Plan for the GLI-Atmosphere sciences (GLI-ATOMOS)

GLI-Atmosphere PI Group

Ver 5.0
(Nov. 2001)

Some issues from GLI2001 WS (1)

- **Algorithm development: on track**
  - **4 day minimum radiances**
  - **L1B analysis flow**
- **Data transfer from EOC to EORC**
  - **All L1B to EORC**
  - **4 day minimum radiances**
  - **Atmospheric L2A-segment**
- **L2A should be browsed**
- **Rstar5b problem: refractive index of water: set water refractive index**
- **EORC access for algorithm and validation studies**
  - **L1B, L2A, and L2 access by Pis; L2 system distribution: Fukushima**
  - **L2 algorithm distribution: not many (Mukai)**
- **EORC should support grass-roots activities by scientists for supporting GLI mission**
  - **EORC should have better computer environment for research**
  - **The present security system produces difficulties in data transfer to EORC**

Some issues from GLI2001 WS (2)

- GLI+POLDER
  - OCTS GAC + POLDER data set distribution to users?
    - 1-10 April 1997: All sensor data
    - All period data of OCTS GAC: GAIT to Mukai: POLDER users, Ackerman
  - More people should study the combined algorithm
- GLI+AMSR
  - Drizzle detection algorithm
  - Ice detection algorithm
- How to solve the Chinese data delay:
  - Net transfer only at Hefei
  - Takamura will make effort, but no quick solution so far

Some issues from GLI2001 WS (3)

- **APEX & ACE-Asia have served as good integration mechanism**
  - **Next plan for IFO: 2003? (APEX-E3 experiment, East China Sea)**
  - **ADEC: Nakajima to Mikami**
  - **Any other campaign in 2003?**
    - **AQUA validation flight (later Summer to Autumn launch)**
    - **ENVISAT validation: (Jan 2002)?**
    - **Kasahara project (Hatakeyama will have aircraft measurements in China)** Instrumentation
  - **I-skyradiometer, shipborne flux measurements, Lidar, CPR,**
  - **PAR: ask LAND**
  - **Flux vs radiance: no issue; spectral: issue**
  - **Chinese GPS: who has data?**
  - **Microwave radiometer at Hefei**
  - **Regular sonde measurements by weather organizations are important**

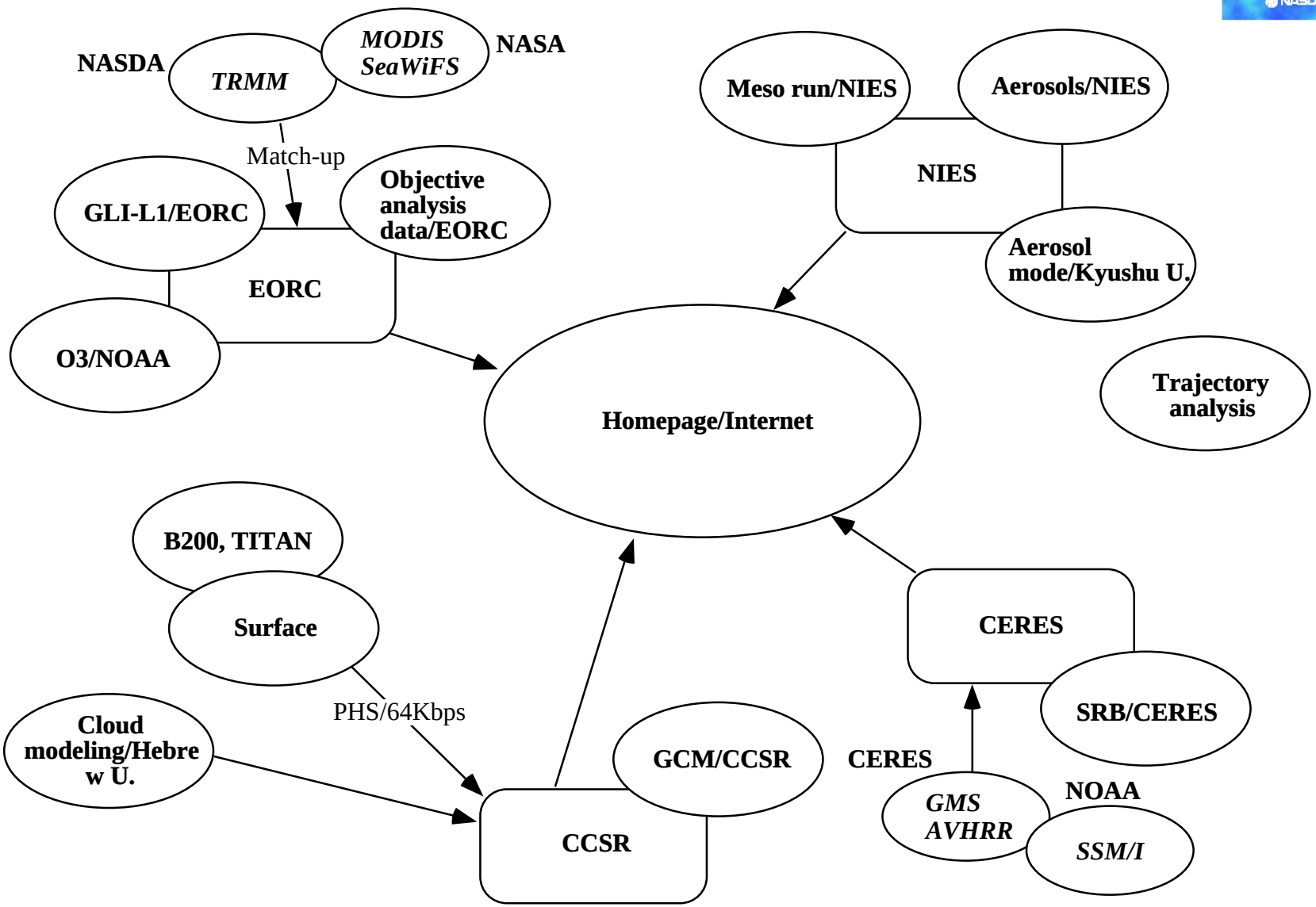
Some issues from GLI2001 WS (4)

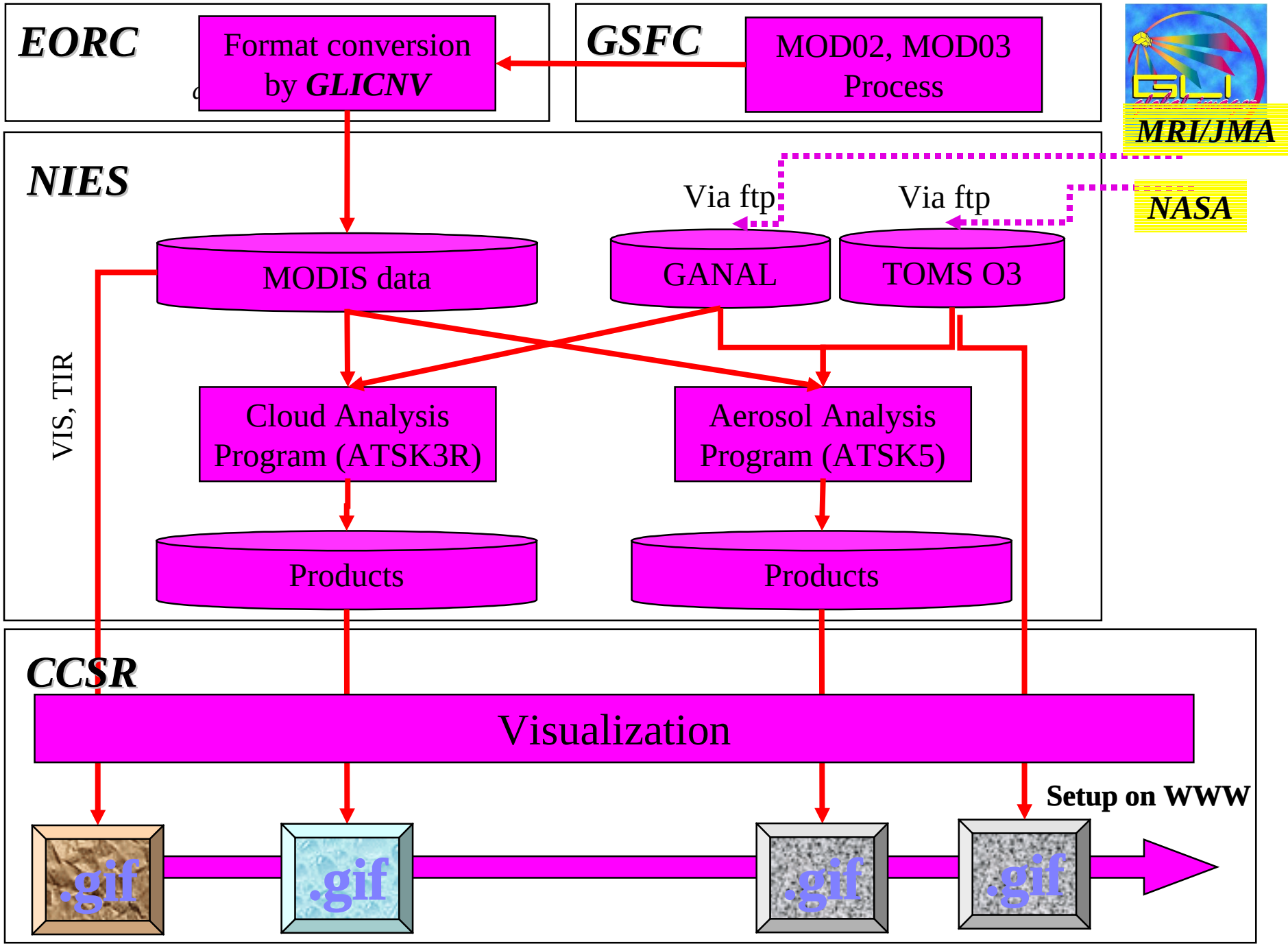
- **Establish a mechanism to transfer validation data from foreign participants**
  - **Automatic data transfer: Coordinator: Nobuhiro KIKUCHI (kikuchi@eorc.nasda.go.jp)**
  - **ARM site: Tom Ackerman through Roger Marchand(Pacific Northwest National Laboratory)**
  - **Pinker**
  - **Kasahara: Letter from Nakajima**
  - **Cheju (Korea): Nakajima wrote a letter**
  - **Vietnam: need scientist interested**
- **Discuss with land and ocean group for coordination of L-up and L-dwn measurements**
  - **Map of validation sites**
  - **Land site has continuous L-up measurements?**
  - **Ishigaki Island, Ariake Ferry, Mirai R/V**
  - **MOBY+AERONET**

