INPUT RADIANCE FOR GEMS

Kyungpook National University

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Aug31-Sep 2

OUTLINE

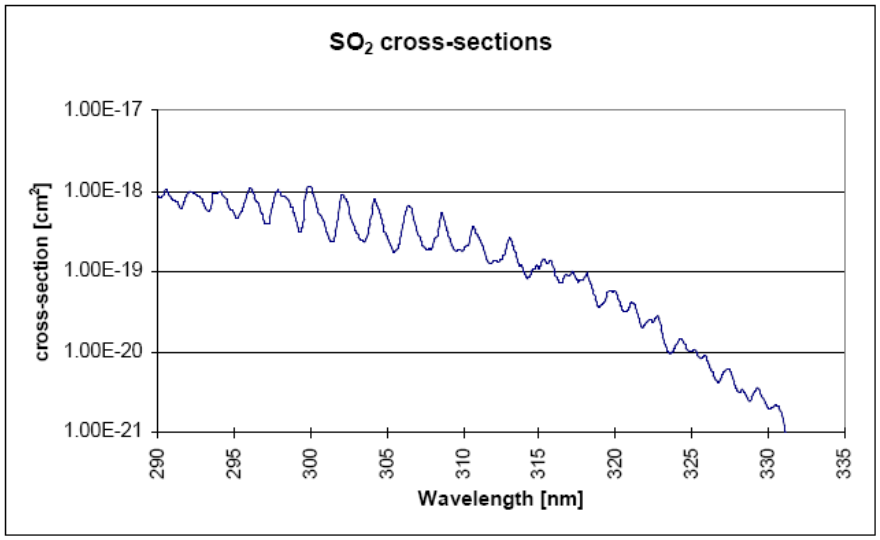
- **LIDORT vs DISORT**
  - Comparison
  - Update
- **Simulation for US76 Atmosphere**
  - Gases
  - Aerosols
  - Cloud

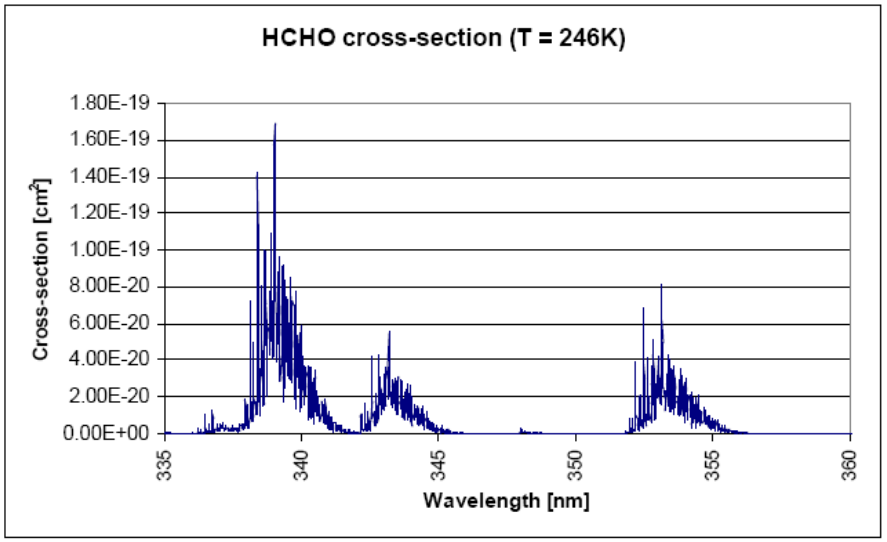
RTM

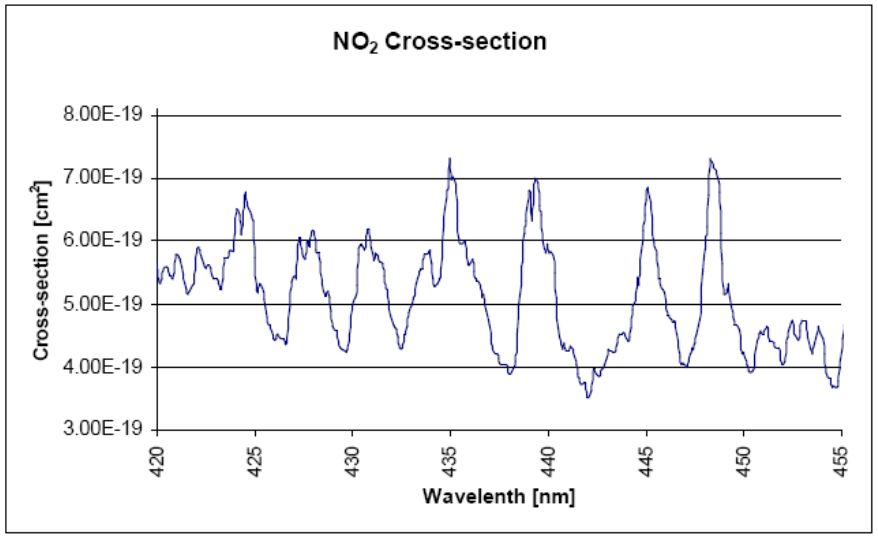
- **Radiative Transfer Models**
  - DISORT
    - Stamnes et al. (1999,2000)
  - LIDORT
    - Spurr et al. (2000)
- **Optical Data**
  - HITRAN2008, GEISA2003
- **Solar Irradiance**
  - R.L. Kurucz (1992)
    - High resolution in 1 cm^{-1} interval
- **Aerosols & Clouds**
  - OPAC
    - Hess et al.(1998)

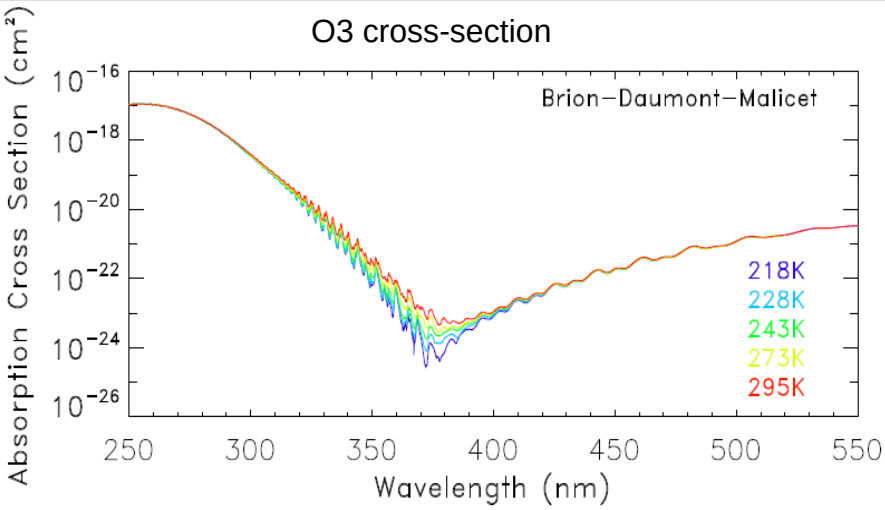
- **Update**
  - O_2-O_2 lines
  - O_3 cross section
  - Bugs
- **Pre-works for LIDORT**
  - Combined Phase function for Aerosols and Air Molecules
  - LUT(Look-up-Table)
- **Online calculations in DISORT**
  - Combined Phase function

