

SATELLITE-BASED ANALYSIS & NOWCASTING

WMO Severe Weather Forecasting Programme (SWFP) Regional Sub-programme for Southeast Asia (SWFP-SeA) Training Desk and Study Visit for Cambodia (Ha Noi, 19 - 23 May 2025)

Wai-Kin Wong Senior Scientific Officer, Forecast Development Division E-mail: wkwong@hko.gov.hk

JMA Himawari-8/9



FY Satellite	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Himawari-8			, ,		unc		-1	1	0	per	atio	nal				In-c	orbi	t sta	and	by	Î
Himawari-9		M	lanı	ufac	turi	-	unc	h	· II	n-or	bit	star	ndb	y		0	pera	atio	nal		
Himawari-9		1				La	unc	h 🛓	e.II	n-or	bit	star	ndb	y		0	pera	atio	nal		

16 Bands of AHI (Advanced Himawari Imager)







	Physical Properties	MSG	MTSAT-1R/-2	Himawari-8/ -9	Channel
	vegetation, aerosol B			0.46 μm	1
Visible	vegetation, aerosol G			0.51 μm	2
	low cloud, fog R	0.635 μm	0.68 μm	0.64 μm	3
	vegetation, aerosol	0.81 µm		0.86 μm	4
Near Infrared	cloud phase	1.64 µm		1.6 µm	5
marcu	particle size			2.3 μ m	6
2	low cloud, fog, forest fire	3.92 µm	3.7 μm	3.9 μm	7
	mid- and upper level moisture	<mark>6.25 μ</mark> m	6.8 μm	6.2 μm	8
	mid- level moisture			6.9 μm	9
	mid- and lower level moisture	7.35 μm		7.3 μm	10
	cloud phase, SO2	8.70 μm		8.6 μm	11
Infrared	ozone content	9.66 µm		9.6 µm	12
)	cloud imagery, information of cloud top	10.8 µm	10.8 μm	10.4 µm	13
	cloud imagery, sea surface temperature			11.2 μm	14
	cloud imagery, sea surface temperature	12.0 µm	12.0 μm	12.4 μm	15
	cloud top height	13.4 µm		13.3 μm	16

http://www.jma.go.jp/jma/jma-eng/satellite/







Himawari Real-time Image

https://www.data.jma.go.jp/mscweb/data/himawari/



Southeast Asia I

https://www.data.jma.go.jp/mscweb/ data/himawari/sat_img.php?area=se1



Hi-res Asia I https://www.data.jma.go.jp/mscweb/ data/himawari/sat_img.php?area=hal









CMA Fengyun 4 (FY-4A and FY-4B)



https://www.nsmc.org.cn/nsmc/en/home/index.html







FY-4 Advanced Geostationary Radiation Imager (AGRI)

FY-4A (14 channels)

FY-4B (15 channels)

0.5K(300K)

Cloud and water vapor

0.9K(240K)

