eCARE Workshop
June 2009

Current Status of eCARE Science Studies in Japan

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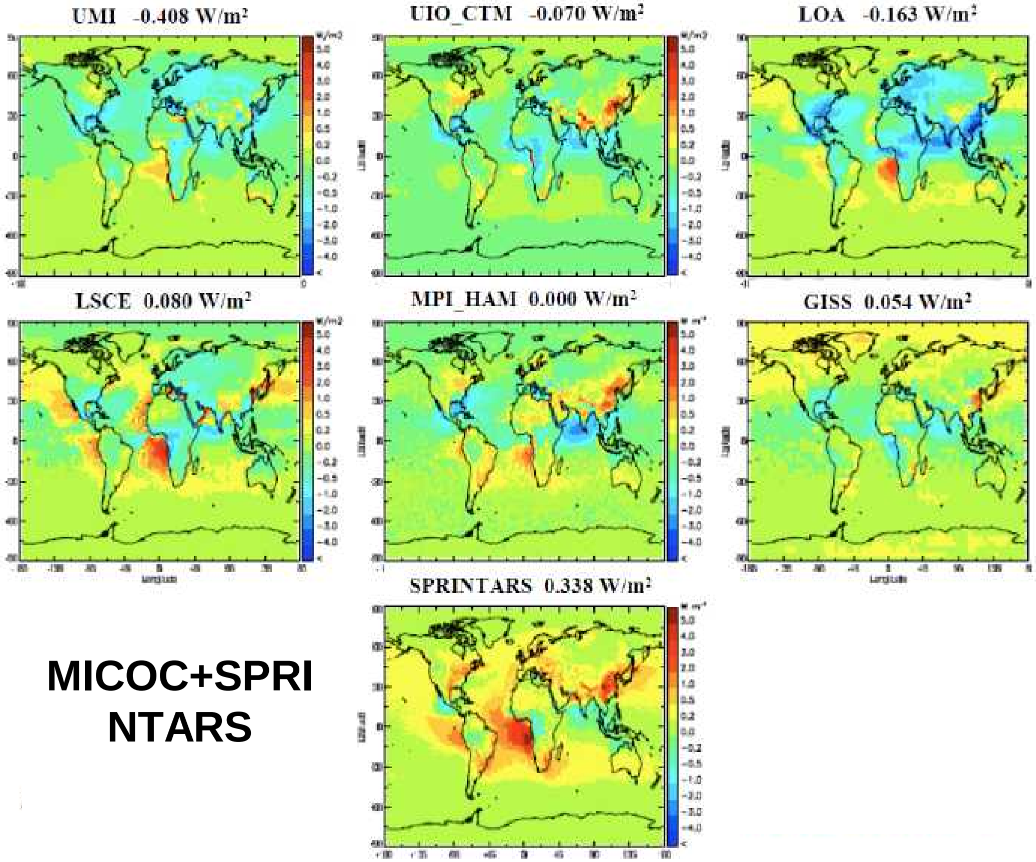
What did we learn about climate effects of aerosols and clouds?

- Cloud forcing for doubling CO_2 has a large model dependence: Warming (TAR) vs cooling (AR4) (some related with aerosol CCN modeling)
- Direct, 1st indirect, and other indirect aerosol forcings: Fraction differences
- Problems in aerosol GCM modeling
  - Model AOT < Satellite AOT (AEROCOM, Schulz et al., 2006)
  - Long-range transportation is still weak (AEROCOM)
  - Wet boundary and upper layers; dry in the middle (Okamoto et al., JGR2007)
- Large surface cooling by aerosols
- Large precipitation change (~1mm/day) due to aerosol direct surface cooling
  - Tele-connection between continents and tropics
  - Large future uncertainties due to uncertainty in the future emission scenario

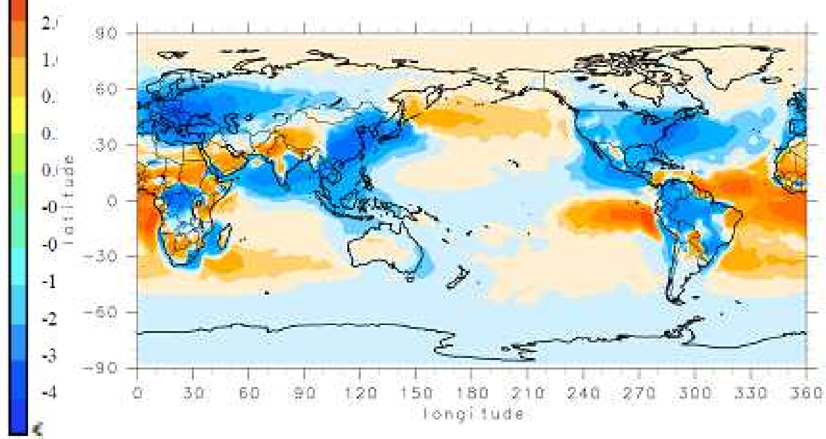
Vertical stratification of aerosol and cloud layers; relation between the two layers

AEROCOM comparison of direct *ARF* at TOA in cloudy sky condition (Schulz et al., 2006)



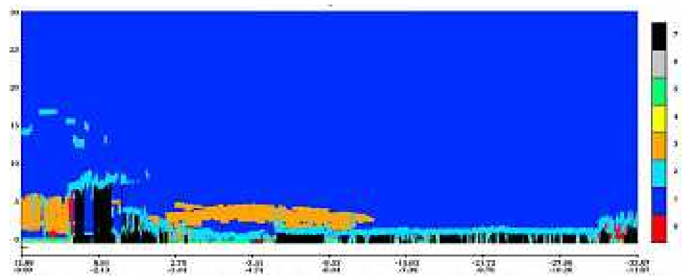
MICOC+SPRINTARS

Aerosol radiative forcing at TOA (Takemura et al., 2005)



- **Positive *RF* over clouds cancel negative *RF* in clear sky (Clear sky: –0.70 Wm^{-2} vs all sky: –0.04 Wm^{-2}).**
- **But aerosol *RF* over clouds largely depend on models.**
- **MIROC simulates more absorbing aerosols above clouds than other GCMs.**

CALIPSO lidar detection of clouds and aerosols
(E. Oikawa, 2009; Courtesy NASA-CALIPSO team)



