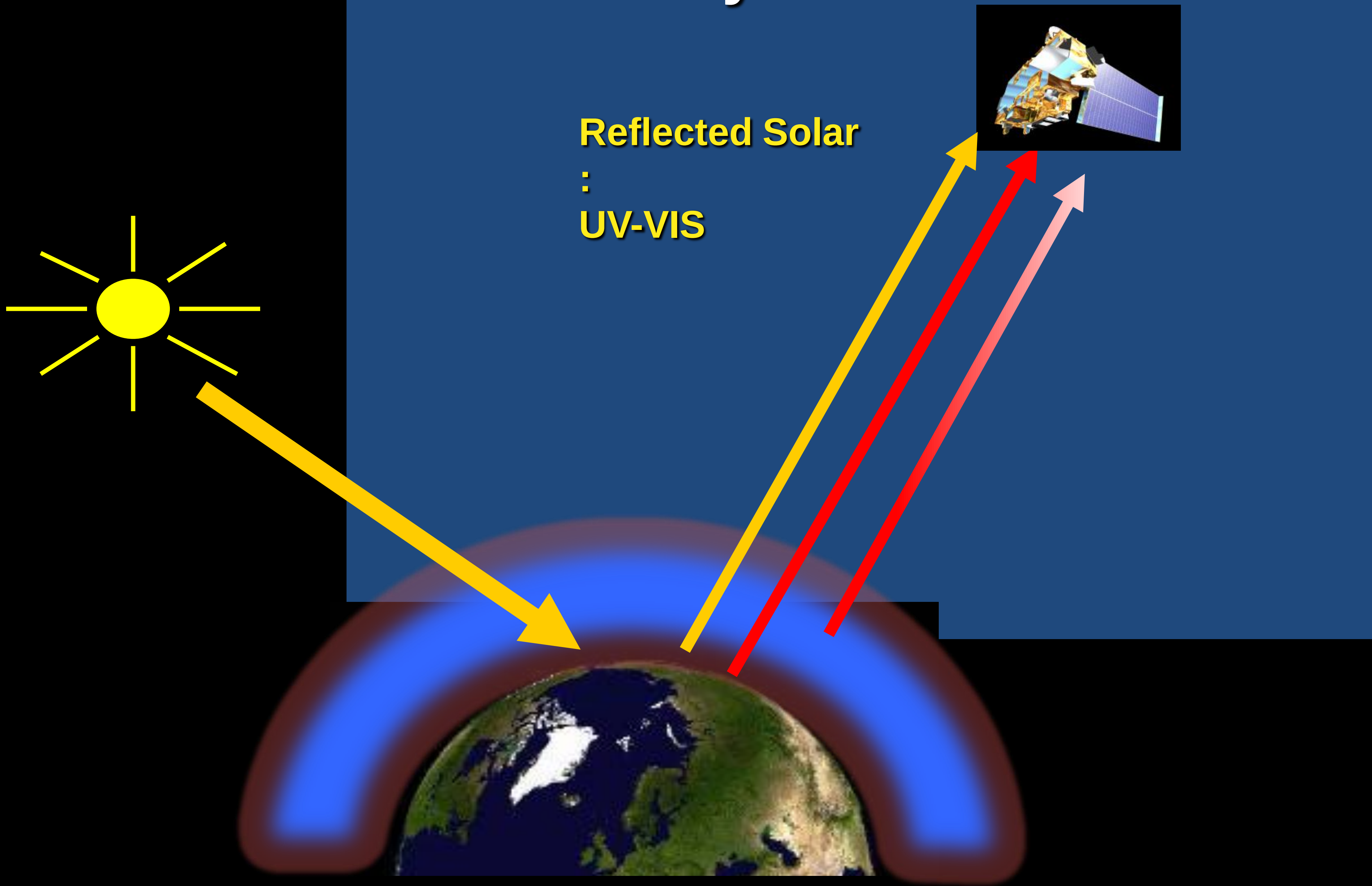
Issues on tropospheric ozone retrieval with geostationary satellite

Jae Hwan Kim[1] and M. J. Newchurch[2]

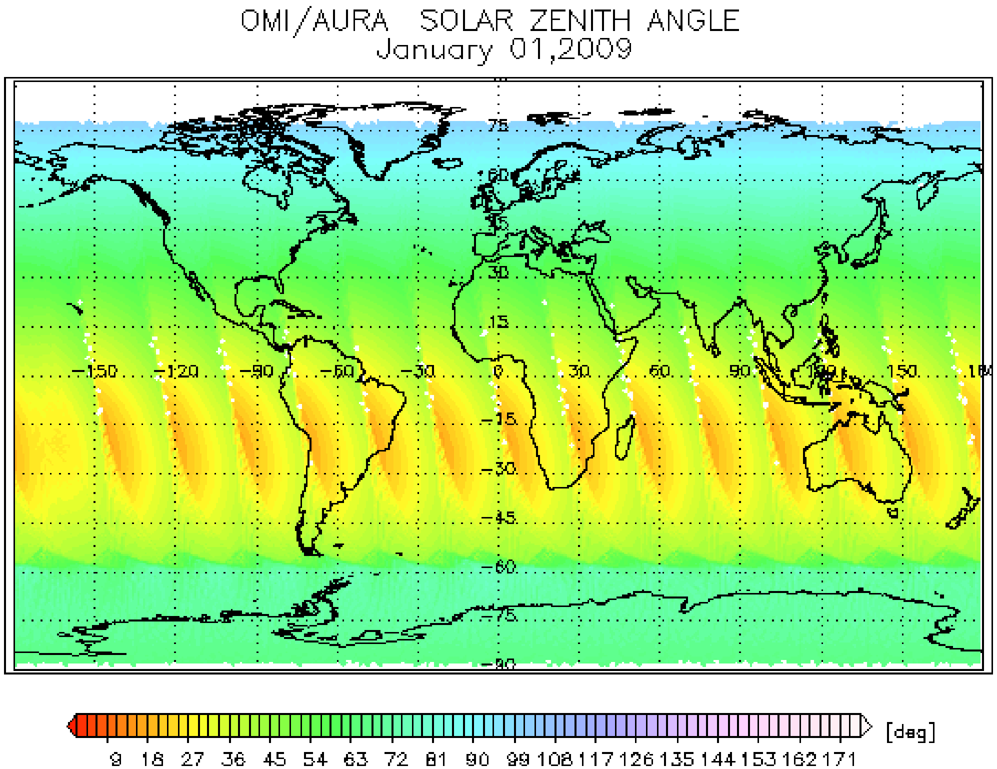
[1]*Pusan National University, Korea*

[2]*University of Alabama in Huntsville*

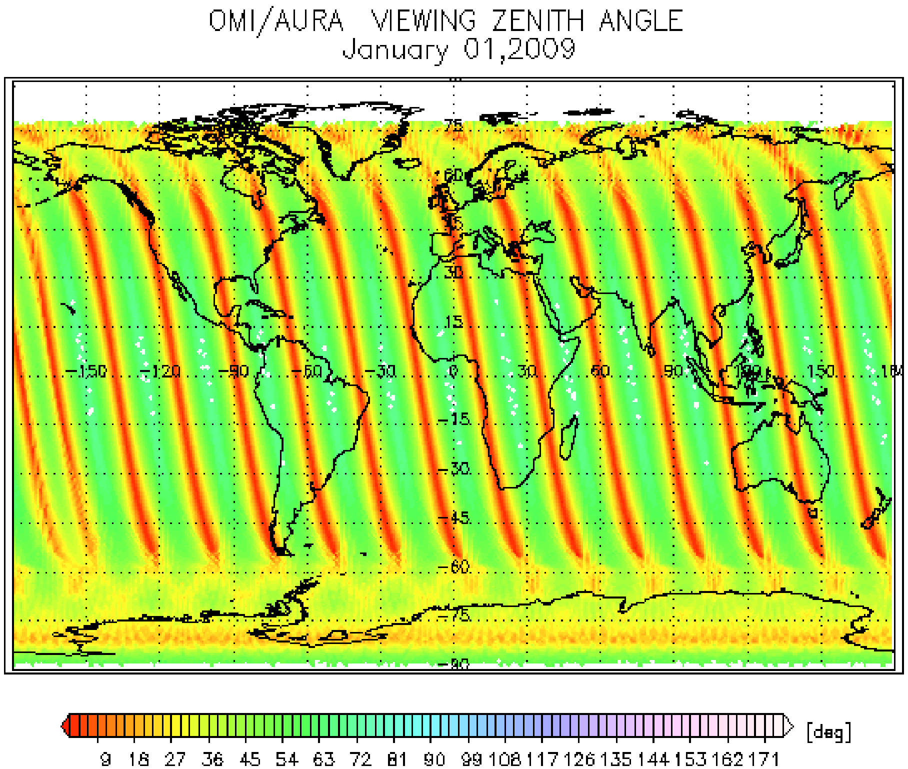
UV-Vis sensor for sunsynchronous satellite



