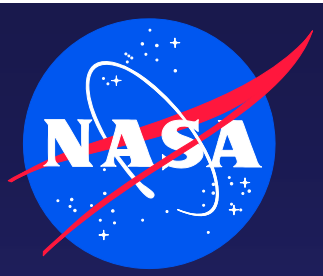

Reconciling Surface-Based Aerosol Retrievals with In-situ Aircraft Measurements in the Baltimore-Washington Area during DISCOVER-AQ.

SUZANNE CRUMEYROLLE

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AAAR Meeting, Minneapolis, 11 October 2012

Deriving Information on Surface Conditions from Column and VERtically Resolved Observations Relevant to Air Quality (DISCOVER-AQ)

Objectives:

1. Relate column observations to surface conditions for aerosols and key trace gases O_3, NO_2, and CH_2O

2. Characterize differences in diurnal variation of surface and column observations for key trace gases and aerosols

3. Examine horizontal scales of variability affecting satellites and model calculations

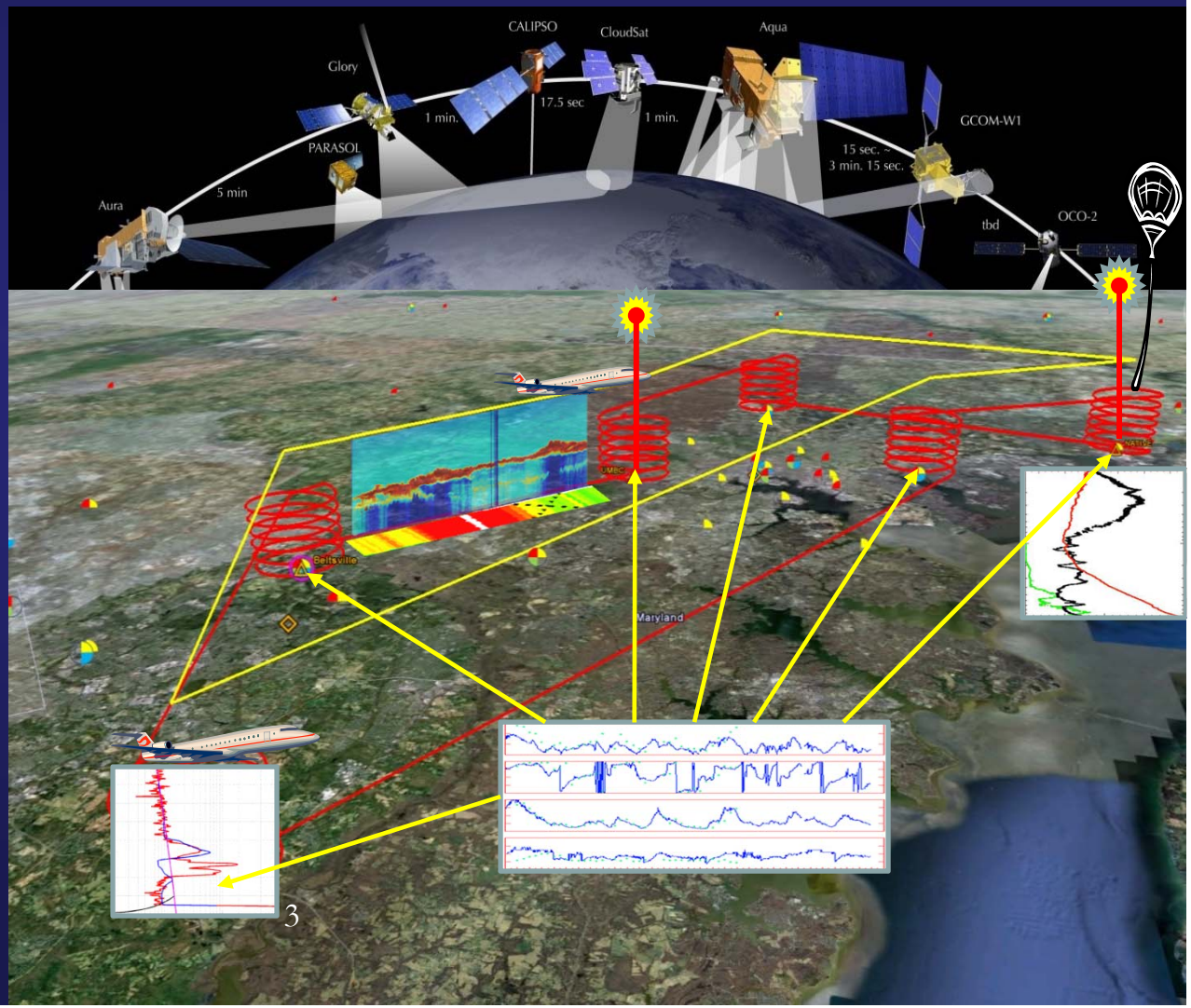
Deployment Strategy

Systematic and concurrent observations
(column-integrated, surface, and vertically-resolved)

