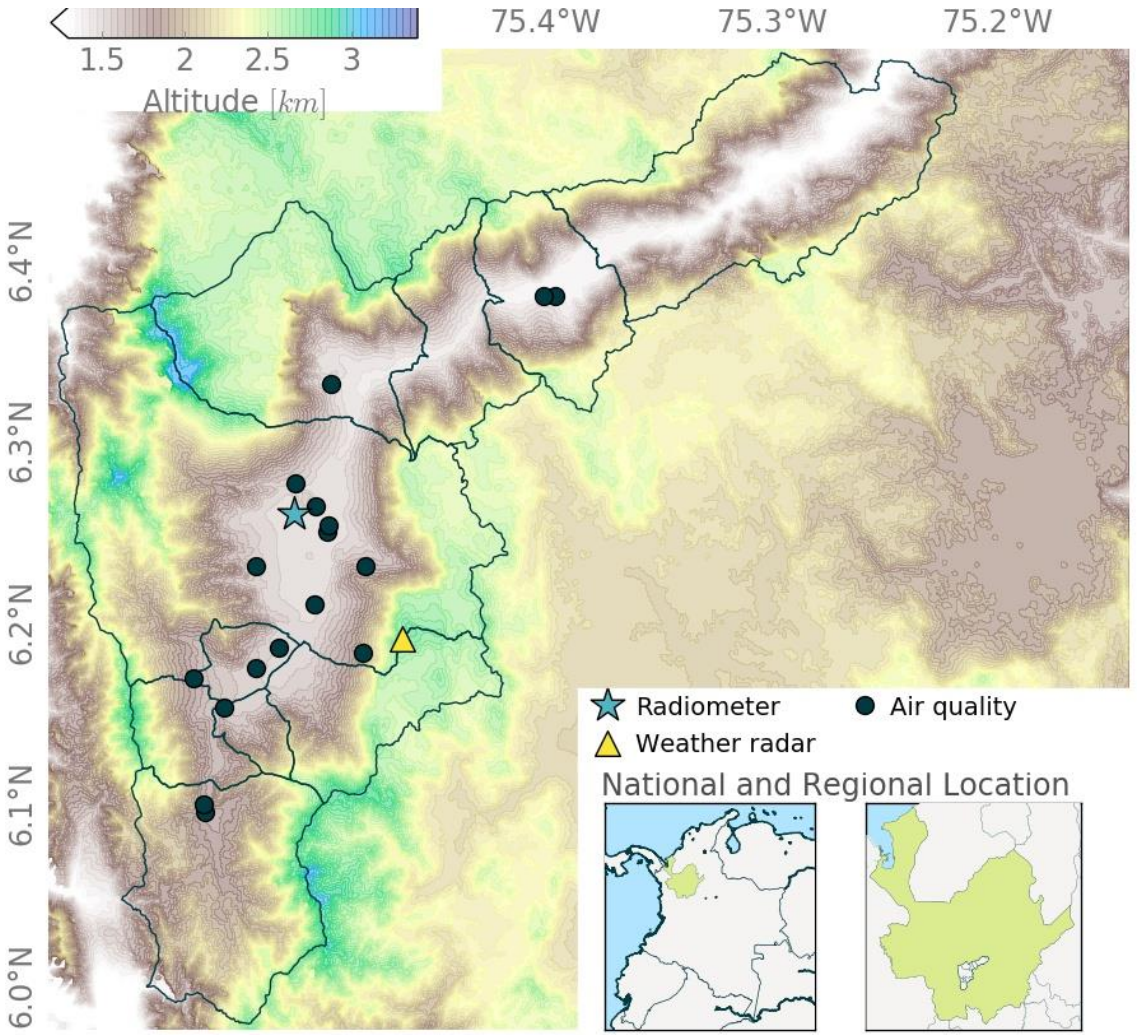
Direct and indirect effects of precipitation on Particulate Matter concentrations in the Aburrá Valley

Natalia Roldán
Carlos D. Hoyos
Laura Herrera

Con el apoyo de:

Un proyecto de:

Aburrá Valley Location



- Densely populated area
- Narrow and steep
- Air pollution is currently a main concern

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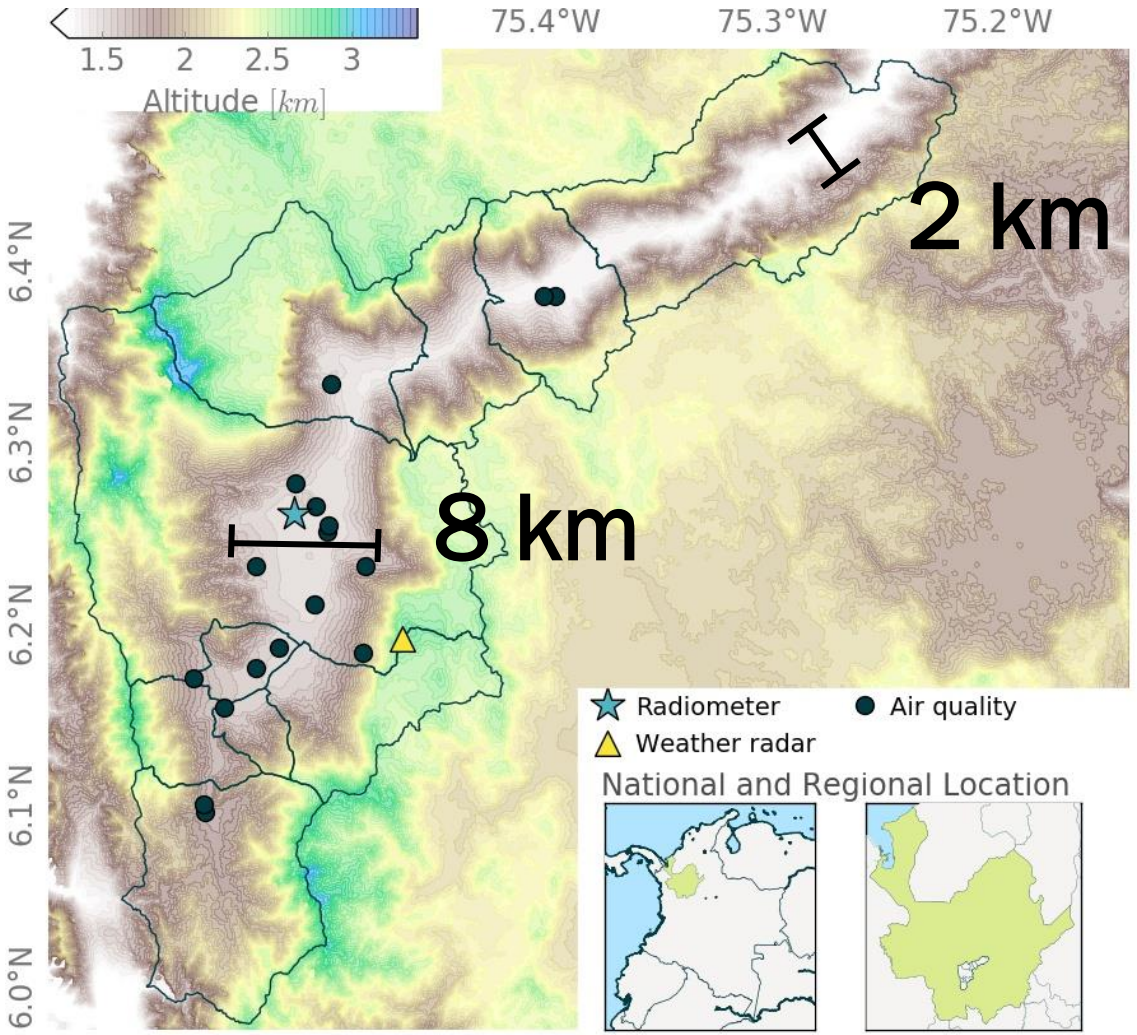

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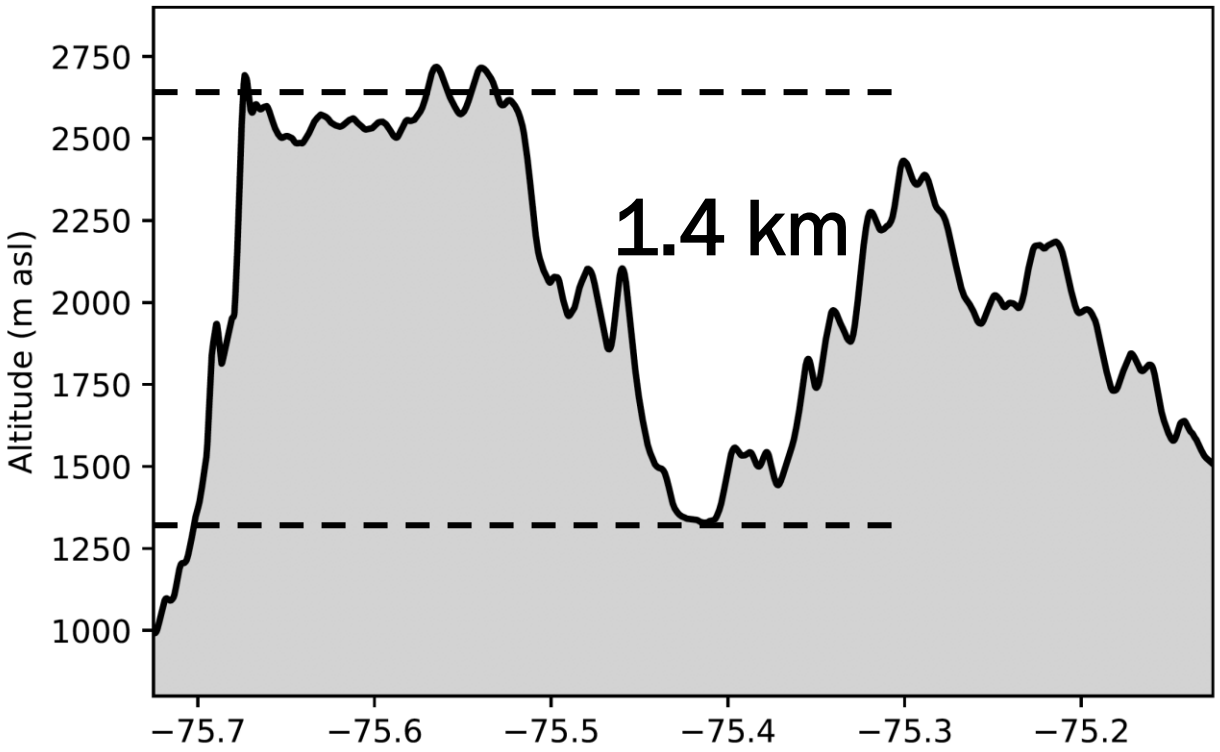

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Aerosol ”Removal” Processes

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- Horizontal **Advection.**

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Laura Herrera, Friday 2:55 pm, La Nouvelle C

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- Dry and Wet deposition.

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Net removal effect is highly non-linear and depend on each other

Sensors and Data

16 BAM-1020

Weather Radar

MW Radiometer

Sensors and Data

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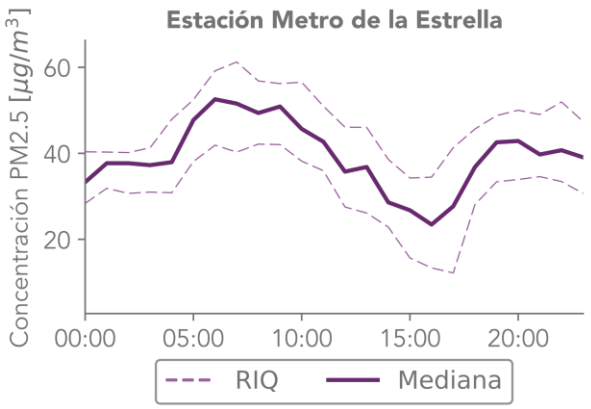

Hourly Records of Particulate matter concentration (PM2.5 and PM10)

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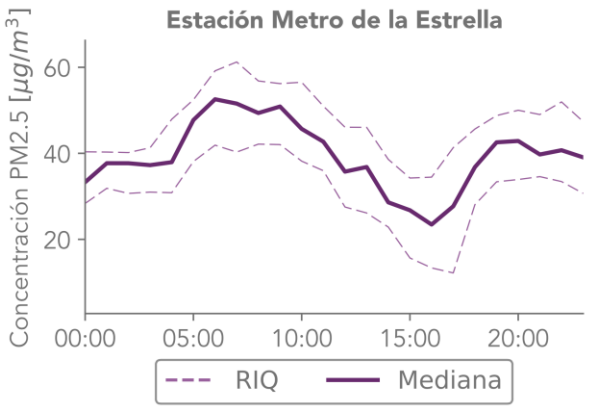

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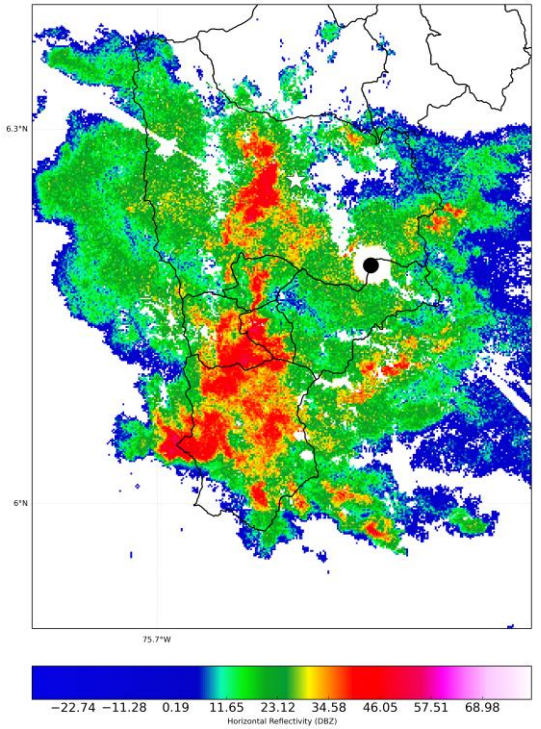

Radar Derived Precipitation

MW Radiometer

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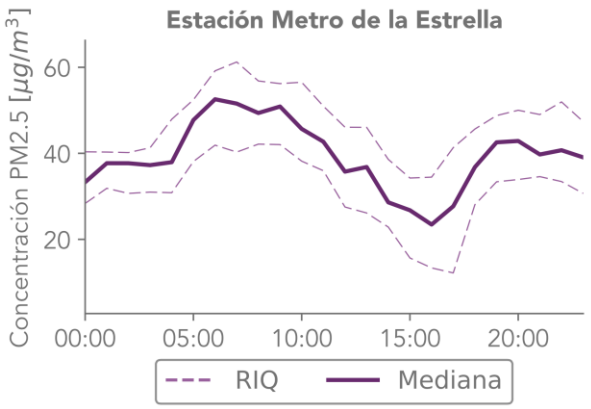

