CGMS

CGMS-35, CMA-WP-8
Prepared by CMA
Agenda Item: II/2
Discussed in WGII

Summary of the Working Paper.

CMA-WP-08 informs CGMS of the work calibrating the FY-2C/D with model simulation method and inter-calibration method with TERRAS/AQUA MODIS data. Inter-calibration experiment using MODIS is operational oriented. The following work has been done in the test:

a. Co-located samples of FY-2 observations and ocean buoys data in cloud-free area have been collected. Information on the surface temperature, longitude and latitude, satellite viewing angel and direction angel for the match-up points are gathered.

b. The atmospheric profiles for each match-up points are picked from NCEP data set.

c. TOA radiance are simulated using MODTRAN, the simulation is then used together with the mean DN of FY-2C channel in a linear regression process to get the calibration coefficients.

d. The procedure and algorithm for calibrating the FY-2C/D with MODIS has established.

e. Inter-calibration experiment was made on November 7, 2006 for FY-2C IR2 with the TERRA MODIS B31. The result is compatible to the operational inter-calibration with NOAA/AVHRR.

FY-2 C/D Calibration by Model Simulation and Inter-calibration

The accuracy of radiance calibration determines the quantitative use of satellite data. Challenge in radiance calibration for thermal channel of geostationary satellite remains. To improve, model simulation and inter-calibration with MODIS measurements are investigated for FY-2C/D. This report summarizes the methods, results and conclusions with the two methods.

1. Model Simulation

Using NCEP data and ocean buoy data to make non-field absolute calibration for FY-2 infrared channel

1.1 Co-location of Ocean Buoy Data and Satellite Data

This study use buoy data of August 18-24, 2006 to co-locate FY-2C infrared channel data by selecting the buoys in cloud-free areas with known longitude, latitude and ocean surface temperature to search for matched satellite spots with known solar angel and satellite direction angel. To take the mean value of the 3×3 block surrounding the match-up point for the window channel.

1.2 NCEP Data and MODTRAND Simulation

Based on longitude and latitude of the match-ups between buoy and satellite spot to search for the atmospheric temperature profile, humidity profile, and pressures from the NCEP data set that coordinates in time and location.

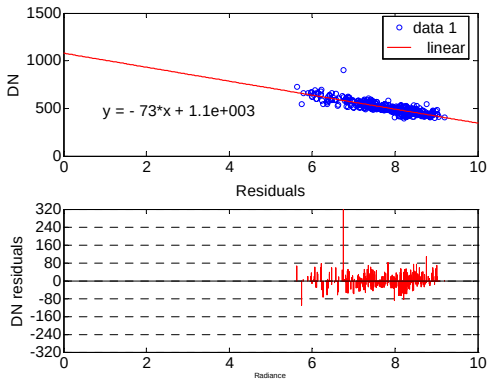
Put the sensor's responding function, atmospheric profiles and satellite viewing angel and direction angel and other necessary information into the MODTRAND model to simulate the channel radiance at the top of atmosphere(TOA) for each match-up point.

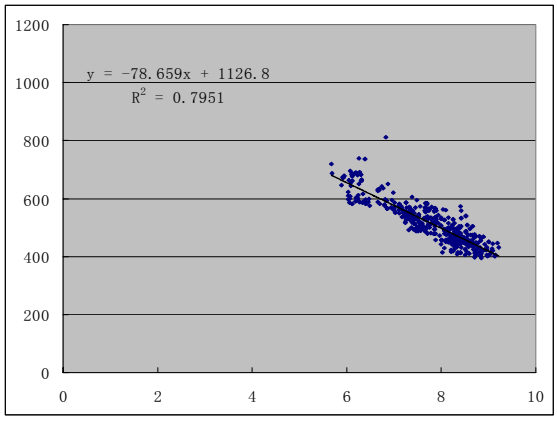
1.3 Calibration Result

Use simulated TOA radiance and the satellite DN value to get the calibration coefficients as shown in Table.1 and Figure 1.

Table.1 Calibration Coefficients

Date	FY-2C IR1			FY-2C IR2		
	A	B	R^2	a	b	R^2
20060818	-73.303	1079.3	0.7082	-86.53	1100.2	0.6706
20060819	-78.659	1126.8	0.7951	-79.462	1046.6	0.6601
20060820	-75.434	1098.3	0.7538	-89.94	1127.6	0.7319
20060821	-65.965	1024.7	0.7588	-76.55	1031.3	0.7283
20060822	-71.735	1065.8	0.768	-84.461	1083.2	0.7404
20060823	-68.395	1031.7	0.7869	-78.4	1031.5	0.7296
20060824	-70.679	1051.3	0.8363	-81.327	1053.8	0.805
20061107	-82.85	1155.7	0.8431	-96.613	1173.5	0.8337





Calibration Result, 18/Auguest/2006 Calibration Result, 19/August/2006

Figure.1 FY-2C IR1Channel Radiance Calibration Result

1.4 Result Analysis and Comparison

Comparing the results in Figure 2, we see the coefficients a, b for two channels at different time have similar trends except for the 3rd calibration result only. The coefficients vary, possibly due to the over-sized matching up area, the number of spots for co-location, and the cloud influence if the target area is not completely clean.

