European Network on New Sensing Technologies for Air Pollution Control and Environmental Sustainability - *EuNetAir*

COST Action TD1105

WGs and MC Meeting at LINKOPING, 3 - 5 June 2015

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Year 3: 1 July 2014 - 30 June 2015 (*Ongoing Action*)

THE 1ST EUNETAIR AIR QUALITY JOINT-EXERCISE INTERCOMPARISON: ASSESSMENT OF MICRO-SENSORS VS. REFERENCE METHODS (Part II)

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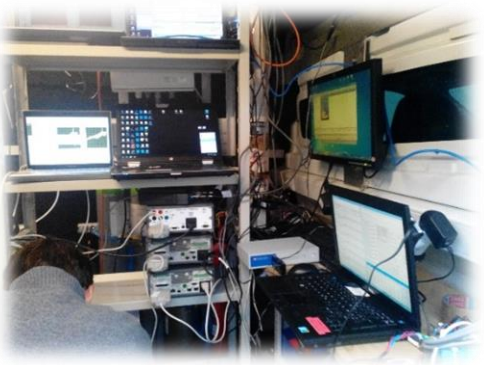
1ST EuNetAir Air Quality Joint-Exercise Intercomparison

- **Air Quality Monitoring Campaign** in Aveiro, Portugal, from **13th to the 27th of October 2014**.

Goal: evaluation and assessment of environmental gas/PM micro-sensors versus air quality standard reference methods.

1ST EuNetAir Air Quality Joint-Exercise Intercomparison

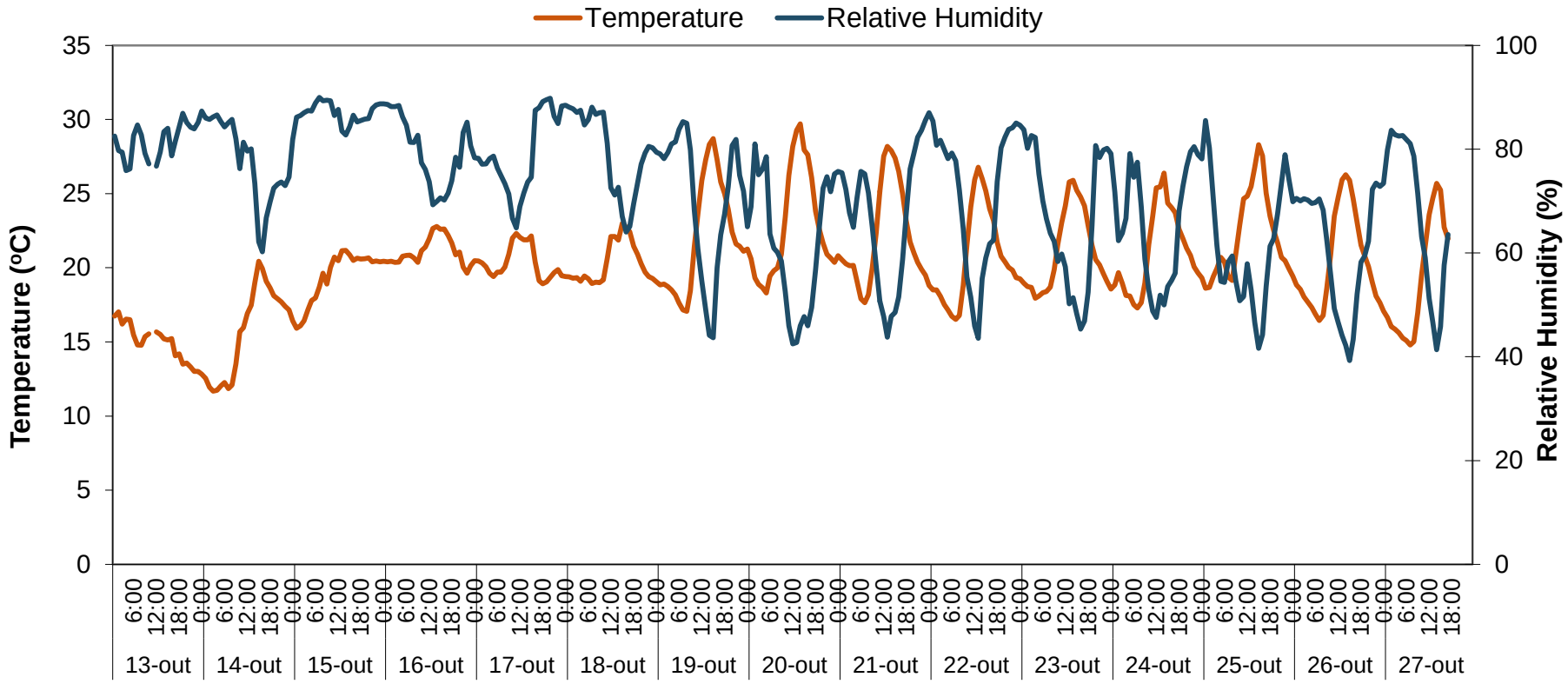
- **Campaign characterization:**
  - **Urban traffic location** in **Aveiro** city centre;
  - **15 teams** from research centres, universities and companies from 12 COST Countries;
  - **IDAD Air Quality Mobile Laboratory** with standard equipment and reference analysers;
  - **Micro-sensors systems** installed side-by-side at IDAD Air Quality Mobile Laboratory

1ST EuNetAir Air Quality Joint-Exercise Intercomparison

- **IDAD Air Quality Mobile Laboratory :**
  - **Monitored variables:**
    - PM10 and PM2.5 (Beta-ray absorption method)
    - CO (nondispersive infrared spectroscopy)
    - NOx (chemiluminescence)
    - Benzene (gas chromatography)
    - O_3 (ultraviolet photometry)
    - SO_2 (ultraviolet fluorescence)
    - meteorological parameters: temperature, humidity, wind velocity/direction, solar radiation, precipitation

Environmental conditions during field campaign

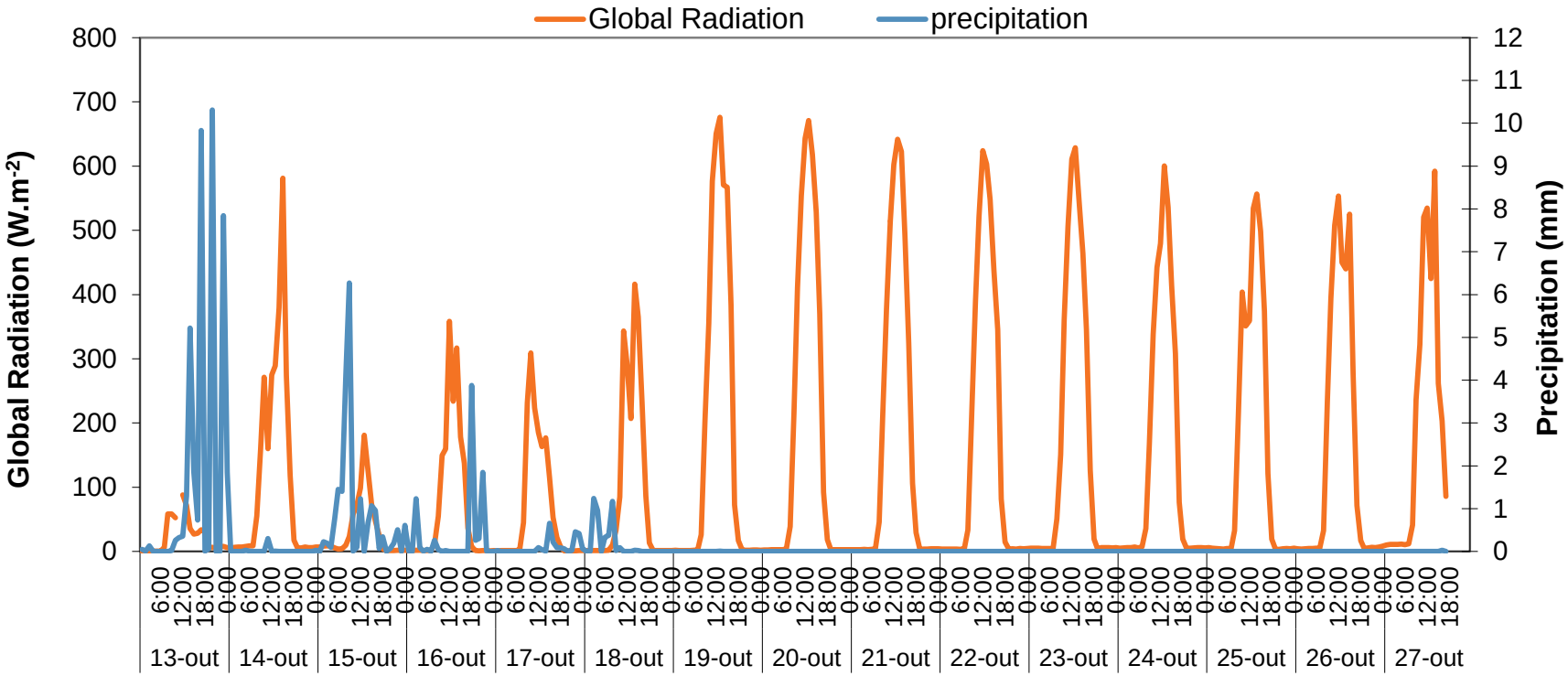
- **Temperature and Relative Humidity:**



