Introduction to GEMS Ultraviolet Product

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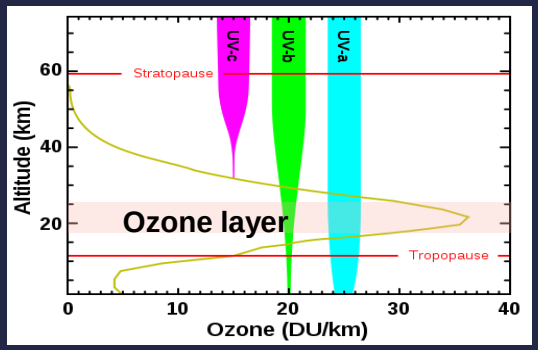
Hana Lee[1], Jhoon Kim[1], Ukkyo Jeong [2,3]

[1] Department of Atmospheric Sciences, Yonsei University
[2] GSFC, NASA
[3] University of Maryland, College Park, MD, USA

Surface UV Radiation

- Ultraviolet Radiation

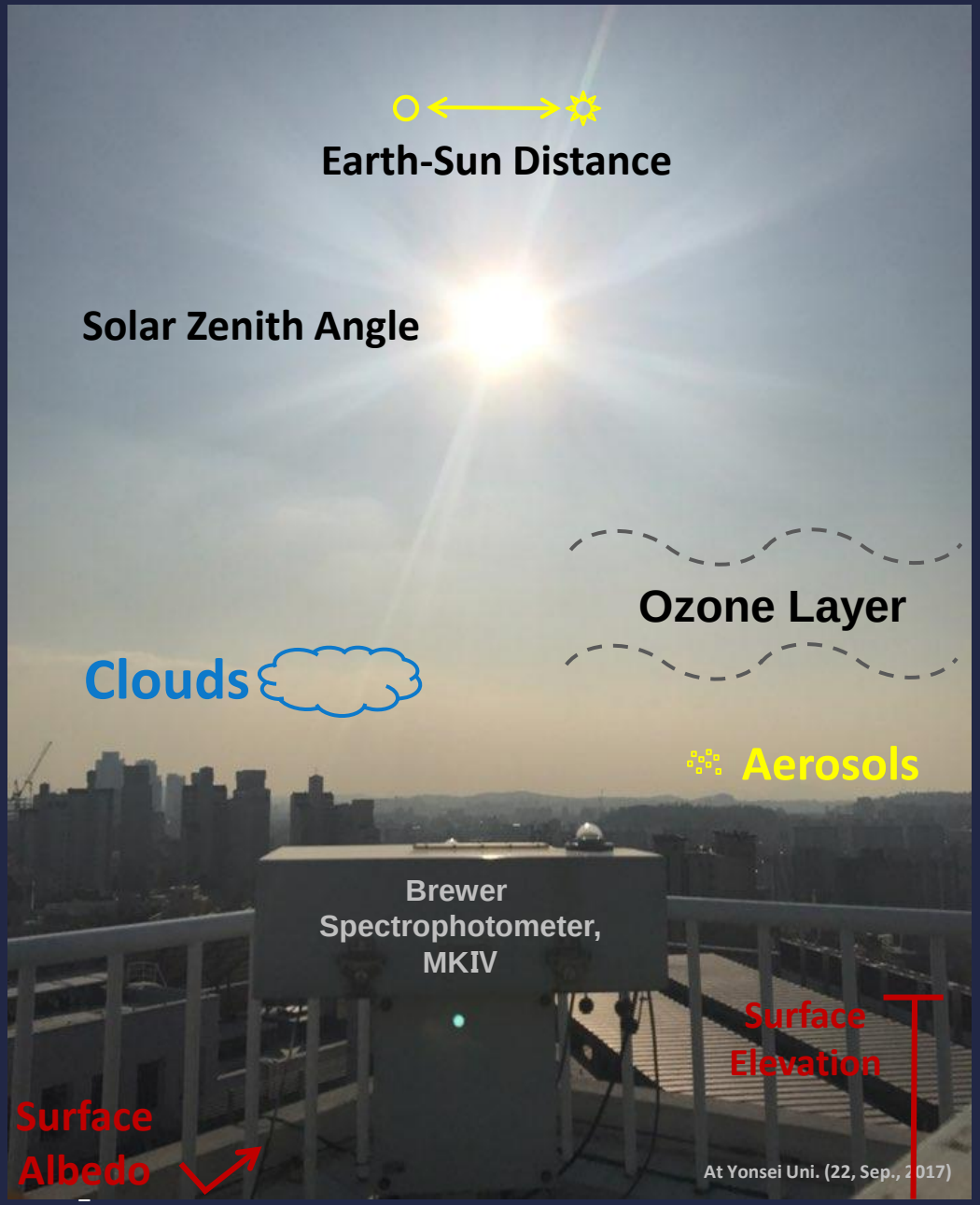


(Credit: NASA, Wikipedia)

→ Surface UV-a and UV-b influences human health, terrestrial and ecosystems.