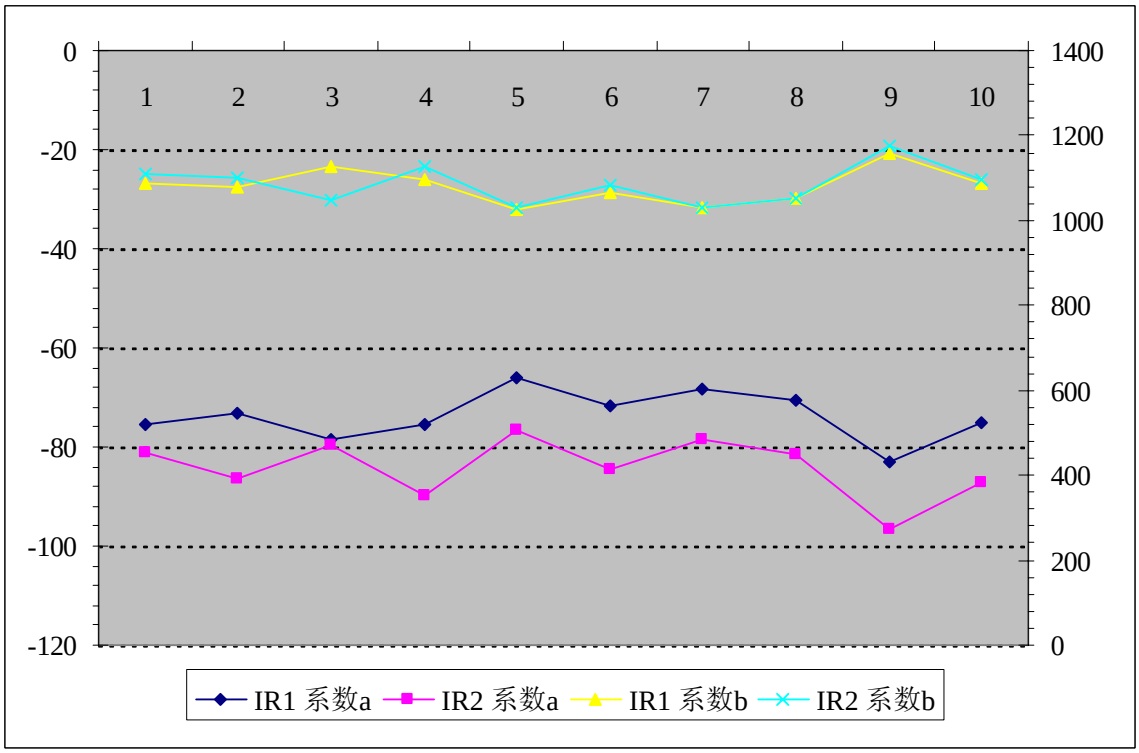


Figure.2 Comparison of Coefficients for Two Channels

2 Inter-calibration between FY-2 and MODIS

Inter-calibration is for channels of similar spectral characteristics of different satellites. The samples must be matched up with respect of time, geometrics, viewing angels, from two satellites observations. Based on the inter-calibration method for FY-2 using the NOAA/AVHRR, the study uses TERRA/AQUA MODIS to calibrate FY-2C/D.

2.1 Inter-calibration

I. Correction for Spectral Response

The spectral response of FY-2 infrared channels and the corresponding channels of TERRA/AQUA MODIS are shown in Figure 3. Big difference in the spectral responses of the sensors leads to different output value given the same input. Because of this, before making inter-calibration, correction is necessary to reduce as much as possible the influence of spectral response difference in FY-2 and MOSIDS channels. Select 43 profiles, representative of most atmospheric situations, and use MODTRAN to simulate the TOA radiance for each spectral band; use the simulations to normalize the spectral responding functions to get the normalized TOA radiance for the corresponding channels of FY-2 and MODIS. Get the linear regression coefficients, or the correction factor, from the normalized radiances of the corresponding channels of FY-2 and MODIS; correction is then made with the factor to the radiance of MODIS; FY-2 radiance is to be deduced. The result of the linear regression coefficients is shown in Table 2 and Figure 4.

