Simultaneously retrieval of aerosol optical depth and surface albedo over land
—A cloud shadow method

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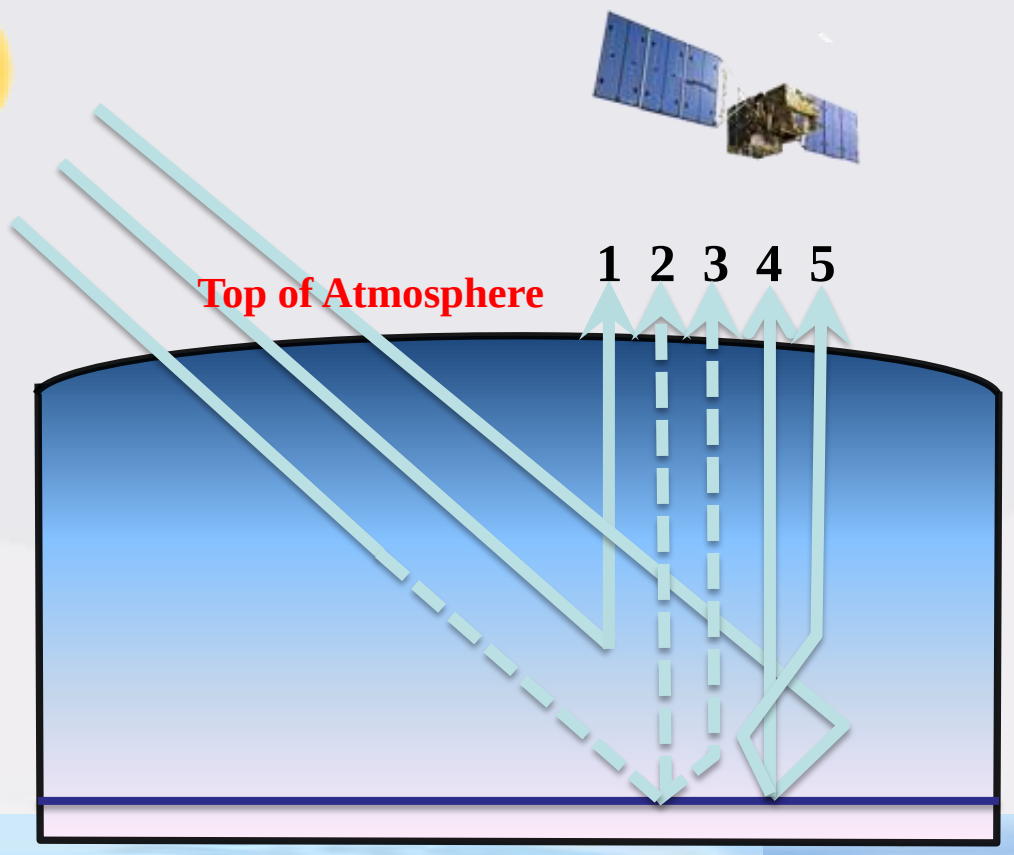
Background



Path Radiance(1)
Solar direct reflected(2,3)
Interactions(4,5)

Forward modeling:

we can tell exactly how the aerosol, surface and their optical properties impact the TOA measurements

Measurements & Inversion:

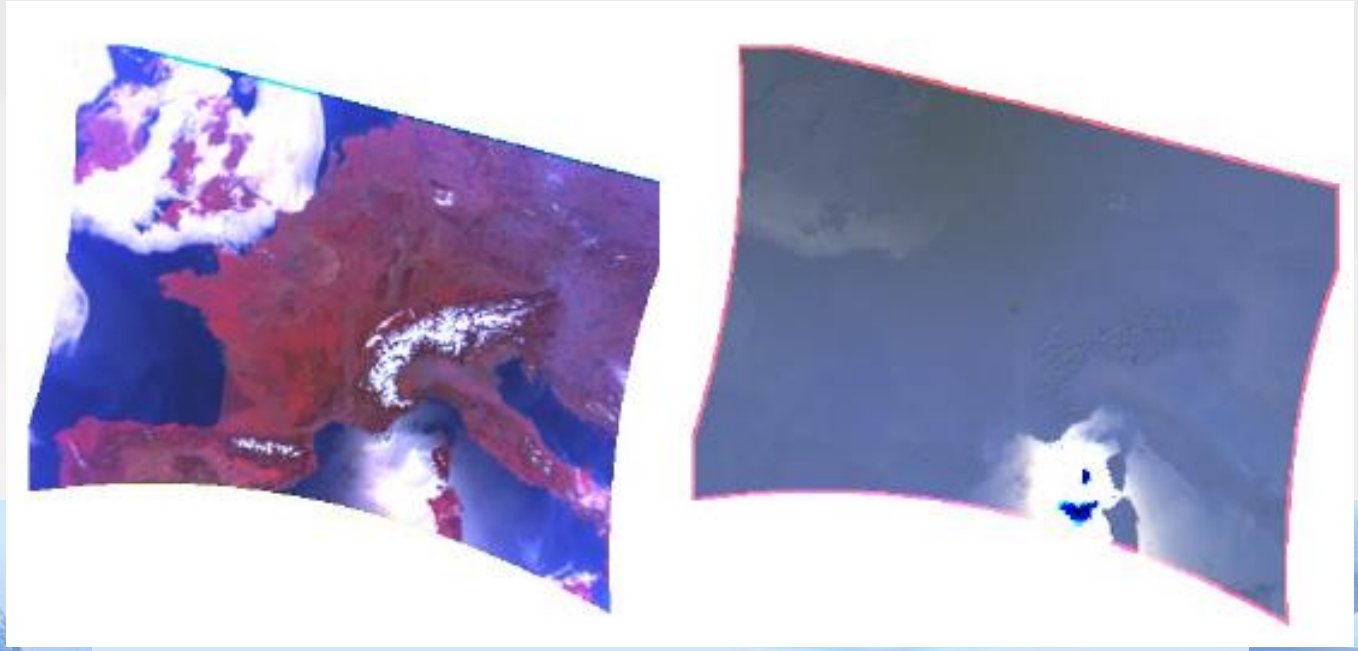
Measurements is the mixed contributions, we can not separate one from the other

