BASIC algorithm evaluation using in-situ measurements from DISCOVER-AQ campaign (2011)

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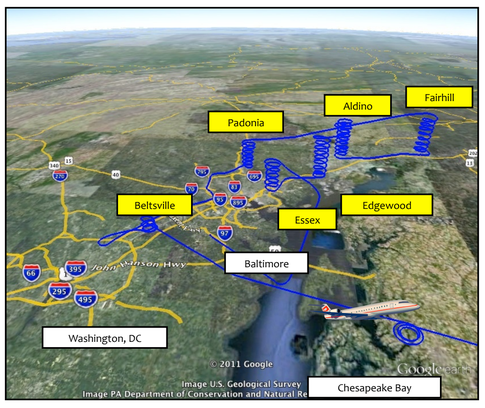
Introduction & Objectives



A challenge for satellites measuring air quality is to distinguish between pollution high in the atmosphere and that near the surface where people breathe. In 2011, NASA began a multi-year airborne field campaign called **D**eriving **I**nformation on **S**urface conditions from **C**olumn and **V**ertically **R**esolved **O**bservations **R**elevant to **A**ir **Q**uality (DISCOVER-AQ) to tackle this challenge.

The objectives of DISCOVER-AQ included :

- Determine the contribution of low level pollution to the AOD
- Examine the AOD contribution of the loadings versus the relative humidity
- Comparison of the ground based and integrated column measurements

247 spirals over the 6 AERONET sites

159 spirals coincident with AERONET measurements (~ one hour window)

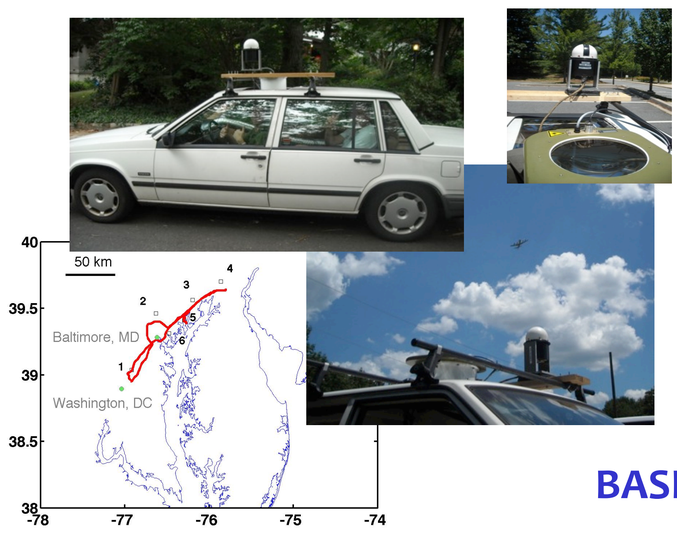
Measurements on the NASA P-3B

- Instruments calibrated before/during/after the campaign
- Data interpolation to the same frequency (1s Merge Files)
- Estimation of the optical properties (AOD, AE, SSA) from the TSI neph 3563

Measured Parameter	Instrument	Size (µm)	Freq (s)
Dry Aerosol Size Distributions Aerosol Volume	TSI - SMPS	0.01 – 0.3	60
	DMT - UHSAS	0.06 – 1	1
	TSI -LAS	0.09 -- 5	1
Dry Total Scattering Coefficient	TSI-3563	< 5	1
f(RH) for Scattering	TSI-3563 (RH~ 80%)	< 5	1
Total Absorption Coefficient	PSAP	< 5	1
Aerosol WSOC concentration	PILS w/Sievers TOC	< 5	10
Aerosol inorganic ion concentration	PILS / offline IC	< 5	240
BC mass concentration	SP2	0.1 – 0.5	1

SMPS – Scanning Mobility Particle Sizer
UHSAS – Ultra-High Sensitivity Aerosol Spectrometer
LAS -- Laser Aerosol Spectrometer
PSAP – Particle Soot Absorption Photometer
PILS – Particle Into Liquid Sampler
TOC – Total Organic Carbon
IC – Ion Chromatography
SP2 – Single Particle Soot Photometer
WSOC – Water Soluble Organic Carbon

