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"Comparison Nucleation Events in Rural and Urban Sites in Po Valley, Italy"

Zurich, June 28th – July 1st, 2015

Realization of an integrated study of atmospheric pollution in Emilia-Romagna region by chemical, physical and toxicological measures and health, epidemiological and environmental evaluation by interpretative models.

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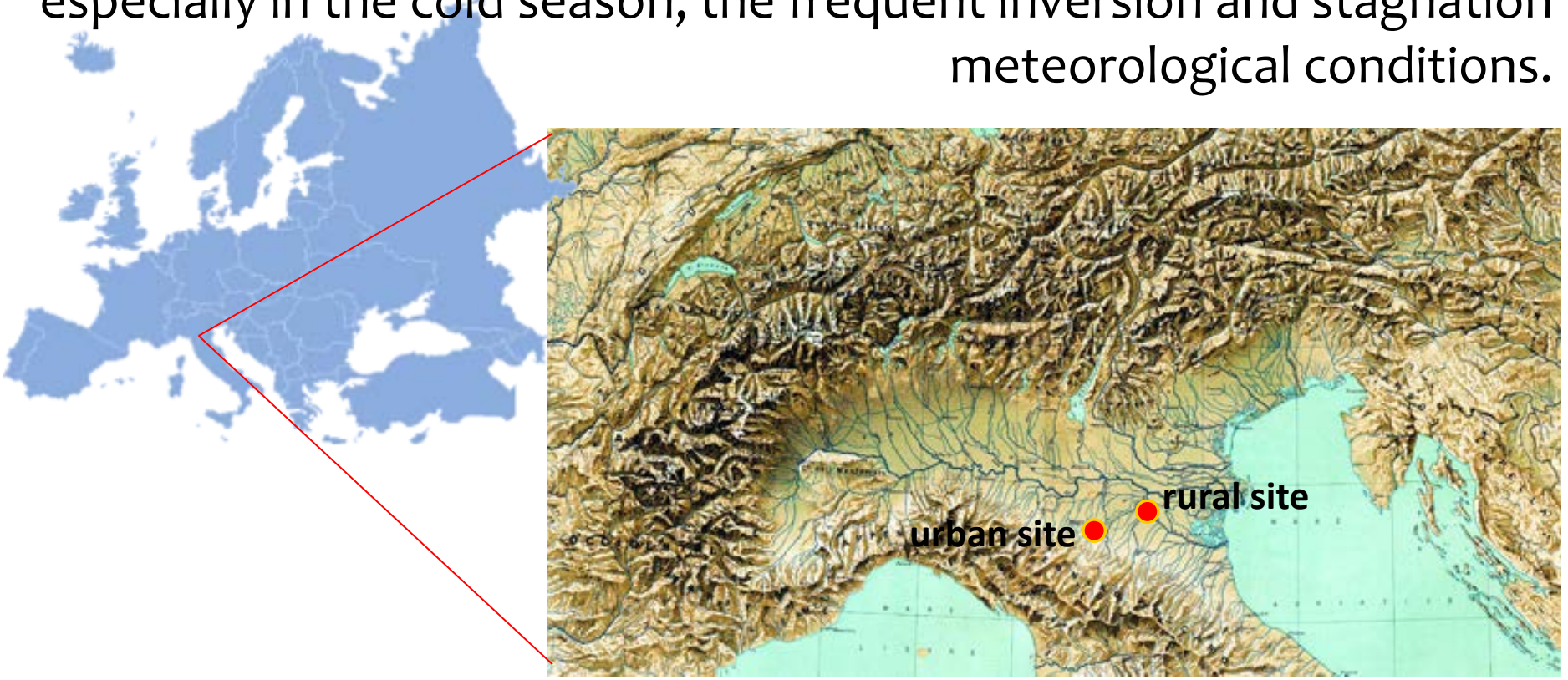
Promoters
Regional Health Policy Department
Regional Environmental and Sustainable Development Department
Coordination
Regional Agency for Prevention and Environment of Emilia-Romagna

Institutes involved:
Institute of Atmospheric Sciences and Climate (CNR-ISAC)
University of Bologna
University of Ferrara
University of Eastern Finland
Finnish Meteorological Institute
Department of Epidemiology of the Regional Health Service (Lazio)
University of Insubria

Monitoring sites

The Po Valley (northern Italy) is characterized by a high density of anthropogenic emissions (mainly are traffic, domestic heating, industry emissions and agriculture) and by frequent exceedance of PM limits set by the EU Air Quality Directive (2008/50/CE) due to, especially in the cold season, the frequent inversion and stagnation meteorological conditions.



Urban site: about 400.000 residents (1.000.000 metropolitan area)
Rural site: about 1.500 residents
The distance between two sites is about 30 Km.

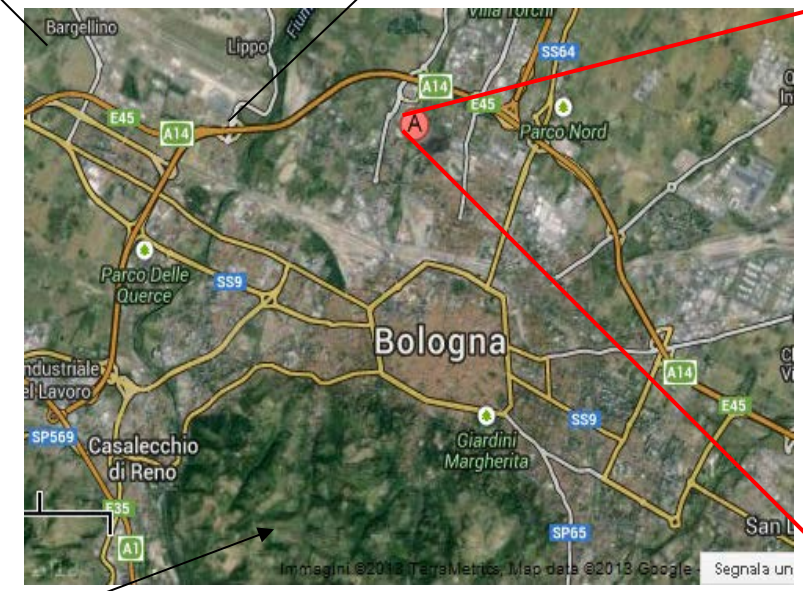
urban area

Measurements period:
February, March, April, May, June, July, September, October 2013

Sampling site: urban background in the city of Bologna, inside the area of National Research Council

airport

highway and major roads



hills

rural area

Farms and open country

Instrumentation

SCANNING MOBILITY PARTICLE SIZER
&
Twin- DIFFERENTIAL MOBILITY PARTICLE SIZER

Long and Nano-DMA (TSI 3081, TSI 3085) & (Hauke-type, Winklmayr et al., 1991)

WCPCs (CPCs TSI 3787, TSI 3788) & Butanol CPCs (TSI 302; TSI 3010)

DIFFERENTIAL MOBILITY ANALYZER –DMA + CONDENSATION PARTICLE COUNTER-CPC

Radioactive source: Kr 85 & Ni-63

Nano: 3-20 nm

Long: 15-600 nm

148 & 119 channels

Time resolution: 5 min & 10 min

Descriptive analysis

Descriptive analysis 1

Average 3-600nm: 9496 cm-3 urban and 6121 cm-3 rural

Madrid 7300-9900 cm-3; London ~12000 cm-3; Milan ~ 26000 cm-3

(Moreno et al., 2011 – Atmos. Env.) (Rodriguez et al., 2007 – Atmos. Env.)

