

# PBL and Aerosol Layer Heights from HSRL

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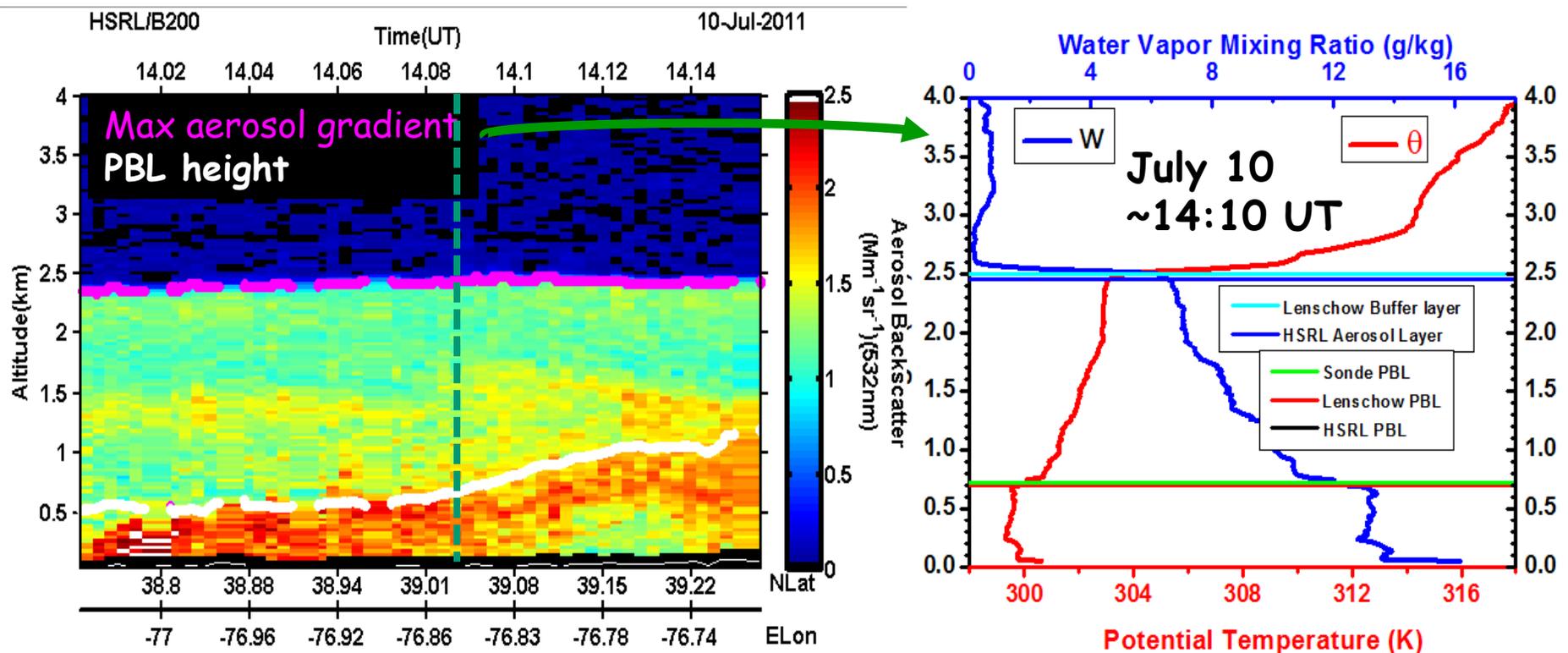
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# HSRL data used to find height of PBL and aerosol layer

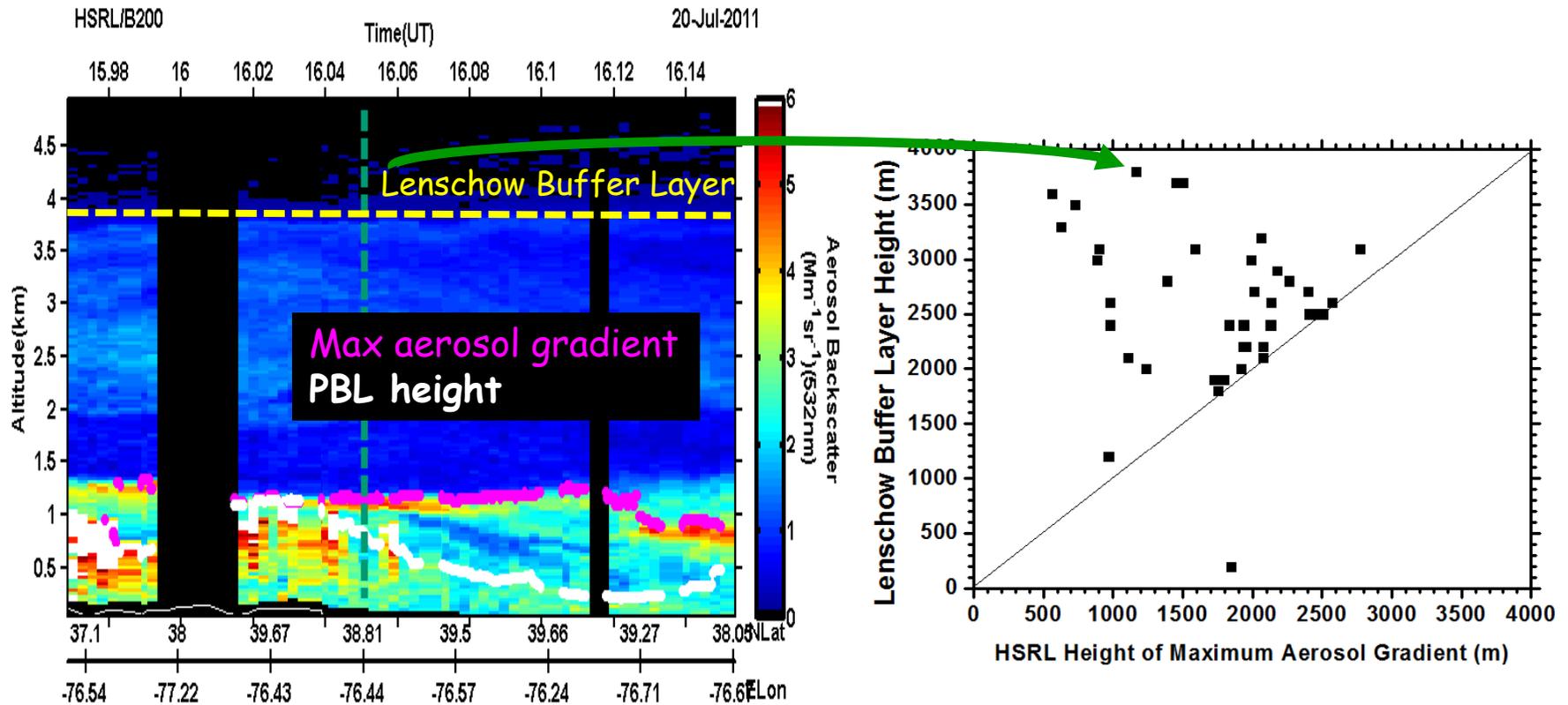
- PBL heights derived from HSRL cloud-screened aerosol backscatter profiles
- Automated technique uses a Haar wavelet covariance transform to identify sharp aerosol gradients at the top of the PBL
- "Best-Estimate" HSRL PBL heights combine results from automated algorithm and manual inspection of HSRL backscatter profiles
- Height of maximum aerosol gradient was also identified to provide an alternative height to describe the depth of the aerosol layer
- These heights often correspond to gradients in potential temperature and water vapor



