

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

COST Action TD1105

Focus Group Meeting on

*Data Analysis of Aveiro Air Quality Sensors Intercomparison*

WHO Collaborating Centre (CC) for Air Quality Management and Air  
Pollution Control - Federal Environment Agency (FEA)  
Berlin, Germany, 17 April 2015

Action Start date: 01/07/2012 - Action End date: 30/06/2016 - Year 3: 2014-15 (*Ongoing Action*)

How to Manage & Process the Aveiro AQ Sensors Database



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Function in the Action: (WG Member)

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# Scientific context and objectives

## Background / Problem statement:

- Many different sensors deployed in Aveiro, with different sampling rates, separate time stamps, different logging methods.
- Mixture of commercial ECC's, modified ECC's, prototype sensors, MOX etc.
- Probably lots of interesting data – especially as first week windy and wet, second week 15 – 36°C diurnal temperature range, low wind speed.
- So far, we have chosen data and aggregated to one-minute for comparison with IDAD AQ suite, and put into the Excel file format.
- **What next?**
- **Context** – what do we see in the data? Causation? Interesting phenomena?
- **Format** – why not also save .csv to allow easy use within other programs?
- **Processing** – OpenAir in R = free package for air quality data analysis with many built in functions specific to air quality interpretation – I am using now..

# The database

- I have taken the following steps with the SNAQ box data:

## LEVEL 0

- Raw binary data from SNAQ boxes (raw signal)
- Processed in Mathematica (!) using existing code gives a raw output file as .csv

## LEVEL 1

- Raw output files are corrected for temperature and humidity effects.
- Converted to concentration values in ppb.
- Basic plots produced for checking and re-processing of the data.

## LEVEL 2

- Additional processing to replace values  $<0.00$  with '-1.00' ('NA')
- Removal of unusual outlying data points caused by power surges (?)
- CO ppb converted to CO ppm.

## LEVEL 3

- Further post-processing of NO to remove temperature affect using a 'MinFilter'.
- subtract  $O_3$  from  $NO_2$  to get  $O_3$  corrected values (because 100 % interference)
- Particle counts converted to  $PM_{2.5}$  and  $PM_{10}$  in  $ug/m^3$  (caveats)

- With each 'Level' I also update a 'Read Me' file – very important – metadata!

