



EU GREEN DEAL

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**PARTNER EVENT
#EUGREENWEEK
30 MAY – 5 JUNE 2022**

IMPROVING AIR QUALITY TOGETHER LIFE IP PrepAIR: project's achievements and main results

31st May 2022

Emilia-Romagna Region
Delegation to the EU

**NEXT
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LIFE 15 IPE IT 013



The composition of PM in the Po Valley

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PREPAIR PROJECT



Action A4: Setting the measuring protocols for special stations.

Action D6: Monitoring the environmental effects of pollutants reduction measures implemented by air quality improvement plans.

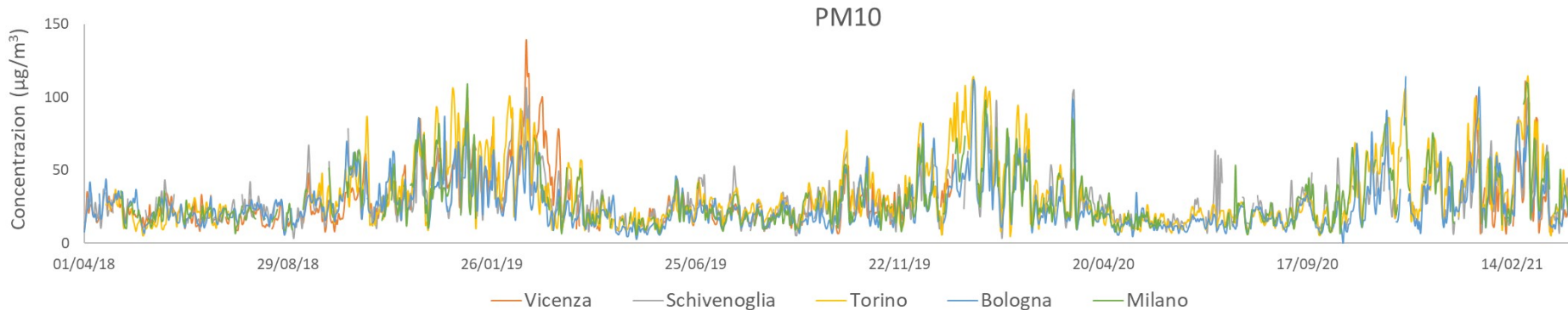
AZIONE D5: Regular assessment (monthly/yearly) of the air quality of the Po basin.

Monitoring stations:

- Four **urban background** sites (Torino, Milano, Vicenza e Bologna)
- One **rural background** site (Schivenoglia)



+ Aosta (another different laboratory) + Milano – via senato as a backup di Milano – via Pascal



Monitoring stations:

- Four **urban background** sites (Torino, Milano, Vicenza e Bologna)
- One **rural background** site (Schivenoglia)



PM10 CHEMICAL COMPOSITION

Chemical analysis results

elemental fraction (crustal)

elemental fraction (not crustal)

SIA { NH_4NO_3

(NH_4)₂SO₄
Ion fraction (not crustal)

OC primary + secondary (SOA)

primary EC

organic matter e H2O

X-ray Fluorescence (XRF): (Z > 11): Al, Si, P, S, Cl, K, Ca, Ti, V, Cr, Mn, Fe, Ni, Cu, Zn, Br, Rb and Pb

Ion chromatography: Na⁺, NH₄⁺, K⁺, Mg²⁺, Ca²⁺, Cl⁻, NO₂⁻, Br⁻, NO₃⁻, PO₄³⁻, SO₄²⁻, Levoglucosan

Thermo-optical method (TOT/TOR): Carbon compounds (OC, EC)

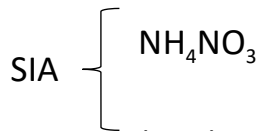
Chemical analysis are performed on a daily basis

PM10 CHEMICAL COMPOSITION

Chemical analysis results

elemental fraction (crustal)

elemental fraction (not crustal)



Ion fraction (not crustal)
 $(\text{NH}_4)_2\text{SO}_4$

OC primary + secondary (SOA)

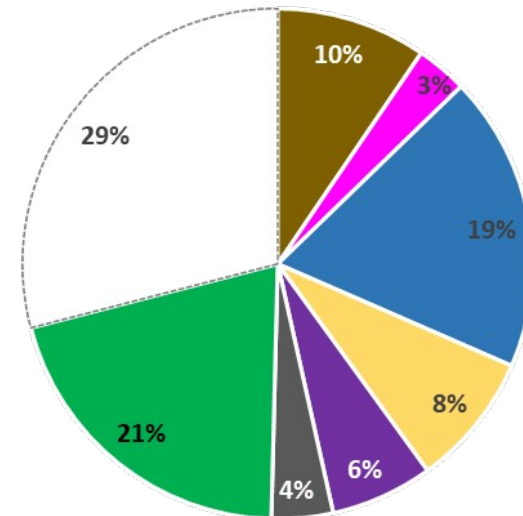
primary EC

organic matter e H2O



PM10 Compound

- Crustal matter
- Anthropogenic compound



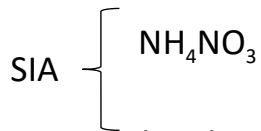
The mineral fraction consists of the naturally occurring elements typical of the earth's crust that are present in the atmosphere due to the mechanical action, both natural (wind) and anthropogenic (vehicular traffic, construction sites, etc.) resuspension of dust from the ground.

