



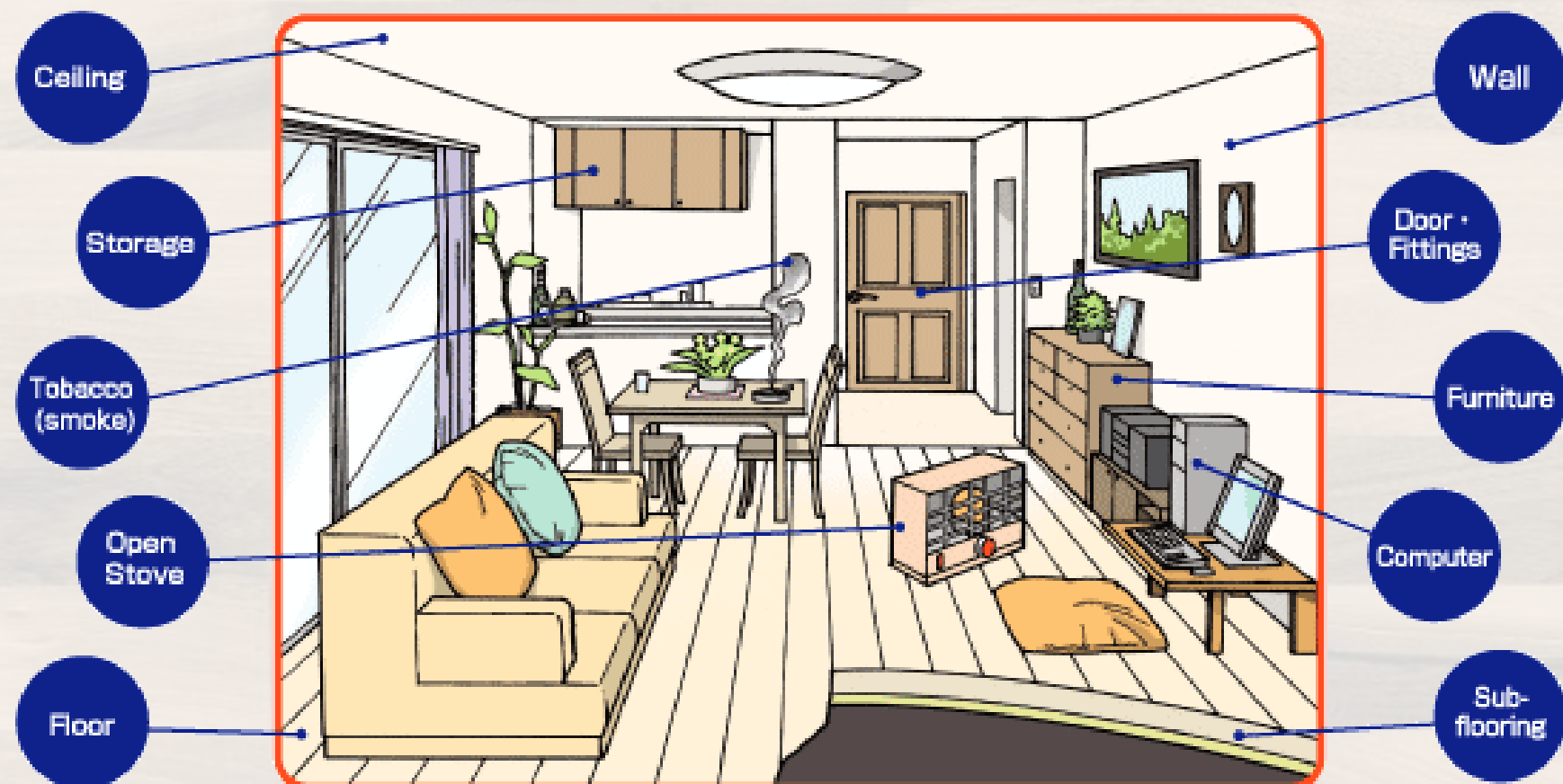
FORMALDEHYDE AND TVOC COMPOUND EMISSION IN WOODEN MODEL HOUSE

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Introduction

- ◉ Indoor air quality
 - ◉ $\geq 80\%$ inhaled air is taken indoor
- ◉ Poor air quality \Rightarrow respiratory diseases, sick building syndrome
 - ◉ VOCs
 - ◉ HCHO
- ◉ Source