# The database

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB
date	time	s1lco	co	s1lno	no	s1lno2	no2	s1lno3	o3	s1lso2	so2	s1lvoc	s1lvoc	s1lco2	s1lco2	s1lufp	s1lpm	s1lufp	s1lpm	s1ltemp	s1ltemp	s1lhr	s1lhr	s1lows	s1lws	s1lwd	s1lwd
14/10/2014	00:30:00	0.062333	0.5	8.914829	0.5	2.61	4.2	72.67968	32.4	21.4	1.3	15.77	123.48	402	407	10.97	16.38	11.99	29	11.6	12.95	94.48	93.87	1.45	1.53	342.97	21.73
14/10/2014	00:31:00	0.061667	0.5	7.115189	0.5	3.01	4.3	71.35729	32.1	25.78	1.3	13.28	124.87	402	407	11.25	23.8	9.19	19.11	11.58	12.94	94.43	93.87	1.59	1.78	1.46	42.32
14/10/2014	00:32:00	0.060333	0.2	8.607879	0.5	3.2	4.4	53.61845	31.9	23.89	1.3	13.56	122.44	402	407	10.65	20.9	10.77	21.65	11.57	12.93	94.42	93.87	1.09	1.53	8.29	53.76
14/10/2014	00:33:00	0.058	0.2	6.919697	0.4	2.82	4.4	80.97844	31.7	25.29	1.3	10.93	125.22	402	407.33	12.72	26.4	10.34	22.15	11.56	12.91	94.38	93.87	1.83	1.65	5.23	58.64
14/10/2014	00:34:00	0.056333	0.2	6.717879	0.4	3.16	4.5	67.20715	31.4	19.76	1.3	8.3	125.57	402	407	10.31	24.27	11.12	25.78	11.55	12.88	94.39	93.87	1.42	1.36	6.87	42.94
14/10/2014	00:35:00	0.069667	0.7	9.116364	0.4	3.38	4.5	81.8659	31.4	21.06	1.3	8.44	128.35	402	407.67	11.12	19.67	9.18	24.55	11.52	12.88	94.36	93.87	1.35	1.7	5.72	59.47
14/10/2014	00:36:00	0.106667	0.9	10.90818	0.4	3.03	4.5	83.81004	31.4	23.33	1.3	1.8	125.57	402.67	407	10.7	22.39	7.68	21.85	11.51	12.86	94.35	93.88	1.88	2.37	340.58	36.36
14/10/2014	00:37:00	0.114333	0.6	11.65727	0.4	2.52	4.5	59.93006	31.6	21.33	1.3	8.3	131.48	403.33	407	9.95	19.64	9.69	20.78	11.5	12.85	94.34	93.87	1.71	1.52	359.36	35.12
14/10/2014	00:38:00	0.101333	0.7	6.445152	0.4	2.94	4.4	77.54858	31.8	28.8	1.3	6.09	130.44	402.67	408	8.13	14.39	8.82	18.74	11.48	12.83	94.32	93.86	1.81	1.99	346.77	40.69
14/10/2014	00:39:00	0.103667	0.4	8.862727	0.4	3.11	4.2	70.14496	32	18.02	1.3	5.67	132.17	402.67	408	7.93	16.47	8.69	20.5	11.47	12.81	94.29	93.86	1.62	1.9	349.11	30.02
14/10/2014	00:40:00	0.090667	0.3	6.810606	0.4	2.71	4	57.32663	32.2	15.99	1.3	4.29	129.39	403	408	8.05	13.46	8.25	23.61	11.47	12.8	94.3	93.85	1.45	1.54	20.07	58.6
14/10/2014	00:41:00	0.066667	0.2	7.057879	0.4	2.53	3.9	92.28519	32.3	30.31	1.3	6.09	128.7	403	408	9.27	33.83	8.06	17.98	11.45	12.79	94.28	93.87	1.83	1.83	349.88	49.2
14/10/2014	00:42:00	0.063	0.3	10.44333	0.4	2.43	3.8	54.7765	32.4	23.1	1.3	5.39	130.44	403.33	408	7.99	15.68	6.95	25.4	11.45	12.78	94.28	93.89	1.28	1.47	346.27	53.24
14/10/2014	00:43:00	0.048667	0.3	14.11242	0.4	2.52	3.8	58.88924	32.4	20.33	1.4	5.12	123.83	403	408	7.14	13.41	7.01	17.64	11.42	12.76	94.28	93.87	1.87	1.42	23.37	80.12
14/10/2014	00:44:00	0.037667	0.2	8.20697	0.4	2.67	3.7	87.94629	32.6	15.02	1.3	NA	124.87	402.33	408	7.32	15.01	7.83	25.57	11.42	12.75	94.28	93.89	1.93	1.84	0.13	51.31
14/10/2014	00:45:00	0.037667	0.1	10.97212	0.5	2.53	3.6	74.90899	32.8	16.98	1.3	NA	128.35	402	407	7.02	20.44	6.01	14.04	11.41	12.74	94.25	93.87	1.49	1.97	2.33	60.4
14/10/2014	00:46:00	0.047667	0.1	24.46	0.5	2.8	3.6	60.05107	33	26.64	1.3	3.32	128	401.33	407	7.56	14.68	6.93	14.24	11.4	12.72	94.23	93.88	1.95	1.89	9.64	42.51
14/10/2014	00:47:00	0.043667	0.1	18.21152	0.4	2.32	3.5	52.61674	33.1	20.71	1.3	2.21	130.09	401	407	6.05	12.03	6.69	16.38	11.39	12.71	94.24	93.9	2.22	2.06	17.57	58.19
14/10/2014	00:48:00	0.056	0.1	17.19364	0.5	2.58	3.5	79.12502	33.2	22.64	1.3	3.59	134.26	400	407	7.14	12.26	6.2	18.49	11.38	12.69	94.22	93.88	1.89	1.96	11.91	49.71
14/10/2014	00:49:00	0.055333	0.2	13.96515	0.5	2.72	3.4	73.05485	33.3	23.35	1.3	4.15	130.09	400	407	6.77	19.3	7.64	18.74	11.36	12.69	94.22	93.92	1.49	1.98	3.47	54.39
14/10/2014	00:50:00	0.053	0.3	11.55697	0.4	2.81	3.3	52.08524	33.4	27.68	1.3	4.15	134.26	399	407	7.47	13.45	7.51	25.71	11.35	12.68	94.23	93.92	1.37	1.42	2.34	45.63
14/10/2014	00:51:00	0.048	0.4	13.11091	0.4	2.48	3.3	69.48475	33.5	24.15	1.3	3.32	133.22	399	407	8.07	13.48	6.93	23	11.34	12.66	94.24	93.92	1.99	1.58	11.28	60.9

