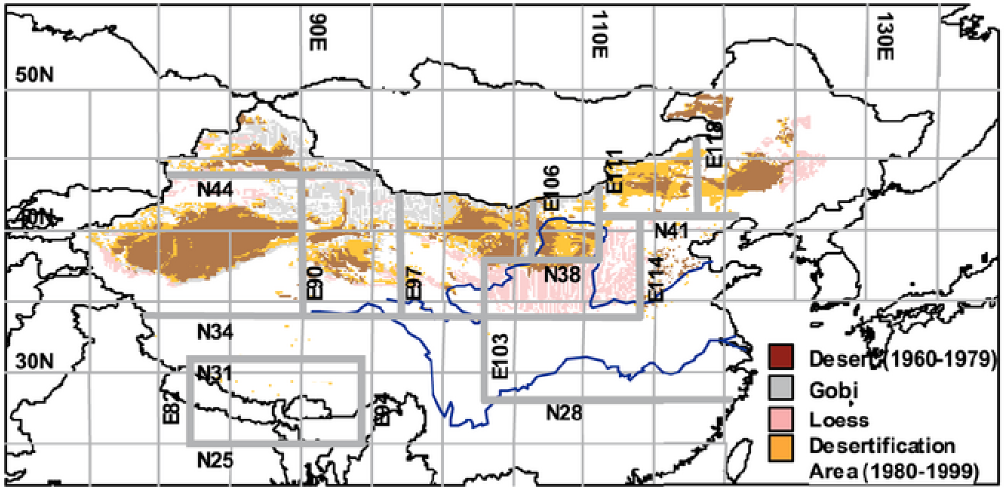
Examining effect of Asian dusts on the AIRS-measured radiances from radiative transfer simulations

Hyo-Jin Han[1], B.J. Sohn[1]
Allen Huang[2], Elisabeth Weisz[2]

[1]School of Earth and Environmental Sciences
Seoul National University, Seoul, Korea

[2]Cooperative Institute for Meteorological Satellite Studies,
University of Wisconsin-Madison, Madison, Wisconsin, USA

Asian Dust



Chinese desert distributions from 1960 to 1979 and desert plus desertification areas from 1980 to 1999. Adapted from Zhang et al. (2003).

Backgrounds

Visible (VIS):

- Effects of dust on blue and yellow bands are much different.
- Limitations over bright surface and daytime-only retrieval

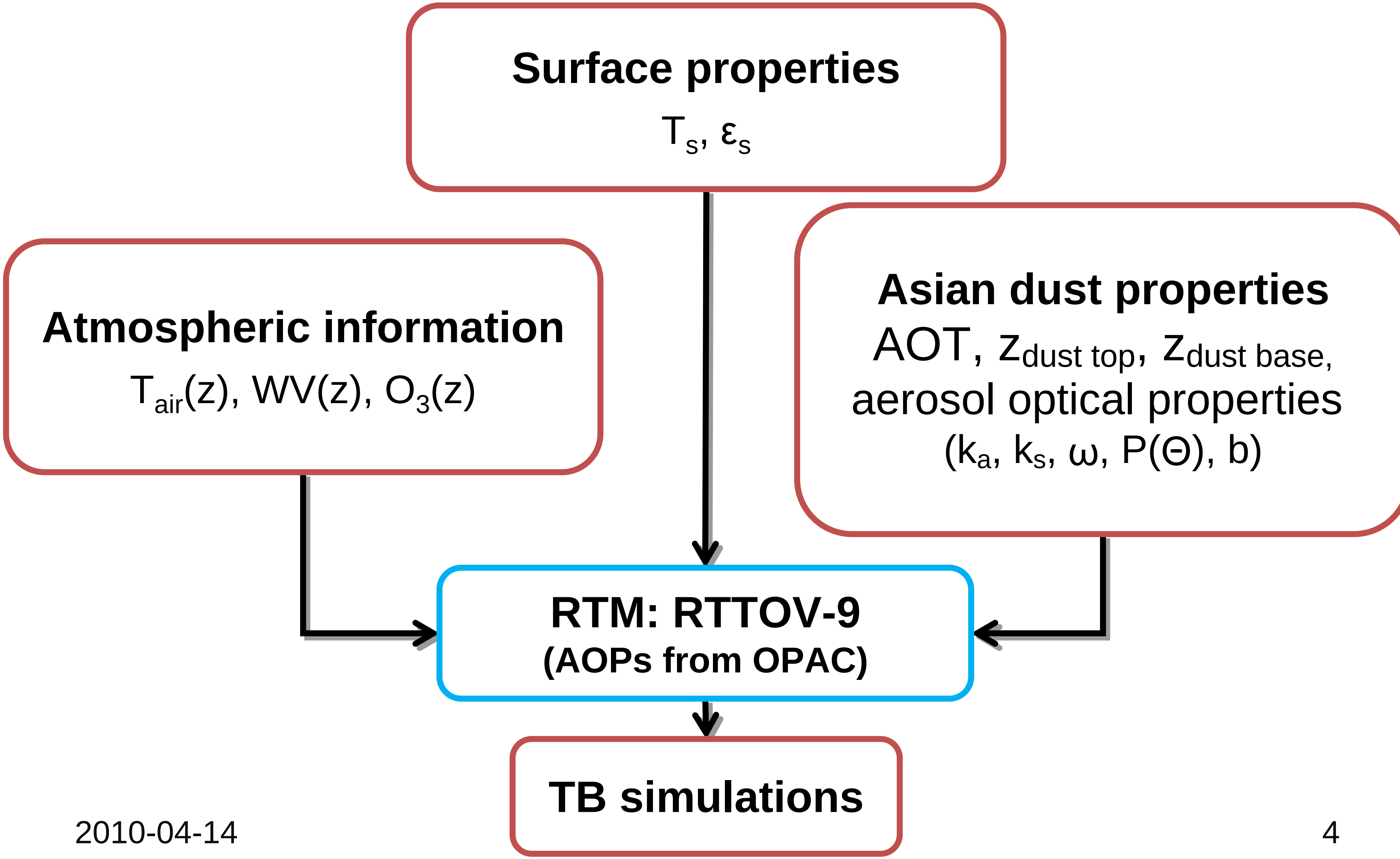
Infrared (IR):

- Dust detection over high-albedo surfaces and during nighttime is possible.
- Sensitive to water vapor and other gases

It is valuable to employ **improved IR measurements** with a sufficient spectral resolution to distinguish the IR radiative signature of mineral dust from others (e.g. Sokolik, 2002).