Some issues from GLI2001 WS (5)

- **Bright target vicarious calibration**
  - **Visible and NIR calibration**
  - **Snow surface: L-dwn to help LAND and CRYO, what sites with skyradiometer?**
- **Cloud:Ask a help from foreign groups**
  - **MODIS: MAS: write to King**
  - **NASDA NEED aircraft capability of calibration**
  - **POLDER team?: Isaka, Mukai to Nakajima**
    - **Cirrus characterization campaign: Airborne POLDER, Polar nephelometer, Cloud particle imager**

APEX IFO operation system




EORC
Format conversion by GLICNV
GSFC
MOD02, MOD03 Process
MRI/JMA
NASA
NIES
Via ftp
Via ftp
MODIS data
GANAL
TOMS O3
VIS, TIR
Cloud Analysis Program (ATSK3R)
Aerosol Analysis Program (ATSK5)
Products
Products
CCSR
Visualization
Setup on WWW
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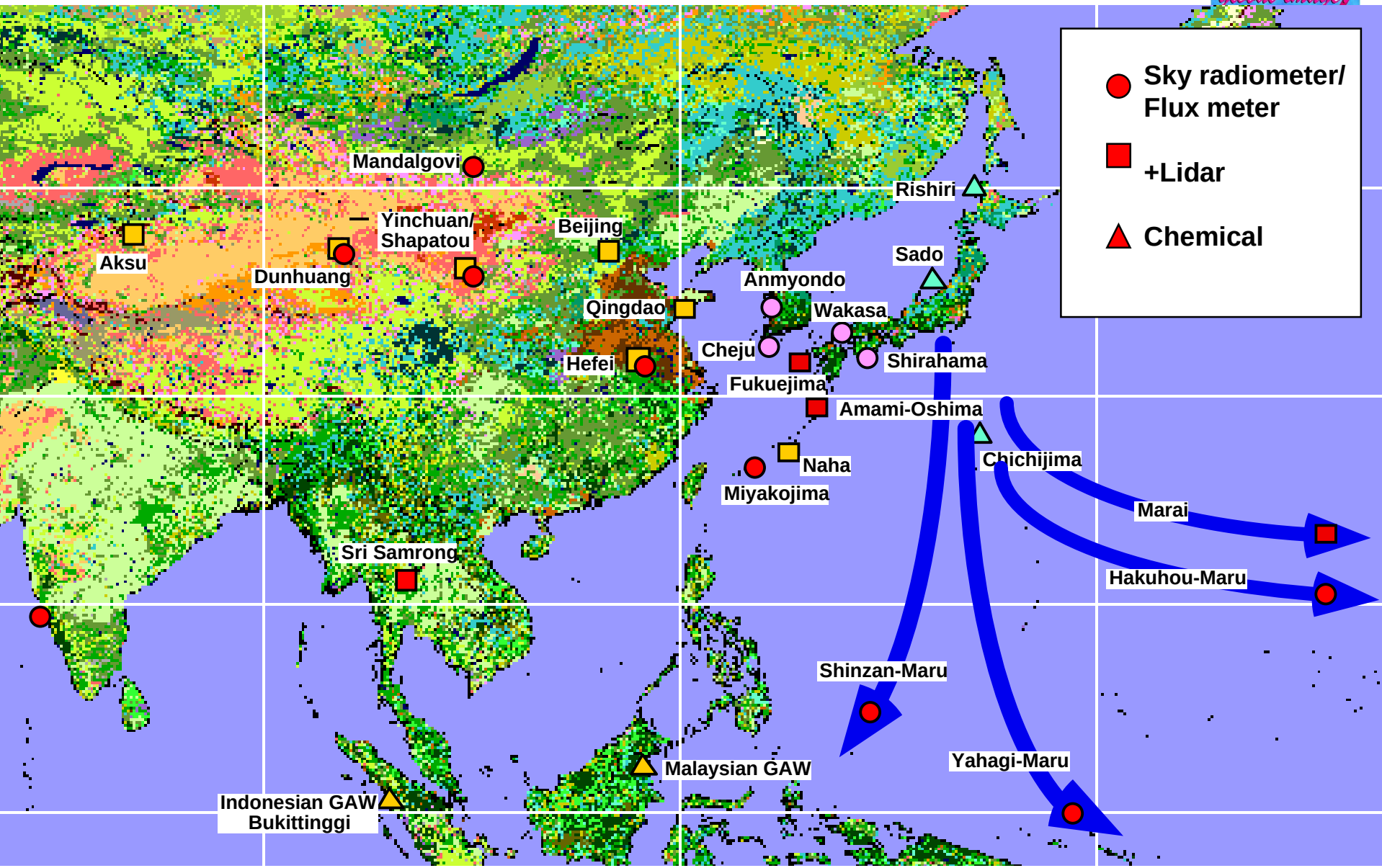
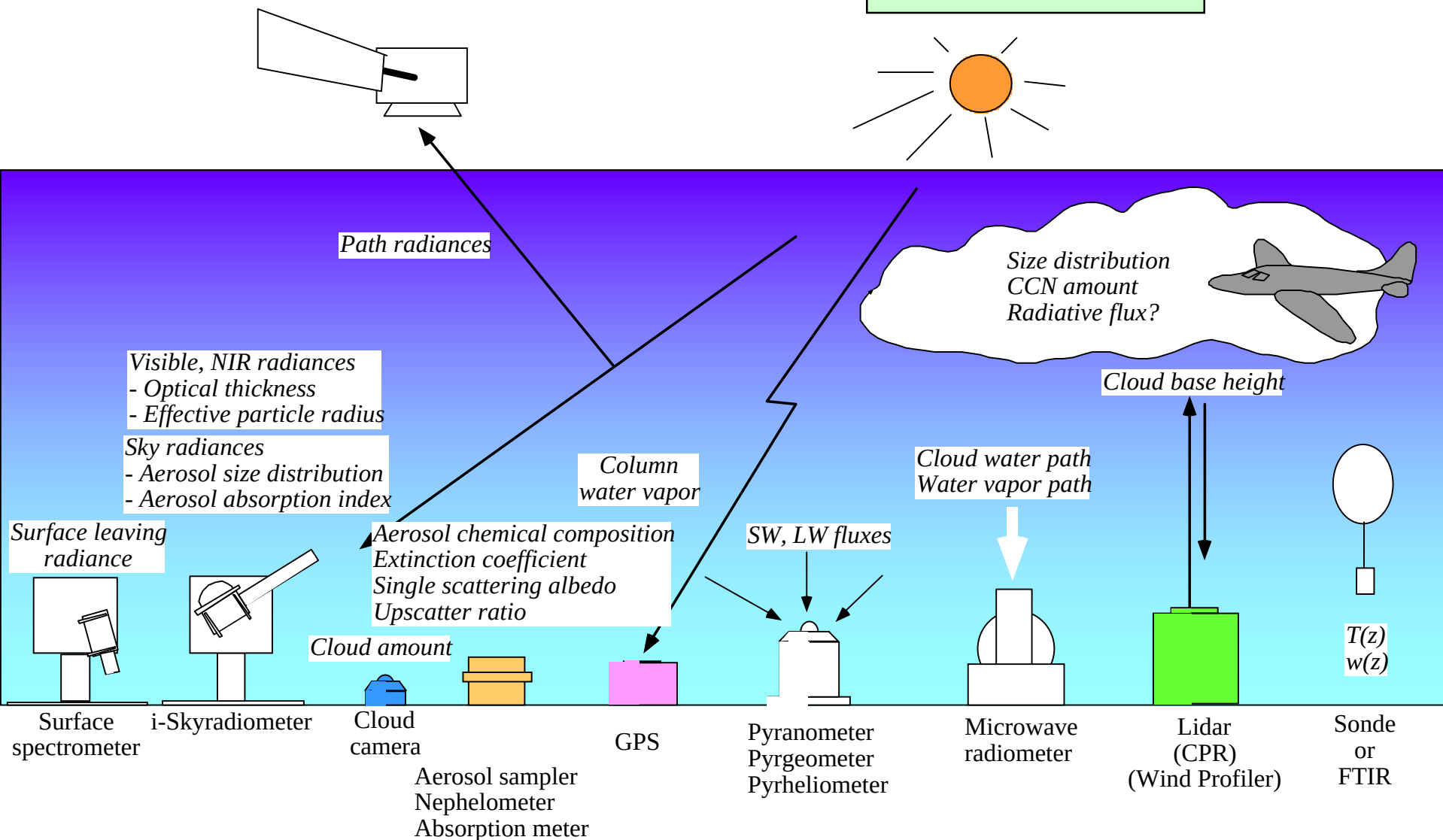
Sites for radiation studies



GLI-ATMOS instrumentation

- Radiative fluxes
- Sky radiance
- Characterization
- Satellite upscale



Strategy of GLI-ATMOS

- Continuous measurements on surface and ship
- Instrumentation for simultaneous validation and vicarious calibration
- Surface radiative budget validation is our final goal for the GLI atmosphere remote sensing

Table 1: Quantities for validation/vicarious calibration

Quantity	Level	Accuracy	Methods	Note
CLFR	S3	5% (large scale)	Surface observation, lidar, GEO, camera	
CLOP	S1	10%	Aircraft, i-skyradiometer POLDER, MODIS, AVHRR	
CLWT	S2	20%	Aircraft, MCWR AMSR, SSM/I	
CLRE	S1	20%	Aircraft, i-skyradiometer +MCWR, CPR+lidar MODIS, AVHRR	
CLTTP	S2	0.5K	Sonde, aircraft	
CLTP	S2	2%	Sonde, aircraft, lidar, CPR	
CLBP	R	20%	Sonde, aircraft, lidar, CPR	
WTVA	R	0.2g/cm2	Sonde, GPS, Sunphotometer AMSR, SSM/I	
AROP	S1	10%	Sky radiometer/sunphotometer POLDER, MODIS, AVHRR	
FSSRF	R	10W/m2	BSRN, GLI-ATMOS, ARM	(**)
FSTOA	R	10W/m2	CERES	(**)
FLTOA	R	10W/m2	CERES	(**)
PRCP	R	factor 2	Radar, CPR, PR, aircraft	warm precipitation
SKR	V	3%	Sky radiometer	vicarious calibration
SLVR	V	3%	Surface-spectrometer	vicarious calibration