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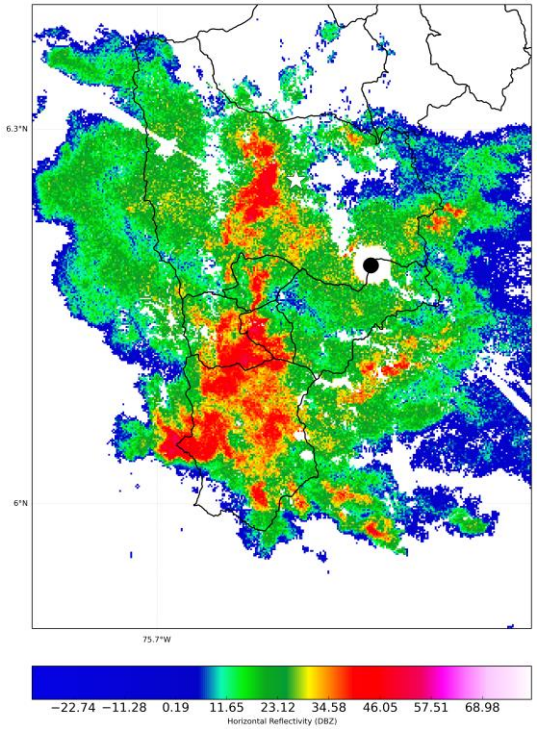

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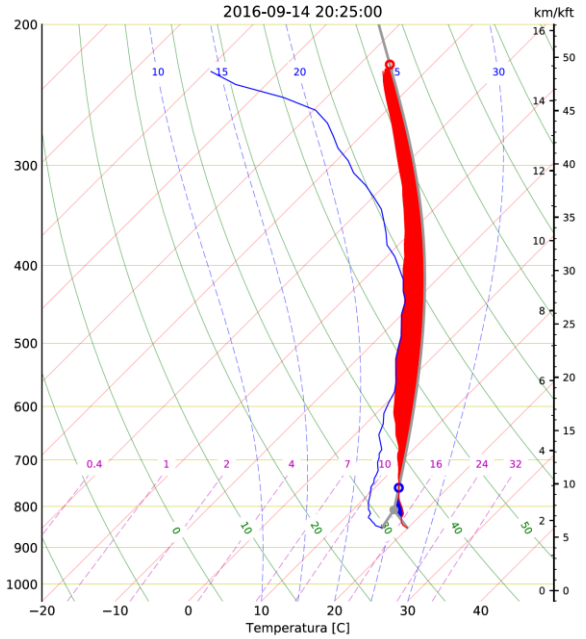

Thermodynamic Profiles

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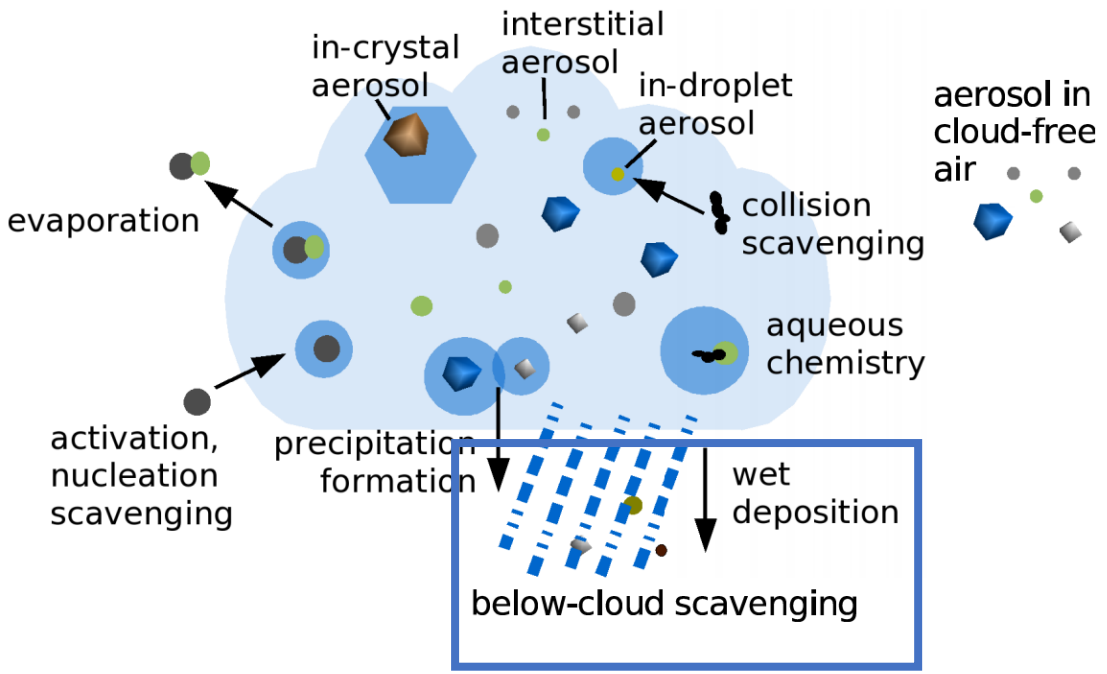
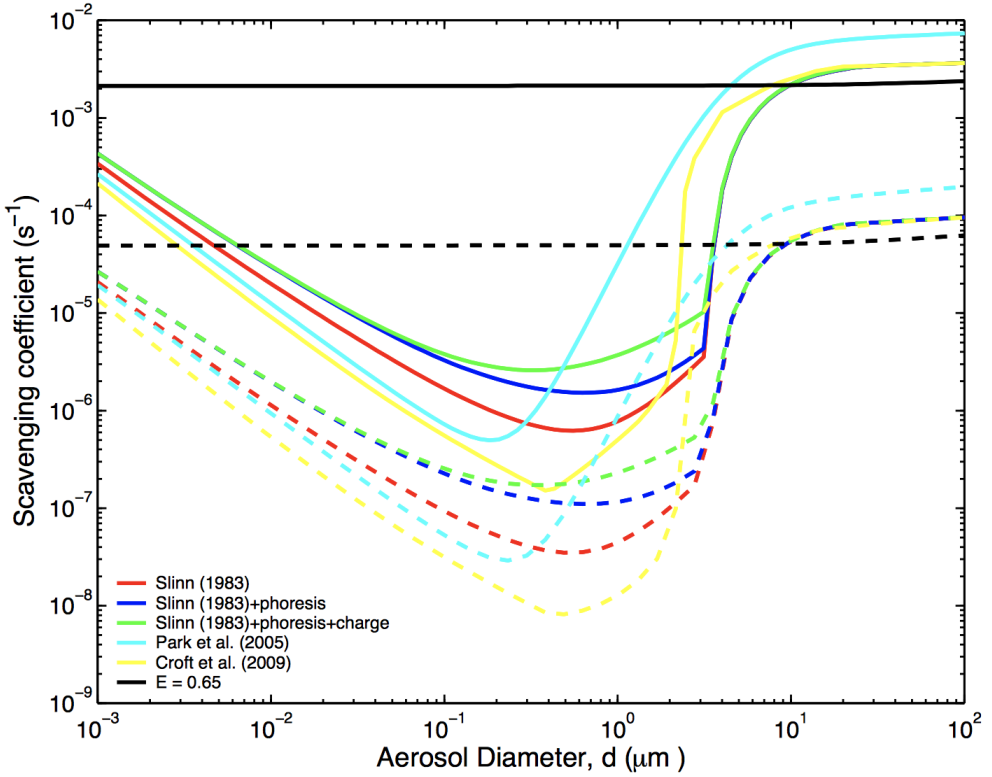
Role of Below-Cloud Scavenging



Hoose et al (2008)



Wang et al (2010)

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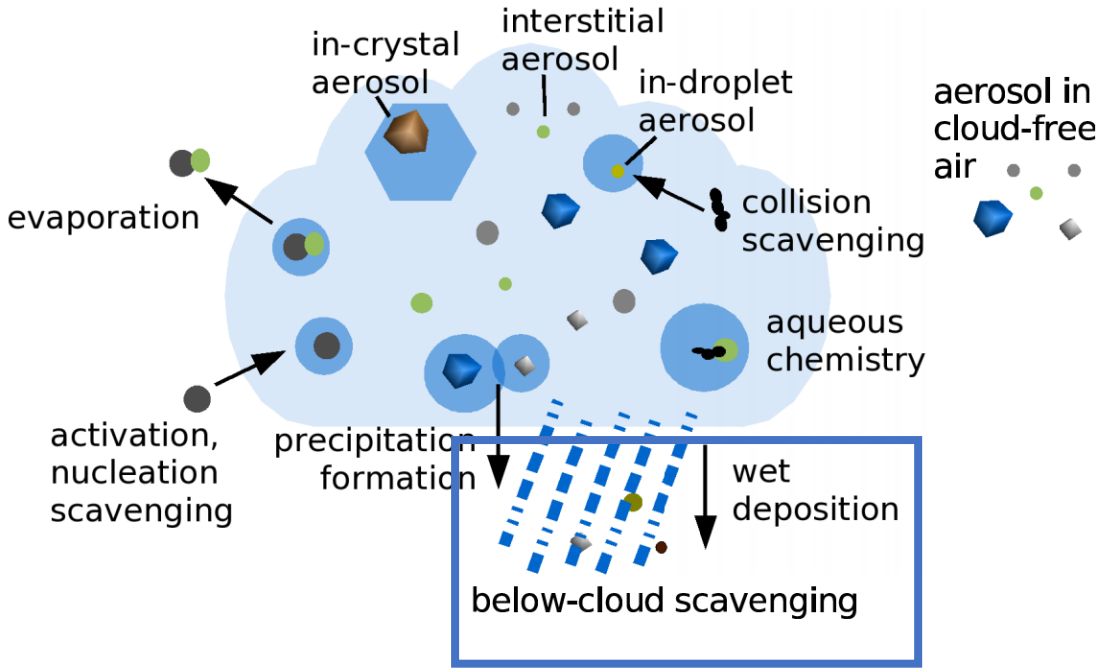

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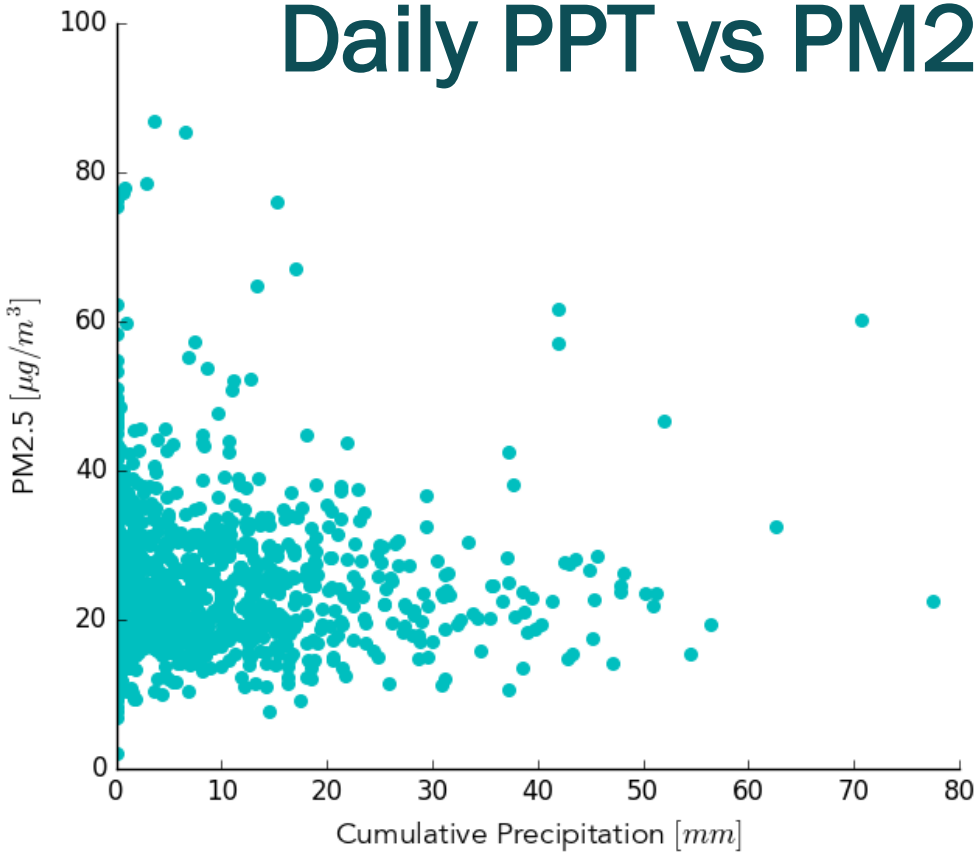
Daily PPT vs PM2.5



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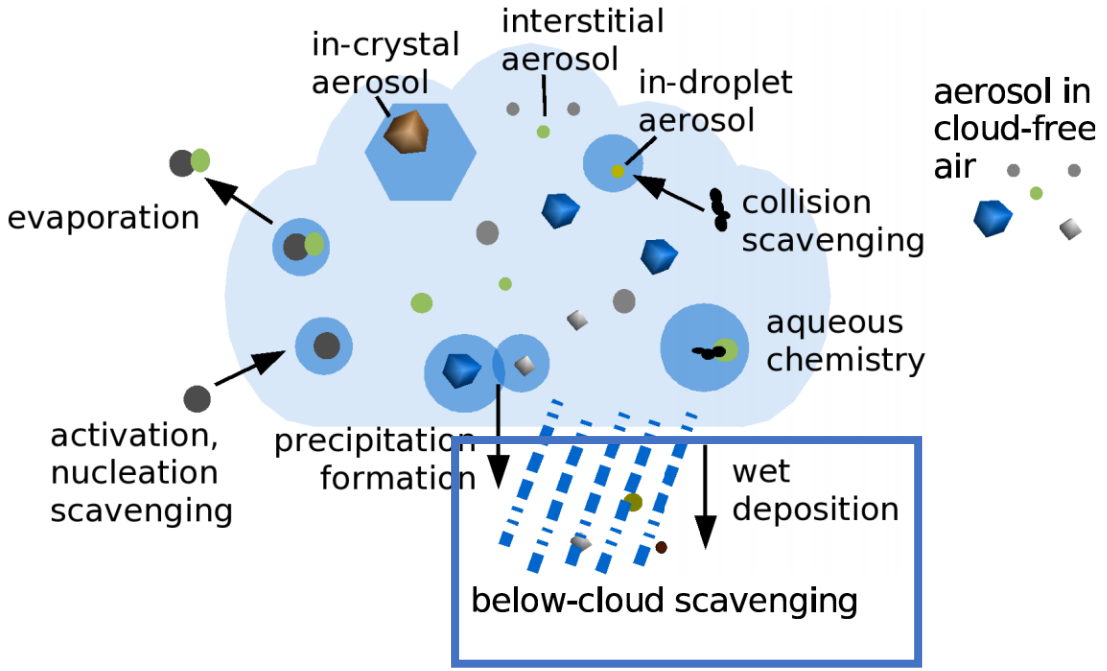