Solar and satellite zenith angles for sun-synchronous satellite AURA-OMI

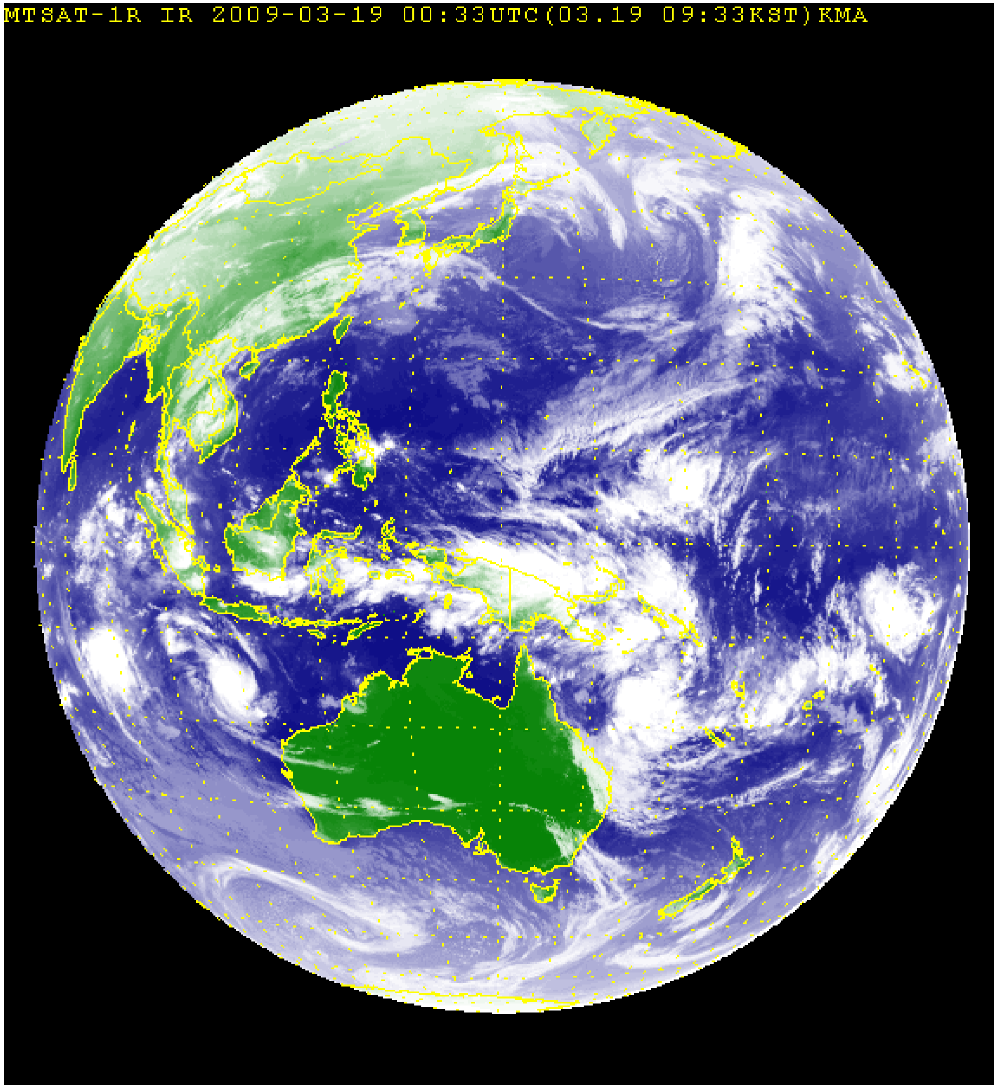


Solar zenith angle

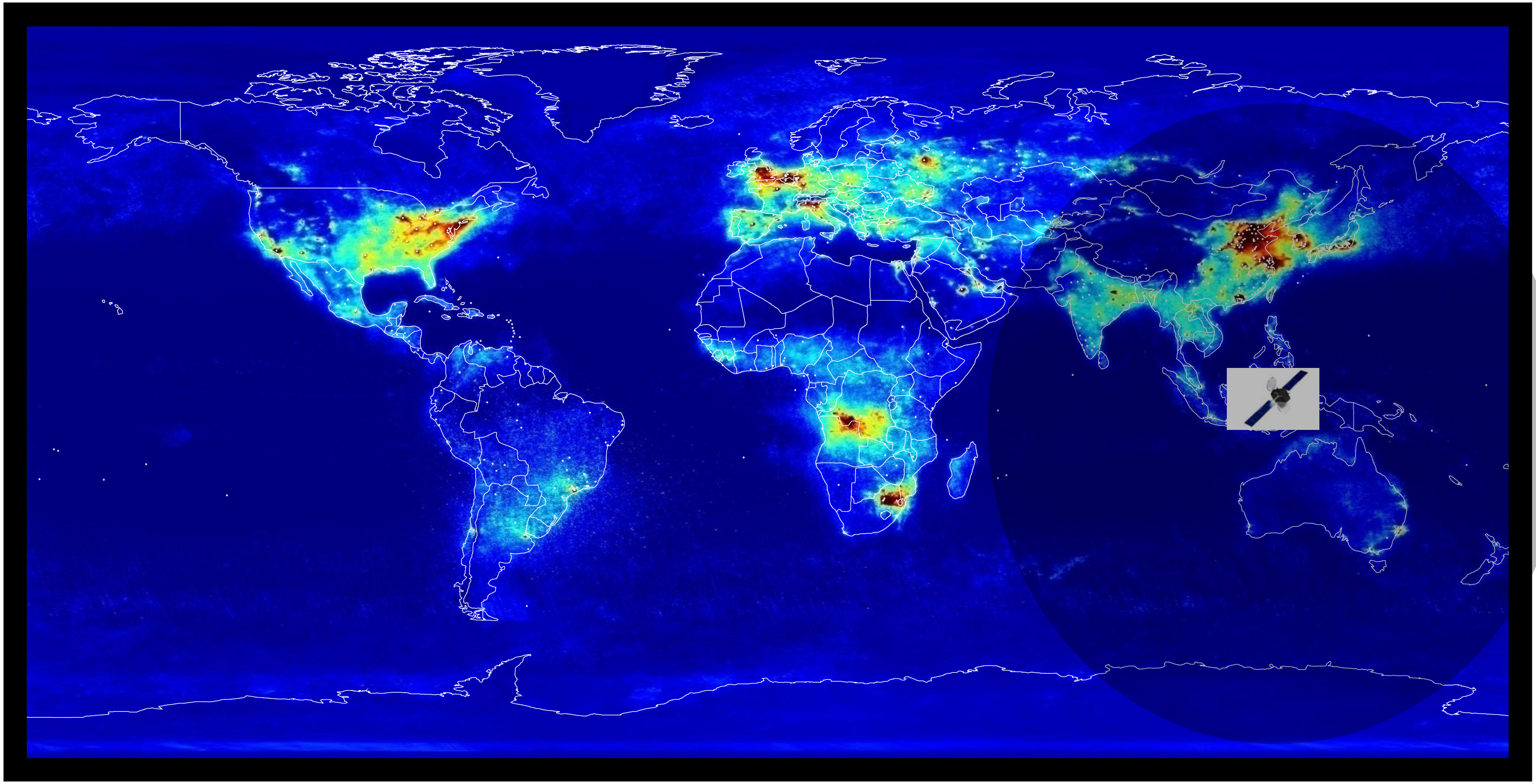


satellite zenith angle

View from geo-stationary satellite MTSAT (135° E)

