



기상청 KOREA METEOROLOGICAL ADMINISTRATION

# Application of RGB imagery to the Korean Peninsula

2015. 11. 09.

Park, Hye-Sook

National Meteorological Satellite Center(NMSC)

Korea Meteorological Administration



## Advantage of Himawari-8 imagery

- Usage of channel images



## Several COMS RGB imagery



## Application of Himawari-8 RGB imagery

# Comparison of Next Generation Satellites

아름다운  
과학을  
가장 먼저  
알려드립니다

채널	Central Wavelength( $\mu\text{m}$ )						
	AMI (GK-2A)	ABI (GOES-R)	AHI (Himawari)	MI (COMS)	SEVIRI (MSG)	MODIS	
1(VIS) blue	0.470	0.470	0.46			0.466 (B03)	
2(VIS) green	<b>0.511</b>		<b>0.51</b>			0.554 (B04)	
3(VIS) red	0.640	0.640	0.64	0.675	0.6	0.647 (B01)	
4(NIR)	0.856	0.865	0.86		0.8	0.857 (B02)	
5(NIR)	<b>1.380</b>	<b>1.378</b>				1.382 (B26)	
6(NIR)	1.610	1.610	1.6		1.6	1.629 (B06)	
NIR		<b>2.250</b>	<b>2.3</b>			2.114 (B07)	
7(IR)	3.830	3.90	3.9	3.75	3.9	3.788 (B20)	
8(WV)	6.241	6.185	6.2		6.2	6.765 (B27)	
9(WV)	6.952	6.95	7.0	6.75		6.765 (B27)	
10(WV)	7.344	7.34	7.3		7.3	7.337 (B28)	
SO <sub>2</sub>	11(IR)	8.592	8.50	8.6		8.7	8.529 (B29)
O <sub>3</sub>	12(IR)	9.625	9.61	9.6		9.7	9.734 (B30)
	13(IR)	10.403	10.35	10.4	10.8	10.8	B30+B31
	14(IR)	11.212	11.20	11.2			11.019 (B31)
	15(IR)	12.364	12.30	12.3	12.0	12.0	12.032 (B32)
CO <sub>2</sub>	16(IR)	13.31	13.30	13.3		13.4	13.365 (B33)

RGB합성

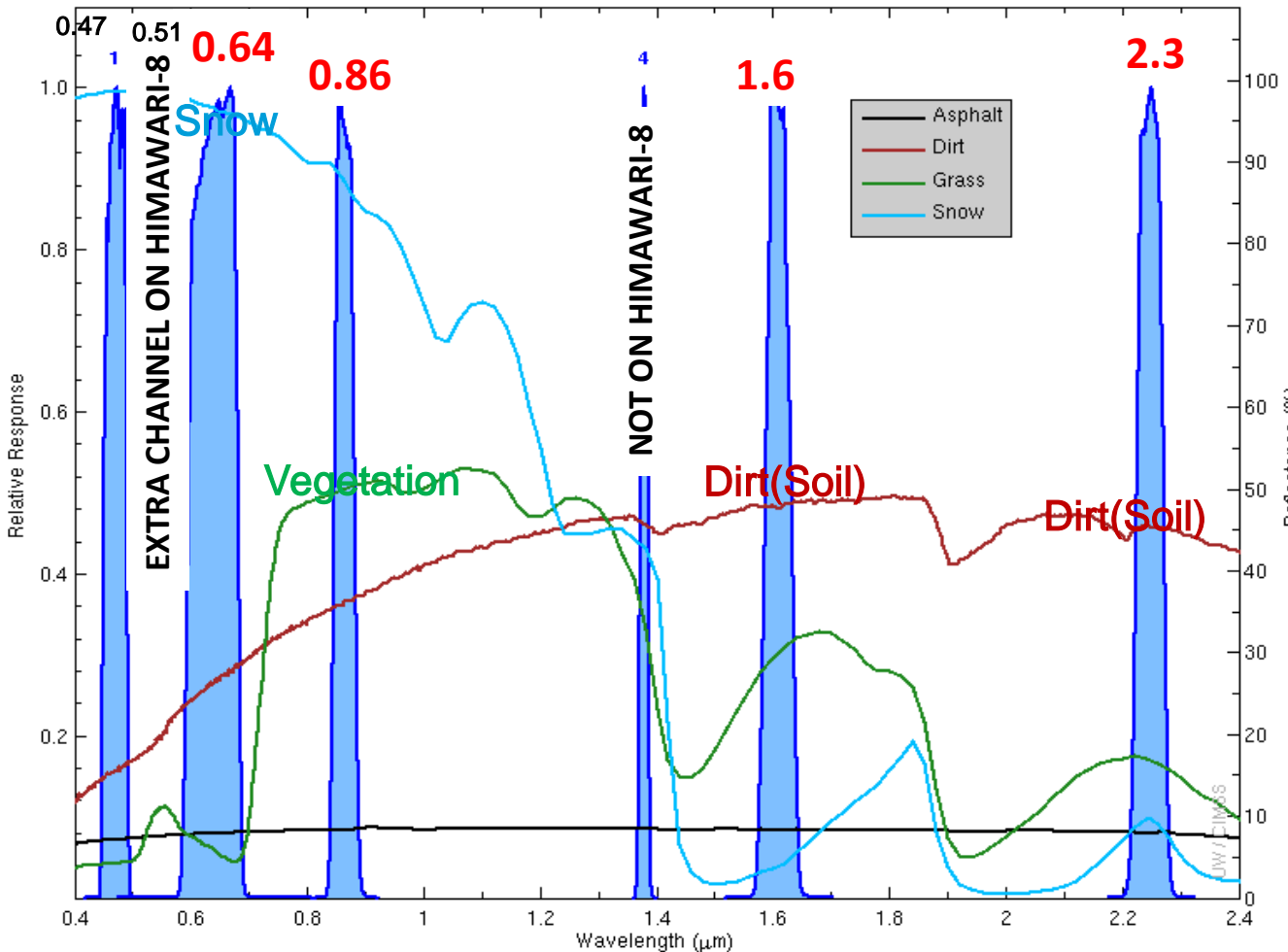
Water Vapor

Atmospheric Window

Very thin cirrus cloud

# Responses of visible channels to surface condition

ABI FM1 (v08Sep2011) Visible SRFs & Various ASTER Reflectance Spectra



Ch. 3 (0.64 μm)	Absorption channel by vegetation <b>Reflection by Snow/ice</b>
Ch. 4 (0.86 μm)	<b>Reflection by vegetation</b> Not sensitive to the dirt
Ch. 5 (1.6 μm)	<b>Strong absorption by Snow/ice</b> <b>Reflection by dirt</b>
Ch. 6 (2.3 μm)	absorption by Snow/ice <b>Strong absorption by vegetation</b> <b>Reflection by burn scars</b>
Ch. 7 (3.9 μm)	<b>Very sensitive to "hot spots"</b>

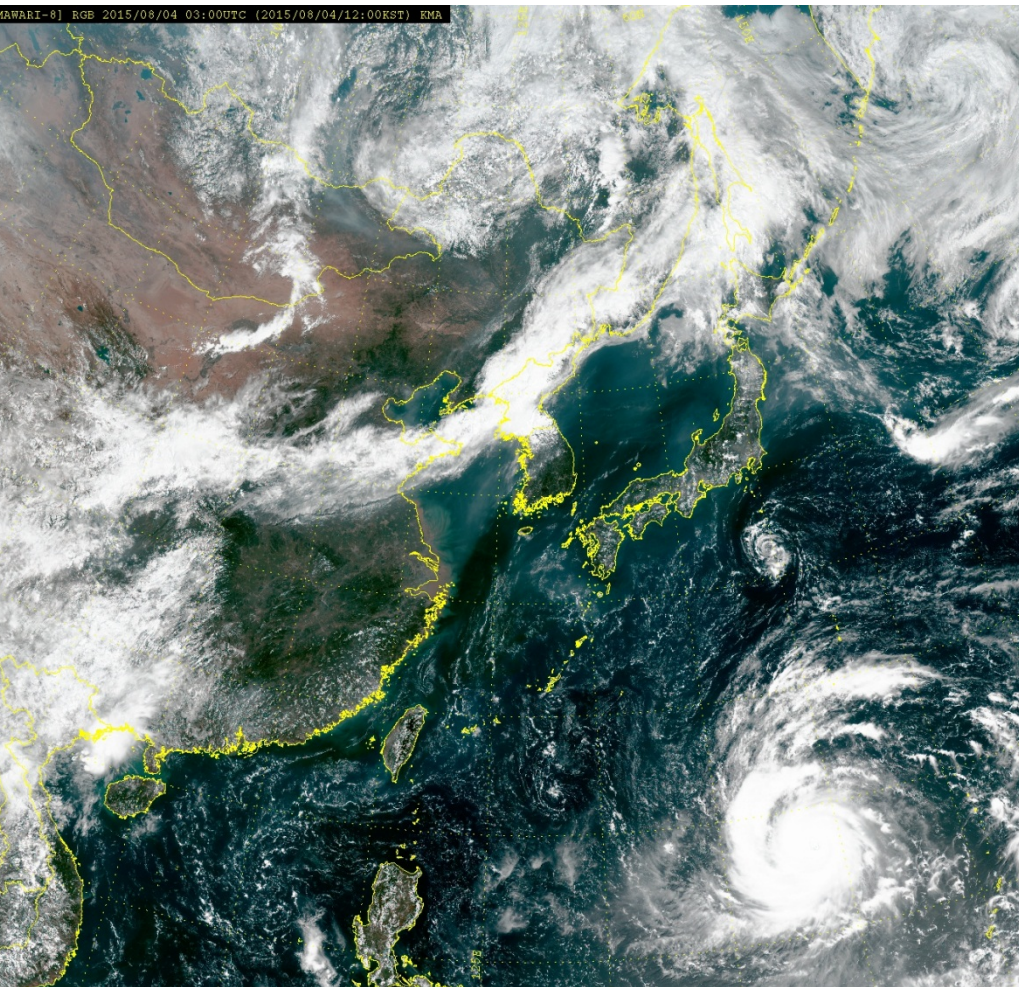
From "Moving from "versus" quantitative products to RGB "with" quantitative products" NOAA/NES DIS/Satellite Applications and Research Advanced Satellite Products Branch (ASPB) Joleen Feltz CIMSS

# Powerful Full Color image

하늘을 친구처럼  
국민을 하늘처럼

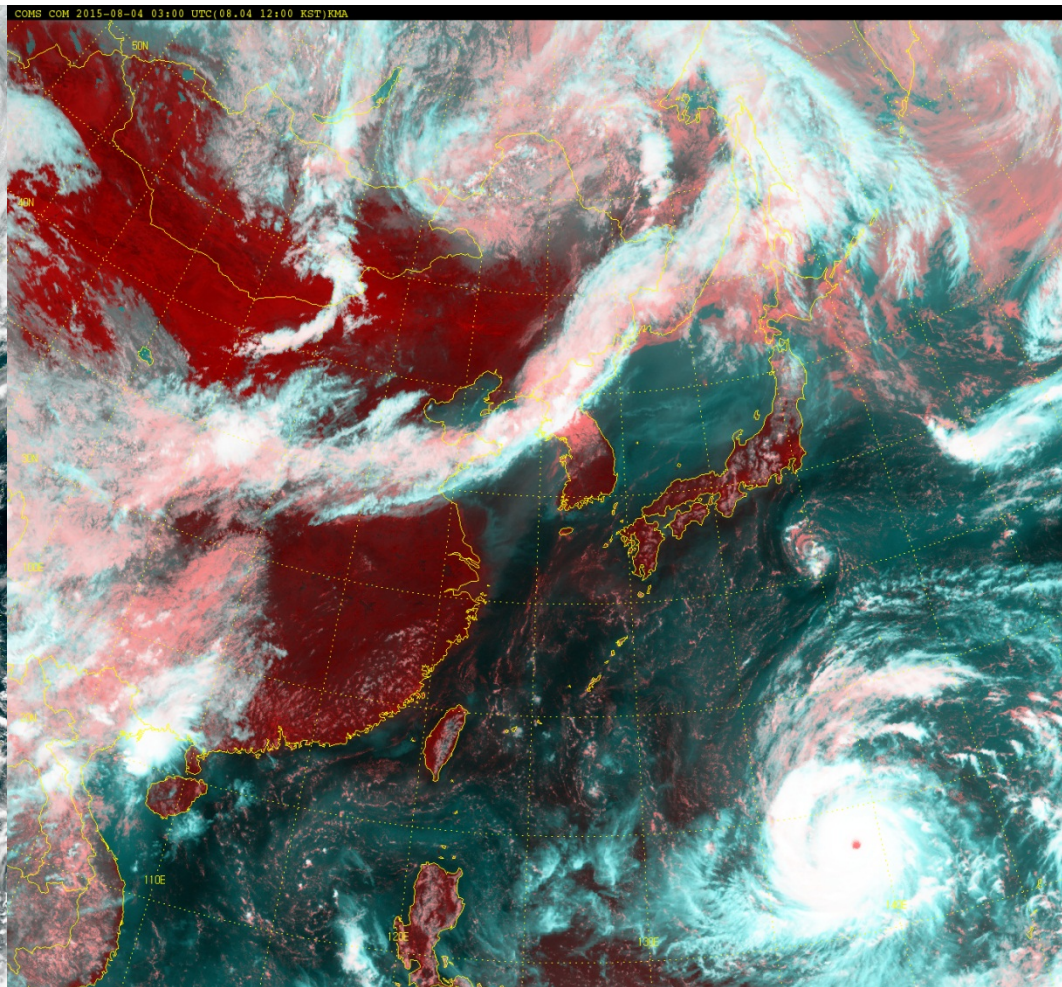


## True Color RGB(Ch1+Ch.2+Ch3)



### Himawari-8

## IR+VIS RGB



### COMS

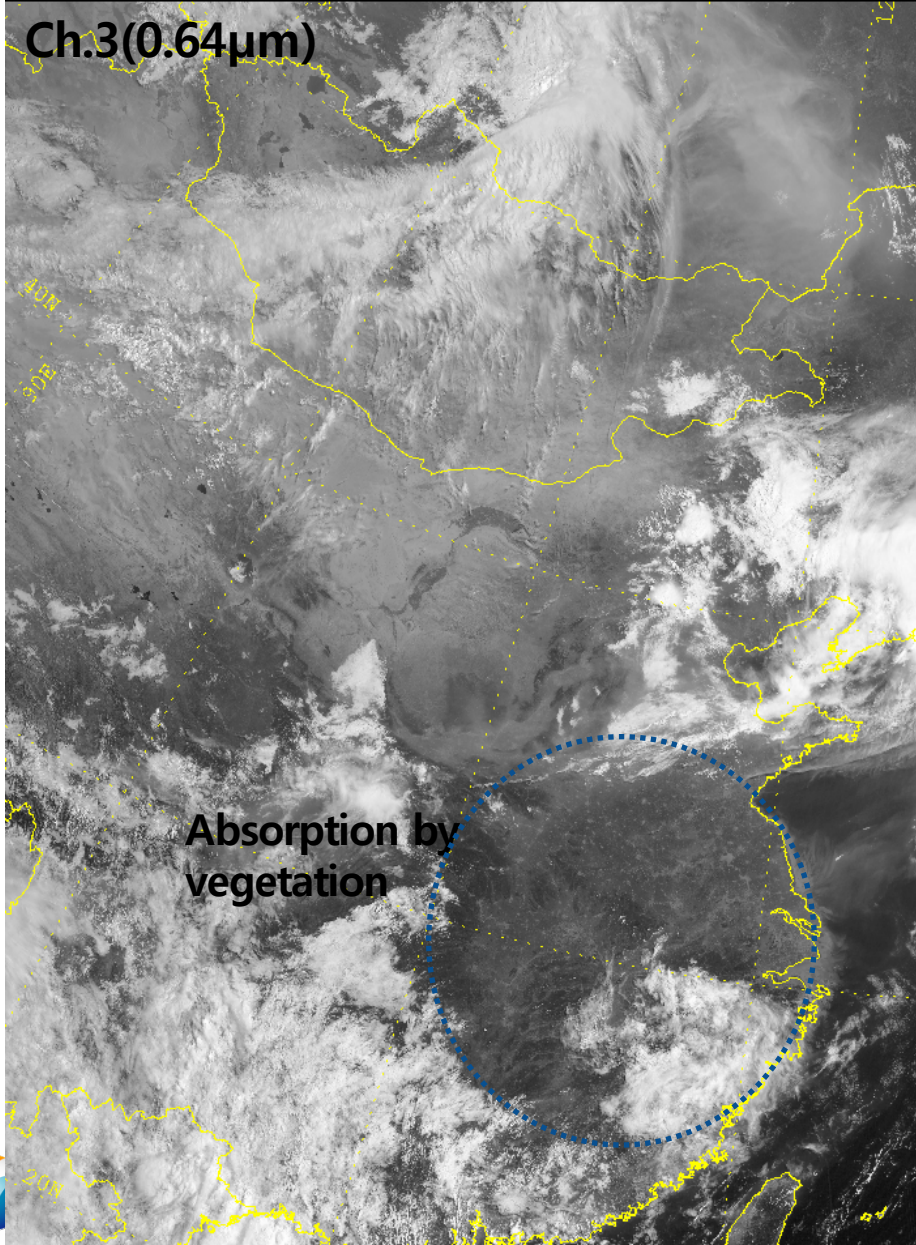
2015 Aug. 4, 03:00UTC

# Ch3(0.64) vs ch4(0.86)

하늘을 친구처럼  
국민을 하늘처럼

[HIMAWARI-8] B03 2015/07/30 00:50UTC (2015/07/30/09:50KST) KMA

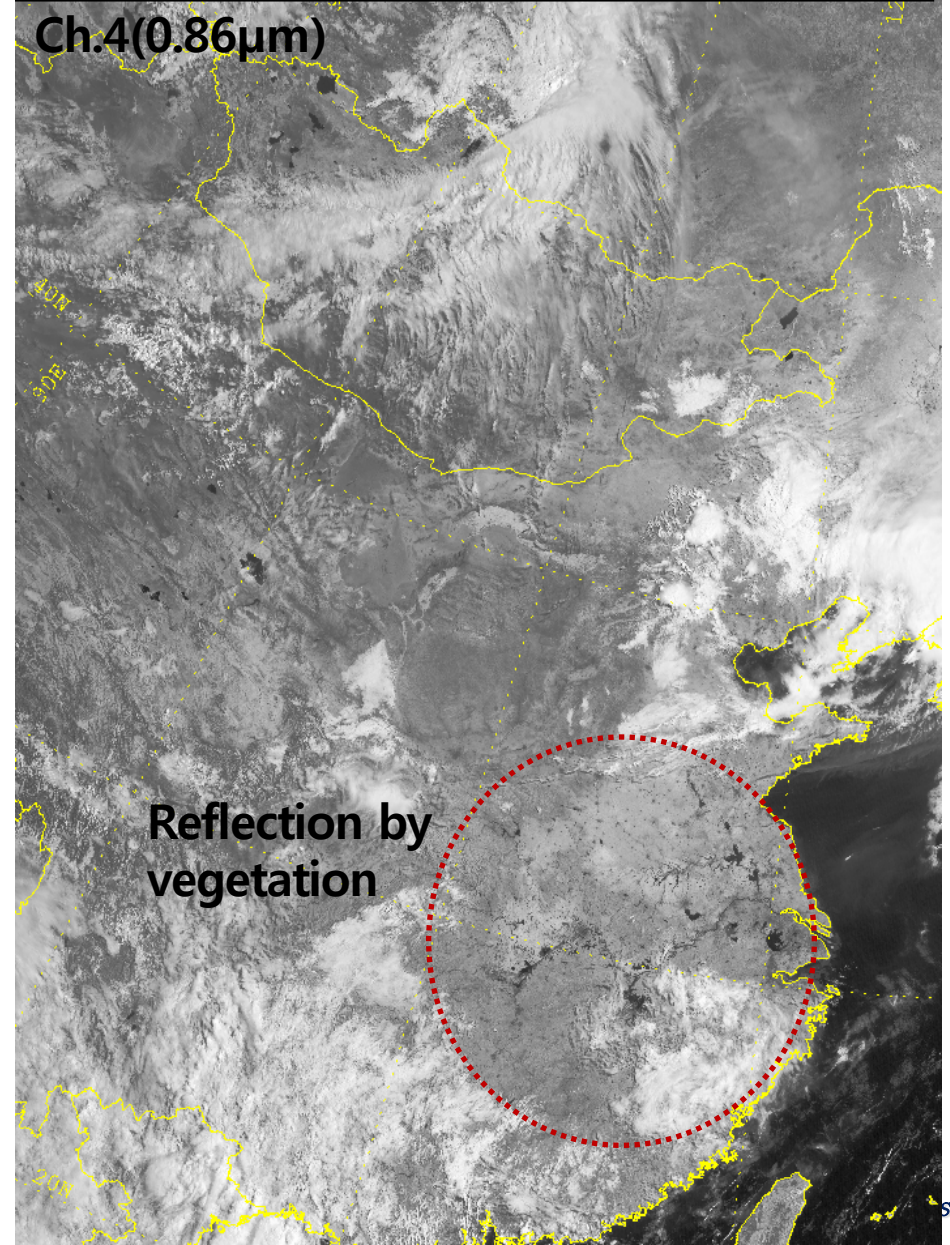
Ch.3(0.64 $\mu$ m)



Absorption by  
vegetation

[HIMAWARI-8] B04 2015/07/30 00:50UTC (2015/07/30/09:50KST) KMA

Ch.4(0.86 $\mu$ m)

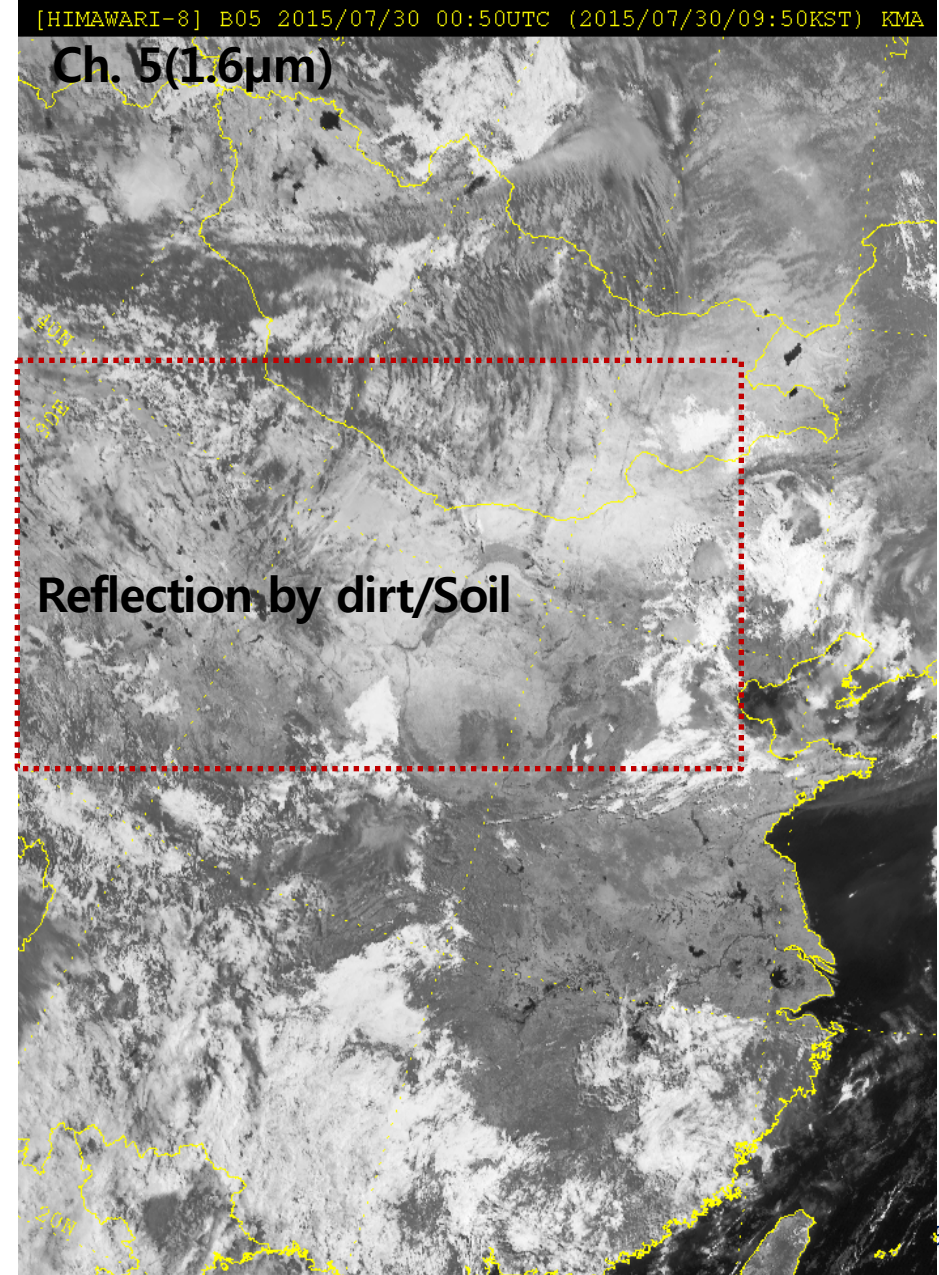
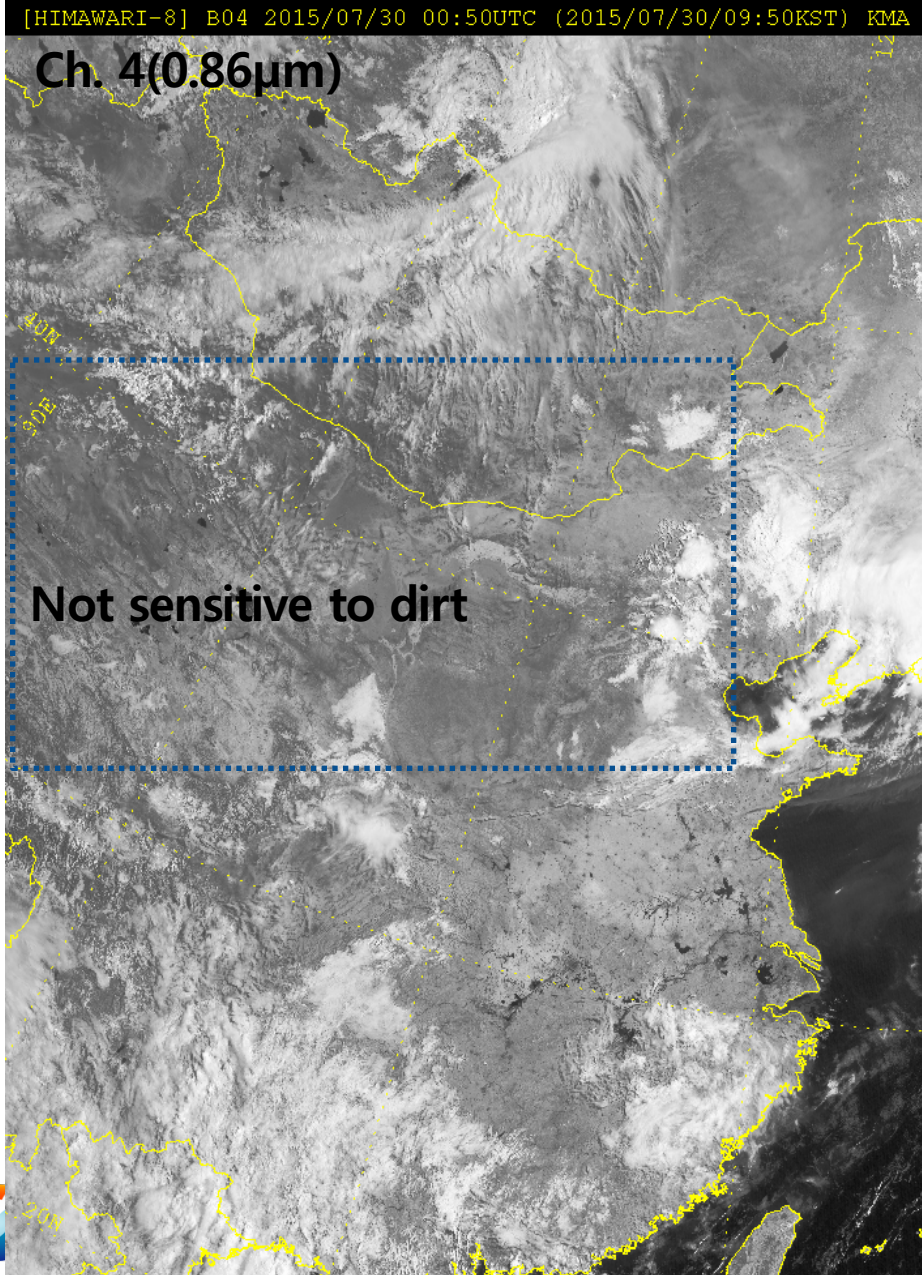


Reflection by  
vegetation



# Ch.4(0.86) vs Ch.6(1.6)

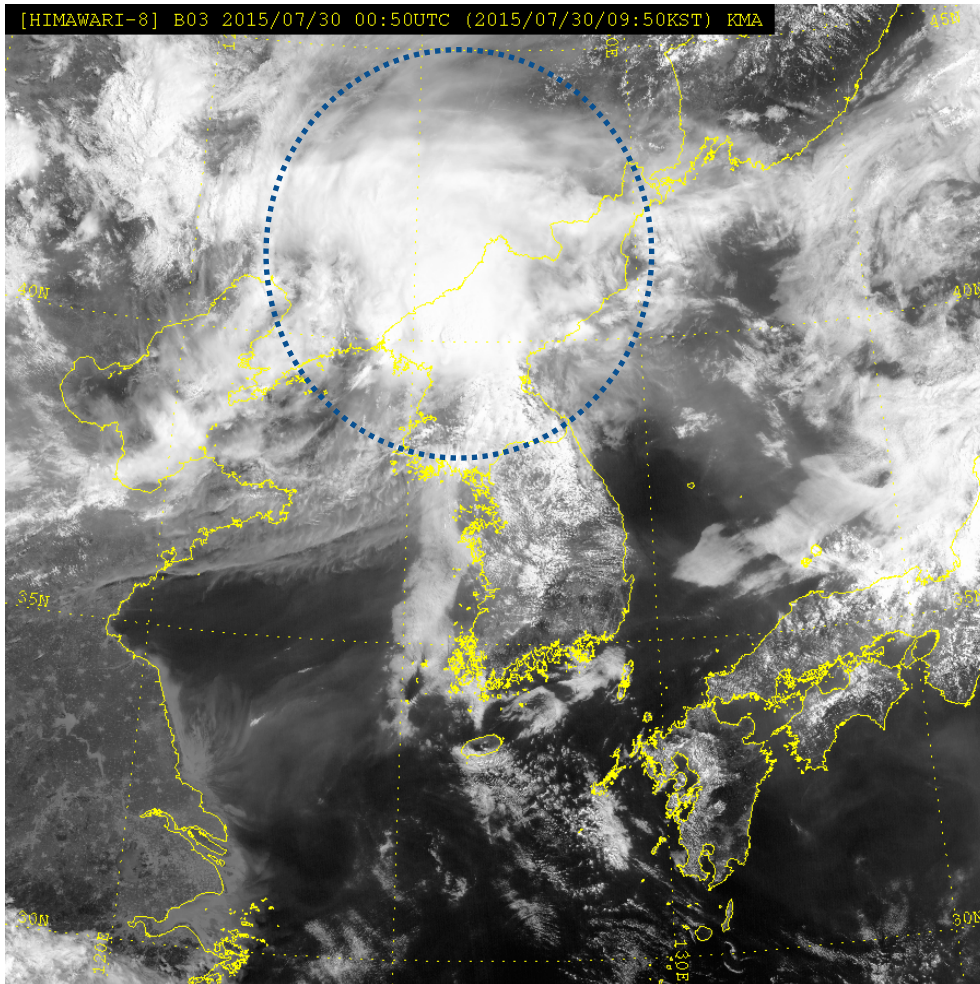
하늘을 친구처럼  
국민을 하늘처럼



# Ch.3(0.64) vs Ch.5(1.6)

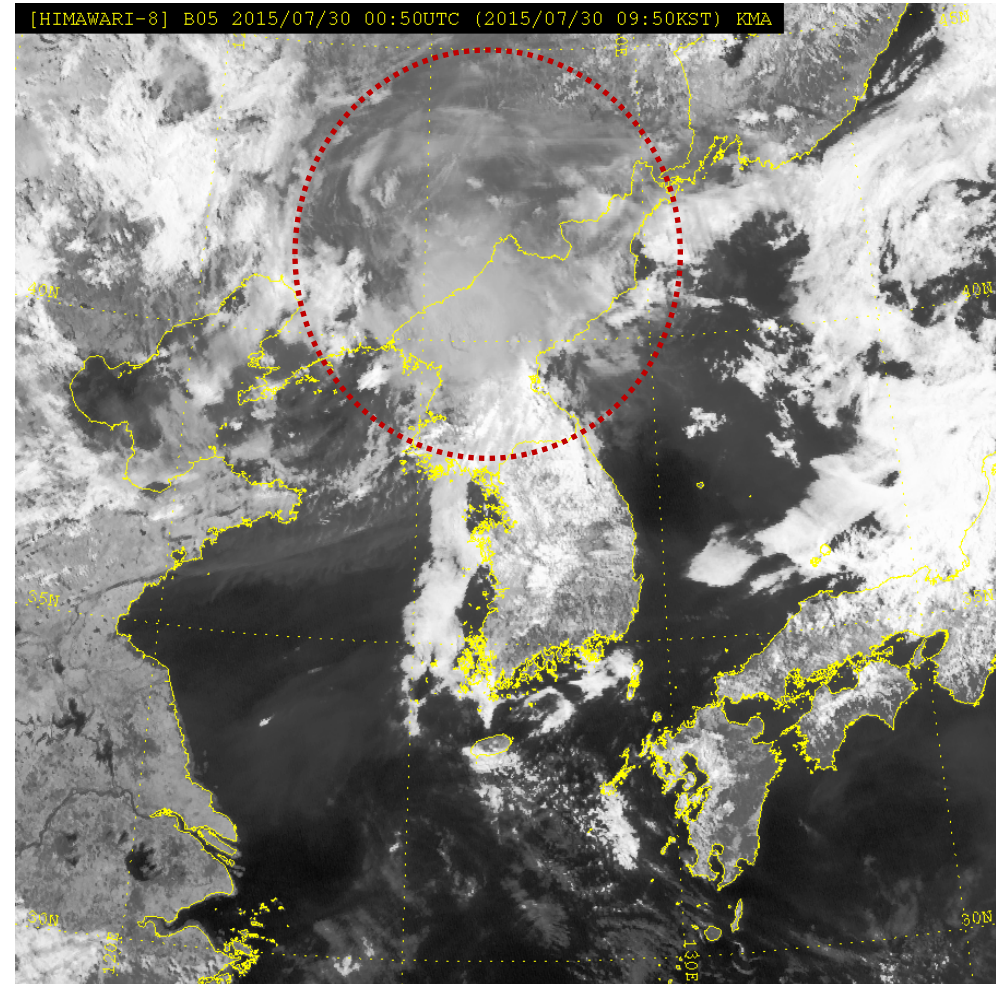
하늘을 친구처럼  
국민을 하늘처럼

## Ch. 3(0.64 $\mu$ m)



Snow/ice Reflection channel

## Ch. 5(1.69 $\mu$ m)



Snow/ice Absorption channel

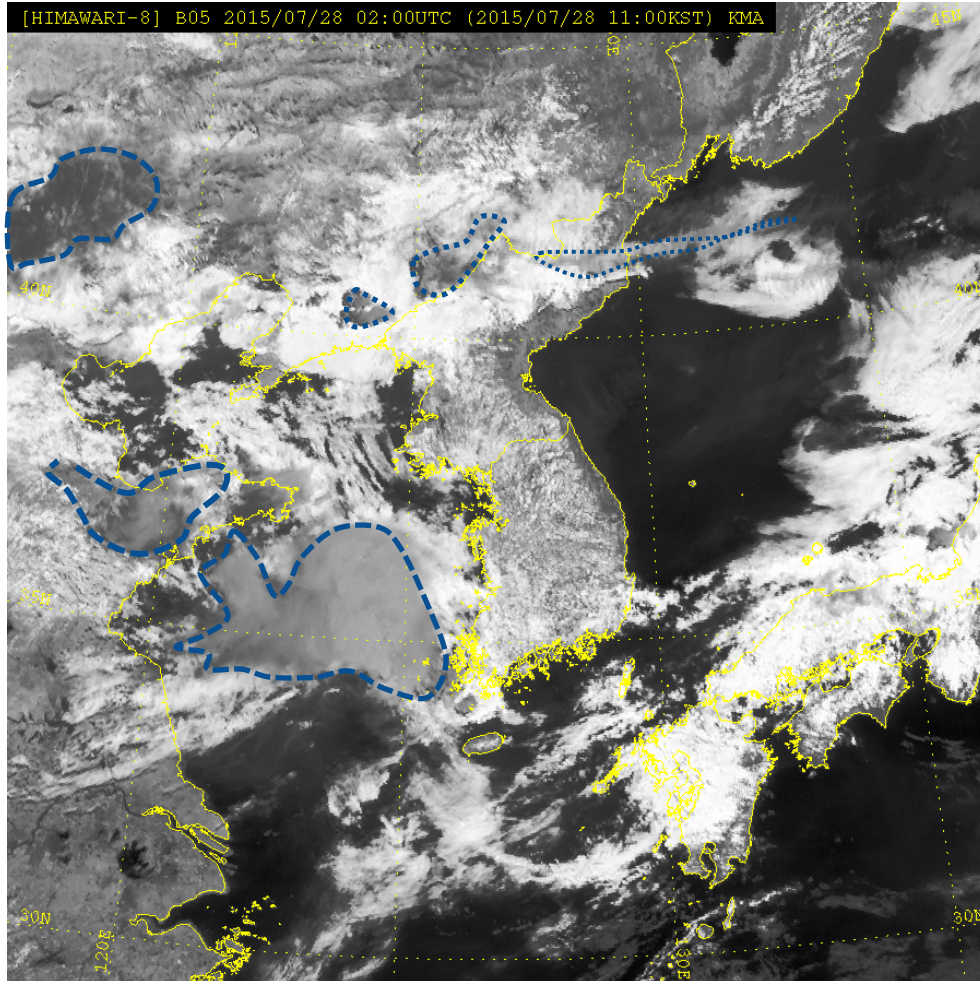
2015 July 30, 00:50UTC



# Ch.5(1.6) vs Ch.13(10.4)

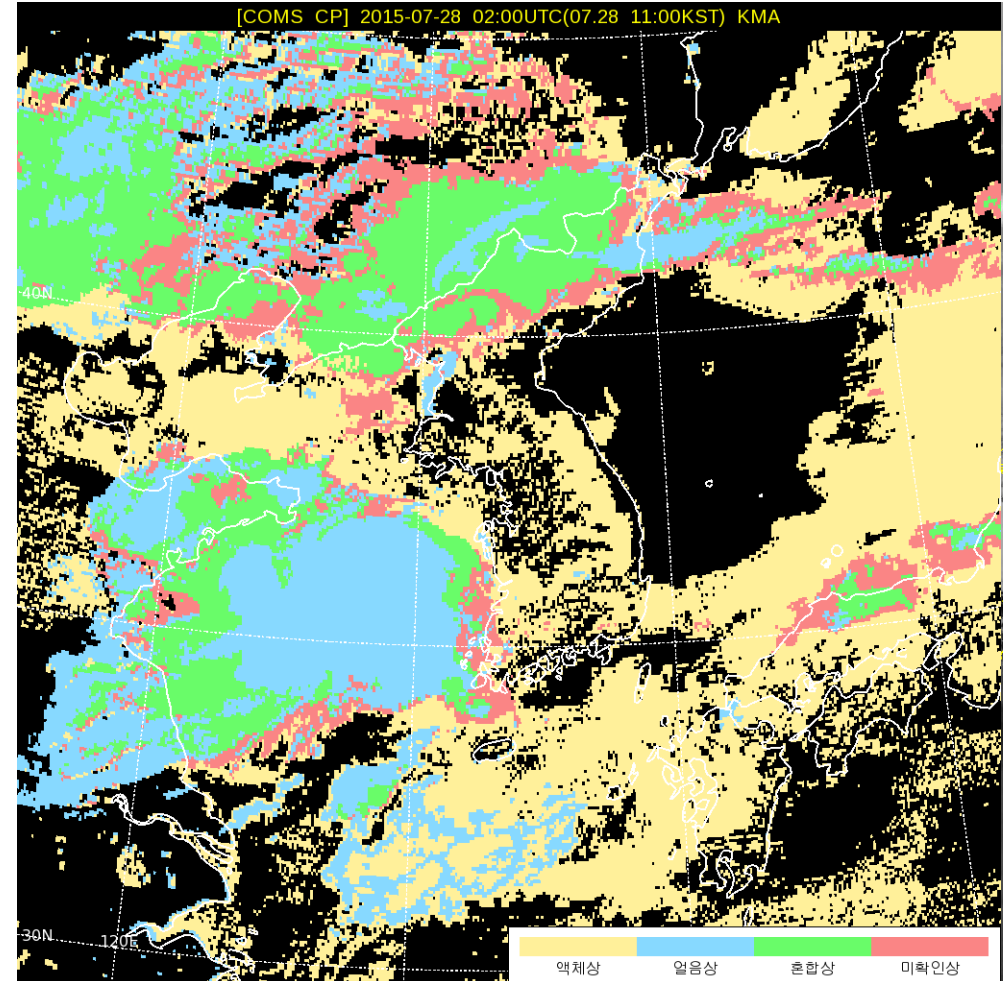
하늘을 친구처럼  
국민을 하늘처럼

## Ch. 5(1.69 $\mu\text{m}$ )



Cloud phase(ice/water) information

## COMS Cloud product

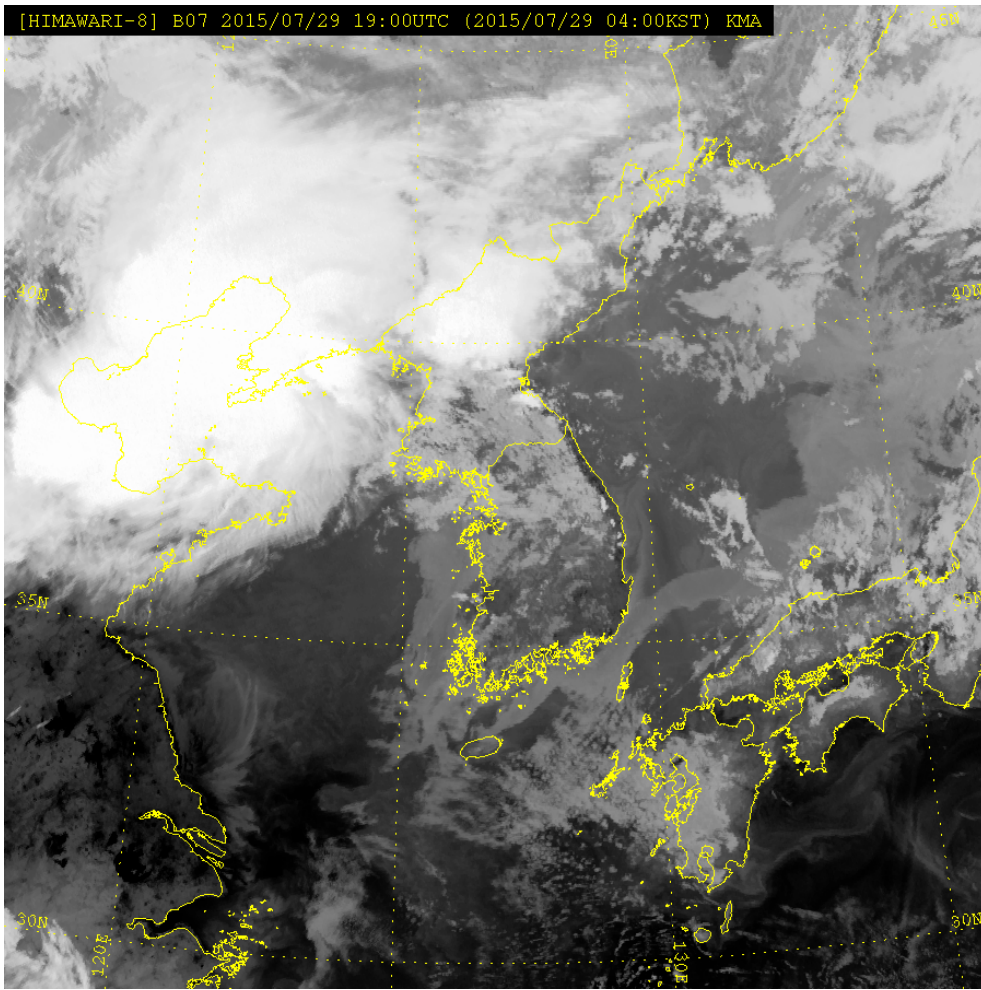


COMS cloud phase image

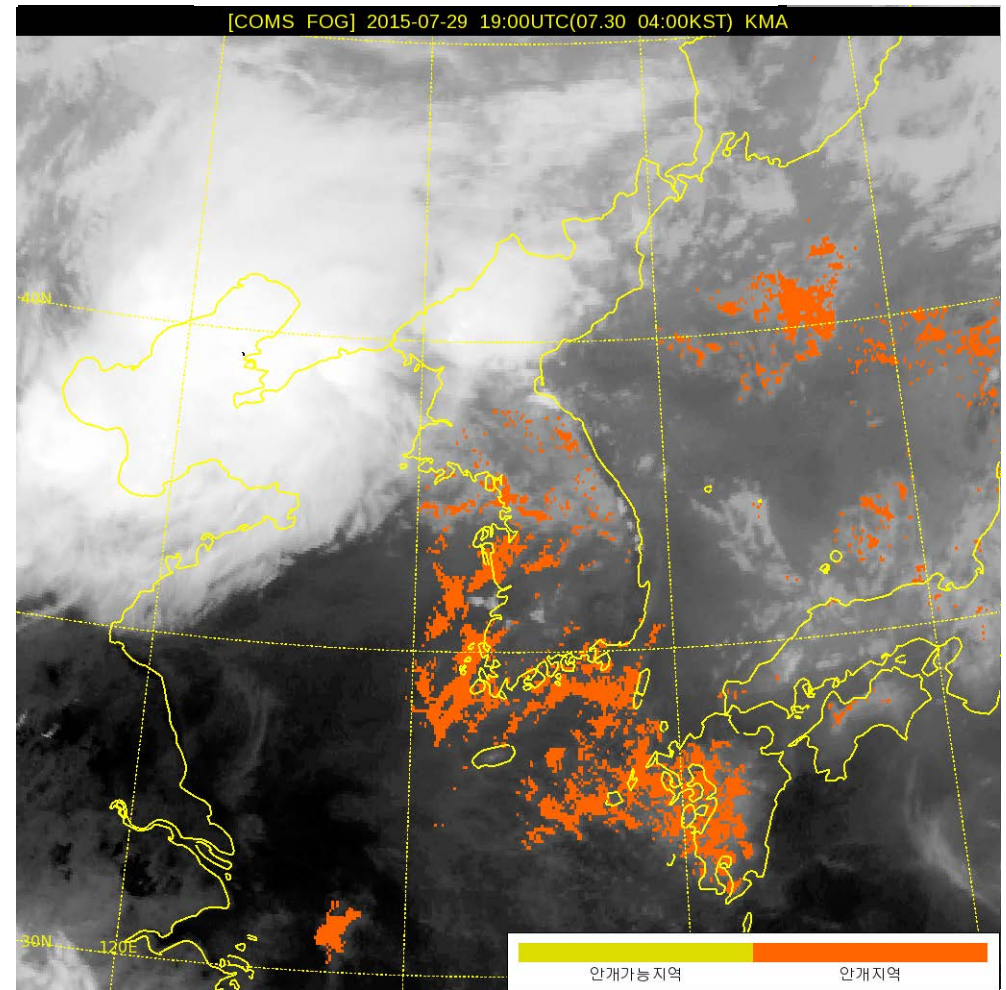
2015 July 28, 02:00UTC



## Ch. 7(3.9 $\mu$ m)



## COMS Fog image



2015 July 30, 19:00UTC

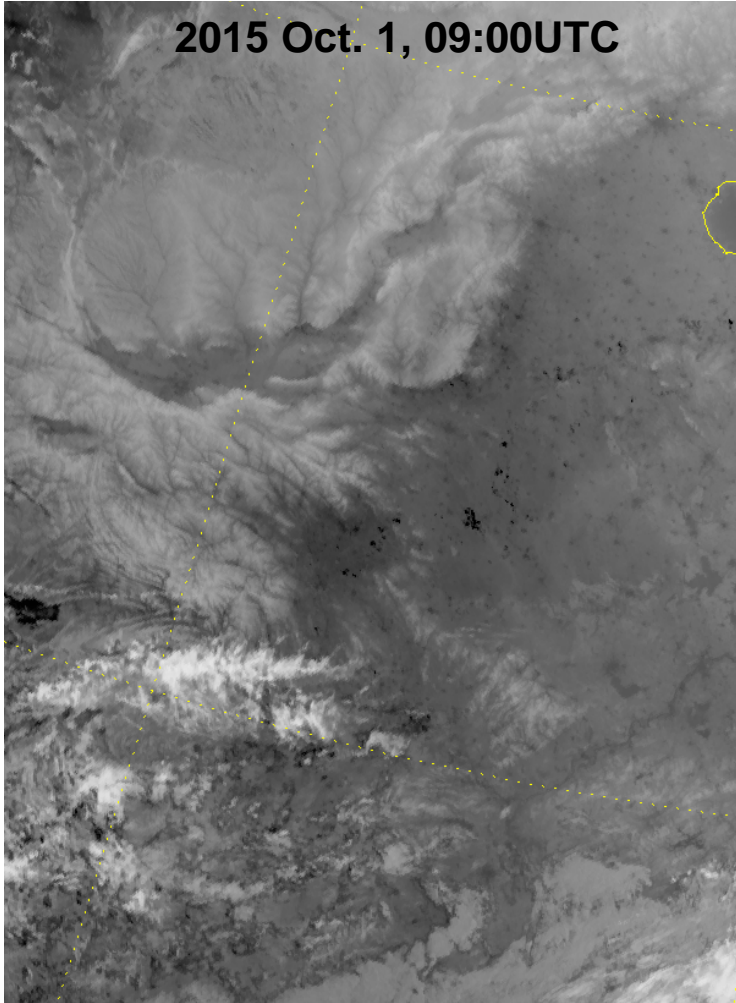
# Ch.7(3.9) vs Ch.13(10.4)

하늘을 친구처럼  
국민을 하늘처럼



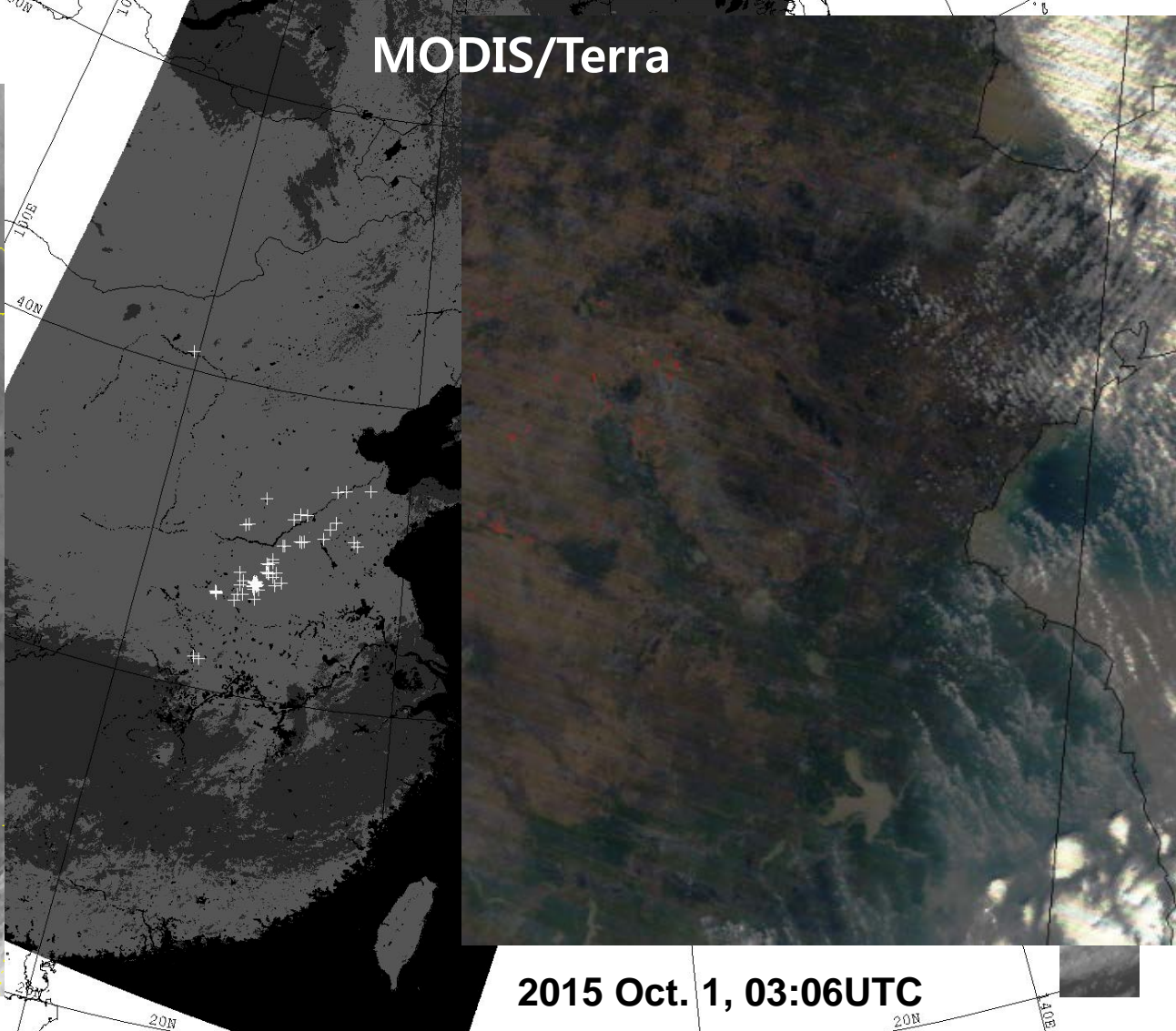
## Ch. 7(3.9 $\mu$ m)

2015 Oct. 1, 09:00UTC



[TERRA-1/MODIS] FIRE\_MASK 2015/10/01 03:06:00 UTC (2015/10/01 12:06 KST) K.M.A.

