Department of Meteorology

University of Reading

Characterising the atmospheric boundary layer over cities in Europe and Asia base ceilometer observations

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NERC Airpro, ICOS, E-PROFILE, ACTRIS, URBANFLUXES, University of Reading, EU-COST

Mixing & aerosol

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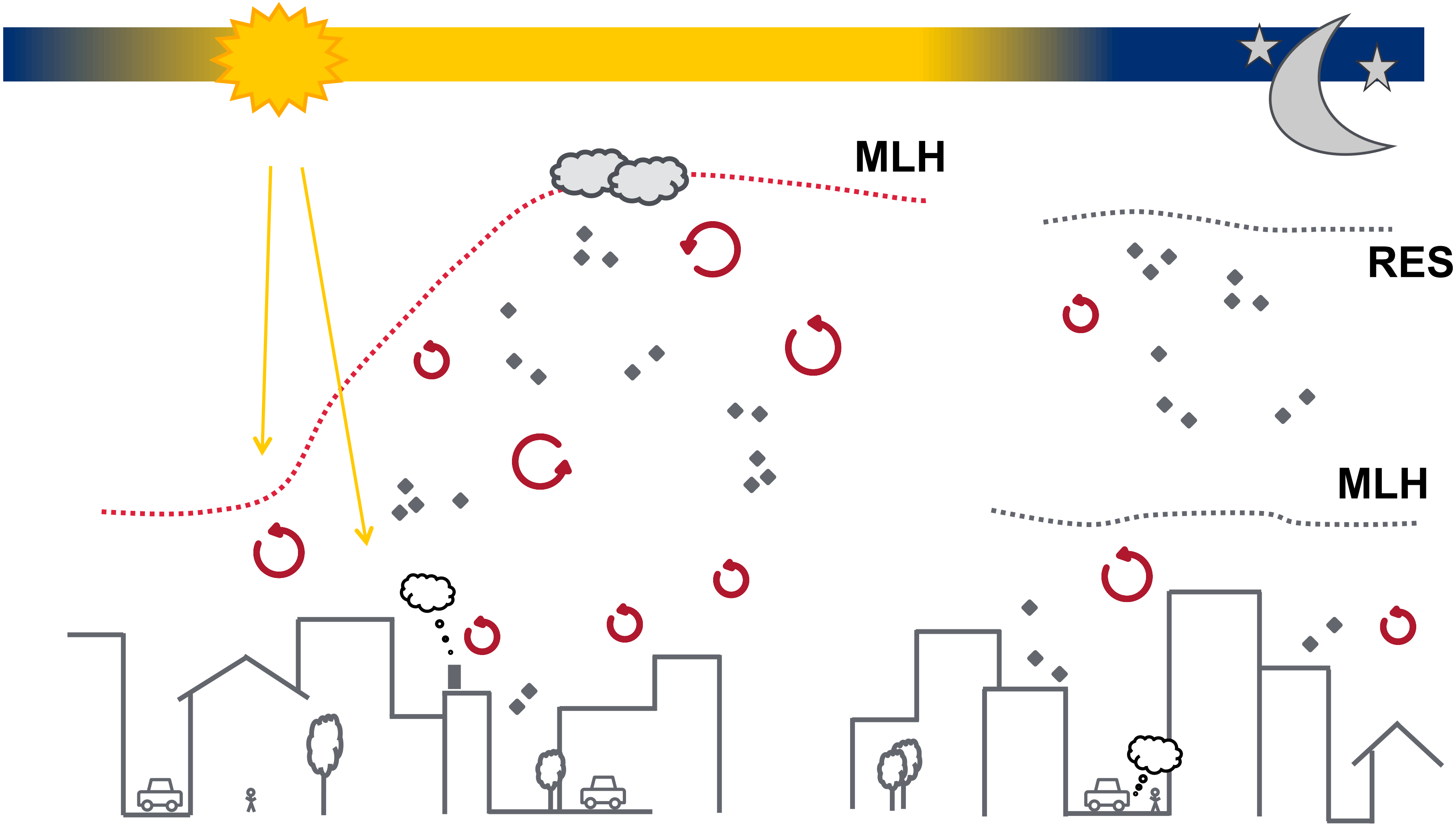
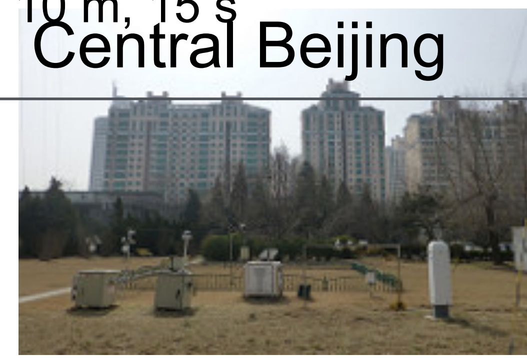


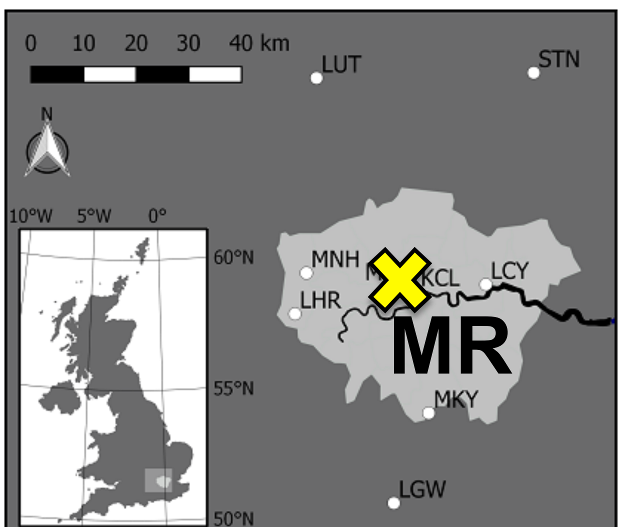
MLH Mixed layer height
RES Residual layer

Observations

- Automatic Lidars and Ceilometers (ALC): Vaicala CL31

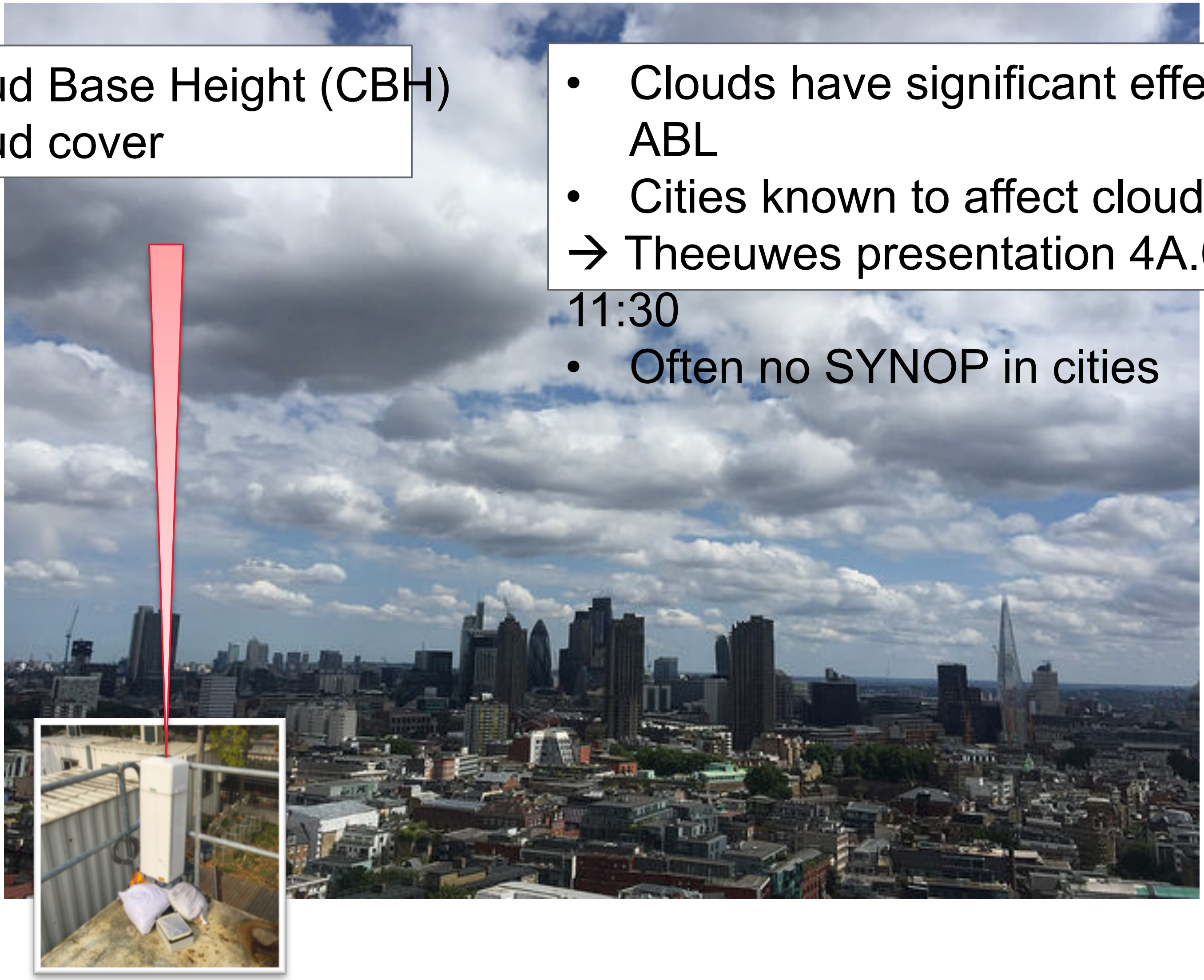
City	London	Paris	Beijing
Analysis Period	2011-2016	2011-2016	Nov 2016 – June 2017
Resolution	10 m, 15 s	10 m, 30 s	10 m, 15 s





SIRTA: Haeffelin et al., 2005, AG

Impact of clouds on MLH?



