Building Performance Report

DTU Bibliotek Engelunds

February 2023

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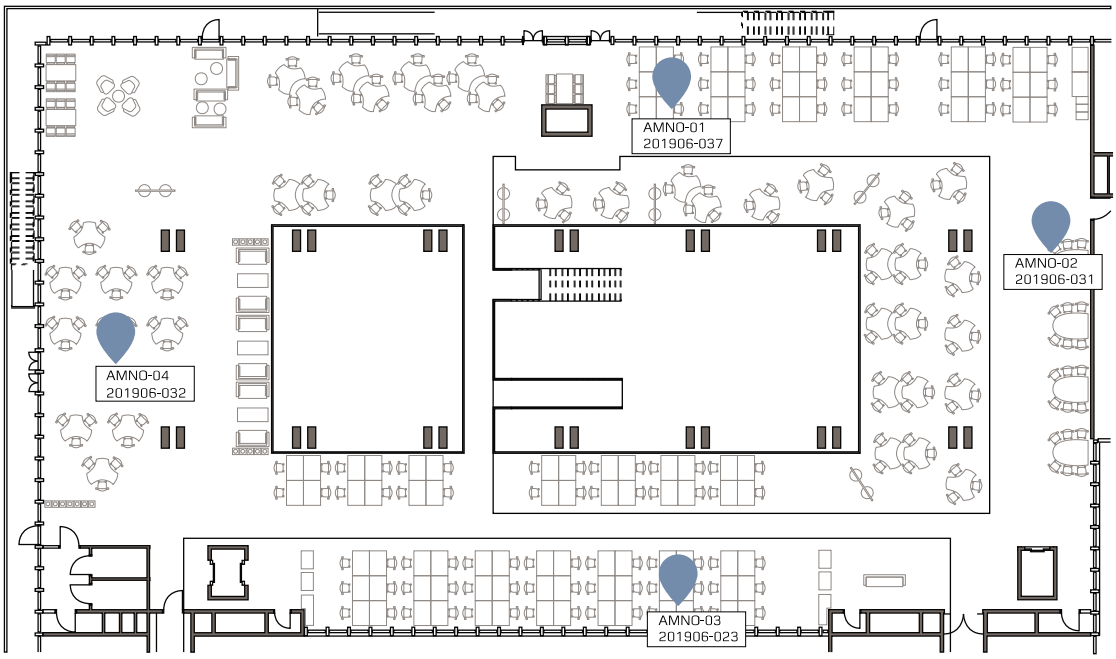
Installation location

Floor plan

DTU-Bibliotek-Engelunds



Guide to Standards and Conventions

Timezones

All dates and timestamps in this report use local time in **Europe/Copenhagen** timezone.

Performance Ratings

All performance ratings in this report – except for the PM2.5 particles – correspond to the indoor environmental quality (IEQ) categories, as defined by the EN 16798 European Standard. PM2.5 limits are based on the WHO 2005 Air Quality guidelines.

Thermal comfort evaluation is based on the PMV (Predicted Mean Vote) score, calculated based on the air temperature and relative humidity, and using certain assumptions corresponding to a typical workplace. Air quality categories depend on the levels of CO_2 (as a proxy for ventilation rate) and fine particles (PM 2.5).

To qualify for a given IEQ category over the period of one month, a space must meet requirements corresponding to this category for at least 88% of its occupied hours during this time (calculated based on hourly average values). In this report, occupied hours are assumed to be 8-17, Monday to Friday.

Recommended limits

Black dashed lines in the line plots (Zone-Wise Daily Values) show recommended limits that in typical conditions should not be exceeded for prolonged periods of time to ensure healthy and comfortable indoor environment.

IEQ categories description

The table below explains the meaning of the IEQ categories, and how they relate to performance ratings used in this report.

Category	Rating	Level of expectation	Description
I	Excellent ★★★★	High	Should be selected for occupants with special needs (children, elderly, persons with disabilities).
II	Good ★★★	Medium	The normal level of expectations used for design and operation.
III	Moderate ★★	Moderate	Will still provide an acceptable environment. Some risk of reduced performance of the occupants.
IV	Poor ★	Low	Values outside the criteria for the above categories. Should only be used for a short time of the year or in spaces with very short time of occupancy.

Evaluation criteria and recommended limit values

The following table clarifies what evaluation criteria are used in this report, and what they are based on.

Parameter	Rating	Rating criteria	Recommended limits	Based on
Thermal comfort [PMV]	★★★★ Excellent	-0.2 < PMV < 0.2	-	DS/EN 16798-1:2019 default criteria
	★★★ Good	-0.5 < PMV < 0.5		
	★★ Moderate	-0.7 < PMV < 0.7		
	★ Poor	otherwise		
Temperature [°C]	-	-	[20; 26]	DS/EN 16798-1:2019 example recommended limits for offices & living spaces (II category)
Relative humidity [%]	-	-	[25; 60]	DS/EN 16798-1:2019 example recommended limits (II category)
Air quality (CO2) [ppm]	★★★★ Excellent	< 950	< 1200	DS/EN 16798-1:2019 default criteria for offices / living rooms
	★★★ Good	< 1200		
	★★ Moderate	< 1750		
	★ Poor	otherwise		
Air quality (PM2.5) [µg/m³]	★★★★ Good	< 10	< 25	WHO 2005 Air Quality guidelines for yearly (10) and daily (25) limits
	★★★ Acceptable	< 25		
	★★ Acceptable short-term	otherwise		
Noise [dB(A)]	★★★ Good	< 85	< 85	OSHA Guildelines
	★ Poor	otherwise		

Building summary

Each space under evaluation is assigned a performance rating based on the data from one month. The meaning of these ratings is explained in the introductory section of this report. A gray cell in the table means that the parameter is not measured by the corresponding device, or that there is not enough data collected for it to be evaluated.

Room	Thermal Comfort	Ventilation (CO_2)	Air Quality (PM2.5)	Acoustics
DA00130003	Poor ★	Excellent ★★★★	Good ★★★★	Good ★★★★
DA00110042	Moderate ★★	Excellent ★★★★	Good ★★★★	Good ★★★★
DA00110033	Poor ★	Excellent ★★★★	Good ★★★★	Good ★★★★
DA00110036	Moderate ★★	Excellent ★★★★	Good ★★★★	Good ★★★★
DA00110039	Good ★★★	Good ★★★	Good ★★★★	Good ★★★★
DA00110043	Moderate ★★	Excellent ★★★★	Good ★★★★	Good ★★★★
DA00110037	Poor ★	Excellent ★★★★	Acceptable short-term ★★	Good ★★★★
DA00110038	Good ★★★	Excellent ★★★★	Good ★★★★	Good ★★★★
DA00110045	Moderate ★★	Excellent ★★★★	Good ★★★★	Good ★★★★
DA00110035	Good ★★★	Excellent ★★★★	Good ★★★★	Good ★★★★
DA00110034	Moderate ★★	Excellent ★★★★	Good ★★★★	Good ★★★★
DA00110040	Good ★★★	Excellent ★★★★	Good ★★★★	Good ★★★★
DA00110041	Moderate ★★	Excellent ★★★★	Good ★★★★	Good ★★★★
DA00110032	Moderate ★★	Excellent ★★★★	Good ★★★★	Good ★★★★
DA00110031	Moderate ★★	Excellent ★★★★	Good ★★★★	Good ★★★★
DA00110047	Good ★★★	Excellent ★★★★	Good ★★★★	Good ★★★★
DA00110044	Good ★★★	Excellent ★★★★	Good ★★★★	Good ★★★★
DA00110049	Moderate ★★	Excellent ★★★★	Good ★★★★	Good ★★★★
DA00130002	Good ★★★	Excellent ★★★★	Good ★★★★	Good ★★★★
DA00130004	Poor ★	Excellent ★★★★	Good ★★★★	Good ★★★★
DA00130001	Good ★★★	Excellent ★★★★	Good ★★★★	Good ★★★★
DA00100001	Moderate ★★	Excellent ★★★★	Good ★★★★	Good ★★★★

Room	Thermal Comfort	Ventilation (CO_2)	Air Quality (PM2.5)	Acoustics
AMNO-01	Good ★★★	Excellent ★★★★	Good ★★★★	–

Air Quality & Thermal Comfort

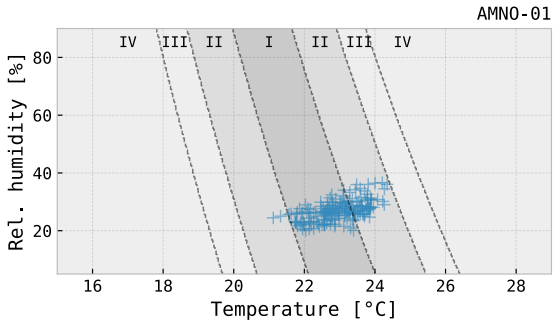
Thermal Comfort Map

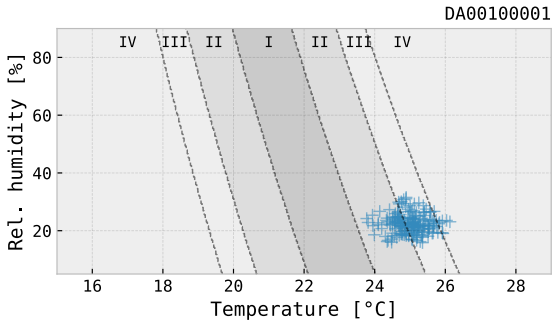
How to read this

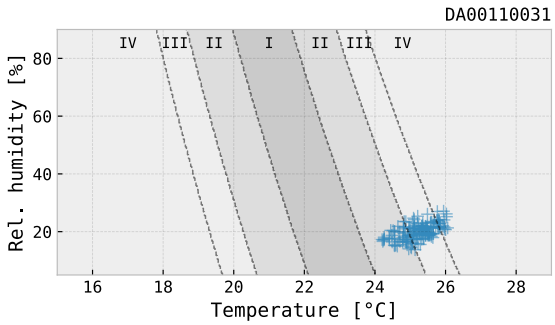
Thermal comfort scatterplots are useful to quickly spot those spaces where thermal conditions often exceed the norms.

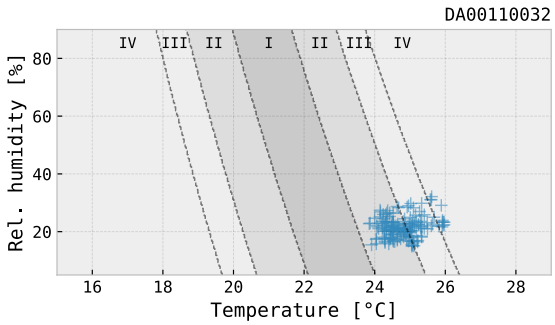
Blue markers show temperature/humidity measurements from the entire period, mean-aggregated into 1 hour buckets. Only measurements taken during occupied hours are included.

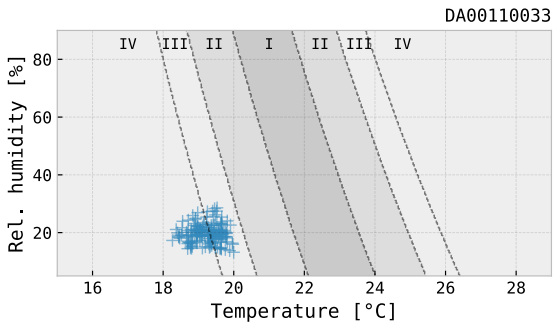
Zones in each graph correspond to thermal comfort categories I-IV. Ideally, all markers should stay within the I or the II zone. If a large number of points is found in zone IV, it may suggest prolonged uncomfortable thermal conditions in a building/space.

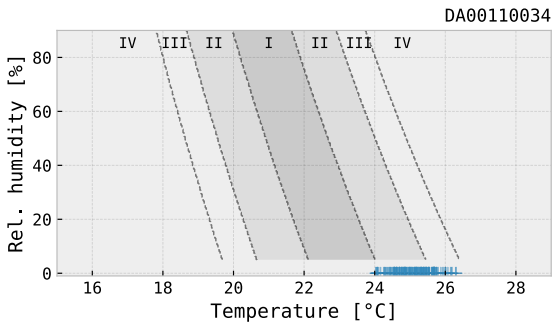












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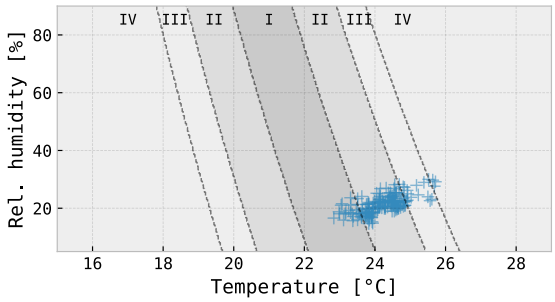

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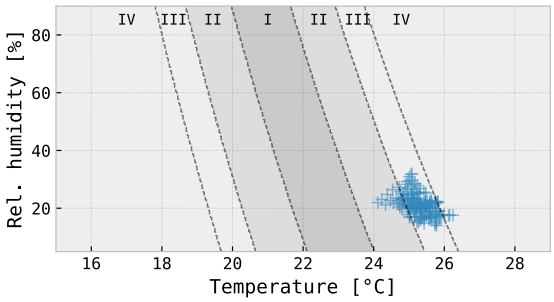

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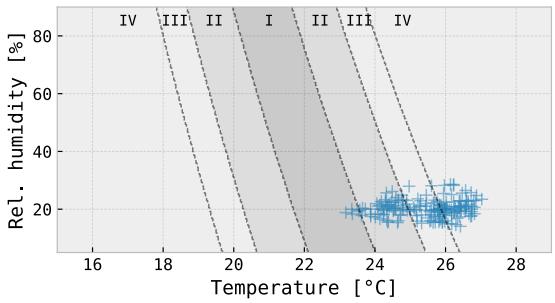

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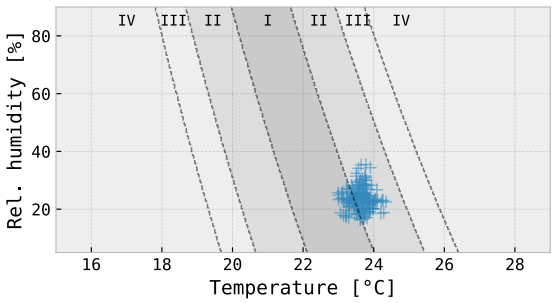

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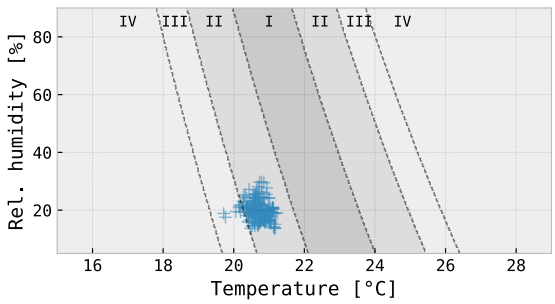

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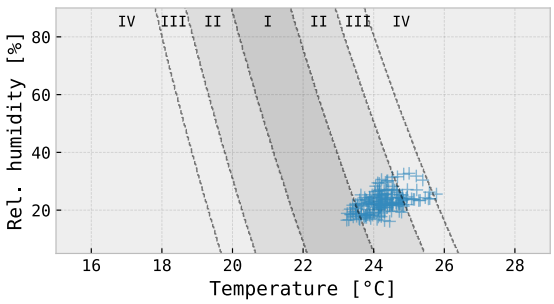

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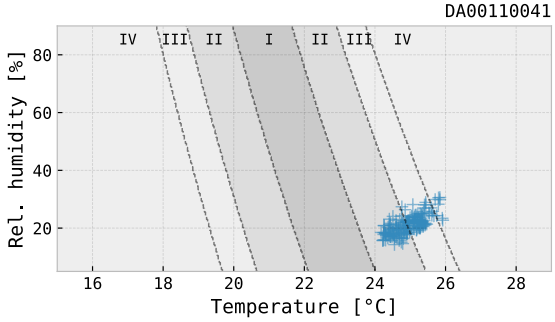

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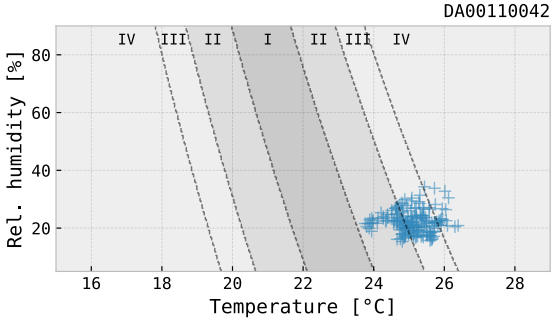

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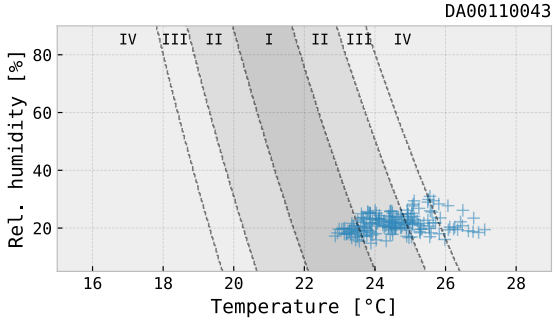

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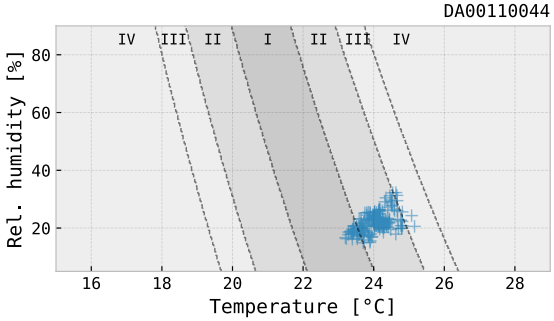

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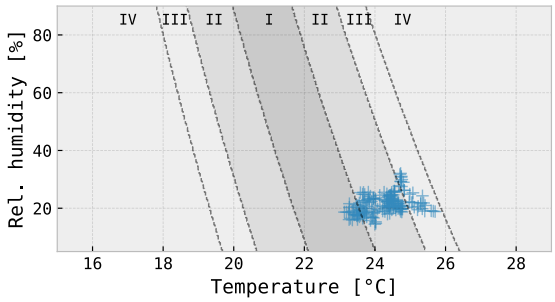

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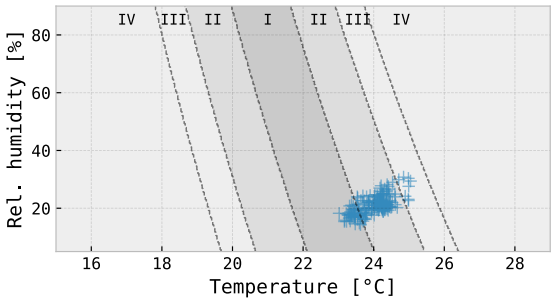

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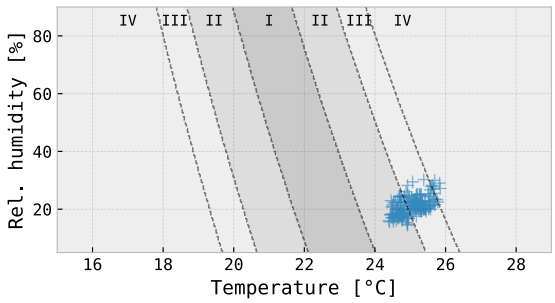

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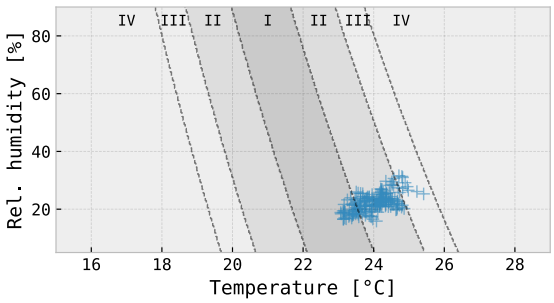

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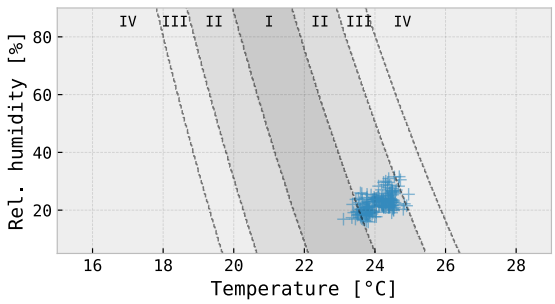

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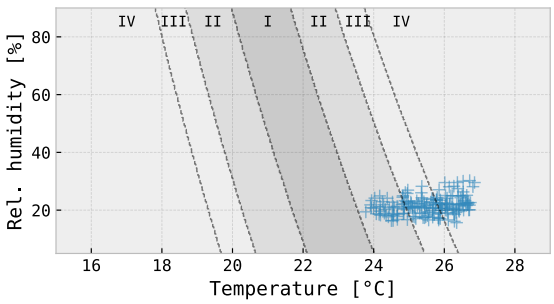

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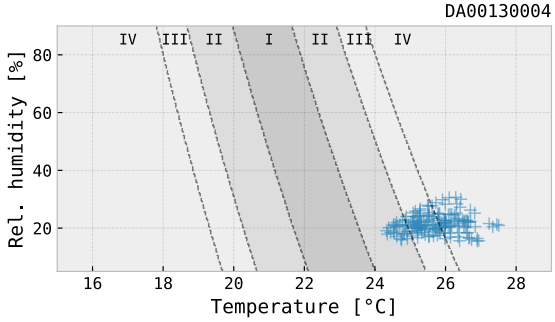


