Effects of moisture and temperature on VOC emissions from evergreen forest and oak savannah soils

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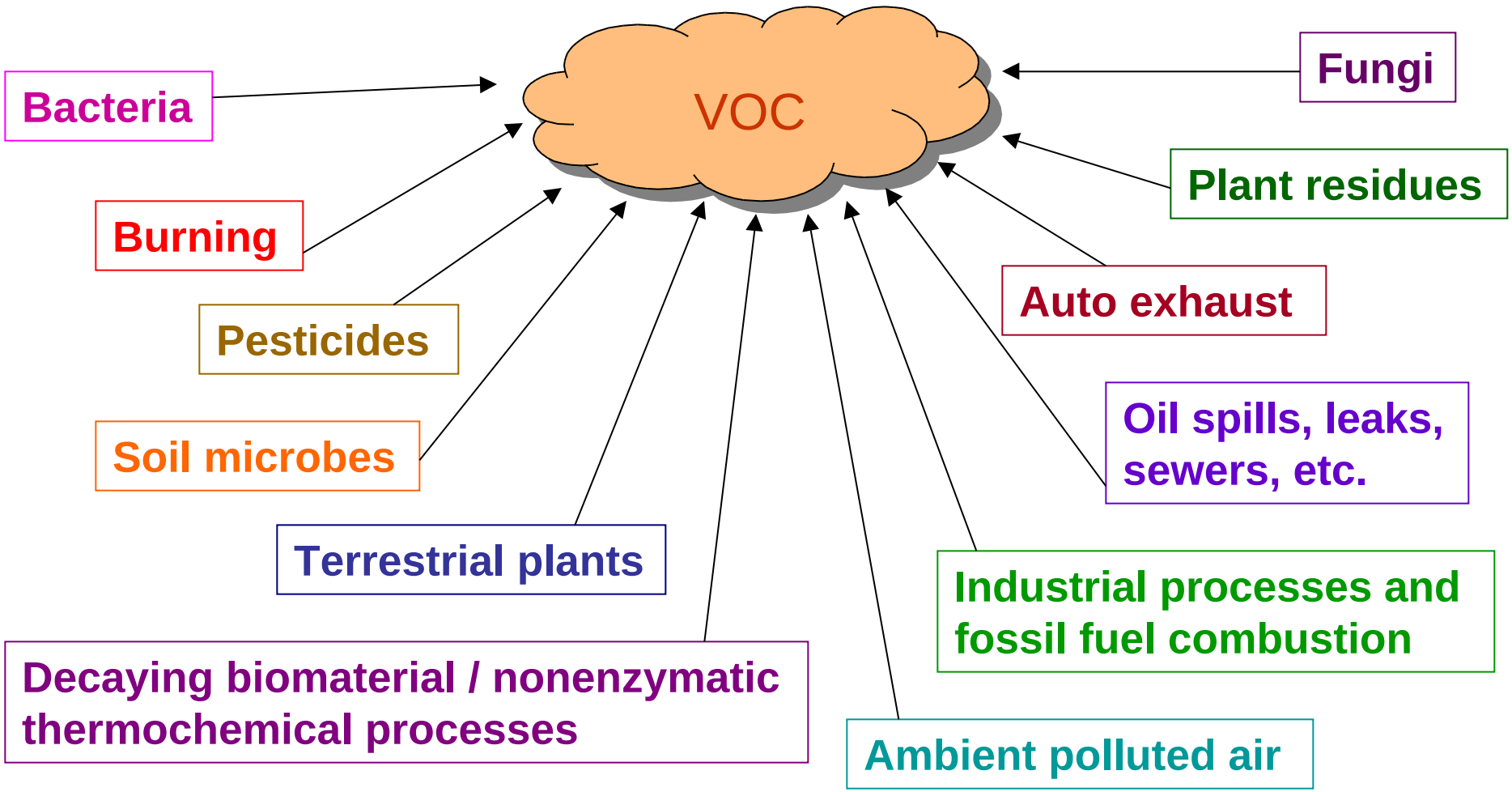
Volatile Organic Carbon Compounds (VOC)