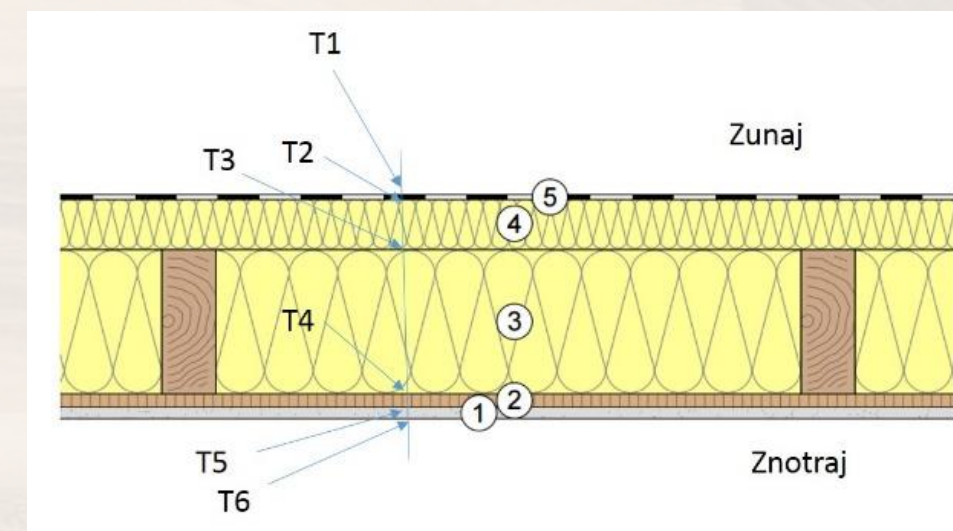


(<http://www.home-air-purifier-expert.com/formaldehyde.html>)

Object in question

Model house

Location: Department of Wood Science and Technology, Ljubljana, Slovenia



Legend:

Znotraj – Inside

1 – Gypsum board

2 – OSB

3 – Timber frame (spruce) + cellulose insulaton

4 – Fiberboard insulate sheeting

5 – Secondary water-shedding layer

Zunaj - Outside

Object in question

- ⊙ Insulation layer
 - ⊙ Cellulose fibres (Montažna gradnja Tadej Zimic s.p.)
 - ⊙ Thickness 160 mm
 - ⊙ Loose fill
 - ⊙ Panel type (laboartory made)
 - ⊙ MUF resin (15% w/w ratio)
 - ⊙ $t_{\text{target}}=80$ mm
 - ⊙ $\rho_{\text{target}}=0.05$ g/cm³
- ⊙ Façade
 - ⊙ 7 wood species (Norway spruce, European larch, beech, sweet chestnut, scots pine, black poplar and ash wood)
 - ⊙ 4 treatment (copper-ethanolamine, montan wax, acrylic surface coating and thermal modification)
 - ⊙ 22 different wood based materials



Object in question

- ⊙ Interior wall
 - ⊙ Low VOC content coating system
 - ⊙ Jupol Classic, JUB kemična industrija d.o.o. Slovenia)
- ⊙ Flooring
 - ⊙ Different wood species
 - ⊙ Three layer parquete flooring system
 - ⊙ Polyurethane coating system
- ⊙ Wires and electrodes for data collection



Data collection

HCHO

- Formaldemeter™ htV-m (PPM Technology, UK)
 - Electrochemical sensing technology
 - The air is drawn into sensor, where small voltage is produced due to oxidation of formaldehyde at one of catalytically active electrodes
 - Sampling rate: every 30 minutes
 - Collected data
 - HCHO conc. in ppm
 - Temperature in °C
 - Humidity in %



TVOC

- IAQ Profile Monitor (PPM Technology, UK)
 - Photo ionization Detector or PID technology
 - The air is drawn into the sensor, where volatile organic compounds are ionized by UV radiation
 - Sampling rate: every 60 seconds
 - Collected data
 - TVOC conc. in ppm
 - Temperature in °C
 - Humidity in %



Data collection

- ⦿ First period: 27.05.2014 (19.06.2014 for TVOC) until 30.09.2014
- ⦿ Second period: 16.03.2015 until 30.06.2015
- ⦿ EMC value (Simpson, 1973)

$$\text{EMC} = \frac{1800}{W} \cdot \frac{K \cdot h}{1 - K \cdot h} + \frac{K_1 \cdot K \cdot h + 2 \cdot K_1 \cdot K_2 \cdot K^2 \cdot h^2}{1 + K_1 \cdot K \cdot h + K_1 \cdot K_2 \cdot K^2 \cdot h^2}$$

T temperature in °C

h humidity (%/100)

