



Supplement of

Estimation of nighttime aerosol optical depths using the ground-based microwave radiometer

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Table S1. The detailed locations of the measurement sites

	MWR site	AERONET site	Sounding site
Geocoordinates	39.80°N,116.47°E	39.95°N,116.32°E	39.80°N,116.48°E
Address	Beijing Nanjiao Meteorological Observatory	Chinese Academy of Meteorological Sciences	Beijing Meteorological Station
Location type	Suburban	Urban	Suburban
Distance to MWR site (km)	0	20.77	1.11

Table S2. The super parameters for the random forest regression model

Parameters	Interpretation	Value
Predictor variable	MWR BT observation at 22 K and V bands	BT
Predicted variable	AOD at five wavelengths and temperature profiles	AOD and temperature
Number of trees	The number of decision trees in the ensemble.	128
Minimum leaf size	Minimum number of observations per tree leaf.	5
In bag fraction	Fraction of observations that are randomly selected with replacement for each bootstrap replica.	1.0
Max features	Number of predictor or feature variables to select at random for each decision split.	5
Prune	The Prune property is true if decision trees are pruned and false if they are not.	False

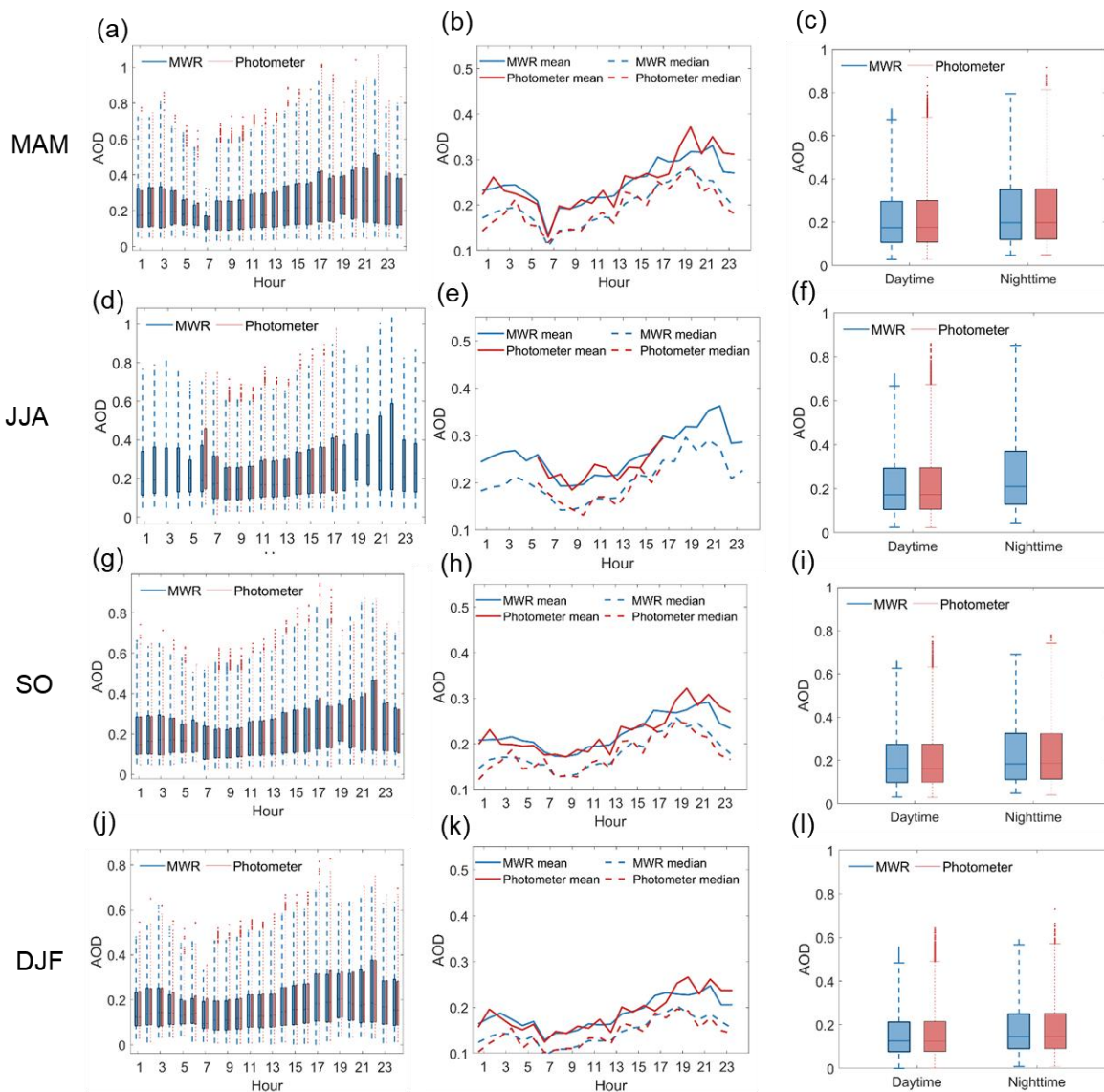


Figure S1. The diurnal cycle of seasonal mean MWR AOD and photometer AOD at 500 nm including (a-c) MAM, (d-f) JJA, (g-i) SO, and (j-l) DJF. (a, d, g, j) The boxplot of hourly MWR AOD (red boxplots) and photometer AOD (blue boxplots). The small dots represent outliers greater than $q_{75} + 1.5(q_{75} - q_{25})$ or less than $q_{25} - 1.5(q_{75} - q_{25})$, where q_{75} and q_{25} correspond to 75th and 25th percentile. (b, e, h, k) The time series of mean AOD (solid lines) and median AOD (dashed lines) of MWR AOD (red lines) and photometer AOD (blue lines). (c, f, i, l) The boxplot of daytime and nighttime AOD. Blue boxes correspond to MWR data, and red boxes correspond to photometer data.

