Mobile observations in North China Plain during MOABAI campaign

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Photography encouraged

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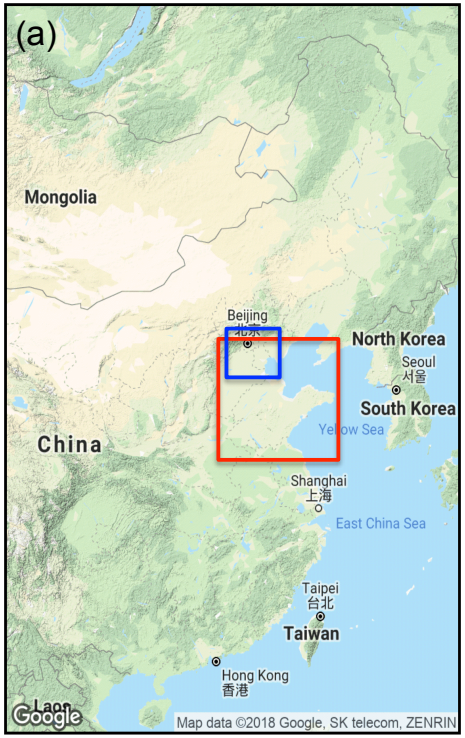
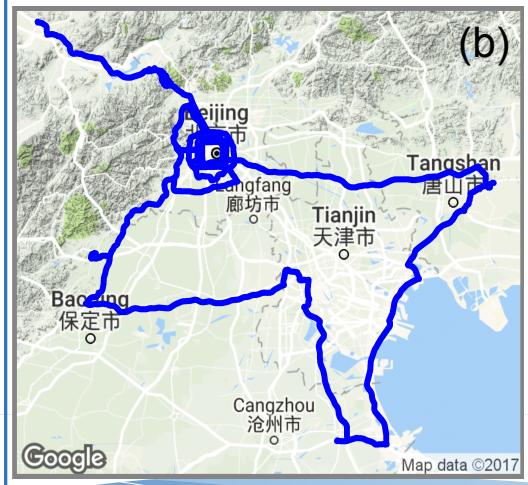
MOABAI campaign

May 2017

Mobile **O**bservation of **A**tmosphere **B**y vehicle-borne **A**erosol Measurement **I**nstruments





Why North China Plain?

- one of the **most populated and polluted regions** of China, where long-standing **heavy pollution** episodes frequently occur
- **lack of simultaneous in-situ and remote sensing** measurements of aerosols and trace gases **at fine spatial and temporal scale**
- **few aerosol observations** sites in the region, more in situ than remote sensing instruments

Popovici et al., in prep.

MOABAI campaign

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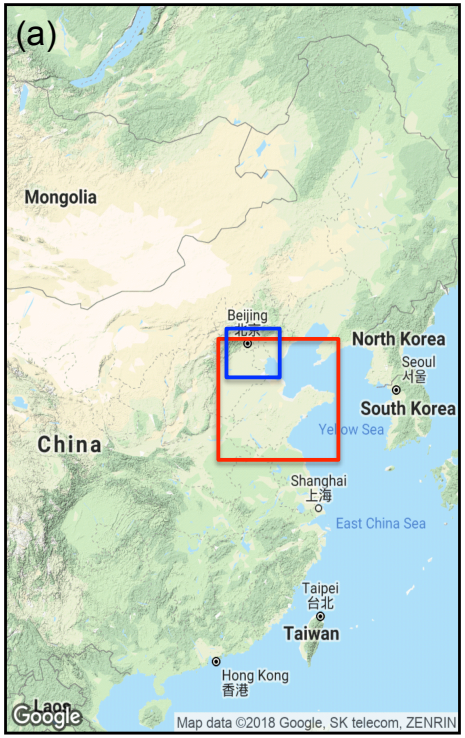
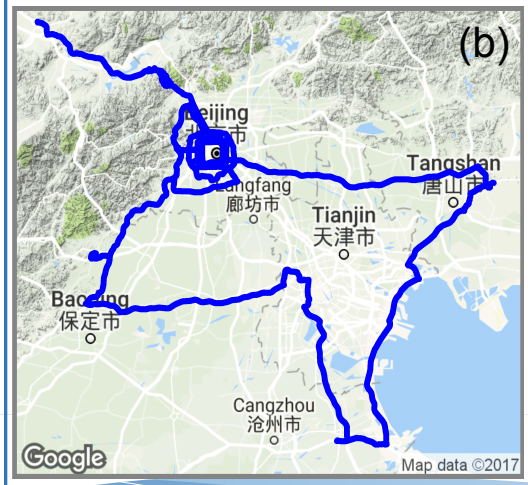




Scientific interests

- get **comprehensive characterization** of aerosol properties and their vertical distribution in **highly variable atmospheres** (clean, heavy pollution, dust transport)
- **couple in situ and remote sensing** for a full characterization of aerosol properties and get vertical profile as close to the surface
- show interest of **mobile system for variability studies**
- capture signatures of **regional transport** of aerosols and **sources**
- provide observations for **assimilation in models** and **satellite data validation**

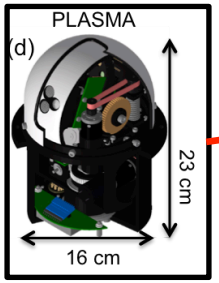
Mobile observations, 9-21 May 2017

- 6 days in Beijing on the $4^{th}/5^{th}/6^{th}$ ring-roads (daytime and nighttime)
- 4 days outside Beijing (Baoding, Tianjin, Tangshan, Xiahuayuan)

Popovici et al., in prep.