SKR: sky radiance; SLVR: surface leaving radiance; CLFR: cloud reflection radiance

(**) monthly regression of instantaneous, 1km data

Table 2 Instruments important for GLI-ATMOS

Prty	Instrument	Quantities for validation (see Table 3)
1	i-Sky radiometer	SKYR, AROP; CLOP, CLRE, CLWT, WTVA ARSZD, ARSSA
1	SW, LW fluxmeter	FSSRFD, FLSRFD; FSSRFU, FLSRFU
1	Pyrheliometer	FSSRF, AROP, WTVA
1	Aerosol samplers	aerosol chemical characterization, support for aerosol retrievals
1	Aethalometer	ARSSA, support for aerosol retrievals
1	Total nephelometer	aerosol extinction coefficient, support for aerosol retrievals, backscattering fraction, 4 wavelengths
1	Sky camera	CLFR (total)
2	Microwave radiometer	CLWT, WTVA
2	GPS	WTVA
2	Lidar	CLBH, ARLH
2	Surface spectrometer	SLVR (Collaboration with LAND/OCEAN)
3	Cloud profiling radar	CLTH, CLBH, CLRE with lidar
3	FTIR	IR surface radiation budget

Shipborne data: after one month, no flux data (<- make effort to obtain)

Table 3: Abbreviation list for measured quantities

Symbol	Quantities
CLFR	Cloud fraction (Total from ground; several height categories from satellite)
CLOP	Cloud optical thickness (Total from ground; several height categories from satellite)
CLWT	Cloud liquid water path (about equal to 2*CLOP*CLRE/3)
CLRE	Effective cloud particle radius
CLTTP	Cloud top temperature
CLTP	Cloud top pressure
CLTH	Cloud top height
CLBP	Cloud bottom pressure
CLBH	Cloud bottom height
WTVA	Column water vapor amount
AROP	Aerosol optical thickness
ARLH	Aerosol layer height
ARSZD	Aerosol size distribution
ARSSA	Aerosol single scattering albedo
FSSRF	Surface shortwave radiative flux (Suffix: D for downward, U for upward)
FLSRF	Surface longwave radiative flux (Suffix: D for downward, U for upward)
FSTOA	Shortwave radiative flux at the top of atmosphere (TOA)
FLTOA	Longwave radiative flux at TOA
PRCP	Precipitation
SLVR	Surface leaving radiances
CLLVR	cloud leaving radiances

Table 4 Necessary data input for GLI-ATMOS

- GLI, AMSR, POLDER matched radiance images
- AMSR L2 products
  - CLWT, WTVA, Precipitation, SST
- JMA objective analysis data
  - T(p), RH(p), Z(p), Surface pressure, surface wind
- TOMS & TOVS
  - Ozone amount

Aerosol validation

- i-Skyradiometer (under construction)
  - λ= 0.32, 0.36, 0.38, 0.4, 0.5, 0.675, 0.778, 0.862, 0.94, 1.05, 1.6, 2.2 μm
  - *dv/dlnr*, τ_λ, $\omega(a+b\lambda)$
  - Dust: UV absorption and extinction at 1.6μm
  - Biogenic: large UV real refractive index
  - Cloud tau and re
- Total nephelometer+Aethalometer
  - *Surface e*, ω, □□□, □□□□□□□□□□□: *Hefei, Amami, Sri-Samrong*
  - TSI-349?: 3 wavelength nephelomter with *b* (new) : Wakasa, Amami???, data analysis is complicated (no continuous)
- Lidar
  - 2 ch, depolarization
  - *b*(z), τ(z) especially for tropical cirrus rejection
  - Eye safe<deleted>, 24hours
  - Need to be collocate with SKYNET sites
- Aerosol sampling
  - Backup for physical characterization
  - Less frequent but needed: Need support-> How many sites (Amami, Fukue, Miyake)

Cloud validation

- Lidar, camera, (shadow band radiometer, 10%)
  - Cloud amounts
- i-skyradiometer
  - Nadir and solar direction at λ = 1.05, 1.6, 2.2 μm
  - (solar direction for calibration)
  - (τ, r_e) from $L^{\downarrow} = f(\tau, r_e)S$; $L^{\uparrow} = g(\tau, r_e)S$ (simultaneous if possible)
  - Cloud liquid water path $W = 2\, r_e\, \tau\, /\, 3$
- MCR: *W*
  - Issue: ice/water
- i-skyradiometer + MCR
  - N_d (r>50μm) Drizzle particle amount + ice water path
- CPR+Lidar (ARM: 35GHz, detection of 20 μm ice particles)
  - r_e(z)
  - Ice/water if depolarization is measured
  - Cloud layering
  - MIRAI R/V measurements
- Aircraft, sonde

Fluxes and others

- Important for consistency check of L2 products; link to climate problem
  - $SW^{\downarrow\uparrow} = (1-n)F_{SWs}^{\downarrow\uparrow}(\tau_a, \alpha, w) + n\,F_{SWc}^{\downarrow\uparrow}(\tau_c, r_e)$
  - $LW^{\uparrow} = (1-n)F_{LWs}^{\uparrow}(T_G, w) + \Sigma_m n_m F_{LWc}^{\uparrow}(T_{mCT})$
  - $LW^{\downarrow} = \Sigma_m n_m F_{LWc}^{\downarrow}(T_{mCB})$
- Up/down shortwave/longwave flux meters
  - Kipp&Zonen shortwave + Eppley longwave: accurate and stable
  - Diffuse shortwave flux must be measured
  - Calibration program
  - Try to follow BSRN standard
- Water vapor
  - Sunphotometry
  - GPS
  - Sonde

Vicarious calibration

- Clear sky condition
  - $L^{\downarrow} = f(\tau, r_e)S$; $L^{\uparrow} = g(\tau, r_e)S + L_g{}^{\uparrow} T(\tau, r_e)\, S$
- Downwelling radiances from i-skyradiometer
- Surface leaving radiance from surface spectrometer
  - Surface spectrometer under construction

Table 7 Airborne measurement facilities useful for GLI-ATMOS

(1) GLI-ATMOS	AMSS, AMR, (PMS)
(2) BRRAA, Thailand	PMS, CCN, King Air x 2, G21
(3) NASA	MAS, Airborne-MISR, lidar
(4) U. Wisconsin	HIS, Imaging FTS
(4) LAMP	PMS, PVM, Nephelometer
(5) Nagoya & Hokkaido U.	PMS
(6) Israel (Rosenfeld)	cloud, radar
(7) ARA, Australia	cloud, aerosol
(8) Europe (Fischer)	cloud, aerosol

Table 8 Tentative schedule of intensive field experiments for GLI validation effort

Period (after launch)	Place and targets
+ 6 months	Pacific Ocean off Japan, vicarious calibration, aerosols
+12 months	Ocean: Pacific Ocean off Japan, aerosol & cloud validation Land: Chiang-Mai, Thailand, biomass burning and precipitation
+24 months	Ocean: Pacific Ocean off Japan, aerosol & cloud validation Land: Chiang-Mai, Thailand, biomass burning and precipitation
+36 months	Follow-on aircraft experiment

Table 9 Milestones for the GLI-ATMOS validation

00 01 02 03 04 05 06 07

11 Launch

2 Data checkout

8 Network initialization

1 Network start ---------->

5 1st IFE

11 2nd IFE

8 4th IFE

8 3rd IFE

2 1st cal meeting

8 2nd cal meeting

10 5th cal meeting

2 3rd cal meeting

8 6th cal meeting

10 4th cal meeting

2 Airborne radiance measurements for cal. (every 6 months)
---------->

GAME

ACE-Asia 1

CEOP

ACE-Asia 2

A pre-launch intensive field campaign

- GLI-ATMOS-E1; APEX-E1
- Dec. 11-23, Amami-Oshima
- Objectives
  - A study of microphysical and radiative property change of water clouds caused by aerosol concentration and property change
  - Validation system check
  - Establishing an operation system for enhanced experiment
  - Pre ACE-Asia experiment
- King-Air B200 + Cessna 404 Titan
- Surface: i-skyradiometer, MCR, Lidar, Aerosol samplers, Total nephelometer+Aethalmeter, flux radiometers

- ACE-Asia IFO: April 2001

Need for new shipborne instrumentation

i-skyradiometer + surface spectrometer
MCR; aerosol sampler
Total nephelometer+Aethalmeter; Lidar, CPR for MIRAI

PREDE POM1 Mrk-II

Commercial V. Yahagi-maru

Table 5: Validation site candidates for GLI-ATMOS and main program names for operating the site

Code	Name	Status	Programs
L1	Sri Samrong	OP	GAME, GLI-ATMOS, SKYNET
L2	Shou-Xian/Hefei	OP	GAME, GLI-ATMOS, SKYNET
L3	Yinchuan	OP	SKYNET
L4	Mandalgovi	OP	SKYNET
L5	Fukue-jima (Amami-Oshima)	OP	GLI-ATMOS, APEX
L6	Miyako-jima	PL	GLI-ATMOS, APEX
S1	Ship-Mirai	TS	Frontier
S2	Line-Australia	PL	GLI-ATMOS, APEX
S3	Line-Persia	PL	GLI-ATMOS, APEX