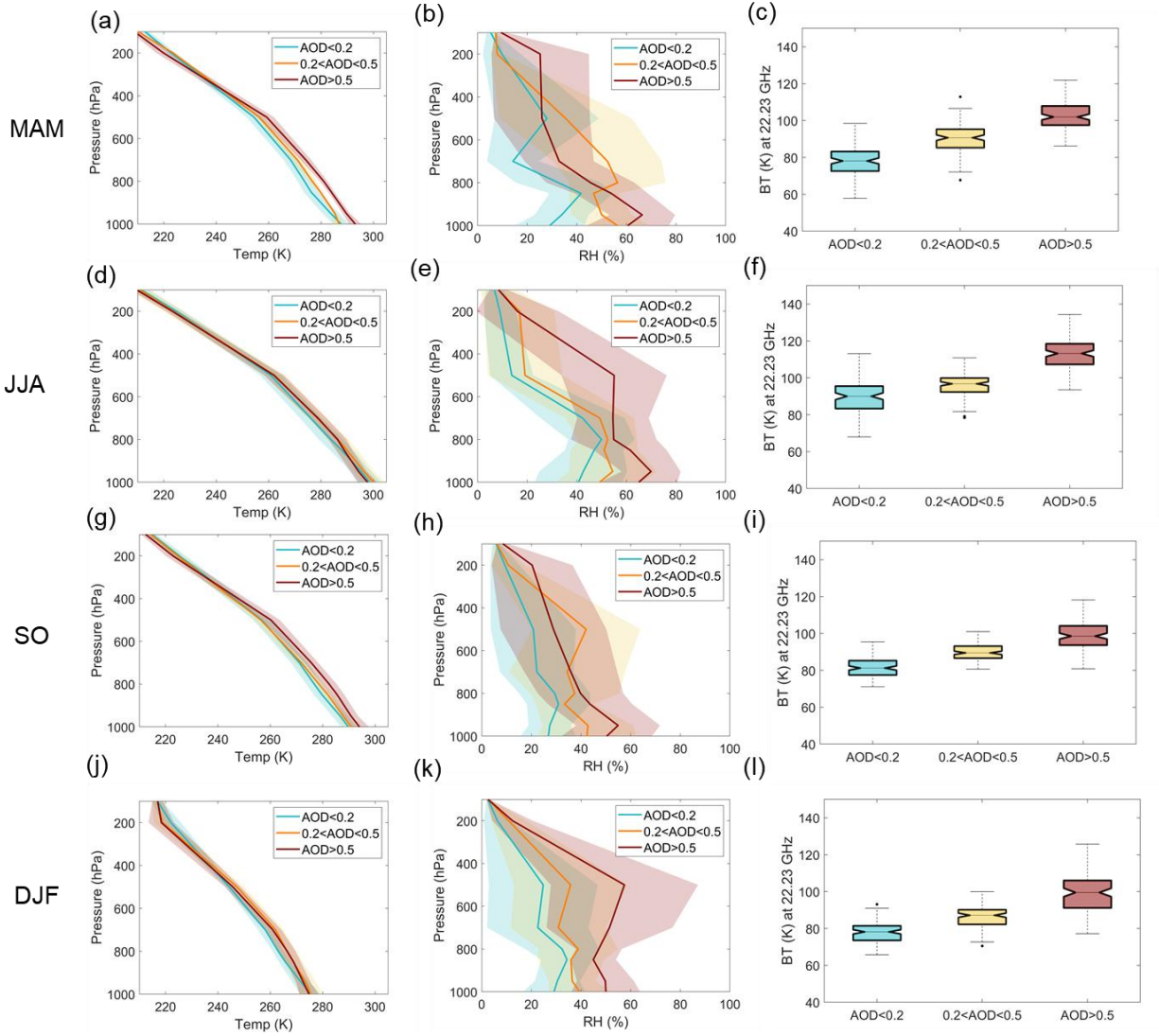


Figure S2. (a-b, d-e, g-h, j-k) The seasonal observational vertical profiles of temperature (Temp, unit: K) and relative humidity (RH, unit: %) under various AOD levels at 550 nm. The cyan, orange, and red solid lines correspond to low-level polluted scenarios ($AOD < 0.2$), mid-level polluted scenarios ($0.2 < AOD < 0.5$), and high-level polluted scenarios ($AOD > 0.5$). (c, f, i, l) Their corresponding brightness temperature (BT, unit: K) at 22.23 GHz calculated by MonoRTM. These seasons include (a-c) MAM, (d-f) JJA, (g-i) SO, and (j-l) DJF. The