

RADIATIVE TRANSFER MODEL FOR GEMS:

INPUT RADIANCE FOR GEMS

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Purposes of the Work

■ Final Aim

□ Developing Radiative Transfer Model for GEMS

- To simulate GEMS measured radiances
- Generate synthetic data to develop retrieval algorithms of pollutant species

■ In 2012

□ Design RTM for GEMS specifications

- Geographic coverage
- GEMS geographic location
- Spectral range



55 N

2

75 E

145 E

Description of RTM

■ RTM frame

- ❑ **LIDORT (Linerized Discrete Ordinate Radiative Transfer; Spurr 2001)**
- ❑ **DISORT (Discrete Ordinate Radiative Transfer; Stamnes et al, 1988, 2000)**

■ Scattering calculation

- ❑ **Rayleigh scattering (Bodhein et al., 1999)**
- ❑ **MIE scattering (Wiscombe, 1980)**

■ Look-Up-Table

- ❑ **Combined Phase functions of Air molecules and Aerosols (Clouds)**

■ **Optical Data and Size Distribution**

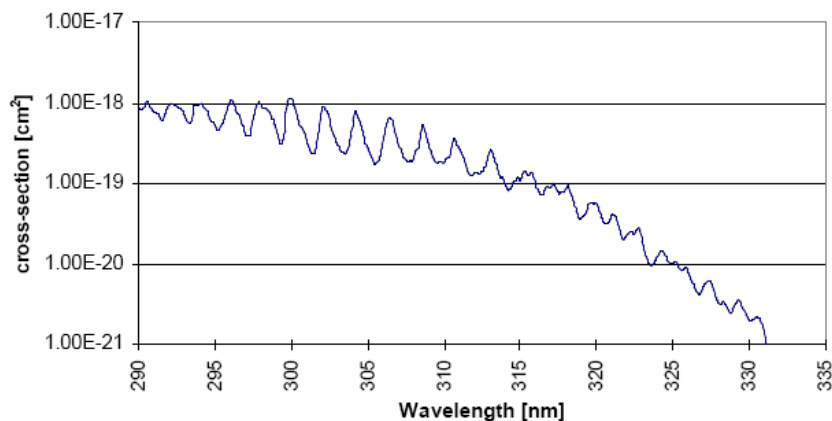
- **OPAC (Optical Properties of Aerosols and Clouds; Hess et al., 1980)**

■ **Other Components**

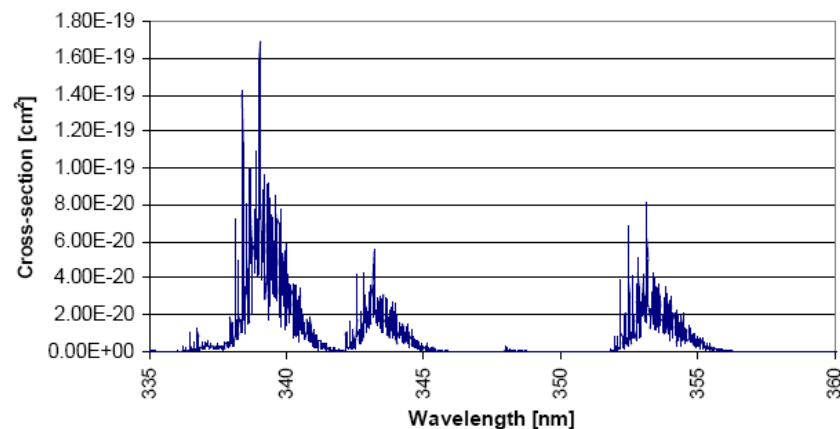
- **Solar Irradiance**
 - ✦ Kurucz solar spectrum data (Kurucz, 1992)
- **Absorption Cross-sections**
 - ✦ HITRAN (Rothman et al., 2009)
 - ✦ BDM (Brion-Daumont-Malicet; Brion et al., 1998)
- **Model Atmospheres**
 - ✦ U.S. Standard Atmosphere (1976)
 - ✦ McClatchey et al. (1972)

