Current Status of convective cloud monitoring at NMSC/KMA

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KMA RDT in 2015

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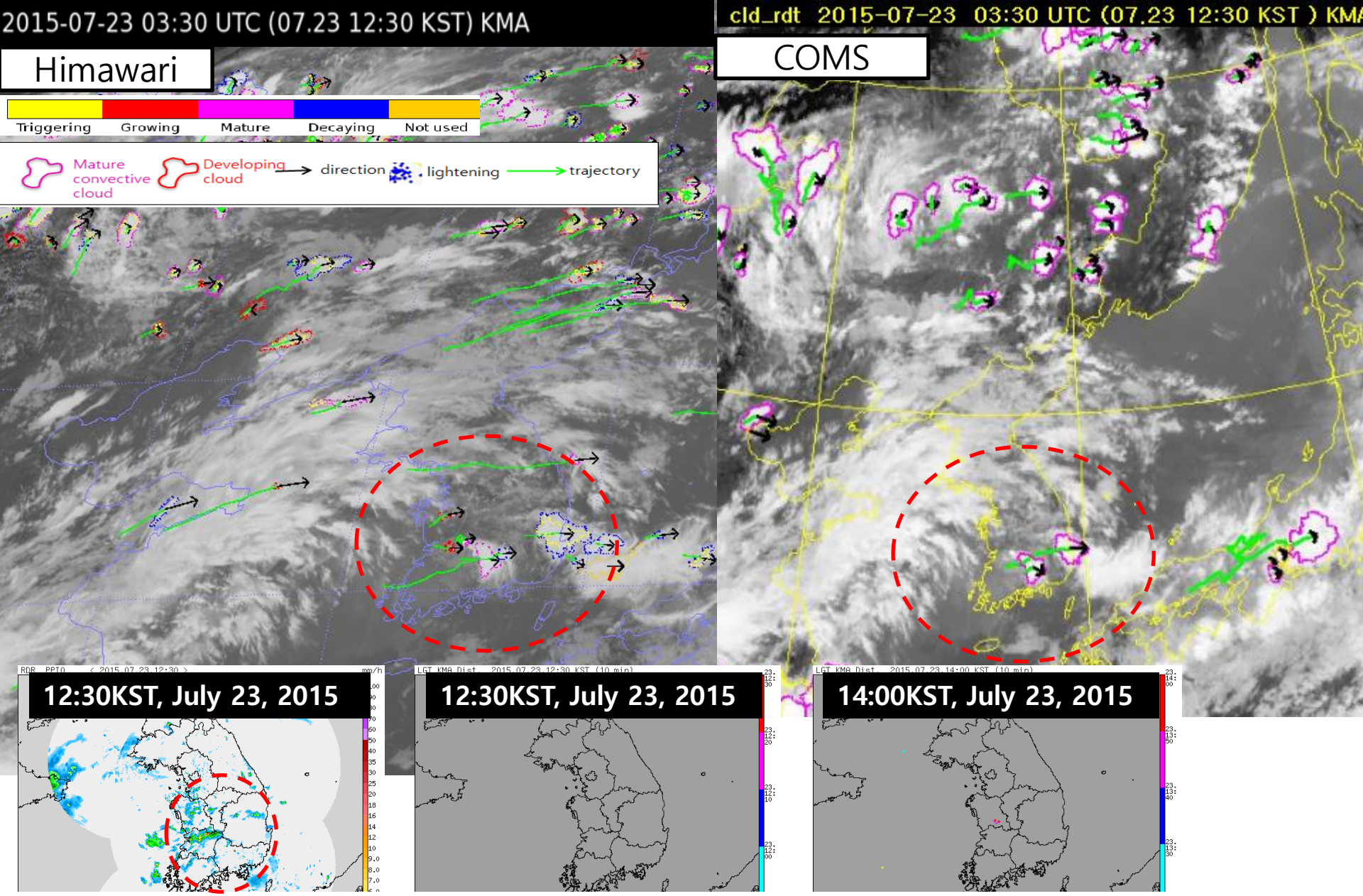
- **We have introduced RDT module(PGE11) and been producing RDT product with COMS data every 15 min. since 1st April 2011.**
- **We have been also producing Himawari RDT(PGE11, v2013).**
  - Started to receive Himawari data from 00UTC, 4th July, 2015
  - No changes in RDT module except for Himawari data adaptation
  - Producing CRR and Cloud Analysis products with Himawari data by using PGE1~3, and 5
  - Compared between COMS RDT(v2009) and Himawari RDT(v2013)
  - Validated RDT results with lightning data over Korean region
  - Made RDT visualization tool to monitor the change the attributes for each convective cell.
- **Actually, we have to do some adjustments to optimize RDT module for Himawari.**



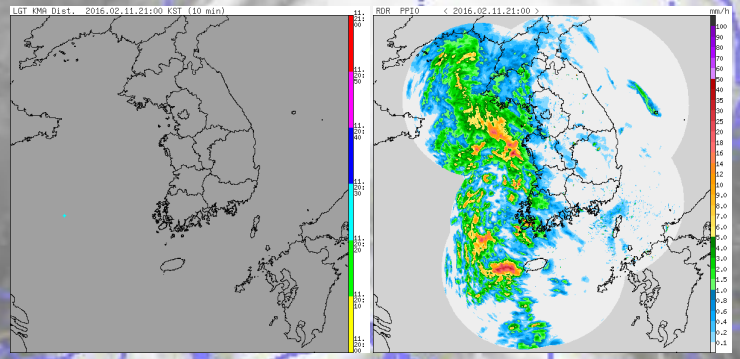
- This is example of comparison between Himawari RDT and COMS RDT
- We can see the small cells developing behind mature convective cloud in southern part of Korean Peninsular.
- Overall, Himawari RDT has a tendency to detect small sized convective cell better than COMS

12:00UTC, Feb. 11, 2016

- Cold air intrusion makes convective clouds developing in west sea of Korea Peninsular in winter time.
- These cloud brought heavy rain with greater than 20 mm/hr.
- However most of cloud cells disappear after discrimination scheme application.
- As shown in right hand side picture, these cells are diagnosed to be non convective from statistical model
- We need new statistical model for winter time convective cloud discrimination

Final convective cloud product

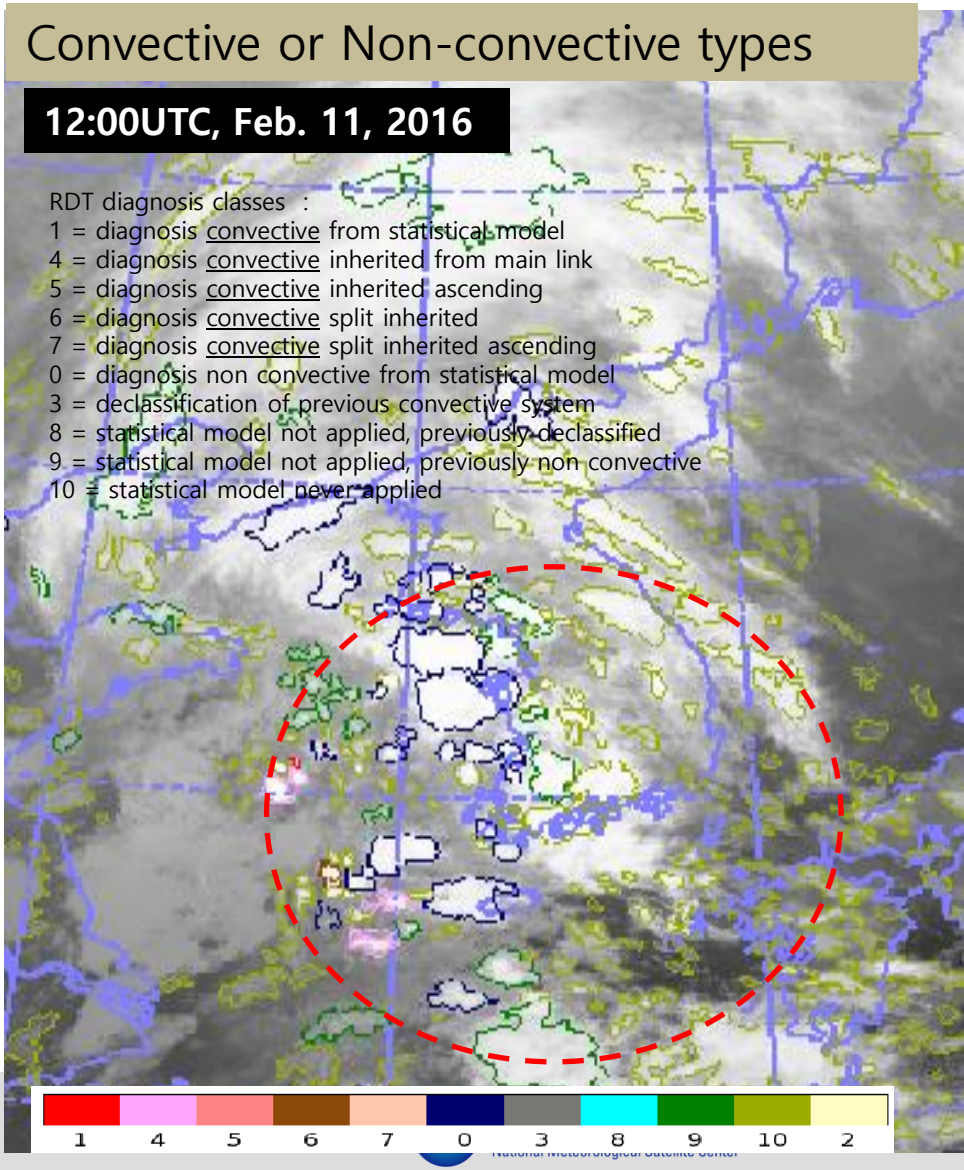
12:00UTC, Feb. 11, 2016



Convective or Non-convective types

12:00UTC, Feb. 11, 2016

RDT diagnosis classes :
1 = diagnosis convective from statistical model
4 = diagnosis convective inherited from main link
5 = diagnosis convective inherited ascending
6 = diagnosis convective split inherited
7 = diagnosis convective split inherited ascending
0 = diagnosis non convective from statistical model
3 = declassification of previous convective system
8 = statistical model not applied, previously declassified
9 = statistical model not applied, previously non convective
10 = statistical model never applied



Validation Results

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(Period : 16:00 UTC 28th July ~ 23:50 UTC 28th July, 2015)

Statistical element / Hypothesis			Trajectory	Section			Time Step		
				H1	H2	H3	H1	H2	H3
Low lightning activity	Population	Conv	36	Red(18), Green(16), Orange(8), Black(6), Gray(2), Violet(0)			Red(31), Green(64), Orange(25), Black(13), Gray(19), Violet(0)		
		NoConv	348	Yellow(365)			Yellow(1844)		
	Score	POD	61.11	55.56	73.33	52.38	54.84	78.12	42.02
		POFD	6.96	6.98	6.88	7.10	5.55	5.45	5.62
		FAR	69.44	71.43	54.17	54.17	85.59	67.53	67.53
		TS	25.58	23.26	39.29	32.35	12.88	29.76	22.42
Moderate Lightning activity	Population	Conv	11	Red(15), Green(10), Orange(4), Black(3), Gray(0), Violet(0)			Red(44), Green(34), Orange(10), Black(11), Gray(9), Violet(0)		
		NoConv	3	Yellow(0)			Yellow(0)		
	Score	POD	78.57	80	85	58.62	66.91	74.58	50
		POFD	0	0	0	0	0	8.7	23.53
		FAR	0	0	0	0	0	8.33	8.33
		TS	78.57	80	85	58.62	65.91	69.84	47.83
Severe lightning activity	Population	Conv	9	Red(11), Green(9), Orange(5), Black(2), Gray(0), Violet(1)			Red(125), Green(35), Orange(13), Black(6), Gray(0), Violet(2)		
		NoConv	0	Yellow(0)			Yellow(0)		
	Score	POD	100	90.91	93.75	60	87.2	88.15	68.79
		POFD	0	0	8.33	33.33	0	2.17	12.5
		FAR	0	0	6.25	6.25	0	0.83	0.83
		TS	100	90.91	88.24	57.69	87.2	87.50	68.39

- We validated Himawari RDT with light data and followed the validation method Meteo-france used.
- We got the different results according to lightning activity.
- In case of low light activity, POD = 61, FAR = 70, higher FAR than that of Meteo-france

Visualization tool for RDT(1)

