Himawari-8/9

Himawari Standard Data

User's Guide

Version 1.2
20 May, 2015

Japan Meteorological Agency
1-3-4 Otemachi, Chiyoda-ku, Tokyo, 100-8122 Japan

Documentation Change Record

Issue/revision	Date	Description
Version 1.0	31 October, 2013	Original edition
Version 1.1	26 January, 2015	Add a column “Valid number of bits per pixel” in Table 1 “Himawari-8 and -9 observation bands”. Correct errors in Table 6 “Block structures”, #4 “Navigation information block” (4, 5, 7, 8). Change the format of Table 6 “Block structures”, #6 “Inter-calibration information block”. Change the URL on p.5 to LRIT/HRIT Global Specification. Change the URL on p.15 to Meteorological Satellite Center.
Version 1.2	20 May, 2015	Change the format of Table 6 “Block structures”, #6 “Inter-calibration information block”.

Contents

1. Introduction

The Japan Meteorological Agency (JMA) plans to begin the operation of its Himawari-8 satellite in 2015 and backup-operation by its Himawari-9 satellite in 2017, with both units scheduled to continue observation until around 2029. The information derived from the satellites will be processed to create Himawari Standard Data in Himawari Standard Format as master data for all products related to information from Himawari-8 and -9. Himawari Standard Data will be provided for each observation (see Section 2) and each band (see Table 1).

Note: In the event of a Himawari-8 failure before Himawari-9 enters stand-by orbit, Himawari Standard Data will be provided using information from Himawari-7 (MTSAT-2) (see Section 6).

Table 1 Himawari-8 and -9 observation bands

Band number	Central wavelength [μm] (nominal values)	Valid number of bits per pixel
1	0.46	11
2	0.51	11
3	0.64	11
4	0.86	11
5	1.6	11
6	2.3	11
7	3.9	14
8	6.2	11
9	7.0	11
10	7.3	12
11	8.6	12
12	9.6	12
13	10.4	12
14	11.2	12
15	12.3	12
16	13.3	11

2. Observation Areas

Himawari-8 and -9 will each carry an Advanced Himawari Imager (AHI) scanning five areas: Full Disk (images of the whole Earth as seen from the satellite), the Japan Area (Regions 1 and 2), the Target Area (Region 3) and two Landmark Areas (Regions 4 and 5). While the scan ranges for Full Disk and the Japan Area will be preliminarily fixed, those of the Target Area and Landmark Areas will be flexible to enable prompt reaction to meteorological conditions. At the beginning of Himawari-8's operation, Landmark Area data will be used only for navigation, and are not intended for use as satellite products. In the future, JMA plans to use Region 5 for observation of phenomena such as rapidly developing cumulonimbus clouds and to provide the resulting data to users. In each 10-minute period, the AHI will scan the Full Disk once, the Japan Area and Target Area four times, and the two Landmark Areas twenty times. These 10-minute divisions are basic units of an observation schedule called a timeline. In Himawari-8 and -9's baseline observation, the timeline will be repeated every 10 minutes except in their housekeeping operation.

The observation areas and frequencies are shown in Table 2, and scan images on a timeline are shown in Figure 1. The observation areas and numbers of pixels are shown in Table 3 (pixel numbers for regional observations may be changed in orbit testing after launch).

Table 2　Himawari-8 and -9 observation areas and frequencies

Observation area		Observations per timeline	Time cycle [min.]	Observations per day
Full Disk	Fixed	1	10	144
Japan Area (Region 1 + Region 2)	Fixed	4	2.5	576
Target Area (Region 3)	Flexible	4	2.5	576
Landmark Area (Region 4)	Flexible	20	0.5	2,880
Landmark Area (Region 5)	Flexible	20	0.5	2,880

