Comparison of Planetary Boundary Layer Height Derived using Different Lidar Systems

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[08].[Atmospheric Boundary layer Processes]

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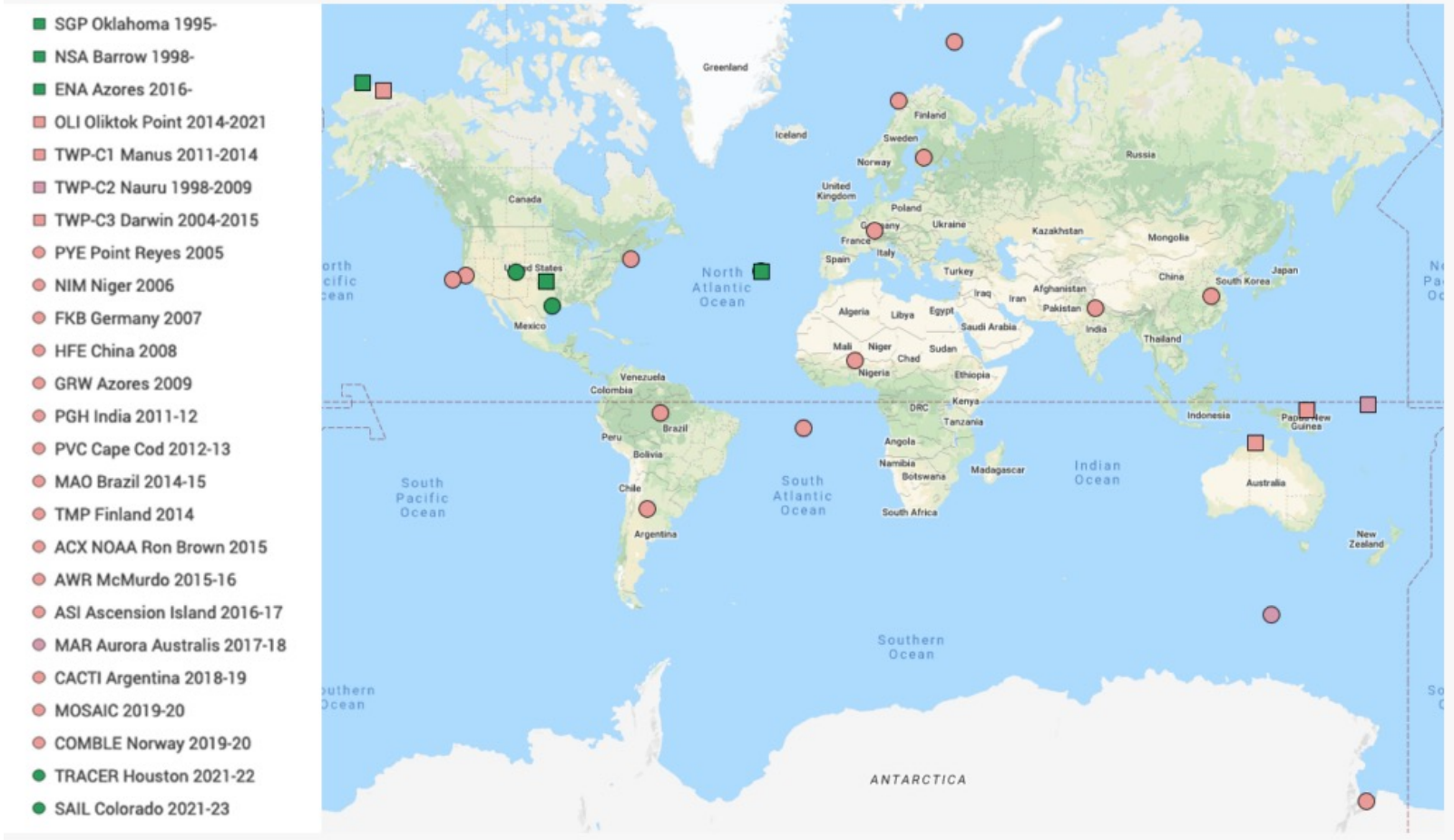
Introduction

- The planetary boundary layer height (PBLHT) has been widely determined using *in situ* radiosonde data. However, radiosonde data has poor temporal resolution
- Lidar remote sensing provides high-temporal and continuous observations. PBLHT can be determined from several methods including methods using gradients of aerosol backscatter intensity from lidar measurements, methods using variance of vertical air motion from Doppler lidar measurements
- DOE ARM (https://www.arm.gov/) deploys state-of-the-arm remote sensing instruments at fixed sites and AMF field campaigns