Input Cross-Sections

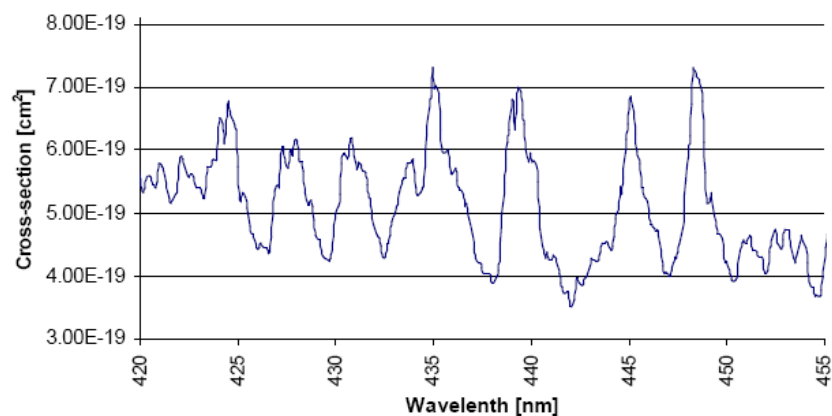
SO₂ cross-sections



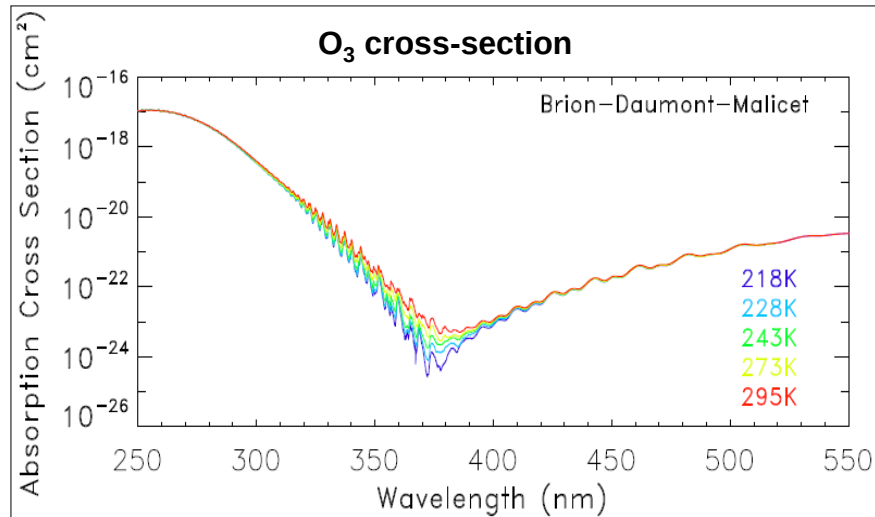
HCHO cross-section (T = 246K)



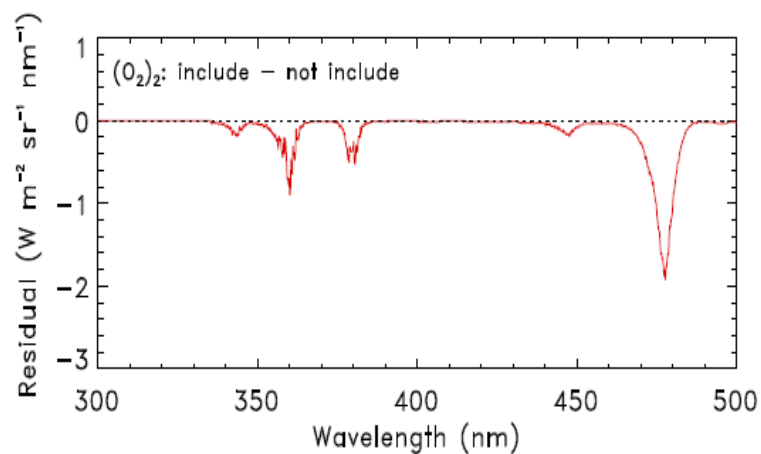
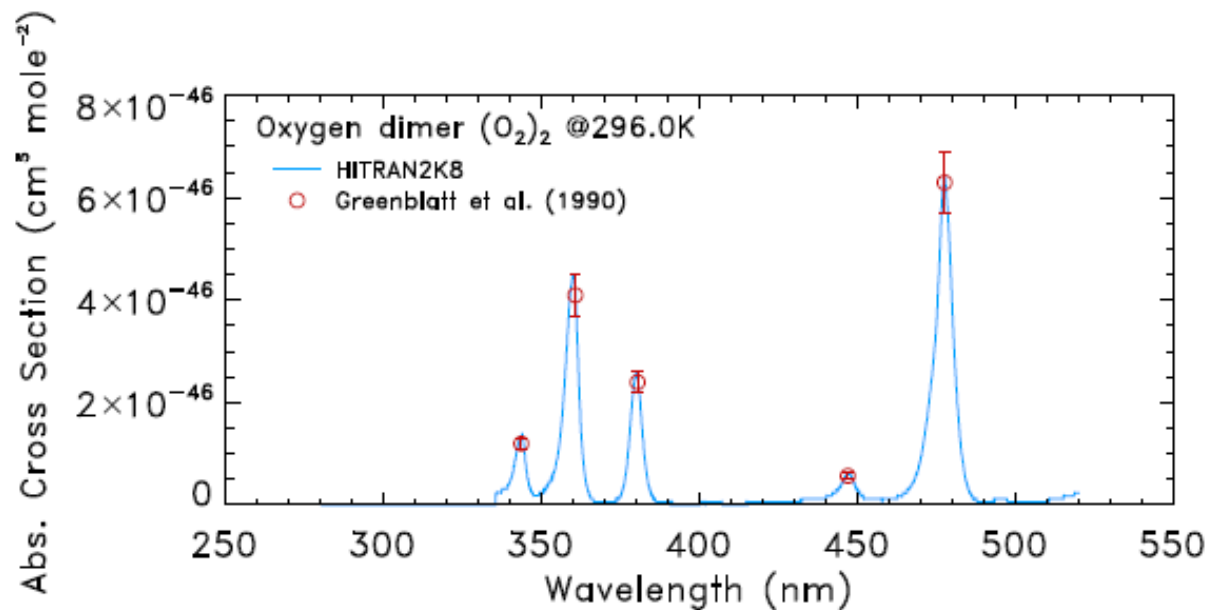
NO₂ Cross-section