Table 2 Linear Regression between FY-2C and TERRA MODIS Spectral Brightness

FY-2 infrared Ch.	A	B	Correlation
IR 1	1.0096	-0.0089	0.9976
IR 2	1.0308	-0.0493	0.9972
IR 3	0.9648	0.0305	0.9929
IR WV	1.1137	0.0612	0.9823

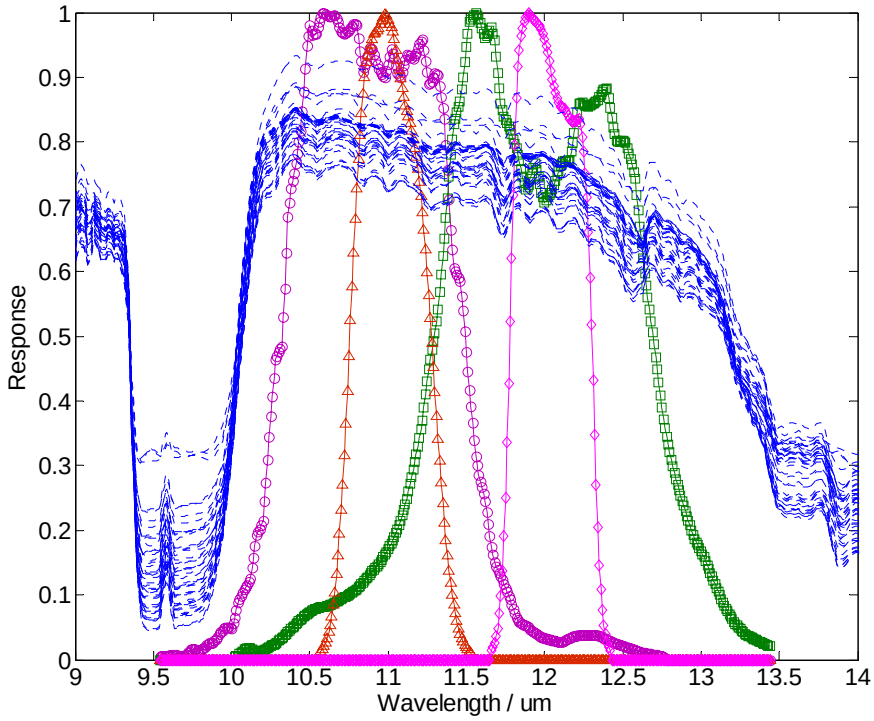


Figure.3 FY-2C IR1,2 Channels vs. TERRA MODIS Channel 31, 32

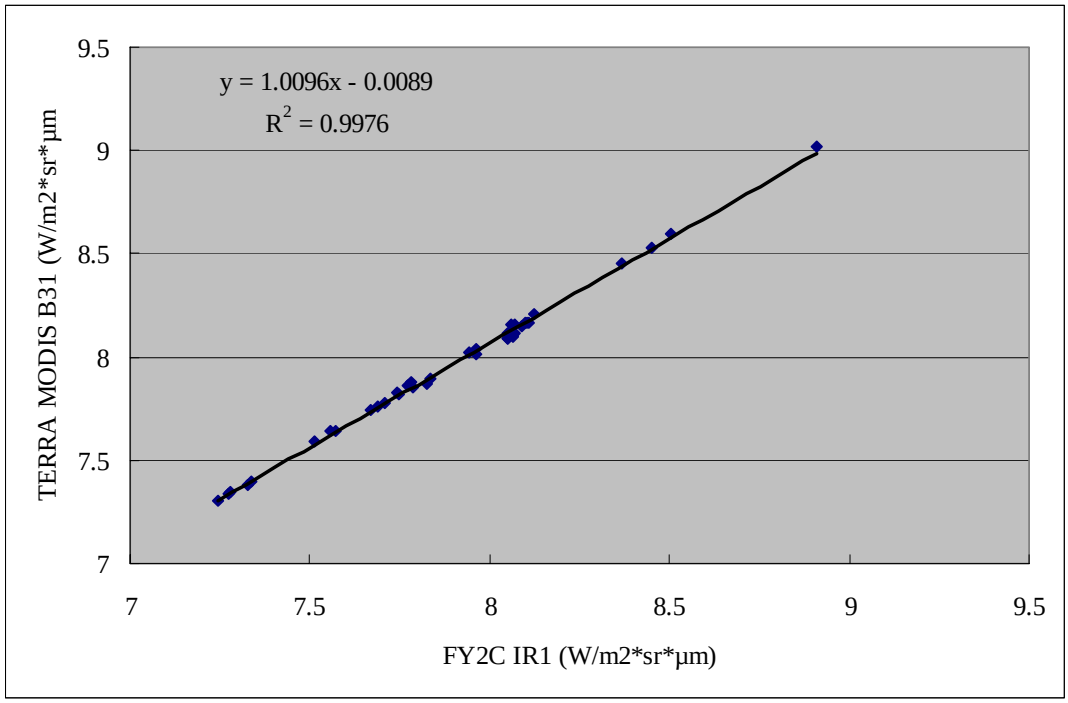


Figure. 4 TERRA MODIS B31 and FY2C IR1 Spectral Match-up

II. Target Area for Inter-calibration

Considering the influence of satellite geometrics and observation time to the inter-calibration, to reduce the impact resulted from viewing angel difference of the satellites, the target area for inter-calibration is within ±20 degree longitude and latitude from the sub-point of FY-2C.

III. Samples