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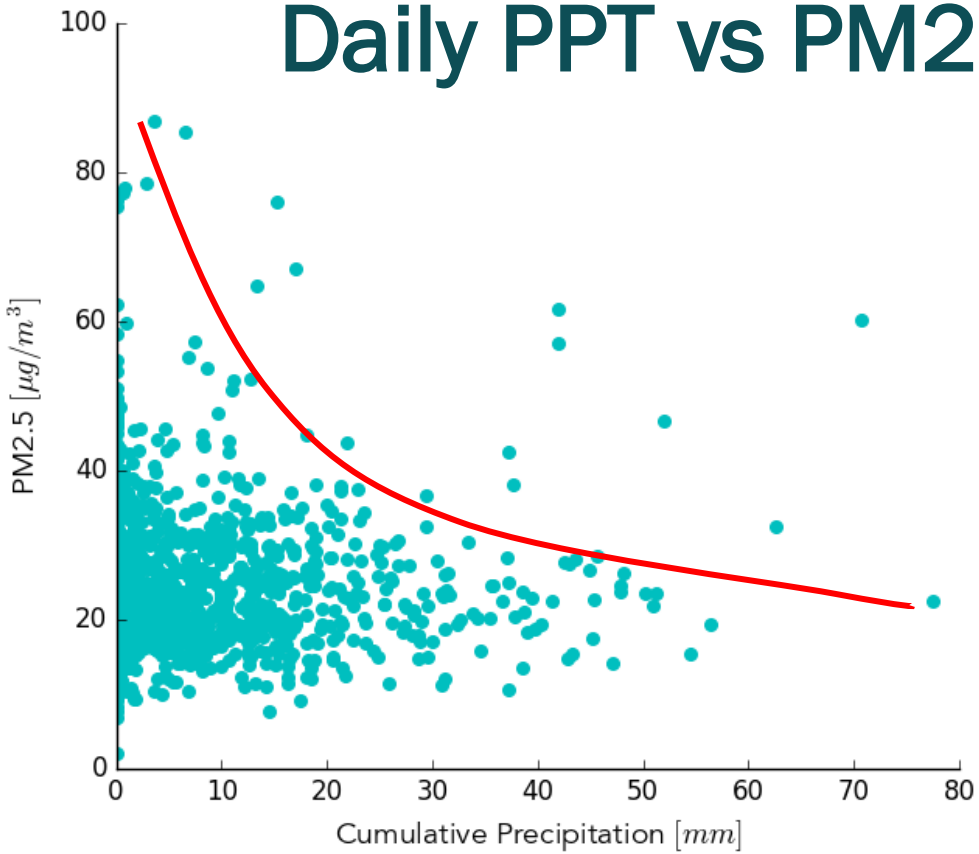

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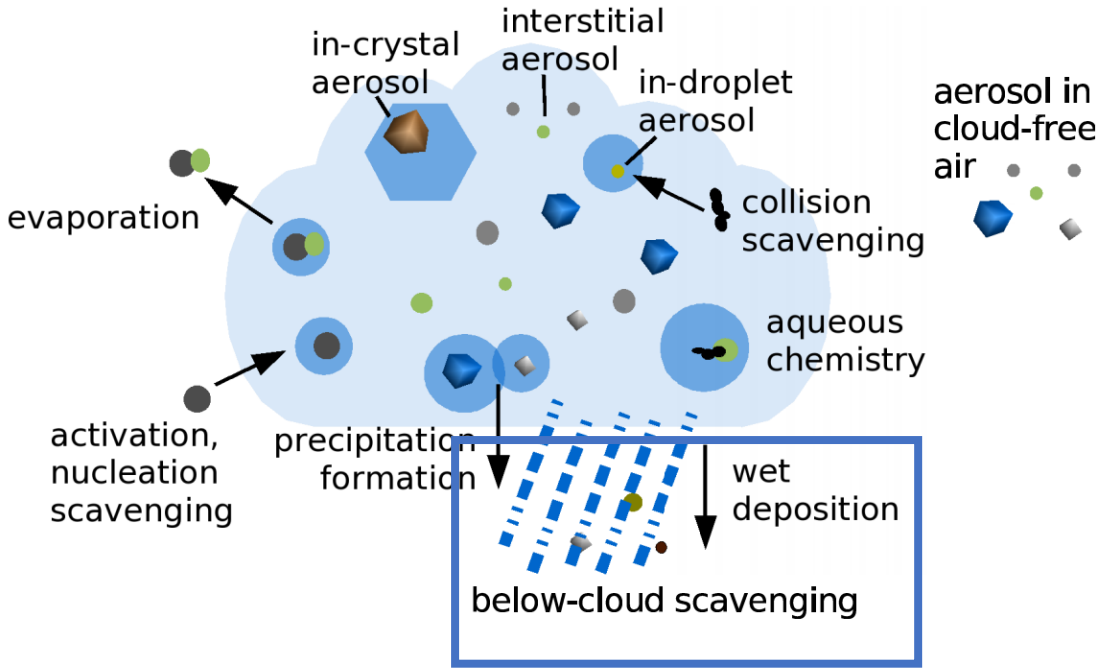

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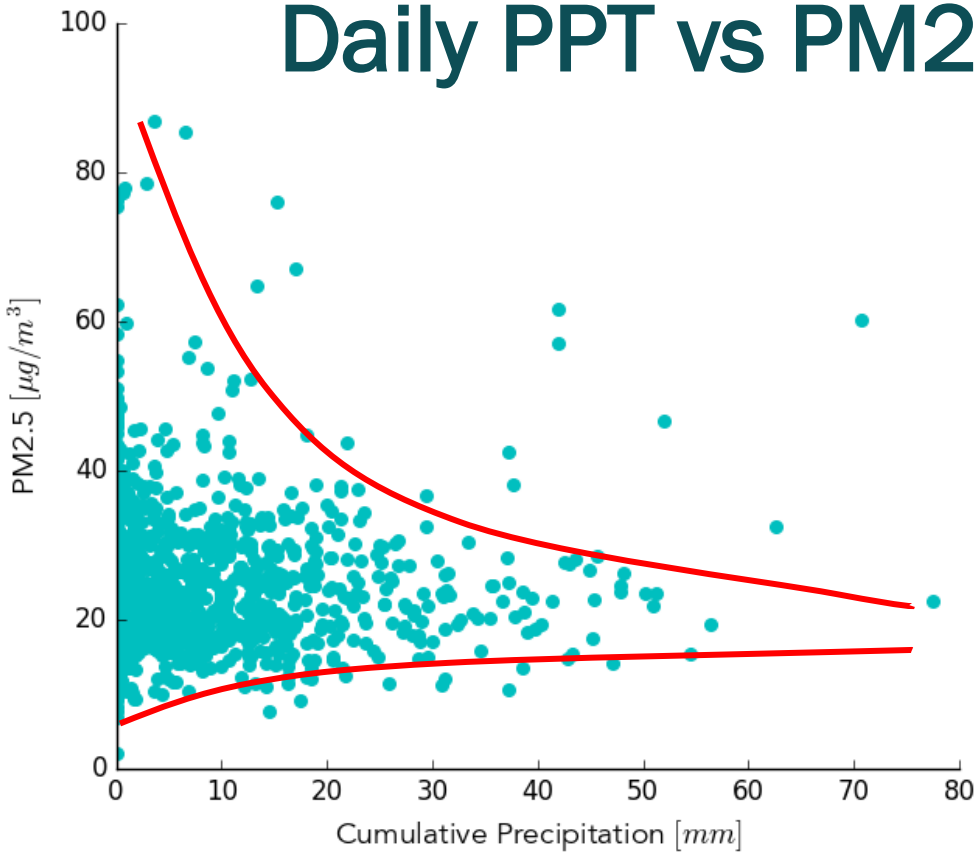

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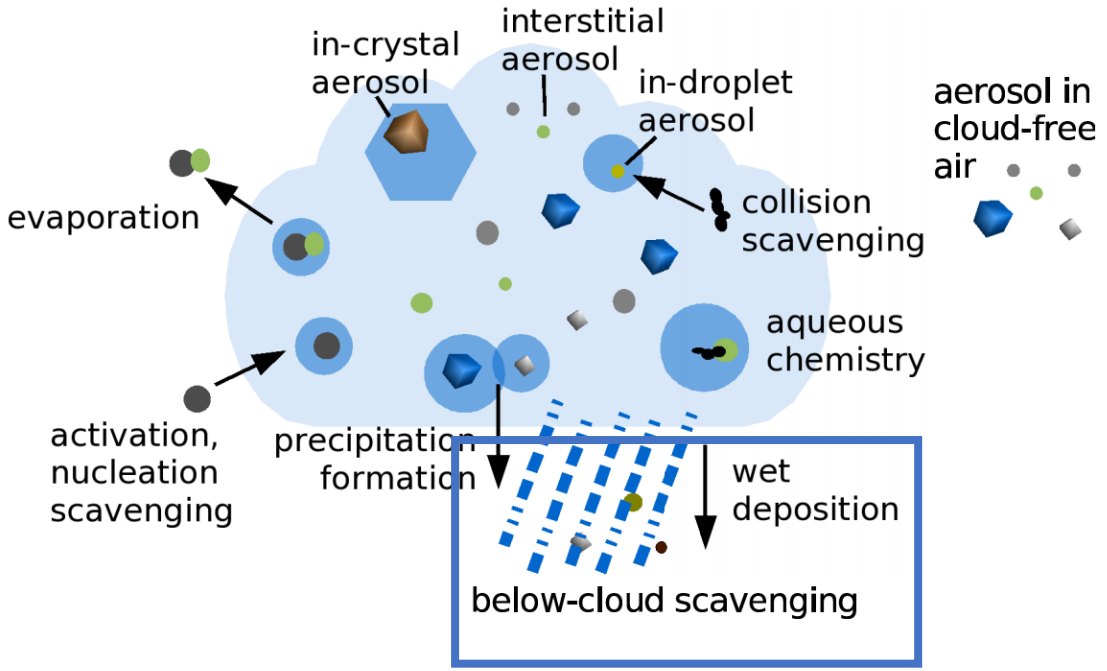

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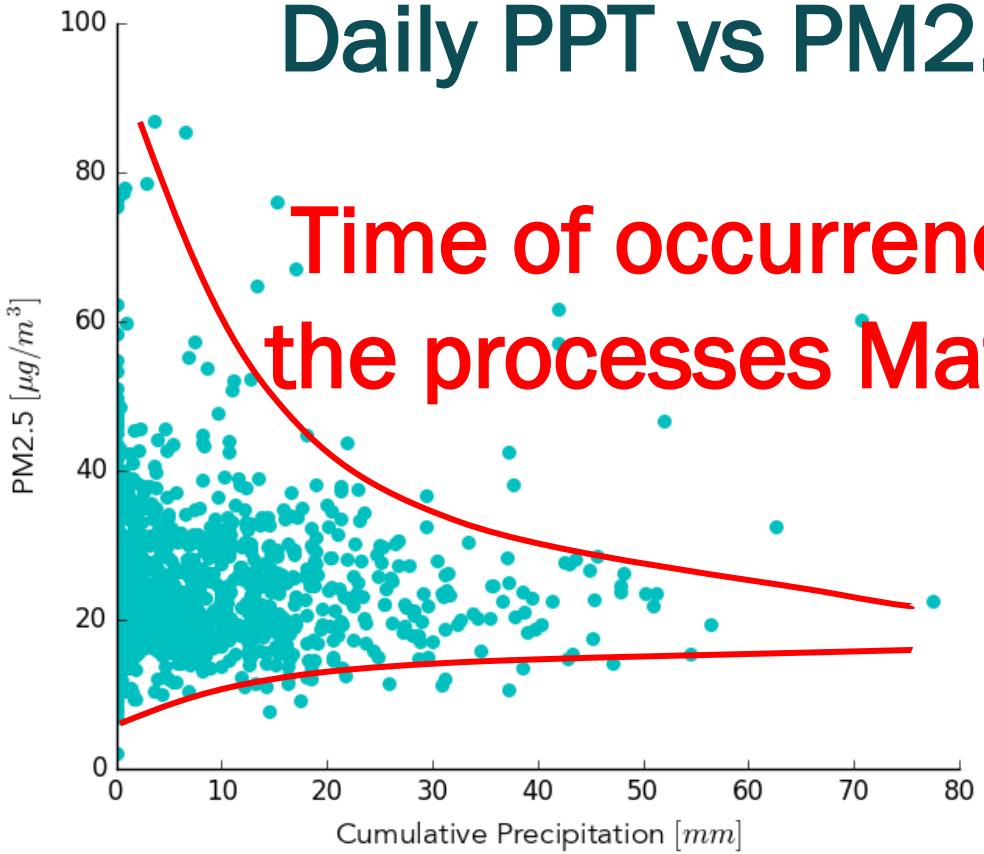
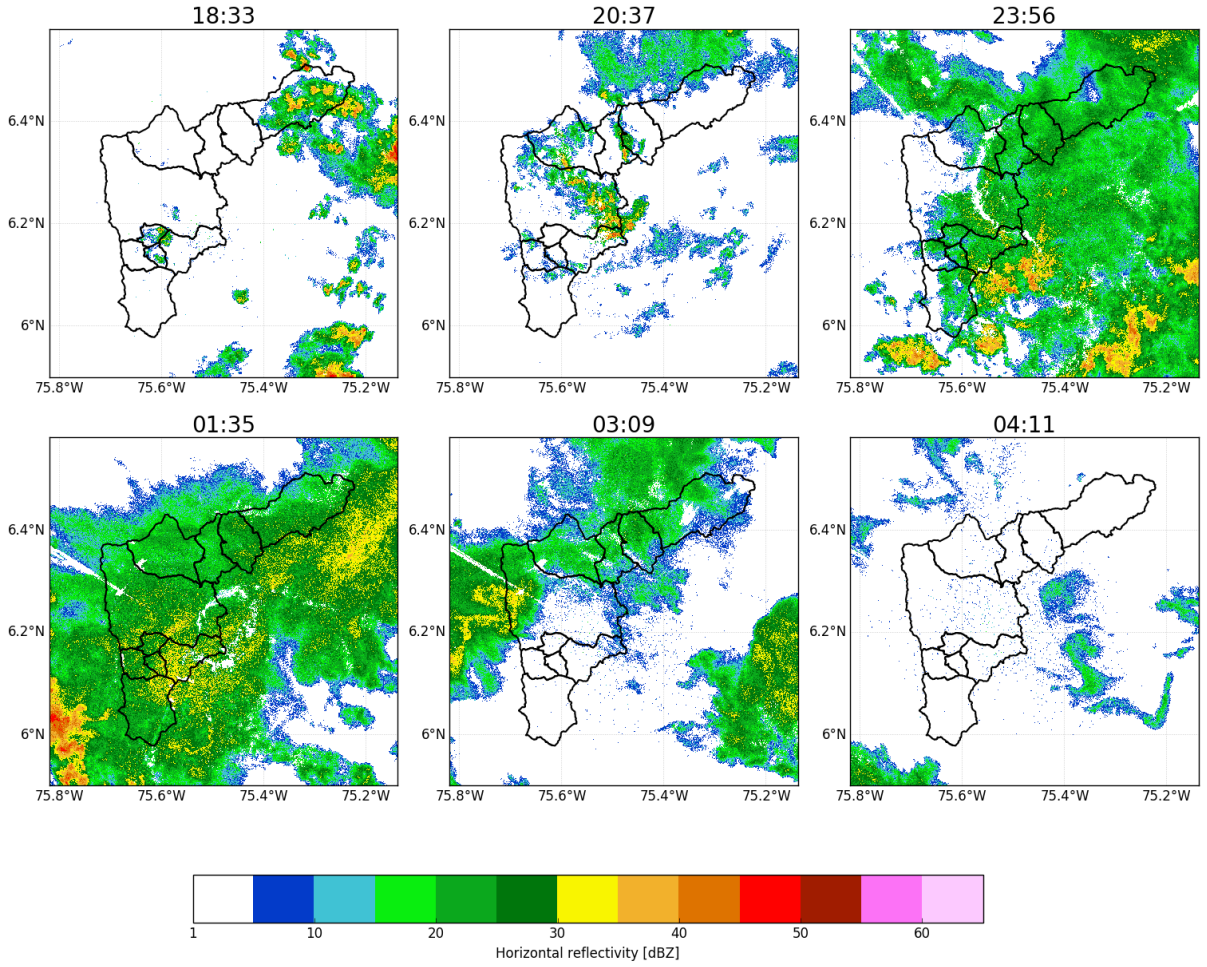


Time of occurrence of the processes Matters!