O₃ cross-section



O_2-O_2 Lines



Calculation of GEMS Nominal Radiance

▣ **Seoul**

- ▣ **Satellite Zenith Angel=43.75, Azimuth Angle=177.99**
- ▣ **S. Equinox, S. Solstice, A. Equinox, W. Solstice**

▣ **Surface**

- ▣ **Lambertian**
 - ✦ **Albedo: 0.3 (for nominal)**

▣ **Aerosols & Clouds**

- ▣ **Aerosols: Lognormal distribution**
 - ✦ **Continental Average for RH=50%, consisting of INSO, WASO50%, SOOT**
- ▣ **Clouds: Modified Gamma distribution**
 - ✦ **COD=0.0**

Input Angles at Seoul

Solar zenith angle and azimuth angle at Seoul

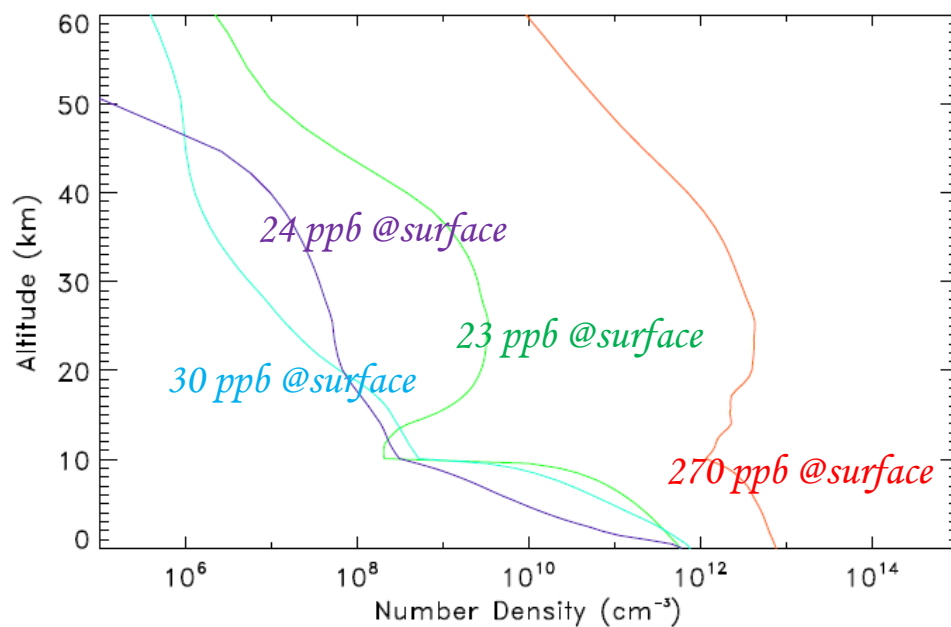
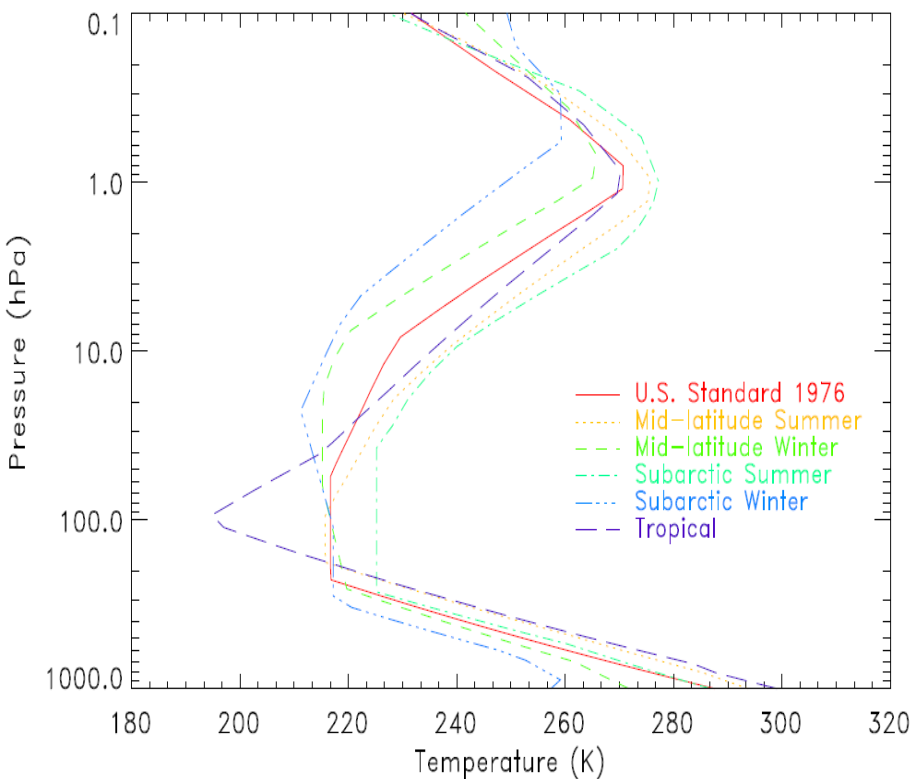
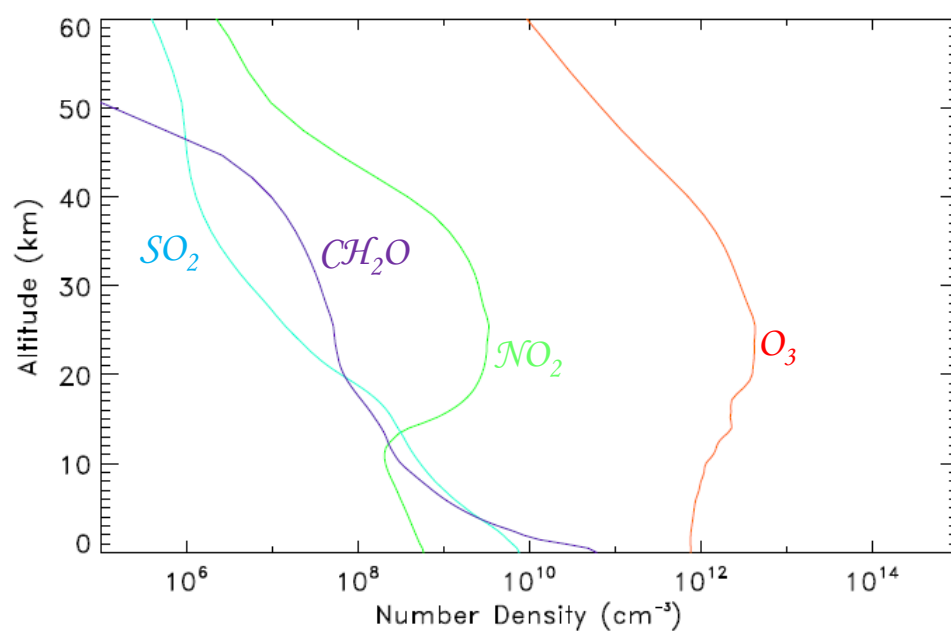
Time(hour)	Spring Equinox		Summer Solstice		Autumn Equinox		Winter Solstice	
	$\mu_0^\dagger$	$\varphi_0^\ddagger$	μ_0	φ_0	μ_0	φ_0	μ_0	φ_0
06	91.18	88.83	76.20	70.82	88.16	91.06	103.68	109.21
07	79.46	98.05	64.76	78.89	76.60	100.40	92.68	117.69
08	67.92	108.00	52.99	87.20	65.19	110.70	82.65	127.12
09	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