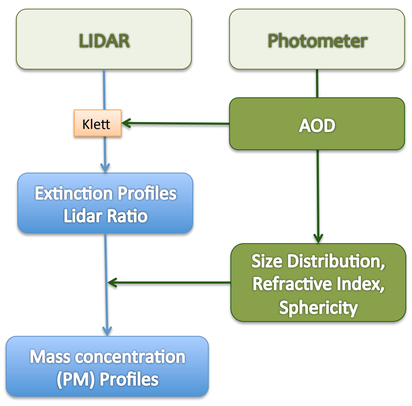
LIDAR and Photometer measurements



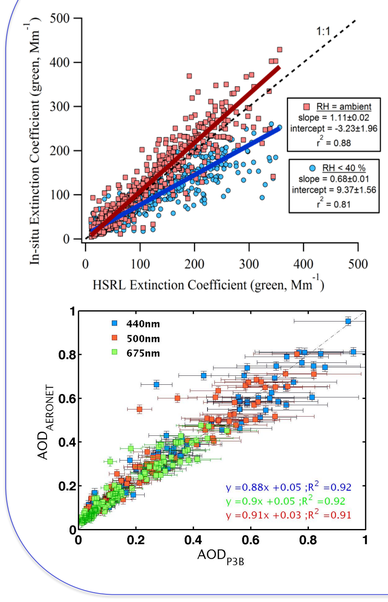
LOA, part of the DRAGON project, equipped a car with a Lidar and photometer (PLASMA).

BASIC algorithm

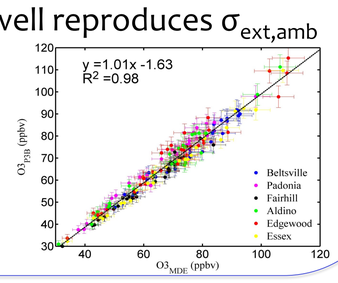
- Corrections are applied to Lidar measurements (Overlap, After-Pulse, etc…)
- Range Corrected signals = input into "BASIC" algorithm (BL, Top Layer heights (Wavelet) and a cloud detection)
- Klett inversion constrained by AOD ➔ Ext. profiles & Lidar ratio (Ext. to Bkscatter Ratio)



Validation of the in-situ measurements



- NOT SHOWN : Measured dry scat. coeff. vs Modeled scat. Coeff. from size distribution ➔ slope = 0,99 et R^2 = 0,98 (**Ziemba et al., 2012**)
- HSRL and AOD vs in-situ measurements ➔ Particle loss in the aerosol inlet are negligible Hygroscopicity model well reproduces $\sigma_{ext,amb}$



- Ozone conc. from P-3B vs ground ➔ BL homogeneity

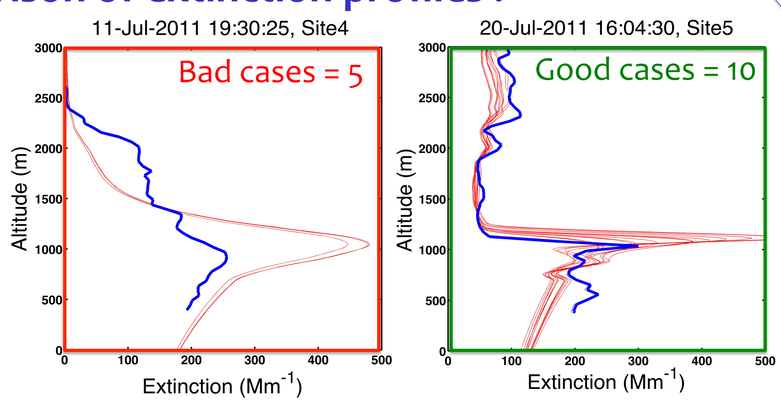
Comparison of extinction profiles :

15 profiles available for comparison with in-situ meas.

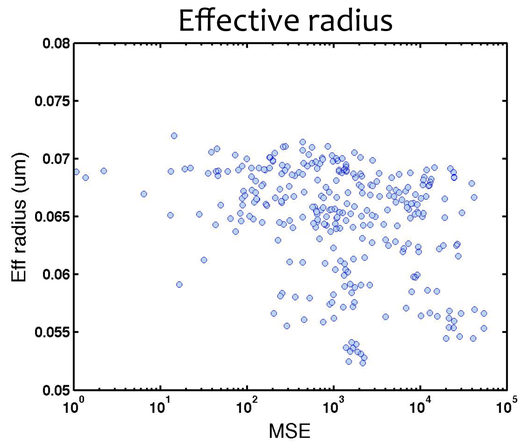
➔ 66% of good Extinction retrievals

Mean Square Error (MSE) :

