

KOMPSAT-2 Image data Manual for User

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Abbreviations and Acronyms

CAP	Catalogue And Product generation S/W
DSM	Direct Sensor Modeling
GSD	Ground Sample Distance
IRPE	Image Reception and Processing Element
KARI	Korea Aerospace Research Institute
KGRS-2	KOMPSAT-2 Grid Reference System
KGS	KOMPSAT-2 Ground Segment
KOMPSAT-2	KOrea Multi-Purpose SATellite
LEOP	Launch and Early Operations Phase
LOD	Line-Of-Detector
LOS	Line-Of-Sight
MCE	Mission Control Element
MS	Multi-Spectral
MSC	Multi-Spectral Camera
MTF	Modulation Transfer Function
PAD	Precision Attitude Determination
PAN	Panchromatic
PDTS	Payload Data Transmission Subsystem
POD	Precision Orbit Determination
PSS	Pass Scheduling System
RAS	Receiving and Archiving System
RFM	Rational Function Model
RPC	Rational Polynomial Coefficients
SNR	Signal to Noise Ratio
TDI	Time Division Integration

1. Introduction

The KOMPSAT-2 Image data Manual was designed and produced by KARI. This document intends for users of data supplied by KOMPSAT-2, and includes basic information about the KOMPSAT-2 system, processing & specification of KOMPSAT-2 imagery data and a brief overview & evaluated values of the theoretical concepts of image quality.

2. The KOMPSAT-2 System

2.1. Mission

The KOMPSAT-2 system allows the acquisition of PAN images at spatial resolution of 1 meter and MS images of 4 meters from space. The mission objectives of the KOMPSAT-2 System are to provide the following capabilities in the field of earth observation.

The KOMPSAT-2 system provides 1) surveillance of large scale disasters and their countermeasures, 2) acquisition of independent high resolution images for GIS, and 3) composition of printed maps and digitized image maps on domestic and overseas territories to users.

Images of the KOMPSAT-2 system may be used for balanced development of world territories and survey of natural resources. Also, KOMPSAT-2 will continue to support satellite earth observation activities that have been served by the KOMPSAT-1 system.

2.1.1. Overview

The Second KOrea Multi-Purpose SATellite (KOMPSAT-2) System consists of Space Segment and Ground Segment. The KOMPSAT-2 Space Segment consists of a single KOMPSAT-2 satellite flying on a sun-synchronous low earth orbit and the MSC as a primary payload. The KGS consists of the KARI site where is located in Daejeon. The KARI site is comprised of the primary Mission and Control Element and the Image data Reception and Processing Element. In order to satisfy the overall missions of the KOMPSAT-2 system the KARI site provides the capability to monitor and control the KOMPSAT-2 satellite, to conduct KOMPSAT-2 mission planning, and to receive, process, and distribute image data.

2.1.2. Mission Orbit Maintenance and Lifetime

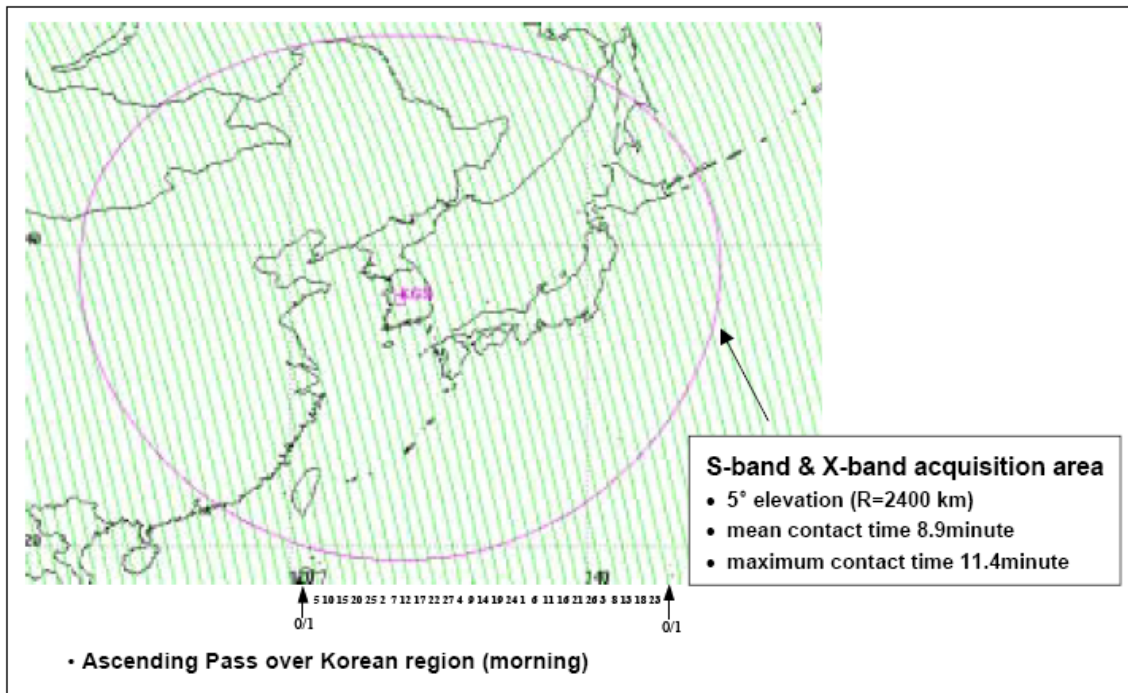


Figure 1 Example of the sequence of ascending passes

The Mission orbit of the KOMPSAT-2 is a sun-synchronous circular orbit with an altitude of 685.13 km. The Orbit inclination is 98.127 degrees and the eccentricity from 0. The satellite operates with a nominal local time of ascending nodes of 10:50 AM ± 10 -15 min. Figure 1 shows ascending passes (solid lines) of the KOMPSAT-2 for 28 day and a boundary of contact (circle) between the KOMSPAT-2 and the KARI site based on the minimum elevation for contact of 5 degrees. The satellite passes Korean region during the day along ascending orbits and during the night along descending orbits. The KOMPSAT-2 satellite is designed for an operational service life of 3 years on the mission orbit.

