Soil Respiration Patterns along a 3000 m elevation gradient

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Why does soil respiration matter?

- The respiration rates of soil microorganisms are important in understanding the soil CO_2 efflux for climatic feedback and soil carbon storage

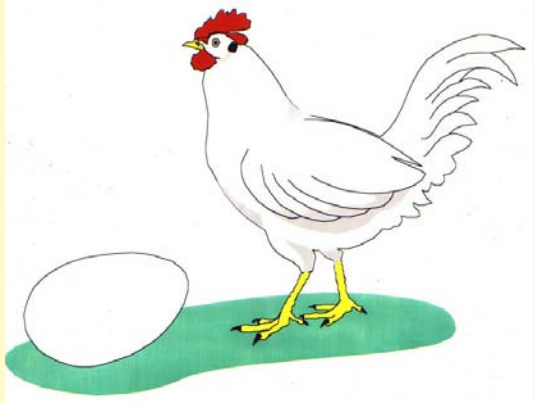
- Determining the temperature at which soil respiration would help determine when will maximum rates of CO_2 be emitted from soils if a change in climate were to occur

Fundamental Question:

- Are the physiological characteristics of soil microorganisms dependent on their immediate surroundings?

or

- Are the physiological characterstics of soil microorganisms dependent on their climate?

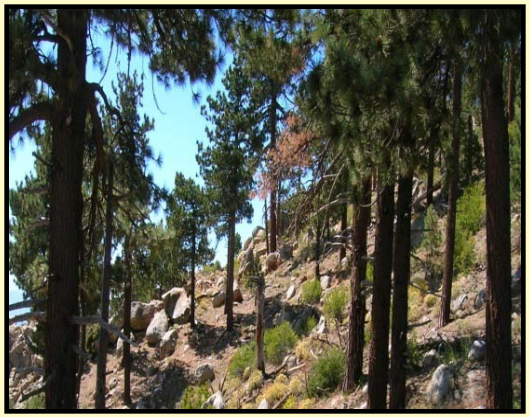


Objectives:

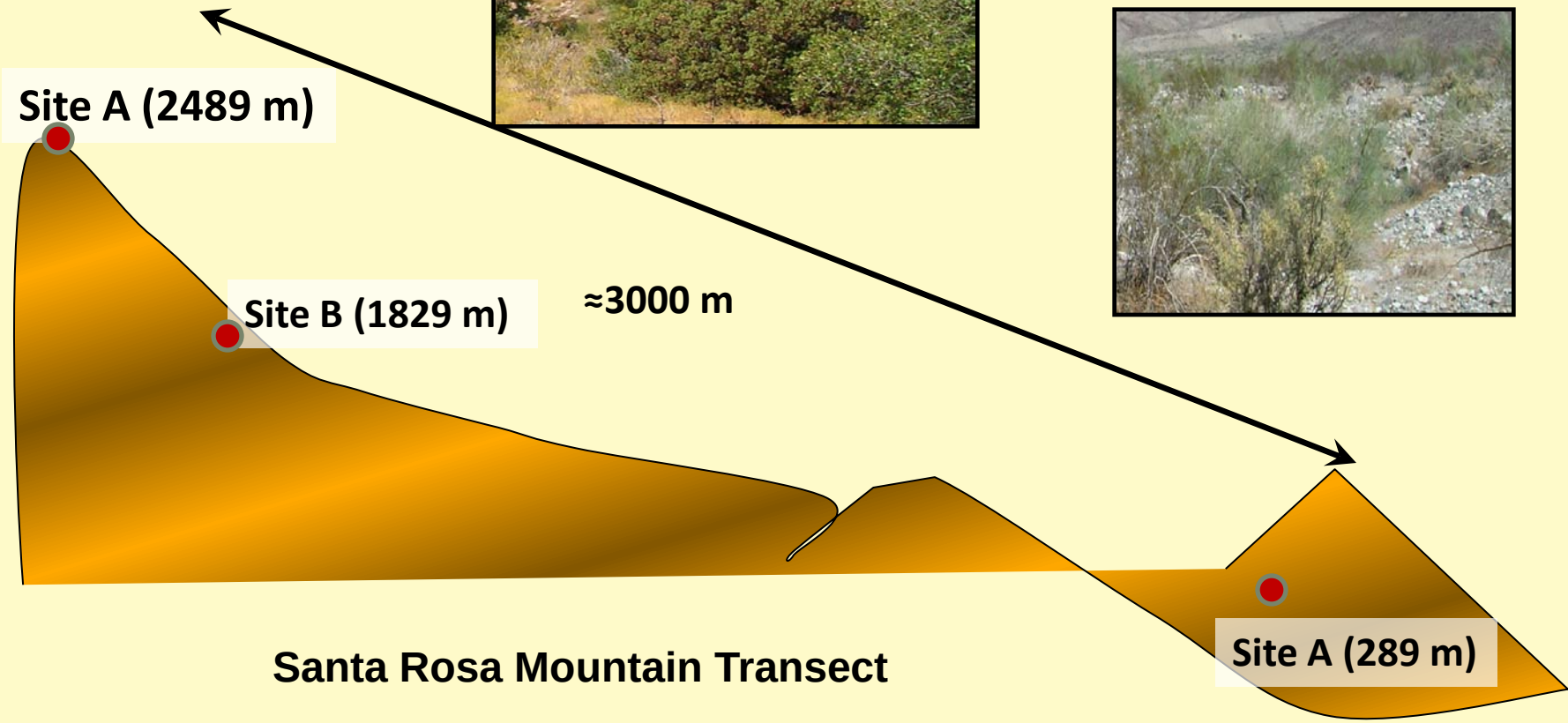
- Determine if microorganisms from hyperthermic soils have a greater adaption to extreme temperature compared to the microorganisms of a cooler, mesic soil.

