# Visible RT simulation methodology at the JMA

Meteorological Satellite Center

Japan Meteorological Agency

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20 Feb. 2008

Motivation

- **No update on GMS-5 visible calibration table during its lifetime between 1995 and 2003**

- **Degradation in GMS-5 visible channel observed (Kurihara and Tokuno (2000))**

- **Preparation of accurate and practicable visible data set required by climatological study**

- **Establishment of a visible image reprocessing technique**

Reflectivity

1.00
0.90
0.80
0.70
0.60
0.50

Cloud

0.10
0.08
0.06
0.04
0.02
0.00

Sea

1996   1998   2000   2002
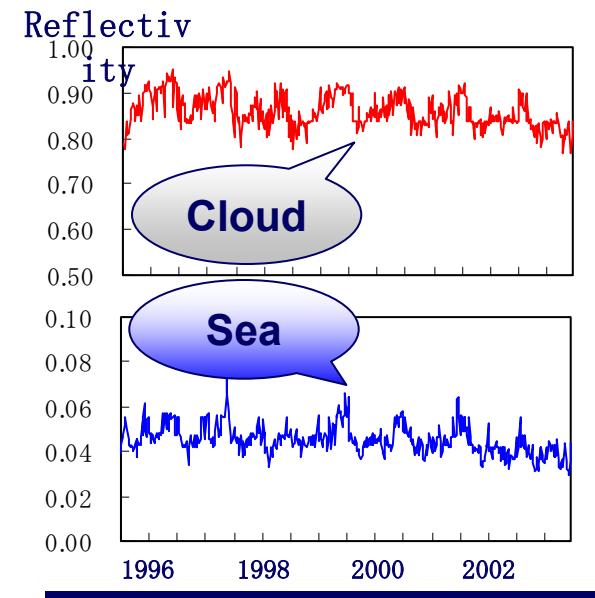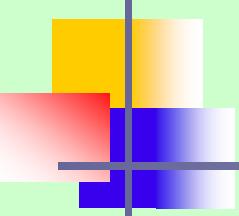
Methodology

Comparison of GMS-5 observations and radiative transfer simulations

(1) Targets
- **Clear sea**, **clear land** and **cloud** as dark, medium and bright targets, respectively

(2) Radiative transfer simulation
- **"RSTAR" developed at Univ. of Tokyo**
- **Inputs independent from GMS-5 measurements**
  - **Terra/MODIS** aerosol, TOMS ozone, JRA-25, Ground obs.

(3) Calibration table
- **Comparison of the simulated radiances with GMS-5 voltage measurements**
- **Digital Number (DN) and radiance table**

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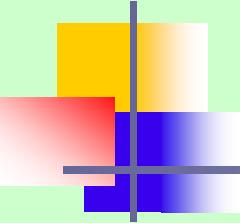
Target : Clear Sea Area

- **Sites selection**
  - **Clear sky and spatially uniform over open ocean**
  - **Wind speed < 10m/s**
  - **τ for aerosol < 0.3**
  - **Sun and satellite angular limitation**

- **Inputs for RT calculation**
  - **Terra/MODIS aerosol product**
  - **Sea surface wind (JRA-25)**
 - **Atmospheric fields (JRA-25)**
  - **Earth Probe/TOMS total ozone prod.**

Aerosol

Wind

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Target : Clear Land Area

- **Sites selection**
  - **Clear sky and spatially uniform land area in Australia**
  - **τ for aerosol < 0.3**
  - **Sun and satellite angular limitation**

- **Inputs for RT calculation**
  - **Aerosol Sunphotometer observation (Contributed by Dr.B.Forgan (BoM))**
  - **BRDF parameter by Terra/MODIS (Lucht et al., 2000)**
  - **Atmospheric fields (JRA-25)**
  - **Earth Probe/TOMS total ozone prod.**


