Thesis for the Degree of Master of Engineering

Cloud location correction of geostationary meteorological satellite data

by

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Pukyoung National University

August 2011

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(정지기상위성자료의 구름위치보정에 관한 연구)

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요 약

정지궤도상에서 위성자료의 위성시차오류(Parallax error)는 적도상에 위치한 위성이 회전타원체인 지구의 중위도 및 고위도 지역의 위성천정각이 큰 위치에 있는 구름을 관측할 때 위성천정각, 구름고도 및 위성방위각에 따라 구름 위치를 원래의 위치가 아닌 다른 위치상에 있는 것으로 관측하는 오류 현상을 뜻한다. 이런 시차오류는 기상위성 산출물 중에서 구름과 관련된 산출물의 위치 오류를 발생시키기 때문에 강수의 유무와 강도를 옳게 분석하더라도 강수위치 선정에 오류를 발생시킬 수 있으며, 지상관측자료 또는 극궤도 위성자료와 검증 시에도 정확도에 영향을 미칠 수 있다. 본 연구에서는 시차오류를 보정하는 방법을 제시하고 보정방법을 검증 및 적용하는데 목적이 있다. 시차오류에 의한 구름위치 보정은 첫째, 위성천정각과 구름고도를 시차보정계산식의 입력 자료로 하여, 구름고도에 맞는 보정된 위성천정각을 산출한다. 둘째, 보정된 위성천정각과 위성방위각을 이용하여 위성시차오류를 보정하여 구름의 원래 위치에 가깝게 옮겨준다. 시차오류는 위성천정각이 증가하고 구름고도가 증가 할수록 더 크게 나타나며, 시차오류로 발생할 수 있는 구름위치오류의 최대치는 위성천정각이 70°, 구름고도가 15km 및 위성방위각이 120°일 때 약 60km에 이를 수 있

다. 또한 동아시아지역(20~50°N)에서는 최대 약 25km의 구름위치오류가 발생할 수 있다. 이런 시차오류에 의한 구름위치오류를 보정한 자료는 극궤도위성자료인 Terra MODIS(Moderate-Resolution Imaging Spectrometer)의 센서천정각 20°이내의 관측 자료와 검증한 결과 정지궤도 기상위성자료의 구름위치오류가 원래 위치에 가깝게 개선된 것을 확인 할 수 있었다. 이런 위성시차오류보정은 향후 아시아 지역의 여러 정지궤도 기상위성의 영상 활용성 증대에도 기여할 것이다.

1. Introduction

The meteorological satellite observational data is one of the important data in the study of the meteorology and weather service. Especially, the output using ground meteorological observational data is limited partially for production of data such as detection of cloud, aerosol, fog, and sea surface temperature etc. but the output using meteorological satellite observational data has merit of small spatial limitations. But the meteorological satellite observational data has weak point of low accuracy compared to the ground meteorological observational data. But the accuracy of this meteorological satellite observational data is improving little by little, and the various correction methods for improvement has been developing and it has been applied newly(BEDKA et al., 2009; Chiaravalloti et al., 2009; Davenport et al., 2008; Gabriele 2008; Joyce 2001; Pesice, 2009; Radova 2008; Sollheim 2008; wong, 2009; Vicente et al., 2002;). There are radiometric correction and geometric correction in the general meteorological satellite observational data correction. The meteorological satellite observational data performed those two corrections is called level1b normally. The meteorological satellite data is produced by using this data but the cloud location error of this data caused by the satellite parallax error was not corrected so it has to be compensated. The satellite parallax error of the satellite data on the geostationary orbit means an error of observing a cloud as being located in a position other than its original position according to satellite zenith angle, cloud height and satellite azimuth angle when the cloud with the big satellite zenith angle in the middle latitude and at high altitudes area of earth as spheroid is observed by the satellite located on equator. In order to increase accuracy of satellite data, this error should be improved, unless this error is corrected, since a cloud will be observed as being located in a position other than its actual position, so it may lead to an error for the selection of precipitation location and the location error of the cloud related data among the meteorological satellite data even through the availability and strength of precipitation is analyzed rightly. According to the 4th report of IPCC(Intergovernmental Panel on Climate Change), the average temperature of earth has been increased about 0.7℃ for latest 100 years(1906~2005) caused by increase of greenhouse gases, and the heavy precipitation will be increased due to this global warming. The convective cloud occurs this heavy precipitation has features with high cloud height. The higher the cloud height is, the more cloud location errors increased by the satellite parallax effect, so it might have effects on the analysis of convective cloud which occurs the heavy precipitation using the satellite data. In addition, it may affect accuracy due to the parallax error upon the validation of the ground observational data or the polar orbit satellite data. As a result, the cloud location error caused by the satellite parallax error may have effects on the weather service or study of meteorology. Vicente et al. (2002) conducted study of correction of this satellite parallax error by using the spherical coordinate system. But 3-D error of the satellite parallax correction occurs based on the error of cloud height for the satellite parallax correction using the spherical coordinate system, so this study corrected the error of satellite parallax correction caused by error of cloud height within 1 dimension by using satellite zenith angle and satellite azimuth angle in order to complement the weak point of satellite parallax correction using the spherical coordinate system. Thus, this study aims to suggest the method of correction of the satellite parallax error and to validation and apply the correction method. The cloud height and satellite zenith angle, satellite azimuth angle were used as the input data of the satellite parallax correction, and the satellite zenith angle was corrected by using cloud height and satellite zenith angle and then the cloud location error was corrected by using corrected satellite zenith angle and satellite azimuth angle finally. The cloud location error was shown as about 60km when the satellite zenith angle was 70°, the cloud height was 15km, and the satellite azimuth angle was 120°.

2. Data and methods

2.1. Data

In order to correct the satellite parallax error of the meteorological satellite data, it is conducted by using the latitude, longitude, cloud height, satellite zenith angle of satellite data, corrected satellite zenith angle and satellite azimuth angle data. As the cloud height data, the data produced by using the satellite data and numerical weather prediction data from the KMA(Korea Meteorological Administration) NMSC(National Meteorological Satellite Center) was used(Choi et al., 2007). The satellite zenith angle(Figure 1) and satellite azimuth angle(Figure 2) were produced by using latitude, longitude data of the satellite. The satellite zenith angle means the angle between a straight line from a point on the earth's surface to the satellite and a line from the same point on the earth's surface that is perpendicular to the earth's surface at that point(the zenith point). In addition, The satellite azimuth angle is the azimuth angle of the satellite in a geostationary orbit. It is most often defined as the angle from due north in a clockwise direction.

As the meteorological satellite data, the MTSAT-2(Multifunctional Transport Satellite-2) satellite is as geostationary orbit meteorological satellite of Japan, and the COMS(Communication, Ocean and Meteorological Satellite) satellite data as the geostationary orbit meteorological satellite of Korea were used. The MTSAT-2 satellite data is located on equator with longitude 145.0°E, and it used the spatial resolution of 4km×4km and 10.8㎛ of central wavelength at the outcomes of observation of infrared rays(Table 1). In addition, the COMS satellite data is located on equator of longitude 128.2°E, and it use the spatial resolution of 4km×4km and 10.8㎛ of central wavelength at the outcomes of observation of infrared rays(Table 1). For validation of data with corrected parallax, it has spatial resolution of 1km×1km which was observed by MODIS(Moderate-Resolution Imaging Spectroradiometer) sensor mounted on the Terra satellite, and the outcomes data of observation of infrared rays with 11.03㎛ of the central wavelength was used(Table 2).