shadings represent the spread of samples with one standard deviation. All differences have passed the significance test of $p\text{-value} \leq 0.01$ by Student's t -test.

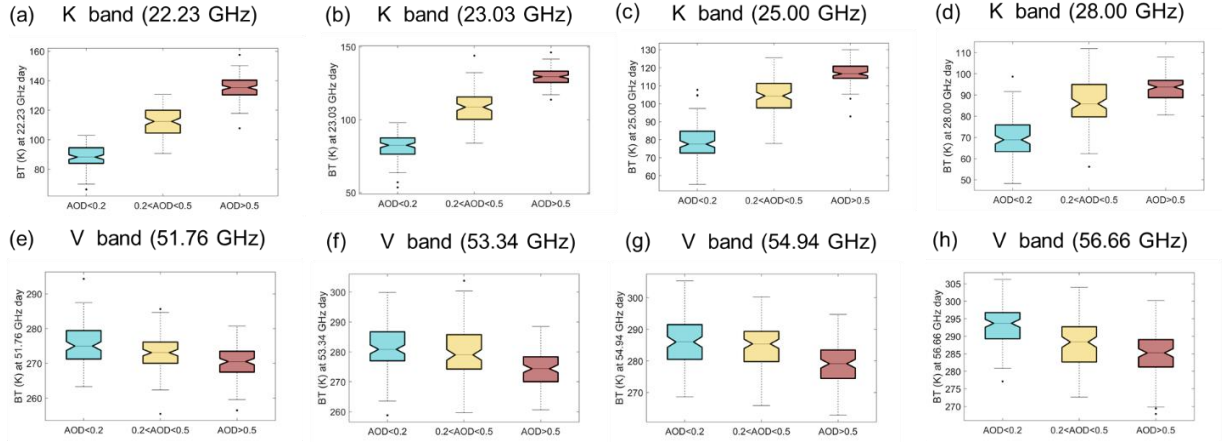


Figure S3. The boxplots of relationship between BT and AOD at 550 nm when fixing the surface temperature at 295-300 K from 00:00 UTC on 5 July 2016 to 00:00 UTC on 8 July 2016 in the WRF-Chem simulation. The frequencies of BT are (a) 22.23 GHz, (b) 23.03 GHz, (c) 25.00 GHz, (d) 28.00 GHz, (e) 51.76 GHz, (f) 53.34 GHz, (g) 54.94 GHz, and (h) 56.66 GHz during the daytime.

