Improvements of LCS accuracy

Achieving near-reference data in challenging environmental conditions

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Intro to
Low Cost Sensors

Reference stations

›300K$

Sensor-based stations

- 85% accuracy
- 2,500 times smaller
- Remote maintenance
- 97% cheaper

‹10K$

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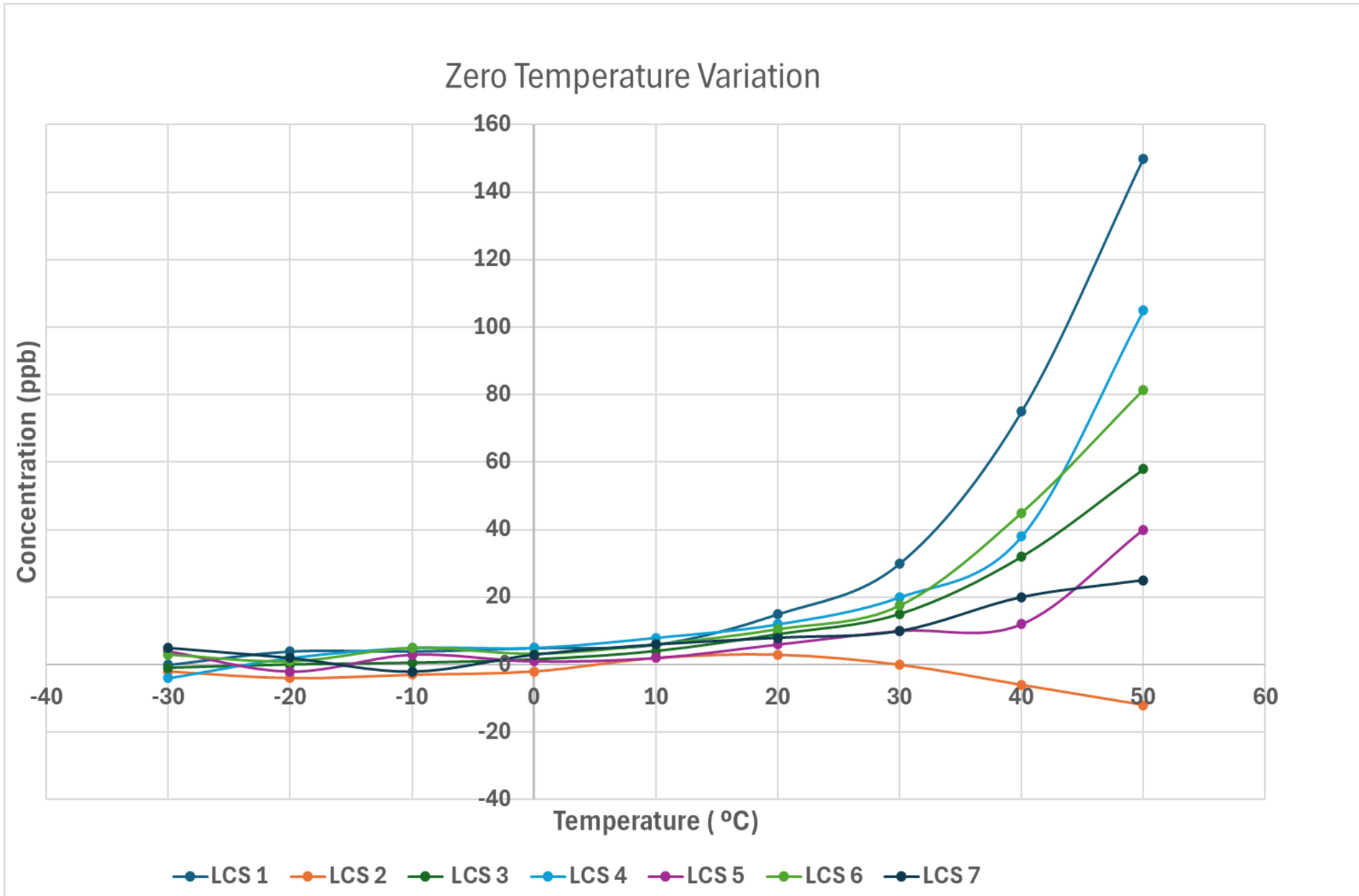
Low cost sensors (LCS):
Main challenges

1. Environmental conditions effects:
    - Non-linear response to temperature (Baseline and Sensitivity)
    - Other environmental conditions produce more complex non-linear effects.
2. Cross-sensitivities of other common atmospheric compounds.
3. Baseline and sensitivity drift over time.

WORLD METEOROLOGICAL ORGANIZATION

Lewis, A., Peltier, W. R., & von Schneidemesser, E. (2018).
Low-cost sensors for the measurement of atmospheric composition: overview of topic and future applications.

Effect of Temperature on LCS: Baseline



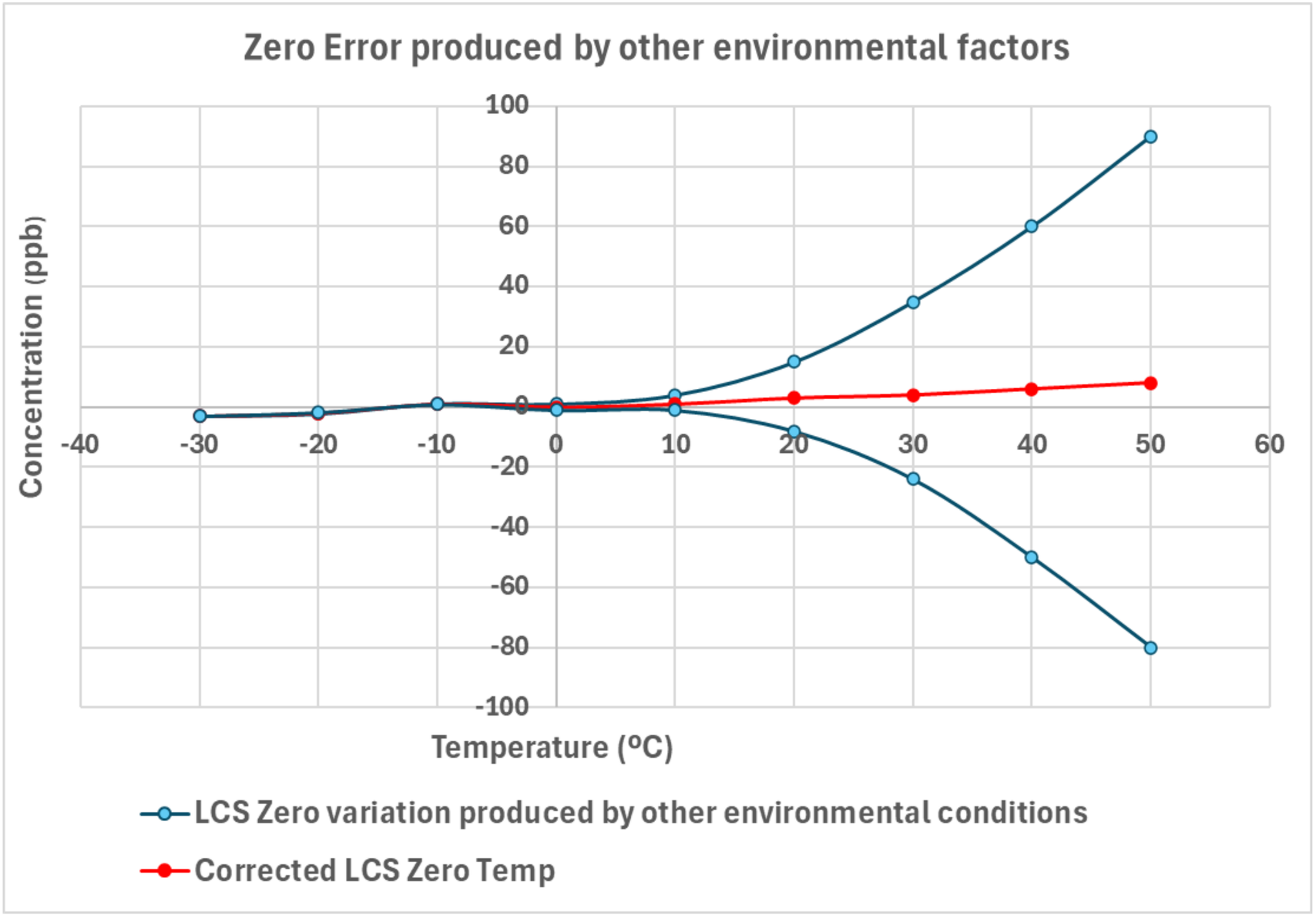
Concentration = 0 ppb
Humidity = Constant 50%
Pressure = Constant 1 atm

