Vicarious calibration of Vis channel activity at the JMA

Meteorological Satellite Center
Japan Meteorological Agency

Prepared for GSICS GRWG-GDWG joint meeting,
28-30 Jan. 2009, JMA

Methodology

① Target selection

- Cloud-free sea, cloud-free land and uniform liquid Cloud Top as dark, medium and bright target

② Observation conversion

- VISSR output voltage, linear to observed radiance, from digital number

③ Stripe noise removal

- Sensitivity difference among the detectors are corrected

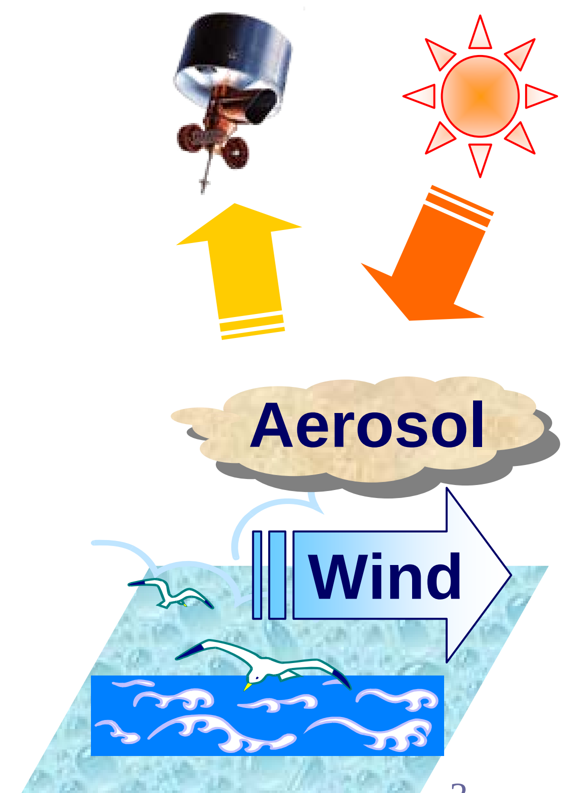
④ Comparison of observation with simulation

- Radiance simulation at the targets
- Derive relationship between observations and simulations

Target : Clear Sea Area

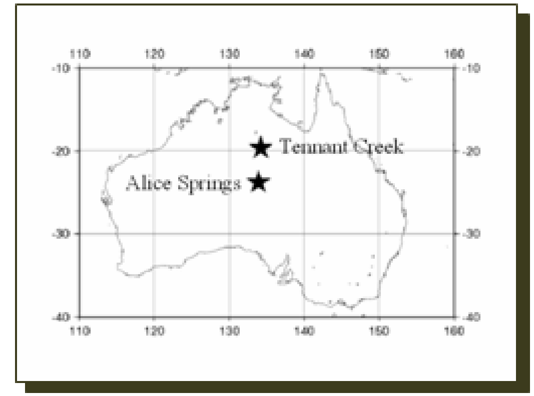
- **Sites selection**
  - Clear sky and spatially uniform over open ocean
  - Wind speed < 10m/s
  - AOT < 0.3
  - Sun and satellite angular limitation

- **Inputs for RT calculation**
  - AOT by Terra/MODIS L1B
  - Sea surface wind (JRA-25)
  - Atmospheric fields (JRA-25)
  - Earth Probe/TOMS total ozone prod.
  - BRDF of ocean surface (Nakajima and Tanaka, 1983)



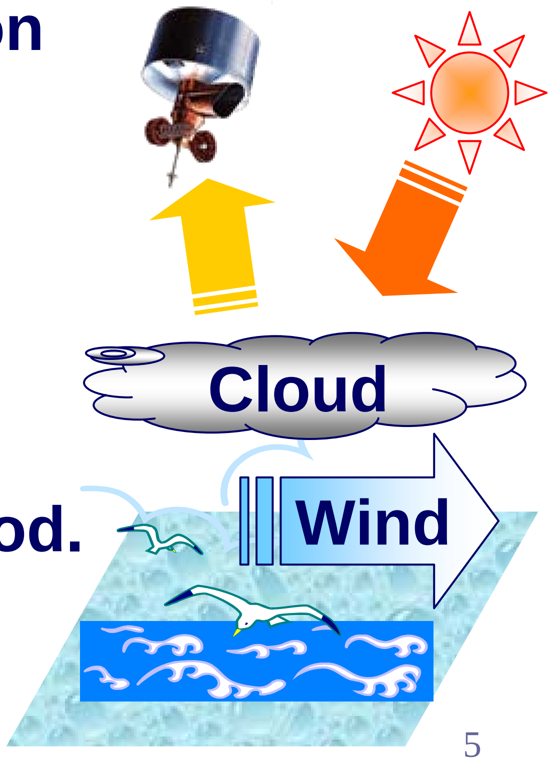
Target : Clear Land Area

- Sites selection
  - Clear sky and spatially uniform land area in Australia
  - AOT < 0.3
  - Sun and satellite angular limitation
- Inputs for RT calculation
  - Aerosol Sunphotometer observation (Contributed by Dr.B.Forgan (BoM))
  - NASA BRDF product by Terra/MODIS (Lucht et al., 2000)
  - Atmospheric fields (JRA-25)
  - Earth Probe/TOMS total ozone prod.