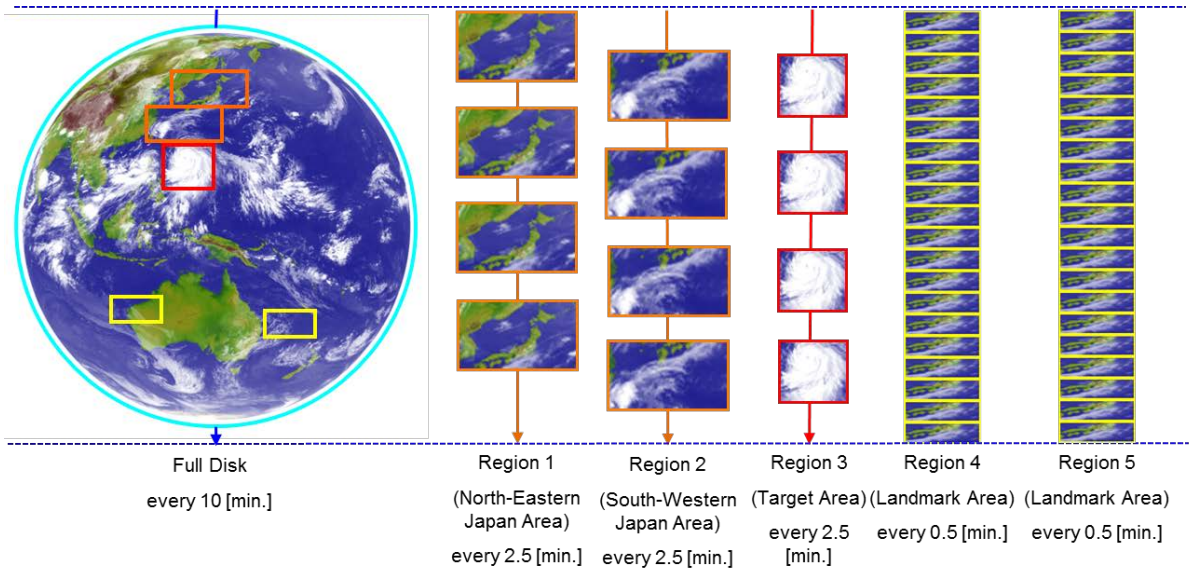

Figure 1　Himawari-8 and -9 scan images on a timeline

Table 3 Himawari-8 and -9 observation areas and numbers of pixels

Observation area	Band number (see Table 1)	Spatial resolution at SSP (sub satellite point) [1] [km]	Numbers of pixels	
			East-west direction	North-south direction
Full Disk	3	0.5	22,000	22,000
	1, 2, 4	1	11,000	11,000
	5 – 16	2	5,500	5,500
Japan Area (Region 1 + Region 2)	3	0.5	6,000	4,800
	1, 2, 4	1	3,000	2,400
	5 – 16	2	1,500	1,200
Target Area (Region 3)	3	0.5	2,000	2,000
	1, 2, 4	1	1,000	1,000
	5 – 16	2	500	500
Landmark Area (Region 4)	3	0.5	2,000	1,000
	1, 2, 4	1	1,000	500
	5 – 16	2	500	250
Landmark Area (Region 5)	3	0.5	2,000	1,000
	1, 2, 4	1	1,000	500
	5 – 16	2	500	250
(During backup operation by Himawari-7 (MTSAT-2)) Full Disk	VIS	1	11,000	11,000
	IR 1 – 4	4	2,750	2,750
(During backup operation by Himawari-7 (MTSAT-2)) Half Disk	VIS	1	11,000	5,500
	IR 1 – 4	4	2,750	1,375

[1] The point of intersection between the surface of the Earth and a straight line connecting the satellite and the Earth's center

3. Map Projection Method

For Himawari Standard Data, Normalized Geostationary Projection is adopted as defined in LRIT/HRIT Global Specification[2] Section 4.4. The projection describes the view from the satellite to an idealized earth.

The parameters of the geographic coordinate system used for Himawari Standard Data are based on WGS84 (World Geodetic System 1984)[3] as recommended in ETSAT6/Doc. 16 (1) Implications of Using the World Geodetic System 1984 (WGS84)[4].

[2] LRIT/HRIT Global Specification, CGMS, 2013
http://www.cgms-info.org/index_.php/cgms/page?cat=PUBLICATIONS&page=Technical+Publications
[3] http://earth-info.nga.mil/GandG/wgs84/
[4] http://www.wmo.int/pages/prog/sat/meetings/ET-SAT-6.php

4. File Naming Convention

In the naming convention for Himawari Standard Data, capitals in file names indicate unique letters, and italics depend on the observation time, band numbers and other parameters. The meanings of italics are shown in Table 4, where the time zone is UTC (Coordinated Universal Time).

Note: Observation data may be divided into segment files as needed (see Table 4 kkll).