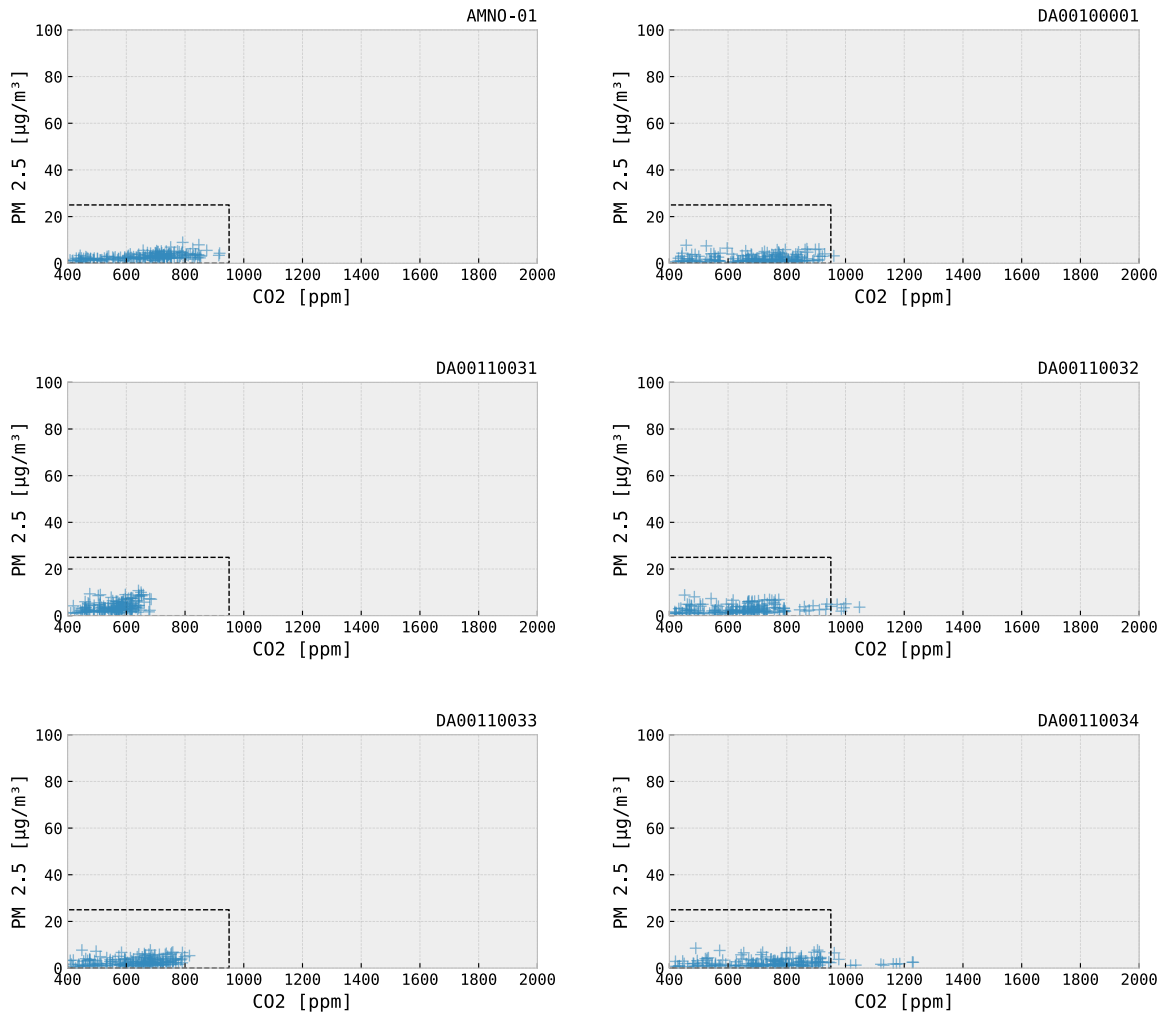
Air Quality Map

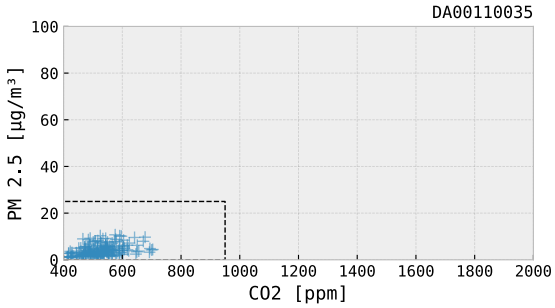
How to read this

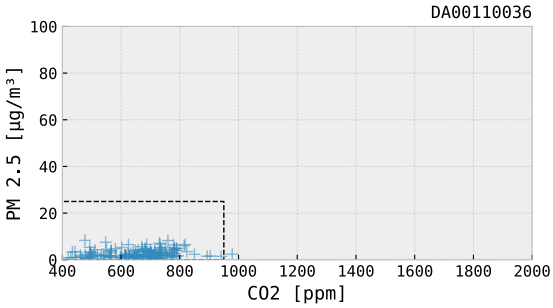
Air quality scatterplots are useful to quickly spot those spaces where CO_2 or particle levels often exceed the norms. The levels of indoor CO_2 and fine particles, and the relationship between them, can be informative of potential issues with ventilation rate, filtration, and recirculation.

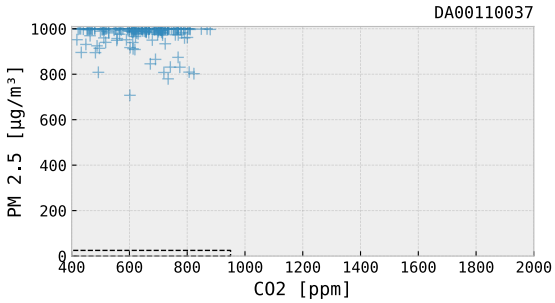
Blue markers show CO_2/PM2.5 measurements from the entire period, mean-aggregated into 1 hour buckets. Only measurements taken during occupied hours are included.

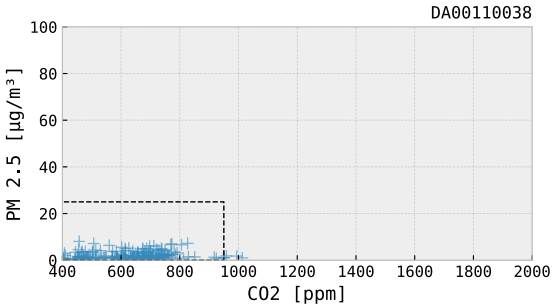
Bounding boxes (black dotted rectangles) in each graph correspond to the recommended limit values for ventilation (950 ppm CO_2) and particle pollution (25 µg/m³ PM2.5). Ideally, all markers should stay within the box. If a large number of points is found outside of the box, it may suggest prolonged low air quality, which can be detrimental to health and comfort of the occupants.

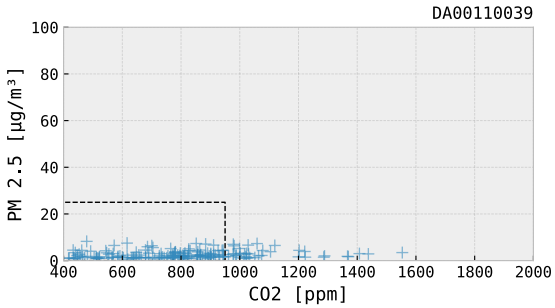


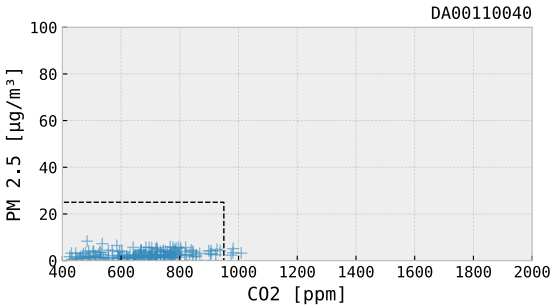


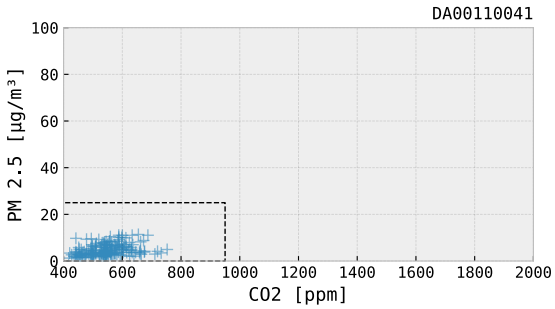


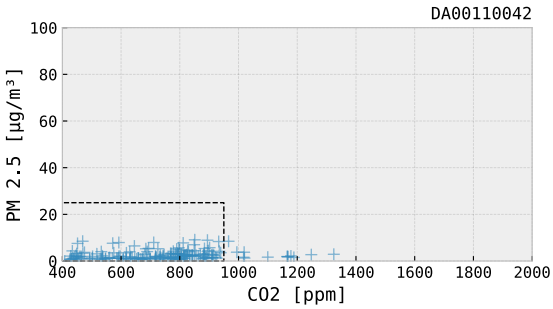


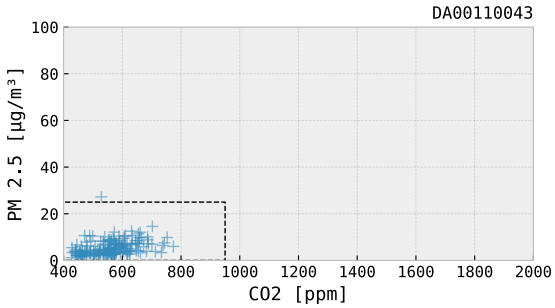


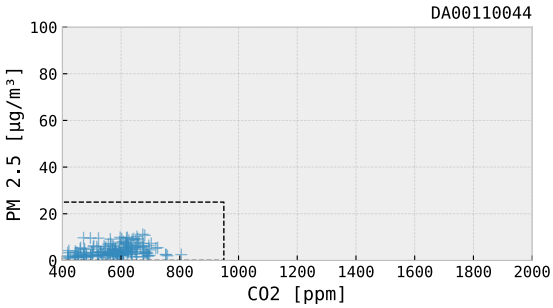


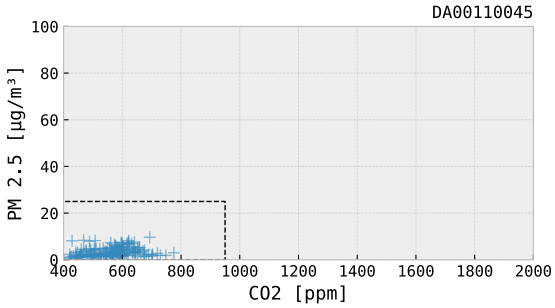


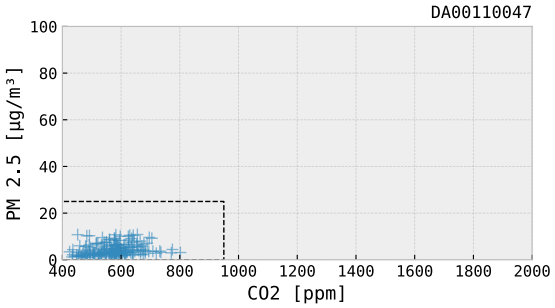


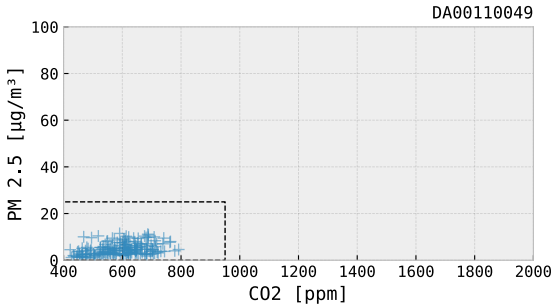


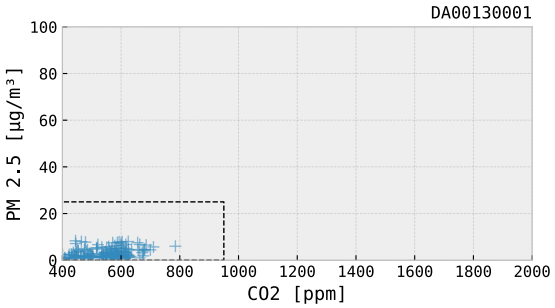


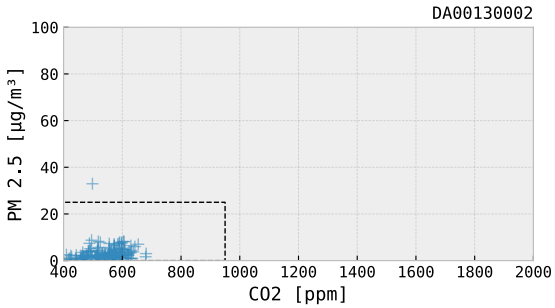


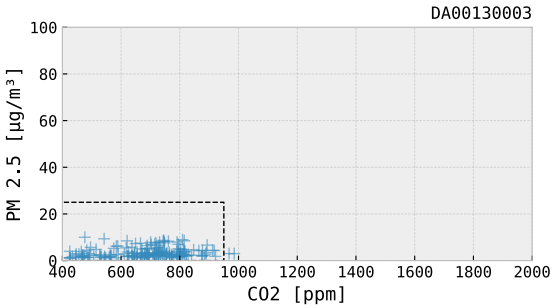


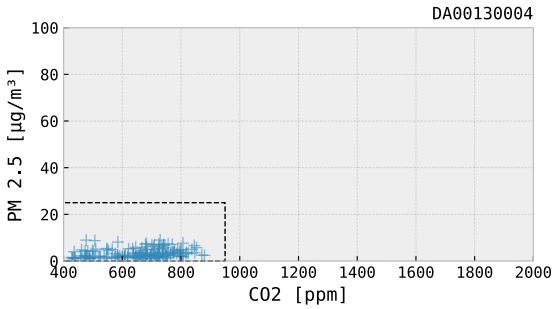










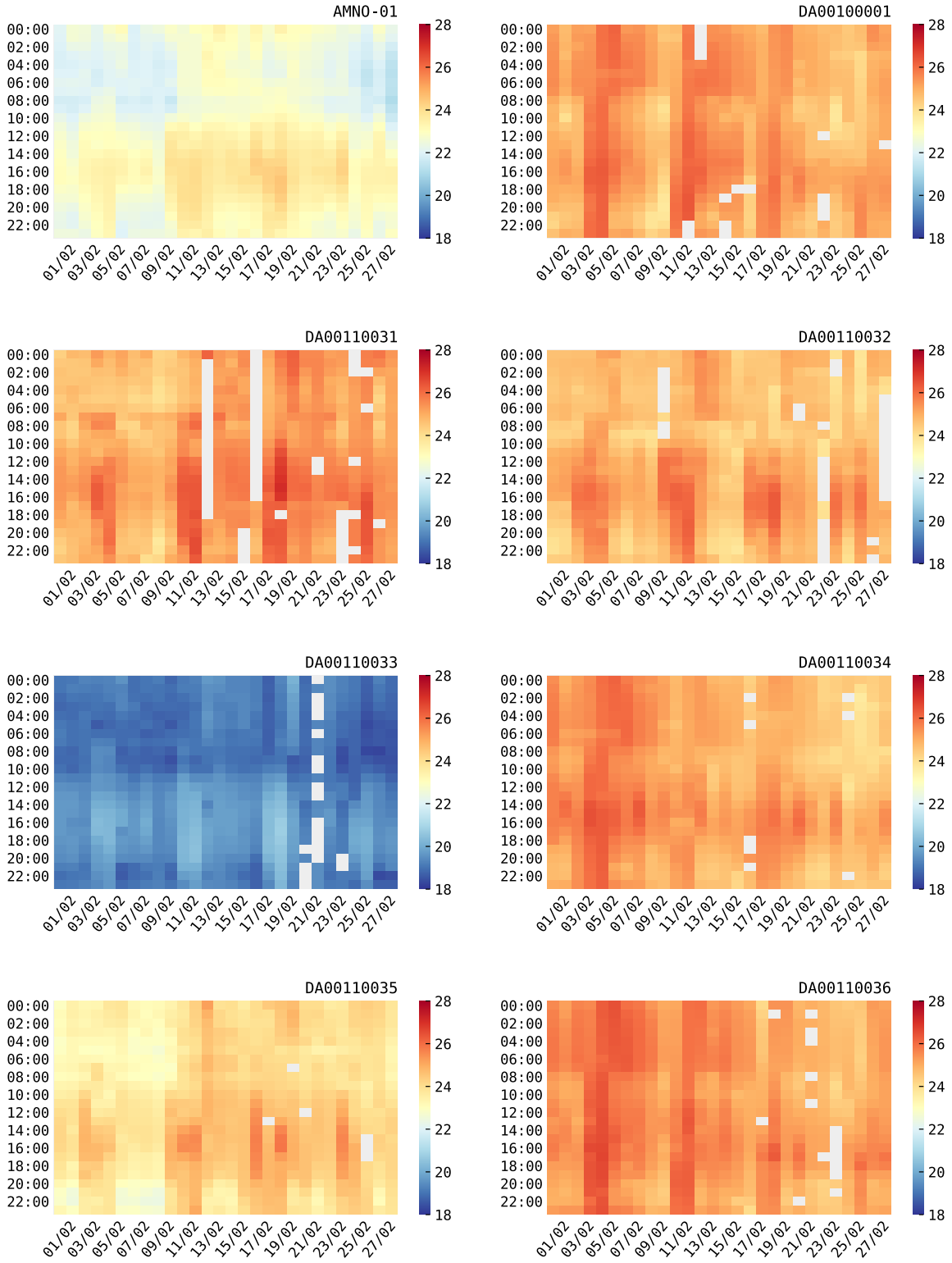


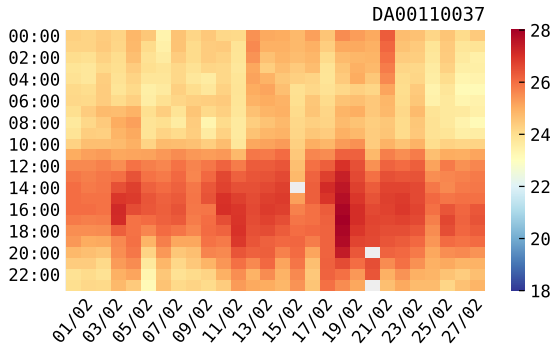
Parameter-wise Profiles

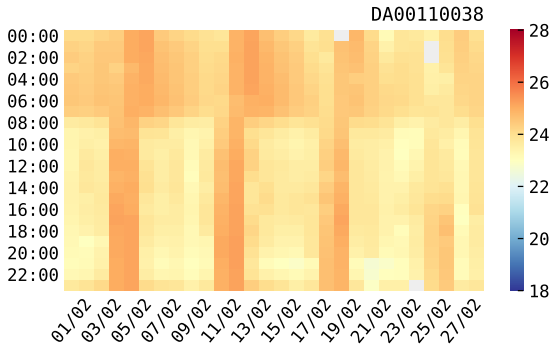
Temperature Profiles [°C]

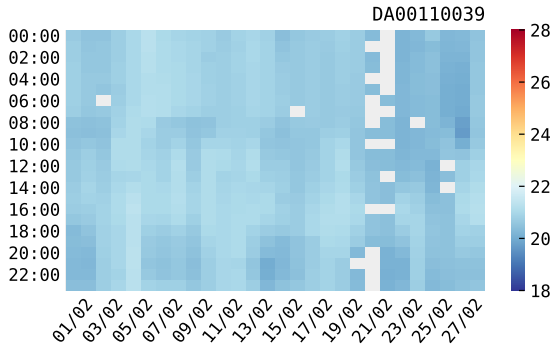
How to read this

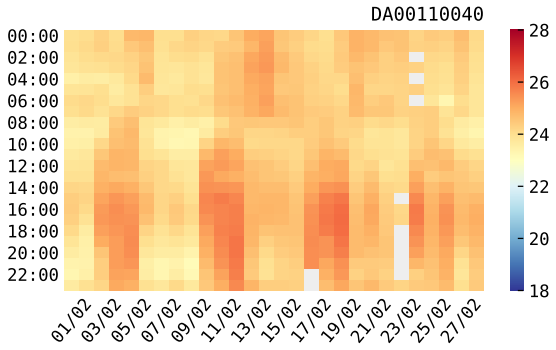
Each tile in the heatmaps below represents a 1-hour average value of temperature. Columns correspond to days of the month, and rows correspond to hours of the day (in local time). These profile heatmaps can be useful to visually identify weekly or daily patterns, differences between days and nights, weekdays and weekends, etc.