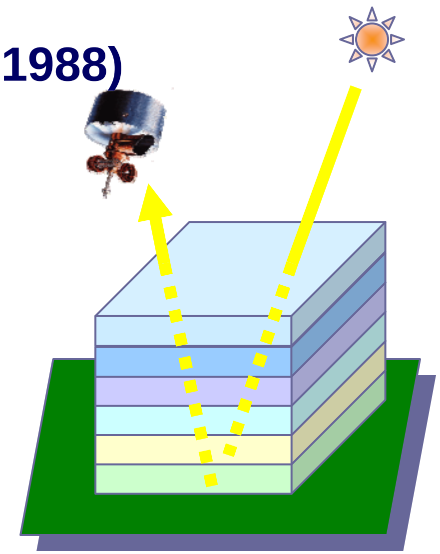
Target : Uniform cloud top

- Sites selection
  - Uniform liquid cloud top over open ocean
  - 20 < COT < 40
  - Sun and satellite angular limitation
- Inputs for RT calculation
  - COT and r_{eff} by Terra/MODIS L1B
  - Sea surface wind (JRA-25)
  - Atmospheric fields (JRA-25)
  - Earth Probe/TOMS total ozone prod.



"RSTAR" – Radiative Transfer Code

- Developed by Dr. NAKAJIMA's Lab. (CCSR, Univ. of Tokyo, etc.)
- General package for simulating radiation fields
  - CKD(correlated k-distribution) method
  - Discrete-Ordinate-Method(DOM) +
    Matrix calculation(Nakajima and Tanaka, 1986, 1988)
  - HITRAN2004 database
  - Wavelengths between 0.2μm to 200μm
  - Parallel atmosphere divided into sub-layers



Input

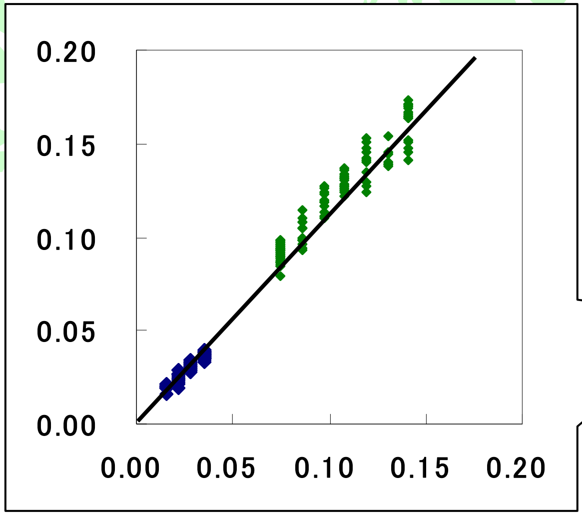
- Sun and view angles
- Sensor's response function
- Atmosphere profile
- Surface condition