The general file name format is:

HS_*aaa*_*yyyymmdd*_*hhnn*_B*bb*_*cccc*_R*jj*_S*kkll*.DAT

Table 4 Definitions of Italics in the file name general format

Character	Description
aaa	Satellite name H08: Himawari-8 H09: Himawari-9 H07: Himawari-7 (MTSAT-2)
yyyy	Observation start time (timeline) [year] (4 digits)
mm	Observation start time (timeline) [month] (01 – 12)
dd	Observation start time (timeline) [day] (01 – 31)
hh	Observation start time (timeline) [hour] (00 – 23)
nn	Observation start time (timeline) [min.] (every 10 min.) During backup operation by Himawari-7 (MTSAT-2), *nn* is equivalent to 00, 15 or 30.
bb	Band number (01 – 16) (see Table 1) During backup operation by Himawari-7 (MTSAT-2): 01: Himawari-7 VIS (central wavelength 0.68 μm) 02: Himawari-7 IR4 (central wavelength 3.7 μm) 03: Himawari-7 IR3 (central wavelength 6.8 μm) 04: Himawari-7 IR1 (central wavelength 10.8 μm) 05: Himawari-7 IR2 (central wavelength 12.0 μm)
cccc	Observation area and number FLDK: Full Disk JPee: Japan Area Observation number on the timeline (ee = 01 – 04)

	R3ff: Region 3 (Target Area) Observation number on the timeline (ff = 01 – 04) R4gg: Region 4 (Landmark Area) Observation number on the timeline (gg = 01 – 20) R5ii: Region 5 (Landmark Area) Observation number on the timeline (ii = 01 – 20) During backup operation by Himawari-7 (MTSAT-2): FLDK: Full Disk HNDK: Half Disk of Northern Hemisphere HSDK: Half Disk of Southern Hemisphere
jj	Spatial resolution at SSP 05: 0.5 km 10: 1 km 20: 2 km 40: 4 km
kkll	Information on the segment division of Himawari Standard Data *kk*: segment number (01 – *ll*) *ll*: total number of segments (01 – 99) (0101: no division)

5. Himawari Standard Format (Version 1.2)

Himawari Standard Format data are comprised of 12 blocks. The file structure is shown in Table 5, and the details of each block are given in Table 6.

Table 5 File structure

Block number	Block name
#1	(Header block) Basic information block
#2	(Header block) Data information block
#3	(Header block) Projection information block
#4	(Header block) Navigation information block
#5	(Header block) Calibration information block
#6	(Header block) Inter-calibration information block
#7	(Header block) Segment information block
#8	(Header block) Navigation correction information block
#9	(Header block) Observation time information block
#10	(Header block) Error information block
#11	(Header block) Spare block
#12	Data block

Table 6 Block structures

Type

C: 1-byte character (ASCII)

I1: unsigned 1-byte integer

I2: unsigned 2-byte integer

I4: unsigned 4-byte integer

R4: IEEE 754-2008 single-precision binary floating point

R8: IEEE 754-2008 double-precision binary floating point

– Times are UTC.

– The term “radiance” refers to spectral radiance.

– The term “backup operation” refers to periods of backup by Himawari-7 (MTSAT-2).

No.	Name	Type	Word size in bytes	Number of words	Value [unit] and remarks
#1 Basic information block					
1	Header block number	I1	1	1	= 1 (Fixed value)
2	Block length	I2	2	1	= 282 [bytes] (Fixed value)
3	Total number of header blocks	I2	2	1	= 11 (Fixed Value)
4	Byte order	I1	1	1	0: Little Endian 1: Big Endian
5	Satellite name	C	1	16	Himawari-8 Himawari-9 (MTSAT-2: backup operation)
6	Processing center name	C	1	16	MSC: Meteorological Satellite Center OSK: Osaka District Meteorological Observatory
7	Observation area	C	1	4	(See Table 4 cccc)
8	Other observation information (Note: processing center use only)	C	1	2	
9	Observation timeline	I2	2	1	hhmm (integer) hh [hour] (00 – 23) mm [min.] (00 – 50, every 10 [min.]) (00, 15 or 30: backup operation)
10	Observation start time	R8	8	1	[MJD (Modified Julian Date)]
11	Observation end time	R8	8	1	[MJD]
12	File creation time	R8	8	1	[MJD]
13	Total header length	I4	4	1	[bytes]

