JMA Inter-Calibration Activities under WMO GSICS Framework

Arata Okuyama[1], Kenji Date[1], Hiroaki Tsuchiyama[1],
Ryuichiro Nakayama[1], Yuki Kosaka[1], Yoshihiko Tahara[1],
Satoru Fukuda[2], Hideaki Takenaka[3], Tamio Takamura[3], Teruyuki Nakajima[2]

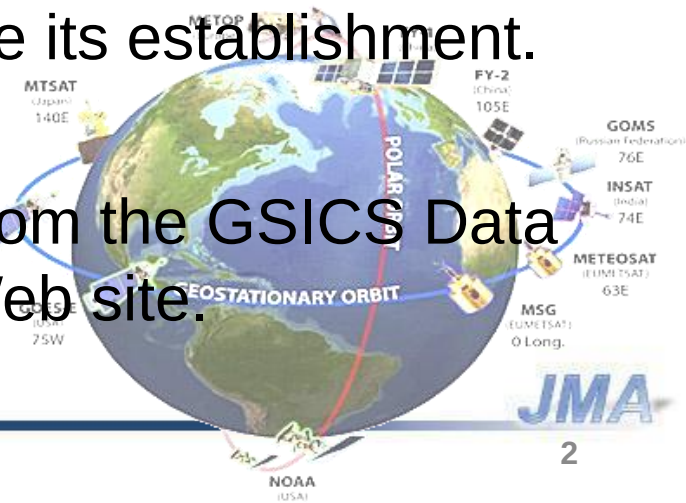
1: Meteorological Satellite Center, Japan Meteorological Agency
2: Atmosphere and Ocean Research Institute, the University of Tokyo
3: Center for Environmental Remote Sensing, Chiba University

okuyama.arata@met.kishou.go.jp

06 Dec. 2011
for The Second Asia/Oceania Meteorological Satellite Users' Conference

What is GSICS?

- Global Space-based Inter-Calibration System (GSICS)
- WMO Space Programme
  - GSICS Implementation Plan and Program formally endorsed at CGMS 34 (Nov. 2006)
- Goal - Ensure consistent accuracy among space-based observations worldwide and contributing to weather forecast, climate monitoring and environmental applications.
- JMA has cooperated the GSICS since its establishment.
- Calibration outcomes are available from the GSICS Data Servers and calibration monitoring Web site.



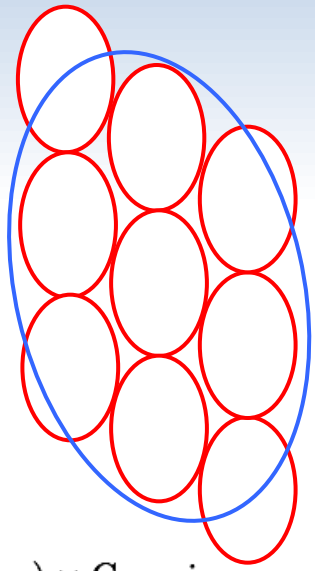
1. Calibration for infrared channel

1. Calibration for infrared channel
2. Calibration for visible channel
3. How to reach the GSICS outcomes

Inter-calibration methodology(1)
Collocation

- **AIRS/IASI FOV ~ 3x3 MTSAT pixels**
- **Criteria**
  - **Time** $|t_{leo} - t_{geo}| < dt_{max}$
  - **SZA** $|\cos\theta_{leo}/\cos\theta_{geo} - 1| < \theta_{max}$
  - **Uniformity** $\underset{9\times9}{\mathrm{STDV}}(I_{geo}) < \mathrm{STDV}_{max}$