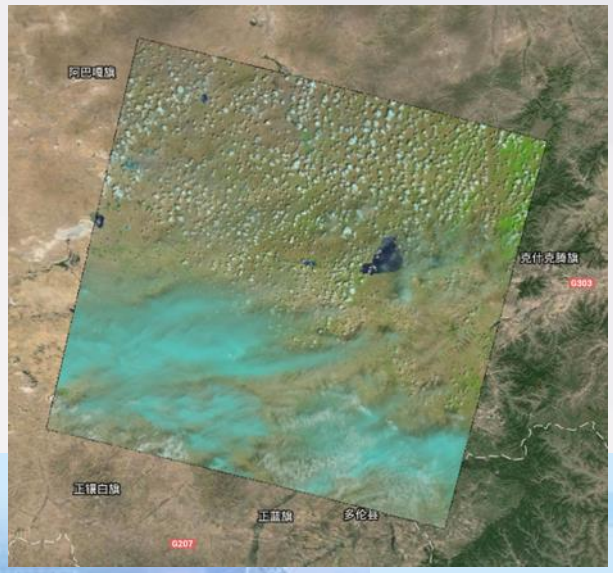
Currently method for aerosol retrieval over land

1. Dark targets (dense dark forest , Kaufman, 1988)
2. Dark target in the UV(Qiu， 1997)
3. Multi-temporal method (very slow change of surface reflectance in a limited time period (Fraser, 1984; Kaufman,1990)
4. target blurring (targets with large different reflectance and changed with time) (Tanre et al.,1988; Holben et al., 1992)
5. Supposed known surface reflectance in UV(Torres, 1998)

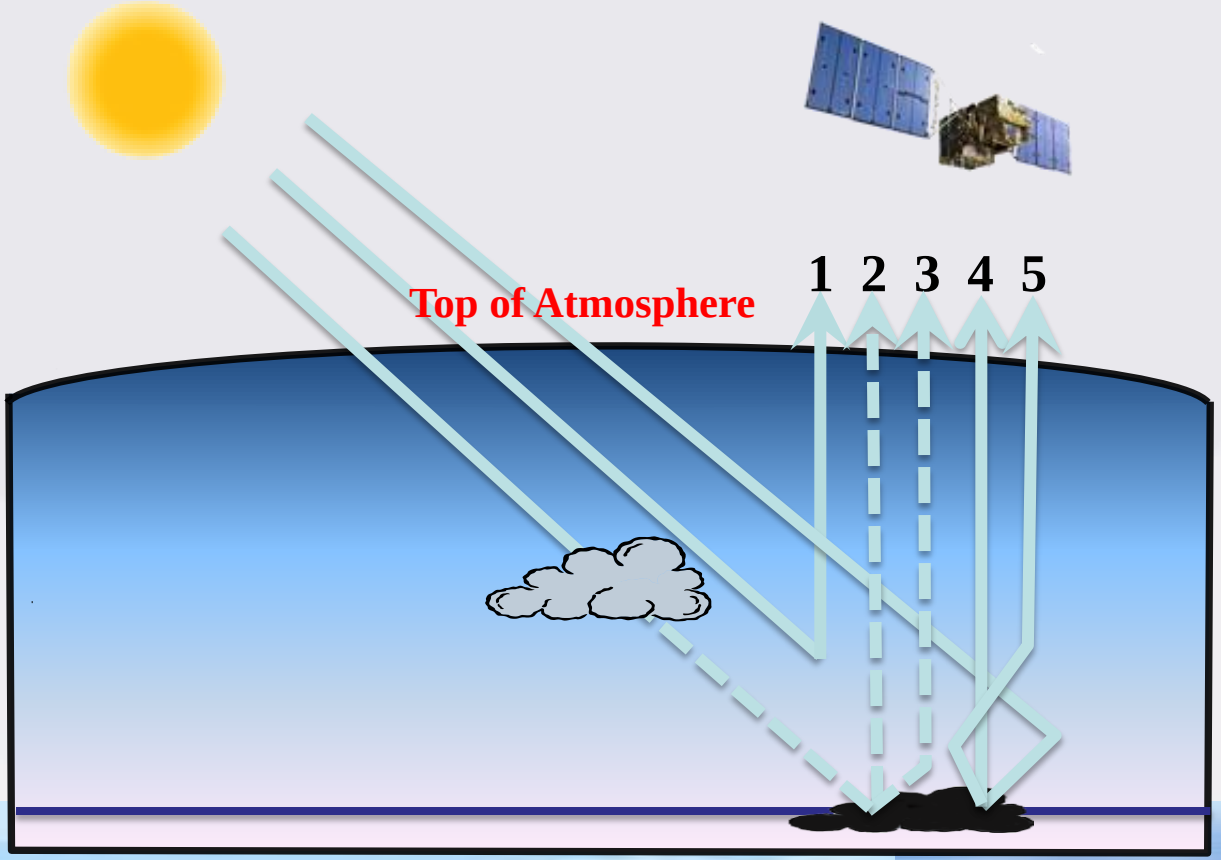
6. Polarization：

Polarized radiance at TOA is not sensitive to surface, but it is high sensitive to aerosol layer height





Landsat 8 image



Duan et al, 2001, J. Remote Sensing, in Chinese

- Sparse scattered cloud.
- The cloud is thick and non transparent for sun beam.
- Homogeneous surface in a limited domain.
- Adjacency effect could be ignored.