14	Total data length	I4	4	1	[bytes]
15	Quality flag 1	I1	1	1	Operation flag Bit 1 (MSB) 0: quality flag 1 valid 1: quality flag 1 invalid (= 1: backup operation) Bit 2: sun-related data degradation (ex. sun avoidance, stray light) 0: no possibility 1: some possibility Bit 3: moon-related data degradation (ex. moon avoidance) 0: no possibility 1: some possibility Bit 4: satellite status 0: in operation 1: test Bit 5 0: not maneuvering 1: maneuvering Bit 6 0: not unloading 1: unloading Bit 7 0: not in solar calibration 1: in solar calibration Bit 8 (LSB) 0: not in solar eclipse 1: in solar eclipse
16	Quality flag 2	I1	1	1	Spare
17	Quality flag 3 (Note: processing center use only)	I1	1	1	
18	Quality flag 4 (Note: processing center use only)	I1	1	1	
19	File format version	C	1	32	(Left-justified string)
20	File name	C	1	128	(See Section 4.)
21	Spare	–	40	1	Spare

#2 Data information block					
1	Header block number	I1	1	1	= 2 (Fixed value)
2	Block length	I2	2	1	= 50 [bytes] (Fixed value)
3	Number of bits per pixel	I2	2	1	= 16 (Fixed value)
4	Number of columns (Number of pixels (east-west direction))	I2	2	1	(See Table 3)
5	Number of lines (Number of pixels (north-south direction))	I2	2	1	(See Table 3)
6	Compression flag for data block #12	I1	1	1	0: no compression (default) 1: gzip 2: bzip2
7	Spare	—	40	1	Spare
#3 Projection information block (See footnote 2; LRIT/HRIT Global Specification Section 4.4, CGMS, 1999)					
1	Header block number	I1	1	1	= 3 (Fixed value)
2	Block length	I2	2	1	= 127 [bytes] (Fixed value)
3	sub_lon	R8	8	1	= 140.7 [degrees] (= 145 [degrees]: backup operation)
4	CFAC	I4	4	1	Column scaling factor (= 40,932,513 (visible band): backup operation) (= 1,0233,128 (infrared band): backup operation)
5	LFAC	I4	4	1	Line scaling factor (= 40,932,513 (visible band): backup operation) (= 1,0233,128 (infrared band): backup operation)
6	COFF	R4	4	1	Column offset (= 5,500.5 (visible band): backup operation) (= 1,375.5 (infrared band): backup operation)
7	LOFF	R4	4	1	Line offset (= 5,500.5 (Full Disk, visible band): backup operation) (= 1,375.5 (Full Disk, infrared

					band): backup operation) (= 5,300.5 (Half Disk of Northern Hemisphere, visible band): backup operation) (= 1,325.5 (Half Disk of Northern Hemisphere, infrared band): backup operation) (= 200.5 (Half Disk of Southern Hemisphere, visible band): backup operation) (= 50.5 (Half Disk of Southern Hemisphere, infrared band): backup operation)
8	Distance from Earth's center to virtual satellite (R_s)	R8	8	1	= 42,164 [km] (Fixed value)
9	Earth's equatorial radius (r_{eq})	R8	8	1	= 6,378.1370 [km] (Fixed value) (Based on WGS84) (= 6,378.1690 [km]: backup operation)
10	Earth's polar radius (r_{pol})	R8	8	1	= 6,356.7523 [km] (Fixed value) (Based on WGS84) (= 6,356.5838 [km]: backup operation)
11	$(r_{eq}^2 - r_{pol}^2) / r_{eq}^2$	R8	8	1	= 0.00669438444 (Fixed value) (Based on WGS84) (= 0.00675701: backup operation)
12	r_{pol}^2 / r_{eq}^2	R8	8	1	= 0.993305616 (Fixed value) (Based on WGS84) (= 0.993243: backup operation)
13	r_{eq}^2 / r_{pol}^2	R8	8	1	= 1.006739501 (Fixed value) (Based on WGS84) (= 1.006803: backup operation)
14	Coefficient for S_d $(R_s^2 - r_{eq}^2)$	R8	8	1	= 1,737,122,264 (Fixed value) (Based on WGS84) (= 1,737,121,856: backup operation)
15	Resampling types (Note: processing center use only)	I2	2	1	