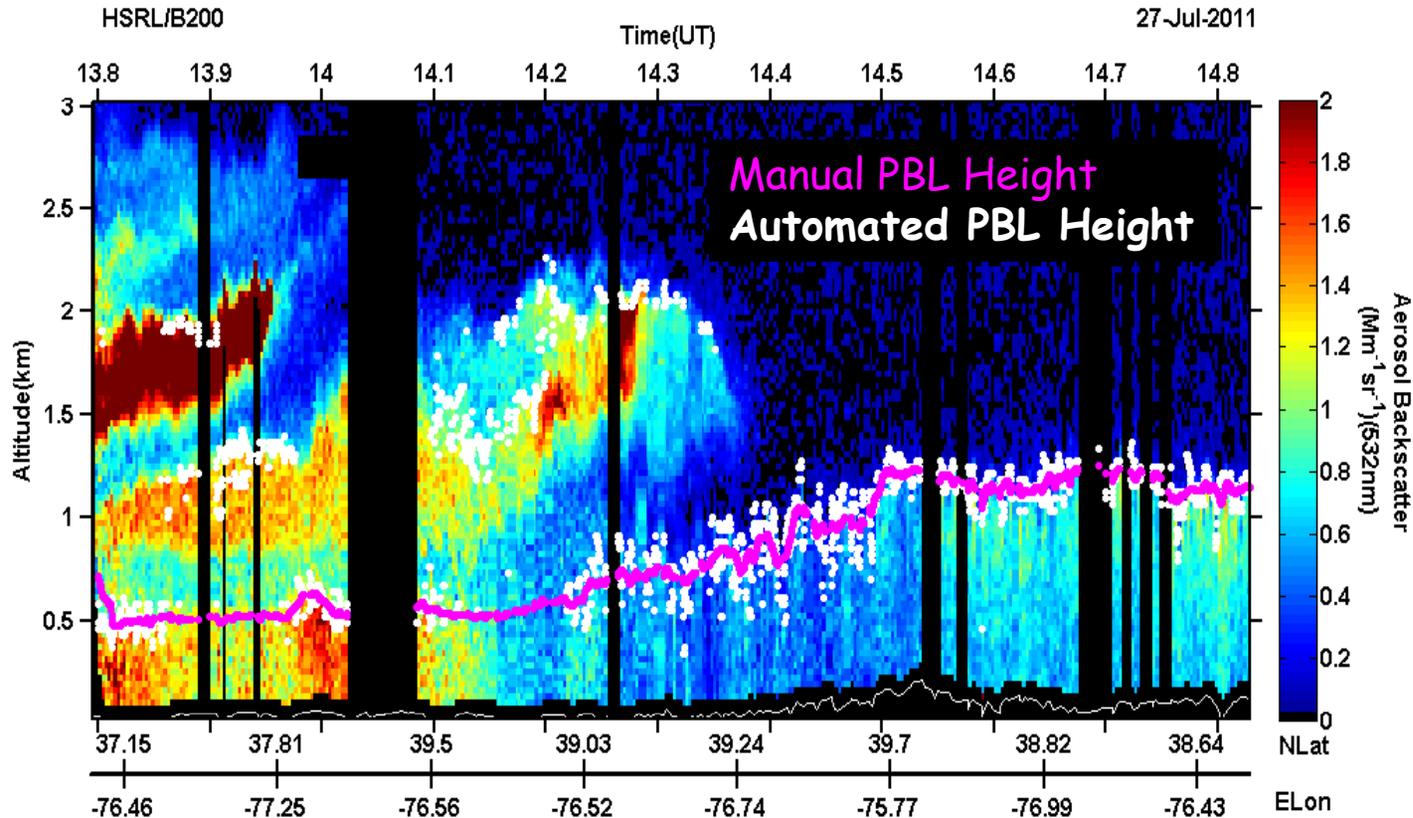
# Lenschow Buffer Layer Heights $\neq$ HSRL Heights of Maximum Aerosol Gradient



- Lenschow buffer layer heights are generally much higher than the HSRL heights of maximum aerosol gradients
- Aerosol scattering and extinction are generally concentrated in the lowest levels so the heights of the maximum aerosol gradients are generally below the height of buffer layer



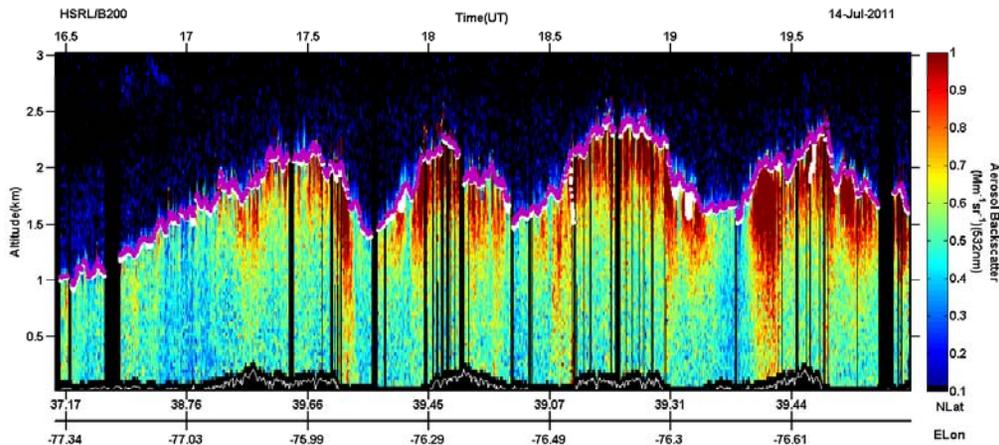
- “Best-Estimate” HSRL PBL heights combine results from automated algorithm and manual inspection of HSRL backscatter profiles
- Elevated aerosol layers may sometimes be mistaken for PBL height



