Analysis of aerosol, cloud, and water vapor using GLI NUV, O_2 absorption, and IR channels

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GLI Workshop in Tsukuba, Jan. 30, 2007

Contents

Algorithm developments:

1. Retrieval of cloud heights
   - using the following GLI Channels: VIS, Oxygen A-band, NIR, TIR;

2. Retrieval of aerosol amount
   - using GLI NUV channels;

3. Retrieval of water vapor amount
   - using GLI NIR channels;

Global analysis of cloud geometrical properties using ADEOS-II / GLI data for radiation budget studies

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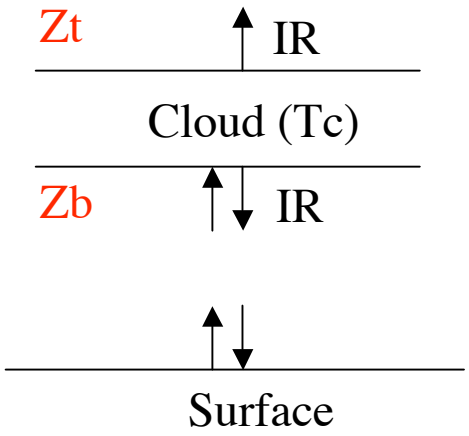
Objective

- Cloud has an influence on the Earth radiation budget
  - For Shortwave and/or Longwave flux at TOA and/or surface;
  - Depending upon optical, microphysical and geometrical properties;
    - Optical thickness, particle size, and layer height;
- There still exists some uncertainty in the estimation of surface radiation budget among observations and/or simulations;
- Retrieval of cloud geometrical properties (ie, cloud layer height)
  - Reducing uncertainty of downward longwave flux;
  - Improvement of surface radiation budget;
  - Air-/space-borne imager-type remote sensing data are useful for extended cloud systems;

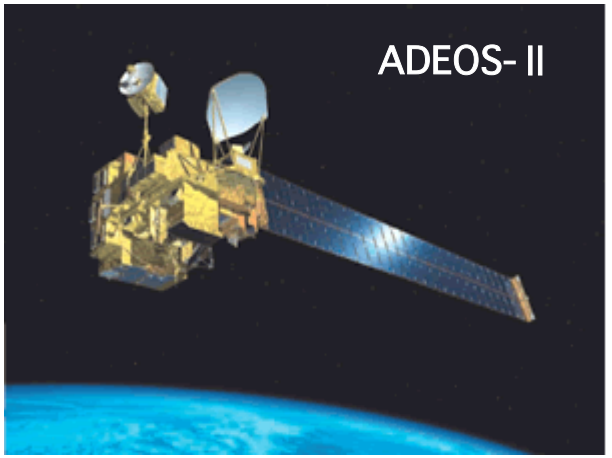


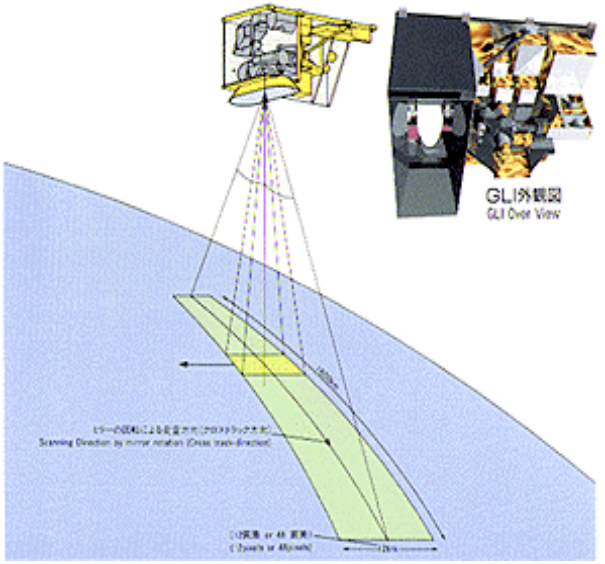
Approach

- **ADEOS-II / GLI**
  - **A nadir looking imager with 1km footprint;**
- **Four-channel algorithm:**

  Visible, Oxygen A-band, NIR, and TIR;
- **Retrieval of cloud properties:**

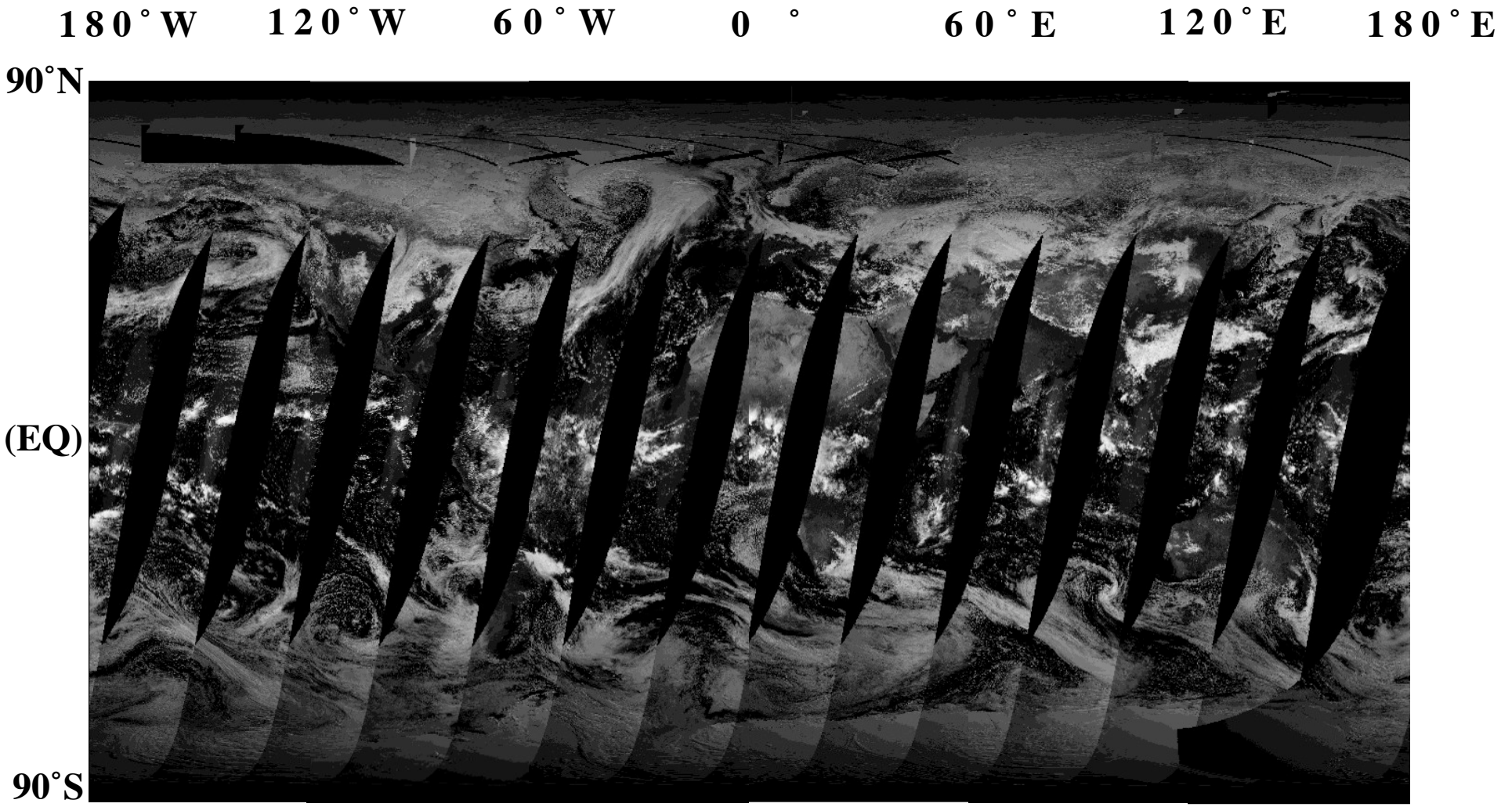
  τ_c, r_e, z_t, and Δz;
- **Application to Global observation dataset;**