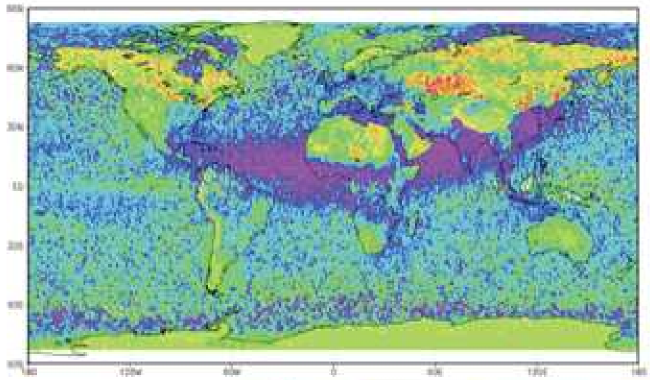
CALIPSO ARF（晴天大気）

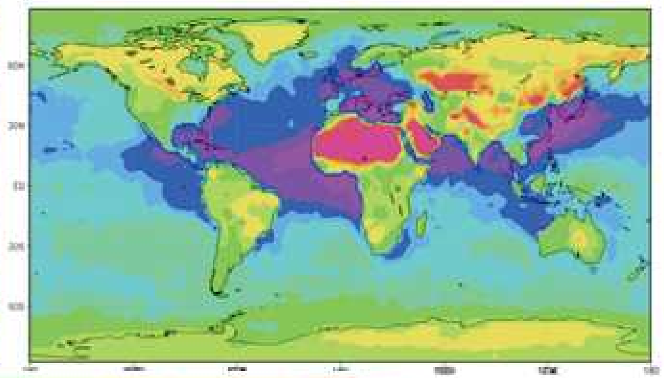
Global -3.64W/m²、Ocean -4.08W/m²

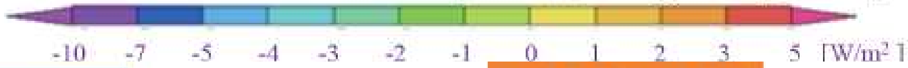
SPRINTARS ARF（晴天大気）

全球平均：-2.56W/m²、海上：-3.77W/m²

Clear sky



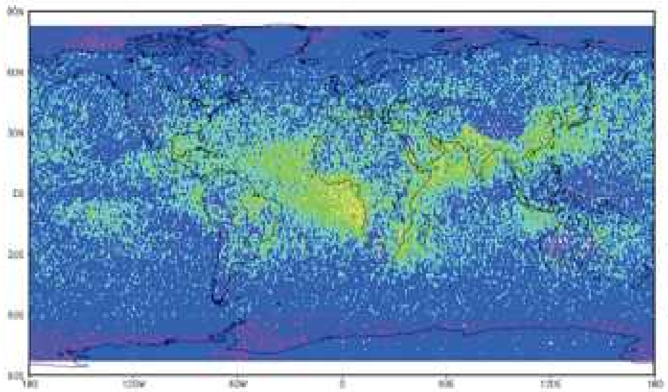


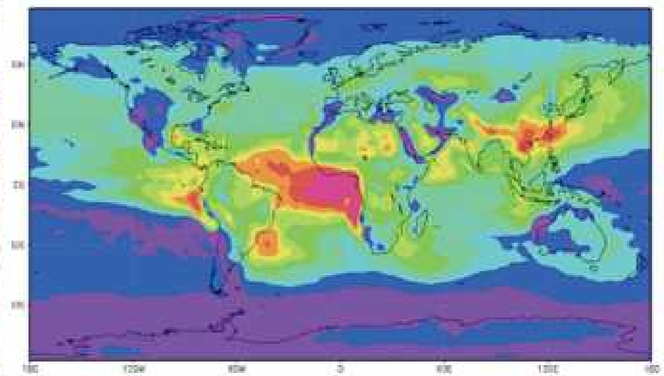


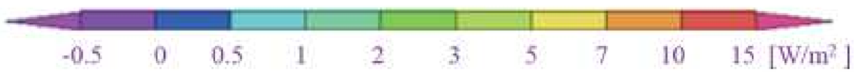
CALIPSO ARF +0.57 W/m²

SPRINTARS ARF +1.33 W/m²

Overcast



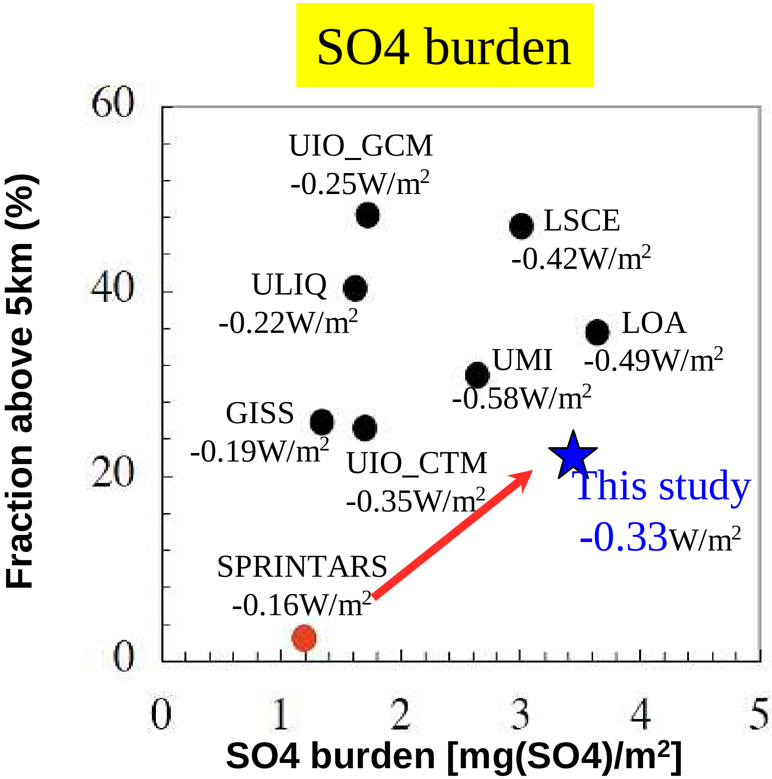


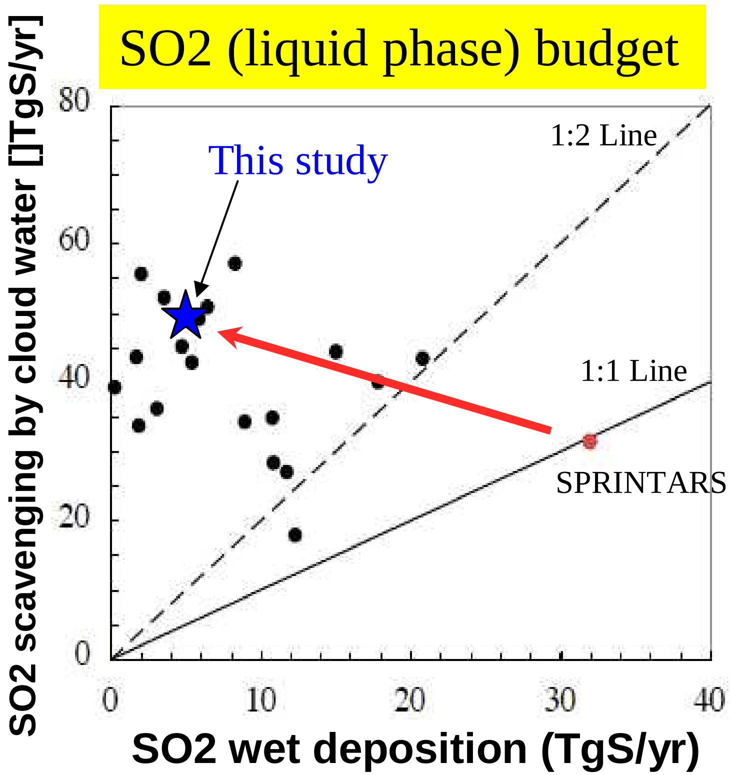