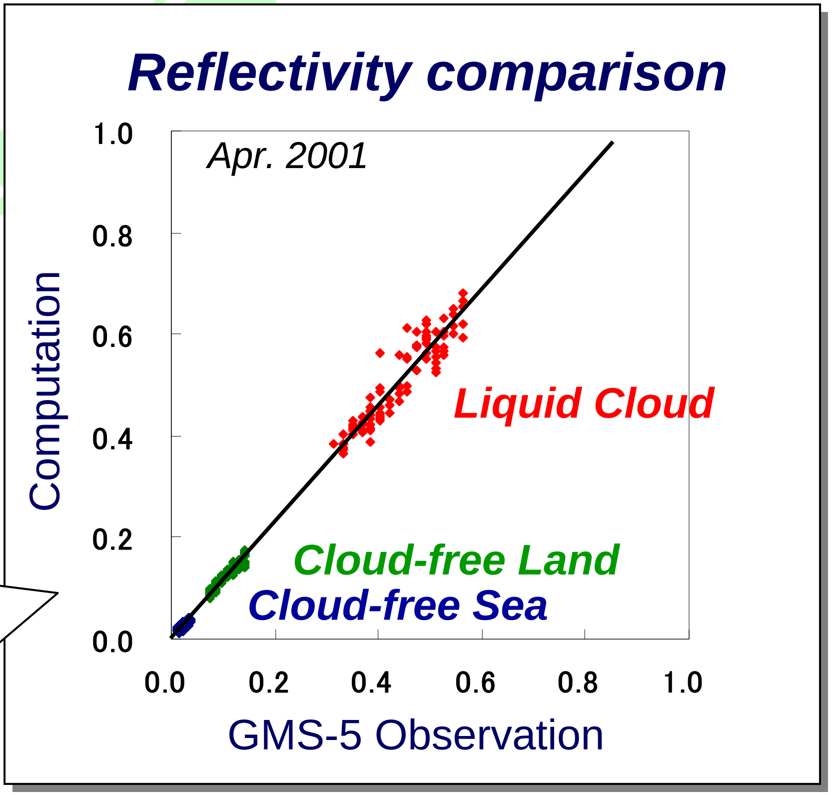
Output

- Radiance, flux

Vicarious calibration (Observation v.s. Computation)

- The scatter plots for three targets are on a linear regression line
- **New Calibration table** can be obtained



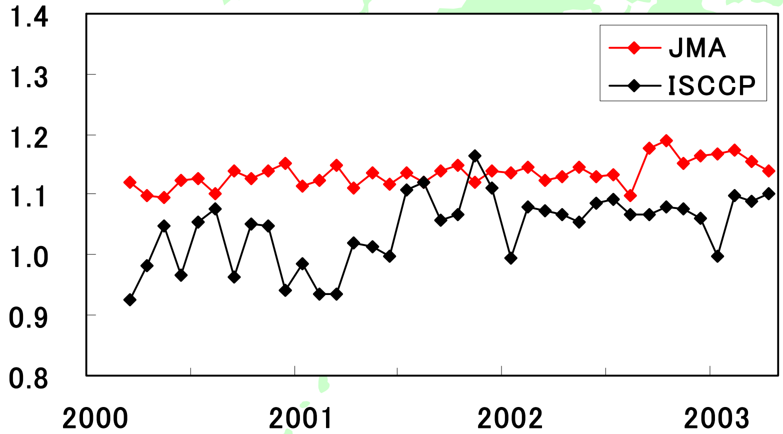


Calculated Coefficients

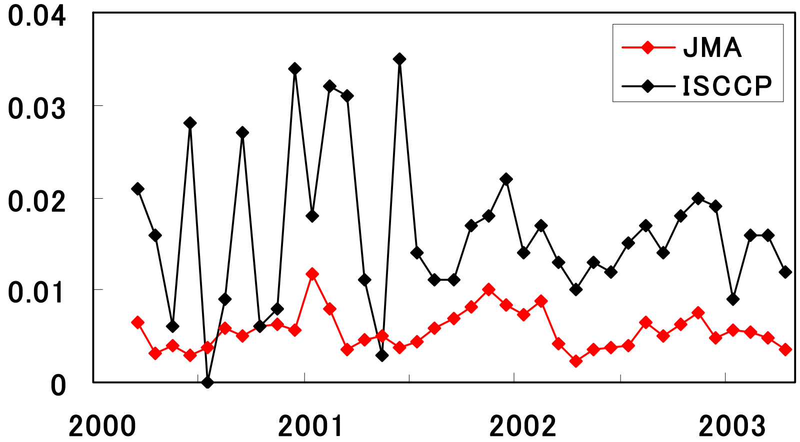
- **Calculated GMS-5 coefficients are more stable than the ISCCP ones.**

