kunak

www.air.kunak.es

Jornada sobre sensores de bajo coste en calidad del aire

Madrid 5-Junio-2018

GOBIERNO DE ESPAÑA

MINISTERIO DE AGRICULTURA, ALIMENTACIÓN Y MEDIO AMBIENTE

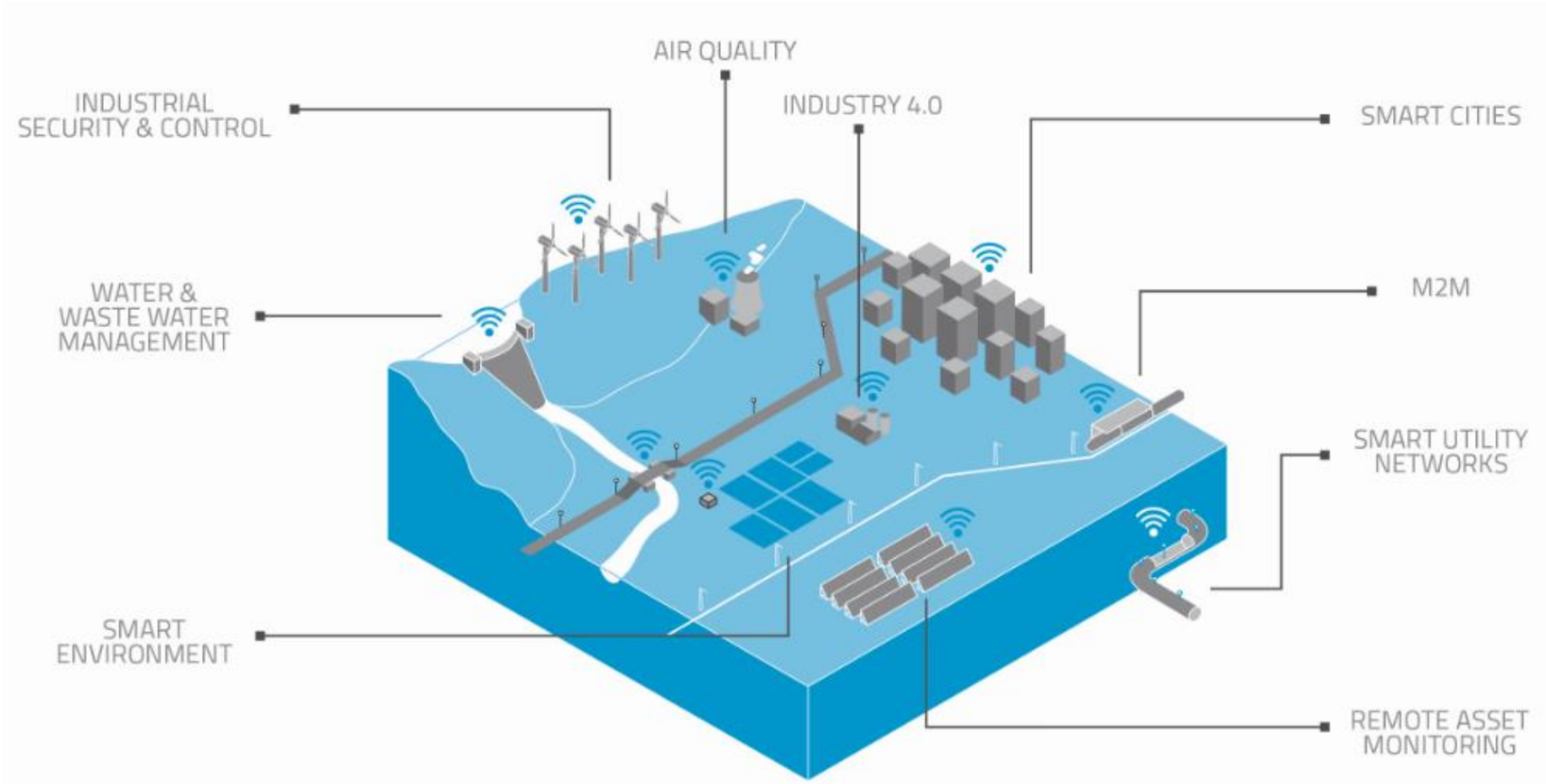
INDICE

kunak®

Sensing Anywhere

Kunak Technologies SL (Navarra)

INFORMACION EN TIEMPO REAL PARA LA TOMA DE DECISIONES

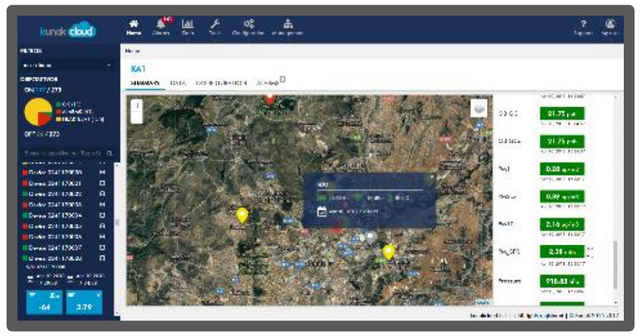


CAPTURA

DISPONIBILIDAD

kunak cloud

DECISIONES



openAPI

INVERSION EN DESARROLLO

Fase 2:
K-SMART ENVIRONMENT

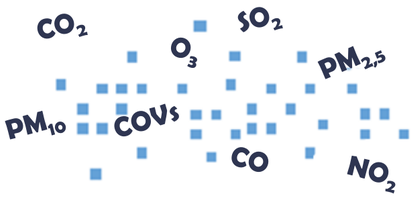
2,2 M €

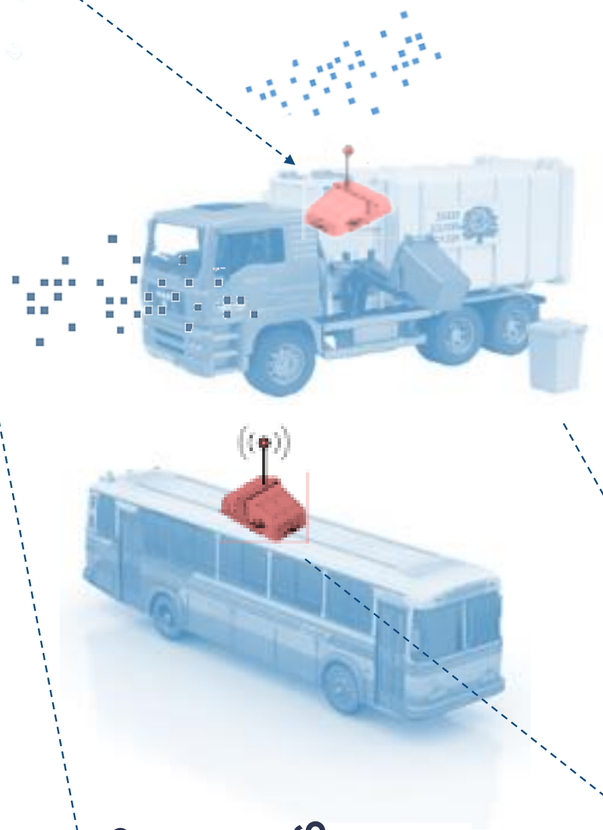
2 AÑOS

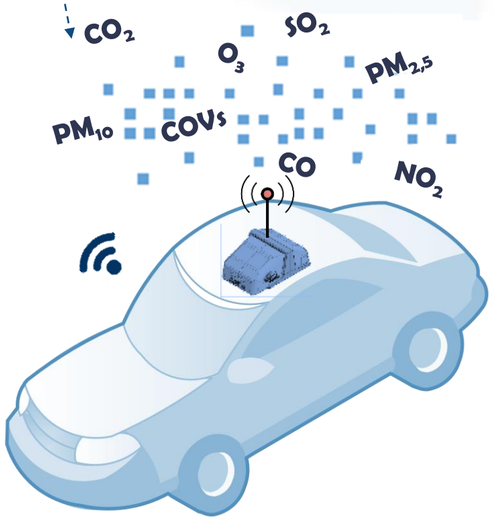
Antecedentes

Calidad del Aire & “Smart City”

GPRS 3G/4G
WIFI



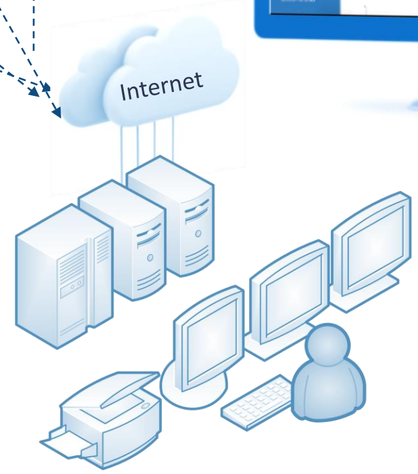




kunak cloud

Smart City Platform

Management tool



red.es

Comisión Europea

Kunak SMART ENVIRONMENT

Producto y sistemas integrados

Low Cost?

TRANSPORTE

DESCANSO

ENERGIA

Low Cost debe ofrecer un ***producto básico,*** *funcional, sin extras…*

Pero de ***similar calidad*** *que el producto tradicional equivalente…*

SENSORES EQ

DATOS BASICOS

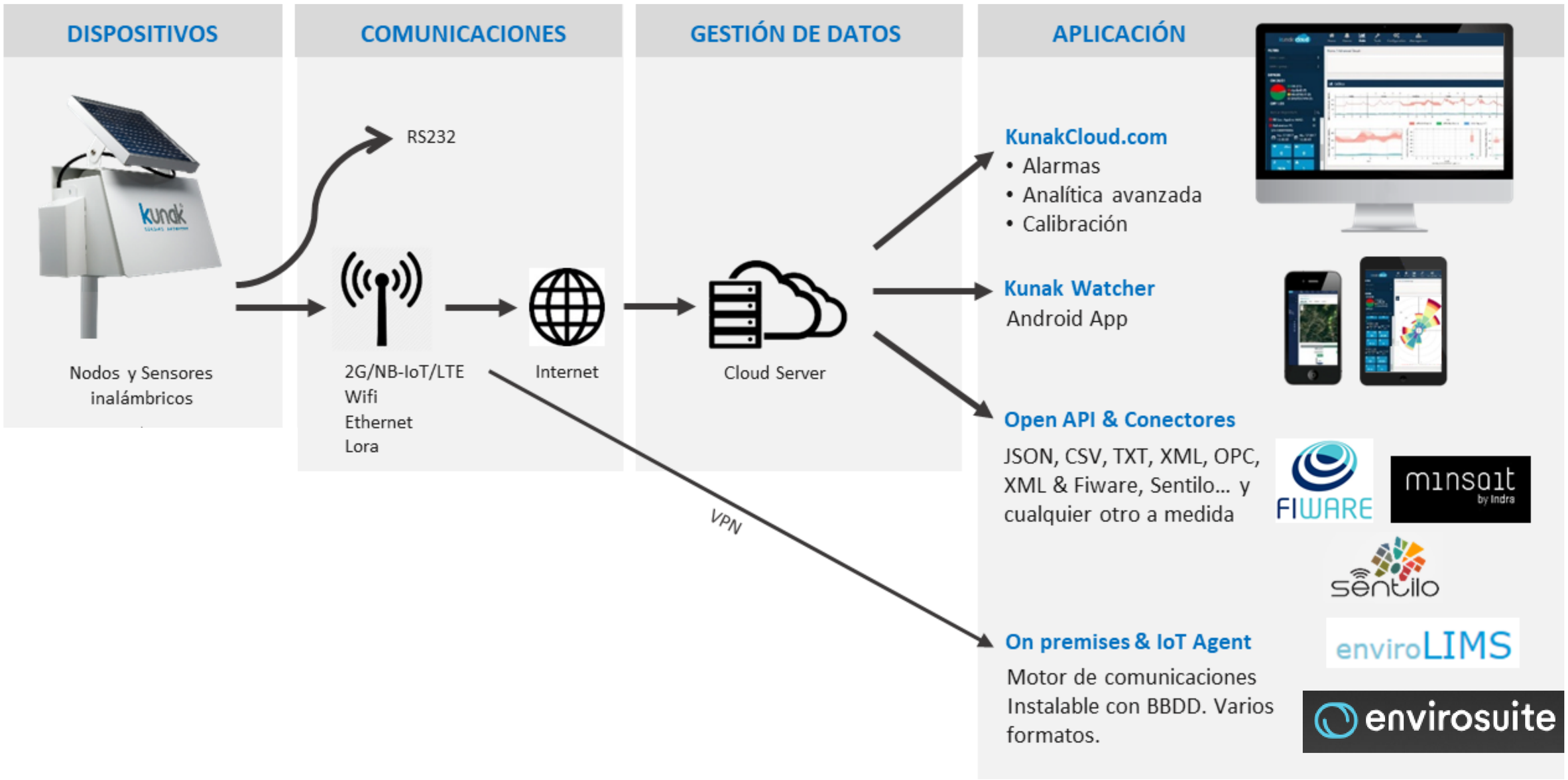
ESTACIONES KUNAK

GESTION MEDIOAMBIENTAL AVANZADA

“ Consideramos que un Sistema de un único sensor es LOW COST si el precio es la mitad o menos que el del equipo de referencia…”
(WMO, 2018)

Arquitectura del Sistema Kunak

Una decision estrategica



Estación Fija Kunak AIR

RUGGED IP67

Can be installed outdoors
On/Off Button and LED Indicator
Includes Wall & mast brackets

Solar panel & Li battery

Optional SOLAR PANEL
Low power consumption 0,35 to 1,8 W

GSM and WiFi capability

OTA (remote firmwarer update)
USB & Bluetooth
RS-485 & RS-232

CONFIGURABLE

PM sensor and up to 6 gas sensors
Other sensors: GPS – NOISE – TEMP – RH – SIGNAL - BATTERY
REMOTE CALIBRATION TOOL (Intelligent algorithms that compensate for aging and environmental conditions)

WEIGHTLESS < 1,5 Kg

Mobile an Easy to deploy

METEO

Can integrate Weather sensors
Wind, rain, solar radiation…

CO, NO, O3, NO2, NOx, SO2, H2S ppb

PM1, PM2.5, PM10 ug

KUNAK ENVIRONMENT® | Technical specifications

TECHNICAL SPECIFICATIONS

Dimensions / Weight	122 x 202 x H: 90 mm / < 1,5Kg
Enclosure	PC IP67 & Metal Panel (optional)
Power consumption	< 10 mA @ 3.7 Vdc.
Battery	8,1 Ah rechargeable (always incl.)
External Supply	5 – 17 Vdc. Charger, Solar panel, etc
Communications	GPRS, Wifi, RS232
Operating Temp.	-20ºC to +50ºC
Built-in Sensors	Internal temperature, battery and signal level, solar panel charge.
GNSS	GPS/Glonass (optional)
Measurement	Continuous sampling (3Hz) *

* Adjustable Data aggregation and sending periods, 10s - 4h. (1h by default).

GAS MEASUREMENT

Gas	Range (1)	Real range (2)	LDL (3)	Precision (4)	Units	Life (months)
NO2	0–20 ppm	0 - 5 ppm	5 ppb	± 8 ppb	ppb or µg/m³	> 24 m
NO	0–20 ppm	0 - 5 ppm	5 ppb	± 5 ppb	ppb or µg/m³	> 24 m
CO	0–200 ppm	0-10 ppm	20 ppb	± 50 ppb	ppb or µg/m³	> 36 m
SO2	0–100 ppm	0-10 ppm	5 ppb	± 20 ppb	ppb or µg/m³	> 36 m
H2S	0–100 ppm	0 - 2 ppm	5 ppb	± 20 ppb	ppb or µg/m³	> 24 m
O3	0–20 ppm	0 - 2 ppm	5 ppb	± 7 ppb	ppb or µg/m³	> 24 m

Temperature	-40 to 125°C
Humidity and Pressure	0 to 100 %RH – 500 to 1500 mb

(1) Limit covered by guarantee (2) Maximum reading (3) Minimum value detected.
(4) Average accuracy of experimental data in field. Without interference

PARTICLE COUNTER

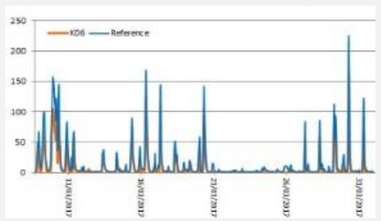
Channels	EN 481 (PM1, PM2.5 and PM10) in µg/m3
Particle Size range	From 0.38 to 17 µm (spherical equivalent size)
Total flow rate	1.2 L/min
Certifications	IEC 60825-1 2014. Class 1 Laser Product

SONOMETER

Parameter	Laeq.
Range	35 – 130 dB
Resolution	0,1 dB
Accuracy	+/- 1db
Frequency range	20 – 12.500 Hz

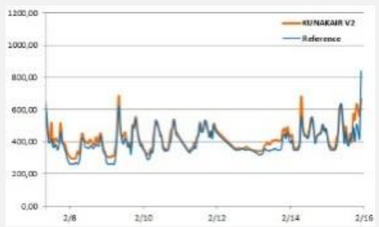
TESTS & ESSAYS

NO $R^2 > 0,96$



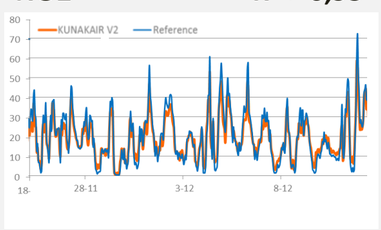
Kunak AIR
Ref. Teledyne 200E
Time

CO $R^2 > 0,83$



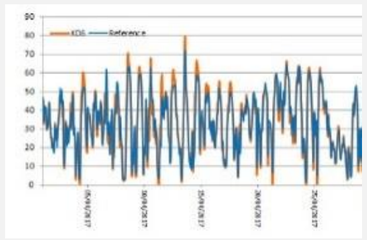
Kunak AIR
Ref. Teledyne 300E
Time

NO2 $R^2 > 0,95$



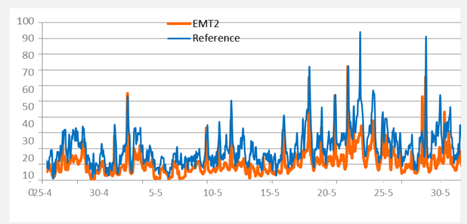
Kunak AIR
Ref. Teledyne 200E
Time

O3 $R^2 > 0,95$



Kunak AIR
Ref. Teledyne 400E
Time

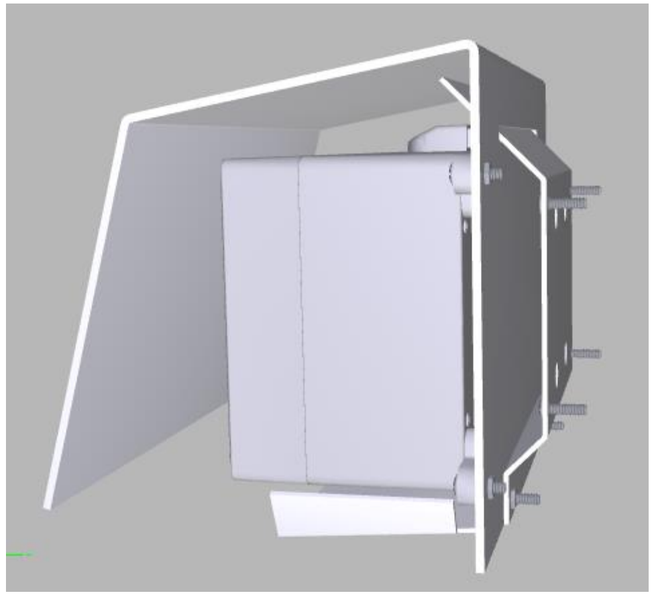
PM10 $R^2 > 0,68$



Precision < ±9,2 µg/m3
Kunak AIR
EMT2 Madrid
Time

FIXED INSTALLATION

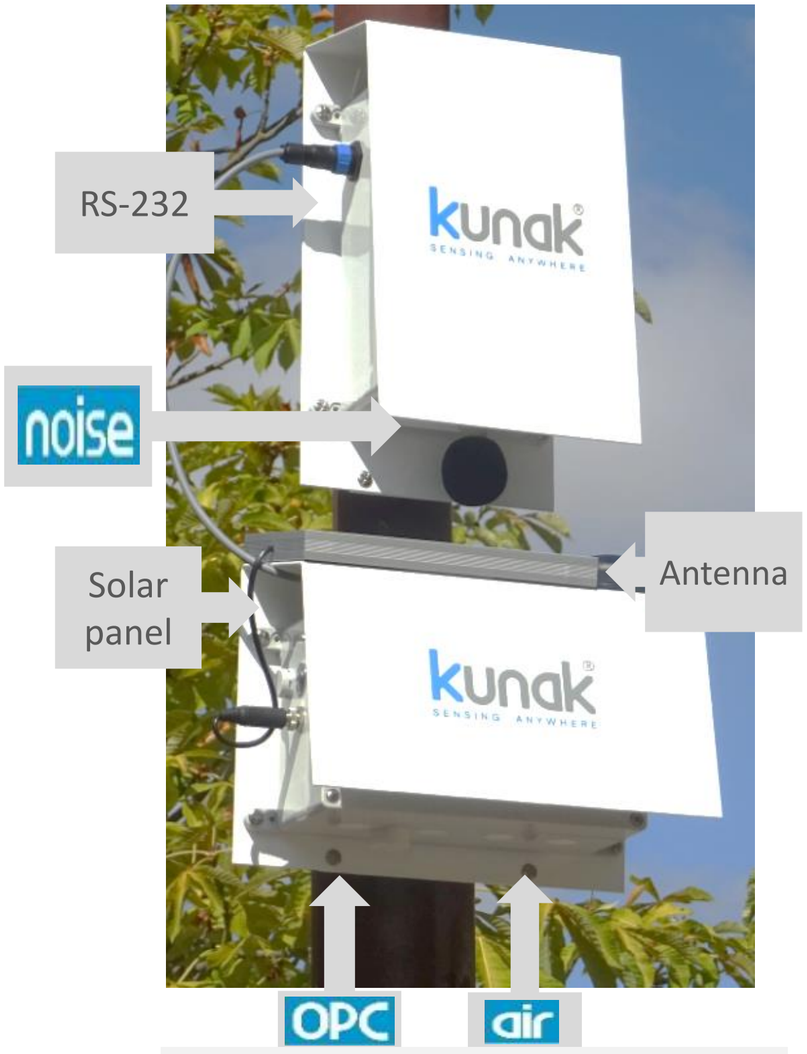
On/Off Button and LED Indicator
2.5mm Power Supply Interface



Easy and secure mounting brackets
For wall and mast

Protection from solar radiation,
both up and below sensors.

Exterior antenna for bad signal areas
Solar panel available



Example of full Kit:

- 1 x AIR, with 4 gases
- 1 x OPC
- 1 x Sonometer.
- 1 x RS-232 cable
- 1 x Solar panel
- 2 x Solar Shields
- 1 x Exterior antenna

EXTERNAL POWER WITH SOLAR PANEL

OPTION A: CONTINOUS MODE: 25W SOLAR PANEL + BIG CAPACITY BATTERY

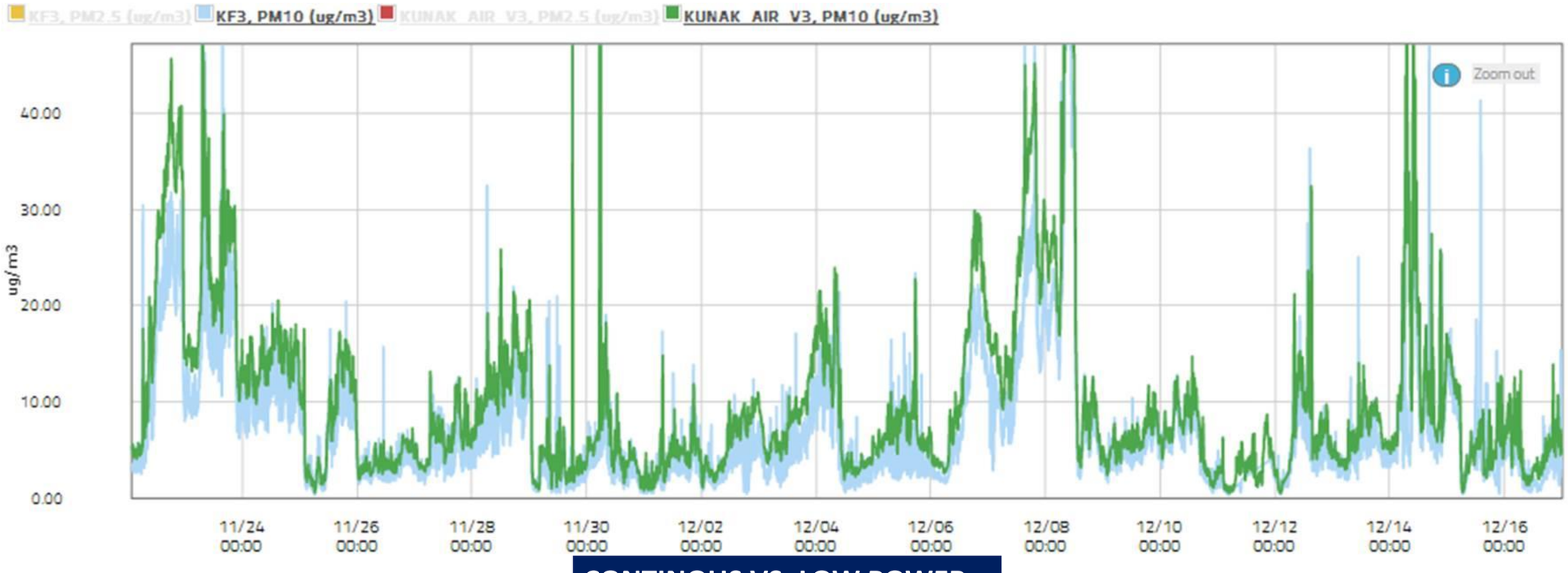
For a continous measurement:

- 25W solar panel with post and wall brackets
- Metal enclosure for battery and regulator, with brackets
- Big capacity battery
- Regulator
- All mounted and cables ready for installing

OPTION B: LOW POWER MODE: 10W SOLAR PANEL + MEDIUM CAPACITY BATTERY

For a 1 minute measurement every 10 minutes:

- 10W solar panel fixed to Kunak shield
- Plastic enclosure
- Medium capacity battery, 42Ah
- All mounted and cables ready for installing



CONTINOUS VS. LOW POWER

Software

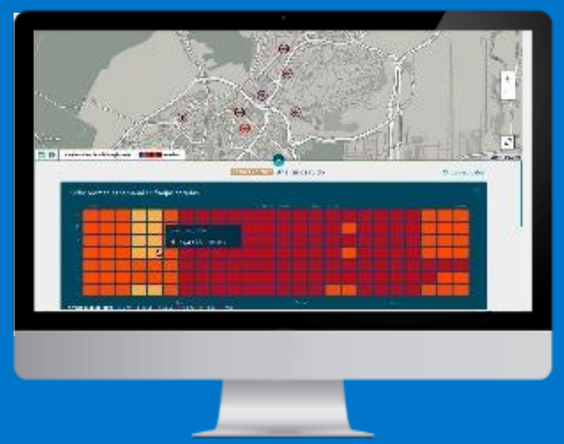
Principales funciones:

- Configurar periodos de lectura y envío, umbrales, alarmas.
- Gestionar perfiles de usuario.
- Geoposicionar equipos y calibrarlos de forma remota.
- Generar gráficas multiparamétricas.
- Integrar la información en cualquier Web o plataforma Smart City.

kunak cloud

KUNAK AIR CLOUD
Software Calidad de Aire y Ruido
www.kunakcloud.com

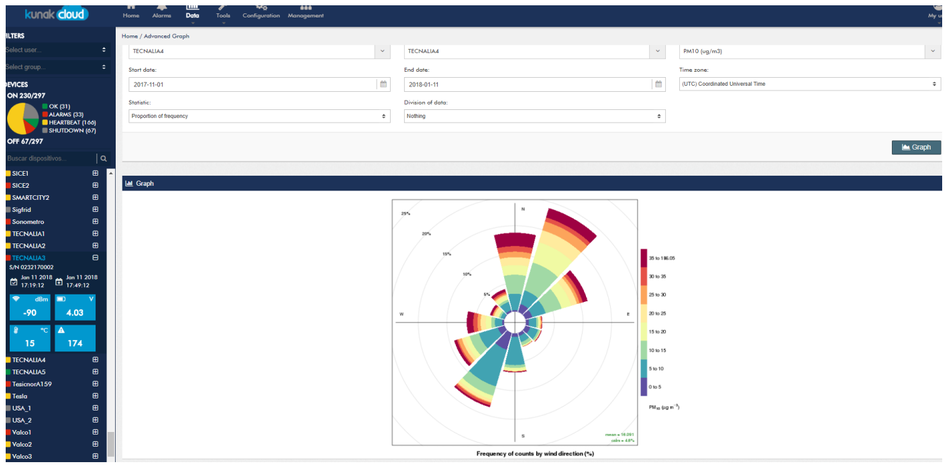
KUNAK WATCHER
App móvil para Android



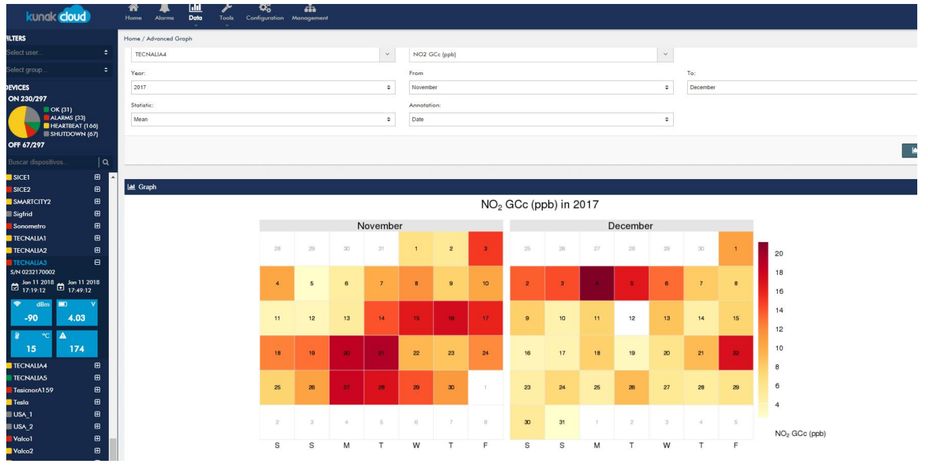
KUNAK OPEN API
Integración en plataformas Smart City