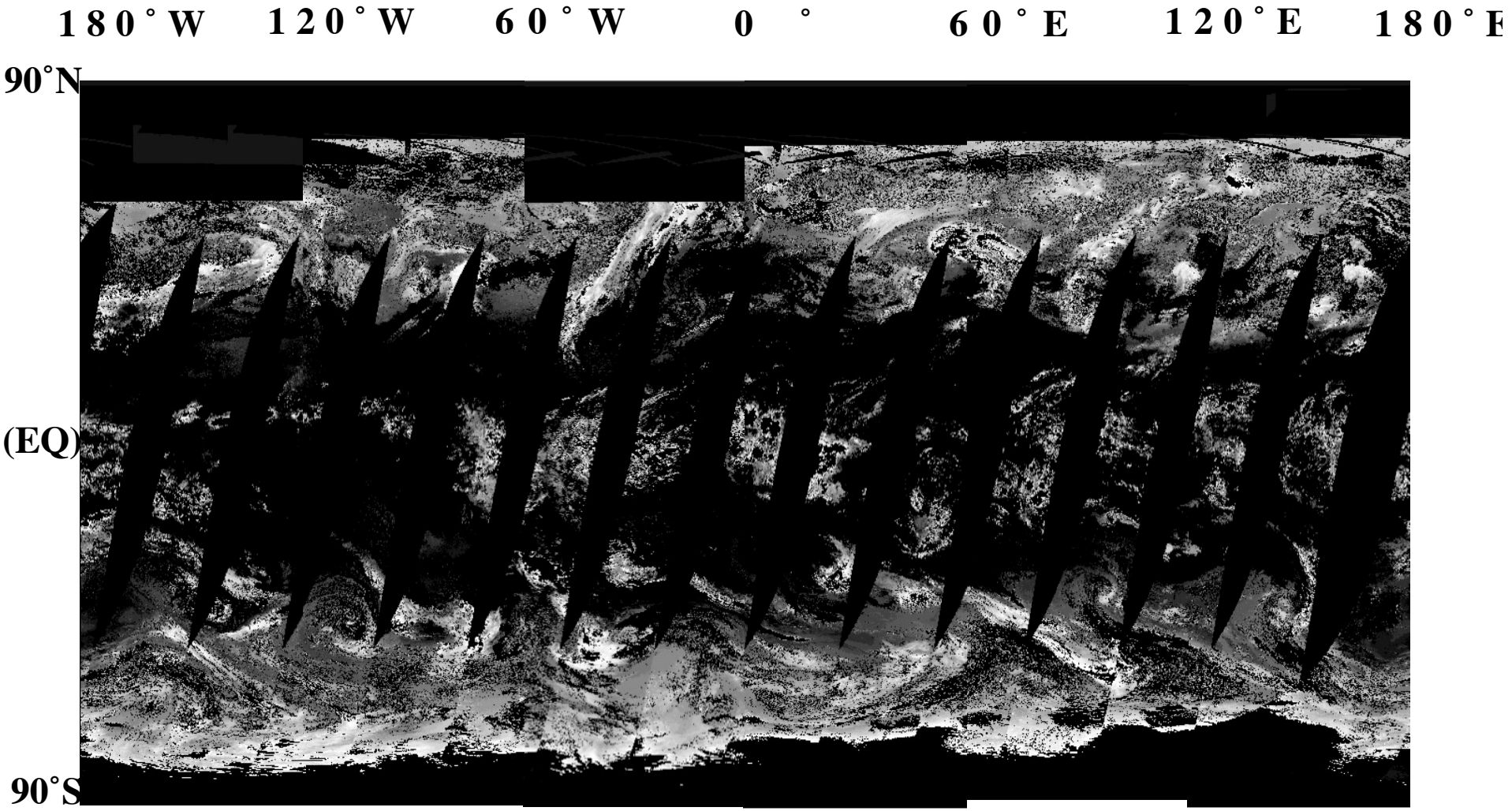
http://sharaku.eorc.jaxa.jp/
http://www.eoc.jaxa.jp/

GLI global data (678nm; Mar. 20, 2003)



