AOMSUC-11, 3 November 2021

Retrieval and Application of Temperature and Humidity Profiles for GK2A/AMI

Byung-il Lee[1], Heewoo Shin[1], Hyein Park[1], Chunman Ryu[1], Jaemyeon Shim[1], Taemyung Kim[2], Myounghwan Ahn[2]

[1]National Meteorological Satellite Center/KMA,
[2]Ewha Womans University

NMSC

Contents

- ❖ Introduction
- ❖ Retrieval algorithm of atmospheric profiles
- ❖ Result and validation
- ❖ Application
- ❖ Summary

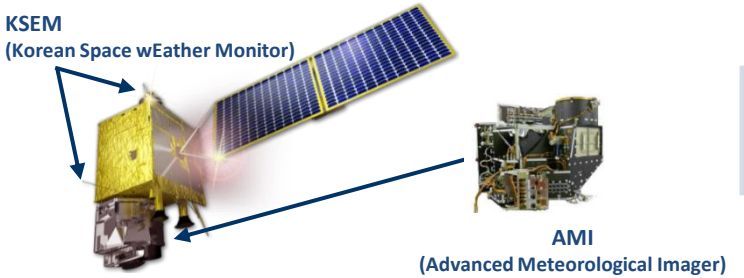
Introduction

Geo-KOMPSAT Series

- Geo-KOMPSAT launched on December 5, 2018 and **operated from July 25, 2019.**
- 16 channels / Full Disk every 10 minutes and the Korean Peninsula area every 2 minutes