Openair Embebido

Pollution Rose

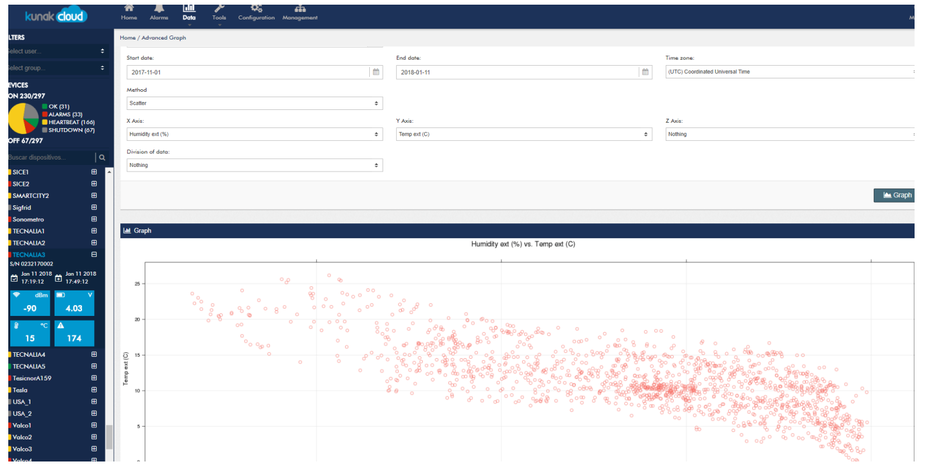


Calendar Plot

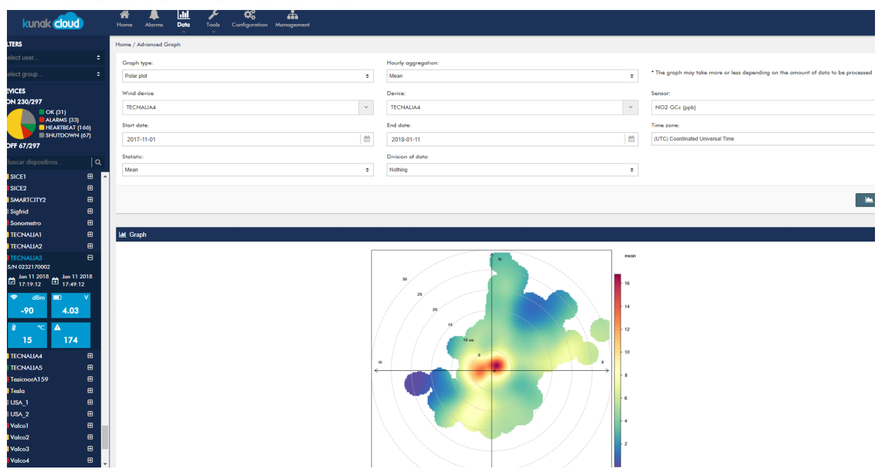


Time Variation

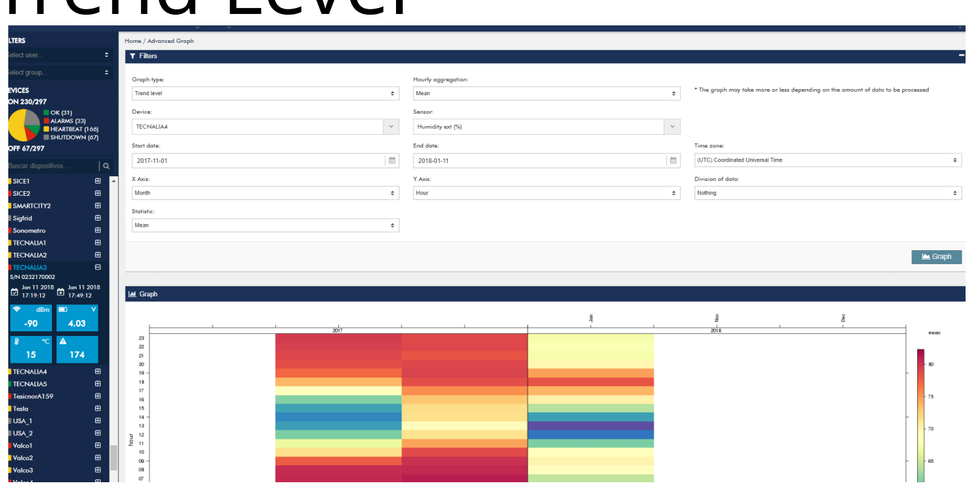
Scatter Plot



Polar Plot



Trend Level



Ensayos y tests

METODOLOGIA

Procedimiento de Tests

- **Installation:** On top of the AQS (3-4 meters)
- **Stabilization time before calibration:** 2 days
- **Calibration procedure:** Zero and Span calibration compared to a Reference using KUNAK Calibration Tool. First 4 days.
- **Post-processing:** None. Real corrected data is calculated directly in the device without any delay. No re-calibrations or corrections are applied during the field tests unless specified. Then, the initial calibration is maintained during the whole field tests.
- **Sampling period:** data is averaged every hour to match data from reference station.
- **100%** of KUNAKAIR data is used for analysis, therefore, any possible outlier is included in the statistics.
- **Validation:** statistics are only calculated if valid Reference Data is available.

KUNAKAIR
K-A10 4GAS + P10
- **O3, NO, NO2, NOx, CO**
- **PM1, PM2.5, PM10**
- **Temp, Humidity**

Reference Station

Análisis y Caracterización de los Resultados

- **Accuracy**: is obtained as the mean absolute error (MAE) between KUNAKAIR measurements and the reference instruments.
- **90% Confidence Interval:** the 90% of the measurements are below this error.
- **Relative Expanded Uncertainty:** $U(y) = 2 * \left(\frac{\sqrt{\frac{RSS}{n-2}}}{u(y)}\right)$
- **Data Quality Objective (DQO)=** concentration value from which DQO is met.
- **Availability:** is defined as the number of 1 hour averaged samples sent by the device **/** number of hours in the month.
- Results also include the average temperature and humidity as well as the average reference concentration and the average measured concentration during the whole tests.
- **Temporal plots, Scatter plots and Time variation of the Mean** are used to analyze the test results.

Objetivo de los Tests

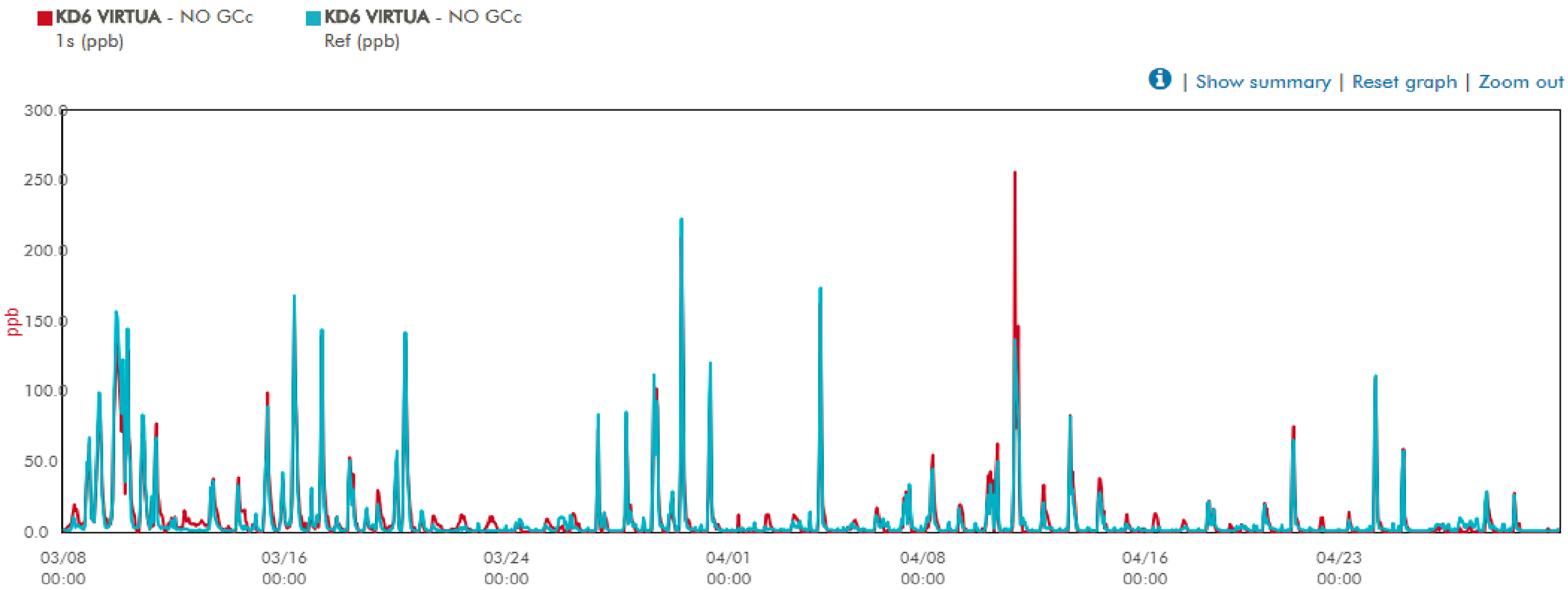
- **Típico comportamiento en campo con un buen mantenimiento y condiciones atmosféricas suaves Barcelona (Mar-Abr'17**). Mismos resultados en otras ubicaciones.
- **Estudio detallado en campo con prestaciones medias esperadas. Sevilla (Dec'17-Mar'18)**
- **Partículas: Madrid y Barcelona.** PM10, PM2.5, PM1.
- **Evolución a largo plazo. Pamplona (Oct'17-May'18)**: Comportamiendo del equipo durante tests a largo plazo de 8 meses de duración con sensores usados. Evaluación del envejecimiento.
- **Variabilidad entre dispositivos. Pamplona (Oct'17-Nov'17):** Analizar el comportamiendo de dos equipos diferentes en la misma ubicación para ver la variabilidad entre ellos y explorar la potencialidad de medidas relativas con estos equipos.
- **Prestaciones a altas temperaturas:** resultados ante condiciones extremas de temperature. **Madrid (Agosto'17)**