## MODIS/Terra



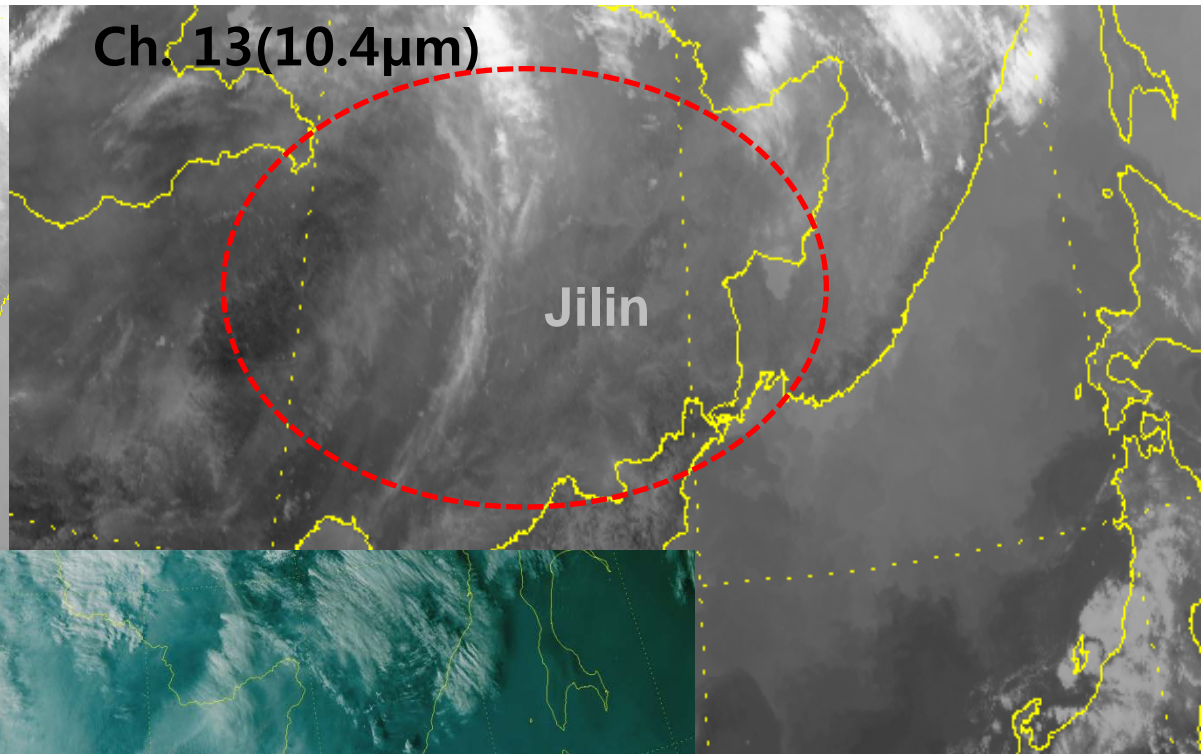
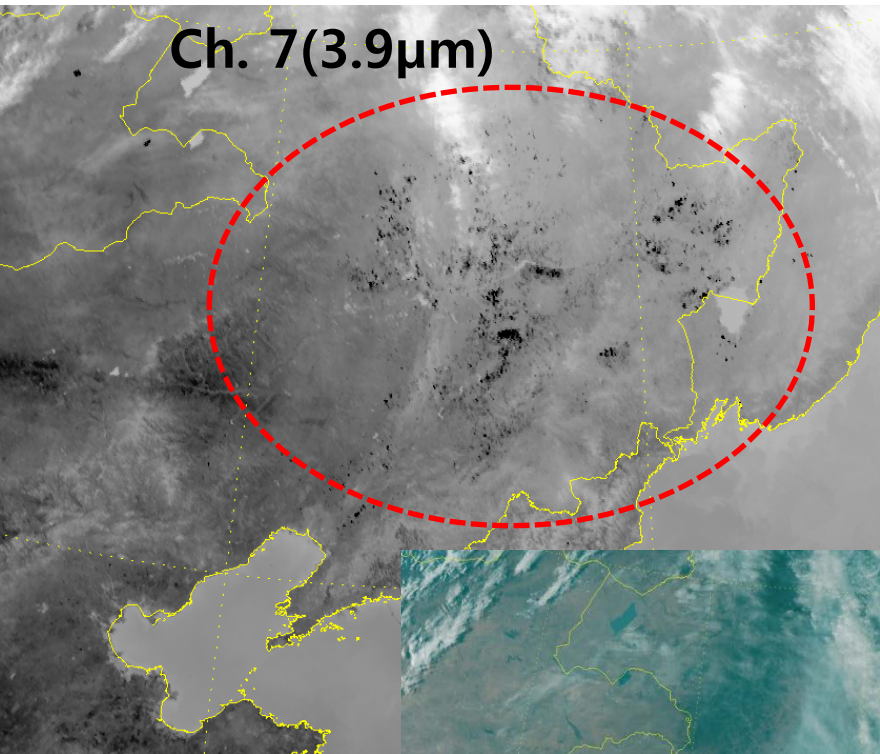
2015 Oct. 1, 03:06UTC

### Detection of Hot Spot, Fire

# Detection of fires

하늘을 친구처럼  
국민을 하늘처럼

06:00UTC 3 Nov. 2015



# 3 Water Vapor channels

하늘을 친구처럼  
국민을 하늘처럼

Himawari synthetic images from "A Correspondence Analysis of VIS and IR bands between MTSAT Imager and Himawari-8/9 AHI T.Kurino JMA/MSC

## ABI bands

8(6.2  $\mu\text{m}$ ), 9(6.9  $\mu\text{m}$ ), 10(7.3  $\mu\text{m}$ )

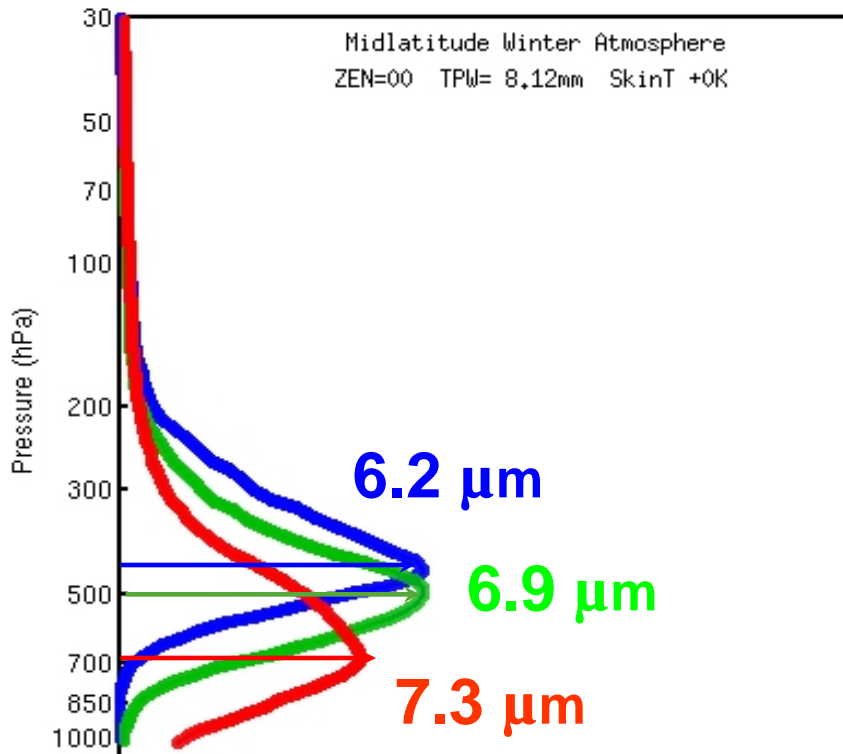
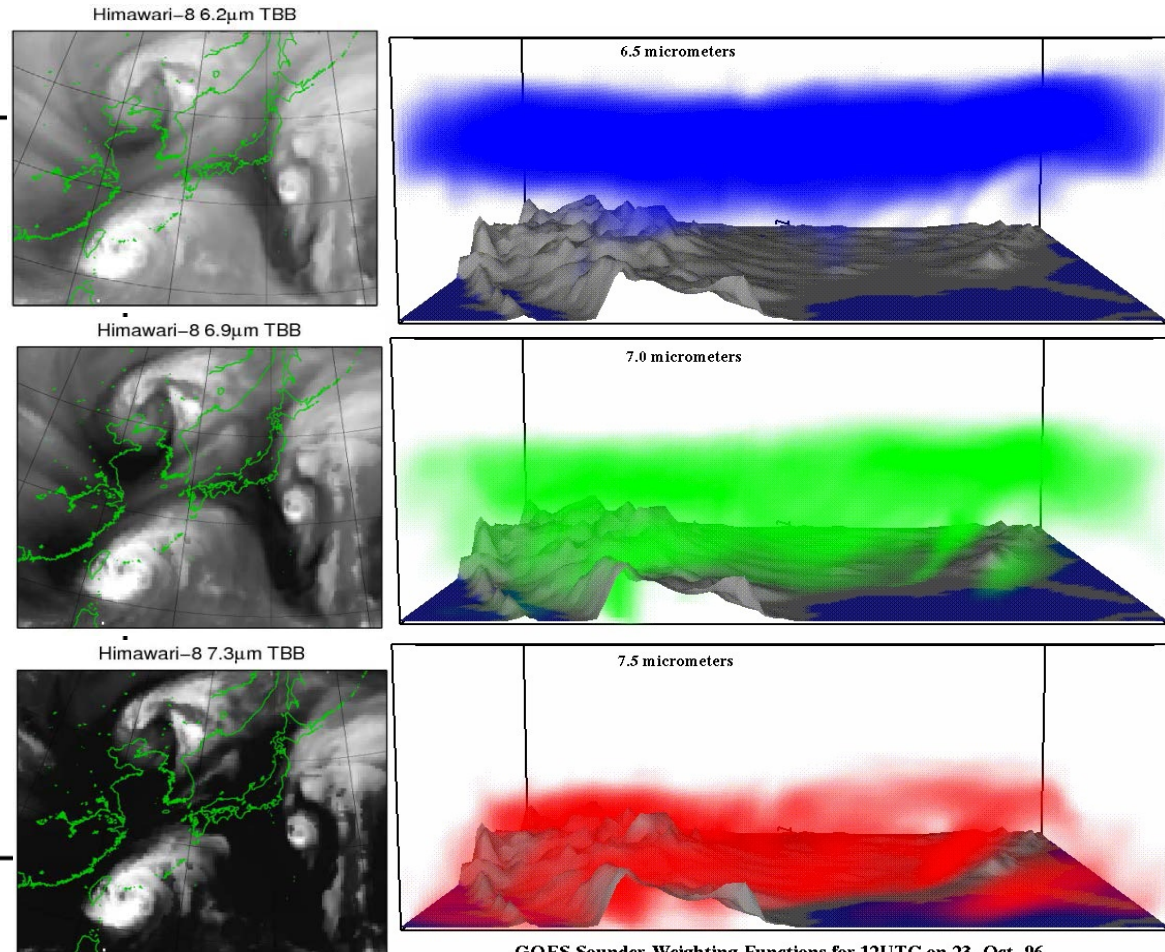


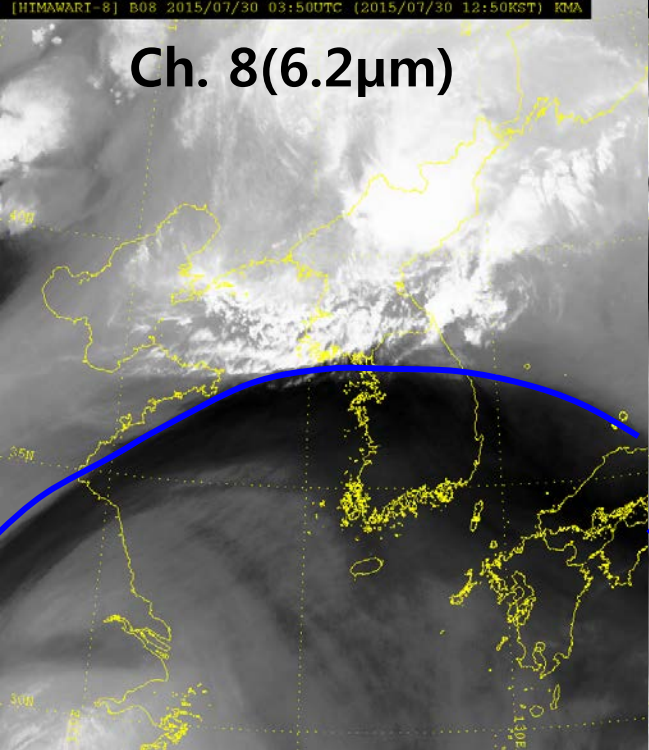
Image courtesy CIMSS (UW Madison)



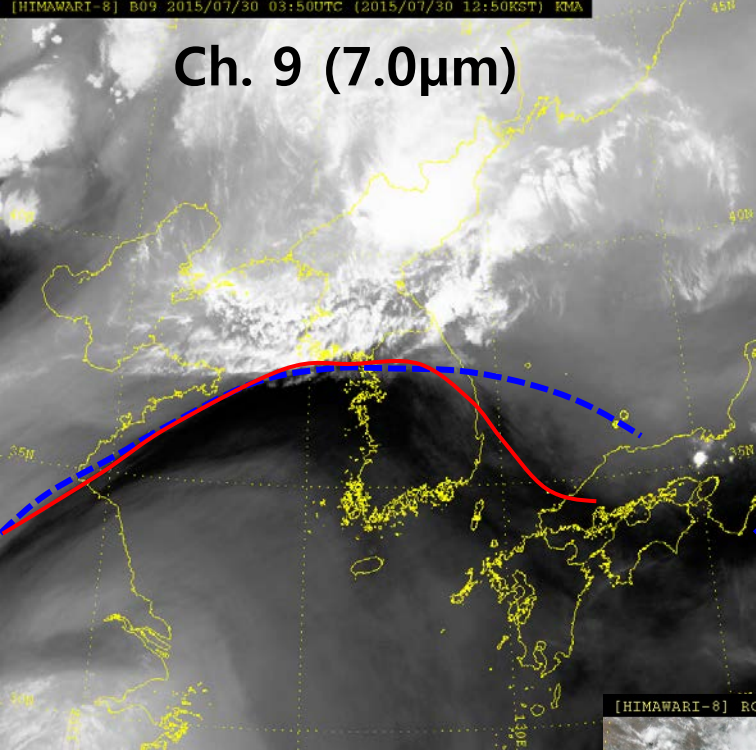
GOES Sounder Weighting Functions for 12UTC on 23-Oct-96  
NOAA/NESDIS

## Northern Hemisphere Winter at Satellite Nadir

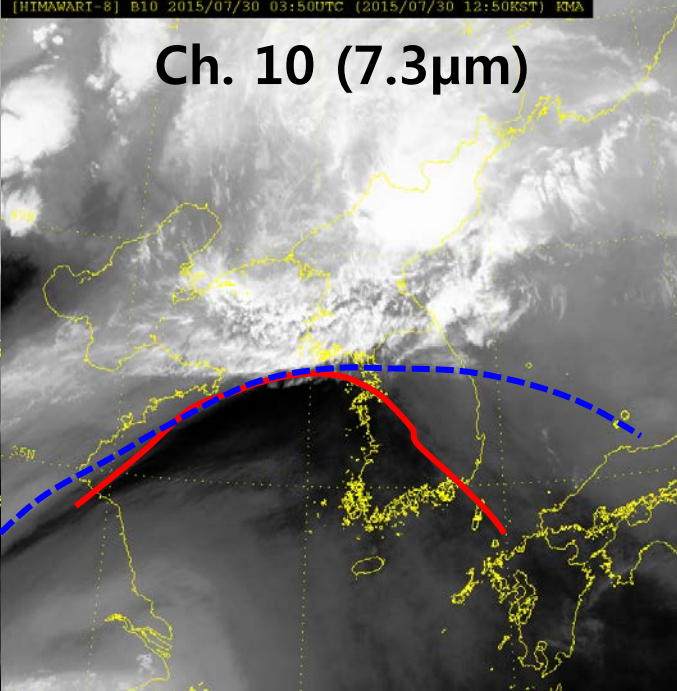
Ch. 8 (6.2μm)



Ch. 9 (7.0μm)



Ch. 10 (7.3μm)



2015 July 30, 03:50UTC

# Analysis of vertical water vapor distribution

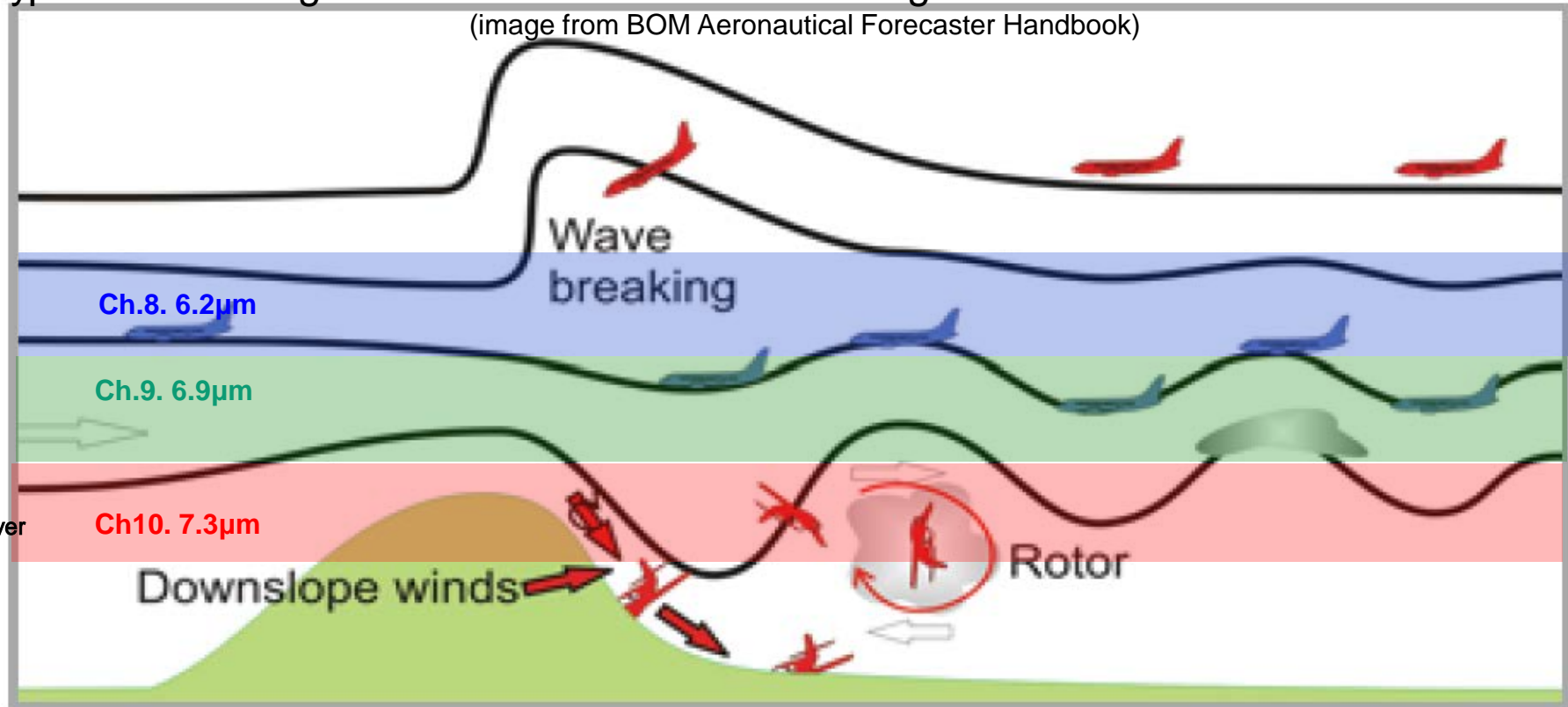


# Mountain wave and Turbulence

하늘을 친구처럼  
국가를 하늘처럼

Typical turbulent regions above and downstream of a ridge in mountain wave environments

(image from BOM Aeronautical Forecaster Handbook)



- Near perpendicular flow to ridge line
- At least 25 knot wind speed at ridge top, normal to ridge, greater than 40 knots for severe turbulence
- Inversion positioned just above ridge top level– enhanced downslope winds

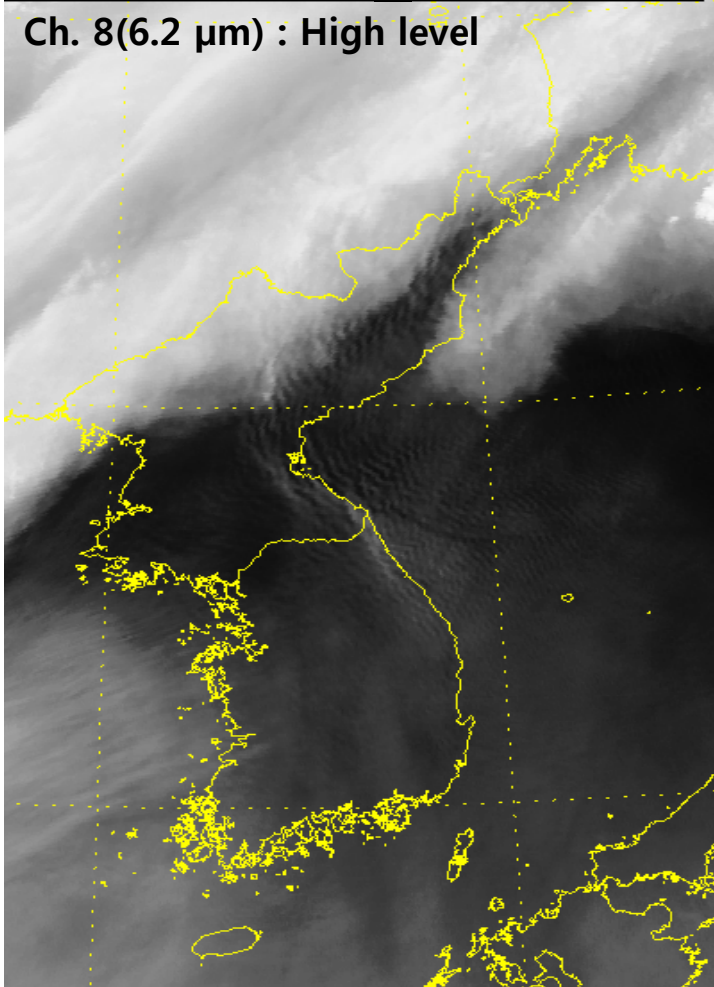
# Mountain waves

하늘을 친구처럼  
국민을 하늘처럼



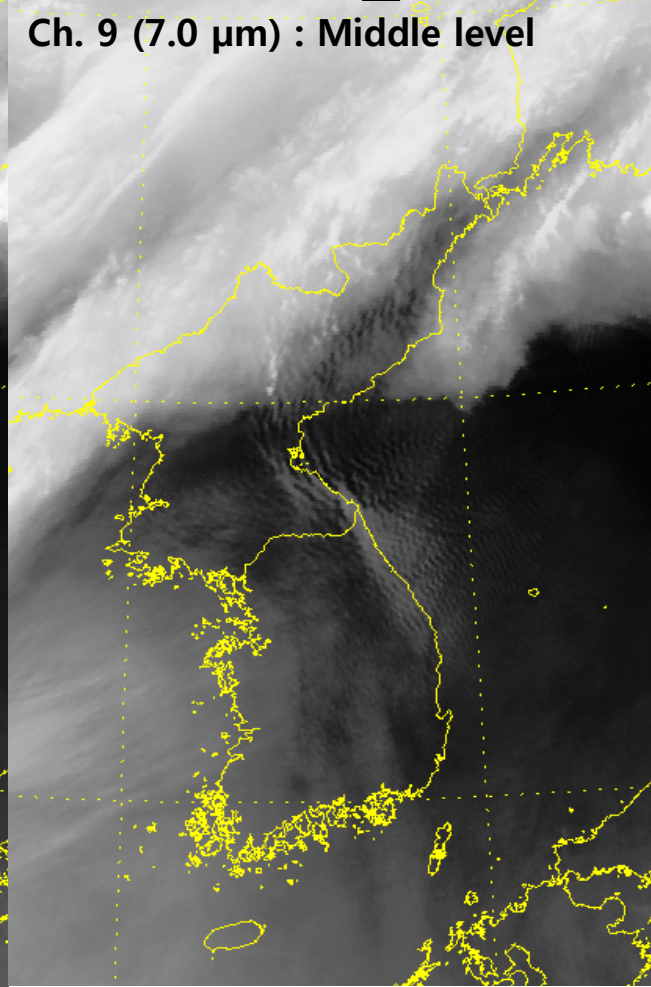
18:00UTC (2015/07/31 03:00KST) KMA

Ch. 8 (6.2  $\mu\text{m}$ ) : High level



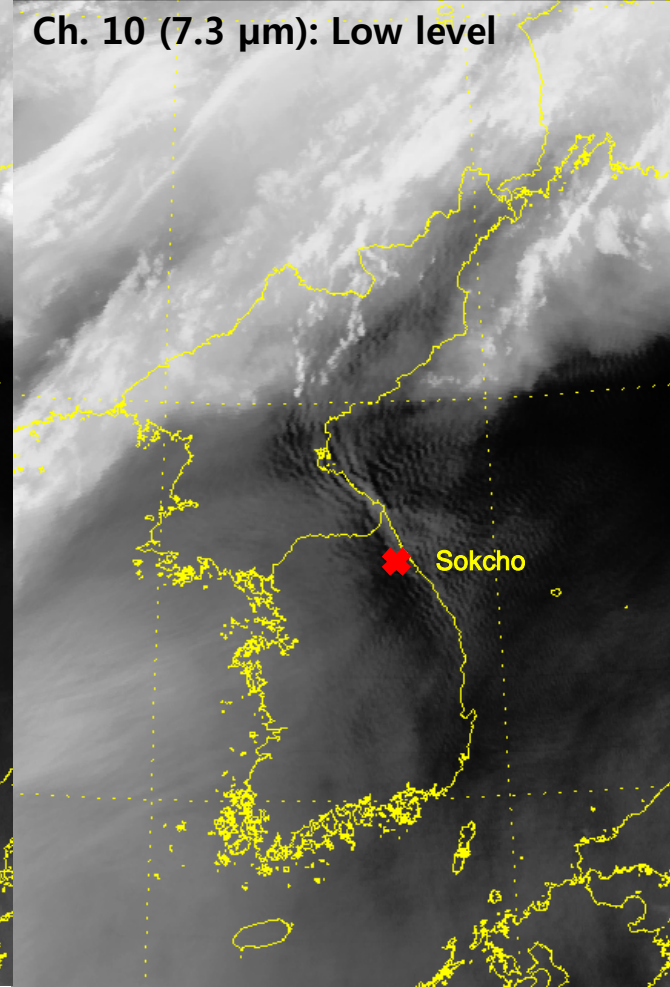
18:00UTC (2015/07/31 03:00KST) KMA

Ch. 9 (7.0  $\mu\text{m}$ ) : Middle level



18:00UTC (2015/07/31 03:00KST) KMA

Ch. 10 (7.3  $\mu\text{m}$ ) : Low level



2015 July. 31, 18:00UTC

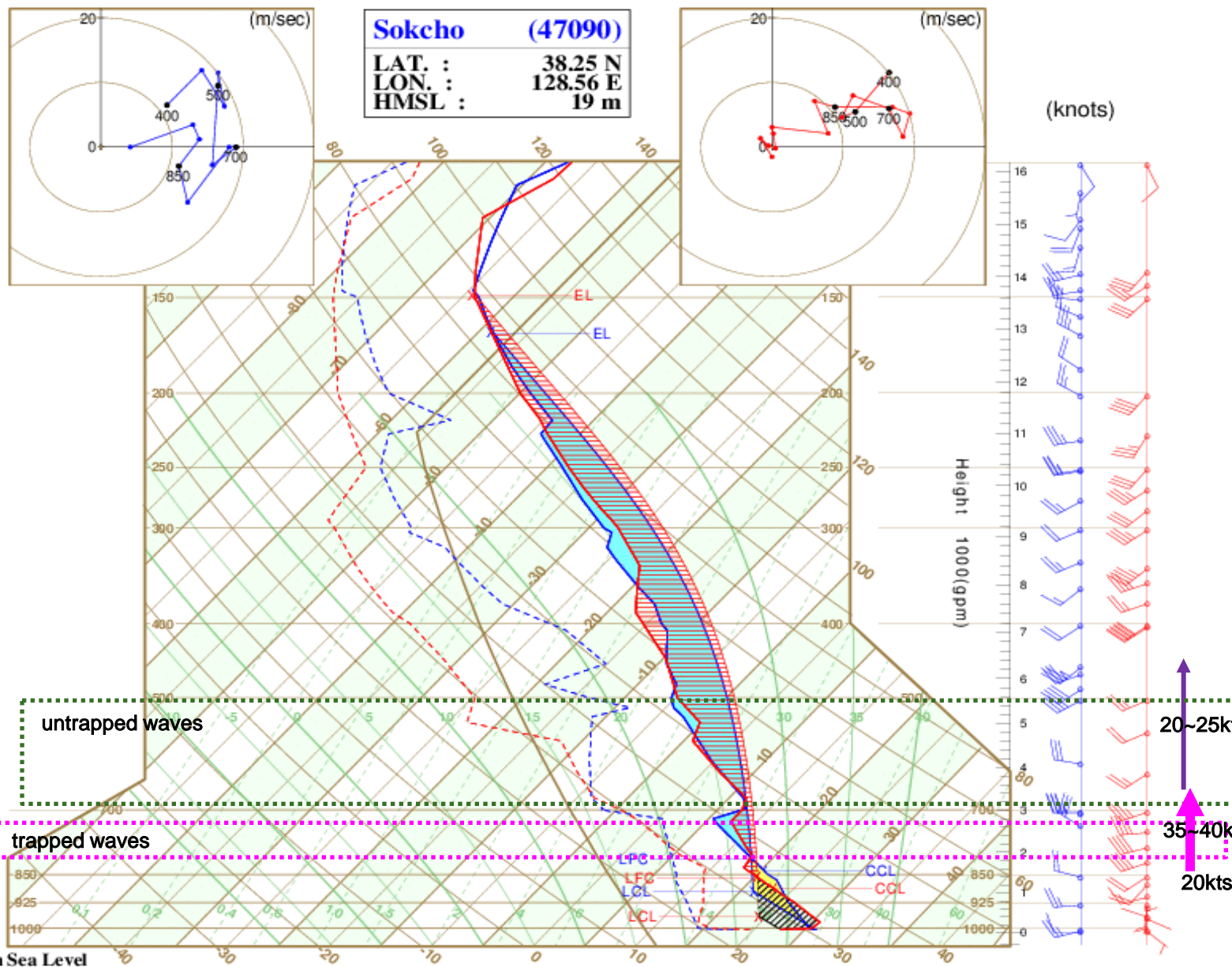


# Skew T - Log P DIAGRAM

Issued at 12UTC 30 Jul 2015  
Valid : 21KST 30 Jul 2015

## OBS ANALYSIS

2015.07.30.09KST	2015.07.30.21KST
1000 hPa Air-mass Temp. 30.6 °C	1000 hPa Air-mass Temp. 30.8 °C
Humi. 51 %	Humi. 55 %
Wind. 255/026 KT	Wind. 130/004 KT
FL (gpm) 4787	FL (gpm) 4910
850EQT (K) 337	850EQT (K) 341
T/P (gpm) -----	T/P (gpm) -----
LCL (gpm) 1043	LCL (gpm) 409
CCL (gpm) 1543	CCL (gpm) 1117
LFC (gpm) 1818	LFC (gpm) 1380
HEL (gpm) 12936	HEL (gpm) 13664
M/W (gpm) -----	M/W (gpm) -----
SSI(850-500) 1.1	SSI(850-500) -0.1
SSI(925-500) -0.0	SSI(925-500) -1.2
SSI(925-700) 3.7	SSI(925-700) 2.4
LI (000-500) -0.9	LI (000-500) -1.4
LI (925-500) -0.1	LI (925-500) -1.3
K-Index 25	K-Index 28
TT-Index 44	TT-Index 45
SRH (m2/s2) 2	SRH (m2/s2) 156
CAPE (m2/s2) 1513	CAPE (m2/s2) 1919
CIN (m2/s2) 81	CIN (m2/s2) 140
TPW(mm) 43.3[102%]	TPW(mm) 42.1 [99%]
Cloud SKC	Cloud BKN
Upper 449 6	Upper 449 22
Middle 515 4	Middle 799 7
Lower 800 7	Lower 833 4
THCKN (10-7) 3069	THCKN (10-7) 3065
CVT Temp. 35.7	CVT Temp. 33.8
Max Temp. 35.6	Max Temp. 34.0
Min Temp. 24.0	Min Temp. 22.5



\*HMSL : Height of barometer above Mean Sea Level



## Usage of the Himawari-8 imagery



## Several COMS RGB imagery

- Convective Cloud RGB
- WV RGB
- FOG RGB

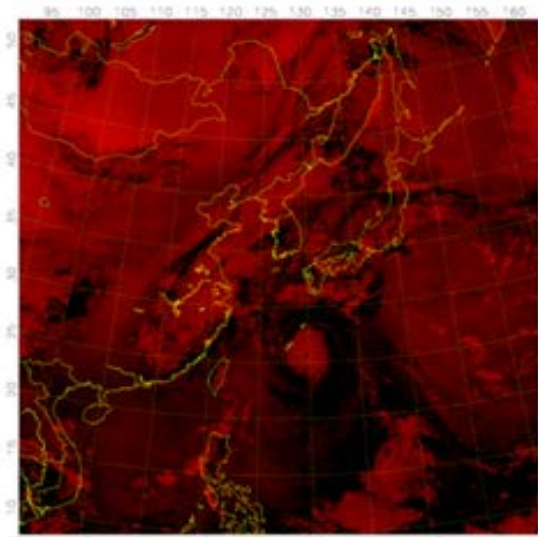


## Application of Himawari-8 RGB imagery

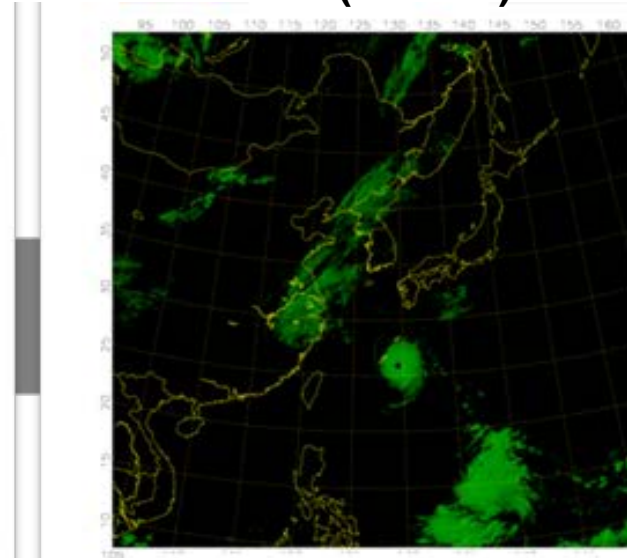
# 2-1. Recipe of Convective clouds RGB

하늘을  
꼭만들  
구름  
다들여름

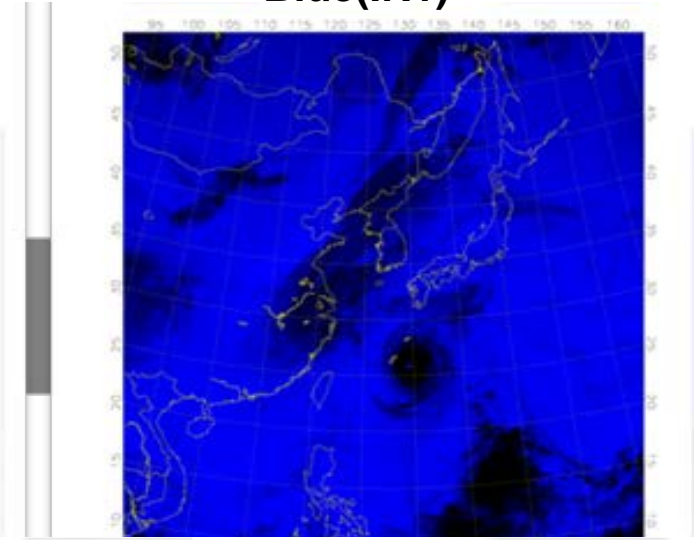
Red(IR2-IR1)



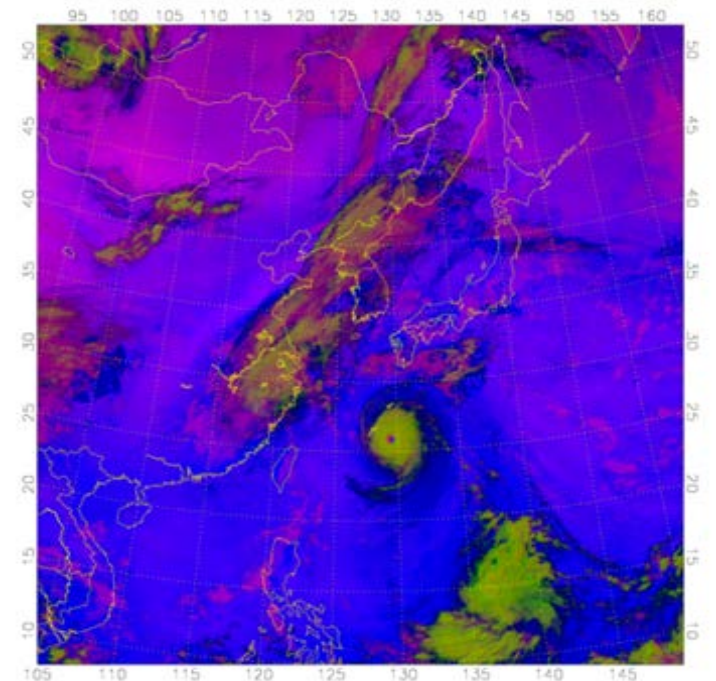
Green(WV-IR1)



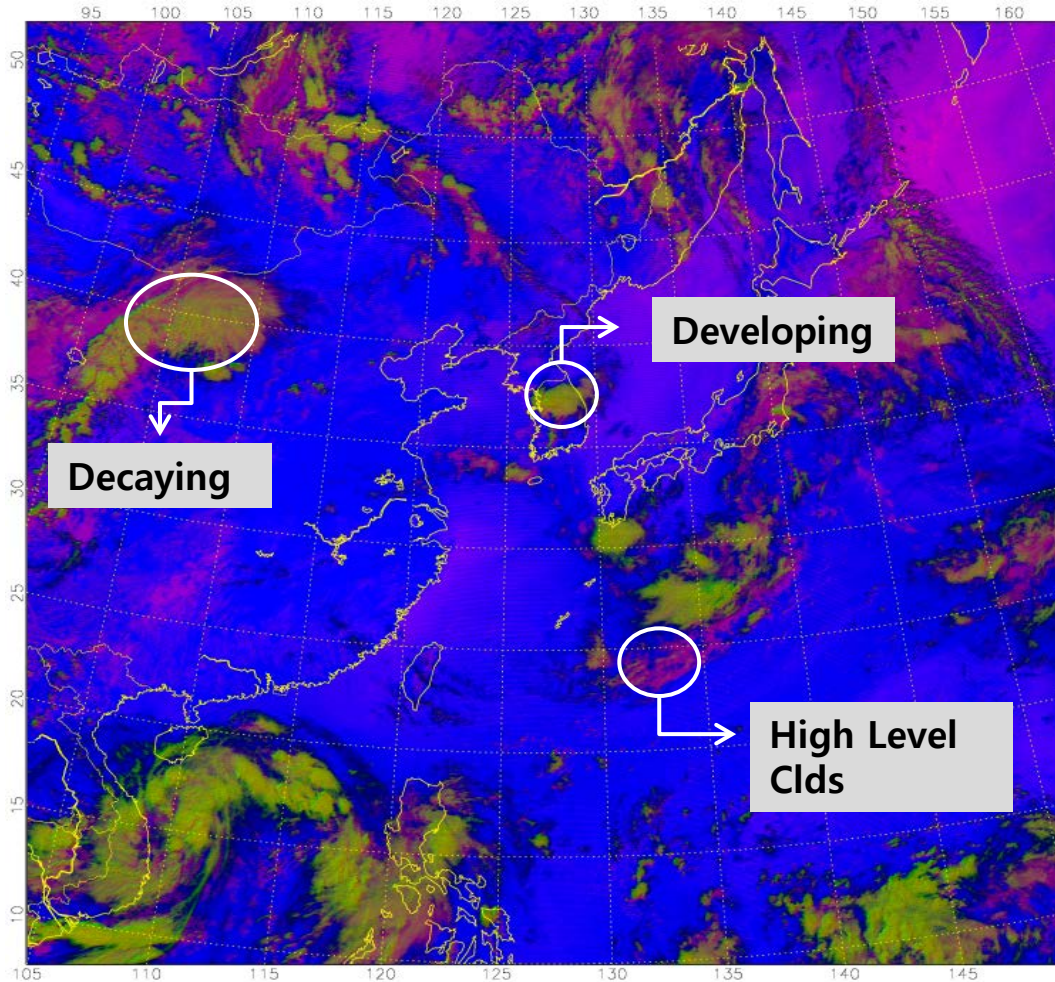
Blue(IR1)



	Used Channels( $\mu\text{m}$ )	Threshold (K)
<b>Red</b>	IR2(12.0) – IR1(10.8)	-4~2
<b>Green</b>	WV(6.75) – IR1(10.8)	-20~15
<b>Blue</b>	IR1 (10.8)	200~310



## Meaning of Colors



- Developing Conv. Clds
- Decaying Conv. Clds.
- High level Cld.
- Low/Mid level Cld.
- Land/Ocean

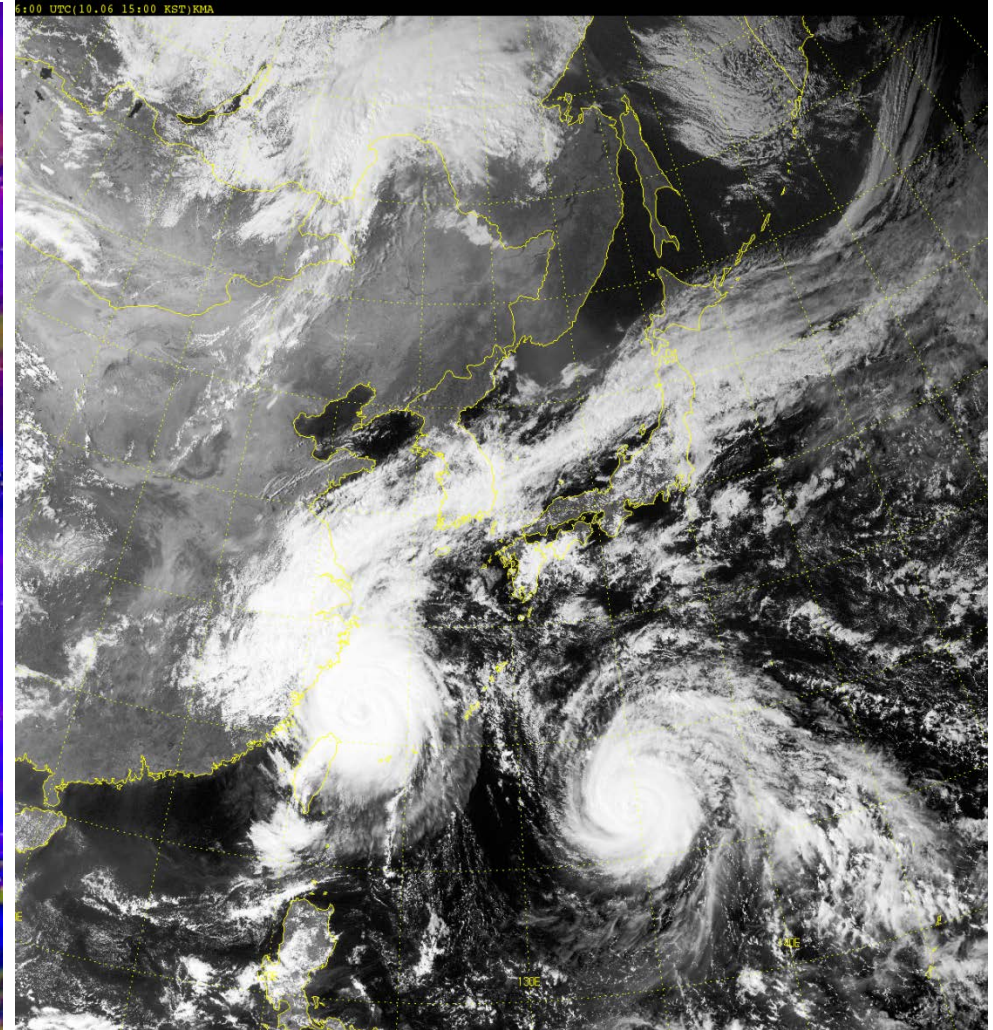
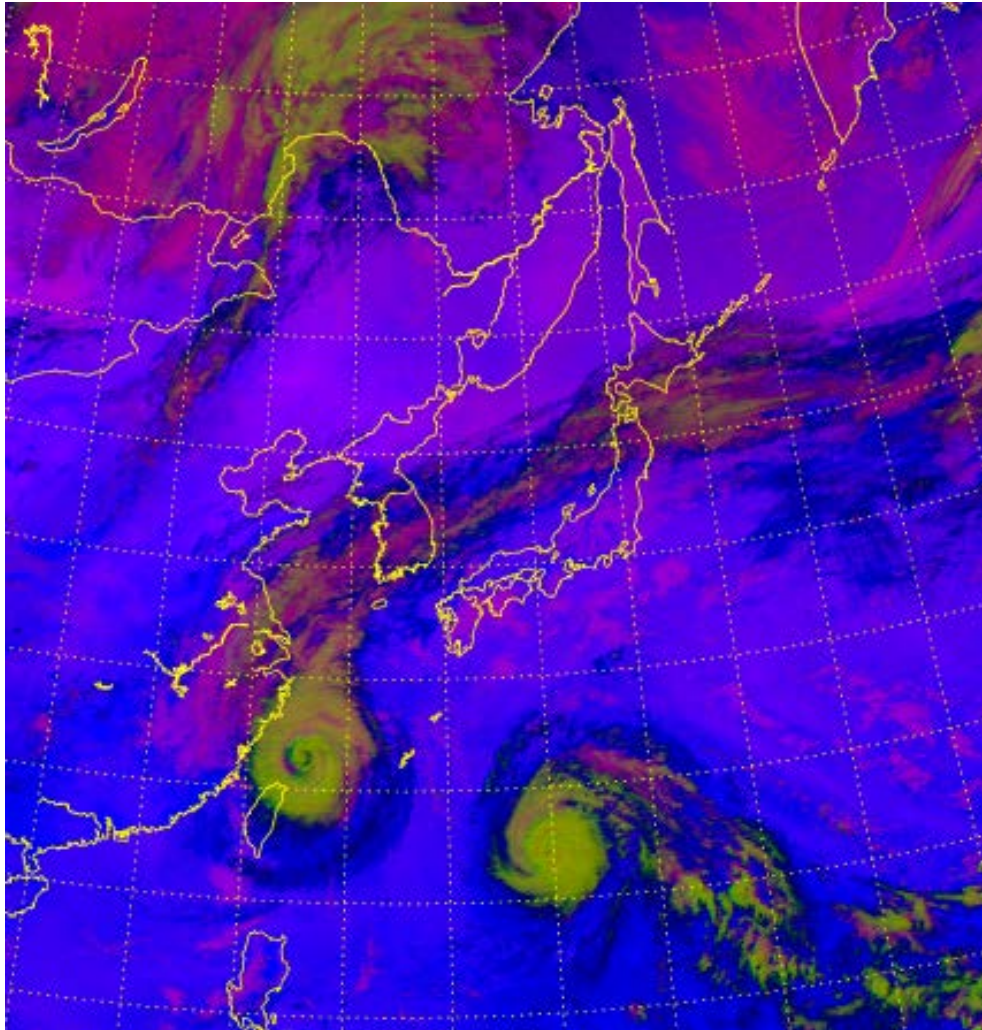
2013.08.06.05:45UTC 국지성 호우

# Usage of Convective clouds RGB

하늘을 친구처럼  
구만하면 하늘처럼

## Analysis of Typhoon-Fitow(TY1323) & Danas(TY1224)

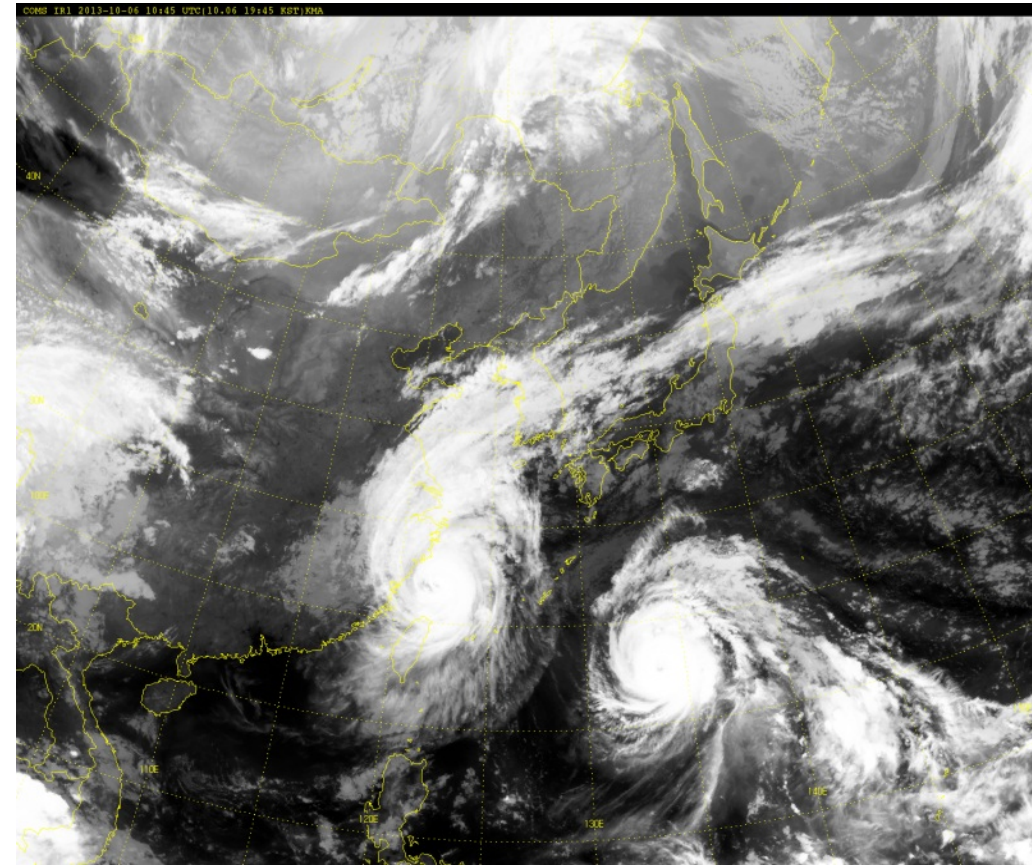
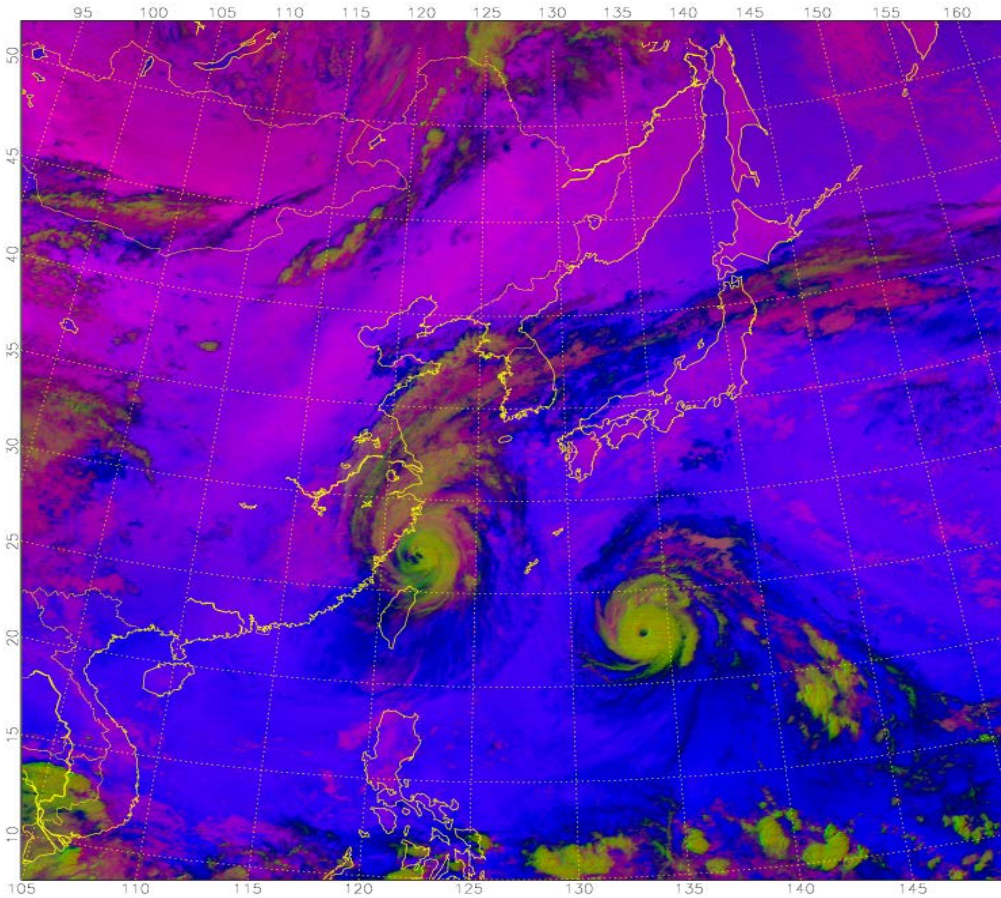
B/W VIS image



2013. 10. 6. 06:00UTC(daytime)

## Analysis of Typhoon-Fitow & Danas

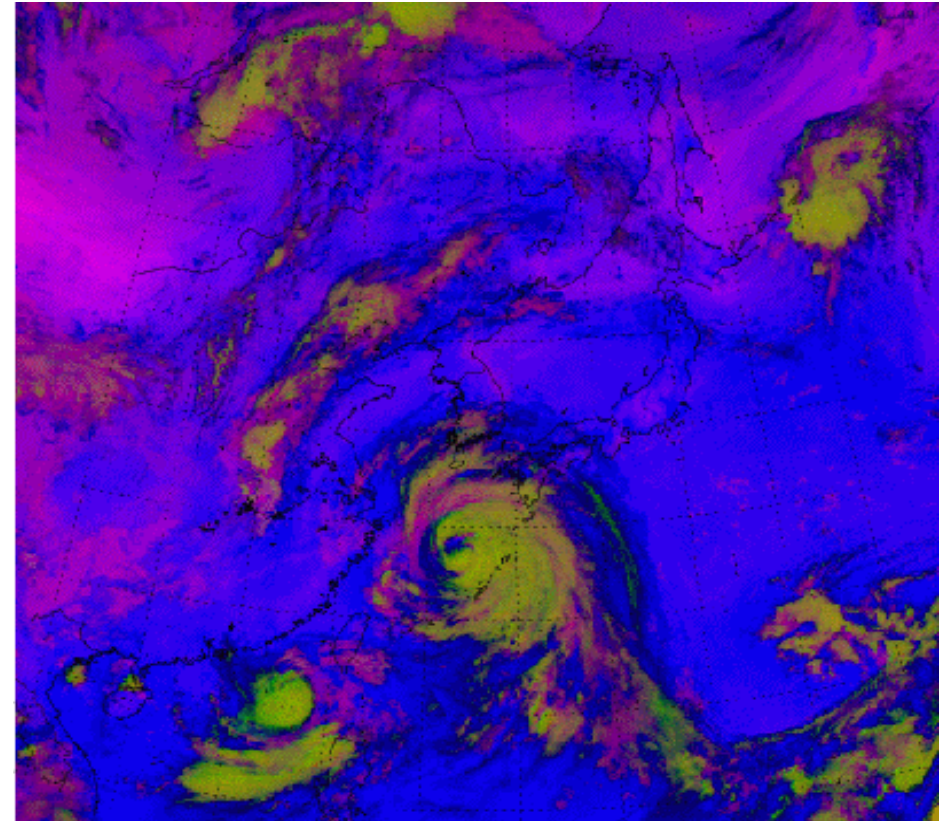
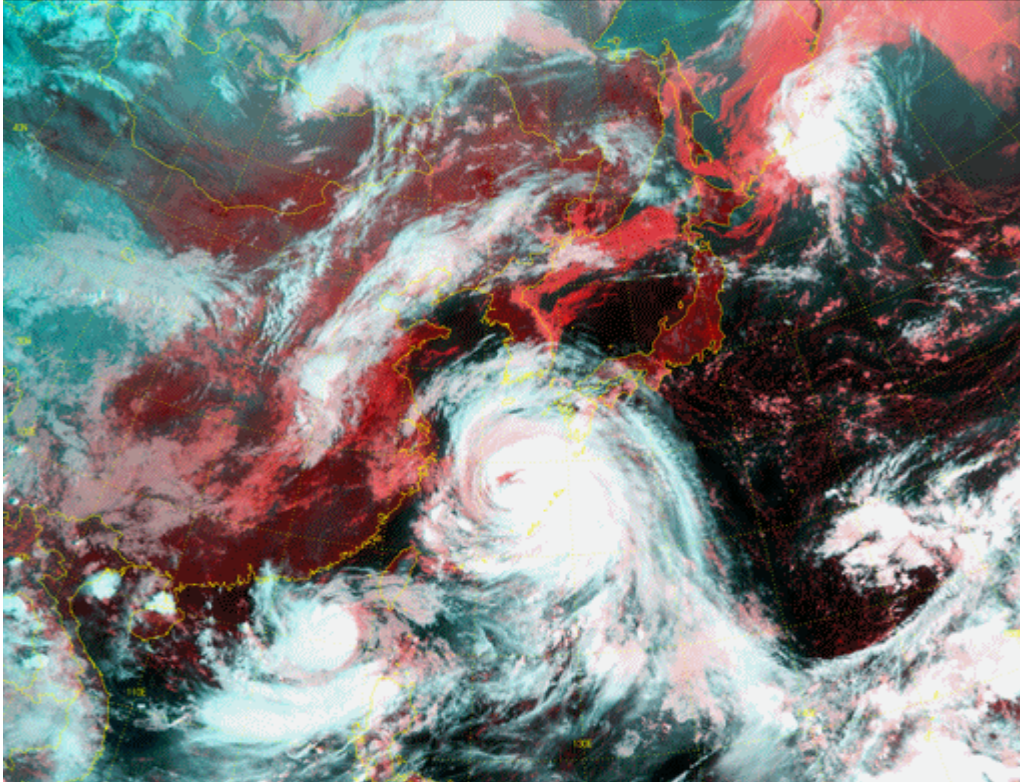
B/W IR image



2013. 10. 6. 10:45UTC(nighttime)

## Typhoon- Bolaven

COMS COM 2012-08-27 00:00 UTC(08.27 09:00 KST)KMA

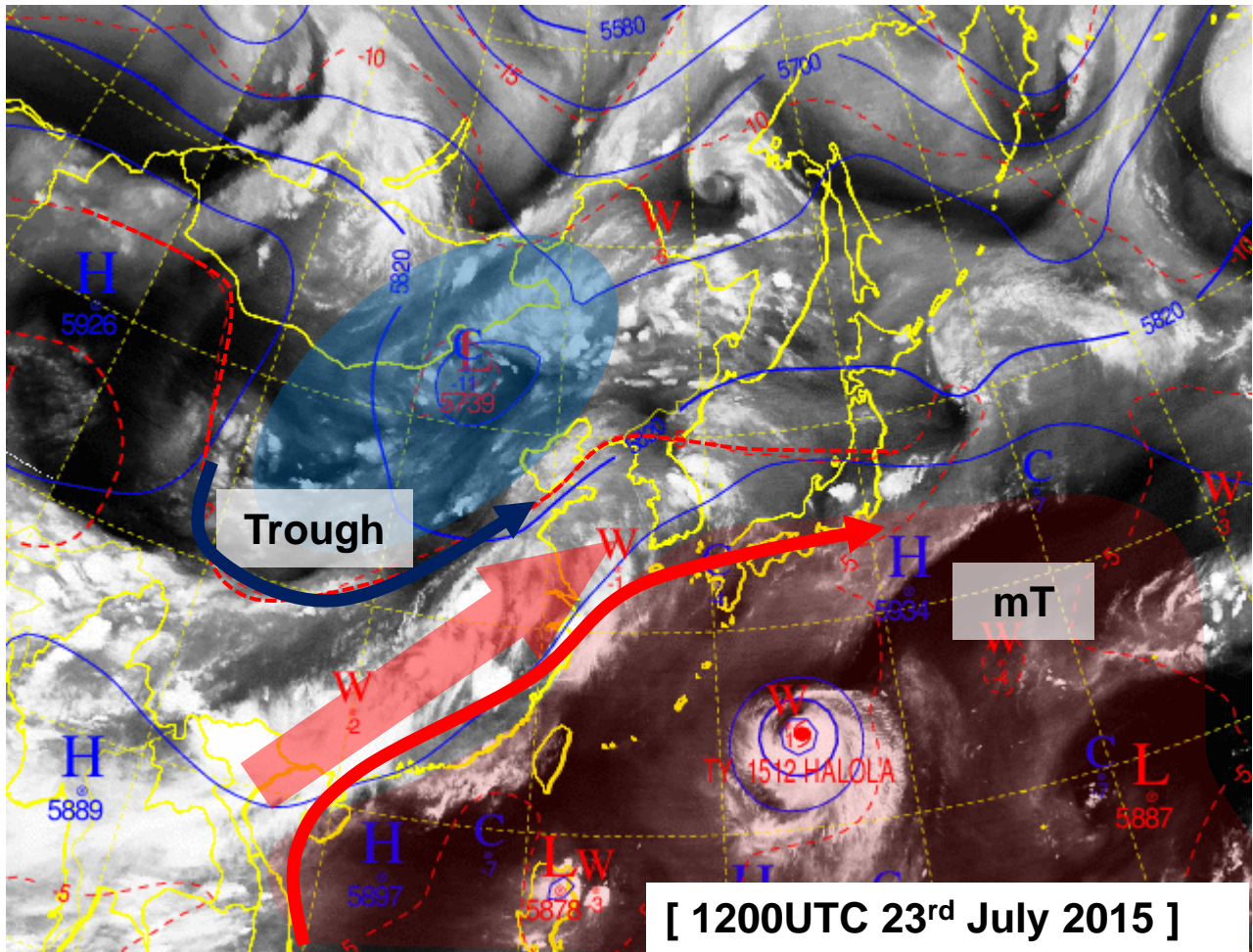


0000UTC 27<sup>th</sup> Aug. ~ 2345 UTC 28<sup>th</sup> Aug. 2012

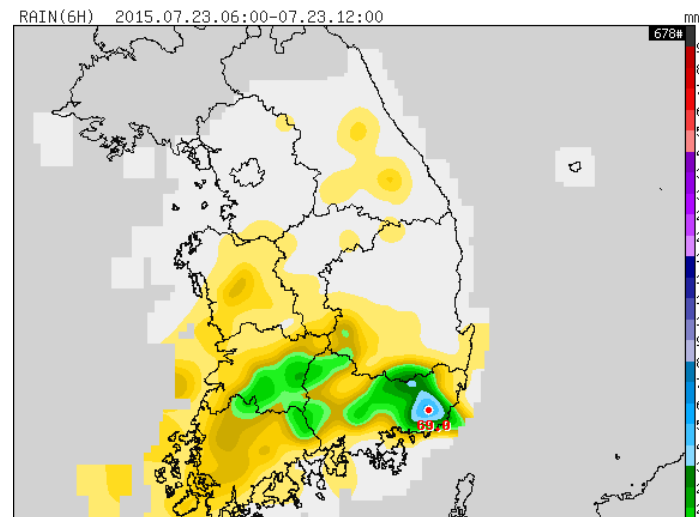
# Application of Convective clouds 아날로그 RGB 국민을 하늘처럼

## - Heavy rainfall -

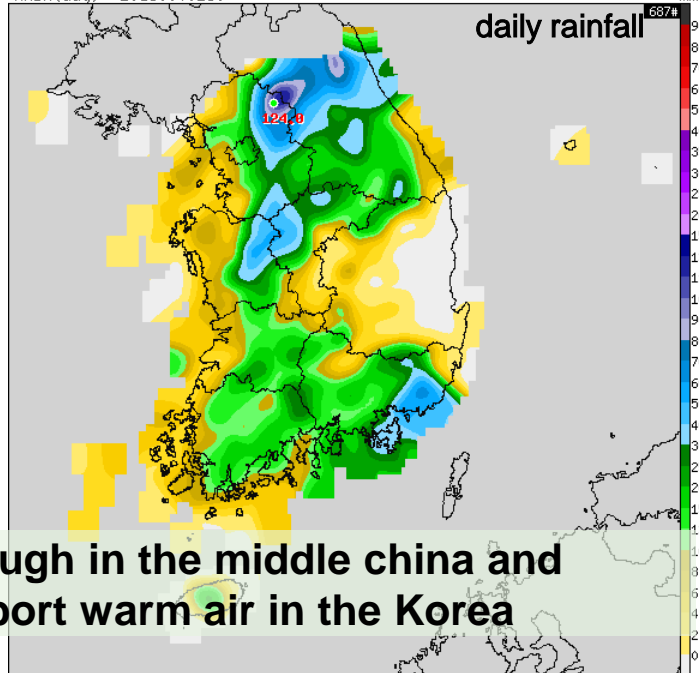
500hPa Chart +WV image



6hr Accumulated rainfall



RAIN(day) 2015.07.23.



