Status of operational AMV from GEO-KOMPSAT-2A(GK2A) at KMA

2021.04.12.

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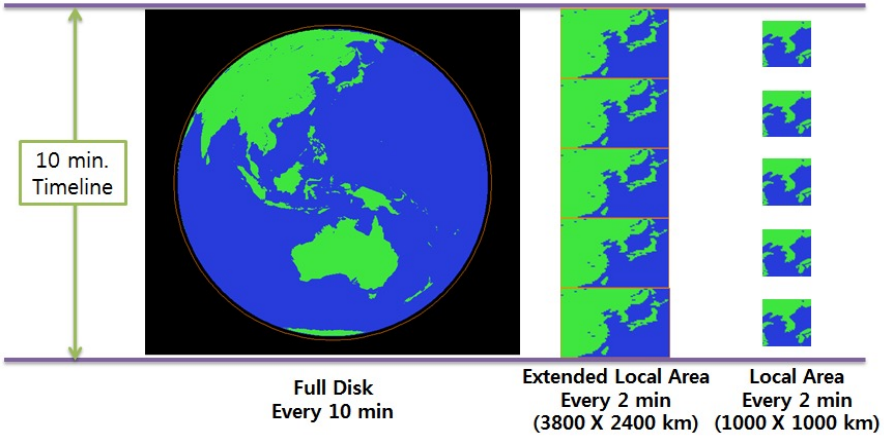
Korea Meteorological Administration (KMA)
National Meteorological Satellite Center (NMSC)

15th International Wind Workshops (12-16 April, 2021)

Current status of GK2A AMVs

Geo-KOMPSAT-2A (GK2A)

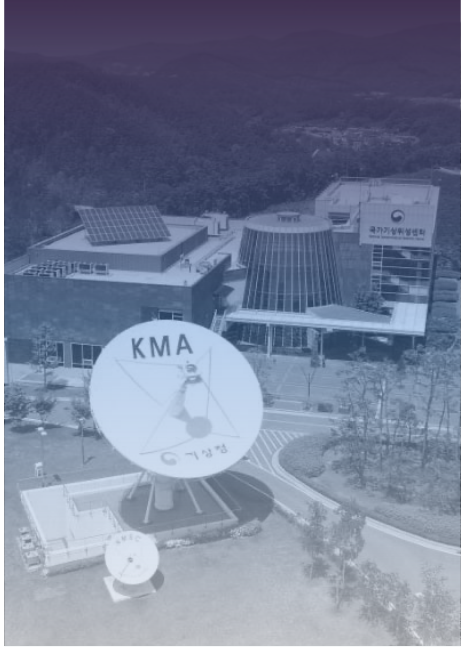
- GK2A was launched in 5th December 2018
- Higher spectral resolution with 16 channels
- Every 10 min for Full Disk, and every 2min for East Asia



Atmospheric Motion Vector

- Officially operating the GK2A AMV since November 2019
- Serviced in BUFR format via GTS: working on applying the new BUFR template (~ May 2021)

GK-2A AMV		
Channels	VIS(03), SWIR(07), WV(08, 09, 10), IR(13, 14)	
Temporal resolution	30 min (FD)	
Spatial resolution	48 × 48 pixels (24 km x 24 km) for VIS 16 × 16 pixels (32 km x 32 km) for the others	
Tracking	Cross Correlation	
Height assignment	Cloud	EBBT & IR/WV intercept (+ Cloud base correction) (+ Inversion layer correction)
	Clear-sky	NTC & NTCC
QC	QI (+ Common QI), EE	



Contents

Impacts of GK2A AMVs in KIM Global NWP Model

- KMA started assimilation of GK2A AMV data into **KIM global NWP model** since **October 2020**

- **Model :**
  KIM Global NWP Model (Operational)
- **DA Method :**
  Hybrid-4D Ensemble VAR (H4DEV)
- **Used channels :** VIS, IR, WV
- **Temporal/Spatial resolution :**
  30 min. / 32km(16x16)