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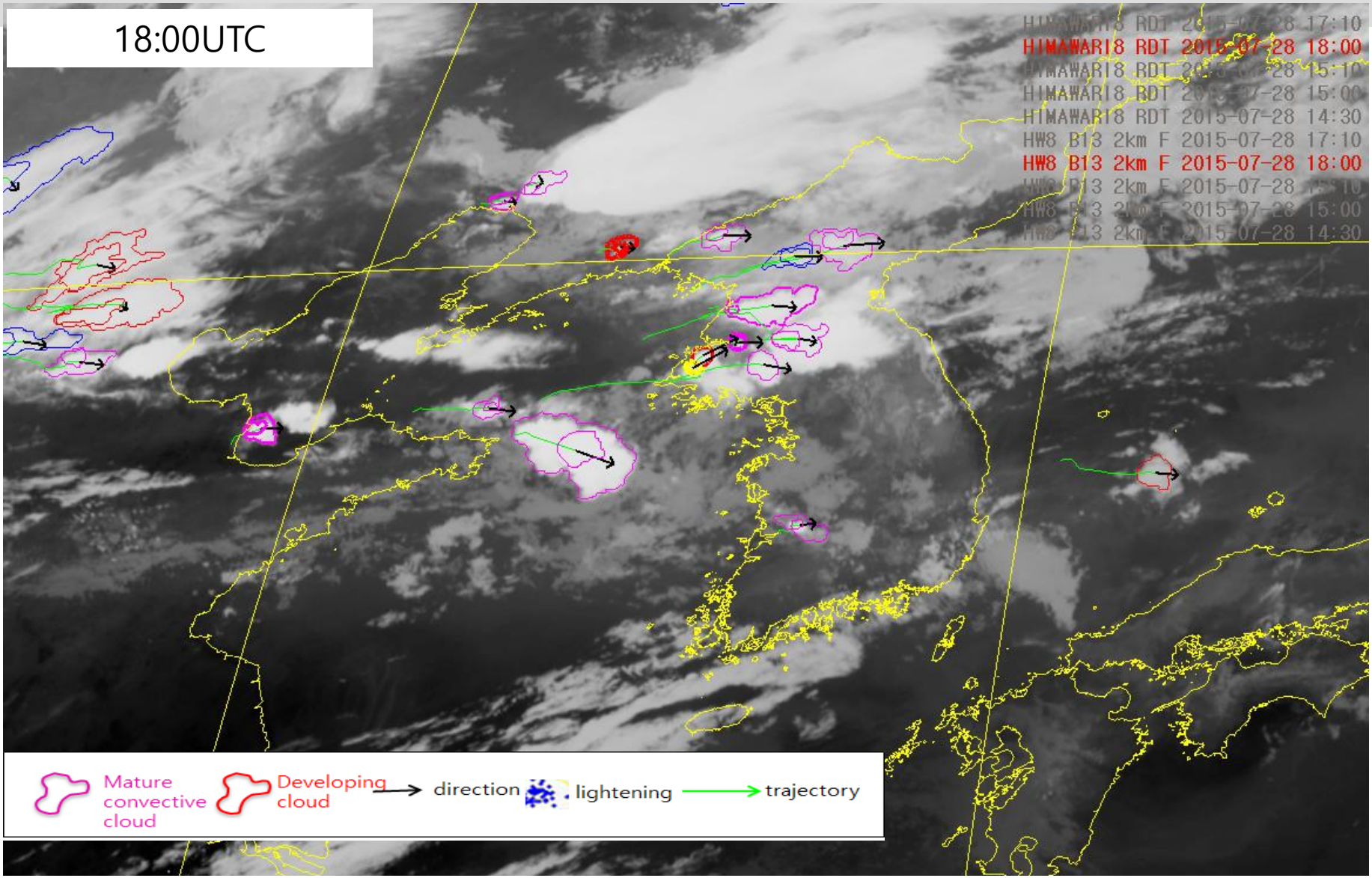

- We made visualization tool to monitor the changes of attributes of convective cloud
- We mimicked the visualization tool of Meteo-france.

Visualization tool for RDT(2)

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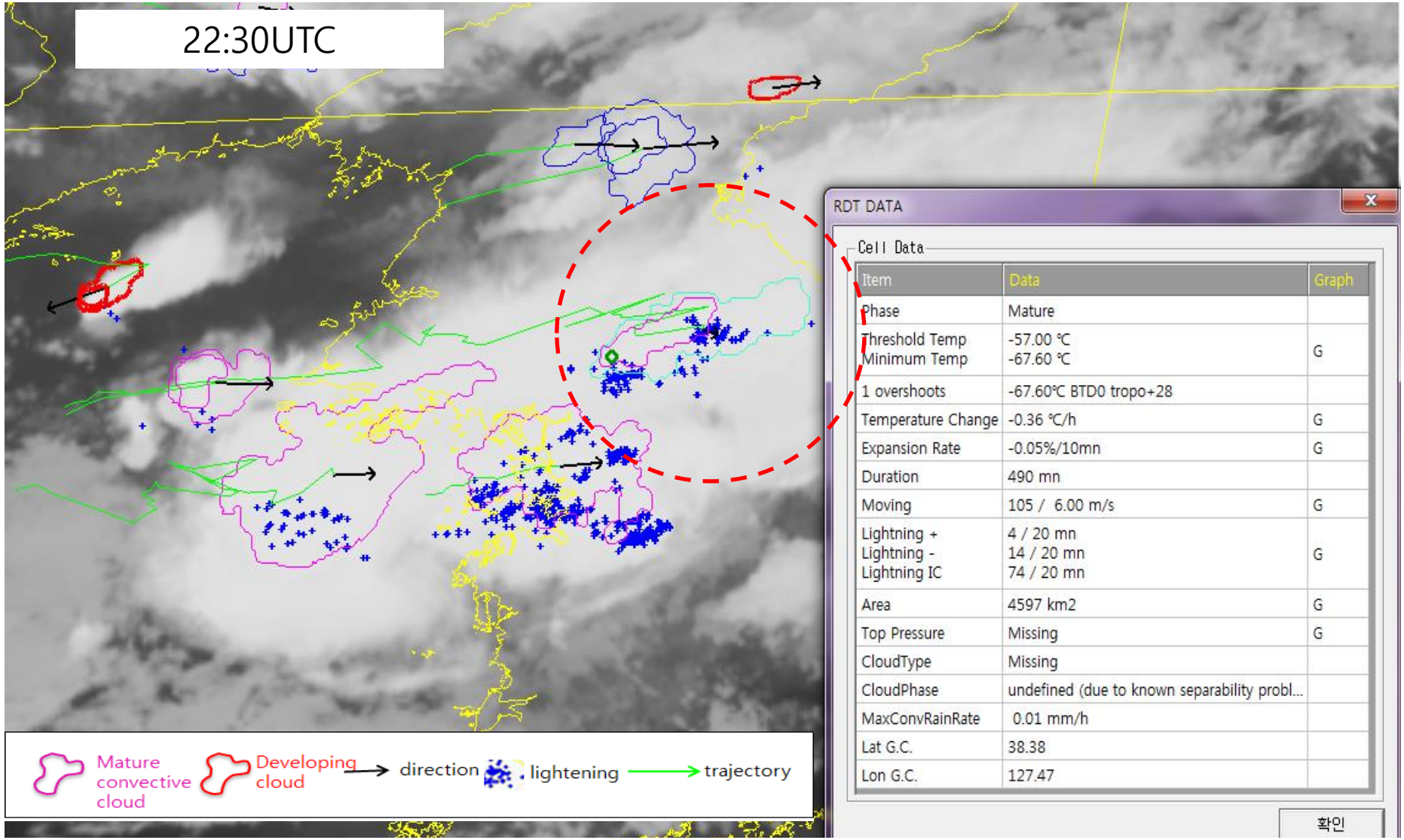
National Meteorological Satellite Center



- We can monitor the phase of cell, information on Overshooting, duration and so on as shown in table.

Visualization tool for RDT(3)

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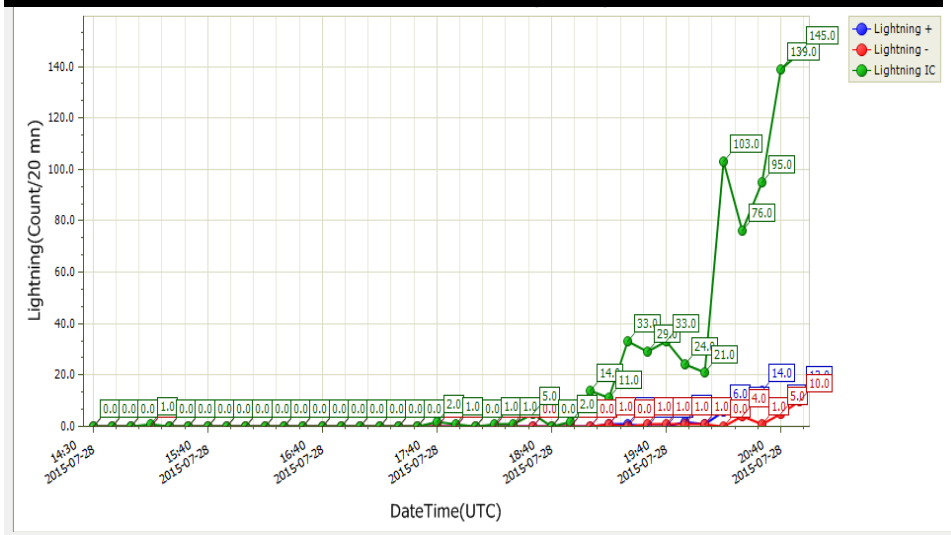
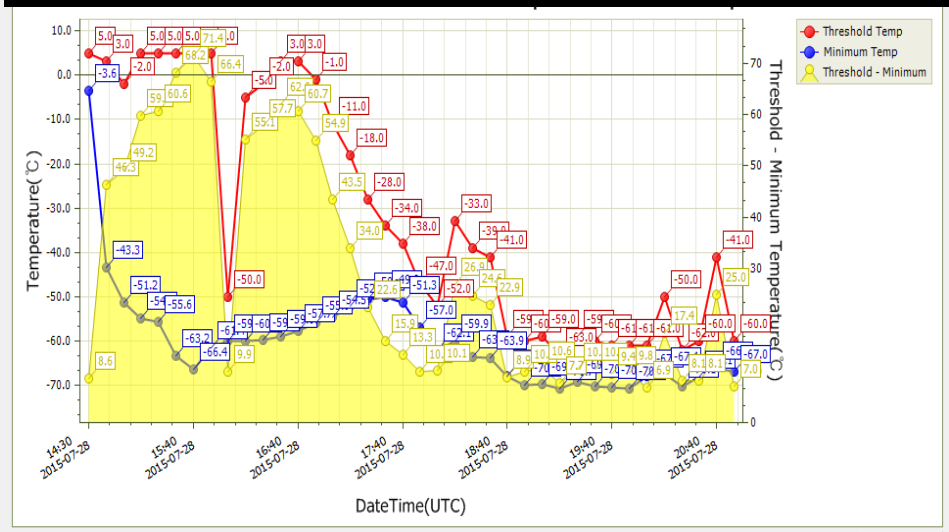
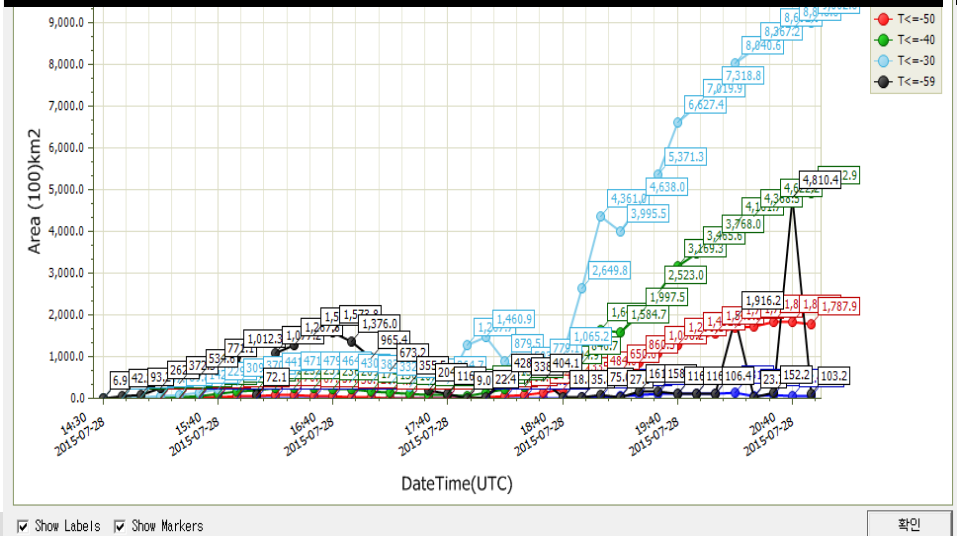
Time series of lightning number



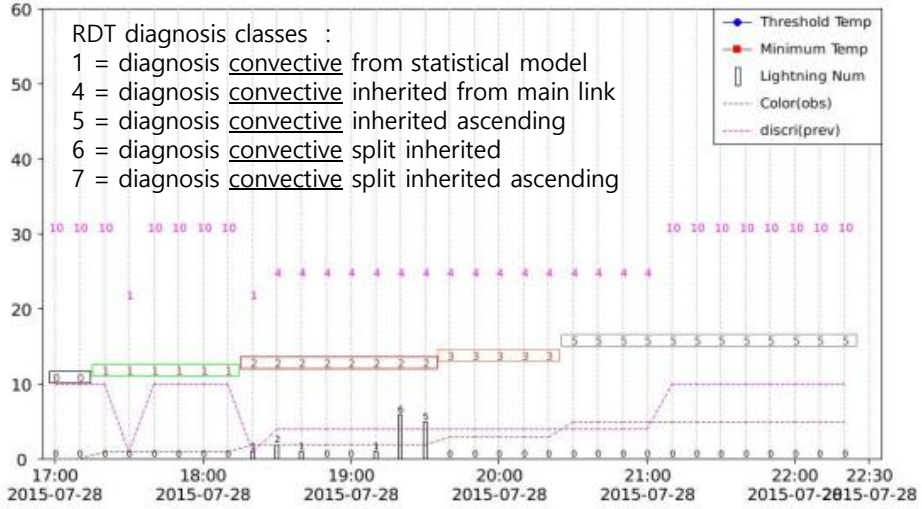
Time series of Threshold Temp. & Minimum Temp.