- Synoptic condition : conversion zone between upper trough in the middle china and mT in the southwest ocean → warm conveyer belt transport warm air in the Korea

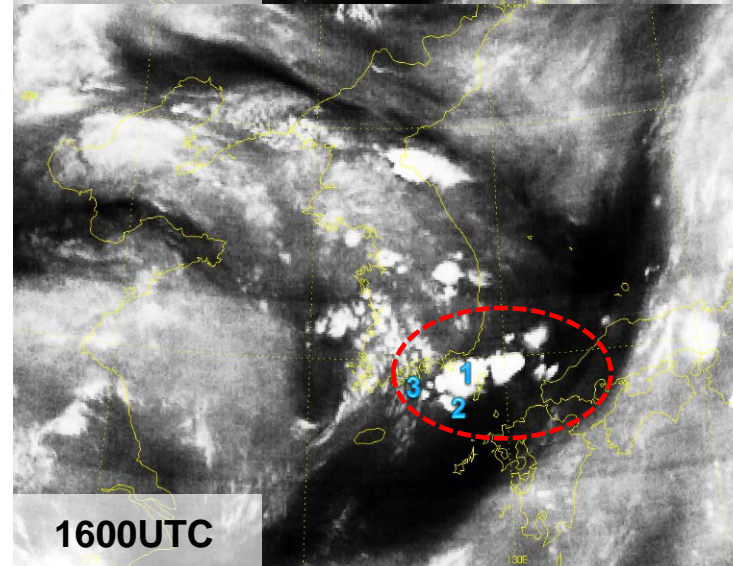
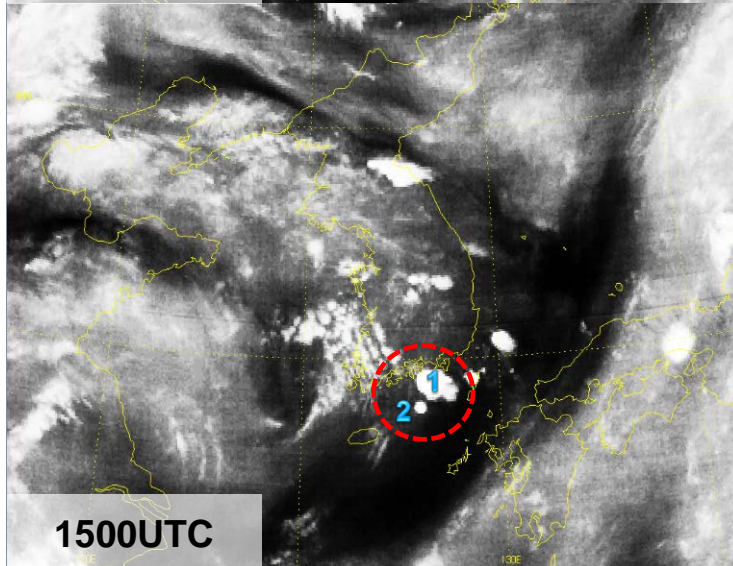
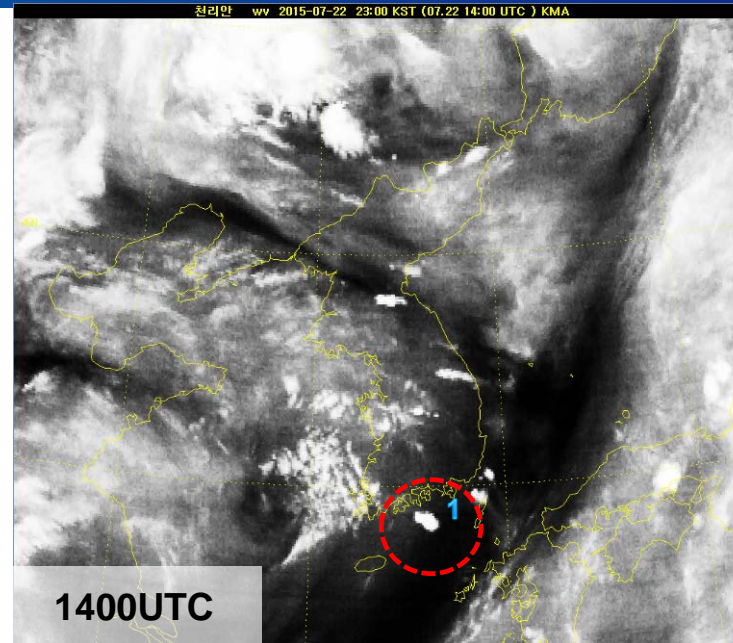
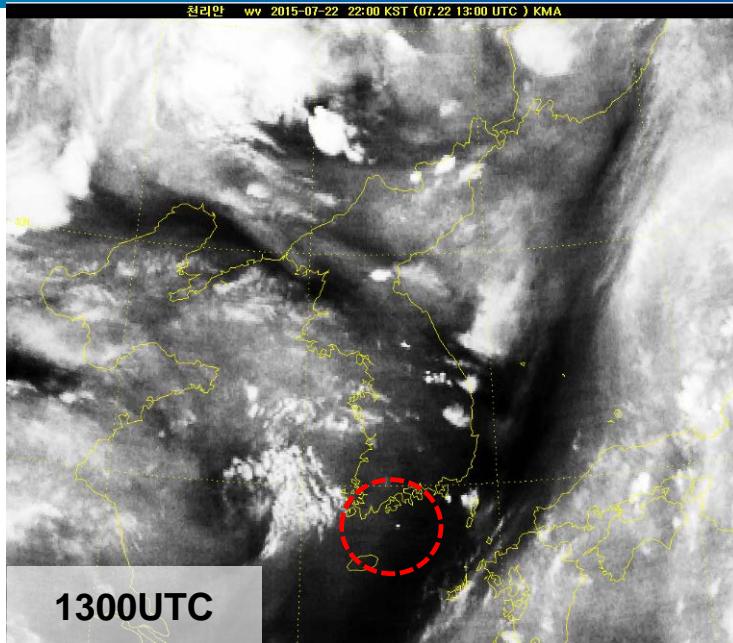


# Formation of cumulus(-1day)

하늘을 친구처럼  
국민을 하늘처럼

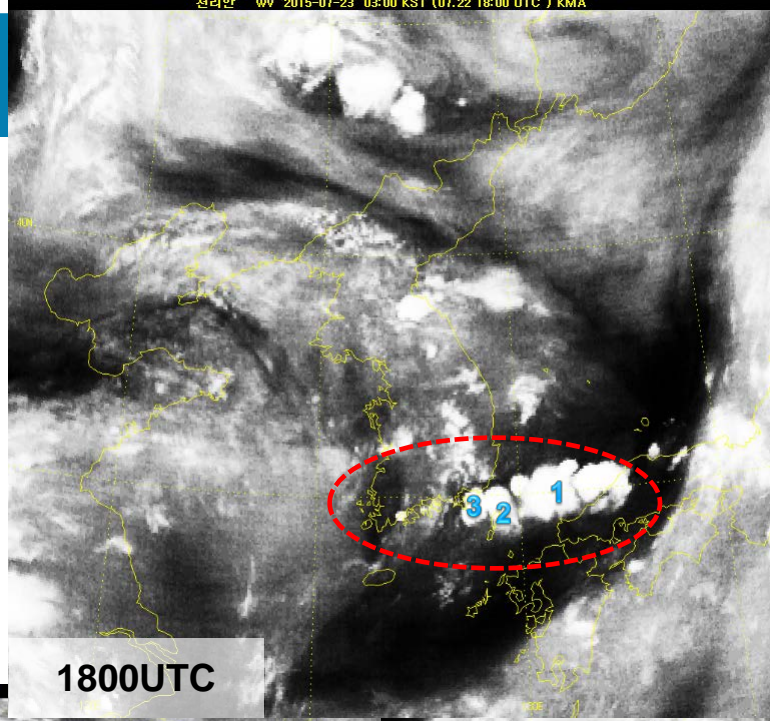


22<sup>nd</sup> July 2015

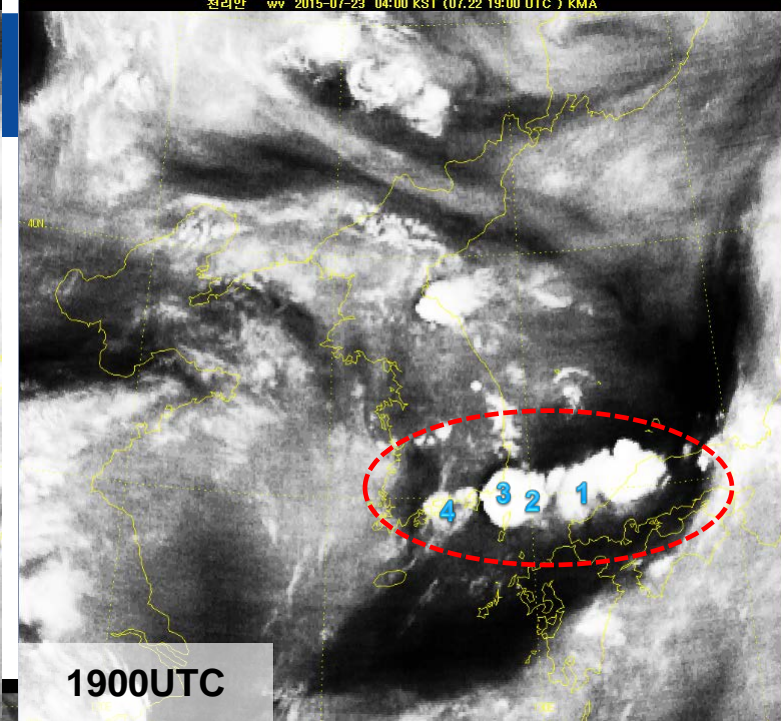




22<sup>nd</sup> July 2015

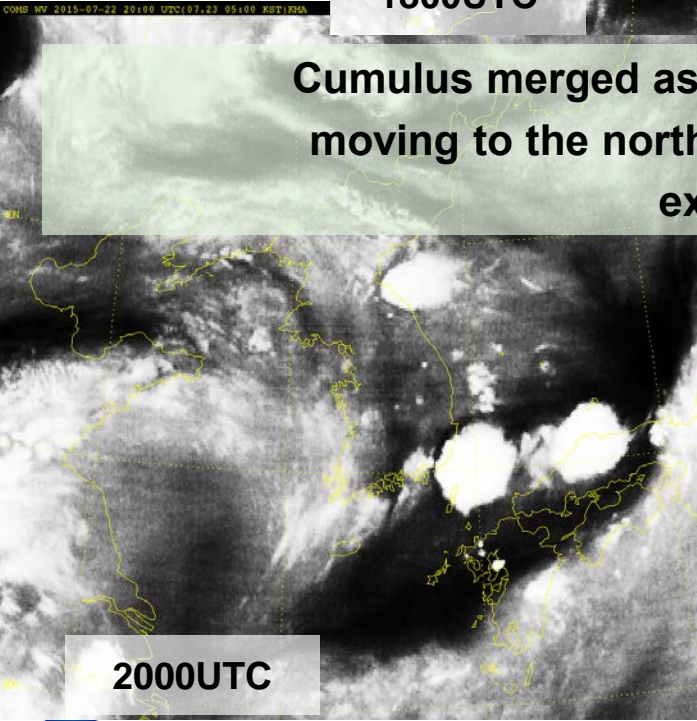


1800UTC

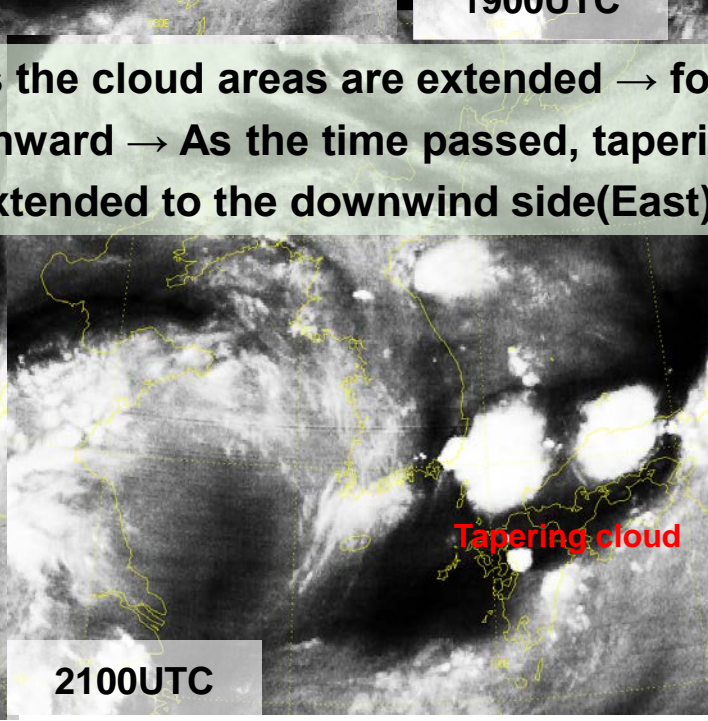


1900UTC

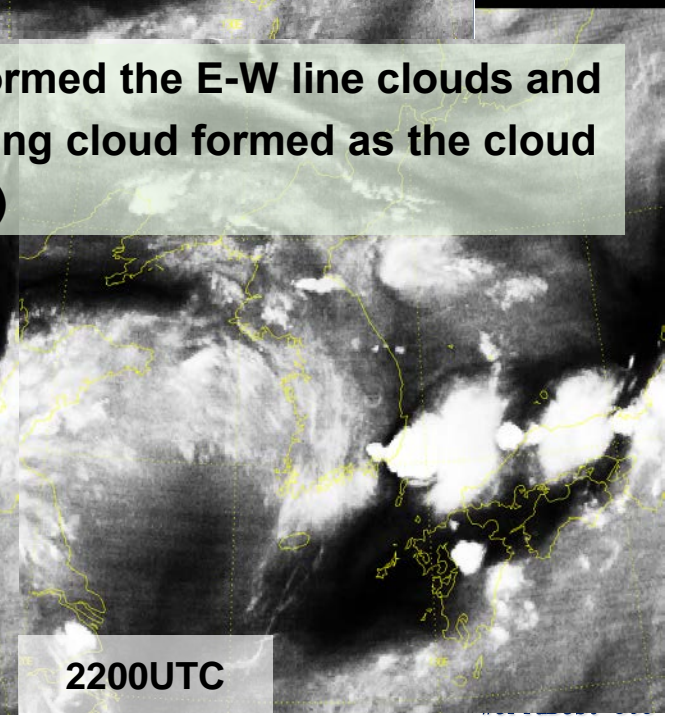
Cumulus merged as the cloud areas are extended → formed the E-W line clouds and moving to the northward → As the time passed, tapering cloud formed as the cloud extended to the downwind side(East)



2000UTC



2100UTC



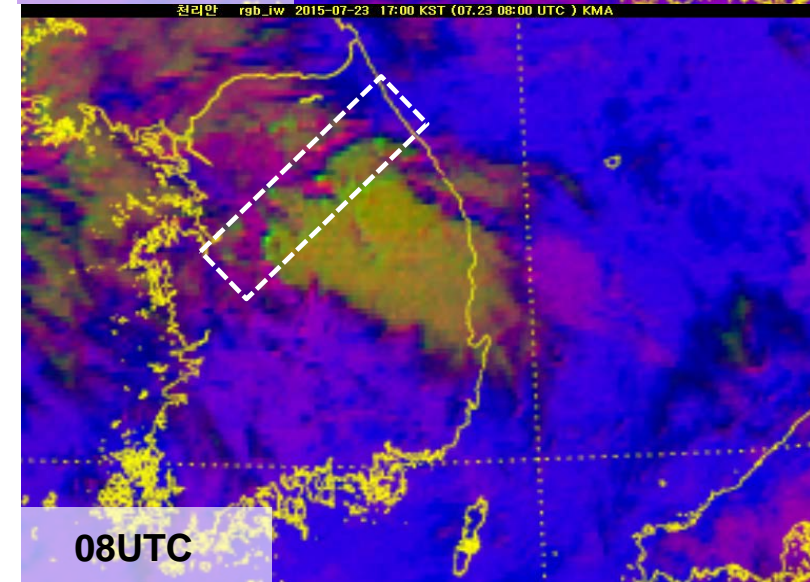
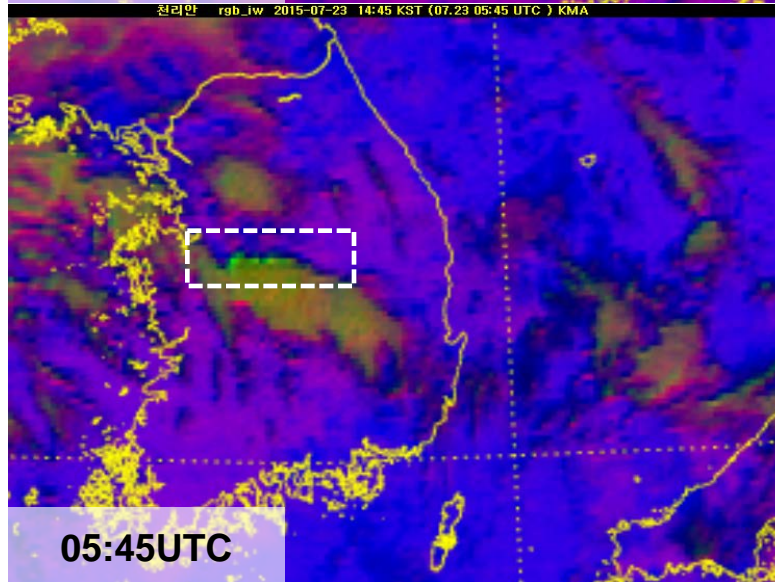
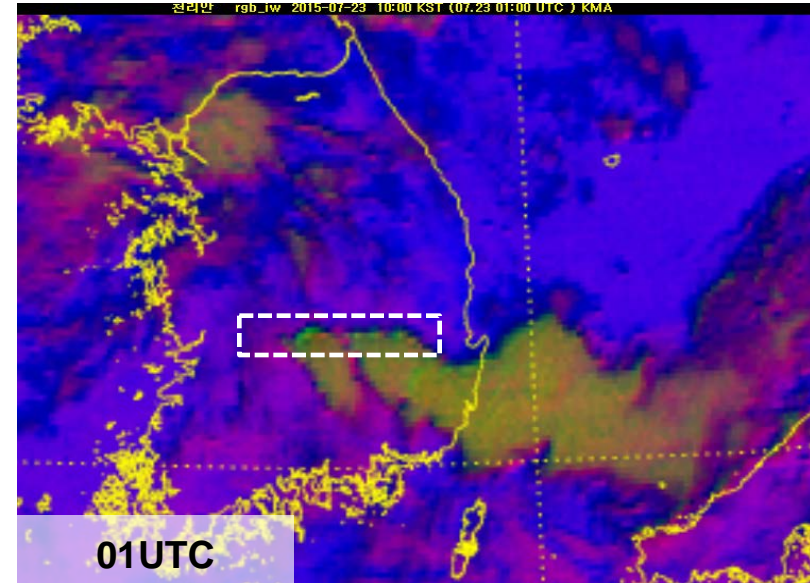
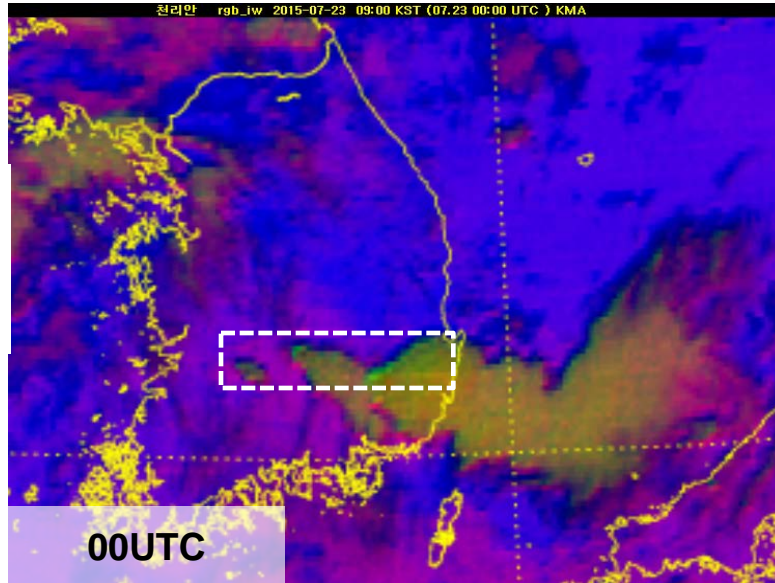
2200UTC

# COMS Convective RGB image :

- northward moving of tapering clouds
- continuous formation of new cells shown light green in front of the moving direction

23<sup>rd</sup> July 2015

- Developing Conv. Cld.
- Decaying Conv. Cld.



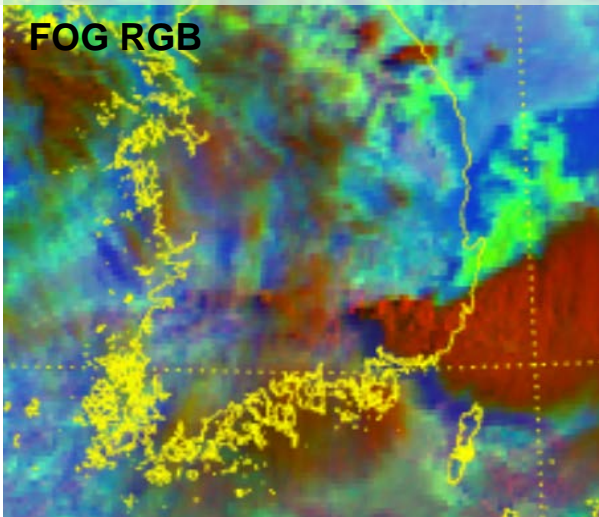
# COMS RGB Fog images → detect well the formation of Tapering clouds 친구처럼

국민을 하늘처럼

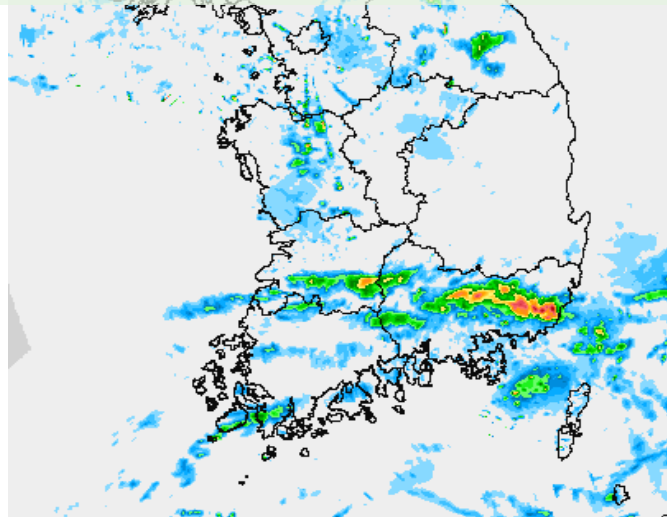
① rainfall area is located in front(north)of the cloud moving direction,

② high towering clouds extended to the leeward side(SouthEast)

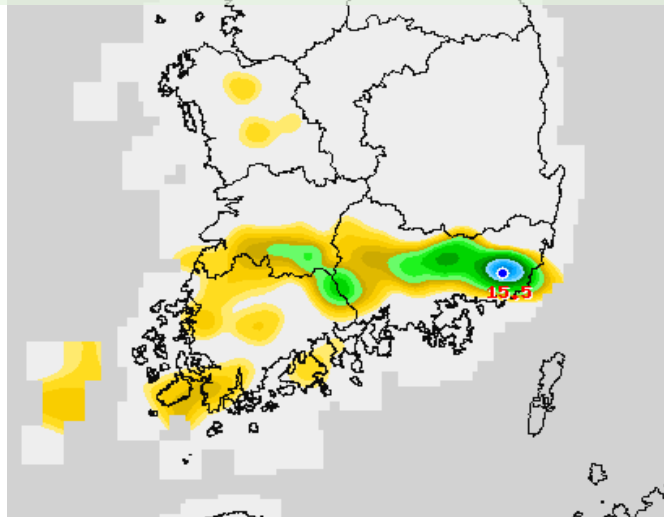
FOG RGB



2230 UTC 22<sup>nd</sup> July

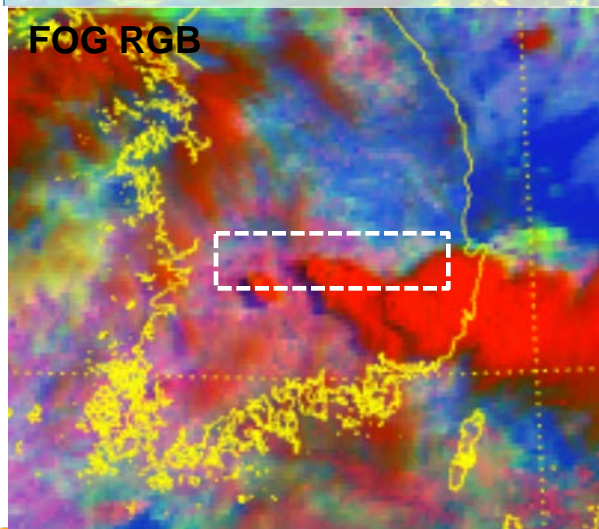


Radar image

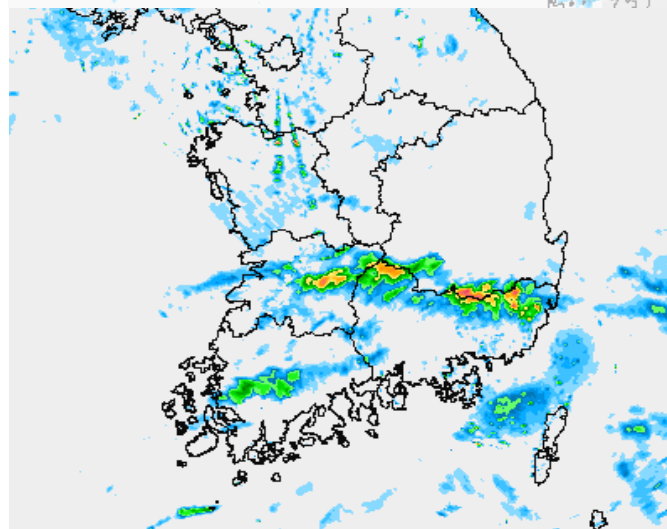


15min accumulated rainfall(AWS)

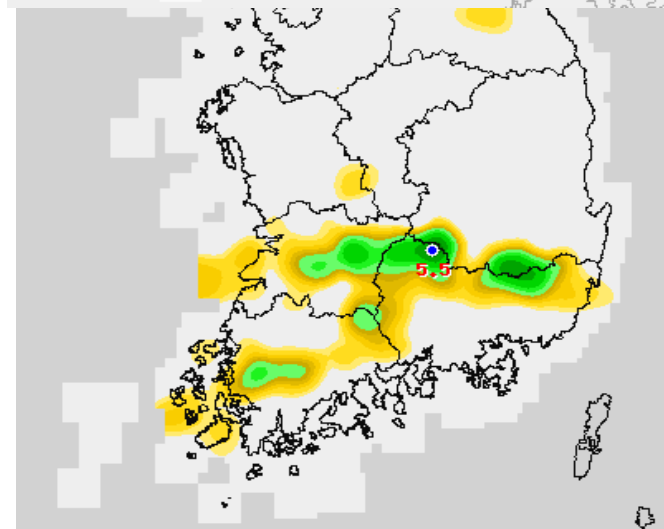
FOG RGB



00UTC 23<sup>rd</sup> July



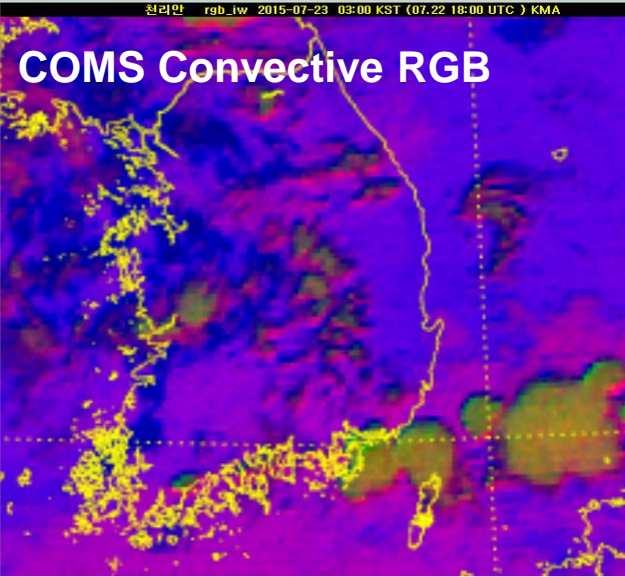
Radar image



15min accumulated rainfall(AWS)

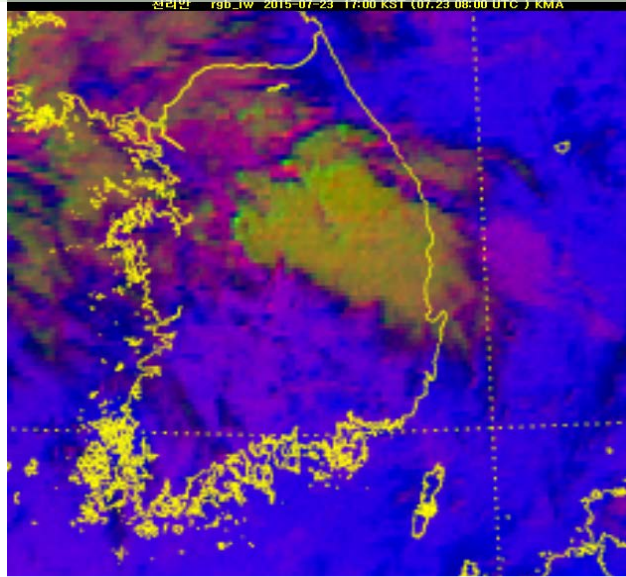


Analysis of Cause → As the time passed, moving direction of cloud areas are coincided well with upper divergence region(200~300hPa)

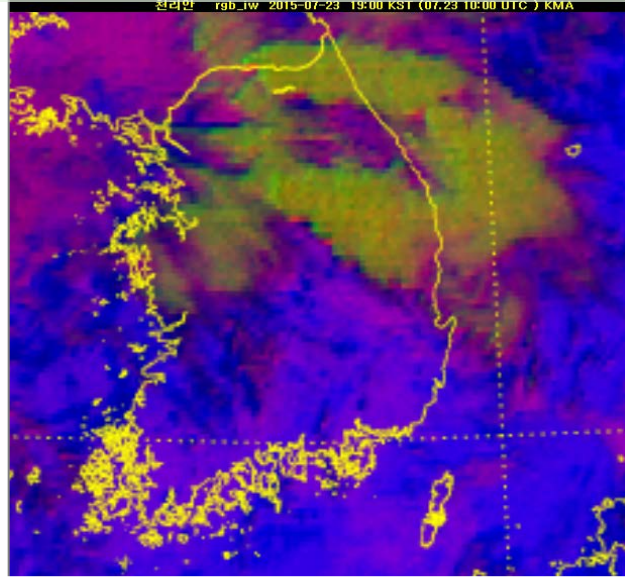


COMS Convective RGB

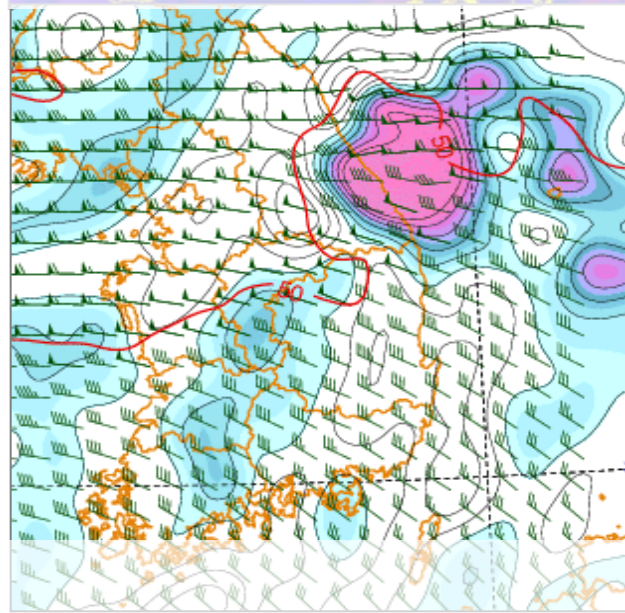
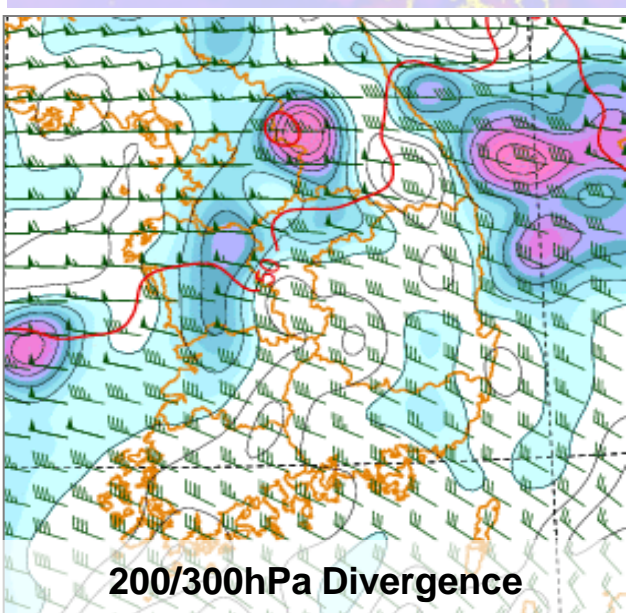
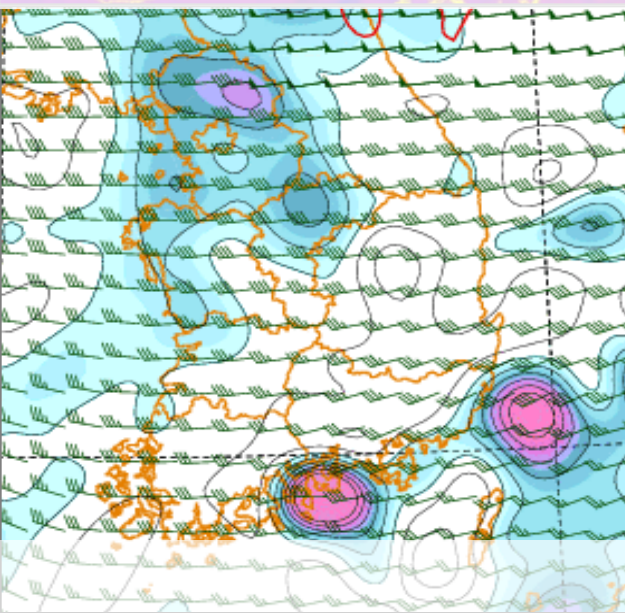
1800UTC 22<sup>nd</sup> July



0800UTC 23<sup>rd</sup> July



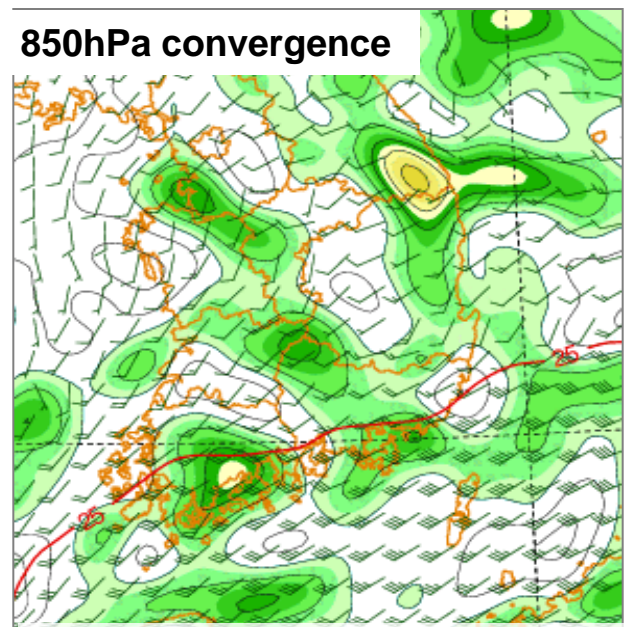
1000UTC 23<sup>rd</sup> July



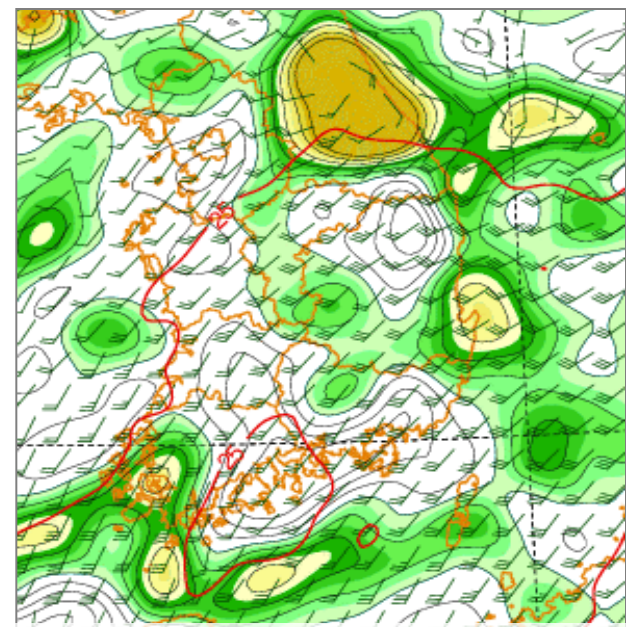
200/300hPa Divergence



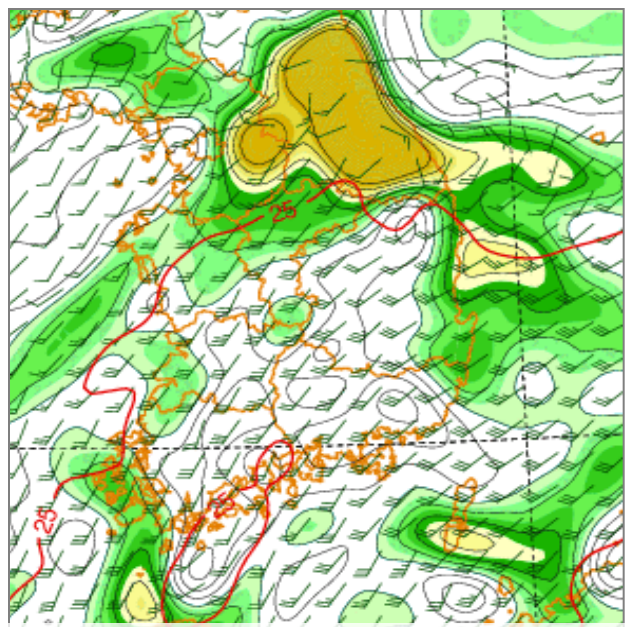
Analysis of Cause → As the time passed, **upper divergence** region(200~300hPa) correspond well with lower convergence region at 850hPa and high humid region at 700hPa



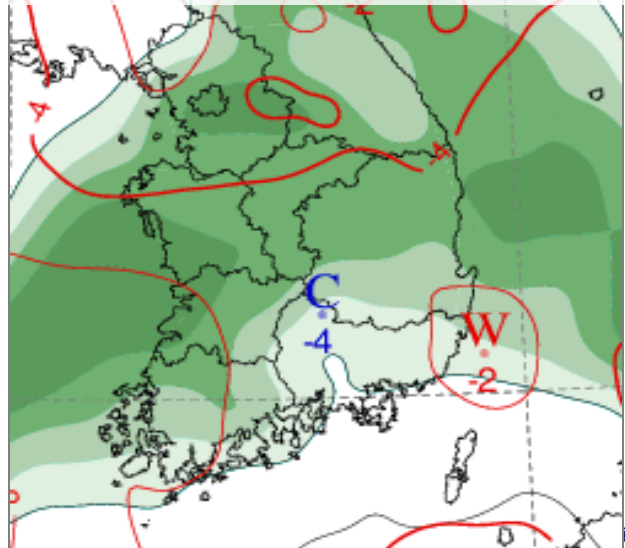
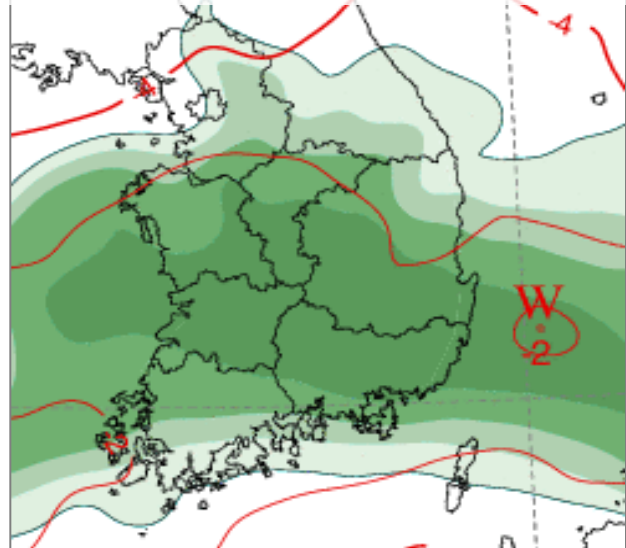
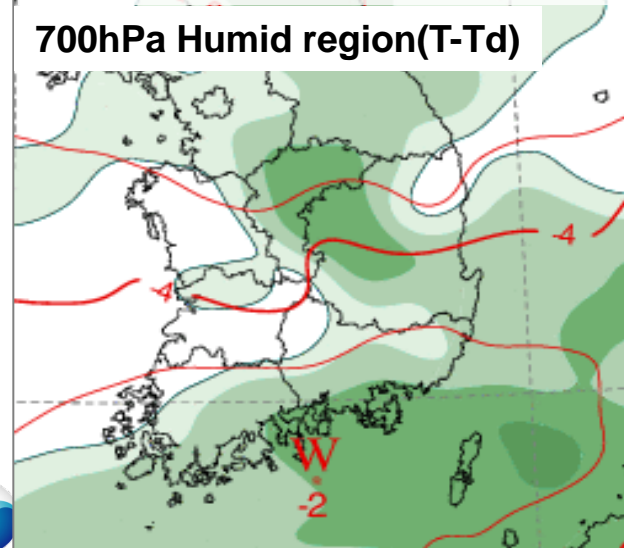
1800UTC 22<sup>nd</sup> July



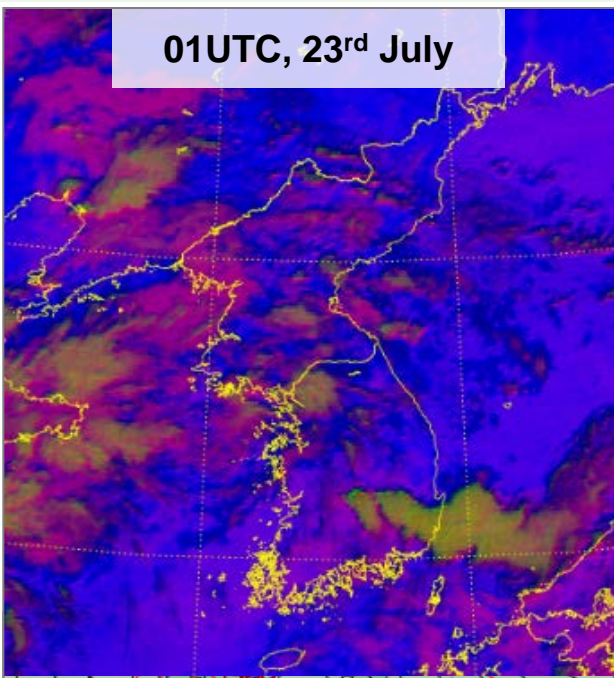
0800UTC 23<sup>rd</sup> July



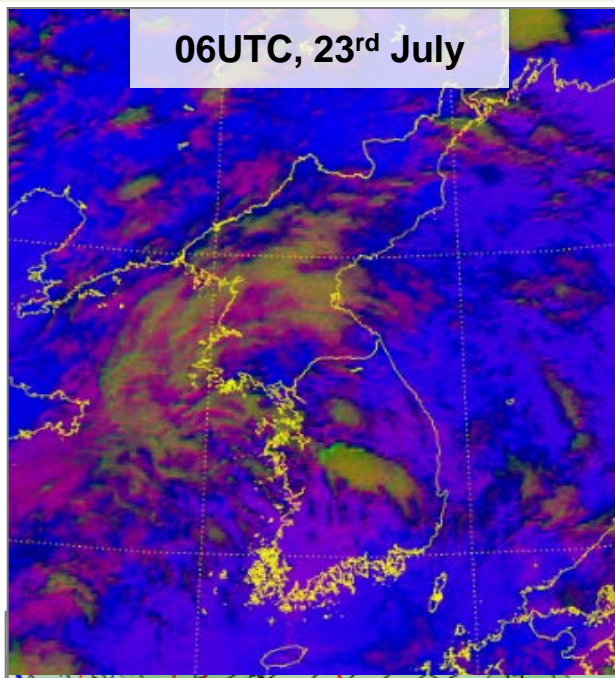
1000UTC 23<sup>rd</sup> July



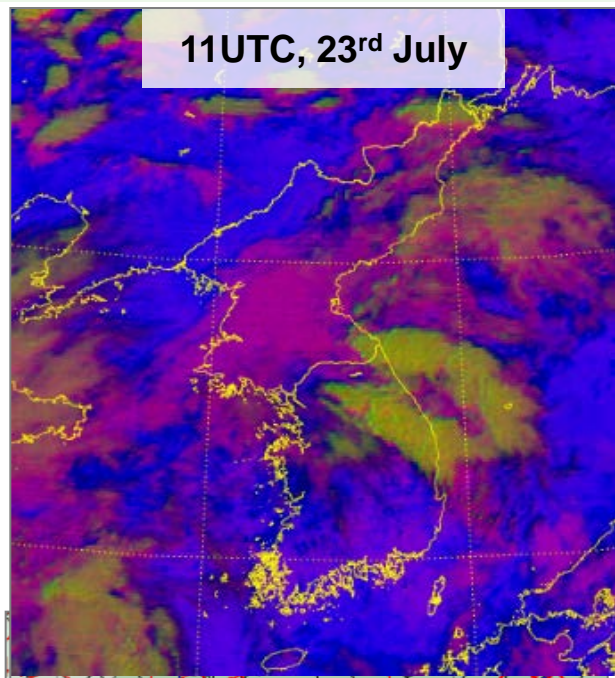
Analysis of Cause → On the other hand, as the low level Jet at the 850hPa moving northward new cells tend to formed in front of the local wind shear region



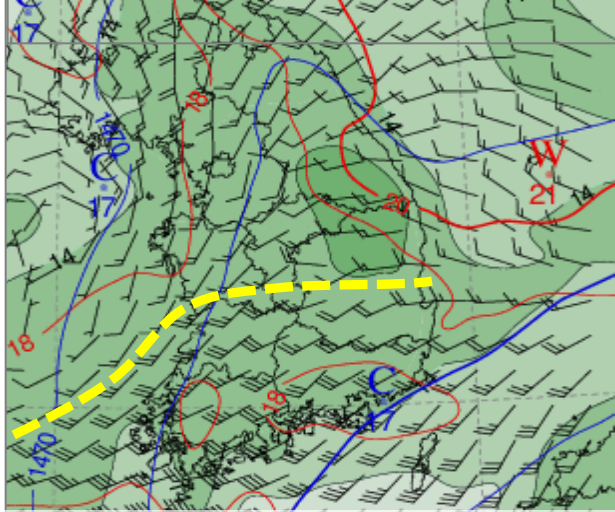
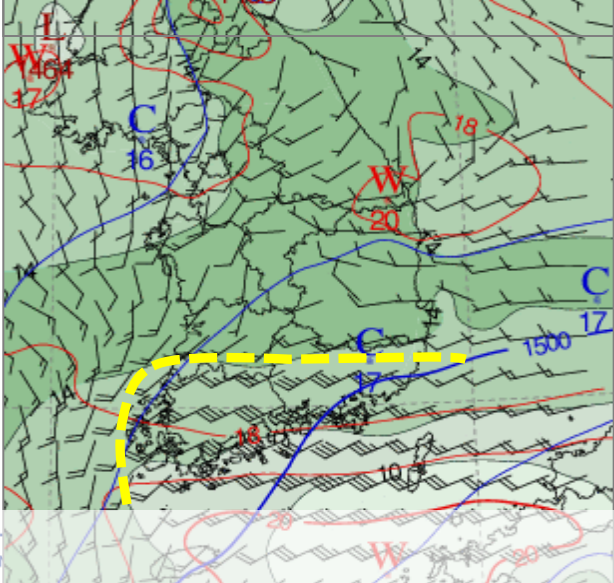
01UTC, 23<sup>rd</sup> July



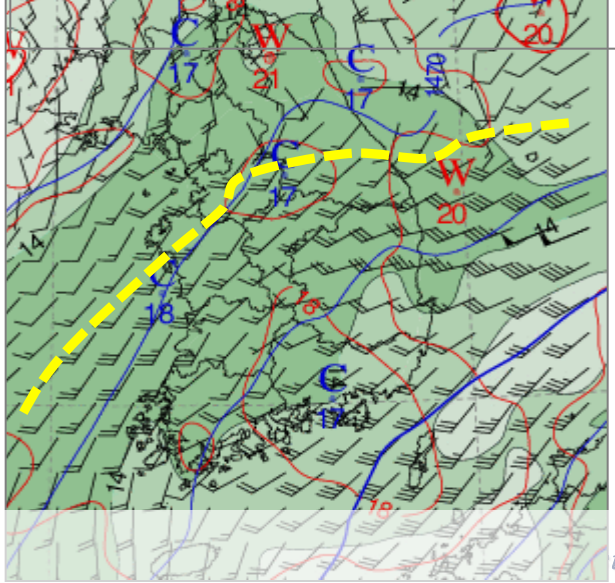
06UTC, 23<sup>rd</sup> July



11UTC, 23<sup>rd</sup> July

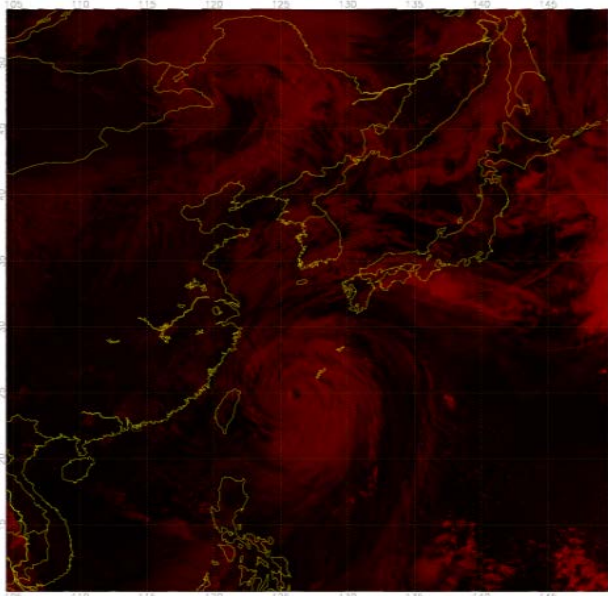


Wind field at 850hPa

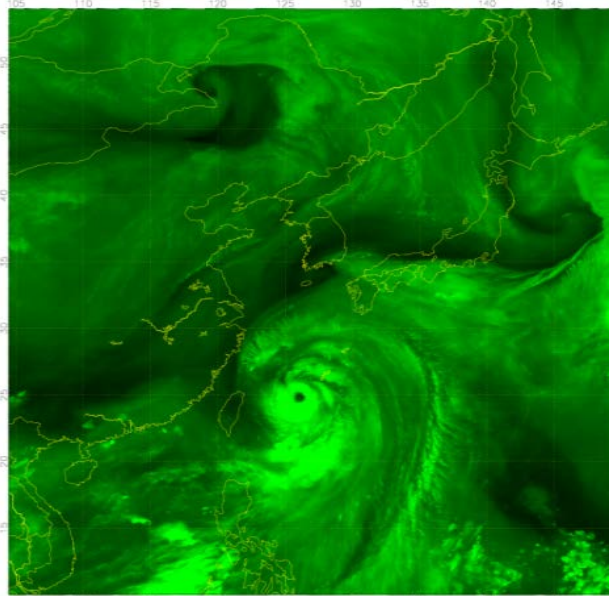


# 2-2. Recipe of Water Vapor RGB (Day)

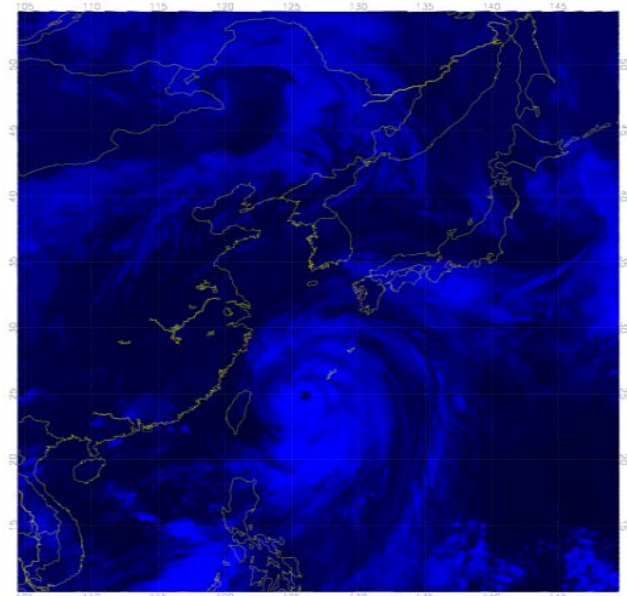
하늘을 친구처럼  
구름을 하늘처럼



VIS



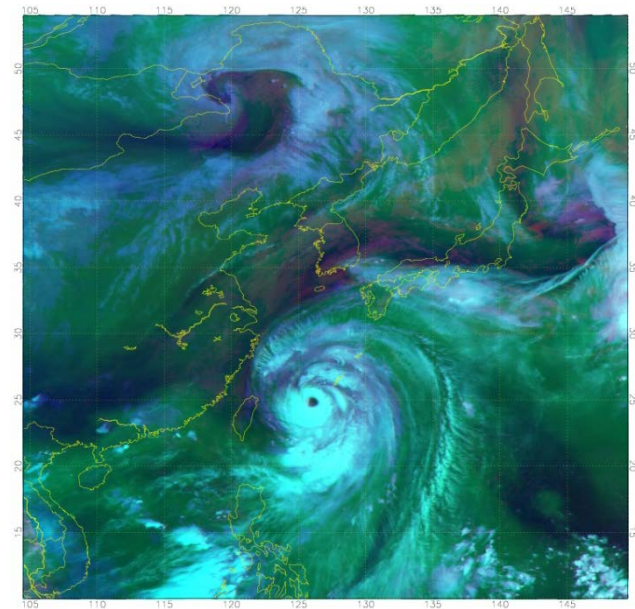
WV



IR1

Daytime (SZA < 85 °)

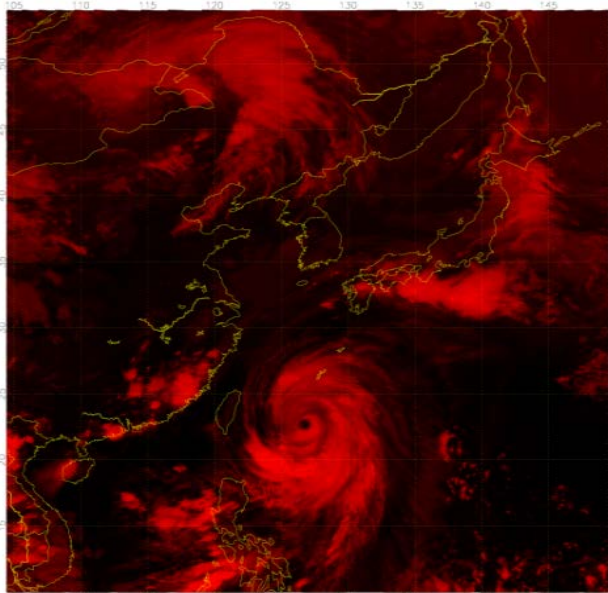
	Channels ( $\mu\text{m}$ )	Threshold
RED	VIS(0.675)	0~100
GREEN	WV(6.7)	210~255
BLUE	IR1(10.8)	210~320