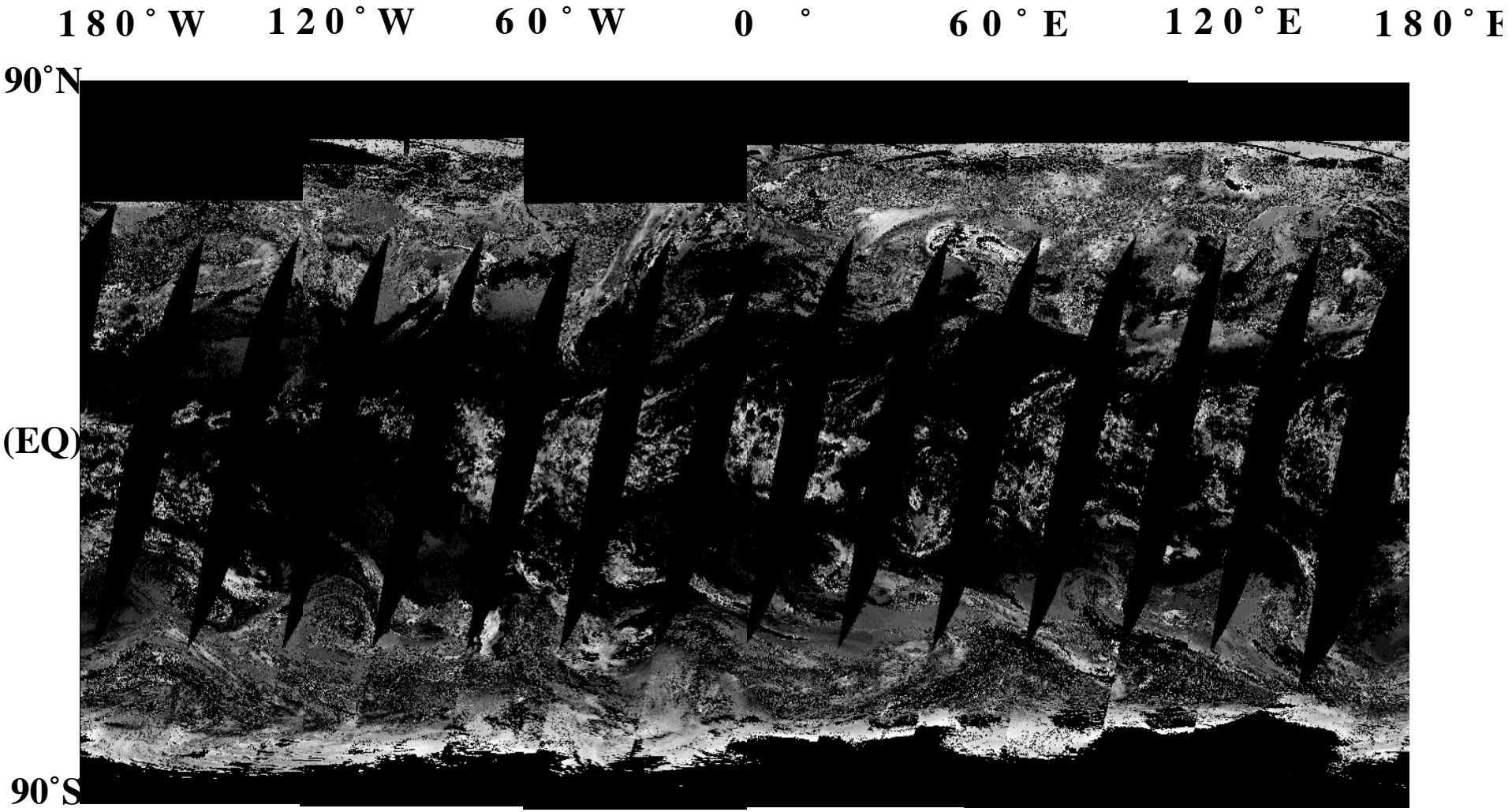
* Segment dataset: GAC type dataset divided every 60˚ in longitude

Cloud top height (Mar. 20, 2003)

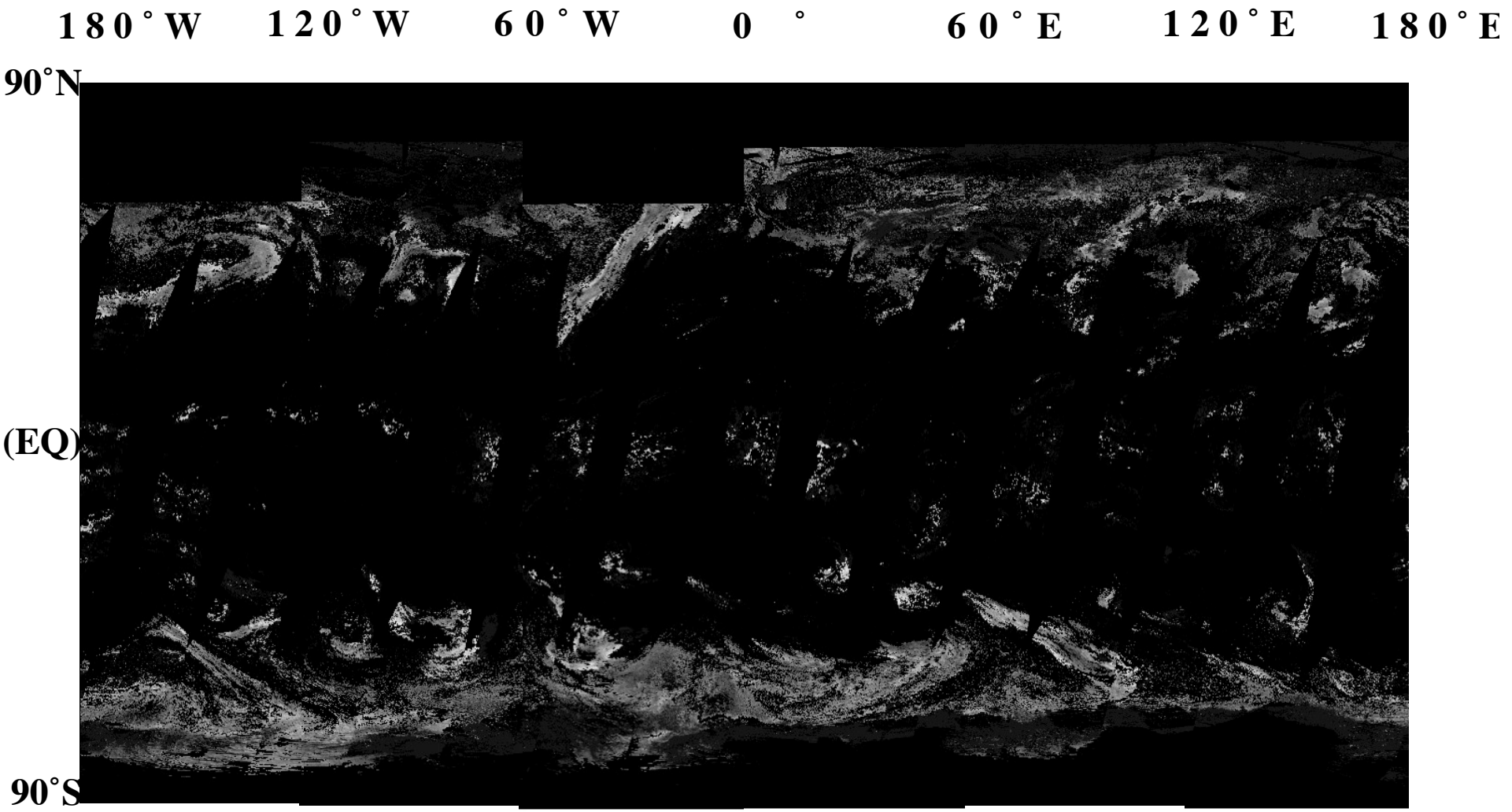


* Future improvement: cloud type flag (water or ice) for cirrus cloud contamination

Cloud geometrical thickness (Mar. 20, 2003)



Cloud bottom height (Mar. 20, 2003)



* A by-product with top height and geometrical thickness

Summary (cloud)

- A four-channel algorithm was developed and applied to the ADEOS-II / GLI global dataset to retrieve cloud geometrical properties as well as optical and microphysical ones.
- An initial global analysis and preliminary results reveal
  - Algorithm works as a whole, but more elaborate analyses are necessary
    - Surface condition: albedo, land/ocean, temerature, and pressure;
    - Atmospheric profile: temperature, relative humidity, and pressure;
    - Cirrus screening: water vapor absorbing band or thermal IR bands;
    - Sun glint screening: scan geometry;
- Future works
  - Validation studies with active sensors;
  - Further global analyses for radiation budget and cloud physics studies;

Characterization of sulfate haze over East Asia retrieved with satellite and ground-based remote sensing data

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Objective

- Air pollution accompanying with recent rapid economic growth in East and South Asia has a potential to influence our environment.
- It is important to investigate aerosol type and distribution with remote sensors and ground based measurements.
- In this study, we characterize a haze event around Japan in autumn of 2003 with observations and chemical transport model simulations.