Source: https://www.ssec.wisc.edu/aeri/

Methods to Derive PBLHT

PBLHT-Sonde:

- Heffter method (Heffter 1980)
- Liu-Liang method: convective, neutral, and stable regimes (Liu and Liang 2010)
- Bulk Richardson Number method (Sorensen 1998)

PBLHT-MPL

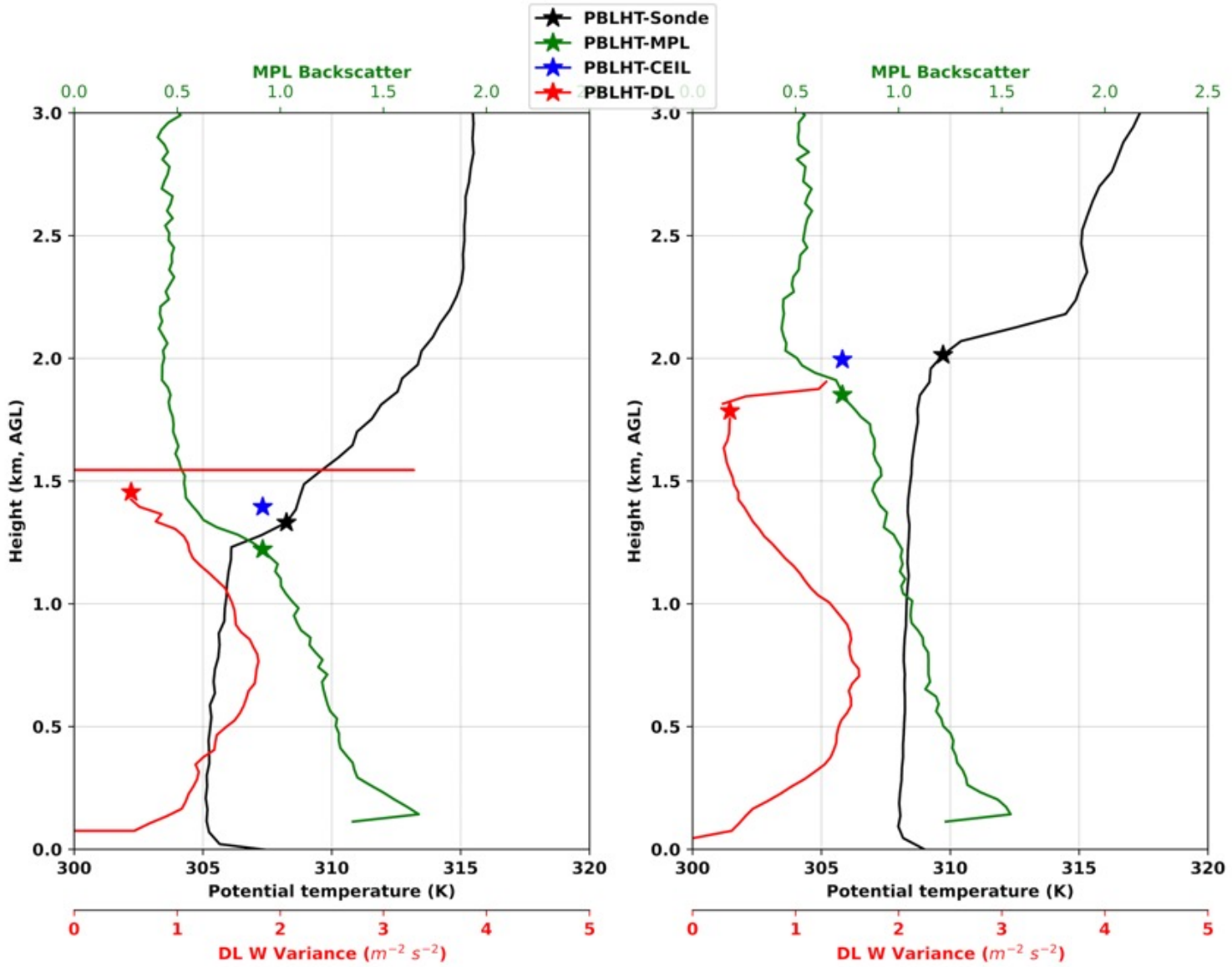
- Wavelet Covariance of lidar backscatter (Sawyer and Li 2013)