Cross-sections

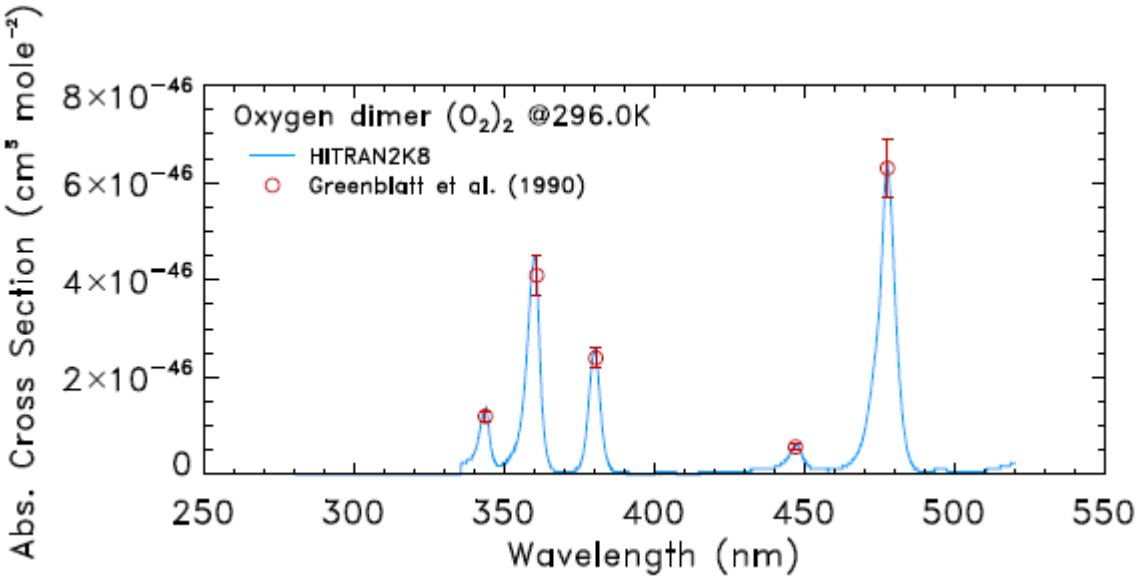


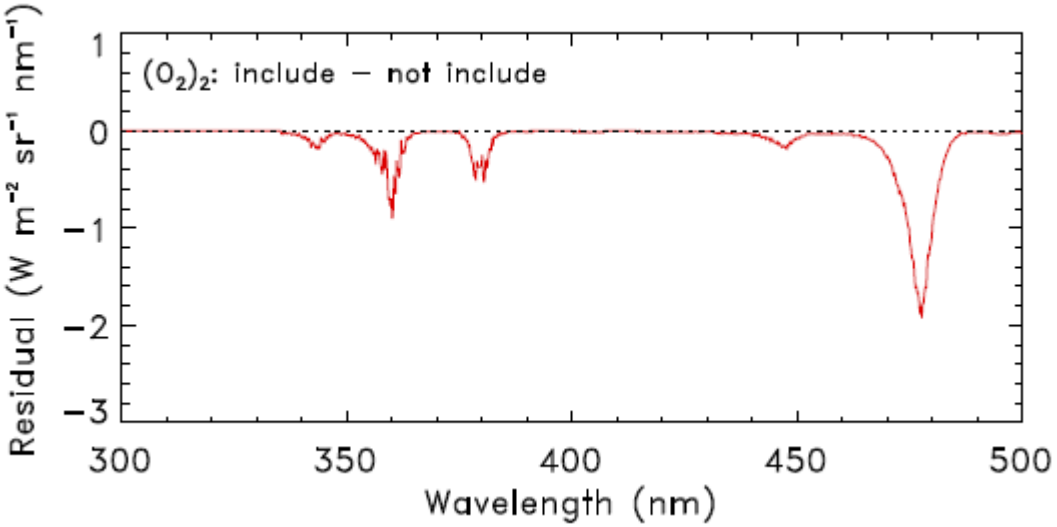




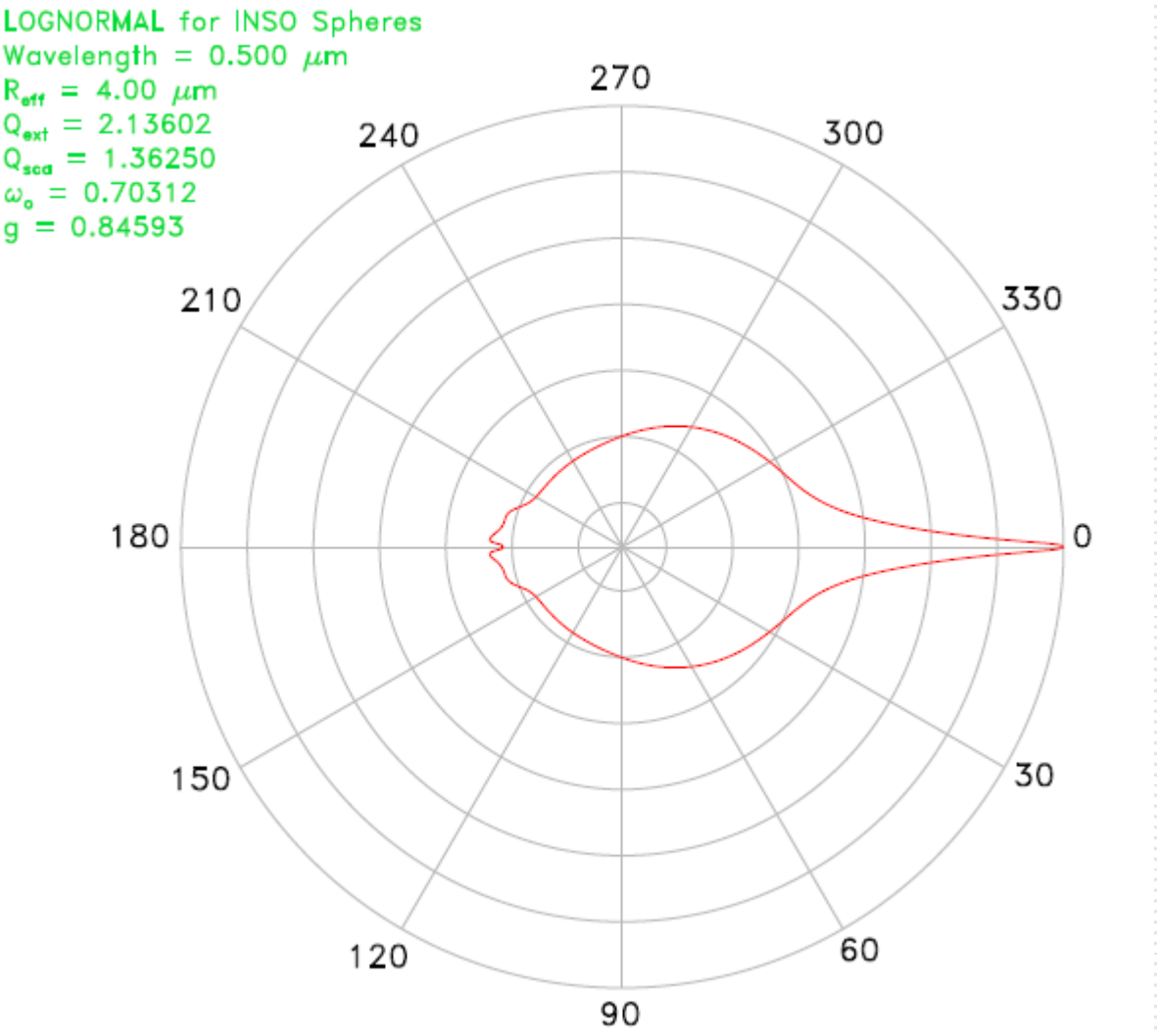


O_2-O_2 Lines

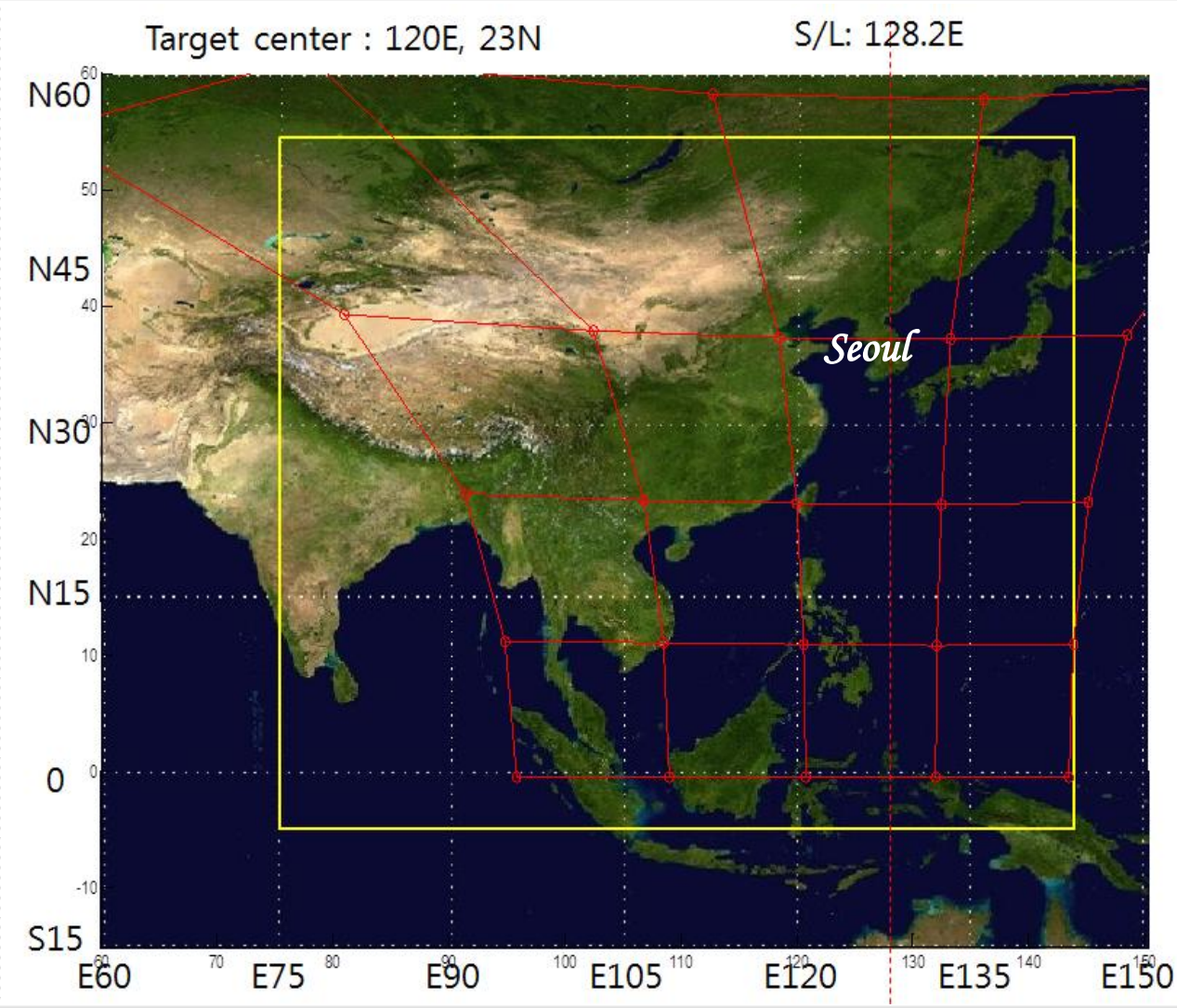

Oxygen dimer $(O_2)_2$ @296.0K
HITRAN2K8
Greenblatt et al. (1990)
Abs. Cross Section (cm^5 $mole^{-2}$)
8×10^{-46}
6×10^{-46}
4×10^{-46}
2×10^{-46}
0
250
300
350
400
450
500
550
Wavelength (nm)


$(O_2)_2$: include − not include
Residual (W m^{-2} sr^{-1} nm^{-1})
1
0
−1
−2
−3
300
350
400
450
500
Wavelength (nm)

