



Dust Contribution in Jordan

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MENA



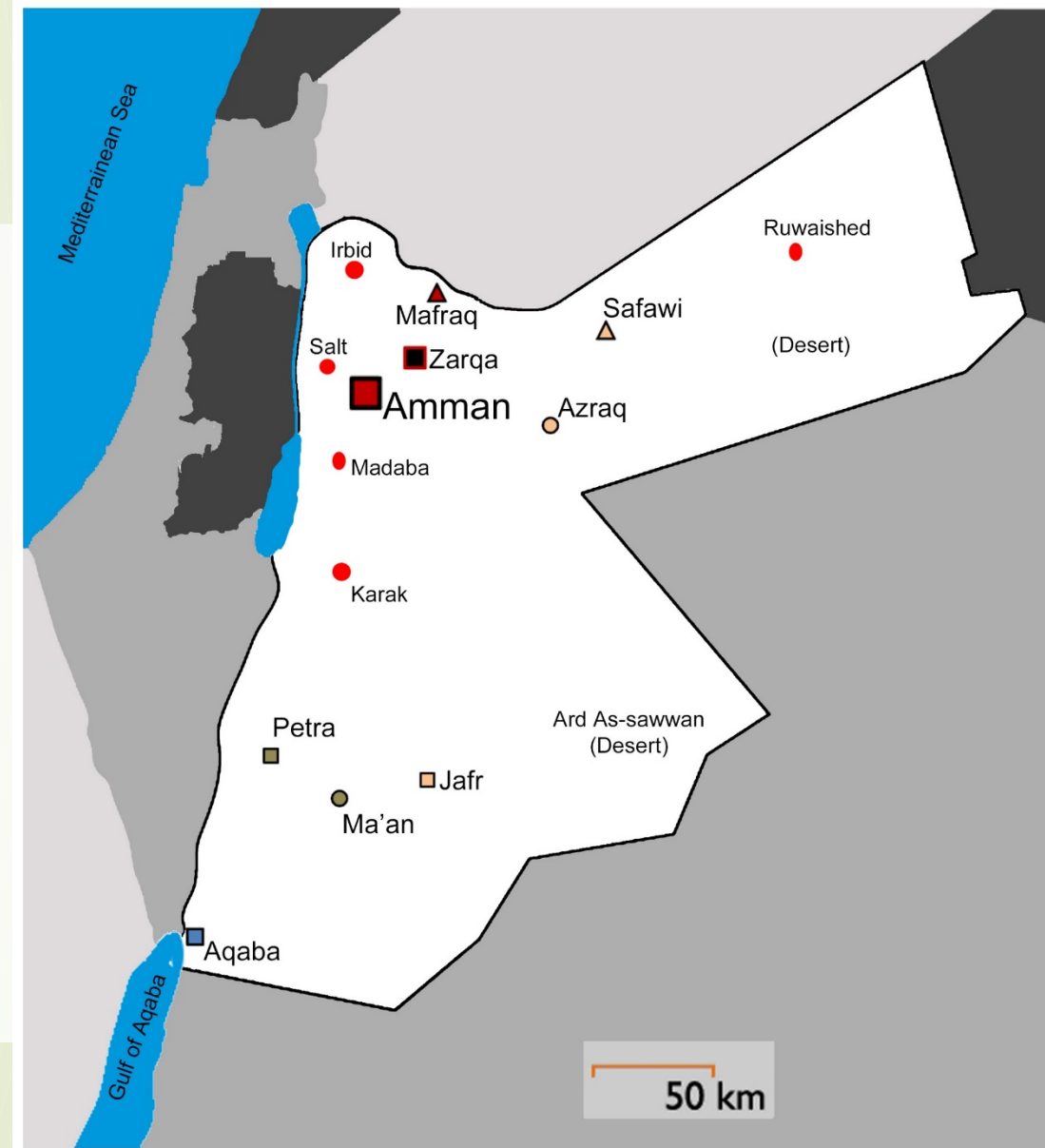
□ **Jordan is a unique place:**

- A small opening on the Red Sea “Aqaba”
- Mediterranean Sea is < 100 km to the west
- South-East is the Arabian desert of Iraq and Saudi Arabia
- North-West is the Fertile Crescent

Jordan

Population ~9.5 million

- SE part is mainly is an arid area “Badia”
- NW part is comprised of high mountains
- Dead Sea and Jordan Valley (-420 m bsl)
- A small opening on the Red Sea “Aqaba”