Example 1: Rain event (overnight local time)



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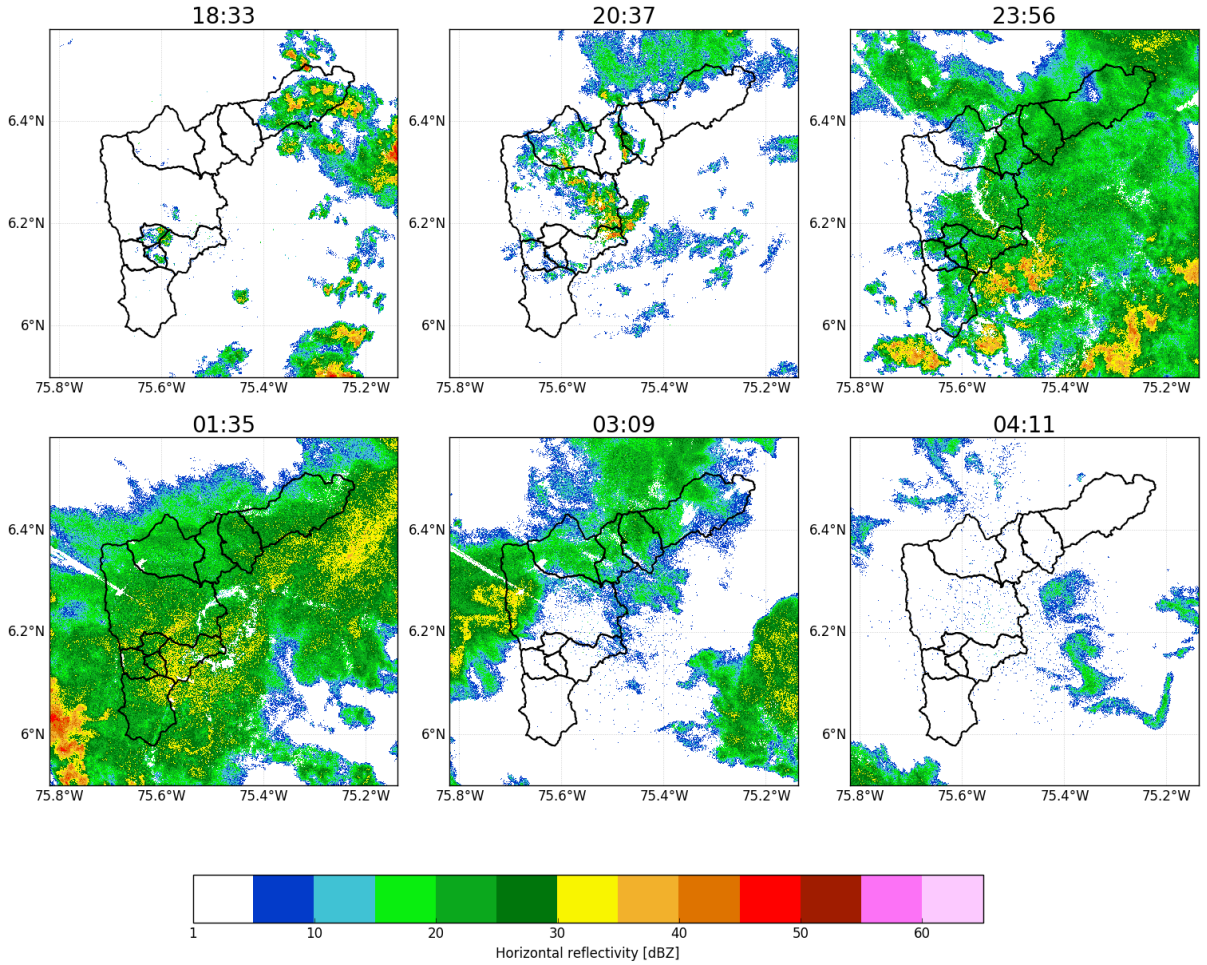

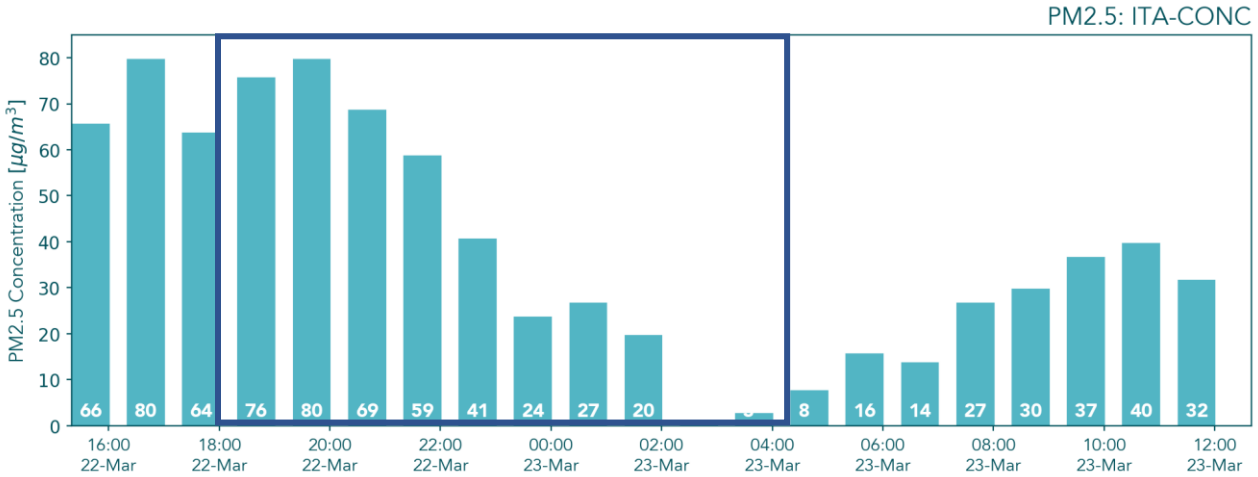

Significant PM2.5 removal

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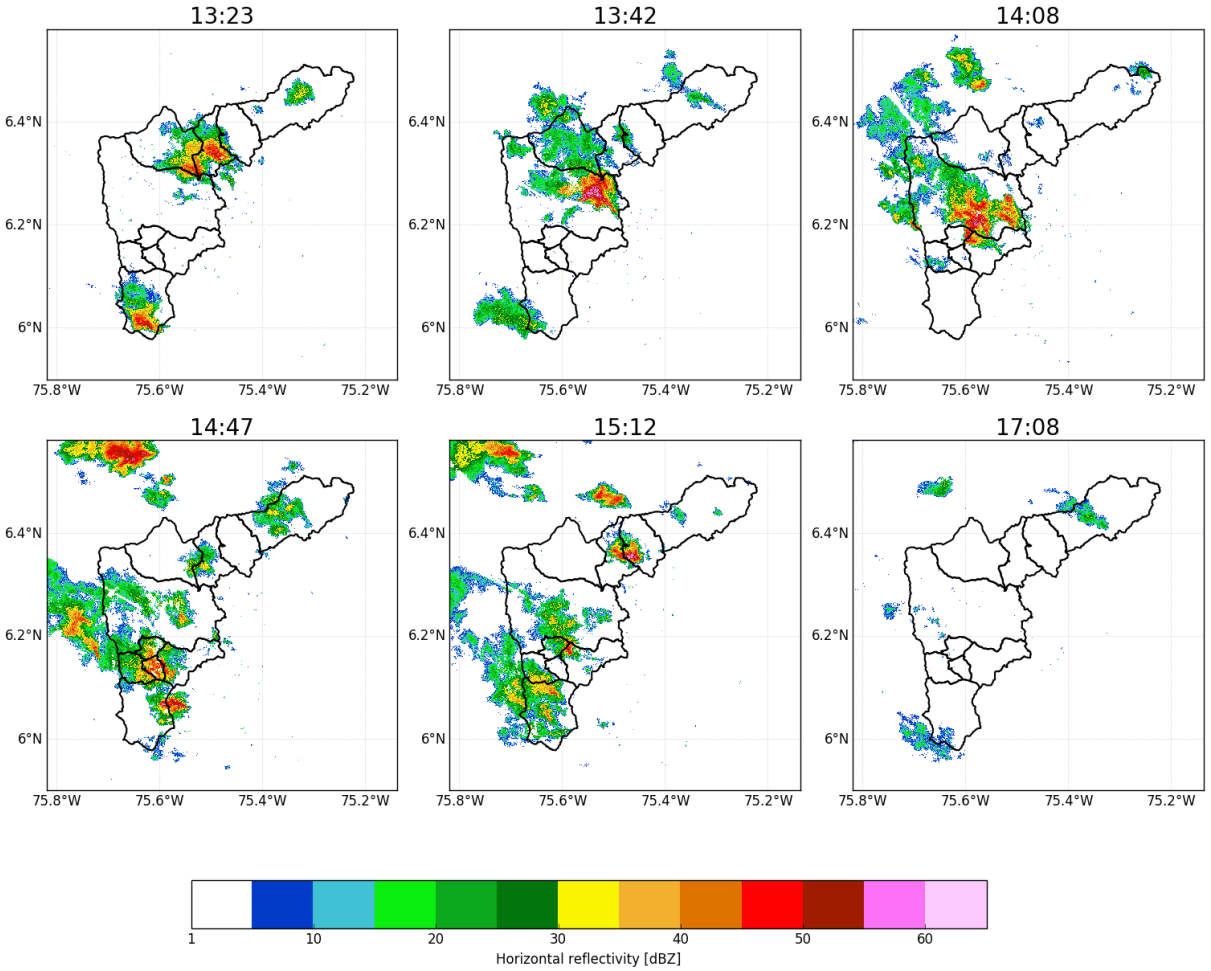
Example 2: Rain event (afternoon local time)



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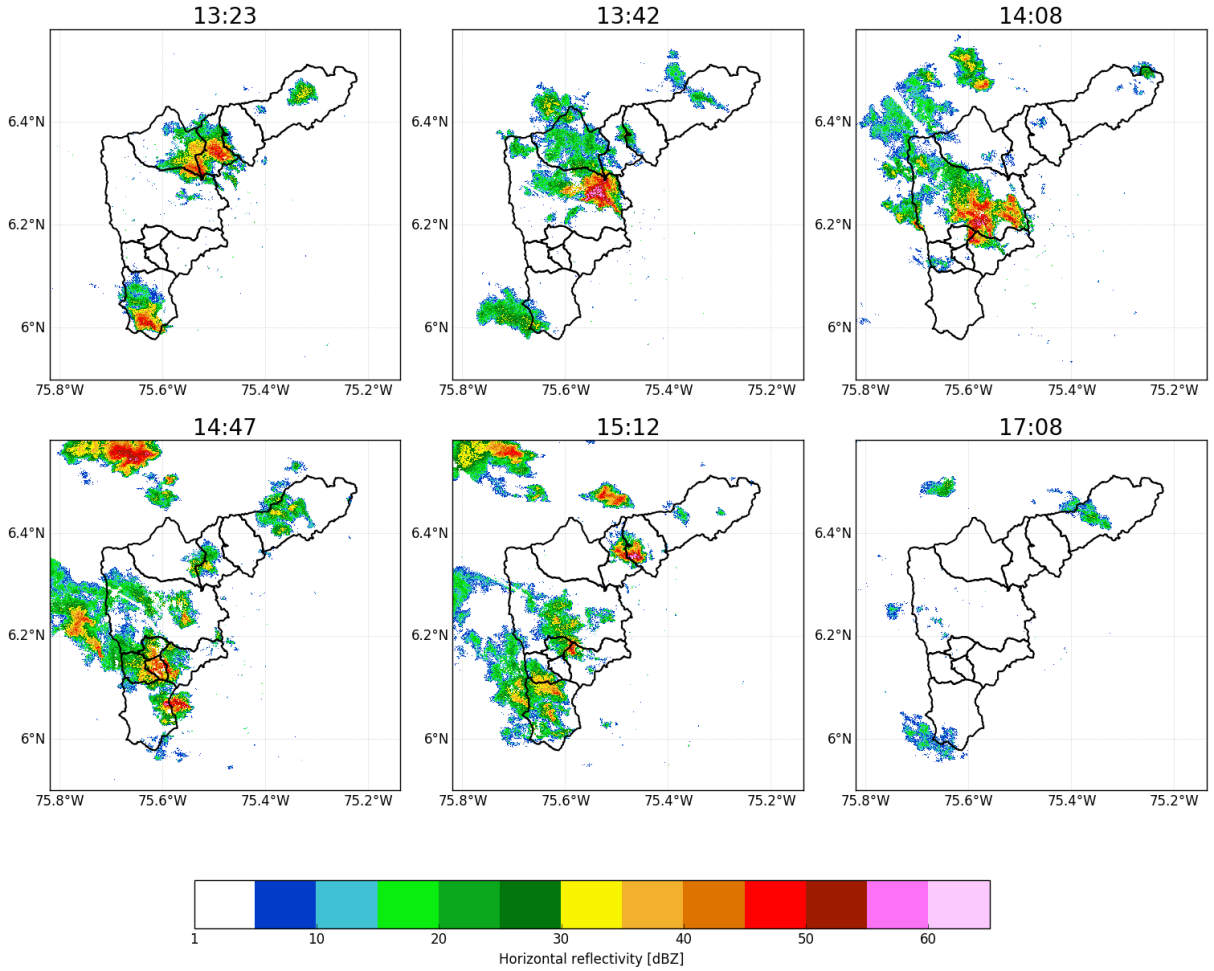