Challenges

1- Non linear response above 10ºC

2- High sensor to sensor variability

Effect of other environmental factors on LCS: Baseline



Concentration = 0 ppb
Zero Temperature Effect = Corrected
Humidity = Variable
Pressure = Variable

Complex non-Linear Effects

Increase the Baseline error

Product Line

kunak air

KUNAK AIR PRO

Multi-pollutant air quality station

KUNAK AIR LITE

Compact air quality station

SMART CARTRIDGES

Plug&Play gas cartridges

KUNAK CLOUD

Professional air quality management platform

Solution

PATENTED

Kunak Smart Gas cartridges solve many of the known issues of sensor technology as sensor variability, factory and field calibration, automatic data invalidation, sensor replacement, network operation and maintenance work.

Near-reference

Data performance similar to reference instruments

Traceable QC & QA

Validated against traceable reference standards

Consistent readings

Low intra-variability across all locations

Endless combinations

Patented GasPlug technology

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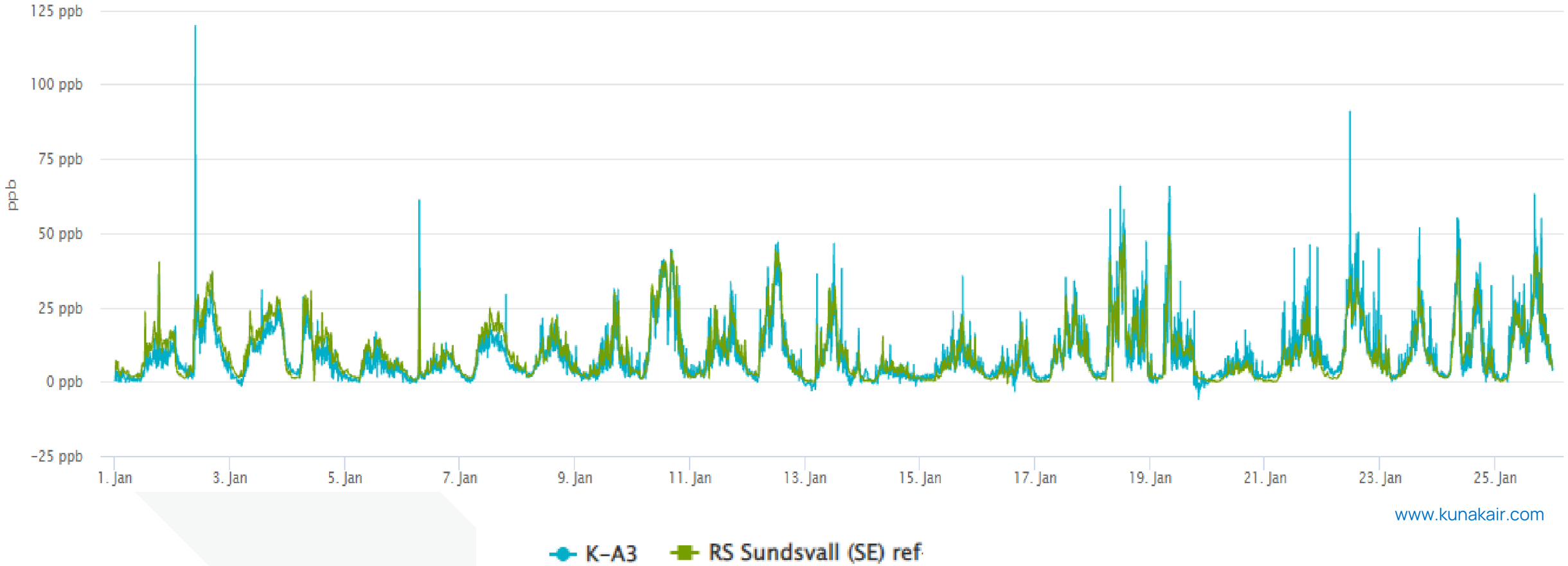
Extreme cold conditions in Sweden: -18°C / NO2

