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Supplement of

Comparison of planetary boundary layer height from ceilometer with ARM radiosonde data

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1. Kernel distribution estimate plots for PBLHT comparisons under low-level cloud-free (LLC-free) stable boundary layer conditions

Under LLC-free stable boundary layer conditions, PBLHT Heffter could produce high PBLHT even then PBLHT CEIL is low at TWP, MAO, ASI, ENA, and AWR (Figure S1). Especially, at ASI and ENA, PBLHT Heffter is consistently much higher than PBLHT CEIL. On the other hand, PBLHT Liu-Liang always produce low PBLHTs that are lower than 0.5 km AGL at all ARM observatories (Figure S2). The dramatic differences between PBLHT estimations with different methods suggest that it is still quite challenging to obtain reliable PBLHT estimations under stable boundary layer conditions.

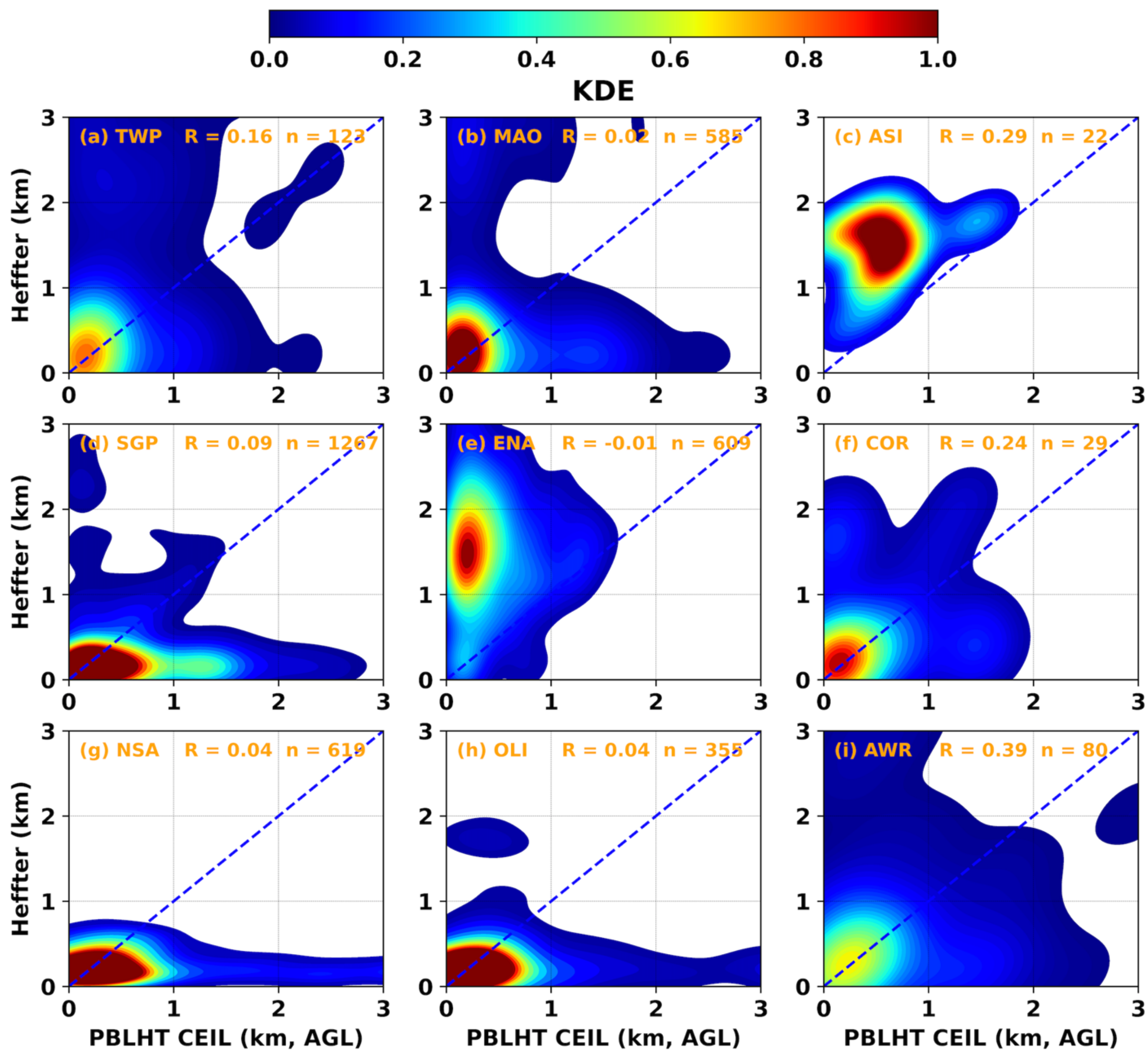

Figure S1: Kernel distribution estimate (KDE) for PBLHT CEIL and PBLHT Heffter comparisons under LLC-free stable boundary layer conditions at the nine ARM observatories. Blue bashed lines are the 1:1 line. *R* is the correlation coefficient and *n* is the sample number.

