DEPLOYMENT OF MOBILE AND FIXED AIR SENSOR PLATFORMS IN THE CITY OF FLORIANÓPOLIS, BRAZIL: PRELIMINARY RESULTS

CMAS 2020

Fernando Campo[1], Andy Blanco-Rodríquez[1], Robson Will[1], Thiago Vieira Vasques[1], Nathan Campos Teixeira[1], Davide Franco[2], Alejandro García-Ramírez[3], Leonardo Hoinaski[1]

[1] *Laboratório de Controle da Qualidade do Ar, Universidade Federal de Santa Catarina, Florianópolis, SC, Brasil*
[2] *Laboratório de Hidráulica Marítima, Universidade Federal de Santa Catarina, Florianópolis, SC, Brasil*
[3] *Centro de Ciências Tecnológicas da Terra e do Mar, Universidade do Vale de Itajaí, Itajaí, SC, Brasil*

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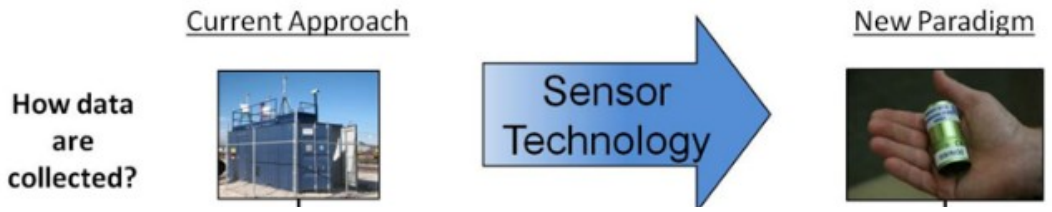
The changing paradigm of air quality monitoring



(Taken from Snyder, et al., 2013)

The Changing Paradigm of Air Pollution Monitoring
Emily G. Snyder, et al., 2013
Environmental Science & Technology 2013 47 (20), 11369-11377
DOI: 10.1021/es4022602

The recent advances in electrical engineering "provide opportunities to enhance a range of existing air pollution monitoring capabilities and perhaps provide avenues to new air monitoring applications"

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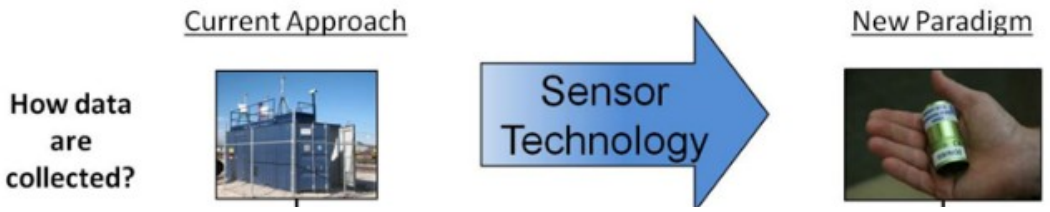

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Low-cost air quality sensors

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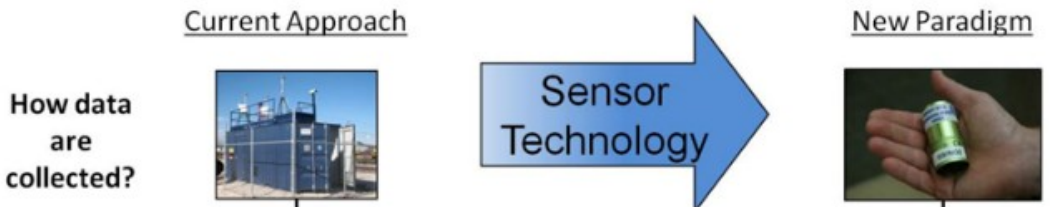

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Low-cost air quality sensors

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Smaller dimensions, lower weight, lower power consumption, easiness of use

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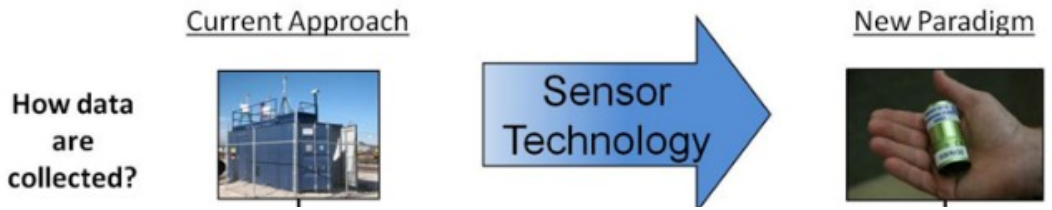

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New air monitoring applications
Promising alternative to traditional methods

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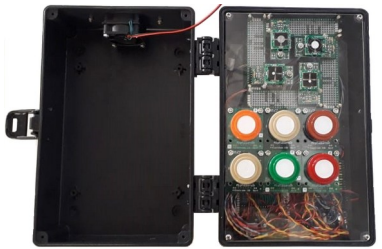
Sensor nodes developed at Federal University of Santa Catarina



Static sensing node

Mobile sensing node

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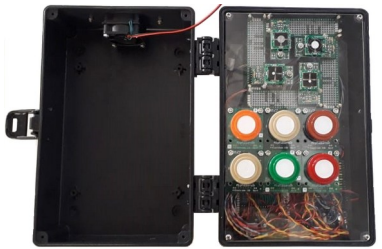

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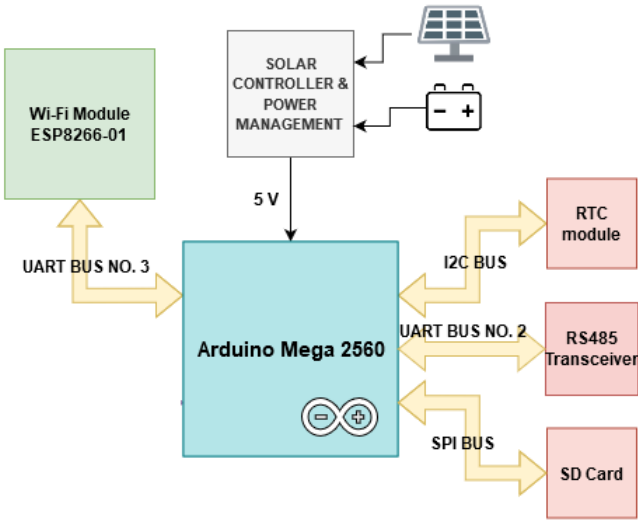

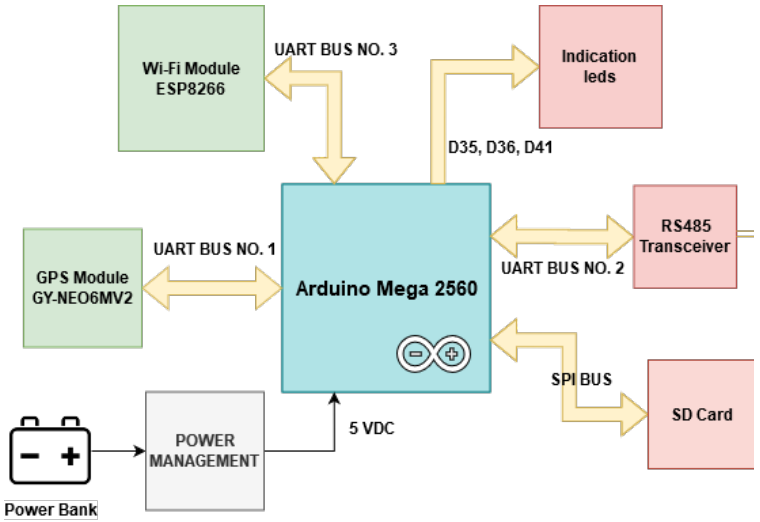

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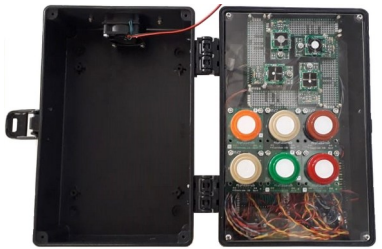

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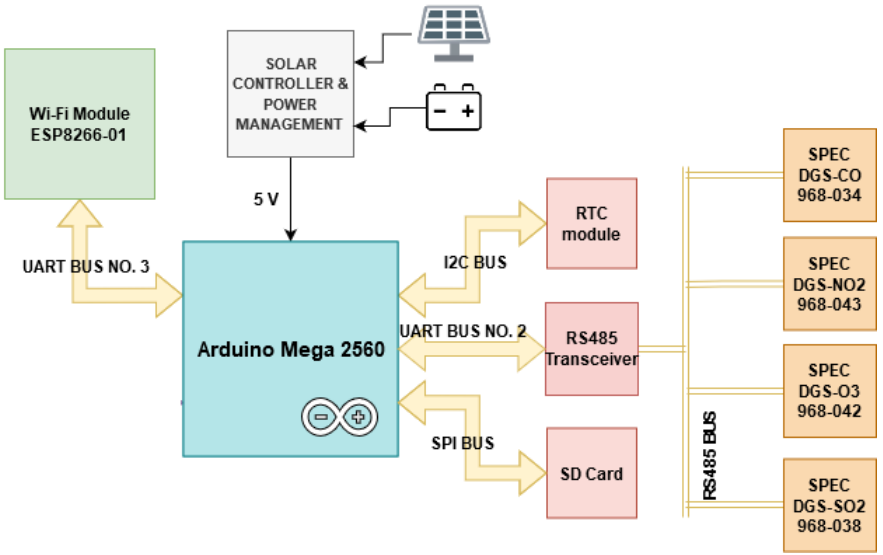

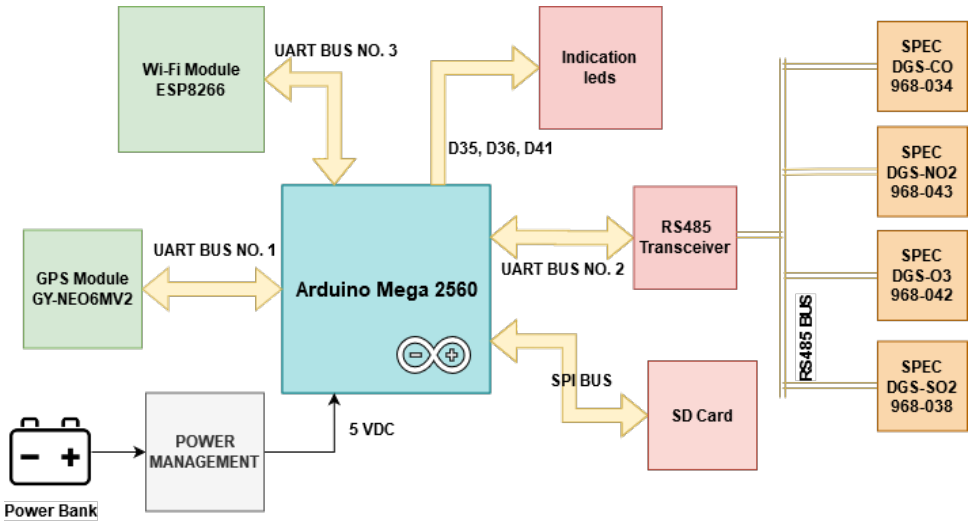

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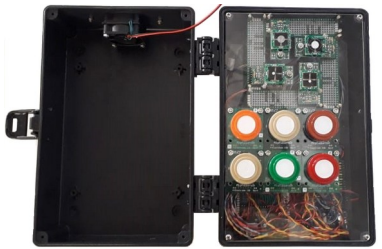

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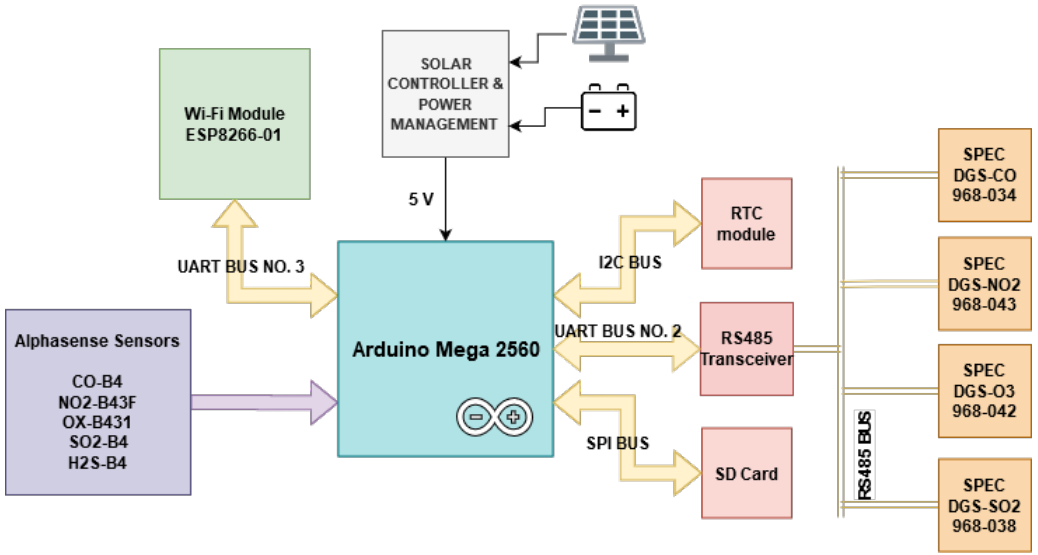
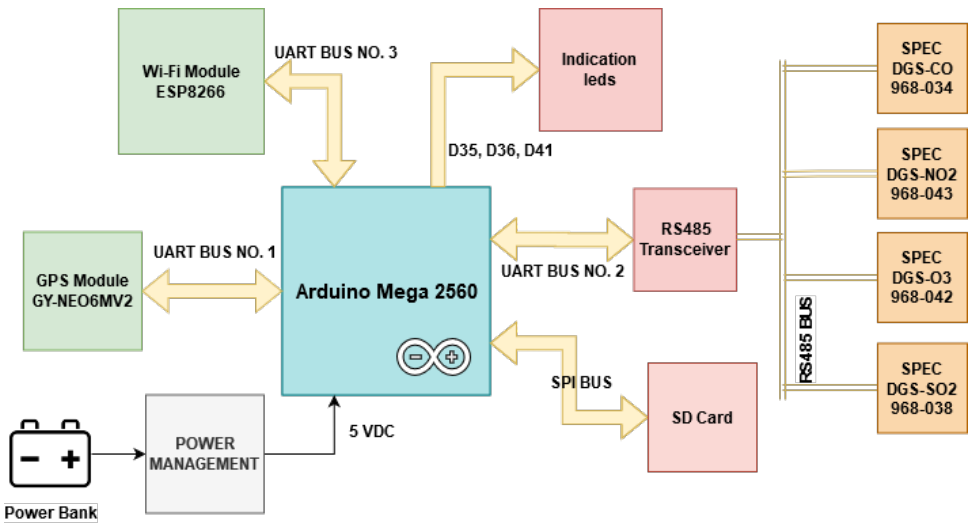




