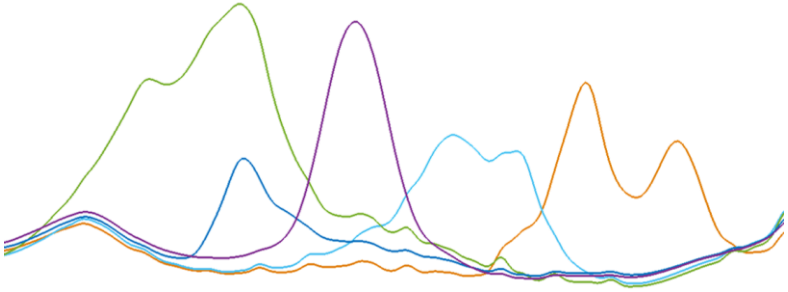
CARBONACEOUS AEROSOL MEASUREMENTS ON SPARTAN FILTER SAMPLES



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UCDAVIS AIR QUALITY RESEARCH CENTER

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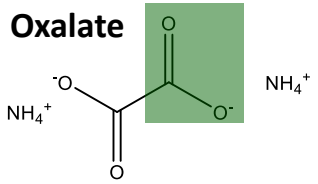
Carbonaceous aerosol measurements in SPARTAN

- Organic carbon (OC) and elemental carbon (EC)
  - IMPROVE, U.S. monitoring network, measures EC and OC
    - Thermal Optical Reflectance (TOR)
    - Quartz Filters, destructive analysis
  - SPARTAN collects only Teflon filters for multiple measurements
- **FT-IR** - reproduce TOR OC and EC on Teflon filters
  - Inexpensive and non-destructive
  - Uses ambient OC and EC data to calibrate FTIR
  - Method developed for IMPROVE (Debus et al., 2022)
  - TOR OC and EC - one year at select MAIA sites to improve SPARTAN and MAIA measurements
- **HIPS**
  - IMPROVE measures light absorption, related to EC or BC
  - measure light absorption on SPARTAN and MAIA filters

More Carbonaceous Aerosol Information: Functional Groups and OM

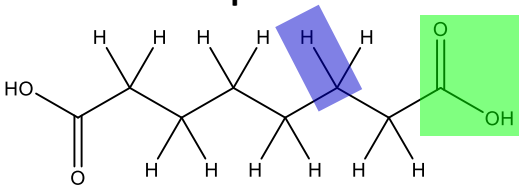
- TOR measures carbon only, assume OM/OC to get OM or OA
- FT-IR measures functional groups
- Weighted sum of functional groups for organic matter (OM)