Some updates in SPRITARS sulfate process

D. Goto (2009)

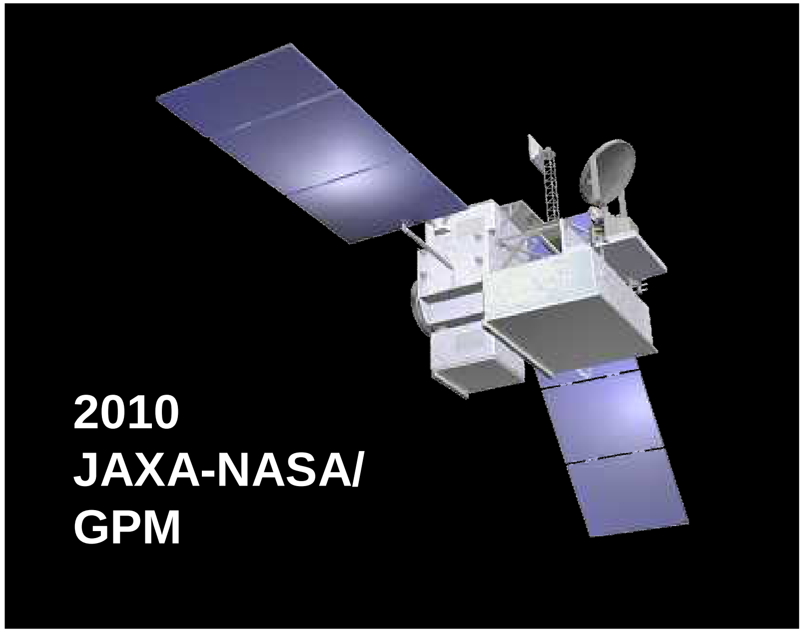
S[1]	N[2]	ADE (W/m^2)
New	New	**-0.62($SO_4+NH_4+NO_3$)**
New	-	**-0.33(SO_4)**
Standard	-	**-0.23(SO_4)**
IPCC-AR4		-0.5($SO_4+NH_4+NO_3$)
AeroCom[3]		-0.35(SO_4)

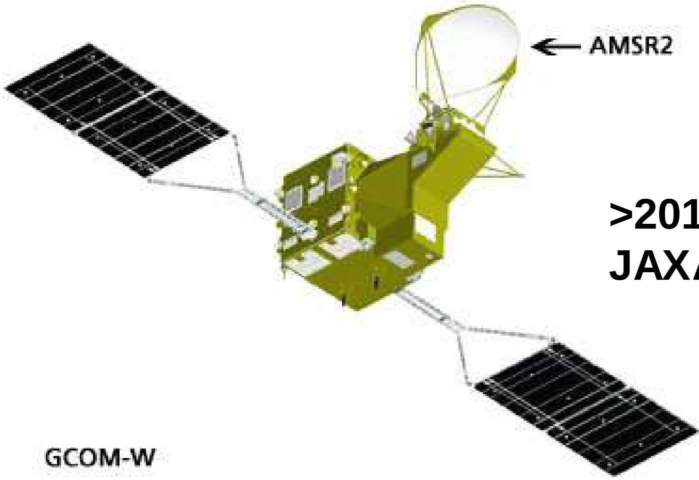




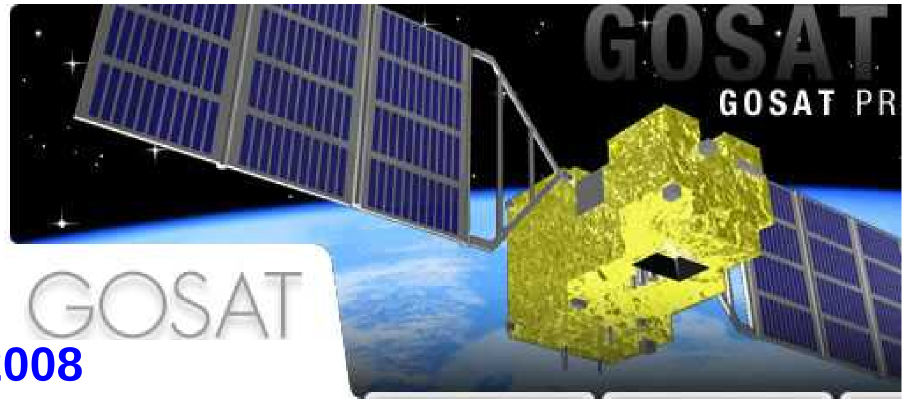
Using Schulz et al. (2006) and Textor et al. (2007)

Next-generation precipitation, cloud and aerosol measurement satellites: Imager, active, and spectrometer