➔ **Improvements of QI criteria and vertical observation errors**

➔ **Increasing of Analysis Increment over Asia region**

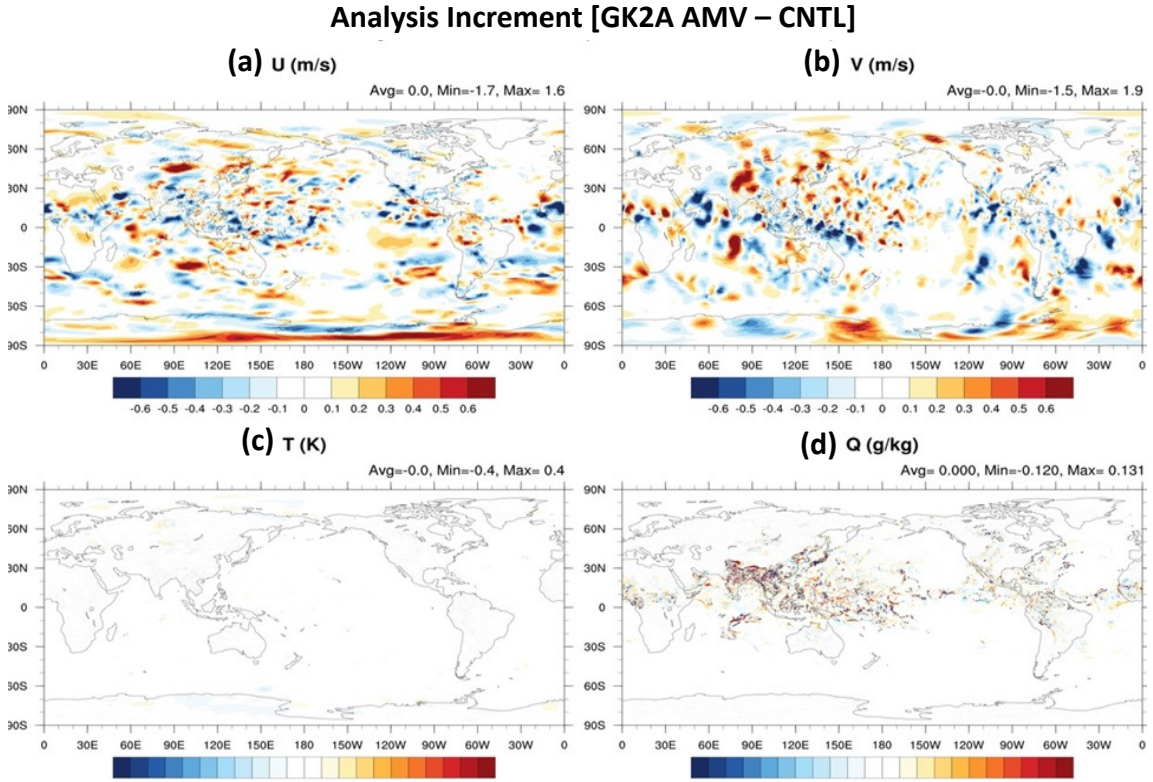
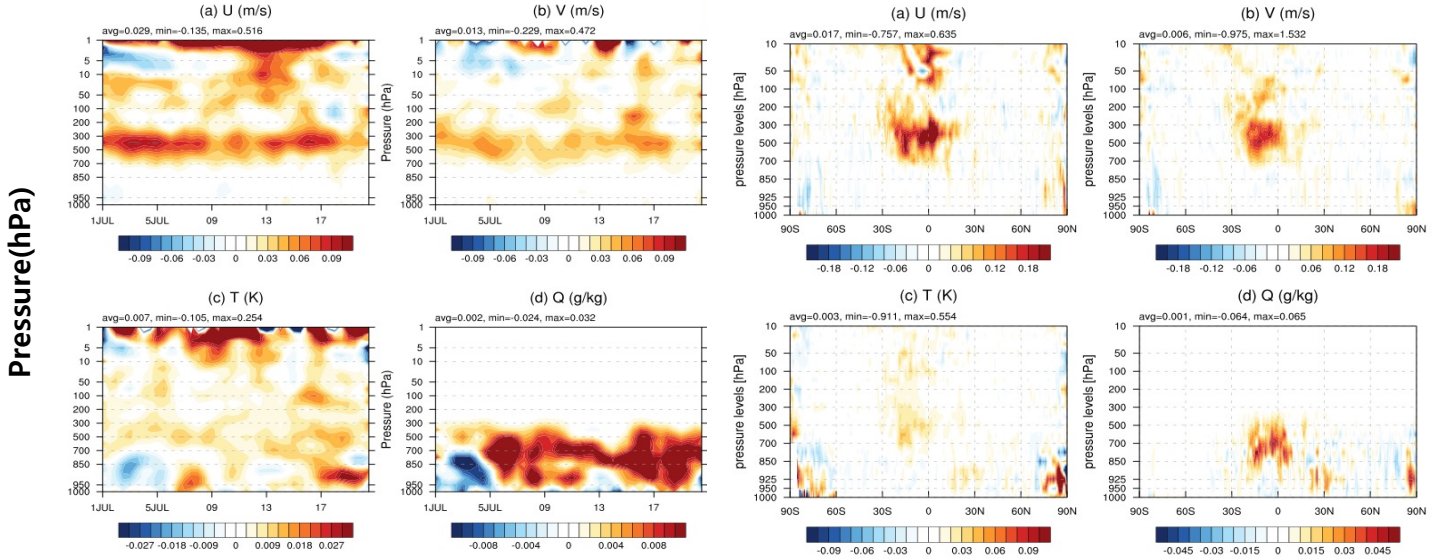