Oxalate



Ammonium oxalate

Aliphatic C-H

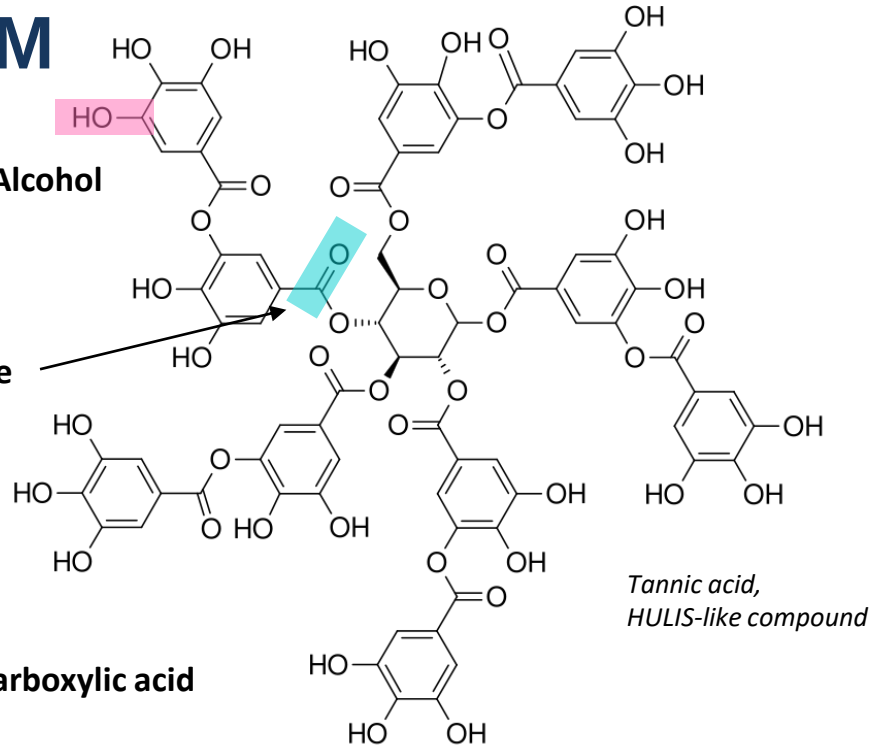


Suberic acid

Alcohol

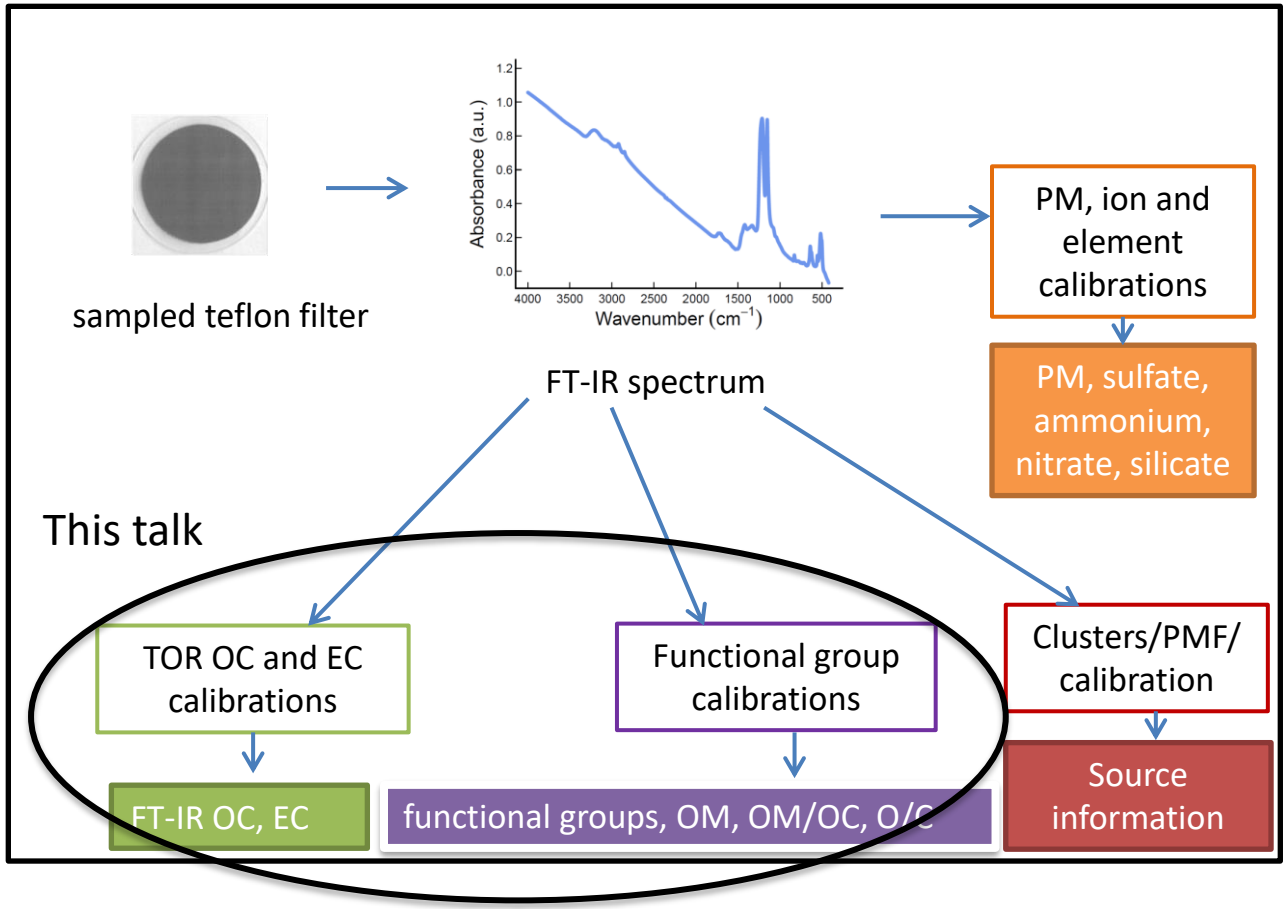
Non-acid, non-oxalate carbonyl

Carboxylic acid