2.1.3. Imaging Performance

The KOMPSAT-2 will allow the generation of high resolution images with a GSD of better than 1 m for PAN data and 4 m for MS data with nadir viewing condition at the nominal altitude of 685 km. The MSC has a single PAN spectral band between 500 - 900 nm and 4 MS spectral bands between 450-900 nm. PAN imaging and MS imaging can be operated simultaneously during mission operations. The swath width is greater than or equal to 15 km at the mission altitude for PAN data and MS data. The system is equipped with a solid state recorder to record images not less than 1,000km long at the end of life. The satellite can be rolled up to ± 30 degrees off-nadir to pre-position the MSC swath. The KOMPSAT-2 can provide across-

track stereo images by multiple passes of the satellite using off-nadir pointing capability. The satellite is compatible with daily revisit operation by off-nadir pointing with degraded GSD. Also, the image products according to the requested products quality standard can be made within one (1) day after satellite passes over the KGS.

2.2. MSC

The KOMPSAT-2 payload consists of the MSC. The MSC is a high spatial resolution imaging sensor which collects visible image data of the earth's sunlit surface.

The MSC, the primary payload for the KOMPSAT-2, is a pushbroom-scanned sensor which incorporates a single nadir looking telescope. The sensor is submerged and rigidly attached to the spacecraft and the optical boresight of the telescope is aligned with the spacecraft +Z direction (nadir). The MSC collects PAN and MS monoscopic images of the earth. Stereoscopic images are made by ground processing of the images from multiple orbits. The MSC pointing is accomplished by rolling the spacecraft, as needed, so that the line of sight of the MSC may pass over the desired location or swath.

At the nominal mission altitude with the spacecraft nadir pointing, the MSC collects data with a GSD of 1 meter for PAN and 4 meters for MS data and with a swath width of approximately 15 km. The MSC is designed to operate with a duty cycle of up to 20 % per orbit.

The MSC characteristics are summarized as follows:

- PAN GSD: 1m
- MS GSD: 4m
- PAN band wavelength: 500~900 nm
- MS bands: 4 bands
- Swath width: 15 km \pm 2%
 - Effective swath width: 13.6 km
- Life time: 3 years
- Duty cycle: 20% per orbit
- SNR: 100 for PAN and MS
- MTF: 8% for PAN, 12% for MS (excluding linear motion, jitter, and drift of satellite)
- Quantization: 10 bits
- PAN Channel
 - Spectral region: 500nm - 900nm
- MS Channel
 - Spectral region

MS1 (Green): 520nm - 600nm

MS2 (Blue): 450nm - 520nm

MS3 (NIR): 760nm - 900nm

MS4 (Red): 630nm - 690nm

- KOMPSAT-2 Mission Requirements:

- Sun synchronous orbit
- Altitude: 685.13km
- Inclination: 98.127°
- Local time of ascending node: 10:50 AM

3. KOMPSAT-2 imagery data

3.1. Standard Products

The standard processing level of the MSC image data that is provided to the users is Level 1R or Level 1G.

Figure 3 shows the sequence of MSC image data processing. The KOMPSAT-2 IRPE processes raw data received from the antenna to Level 1A automatically. Level 1R and Level 1G image data are only processed if there is a request to do. Processing levels are defined below.

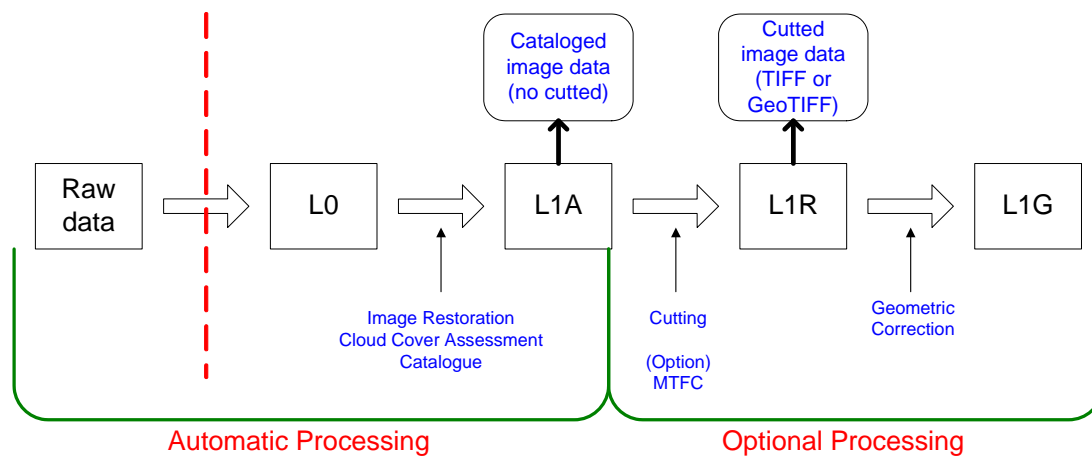


Figure 2 MSC image data Level processing

3.1.1. Processing Level Definition of MSC image data product

< Level 1R >

Level 1R data is the image data cut by catalogue (15000 column X 15500 line), optionally MTF corrected and stored by Tiff format. (Generally, the remote sensing satellite image data is radiometrically corrected in the processing step of Level 1R. However for the MSC image data it is not, because MSC image data is already radiometrically corrected by the NUC (Non-Uniformity Correction) within the MSC.). If user wants, MTFC (MTF correction or MTF compensation) will be applied to the Level 1R image data optionally.

< Level 1G >

Level 1G data is geometrically corrected from Level 1R image data using KOMPSAT-2 ancillary data only and stored by GeoTiff format. Level 1G data projected onto ellipsoid (h=0),

map oriented and terrain displacement. If user wants, MTFC (MTF correction or MTF compensation) will be applied to the Level 1R image data optionally.

3.4. KOMPSAT-2 Grid Reference System

The KGRS-2 consists of a set of grid points aligned with the KOMPSAT-2 orbital ground track, numbered with reference to the earth's geographic coordinate system. The derivations in the following sections are based upon an earlier derivation for the KOMPSAT-1 Grid Reference System. The KGRS-2 is designed to be a right-handed (K, J) system, with the K-coordinate denoting relative longitudinal position on the earth's surface (increases to the right on a map), and the J-coordinate denoting relative latitudinal position (increases upwards on a map). The numbering of K begins with the prime meridian (0 longitude) for $K = 1$, with K increasing as longitude increases. The numbering of J uses a fixed value of $J = 1000$ at all points on the equator, with J increasing as latitude increases.