エアロゾルの主な発生要因

ADEOS-Ⅱ /GLI

Global Imager (GLI)

Operation:

December 2002 to October 2003

Channels: 36

from 380nm (NUV) to 12 μm (TIR)

Recursive period: 4 days

Spatial resolution: 1km (IFOV) and 1600km (Swath)

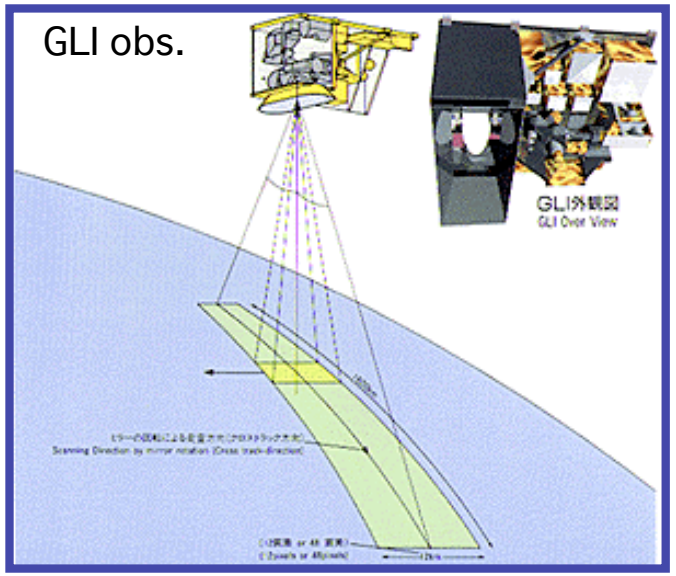
Data to be analyzed

Date: September 16, 2003

Band: Near Ultraviolet (NUV);

380nm (ch1) and 400nm (ch2)

Scene: around Japan



http://sharaku.eorc.jaxa.jp/
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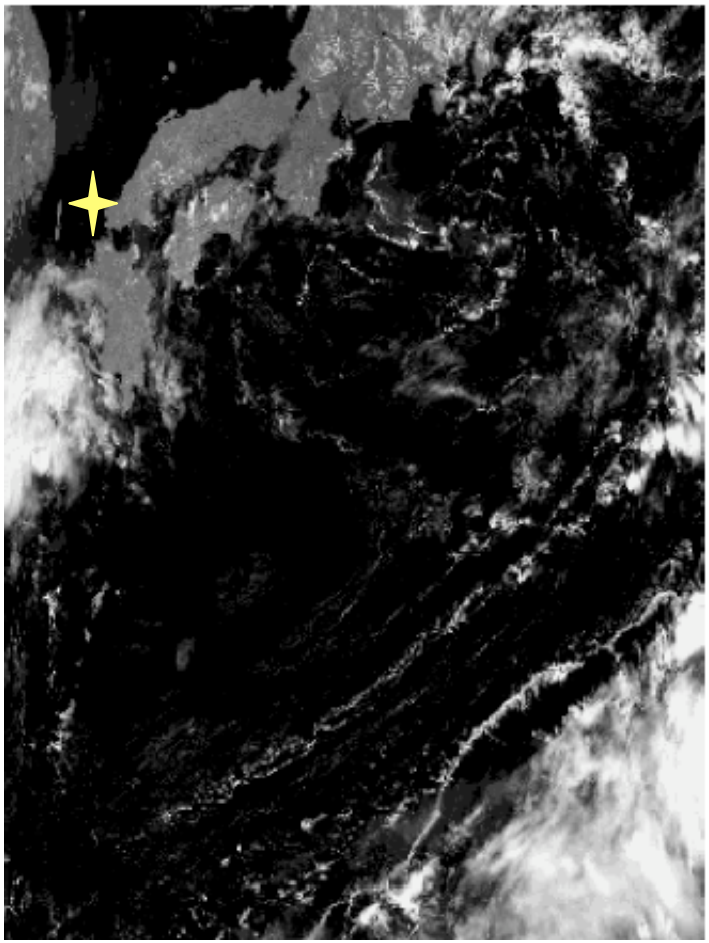
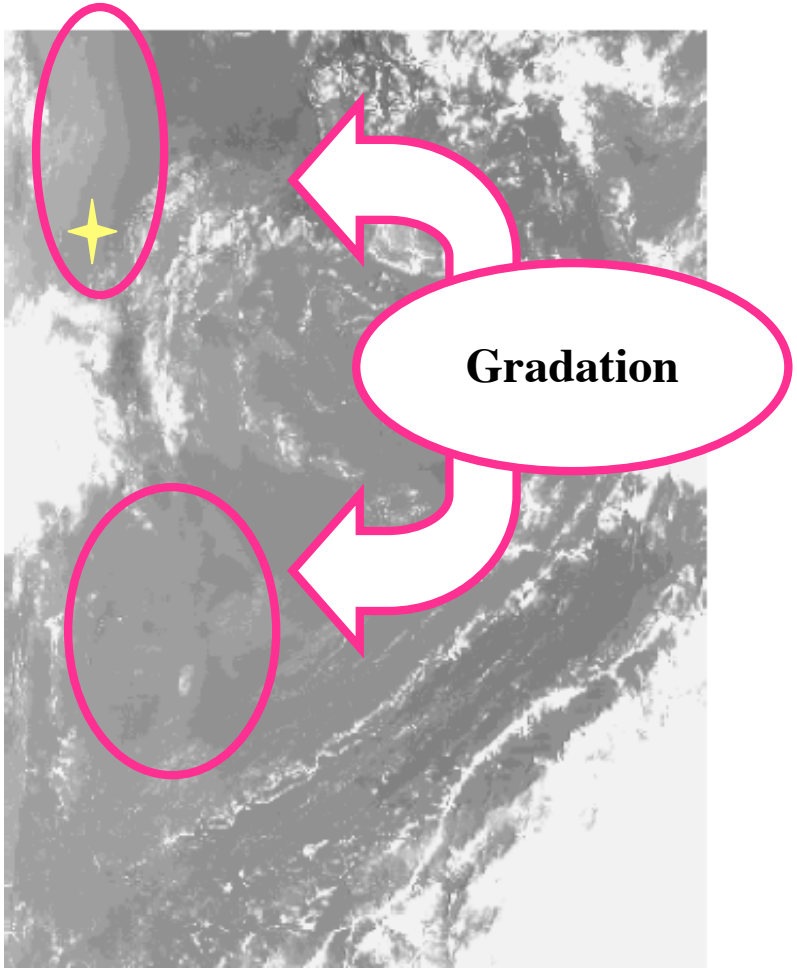
GLI image (Sept. 16, 2003)