Tannic acid, HULIS-like compound

FTIR measures carbonaceous aerosol from Teflon filters



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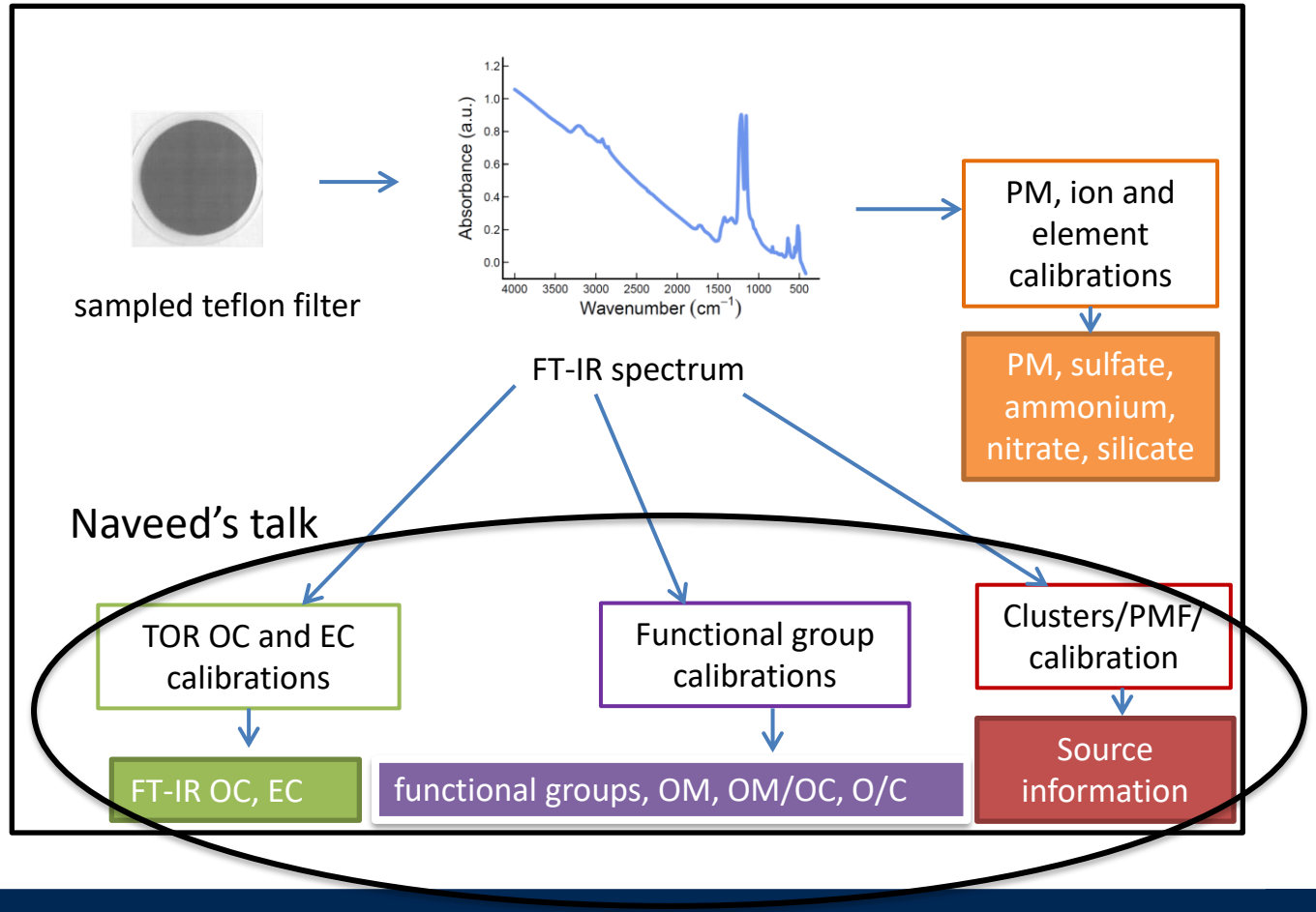
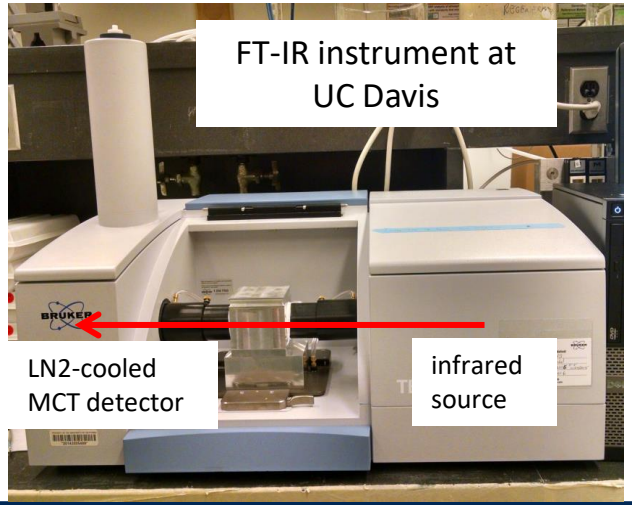


