UMBC Intercomparisons
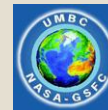# Ground-based Lidar, BAM and Nephelometer vs. Aircraft HSRL, in-situ SO_4^{2-} and f(RH)

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DISCOVER-AQ

General Lidar Equation

$$P(\lambda_0, z) = \frac{KO(\lambda_0, z)}{z^2} \beta(\lambda_0, z) \exp[-2\int_0^z \alpha(\lambda_0, z')dz']$$

Overall, extinction retrievals from ELF agree very well with HSRL measurements. Cases in which good agreement occurs indicate very well mixed aerosols within the PBL, when S does not vary with height.

LARC HSRL

$$P(\lambda_{Ra}, z) = \frac{K'O(\lambda_{Ra}, z)}{z^2} \beta(\lambda_{Ra}, z) \exp[-\int_0^z (\alpha(\lambda_0, z') + \alpha(\lambda_{Ra}, z'))dz']$$
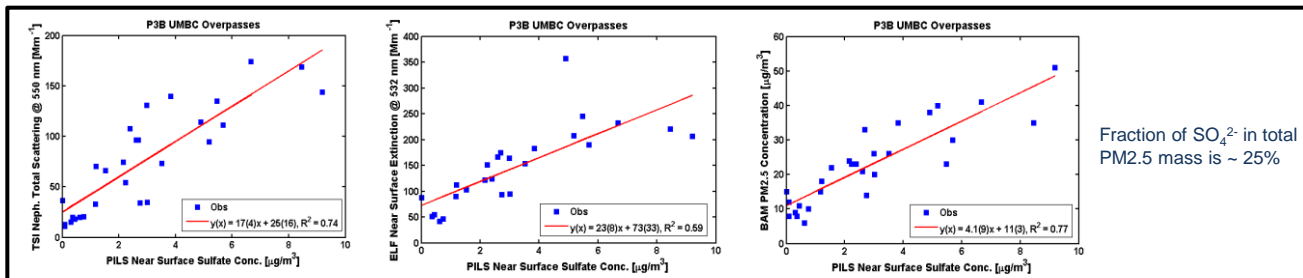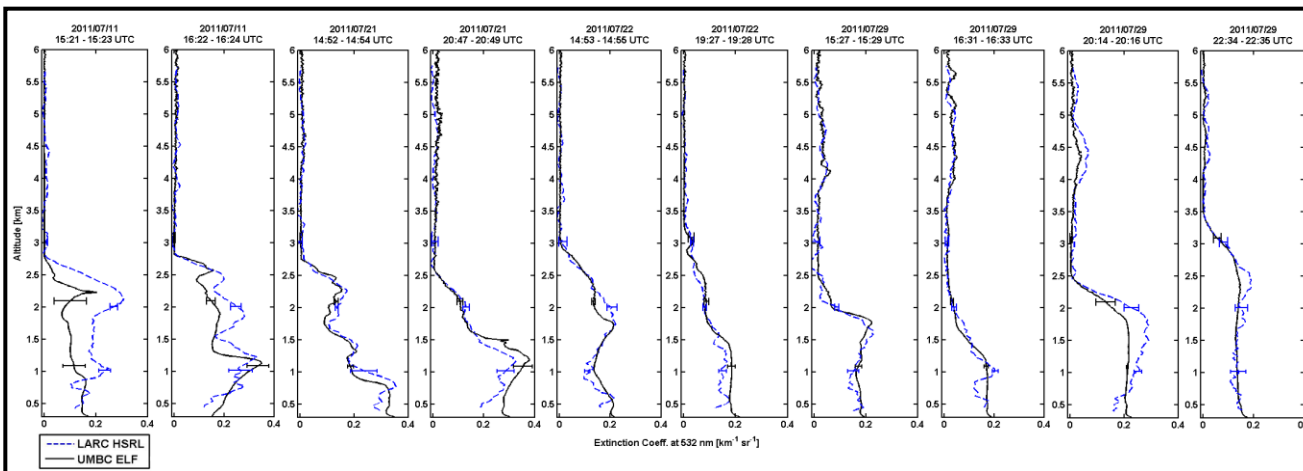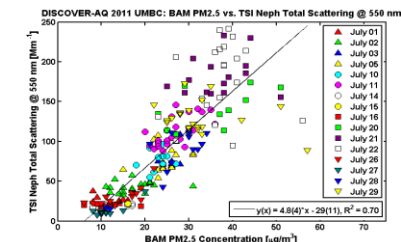
$$\alpha_{aer}(\lambda_0, z) = \frac{\frac{d}{dz}\ln\left[\frac{N_{Ra}(z)}{P(\lambda_{Ra}, z)z^2}\right] - \alpha_{mol}(\lambda_0, z)}{1 + \left(\frac{\lambda_0}{\lambda_{Ra}}\right)^{\dot{a}(z)}}$$