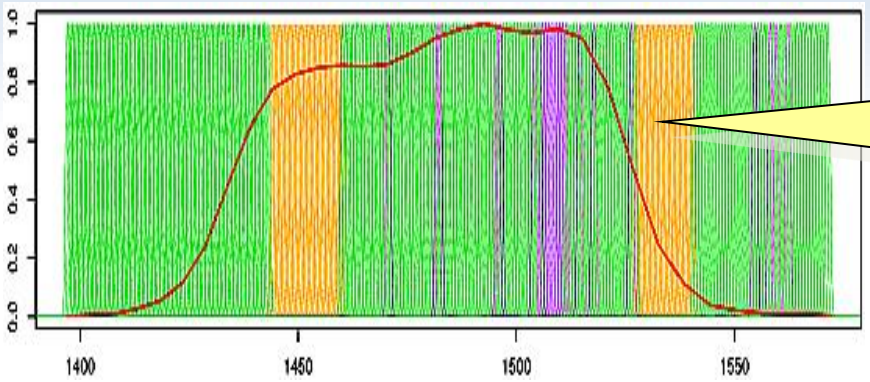
$$|\underset{3\times3}{\mathrm{AVE}}(I_{geo}) - \underset{9\times9}{\mathrm{AVE}}(I_{geo})| < \frac{81-9}{9(9-1)}\underset{9\times9}{\mathrm{STDV}}(I_{geo}) \times \mathrm{Gaussian}$$



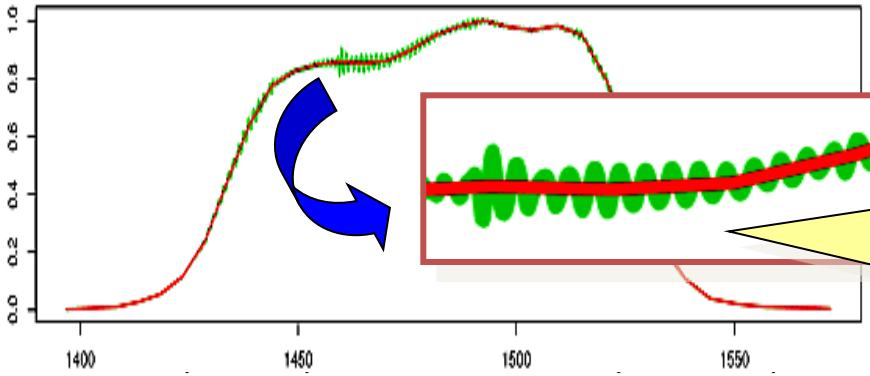
MTSAT-2 channel	Condition	dt_{max} (minutes)	MaxRate OptPathDiff	MaxSTDV (mW.m^{-2}.sr^{-1}.cm)	Gaussian
IR1 (10.8 μm)	Clear	5	0.01	1.65	2
	Cloudy	5	0.03	3.31	2
IR2 (12.0 μm)	Clear	5	0.01	1.82	2
	Cloudy	5	0.03	3.64	2
IR3 (6.8 μm)	All	5	0.01	0.311	1
IR4 (3.8 μm)	Clear	5	0.01	0.0151	2
	Cloudy	5	0.03	0.0302	2

* Clear if TB(IR1) > 275 K

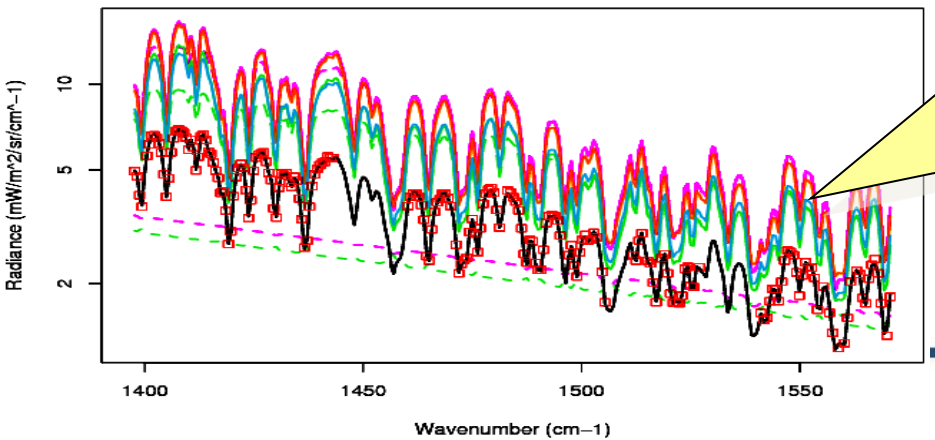
Inter-calibration methodology(2)
GEO Radiance Estimation from Hyper Sounder Obs.