Table 1. The specification of MTSAT-2 and COMS

Band	Center (㎛)	Range (㎛)	Resolution (km × km)
IR1*	10.8	10.3~11.3	4
IR2	12.0	11.5~12.5	4
WV	6.75	6.5~7.0	4
SWIR	3.75	3.5~4.0	4
VIS	0.675	0.55~0.80	1

*Used in this study

Table 2. The specification of MODIS

Band	Range (㎛)	Resolution (km × km)	Band	Range (㎛)	Resolution (km × km)
1	0.620~0.670㎛	0.25	19	0.915~0.965㎛	1
2	0.841~0.876㎛	0.25	20	3.660~3.840㎛	1
3	0.459~0.479㎛	0.5	21	3.929~3.989㎛	1
4	0.545~0.565㎛	0.5	22	3.929~3.989㎛	1
5	1.230~1.250㎛	0.5	23	4.020~4.080㎛	1
6	1.628~1.652㎛	0.5	24	4.433~4.498㎛	1
7	2.105~2.155㎛	0.5	25	4.482~4.549㎛	1
8	0.405~0.420㎛	1	26	1.360~1.390㎛	1
9	0.438~0.448㎛	1	27	6.535~6.895㎛	1
10	0.483~0.493㎛	1	28	7.175~7.475㎛	1
11	0.526~0.536㎛	1	29	8.400~8.700㎛	1
12	0.546~0.556㎛	1	30	9.580~9.880㎛	1
13	0.662~0.672㎛	1	31*	10.780~11.280㎛	1
14	0.673~0.683㎛	1	32	11.770~12.270㎛	1
15	0.743~0.753㎛	1	33	13.185~13.485㎛	1
16	0.862~0.877㎛	1	34	13.485~13.785㎛	1
17	0.890~0.920㎛	1	35	13.785~14.085㎛	1
18	0.931~0.941㎛	1	36	14.085~14.385㎛	1

*Used in this study

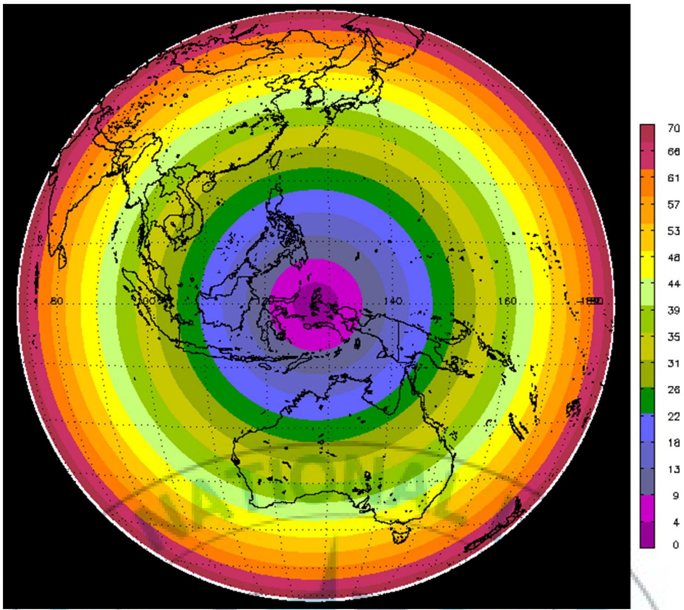


Figure 1. Satellite zenith angle.

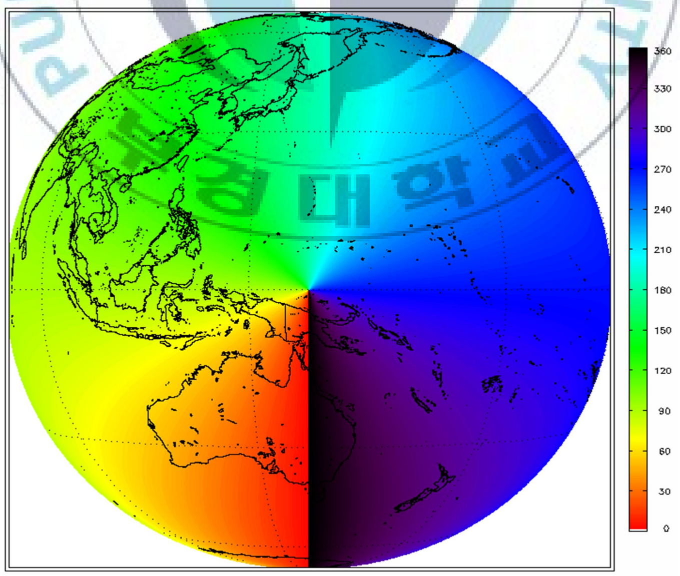


Figure 2. Satellite azimuth angle.

2.2. Methods

2.2.1. Satellite zenith angle correction

In order to correct the parallax, cloud pixel and clear pixel should be divided among the meteorological satellite data. As the cloud pixel data, the data which is produced by the KMA NMSC were used(Chung et al., 2006). And then, the satellite zenith angle and cloud height data should be used as the input data for the cloud pixel, so the satellite zenith angle by each pixel can be corrected. As the cloud height data, the data which is produced by the KMA NMSC were used(Choi et al., 2007). In order to reduce the parallax correction error due to the cloud height data, the each pixel value of the cloud height data should be used by making average of around 8 pixel values. The satellite altitude, radius of the earth, cloud height, satellite zenith angle are values that were already known, so the it can be used for calculate the corrected satellite zenith angle(θ') by using formula (1)-(4). The important value for correction of the satellite zenith angle correction is the cloud height value. Depending to accuracy of the cloud height value, it can have effects on accuracy of satellite zenith angle correction.

To calculate Φ by using sine rule in $\Delta P_oOP_c'$ and ΔP_oOS(Figure 3),

$$\Phi = \arcsin(R_e \sin(\pi - \theta)/R_{cld}) - \arcsin(R_e \sin(\pi - \theta)/R_{sat}) \qquad (1)$$

R_e means the radius of the earth value by pixel which is given as function of latitude(l) considering the earth spheroid, and the semi-major axes(a) used 6378km, the minor semi axis(b) used 6357km. R_e is as formula (2). R_{cld} means the distance from the center of earth to the cloud, and R_{sat} means distance from the center of earth to the satellite(Figure 3).

$$R_e = ab/\cos l \sqrt{a^2 + b^2 \tan^2 l} \qquad (2)$$

To calculate the distance(d) from the satellite to the location on the corrected surface of the cloud by using the law of cosines from Δ P_cOS,

$$d = \sqrt{R_{sat}^2 + R_e^2 - (2R_{sat} R_e \cos\Phi)} \qquad (3)$$

To calculate θ' by using sine rule in ΔPcOS,

$$\theta' = \pi - \arcsin(R_{sat} \sin\Phi / d) \qquad (4)$$

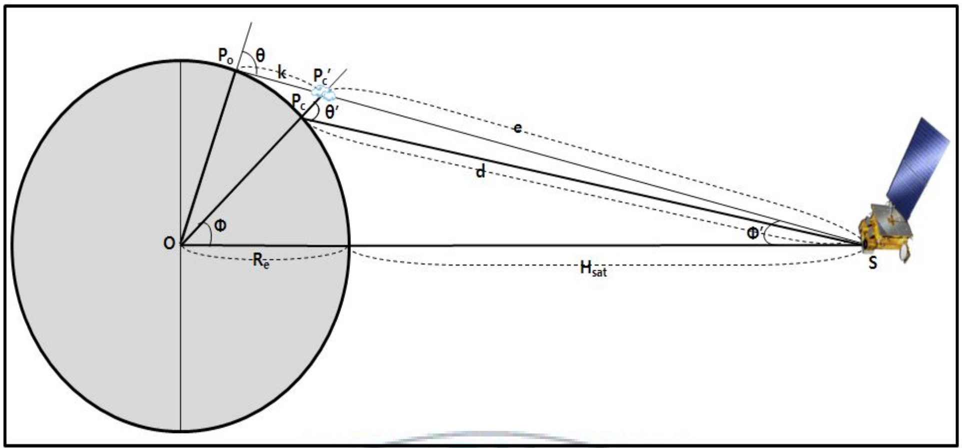


Figure 3. The schematic diagram of satellite zenith angle correction.