- **First week: high relative humidity and lower temperatures.**
- **Second week: lower relative humidity and high temperatures.**

Environmental conditions during field campaign

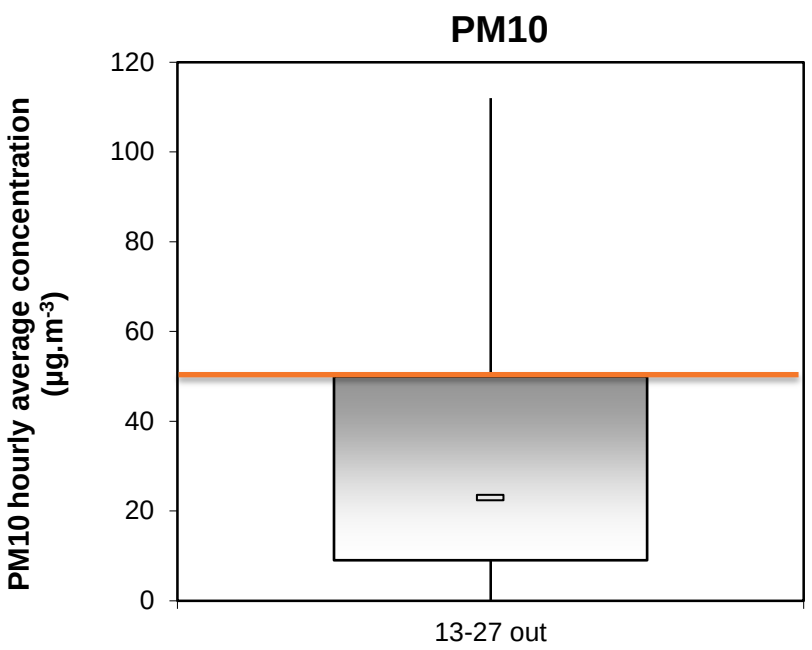
- **Other meteorological parameters:**

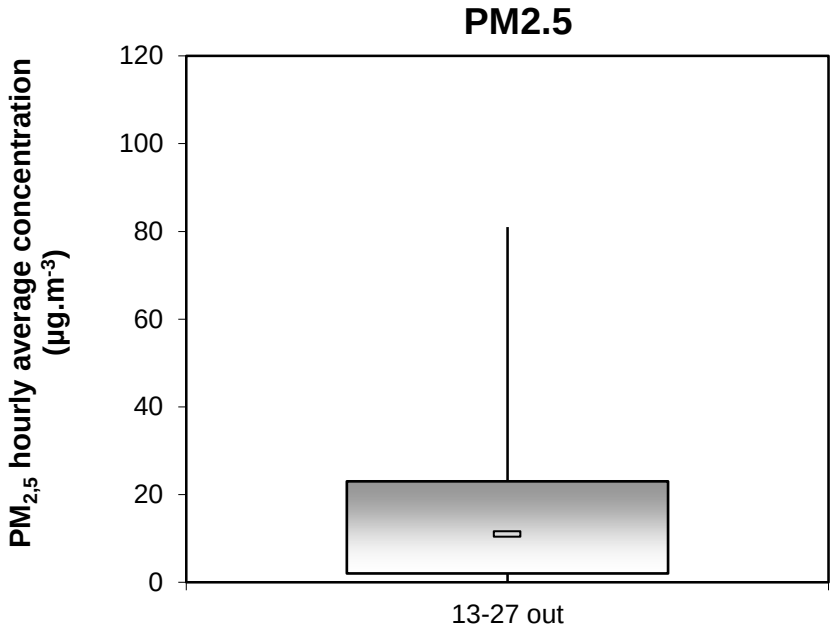


- **First week: long periods of precipitation, low global radiation and strong wind**
- **Second week: no periods of precipitation, higher global radiation and lower wind velocities.**

Environmental conditions during field campaign

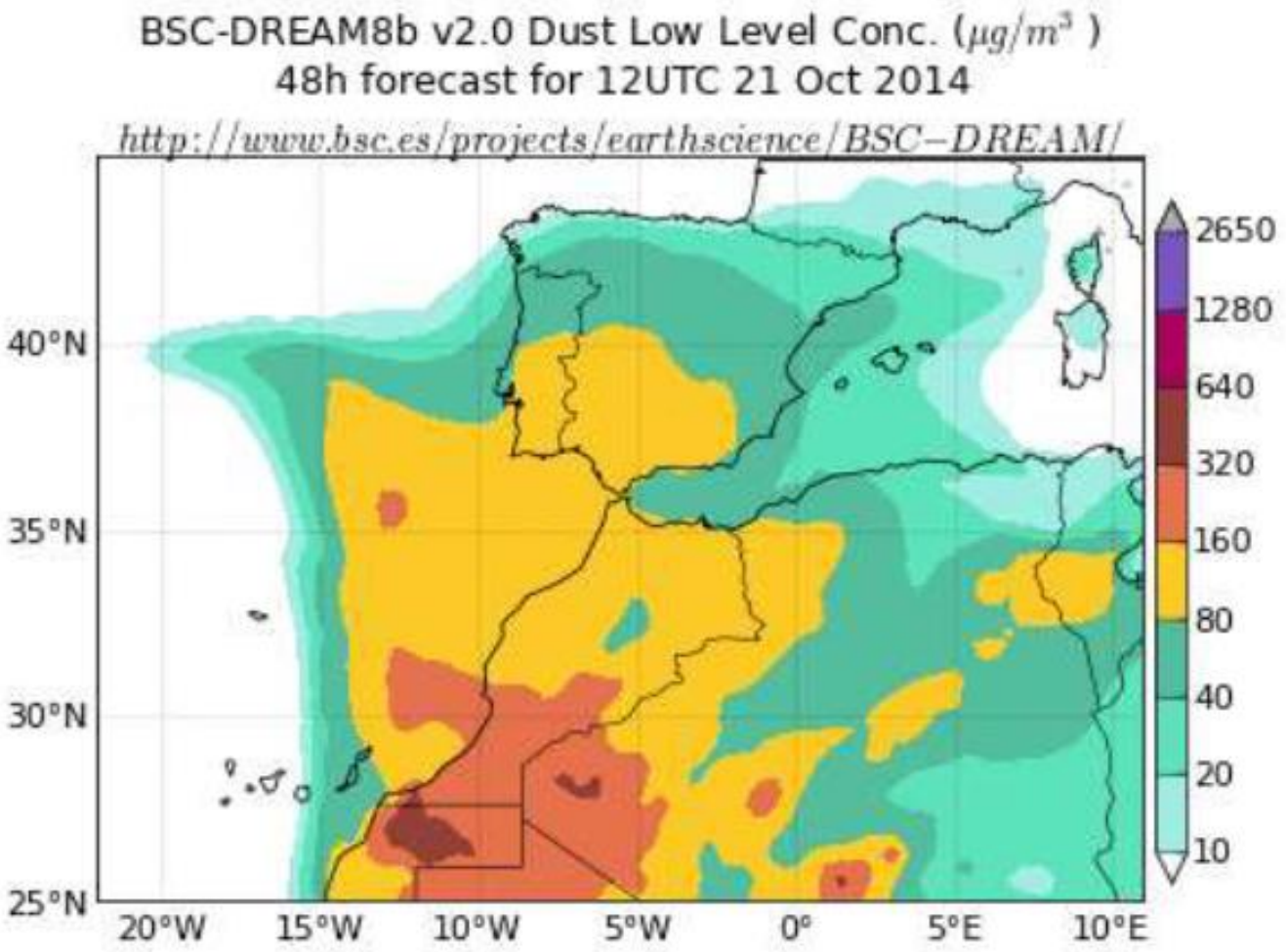
- **Particulate Matter**





- **PM10 daily limit value of 50 µg.m^{-3}** for the protection of human health **was exceeded 6 times** from the 20th to the 25th of October.