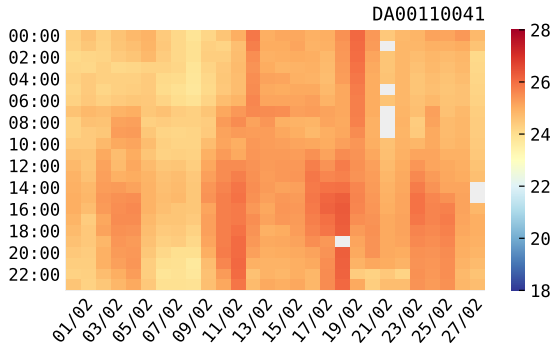


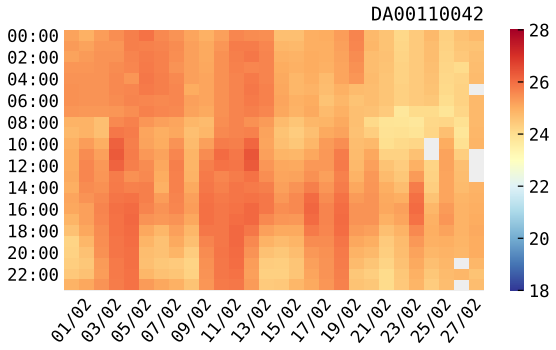


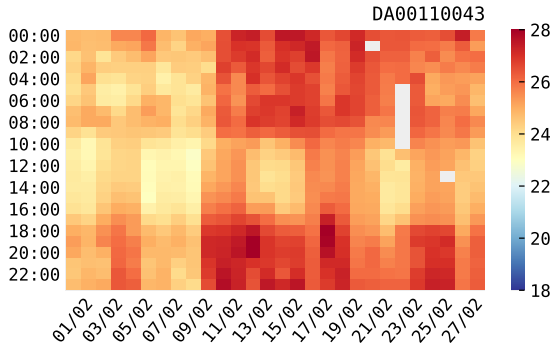


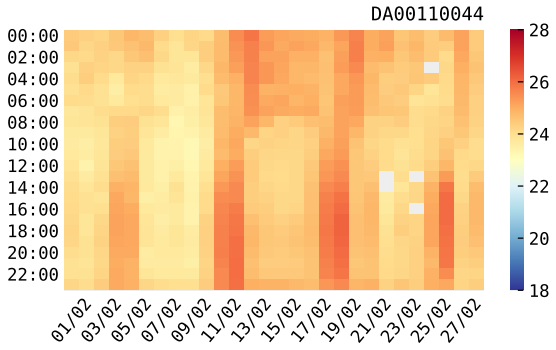


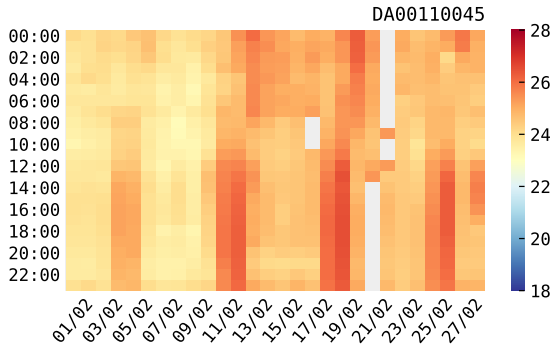


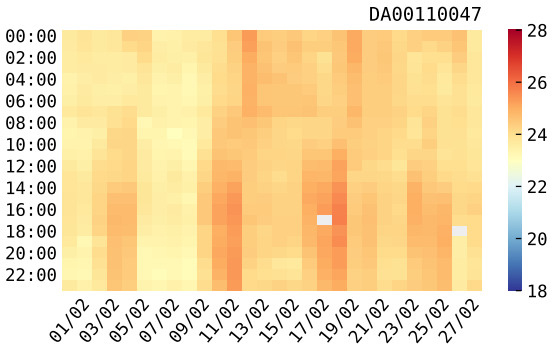


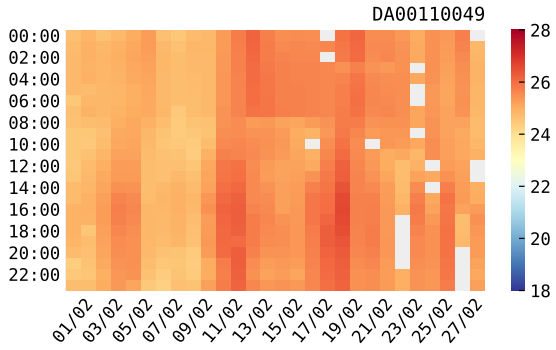


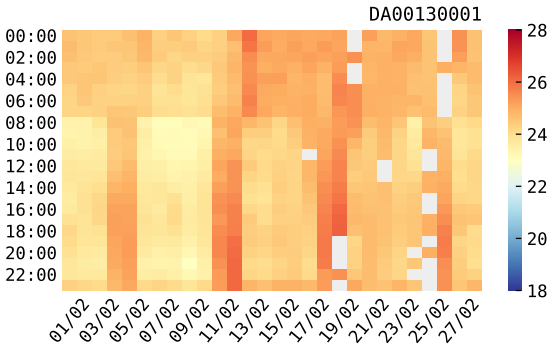


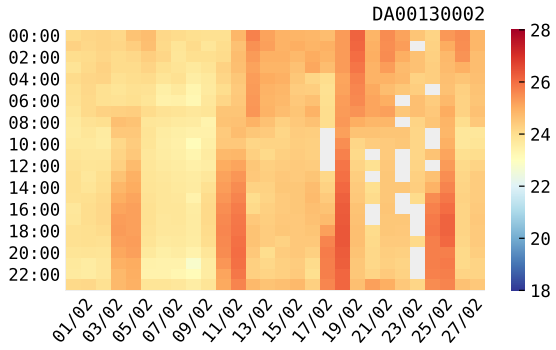


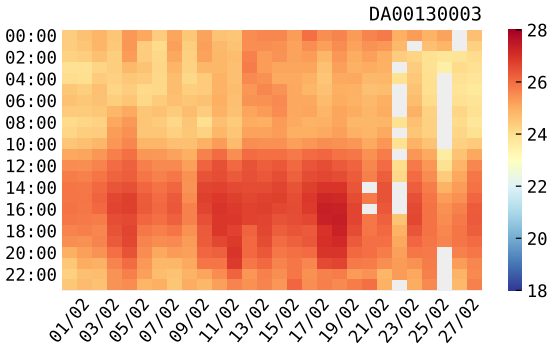


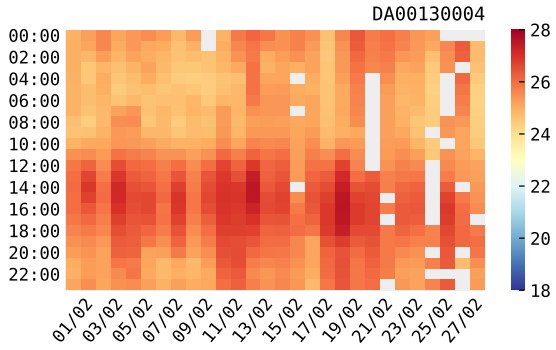








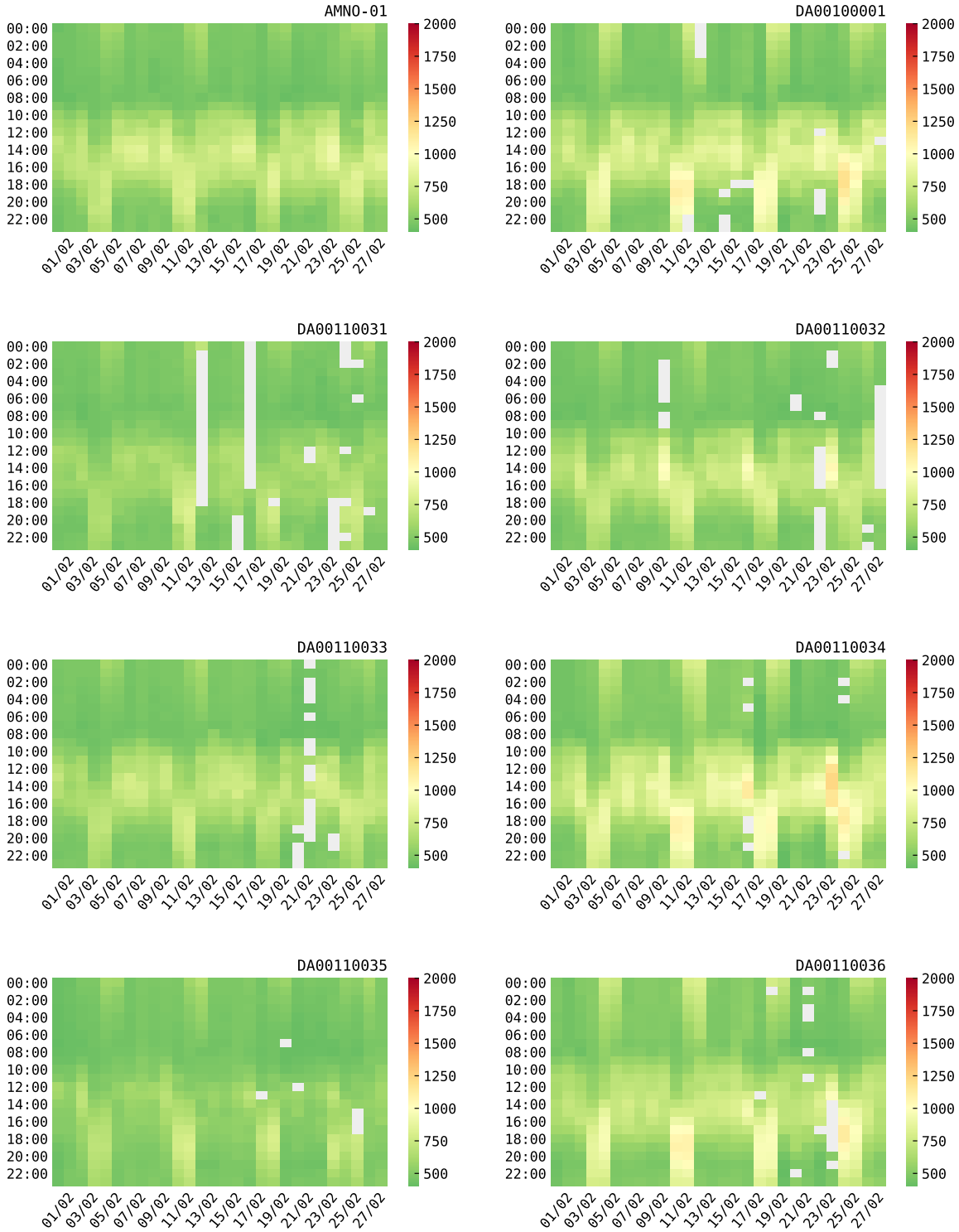


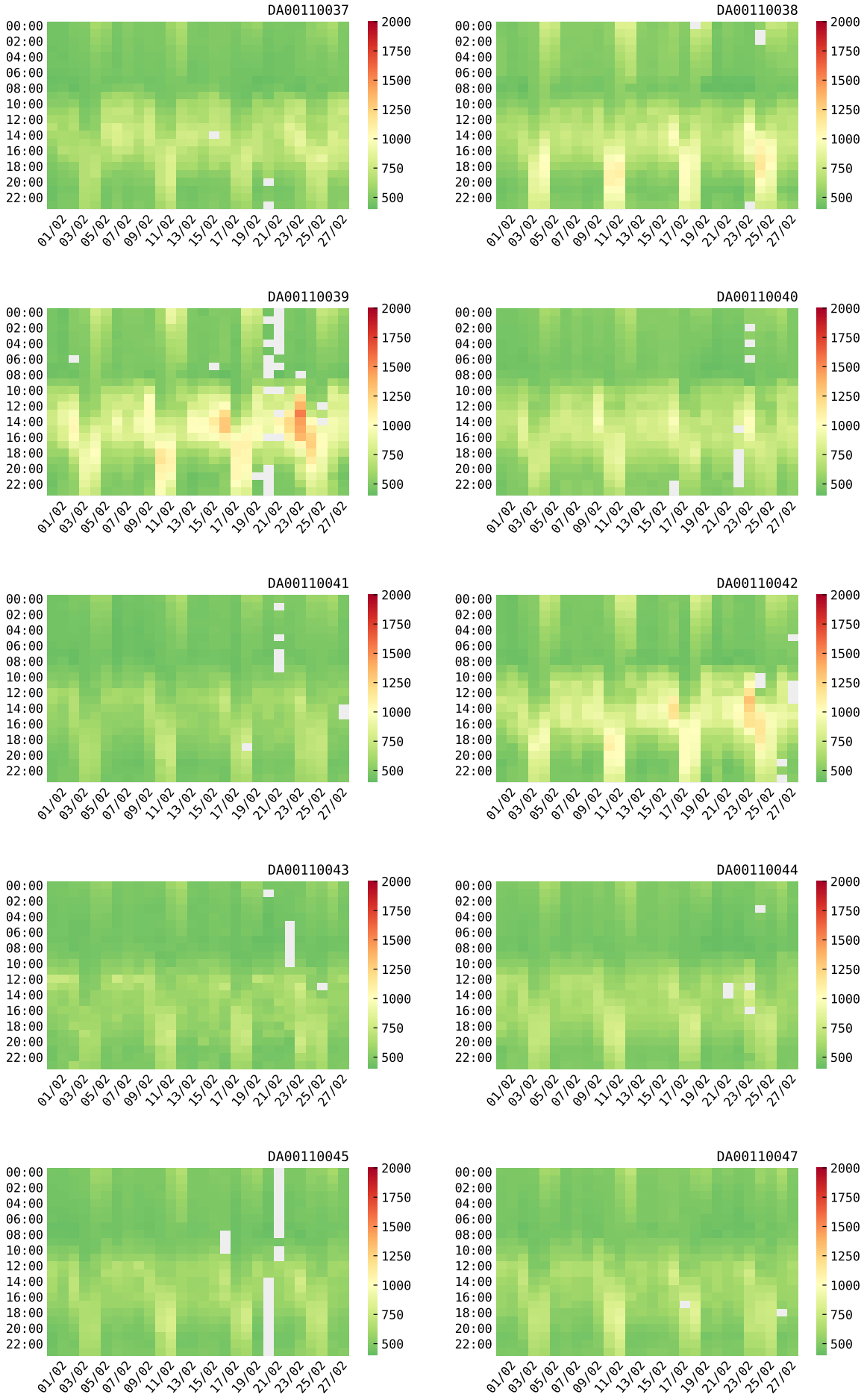


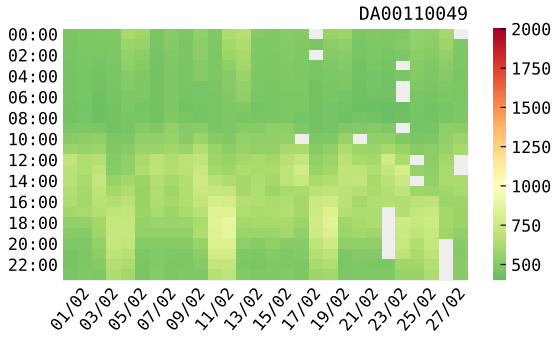
CO_2 Profiles [ppm]

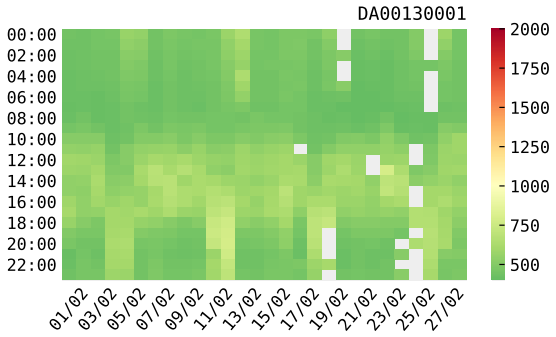
How to read this

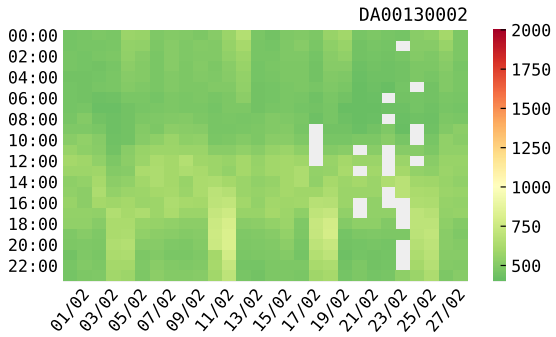
Each tile in the heatmaps below represents a 1-hour average value of CO_2. Columns correspond to days of the month, and rows correspond to hours of the day (in local time). These profile heatmaps can be useful to visually identify weekly or daily patterns, differences between days and nights, weekdays and weekends, etc.

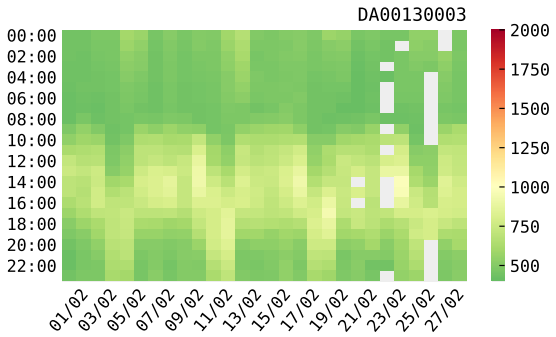


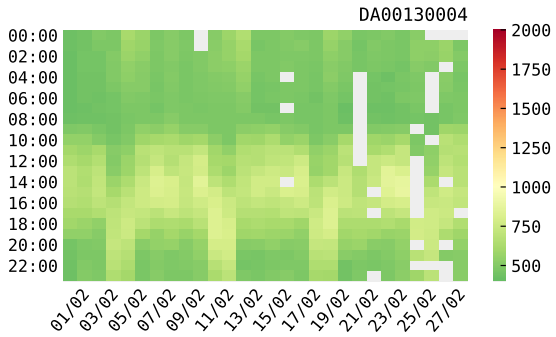








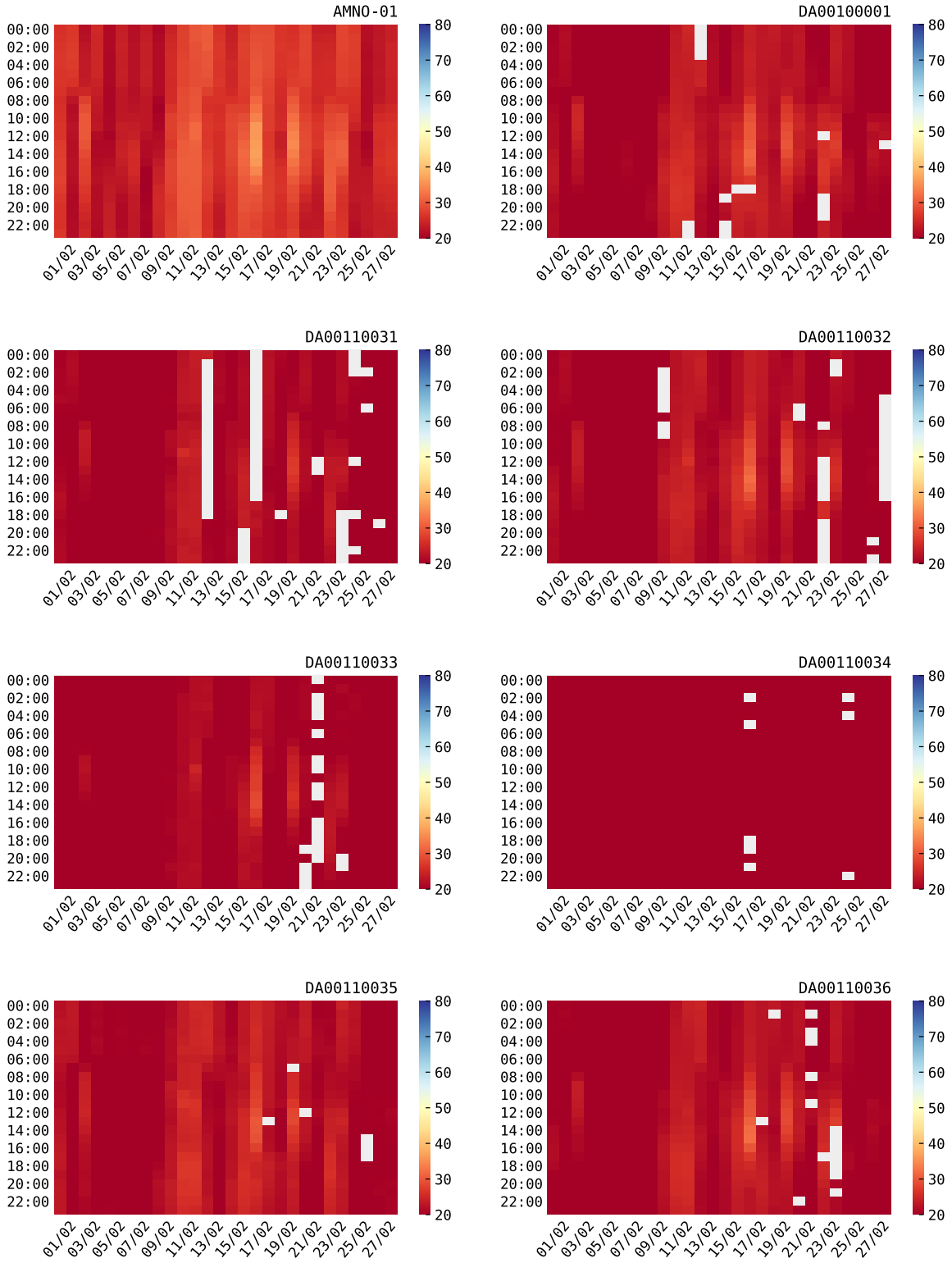


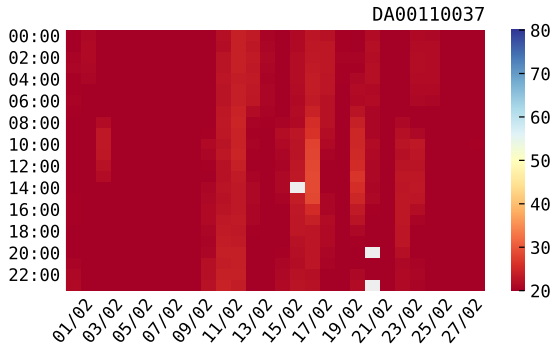


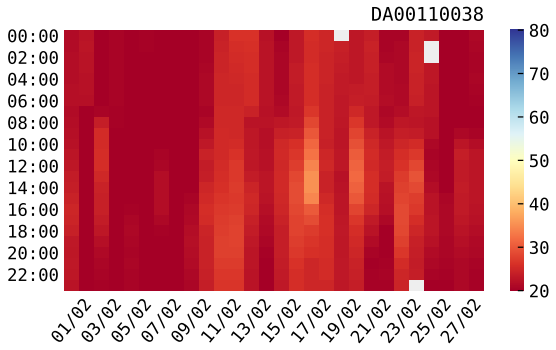
Relative Humidity Profiles [%]

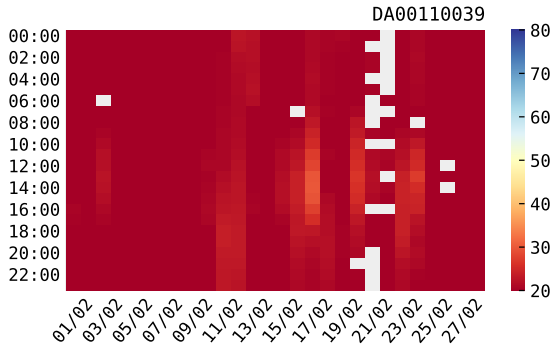
How to read this

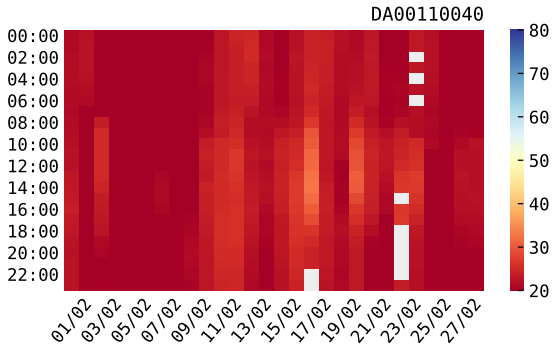
Each tile in the heatmaps below represents a 1-hour average value of relative humidity. Columns correspond to days of the month, and rows correspond to hours of the day (in local time). These profile heatmaps can be useful to visually identify weekly or daily patterns, differences between days and nights, weekdays and weekends, etc.