The contribution of ultrafine particles (UFP, 3-100 nm) to TPC (Total Particle Concentration) levels were respectively **82%** for urban site and **78%** for rural site.

in agreement with data reported for other urban areas with a comparable meteorological features:

Modena 78% (10-700nm; Bigi et al., 2011 – Water Soil Pollut.)

Milano 79% (10-20000nm; Lonati et al., 2011 – Atmos. Env.)

Correlation between urban and rural site

> 100nm 0.751

< 100nm 0.209

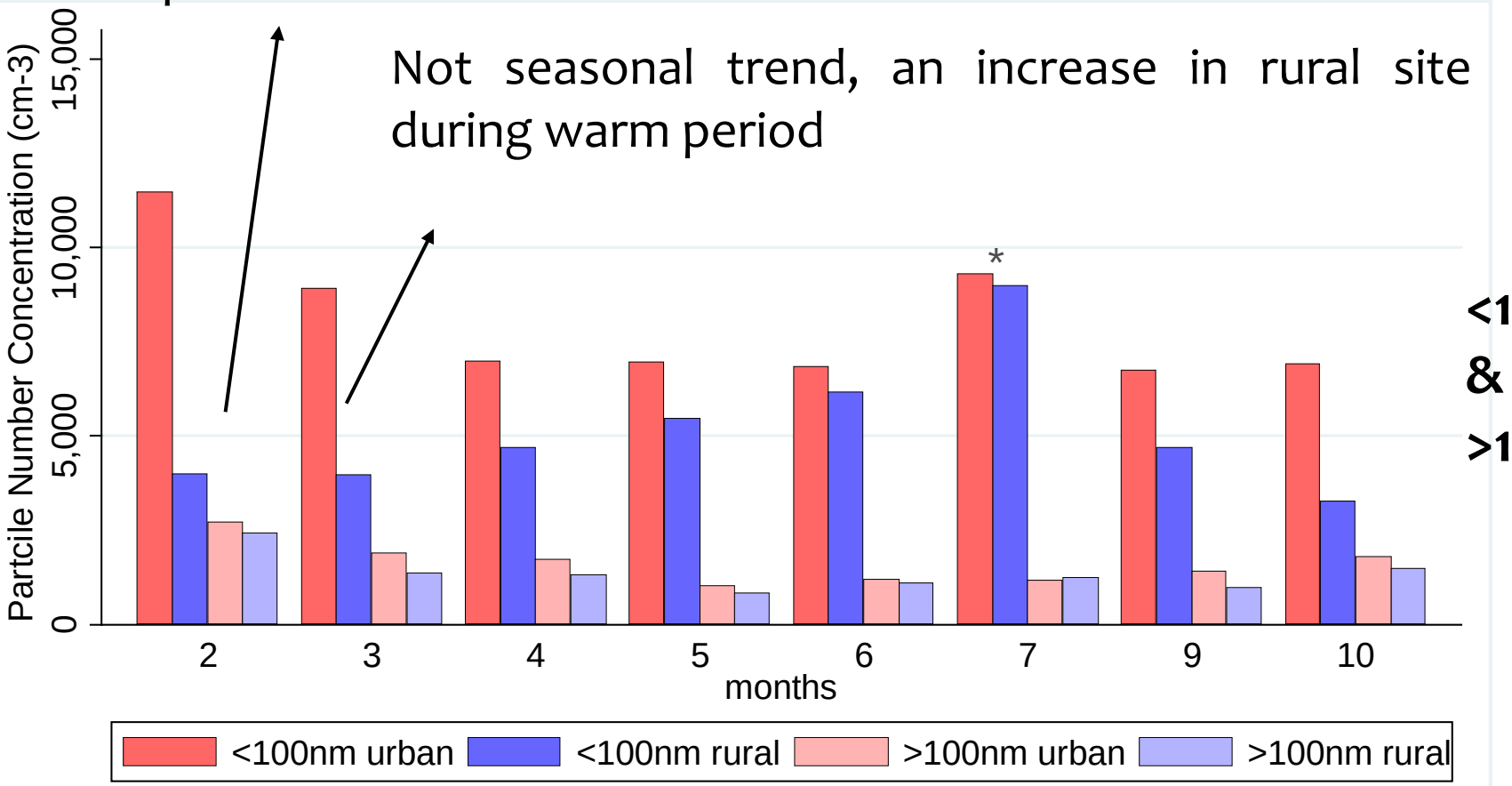
corr >100nm vs PM2.5 → 0.835/0.857

corr PM2.5 urban*vs*rural: 0.932 (daily db)

Descriptive analysis 2: monthly average 2013

Typical season influence: maximum values in winter period, with atmospheric stagnant conditions, same as the other pollutants

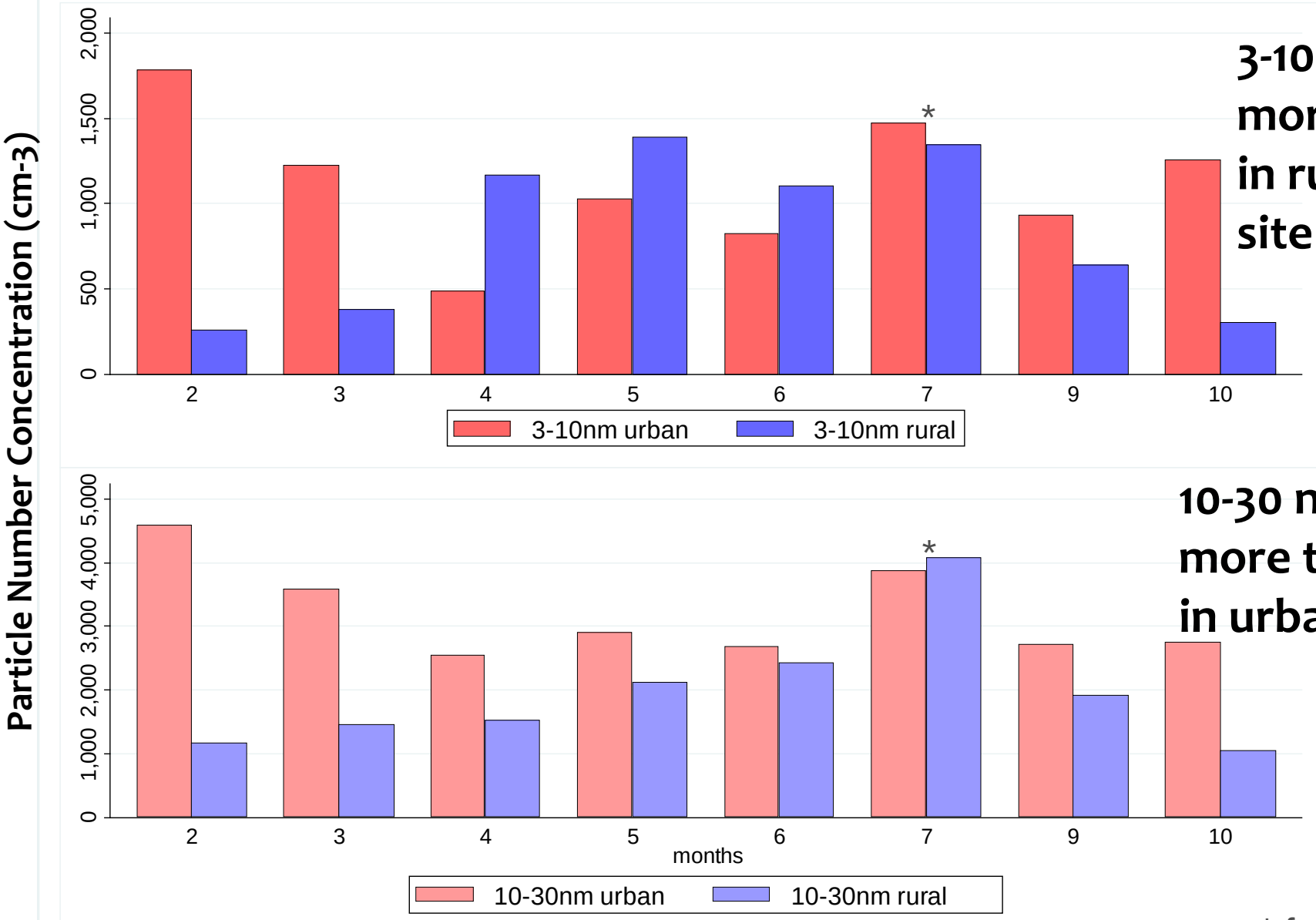
Not seasonal trend, an increase in rural site during warm period