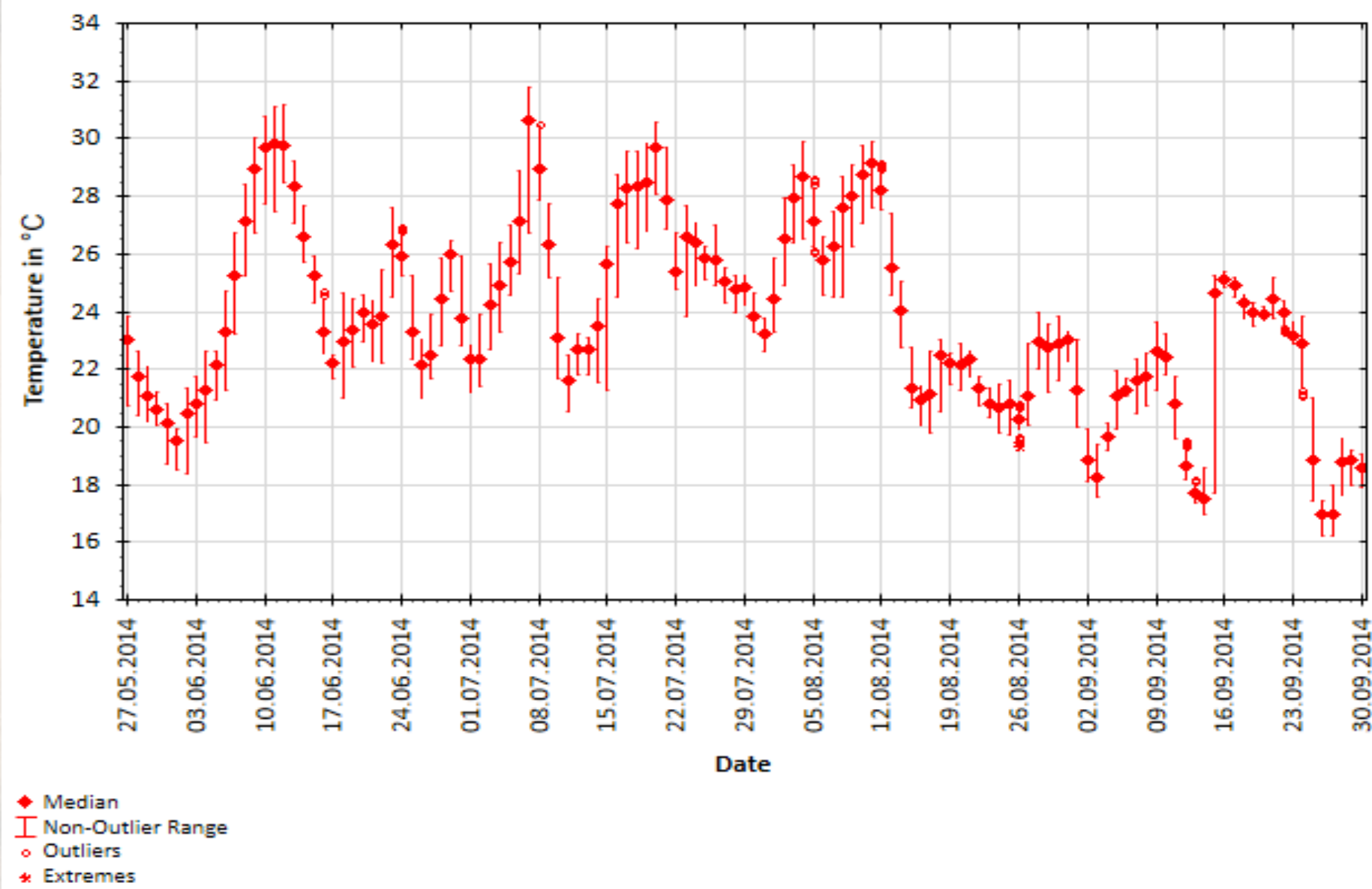
$$W = 349 + 1.29 \cdot T + 0.0135 \cdot T^2$$

$$K = 0.805 + 0.000736 \cdot T - 0.00000273 \cdot T^2$$

$$K_1 = 6.27 - 0.00938 \cdot T - 0.000303 \cdot T^2$$

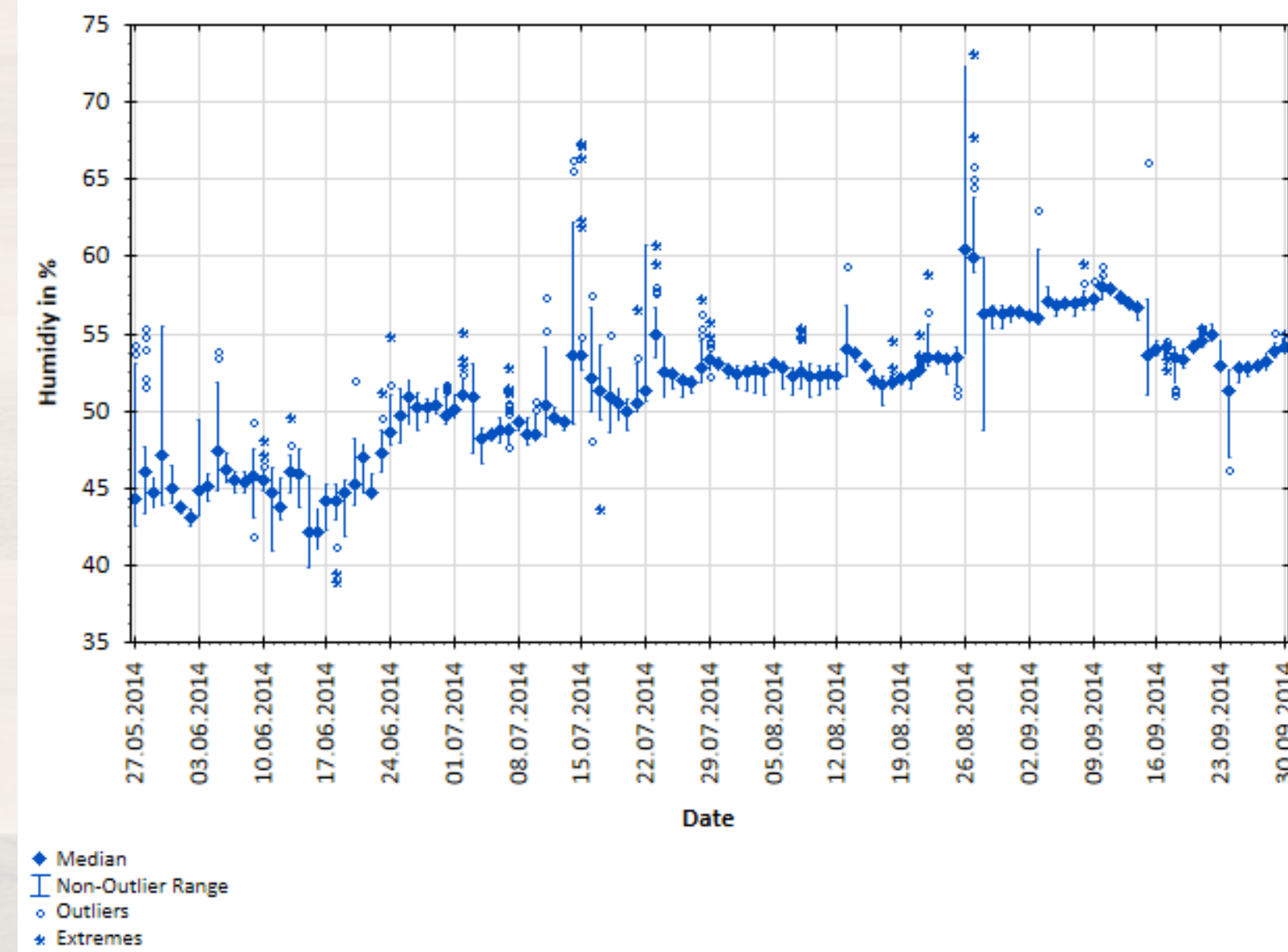
$$K_2 = 1.91 + 0.0407 \cdot T - 0.000293 \cdot T^2$$