Туре	Central wavelength	Band	SNR or NEAT @ specified input	Spatial resolution	Main purpose	Band	d Center wave length (µm)	Band width (µm)	Spatial resolution(km)	Sensitivity/SNR		Main purpose
Visible & Near-Infrared	0.47µm	0.45 ~ 0.49µm	S/N≥90 @ p=100%	1km	Aerosol	1	0.47	0.45~0.49	1	S/N≥90(ρ=100%)		Aerosol
	0.65µm	0.55 ~ 0.75µm	S/N≥200 @ p=100%	0.5~1km	Fog, cloud	2	0.65	0.55~0.75	0.5	S/N≥150(ρ=100%)@0.5km	S/N≥3(ρ=1%)@1km	Fog, cloud
	0.825µm	0.75 ~ 0.90µm	S/N≥200 @ ρ=100%	1km	Vegetation	3	0.825	0.75~0.90	1	S/N≥200(ρ=100%)	S/N≥3(ρ=1%)	Vegetation
Short-wave Infrared	1.375µm	1.36 ~ 1.39µm	S/N≥90 @ p=100%	2km	Cirrus	4	1.379	1.371~1.386	2	S/N≥120(ρ=100%)	S/N≥2(ρ=1%)	Cirrus
	1.61µm	1.58 ~ 1.64µm	S/N≥200 @ p=100%	2km	Cloud, snow	5	1.61	1.58~1.64	2	S/N≥200(ρ=100%)	S/N≥3(ρ=1%)	Cloud, snow
	2.25µm	2.1~2.35µm	S/N≥200 @ ρ=100%	2~4km	Cirrus, aerosol	6	2.25	2.10~2.35	2	S/N≥200(ρ=100%)	S/N≥2(ρ=1%)	Cirrus, aerosol
Mid-wave Infrared	3.75µm	3.5~4.0μm (high)	NE∆T≤0.7K @ 300K	2km	Fire	7	3.75	3.50~4.00(high)	2	≤0.7K(315K)		Fire
	3.75µm	3.5~4.0µm (low)	NE∆T≤0.2K @ 300K	4km	Land surface	8	3.75	3.50~4.00(low)	4	0.2K(300K)	2K(240K)	Land surface
Water vapor	6.25µm	5.8~6.7µm	NE∆T≤0.3K @ 260K	4km	High level water vapor	9	6.25	5.80~6.70	4	0.2K(300K)	0.9K(240K)	High level water vapor
	7.1µm	6.9~7.3µm	NE∆T≤0.3K @ 260K	4km	Middle level water vapor	10	6.95	6.75~7.15	4	0.25K(300K)	0.9K(240K)	Mid level water vapor
Long-wave Infrared	8.5µm	8.0~9.0µm	NE∆T≤0.2K @ 300K	4km	Water vapor, cloud	11	7.42	7.24~7.60	4	0.25K(300K)	0.9K(240K)	Low level water vapor
	10.7µm	10.3 ~ 11.3µm	NE∆T≤0.2K @ 300K	4km	Surface temperature	12	8.55	8.3~8.8	4	0.2K(300K)	0.4K(240K)	Cloud
	12.0µm	11.5 ~ 12.5µm	NE∆T≤0.2K @ 300K	4km	Surface temperature	13	10.80	10.30~11.30	4	0.2K(300K)	0.4K(240K)	Surface temperature
	13.5µm	13.2 ~ 13.8µm	NE∆T≤0.5K @ 300K	4km	Cloud thickness	14	12.00	11.50~12.50	4	0.2K(300K)	0.4K(240K)	Surface temperature
1	Visible & Near-Infrared Short-wave Infrared Mid-wave Infrared Water vapor	Name 0.47μm 0.65μm 0.65μm 0.825μm 0.825μm Short-wave Infrared 1.375μm 1.61μm 2.25μm Mid-wave Infrared 3.75μm Water vapor 6.25μm Cong-wave Infrared 3.75μm Long-wave Infrared 8.5μm 10.7μm 12.0μm	Number of the second	Visible & Near-Infrared 0.47μm 0.45 ~ 0.49μm S/N≥90 @ p=100% 0.65μm 0.55 ~ 0.75μm S/N≥200 @ p=100% 0.825μm 0.75 ~ 0.90μm S/N≥200 @ p=100% 0.825μm 0.75 ~ 0.90μm S/N≥200 @ p=100% Short-wave Infrared 1.375μm 1.36 ~ 1.39μm S/N≥200 @ p=100% 1.61μm 1.58 ~ 1.64μm S/N≥200 @ p=100% 2.25μm 2.1 ~ 2.35μm S/N≥200 @ p=100% Mid-wave Infrared 3.75μm 3.5 ~ 4.0μm (high) NEΔT≤0.7K @ 300K Mid-wave Infrared 3.75μm 3.5 ~ 4.0μm (low) NEΔT≤0.2K @ 300K Water vapor 6.25μm 5.8 ~ 6.7μm NEΔT≤0.2K @ 300K Long-wave Infrared 8.5μm 8.0 ~ 9.0μm NEΔT≤0.2K @ 300K Long-wave Infrared 10.7μm 10.3 ~ 11.3μm NEΔT≤0.2K @ 300K	Visible & Near-Infrared 0.47μ m $0.45 \sim 0.49\mu$ m $S/N \ge 00 @ p = 100\%$ $1km$ 0.65μ m $0.55 \sim 0.75\mu$ m $S/N \ge 200 @ p = 100\%$ $0.5^{-}1km$ 0.85μ m $0.55 \sim 0.90\mu$ m $S/N \ge 200 @ p = 100\%$ $1km$ 0.825μ m $0.75 \sim 0.90\mu$ m $S/N \ge 200 @ p = 100\%$ $1km$ 0.825μ m $0.75 \sim 0.90\mu$ m $S/N \ge 200 @ p = 100\%$ $2km$ 1.61μ m $1.36 \sim 1.39\mu$ m $S/N \ge 200 @ p = 100\%$ $2km$ 1.61μ m $1.58 \sim 1.64\mu$ m $S/N \ge 200 @ p = 100\%$ $2km$ 2.25μ m $2.1 \sim 2.35\mu$ m $S/N \ge 200 @ p = 100\%$ 2κ m $0.45 \sim 0.40\mu$ m (high) $N E\Delta T \le 0.7K @ 300K$ $2km$ Mid-wave Infrared 3.75μ m $3.5 \sim 4.0\mu$ m (how) $N E\Delta T \le 0.2K @ 300K$ $4km$ Water vapor 6.25μ m $5.8 \sim 6.7\mu$ m $N E\Delta T \le 0.3K @ 260K$ $4km$ Long-wave Infrared 8.5μ m $8.0 \sim 9.0\mu$ m $N E\Delta T \le 0.2K @ 300K$ $4km$ Long-wave Infrared 8.5μ m $8.0 \sim 9.0\mu$ m $N E\Delta T \le 0.2K @ 300K$ $4km$	Visible & Near-Infrared Visible & Near-Infrared 0.47μ m $0.45 \sim 0.49\mu$ m $S/N \geq 90 @ p = 100\%$ 1kmAerosol 0.65μ m $0.55 \sim 0.75\mu$ m $S/N \geq 200 @ p = 