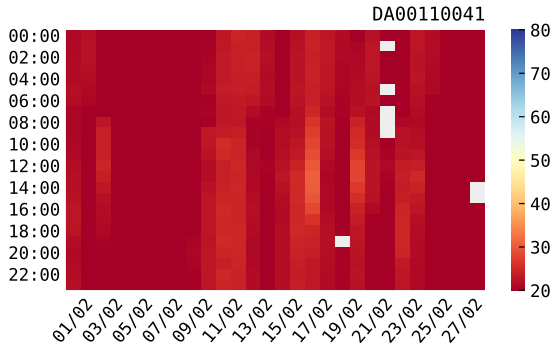


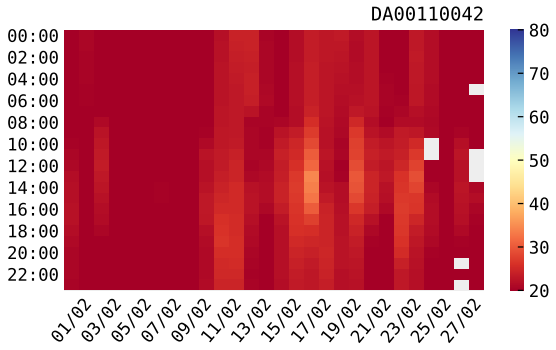


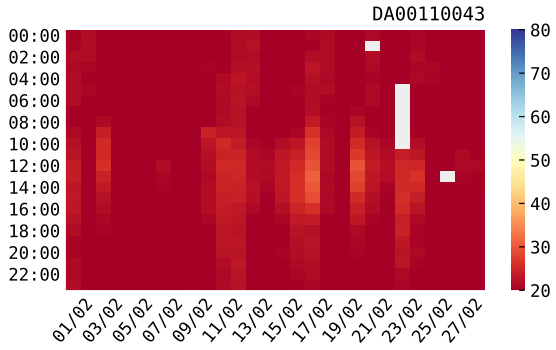


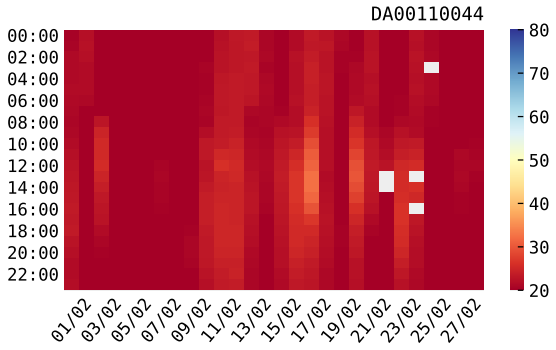


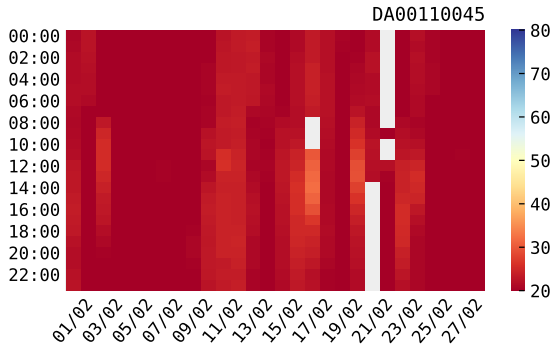


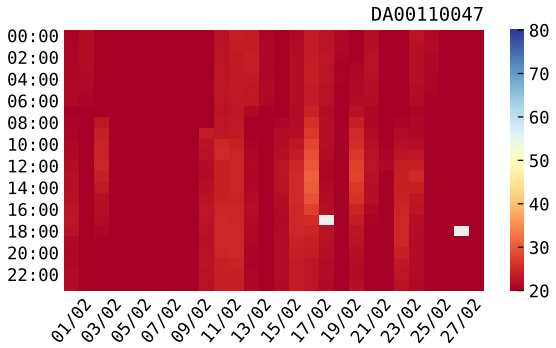


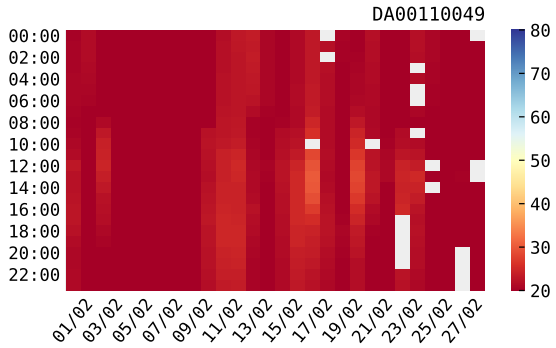


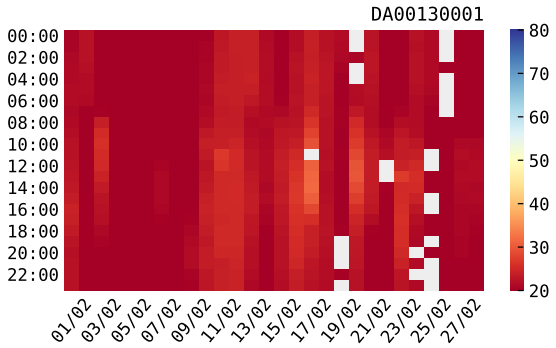


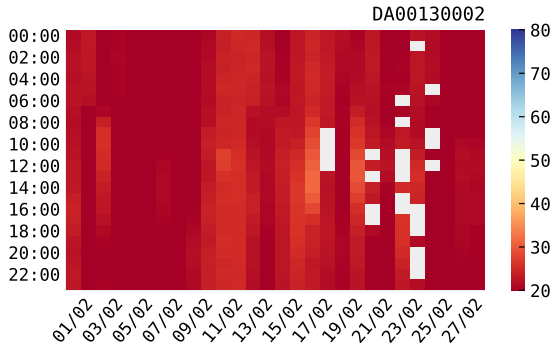


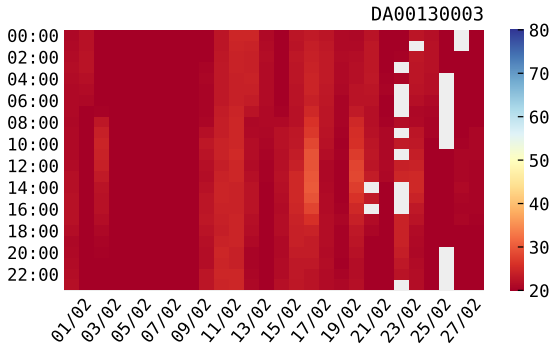


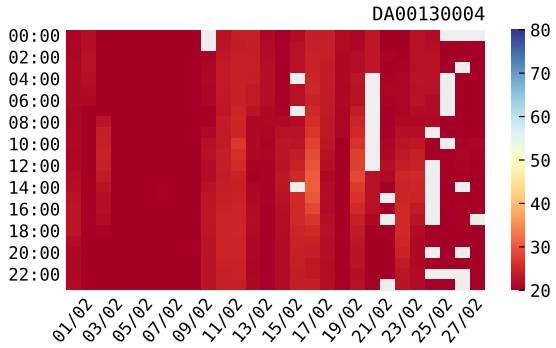








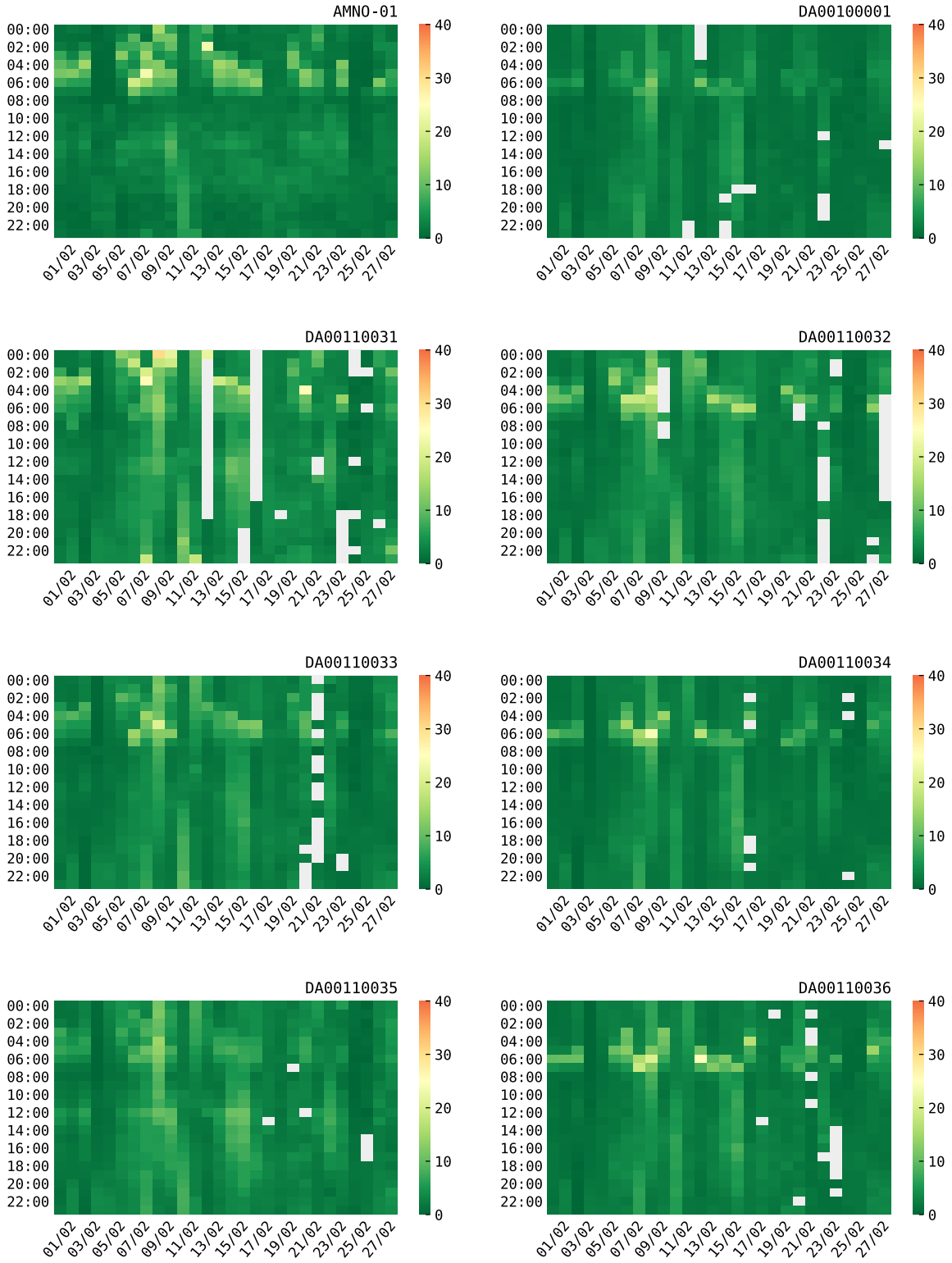


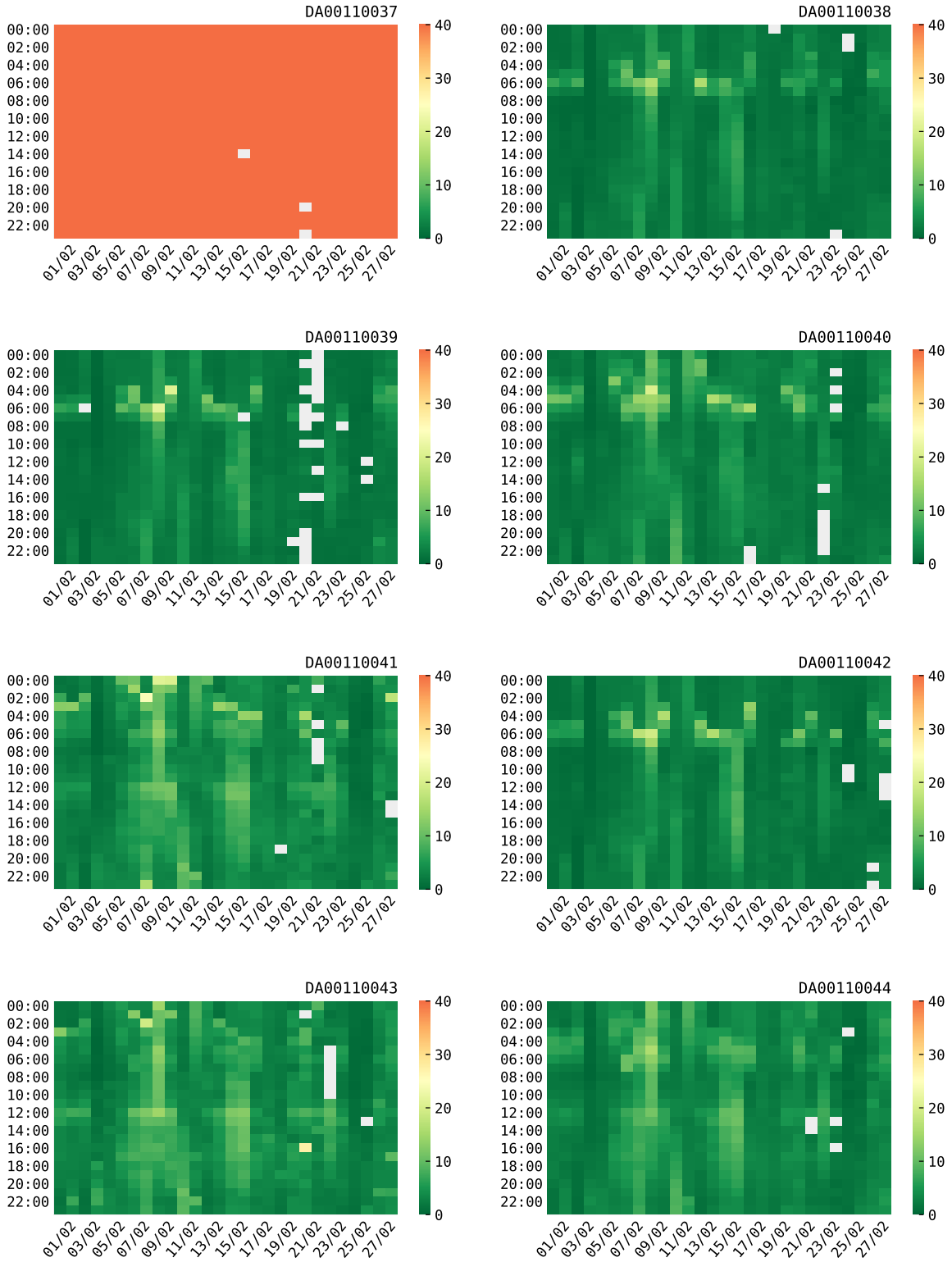


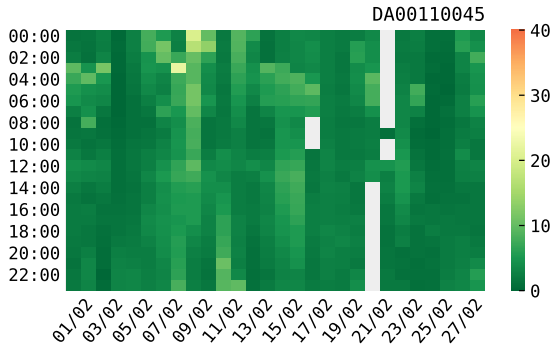
PM 2.5 Particles Profiles [µg/m³]

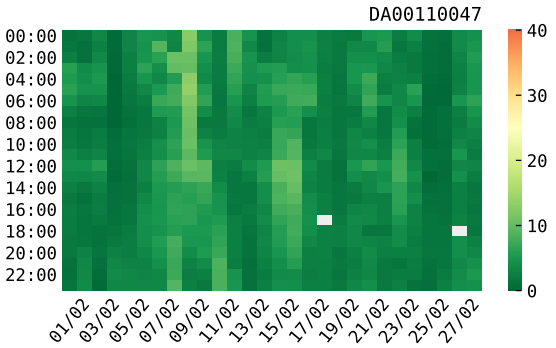
How to read this

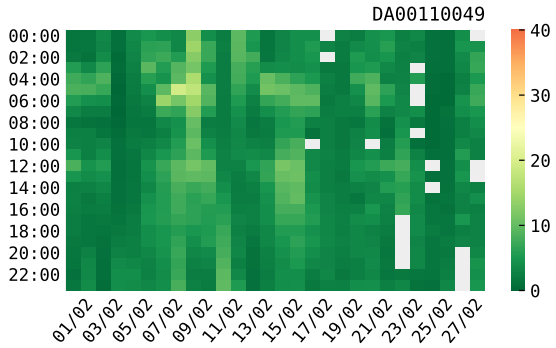
Each tile in the heatmaps below represents a 1-hour average value of PM2.5. Columns correspond to days of the month, and rows correspond to hours of the day (in local time). These profile heatmaps can be useful to visually identify weekly or daily patterns, differences between days and nights, weekdays and weekends, etc.