Amman



Capital city

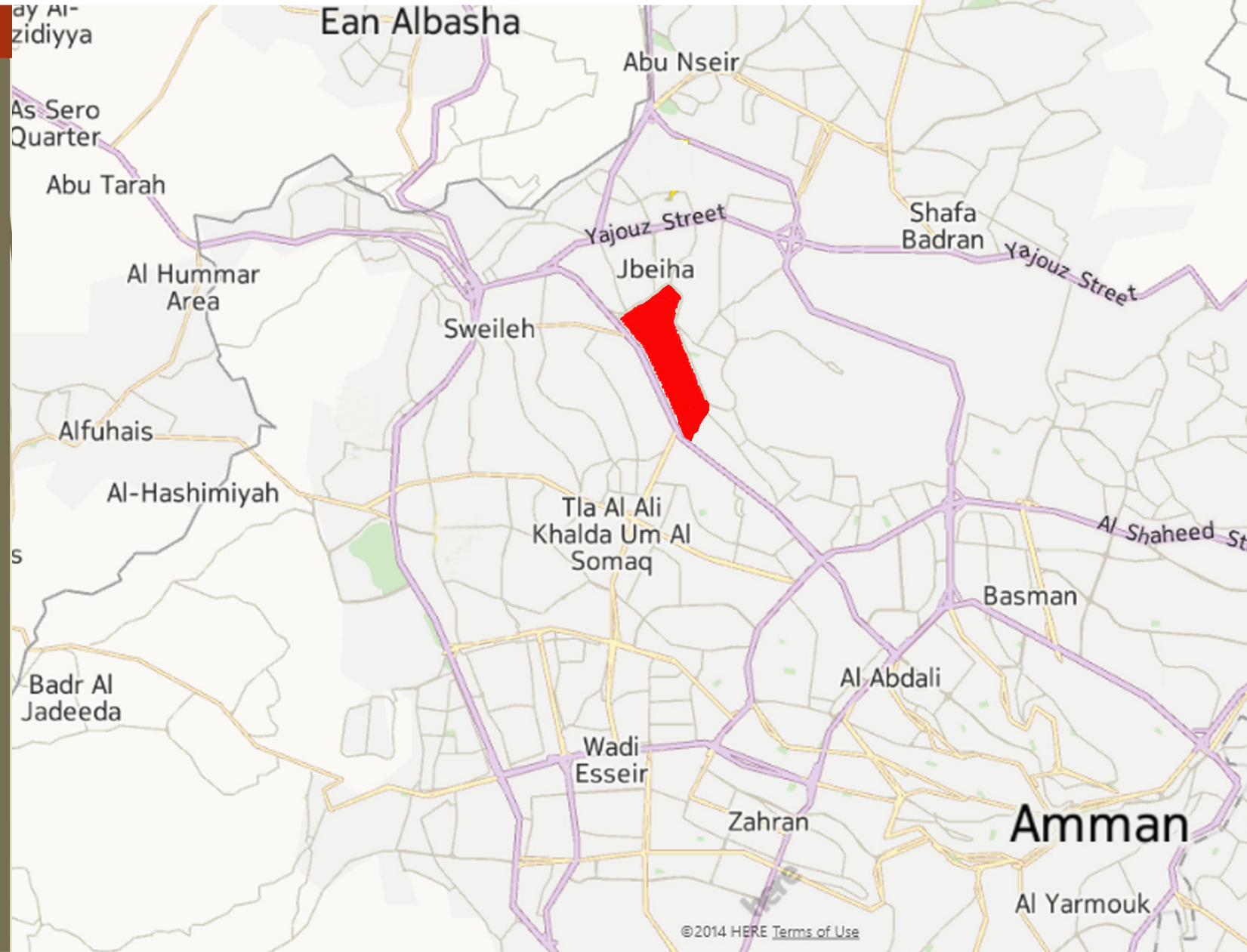
~ 50×50 km²

More than ½ Population resides in Amman

Complex terrain of several mountains

University of Jordan campus

Urban background





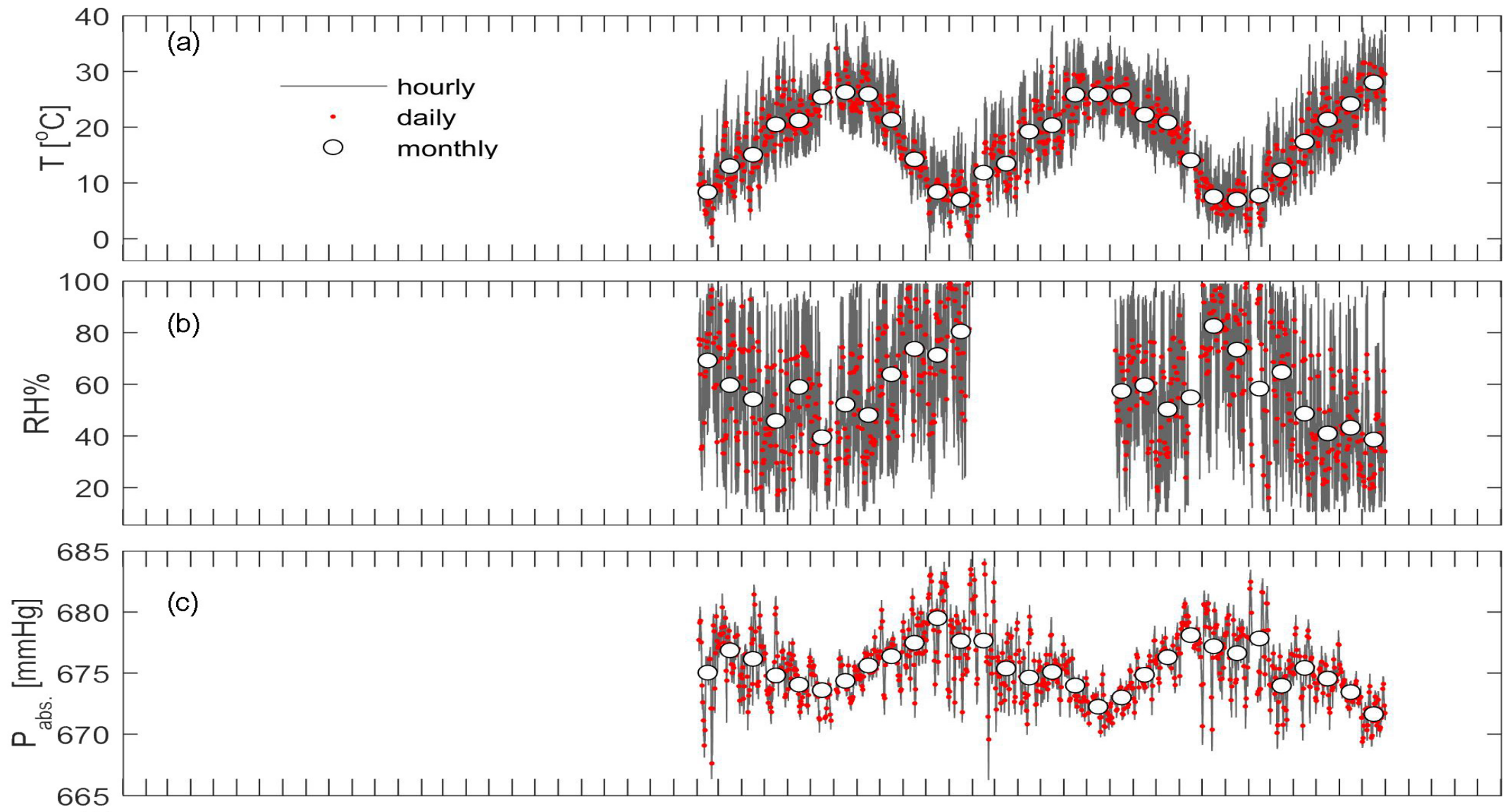


Experimental Setup

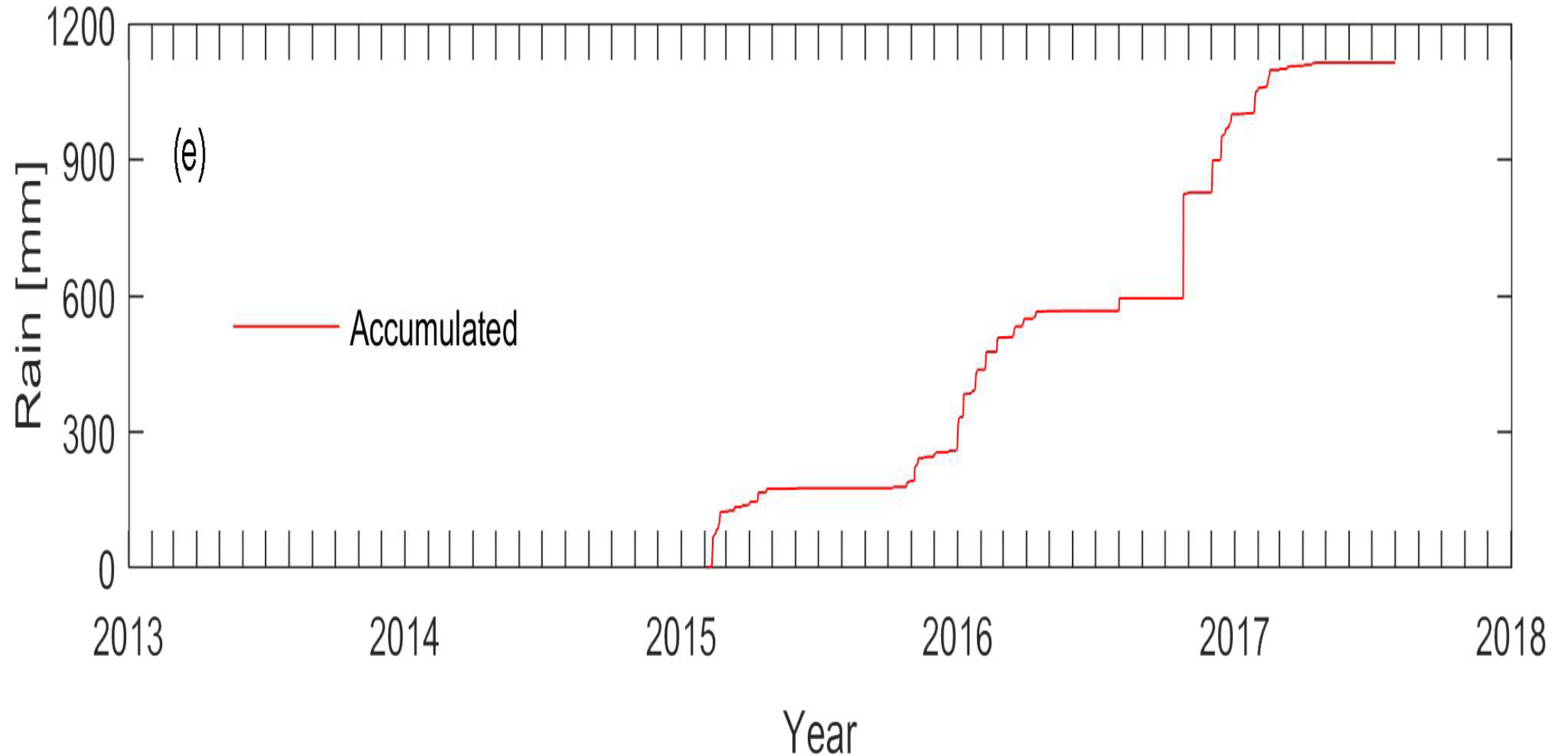
Particle Number Size Distribution

- ▢ November 2013 – July 2017
- ▢ 3rd floor, Department of Physics, at the center of the University of Jordan campus
- ▢ Optical Particle Sizer (OPS, TSI model 3330)
 - ▢ Continuously measured the particle number size distribution / 5-minute resolution
 - ▢ optical diameter 0.3–10 μm
 - ▢ 13 equally size bins based on a lognormal scale
 - ▢ flow rate ~ 1 L/min
 - ▢ Standard 37 mm filter media for gravimetric analysis and ATR-FTIR
- ▢ Particle number concentration and mass concentration ($\mu\text{g}/\text{m}^3$) in two size-fractions:
 - ▢ accumulation mode (diameter 0.3–1 μm)
 - ▢ coarse mode (diameter 1–10 μm)
- ▢ On-site weather conditions / 5-minute resolution

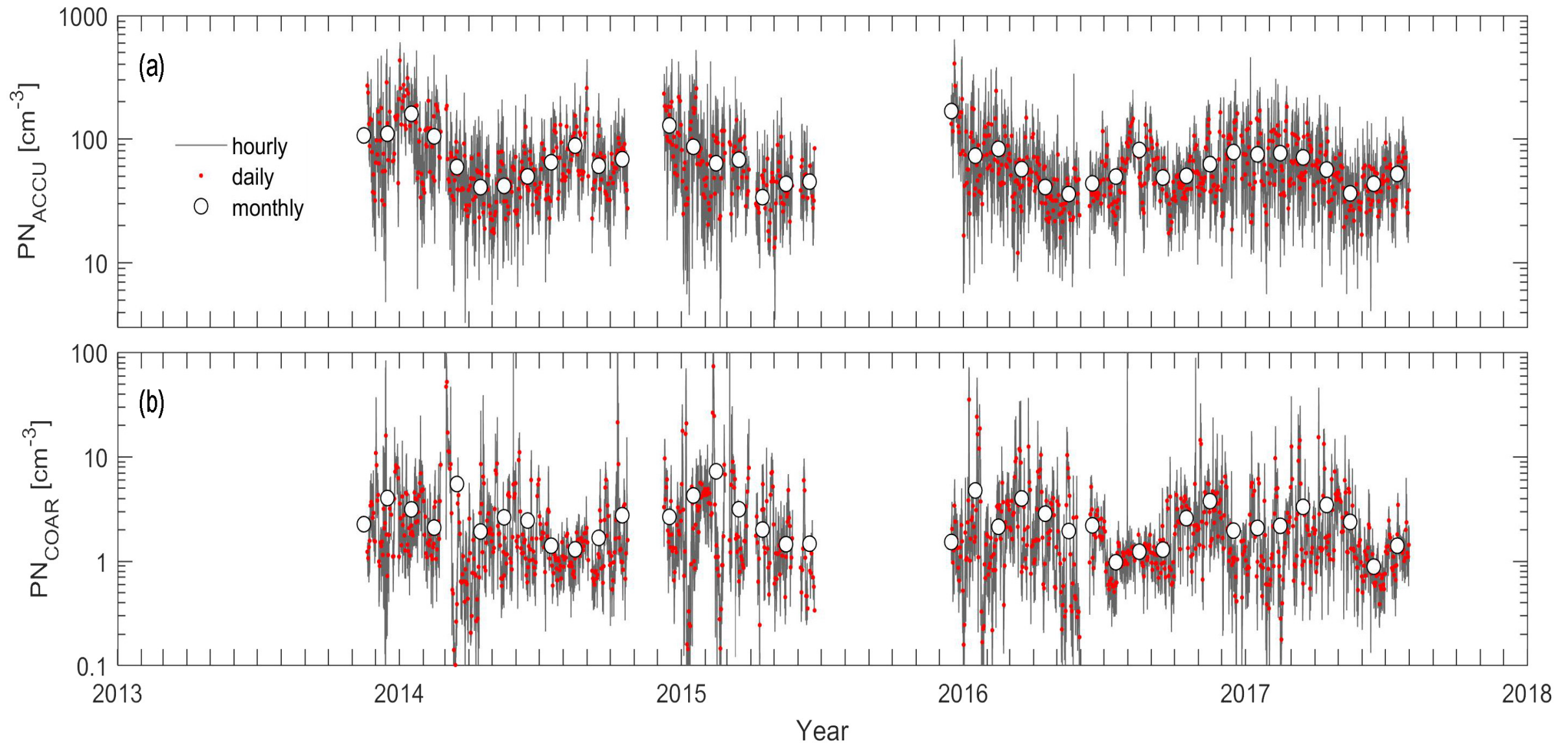
Overall weather conditions – T, RH, and P



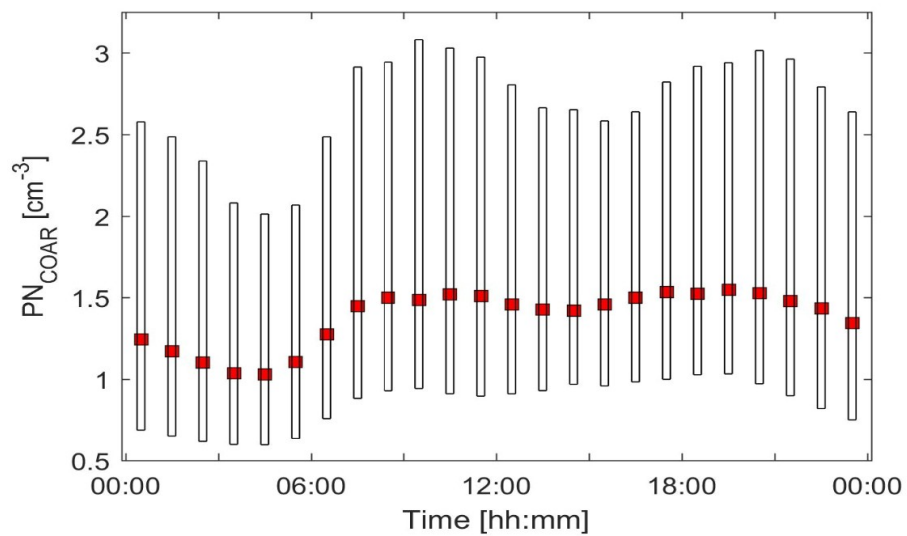
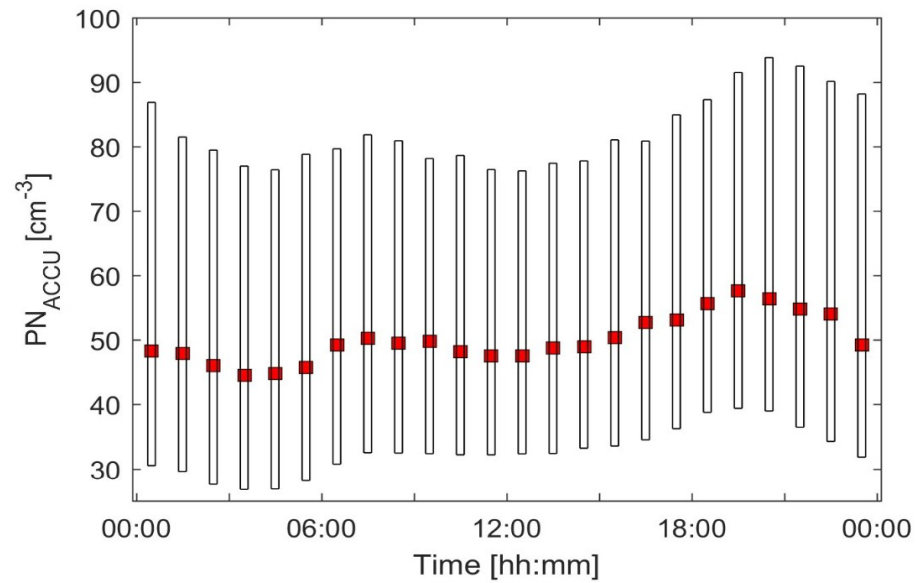
Overall weather conditions – Precipitation