Input Atmosphere

Mixing Ratios (ppb) at surface

	NO_2	SO_2	CH_2O	O_3
<i>clean</i>	0.023	0.3	2.4	27
<i>polluted</i>	23	30	24	270



Outline of Results

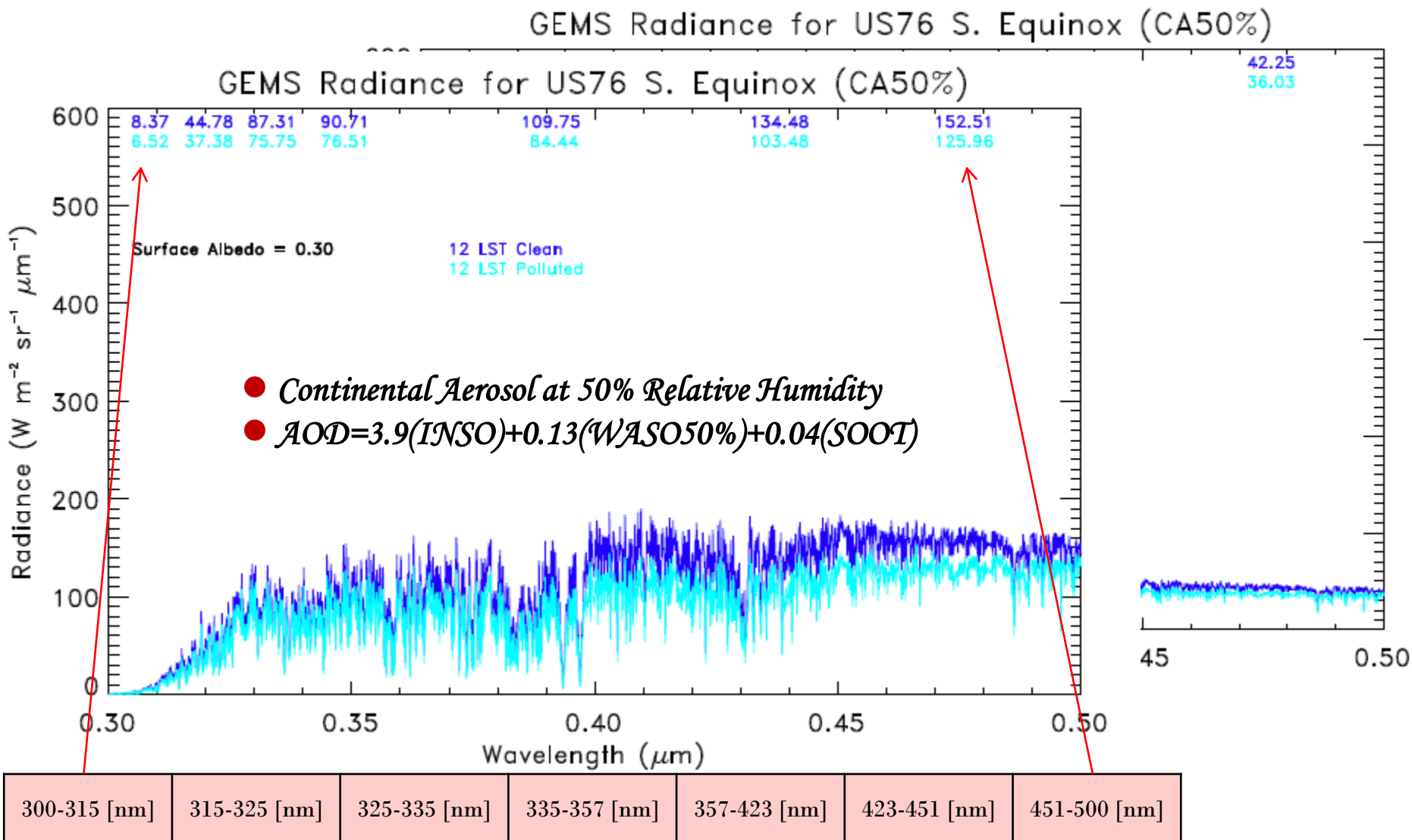
□ **Clean vs Polluted**

- Pollutants reduce nominal radiances, which depend on the amount of pollutant species in the atmosphere.