Van and instrumentation

MAMS (LOA/France)
Mobile Aerosol Monitoring System
Popovici et al., 2018, AMT



LOA/CIMEL

LAGEO/IAP/CAS

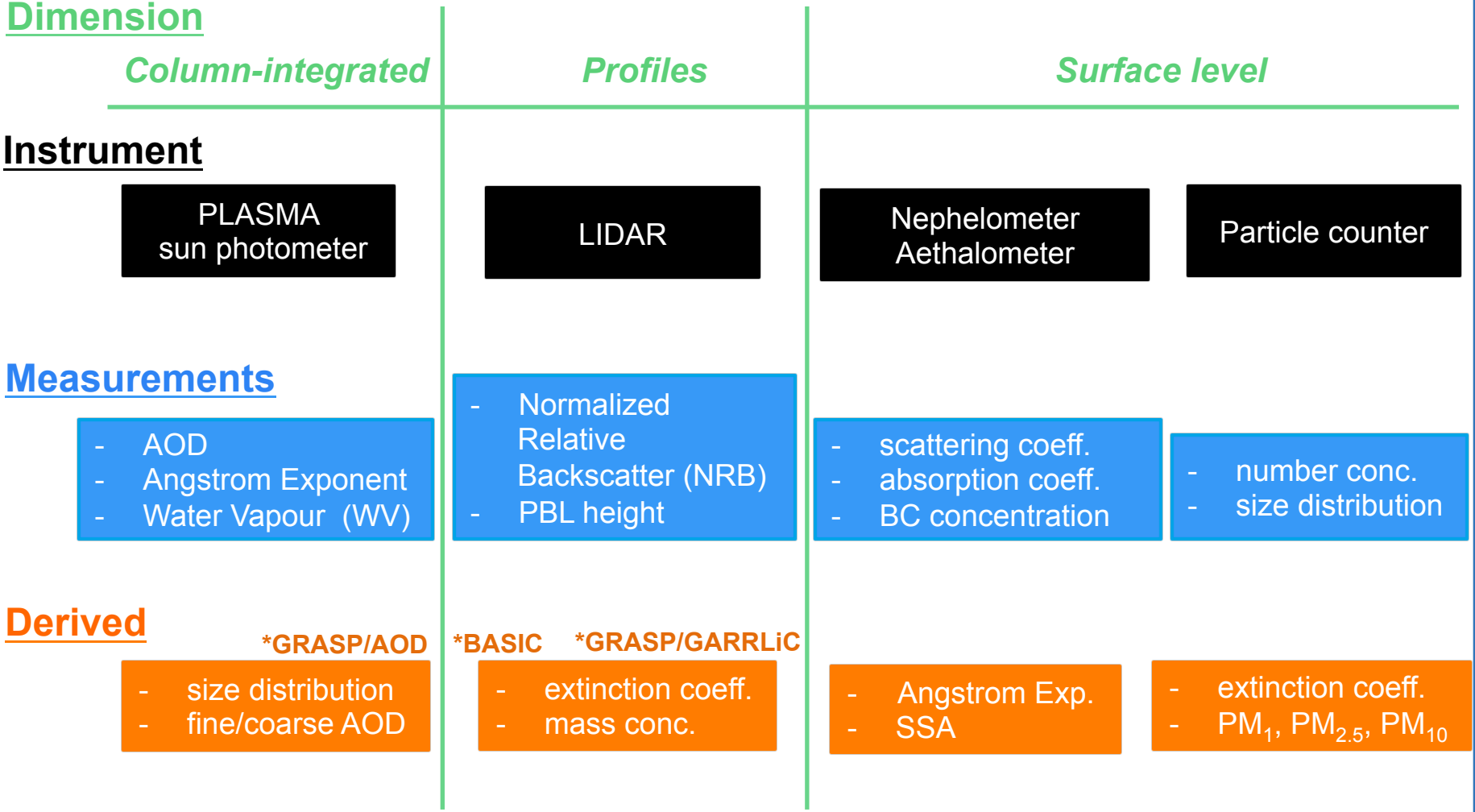
- Cimel CE370 micropulse LIDAR (532 nm, eye-safe)
- PLASMA sun photometer (339, 379, 440, 500, 674, 870, 940 1019 and 1643 nm)

follows standard calibration protocol and is included in AERONET

performs only direct sun measurements

- polar nephelometer (Aurora 4000, Ecotech) (450, 535 and 635 nm)
- aethalometer (AE33, Magee Scientific) (370, 470, 520, 590, 660, 880 and 950 nm)
- optical particle counter (Sky-OPC, Grimm) (0.25-32 μm diameter, 31 channels)
- trace gas analysers (NO_2, SO_2, O_3)
- weather station (p, T, RH)

Aerosol properties and methodology

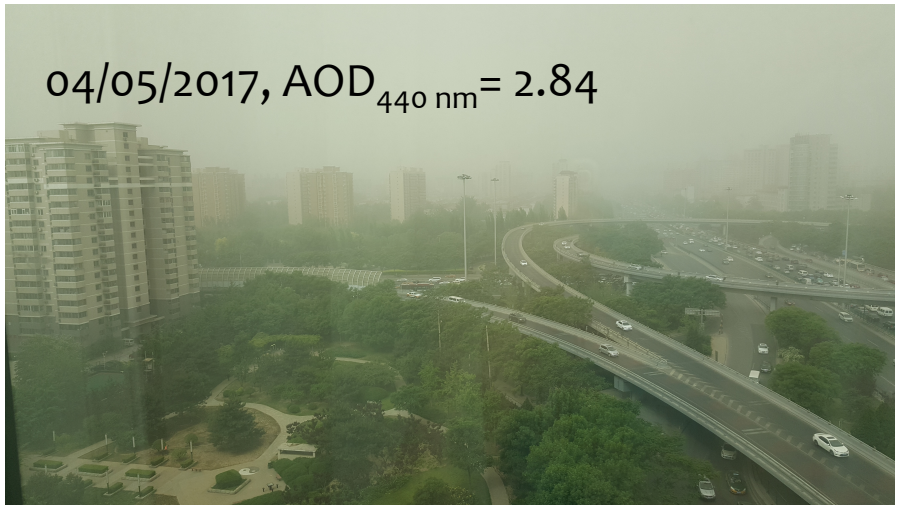


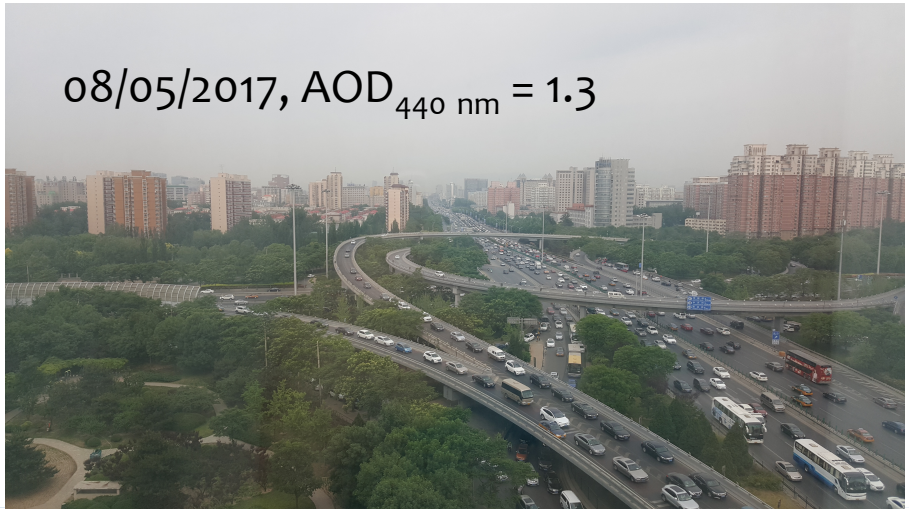
*BASIC – (Mortier, 2013), (Popovici et al., AMT 2018)

*GRASP – Generalized Retrieval of Aerosol and Surface Properties (Dubovik et al., 2011, 2014)

*GRASP/AOD – (Torres et al., AMT 2017) *GRASP/GARRLIC – (Lopatin et al., AMT 2013)