Static sensor node deployment

- Installed at the University campus
- Sensor:

  Prototype of a static sensor node developed at the laboratory
- Close to a street with regular flow of heavy vehicles (public transportation)
- First period of measurements:

  March 14, 2020 - May 26, 2020

  (Solar panel and battery)
- Second period of measurements:

  July 14, 2020 - September 3, 2020 (Connected to electric power network)

Mobile sensor node deployment

- Sensors:
  - Prototype of a mobile sensor node developed at the laboratory
  - Sniffer 4D from Shenzhen Soarability Technologies Co., Ltd. (uses Alphasense sensors)

- Measurements were taken on **streets** with medium traffic and **residential areas** during a time span of **four weeks**

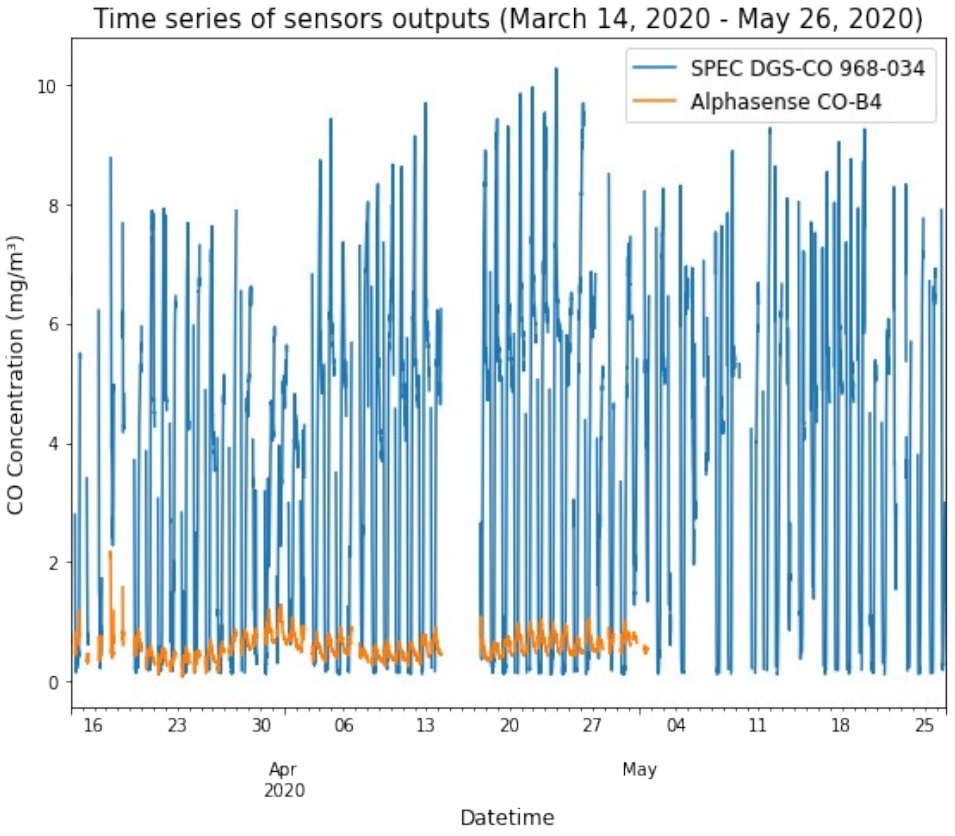
- Readings were made from **Monday to Sunday** at three different moments of the day according to traffic pattern
  - Intense traffic (07H00 – 10H00)
  - Quite traffic (14H00 – 16H00)
  - Intense traffic (17H00 – 19H00)

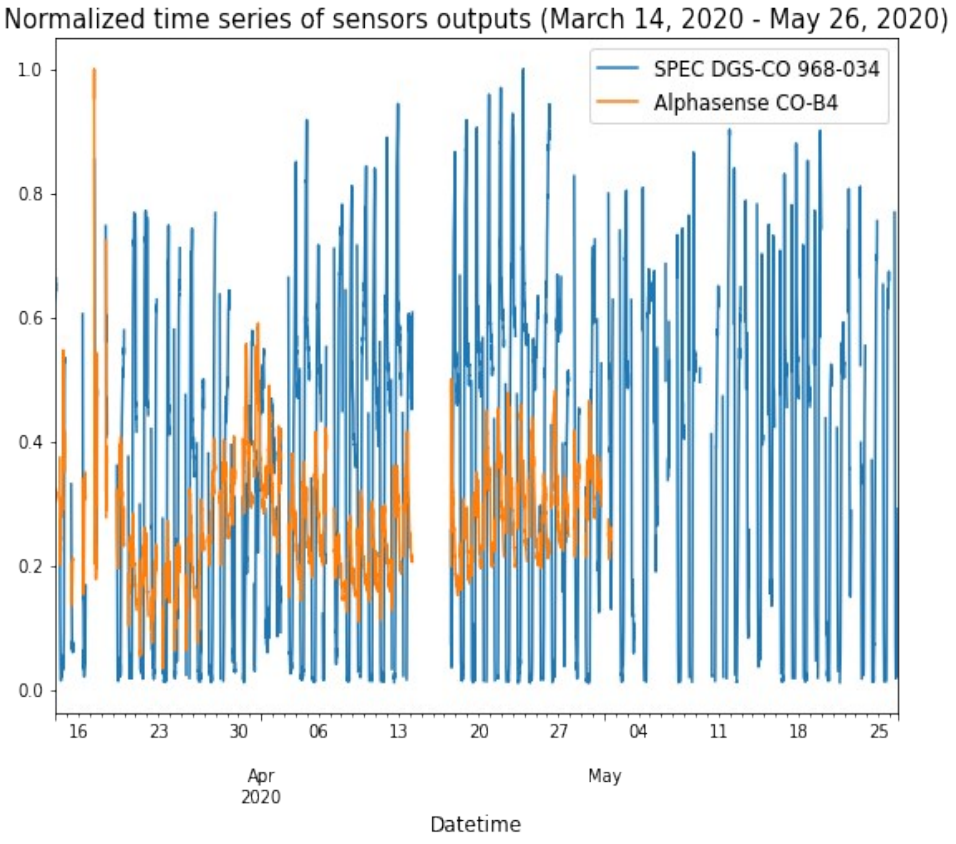
Main goals

- Preliminary analysis on the sensors’ performance

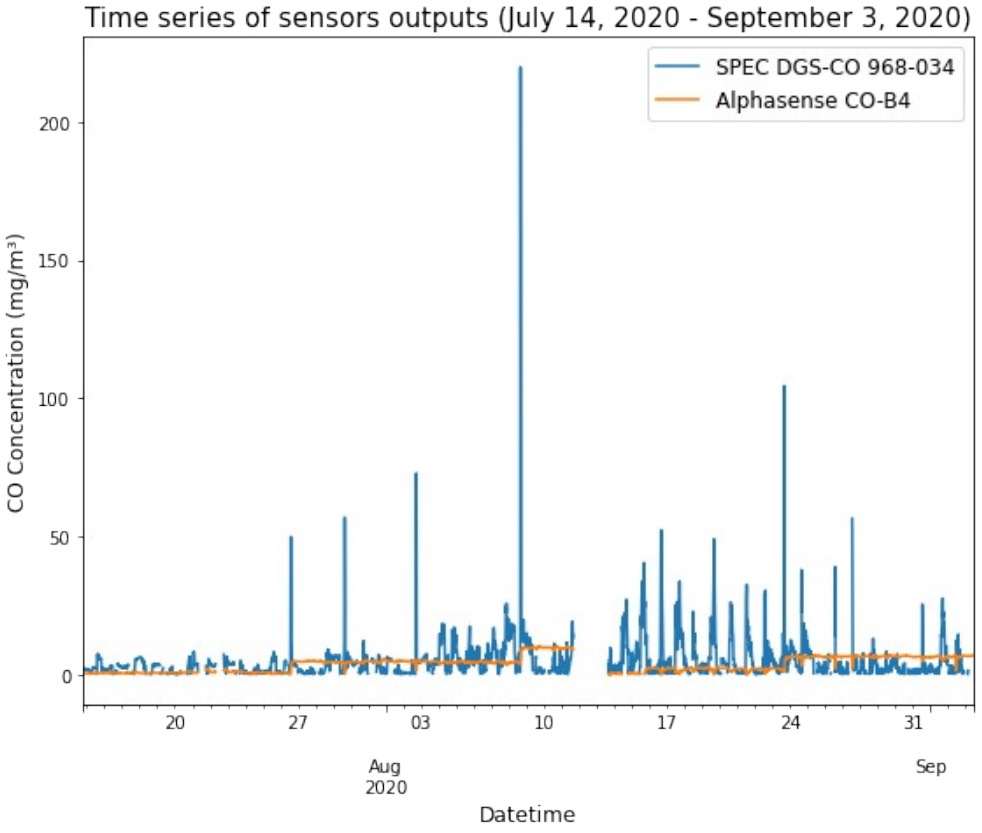
- Questions:
  - Are the responses of sensors from different manufacturers correlated for the same pollutant?
  - Do the sensors detect daily and weekly variations on traffic patterns?
  - Do sensors' responses correspond to the level of pollution expected at specific locations?
  - What is the effect of environmental conditions, like temperature or relative humidity, on sensor response?

Preliminary results static sensor node: sensors outputs

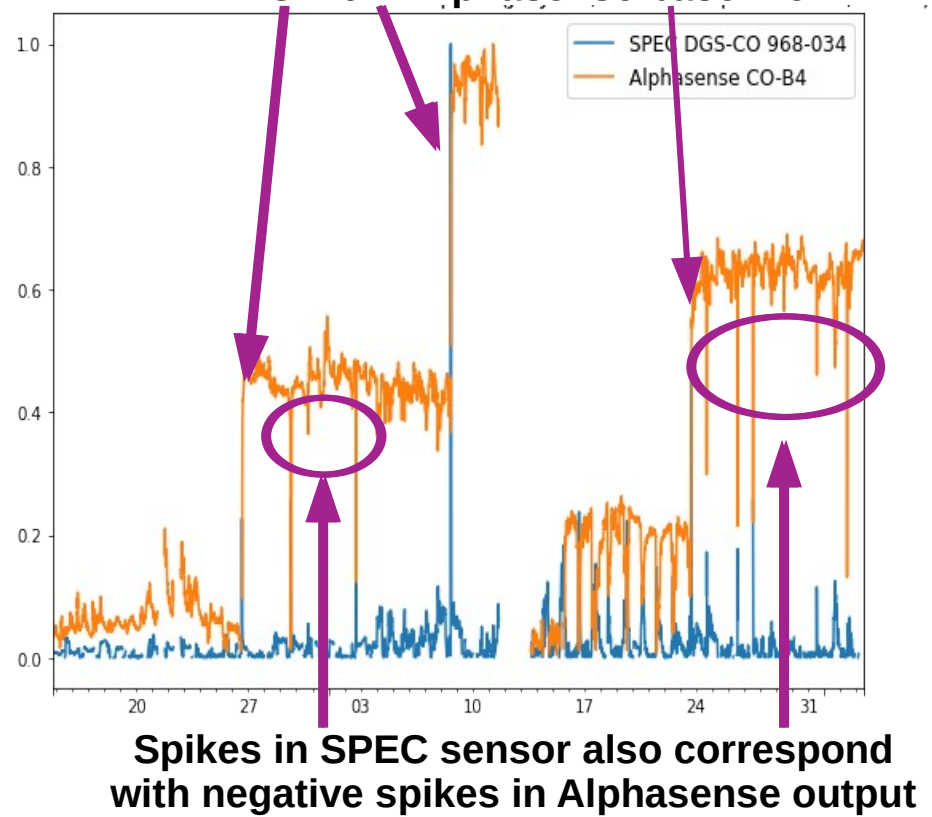




Preliminary results static sensor node: readings from second campaign not considered