Temperature



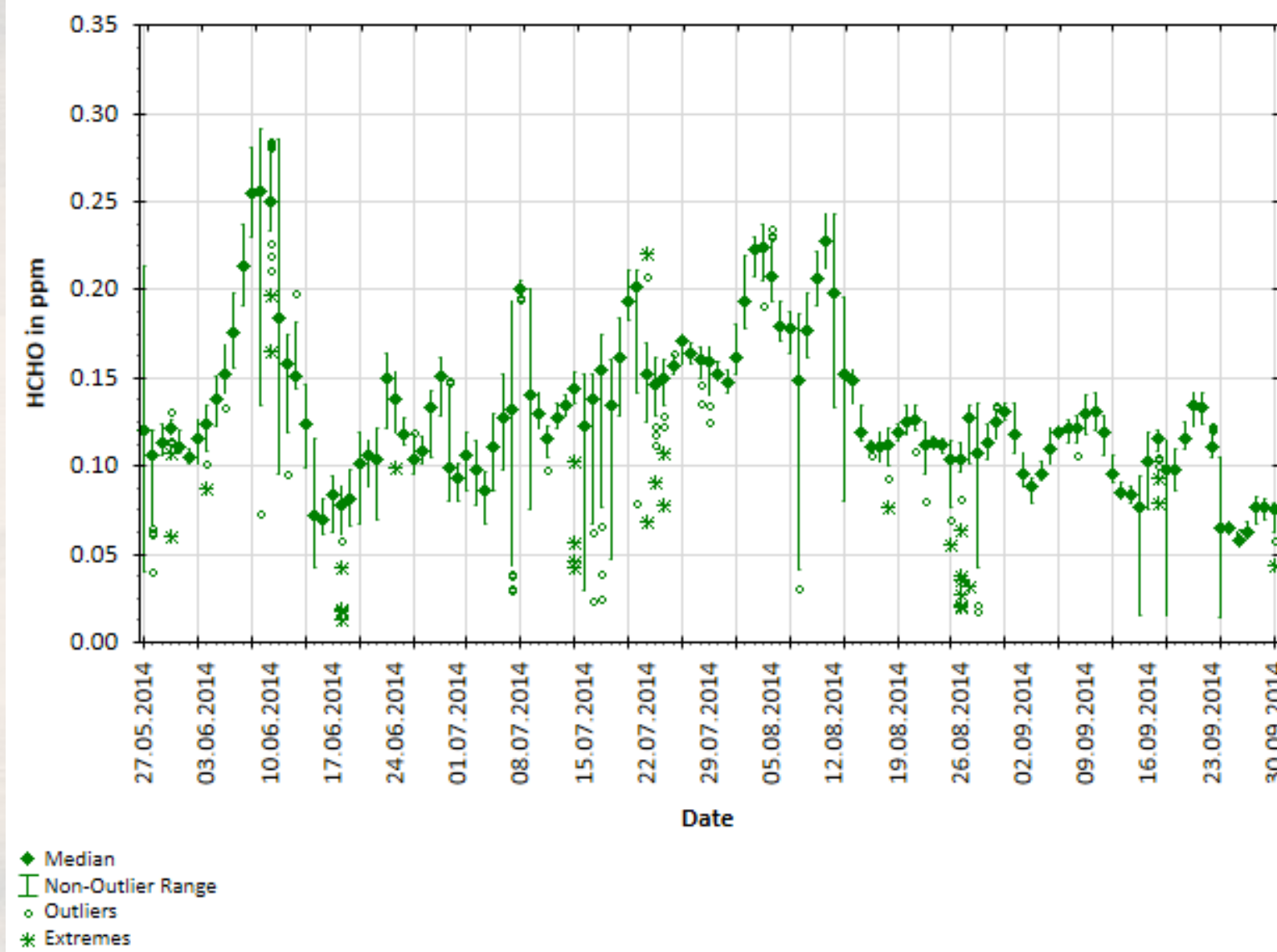
- ⊙ $T_{\text{average}} \approx 24^{\circ}\text{C}$
- ⊙ $T_{\text{average}} \approx 24^{\circ}\text{C}$