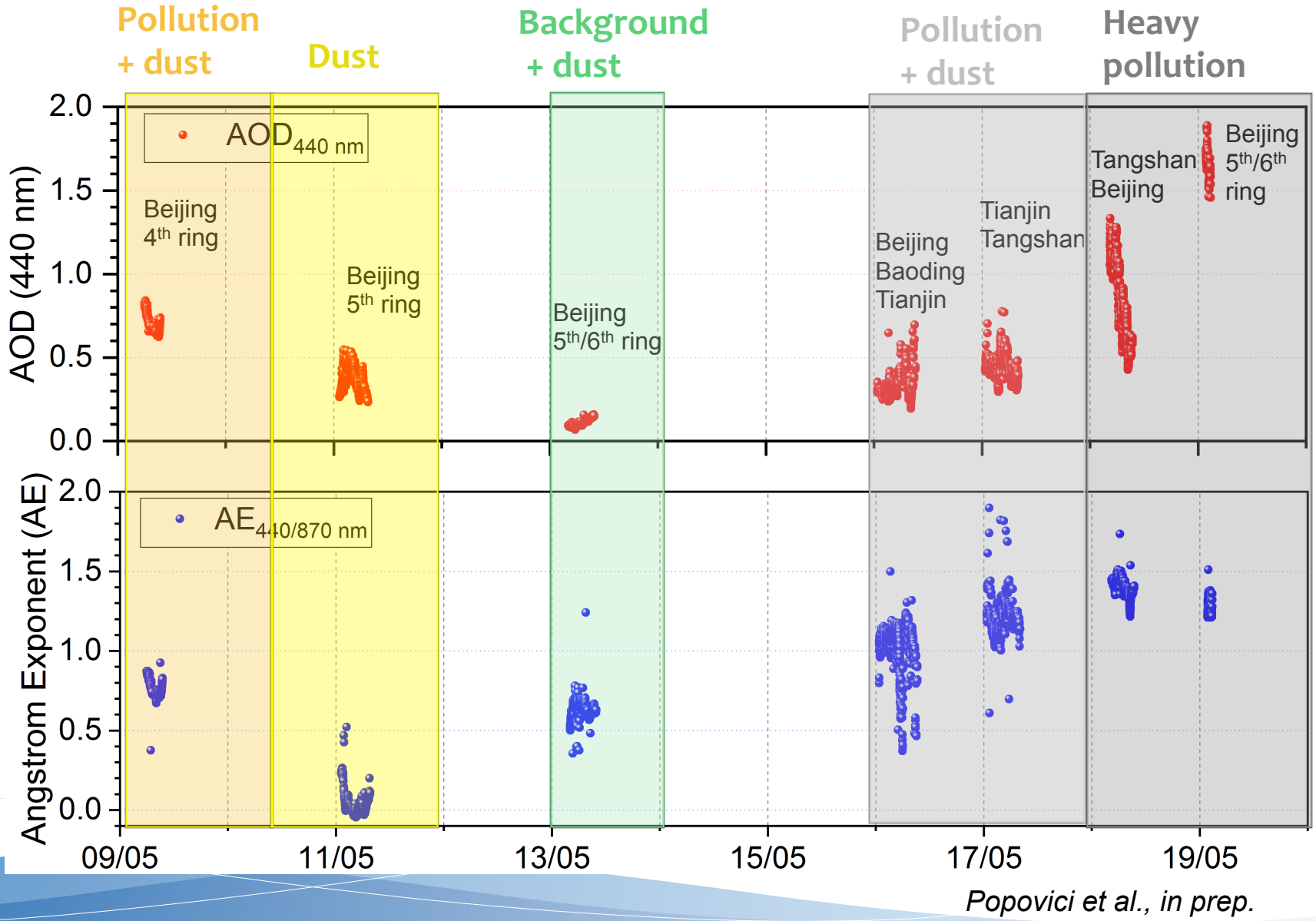
Aerosol variability during MOABAI





One week in Beijing

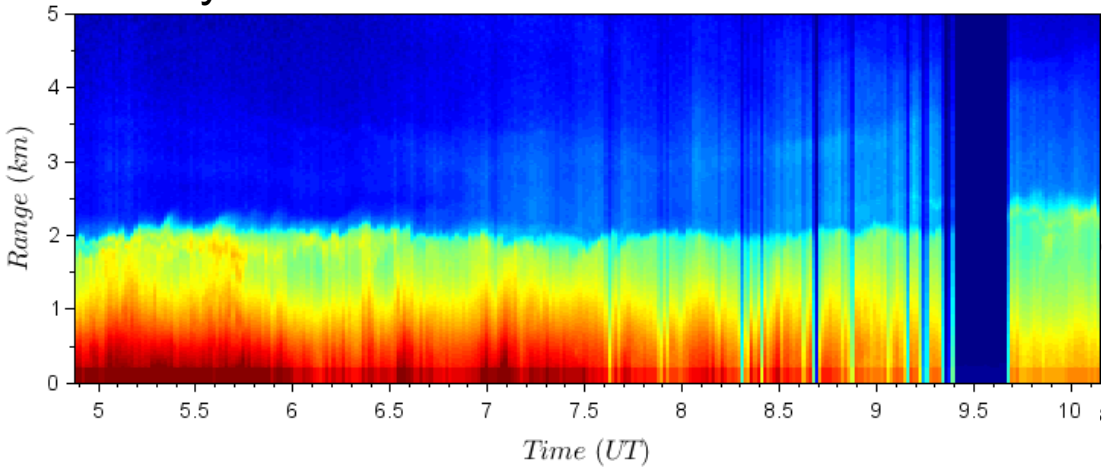
Aerosol variability during MOABAI

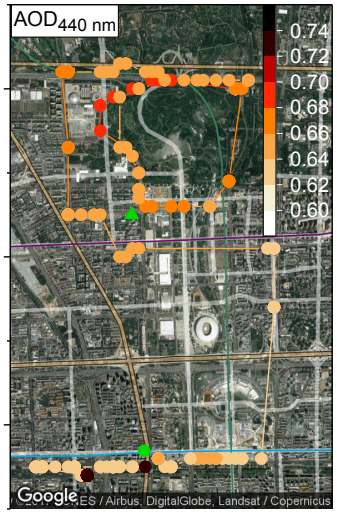


Popovici et al., in prep.