For the TOA reflectance

$$I(\mu_o,\mu_v,\varphi)=I_p(\mu_o,\mu_v,\varphi)+\frac{T(\mu_o)T(\mu_v)\rho(\mu_o,\mu_v,\varphi)}{1-\rho(\mu_o,\mu_v,\varphi)S}$$

For the Lambertian Surface

$$I=I_p+\frac{T(\mu_o)T(\mu_v)A}{(1-AS)}$$

$$T(\mu_0)=\mu_0 e^{-\tau/\mu_0}+t_{dif}(\mu_0)$$

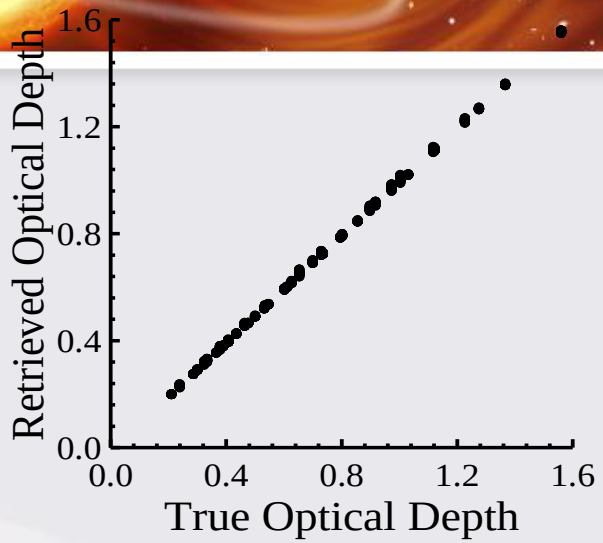
$$I_{TOA} = I_{path} + T(\mu_o)T(\mu_v)A + T(\mu_o)T(\mu_v)SA^2 + o(S^2A^3)$$

Over shadow

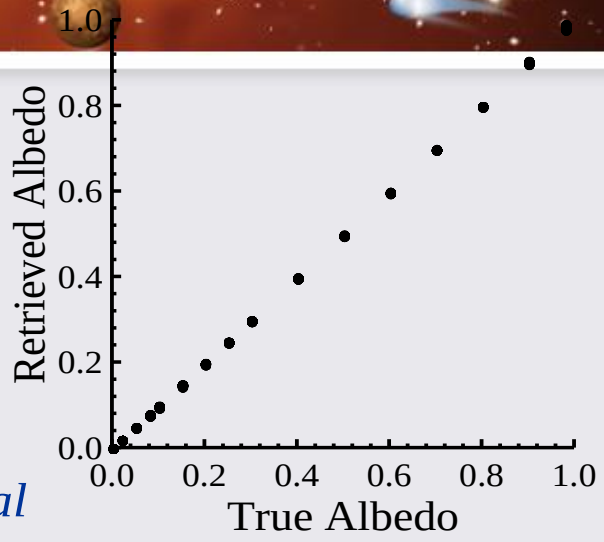
$$I'_{TOA} = I_{path} + t_d(\mu_o)T(\mu_v)A + t_d(\mu_o)T(\mu_v)SA^2$$

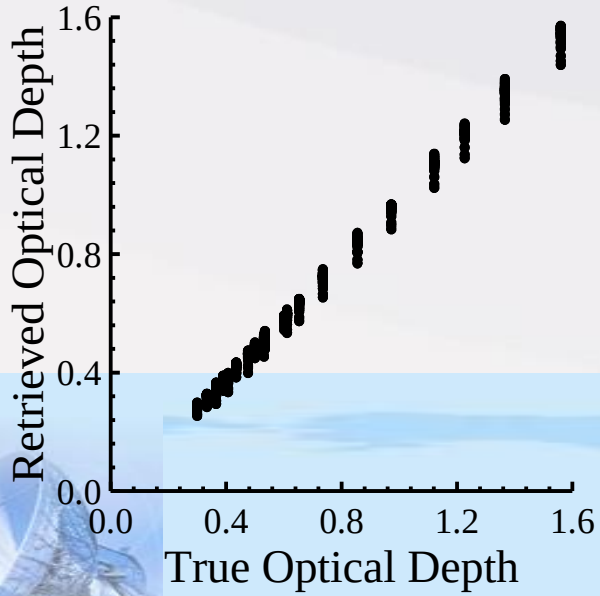
Over bright targets

$$I_{TOA} = I_{path} + [e^{-\tau/\mu_0} + t_d(\mu_0)]T(\mu_v)A + [e^{-\tau/\mu_0} + t_d(\mu_0)]T(\mu_v)SA^2$$

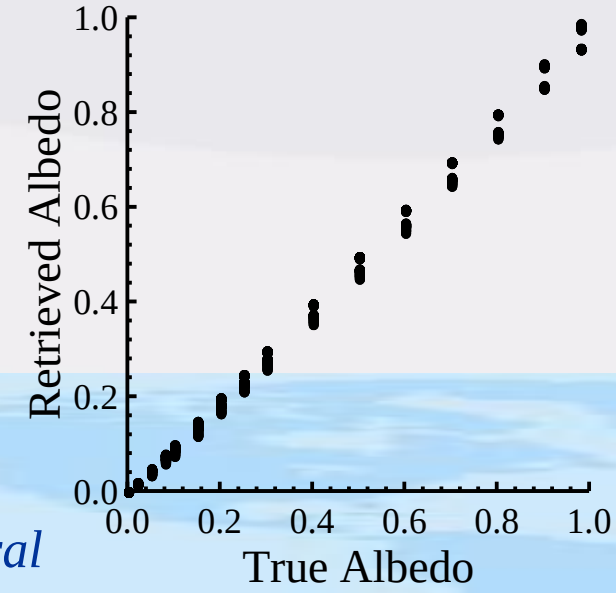


Rural





Rural



Simulated retrieval for rural aerosol type

This method was improved by rewrite the formula as:

$$I = I_p + \frac{T(\mu_o)T(\mu_v)A}{(1-AS)} \qquad T(\mu_0) = \mu_0 e^{-\tau/\mu_0} + t_{dif}(\mu_0)$$