Humidity



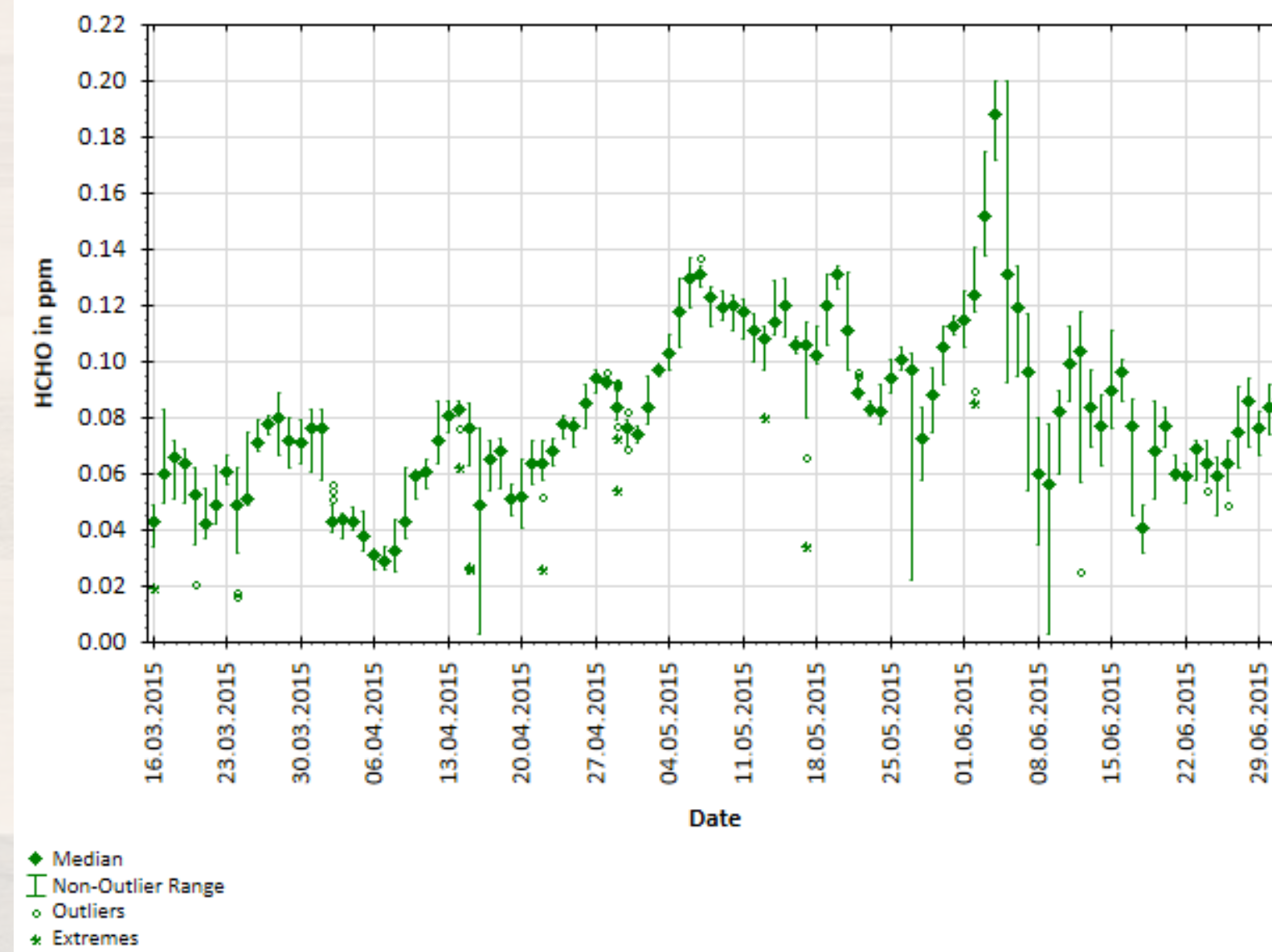
- ⊙ $h_{\text{average}} \approx 51^{\circ}\text{C}$
- ⊙ $h_{\text{average}} \approx 36^{\circ}\text{C}$

