Status of AMV Algorithm Development of Geo-KOMPSAT 2A

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[IWW-13, Jun. 27 ~ Jul. 1, 2016, Monterey, US]

Introduction

KMA/NMSC plans to launch the next Korean geostationary meteorological satellite **GEO-KOMPSAT-2A (GK-2A) in May 2018.** The GK-2A will have Advanced Meteorological Imager (AMI) like Himawari-8/AHI and GOES-R/ABI.

KMA/NMSC has started to develop algorithm of fifty-two meteorological products for GK-2A. These products include scene analysis and surface information, cloud and precipitation, aerosol and radiation, and atmospheric information. The Atmospheric Motion Vectors(AMVs) also included in fifty-two products to support numerical weather prediction and forecasting.

In this paper, we will **introduce development status and future plan of the Atmospheric Motion Vectors algorithm for GK-2A**.

Product Generated

AMI(Advanced Meteorological Imager)

AMI (Resolution)		AHI
1 blue	0.47 (1km)	0.46
2 green	0.511 (1km)	0.51
★ 4 red	0.64 (0.5km)	0.64
6	0.856 (1km)	0.86
5	1.38 (2km)	
6	1.61 (2km)	1.6
		2.3
★ 7	3.830 (2km)	3.9
★ 8	6.241 (2km)	6.2
★ 9	6.952 (2km)	7.0
★ 10	7.344 (2km)	7.3
11	8.592 (2km)	8.6
12	9.625 (2km)	9.6
13	10.403 (2km)	10.4
★ 14	11.212 (2km)	11.2
15	12.364 (2km)	12.3
★ 16	13.31 (2km)	13.3

★ : used for AMV

| Specification | | |
|---|---|
| Geographic Coverage (planned proposal) | Full disk(-80~80°N, -180~180 °E) Extended Local Area(24~49°N, 106~147°E) |
| Horizontal Resolution | IR: 50 km VIS: 25km |
| Output time interval | FD: 1 hour ELA: 10 minute |
| Measurement Range | Speed: 3 ~ 133 m/s(IR), 1~90 m/s(VIS) Degrees: 0 to 360 degrees |
| Measurement Accuracy (Requirement) | Mean Vector Difference: 7.5 m/s |

[Specification for GK-2A AMV algorithm]

Algorithm option	Content
Target area size	25x25 pixel
Search area size	IR: 81x81 pixel VIS: 109x109pixel
Image time interval	FD: 10 minute ELA: 2.5 minute
Proxy data	Himawari-8 (AHI)
Cloud product	CLD and CTP by GK-2A
Forecast Model	KMA Unified Model
RTM model	RTTOV
Validation data	Radiosonde(GTS) KMA Unified Model

[Derailed items for GK-2A AMV algorithm]

