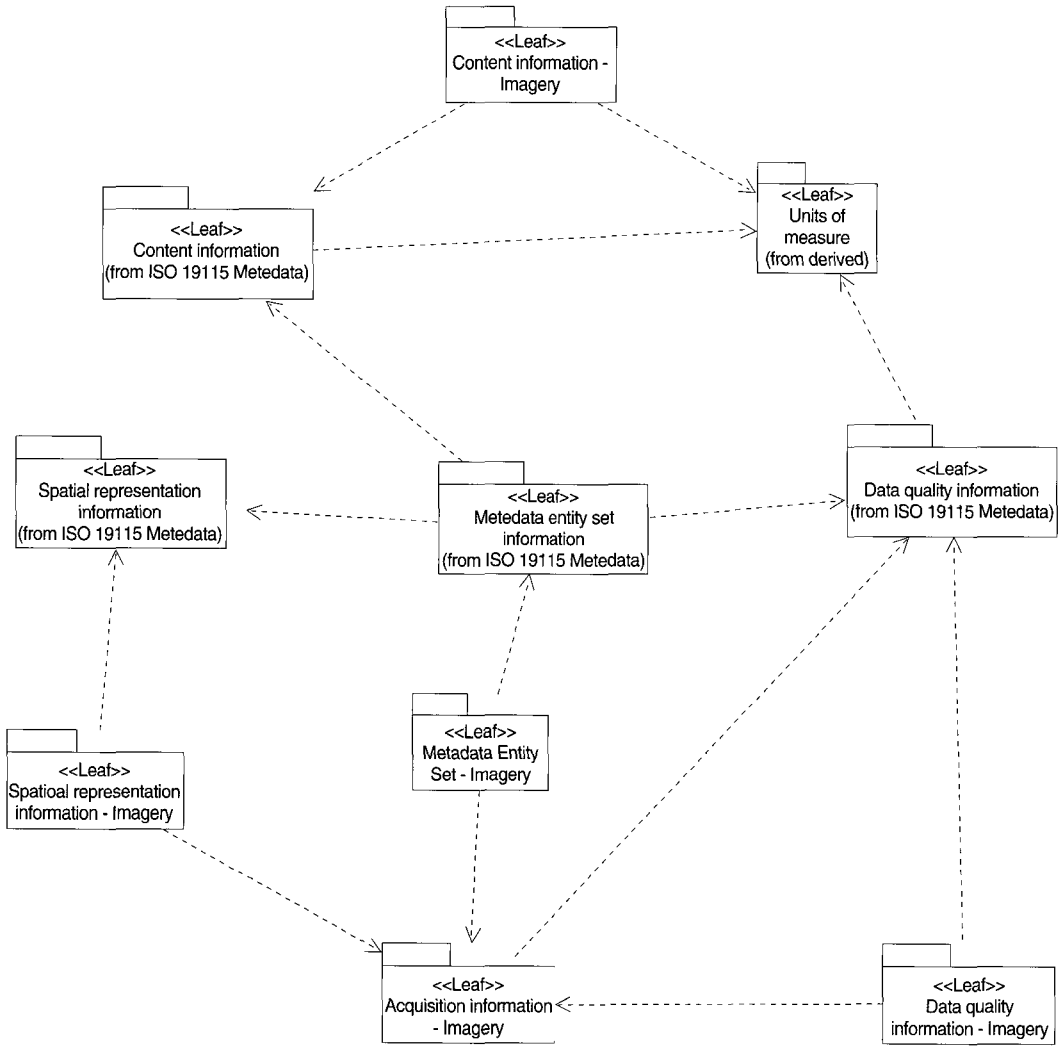

Fig. 4. Metadata Package in ISO working draft 19115-2.

information containing the names of satellites, coordinates of central points, x coordinates of the minimum boundary rectangle with low left corner, y coordinates of the minimum boundary rectangle with low left corner, x coordinates of the minimum boundary rectangle with low right corner, y coordinates of the minimum boundary the rectangle with low right corner, x coordinate of the minimum boundary rectangle with upper right corner, y coordinates of the minimum boundary rectangle with upper right corner, x coordinates of the minimum boundary rectangle with upper left corner, y coordinates of the minimum boundary rectangle with upper left corner, the recording media, the status of recording, the realm to be covered, the intensity of Asian Dust, the intensity of fog, and the intensity of precipitation.

The second metadata group on the raw file is composed of the angles of image capturing, the sun angles, the sun azimuth, the file types, the directory structure in network in computing environment, the media storage, the projection information, the

coordinates of control points, the time of capturing, the image width size, the image height size, the file name, the quality information, the data publicity, the status of deletion, the sources information to purchase, and the source to exchange and sensor information.