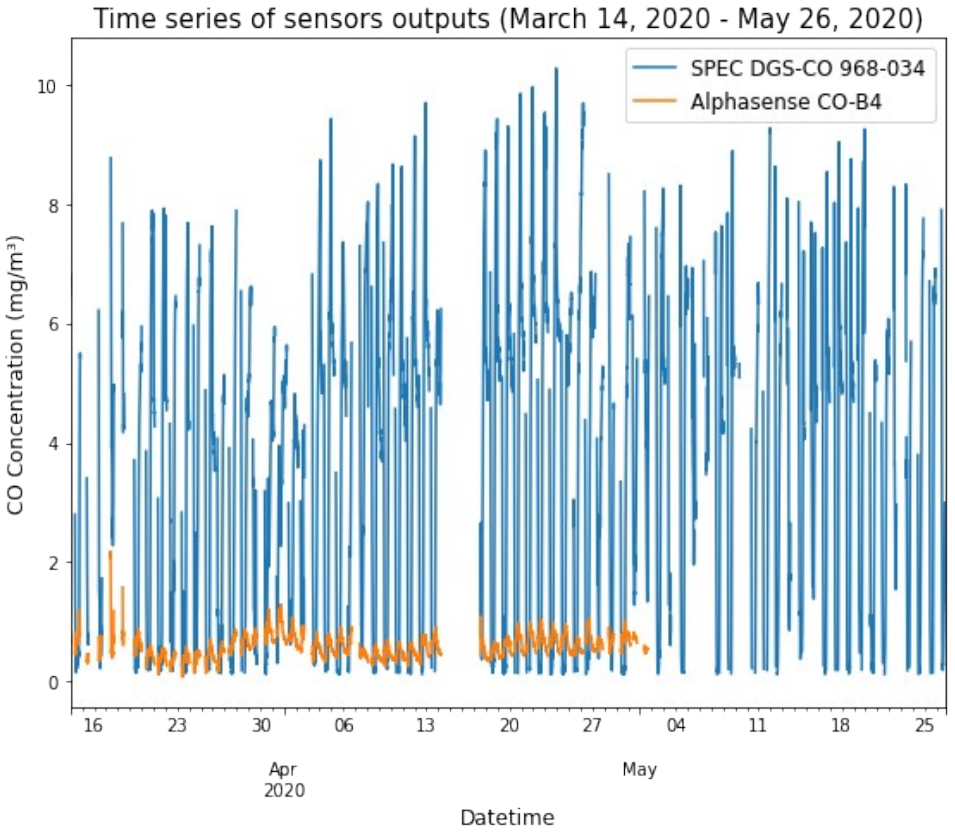


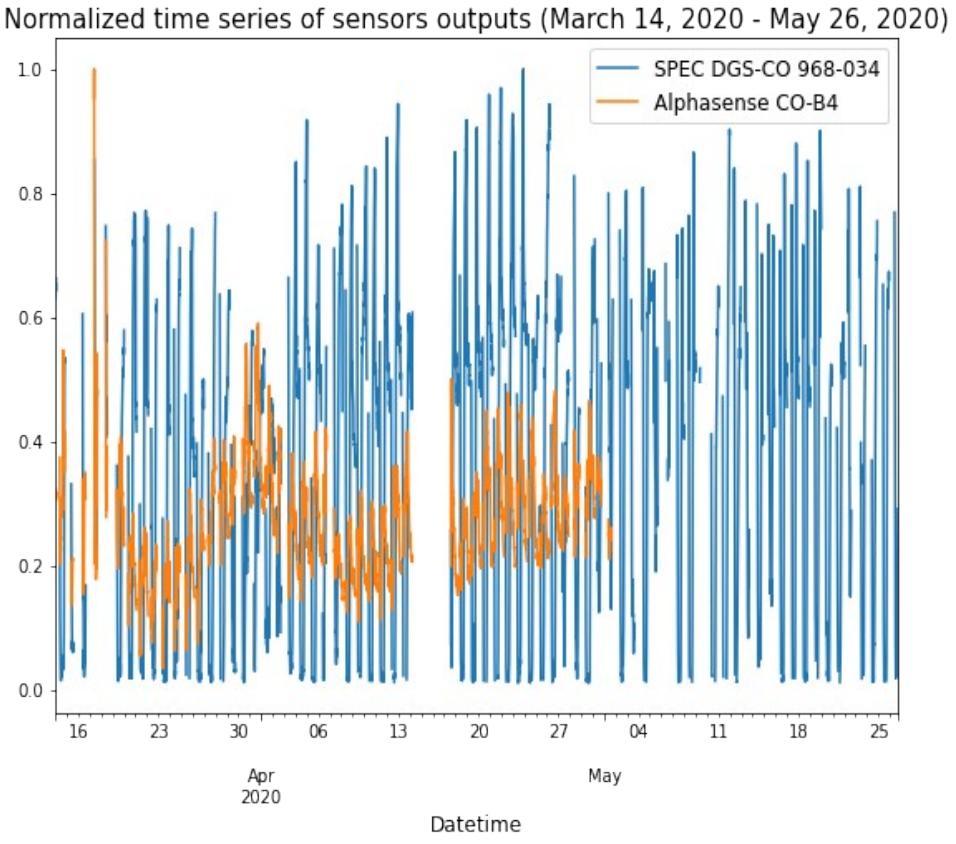
Spikes in SPEC's output correspond with shift in Alphasense baseline



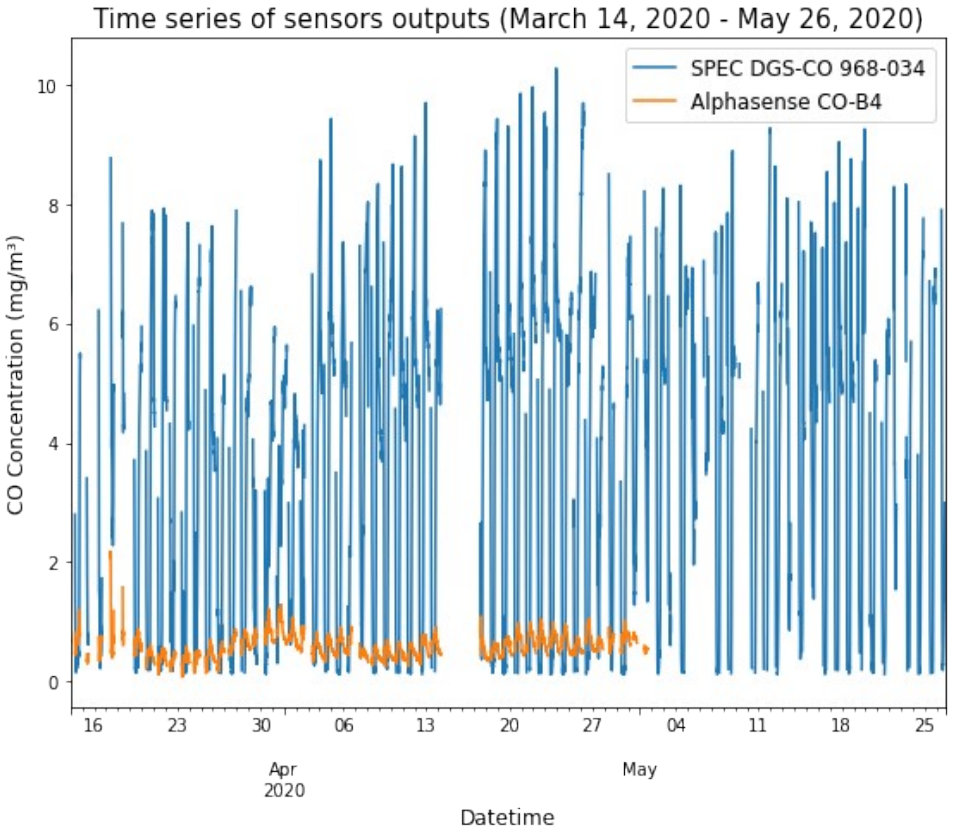
Spikes in SPEC sensor also correspond with negative spikes in Alphasense output

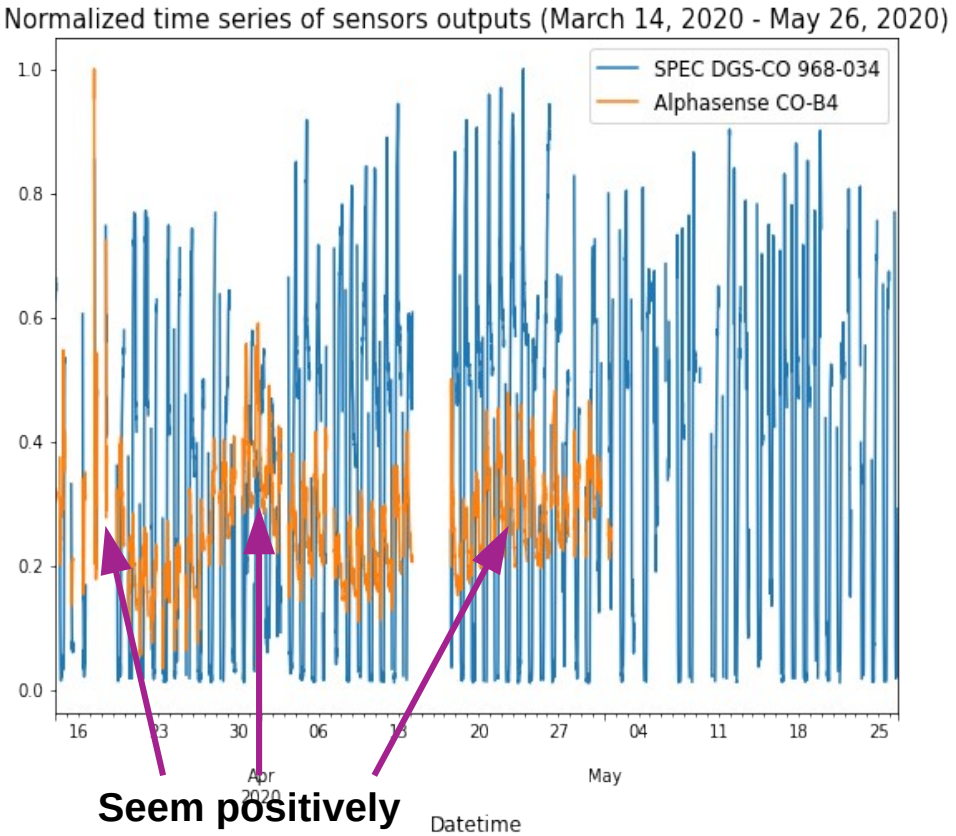
Preliminary results static sensor node: sensors outputs





Preliminary results static sensor node: normalized outputs





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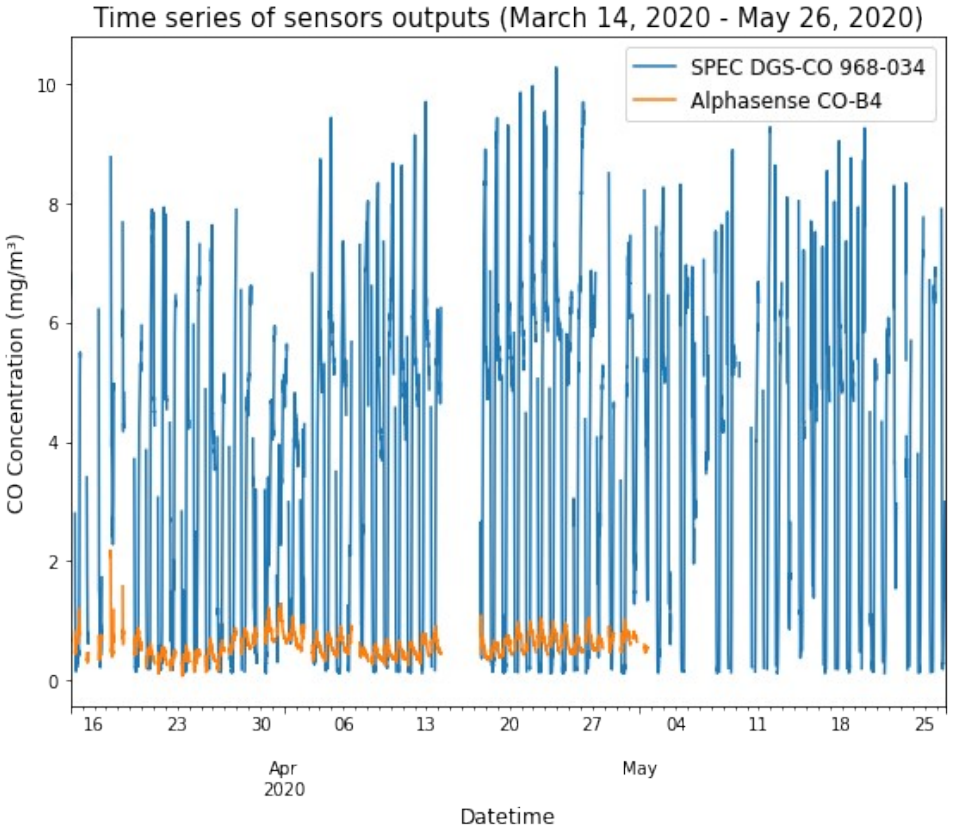
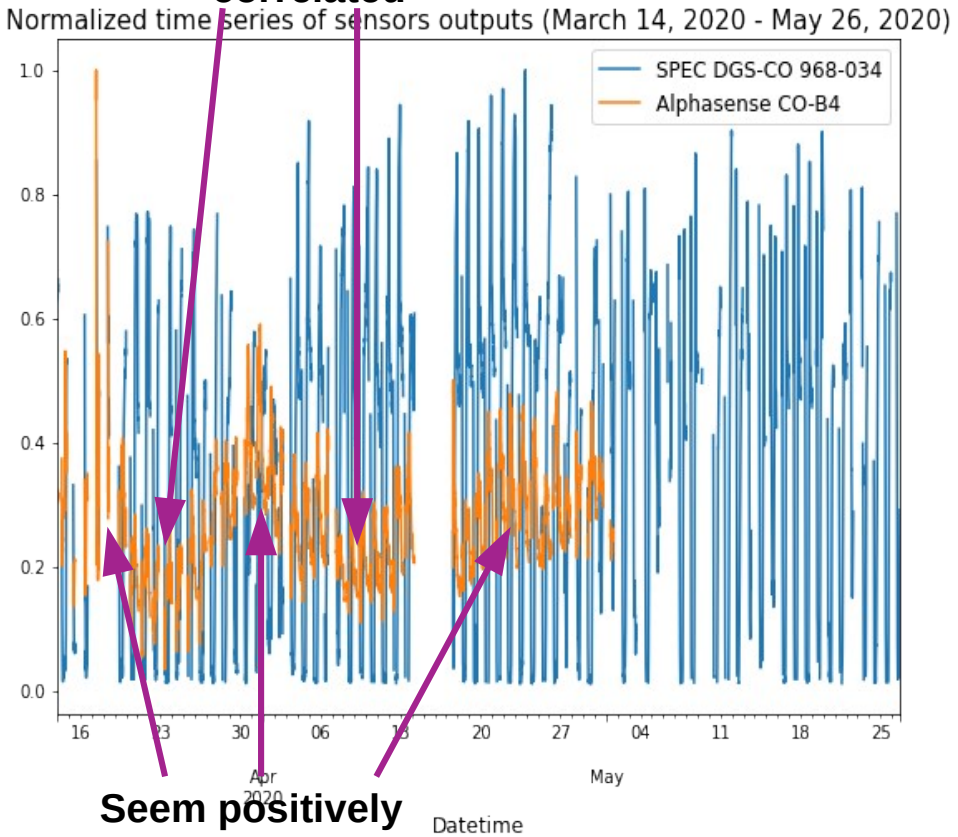
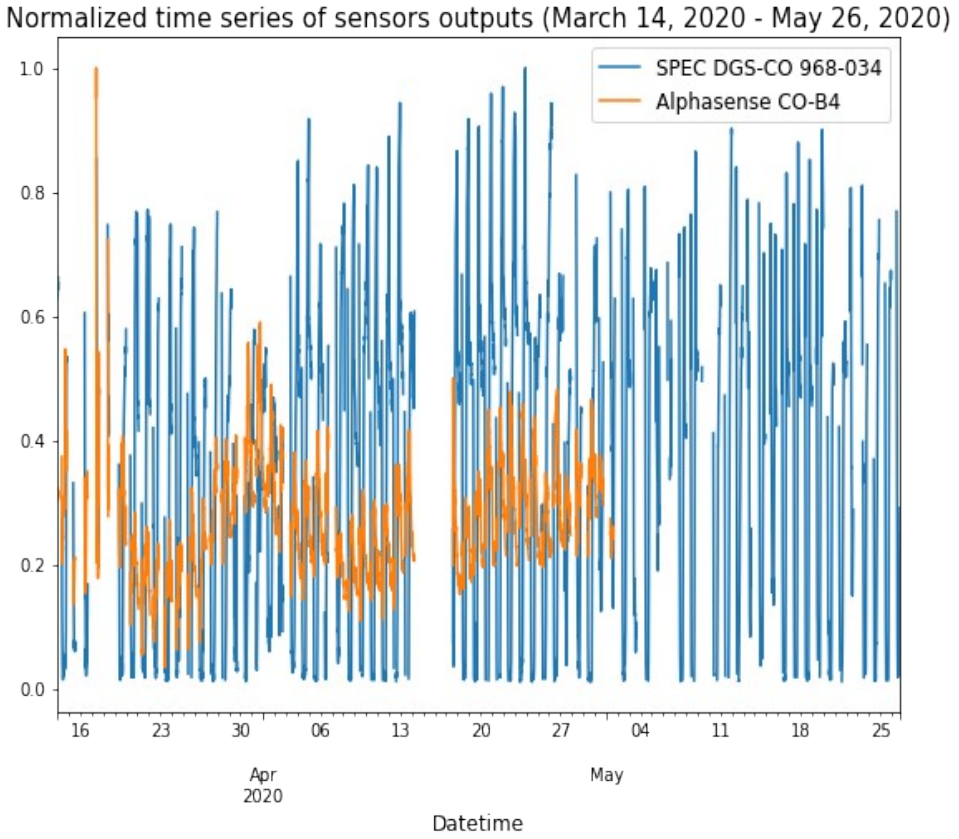