Algorithm Description
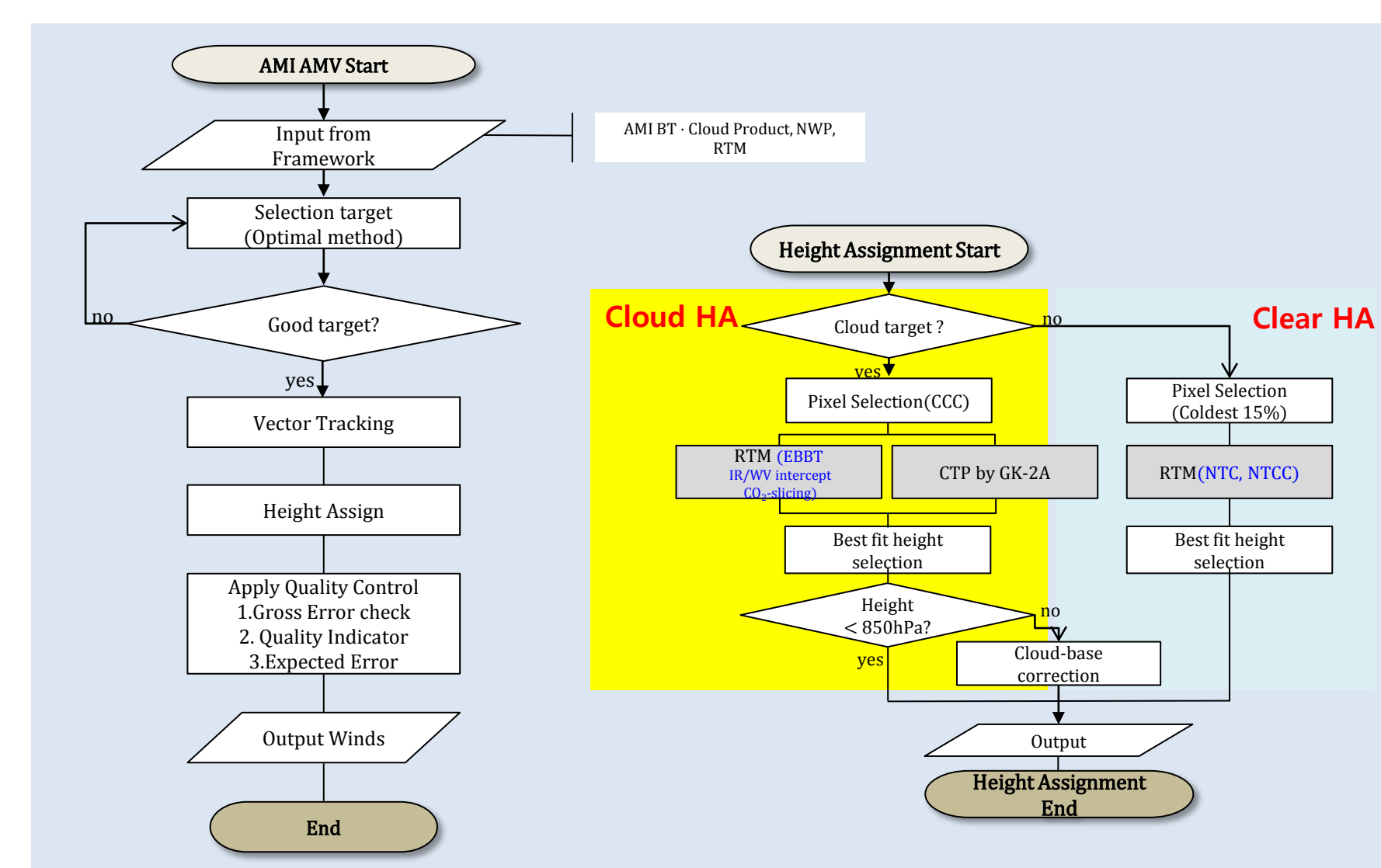
[Flow-chart of GK-2A AMV Algorithm]

Data Set

- **Target Selection**
  - optimal method
- **Tracking**
  - Cross Correlation
- **Height Assignment**
  - EBBT, STC, CO2-Scliging, **CTP(GK-2A)**
  - NTC, NTCC

- **Satellite data**
  : Himawari -8 L1B
- **date**
  : 19 August 2015
- **Product time interval**
  : 1 hour
- **satellite image time interval**
  : 10 min.

CCC (Cross Correlation Contribution)

