AMVs Quality Control Method for Geo-Kompsat-2A

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Introduction

The second generation geostationary satellite of Korea (Geo-KOMPSAT 2A; GK-2A) is scheduled to be launched in mid 2018. The Advanced Meteorological Imager on GK-2A will have sixteen spectral bands with 0.5-2 km spatial resolution and will scan every 10 minutes for the Full Disk. It will provide four times better spatial and temporal resolution, and three times better spectral information compared to the Communication, Ocean and Meteorological satellite Meteorological Imager, currently operating satellite. A new GK-2A AMVs algorithm is under development. Total ten types of wind vector, which consist of 7 cloud targets from 7 channels and 3 clear targets from 3 water vapor channels, will be obtained every hour over full-disk region.

GK-2A AMVs Quality Control (QC) will be performed in two approaches. The first one is well-known Quality Indicator (QI) based on vector consistencies and the other one is Expected Error (EE) based on multiple linear regression analysis with past collocation data. This poster present the QC method for AMVs algorithm for the GK-2A and shows recent QI optimization study results.

GK-2A AMVs Specification

	COMS AMVs	GK-2A AMVs
Target Selection	Regular	Optimal
Target Size	24x24 (96x96 km² at nadir)	16x16 (32x32 km² at nadir)
Tracking Method	Cross Correlation	Cross Correlation
Height Assignment		
Clear Target	NTC, NTCC	NTC, NTCC
Cloud Target	STC, EBBT, IR/WV intercept	EBBT, CO_2 Slicing, IR/WV intercept
Quality Control	QI	QI, EE

Sensor Information

		GK-2A AMI
Spectral Coverage		16 bands
Spatial Resolution	0.6 ㎛	0.5 km
	Visible	1.0 km
	Infrared	2.0 km
Temporal Resolution	Full Disk	10 mins
	LA	2.5 mins

QUALITY CONTROL METHOD

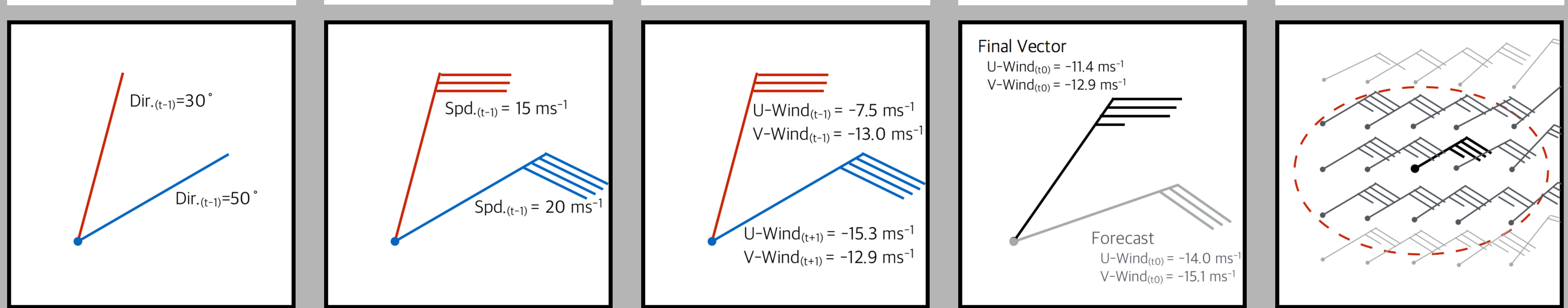
QI — Fast, Linear

EE — Slow, non-Linear

Quality Indicator (QI)

The Quality Indicator is an index which computed by weighted averaged 5 contingency tests, temporal direction consistency, temporal speed consistency, temporal vector consistency, spatial vector consistency, and consistency with the forecasted wind (Holmlund, 1998). Current COMS AMVs has been used only QI as their Quality Control (QC).

Temporal Direction Consistency	Temporal Speed Consistency	Temporal Vector Consistency	Forecast Consistency	Spatial Vector Consistency



$$\mathrm{QI} = \sum_{i=1}^{5} W_i \Phi_i$$

❖ Direction Test

$$\Phi_{dir.} = 1 - \left[\tanh\left\{\frac{Diff.(Dir.)}{coeff.A \cdot \exp\left(\frac{-Spd._{avg}}{coeff.B}\right) + coeff.C \cdot Spd._{avg} + coeff.D}\right\}\right]^{coeff.E}$$

❖ Others

$$\Phi_{other} = 1 - \left[\tanh\left\{\frac{Diff.}{MAX(coeff.A \cdot Spd._{avg},\ coeff.B) + coeff.C}\right\}\right]^{coeff.D}$$

Current GK-2A QI Coeff.s

	A	B	C	D
Direction	20	10	10	4
Speed	0.2	0.01	1.0	2.5
Vector	0.2	0.01	1.0	3.0
Forecast	0.2	0.01	1.0	3.0
Buddy	0.2	0.01	1.0	3.0

Expected Error (EE)

The Expected Error (EE) is calculated from the 9 components which are the wind speed, the wind speed and temperature shear, the pressure level and the five QI values. The vertical wind and temperature shear are clearly related to AMVs error, determining how heigh assignment errors influence AMV quality. Least square regression is used to compute the root mean square error from the EE components. The EE will be used GK-2A AMVs quality control algorithms with QI.