Figure. Global horizontal distributions of the analysis increment for (a) zonal wind, (b) meridional wind, (c) temperature and (d) specific humidity for the month of August 2019

Impacts of GK2A AMVs in KIM Global NWP Model

Difference of RMSE between control and analysis(initial) against IFS [Control – Experiment]



Red : Improvement
Blue : Degradation

Figure. Vertical profiles of temporal mean(left panels) zonal mean(right panels) of the analysis error difference between CTL and EXP for (a) zonal wind, (b) meridional wind, (c) temperature and (d) specific humidity during the month of August 2019. The analysis error is defined as the root mean square (RMS) difference against the verifying IFS analysis. Positive values signify an error reduction due to the GK2A AMV

Impacts of GK2A AMVs in KIM Global NWP Model

RMSE improvement between control and forecast(1~5day) against IFS [Control – Experiment]

(a) RMSE improvements (00 UTC)

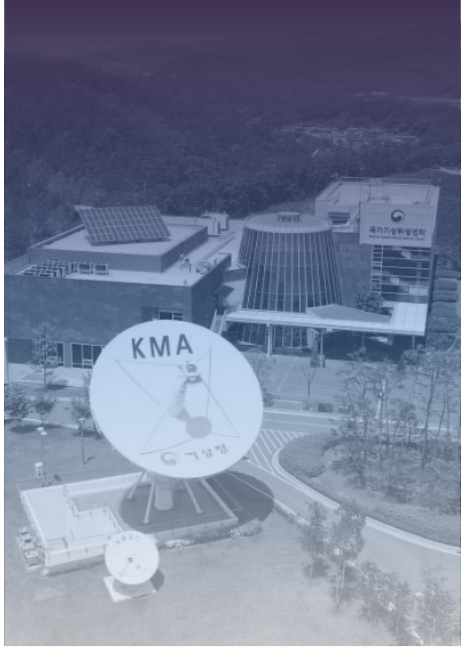
	NH						SH						TR						ASIA					
fcst time (hr)	00	24	48	72	96	120	00	24	48	72	96	120	00	24	48	72	96	120	00	24	48	72	96	120
s700hPa	-0.07	0.14	0.73	0.24	1.3	0.76	0.18	0.4	1.38	0.97	0.22	0.32	1.99	1.78	1.16	1.25	0.35	-0.02	0.85	-0.5	0.56	0.33	1.56	0.79
w250hPa	0.49	0.21	0.7	0.51	0.68	-1.06	1.48	1.0	0.86	1.9	0.28	0.67	1.03	0.71	-0.59	1.28	0.99	0.49	0.94	0.94	1.54	-0.19	1.24	-1.7
w500hPa	-0.01	0.28	0.99	0.11	0.5	0.52	0.27	0.17	1.07	1.09	-0.05	-0.33	3.71	2.87	2.3	1.76	1.7	2.06	-0.09	-0.33	1.55	-0.6	-0.76	0.7
w850hPa	0.07	0.14	0.33	0.27	0.73	-0.07	-0.07	-0.16	0.61	1.15	0.02	-0.83	-0.33	-0.1	0.78	1.14	0.55	-0.12	-0.56	-1.08	0.33	0.5	1.17	1.2
z250hPa	3.23	1.46	2.46	1.84	1.74	-0.01	2.87	2.36	1.87	2.84	0.79	-0.93	3.33	2.65	1.69	1.18	-0.35	1.3	0.8	0.1	3.26	0.53	1.15	0.54
z500hPa	3.67	3.24	3.12	1.65	2.09	0.87	1.66	1.56	2.03	2.45	0.57	-2.36	5.37	3.74	2.94	0.64	0.55	0.97	-0.09	0.11	2.99	1.83	1.86	2.21
z850hPa	4.69	1.79	1.06	0.91	1.34	0.93	1.68	0.86	2.04	2.17	0.88	-2.7	2.85	0.33	1.29	1.38	-0.25	1.14	2.44	-0.43	1.15	4.66	3.85	3.01
t250hPa	-0.05	0.74	0.87	1.12	0.14	0.13	1.04	0.73	1.24	2.1	0.76	-0.26	1.24	0.47	0.77	0.66	0.74	-0.05	-1.16	1.01	1.45	1.23	0.51	0.54
t500hPa	0.29	0.45	0.63	0.8	0.86	-0.29	0.78	0.56	0.62	1.39	0.45	1.24	3.09	1.5	1.57	0.57	-0.06	0.12	0.09	0.18	-0.09	-0.23	-0.2	-0.15
t850hPa	-0.02	0.57	0.46	0.91	0.83	1.22	-0.41	-0.71	-0.2	0.23	0.39	-0.42	0.54	-0.05	0.28	0.54	1.02	-0.7	0.39	0.93	-0.03	2.52	3.69	2.11

(b) RMSE improvements (12 UTC)