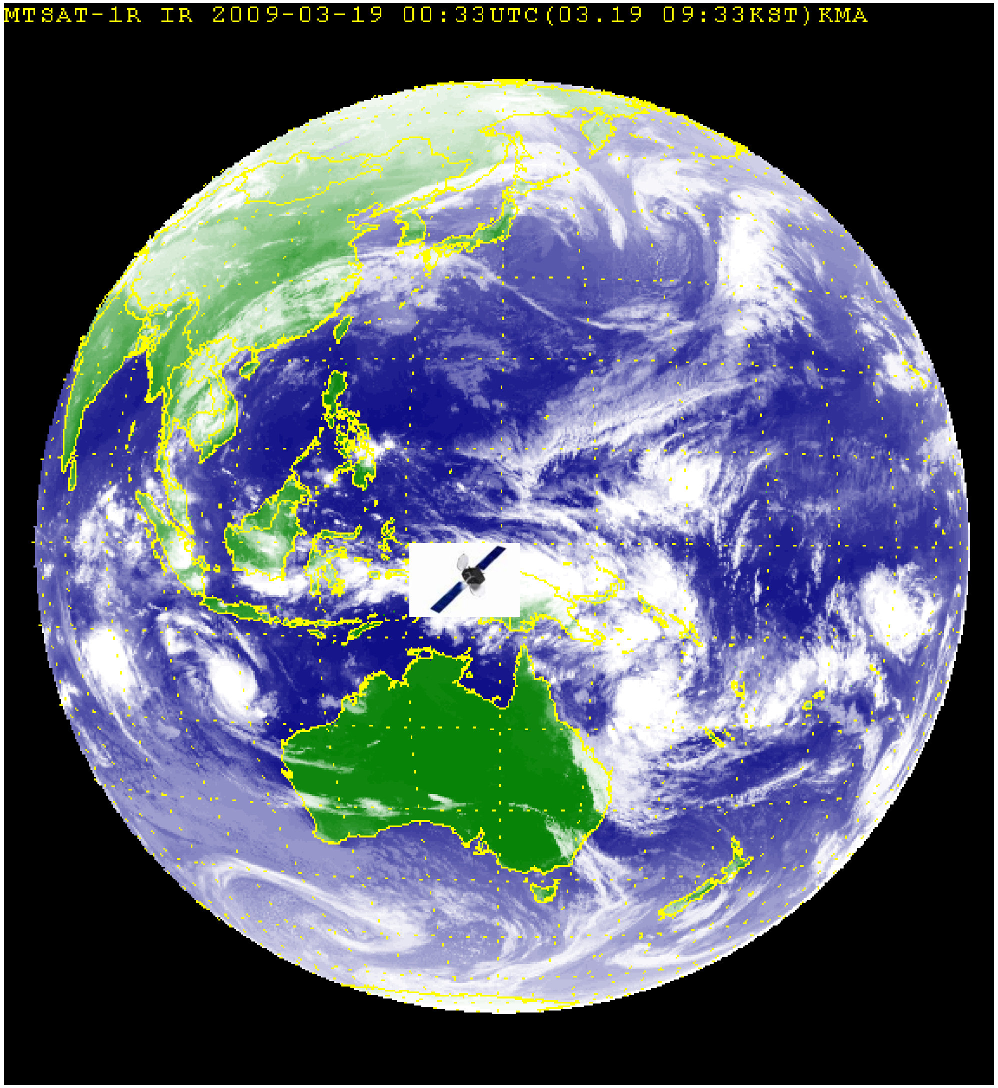


Future Geo-Satellite-View of Air Pollution Map

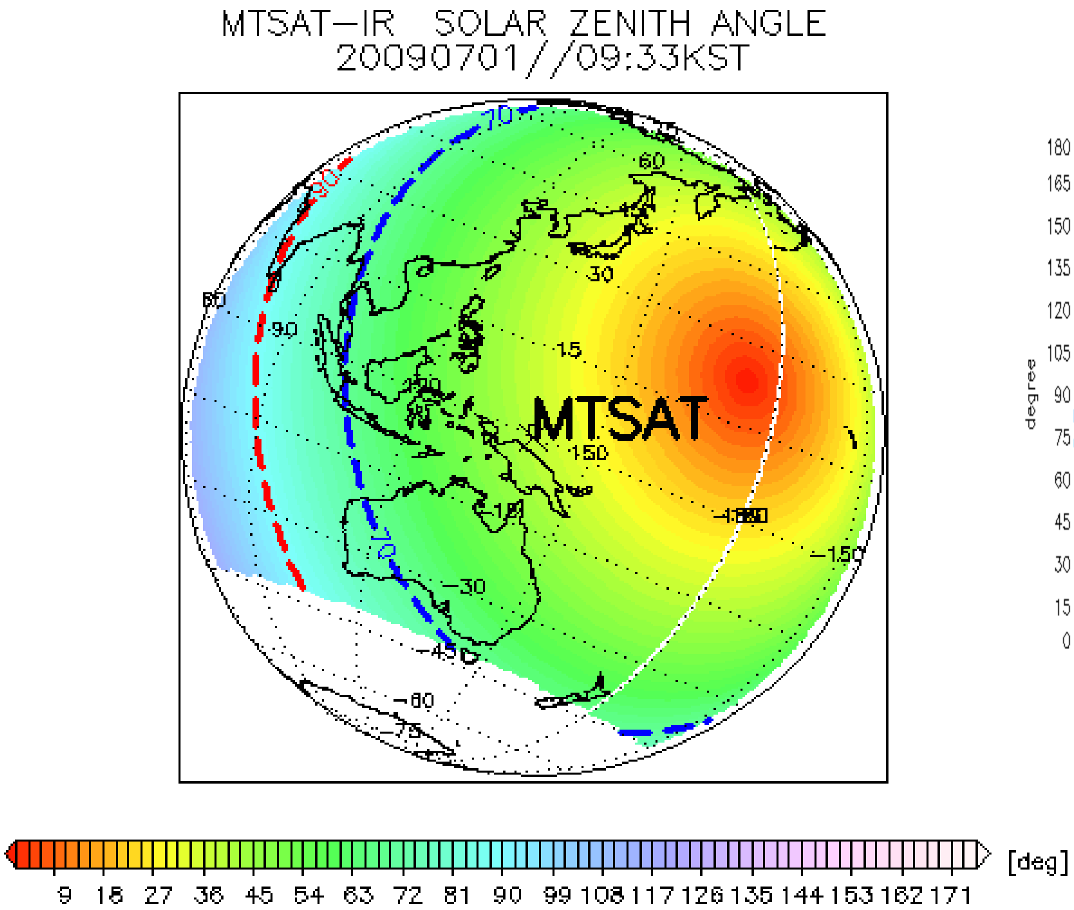


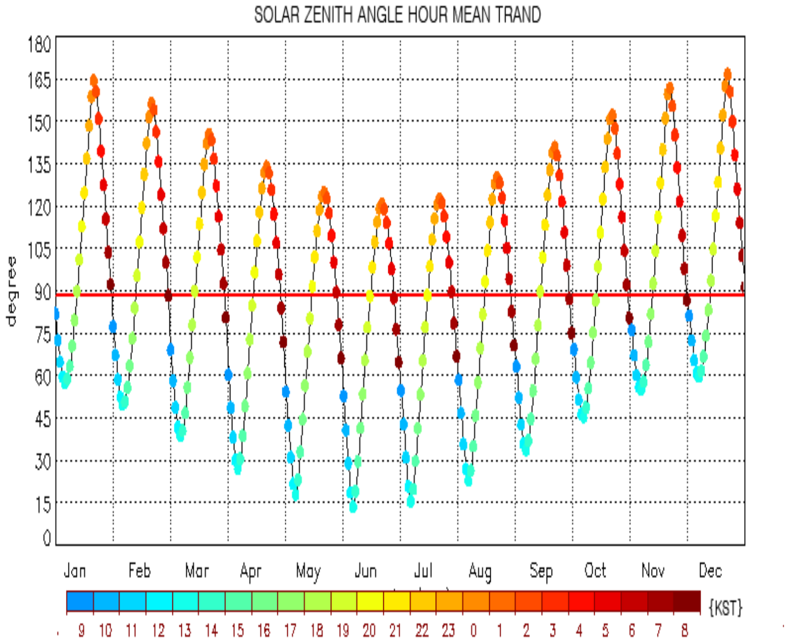
➢ NO2 (tropospheric ozone precursor) map from OMI

View from geo-stationary satellite MTSAT (135° E)

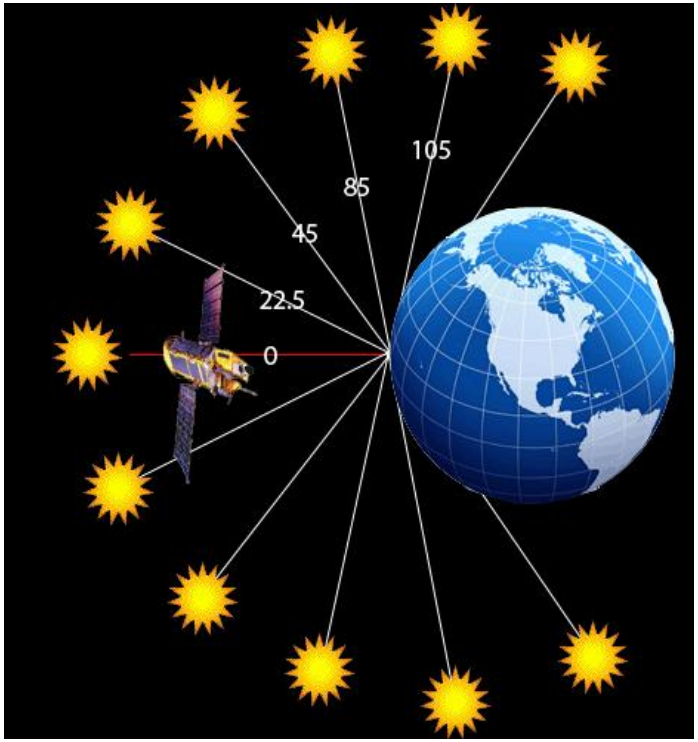


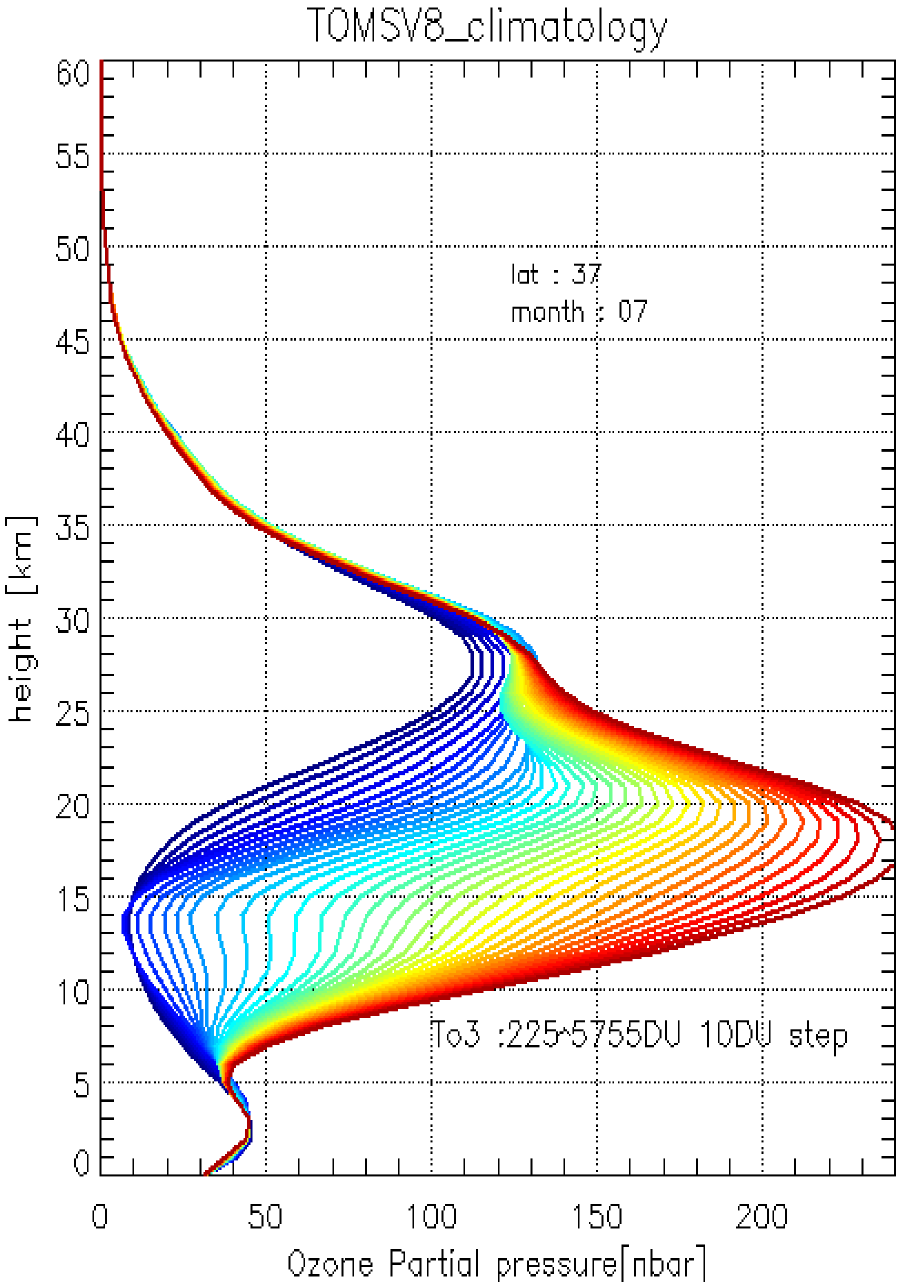
Solar zenith angle from geostatonary satellite (MTSAT)