GK2A

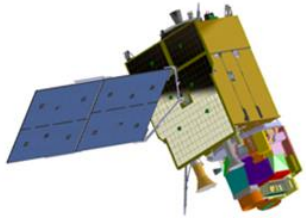
Launched on December 5, 2018

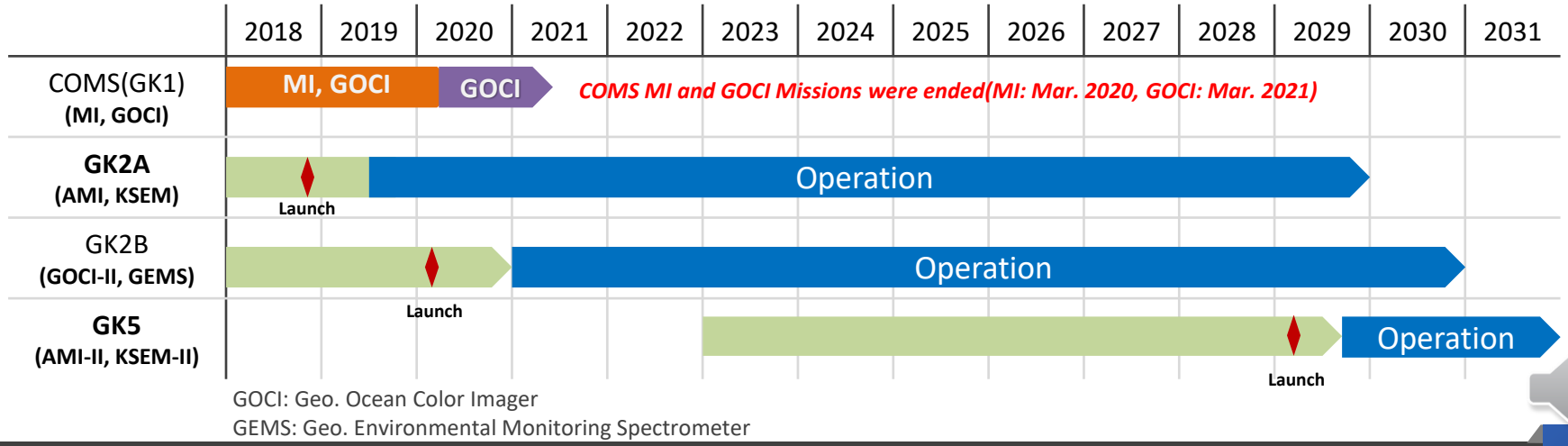


Preparing for continuity

GK5

Will be Launched on 1st Q, 2029



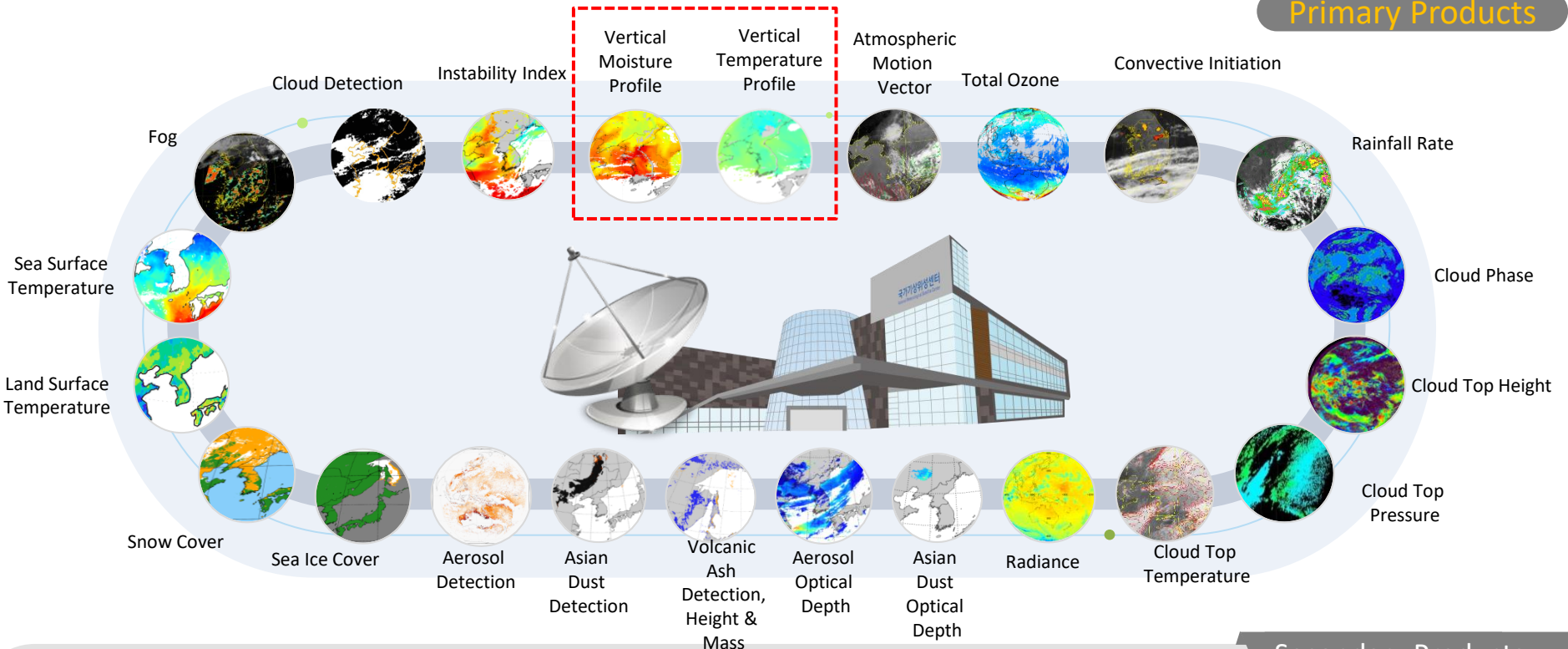


GOCI: Geo. Ocean Color Imager
GEMS: Geo. Environmental Monitoring Spectrometer

Introduction

52 Meteorological Products from GK2A/AMI

Primary Products

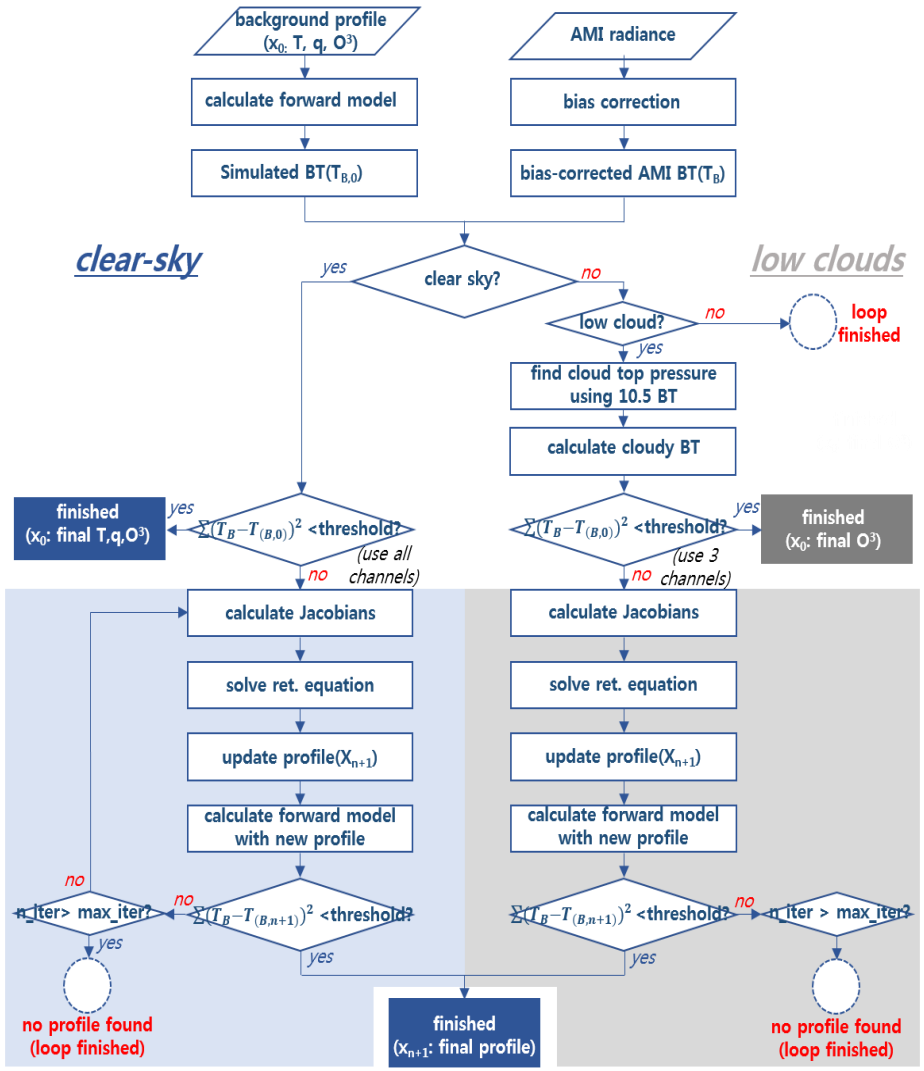


Secondary Products

- Fire Detection
- Vegetation Index
- Vegetation Green Fraction
- Surface Emissivity
- Surface Albedo
- Snow Depth
- Ocean Current
- Cloud Type
- Cloud Amount
- Cloud Optical Depth
- Cloud Effective Radius
- Cloud Liquid Water Path
- Cloud Ice Water Path
- Cloud Layer/Height
- Probability of Rainfall
- Rainfall Potential
- Aerosol Particle Size
- Visibility
- Absorbed SW Radiation (SFC)
- Downward SW Radiation (SFC)
- Reflected SW Radiation (TOA)
- Downward LW Radiation (SFC)
- Upward LW Radiation (SFC)
- Upward LW Radiation (TOA)
- Aircraft Icing
- Overshooting Top Detection
- SO2 Detection
- Total Precipitable Water
- Clear Sky Turbulence

Retrieval Algorithm

Flowchart of AAP algorithm



- Name: AMI Atmospheric Profile(AAP)
  - Iterative Optimal Estimation *(Rodgers, 2000)*
- RTM Forward Model
  - RTTOV v12.1
- Input
  - GK2A AMI L1B, CLD
  - Error covariance(Observation/Background)
  - Surface Emissivity(Monthly)
- Temporal and Spatial Resolution
  - Full Disk(6km) / 10min
- Products
  - 54-levels T & q profiles
  - TOZ (Total Ozone)
  - TPW (Total Precipitable Water)
  - AII (CAPE, KI, LI, SI, TTI)

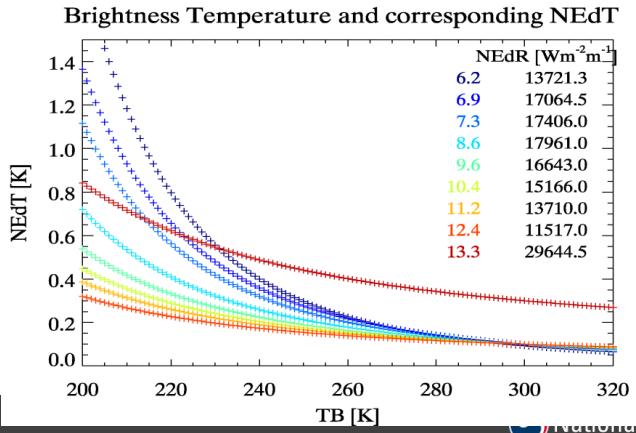
[GK2A AAP ATBD, 2018 / Lee et al., 2017]

Retrieval Algorithm

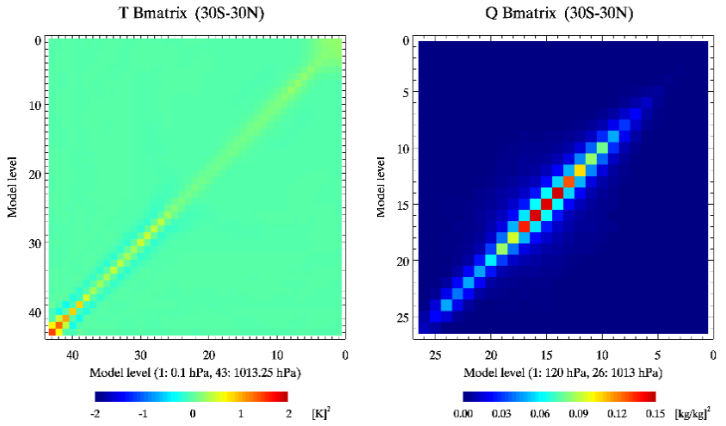
Input for AAP algorithm

- Primary Sensor Data
  - **Calibrated TB for IR bands 8-16**
    - WV6.2, WV6.9, WV7.3, IR8.6(sea only), IR9.6, IR10.4, IR11.2, IR12.4, and IR13.3
  - GK2A/AMI Cloud mask
  - Satellite geographical data(LZA, Lat/lon, lsmask)
- Ancillary Data
  - Dynamic data: NWP model forecast fields, Total column ozone,
  - Static data: Ozone profile, Observation/Background error covariance matrix, Land surface emissivity,