The definition of the KGRS-2 constants depends upon certain orbital parameters for the KOMPSAT-2 satellite. These orbital parameters are:

- $i = 98.127$ (orbital inclination)
- $e = 0.0$ (eccentricity of circular orbit)
- $h = 685.13$ km (altitude of orbit)
- $a = 7063.275$ km (orbital semi-major axis)
- $rep = 409$ orbits (repetition rate of orbital cycle)
- $p = 5907.72$ s (period of orbit (seconds))
- $s = 13.6$ km (effective swath)

The KGRS-2 coordinate system is applicable for all latitudes reached by the KOMPSAT-2 spacecraft. Due to the inclination of the KOMPSAT-2 ($i = 98.127$), the applicable latitude range is from -81.873 (at an orbital elongation of -90) to $+81.873$ (at an orbital elongation of $+90$). Within that latitude range, the J coordinates are numbered from $J = 332$ to $J = 1668$, with $J = 1000$ at the equator. The K coordinates range from $K = 1$ to $K = 2863$.

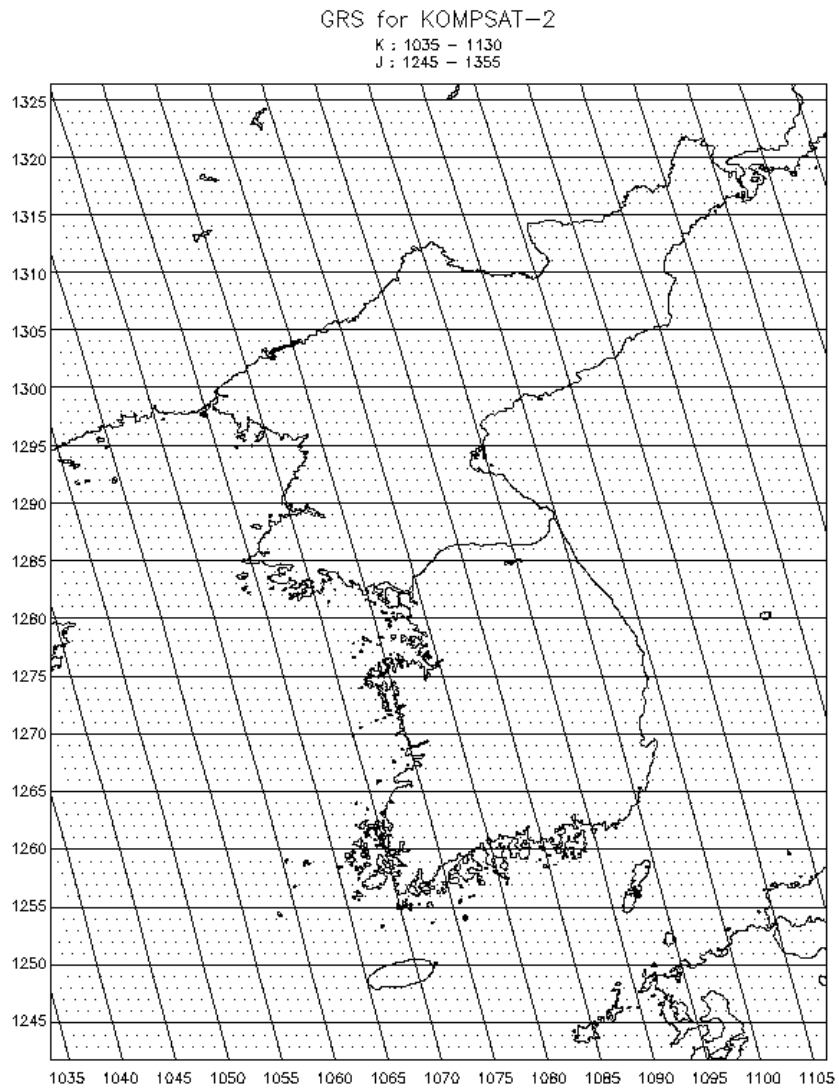


Figure 3 Example of KGRS-2 nearby Korea

4. MSC image data format

4.1. File Naming Convention

4.1.1. TIFF Level 1R

MSC_YYMMDDHhmmss_nnnnn_PPPPrrrrPAxx_tt.tif - PAN

MSC_YYMMDDHhmmss_nnnnn_PPPPrrrrMXAxxB_tt.tif - MS

YYMMDDHhmmss – Scene center time in UTC

nnnnn – Orbit number

PPPP – Path number

rrrr – Row number

P – P(Pan only)

MX - M(MS only) X(1,2,3,4)

A – P(positive), N(negative) tilt angle

xx – Tilting angle(first two digit)

B – G(Green), B(Blue), N(NIR), R(Red)

tt – 1R

4.1.2. GeoTIFF Level 1G

MSC_YYMMDDHhmmss_nnnnn_PPPPrrrrPAxx_tt.tif - PAN

MSC_YYMMDDHhmmss_nnnnn_PPPPrrrrMXAxxB_tt.tif - MS

YYMMDDHhmmss – Scene center time in UTC

nnnnn – Orbit number

PPPP – Path number

rrrr –Row number

P – P(Pan only)

MX - M(MS only) X(1,2,3,4)

A – P(positive), N(negative) tilt angle

xx – Tilting angle(first two digit)

B – G(Green), B(Blue), N(NIR), R(Red)

tt – 1G

4.1.3. Tiff and GeoTIFF – Ancillary text file

MSC_YYMMDDHhmmss_nnnnn_PPPPrrrrPAxx_tt.txt - PAN
MSC_YYMMDDHhmmss_nnnnn_PPPPrrrrMXAxxB_tt.txt - MS
MSC_YYMMDDHhmmss_nnnnn_PPPPrrrrPAxx_tt.eph - PAN
MSC_YYMMDDHhmmss_nnnnn_PPPPrrrrMXAxxB_tt.eph - MS
MSC_YYMMDDHhmmss_nnnnn_PPPPrrrrPAxx_tt.rpc - PAN
MSC_YYMMDDHhmmss_nnnnn_PPPPrrrrMXAxxB_tt.rpc - MS

YYMMDDHhmmss – Scene center time in UTC

nnnnn – Orbit number

PPPP – Path number

rrrr – Row number

P – P(Pan only)

MX - M(MS only) X(1,2,3,4)

A – P(positive), N(negative) tilt angle

xx – Tilting angle(first two digit)

B – G(Green), B(Blue), N(NIR), R(Red)

tt – 1R or 1G

4.1.4. Browse & Thumbnail

MSC_YYMMDDHhmmss_nnnnn_PPPPrrrrTt_br.jpg
MSC_YYMMDDHhmmss_nnnnn_PPPPrrrrTt_tn.jpg
YYMMDDHhmmss – The first imaging time (UTC)
nnnnn – Orbit number
PPPP – Path number
rrrr – The first row number
T – P(Pan only) M(MS only) B(Pan+MS)
tt – 1R or 1G

4.2. Archived Media

The MSC image data will be basically archived in DVD or CD for Users.