Here is the latest file....but saved as .csv so I can manipulate in R and use OpenAir.

- I chose data from 14/10/14 00:30:00 – 27/10/14 14:29:00 – 20s data
- SNAQ10 ECC's not included – seems to be issue with power surges!
- Still need to add in units! OpenAir will automatically arrange if included..
- Meta-data recorded in READ ME file – have YOU recorded meta-data???
- Should we have a separate file for ALL meta-data (including photos)?

# Sensors

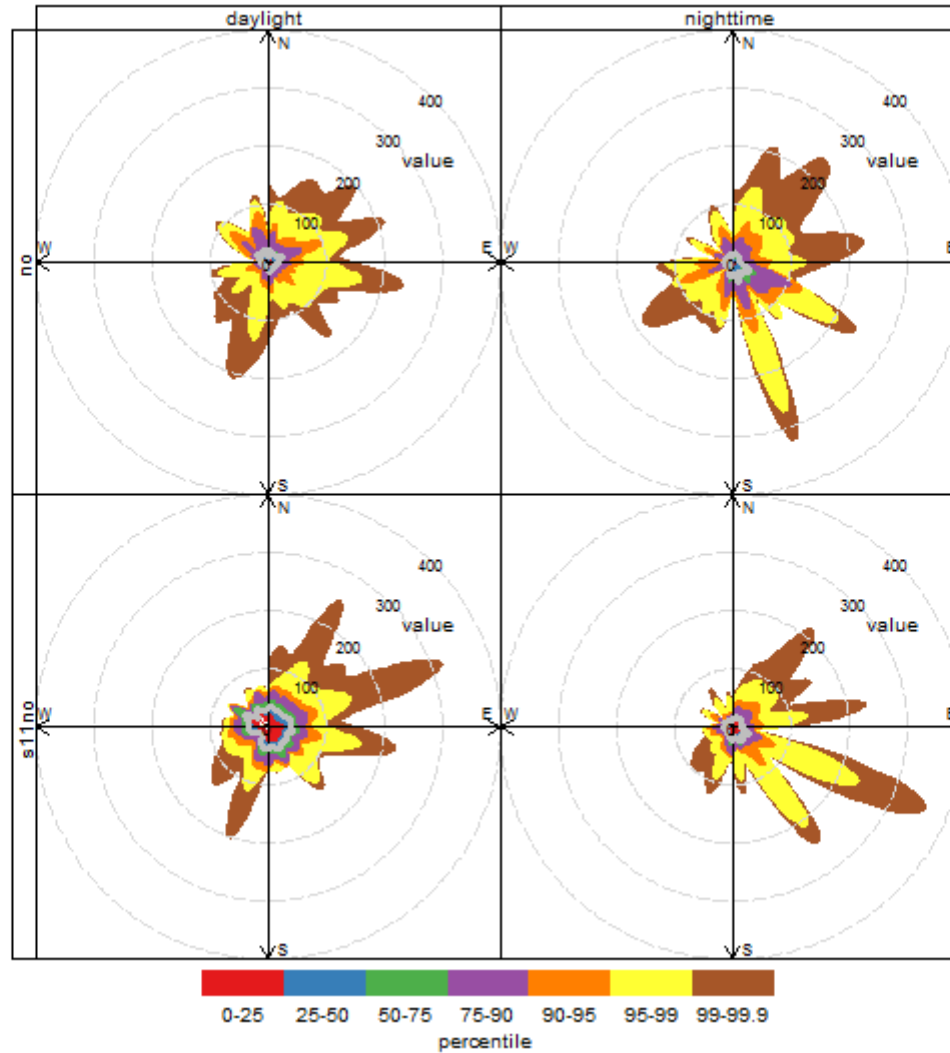
Percentage retrieval and performance of SNAQ11 and SNAQ10 boxes Aveiro intercomparison