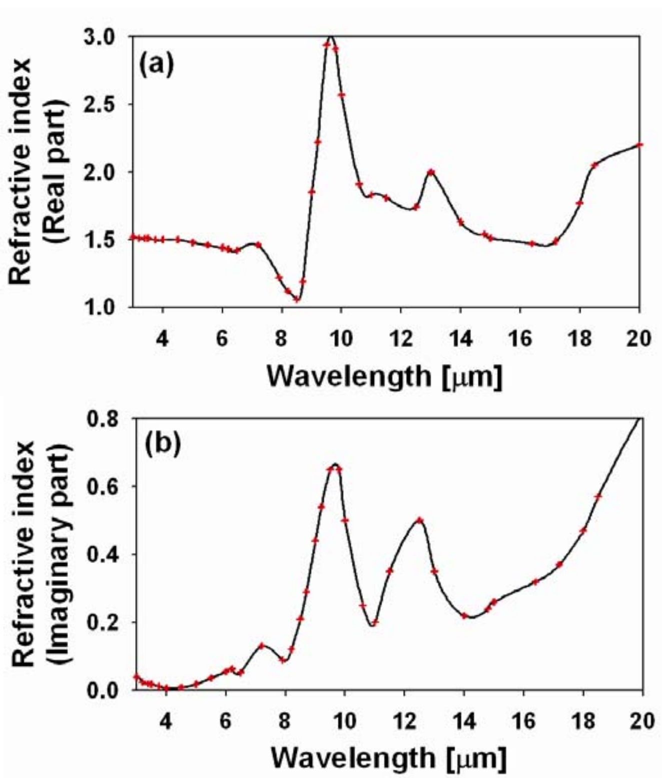
➡ **Hyperspectral sensors** (AIRS, IASI)

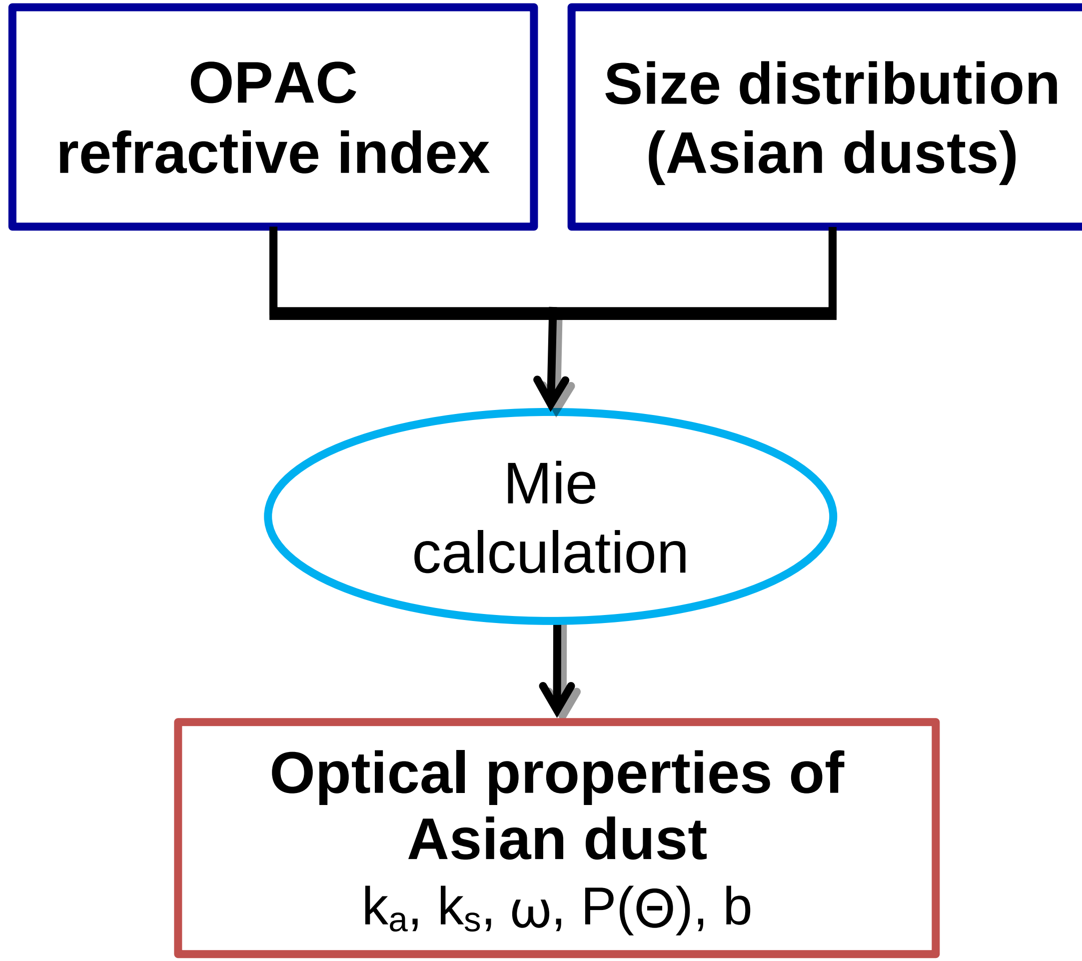
Radiative transfer simulation procedures



Aerosol optical properties: refractive index

Refractive index for mineral dust in OPAC

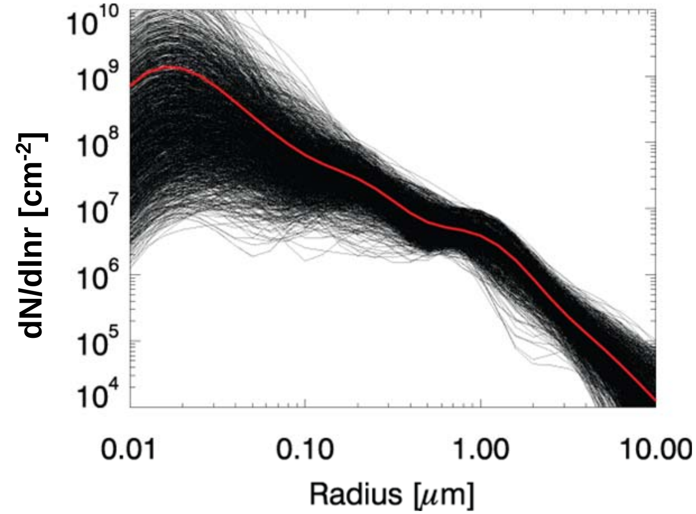




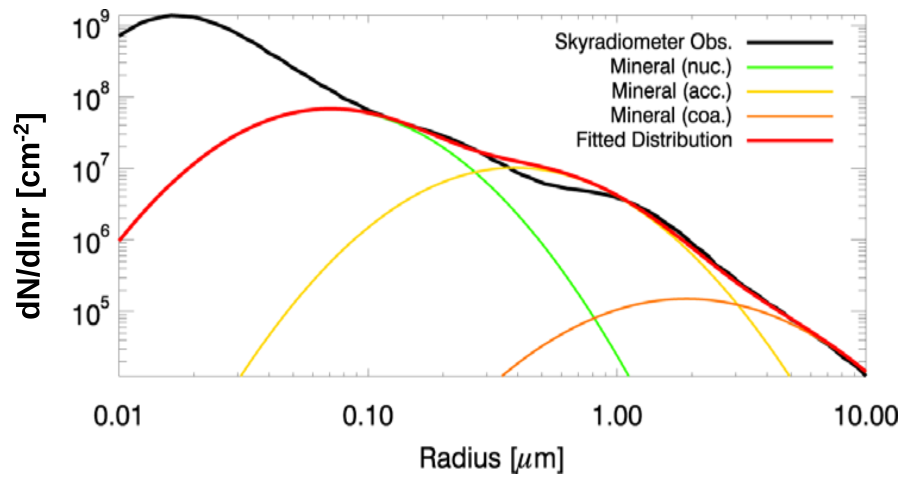
Aerosol optical properties: size distribution