4.3. Composition in an Archived media

4.3.1. TIFF and GeoTIFF

The composition in an archived media for storing plural scenes in one media is the same as the GeoTiff (Level 1G or Level 1R) or Tiff (Level 1R) format. However, in case of TIFF & GeoTIFF, each 'SCENE_NNN' directory has image files, the number of which is the same as the number of image bands, and the three files of a Browse image data, a Thumbnail image data and ancillary text file. The "readme.txt" file in Root directory has the information of all files in the archived media.

5. GeoTIFF and Ancillary data

5.1. GeoTIFF Overview

The GeoTIFF tags conform to a hierarchical data structure of tags and keys. This is similar to the tags which have been implemented in the "basic" and "extended" TIFF tags already supported in TIFF Version 6 specification. A GeoTIFF library and software tool is required to access GeoTIFF data. The GeoTIFF homepage (<http://www.remotesensing.org/geotiff>) is offered information about the GeoTIFF library and software tool since it has been open software. The following references are highly recommended to comprehend this data format. These are also designate in GeoTIFF website.

GeoTIFF Format Specification Version: 1.8.2

5.2. The version of GeoTIFF

The GeoTIFF file is produced based on GeoTIFF Revision 1.0.

5.3. The Content of an ancillary data text file

The ancillary data text file consists of ephemeris information data file and general information data file. The ephemeris information data file uses the "EPH" file extension and general information data file uses the "TXT" file extension

5.3.1 The ephemeris information data file

Field name	Format	Remark
IMG_ACQISITION_START_TIME	%4d %2d %2d %2d %2d %8.6f	Imaging start time (YYYY MM DD hh mm ss.sssss). UTC
IMG_ACQISITION_END_TIME	%4d %2d %2d %2d %2d %8.6f	Image end time (YYYY MM DD hh mm ss.sssss).

BEGIN_EPHEMERIS_BLOCK		
NMR_EPH	%d	Ephemeris Number
EPH_TIME	%4d %2d %2d %2d %2d %8.6f	Ephemeris Time (YYYY MM DD hh mm ss.ssssss). UTC
EPH_POD_POS_XYZ_ECEF_KM	3[%10.5f]	Position X, Y, Z (WGS84, ECEF) (Km)
EPH_POD_VEL_XYZ_ECEF_KMS	3[%11.7f]	Velocity X, Y, Z (WGS84, Km/sec)
EPH_PAD_RPY_DEG	3[%14.9f]	Attitude Angle Roll, Pitch, Yaw (degree)
EPH_SUN_ANGLE_DEG	2[%12.7f]	Solar Azimuth Angle, Solar Elevation Angle (degree)
END_EPHEMERIS_BLOCK		
AUX_SATELLITE_NAME	%s	KOMPSAT2
AUX_SATELLITE_SENSOR	%s	KOMPSAT2 Sensor name(MSC)
AUX_TILT_ANGLE_ROLL_DEG	%7.3f	Roll Tilt angle (degree)
AUX_TILT_ANGLE_PITCH_DEG	%7.3f	Pitch Tilt angle (degree)
AUX_BITS_PER_PIXEL	%d	Bit per Pixel
AUX_SAMPLES_PER_LINE_PAN+MS	%d	Sample per Line in PAN+MS
AUX_LINES_PER_IMAGE_PAN+MS	%d	Line number in PAN+MS
AUX_SCENE_CENTER_XY_PIXEL	%d %d	Pixel value of Image center for Pan and MS (pixel) (across-track, along-track)
AUX_IMAGE_GSD_METER	2[%5.3f]	P+MS GSD(meter) (along-track, across-track)
AUX_LINE_SCAN_TIME_USEC	[%12.9f]	Line Scan Time for PAN and MS(sec)
AUX_IMAGE_SATELLITE_AZIMUTH_DEG	%f	Satellite azimuth angle(degree) Angle between the projection of the image center and local counted from local north(clock-wise)
AUX_IMAGE_SATELLITE_INCIDENCE_DEG	%f	Ground incidence angle at the image center(degree)
AUX_IMAGE_PAD_POD_FLAG	%s	POD/PAD (Yes or No) (TRUE, FALSE)
AUX_PROJECTION_NAME	%s	Projection name (UTM, TM)
AUX_PROJECTOIN_PARAMETER	%s	Parameter value (UTM: Hemisphere, Zone #, TM: West, Middle, East) (ex: HEMISPHERE_ZONE23, TM_MIDDLE)
AUX_PROJECTOIN_ELLIPSOID	%s	Ellipsoid name (Bassel, WGS84, etc)
AUX_RESAMPLING_NAME	%s	Resampling method (NN (Nearest Neighbor, BL (Bilinear), CC (Cubic Convolution))

AUX_LOCATION_KGRS_KJ	%d %d	KOMPSAT-2 Grid Reference System (K, J)
AUX_IMAGE_SHIFT_TO_ALONG	%d	Image shift along track
AUX_IMAGE_ORBIT_NUMBER	%d	Image orbit number
AUX_IMAGE_CENTER_LATLONG_DEG	2[%13.8f]	Center Latitude and Longitude (degree)
AUX_IMAGE_CENTER_ALTITUDE	%f	Satellite altitude from WGS 84 ellipsoid at the image center(meters)
AUX_IMAGE_TL_LATLONG_DEG	2[%13.8f]	Top Left(0,0) Latitude and Longitude (degree)
AUX_IMAGE_TC_LATTONG_DEG	2[%13.8f]	Top Center(samples/2,0) Latitude and Longitude (degree)
AUX_IMAGE_TR_LATTONG_DEG	2[%13.8f]	Top Right(samples,0) Latitude and Longitude (degree)
AUX_IMAGE_BL_LATLONG_DEG	2[%13.8f]	Bottom Left(0,lines) Latitude and Longitude (degree)
AUX_IMAGE_BC_LATTONG_DEG	2[%13.8f]	Bottom Center(samples/2,lines) Latitude and Longitude (degree)
AUX_IMAGE_BR_LATTONG_DEG	2[%13.8]	Bottom Right(samples, lines) Latitude and Longitude (degree)
AUX_STRIP_ACQ_DATE_UT	4d% 2d% 2d%	Strip imaging Date (YYYYMMDD)
AUX_STRIP_ACQ_START_UT	%2d %2d %8.6f	Strip imaging start time (hhmmss.ssssss)
AUX_STRIP_ACQ_CENTER_UT	%2d %2d %8.6f	Strip imaging center time (hhmmss.ssssss)
AUX_STRIP_ACQ_END_UT	%2d %2d %8.6f	Strip imaging end time (hhmmss.ssssss)
AUX_STRIP_ACQ_DURATION_SEC	[%12.9f]	Strip Imaging duration (sec)