	Min	Avg	Max
T (°C)	-18.8	-2.2	8.5
RH(%)	46.3	80.5	100

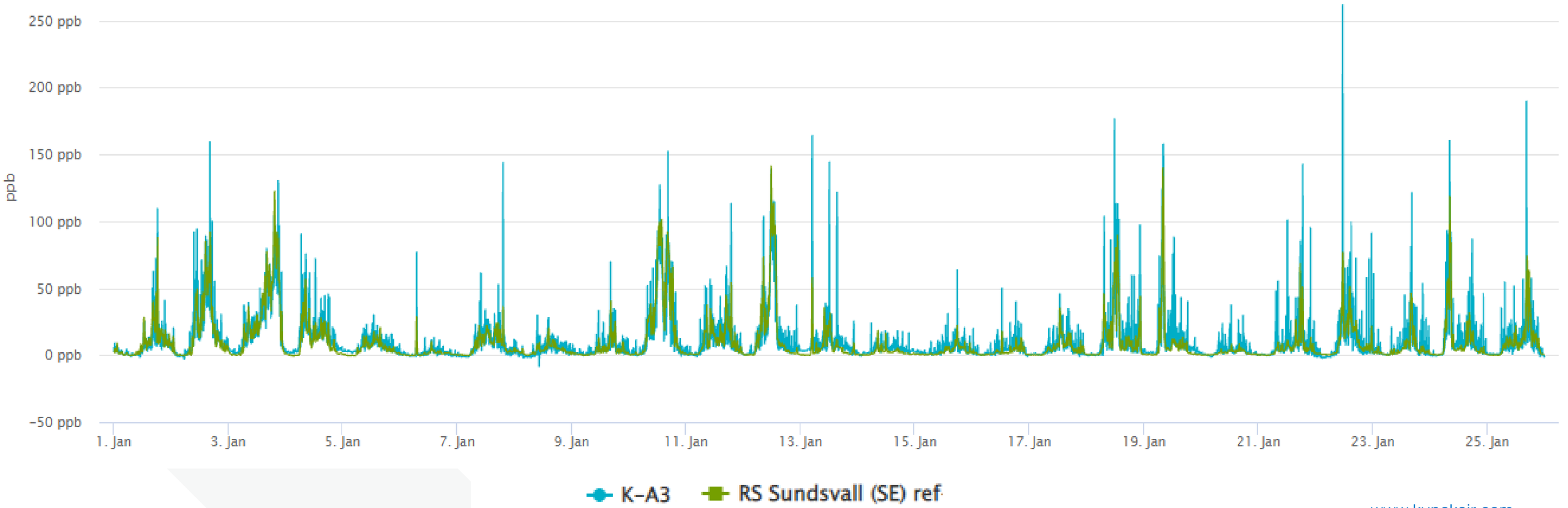
NO2	R2	LR
	0,93	Y= 1*X + 2,1



Extreme cold conditions in Sweden: -18°C / NO

	Min	Avg	Max
T (°C)	-18.8	-2.2	8.5
RH(%)	46.3	80.5	100

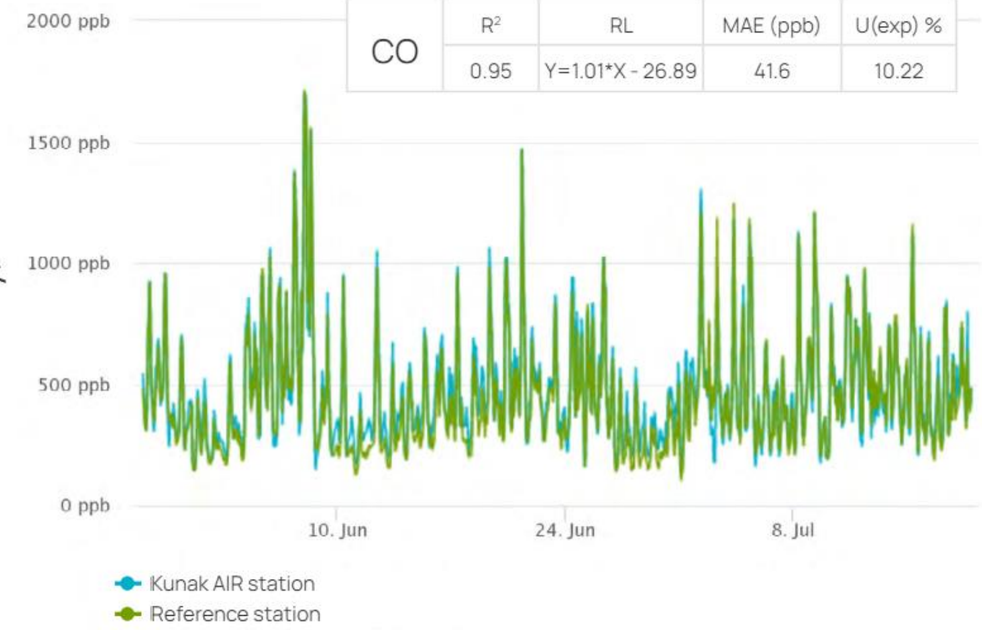
NO	R2	LR
	0,96	Y= 1,1*X - 2



Kunak sensors performance in standard conditions

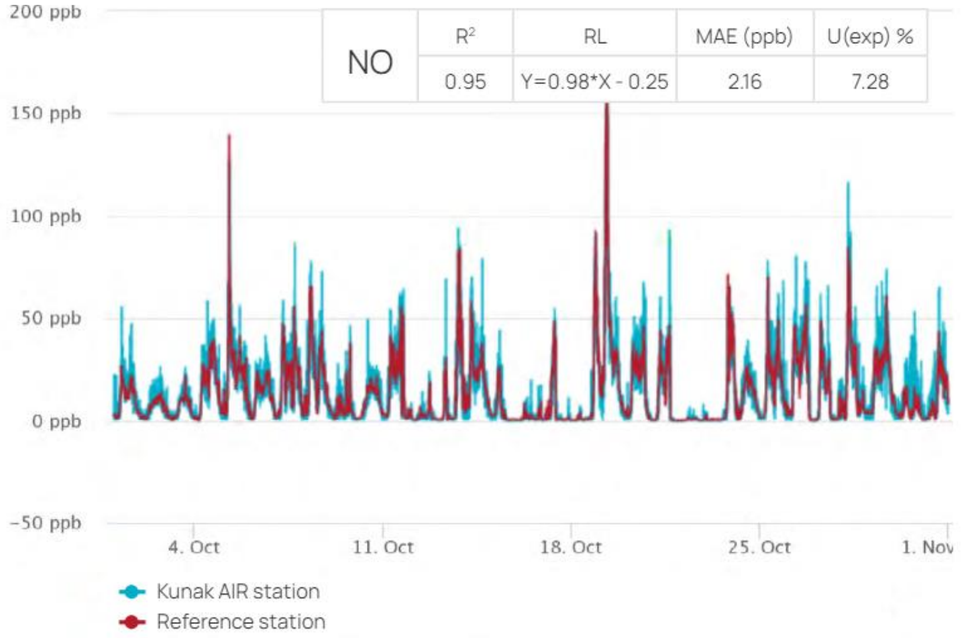