NASA UC-12 (Remote sensing)
Continuous mapping of aerosols with HSRL and trace gas columns with ACAM

NASA P-3B (in situ meas.)
In situ profiling of aerosols and trace gases over surface measurement sites
➔ 247 spirals

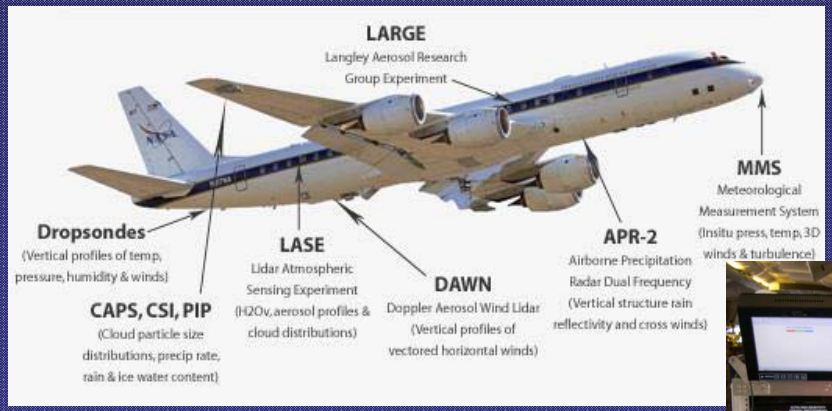
Ground sites
In situ and remote sensing measurements of trace gas and aerosol



Courtesy of J. Crawford

Instrumentation

LARGE Instrumentation



- **Aerosol Concentrations:**
  - Total and Non-Volatile
  - CCN spectra
- **Aerosol Sizes (10 nm -5μm)**
- **Chemical Composition**
  - filter collection and analyses for ionic content
- **Optical Properties:**
  - Scattering (Dry and Wet)
  - Absorption Coefficients (Extinction)
  - Single Scattering Albedo

Ground-based Instrumentation

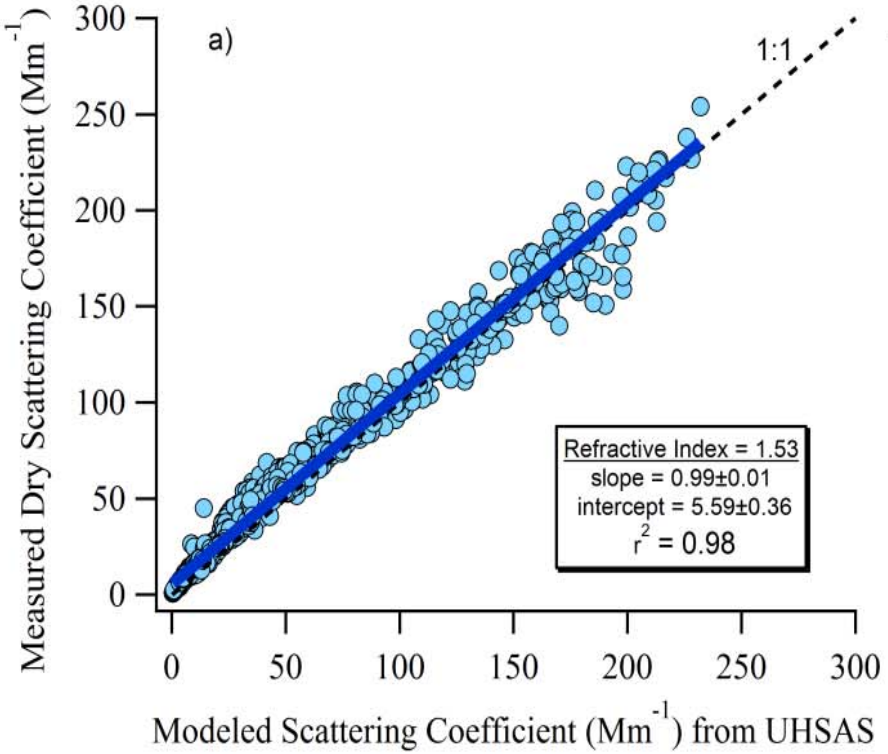
- **MDE sites :**
  - PM 2.5
  - MTO (P, RH, Precip, Temp, RAD, WS, WD)
  - Gases (O_3, NO_x,SO_2)
- **Aeronet :**
  - AOD
  - Size Distribution
  - Angstrom Exponent

