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PRELIMINARY STUDY ON INTERCALIBRATION OF THE VISIBLE CHANNELS BETWEEN GMS-5 AND NOAA-14

This paper presents the results of preliminary study on inter-calibration of the visible channels between GMS-5 and NOAA-14.

Preliminary Study on Inter-calibration of the visible channels between GMS-5 and NOAA-14

. Introduction

Recently it has become possible to utilize the data of several satellites, which inevitably necessitates the comparison of the data observed from different satellites. To use quantitatively the data it is required to calibrate the observed raw radiative data. Calibration for the IR channels of GMS-5 (e.g., Tokuno et al., 1997) is operationally carried out on-board employing a black-body as in the case of GOES (e.g., Menzel et al., 1981). However digital counts of GMS-5 visible channel are converted into albedo (hereafter, GMS-5 albedo) by using the fixed conversion table, which was made based on pre-launch data. To use GMS-5 visible data quantitatively, we propose a method to convert GMS-5 visible counts to albedo (hereafter, NOAA albedo) measured by NOAA AVHRR channels 1 and 2. Also we report preliminary results of applying the method to the case of clear condition.

. A method to convert GMS-5 visible counts into equivalent NOAA albedo

The NOAA albedo is computed as a linear function of the input data value as follows (Kidwell, 1997):

$$A(NOAA) = S\,C(NV) + I \qquad (1)$$

,where A(NOAA) is NOAA albedo , C(NV) is the input data value in counts, and S and I are respectively, the scaled sloped and intercept values. The visible channels (1 and 2) are calibrated using equation (1) to obtain the albedo.
On the other hand, the GMS-5 albedo is computed as a quadratic equation of the input data value as follows (GMS USER'S GUID, 1997):

$$A(GMS) = \{(C(GV) - b_0) / b_1\}^2 / a - V_0 / a \qquad (2)$$

,where A(GMS) is GMS albedo, C(GV) is the input data value in counts, b_0 , b_1 and a are constants determined from the pre-launch test data and V_0 is the output (bias) voltage when VISSR views the space.
As the coefficient b_0 is disregarded as compared to C(GV), the equation (2) can be approximately expressed by the following quadratic equation:

$$A(GMS) = \{(C(GV) / b_1\}^2 / a - V_0 / a \qquad (3)$$

We assume the following relation between A(NOAA) and A(GMS) considering the difference of the spectral response functions of both satellites.

$$A(NOAA) = A(GMS) + \Delta a \qquad (4)$$

,where Δa is a bias albedo.
Then from the equations (1), (3) and (4), the relation between C(GV) and C(NV) is expressed by Eq.(5).

$$C(NV) = \alpha(C(GV))^2 + \beta \qquad (5)$$

,where $\alpha = (1/ab_1{}^2S)$ and $\beta = - V_0 / Sa - (I + \Delta a) / S$

Coefficients α and β can be derived by a regression analysis between C(NV) and C(GV) in appropriate areas..
Finally we can obtain the following equation to convert C(GV) into equivalent NOAA albedo (A(GN)) from the equations (1) and (5).

$$A(GN) = \chi(C(GV))^2 + \delta \qquad (6)$$

,where $\chi = S \cdot \alpha$ and $\delta = I + \beta$

In the following section, we show preliminary results of applying the method mentioned above to the case of clear condition.

□. Results

Utilizing the data of clear condition over sea during the period of April 21 1997 through December 11 1997, analysis is made on the relationship between GMS-5 visible counts and NOAA-14 AVHRR channels 1 and 2 counts. The data is selected manually through a histogram analysis of count value considering the following conditions.
□ The difference of observation time between GMS-5 and NOAA-14 is within 30 minutes.
□ View angle of the target region is within 10 degrees from the nadir of both satellites.

GMS-5 visible channel consists of four detectors. Figure 1 shows the result of comparison between GMS-5 visible (detector-1) counts and NOAA-14 AVHRR channels 1 and 2 counts, respectively.

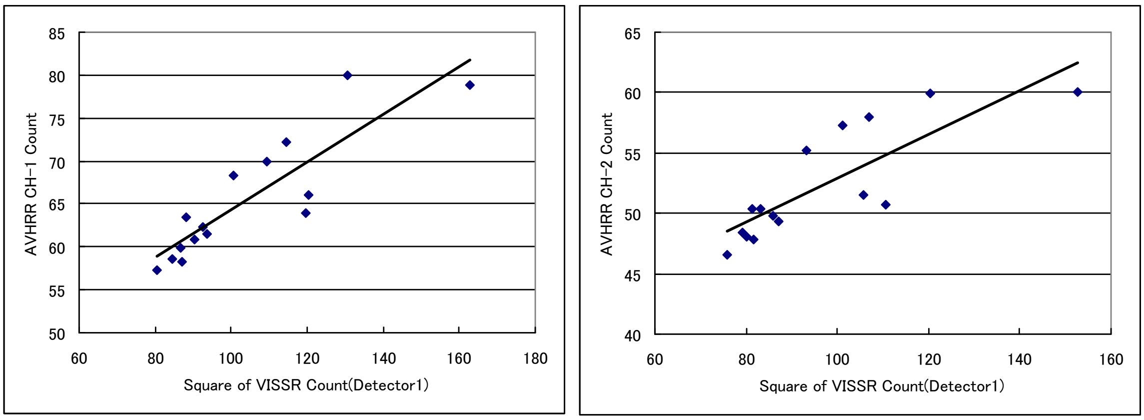

Fig.1 Relation between GMS-5 visible (detector 1) counts and NOAA-14 AVHRR channels 1 (left) and 2 (right) counts respectively.