<NEDT>



<Background error covariance matrix>

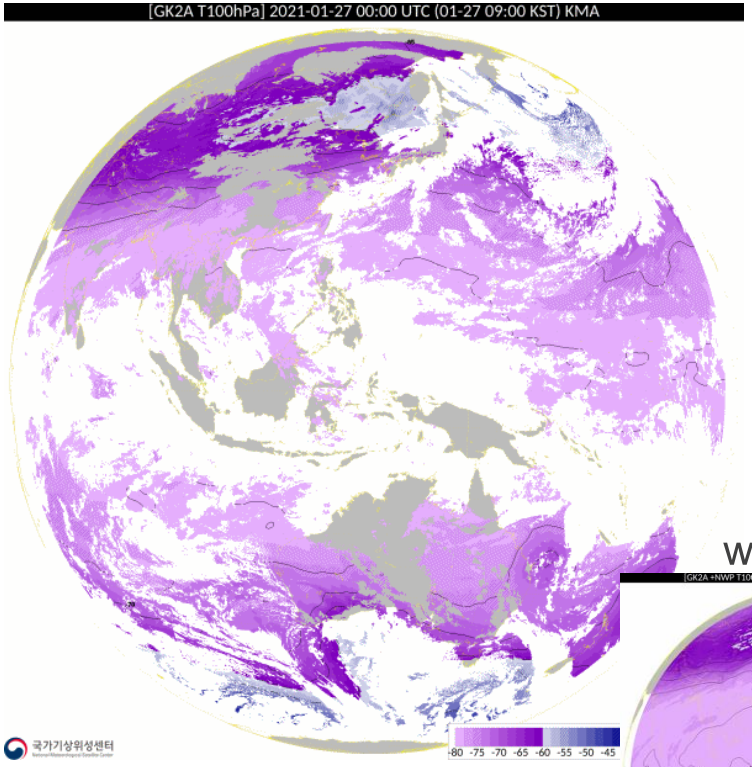


Result and Validation

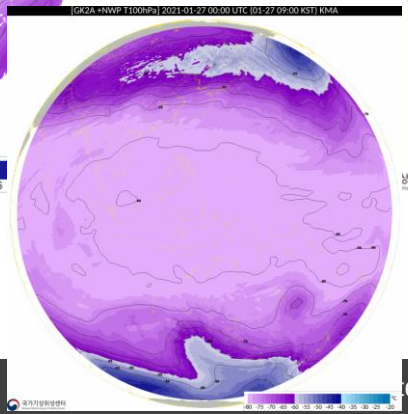
Output: T & q profiles (with NWP)

- At reference levels : 100, 200, 300, 400, 500, 700, 850, 925, 1000hPa

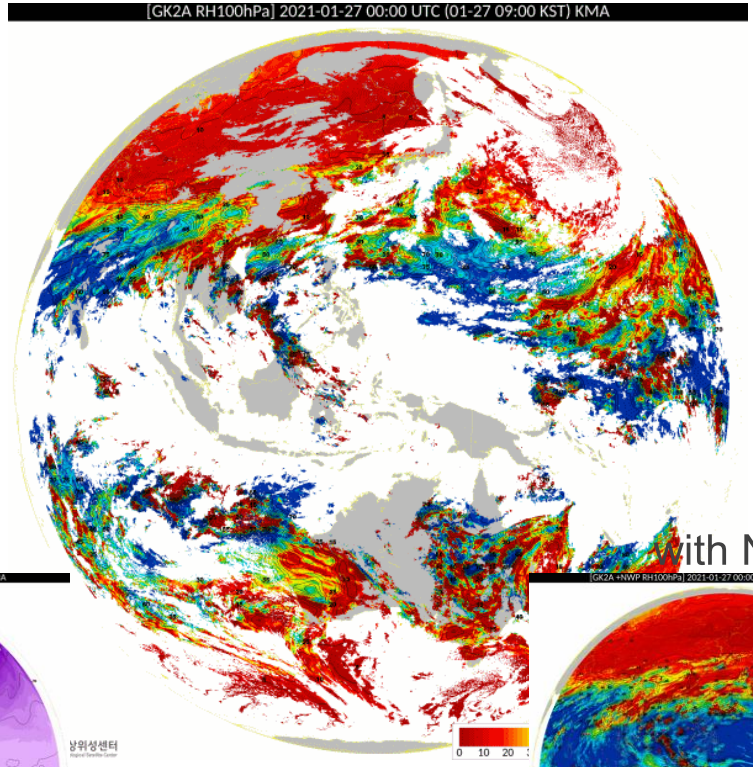
Temperature



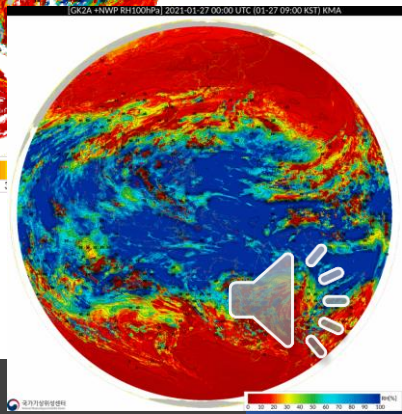
with NWP



Relative Humidity



with NWP

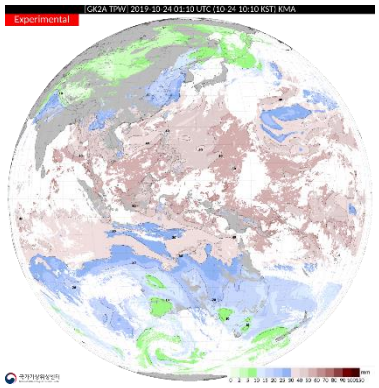


Result and Validation

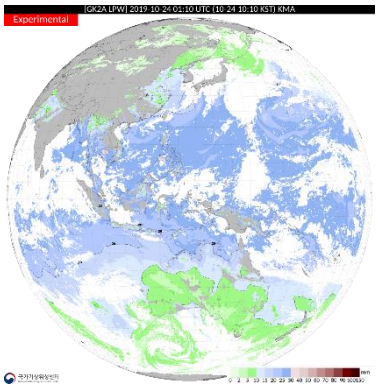
Output: TPW, All

- Fusion with NWP data

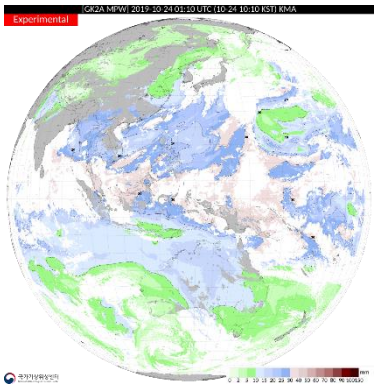
TPW



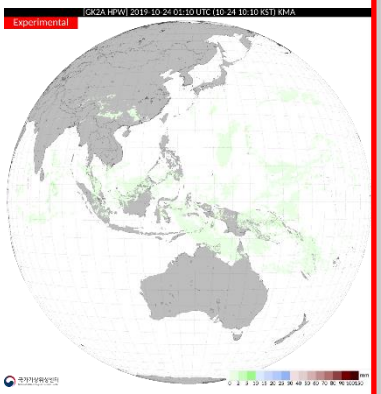
LPW



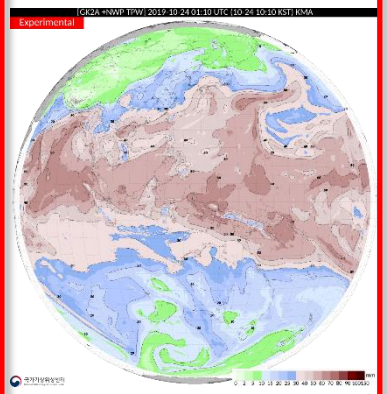
MPW



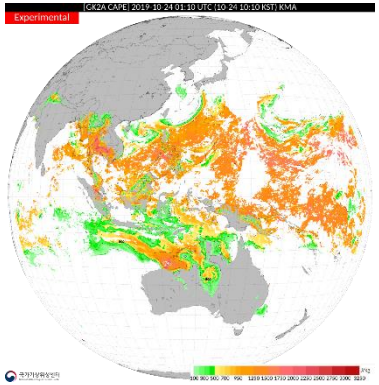
UPW



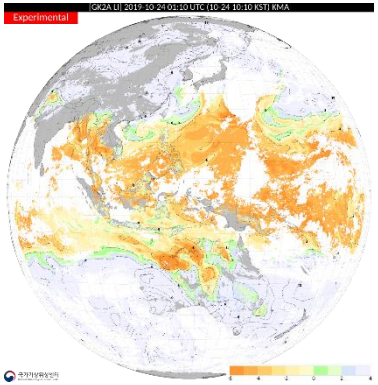
TPW (with NWP)