Mexico City, Mexico

CO	R^2	RL	MAE (ppb)	U(exp) %
	0.95	Y=1.01*X - 26.89	41.6	10.22



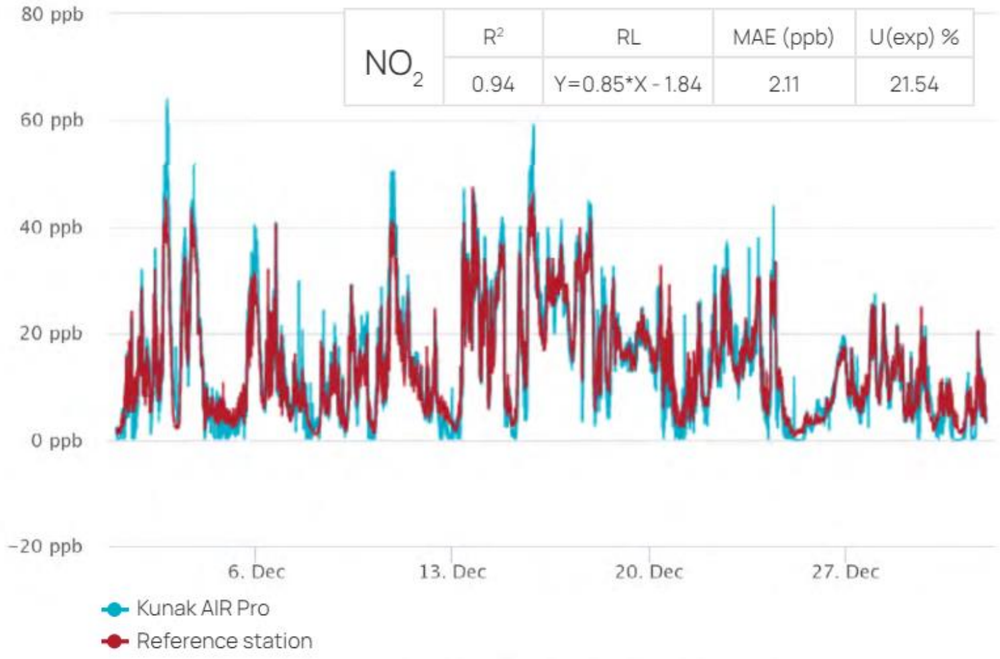
Stockholm, Sweden

NO	R^2	RL	MAE (ppb)	U(exp) %
	0.95	Y=0.98*X - 0.25	2.16	7.28



Manchester, Uk

NO_2	R^2	RL	MAE (ppb)	U(exp) %
	0.94	Y=0.85*X - 1.84	2.11	21.54



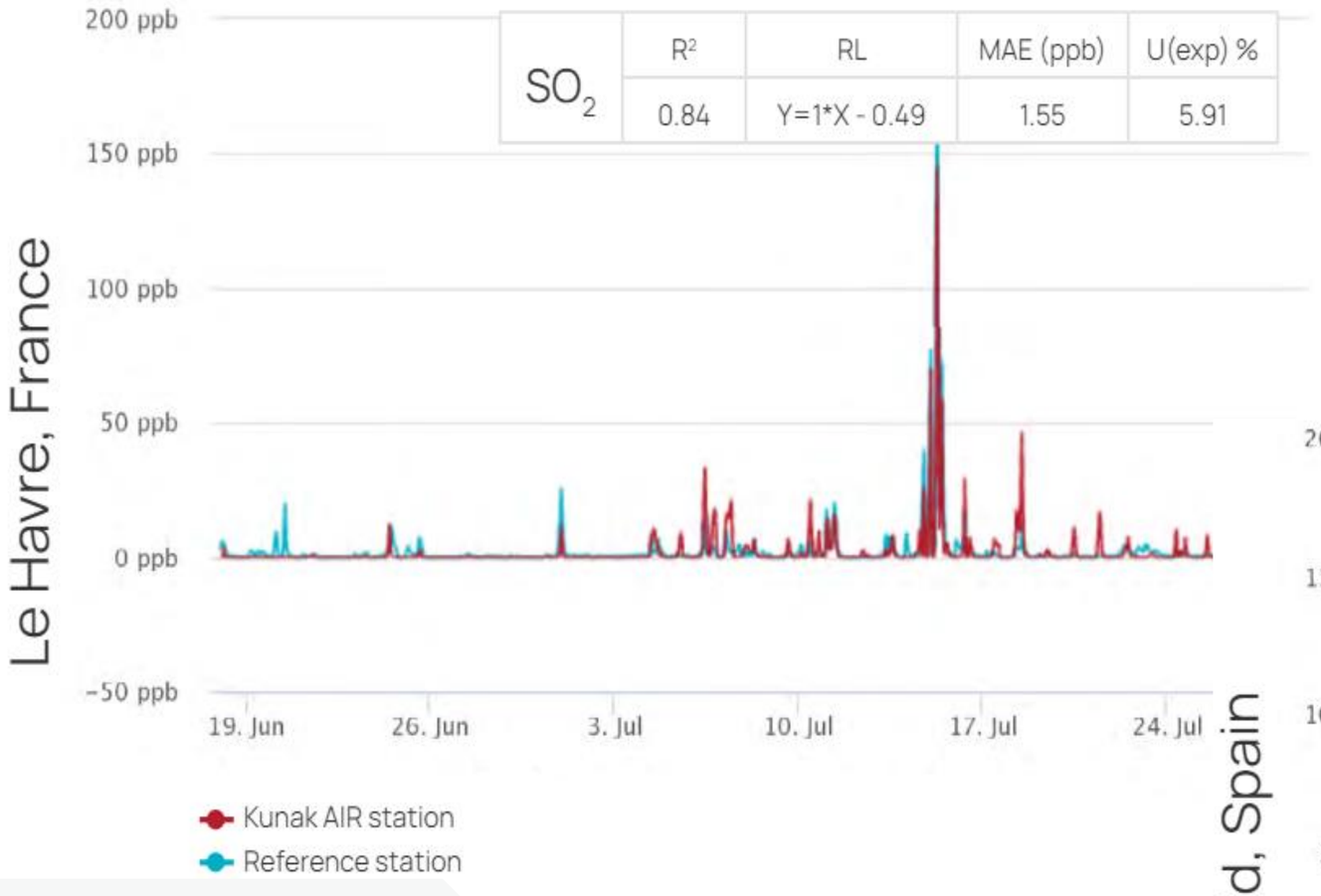
Barcelona, Spain

O_3	R^2	RL	MAE (ppb)	U(exp) %