100\%$ $0.5 \sim 1km$ Fog. oloud 0.825μ m $0.75 \sim 0.90\mu$ m $S/N \geq 200 @ p = 100\%$ $1km$ VegetationShort-wave Infrared 1.375μ m $1.36 \sim 1.39\mu$ m $S/N \geq 200 @ p = 100\%$ $2km$ Cloud, snow 1.61μ m $1.58 \sim 1.64\mu$ m $S/N \geq 200 @ p = 100\%$ $2km$ Cloud, snow 2.25μ m $2.1 \sim 2.35\mu$ m $S/N \geq 200 @ p = 100\%$ $2-4km$ Cloud, snowMid-wave Infrared 3.75μ m $3.5 \sim 4.0\mu$ m (high) $N E \Delta T \leq 0.7 K \oplus 300 K$ $2km$ Cloud, snowMid-wave Infrared 3.75μ m $3.5 \sim 4.0\mu$ m (low) $N E \Delta T \leq 0.2 K \oplus 300 K$ $4km$ High level water vaporMater vapor $6.8 \sim 7.3\mu$ m $N E \Delta T \leq 0.2 K \oplus 300 K$ $4km$ Middle level water vaporLong-wave Infrared 8.5μ m $8.0 \sim 9.0\mu$ m $N E \Delta T \leq 0.2 K \oplus 300 K$ $4km$ Surface temperature 10.7μ m $10.3 \sim 11.3\mu$ m $N E \Delta T \leq 0.2 K \oplus 300 K$ $4km$ Surface temperature	Visible & Near-Infrared 0.47µm 0.45~0.49µm S/N≥90 @ p=100% 1km Aerosol 1 Visible & Near-Infrared 0.65µm 0.55~0.75µm S/N≥00 @ p=100% 0.5~1km Fog, eloud 2 3 0.825µm 0.75~0.90µm S/N≥00 @ p=100% 1km Vegetation 4 3 Short-wave Infrared 1.375µm 1.36~1.39µm S/N≥00 @ p=100% 2km Cloud, enow 5 6 1.61µm 1.58~1.64µm S/N≥200 @ p=100% 2-4km Cloud, enow 5 6 Mid-wave Infrared 3.75µm S.5~4.0µm (high) NE∆T≤0.7K @ 300K 2km Land surface 7 7 Mid-wave Infrared 3.75µm 3.5~4.0µm (high) NE∆T≤0.2K @ 300K 4km Land surface 9 1 1 Mid-wave Infrared 6.25µm 5.8~6.7µm NE∆T≤0.2K @ 300K 4km Middle level water vapor 10 Mater vapor 6.3%7.3µm NE∆T≤0.2K @ 300K 4km Middle level water vapor 10 Long-wave Infrared 8.5µm	Visible & Near-Infrared 0.47µm 0.45 ~ 0.49µm S/N≥00 @ p=100% 1km Aerosol Visible & Near-Infrared 0.65µm 0.55 ~ 0.75µm S/N≥00 @ p=100% 0.5~1km Fog. oloud 1 0.60 0.825µm 0.75 ~ 0.90µm S/N≥00 @ p=100% 1km Vegetation 3 0.825 Short-wave Infrared 1.375µm 1.36 ~ 1.39µm S/N≥00 @ p=100% 2km Cloud, snow 4 1.379 1.61µm 1.58 ~ 1.64µm S/N≥00 @ p=100% 2km Cloud, snow 5 1.61 2.25µm 2.1 ~ 2.35µm S/N≥00 @ p=100% 2km Cloud, snow 6 2.25 Mid-wave Infrared 3.75µm S/N≥00 @ p=100% 2km Cloud, snow 6 2.25 Mid-wave Infrared 3.75µm S/N≥00 @ p=100% 2km Cloud, snow 6 2.25 Mid-wave Infrared 3.75µm S/N ≥00 @ p=100% 2km Land surface 7 3.75 Mid-wave Infrared 3.75µm S.6 - 0µm NEAT S0.3K @ 260K 4km Land	Visible & Near-Infrared 0.65µm 0.45 ~ 0.49µm S/N≥00 © p=100% 1km Aerosol 1 0.47 0.45 ~ 0.49 0.65µm 0.55 ~ 0.75µm S/N≥00 © p=100% 0.5 ~ 1km Fog.oloud 2 0.65 0.55 ~ 0.75µm 0.45 ~ 0.90µm S/N≥00 © p=100% 1km Vegetation 3 0.825µm 0.85 0.75 ~ 0.90µm S/N≥00 © p=100% 2km Cirus 3 0.825 0.75 ~ 0.90µm 1.37 ~ 1.386 Short-wave Infrared 1.375µm 1.36 ~ 1.39µm S/N≥00 © p=100% 2km Cirus, aerosol 4 1.379 1.371 ~ 1.386 2.25µm 2.1 ~ 2.35µm S/N≥00 © p=100% 2km Cirus, aerosol 5 1.61 1.58 ~ 1.64µm 3.75µm S.5 ~ 4.0µm (hig) NEΔTS.0.7K © 300K 2km Cirus, aerosol 6 2.55 3.50 ~ 4.00(high) Mide vapor 6.59µm S.5 ~ 4.0µm (hig) NEΔTS.0.3K © 260K 4km Land surface 7 3.75 3.50 ~ 4.00(high) Mater vapor 6.25µm S.8 ~ 6.7µm NEΔTS.0.3K © 260K 4km Mid	Nindle & Near-Infrare 0.47μ $0.45-0.49\mu$ $SN \ge 0 \circ p = 100\%$ $1km$ $Aerosel$ 0.65μ $0.55-0.75\mu$ $SN \ge 20 \circ p = 100\%$ $0.5-1km$ $Fog, oloud$ 2 $0.65-0.75\mu$ $0.55-0.75\mu$ $0.5-0.75\mu$	Visible & Near-Infrared 0.47µm 0.45 - 0.49µm SN290 © p=100% 1km Aeroel Visible & Name 0.55 - 0.75µm SN2200 © p=100% 0.51km Fog, oloud 0.5 0.55 - 0.75µm 0.51km 0.51km Visible & Name 0.55 - 0.75µm 0.51km Fog, oloud 0.5 0.55 - 0.75µm 0.51km SN2200 © p=100% 1km Visible & Name 0.55 - 0.75µm 0.55 - 0.75µm 0.52 - 0.75µm 0.52 - 0.75µm SN2200 © p=100% 1km Visible & Name 0.55 - 0.75µm 1.37 - 1.380 2.0 - 0.51µm SN2200 © p=100% 2km Cirus 0.61 - 0.91 1.37 - 1.386 2 SN2200 © p=100% 2km Cirus 0.61 - 0.91 1.37 - 1.386 2 SN2200 © p=100% 2km Cirus 0.61 - 0.91 1.37 - 1.386 2 SN2200 © p=100% 2km SN220 © p=100% Name Name 1.61 µm 1.58 - 1.64 µm 2 SN2200 © p=100% 2km Name Name	Value best of the sector of