5.3.2 General information data file

Field Name	Format	Remark
INST_LAST_NUC_DATE	%4d %2d %2d	Last update date of NUC (YYYYMMDD)

INST_LAST_GEO_DATE	%4d %2d %2d	Last update date of Geometric Cal/Val parameters(YYYYMMDD)
INST_COMPRESSION_FLAG	%s	Compression Yes or No (ex: TRUE, FALSE)
INST_COMPRESSION_RATIO_OF_PAN	%d	PAN Compression Ratio
INST_COMPRESSION_RATIO_OF_MS	4[%d]	MS1, MS2, MS3, MS4 Compression Ratio (ex: 1 2 3 4)
INST_TDI_GAIN_OF_PAN	%d	PAN TDI level (gain)
INST_TDI_GAIN_OF_MS	4[%d]	MS1, MS2, MS3, MS4 TDI level (gain) (ex: 1 2 3 4)
INST_ELEC_GAIN_OF_PAN	13[%d]	PAN Electrical Gain (12) (ex: 1 2 3 4 5 6 1 2 3 4 5 6)
INST_ELEC_GAIN_OF_MS	5[%d]	MS Electrical Gain (4) (ex: 1 2 3 4)
INST_ELEC_OFFSET_OF_PAN	13[%d]	PAN Electrical Offset (12) (ex: 1 2 3 4 5 6 1 2 3 4 5 6)
INST_ELEC_OFFSET_OF_MS	5[%d]	MS Electrical Offset (4) (ex: 1 2 3 4)
INST_BAND_DISPLAY	%s	Band identification (PAN, R, B, NIR, R)
INST_BAND_WIDTH	%d	Spectral Band width in micro(400, 80, 70, 140, 60)
INST_PAN_CCD_ALIGNMENT	4[%12.7f]	PAN CCD alignment (meter)
INST_MS_CCD_ALIGNMENT	4[%12.7f]	MS CCD alignment (meter)
INST_PAN_FOCAL_LENGTH	%[%12.8f]	PAN Focal length(meter)
INST_MS_FOCAL_LENGTH	%[%12.8f]	MS Focal length(meter)
INST_CCD_MODE	%s	PAN and MS of Primary or Redundant
CAL_MTF_OF_PAN	%d	PAN MTF value at Nyquist Frequency
CAL_MTF_OF_MS	4[%d]	MS MTF value at Nyquist Frequency
CAL_RADIANCE_GAINOFFSET_PAN	2[%6.2f %6.2f]	Gain/Offset to convert DN to Radiance in PAN
CAL_RADIANCE_GAINOFFSET_MS	4[%6.2f %6.2f]	Gain/Offset to convert DN to Radiance in MS
BEGIN_CALGCP_BLOCK		
NMR_GCP	%d	GCP Number
CAL_GCP_XY_LLH_UTM	5[%14.9f]	GCP (X, Y, Lat, Long, Height) (WGS84, UTM)
END_CALGCP_BLOCK		
CAL_DEM_FILE	%s	File name for DEM data CALDEM_071122100001_12345_00010001PP10_1G.txt

		CALDEM_071122100001_12345_00010001MP1 0_1G.txt NULL (no DEM)
AUX_FILE_NAME	%s	Each PAN, MS1, MS2, MS3 and MS4 Image File Name
AUX_STRIP_ID	%s	Associated data strip ID
AUX_STRIP_BEGIN_END	%d %d	First and last line of the image into the data strip
AUX_IMAGE_LEVEL	%s	Image Level (ex: L1A, L1R, L1G)
AUX_PRODUCT_LEVEL	%s	Product Level (ex: L1A, L1R, L1G)
AUX_CLOUD_STATUS	%d	Cloud Status
AUX_IMAGE_QUALITY	%s	Image Quality
AUX_IMAGE_BAD_LINES	%d	Bad/reduced quality lines
AUX_IMAGE_BAD_COLS	%d	Bad/reduced quality columns
AUX_SATELLITE_NAME	%s	Satellite Name (KOMPSAT2)
AUX_SATELLITE_SENSOR	%s	Sensor Name (MSC)
AUX_TILT_ANGLE_ROLL_DEG	%7.3f	Roll Tilt angle (degree)
AUX_TILT_ANGLE_PITCH_DEG	%7.3f	Pitch Tilt angle (degree)
AUX_BITS_PER_PIXEL	%d	Bit per Pixel
AUX_SAMPLES_PER_LINE_PAN+MS	%d	Sample per Line in PAN+MS
AUX_LINES_PER_IMAGE_PAN+MS	%d	Line number in PAN+MS
AUX_SCENE_CENTER_XY_PIXEL	%d %d	Pixel value of Image center for PAN and MS (along-track, across-track)
AUX_IMAGE_GSD_METER	2[%5.3f]	PAN+MS GSD(meter) (along-track, across- track)
AUX_LINE_SCAN_TIME_USEC	%f	Line Scan Time for PAN and MS(sec)
AUX_IMAGE_SATELLITE_AZIMUTH_DEG	%f	Satellite azimuth angle(degree) Angle between the projection of the image center and local counted from local north(clock-wise)
AUX_IMAGE_SATELLITE_INCIDENCE_DEG	%f	Ground incidence angle at the image center(degree)
AUX_IMAGE_PAD_POD_FLAG	%s	POD/PAD (Yes or No) (TRUE, FALSE)
AUX_IMAGE_MTF_FLAG	%s	MTF (Yes or No) (TRUE, FALSE)
AUX_PROJECTION_NAME	%s	Projection name (UTM, TM)
AUX_PROJECTOIN_PARAMETER	%s	Parameter value (UTM: Hemisphere, Zone #, TM: West,