	0.95	Y=1.02*X - 1.11	1.99	17.42

Kunak sensors performance in standard conditions

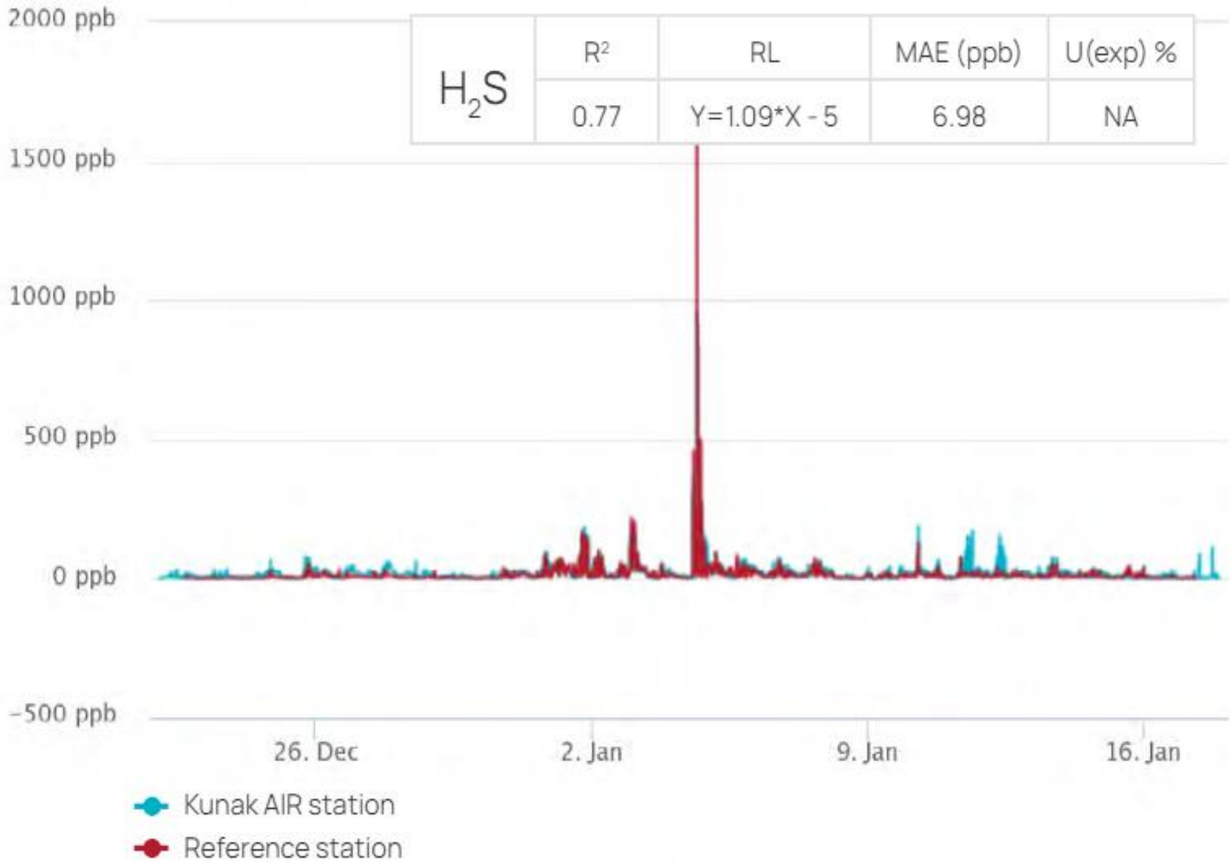
Le Havre, France

SO_2	R^2	RL	MAE (ppb)	U(exp) %
	0.84	Y=1*X - 0.49	1.55	5.91

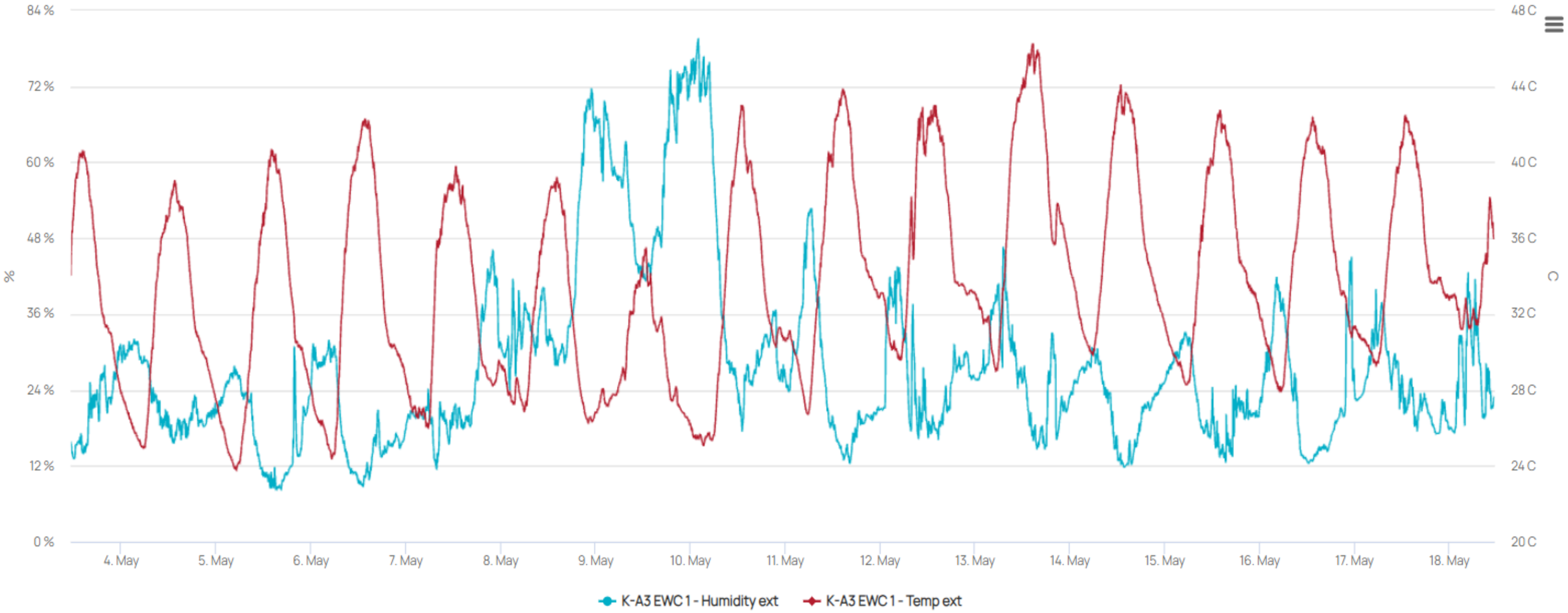


Madrid, Spain

H_2S	R^2	RL	MAE (ppb)	U(exp) %
	0.77	Y=1.09*X - 5	6.98	NA

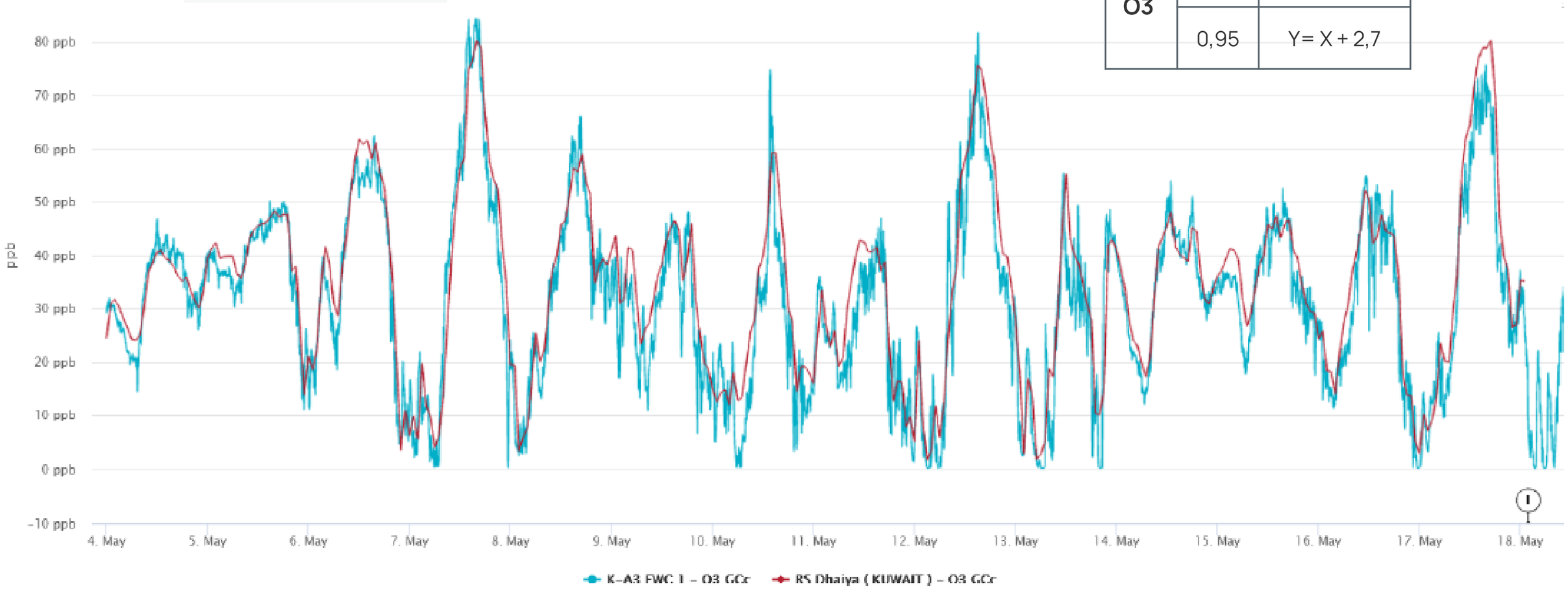