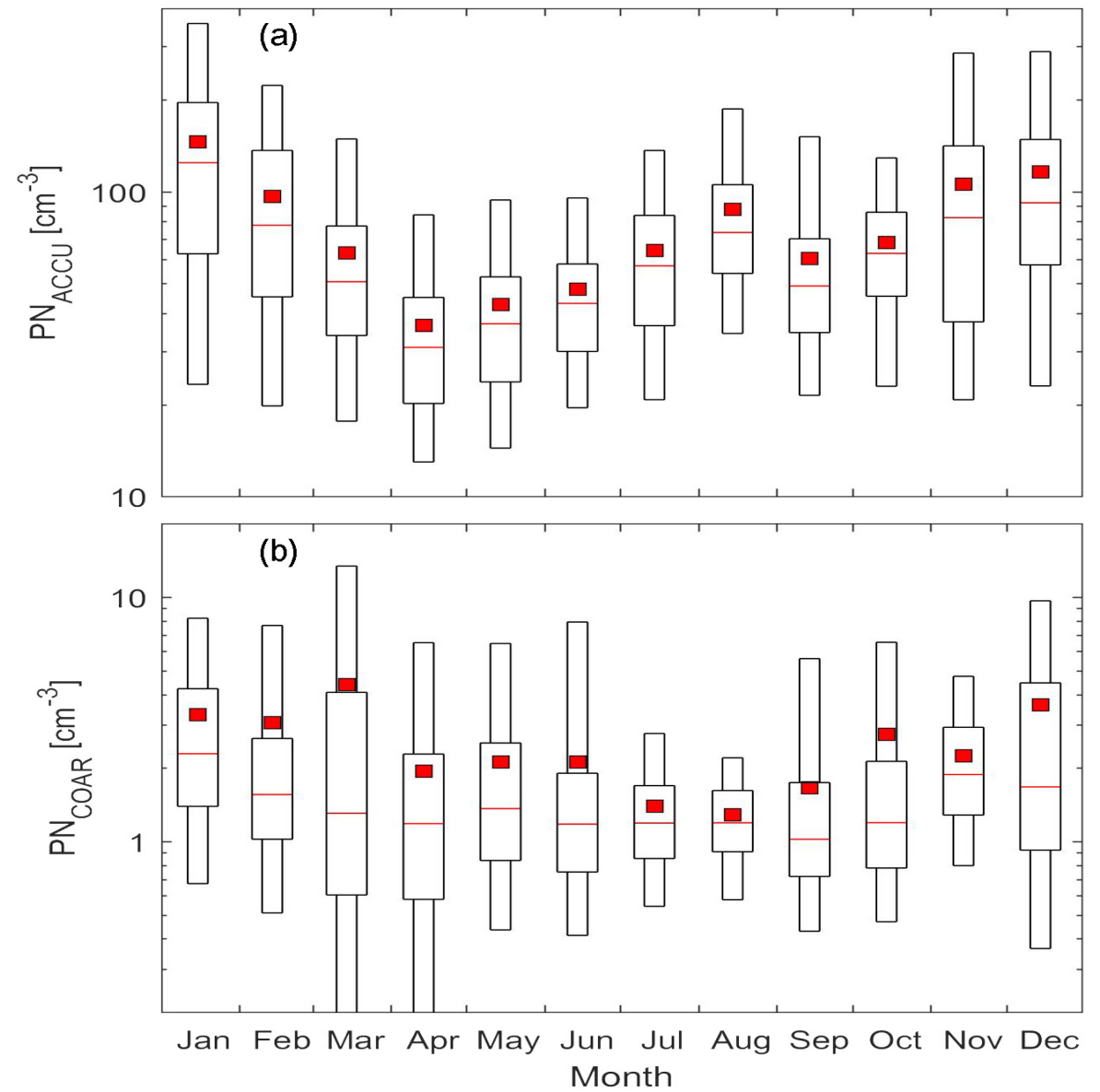
Particle number concentrations



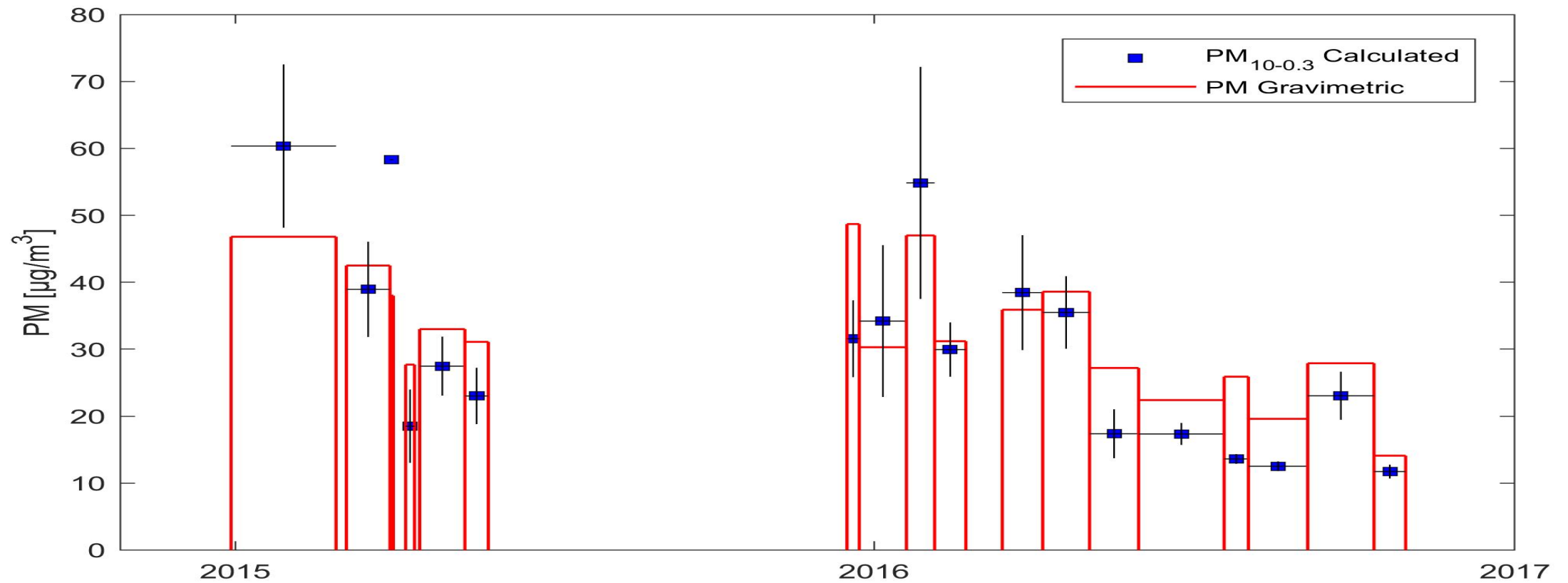
Diurnal

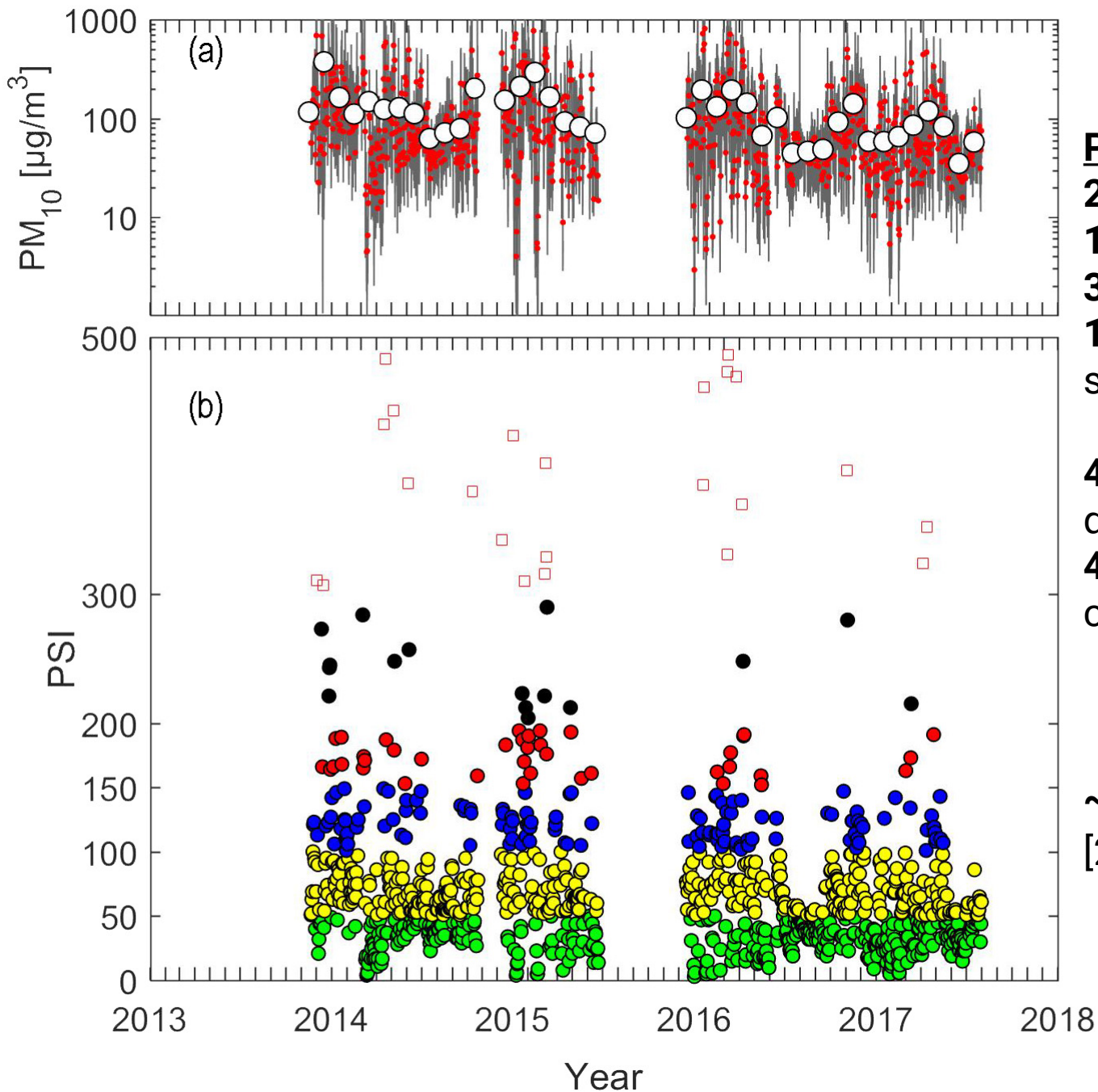


Seasonal



Gravimetric versus Calculated PM concentrations





Pollution Standard Index

23 days hazardous

16 days very unhealthy

39 days unhealthy

126 days were unhealthy for sensitive groups

425 days moderate air quality conditions

426 good air quality conditions

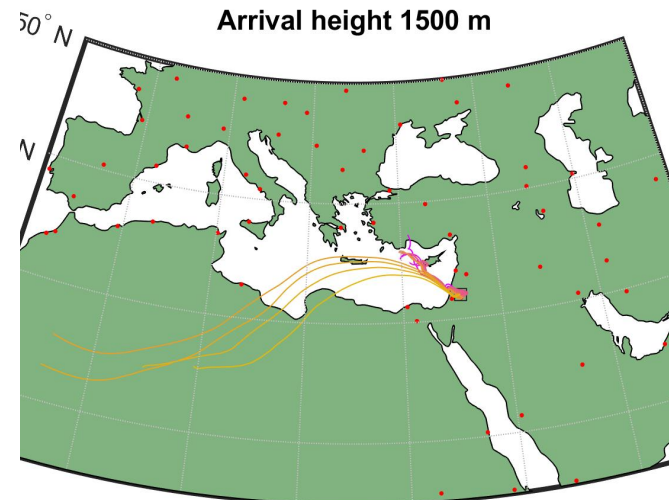
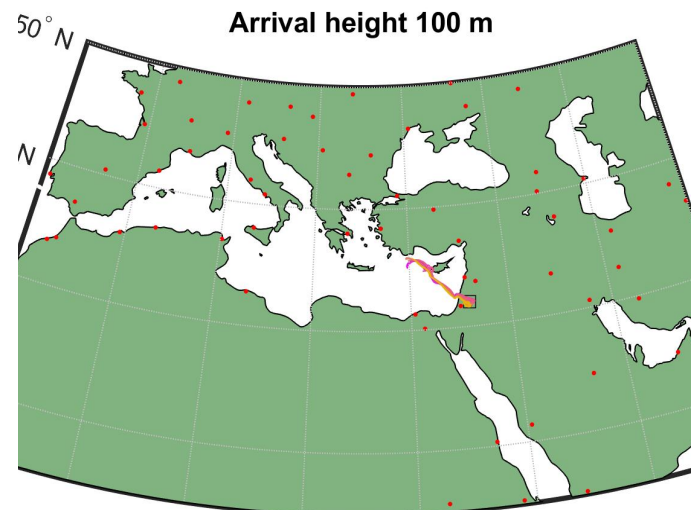