1. "Gap channels" introduced
To fill the spectral gaps of a LEO hyper sounder



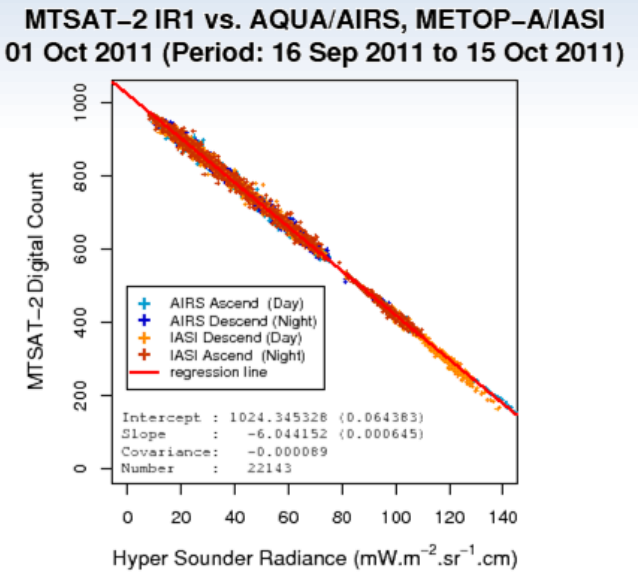
2. "Super channel" generated
To imitate a GEO channel from the hyper and gap channels by the "constraint method"



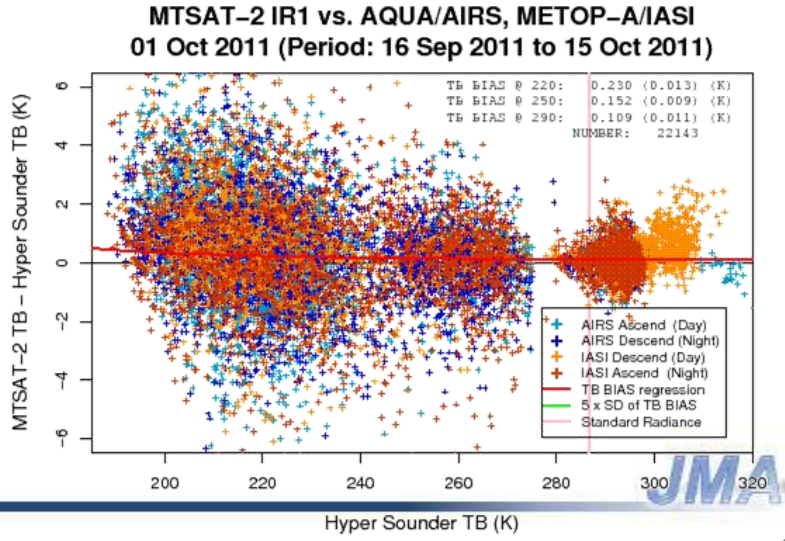
3. Radiances of missing hyper and gap channels estimated
by using valid hyper channel observations and beforehand simulated radiances for 8 profiles

Intercalibration outcomes

- Statistics
  - Regression coefficients
  - TB residuals at references
    - 290 K, 250 K and 220 K
  - All MTSAT-1R/2 IR channels



- Showcase
  - Temporal sequence charts
  - Scatter plots
  - GSICS Correction



Diagnosis

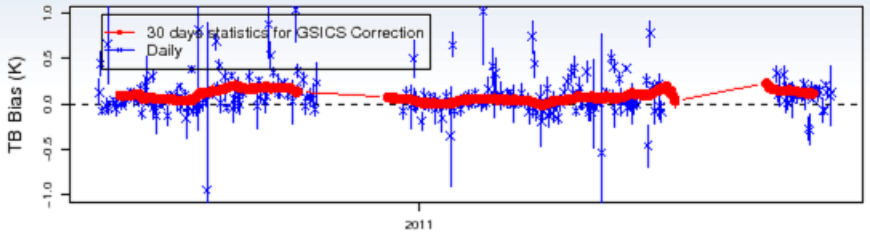
- Midnight calibration error
  - MTSAT-2 infrared channels have TB bias compared with IASI and AIRS in eclipse season midnight.
  - This error is significant for 12.0um(IR2) and moderate for 10.8um(IR1) and 3.8um(IR4).
  - Maximum bias for the 12.0um is around +1.0K.