1. Influence of changing SZA on tropospheric gas retrival





2. Wavelength coverage for geostatonary satellite

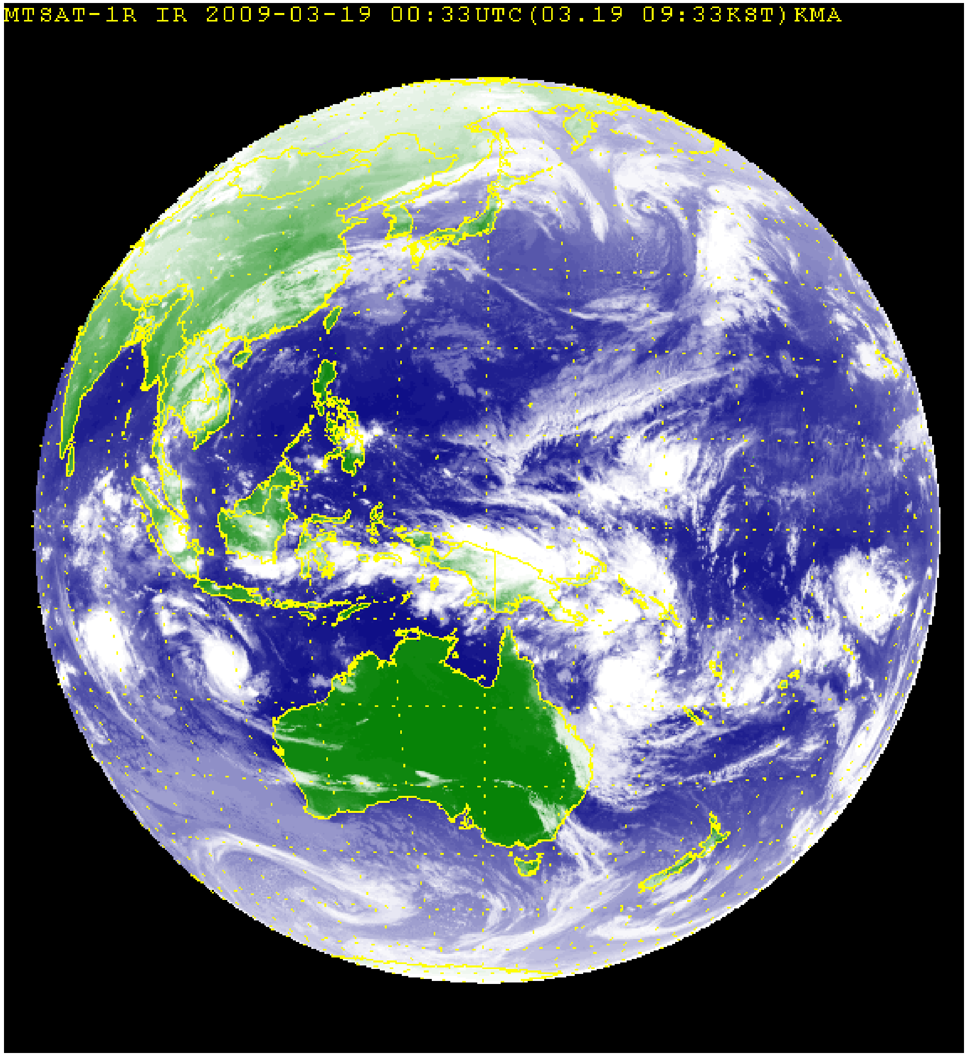
- Wavelength coverage for OMI : 270-500nm

- We plan to have a wavelength coverage of 300 – 500nm

- Ball Aerospace suggests 310 – 500nm to reduce cost.

➔ How does this wavelength coverage change affect ozone retrieval?

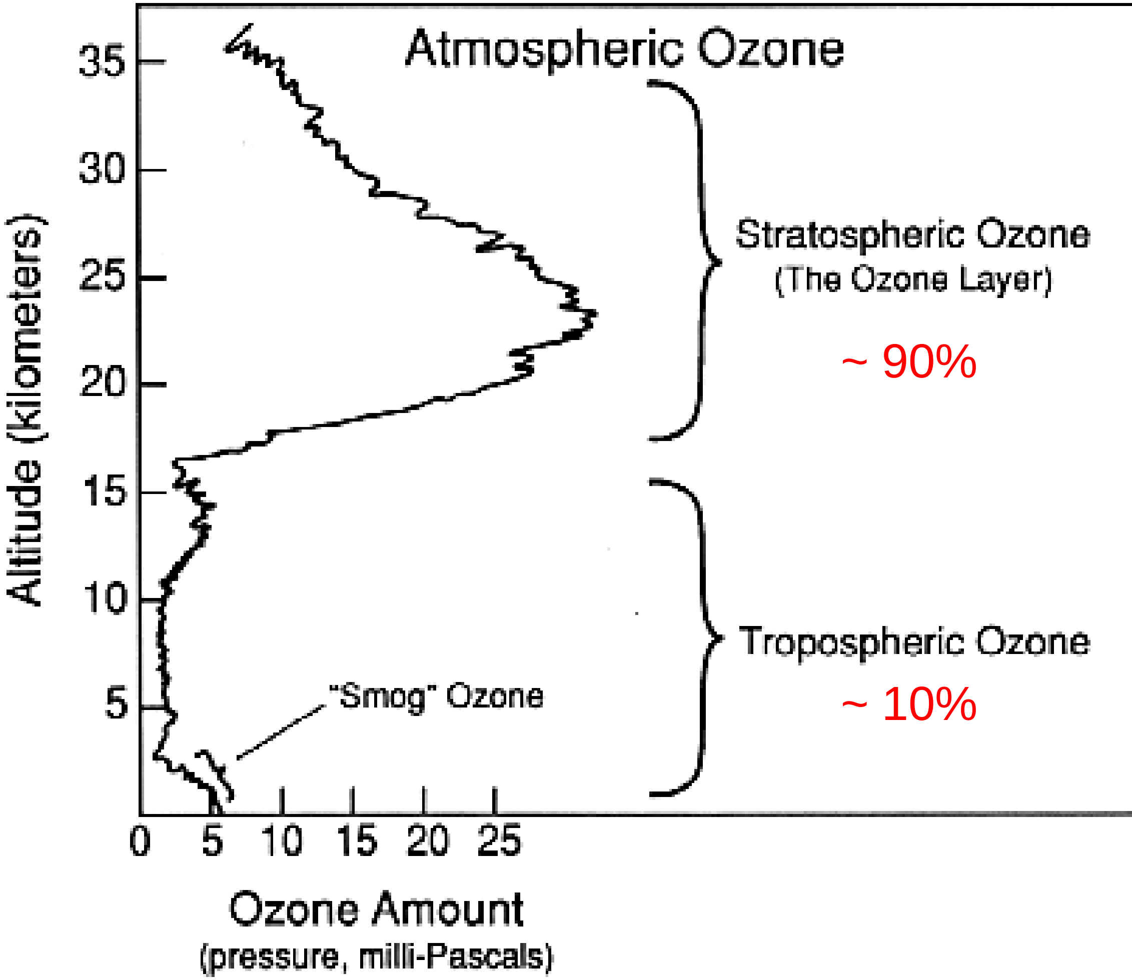
3. Cloud interference on the measurements ➔ How to get the cloud top pressure



- To make good measurements above clouds, we need the cloud top pressure!

- Can we determine well the cloud top pressure information.

Difficulty in detecting tropospheric ozone from satellites



• Contains 90% of Atmospheric Ozone • Beneficial Role: Acts as Primary UV Radiation Shield • Current Issues: – Long-term Global Downward Trends – Springtime Antarctic Ozone Hole Each Year
• Contains 10% of Atmospheric Ozone • Harmful Impact: Toxic Effects on Humans and Vegetation • Current Issues: – Episodes of High Surface Ozone in Urban and Rural Areas

Tropospheric ozone retrieval methods with satellites

- Tropospheric ozone residual method

  - Total ozone – stratospheric ozone (J. Fishman, J. Ziemke)

    Requires an additional stratospheric ozone information from other satellite

  - Cloud Slicing Method (J. Ziemke and PK. Bhartia)

    Requires presence of clouds and information for cloud top height

- Scan angle geometry method (J. Kim and M. Newchurch)

  - Requires multi-angle measurements

- Optimal estimation method (X. Liu)

  - requires wavelength coverage (270 – 340nm)

Issues on tropospheric ozone retrieval with geo-satellite

- Do much measured radiances contain tropospheric ozone information content?

  - How does the change in solar zenith angle during a day affect ozone (gases) retrieval

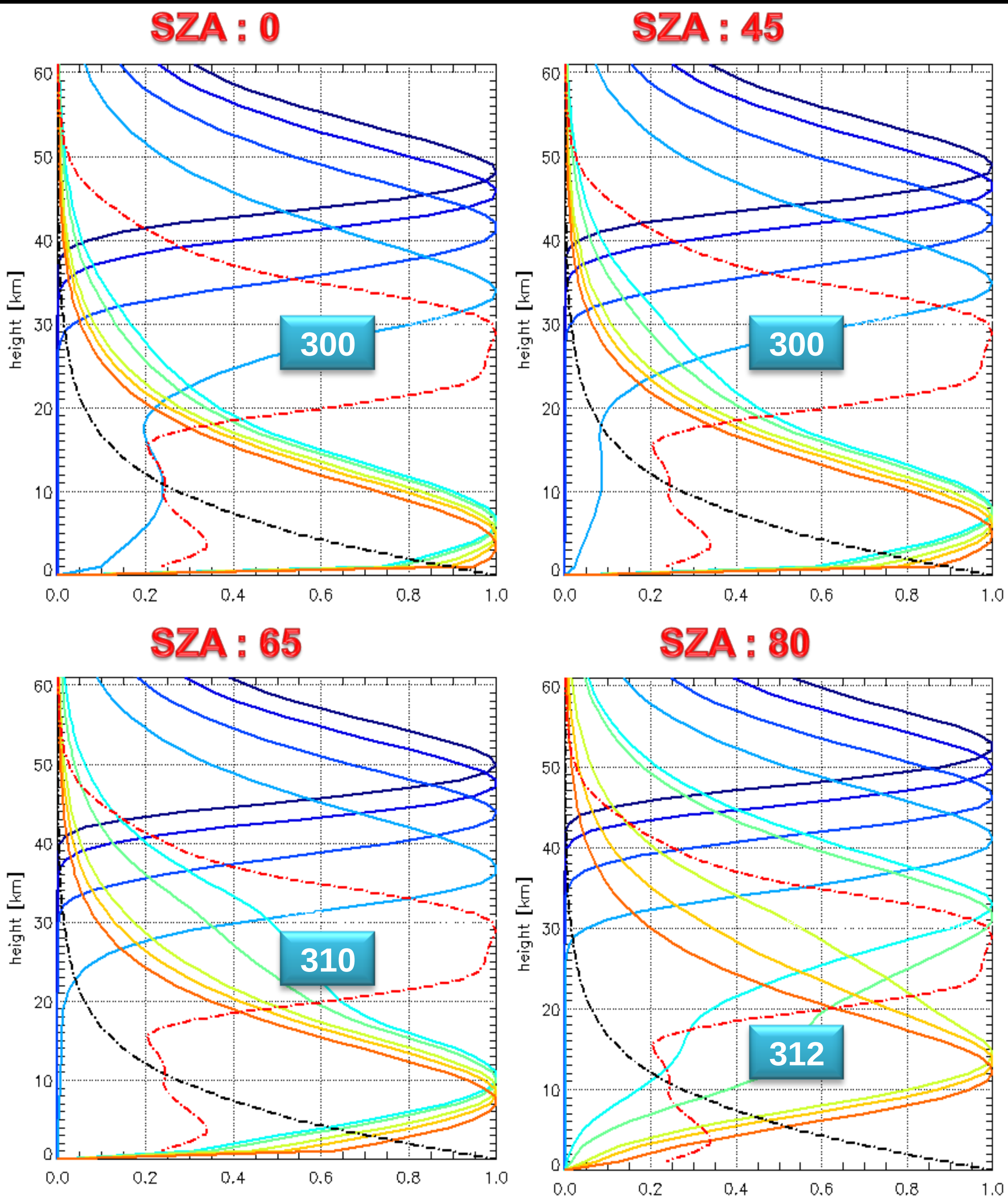
  - How does the change in wavelength coverage affect ozone retrieval?