- Satellite Instrument
  - TOMS, OMI (Eck et al., 1995, Krotkov et al., 2001)
  - SCIAMACHY/GOME-2 (Hassinen et al., 2016)

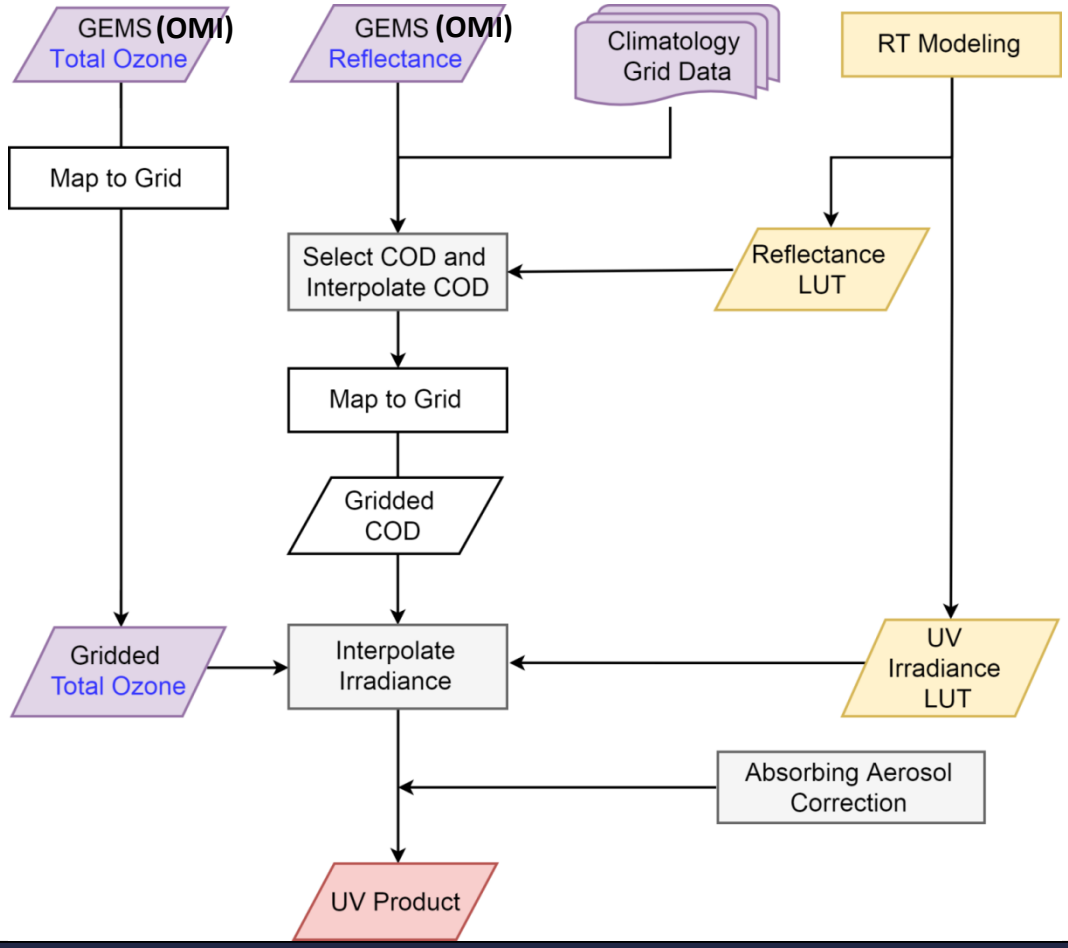
→ Satellite measurements can be used as input data to radiative transfer modelling, giving estimates of the surface UV radiation.



1. UV Product algorithm

- ✓ GEMS UV algorithm builds on the heritage OMI and TROPOMI algorithms.
- ✓ RTM Model: VLIDORT v2.6 (Scalar Calculation)
- ✓ Calculation Range: 280-400 nm (0.5 nm intervals)