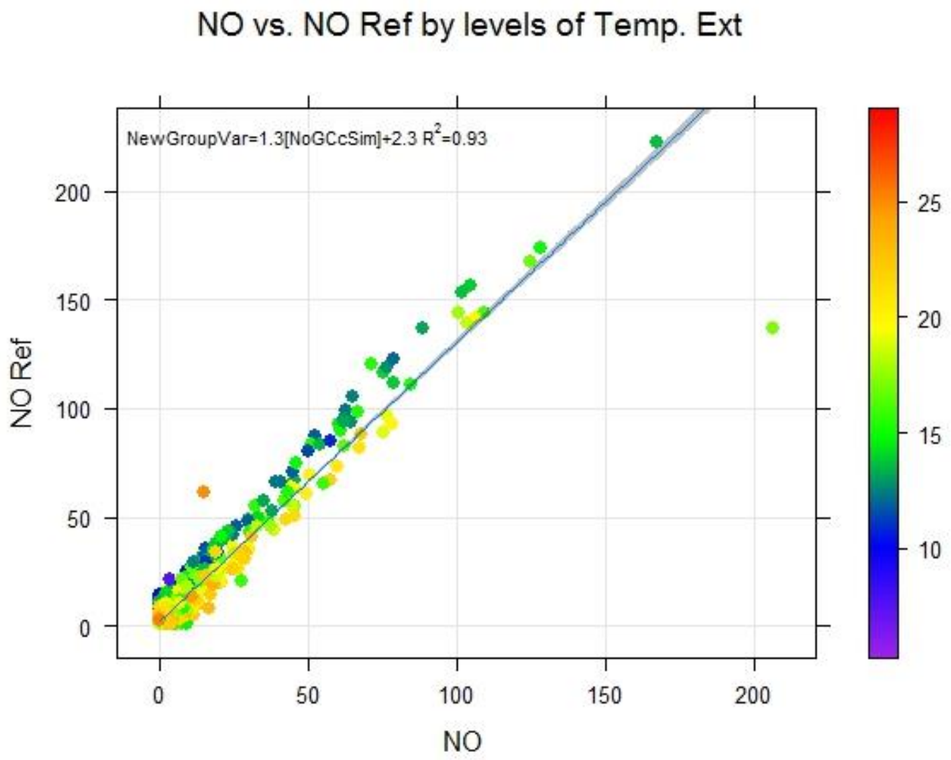
Prestaciones Típicas

Barcelona

MAR-ABR’17

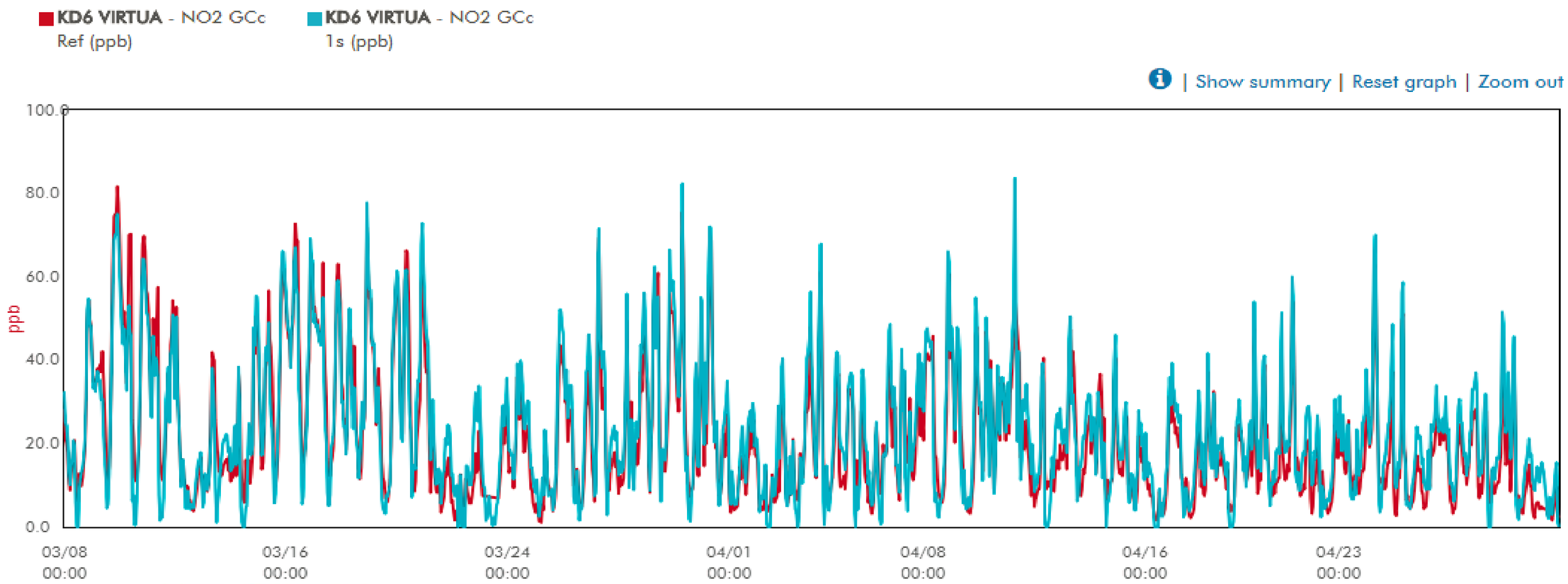
Nitrogen Oxide (NO) MAR-ABR-17

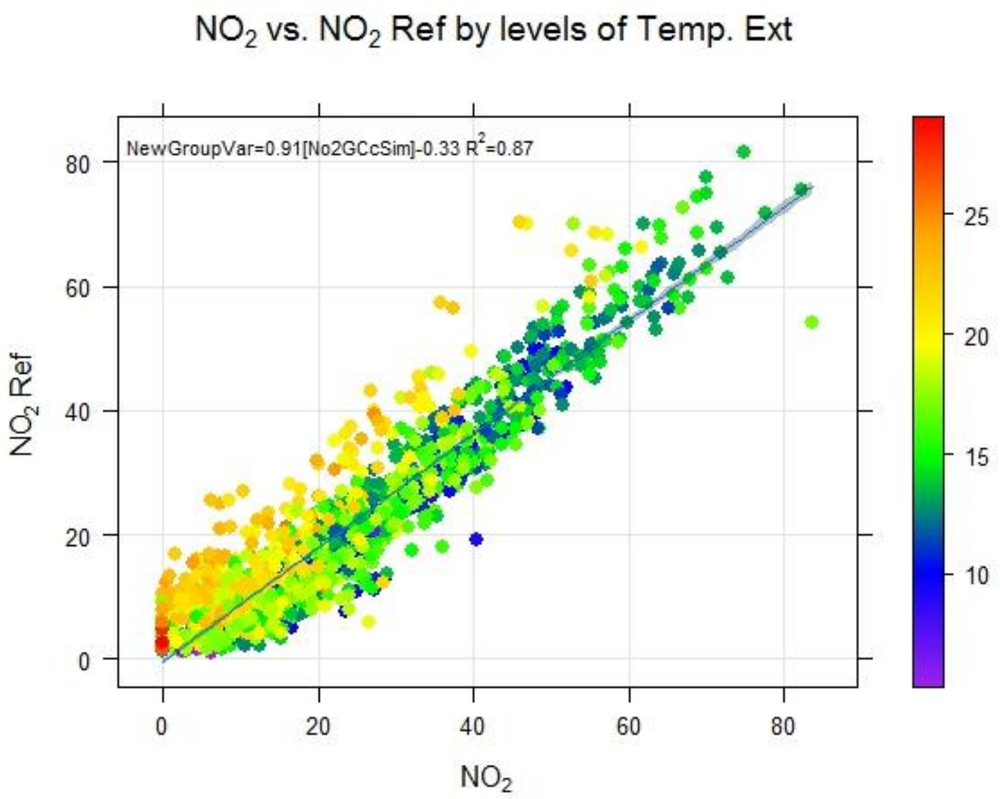




- R^2=0.93
- Accuracy: 4 ppb

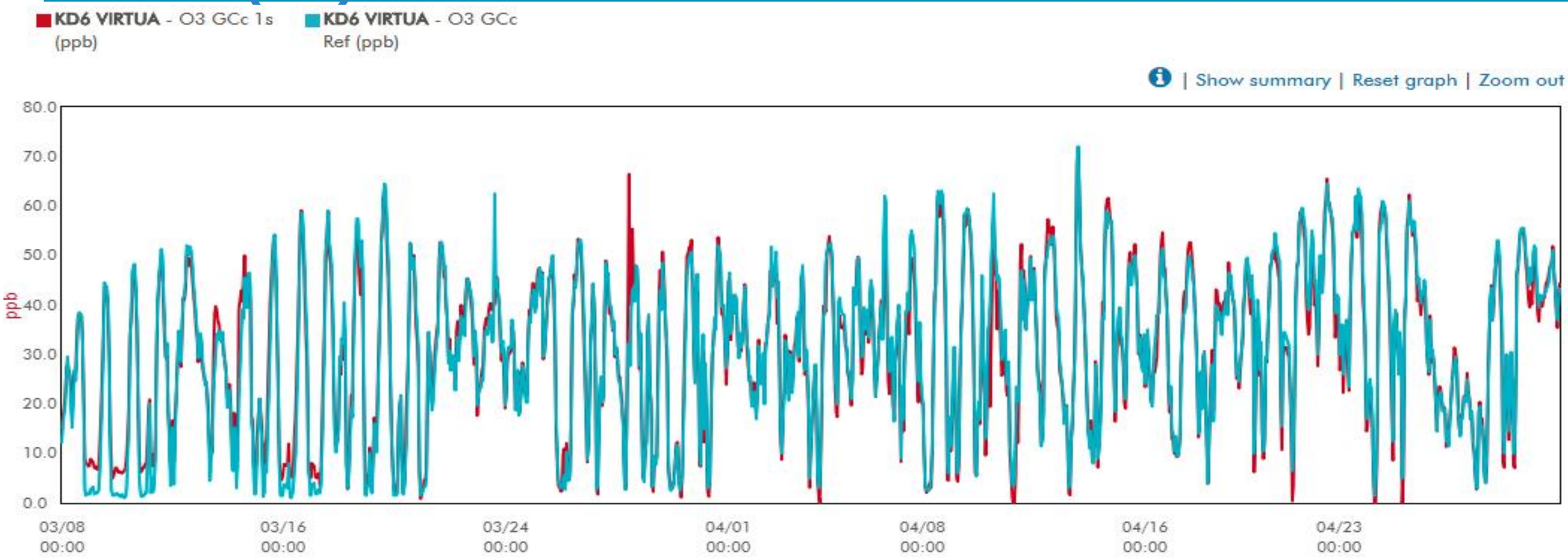
Nitrogen Dioxide (NO2) MAR-ABR-17

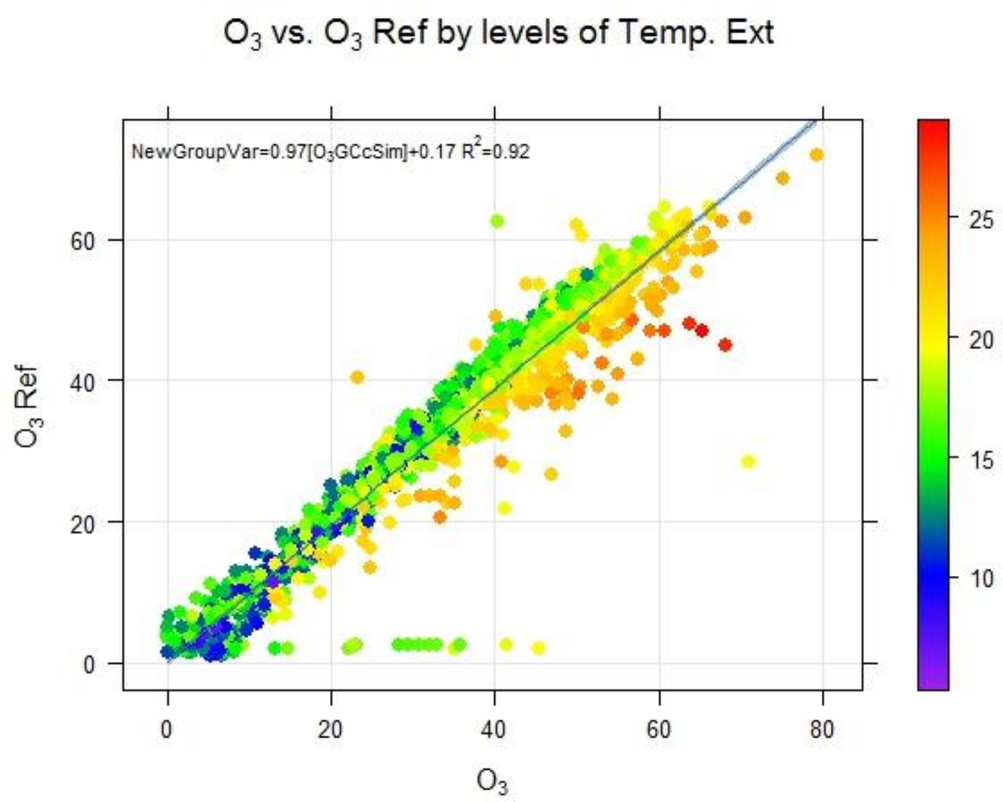




- R^2=0.87
- Accuracy: **4.7 ppb**

Ozone (O3) MAR-ABR-17



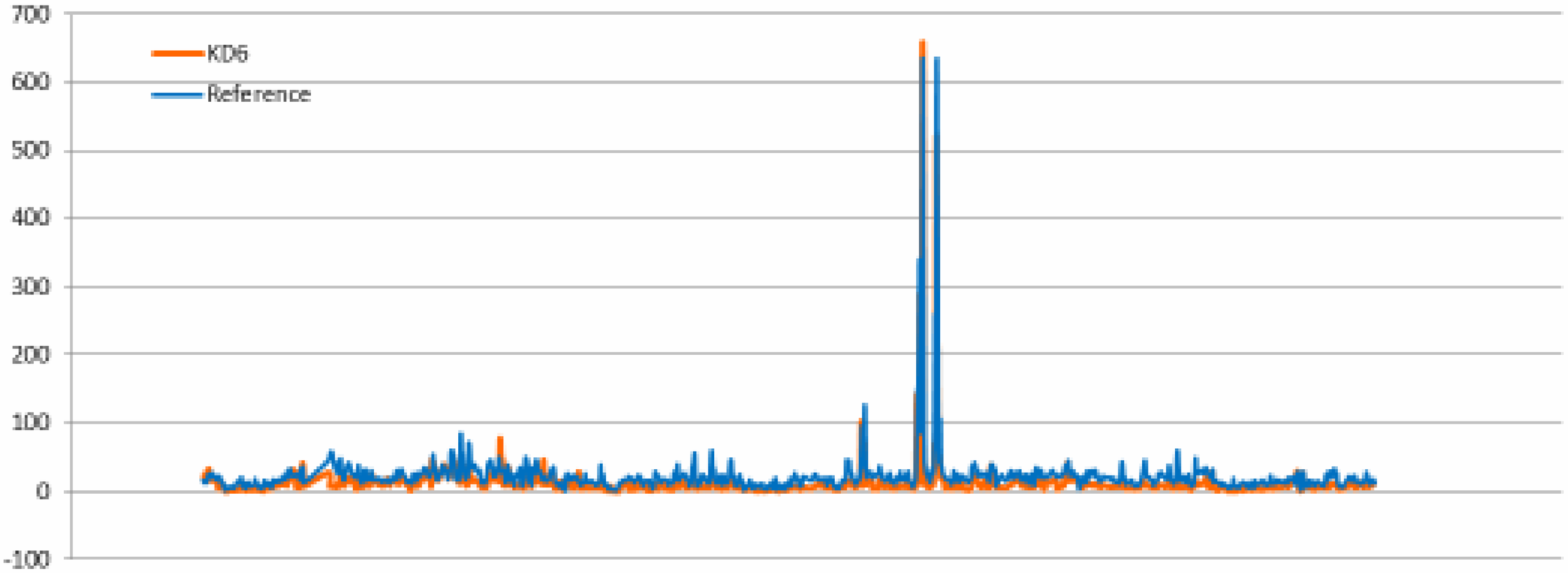


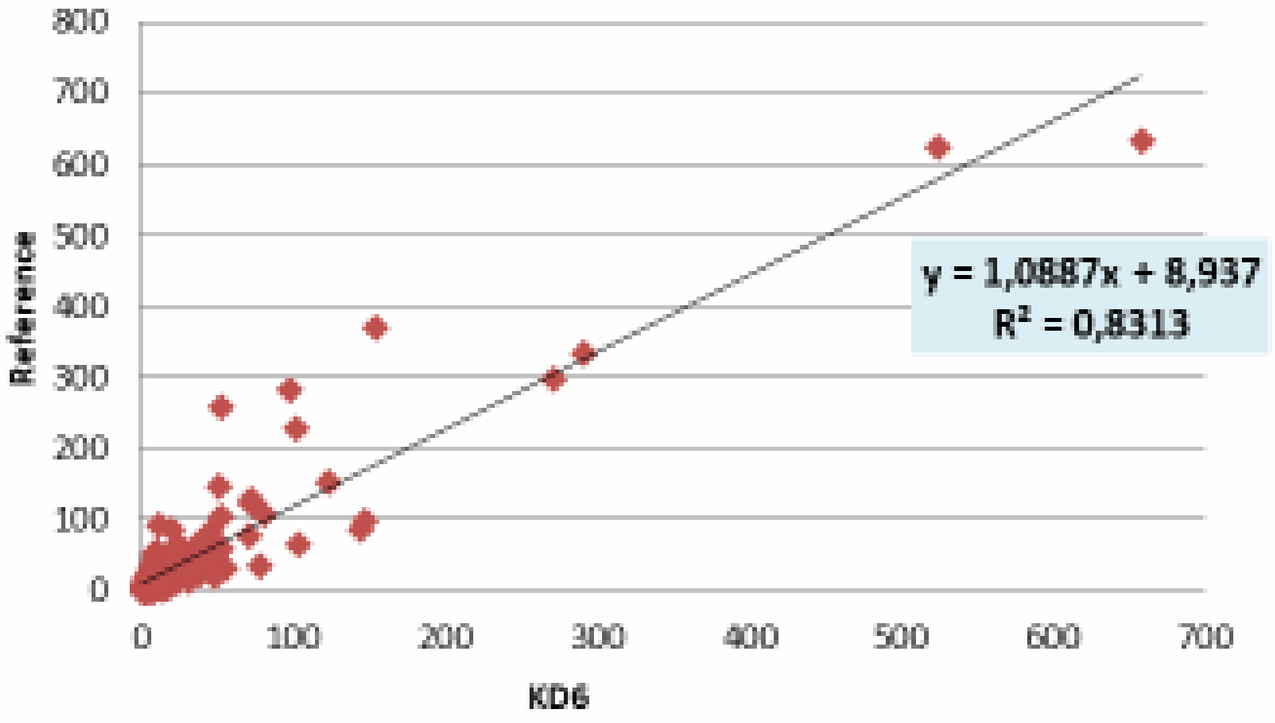
- R^2=0.92
- Accuracy: **2.5 ppb**

PARTÍCULAS

PM10, PM2.5, PM1

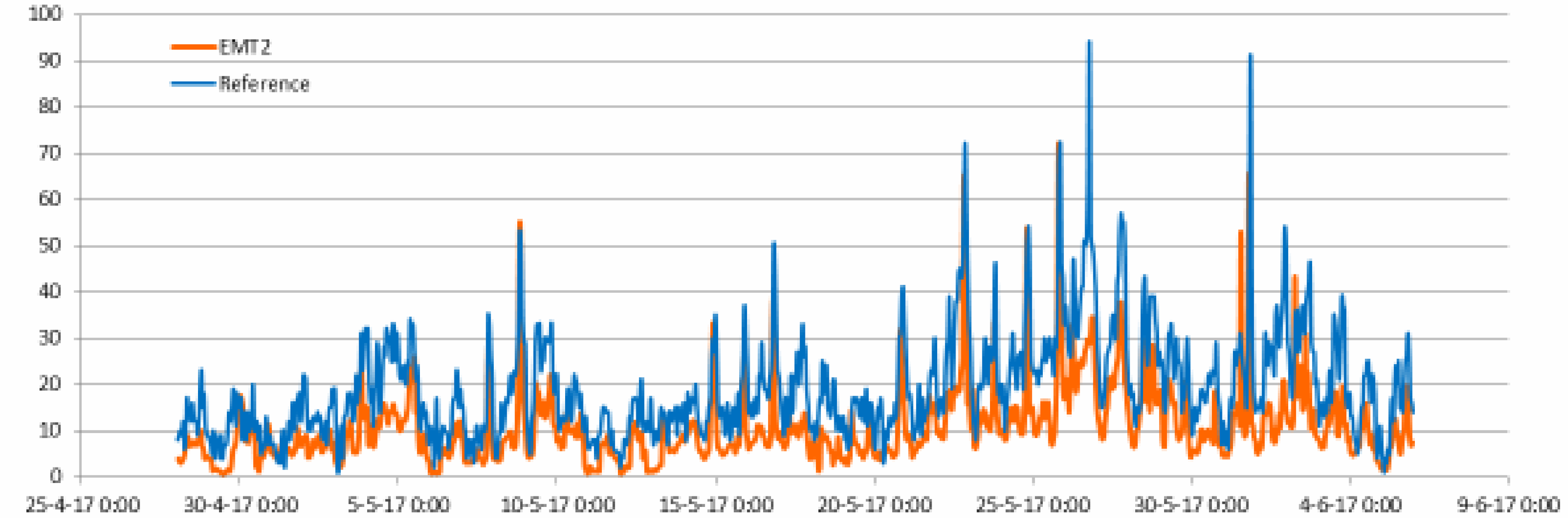
2- PM10. Barcelona

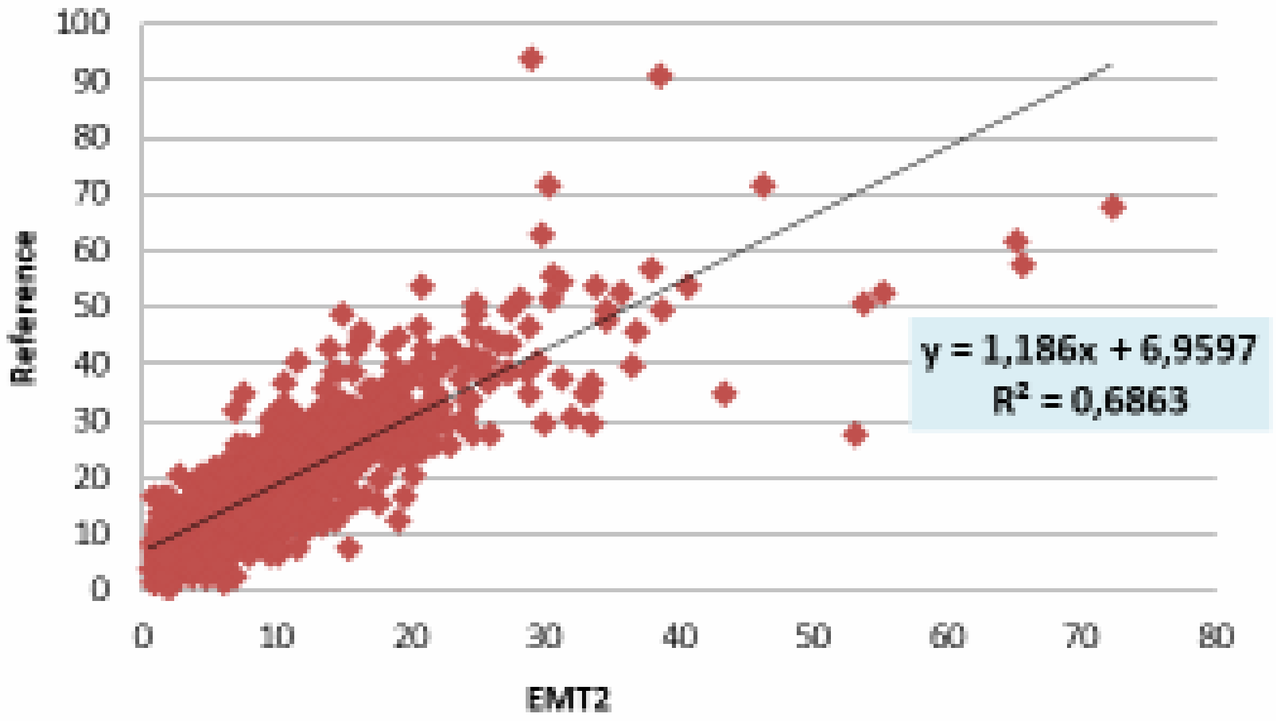




- Correlation with Official Air Quality Station: $R^2 > 0,83$
- Accuracy: 10.8 µg/m³

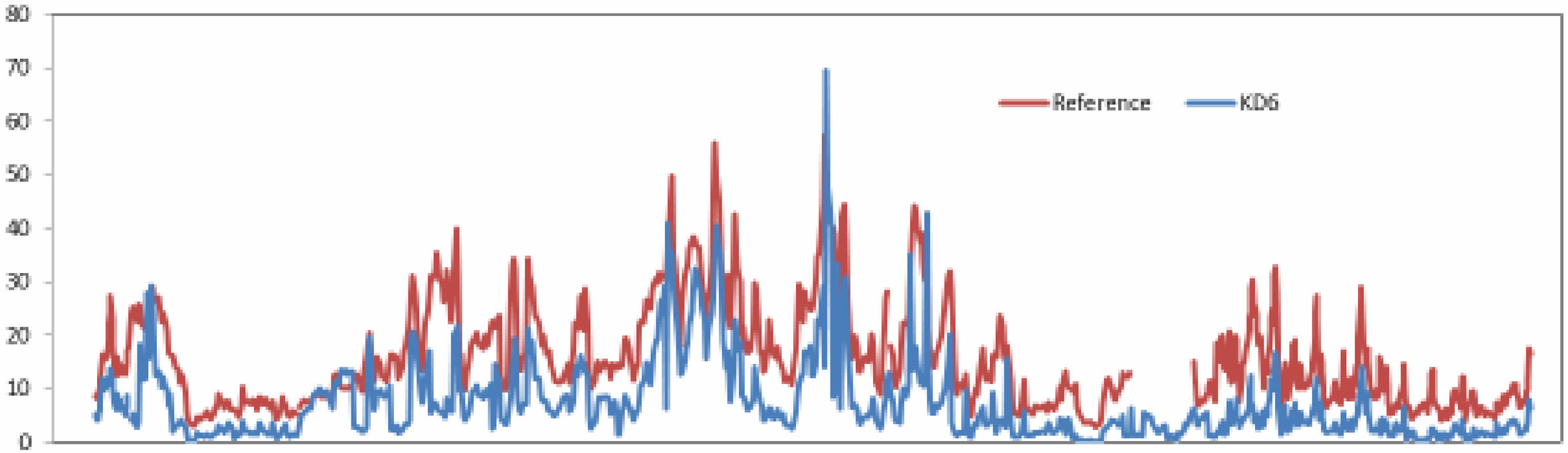
2- PM10. Madrid

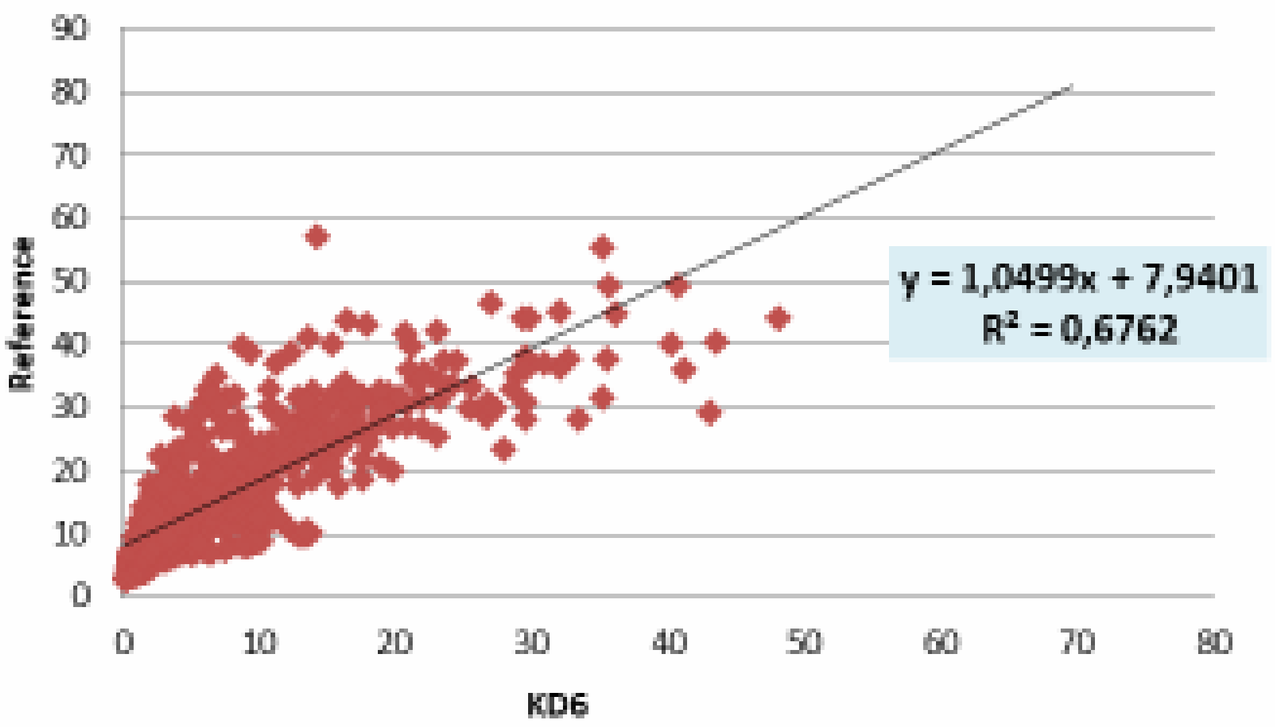




- Correlation with Official Air Quality Station: $R^2 > 0,68$
- Accuracy: 9.2 µg/m³

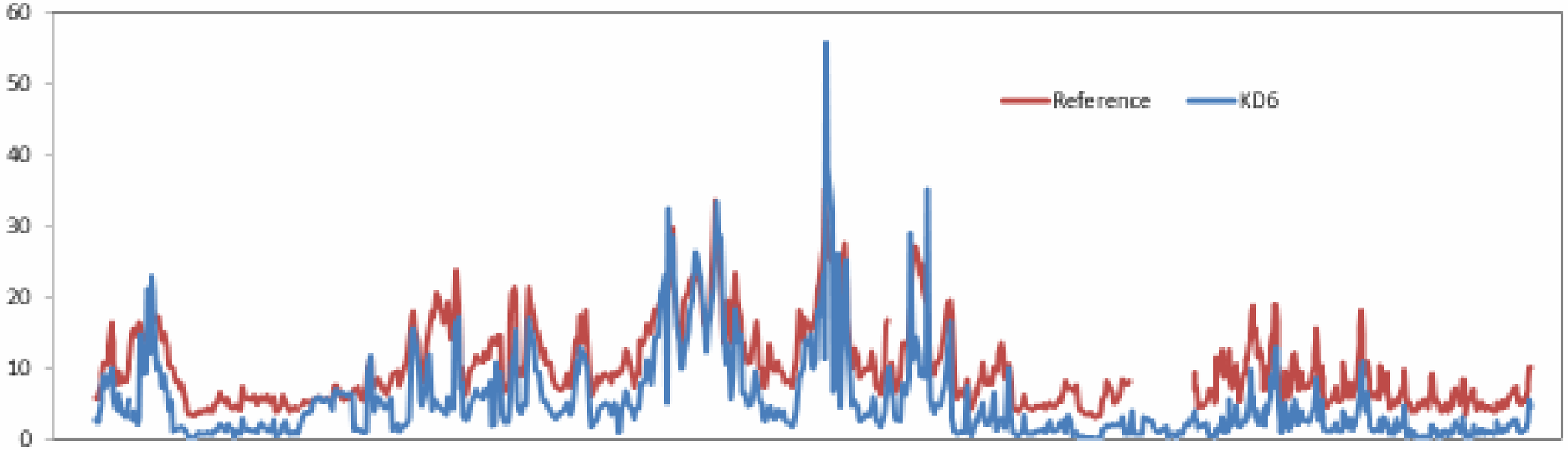
3- PM2.5. Barcelona

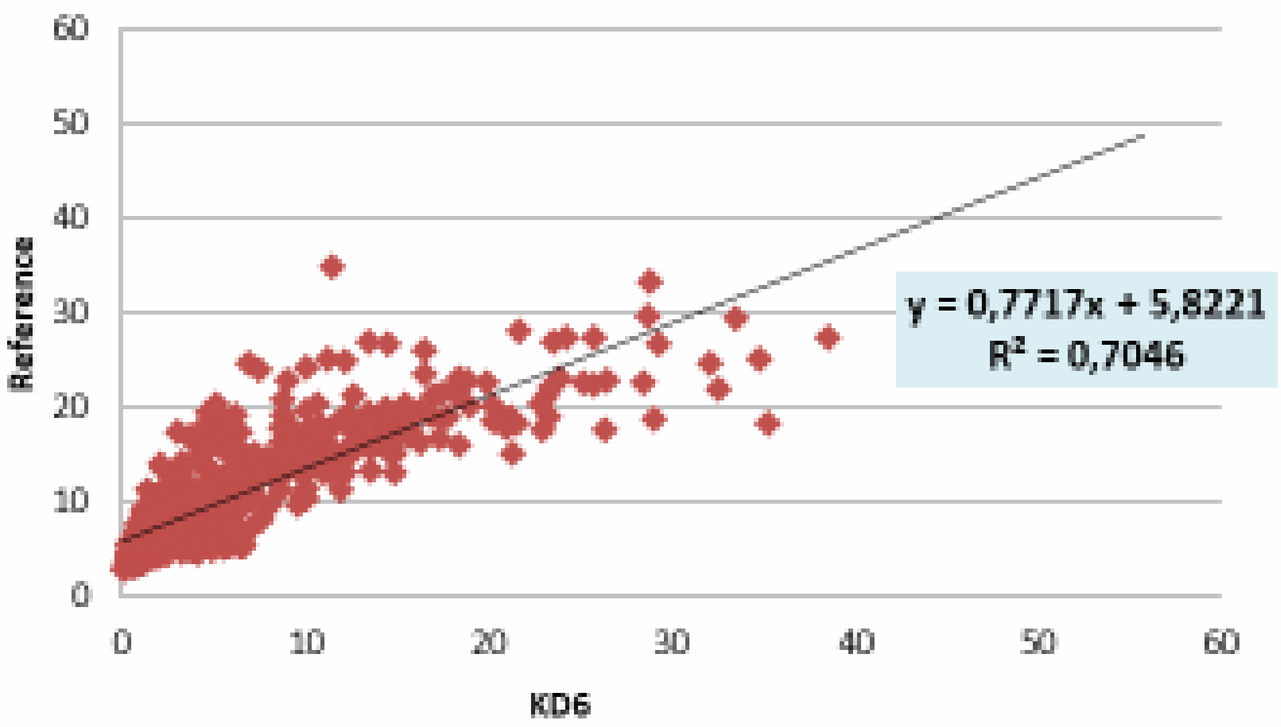




- Correlation with Official Air Quality Station: $R^2 > 0,67$
- Accuracy: **8.23 µg/m³**

4- PM1. Barcelona





- Correlation with Official Air Quality Station: $R^2 > 0,7$
- Accuracy: 4.93 µg/m³

Prestaciones Medias Esperadas

SEVILLA

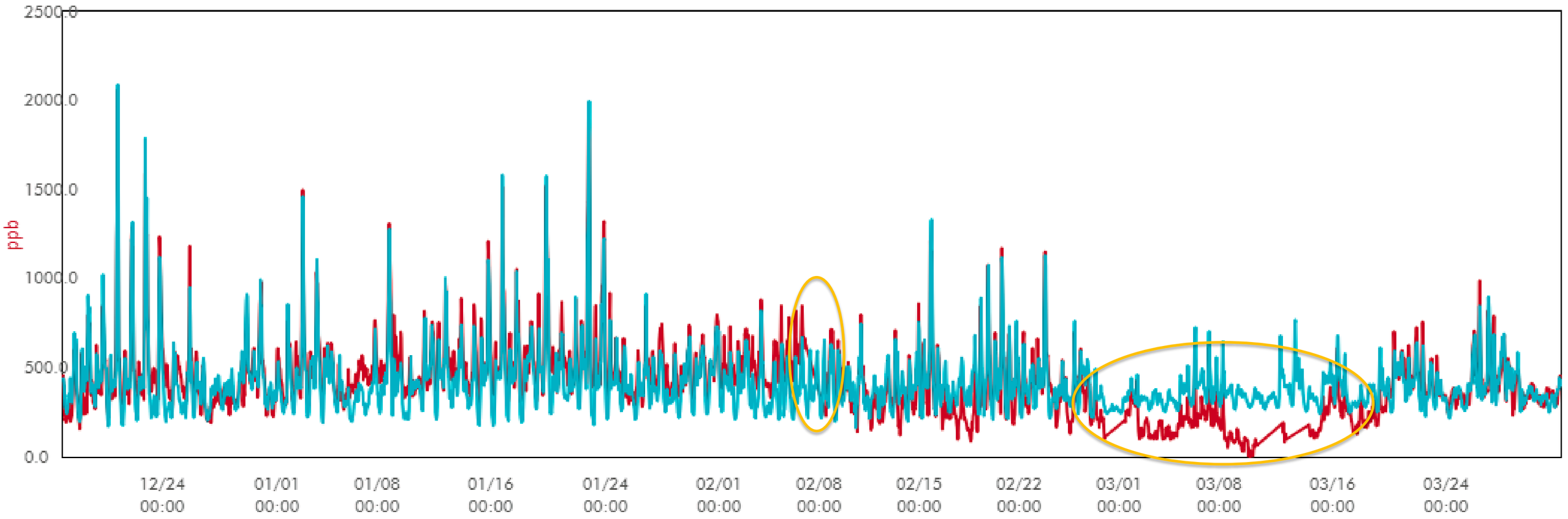
DEC’17-ABR’18

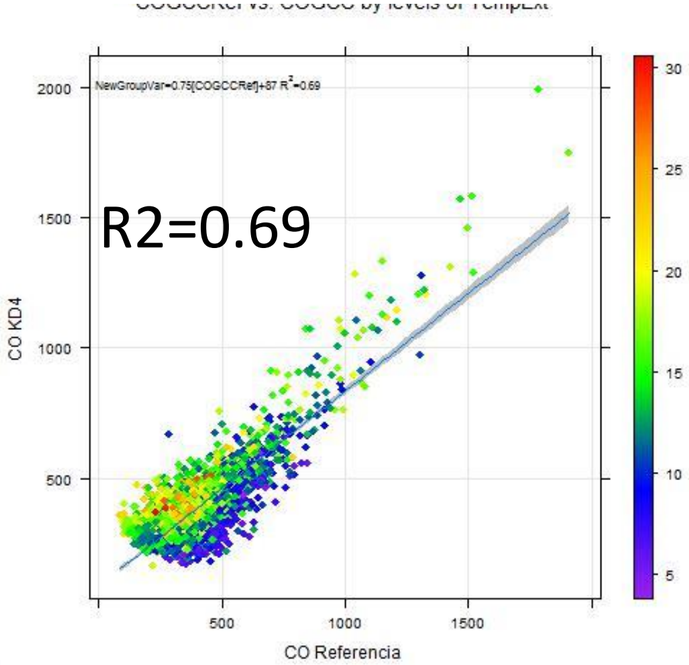
Carbon Monoxide (CO) DEC-MAR-18

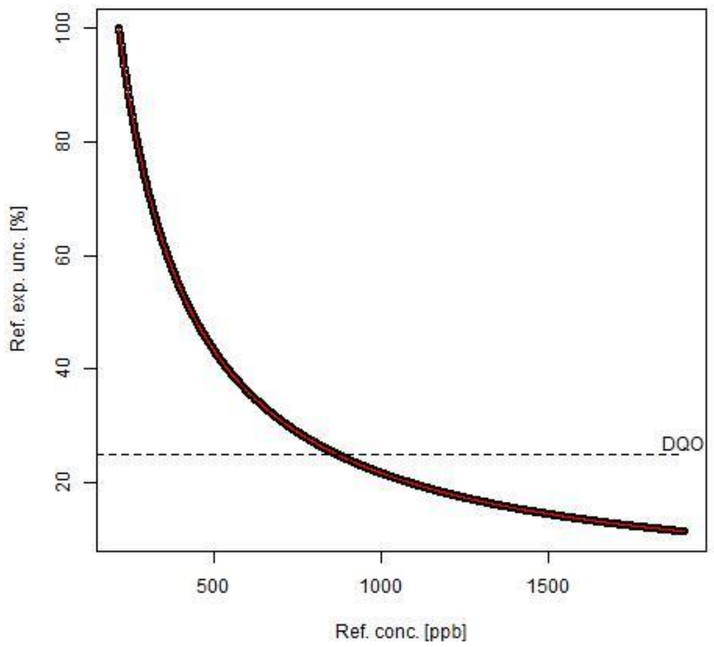
KD4 VIRTUAL - CO GCc Ref (ppb)

KD4 VIRTUAL - CO GCc 1s (ppb)

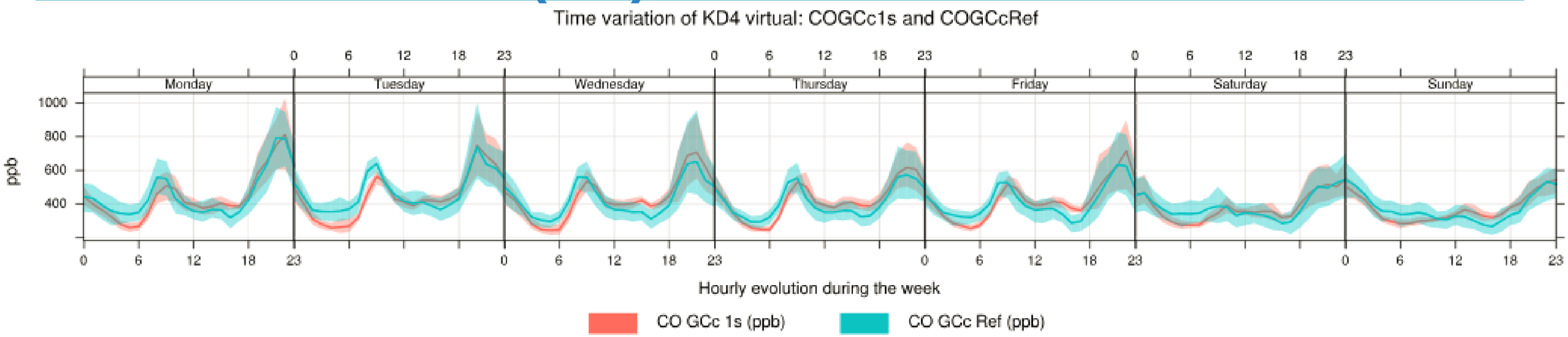
| Show summary | Reset graph | Zoom out

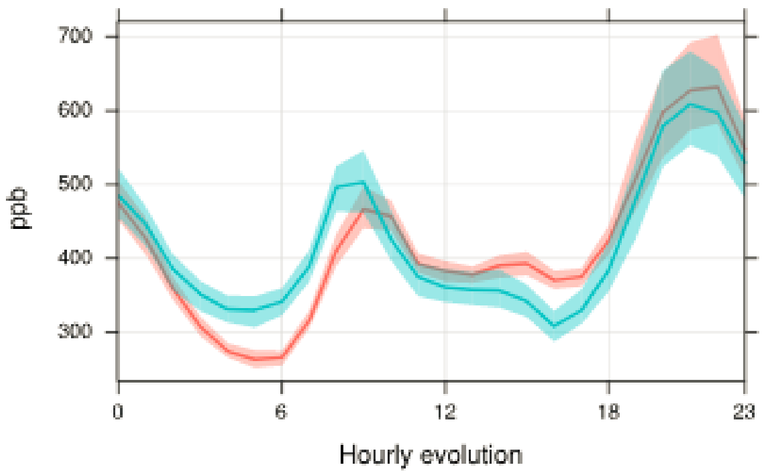


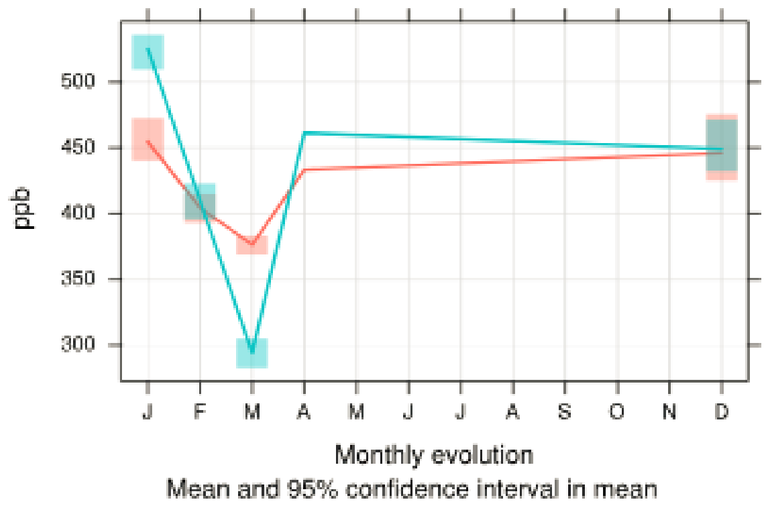


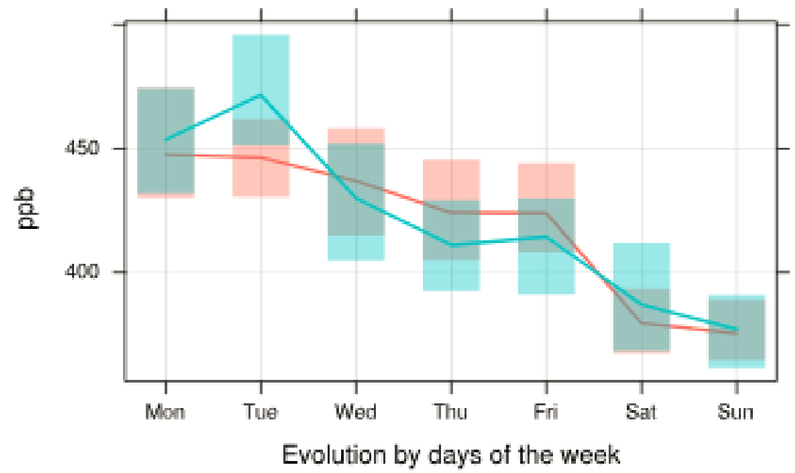


Carbon Monoxide (CO) DEC-MAR-18









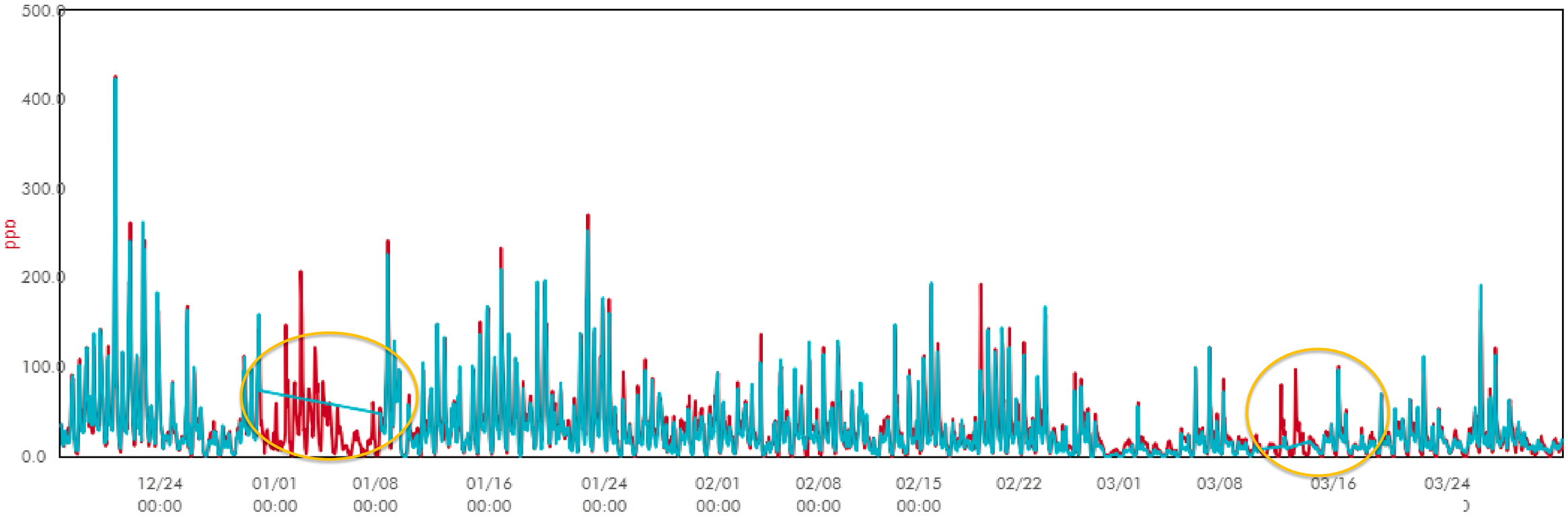
R^2	Accy (ppb)	90% Conf. (ppb)	DOQ (ppb)	Avg. T (ºC)	Avg. RH (%)	Avg. GC. Ref (ppb)	Avg. GC. DUT (ppb)	AV Ref/DUT
0.69	86,79	177.97	834	13.99	64.28	445	419.9	82% / 100%