- Hydrocarbon chains, halogenated-VOCs, oxygenated-VOCs, PAHs…
- Precursors for tropospheric ozone, sources of aerosols, and/or products of hydrocarbon oxidation; i.e., reaction pathways important
- May be toxic to humans, animals, and the environment
- Global budgets unbalanced (Khalil and Rasmussen, 2000)
- Lack of information about processes in soils producing VOC (Schade and Goldstein, 2001, Khalil and Rasmussen, 2000)
- Soil emissions provide information about the nature of the soil microbial community (Stahl and Parkin, 1996)
- Diurnal and seasonal variations in emissions suggest importance of light, temperature, and moisture (Goldstein et. al, 1996)

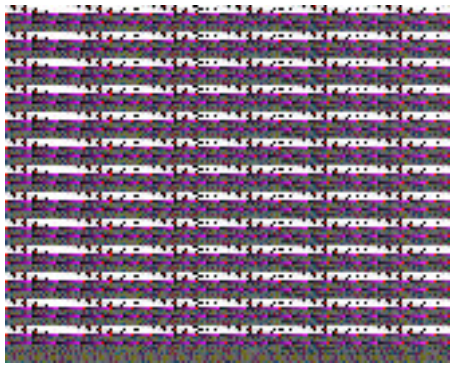
Biotic and Abiotic Sources of VOCs



Experimental Soil Flux Measurements of VOC and CO_2

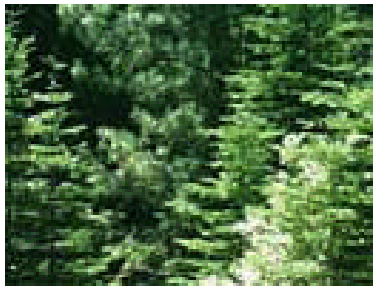
Tonzi field site:

oak savannah; mostly grassland, sparse oak trees; 10 cm soil cores taken 1 m from oak trunk; soil CO2 and soil temp-erature monitored



Blodgett field site:

Sierra Nevada mixed conifer forest; Goldstein tower situated in ponderosa pine plantation; 10 cm soil cores taken 1 m from pine trunk; soil CO2 and soil temperature monitored



Materials and Methods

-Leaf/grass/litter removed from immediate area

-Five cores taken from each site and homogenized

-Small soil sub-sample from each site analyzed for C, N, O

-Another sub-sample from each site removed and dried in 65C oven, field soil water content calculated