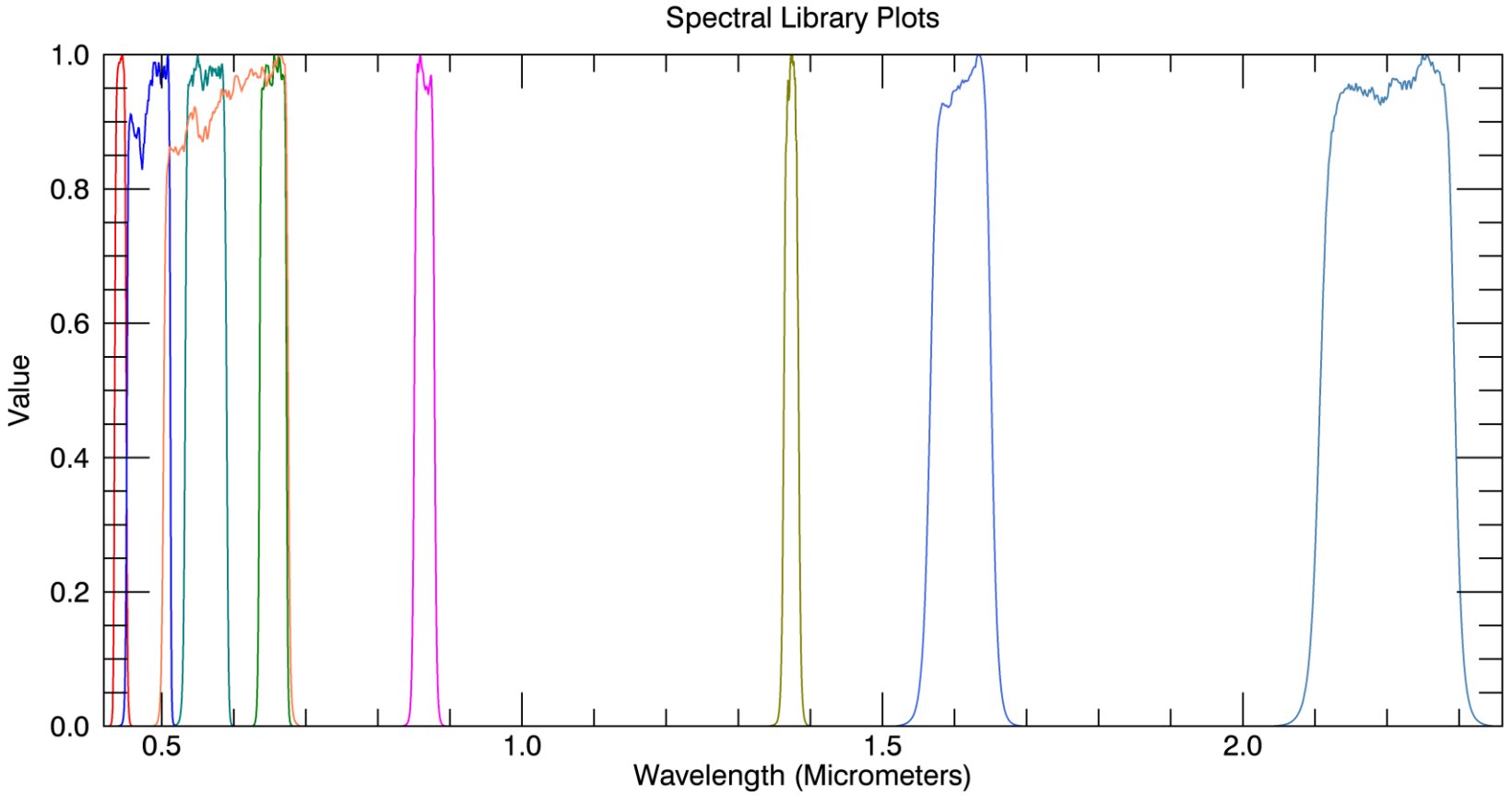
$$\Rightarrow \qquad \frac{I_b - I_{path}}{I_s - I_{path}} = \frac{\mu_0 e^{-\tau/\mu_0} + T_{dif}(\mu_o)}{T_{dif}(\mu_o)}$$

Let: $\varepsilon = \sum_{\lambda} f^2 \qquad f = \frac{I_b - I_s}{I_s - I_p} - \frac{\mu_0 e^{-\tau/\mu_0}}{T_{dif}(\mu_o)}$

And the AOD can be derived by searching LUT

Vincent(2006), Sweat(2008) , Chen et al.,(2008)

