

Supplementary Material

Emissions of Fungal Volatile Organic Compounds in Residential Environments and Temporal Emission Patterns: Implications for Sampling Methods

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S1. Determination of fungal concentrations

After collecting bio-aerosols samples from 11 residential environments for measuring fungal concentrations, we sent MEA, used for a fungal growth medium, to our laboratory and cultivated fungi for 5 – 7 days at a temperature of 28°C. We counted the number of colonies every 24 hours to estimate airborne fungal concentrations. Equations used for estimating the airborne fungal concentrations are as below.

$$V = \frac{Q \times t}{10^3}$$

$$V_{25} = V \times \frac{T_{25}}{T}$$

$$C = \frac{CFU}{V_{25}}$$

where, V: Volume of collected air [m³]

Q: Flow rate when collecting air samples [liter/min]

t: Sampling duration [min]

V₂₅: Converted volume of collected air at a temperature of 25 °C [m³]

T₂₅: Absolute temperature of 25 °C [= 298K]

CFU: Number of fungal colonies

C: Airborne fungal concentration [CFU/m³]

S2. Analysis of samples obtained from active air samplers

After collecting air samples from the active air samplers, we desorbed analytes using thermal desorption (Markes Unity Series 2, Markes International Ltd.) coupled with gas chromatography (Agilent 7820 A, Agilent Technology, USA) mass spectrometry (Agilent 5977 E, Agilent Technology, USA). We confirmed compounds using the Reference Standard Library (NT Search 2.0, National Institute of Standard and Technology, USA). For the quantitative analysis, we made calibration curves with the liquid standard adsorbed on the Tenax-TA tube with four different concentrations (i.e., 5, 10, 50, 500 ng/tube). In case that the quantification was not attainable for some compounds, we converted their concentrations with respect to benzene concentration. Correlation coefficients in the calibration curves were higher than 0.999 with all four concentrations (data not shown) and method detection limits ranged from 0.02 $\mu\text{g}/\text{m}^3$ (Xylene) to 0.25 $\mu\text{g}/\text{m}^3$ (Ethylbenzene).

S3. Analysis of samples obtained from passive air samplers

We analyzed the air samples obtained from passive air samplers using thermal desorption coupled with GC-MS under the same experimental conditions as the above section (S2).

Table S1. Characteristics of 11 residential environments recruited for our field experiments.

| Household ID | Household characteristics | | | |
|--------------|------------------------------------|----------------|------------------|------------------------------|
| | Types | House age (yr) | No. of residents | Note |
| R1 | Apartment (7 th floor) | 17 | 4 | Interior remodeling (summer) |
| R2 | Apartment (1 st floor) | 17 | 4 | Pet |
| R3 | Apartment (5 th floor) | 25 | 4 | - |
| R4 | Apartment (5 th floor) | 23 | 4 | - |
| R5 | Apartment (2 nd floor) | 26 | 4 | - |
| R6 | Townhouse (4 th floor) | 20 | 4 | - |
| R7 | Apartment (5 th floor) | 18 | 4 | Pet (winter only) |
| R8 | Apartment (14 th floor) | 20 | 4 | - |
| R9 | Apartment (4 th floor) | 5 | 4 | - |
| R10 | Apartment (4 th floor) | 33 | 3 | - |
| R11 | Apartment (8 th floor) | 16 | 5 | - |

Table S2. Description of analysis conditions of thermal desorption coupled with gas chromatography/mass spectrometry (TD-GC-MS).

| Thermal desorption (UNITY2, Markes International, UK) | | |
|--|----------------------------------|---|
| | Desorption temperature | 300°C for 10 min |
| | Split ratio | 20:1 |
| | Cold trap temperature | -10°C |
| Gas chromatography (7820A, Agilent Technologies, USA) | | |
| Oven | Initial temperature | 35°C |
| | Initial hold | 5 min |
| | Ramp 1 temperature increase rate | 10°C/min |
| | Ramp 1 temperature | 220°C |
| | Ramp 1 hold | 0 min |
| | Ramp 2 temperature increase rate | 4°C/min |
| | Ramp 2 temperature | 280°C |
| | Ramp 2 hold | 15 min |
| | Total running time | 53.5 min |
| | Maximum temperature | 320°C |
| | Equilibration time | 0.2 min |
| Column | Model | DB-5 |
| | Dimension | 60 m length, 0.32 mm internal diameter, 1 µm film thickness |
| Mass spectrometry (5977E, Agilent Technologies, USA) | | |
| | Acquisition type | Scan mode |
| | Tune type | Electron ionization |
| | Start mass | 17 |
| | End mass | 350 |
| | Threshold | 150 |