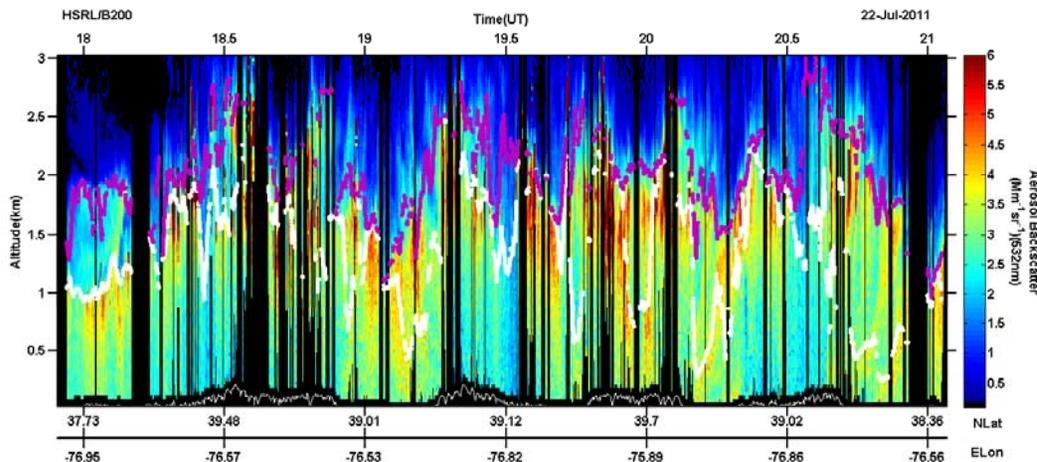
# HSRL PBL Height Advisory



Some cases are straightforward ...



...and some are not.

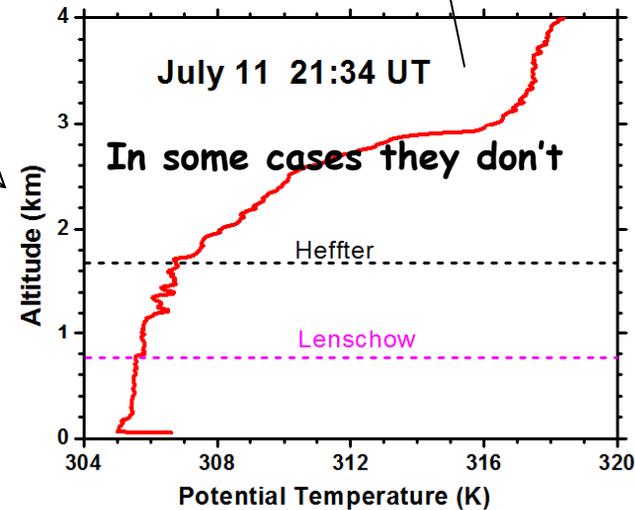
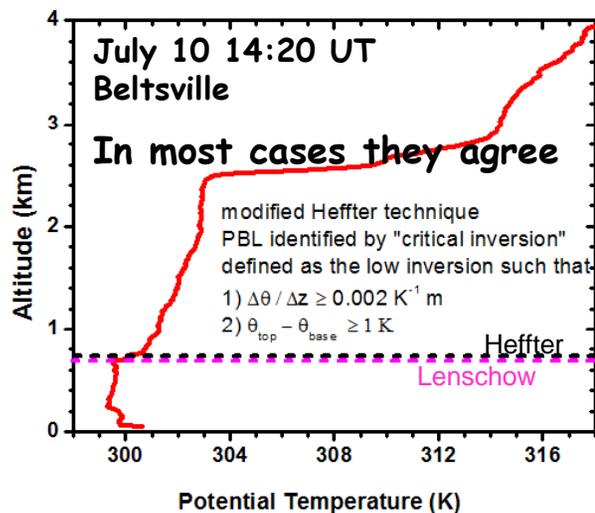
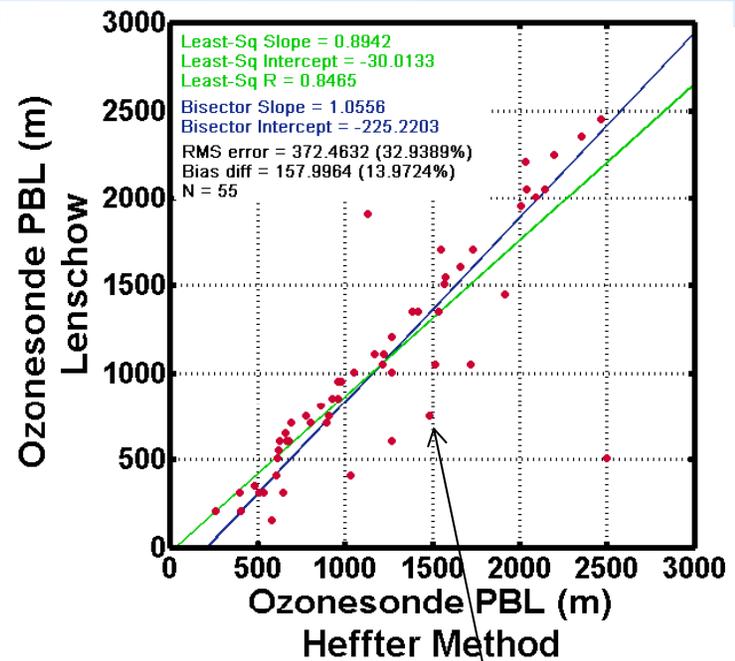


Given the variety of ways to define, retrieve, and use PBL heights, as well as the difficulty in determining PBL height in complex atmospheric conditions, the HSRL heights may or may not be useful for a given application. **Therefore, we strongly recommend that users: 1) read the readme file to learn about the methodology, and 2) examine the supplied imagery to gauge the suitability and uncertainty of these results.**