2.2.2. Satellite parallax correction

Next, by correcting the cloud location error due to the satellite parallax effect by using the corrected satellite zenith angle, original satellite zenith angle and satellite azimuth angle data, the satellite data can be corrected as closely to the actual location of the cloud. After finding the pixel with the same value of the corrected satellite zenith angle in the original satellite zenith angle within the pixels with the same satellite azimuth angle for each pixel, satellite pixel data are moved to this position(Figure 4). These corrected pixel values are corrected to the same image as Figure 6(a) in the original satellite data(Figure 5). The value appeared as black pixel in the image of Figure 6(a) was shown after the location of the cloud was moved to the actual location after parallax correction, actually it cannot be observed from the satellite by being hidden for the cloud. Finally, each black pixel puts the value by getting average of pixel values among around 8 pixels as image of the Figure 6(b).

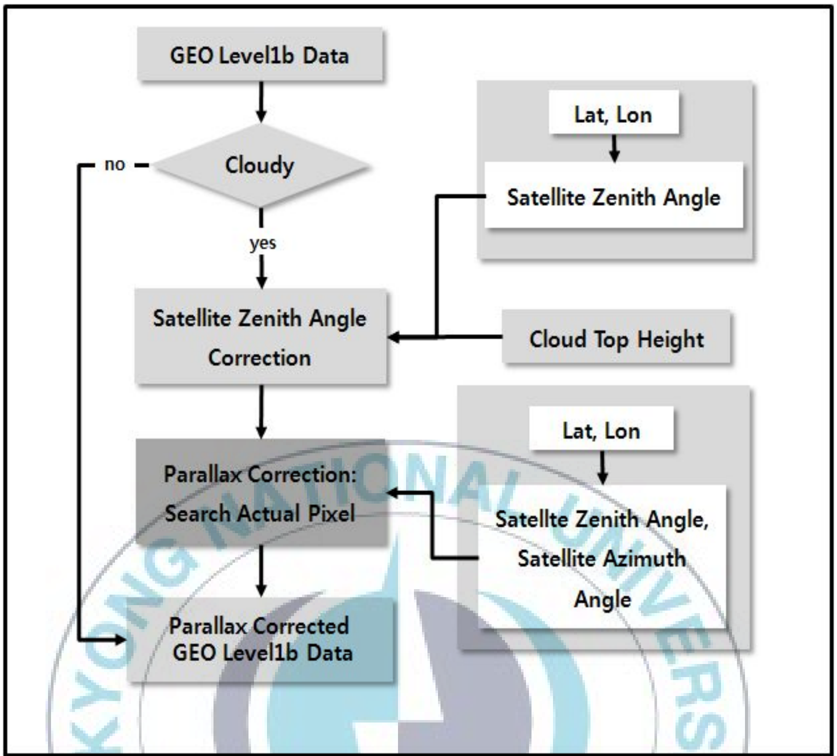


Figure 4. Flow chart of parallax correction method.

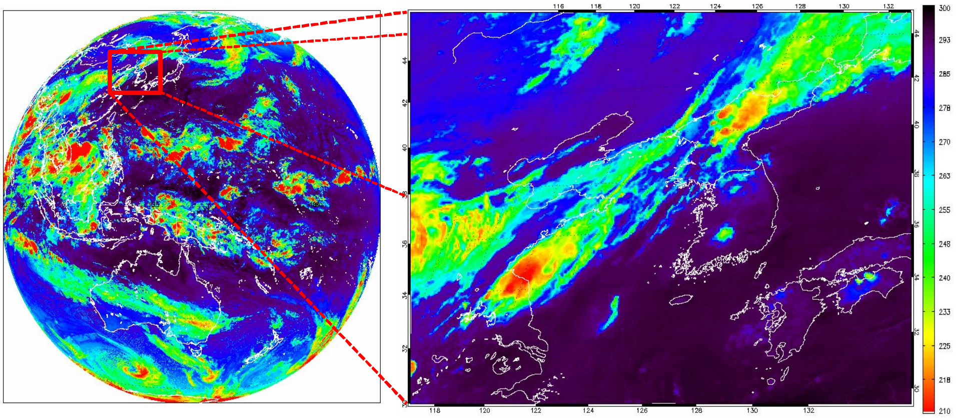


Figure 5. MTSAT-2 IR1(10.8㎛) TBB at 1333UTC 22 Aug. 2010. (Before parallax correction)

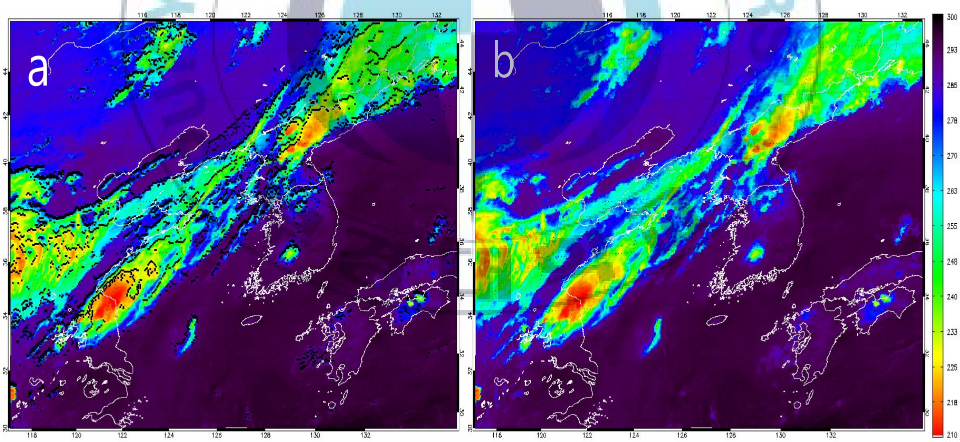


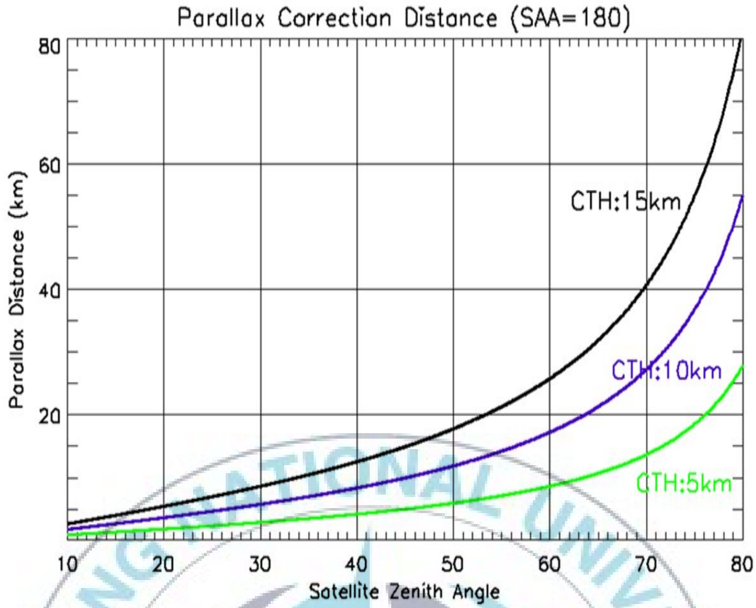
Figure 6. MTSAT-2 IR1(10.8㎛) TBB at 1333UTC 22 Aug. 2010. (After parallax correction)