15 13.3

Source: https://www.nsmc.org.cn/nsmc/en/instrument/AGRI.html

An additional band (Bands 9-11) in FY-4B to better resolve mid-level and low-level water vapour

4

13.00~13.60





FY-4B Imagery

https://www.nsmc.org.cn/nsmc/en/image/ index.html?id=FY4B AGRI IMG REGI GCLR GLL



Satellite Program Operation Imagery and Product Application Belt & Road About NSMC Data Support

Home / Imagery and Product

FY-4B Image ¥

Videos Featured Image



































Fengyun Satellite Weather Application Platform (SWAP)

http://rsapp.nsmc.org.cn/geofy/en/

A web-GIS interactive display of FY4B (and FY4A / FY2H) images





Training Desk and Study Visit for Cambodia (Ha Noi, 19-23 May 2025)

Using multi-spectral satellite images in weather monitoring

Channel	Himawari-8/ -9	MTSAT-1R/-2	MSG	Physical Properties	
1	0.46 μm			vegetation, aerosol B	
2	0.51 μm			vegetation, aerosol G	Visible
3	0.64 μm	0.68 µm	0.635 μm	low cloud, fog R	
4	0.86 µm		0.81 µm	vegetation, aerosol	
5	1.6 µm		1.64 µm	cloud phase	Near Infrared
6	2.3 μm			particle size	minarcu
7	3.9 μm	3.7 μm	3.92 μm	low cloud, fog, forest fire	
8	6.2 μm	<mark>6.8</mark> μm	6.25 μm	mid- and upper level moisture	
9	6.9 μm			mid- level moisture	
10	7.3 μm		7.35 μm	mid- and lower level moisture	
11	8.6 µm		8.70 μm	cloud phase, SO2	
12	9.6 µm		9.66 µm	ozone content	Infrared
13	10.4 µm	10.8 µm	10.8 µm	cloud imagery, information of cloud top	
14	11.2 μm			cloud imagery, sea surface temperature	
15	12.4 μm	12.0 μm	12.0 µm	cloud imagery, sea surface temperature	
16	13.3 μm		13.4 µm	cloud top height	





Band01 (0.46 μm) Band02 (0.51 μm) Band03 (0.64 μm) Band04 (0.86 μm) Band05 (1.6 μm) Band06 (2.3 μm)



香港天文台 HONG KONG OBSERVATORY

Use and Interpretation of Satellite RGB Imagery for Severe Weather Nowcasting





RGB Composite Imagery

- What is RGB technique?
 - To derive various information of cloud characteristics by colorizing and composing different channels of satellite imagery
 - Advantage:
 - simple process by composition of real-time images to create RGB product on-the-fly
 - various information derivable by RGB image
 - "natural texture" of single channel images can be retained in RGB product





JMA MSC Himawari RGB Quick Guides



Meteorological Satellites

Introduction

News Release Archive

Real-time Imagery

Real-time Imagery (Rapid Scan)

Image Gallery

Operational Information

Data Access

For NMHSs

HimawariRequest

About Us

Links

Site Map

HOME > Services > Meteorological Satellites > NMHSs > VLab > Himawari RGB Quick Guide

🗖 imawari RGB Quick Guides

Outline

Himawari RGB Quick Guides provide basic summaries on the use of RGB composite imagery.

They are designed simply with front and reverse sides for ease of printing and lamination. A total of 18 Quick Guides are provided in relation to SATAID software to facilitate daily work.

Guides contain information on:

- 1. Main application(s), benefits and limitations
- 2. Typical cases
- 3. Color interpretation
- 4. RGB recipe (RGB composition: combinations of imagery assigned to the three primary colors with recommended thresholds) and related specifications

Himawari RGB Quick Guides

Click on an RGB name or image to download the relevant content.