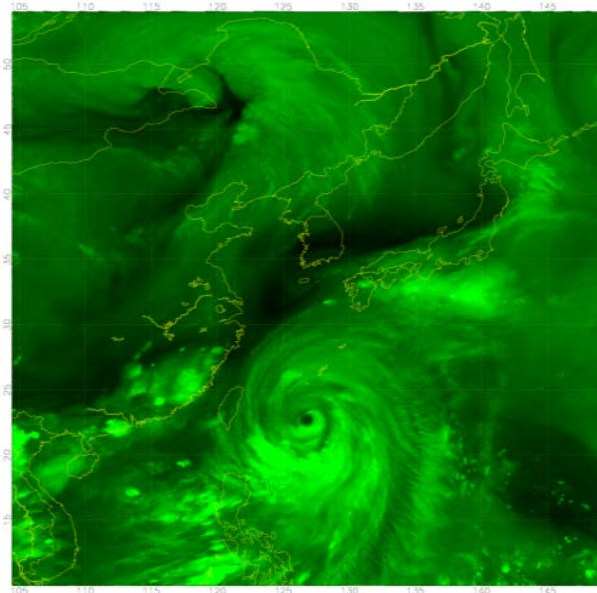


# Recipe of Water Vapor RGB(Nighttime)

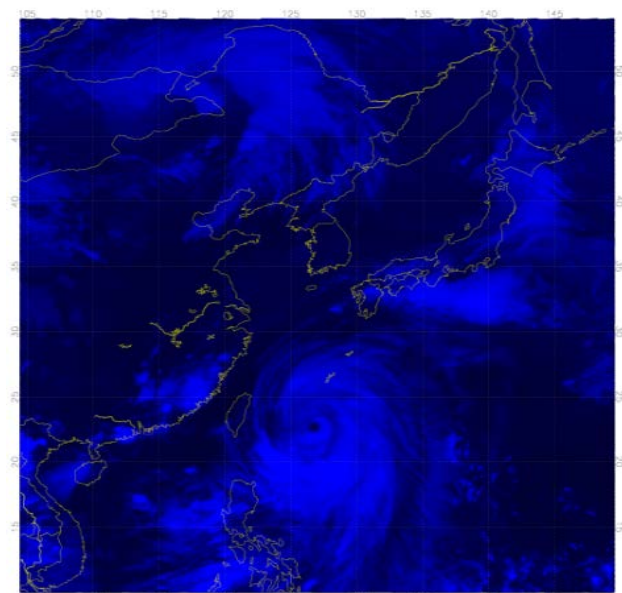
하늘은 선구처럼  
구름은 하늘처럼



SWIR



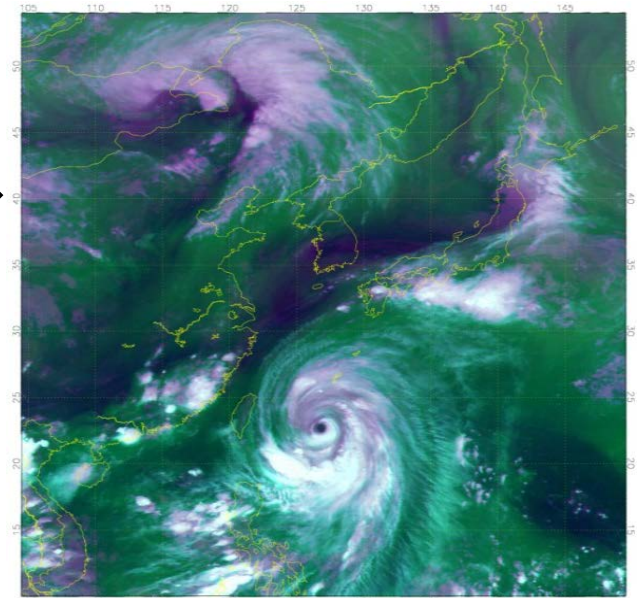
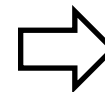
WV



IR1

Nighttime(SZA > 85 °)

	Channels ( $\mu\text{m}$ )	Threshold
RED	SWIR(3.75)	200~300
GREEN	WV(6.7)	210~255
Blue	IR1(10.8)	210~320



# Interpretation of WV RGB (Daytime)

하늘은 치고처럼  
국민을 휘둘러

## Daytime

### Meaning of Colors



Water Vapor



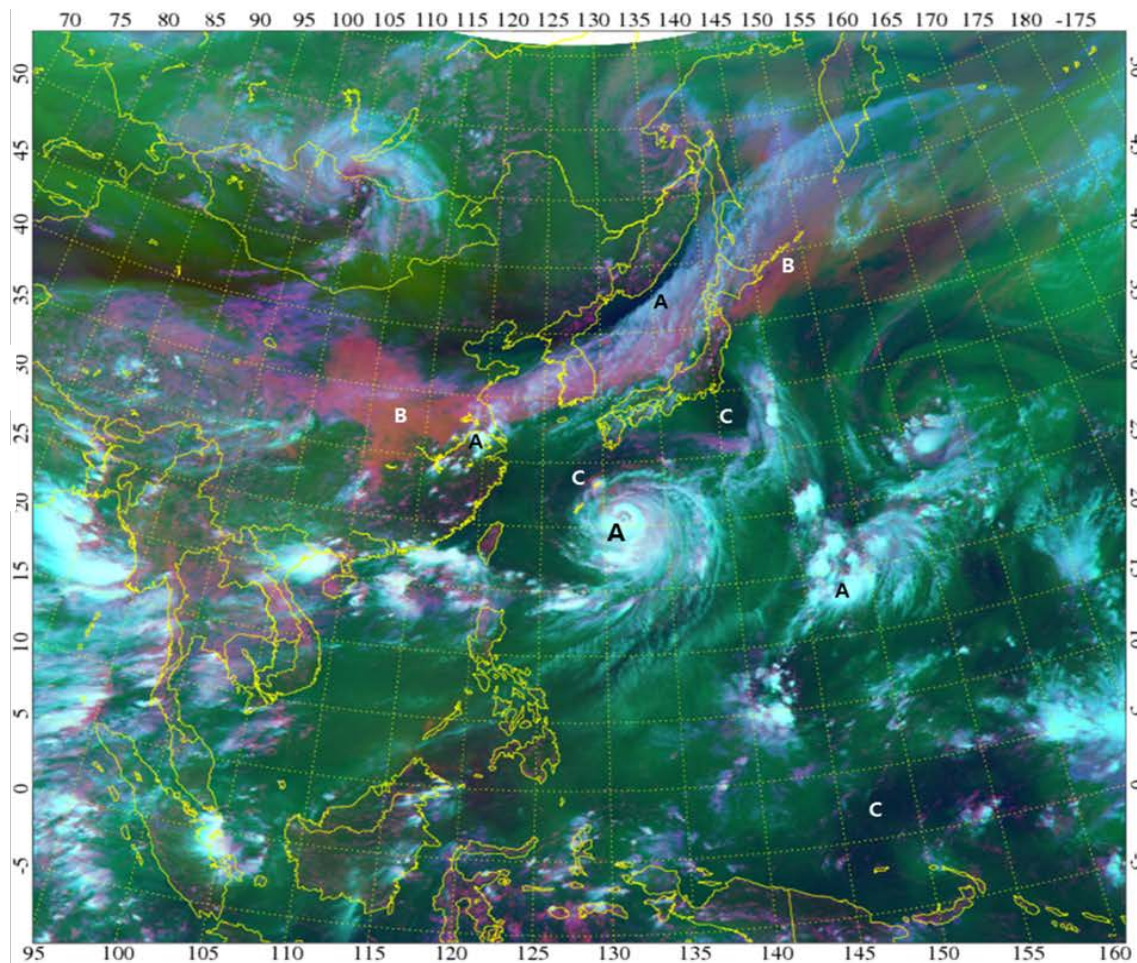
Dry area



High level cloud  
Well developed  
clouds



Low level  
Clds

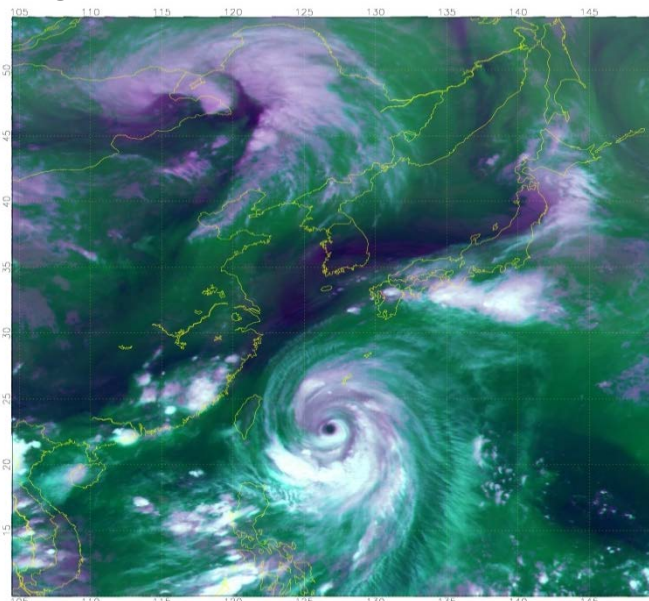


# COMS Water Vapor RGB

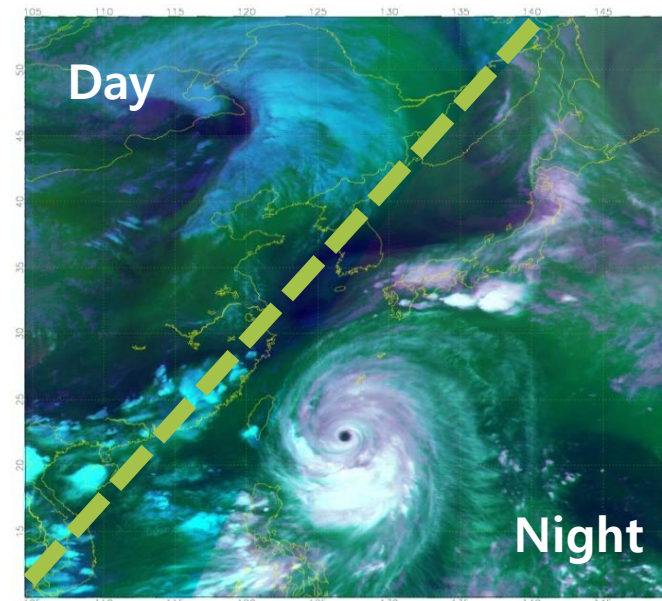
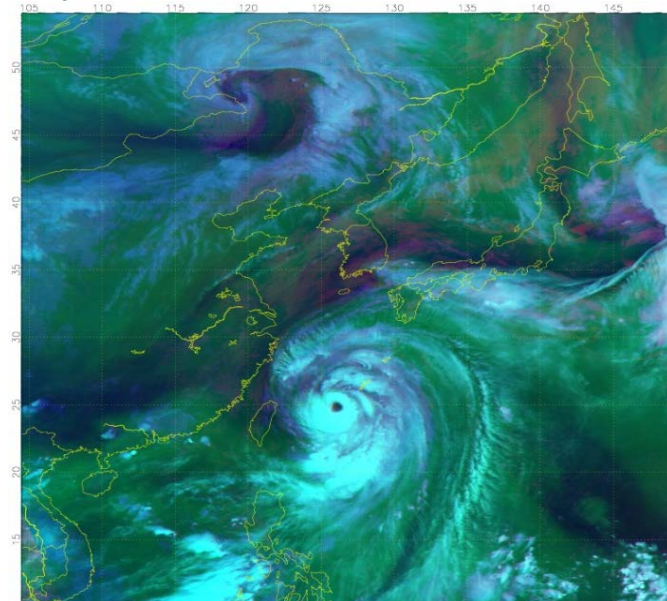
하늘을 친구처럼  
국민을 하늘처럼

- Detection the low level clouds both day and nighttime
- Monitoring of the WV distribution in the middle/upper level atmosphere
- Detection of the well-developed high clouds shown white
- Discontinuity during the dawn/dusk

Nighttime (**SWIR** + WV + IR1)



Daytime (**VIS** + WV + IR1)



Discontinuity  
- solar zenith angle  $85^\circ$

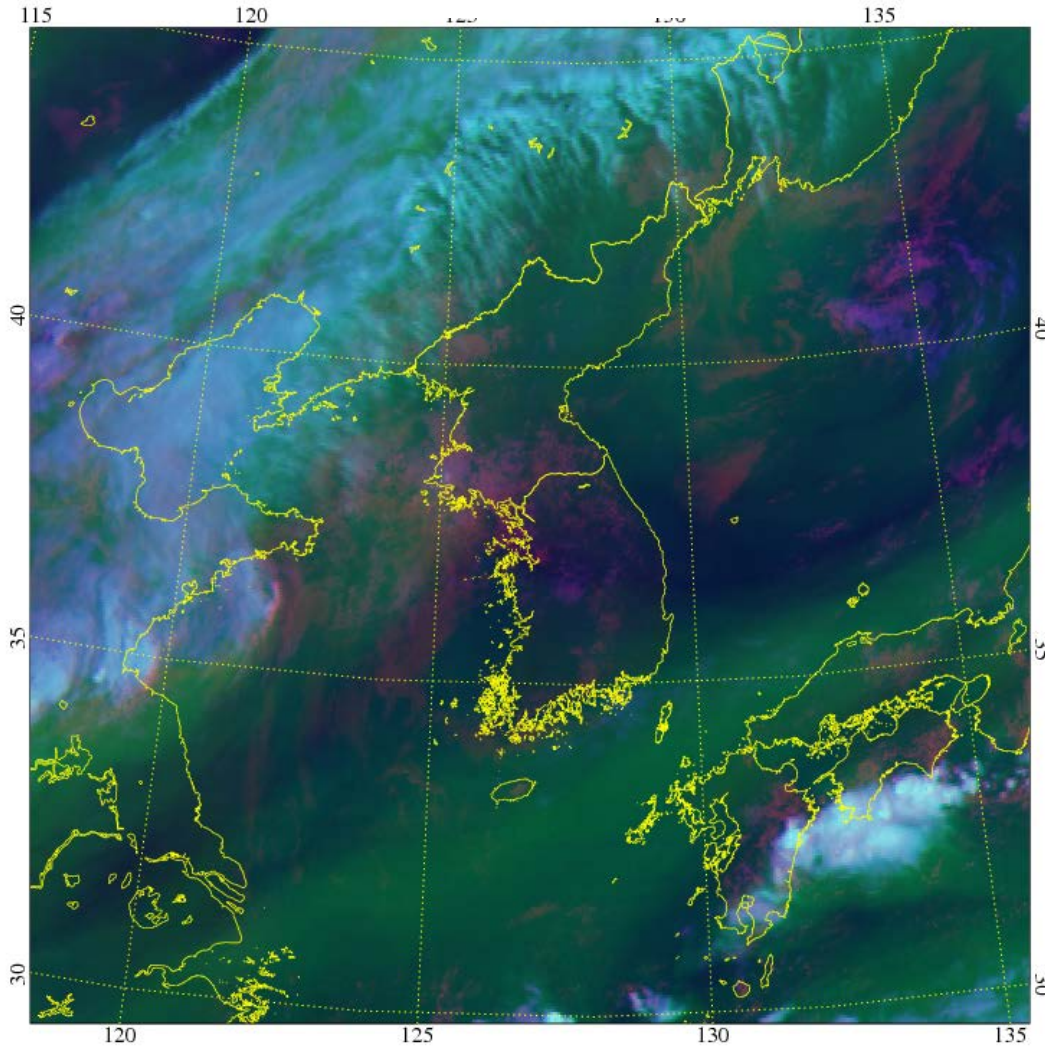
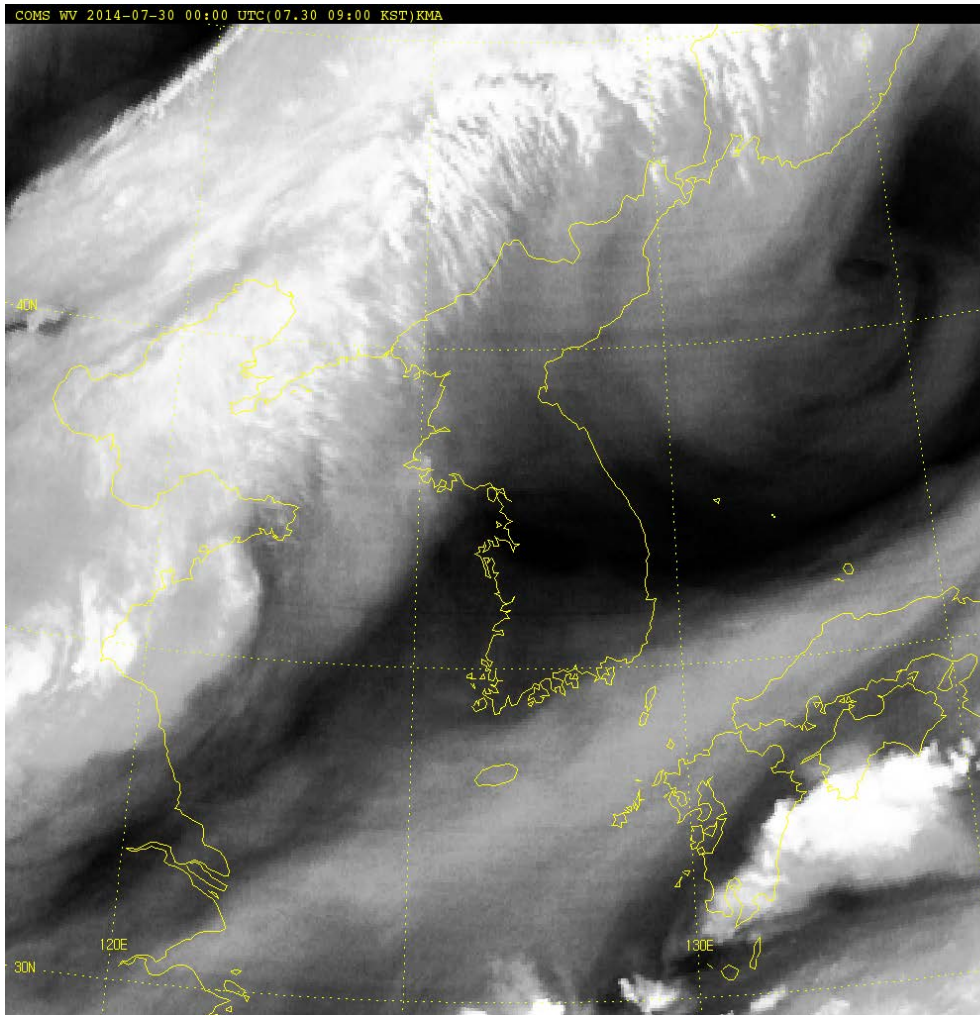
# Advantage of WV RGBs

하늘을 친구처럼  
국민을 하늘처럼



## WV

## WV RGB

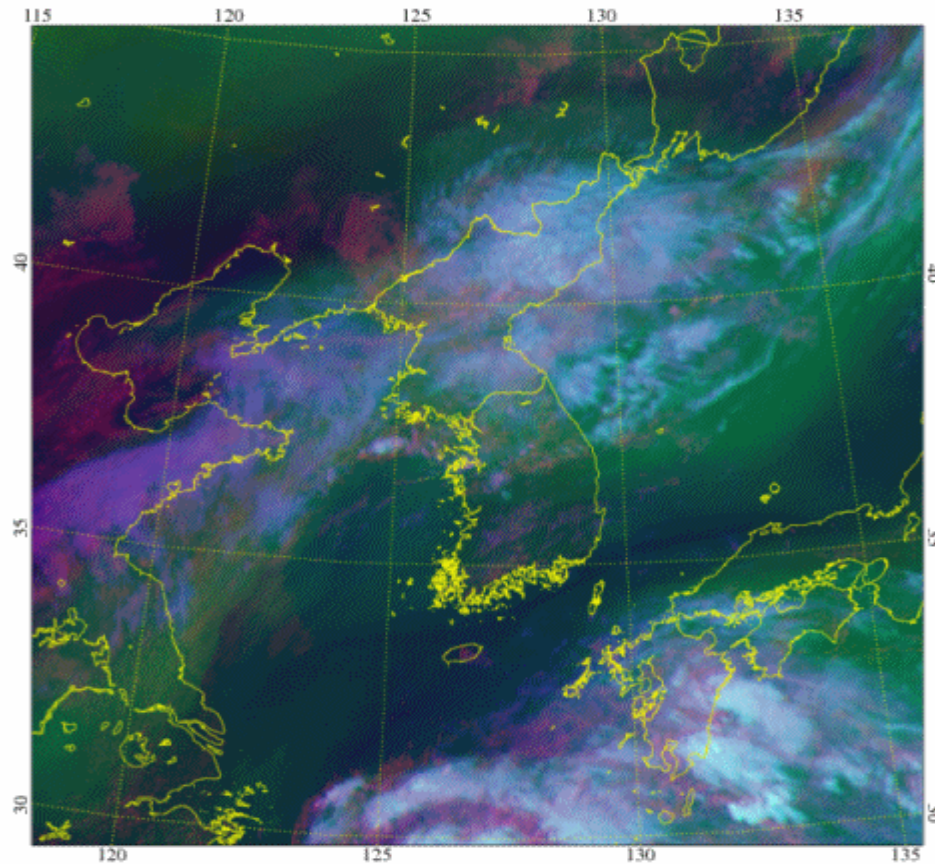


0000UTC 30<sup>th</sup> July, 2014

# Usage of WV RGBs

하늘을 친구처럼  
국민을 하늘처럼

## Monitoring of Rapidly Developing Clouds



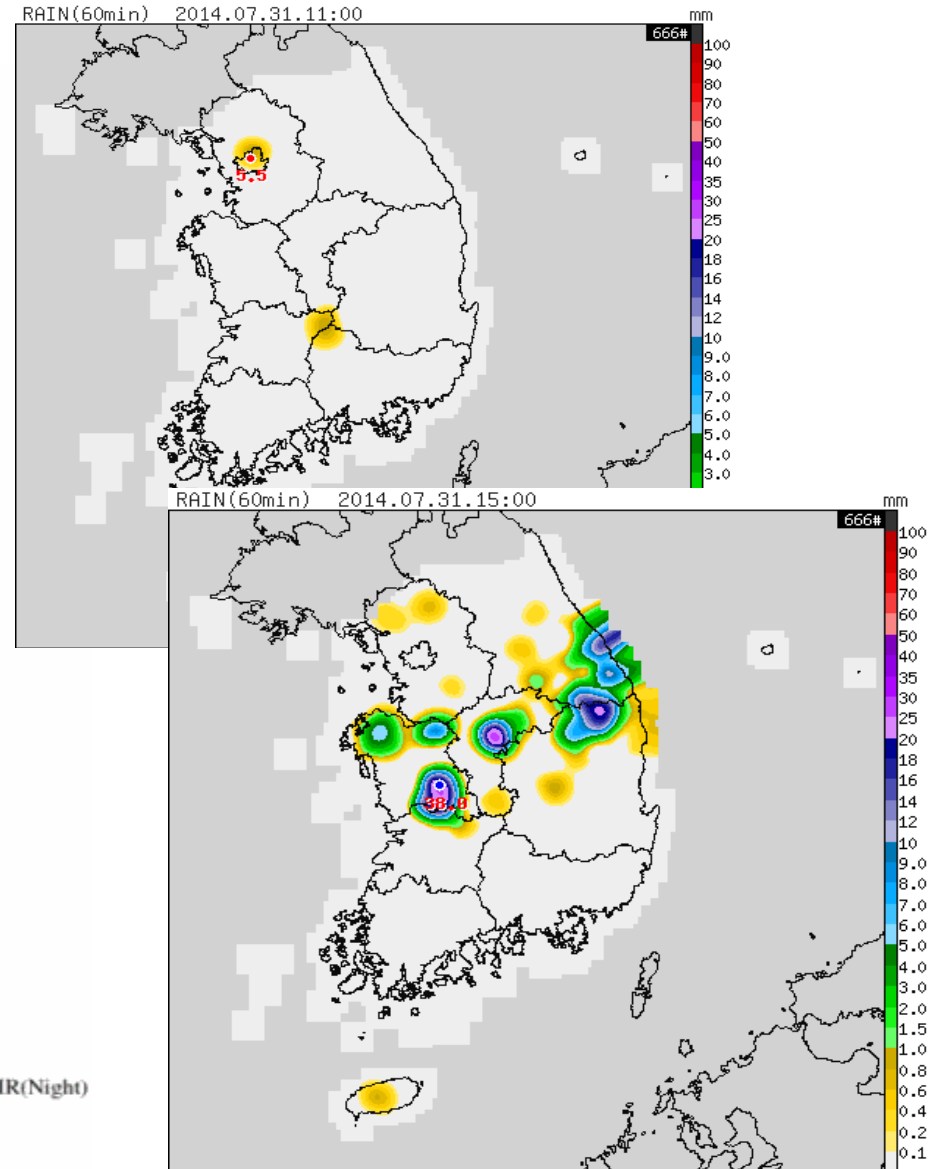
COMS RGB Product - Cloud & Water Vapor Analysis

2014.07.31, 00:45

Red : VIS(Day) or SWIR(Night)

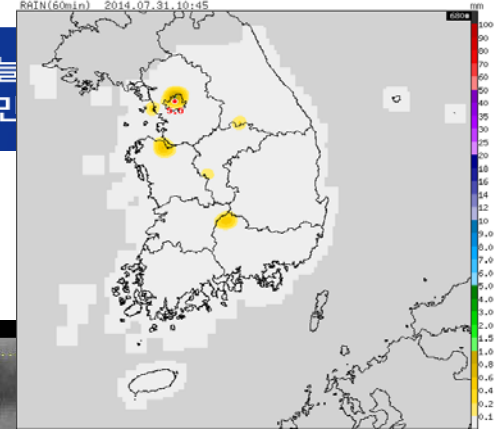
Green : WV - IR1

Blue : IR1

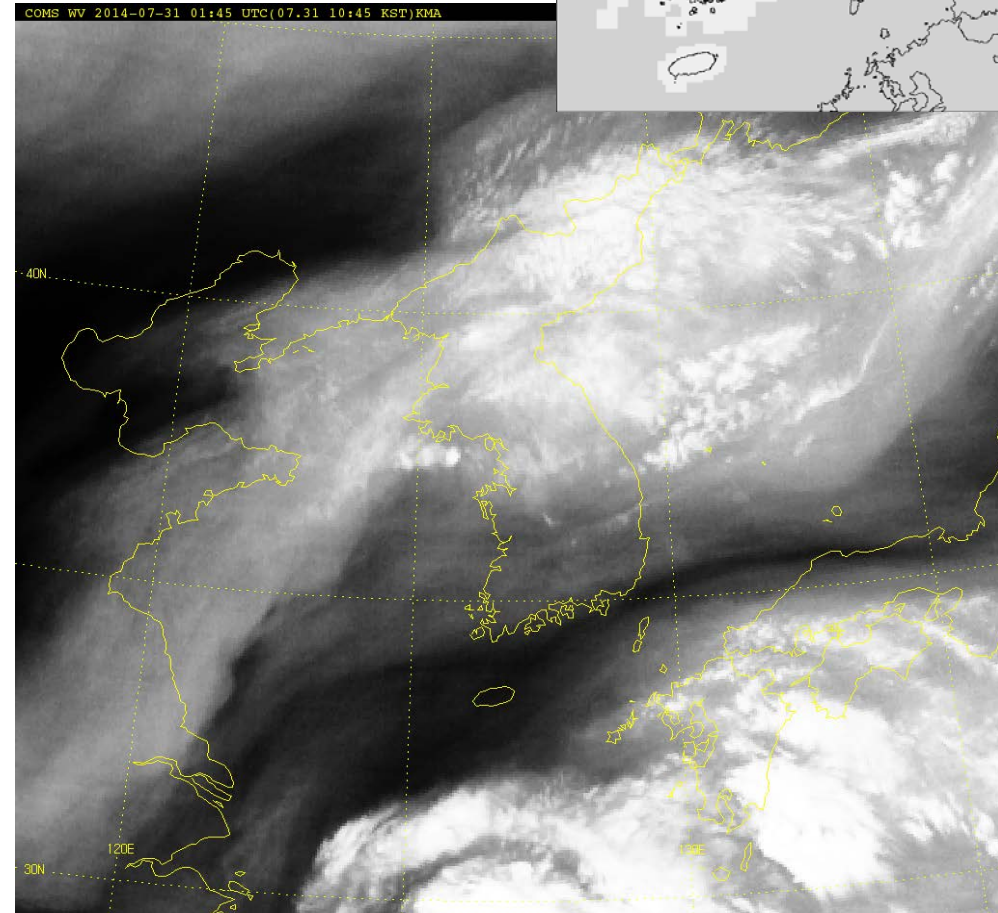
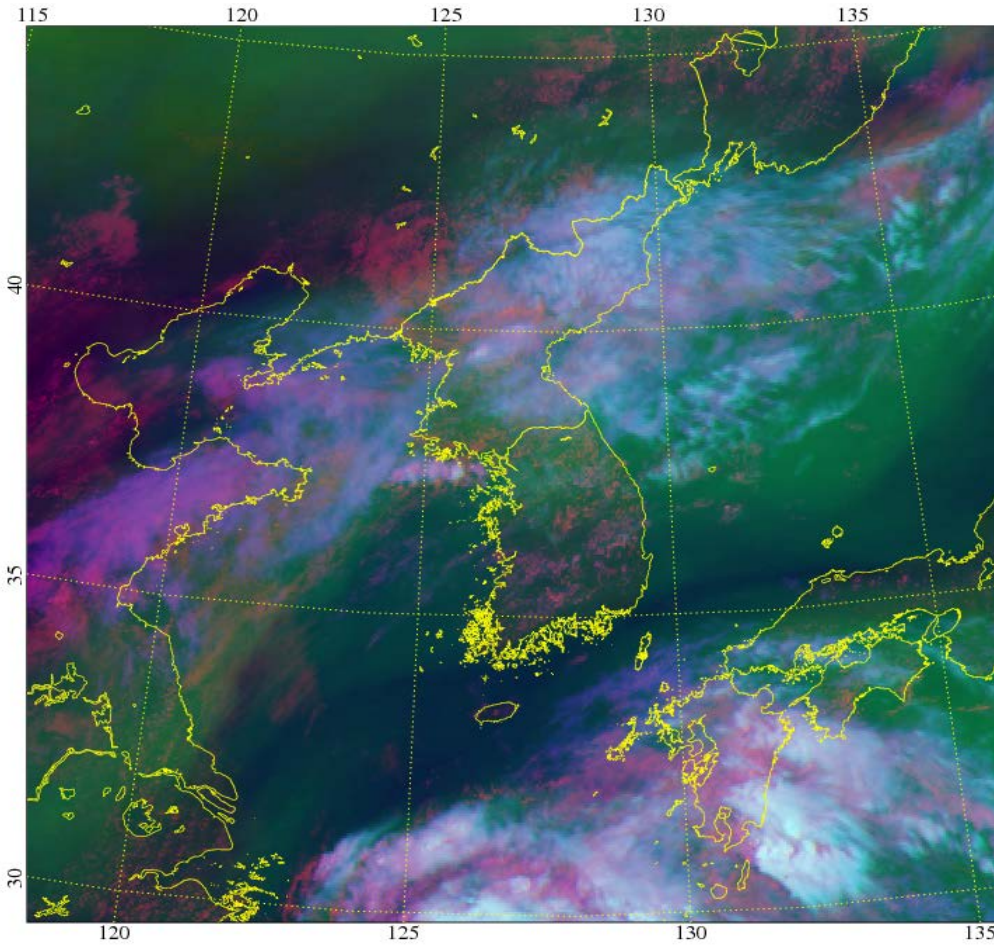


# Usage of WV RGBs

하늘  
국민



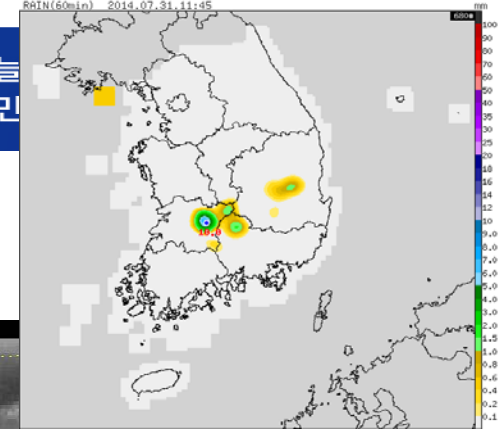
## Before the Convective clouds



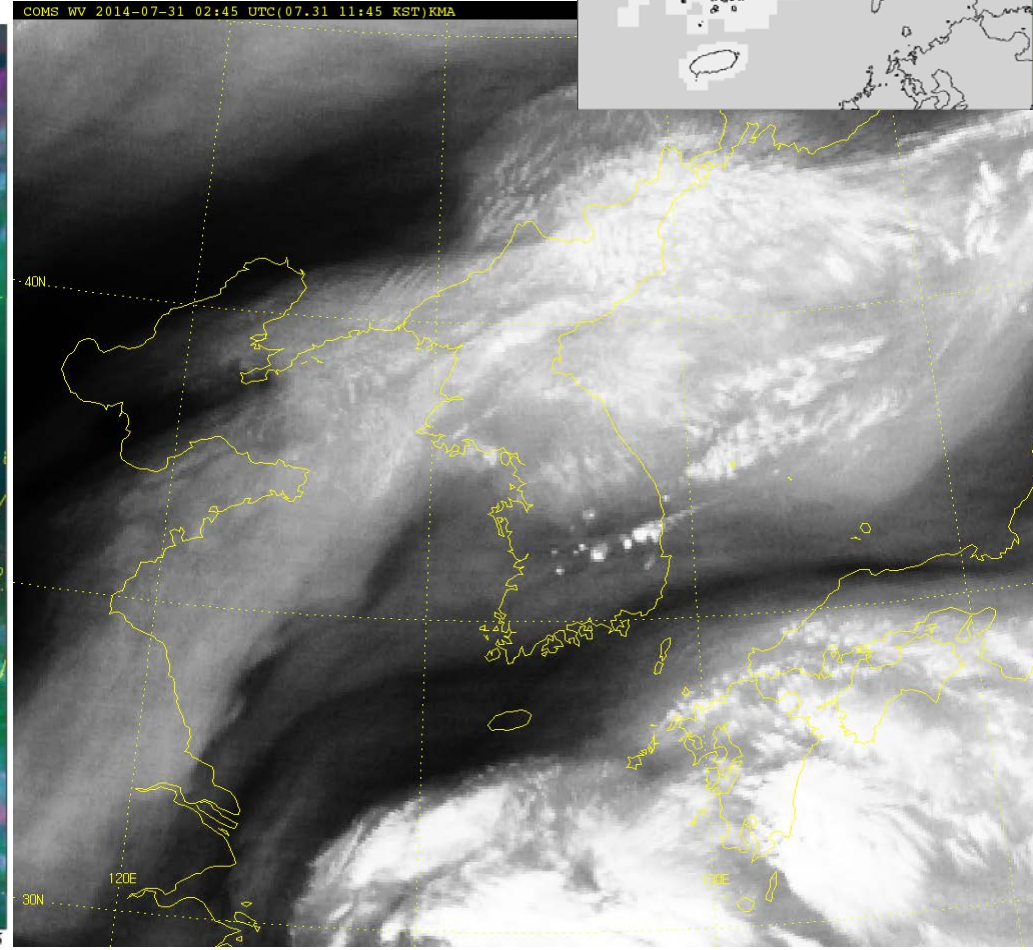
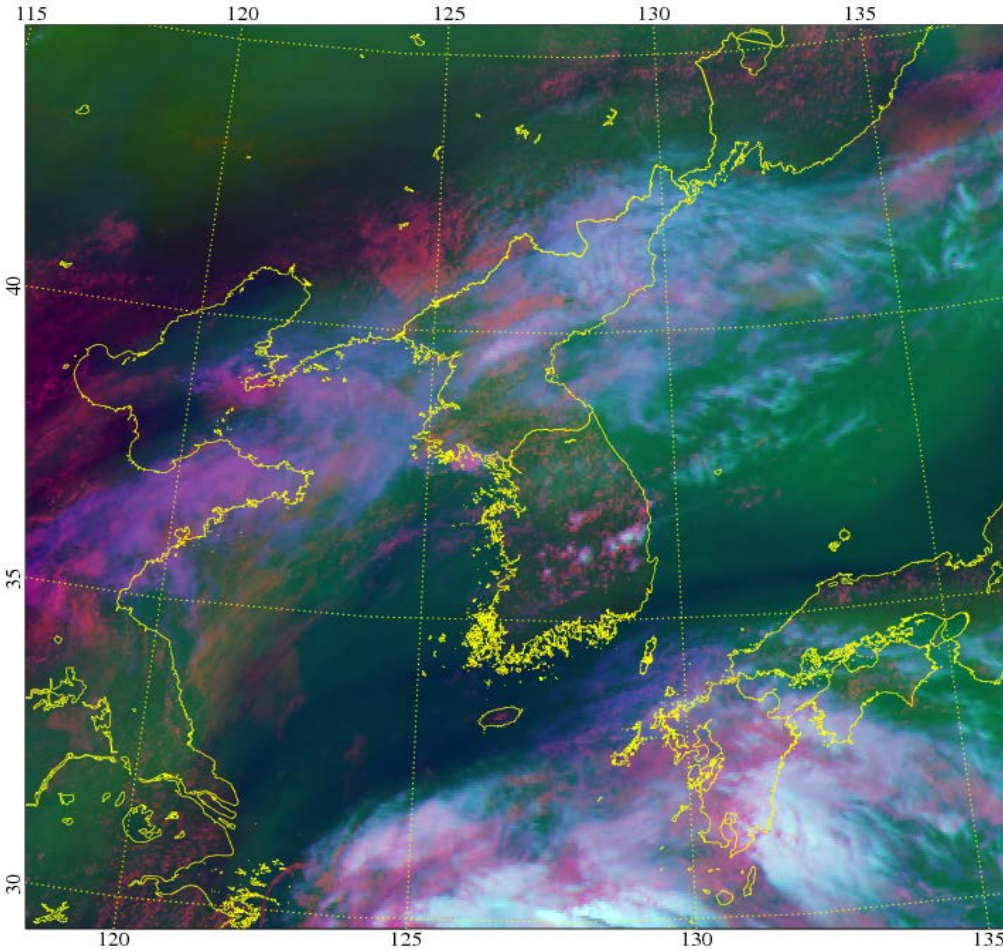
0145UTC 31<sup>st</sup> July, 2014

# Usage of WV RGBs

하늘  
국민



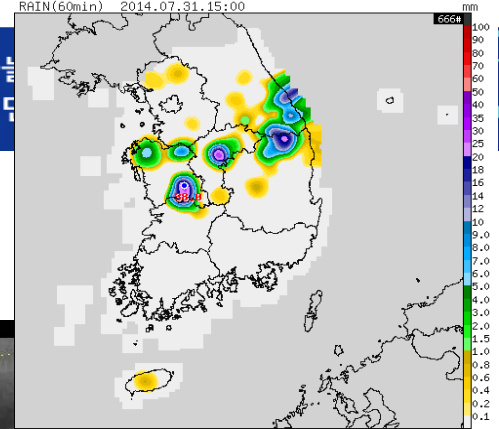
## Early stage of Convective clouds



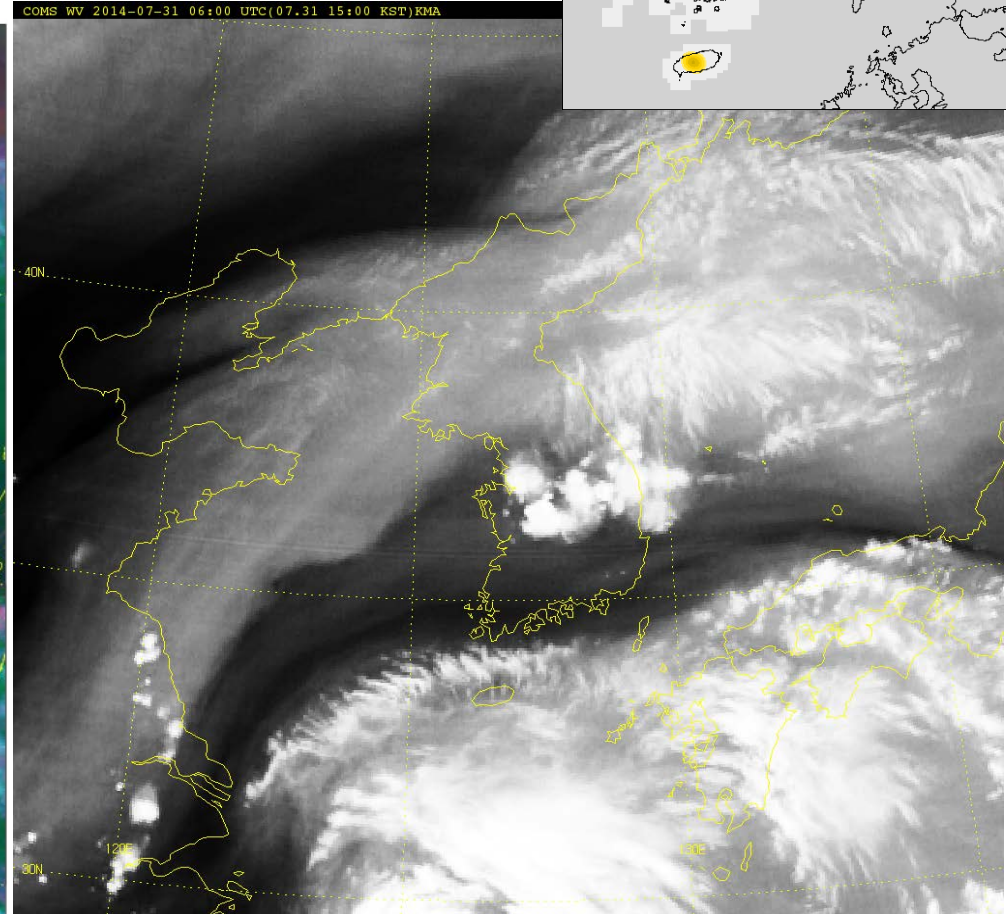
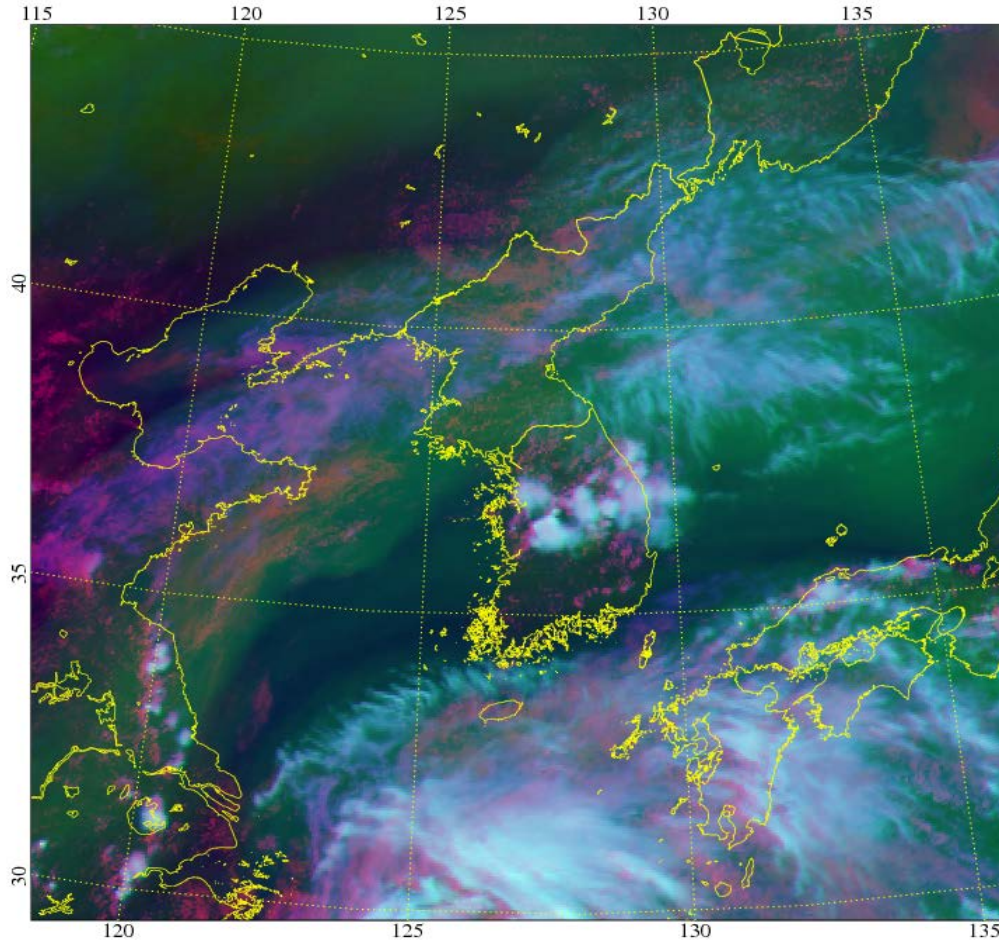
0245UTC 31<sup>st</sup> July, 2014

# Usage of WV RGBs

하늘  
국도



## Mature stage of Convective clouds

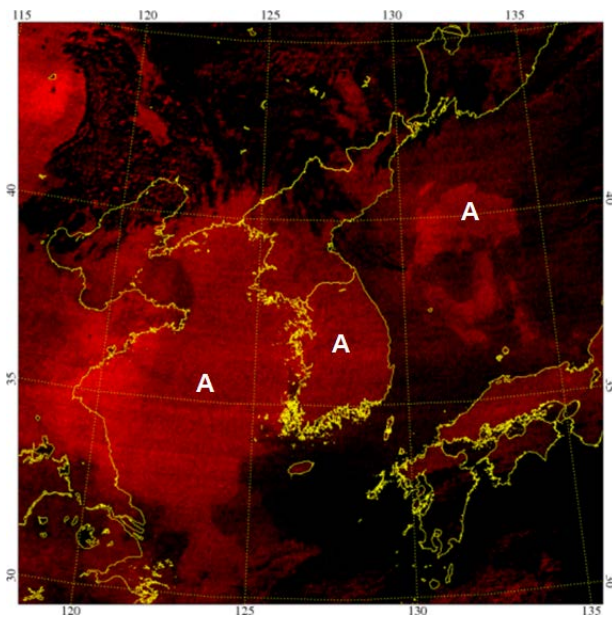


0600UTC 31<sup>st</sup> July, 2014

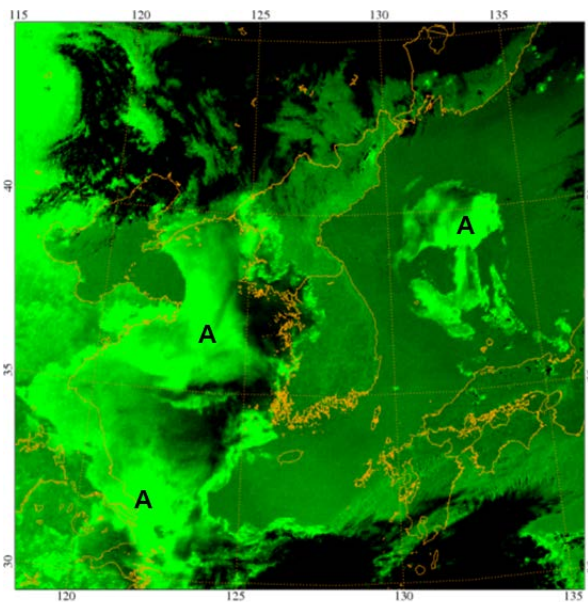


# 2-3. Recipe of Fog RGB(Day)

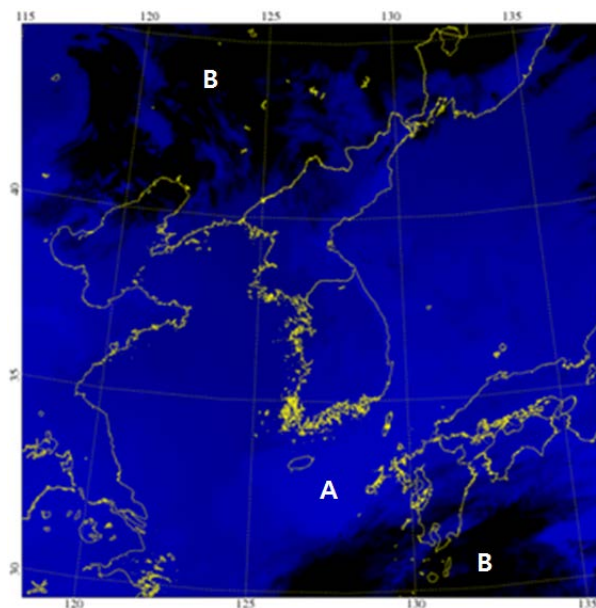
하늘을 친구처럼  
구민을 하늘처럼



VIS



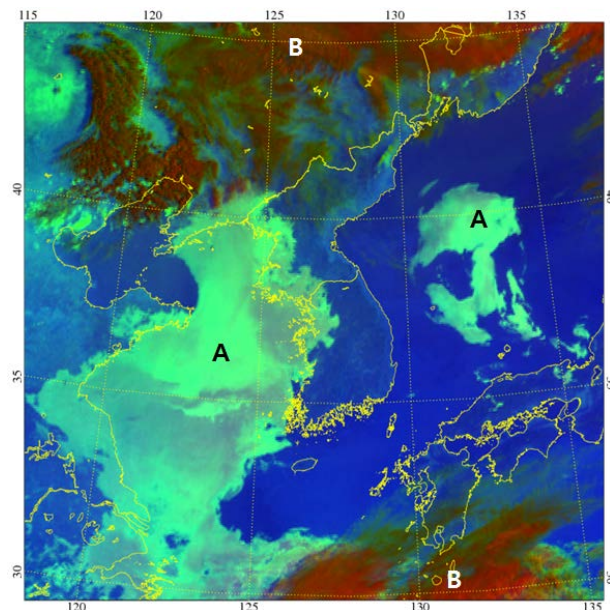
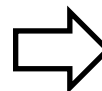
SWIR



IR1

Daytime (SZA < 85 °)

	Channels ( $\mu\text{m}$ )	Threshold
RED	VIS(0.675)	0~50
GREEN	SWIR(3.7)	0~20
Blue	IR1(10.8)	250~300








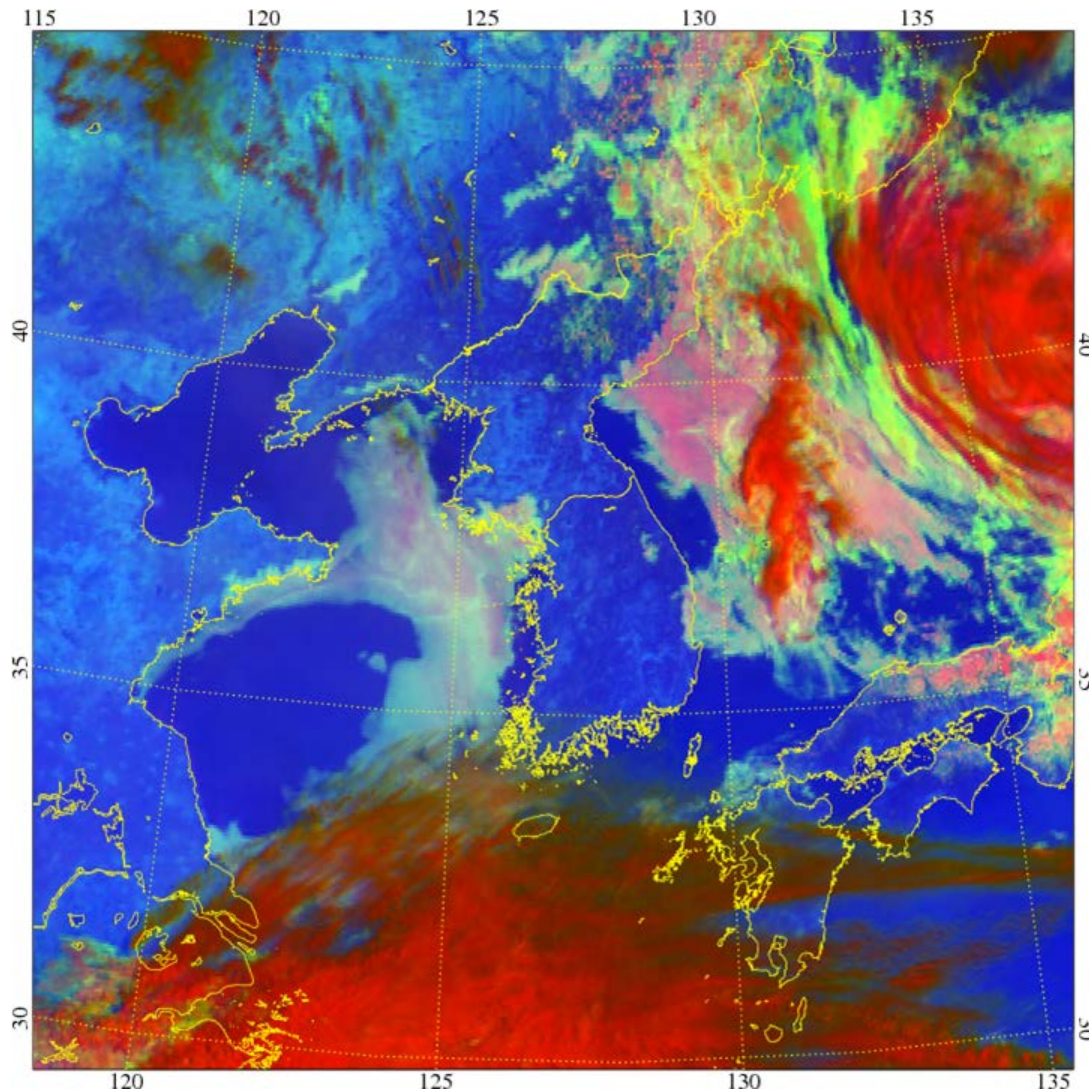
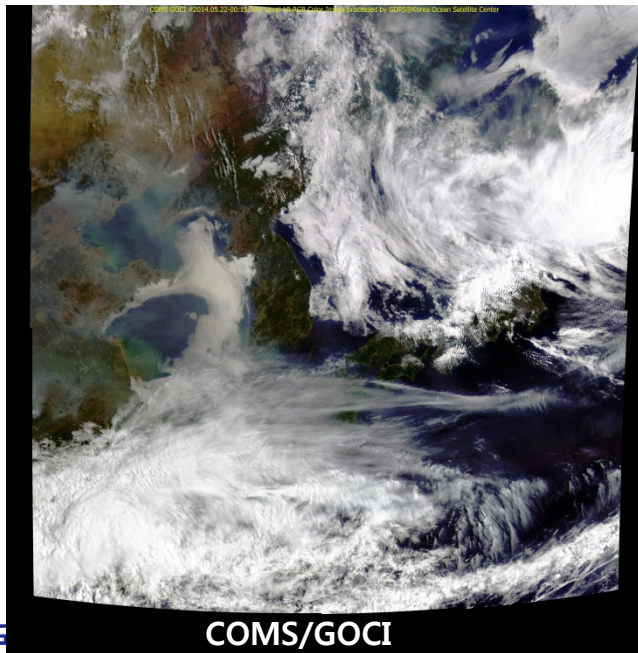
# Interpretation of WV RGB (Daytime)

하늘은 치수처럼  
국민을 화를처럼

## Daytime

### Meaning of Colors

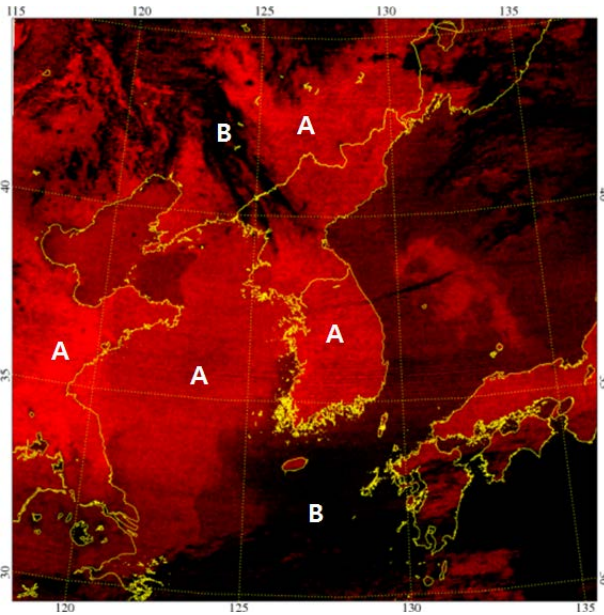
-  Fog
-  Low cloud
-  Land
-  Ocean
-  Thick High Cls



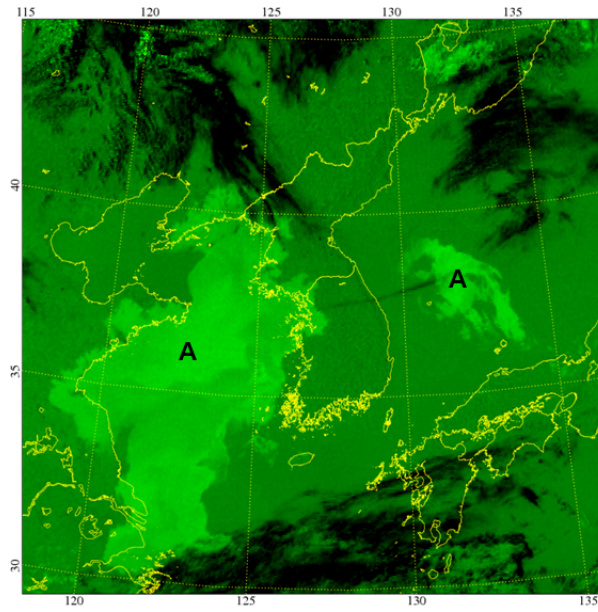
2014.05.22.00:00UTC

# Recipe of Fog RGB(Night)

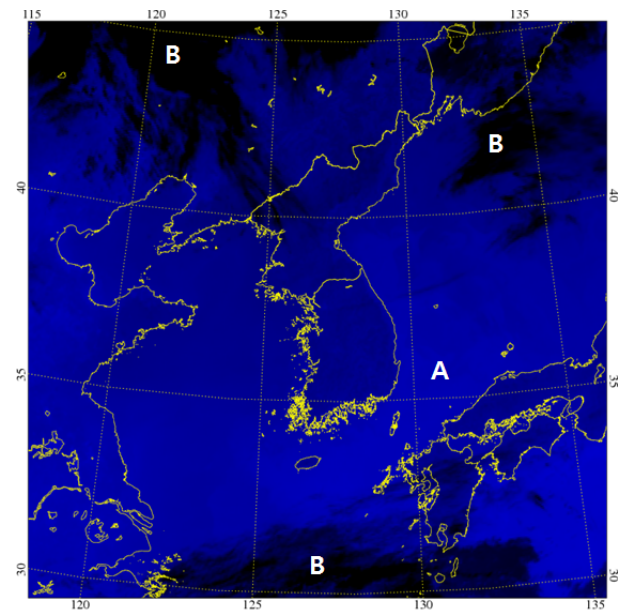
하늘을 친구처럼  
국민을 하늘처럼



IR1-IR2



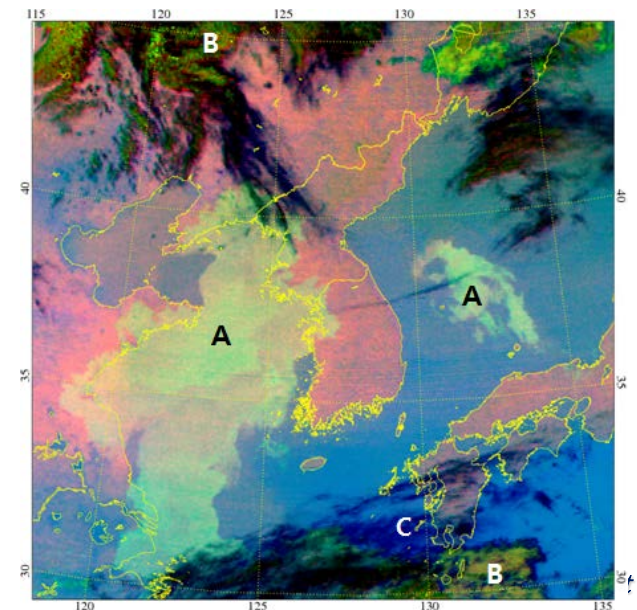
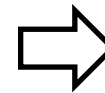
SWIR-IR1