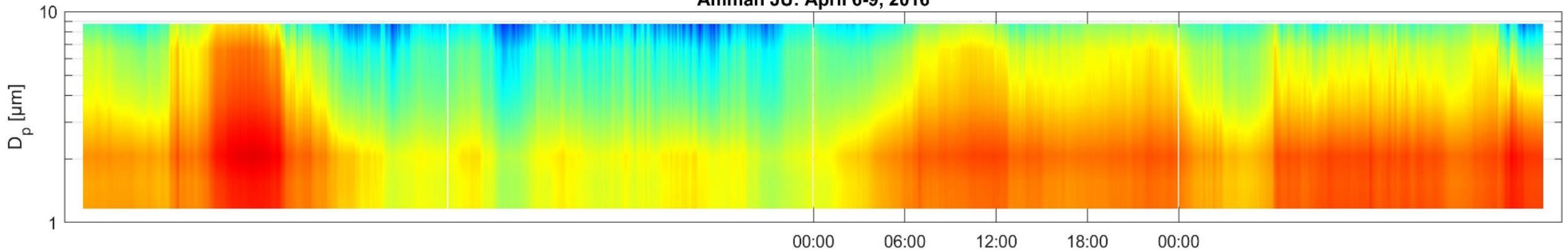
~71% < JO PM_{10} guideline
[24-h PM_{10} < $120 \mu g m^{-3}$]



Case Studies and Examples

Saharan Dust Episodes (April 8–13, 2016)

Amman JU: April 6-9, 2016

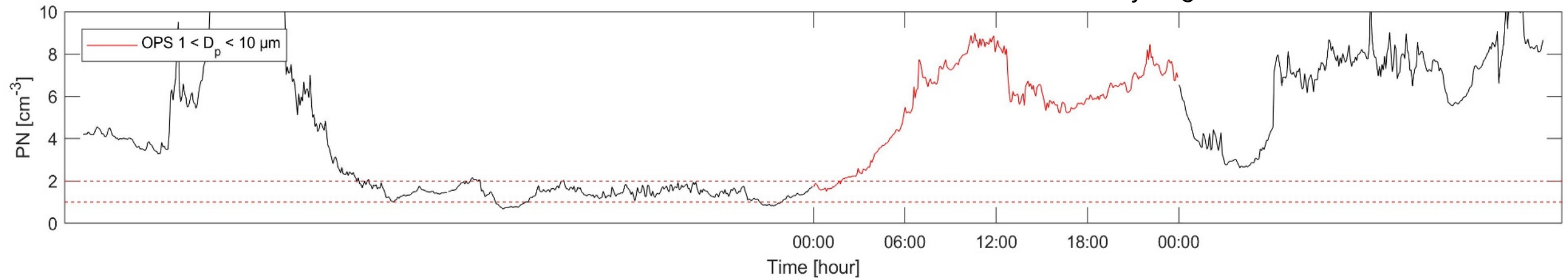


April 8-13, 2016

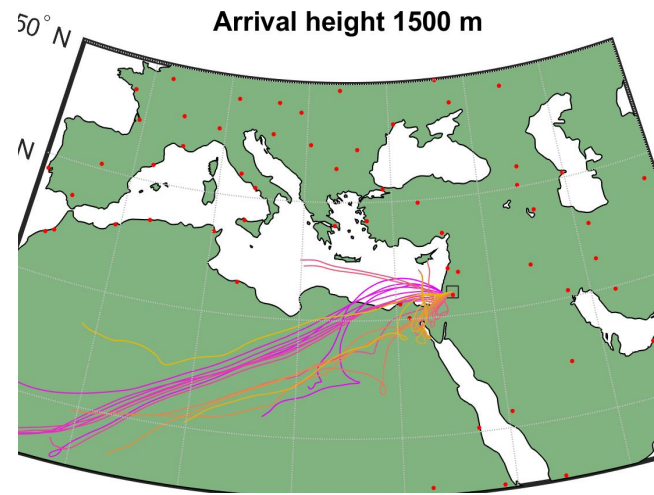
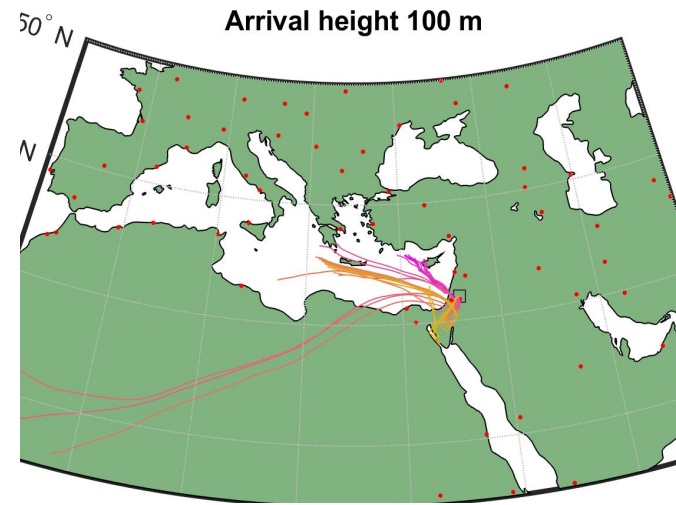
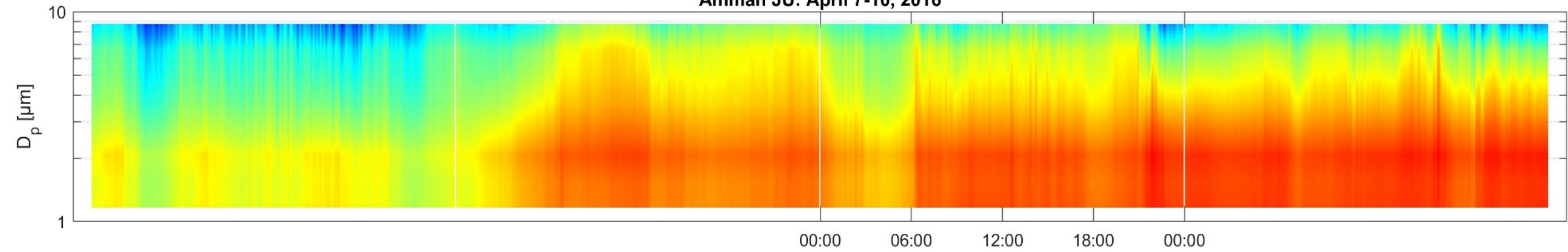
Saharan Dust Episode

April 8th:

100m BT does not indicate dust source region
1500m BT clearly originates from Sahara