# HSRL PBL heights are compared with PBL heights derived from sonde potential temperature profiles



- PBL heights were computed from ozonesonde potential temperature ( $\theta$ ) profiles in order to evaluate PBL heights derived from HSRL cloud-screened aerosol backscatter profiles
- An automated technique that is based on the Heffter (1980) and Hayden et al. (1997) techniques was used. This uses thresholds on the potential temperature lapse rate and strength of the inversion
- The PBL heights computed using these potential temperature profiles were in generally good agreement with those provided by Don Lenschow. In some cases, Heffter method PBL heights are higher than the Lenschow heights because lapse rate and/or  $\Delta\theta$  were too small

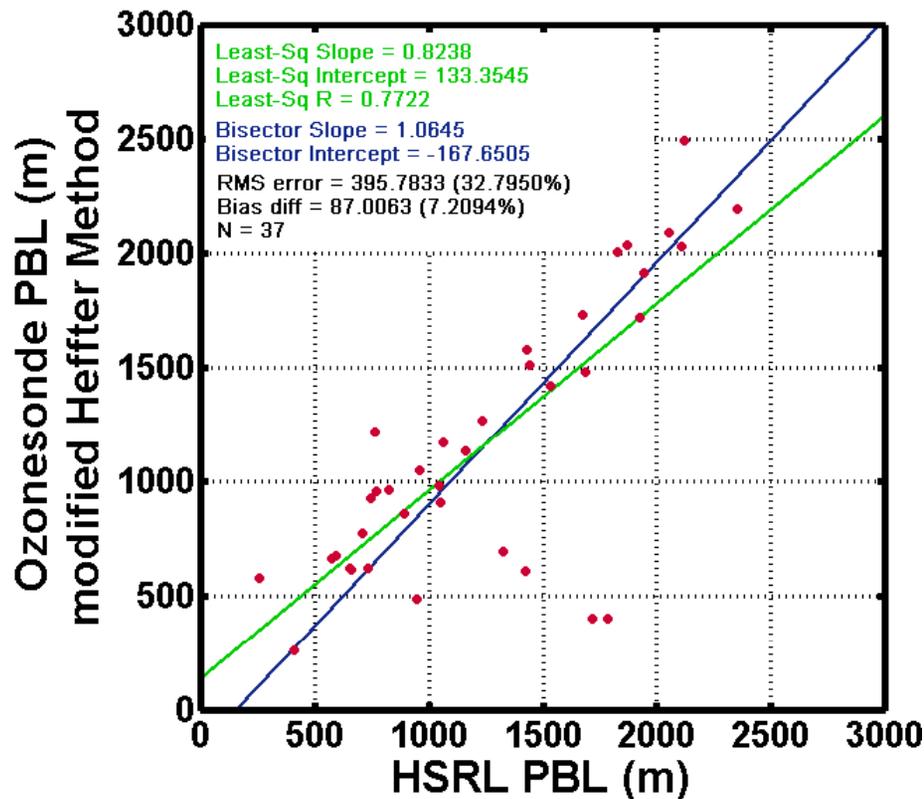


# Comparison of HSRL and Ozone-sonde PBL heights

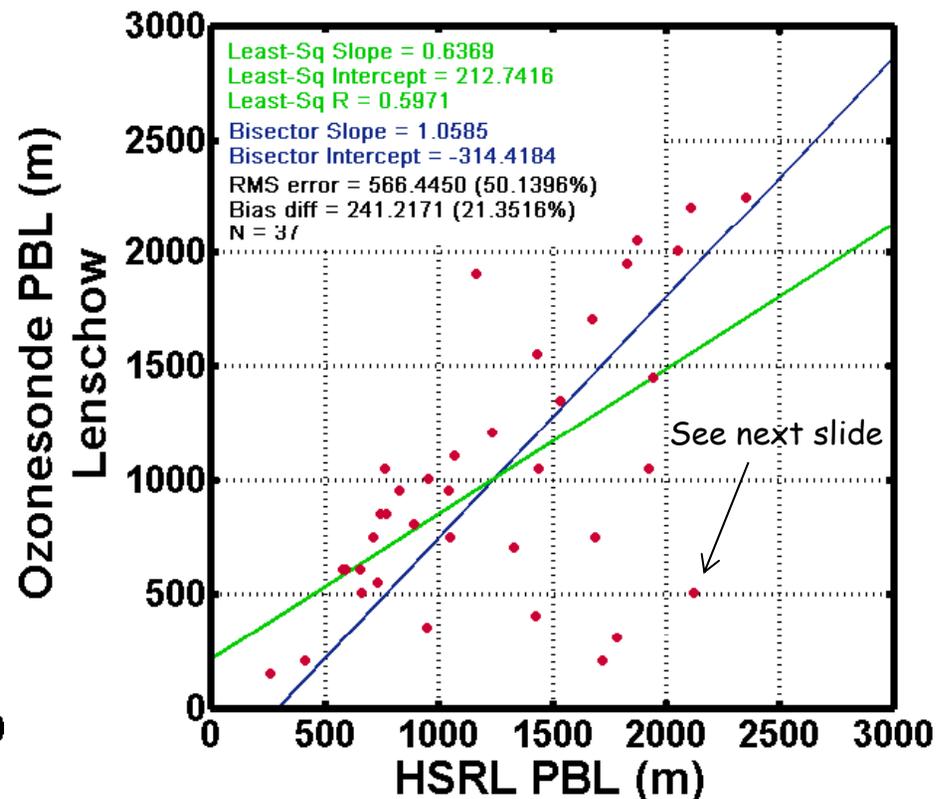


- HSRL PBL heights were compared to PBL heights derived from the ozone-sondes
- HSRL PBL heights generally were in better agreement with those from modified Heffter technique than those from Lenschow