Environmental conditions during field campaign

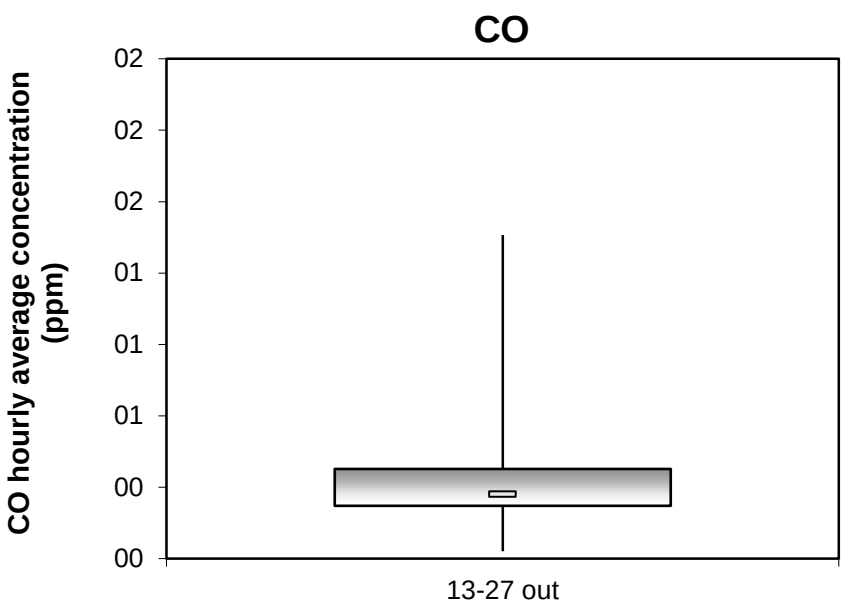


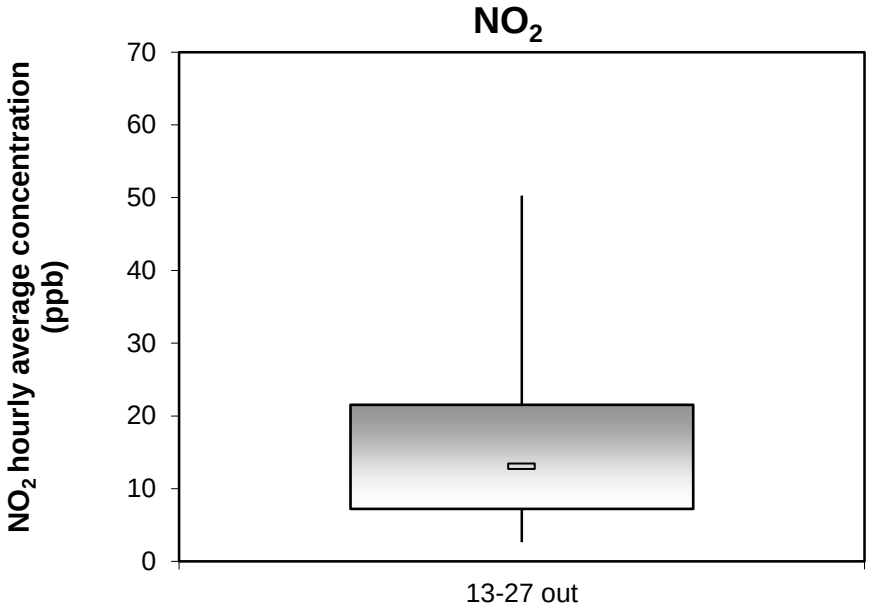
PM10 daily limit value was exceeded due to:

- **traffic emissions and meteorological conditions;**
- **natural events due to transport of particles from North Africa, from the 18th to 31st of October.**

Environmental conditions during field campaign

- **Carbon Monoxide and Nitrogen Dioxide:**

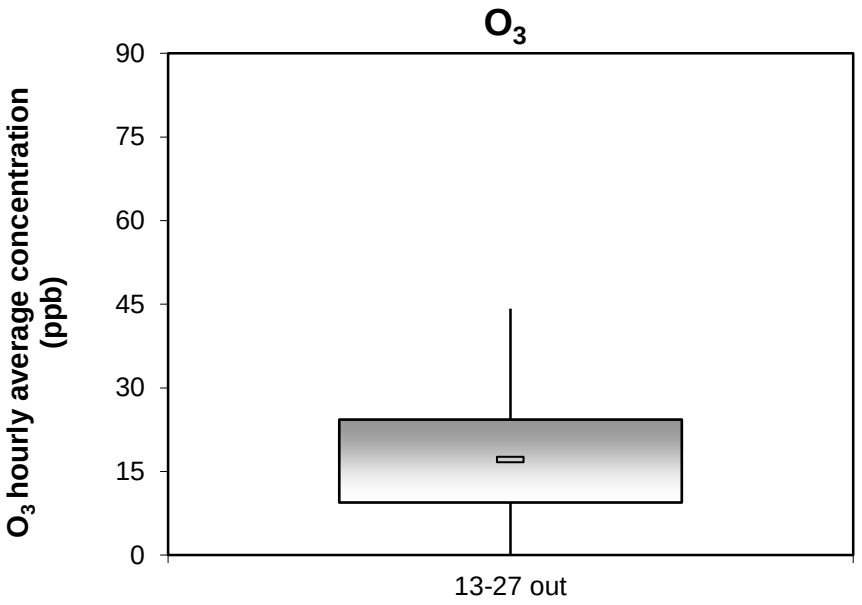


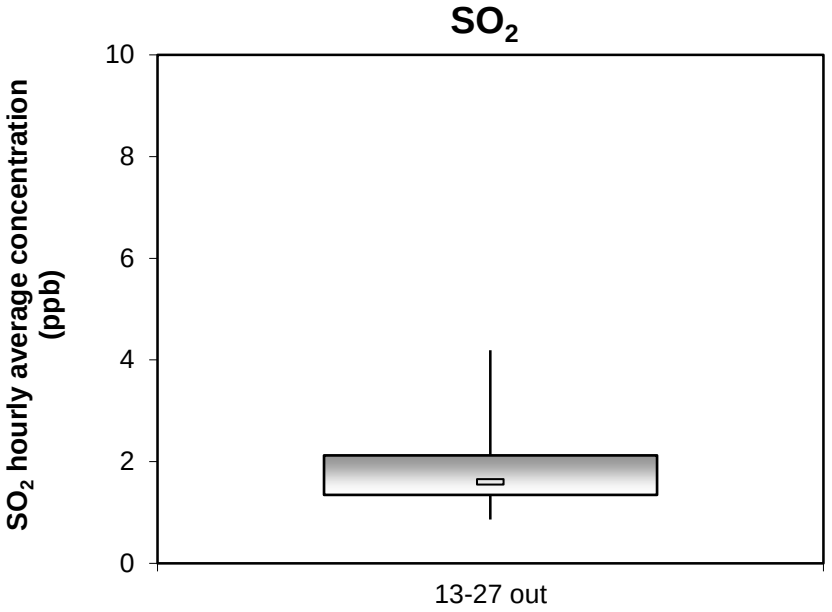


- **CO maximum daily eight hour mean limit value of 10 mg.m^{-3} was not exceeded.**
- **NO_2 one hour limit value of 200 µg.m^{-3} was not exceeded.**