$$L_{New} = Slope * L_{org} + Intercept$$

Slope



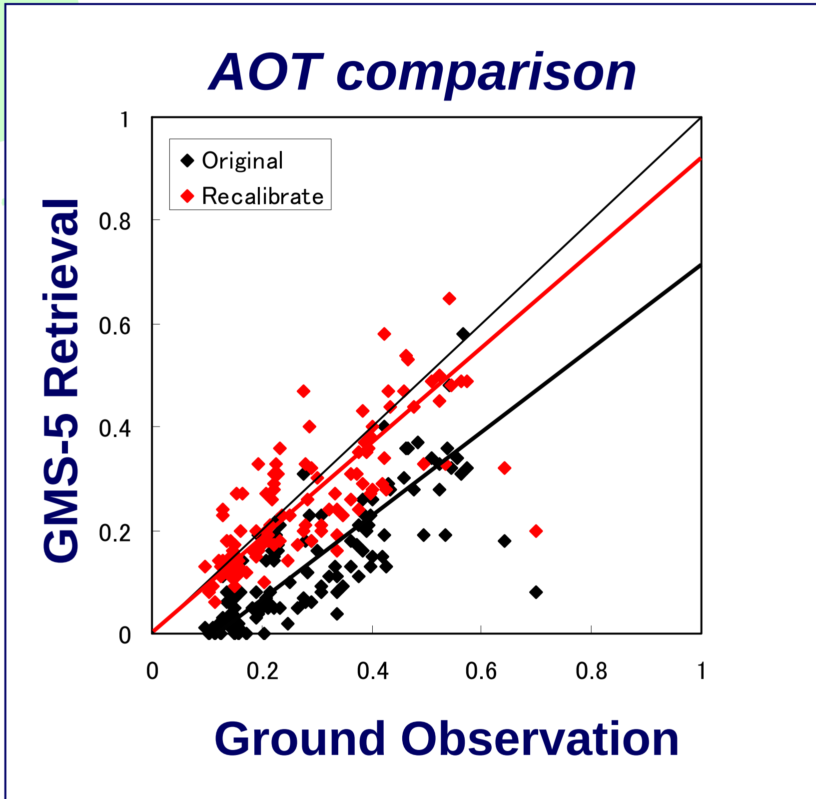
Intercept



Validation : Aerosol Optical Thickness

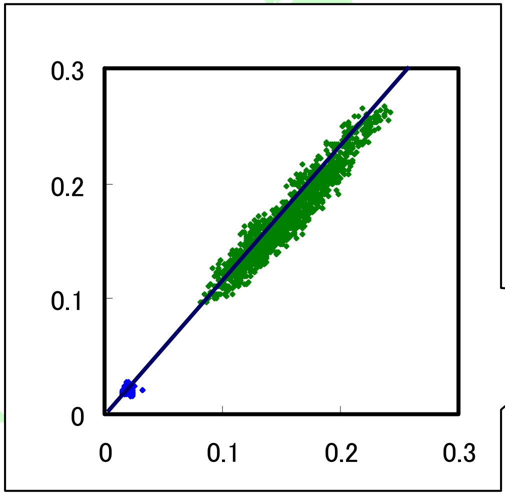
- **Compared JMA/MSC aerosol product with ground observations (Sunphotometer)**
- **Underestimated AOT is improved**

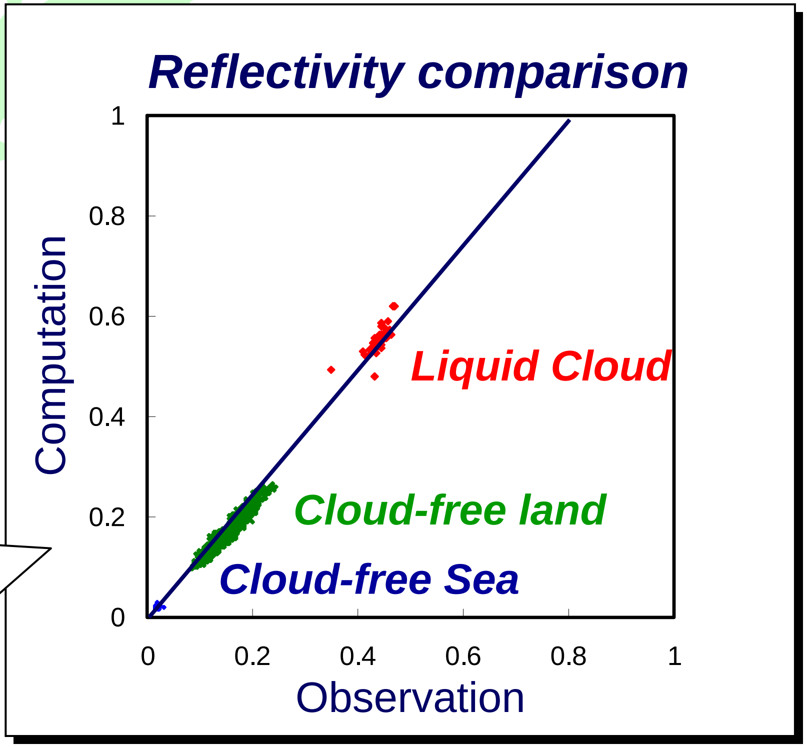
JMA ground observation sites



MTSAT-1R Calibration – Trial –

- Observation – Computation scatter plot is on a regression line for all targets
- New Calibration table can be obtained
- Validation is an issue in the future