IR1

Nighttime(SZA > 85 °)

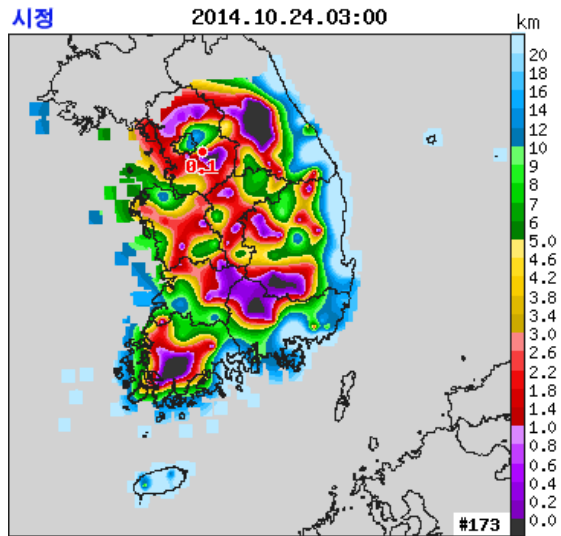
	Channels ( $\mu\text{m}$ )	Threshold(K)
RED	IR1(10.8)-IR2(12.0)	-1~1
GREEN	SWIR(3.75)-IR1(10.8)	-8~8
Blue	IR1(10.8)	250~300



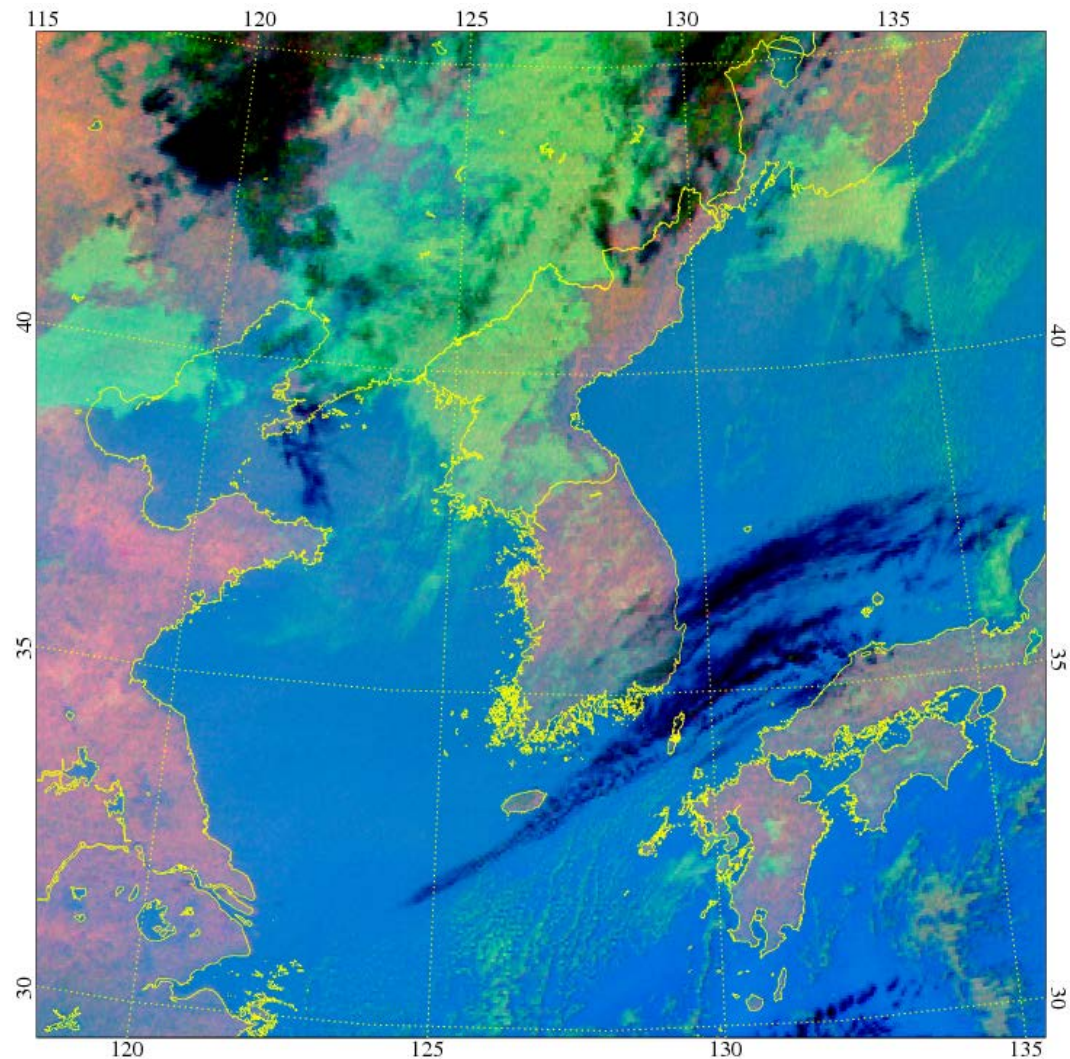
## Nighttime

### Meaning of Colors

- Fog
- High clouds
- Thick High Cloud
- Low cloud



Visibility

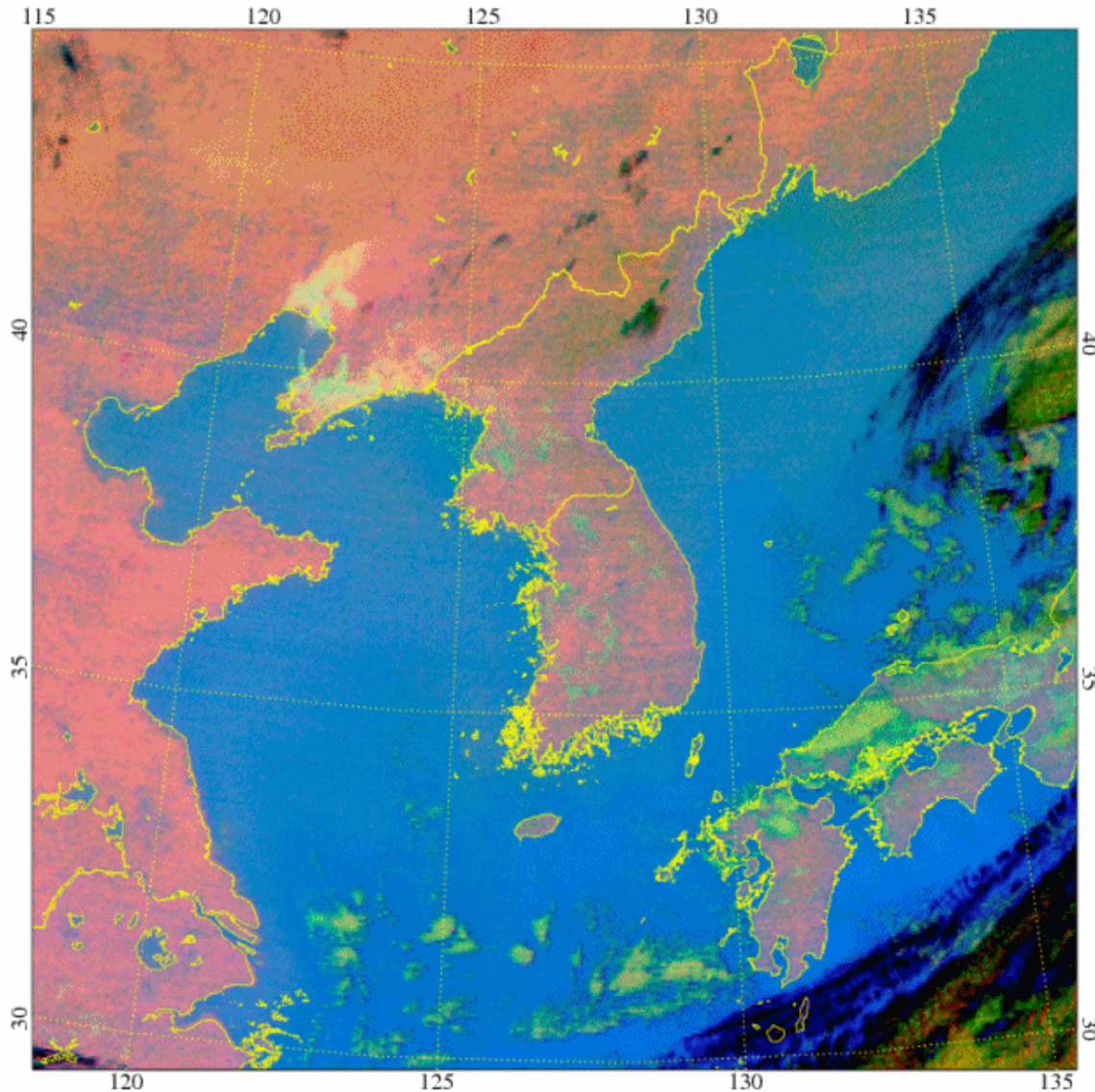


2014.10.24.03:00UTC

# Monitoring of Fog area

하늘을 친구처럼  
국민을 하늘처럼

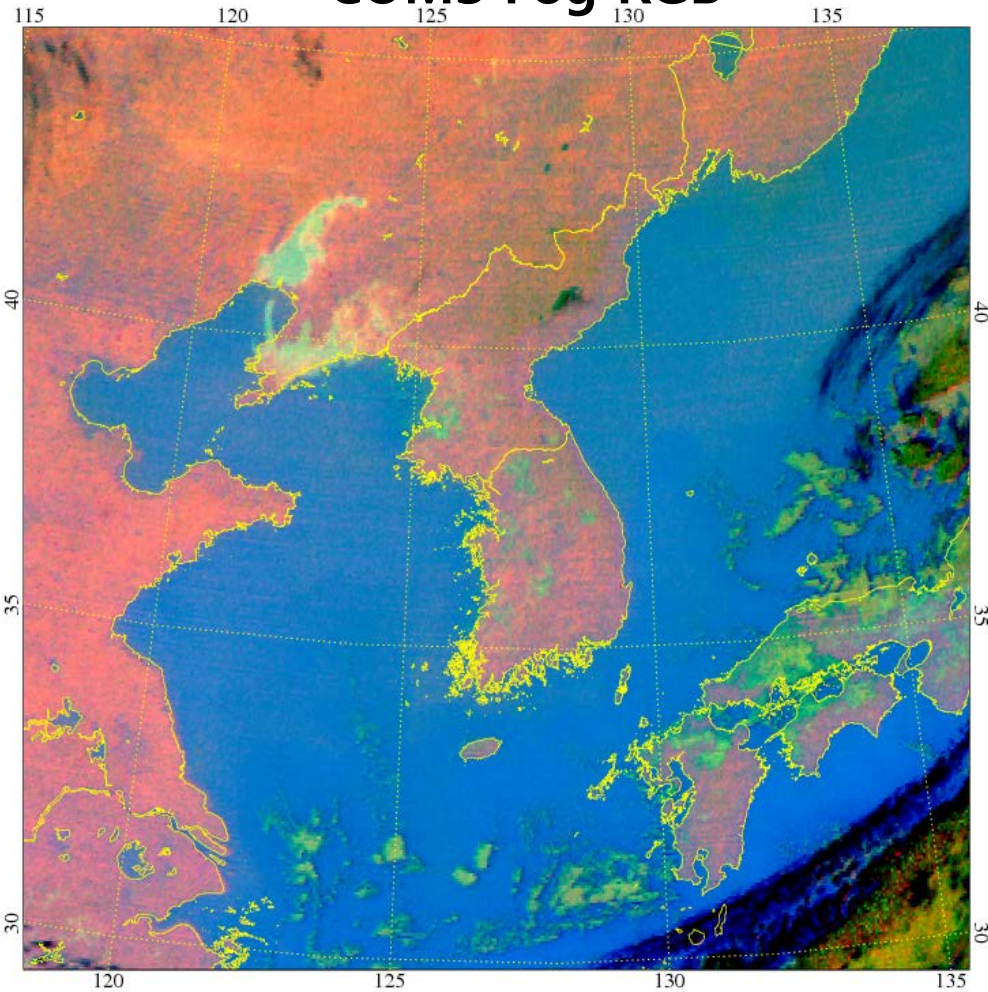
1745UTC, 2<sup>nd</sup> Nov.~00:45UTC 3<sup>rd</sup> Nov. 2015



# Comparison of Fog Products

하늘을 친구처럼  
구민을 하늘처럼

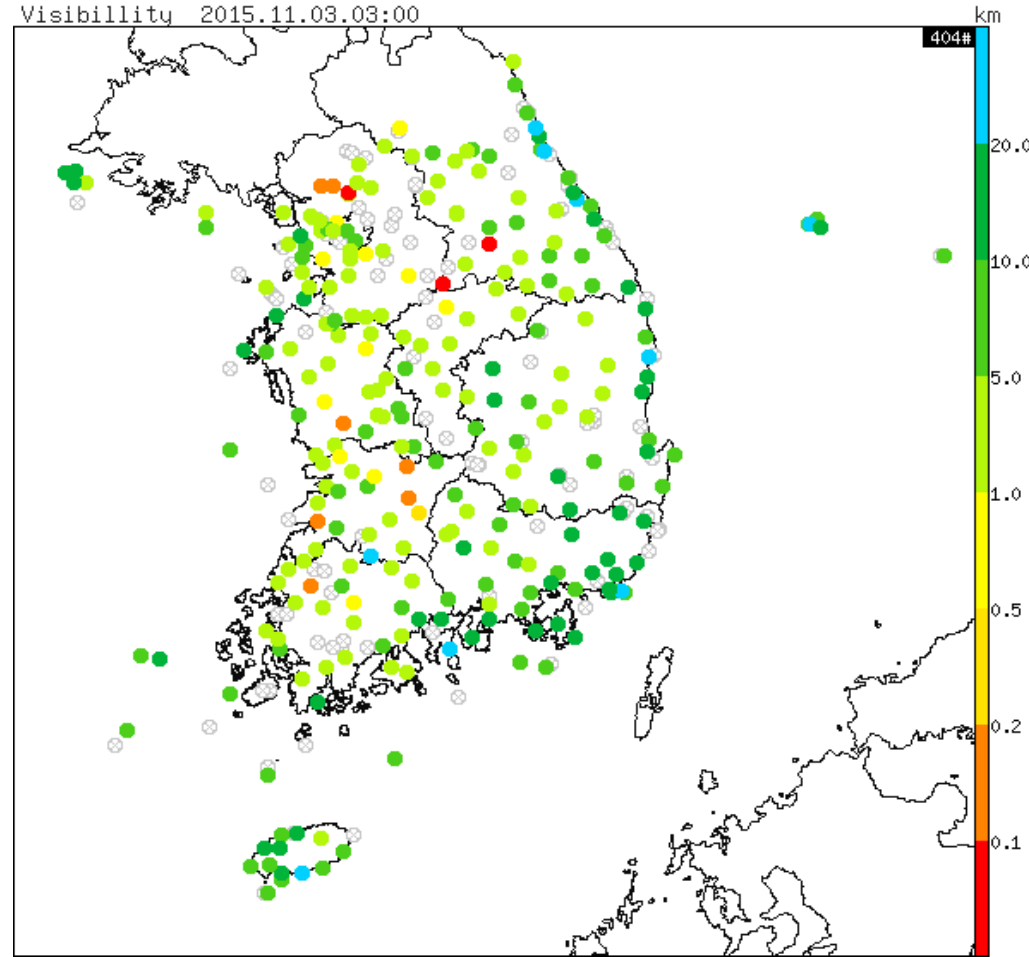
## COMS Fog RGB



COMS RGB Product - Fog Analysis  
2015.11.02, 18:00

>> Day <<  
Red : VIS  
Green : SWIR Reflectance  
Blue : IR1

## Visibility



1800UTC 2<sup>nd</sup> Nov., 2015

>> Night <<  
Red : IR1 - IR2  
Green : SWIR - IR1  
Blue : IR1

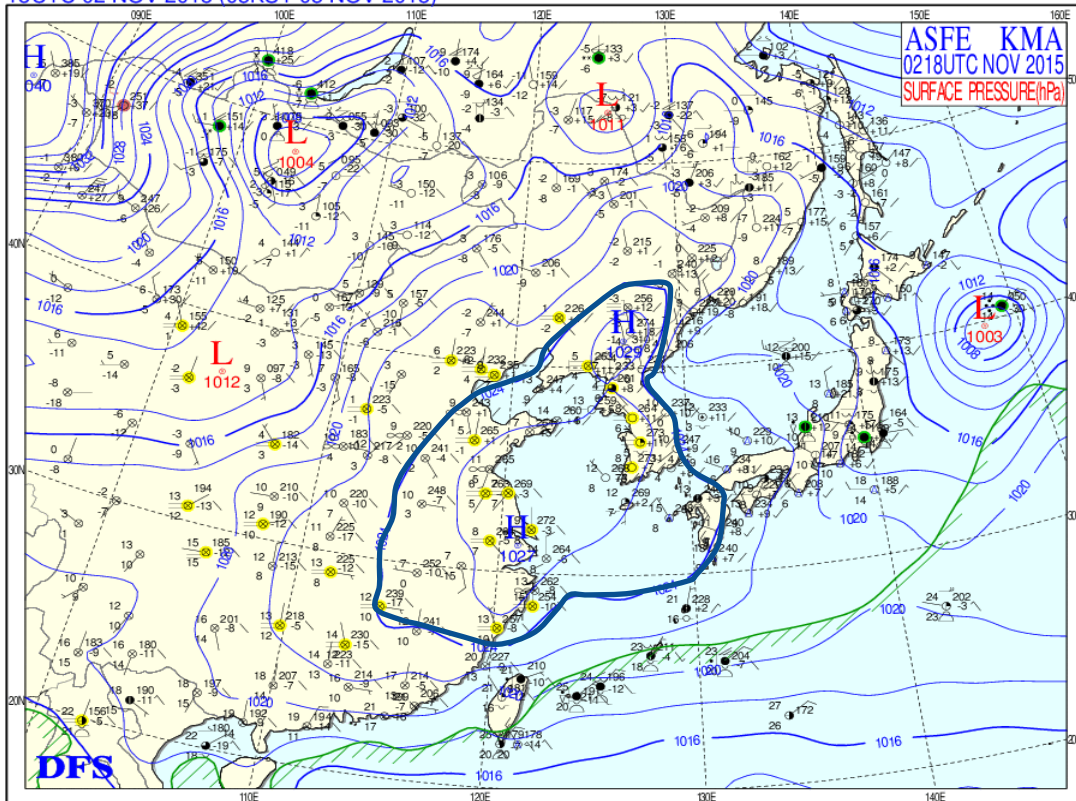
# Advection Fog

하늘을 친구처럼  
구름을 하늘처럼

1000hPa UM prediction field

1800UTC 2<sup>nd</sup> Nov. 2015

18UTC 02 NOV 2015 (03KST 03 NOV 2015)

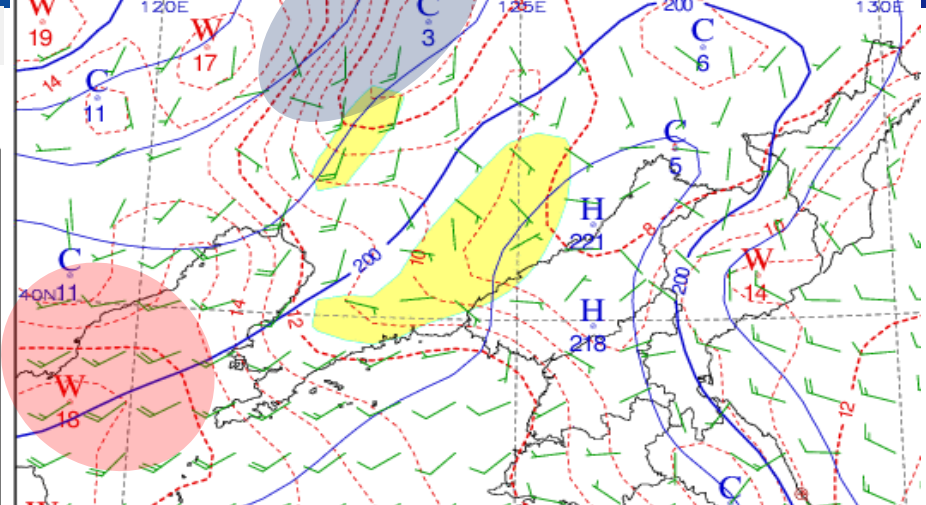


Korea Meteorological Administration(KMA)

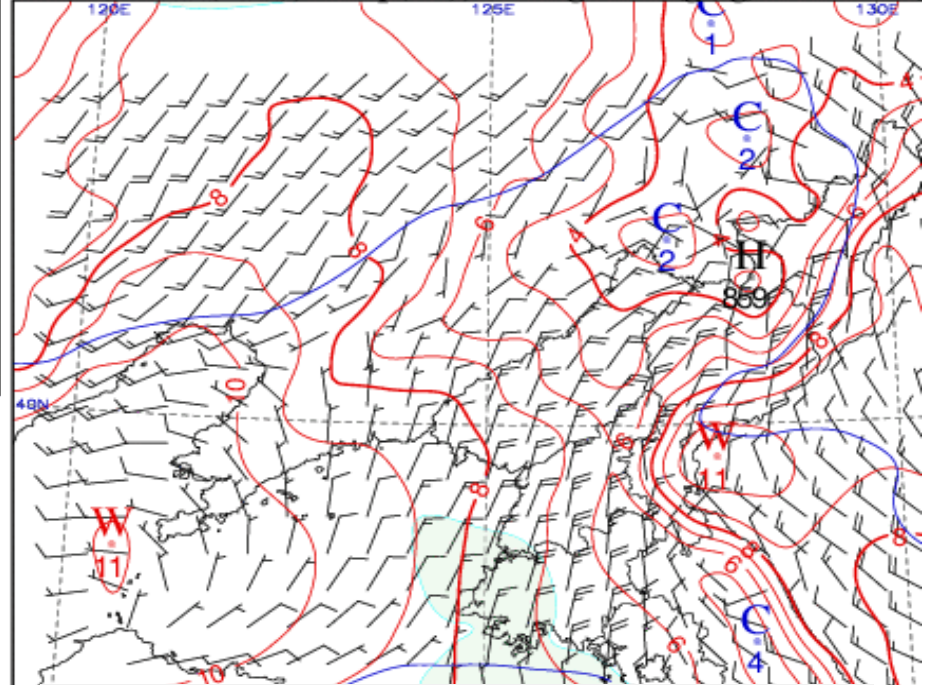
18UTC 02 NOV 2015 (03KST 03 NOV 2015)

1. Stable condition in the High pressure area over the Korean Peninsula
2. 1000hPa : Warm area over the gulf of Pohai, Cold area over the northeast of Pohai cause the south-westy wind
3. Transport of warm air over the ocean give rise to the advection fog

1000hPa Height(m), Temp.(C), Wind(kt) and T-Td(C) RDAPS



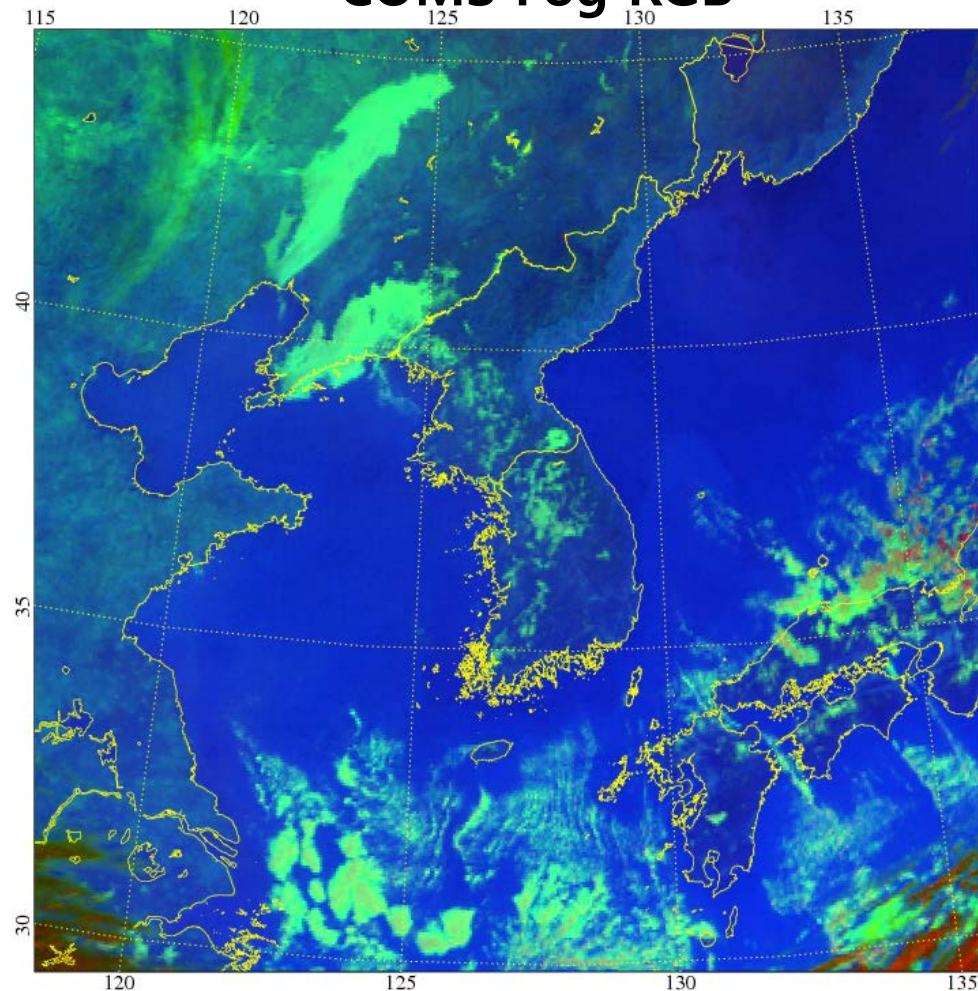
925hPa GPH(15m), Temp(1C), Mixing Ratio(g/kg) KLPS



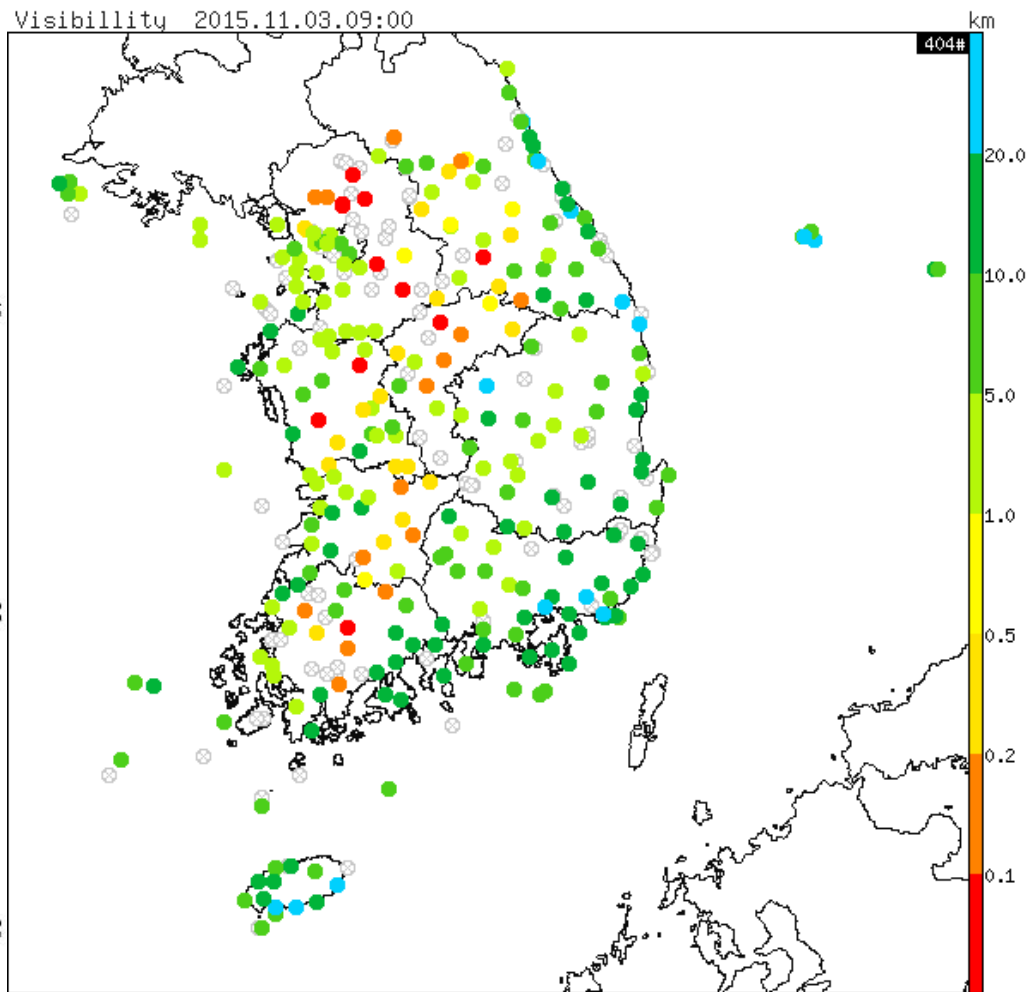
2015.11.3.03:00KST 925hPa KLAPS Analysis field

6hr after

### COMS Fog RGB



### Visibility



COMS RGB Product - Fog Analysis

2015.11.03, 00:00

00UTC 3<sup>rd</sup> Nov., 2015

>> Day <<

Red : VIS

Green : SWIR Reflectance

Blue : IR1

>> Night <<

Red : IR1 - IR2

Green : SWIR - IR1

Blue : IR1

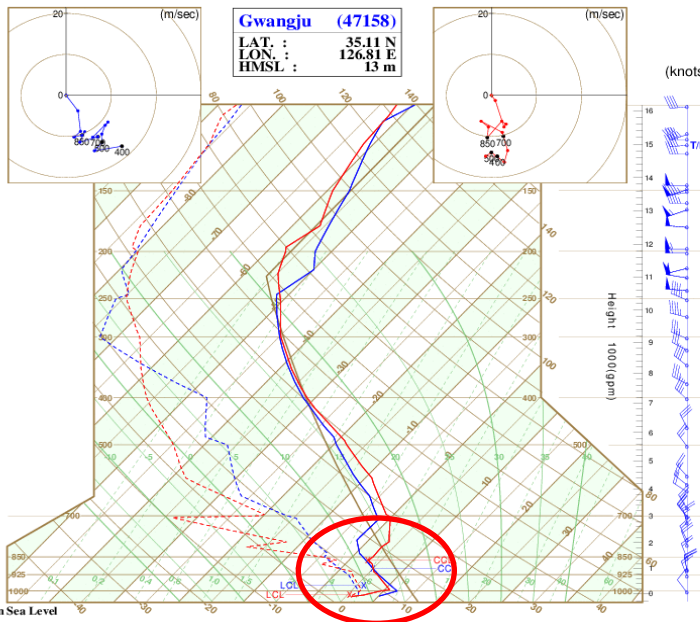


### Skew T - Log P DIAGRAM

Issued at 18UTC 02 Nov 2015  
Valid : 03KST 03 Nov 2015

**OBS ANALYSIS**

2015.11.02.21KST	2015.11.03.09KST
1000 hPa Air-mass	1000 hPa Air-mass
Temp. 12.2 °C	Temp. 9.6 °C
Humi. 65 %	Humi. 80 %
Wind. 325/008 KT	Wind. 325/002 KT
FL (gpm) 1699	FL (gpm) 2915
850EQT (K) 296	850EQT (K) 298
T/P (gpm) 15045	T/P (gpm) 15045
LCL (gpm) 332	LCL (gpm) ----
CCL (gpm) 997	CCL (gpm) 1323
LFC (gpm) ----	LFC (gpm) ----
HEL (gpm) ----	HEL (gpm) ----
M/W (gpm) ----	M/W (gpm) ----
SSI(850-500) 11.0	SSI(850-500) 11.6
SSI(925-500) 9.1	SSI(925-500) 10.5
SSI(925-700) 6.9	SSI(925-700) 8.5
LI (000-500) 8.6	LI (000-500) 11.0
LI (925-500) 9.2	LI (925-500) 10.5
K-Index 3	K-Index -4
TT-Index 37	TT-Index 35
SRH (m2/s2) 5	SRH (m2/s2) 53
CAPE (m2/s2) ----	CAPE (m2/s2) ----
CIN (m2/s2) ----	CIN (m2/s2) ----
TPW(mm) 14.0 [93%]	TPW(mm) 11.9 [79%]
Cloud SCT	Cloud BKN
Upper 400 15	Upper 449 26
Middle 799 6	Middle 792 16
Lower 925 5	Lower 912 3
THCKN (10-7) 2882	THCKN (10-7) 2898
CVT Temp. 15.5	CVT Temp. 16.9
Max Temp. 16.6	Max Temp. 18.5
Min Temp. 4.3	Min Temp. 5.9



1800UTC 2<sup>nd</sup> Nov. 2015

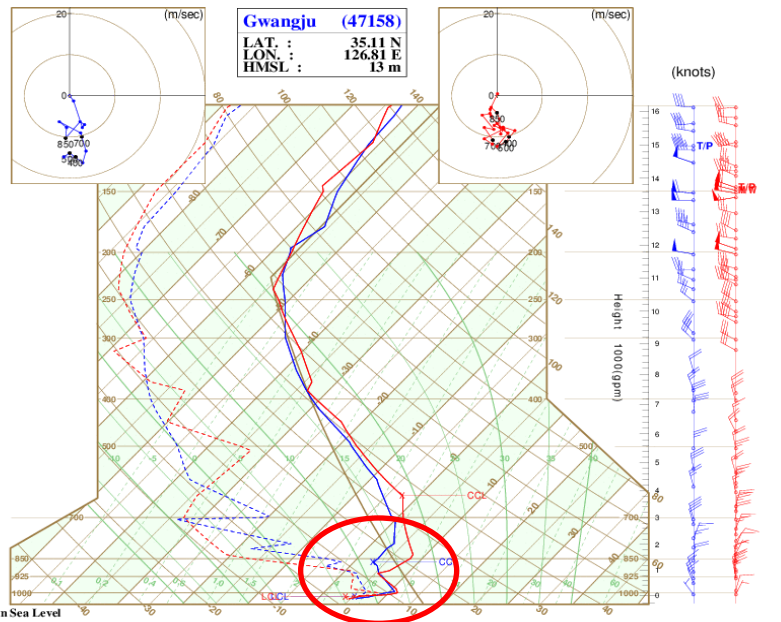
6hr after

### Skew T - Log P DIAGRAM

Issued at 00UTC 03 Nov 2015  
Valid : 09KST 03 Nov 2015

**OBS ANALYSIS**

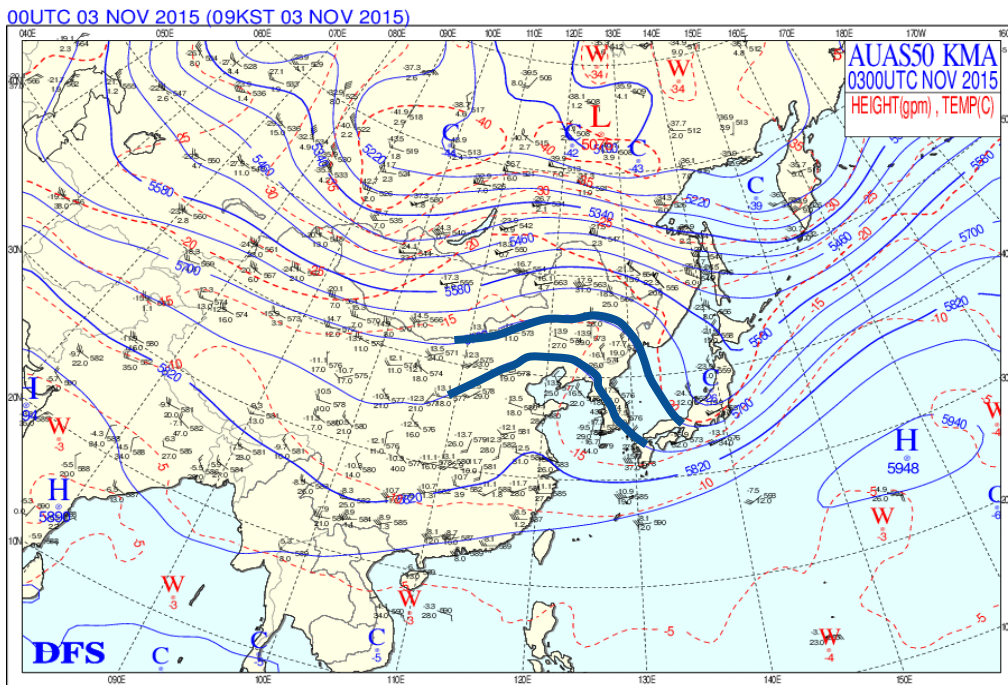
2015.11.03.09KST	2015.11.03.09KST
1000 hPa Air-mass	1000 hPa Air-mass
Temp. 9.6 °C	Temp. 11.4 °C
Humi. 80 %	Humi. 91 %
Wind. 325/002 KT	Wind. 025/007 KT
FL (gpm) 2915	FL (gpm) 3191
850EQT (K) 298	850EQT (K) 298
T/P (gpm) 15045	T/P (gpm) 13793
LCL (gpm) 332	LCL (gpm) ----
CCL (gpm) 1323	CCL (gpm) 3817
LFC (gpm) ----	LFC (gpm) ----
HEL (gpm) ----	HEL (gpm) ----
M/W (gpm) ----	M/W (gpm) 13707
SSI(850-500) 11.6	SSI(850-500) 12.6
SSI(925-500) 10.5	SSI(925-500) 11.8
SSI(925-700) 8.5	SSI(925-700) 10.5
LI (000-500) 11.0	LI (000-500) 12.2
LI (925-500) 10.5	LI (925-500) 11.9
K-Index -4	K-Index -25
TT-Index 35	TT-Index 26
SRH (m2/s2) 53	SRH (m2/s2) 0
CAPE (m2/s2) ----	CAPE (m2/s2) 0
CIN (m2/s2) ----	CIN (m2/s2) ----
TPW(mm) 11.9 [79%]	TPW(mm) 10.1 [68%]
Cloud BKN	Cloud SCT
Upper 449 26	Upper 384 19
Middle 792 16	Middle 510 17
Lower 912 3	Lower 911 4
THCKN (10-7) 2898	THCKN (10-7) 2915
CVT Temp. 16.9	CVT Temp. 37.8
Max Temp. 18.5	Max Temp. 23.9
Min Temp. 5.9	Min Temp. 11.1



0000UTC 3<sup>rd</sup> Nov. 2015.

# Radiation Fog

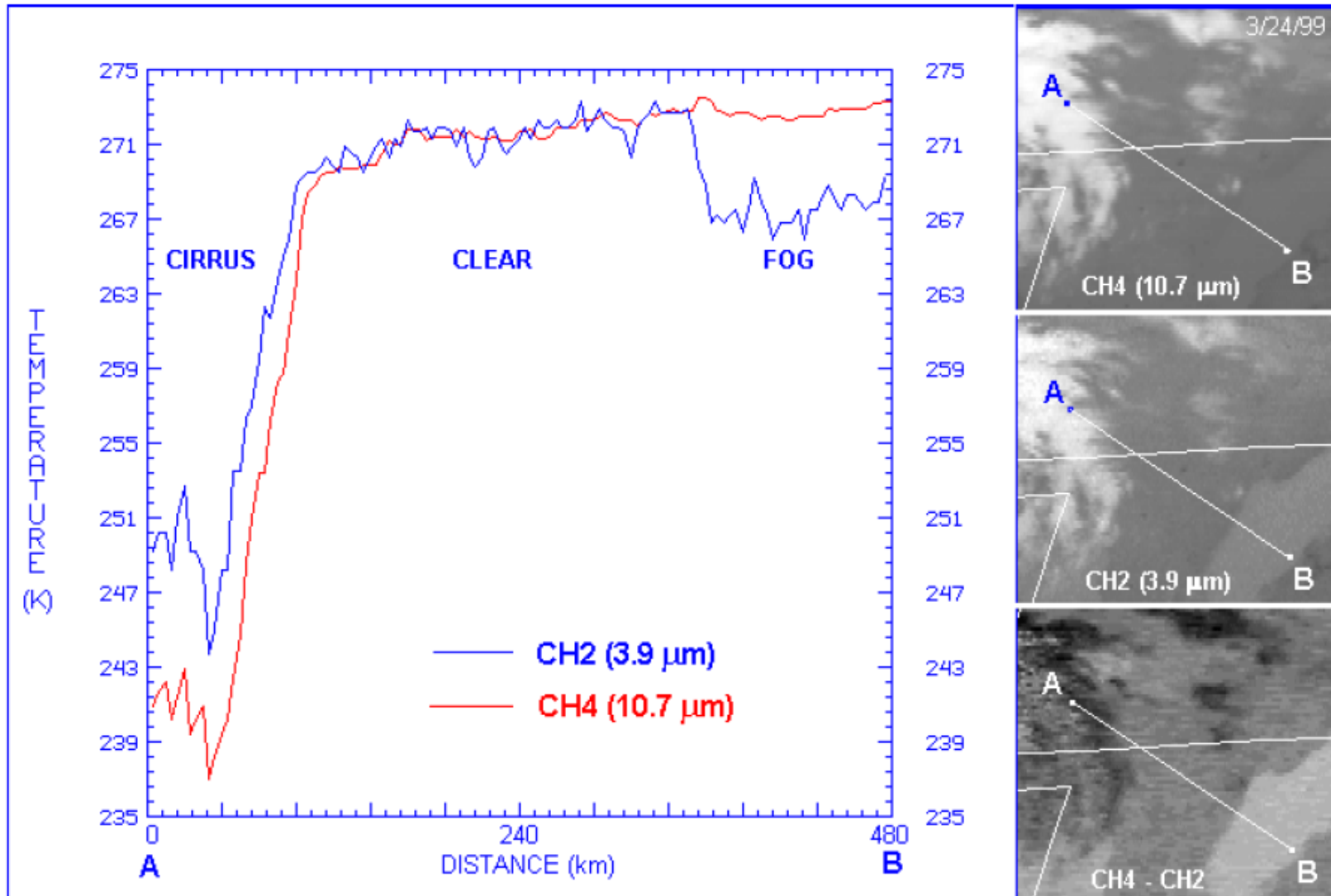
1. Surface inversion layer become stronger
2. Subsidence inversion layer between 925~850hPa also became stronger
3. On the 500hPa Chart at 0000UTC 3<sup>rd</sup> Nov. upper ridge developing over the Korean Peninsular which cause the sinking



# COMS Fog Products

하늘을 친구처럼  
국민을 하늘처럼

$$\text{DCD}(\text{dual Channel Difference}) = \text{TB}(\text{SWIR}) - \text{TB}(\text{IR1}) < 0$$



# COMS Fog Algorithm

하늘을 친구처럼  
국민을 하늘처럼

## Daytime Fog ( $SZA \leq 60$ )

Mod\_Rvis > 30

$0 < CSTB - TB11 < 10$

Yes

Fog

No

Cloud

- Mod\_Rvis : albedo normalized by solar zenith angle
- CSTB : maximum simulated TB at IR1(11um) for 15 days during the clear sky

## Dawn/Dusk Fog ( $60 < SZA < 90$ )

동적경계값 적용

$thr\_min\_btd24 < BTD(3.7-11) < thr\_max\_btd24$

$0 < CSTB - TB11 < 10$

Yes

Fog

Cloud

## Night time Fog ( $SZA \geq 90$ )

$-9.5 < BTD(3.7-11) < -2.5$

$0 < CSTB - TB11 < 10$

Yes

Fog

No

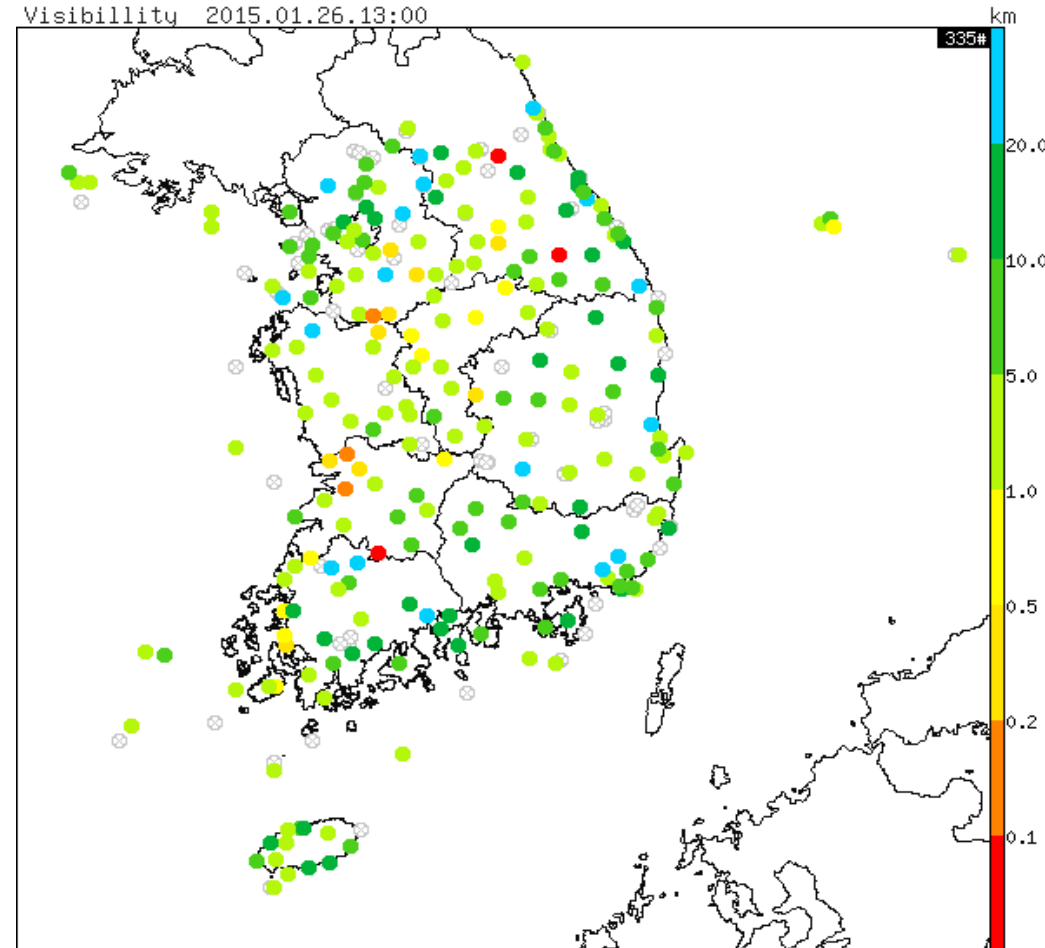
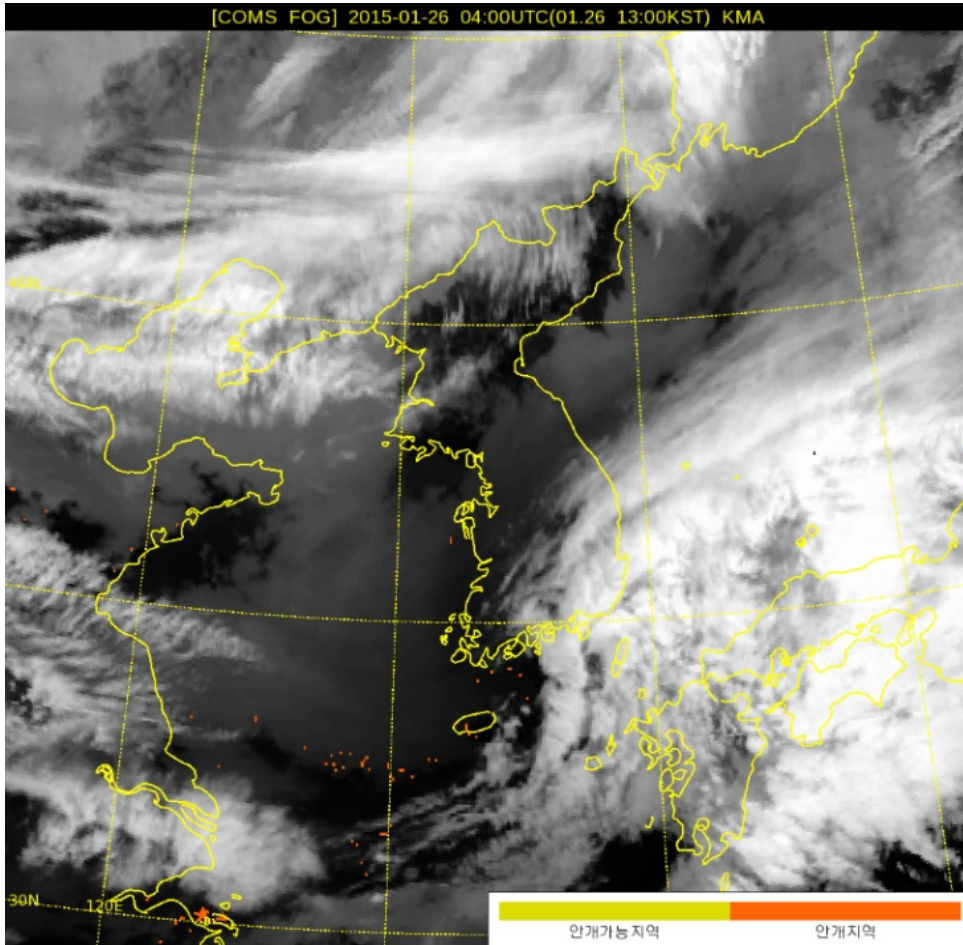
Cloud

# Problem 1 of COMS Fog Product

하늘을 친구처럼  
복판을 하늘처럼

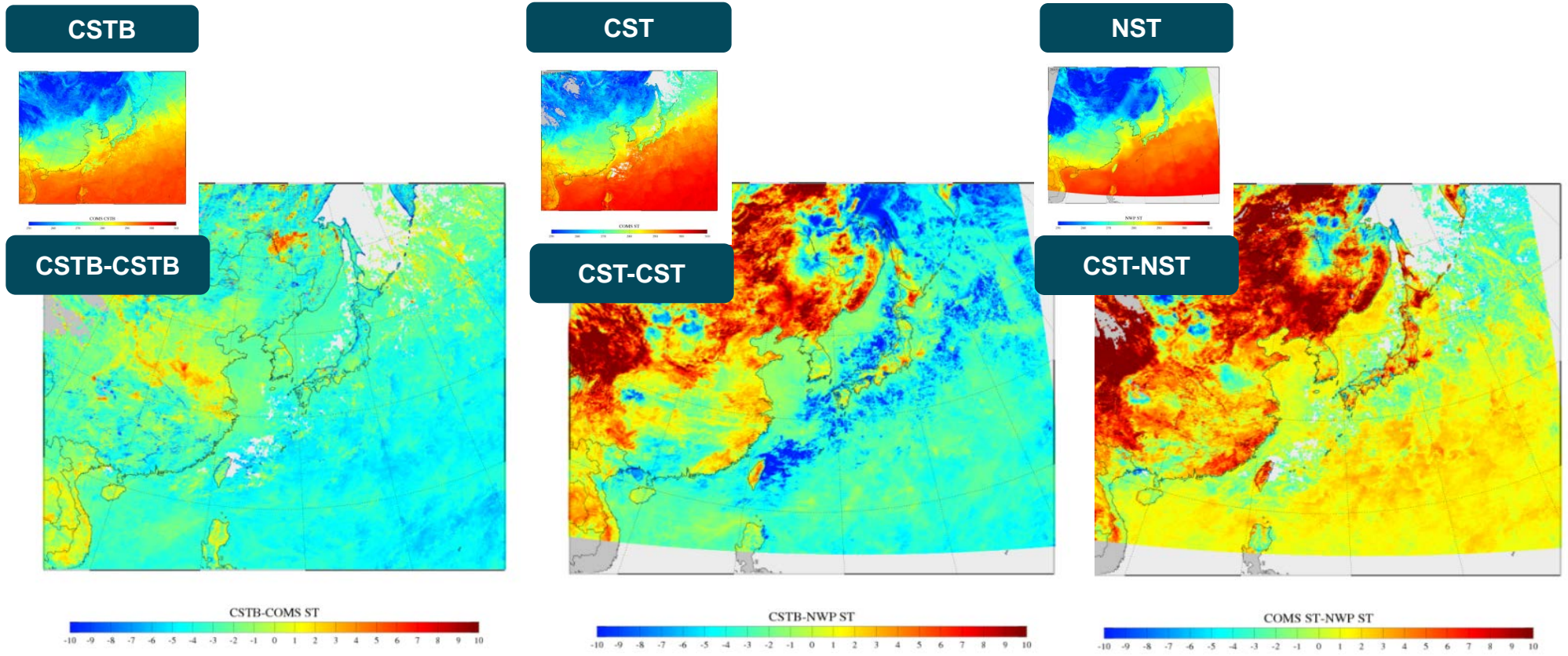


## ◆ No detection of fog due to excessive screening of clouds



04UTC 26<sup>th</sup> Jan., 2015

# ◆ Investigate the effect of CSTB-TB by changing the surface temperature

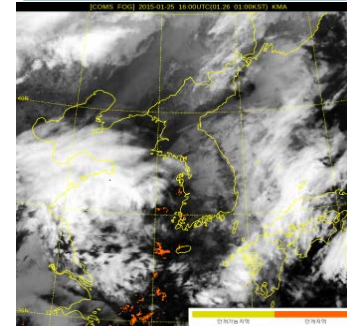


**Fog Area : surface temp. – TB(IR1) < 10K**

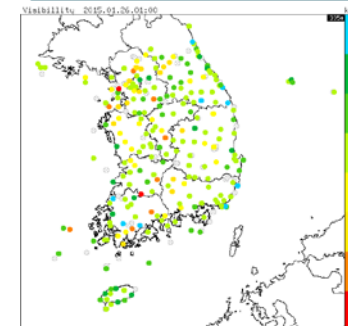
1. Test 1 : simulated maximum TB(IR1) for 15days during clear sky(CSTB)
2. Test 2 : maximum SST and LST from COMS for 15days (CST)
3. Test 3 : surface Temp. estimated by KMA's NWP model(RDAPS)(NST)

# Result of fog tests

COMS FOG

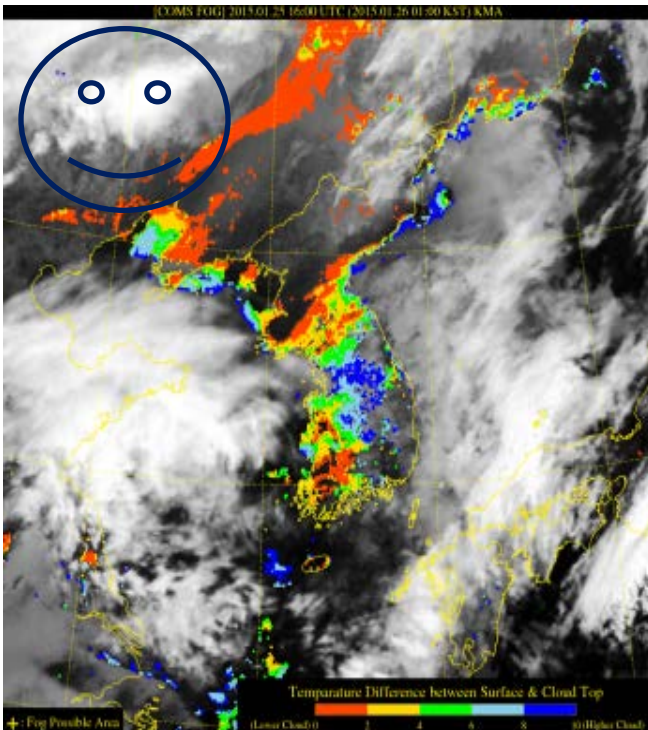


Visibility

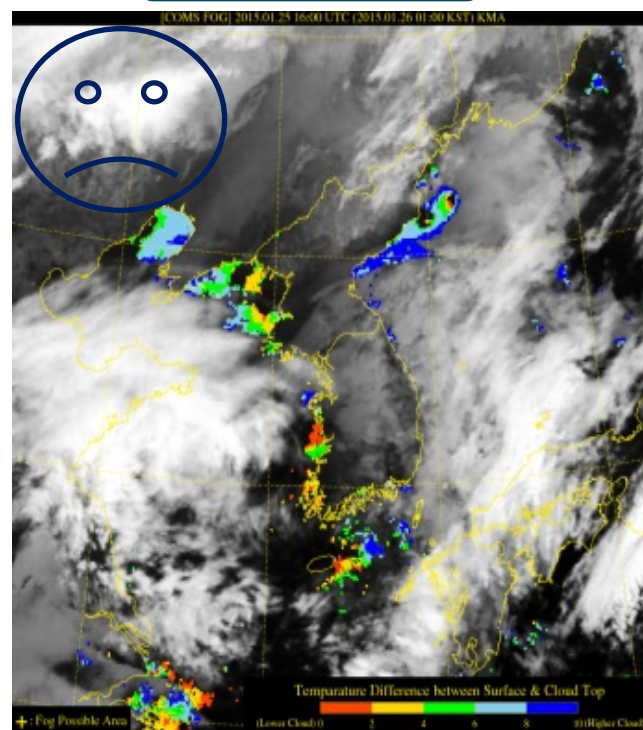


04UTC 26<sup>th</sup> Jan., 2015

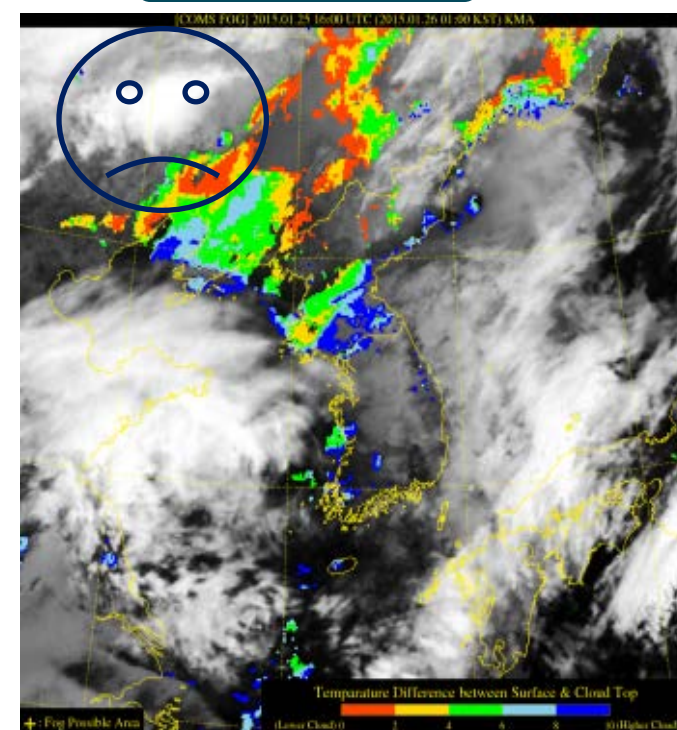
Test 1: CSTB



Test 2: CST



Test 3: NST





# Improvement 1 of COMS Fog detection

한글은 추고처럼  
국문은 뒤를처럼

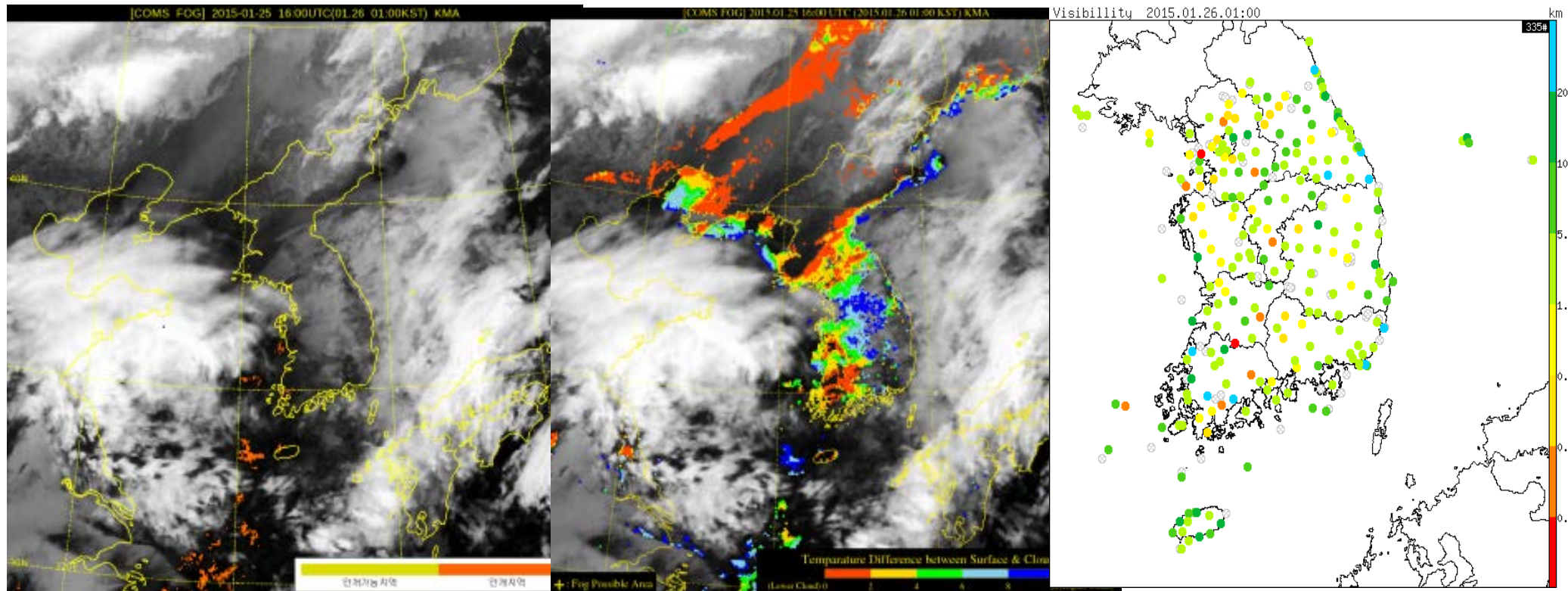
- ◆ Simplified the cloud screening method using the temp. difference between surface and fog area