		Middle, East) (ex: HEMISPHERE_ZONE23, TM_MIDDLE)
AUX_PROJECTOIN_ELLIPSOID	%s	Ellipsoid name (Bassel, WGS84, etc)
AUX_RESAMPLING_NAME	%s	Resampling method (NN (Nearest Neighbor, BL (Bilinear), CC (Cubic Convolution))
AUX_LOCATION_KGRS_KJ	%d %d	KOMPSAT2 Grid Reference System (K, J)
AUX_IMAGE_SHIFT_TO_ALONG	%d	Image shift along track
AUX_IMAGE_ORBIT_NUMBER	%d	Image orbit number
AUX_IMAGE_CENTER_LATLONG_DEG	2[%13.8f]	Center Latitude and Longitude (degree)
AUX_IMAGE_CENTER_ALTITUDE	%f	Satellite altitude from WGS 84 ellipsoid at the image center(meters)
AUX_IMAGE_TL_LATLONG_DEG	2[%13.8f]	Top Left(0,0) Latitude and Longitude (degree)
AUX_IMAGE_TC_LATTONG_DEG	2[%13.8f]	Top Center(samples/2,0) Latitude and Longitude (degree)
AUX_IMAGE_TR_LATTONG_DEG	2[%13.8f]	Top Right(samples,0) Latitude and Longitude (degree)
AUX_IMAGE_BL_LATLONG_DEG	2[%13.8f]	Bottom Left(0,lines) Latitude and Longitude (degree)
AUX_IMAGE_BC_LATTONG_DEG	2[%13.8f]	Bottom Center(samples/2,lines) Latitude and Longitude (degree)
AUX_IMAGE_BR_LATTONG_DEG	2[%13.8]	Bottom Right(samples, lines) Latitude and Longitude (degree)
AUX_STRIP_ACQ_DATE_UT	4d% 2d% 2d%	Strip imaging Date (YYYYMMDD)
AUX_STRIP_ACQ_START_UT	%2d %2d %8.6f	Strip imaging start time (hhmmss.ssssss)
AUX_STRIP_ACQ_CENTER_UT	%2d %2d %8.6f	Strip imaging center time (hhmmss.ssssss)
AUX_STRIP_ACQ_END_UT	%2d %2d %8.6f	Strip imaging end time (hhmmss.ssssss)
AUX_STRIP_ACQ_DURATION_SEC	[%12.9f]	Strip Imaging duration (sec)
AUX_IMAGE_L0_PROCESSED_UT	%4d %2d %2d %2d	Time that process the Level 0 (YYYYMMDDHHMMSS.SS)

	%2d %5.2f	
AUX_IMAGE_L1A_PROCESSED_UT	%4d %2d %2d %2d %2d %5.2f	Time that process the Level 1A (YYYYMMDDHHMMSS.SS)
AUX_IMAGE_L1R_PROCESSED_UT	%4d %2d %2d %2d %2d %5.2f	Time that process the Level 1R (YYYYMMDDHHMMSS.SS)
AUX_IMAGE_MINMAX_OF_PAN+MS	%d %d	Maximum and Minimum DN value in PAN+MS
AUX_RECEIVED_STATION_NAME	%s	Ground station Name that received
AUX_RECEIVED_STATION_ LOCATION_LATLONG_DEG	2[%13.8f]	Location of Latitude, Longitude(degree)
AUX_PROCESSED_STATION_NAME	%s	Ground station Name that processed
AUX_PROCESSED_STATION_ LOCATION_LATLONG_DEG	2[%13.8f]	Location of Latitude, Longitude(degree)
AUX_PROCESSED_PRODUCER	%s	Operator name (ex: OperatorA)
AUX_PROCESSED_SW_VER	%s	Name of Image data processing S/W
AUX_REQUESTER_NAME	%s	Requester Name
AUX_REQUESTER_COMPANY	%s	Request Company
AUX_REQUESTER_DATETIME	%s	(YYYYMMDDHHMM)
COPYRIGHT	%s	Copyright and restricated use
LICENCE	%s	Licencing information

6. RPC

The RPC for the KOMPSAT-2 MSC sensor is generated from the resulted KOMPSAT-2 DSM using the RFM.

KOMPSAT-2 RFM is forward method which can be calculated from ground coordinate (Latitude, Longitude, Height) to image coordinate (Column, Row). Auxiliary file(***.rpc, NITF) gives RPC parameters for “ground to image” location model.

A least-squares approach is utilized to determine the RPC a_n, b_n and d_n from a three-dimensional ground coordinates generated using the KOMPSAT-2 MSC camera model. The basic relationship of the KOMPSAT-2 MSC camera model that describes the ground coordinates in term of sensor coordinates is realized by the co-linearity condition in which the KOMPSAT-2 MSC perspective center, an image point and the corresponding ground point are assumed to be on one straight line. The 3D ground coordinates of object points in RFM are generated by intersecting the rays emanating from a 2-D grid of image with a number of constant elevation planes. (See Figure 12)

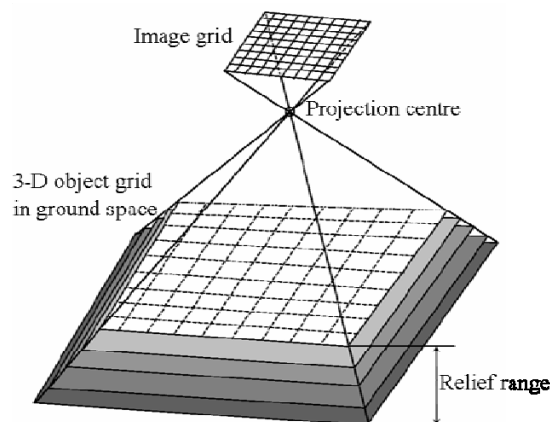


Figure 4 Use a 3-D object grid to solve for the RFM

In the RFM, image pixel coordinates (c, r) are expressed as the ratios of polynomials of ground coordinates (X, Y, Z). In order to improve the numerical stability of equations, the two image coordinates and three ground coordinates are normalized to fit the range from -1.0 to 1.0 using offset values and scale factors. Coefficients of the RFM are called RPC. In general, distortions caused by optical projection can be represented by ratios of first order polynomials, while corrections such as earth curvature, atmospheric refraction, and lens distortion etc., can be well approximated by second order polynomials. Some other unknown distortions with high order components can be modeled using a RFM with third order polynomials.

