

# A Comparison of Wintertime Atmospheric Boundary Layer Heights Determined by Tethered Balloon Soundings and Lidar at the Site of SACOL

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**Table S1.** Detailed information of the tethered sounding system KZXLT-II.

Balloon material	Polyethylene composite film, Polyurethane, etc.
Volume	10 m <sup>3</sup>
Load	1.4-2 kg
Rope material	High strength and high modulus materials
Rope pull	1500 N
Rate of rise and fall	0~60 m·min <sup>-1</sup> (Continuous-adjustable)
Atmospheric pressure	300~110 hPa (±0.5 hPa)
Temperature	-40~50 °C (±0.2 °C)
Relative humidity	0~100 % (±2 %)
Wind direction	0~360° (Resolution is 0.5°)
Wind speed	0~20 m·s <sup>-1</sup> (Resolution is 0.1 m·s <sup>-1</sup> )
GPS	Resolution is 3 m

**Table S2.** Detailed information of the Sigma MiniMPL lidar

Material	NASA Space Department materials
Detector	Avalanche laser APD, Photon counting model
Laser wavelength	532 nm
Pulse frequency	2500 Hz
Pulse energy	3~4 $\mu$ J
Maximum detectable range	15 km
Time resolution	1 min
Vertical resolution	30 m
Blind zone	100 m

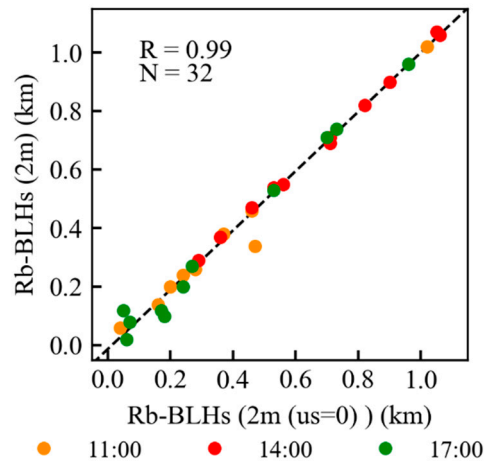
$$bias = \frac{1}{m} \sum_{i=1}^m (x_i - y_i) \quad (S1)$$

$$standard\ deviation = \sqrt{\frac{1}{m} \sum_{i=1}^m \left( (x_i - y_i) - \overline{(x - y)} \right)^2} \quad (S2)$$

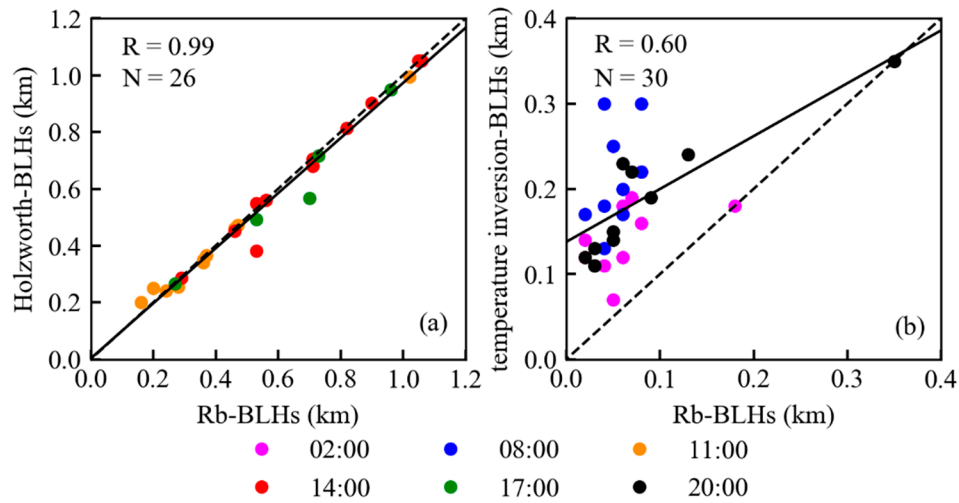
$$t = \frac{\overline{X} - y}{S} \sqrt{N} \quad (S3)$$

where  $\overline{X}$  is the mean of the aerosol BLH samples,  $y$  is the radiosonde BLHs mean,  $S$  is the standard deviation of samples differences, and  $N$  is the number of pair samples. It was not rejected when the calculated  $t$  test value ( $t$ ) was within  $\pm 1.96$  and the  $p$  value was greater than 0.05 or 5% significance level.