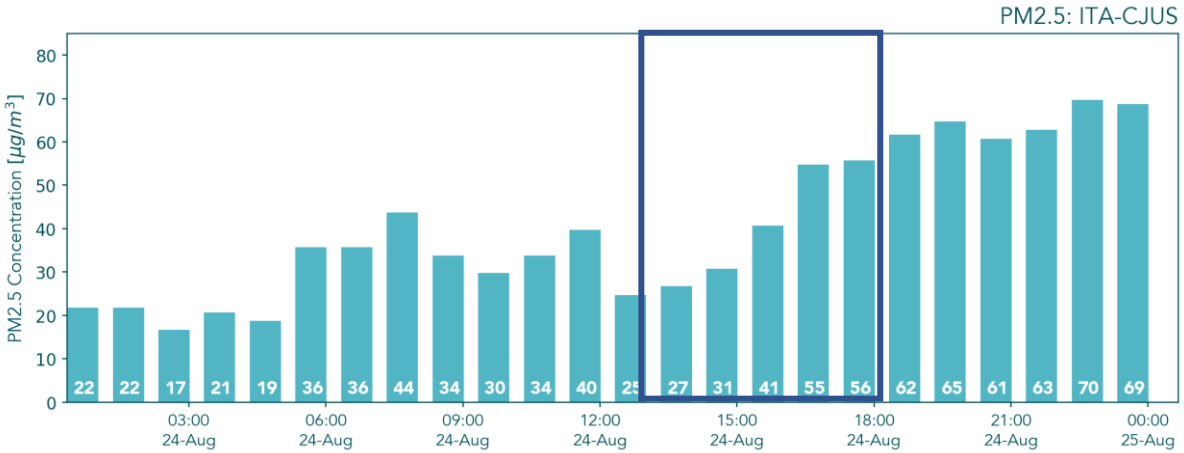

Significant increase in PM2.5 concentrations

Methodology (Bayesian Analysis)

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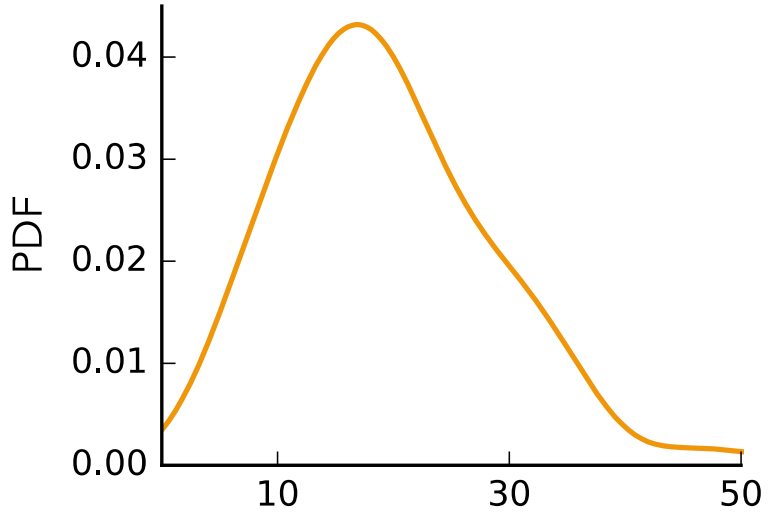

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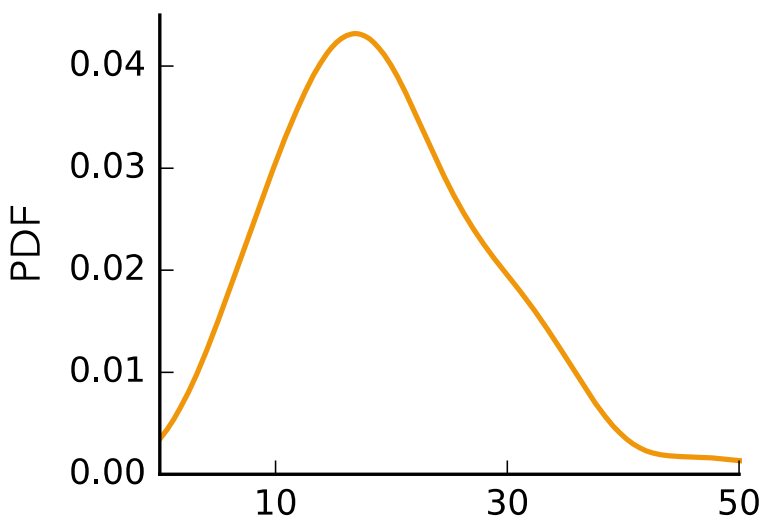

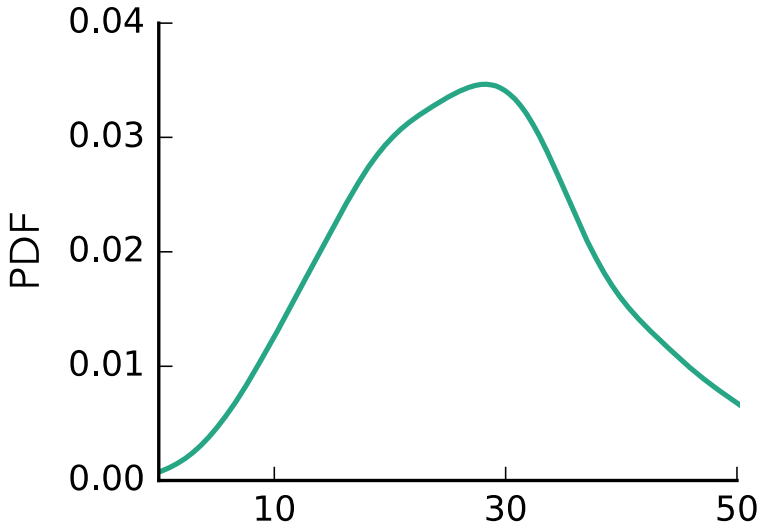

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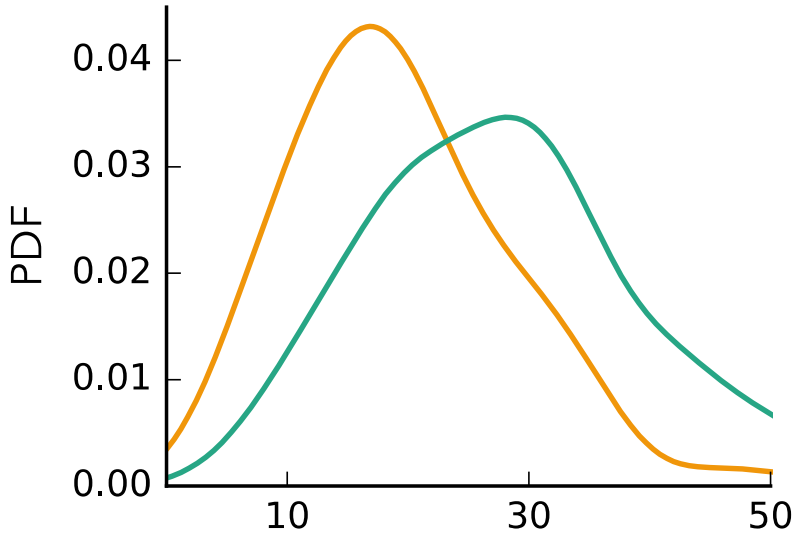
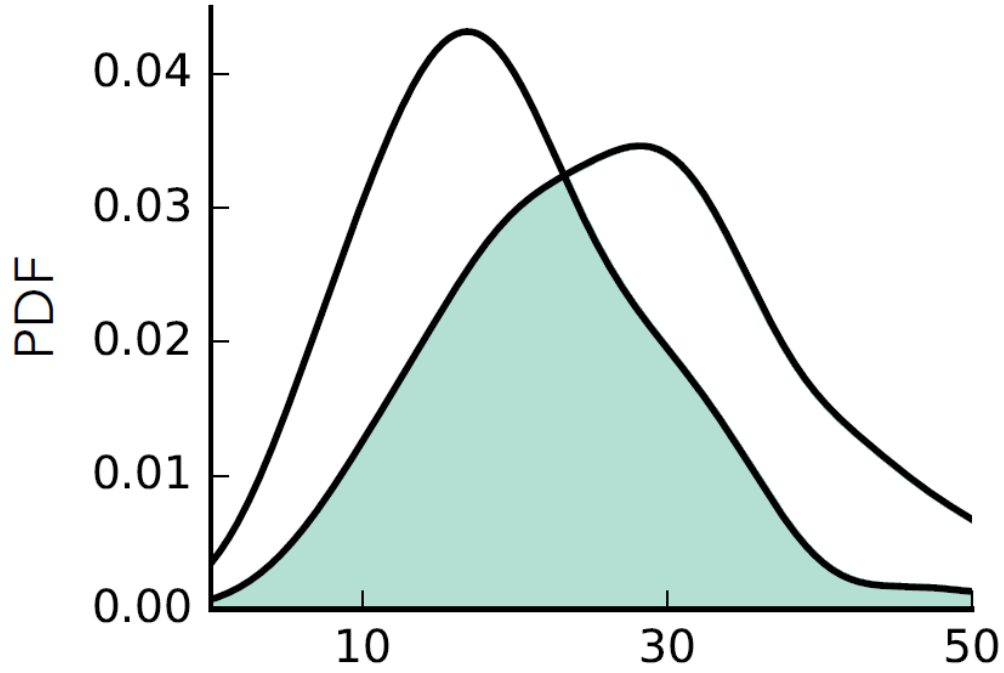


Overlapping Coeficient Complement (OVL-C)



Intersection area between PDF:

$$0 < OVL < 1$$

OVL coefficient is plotted and evaluated as its complement:

$$\boldsymbol{OVL - C} = 1 - OVL$$

When precipitation PDF median was lower, it was multiplied by -1

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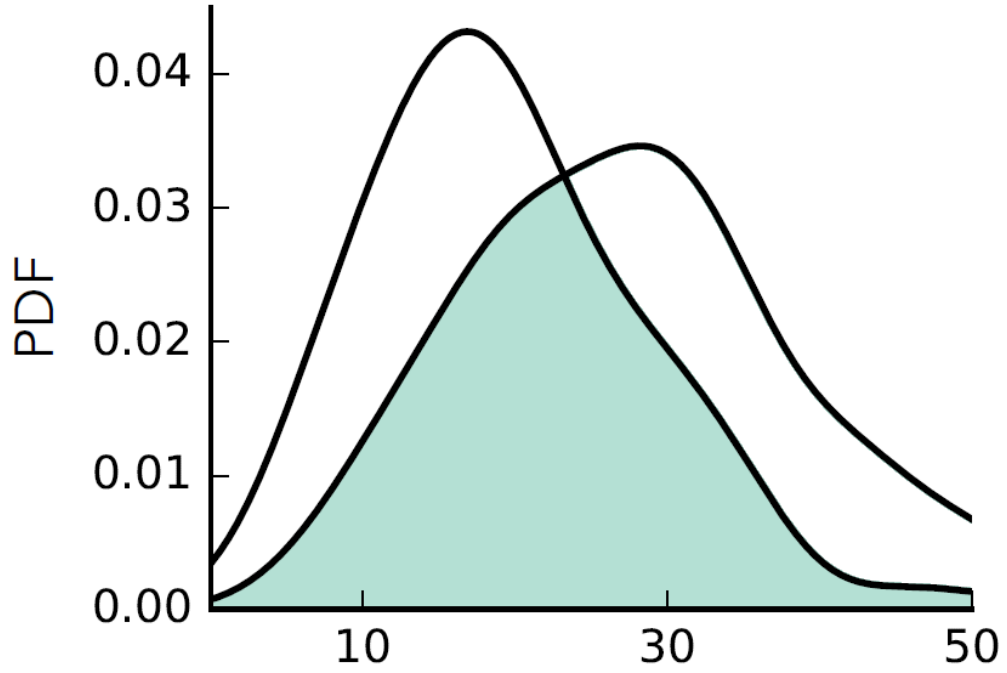

Wilcoxon Mann-Whitney hypothesis test was assesed.

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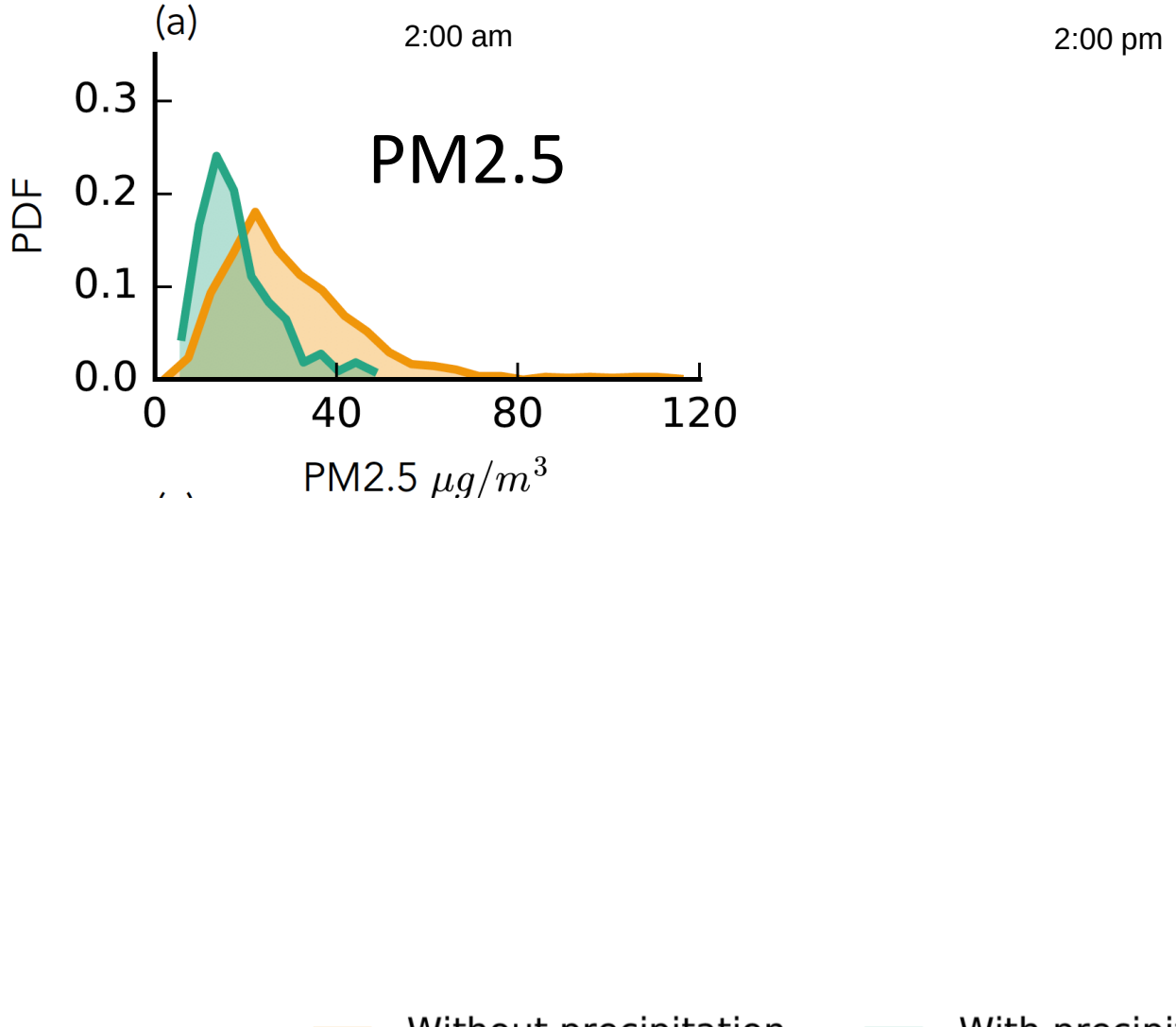
Probability Density Functions (PDF)

- PM concentrations were conditioned by hour of the day and with and without precipitation (PDFs were plotted with one hour lag).

- Net effect: PM concentration increases when rainfall occurs during daytime.