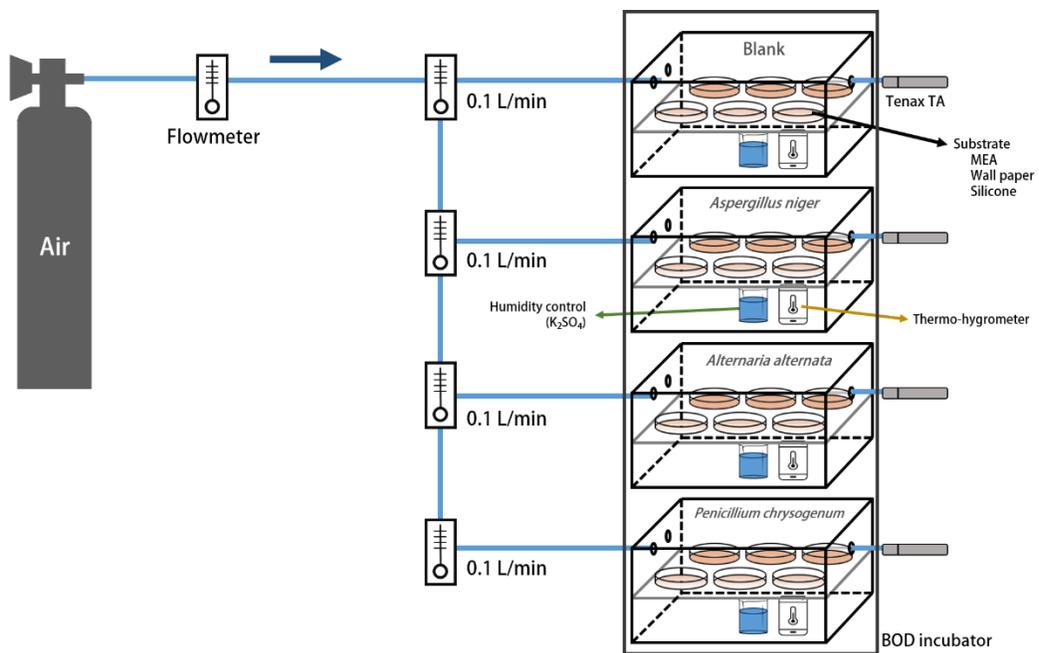


Figure S1. Schematic drawing of experimental setup for mVOCs emission testing.