PM10 CHEMICAL COMPOSITION

Chemical analysis results

elemental fraction (crustal)

elemental fraction (not crustal)



Ion fraction (not crustal)
 $(\text{NH}_4)_2\text{SO}_4$

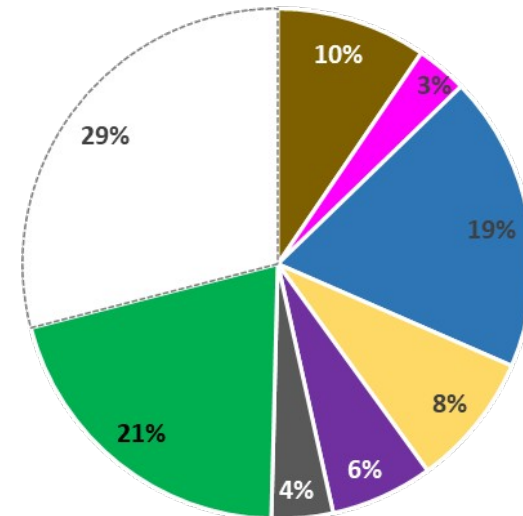
OC primary + secondary (SOA)

primary EC

organic matter e H2O

PM10 Compound

- Crustal matter
- Anthropogenic compound
- Ammonium Nitrate
- Ammonium Sulphate
- Other ions



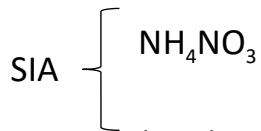
Sulfates, nitrates and ammonium are the majority ions, mainly found as ammonium sulfate and ammonium nitrate. They are formed in the atmosphere principally from the reaction of ammonia, emitted mainly from agricultural activities and livestock farms, with nitrogen and sulfur oxides. These ions are formed in moving air masses, spreading uniformly over the land.

PM10 CHEMICAL COMPOSITION

Chemical analysis results

elemental fraction (crustal)

elemental fraction (not crustal)

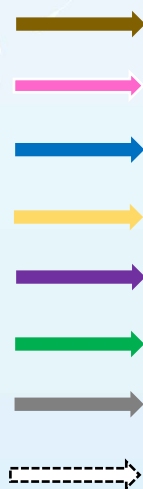


Ion fraction (not crustal)
(NH_4)₂SO₄

OC primary + secondary (SOA)

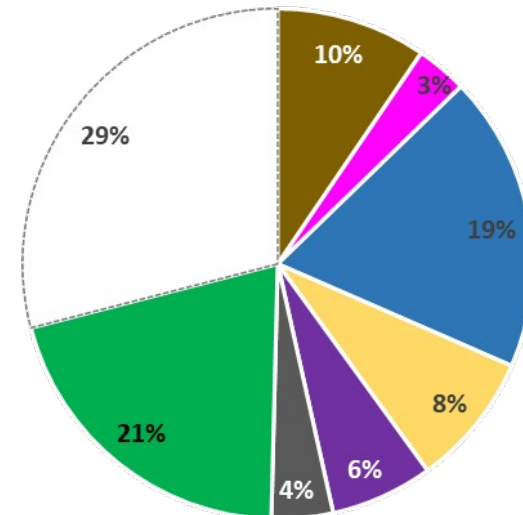
primary EC

organic matter e H2O



PM10 Compound

- Crustal matter
- Anthropogenic compound
- Ammonium Nitrate
- Ammonium Sulphate
- Other ions
- Organic carbon
- Elementar carbon
- Not defined



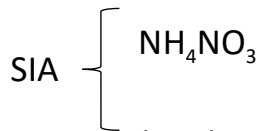
The carbonaceous fraction is separated into elemental carbon (EC) and organic carbon (OC). EC is a primary pollutant emitted during incomplete combustion of fossil fuels and biomass. OC is a partly primary and partly secondary pollutant. Secondary OC can be formed as a result of photochemical oxidation of volatile precursors (VOCs).

PM10 CHEMICAL COMPOSITION

Chemical analysis results

elemental fraction (crustal)

elemental fraction (not crustal)

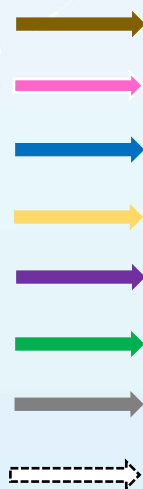


Ion fraction (not crustal)
 $(\text{NH}_4)_2\text{SO}_4$

OC primary + secondary (SOA)

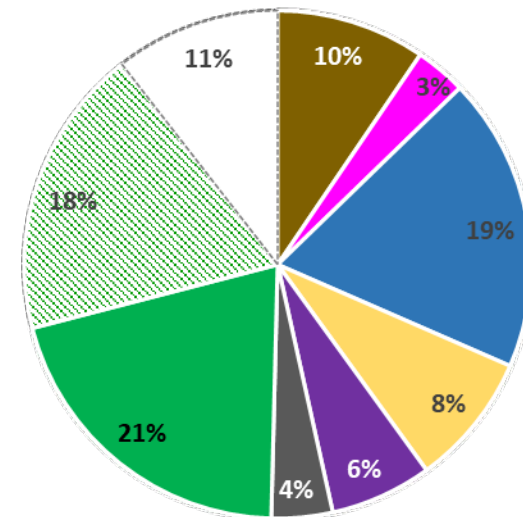
primary EC

organic matter e H2O



PM10 Compound

- Crustal matter
- Anthropogenic compound
- Ammonium Nitrate
- Ammonium Sulphate
- Other ions
- Organic carbon
- Elementar carbon
- Not defined