Vertical and spatial variability of aerosols
BEIJING

9 May 2017



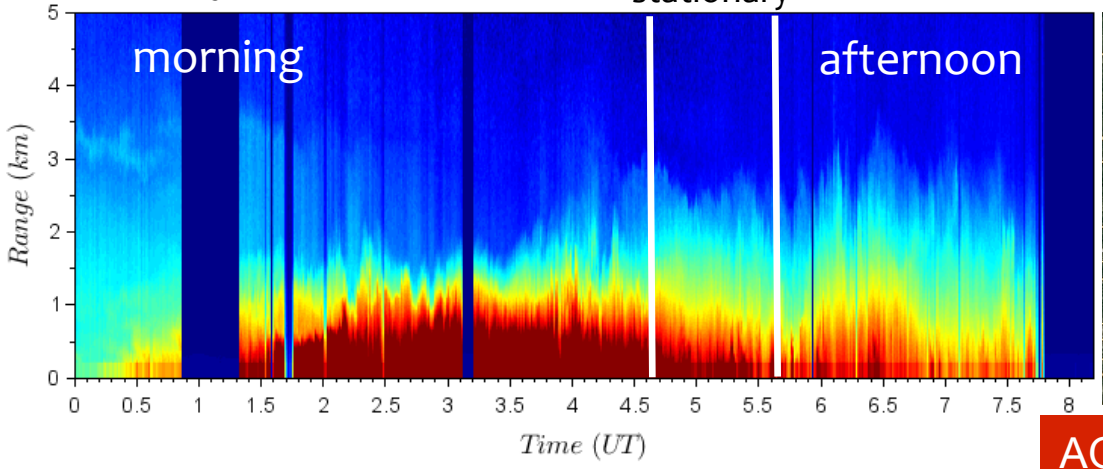


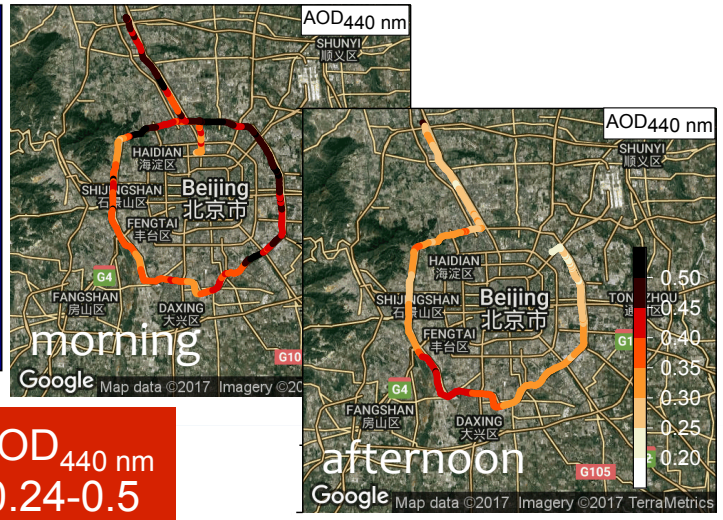
AOD$_{440\ nm}$
0.62-0.7

AE
0.6-0.8

11 May 2017

stationary



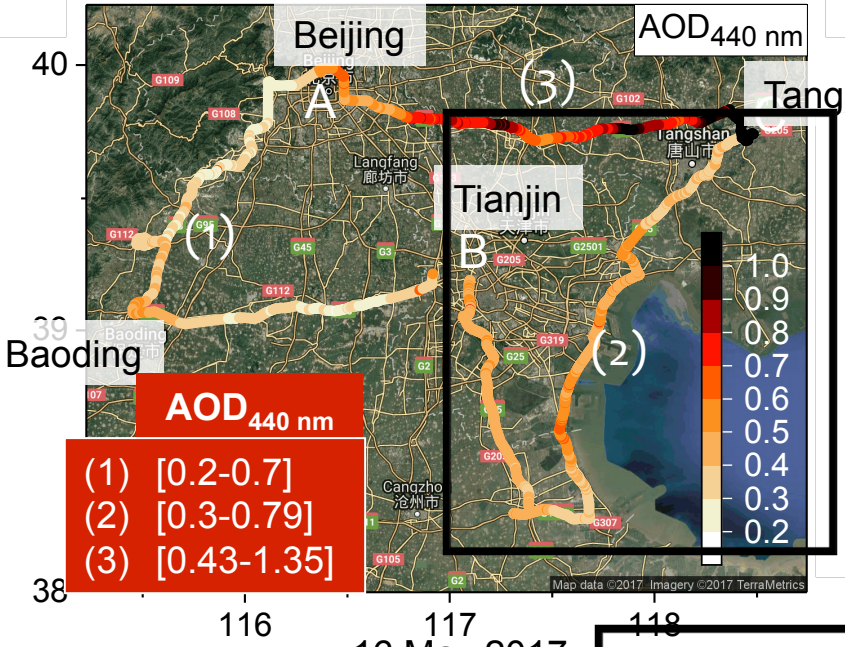


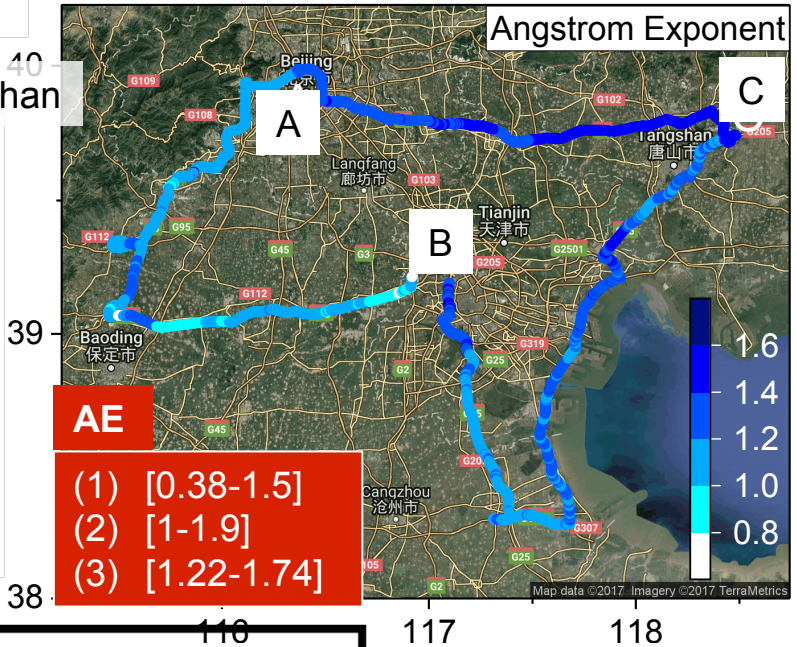
AOD$_{440\ nm}$
0.24-0.5

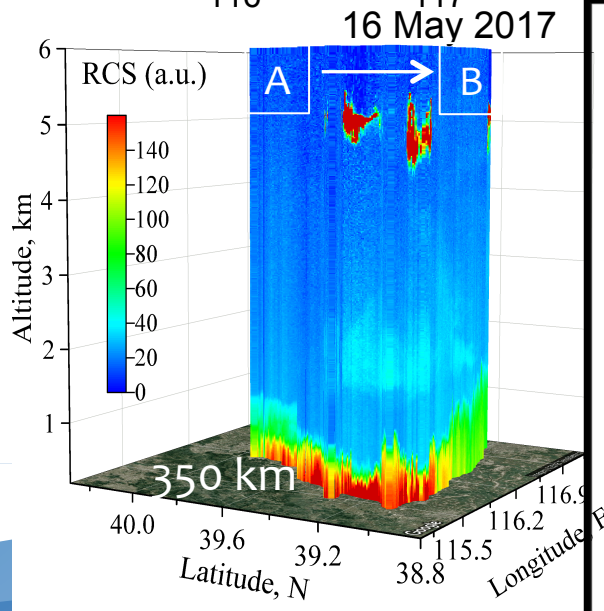
AE < 0.2

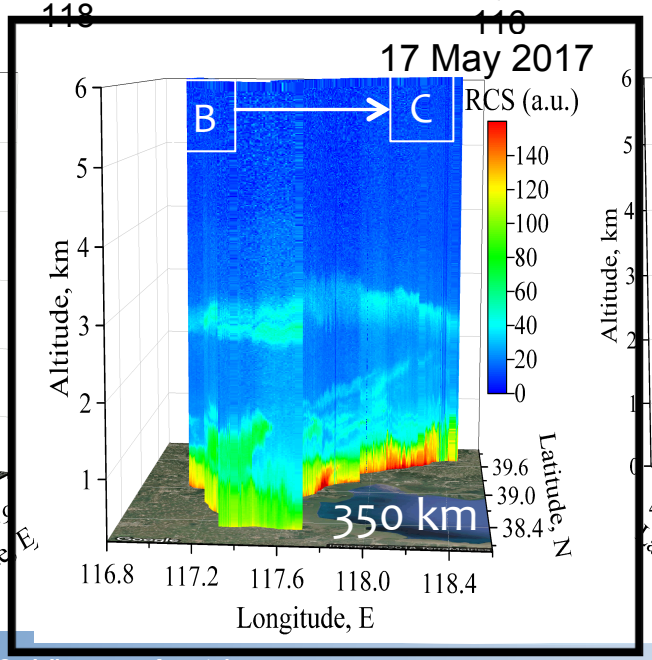
Popovici et al., in prep.

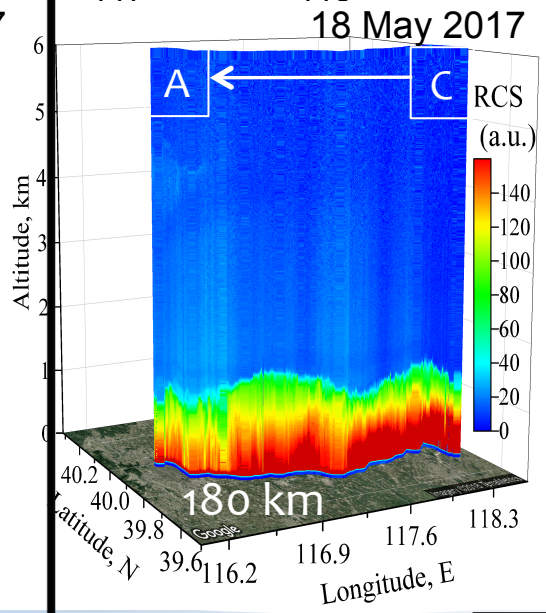
Variability along Beijing-Baoding-Tianjin-Tangshan











Popovici et al., in prep.

Binhai New Area

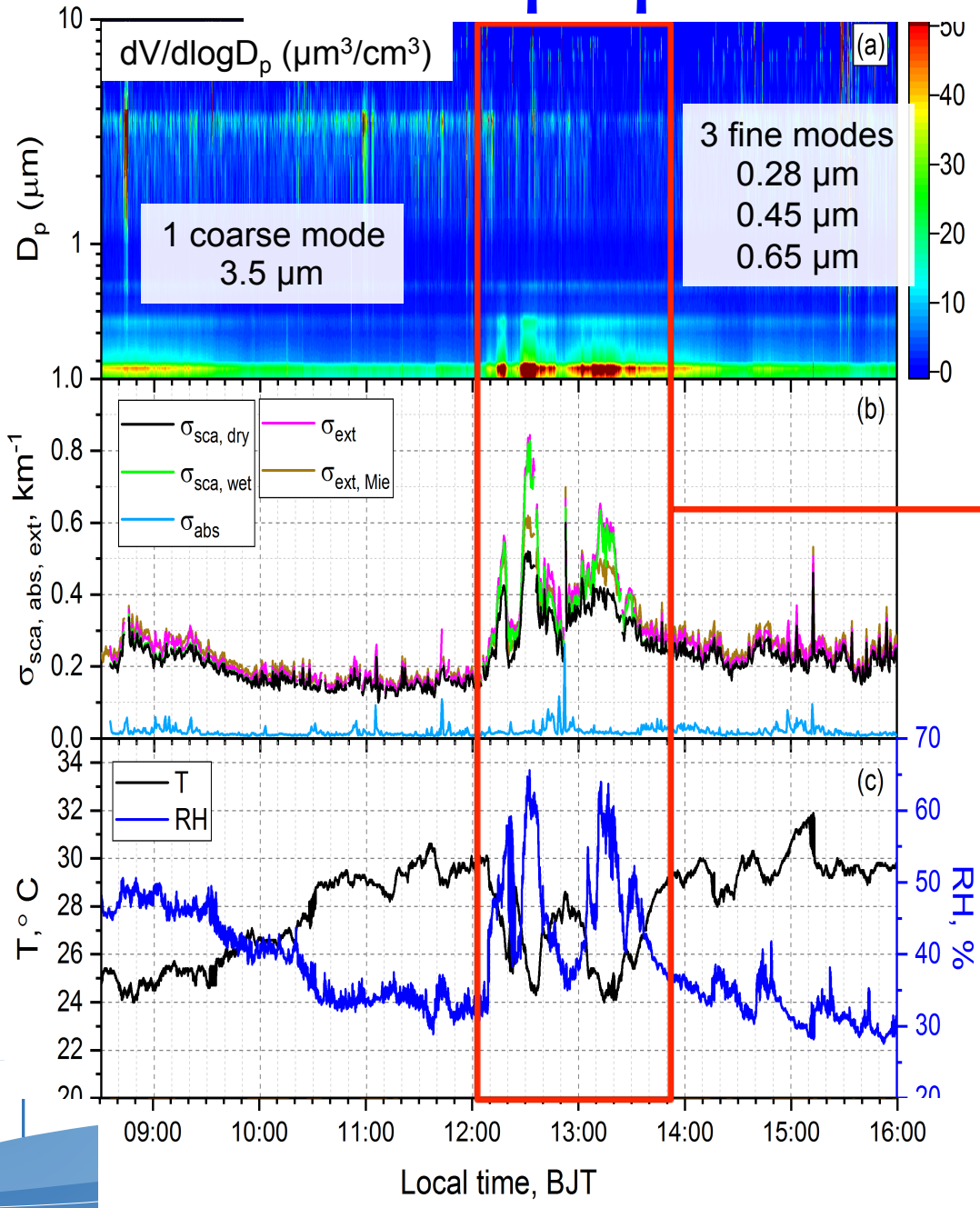
Coastal landscape map of Tianjin Binhai New Area in 2013 showing the location of salt pans (pink), urban land (red) and harbour (dark red) (from Wang et al. (2015))

- Founded to promote the economic growth of Tianjin; composed of former districts of Tanggu, Hangu and Dagang and part of the Dongli and Jinan District
- The area accounted 271 industrial enterprises in 2012, resulting in heavy pollution in the region (Kong et al., 2010; Su et al., 2017)
- Various industries : machinery factories, petro-chemical manufacturing plants, automotive fitting factories, electronics facilities, sea salt production, shipbuilding and port activity