Extreme Hot Conditions in Kuwait: 24° - 47°C, low RH

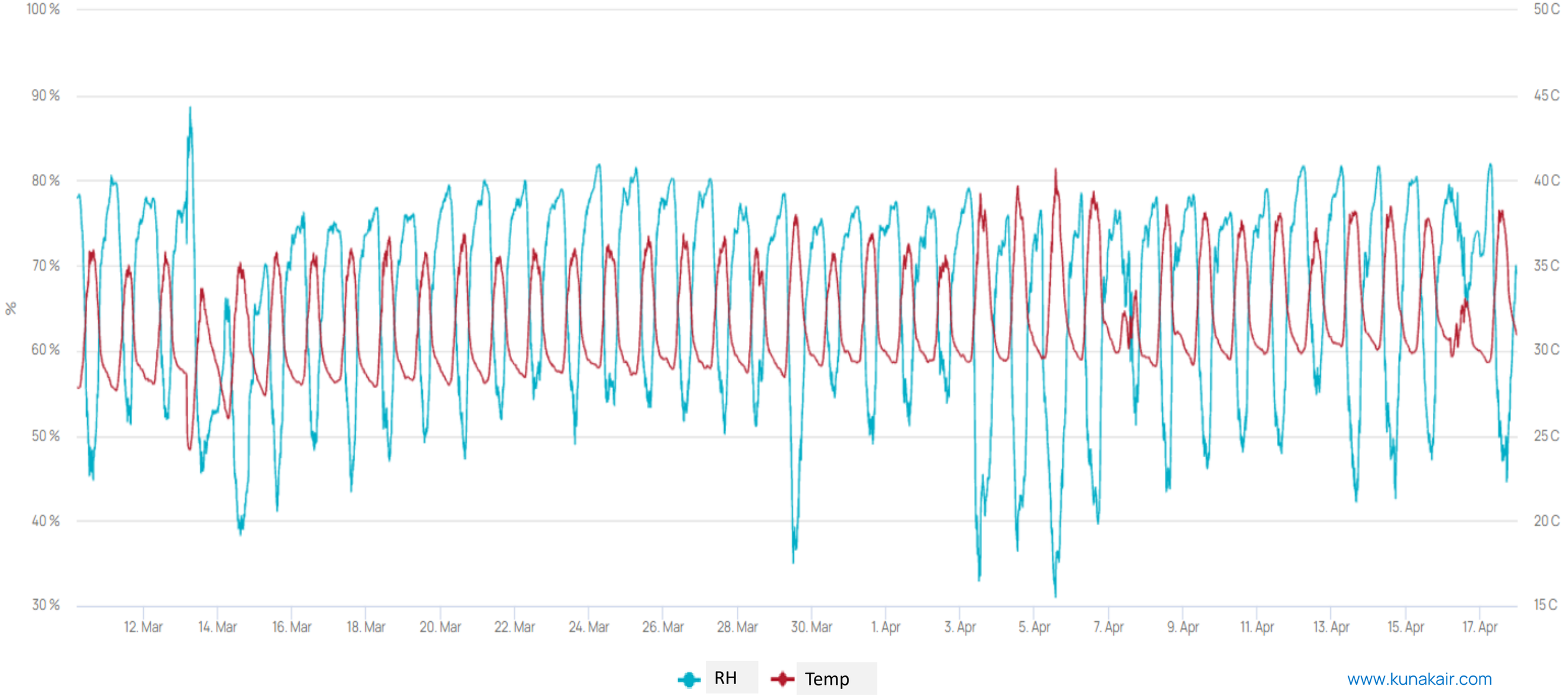


Extreme Hot Conditions in Kuwait: O3

O3	R2	LR
	0,95	Y= X + 2,7



Extreme Hot Conditions in Thailand: 24° - 40°C, High RH



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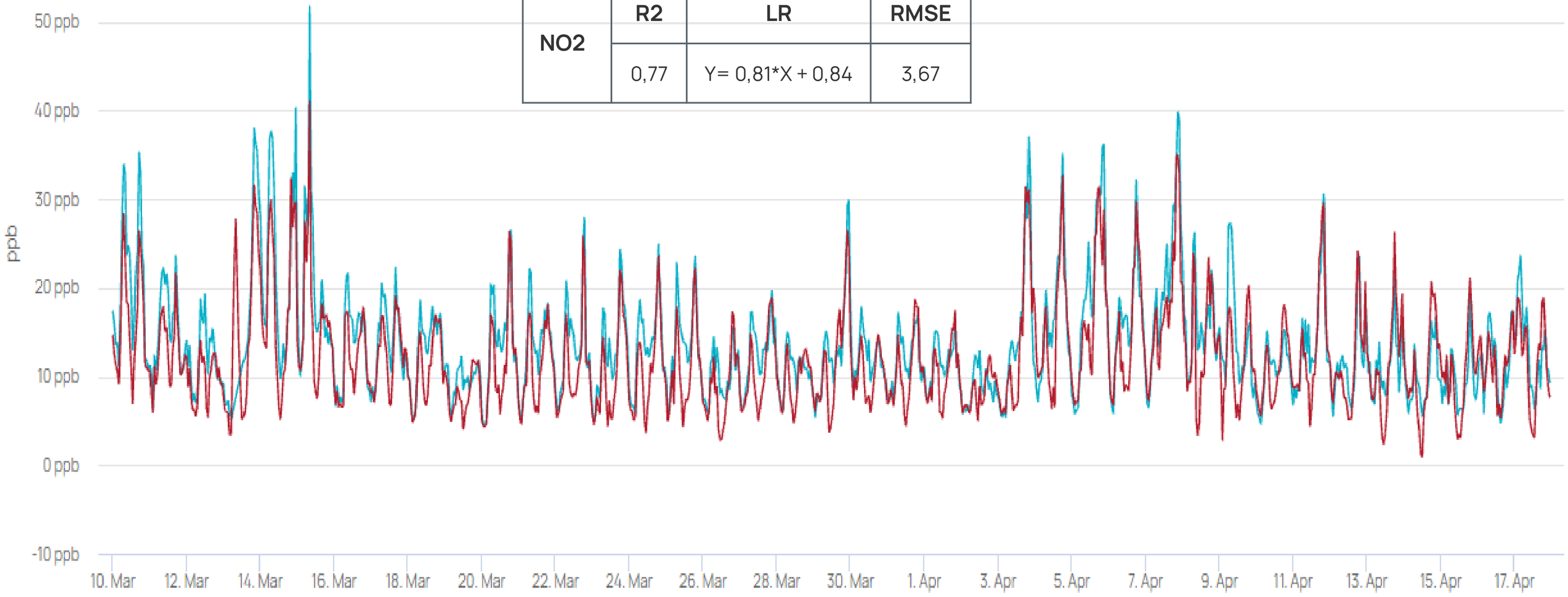
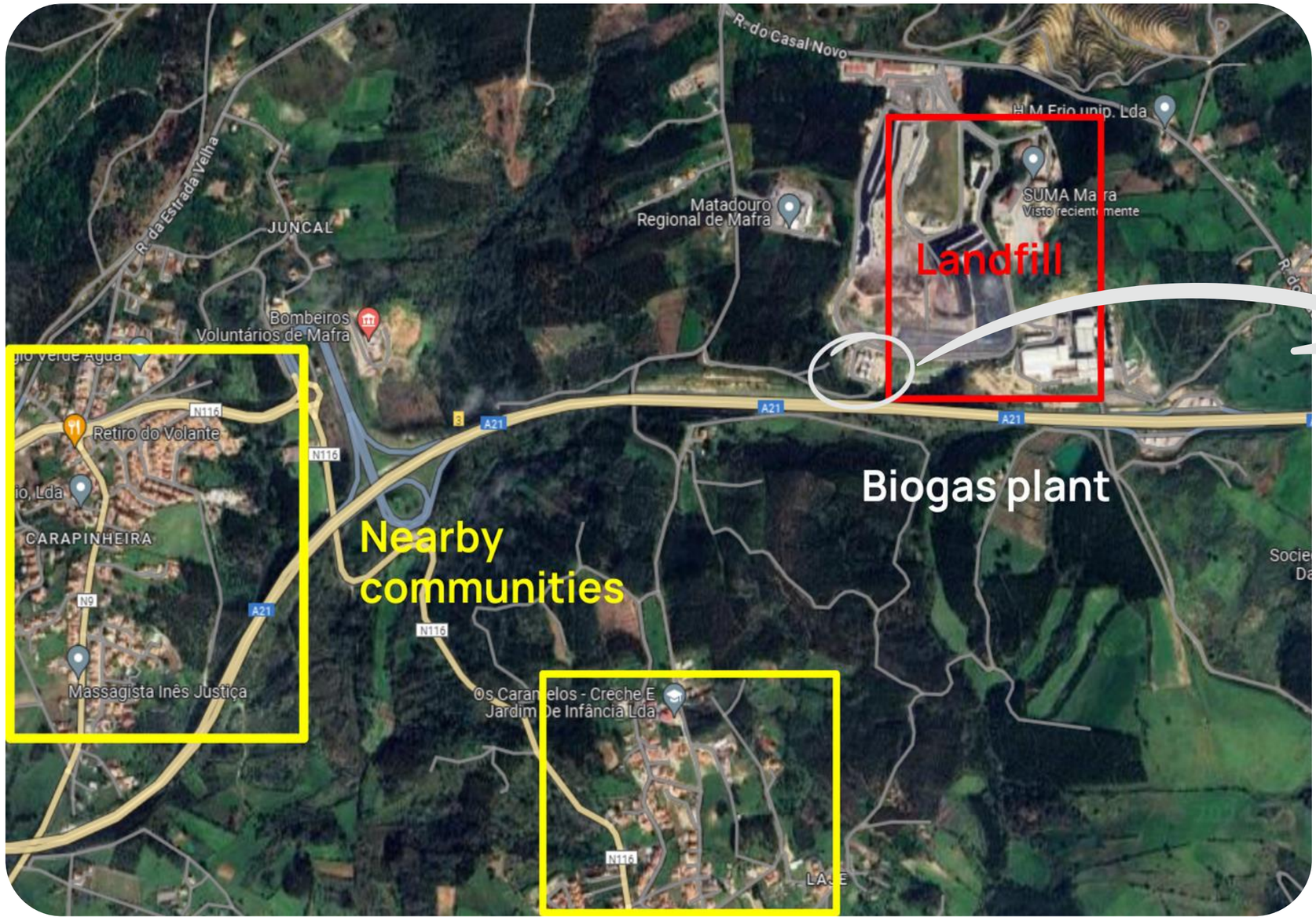
Extreme Hot Conditions in Thailand: NO2