Time series of convective cloud area



Convective cloud Trajectory



- We can also see time-series of attributes for each cell from visualization tool

KMA RDT in 2016

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- To seek main characteristics (dominant variables) to discriminate convective cloud
- To make new logistic regression coefficients using lightning data over Korean region and produce Himawari RDT product with these values.
- To collaborate with Meteo-france , RDT developer to optimize RDT module with Himawari data.

Geo-KOMPSAT-2A (GK-2A)

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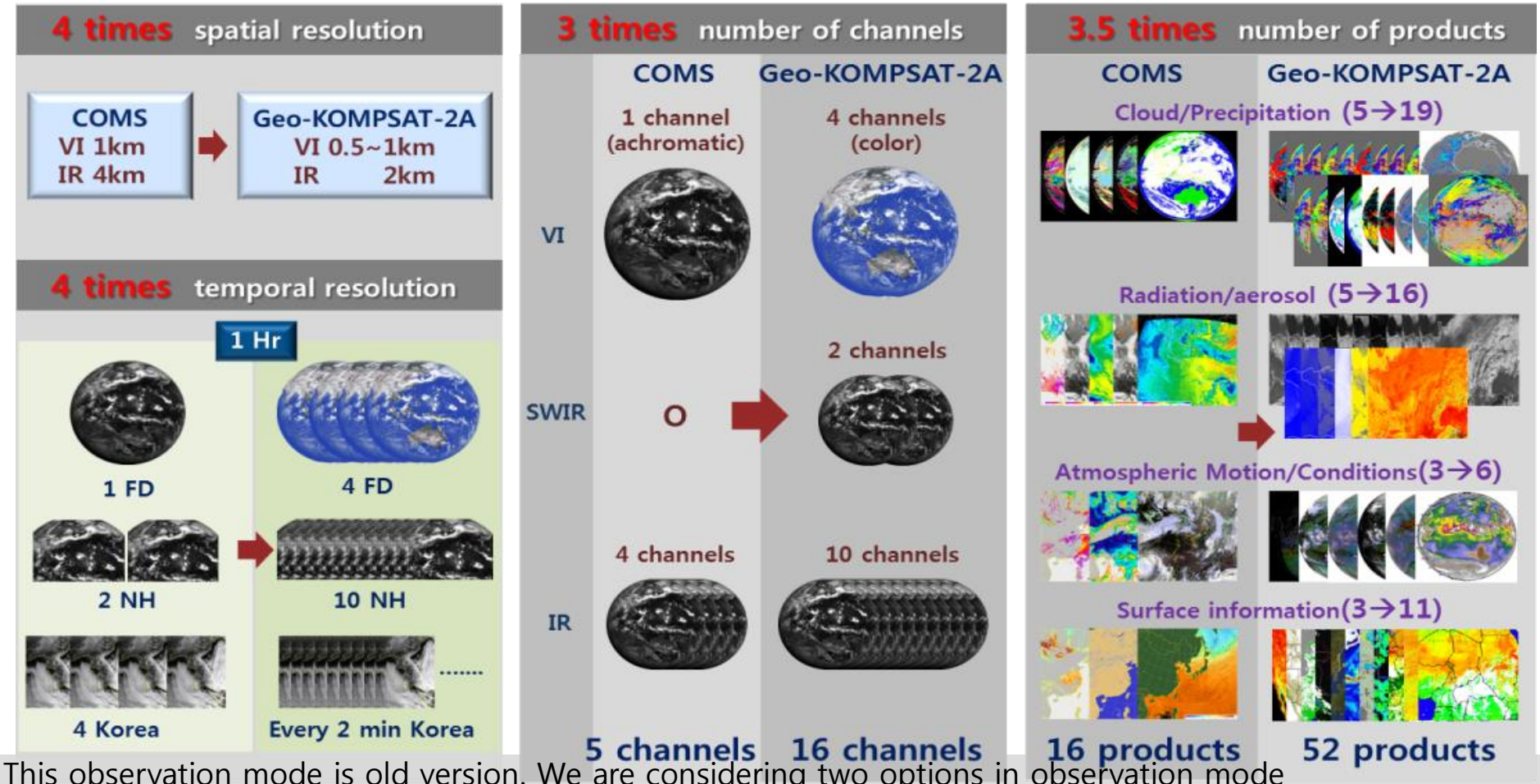
National Meteorological Satellite Center

- The Next Korean geostationary meteorological satellite which will be launched in 2018
- **Mission :** Enhancing weather forecast/climate monitoring and application to disaster mitigation and so on based on high resolution measurements
- **Payloads :** Advanced Meteorological Imager, Space Weather monitoring

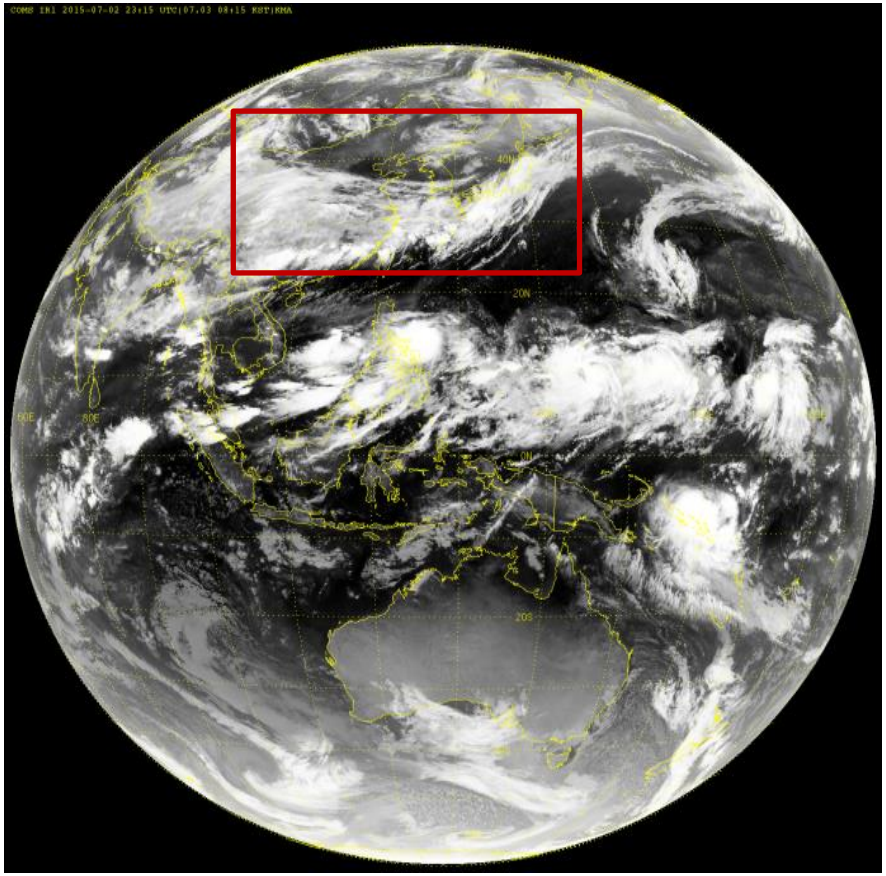


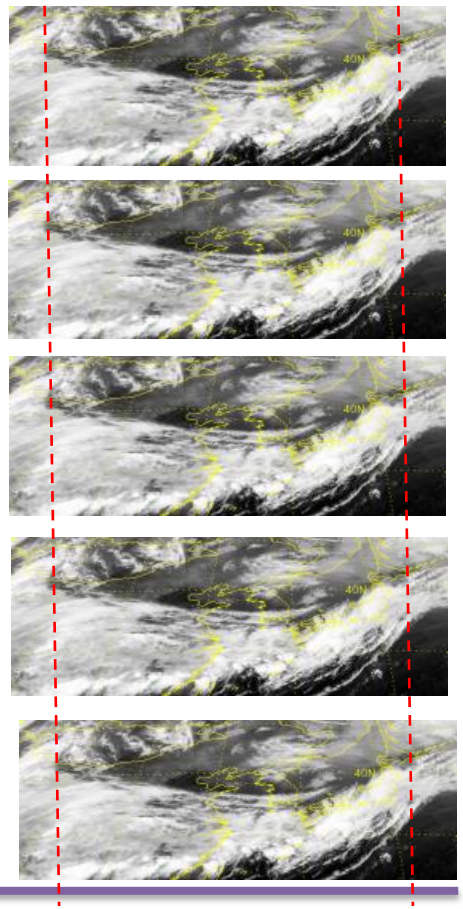
This observation mode is old version. We are considering two options in observation mode

Observation Option#2 - Extended Local Area(2)

- If we reduce the size of Extended local area like below pictures, we can get Full Disk every 10 min and ELA images every 2 min.
- Currently, this option is considered significantly but it is not fixed.

10 min.
Timeline





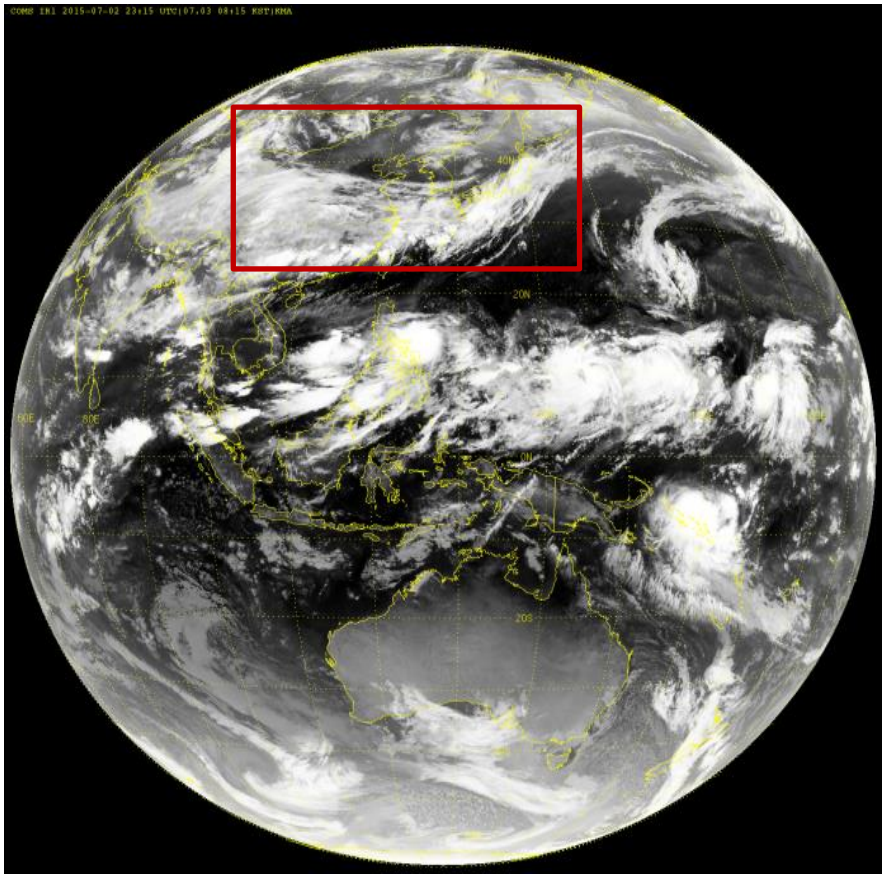
Full Disk
Every 10 min.