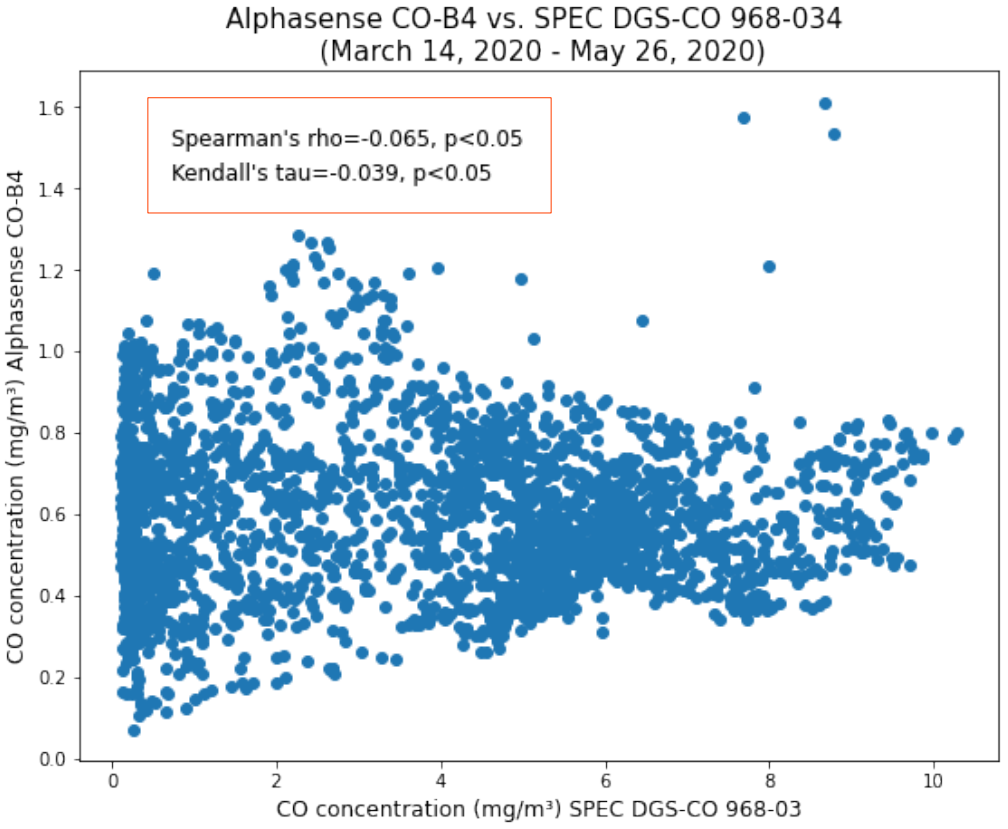


Seem negatively correlated

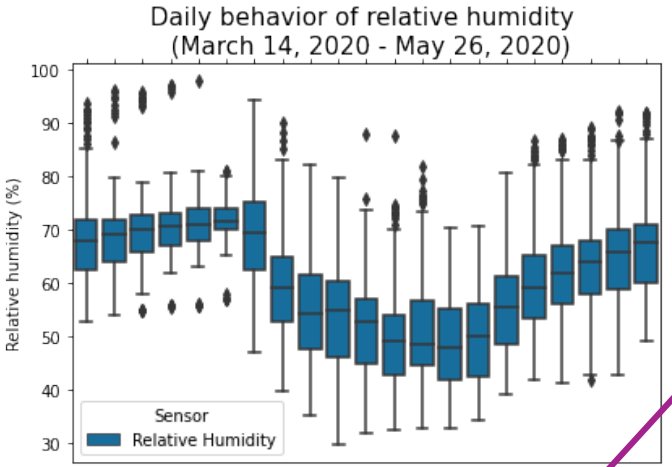
Seem positively correlated

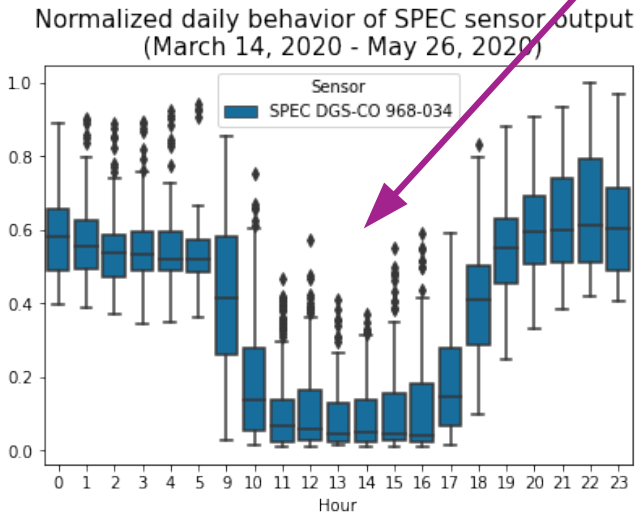
Preliminary results with static sensor node: are the outputs of the sensors correlated?



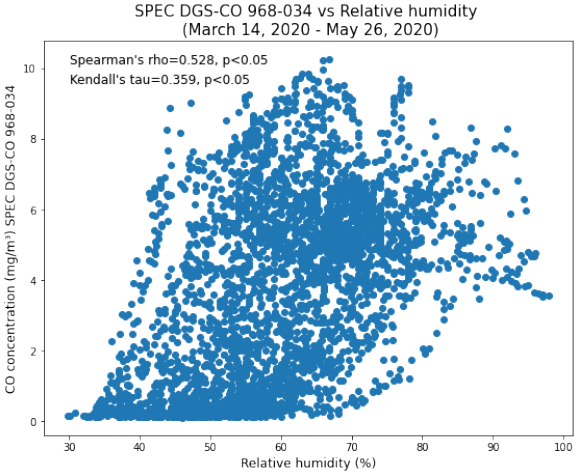


The influence of relative humidity on the daily pattern of the responses





- SPEC response seems to be driven by relative humidity (daily pattern)



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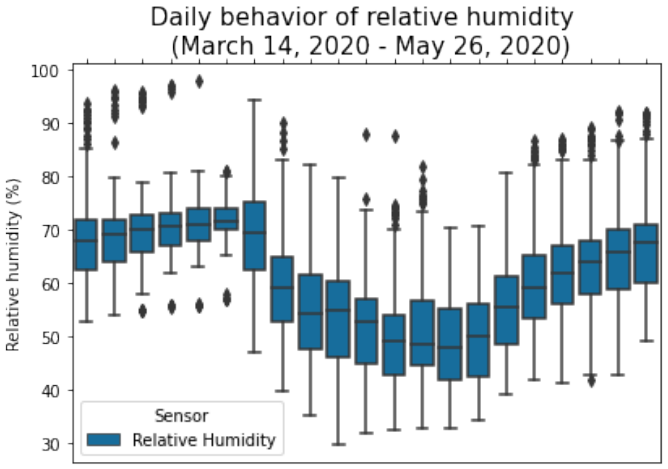
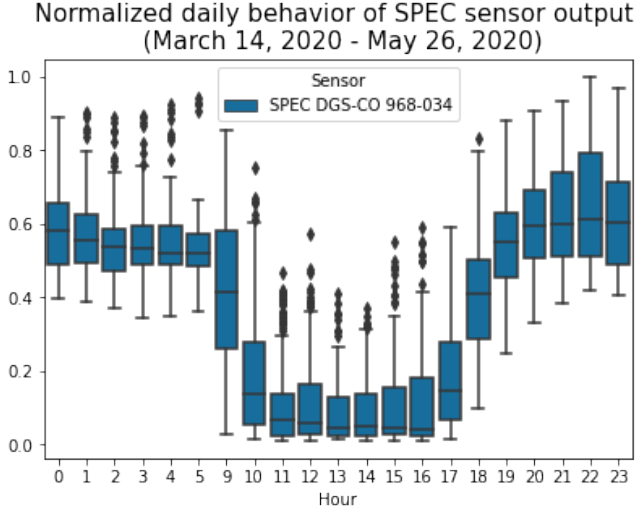
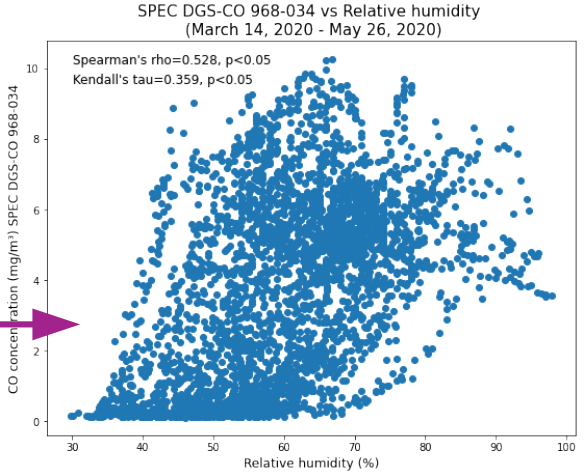




- SPEC response seems to be driven by relative humidity (daily pattern)
- SPEC sensor showed correlation to relative humidity:

  Spearman's: 0.5

  Kendall's: 0.4



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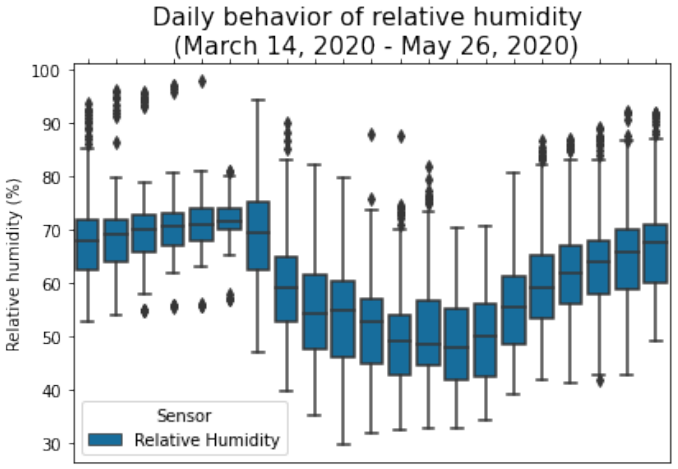