Phase function



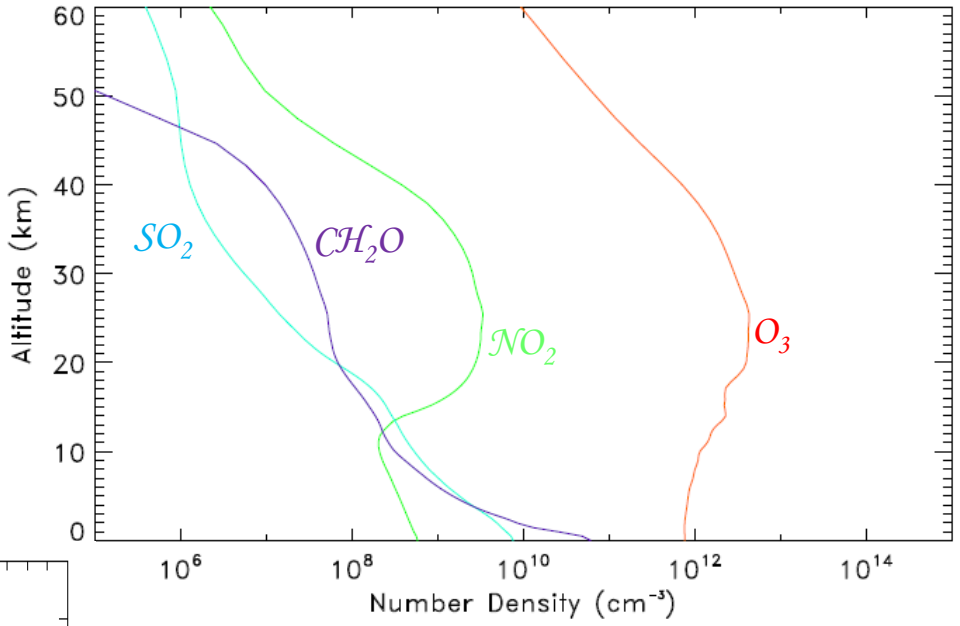
Projected Field of View

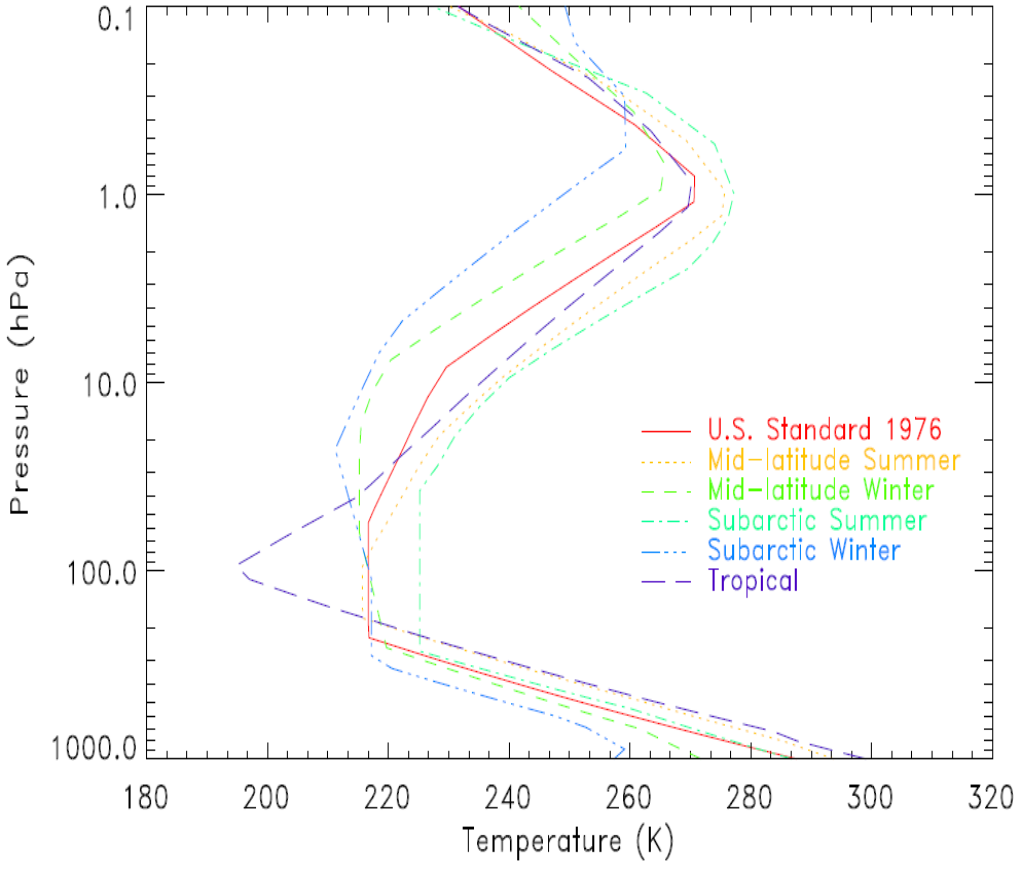


Projected FOV

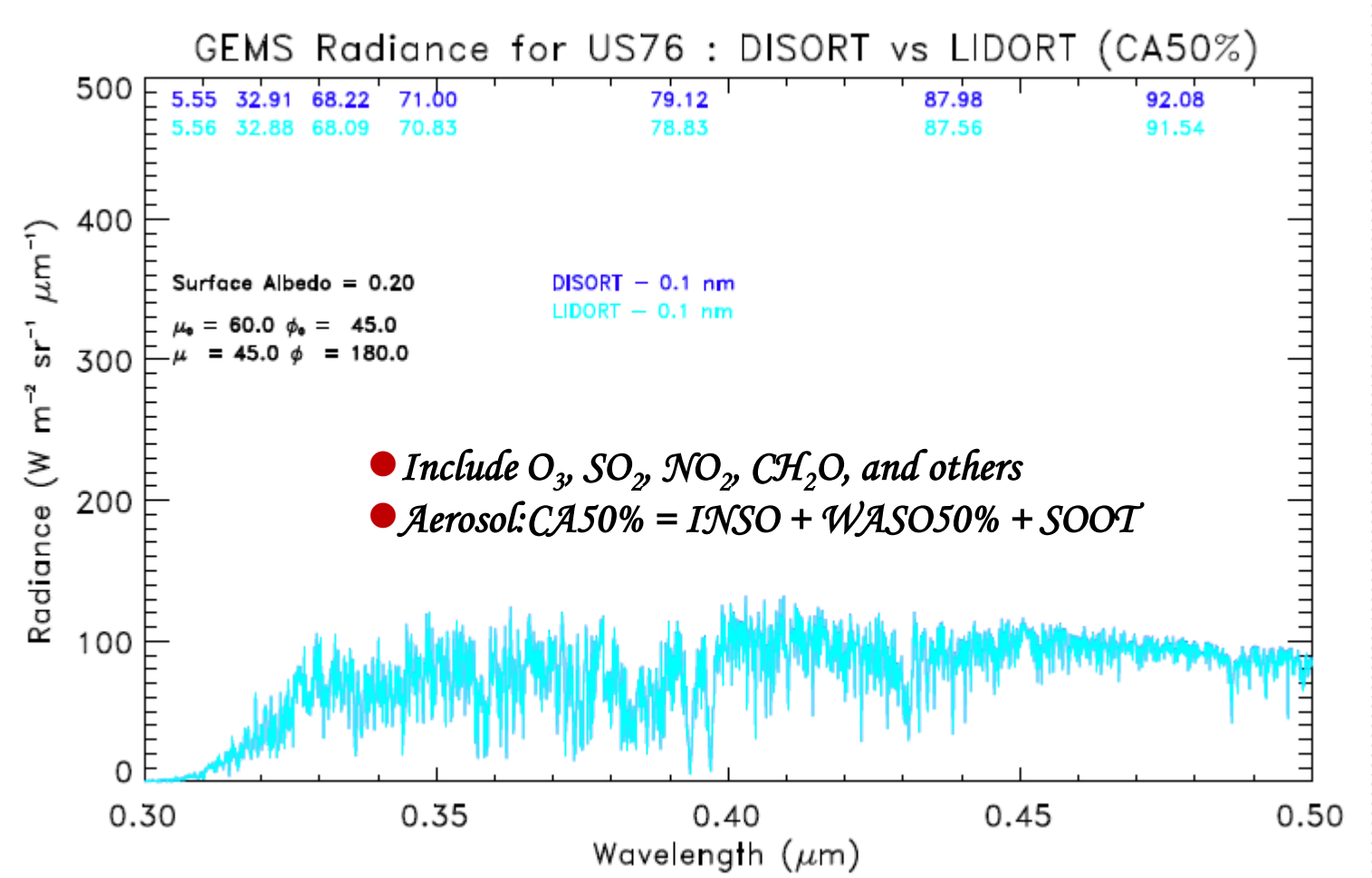
Region of interest

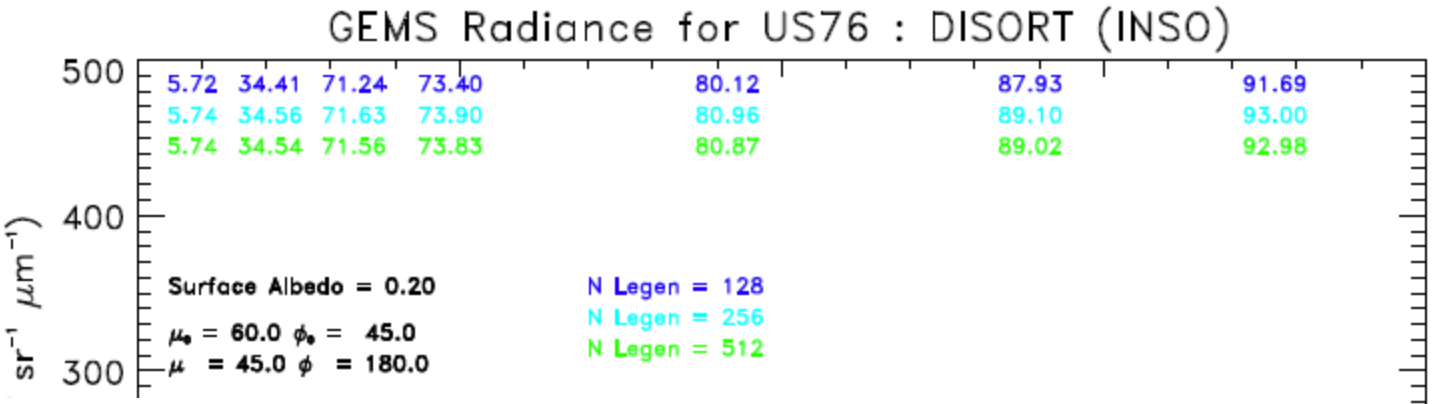
Atmosphere

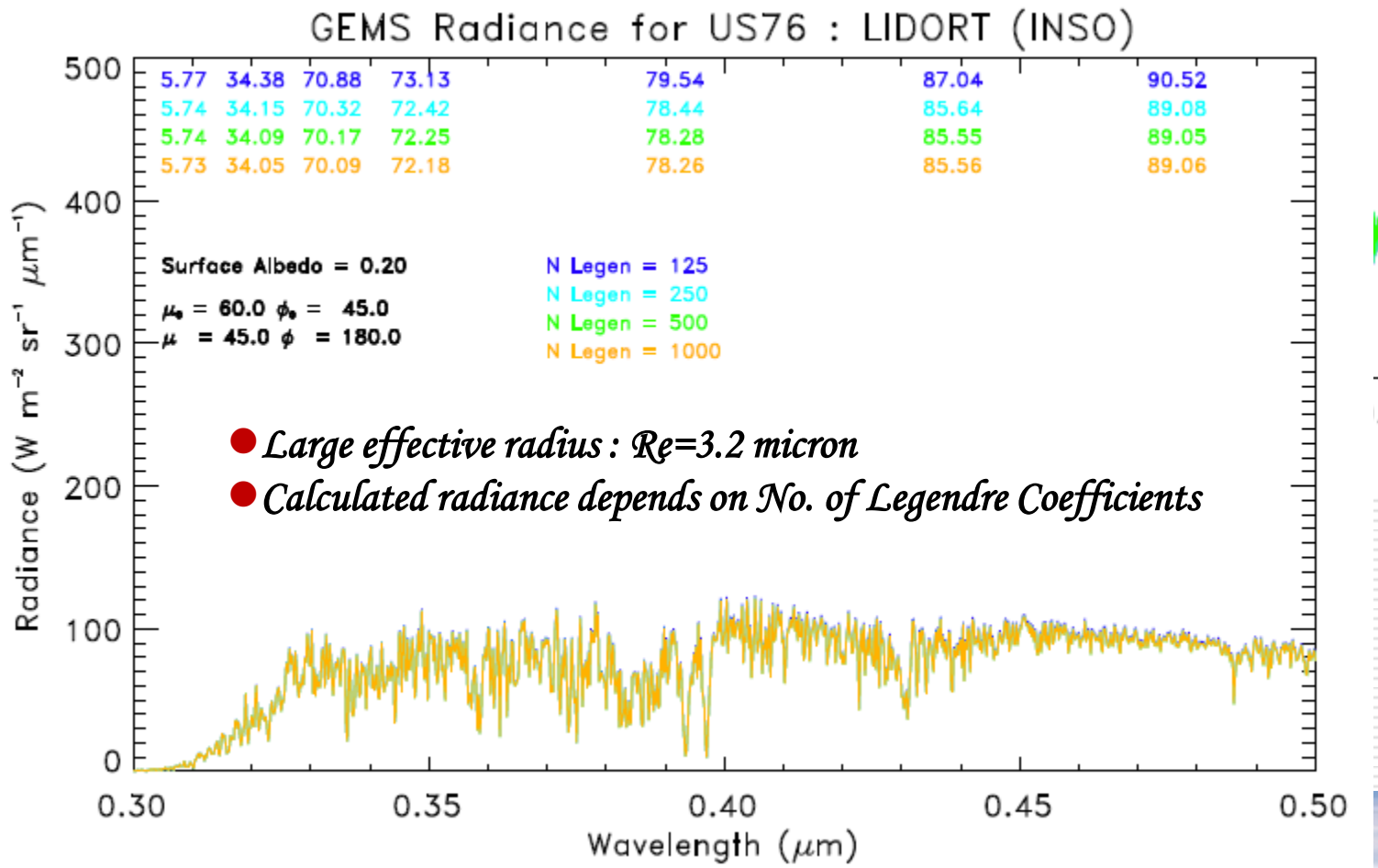

Altitude (km)
Number Density (cm^{-3})
SO_2
CH_2O
NO_2
O_3

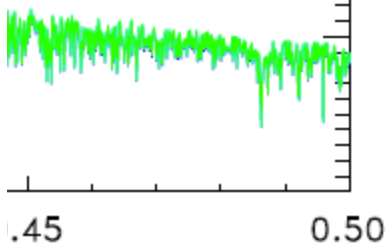

Pressure (hPa)
Temperature (K)
U.S. Standard 1976
Mid-latitude Summer
Mid-latitude Winter
Subarctic Summer
Subarctic Winter
Tropical

LIDORT VS DISORT (AI-2)