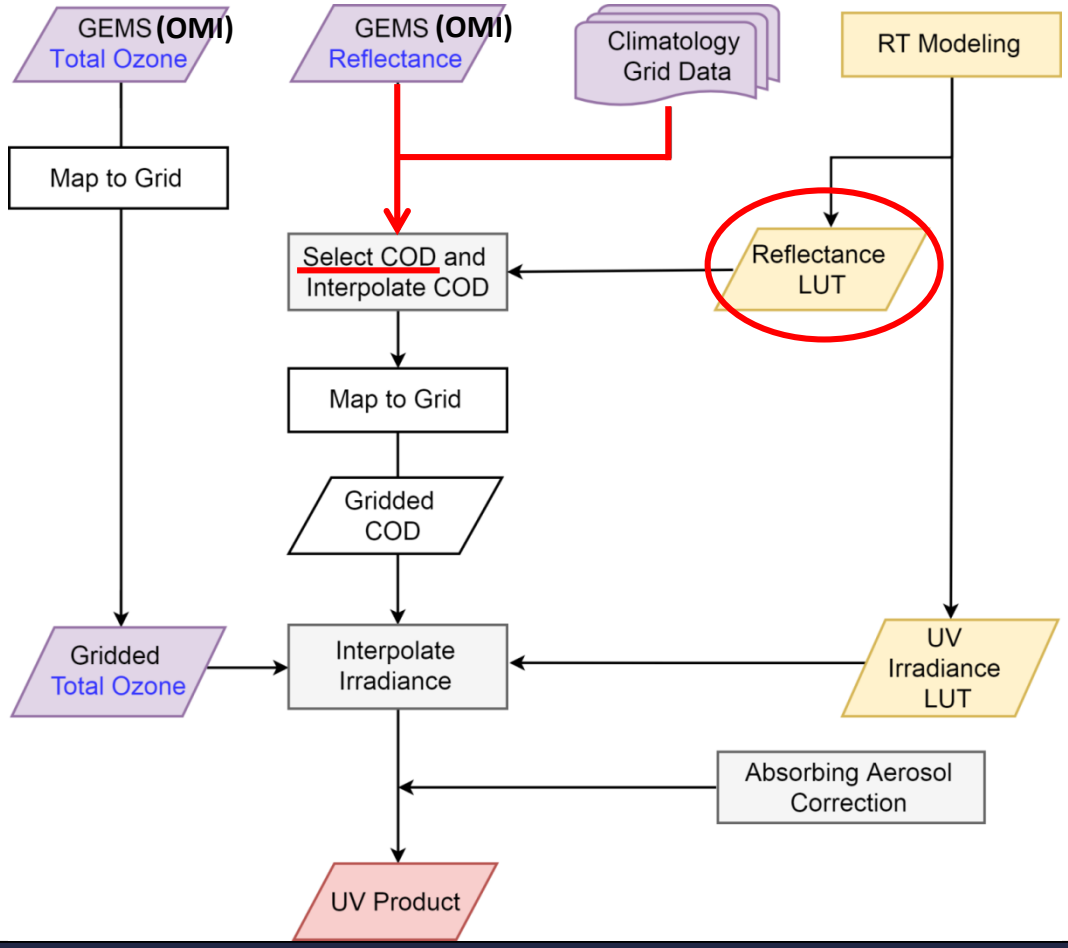
Schematic flow chart of the UV Product



1. UV Product algorithm

- ✓ RTM Model: VLIDORT version 2 (Scalar Calculation)
- ✓ Calculation Range: 280-400 nm
- ✓ Total Ozone, Reflectance: OMI Data

Schematic flow chart of the UV Product



1) node point of the LUT for Reflectance at 360 nm

Parameter	unit	Node values
SZA	Degree	0, 5,10,…,69
VZA	Degree	0, 5,10,…,69
RAA	Degree	0, 20, 40,…, 180
Cloud Optical Depth		**0, 0.5, 1.0, 2.0, 4.0, 8.0, 16.0, 32.0, 64.0, 128.0, 256.0, 500.0**
Surface albedo		0, 0.3, 0.6, 1.0
Surface Pressure	atm	0.7, 1.0
TOMS profiles		Middle latitude 325 DU

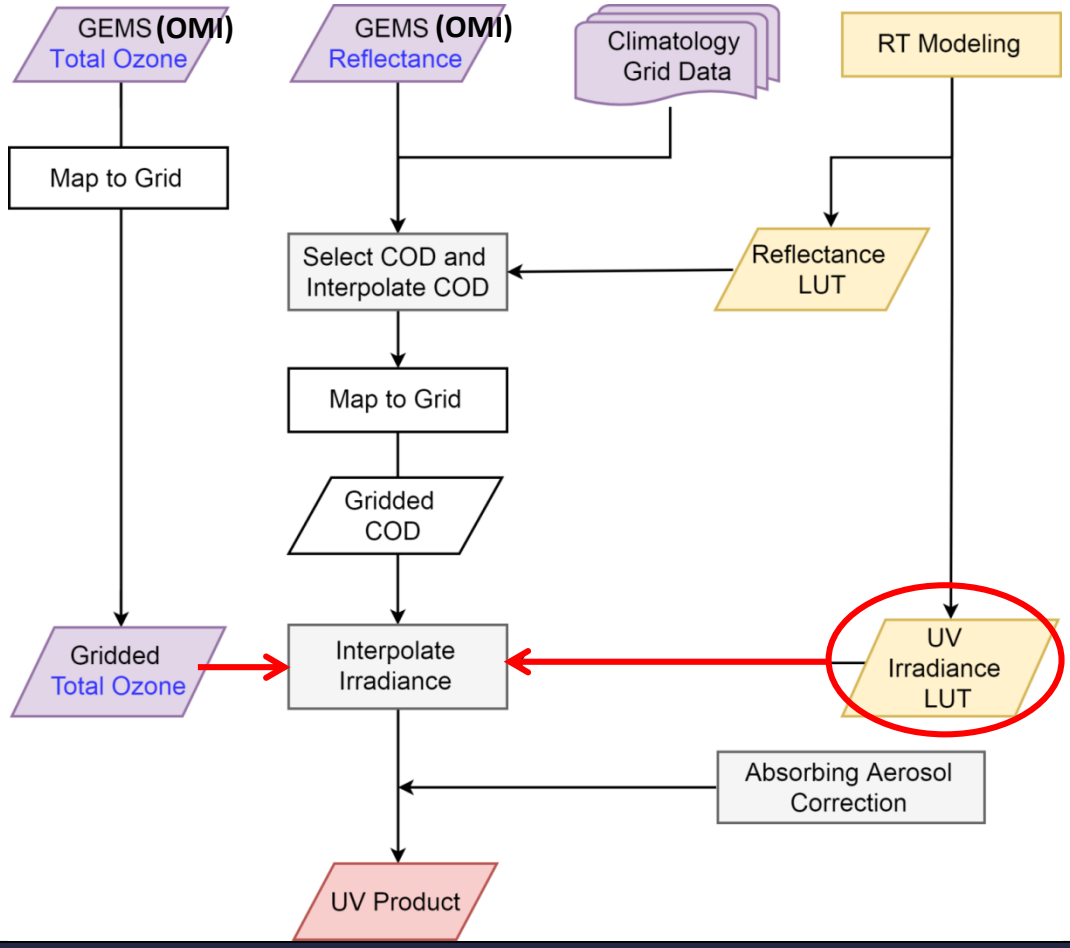
- ✓ Cloud Model: C1 Model (Deirmendjian, 1969)
- ✓ Cloud optical depth of a homogeneous water cloud.

- Select the best match cloud optical depth with the measured Reflectance given the other input parameter from climatology grid data.