NIR (866nm)



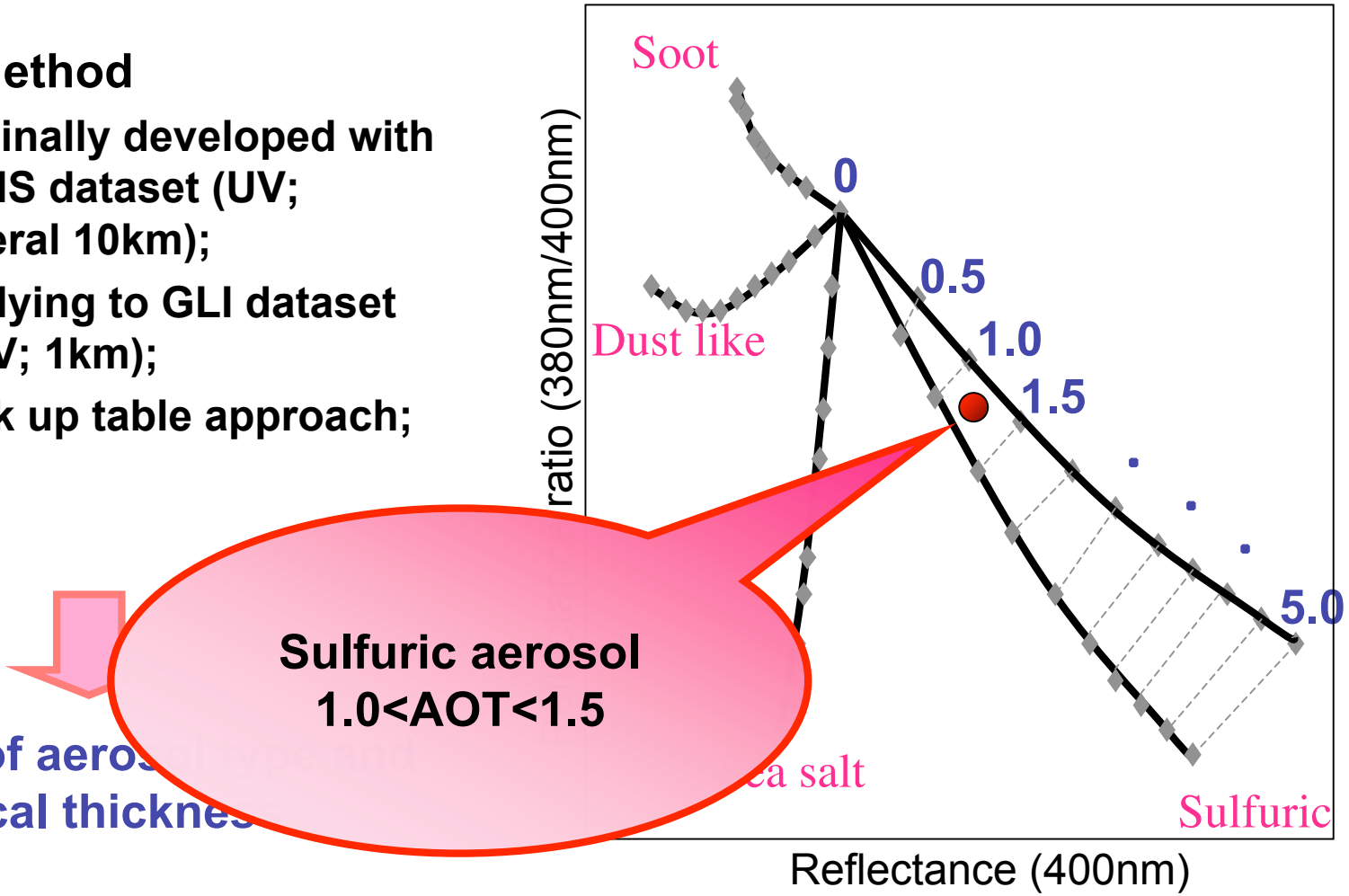
NUV (400nm)

✦ Shipborne measurements with R/V Shirase

Aerosol retrieval with NUV observation

Direct Method

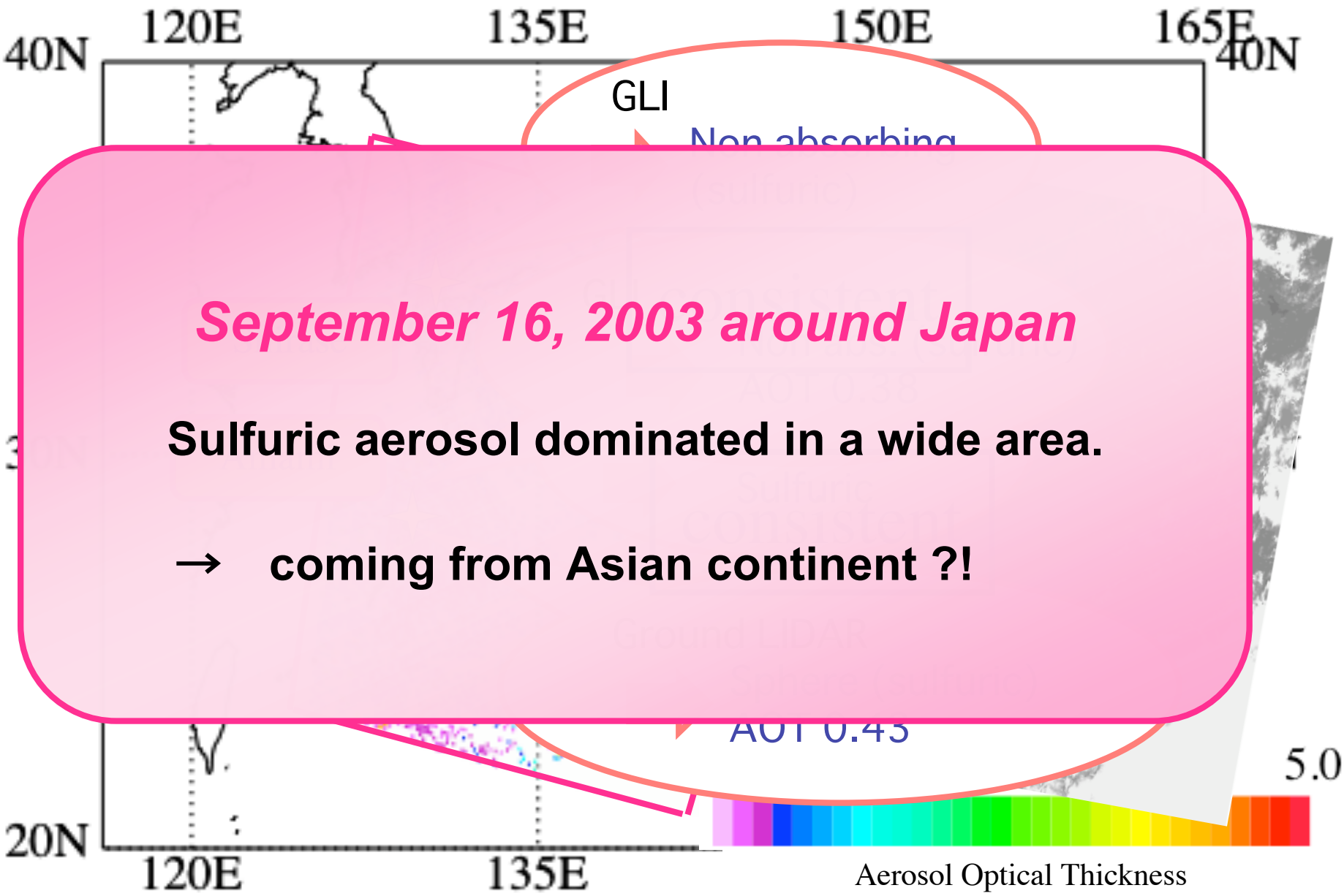
- **Direct method**
  - **Originally developed with TOMS dataset (UV; several 10km);**
  - **Applying to GLI dataset (NUV; 1km);**
  - **Look up table approach;**



