Temperature response of enzyme activity at depth in a bog at Marcell Experimental Forest, MN, USA

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introduction: SPRUCE

Spruce and

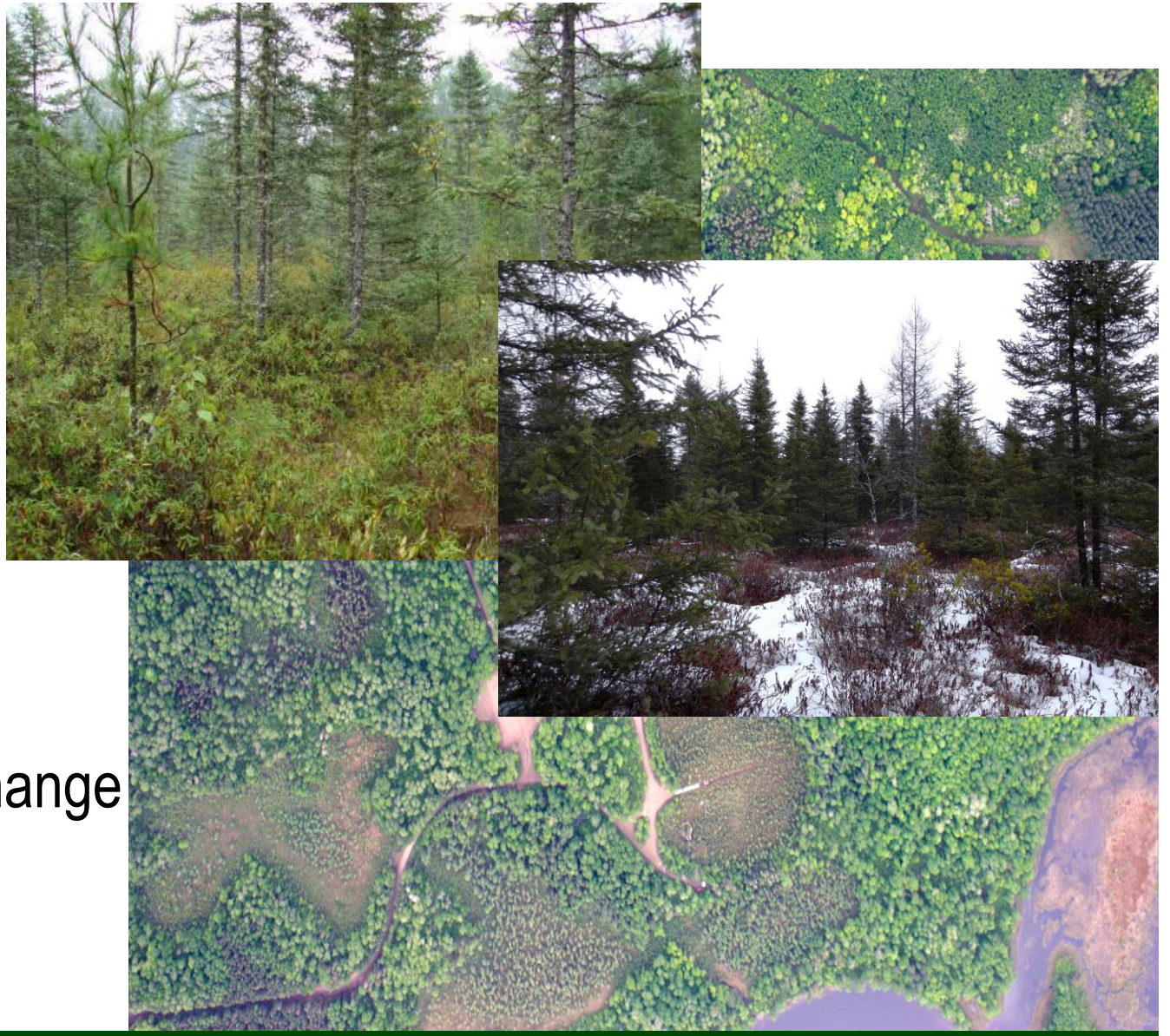
Peatland

Responses

Under

Climate and

Environmental change