1. UV Product algorithm

- ✓ RTM Model: VLIDORT version 2 (Scalar Calculation)
- ✓ Calculation Range: 280-400 nm
- ✓ **Applied action spectra:** DNA, Plant response, Vitamin D, CIE

Schematic flow chart of the UV Product



1) node point of the LUT for Reflectance at 360 nm

Parameter	unit	Node values
SZA	Degree	0, 5,10,…,69
VZA	Degree	0, 5,10,…,69
RAA	Degree	0, 20, 40,…, 180
Cloud Optical Depth		**0, 0.5, 1.0, 2.0, 4.0, 8.0, 16.0, 32.0, 64.0, 128.0, 256.0, 500.0**
Surface albedo		0, 0.3, 0.6, 1.0
Surface Pressure	atm	0.7, 1.0
TOMS profiles		Middle latitude 325 DU

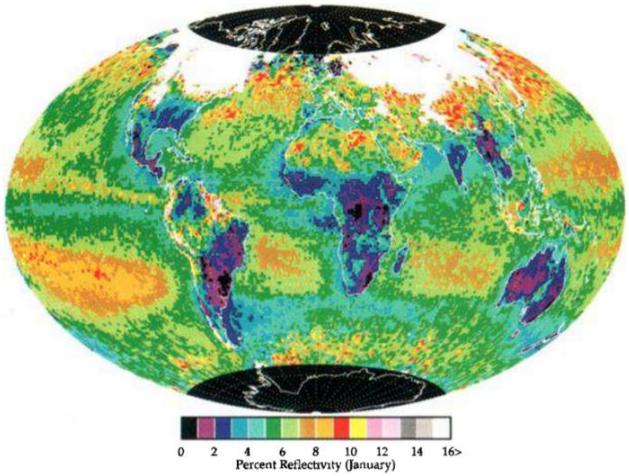
2) node point of the LUT for UV irradiance

Parameter	unit	Node values
SZA	Degree	0, 5,10,…,69
TOMS profiles		Low, Middle and High latitude
Cloud Optical Depth		**0.39,0.92,1.7,2.7,4.1,6.1, 8.9,13,18, 25, 36, 50, 70, 96, 130, 190, 260, 360, 500.0**
Surface albedo		0, 0.3, 0.6, 1.0
Surface Pressure	atm	0.7, 1.0

1.1 Climatology Grid data & Absorbing Aerosol Correction

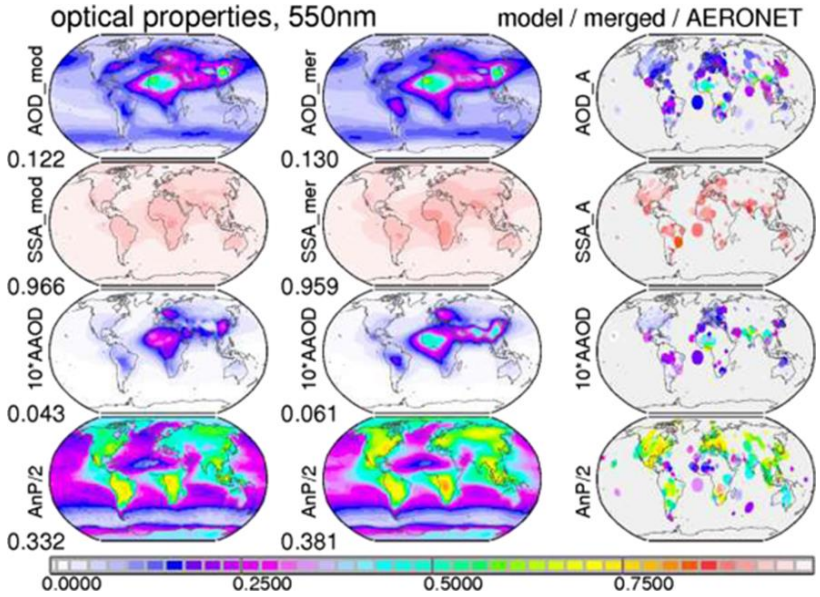
Surface Pressure	GTOPO30
Surface Albedo	Herman and Celarier (1997) + National Snow and Ice Data Center (NSIDC)
Aerosol Climatology	Kinne et al. (2013) (550nm, Monthly), **MAC-V1**

- **Surface Albedo, Herman and Celarier (1997)**



✓ The monthly values of LER for January, obtained from 14.5 years of TOMS 380 nm LER data