Complex region, with various aerosol types from local sources, added to regular dust transport in spring; microphysical and optical properties of aerosols are not well characterized in this region, much less at a fine scale

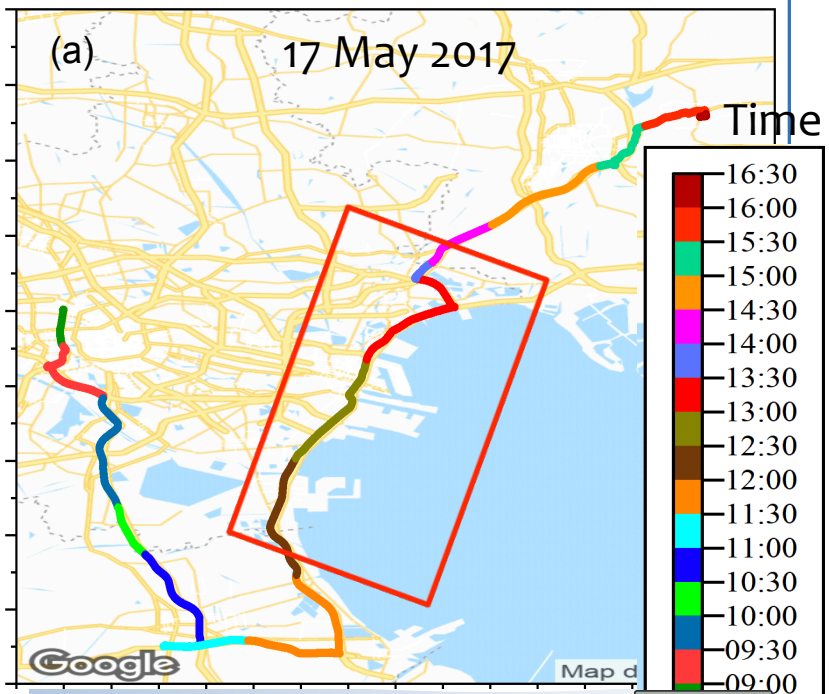
First time to conduct mobile observations (remote sensing and in situ) in Tianjin and in the Binhai New Area

Aerosol properties measured by in situ



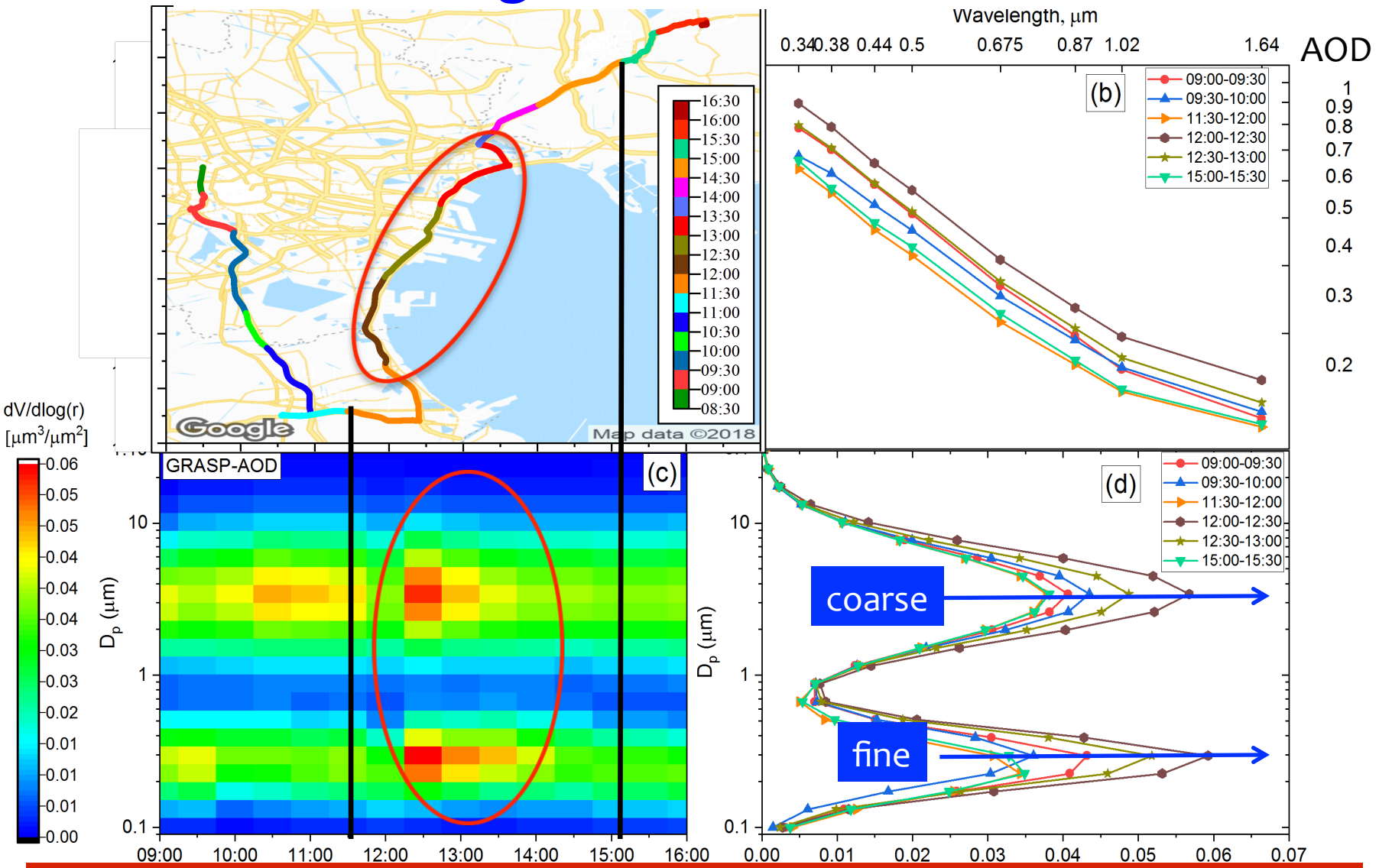
Particle **concentrations and scattering coefficients increase when RH increases** after reaching the coastal region, 2 to 3 times higher than on the rest of the transect (ship exhaust and sea salt particles are hygroscopic).

sea breeze event



Popovici et al., in prep.