16	Resampling size (Note: processing center use only)	I2	2	1	
17	Spare	—	40	1	Spare
#4 Navigation information block					
1	Header block number	I1	1	1	= 4 (Fixed value)
2	Block length	I2	2	1	= 139 [bytes] (Fixed value)
3	Navigation information time	R8	8	1	[MJD]
4	SSP longitude	R8	8	1	[degrees] (= -10^{10} (no information): backup operation)
5	SSP latitude	R8	8	1	[degrees] (= -10^{10} (no information): backup operation)
6	Distance from Earth's center to Satellite	R8	8	1	[km] (= -10^{10} (no information): backup operation)
7	Nadir[5] longitude	R8	8	1	[degrees] (= -10^{10} (no information): backup operation)
8	Nadir latitude	R8	8	1	[degrees] (= -10^{10} (no information): backup operation)
9	Sun's position	R8	8	3	[km] (x, y, z) (J2000 inertial coordinate)
10	Moon's position	R8	8	3	[km] (x, y, z) (J2000 inertial coordinate) (= -10^{10} (no information): backup operation)
11	Spare	—	40	1	Spare
#5 Calibration information block					
1	Header block number	I1	1	1	= 5 (Fixed value)
2	Block length	I2	2	1	= 147 [bytes] (Fixed value)
3	Band number	I2	2	1	(See Table 1) (= 1 (Himawari-7 VIS 0.68 [μm]): backup operation) (= 2 (Himawari-7 IR4 3.7 [μm]): backup operation) (= 3 (Himawari-7 IR3 6.8 [μm]):

[5] The point of intersection between the sensor nadir and the surface of the Earth

					backup operation) (= 4 (Himawari-7 IR1 10.8 [μm]): backup operation) (= 5 (Himawari-7 IR2 12.0 [μm]): backup operation)
4	Central wave length	R8	8	1	[μm] (Fixed value for each band)
5	Valid number of bits per pixel	I2	2	1	11, 12 or 14 (Band-dependent) (= 10: backup operation)
6	Count value of error pixels	I2	2	1	= 65,535 (Fixed value)
7	Count value of pixels outside scan area	I2	2	1	= 65,534 (Fixed value)
8	Gain for count-radiance conversion equation	R8	8	1	*Radiance* = *Gain x Count + Constant* Radiance [W / (m^2 sr μm)] Gain [W / (m^2 sr μm count)] Constant [W / (m^2 sr μm)] Count (See Block #12 1 count value of each pixel)
9	Constant for count-radiance conversion equation	R8	8	1	
	Infrared band (Band No. 7 – 16) (Band No. 2 – 5: backup operation (See Table 4 bb))				
10	Correction coefficient of sensor Planck functions for converting radiance to brightness temperature (c_0)	R8	8	1	*Te*: effective brightness temperature *Tb:* brightness temperature *I*: radiance λ : central wave length $T_e(\lambda, I) = \frac{hc}{k\lambda} \frac{1}{\ln\left(\frac{2hc^2}{\lambda^5 I} + 1\right)}$ $T_b = c_0 + c_1 T_e + c_2 T_e^2$ c_0 [K] c_1 [1] c_2 [K^{-1}]
11	(c_1)	R8	8	1	
12	(c_2)	R8	8	1	
13	Correction coefficient of sensor Planck functions for converting brightness temperature to radiance (C_0)	R8	8	1	$T_e = C_0 + C_1 T_b + C_2 T_b^2$

14	(C_1)	R8	8	1	$I(\lambda, T_e) = \frac{2hc^2}{\lambda^5} \frac{1}{\exp(\frac{hc}{k\lambda T_e}) - 1}$ C_0 [K] C_1 [1] C_2 [K^{-1}]
15	(C_2)	R8	8	1	
16	Speed of light (c)	R8	8	1	[m/s]
17	Planck constant (h)	R8	8	1	[Js]
18	Boltzmann constant (k)	R8	8	1	[J/K]
19	Spare	—	40	1	Spare
	Visible, near-infrared band (Band No. 1 – 6) (Band No. 1: backup operation (See Table 4 bb))				
10	Coefficient (c') for transformation from radiance (I) to albedo (A) [6]	R8	8	1	$A = c' I$ A [1] c' [(m^2 sr μm) / W] I [W / (m^2 sr μm)]
11	Spare	—	104	1	Spare
#6 Inter-calibration information block [7]					
1	Header block number	I1	1	1	= 6 (Fixed value)
2	Block length	I2	2	1	= 259 [bytes] (Fixed value)
3	GSICS calibration coefficient (Intercept)	R8	8	1	Calibration coefficients from the Global Space-based Inter-Calibration System (GSICS) [8]. Intercept [W / (m^2 sr μm)] Slope [W / (m^2 sr μm count)] Quadratic term [W / (m^2 sr μm count^2)]
4	GSICS calibration coefficient (Slope)	R8	8	1	
5	GSICS calibration coefficient (Quadratic term)	R8	8	1	
6	Radiance bias for standard scene	R8	8	1	Radiance bias and its uncertainty for standard scene. Undefined value = -10^{10} (Band No. 1-6) [K] (Band No. 7-16)
7	Uncertainty of radiance bias for standard scene	R8	8	1	
8	Radiance for standard scene	R8	8	1	
9	Start time of GSICS Correction validity period	R8	8	1	[MJD]
10	End time of GSICS Correction validity period	R8	8	1	