FT-IR lab in Air Quality Research Center At UC Davis

IMPROVE Teflon
Filter in FT-IR holder



FT-IR instrument at
UC Davis

LN2-cooled
MCT detector

infrared
source

- Routinely analyze Teflon filters by FT-IR
  - SPARTAN ~2000 filters since 2018
  - MAIA ~150 samples since 2022
  - IMPROVE ~130,000 filters since 2015
  - CSN ~75,000 filters since 2017-2022
  - SEARCH ~5000 filters (2009-16)
  - Lab studies and field campaigns
- Methods
  - 5 minutes per filter, ~40 hrs/wk
  - 3 FT-IR instruments
  - Weekly QC
  - Analyzed prior to XRF (Wash U)

Light Absorption

Analysis performed by HIPS

Hybrid Integrating Plate/Sphere

Absorptance: $A = 1 - T/(1 - R)$

HIPS data reported as inferred atmospheric absorption coefficient:

$$Fabs \equiv \frac{f}{V} ln\left(\frac{1 - r}{t}\right)$$

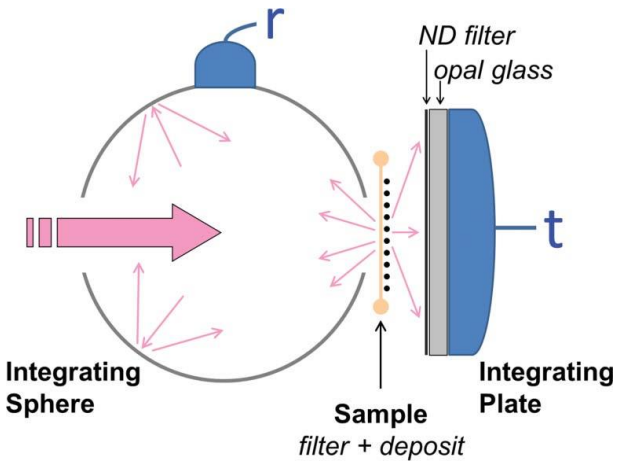
f = filter deposit area,

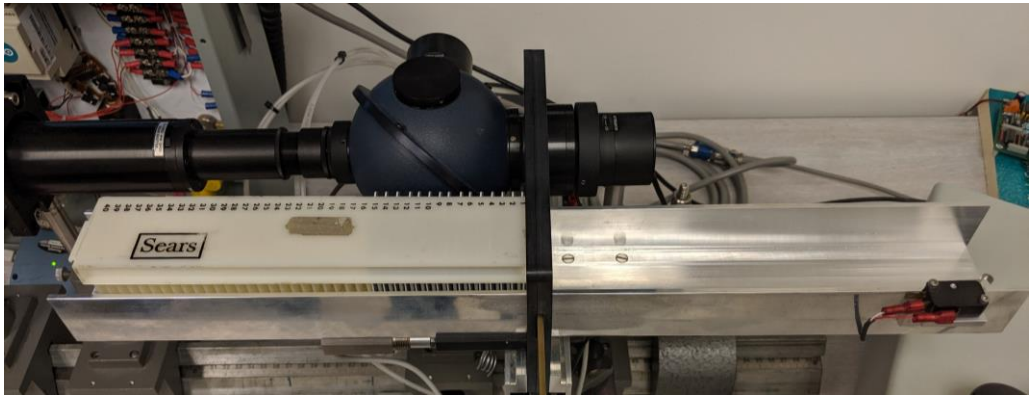