PBLHT-CEIL

- CL31 built-in software using an enhanced gradient method

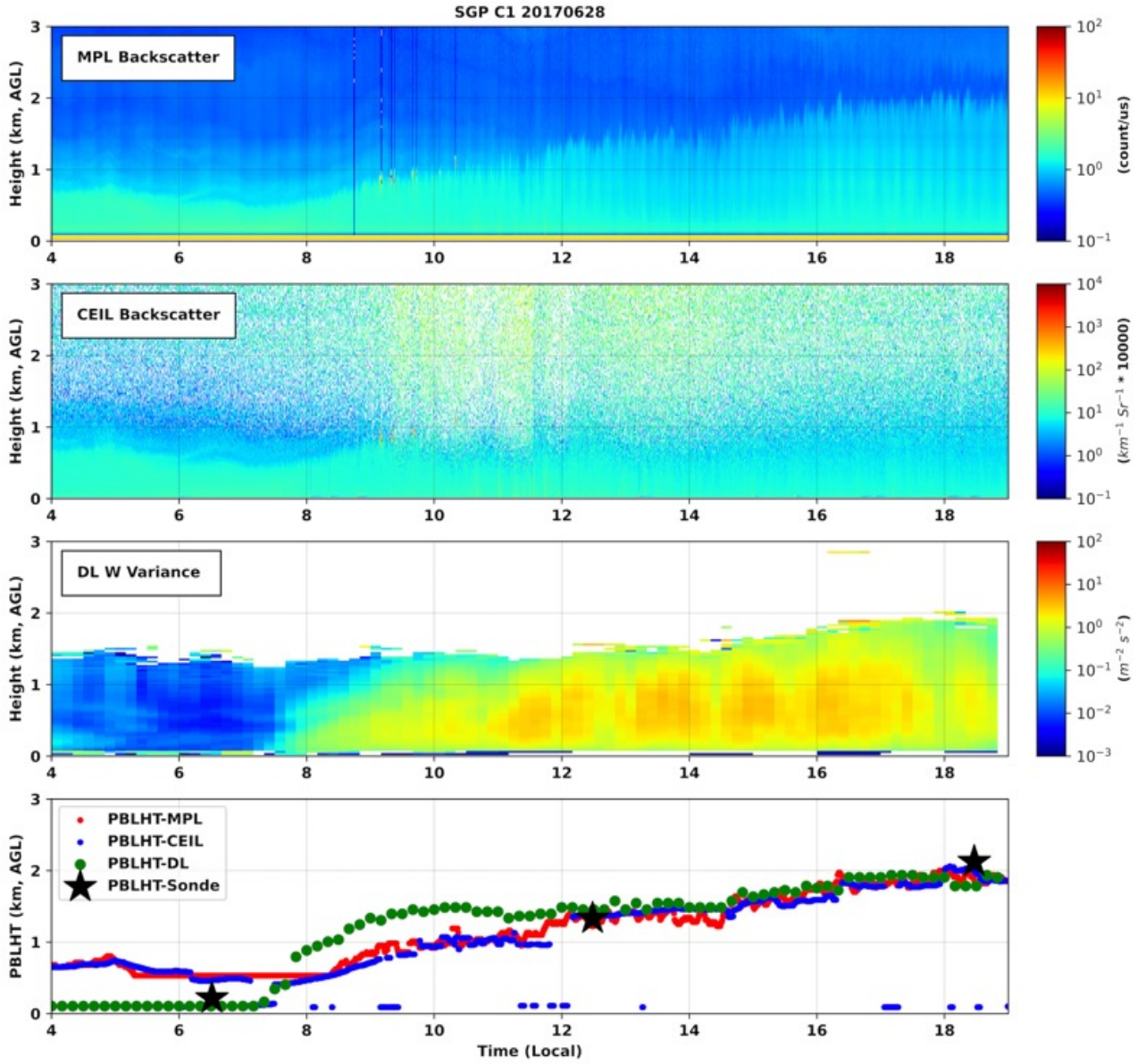
PBLHT-DL

- W Variance threshold of 0.04 $m^{-2}s^{-2}$ (Berg et al., 2017)