- IR & VIS channels and cloudy targets in WV channels.
- The individual contribution of each pixel is calculated to select target and assign height in target area.
- Be using cross correlation coefficient that is calculated in feature tracking step(Büch et al., 2006. Regis Borde and Ryo Oyama, 2008).
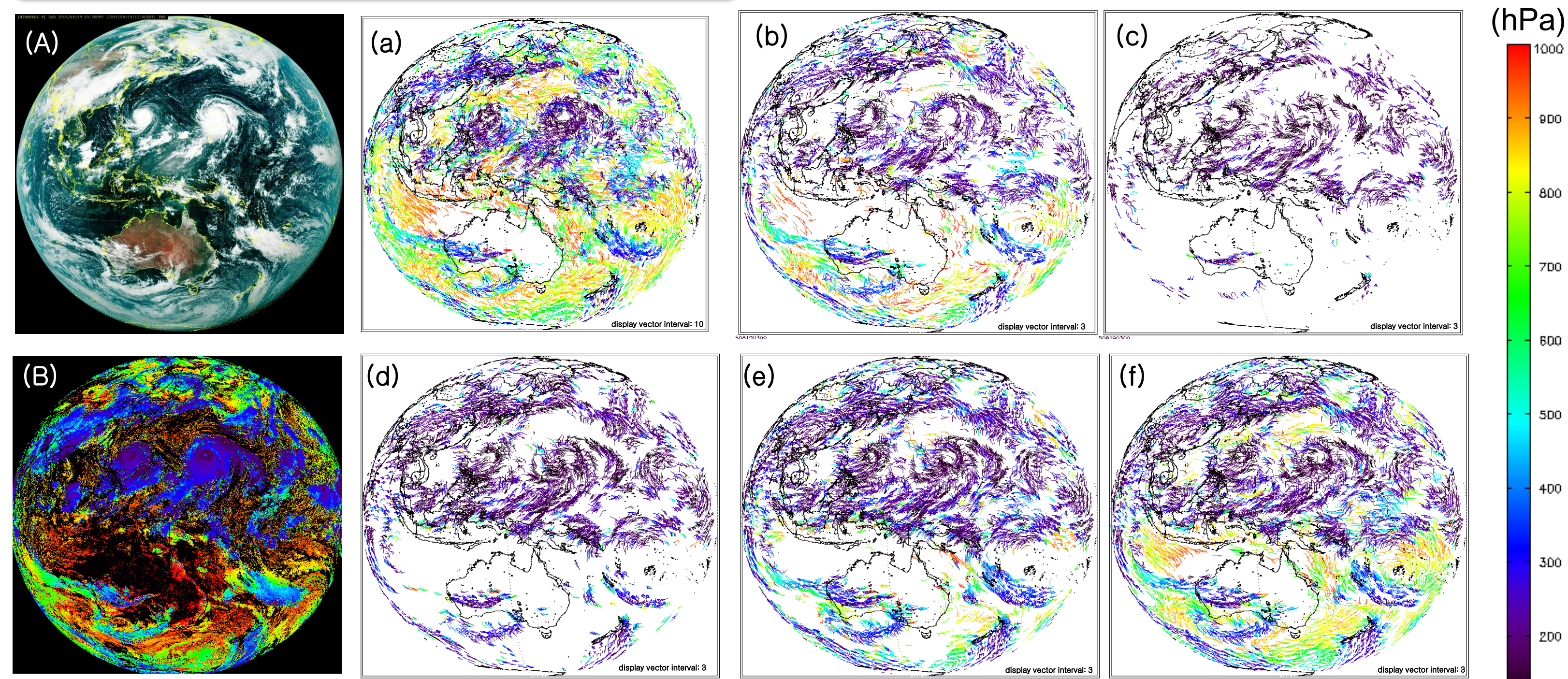- The CCij is defined by Buche et al.(2006).

$$CC(m,n) = \frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N}\frac{a_{i+m,j+n} - \bar{a}(m,n)}{\sigma_a(m,n)}\frac{b_{ij}-\bar{b}}{\sigma_b}$$

$$CC(m,n) = \sum_{i,j}^{M,N} CC_{i,j}(m,n)$$

$$P = \frac{\sum_{cc_{i,j}>cc_{i,thres}} CC_{i,j}\,CTP_{i,j}}{\sum_{cc_{i,j}>cc_{i,thres}} CC_{i,j}}$$

a : BT(target in search area)
$\bar{a}$: mean(a)
b : BT(target area)
$\bar{b}$: mean(b)
m,n: Target size(24x24 pixel)

Results

[Atmospheric motion vectors derived from full disk 10-minute Himawari-8 AHI data at 03UTC on 19 August 2015. Channels used: (a) 0.8 ㎛, (b) 3.9 ㎛, (c) 6.2 ㎛, (d) 7.0 ㎛, (e) 7.3 ㎛ and (f) 11.2 ㎛. (A) is RGB imagery and (B) is cloud top pressure from GK-2A's algorithm]