<100 nm & >100nm

* few days

Descriptive analysis 3: monthly average 2013

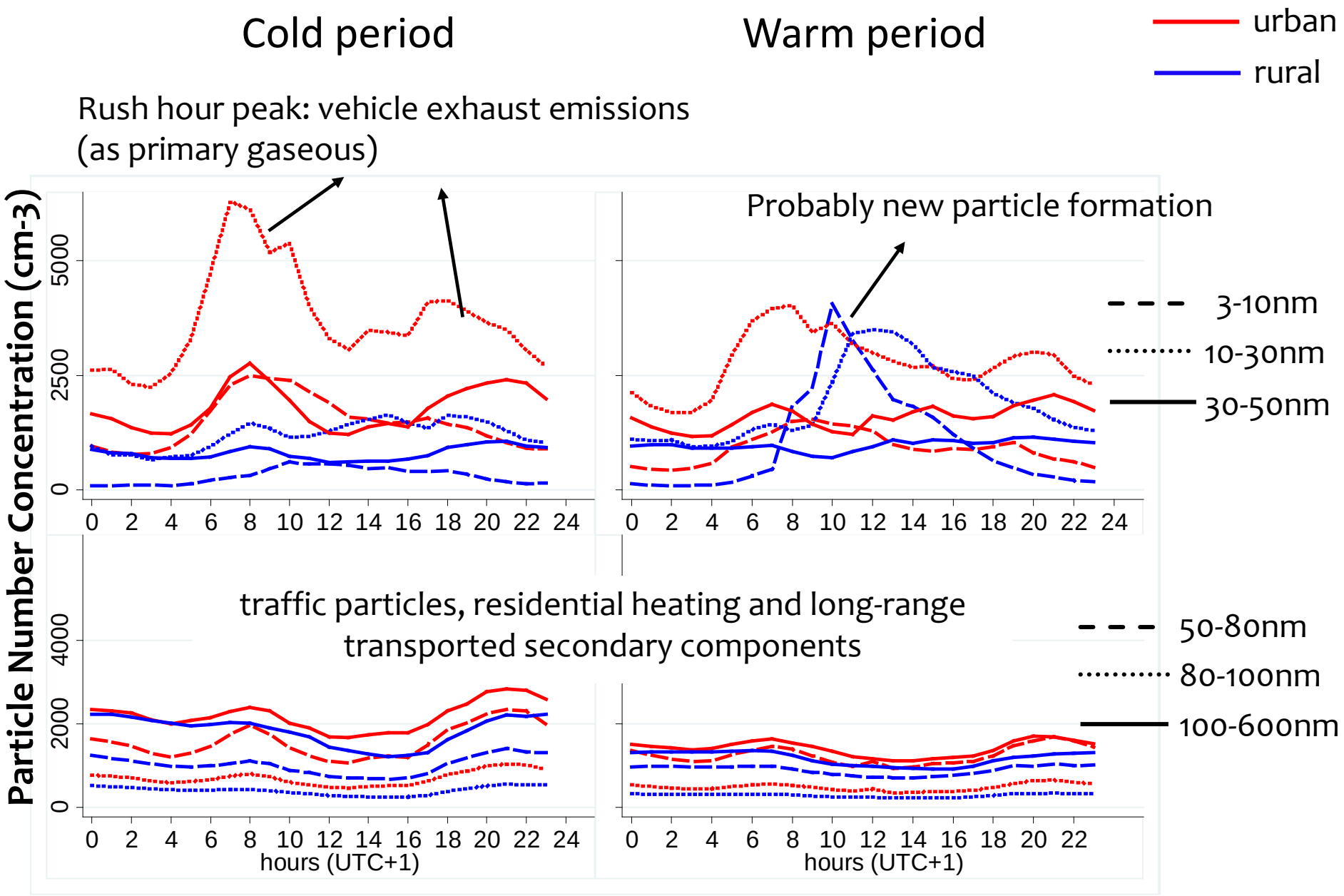


3-10 nm more NPF in rural site

10-30 nm more traffic in urban site

* few days

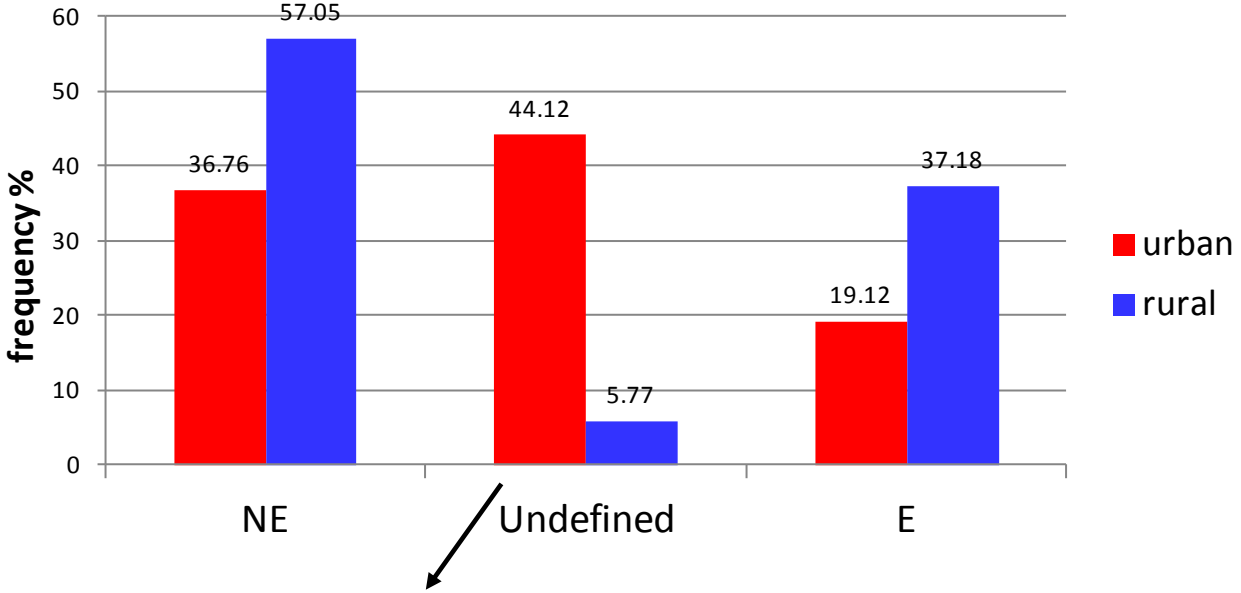
Descriptive analysis 3: diurnal pattern



Analysis of Nucleation Events

Percentage of Event, Undefined and Non-Event

Classification events by Hamed et al., 2005 - Atmos. Chem. Phys.