Sulfuric aerosol
1.0<AOT<1.5

Retrieval of aerosol type and optical thickness

Retieved aerosol optical thickness (Sulfuric)



September 16, 2003 around Japan

Sulfuric aerosol dominated in a wide area.

→ coming from Asian continent ?!

Summary (aerosol)

- **GLI NUV (380 nm) enables us to retrieve Asian Haze properties in 1-km resolution;**
  - **Comparison to the *in situ* observations, such as surface sampling as well as lidar and skyradiometer, indicated the retrieved optical thickness was reasonable;**
- **Combined analyses of surface, satellite, and model simulation are useful (necessary) to characterize aerosol properties**
  - **Chemical type, amount, microphysics, distribution, transportation (source and sink), and so on;**
- **Aerosol layer height is one of the greatest error sources for absorbing aerosols;**
  - **LIDAR observation will help us;**
  - **O_2 A-band (763nm) will be a possible candidate in GLI analysis;**

Retrieval of precipitable water using ADEOS-II / GLI Near Infrared data

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Akihiro Uchiyama
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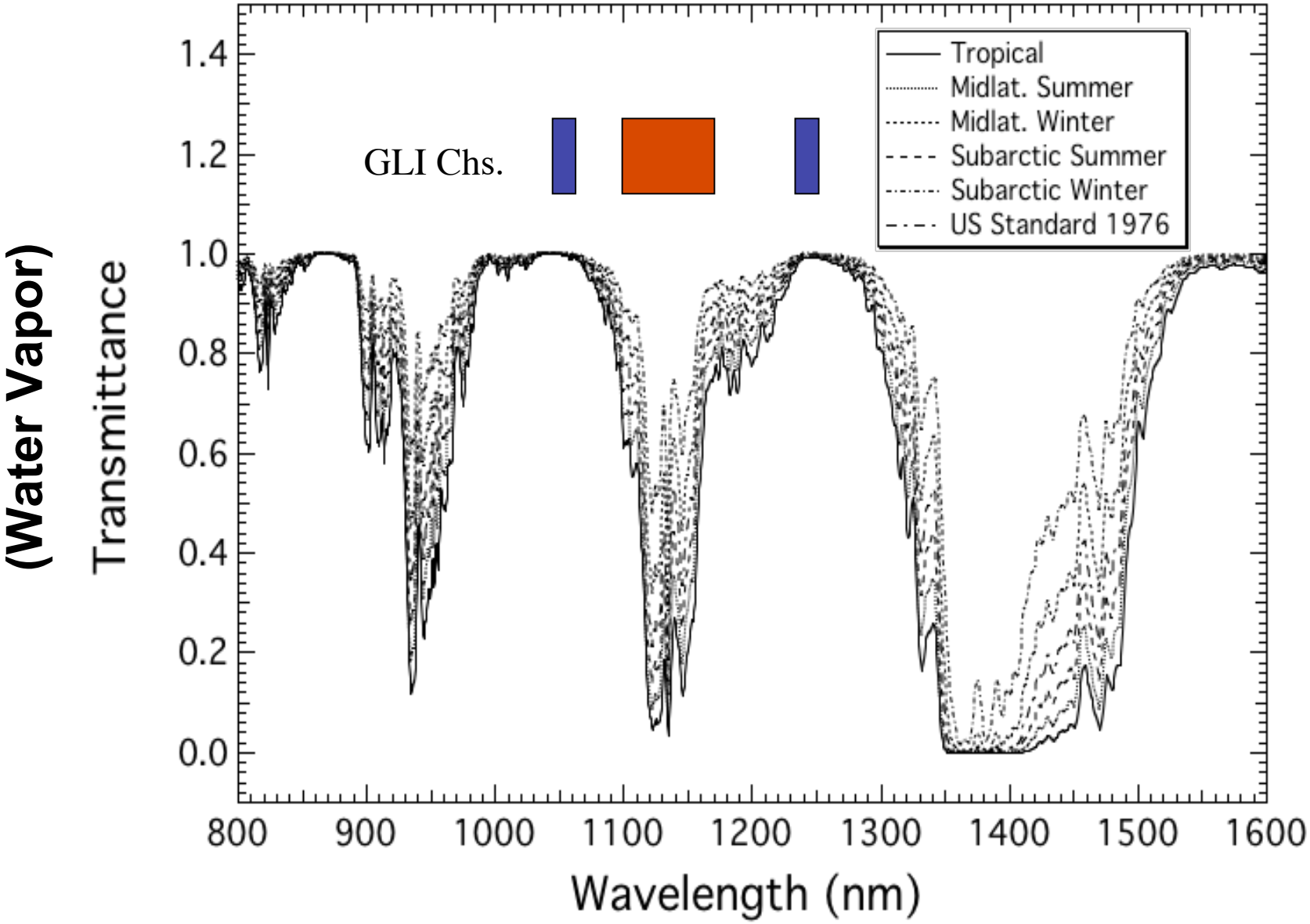
Objectives

- **Water vapor: Integrated amount (precipitable water);**
  - **A key parameter in an aerosol-cloud interaction as well as radiation budget study;**
- **Utility: Atmospheric product (clear sky) or correction;**
  - **Over land, in particular (AMSR only over ocean);**
- **Applications to ADEOS-II / GLI;**
  - **The MODIS algorithm (King et al. 1992; Kaufman and Gao 1992);**
- **Advantage of GLI analysis:**
  - **on a pixel-by-pixel (about 1 km^2) basis;**
  - **Fully synchronized data set with other channels;**
  - **Cloud and ecosystem flags from GLI processing flow;**
  - **Atmospheric correction for surface products, e.g., vegetation, snow/ice, etc.;**