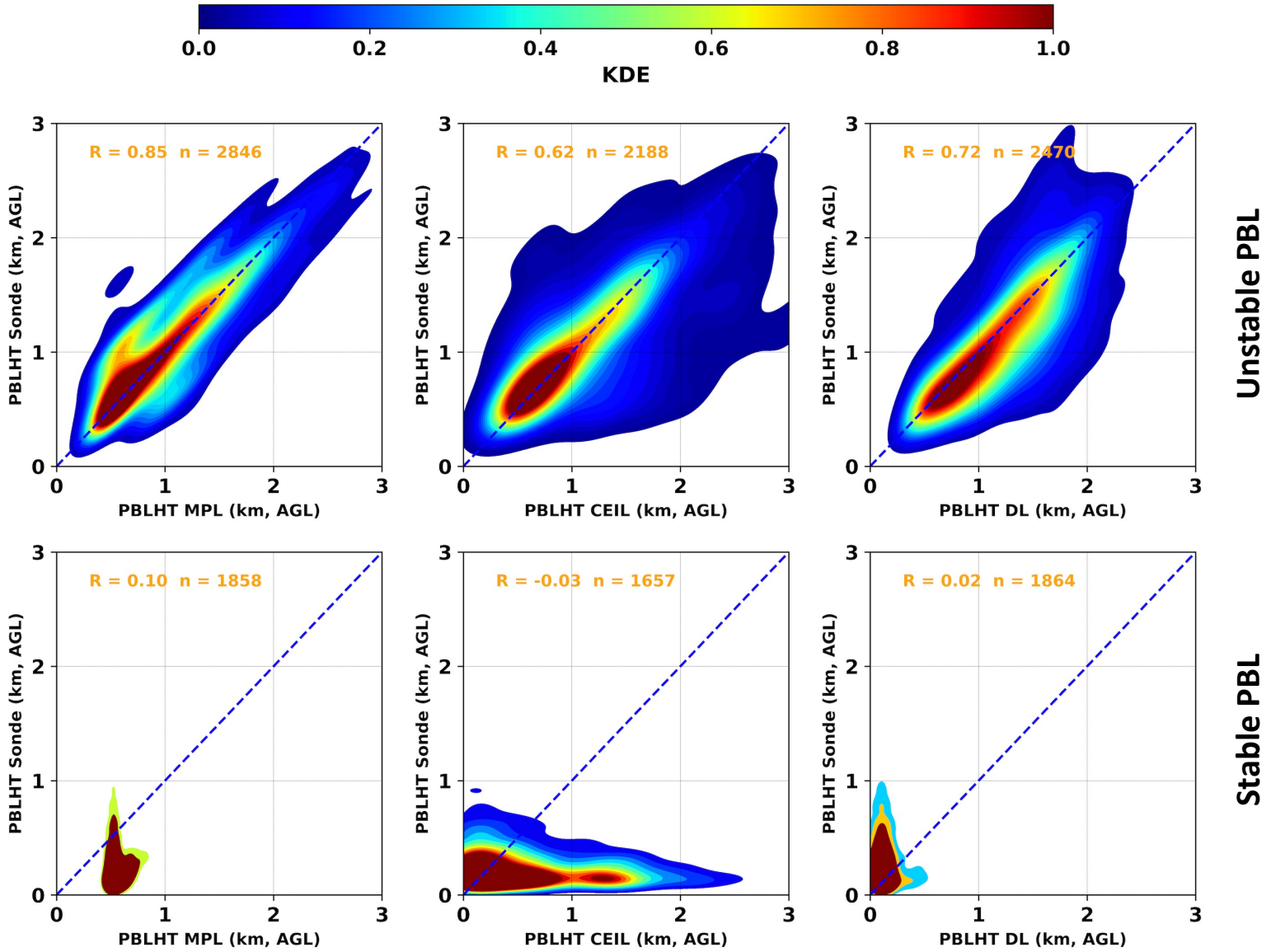
Methods to Derive PBLHT

Measurements	Characteristics	ARM sites
Sonde	Reliable Poor temporal resolution	SGP(2001-2021), ENA(2013-2021), NSA(2002-2021), AMF field campaigns
Micropulse Lidar	Strong aerosol signal Overlap correction issues below 400m; elevated aerosol layers	SGP (2014-2021), CACTI
Ceilometer	Read-time display and monitoring Elevated aerosol layers	SGP (2012-2021), ENA (2013-2021), NSA (2013-2021), AMF field campaigns
Doppler Lidar	Good for PBL development state Low SNR > 2km	SGP (2010-2021)