Hyytiala: 24%
(Dal Maso et al., 2005 – Boreal Env. Res.)

Madrid 17% rural
(Moreno et al., 2011 – Atmos. Env.)

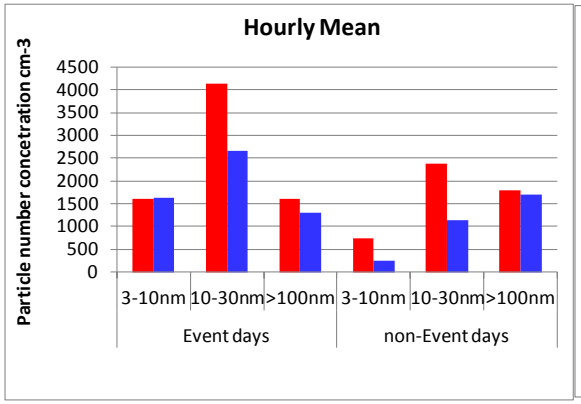
Hong Kong (winter): 23%
(Wang et al., 2014 – Atmos. Env)

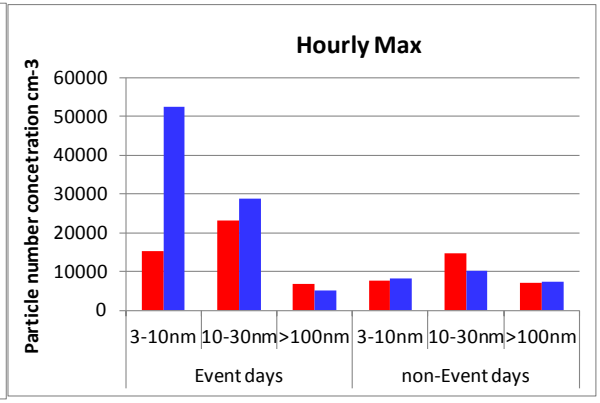
Beijing (summer): 15-20%
(Yue et al., 2009 – J. of Geopysical Res.)

Ultrafine particle event without growth into larger particles and/or 'spot' primary emissions (traffic, industry, residential heating...)

May&June
urban - 30% -rural - 64%

15% in the same days
(deleting Bad&Nodata)