→ Cloud Base Height (CBH)
→ Cloud cover

- Clouds have significant effect on ABL
- Cities known to affect cloud cover

→ Theeuwes presentation 4A.6 Tue 11:30

- Often no SYNOP in cities

ABL classification

ABL classification scheme based on
- Cloud cover
- Variability of CBH
- precipitation flag
- MLH in relation to CBH

→ Cu & St

5 Simplified classes

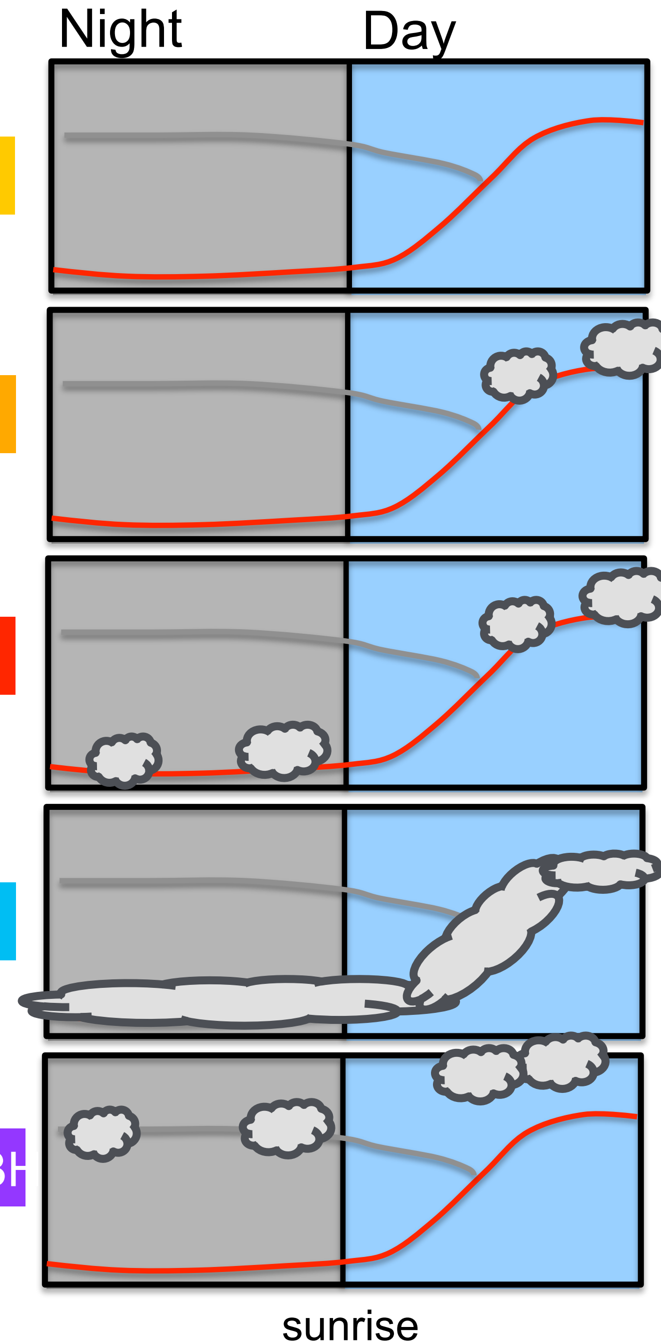
Clear

ClearCu

Cu

St