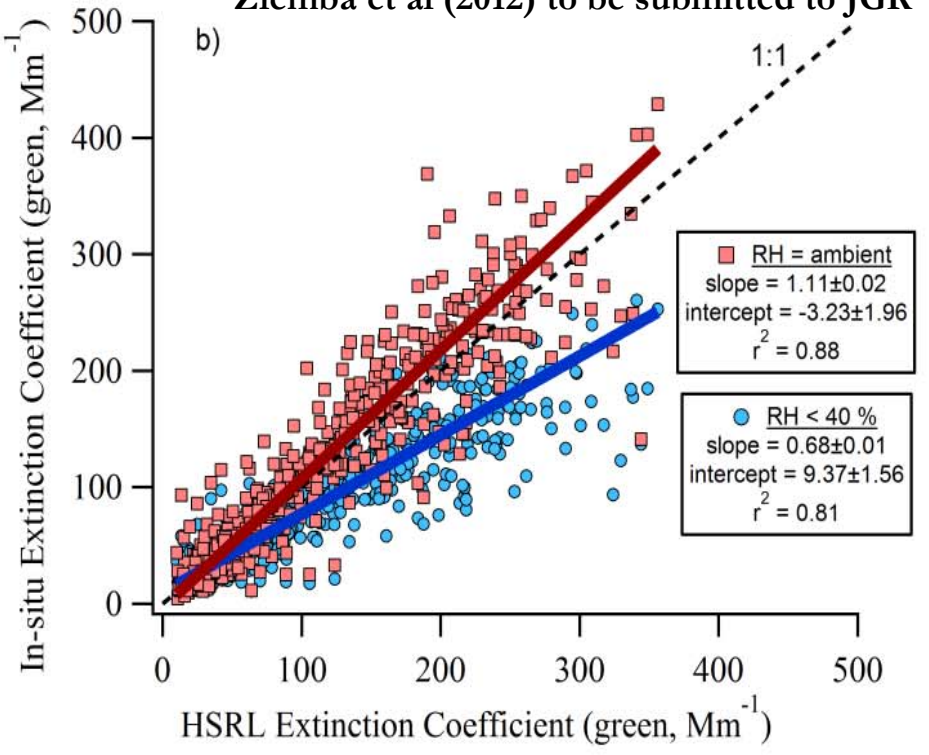
Validation of the P-3B Measurements

Scattering coefficient :
- In-situ measurement (Neph)
- Mie calculation from in-situ size distribution

Extinction coefficient :
- In-situ measurement (Neph + PSAP)
- High Spectral Resolution Lidar (UC-12)