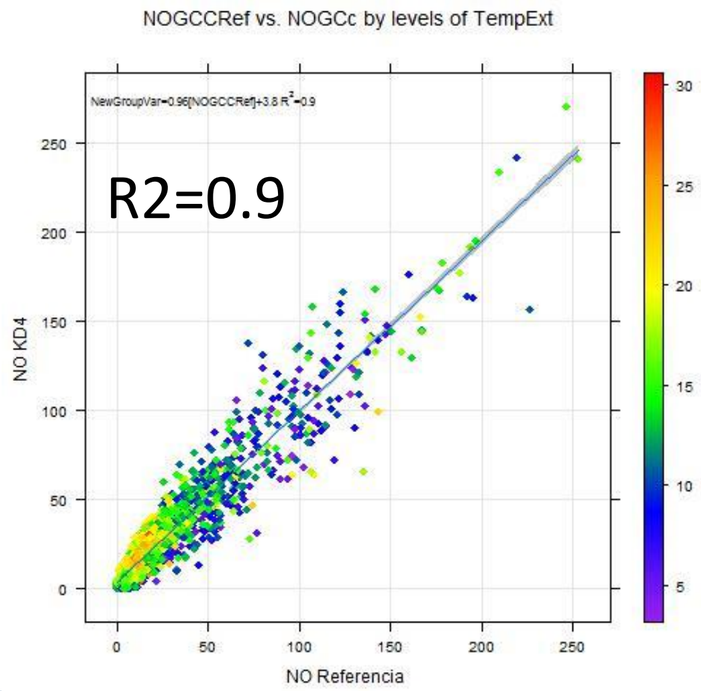
Nitrogen Oxide (NO) DEC-MAR-18

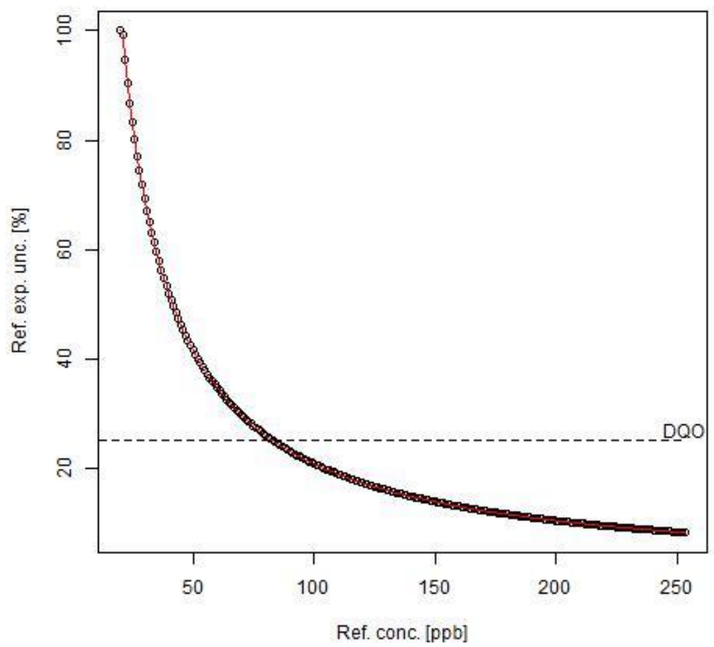
KD4 VIRTUAL - NO GCc
1s (ppb)

KD4 VIRTUAL - NO GCc
Ref (ppb)

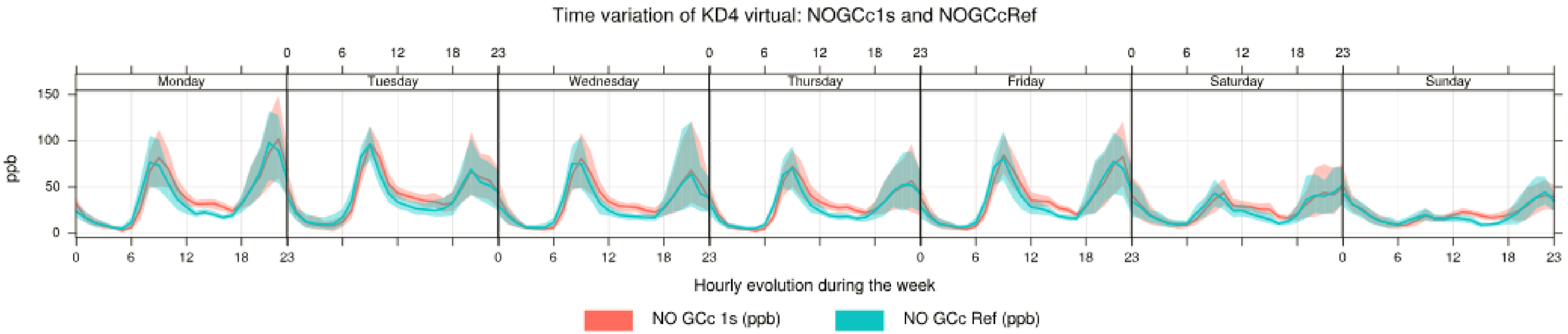
| Show summary | Reset graph | Zoom out

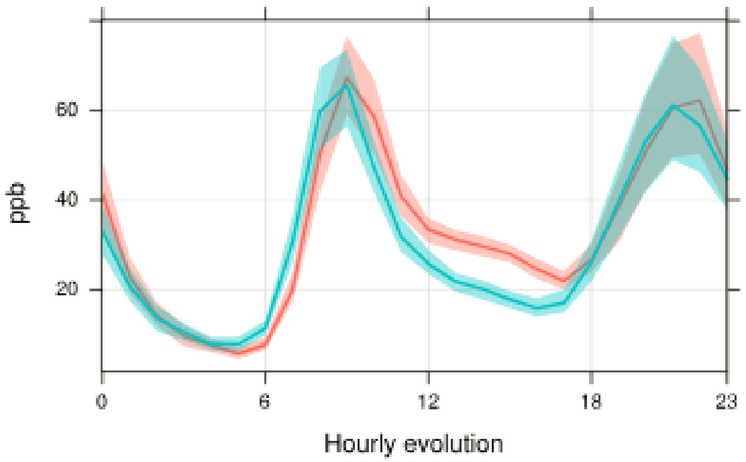


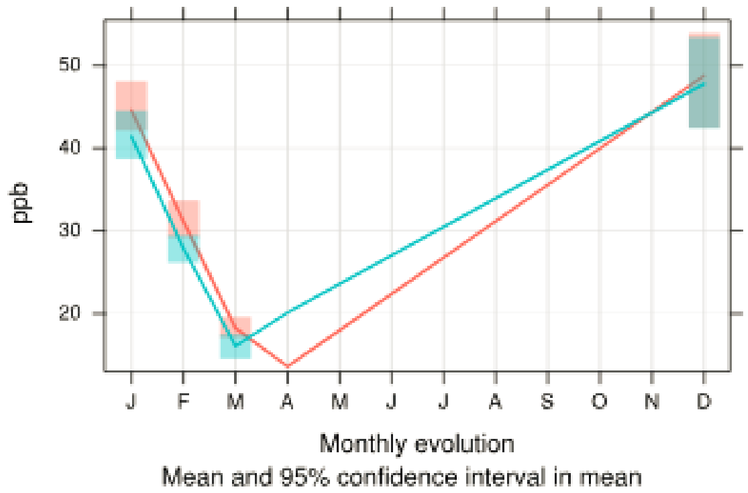


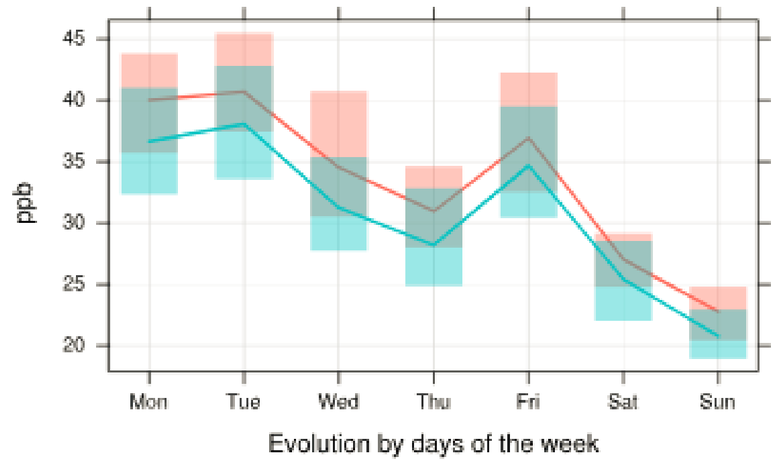


Nitrogen Oxide (NO) DEC-MAR-18



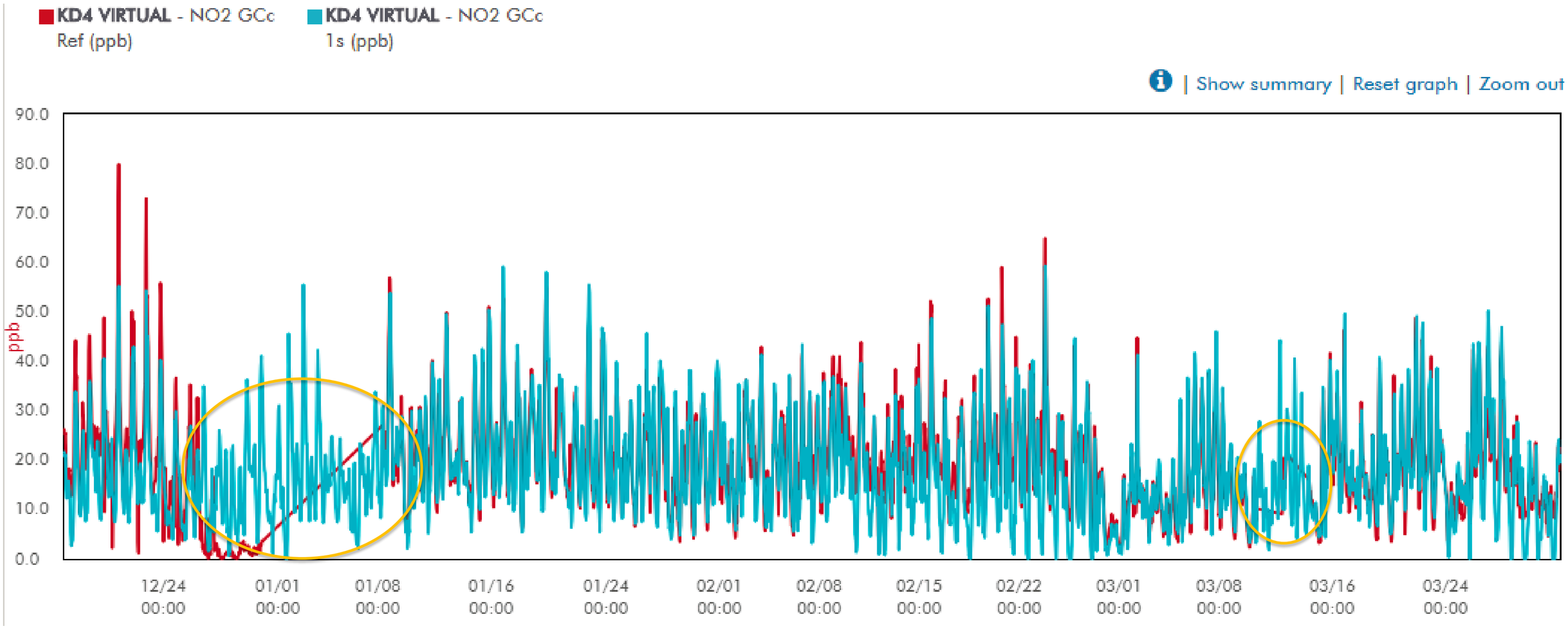


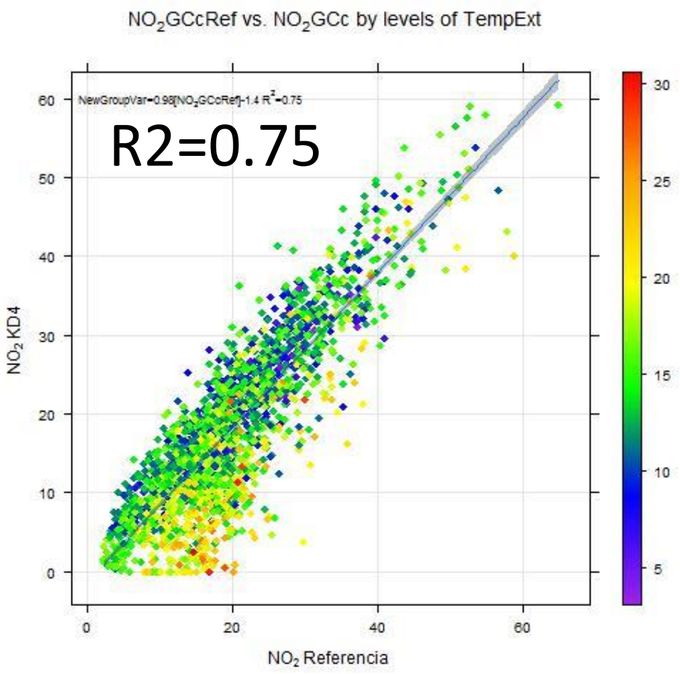


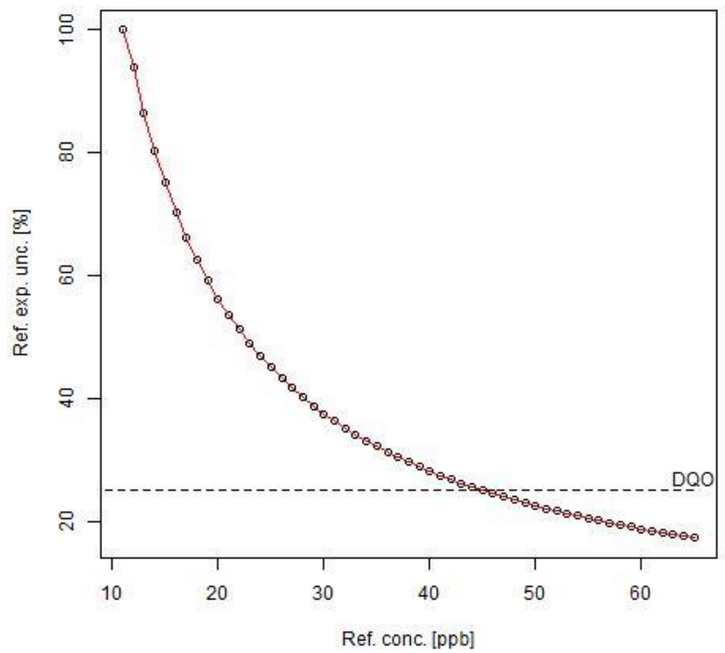


R^2	Accy (ppb)	90% Conf. (ppb)	DOQ (ppb)	Avg. T (ºC)	Avg. RH (%)	Avg. GC. Ref (ppb)	Avg. GC. DUT (ppb)	AV Ref/DUT
0.90	7.3	15.8	81	14	63.4	27.3	29.9	87%/ 100%

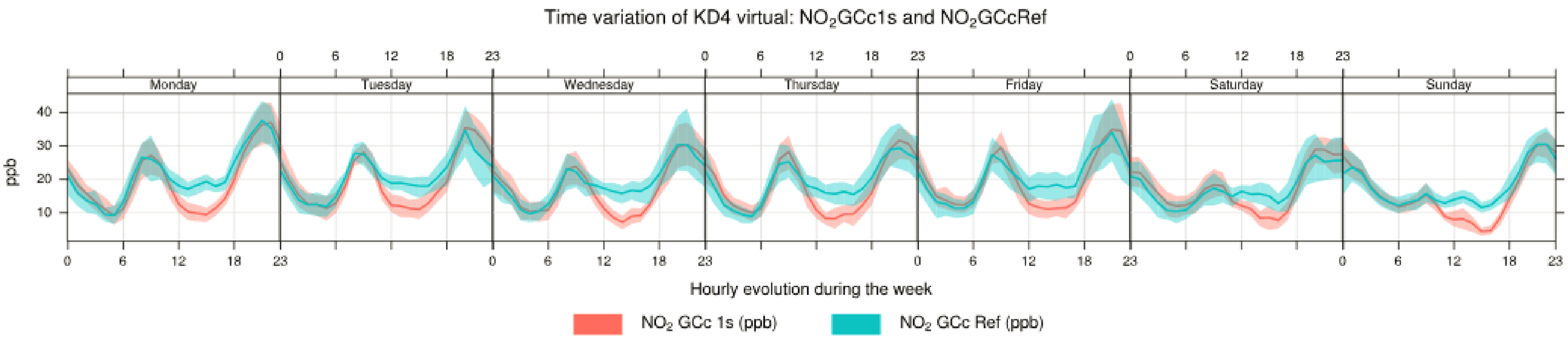
Nitrogen Dioxide (NO2) DEC-MAR-18

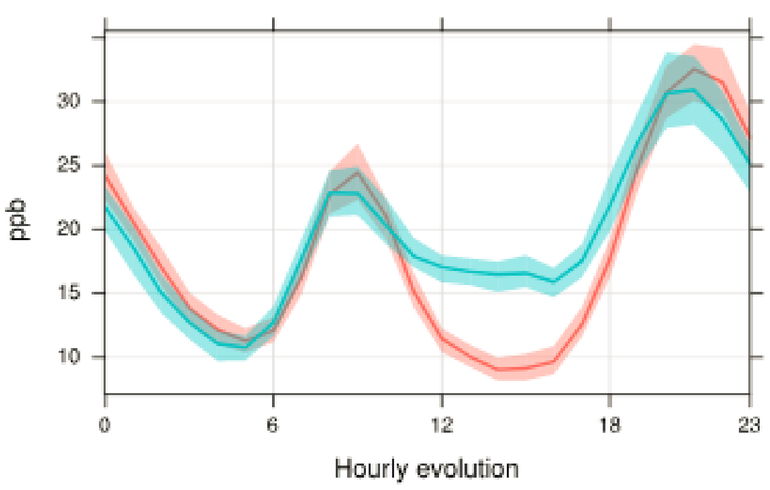


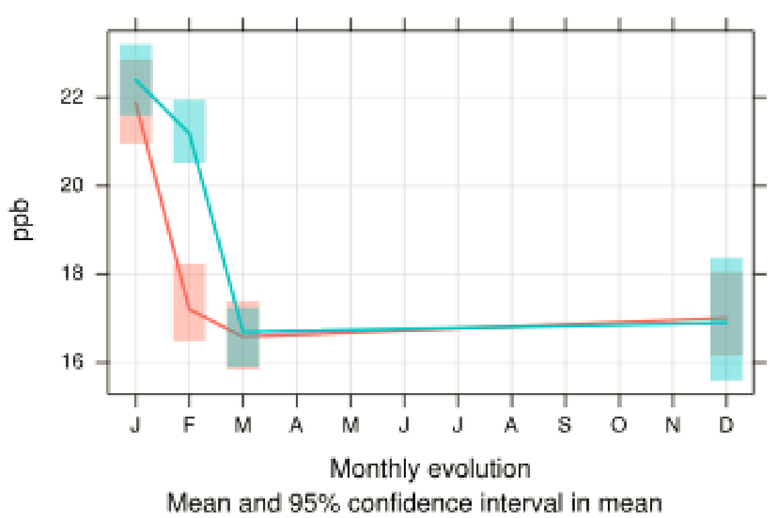


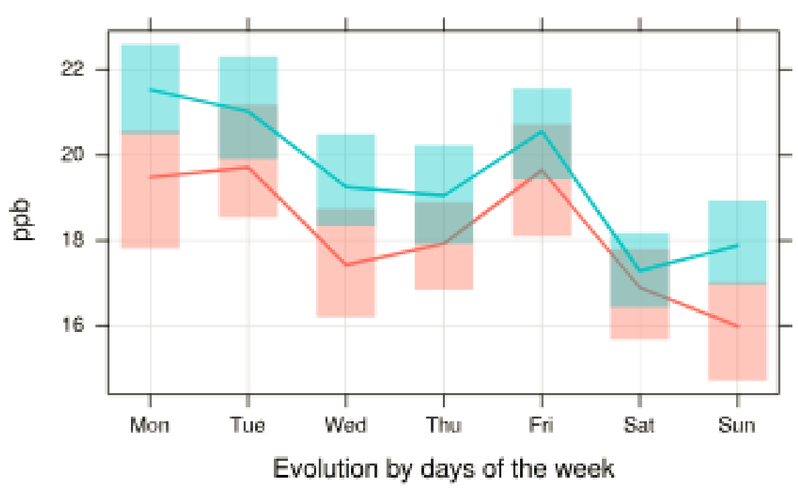


Nitrogen Dioxide (NO2) DEC-MAR-18



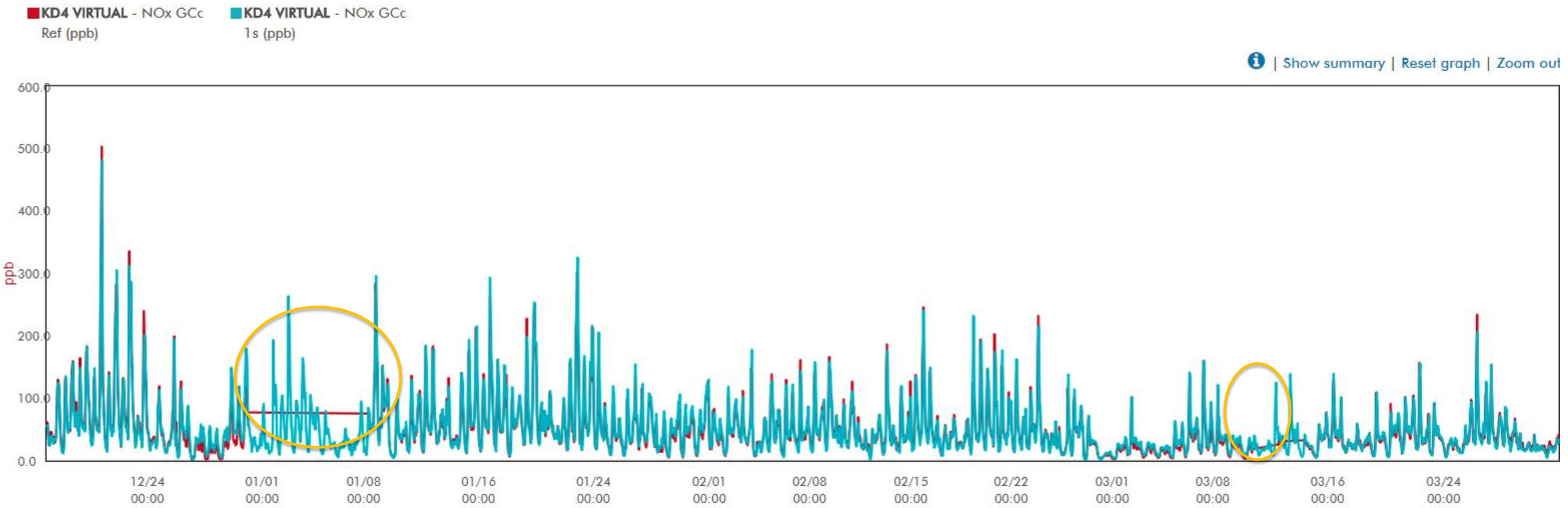


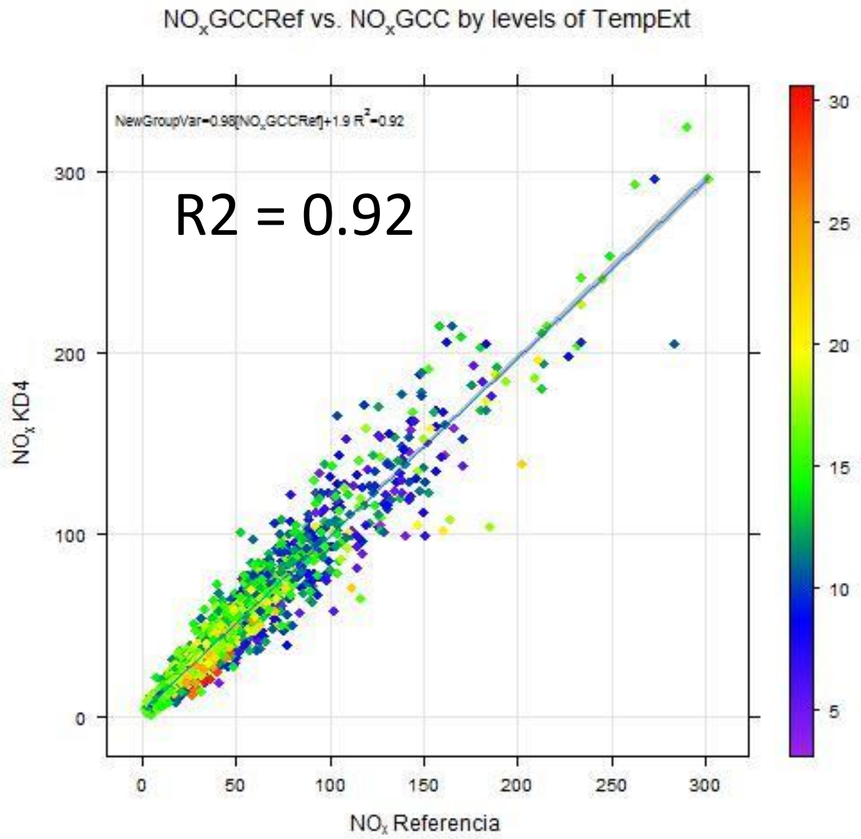


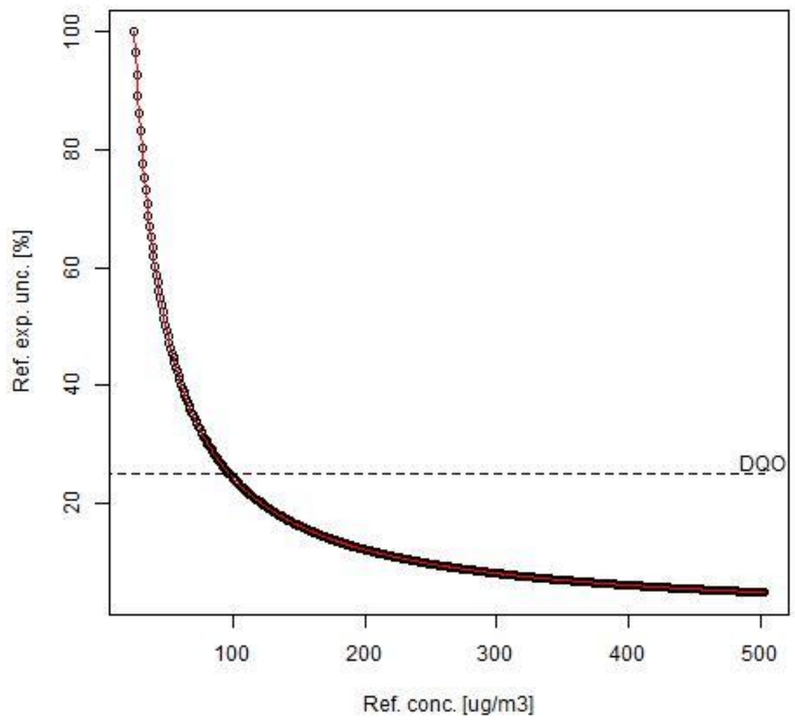


R^2	Accy (ppb)	90% Conf. (ppb)	DOQ (ppb)	Avg. T (ºC)	Avg. RH (%)	Avg. GC. Ref (ppb)	Avg. GC. DUT (ppb)	AV Ref/DUT
0.75	4.19	9.66	44	13.9	64.28	19.81	18.06	87%/ 100%