Environmental conditions during field campaign

- **Ozone and Sulphur Dioxide:**





- **O_3 one hour information value of 180 µg.m^{-3} and alert thresholds value of and 240 µg.m^{-3} weren't exceeded.**
- **SO_2 one hour limit value of 350 µg.m^{-3} was not exceeded.**

Assessment of Micro-Sensors versus Reference Methods - Preliminary Results

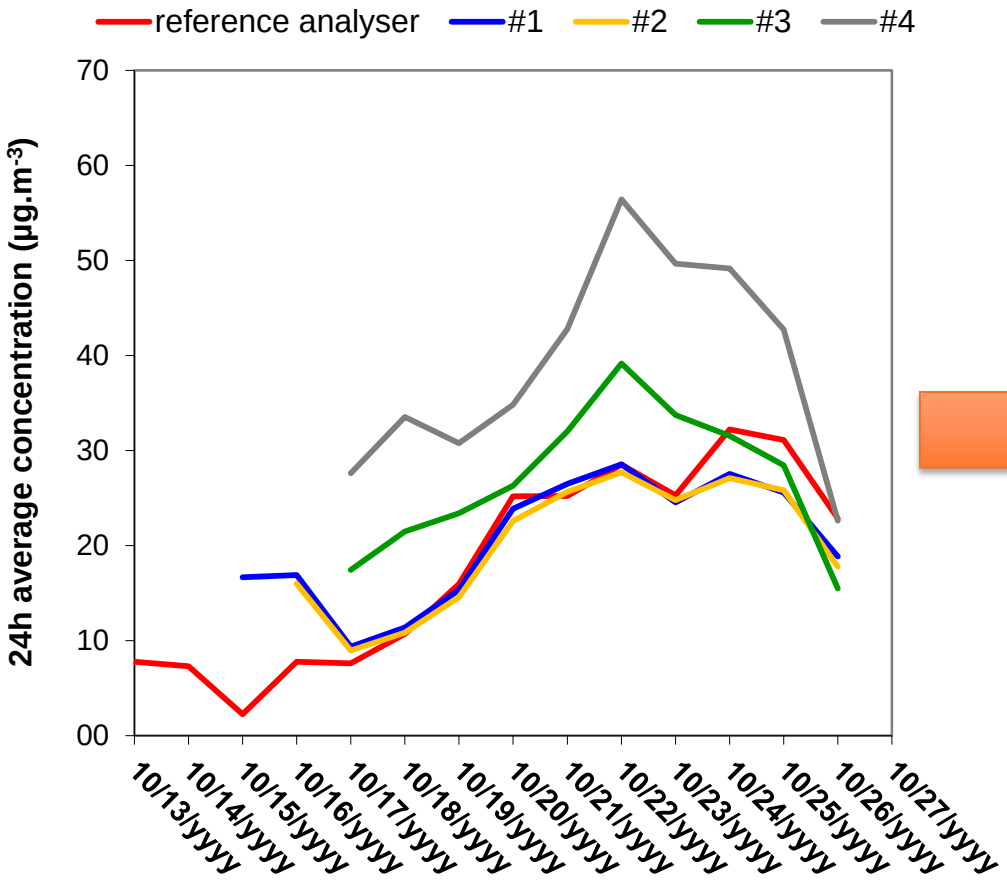
- Micro-sensors typologies and monitored pollutants
- Correlation with reference measurements
- Correlation matrix (T, HR, other pollutants)
- Evaluation of influence on error

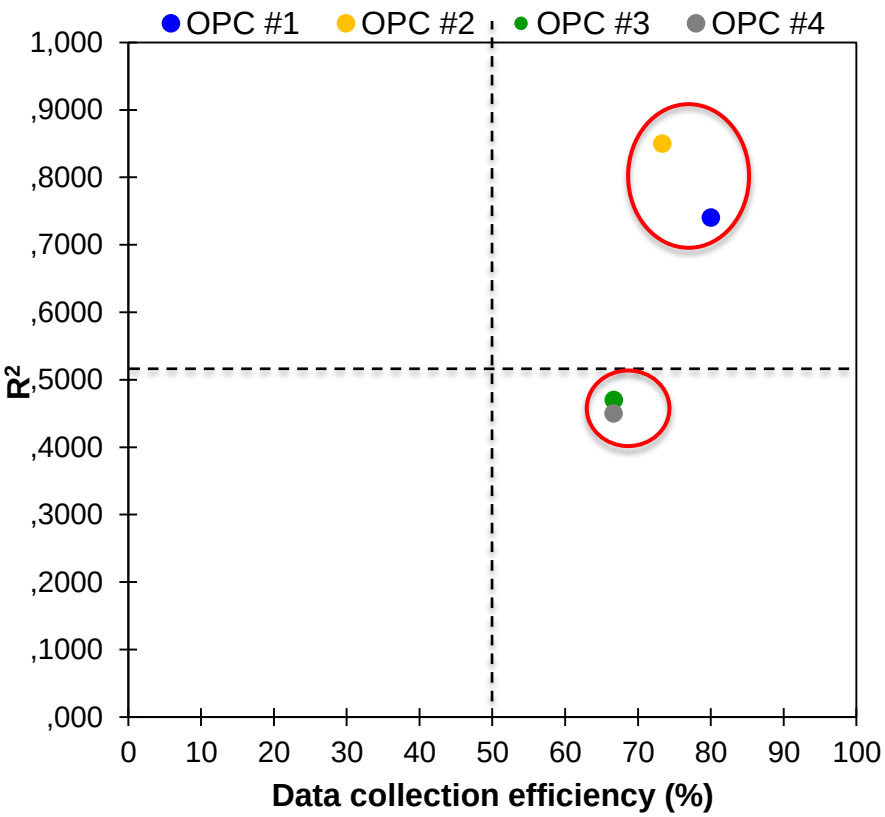
Micro-sensors typologies and monitored pollutants

- Electrochemical sensors:
  - NO, NO_2, CO, O_3, SO_2
- Optical sensors:
  - PM1, PM2.5, PM10
- Metal Oxide Semiconductor based sensors (MOS):
  - NO_2, VOC, CO, O_3, SO_2
- Non dispersive infrared technology sensors (NDIR):
  - CO_2
- Photoionization detection sensors (PID):
  - VOC