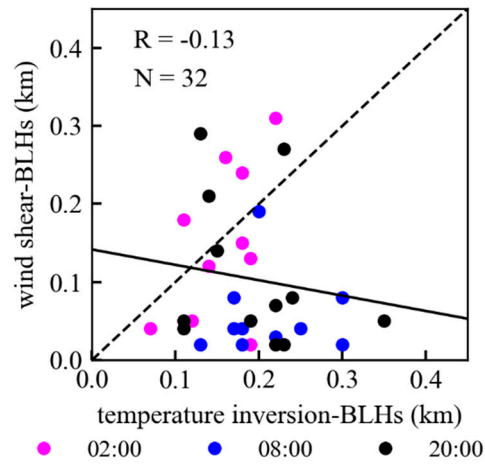
$$root - mean - square\ error = \sqrt{\frac{1}{m} \sum_{i=1}^m (x_i - y_i)^2} \quad (S4)$$



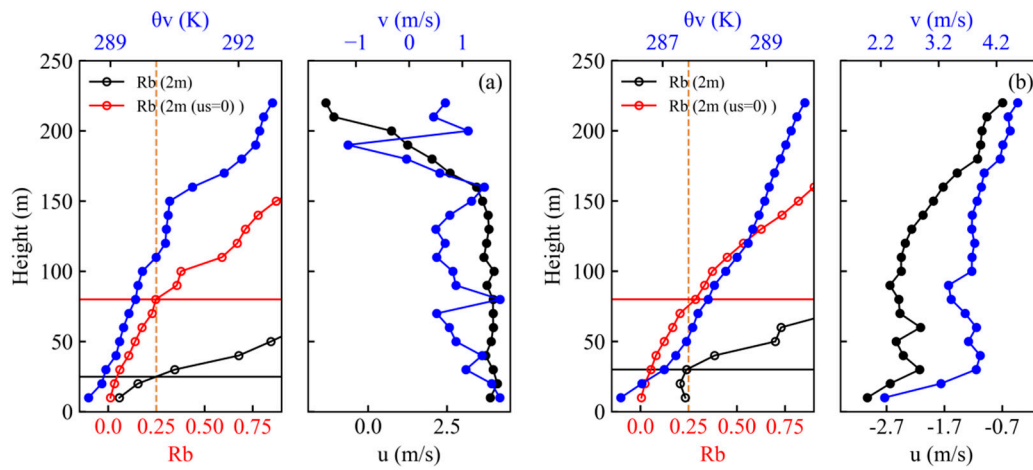
**Figure S1.** Comparisons between BLHs derived from bulk Richardson number (Rb) method with  $us=0$  and  $us \neq 0$  in daytime