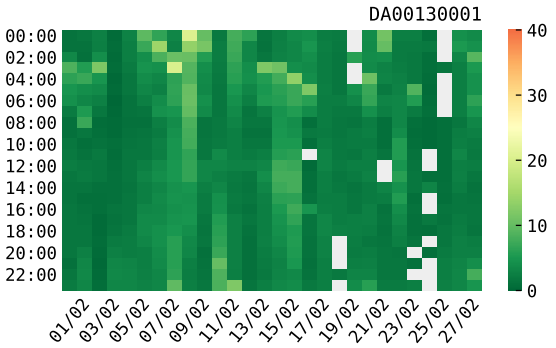


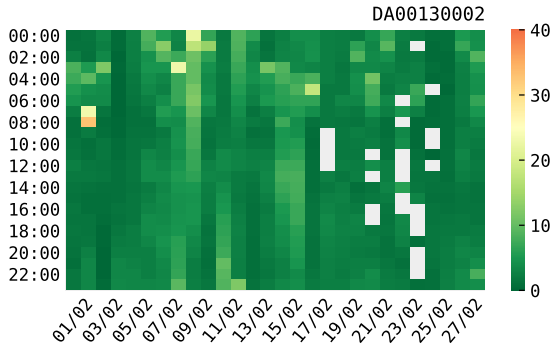


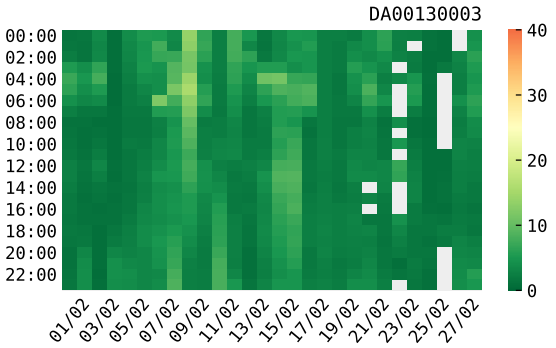


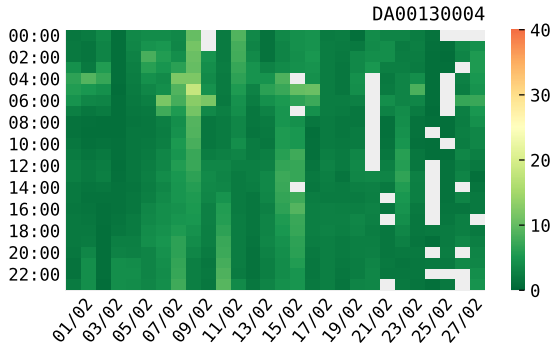










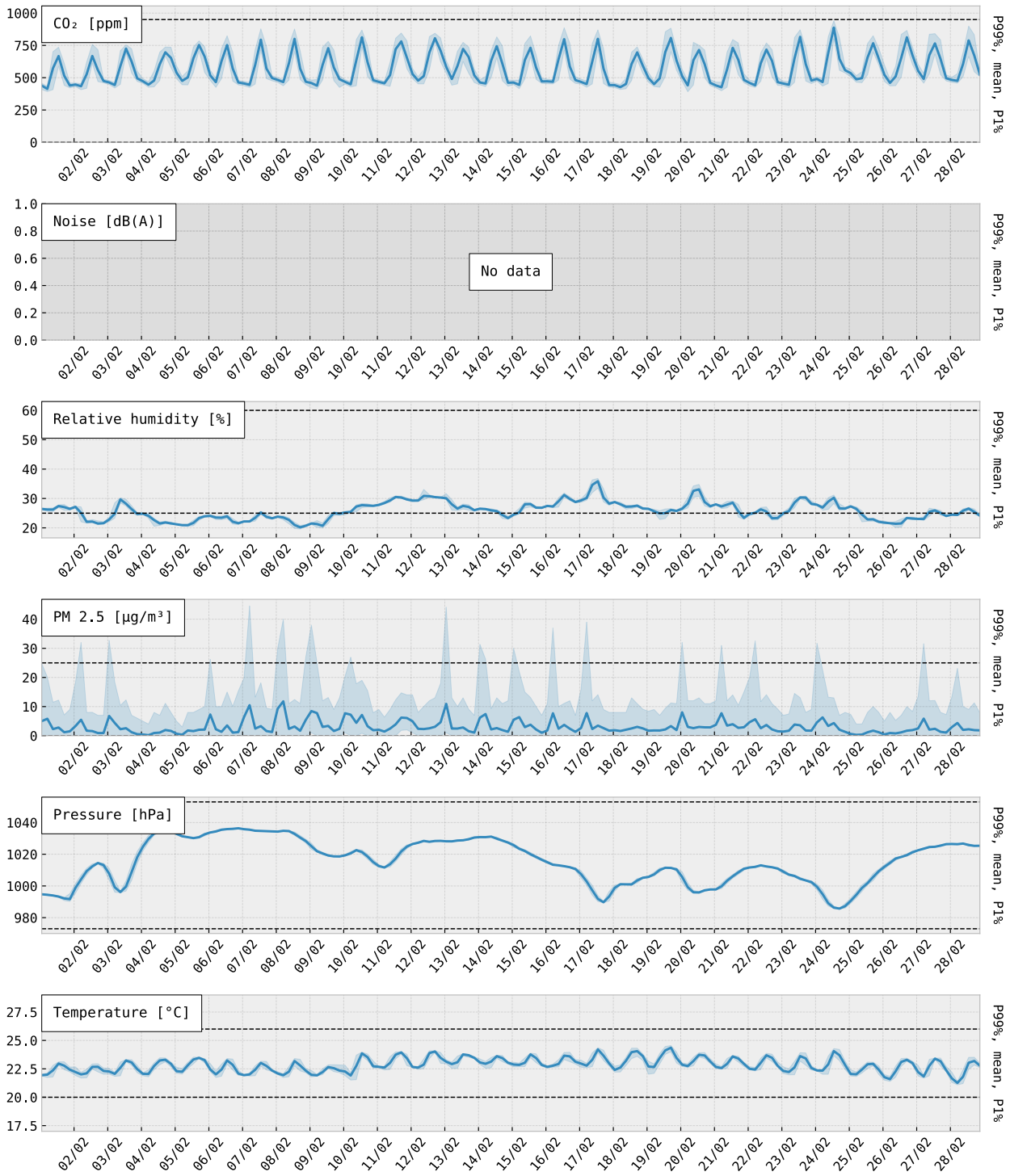


Zone-wise Daily Values

AMNO-01

How to read this

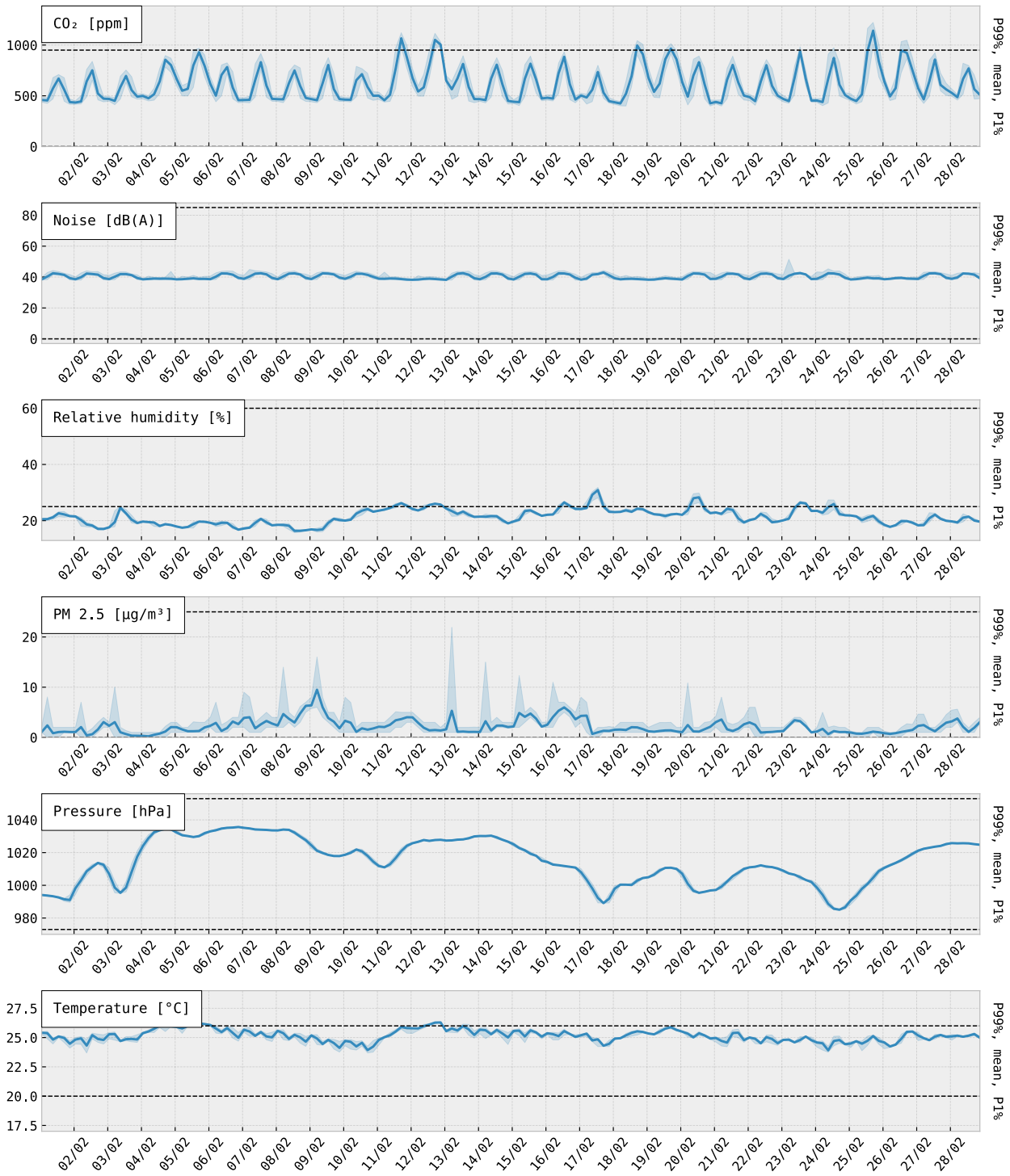
Line graphs are a useful tool to gain a quick insight into how the conditions develop over the course of the month, to spot obvious trends, unusual events, and to locate potential periods of time when the norms were exceeded. Data in the line plots below are aggregated into 4-hour buckets. Dark blue lines show mean values. Light blue ribbons show intervals between the 1st and the 99th percentile values during each 4-hour period.



DA00100001

How to read this

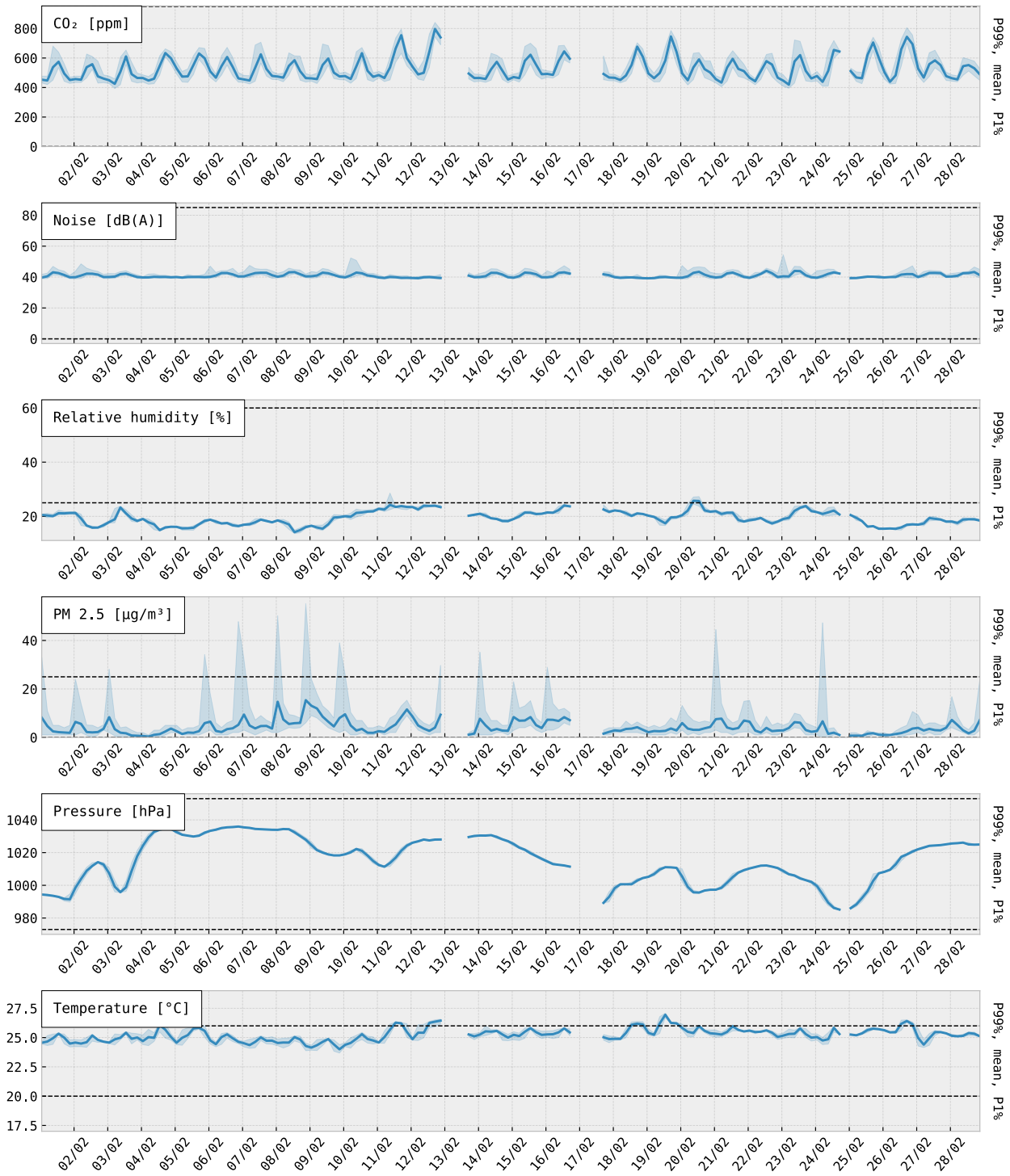
Line graphs are a useful tool to gain a quick insight into how the conditions develop over the course of the month, to spot obvious trends, unusual events, and to locate potential periods of time when the norms were exceeded. Data in the line plots below are aggregated into 4-hour buckets. Dark blue lines show mean values. Light blue ribbons show intervals between the 1st and the 99th percentile values during each 4-hour period.



DA00110031

How to read this

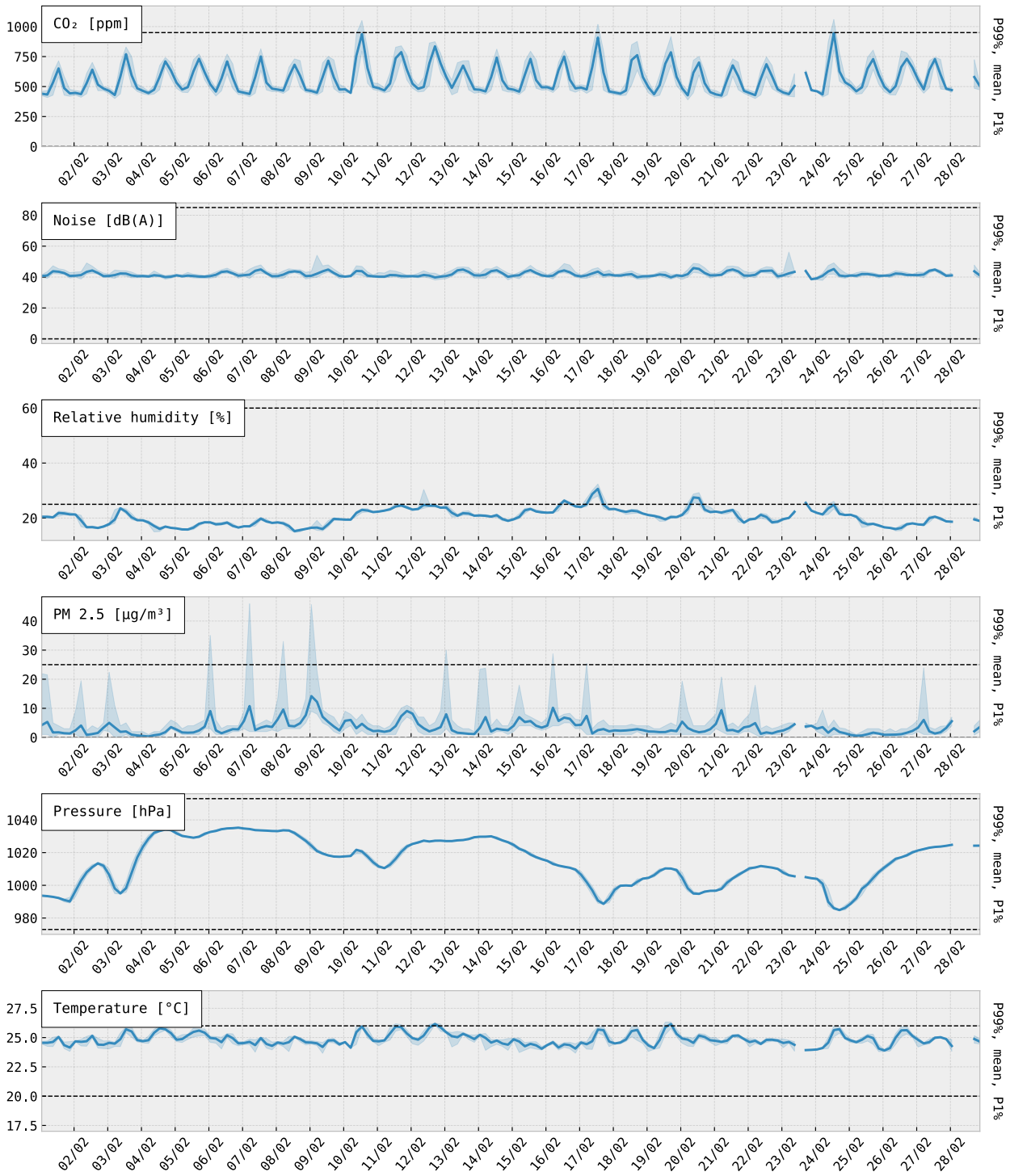
Line graphs are a useful tool to gain a quick insight into how the conditions develop over the course of the month, to spot obvious trends, unusual events, and to locate potential periods of time when the norms were exceeded. Data in the line plots below are aggregated into 4-hour buckets. Dark blue lines show mean values. Light blue ribbons show intervals between the 1st and the 99th percentile values during each 4-hour period.



DA00110032

How to read this

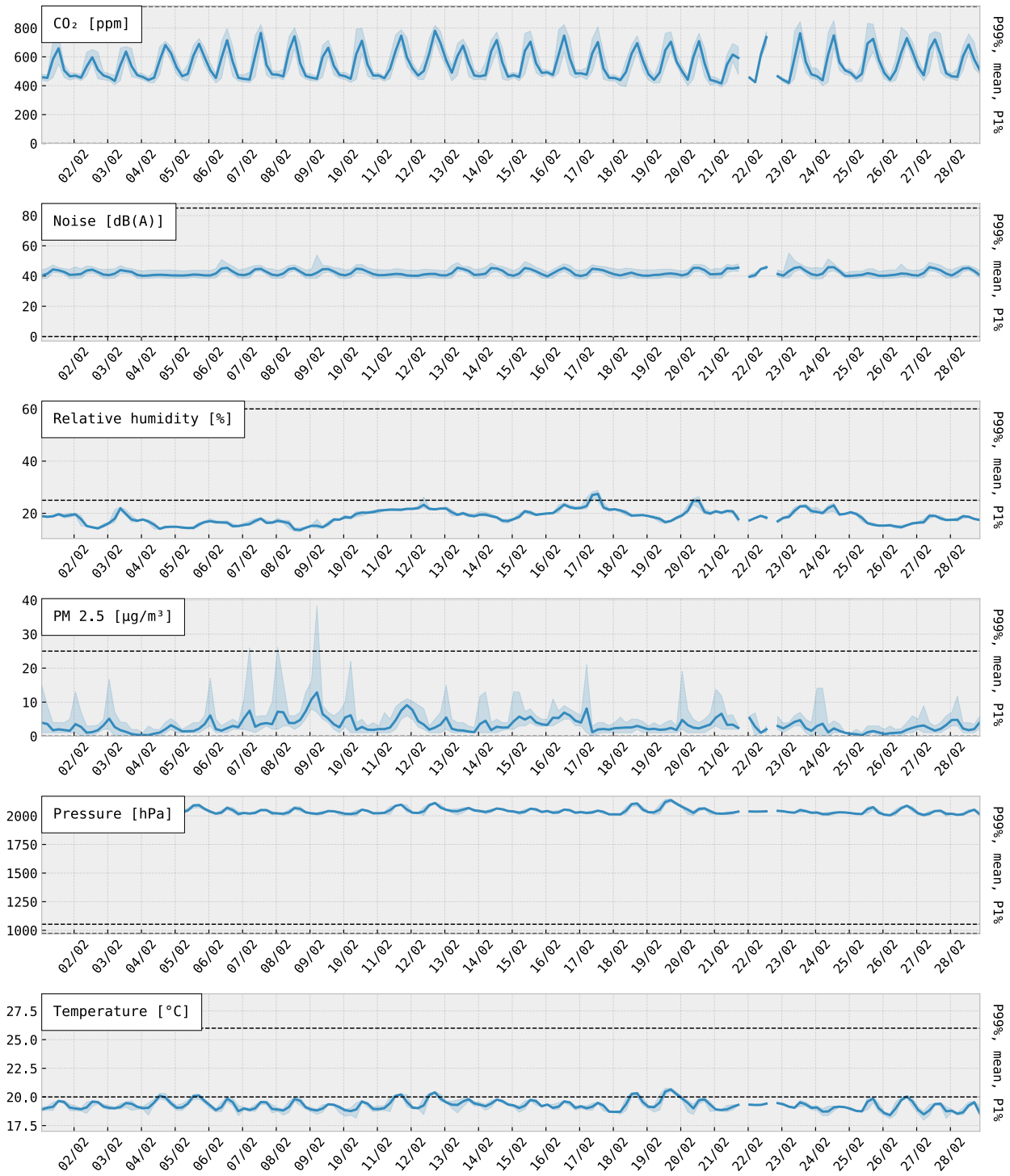
Line graphs are a useful tool to gain a quick insight into how the conditions develop over the course of the month, to spot obvious trends, unusual events, and to locate potential periods of time when the norms were exceeded. Data in the line plots below are aggregated into 4-hour buckets. Dark blue lines show mean values. Light blue ribbons show intervals between the 1st and the 99th percentile values during each 4-hour period.



DA00110033

How to read this

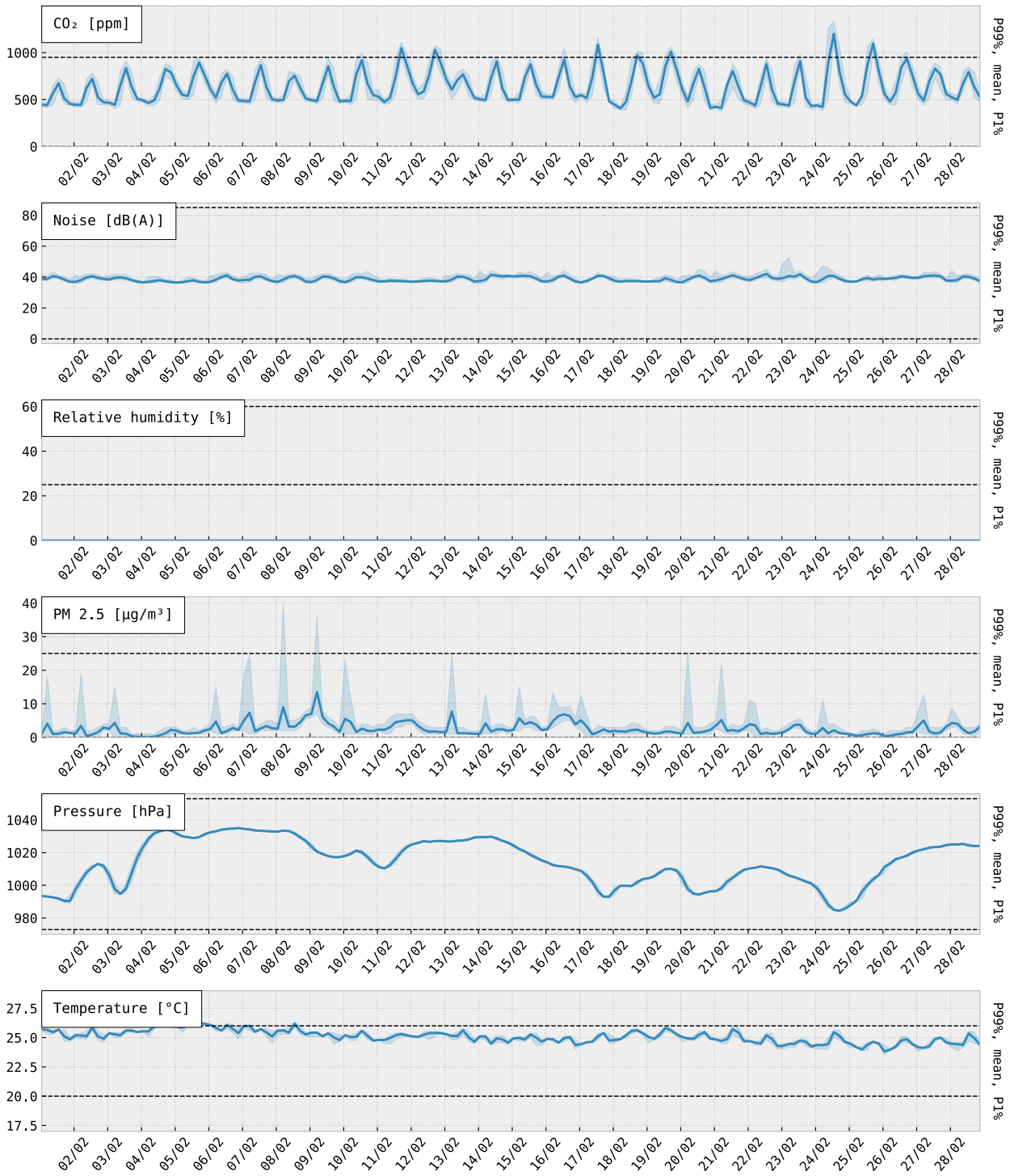
Line graphs are a useful tool to gain a quick insight into how the conditions develop over the course of the month, to spot obvious trends, unusual events, and to locate potential periods of time when the norms were exceeded. Data in the line plots below are aggregated into 4-hour buckets. Dark blue lines show mean values. Light blue ribbons show intervals between the 1st and the 99th percentile values during each 4-hour period.