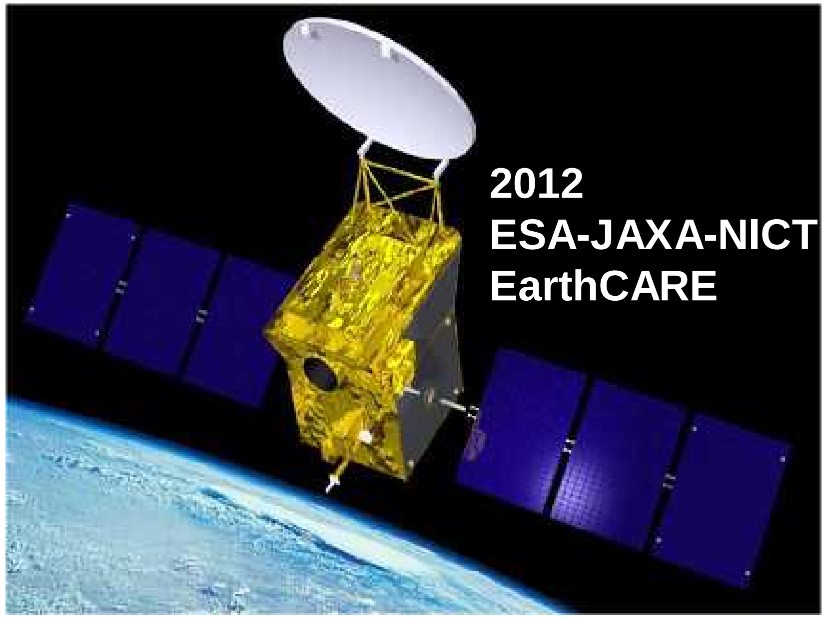




>2010
JAXA/GCOM-W & C



2008
MOE-JAXA/GOSAT



Japanese contribution

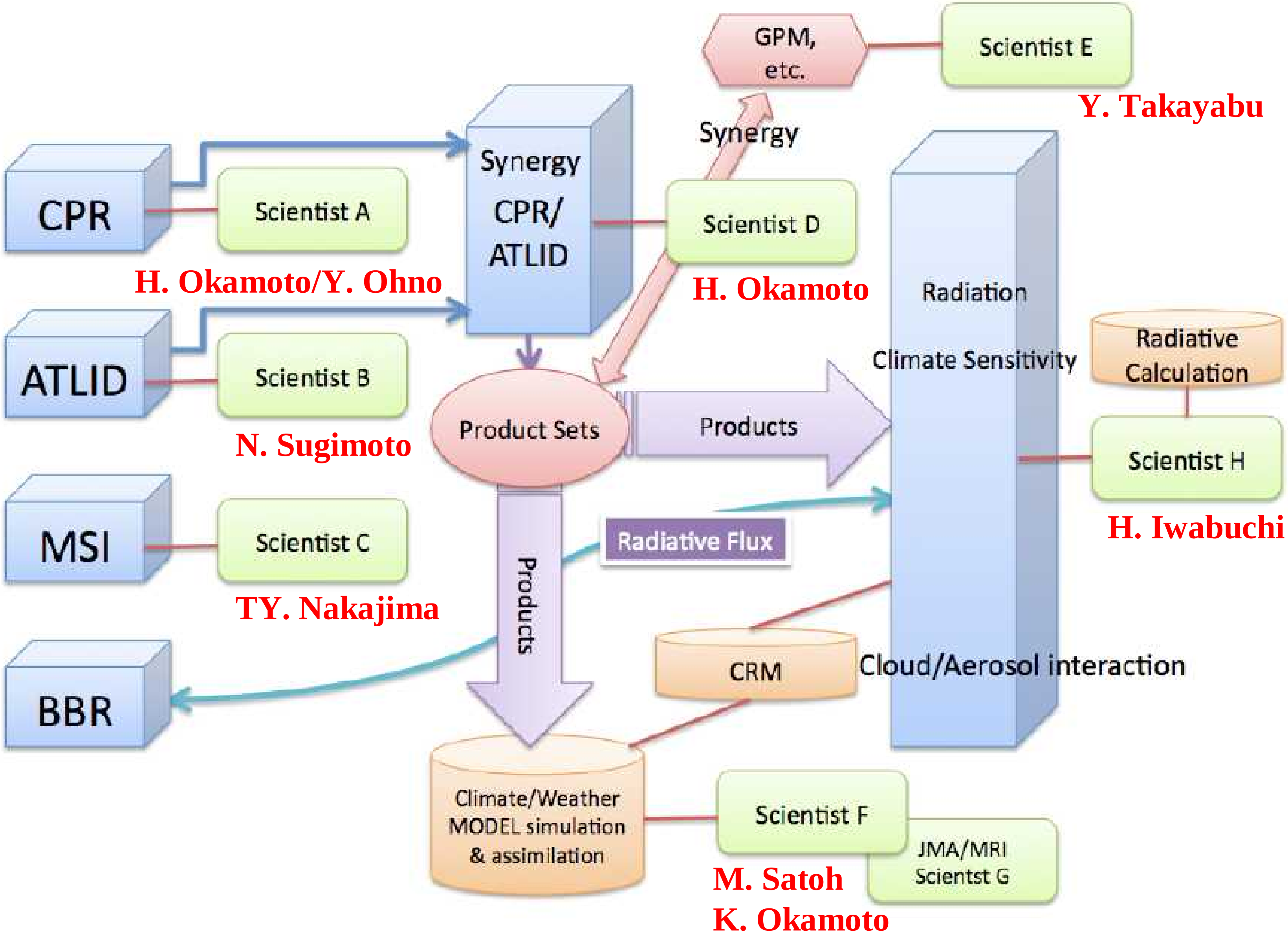


Figure 1. Structure of research activities in the Japanese Science Plan

Remote sensing products

Horizontal aerosol properties

MSI: AOTocean, ANGocean, AOTland

Horizontal cloud properties

MSI: FlagC, COT, CDR16, CDR21, CTT, CTH
MSI+CPR+ATLID: FlagC, COT

Horizontal rain properties

MSI+Active?

Vertical properties (aerosol)

Multi aerosols?

ATLID: Caero, EXT(ws, dust, ssalt, bc)
ATLID+MSI: EXT(ws, dust, ssalt, bc),
ER(ws, dust, ssalt, bc)

Need high resolution!

Vertical properties (cloud)

ESA+Japan!

Vertical properties (rain)

CPR: Zinteg, DV, Zcorrect, DVcorrect, Zmulti;
A{Type, ER(liquid, ice),
WC(liquid, ice, rain, snow) (Ze/Ze-Vd)}
CPR+ATLID: **A**; **B**{RR, RRsnow, Vair}
CPR+ATLID+MSI: **A**; **B**; LWP, IWP
ATLID: Type, **C**{EXT, BACK, LDR,DPOL}cloud

IPA
+diffusion correc.
3D simple
3D iteration

Make sure at least one path has to be secured

Scene generator

J-EarthCARE simulator

ECSIM

10 W/m2

Flux profile/Heating rate profile

Comparison of sensitivity factors of low-level cloud parameters (*CDR* and *LWP*) vs aerosol number *Na* (Nakajima and Schulz, 2009)