The ordinate is the NOAA-14 AVHRR channels 1 (left) and 2 (right) counts respectively and abscissa is the square of GMS-5 visible counts. It can be seen that there is a good linearity in the relationship of two items. Based on this analysis by the least square method, coefficients α and β in Eq.(5) are derived. The obtained values of α and β and correlation coefficient of determination for four detectors of GMS-5 visible channel are shown in Table 1.

Table 1 The coefficients α and βand correlation coefficients (R2)

GMS-5	N0AA-14 (ch-1)			NOAA-14(ch-2)		
	α	β	R2	α	β	R2
Detector1	0.29	37	0.76	0.18	35	0.68
Detector2	0.32	36	0.77	0.19	35	0.66
Detector3	0.28	38	0.78	0.17	35	0.68
Detector4	0.28	37	0.76	0.17	35	0.66

Applying the coefficients α and βobtained above to Eq.(6), we can obtain the coefficients χ andδ in Eq.(6). The obtained values ofχ andδare shown in Table-2.

Table 2 The coefficientsχ andδ

GMS-5	N0AA-14 (ch-1)		NOAA-14(ch-2)	
	χ	δ	χ	δ
Detector1	0.039	-0.56	0.030	-1.0
Detector2	0.042	-0.63	0.032	-1.0
Detector3	0.038	-0.49	0.028	-0.9
Detector4	0.037	-0.59	0.027	-1.0

Applying the coefficientsχ andδ obtained above to Eq.(6), we can obtain equivalent NOAA albedo from GMS-5 visible counts.

To investigate the accuracy of the proposed method, we compared A(GN) with A(NOAA) in the dependant data. An example is shown in Fig.2. In Table 3 the comparison coefficients between two items, i.e., number of comparison (N), the mean albedo of difference (BIAS), the R.M.S. difference (RMS), mean NOAA albedo (MEAN) are shown. The difference between A(GN) and A(NOAA) for mean NOAA albedo of AVHRR ch-1 and ch-2 are about 13% and 23% respectively, while the error is almost same among four detectors of GMS-5 visible channel. The difference for AVHRR ch-2 is larger than that for AVHRR ch-1. The cause of this difference might be due to the difference between two response functions.

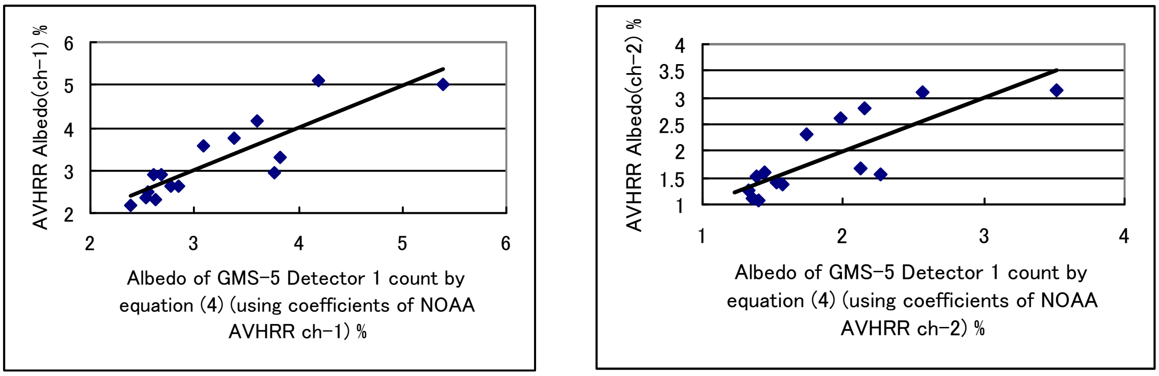

Fig.2 Relation between equivalent NOAA albedo (A(GN)) from GMS-5 visible detector 1 and NOAA albedo (A(NOAA)).

Table 3 The comparison coefficients; number of comparison (N), the mean albedo of difference (BIAS), the R.M.S. difference (RMS), mean NOAA albedo (MEAN).

A(GN)	A(NOAA) (ch-1)				A(NOAA) (ch-2)			
	N	RMS	BIAS	MEAN	N	RMS	BIAS	MEAN
Detector1	15	0.45	0.00	3.21	15	0.41	0.00	1.83
Detector2	15	0.42	0.00	3.22	15	0.42	0.00	1.84
Detector3	15	0.42	0.00	3.21	15	0.41	0.00	1.83
Detector4	15	0.44	0.00	3.21	15	0.42	0.00	1.83

□. Conclusion

Foregoing analysis indicate that the procedure proposed in this paper is effective to the clear region over sea. We are going to apply the procedure to independent data and continue further inter-calibration activities for other region (e.g. desert, cloud).

Reference

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