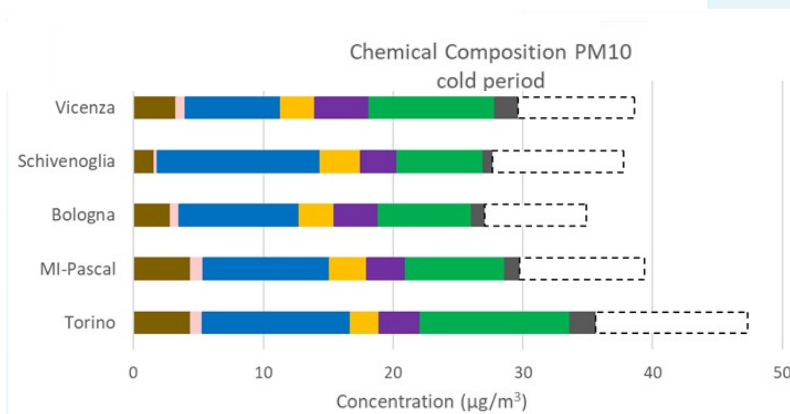
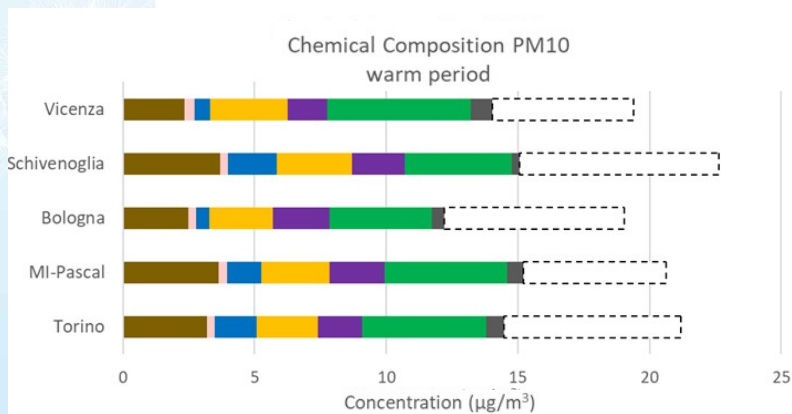
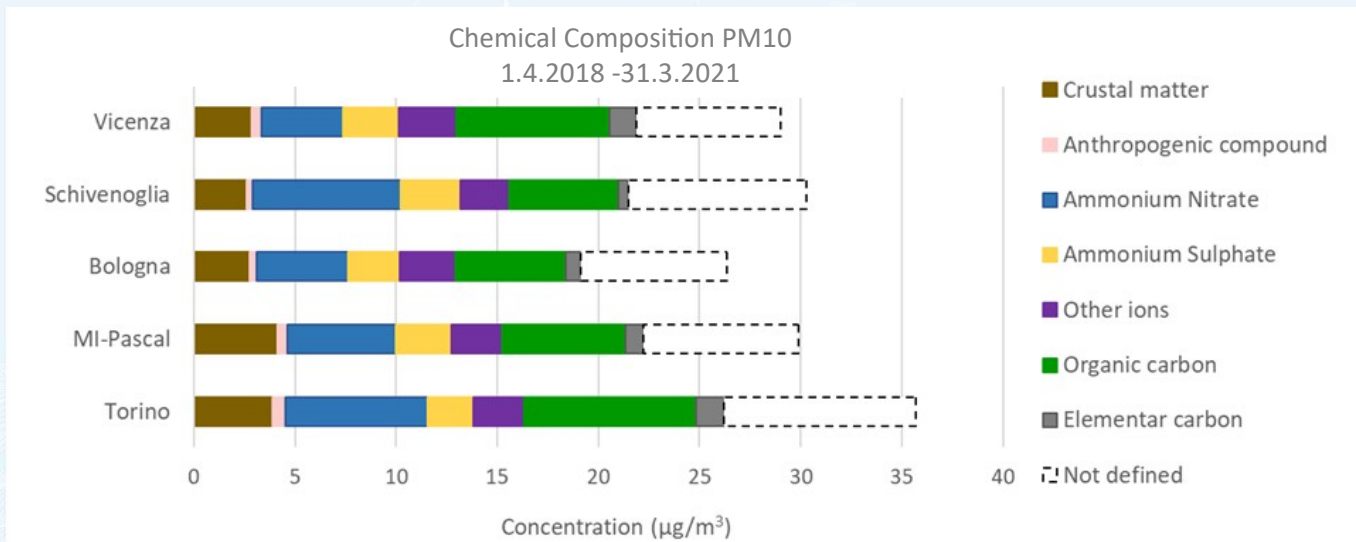
SIA: Secondary Inorganic Aerosol (Ammonium Nitrate + Ammonium Sulphate)

SOA: Secondary Organic Aerosol



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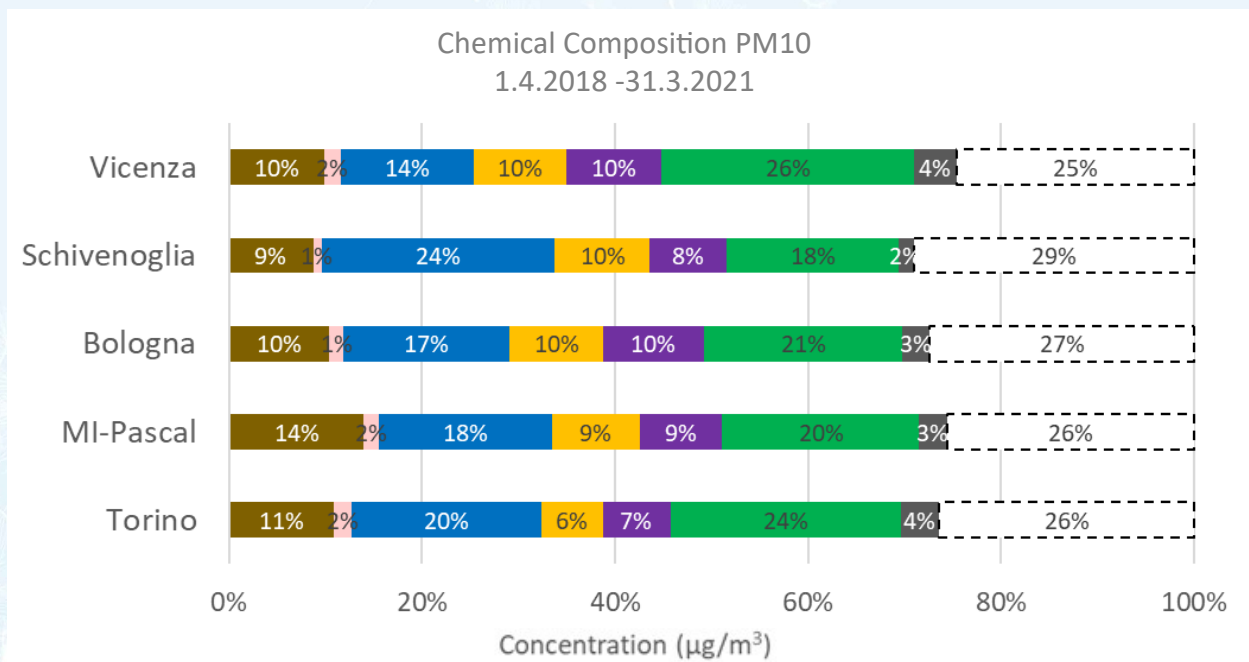
PM10 CHEMICAL COMPOSITION