Amman JU: April 7-10, 2016

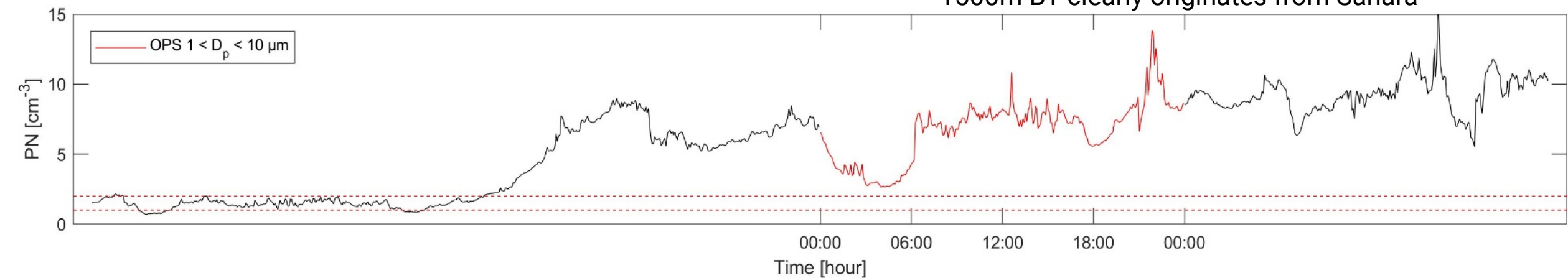


April 8-13, 2016

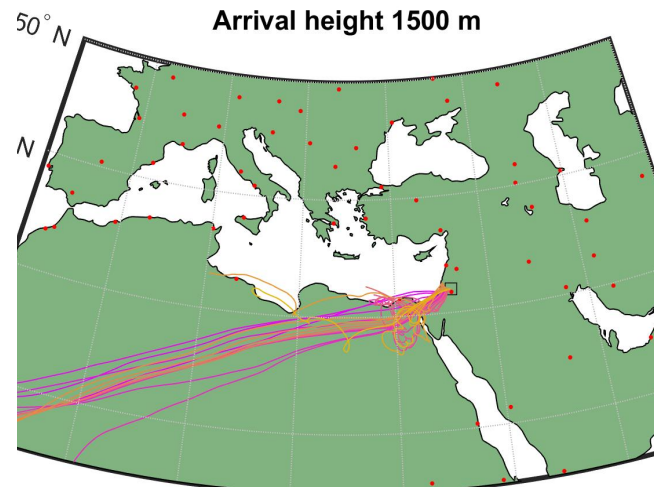
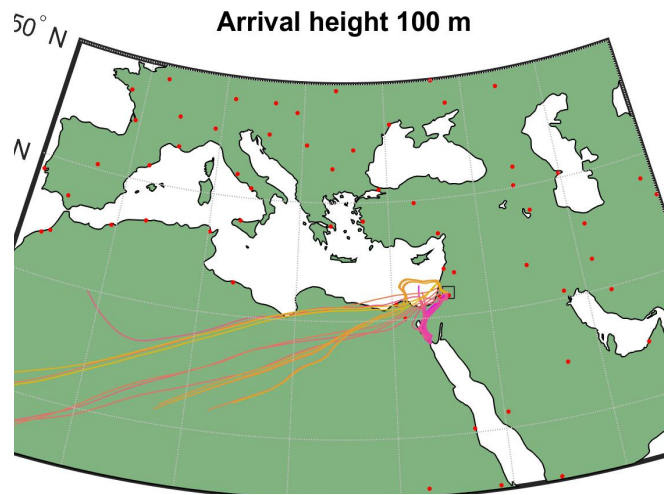
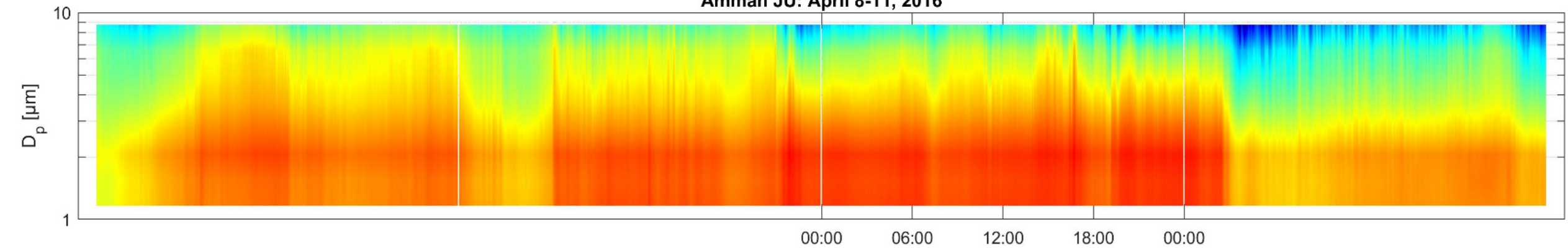
Saharan Dust Episode

April 9th:

100m BT mixed between marine and Saharan
1500m BT clearly originates from Sahara



Amman JU: April 8-11, 2016



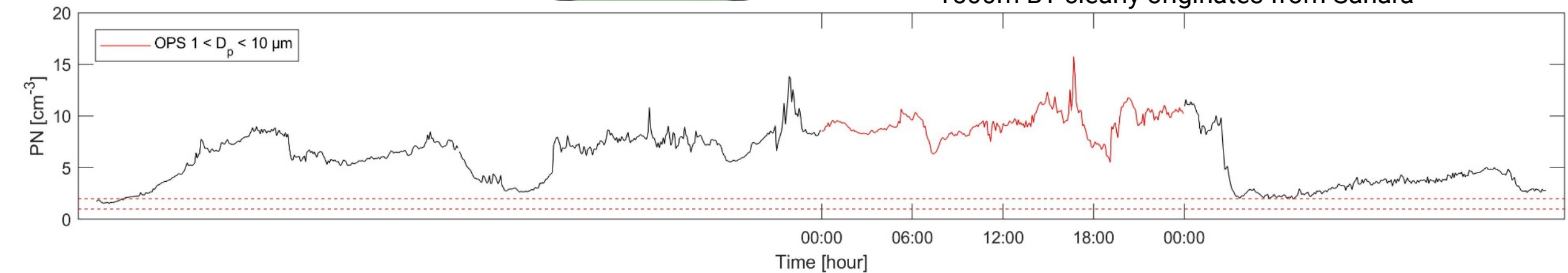
April 8-13, 2016

Saharan Dust Episode

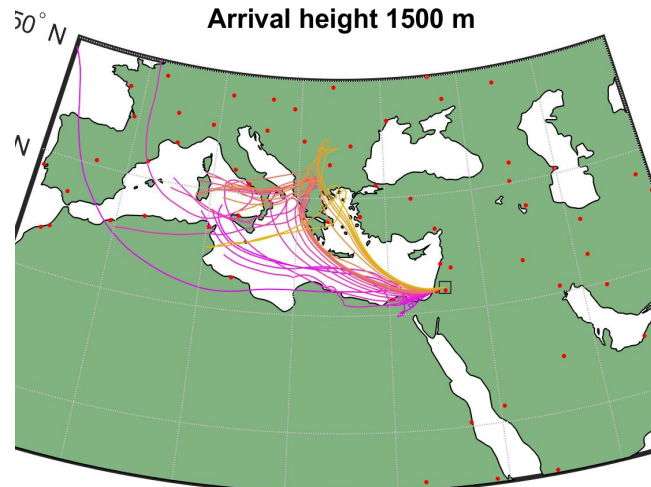
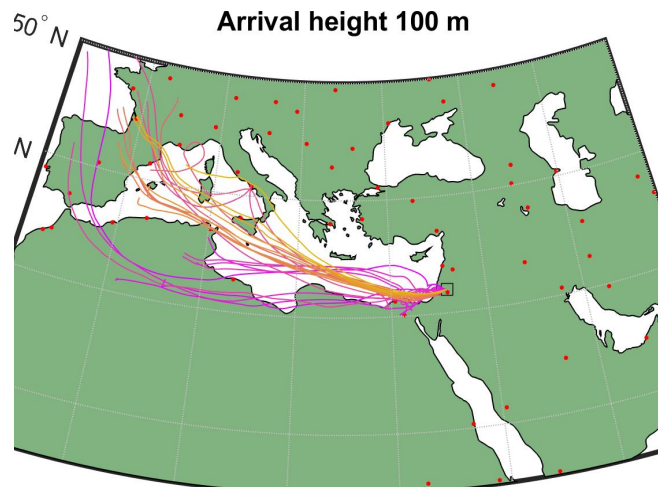
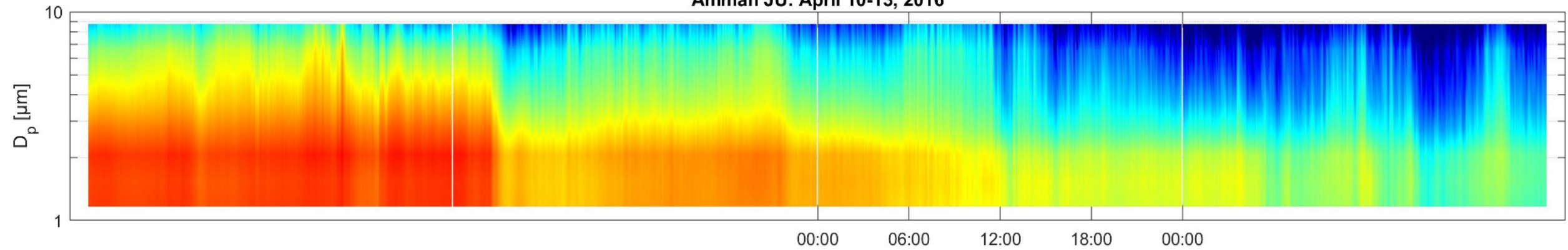
April 10th:

100m BT clearly originates from Sahara

1500m BT clearly originates from Sahara



Amman JU: April 10-13, 2016



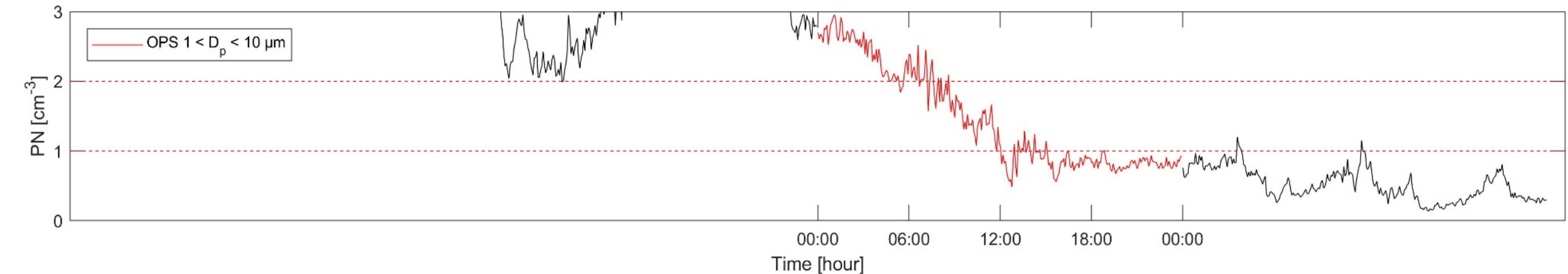
April 8–13, 2016 Saharan Dust Episode

episode **ends on April 13th** / precipitation

April 12th:

100m BT started to be marine

1500m BT started to be marine

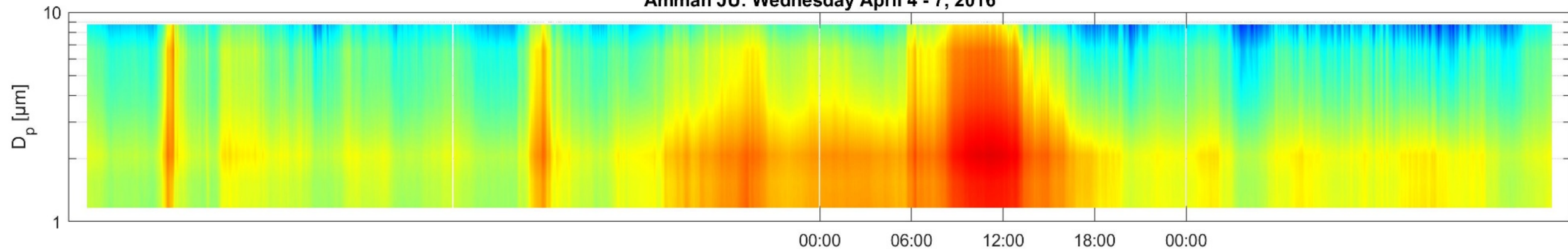




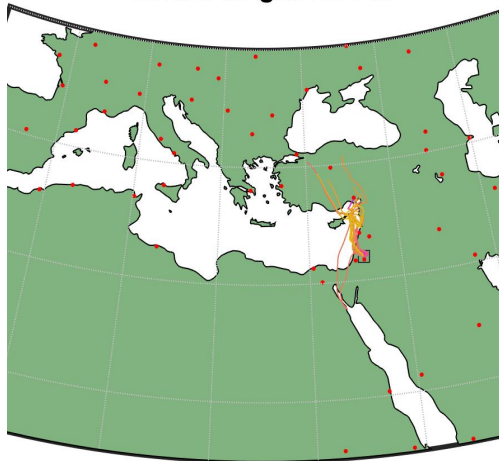
Case Studies and Examples

Levant Dust Episodes (April 5–6, 2016)