3. Result and Discussions

3.1. Analysis of cloud location error

3.1.1. Error from changes of cloud height and SZA

By using the satellite parallax correction program which was developed in this study, the occurrence of cloud location error caused by the satellite parallax effect and the each case of the cloud height with 5km,10km,15km and the satellite azimuth angle with 180°, 120° were calculated. As the calculated outgoing of the Figure 7, the cloud location error due to the parallax effects increased differently depending on increase of cloud height and satellite zenith angle. Commonly, only the satellite data within 70° of satellite zenith angle was used, so it can be seen that the maximum value of the cloud location error which may be occurred in the full disk area is about 40km when the satellite azimuth angle was 180°, and is about 60km when the satellite azimuth angle was 120°. In addition, the maximum distance of the cloud location error was shown that the cloud height is 15km in the region that the satellite azimuth angle was 120°, the satellite zenith angle was 70°, and the latitude, longitude were 50°N, 90°E, and the cloud location error showed about 60km difference. It means difference of 15 pixels in the satellite data with 4km resolution. The maximum value which can be occurred in the region of the East Asia (20~50°N) is the cloud location error of about 25km.



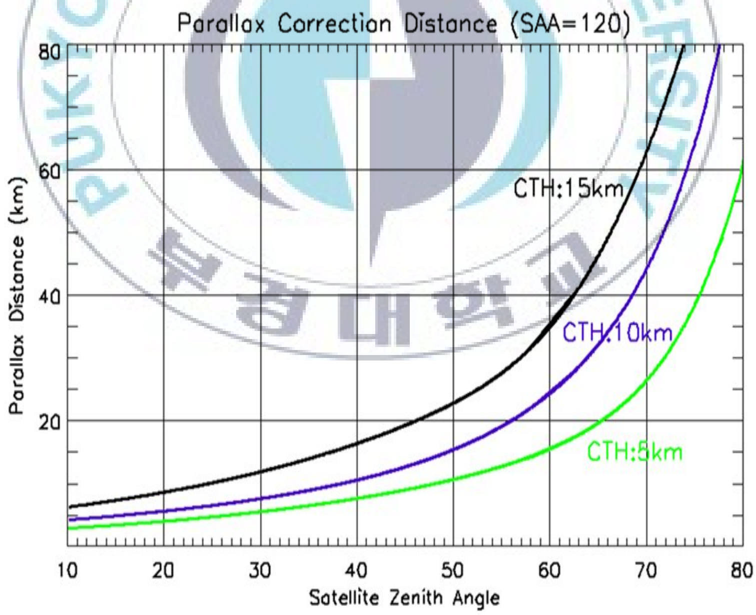


Figure 7. Parallax correction distance at satellite azimuth angle 180°, 120°.

3.1.2. Parallax error of COMS and MTSAT-2

Figure 8 shows that the difference of distance of the cloud location error due to the parallax effects when the cloud of 15km cloud height was observed from COMS and MTSAT-2 satellite with each different observation position was calculated by using formula (5)-(7). In order to calculate the distance of cloud location error between two satellite data, first, the corrected satellite zenith angle data of COMS and MTSAT-2 were used as the input data. In here, as the altitude of corrected satellite zenith angle data, the cloud height was set as 15km in order to calculate maximum value of cloud location error. Next, after finding region with same latitude, longitude from the COMS and MTSAT-2 data by each pixel, e and k value of two satellites was calculated by substituting corrected satellite zenith angle data of two satellites to the formula (5)-(7)(Figure 3). Finally, the distance between the two clouds because of the error of the cloud location is calculated by substituting the values, e and k of them to Formula (8).

To calculate d by using sine rule and law of cosines in ∆PcOS,

$$d = \sqrt{R_e^2 + R_{sat}^2 - 2R_e R_{sat}\cos(\theta' - (\arcsin(R_e \sin(\pi - \theta')/R_{sat})))} \quad (5)$$

R_e means the radius of the earth value by pixel which is given as function of latitude(l) considering the earth spheroid, and the semi-major axes(a) used 6378km, the minor semi axis(b) used 6357km. R_e is as formula (2). R_{sat} means distance from the center of earth to the satellite(Figure 3).

To calculate e by using sine rule and law of cosines in $\Delta P_c'OS$,

$$e = \sqrt{R_{cld}^2 + R_{sat}^2 - 2R_{cld}R_{sat}\cos(\theta' - (asin(R_e \sin(\pi - \theta')/R_{sat})))} \quad (6)$$

R_{cld} means the distance from the center of earth to the cloud(Figure 3).

To calculate k by using sine rule in $\Delta P_c'P_cS$ and $\Delta P_c'OP_o$,

$$k = \sqrt{R_e^2 + R_{cld}^2 - 2R_e R_{cld}\cos(asin(R_{sat}\sin\Phi'/R_e) - asin(R_{sat}\sin(\theta' - (asin(R_e \sin(\pi - \theta')/R_{sat})))/e)} \quad (7)$$

To calculate the distance(w) between the clouds due to the cloud location error of two satellite by using e and k.

$$w = \sqrt{k^2 + k'^2 - 2kk'\cos(\pi - \arccos((12325.1km^2 - e^2 - e'^2)/(2ee')))} \quad (8)$$

In the outgoing of calculating the difference of distance of the cloud location error due to parallax effects when the cloud with 15km height was observed by COMS and MTSAT-2 satellites with each different observation position, the distance of the cloud location error between two points when the cloud was observed in each different location by observing two clouds with 6~32km. This value is the maximum value which can be occurred by the cloud height of 15km, it showed about 6~8km from Korean peninsula region, 8~12km from Chinese region, 12~32km from Mongolia region(Figure 8). Figure 9 showed the image which observed clouds in the COMS and MTSAT-2 satellite at the same time. In this image, the observation position of two satellites is different when COMS is 128.2°E, MTSAT-2 is 145.0°E, so the location of the cloud was observed differently by the satellite parallax error. Figure 10 shows the imaged with corrected parallax in the data of Figure 9, so it can be confirmed that the clouds which was observed as each different location before correction were moved to the almost same region. In addition, comparing the corrected image of Figure 10 with MODIS(Figure 11) data with a few parallax error, it can be seen that the observed location of the cloud in two satellites was moved closely to the actual location. And for the quantitative analysis before and after correction, it was compared MODIS data about same latitude, longitude data and temperature of cloud are under 250K. As comparison outgoing between MTSAT-2 data and MODIS data, R(Correlation coefficients) was 0.5692, RMSE(Root Mean Square Error) was 8.1983K before correction, but R was 0.7885, RMSE was 5.2346K after correction in the better results. As comparison outgoing between COMS and MODIS data, it can be seen that R was 0.6203, RMSE was 7.5390K before correction, but R was 0.8066, RMSE was 4.9243K after correction in the better results(Table 3). In here, it is validation index which express that R means correlation coefficients and same as formula(9), how the value of COMS and MTSAT-2 data correspond to MODIS value well. As a good measured value for knowing the linear association, the correlation coefficient is degree to measure visually how close the points on the scatter plot is with the straight line. y_i of formula (9) means value of MODIS data and x_i showed value of COMS and MTSAT-2 data. The scope is between -1 and 1, the closer to 1 it is means better value. In addition, RMSE is as formula (10) as the root mean square error, one of the factors to measure accuracy of overall prediction provides the average scale of error. The values are from 0 to infinity, the closer to 0 it is means smaller error of prediction. This value is sensitive especially for the value of big estimated error.