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PM10 CHEMICAL COMPOSITION



- Crustal Matter
- Anthropogenic compounds
- Ammonium Nitrate
- Ammonium Sulphate
- Other Ions
- Organic Carbon
- Elemental Carbon
- Not defined

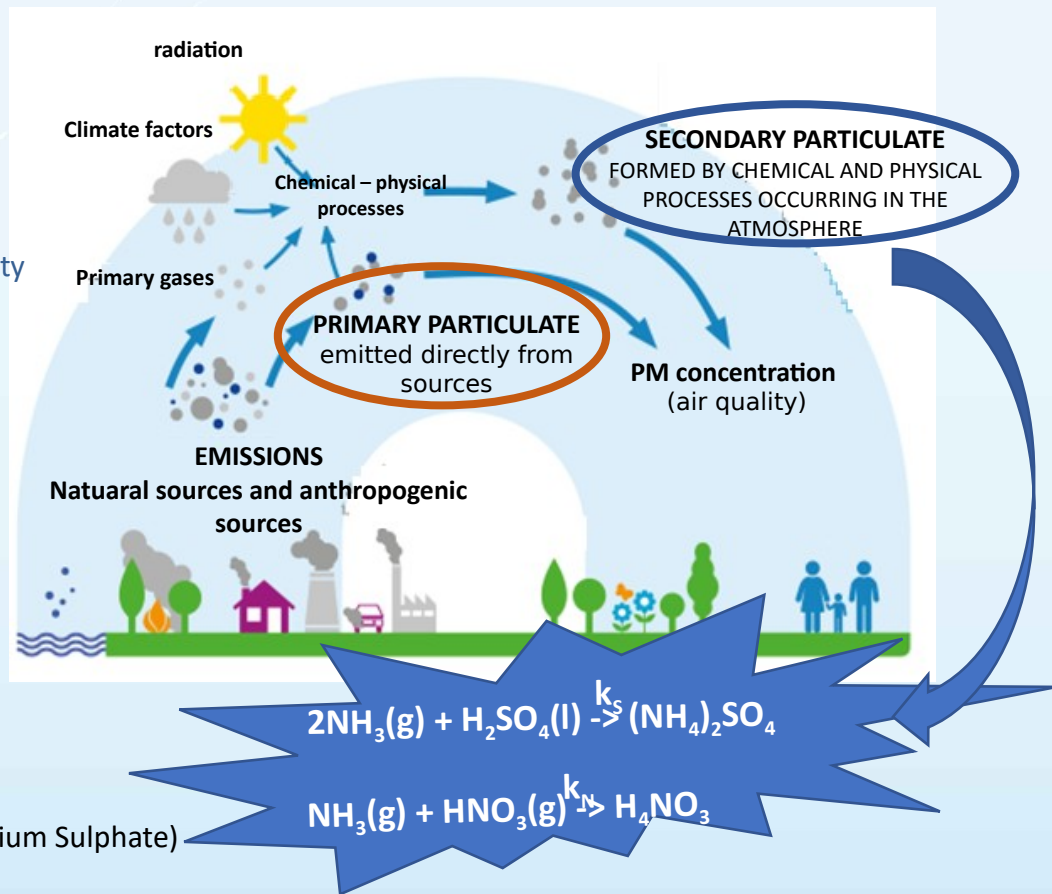
Secondary inorganic (SIA) is one of the major components of PM10 and is homogeneously present over the Po Valley

PM10 CHEMICAL COMPOSITION

Secondary compounds are definitely the majority contributors to PM, and their formation is very complex (Gilardoni et al., 2011).

There are three important variables in the Po Valley:

- ✓ **geography of the territory** } i.e. Atmospheric stability
- ✓ **weather conditions** } The stability may favor the condensation of volatile precursors
- ✓ **precursors**



SIA: Secondary Inorganic Aerosol (Ammonium Nitrate + Ammonium Sulphate)