The third metadata group on binary file is composed of raw file information, image width size, image height size, file type, basic data code, projection information, coordinate of the realm, a bit of color, file size, date of creating, file name, openness, deletion, directory structure in network, location of media storage, satellite, satellite data code, and realm.

The fourth metadata group is about the image file, which is composed of the raw data information, the image width size, the image height size, the file type, the basic data code, projection, the coordinates of realm to be covered, the bit of color, the file size, the date of creation, the file name, the data quality, the publicity of data, the status of deletion, the directory structure in network, the location of media storage, the satellite, the satellite data code, and the realm to be covered.

The fifth metadata on projection includes ellipsoid information, the back scattering coefficients, the coordinate system, the starting point and the projection name.

The sixth metadata on propagation contains the data manager's name, the cost information, the contact point, and supplementary information. Process information also includes image processing module name and hardware equipment information. Metadata of management information calls for the manager name and the technician name.

Final metadata on satellite includes the name of satellite, the name of sensor, the capture GSDCROSS, the capture GSDALONG, the spatial resolution, the radiometric resolution, the sun angle TDI mode, the sun angle, the sun azimuth, the number of sensors, and the temporal resolution.

5. Decision on Naming Rule

Satellite launch and control institutes are not always the same; there is no standard of naming rules, so the principles of naming are not consistent. When the satellite managers are changed, it takes long time to have the reconnaissance of the name and many shell program related to each satellite images. There were fifteen ways to name satellite images in KMA, which cause confusion codes with date in interpretation.

The names of satellite are with small character including number such as coms, gms5, goes9, meteo5, meteo9, fy2c, fy2b, noaa12, noaa14, noaa 18, terra, aqua, qscat, orbv2, mtsatir, dmsp, and trmm. The second portion is assigned for the name of sensor or the distribution format such as svissr (for gmas5), gvar (for goes9), hri (meteo5), svissr (fy2c), avhrr (noaa##), modis (terra), modis, airs, amsre, amsu1, amsu2, ceresp, ceresm, hsb, gbad (for aqua), seawind (for qscat) seawifs (for orbv2), hirid, hrit (for mtsatir), ssmo (for dmsp), tmi, pr (for trimm) and mi (for coms).

For all the raw data has "raw" as code 1 and "zzz" as code 2, regardless of different satellite name. For the binary data may have six kinds of code 1 "vis" (visible band), "ir1"(infrared band with the average of 11 m), "ir2"(infrared band with the average of 12 m), "swir"(shortwave infrared band with the average of 3.7 m, "nir"(near infrared band with the average of

Table 1. Standardized Naming Rules for Satellite images.

Class	Name of Satellite	Name of Sensor	Code1	Code2	Code3	Date of Production	Extension
Form	Varchar(4~7)	varchar(2-10)	varchar(2-10)	Varchar(3-10)	varchar(1-2)	yyyymmddhhmn	varchar(3-4)
Example	gms5	modis	ir1	hirid	a	2000010101	gif

Table 3. Code 3 list for realm information in naming rules.

number	code3	explanation
1	f	full globe (full)
2	g	globe (global)
3	k	Korean peninsular (Korea)
4	a	asia (asia)
5	e	east asia (east asia)
6	w	wet asia (west asia)
7	q	iraq (iraq)
8	p	point data (point)
9	ca	asia & pacific in northern hemisphere
10	cs	COMS limited southern hemisphere
11	cn	COMS extended northern hemisphere
12	la	COMS local area
13	nh	northern hemisphere
14	sh	southern hemisphere
15	ac	asia composite

1~2 m), "wv"(water vapor with the average of 6.7 m).

For the basic images without any processing may have seven kinds of code 1, such as "ir"(infrared), "eir"(enhanced infrared), "rgb"(red-green-blue), "vis"(visible), "wv"(water vapor), "swir"(shortwave infrared) and "nir"(near infrared). Code 3 for basic image maybe one of the seven, such as zzz (default), iv (infrared and visible combination image), vv (visible channel only), web (web service image), mmt (METEO and MTSAT combination image), mgo (METEO and GOES combination image), and mgm (METEO and GMS combination image). AMSR-E has mic as a code 1, and may have different code 2 which includes wavelength in hertz and vertical or horizontal information, such as "18gh" 18GHz-H (AMSR-E).