WMO-recommended schemes



Example of RGB product (1) – False Color Imagery







Band01 (0.46 μm) | Band02 (0.51 μm) Band03 (0.64 μm) Band04 (0.86 μm) Band05 (1.6 μm) Band06 (2.3 μm)





2024-05-04 08:30 UTC

Band03 (0.64 μm)



Band13 (10.4 μm)



Band02 (0.51 μm)











JAXA Global Rainfall Watch (<u>https://sharaku.eorc.jaxa.jp/GSMaP/index.htm</u>)

24 hours accumulated rainfall at 17:00 UTC 4 May 2024





RGB Composite Imagery

Band	Himawari-8/ AHI	MTSAT-2/ IMAGER	Physical Properties	Natural Color	Day Microphysics	Night Microphysics	Day Snow- Fog	Day Convective Storm	Dust	Airmass
1	$0.47\mu{ m m}$		vegetation, aerosol B							
2	$0.51\mu{ m m}$		vegetation, aerosol G							
3	0.64 µm	0.68 µm	low cloud, fog R	Х				Х		
4	0.86 µm		vegetation, aerosol	Х	Х		Х			
5	1.6 µm		cloud phase	Х			Х	Х		
6	2.3 µm		particle size							
7	3.9 µm	3.7 μm	low cloud, fog, forest fire		Х	Х	Х	Х		
8	6.2 μm	6.8 µm	upper level moisture					Х		Х
9	6.9 µm		mid- and upper level moisture							
10	7.3 µm		mid- level moisture, SO2					Х		Х
11	8.6 µm		cloud phase, SO2						Х	
12	9.6 µm		ozone content							Х
13	10.4 µm	10.8 µm	cloud imagery, information of cloud top		х	х		Х	Х	Х
14	11.2 µm		cloud imagery, sea surface temperature							
15	12.4 µm	12.0 µm	cloud imagery, sea surface temperature			Х			Х	
16	13.3 µm		cloud top height							
			香港天文台 HONG KONG OBSERVATORY	WMC	Severe Weather Training Desk and	Forecasting Programm d Study Visit for Camb	e Regional Su odia (Ha Noi	b-programme for Sou , 19-23 May 2025)	utheast Asia (SWFP-SeA)



JMA MSC Himawari RGB Quick Guides



Meteorological Satellites

Introduction

News Release Archive

Real-time Imagery

Real-time Imagery (Rapid Scan)

Image Gallery

Operational Information

Data Access

For NMHSs

HimawariRequest

About Us

Links

Site Map

HOME > Services > Meteorological Satellites > NMHSs > VLab > Himawari RGB Quick Guide

🗖 imawari RGB Quick Guides

Outline

Himawari RGB Quick Guides provide basic summaries on the use of RGB composite imagery.

They are designed simply with front and reverse sides for ease of printing and lamination. A total of 18 Quick Guides are provided in relation to SATAID software to facilitate daily work.

Guides contain information on:

- 1. Main application(s), benefits and limitations
- 2. Typical cases
- 3. Color interpretation
- 4. RGB recipe (RGB composition: combinations of imagery assigned to the three primary colors with recommended thresholds) and related specifications

Himawari RGB Quick Guides

Click on an RGB name or image to download the relevant content.

WMO-recommended schemes



Online resources

- Himawari Real-Time Image (including RGB products)
 - <u>https://www.data.jma.go.jp/mscweb/data/himawari/sat_img.php</u>
 - Select "Southeast Asia I" or "Hi-res Asia I"
- Reference on RGB product
 - <u>https://www.data.jma.go.jp/mscweb/en/product/product.html</u>
 - <u>https://www.jma.go.jp/jma/jma-eng/satellite/VLab/RGB_QG.html</u>
 - Introduction to Himawari-8 RGB Composite Imagery





https://www.data.jma.go.jp/mscweb/data/himawari/sat_img.php

"Southeast Asia I" Meteorological Satellite Center HOME > Real-Time Image > Full Disk, Japan and Individual Sectors Real-Time Image Terms of reference Himawari Real-Time Image The RGB composite imagery is produced by composing satellite images colored in red, green and blue. Details are refer to "RGB Training Library (JMA website)". Select Area Band Southeast Asia 1 Day Microphysics RGB ~ Time Animation 06:40 UTC 15 May 2025 V Prev Next Last 1 Hour V Play Stop

"Hi-res Asia I"



Hi-res Asia 1 Time 06:40 UTC 15 May 2025 V Prev Next Animation Last 1 Hour V Play Stop







(I) Natural Color RGB

Channel	Himawari-8/ -9	MTSAT-1R/-2	MSG	Physical Properties	
1	0.46 μm			vegetation, aerosol B	
2	0.51 μm			vegetation, aerosol G	Visible
3	0.64 μm	0.68 µm	0.635 μm	low cloud, fog R	
4	0.86 μm		0.81 µm	vegetation, aerosol	
(5)	1.6 µm		1.64 μm	cloud phase	Near Infrared
6	2.3 μm			particle size	innarca
7	3.9 μm	3.7 μm	3.92 µm	low cloud, fog, forest fire	
8	6.2 μm	<mark>6.8</mark> μm	6.25 μm	mid- and upper level moisture	
9	7.0 μm			mid- level moisture	
10	7.3 μm		7.35 μm	mid- and upper level moisture	
11	8.6 µm		8.70 μm	cloud phase, SO2	
12	9.6 µm		9.66 μm	ozone content	Infrared
13	10.4 μm	10.8 µm	10.8 µm	cloud imagery, information of cloud top	
14	11.2 μm			cloud imagery, sea surface temperature	
15	12.3 μm	12.0 μm	12.0 μm	cloud imagery, sea surface temperature	
16	13.3 μm		13.4 μm	cloud top height	

These channels have reflection characteristics for land/ sea surface conditions (such as snow/ ice covered area, vegetation) respectively.