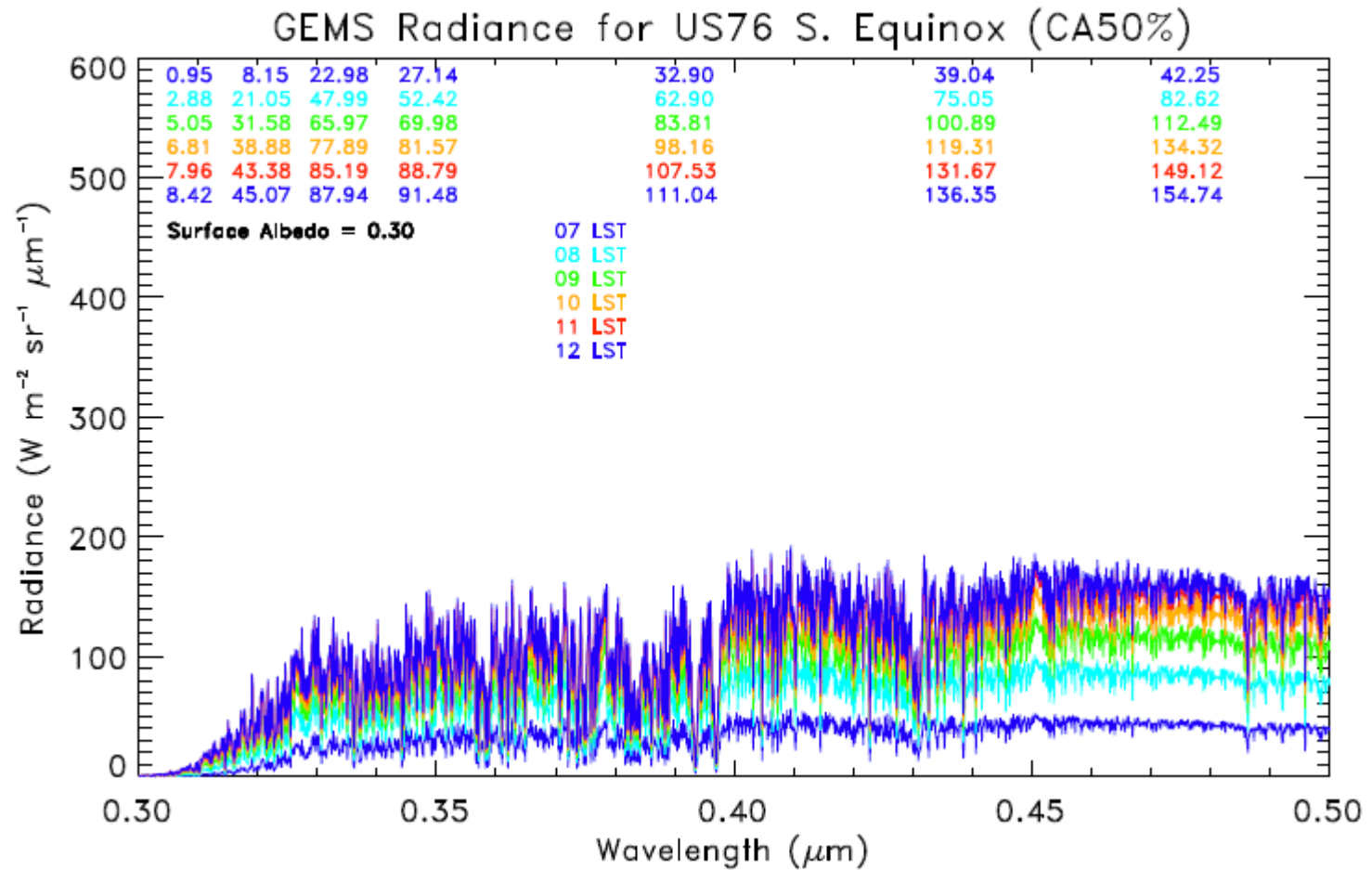
□ **Nominal Radiances: Revisit**

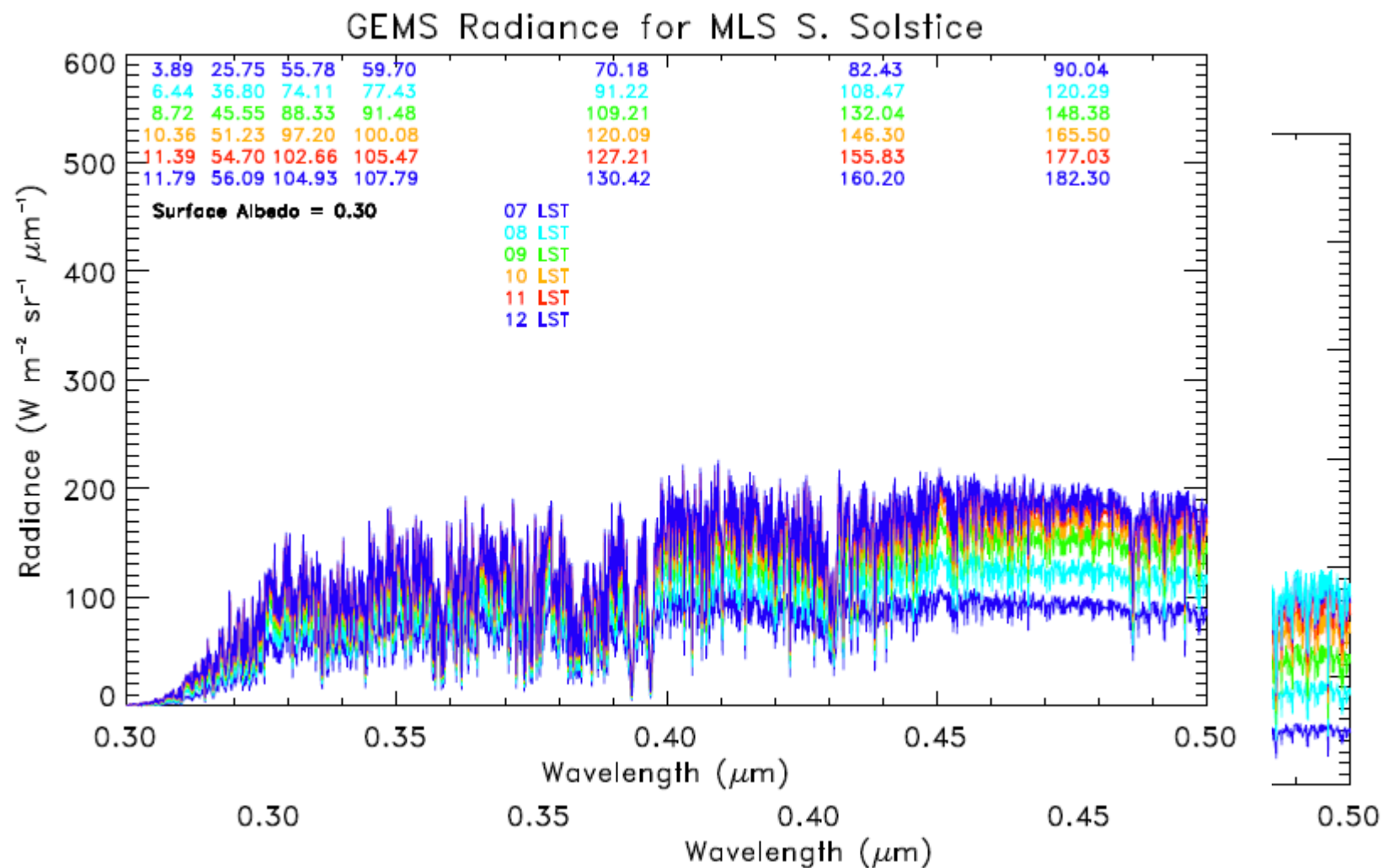
- Previous calculations were done for Spring Equinox: representative condition of 4 seasons
- Present calculations are done for Spring Equinox, Summer Solstice, Autumn Equinox, Winter Solstice