UMBC ELF

$$P(\lambda_0, z) = \frac{KO(\lambda_0, z)}{z^2} \beta(\lambda_0, z) \exp[-2\int_0^z S(\lambda_0, z')\beta(\lambda_0, z')dz']$$

Extinction-to-Backscatter or Lidar Ratio (S)

$$S(\lambda_0, z) \cong S(\lambda_0) = \frac{\alpha_{aer}(\lambda_0, z)}{\beta_{aer}(\lambda_0, z)}$$

2011/07/11 15:21 - 15:23 UTC; 2011/07/11 16:22 - 16:24 UTC; 2011/07/21 14:52 - 14:54 UTC; 2011/07/21 20:47 - 20:49 UTC; 2011/07/22 14:53 - 14:55 UTC; 2011/07/22 19:27 - 19:28 UTC; 2011/07/29 15:27 - 15:29 UTC; 2011/07/29 16:31 - 16:33 UTC; 2011/07/29 20:14 - 20:16 UTC; 2011/07/29 22:34 - 22:35 UTC

Extinction Coeff. at 532 nm [km^{-1} sr^{-1}]

- - - LARC HSRL
—— UMBC ELF

P3B UMBC Overpasses — TSI Neph. Total Scattering @ 550 nm [Mm^{-1}] vs. PILS Near Surface Sulfate Conc. [μg/m^3]
Obs; y(x) = 17(4)x + 25(16), R^2 = 0.74

P3B UMBC Overpasses — ELF Near Surface Extinction @ 532 nm [Mm^{-1}] vs. PILS Near Surface Sulfate Conc. [μg/m^3]
Obs; y(x) = 23(8)x + 73(33), R^2 = 0.59

P3B UMBC Overpasses — BAM PM2.5 Concentration [μg/m^3] vs. PILS Near Surface Sulfate Conc. [μg/m^3]
Obs; y(x) = 4.1(9)x + 11(3), R^2 = 0.77

Fraction of SO_4^{2-} in total PM2.5 mass is ~ 25%

Assumptions:
-- BAM and NEPH measure dry aerosols;
-- ELF measures aerosols at ambient conditions;

DISCOVER-AQ 2011 UMBC: BAM PM2.5 vs. TSI Neph Total Scattering @ 550 nm
y(x) = 4.8(4)*x - 29(11), R^2 = 0.70

Specific Scattering Coefficient (SSC):

$$SSC = \frac{Scattering}{MassConc.} = 4.8 \pm 0.4 [m^2 g^{-1}]$$

Extinction was dominated by scattering
Neph = 1.23(12)xELF + 41(13), R^2 = 0.63

DISCOVER-AQ 2011 UMBC: BAM PM2.5 vs. ELF Near-Surface Extinction
y(x) = 6.5(7)*x - 12(17), R^2 = 0.63
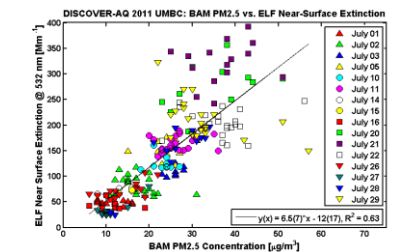
$$\alpha_{dry} = \frac{\alpha_{amb}}{f(RH)} = SSC \times PM2.5$$

$$f(RH)_{UMBC} = \frac{6.5}{4.8} = 1.35$$

$$f(RH)_{P3B} = 1.7 \pm 0.2 \approx f(RH)_{UMBC} - 1.7\sigma_{P3B}$$

P3B UMBC Overpasses at 372m ± 31m