	NH																		ASIA					
fcst time (hr)	00	24	48	72	96	120	00	24	48	72	96	120	00	24	48	72	96	120	00	24	48	72	96	120
s700hPa	-0.34	0.06	0.82	1.14	1.43	1.49	0.28	0.39	0.44	0.88	0.84	0.34	2.06	1.85	1.12	0.99	0.86	1.0	0.15	-0.6	0.01	0.04	1.51	0.1
w250hPa	0.01	0.13	1.01	1.14	1.19	1.77	0.38	0.61	0.65	2.31	0.74	0.76	0.68	0.91	0.71	1.16	1.29	1.52	0.15	-0.14	1.33	0.38	-2.96	-0.03
w500hPa	0.19	0.45	0.77	0.42	0.88	2.49	-0.18	0.4	0.12	0.52	0.09	-0.43	4.29	2.94	2.64	3.08	1.88	1.22	0.14	0.22	1.17	1.07	-2.06	1.3
w850hPa	0.26	0.17	0.45	0.99	0.86	2.75	-0.02	-0.41	-0.57	0.69	1.44	-0.02	-0.39	0.43	0.81	0.95	0.53	-0.66	0.09	-0.52	0.54	0.84	-1.37	2.92
z250hPa	4.15	1.23	3.12	2.64	3.45	4.31	1.45	1.04	0.35	2.06	0.75	0.11	6.01	2.64	3.31	2.06	1.2	1.76	2.01	-1.42	3.27	1.62	-2.57	-0.39
z500hPa	2.74	2.29	3.18	2.65	2.58	3.76	1.1	0.59	0.26	1.64	-0.21	-0.77	4.76	3.16	3.19	1.51	1.83	3.24	0.91	0.29	2.26	3.19	-2.85	-1.35
z850hPa	2.93	2.31	1.73	0.41	1.28	3.19	1.08	0.04	-0.5	1.25	1.27	0.97	4.32	1.49	1.07	0.36	0.36	2.53	2.65	1.91	0.59	0.09	-4.46	-6.38
t250hPa	0.25	0.46	1.14	1.19	0.02	2.05	0.19	0.58	-0.11	1.51	2.07	1.63	1.23	0.18	0.5	0.95	-0.05	0.48	-0.37	1.4	2.51	1.13	-1.88	0.28
t500hPa	0.76	0.58	0.77	1.42	1.63	2.8	0.84	0.23	-0.24	0.53	0.83	-0.15	3.05	1.62	1.21	1.57	0.58	0.44	-0.01	-0.08	0.9	1.4	-3.28	1.56
t850hPa	0.46	0.26	0.52	0.73	0.47	0.75	-0.44	-0.58	-0.89	0.06	1.06	0.79	0.26	0.18	0.64	0.74	1.27	1.33	0.5	-0.7	-0.05	2.4	1.73	0.09

➔ **Large positive Impacts for analysis and forecast over Northern hemisphere and Tropics**

Figure. RMSE improvement of analysis and forecast(up to 5 day) for specific humidity, wind, geopotential height and temperature for the month of August 2019. The analysis error is defined as the root mean square (RMS) difference against the verifying IFS analysis. Green panels signify an error reduction due to the GK2A AMV



Contents

AMV Algorithm Updates

Cloud base correction

- **Remove cloud base correction** because of the error that occurs in the process of estimating cloud base temperature

➔ **(CALIPSO)** The new AMVs better match the actual altitude of the clouds(CALIPSO level 2 vertical feature mask)

➔ **(NWP)** RMSVD of low-level(700-100hPa) visible AMVs decreased in the seas of the southern hemisphere

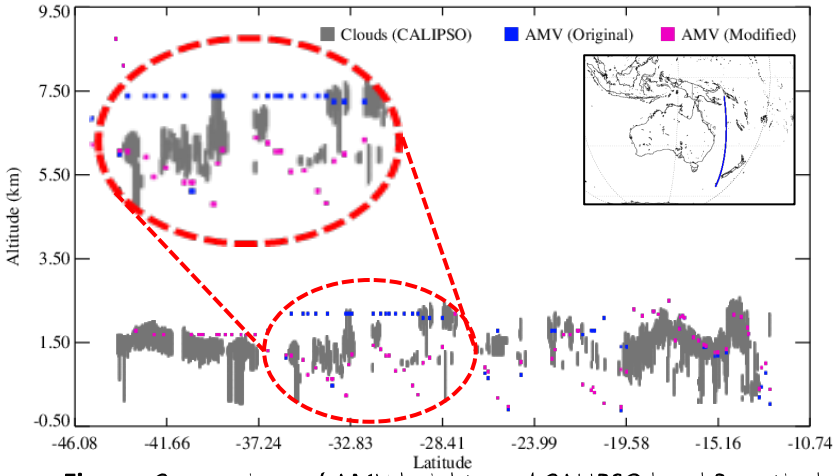


Figure. Comparison of AMV heights and CALIPSO level 2 vertical feature mask products for 03:30 UTC on 19 August 2019 (Grey: clouds, blue: original AMV, pink: updated AMV)