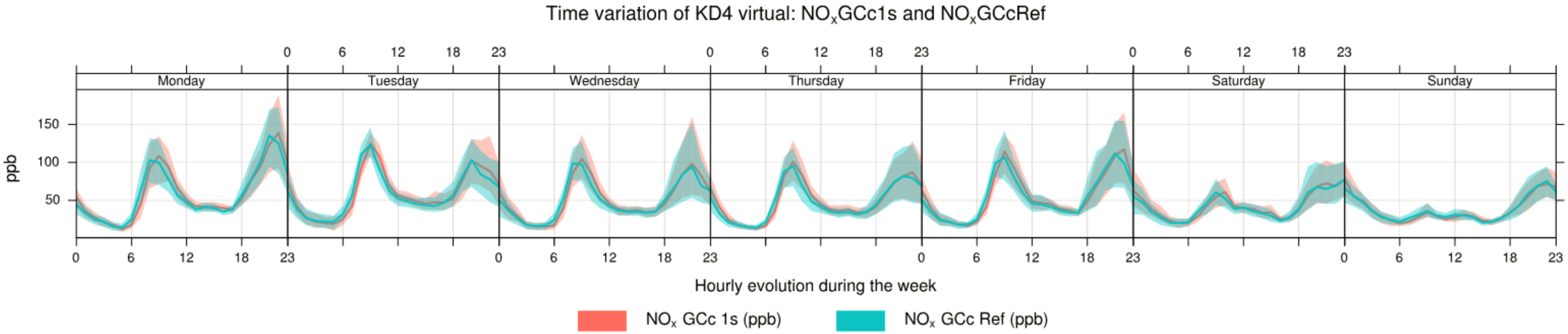
Nitrogen Oxides (NOx) DEC-MAR-18

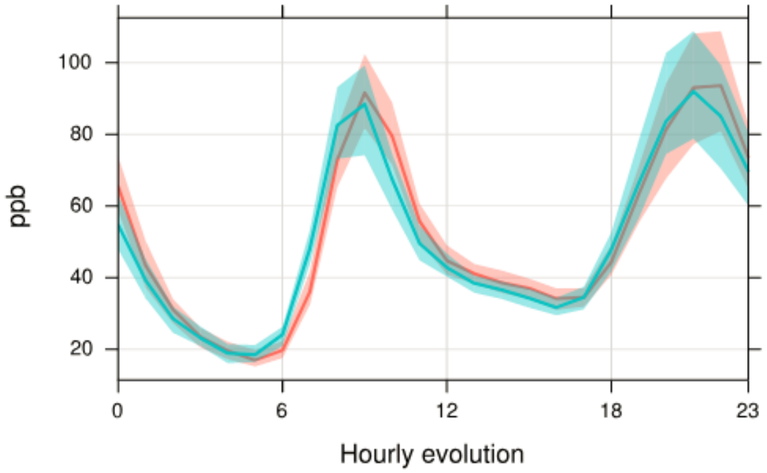


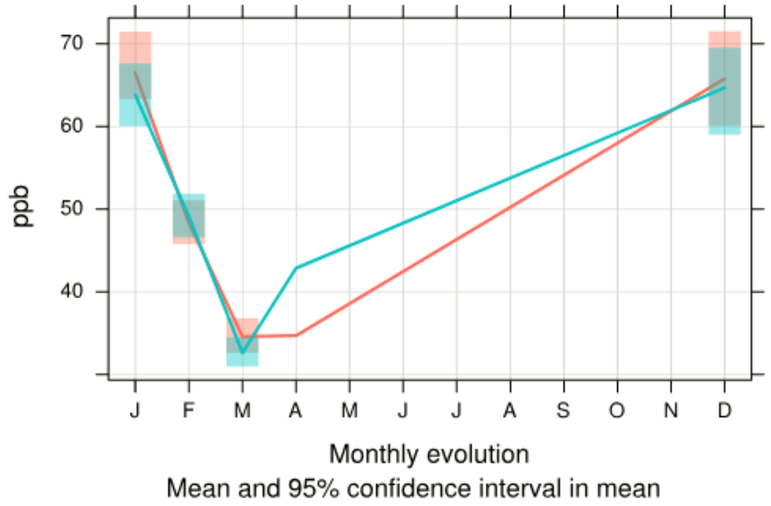


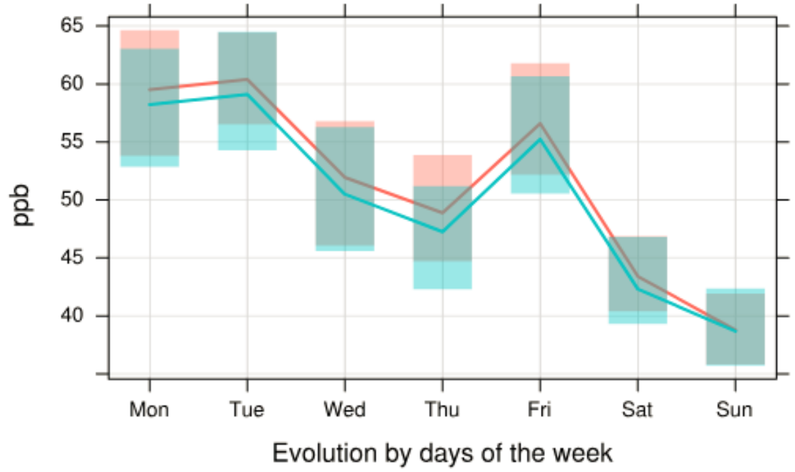


Nitrogen Oxides (NOx) DEC-MAR-18



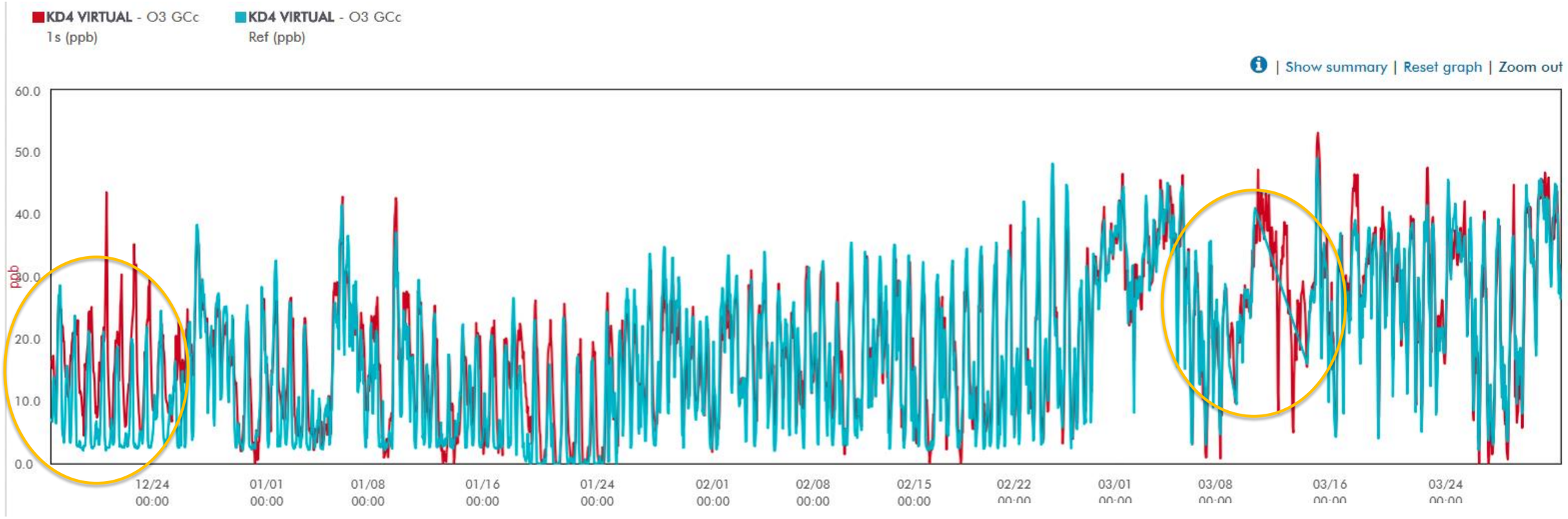


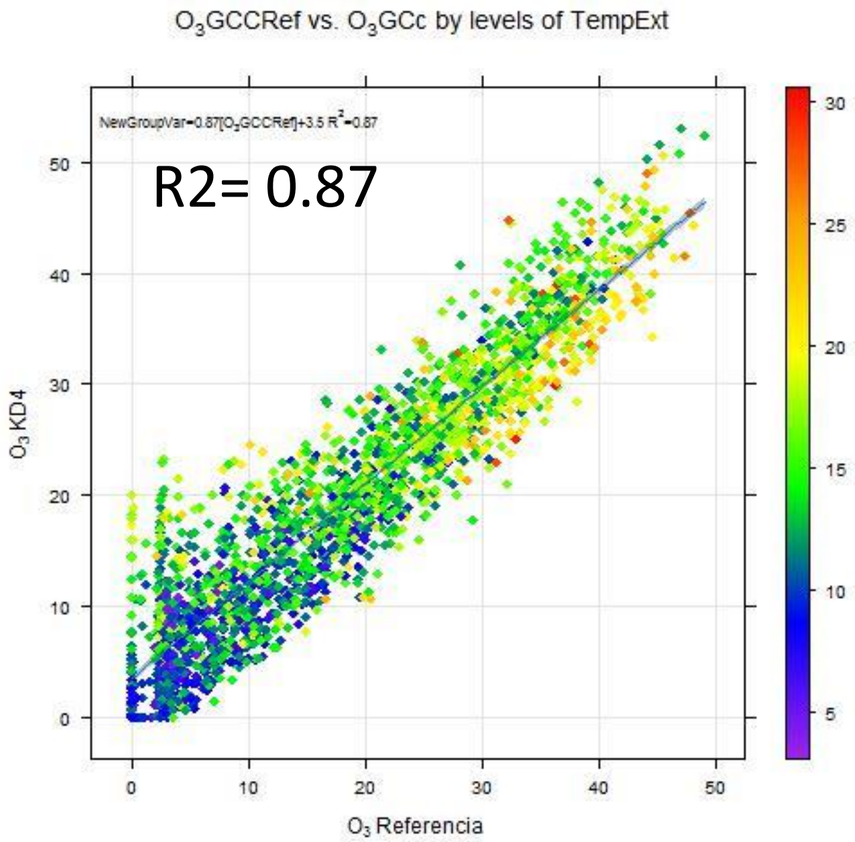


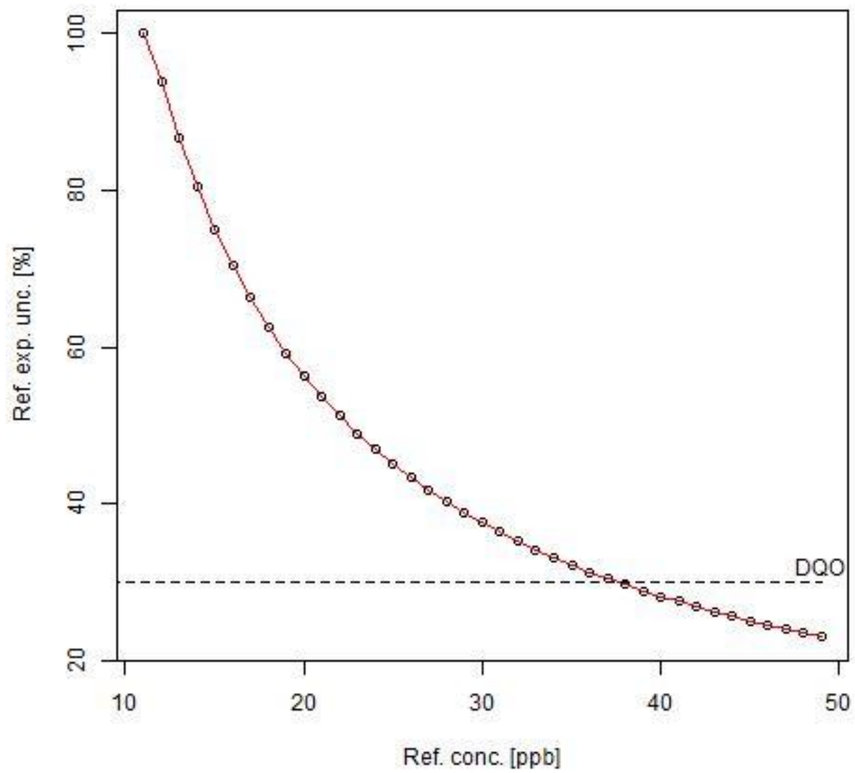


R^2	Accy (ppb)	90% Conf. (ppb)	DOQ (ppb)	Avg. T (ºC)	Avg. RH (%)	Avg. GC. Ref (ppb)	Avg. GC. DUT (ppb)	AV Ref/DUT
0.92	7.17	16.44	93	14	63.4	47.13	48.06	87%/ 100%

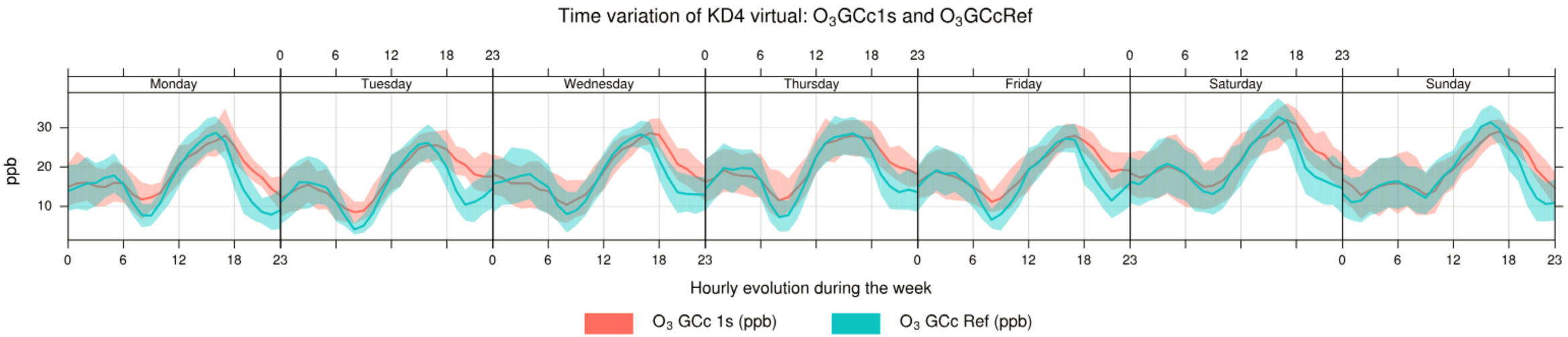
Ozone (O3) DEC-MAR-18

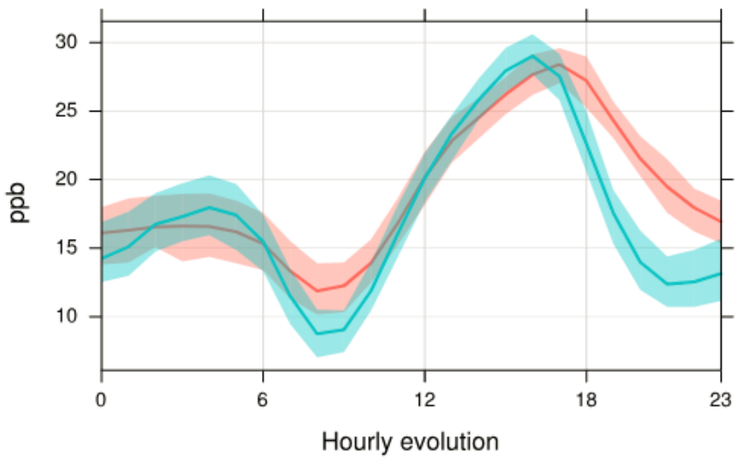


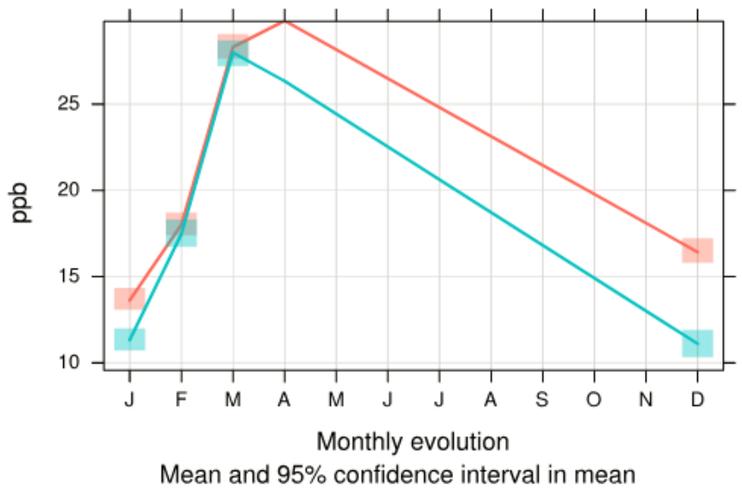


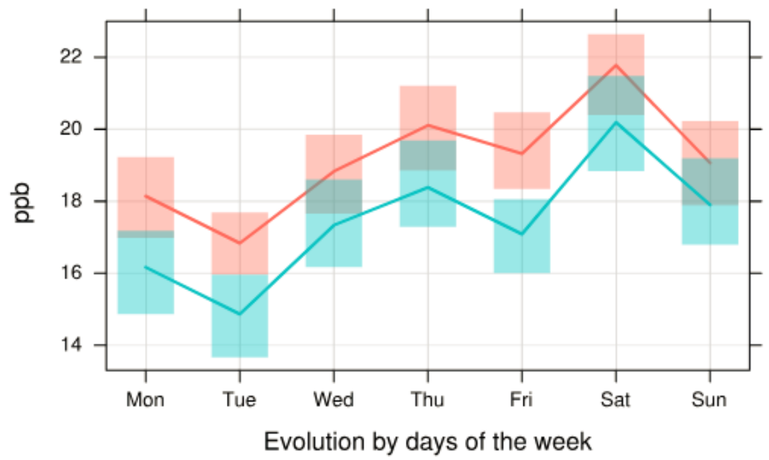


Ozone (O3) DEC-MAR-18









R^2	Accy (ppb)	90% Conf. (ppb)	DOQ (ppb)	Avg. T (ºC)	Avg. RH (%)	Avg. GC. Ref (ppb)	Avg. GC. DUT (ppb)	AV Ref/DUT
0.87	3.48	7.21	37	13.9	63.8	18.9	20.07	95%/ 100%

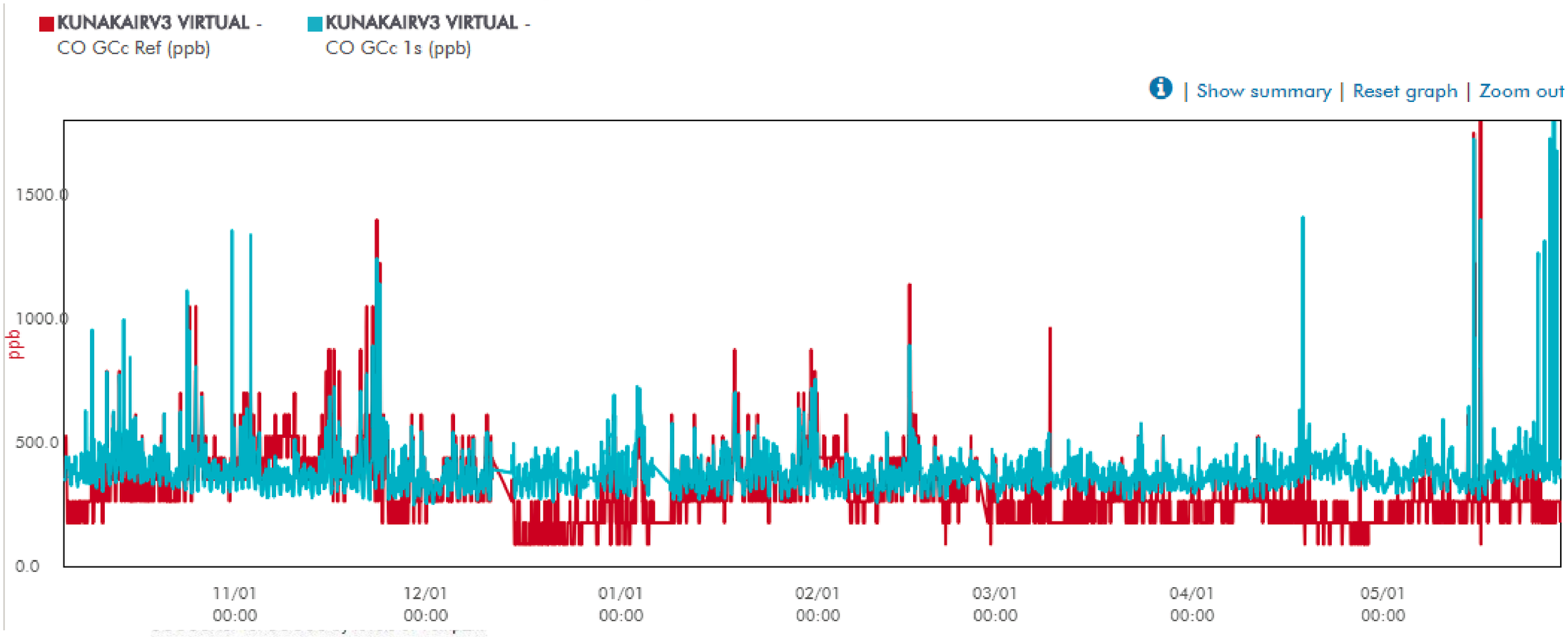
Evolución a Largo Plazo

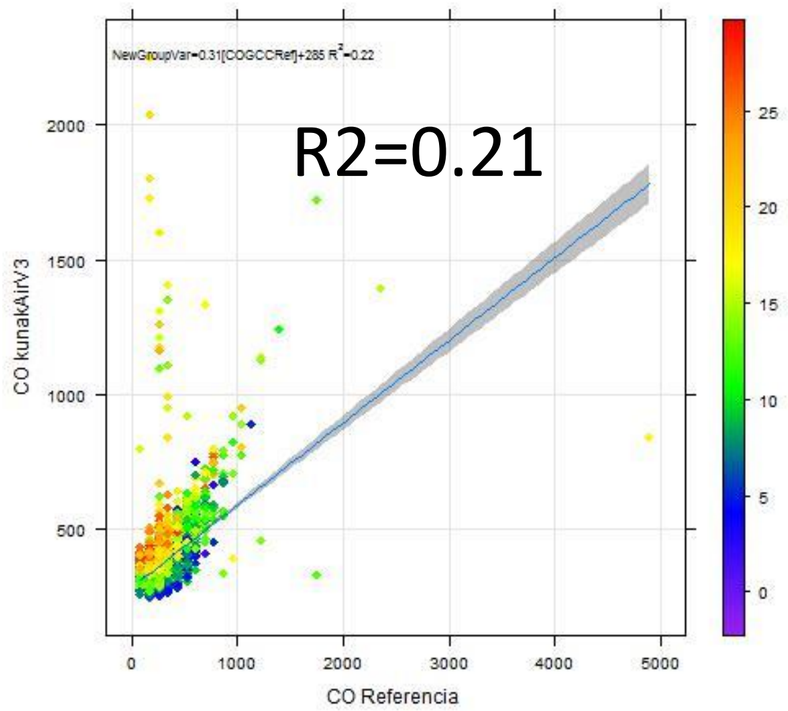
PAMPLONA

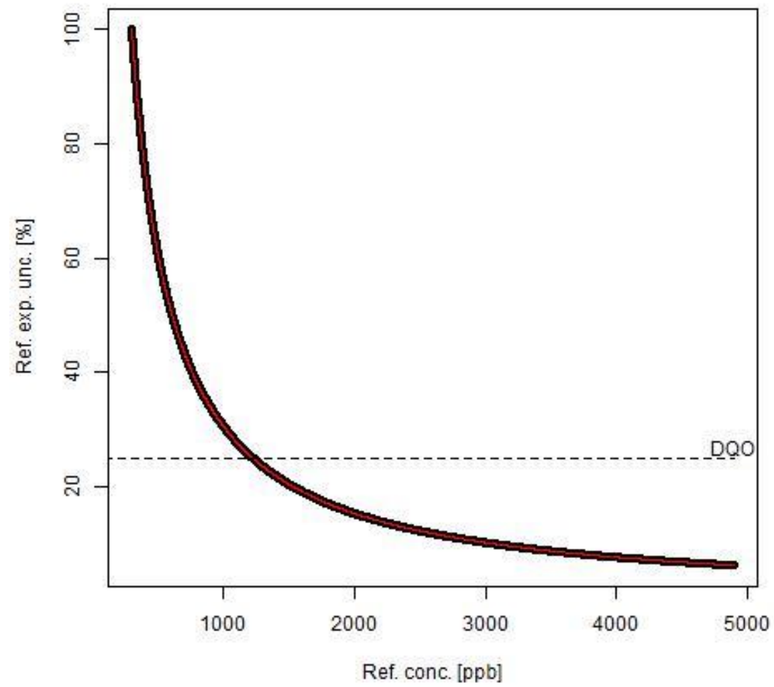
OCT’17-MAY’18

(8 meses, sensores usados)

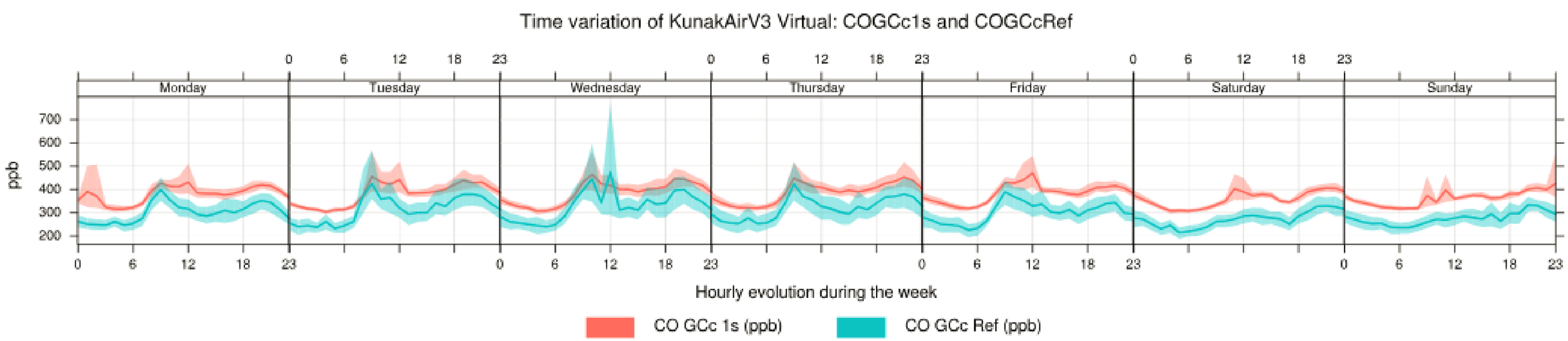
Carbon Monoxide (CO) OCT'17-MAY'18

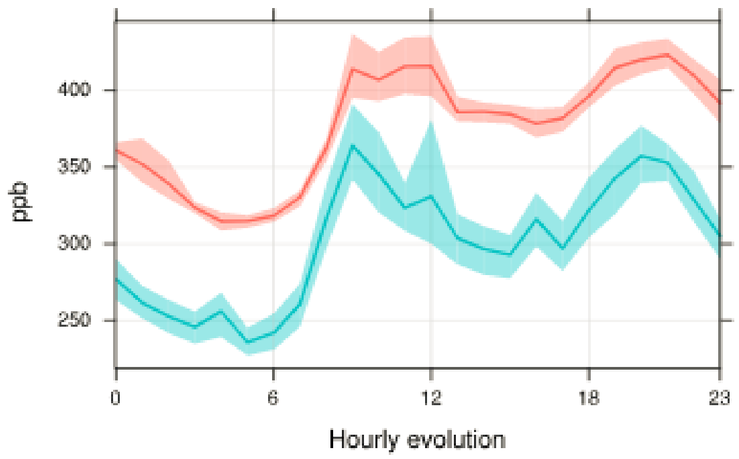


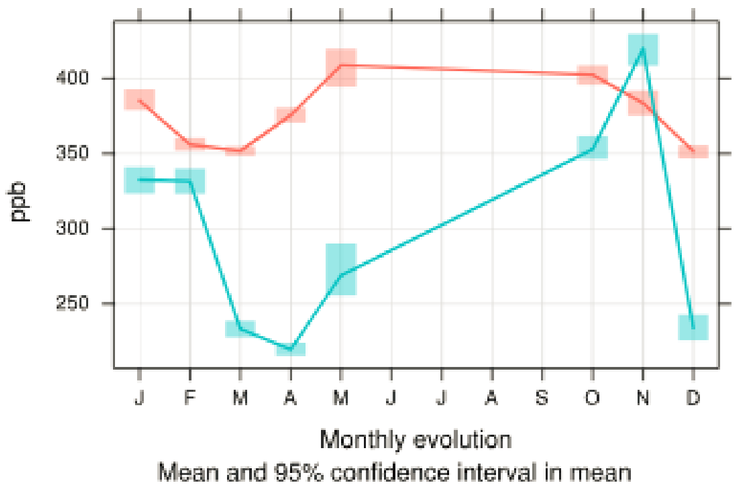


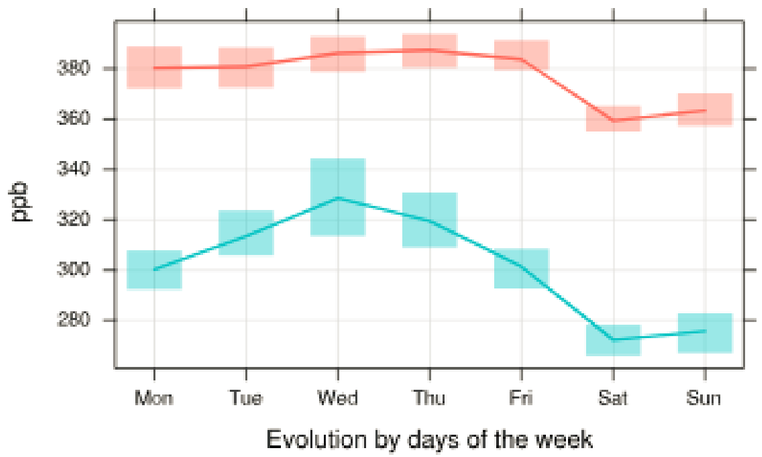


Carbon Monoxide (CO) OCT'17-MAY'18



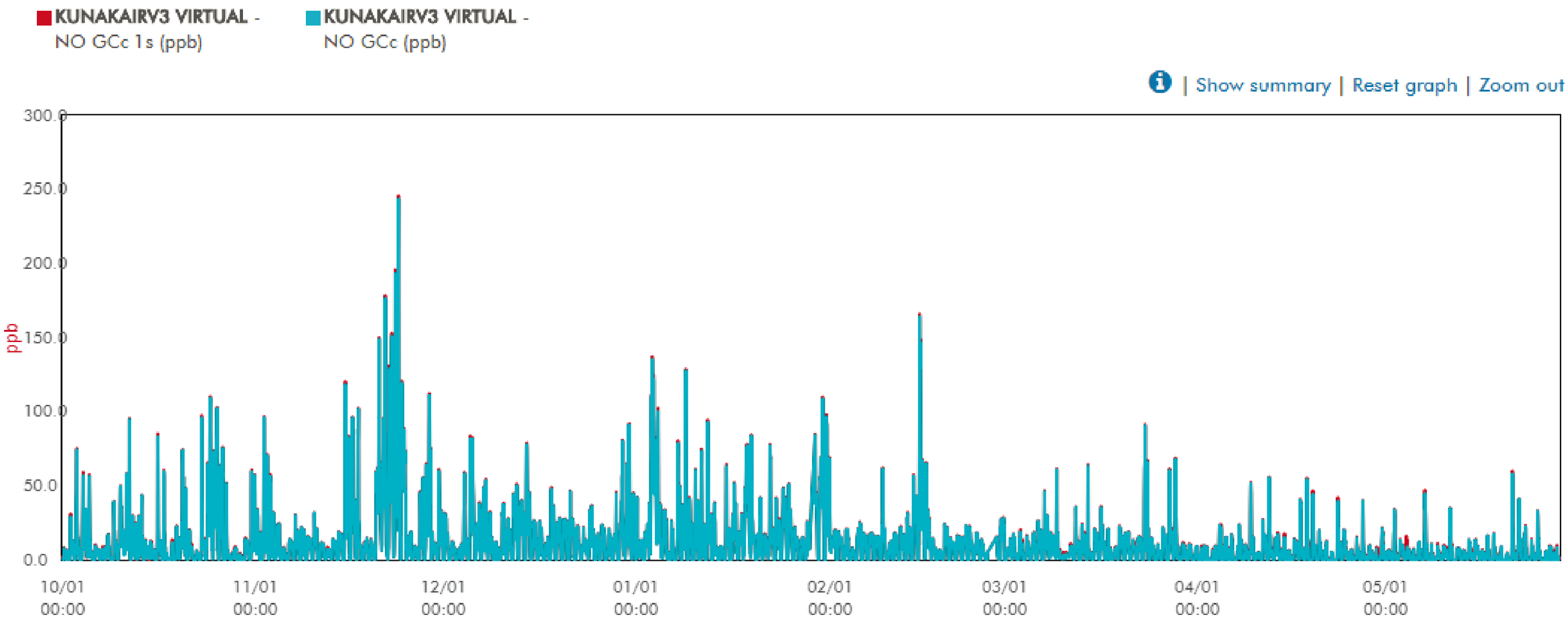


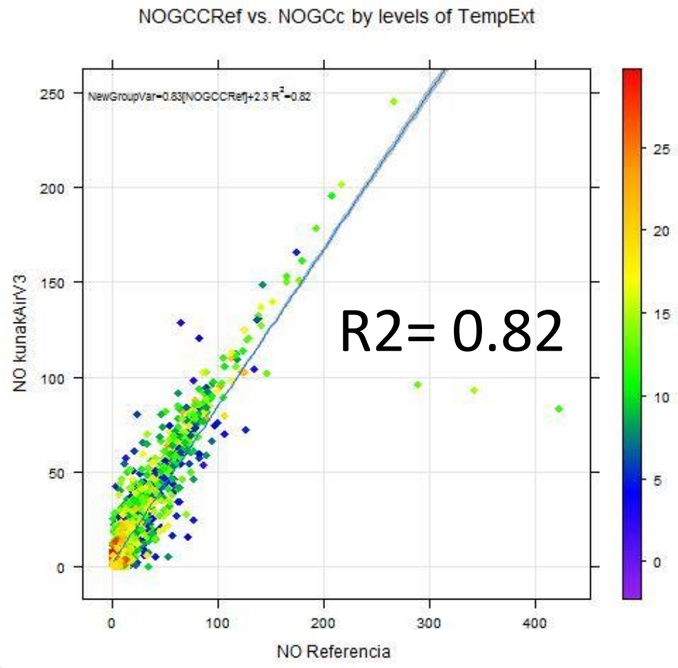


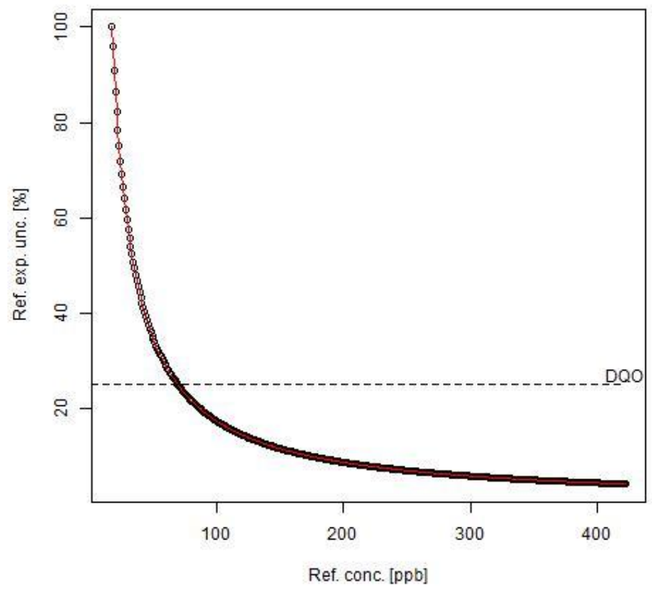


R^2	Accy (ppb)	90% Conf. (ppb)	DOQ (ppb)	Avg. T (ºC)	Avg. RH (%)	Avg. GC. Ref (ppb)	Avg. GC. DUT (ppb)	AV Ref/DUT
0.21	108.1	198.4	1185	11.82	66.9	301.49	377.09	92% / 96%