$$R = \sum_{i=1}^{N}(x_i - \overline{x_i})(y_i - \overline{y_i}) / N S_x S_y \quad (9)$$

$$RMSE = \sqrt{\sum_{i=1}^{N}(x_i - y_i)^2 / N} \quad (10)$$

It was seen that the cloud location of two satellite data due to the parallax error through the quantitative analysis, and it was confirmed that the cloud location errors of two satellite data was corrected closely to the original location through this qualitative analysis. If this satellite data parallax correction is applied to the cloud related data, the accuracy will be increased and it is expected to be help for image availability and study of COMS data and MTSAT-2 data. But the cloud height data includes is the level 2 data which was produced by using level1b data so the some error can be included in this data, due to this error, somewhat errors may be included in the parallax correction outgoing data.

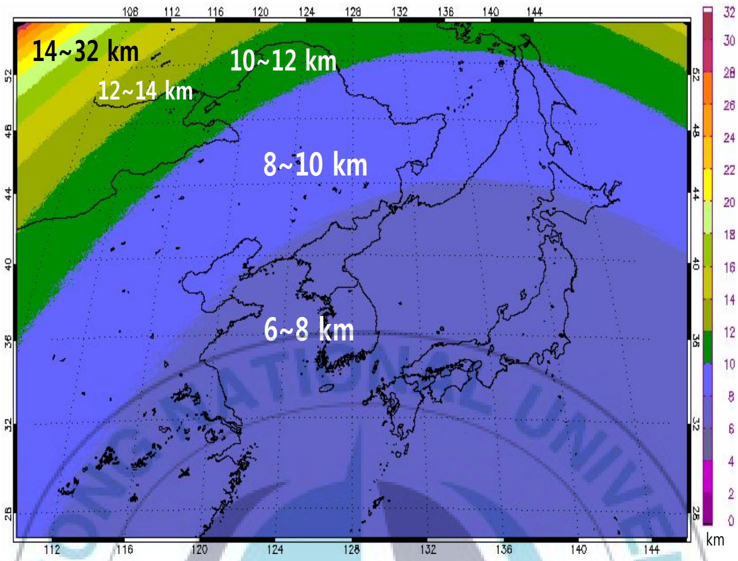


Figure 8. Cloud location difference distances between COMS and MTSAT-2 caused by parallax effects(cloud height:15km).

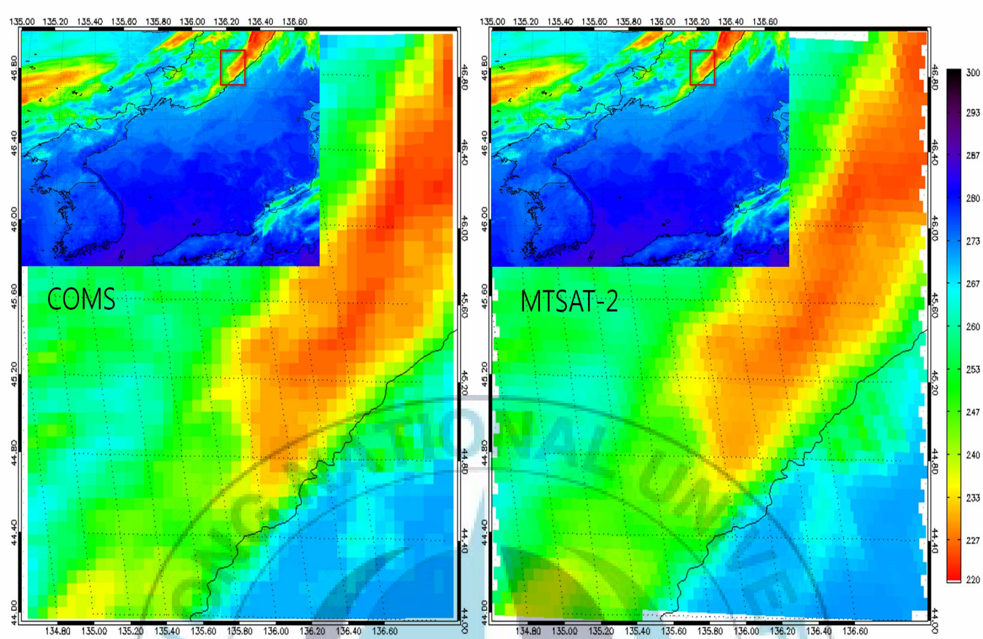


Figure 9. COMS & MTSAT-2 IR1(10.8㎛) TBB at 1300UTC 9 Apr. 2011. (Before parallax correction)

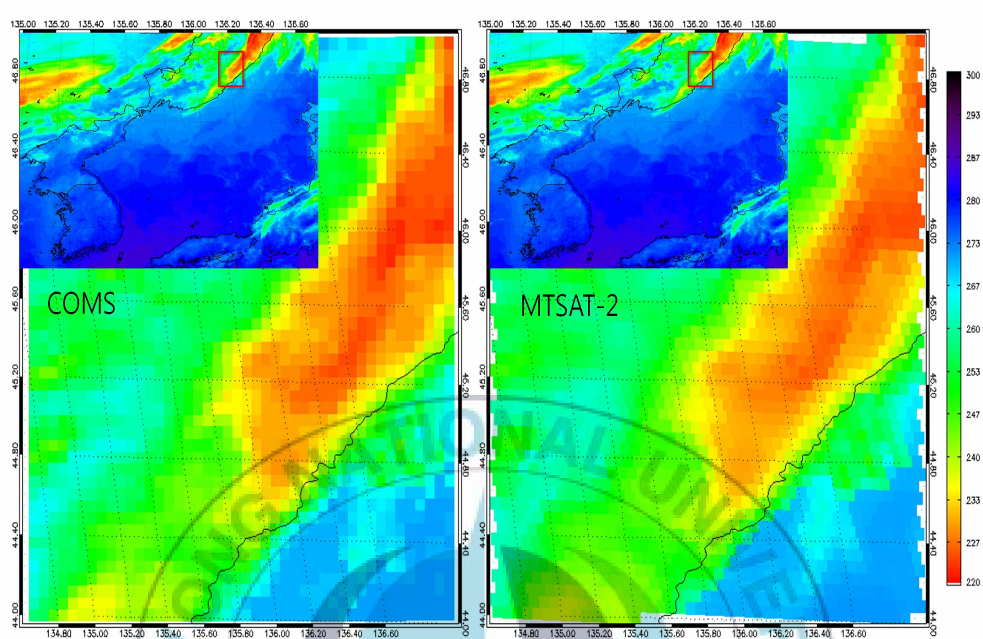


Figure 10. COMS & MTSAT-2 IR1(10.8㎛) TBB at 1300UTC 9 Apr. 2011. (After parallax correction)

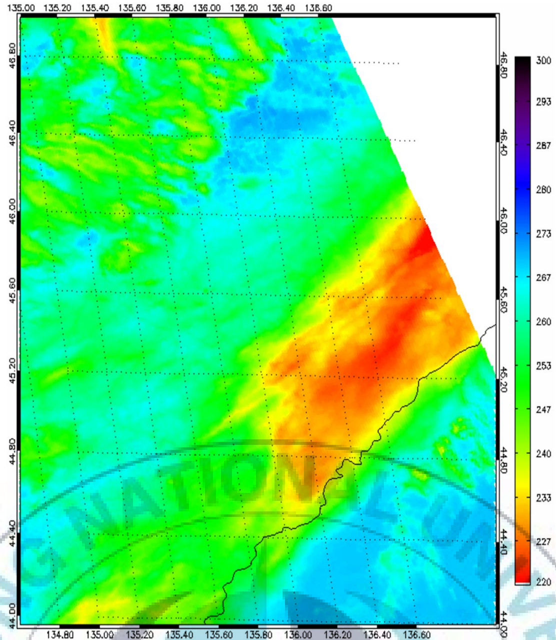


Figure 11. Terra MODIS IR(11.03㎛) TBB at 1300UTC 9 Apr. 2011.