From the formula below, use the special correction factor to correct the radiance of MODIS and get the FY-2C channel radiance.

$$L_{fy} = L_{modis}/a - b/a$$

in which, L_{MODIS} is the mean of pixels on MODIS image, a, b are the spectral correction factors obtained by linear regression between FY-2C channel and corresponding MODIS channel.

Next step, from the co-located area to get the mean DN value of the FY-2C channel, the inter-calibration is then made possible.

2.2 Calibration Experiment

Use the above method to make inter-calibration on November 7, 2006 with TERRA MODIS B31 for FY-2C IR1. The result is shown in Figure 6.

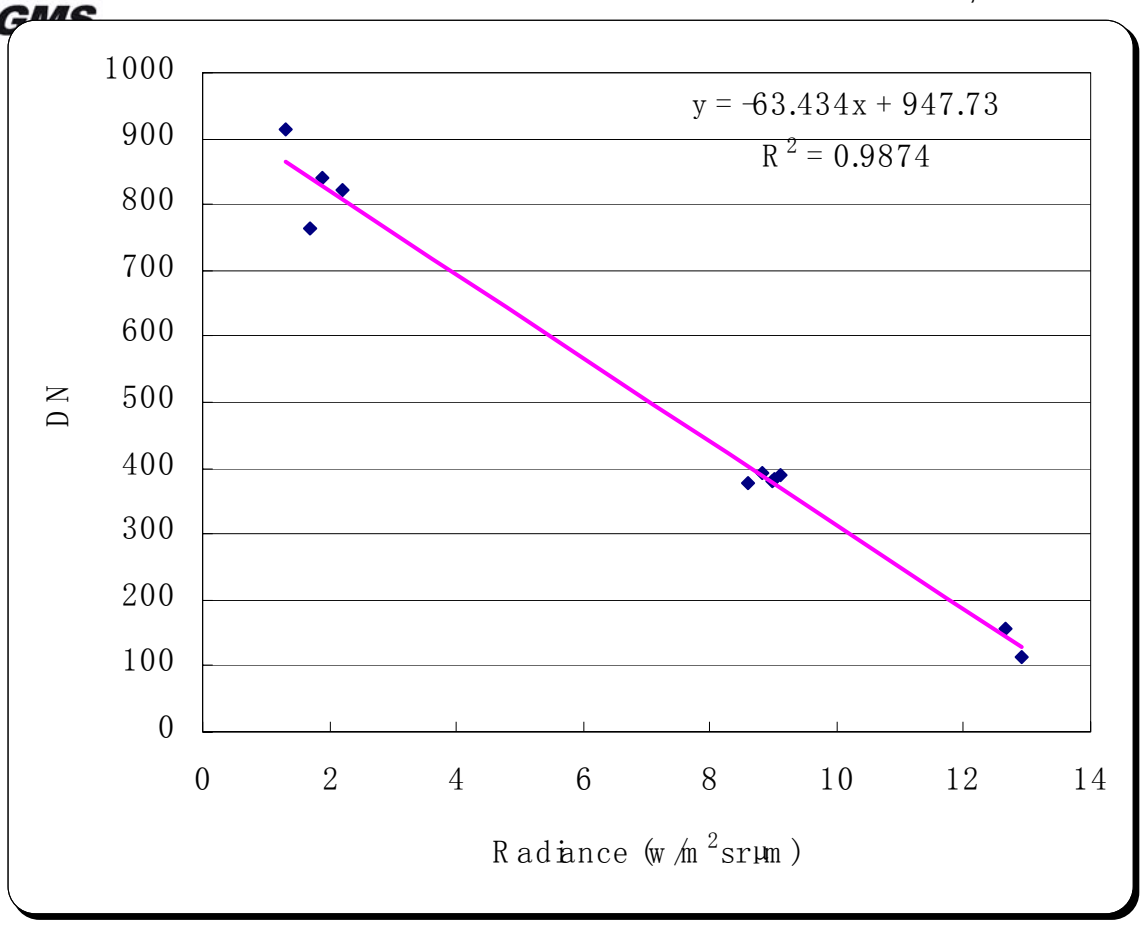


Figure 6. Result of inter-calibration with MODIS

To compare with operational FY-2C calibration, the result is shown as Figure 7.