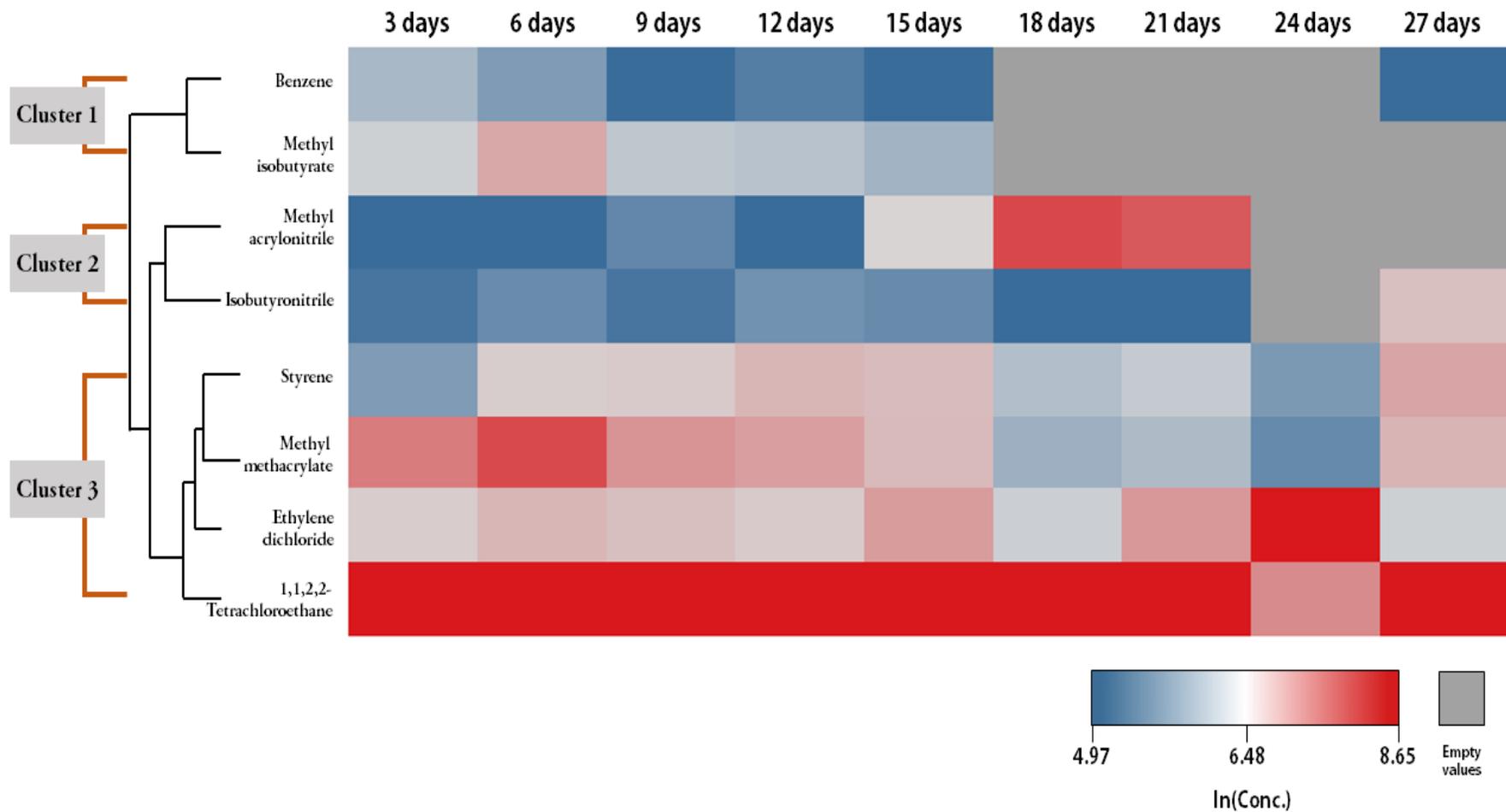


Figure S2. Temporal emission patterns of mVOCs originating from *Aspergillus niger* grown on MEA during the cultivation period. Depending on the temporal emission patterns, compounds were classified into three clusters.