Processed images have thematic acronyms as a code 1, pressure size and weather station number as a code 2. Code 1 is such as "fog"(fog), "cld"(cloud), "dust"(dust), "sst"(sea surface temperature), "sfc "(teperature), "amv"(atmospheric motion vector), "tovs"(top of vector scalar) "atovs"(top of vector scalar),"fire"(fire), "typn"(typhoon), "ozon"(ozone),

Table 4. Typical Examples of Naming Rules.

data	satellite	sensor	code1	code2	examples
raw data	gms5	svi	raw	zzz	gms5_svissr_raw_zzz_f_200311140300.pass
	mtsat1r	ssr	raw	zzz	mtsat1r_hrit_raw_ zzz_f_200611140300.hdf
	mtsat1r	hrit	raw	zzz	mtsat1r_hirid_raw_ zzz_s_200611140000.pass
	coms		le0	zzz	coms_mi_le0_zzz_ca_200901010000.hdf
binary data	noaa17	avhrr	vis	ch1	noaa17_avhrr_vis_ch1_a_200611140257.bin
	meteo5	hri	ir1	ch1	meteo5_hri_ir1_ch1_k_200611140300.bin
	mtsat1r	hrit	ir2	ch2	mtsat1r_hrit_ir2_ch2_f_200611140333.bin
	goes9	gvar	swir	ch2	goes9_gvar_swir_ch2_f_200611140327.bin
	gms5	svissr	wv	ch3	gms5_svissr_wv_ch3_a_200611140300.bin
image (basic)	mtsat1r	hirid	ir	ch2	mtsat1r_hirid_ir_ch2_a_200611140100.gif
	noaa12	avhrr	vis	web	noaa12_avhrr_vis_web_k_200611140100.gif
	meteo5	hri	wv	mmt	meteo5_hri_wv_mmt_g_200611140100.gif
	fy1d	mvisr	rgb	vv	fy1_mvisr_rgb_vv_f_200611140101.gif
	gms5	svissr	rgb	iv	gms5_svissr_rgb_iv_a_200611140600.gif
image (proces sed)	goes9	gvar	fog	zzz	goes9_gvar_fog_zzz_k_200611140600.gif
	goes9	gvar	dust	dcdc	goes9_gvar_dust_dcdc_a_200611140600.gif
	mtsat1r	hrit	dust	iddi	mtsat1r_hrit_dust_iddi_a_200611140600.gif
	gms5	svissr	sst	1dm	gms5_svissr_sst_1dm_a_200611140600.gif
	noaa17	avhrr	atovs	h850	noaa17_avhrr_atovs_h850_a_200611140641.gif
	terra	modis	cld	phase	terra_modis_cld_phase_a_200611270140.gif
	aqua	modis	humid	tpw	aqua_modis_humid_tpw_a_200611270320.gif
	aqua	amsre	sst	zzz	aqua_amsre_sst_zzz_a_200611270320.gif

"nid"(normalized intensity difference), rain (rain), humid (humidity), olr (outer long radiation). Code 3 is assigned for the realm to be covered in Table 3.

6. Meanings of Archiving

The efficient storage and management of meteorological satellite images is the first stage for system implementation for inner research groups of KMA and for service implementation for outer groups, who is to say, further users of satellite imagery.

Archiving of data in the past tends to be set a record for future utilization. Here we have to start to think how to utilize the archived images for further analyses and better services. Most steps of image archiving are focused to gather all the images, not to produce meaningful images by applying various algorithms and logics. Only cloud data have been drawn from the archived images at this year of 2005 and 2006. After this system is open to public and experts groups who want to have an access to satellite images, it is possible to download all the data with metadata and raw data in more popular format than before. More various algorithms can be applied to satellite images by providing data.

Interactive systems with public may be going to cause much burden on the officers who is in charge of data distribution. Here we have developed the semi-automatic procedure to give a notice to public request by compressing data with metadata and viewing thumbnail images. NASA and European Space Agency have developed similar systems, but there is no online service for data providing until now.

7. Conclusions

Satellite images of high temporal resolution need to distribute timely and a full set of metadata. Satellite Imagery Information System will enable managers of the meteorological satellite images to monitor the current stage from receiving to providing them beyond the organization. We arranged the steps of archiving procedure, metadata and naming rules, which were applied to all the satellite images in KMA and will be applied to satellite images to be obtained in the future.

Reference

Chang, E. M. and Shin, S. H., 2005. *A Study of Production Specification of Digital Elevation Model*. National Geographic Information Institute.

Chang, E. M., 2005. *Portrayal standard development for gridded data*, Korean Standard Association.

Chang, E. M., 2005. *A study for standard of orthophoto production specification*, National Geographic Information Institute .

International Standard Organization, *Geographic information Metadata Part2: Extensions for imagery and gridded data*, ISO TC 211 N1931 .

Korean Meteorological Agency, 2006,6. Note, *An Experiment and Technical Note for Standard Format Decision on Satellite Imagery.*

Ministry of Science and Technology, 2006. "*Strategic Study for Empowerment of Satellite image information*".

Sea Space, 2006, TerraScan 3.2 Manual, USA.

http://goes.gsfc.nasa.gov/

http://www.jaxa.jp/index_e.html

http://www.esa.int/esaCP/index.html

http://www.ngi.go.kr/index.html

http://www.kari.re.kr/

http://www.kmi.re.kr/