Fog area :  $(CSTB - TB11) < 10$

OLD

NEW

Visibility

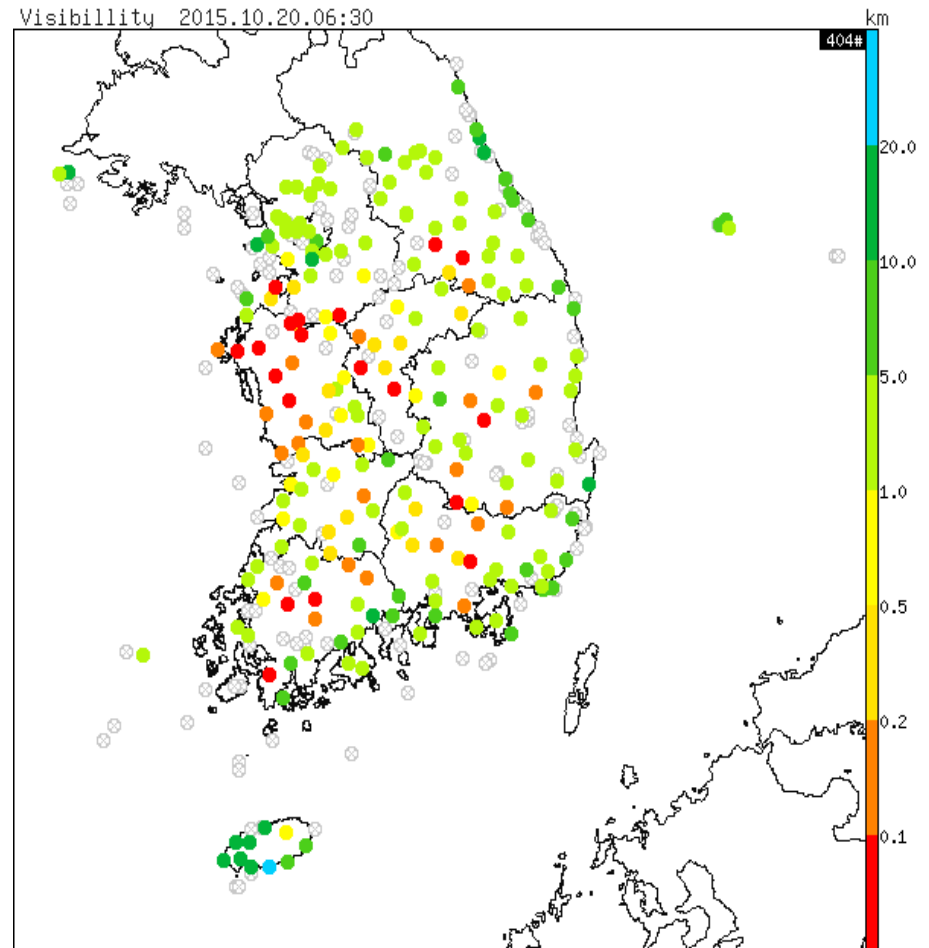
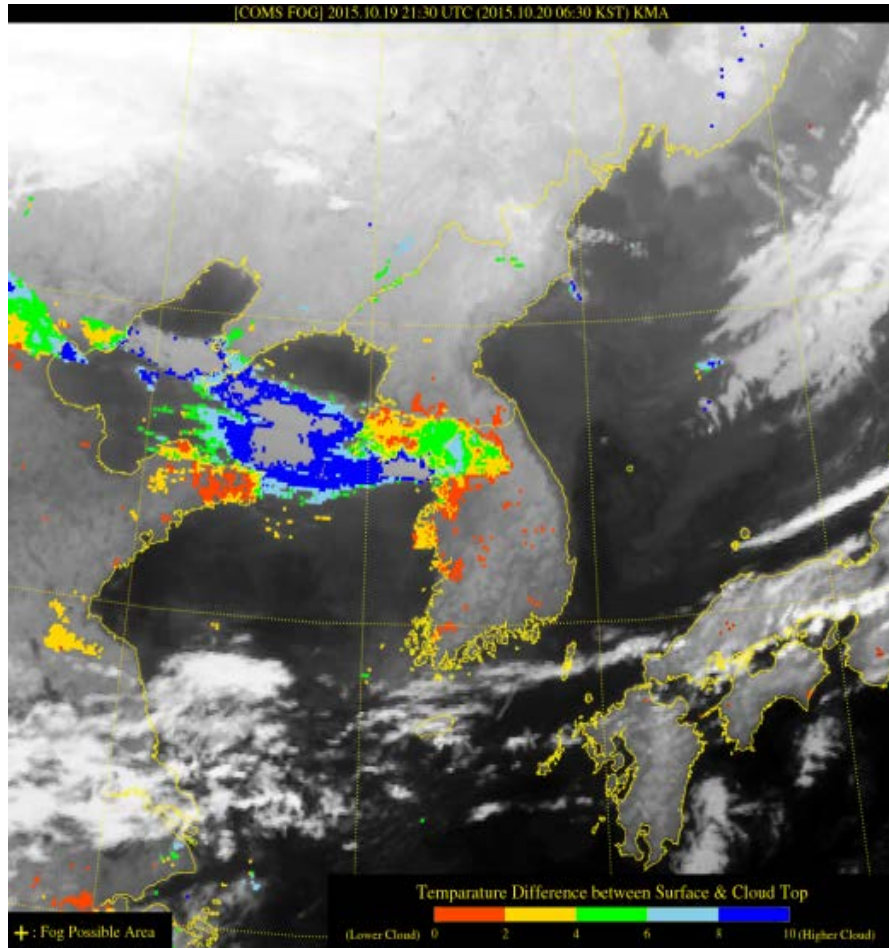




# Problem 2 of COMS Fog Product

하늘을 친구처럼  
복합을 하늘처럼

## ◆ Insufficient detection of fog during the nighttime and dawn

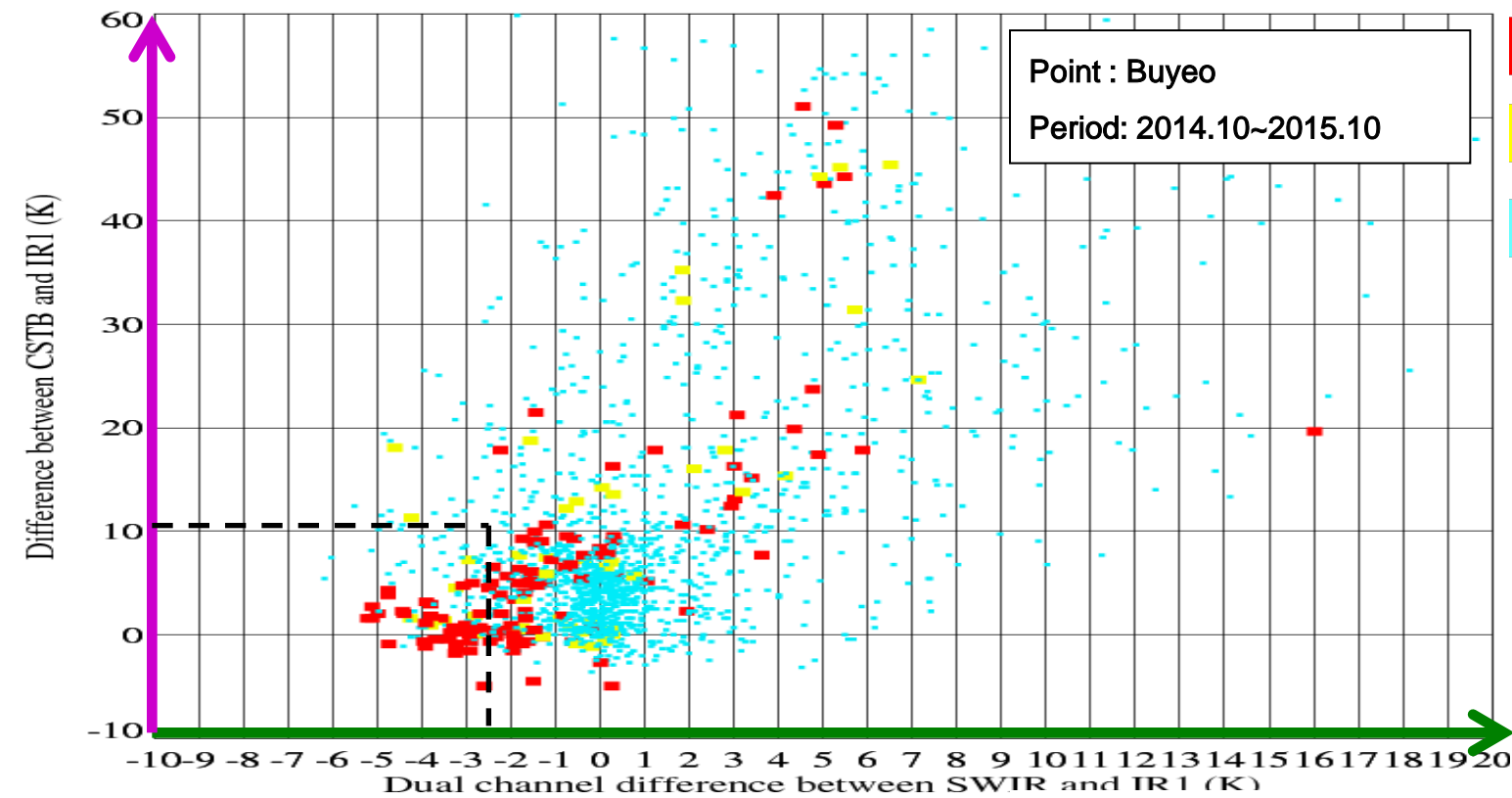


2130UTC 20<sup>th</sup> Oct., 2015

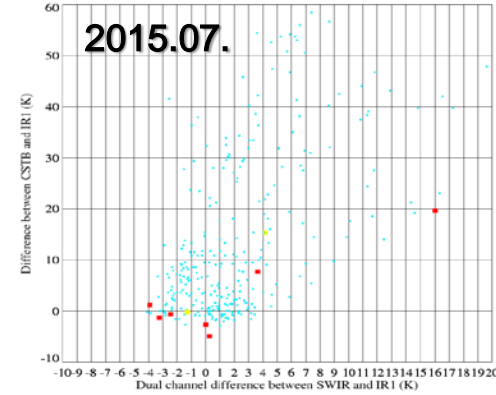
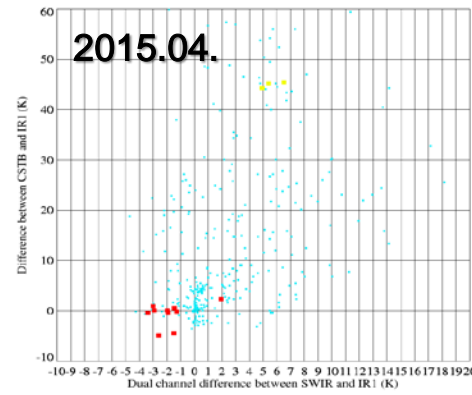
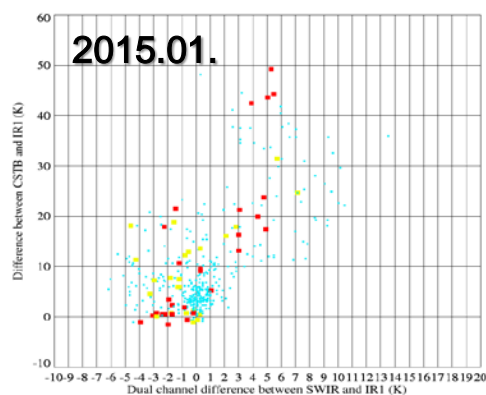
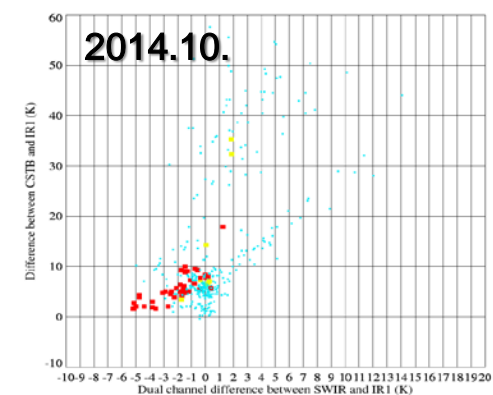
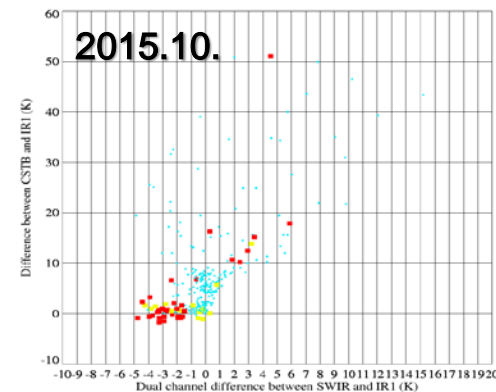
# AWS visibility VS (Xaxis) BTD3.7-11 VS (Yaxis) CSTB-IR1

- Investigate new DCD threshold during nighttime

하늘을 친구처럼  
국민을 하늘처럼

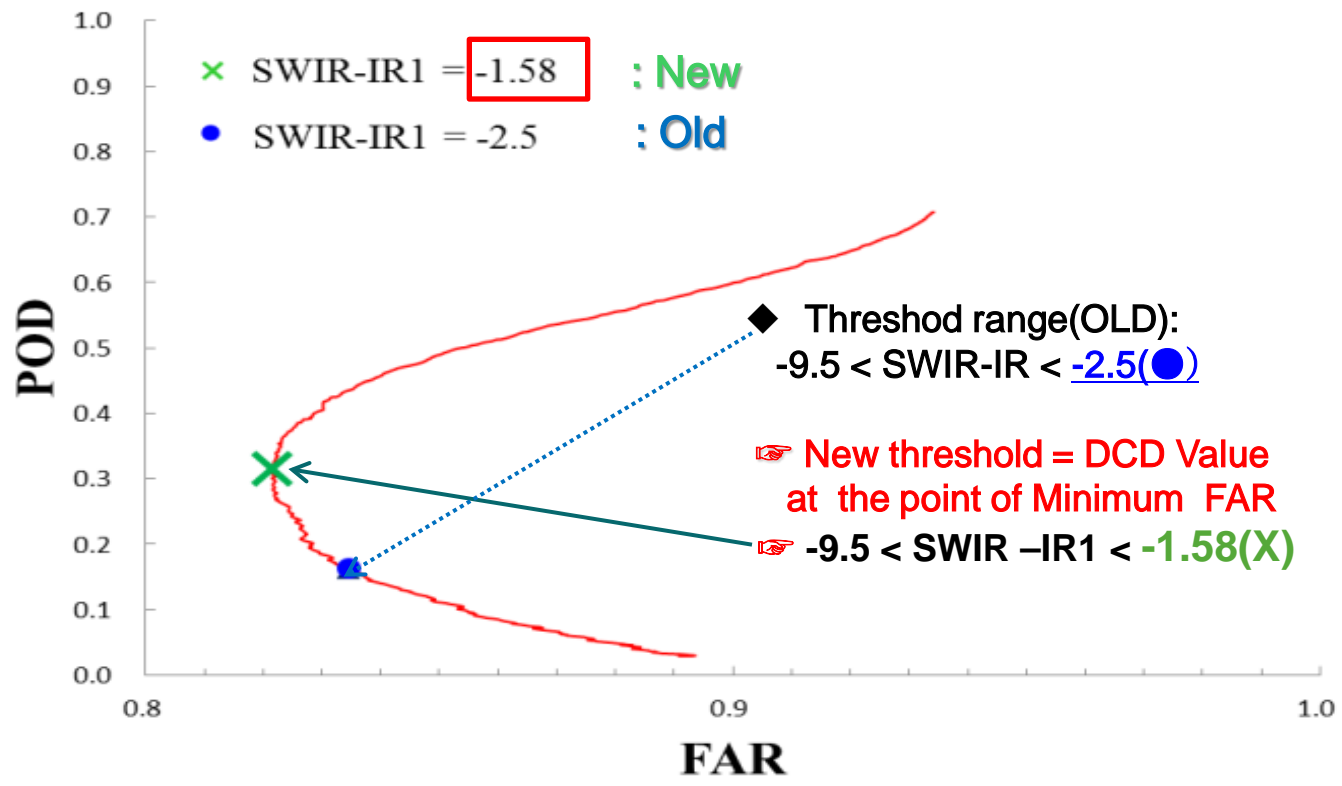


- : AWS vis. < 1 km
- :  $1\ km \leq AWS\ vis. < 2\ km$
- : AWS vis.  $\geq 2\ km$



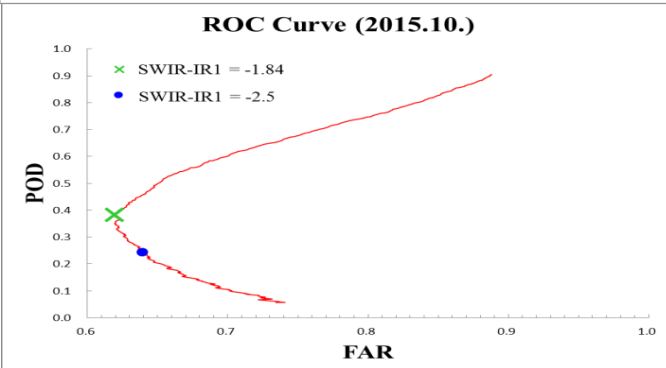
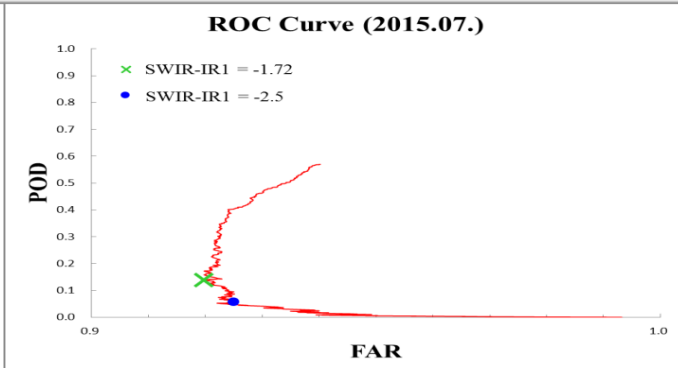
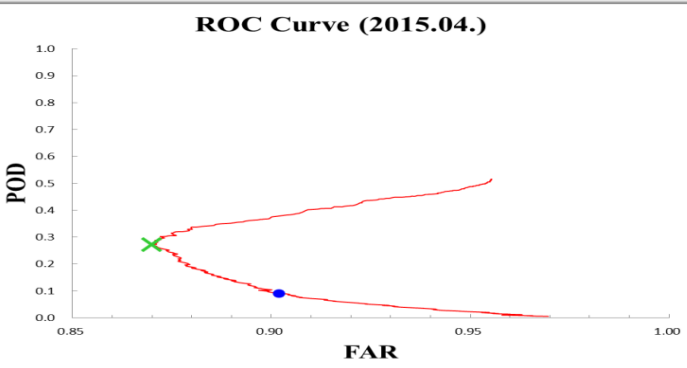
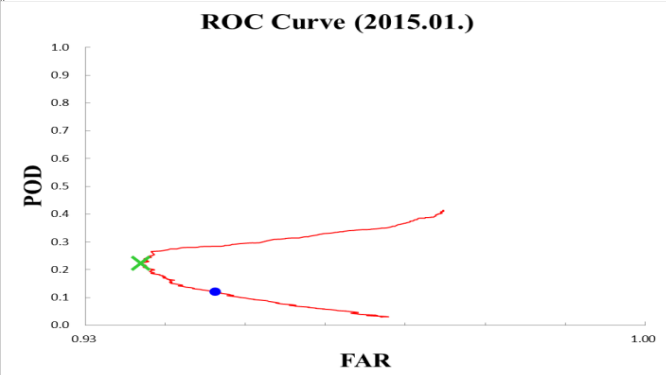
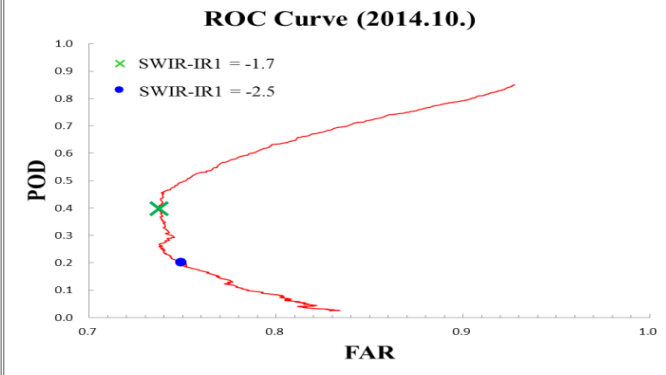
# Analysis of ROC (Receiver Operating Characteristic) to find new threshold

## ROC Curve (whole period)



AWS visibility points: 227points

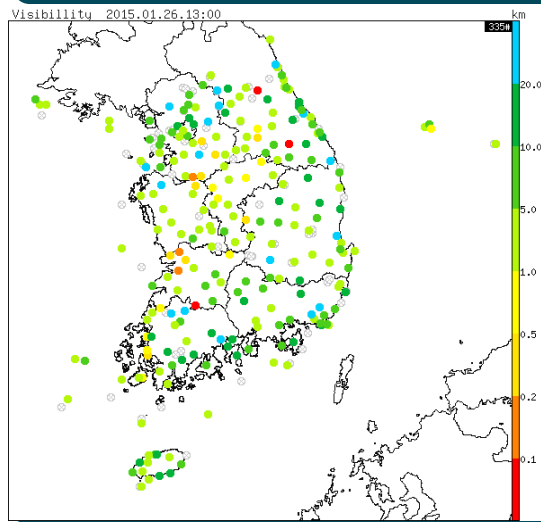
Period : 2014.10~2015.10



# Improvement 2 of Fog detection(Frontal Fog)

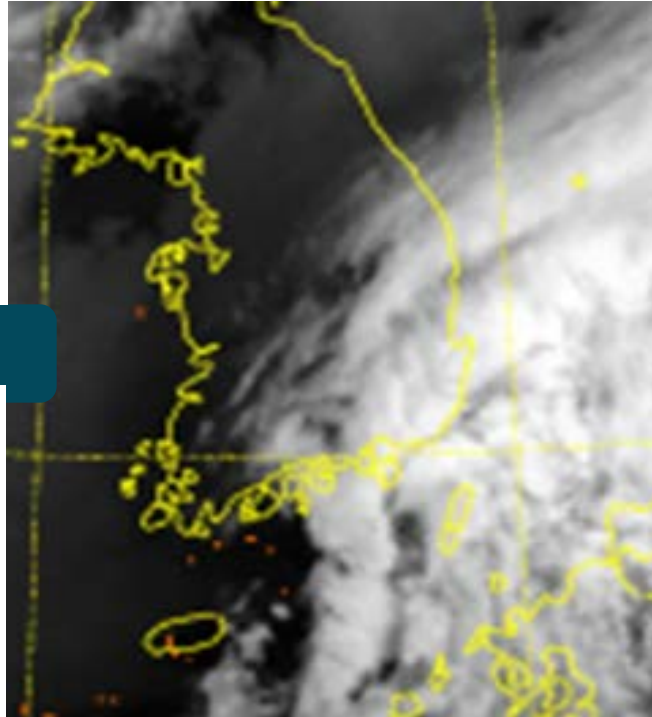
하늘을 친구처럼  
관심을 하늘처럼

## Visibility



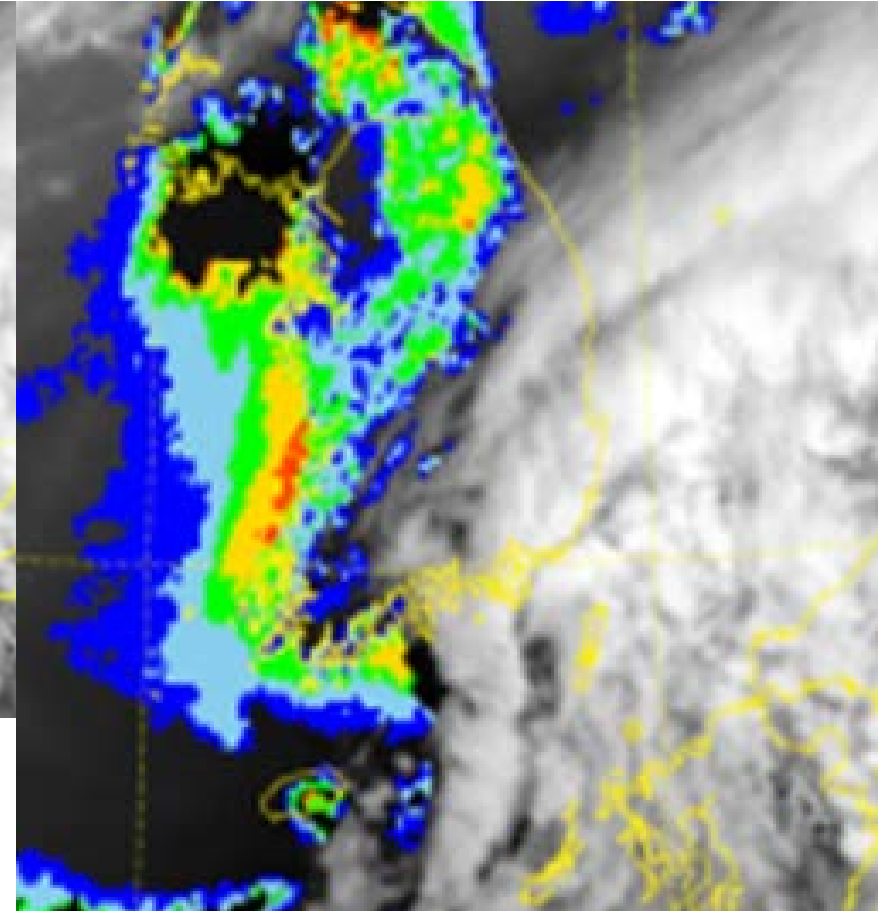
## COMS FOG(Old)

- Cloud screening using multi channels
- Nighttime fog :  $-9.5 < \text{DCD}(\text{SWIR}-\text{IR}) < -2.5$

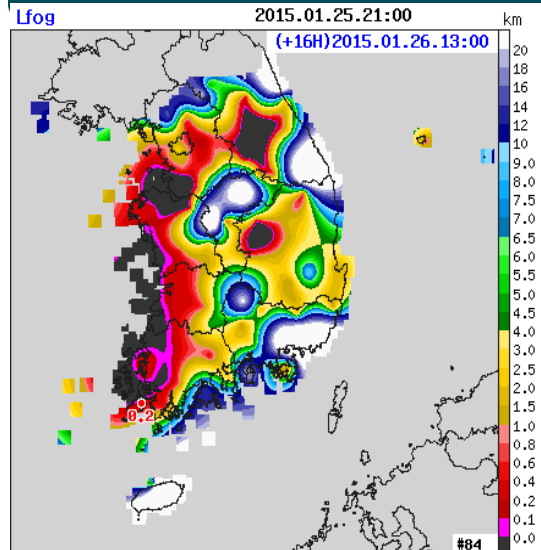


## COMS FOG(New)

- Cloud screening :  $\text{CSTB} - \text{IR} < 10$ .
- Nighttime fog :  $-9.5 < \text{DCD}(\text{SWIR}-\text{IR1}) < -1.58$



## LDAPS fog (NWP)



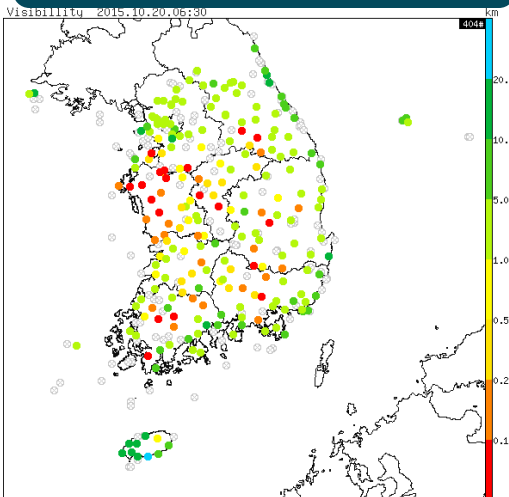
0400UTC 26<sup>th</sup> Jan. 2015

# Improvement of Fog detection(Radiation Fog)

하늘을 친구처럼  
지구를 하늘처럼



## Visibility



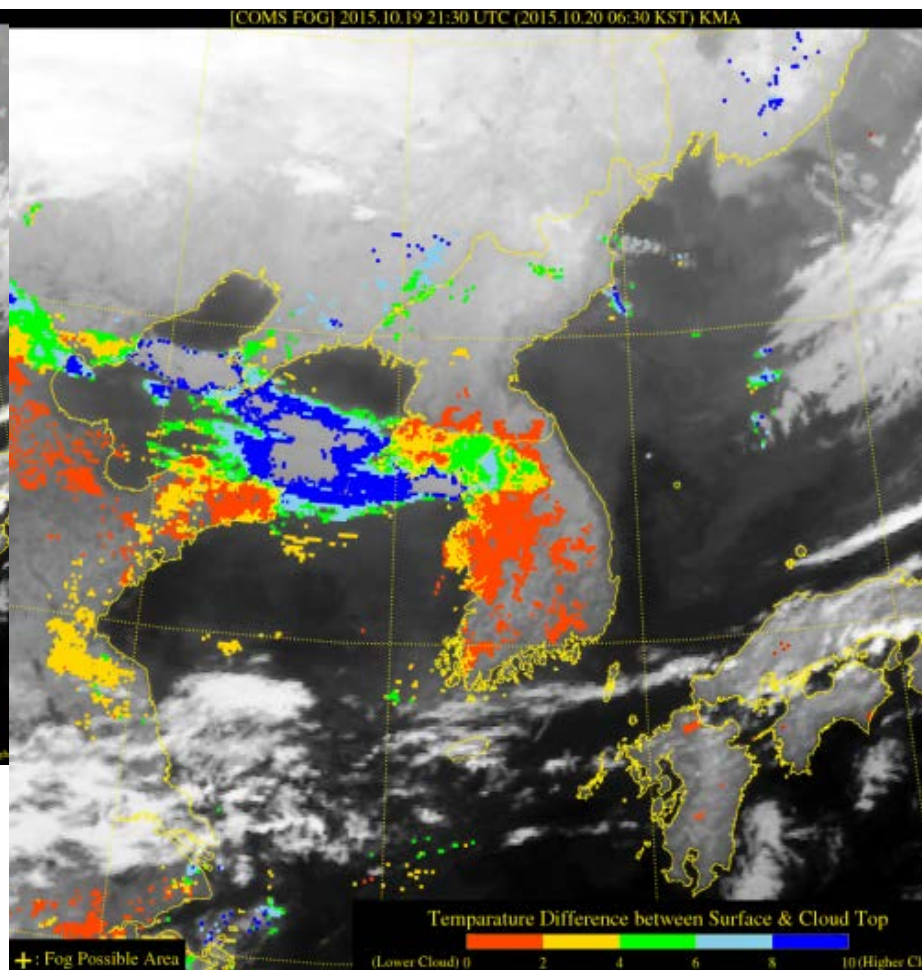
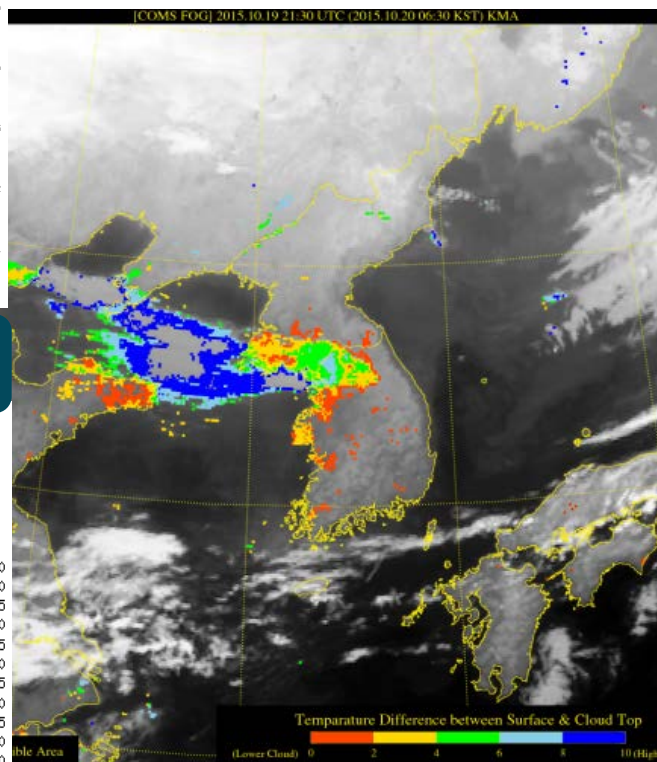
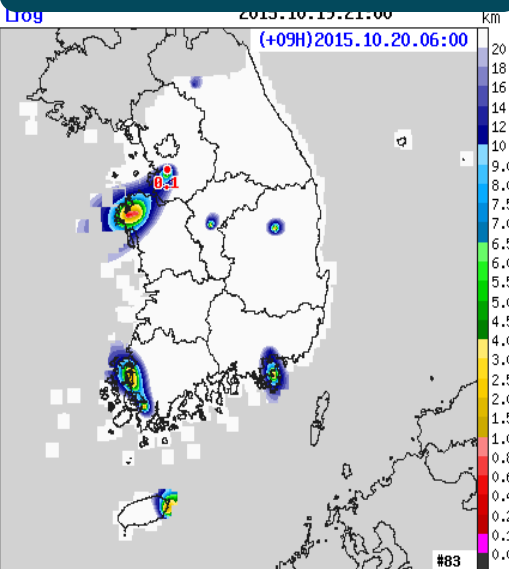
## COMS FOG(Old)

$0. < CSTB - IR < 10.$   
 $-9.5 < DCD(SWIR-IR1) < -2.5$

## COMS FOG(New)

$CSTB - IR < 10.$   
 $-9.5 < DCD(SWIR-IR1) < -1.58$

## LDAPS fog (NWP)



2130UTC 19<sup>th</sup> Oct. 2015

# Improvement of Fog detection(Radiation Fog) 하늘을 친구처럼 보는 하늘처럼

1500 UTC

1600UTC

1700UTC

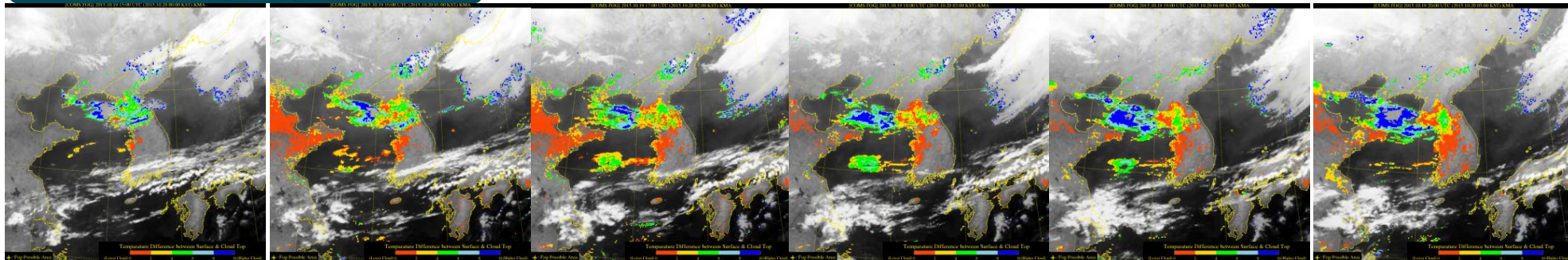
1800UTC

1900UTC

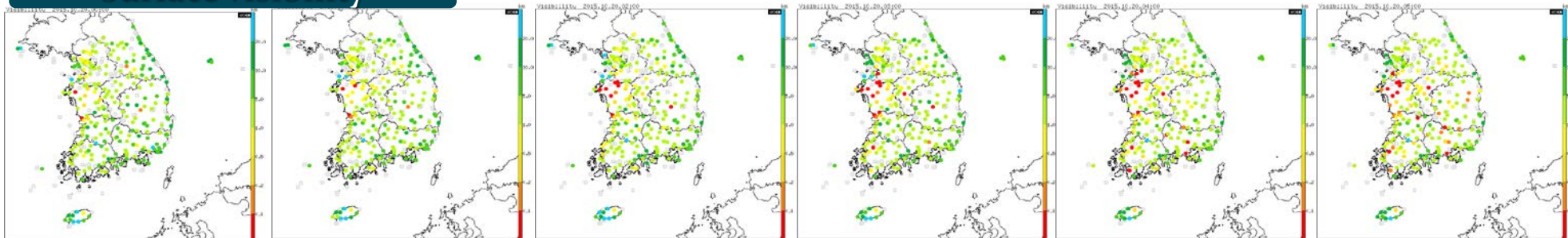
2000UTC

## COMS FOG(NEW)

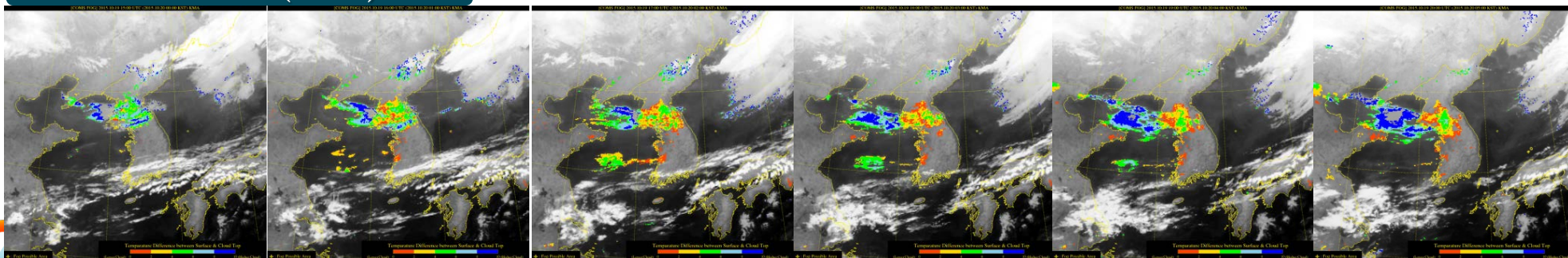
19<sup>th</sup> Oct. 2015



## Surface visibility



## COMS FOG(OLD)



# Improvement of Fog detection (Advection & Radiation Fog)

하늘을 친구처럼

가깝게

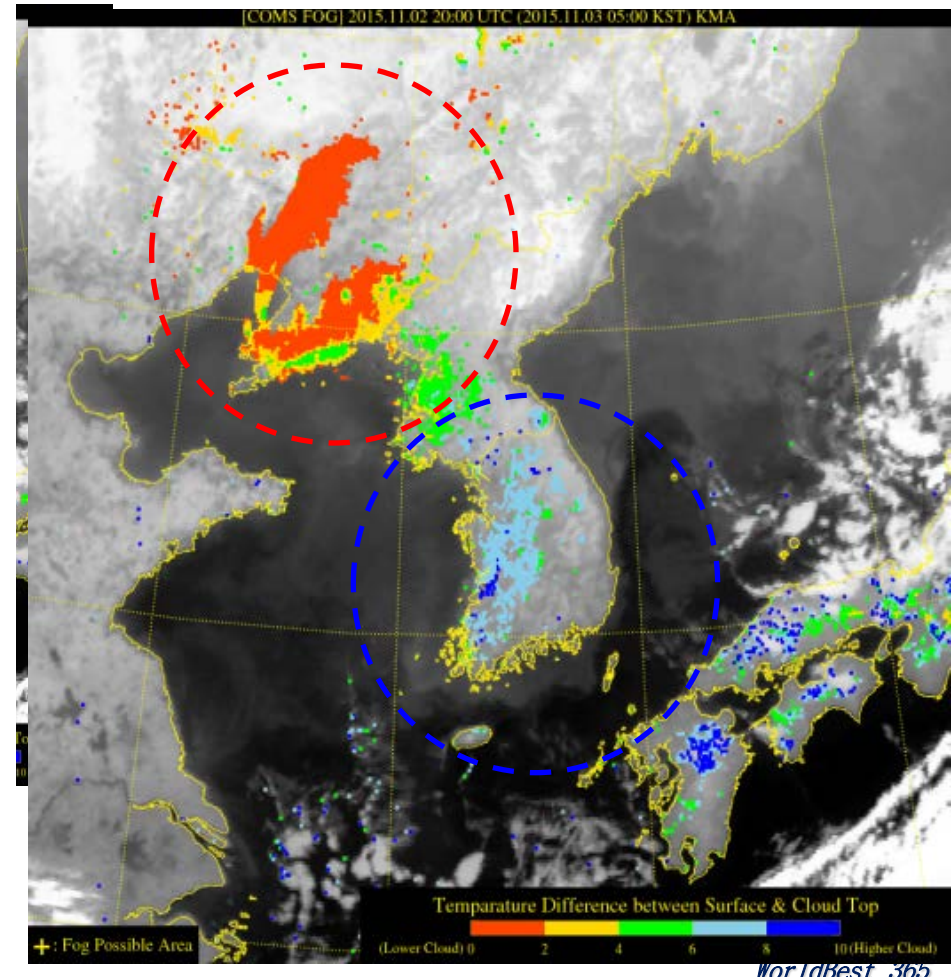
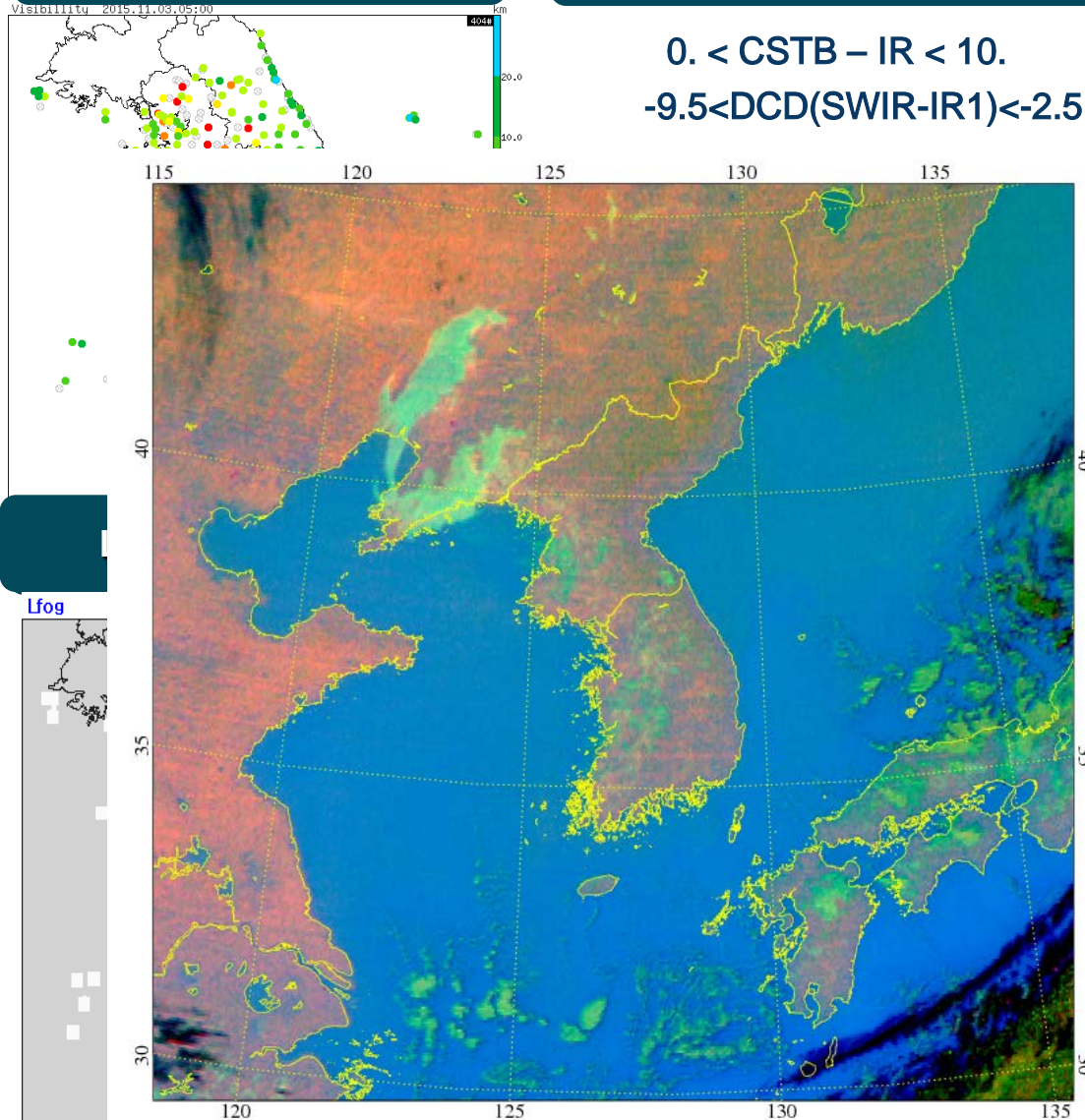
## Visibility

## COMS FOG(Old)

## COMS FOG(New)

$0. < CSTB - IR < 10.$   
 $-9.5 < DCD(SWIR-IR1) < -2.5$

$CSTB - IR < 10.$   
 $-9.5 < DCD(SWIR-IR1) < -1.58$





Usage of the Himawari-8 imagery



Several COMS RGB imagery



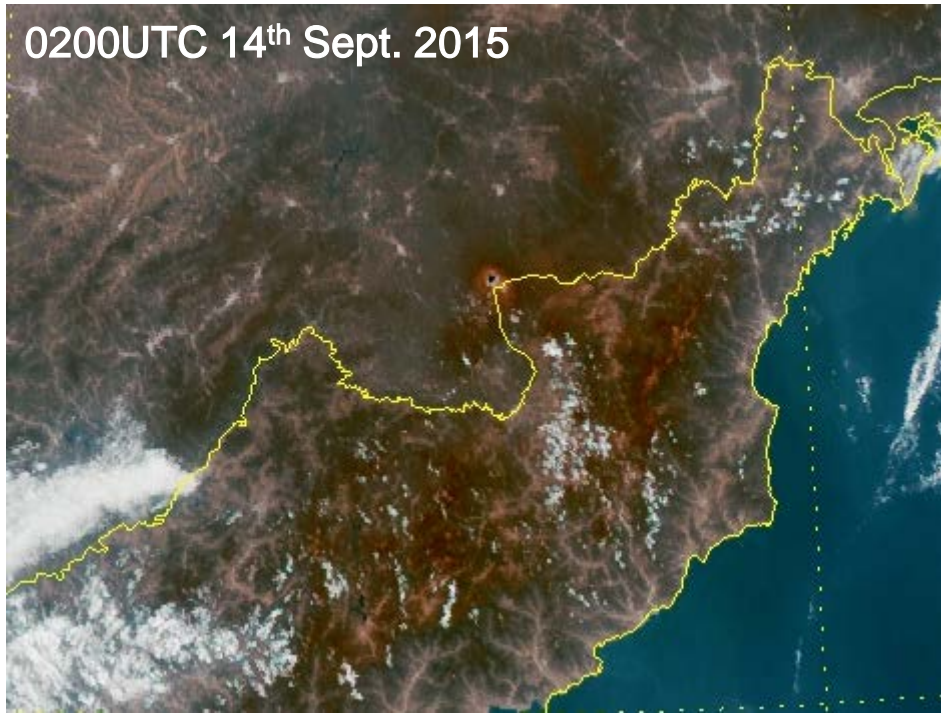
**Application of Himawari-8 RGB imagery to the  
Korean Peninsula**

- True Color RGB
- Dust RGB
- Water Vapor RGB
- Day convective RGB





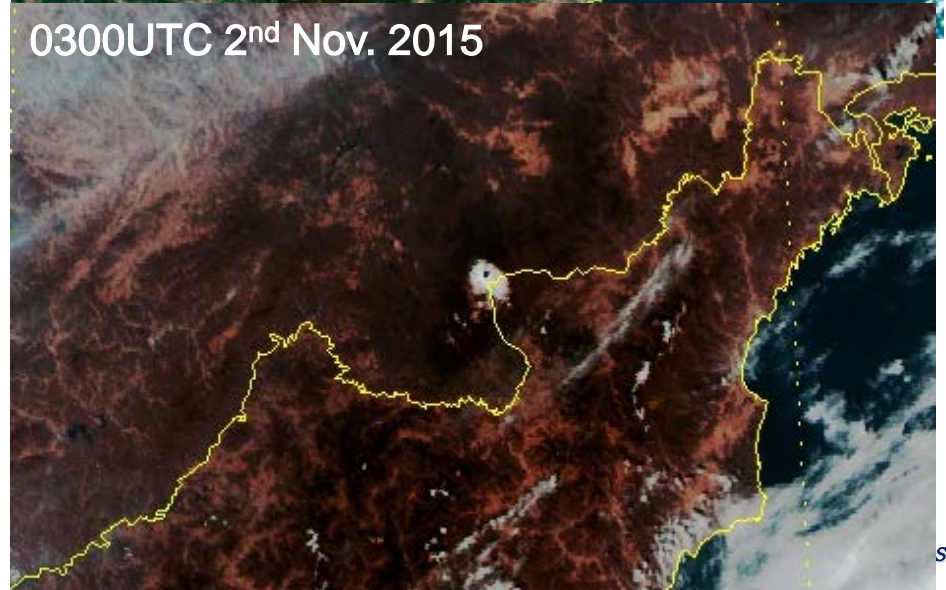
0200UTC 14<sup>th</sup> Sept. 2015



0300UTC 3<sup>rd</sup> Oct. 2015



0300UTC 2<sup>nd</sup> Nov. 2015



## Change of Surface

- Vegetation
- **Snow**
- Sea ice
- etc.

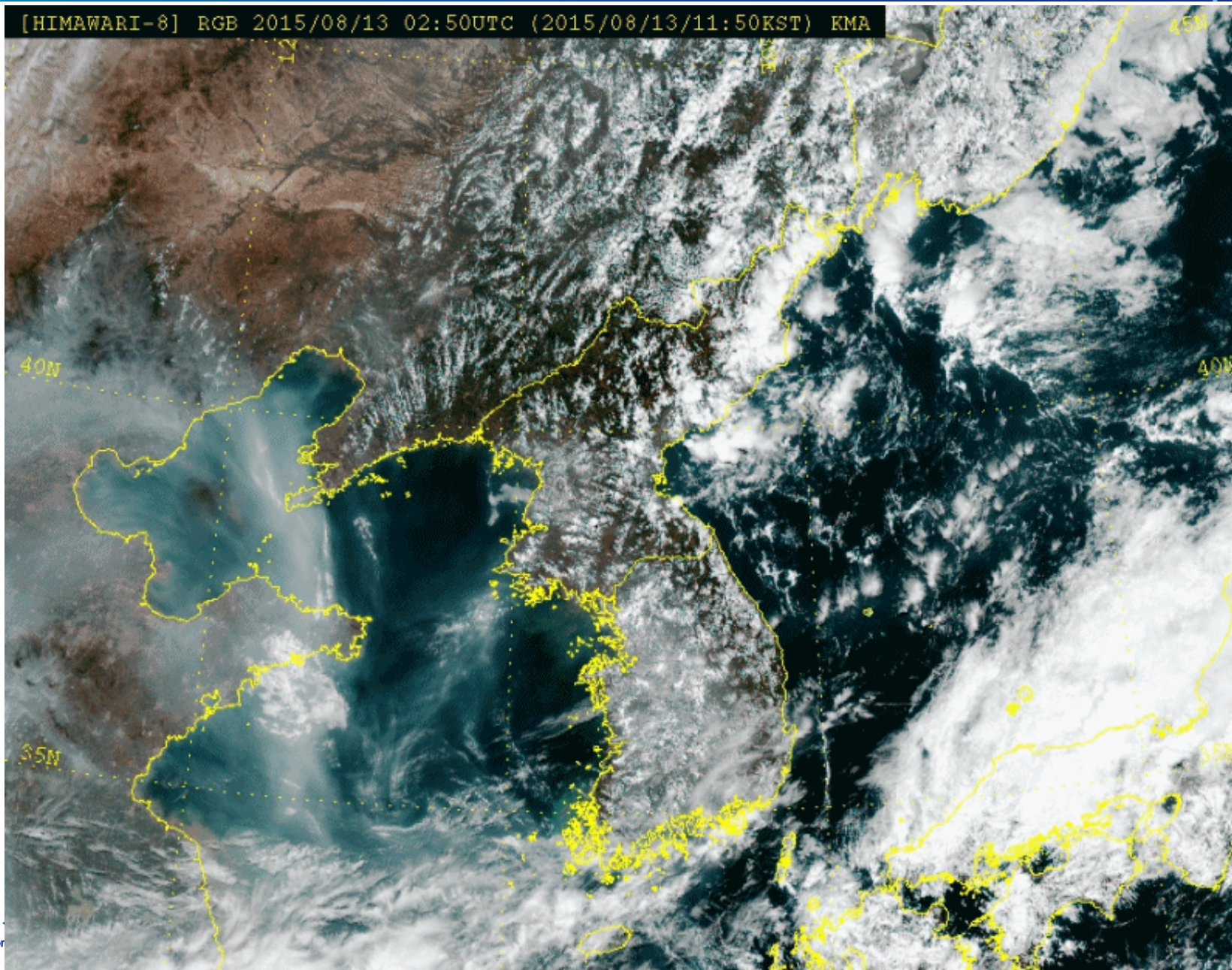
# True Color RGB-Convective Clouds

하늘은 지구처럼  
국가는 하늘처럼



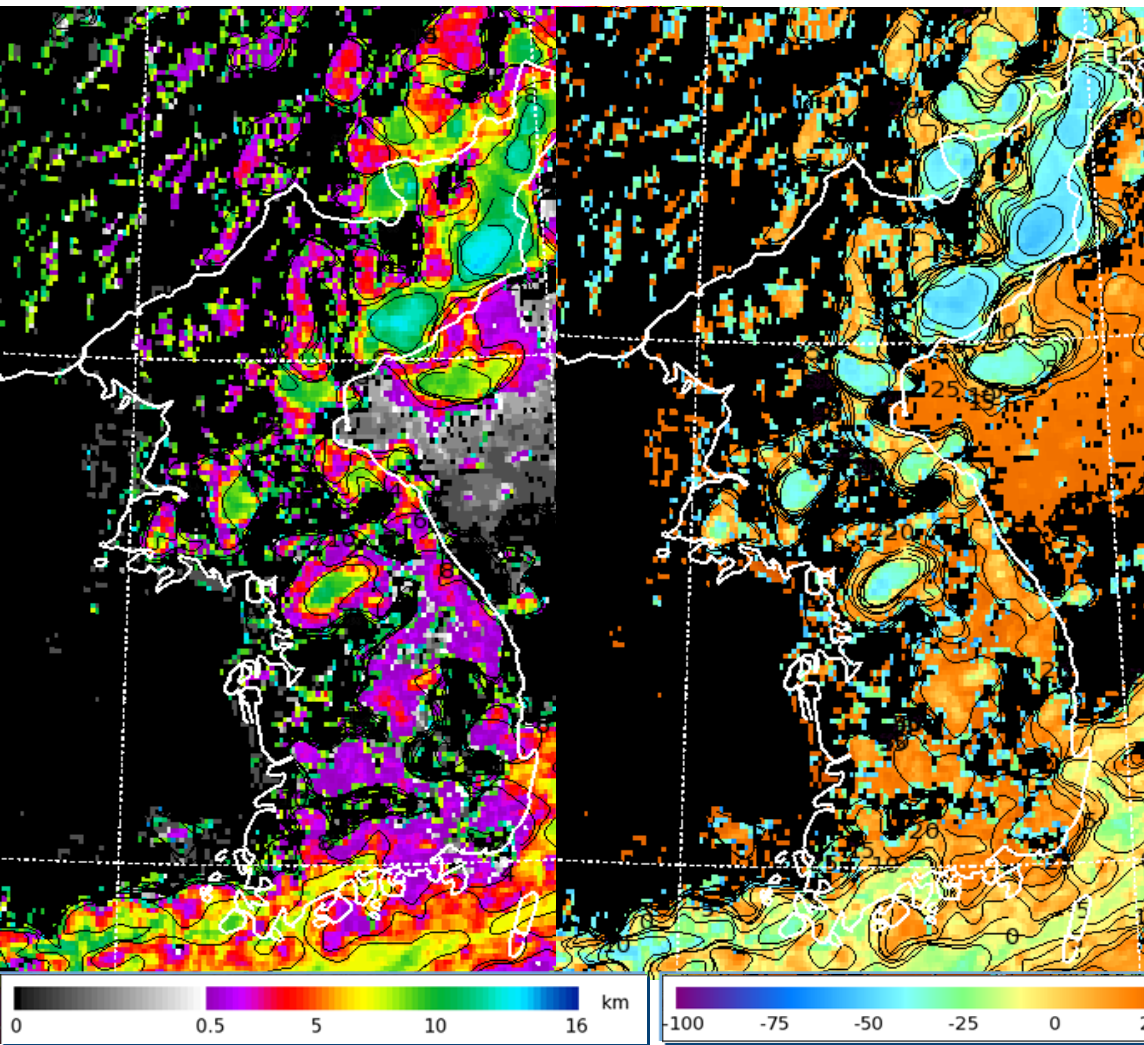
13<sup>th</sup> Aug.,  
2015

[HIMAWARI-8] RGB 2015/08/13 02:50UTC (2015/08/13/11:50KST) KMA



# Characteristics of convective clouds

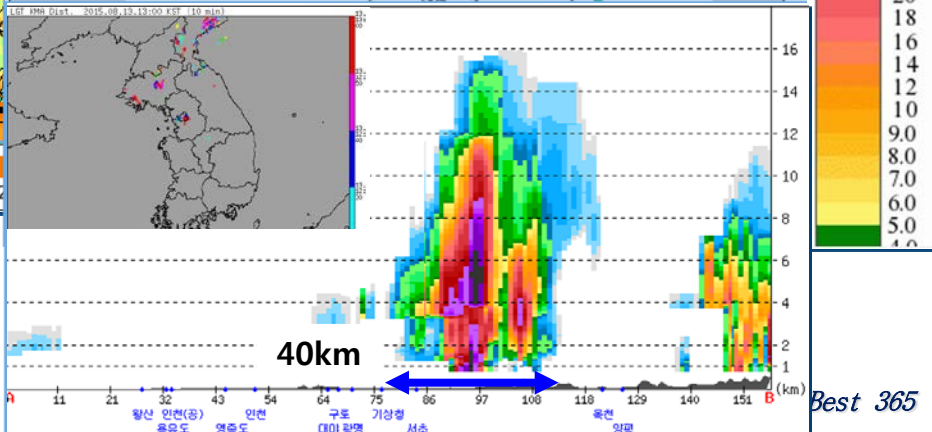
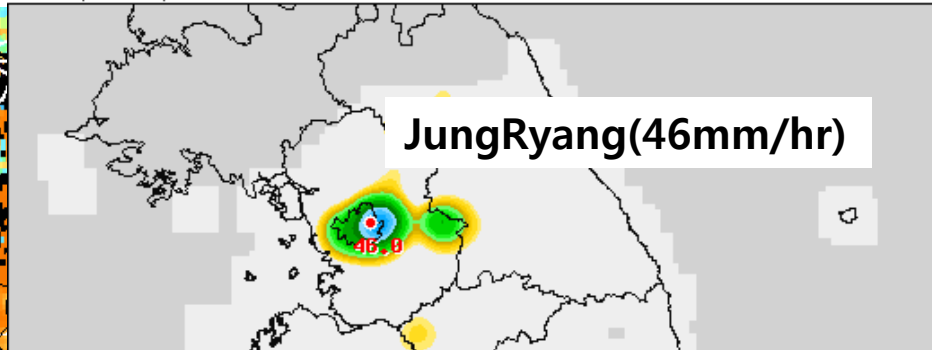
하늘을 친구처럼  
구름을 이웃처럼



Cloud Top height

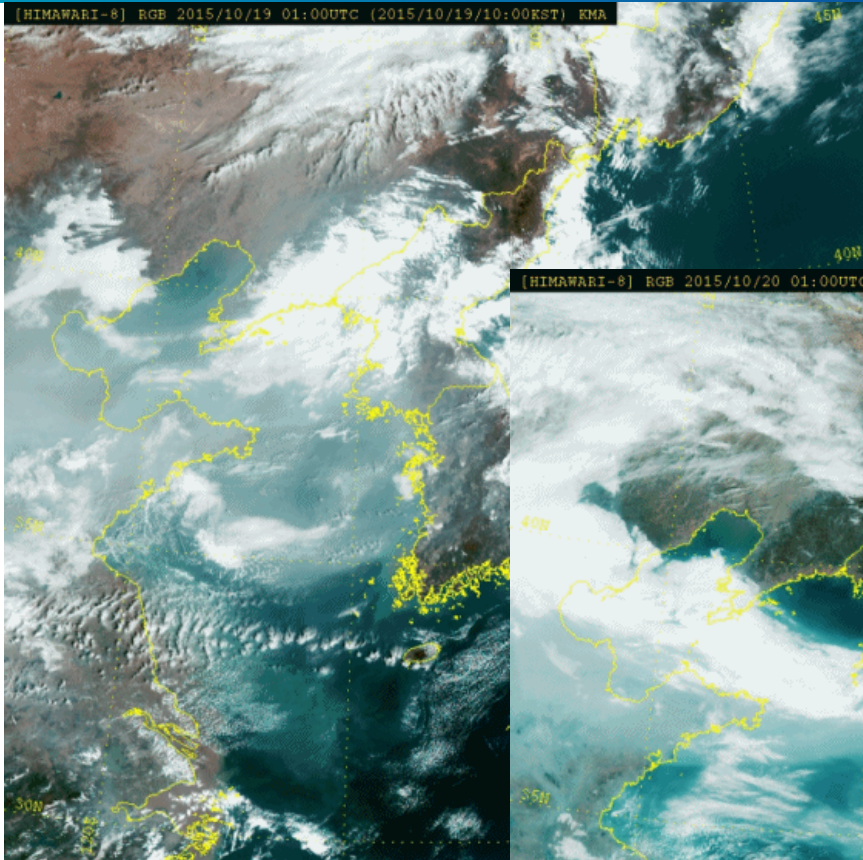
Cloud Top Temp.