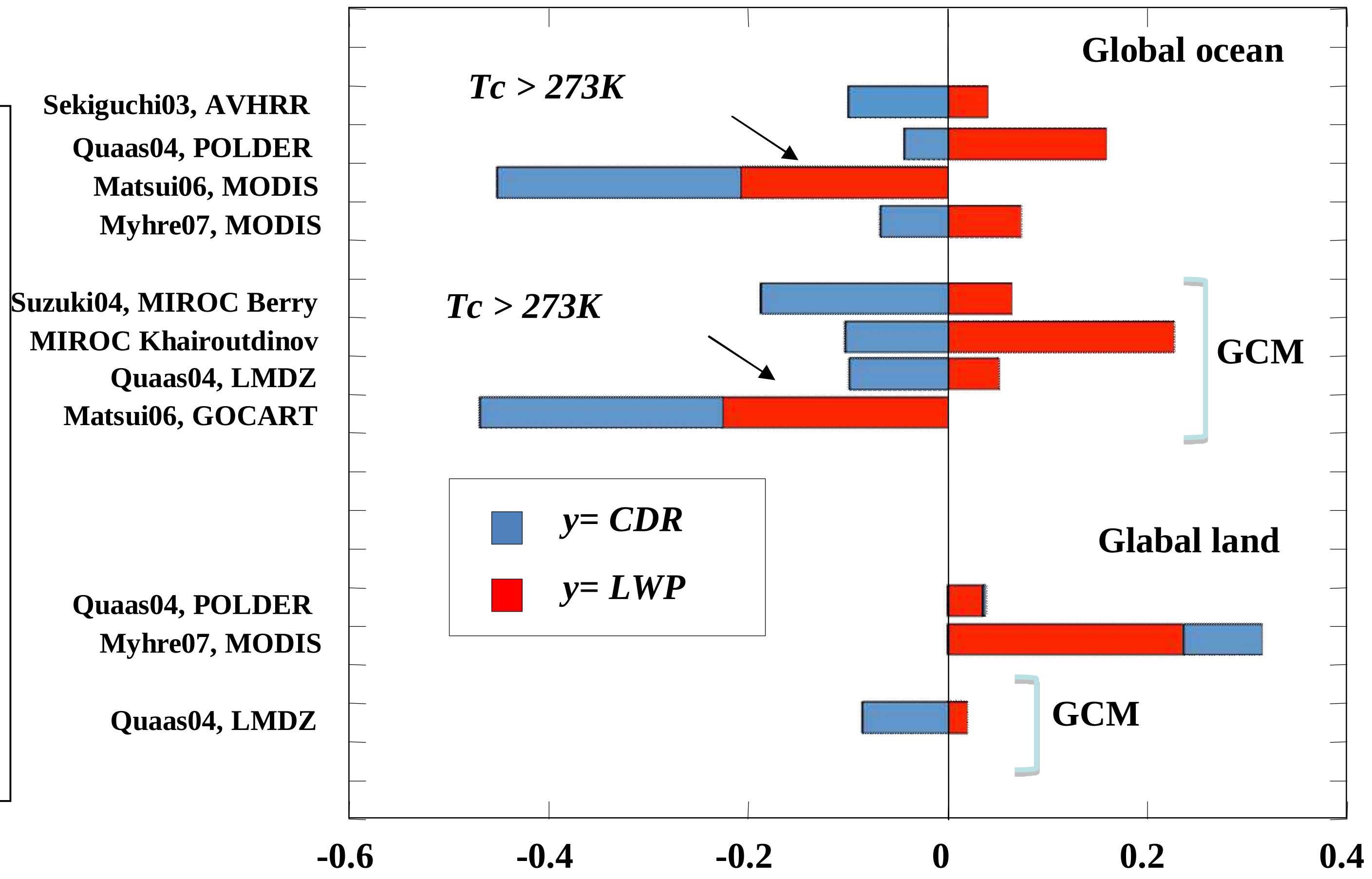
COT: Cloud optical thickness
CDR: Effective cloud droplet radius
LWP:Cloud liquid water path

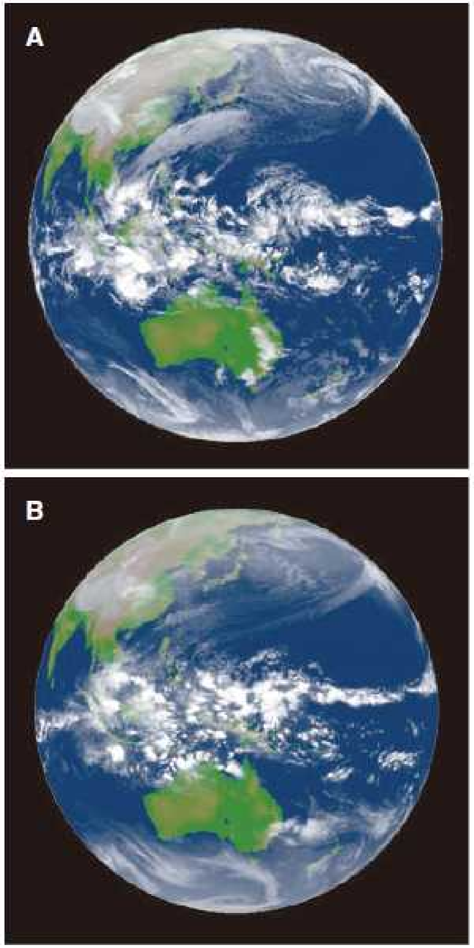
$$CDR = \frac{3LWP}{2\rho_w COT}, \quad b(y) = \frac{dy}{d\log N_a}$$

$$b(\log LWP) = b(\log COT) + b(\log CDR)$$

Sensitivity of cloud parameters to aerosol number vary depending on studies:

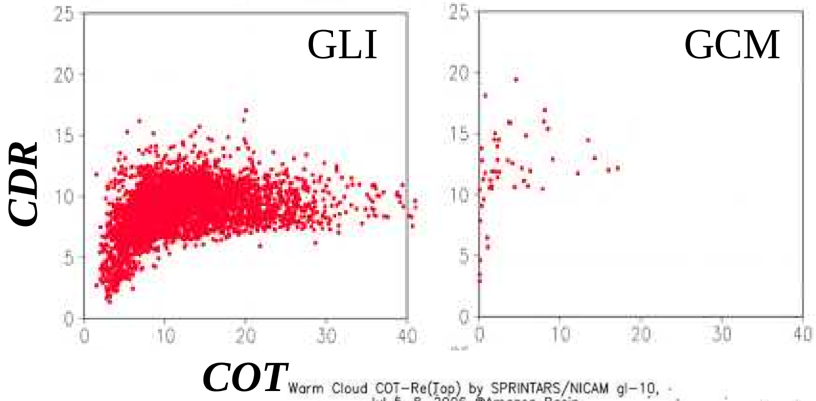
- **Good agreement over ocean between satellite and GCMs.**
- **Very warm clouds have negative *LWP* sensitivity (Matsui06).**
- **Difficult to simulate the positive CDR sensitivity (anti-Twomey effect) over land.**