MLH < CBH

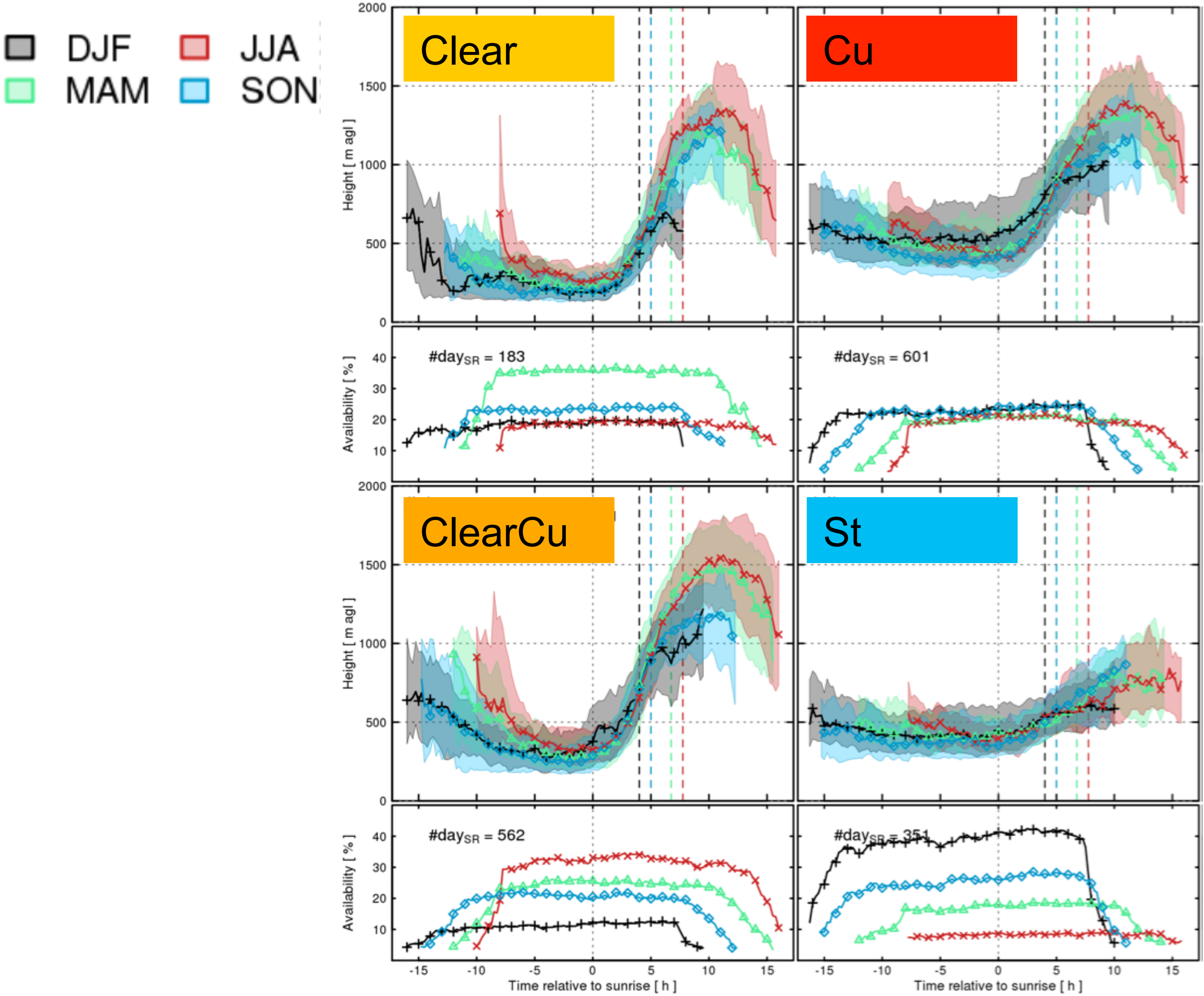


rain

other

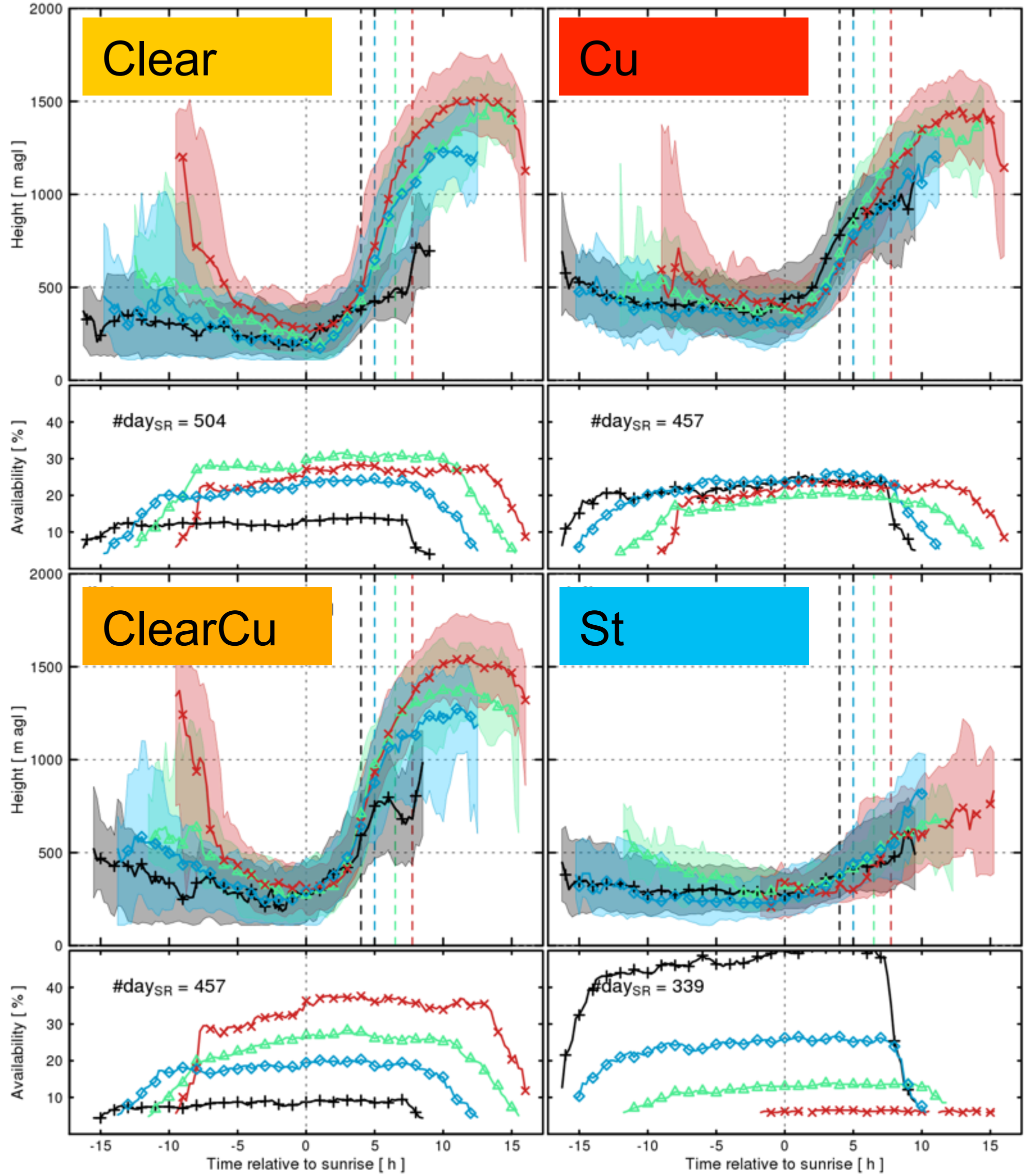
Kotthaus and Grimmond, 2018b, QJRMS

London



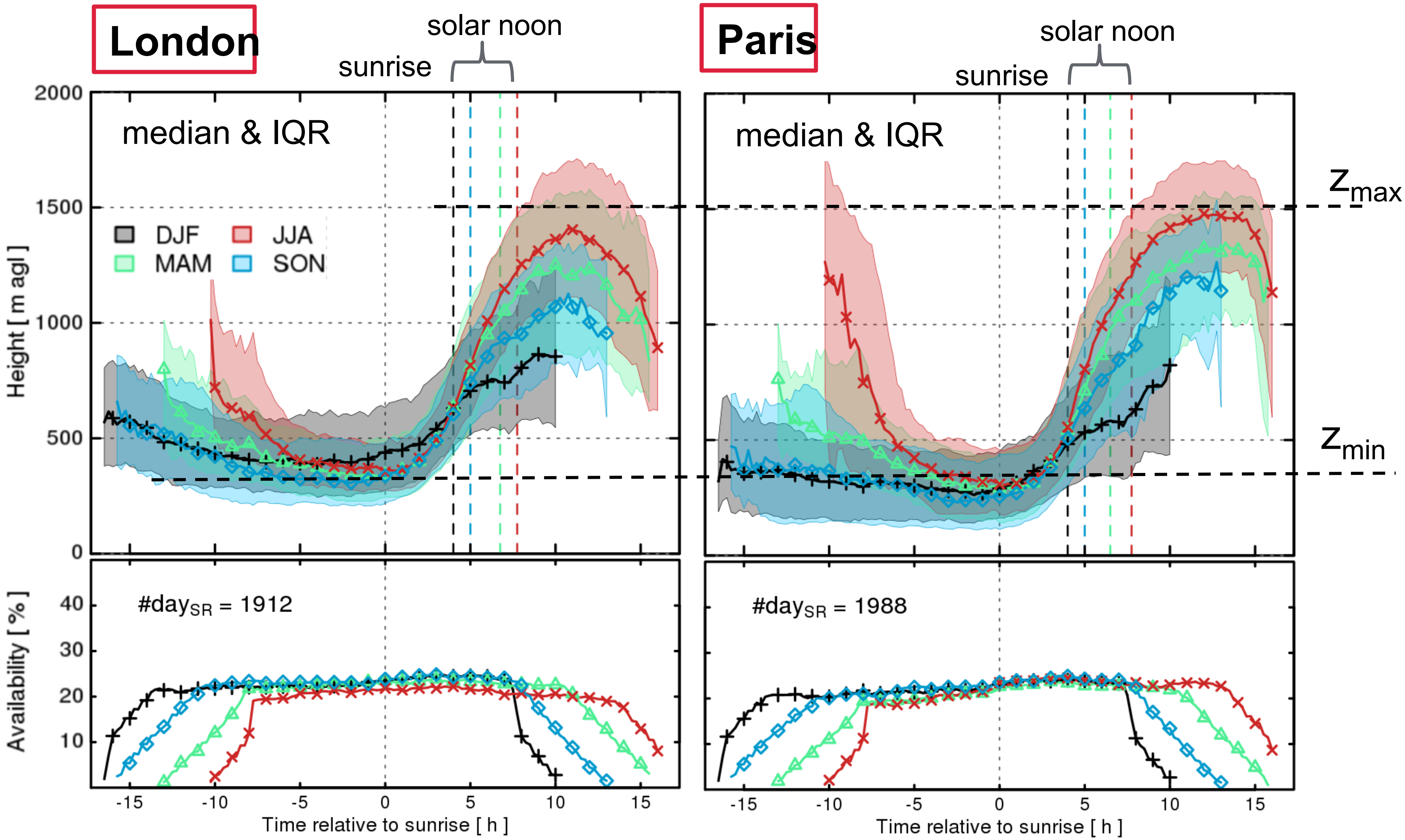
Kotthaus and Grimmond, 2018b, QJRMS

Paris



Kotthaus and Grimmond, 2018b, QJRMS

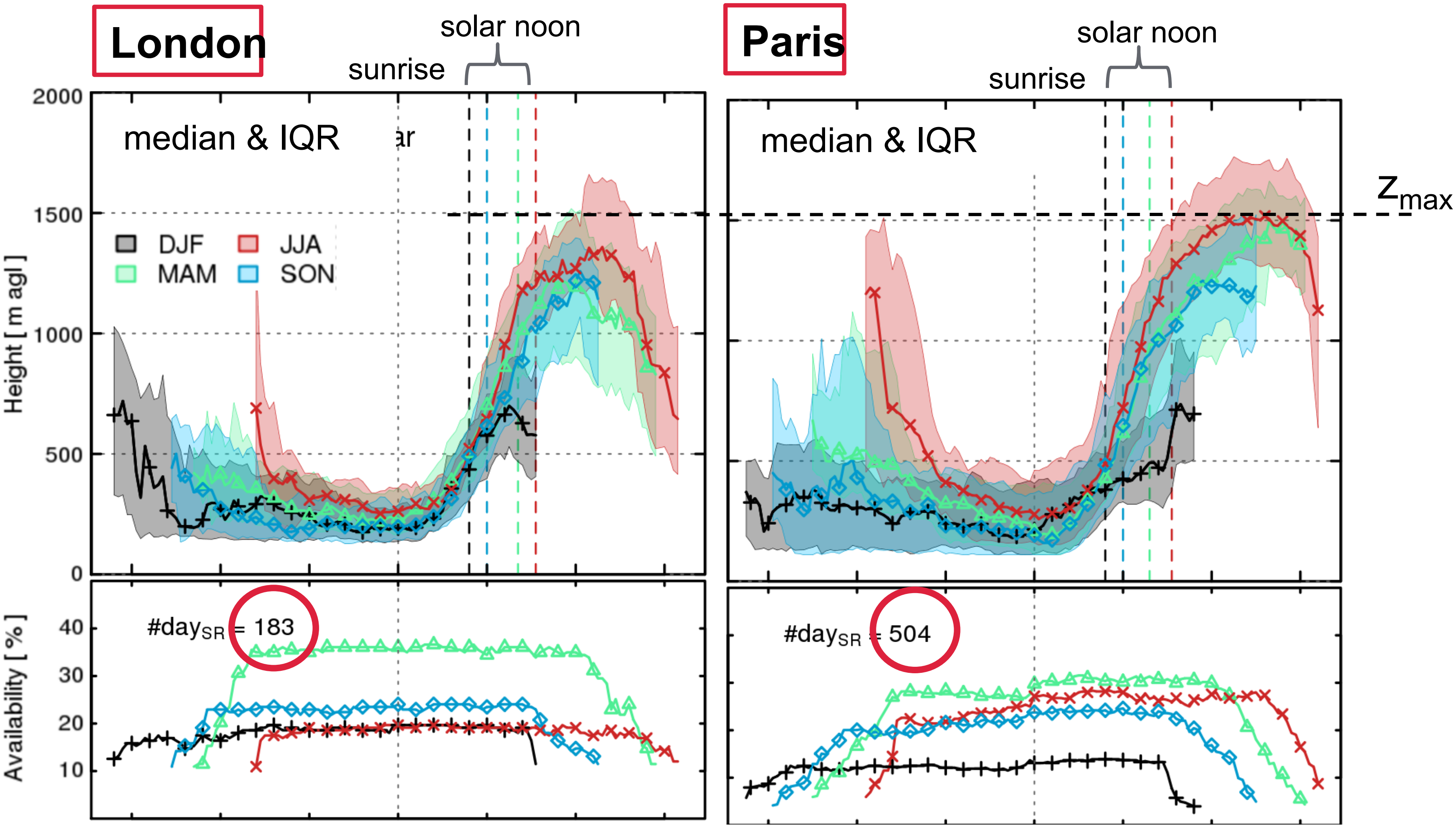
MLH comparison - ALL



Kotthaus and Grimmond, 2018b, QJRMS

Kotthaus et al., in prep

MLH comparison - Clear