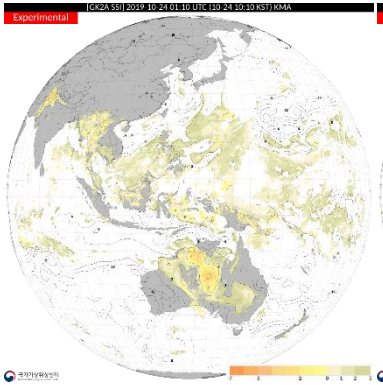
CAPE



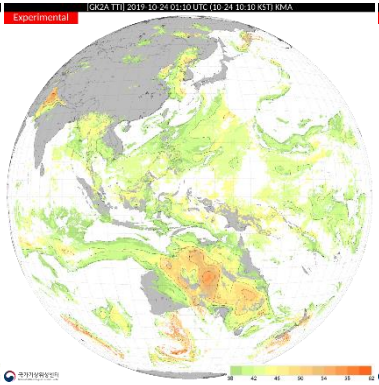
LI



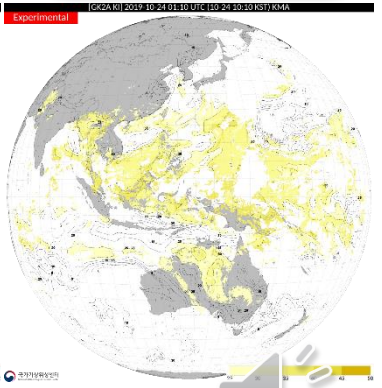
SSI



TTI



KI

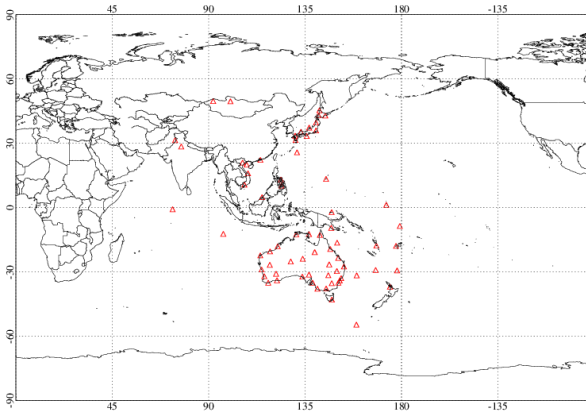


Result and Validation

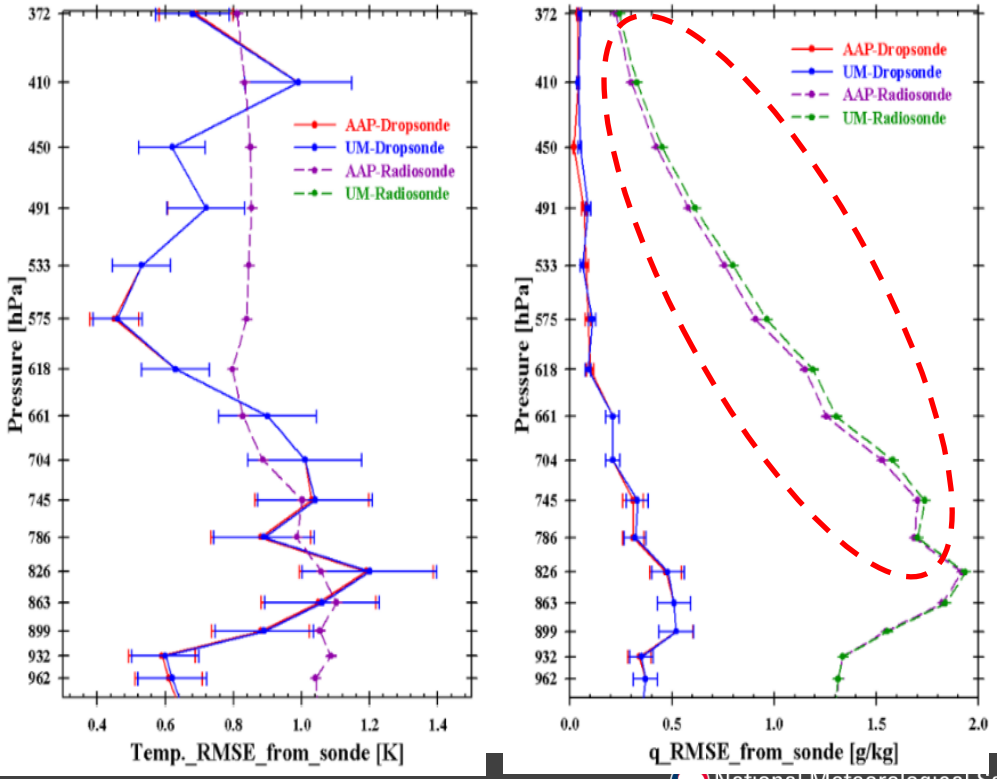
Validation

- 65 stations Radiosonde(Vaisala RS92) used for the validation
- Average 20% reduction in rmse compare to the first-guess
  - Improve moisture information in middle- and upper-layer

<Radiosonde stations>



< Accuracy of AAP algorithm>



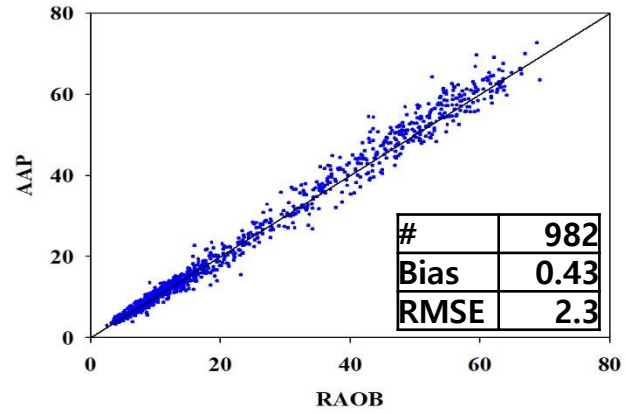
		Bias	RMSE
T profile [K] (sfc.-400hPa)		-0.14	0.91
Q profile (RH) [%]	(sfc.-300hPa)	1.32	12.01
	(300-100hPa)	-0.47	11.63
TPW [mm]		0.43	2.3
All	LI [℃]	1.17	3.07
	CAPE [J/kg]	52.97	532.35
	SSI [℃]	0.52	2.0
	TTI [℃]	(All) 0.67 (Unstable) -0.35	(All) 4.6 (Unstable) 1.9
	KI [℃]	0.88	4.72

Result and Validation

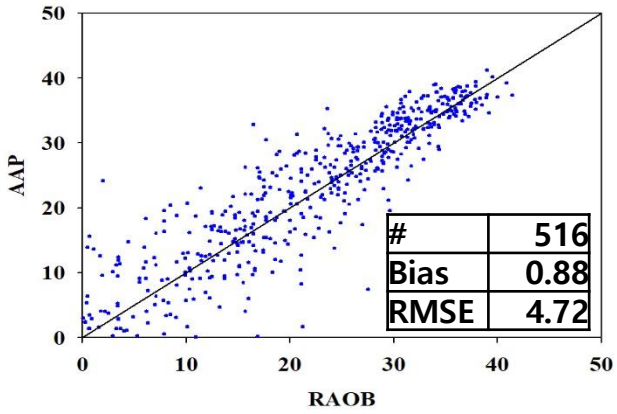
Validation

- Validation of AAP products with radiosonde meet user requirement

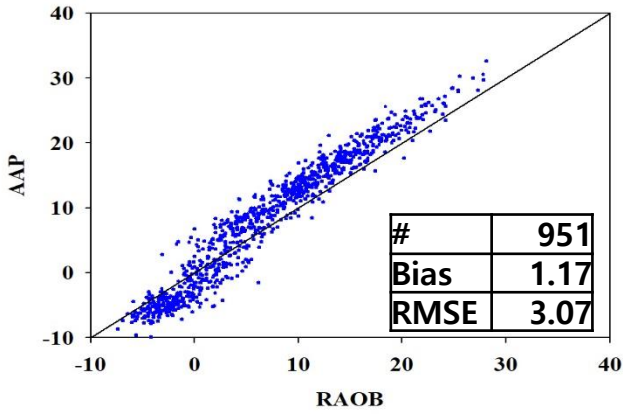
TPW [mm]