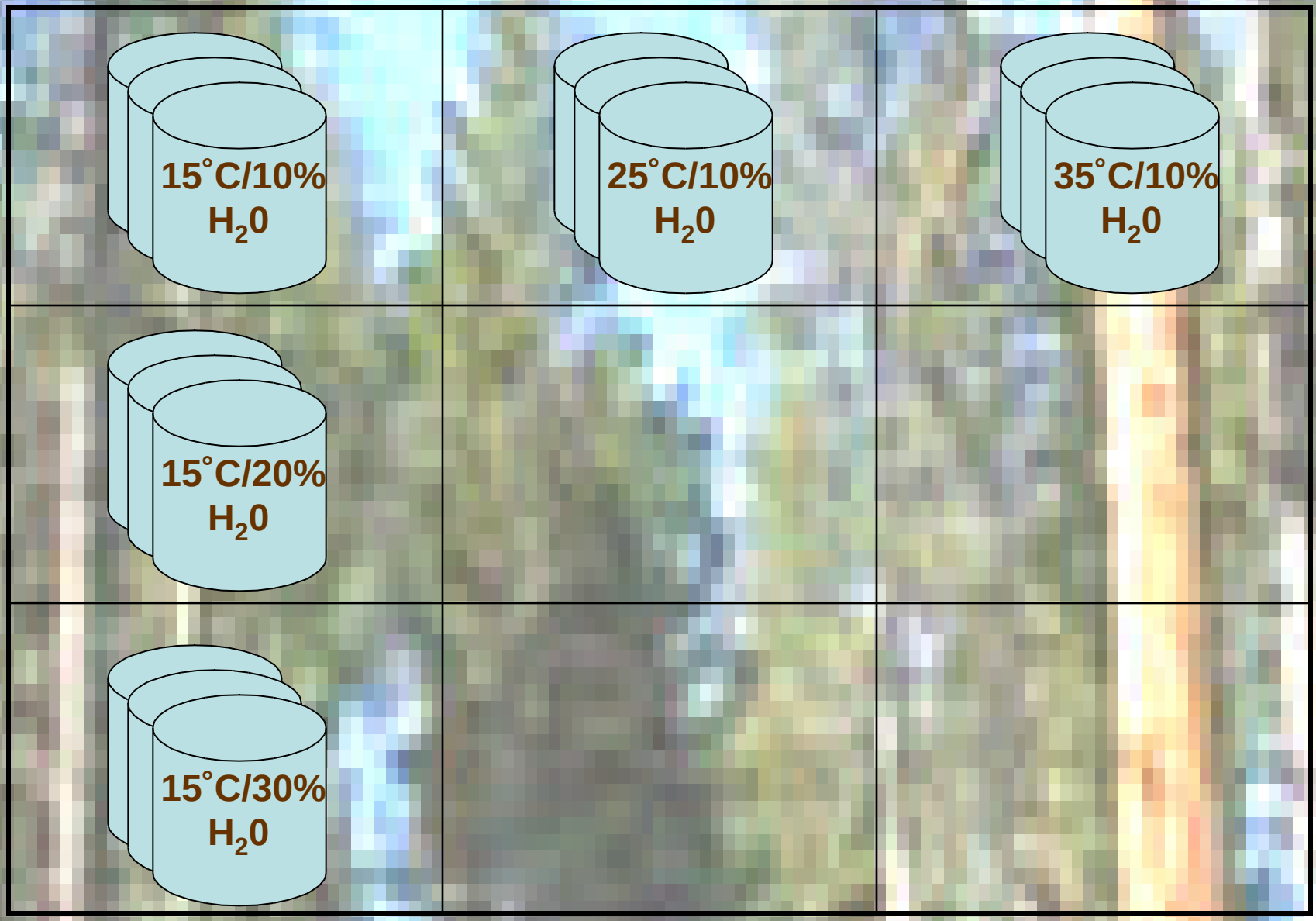
-Soils from each site partitioned into 15 glass bottles (280 mL)

-Bottles covered in perforated plastic; water content checked daily

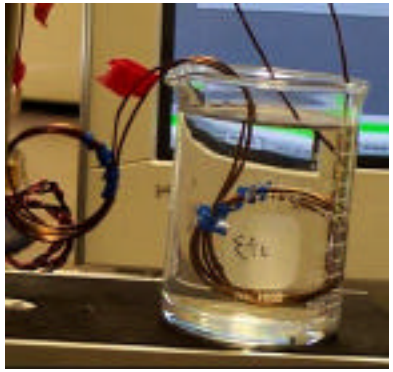
-VOC detected using GC/Mass Spectrometry and Flame Ionization Detector