Kotthaus and Grimmond, 2018b, QJRMS

Kotthaus et al., in prep

ABL classification scheme

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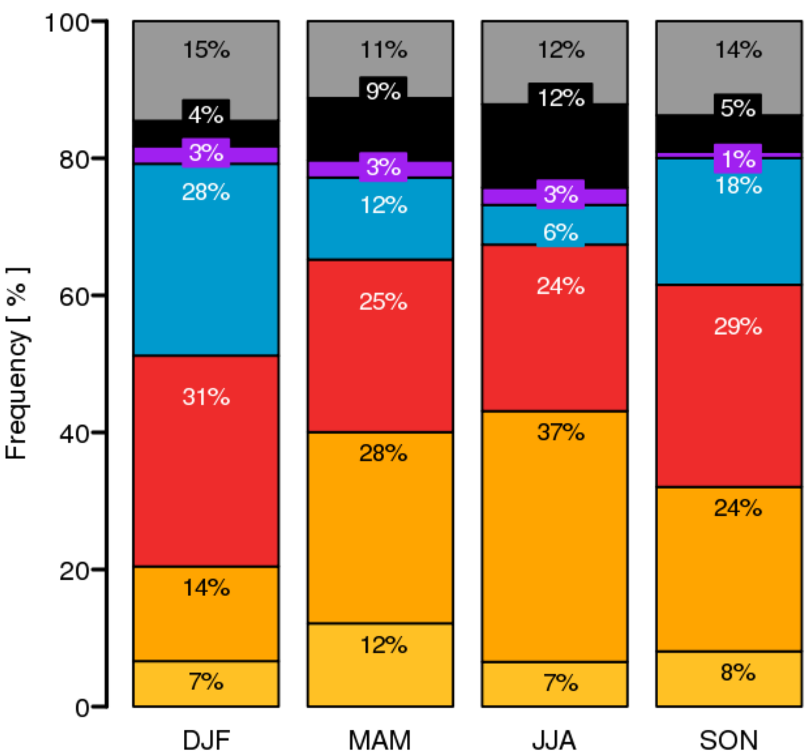
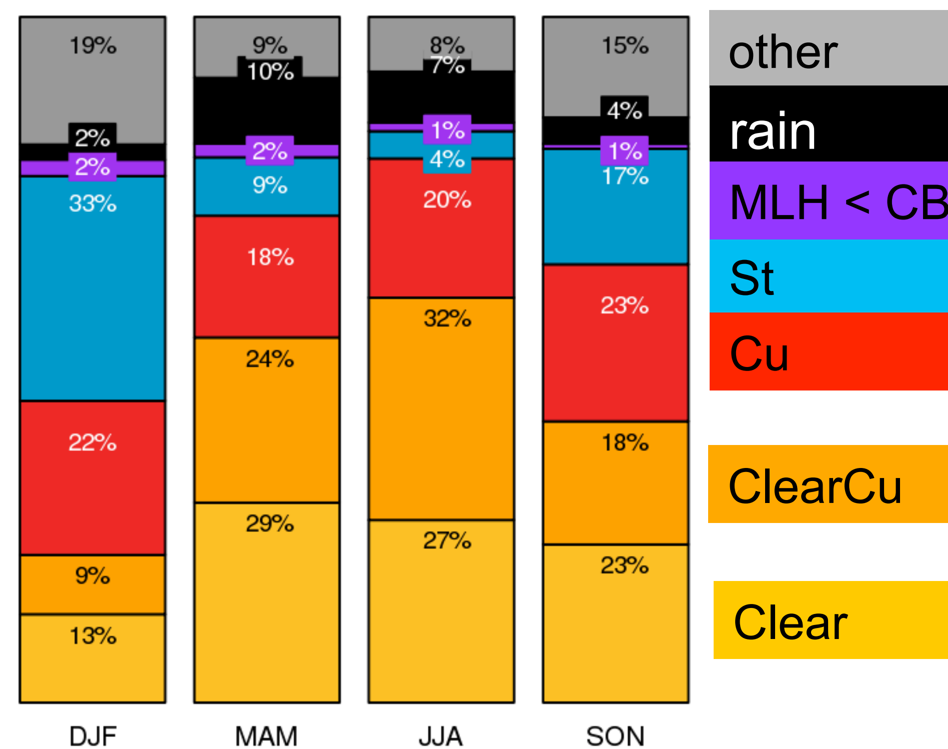
London



Paris

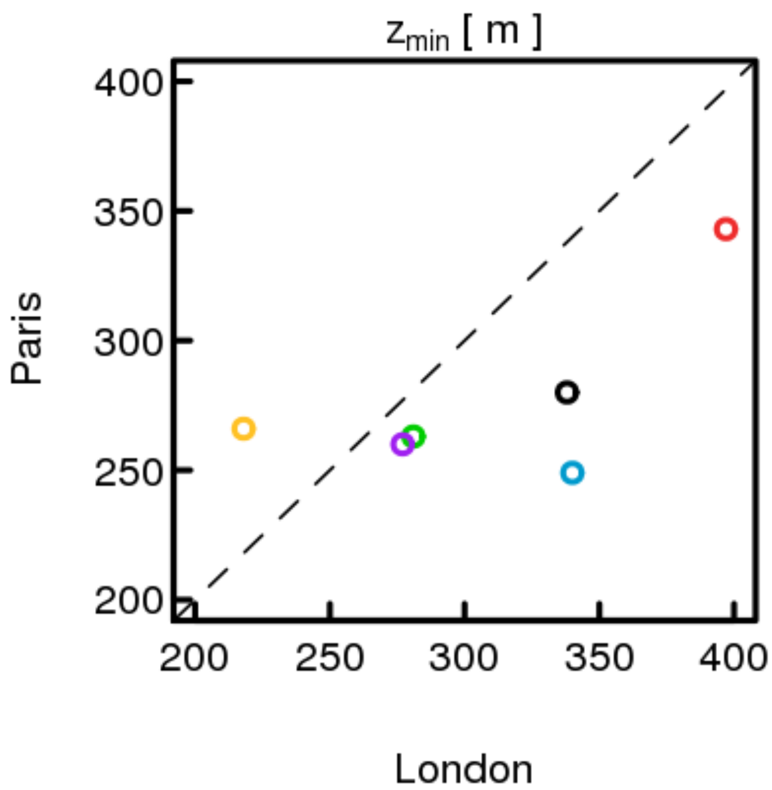


Kotthaus and Grimmond, 2018b, QJRMS

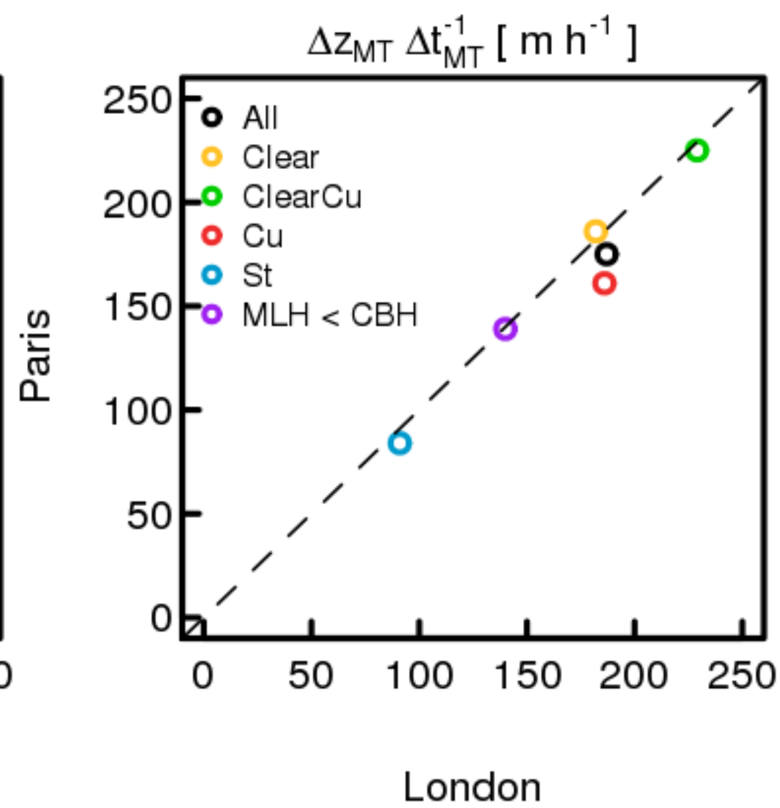
Kotthaus et al., in prep

Applicable to Paris?