* Bias = MTSAT2 – AIRS/IASI

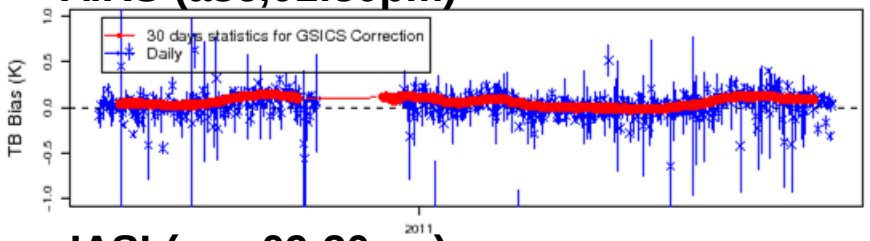
MTSAT-2 12.0um(IR2)

TB bias at Std. Radiance (285.94K)

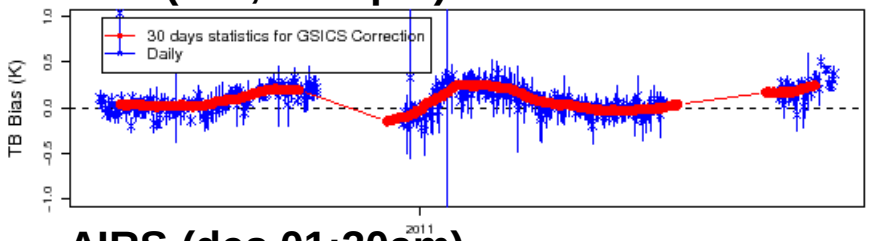
IASI (des,09:30am)



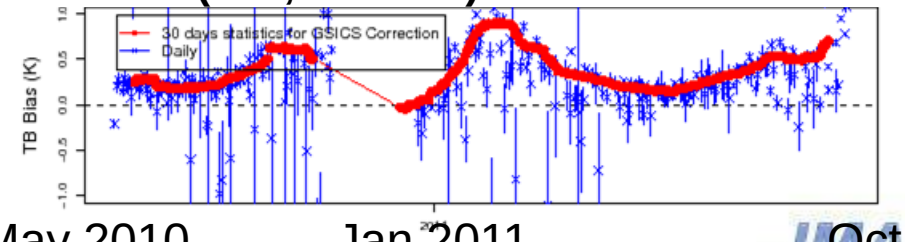
AIRS (asc,01:30pm)



IASI (asc,09:30pm)



AIRS (des,01:30am)



May 2010 Jan.2011 Oct.