- Are these microorganisms be affected by moisture, vegetation, or organic matter content

Site details and sample collections



Five field replicated soil samples (0-15 cm) collected from canopy and interspace position
Total 30 soil samples



Santa Rosa Mountain Transect

Site	Soil Family	Mean Annual Temp. °C	Mean Annual Precipitation cm	Landform	Horizons	Parent Material	Soil texture & pH
A	Carrizo stony sand: Sandy-skeletal, mixed, hyperthermic Typic Torriorthents	20	8	Toeslope	0-10 inches: Stony Sand 10 -39 inches: Very gravelly coarse sand	Alluvium derived from granite	Sand 7.9
B	Modesto Fine Loamy: Loamy, mixed, thermic, shallow Typic Xerochrepts	15	51	Backslope	0 to 8 inches: Fine sandy loam 8 to 28 inches: Sandy clay loam	Residuum weathered from sandstone and/or granodiorite	Sandy loam 6.7
C	Crouch rocky sandy loam Coarse-Loamy, Mixed, Mesic Ultic Haploxerolls	10	51	Backslope	0 to 11 inches: Sandy loam 11 to 28 inches: Sandy Loam	Residuum weathered from granodiorite and/or granite	Sandy loam 6.1

Experiments

1. Determine the temperature of peak soil respiration for each site along the elevation gradient.

2. Repeat this process with changing variables:

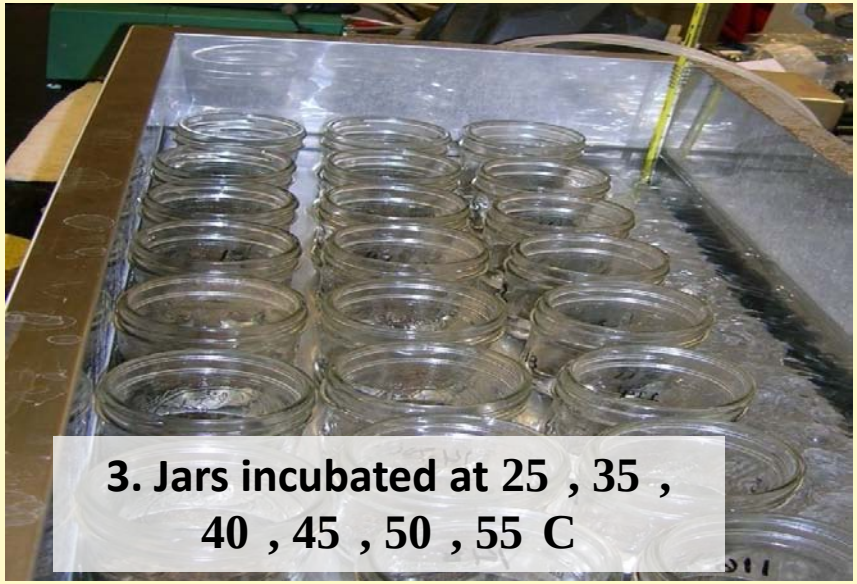
- Moisture at: 20%, 40%, 80% Water Holding Capacity

- Interspace vs Canopy

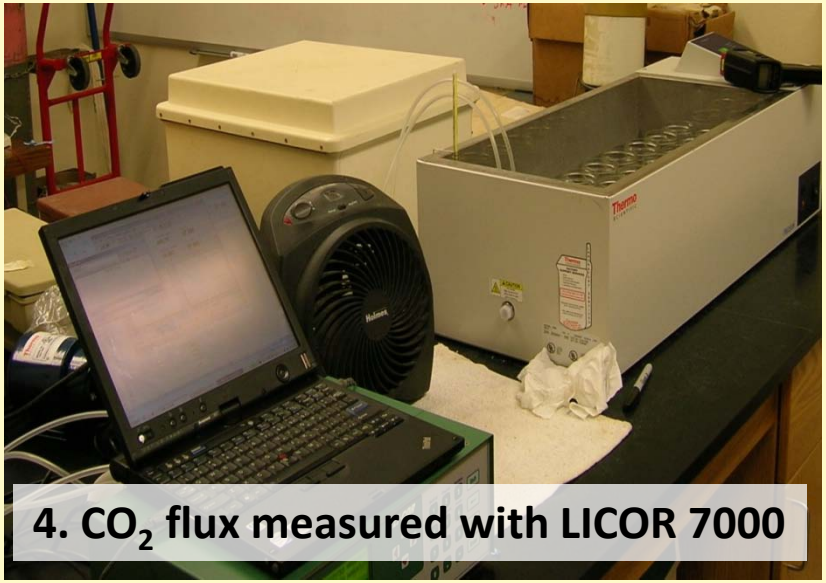
Soil incubation and CO_2 flux measurement