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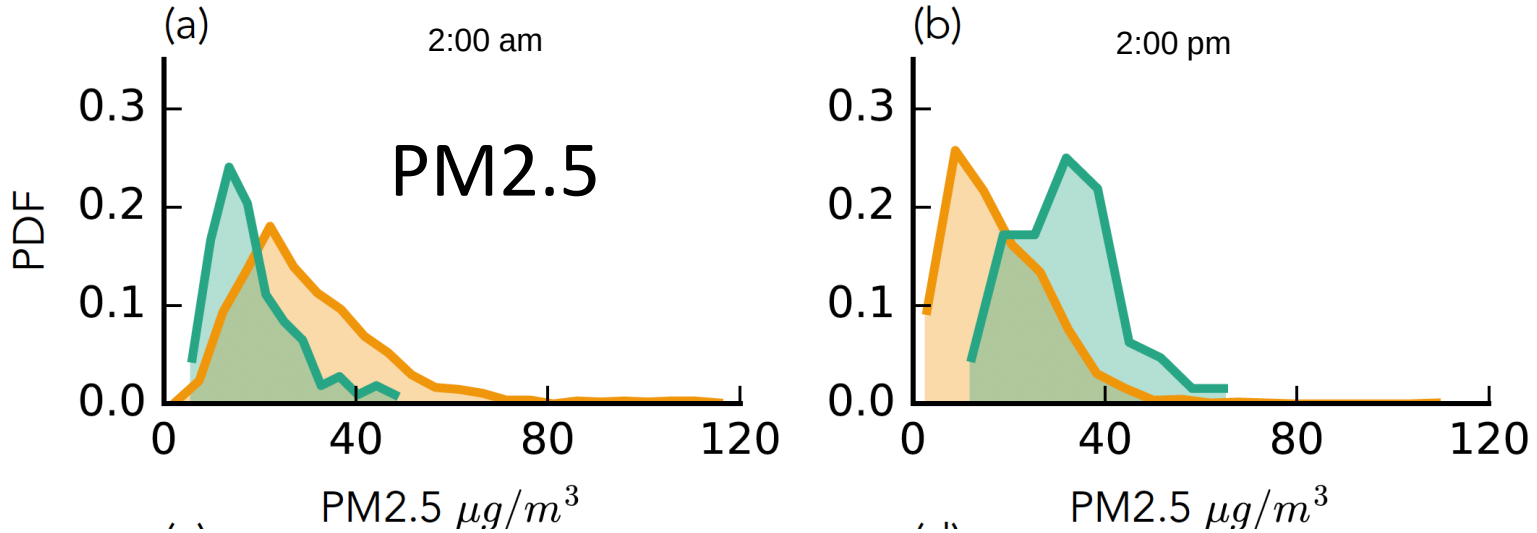

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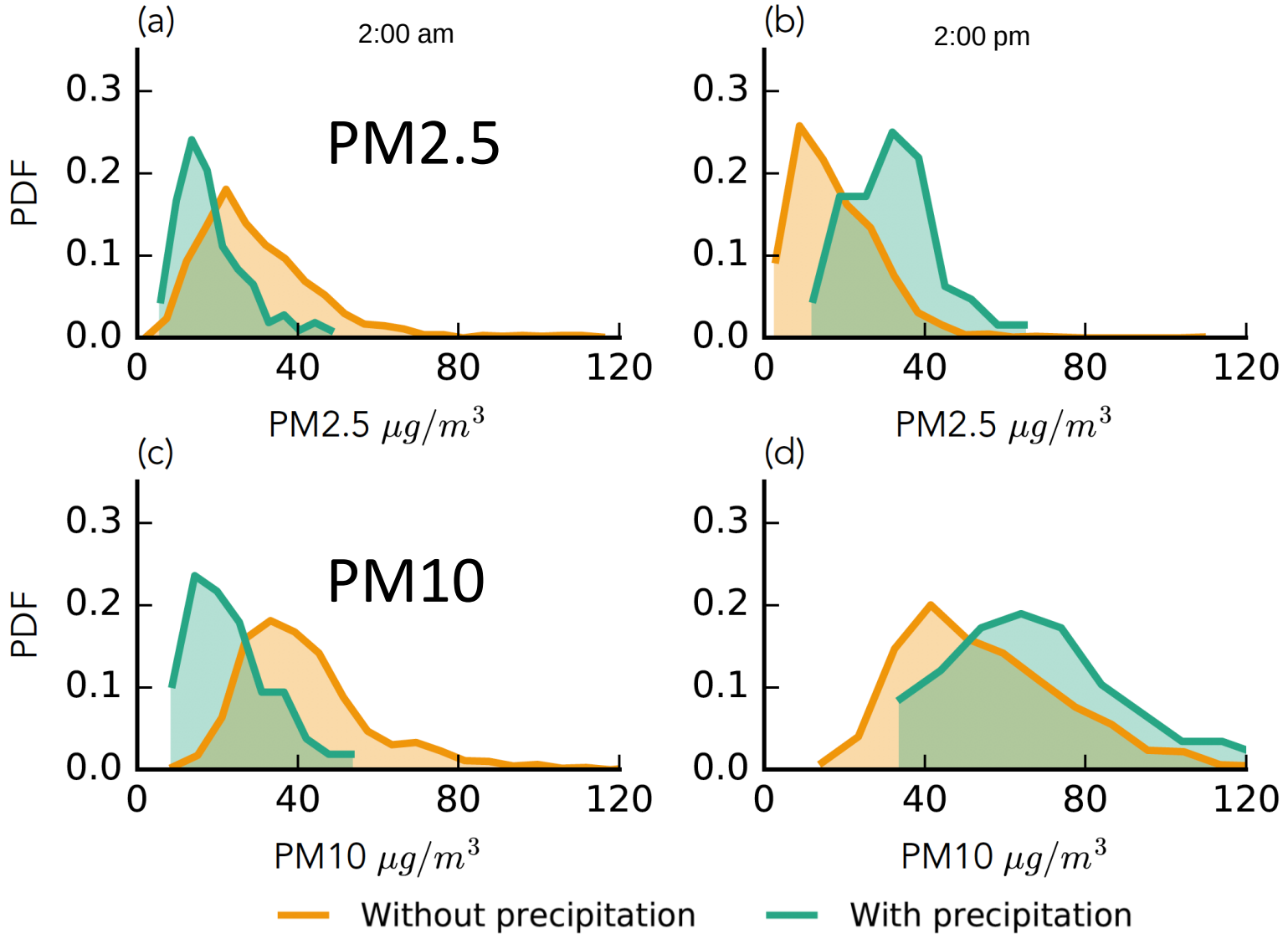
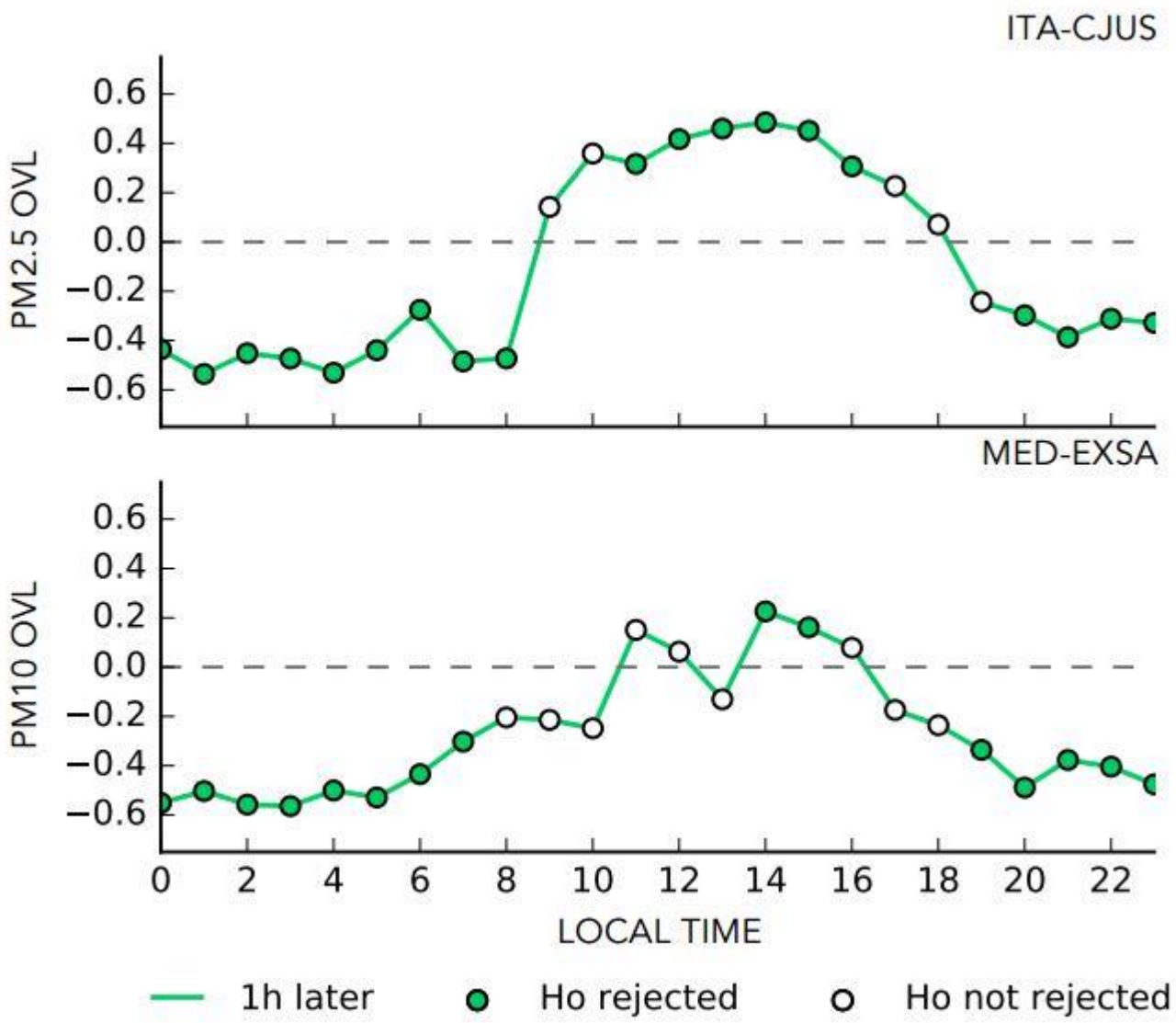


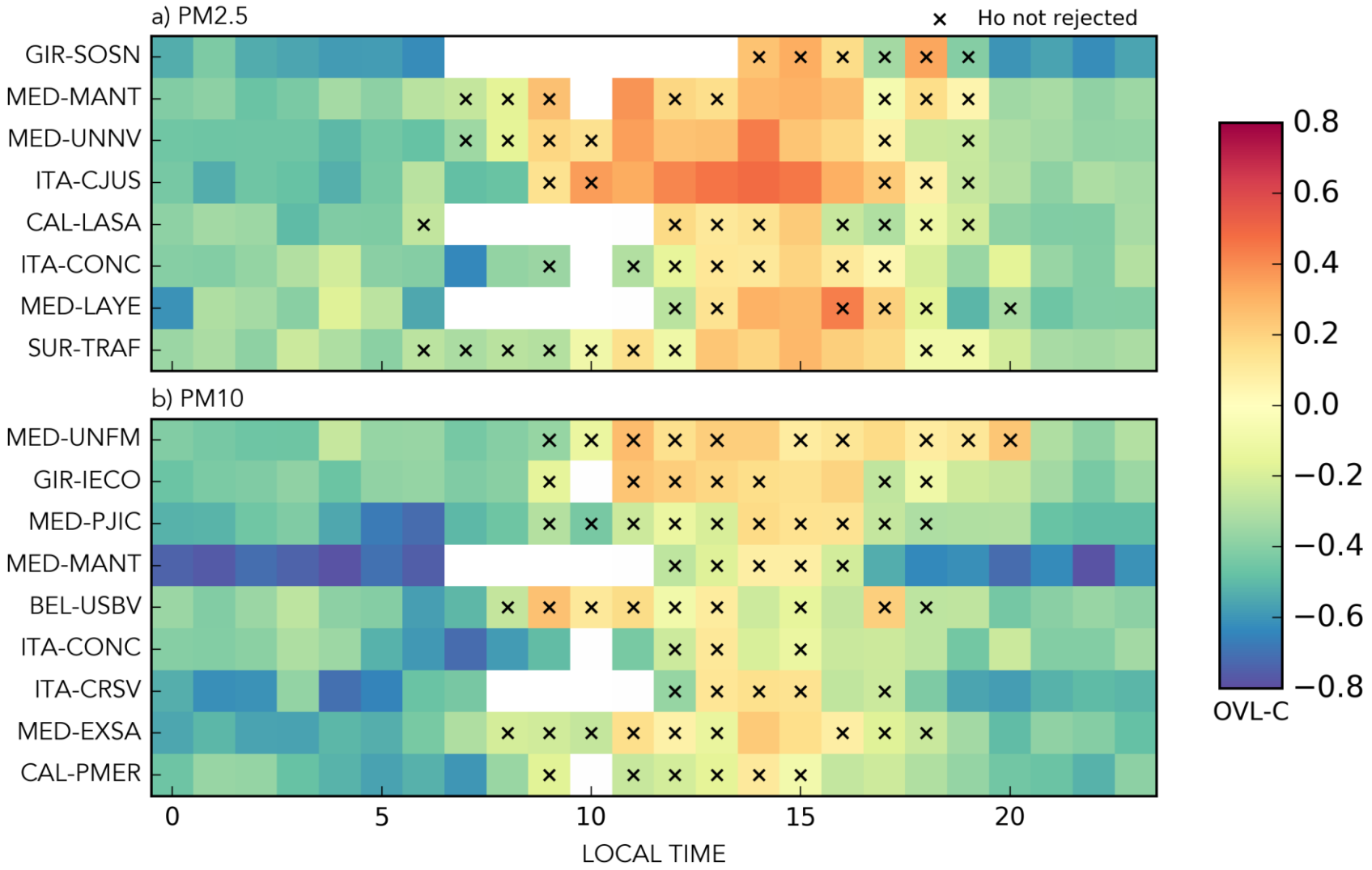
Diurnal Cycle



In hours with **positive sign** the lower troposphere is **typically unstable**.