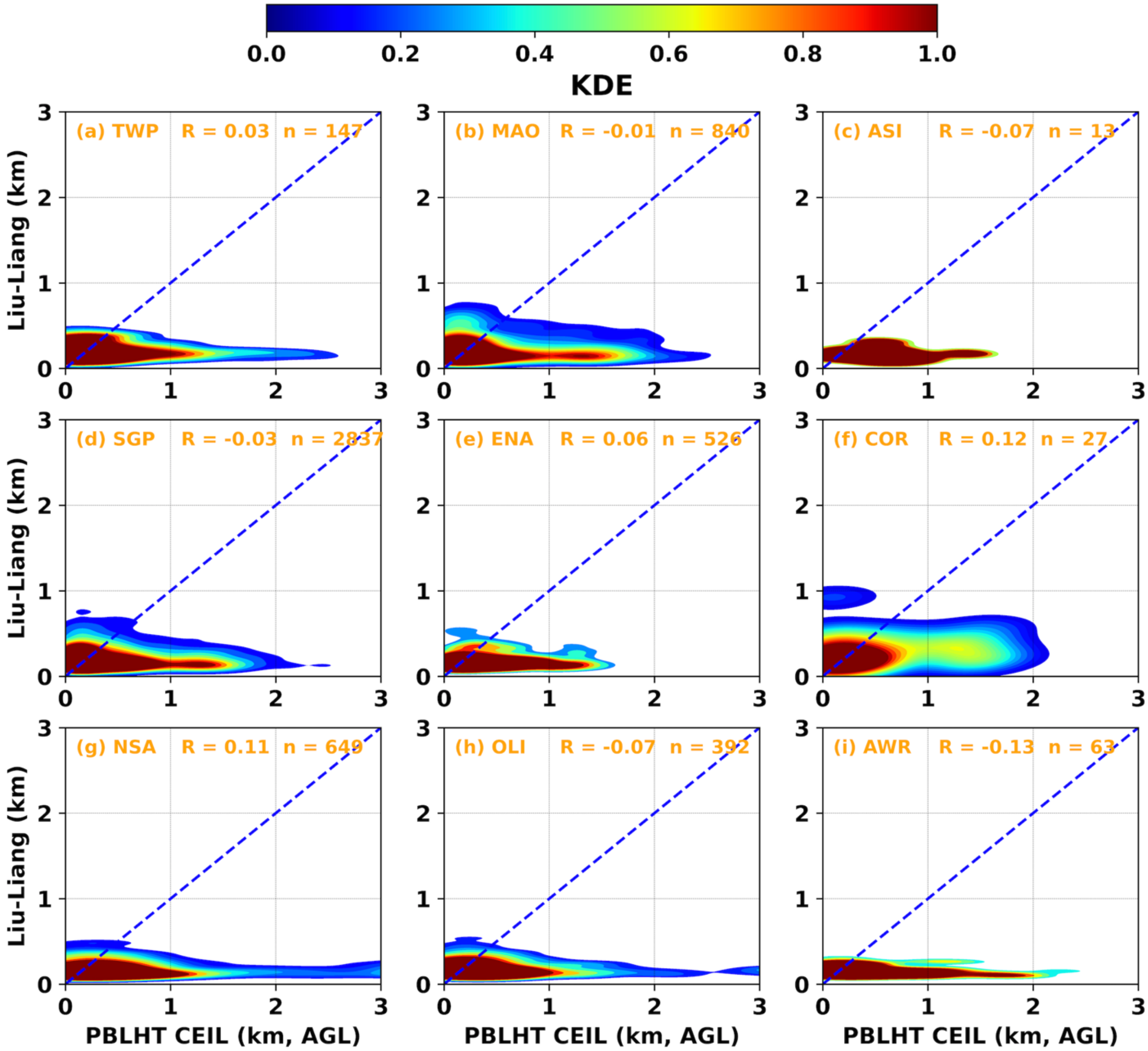

Figure S2: Similar to Figure S1, but for PBLHT CEIL and PBLHT Liu-Liang comparisons.

2. PBLHT comparisons for Low-level cloudy (LLC) stable boundary layer conditions

Comparisons of LLC cloud base and PBLHT CEIL show they match well generally, however, TWP, MAO, and ENA show consistently higher LLC cloud bases than PBLHT CEIL (Figure S3), probably because these observatories often have low-level clouds that are decouple from the boundary layer. This also indicates that the PBLHT CEIL algorithms can pick up PBLHTs under LLC cloudy conditions. Similar to LLC-free stable boundary layer conditions, most correlation coefficients including those of PBLHT Heffter, and PBLHT Liu-Liang are close to zero, and some comparisons are even negatively correlated under LLC stable boundary layer condition (Figure S4). PBLHT Liu-Liang always produce low PBLHTs that are lower than 0.5 km AGL at all ARM observatories (Figure S5).