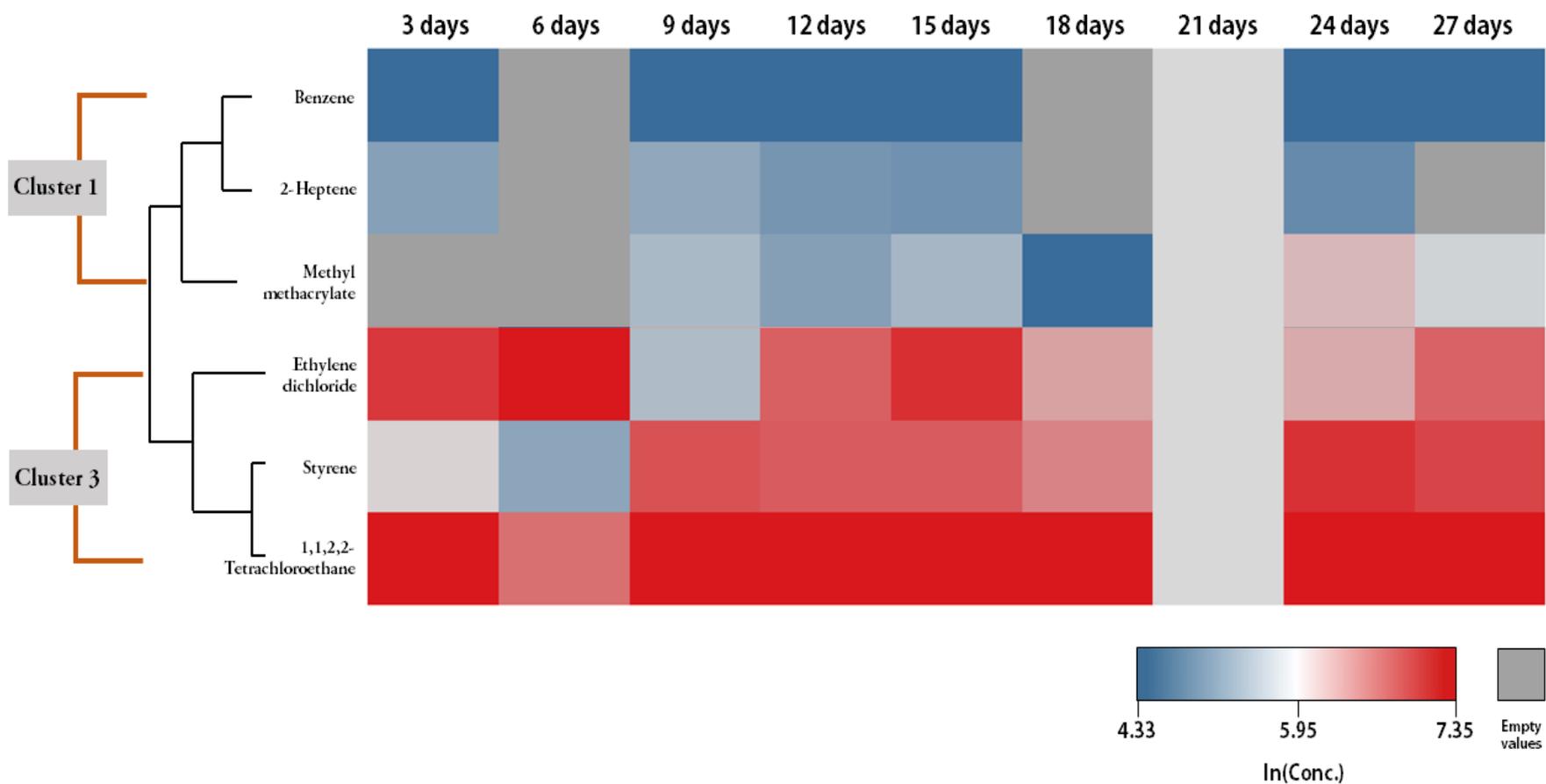


Figure S3. Temporal emission patterns of mVOCs originating from *Alternaria alternata* grown on MEA during the cultivation period. Depending on the temporal emission patterns, compounds were classified into two clusters.