Validation Results

		Sample		MVD		RMSVD		Bias		Mean WS	
		NWP	Sonde	NWP	Sonde	NWP	Sonde	NWP	Sonde	NWP	Sonde
VIS (0.8㎛)	All	195240	1762	2.15	4.59	2.57	5.42	-0.26	-0.71	13.33	17.55
	High	44537	1122	3.03	5.10	2.59	5.94	-0.72	-0.80	23.52	21.90
	Mid	39789	294	2.60	4.20	2.99	4.89	-0.35	-0.96	13.93	12.20
	Low	110914	346	1.63	3.27	1.81	3.87	-0.04	-0.21	9.02	7.55
SWIR (3.9㎛)	All	152434	1785	3.20	5.52	3.79	6.59	-0.78	-1.19	15.57	19.10
	High	65491	1545	3.74	5.71	4.40	6.76	-1.09	-1.17	20.50	20.51
	Mid	35958	192	3.38	4.34	3.94	5.42	-0.88	-1.83	14.61	10.19
	Low	50985	48	2.37	4.05	2.68	6.59	-0.33	0.72	9.90	9.42
WV (6.2㎛)	All	46999	1413	3.90	6.40	4.50	7.52	-0.09	-0.14	20.01	23.86
	High	46250	1408	3.89	6.41	4.48	7.53	-0.12	-0.15	20.49	23.91
	Mid	700	5	4.77	4.10	5.44	4.41	1.19	2.13	17.83	10.77
	Low	49	-	3.82	-	4.27	-	2.55	-	13.22	-
WV (7.0㎛)	All	91536	2486	4.01	6.02	4.72	7.07	-0.44	-0.74	23.34	24.05
	High	86542	2462	3.98	6.02	4.68	7.07	-0.51	-0.78	23.70	24.09
	Mid	4627	24	4.71	5.87	5.45	6.98	0.80	3.88	17.58	20.12
	Low	367	-	3.66	-	4.10	-	1.28	-	11.52	-
WV (7.3㎛)	All	147092	3029	3.77	5.60	4.42	6.55	-0.60	-0.78	20.98	22.28
	High	110008	2859	3.80	5.60	4.45	6.56	-0.68	-2.27	22.58	22.83
	Mid	27150	161	3.98	5.53	4.62	6.52	-0.39	-1.88	17.72	13.10
	Low	9934	9	2.92	4.38	3.35	5.27	-0.37	-0.86	12.11	13.06
IR (11.2㎛)	All	184949	2616	3.29	5.53	3.91	6.49	-0.76	-0.98	19.81	19.81
	High	94691	2294	3.77	5.70	2.61	6.67	-0.96	-0.95	22.14	21.18
	Mid	35202	213	3.57	4.74	4.15	5.48	-0.91	-1.66	15.34	11.23
	Low	55056	109	2.30	3.52	4.42	4.04	-0.33	-0.39	9.77	7.75

[Comparison statistics of GK-2A's AMVs using Himawari-8/AHI as proxy data, NWP winds from KMA Unified Model, and Radiosonde winds on 19 August 2015. Collocation times are 00, 06, 12 and 18 UTC and QI > 0.85.]