- Can we determine cloud top pressure?

LIDORT

- **Linearized Discrete Ordinate Radiative Transfer by Spurr**

Single scattering contribution Function (SSCF)



Ozone (325DU): -----

air dens: black

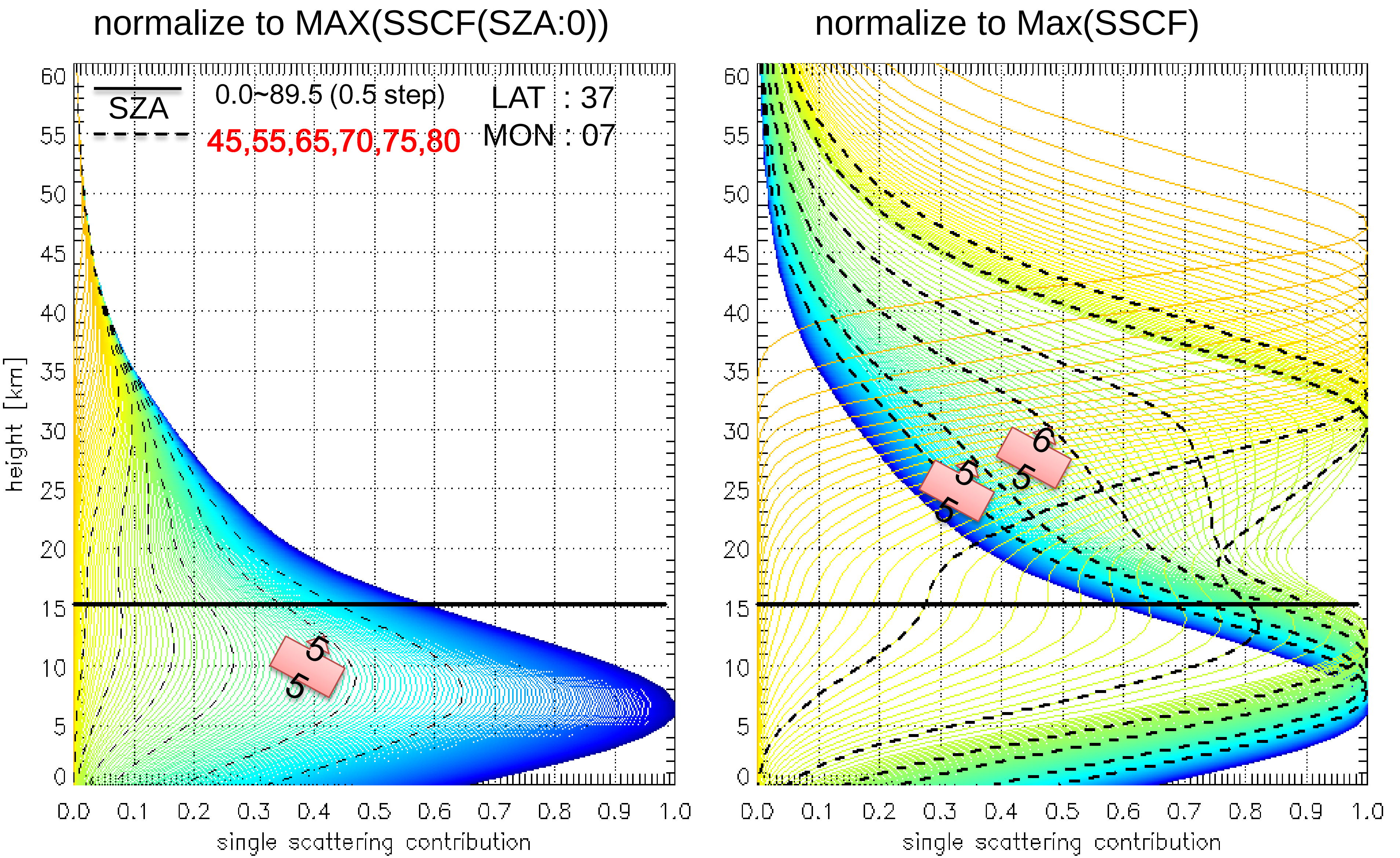
Solid line : SSCF

wavelength :
270, 280, 290, 300
310, 312, 317, 322, 331

SSCF sensitivity Test FOR solar zenith anlge

wavelength
310nm

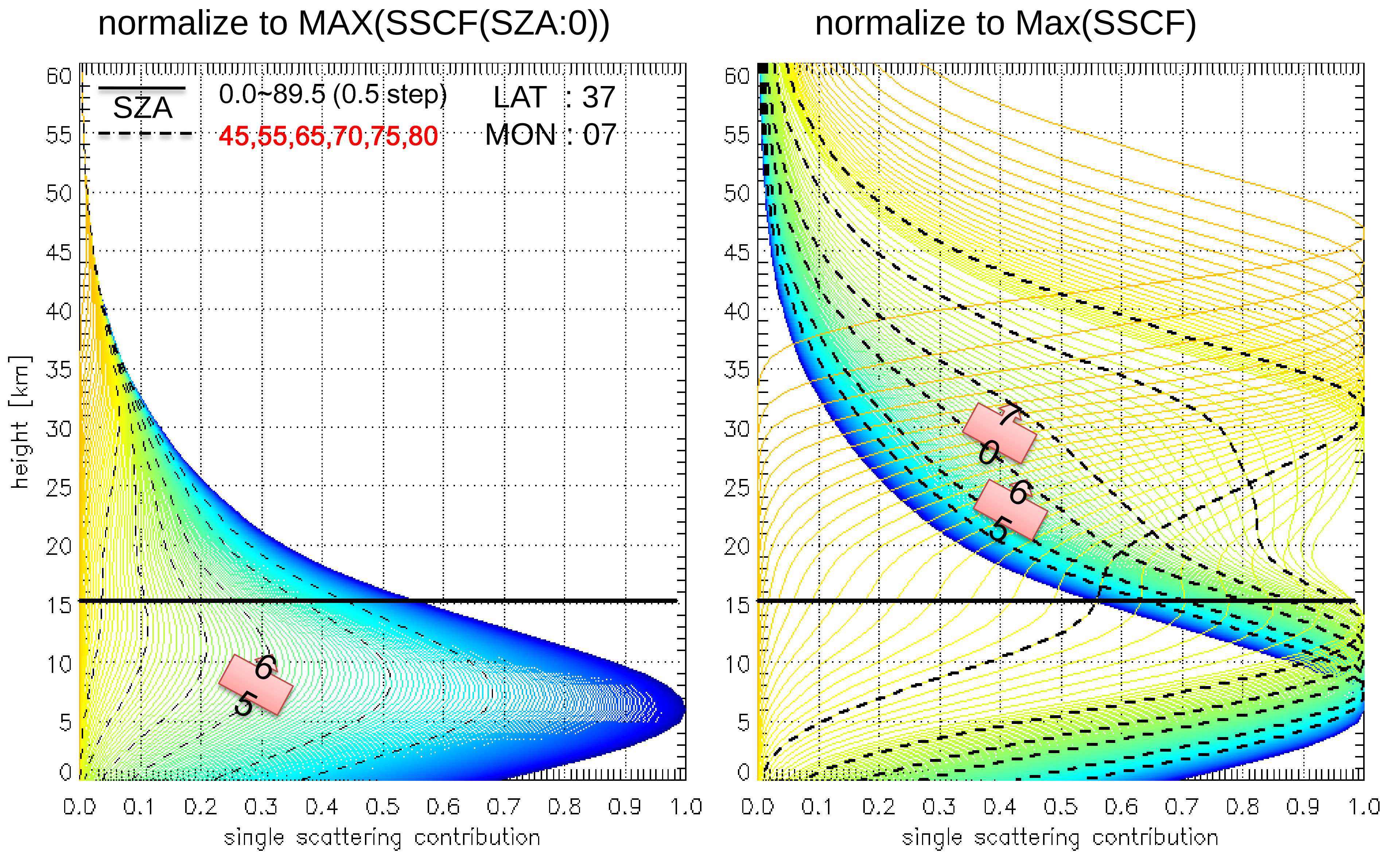