Ziemba et al (2012) to be submitted to JGR

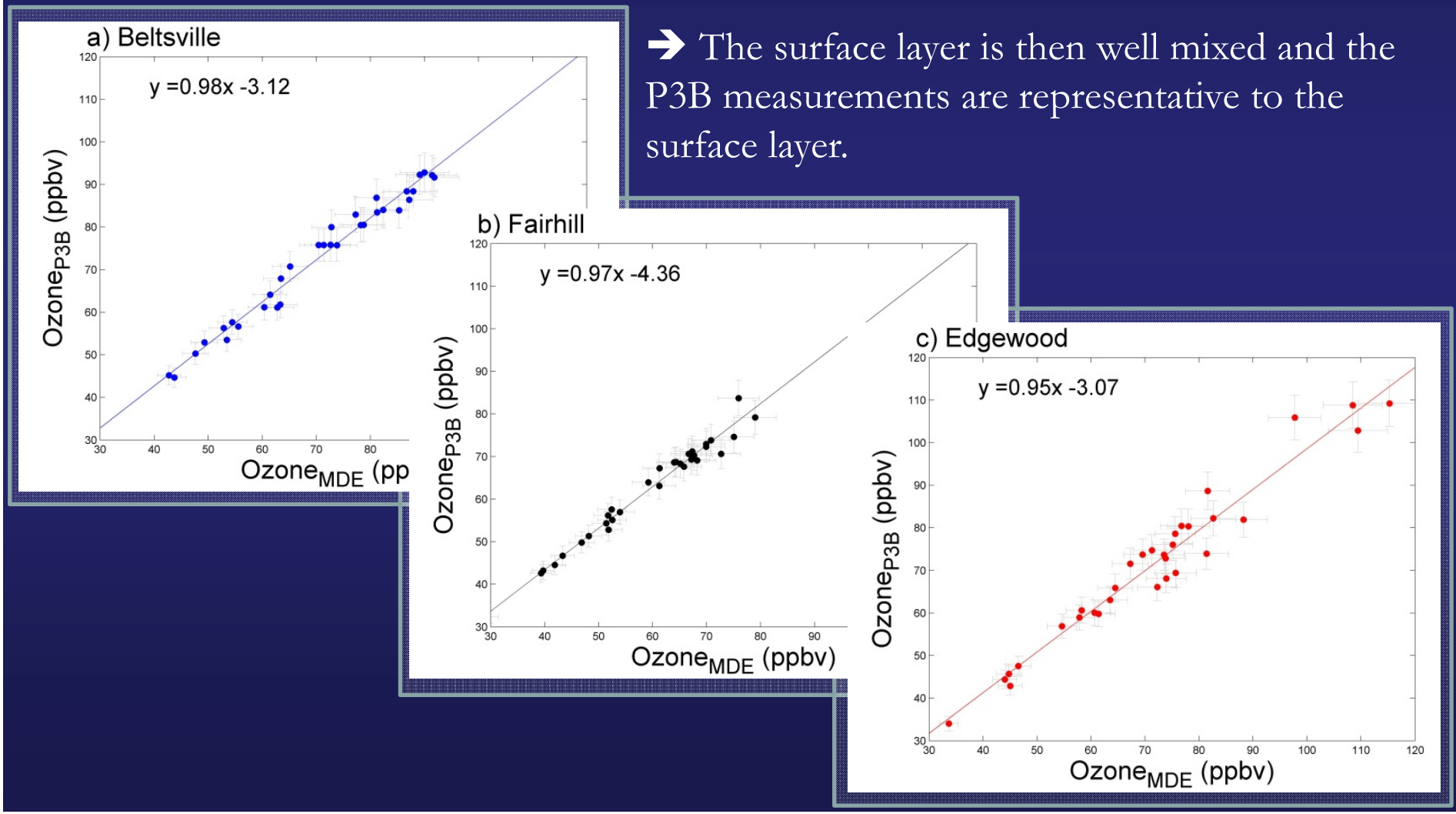




- Confidence in the dry size distribution and the scattering coefficient measurements
- Particle loss in the aerosol inlet are likely negligible
- The hygroscopicity model reproduces $\sigma_{ext,amb}$ quite well.