SOA: Secondary Organic Aerosol

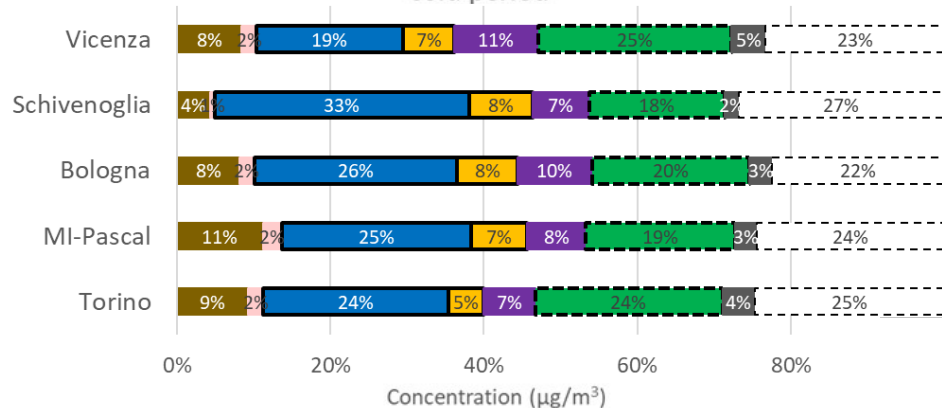


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PM10 CHEMICAL COMPOSITION

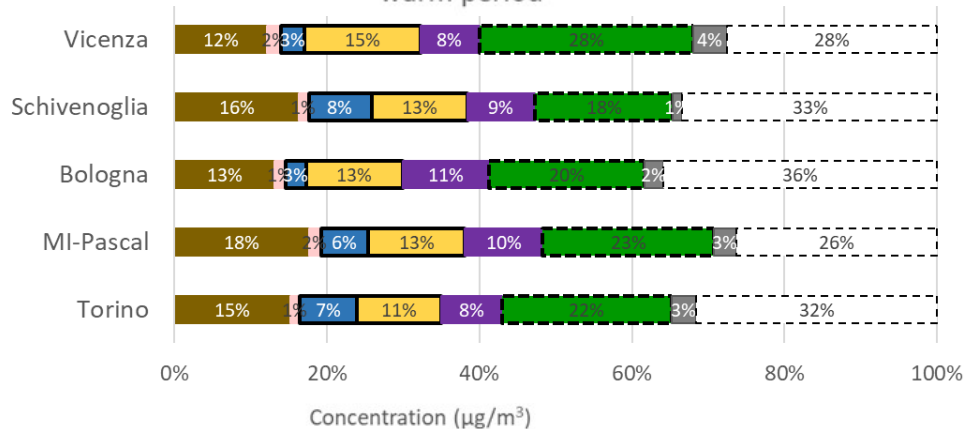


Chemical Composition PM10 cold period



Cold season: increased contribution of inorganic secondary

Chemical Composition PM10 warm period



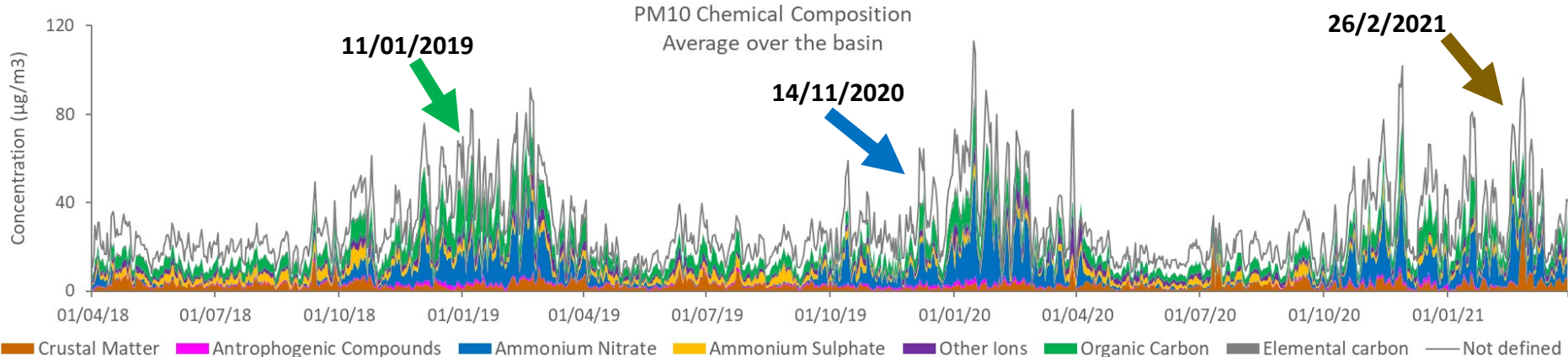
Warm season: increased contribution of crustal matter



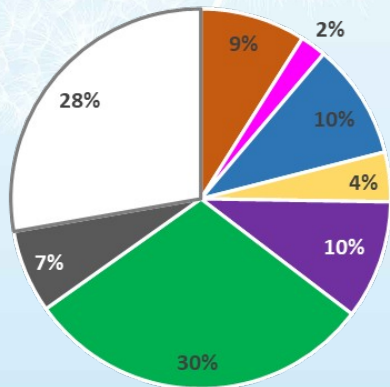


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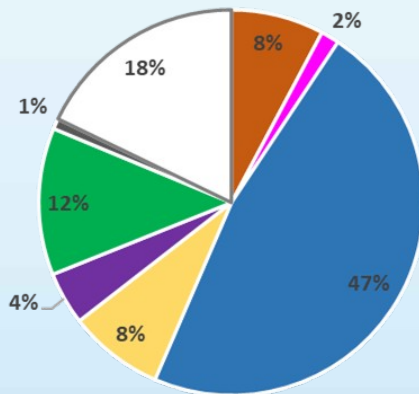
PM10 CHEMICAL COMPOSITION



