

JAXA Himawari Product as a Display Content

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ABSTRACT

Himawari is the Japanese geostationary satellite operated by Japan Meteorological Agency. Its latest generation significantly improved spatiotemporal and spectral resolutions, extending capability of serving as display contents. This paper outlines the JAXA Himawari products, with visualization examples of products related to RGB images, atmospheric pollutants and clouds.

1 INTRODUCTION

Earth observation data by satellites are served as display contents in various field including media, entertainments, education and arts. In response to technology advances of the observation sensors, the capability in using the observation data as display contents has been increasing and utilized to the traditional displays as well as the recent applications such as in VR devices.

Along with this sensor improvement, the most recent generation of Himawari satellite (Himawari-8 and Himawari-9) has advanced its sensor specification from its previous generations [1]. Himawari is a Japanese geostationary satellite developed by Japan Meteorological Agency (JMA) and has been in operation since 1970s. Compared to the former generation, Himawari-8/9 mainly improved the following three specifications: 1) temporal resolution; 2) spatial resolution; and 3) spectral resolution. First, the temporal resolution has increased by 3 times, observing the Asia-Oceania regions every 10 minutes. The measurement thus obtained are often shown more as a “video” rather than a snapshot image. Secondly, the spatial resolutions have improved twice (Table 1), for example, from 2km to 0.5 km in the visible band, allowing to capture more detailed structure of observation targets. Lastly, the number of observation band increased from 5 bands to 16 bands (Table 1). In particular, the visible wavelength increased from 1 band to 3 band, offering RGB color images from the previous gray scale images.

Generally speaking, the increase in observation bands means that we could obtain more spectral information on observation targets. This motivated research and development in JAXA to derive geophysical products from Himawari measurements. Since JAXA has been developing algorithms for retrieving geophysical products using multispectral imager observations similar to Himawari-8 (such as in GCOM-C Satellite Project), it applied this retrieval algorithms to Himawari-8 observations to develop JAXA Himawari-8 Products.

2 JAXA Himawari Products

Following the agreement signed with the JMA, the Himawari system was constructed in JAXA that generates, distributes and archives the Himawari geophysical products. Since its launch in 2014, JAXA Earth Observation Research Center (EORC) has been receiving Himawari-8 Level 1 data (close to raw data) from JMA in near real time within 30 minutes after observation.

Table. 1 Specification of Himawari-8/9 Compared Against the Previous Himawari Generation (MTSAT-1R/2). (Adapted from [2])

Wave length [μm]	Himawari-8/9		MTSAT-1R/2	
	Band number	Spatial resolution at SSP [km]	Channel name	Spatial resolution at SSP [km]
0.47	1	1	-	-
0.51	2	1	-	-
0.64	3	0.5	VIS	1
0.86	4	1	-	-
1.6	5	2	-	-
2.3	6	2	-	-
3.9	7	2	IR4	4
6.2	8	2	IR3	4
6.9	9	2	-	-
7.3	10	2	-	-
8.6	11	2	-	-
9.6	12	2	-	-
10.4	13	2	IR1	4
11.2	14	2	-	-
12.4	15	2	IR2	4
13.3	16	2	-	-

The algorithms developed are then applied simultaneously to retrieve geophysical products. Show in Table 2 is the list of JAXA Himawari products (as of August 2020). Over 10 geophysical algorithms have been developed in collaboration with external research institutes. The original Himawari Level 1 data is distributed in a special format called “Himawari Standard Data (HSD)” [3]. For user convenience, JAXA also distributes Himawari Level 1 NetCDF products with an equal latitude-longitude gridding, resampled from the L1 HSD data. The majority of the Himawari geophysical products (namely, Level 2 to Level 4 Products) are disseminated in NetCDF format (except for the Wild Fire Product in the CSV text format).

All the products are disseminated from JAXA Himawari Monitor Website (<https://www.eorc.jaxa.jp/ptree>). Users are able to obtain the data products free of charge via FTP protocol after a simple user registration.

Table. 2 List of Himawari Products Distributed from JAXA

Product		Grid size	Interval	Format
Level 1				
Reflectance (6 bands)/ Brightness Temperature (10 bands)		500m/1km /2km	10min ^{*1} 2.5min ^{*2}	HSD
		0.02/0.05deg ^{*1}	10min	NetCDF
		0.01deg ^{*2}		
Level 2 and 3				
Atmosphere	Aerosol ^{*3} (e.g. atmospheric pollutants)	5km	10min/ 1hr/1dy /1month	NetCDF
	Cloud	5km	10min	
Ocean	Sea surface temperature	2km	10min/ 1hr/1dy /1month	
	Ocean color (Chlorophyll-a)	5km ^{*1} /1km ^{*2}	1hr/1dy /1month	
Land	Wildfire	2km	10min/ 1hr/1dy /1month	CSV
Radiation	Photosynthetically active radiation & shortwave radiation	5km ^{*1} /1km ^{*2}	10min/ 1hr/1dy /1month	NetCDF
	Photovoltaic power ^{*4}	1km/4km	10min	-
Level 4				
Model	Aerosol	~0.37deg ^{*3}	1hr	NetCDF
	Sea surface temperature	~1/36deg ^{*2}	1hr	NetCDF

^{*1}Full disk ^{*2}Japan ^{*3}Image only

3 Application Examples of Himawari-8 Measurements for Digital Contents

In this section, we introduce three applications of Himawari-8 measurements in particular to exemplify the potential capability of Himawari-8 measurements to be used in digital contents.