Formaldehyde – first period



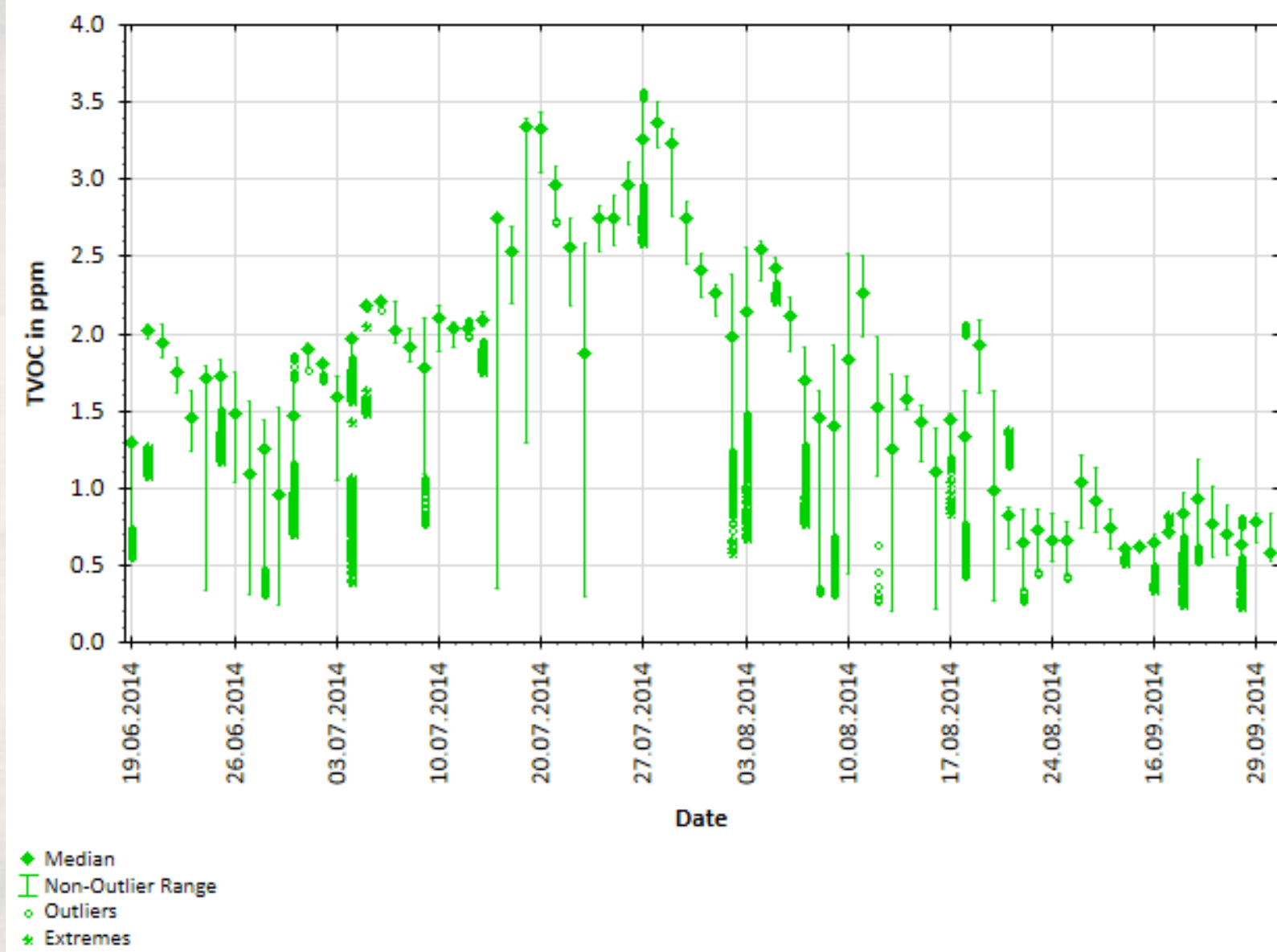
○ Average: 0.130 ppm

Formaldehyde – second period



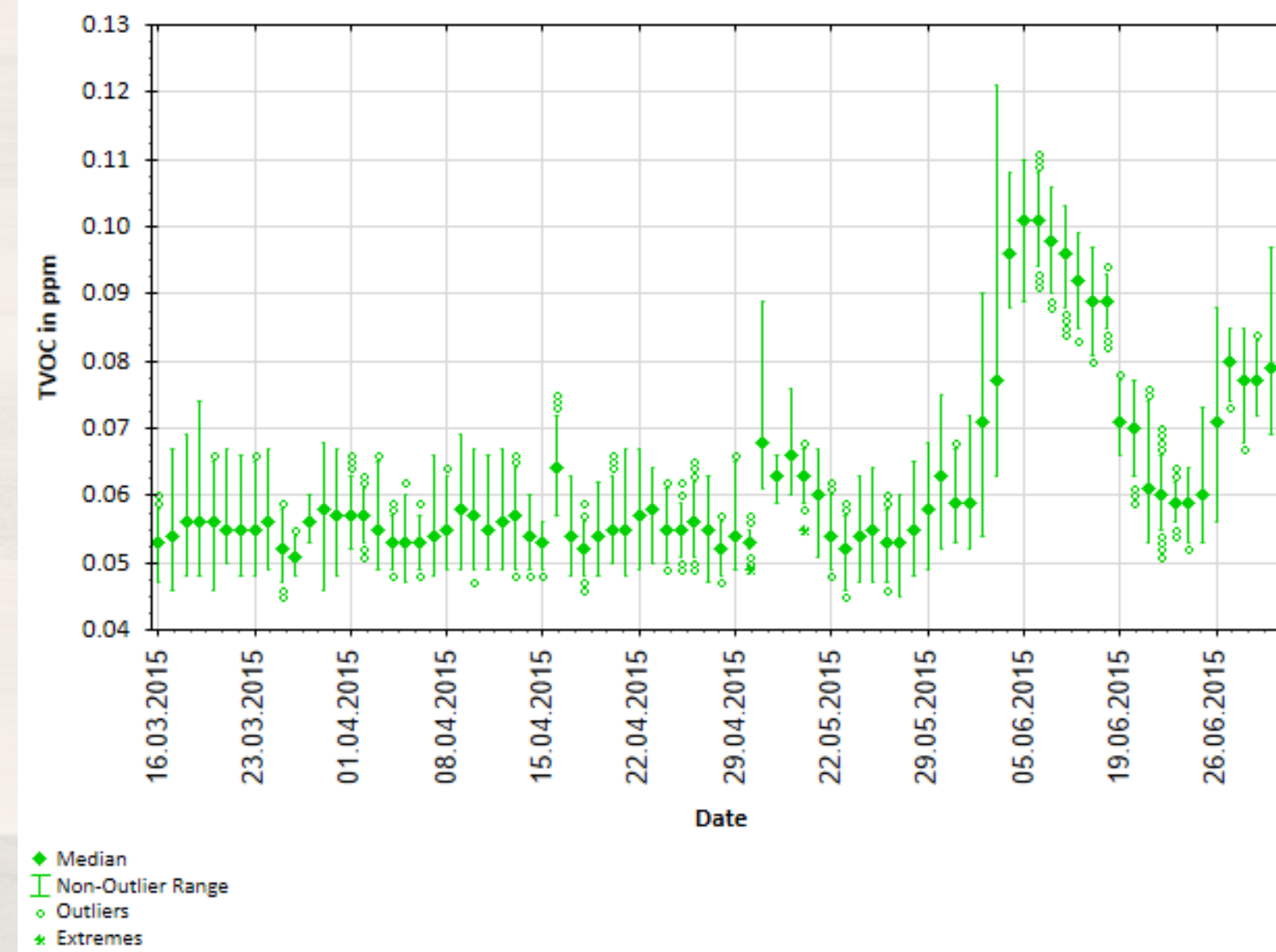
○ Average: 0.100 ppm

TVOC – first period



⊙ Average: 1.687 ppm

TVOC – second period

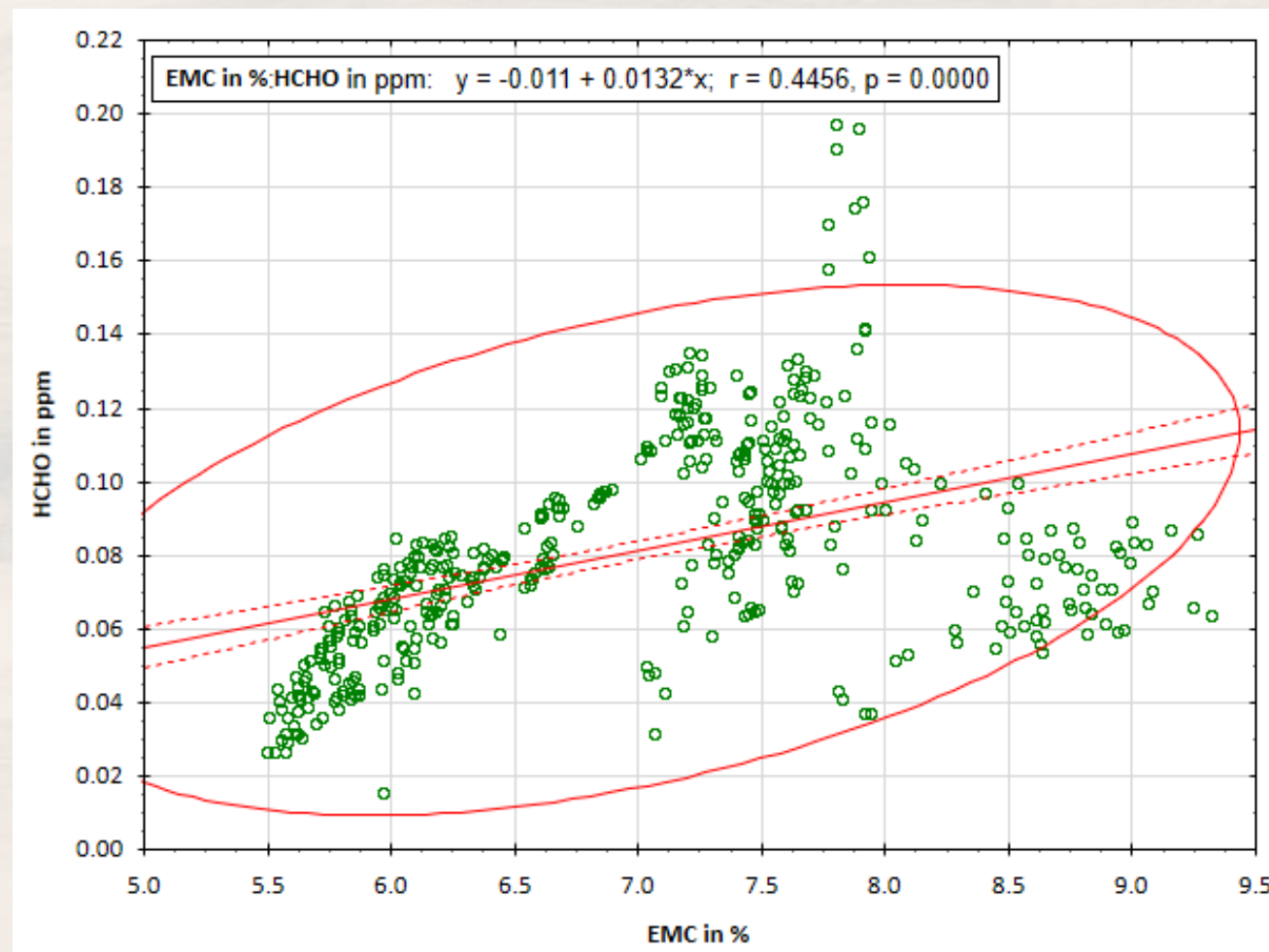


⊙ Average: 0.062 ppm