- The MVDs of the Visible AMVs on 19 August 2016 are 2.15 m/s and 4.59 m/s, respectively, with corresponding RMSVD values of 2.57 m/s and 5.42 m/s.
- The MVDs of the SWIR AMVs are 3.20 m/s and 5.52 m/s, respectively, with corresponding RMSVD values of 3.79 m/s and 6.59 m/s.
- The MVDs of the WV AMVs is from 3.77 m/s to 4.01 m/s using collocated forecast model, and from 5.60 m/s to 6.40 m/s using collocated Radiosonde observations.
- The MVDs of the IR AMVs are 3.29 m/s and 5.58 m/s, respectively, with corresponding RMSVD values of 3.91 m/s and 6.49 m/s.
- The biases of the AMVs are negative generally. This means the GK-2A's AMVs is slower than winds from NWP and Radiosondes.
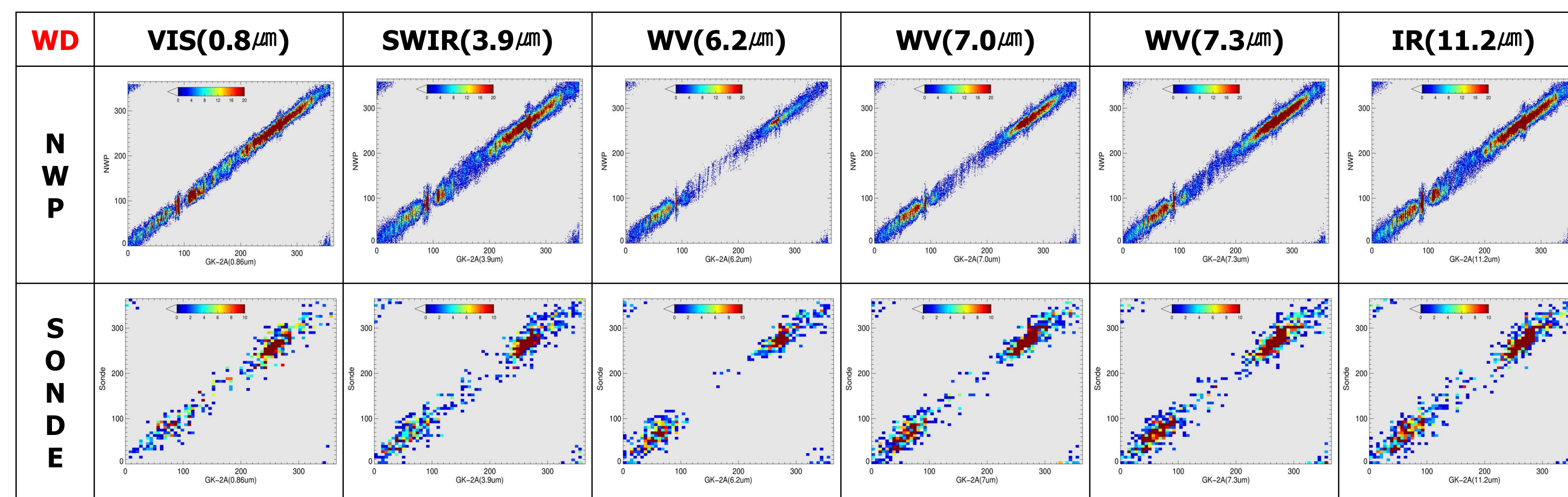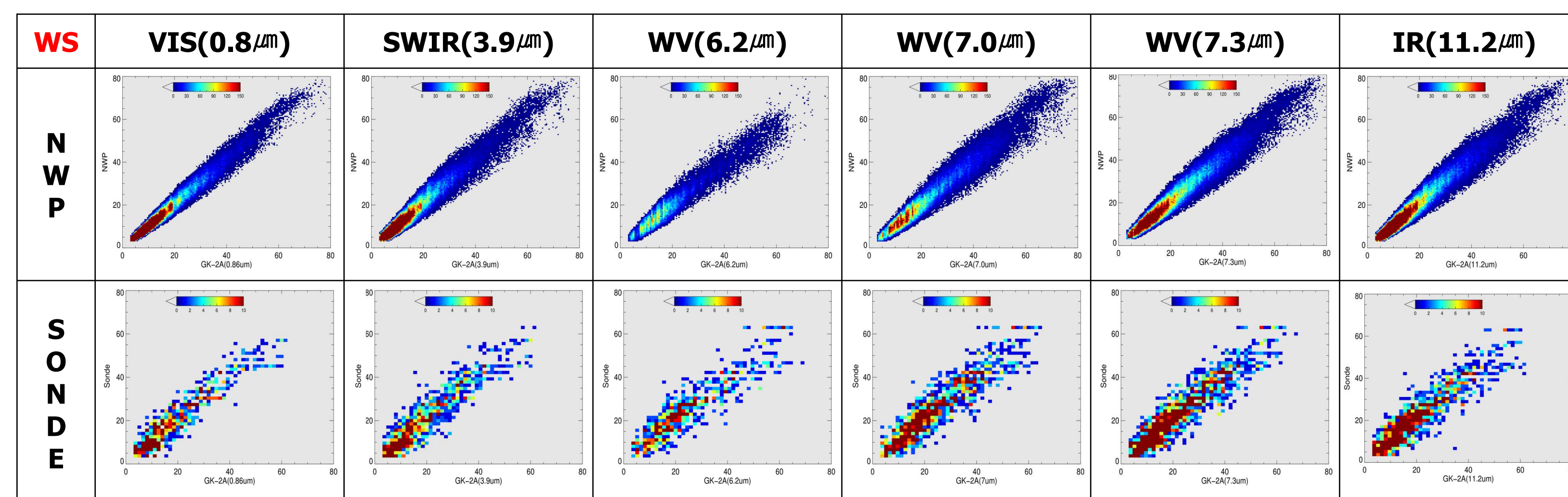
[Scatter plots of GK-2A AMVs with KMA Unified Model (NPW) and Radiosonde (SONDE). Upper panels are wind speed(m/s) and bottoms are wind direction (degree) (QI with forecast > 0.85)]

- These scatter plots are shown for comparisons with wind speed and direction of NWP model and Radiosonde observations.
- In the plots of wind direction, differences of GK-2A's AMVs and NWP are relatively large around 90° and 270°.

Summery & Future Plan

- KMA/NMSC has developed AMV algorithm of GK-2A using Himawari-8/AHI data as a proxy data.
- We are going to do further studies for optimal search and target areas and additional channels uses such as the test the 1.38 ㎛ channels for cirrus tracking.
- The CO_2 slicing method for height assignment will be included in the algorithm and the cloud base correction of low clouds (SC and St) will be studied.
- High resolution AMVs using rapid scan data over the local area will be studied for the monitoring of mesoscale weather events.