OP: operated; TS: testing; PL: planning

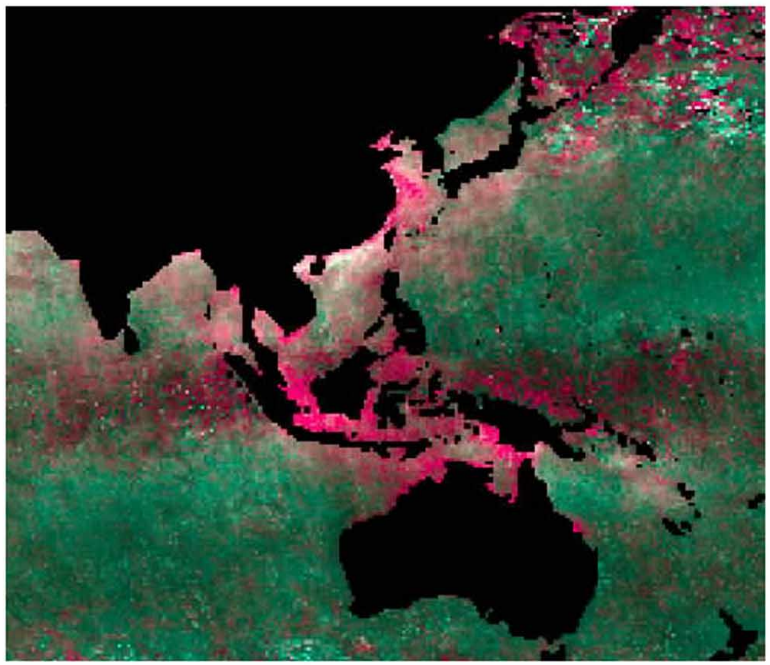
Table 6 Validation sited useful for GLI-ATMOS

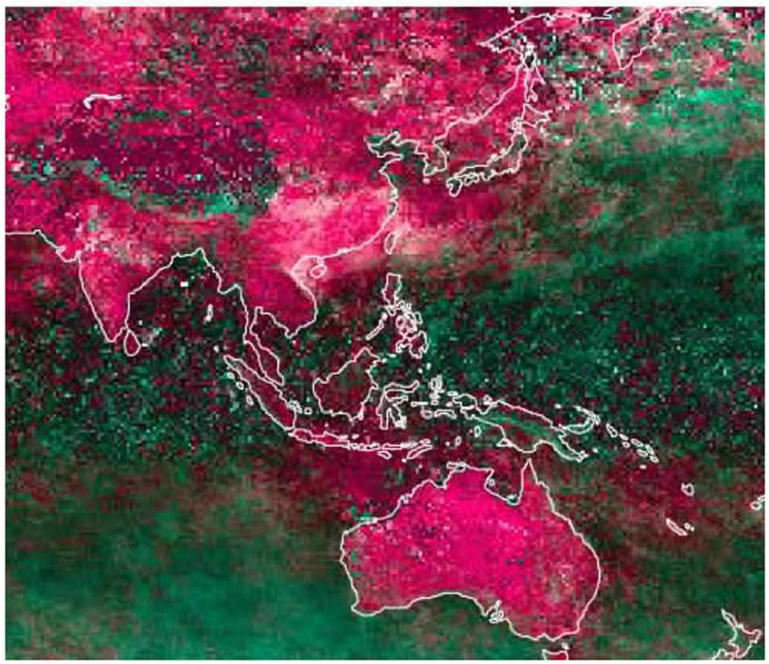
Code	Name
A1	Anmyondo, Korean METRI site
A2	Cheju Island, Korean GAW site
A3	Bukittinggi, Indonesian GAW site
A4	Linan, China-map site
A5	Taiwan sites
A6	Tombstone, Arizona: ARS site with a sunphoto/sky radiometer
A7	US ARM sites (New PIs)
A8	Sdeboker, Israel: Saharan dust measurements
A9	IMPROVE: Visibility and aerosol chemical netowrk
A10	AERONET: Sky radiometer network, Holben
A11	SURFRAD: radiation and optical thickness measurements, Del'isi
	6 sites with shadow band radiometers

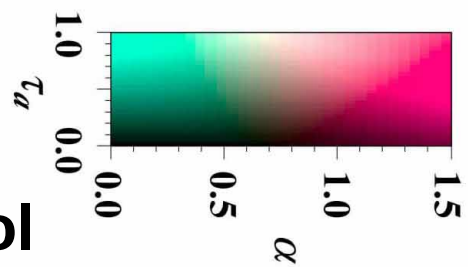
Objectives of the APEX

- Understanding the aerosol indirect effect
- Modeling of the process
- Evaluate the indirect effect of man-made aerosols