Correlation with reference measurements

- **PM2.5:**

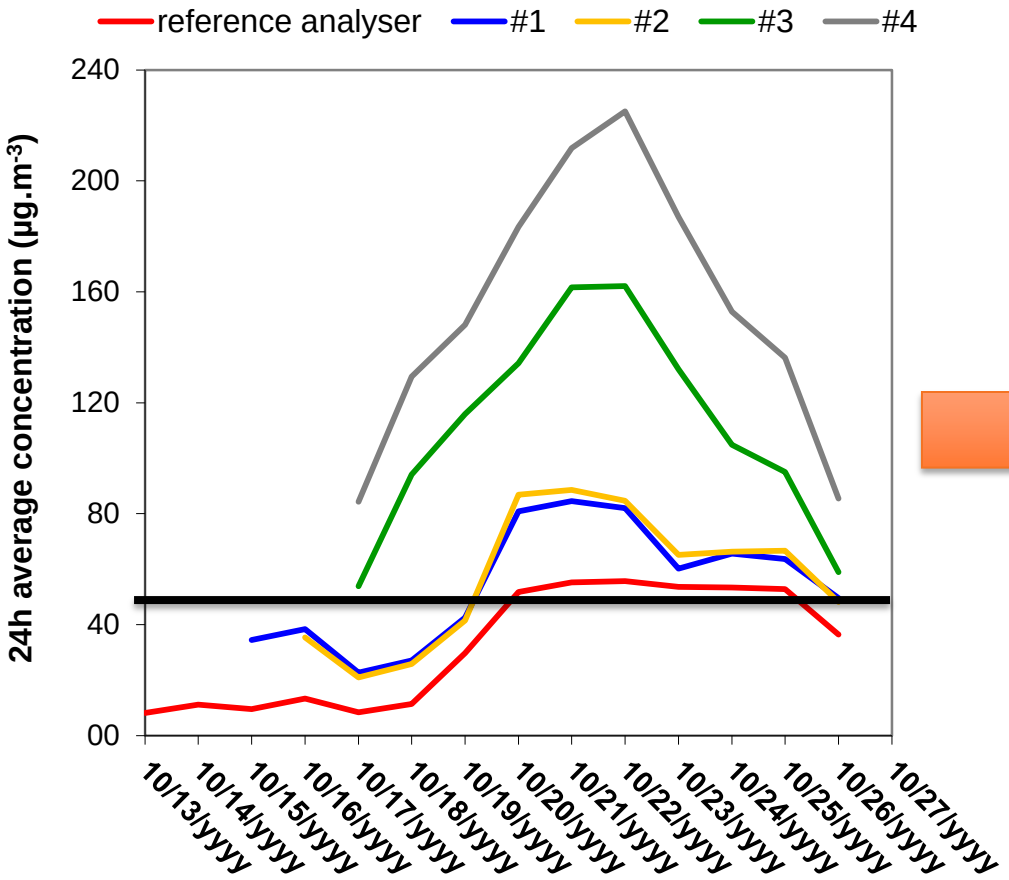


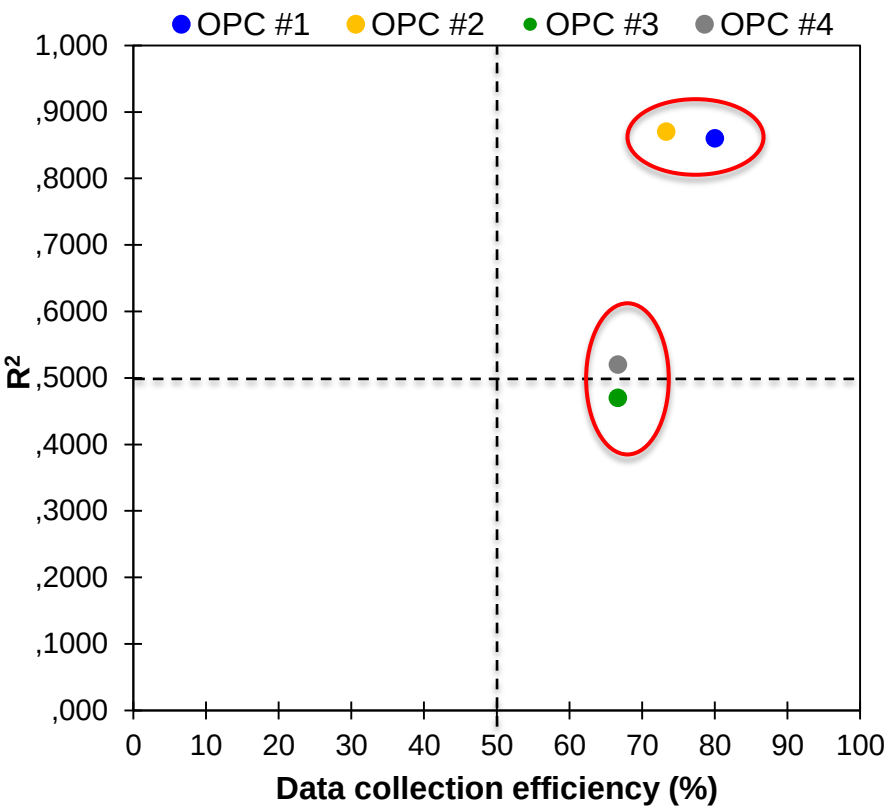


- **The OPC sensors for PM2.5 presented correlations varying between 0.45-0.85 and data collection efficiencies in the range of 67-80%.**

Correlation with reference measurements

- **PM10:**

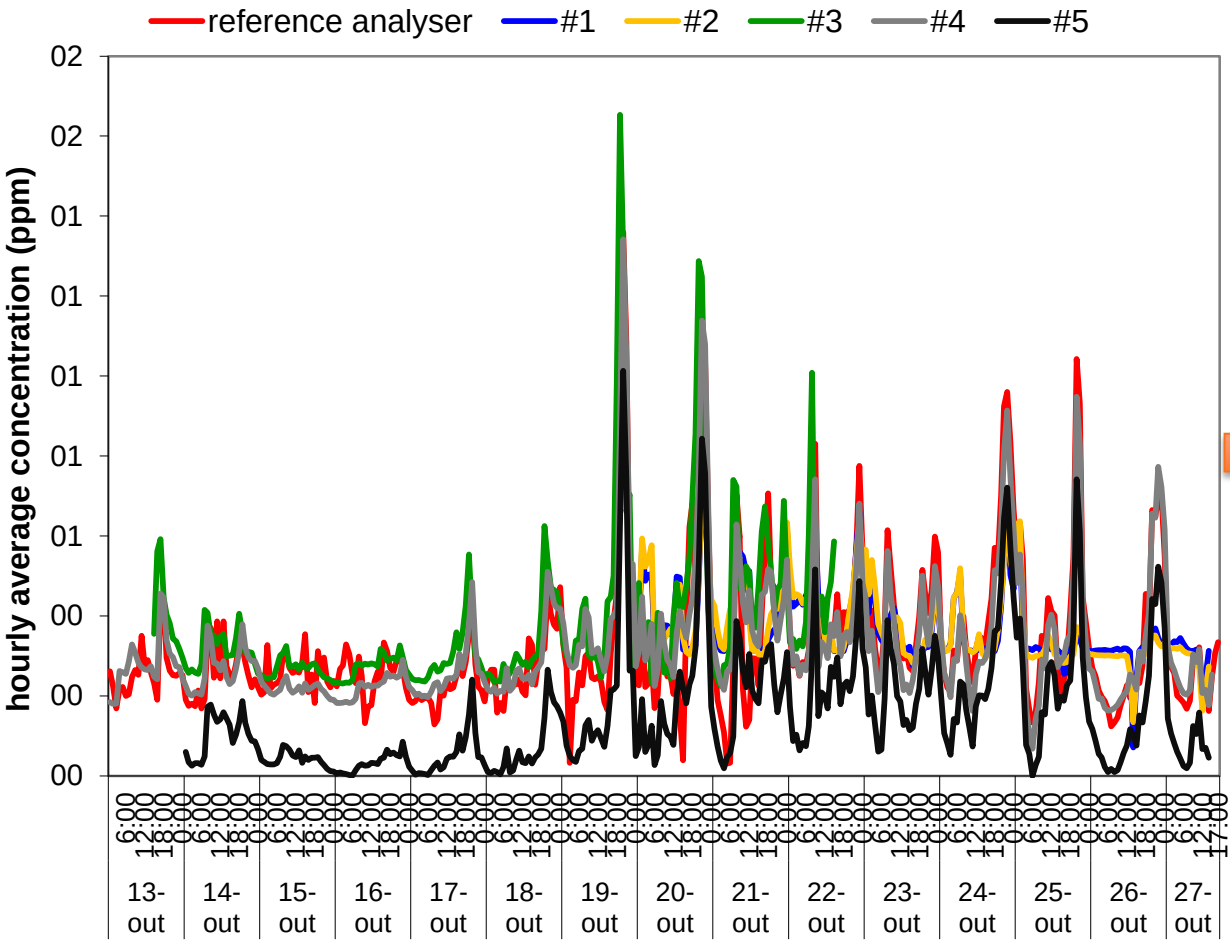


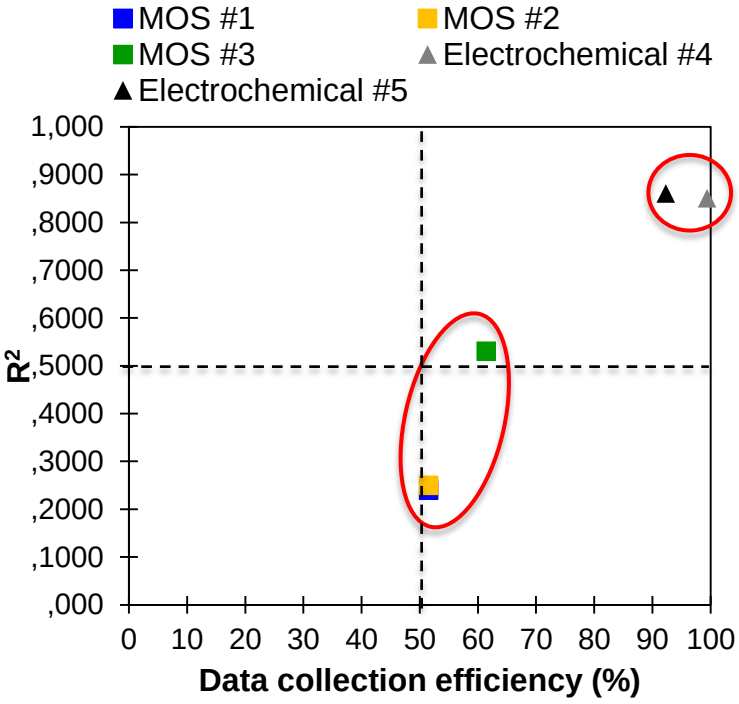


- **The OPC sensors for PM10 presented correlations varying between 0.47-0.87 and data collection efficiencies in the range of 67-80%.**