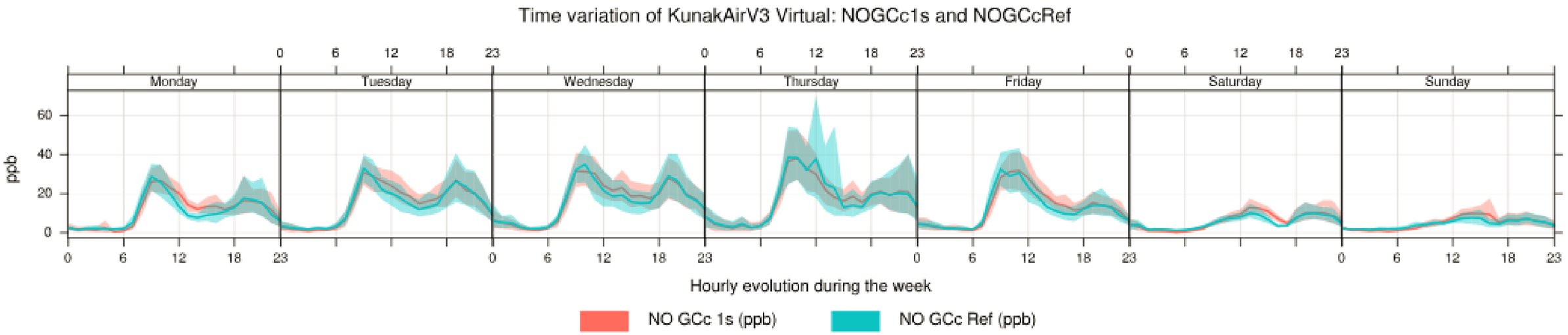
Nitrogen Oxide (NO) OCT'17-MAY'18

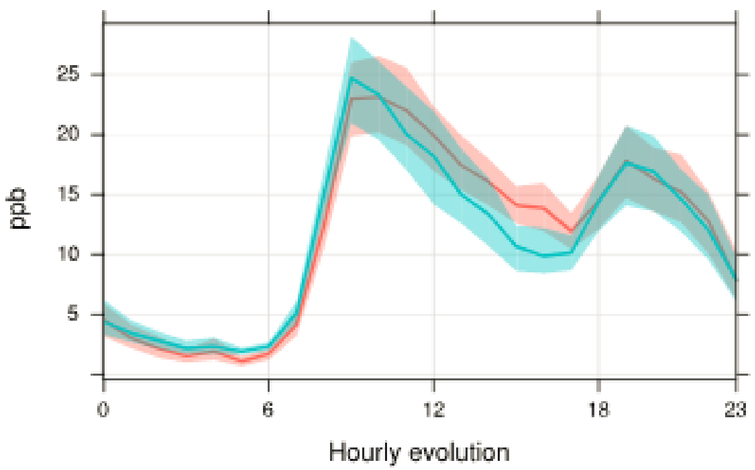


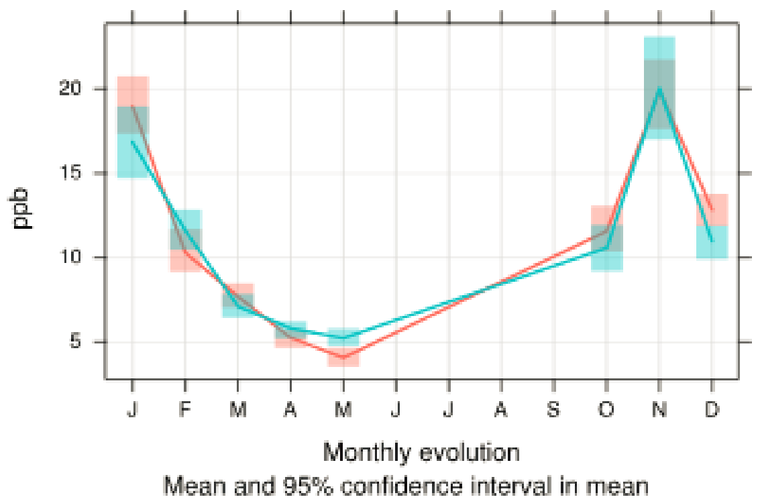


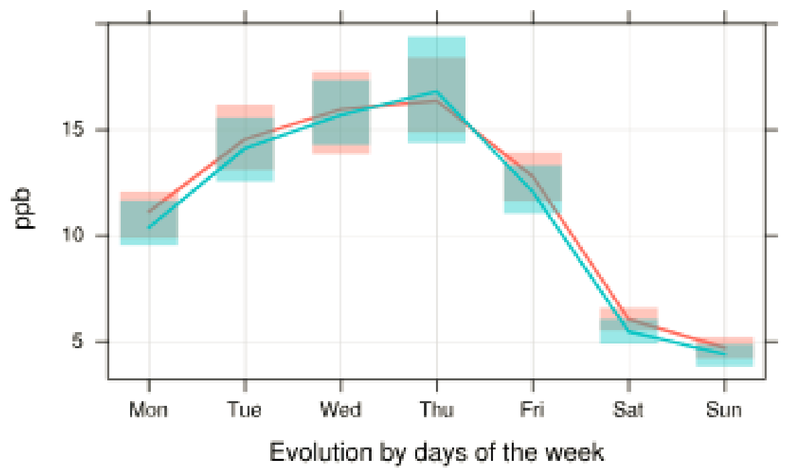


Nitrogen Oxide (NO) OCT'17-MAY'18









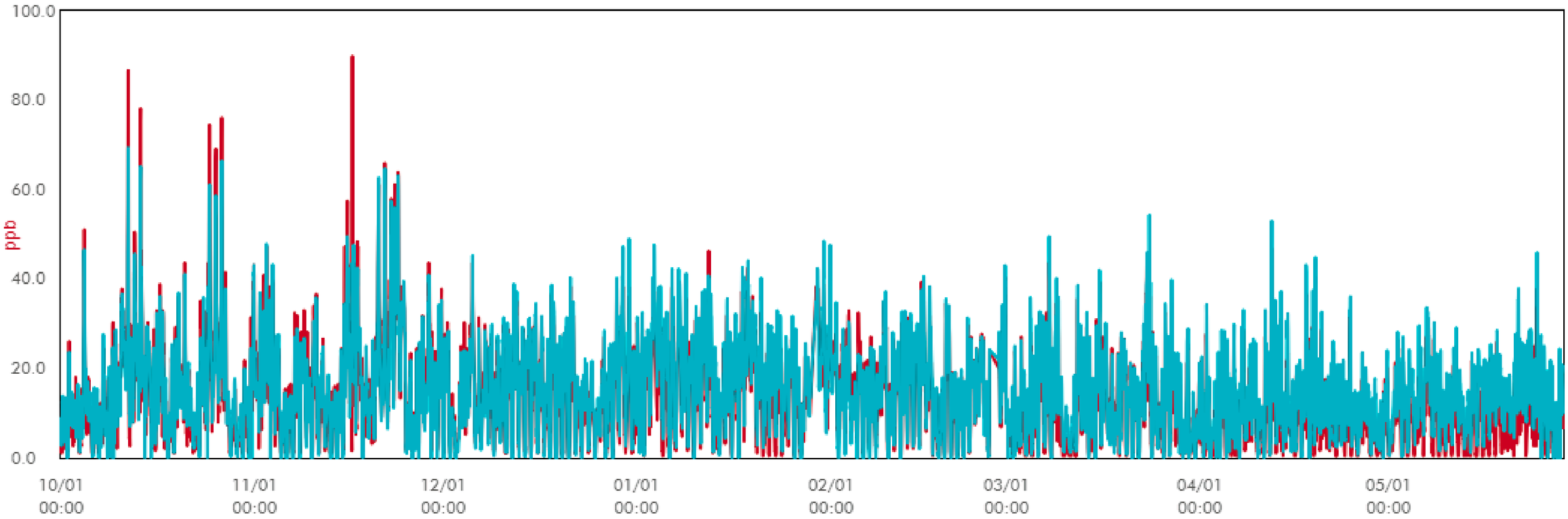
R^2	Accy (ppb)	90% Conf. (ppb)	DOQ (ppb)	Avg. T (ºC)	Avg. RH (%)	Avg. GC. Ref (ppb)	Avg. GC. DUT (ppb)	AV Ref/DUT
0.82	3.6	7.5	67	11.6	67.9	11.1	11.5	95% / 98%

Nitrogen Dioxide (NO2) OCT'17-MAY'18

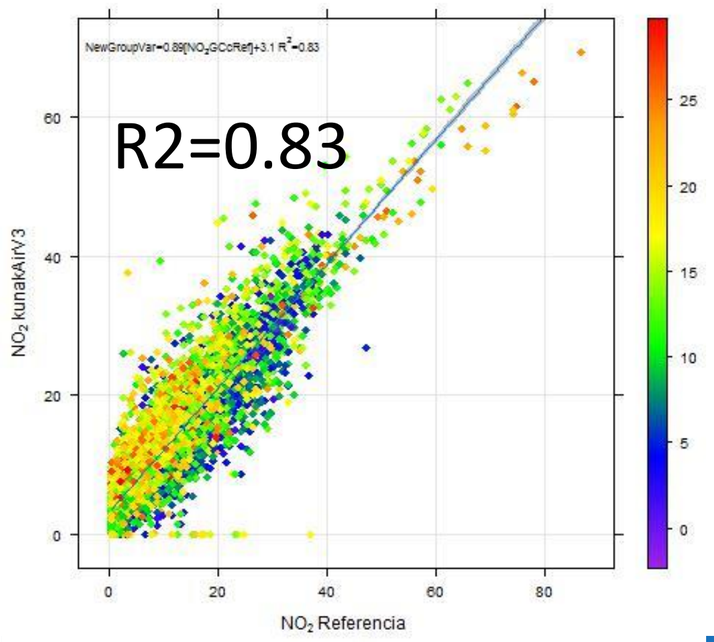
KUNAKAIRV3 VIRTUAL - NO2 GCc Ref (ppb)

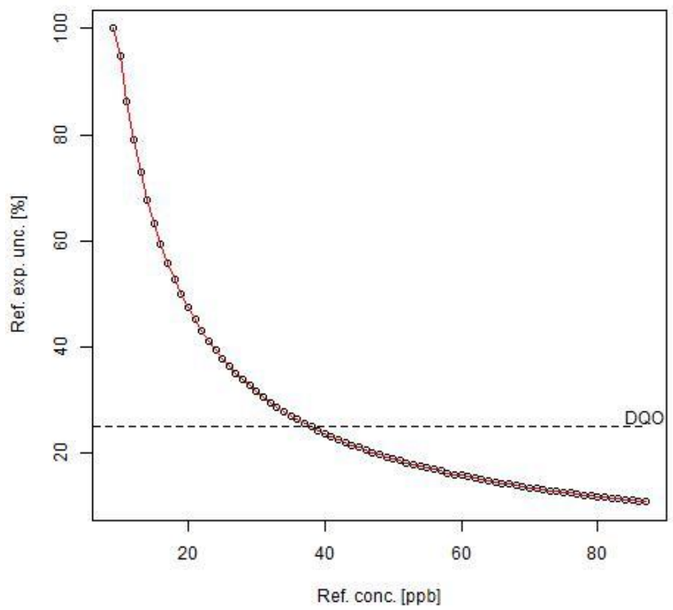
KUNAKAIRV3 VIRTUAL - NO2 GCc 1s (ppb)

| Show summary | Reset graph | Zoom out

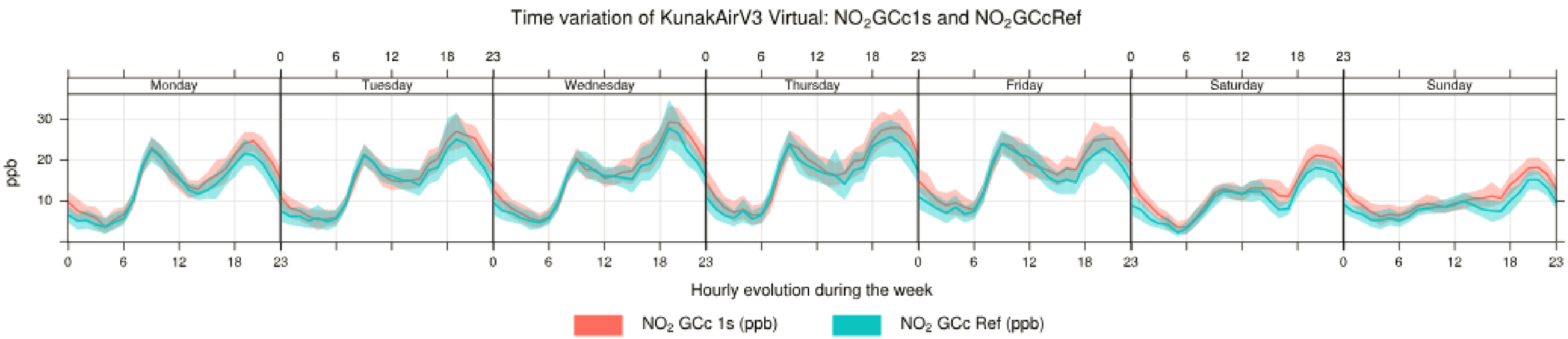


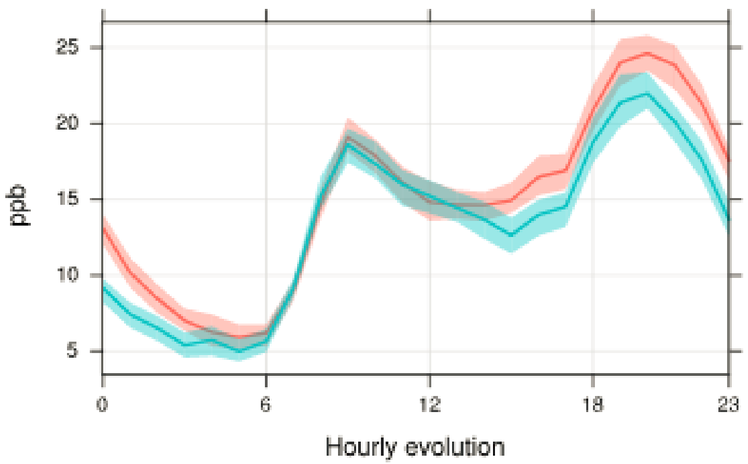
NO_2GCcRef vs. NO_2GCc by levels of TempExt

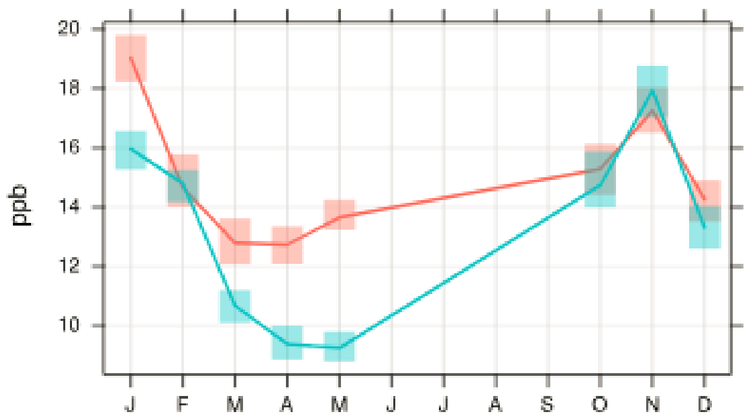


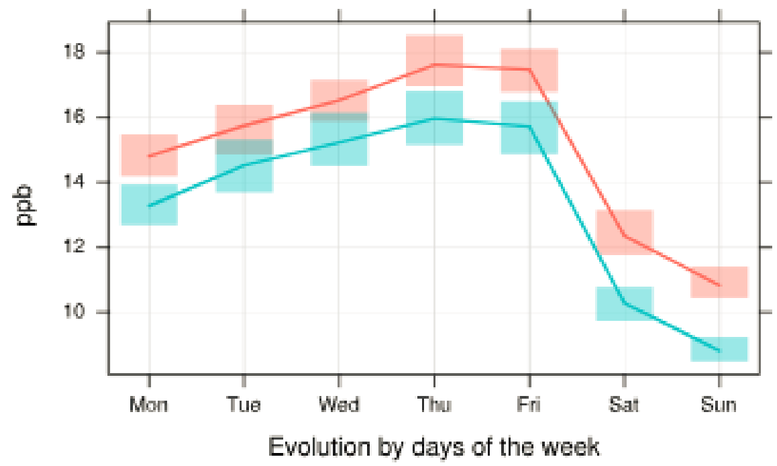


Nitrogen Dioxide (NO2) OCT'17-MAY'18



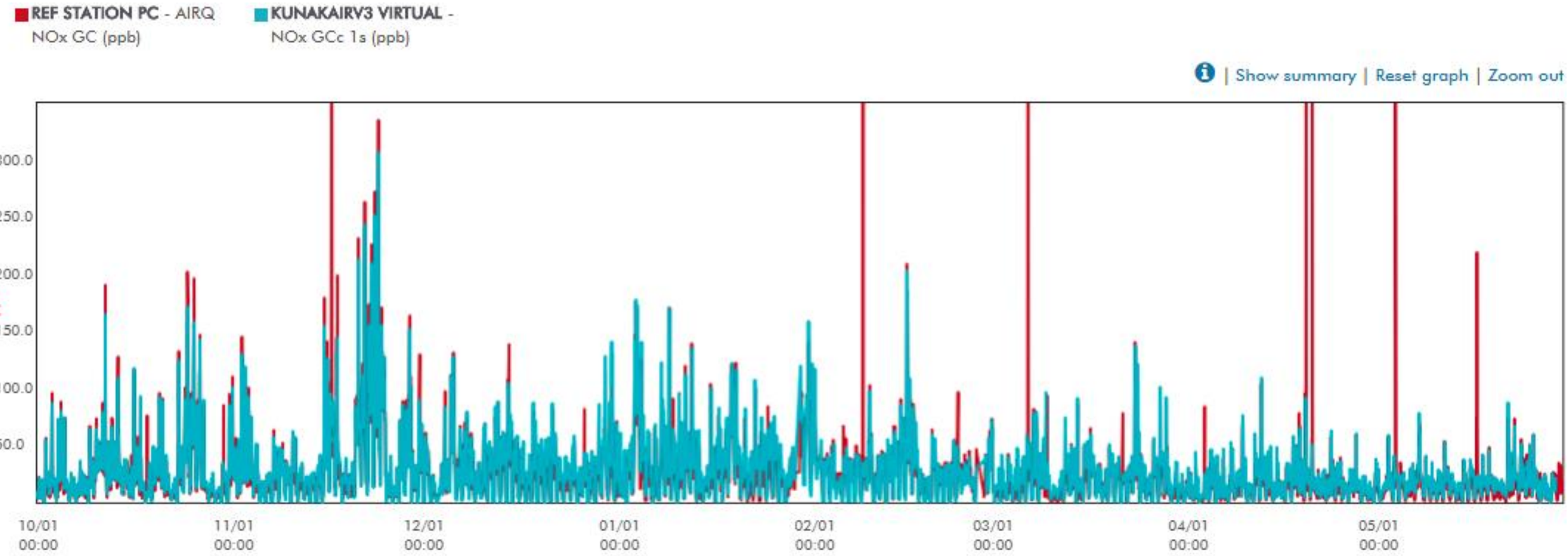


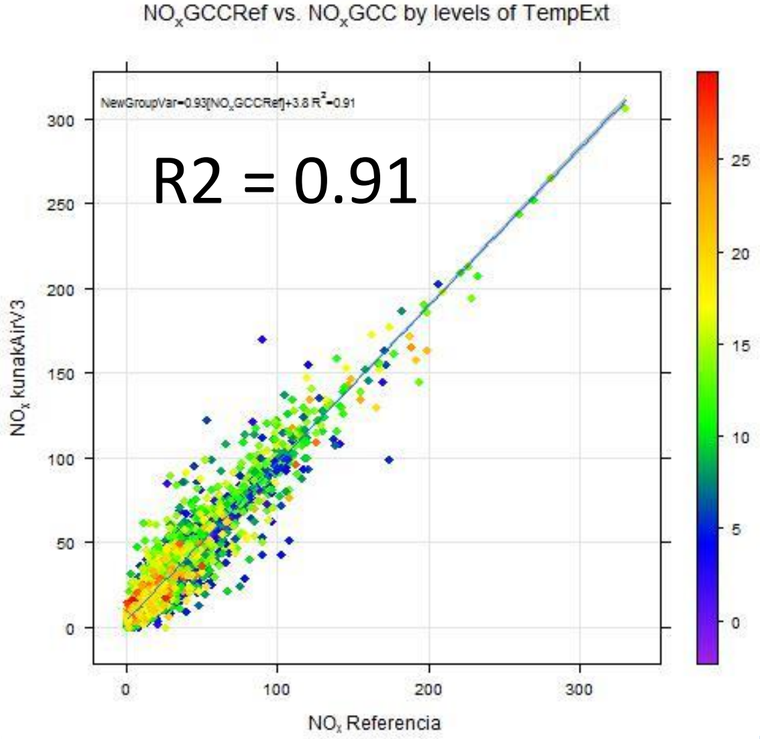


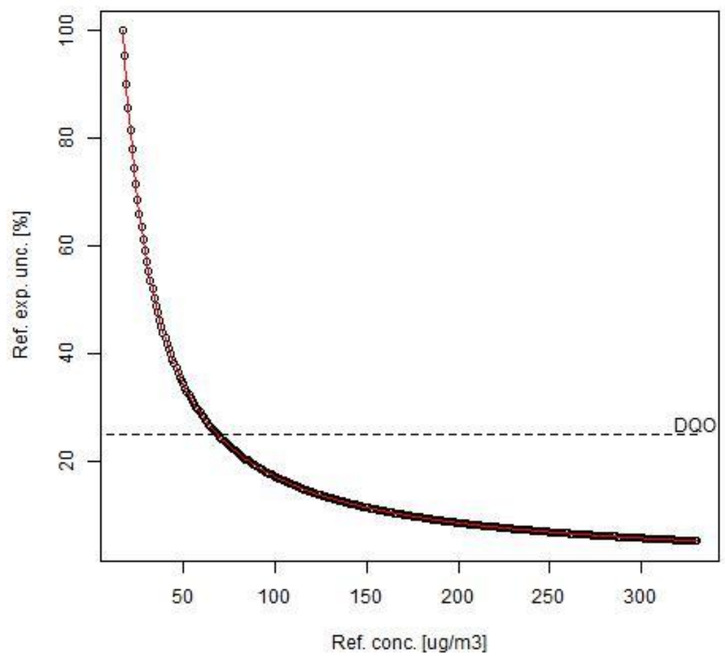


R^2	Accy (ppb)	90% Conf. (ppb)	DOQ (ppb)	Avg. T (ºC)	Avg. RH (%)	Avg. GC. Ref (ppb)	Avg. GC. DUT (ppb)	AV Ref/DUT
0.83	3.4	7.63	37	11.58	67.5	13.3	14.9	95% / 100%