### HSRL PBL heights vs. modified Heffter PBL Height



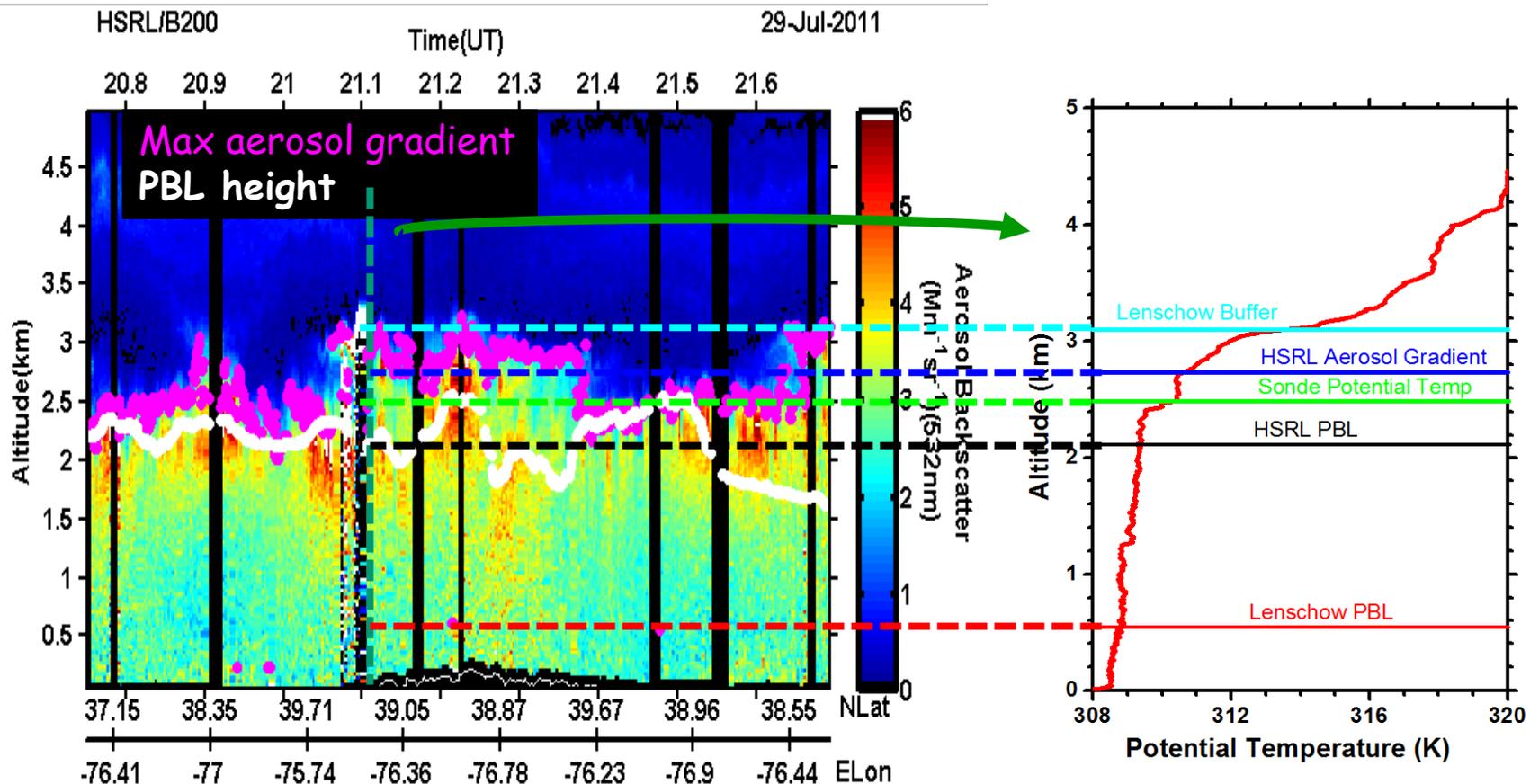
### HSRL PBL heights vs. Lenschow PBL Height



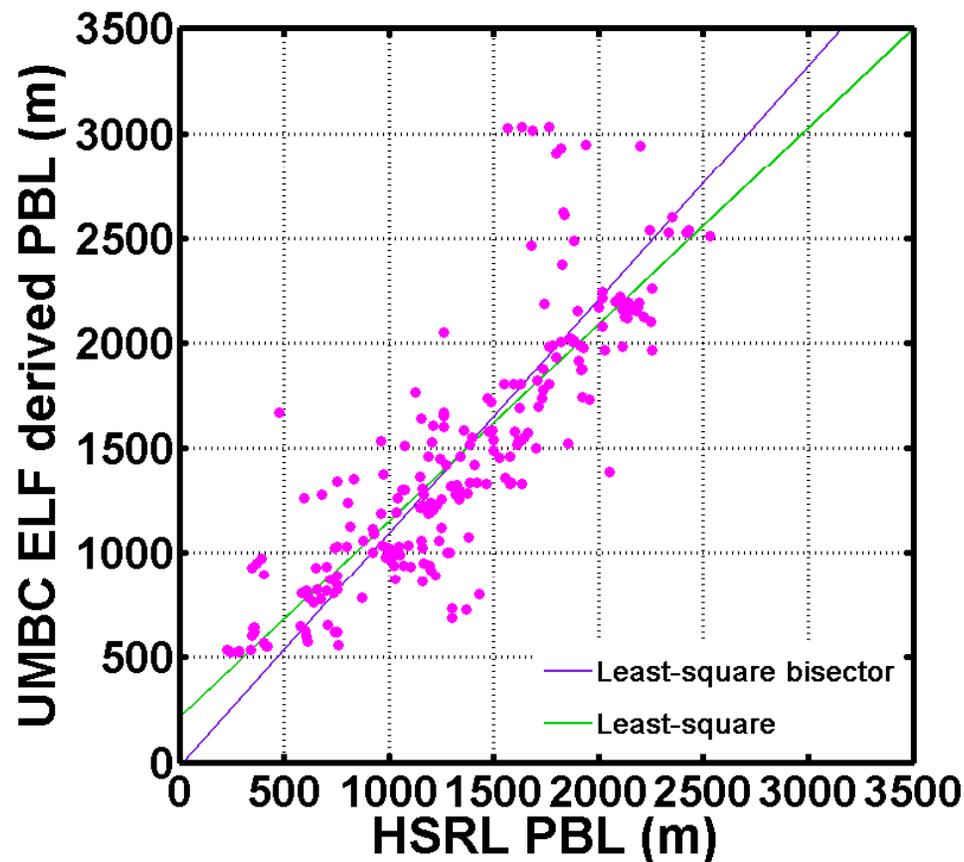
# Why are there sometimes large differences between HSRL and Lenschow PBL heights?