Dust observations at Dunhuang
Location: 94.8 N, 40.1 E
Period: Oct. 1998 – Jan. 2007
Dust event threshold: AOT > 0.5
α < 0.3

Number size distribution



Mineral dust modes in OPAC
- Nucleation mode
- Accumulation mode
- Coarse mode



AIRS TB simulations for dust cases

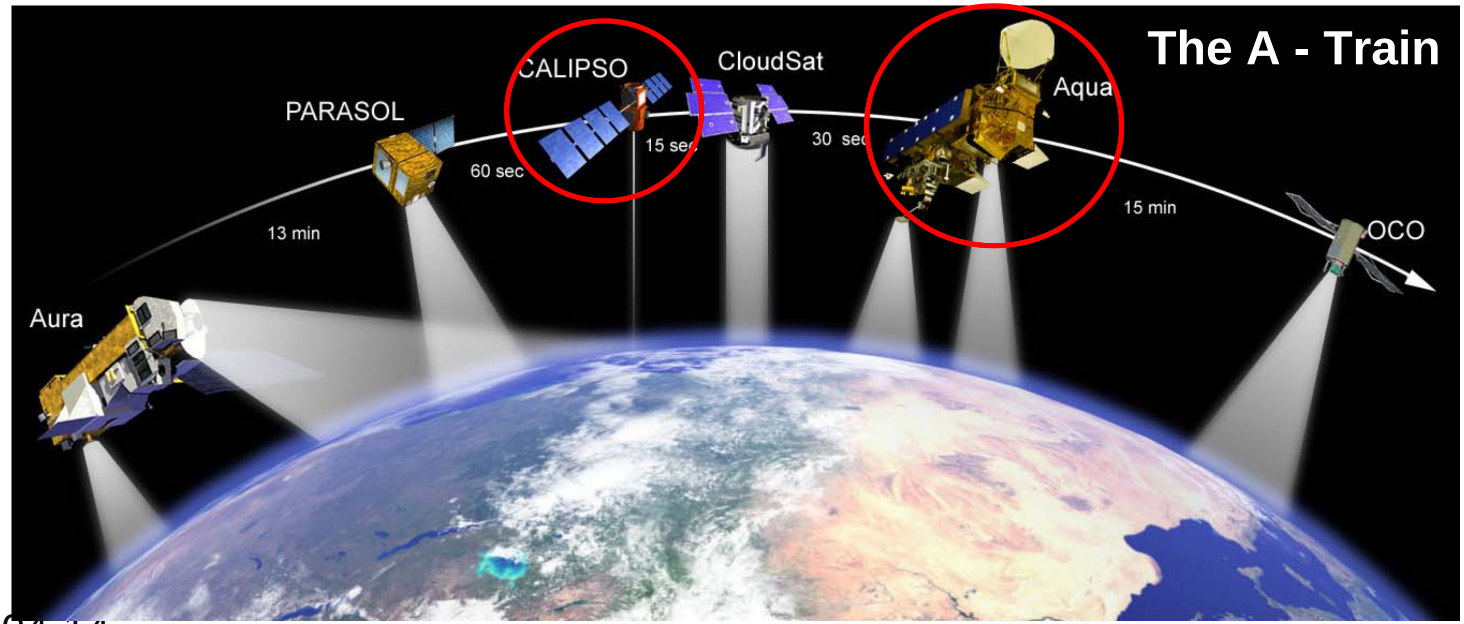
AIRS

- Level 1B spectrum
- Level 2 support product:

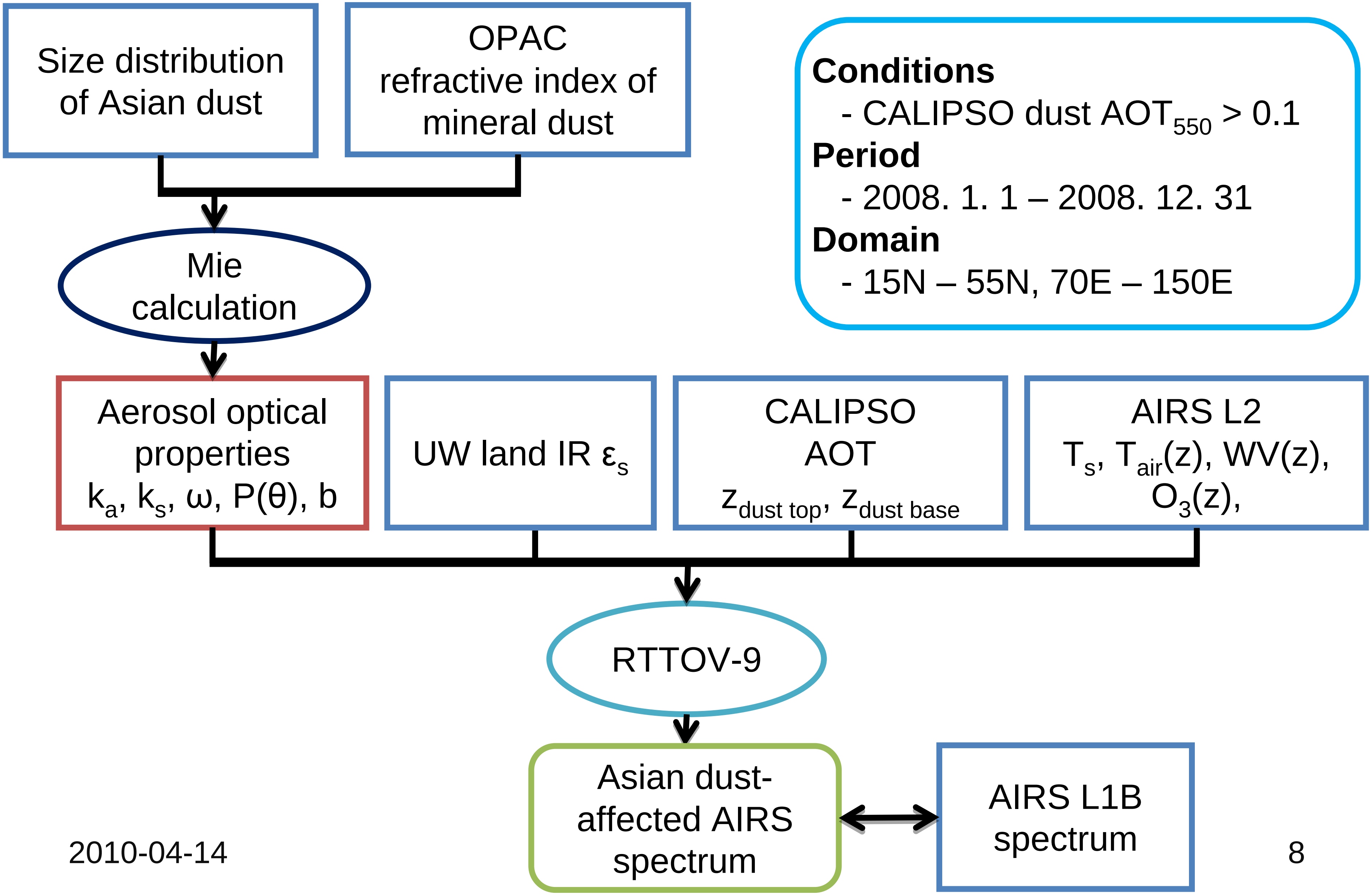
  T_s, $T_{air}(z)$, WV(z), and $O_3(z)$

