The Science Behind Cannabis Odors

Introduction

It started with a phone call. A greenhouse operator in California was fielding yet another complaint from a nearby resident. Despite their best efforts—carbon filters, a misting system, and scrubbers—complaints kept rolling in. A few complaints grew into community-wide opposition, eventually reaching the Board of Supervisors. Regardless of the residents' true motives, they were using odor as the stick to push cannabis out of their community.

Odors are like Onions

My good friend Shrek once said, "Odors are like onions". Not only can they stink, but they've got layers. Peeling back these layers requires science and strategy.

Terpenes should be no stranger to the audience of this magazine. They are the chemical compounds responsible for the smell, taste, and color of every plant. Terpenes have long been believed to be the sole culprit of the cannabis odor. While they certainly make up a portion of the cannabis odor profile, through our research, we have discovered that they are not the only contributors.

Below is a list of common terpenes, plants associated, and descriptions of odor:

Terpene	Associated Plant(s)	Odor Character
Beta-caryophyllene	Hops, cloves, rosemary	Pepper, wood, spice
Beta-pinene	Coniferous plants	Woody, pine, earthy
Myrcene	Mangoes	Musk, herbal, citrus
Limonene	Citrus plants	Citrus, lemon
Linalool	Lavender	Floral, citrus, spice

While terpenes play a key role in the plant's aroma, you'll notice a lot of the descriptions above are relatively pleasant smells. These notes are present and often used to describe cannabis, but one major odor descriptor is missing: the signature *skunky* smell.

Leveraging our expertise in odor management, we took a scientific approach to uncovering the skunky signature of cannabis. SCS Engineers' core business is in the solid and hazardous waste management sector, such as landfills, recycling facilities, and wastewater treatment plants, where sulfur compounds—namely hydrogen sulfide (H_2S)—are major odor sources. Thus, sulfur compounds became a natural starting point for our investigation. We collected a half ounce of wet flower of eight (8) different cannabis strains with varying odor profiles, blended each strain individually, took a headspace sample of the

blender, and sent the samples to a certified lab for analysis. The lab used methods EPA TO-15 to analyze for volatile organic compounds (VOCs) and ASTM D-5504 for sulfurs. The data confirmed that the strains with the highest concentration of sulfur compounds were anecdotally the "dankest" ones.

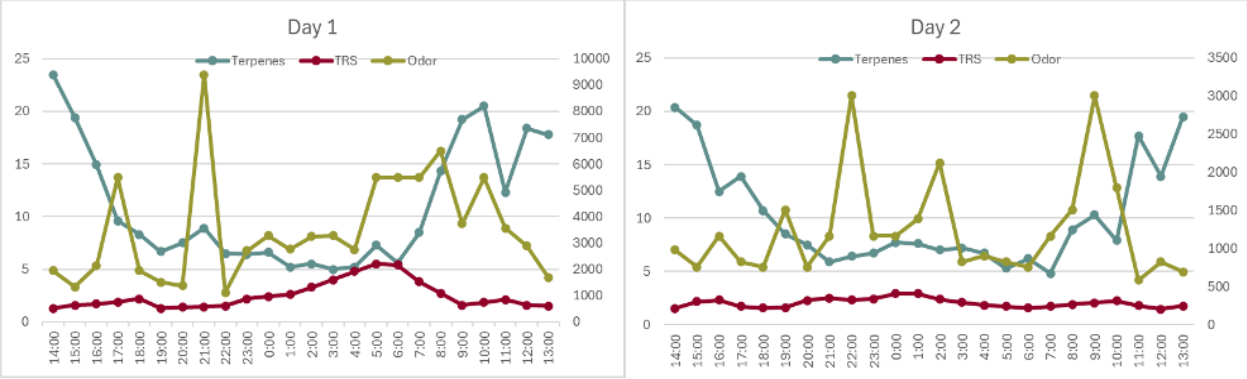
Getting into the Weeds

In Santa Barbara County, California, cultivation sites are located near high schools, public parks, and neighborhoods, sometimes across the street or sharing fence lines. The properties themselves had a floral, vegetative odor; but half a mile down the road, one would drive into a skunky cloud. Over the course of 2022, SCS Engineers conducted a series of 24-hour tests in these greenhouses.

One such test took simultaneous measurements of terpenes, sulfurs, and odors over two (2) 24-hour periods. Terpene and sulfur measurements were continuously measured and averaged over a 1-hour period, while odor grab-samples were collected over a 1-hour period and sent to a certified odor lab for analysis.