V = volume of air sampled

Fabs reported in units of $(Mm)^{-1}$

IMPROVE samples since 1988

SPARTAN samples since 2018

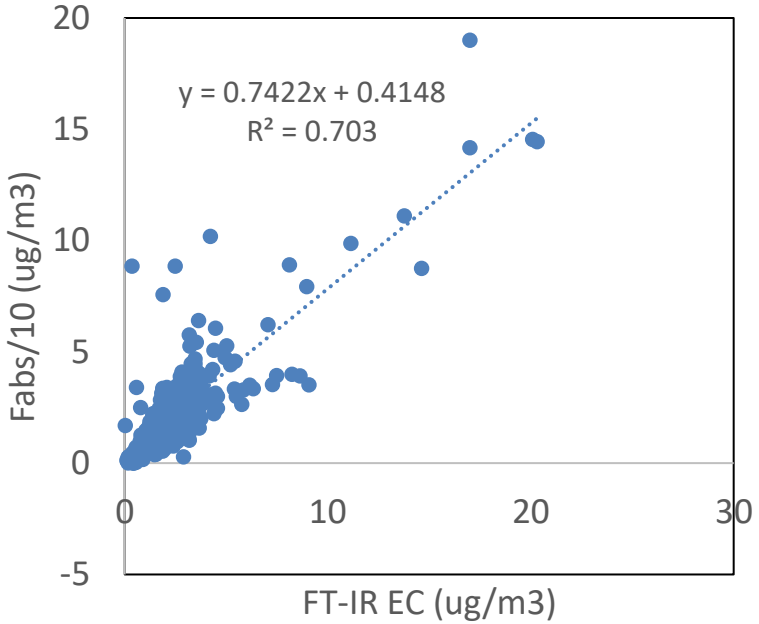




White, W. H., Trzepla, K., Hyslop, N. P., Schichtel, B. A. 2016. Aerosol Science and Technology, 50:9, 984-1002.

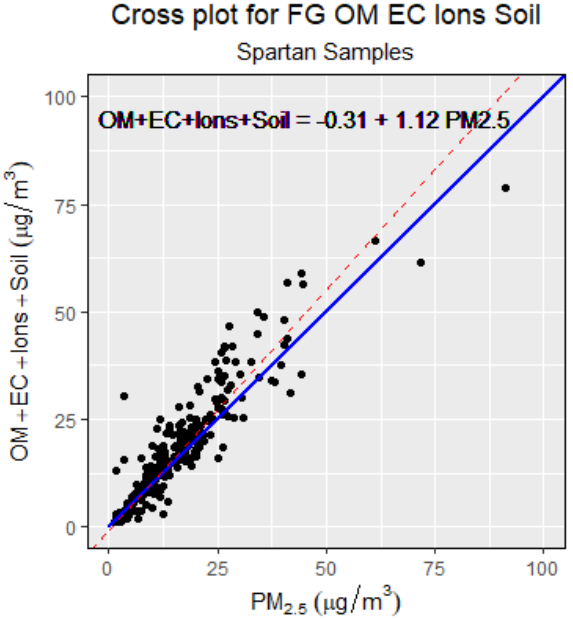
Relationship between light absorption and EC

- Light absorption caused by
  - EC (primarily)
  - Fe
  - Some organics
- Light absorption efficiency varies with composition
- Convert Fabs to μg/m^3 EC
  - Assume absorption efficiency of 10
- Useful to QC FT-IR EC measurements



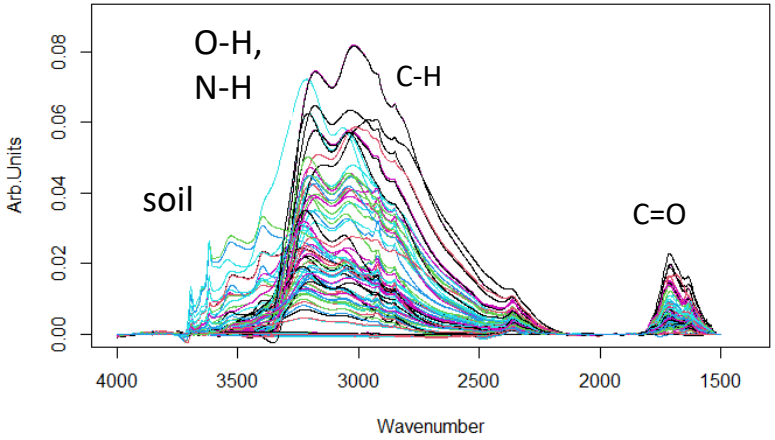
QC for functional groups and OC

- Unlike EC, OC has no independent measurement for QC
- Compare sum of components to mass
- Figure suggests some over prediction of functional groups
- Working to improve functional groups, especially sites with high soil and high nitrate