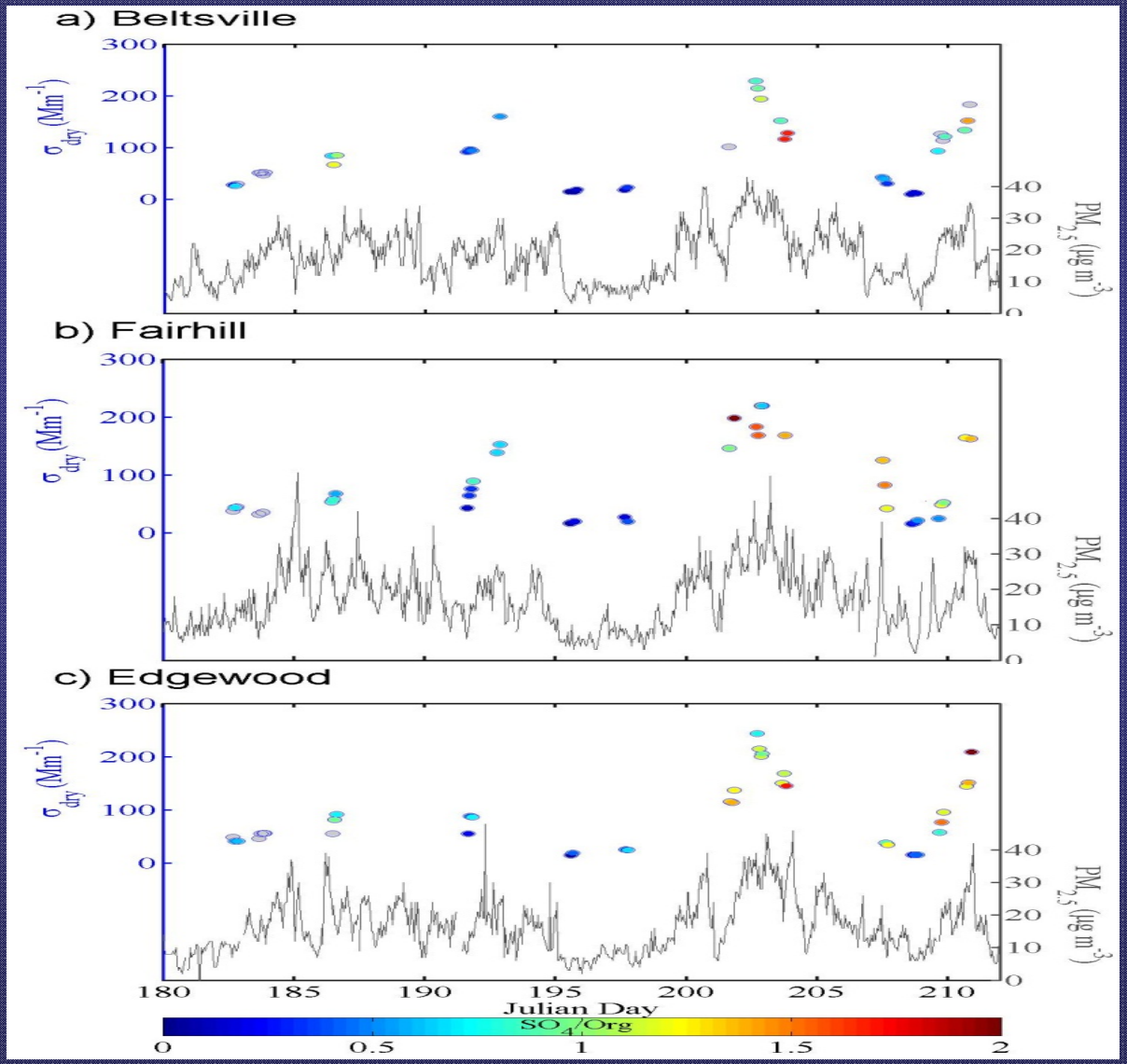
Homogeneity of the BL

- Ozone measured at the lower level of the P3B profiles and at the ground sites are similar



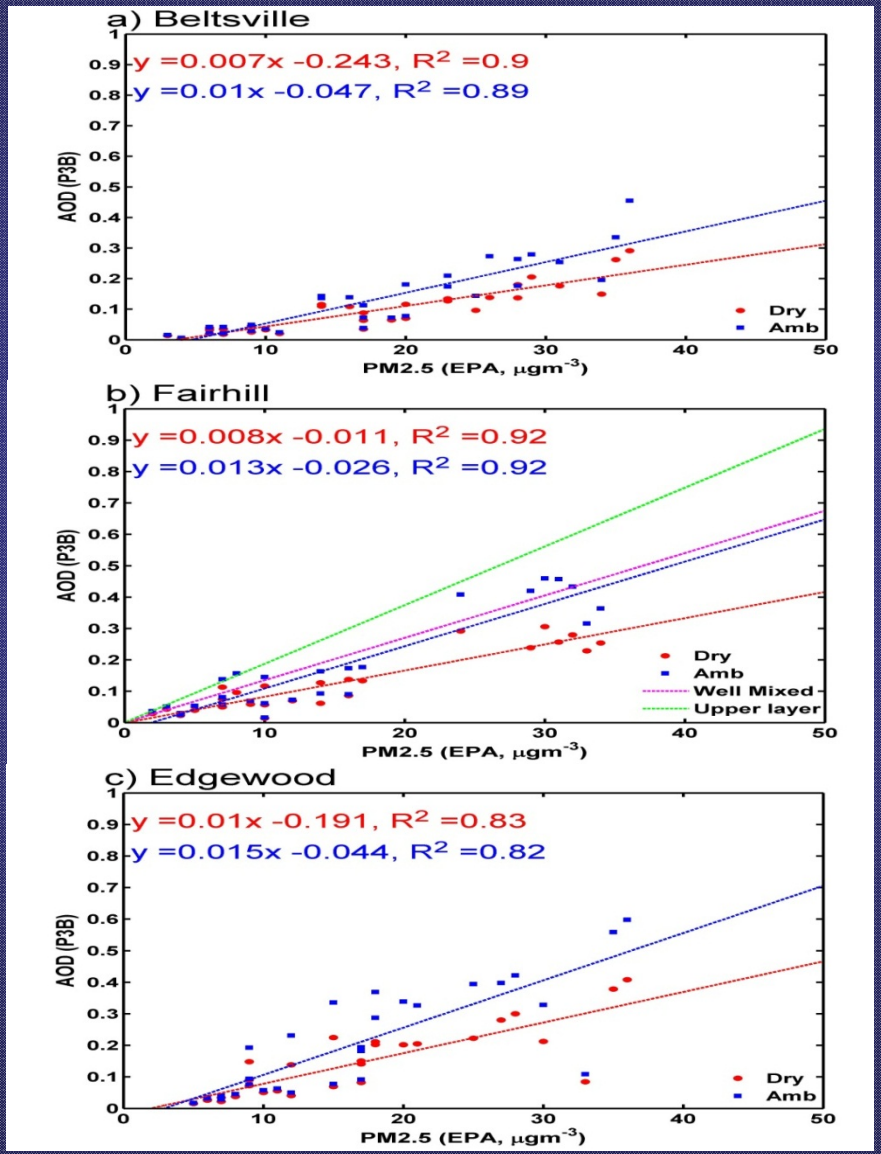
➔ The surface layer is then well mixed and the P3B measurements are representative to the surface layer.