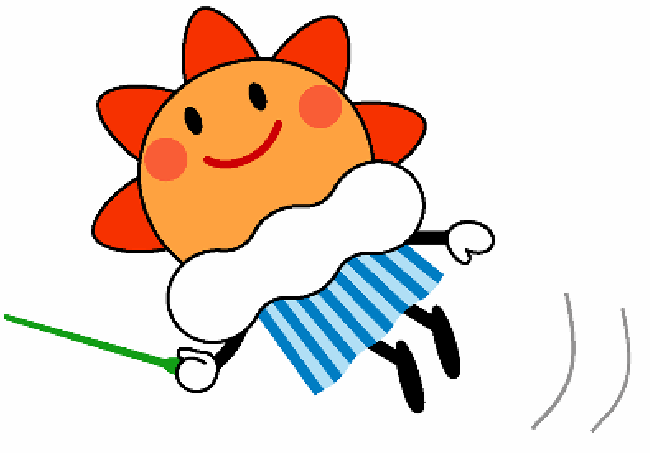




Future Plan

- Extend calibration period prior to 2000 and generate calibrated data set for all the operation period of GMS-5
  - AVHRR instead of MODIS
- Evaluate and update the calibration table
- Reprocess MTSAT-1R visible observation data

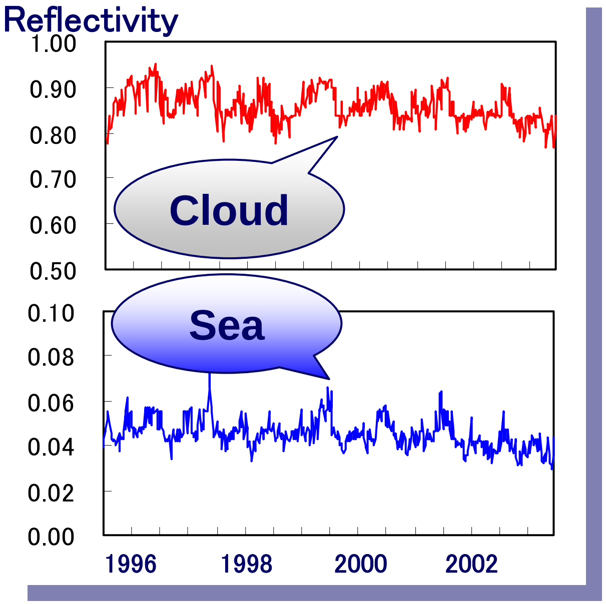
Thank you !



Motivation

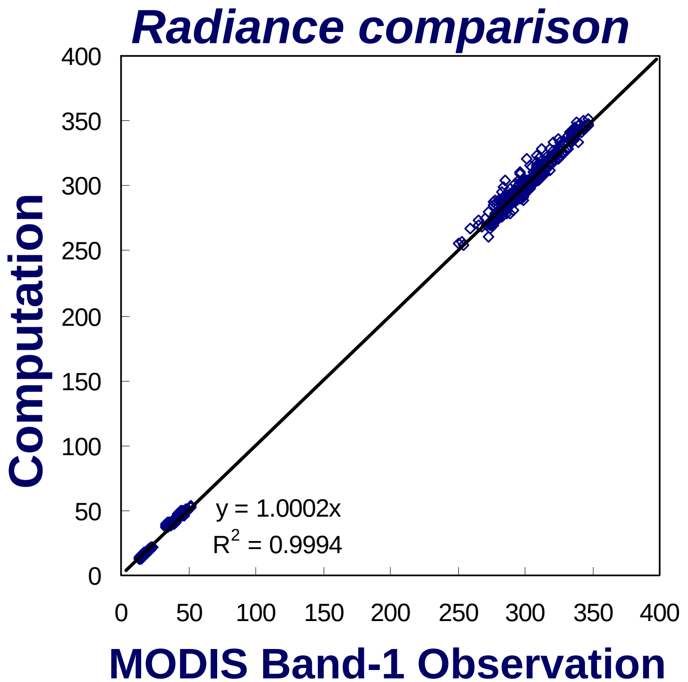
- No update on GMS-5 visible calibration table during its lifetime between 1995 and 2003
- Degradation in GMS-5 visible channel observed (Kurihara and Tokuno (2000))

- Preparation of accurate and practicable visible data set required by climatological study
- Establishment of a visible image reprocessing technique