Nitrogen Oxides (NOx) OCT'17-MAY'18

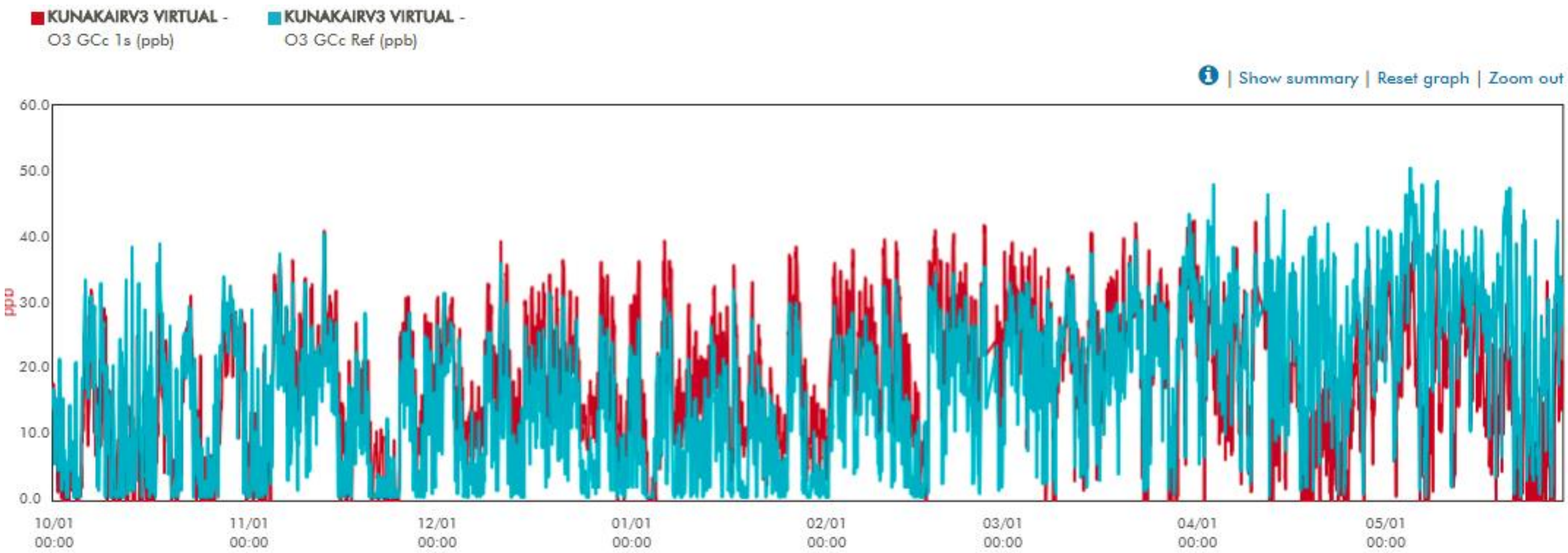


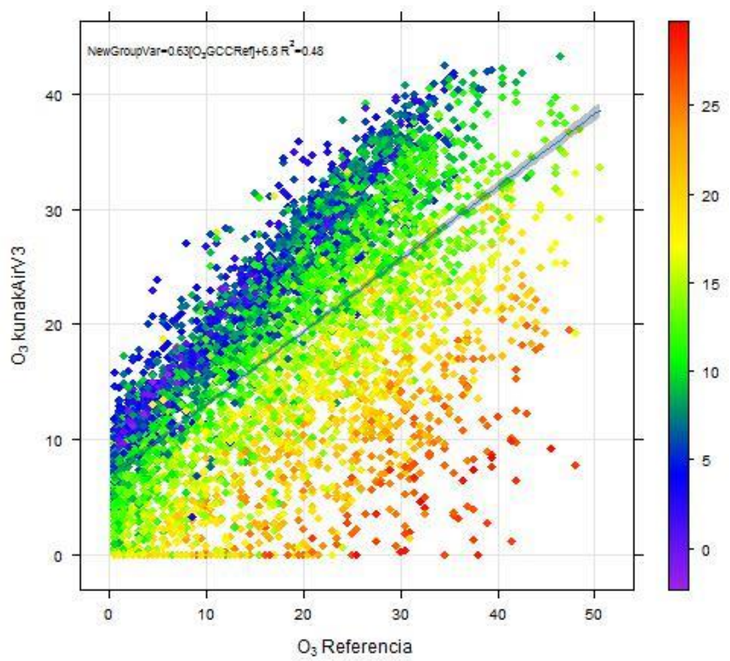


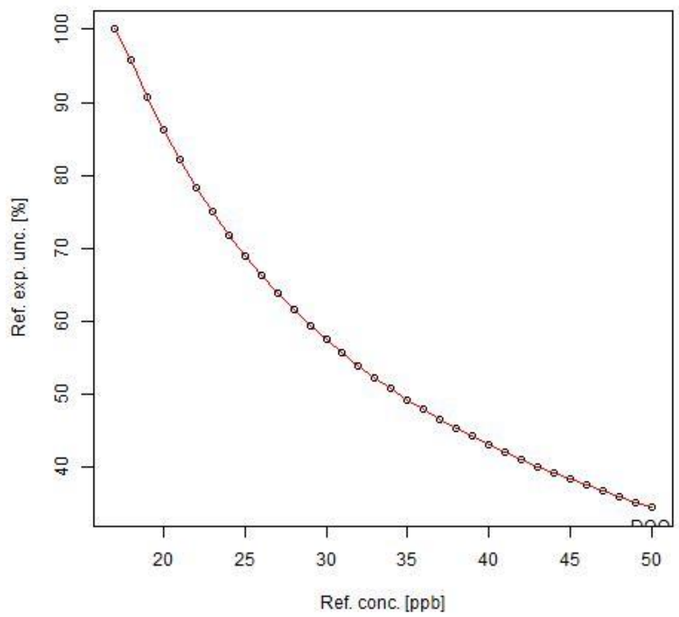


R^2	Accy (ppb)	90% Conf. (ppb)	DOQ (ppb)
0.91	5.65	12.2	66

Ozone (O3) OCT'17-MAY'18







R^2	Accy (ppb)	90% Conf. (ppb)
0.48	6.87	12.7

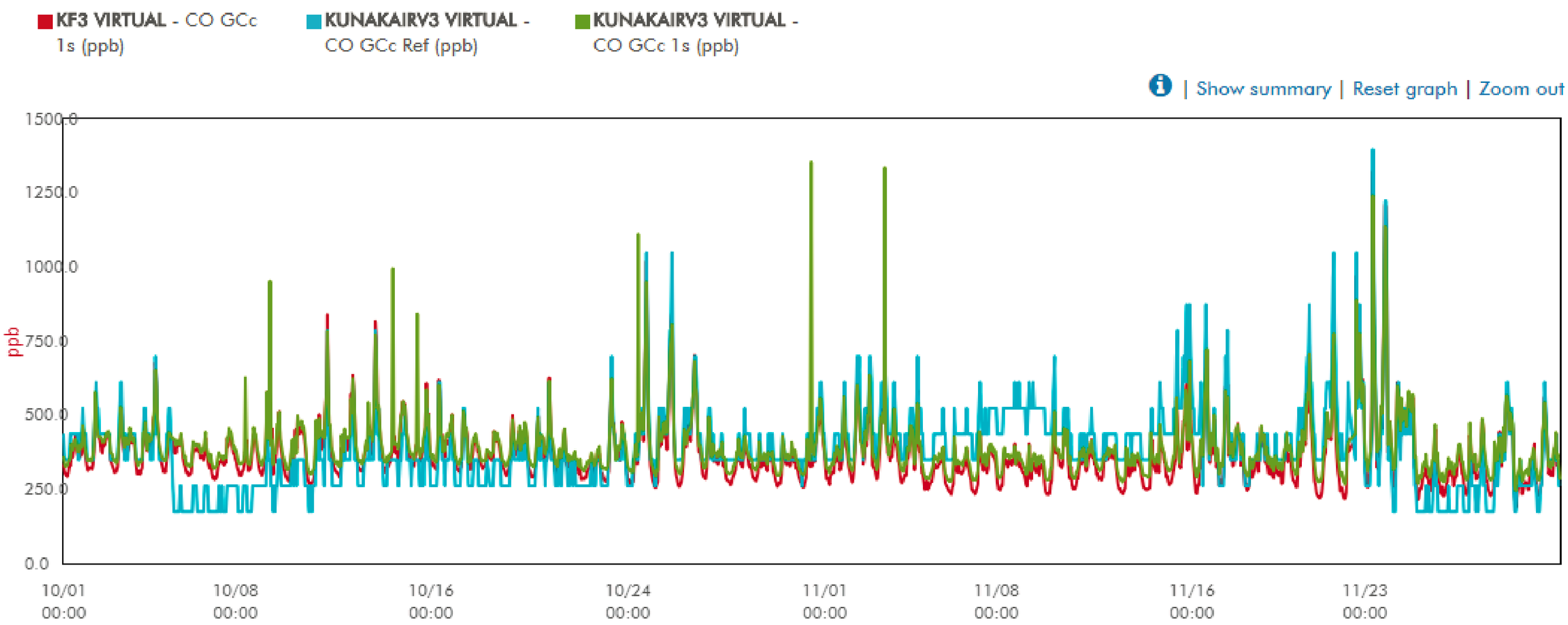
Variabilidad entre

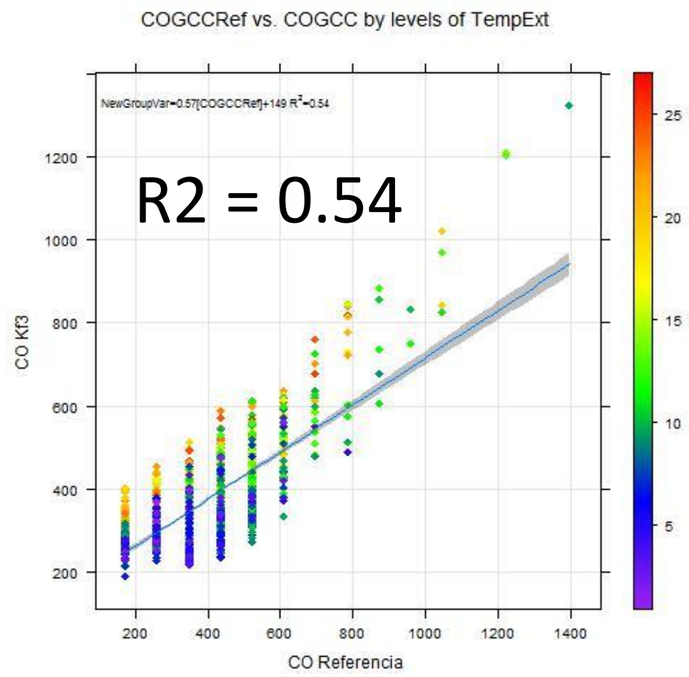
Dispositivos

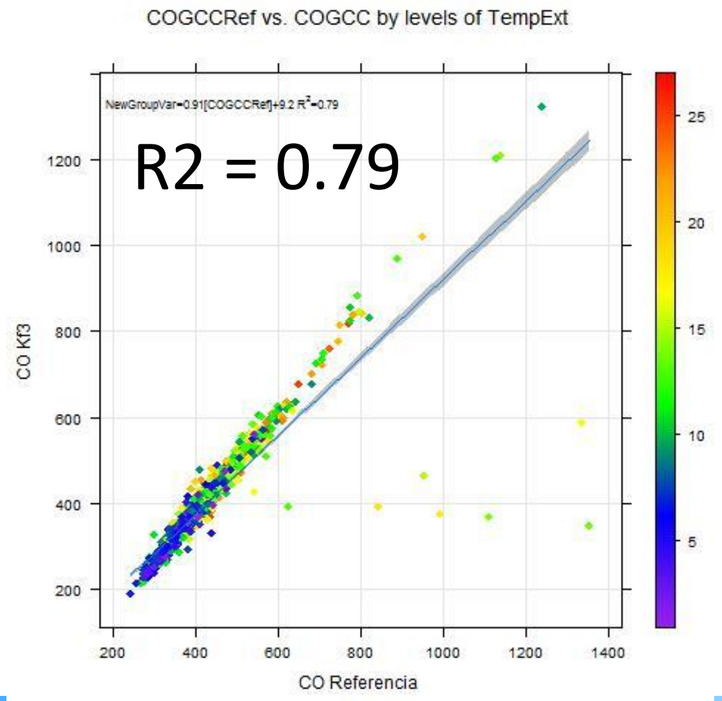
PAMPLONA

OCT’17-NOV’17

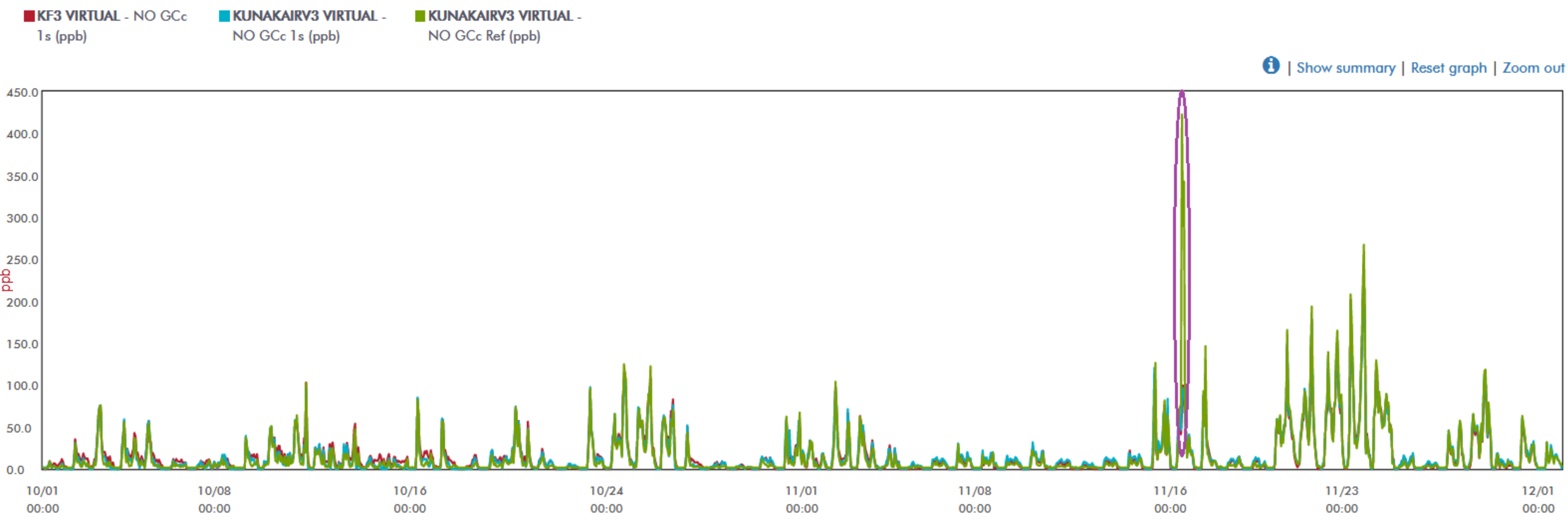
Carbon Monoxide (CO) OCT-NOV-17

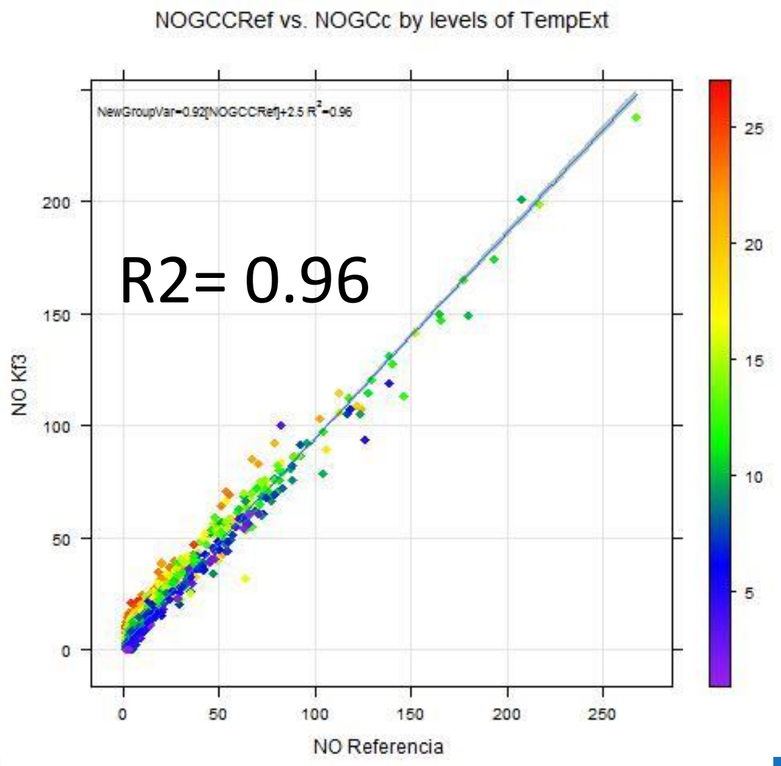


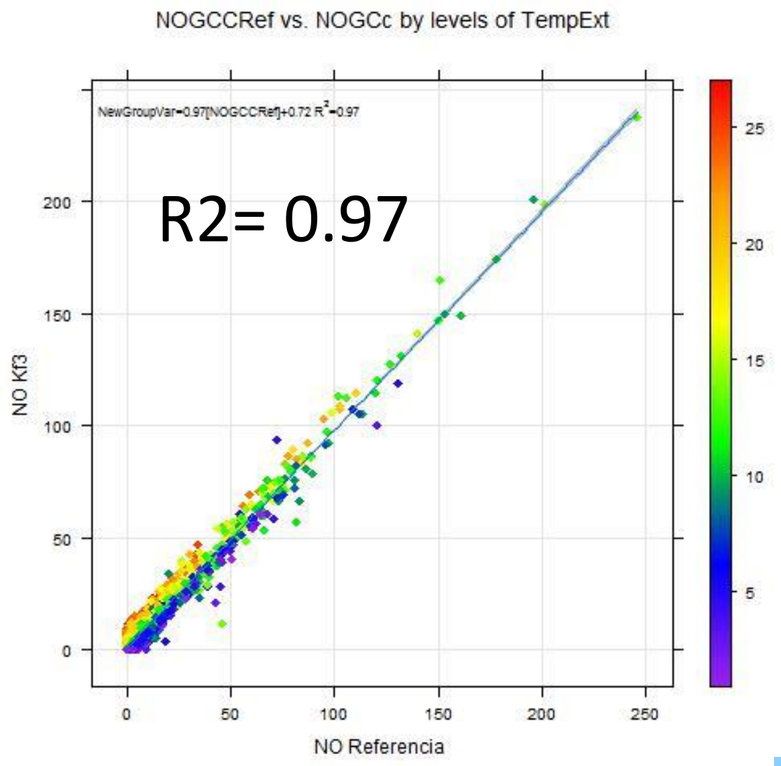




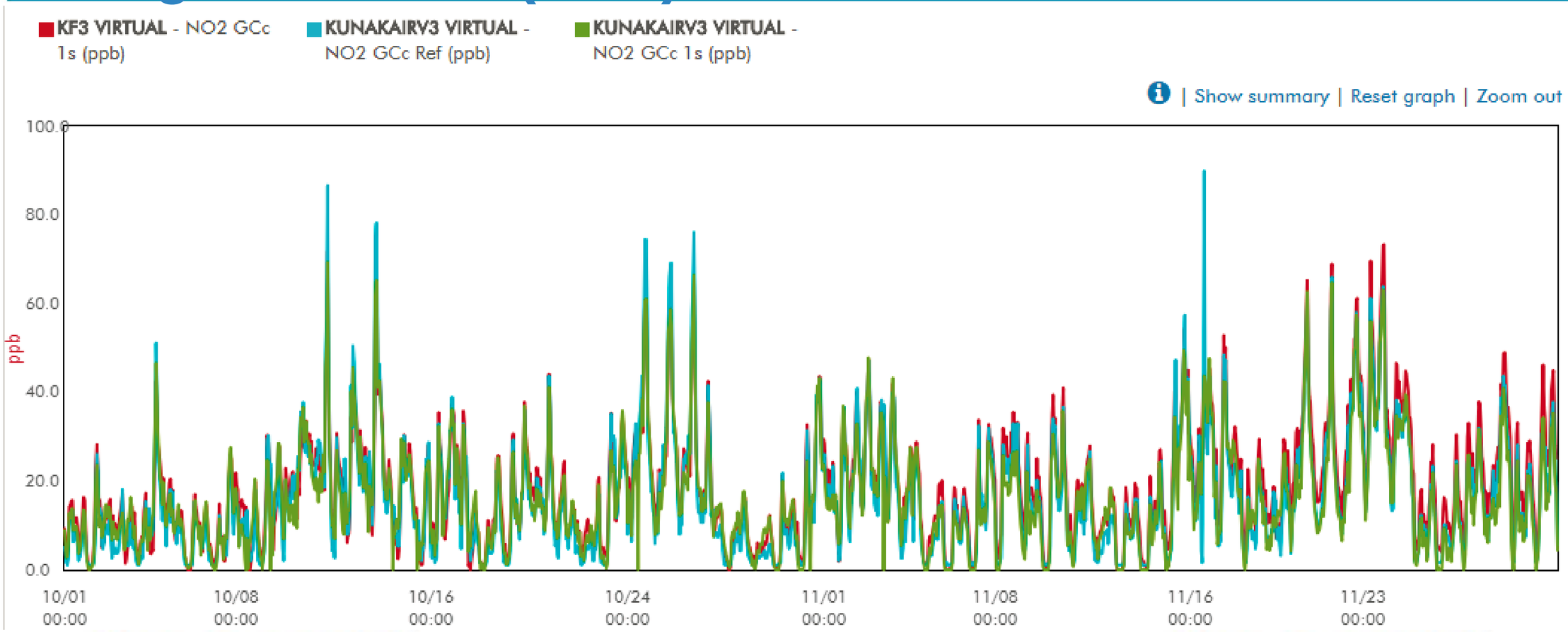
Nitrogen Oxide (NO) OCT-NOV-17

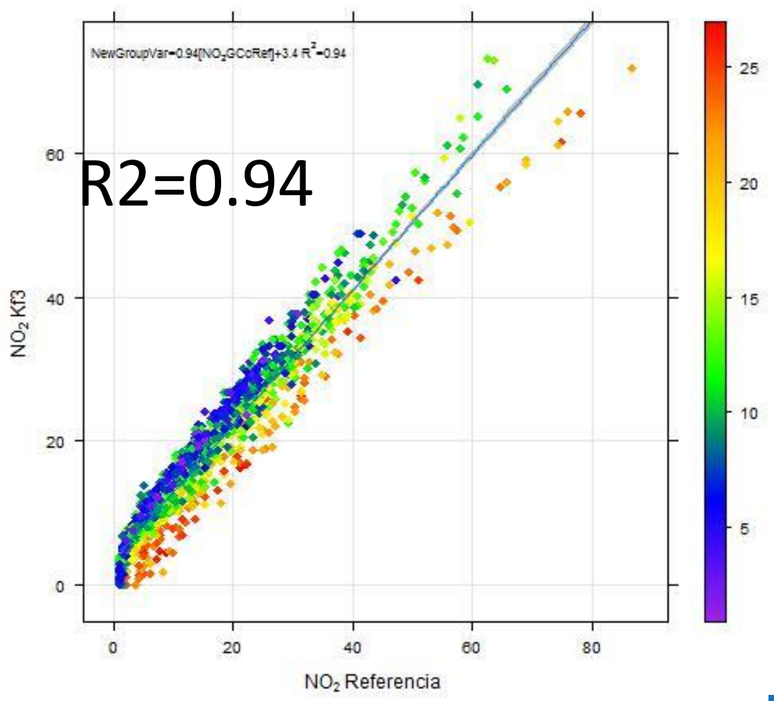


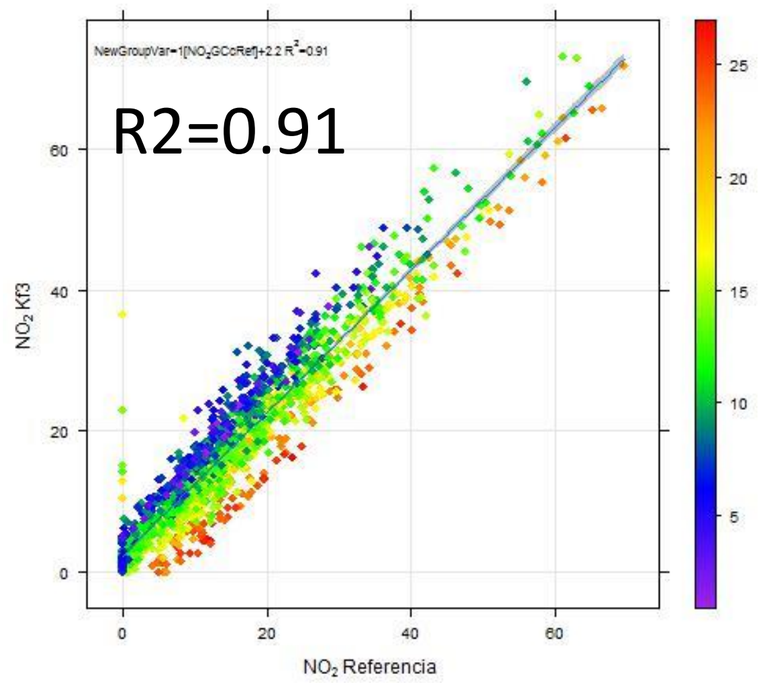




Nitrogen Dioxide (NO2) OCT-NOV-17







PM10-PM2.5. OCT-NOV-17

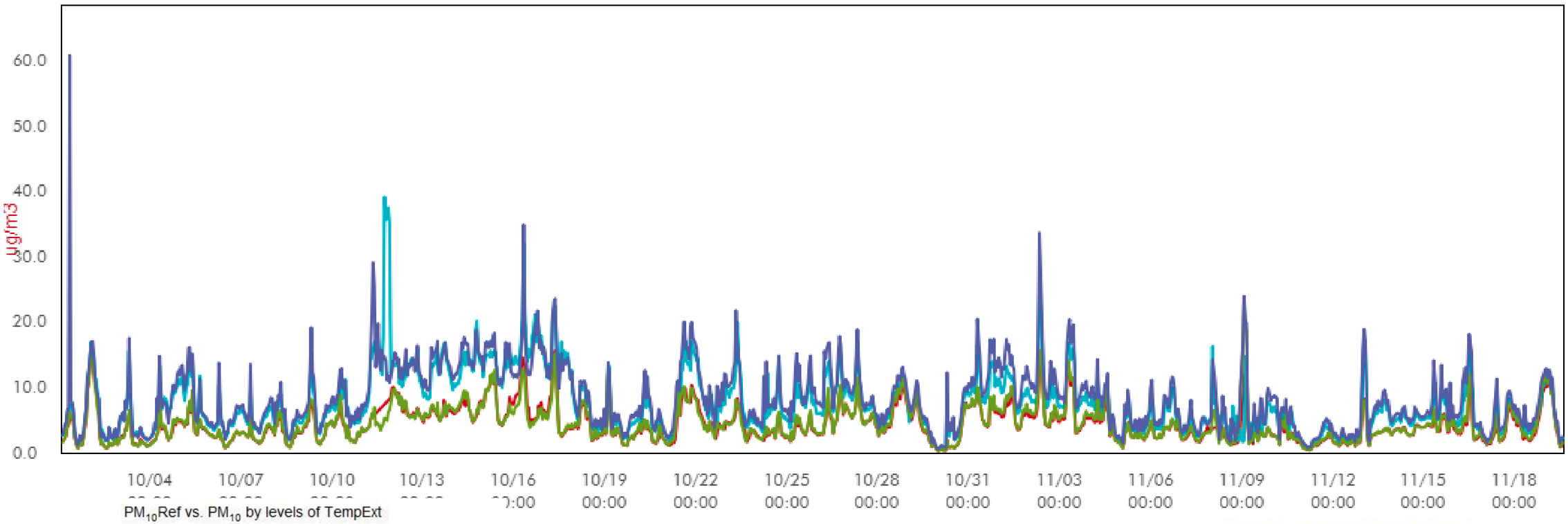
KF3 VIRTUAL - PM2.5 (ug/m3)

KF3 VIRTUAL - PM10 (ug/m3)

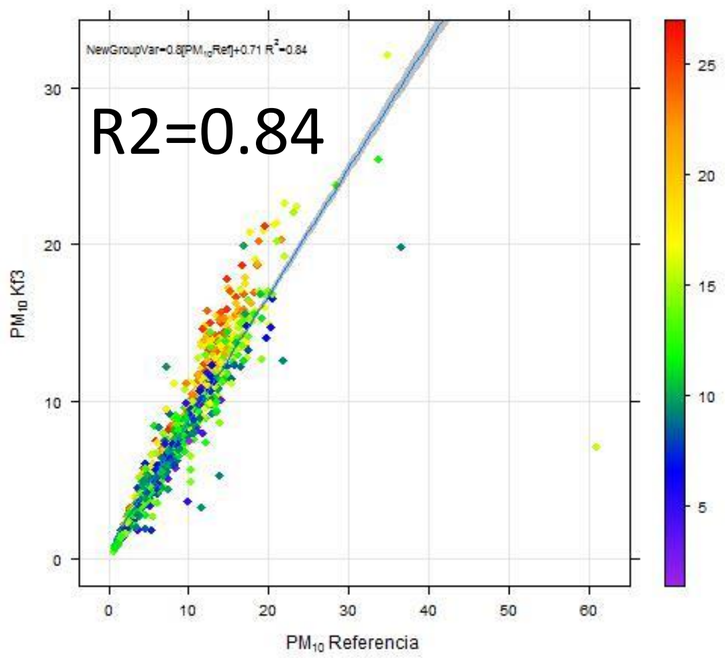
KUNAKAIRV3 VIRTUAL - PM2.5 (ug/m3)

KUNAKAIRV3 VIRTUAL - PM10 (ug/m3)

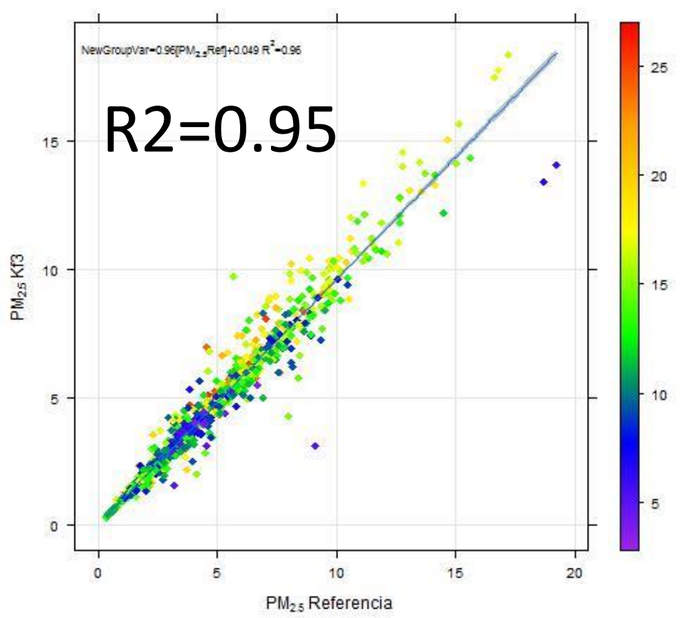
| Show summary | Reset graph | Zoom out



PM_{10}Ref vs. PM_{10} by levels of TempExt



$PM_{2.5}$Ref vs. $PM_{2.5}$ by levels of TempExt



3- Resumen Resultados OCT-NOV-17

	R^2 DUT1 vs Ref	R^2 DUT1 vs DUT2	Accy (ppb) DUT1 vs Ref.	Accy (ppb) DUT1 Vs DUT2
CO	0.53	0,79	74.41	29.15
NO	0.96	0.97	2.82	3.77
NO2	0.94	0.91	3.39	3.49
PM10	-	0.84	-	1.13
PM2.5	-	0.95	-	0.35