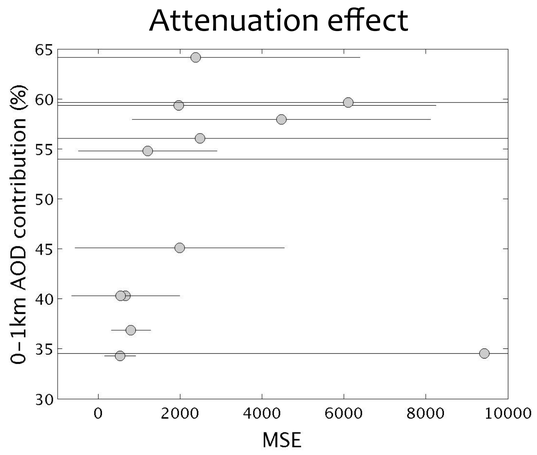
$$\mathrm{MSE} = \frac{1}{n}\sum_{i=1}^{n}(\hat{Y}_i - Y_i)^2$$



Impact on retrieval's quality



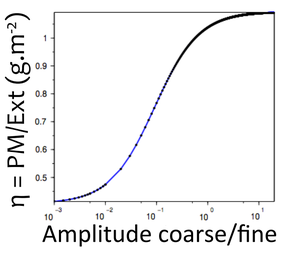
Cases with smaller particles are always related with high MSE



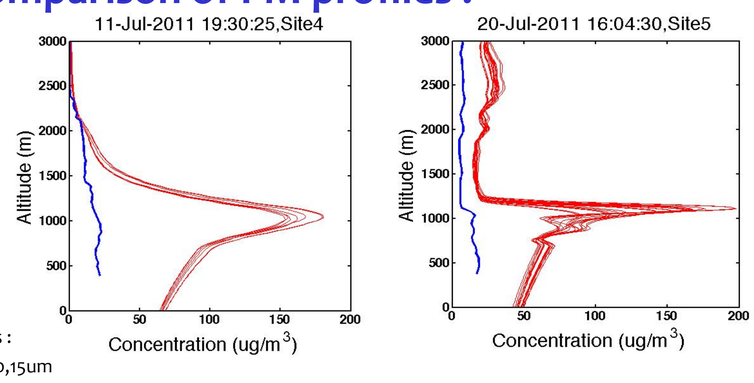
The MSE is not related to the contribution of the lower layers.

Comparison of PM profiles :

Large overestimation of the PM profiles by BASIC ➔ due to non accurate AERONET SD ?

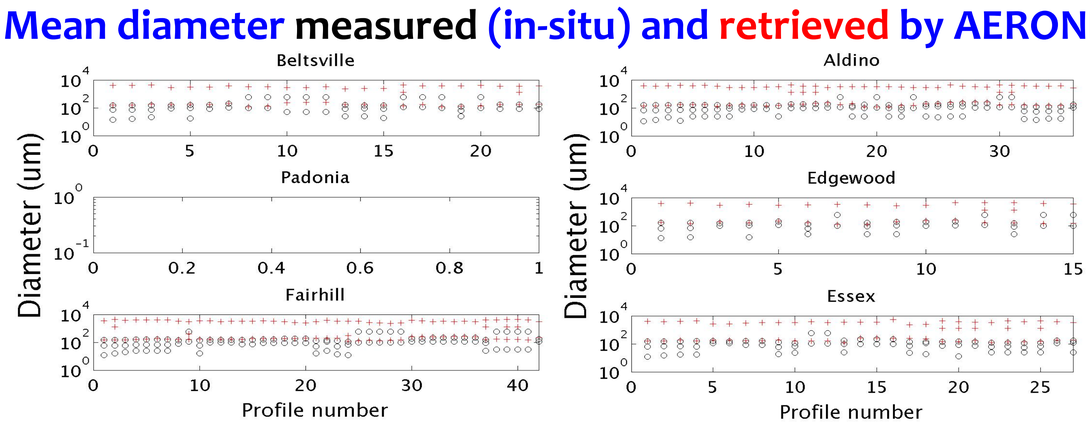


Inputs :
$R_{m,f}$ =0,15um
σ_f = 0,05
$R_{m,c}$ =1,5um
σ_c = 0,05
ρ = 2.6 kg.m^{-3}
Mortier, 2013



Sensitivity calculations show that η is largely dependent on the coarse mode volumic contribution

Mean diameter measured (in-situ) and retrieved by AERONET



Coarse mode always retrieved by AERONET but never measured.

Conclusions :

DAQ is a unique oportunity to test and validate the algorithm retrievals (Data are free of use)

BASIC is doing a great job to retrieve the extinction coefficient not so well for the PM

Need to isolate parameters that causes BASIC discrepancies

Future Work :

Applying this code to satellite measurements

Test other algorithms (GARLIC, LIRIC, GRASP …)

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