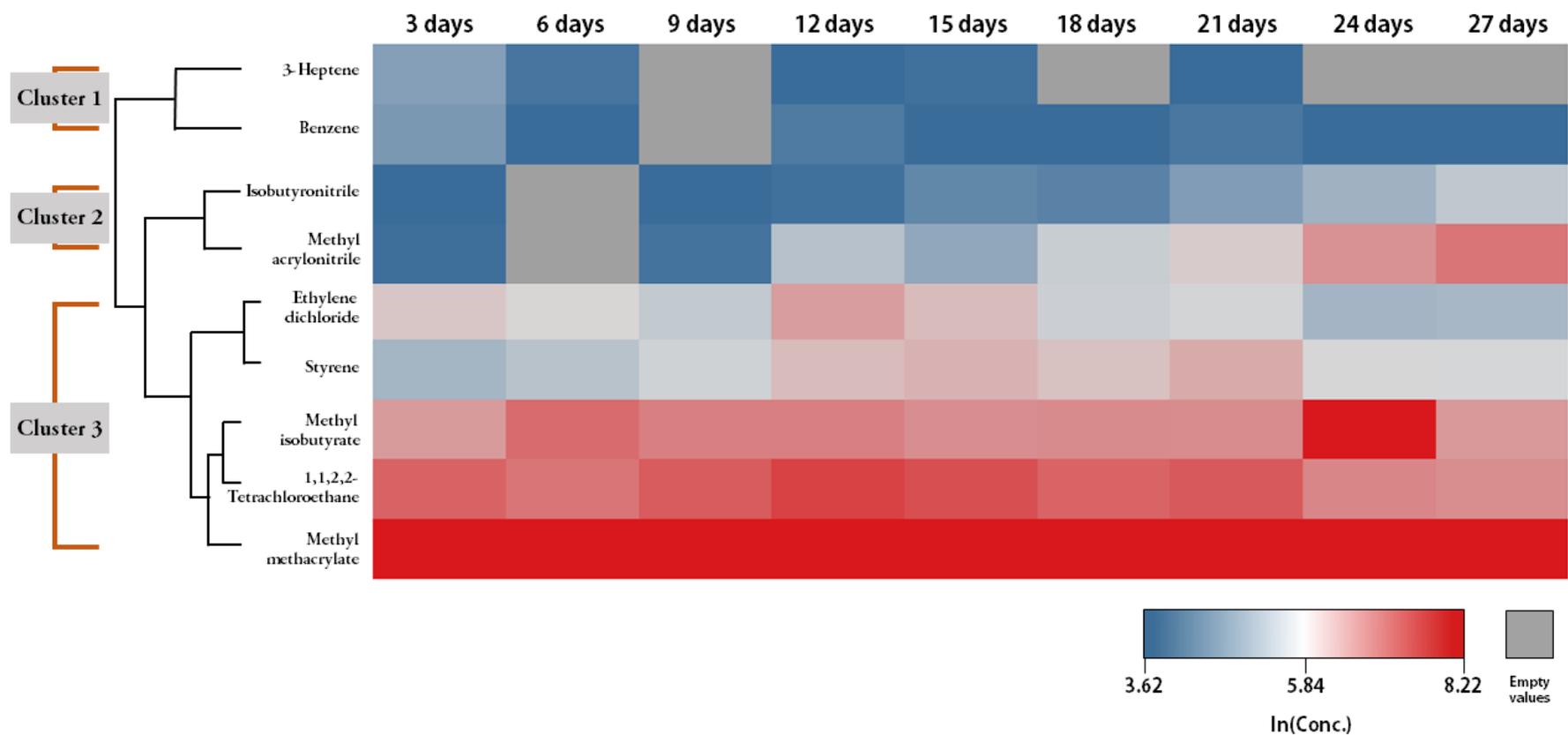


Figure S4. Temporal emission patterns of mVOCs originating from *Penicillium chrysogenum* grown on MEA during the cultivation period. Depending on the temporal emission patterns, compounds were classified into three clusters.