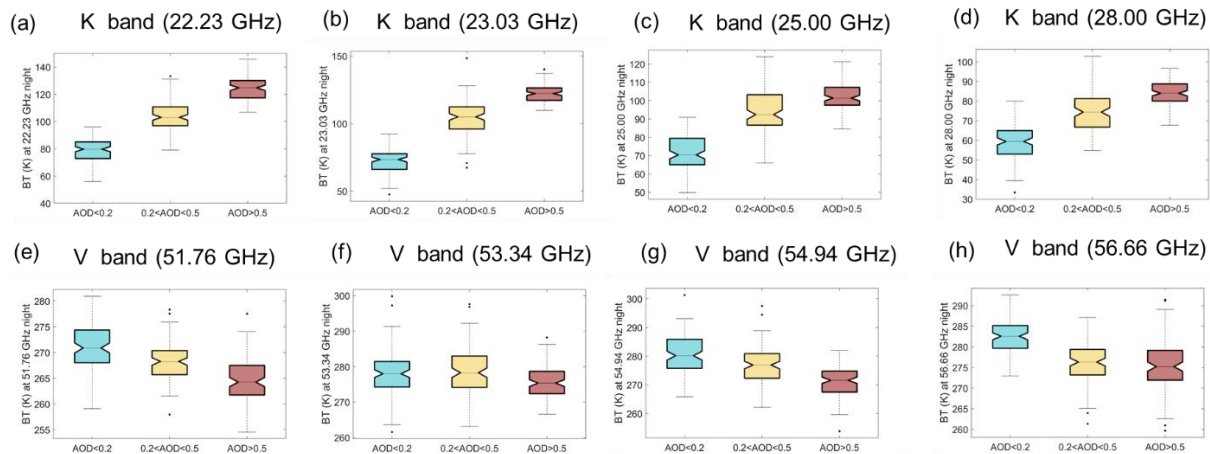


Figure S4. Similar to Figure S3, but for the nighttime.

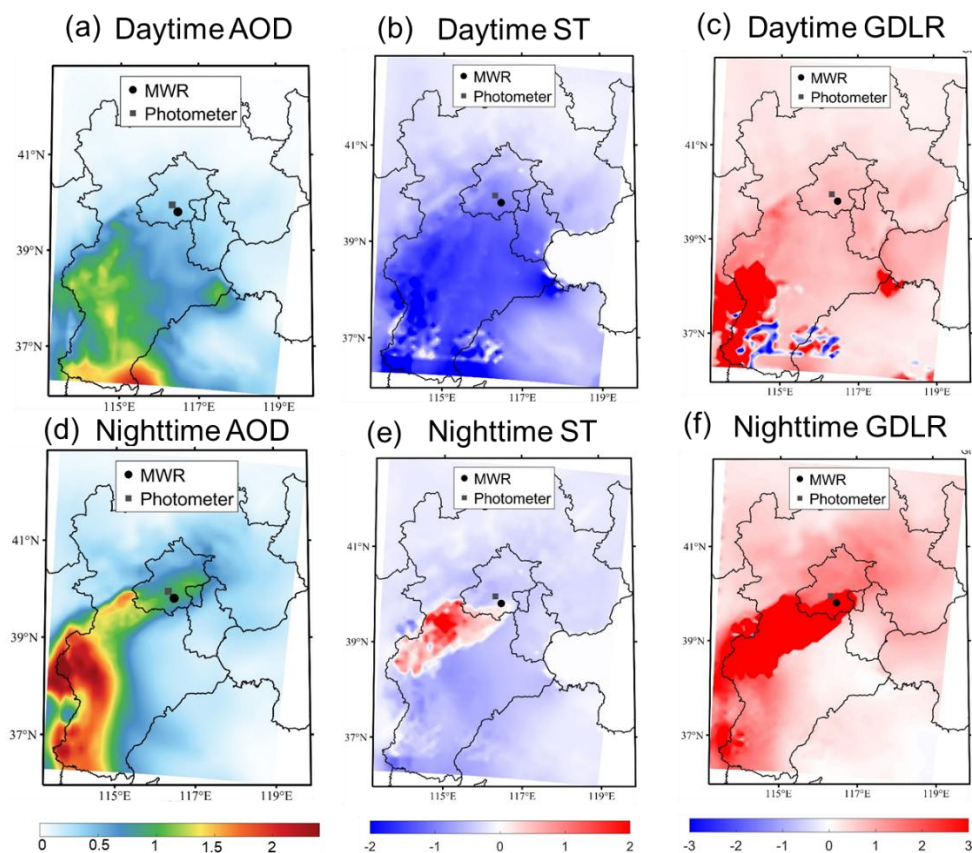


Figure S5. The difference of (a, d) aerosol optical depth (AOD, unitless), (b, e) surface temperature (ST, K), and (c, f) ground downward longwave radiation (GDLR, W/m²) between summertime EXP_AER and EXP_NOAER experiments (EXP_AER-EXP_NOAER) during the (a-c) daytime and (d-f) nighttime. The black circle indicates the MWR, and the dark grey square indicates the photometer. The daytime corresponds to the period from 22:00 UTC 7 July 2016 to 10:00 UTC 7 July 2016. The nighttime corresponds to the period from 10:00 UTC 7 July 2016 to 22:00 UTC 7 July 2016.