Aerosol

BRDF
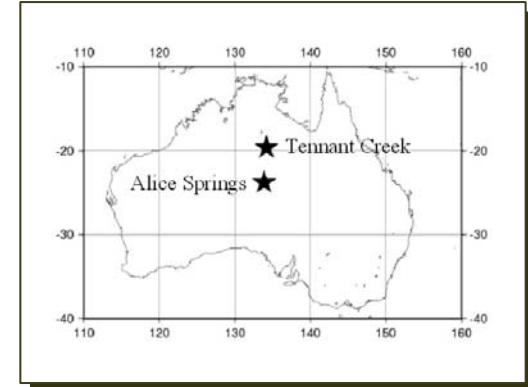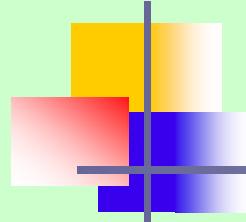
Target : Cloudy Area

- **Sites selection**
  - **Cloudy sky and spatially uniform over open ocean**
  - **20 < τ for cloud < 40**
  - **Sun and satellite angular limitation**

- **Inputs for RT calculation**
  - **Terra/MODIS Cloud product**
  - **Sea surface wind (JRA-25)**
  - **Atmospheric fields (JRA-25)**
 - **Earth Probe/TOMS total ozone prod.**

Cloud

Wind
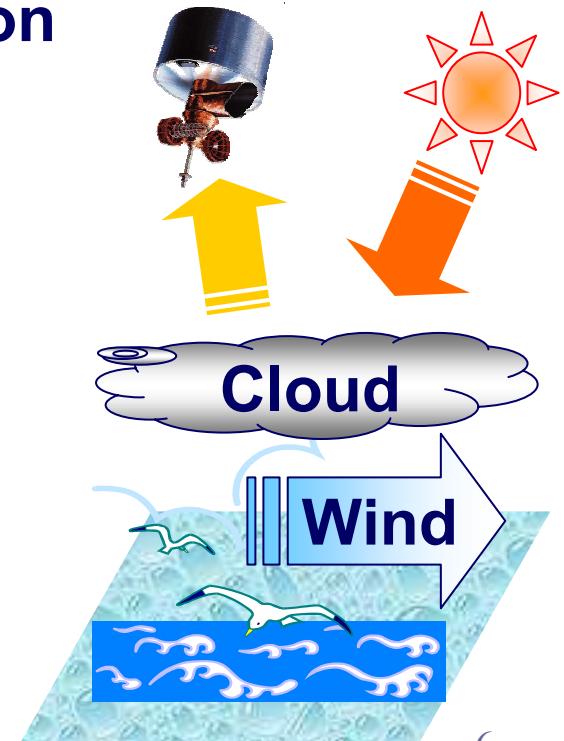
"*RSTAR*" – *Radiative Transfer Code*

- **Developed by Dr. NAKAJIMA (CCSR, Univ. of Tokyo)**
- **General package for simulating radiation fields**
  - **k - distribution method**
  - **HITRAN2004 database**
  - **Wavelengths between 0.2μm to 200μm**
  - **Absorption and scattering schemes**
  - **Parallel atmosphere divided into sub-layers**

Input
- **Sun and view angles**
- **Sensor's response function**
- **Atmosphere profile**
- **Surface condition**