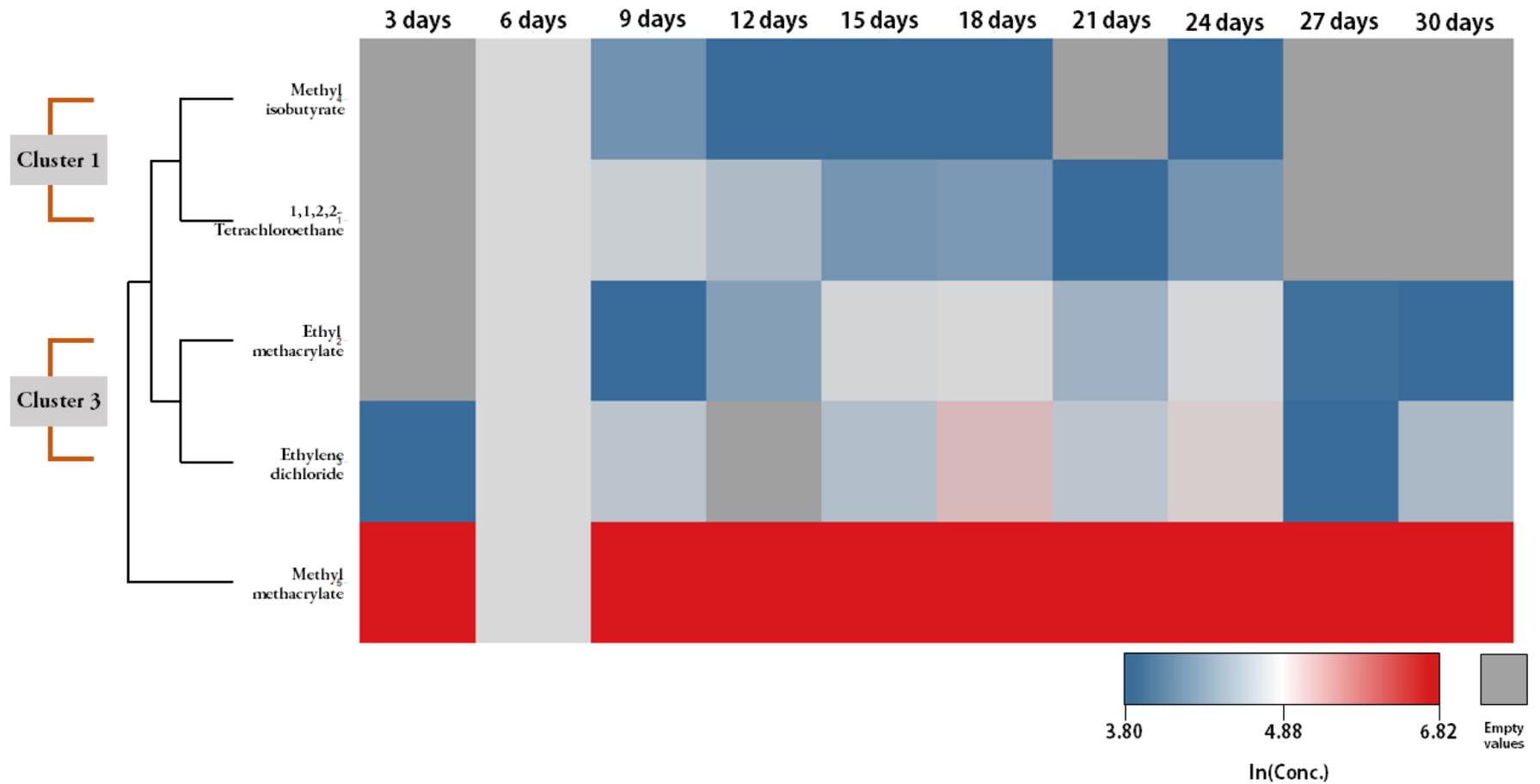


Figure S5. Temporal emission patterns of mVOCs originating from *Aspergillus niger* grown on PVC wall paper during the cultivation period. Depending on the temporal emission patterns, compounds were classified into two clusters.

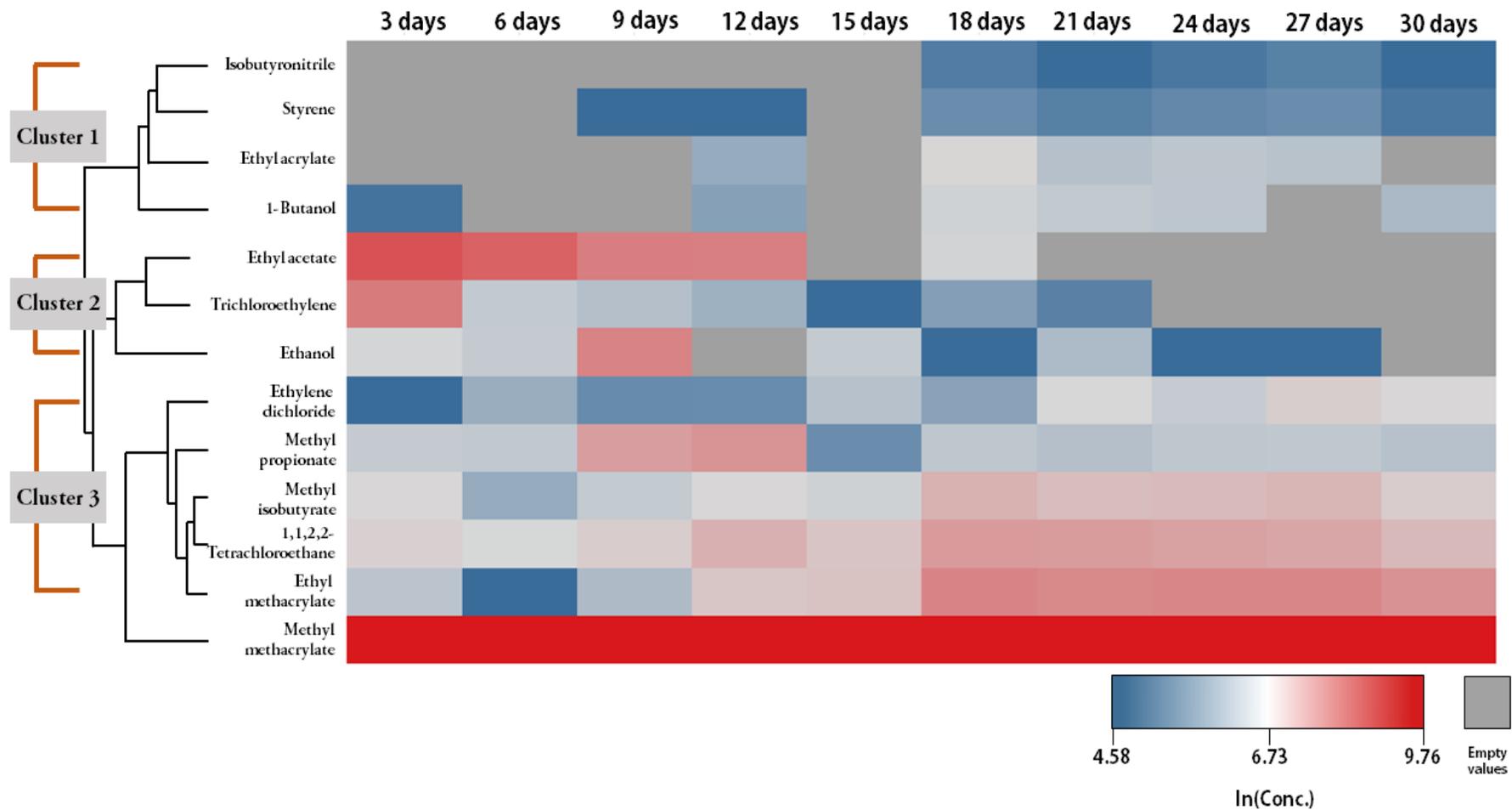


Figure S6. Temporal emission patterns of mVOCs originating from *Penicillium chrysogenum* grown on PVC wall paper during the cultivation period. Depending on the temporal emission patterns, compounds were classified into three clusters.