Satellite zenith angle : 0



SSCF sensitivity Test FOR solar zenith anlge

wavelength 312nm

Satellite zenith angle : 0

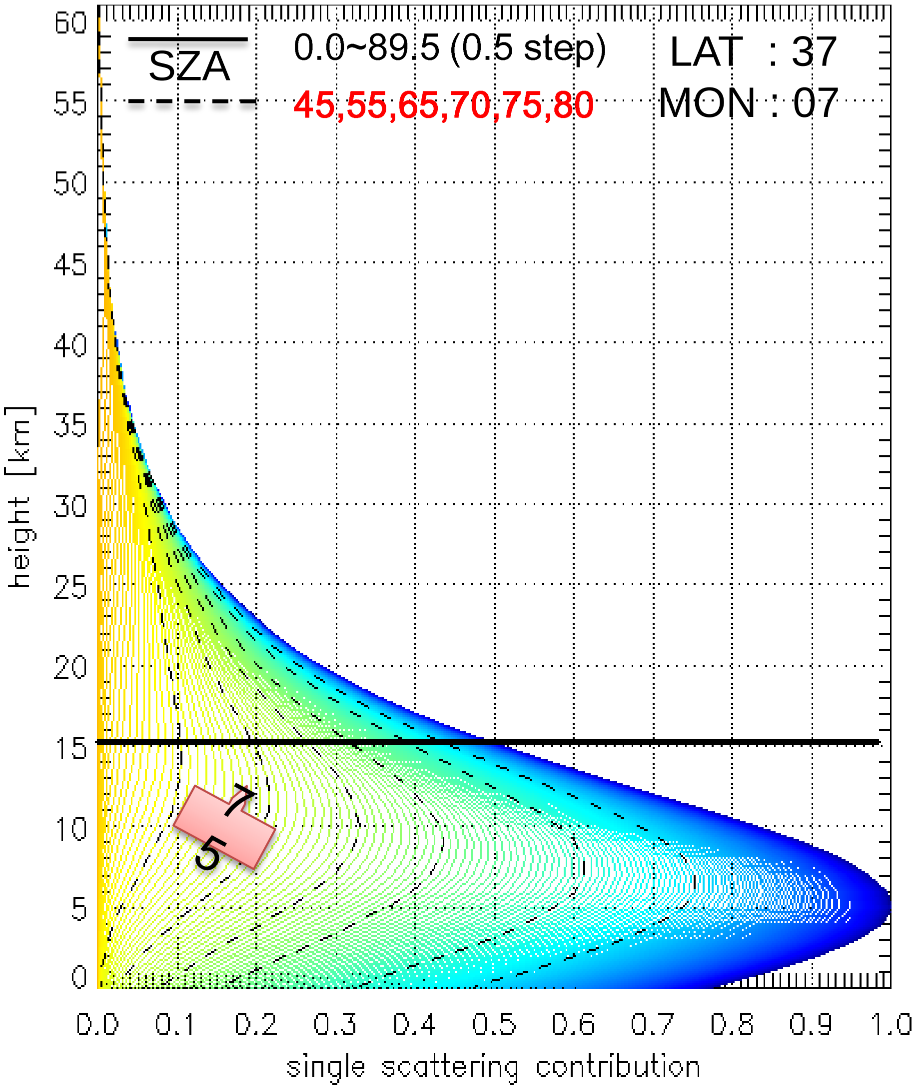


SSCF sensitivity Test FOR solar zenith anlge

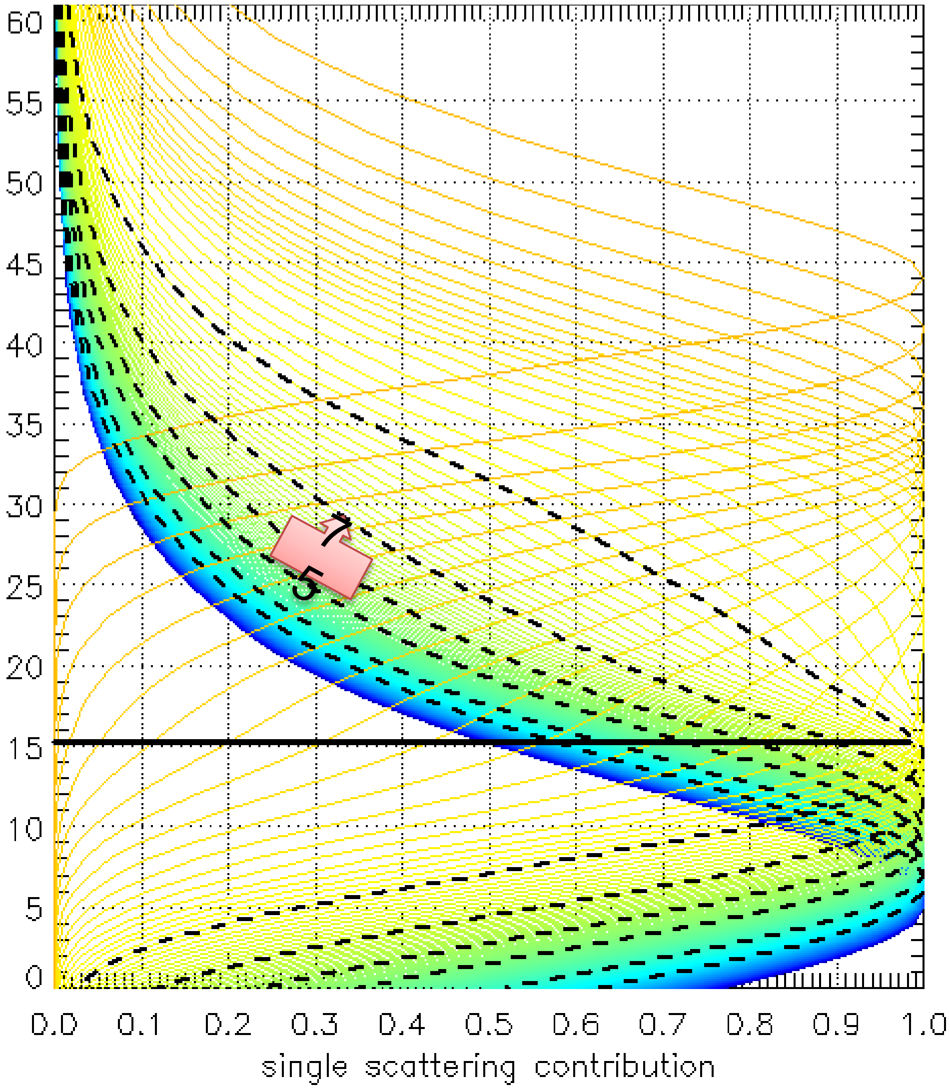
wavelength 317nm

Satellite zenith angle : 0

normalize to MAX(SSCF(SZA:0))



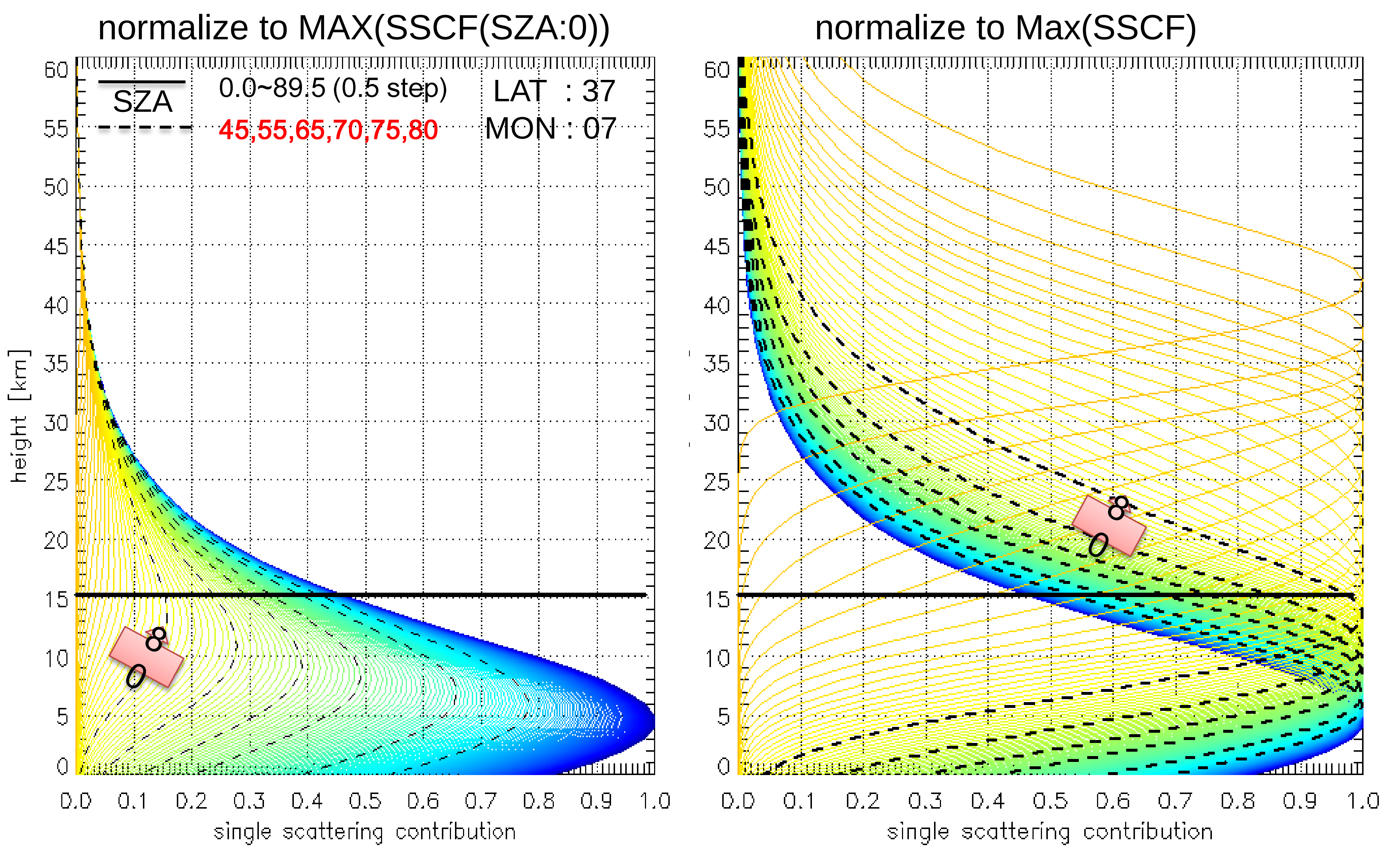
normalize to Max(SSCF)