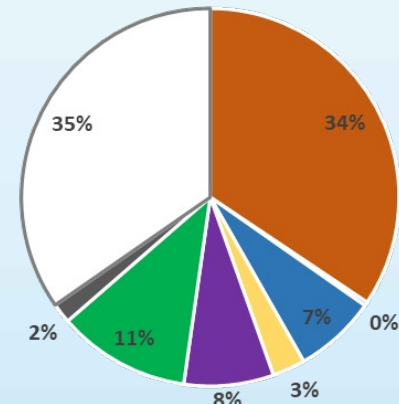
11/01/2019



14/11/2020



26/2/2021



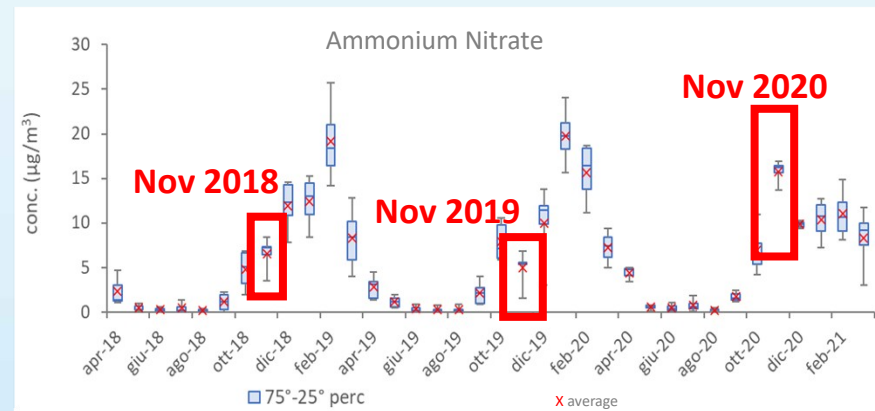
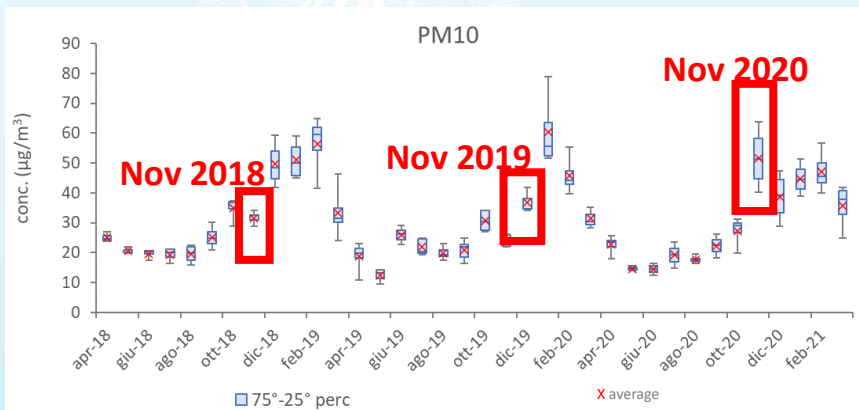
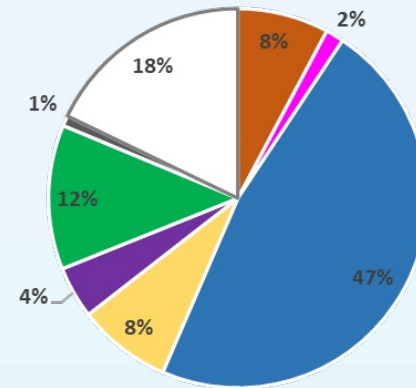
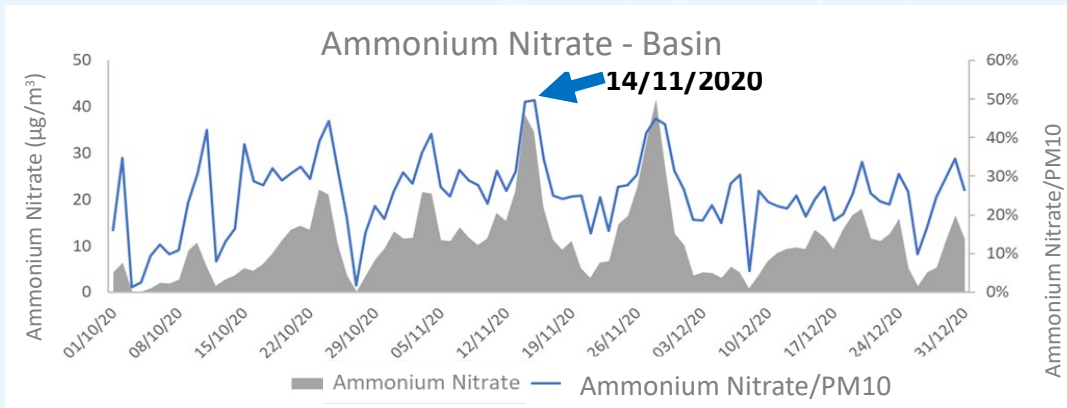


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PM10 CHEMICAL COMPOSITION



14 Nov 20



Accumulation episode: Increased NO3/PM10 ratio

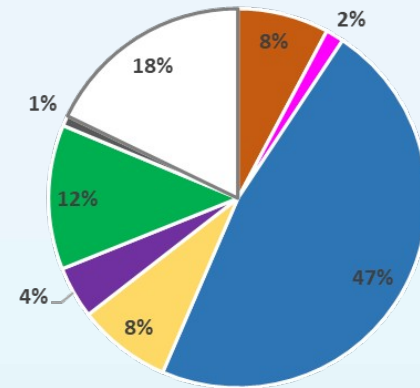
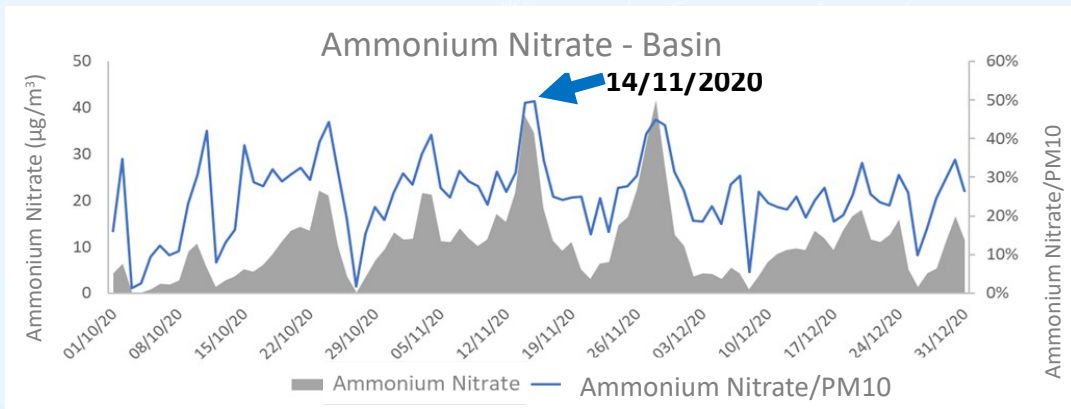