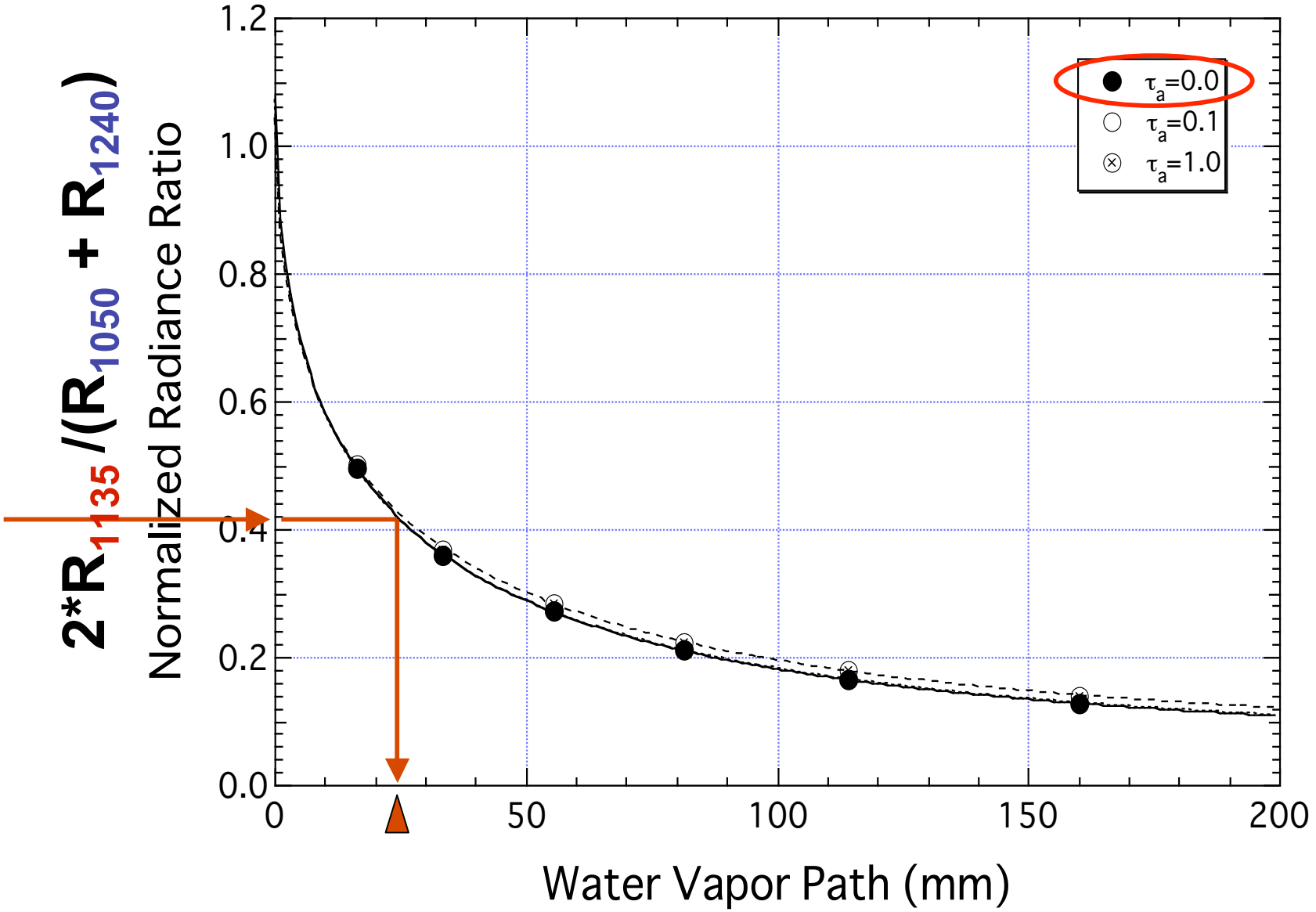
Approach

- **Radiance Ratio Method:**
  - **Near Infrared (ADEOS-II / GLI Application);**
    - **Water vapor absorbing band (1135 nm), and;**
    - **Non-absorbing band (1050 or 1240 nm);**
  - **Daytime Retrieval;**
  - **Under a clear sky condition;**
  - **Surface albedo: high or moderate (over land);**
  - **Aerosol loading: up to moderate (1.0 @ 500 nm);**
- **Analysis and Validation:**
  - **Implemented to EORC (ATSK6p);**
  - **GLI analysis: April and August, 2003 @ Global;**
  - **Comparison to radiosonde observations, and so on;**
  - **Re-evaluation of algorithm;**

Physical background



Calibration (Bright Surface; Lambertian 50%)