Evaluation of Radiance Simulation by MODIS

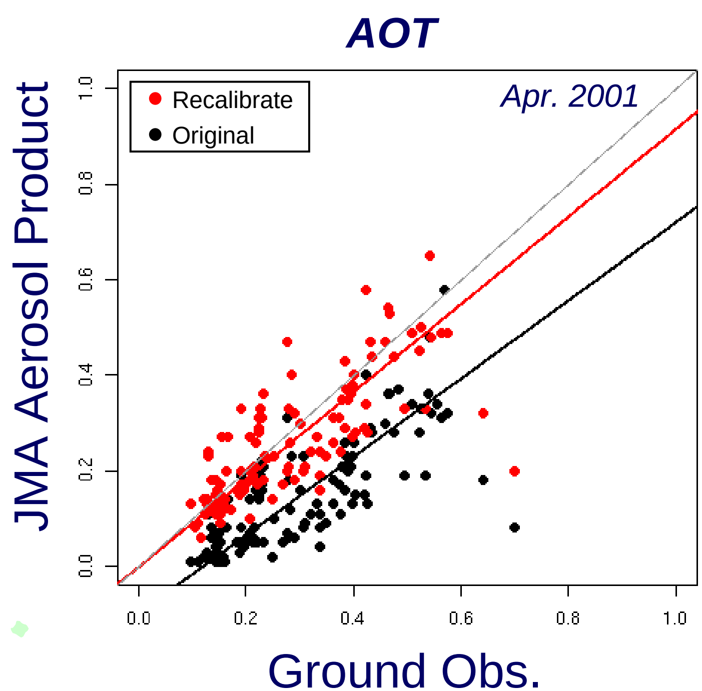
- MODIS carries onboard visible calibration. It's observations are reliable.
- The radiance simulation techniques employed by this study evaluated by using MODIS data.
- Computation and observation show good consistency
  - RMSE is around 1%

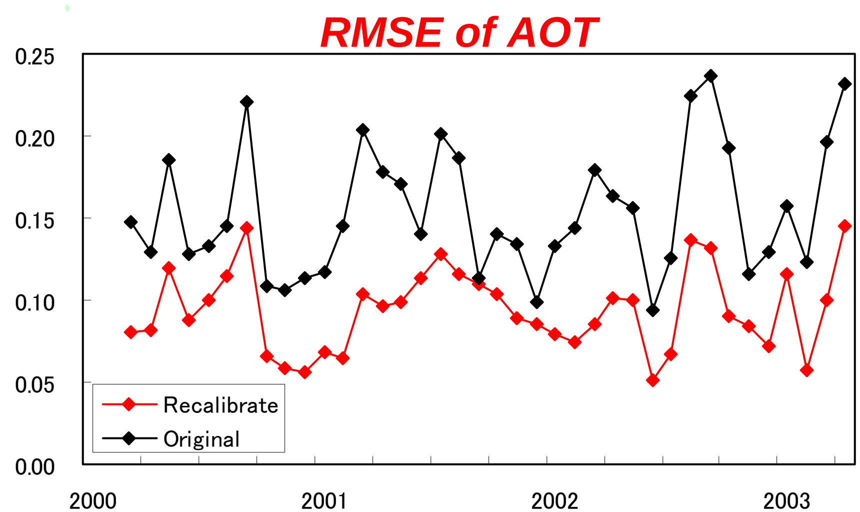


Validation : Aerosol product

- <u>**Comparison**</u>
  JMA/MSC aerosol product *vs*
  ground observations (Sunphotometer)
- **Underestimated AOT is improved**