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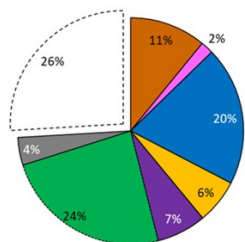
PM10 CHEMICAL COMPOSITION



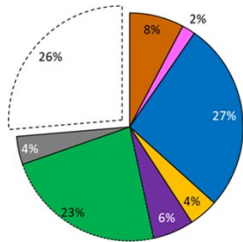
14 Nov 20
Pre Regions Engaged to Policies of Air



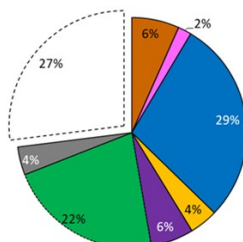
PM10 Chemical Composition Total (sept2018 – mar2021)



Complete dataset



PM10 > 50 $\mu\text{g}/\text{m}^3$



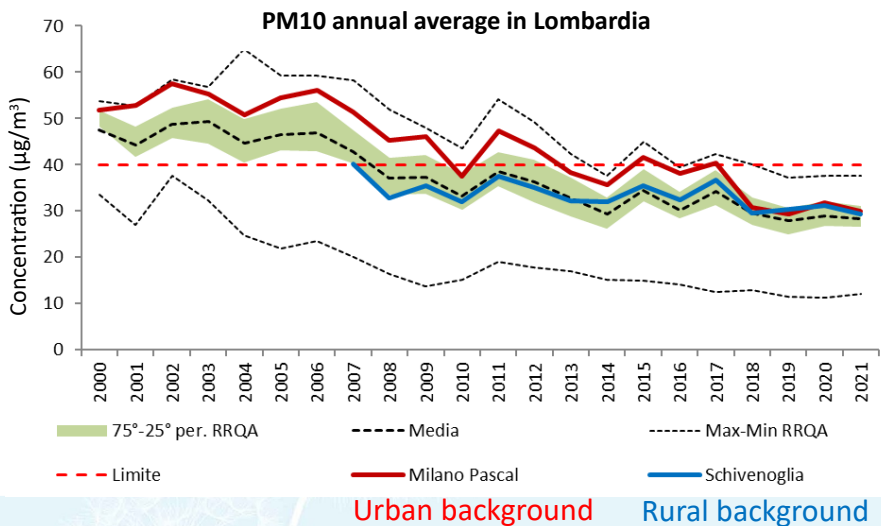
PM10 > 75 $\mu\text{g}/\text{m}^3$

Variation of NO₃/PM₁₀ as PM₁₀ concentrations increase.



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PM10 CHEMICAL COMPOSITION: FOCUS ON MILANO



Air quality network ARPA Lombardia: 65 PM10 monitoring stations

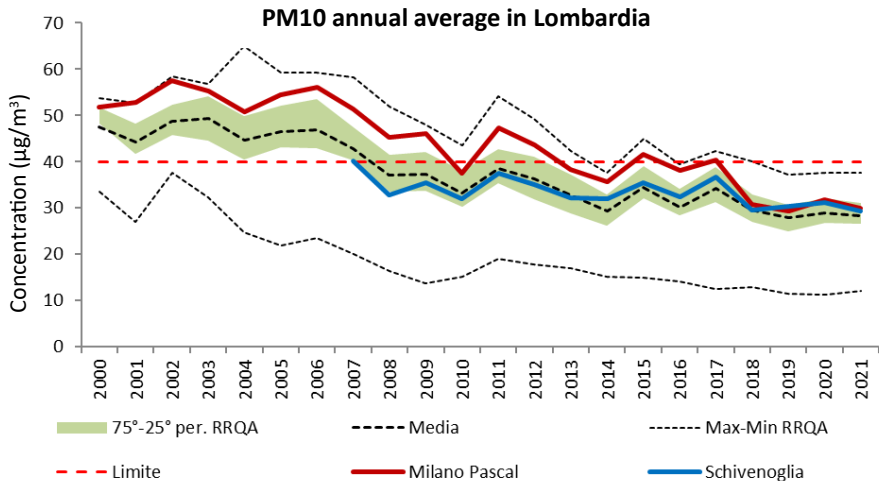
PM10 concentrations show a downtrend during the years. This downtrend is more evident in Milano, particularly in the last 5 years.