Time (UTC)	Satellite	Before correction		After Correction		Collocation number
		R	RMSE (K)	R	RMSE (K)	
‘11.04.09 1300	MTSAT-2	0.5692	8.1983	0.7885	5.2356	37073
'11.04.09 1300	COMS	0.6203	7.5390	0.8066	4.9243	30279

Table 3. The validation result between estimated MTSAT-2(COMS) and Terra MODIS.

3.2. Parallax correction validation

In order to validate the improvement of the cloud position correction due to the satellite parallax effect, the infrared rays(11.03㎛) observation data(brightness temperature) of MODIS sensor were used. There was the cloud location error due to satellite parallax error in the region with big sensor zenith angle from the polar orbit satellite data, so only data within the sensor zenith angle 20° was used to validate, and as the corresponding method of timespace, the validation was conducted by using area average of 5×5 pixel based on the MODIS pixel with correspondent latitude, longitude with MTSAT-2 pixel and the case that the time difference between two satellite are within ±5 minutes. As the validation result of Table 4(a), average of R was improved about +0.03, average of RMSE was about -1.8K in all cloud pixels, and as Table 4(b), in the pixels with the brightness temperature under 240K, average of R was improved about +0.14, maximum +0.21, RMSE was average about -3.5K, maximum -5.3K could be confirmed. In the Figure 12, 14, 16, 18, MODIS brightness temperature image within sensor zenith angle 20° was used for the validation data of the satellite parallax correction image, it is the observation data of the nadir region of the polar orbit satellite, so there is only a few cloud location error due to the satellite parallax effect. Figure 13(a), 15(a), 17(a), 19(a) is image before parallax correction, and the Figure 13(b), 15(b), 17(b), 19(b) is image after parallax correction. As it is shown in the image after parallax correction, the location error of the cloud was corrected to the direction of the nadir of the MTSAT-2 satellite, it can be seen that the cloud was moved closely to the actual location compared to the MODIS brightness temperature image. Among validated data, the data of Figure 15 showed the best result. In the validation result of Figure 15 data, R was about 0.06, RMSE was about 3.1K in all cloud pixels, and the result that R was improved about 0.21, RMSE was about 5.3K was confirmed in the pixel with under 240K of brightness temperature.

Table 4. The validation result between estimated MTSAT-2 and Terra MODIS.

(a) All cloud pixels

Time (UTC)	Before correction		After Correction		Collocation number
	R	RMSE(K)	R	RMSE(K)	
2010.07.31 1233	0.9324	5.4959	0.9697	4.3573	306387
2010.08.06 1333	0.9245	7.4033	0.9330	6.7096	188405
2010.08.22 1333	0.9052	9.2150	0.9614	6.0656	141878
2010.09.06 0333	0.9399	8.5010	0.9722	5.7981	242393
2010.09.08 1233	0.9619	8.6785	0.9817	6.1944	230409
2010.09.29 0333	0.9374	5.4615	0.9515	5.0886	302554

(b) Pixels with TBB <=240K

Time (UTC)	Before correction		After Correction		Collocation number
	R	RMSE(K)	R	RMSE(K)	
2010.07.31 1233	0.6120	7.0176	0.7767	4.6100	49485
2010.08.06 1333	0.6637	8.3732	0.7763	5.4481	7538
2010.08.22 1333	0.4886	11.5241	0.7030	6.2736	17658
2010.09.06 0333	0.7784	9.7816	0.9007	6.2103	58901
2010.09.08 1233	0.8537	9.0052	0.9535	5.0292	70514
2010.09.29 0333	0.4150	10.2401	0.5338	7.5517	12367

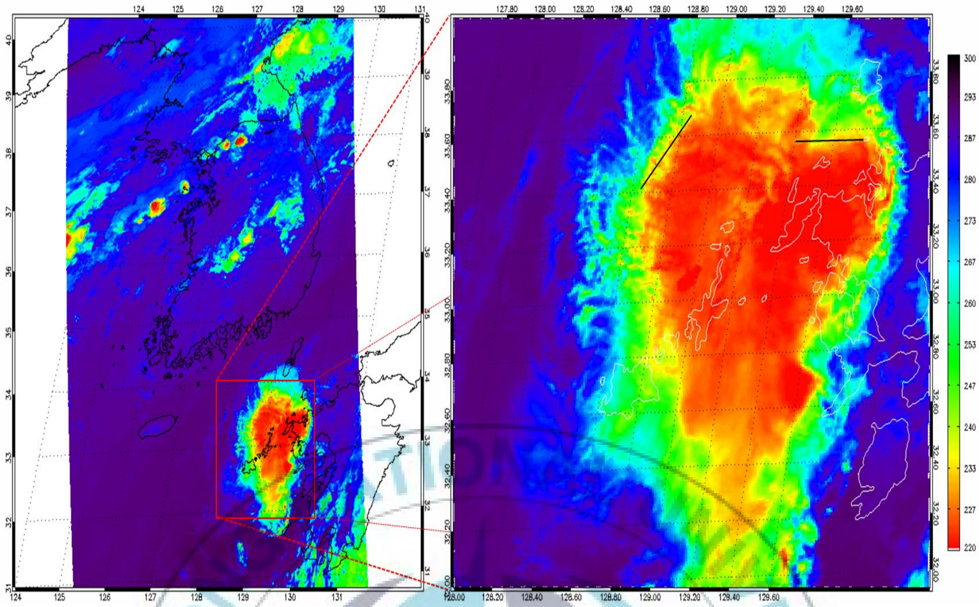


Figure 12. Terra MODIS IR(11.03㎛) TBB at 1335UTC 6 Aug. 2010.