MLH minimum

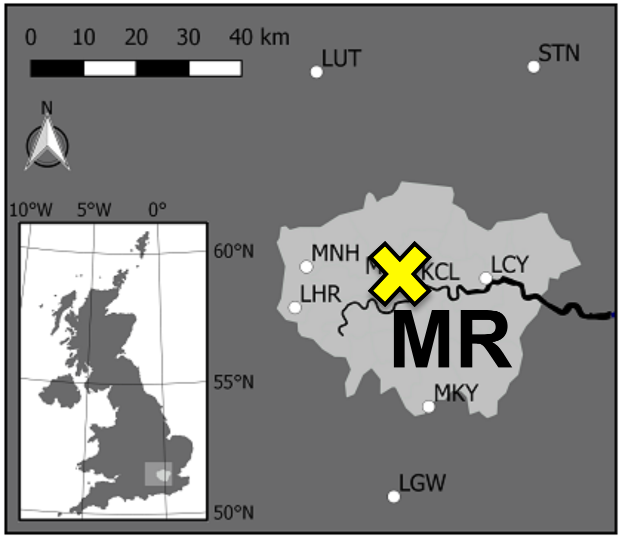


Morning growth rate



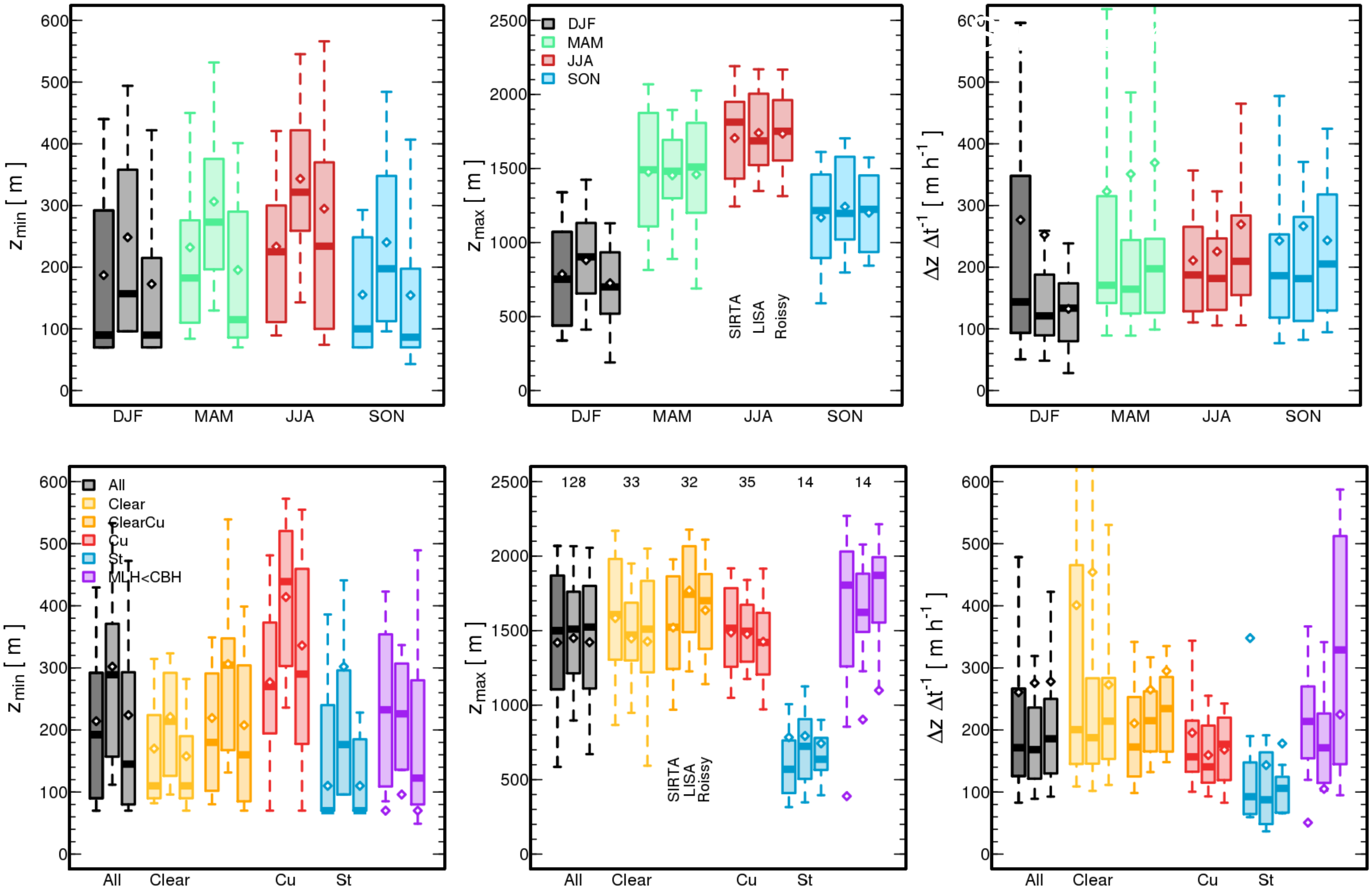
Suburban Paris vs central London

- Land cover (local)
- Land cover (upwind)
- Topography
- Synoptic background
- …



SIRTA: Haeffelin et al., 2005, AG

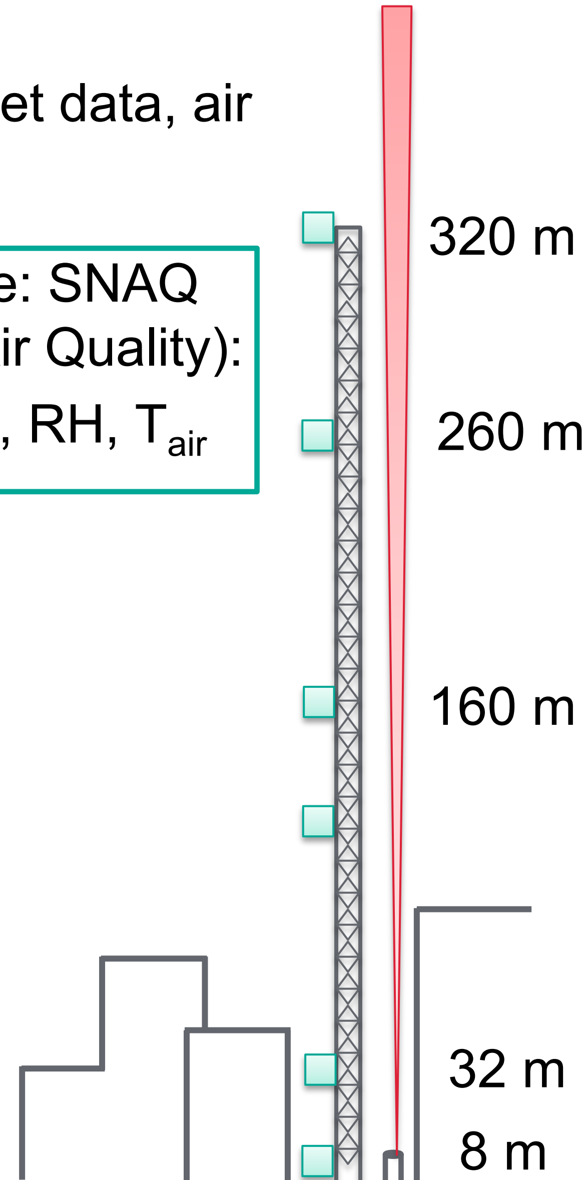
Suburban vs central Paris



Beijing: IAP site

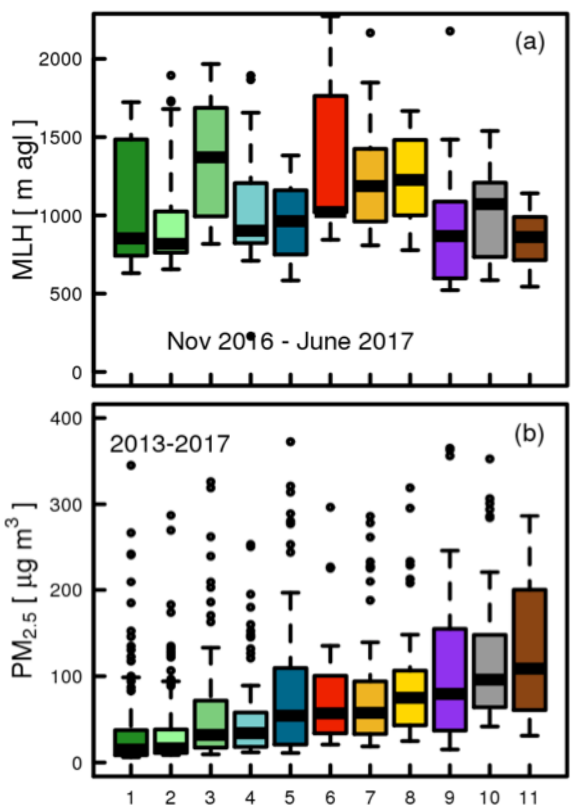
APHH Airpro Fluxes, met data, air quality

University of Cambridge: SNAQ (Sensor Networks for Air Quality): CO, CO_2, NO, O_3, wind, RH, T_{air}

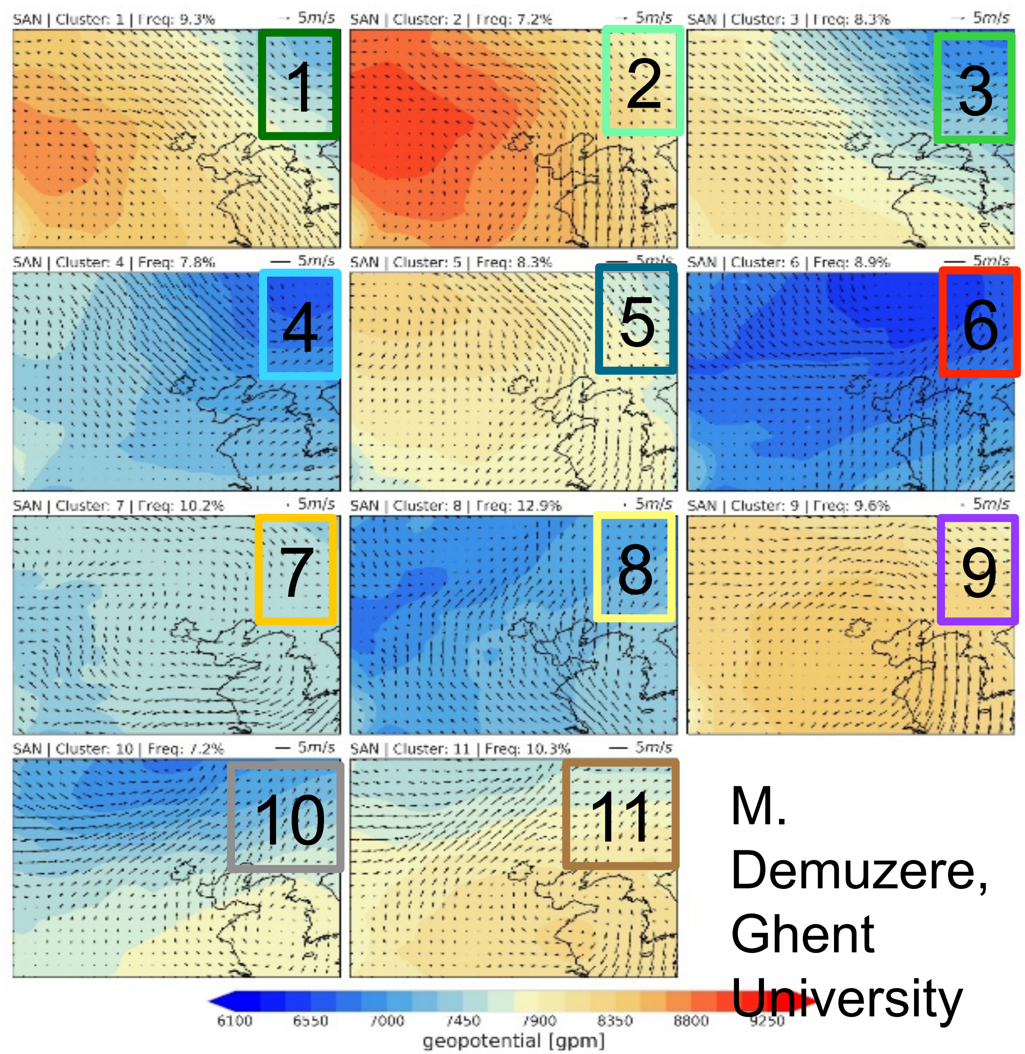


MLH by synoptic class

- Beijing MLH Nov 2016 – June 2017
- Stratified by synoptic class
- Sorted by local PM2.5 observed at IAP tower