Correlation with reference measurements

- **CO:**

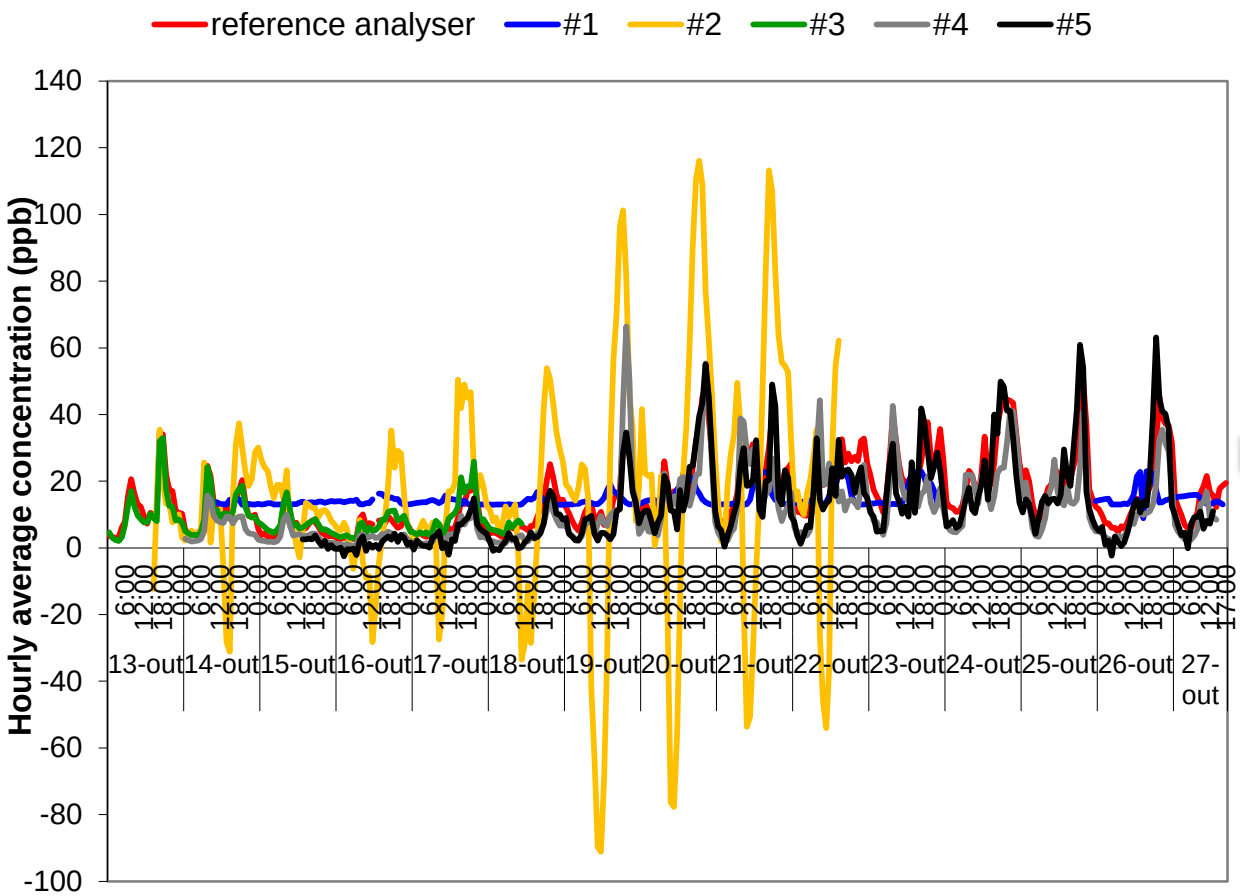


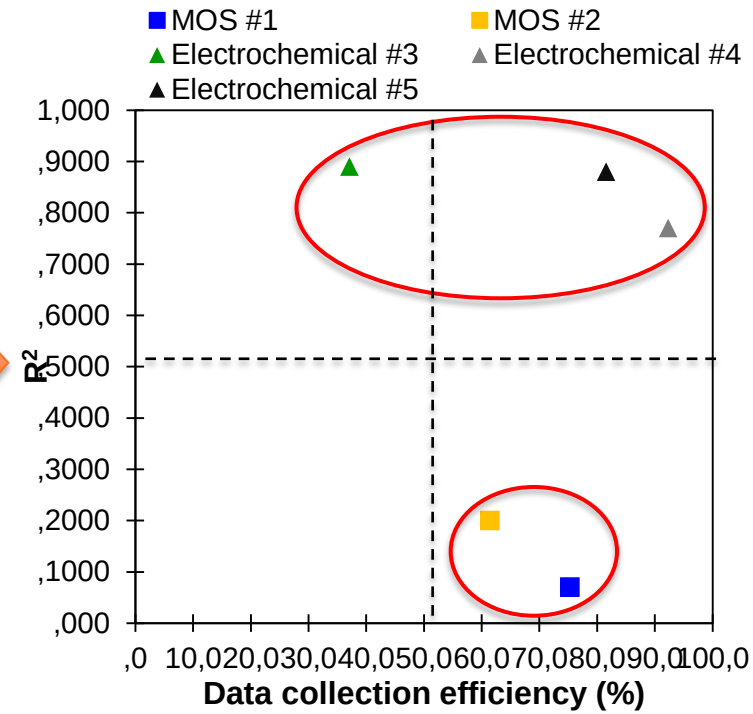


- **Electrochemical sensors showed a greater correlation with the reference method and a higher efficiency collecting data than MOS sensors.**

Correlation with reference measurements

- NO_2:

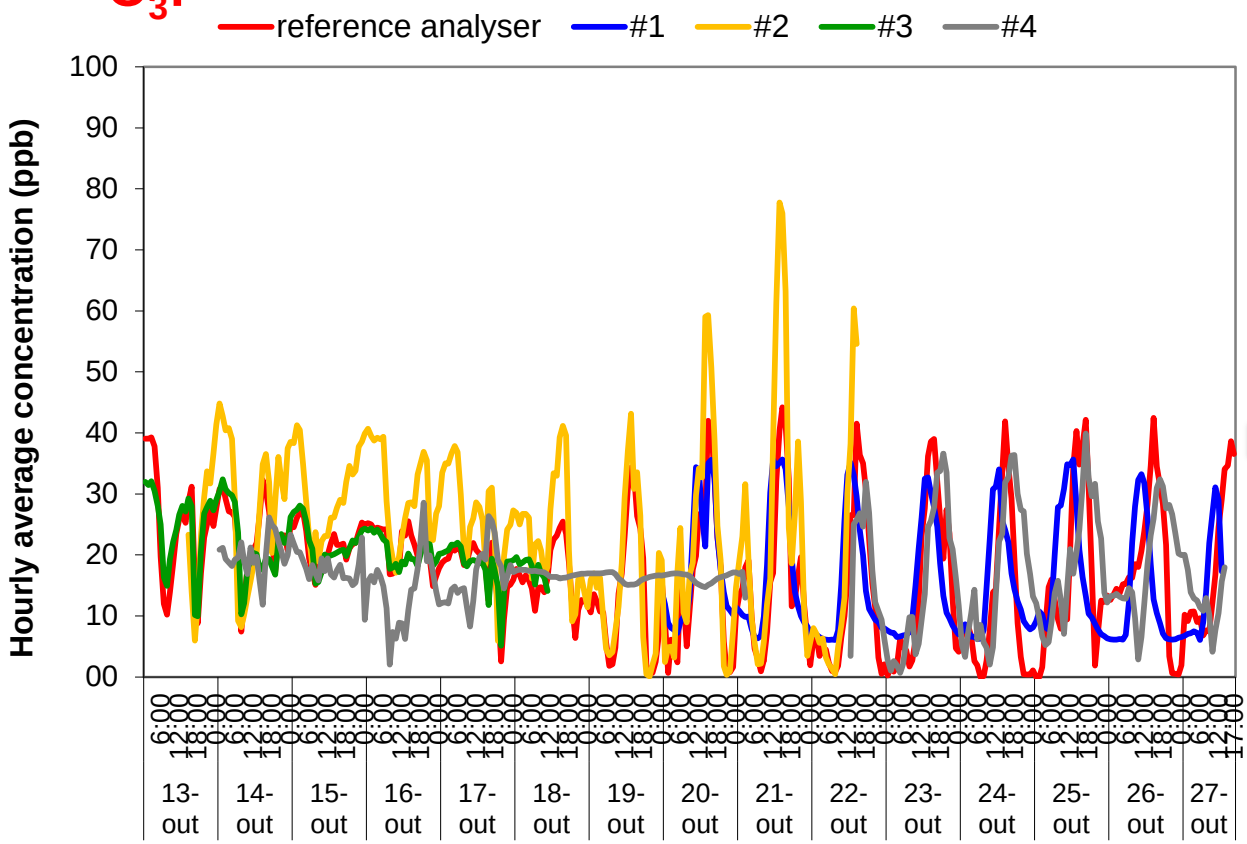


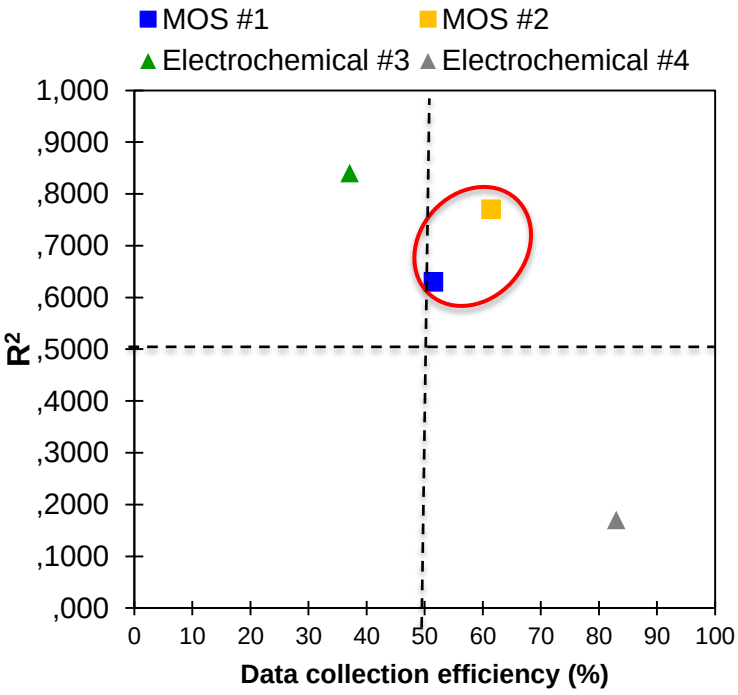


- **Electrochemical sensors showed a greater correlation with the reference method and in most cases a higher efficiency collecting data than MOS sensors.**

Correlation with reference measurements

- O_3:

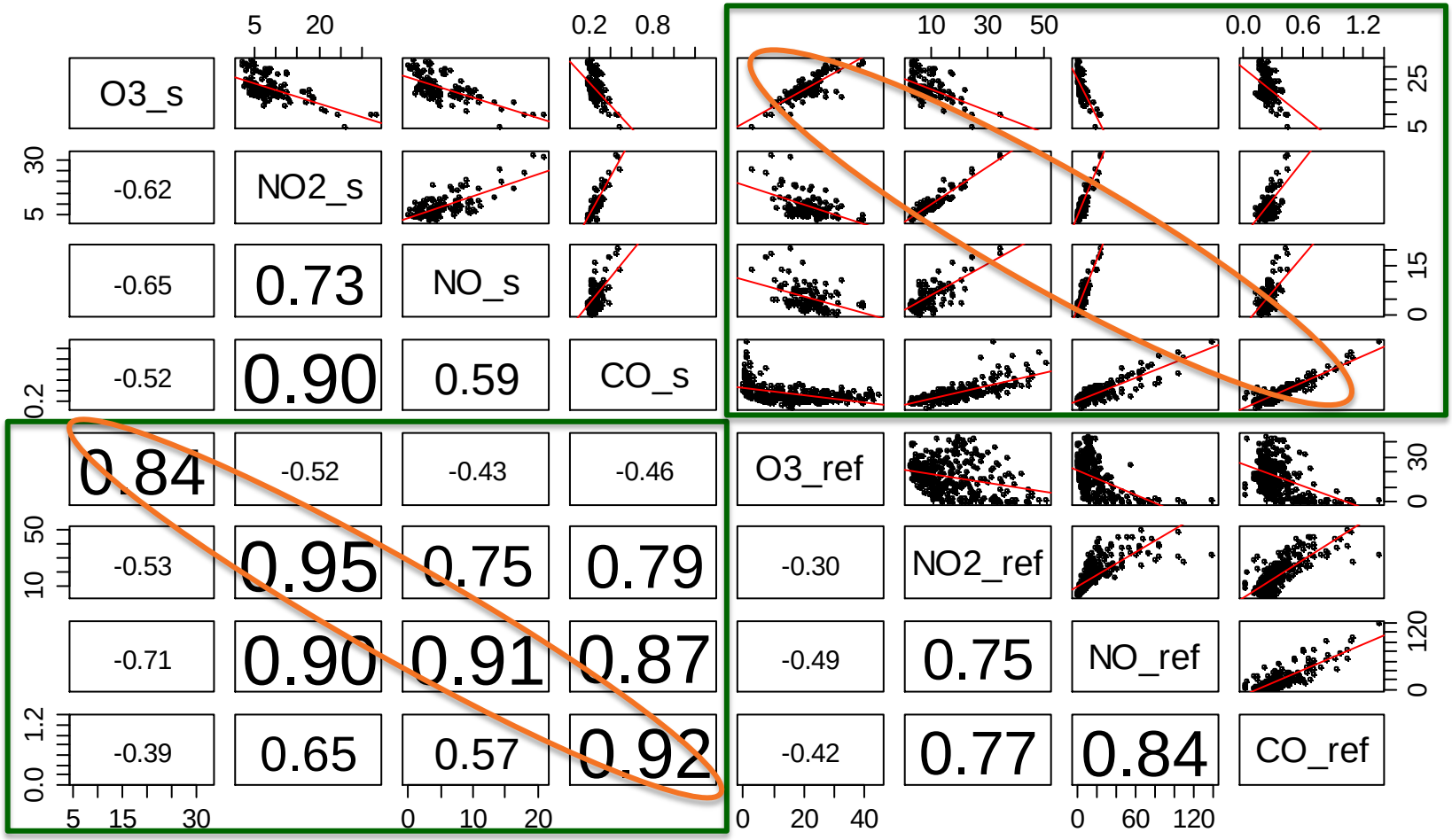




- **Electrochemical sensors: correlations between 0.17-0.84 and data collection efficiencies in the range of 37-83%**
- **MOS sensors: correlations between 0.63-0.77 and data collection efficiencies in the range of 52-62%.**