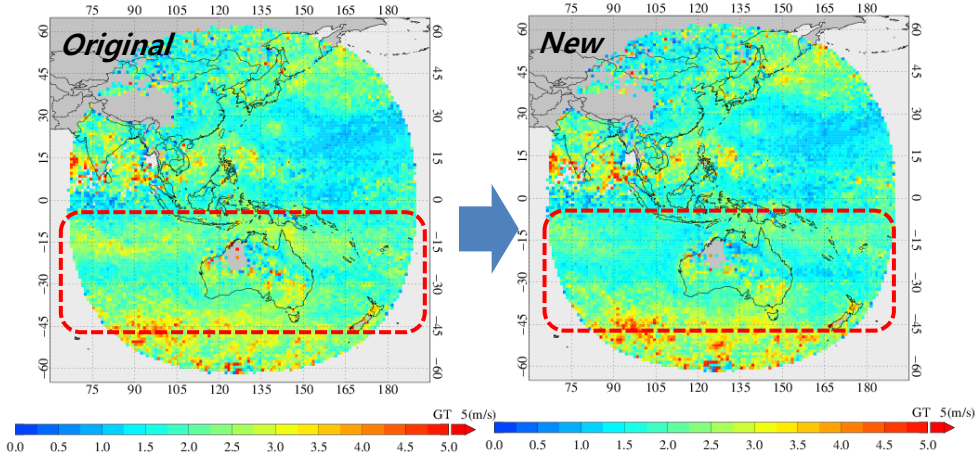


Figure. RMSVD of GK2A visible AMV(700-1000hPa only) against NWP wind field for the month of August 2019

AMV Algorithm Updates

Multi-Layer cloud flag

- Slow speed bias caused by multi-layer clouds
- Add multi-layer flags in order for users to selectively filter out low-quality data (applied only to infrared and short wave infrared channel)
- Use the local mean and standard deviation information to identify clusters of points sharing common characteristics (2012, Bresky at al.)
  - ✓ Bresky, W.C., Daniels, J.M., Bailey, A.A., and S.T. Wanzong, 2012: New methods toward minimizing the slow speed bias associated with atmospheric motion vectors, *Journal of applied meteorology and climatology*, Volume 5, Issue 12, pp.2137-2151.

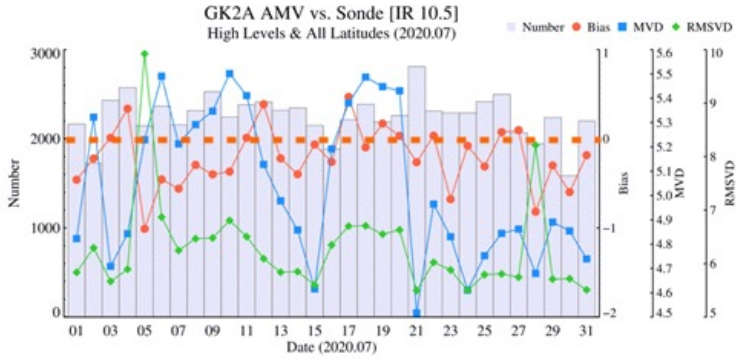


Figure. Time series of the speed bias, mean vector difference (MVD) and root mean squared vector difference (RMSVD) between the GK2A IR105 AMVs and radiosonde winds

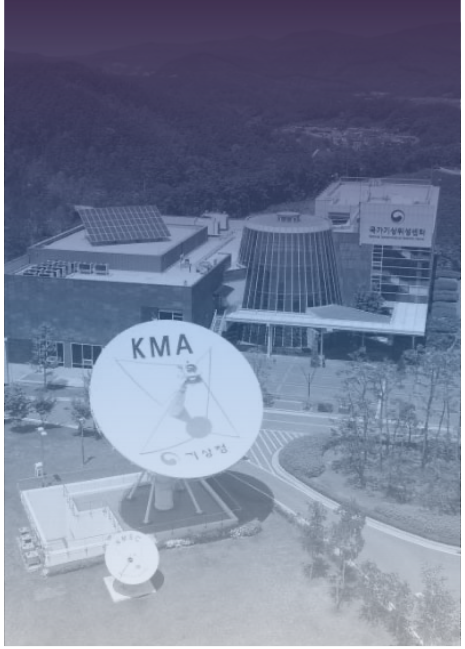
➔ **Slow speed bias has been improved**

➔ **Effective in distinguishing bad quality vectors?**

- (Radiosonde) The accuracy in single-layer clouds is worse than in multi-layer clouds