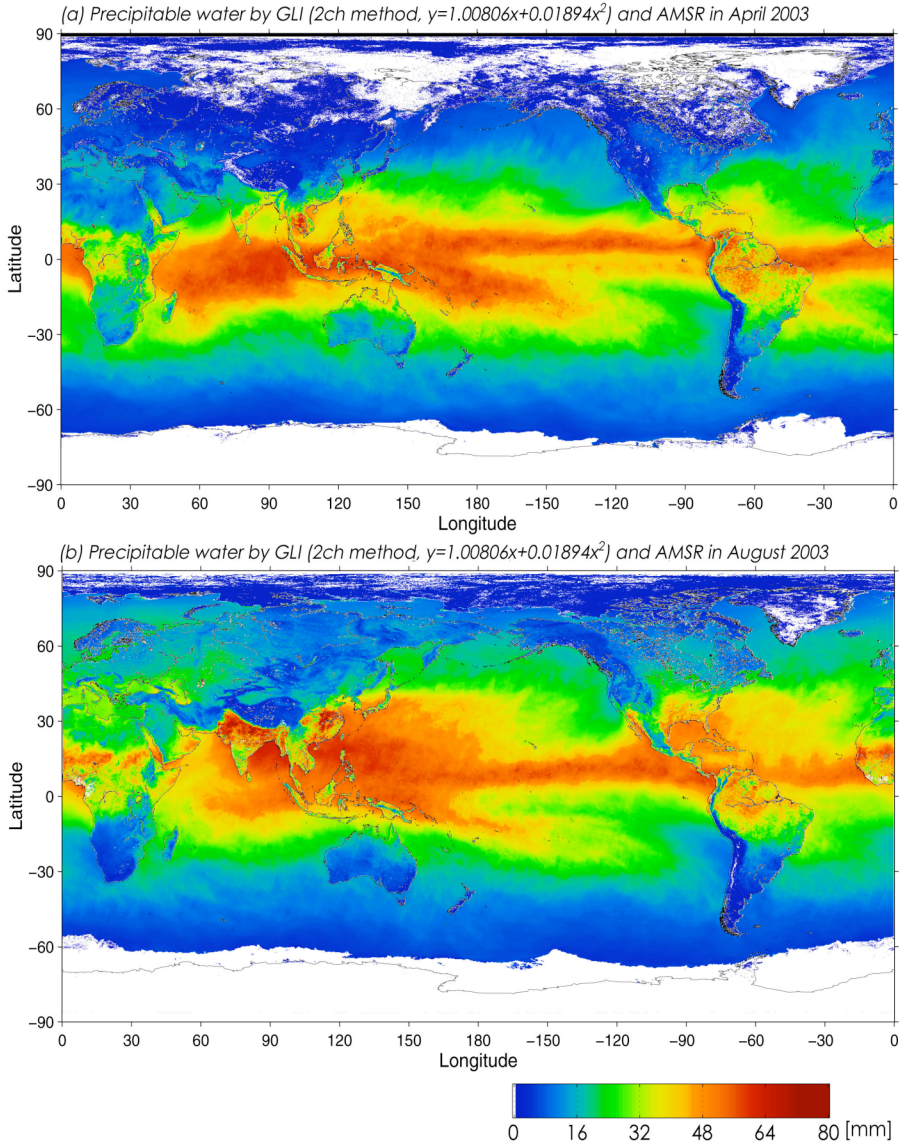


* We adopt the calibration curve under Lambertian surface (50% reflectivity) condition without aerosol loading in this analysis;

Precipitable water with GLI (over Land; 2ch); Seasonal contrast

April 2003

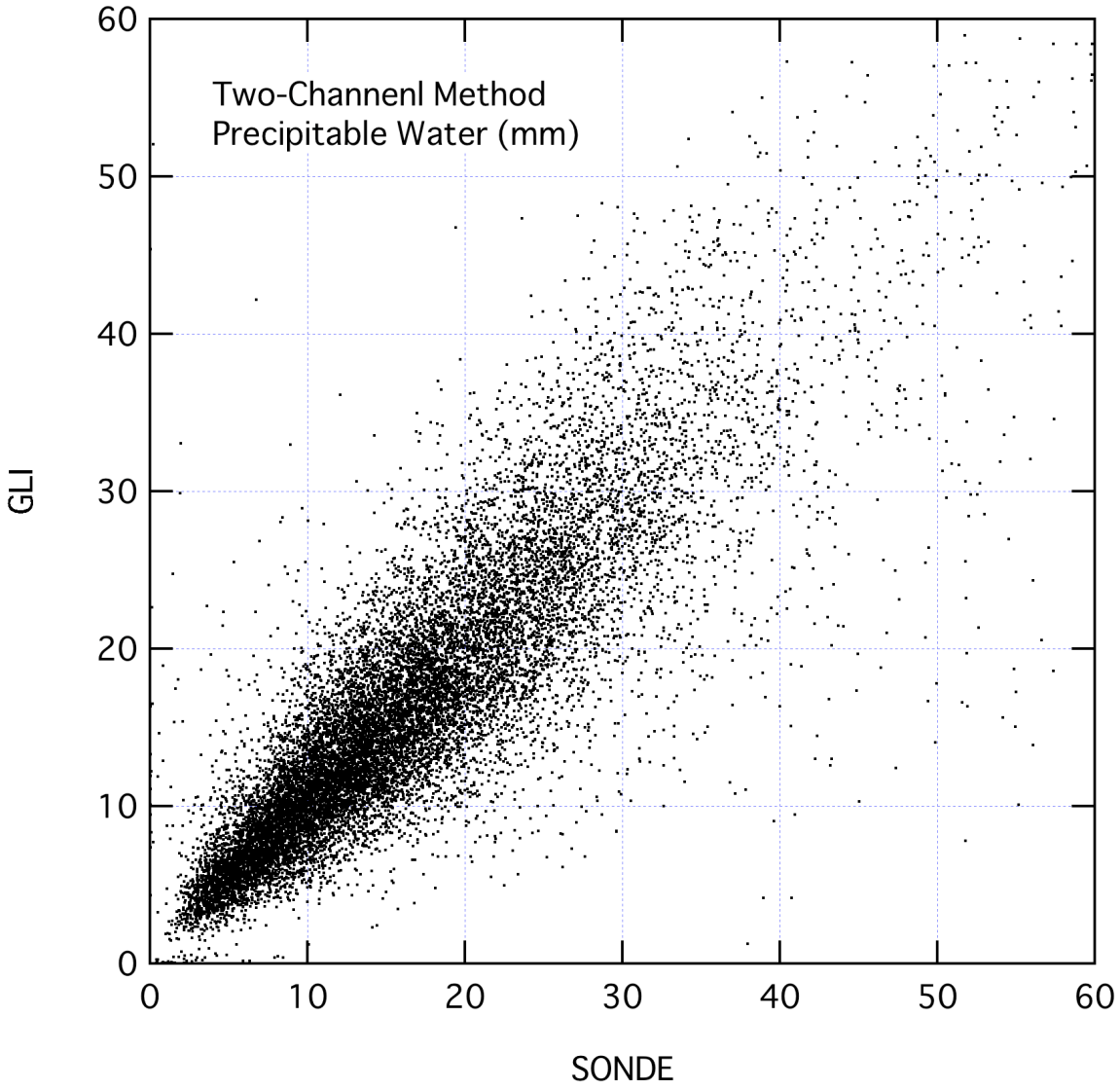
August 2003



- Comparison between spring (April) and summer (August);
  - Good seasonal contrast;
- GLI precipitable water was corrected after the validation with radio sonde;
- Precipitable water over ocean is retrieved with AMSR;

(provided by courtesy of JAXA EORC)

Re-validation with radiosondes



- **Good correlation between GLI and Radiosondes;**
  - **Even with a time lag by a few hours;**

➢ **A poster presentation by Dr. N. Kikuchi of JAXA EORC;**

N. Kikuchi (2007)

Summary (water vapor)

- GLI NIR enables us to retrieve precipitable water over land in 1-km resolution under a clear-sky condition;
- Global analysis over land
  - Combined results with water vapor over ocean with AMSR;
  - Good seasonal variation;
- Re-evaluation of calibration curve
  - Improvement of water vapor amount estimation;
  - Re-analysis on a global basis in the future;

Final Summary

Table 1. The development status (self-evaluation)

	Algorithm	Global analysis	Validation (precision)	Paper preparation	Relevant Channel
Cloud heights	***	***	**	**	O_2 A-band
Aerosol type over land	**	**	**	**	NUV
Water vapor amount	***	***	***	**	WV-NIR
Water vapor profile	**	*	*	*	WV-IR (#)

*** Almost done; ** Ongoing; * Future works;

A possible retrieval algorithm for water vapor profile with GLI water vapor IR bands;