Variability of PM concentration explained by meteorological variables

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Motivation

- PM concentration in megacities impacts inhabitant health

- To predict PM concentrations:
  - Near-range forecast: Chemistry-transport (dispersion) models
  - **For medium-range forecast**: Numerical **Weather** Prediction forecast

How can this be done? **Links between meteorological conditions and PM concentrations!**

Geiß et al., 2017: Mixing layer height as an indicator for urban air quality?

'It seems to be unrealistic to find correlations between ABLH and near-surface pollutant concentrations representative for a city like Berlin (flat terrain), in particular when traffic emissions are dominant.'

Processes affecting PM concentration

PM1: Concentration and chemical composition (NO3, OM, SO4 and BC)

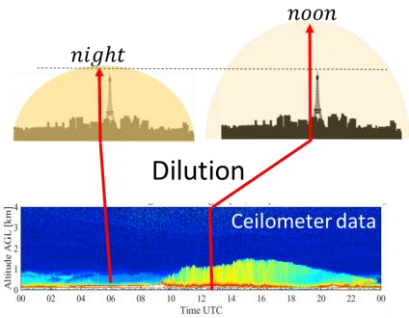
Temperature at surface

Emission

Particle Matter concentration

ABL height
Kotthaus' algorithm, CABAM

Dilution



Accumulation

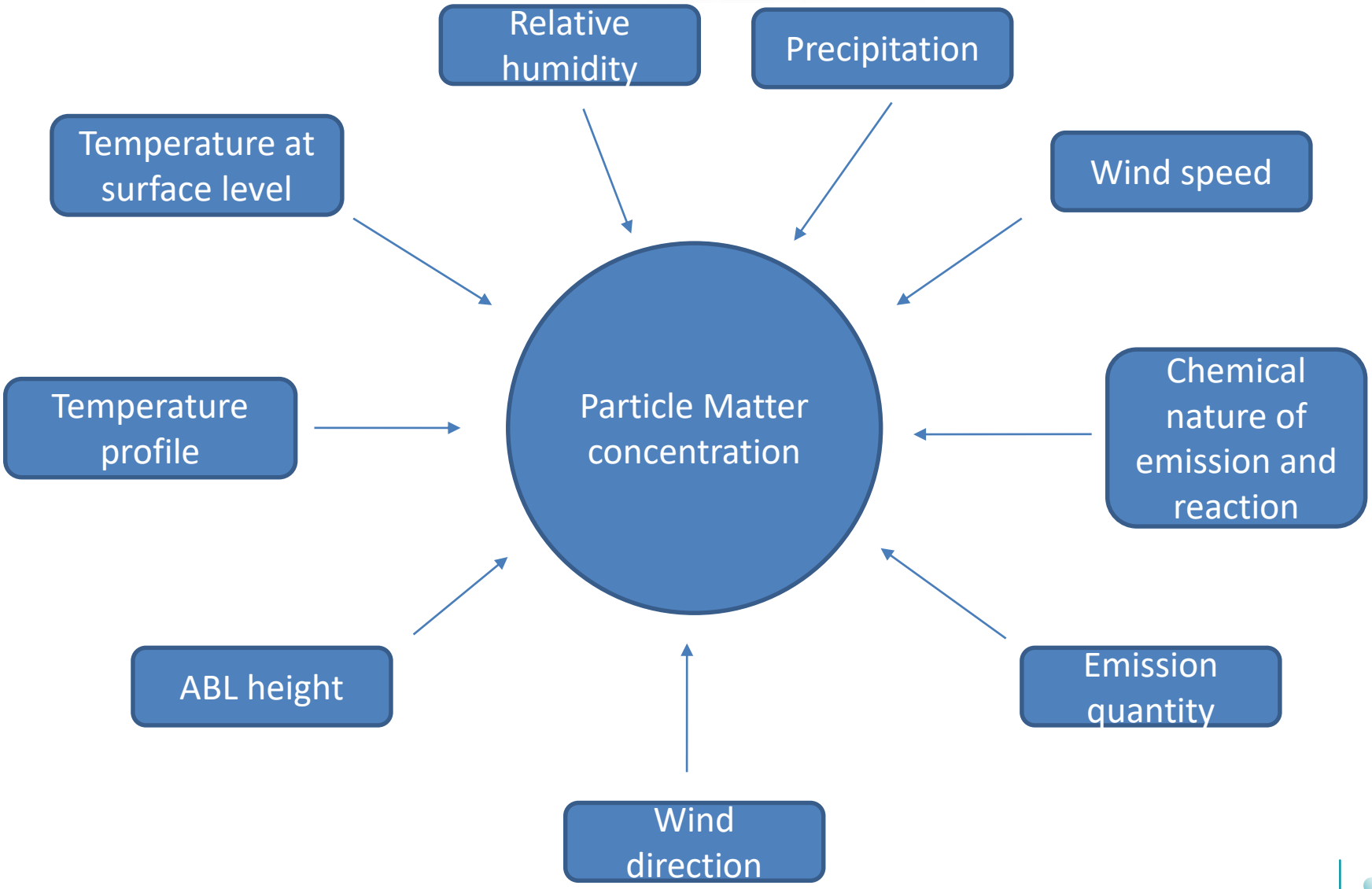
Days without rain

Wind speed
Wind direction

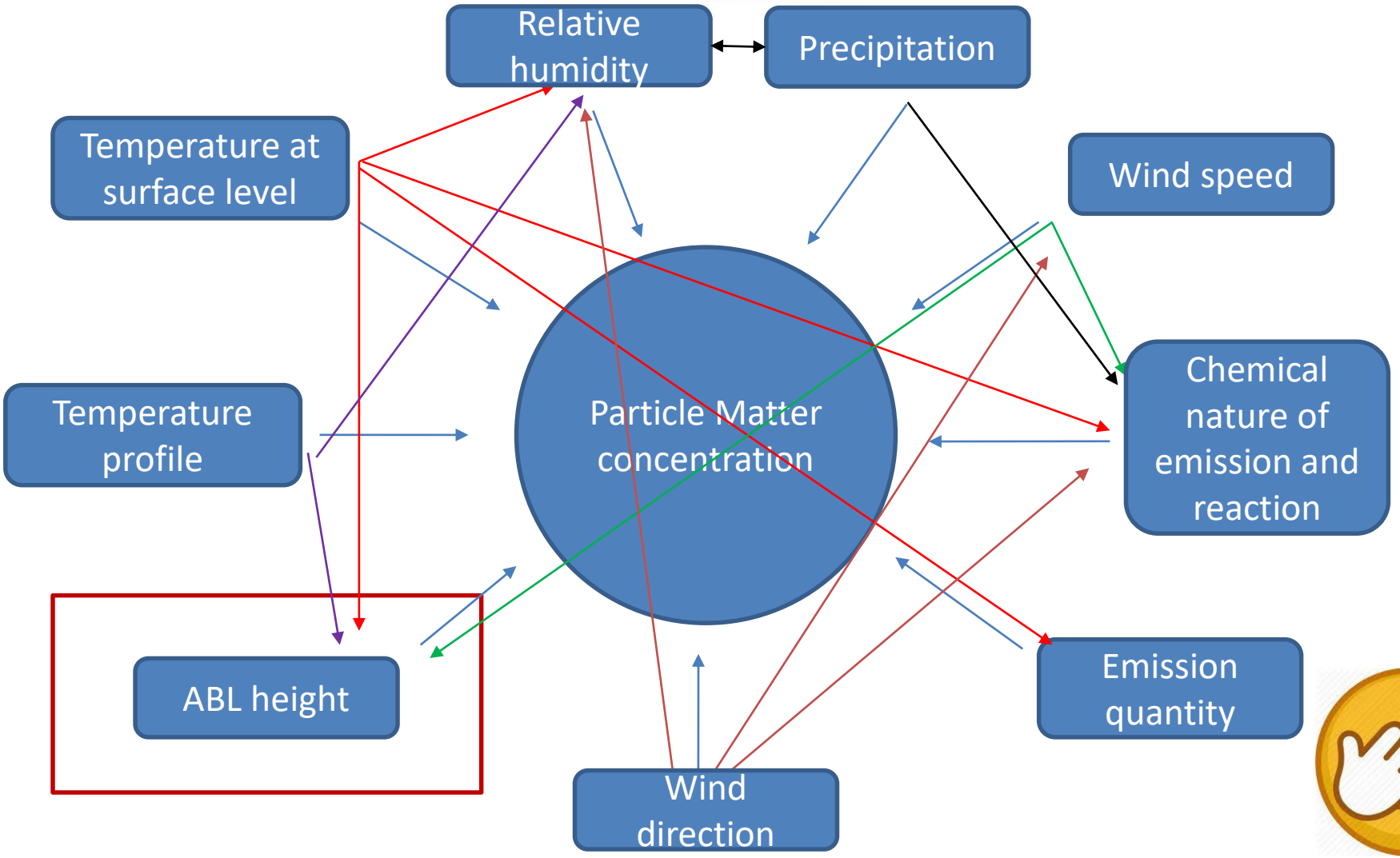
Advection

Paris 2011-2016: ReOBS
DAILY MEAN VALUES

PM concentration and relevant parameters



PM concentration and relevant parameters



We need to disentangle different influences

Main PM1 pollution component analysis: NO3 and OM

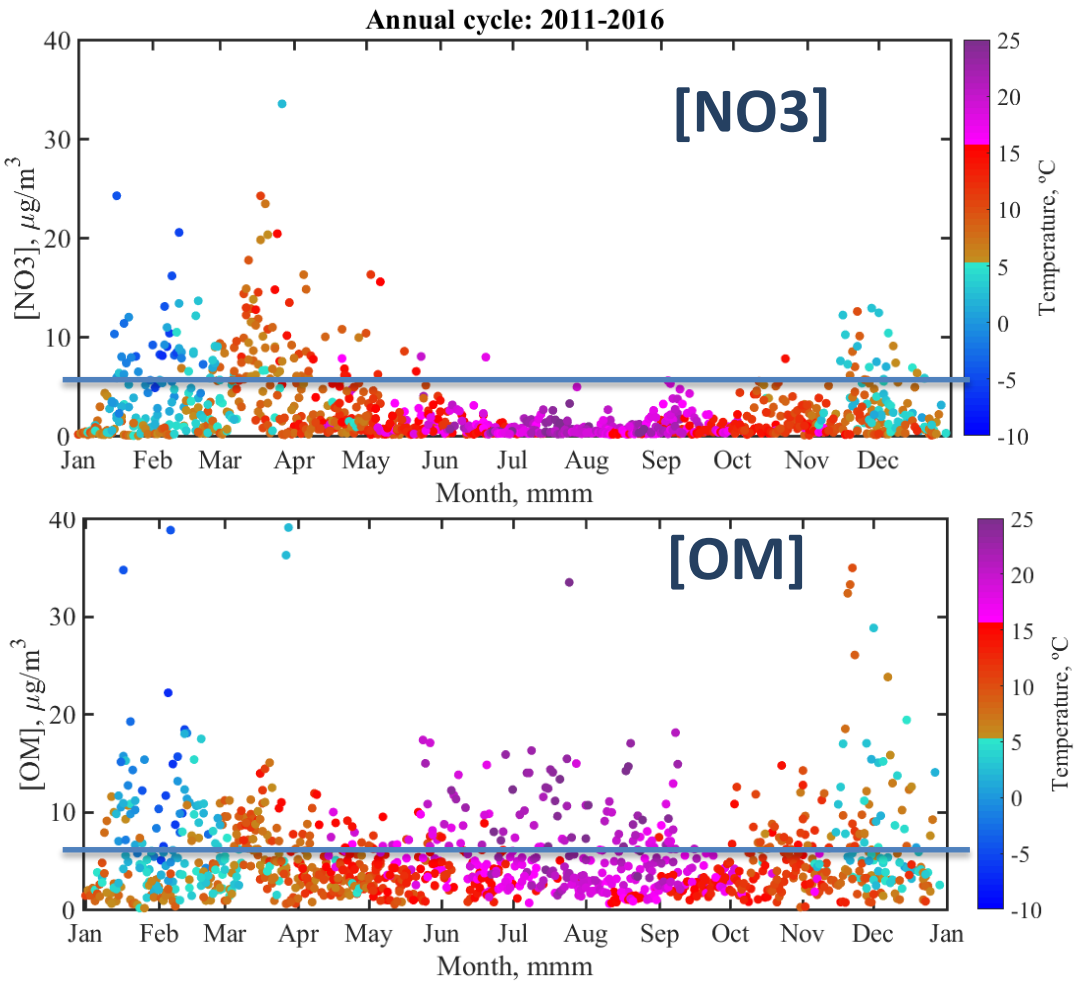
[NO3] and **[OM]** is analysed since [NO3] + [OM] ~ 70% of [PM1]

[NO3] peaks in:

- **Winter:** Low Temperature
- **Spring:** Agricultural source

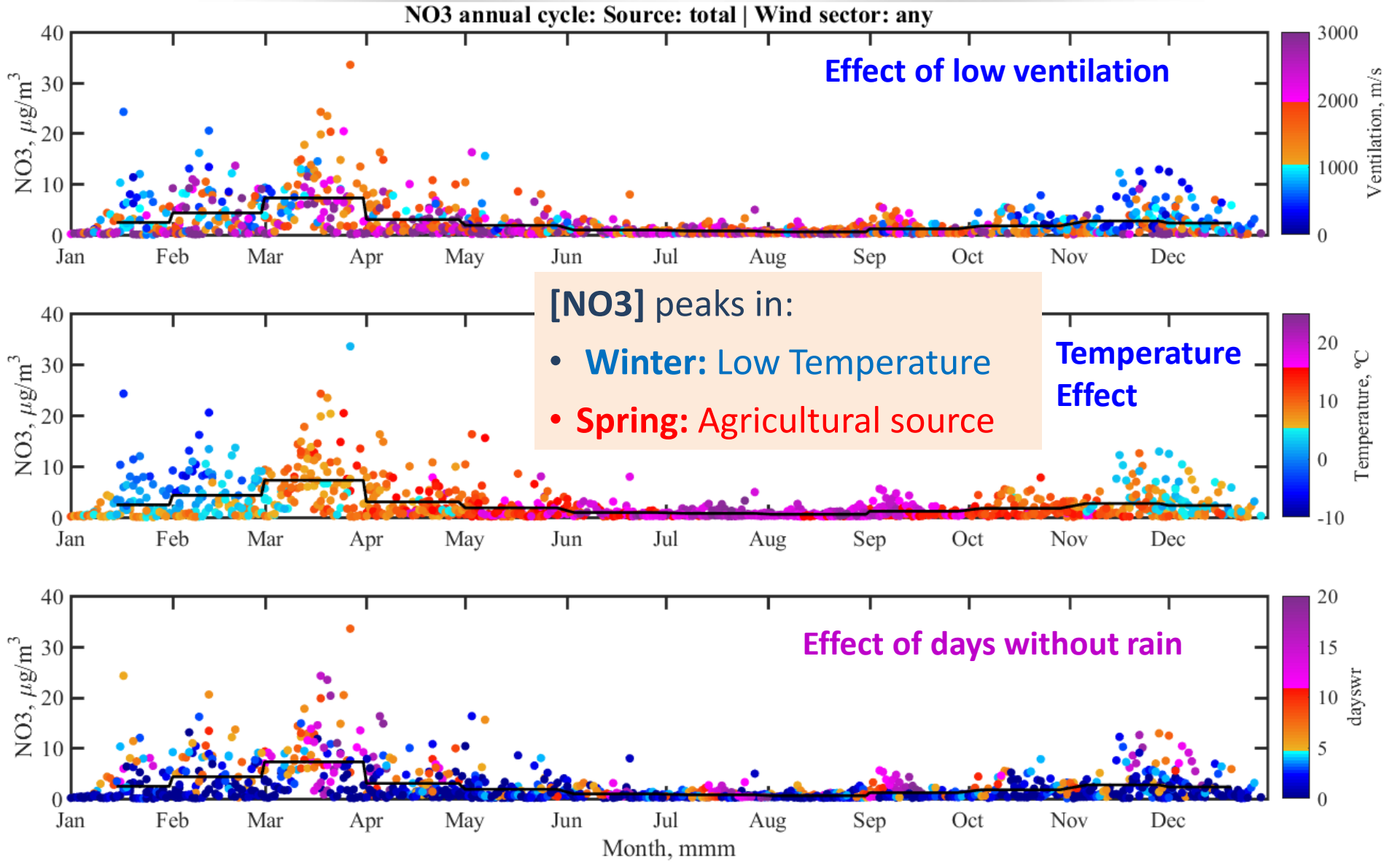
[OM] peaks in all seasons

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