-Protocol adapted continually to improve detection limits

Soil treatments: varying moisture and temperature



GC/MS-FID Protocol for Detecting Trace VOCs



-Moisture content adjusted to appropriate level before closing bottles

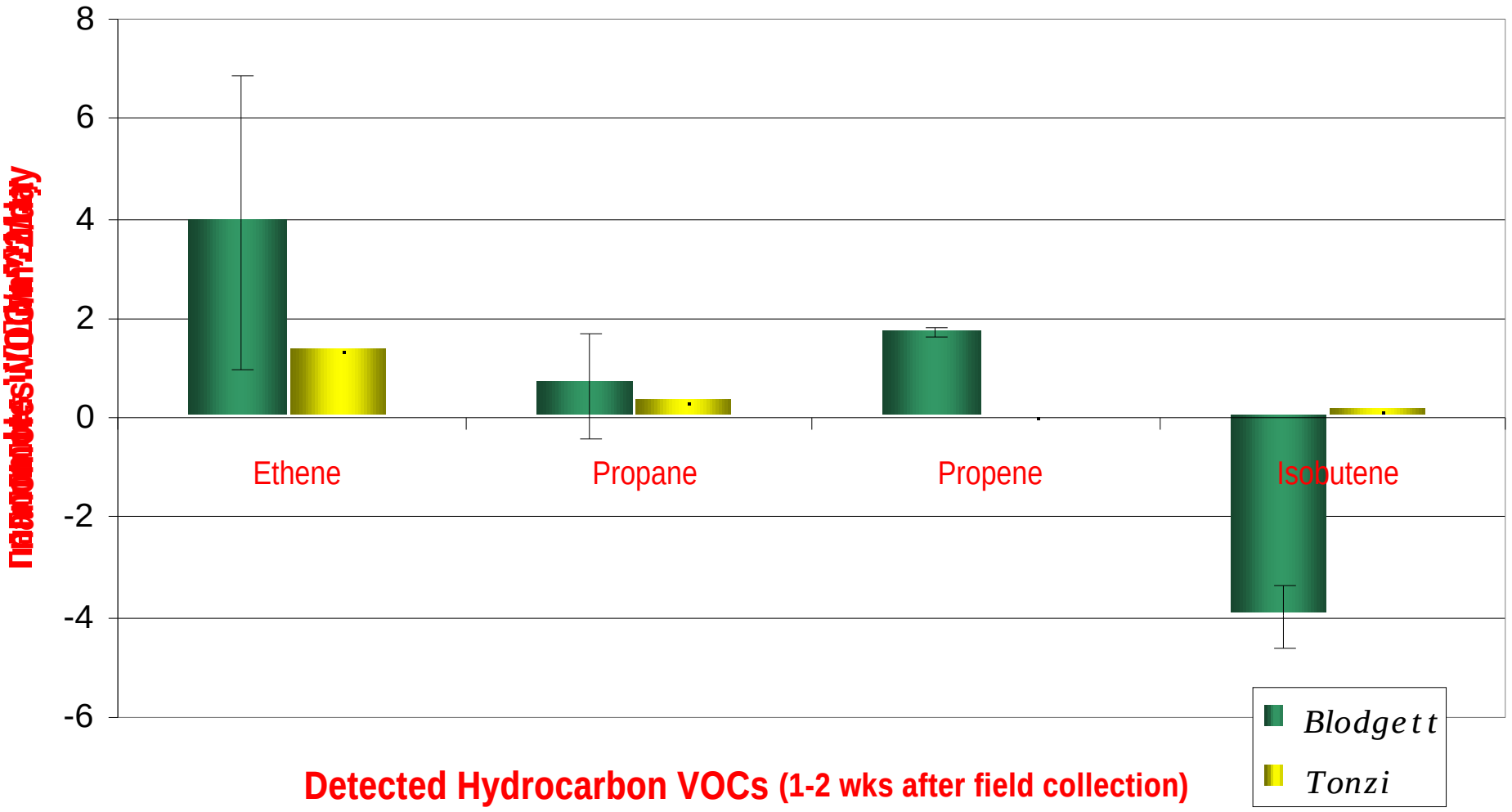
-Bottles closed weekly using teflon-coated plastic screw caps with inserted gas-impermeable black butyl rubber septum (tested for off-gassing prior to beginning experiment)

-After 1-2 day incubations, Gastight® syringe sample (2mL-20mL) taken for GC/MS-FID analysis

-Two double-focus loops (~1.2mL) attached to GC system and submerged in liquid Argon to cryo-trap and focus before injection