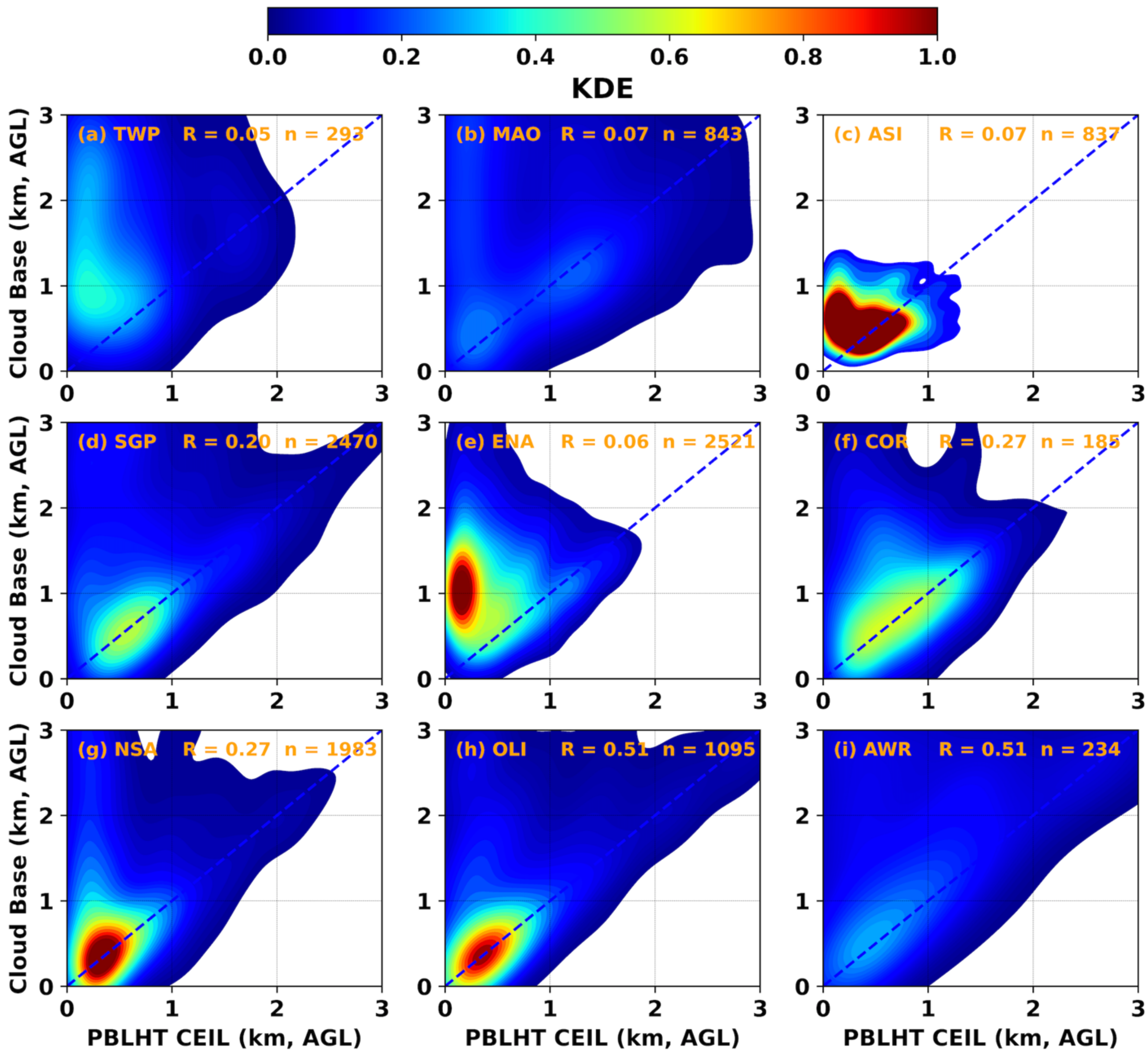

Figure S3: KDE for LLC cloud base and PBLHT CEIL comparisons.

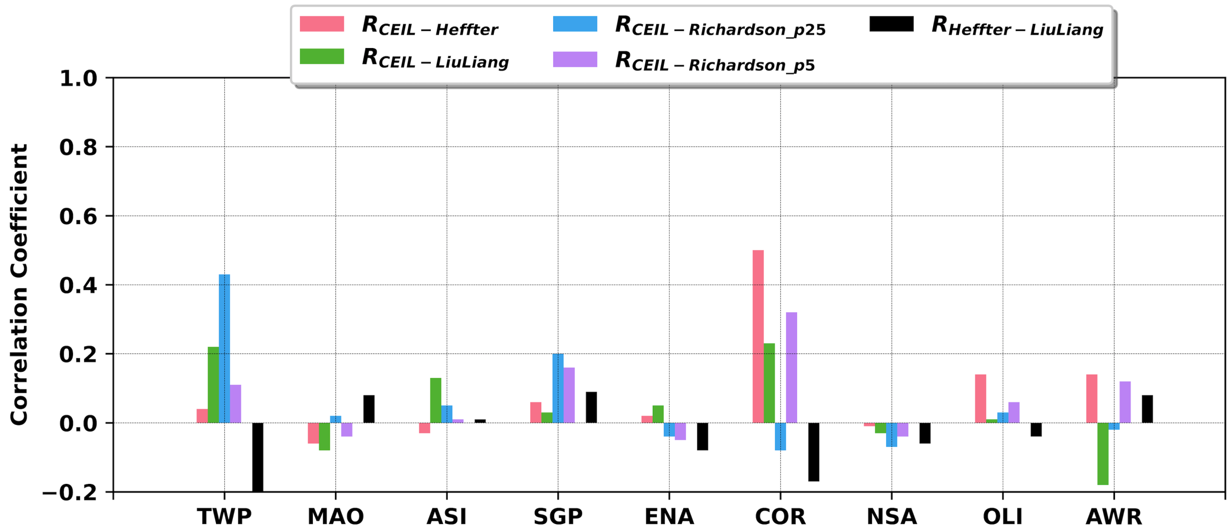

Figure S4: correlation coefficients between PBLHT CEIL and PBLHT Heffter ($R_{CEIL\text{-}Heffter}$), PBLHT Liu-Liang ($R_{CEIL\text{-}LiuLiang}$), PBLHT Richardson ($R_{CEIL\text{-}Richardson\_p25}$ *and* $R_{CEIL\text{-}Richardson\_p5}$) under LLC stable boundary layer conditions. Correlation coefficients between PBLHT Heffter and PBLHT Liu-Liang are also plotted ($R_{Heffter\text{-}LiuLiang}$).