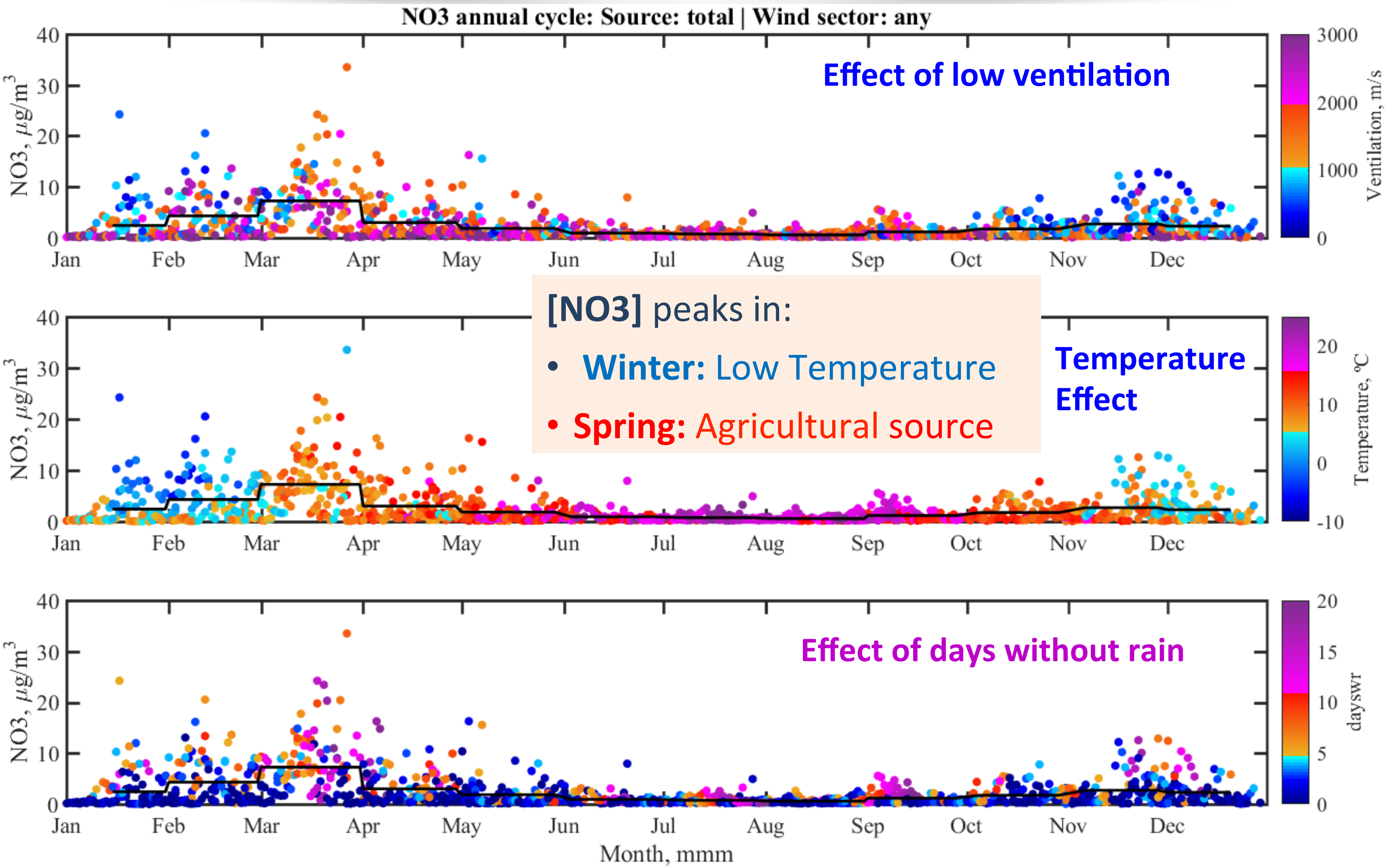
Shi et al., in prep



M. Demuzere, Ghent University

Circulation types: COST733

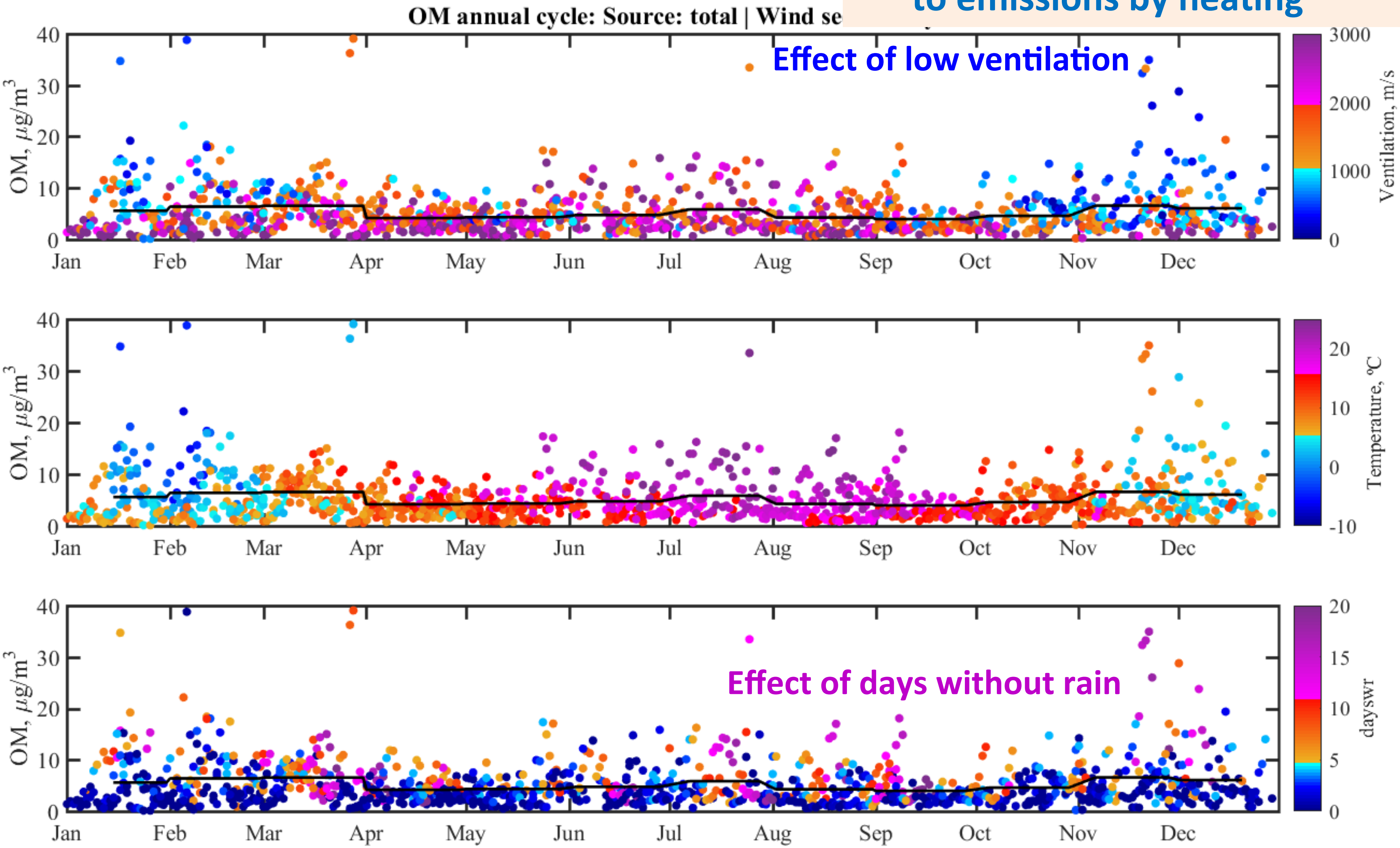
Main PM1 pollution component analysis: NO3



Main PM1 pollution component analysis: OM

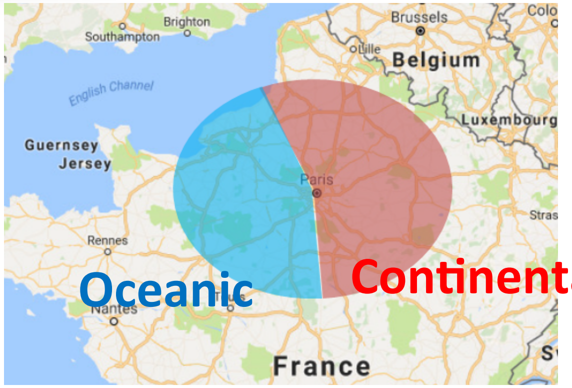
[OM] peaks in all seasons

- **Winter: strongest events due to emissions by heating**



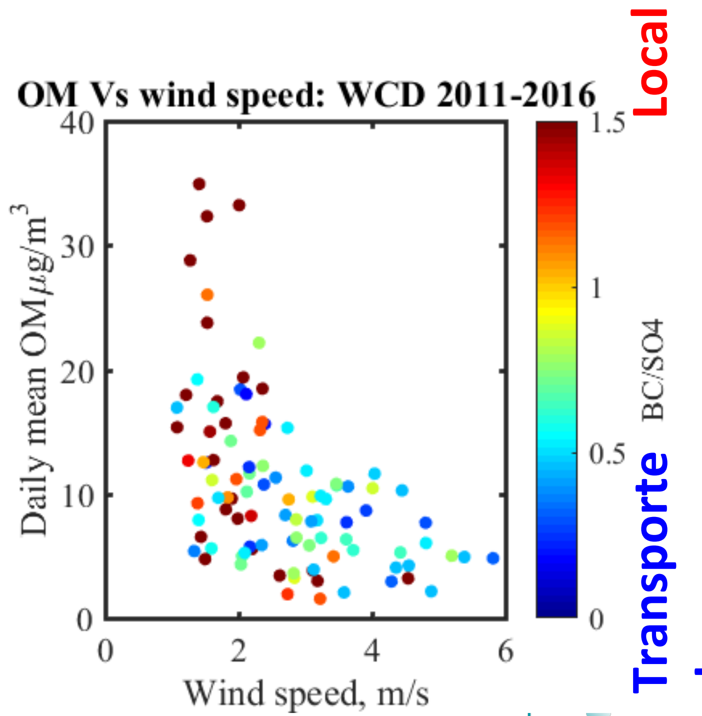
Pollution as a function of air mass origin