Output
- **Radiance, irradiance**
- **Optical depth**
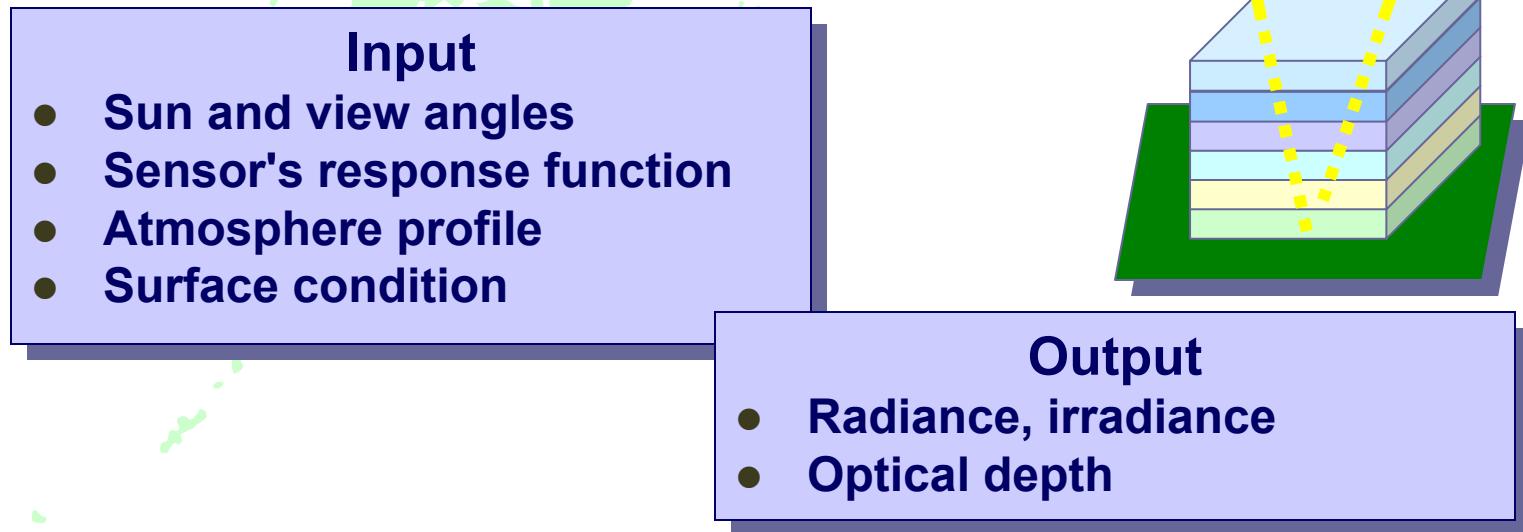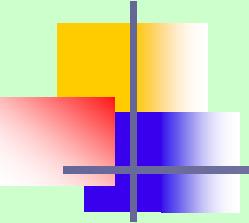
Validation of RT Simulation

The proposed RT simulation is validated by comparing Terra/MODIS radiance data

- **On-board visible calibration for Terra/MODIS**

- **RT simulated values are nearly equal to MODIS radiances**

- **The methodology is reasonable**

RT calculation

$y = 1.0124x$

$R^2 = 0.9994$

RSTAR6 calc. [W/m²/str/μm]

- Clear Sea
- Clear Land
- Cloud

MODIS Obs. Band 1 (0.620-0.670 um)
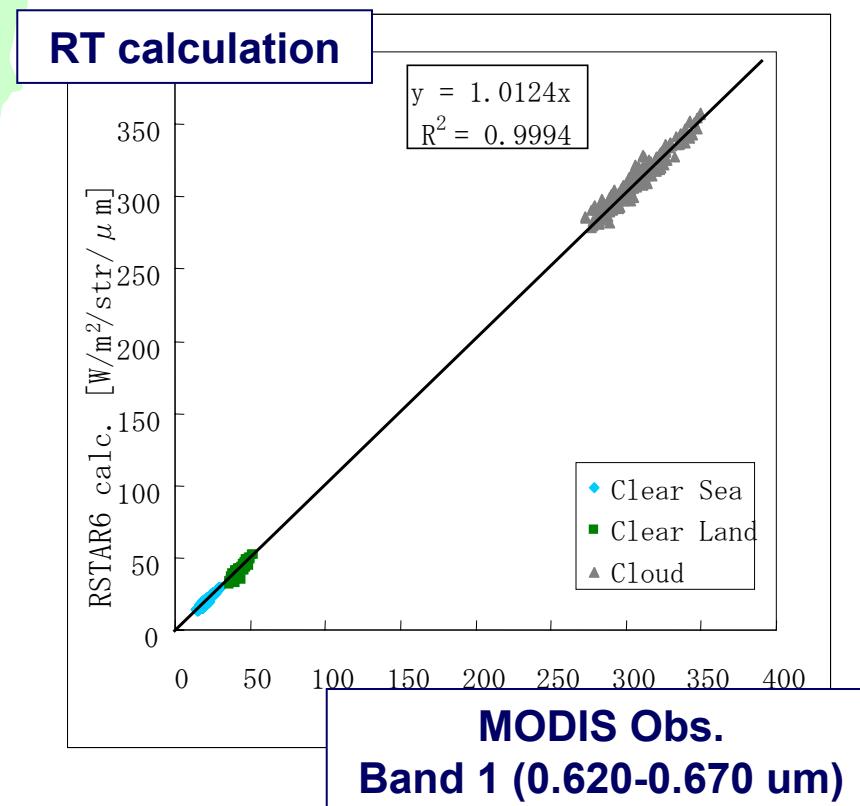
GMS-5 VIS Calibration Table