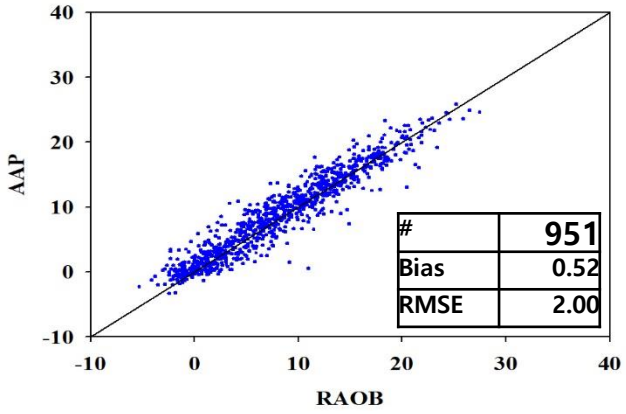
KI [°C]



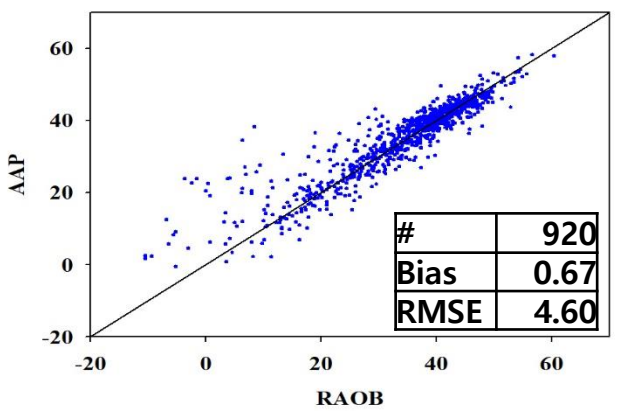
LI [°C]



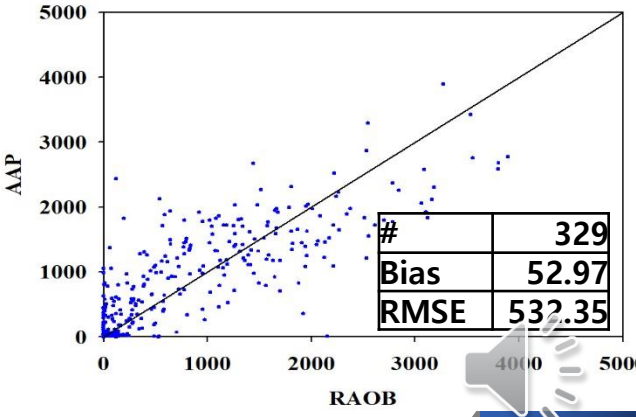
SI [°C]



TTI [°C]



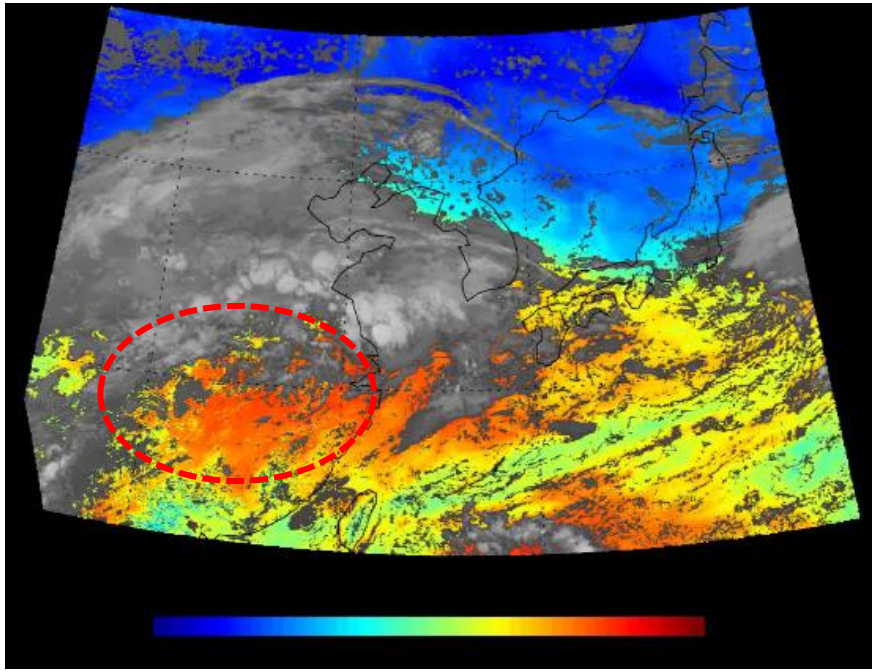
CAPE [J/kg]



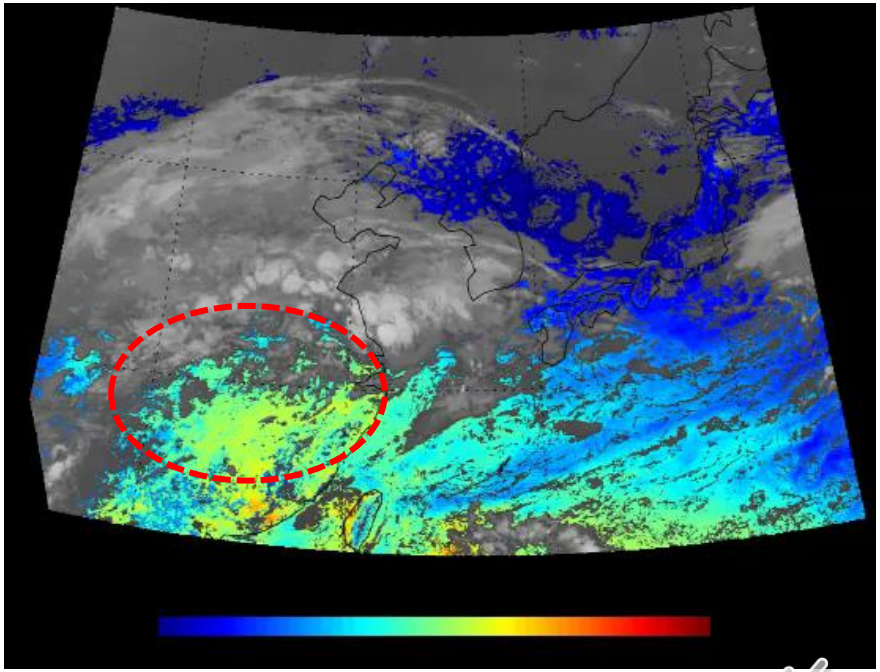
Application

- Application of AMI/GK2A Atmospheric Profile(AAP) algorithm
  - Monitoring unstable area and convective cloud: Convective clouds can be occurred in high value of TPW and CAPE