- HSRL PBL heights are sometimes (much) higher than the Lenschow PBL heights because of fundamental differences in the heights of aerosol and temperature gradients; similar differences have been reported in previous studies
- In late afternoon, active convection weakens and ceases, but aerosol gradients remain aloft above developing temperature gradients, so HSRL sees these higher aerosol gradients
- Please be aware of how the PBL height was defined and retrieved



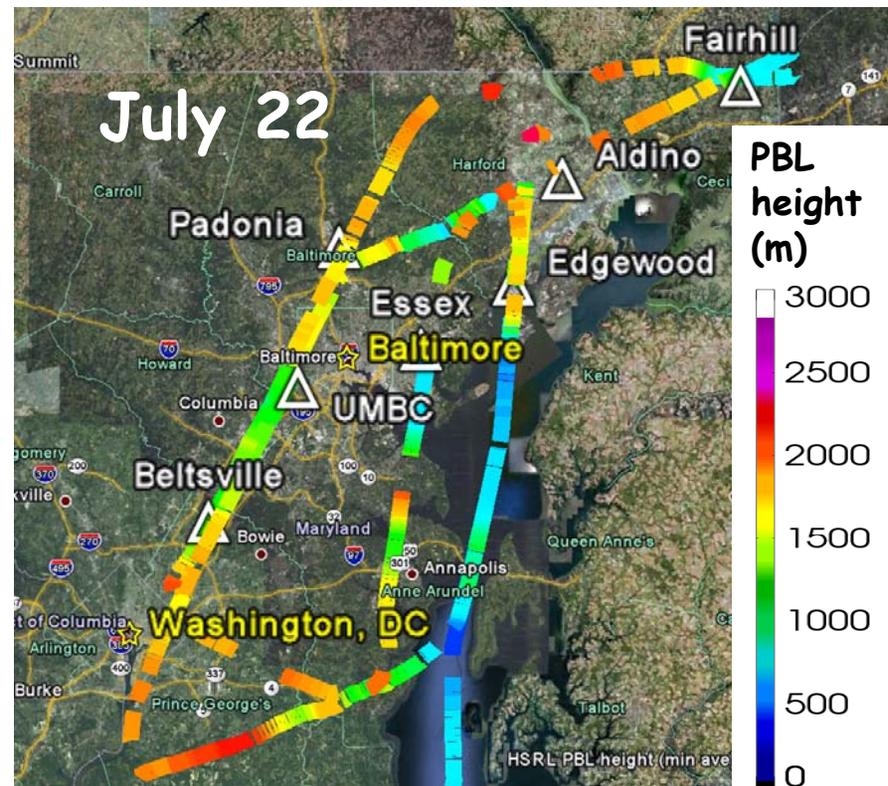
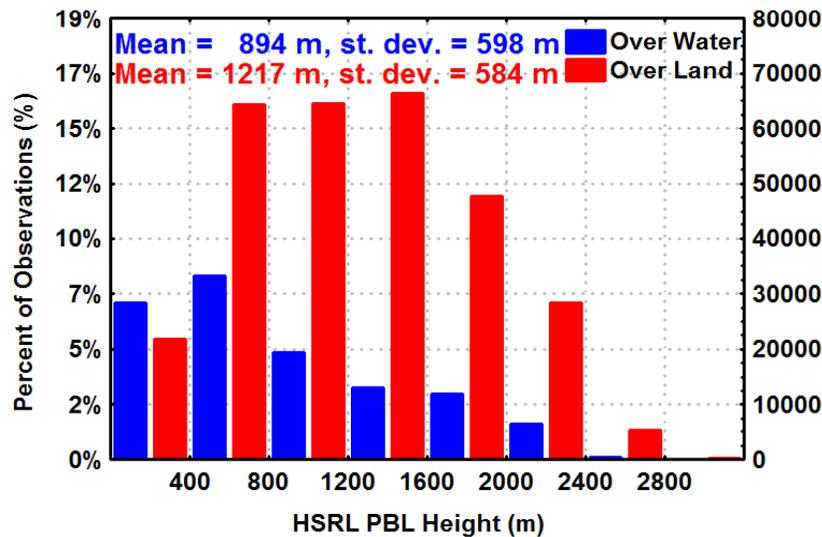
# HSRL and UMBC ELF lidar PBL heights