CALIPSO

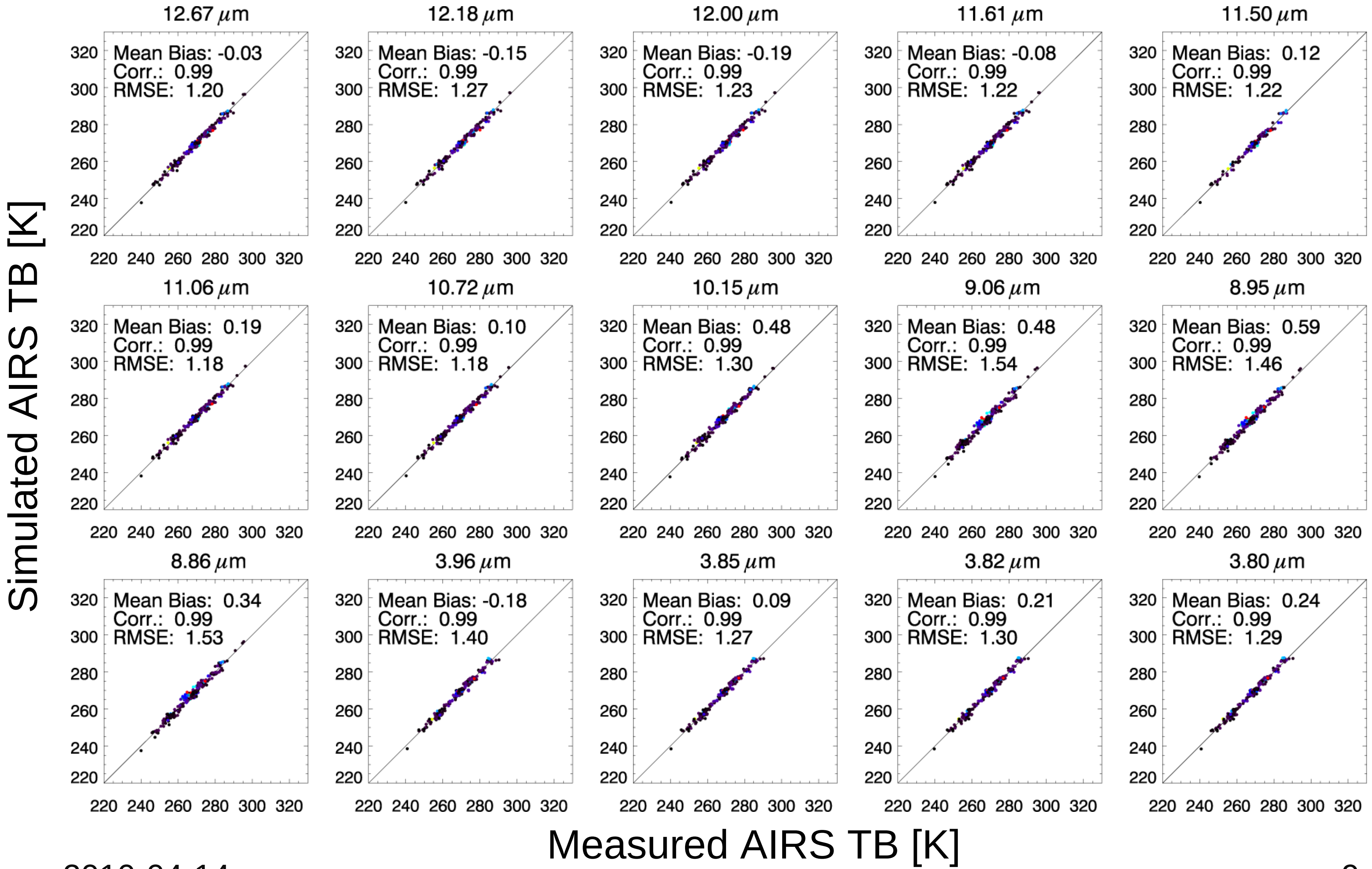
- AOT, $z_{dust\ top}$, $z_{dust\ base}$, Feature Classification Flags



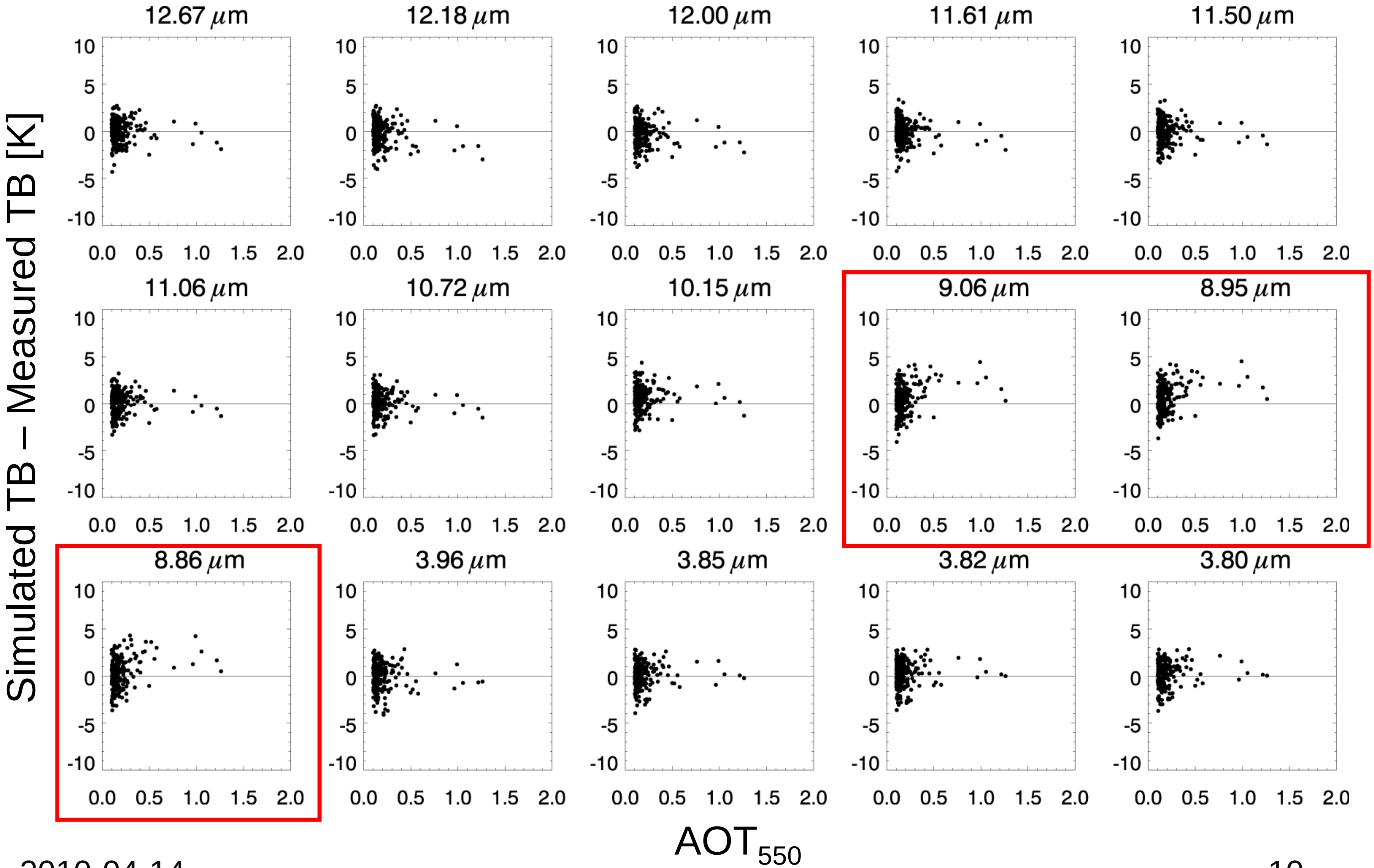
Simulation of dust affected AIRS spectrum