Column-integrated volume size distribution



- both fine and coarse modes increase when reaching the polluted coastal region
- possibly due to fine particles growth (water uptake) and increase of coarse mode due to sea salt presence

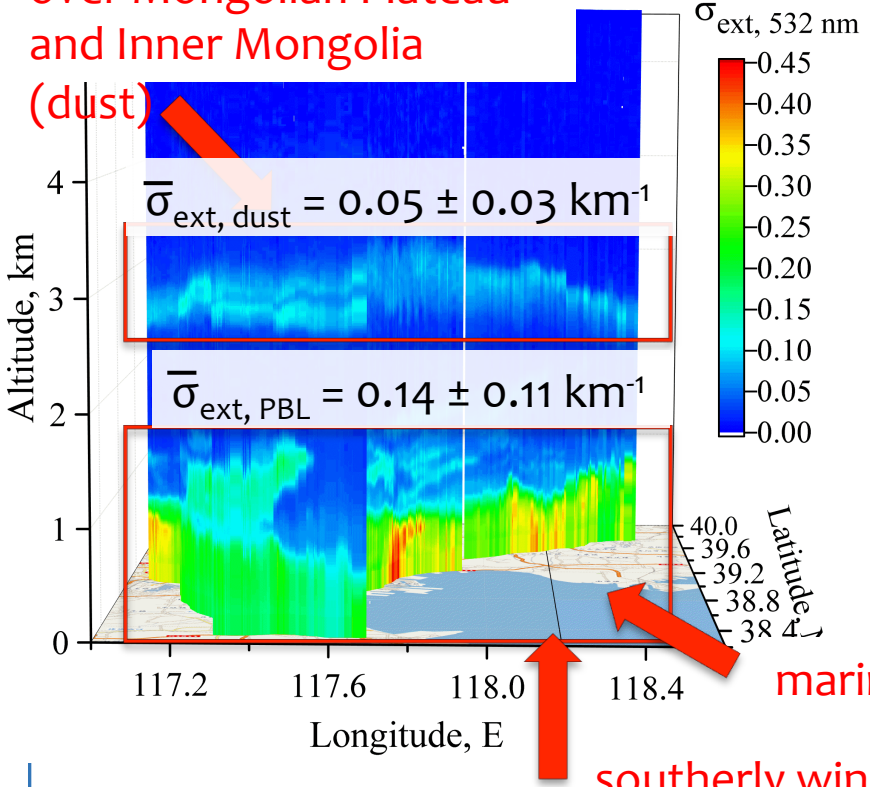
Popovici et al., in prep.

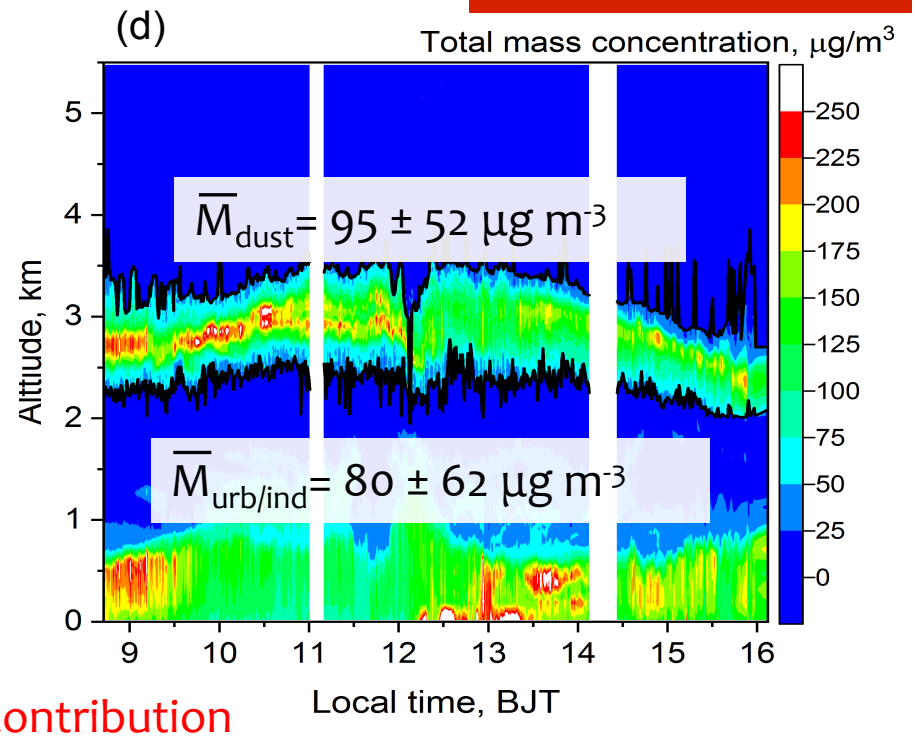
Extinction and mass concentration profiles

Extinction at 532 nm

Mass concentration

over Mongolian Plateau and Inner Mongolia (dust)