The RFM is given as;

$$c_n = \frac{p1(X_n, Y_n, Z_n)}{p2(X_n, Y_n, Z_n)}$$

$$r_n = \frac{p3(X_n, Y_n, Z_n)}{p4(X_n, Y_n, Z_n)}$$

$$p2 \equiv p4$$

r_n, c_n : the normalized row and column index of pixels in image.

X_n, Y_n, Z_n : the normalized coordinate values of object points in ground space(Longitude, Latitude, Height)

$p1(X_n, Y_n, Z_n)$, $p2(X_n, Y_n, Z_n)$ and $p3(X_n, Y_n, Z_n)$ are expressed as

$$p1(X_n, Y_n, Z_n) = a_0 + a_1X + a_2Y + a_3Z + a_4X^2 + a_5XY + a_6XZ + a_7Y^2 + a_8YZ + a_9Z^2 + a_{10}X^3 + a_{11}X^2Y + a_{12}X^2Z + a_{13}XY^2 + a_{14}XYZ + a_{15}XZ^2 + a_{16}Y^3 + a_{17}Y^2Z + a_{18}YZ^2 + a_{19}Z^3$$

$$p2(X_n, Y_n, Z_n) = 1 + b_1X + b_2Y + b_3Z + b_4X^2 + b_5XY + b_6XZ + b_7Y^2 + b_8YZ + b_9Z^2 + b_{10}X^3 + b_{11}X^2Y + b_{12}X^2Z + b_{13}XY^2 + b_{14}XYZ + b_{15}XZ^2 + b_{16}Y^3 + b_{17}Y^2Z + b_{18}YZ^2 + b_{19}Z^3$$

$$p3(X_n, Y_n, Z_n) \equiv p4(X_n, Y_n, Z_n) = 1 + d_1X + d_2Y + d_3Z + d_4X^2 + d_5XY + d_6XZ + d_7Y^2 + d_8YZ + d_9Z^2 + d_{10}X^3 + d_{11}X^2Y + d_{12}X^2Z + d_{13}XY^2 + d_{14}XYZ + d_{15}XZ^2 + d_{16}Y^3 + d_{17}Y^2Z + d_{18}YZ^2 + d_{19}Z^3$$

The total number of RPC for each polynomial is $\{(N+1)(N+2)(N+3)\}/6$. For example, when N is 3, each $p1(X_n, Y_n, Z_n)$, $p2(X_n, Y_n, Z_n)$ and $p3(X_n, Y_n, Z_n)$ equation becomes a 3rd order three-dimensional polynomial with 20 coefficients.

The normalization of the coordinates is computed using the following equations:

$$r_n = \frac{r - r_o}{r_s}, \quad c_n = \frac{c - c_o}{c_s},$$

$$X_n = \frac{X - X_o}{X_s}, \quad Y_n = \frac{Y - Y_o}{Y_s}, \quad Z_n = \frac{Z - Z_o}{Z_s}$$

r_o, c_o, X_o, Y_o and Z_o are the offset values

$$r_o = \frac{r_{\max} + r_{\min}}{2}$$

$$c_o = \frac{c_{\max} + c_{\min}}{2}$$

$$X_o = \frac{X_{\max} + X_{\min}}{2}$$

$$Y_o = \frac{Y_{\max} + Y_{\min}}{2}$$

$$Z_o = \frac{Z_{\max} + Z_{\min}}{2}$$

r_s , c_s , X_s , Y_s and Z_s are the scale factors

$$r_s = \frac{r_{\max} - r_{\min}}{2}$$

$$c_s = \frac{c_{\max} - c_{\min}}{2}$$

$$X_s = \frac{X_{\max} - X_{\min}}{2}$$

$$Y_s = \frac{Y_{\max} - Y_{\min}}{2}$$

$$Z_s = \frac{Z_{\max} - Z_{\min}}{2}$$

7. Contact

7.1. How to access the KOMPSAT-2 imagery data you want to get?

This section describes the KOMPSAT-2 data policy. KARI is a non-profit organization supported and funded by the government of the Republic of Korea.

KARI has been granted the property rights, distribution rights and sales rights of the KOMPSAT-2 products on behalf of the Korean government. According to the decision from the Korean government regarding worldwide commercialization of KOMPSAT-2 imagery, KARI assigns Korea Aerospace Industry (hereinafter referred to as the "KAI") and SPOT Image inc. in promoting the KOMPSAT-2 sales. KAI is responsible for the customers incorporated or with a billing office in the United States of America, UAE, Saudi Arabia, Kuwait, Qatar, Oman, Yemen, Egypt, Iran, Iraq, Jordan, Lebanon, and Syria. SPOT Image is responsible for the customers incorporated or with a billing office in the rest of the world except Korean peninsula.

KARI shall be entitled to distribute the KOMPSAT-2 products to Category-1 customers directly and without any limitations. A Category-1 customer means any third parties requesting products within a Category-1 projects as identified by KARI. Category-1 projects mean any scientific and educational research projects, demands from the Korean government and specific Public Relations activities managed on a non-commercial and non-profit basis.

KARI and/or its representative will operate, maintain and manage its own archive and catalog search system for the customers.

KARI has developed the KOMPSAT-2 satellite as per the national space development plan, so the needs of the Korean government shall be considered with the highest priority, pursuant to the Korean national policy and benefits. Furthermore, the distribution and sales of the KOMPSAT-2 products and/or services shall be in accordance with the Korean government's policy and national interests. When necessary and for the Korean government, KARI shall be entitled to limit the distribution and sales of the KOMPSAT-2 products subject to the Korean government distribution guidelines.

7.2. Homepage

The customers for KOMPSAT-2 data can access the search and catalog system for KOMPSAT-2 data through the KARI homepage (www.kari.re.kr) or homepage of the Space Capture2 (www.spacecapture.kr).