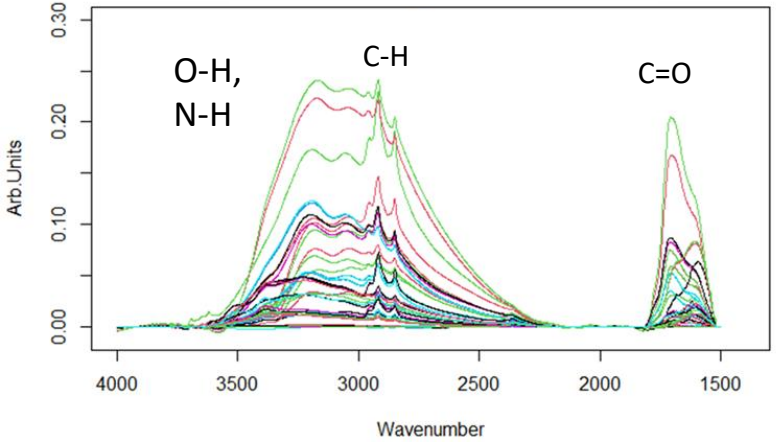


FT-IR spectra of SPARTAN samples

Rehovot, Israel

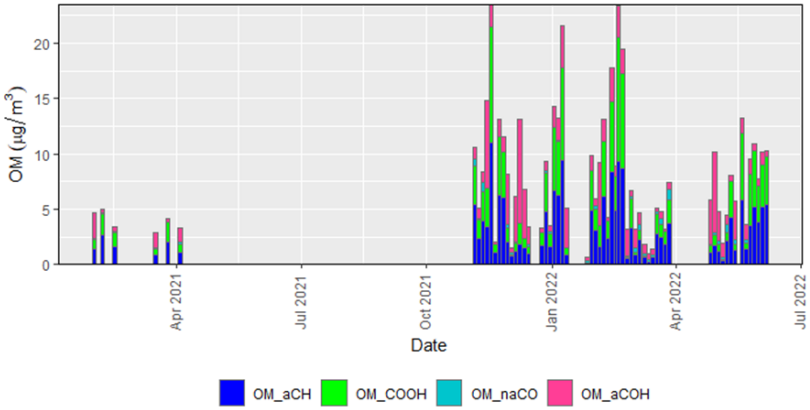


Dhaka, Bangladesh

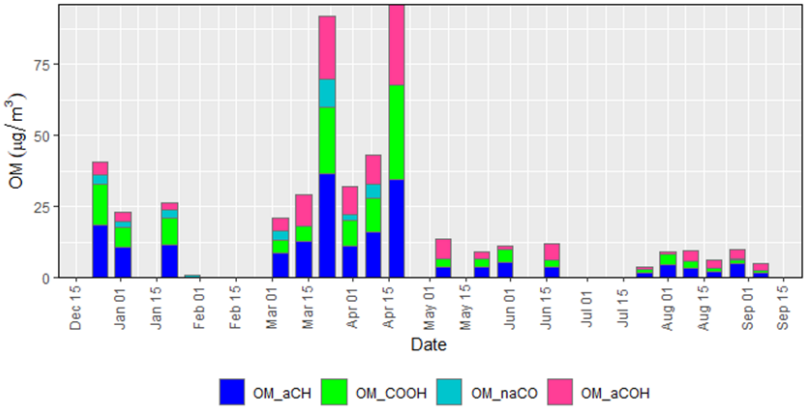


Functional Group Measurements

Rehovot, Israel, Jan 2021 – June 2022



Dhaka, Bangladesh, Jan 2021- Sept 2021



Measuring Carbon by FT-IR and HIPS for SPARTAN

- FT-IR and HIPS are non-destructive, fast, low-cost method
- Use Teflon filter (SPARTAN sampling)
- Measure organic carbon and elemental carbon
    - OC and EC using FT-IR
    - Calibrate to IMPROVE, next calibrate to MAIA TOR samples
- Measure light absorption for optical measurement and to QC FT-IR EC
- Measure organic functional groups
    - Same FT-IR spectra as OC and EC
    - Composition of OM
    - Sources