Correlation matrix: electrochemical microsensors

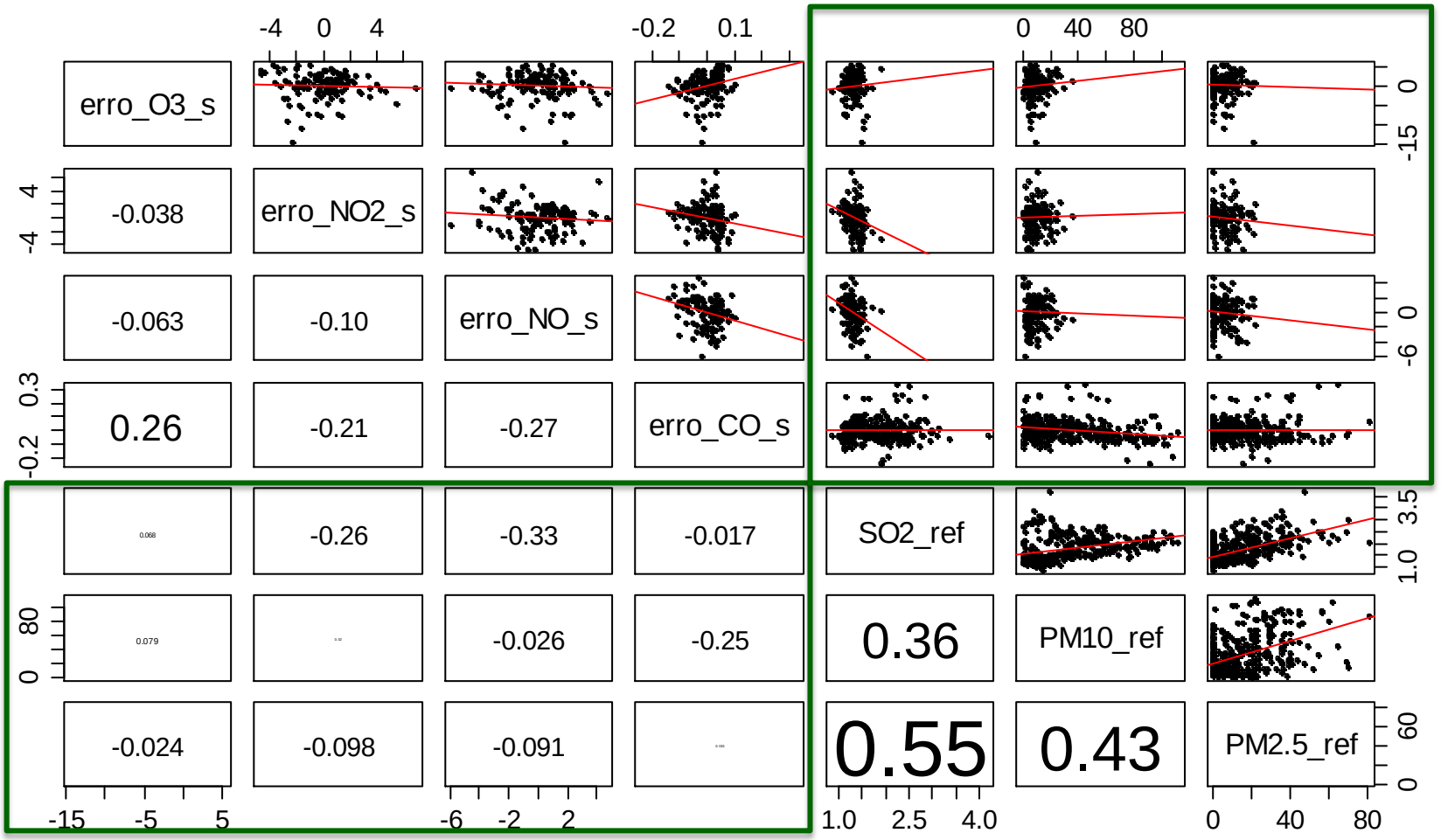
- **Microsensors vs. reference equipment measurements:**



- **Electrochemical sensors: Strong Pearson correlations (0.84-0.95)**

Correlation matrix: electrochemical microsensors

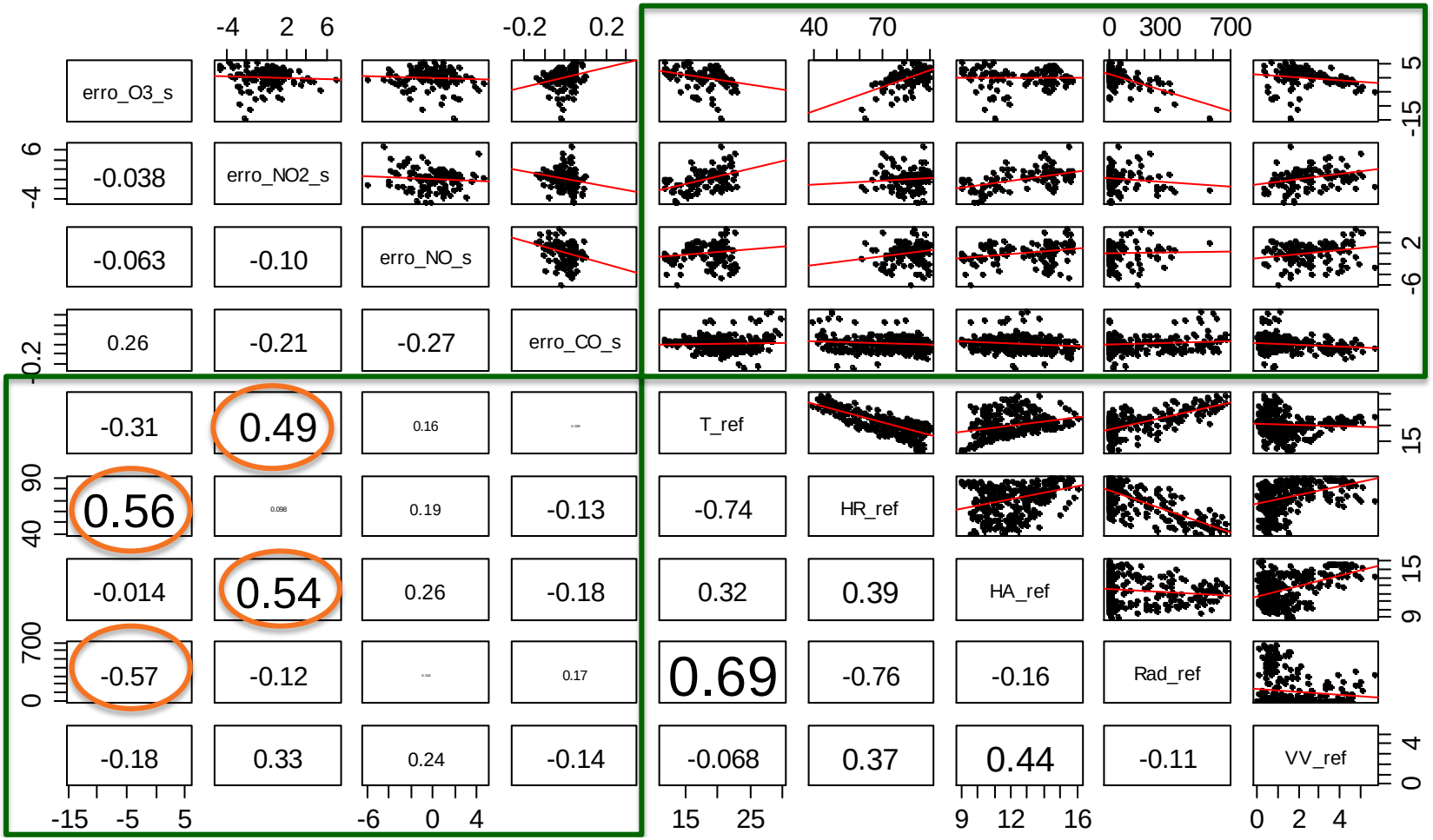
- **Interfering pollutants in measurement error:**



- **Electrochemical sensors measurements are not affected by other pollutants.**
- **Weak Pearson correlations between the error of microsensors measurement and interfering pollutants measured by reference equipment**

Correlation matrix: electrochemical microsensors

- **Interfering meteorological parameters in measurement error:**



- **Moderate correlations between the error of O_3 and NO_2 microsensors measurement and interfering meteorological parameters such as Rad, RH, T, H_2O.**
- **Weak correlations between the error of NO and CO microsensors measurement and interfering meteorological parameters.**

CONCLUSIONS

- In the current status of the evaluation it was identified :
  - Statistical data describing the measurements
  - Specific/common behavior between sensors
  - Relationships with other variables
  - Update data and building database
  - Next steps: development of a validation and evaluation protocol with specifications to field applications
- There is a strong correlation in a significant part of the measurements between electrochemical micro-sensors and standard method
- It is of paramount importance to further develop the data treatment of sensor signals from field campaigns, namely sensitivity and selectivity (known interference) to stablish an effective evaluation protocol

Thank you!

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