JMA's sunphotometer site

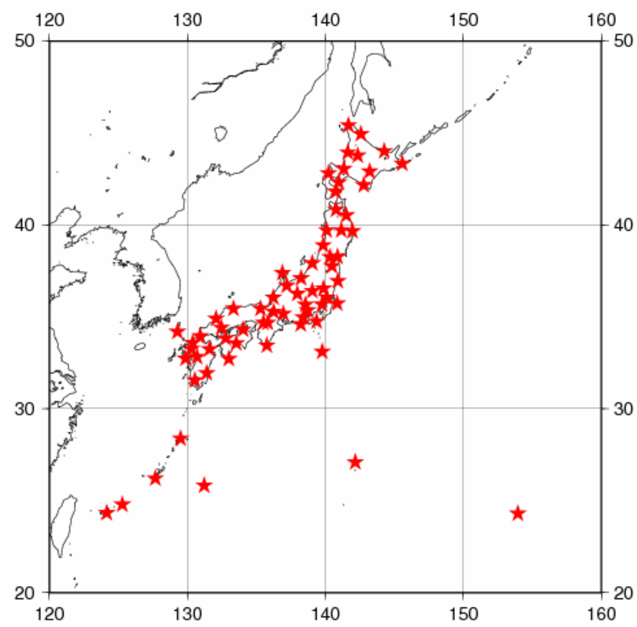




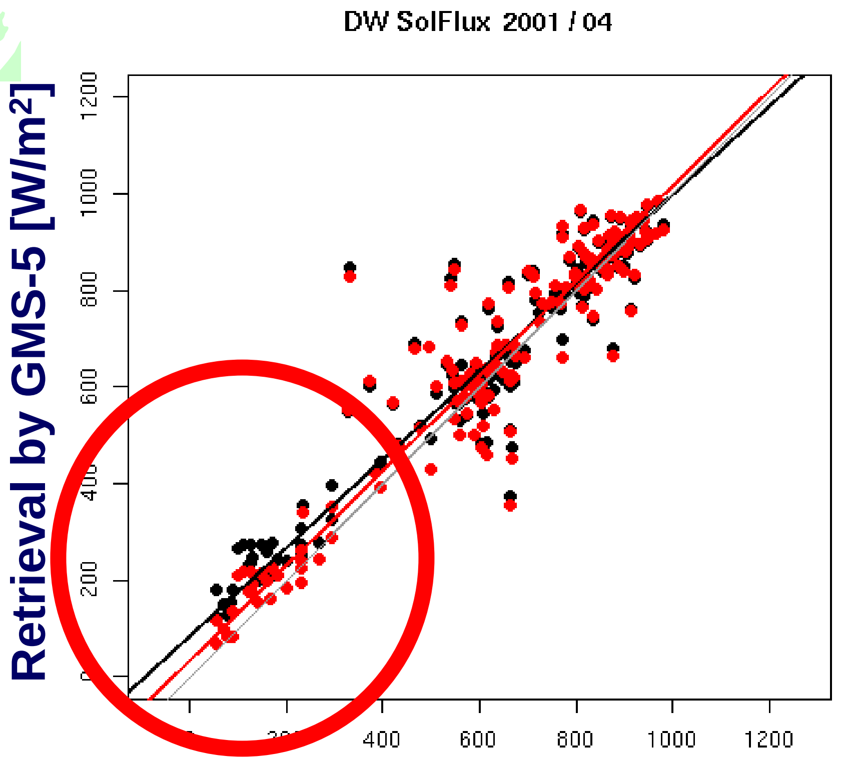
Validation : Downward solar flux product

- Comparison between JMA/MSC downward solar flux product and pyranometer observation (daily average)
- Downward solar flux product improved in cloudy area