Identify conditions with high pollutant concentration

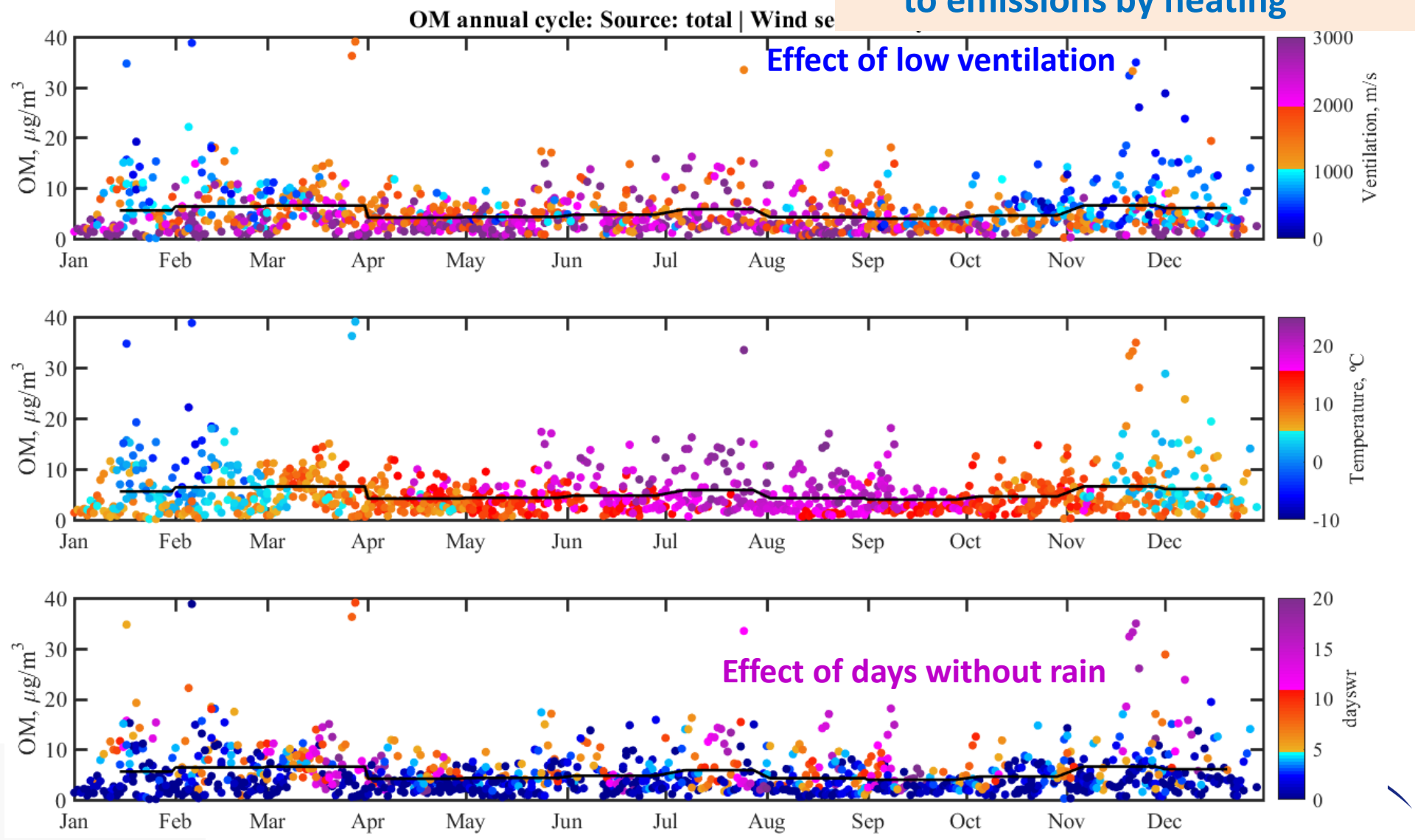
Main PM1 pollution component analysis: NO3