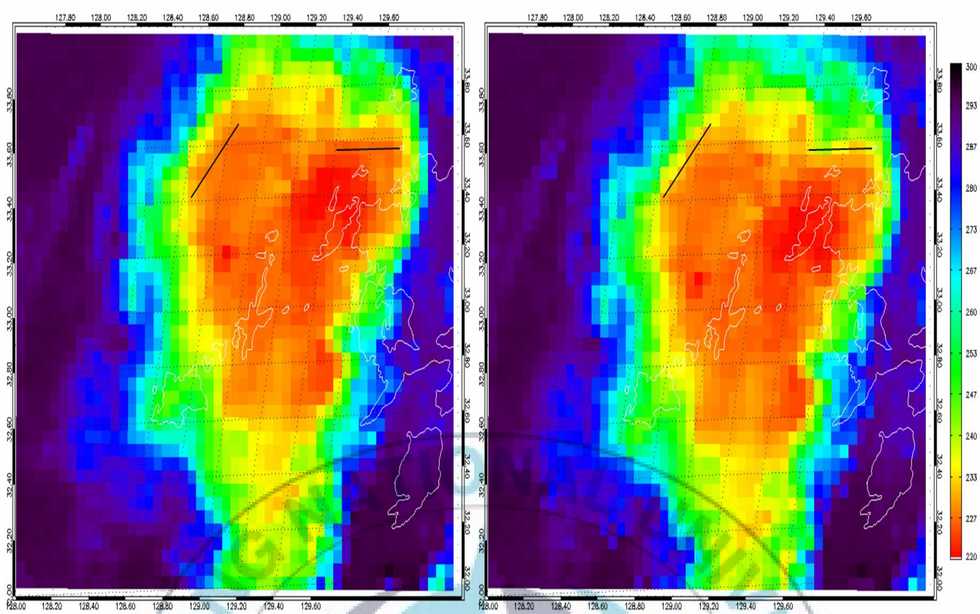


Figure 13. MTSAT-2 IR1(10.8㎛) TBB at 1333UTC 6 Aug. 2010.

(a: Before parallax correction, b: After parallax correction)

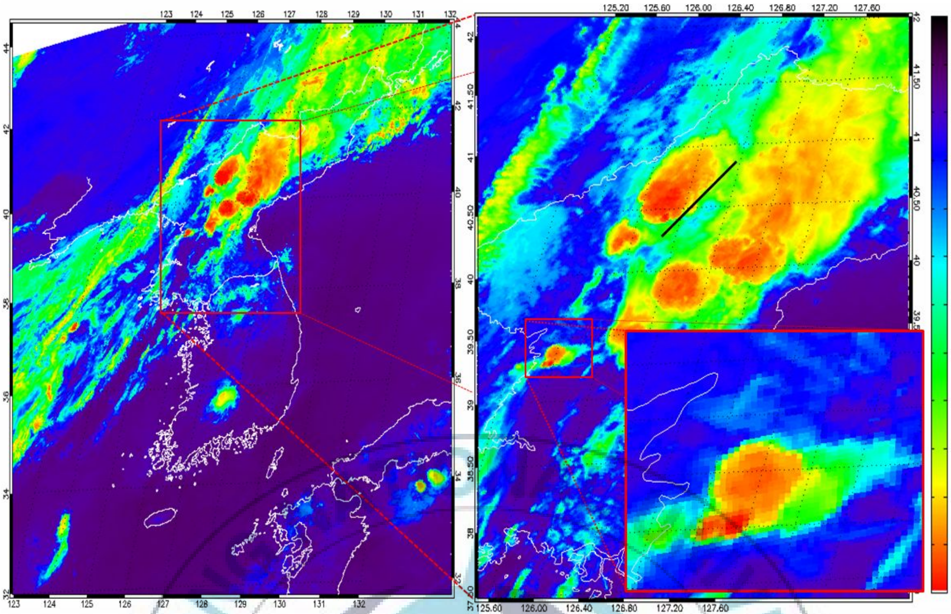


Figure 14. Terra MODIS IR(11.03㎛) TBB at 1335UTC 22 Aug. 2010.

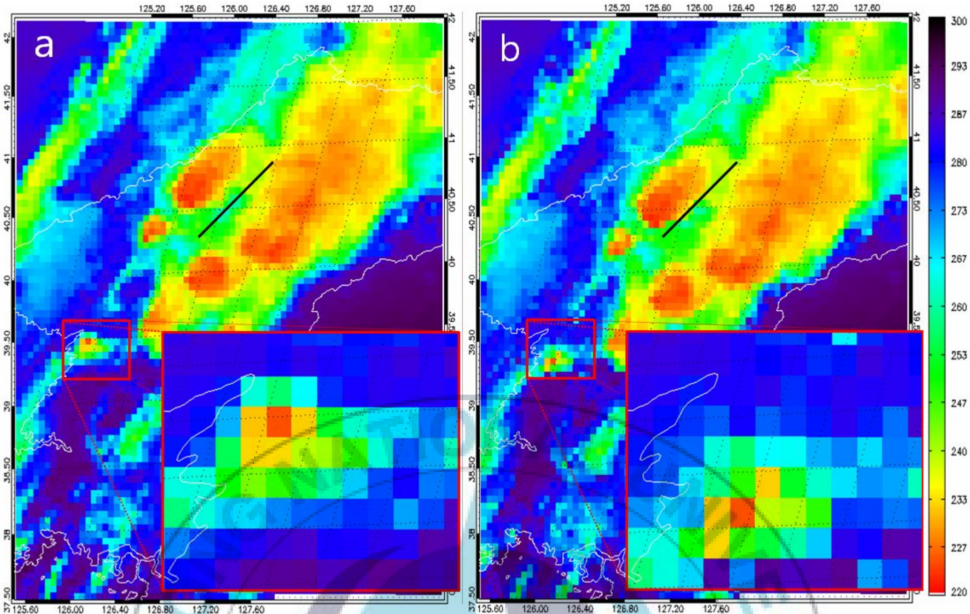


Figure 15. MTSAT-2 IR1(10.8㎛) TBB at 1333UTC 22 Aug. 2010. (a: Before parallax correction, b: After parallax correction)

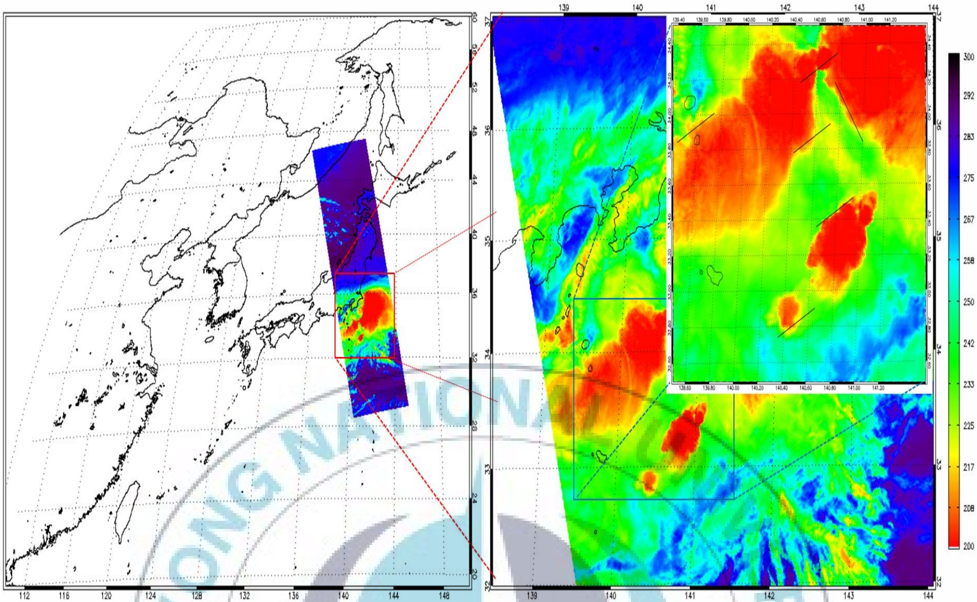


Figure 16. Terra MODIS IR(11.03㎛) TBB at 1240UTC 8 Sep. 2010.