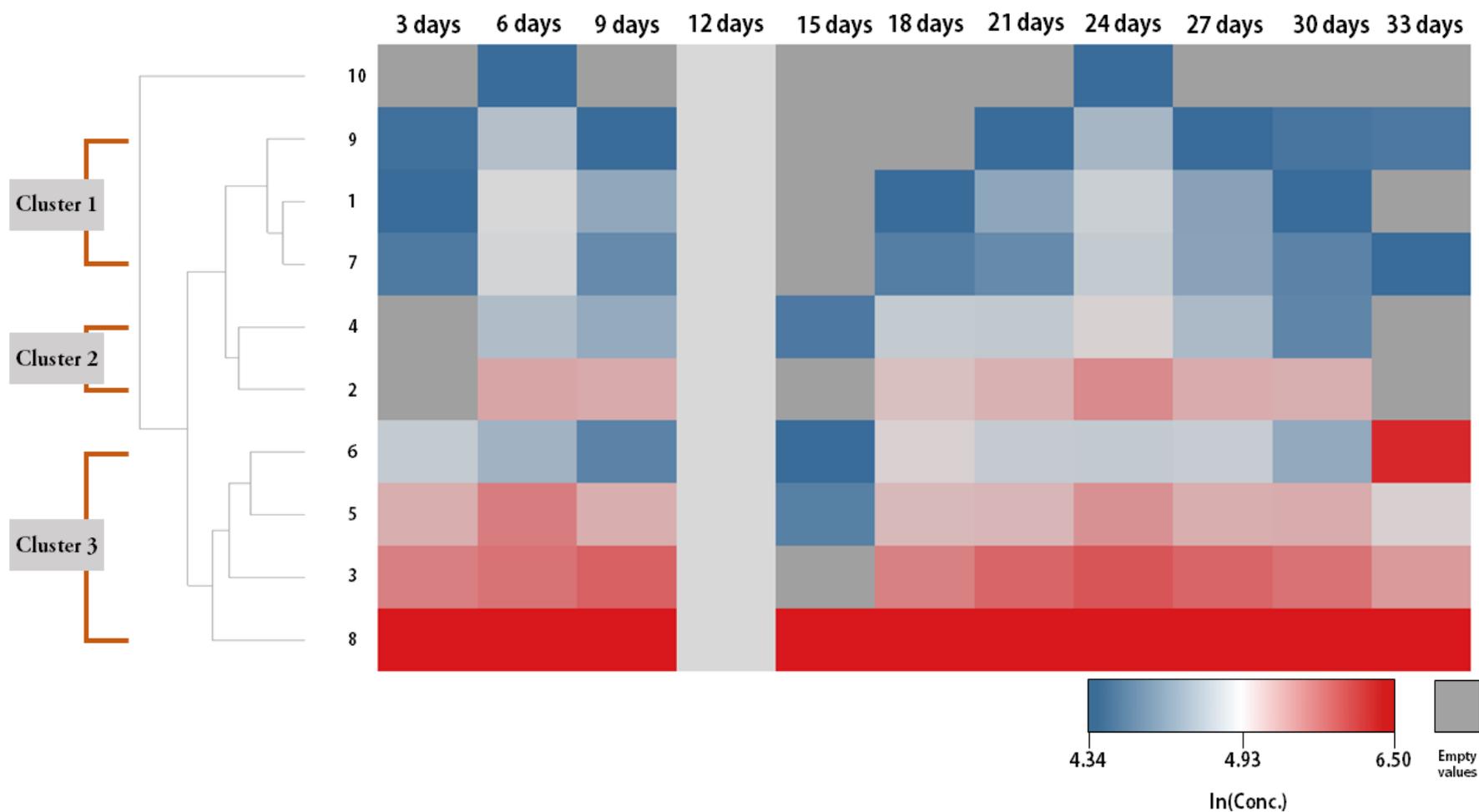


Figure S7. Temporal emission patterns of mVOCs originating from *Alternaria alternata* grown on silicone rubber during the cultivation period. Depending on the temporal emission patterns, compounds were classified into three clusters. Compounds were symbolized with numbers in the y-axis (See Table S5 for detailed information).