Sensor *	SNAQ 10**	SNAQ 11	Range (ppb)	Response Time (s)	LOD ( ppb)	Noise $\pm 2$ StdDev (ppb)
CO (ECC)	0 % ??	94 %	500000	< 20	60	20
NO (ECC)	0 % ??	99 %	20000	< 25	5	80
NO2 (ECC)	0 % ??	99 %	20000	< 30	5	15
O3 (ECC)	0 % ??	63 %	5000	< 15	5	5
SO2 (ECC)	0 % ??	97 %	50000	< 20	45	15
VOC (PID)	91 %	90 %	50000	< 3	1	3
PM (OPC)	99 %	99 %	0.38 – 17.4 $\mu\text{m}$	730 $\mu\text{s}$	0.38 micron	N/A
WindSonic (ws)	99%	99%	0 – 60 $\text{ms}^{-1}$	0.25	0.01 $\text{ms}^{-1}$	$\pm 2$ % (ws)
WindSonic (wd)	99%	99%	0 – 359°	0.25	1°	$\pm 2$ % (wd)
PT1000 (temp)	99 %	99 %	-30 – 200°C	1	0.1	$\pm 0.1$ °C (t)

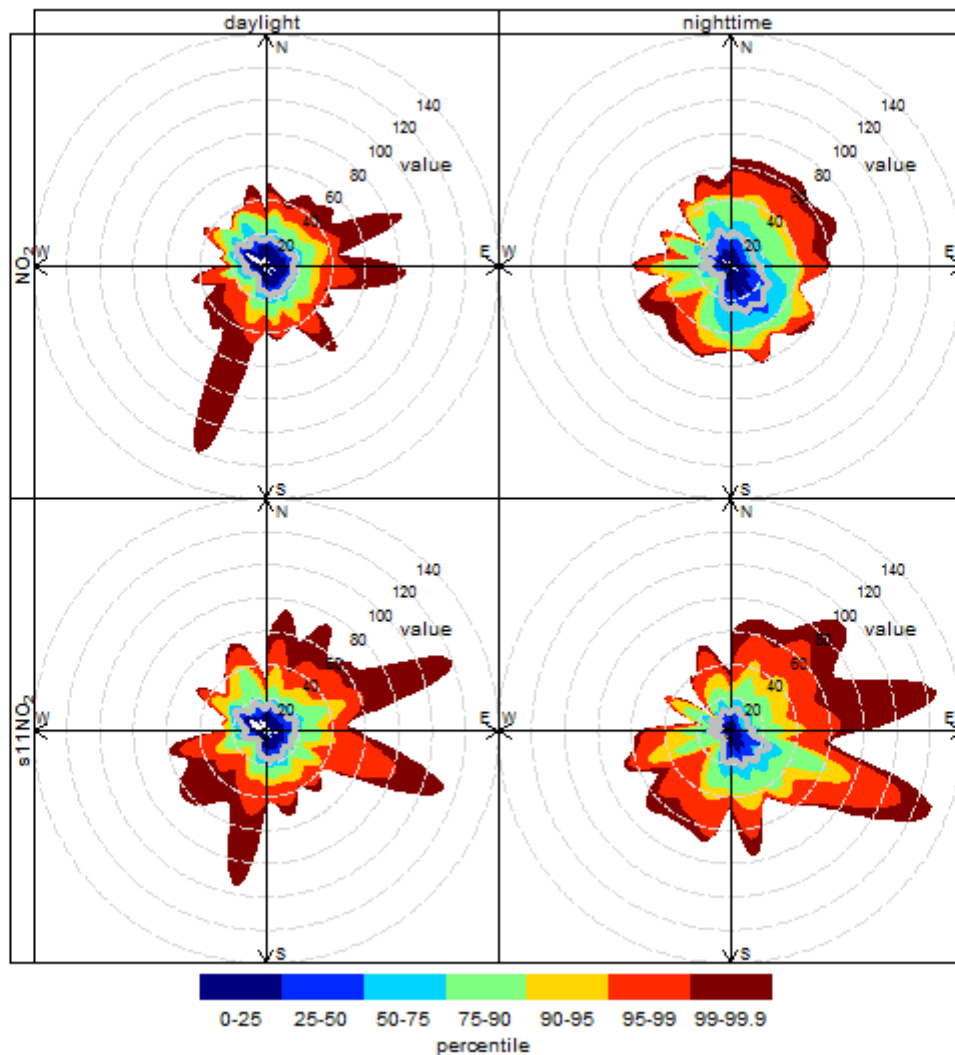
\* Data taken from Alphasense + Gill product data sheets