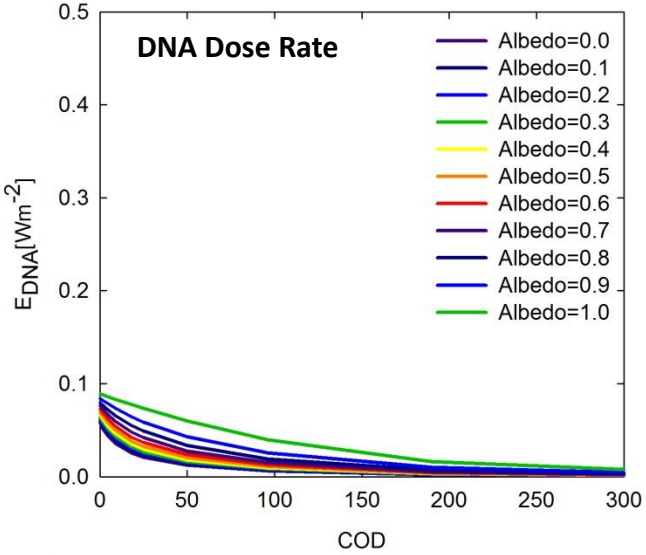
- **MAC-V1, Kinne et al. (2013)**

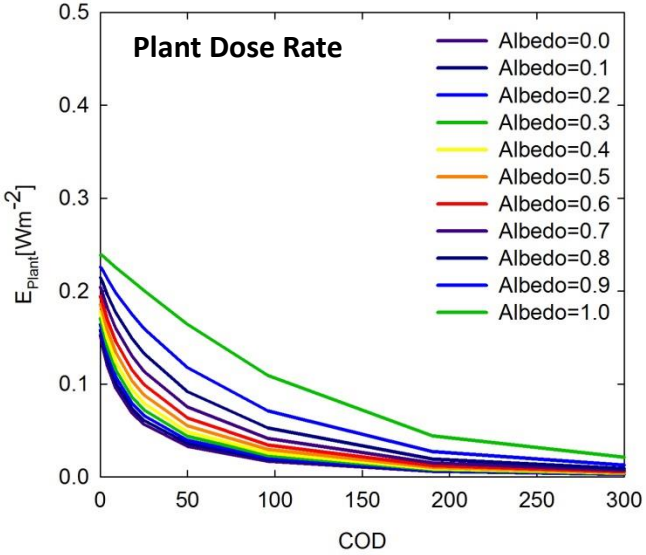


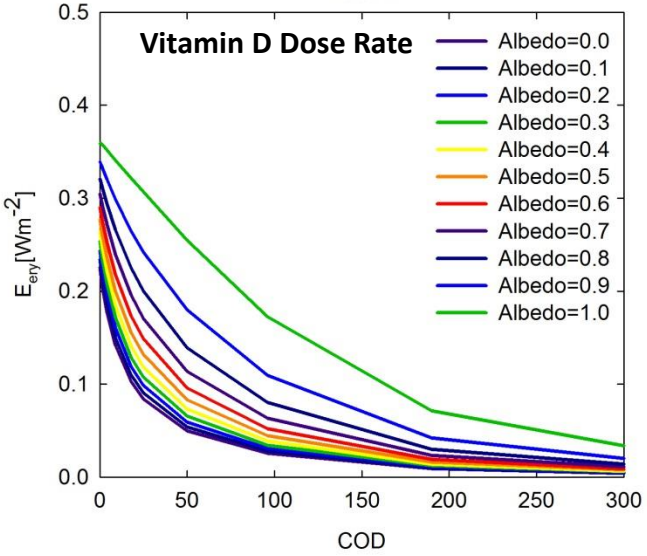
- **Absorbing Aerosol Correction,** OMI/TROPOMI (Arola et al. 2009)

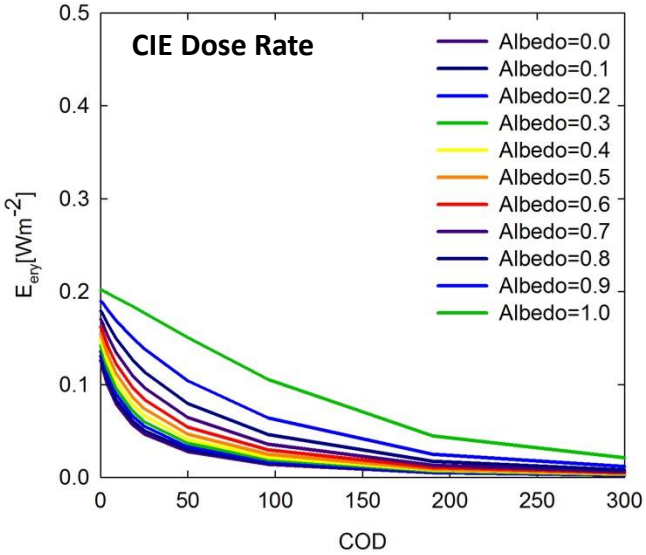
$$C_a = 1/(1 + 3\tau_{aa})$$, τ_{aa}: aerosol absorption optical depth, 3: average conditions

2. Sensitivity test (COD & Surface Albedo)







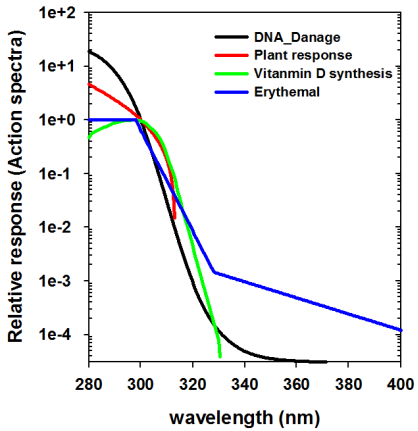


- ✓ High surface albedo may enhance the UV level at the surface significantly due to **multiple scattering** between the surface and the atmosphere above.

- ✓ **VLIDORT Input**

  SZA=40.0
  AOD=0
  COD=0, 0.5, 1.0, 2.0, 4.0, 8.0, 16.0, 32.0, 64.0, 128.0, 256.0, 500.0

- ✓ **Action Spectra**



DNA: 280~400nm (Setlow, 1974)
Plant: 280~313nm (Caldwell,1971)
VitD: 280~330.5nm (CIE, 2006)
CIE: 280~400nm
(McKinlay and Diffey, 1987)