Step 1. Collect past collocated data between AMV and rawinsonde observation
Step 2. Obtain linear regression coefficients (= EE coefficients) against the wind vector difference

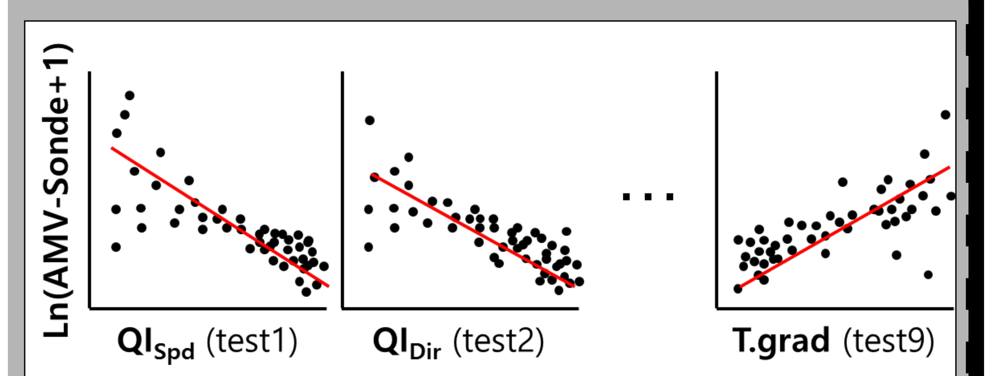
$$\ln(DIFF(AMV, RAOB) + 1) = Const. + a_1x_1 + a_2x_2 + \cdots + a_9x_9$$

<Components>

1. QI_{speed}
2. $QI_{direction}$
3. $QI_{vector\ diff.}$
4. $QI_{local\ vector}$
5. $QI_{forecast}$
6. Wind Speed
7. Pressure Level
8. Wind Shear (at 200 hPa)
9. Temp. Gradient (at 200 hPa)

Step 3. Compute EE at every AMVs using EE coefficients

$$EE = exp(Const. + a_1x_1 + \cdots + a_9x_9) - 1 \approx DIFF(AMV, RAOB)$$



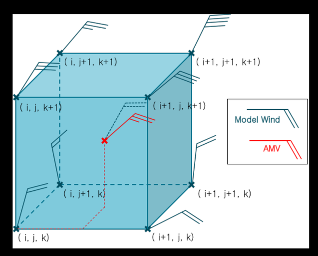
QI COEFs. OPTIMAZATION

Dataset

Time	2016. 07. 01 ~ 2016. 07. 06 (00, 06, 12, 18 UTC)
AMV	GK-2A AMV (ch.14[11.2 ㎛])
Reference [Wind]	ECMWF ERA Interim (0.75x0.75)
Reference [Height]	CALIPSO/CALIOP Cloud Top Pressure

Step 1: Collocation [Wind]

Time	No Interpolation	
Space	Linear Interpolation	Horizontal (4 points)
		Vertical (2 points)