3.1 RGB Images

As shown in Table 1, the Himawari-8 sensor has three visible observation bands centering at 0.47 μ m, 0.51 μ m and 0.64 μ m. The three bands are often used to visualize observation data in color images, by assigning 0.64 μ m to red, 0.51 μ m to blue and 0.47 μ m to green colors. Figure 1 shows one such example utilized in the JAXA Himawari Monitor website. The image shows an observation data taken on 14 August 2019 when the Typhoon “Krosa” was heading to Japan. The Typhoon was formed on 6 August and traveled through Pacific Ocean and Japan until on 16 August when it changed to extratropical cyclone in the West of Hokkaido. During this time, the Himawari was observing the typhoon continuously, tracking its path every 10 minutes.

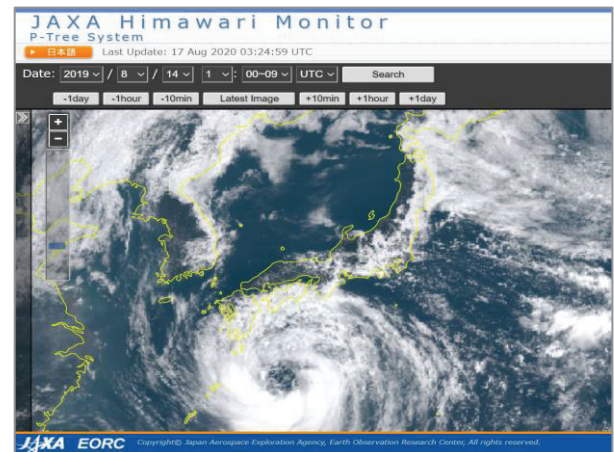


Fig. 1 RGB Images Shown in JAXA Himawari Monitor Website

3.2 Video Contents

The frequent observation data of Himawari have also been used in creating video contents. Figure 2 shows a visualization of an animation of “aerosols”, which is fine particles in the atmosphere (such as PM2.5 and yellow dust “Kosa”). The case in Fig. 2 illustrates an observation taken on April 2018 when continental atmospheric pollutants reached Northern Kyushu. The color shows an index of its concentration (denoted as “aerosol optical thickness”), illustrating dense atmospheric pollutants in red regions. 5 km resolution dataset shows detailed structure of the pollutants, showing Jeju island with surface elevation as high as 1,950 km trapping the

pollutant transport during 15:00 to 16:30 JST.

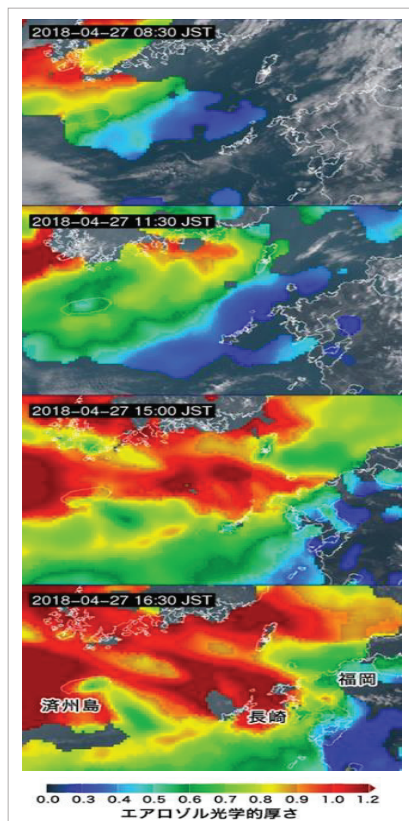


Fig. 2 Snapshots of an Animation on Atmospheric Pollutant Event in 27 April 2018. (Adapted from [4])

3.3 Dagik Earth Display

For a further application, JAXA has been creating projection and VR contents for exhibitions in conferences, museums and open day events. Figure 3 shows a case of a video projection called “Dajik Earth” in JAXA Earth Observation Center Open Day. The projection shows the movement of rainfall by JAXA GSMap Product overlaid onto the Himawari infrared cloud background image. The similar videos with recent observation can be viewed in the Dagik webpage (<http://dagik.org/rain/>). With the composite of the other geostationary observations, the rainfall data are visualised every 1 hour in approximately 10 km resolution, enabling to show the movement of typhoons in tropical regions and frontal precipitation in mid-high latitudes.



Fig. 3 Dajik Earth Display Shown in JAXA Earth Observation Center (EOC) Open Day. (Extracted from [5])

4 Summary

The latest generation of the Himawari geostationary satellite has improved its sensor specification, particularly in spectral and spatiotemporal resolutions. Taking the advantage this, JAXA has been developing over 10 geophysical products, including those related to the RBG images, atmospheric pollutants and clouds. Although not yet fully explored, those products have the potential capability in offering as original datasets in wider area of display applications than before to better dictate satellite observation in media, exhibitions and educations.

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