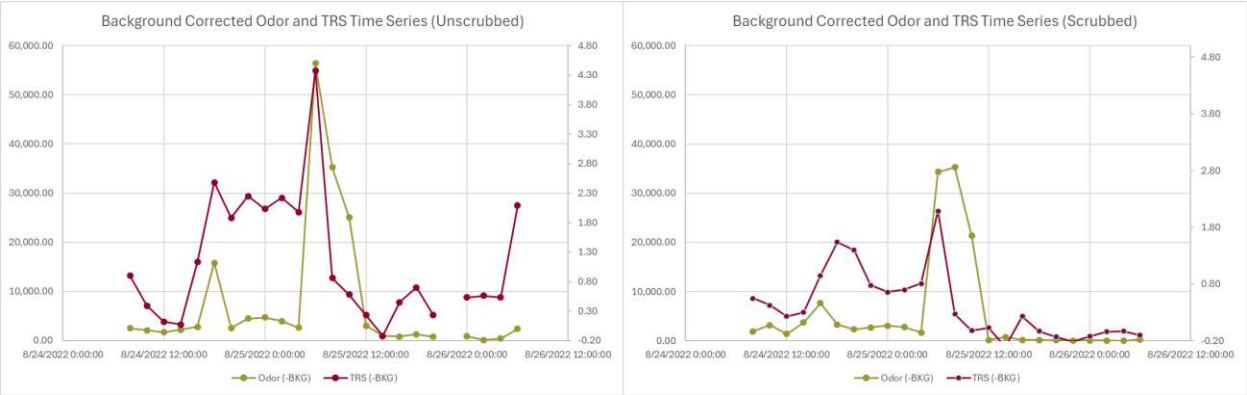
In the graphs below, terpenes, sulfurs (TRS), and odor concentrations are plotted over the course of two (2) days, starting at 14:00. There are two (2) unique takeaways from this:

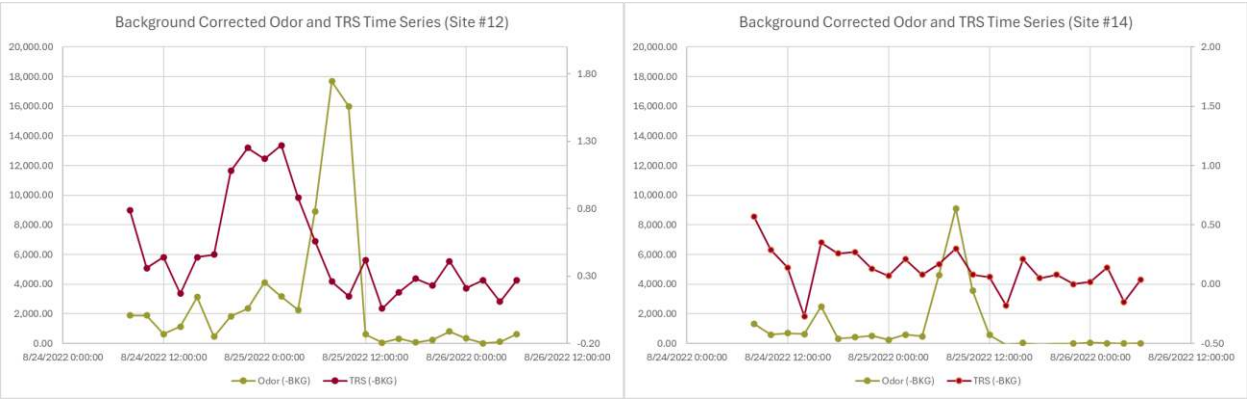
1) There is a clear diurnal terpene trend, dipping at night and peaking during the day.
2) While we cannot definitively point out any correlation between sulfurs and odor, it is clear there is no correlation between terpenes and either of the other two.



To further examine the relationship between sulfurs and odor, a second, more elaborate 24-hour test was conducted. Two (2) greenhouses of nearly identical size and layout were planted with the same strains in the same quantity at the same time. Fourteen sample locations were chosen within and around the greenhouse. Over the course of 48-hours, inclusive of a harvesting event, sulfurs were measured continuously and two-hour grab samples of odor were collected and analyzed at a nearby odor lab. The results of this study are below, with two (2) key takeaways:

1) Within the greenhouse and at the greenhouse's ridge vents, sulfurs and odors track incredibly well.
2) Outside of the greenhouse, the correlation does not hold.





Conclusion: Peeling Back the Layers of Cannabis Odors

Both terpenes and sulfurs smell, but sulfurs are the lingering scent that raise complaints. Odors from cannabis are more prominent with respect to variables such as time of day, light exposure, strain, maturity, and agitation, among others. Knowing how local meteorology can influence downwind perception of odor is crucial to being a good neighbor. While there is no "one size fits all" approach to odor control, addressing the *skunky* element of odors—the sulfurs—as well as implementing odor mitigation or management plans into standard operating procedures can reduce complaints. Having a robust complaint system provides further utility for remediation.

Biting into the whole onion may be overwhelming, but addressing the problem layer by layer, compound by compound can turn a community-wide problem into a manageable solution.