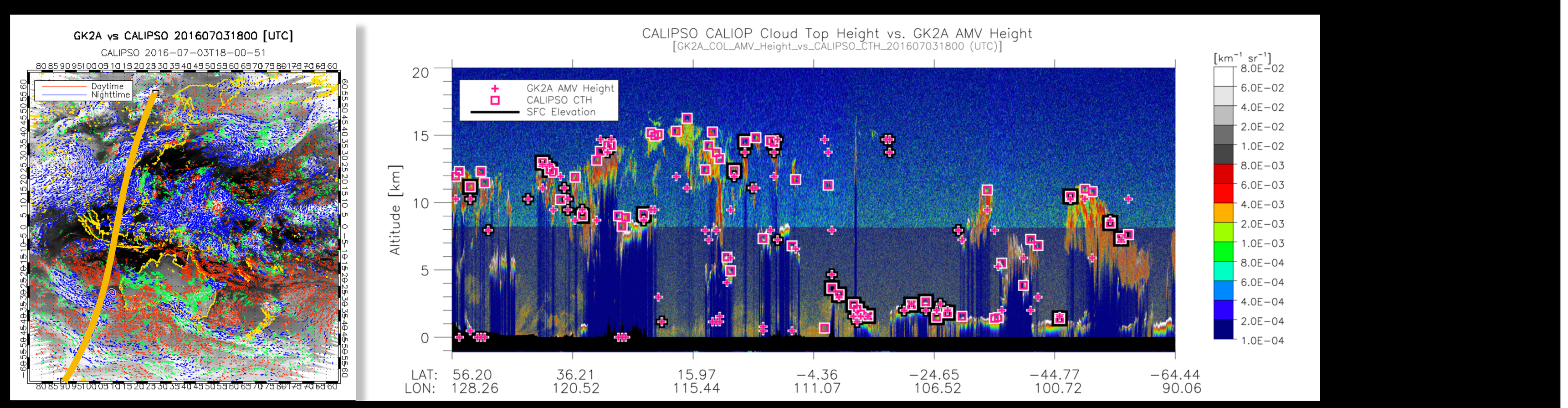
Step 2: Collocation [Extraction]

AMV Error = Tracking Error + ~~Height Assignment Error~~

In order to focus on the error caused by target tracking, we extracted vectors with little difference (| AMV pres. - CAL.CTP | < 0.1) from CALIPSO/CALIOP CTP.

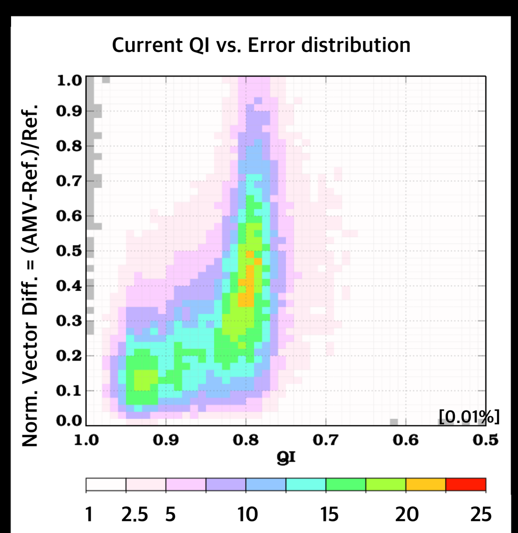
Time		within 30 mins
Space	Horizontal	< 20 km
	Vertical	< 0.1 CTP hPa

(total CALIPSO 10 orbits were selected)



<CALIPSO/CALIOP CTP vs. GK2A AMV Height at 2016 0703 1800 UTC >

Results



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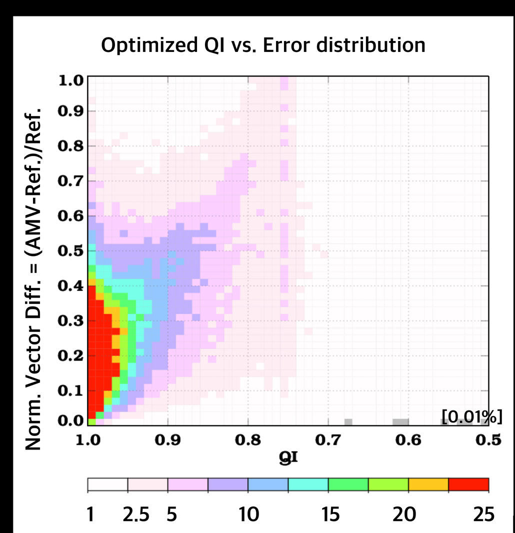

Optimized GK-2A QI Coeff.s

	A	B	C	D
Direction	20	10	10	4
Speed	0.2	0.01	1.0	4.0
Vector	0.4	0.01	1.0	4.0
Forecast	0.4	0.01	1.0	4.0
Buddy	0.4	0.01	1.0	4.0

- A peak at current QI 0.8 was removed.
- The optimized QI shows concentrated distribution around QI=1.
- It is difficult to establish a linear relationship between QI and normalized Error.
- Even though we used a collocated dataset with minimized height assignment error, QI values are generally too high compared to vectors with large errors

Plan

- Updating EE coefficients using the optimized QI coefficients.
- Optimization of QI coefficients using the best-fit height.
- Find more accurate and objective AMVs error estimation methods (e.g., random forest, maximum entropy model).

References

Holmlund, K., 1998: The utilization of statistical properties of satellite-derived atmospheric motion vectors to derive quality indicators, Weather and Forecasting, 13, 1093-1104.
Le Marshall et al., 2004: Error characterization of atmospheric motion vectors. Aust. Met. Mag. 53,p. 123-131.