[6] $A = \pi I / S_0$
S_0: band solar irradiance [W / (m^2 μm)]
[7] -10^{10} (undefined value) for No. 3-12 in the case GSICS Correction is N/A or backup operation is performed.
[8] http://ds.data.jma.go.jp/mscweb/data/monitoring/calibration.html

11	Radiance validity range of GSICS calibration coefficients (upper limit)	R4	4	1	[W / (m^2 sr μm count)] (Band No. 1-6) [K] (Band No. 7-16)
12	Radiance validity range of GSICS calibration coefficients (lower limit)	R4	4	1	
13	File name of GSICS Correction	C	1	128	Reference GSICS Correction file
14	Spare	—	56	1	Spare
#7 Segment information block					
1	Header block number	I1	1	1	= 7 (Fixed value)
2	Block length	I2	2	1	= 47 [bytes] (Fixed value)
3	Total number of segments	I1	1	1	(1: no division)
4	Segment sequence number	I1	1	1	
5	First line number of image segment	I2	2	1	
6	Spare	—	40	1	Spare
#8 Navigation correction information block					
1	Header block number	I1	1	1	= 8 (Fixed value)
2	Block length	I2	2	1	[bytes]
3	Center column of rotation	R4	4	1	[columns]
4	Center line of rotation	R4	4	1	[lines]
5	Amount of rotational correction[9]	R8	8	1	[μrad]
6	Number of correction information data for column and line direction	I2	2	1	
7	Line number after rotation	I2	2	1	
8	Shift amount for column direction	R4	4	1	[columns]
9	Shift amount for line direction	R4	4	1	[lines]
	(7) – (9) Repeats of (6)				
10	Spare	—	40	1	Spare
#9 Observation time information block					
1	Header block number	I1	1	1	= 9 (Fixed value)
2	Block length	I2	2	1	[bytes]
3	Number of observation times	I2	2	1	
4	Line number	I2	2	1	

[9] Correction follows the following procedure:

(1) Rotate all pixels according to the “No. 5 Amount of rotational correction”.

(2) Translate all pixels in the line indicated by the “No. 7 Line number after rotation” according to “No. 8 Shift amount for column direction” and “No. 9 Shift amount for line direction”. The line numbers are discrete values. For a middle line, translate according to the interpolated shift amount.

5	Observation time	R8	8	1	[MJD]	
	(4) – (5) Repeats of (3)					
6	Spare	—	40	1	Spare	
#10 Error information block						
1	Header block number	I1	1	1	= 10	(Fixed value)
2	Block length	I4	4	1	[bytes]	
3	Number of error information data	I2	2	1	(= 0: backup operation)	
4	Line number	I2	2	1		
5	Number of error pixels per line	I2	2	1		
	(4) – (5) Repeats of (3)					
6	Spare	—	40	1	Spare	
#11 Spare block						
1	Header block number	I1	1	1	= 11	(Fixed value)
2	Block length	I2	2	1	= 259 [bytes]	(Fixed value)
3	Spare	—	256		Spare	
#12 Data block						
1	Count value of each pixel	I2	2	Number of pixels = Number of columns × Number of lines (See Table 3) (See Block #2 4 Number of columns) (See Block #2 5 number of lines)	(See Block #5 6 count value of error pixels) (See Block #5 7 Count value of pixels outside scan area)	

6. Backup Operation by Himawari-7 (MTSAT-2)

In the event of Himawari-8 failure before Himawari-9 starts operation as a second satellite, JMA will disseminate Himawari-7 (MTSAT-2) observation data as backup. In such cases, only full-disk or half-disk (Northern or Southern Hemisphere) observations will be made every 15 or 30 minutes, and no regional observations will be made. There will be five bands (one visible and four infrared) and a total of 56 images per day.