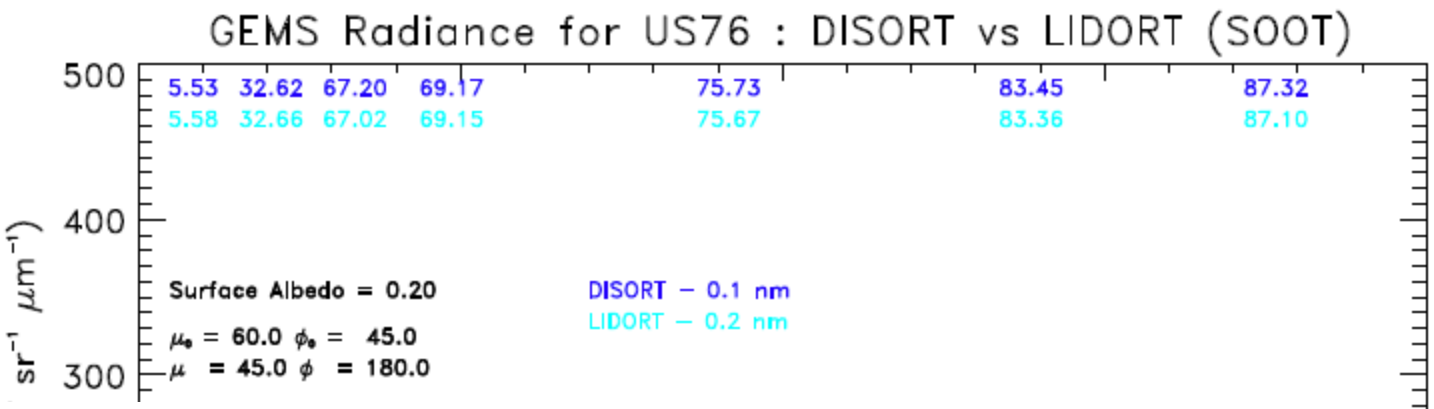


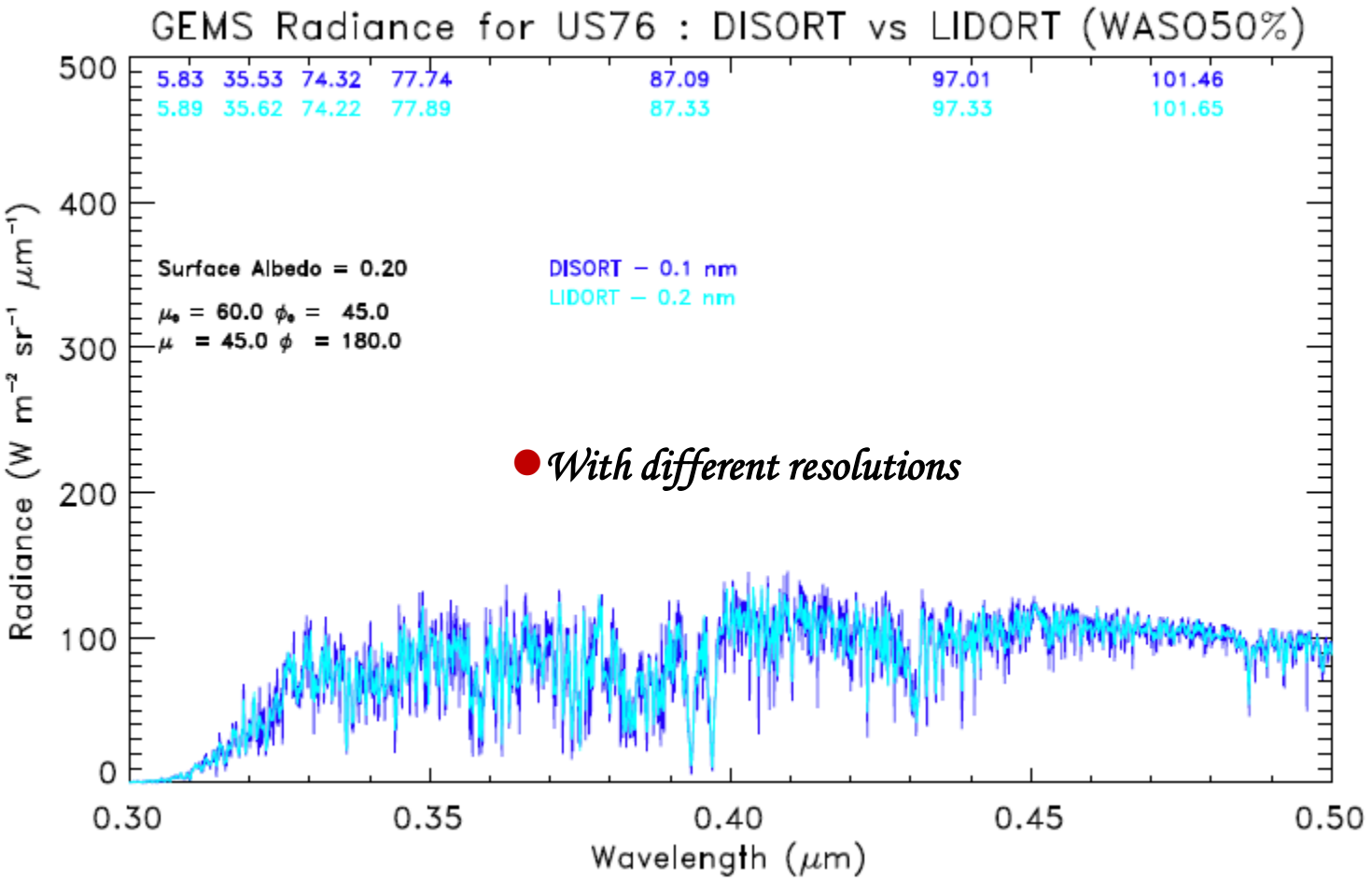


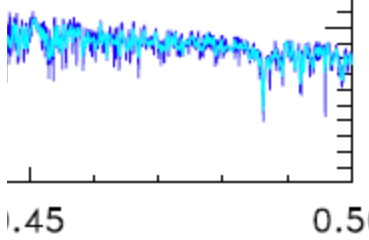




- *Large effective radius : Re=3.2 micron*
- *Calculated radiance depends on No. of Legendre Coefficients*

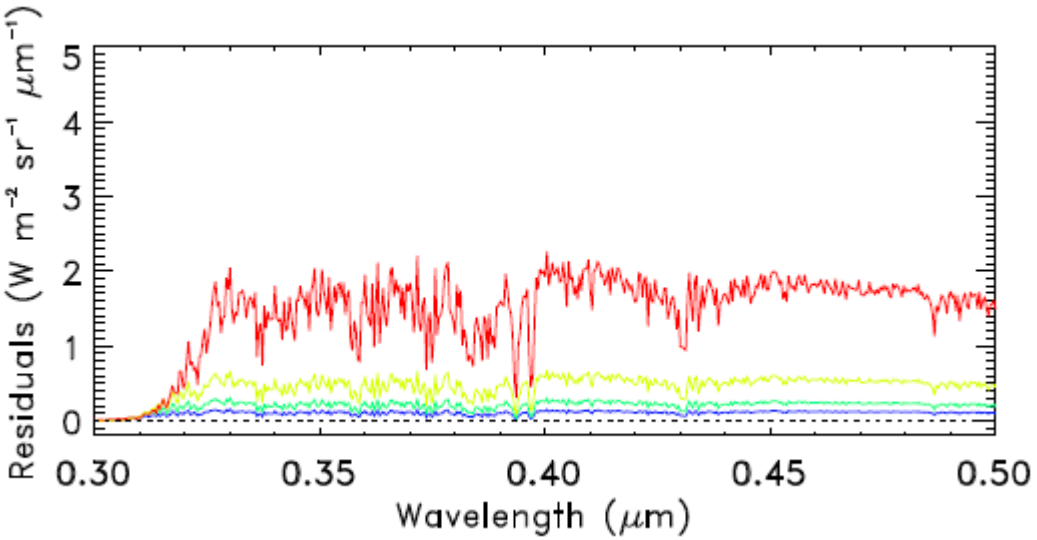






- *With different resolutions*

- *Effect of earth curvature*
  - *with CA50% aerosols*
  - *Solar Zenith Angles: 55, 65, 75, 85 degrees*
  - *Satellite Zenith Angle: 45 degrees*
  - *Relative Azimuth Angel: 135 degrees*
- *Plane parallel atmosphere is valid up to SZA=75 degrees*



SIMULATION CONDITIONS

- **Seoul**
  - Satellite Zenith Angel=43.75, Azimuth Angle=177.99
  - S. Equinox, S. Solstice, W. Solstice
- **Surface**
  - Lambertian
    - Albedo: 0.1 and 0.9 (for winter)
- **Aerosols & Clouds**
  - Aerosols: Lognormal distribution
    - Continental Average for RH=50%, consisting of INSO, WASO50%, SOOT
  - Clouds: Modified Gamma distribution
    - Stratus with COD=0.5,2.5,5.0,10.0,17.0,20.0,42.5,