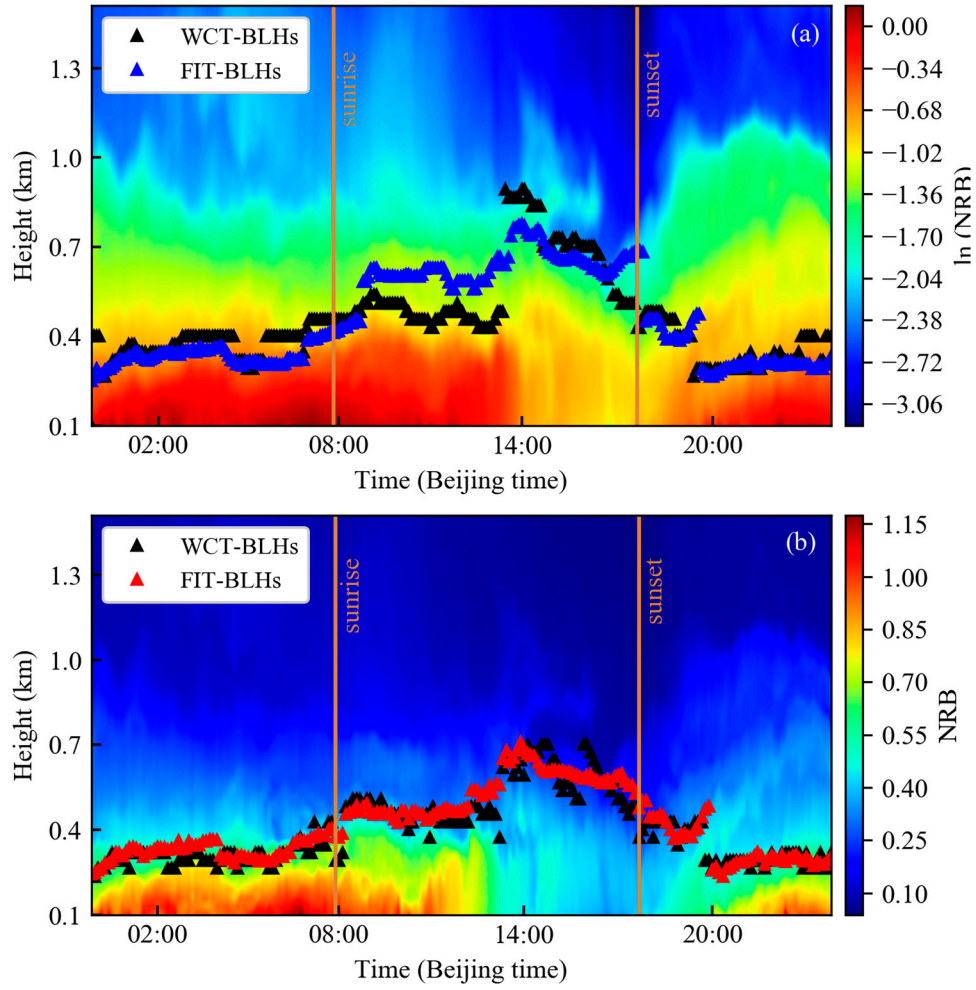
**Figure S2.** Comparisons between BLHs derived from bulk Richardson number (Rb) method and tethered balloon sounding (TBS) method (a) Holzworth method in daytime and (b) temperature inversion method in nighttime



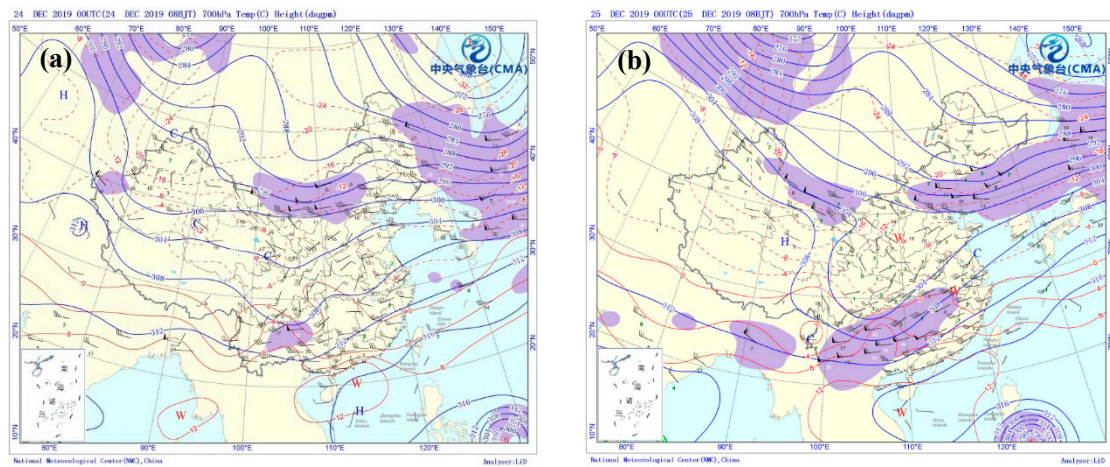
**Figure S3.** Comparisons between BLHs derived from temperature inversion method and wind shear method in nighttime