DA00110034

How to read this

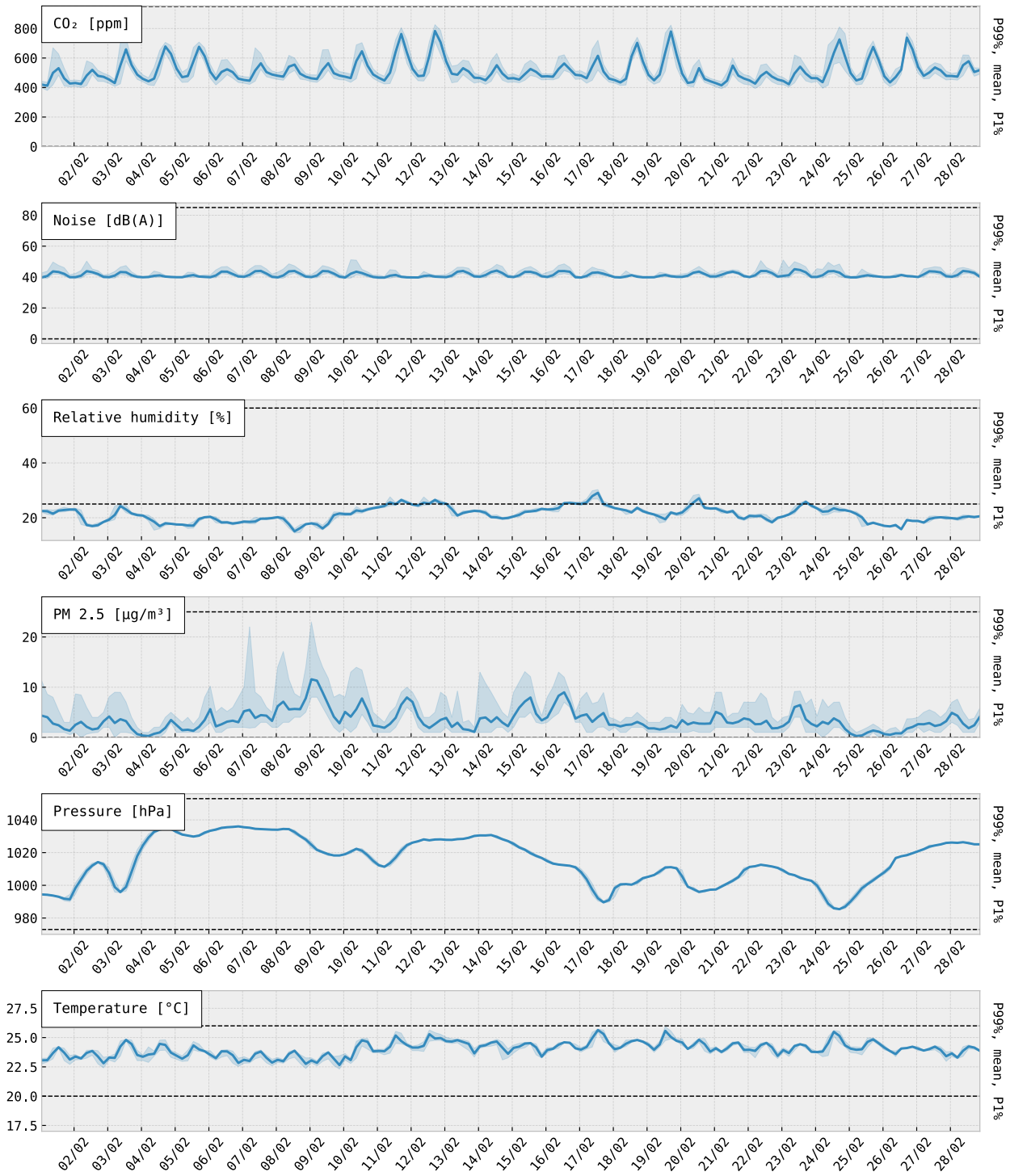
Line graphs are a useful tool to gain a quick insight into how the conditions develop over the course of the month, to spot obvious trends, unusual events, and to locate potential periods of time when the norms were exceeded. Data in the line plots below are aggregated into 4-hour buckets. Dark blue lines show mean values. Light blue ribbons show intervals between the 1st and the 99th percentile values during each 4-hour period.



DA00110035

How to read this

Line graphs are a useful tool to gain a quick insight into how the conditions develop over the course of the month, to spot obvious trends, unusual events, and to locate potential periods of time when the norms were exceeded. Data in the line plots below are aggregated into 4-hour buckets. Dark blue lines show mean values. Light blue ribbons show intervals between the 1st and the 99th percentile values during each 4-hour period.



DA00110036

How to read this

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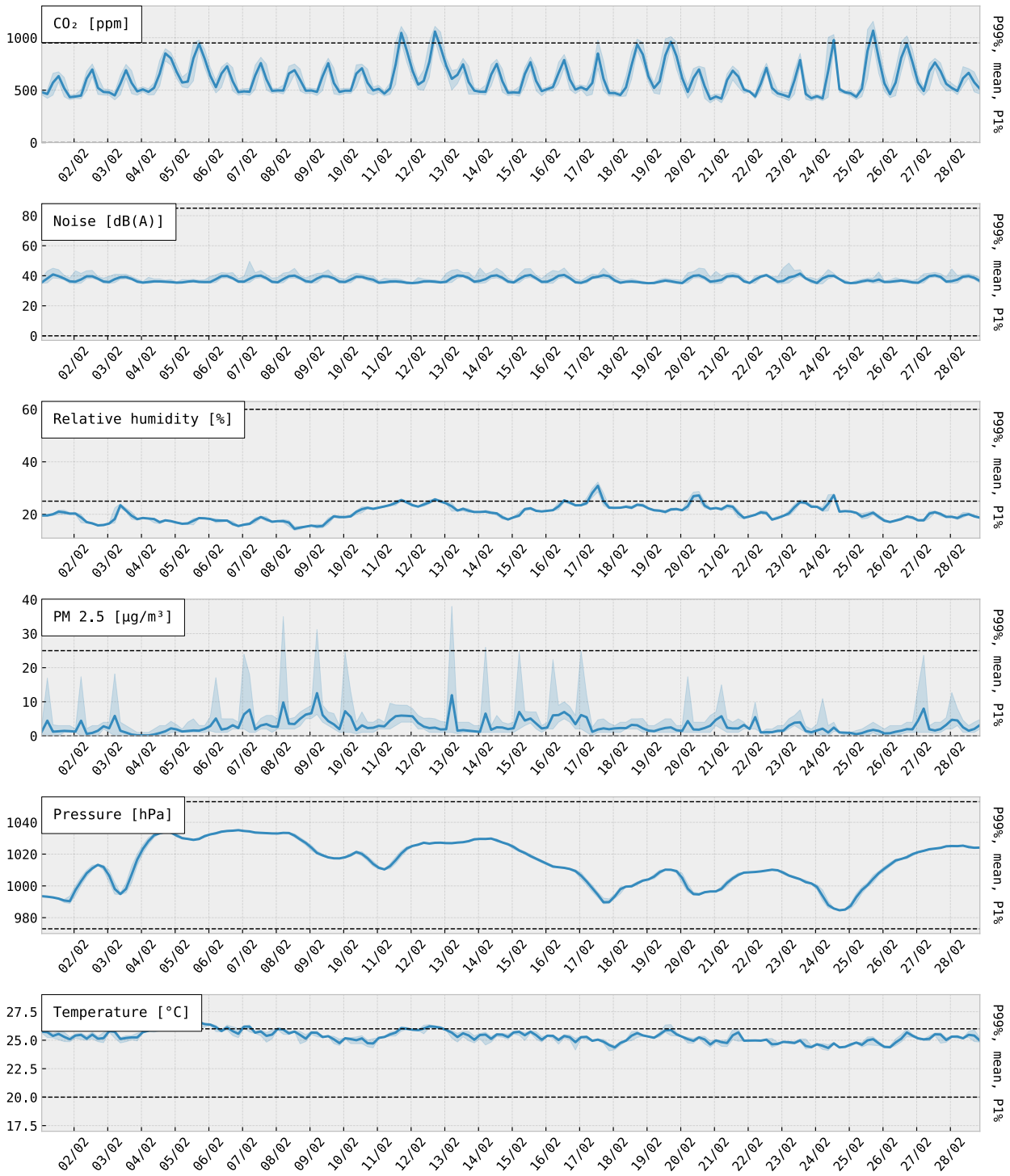

DA00110037

How to read this

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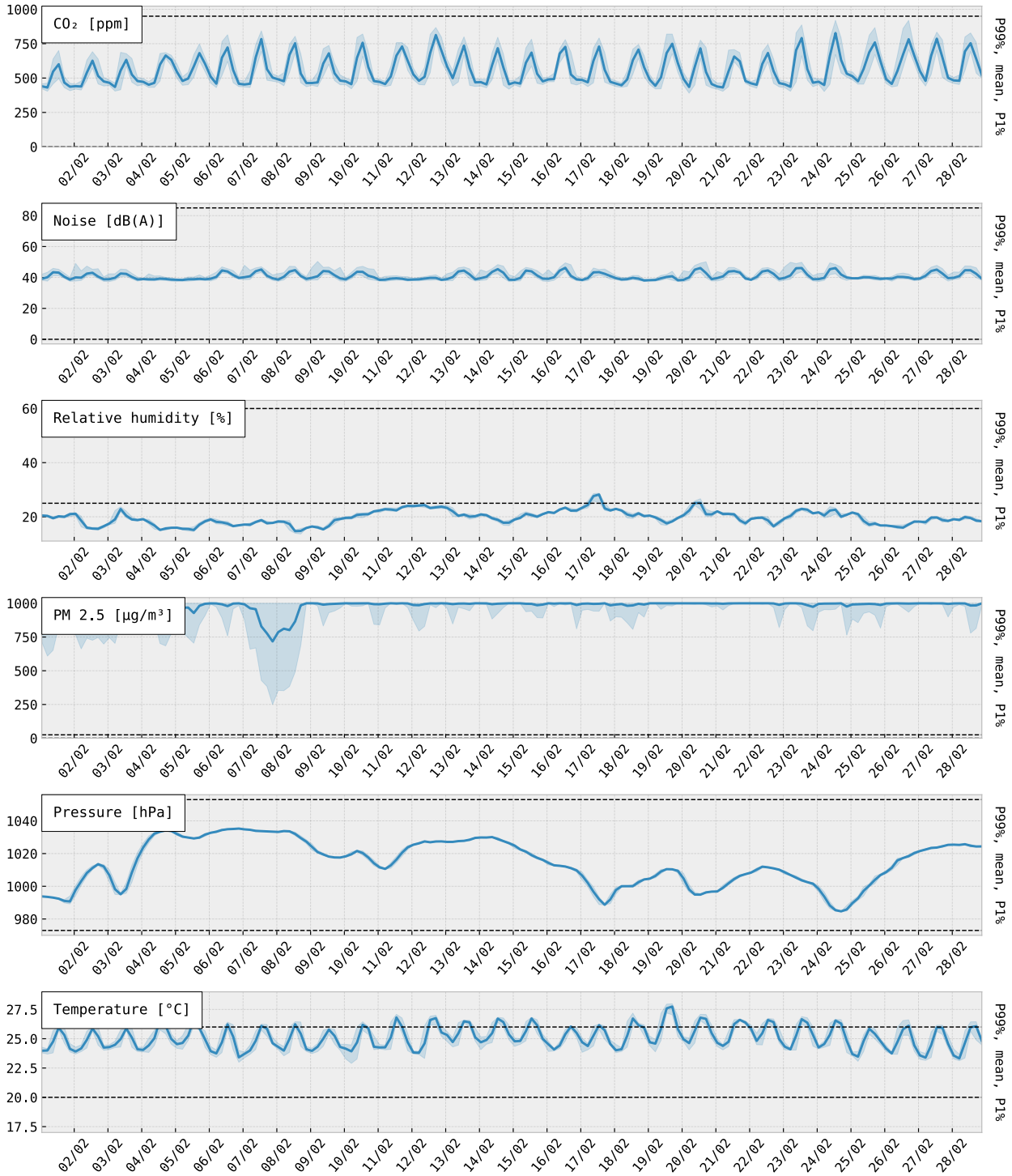

DA00110038

How to read this

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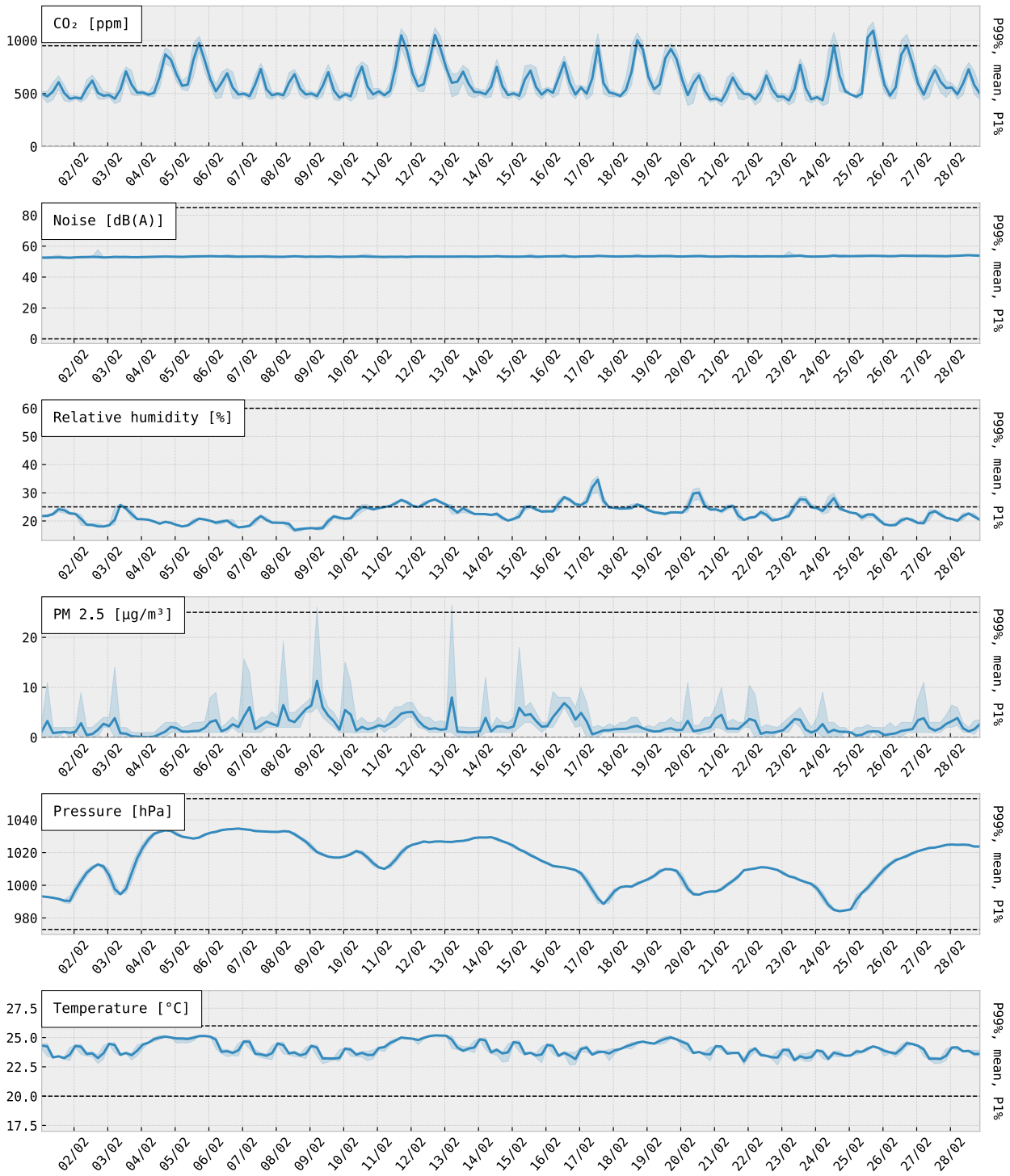

DA00110039

How to read this

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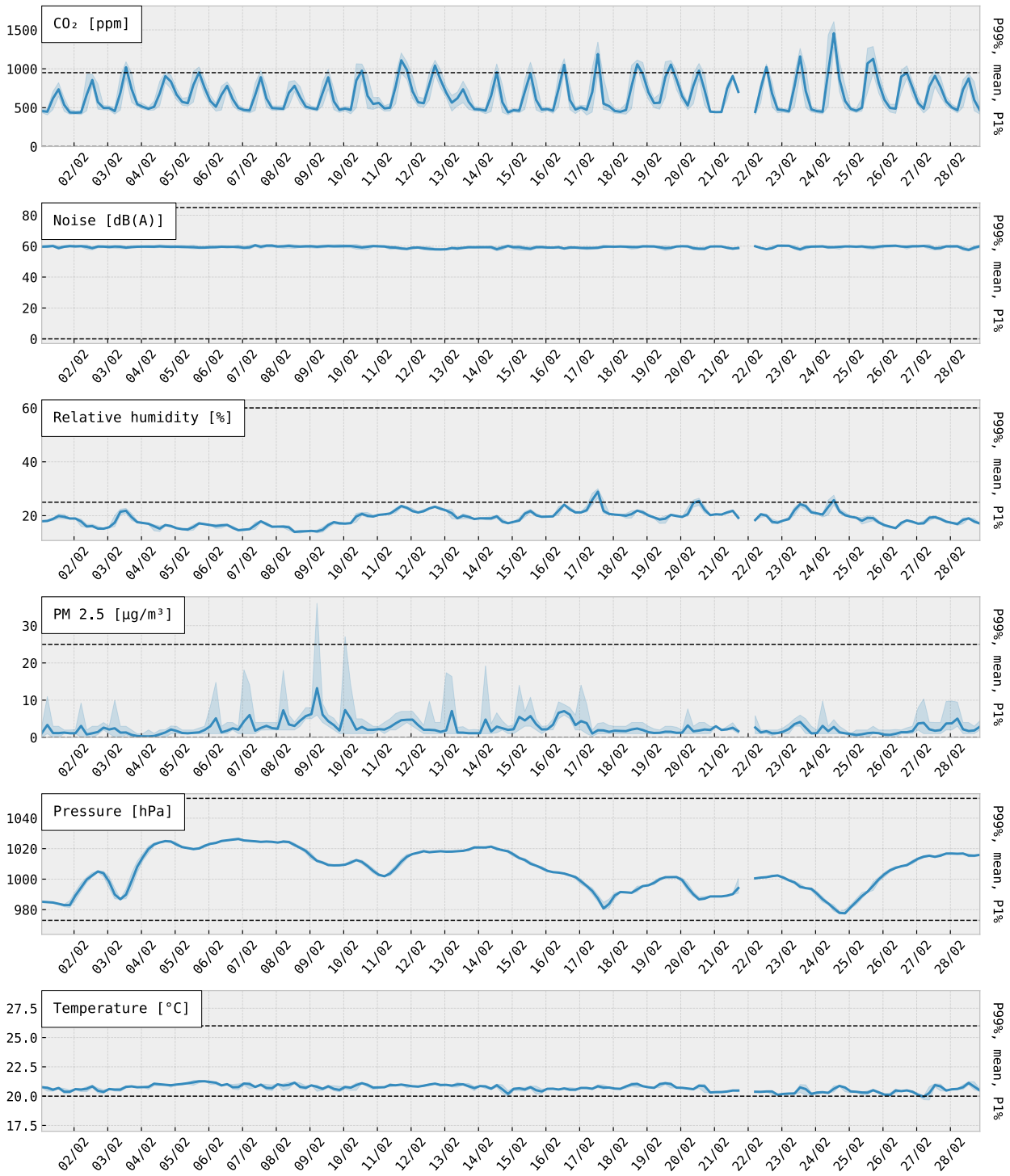

DA00110040

How to read this

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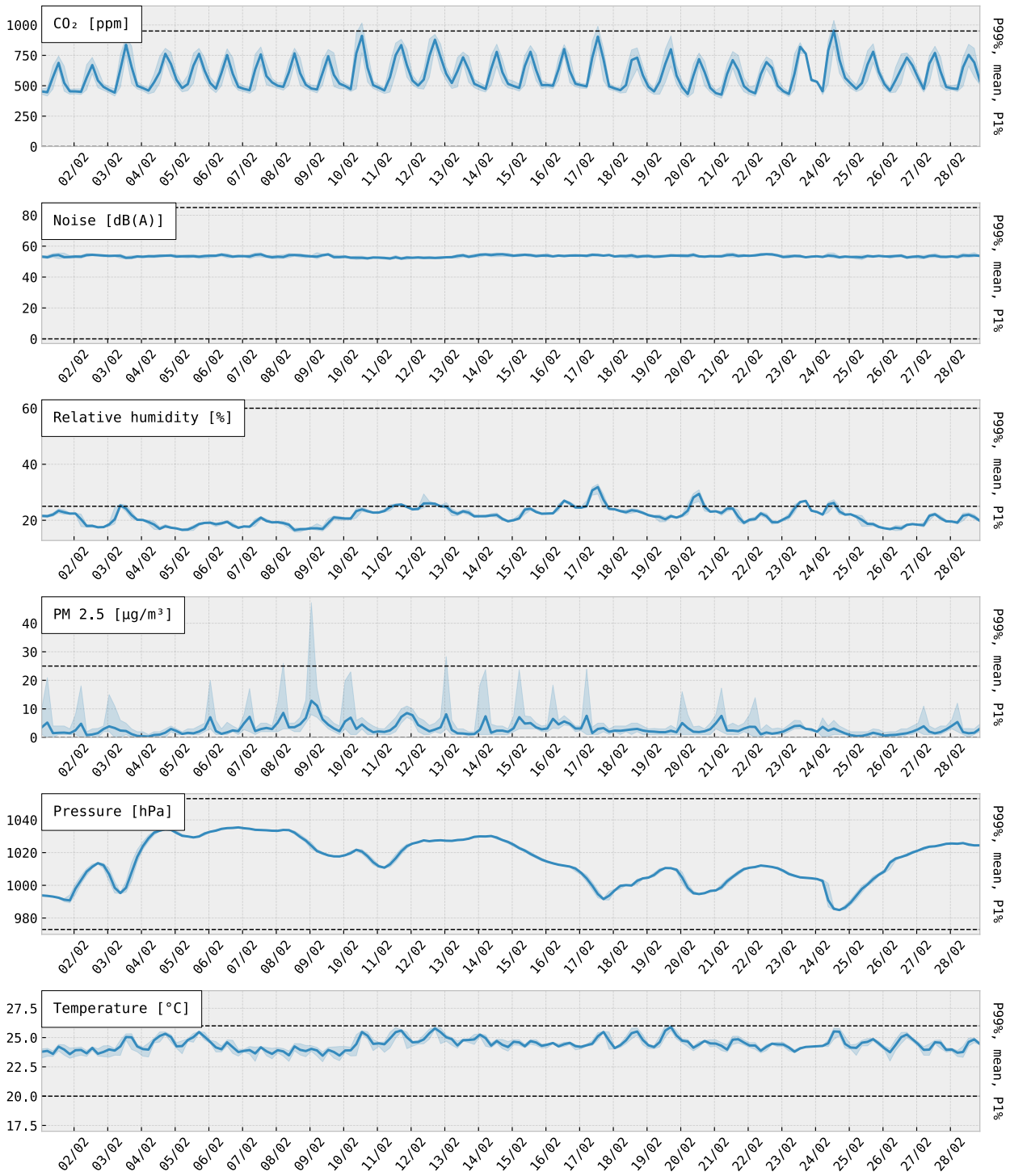