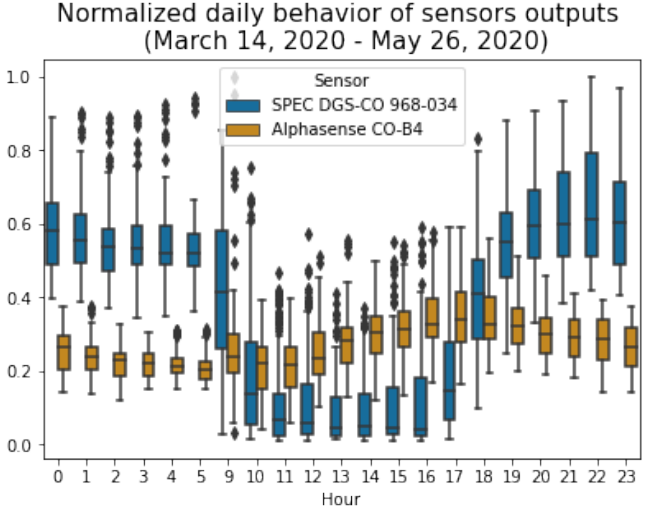

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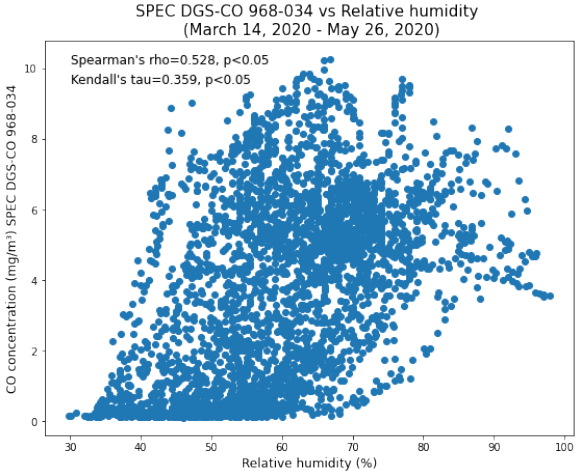

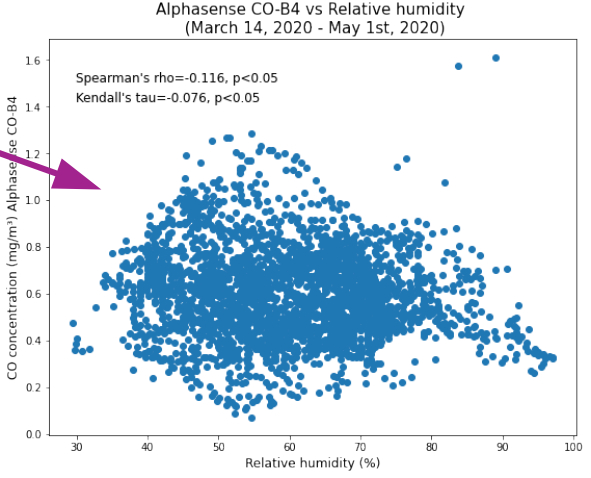

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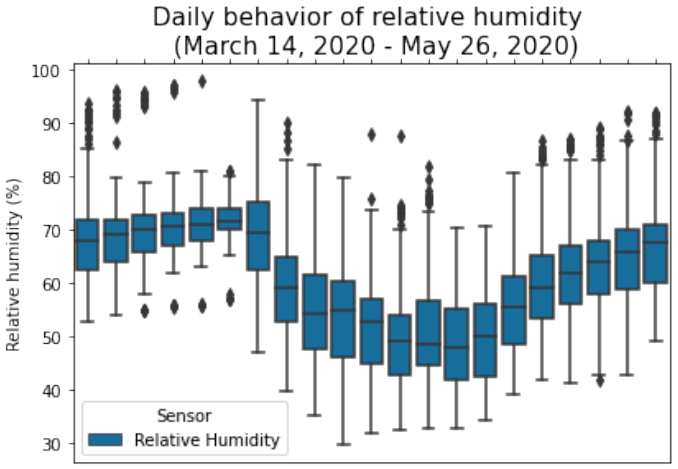

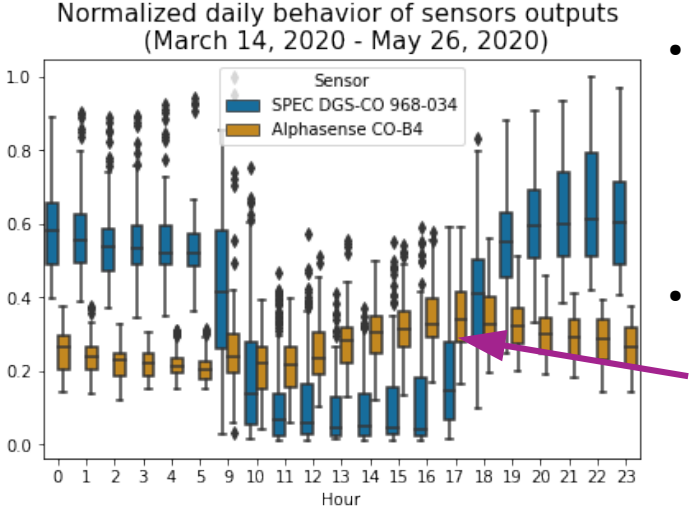

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  - Kendall's: 0.4
- Alphasense showed very low correlation to relative humidity
  - Spearman's: 0.1
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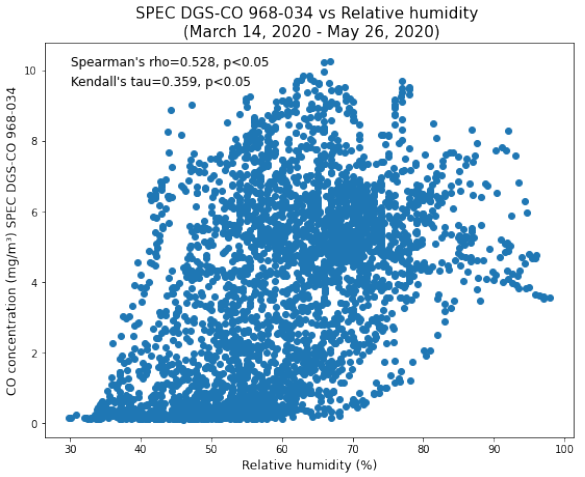
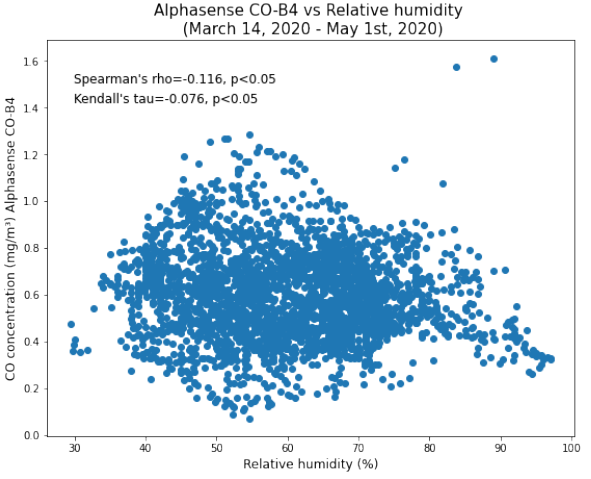
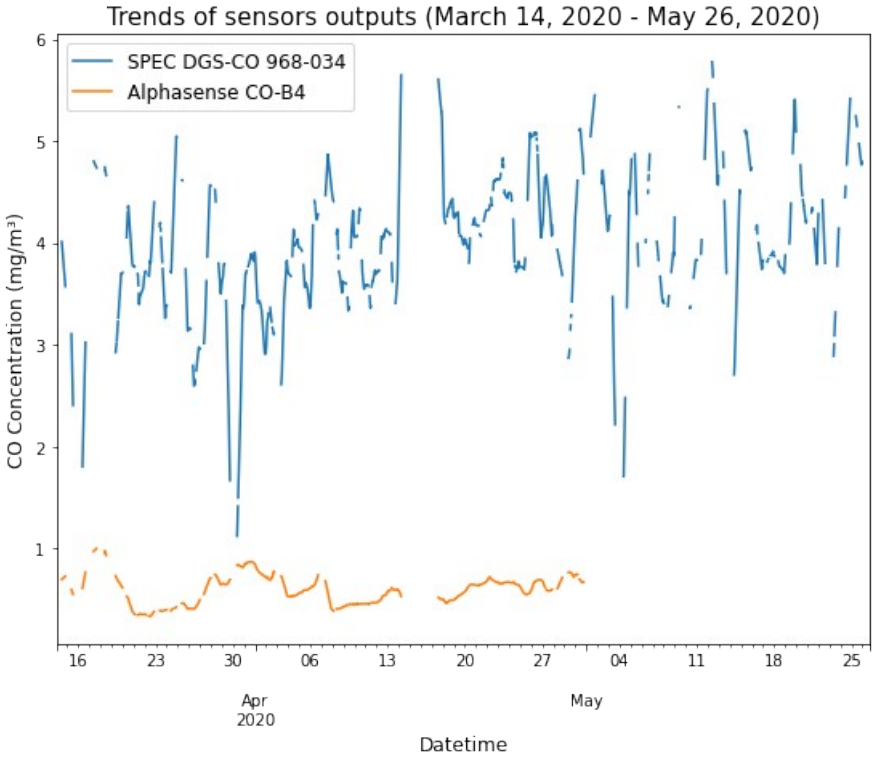
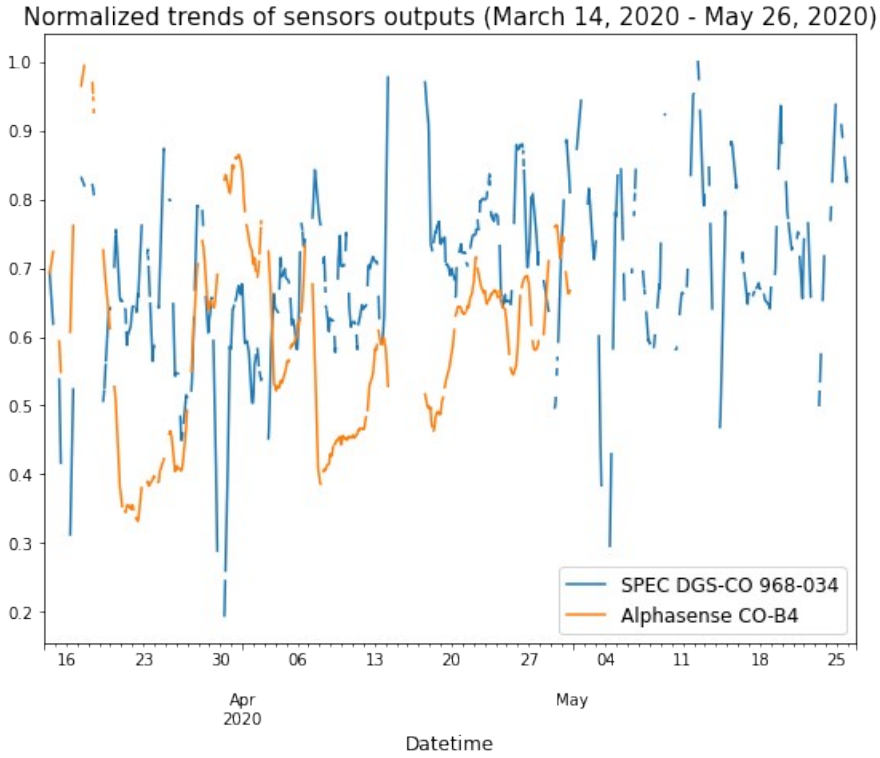
- Alphasense sensor detected higher concentration levels during rush hours





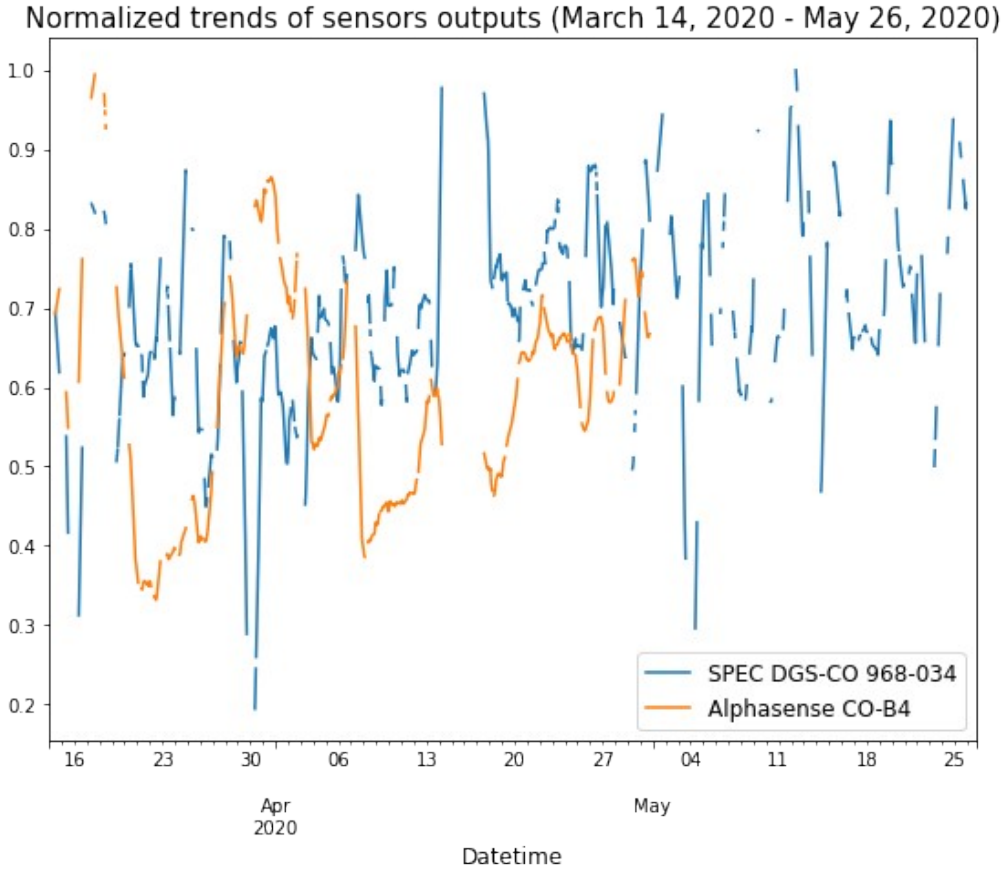
Preliminary results with static sensor node: correlation between sensors trends