NO2	R2	LR	RMSE
	0,77	Y= 0,81*X + 0,84	3,67

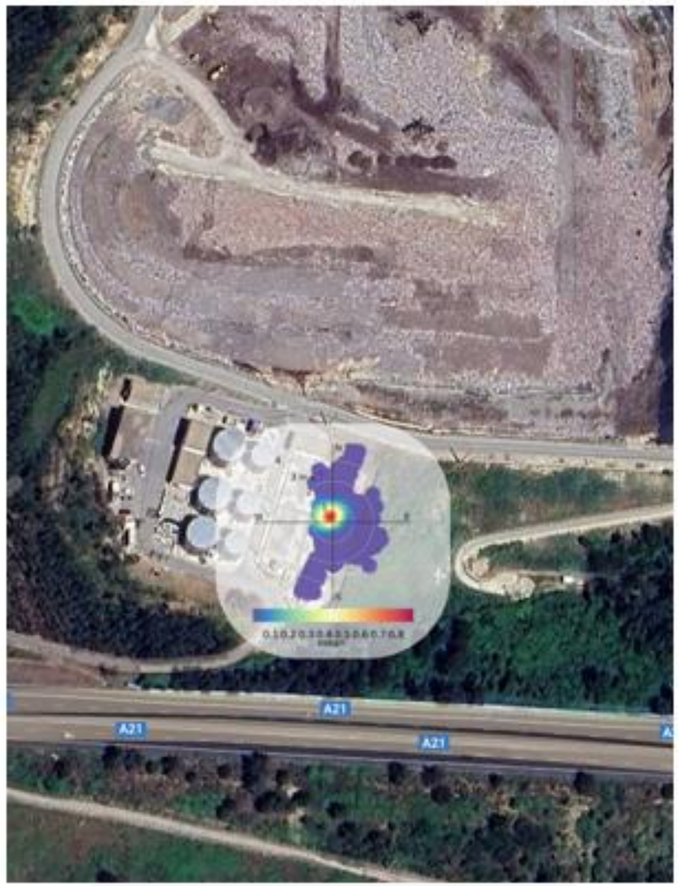


Case study
Community close to a landfill and biogas plant

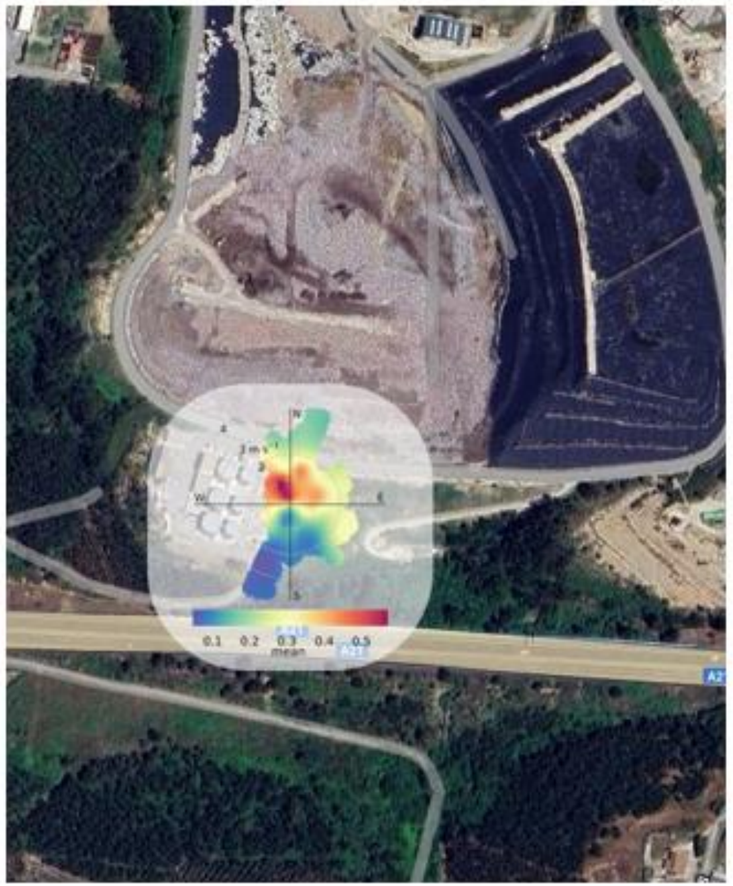


Case study
Where does each emission come from?