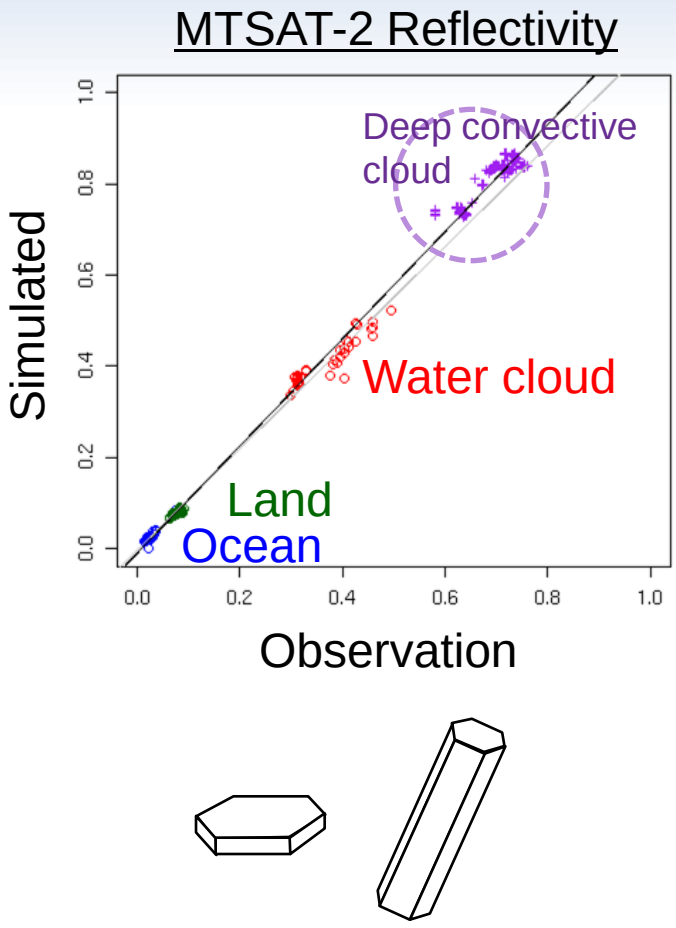
2. Calibration for visible channel

1. Calibration for infrared channel
2. Calibration for visible channel
3. How to reach the GSICS outcomes

Calibration methodology

- Vicarious calibration approach
- Observation data is evaluated via radiative transfer model (RSTAR).
- Cloud-free ocean, Cloud-free land and Water cloud top, are adopted as simulation targets.
- Cloud and aerosol optical parameters are retrieved from MODIS L1B.
  - Cloud analysis tool (CAPCOM)
  - Aerosol analysis tool (REAP)

- Deep convective cloud target is current issue.
  - Scattering process by non-spherical ice particles are investigated.
  - Light scattering analysis tool(LISAS_goa)

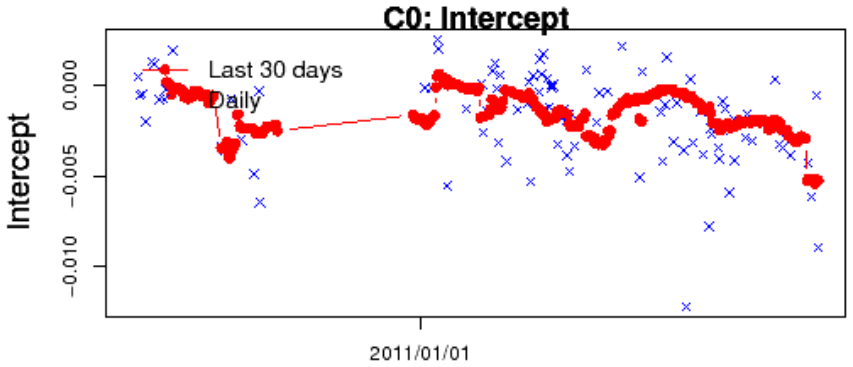


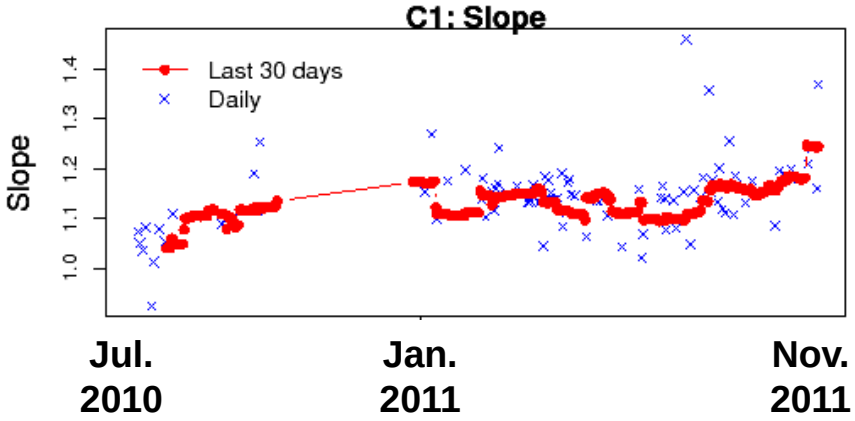
Visible calibration related works have been pursued with collaborative researches with Atmosphere and Ocean Research Institute (AORI), the University of Tokyo and Center for Environmental Remote Sensing, Chiba University (CEReS).