1. 50g soils incubated at 25°C

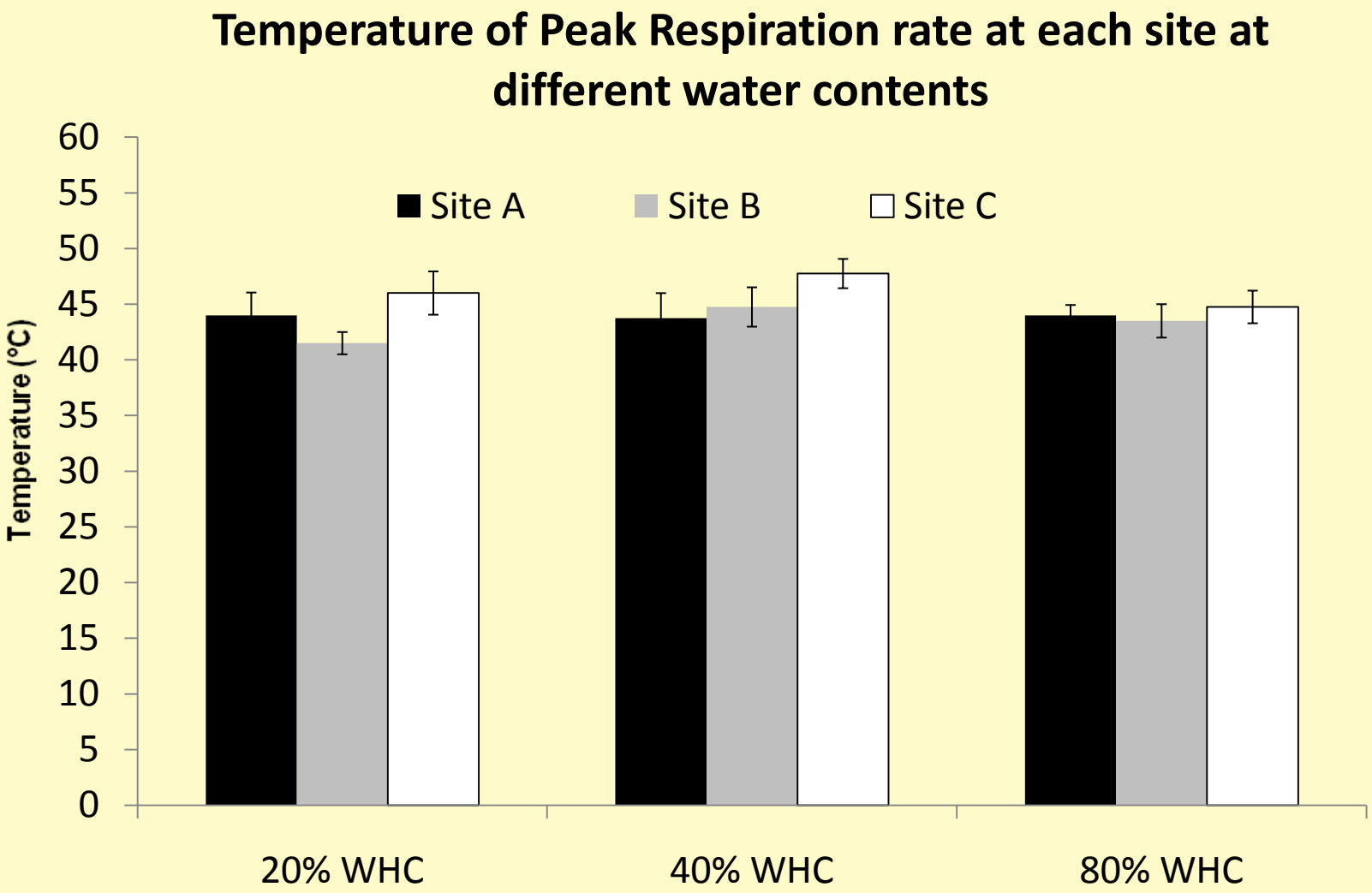
2. Soil jars incubated for 5 days



3. Jars incubated at 25 , 35 , 40 , 45 , 50 , 55 C



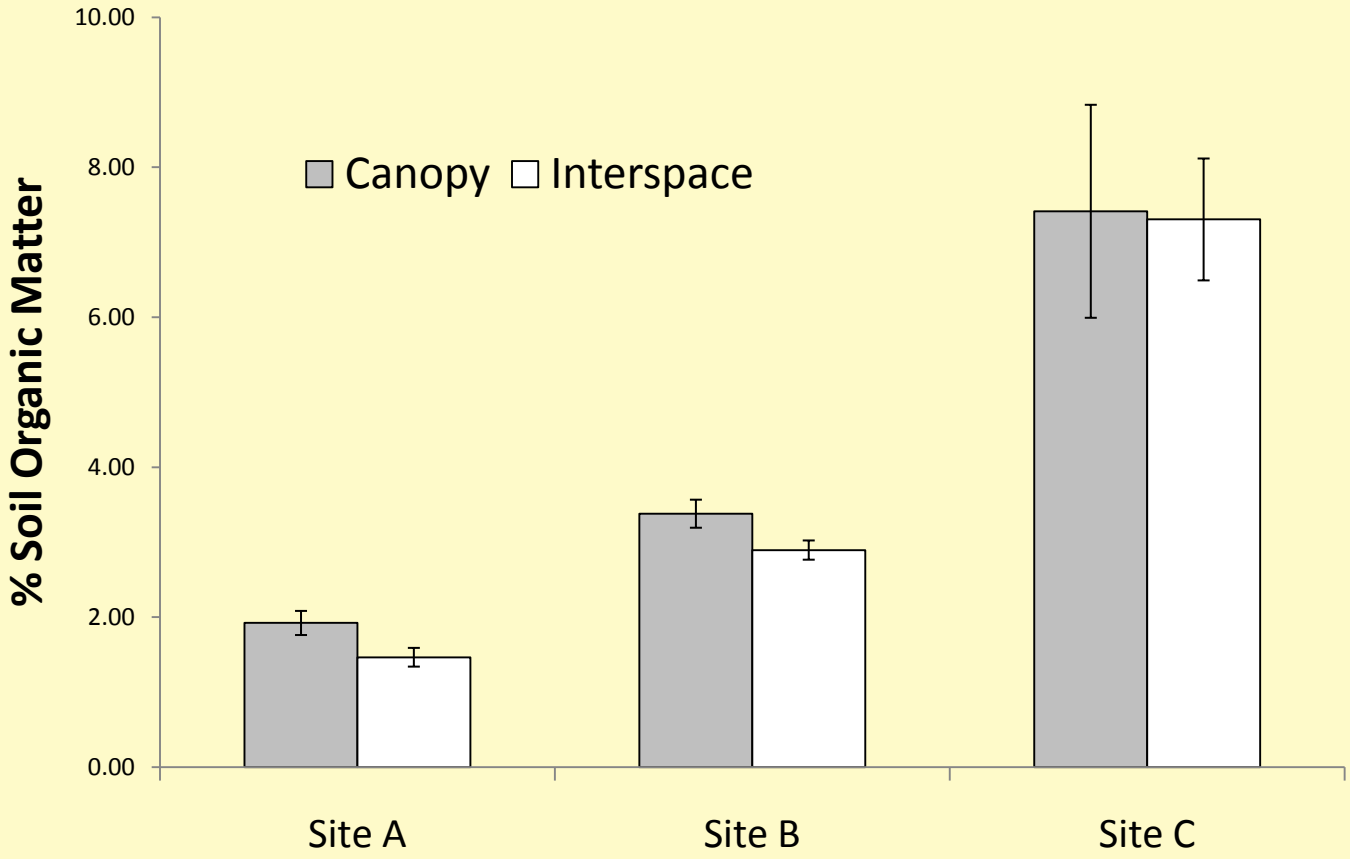
4. CO_2 flux measured with LICOR 7000



There was no significant difference between respiration temperatures between any of the sites at all three water contents.(P>0.05).

Temperature of Peak Respiration ±(SE) °C			
Canopy	Site A	Site B	Site C
20% Water Content	46± (2.3)	43±(1.2)	44±(1.9)
40% Water Content	50±(1.4)	49.5±(1.5)	46.5±(1.3)
80% Water Content	43.5±(1.5)	44±(2.9)	47.5±(2.2)
Interspace	Site A	Site B	Site C
20% Water Content	42±(3.4)	40±(1.4)	48±(3.4)
40% Water Content	37.5±(1.1)	40±(0.8)	49±(5.8)
80% Water Content	44.5±(1.2)	43±(1.2)	42±(0.9)

% Soil Organic Matter at each Site



Sites A and B have significantly different amounts of Soil organic matter ($P<0.05$). Soil organic matter increased along with elevation due to vegetation.