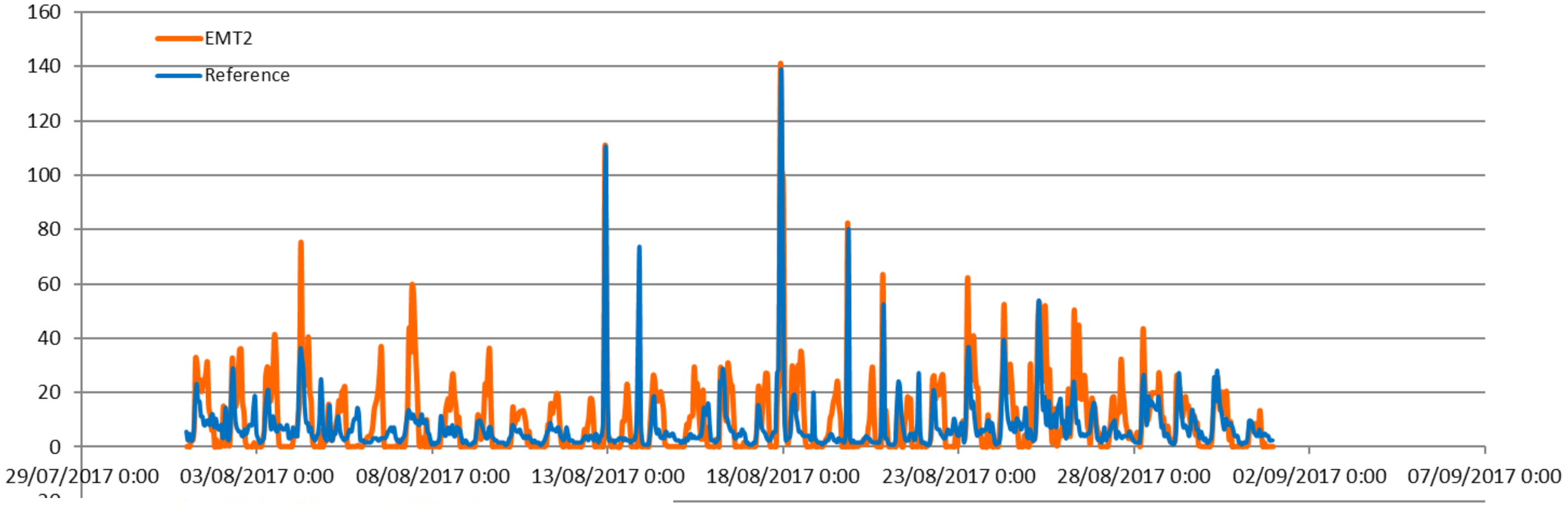
Prestaciones a Altas Temperaturas

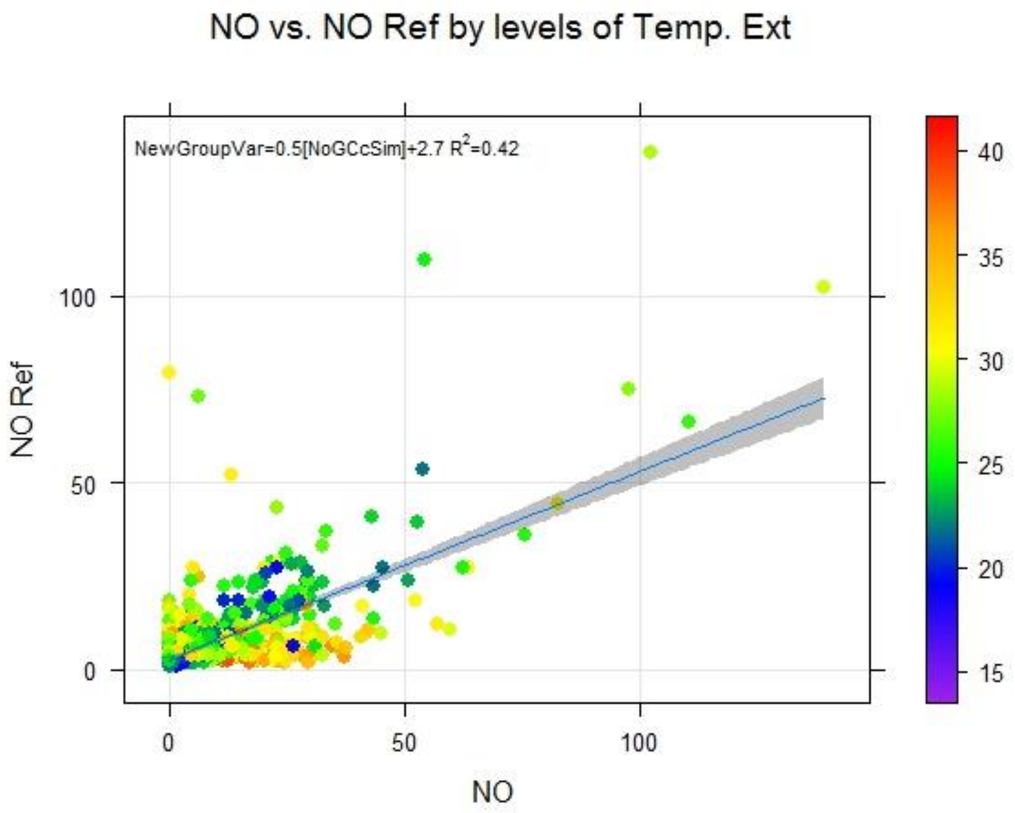
MADRID

Agosto’17

	August-17		
	Min	Avg	Max
T (ºC)	13.5	28.06	41.64
RH (%)	7.5	32.84	96.51

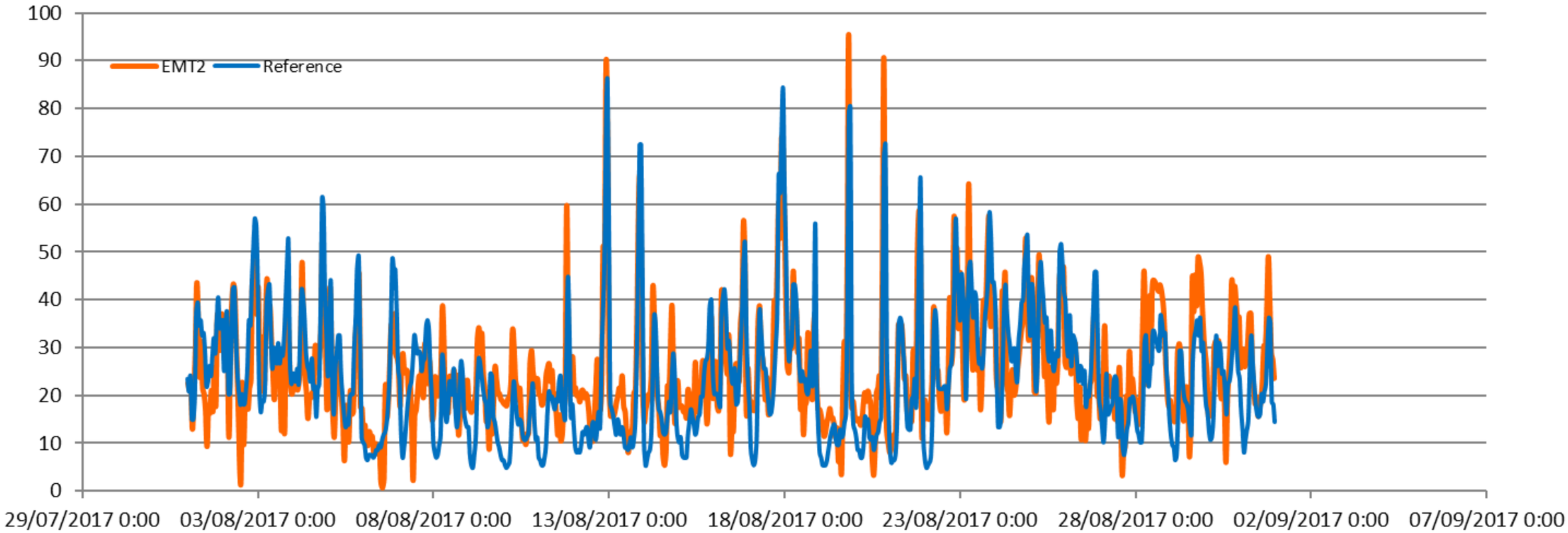
Nitrogen Oxide (NO)

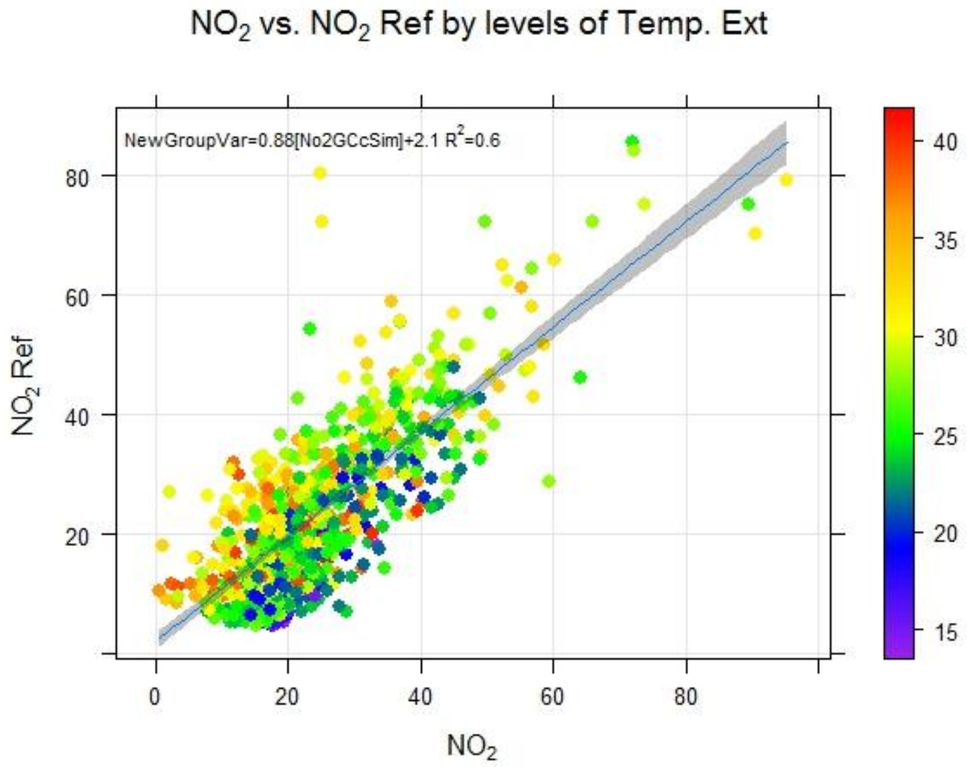




- R^2=**0.42**
- Accuracy: **7.1 ppb**

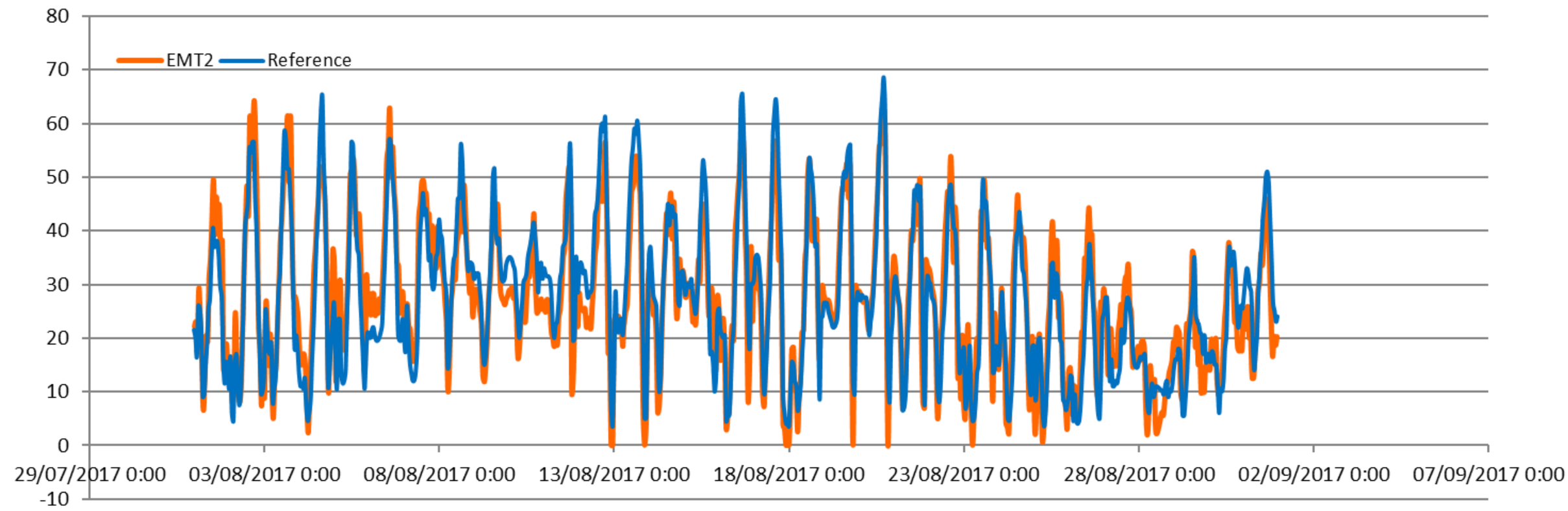
Nitrogen Dioxide (NO2)

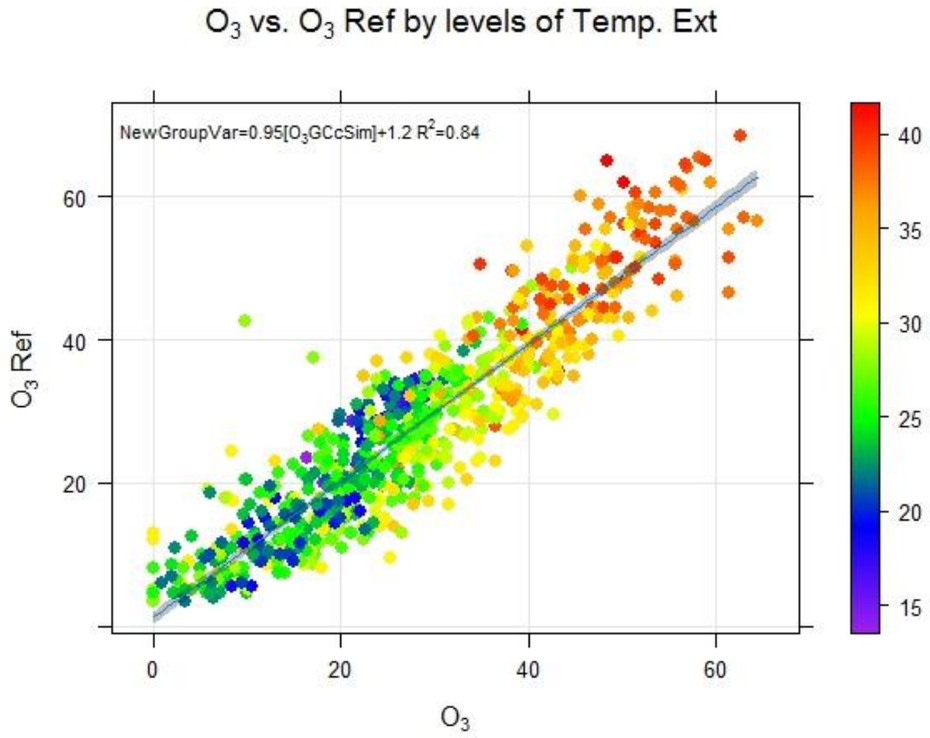




- R^2=0.6
- Accuracy: 6.8 ppb

Ozone (O3)





- R^2=**0.84**
- Accuracy: **4.5 ppb**

CONCLUSIONES

- ✓ PROBADO
- ✓ ALTAS CORRELACIONES Y EXACTITUD
- ✓ EXCELENTES DISPOSITIVOS PARA EVALUACIÓN DE TENDENCIAS MEDIAS
- ✓ ERRORES ACOTADOS
- ✓ EXPERIMENTOS REPETIDOS CON MISMOS RESULTADOS
- ✓ PRESTACIONES CONOCIDAS PARA LAS DIFERENTES CONDICIONES AMBIENTALES
- ✓ TODOS LOS EQUIPOS MIDEN IGUAL
- ✓ ENVEJECIMIENTO CONOCIDO
- ✓ CALIBRACIONES TRIMESTRALES MEJORAN LAS PRESTACIONES

Aplicaciones - Limitaciones

APLICACIONES & LIMITACIONES

INFORMACION EN TIEMPO REAL PARA LA TOMA DE DECISIONES

INFORMACION CUALITATIVA

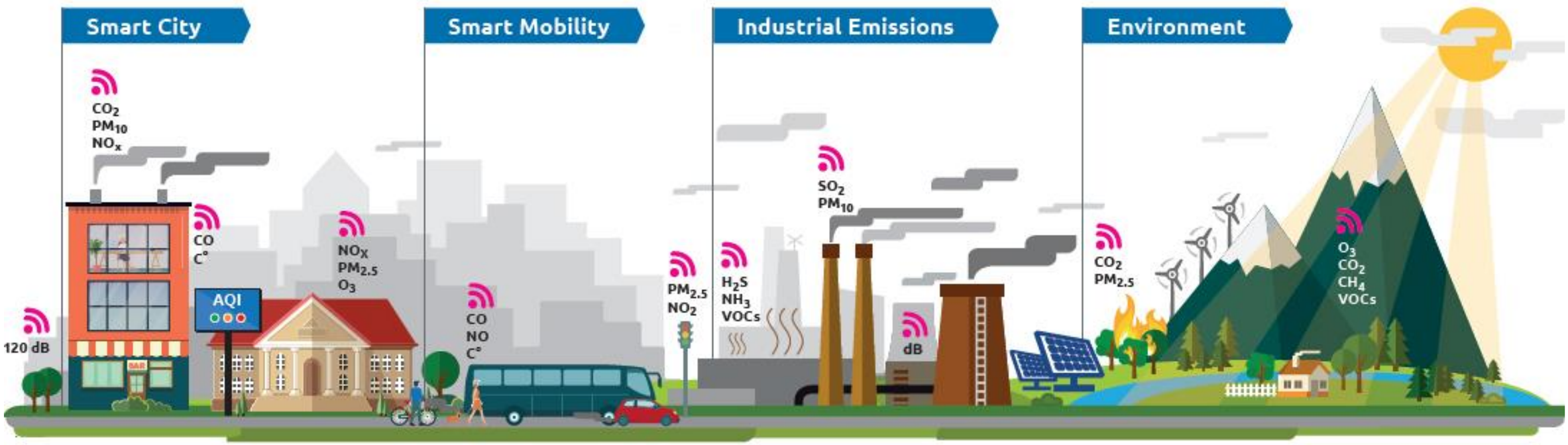
- Variabilidad Espacial
- Variabilidad Temporal

CONTROL CUANTITATIVO

- Medida indicativa Directiva 208/50/EC
- Medida de referencia Directiva 208/50/EC

- Gestión de la Calidad del Aire
- Cumplimiento de Legislación Ambiental

Aplicaciones



- **Extensión de redes** integradas en Plataformas SC
- Diseño Urbano **Sostenible**
- **Información Pública** en tiempo real
- **Educación** y concienciación

- Control de Sistemas de **Tráfico Inteligente**
- **Mapeo** desde vehículos

- Controlar **focos** de contaminación y olores
- Controlar **perímetros** industriales

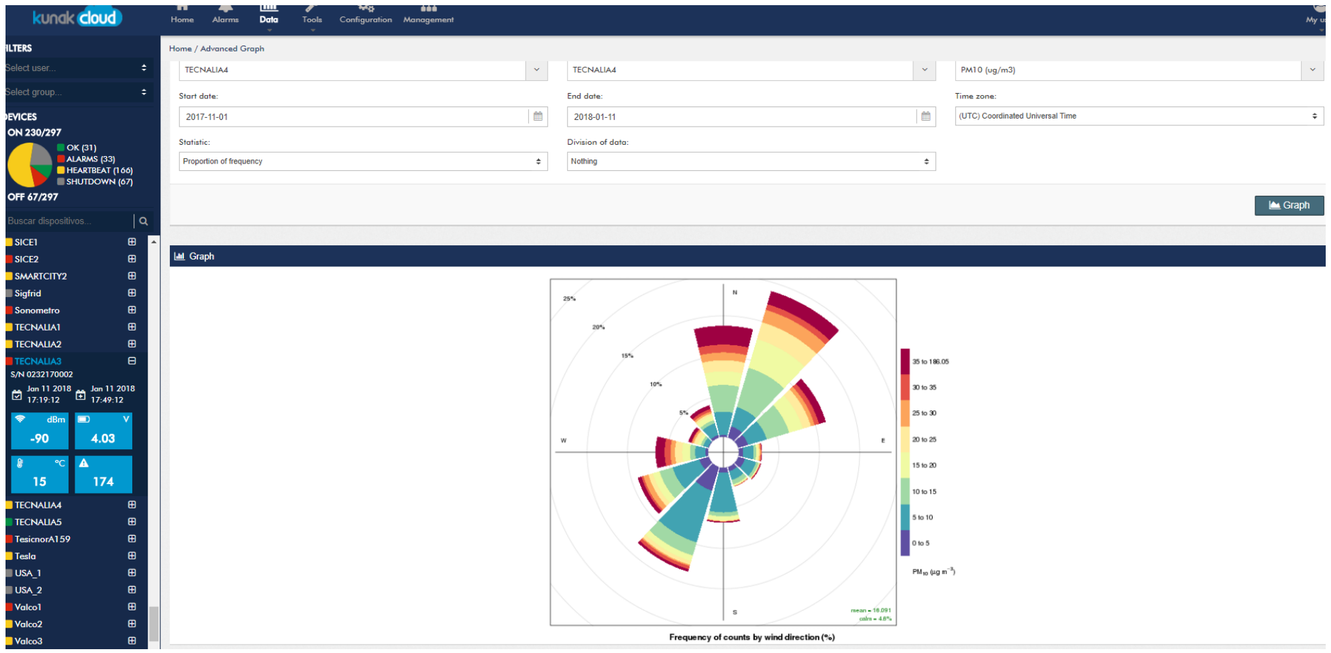
- Evaluar el **impacto** ambiental

- Rápidos despliegues en **investigación** y consultoría
- **Alerta** temprana de Ozono y otros riesgos
- Mejora de **Modelos**

CASO DE ÉXITO | LIFE RESPIRA

CASO DE ÉXITO | SISTEMAS DE TRAFICO INTELIGENTE (MEXICO)

CASO DE ÉXITO | RED PERIMETRAL INDUSTRIAL

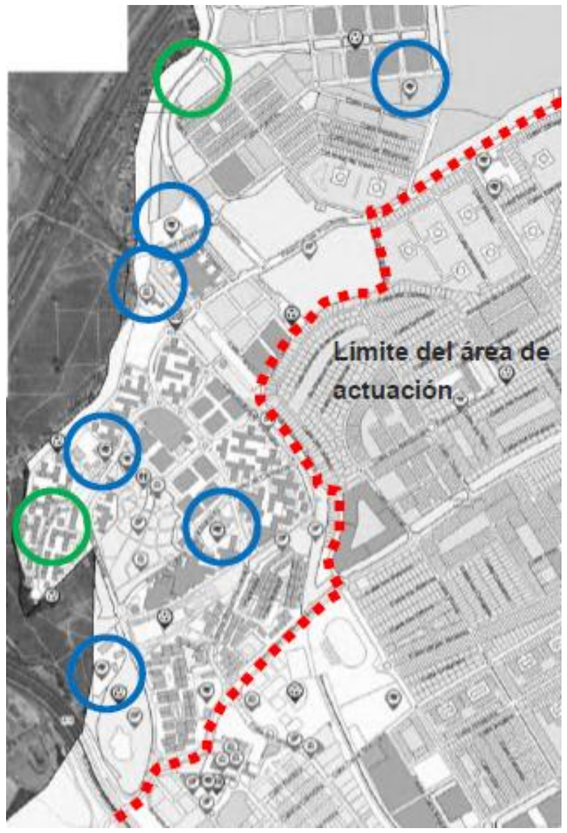


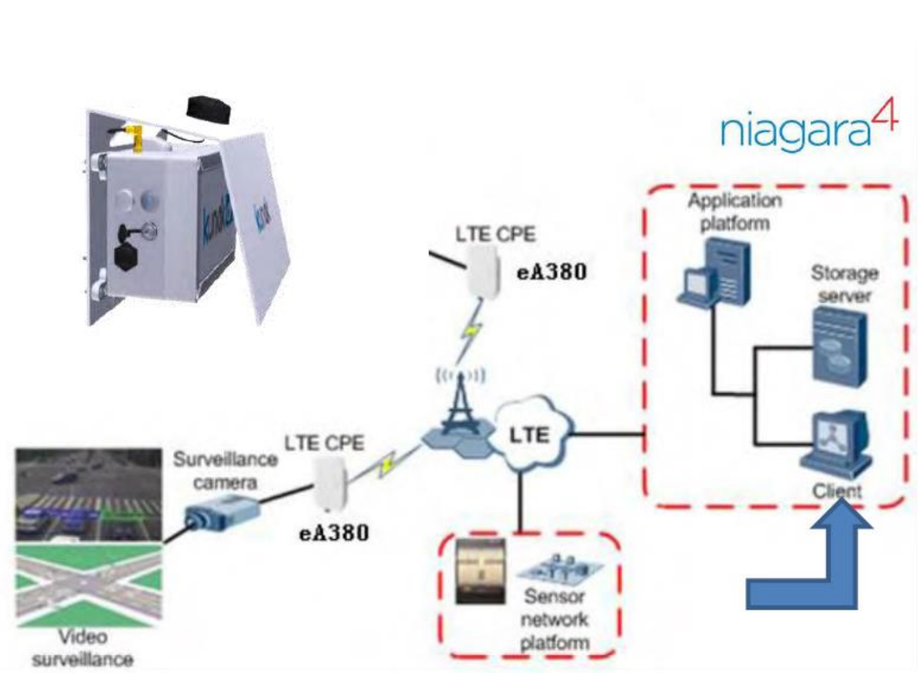
CASO DE ÉXITO | RED CALIDAD DEL AIRE PARA EDUSI

LABAQUA

RIVAS VACIAMADRID

IV CONGRESO CIUDADES INTELIGENTES
Madrid 30-31 Mayo 2018

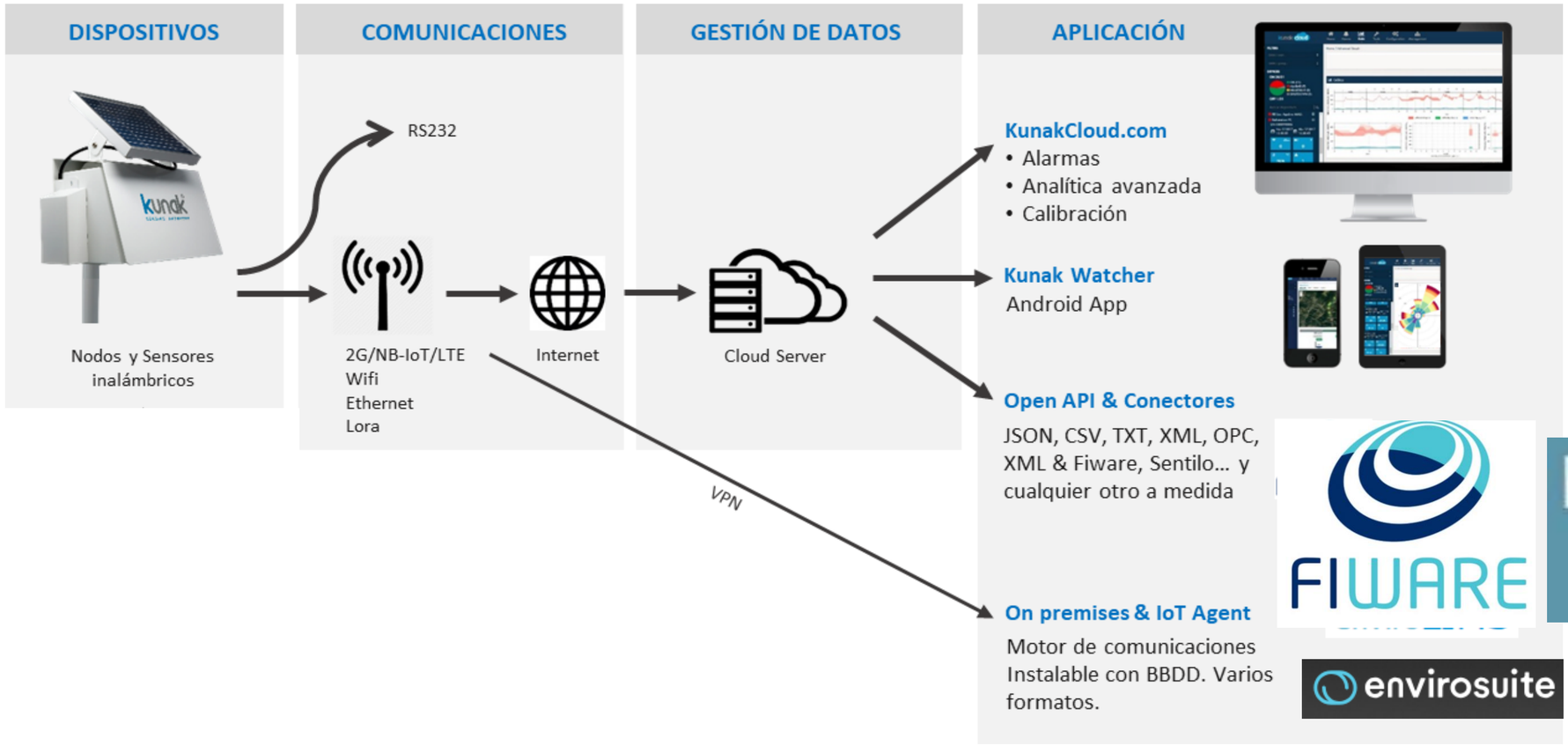


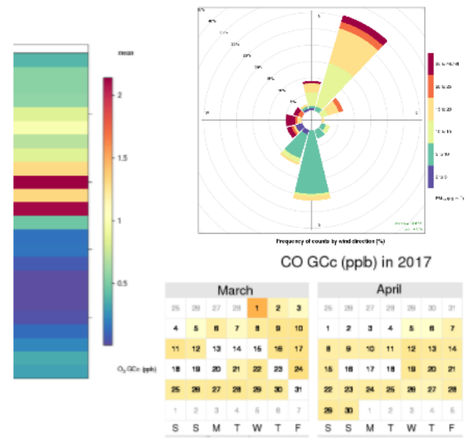


Conclusiones

CADENA DE VALOR

INFORMACION EN TIEMPO REAL PARA LA TOMA DE DECISIONES





FIWARE

Enviro LIMS

sentilo

Diseño de red - Plan de Implantación macro - micro

Plan de Mantenimiento y calibración

Validación e informes

red.es

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Gracias!

www.air.kunak.es

info@kunak.es