GMS-5 observation and RT simulation comparison

New Calibration Table

RT simulation (radiance)

$$y = 111.76x - 3.5$$
$$R^2 = 0.9933$$

Clear Sea
Clear Land
Cloud

Radiance (W/m2/μm/str)

400
350
300
250
200
150
100
50
0

0   0.5   1   1.5   2   2.

Observations (Voltage)

100
90
80
70
60
50
40
30
20
10
0

0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1

Radiance [W/m2/μm/str]

600
550
500
450
400
350
300
250
200
150
100
50
0

Recalibrated

Original

0   10   20   30   40   50   60

Digital Number
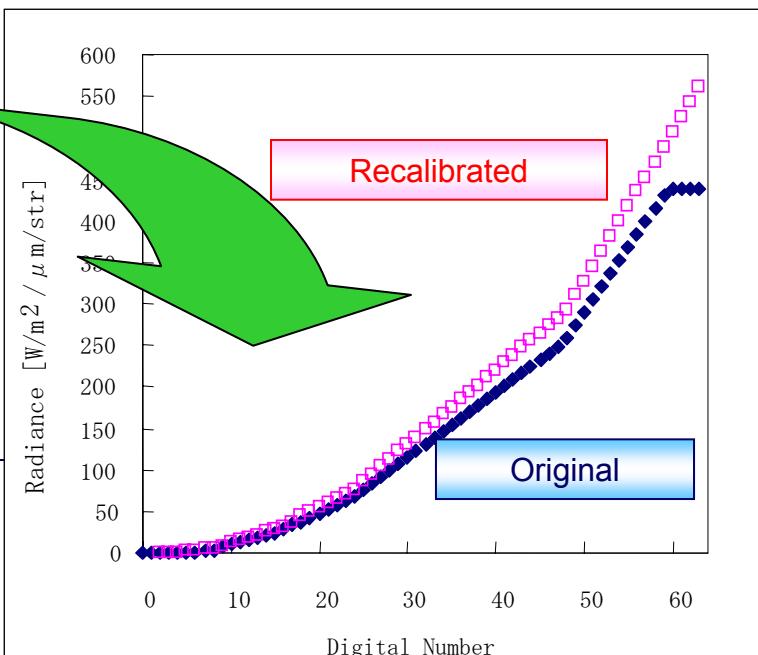
Reprocessed GMS-5 VIS Calibration Coefficients
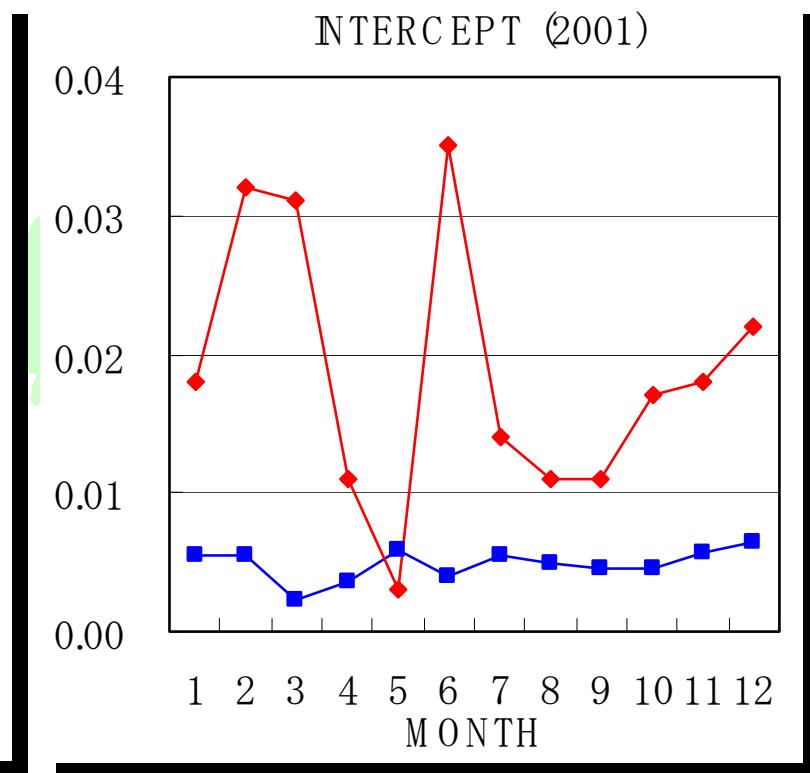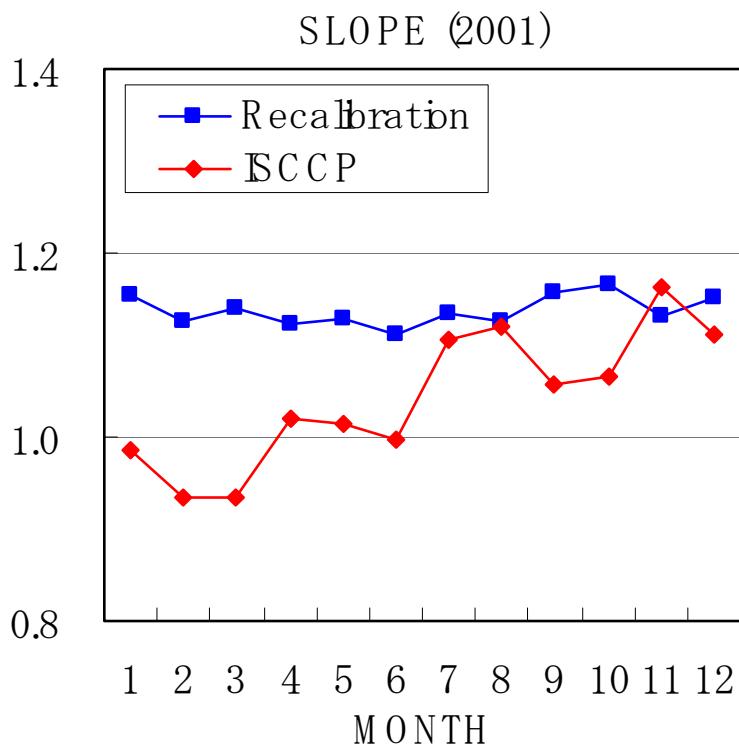
Coefficients comparison between
ISCCP and recalibration