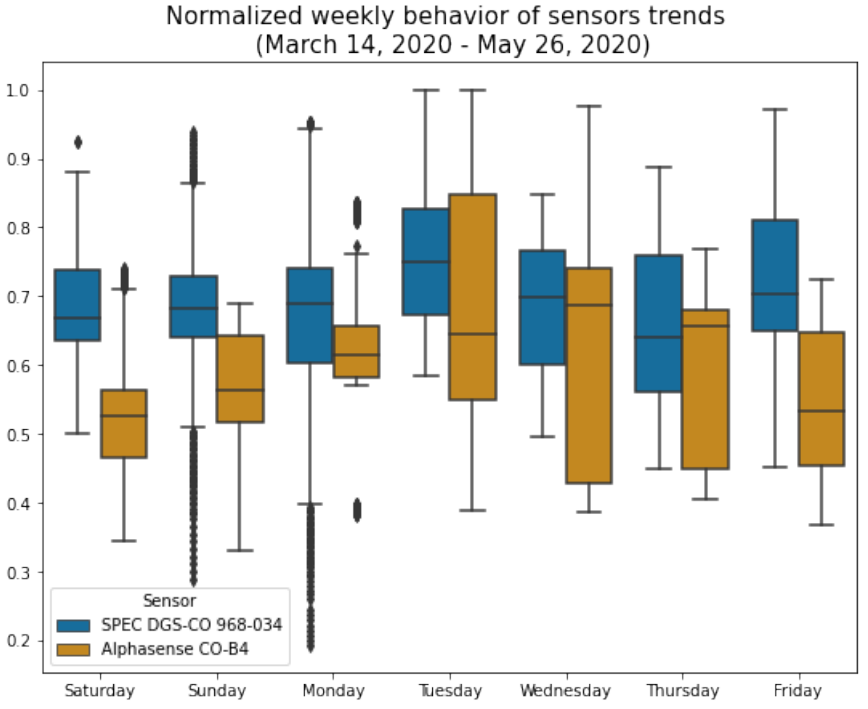




Spearman's correlation: -0.002, p<0.05
Kendall's correlation: 0.008, p<0.05

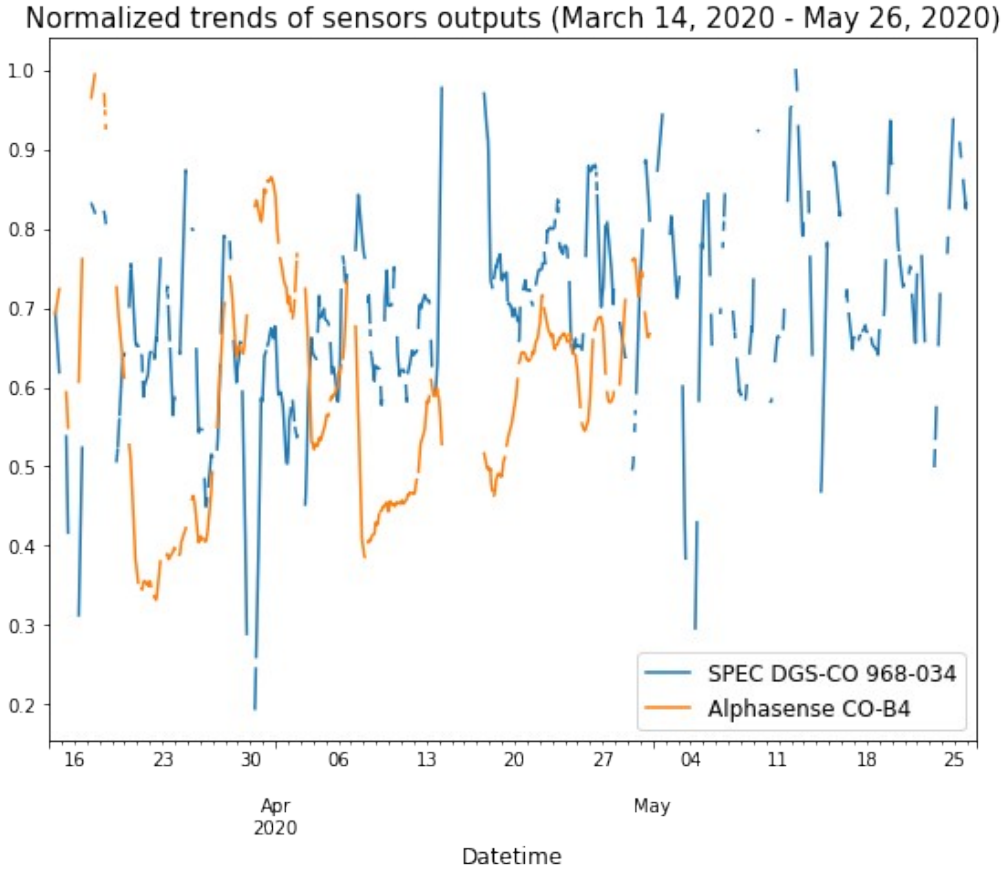
Preliminary results with static sensor node: sensors trends and weekly pattern

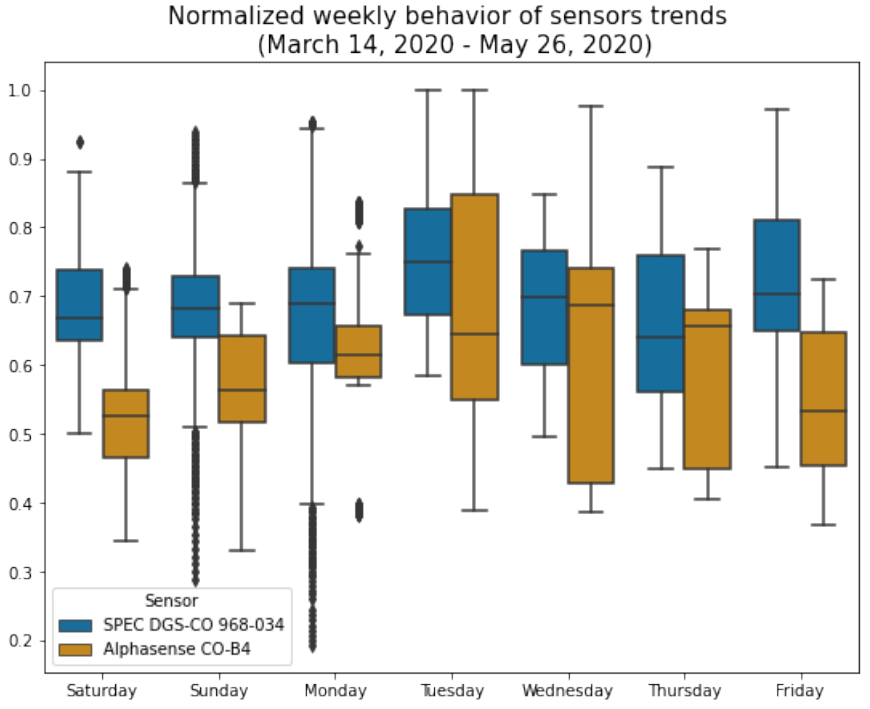




SPEC sensor remained with little variation throughout the week

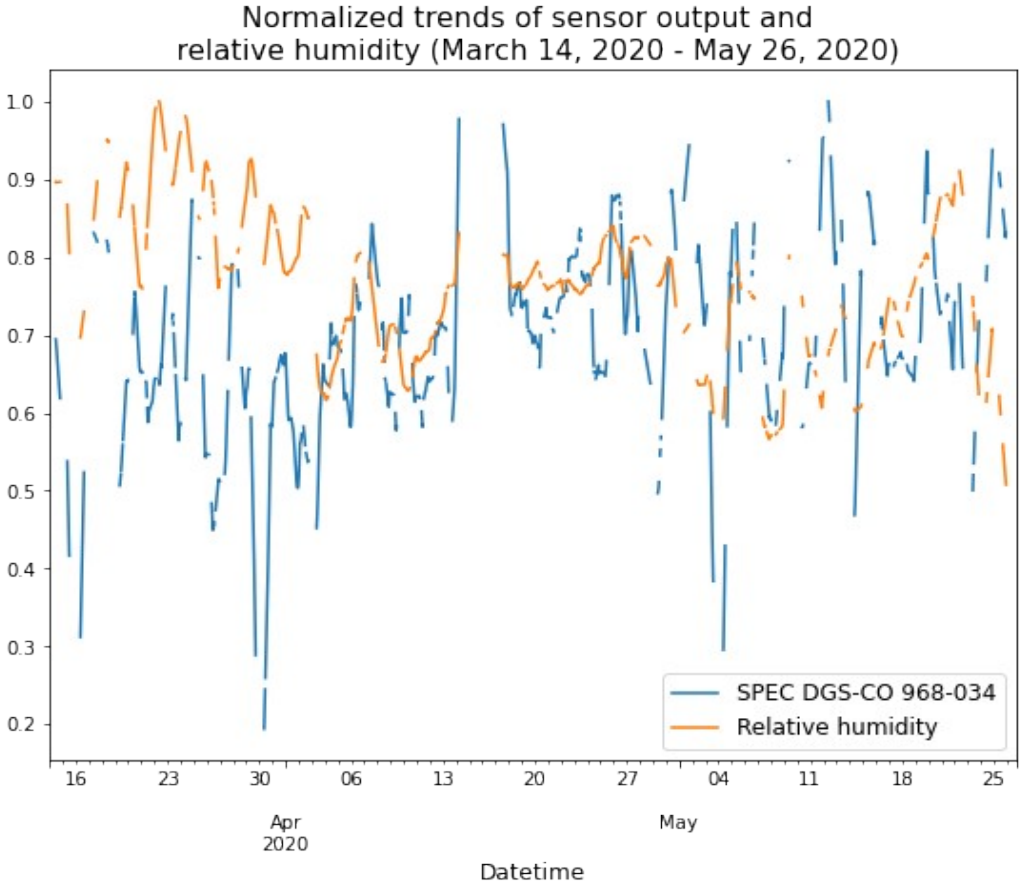
Preliminary results with static sensor node: sensors trends and weekly pattern





In general, readings from Alphasense CO-B4 had lower median values and lower variation on weekends than on weekdays

Preliminary results with static sensor node: relation with long term relative humidity