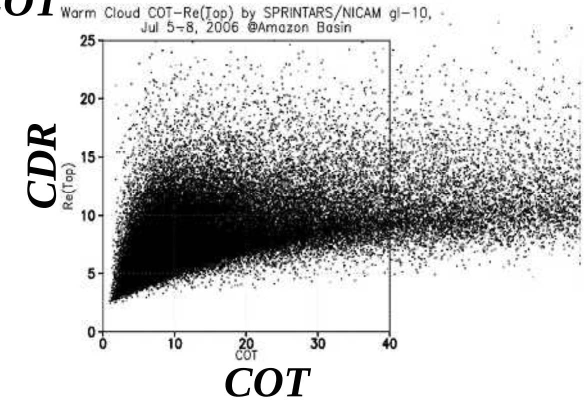


Relation of CDR vs cloud optical thickness (COT) by MIROC-GCM, NICAM, and ADEOS-II/GLI satellite (Suzuki and Stephens, 2008)

Low clouds

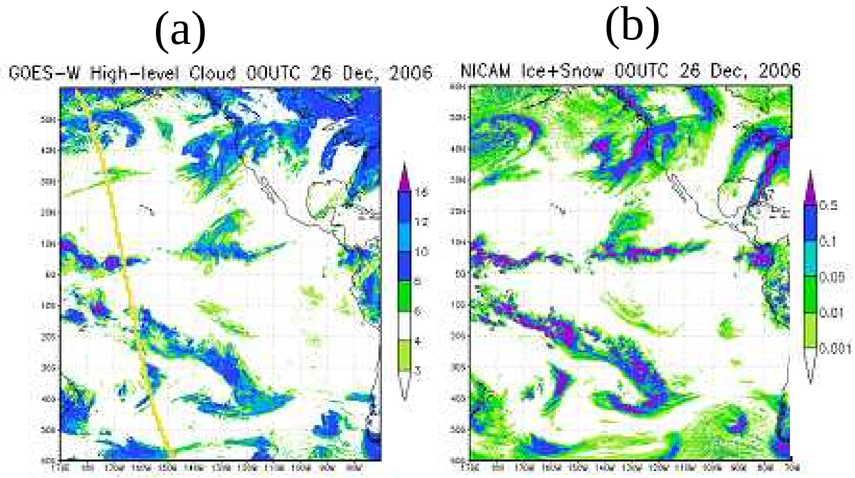


NICAM 7km
Amazon basin

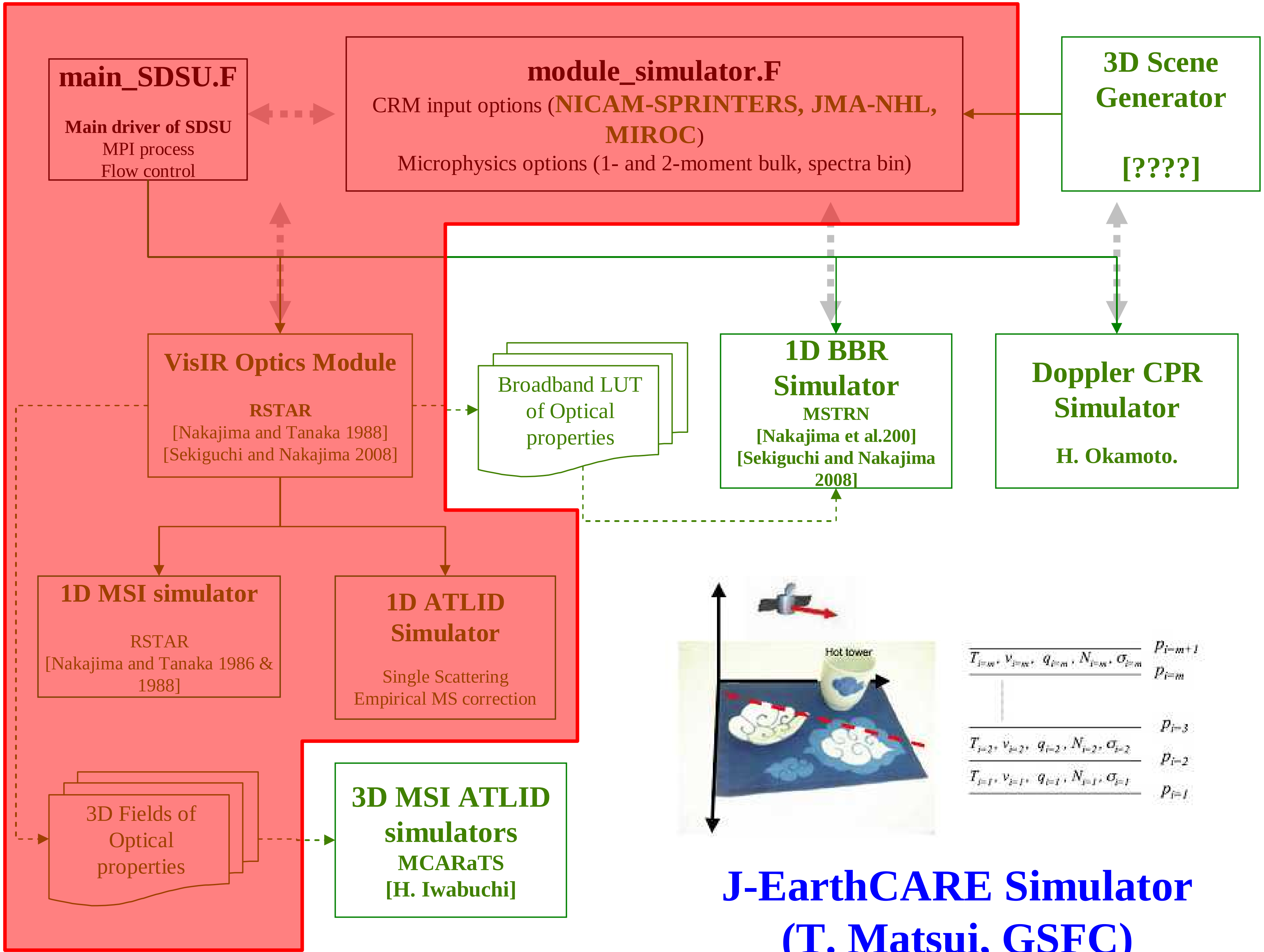


MJO Simulation by NICAM 3.5km model (B)
vs (A) MTSAT-1R satellite OLR (31 Dec 2006)
(Miura et al., 2007).

High clouds



Comparison of upper cloud ice and snow simulation by NICAM (b) vs GOES split window result (a) (Inoue et al., 2009).