Validation : Aerosol product

- **Comparison between JMA/MSC AOT and sunphotometer observation**

- **Aerosol Optical Thickness (AOT) product improved**

April, 2001

JMA's sunphotometer site

$$y = 0.8501x + 0.0272$$

$$y = 0.6976x - 0.0677$$

AOT (Retrieval by GMS-5)

AOT (Sunphotometer)

Original
Reprocess
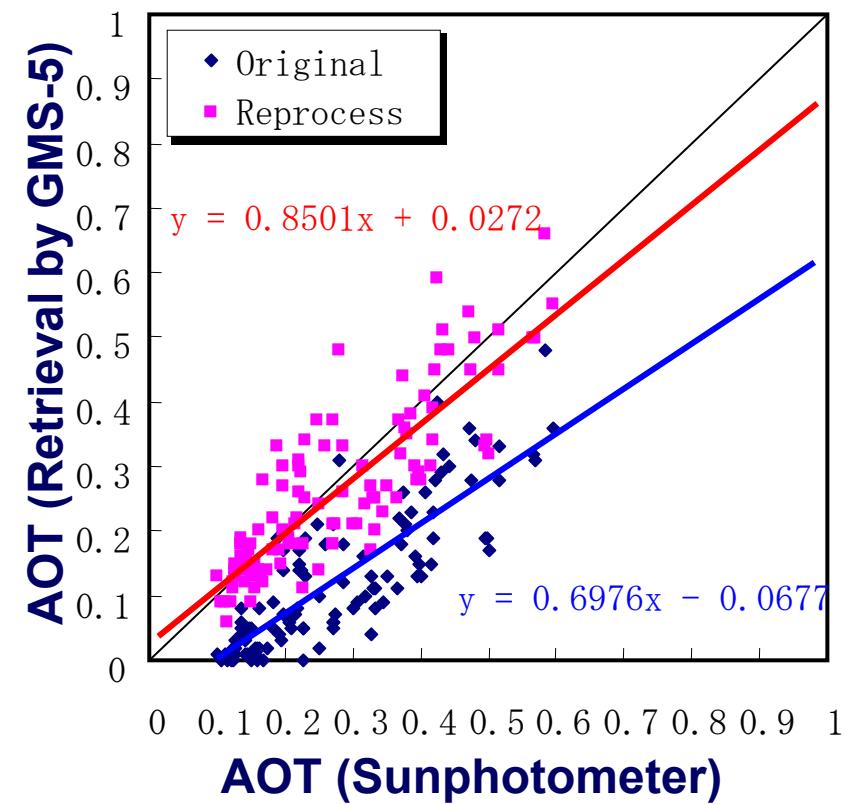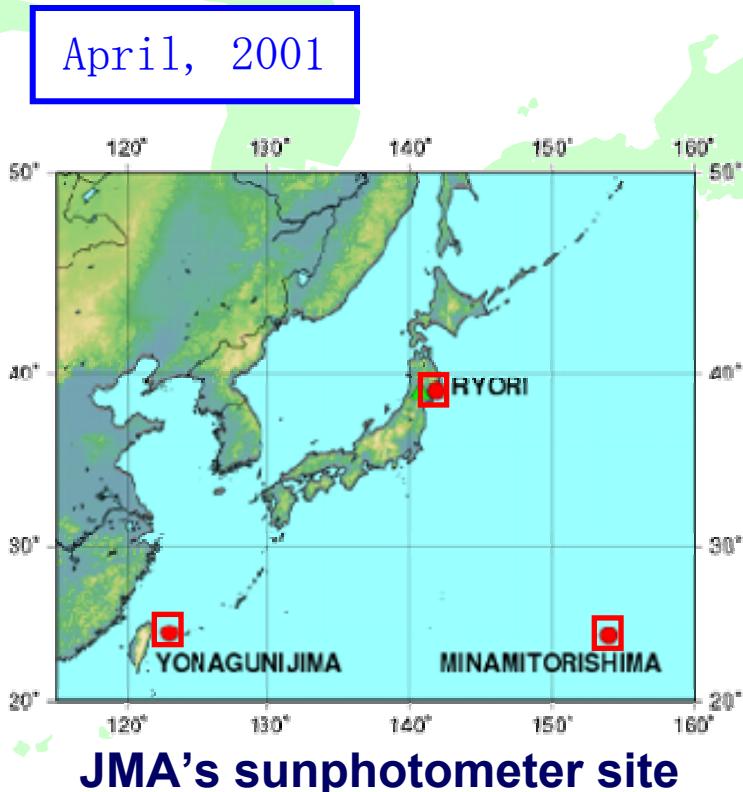
Validation :
Downward solar flux product

- **Comparison between JMA/MSC downward solar flux product and pyranometer observation (daily average)**

- **Downward solar flux product** **improved in cloudy area**

April, 2001

JMA's pyranometer site

$y = 0.8975x + 31.933$

$y = 0.9961x + 0.6383$

◇ Original
□ Reprocessed

Retrieval by GMS-5 [W/m²]