**Figure S4.** Profiles of (a) 02:00 (Beijing time) and (b) 08:00 (Beijing time), 24 December 2019 explain the low SBL height when the  $u_s$  and  $v_s$  were not set to zero in the bulk Richardson number (Rb) method in nighttime

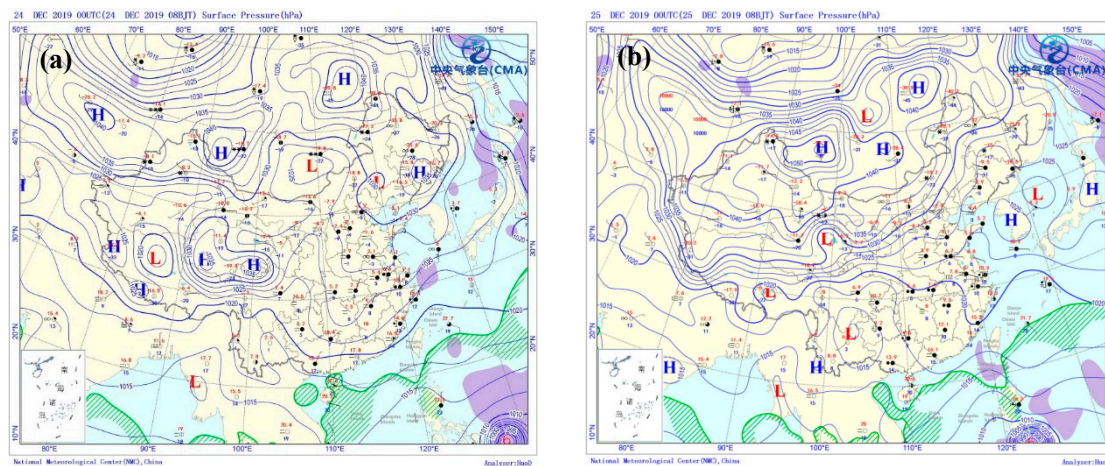


**Figure S5.** Difference of atmospheric aerosols and BLHs by Wavelet Covariance Transform (WCT) and Ideal Profile Fitting (FIT) method on 12 December 2019 (a) based on logarithm of the normalized range-corrected backscattering signal ( $\ln(\text{NRB})$ ) and (b) normalized range-corrected backscattering signal (NRB)



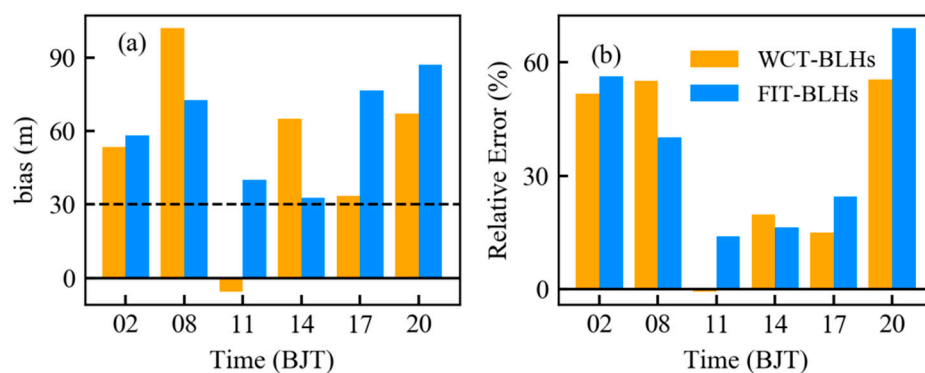
**Figure S6.** Weather maps at 700hPa on (a) 24 December and (b) 25 December 2019

(The Weather maps are available from <http://www.nmc.cn/> )



**Figure S7.** Weather maps at surface on (a) 24 December and (b) 25 December 2019

(The Weather maps are available from <http://www.nmc.cn/> )



**Figure S8.** (a) bias and (b) relative errors between lidar-BLHs and TBS-BLHs. The WCT-BLHs and FIT-BLHs were BLHs derived by WCT and FIT methods based on lidar data, respectively.