Channel	Statistics	Radiosonde		NWP (UM)	
		All	QC_Flag	All	QC_Flag
SWIR (3.8 um)	Bias	-0.38	0: -0.20 1: -0.67	-0.47	0: -0.39 1: -0.71
	RMSVD	6.44	0: 6.48 1: 6.37	3.41	0: 3.30 1: 3.71
IR (10.5 um)	Bias	0.04	0: 0.20 1: -0.16	-0.21	0: -0.16 1: -0.32
	RMSVD	6.28	0: 6.30 1: 6.25	3.34	0: 3.24 1: 3.58

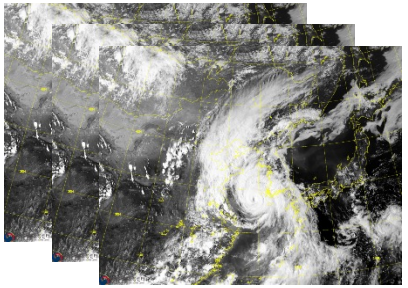
Table. Error statistics of AMV retrievals compared with radiosonde and NWP model for the month of August in year 2019 (QC_Flag: 0 - single clouds, 1 - multi clouds)



Contents

Development of High Resolution AMV

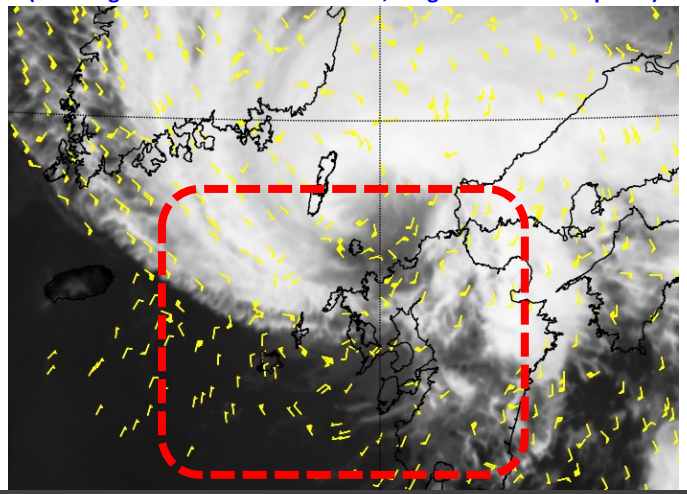
- **Key objective:** analysis of local winds and circulation in the lower layer, etc
- Input data : VIS (0.5 km) images with 2 minutes interval (ELA area)
- Tracking method : Optical flow
  (using OpenCV library in Python, Farneback algorithm)



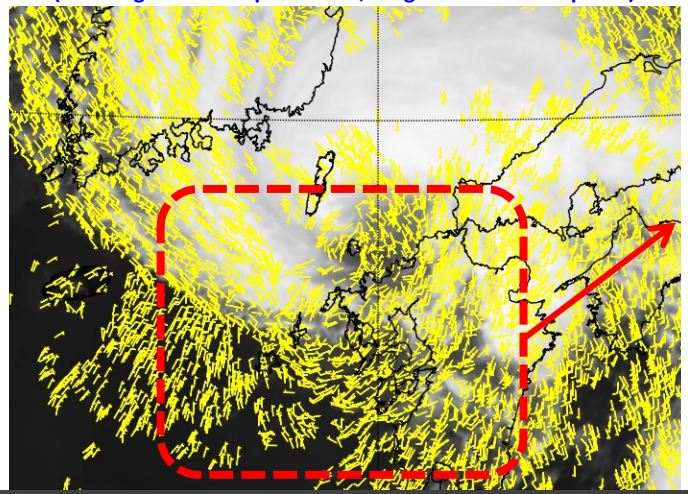
ELA area
Every 2 min.
3800 * 2400 km

➔ **Case 1: Typhoon Francisco (2019.08.06. 04:00 UTC)**

AMV
(Tracking method: cross correlation, Target size : 48 x 48 pixels)