SSCF sensitivity Test FOR solar zenith anlge

wavelength 322nm

Satellite zenith angle : 0

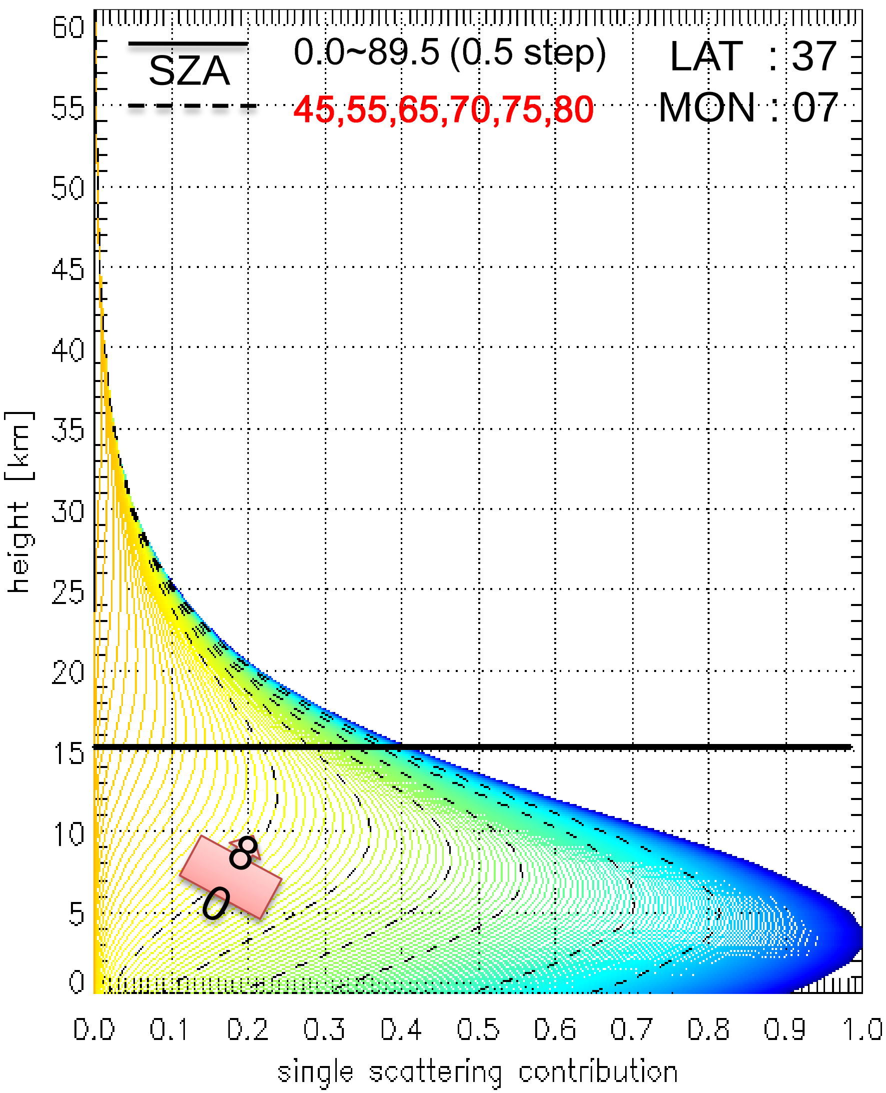


SSCF sensitivity Test FOR solar zenith anlge

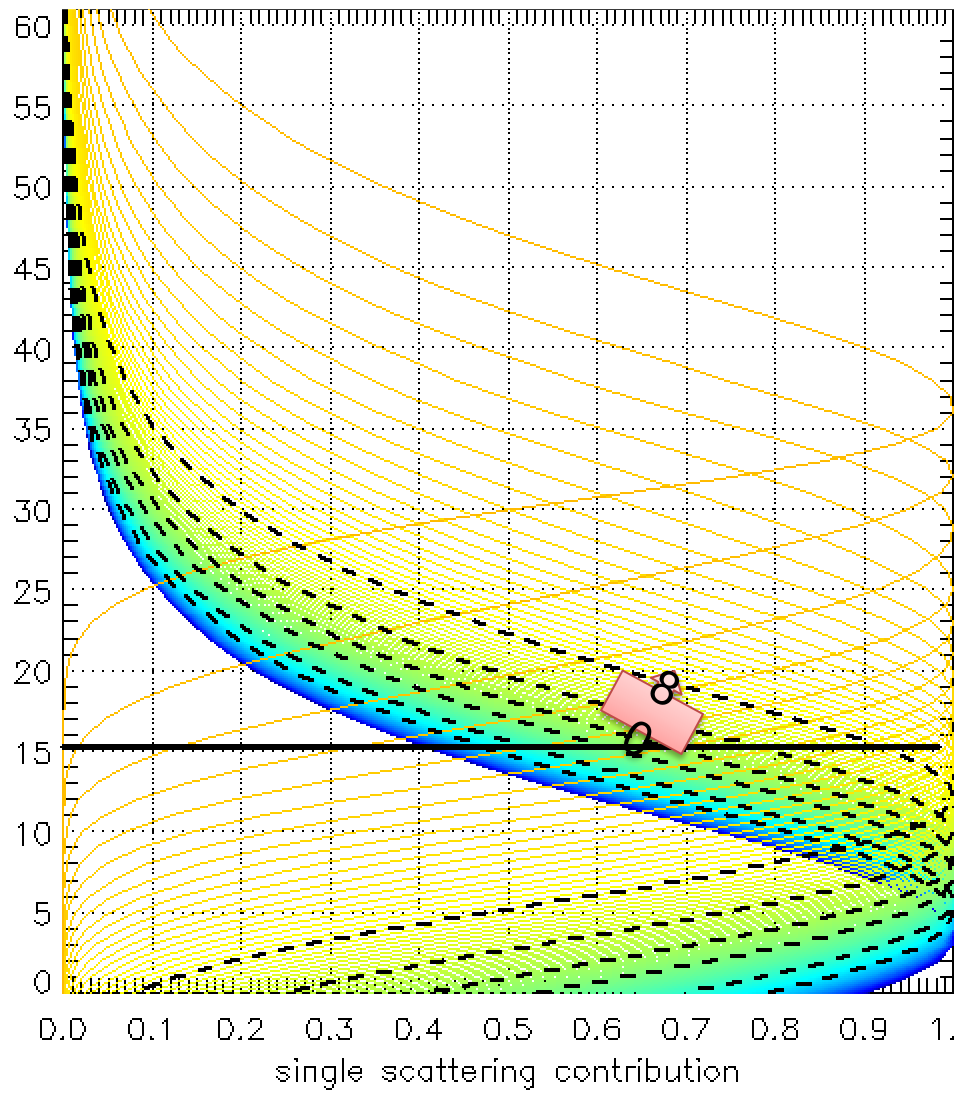
wavelength
331 nm

Satellite zenith angle : 0

normalize to MAX(SSCF(SZA:0))



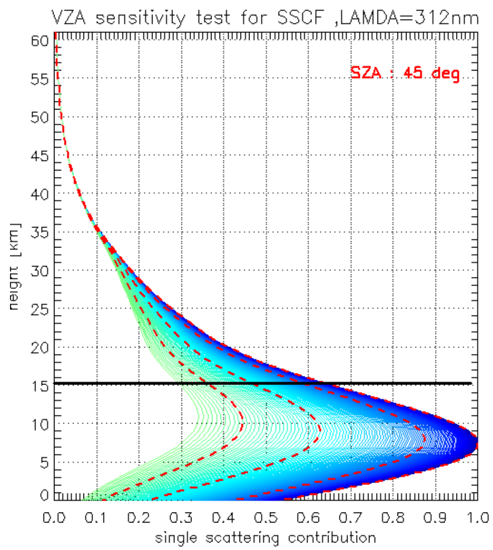
normalize to Max(SSCF)

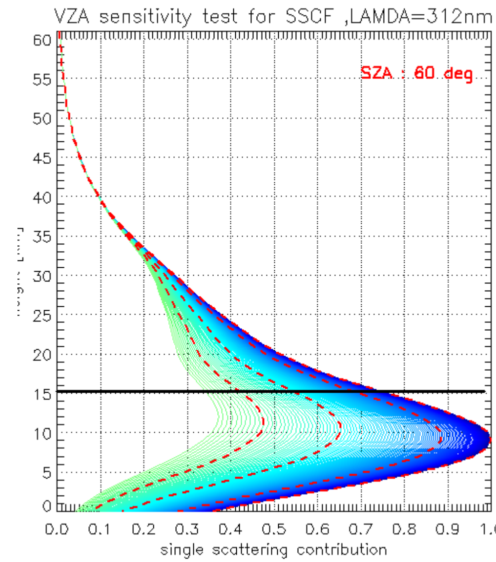


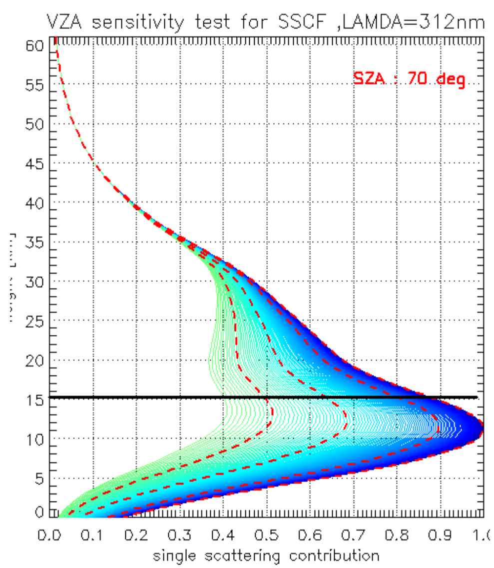
SSCF sensitivity Test FOR Viewing zenith anlge