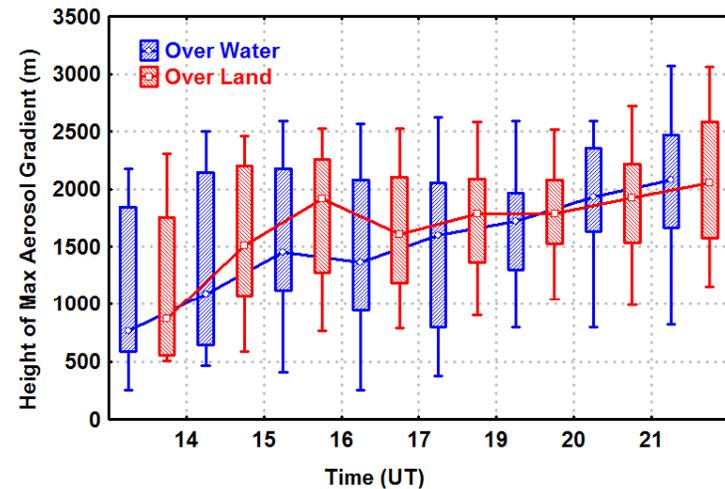
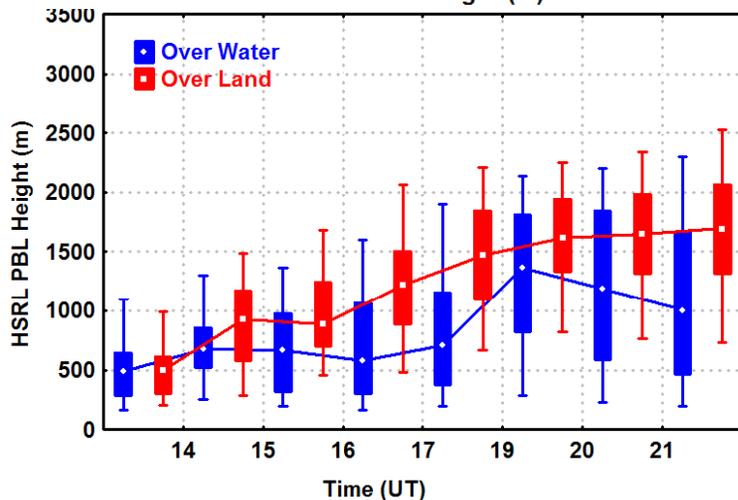
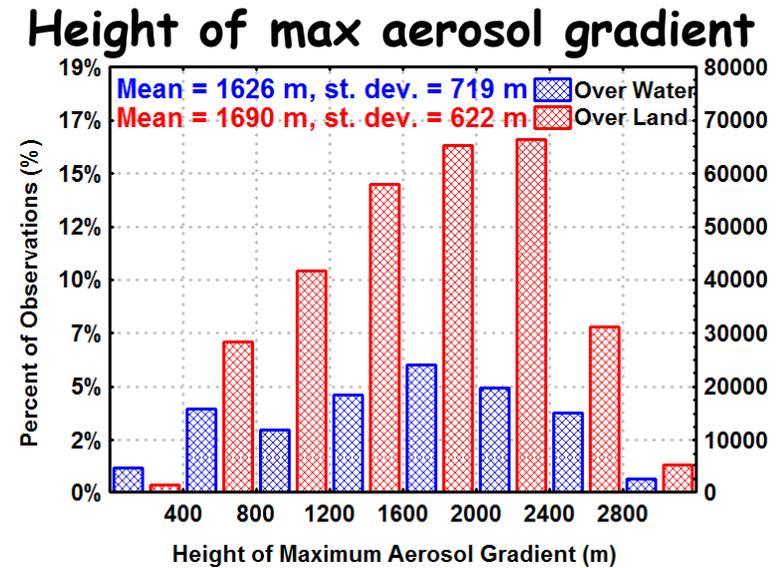
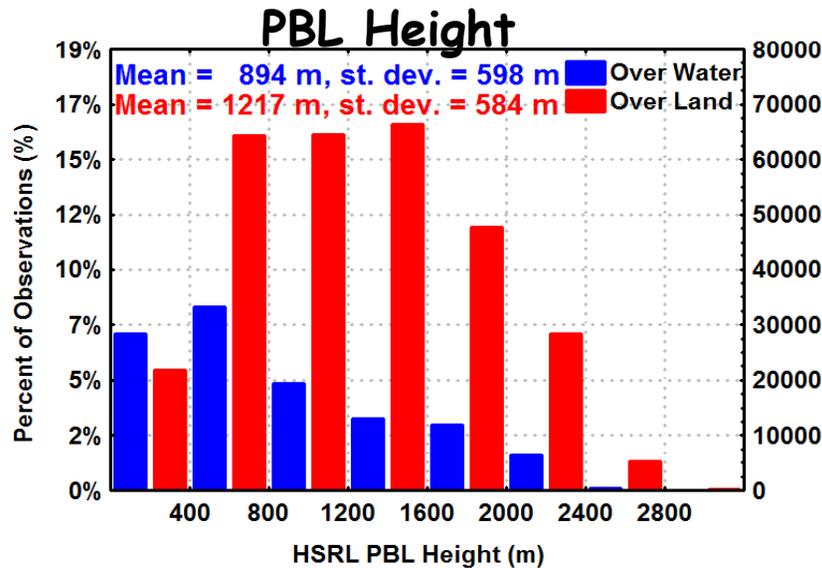
## HSRL 10 minutes/10 km within UMBC

|                                  |                      |
|----------------------------------|----------------------|
| R                                | 0.8422               |
| R <sup>2</sup>                   | 0.7093               |
| N                                | 220                  |
| Least-squares bisector slope     | 1.1147               |
| Least-squares bisector intercept | -22.9920             |
| Least-squares slope              | 0.9403               |
| Least-squares intercept          | 209.7942             |
| RMS Error                        | 355.5927 (25.4054%)  |
| Bias Difference                  | -130.1266 (-9.2969%) |

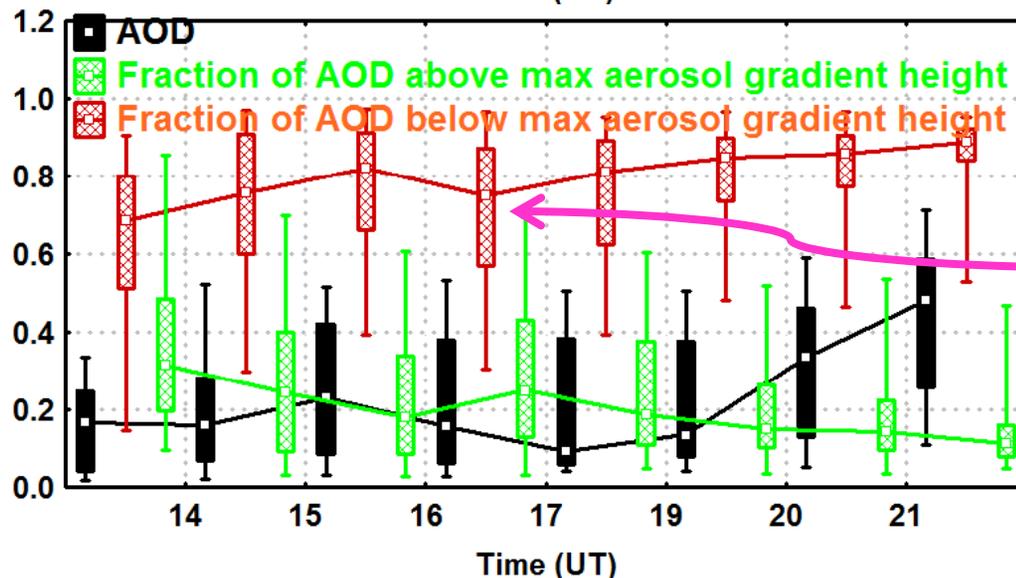
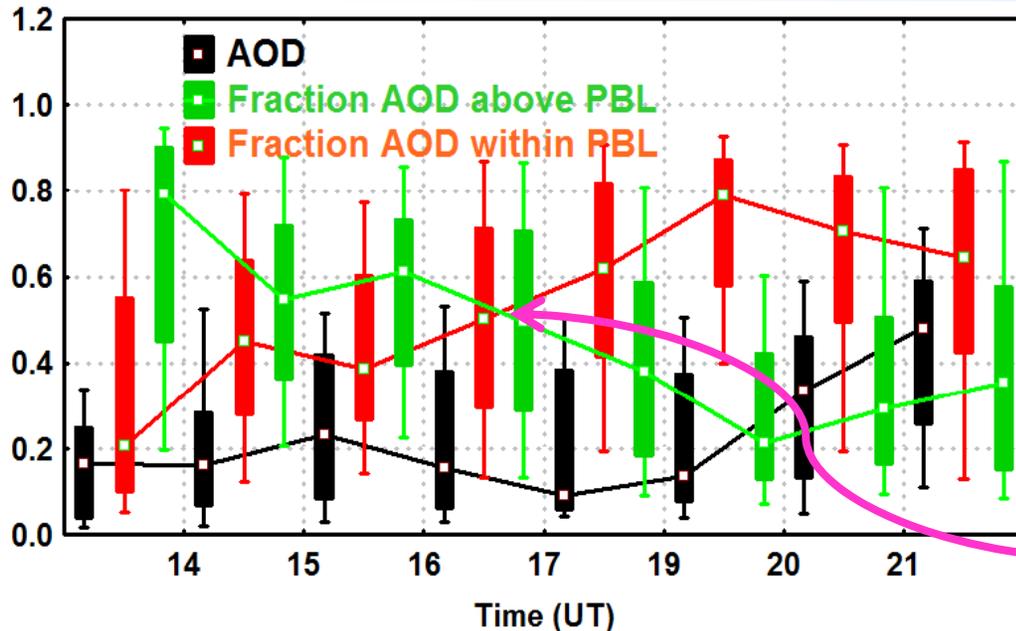
- PBL heights generally higher **over land** than **over water** (Chesapeake Bay)