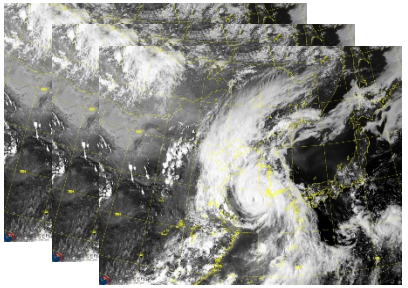
RS-AMV
(Tracking method: optical flow, Target size : 10 x 10 pixels)



- ✓ As the typhoon went north and passed through the Kyushu, the upper and lower layers of the typhoon were separated
- ✓ **The cyclonic circulation in the lower layer**
- ✓ Divergence of wind in the upper later

Development of High Resolution AMV

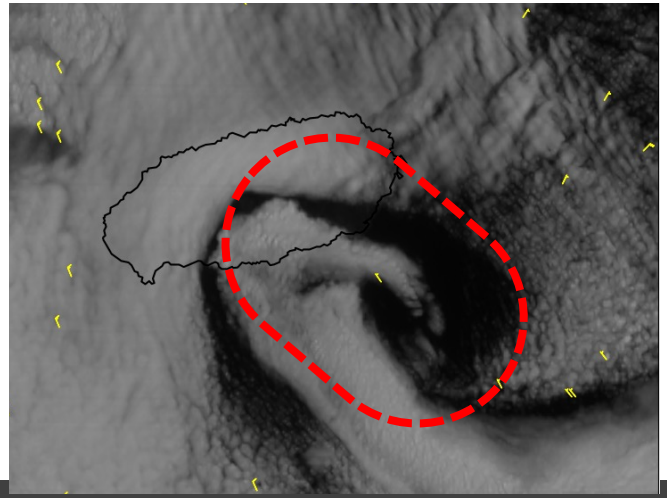
- **Key objective:** analysis of local winds and circulation in the lower layer, etc
- Input data : VIS (0.5 km) images with 2 minutes interval (ELA area)
- Tracking method : Optical flow
  (using OpenCV library in Python, Farneback algorithm)



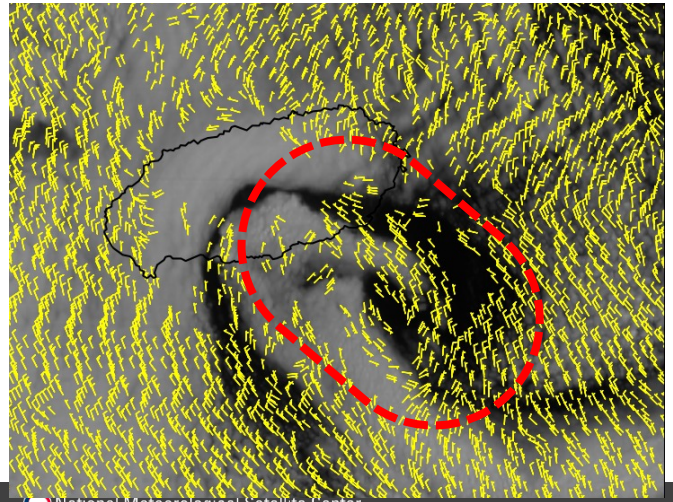
ELA area
Every 2 min.
3800 * 2400 km

➔ **Case 1: Vortex (2021.04.04.01:00 UTC)**

AMV
(Tracking method: cross correlation, Target size : 48 x 48 pixels)



RS-AMV
(Tracking method: optical flow, Target size : 10 x 10 pixels)



✓ **A vortex formed in the south of Jeju Island**

✓ To produce local flow, we need to reduce the target size

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Thank you

Korea Meteorological Administration (KMA)
National Meteorological Satellite Center (NMSC)