TPW



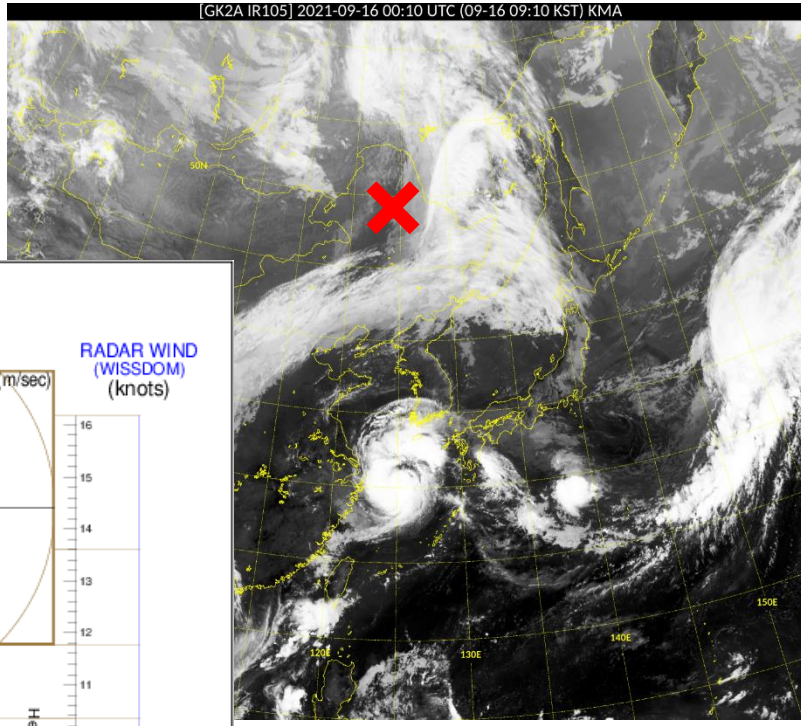
CAPE

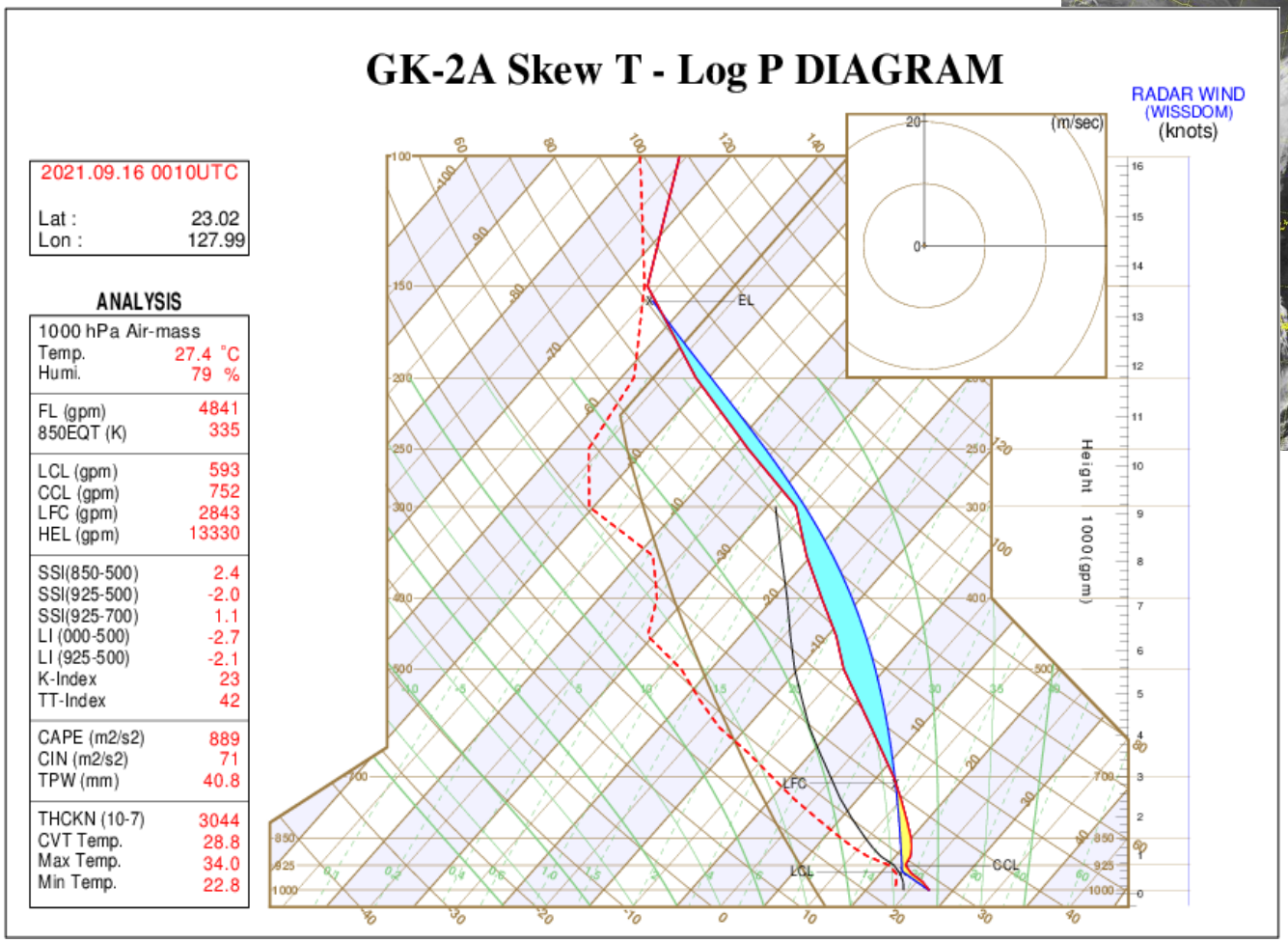


Application

Application

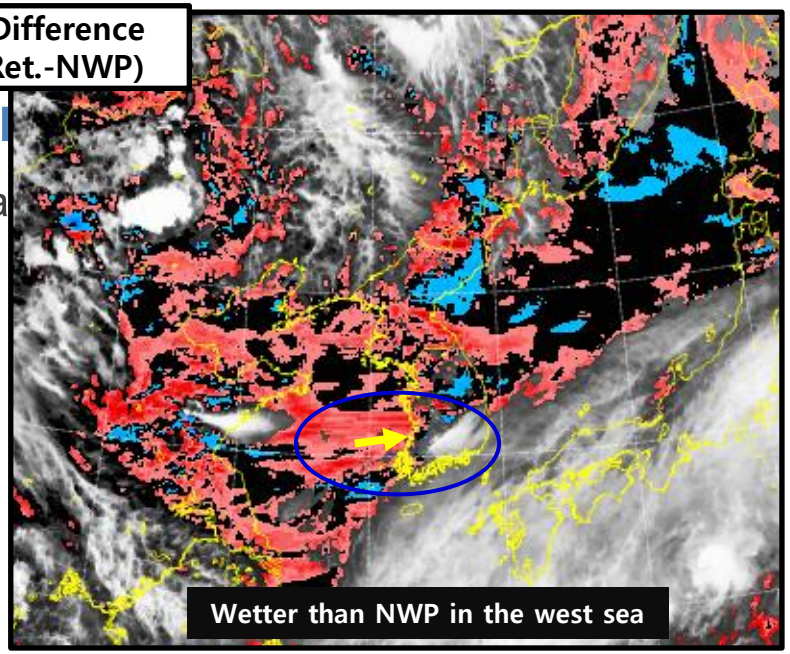
- SkewT-LogP diagram



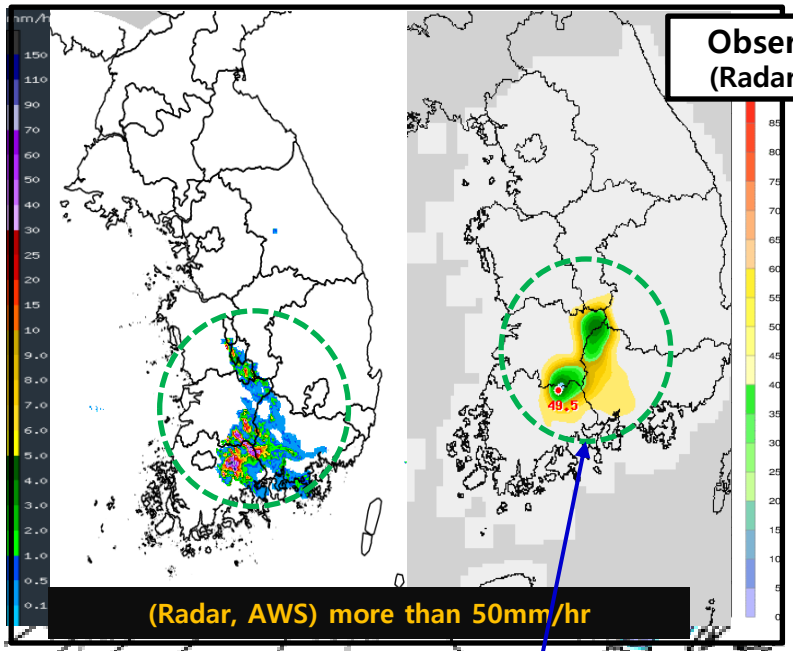


Application