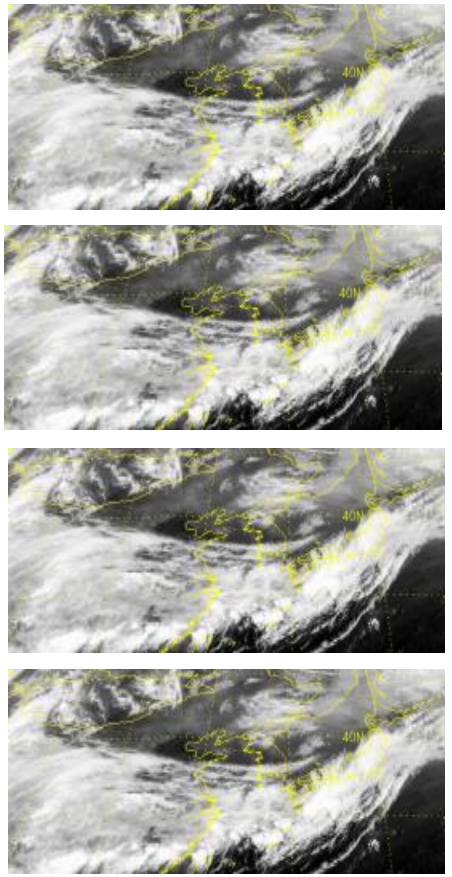
Extended Local Area
Every 2 min.
(4300 X 2900 pixel)

Observation Option#1 - Extended Local Area(1)

- We can get one Full Disk every 10 and 4 ELA images every 2.5min.

10 min.
Timeline





Full Disk
Every 10 min.

Extended Local Area
Every 2.5 min.
(4300 X 2900 pixel)

GK-2A CI algorithm(1)

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- **Definition :** Detection of convective clouds which would be rapidly developed into cumulonimbus and cause severe weather within 2 hour (Walker and Mecikalski, 2011)
- **Required Accuracy :** 70 %, R=0.6
- **Proxy data :** Himawari-8/AHI L1B visible and infrared
- **Ancillary data** : Lon/Lat, VZA

- **Algorithm steps**
  - Convective cloud mask
  - Clustering (watershed segmentation)
  - Cooling rate tests
  - Two-channel threshold tests

- **Validation :** Radar CAPPI 1.5 ㎞ Reflectivity

GK-2A CI algorithm(2)

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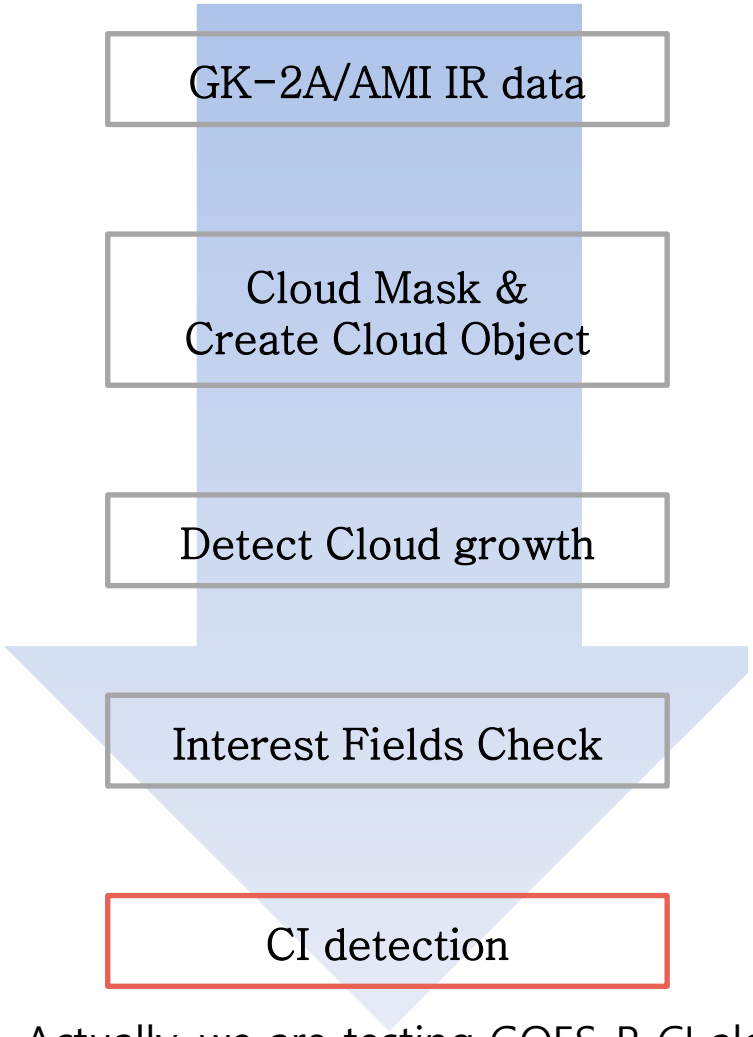

#	Tests (㎛)	Physical Basis (Mecikalski et al. 2010)	Critical Value (℃)
1	6.15-11.2	Cloud Depth	-30 to -10
2	6.12-7.4	Cloud Depth	-25 to -5
3	11.2	Cloud Depth/Glaciation	-20 to 5
4	8.5-11.2	Glaciation	-10 to -1
5	Tri-channel[1)] Diff	Glaciation	-10 to 0
6	5 min Tri-channel Diff	Glaciation Trend	> 0
7	5 min 12.3-11.2	Cloud Depth	> 0.5
8	12.3-11.2	Cloud Depth	-3 to 0
9	5 min 11.2	Cloud Growth	< -1.33
10	5 min 6.15-7.4	Cloud Depth Trend	> 0
11	5 min 6.15-11.2	Cloud Depth Trend	> 0.5
12	13.3-11.2	Cloud Depth	-20 to -5

[1)] Tri channel: (8.6 ㎛-11.2 ㎛)-(11.2 ㎛-12.3 ㎛)

(GOES-R CI ATBD)

- Actually, we are testing GOES-R CI algorithm for preliminary study.
- GOES-R CI has totally 12 tests.
- We just use 6 tests, blue colored tests as shown in the above table in order to detect CI.

Preliminary results

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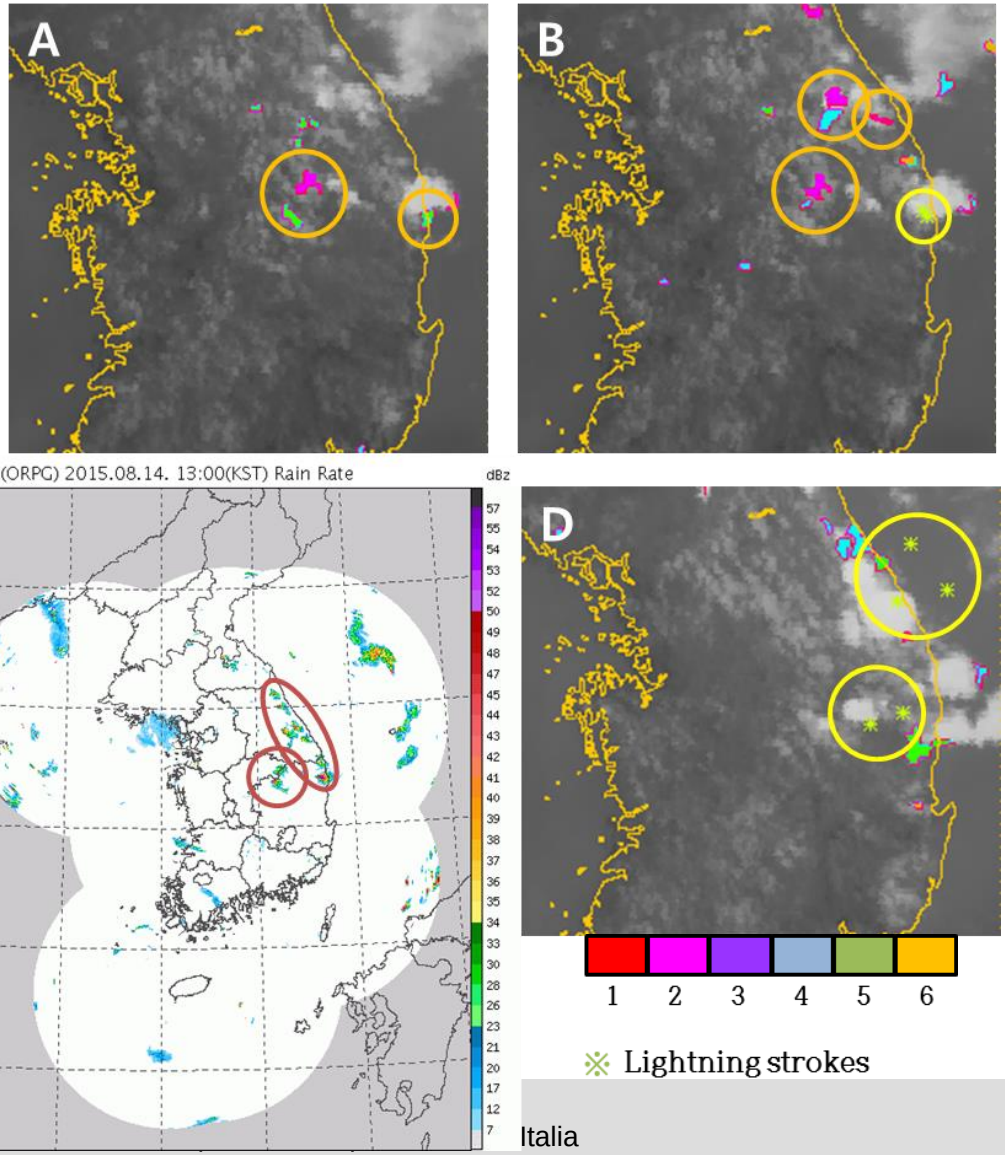
Results of GK-2A CI algorithm



Figure

A: 2015.8.14. 03:30 UTC (First CI)
B: 2015.8.14. 03:40 UTC (CI)
C: 2015.8.14. 04:00 UTC
(Radar echo over 35 dBZ)
D: 2015.8.14. 05:20 UTC (First LGT Strokes)

Lead Time:

- 30 minutes earlier than 35 dBZ of Radar echo
- about 2 hours earlier than first lightning strokes

Validation and Accuracy

Period : 2015.8.13-8.15(days)
Data: Radar echo CAPPI 1.5 ㎞ composite reflectivity
Scores: POD 40.43%, FAR 71.83%

Future Plans for GK-2A CI

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- **CCM for nighttime**
  - We plan to develop nighttime CCM, Current CCM scheme is composed of visible and infrared channels tests and used only for daytime.
  - Thus, CI algorithm will also be divided into daytime and nighttime.

- **Optimization and Application of Machine Learning**
  - Thresholds of two-channel threshold scheme will be optimized by machine learning method with radar echo and lightning data.
  - Decision tree and random forest method will be combined for discrimination.
  - Datasets for training and validation will be tested for seasonal convective clouds.
  - If GK-2A observes the extended local area (ELA) every 2.5 min. or 2. min, we need to study new threshold etc. for CI.

- **Link of GK-2A CI and RDT**
  - GK-2A convective cloud monitoring will be based on RDT(PGE11) module

THANK YOU!