Pollutant	Season	Wind sector	Deposition	Code
[NO3]	Spring	Continental	Dry	SCD
	Winter			WCD
[OM]	Winter			

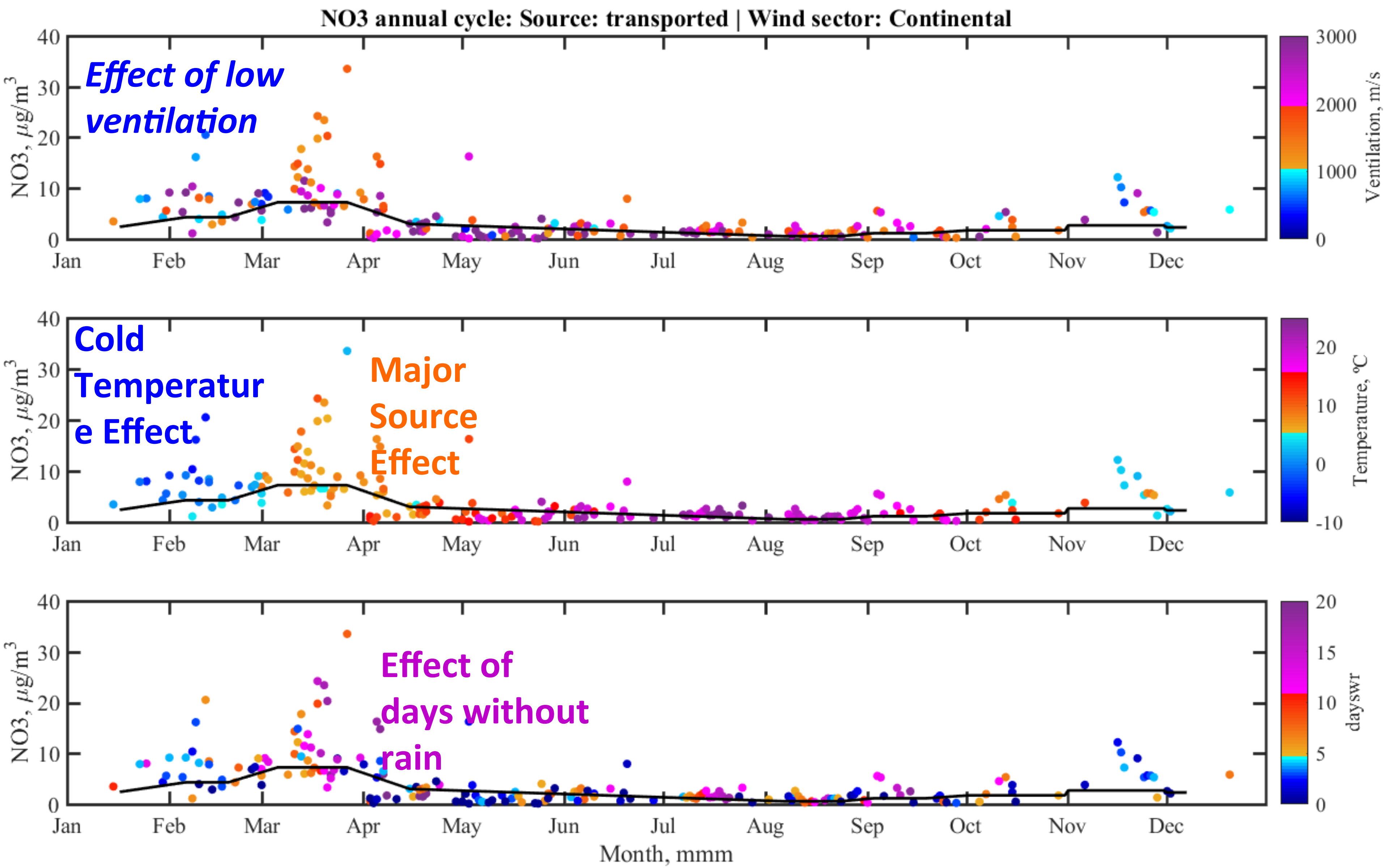


- Oceanic VS Continental Wind Sector
- For Continental: Local vs Transported pollution
  - **Local/Transported** by [BC]/[SO4] (Petit et al., 2015) because:
    - BC: primary
    - SO4: secondary

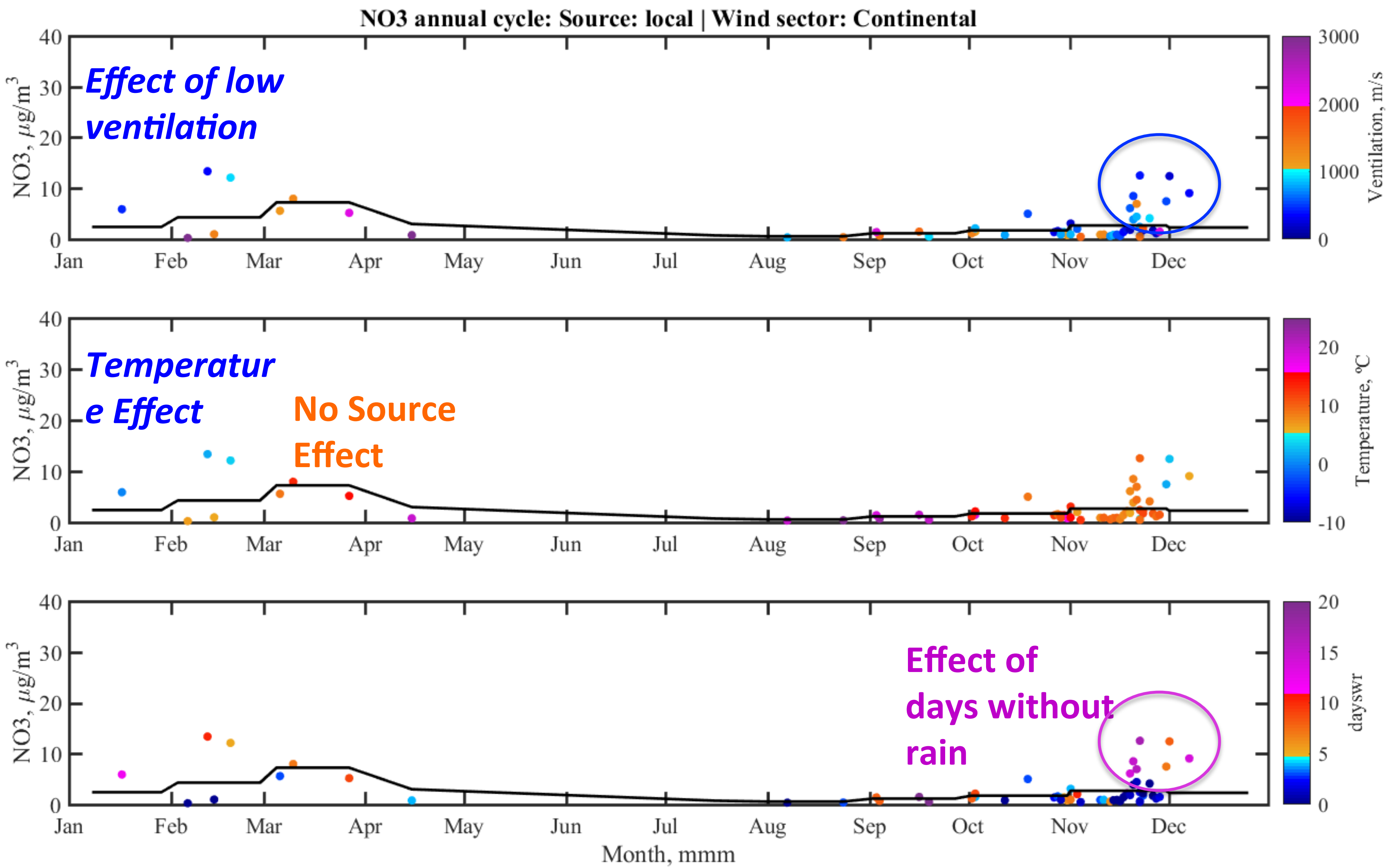
- **Local**: BC/SO4 > 1,5
- Mixed: 0.5<BC/SO4 < 1,5
- **Transported**: BC/SO4 < 0,5