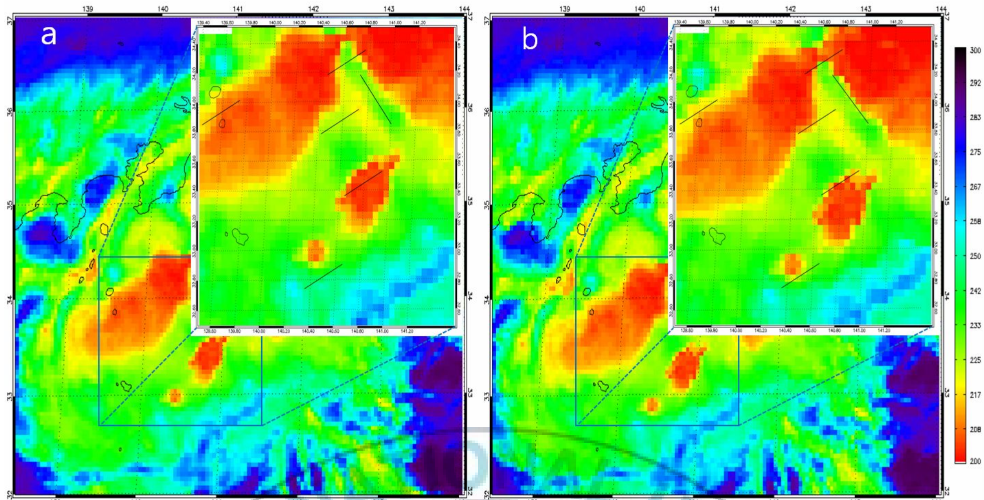


Figure 17. MTSAT-2 IR1(10.8㎛) TBB at 1233UTC 8 Sep. 2010.

(a: Before parallax correction, b: After parallax correction)

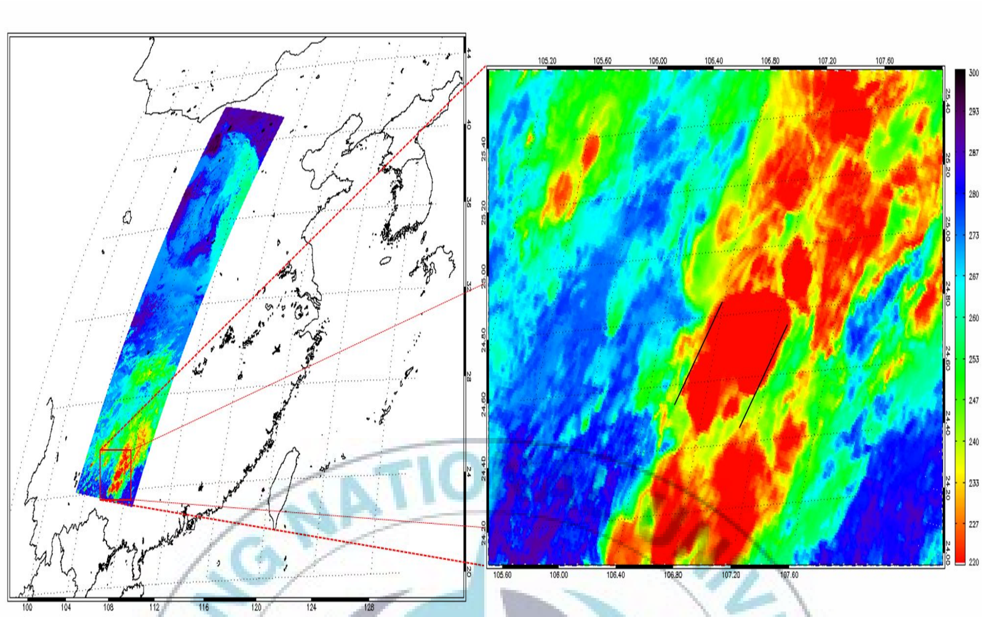


Figure 18. Terra MODIS IR(11.03㎛) TBB at 0335UTC 29 Sep. 2010.

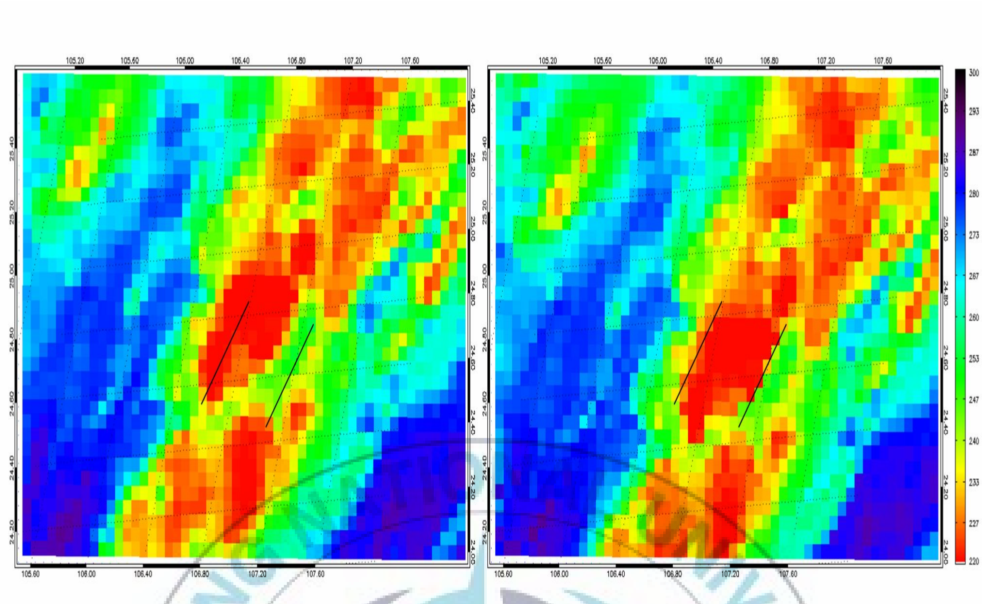


Figure 19. MTSAT-2 IR1(10.8㎛) TBB at 0333UTC 29 Sep. 2010.

(a: Before parallax correction, b: After parallax correction)

4. Conclusions

In order to correct cloud location error due to satellite parallax effect in the satellite data, the corrected satellite zenith angle using correction formula of satellite zenith angle and original satellite zenith angle, satellite azimuth angle were used for correction of the cloud location error. In the validation, using the MODIS sensor as the observed data of Terra satellite as the polar orbit satellite with only a few cloud location error was used. But even though it is observed polar orbit satellite data above the cloud, there is the cloud location error due to parallax effects in the region with big sensor zenith angle of the polar orbit satellite, so the only data within sensor zenith angle 20° was used. As the validation result, average of R was improved about +0.03, RMSE was about -1.8K in all cloud pixels, and it can be seen that average of R was improved about +0.14, maximum +0.21, RMSE was average about -3.5K, maximum -5.3K in the pixel with under 240k of brightness temperature. Considering the cloud location error due to the satellite parallax error confirmed in this study is maximum 60km, the parallax effects can be took on cloud analysis of meteorological satellite image and cloud related meteorological satellite data accuracy. In addition, if the cloud with 15km height is observed in the COMS and MTSAT-2 satellite with each different observation position at the same time, the cloud location error of two satellites shows the about 30km of maximum distance difference in the region with middle latitude(25~55°N) of cloud location error. This difference can occur location error between the cloud images observed from each sensor when the various geostationary orbit satellites were used in East Asia region. In this regard, the satellite parallax correction is expected to contribute to the data related to the image and cloud of satellite of the various geostationary orbit meteorological satellite, and it is expected to improve the accuracy by correction of location of meteorological phenomenon region for validation of cloud related data. In addition, if the sensor spatial resolution of follow-up meteorological satellite is improved, then the cloud location error due to satellite parallax error may be shown remarkably, so the significance of satellite parallax correction will be increase in the future.

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