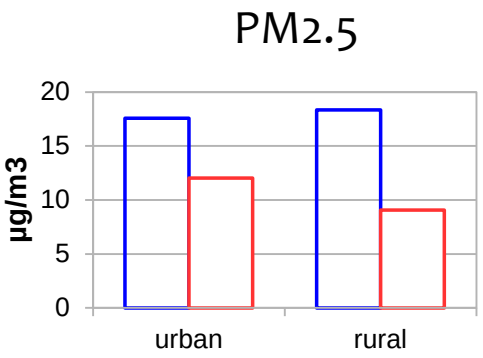


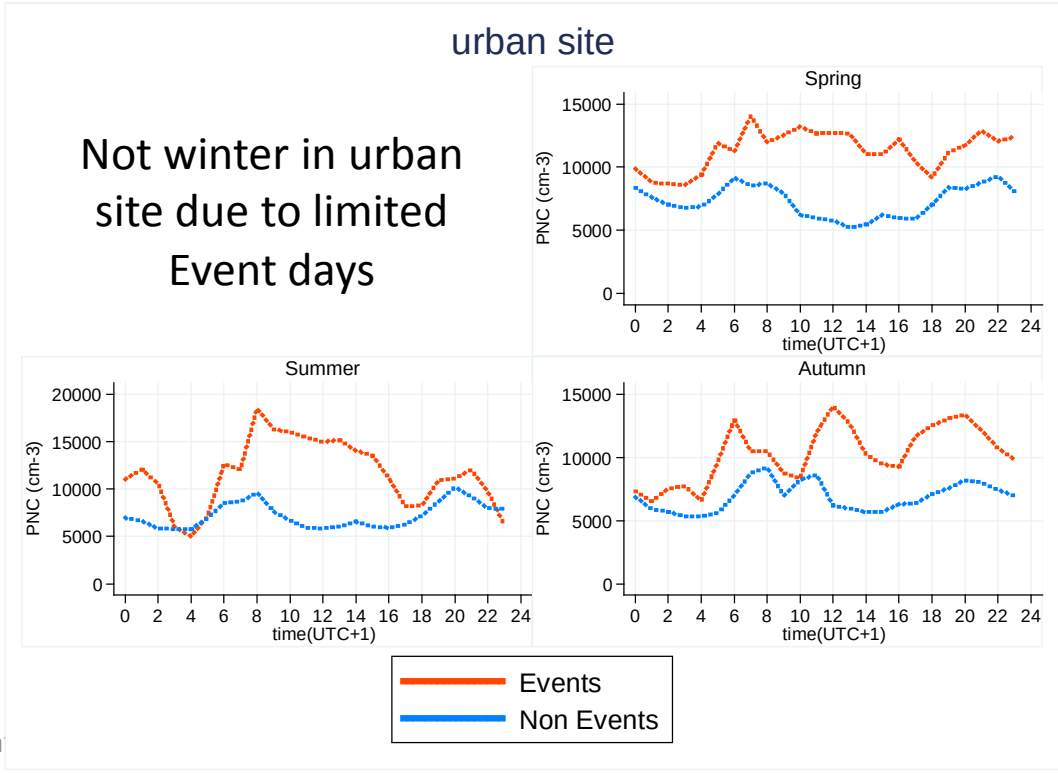


Diurnal pattern

Event days and non-Event days

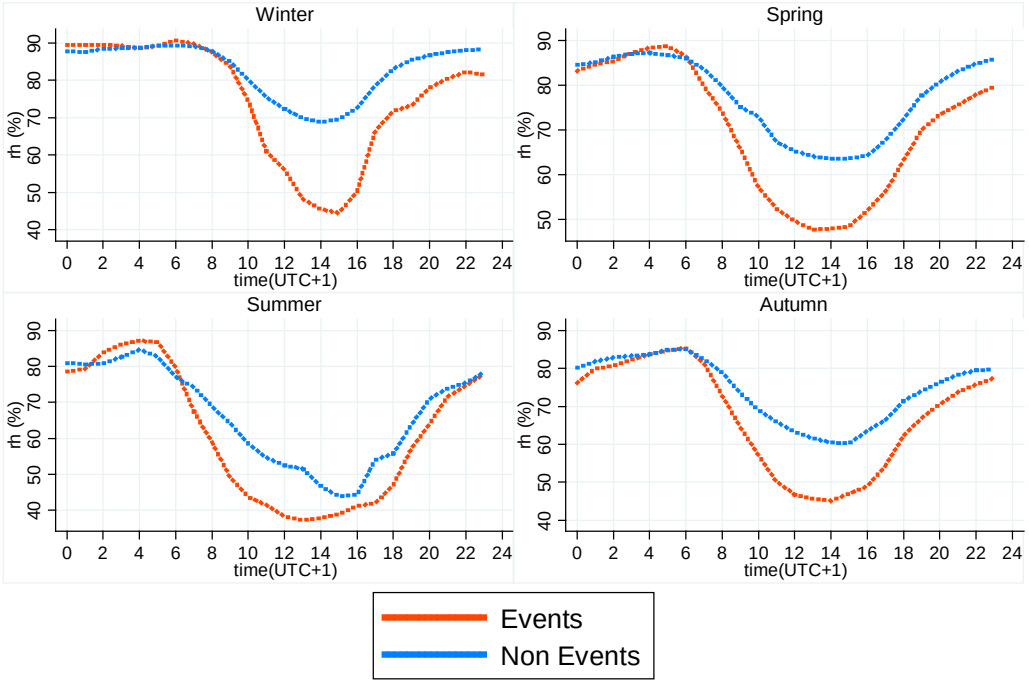
Particle Number Concentration



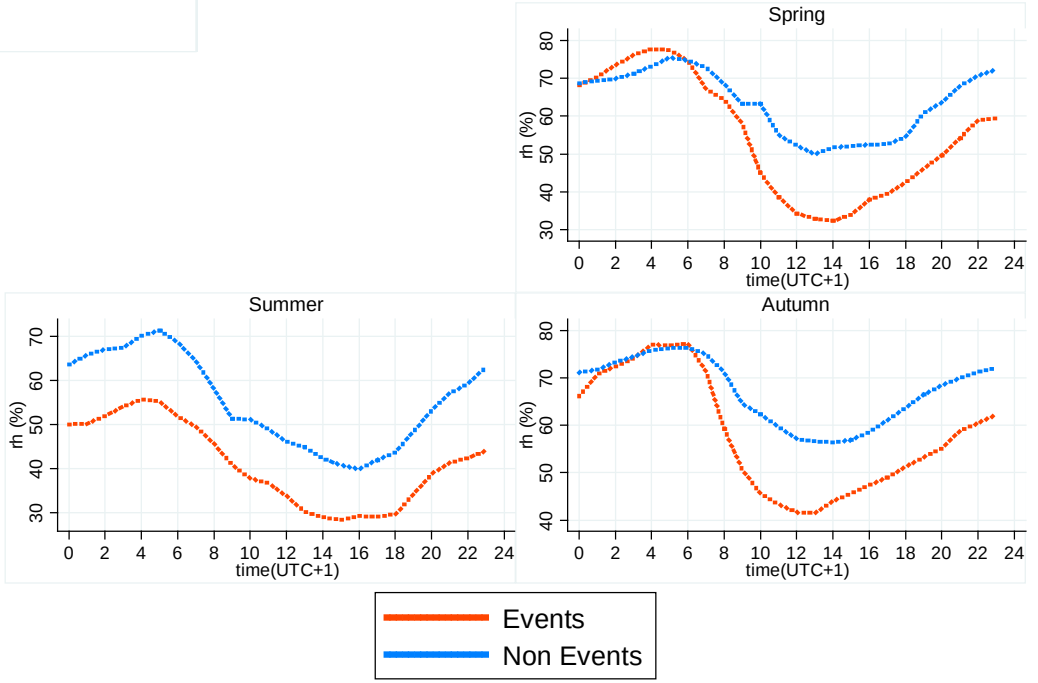


Relative humidity

rural site

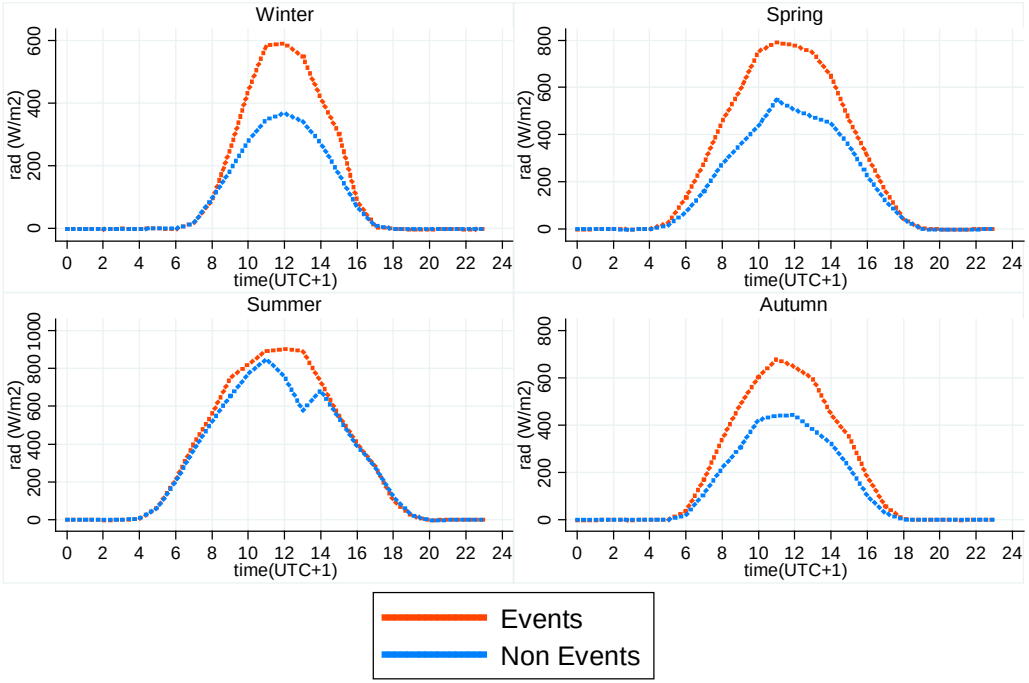


urban site

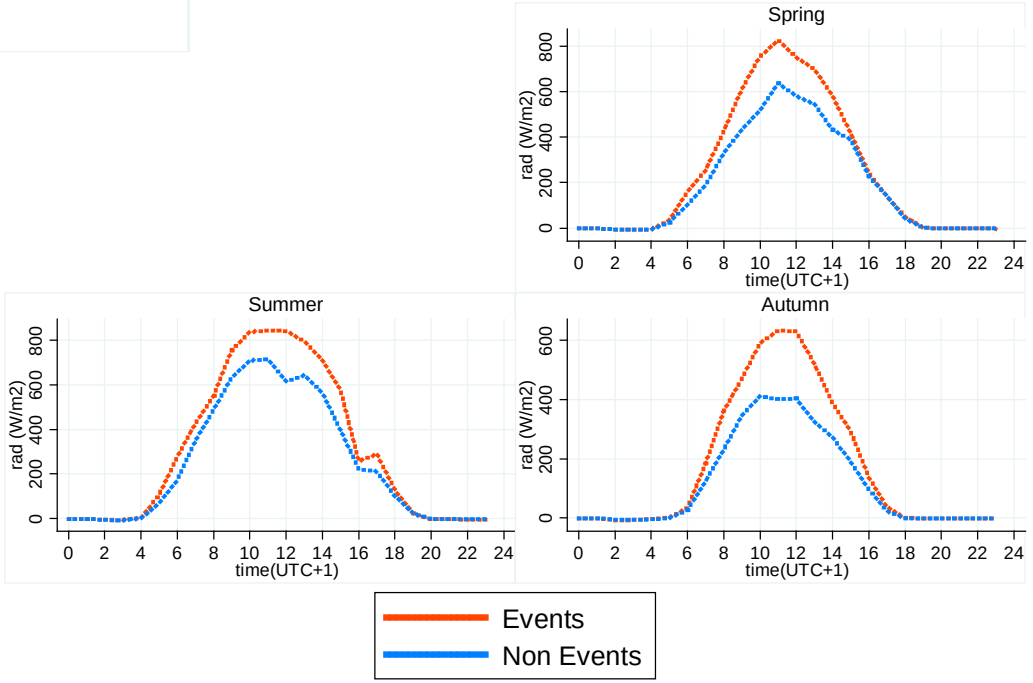