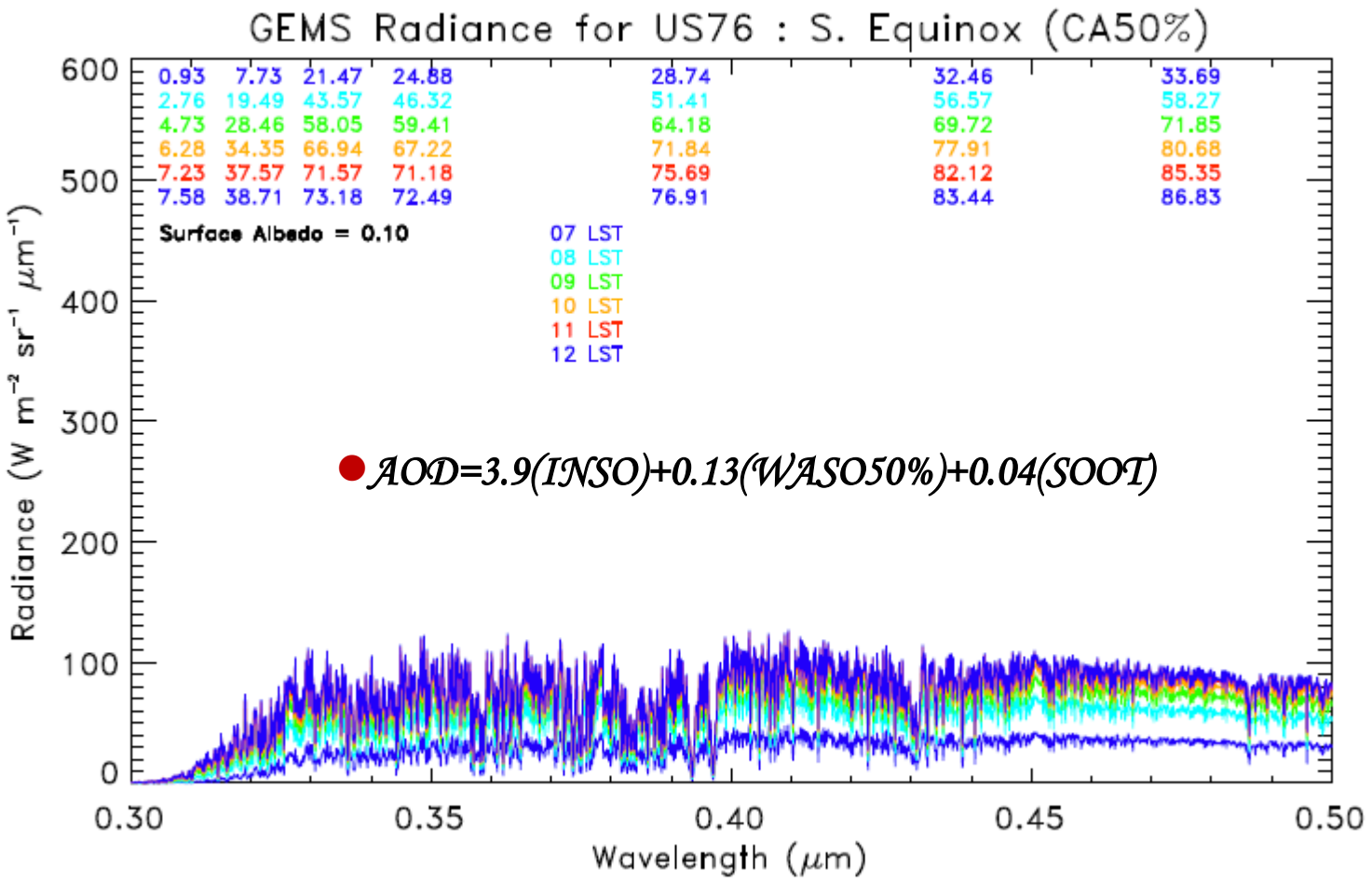
GEMS 측정 에너지 모의

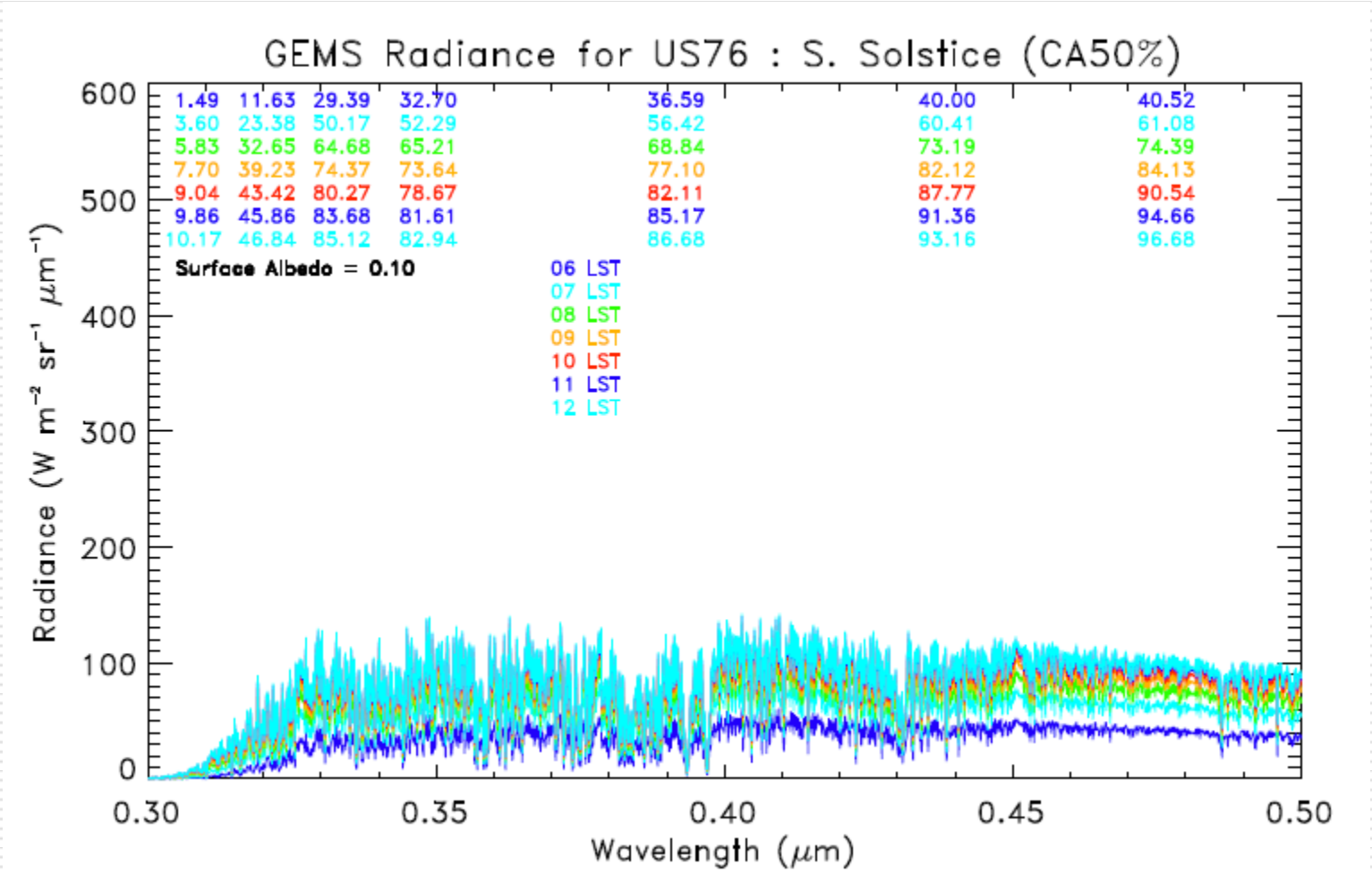
Time(hour)	Spring Equinox		Summer Solstice		Autumn Equinox		Winter Solstice	
	μ_o†	φ_o‡	μ_o	φ_o	μ_o	φ_o	μ_o	φ_o
06	91.18	88.83	76.20	70.82	88.16	91.06	103.68	109.21
07	79.46	98.05	64.76	78.89	76.60	100.40	92.68	117.69
08	67.92	108.00	52.99	87.20	65.19	110.70	82.65	127.12
09	57.05	119.68	41.12	96.76	54.61	123.01	73.95	137.95
10	47.53	134.39	29.57	109.80	45.62	138.73	67.01	150.54
11	40.49	153.55	19.33	132.57	39.45	159.06	62.50	164.91
12	37.43	177.02	14.13	178.45	37.60	183.07	60.98	180.43
13	39.30	201.11	18.85	225.62	40.67	206.44	62.67	195.92
14	45.50	221.47	28.95	249.30	47.71	225.54	67.33	210.20
15	54.52	237.18	40.48	262.64	57.21	240.23	74.39	222.70
16	65.12	249.48	52.34	272.32	68.07	251.90	83.17	233.44
17	76.54	259.77	64.12	280.66	79.61	261.85	93.29	242.79
18	88.10	269.11	75.58	288.73	91.35	271.07	104.30	251.25

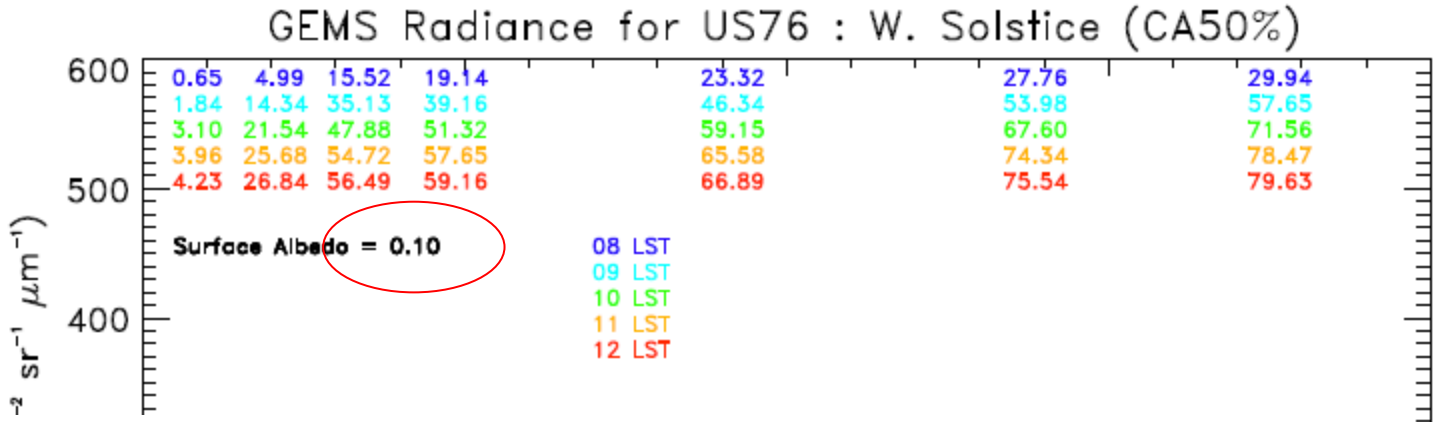
† *Solar Zenith Angle*

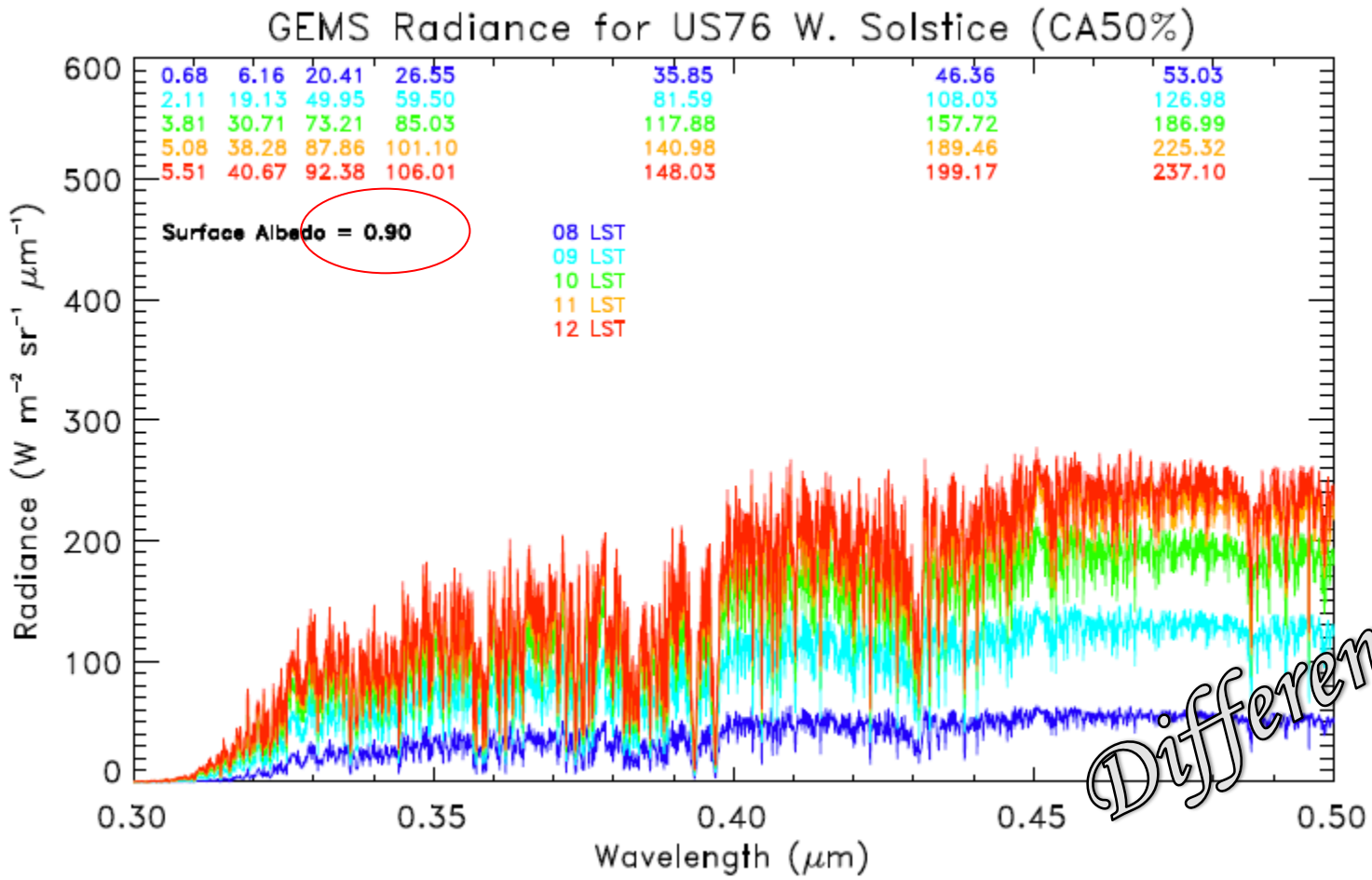
‡ *Solar Azimuth Angle*

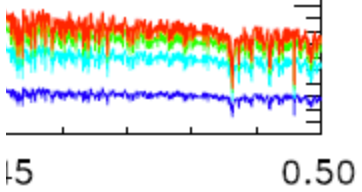
Results with Aerosols




GEMS Radiance for US76 : S. Solstice (CA50%)
1.49 11.63 29.39 32.70 36.59 40.00 40.52
3.60 23.38 50.17 52.29 56.42 60.41 61.08
5.83 32.65 64.68 65.21 68.84 73.19 74.39
7.70 39.23 74.37 73.64 77.10 82.12 84.13
9.04 43.42 80.27 78.67 82.11 87.77 90.54
9.86 45.86 83.68 81.61 85.17 91.36 94.66
10.17 46.84 85.12 82.94 86.68 93.16 96.68
Surface Albedo = 0.10
06 LST
07 LST
08 LST
09 LST
10 LST
11 LST
12 LST
Radiance (W m⁻² sr⁻¹ μm⁻¹)
600
500
400
300
200
100
0
0.30
0.35
0.40
0.45
0.50
Wavelength (μm)