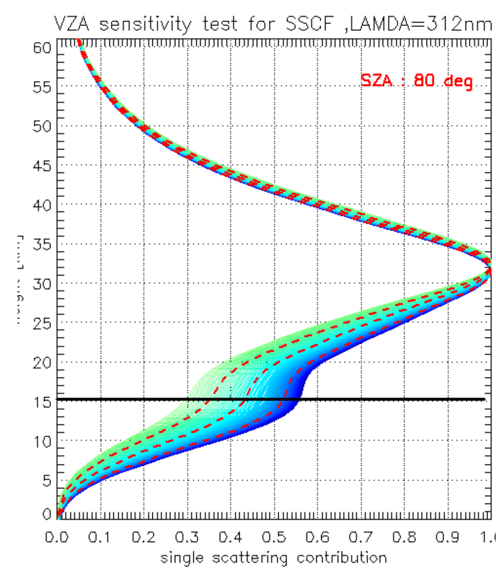
wavelength
312nm

VZA range : 0.0~65 , 0.5step   ----- 0,30,50,60





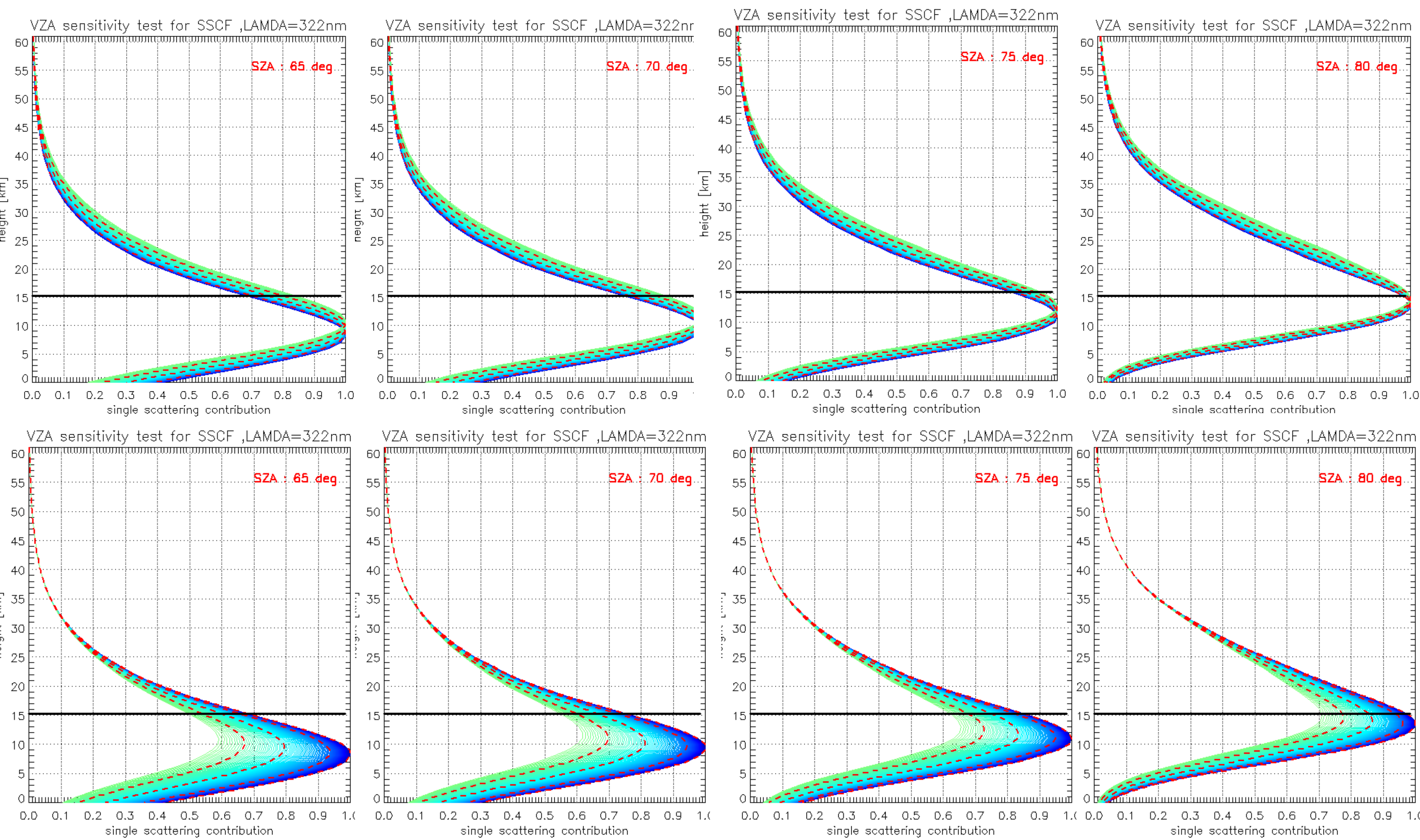




SSCF sensitivity Test FOR Viewing zenith anlge

LAMDA
322nm

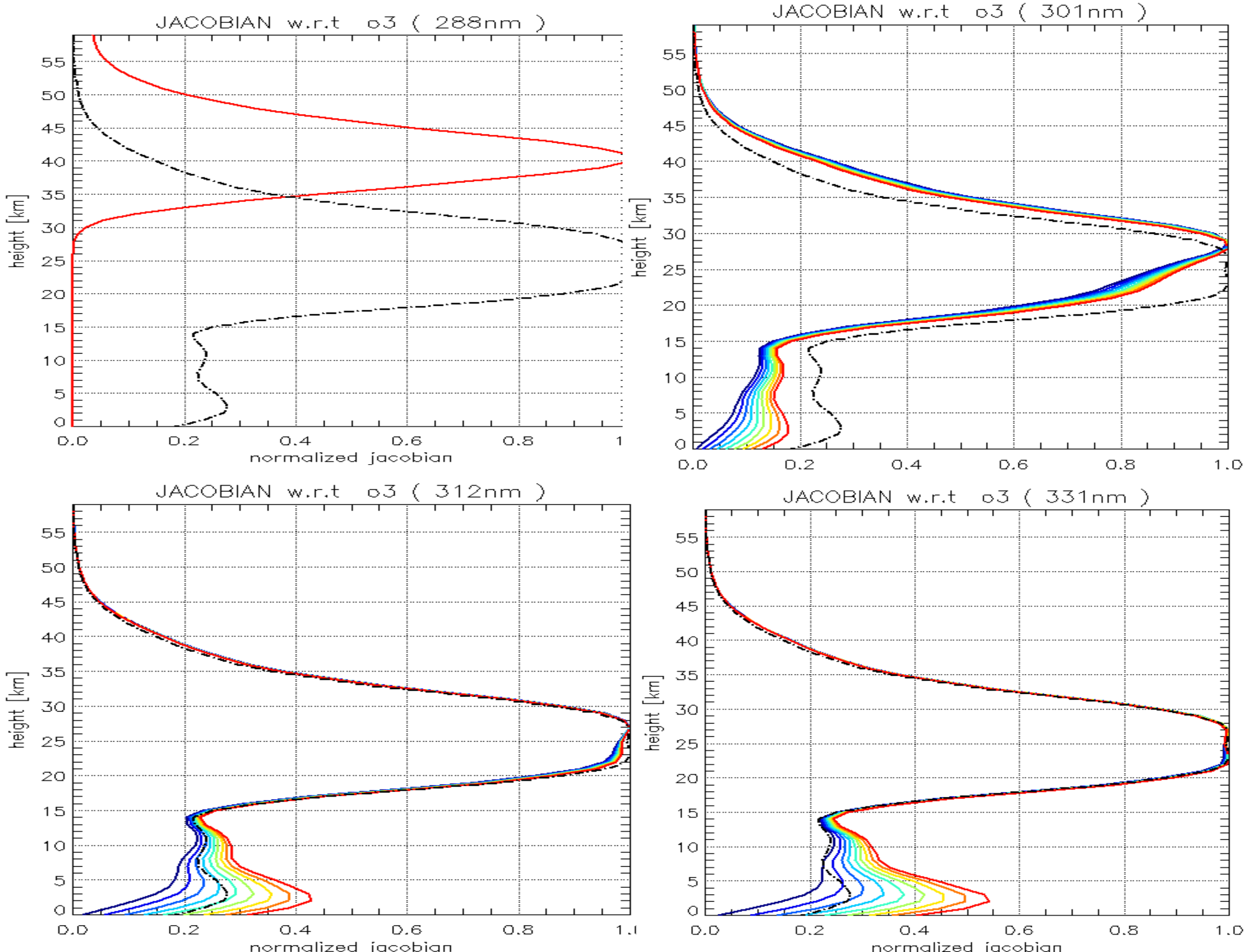
VZA range : 0.0~65 , 0.5step   ----- 0,30,50,60



Averaging kernel as a function of surface reflectivities

ALBEDO LEVEL : 0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9

<-colder color ->warmer color

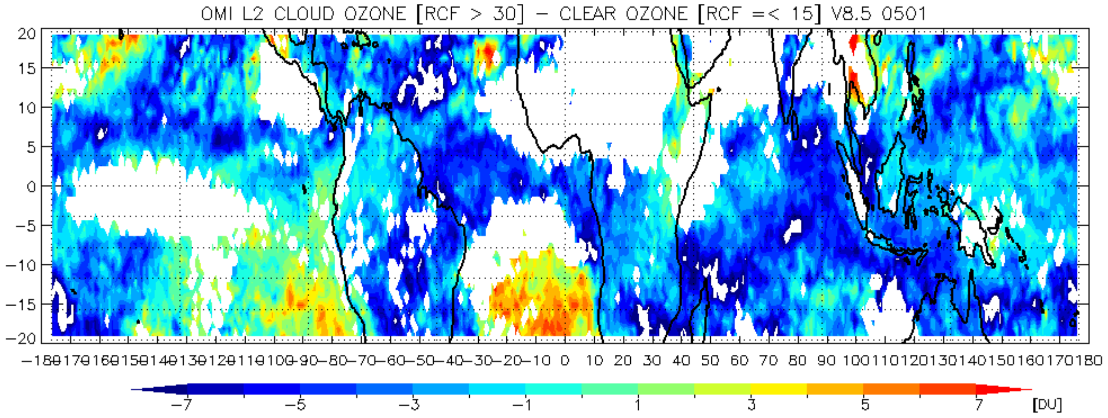


Good sensitivity over a high reflecting surface

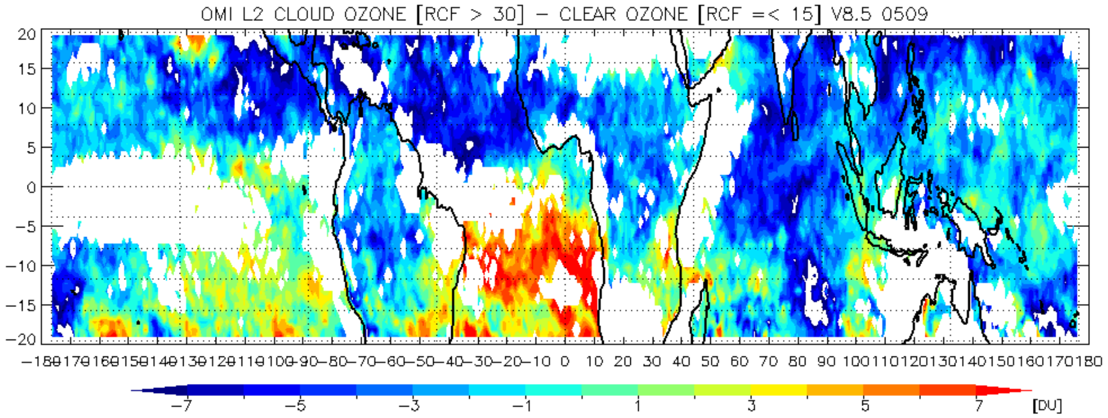
Cloud top pressure retrieval and its error

- cloud-pressure climatology based on thermal infrared cloud-top pressures

- O2-O2 absorption (The new OMI V8.5 uses the optical centroid cloud top p
  ressure in deep convective clouds)



Total ozone difference between clear and cloudy regions in January 2005



Total ozone difference between clear and cloudy regions in September 2005

summary

- The lowest wavelength for tropospheric ozone retrieval must be lower than at least 300nm.

- Solar and satellite zenith angle

  affect the contribution function and cause changes in tropospheric gases information contents ➔ may loose tropospheric information

➔ change in solar zenith angle will provide the same effect as of multi-angle measurements

➔ can be use to improve retrieval sensitivity and better a vertical gas profiling.

- A better way of determining cloud top pressure is required

summary

- Cloud will hinder the satellite measurement for the lower troposphere.
- Geo-satellite solve this problem because of continuous measurement

  ➔ improve measurement capability and sensitivity.

- Cloud produces the retrieval error. If we use this error backward, we may be able to figure out the height and characteristics of clouds (distinguish between fog and stratus cloud)

- We will be able to find the interaction between chemistry and meteorology.