RGB "Natural Colors" scheme (RGB : B05/B04/B03) R : B05(N2 1.6) Range : 0 ~ 100 [%] Gamma : 1.0 G : B04(N1 0.86) Range : 0 ~ 100 [%] Gamma : 1.0 B : B03(VS 0.64) Range : 0 ~ 100 [%] Gamma : 1.0



Band01 (0.46 μm) Band02 (0.51 μm) Band03 (0.64 μm) Band04 (0.86 μm) Band05 (1.6 μm) Band06 (2.3 μm)







2024-05-04 08:30 UTC



High-level ice clouds

Ocean Vegetation Desert Snow

Low-level water clouds





(I) Natural Color RGB

- Main applications:
 - Identification of surface characteristics (vegetation, bare soil and snow) and ice / water clouds
- Benefits:
 - Stratification of high-level ice clouds and low-level water clouds
 - Quick and intuitive identification of surface characteristics
- Limitation:
 - Only daytime
 - Similarity of colour of high-level ice cloud and snow-/ice-covered surfaces
 - Cyan areas may represent <u>contributions from both ice and water cloud with large</u> <u>droplets</u> due to contribution from band05 (1.6 μm)



(2) Day Convective Storms RGB

Channel	Himawari-8/ -9	MTSAT-1R/-2	MSG	Physical Properties	
1	0.46 μm			vegetation, aerosol B	
2	0.51 μm			vegetation, aerosol G	Visible
3	0.64 μm	0.68 µm	0.635 μm	low cloud, fog R	
4	0.86 µm		0.81 µm	vegetation, aerosol	
5	1.6 µm		1.64 μm	cloud phase	Near Infrared
6	2.3 μm			particle size	innarea
G	3.9 μm	3.7 μm	3.92 μm	low cloud, fog, forest fire	
8	6.2 μm	<mark>6.8 μ</mark> m	6.25 μm	mid- and upper level moisture	
9	7.0 μm			mid- level moisture	
10	7.3 μm		7.35 μm	mid- and upper level moisture	
11	8.6 μm		8.70 μm	cloud phase, SO2	Infrared
12	9.6 μm		9.66 µm	ozone content	Infrared
13	10.4 μm	10.8 μm	10.8 µm	cloud imagery, information of cloud top	
14	11.2 μm			cloud imagery, sea surface temperature	
15	12.3 μm	12.0 μm	12.0 µm	cloud imagery, sea surface temperature	
16	13.3 μm		13.4 µm	cloud top height	

G KONG OBSERVATORY

The phase and size of cloud particles distinction can be revealed from these <u>differences</u>.

RGB "Day Convective Storms" scheme (RGB : B08-B10/B07-B13/B05-B03)

R : B08(VVV6.2) – B10(VVV 7.3) Range: -35 ~ 5 [K] Gamma: 1.0 G : B07(I4 3.9)-B13 (IR10.8) Range: -5 ~ 60 [K] Gamma: 0.5 B : B05(NIR1.6)-B03(VIS0.6) Range: -75 ~ 25 [%] Gamma: 1.0



Severe Weather Forecasting Programme Regional Sub-programme for Southeast Asia (SWFP-SeA) Training Desk and Study Visit for Cambodia (Ha Noi, 19-23 May 2025)

香港天文台______ — — 🛞 WMO

2024-05-04 08:30 UTC





Ocean

Land





(2) Day Convective Storm RGB

- Main applications:
 - Identification of high-level cloud tops and/or small ice particles conducive to severe / significant convection with strong updraft
- Benefits:
 - Distinctive yellow patterns denoting cumulonimbus (Cb) clouds with strong updraft and severe weather
- Limitation:
 - Only daytime
 - Less clear for low-level clouds and surface conditions
 - Possible mixed with other high-level clouds (e.g. lee side of mountainous ranges) leading to reduced clarity for convective clouds





Exercise I

2024-10-04 05:00 UTC

I. What types of clouds are present in A and B?

- Referring to the images in the next
 2 pages, identify the development
 of the clouds in A, and nowcast
 for the following 1-2 hours.
- 3. Would you expect any new convective developments in or near provinces / cities such as Phnom Penh and Prey Veng ?





2024-10-04 05:30 UTC

2024-10-04 06:00 UTC









2024-10-04 06:30 UTC

2024-10-04 07:00 UTC







(3) Day Microphysics RGB

Channel	Himawari-8/ -9	MTSAT-1R/-2	MSG	Physical Properties	
1	0.46 μm			vegetation, aerosol <mark>B</mark>	
2	0.51 μm			vegetation, aerosol G	Visible
3	0.64 μm	0.68 µm	0.635 μm	low cloud, fog R	
4	0.86 μm		0.81 μm	vegetation, aerosol	
5	1.6 µm		1.64 µm	cloud phase	Near Infrared
6	2.3 μm			particle size	innarca
7	3.9 μm	3.7 μm	3.92 μm	low cloud, fog, forest fire	
8	6.2 μm	6.8 μm	6.25 μm	mid- and upper level moisture	
9	6.9 μm			mid- level moisture	
10	7.3 μm		7.35 μm	mid- and lower level moisture	
11	8.6 µm		8.70 μm	cloud phase, SO2	
12	9.6 µm		9.66 µm	ozone content	Infrared
13	10.4 µm	10.8 μm	10.8 µm	cloud imagery, information of cloud top	
14	11.2 μm			cloud imagery, sea surface temperature	
15	12.4 μm	12.0 μm	12.0 μm	cloud imagery, sea surface temperature	
16	13.3 μm		13.4 µm	cloud top height	

B04 – high reflectivity for snow/ice covered area and clouds (sea surface looks dark); reflection characteristics vary with phase and size of cloud particles (smaller particle has higher reflectivity)