Different Albedo

Summary with CA50% Aerosols

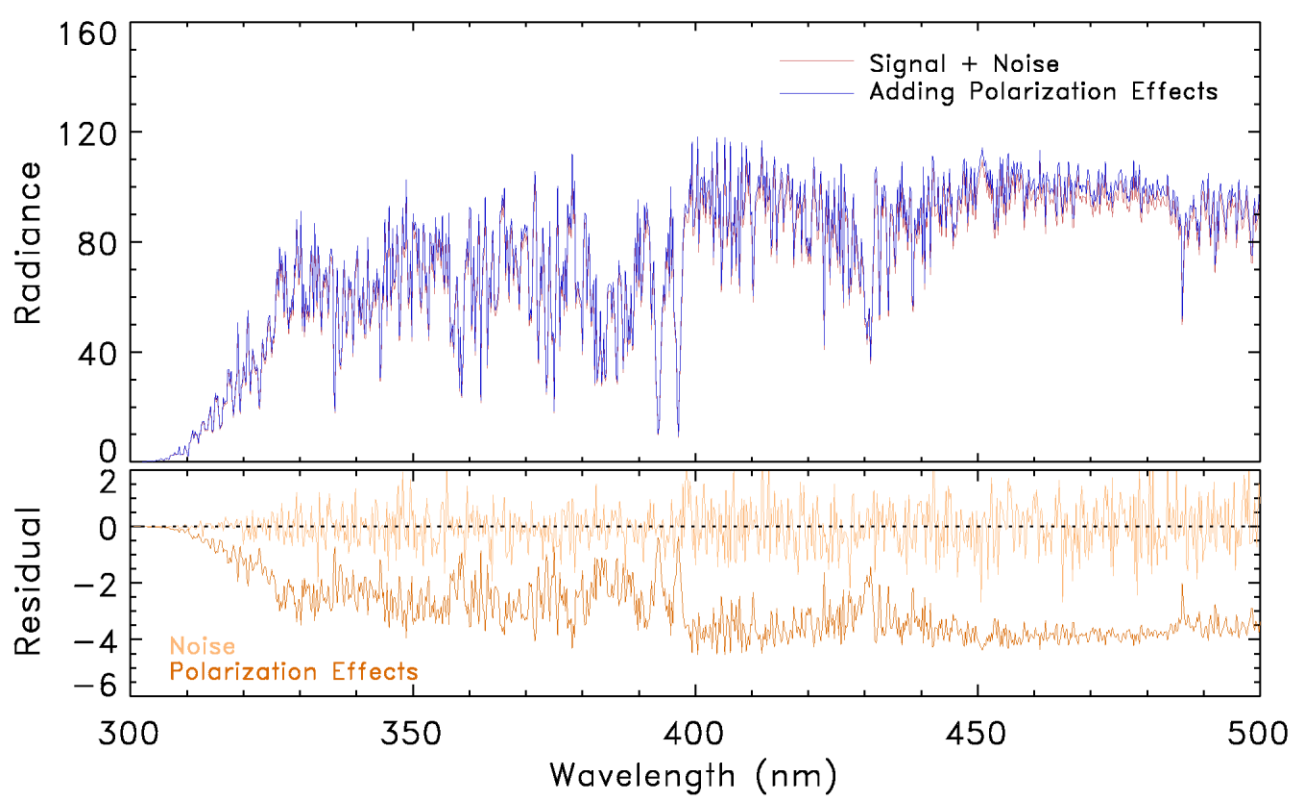
CA50%=INSO + WASO50% + SOOT

Radiance [W m^{-2} μm^{-1}] for US76			
Spectral range [nm]	Min	Max	Max
	@ 08 LST W. Solstice	@ 12 LST S. Solstice	@ 12 LST W. Solstice
	Albedo=0.1	Albedo=0.1	Albedo=0.9 (snow cover)
300-315	0.65	10.17	5.51
315-325	4.99	46.84	40.67
325-335	15.52	85.12	92.38
335-357	19.14	82.94	106.01
357-423	23.32	86.68	148.03
423-451	27.76	93.16	199.17
451-500	29.94	96.68	237.10

Results with Noise (AI-12)

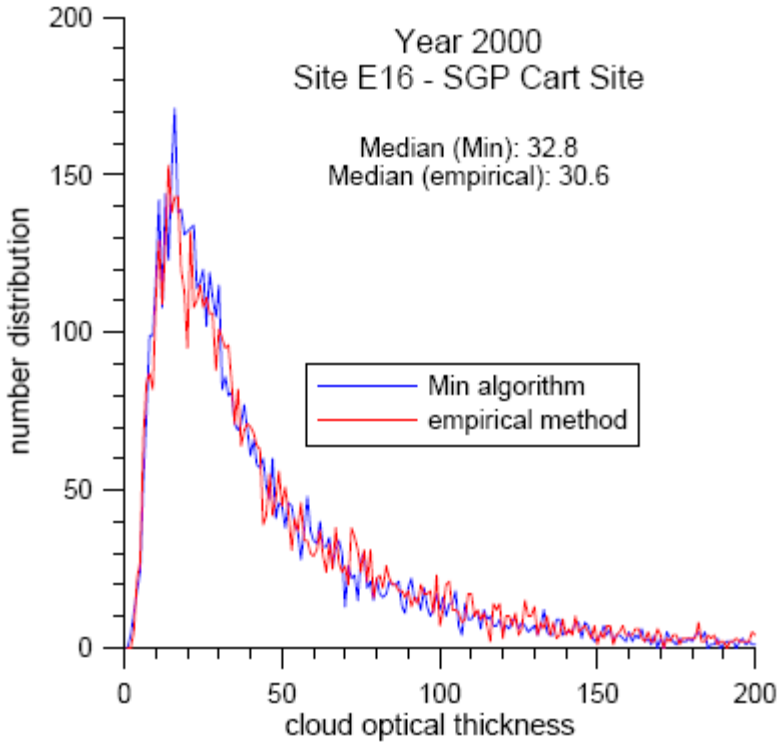
- *Polarization : Bias, random*
  - *caused by aligned aerosols and cloud particles with earth magnetic (electric) fields OR reflected ice surface ?*
- *NESR of detector : random*

- *GEMS_Noise.f : random noise + Bias*

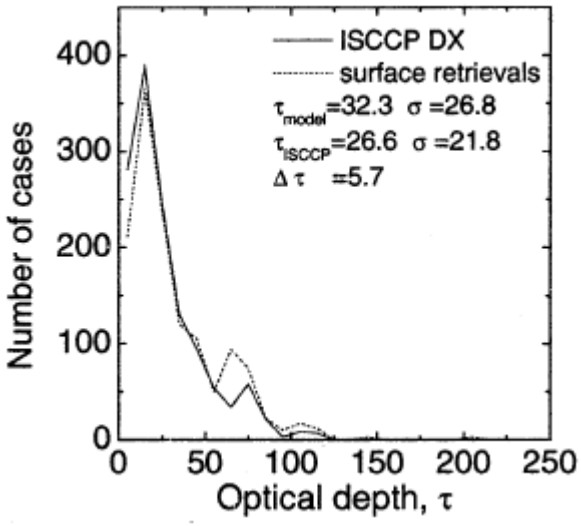


Results with Clouds (AI-5)

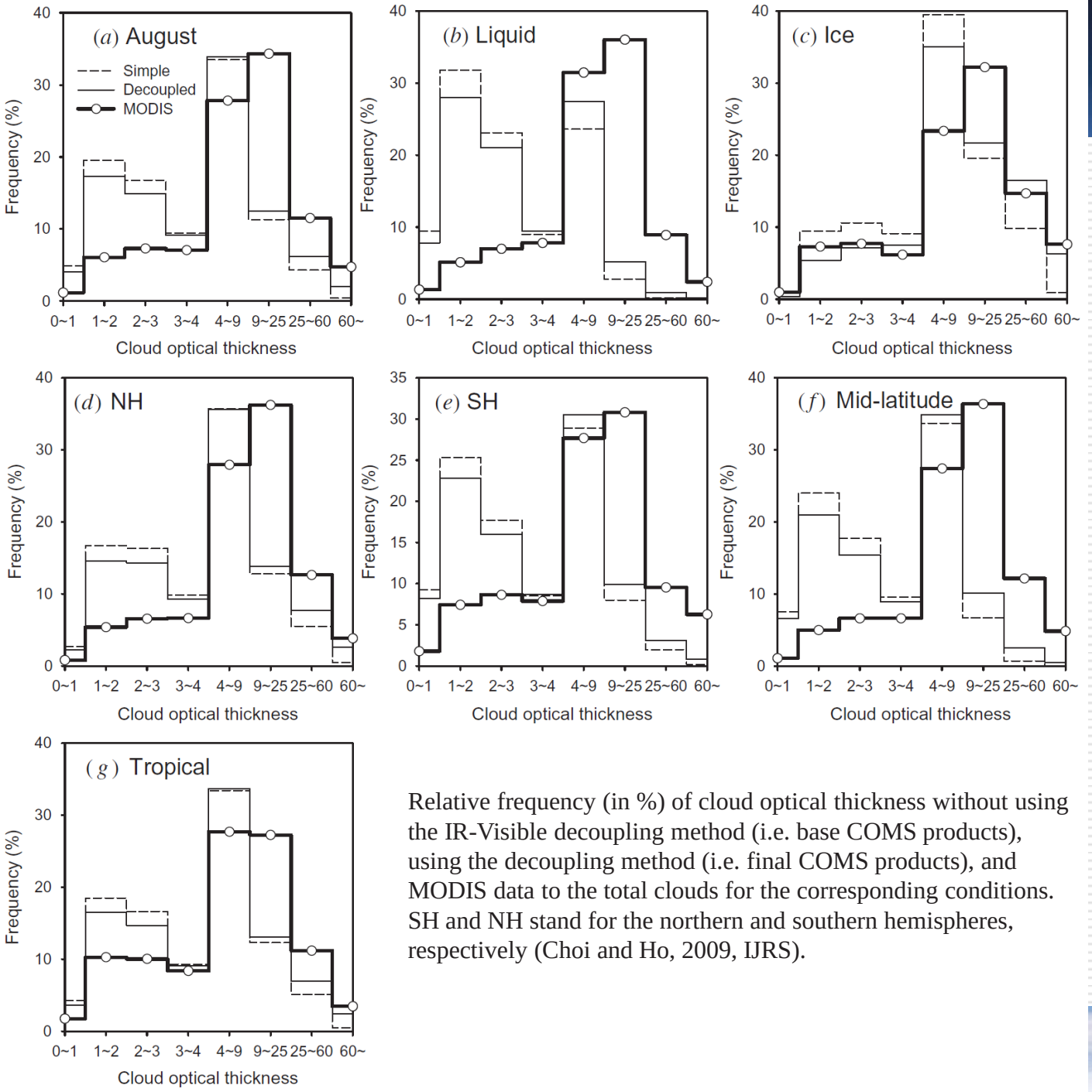
Maximum radiance could be occur when GEMS observes clouds !!