CH_4



NH_3

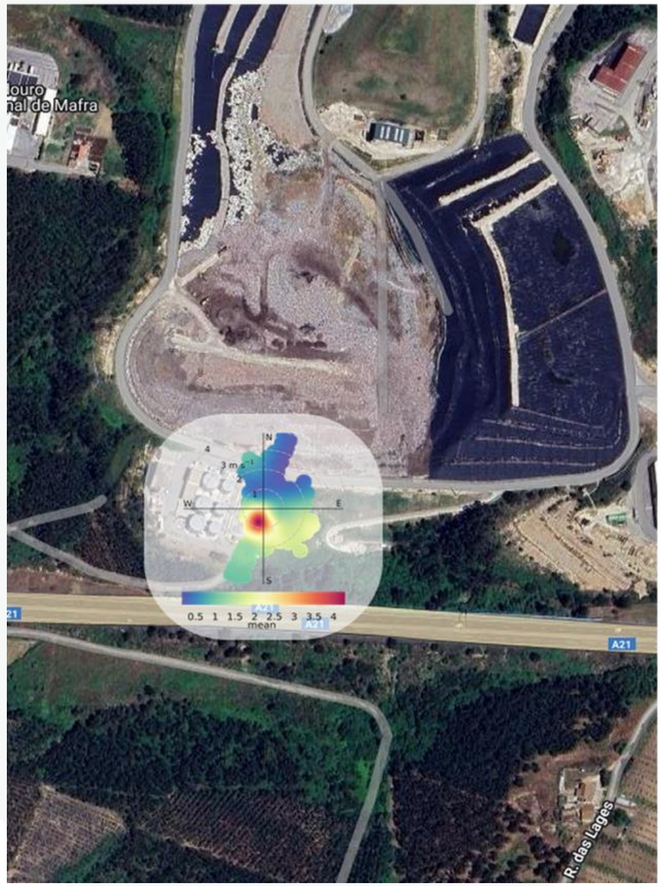


H_2S

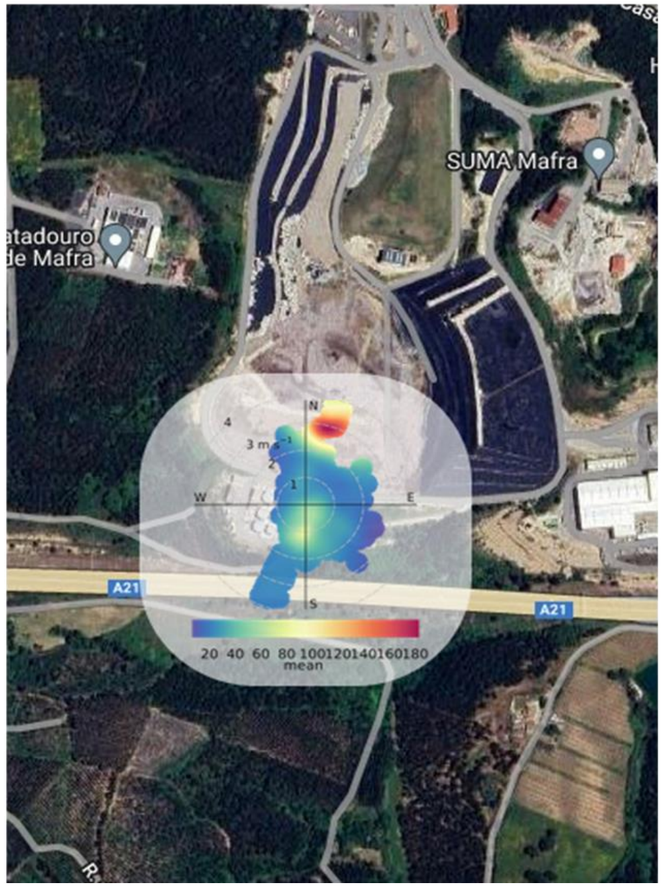
Case study

Where does each emission come from?

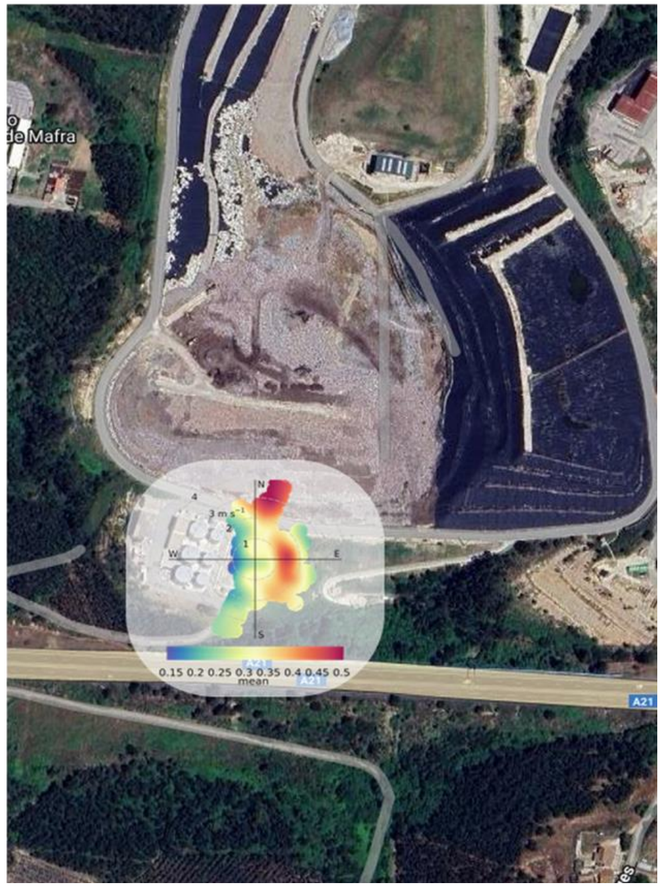
NO_2



PM_{10}



VOCs



Key takeaways

LCS challenges: environmental effects have a great impact on sensor performance.

Conclusions:

- Temperatures below 10ºC are not a major issue.
- Above 20ºC, the higher the temperature the more impact have the environmental conditions on sensor performance
- Optimal characterization and calibration is required to obtain near-reference data complying with EPA Performance Guidelines for LCS in any kind of environment.
- Accurate measurements can be achieved for all the gases and PM, making this technology suitable for many applications in air quality and industrial Monitoring.

Ask for field evaluations in extreme environmental conditions to compare between technologies and manufacturers.

Thank you

Looking for more insights?

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booth: 407

Reach out
jfernandez@kunak.es

Visit
www.kunakair.com

How does Kunak **ensure data quality?**

1. Sensor selection

Old sensors

2 Characterisation

3 Calibration

4 Validation

5 Field deployment

6 Operation and maintenance

7 Cartridge replacement

QC/QA Factory

SOP Field

Kunak calibration certificate