B07 – 3.9 micron image has reflection characteristics depending on phase and size of cloud particles – useful to distinguish cloud layer and convective clouds, etc. (smaller particle has higher reflectivity)

BI3 – atmospheric window channel, with whitish (darker) areas corresponding to low (higher) brightness temperature – i.e. high-level cloud and developed Cbs (clouds on lower levels)

RGB "Day Microphysics" scheme (RGB : B04/B07/B13)

R : B04(NIR0.86) Range: 0 ~ 100 [%] Gamma: 1.0 G : B07(I4 3.9) Range: 0 ~ 60 [%] Gamma: 2.5 (Summer) Range: 0 ~ 25 [%] Gamma: 1.5 (Winter) B : B05(IR10.4) Range: 203 ~ 323 [K] Gamma: 1.0 (reverse)



🎒 WMC

Band01 (0.46 μm) Band02 (0.51 μm) Band03 (0.64 μm) Band04 (0.86 μm) Band05 (1.6 μm) Band06 (2.3 μm)



MO

2024-05-04 08:30 UTC



Colour interpretation for Day Microphysics RGB

Color	Interpretation
	Deep precipitating cloud (precipitation is not necessarily reaching the ground) - bright, thick, large ice particles, cold cloud
	Deep precipitating cloud (Cb cloud with strong updrafts and severe weather)* - bright, thick, small ice particles, cold cloud *or thick, high-level lee cloudiness with small ice particles
	Thin Cirrus cloud (large ice particles)
	Thin Cirrus cloud (small ice particles)
	Super-cooled, thick water cloud - bright, thick, small droplets
	Super-cooled, thick water cloud - bright, thick, large droplets
	Super-cooled thin water cloud with large droplets
	Super-cooled, thin water cloud with small droplets
	Thick water cloud (warm rain cloud) - bright, thick, large droplets
	Thick water cloud (no precipitation) - bright, thick, small droplets
	Thin water cloud with large droplets
	Thin water cloud with small droplets
	Ocean
	Vegetation
	Desert/Fire (Hot spot)
	Snow/Ice




(3) Day Microphysics RGB

- Main applications:
 - Provide a complex cloud analysis, distinguish ice from water phase, and to provide information on cloud top particle size, temperature and cloud optical thickness.
 - Monitor the development of convection, fog and low clouds
- Benefits:
 - Good colour contrast between ice and water clouds, especially for water clouds with small droplets and snow on ground
 - Provides information on cloud particle size, optical thickness and cloud top temperature. Orange colour indicates the presence of small ice crystals on top of cumulus clouds.
 - Detection of super-cooled water clouds and wildfires.
- Limitations:
 - Only daytime
 - Pixel colour fades during dawn/dusk when the sun's angle is low
 - Many colour shades needs practice for proper interpretation





Exercise 2 2024-10-04 05:00 UTC

I. Identify types of clouds in A and B?

2. How do they compare with your results using Day Convective RGB?







(4) Night Microphysics RGB

Channel	Himawari-8/ -9	MTSAT-1R/-2	MSG	Physical Properties			
1	0.46 μm			vegetation, aerosol B			
2	0.51 μm			vegetation, aerosol G	Visible		
3	0.64 μm	0.68 µm	0.635 μm	low cloud, fog R			
4	0.86 µm		0.81 µm	vegetation, aerosol			
5	1.6 μm		1.64 µm	cloud phase	Near Infrared		
6	2.3 μm particle size				IIIIareu		
7	3.9 μm	3.7 μm	3.92 µm	low cloud, fog, forest fire			
8	6.2 μm	6.8 μm	6.25 μm	mid- and upper level moisture			
9	6.9 μm			mid- level moisture			
10	7.3 μm		7.35 μm	mid- and upper level moisture			
11	8.6 µm		8.70 μm	cloud phase, SO2 ozone content	Infrared		
12	9.6 μm		9.66 µm				
13) 10.4 μm 10.8 μ		10 X IIm -	cloud imagery, information of cloud top	p		
14	11.2 μm			cloud imagery, sea surface temperature			
15	12.4 μm	12.0 μm	12.0 μm	cloud imagery, sea surface temperature			
16	13.3 μm		13.4 µm	cloud top height			

This RGB is effective to distinguish clouds with high cloud top (such as Cb) and fog or low-level clouds because the difference of 3.9 micron is included in this scheme.

RGB "Night Microphysics" scheme (RGB: B15-B13 /B13-B07/B13) R : B15(IR2 12.3) - B13(IR 10.4) Range: -4 ~ 2 [K] Gamma : 1.0 G : B13(IR 10.4) - B07(IR4 3.9) Range : 0 ~ 10 [K] Gamma : 1.0 B : B13(IR 10.4) Range : 243 ~ 293 [K] Gamma : 1.0



🖄 WM

2024-05-04 II:40 UTC



Interpretation of colors for "Night Microphysics"



Ocean

IRI (BI3) image



Land





2023-09-27 12:30 UTC



Interpretation of colors for "Night Microphysics"







(4) Night Microphysics RGB

- Main applications:
 - Cloud analysis and detection of fog / low clouds during nighttime
- Benefits:
 - Good contrast between water cloud (fog / log clouds) and cloud-free surfaces
 - Effective for nighttime cloud analysis
 - Useful for identifying fire hotspots
- Limitations:
 - Good for nighttime only (all clouds appear magenta during daytime)
 - Ambiguity to differentiate fog from low-clouds only from Night Microphysics RGB
 - Fog / low clouds may appear mixed with surface thermal conditions (i.e. diurnal / latitudinal and seasonal variations)





Comparing RGB imagery with radar observation





2023-10-20 04:30 UTC



Credit: CMA





2023-10-20 04:30 UTC



Credit: CMA





2023-10-20 04:30 UTC



Credit: CMA





2023-10-20 14:30 UTC







Artificial Intelligence / Machine Learning in Satellite Analysis and Nowcast Products





Multi-layer perceptron artificial neural network (MLPANN)

• Features of MLPANN:

Neural Network Architecture	Deep neural networks		
Training Algorithm	Backpropagation		
Learning Strategy	Supervised learning		



Two-step procedure in backpropagation network – activity from input pattern flows forward through the network while the error flows backward to adjust the weights.