Simulated AIRS TB vs. measured AIRS TB

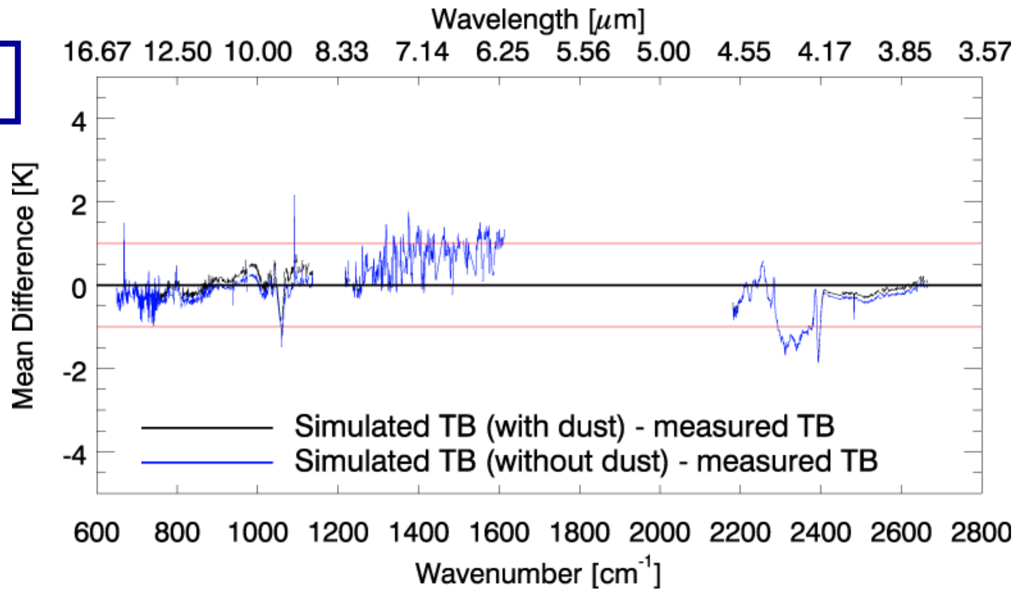


Simulated TB – measured AIRS TB vs. AOT

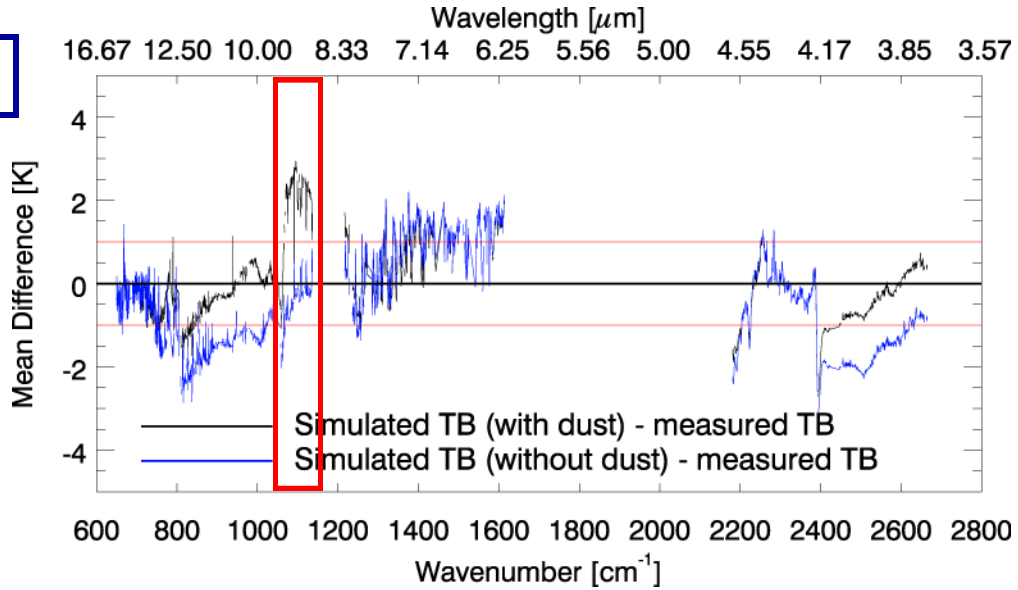


Mean simulated TB - measured AIRS TB

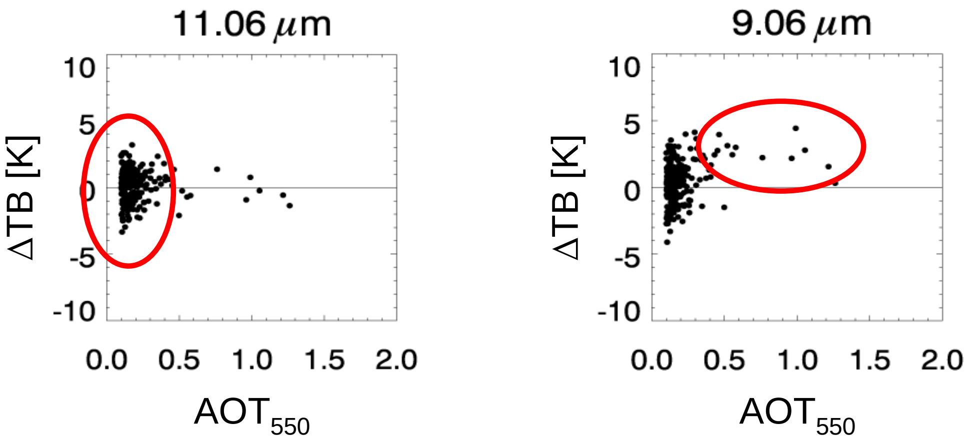
$AOT_{550} < 0.5$



$AOT_{550} \geq 0.5$



Conclusions



- For weak dust cases, simulation errors can be occurred due to the inexact surface information.
- Results show the improved performance over spectral ranges of 10.2 – 12.7 μm and 3.8 – 4.1 μm when the dust effect was added.
- However, over spectral range of 8.8 – 9.3 μm, TB difference between simulation and measurement was increased.
- Overestimation in the range of 8.8 – 9.3 μm is probably because this spectral region is very sensitive to dust composition (Sokolik, 2002).
- It is expected that the results can be incorporated for developing dust retrieval algorithm from hyperspectral images such as AIRS and IASI.

Thank You!

Aerosol optical properties: size distribution (1)

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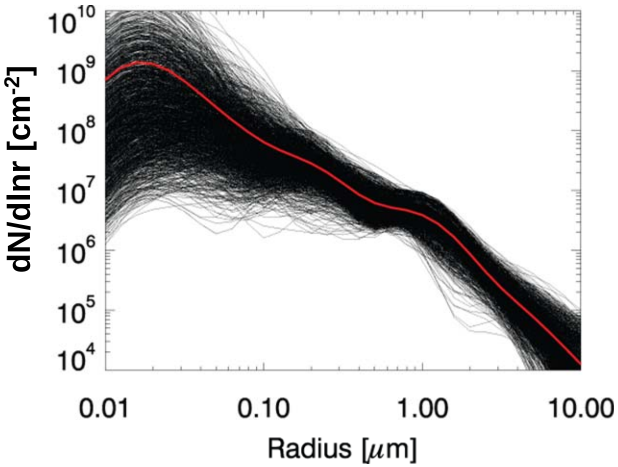
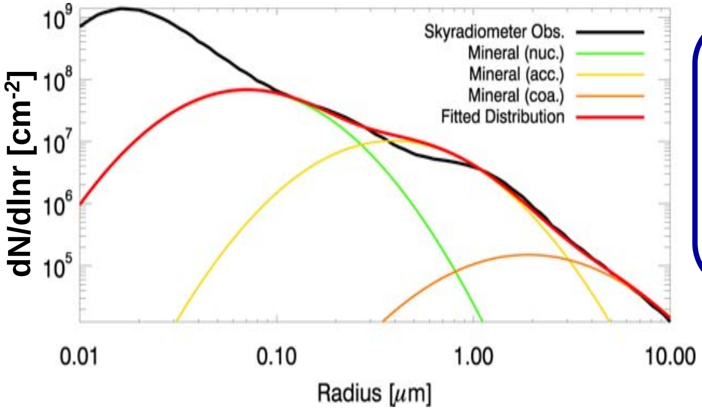
Number size distribution

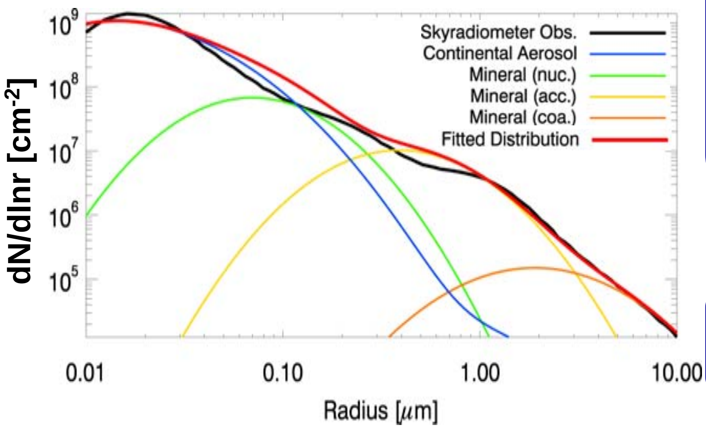


(1) Mineral dust only



Mineral dust only
- Nuc. mode
- Acc. mode
- Coa. mode

(2) Continental aerosol added



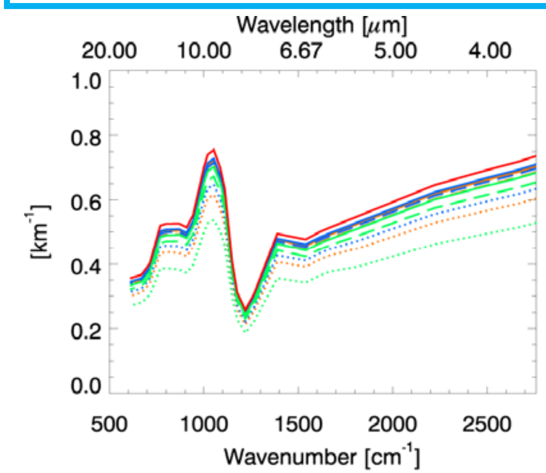
Mineral dust only
- Nuc. mode
- Acc. mode
- Coa. mode