Solar Radiation

rural site

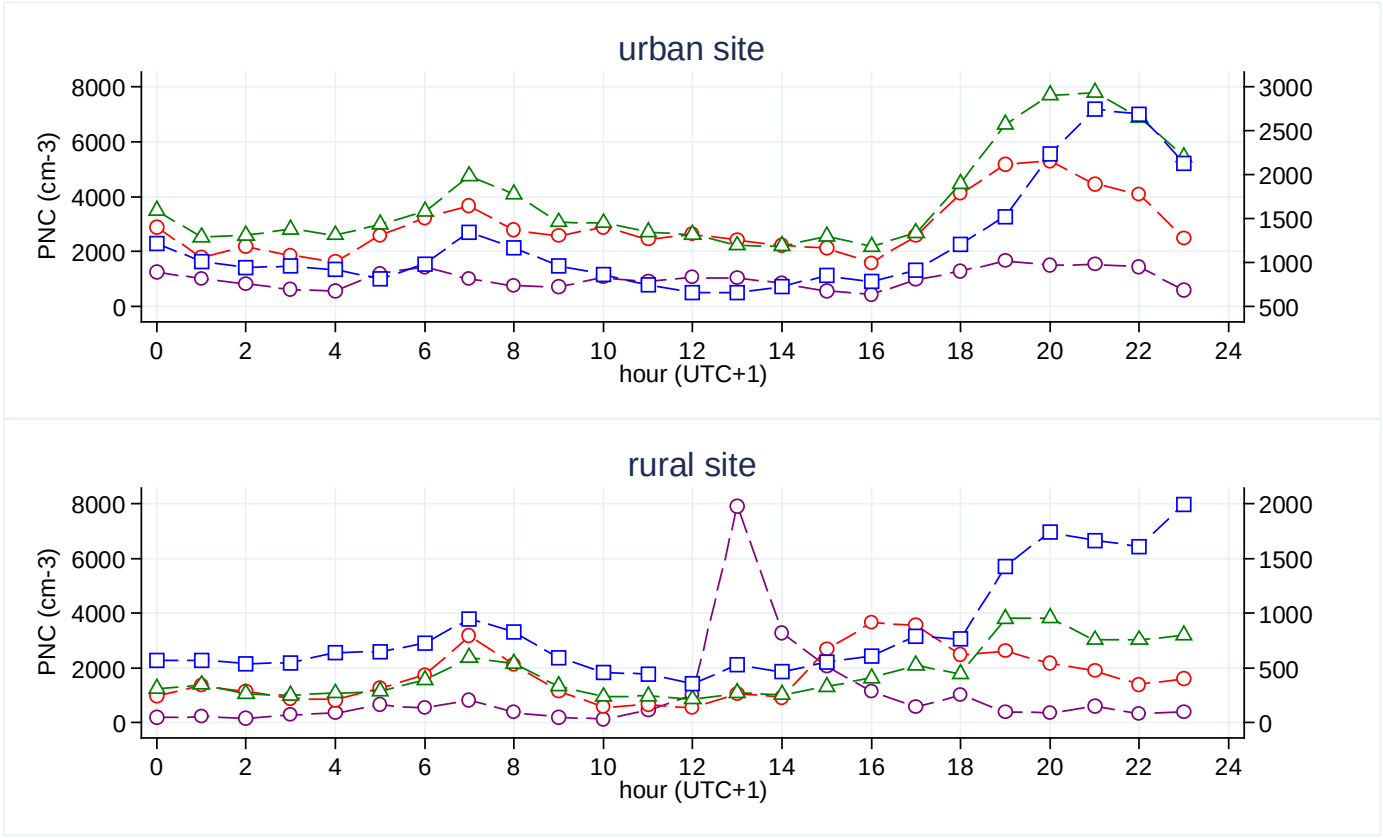


urban site

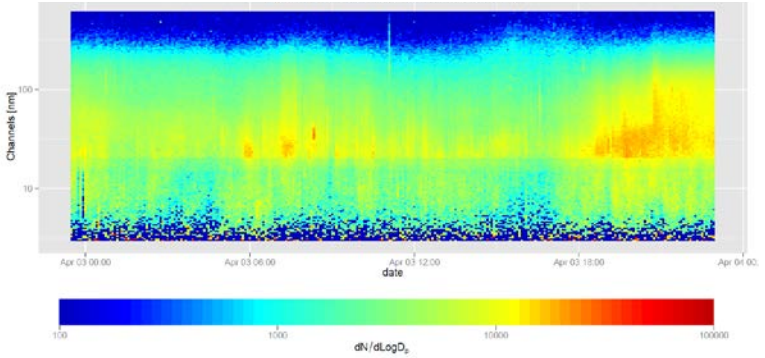


3 case studies
Event days, non-Event days and Event in the same day

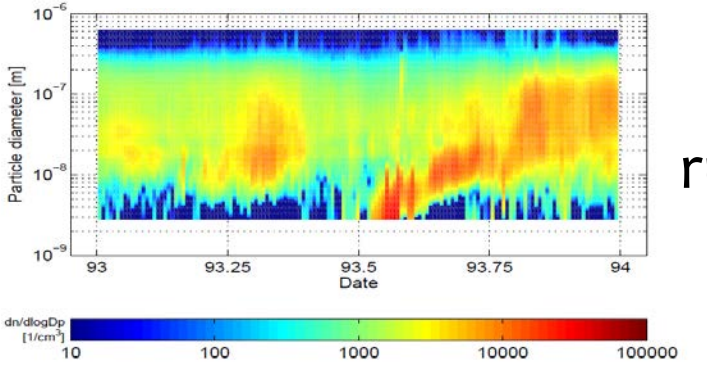
April 2013 – Event in a rural site



Similar meteo conditions, just a stronger advection in rural site in the first morning hours.