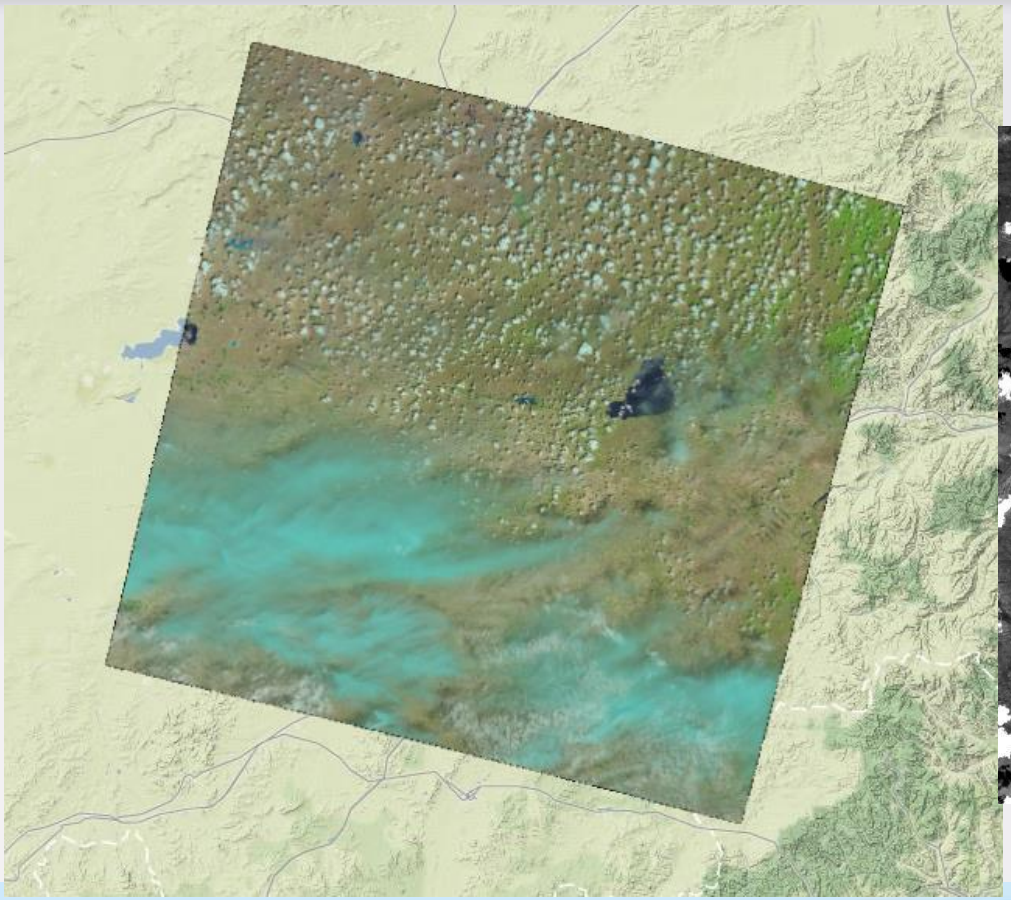
OLI / Landsat 8

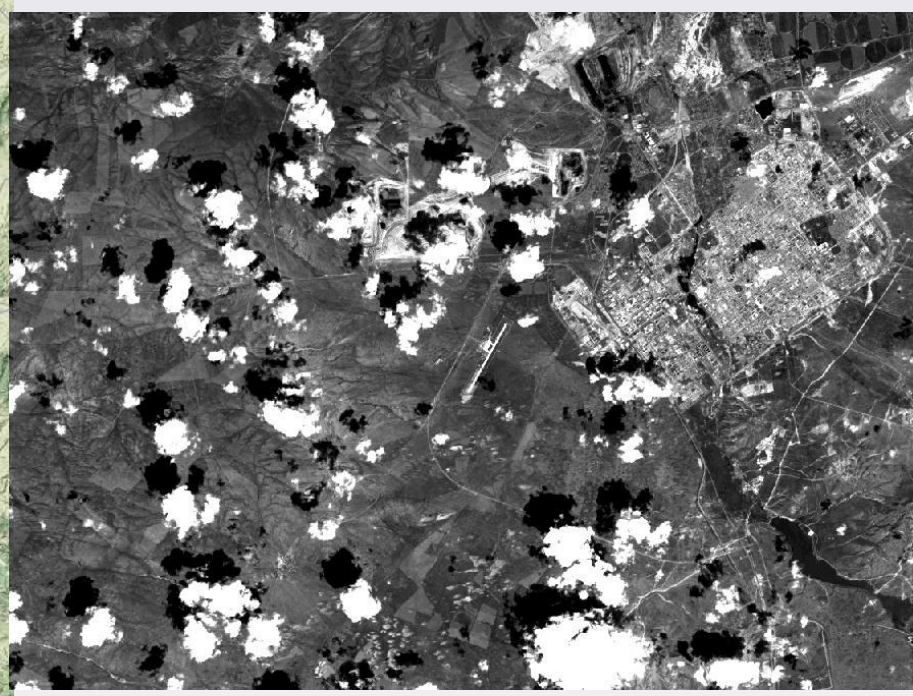


Specification of OLI / Landsat 8

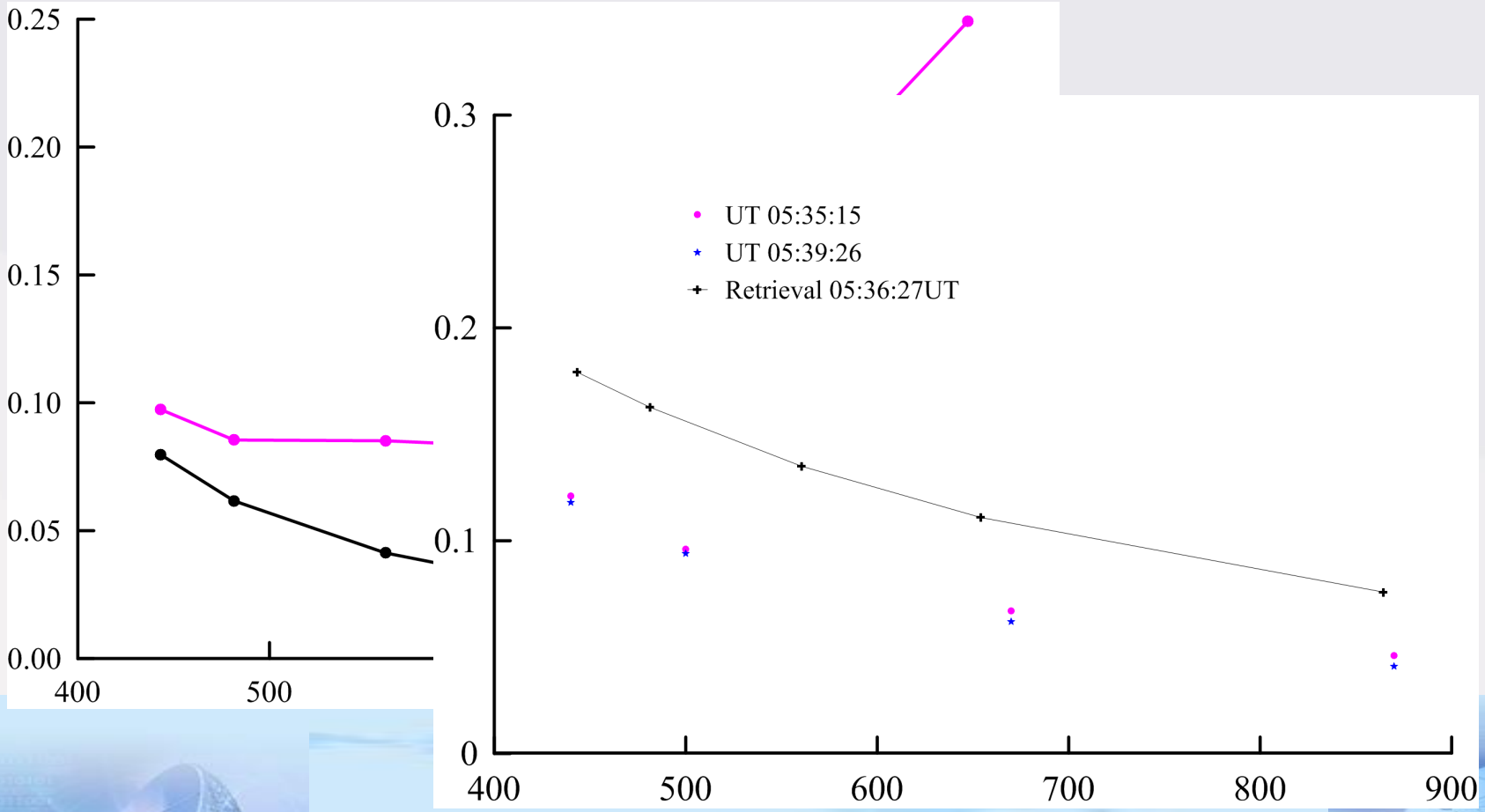
Landsat 8 Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS) Launched February 11, 2013	Bands	Wavelength (micrometers)	Resolution (meters)
	Band 1 - Coastal aerosol	0.43 - 0.45	30
	Band 2 - Blue	0.45 - 0.51	30
	Band 3 - Green	0.53 - 0.59	30
	Band 4 - Red	0.64 - 0.67	30