+

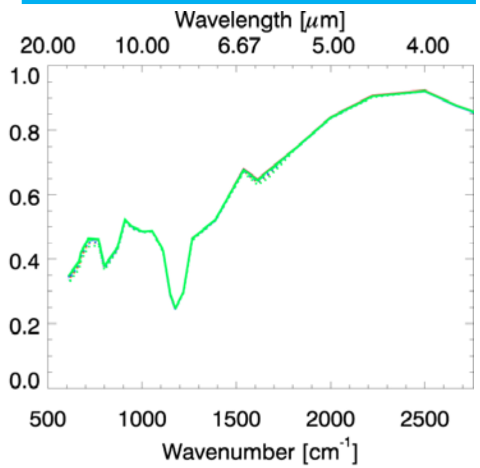
Continental aerosol

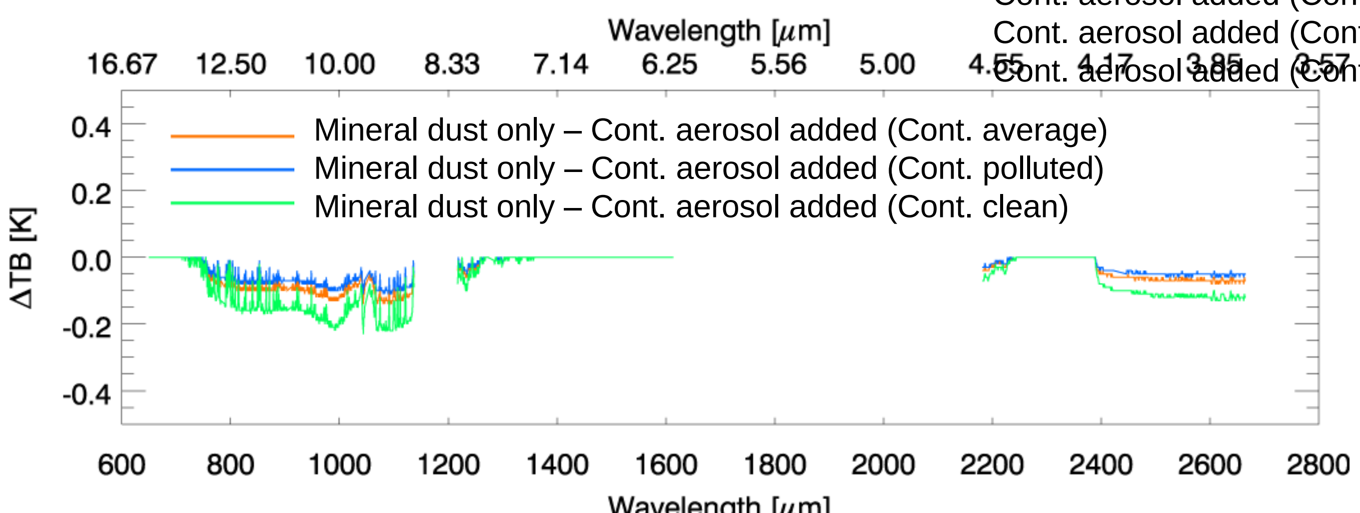
Aerosol optical properties: size distribution (2)