DA00110041

How to read this

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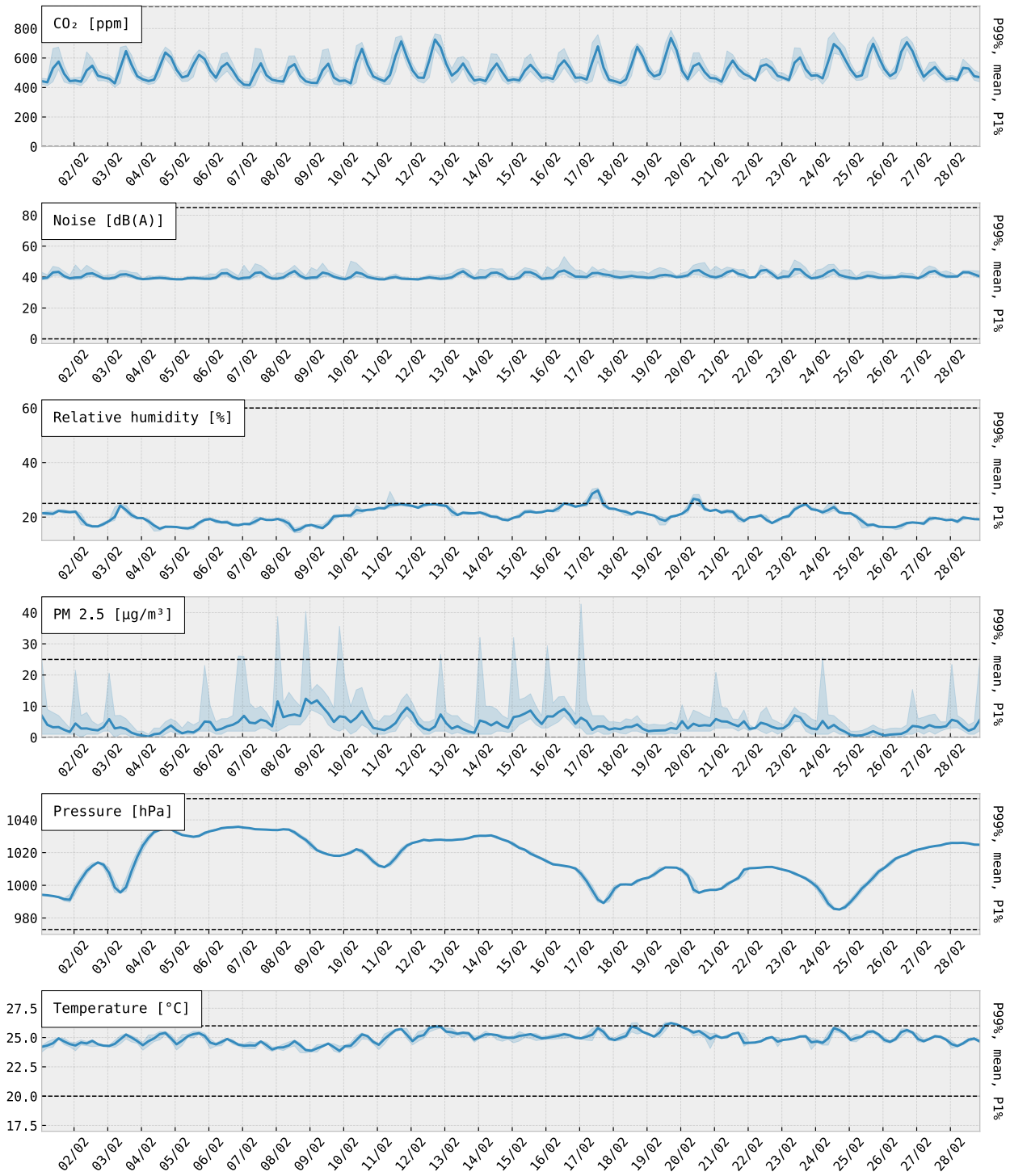
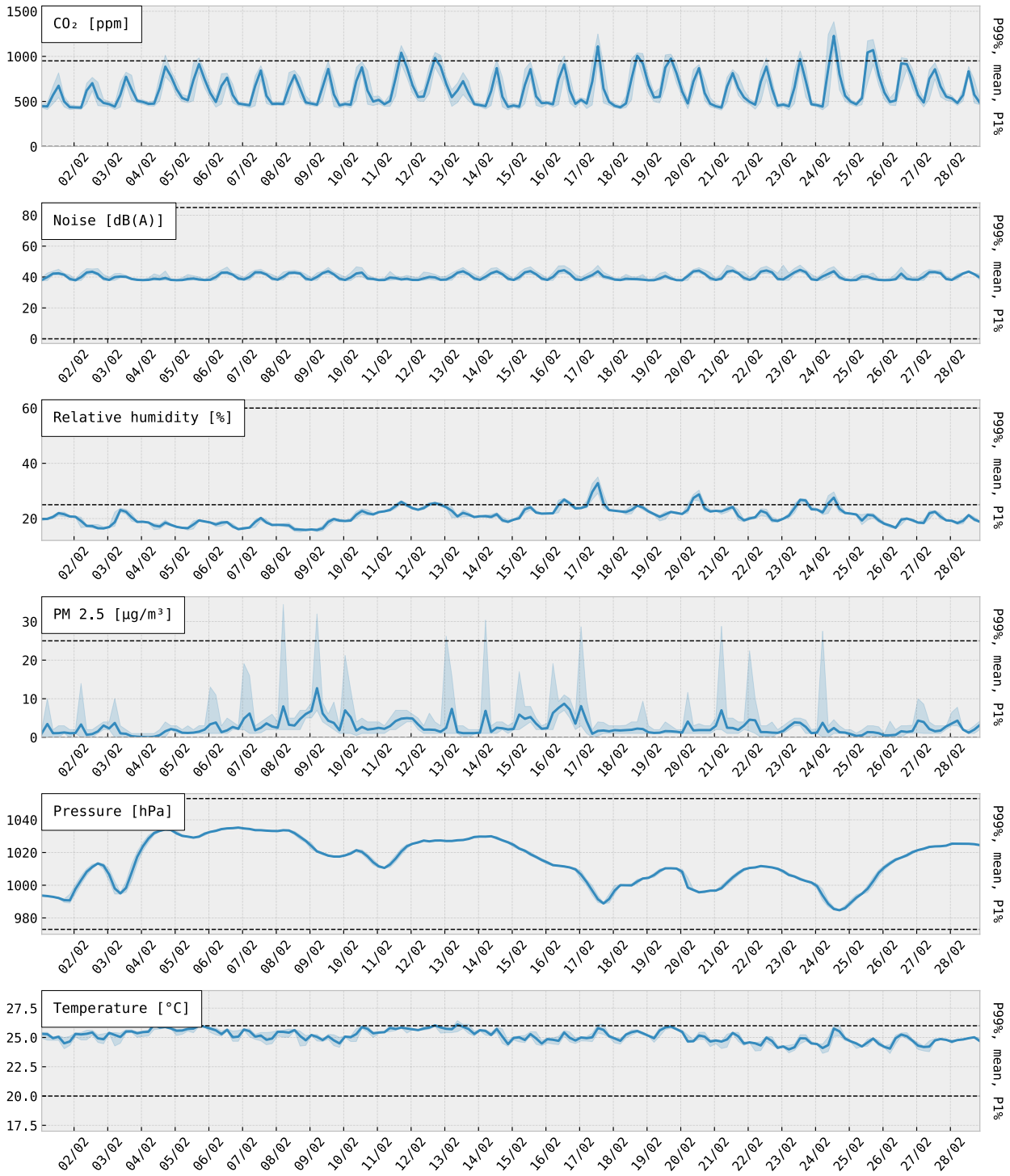


DA00110042

How to read this

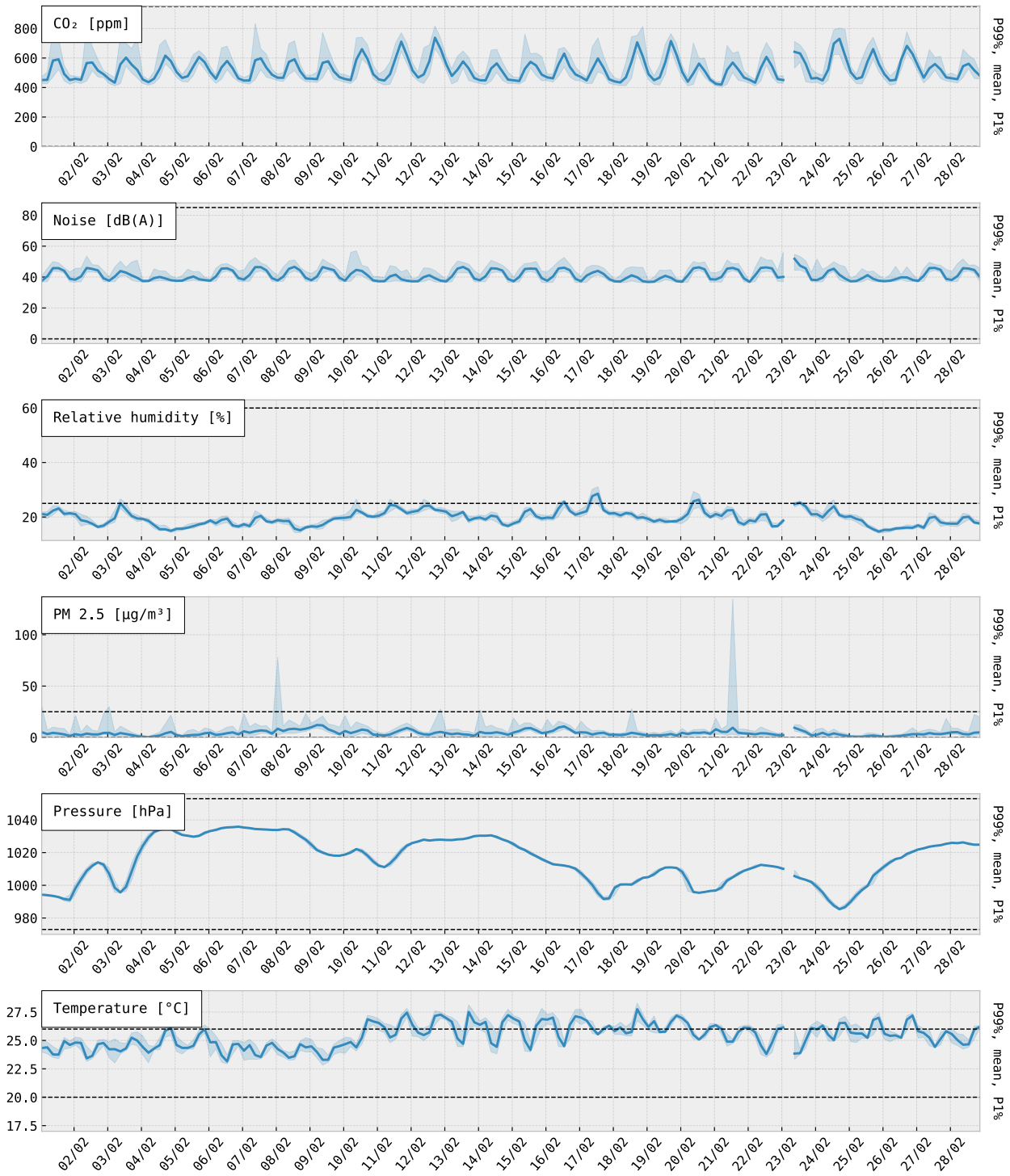
Line graphs are a useful tool to gain a quick insight into how the conditions develop over the course of the month, to spot obvious trends, unusual events, and to locate potential periods of time when the norms were exceeded. Data in the line plots below are aggregated into 4-hour buckets. Dark blue lines show mean values. Light blue ribbons show intervals between the 1st and the 99th percentile values during each 4-hour period.



DA00110043

How to read this

Line graphs are a useful tool to gain a quick insight into how the conditions develop over the course of the month, to spot obvious trends, unusual events, and to locate potential periods of time when the norms were exceeded. Data in the line plots below are aggregated into 4-hour buckets. Dark blue lines show mean values. Light blue ribbons show intervals between the 1st and the 99th percentile values during each 4-hour period.



DA00110044

How to read this

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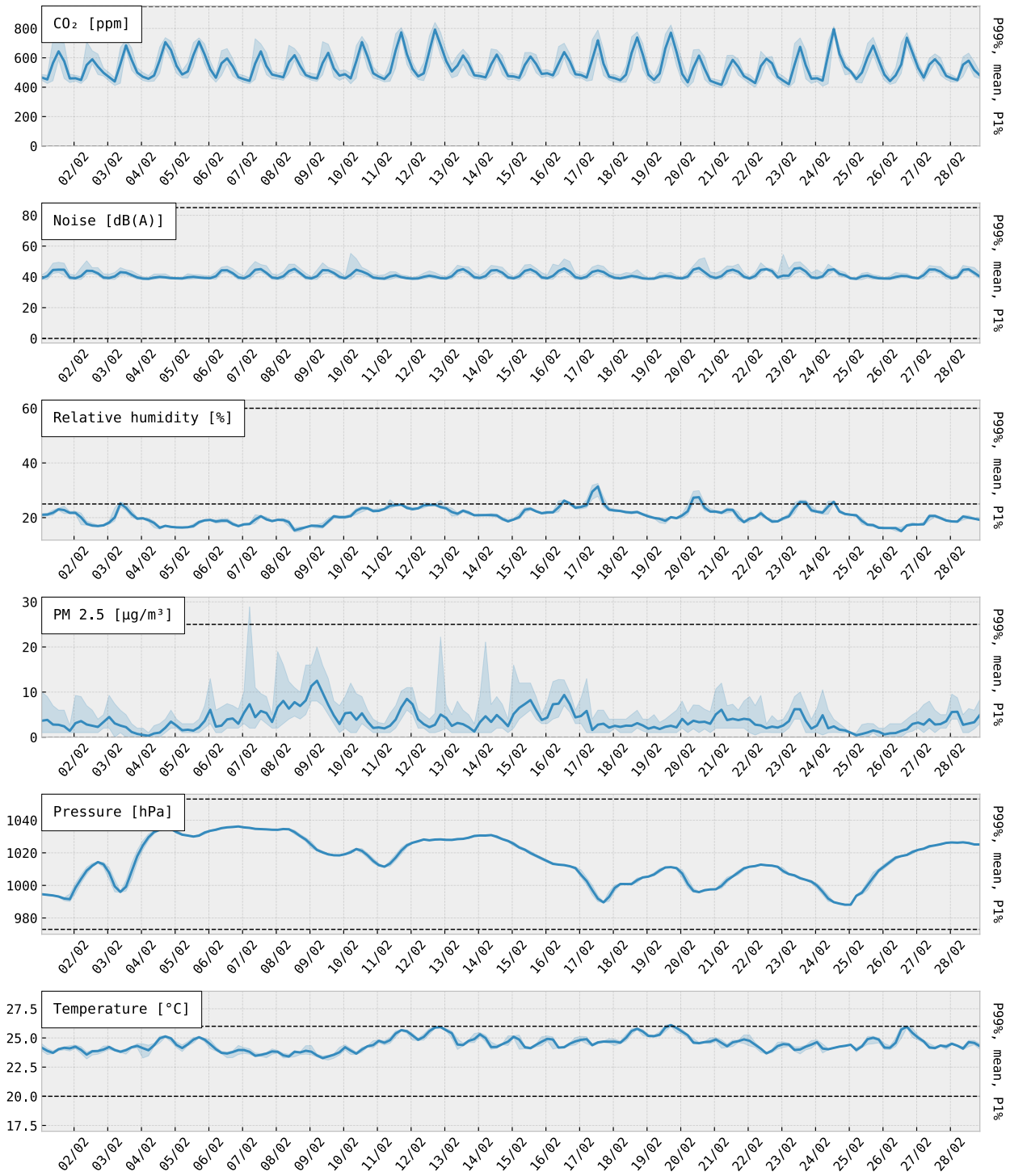

DA00110045

How to read this

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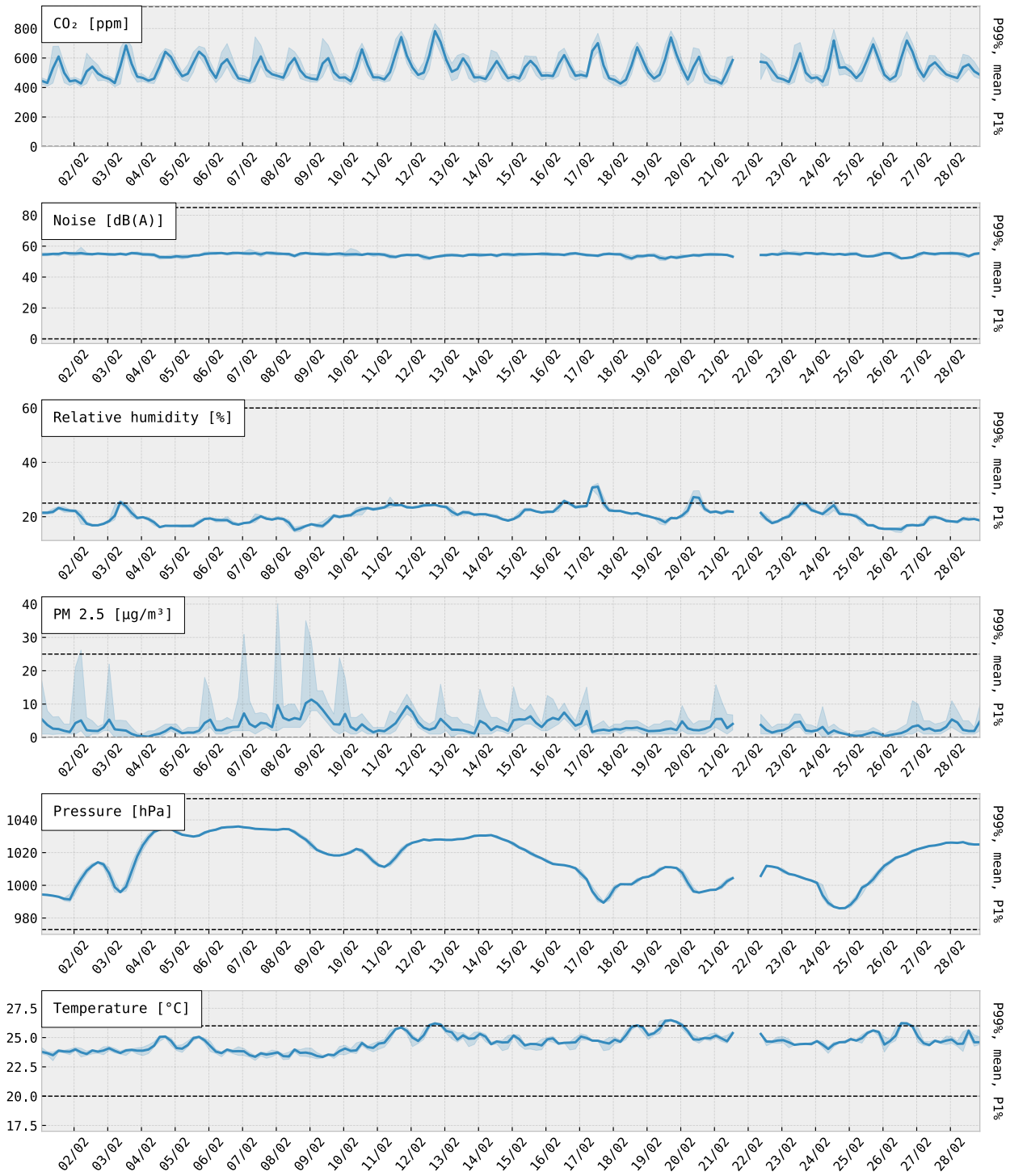
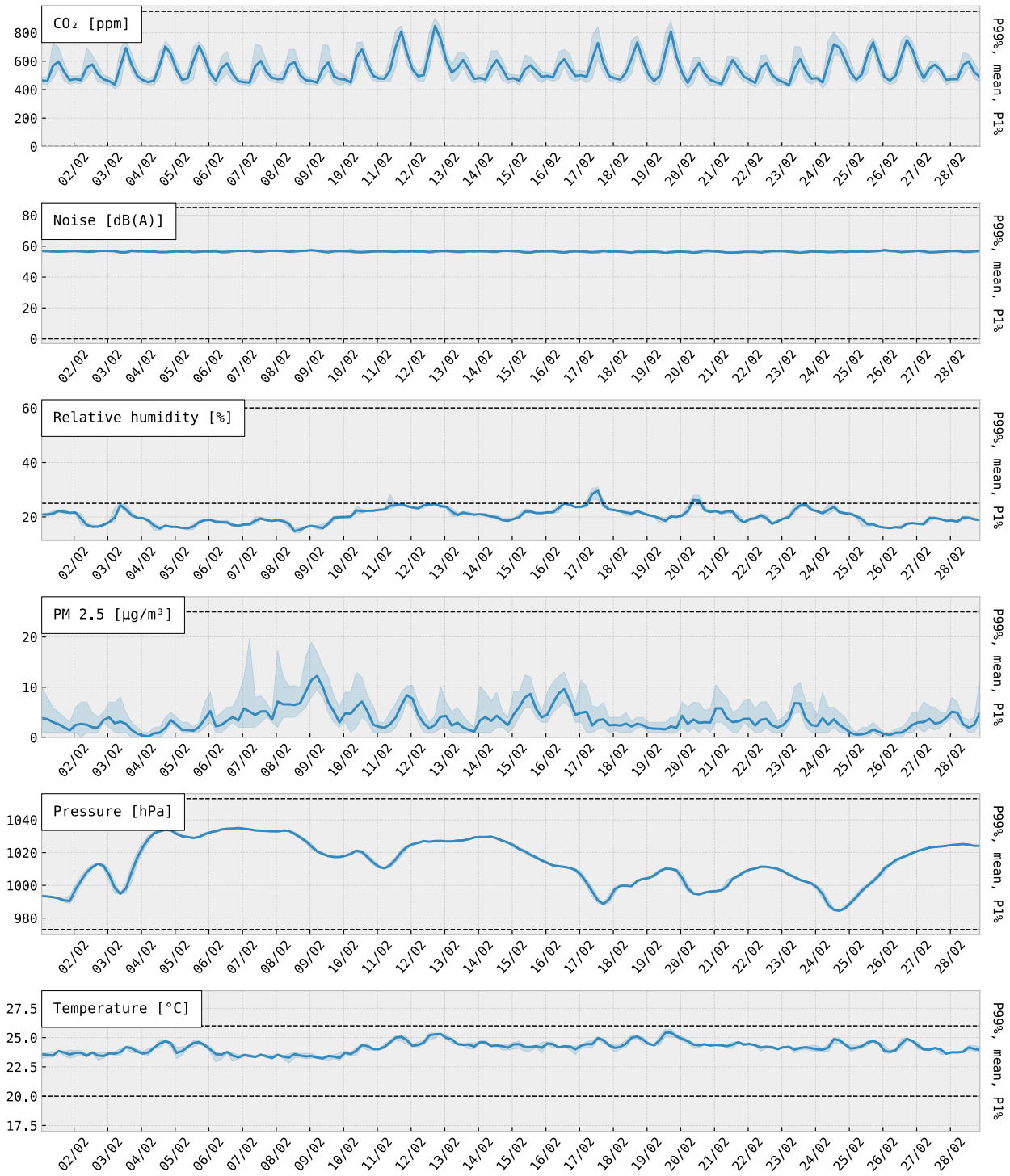


DA00110047

How to read this

Line graphs are a useful tool to gain a quick insight into how the conditions develop over the course of the month, to spot obvious trends, unusual events, and to locate potential periods of time when the norms were exceeded. Data in the line plots below are aggregated into 4-hour buckets. Dark blue lines show mean values. Light blue ribbons show intervals between the 1st and the 99th percentile values during each 4-hour period.