	Band 5 - Near Infrared (NIR)	0.85 - 0.88	30
	Band 6 - SWIR 1	1.57 - 1.65	30
	Band 7 - SWIR 2	2.11 - 2.29	30
	Band 8 - Panchromatic	0.50 - 0.68	15
	Band 9 - Cirrus	1.36 - 1.38	30
	Band 10 - Thermal Infrared (TIRS) 1	10.60 - 11.19	100
	Band 11 - Thermal Infrared (TIRS) 2	11.50 - 12.51	100

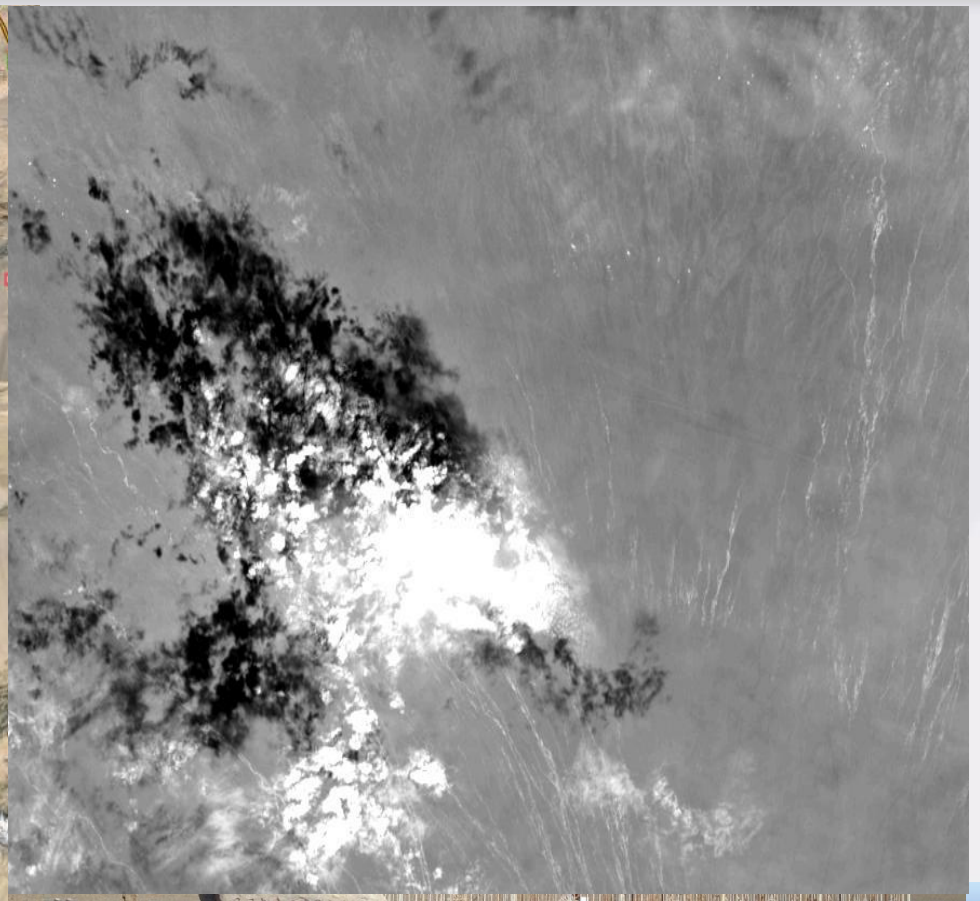
* TIRS bands are acquired at 100 meter resolution, but are resampled to 30 meter in delivered data product