3. Validation data

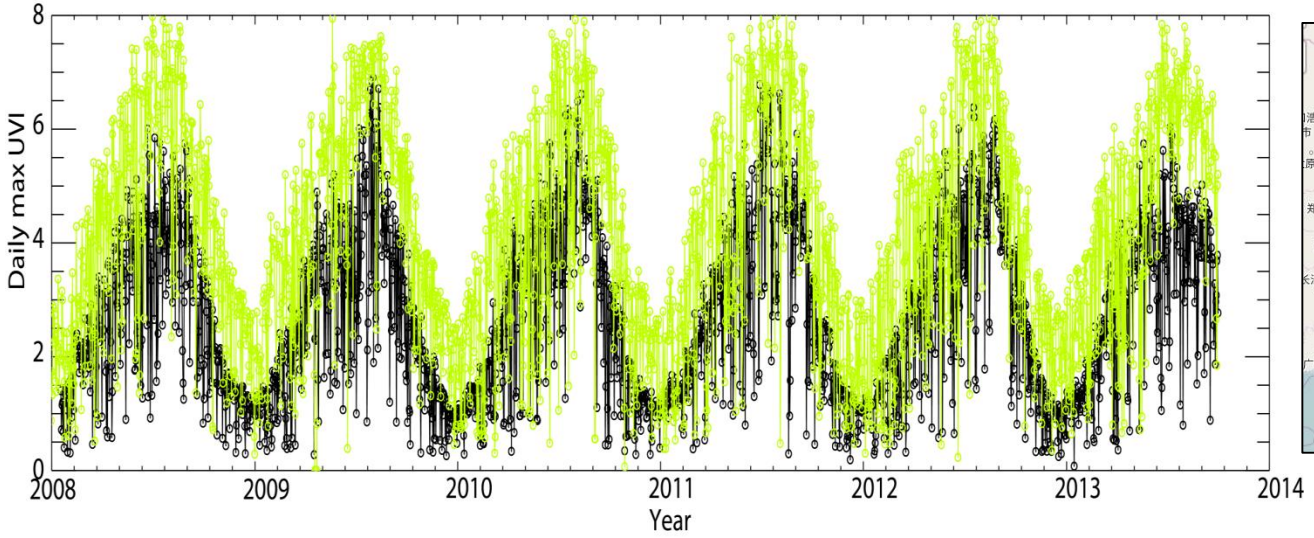
1) Ground-based data

a) Yonsei University (Period: 2004.10~2015.12)

- Instrument : Brewer spectrophotometer (#144)
- Data: Spectral Irradiance, UV Index

b) WOUDC Site (Period : 2008.10~2013.12, Site: **Tsukuba**, **Naha**)

- Instrument: Brewer spectrophotometer
- Data: Spectral Irradiance, UV Index



2) Satellite data (OMI, GOME-2, TROPOMI)

- Data: UV Index

4. Future Study

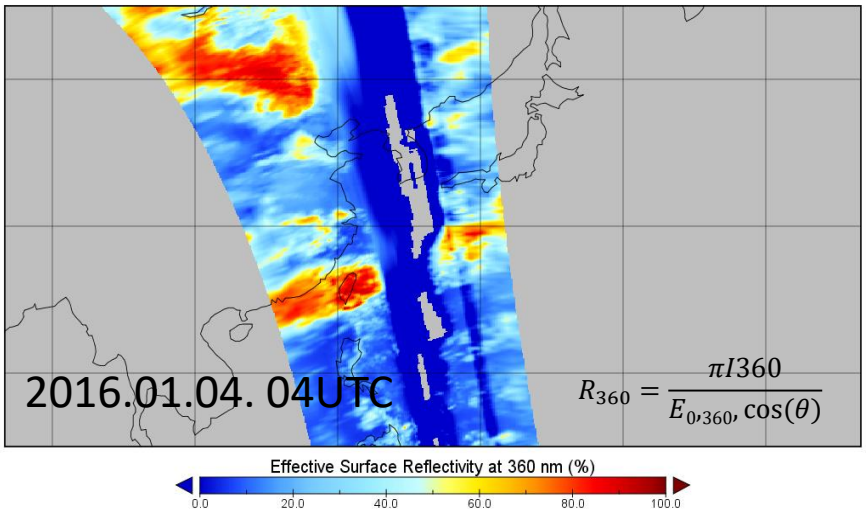
- Validation
  - Comparison of estimated surface Irradiance with Ground-based data.

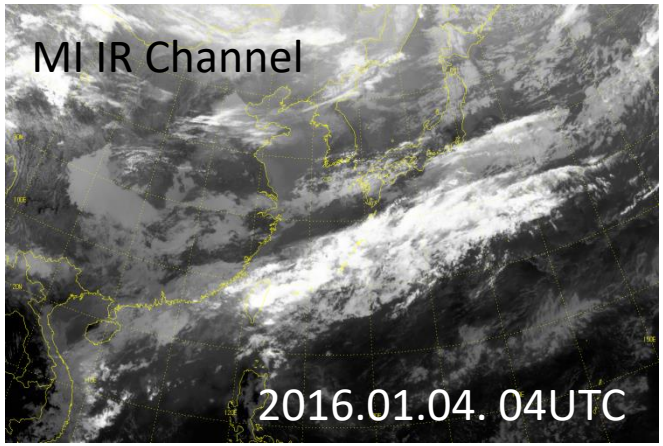
- Cloud Information
  - Reflectance (360 nm) from OMI
  - Cloud radiance fraction

Thanks for your attention.

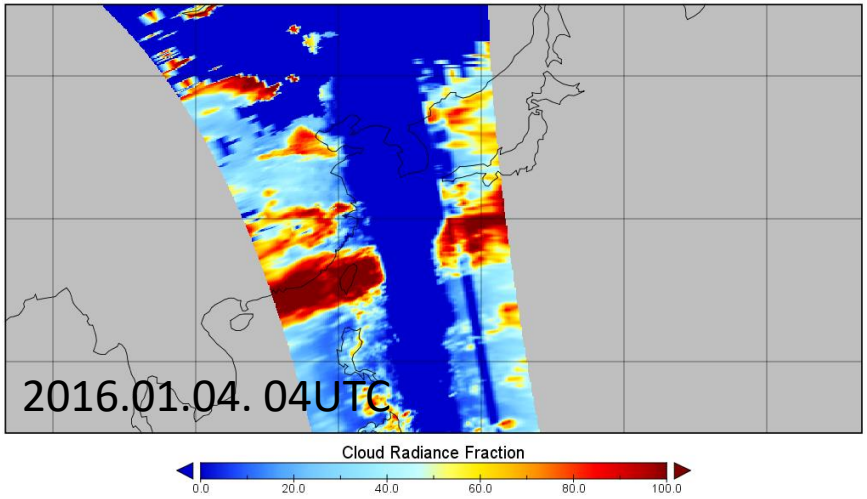
Cloud Information, 2016.01.04. 04UTC

Algorithm 1. Surface Reflectivity (360 nm), (OMTO3 L2)