marine contribution

southerly winds associated with heavy pollution

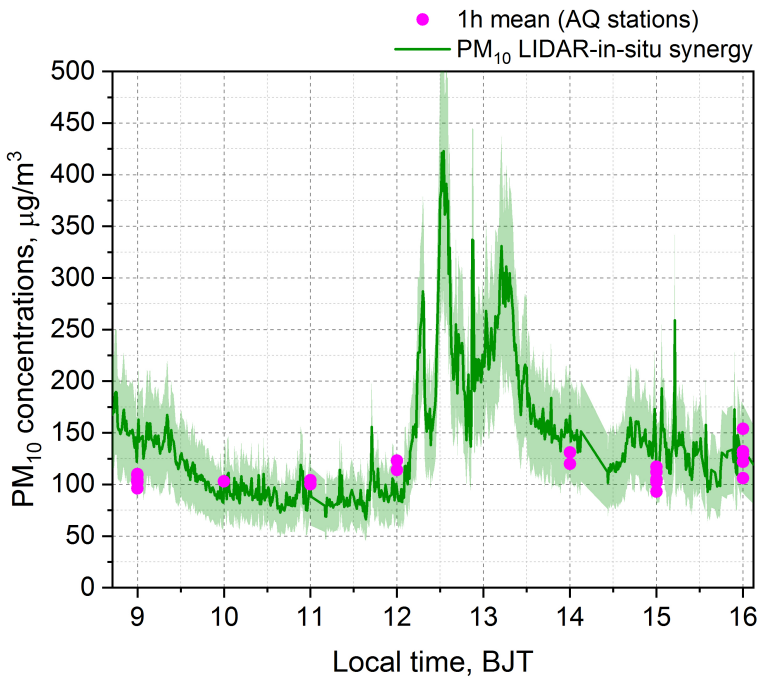
- 30% uncertainty

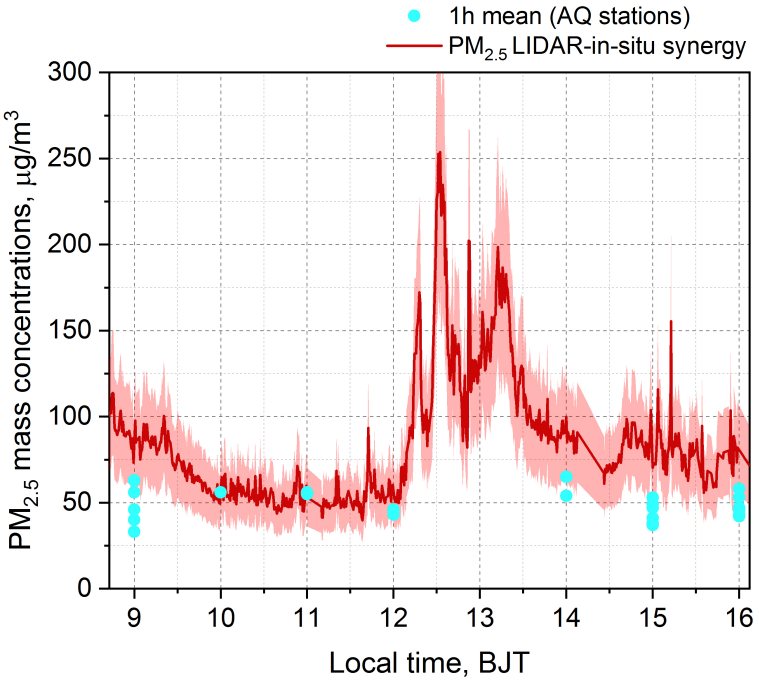
Lidar ratio – aerosol type

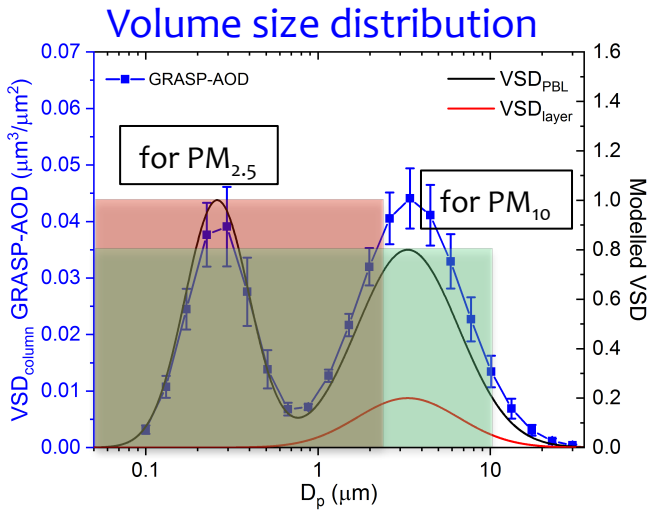
Tianjin (66 ± 10 sr) – urban/industrial
New Binhai Area (35 ± 12 sr) – industrial/marine polluted
Tangshan (57 ± 14 sr) – urban/industrial

Popovici et al., in prep.

PM_{10} and $PM_{2.5}$ concentrations at surface level







- rather good agreement between mass calculations and AQ measurements
- lidar/in-situ-derived PM_{10} with their uncertainties are within the levels recorded at AQ stations

Popovici et al., in prep.

Conclusions

- We have performed mobile observations in various atmospheric conditions:

1. moderate pollution with dust transported from Gobi desert
2. higher pollution when crossing Baoding, Tianjin and Tangshan
3. heavy pollution when air masses moved from South
4. dust presence in most of the cases (common in spring)
5. elevated dust layers in free troposphere from NW (Inner Mongolia)

- In the case of pollution days, the PBL extended up to 1 - 1.5 km altitude and the days were marked by high AOD at 440 nm (0.8 - 1.8), highest values being recorded when the air masses were moving from South. Angstrom Exponent (AE) values (1.2 – 1.6) indicates fine particles predominance

- expertise of LOA/CIMEL proven during the MOABAI campaign

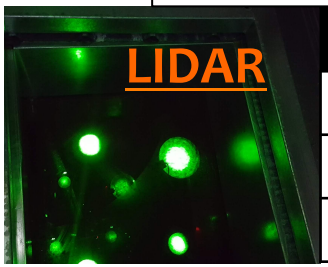
- an instrumented van is easier to be deployed in case of fast need for variability studies than setting up large campaigns which require more permissions and people involved

- advantage of CIMEL micropulse LIDAR : applicable for various applications, robustness, flexibility

Perspectives and news on Mobile Observations

- deployment of ship-borne photometer for 1 year in Arctic and involvement in future campaigns (SEA2CLOUDS-New Zealand, Marion Dufresne-France)
- testing of CE318-T for car-based mobile observations (to be validated)
- development of PLASMA-3 mobile photometer, able to perform sun/sky/lunar/ polar measurements during motion (in progress) (LOA)
- perform advanced aerosol properties retrievals of combined sun/sky and multi-wavelength (2-3 λ) LIDAR elastic measurements (GRASP/GARRLIC)
- involvement of CIMEL (people, LIDARs, sun photometer) in FIREX campaign/USA (July-September 2019) (https://espo.nasa.gov/firex-aq/)
- involvement of CIMEL LIDAR in a campaign on an industrial site in France, to measure diffuse emissions
- invest in research towards trace gas monitoring by LIDAR: O_3, CH_4, CO_2, hyperspectral measurements (in collab. with LATMOS)

CIMEL solutions for mobile observations



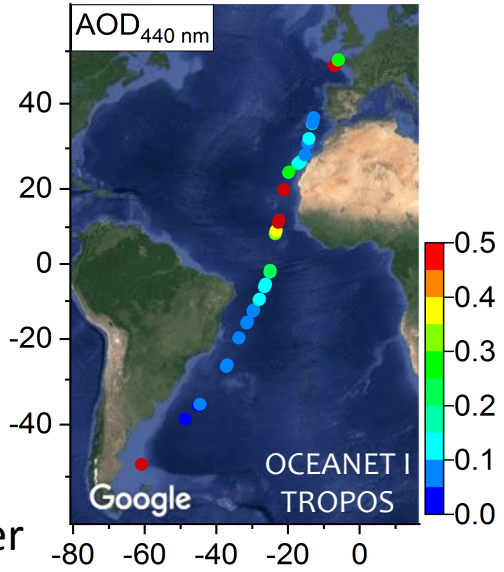
CE370	CE376
532 nm	532 nm, 808 nm
1 channel	4 channels
no depolar.	depolarization

Testing and calibration at LOA platform

ACTRIS QC procedures
Lical trainings followed

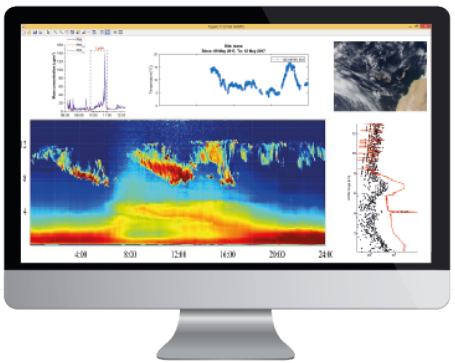
Sun/Sky/Lunar photometer

Shipborne
CE318-T photometer



iAAMS (software)

Integrated Automatic Aerosol Monitoring Software



- **Synergy between CIMEL LiDARs and CE318-T photometers**
- **Data exportation (NASA – AERONET compatible)**
- **Data processing through complex algorithms**
- **Dashboard & processing customization**
- **Flexible network management**

AAMS – Mobile System

Popovici et al., 2018, AMT

in collaboration with LOA/CaPPA

Contact: i-popovici@cimel.fr

Thank you for your attention!

Contact: i-popovici@cimel.fr