pyranometer [W/m²]
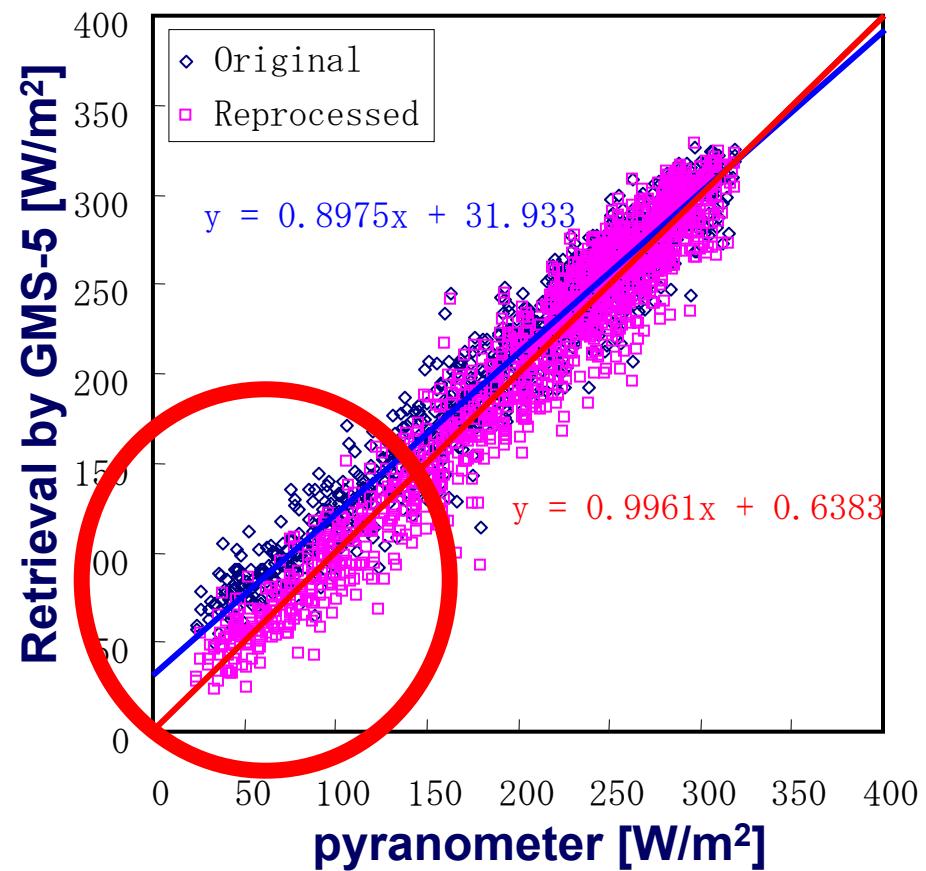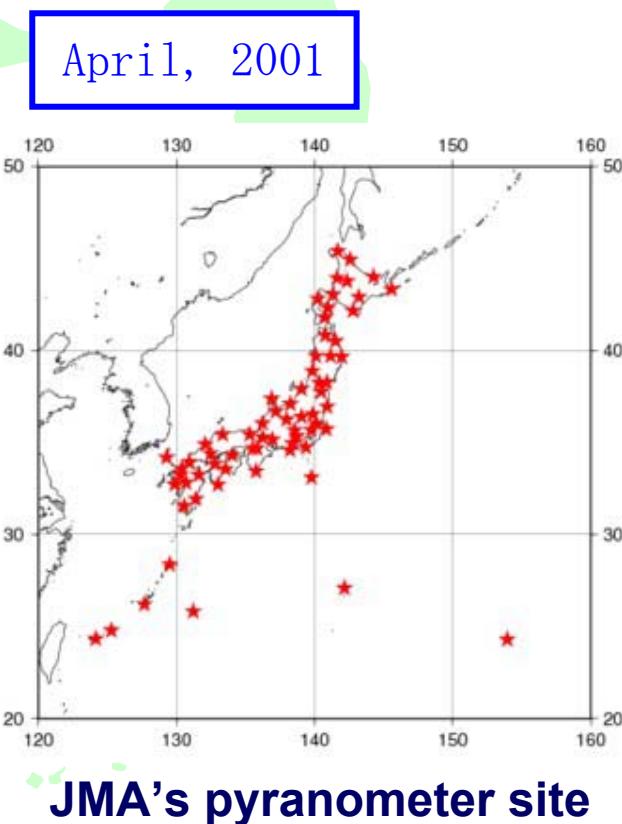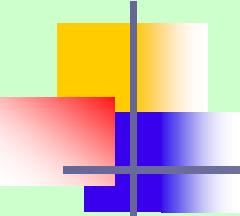
Future Plan

- **Evaluate and update the calibration table**

- **Reprocess GMS-5 all visible observation data in its operational period (1995-2003) by using NOAA/AVHRR and Terra/MODIS**
  - **Reprocessing in 2001 is completed**

- **Reprocess MTSAT-1R visible observation data**

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Thank you !