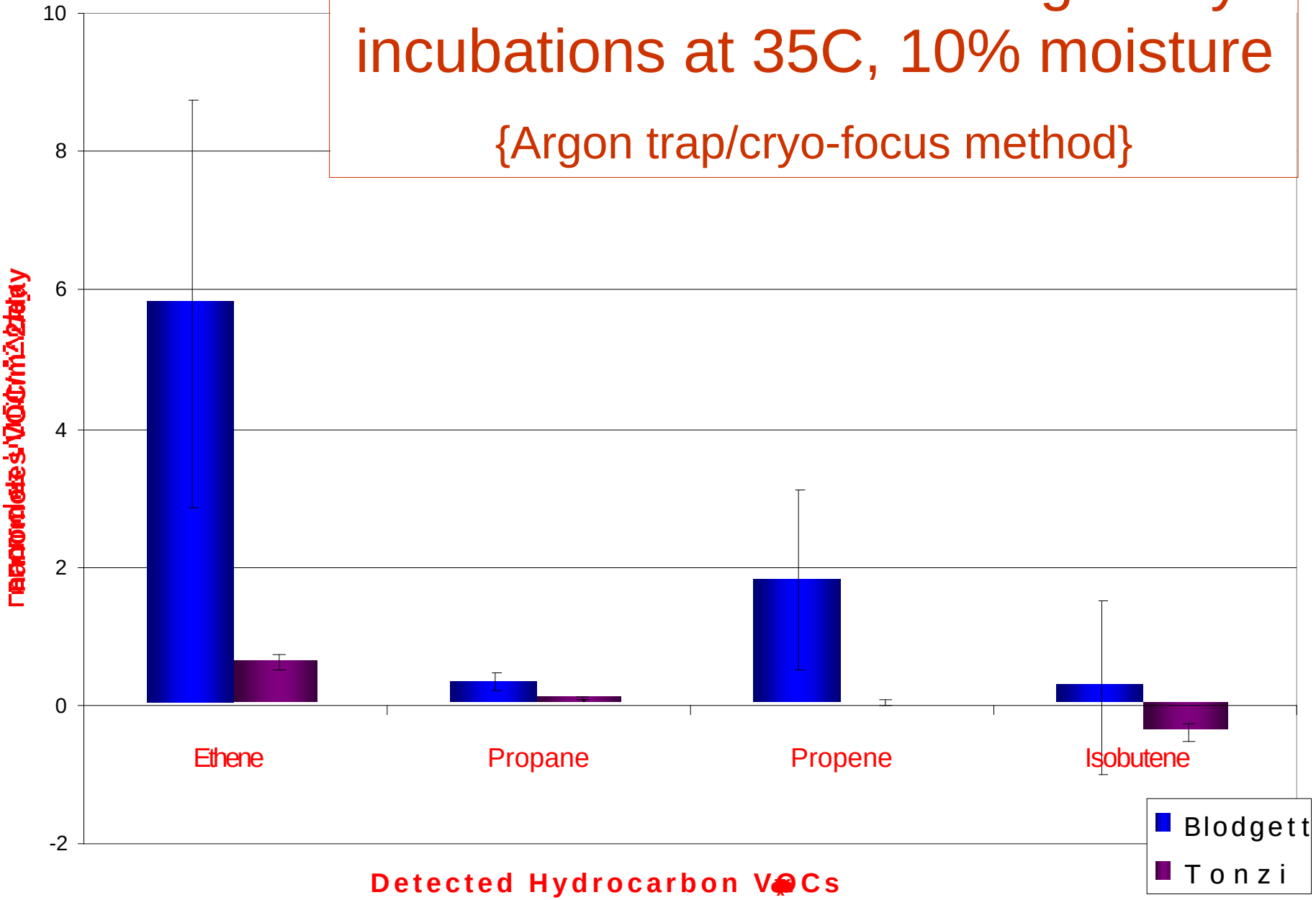
-Re-volatilization occurred for 1 min, then sample connected in line with He gas and dual MS and FID columns