Normalized extinction coefficient



Single scattering albedo

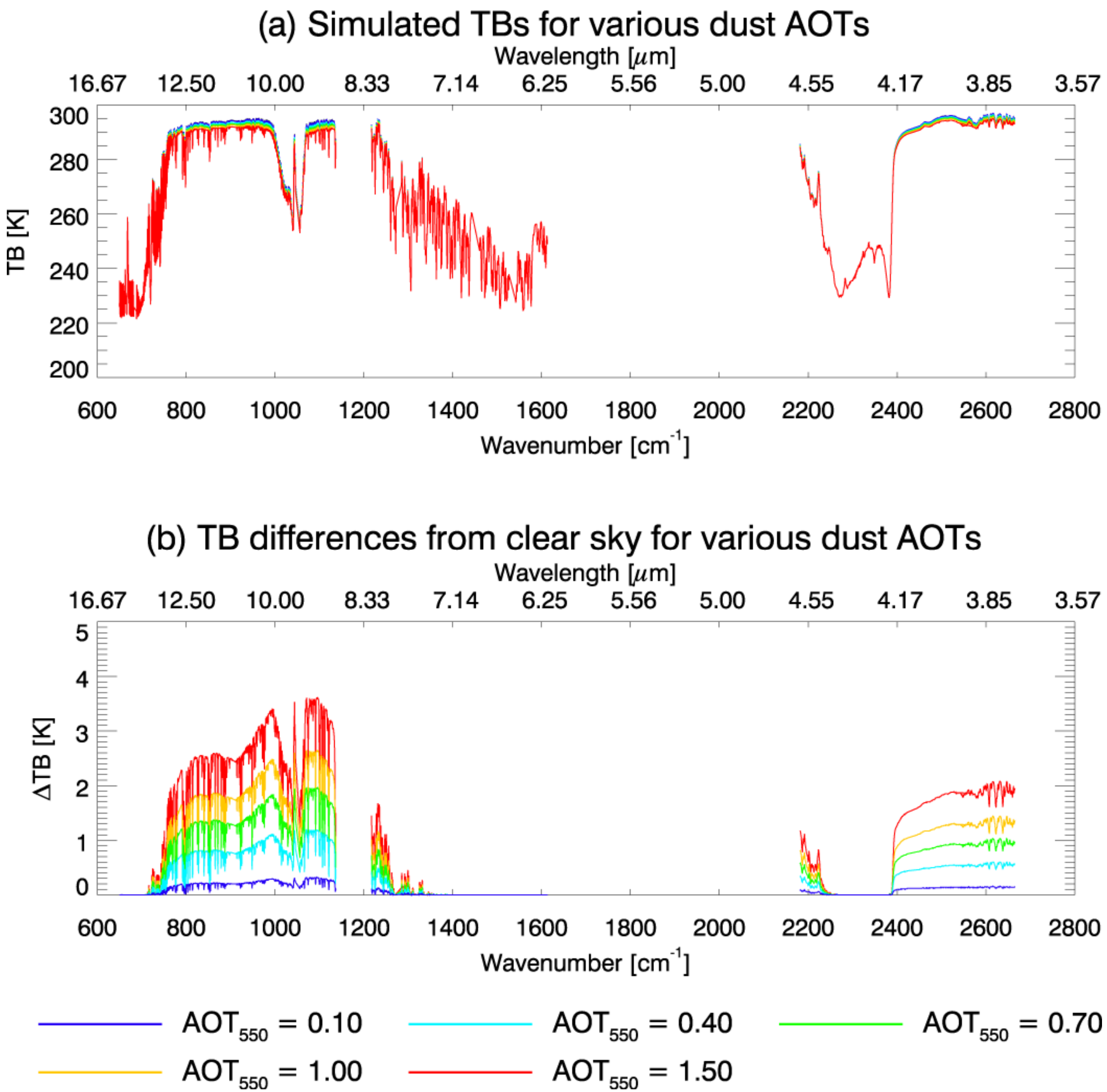




AOT_{550}: 0.7, z_{dust}: 2 km

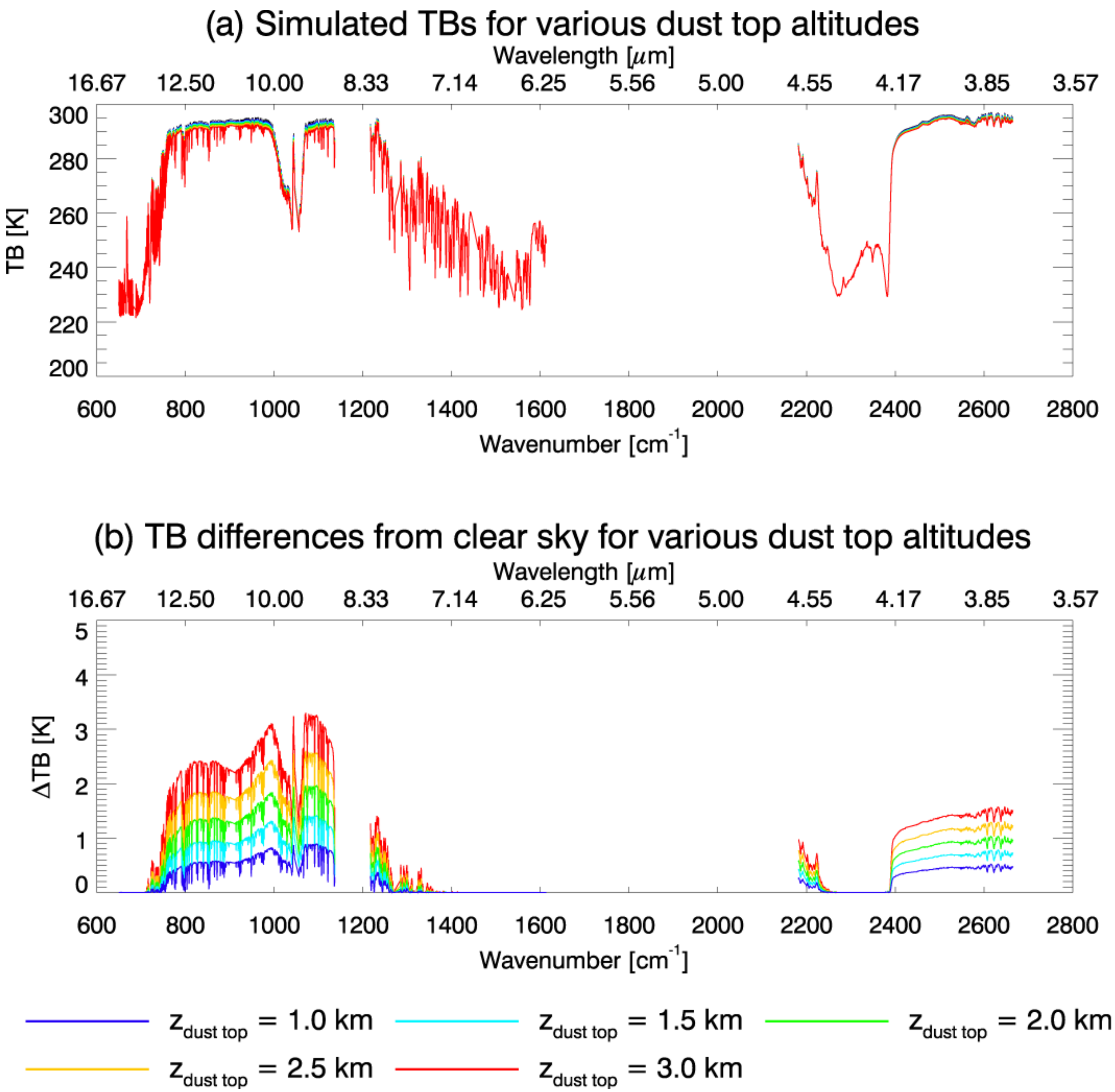
Mid-latitude summer atmosphere profile

Sensitivity to AOTs



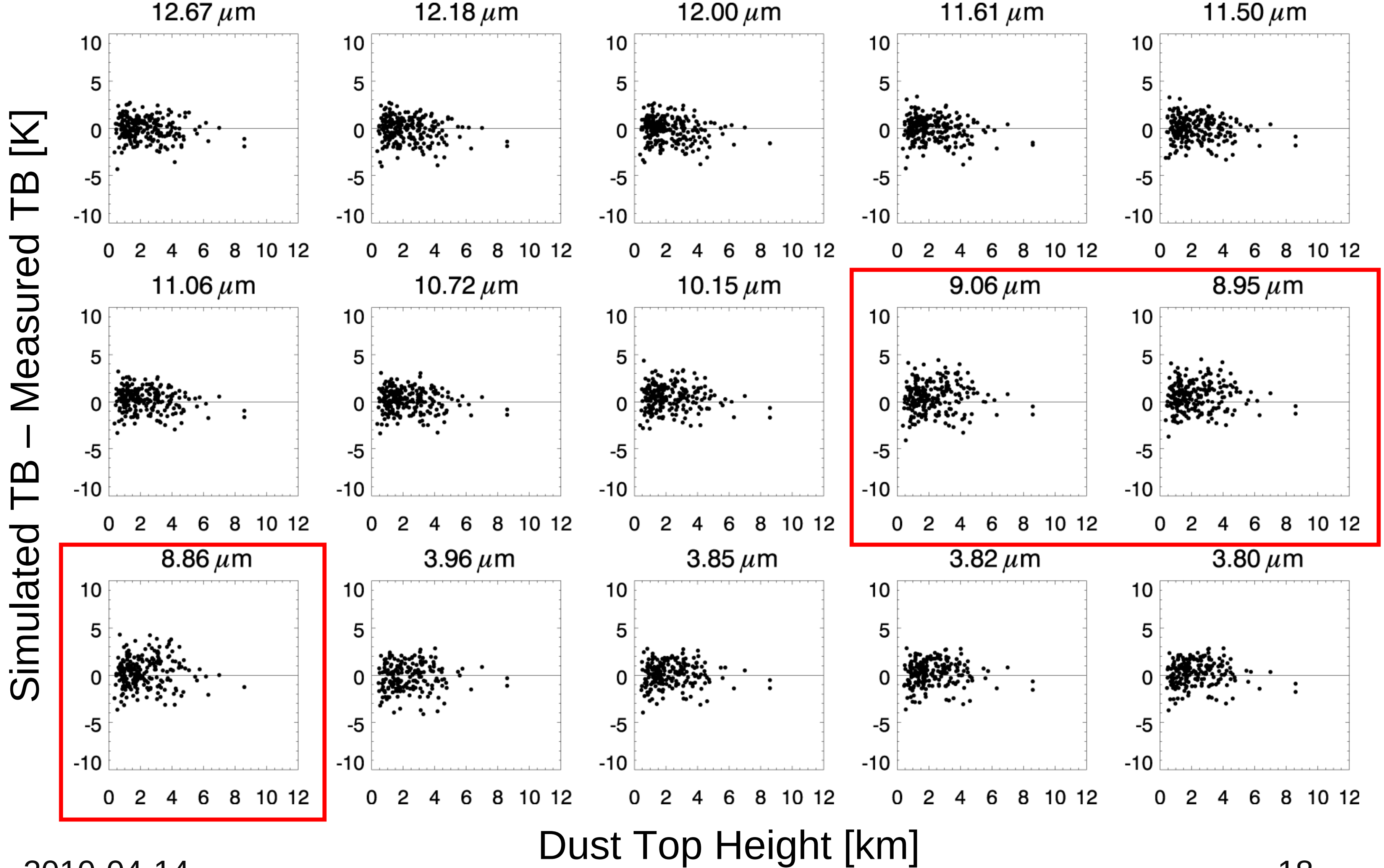
Standard atmospheric profile
(Mid-latitude summer)
Size distribution at Dunhuang
Refractive index in OPAC
A single dust layer
$z_{dust\ top}$ = 2 km
ε_s = 1.00

Sensitivity to the dust top



Standard atmospheric profile
(Mid-latitude summer)
Size distribution at Dunhuang
Refractive index in OPAC
A single dust layer
$AOT_{550} = 0.7$
$\varepsilon_s = 1.00$

Simulated TB – measured AIRS TB vs. Dust top



Skyradiometer measurements at Dunhuang

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