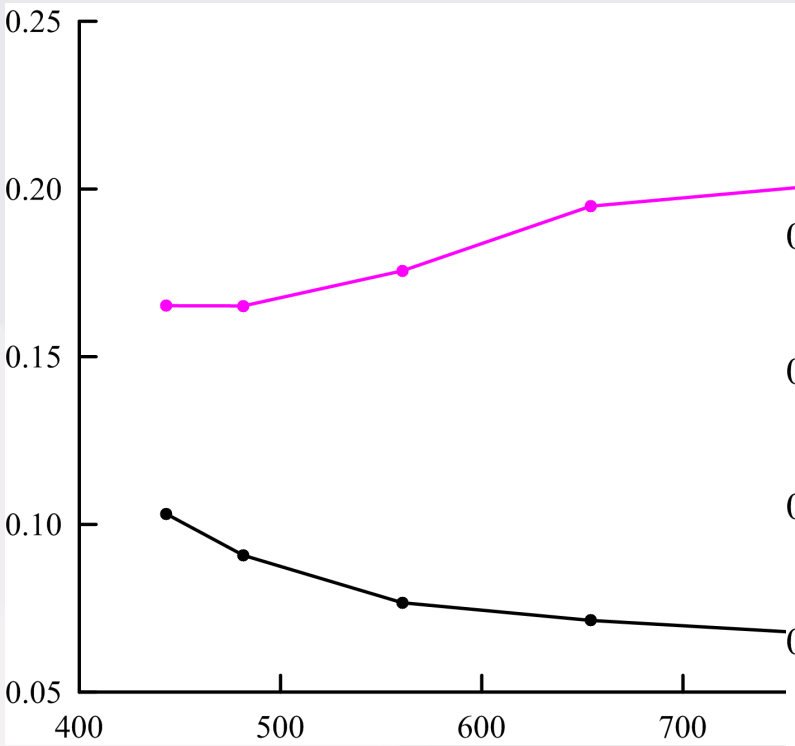


Aug. 23, 2013, Xilinhot, Inner Mogolia, China


0.25
0.20
0.15
0.10
0.05
0.00
400
500
0.3
0.2
0.1
0
400
500
600
700
800
900
UT 05:35:15
UT 05:39:26
Retrieval 05:36:27UT



Aug. 25, 2013, Dunhuang, China


0.25
0.20
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400
500
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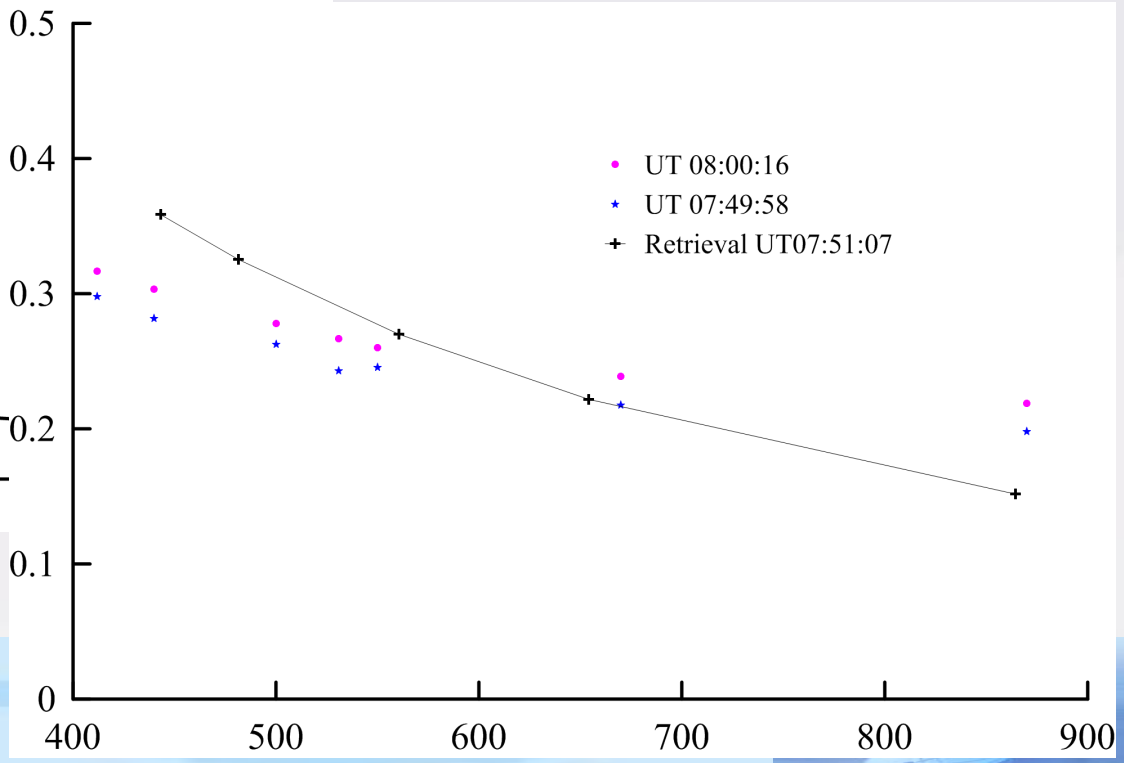
0.5
0.4
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0.2
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400
500
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UT 08:00:16
UT 07:49:58
Retrieval UT07:51:07