Soil VOC fluxes following 2 day incubations at 35C, 10% moisture

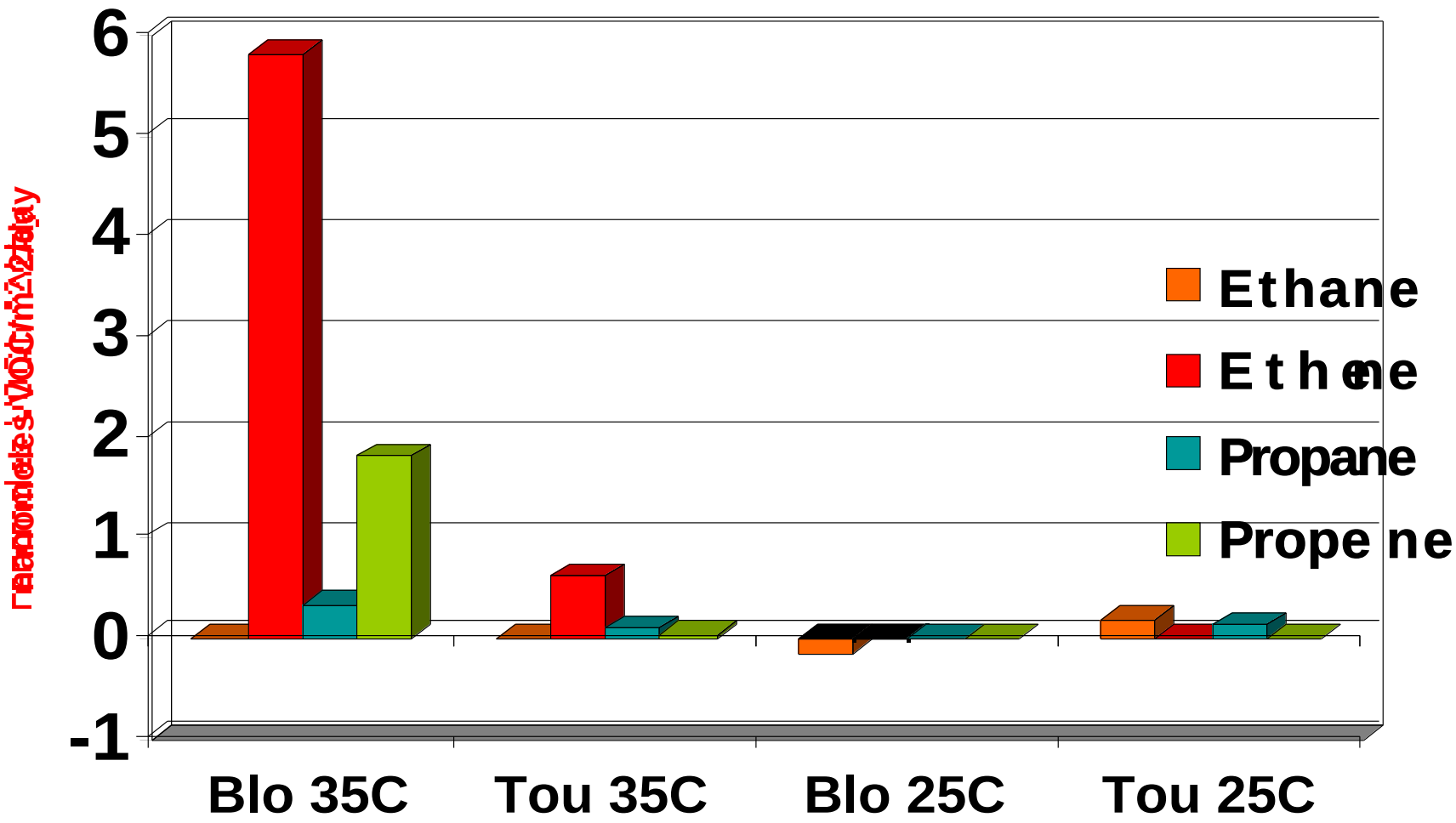


Soil VOC fluxes following 2 day incubations at 35C, 10% moisture

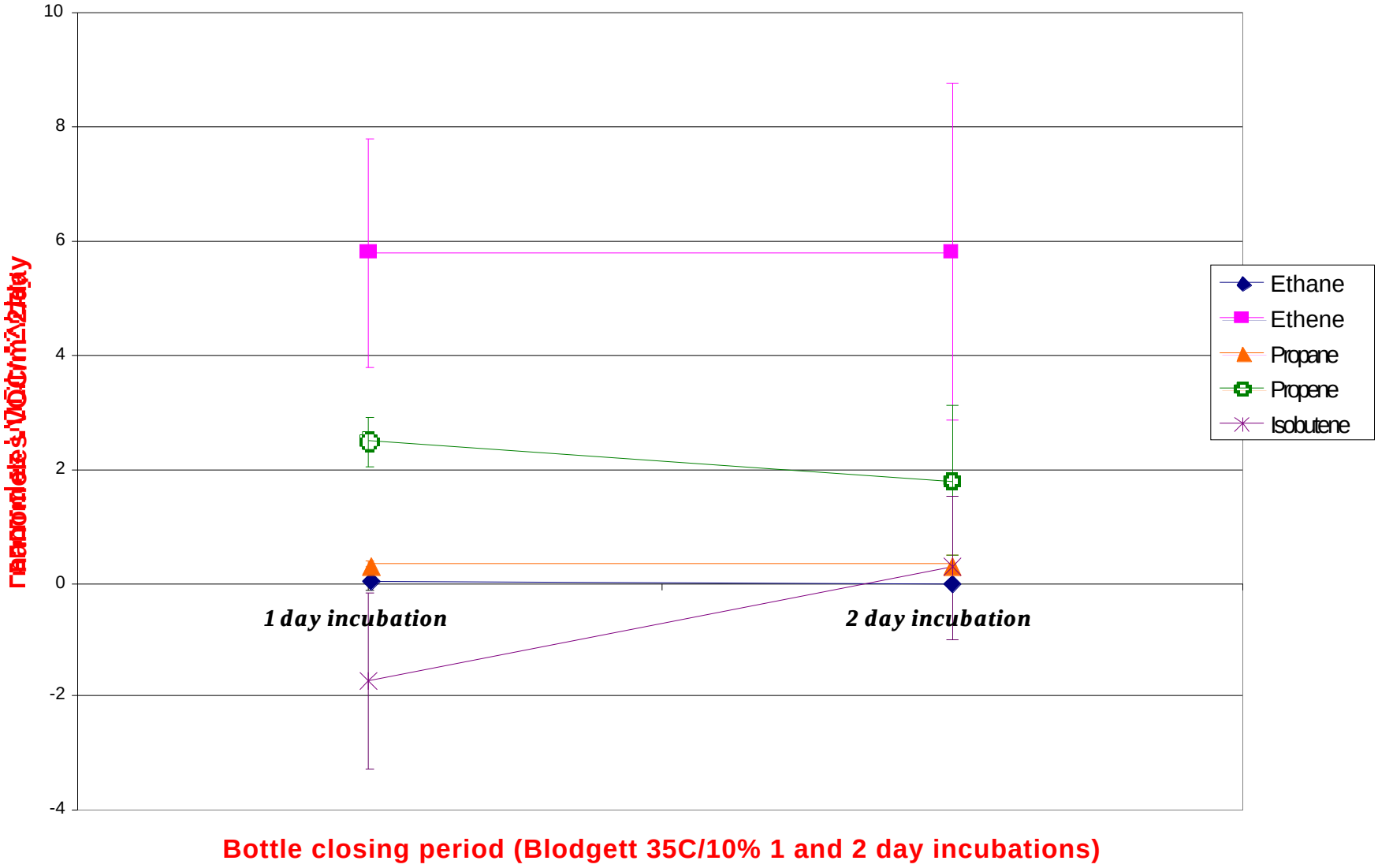
{Argon trap/cryo-focus method}



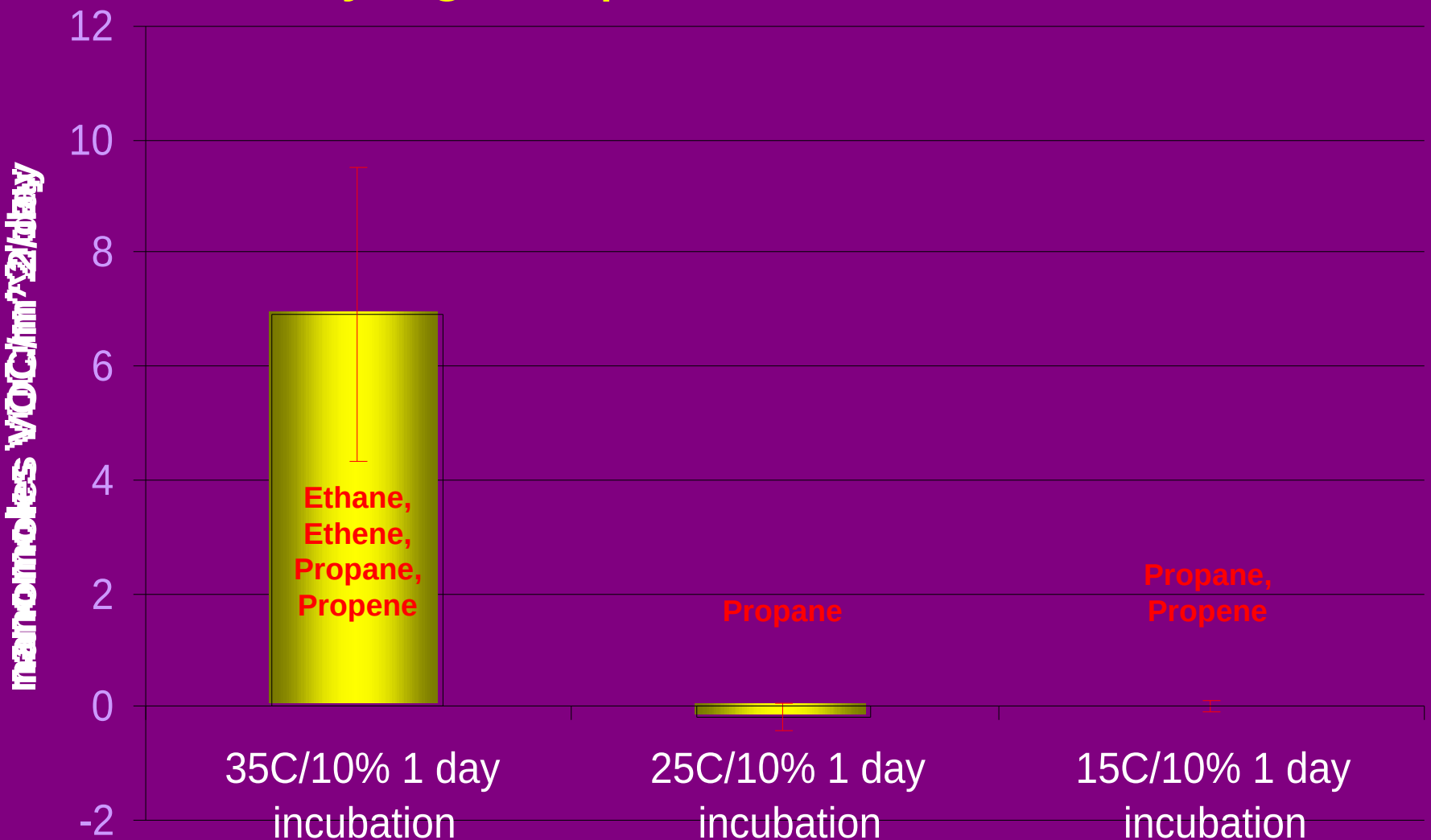
Characteristic VOCs emitted with varying temperatures



Changes in flux with incubation time



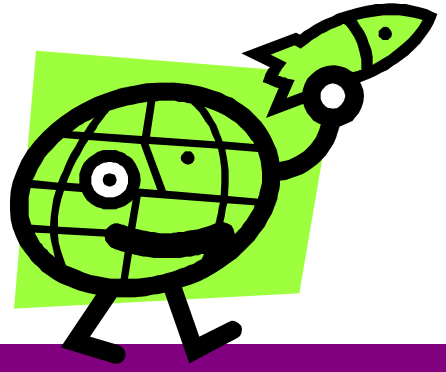
Comparing total soil VOC fluxes with varying temperature treatments



Conclusions

- Soil VOC emissions increase with increasing temperature
- Pine forest soils (Blodgett) produce more total NMHC than Tonzi oak savannah
- A different experimental setup is necessary to determine moisture impact on VOC
- Soils appear to be sources of ethene, propene, and propane at 35C/10% moisture

Future Aims



-to compare VOC data with CO2 flux data over a period of time of soil incubation experiments

-to extrapolate results to an ecosystem level using available models and vegetation/topographic information

-to continue monitoring NMHC from soils in different ecosystems and relate regional VOC fluxes to global budgets

-to attempt to distinguish among abiotic and biotic contributors to VOC production in soils

-to analyze leaf/grass litter from these sites for VOC

DOE-OBER

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