Main PM1 pollution component analysis: OM

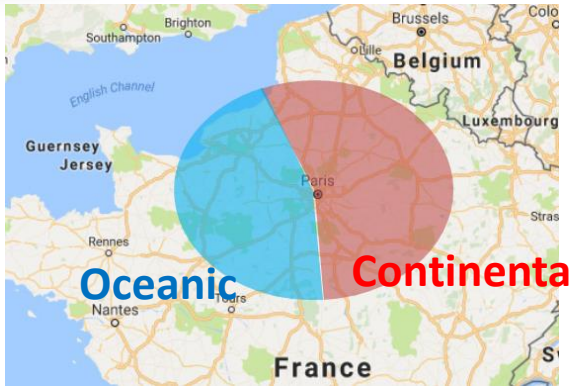
[OM] peaks in all seasons

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



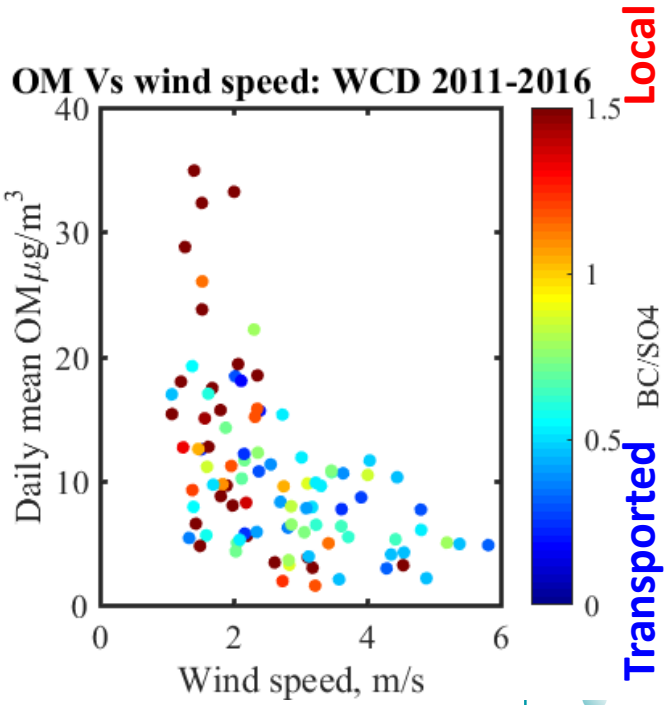
Pollution as a function of air mass origin

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

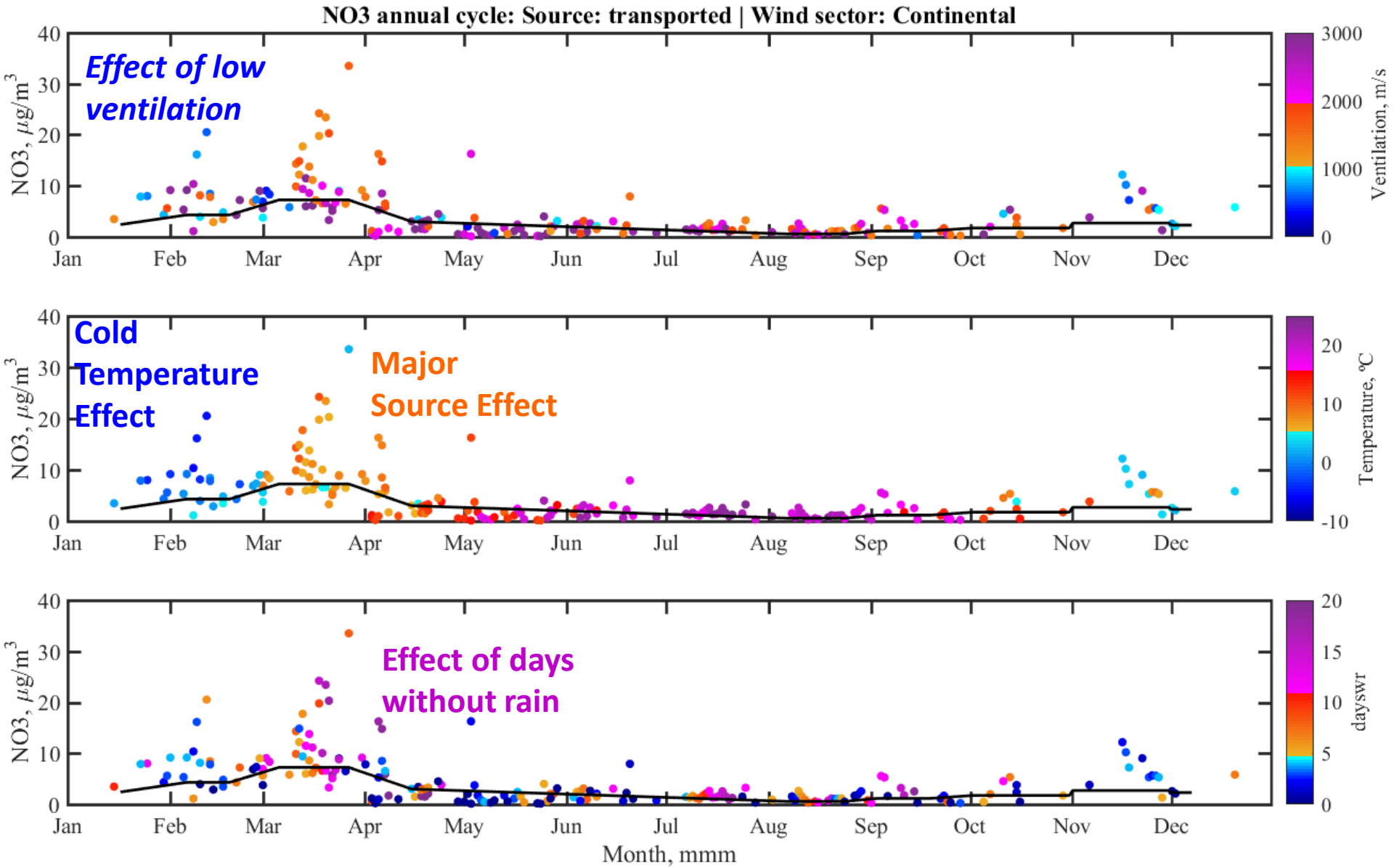


- Oceanic VS Continental Wind Sector
- For Continental: Local vs Transported pollution
  - **Local/Transported** by [BC]/[SO4] (Petit et al., 2015) because:
    - BC: primary
    - SO4: secondary