Formaldehyde

	First period	Second period
Temperature	0.7174	0.5192
Humidity	0.0426	0.5035

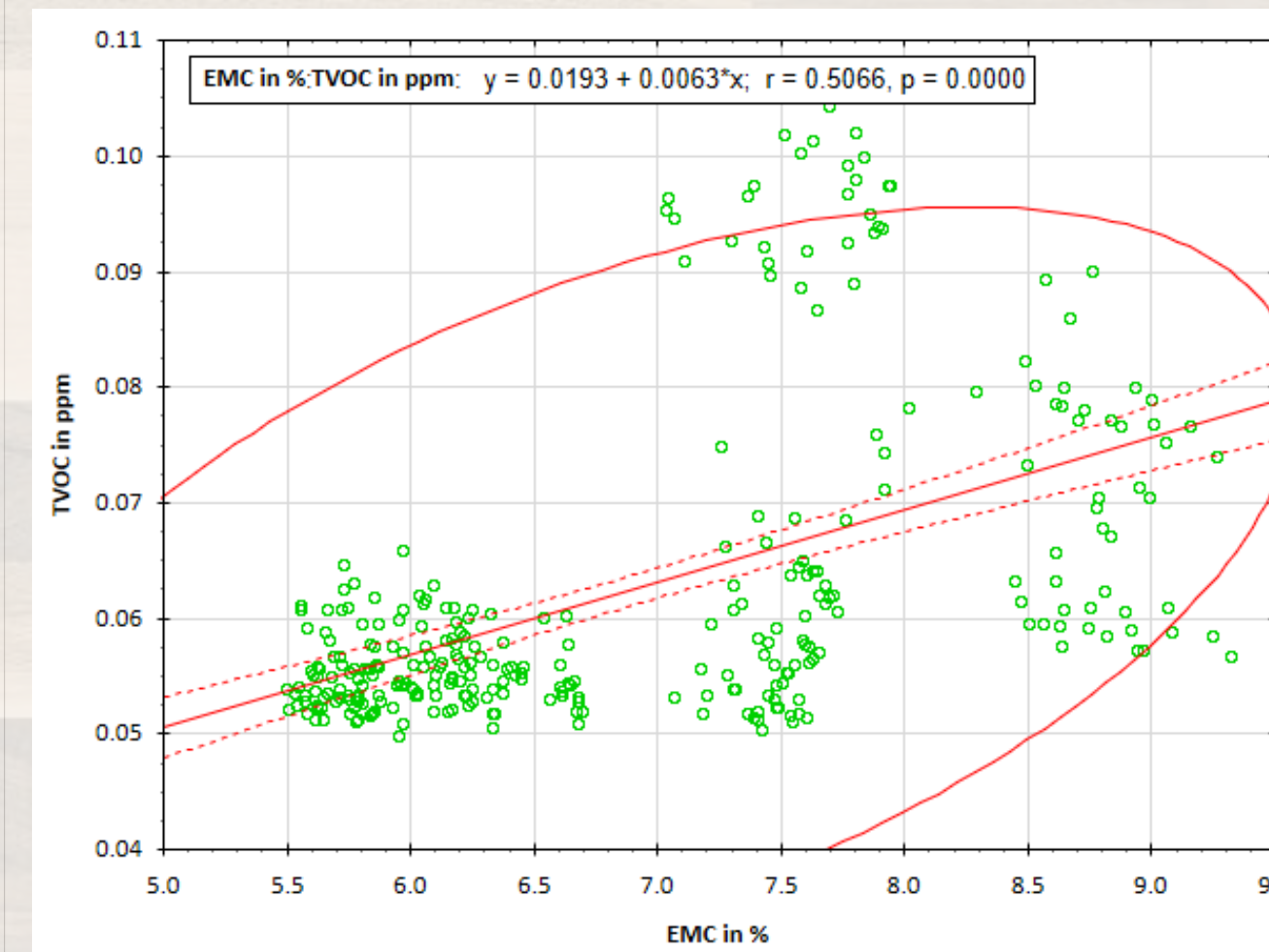
● EMC



TVOC

	First period	Second period
Temperature	0.4451	0.8695
Humidity	-0.2129	0.5420

● EMC



Conclusions

- ⦿ Indoor conditions influences the indoor HCHO and TVOC concentration
- ⦿ In first period only correlation with indoor temperature was determined
- ⦿ In the secon period corelation with indoor temperature and humidity were determined
- ⦿ Increase in EMC resulted in increase in HCHO and TVOC concentration

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THANK YOU FOR YOUR ATTENTION!