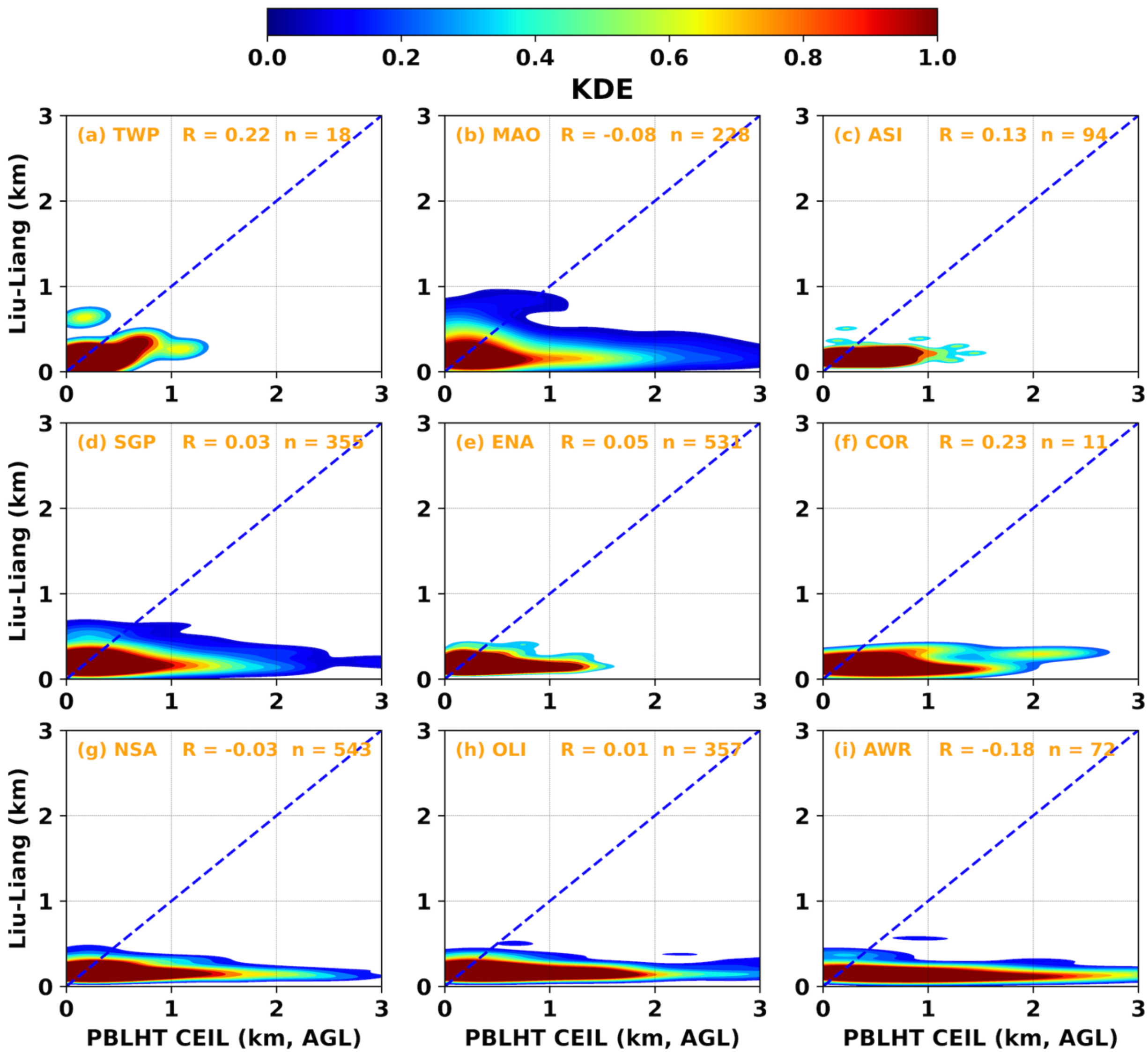

Figure S5: Similar to Figure S1, but for PBLHT CEIL and PBLHT Liu-Liang comparisons under LLC stable boundary layer conditions.