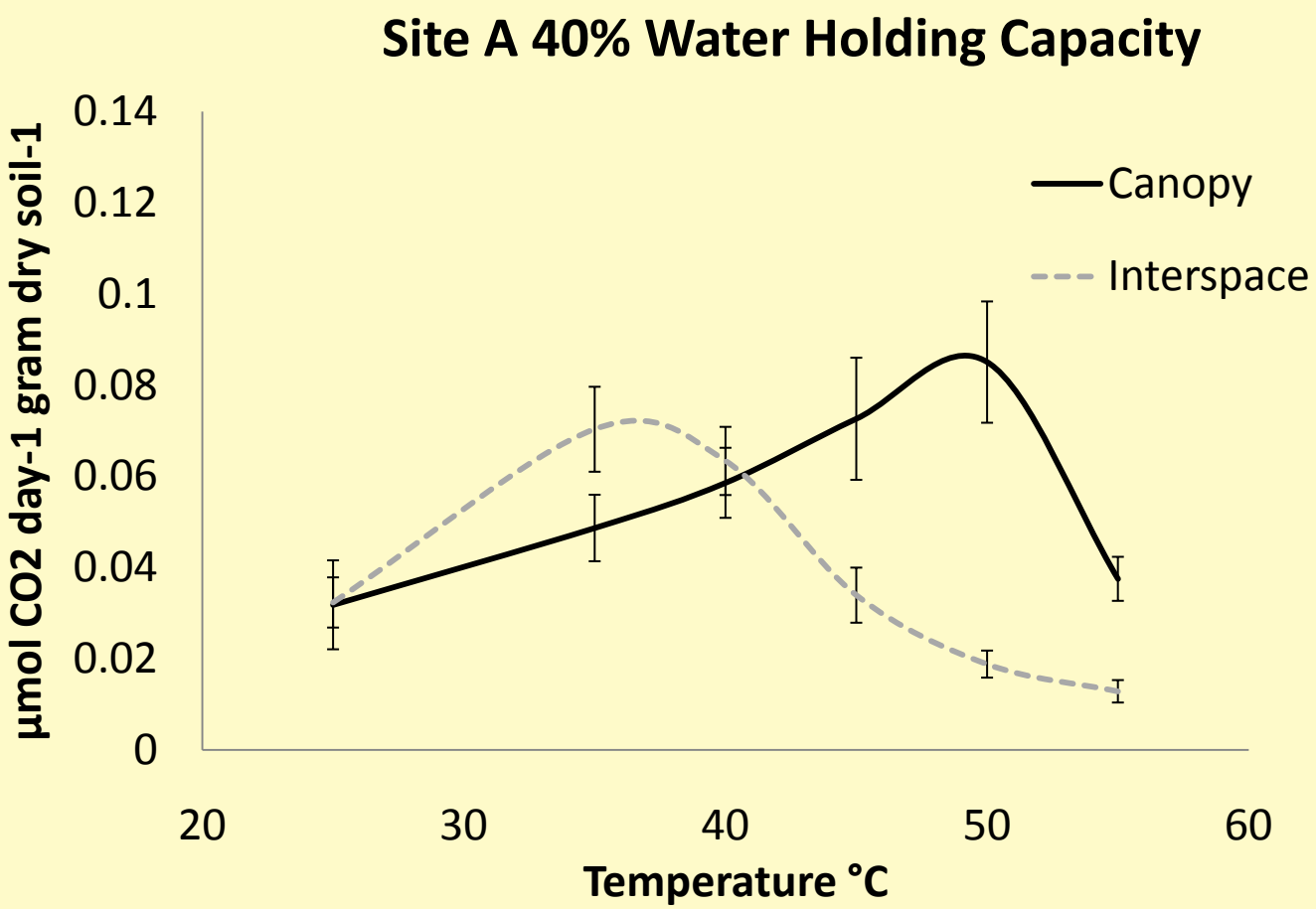


Figure 2 Site A canopy and interspace soils have different respiration patterns and a significantly different temperatures of optimal respiration ($P<0.05$).