T. Nakajima et al. (GRL 2001)

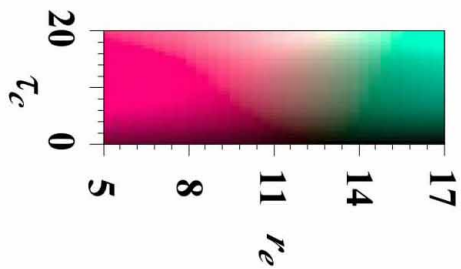






Red: small

Blue: large

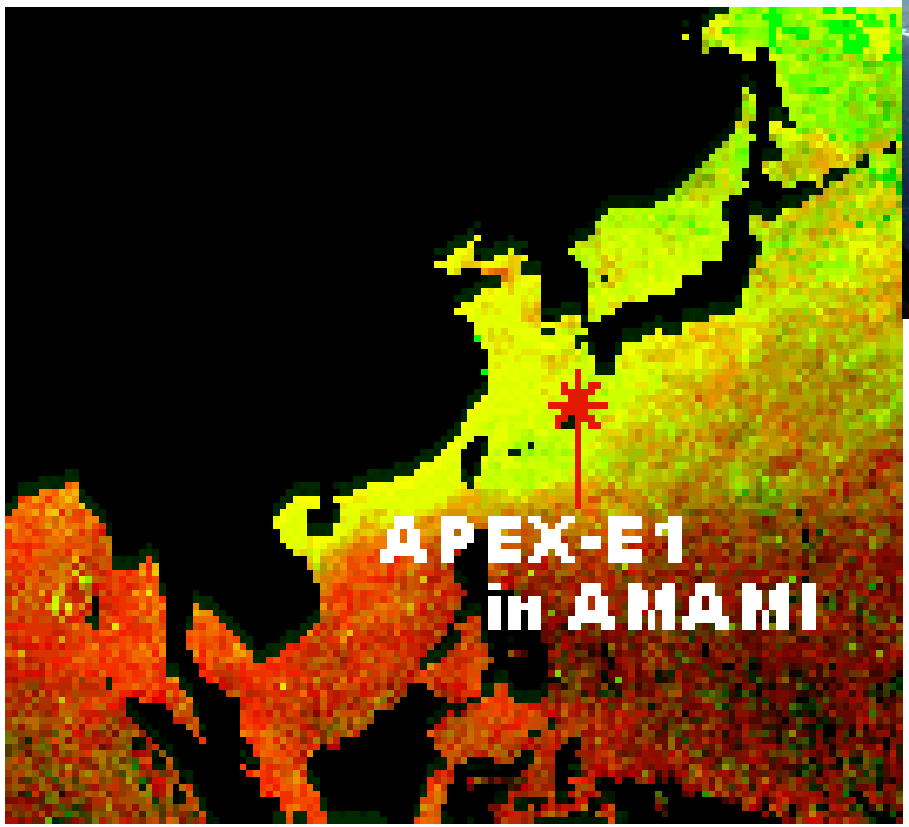


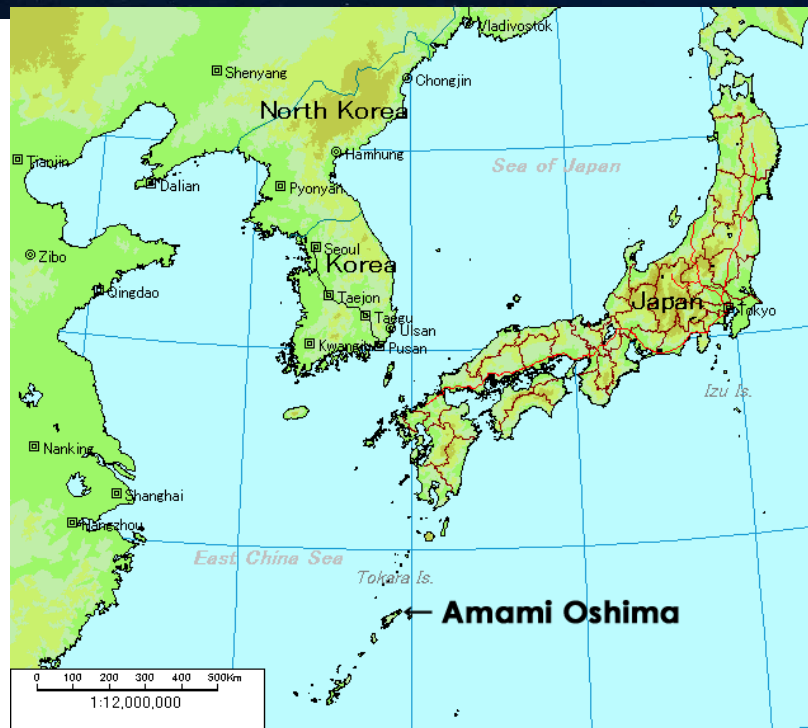
Aerosol

Low clouds

APEX Experiment

- Amami-Oshima and Fukue-Jima Islands
- E1: 2000.12.13-25
- E2: 2001.4.1-30

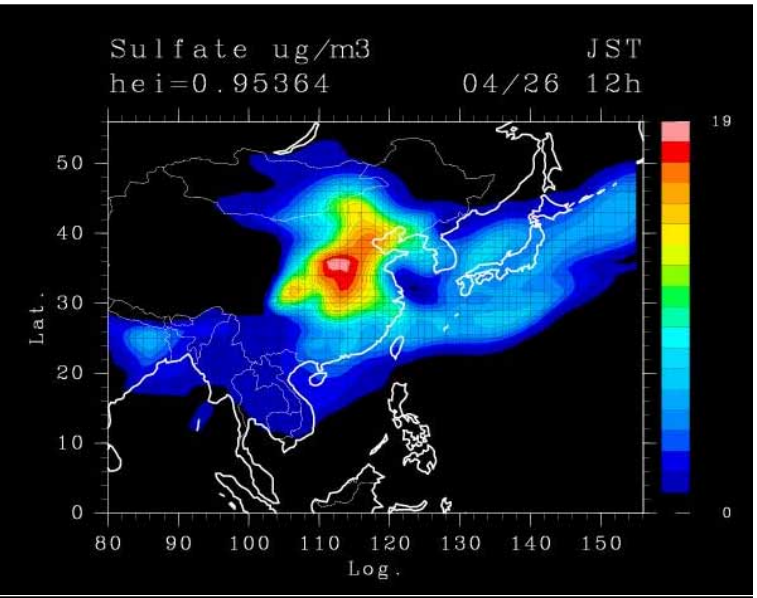


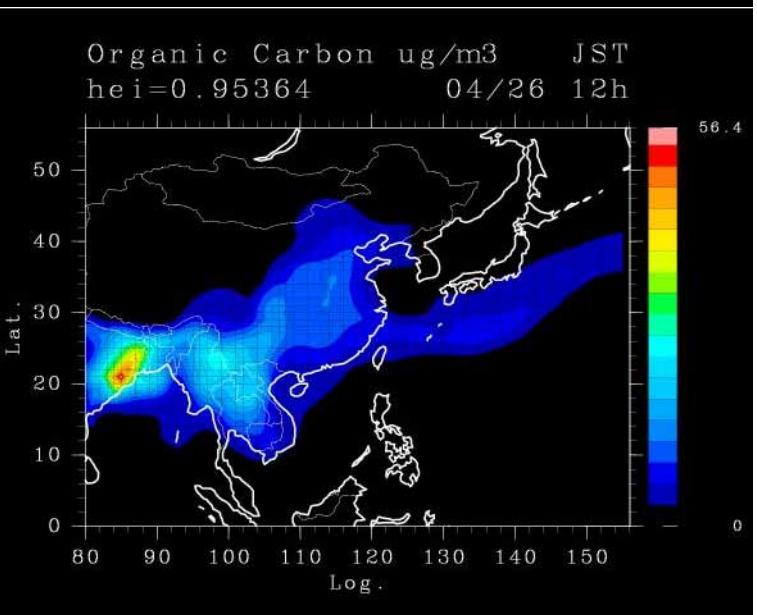


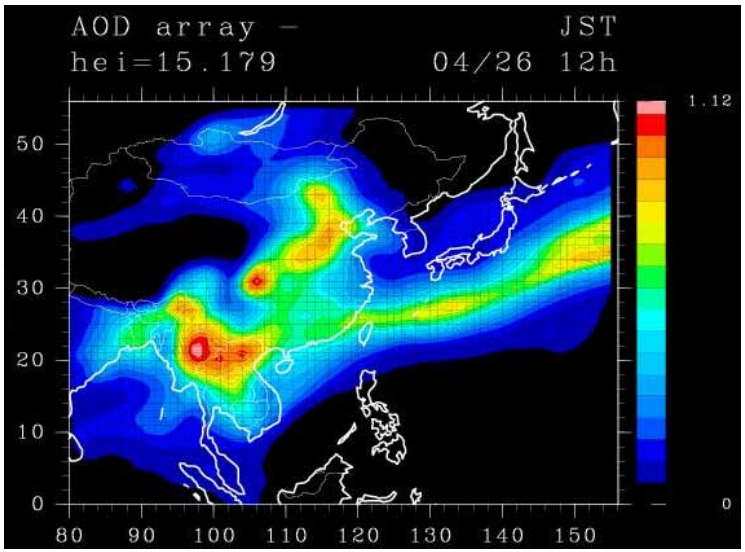
Yellow: large $N_{aerosol}$, large N_{cloud}

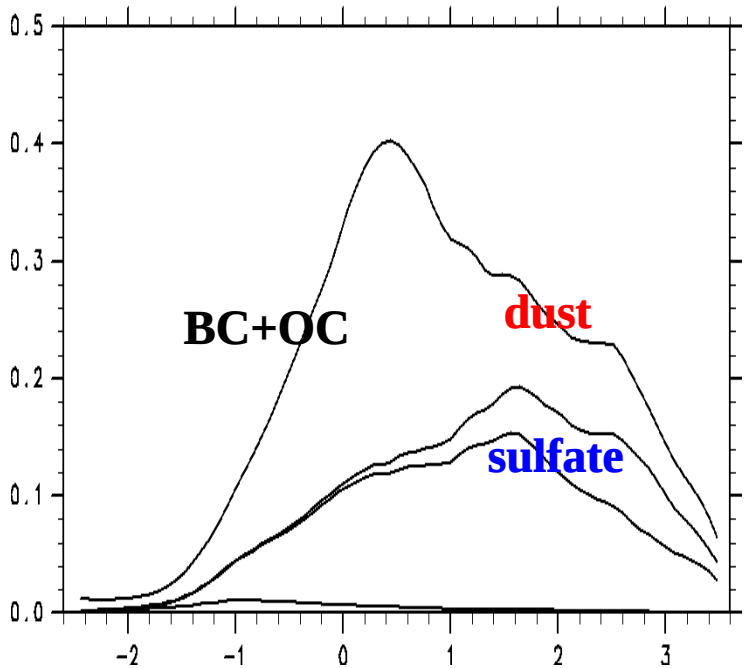
Red: large $N_{aerosol}$, small N_{cloud}

Large contrast between Cheju and Amami Islands









I. Uno (2001)

MODIS Aerosol Parameters (Ver.2)

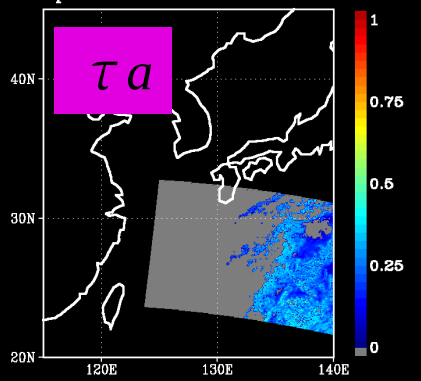
Date: 17 DEC 2000

MODIS Level-1b data provided by:
NASA-MODIS/GES-DAAC.

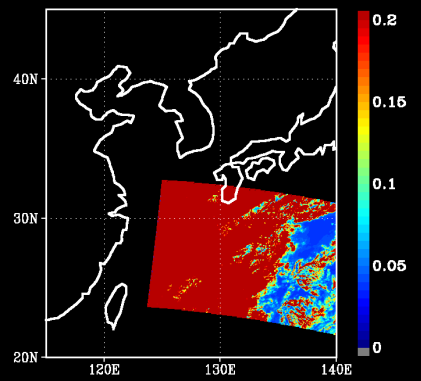
Retrieval Algorithm:
ATSK5 on the GLI system.

Processed by:
Yi Liu (EORC/NASDA)

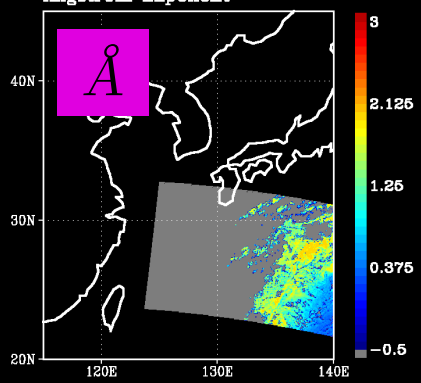
Optical Thickness



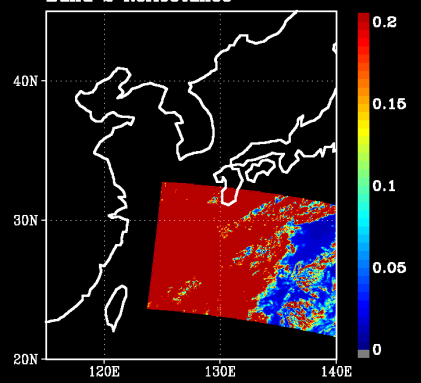
Band 1 Reflectance



Angstrom Exponent

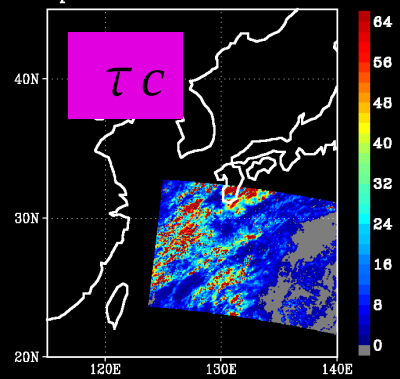


Band 2 Reflectance



MODIS Cloud Parameters (Ver.2)

Optical thickness



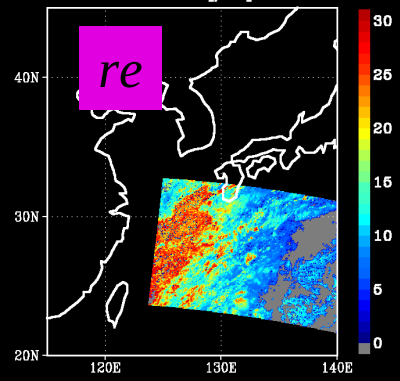
Date: 17 DEC 2000

MODIS Level-1b data provided by:
NASA-MODIS/GES-DAAC.

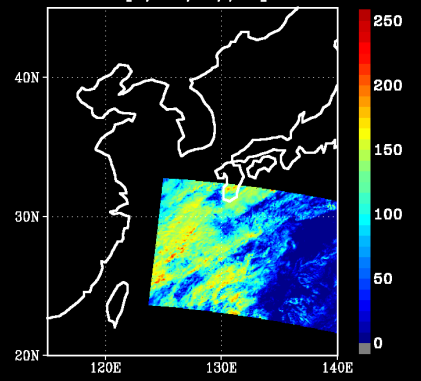
Retrieval Algorithm:
ATSK3_R on the GLI system.