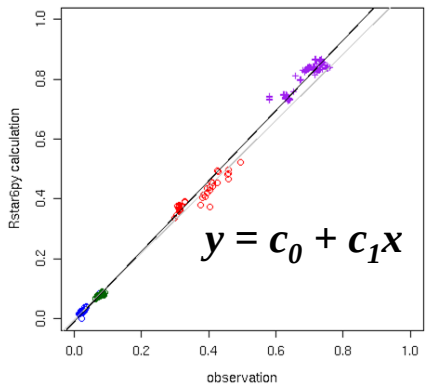
Calibration outcomes

- Statistics
  - Regression coefficients
- Showcase
  - Temporal sequence charts
  - Scatter plots
  - Statistics in text (CSV)

MTSAT-2 Visible calibration coeff.



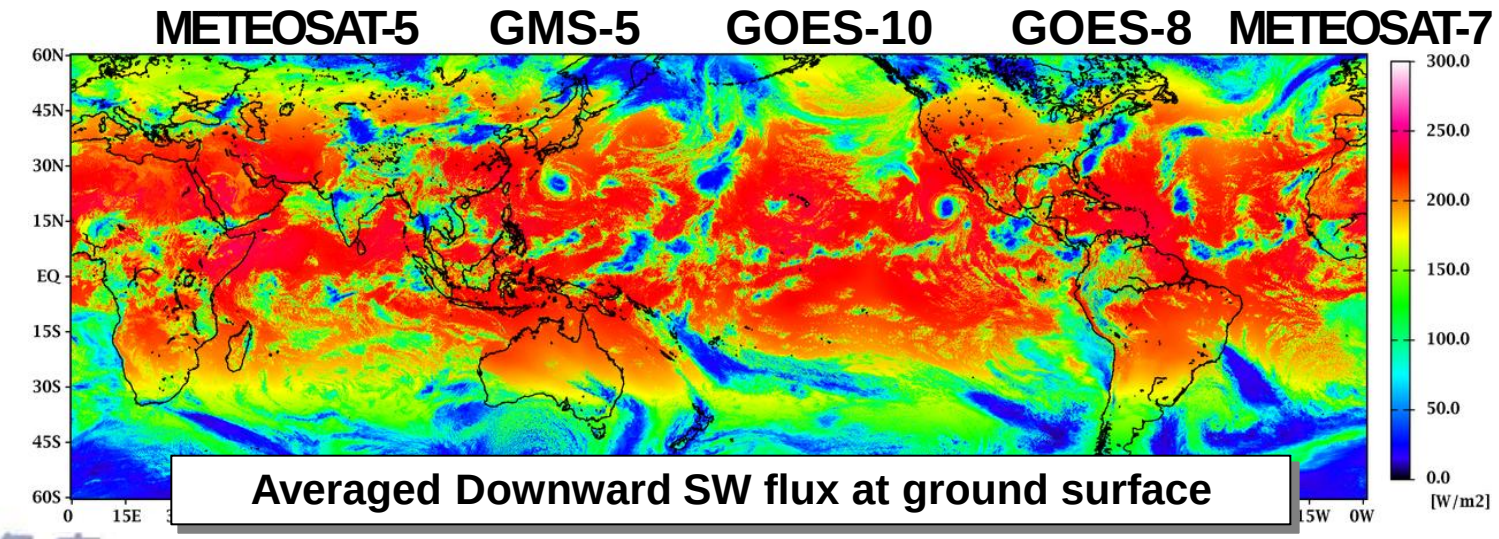




Application

Downward shortwave flux at ground surface

- The calibration method can be applicable to other GEO satellite imagers, such as GOES and METEOSAT.
- Downward solar flux can be retrieved from the GEO satellite images and compositted.
- There seems to be no “gap” on the composite solar flux image.
- All GEO satellite data looks well calibrated.