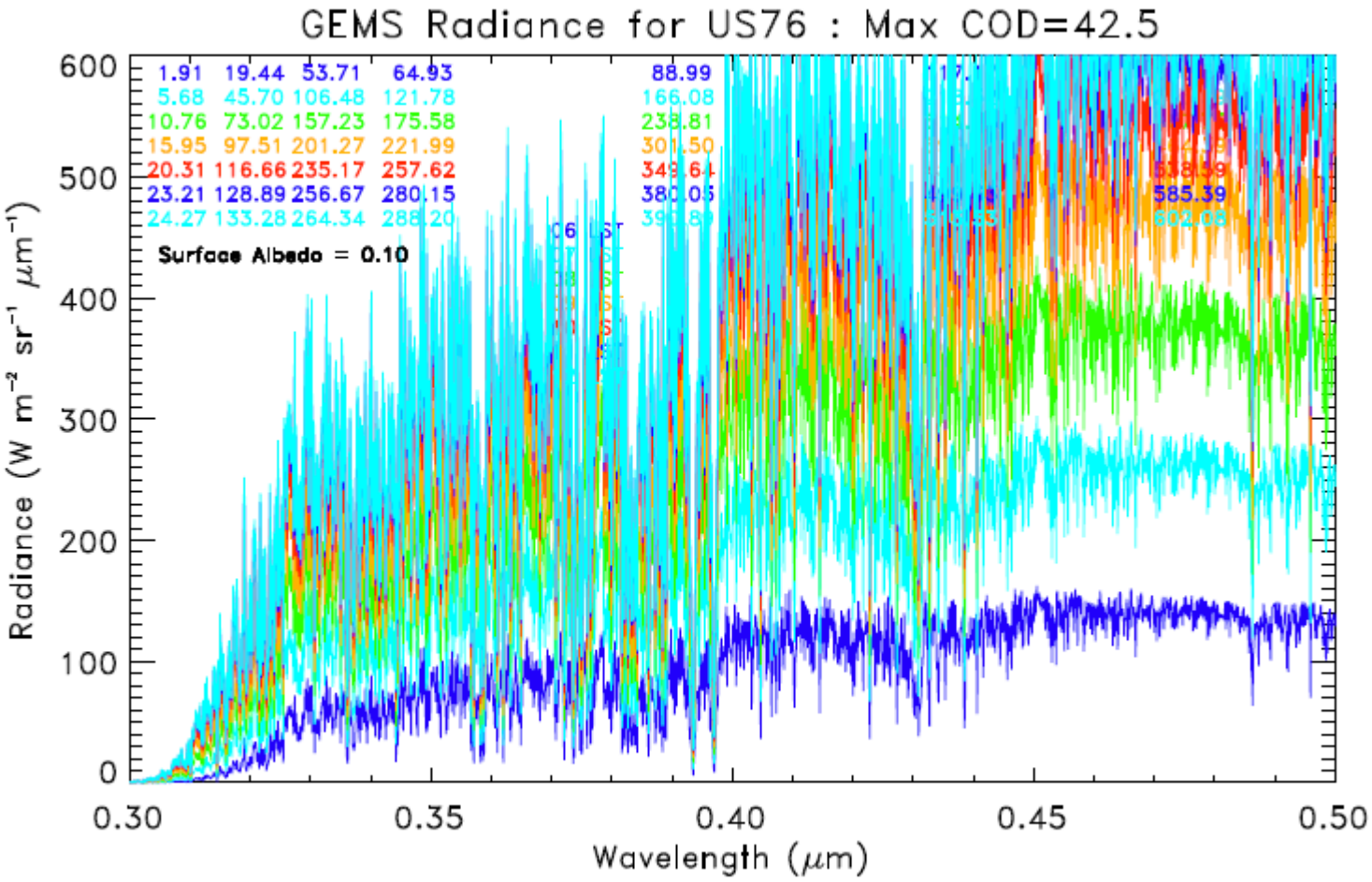
Barnard and Long (2003)



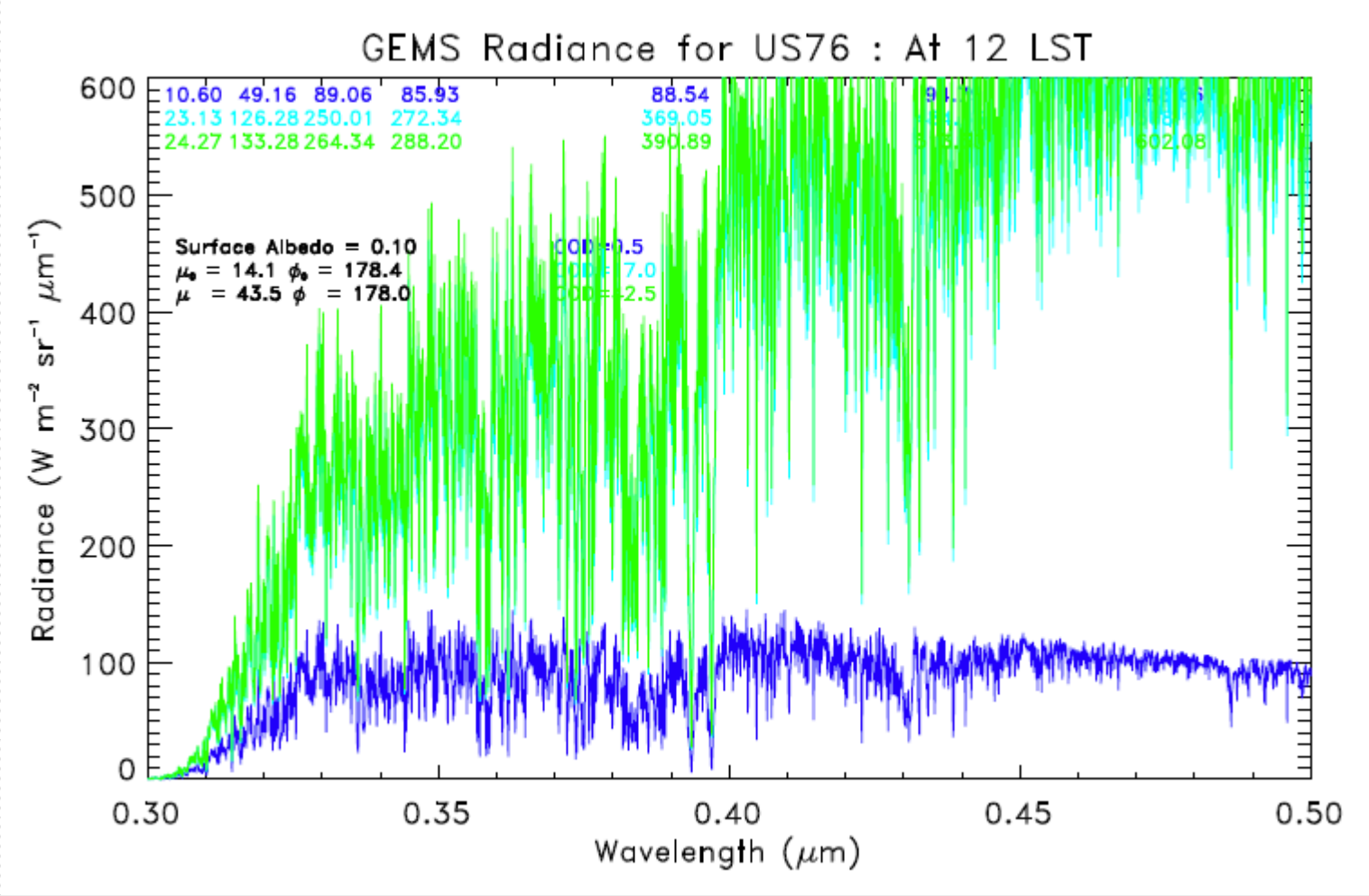
Alexander et al. (2001)

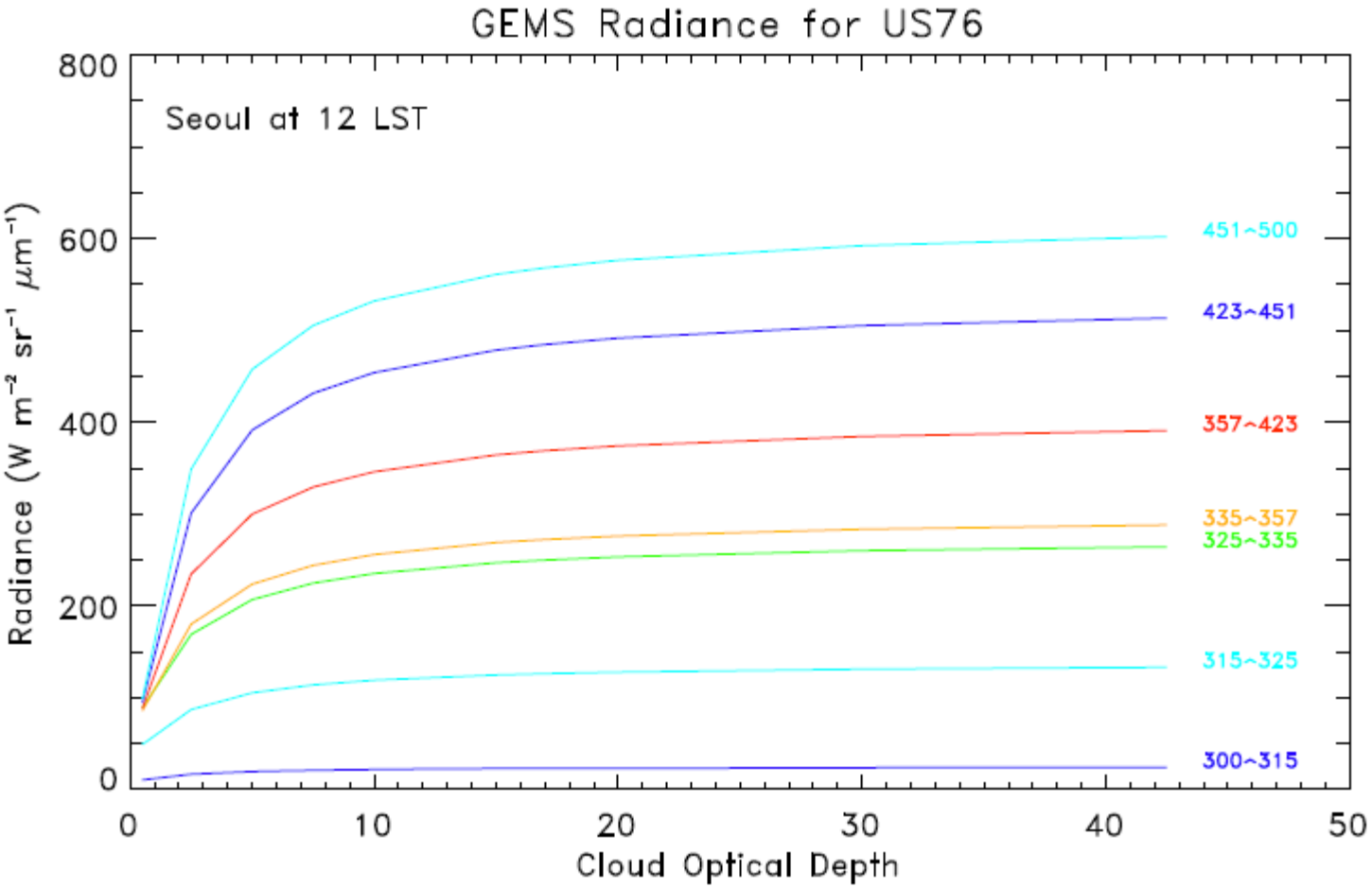


Relative frequency (in %) of cloud optical thickness without using the IR-Visible decoupling method (i.e. base COMS products), using the decoupling method (i.e. final COMS products), and MODIS data to the total clouds for the corresponding conditions. SH and NH stand for the northern and southern hemispheres, respectively (Choi and Ho, 2009, IJRS).