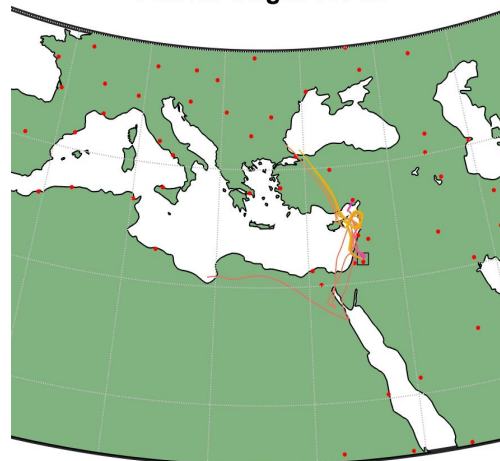
Amman JU: Wednesday April 4 - 7, 2016



Arrival height 1500 m

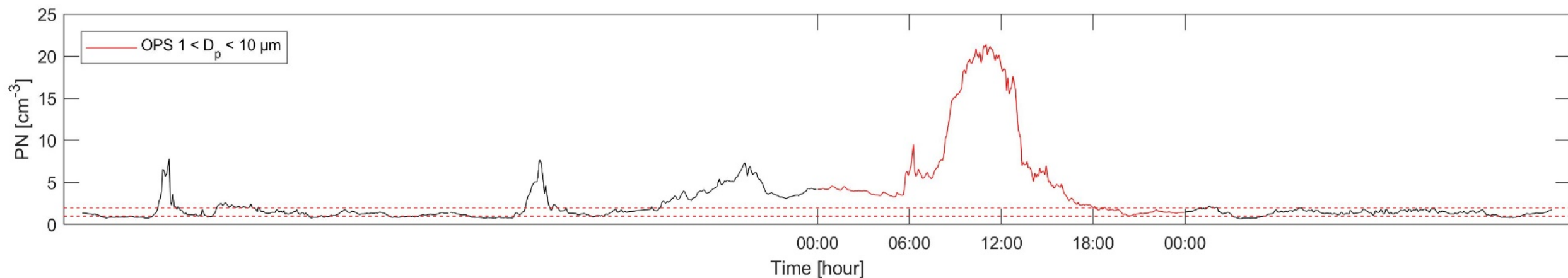


Arrival height 100 m



April 5–6, 2016

**Short Dust Episode
originated within the
Levant Region**

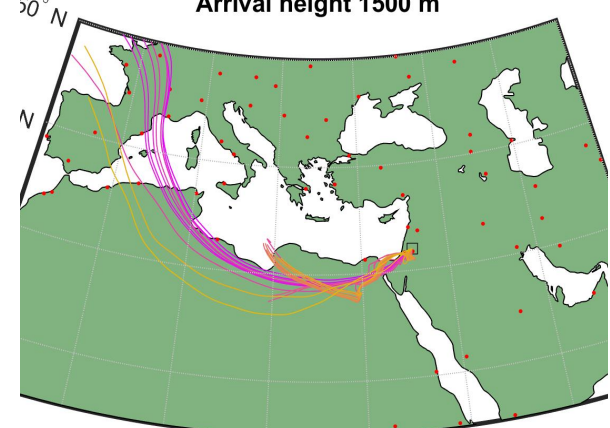
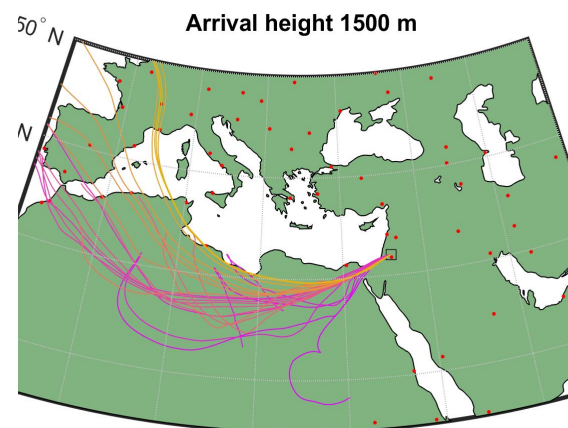
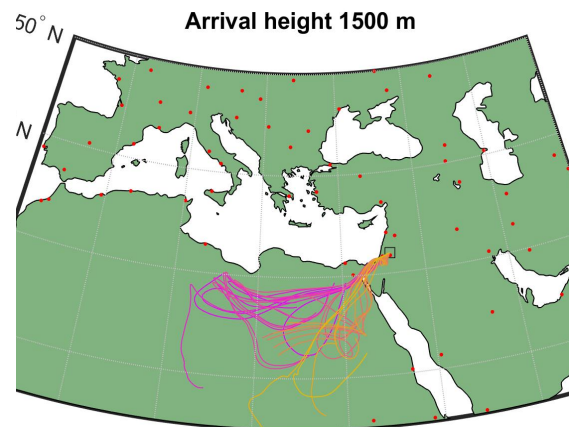
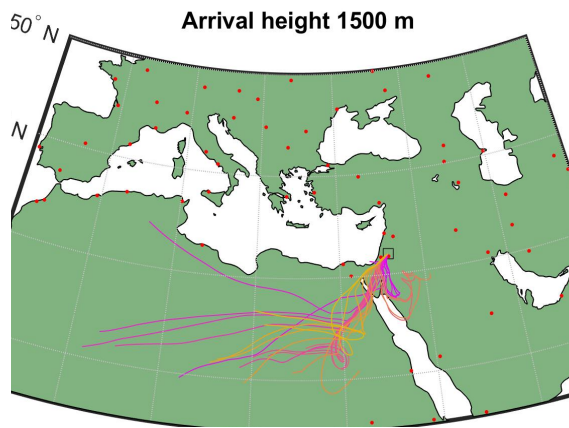
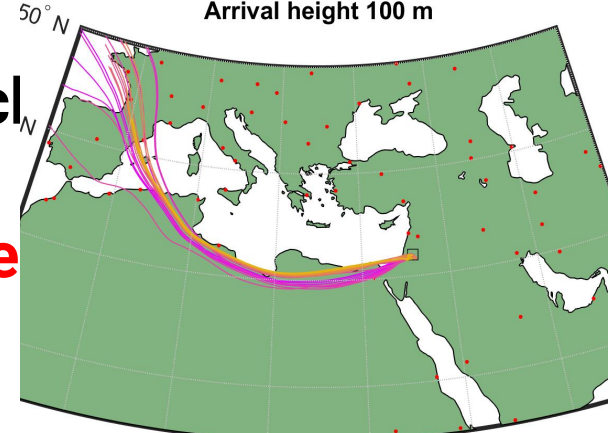
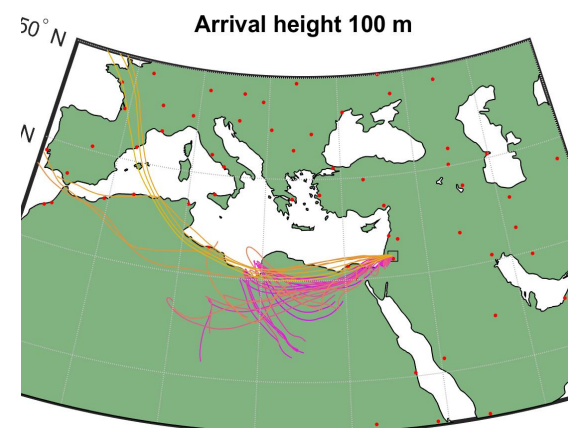
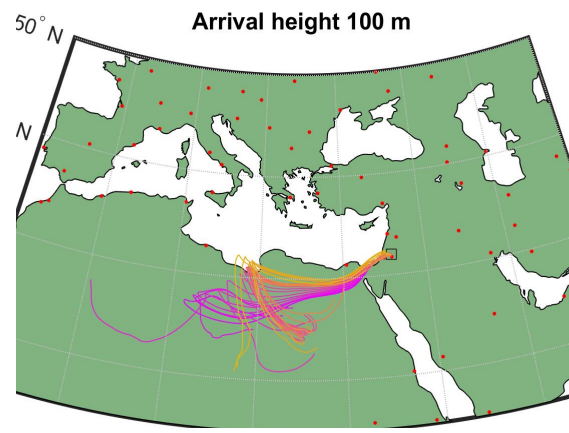
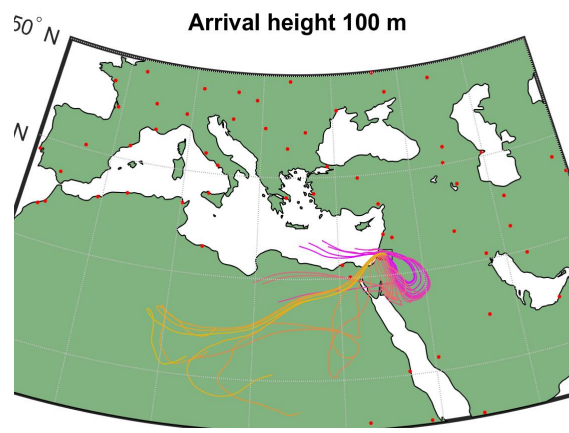
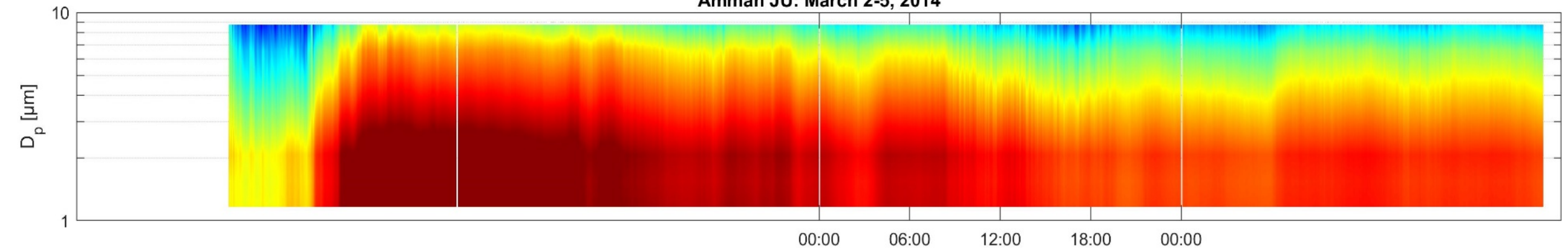