RAIN(60min) 2015.08.13.13:00



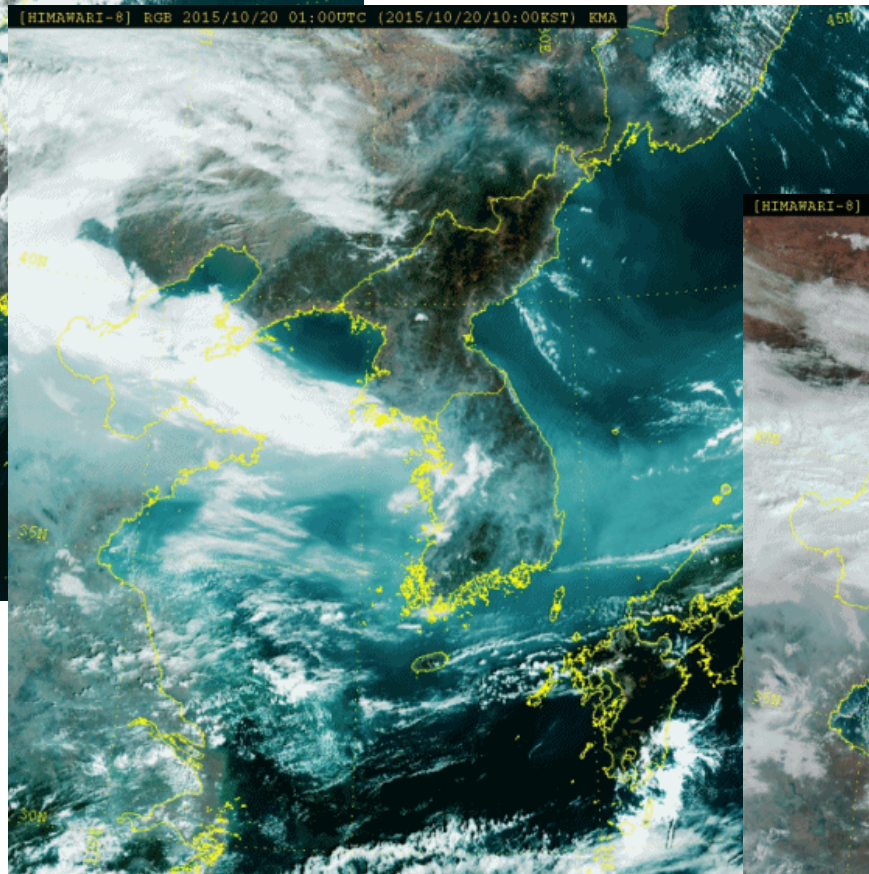
# Monitoring of Haze

하늘을 친구처럼  
국민을 하늘처럼

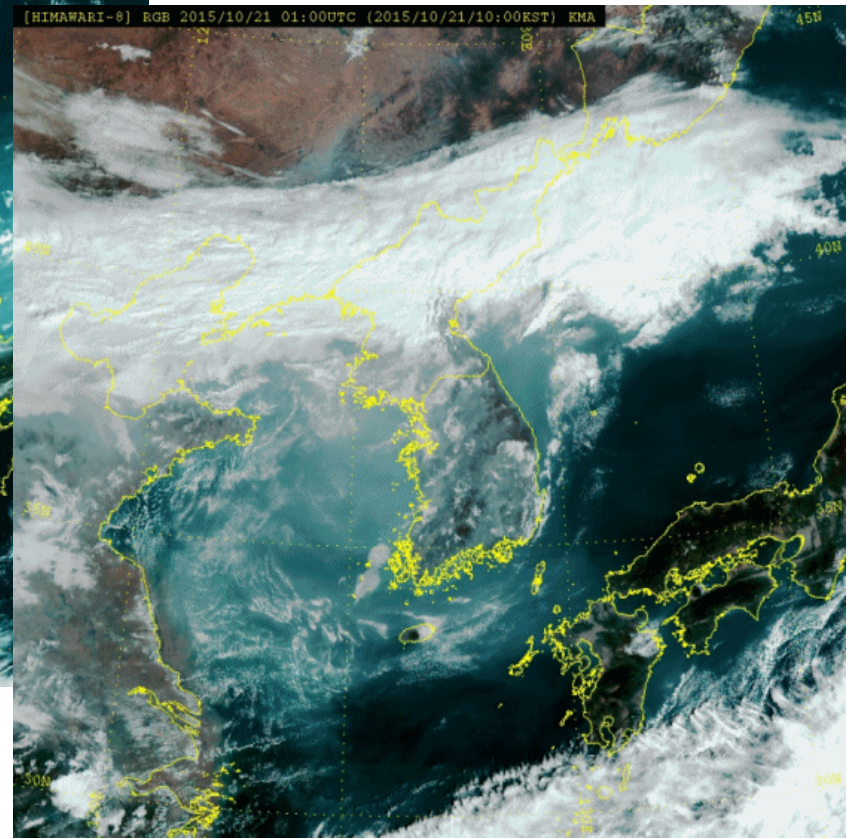


19 Oct., 2015

20 Oct., 2015



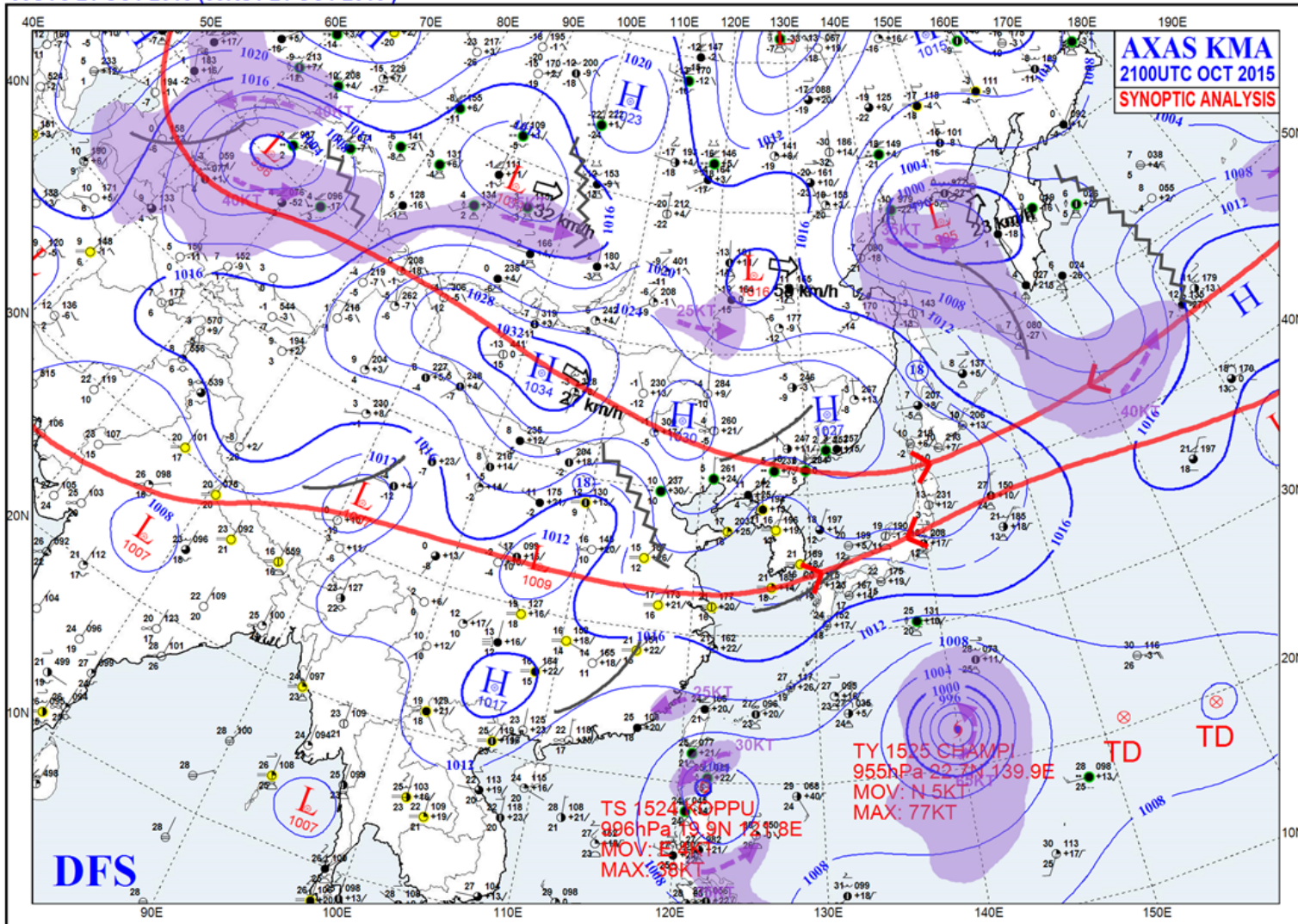
21 Oct., 2015



# Surface Condition

하늘을 친구처럼  
국민을 하늘처럼

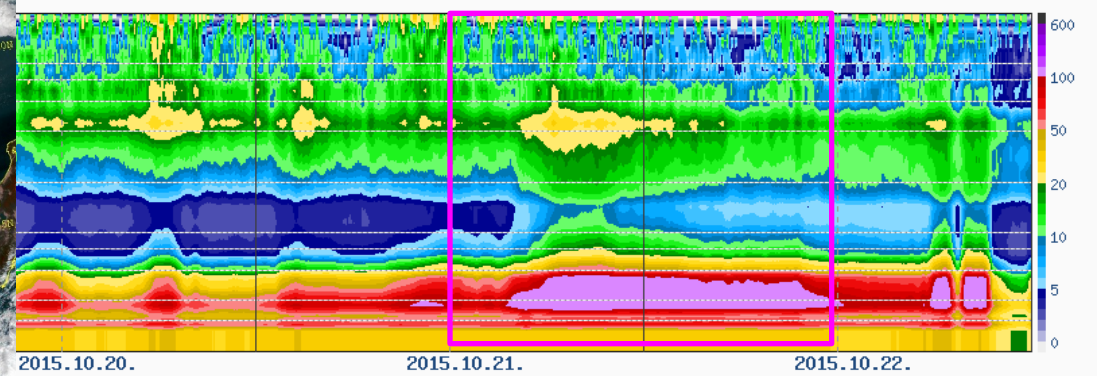
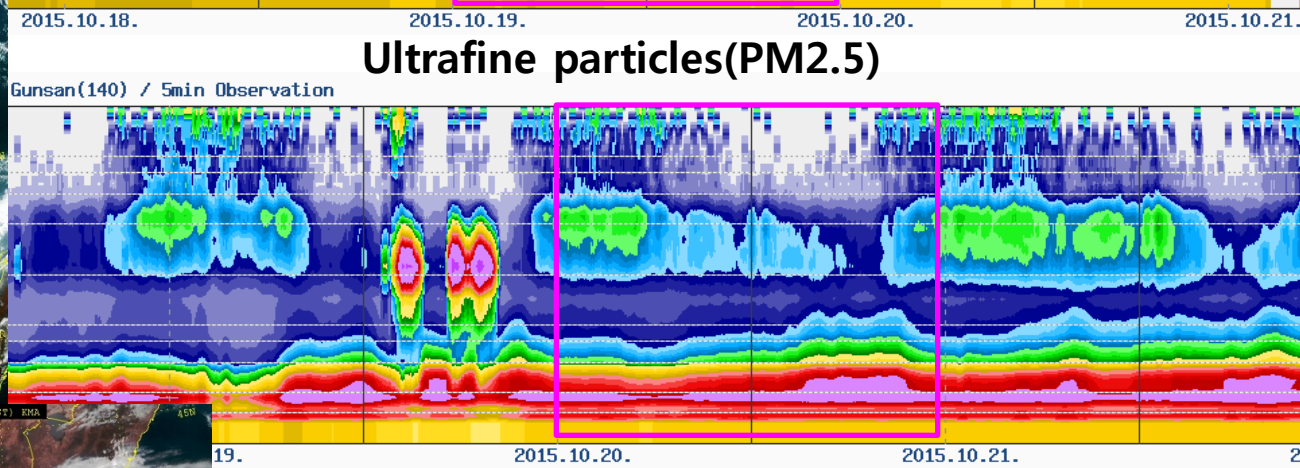
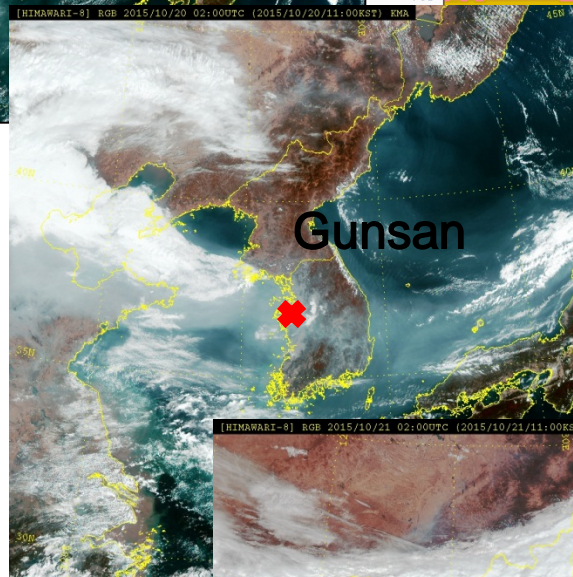
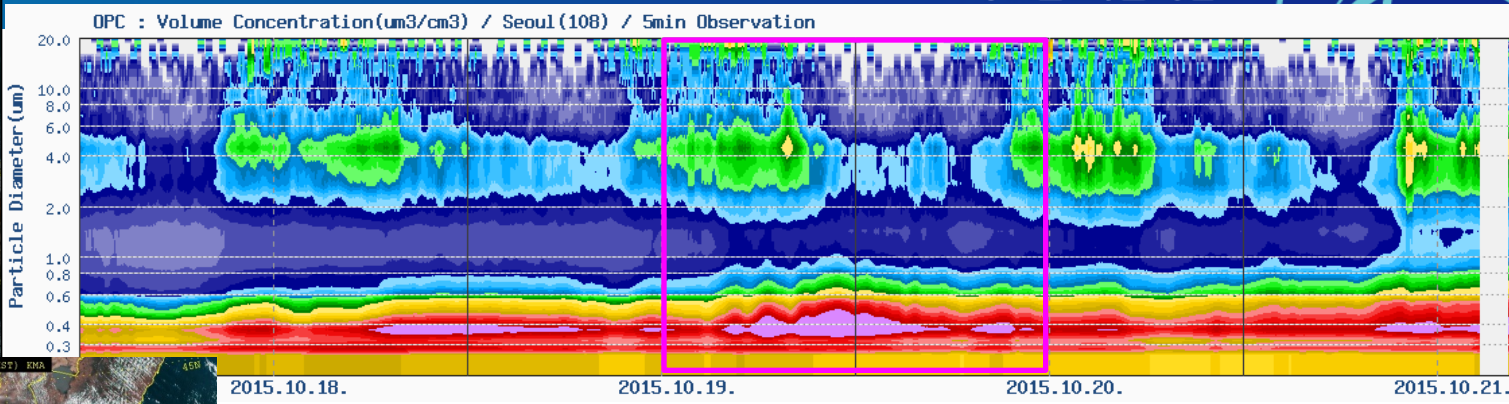
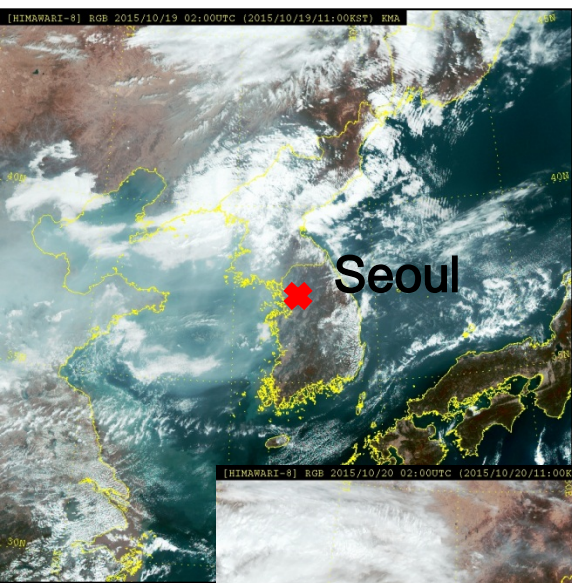
00UTC 21 OCT 2015 (09KST 21 OCT 2015)



Korea Meteorological Administration(KMA)

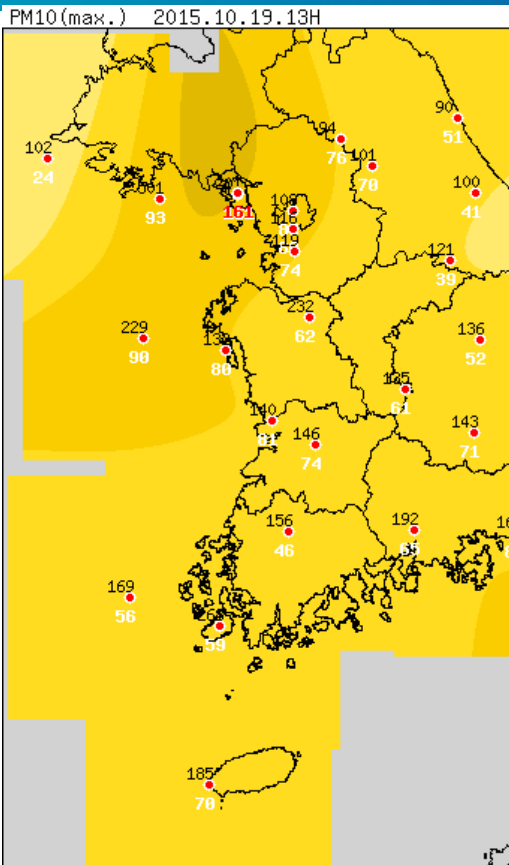
00UTC 21 OCT 2015 (09KST 21 OCT 2015)

# Distribution of Particle Size

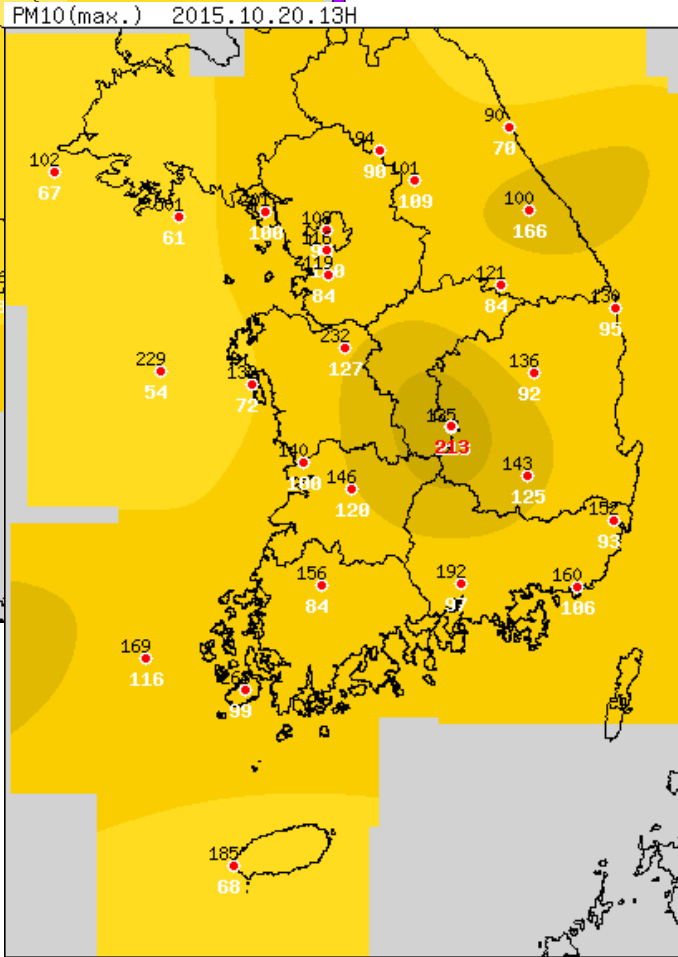


# Distribution of Max PM10 Density

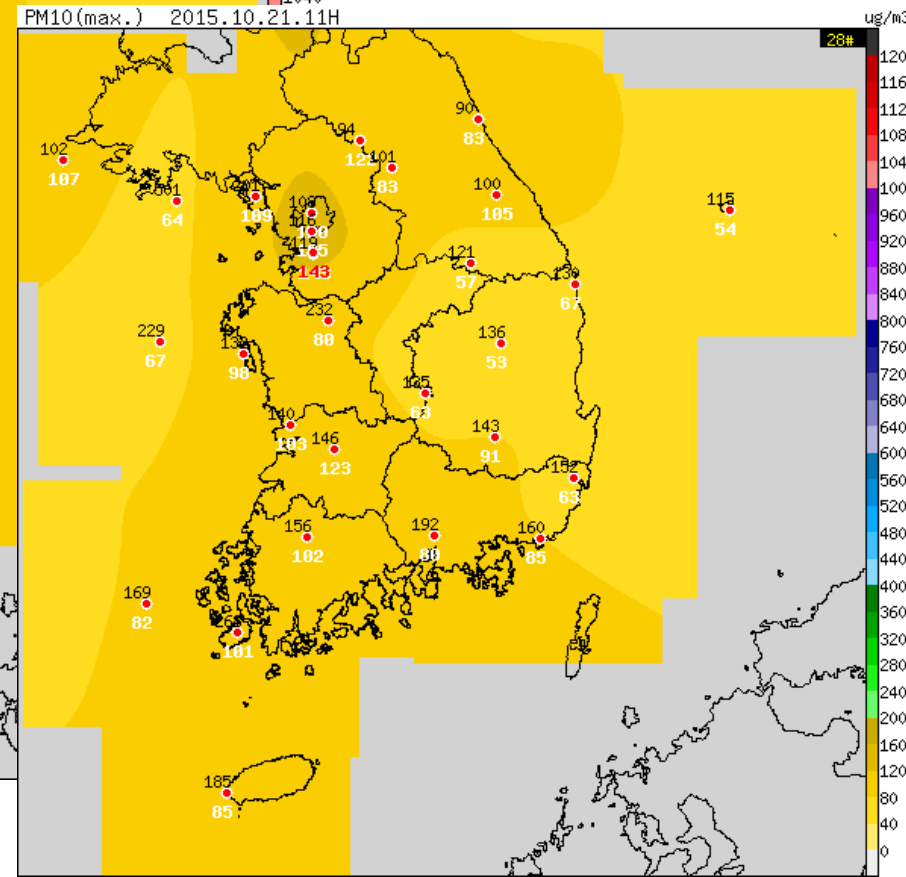
하늘을 친구처럼  
지구를 이웃처럼



20 Oct.2015



21 Oct.2015



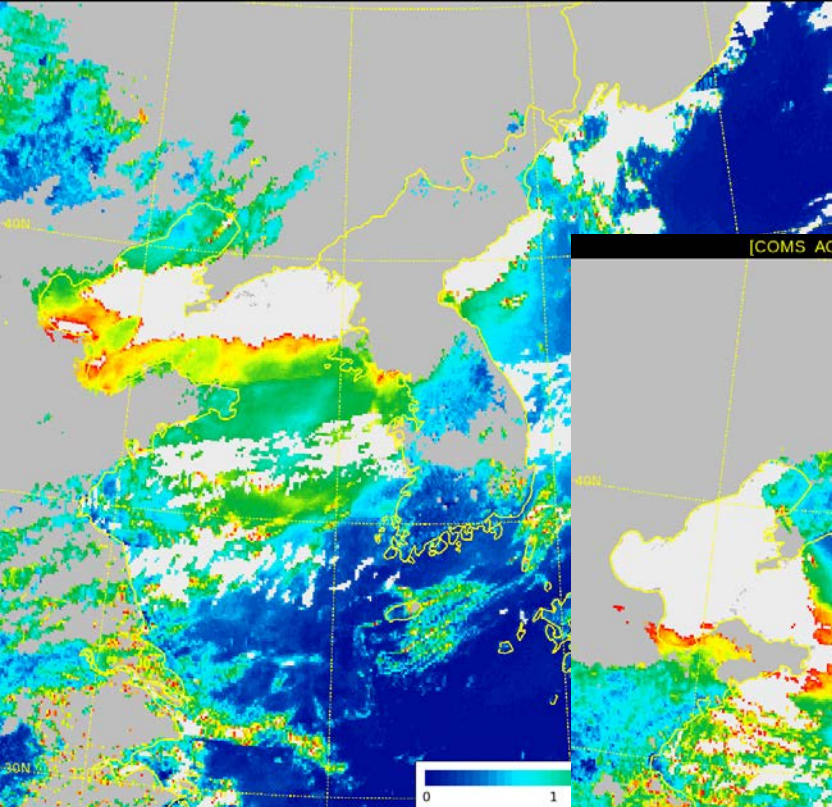
19 Oct.2015

# Aerosol Optical Thickness(COMS)

하늘을 친구처럼  
국민을 하늘처럼

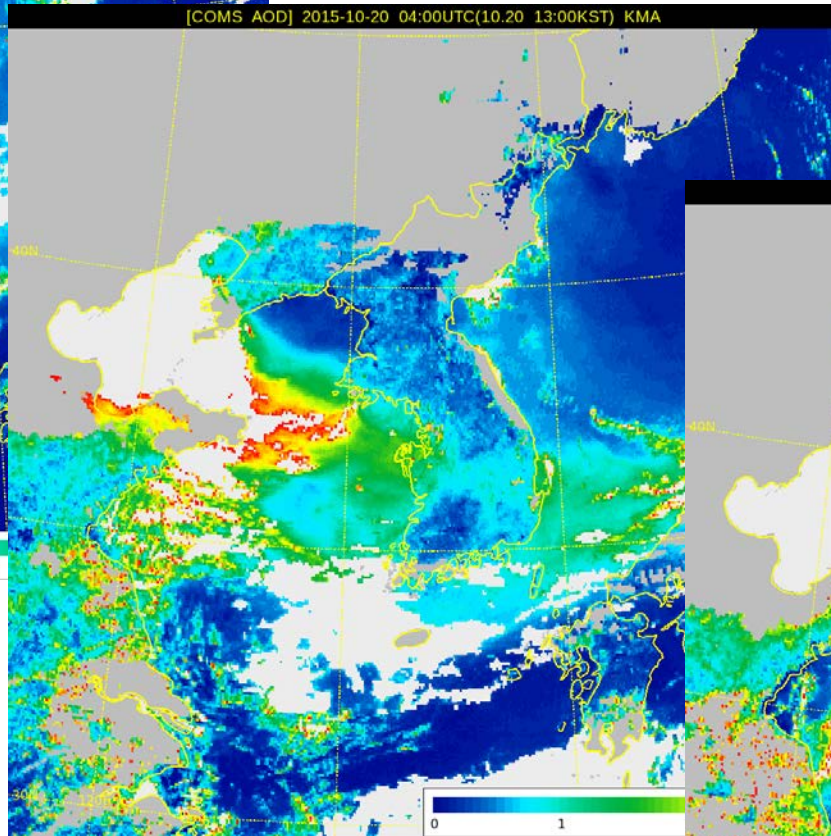


[COMS AOD] 2015-10-19 04:00UTC(10.19 13:00KST) KMA



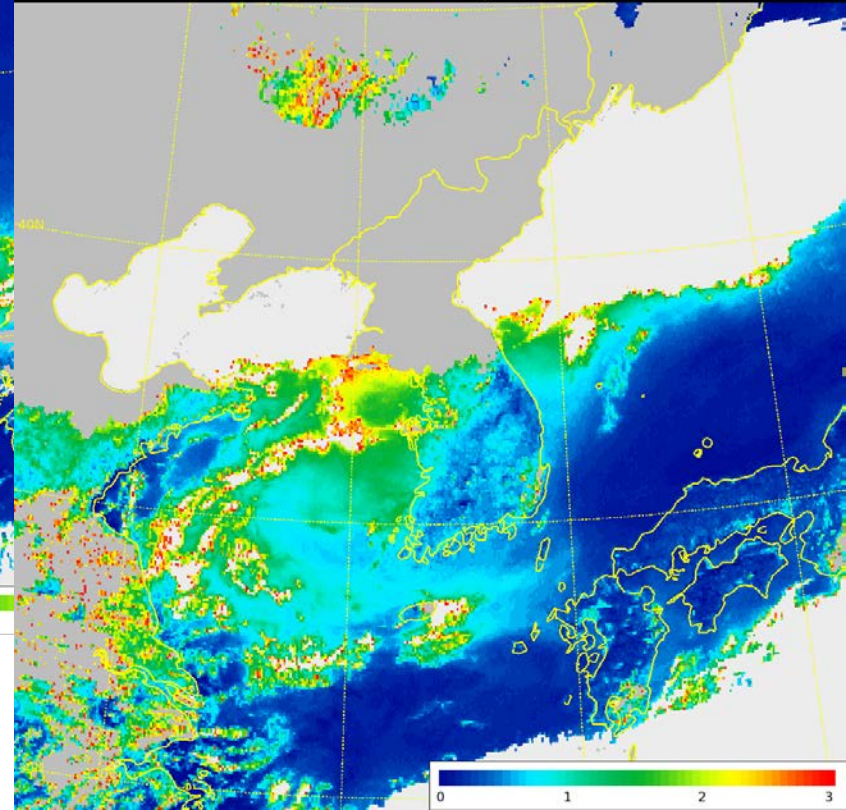
20 Oct.2015

[COMS AOD] 2015-10-20 04:00UTC(10.20 13:00KST) KMA



21 Oct.2015

[COMS AOD] 2015-10-21 04:00UTC(10.21 13:00KST) KMA



19 Oct.2015

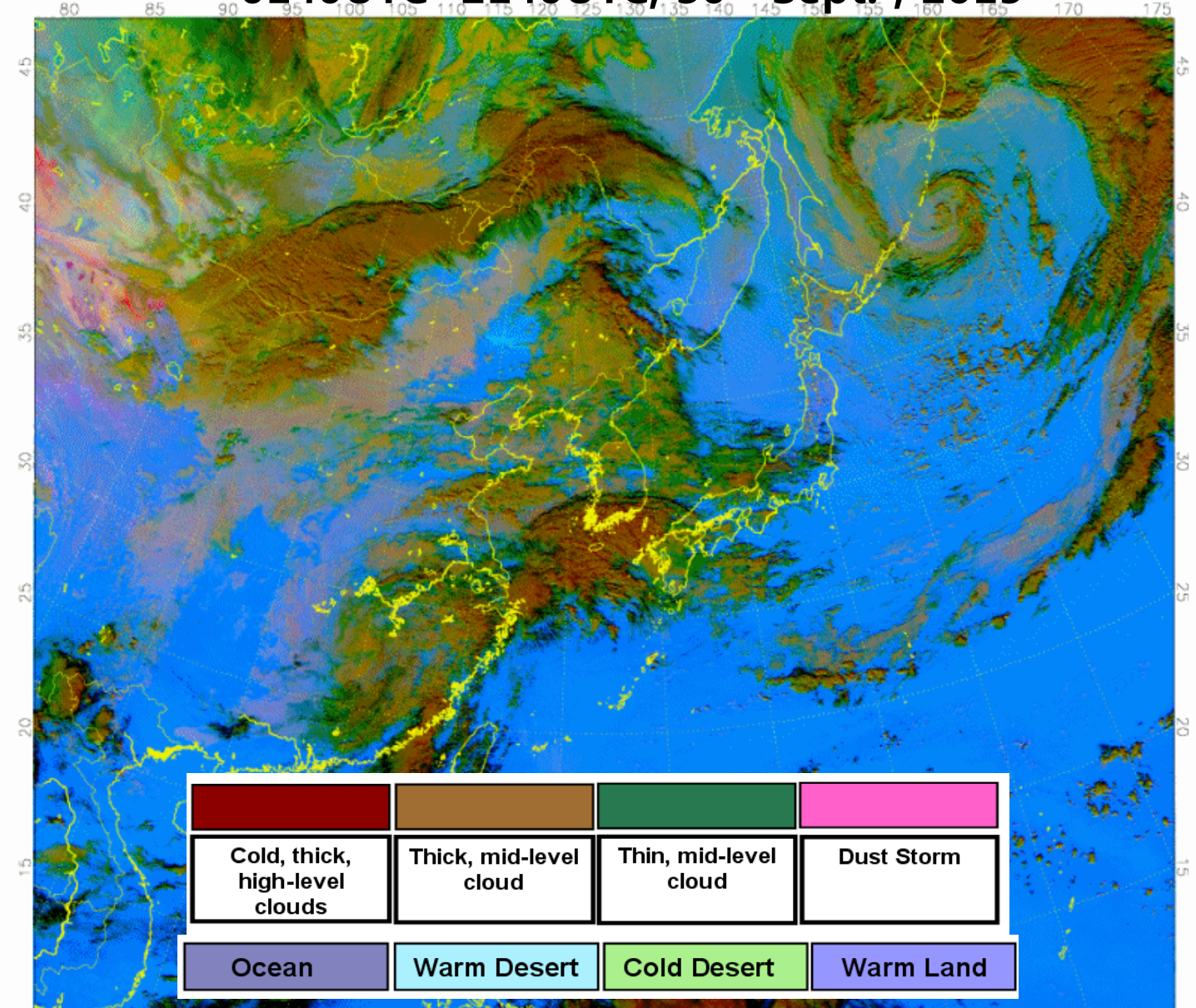


# Application of Himawari Dust RGB

하늘을 친구처럼  
보면 하늘처럼



0140UTC~2140UTC, 30<sup>th</sup> Sept. , 2015



# Comparison of other products

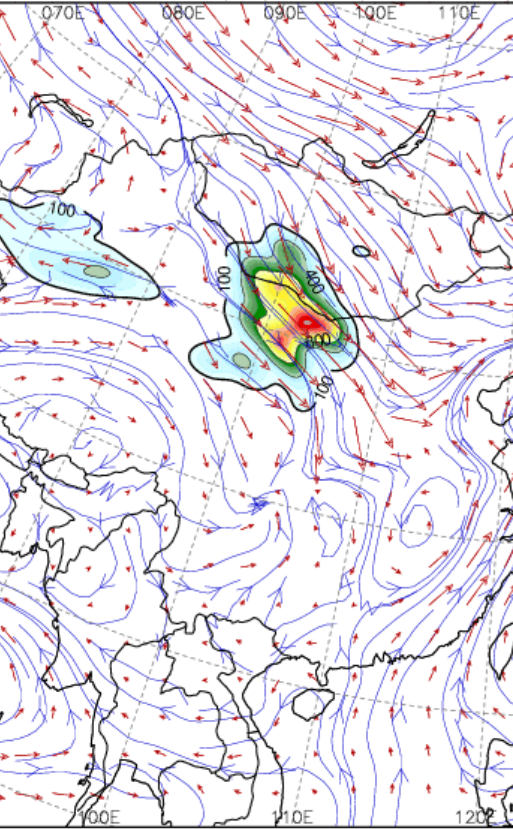
하늘을 친구처럼  
국민을 하늘처럼



2015.Sept. 30

지표면 PM<sub>10</sub> 농도

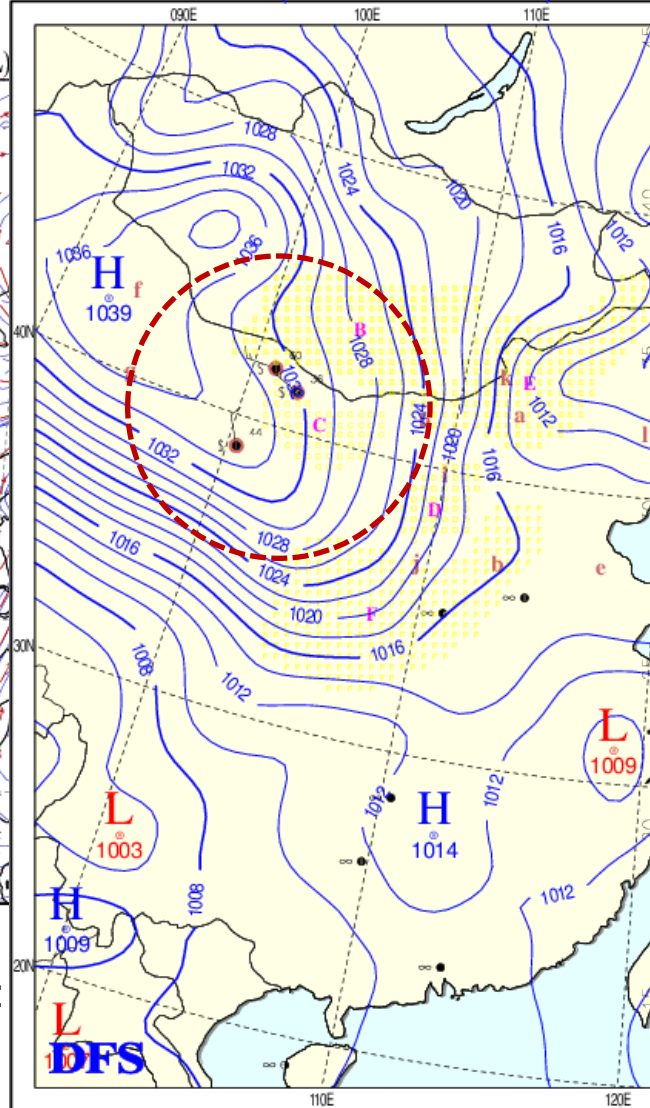
Line and Wind Vector(m/s) at k=15(~1500m AGL)



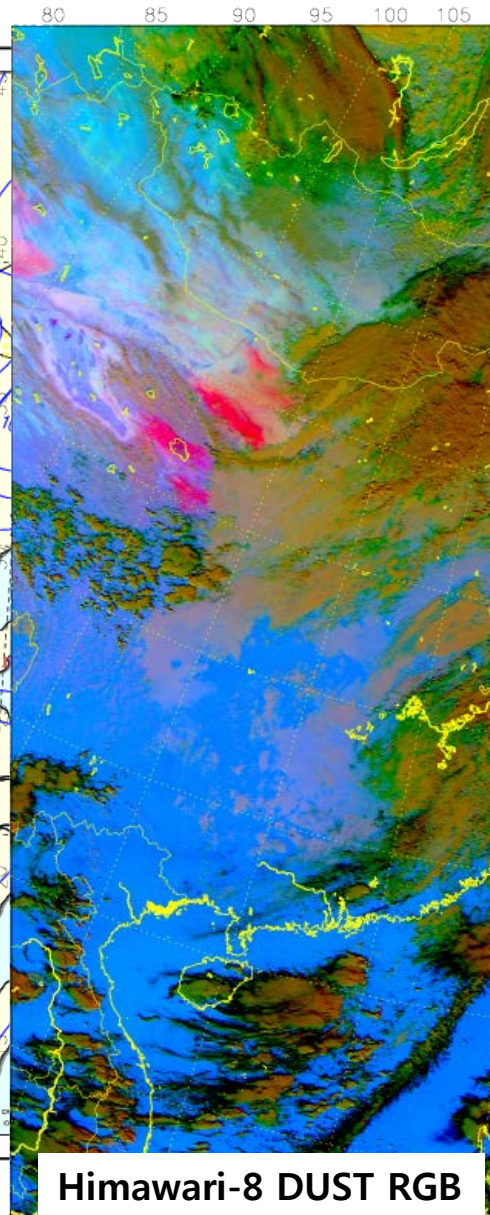
03h) [ → ] 10 m/sec

dust prediction charts at 09UTC

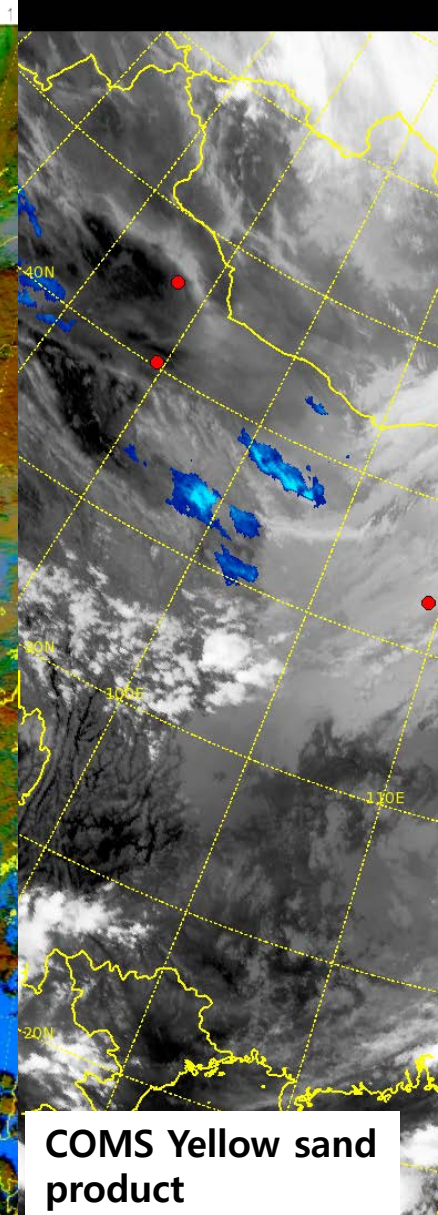
09UTC 30 SEP 2015 (18KST 30 SEP 2015)



dust charts(0900UTC)



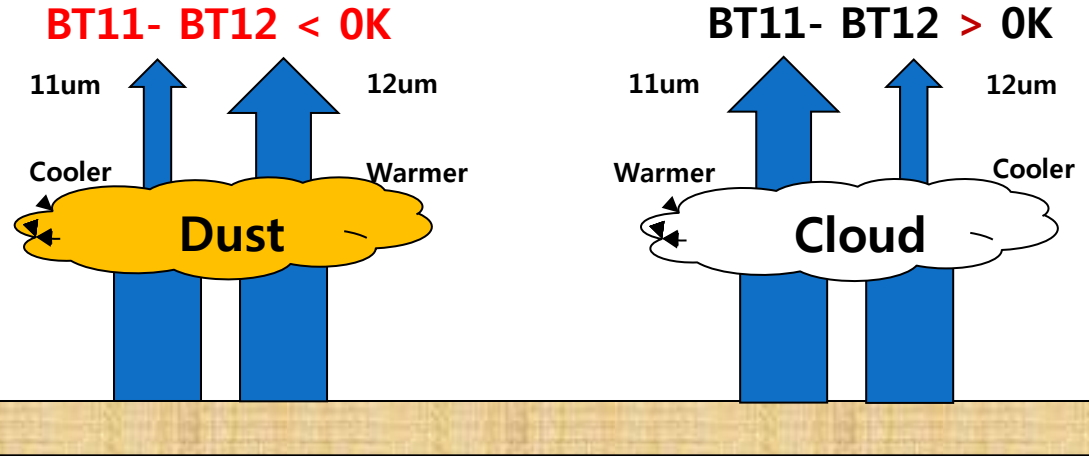
Himawari-8 DUST RGB



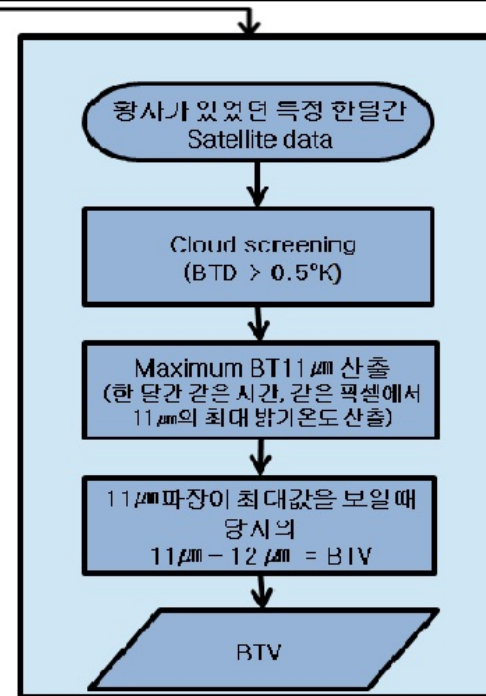
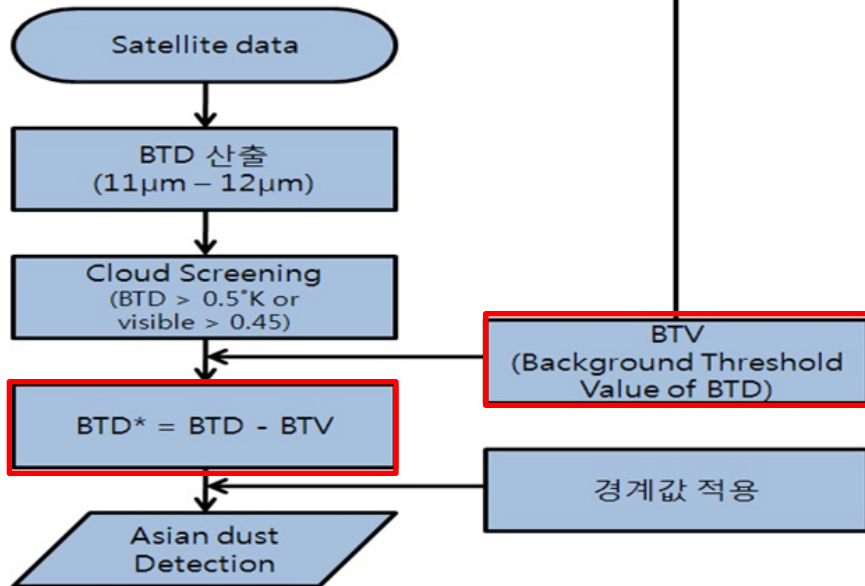
COMS Yellow sand product

## Aerosol Index(AI)

$$BTD(\text{Brightness Temperature Difference}) = TB(11\mu\text{m}) - TB(12\mu\text{m})$$



### Flow chart

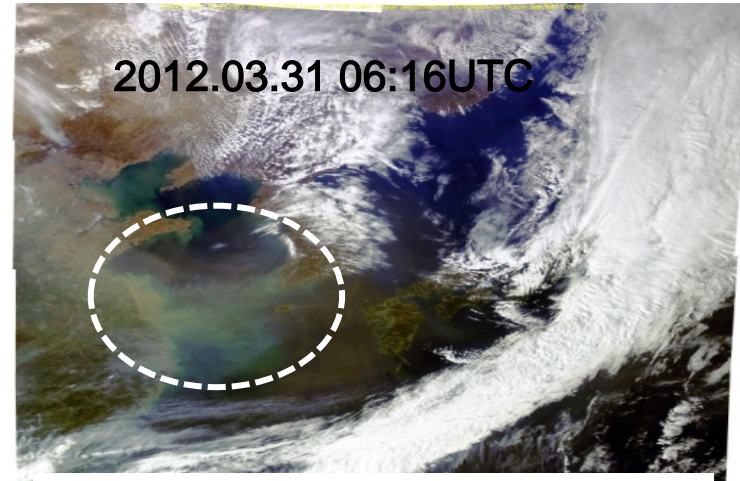
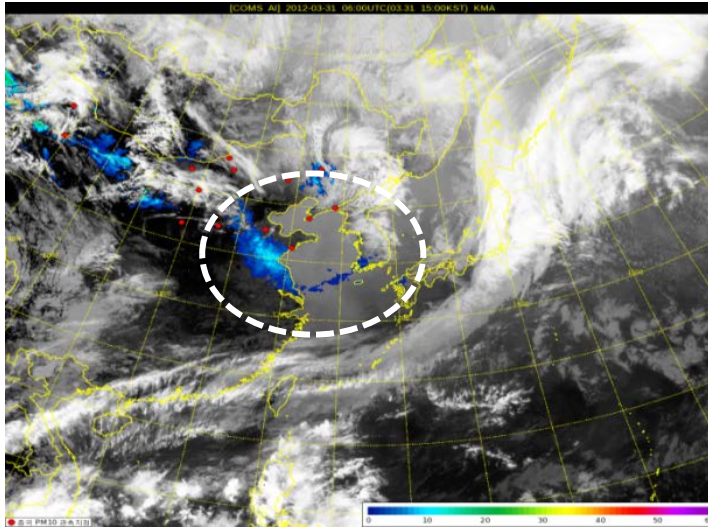


# Limitation of COMS AI products



## ◆ Underestimation of Dust over the Ocean(WV effects)

- decrease of BTD due to decrease of TB(12um) which absorbed by abundant WV

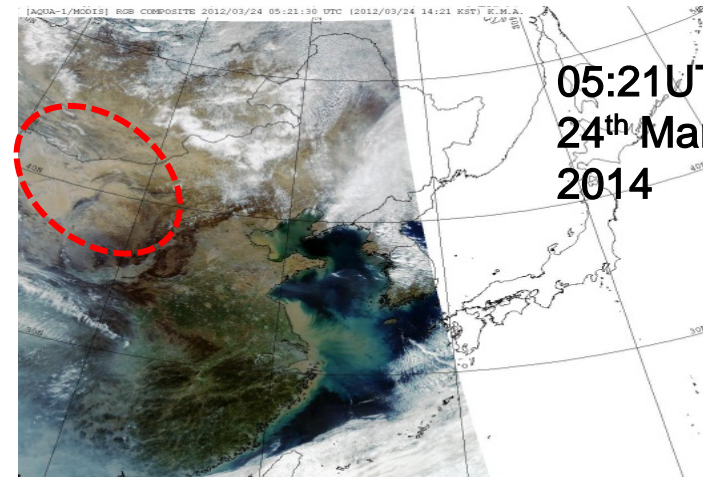
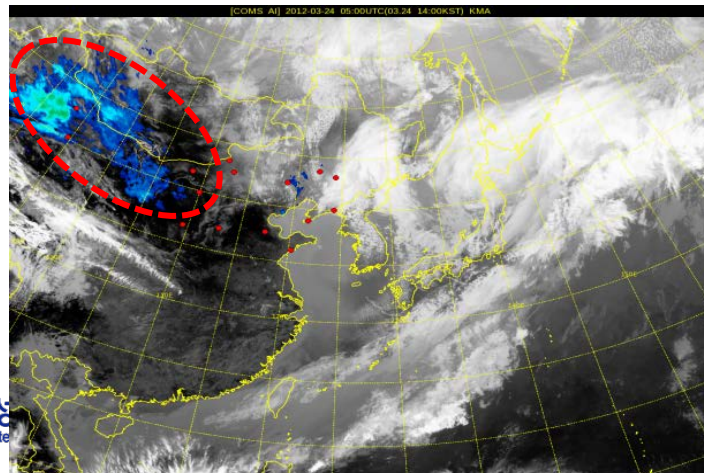