- *For Sumer Solstice*


GEMS Radiance for US76 : At 12 LST
10.60 49.16 89.06 85.93
23.13 126.28 250.01 272.34
24.27 133.28 264.34 288.20
88.54
369.05
390.89
Surface Albedo = 0.10
μ₀ = 14.1 φ₀ = 178.4
μ = 43.5 φ = 178.0
COD=0.5
COD= 7.0
COD=12.5
Radiance (W m⁻² sr⁻¹ μm⁻¹)
Wavelength (μm)
0
100
200
300
400
500
600
0.30
0.35
0.40
0.45
0.50



- *Radiance increase is small, above COD of about17.*

Summary with Clouds

- Radiance changes are small from COD=17 to COD=42.5

Radiance [W m^{-2} μm^{-1}] for US76			
Spectral range [nm]	Min	Mid	Max
	@ 06 LST	@ 09 LST	@ 12 LST
	COD=0.5	COD=17.0	COD=42.5
300-315	1.53	15.32	24.27
315-325	12.42	93.07	133.28
325-335	31.75	191.76	264.34
335-357	35.43	211.32	288.20
357-423	39.51	286.78	390.89
423-451	42.82	376.81	513.53
451-500	43.09	441.53	602.08

Thank You

Backups

Albedo

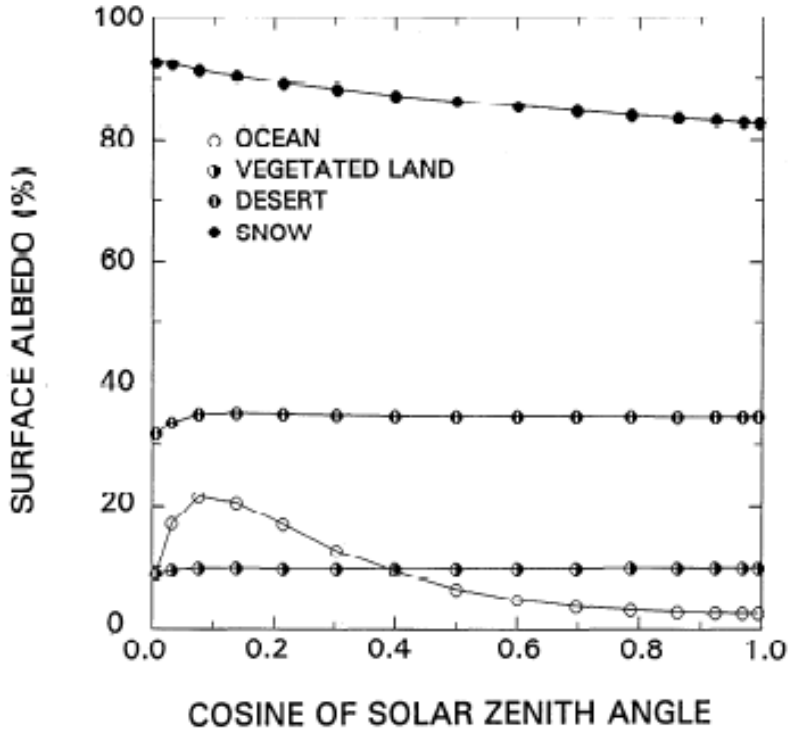


Figure 2. Dependence of surface albedo on SZA for ocean, vegetated land, desert, and fresh snow/ice.

Z. Li & L. Garand(1994)

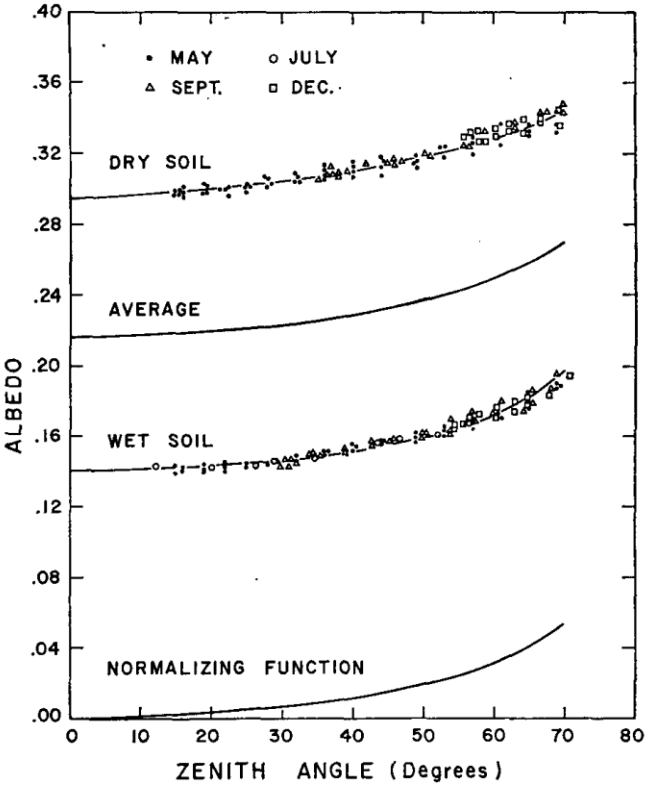
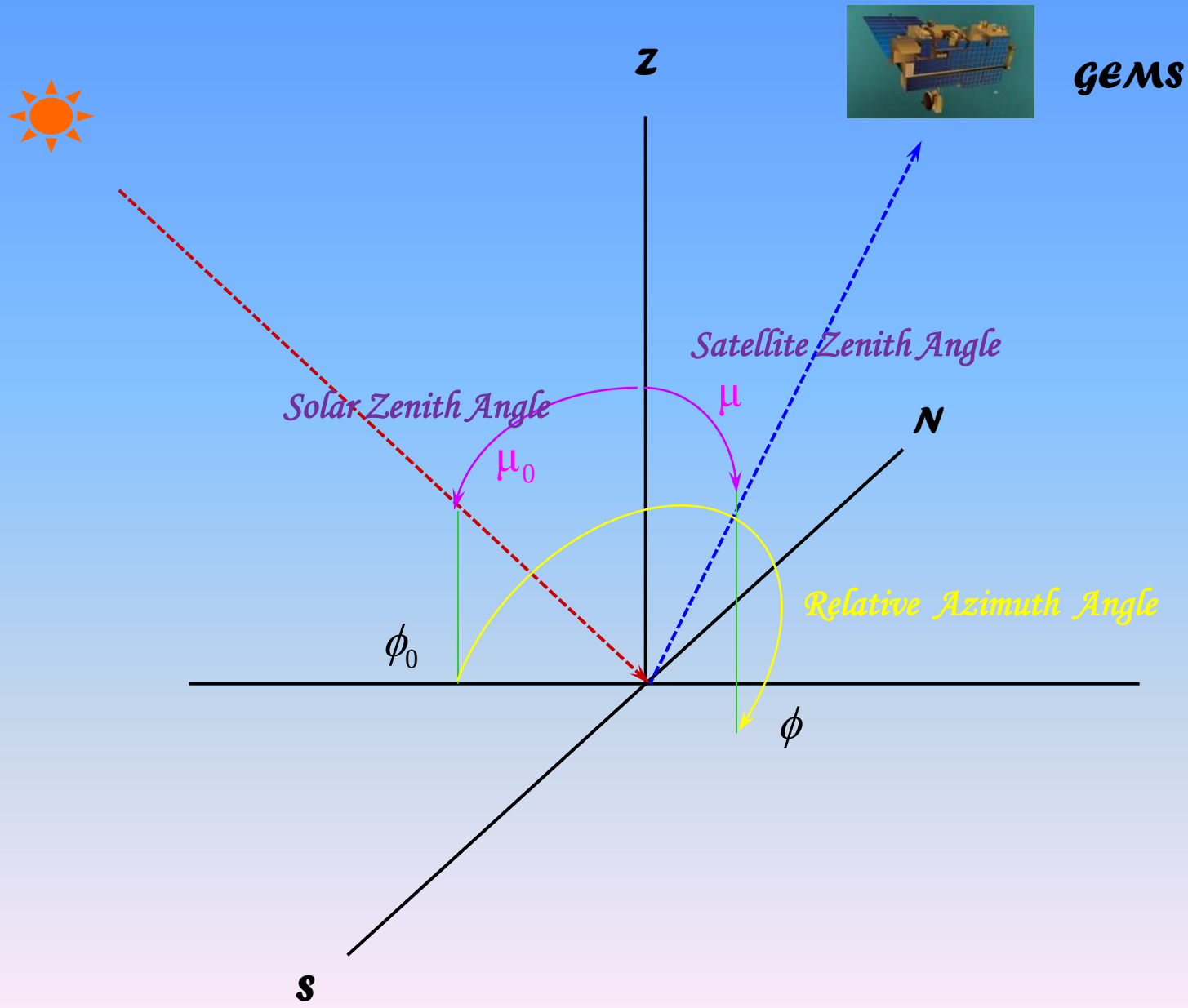


FIG. 2. Wet and dry soil albedo vs zenith angle for the four experiments, plus the normalization function derived therefrom to remove zenith angle effects from all of the raw albedo data.

S. B. Idso et al.(1975)


Z
GEMS
Satellite Zenith Angle
μ
Solar Zenith Angle
μ0
N
Relative Azimuth Angle
ϕ0
ϕ
S

2010

GEMS Radiances are in [W m^{-2} μm^{-1}]			
Spectral range [nm]	Nominal Radiance	Min Radiance	Max Radiance
300-315	7.98	0.09	25.64/30.17
315-325	43.36	0.29	108.32/130.46
325-335	86.63	1.01	198.09/241.18
335-357	91.39	1.69	209.95/259.71
357-423	108.66	2.01	277.96/354.23
423-451	130.75	2.36	358.52/466.31
451-500	145.49	2.34	418.84/549.86

OMI Radiances are in [W m^{-2} μm^{-1}]			
Spectral range [nm]	Nominal Radiance	Min Radiance	Max Radiance
300-315	3.35	0.08	21.16
315-325	39.19	0.33	116.05
325-335	58.72	1.02	190.48
335-357	65.29	2.61	214.15
357-423	76.74	3.92	311.18
423-451	95.52	4.85	412.13
451-500	106.49	4.32	493.30