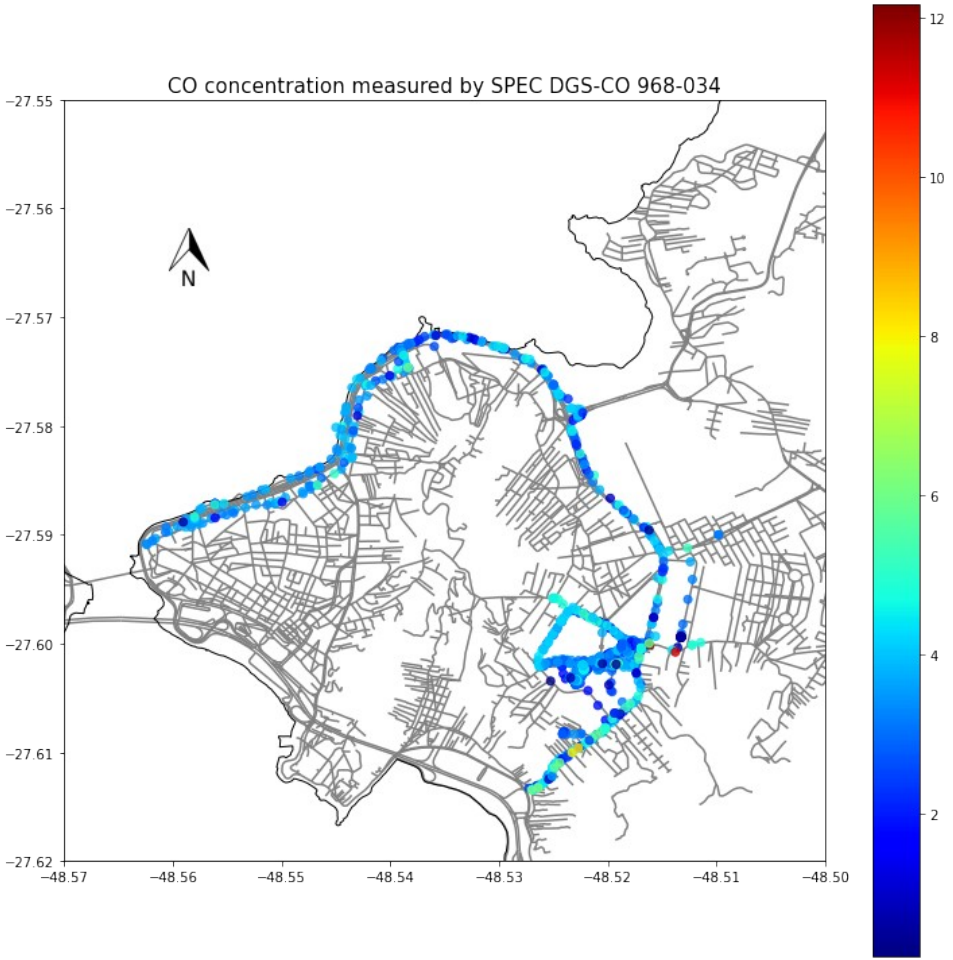


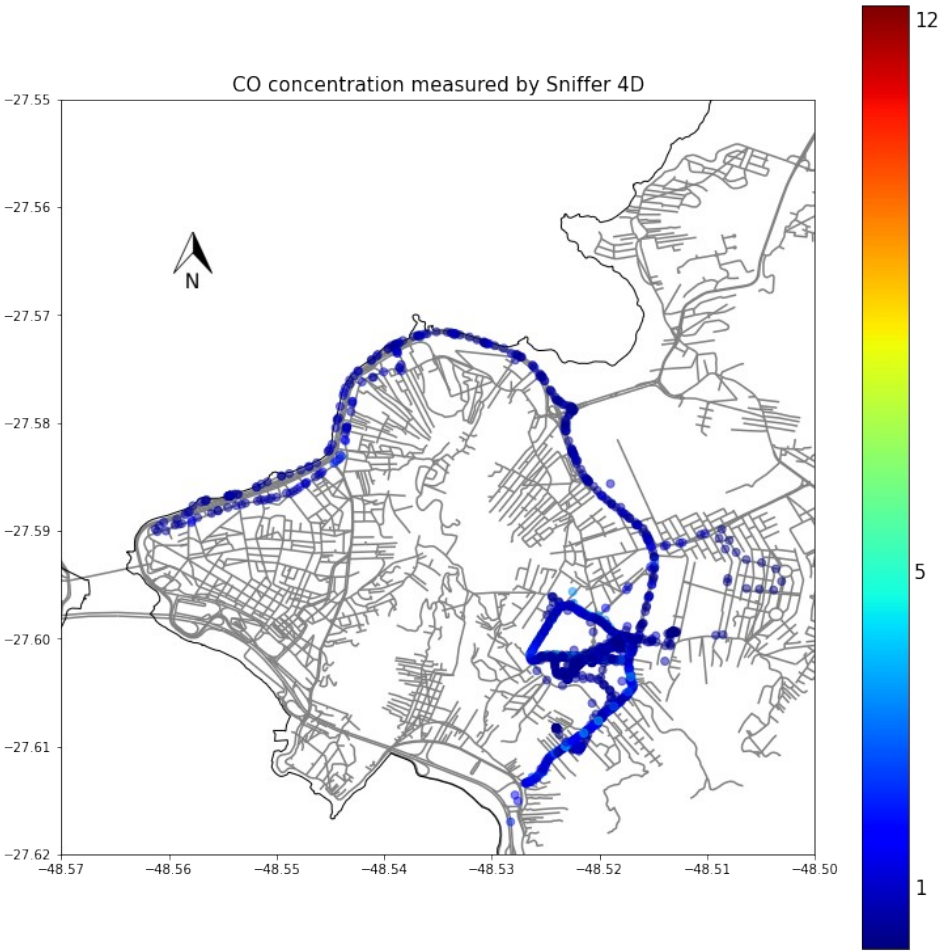
Correlation between SPEC sensor output trend and relative humidity was low

Spearman's correlation (trends): -0.084, $p<0.05$

Kendall's correlation (trends): -0.053, $p<0.05$

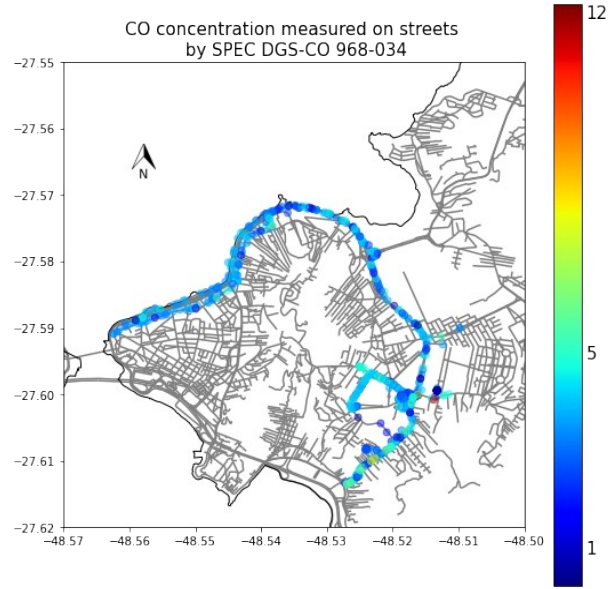
Preliminary results with mobile sensor node

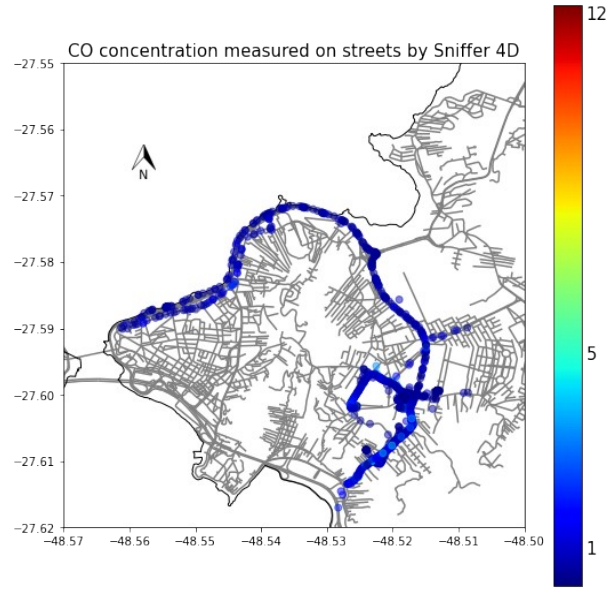


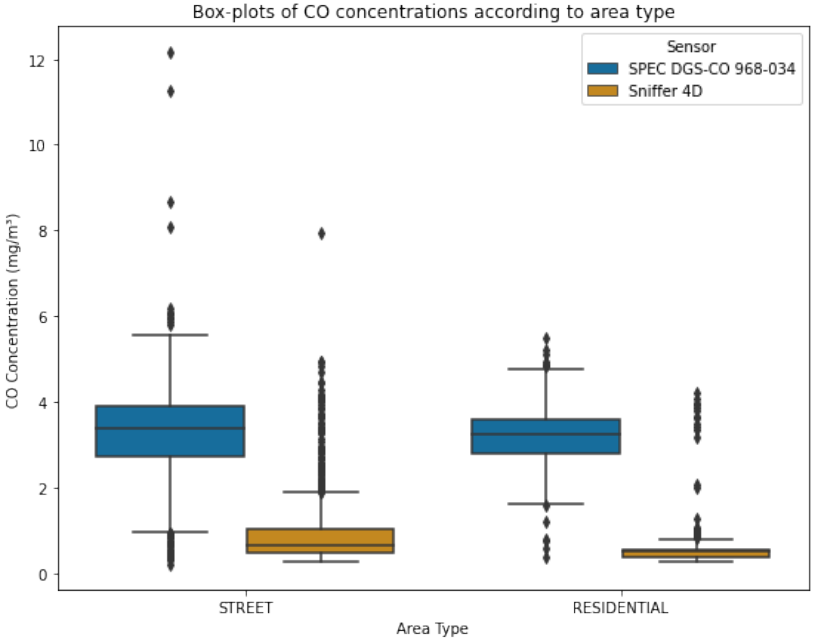


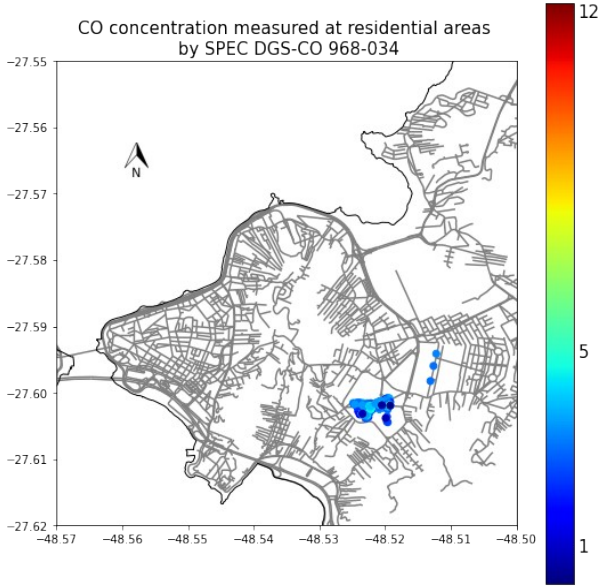
Preliminary results with mobile sensor node

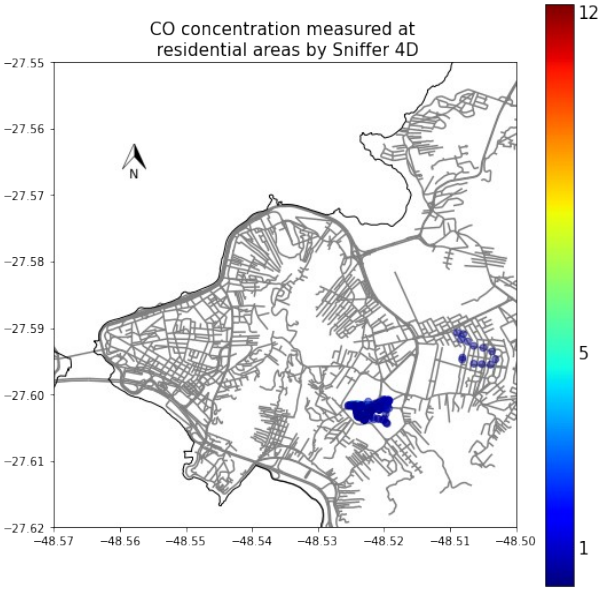
Comparison between concentration levels on streets and residential areas





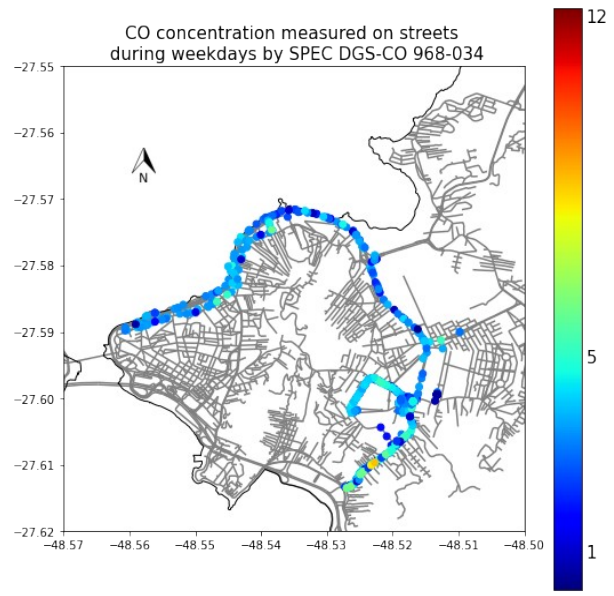


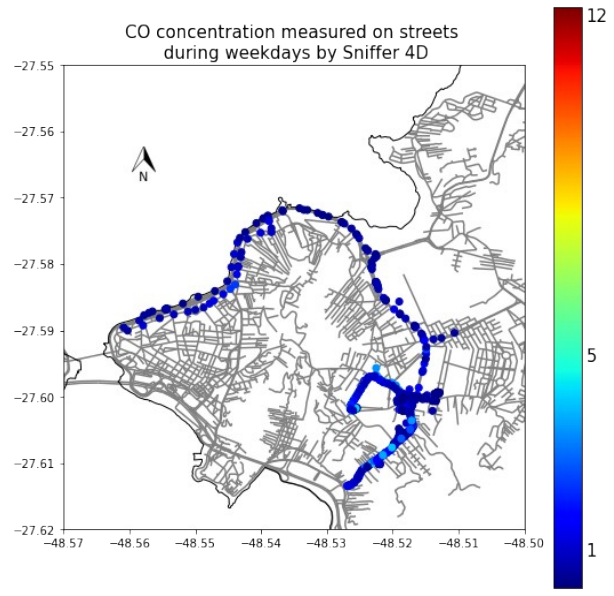


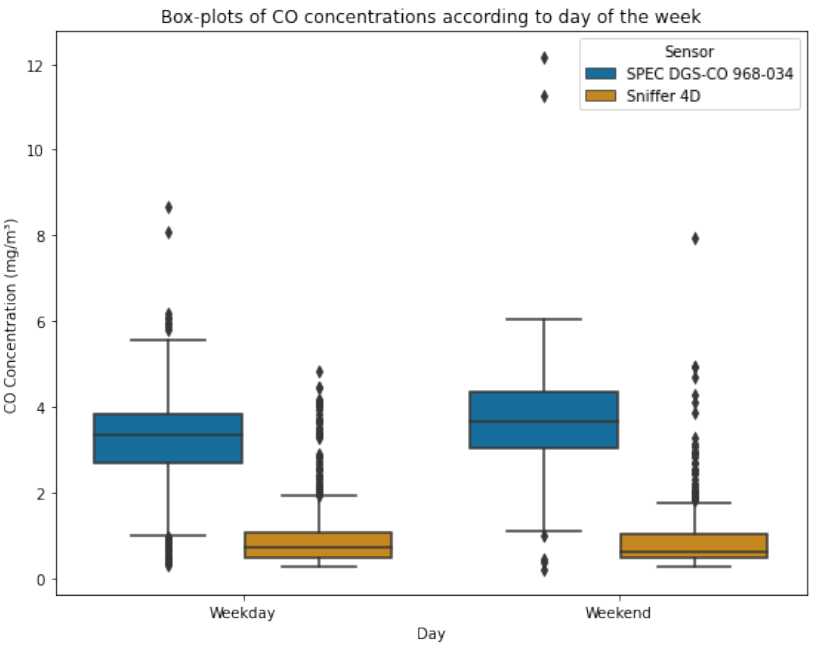


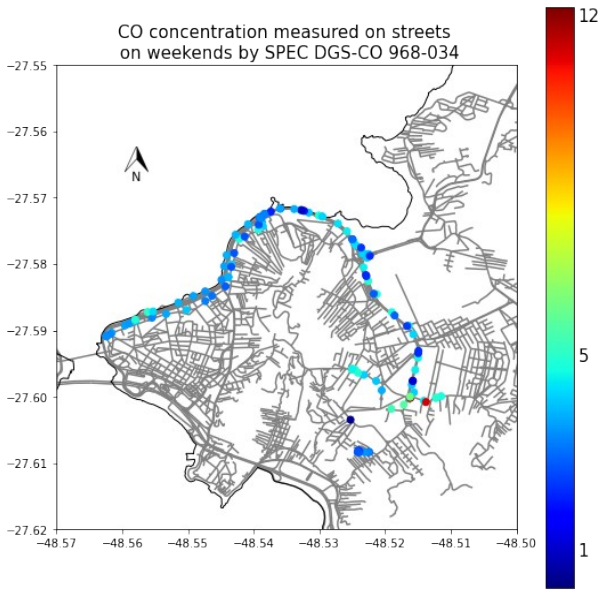
Preliminary results with mobile sensor node