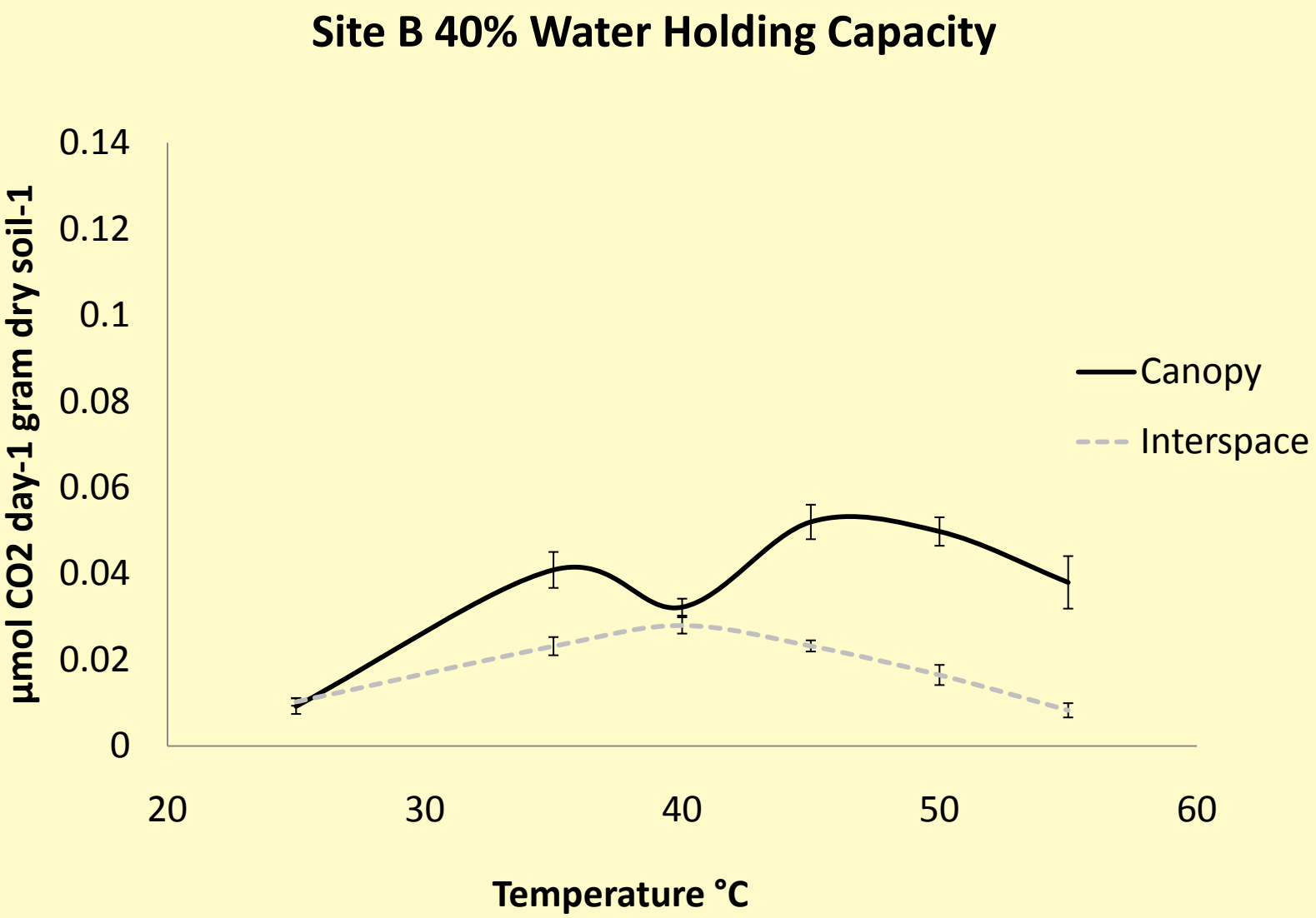


Figure 3 Site B canopy and interspace soils have different respiration patterns and a significantly different temperatures of optimal respiration (P<0.05).