NO3 Continental & Transported

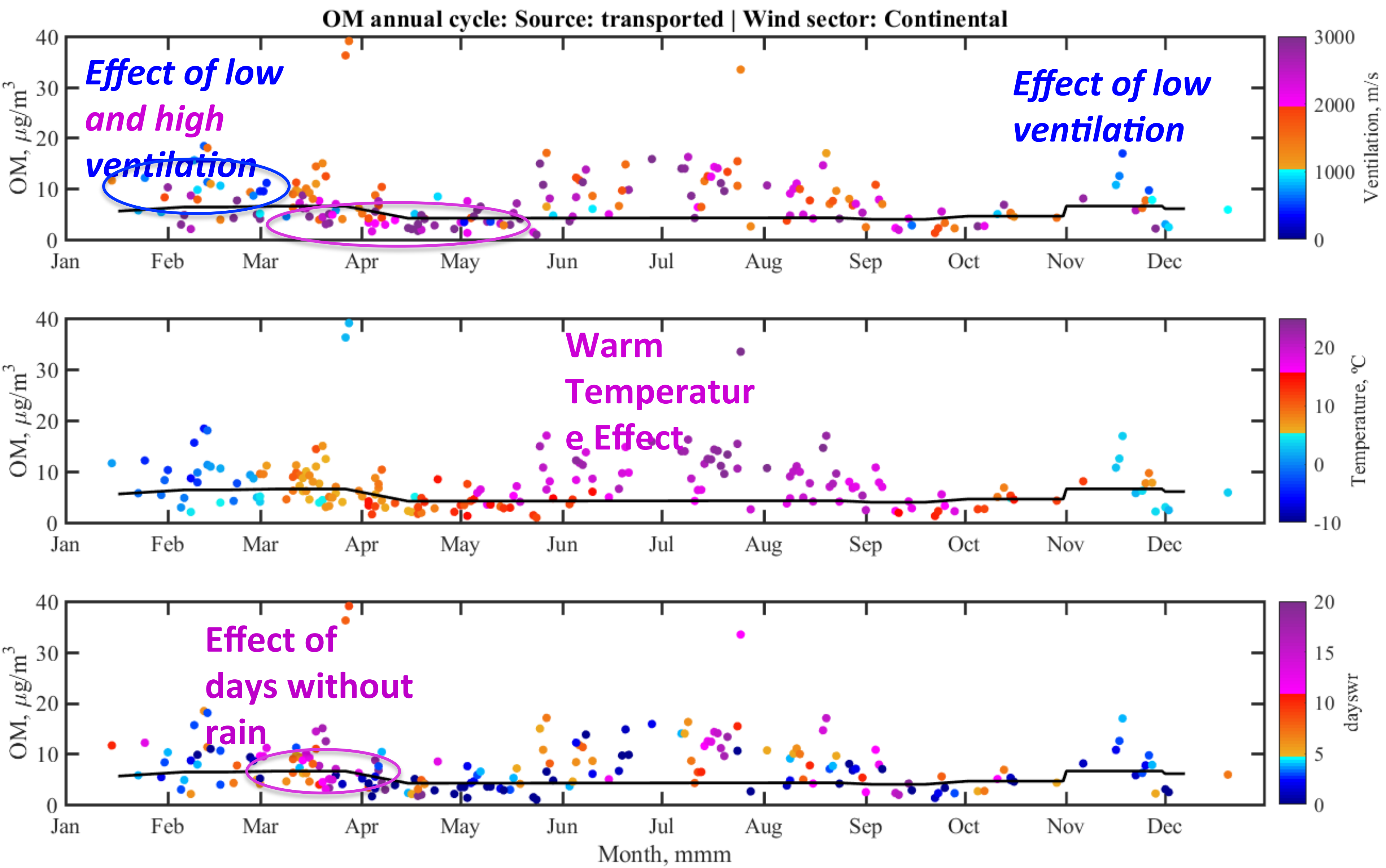


NO3 Continental & Local



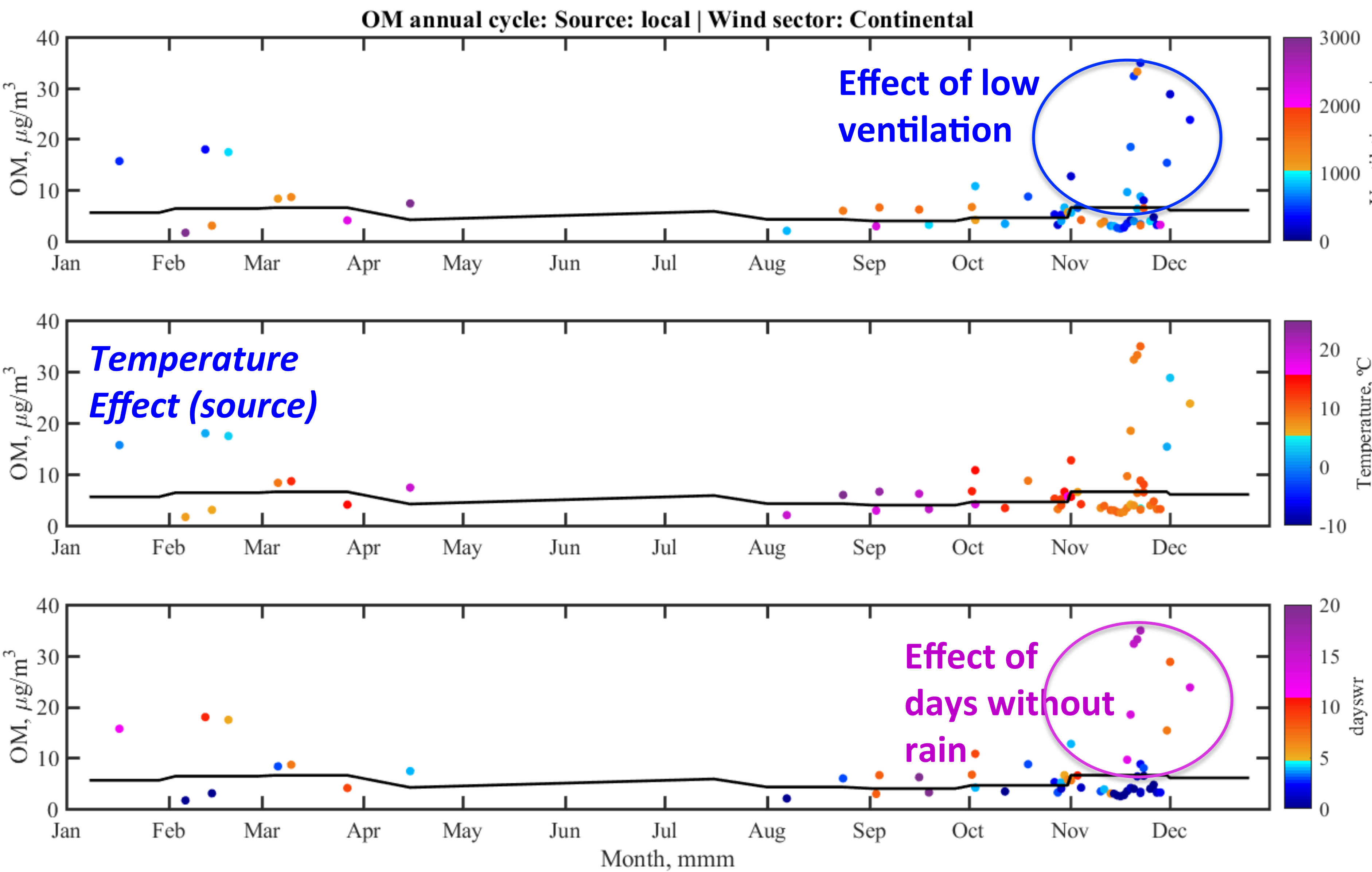
OM Continental & Transported

Multi-parameter effects



OM Continental & Local

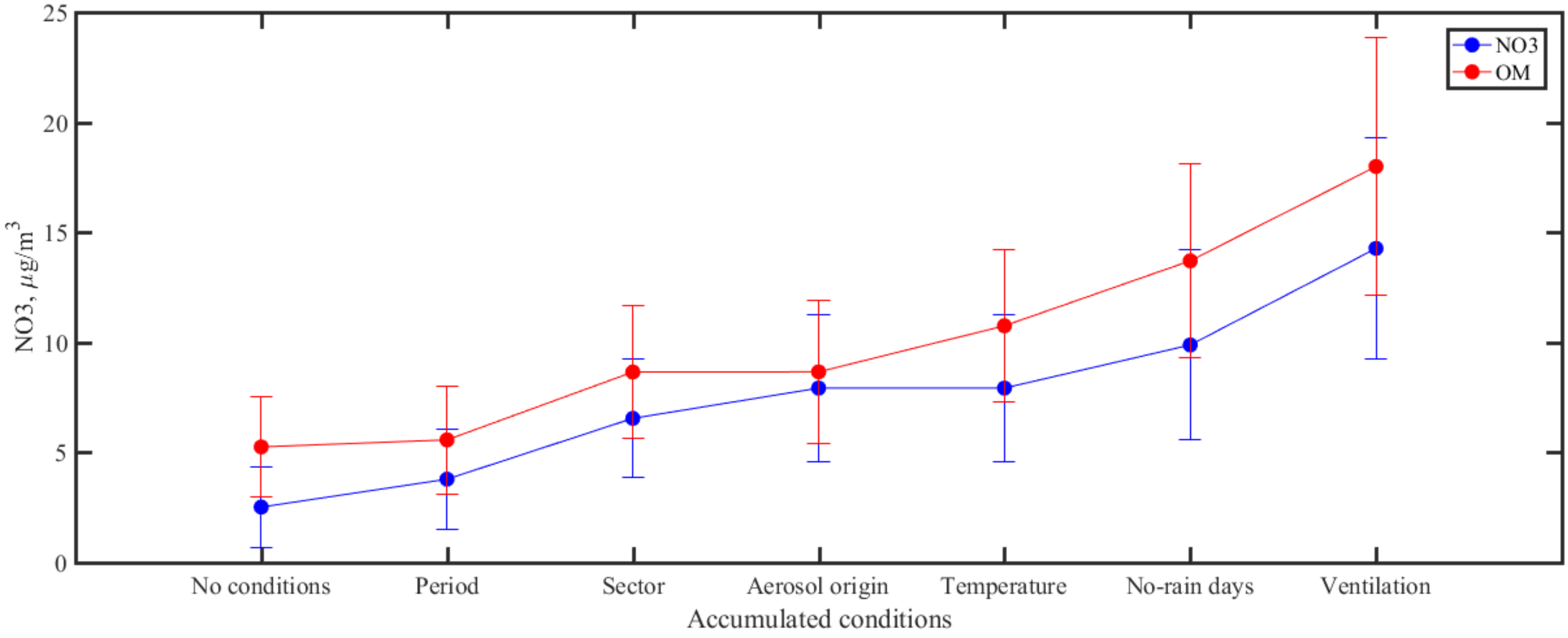
Multi-parameter effects



Cumulative multi-parameter conditions

Pollutant	Period	Wind Sector	Aerosol origin	Temperature	No rain days	Ventilation
NO3	Nov-April	Continental	Trans-ported	T<5 if Nov-April T<15 if March-April	>=5	<2000
OM	Nov-April June-August	Continental	Trans-ported and local	T<5 if Nov-April T>18 if June-August	>=5	<2000

Cumulative multi-parameter conditions



Conclusions

- "CABAM" algorithm to characterise ABL based on Vaisala ceilometer data
  a) MLH detection
  b) ABL classification according to cloud cover and type
- Long-term statistics for central London and suburban Paris:
  - Paris tends to have lower MLH during night and higher daytime values
  - ABL class depending on cloud type is crucial for interpretation of overall statistics
  - Simple parameterisation developed for London reveals differences in diurnal cycle (evening decay phase)
  - Further analysis needed: e.g. land cover, synoptic background
- Beijing: lower MLH compared to London and Paris
- Clear dependence of MLH on synoptic background
- Profile along 320 m tower → stratification in accordance with MLH