In Milano Pascal the PM10 chemical composition is measured every day since 2013, so we can observe the trend of different PM10 fractions during the year

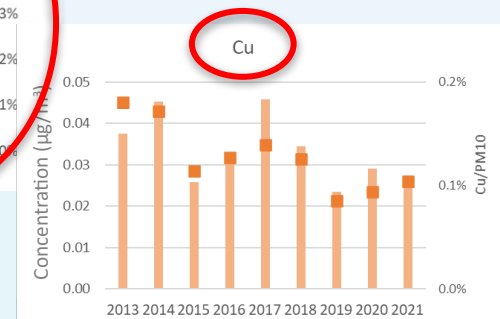
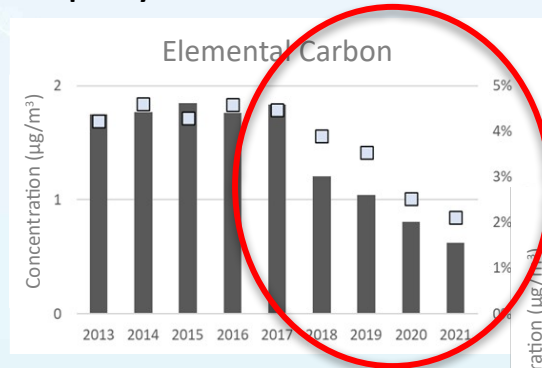


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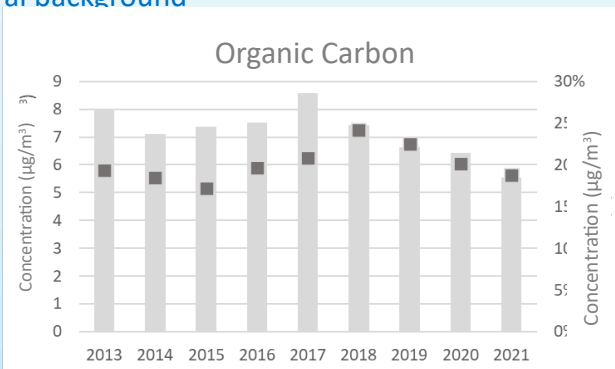
PM10 CHEMICAL COMPOSITION: FOCUS ON MILANO



Air quality network ARPA Lombardia: 65 PM10 monitoring stations



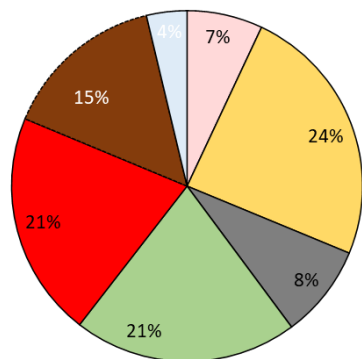
Urban background Rural background



PM10 CHEMICAL COMPOSITION: FOCUS ON MILANO

PMF5 2013 - 2021

PM10 source apportionment
Milano Pascal
2013 - 2021

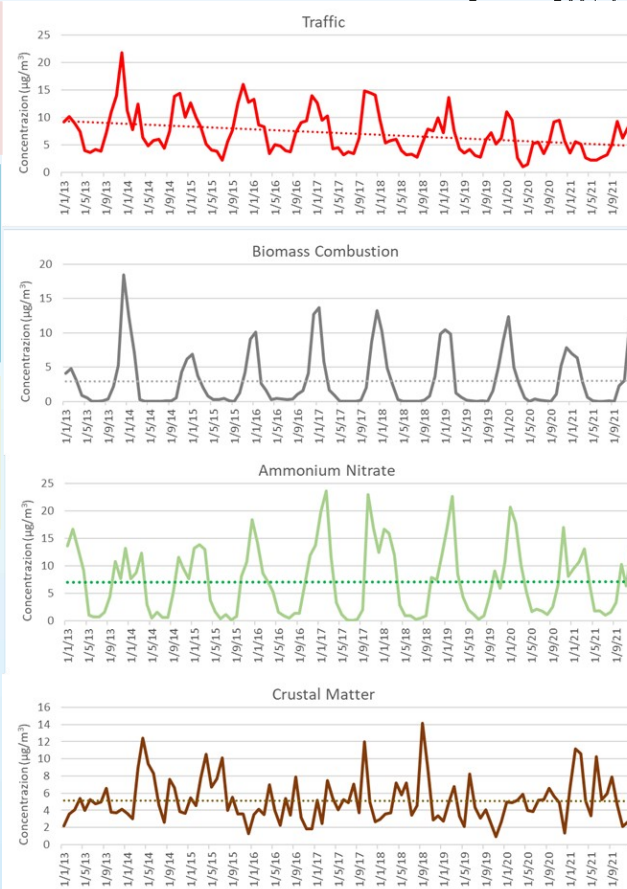


- Crustal Matter
- Biomass Burning
- Sulphate and Organic Carbon
- Ammonium Nitrate
- Cl
- Other Anthropogenic Activities
- Traffic

The traffic contribution decreases along the years.

PM10 concentrations show a downtrend during the years moreso in Milano.

Secondary inorganic ions constant over time.



Work in progress

Action D6 - Final report about the source apportionment of PM10 collected in special stations



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CONCLUSIONS



- ❖ Establishment of a **measurement network** for chemical characterization of PM10.
- ❖ **PM10** concentrations were generally comparable over the Po Basin.
- ❖ **The main fractions** of PM10 are the inorganic secondary compounds (27% of PM10; 19% as ammonium nitrate and 8% as ammonium sulfate) and the carbonaceous fraction (24% of PM10; 21% as organic carbon and 3% as elemental carbon). The percentage chemical composition of the Po Basin, beyond the differences in absolute value, shows good uniformity.
- ❖ **Secondary compounds** are the major contributors to PM, and their formation is very complex. There are three important variables in the Po Valley: land geography, meteorological conditions and precursors.
- ❖ **Time Trends in Milano :**
 - ✓ PM10 concentrations in Milano show a downtrend during the years.
 - ✓ The traffic contribution decreases along the years.
 - ✓ Secondary inorganic ions concentrations are constant over time.

Work in progress: Final Report Elaboration of the results with source apportionment techniques



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Thanks for your attention

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PROVINCIA AUTONOMA DI TRENTO



Agenzia Regionale per la Prevenzione e Protezione Ambientale del Veneto



ARSO ENVIRONMENT
Slovenian Environment Agency



Comune di Bologna



Comune di Milano



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