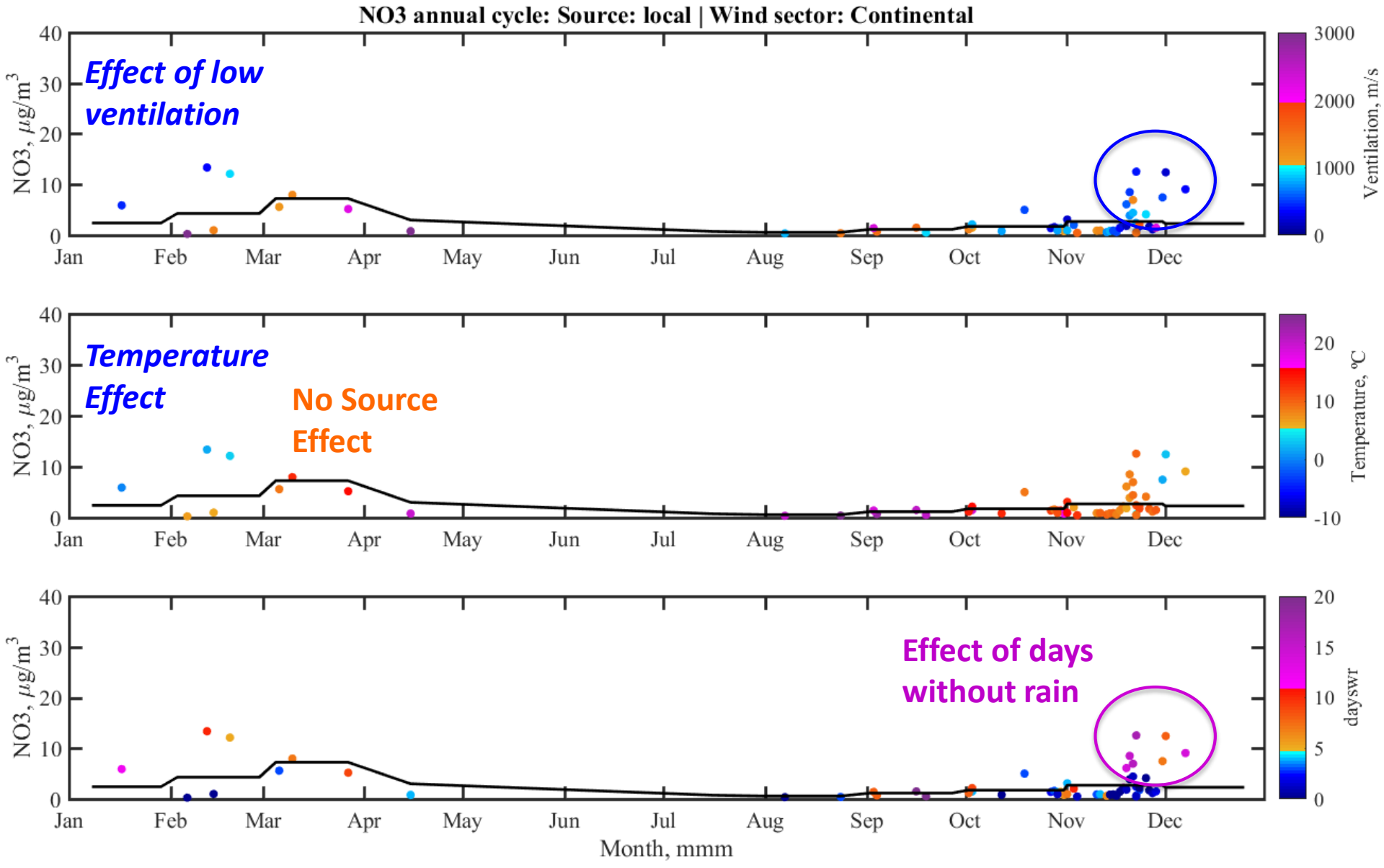
- **Local**: BC/SO4 > 1,5
- Mixed: 0.5<BC/SO4 < 1,5
- **Transported**: BC/SO4 < 0,5