DA00110049

How to read this

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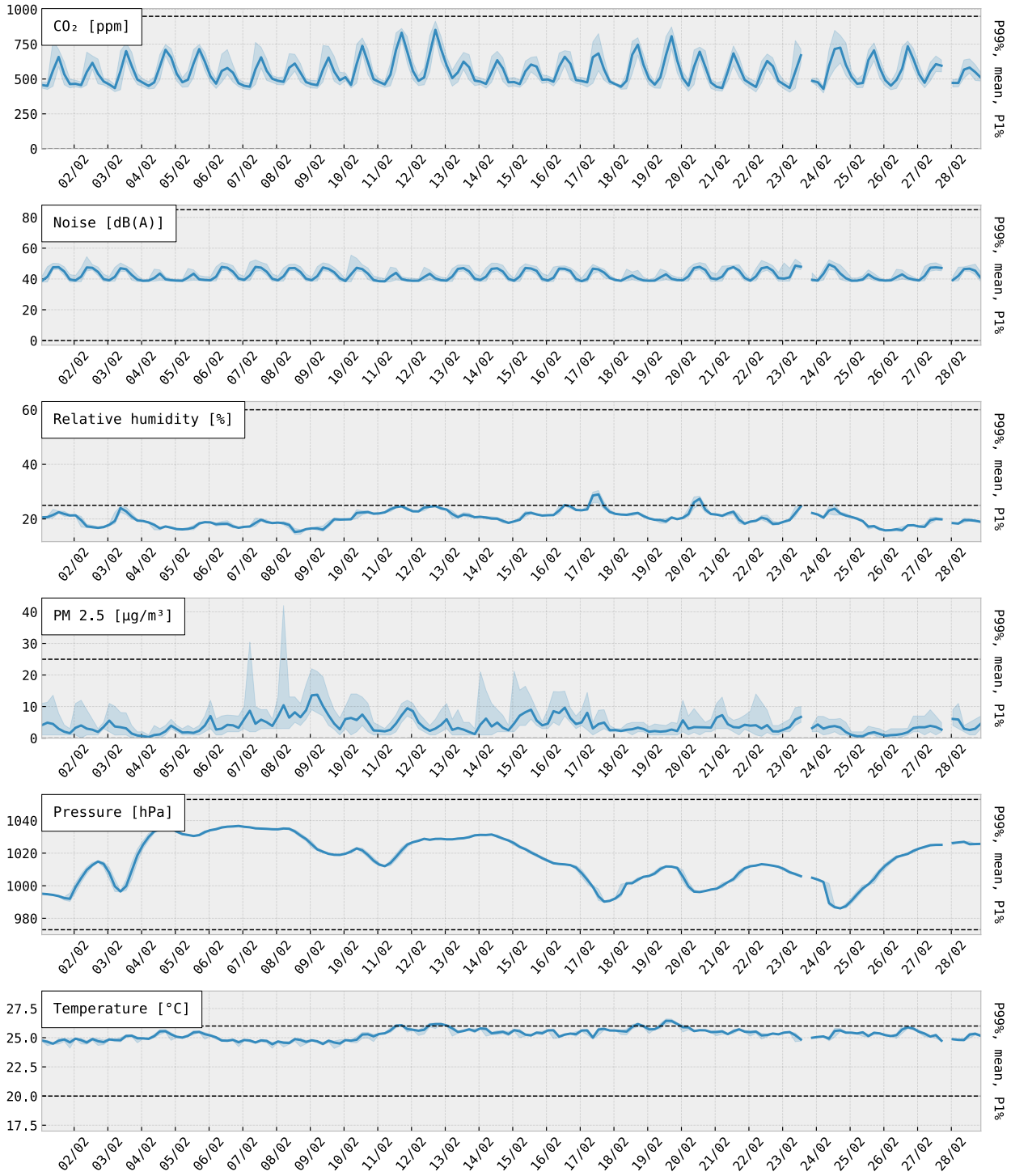

DA00130001

How to read this

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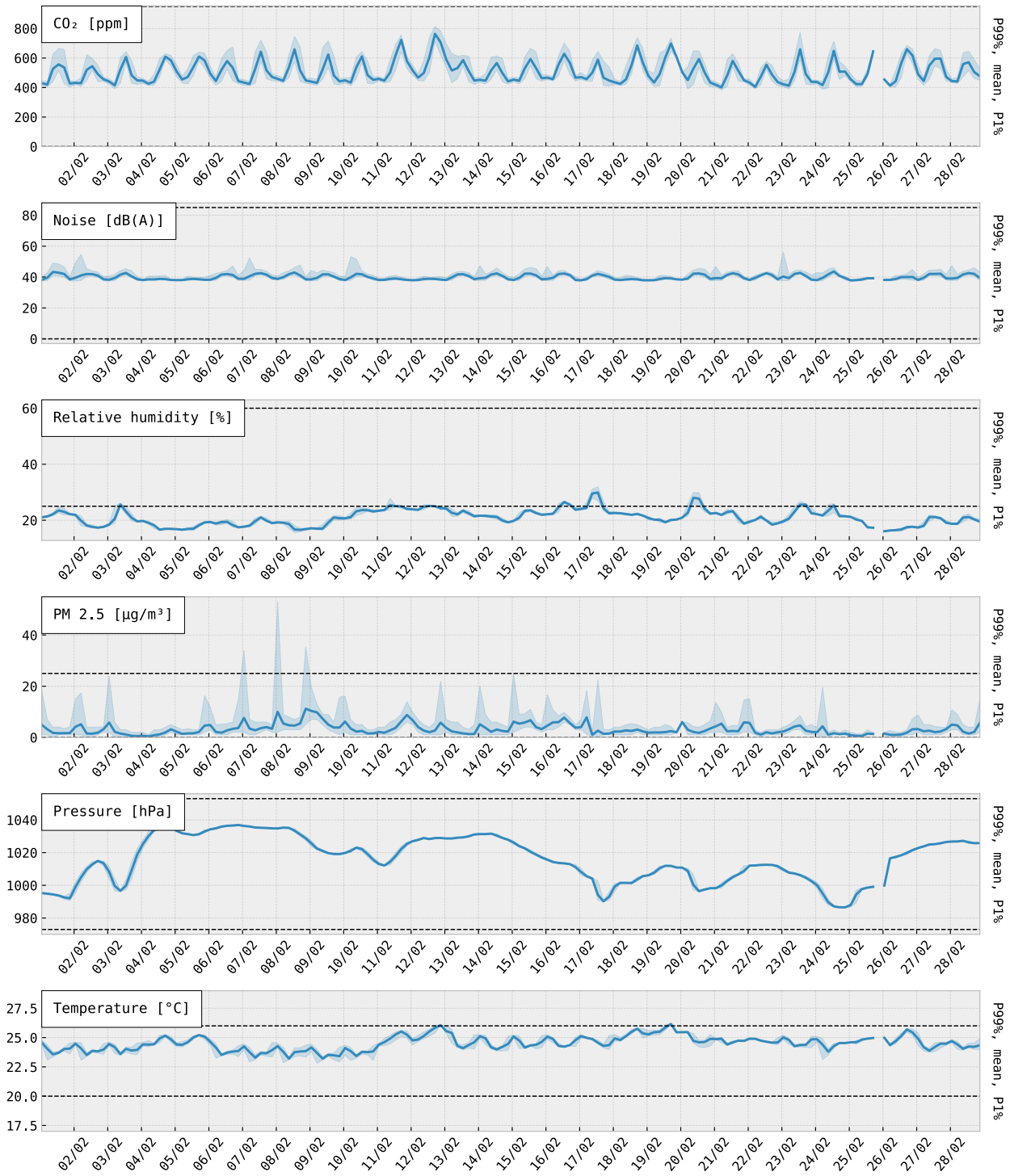

DA00130002

How to read this

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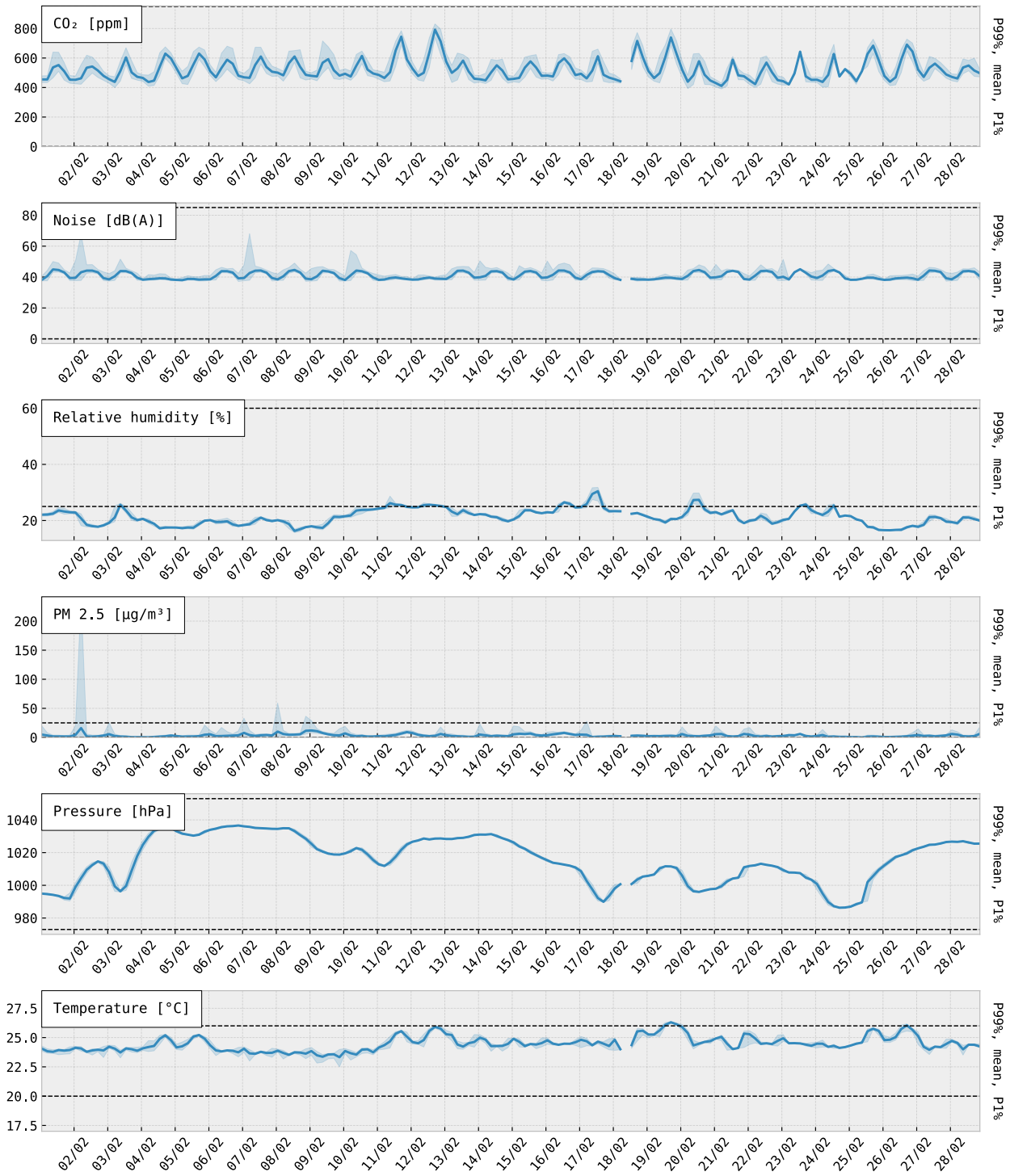

DA00130003

How to read this

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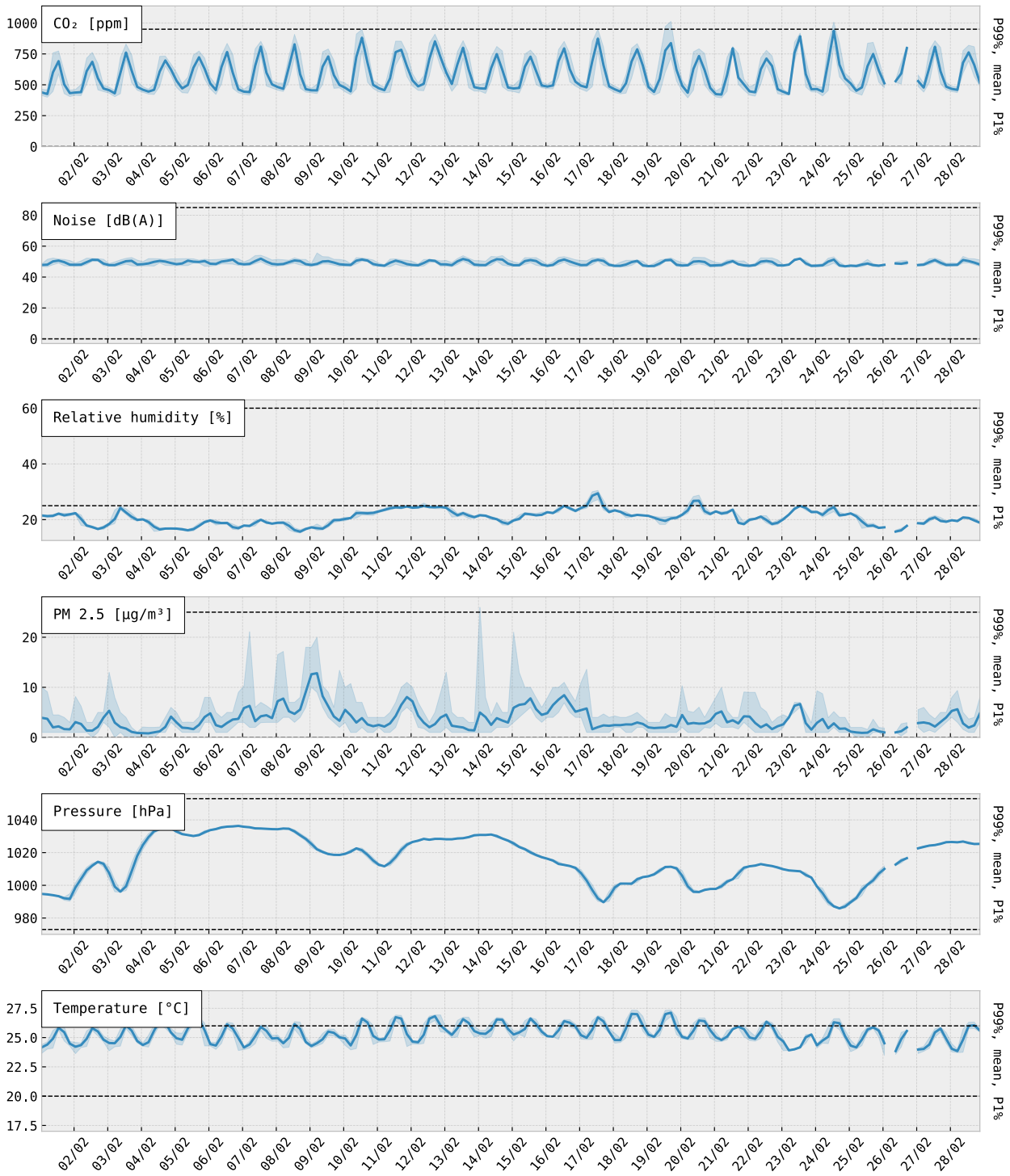

DA00130004

How to read this

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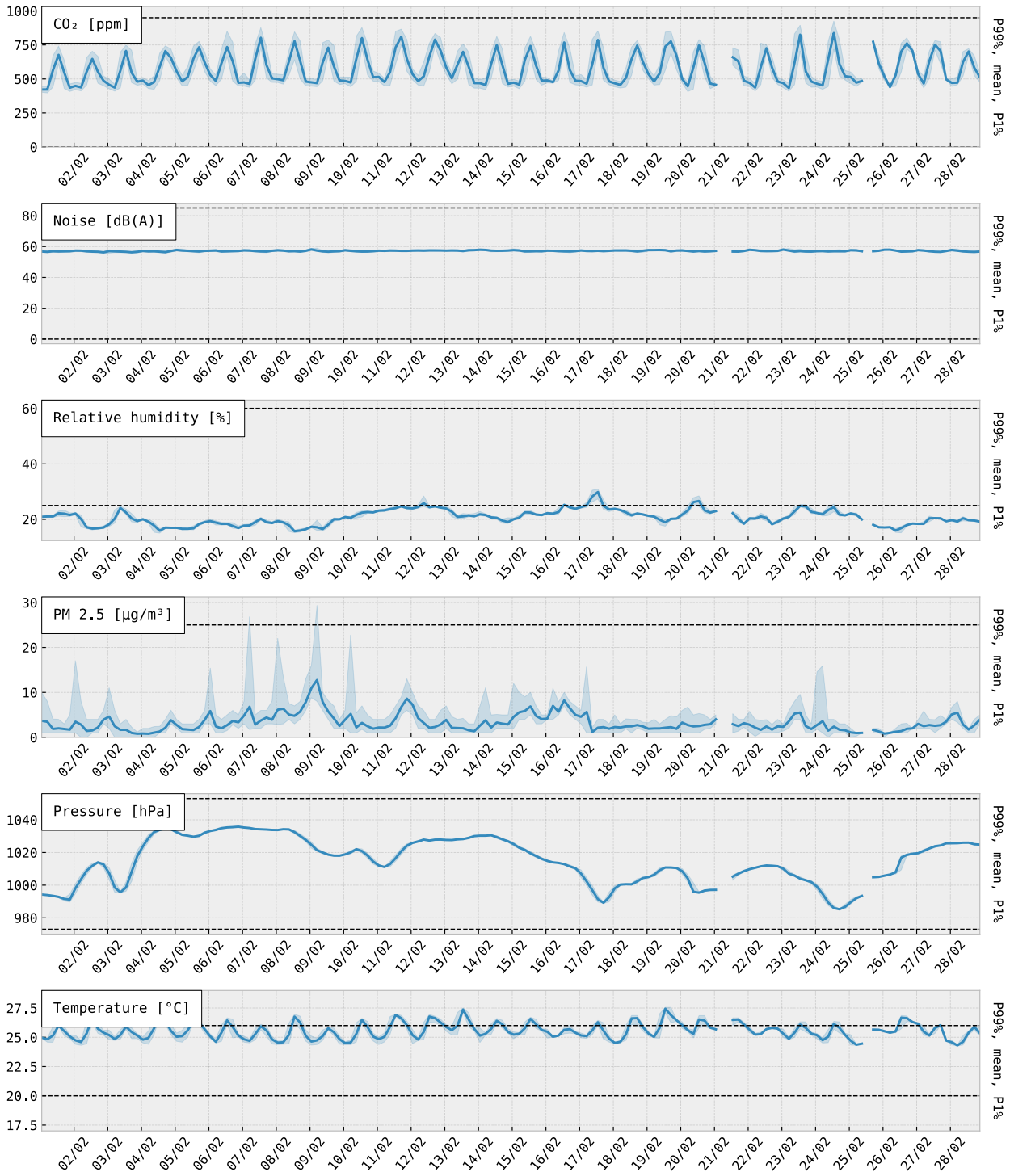

Appendix I. Installed devices

Name	Device ID	Type
DA00130003	012398F4AB3ED774FF	Ambinode
DA00110042	0123A8032A74EA18FF	Ambinode
DA00110033	0123A8032A74EA34FF	Ambinode
DA00110036	0123A8032A74EA84FF	Ambinode
DA00110039	0123A8032A74EACCFF	Ambinode
DA00110043	0123A8032A74EAE4FF	Ambinode
DA00110037	0123A8032A74EAF4FF	Ambinode
DA00110038	0123A8032A74EB00FF	Ambinode
DA00110045	0123A8032A74EB04FF	Ambinode
DA00110035	0123A8032A74EB0CFF	Ambinode
DA00110034	0123A8032A74EB18FF	Ambinode
DA00110040	0123A8032A74EB20FF	Ambinode
DA00110041	0123A8032A74EB2CFF	Ambinode
DA00110032	0123A8032A74EB44FF	Ambinode
DA00110031	0123A8032A74EB54FF	Ambinode
DA00110047	0123A8032A74EB94FF	Ambinode
DA00110044	0123A8032A74EBA4FF	Ambinode
DA00110049	0123F4CFA2823F90FF	Ambinode
DA00130002	0123F4CFA2830FACFF	Ambinode
DA00130004	0123F4CFA2838770FF	Ambinode
DA00130001	0123F4CFA2838E44FF	Ambinode
DA00100001	0123F4CFA2838FF0FF	Ambinode
AMNO-01	84:0D:8E:2E:C2:18	Ambinode

Contact

Leapcraft ApS

Strandgade 54
1410 Copenhagen K, Denmark

CVR/VAT#: 35472762

leapcraft.com