J-EarthCARE Simulator (T. Matsui, GSFC)

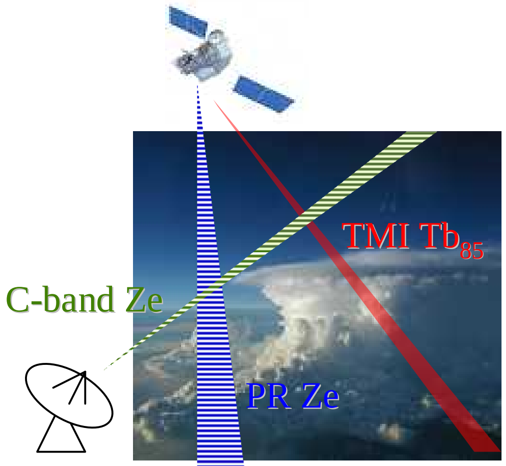
Radiance-Based Model Evaluation

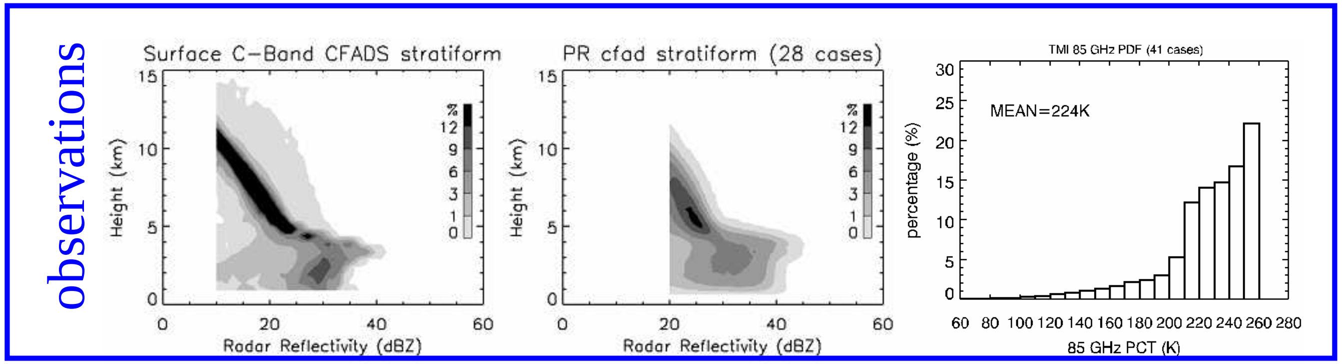
Model: 2D Goddard Cumulus Ensemble (GCE) model with Spectra-bin Microphysics

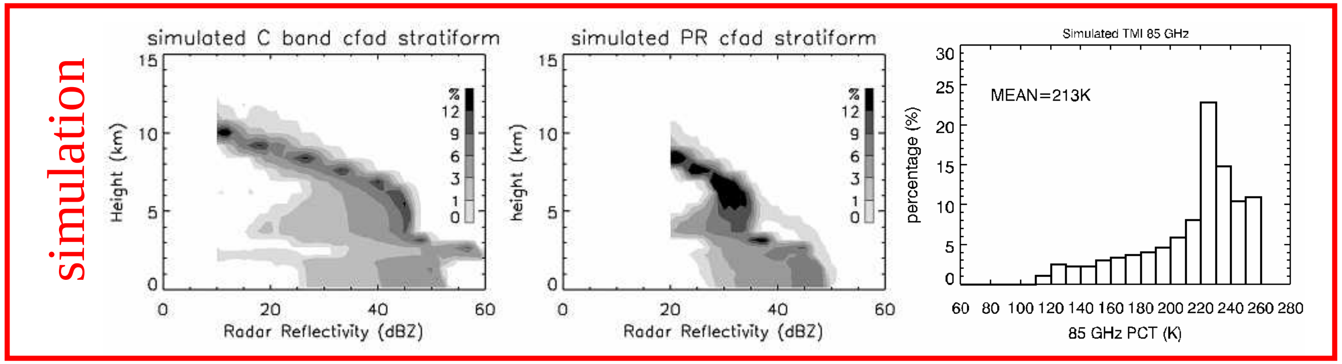
Simulation: Continental MCS case using PRESTORM sounding

Observations: Ground-based C-band radar & TRMM PR (14GHz) and TMI Tb (85GHz)

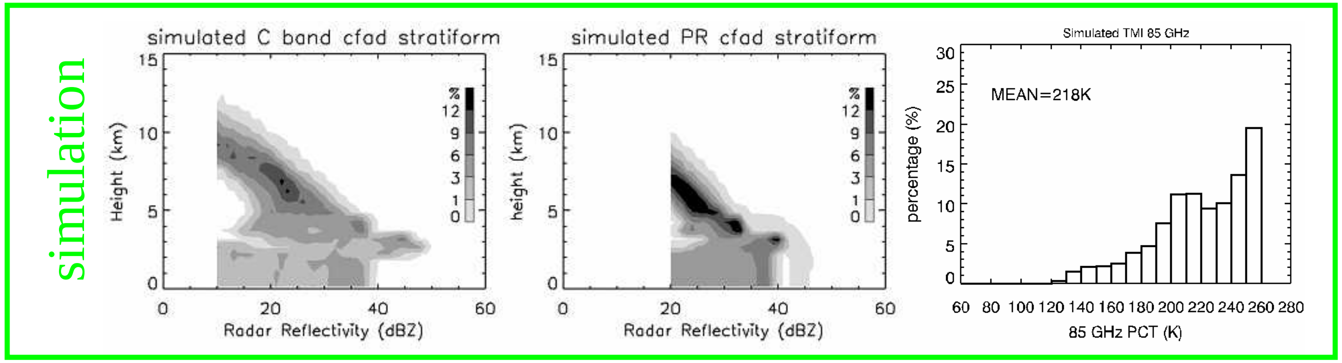
Goal: Evaluate and improve simulation using satellite simulators.