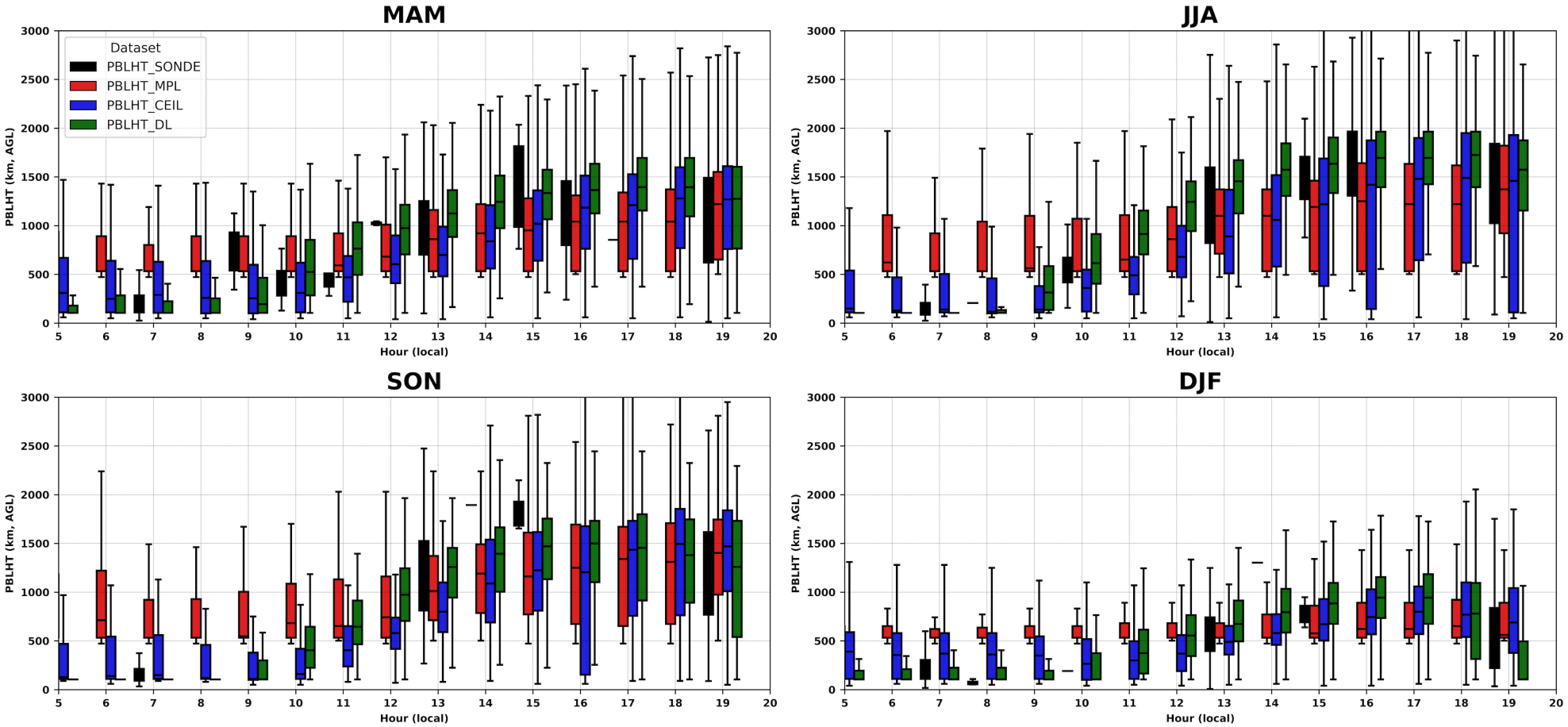


Comparison of Derived PBLHT

- PBLHT from different lidar measurements compare well with PBLHT_SONDE under neutral and convective PBL regimes but has no correlation with PBLHT_SONDE under the stable PBL regime.



Diurnal Cycles and Seasonal Variations of PBLHT



- PBLHTs from lidar measurements show similar diurnal cycles and seasonal variations as PBLHT SONDE
- During daytime, generally PBLHT_DL > PBLHT_CEIL > PBLHT_MPL