Comparison aircraft (P-3B) with PM2.5 measurements

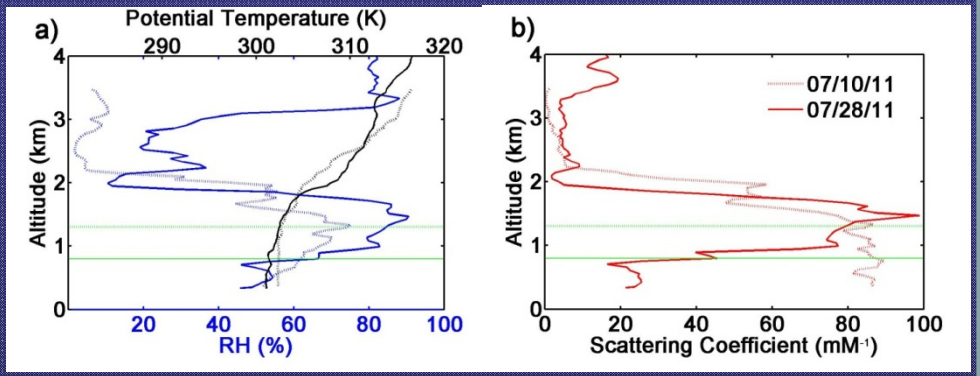


- Time series of PM2.5 and scattering coefficient show a strong relationship : Beltsville and Edgewood ($R^2 > 0.9$) the correlation coefficient is lower at Fairhill ($R^2 = 0.89$)
- High $PM_{2.5}$ are associated with high concentration of sulfate coming from the Ohio river valley (back-trajectories study)

Aerosol Optical Depth (AOD)



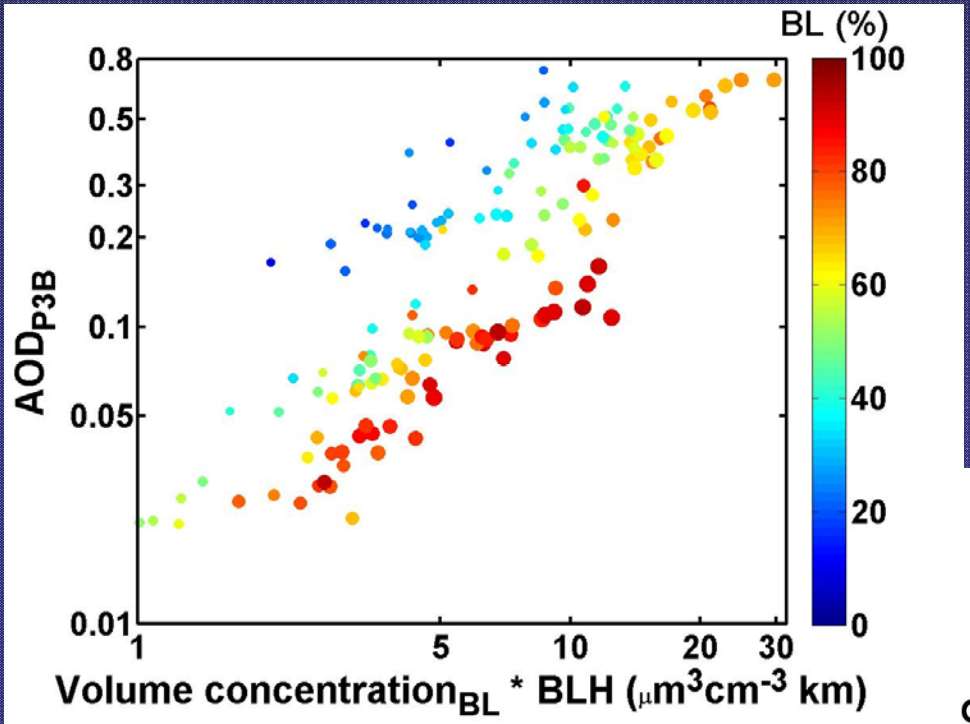
- AOD is calculated from the dry and ambient extinction measured on board the P3B.
- Comparison with the PM2.5 measured in an 30 minutes window
- Correlation coefficients are high >0.82 and corresponding to previous studies on the east coast of US