Himawari IR vs. COMS IR

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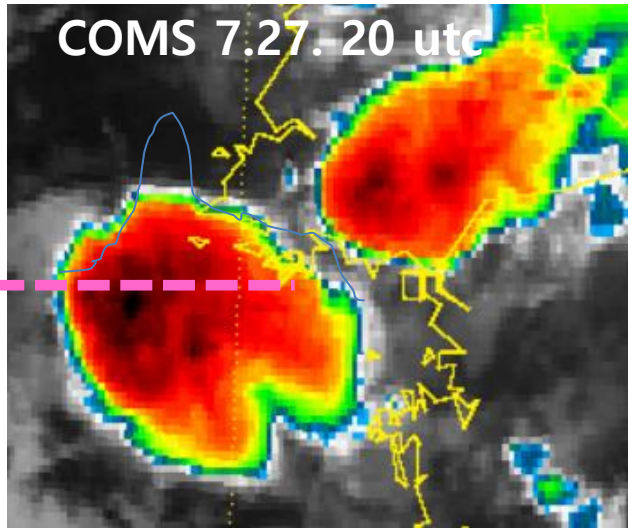

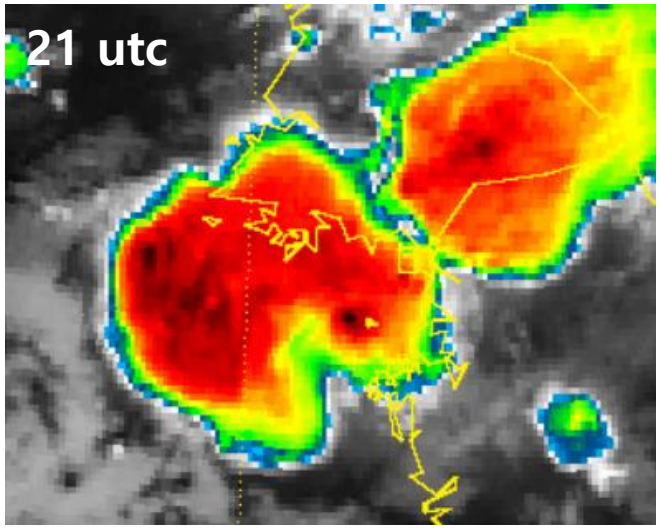

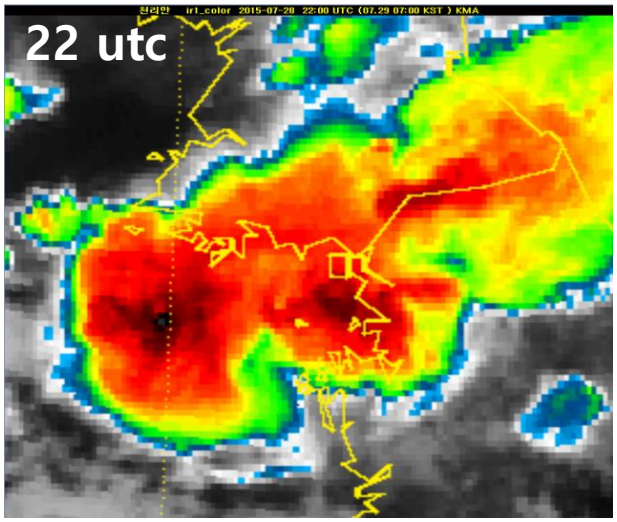

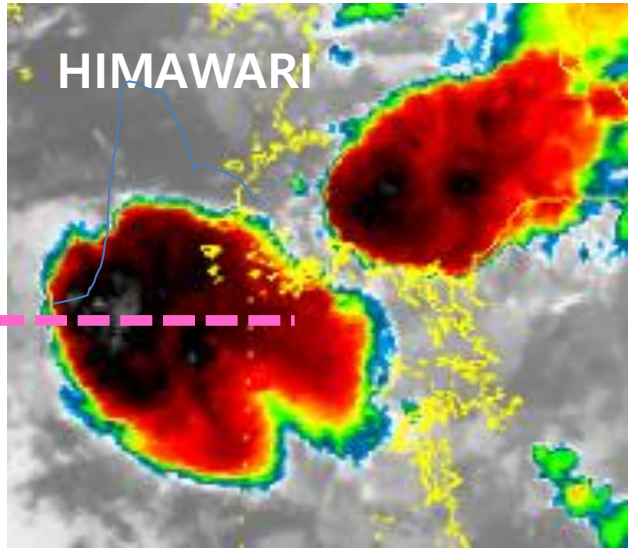

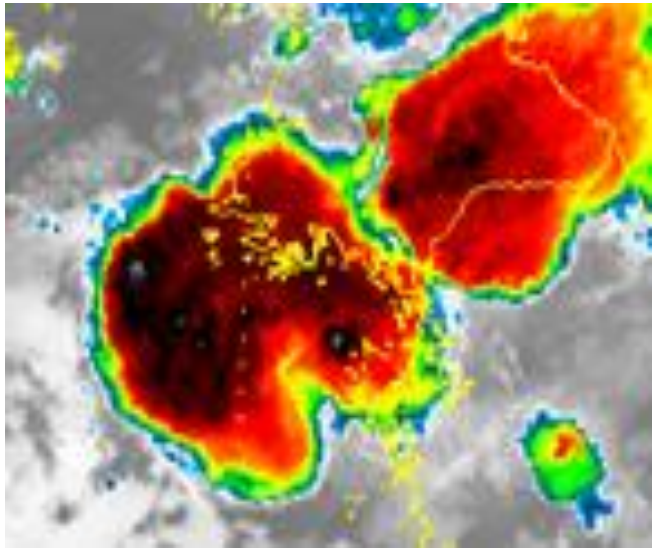

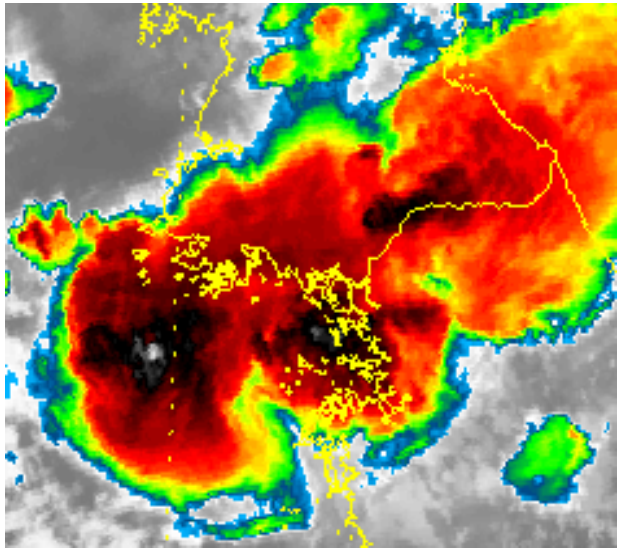

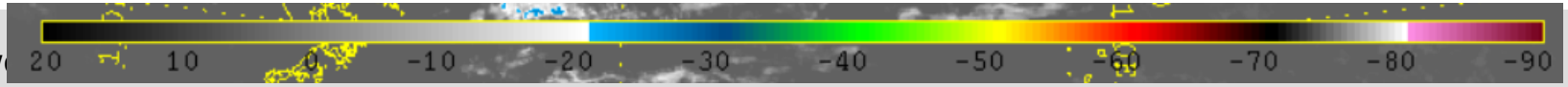

Himawari WV vs. COMS WV

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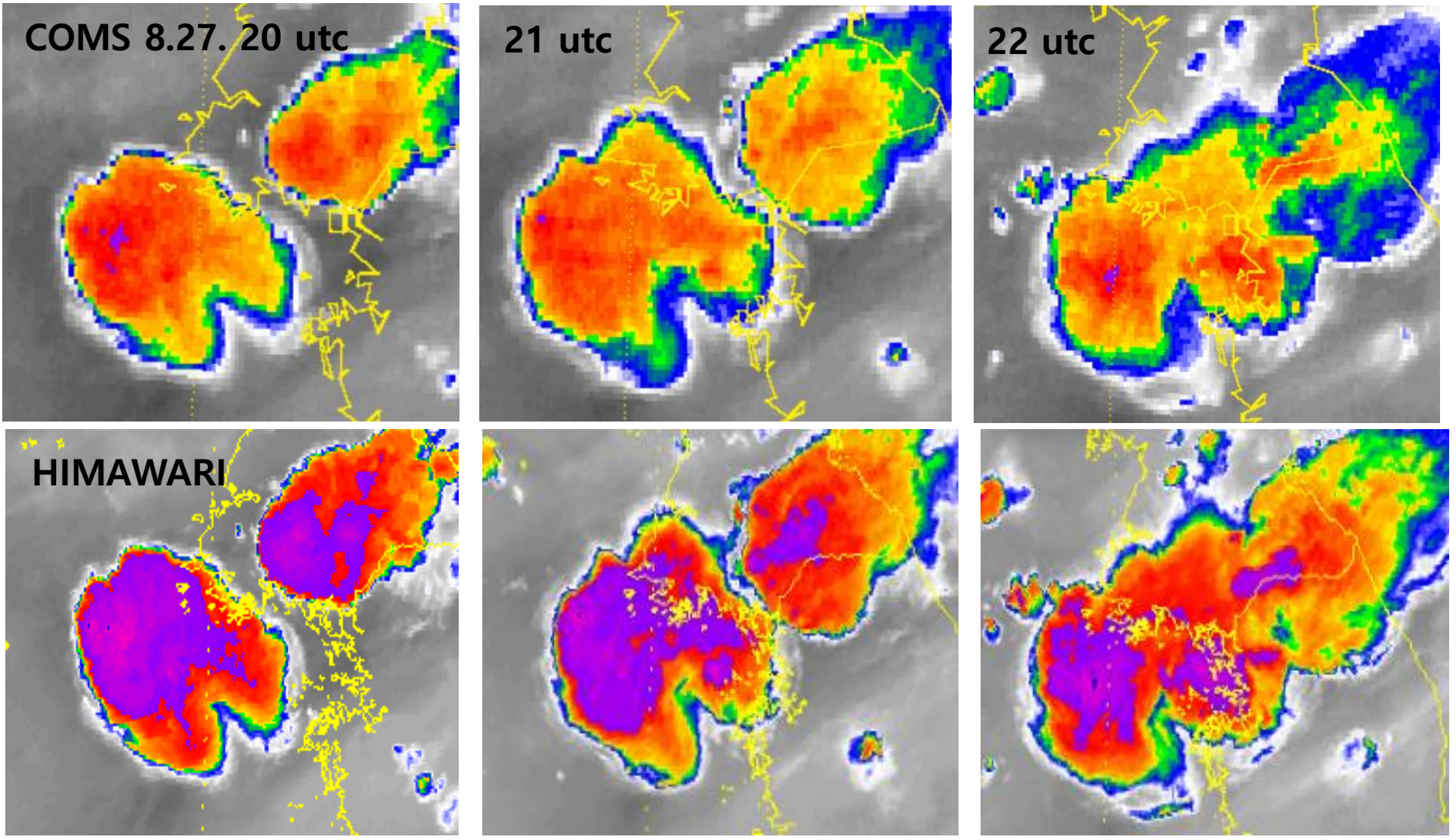
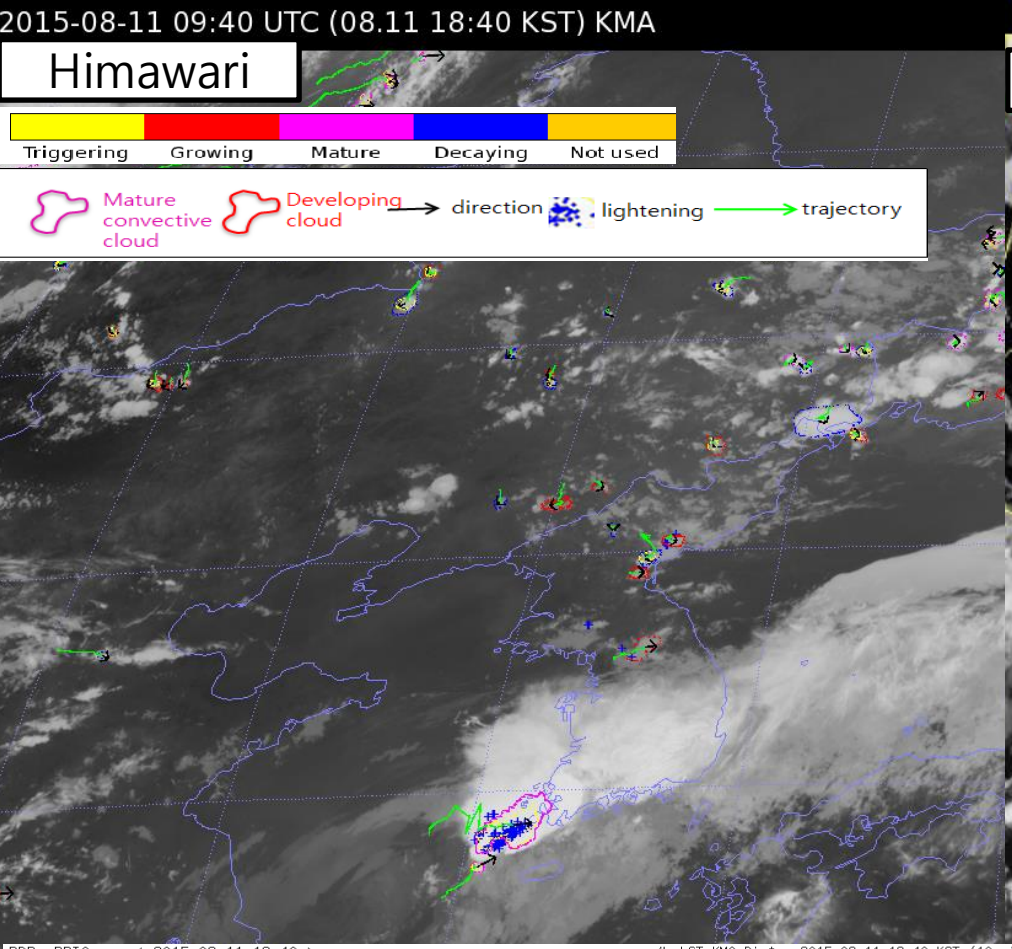
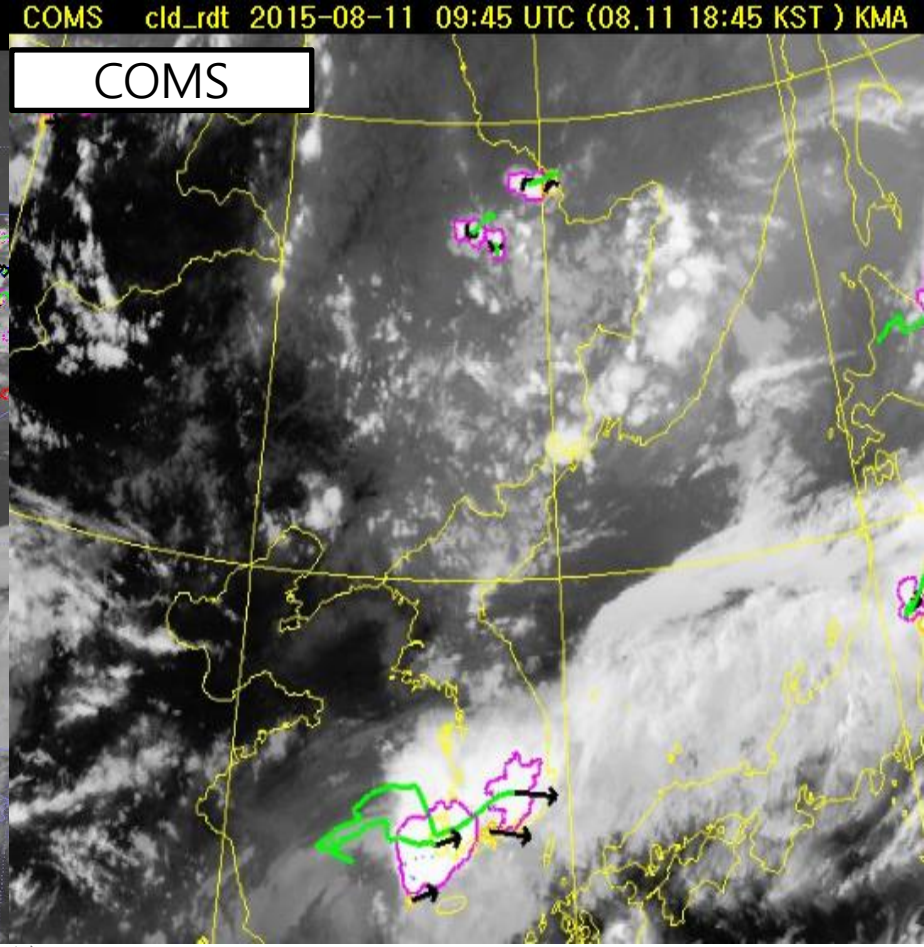
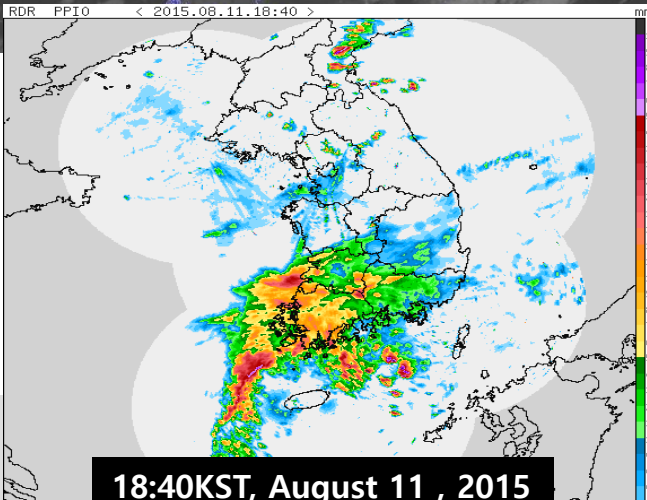
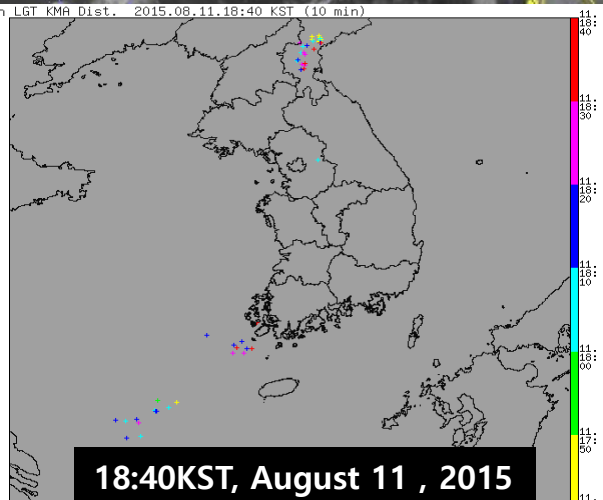