Machine Learning Satellite Retrieved Reflectivity



16 Bands of AHI (Advanced Himawari Imager)					(Adva	nced Himawari Imager)	Input	Description
MTSAT Channels		Bai	nd	Wavelength [µm]	Spatial Resolution	True Color Image	B03 (VIS0.64)	VIS0.64. Reflectivity of B03 depends on optical thickness. Thick cloud are displayed in white.
VIS IR4	IR4 N1 Near Infrared 0.86 1 km Aerosol 6 N3 1.6 2 km Size of the cloud droplet Size of the cloud droplet Fog, Hot spot (Forest fire) 7 14 3.9 2 km Fog, Hot spot (Forest fire) Water vapor 9 W2 7.0 2 km Water vapor SO ₂ (Sulfur dioxide)	B05 (NIR1.6) - B04 (N1 0.86)	Difference between NIR1.6 and N1 0.86. B04 has high reflectivity for snow/ice covered area and clouds, sea surface looks dark. Reflection characteristic of B05 depends on the phase and size of cloud particles. On difference image, thick clouds with large ice particles are displayed in black (dark), low clouds and land/sea surface look whitish (bright)					
IR3 (WV)		B08 (WV6.2) - B10 (W3 7.3)	Difference between WV6.2 and W3 7.3. On difference image, thick clouds with high cloud are displayed in white, low clouds and thin Ci are indistinct.					
IR1 IR2	12 13 14 15	IR L2	Infrared	9.6 10.4 11.2 12.3	6 2 km .4 2 km .2 2 km Atmospheric Windows	B13 (IR10.4)	IR10.4, Atmospheric window band, available for 24 hours. High-level clouds and developed Cbs appear in white, mid-level cloud appear in bright gray.	
	101112.1514.1616CO13.32 kmCO2 (Carbon dioxide)		B13 (IR10.4) - B15 (I2 12.3)	Difference between IR 10.4 and I2 12.3. Absorption by water vapor of B15 is slightly larger than that of B13. On difference image, thick cloud and low-level cloud contribute to rather grey color, high-level cloud contributes bright color.				













Equinox day diff.



2024-05-04 08:30 UTC







Band13 (10.4 μm)



Band02 (0.51 μm)







2024-05-04 08:30 UTC















Website: https://rsmc.hko.gov.hk/



Hong Kong Observatory Nowcasting Services

The Hong Kong Observatory (HKO) has been operating its nowcasting services since 1999. In this connection, HKO has developed a suite of nowcasting systems, including the "Short-range Warning of Intense Rainstorms in Localized Systems" (SWIRLS), to aid rainstorm warning operation as well as high-impact weather forecasting for the public and the aviation community. HKO's nowcasting system has been put to use in various WMO Forecast Demonstration Projects and was demonstrated to be among the best performers. In recent years, HKO develops a community version of its nowcasting system (Com-SWIRLS) to promote knowledge exchange in radar nowcasting techniques and for wider application of nowcasting system. HKO is ready to provide nowcasting services to international users in accordance with the standard and requirements for Regional Specialized Meteorological Centre (RSMC) for nowcasting as described in the WMO Manual on the Global Data-Processing and Forecasting System (GDPFS) (WMO-No. 485).

Location-specific Rainfall Nowcast



Significant Convection Nowcast over East Asia



Significant convection nowcast at the fourth hour (in UTC) using retrieved reflectivity (blue ≥24 dBZ, orange ≥33 dBZ and red ≥41 dBZ) from Himawari-8 data and updated every 10 minutes. Lightning counts are marked in yellow (sparse) to brown (dense) with green polygons on areas with high reflectivity or dense lightning.

Significant Convection Nowcast (I-6 hr) using Himawari-9 ML retrieved reflectivity

Initial time: 2024-05-04 06:30 UTC









2024-05-04 08:30 UTC

Forecast locations (at T+2 h)

Colour interpretation for Day Microphysics RGB

 Color
 Interpretation

 Deep precipitating cloud (precipitation is not necessarily reaching the ground) - bright, thick, large ice particles, cold cloud

 Deep precipitating cloud (Cb cloud with strong updrafts and severe weather)* - bright, thick, small ice particles, cold cloud

 *or thick, high-level lee cloudiness with small ice particles









- Resources of online satellite products for analysis of convective weather
- Principle of RGB techniques
 - False color (visible + infrared)
 - Natural Color
 - Day Convective Storm
 - Day Microphysics
 - Night Microphysics
- Machine learning retrieved (simulated radar) reflectivity from Himawari multi-spectral imagery
- RSMC Nowcasting website showing nowcast of significant convective areas up to the next 6 hours







Thank you very much