Outlooks

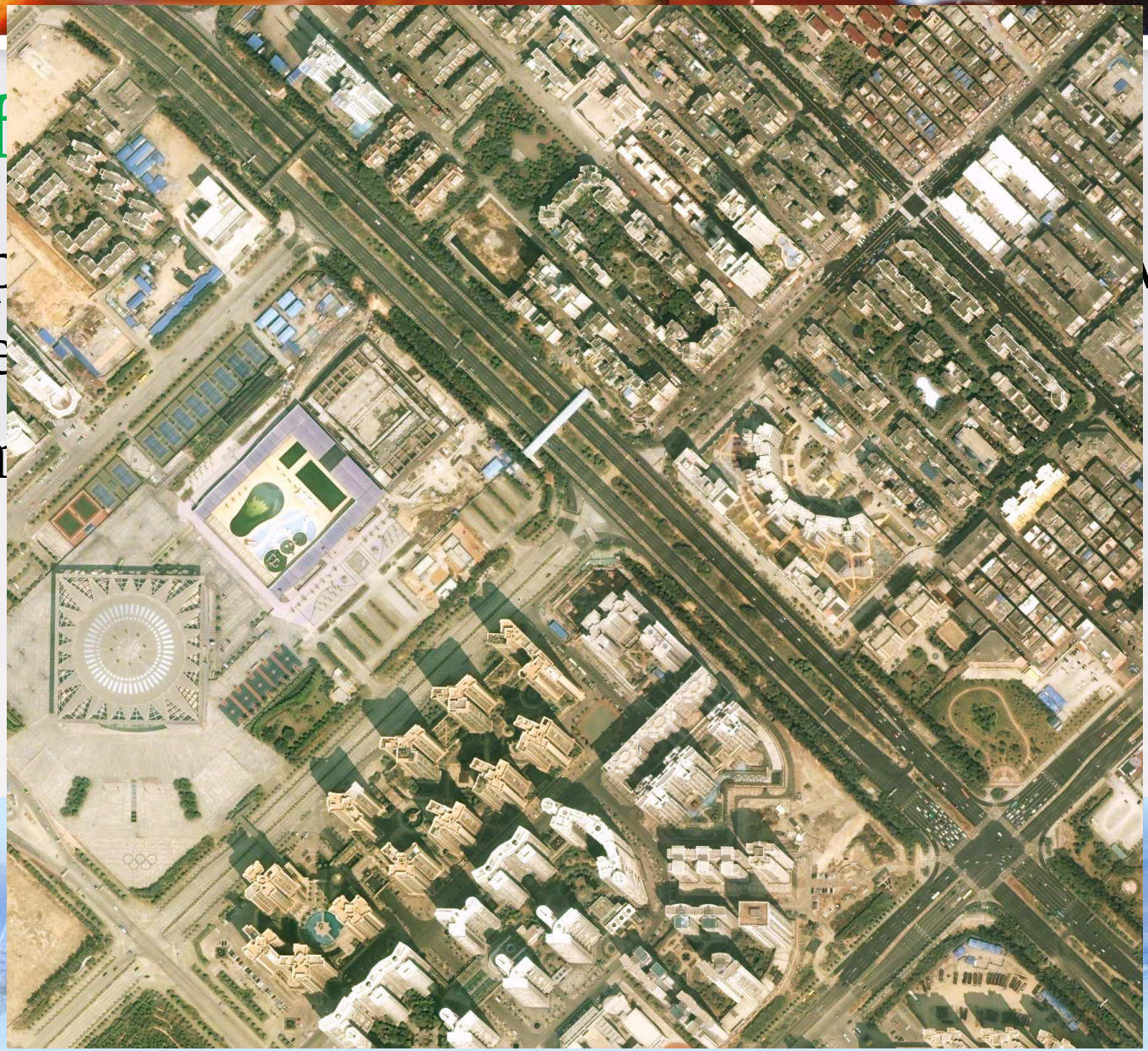
Currently, only the continental aerosol model is used.
More aerosol model will be considered later

TABLE 4: OPTICAL PROPERTIES OF THE AEROSOL MODELS USED FOR THE C005-L LOOKUP TABLE

Model	Mode	r_v (μm)	σ	V_0 ($\mu m^3/\mu m^2$)	Refractive Index: k
Continental					
	Soluble	0.176	1.09	3.05	1.53-0.005i; 0.47 μm 1.53-0.006i; 0.55 μm 1.53-0.006i; 0.66 μm 1.42-0.01i; 2.12 μm
	Dust	17.6	1.09	7.364	1.53-0.008i; 0.47 μm 1.53-0.008i; 0.55 μm 1.53-0.008i; 0.66 μm 1.22-0.009i; 2.12 μm
	Soot	0.050	0.693	0.105	1.75-0.45i; 0.47 μm 1.75-0.44i; 0.55 μm 1.75-0.43i; 0.66 μm 1.81-0.50i; 2.12 μm

Benif

- Ap
ice
- Sm

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Thanks for the attention