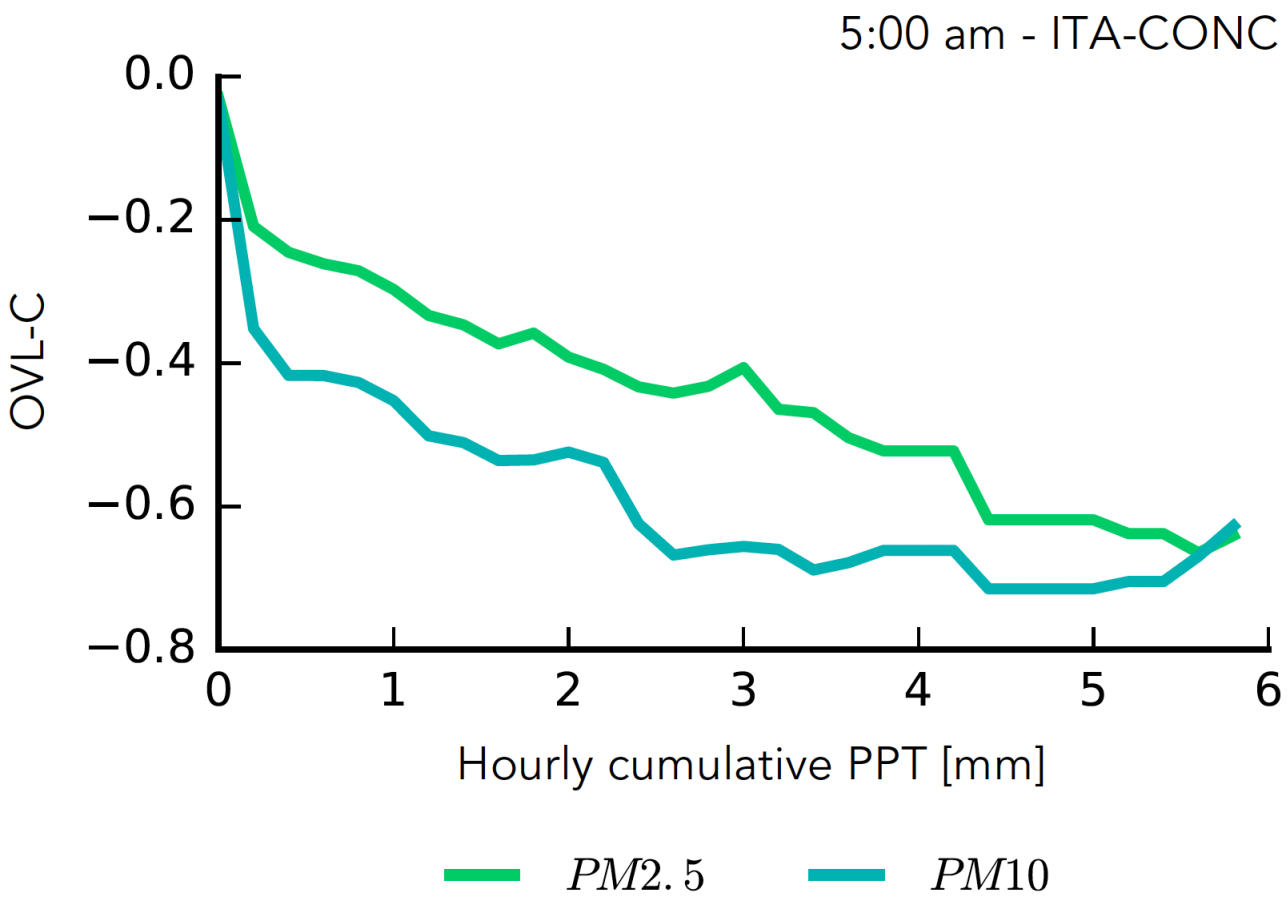
Precipitation's role in aerosol concentration is strongly **dependent on the diurnal cycle of atmospheric stability.**

PM stations



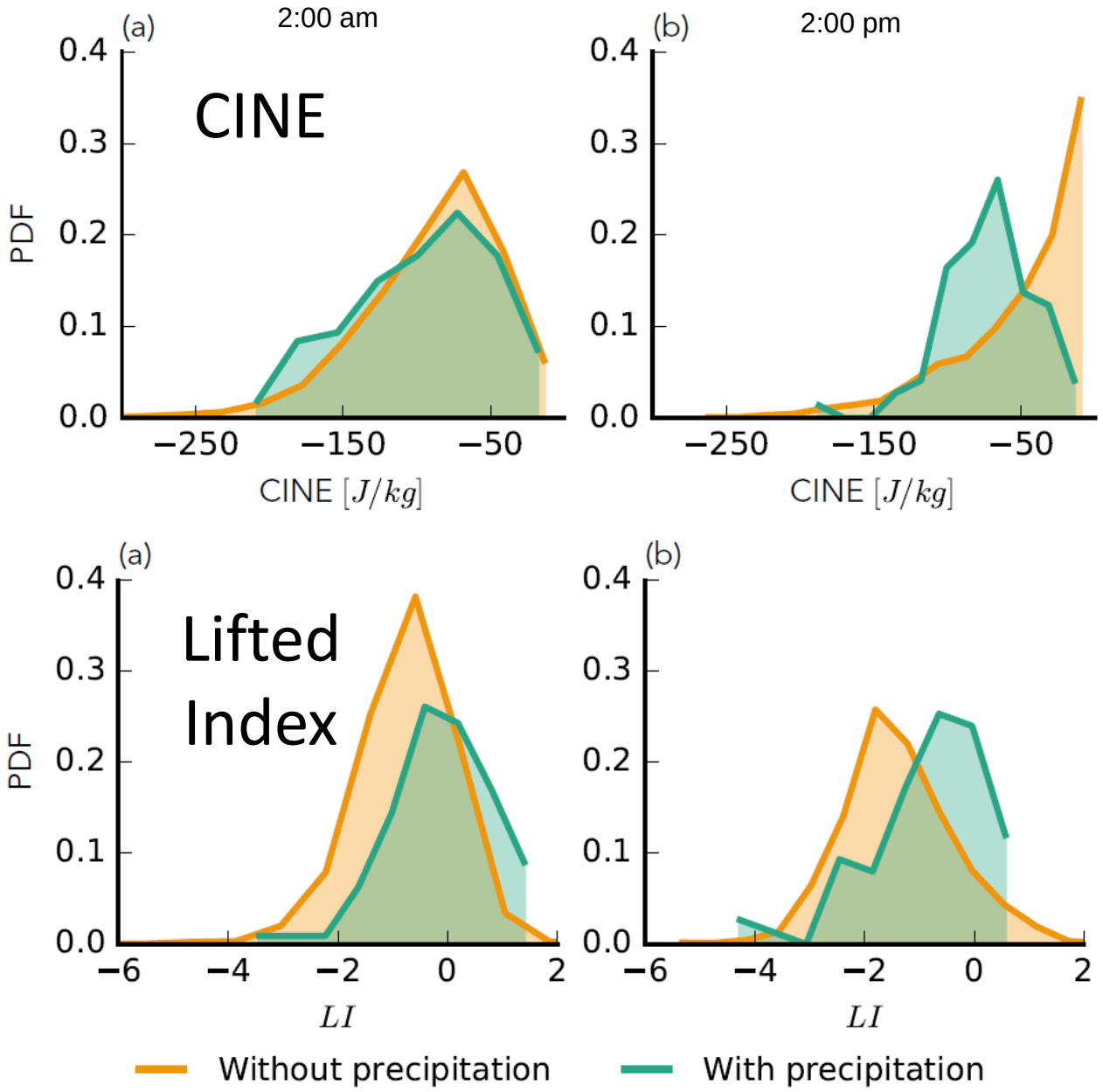
There is a **similar behavior** in all air quality stations.

- As cumulative precipitation increases the effects become **stronger.**
- There is an important dependence of wet deposition in **particulate size**

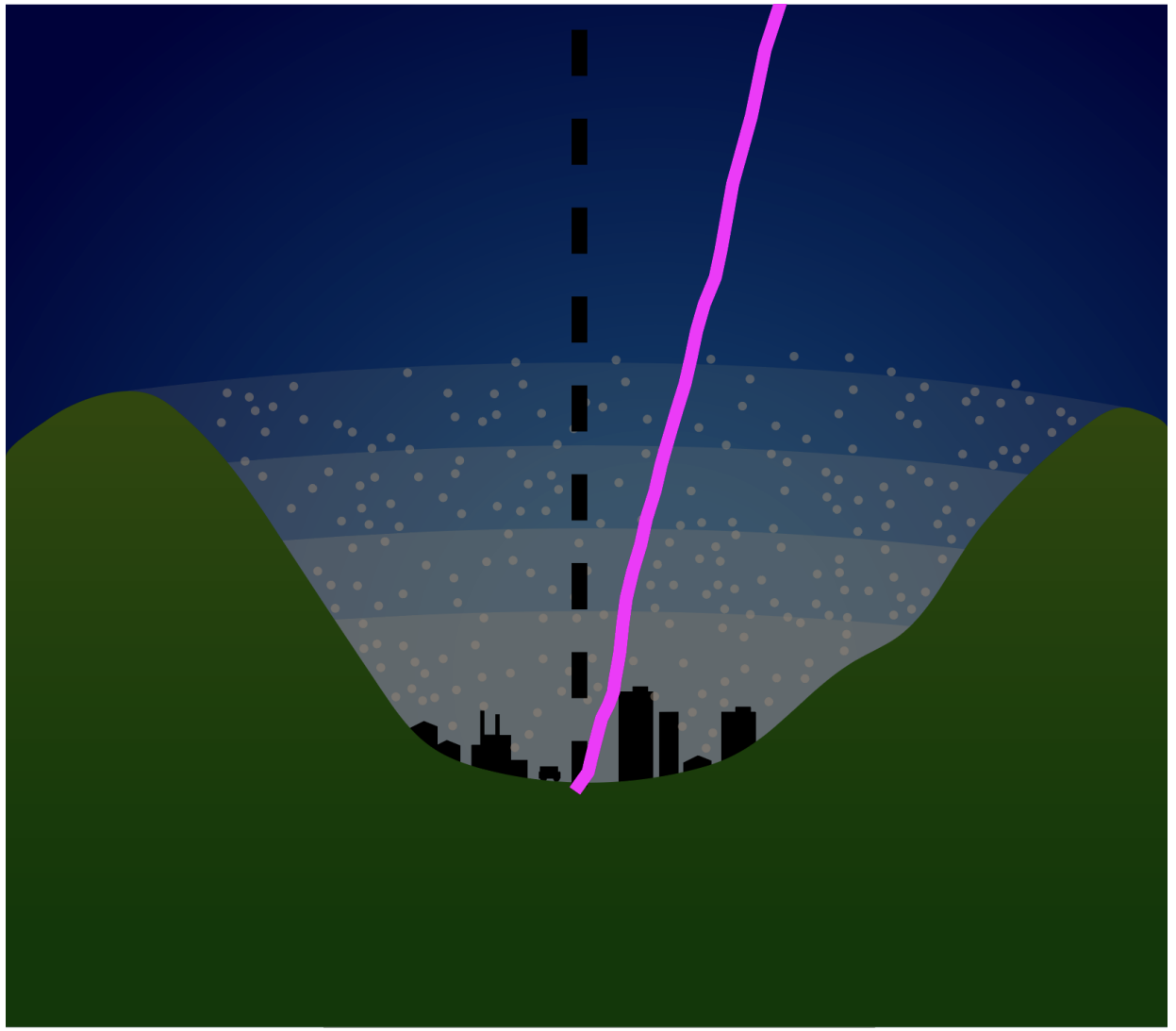


Thermodynamic Indices

CINE and LI suggest that precipitation **leads to stable atmospheric conditions** during afternoon.



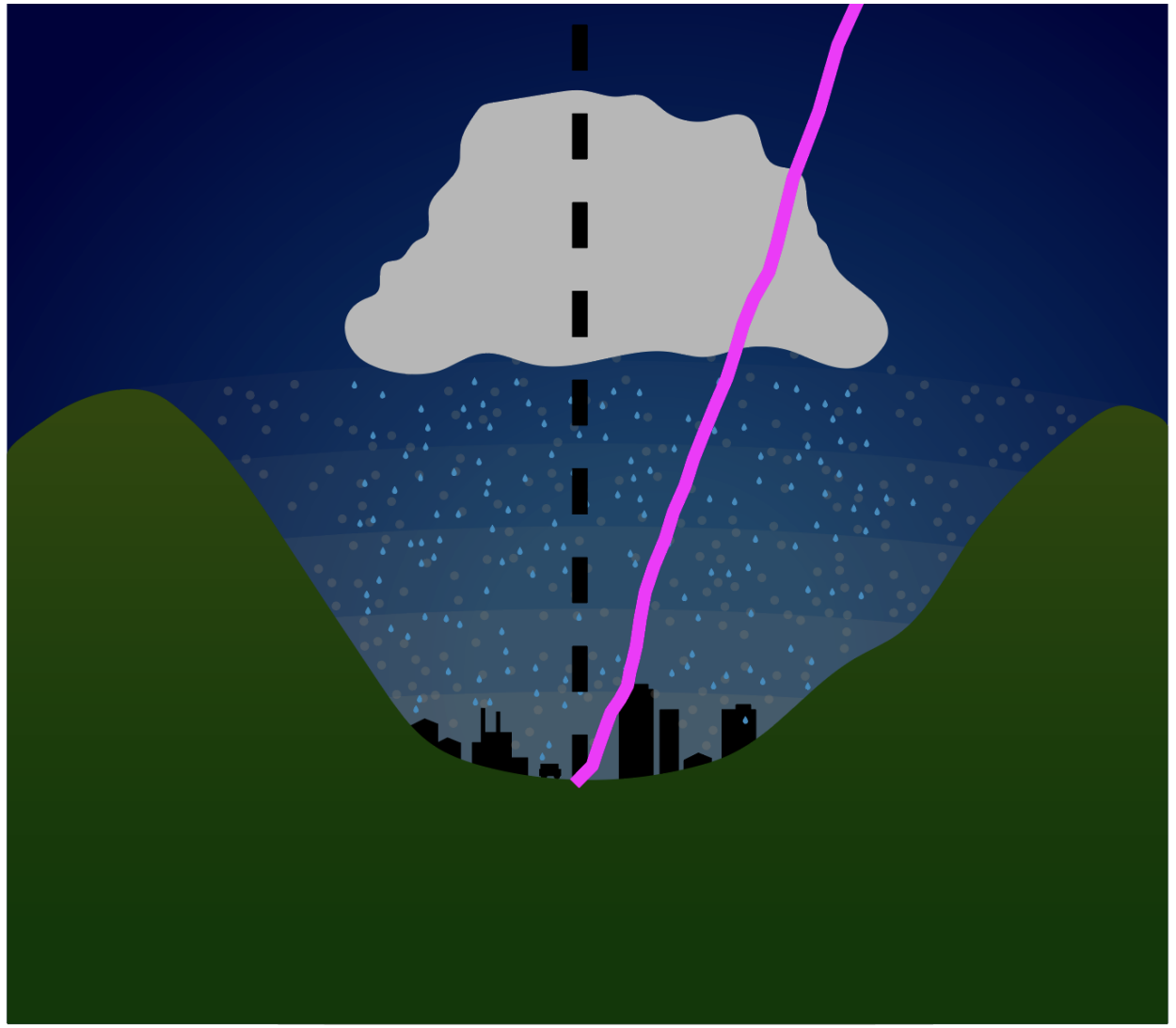
Summary: Night-time



Summary: Night-time

Potential temperature profiles:

already stable conditions



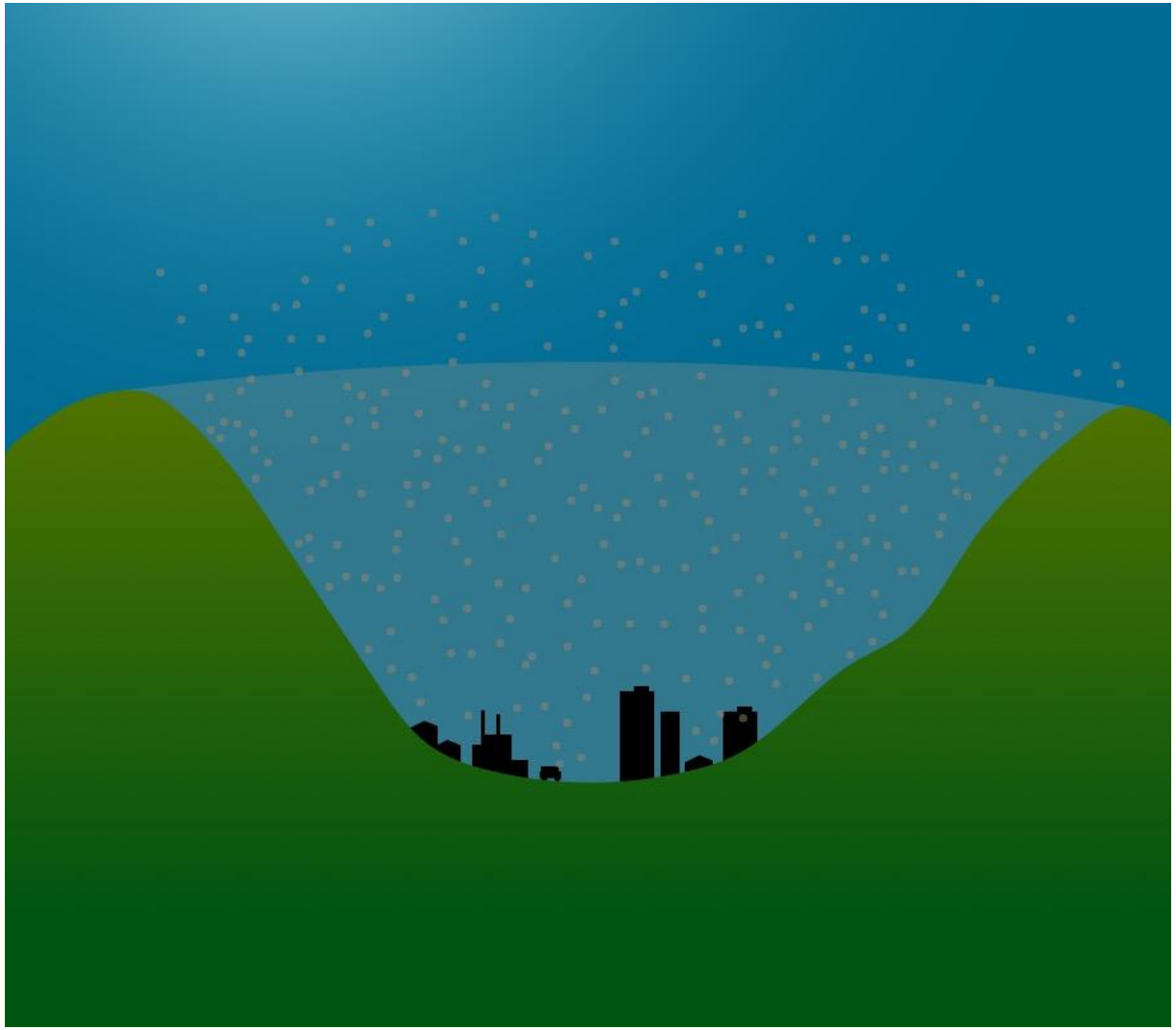
Summary: Night-time

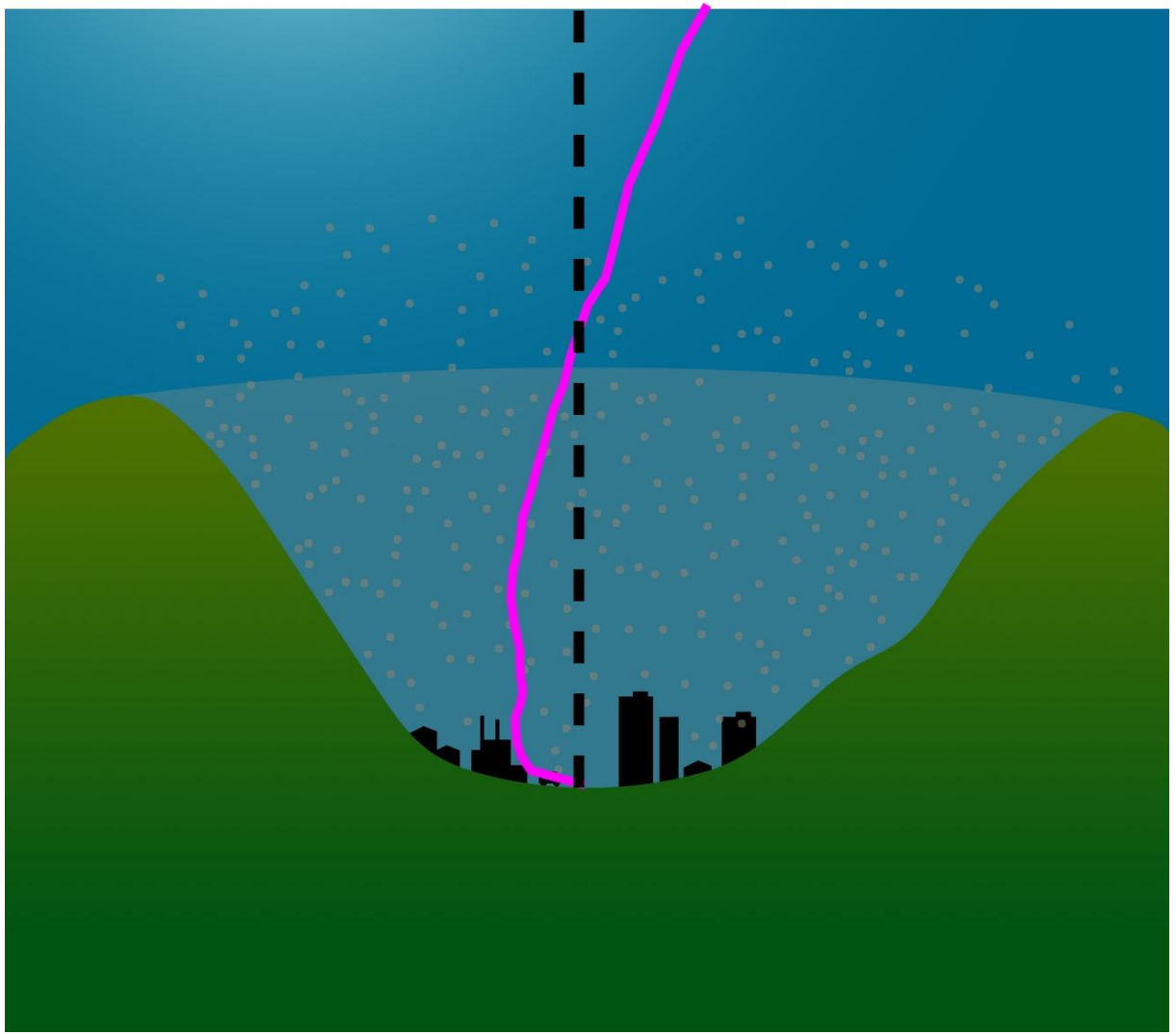
Potential temperature profiles:

already stable conditions

Net effect: Aerosol washout

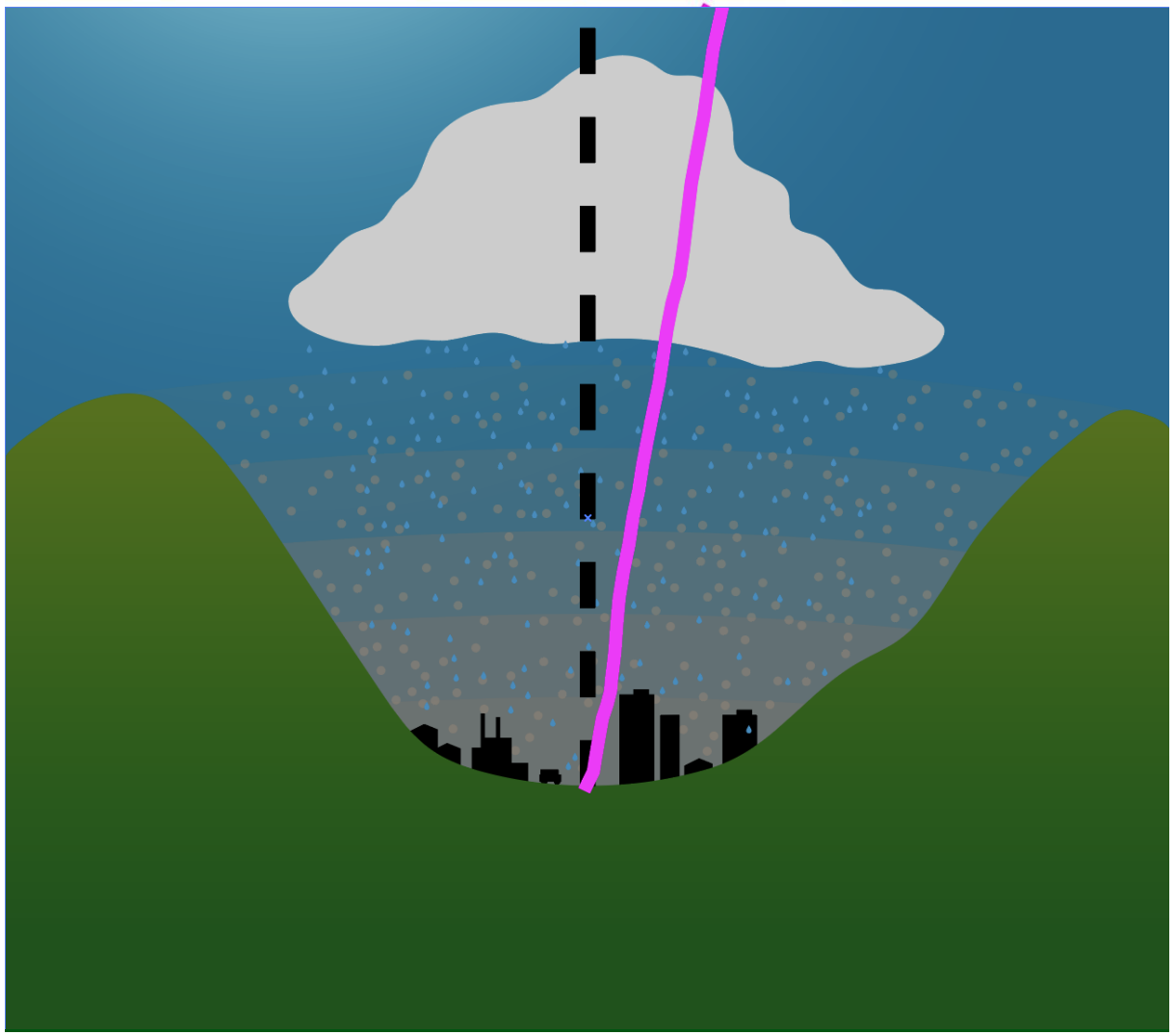
Summary: Daytime





Summary: Daytime

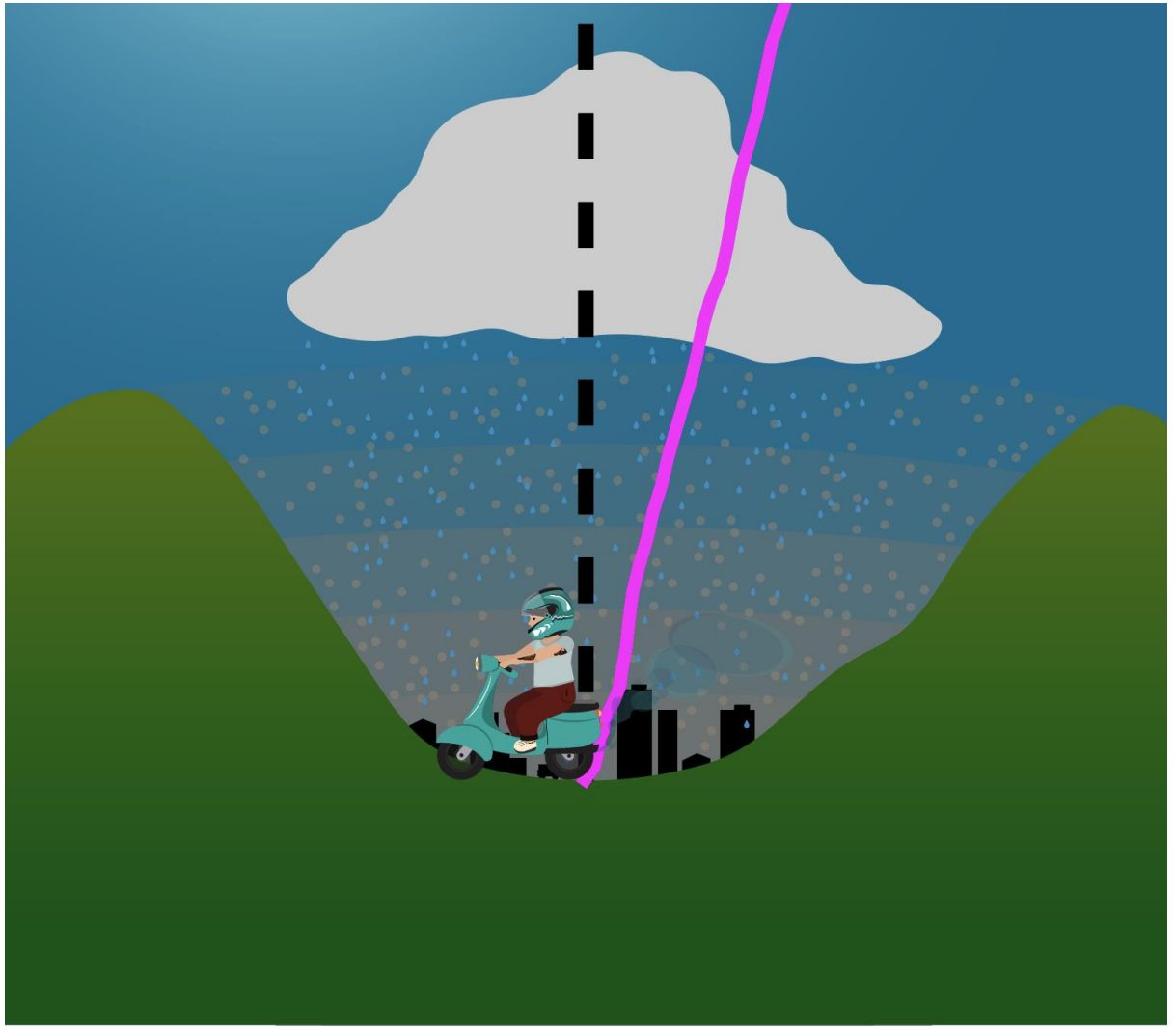
Potential temperature profiles: unstable conditions



Summary: Daytime

Potential temperature profiles: unstable conditions

Rainfall stabilizes the atmosphere



Summary: Daytime

Potential temperature profiles: unstable conditions

Rainfall stabilizes the atmosphere.

Emissions continue: Net effect is to increase PM concentration

Thanks!

Contact: nroldanh@unal.edu.co

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