- PBL heights generally higher **over land** than **over water** (Chesapeake Bay)
- In contrast, height of maximum aerosol gradient about the same **over land** and **water**
- PBL height and height of maximum aerosol gradient increased during the day



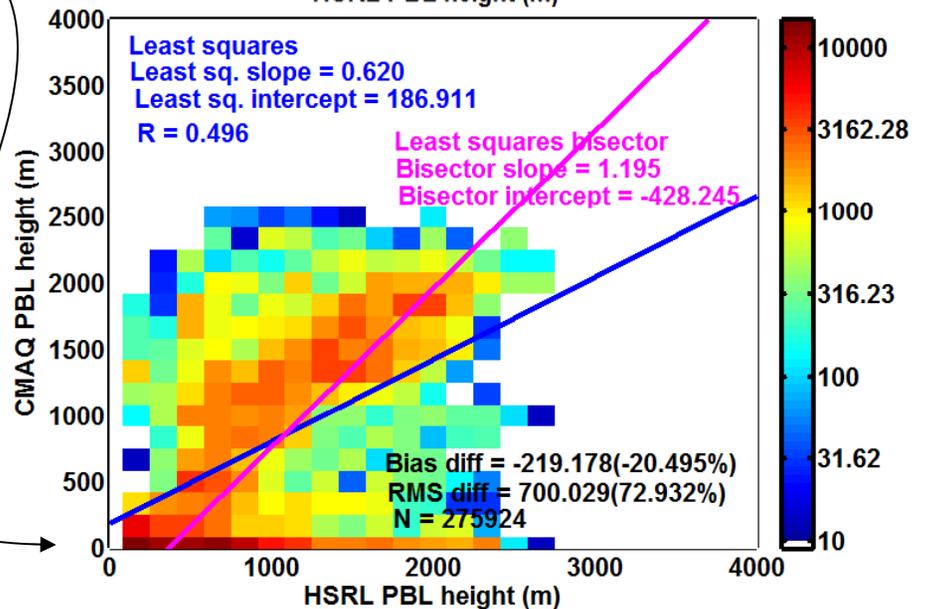
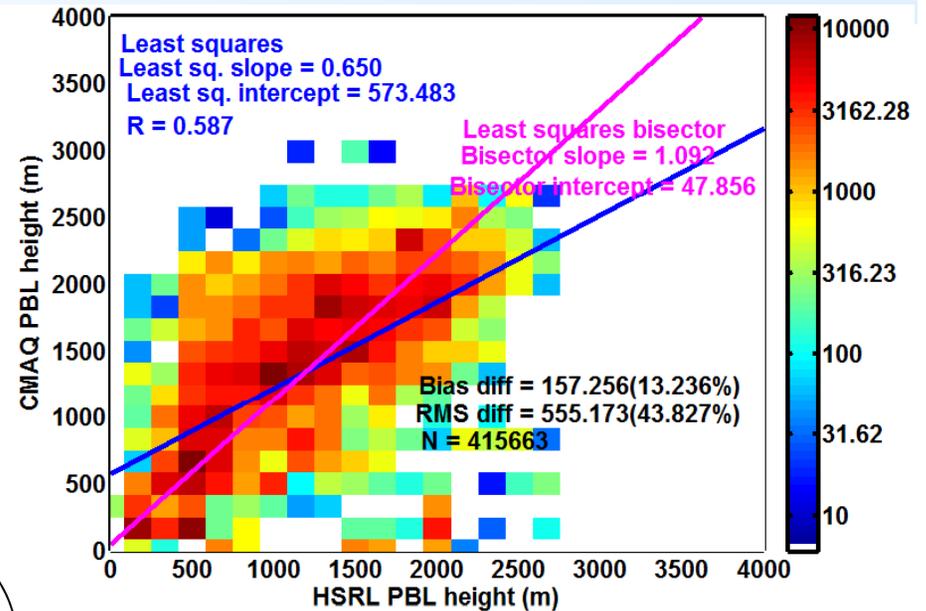
# AOD above and within PBL and Aerosol Layer



- HSRL measurements are used to determine the fraction of AOD in 0-7 km layer that is:
  - below and above the PBL height
  - below and above the height of the maximum aerosol gradient
- Before about local noon (~16 UT), more AOD above PBL than within PBL
- After about local noon (~16 UT), more AOD within PBL than above PBL
- About 70-90% of AOD was below the height of the maximum aerosol gradient
- Significant increase in AOD after 19 UT

# NOAA CMAQ PBL heights vs. HSRL PBL heights

- Over land, NOAA CMAQ PBL heights are generally slightly higher than HSRL
- Over water, NOAA CMAQ PBL heights are sometimes higher and sometimes very low compared to HSRL



July 22 19 UT (7 hour forecast)

PBL height (m)