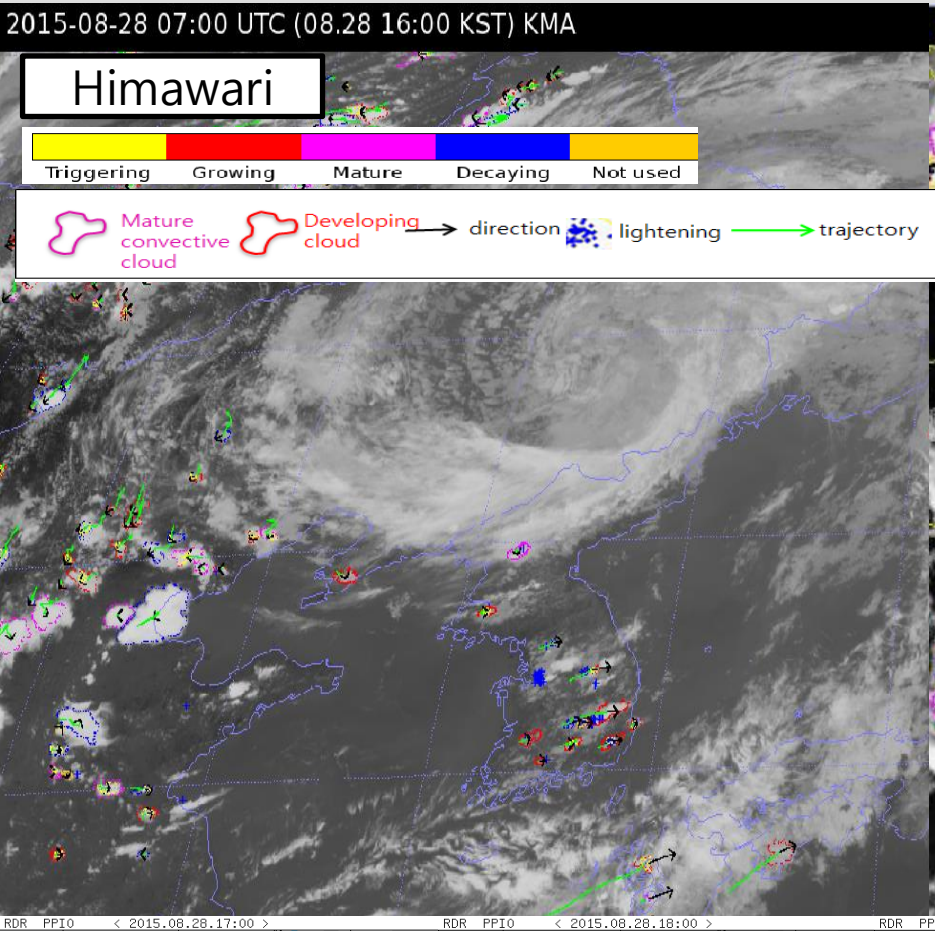


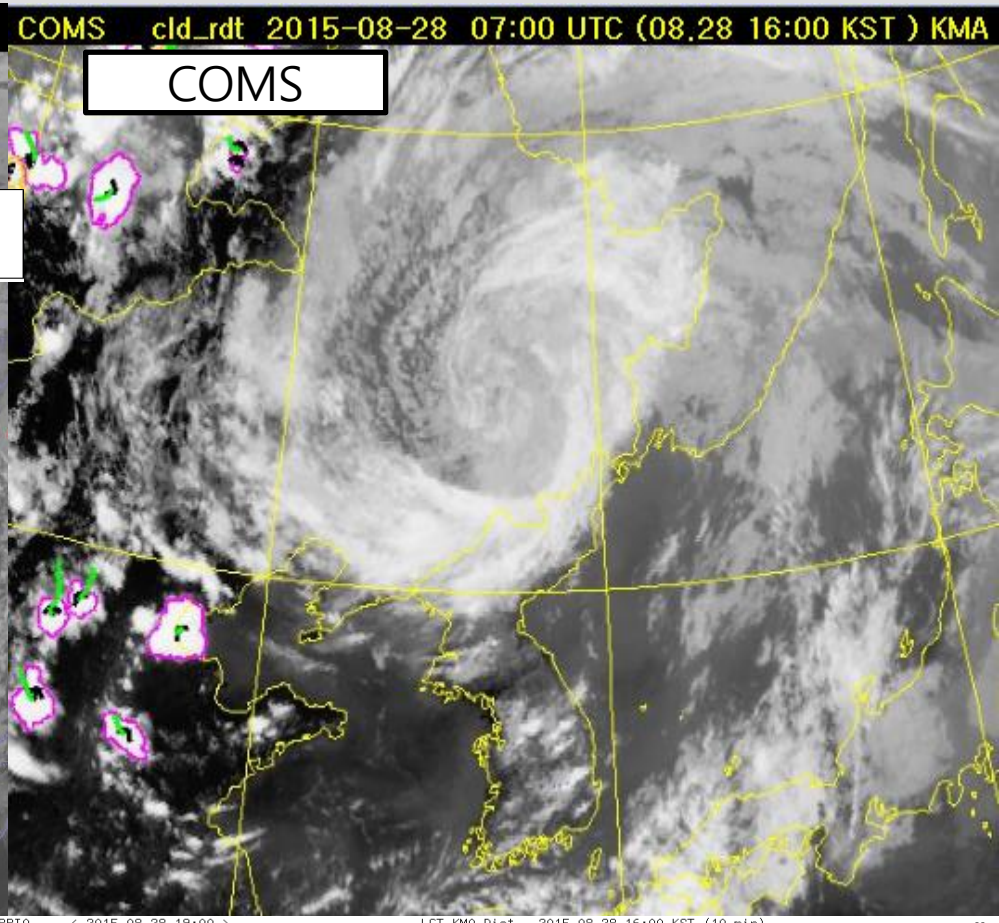

2015-08-11 09:40 UTC (08.11 18:40 KST) KMA
Himawari
Triggering
Growing
Mature
Decaying
Not used
Mature convective cloud
Developing cloud
direction
lightening
trajectory

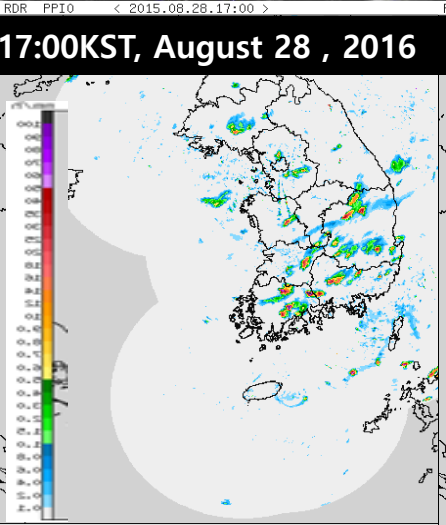

COMS cld_rdt 2015-08-11 09:45 UTC (08.11 18:45 KST) KMA
COMS


RDR PPI0 < 2015.08.11.18:40 >
18:40KST, August 11 , 2015


mm/h LGT KMA Dist. 2015.08.11.18:40 KST (10 min)
18:40KST, August 11 , 2015


2015-08-28 07:00 UTC (08.28 16:00 KST) KMA
Himawari
Triggering
Growing
Mature
Decaying
Not used
Mature convective cloud
Developing cloud
direction
lightening
trajectory