Processed by:
Takashi Y. Nakajima (EORC/NASDA)

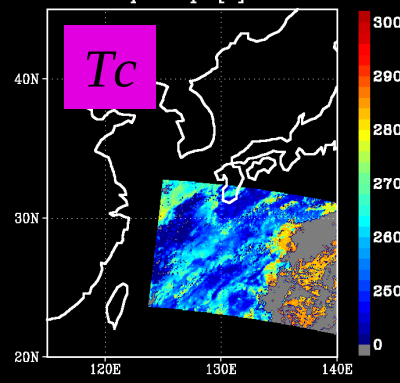
Effective radius [μm]



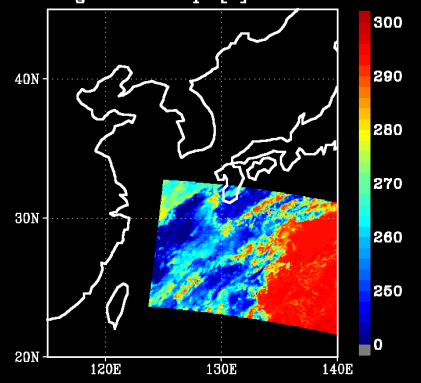
Band 2 [W/m2/sr/μm]



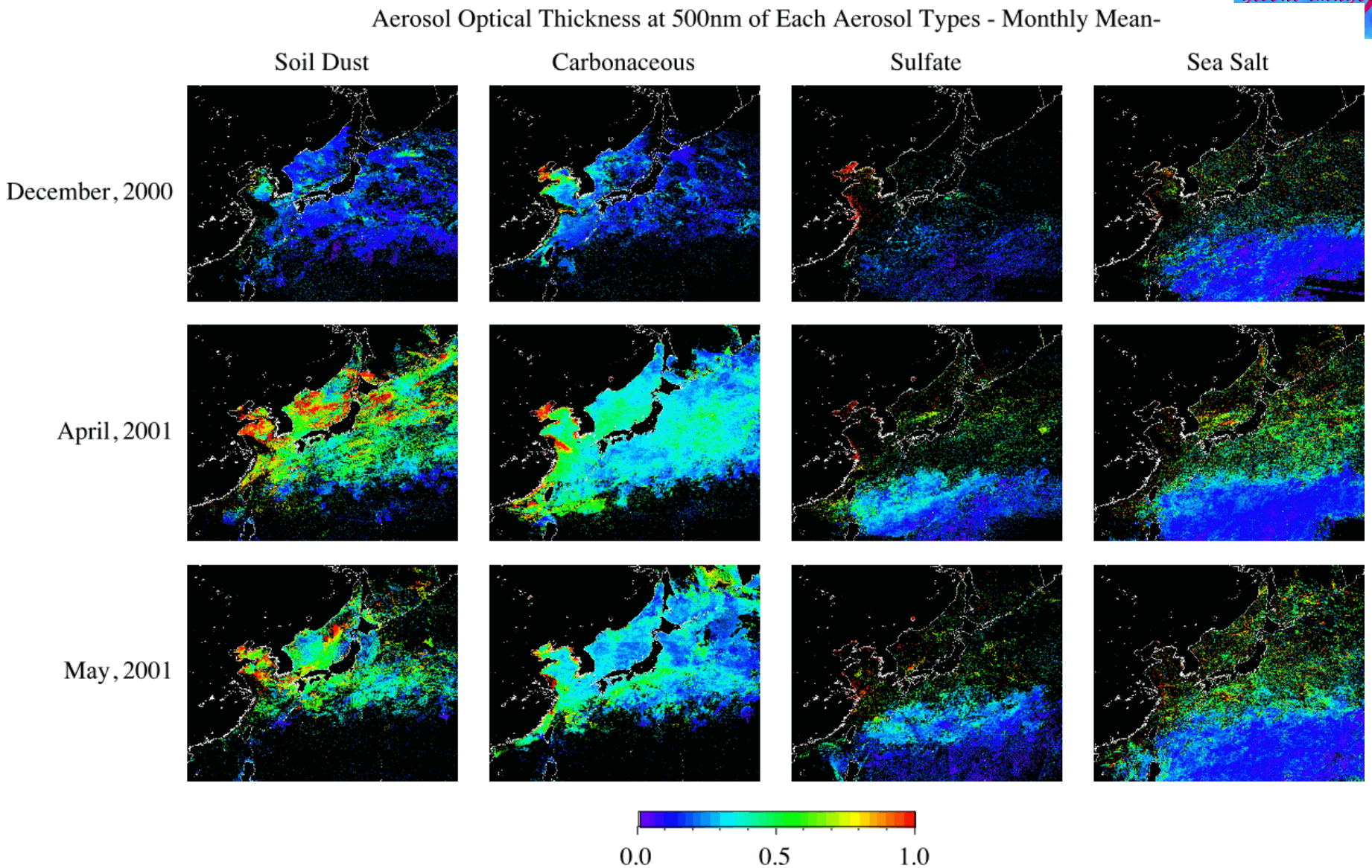
Cloud Top Temp. [K]



Brightness temp. [K]

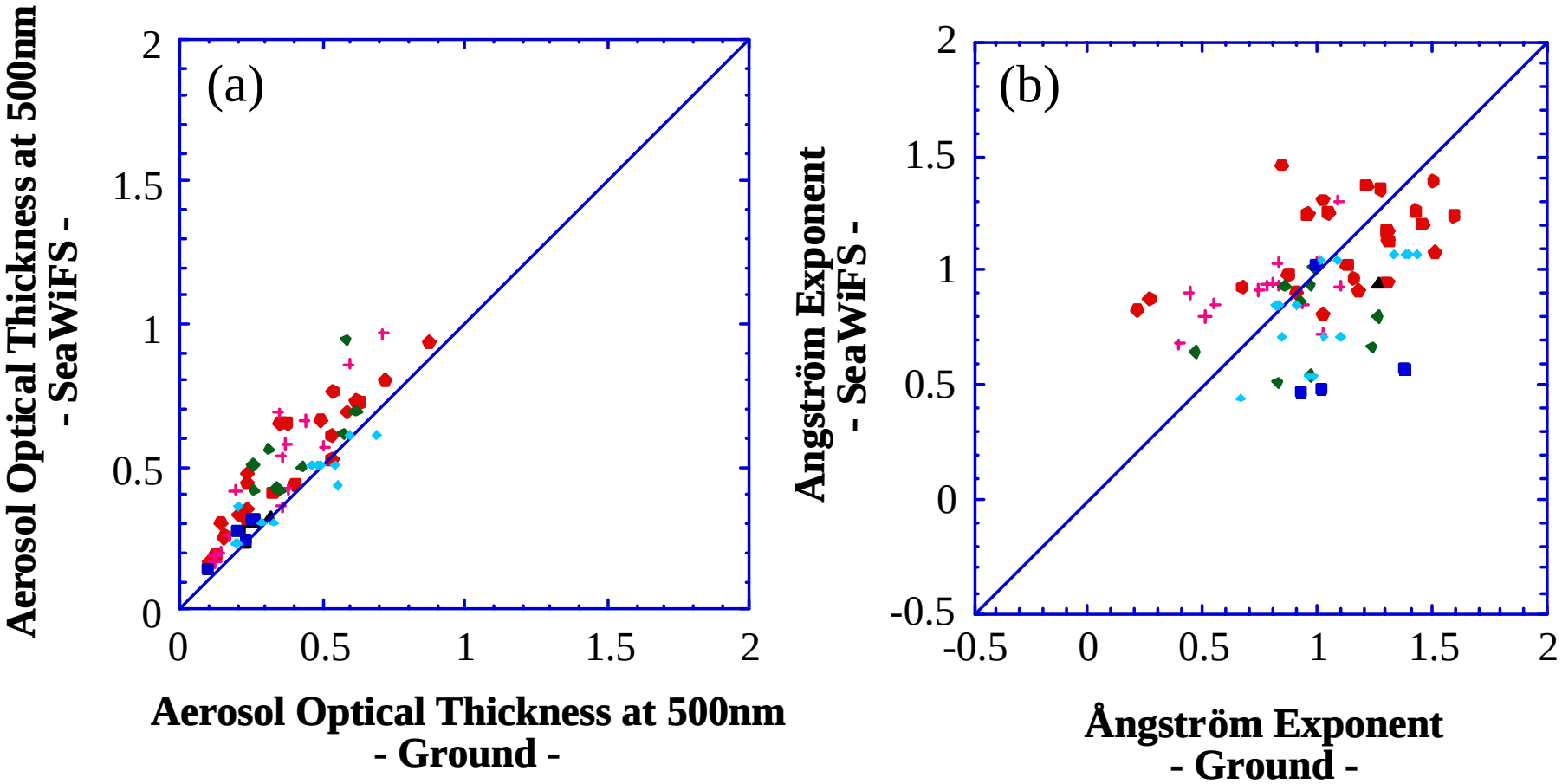


Aerosol type classfication by SeaWiFS

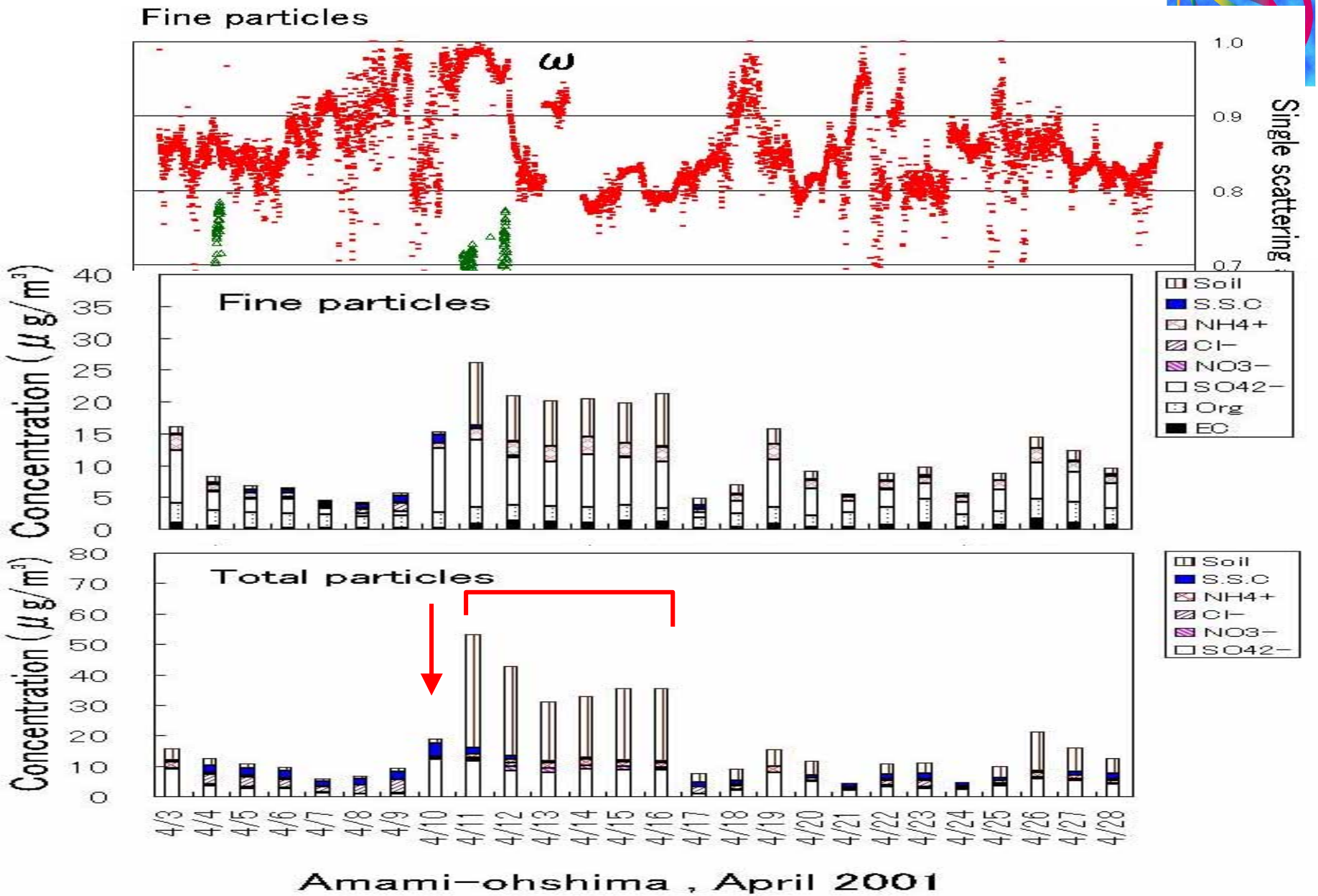


Higurashi (2001)