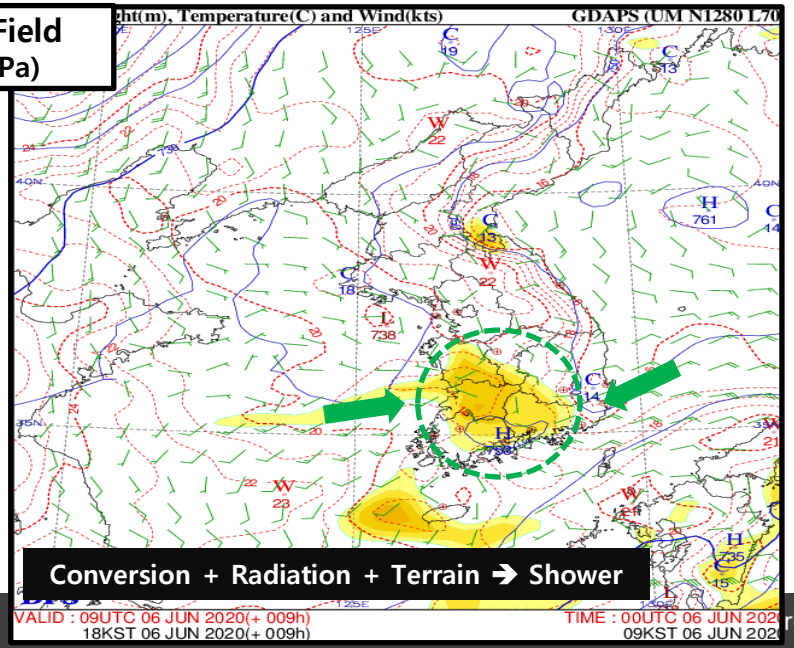
MPW Difference (SAT Ret.-NWP)



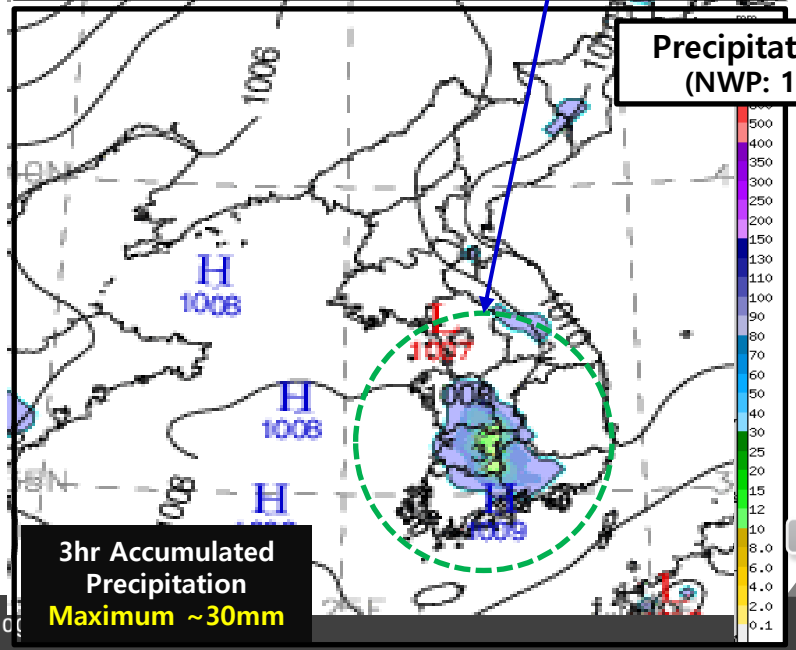
Observation (Radar+AWS)



Wind Field (850hPa)



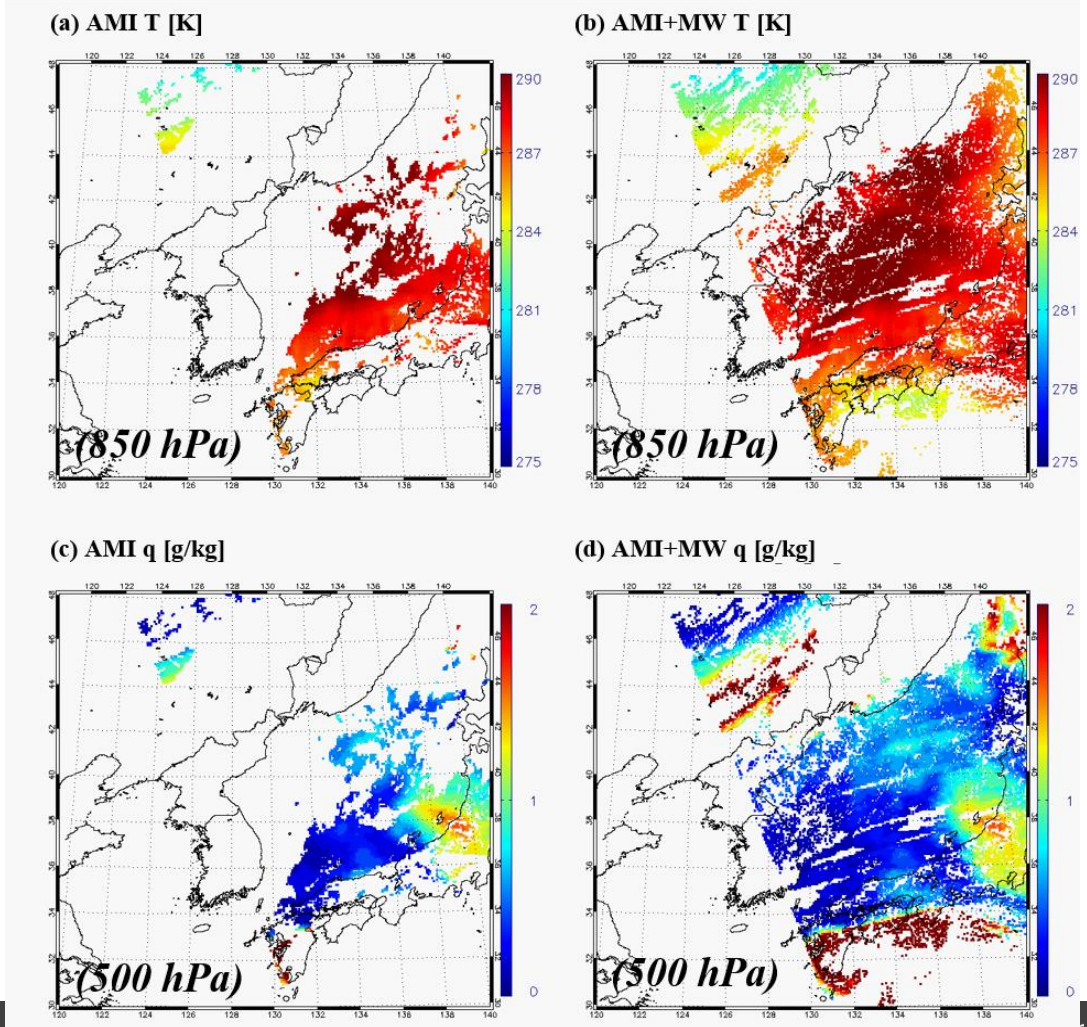
Precipitation Rate (NWP: 15~18h)