COMS cld_rdt 2015-08-28 07:00 UTC (08.28 16:00 KST) KMA
COMS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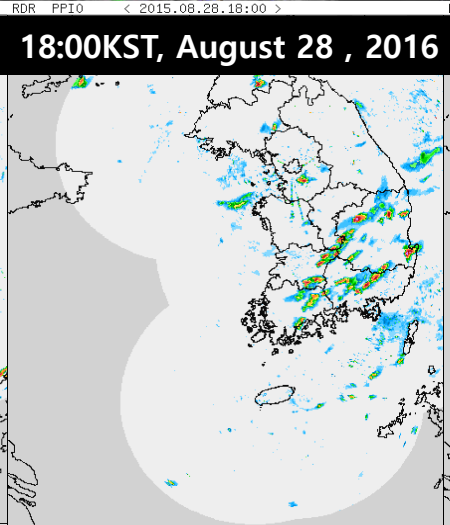
17:00KST, August 28 , 2016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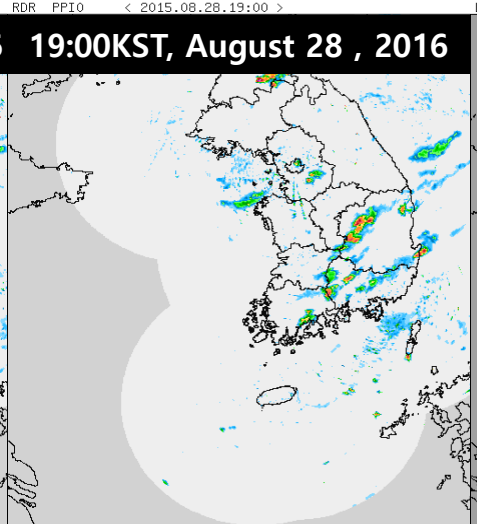
18:00KST, August 28 , 2016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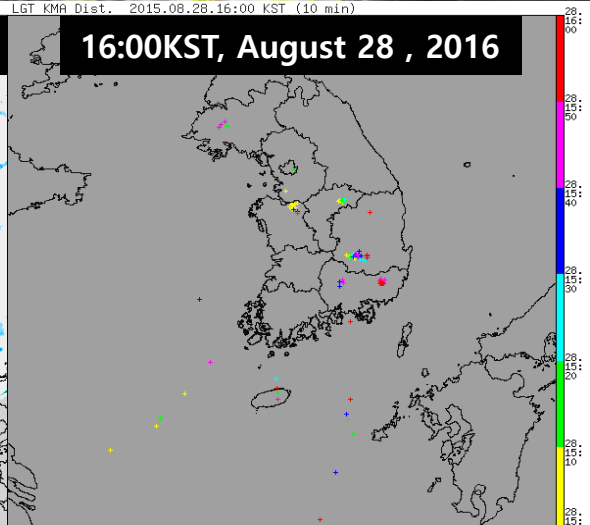
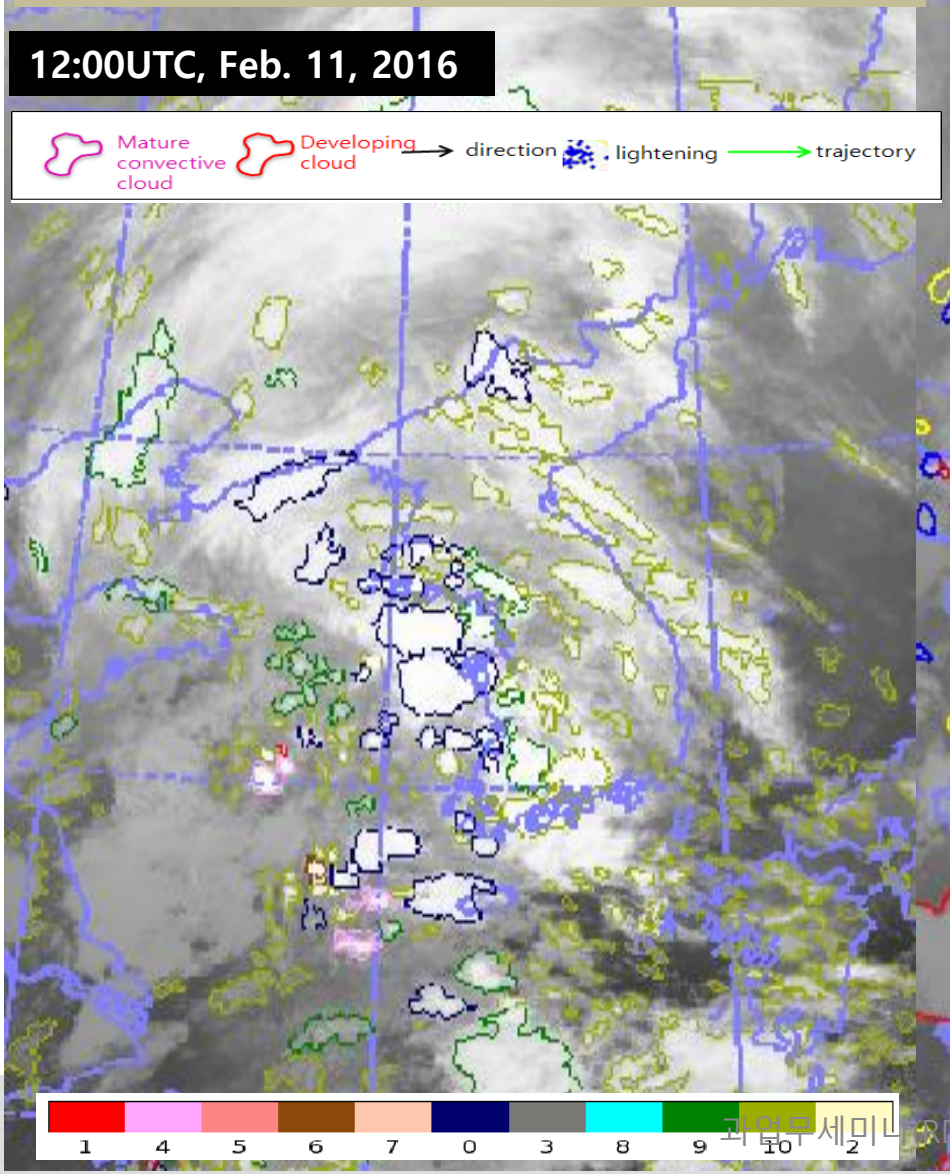
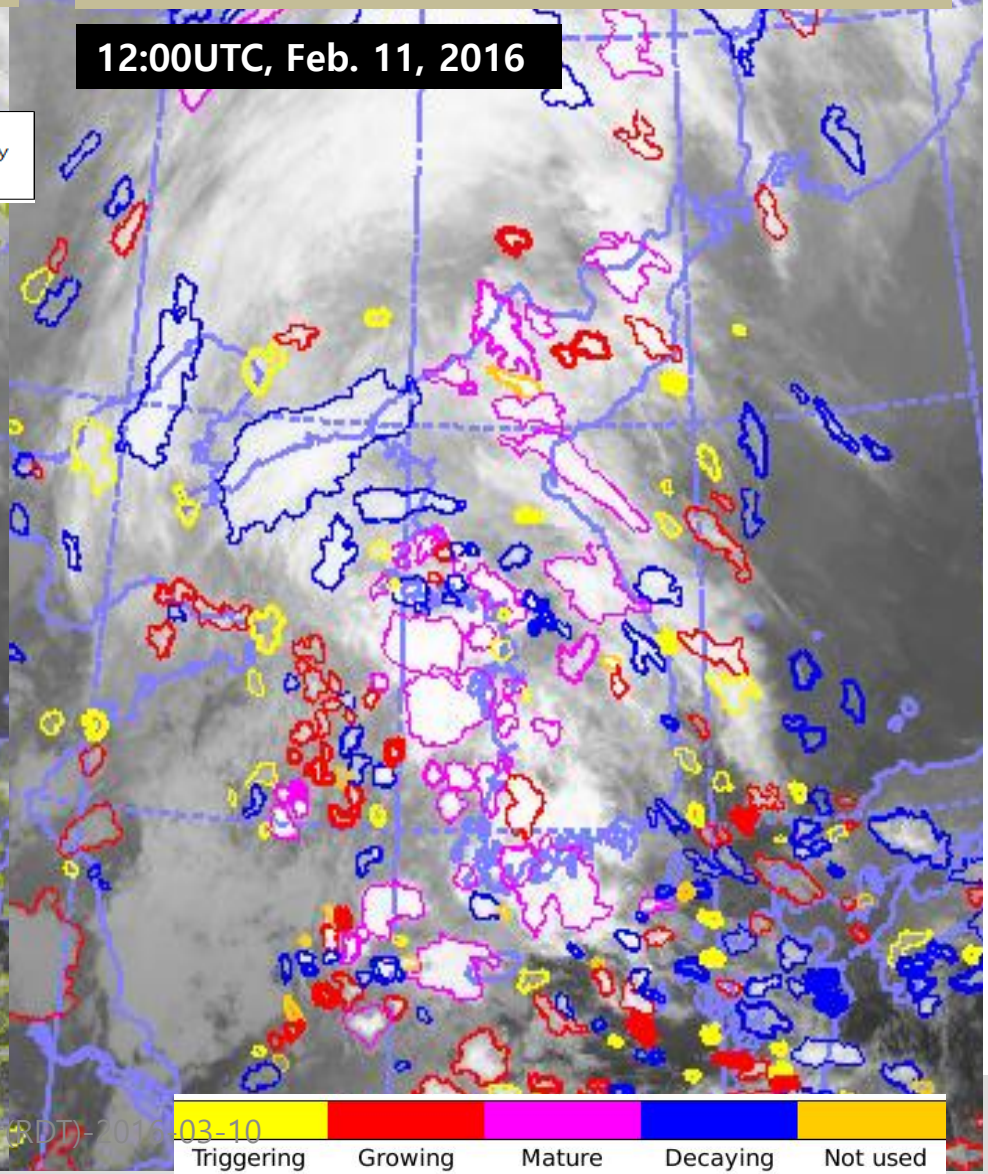