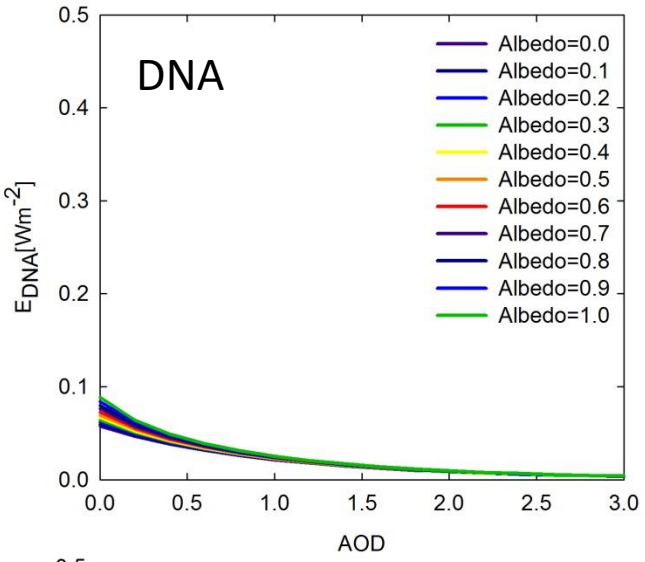


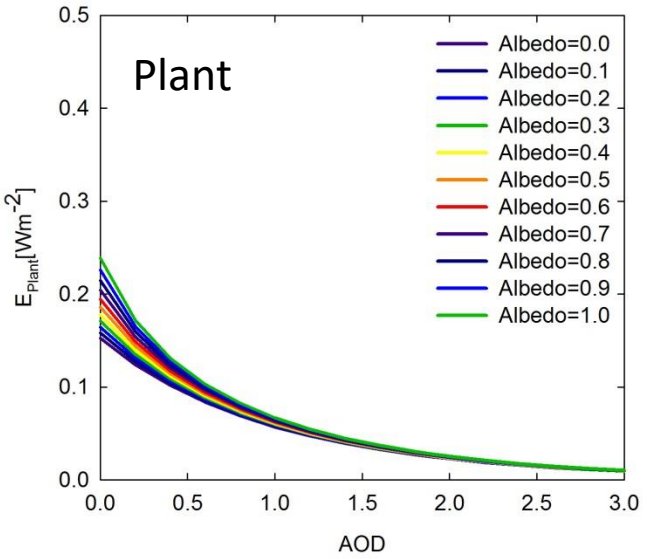


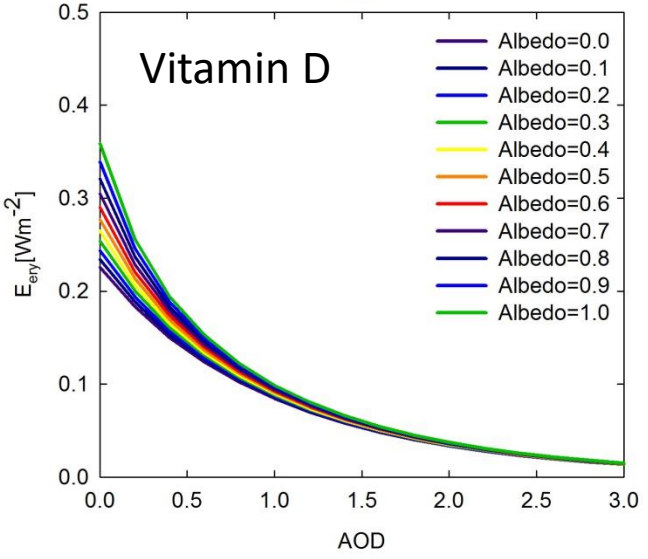
Algorithm 2. Cloud Radiance Fraction, (OMDOAO3 L2)