6 months later…



T. Matsui, GSFC

Reference

From Li et al. (2009)

Some estimates for CDR sensitivity for NICAM model (Suzuki et al., 2008)

$$\frac{\partial \log_{10} r_e}{\partial \log_{10} AI} \approx -0.176 \quad \Rightarrow \quad \frac{\partial \ln r_e}{\partial \ln N_a} \approx -0.153$$

Low clouds

$N_a \propto (AI)^{0.87}$ ~ -0.138 (AVHRR, Nakajima et al., 2001)

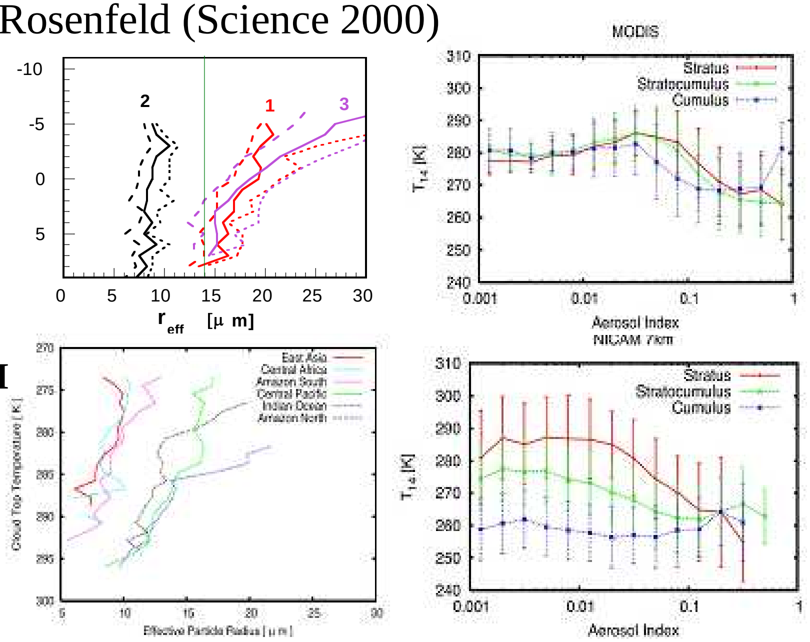
(Nakajima et al., 2001) ~ -0.097 (POLDER, Breon et al., 2002)

Rosenfeld (Science 2000)

AVHRR

T14

NICAM

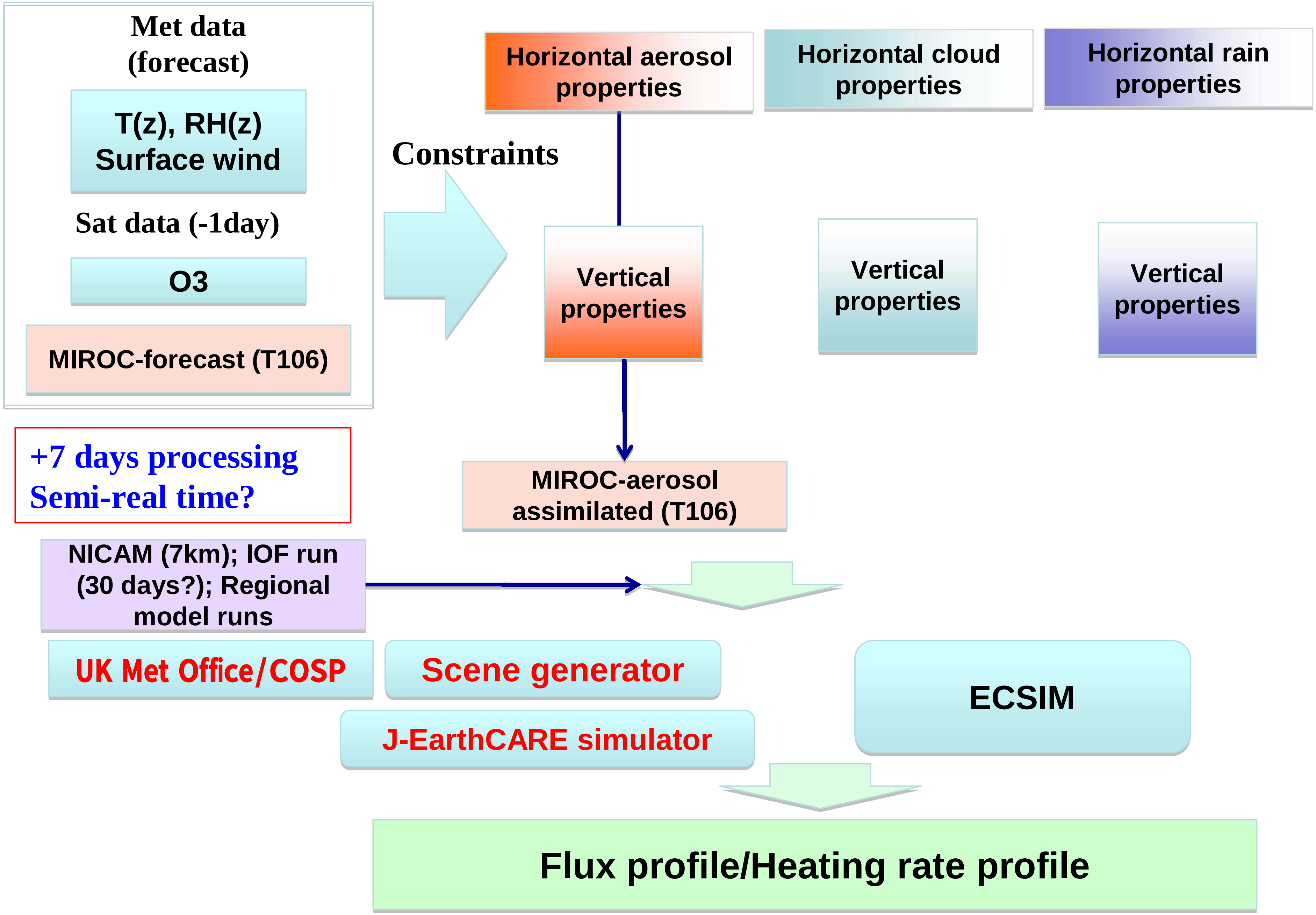


Cloud temperature at *CDR*= 14 micron (T14, Rosenfeld, 2000) vs CDR and Aerosol index (*AI*) relation by AVHRR and NICAM (Suzuki et al., 2008).

High resolution modeling is giving new aerosol-cloud interaction simulation results

- **Cloud amounts for all types OK**
- **Microphysics for stratus OK**
- **Positive correlation of *CDR-AI* for convective clouds, but not enough by NICAM**
- **Discrepancy in absolute values**

Ancillary and model products



Japanese contribution to eCARE mission

- Japanese community of remote sensing
  - Passive remote sensing (ADEOS/OCTS, ADEOS-II/GLI, GOSAT; TRMM, GPM etc)
  - Active remote sensing (NIES lidar system, MIRAI lidar and 94GHz radar system etc)
  - SKYNET surface network for GEOSS
  - Capacity building needed
- Japanese community of modeling
  - CCSR-NIES-FRCGC/MIROC GCM
  - FRCGC-CCSR/NICAM
  - ES and Peta-flops machine (2012)
- JAXA needs an open system based on a RA
  - Core science activities have to be defined for internal review
  - Have a responsibility to build L2 and L3 products
  - Task share with JADE, ESA/CASPER is subject for discussion; Optimal task share should be made