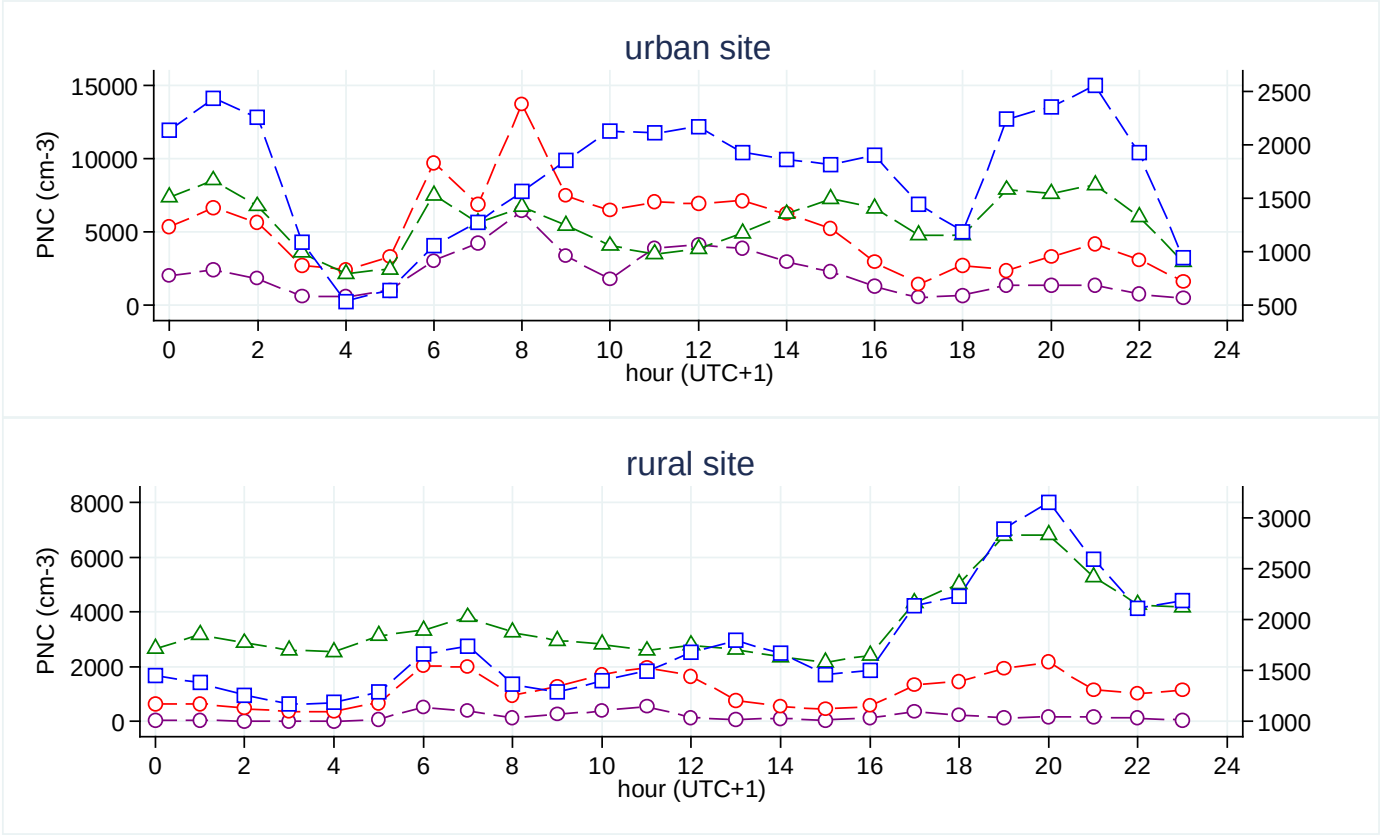


urban

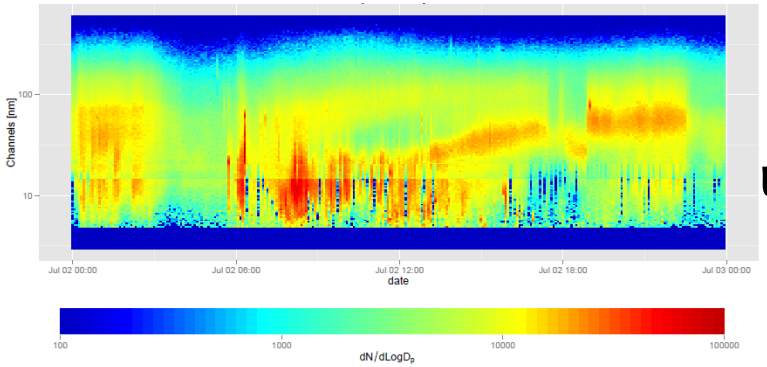


rural

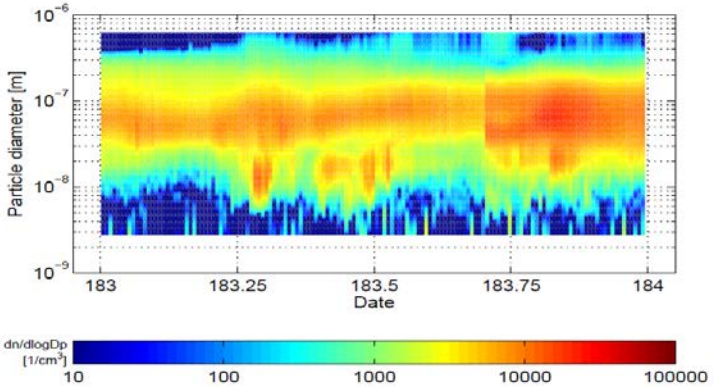
July 2013 – Event in a urban site



Different relative humidity and wind speed in the first morning hours.