NO3 Continental & Transported

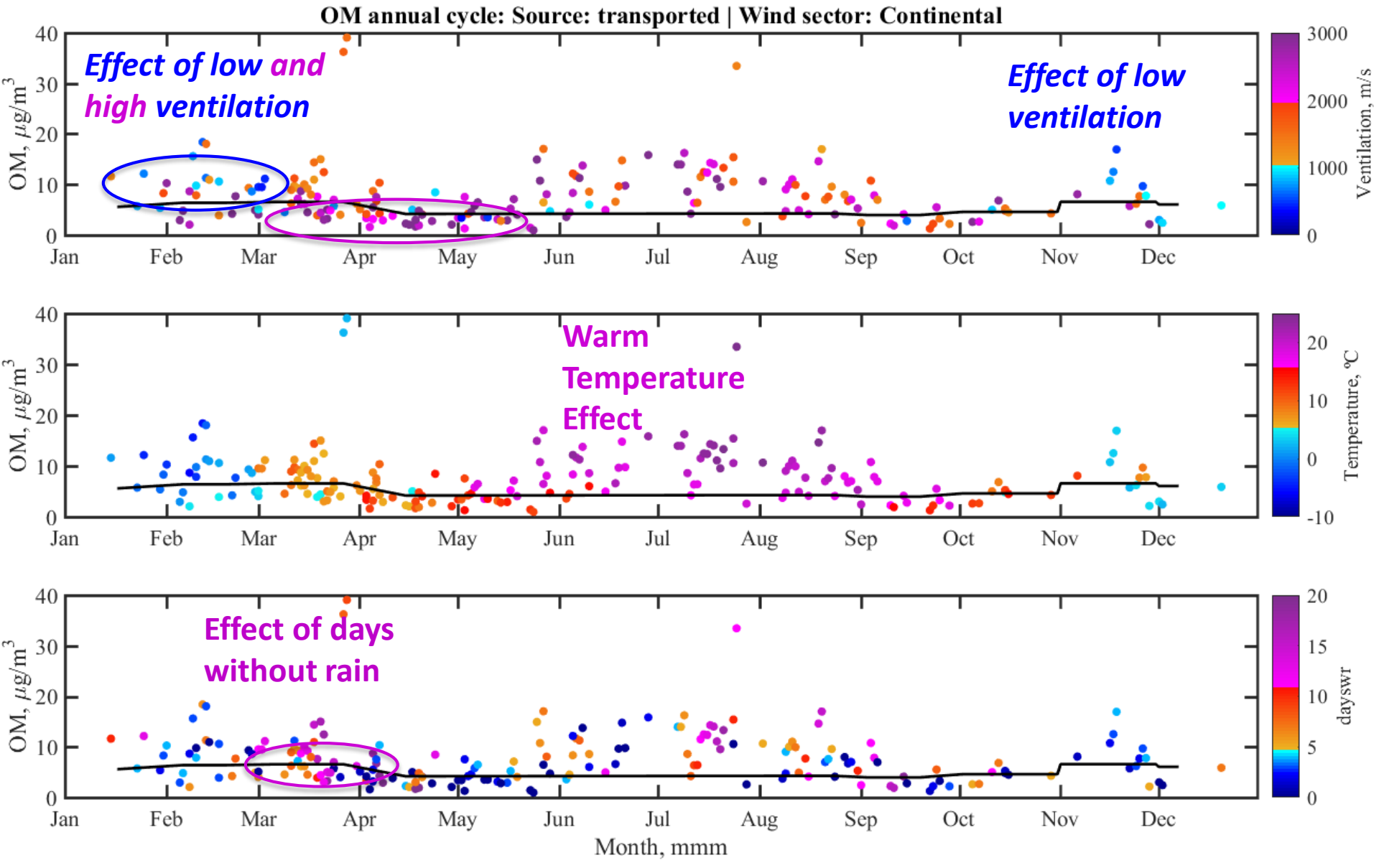


NO3 Continental & Local



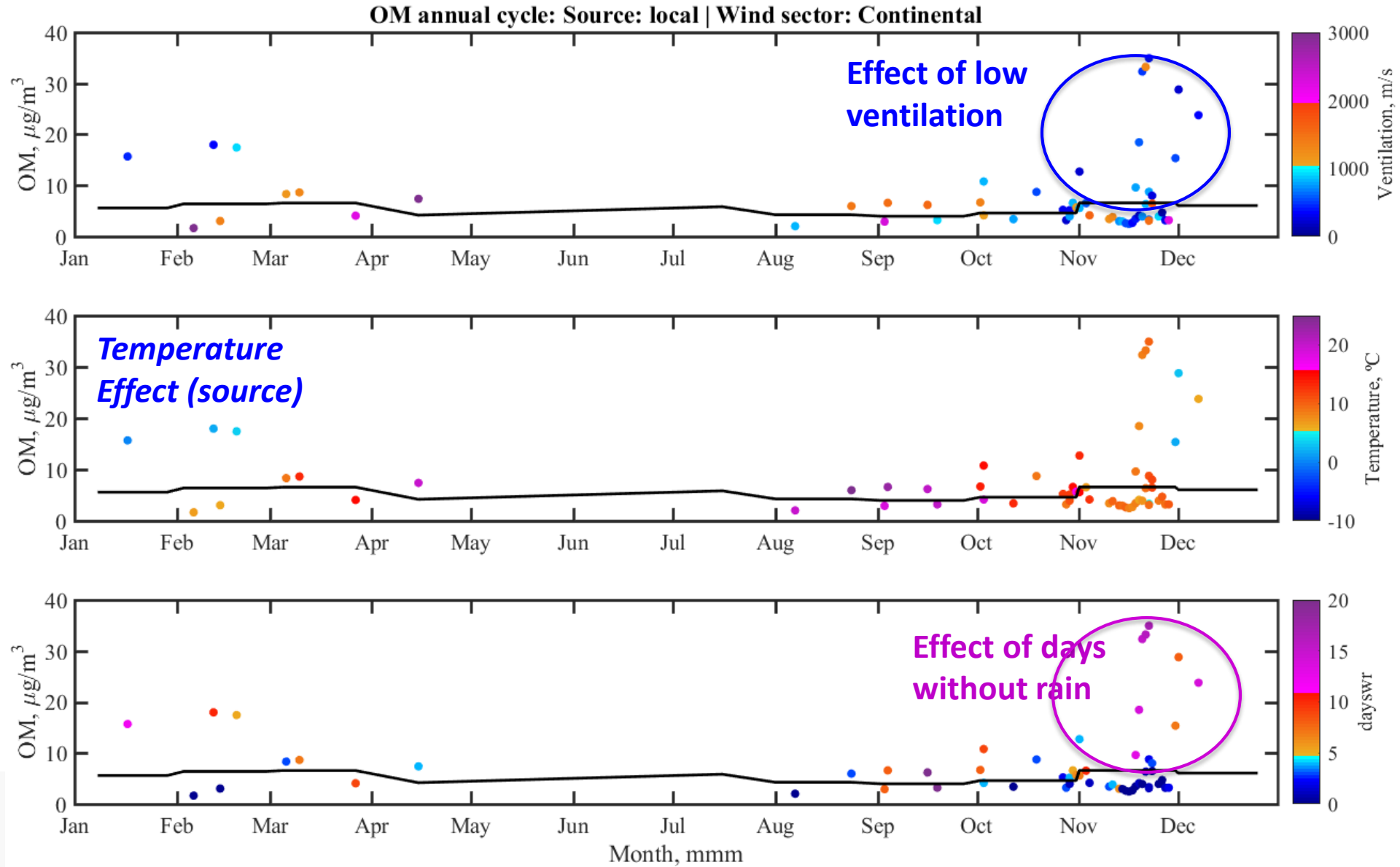
OM Continental & Transported

Multi-parameter effects



OM Continental & Local

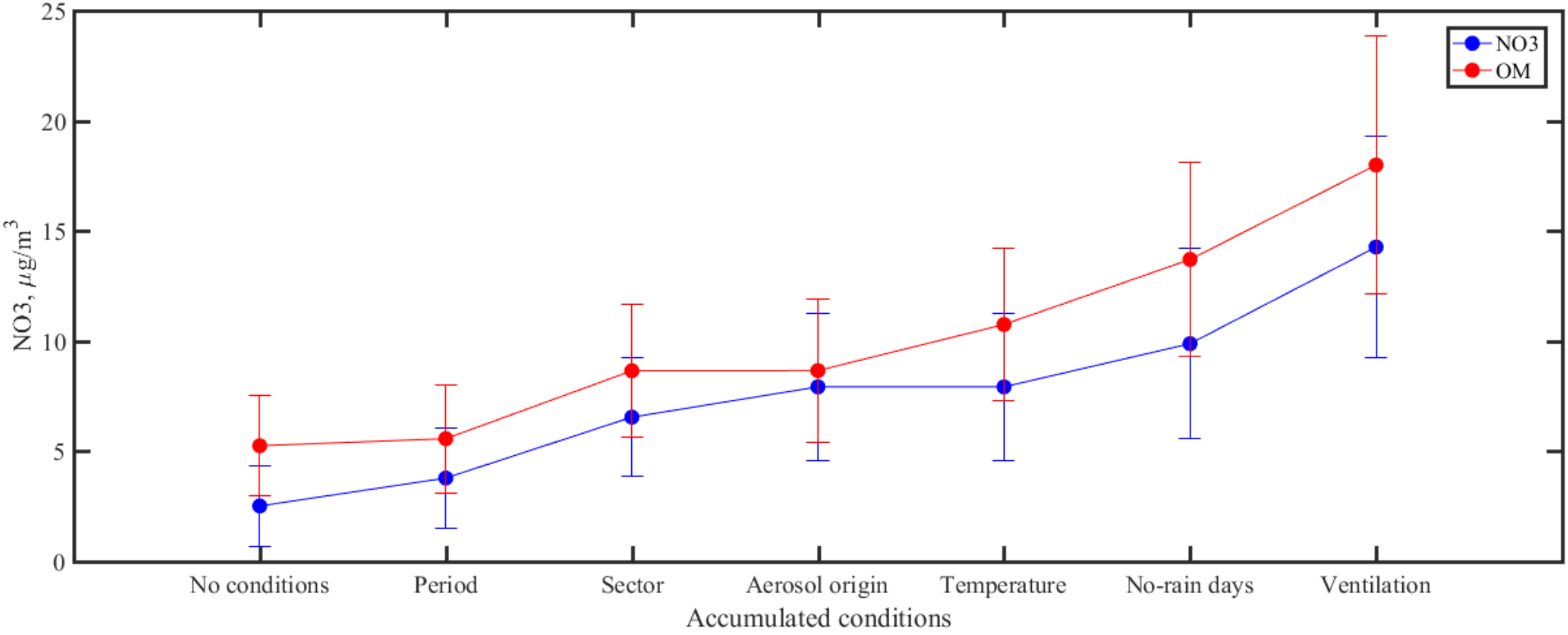
Multi-parameter effects



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

- Pollution events occur in contrasted situations (high/low wind/ABLH/T)
- Strongest [NO3] and [OM] pollution events: continental advection, dry conditions, and low temperatures [NO3, OM] and high temperatures [OM]
- Wind speed and ABL height influence is usually masked by other factors
- To isolate the ABL height influence, we had to identify conditions where other variables are kept constant
- Cumulative multi-parameter conditions lead to significantly different higher pollutant concentrations
- First step to links between meteorological variables and pollutant concentrations

Thanks for your attention

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