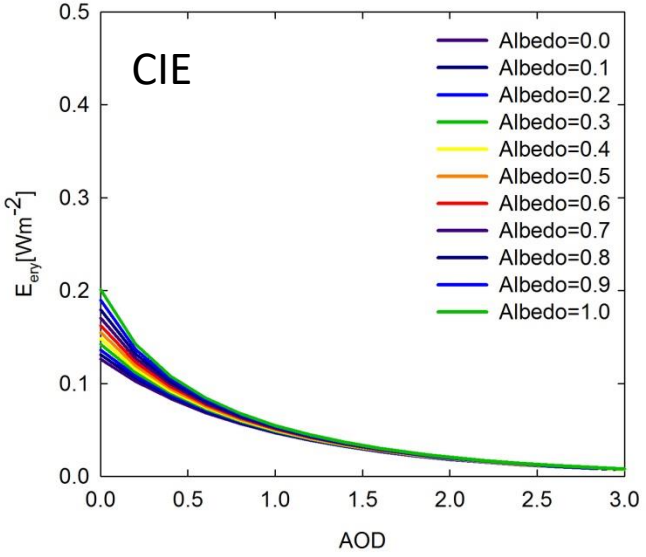


2. Sensitivity test (AOD)



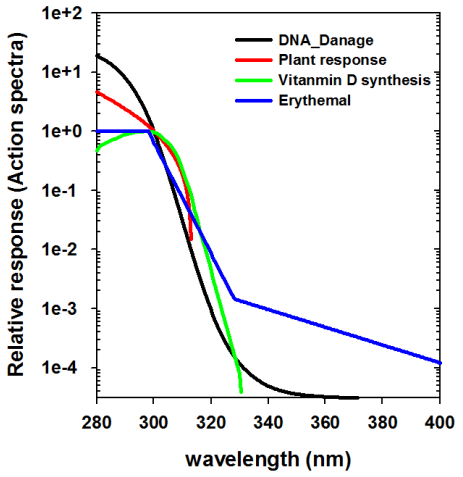






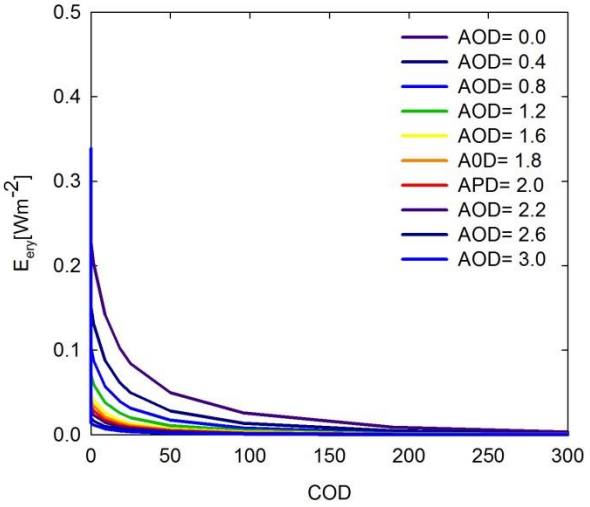
SZA=40.0
COD=0

DNA: 280~400nm
Plant: 280~313nm
VitD: 280~330.5nm
CIE: 280~400nm

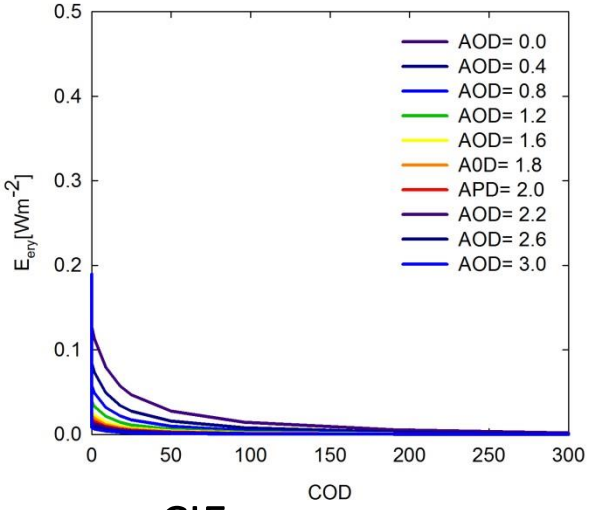


2. Sensitivity test (COD & AOD)

Vitamin D



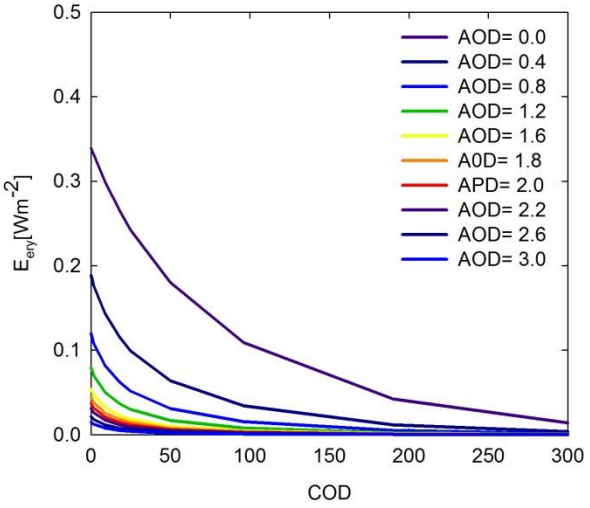
CIE



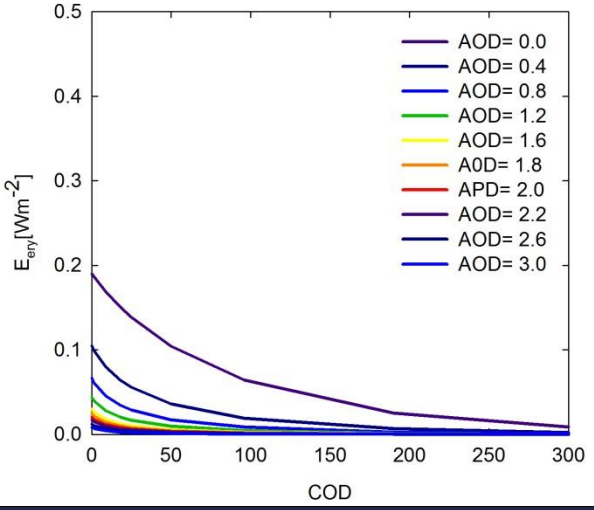
SZA=40.0
Albedo=0.0

AOD=[0.0, 0.4, 0.8, 1.2,1.6, 1.8, 2.0, 2.2, 2.6, 3.0]
COD=[0.0, 1.7, 8.9, 18.0, 25.0, 50.0, 96.0, 190.0,300.0] ;20

Vitamin D



CIE



SZA=40.0
Albedo=0.9

AOD=[0.0, 0.4, 0.8, 1.2,1.6, 1.8, 2.0, 2.2, 2.6, 3.0]
COD=[0.0, 1.7, 8.9, 18.0, 25.0, 50.0, 96.0, 190.0,300.0] ;20

Offline Product