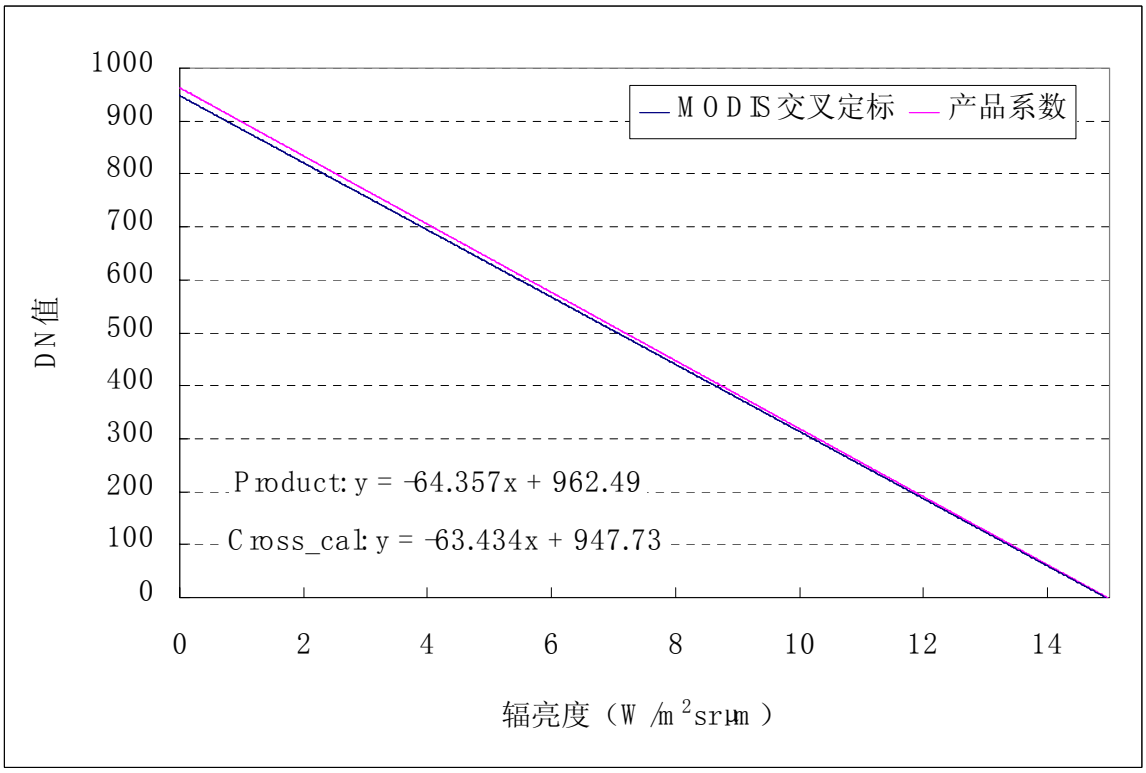


Figure 7. Comparison with FY-2C operational calibration

From Figure 7 we see that experiment using MODIS is compatible with operational calibration of FY-2C with the NOAA/AVHRR. The accurate MODIS IR-channel calibration is guarantee for FY-2C calibration. The experiment proves from one-side that the operationally used inter-calibration with the NOAA/AVHRR has equally good performance and can meet the requirement for quantitative application.

3. Summary

The study is made for operational purpose. Work has been done as follows:

a. To find match-ups between FY-2 and ocean buoys data in cloud-free area. Information such as the surface temperature, longitude and latitude, satellite viewing angel and direction angel for the match-up points are obtained.

b. To get from NCEP data set the profiles of atmosphere for each match-up points.

c. To simulate TOA radiance by MODTRAN. Use the simulated TOA radiance and mean DN from satellite channel to make linear regression and 10 sets of calibration coefficients. Comparison is made with the operational results.

d. To have established the FY-2 and MODIS inter-calibration algorithm; obtained the correction factor for spectral response.

e. Inter-calibration was made on November 7, 2006 for FY-2C IR2 with the TERRA MODIS B31. The result is similar with the operational inter-calibration result by NOAA/AVHRR.