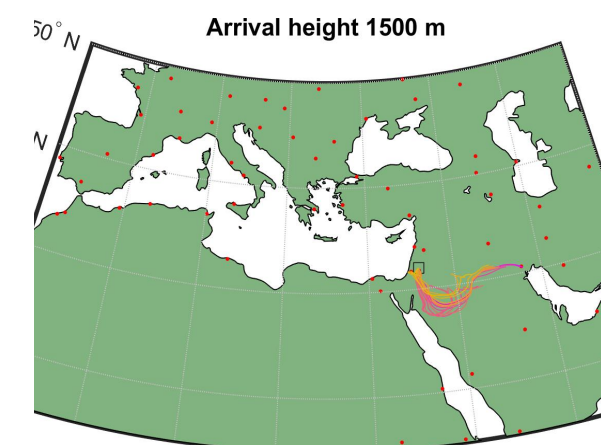
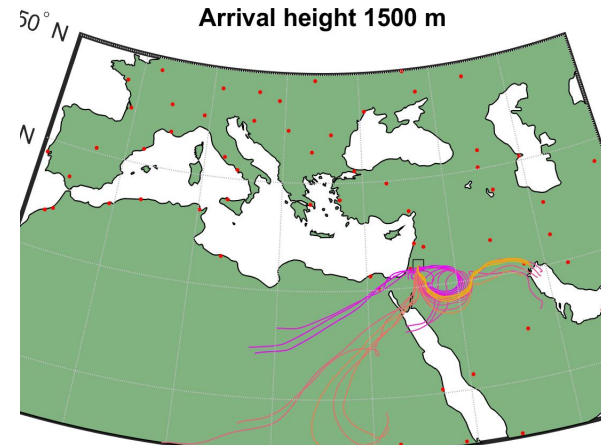
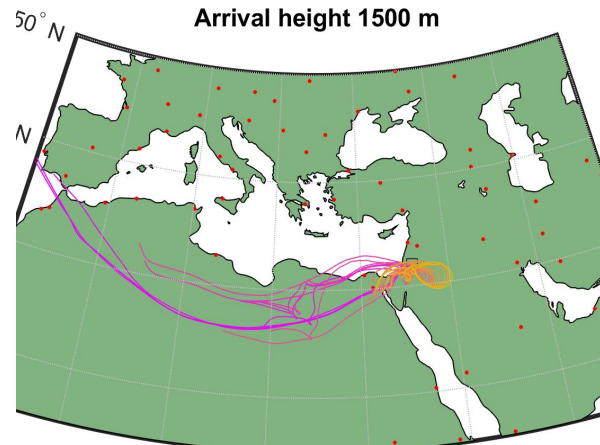
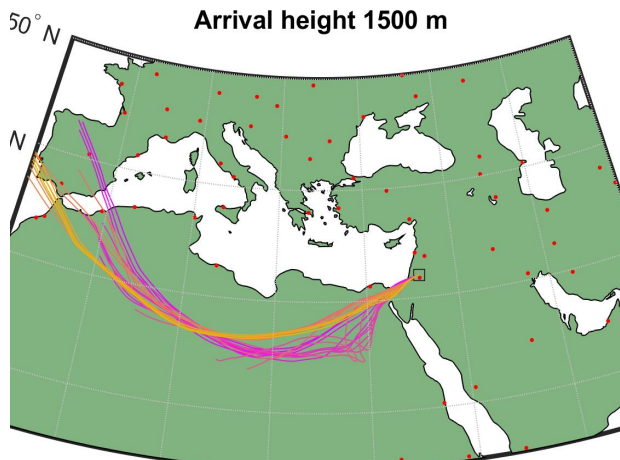
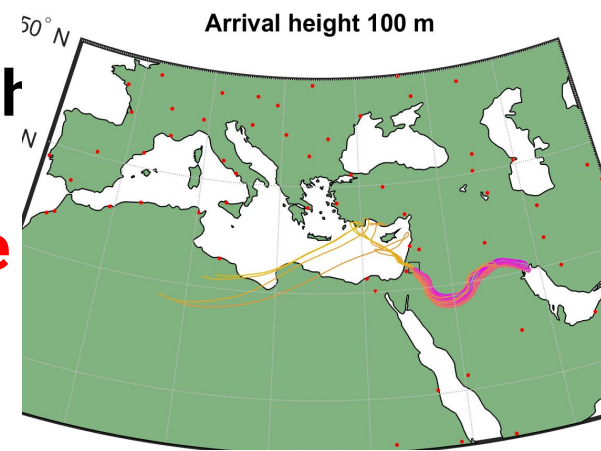
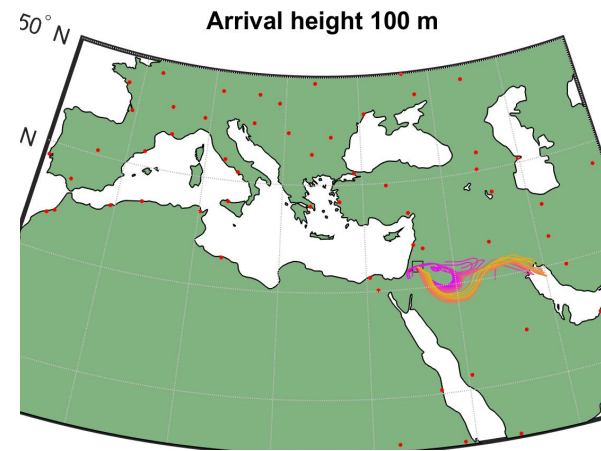
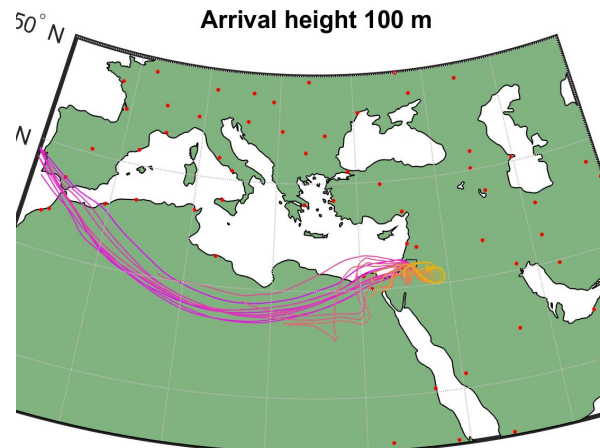
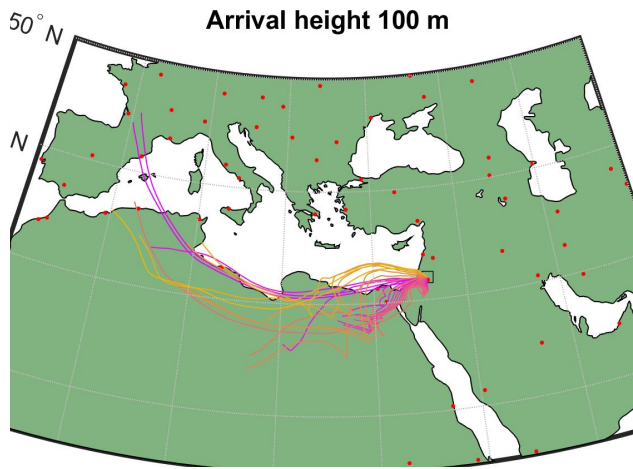
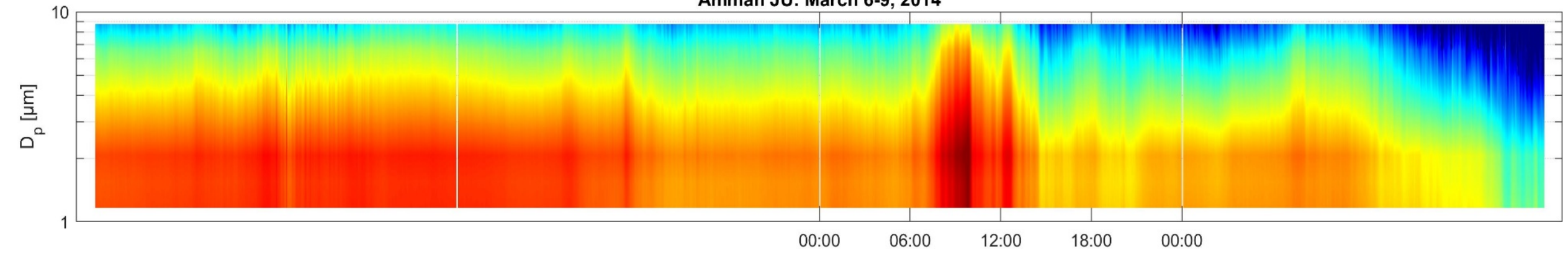
Case Studies and Examples

Intense Saharan-Levant-Arabian Dust Episodes (March 2 – 9, 2014)

Amman JU: March 2-5, 2014



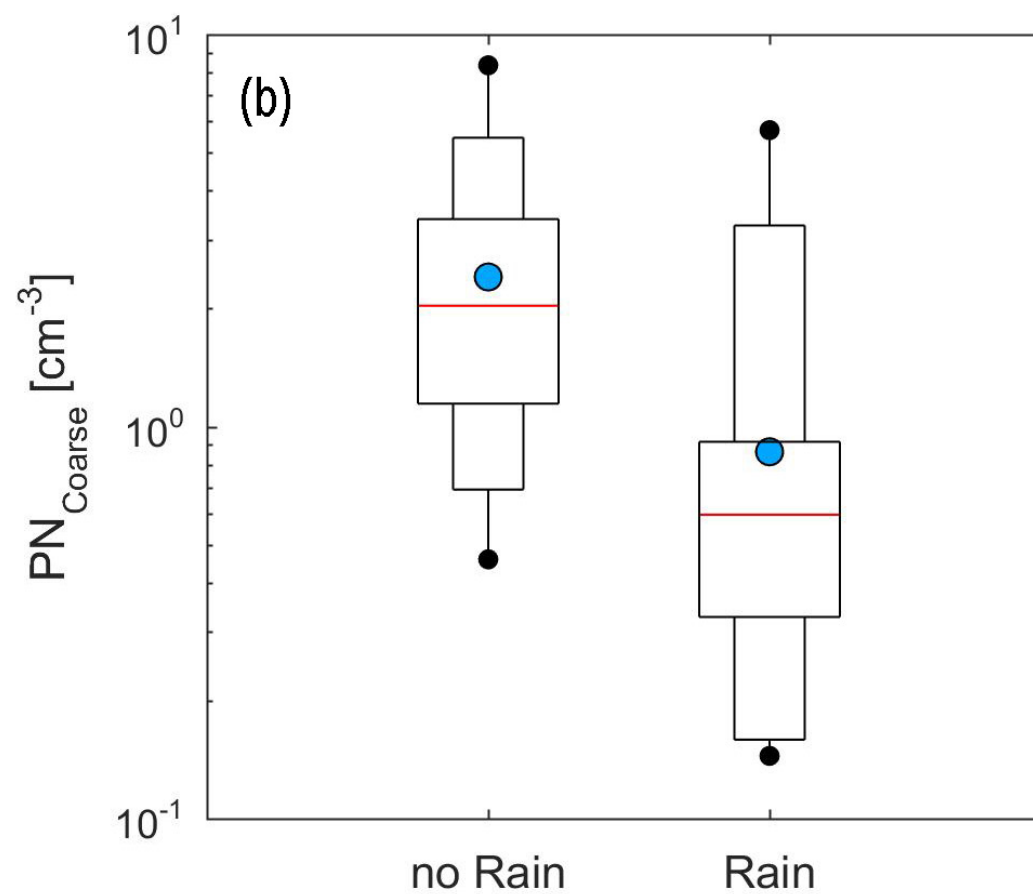
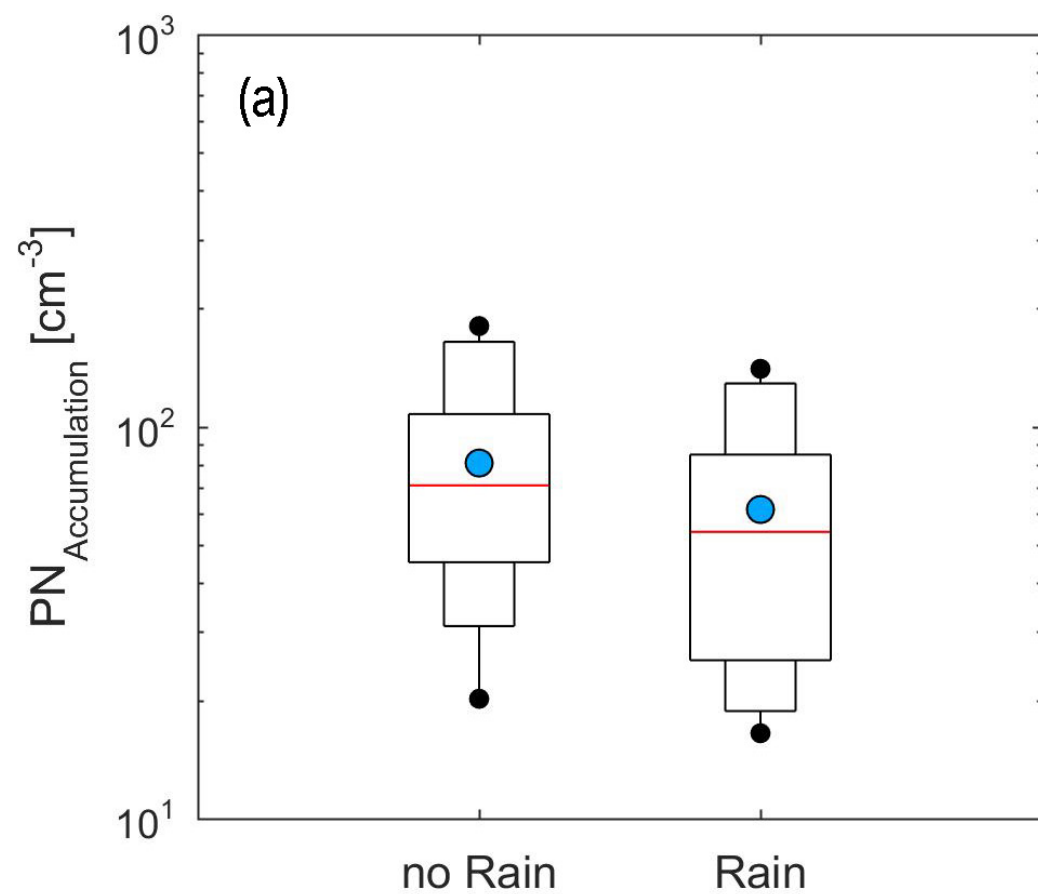
Amman JU: March 6-9, 2014