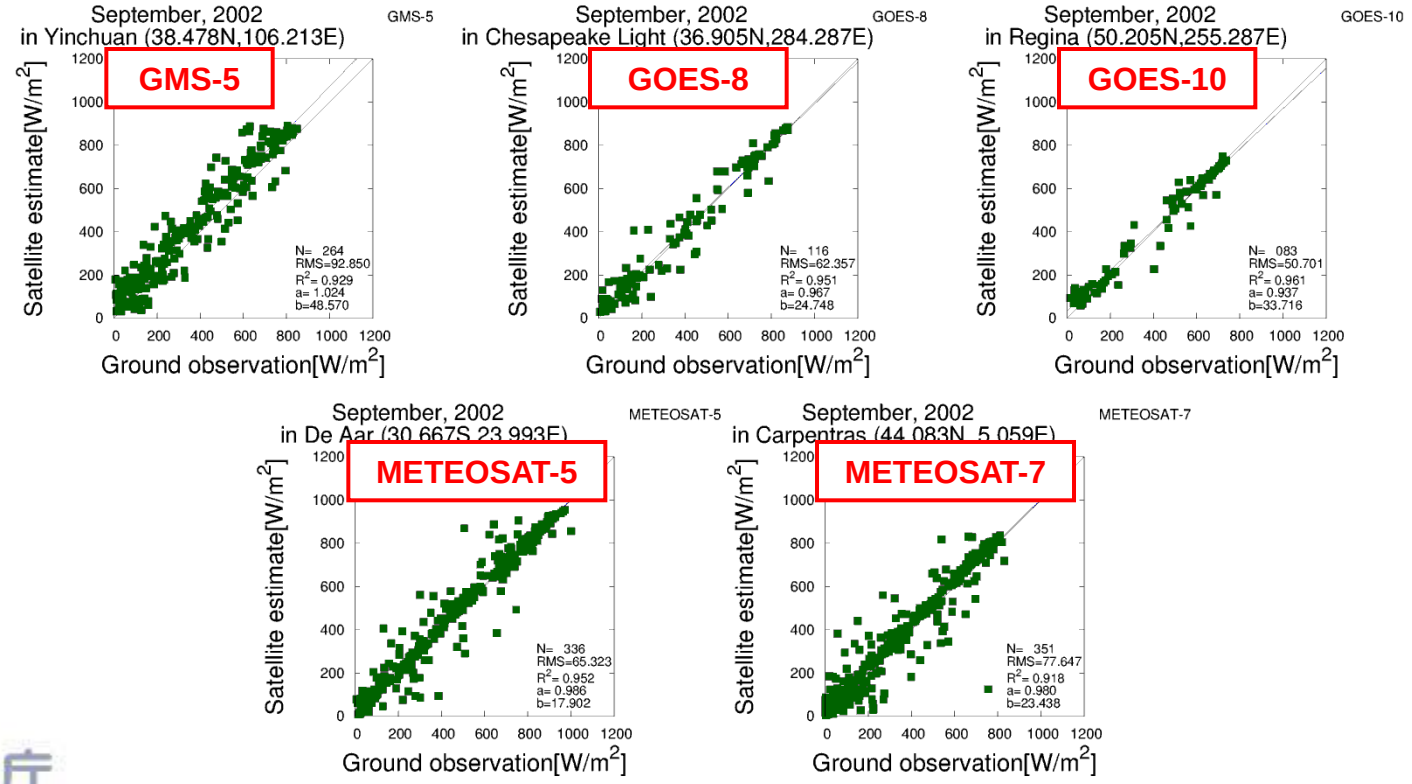


Averaged Downward SW flux at ground surface

EXAM SYSTEM [Takenaka et al., 2011, JGR-atmosphere]

Validation

- Comparison with BSRN and SKYNET
  - The composite solar flux is compared with ground observation, BSRN and SKYNET to evaluate the calibration technique.
  - Following figures show good consistency between the retrieved and observed solar fluxes.