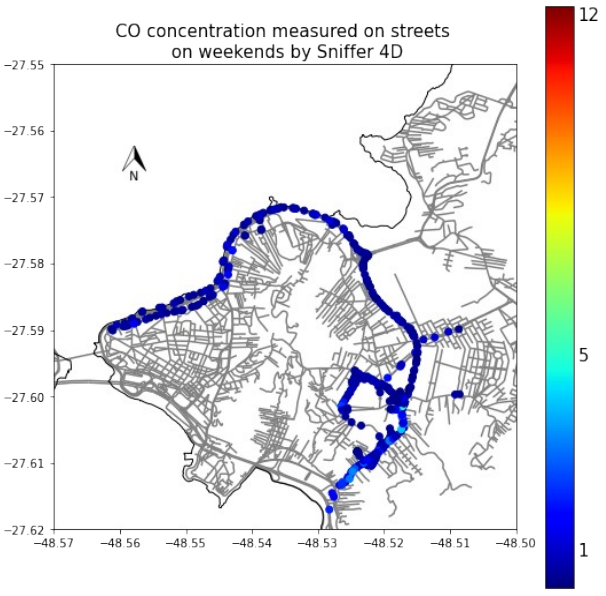
Comparison between concentration levels on streets during weekdays and weekends





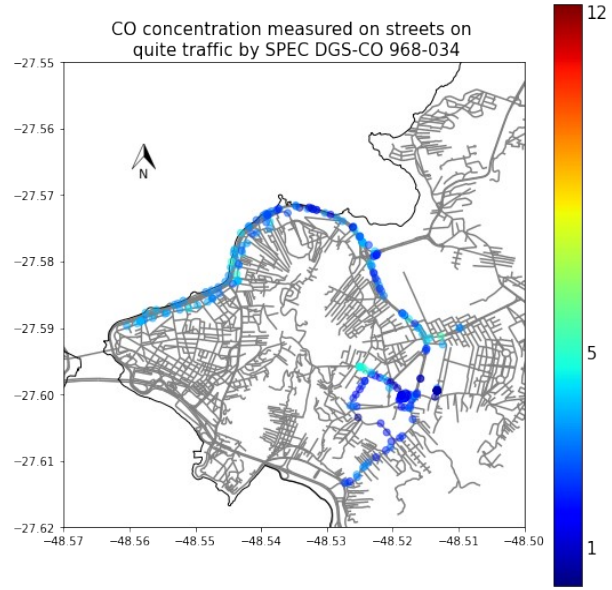


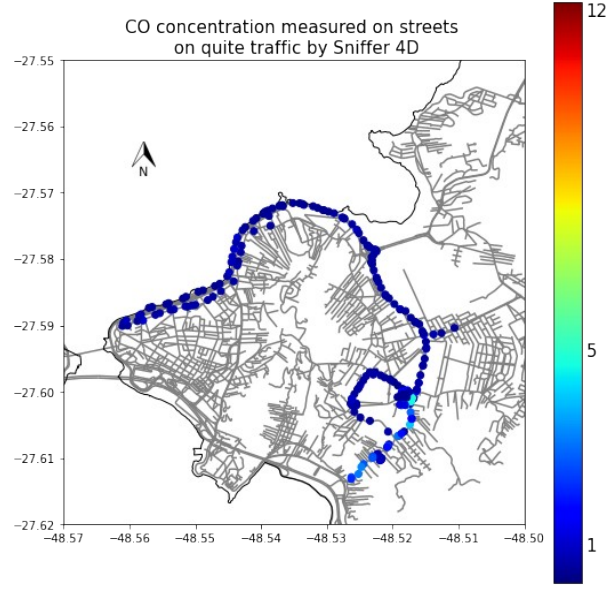


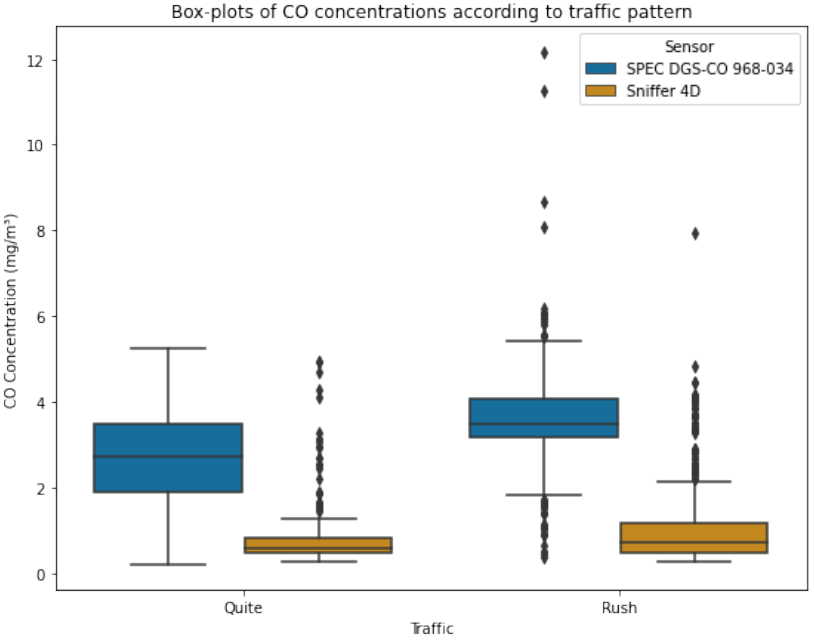


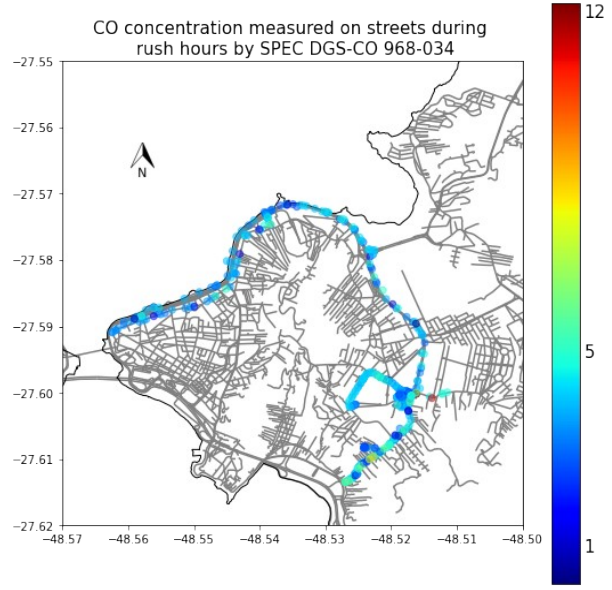
Preliminary results with mobile sensor node

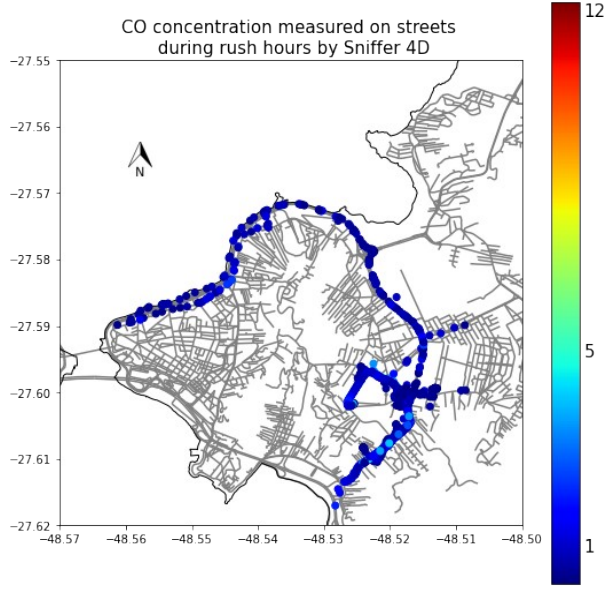
Comparison between concentration levels on streets according to traffic patterns



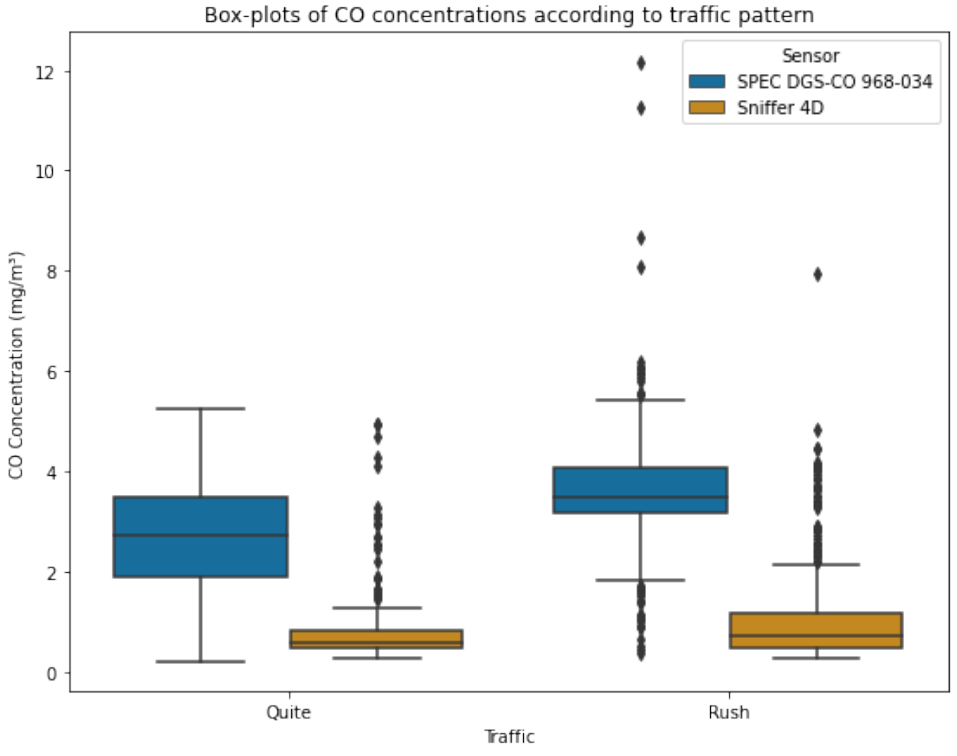


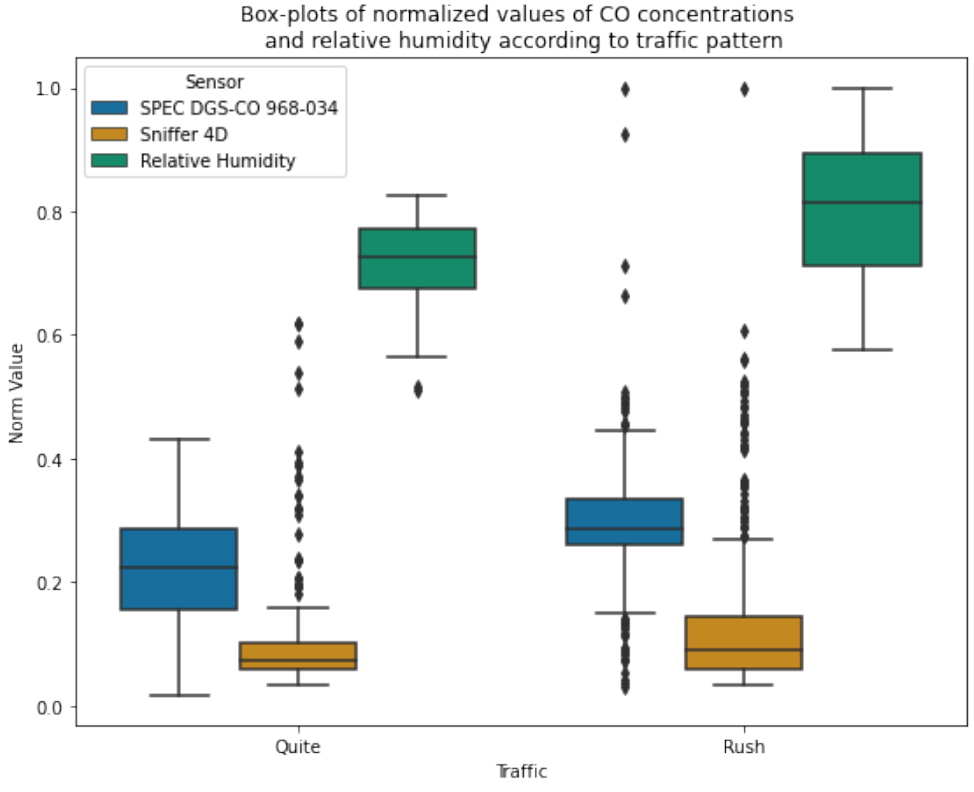






Preliminary results with mobile sensor node: Comparison between concentration levels on streets according to traffic patterns





Conclusion

- The responses from Alphasense and Spec sensors were not correlated
- The Alphasense CO-B4 sensor detected higher concentrations during rush hours
- The daily variation on relative humidity was the main driver for the responses of the Spec sensors
- Long term variation of Spec DGS-CO sensor response wasn’t correlated to relative humidity
- Alphasense CO-B4 sensor showed very low correlation to relative humidity
- SPEC Sensors weren’t sensitive to the level of ambient air CO concentrations to which they were exposed in the static node

Conclusion

- No considerable differences were perceived between readings taken on different areas (streets and residential) or different days of the weeks (weekday and weekend)
- Sensor showed higher values in rush hours but this could have been influenced by the relative humidity
- Further hardware improvement should be made on filtering electrical noise and on airflow
- Both mobile and static nodes will be tested against reference instruments on the laboratory

Thank you!

Contact: fernando.campo@posgrad.ufsc.br

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