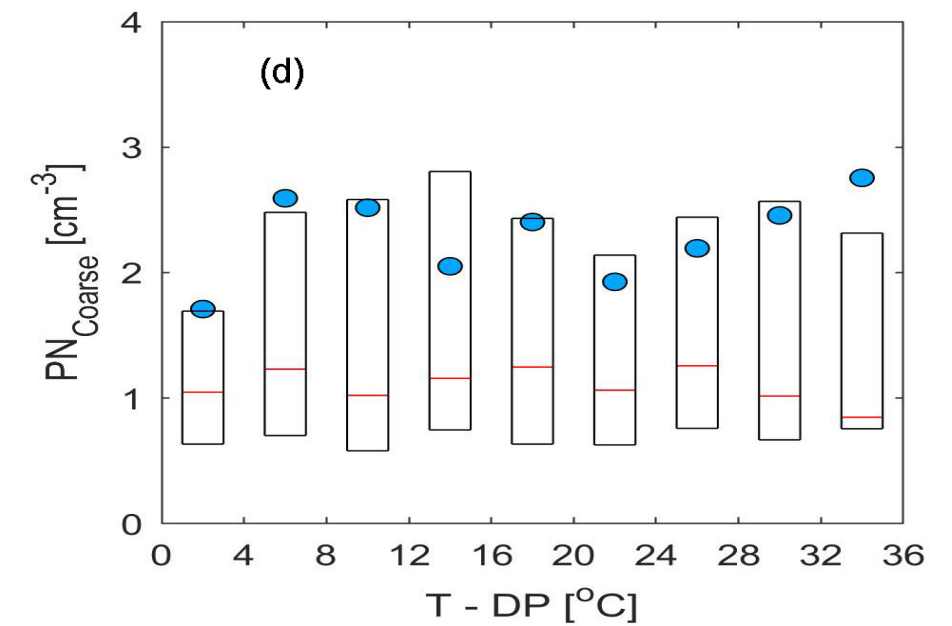
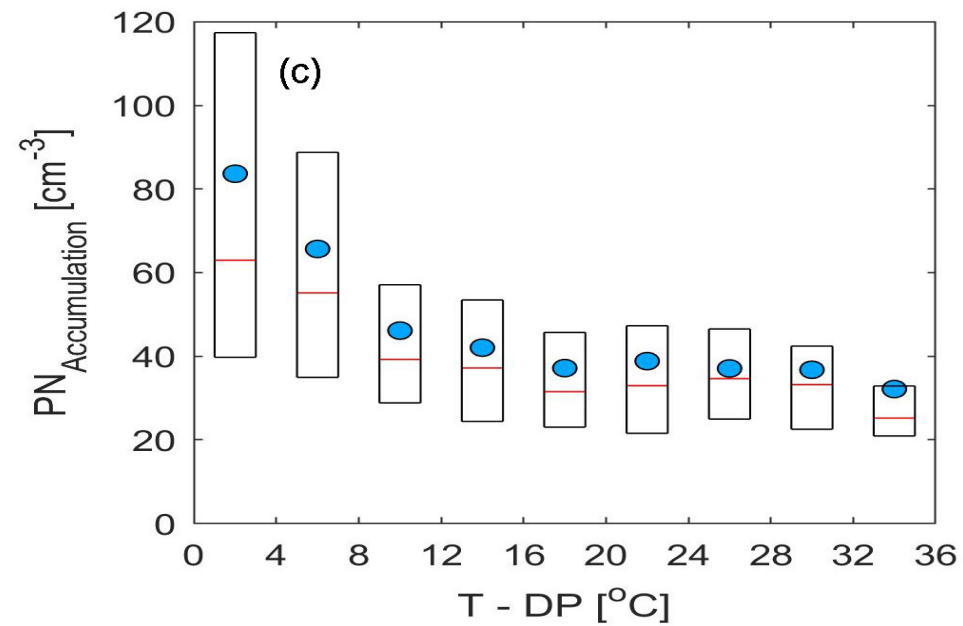
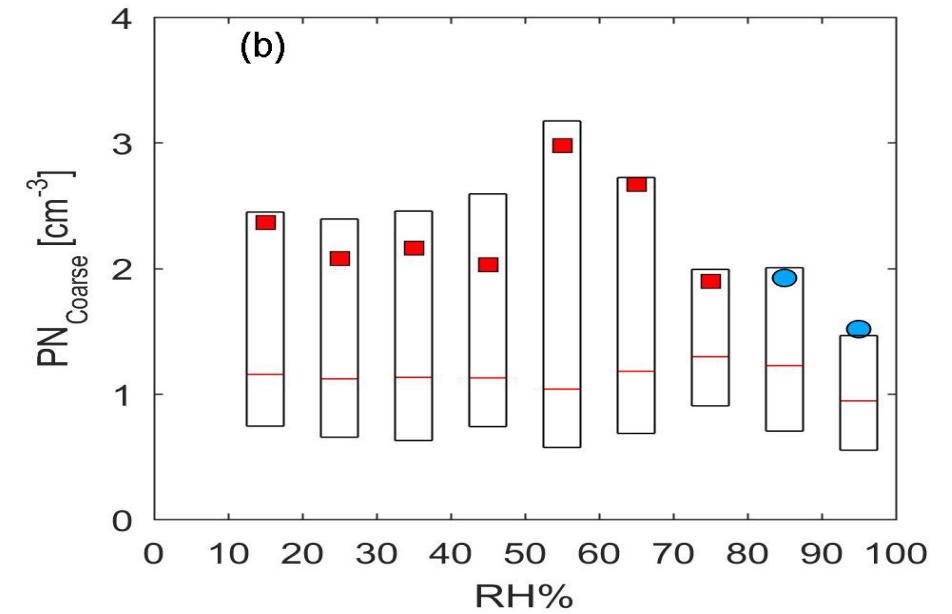
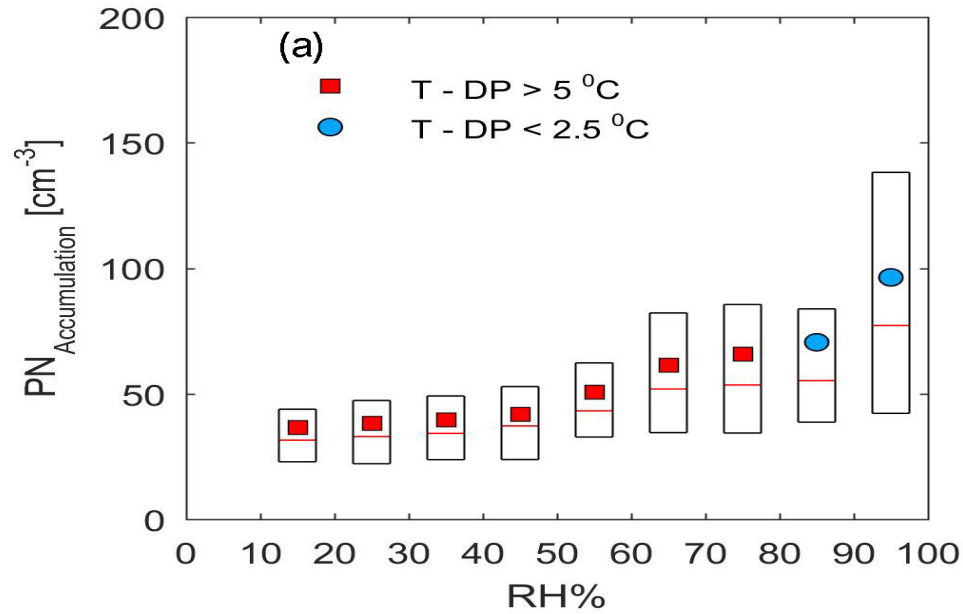


Influence of Dew Formation

Wash-out by rain



Effect of dew-formation on particulate matter



Summary...

- ❑ Clear **seasonal variation** for the accumulation and coarse modes concentrations:
 - ❑ high concentrations in winter
 - ❑ Coarse mode concentrations $> 1.5 \text{ cm}^{-3}$ in winter and early spring (reasons sand and dust storms)
 - ❑ Coarse mode concentrations range $1-1.5 \text{ cm}^{-3}$ throughout the summer
 - ❑ High PM concentration (monthly mean $\sim 375 \mu\text{g m}^{-3}$) in winter
 - ❑ Low PM concentrations (monthly mean $\sim 35 \mu\text{g m}^{-3}$) in summer
- ❑ **Local dust resuspension** is a major problem that persists on daily basis...
- ❑ **Dew Formation:**
 - ❑ Accumulation mode particle concentration increased during dew formation
 - ❑ Coarse mode particle concentration decreased during dew formation