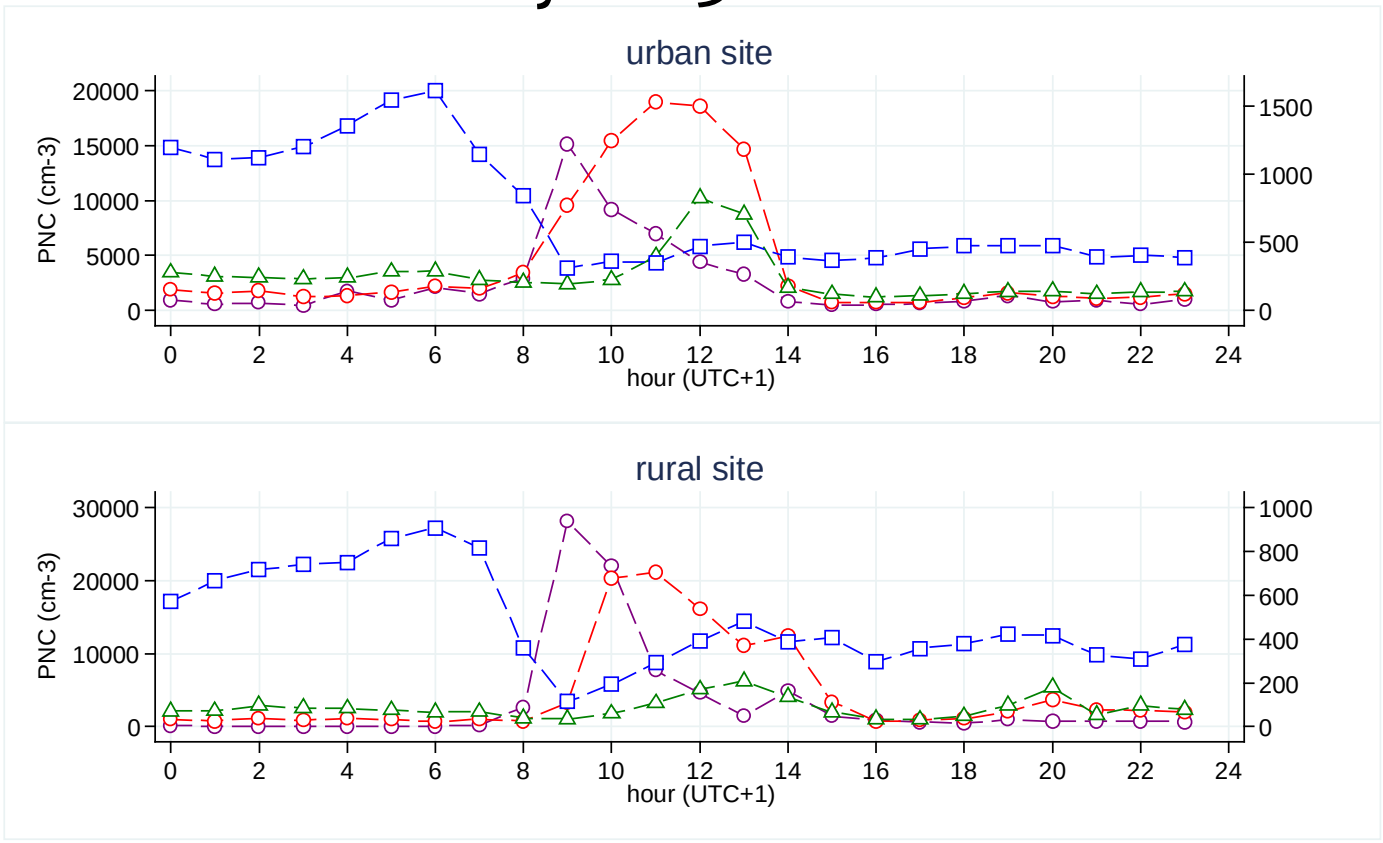


urban



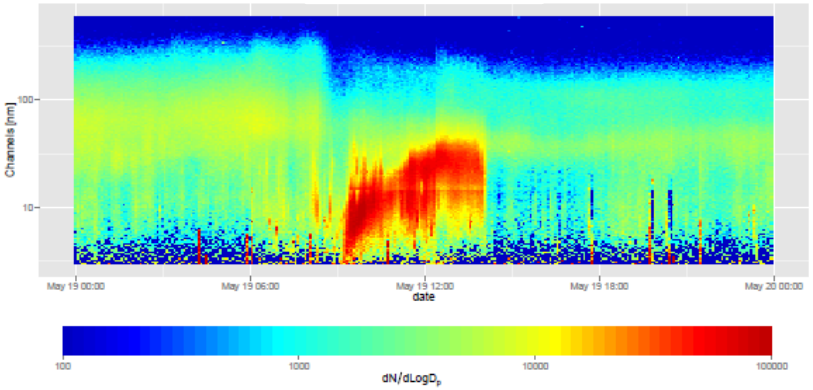
rural

May 2013 – Event in both sites

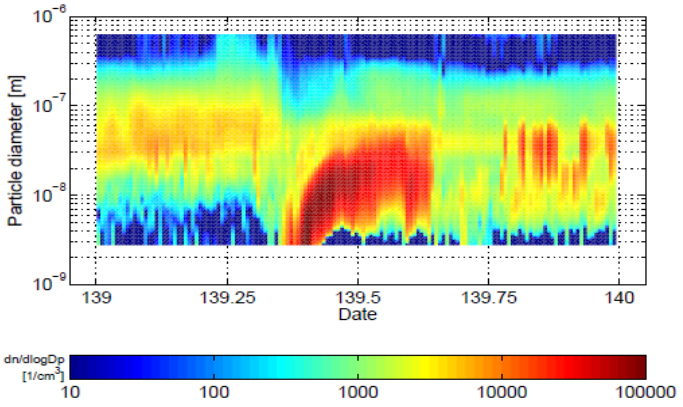


Similar relative humidity and radiation; high wind speed before both Events

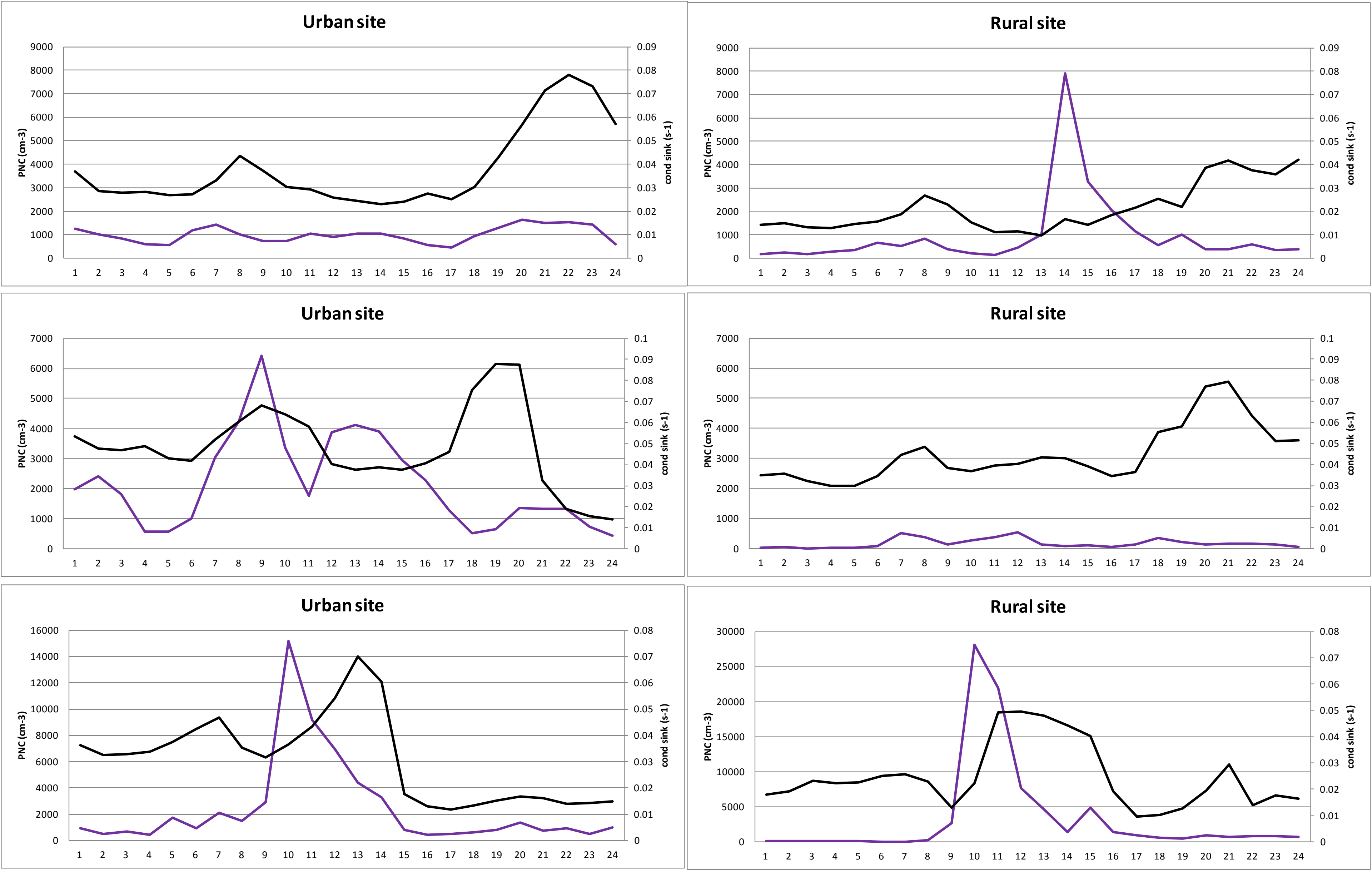
3-10nm 10-30nm 25-90nm 90-600 nm



urban



rural



3-10nm

Condensation Sinks

$CS_j = 2 \pi\ Dj\ \Sigma i\ \beta ij\ dpi\ Ni$

(Cond Sinks by Lehtinen K.E.J. Et al., 2003; Kuuluvainen H. et al., 2010)

In summary

.Photochemistry enables New Particle Formation in a polluted area of PO valley either in the rural site and in urban background site

.Three case studies: the wind velocity is the meteorological factor that seems to have more influence on the NPF.

.In this study I found that in order to have a NPF Event, the solar radiation and relative humidity play a fundamental role.

.Most events that occurred in the urban site also occurred in the rural site.

.For this study there are no information for precursors (still a work in progress)

Thank you for your attention!

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