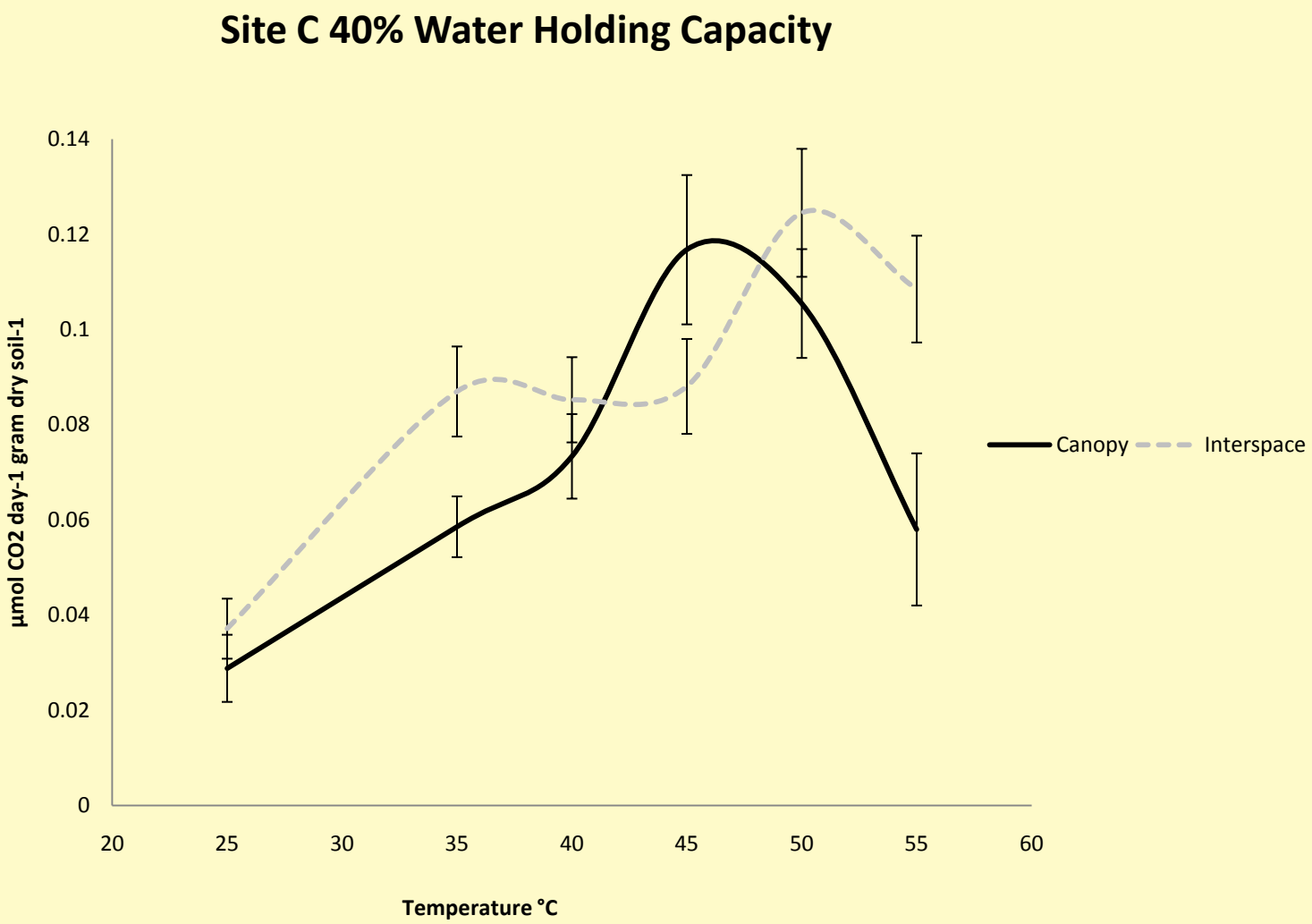


Figure 4 Site C canopy and interspace soils have similar temperatures of optimal respiration (P<0.05).

Conclusions

1. Soil Microorganisms capable of remaining metabolically active at extreme temperatures are not confined to hyperthermic areas as mesic soils had a similar respiration patterns.

2. Soil respiration rates increased with increasing water content for both canopy and interspace soils at all sites but increasing water content did not change the temperatures of peak respiration at all sites.

3. Site A and Site B Interspace and canopy samples had different amounts of organic matter and different temperatures of peak respiration while Site C had similar amounts of organic matter and temperatures of peak respiration. This suggests that heat-tolerant microorganisms vary from local-scale variables, rather than climatically.