06:00UTC 31<sup>st</sup> March 2012

## ◆ Overestimation of Dust in the source region (surface heating)

- increase of BTD due to surface heating

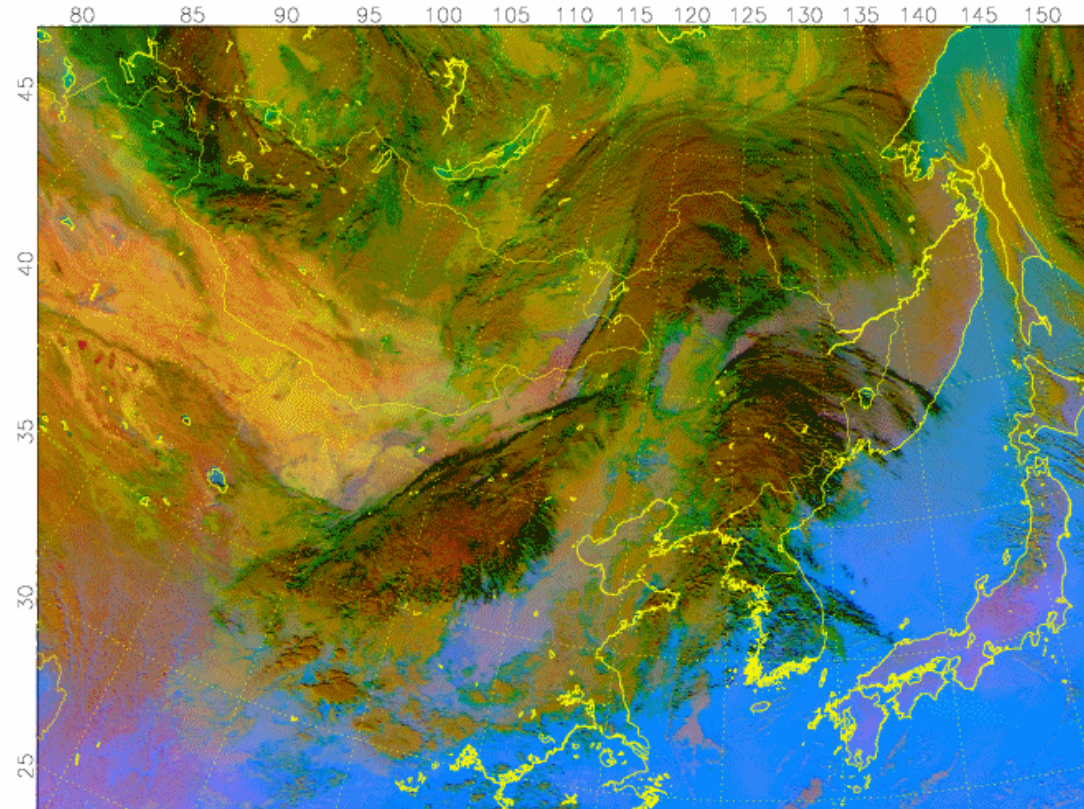
05:00UTC  
24<sup>th</sup> March  
2014



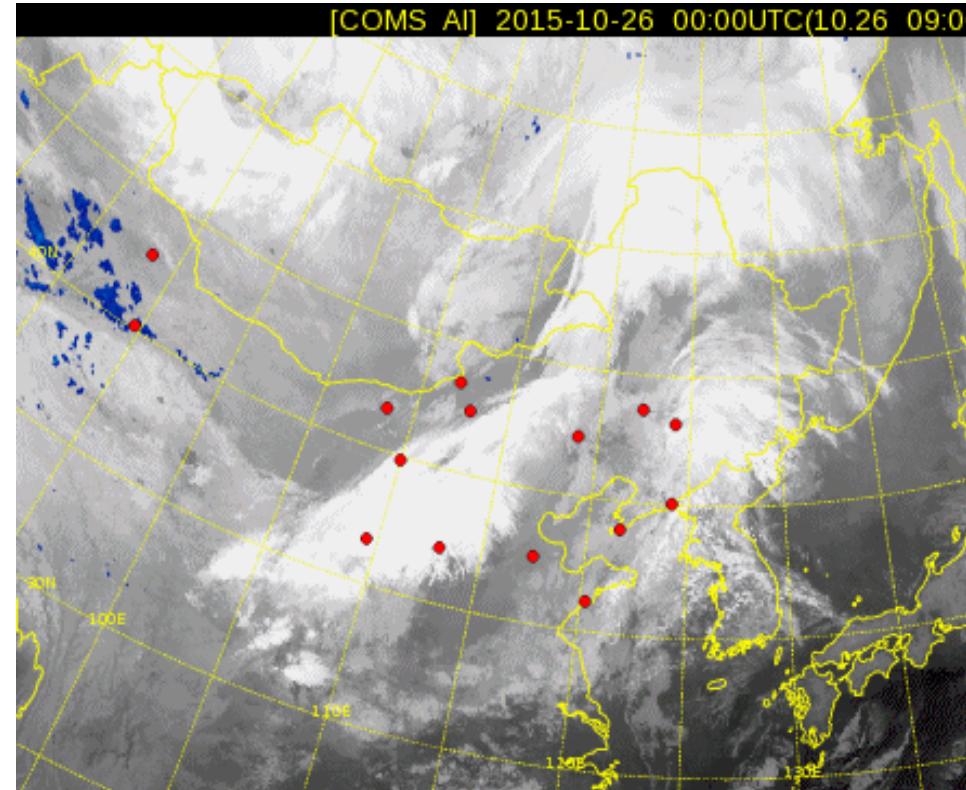
05:21UTC  
24<sup>th</sup> March  
2014



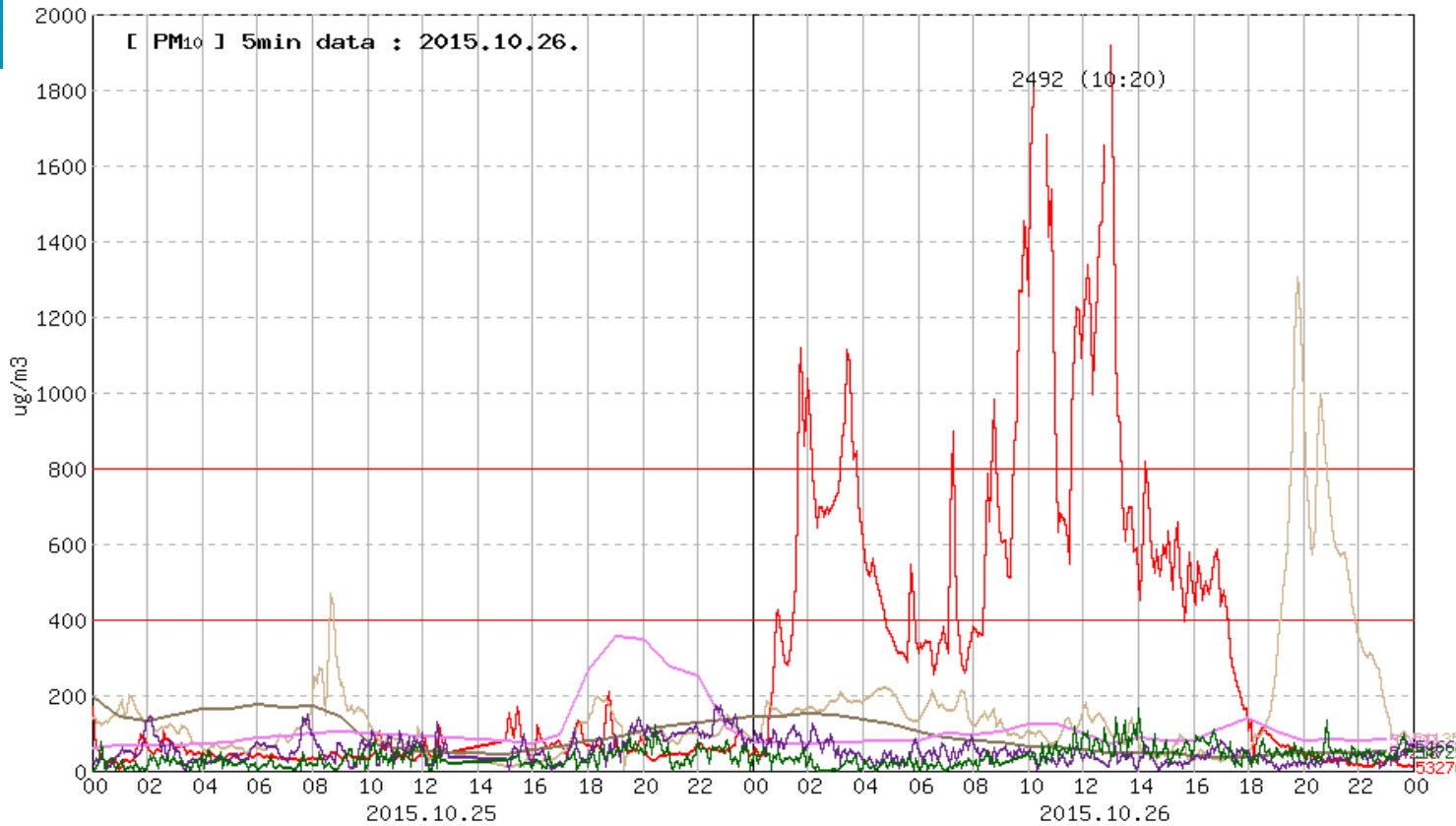
## DUST RGB(Himawari)



## AI products(COMS)



00UTC 26<sup>th</sup> Oct. ~02UTC 27<sup>th</sup> Oct. 2015

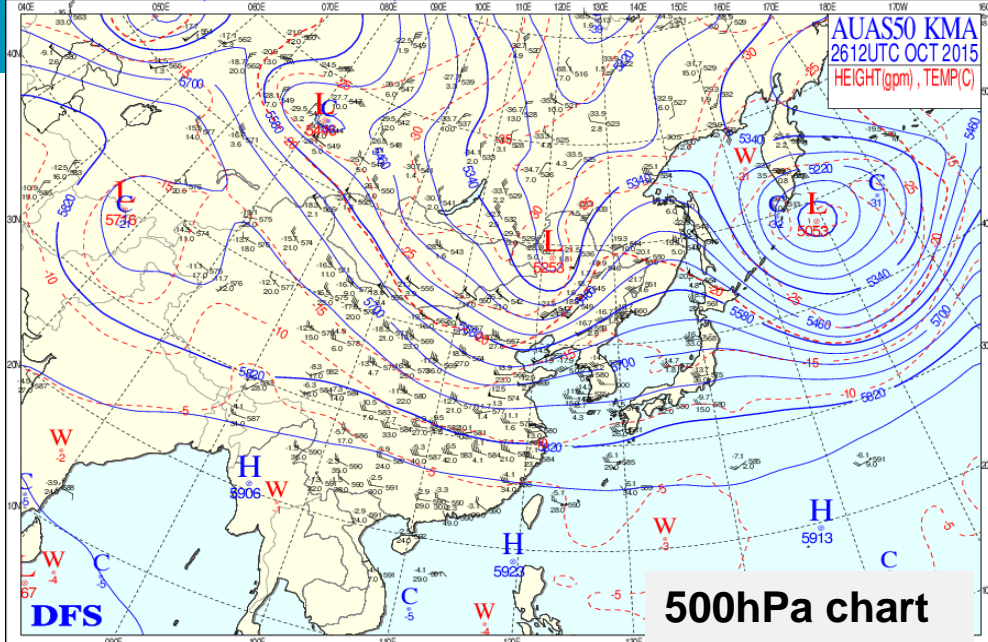


- |                  |           |
|------------------|-----------|
| 54662 다렌         | 54135 통라도 |
| <b>53276 주리허</b> | 54725 후이민 |
| 54157 스피링        | 54218 츠핑  |
| 54497 단둥         |           |

## Time series of PM10 density

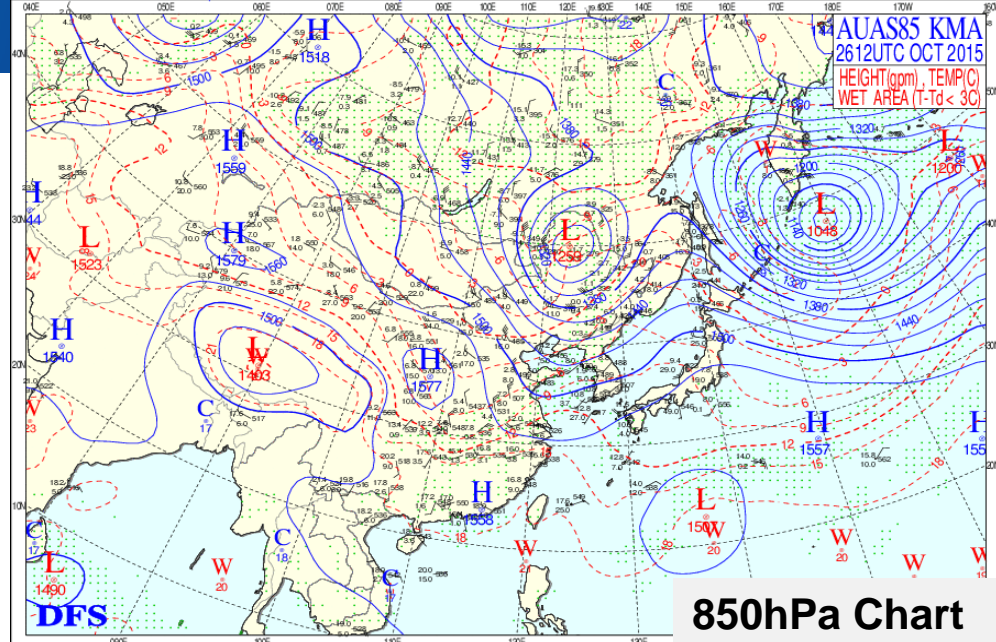


12UTC 26 OCT 2015 (21KST 26 OCT 2015)

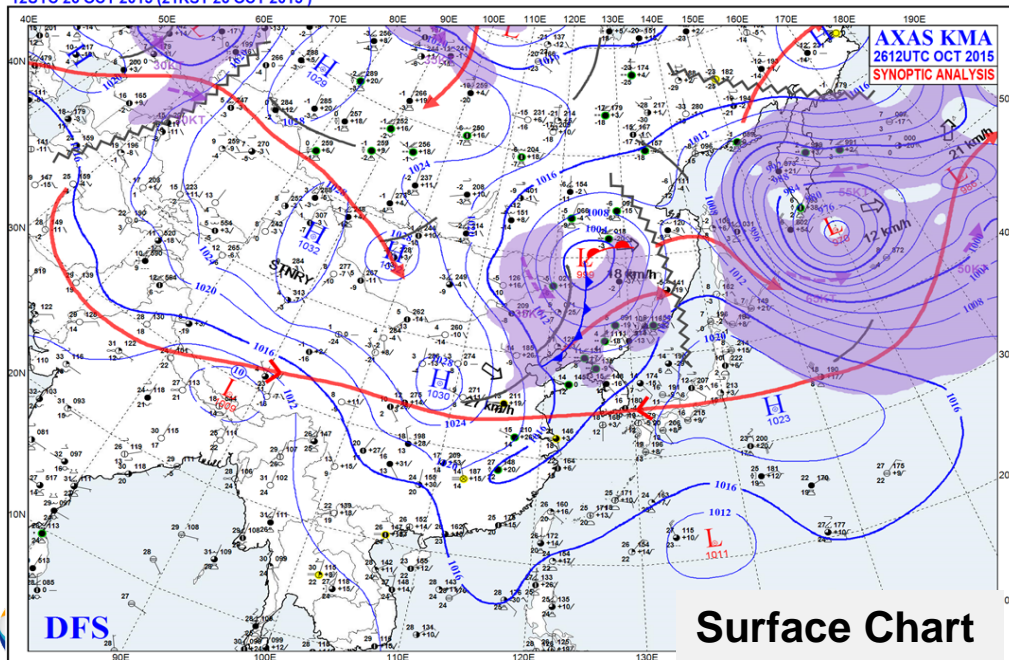


Korea Meteorological Administration(KMA) 12UTC 26 OCT 2015 (21KST 26 OCT 2015)

12UTC 26 OCT 2015 (21KST 26 OCT 2015)

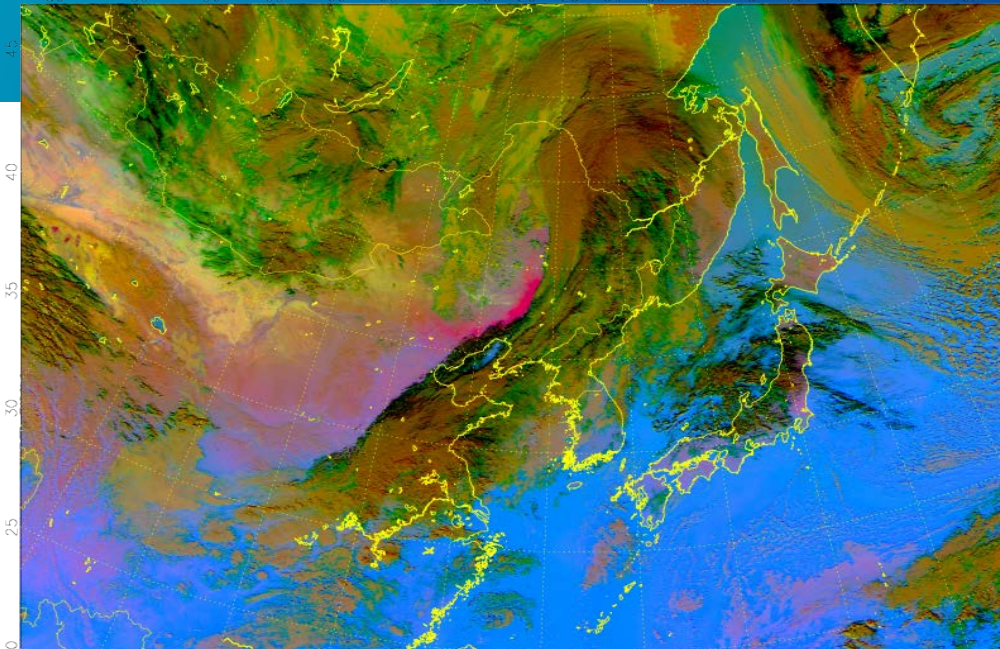


Korea Meteorological Administration(KMA) 12UTC 26 OCT 2015 (21KST 26 OCT 2015)



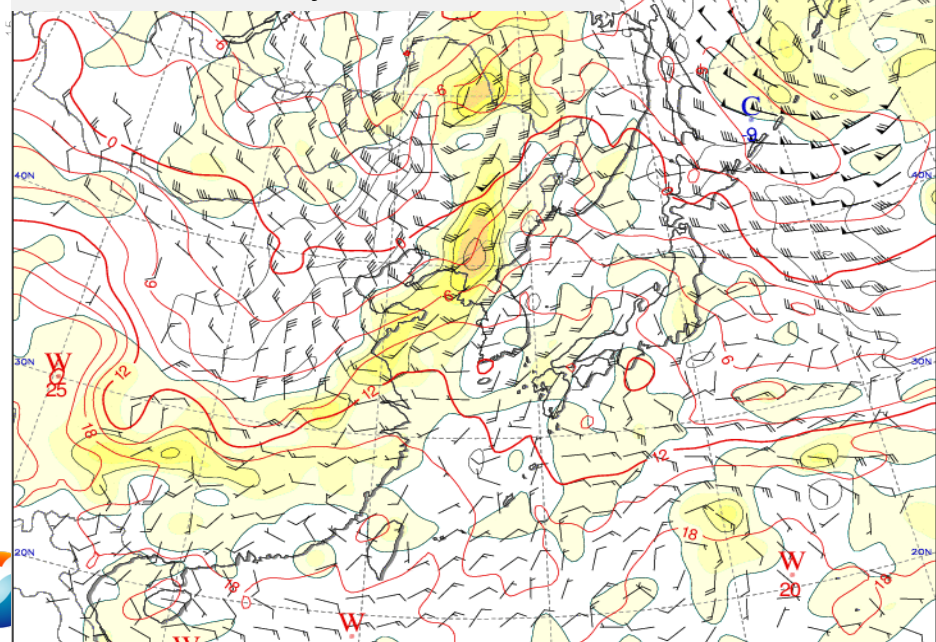
Korea Meteorological Administration(KMA) 12UTC 26 OCT 2015 (21KST 26 OCT 2015)

1. 500hPa chart : Deep upper trough
2. 850hPa chart : Surface trough accompanied by upper trough.
  - Temperature trough also developed in the rear of upper trough
3. Surface chart : cold front at the rear of the surface low
  - subsidence of yellow sand

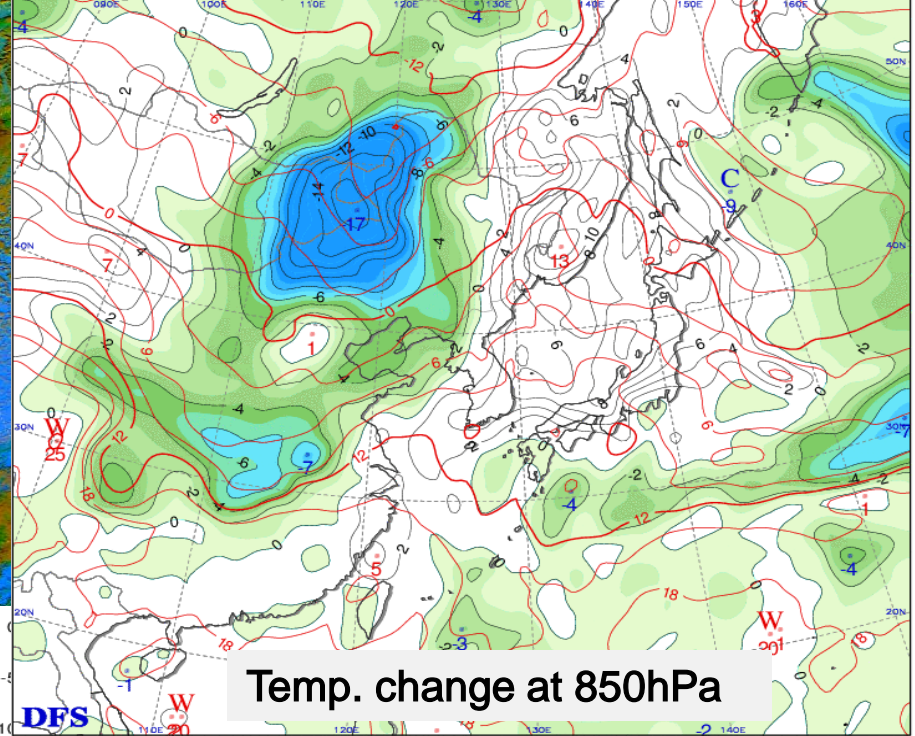


850hPa Temperature(C), 700hPa P-Velocity(hPa/hr) RDAPS (UM 12km L70)

**Vertical Velocity at 700hPa**



850hPa Temp(C) and Tendency for 24 hours(C/day) RDAPS (UM 12km L70)

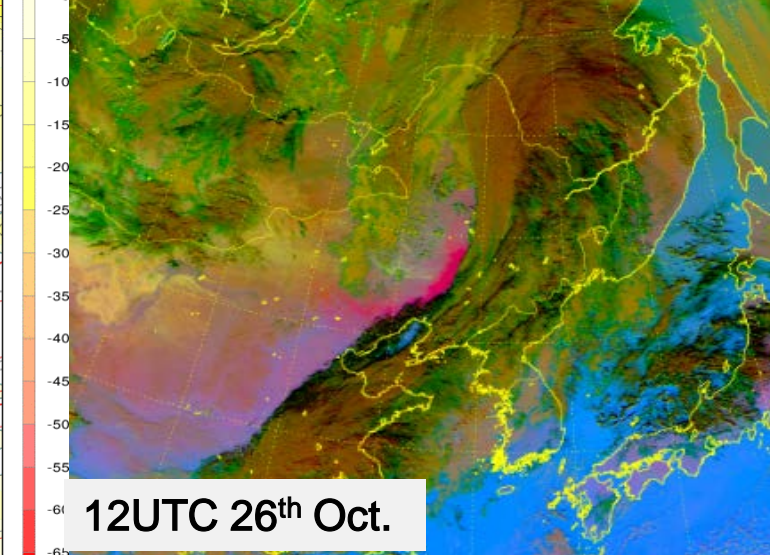
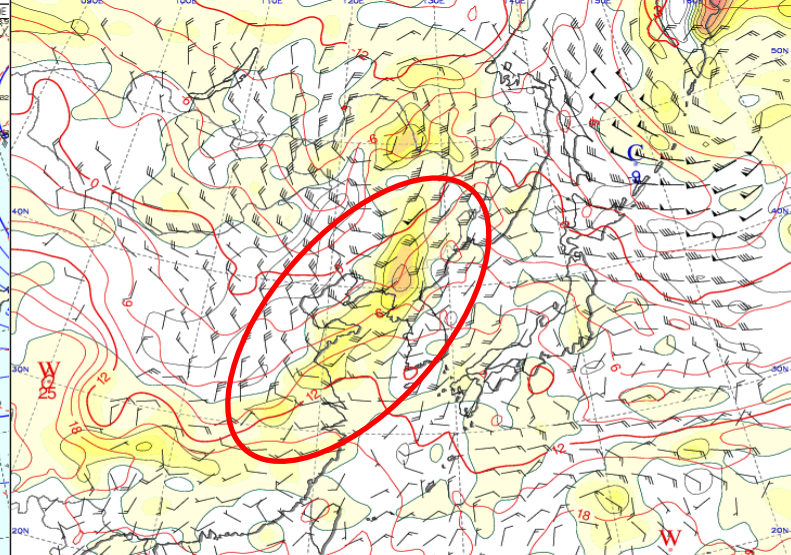
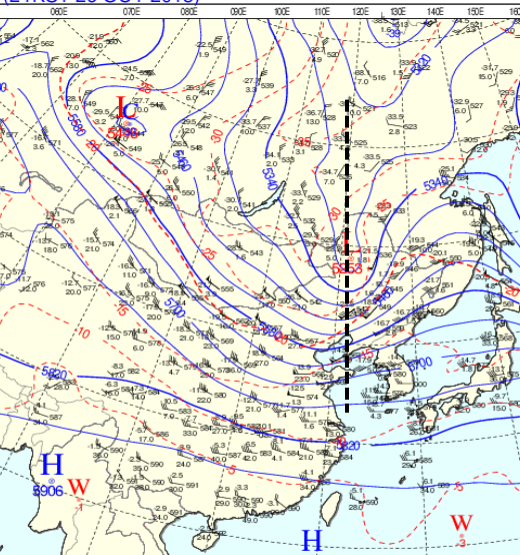
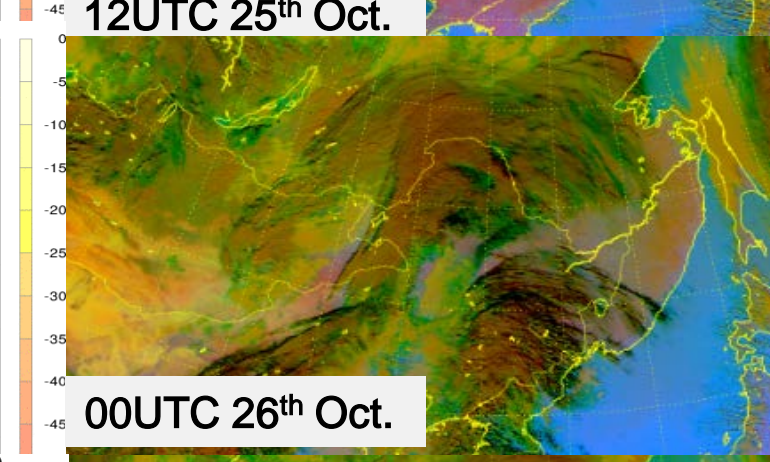
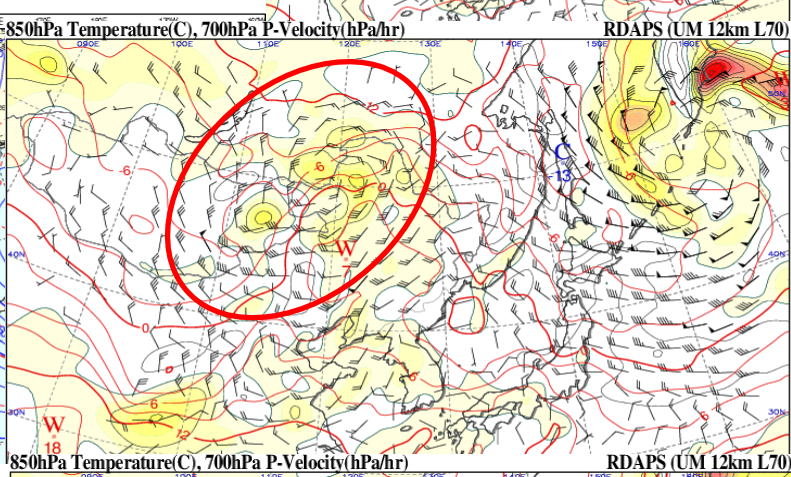
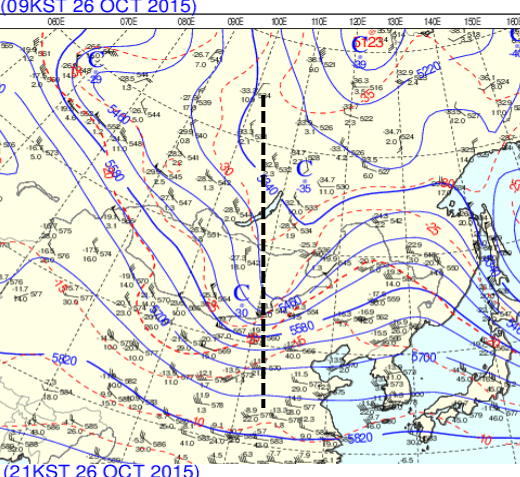
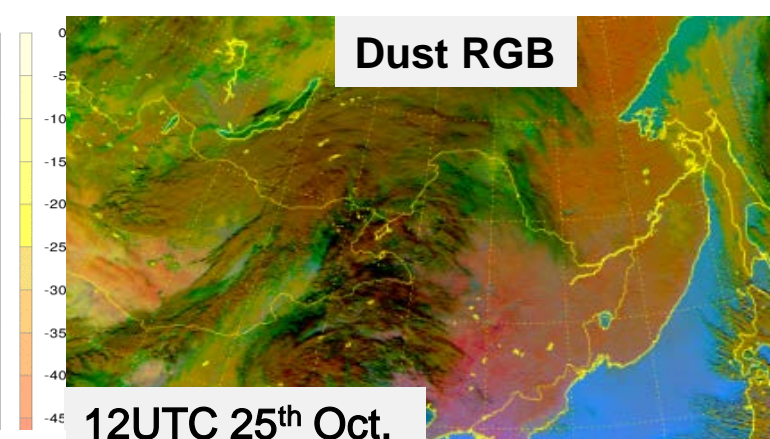
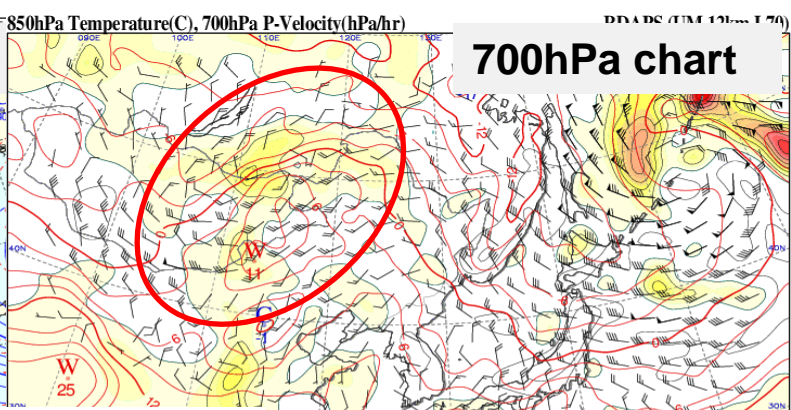
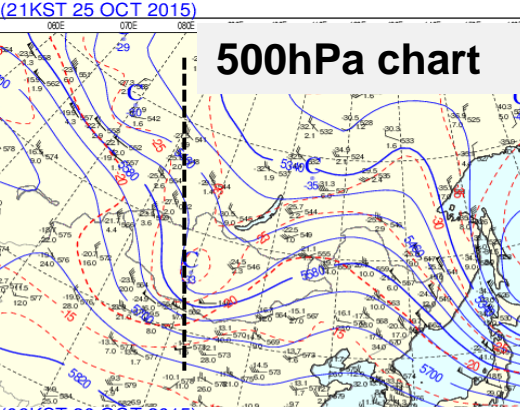


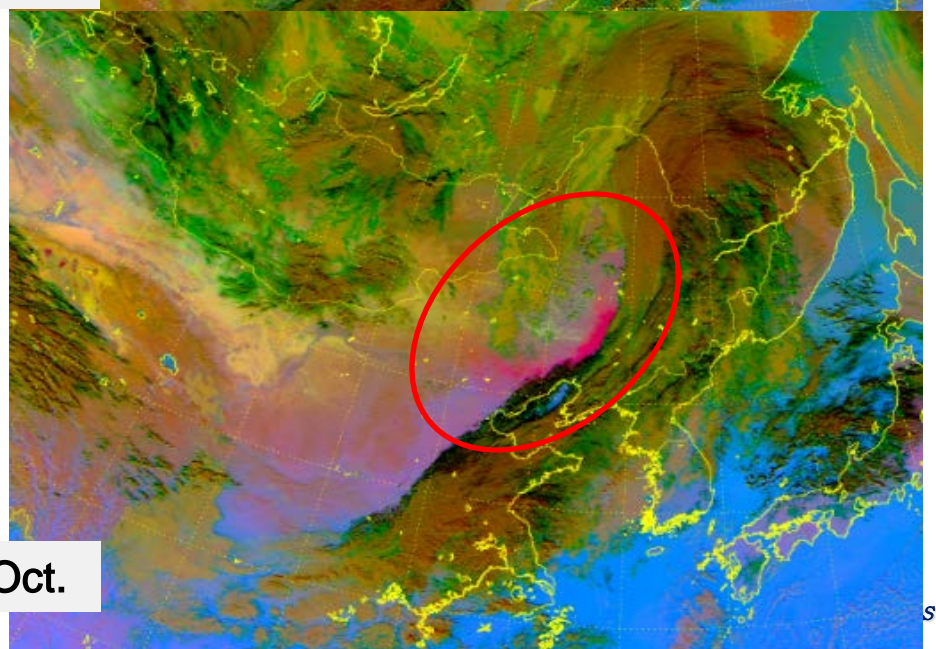
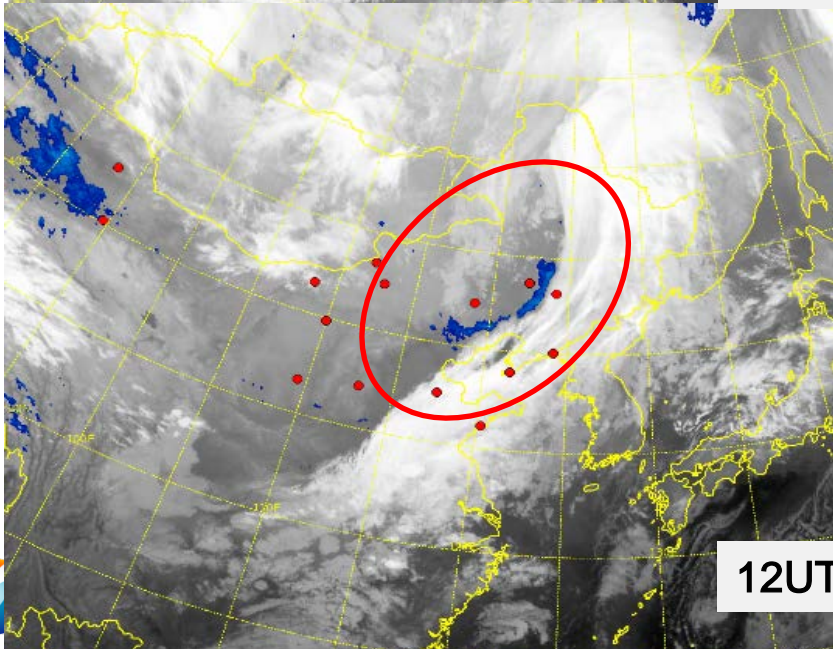
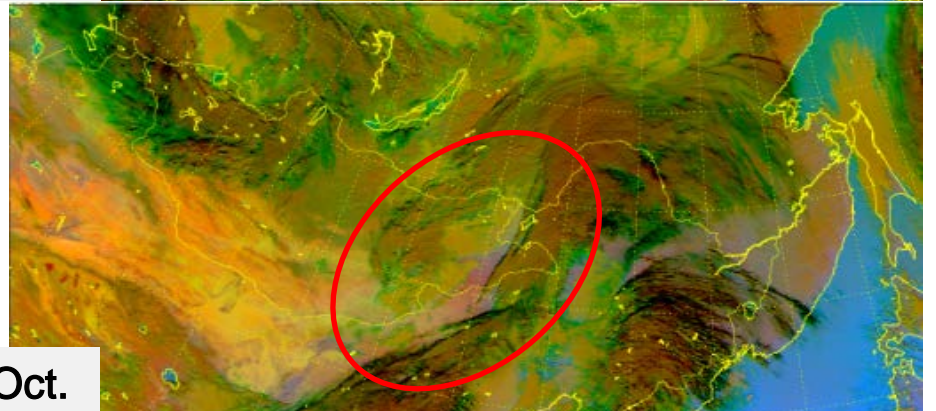
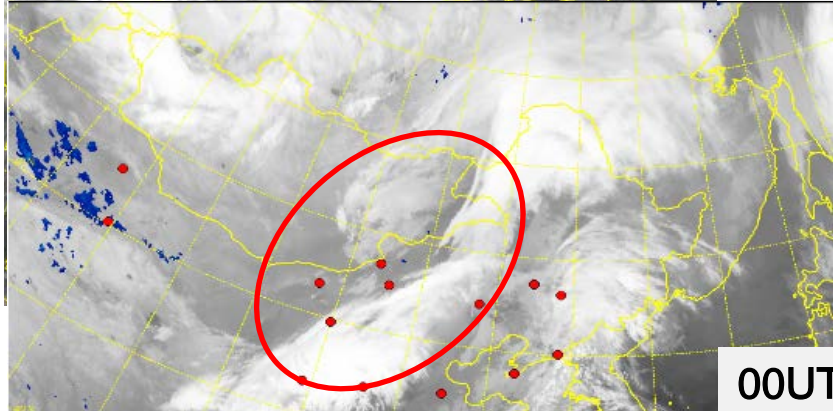
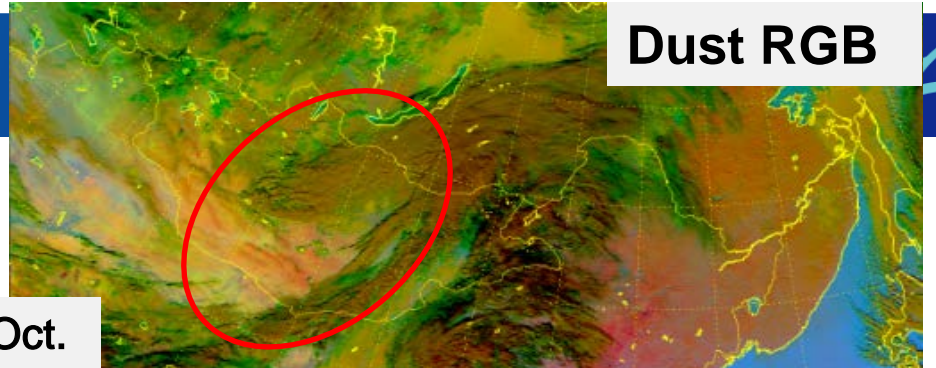
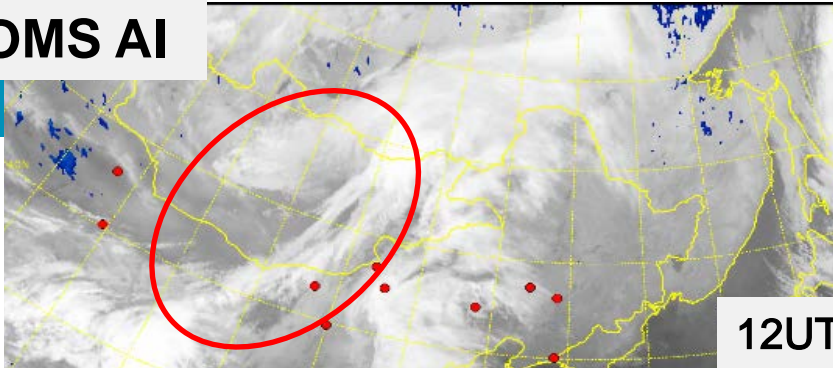
**Temp. change at 850hPa**

VALID : 12UTC 26 OCT 2015(+ 00h) TIME : 12UTC 26 OCT 2015  
 21KST 26 OCT 2015(+ 00h) 21KST 26 OCT 2015

1. Strong vertical velocity area at 700hPa = outbreak of yellow sand and moving along the updraft
2. Drop area in temperature at 850hPa = rear of the cold front = subsidence of yellow sand into the surface







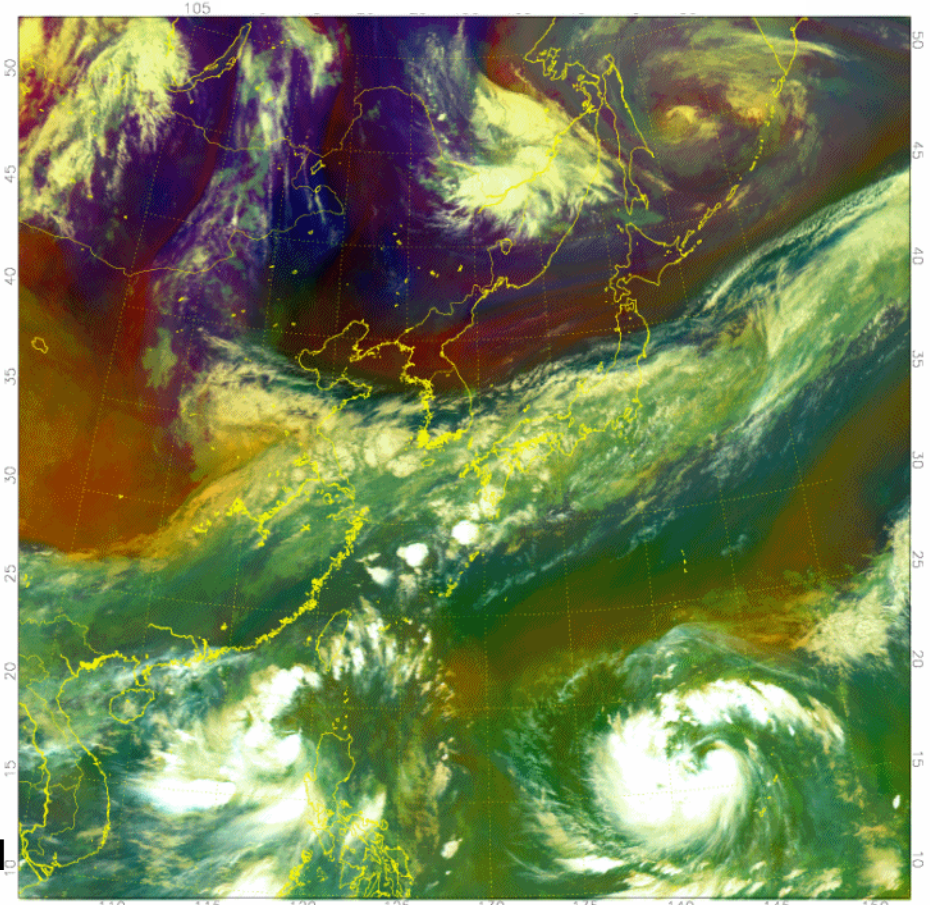
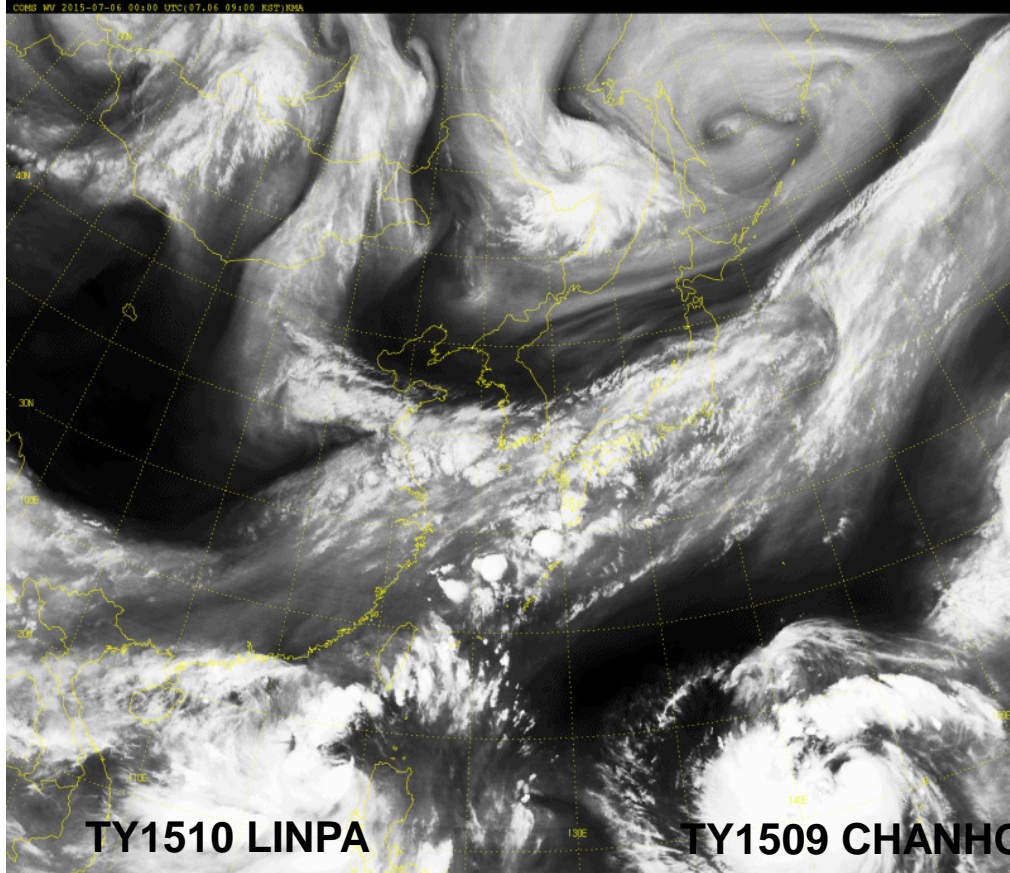
# Usage of Airmass RGB

하늘을 친구처럼  
국민을 하늘처럼

COMS(WV)

6<sup>th</sup> July 2015

Himawari(Airmass RGB)



00:00~01:30 UTC(15min)

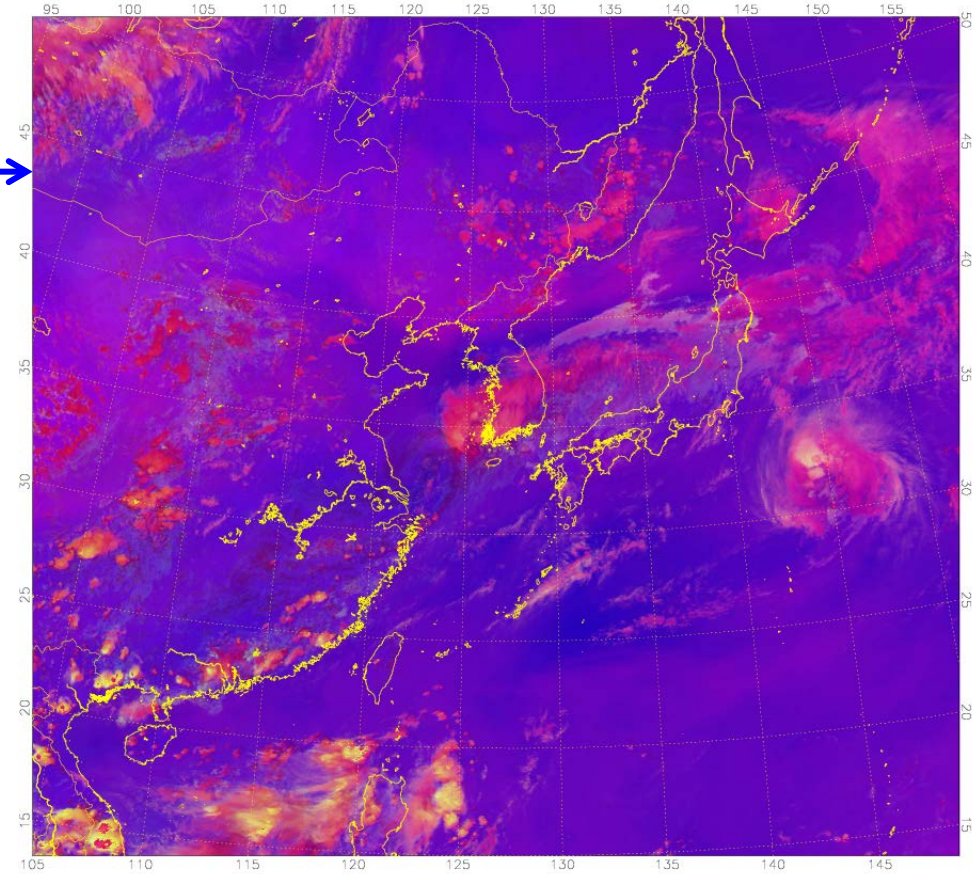
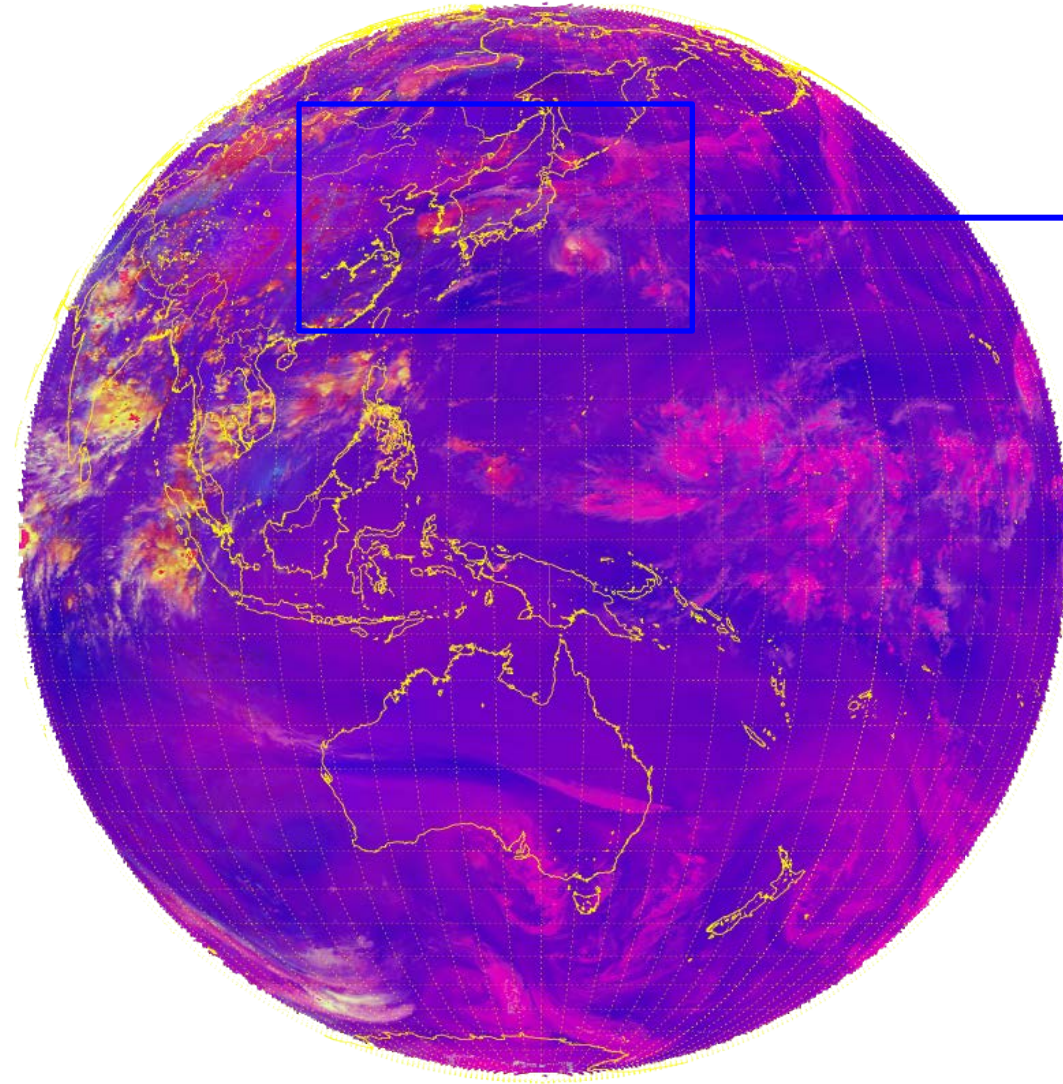
00:00~01:30 UTC(10min)

High cloud(white)  
Mid cloud(light yellow)  
tropical airmass(green)- warm air mass  
polar airmass(blue)-cold air mass  
Dry airmass (red)

# Daytime Convective Strom RGB

하늘을 친구처럼  
국민을 하늘처럼

0730UTC 11 Aug. 2015

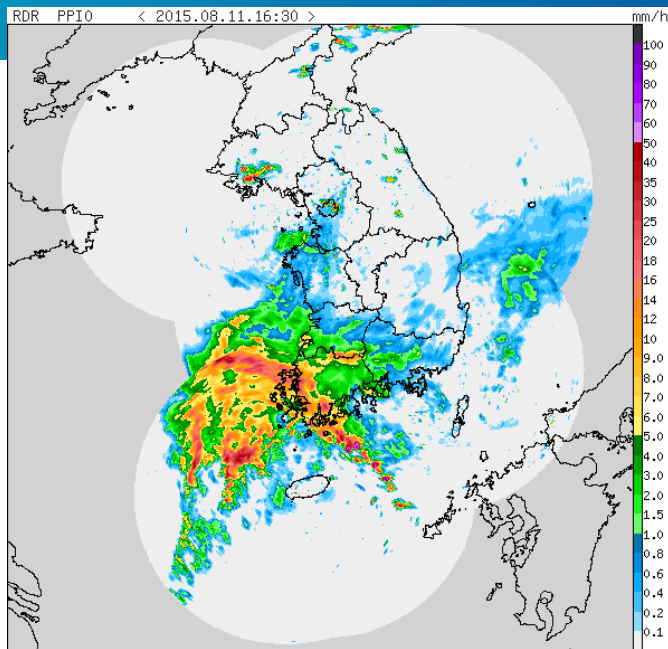


Himawari RGB Composite Image\_Day Convective Strom  
( R: WV6.2 - WV7.3 / G: IR3.9 - IR10.4 / B: NIR1.6 - VIS0.6 )  
2015.08.11, 07:30 (UTC)

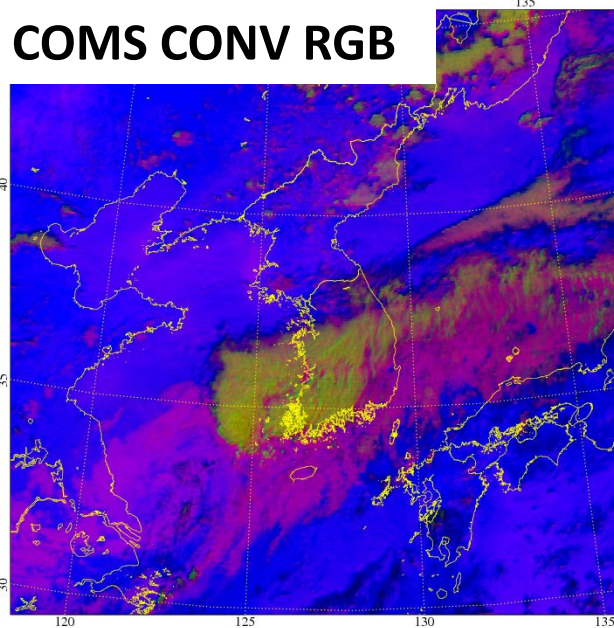


# 0730UTC 11 Aug. 2015

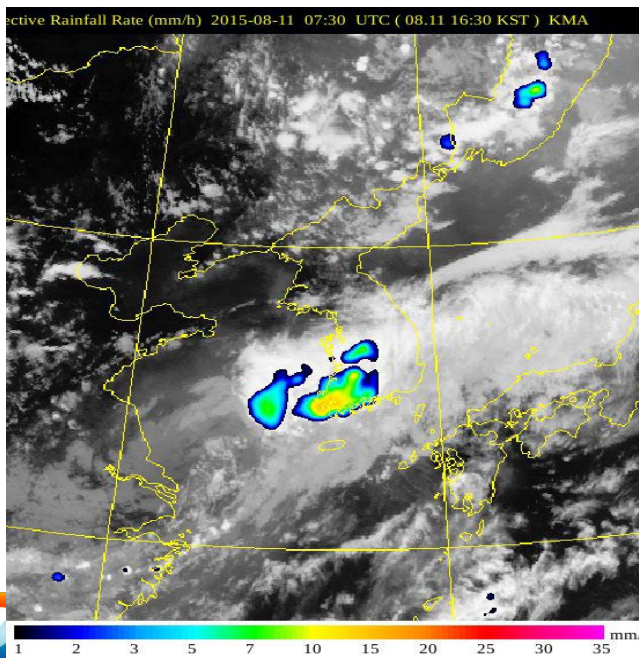
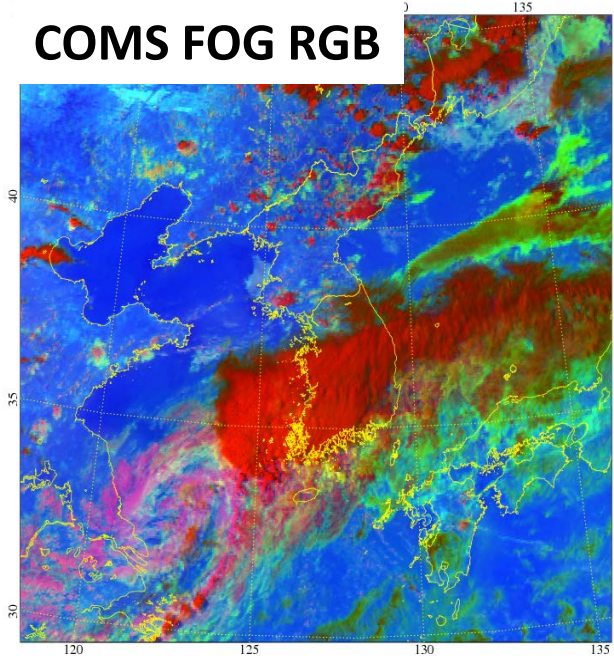
하늘을 친구처럼



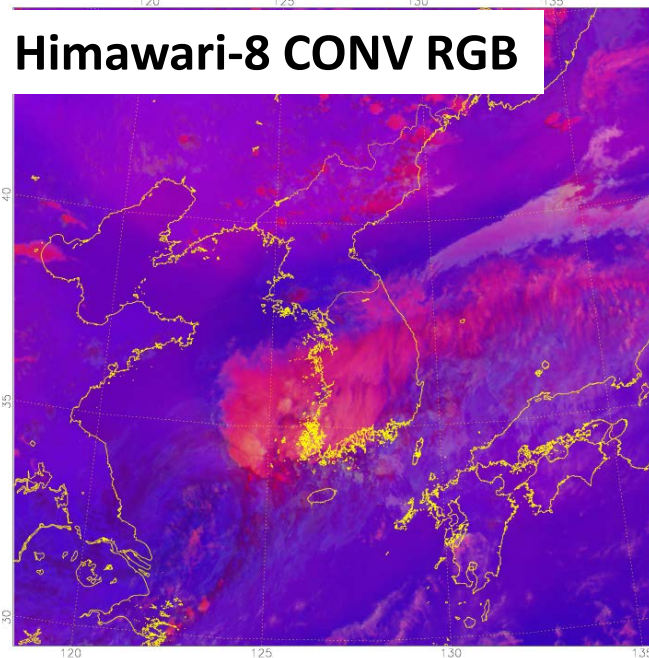
### COMS CONV RGB



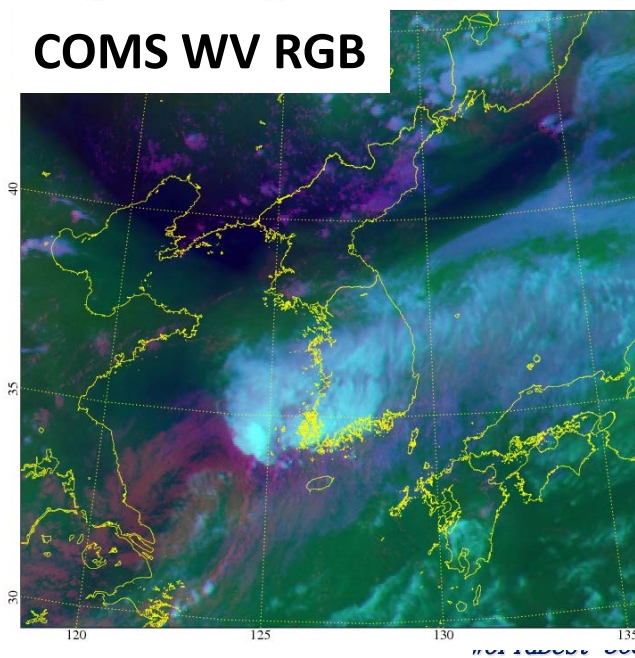
### COMS FOG RGB



### Himawari-8 CONV RGB



### COMS WV RGB



# Thank you

[hspark@kma.go.kr](mailto:hspark@kma.go.kr)  
<http://nmsc.kma.go.kr>