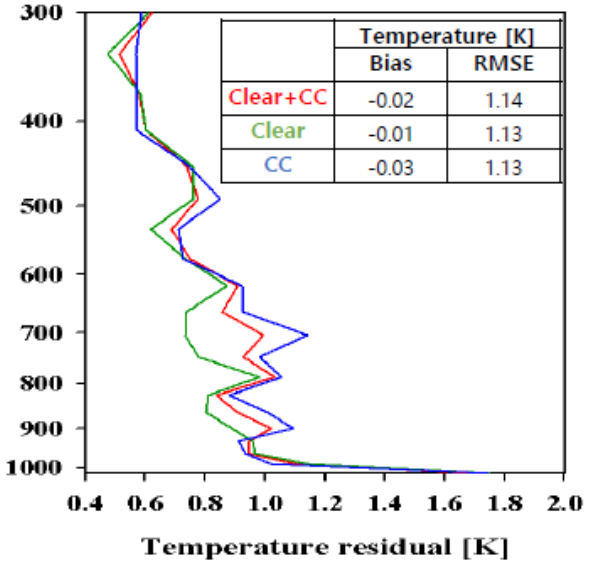


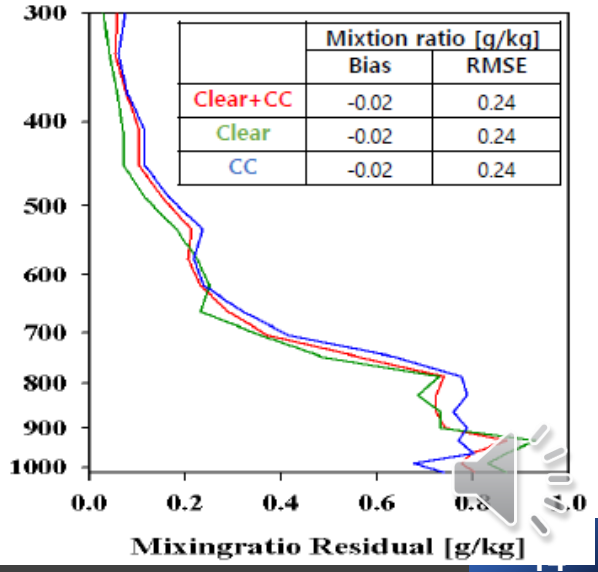
Application

Expand the AAP Algorithm for MW

- AMI/GK2A+ AMSU-A/Metop + ATMS/NOAA



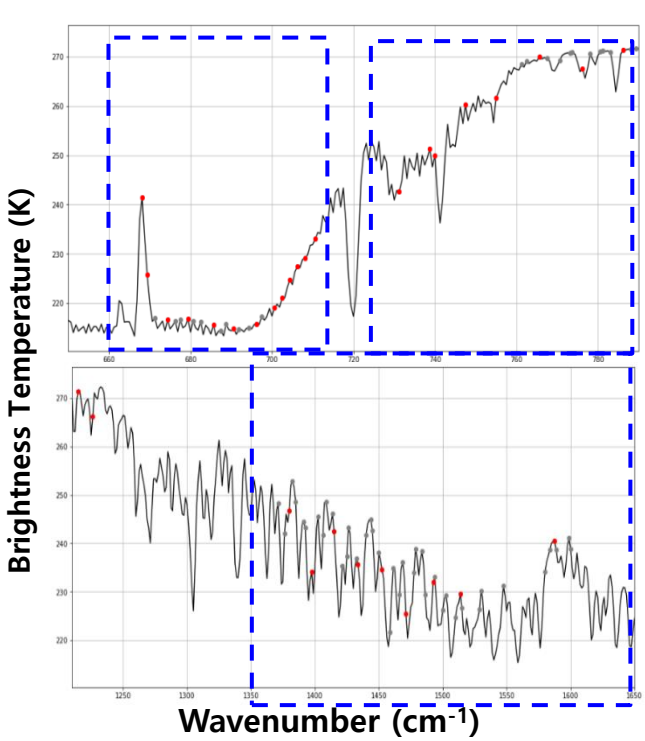


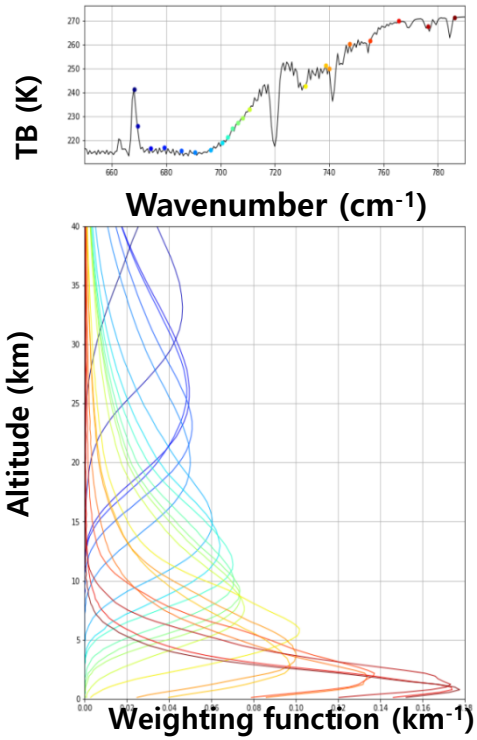


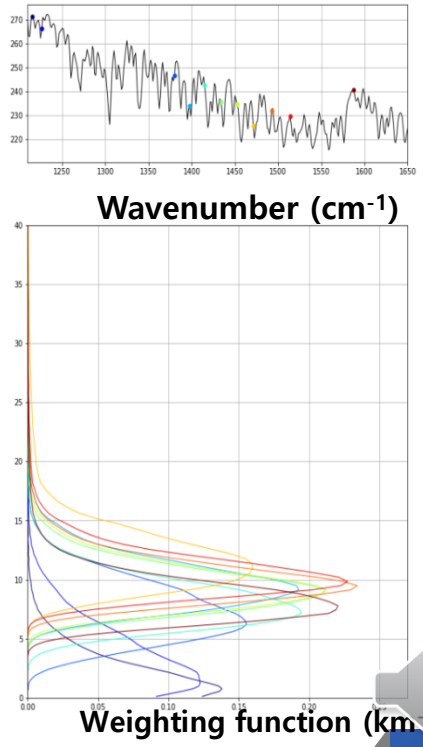
Application

Expand the AAP Algorithm for Hyperspectral

- Channel selection for hyperspectral sensor
  - Step1: Sensitivity for observation error and gas absorption (T: 128, q: 149)
  - Step2: Selection of local maximum (T: 43, q: 50)
  - Step3: Consider weight function, remove channels clustered in a layer (T: 21, q: 11)
  - For surface : 2 dirty window : 861.25, 875cm^{-1}, 2 clean Window: 901.25, 943.125cm^{-1}







Summary

- KMA has developed an algorithm to retrieve atmospheric temperature and humidity profiles using GK2A/AMI.
  - 1D-var based AMI Atmospheric Profile(AAP) algorithm
  - Every 10 minutes with 6km horizontal resolution in clear sky
- The validation with radiosonde shows temperature RMSE of about 0.9K (between surface and 400hPa) and relative humidity of about 12% (between surface and 300hPa).
- Monitoring unstable area and convective cloud using AAP products
- To improve current limitations of AAP such as first-guess dependency and clear sky only retrieval (because AMI has only 8 infrared channels)
  - Trying to expand AAP algorithm to utilize the microwave sounder and hyperspectral sounder.

Thank you!

NMSC