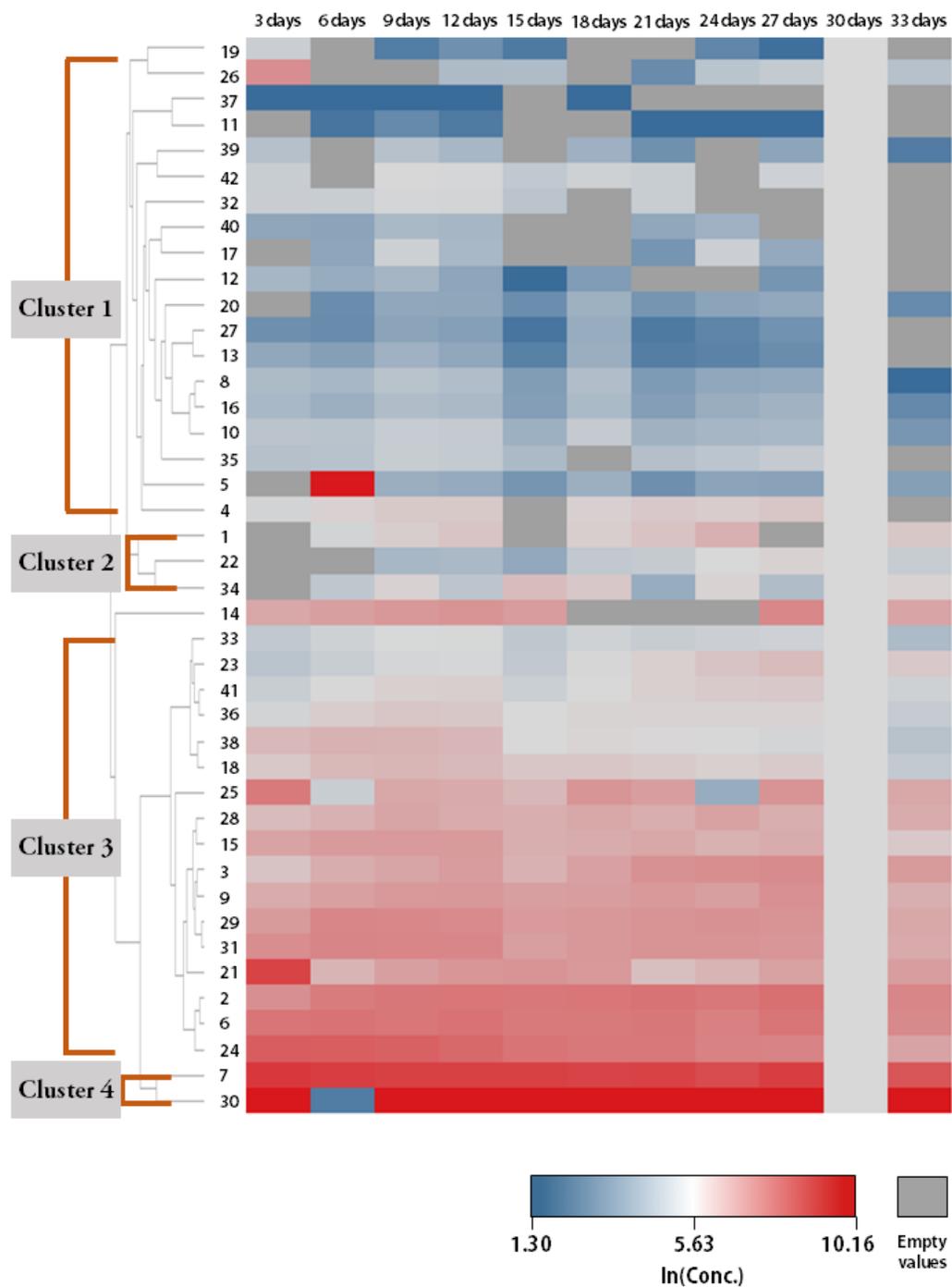


Figure S8. Temporal emission patterns of mVOCs originating from *Penicillium chrysogenum* grown on silicone rubber during the cultivation period. Depending on the temporal emission patterns, compounds were classified into four clusters. Compounds were symbolized with numbers in the y-axis (See Table S5 for detailed information).