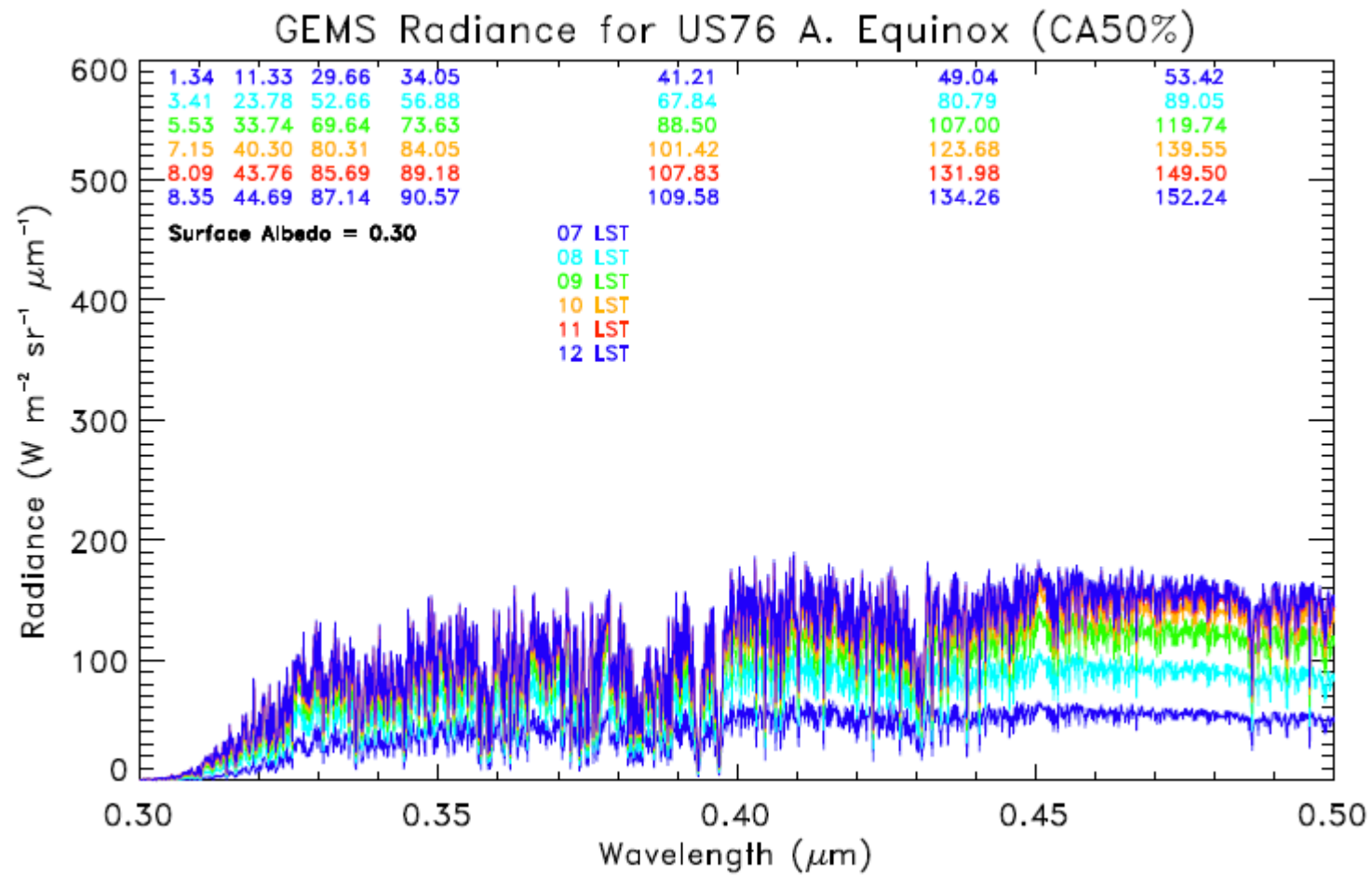
Clean vs Polluted

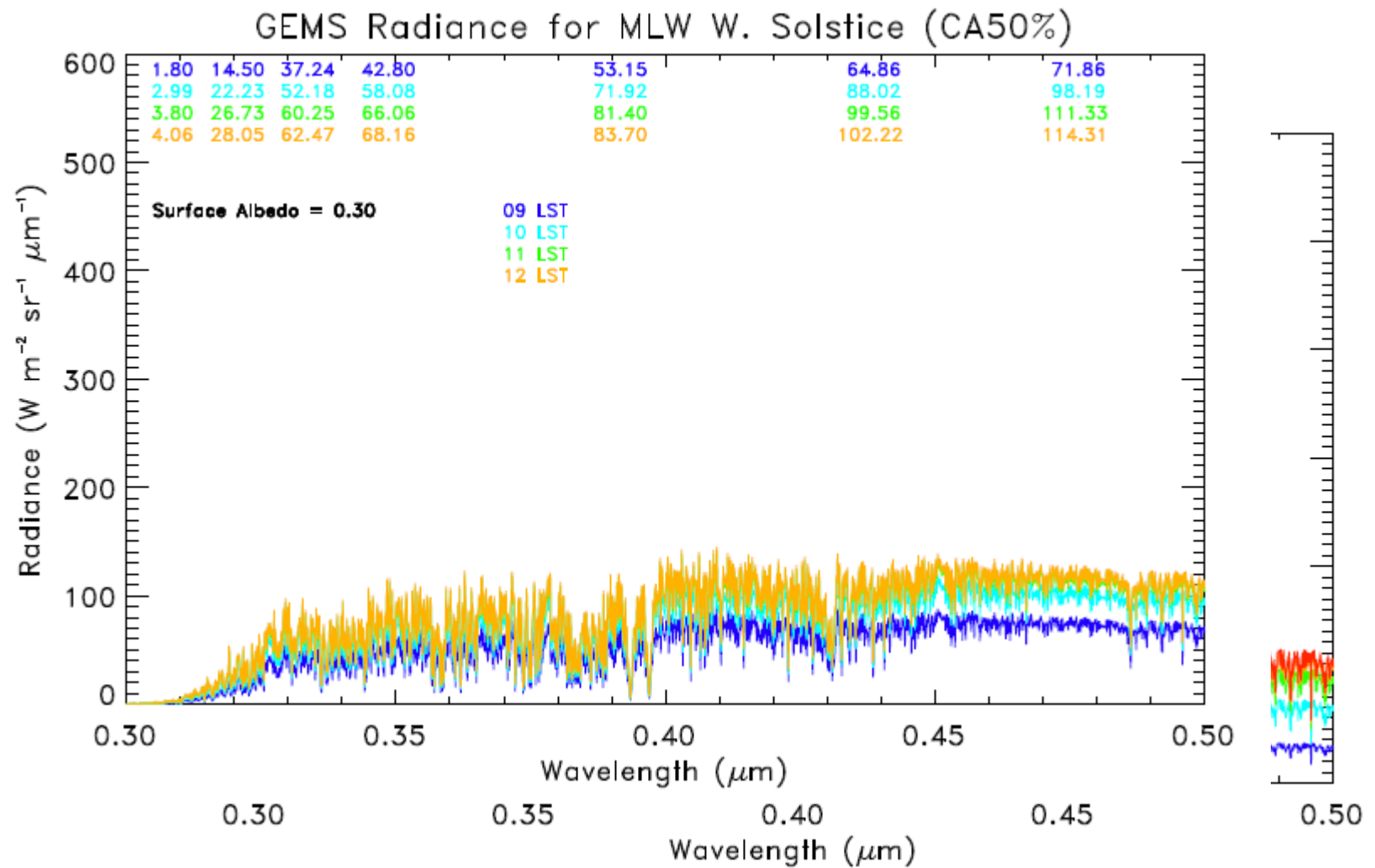


Input Radiances for 4 Seasons









NORMAL RADIANCE: SUMMARY

Nominal Radiance [$\text{W m}^{-2} \mu\text{m}^{-1}$] for US76							
	300-315 [nm]	315-325 [nm]	325-335 [nm]	335-357 [nm]	357-423 [nm]	423-451 [nm]	451-500 [nm]
Mean for All	6.445	36.393	73.779	77.780	93.856	114.046	128.130
Mean for SE	6.224	35.992	72.996	76.848	92.688	112.654	126.658

✦ *For Solar zenith angels $> 70^\circ$*

NORMAL RADIANCE: SUMMARY

Typo

Nominal Radiance [$\text{W m}^{-2} \mu\text{m}^{-1}$] for US76						
Spectral range [nm]	평균(7시-12시) Non-polluted	평균(7시-12시) Polluted	(Non-polluted x 0.5) + (Polluted x 0.5)	평균(8시-12시) Non-polluted	평균(8시-12시) Polluted	(Non-polluted x 0.5) + (Polluted x 0.5)
300-315	5.345	4.302		6.224	4.926	
315-325	31.352	26.600		35.992	30.41	
325-335	64.660	56.705		72.996	63.766	
335-357	68.562	58.485		76.848	65.234	
357-423	82.723	64.280		96.688	71.562	
423-451	100.385	77.332		112.654	86.358	
451-500	112.59	92.458		126.658	103.744	

Thank You