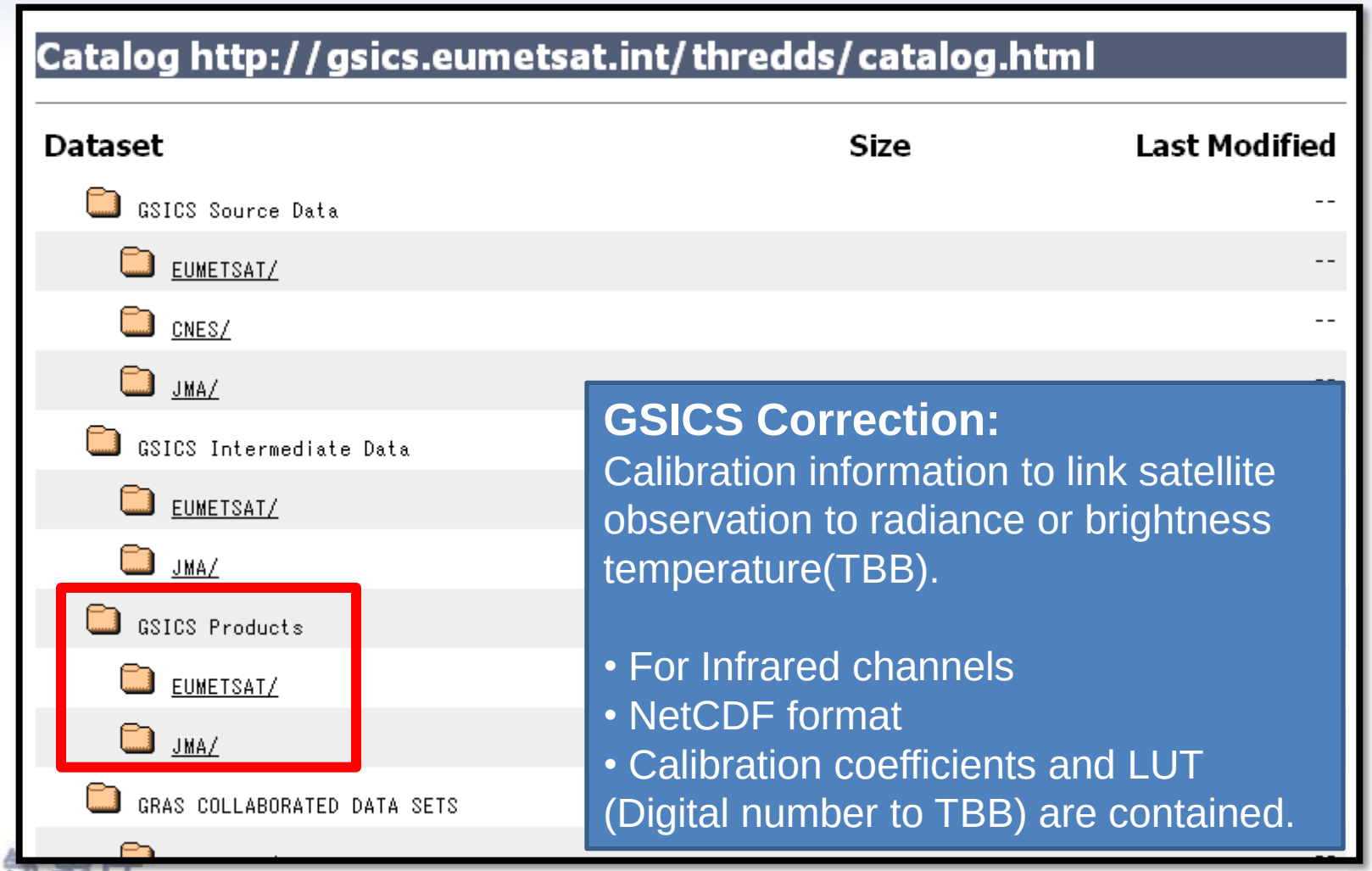
EXAM SYSTEM [Takenaka et al., 2011, JGR-atmosphere]

3. How to reach the GSICS outcomes

1. Calibration for infrared channel
2. Calibration for visible channel
3. How to reach the GSICS outcomes

GSICS portal and Wiki

How to get GSICS Correction



GSICS Correction:
Calibration information to link satellite observation to radiance or brightness temperature(TBB).

- For Infrared channels
- NetCDF format
- Calibration coefficients and LUT (Digital number to TBB) are contained.

Summary

- Infrared channel
  - Inter-calibration has been performed by using hyper-sounder AIRS and IASI observations.
  - Calibration monitoring page and calibration dataset are available on JMA/MSC Web site and GSICS data server, respectively.
- Visible channel
  - JMA/MSC has developed a vicarious calibration approach using a radiative transfer model with collaborative researches with the AORI and the CEReS.
  - Calibration monitoring is available on JMA/MSC Web site.
- How to reach the GSICS outcomes

Thank you !