Comparison with ground-based values



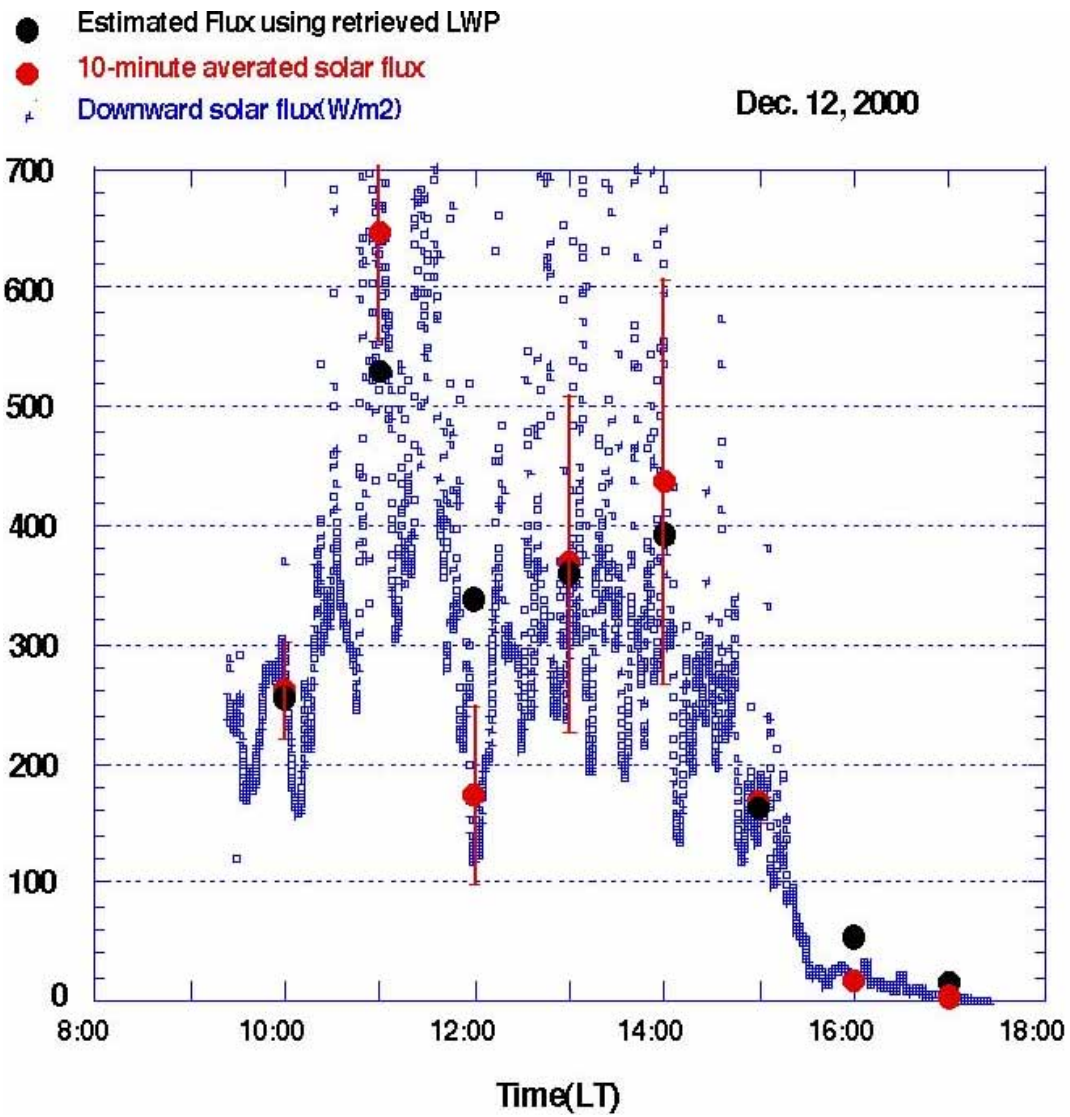
Events of 10 and 11-16 April at Amami



S. Ohta (2001)

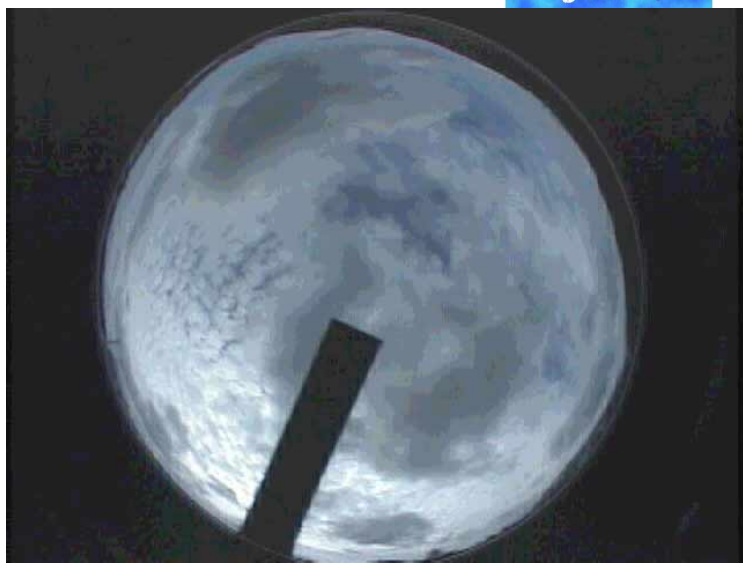
Calculation of downward solar flux

Mirowave Rd. + Sky camera, APEX-E1

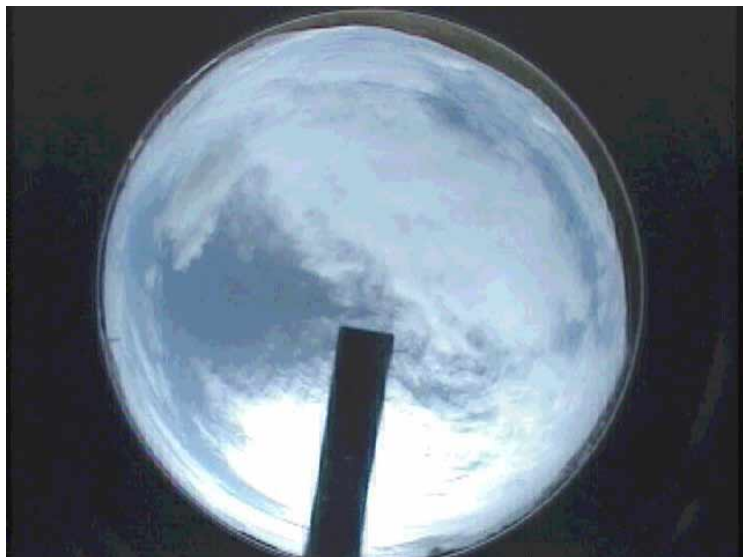


T. Takamura (2001)

10:00 Dec.11, 2000

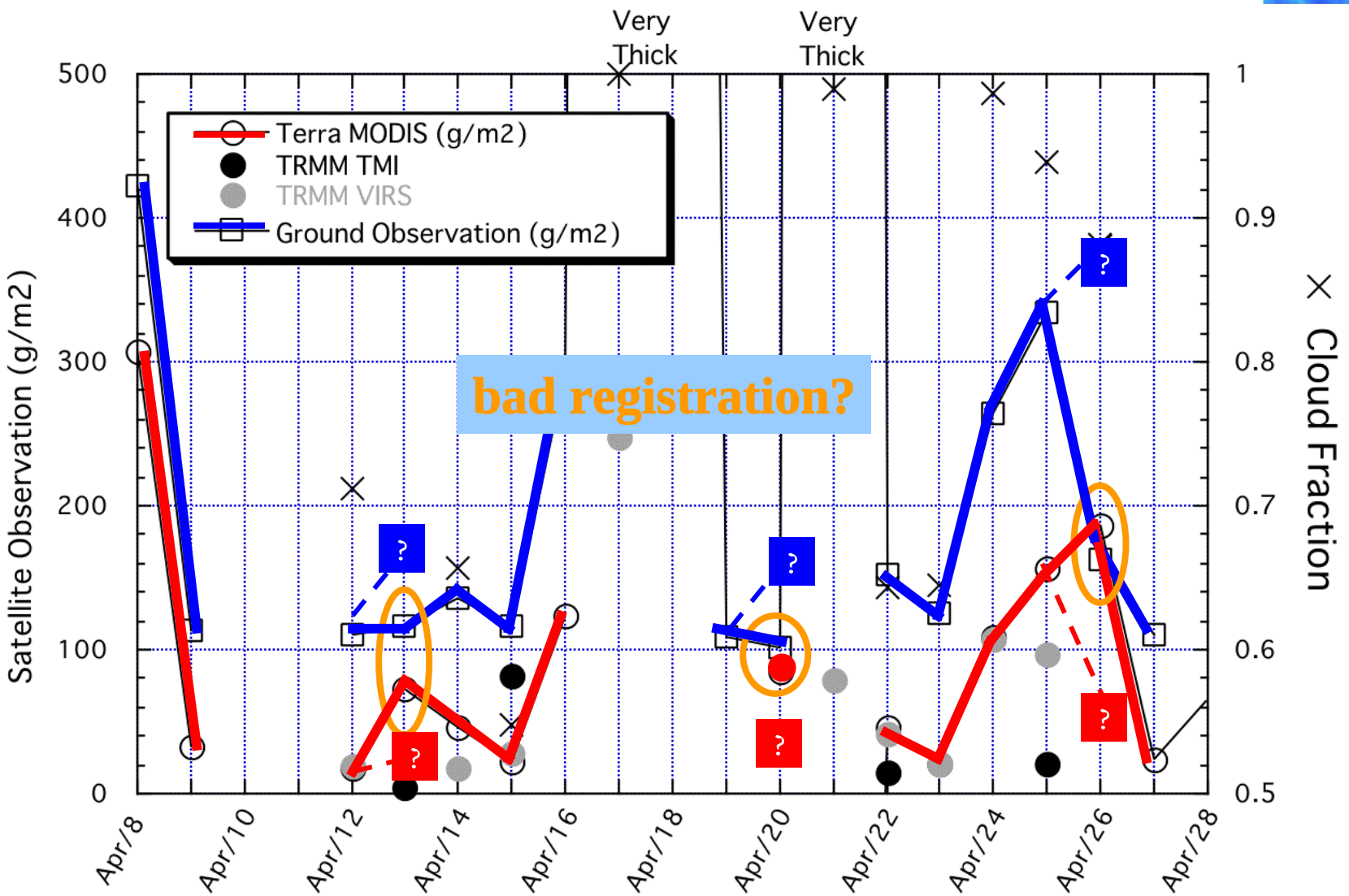


11:00 Dec.11, 2000

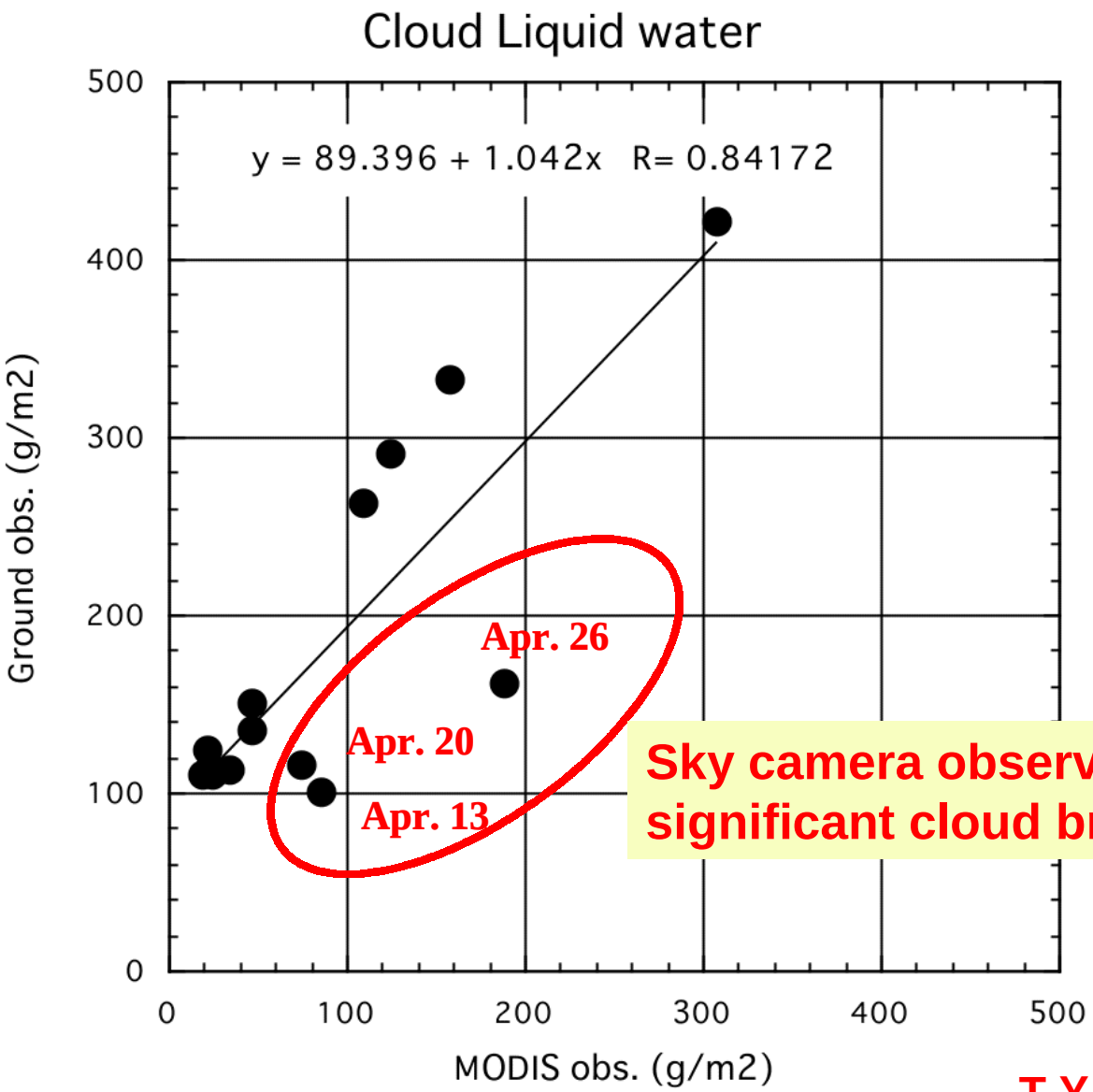


MODIS versus Ground measurements.

(Cloud Liquid Water Path, g/m²)



Correlation between MODIS and Ground Obs.

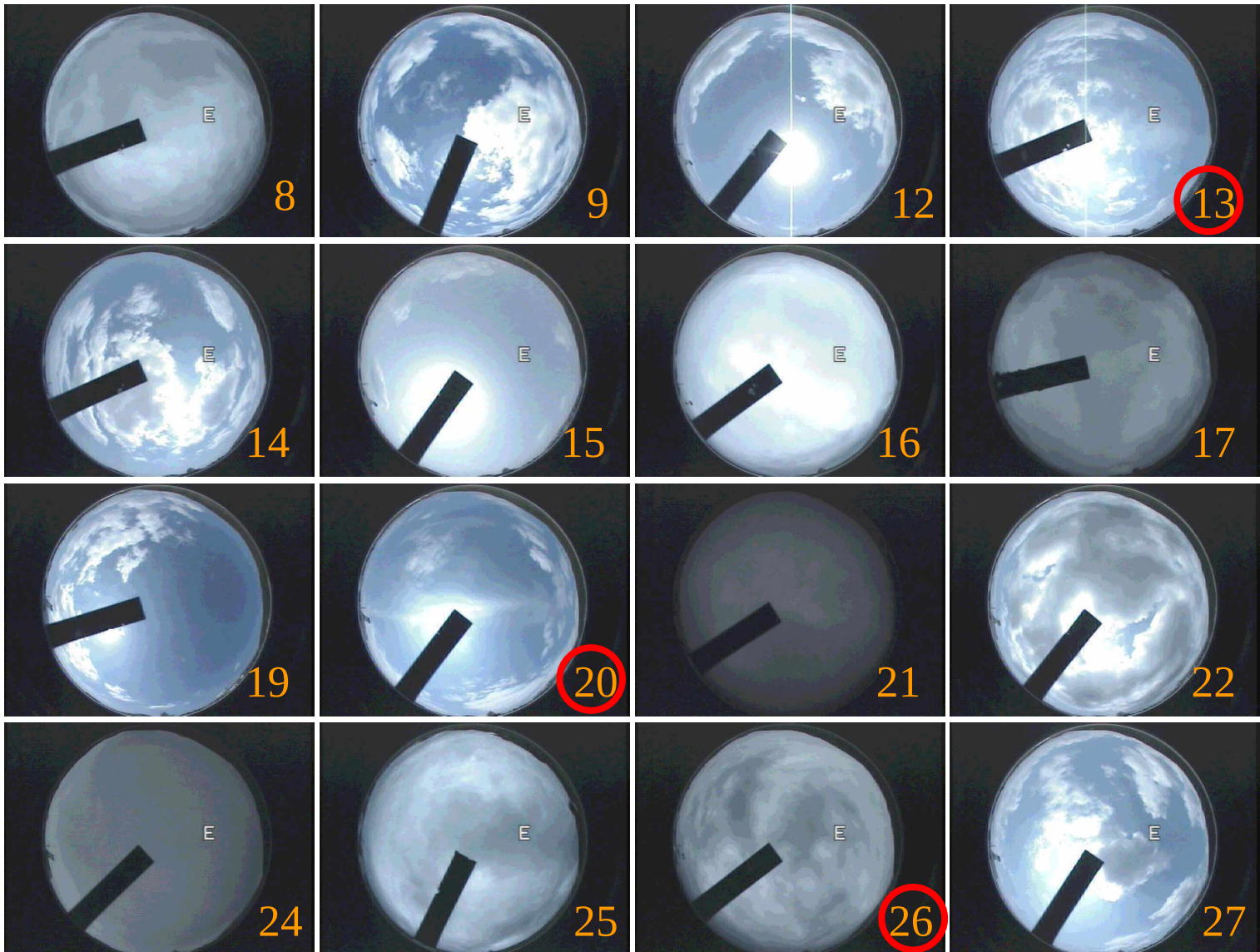


Sky camera observed significant cloud brokenness

T.Y. Nakajima (2001)

•Sky Camera @ Amami-Oshima(28.44N, 129.70E)

•Sky Camera @ Amami-Oshima(28.44N, 129.70E)



Some issues from GLI2000 WS

- **APEX experiment as execise of GLI remote sensing**
- **Shimoda?: ARM and AERONET data are used?:yes; SKYNET in Asia**
- **Stamnes? Spectral single scattering albedo: possible from sun/sky, better over snow**
- **Jens?: Vicarious calibration possible?**
  - **Low reflectance target: surface leaving radiometer+ I-skyradiometer**
  - **High reflectance target: aircraft (MODIS Gr.), Australian desert**
  - **Relative calibration with deep convective clouds**