\*\* SNAQ10 ECC data affected by power surges

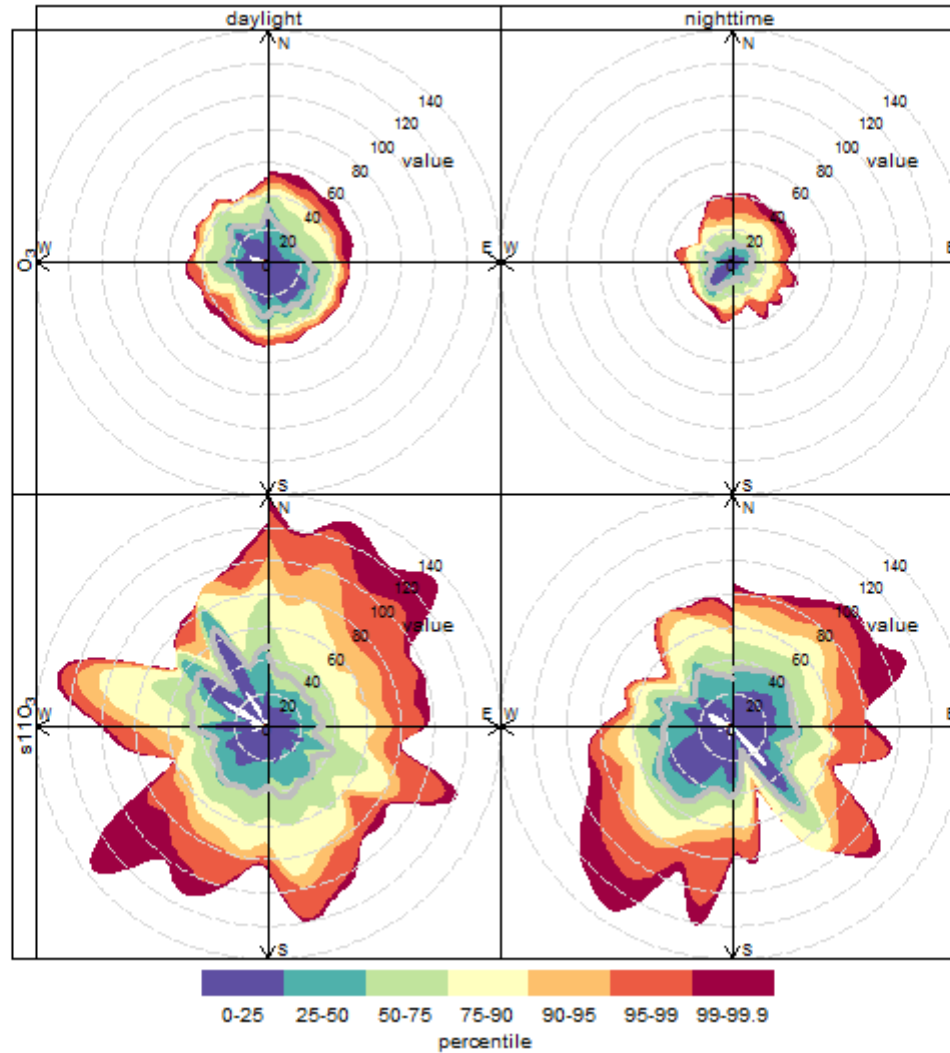
# Some OpenAir plots...NO



# Some OpenAir plots...NO<sub>2</sub>

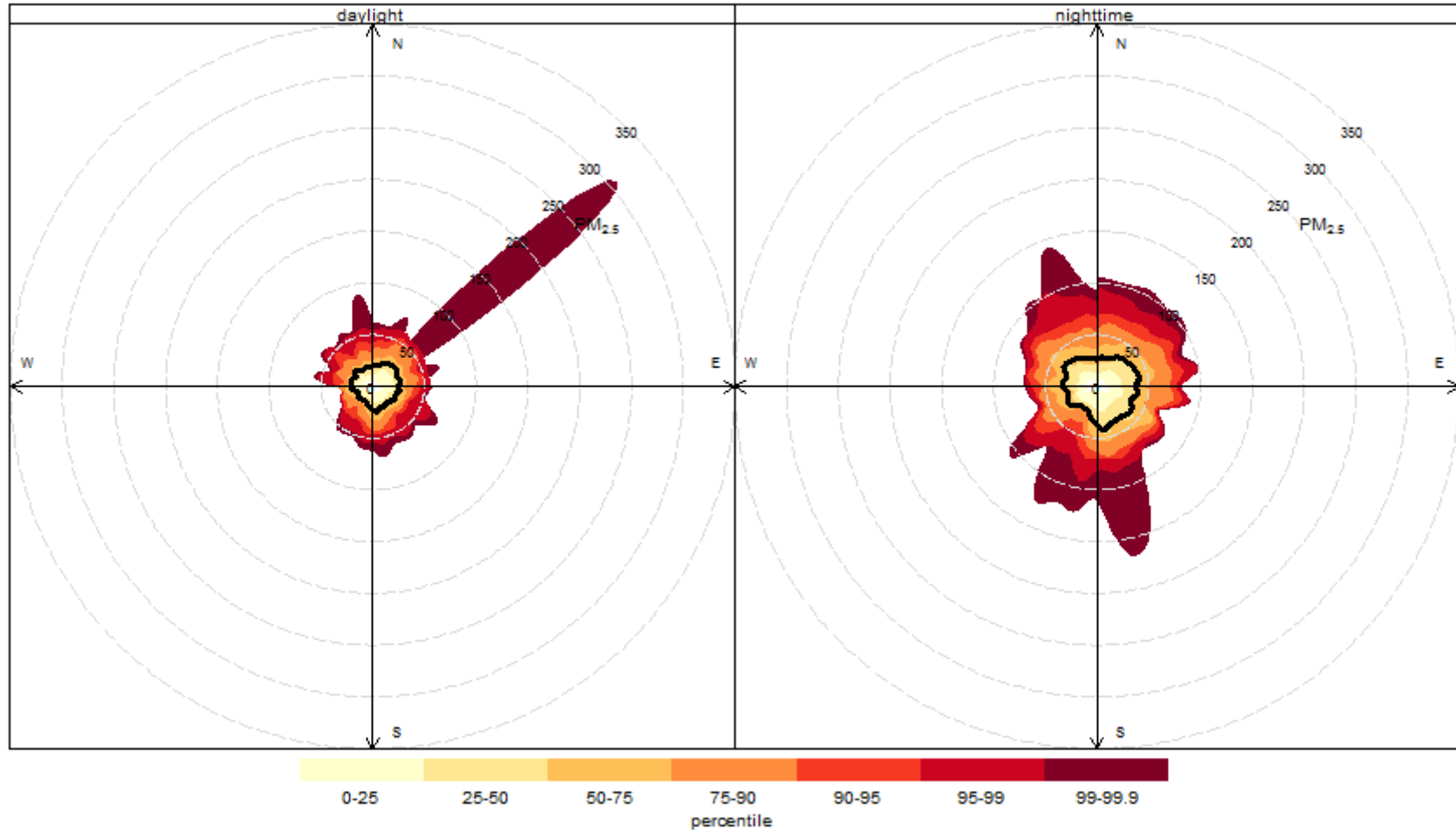


# Some OpenAir plots...O<sub>3</sub>





# Some OpenAir plots...PM



# Conclusions

- The Aveiro Sensors database should be user-friendly!
- I have updated the Excel file, and I happy to share the .csv file
- With further practice in using OpenAir, I hope to extract plots which highlight events and phenomena worthy of further investigation with the other participants in the Aveiro Intercomparison.
- Would be useful to have a central point for meta-data, including photographs (pick the best ones, annotate them so easy to find)
- Would be useful to get traffic flow / traffic type information (IDAD)
- Would be useful to get details of nearby point sources (IDAD)
- Would be great to get IDAD PM data!