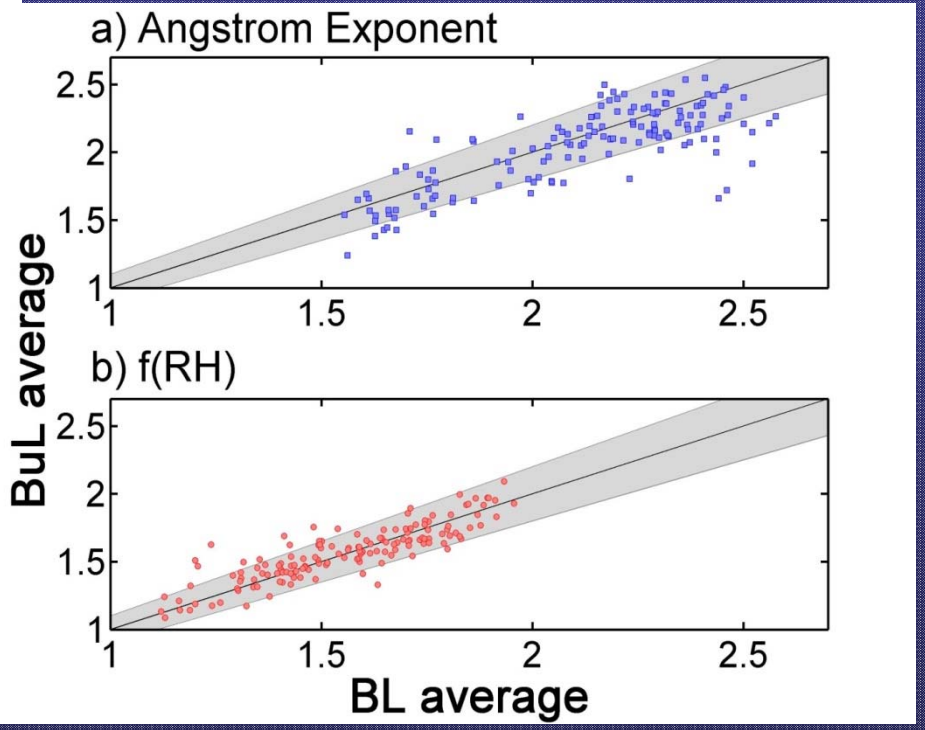
- Different study cases were observed:

- Well mixed layer
- Uplifted layer

Aerosol Optical Depth (AOD): Vertical distribution

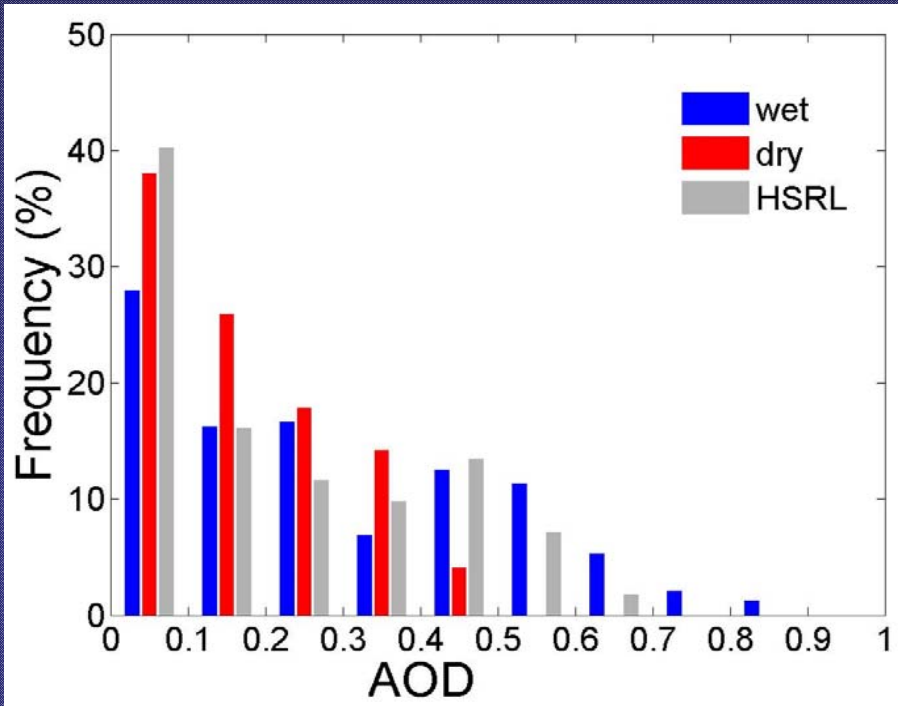


- Knowing the vertical distribution is crucial to determine the air quality from the column integrated measurements



- Most of the cases observed during DAQ are 'Well mixed'
- The BL and the BuL are strongly related and the aerosols are really similar ➔ This explain why the relationship shown before is really strong

Aerosol Optical Depth (AOD): Relative humidity

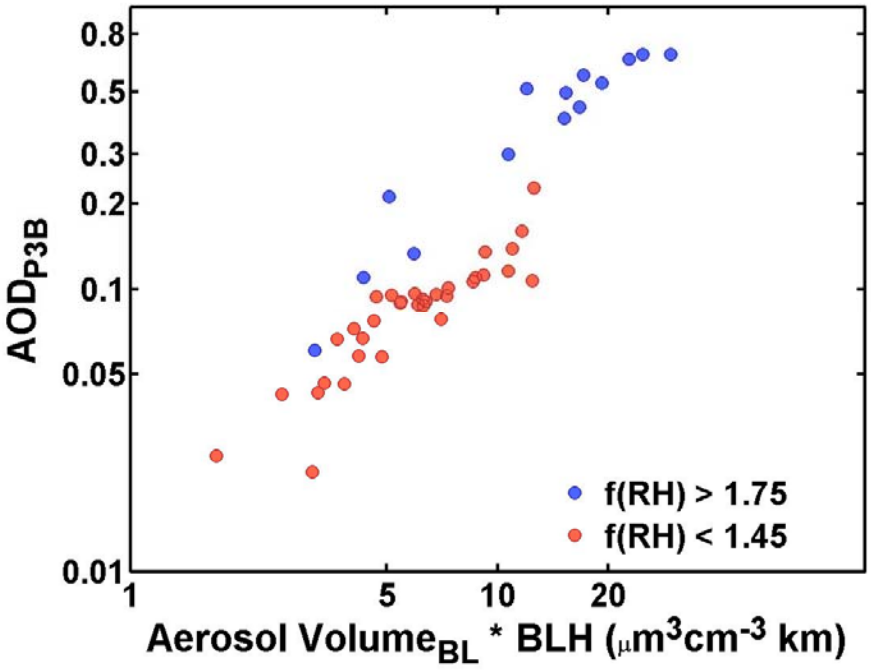


AOD ≤ 0.3 : driven by the aerosol loadings

AOD > 0.4 : ➔ driven by the RH

Taking into account only the cases when the BL contribution > 60 %, the impact of the f(RH) may be studied

The variability of the f(RH) profiles is low ➔ error due to using the RH at the ground 5-8%



Conclusions

- AOD vs PM2.5 gives a good relation but the variability would lead to wrong estimation of the PM2.5
- Including the BLH and the BL contribution show few tendencies → BLH is necessary but not enough the contribution has to be known
- RH at the ground is for this region and this period a good approximation → due to well mixed BL and/or BL and BuL strongly related to each other.
- F(RH) effect is secondary compare to the BL contribution but is still important factor of 2 + vertical variability during DAQ is low so the use of a surface measurement of f(RH). Is this always the case ?