April, 2001



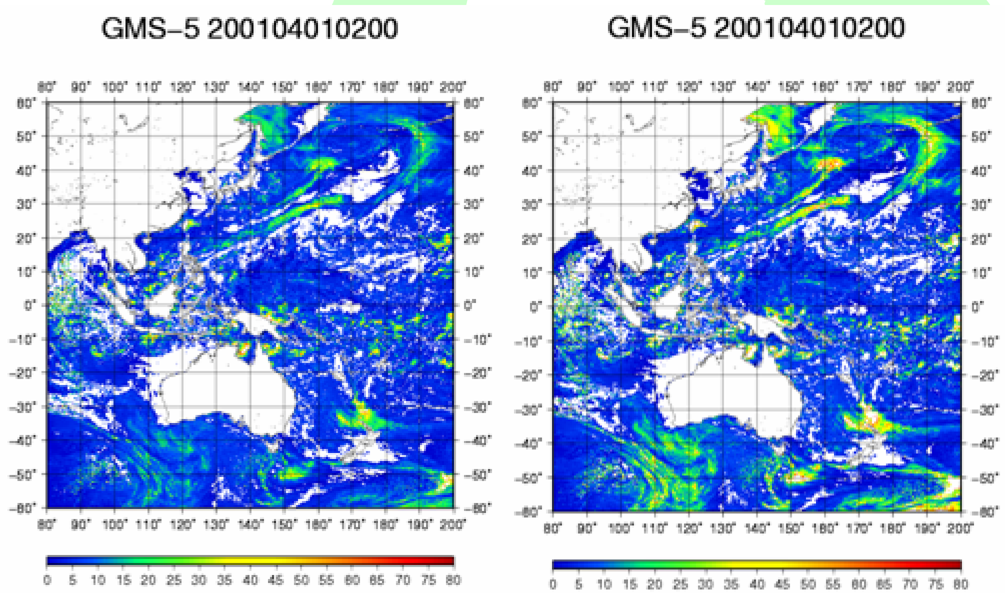
JMA's pyranometer site



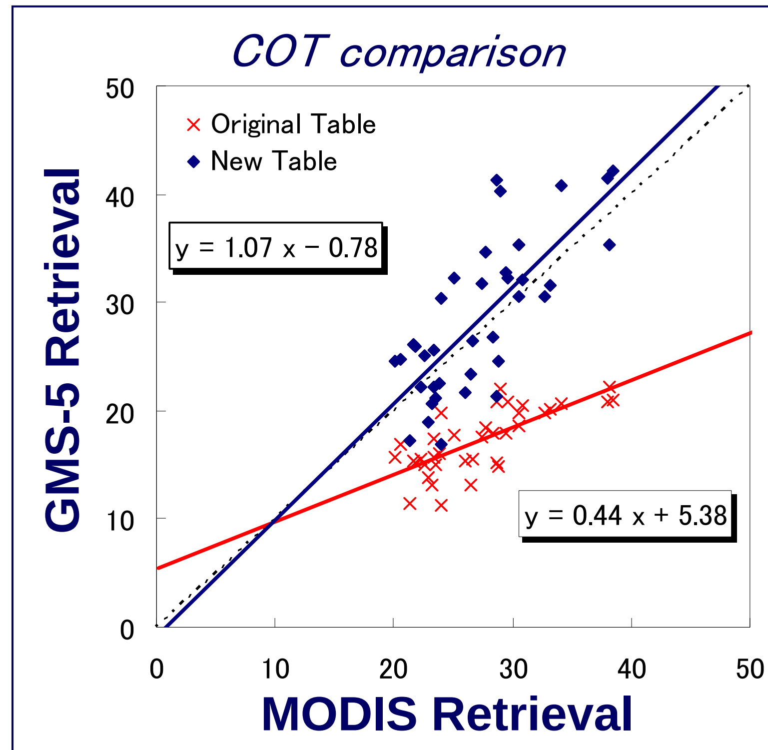
pyranometer [W/m²]

Validation : Cloud Optical Thickness

- **Compared retrieved COT from GMS-5 with the one from MODIS**
- **Underestimated COT is improved**



Old calibration table   New calibration table



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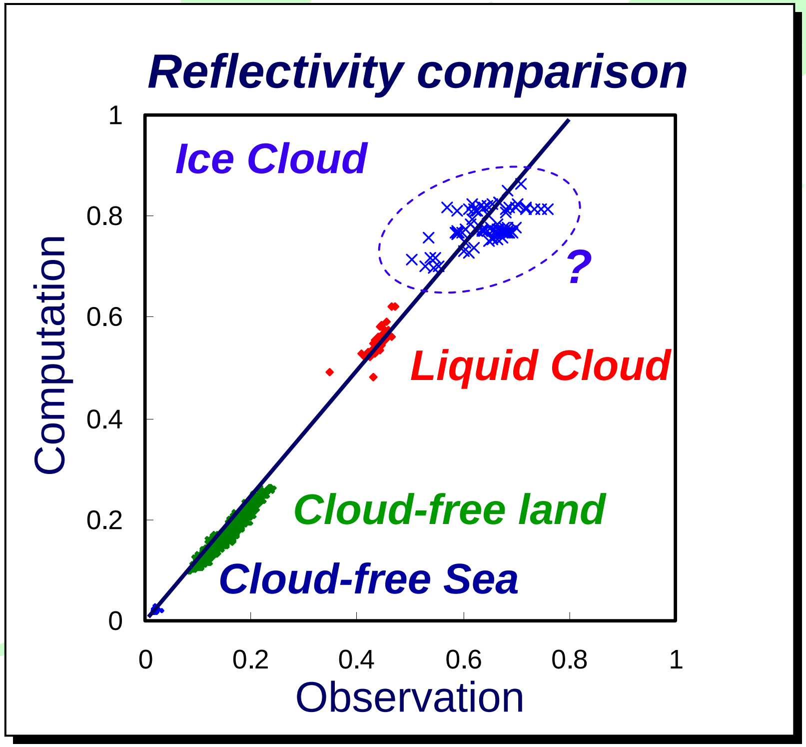

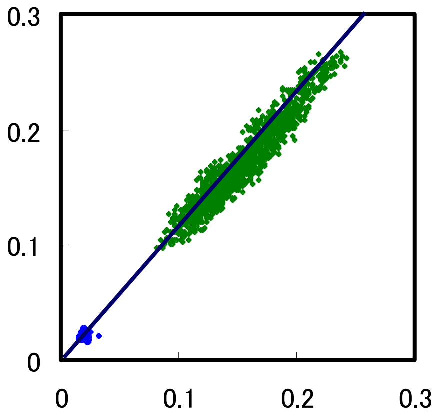

Conclusion

- GMS-5 Visible calibration method is developed using three targets, cloud-free sea, cloud-free land, and uniform liquid cloud top
- New calibration coefficients are more stable than ISCCP
- Improvement of aerosol and other products are recognized

Plan

- Extend calibration period prior to 2000 and generate calibrated data set for all the operation period of GMS-5
  - AVHRR instead of MODIS