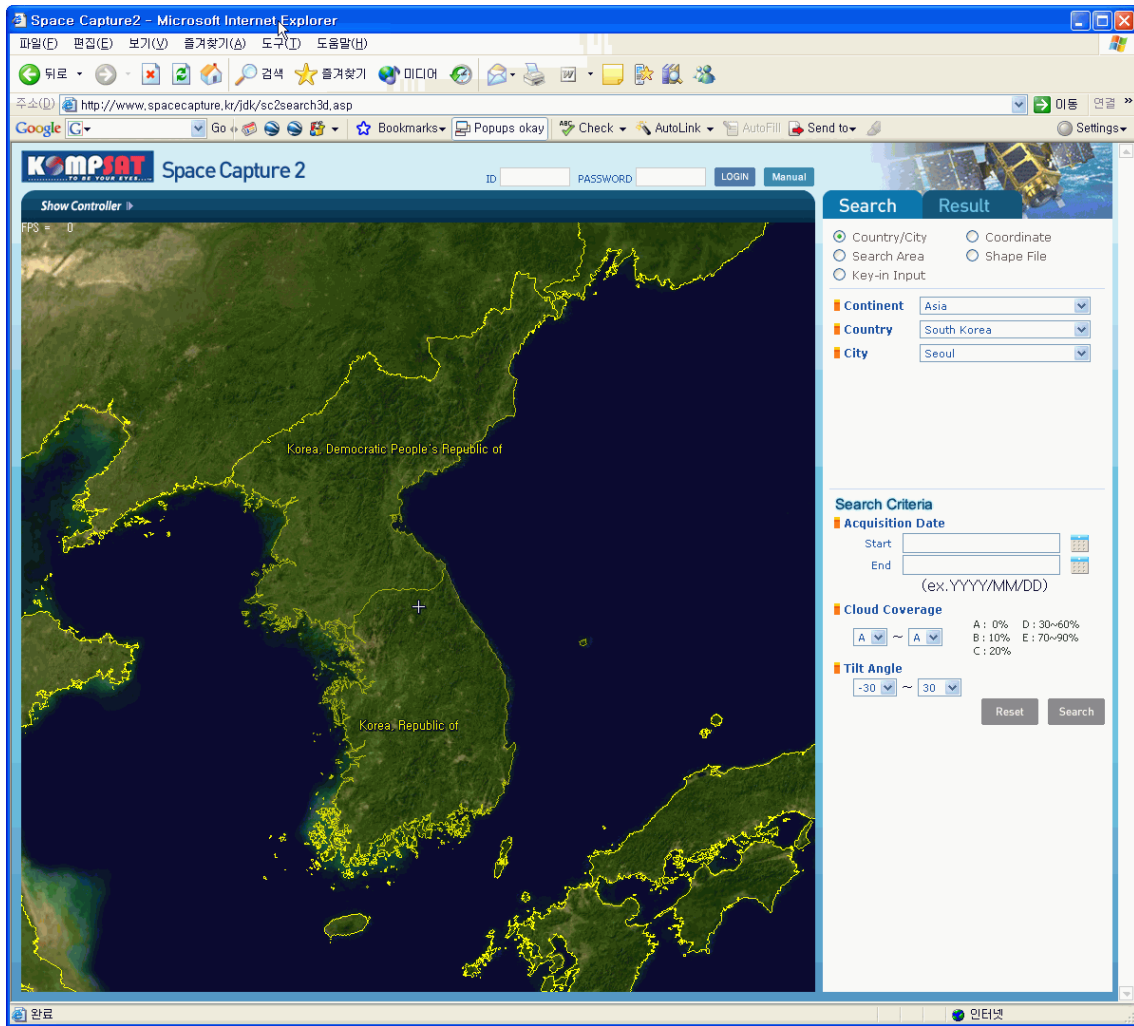


Figure 5 Space Capure2 Homepage

8. Regulations governing Image Distribution

The policy of commercial distribution of KOMPSAT-2 satellite imagery will be described in this section

8.1. Copyright

In brief, copyright covers a certain number of rights granted to the author of an original work, whether scientific or artistic in nature, which are added to the usual right of ownership. These rights are granted exclusively and automatically, at least under the copyright laws of the Republic of Korea.

The users of KOMPSAT-2 data acknowledge the right of KARI to copyright protection and/or protection against unauthorized use of the KOMPSAT-2 products, in accordance with the copyright laws of the Republic of Korea and applicable international agreements. The intellectual property rights related to the KOMPSAT-2 products are protected through the end-user license agreement. The users of KOMPSAT-2 data undertake to have printed the following copyright notice on all products, in such a way that KARI's copyright be plain to all "© KARI _____. (year appearing on the product delivered by KARI)."

The author of a Derived Works and Products is entitled to his own copyright in return for his creative contribution. This copyright is complementary to that owned by KARI.

8.2. General Terms of Sale

KARI has launched an optical remote sensing satellite with a very high-resolution sensor known as KOMPSAT-2 by July 28, 2006. KOMPSAT-2 data is now available for commercial uses in 2007. KARI is operating KOMPSAT-2 during its life time to satisfy both the government needs and commercial needs. In addition and on behalf of the Korean government, KARI intends to market any customers for the KOMPSAT-2 products and related services.

When the user buys a KOMPSAT-2 image and pays the current stated price, he obtains in return one or more copies of the products requested. However, the sale is subject to the following conditions:

- the user can only use the KOMPSAT-2 products for his own private needs and is forbidden to make these products or reproductions of these products available to a third party, either on a non-paying or a paying basis, whether temporarily or permanently.

- KARI may, however, grant approval to the user to sell these data and reproductions derived from them.
- All KOMPSAT-2 products, Data and Derived Works, must bear the indication: all “© KARI _____. (year appearing on the product delivered by KARI) and be accompanied by a note setting forth the above regulations.

Purchase of a KOMPSAT-2 image gives the owner what is generally referred to as a right of private use, which includes the right to transform the image. On the other hand, any and all collective and public use is prohibited and particularly any right to distribute the image.

The specific terms and conditions of KOMPSAT-2 data sales will be specified through the SPOT Image and KAI, respectively.

8.3. Special Agreement

The users of KOMPSAT-2 data agree to make the KOMPSAT-2 products available on an open and non-discriminatory basis consistent with United Nations Resolution A/41/65 of December 3, 1986 on “The Principles Relating to the Remote Sensing of Earth from Space”.

The specific terms and conditions of KOMPSAT-2 data sales will be specified through the SPOT Image and KAI, respectively. If the purchaser wishes to make a different use of the purchased images than provided for in the General Terms of Sale, they should try to contact the commercial provider of the image, either SPOT Image or KAI.