LGT KMA Dist. 2015.08.28.16:00 KST (10 min)
16:00KST, August 28 , 2016

Convective or Non-convective types



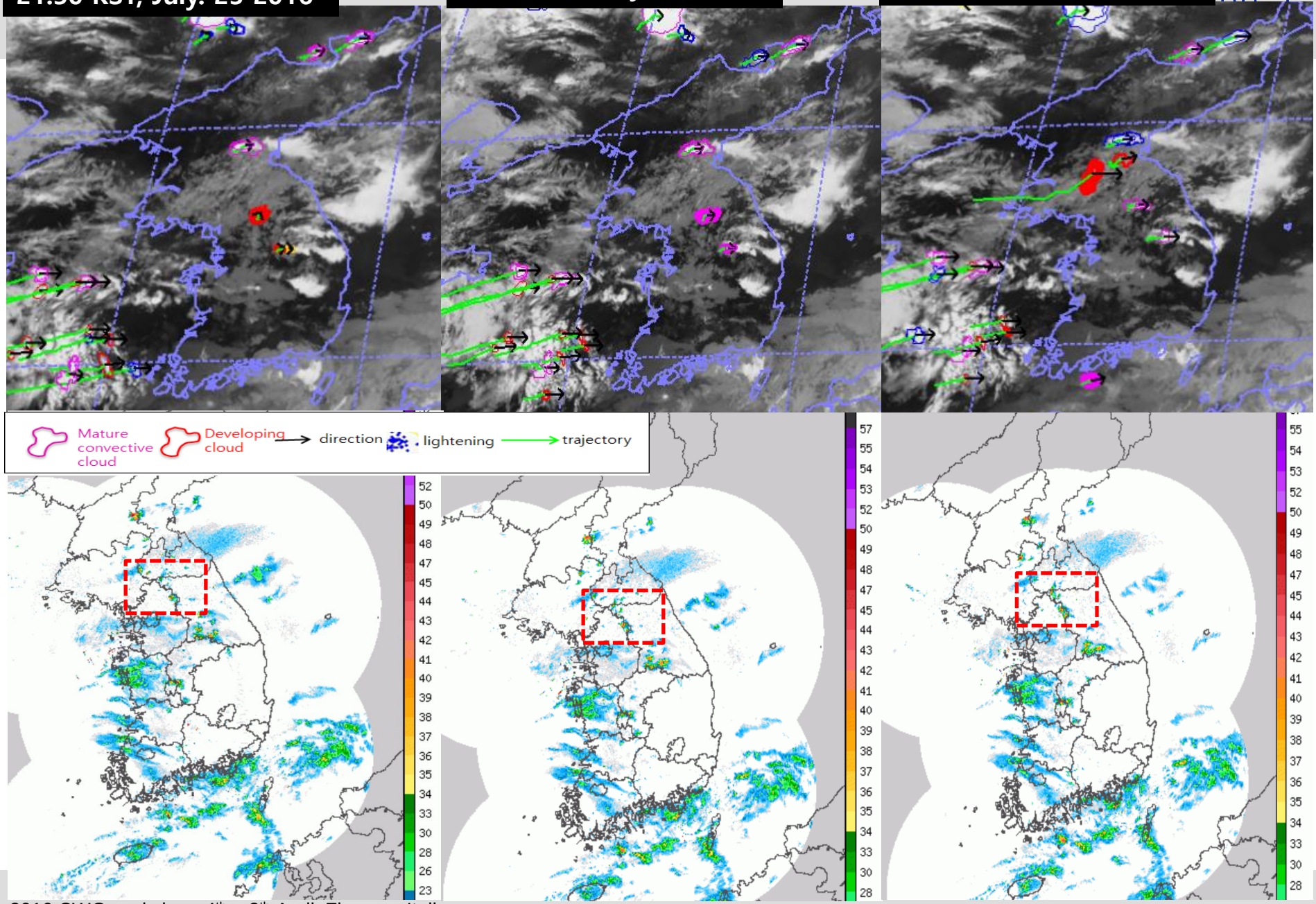
Development steps of cloud cells

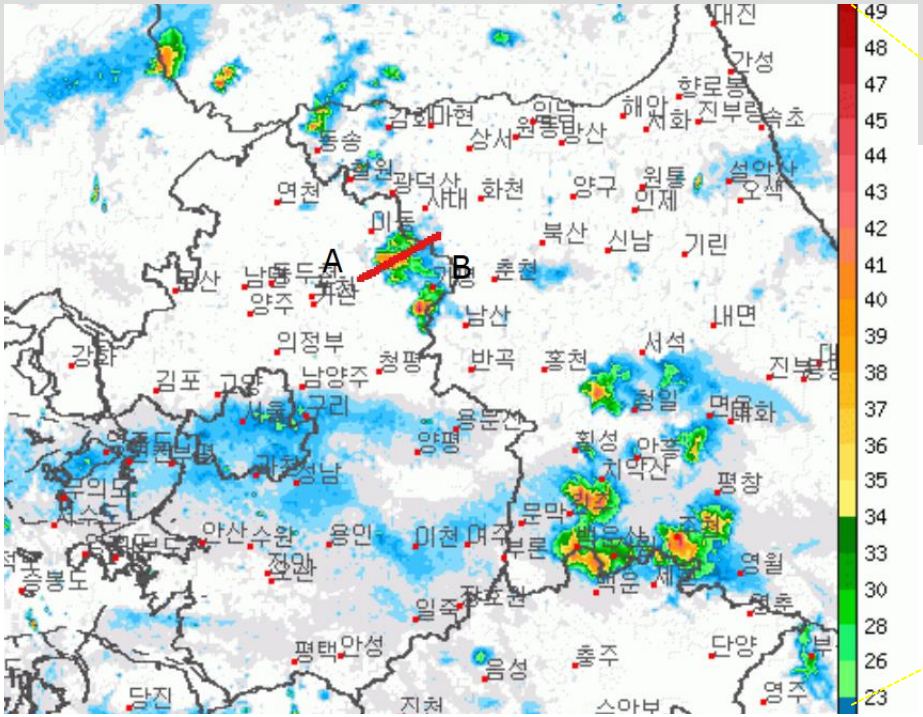


21:50 KST, July. 23 2016

22:00 KST, July. 23 2016

22:10 KST, July. 23 2016





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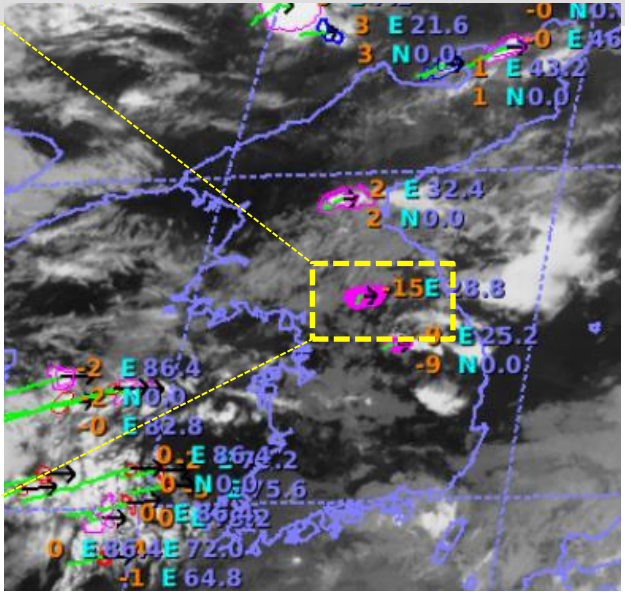

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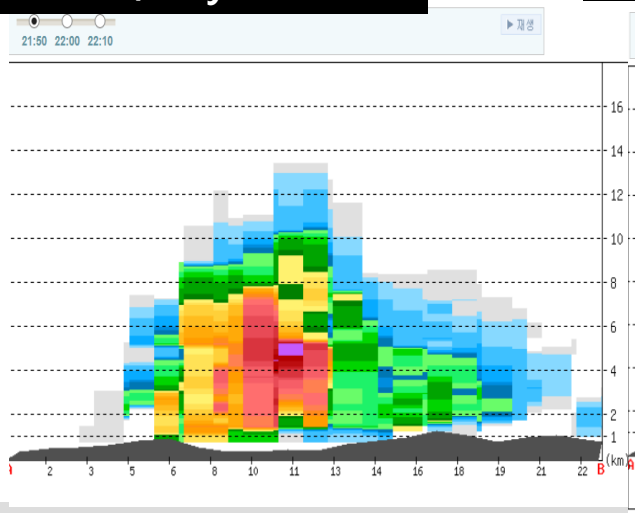

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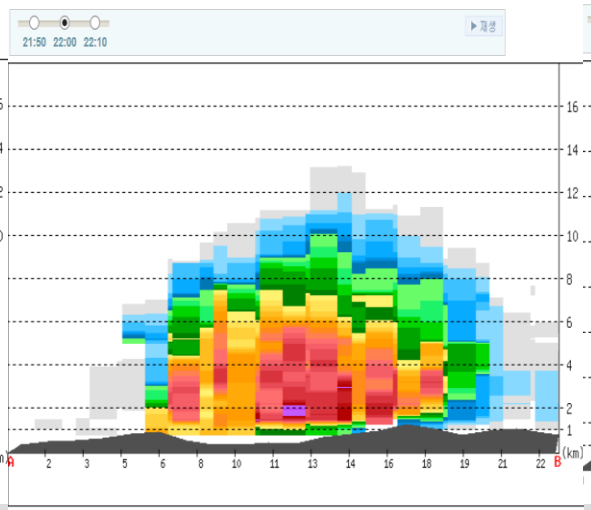

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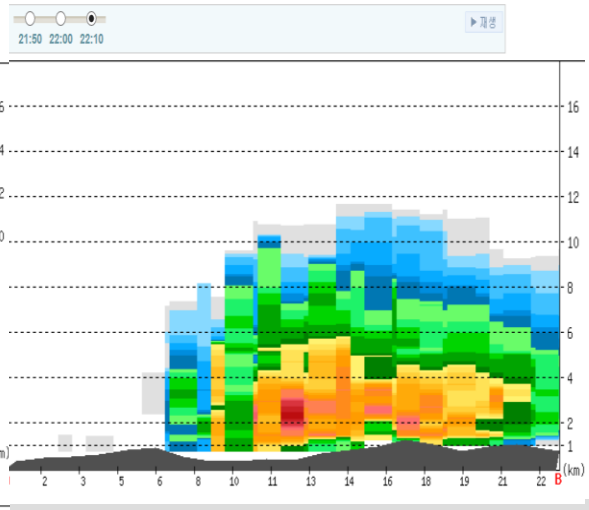

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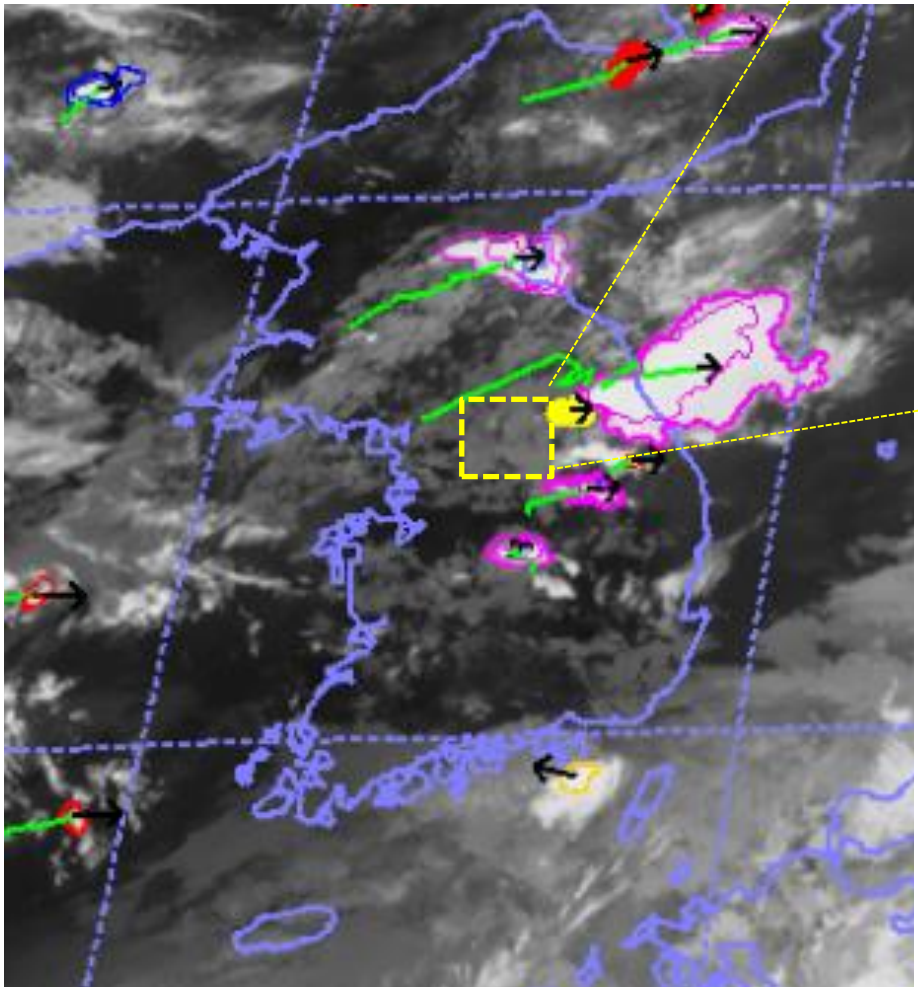

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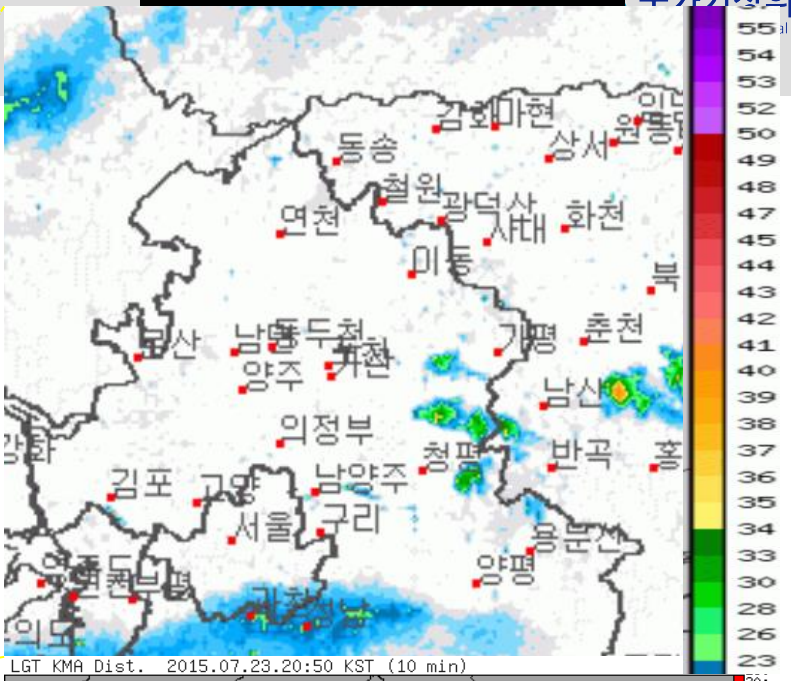

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