introduction: SPRUCE design

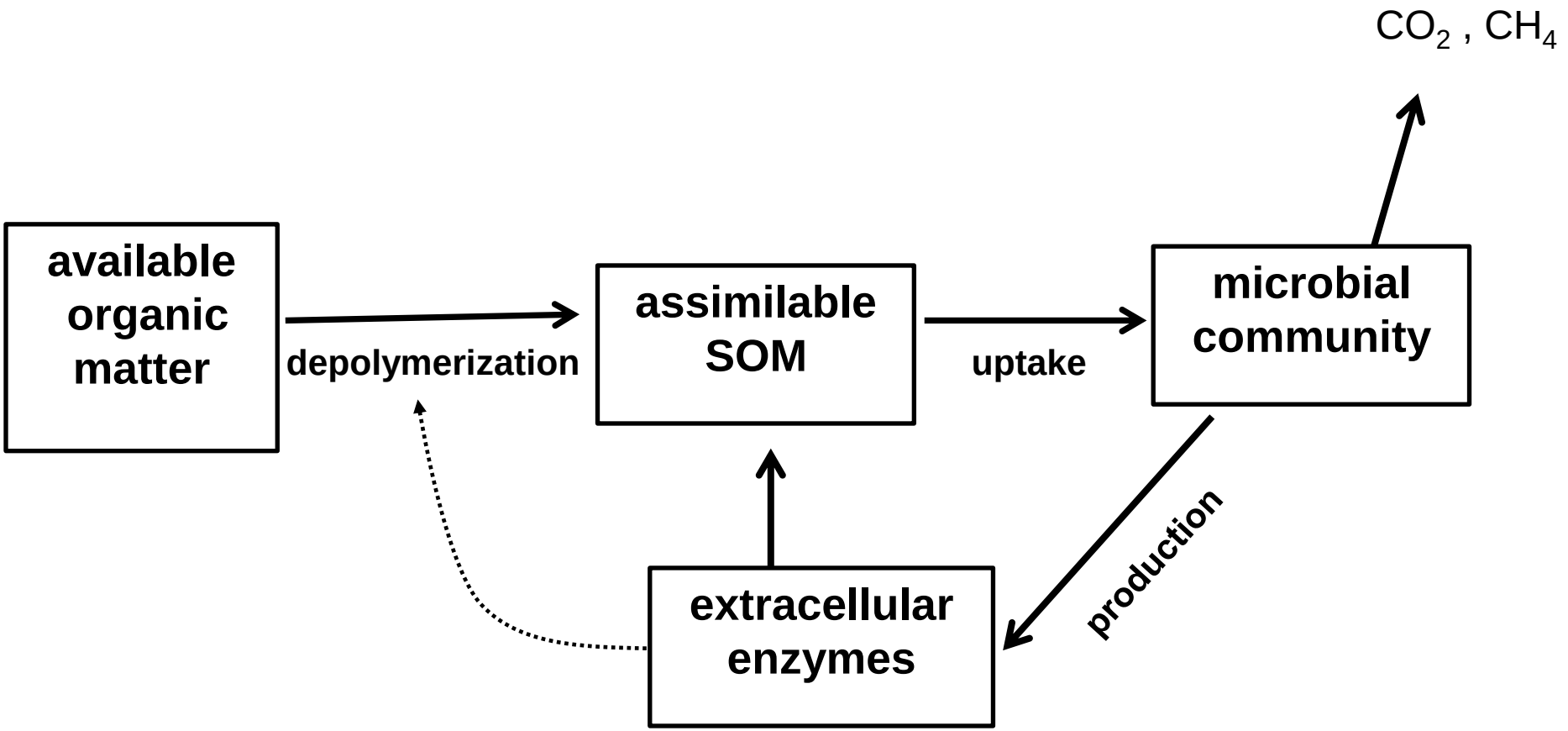
- Warming – above and belowground
  - 0-9° C above ambient
- CO_2
  - ambient and elevated

Full-scale prototype of the enclosure for testing evaluation and continued improvement constructed at ORNL.

Information about SPRUCE

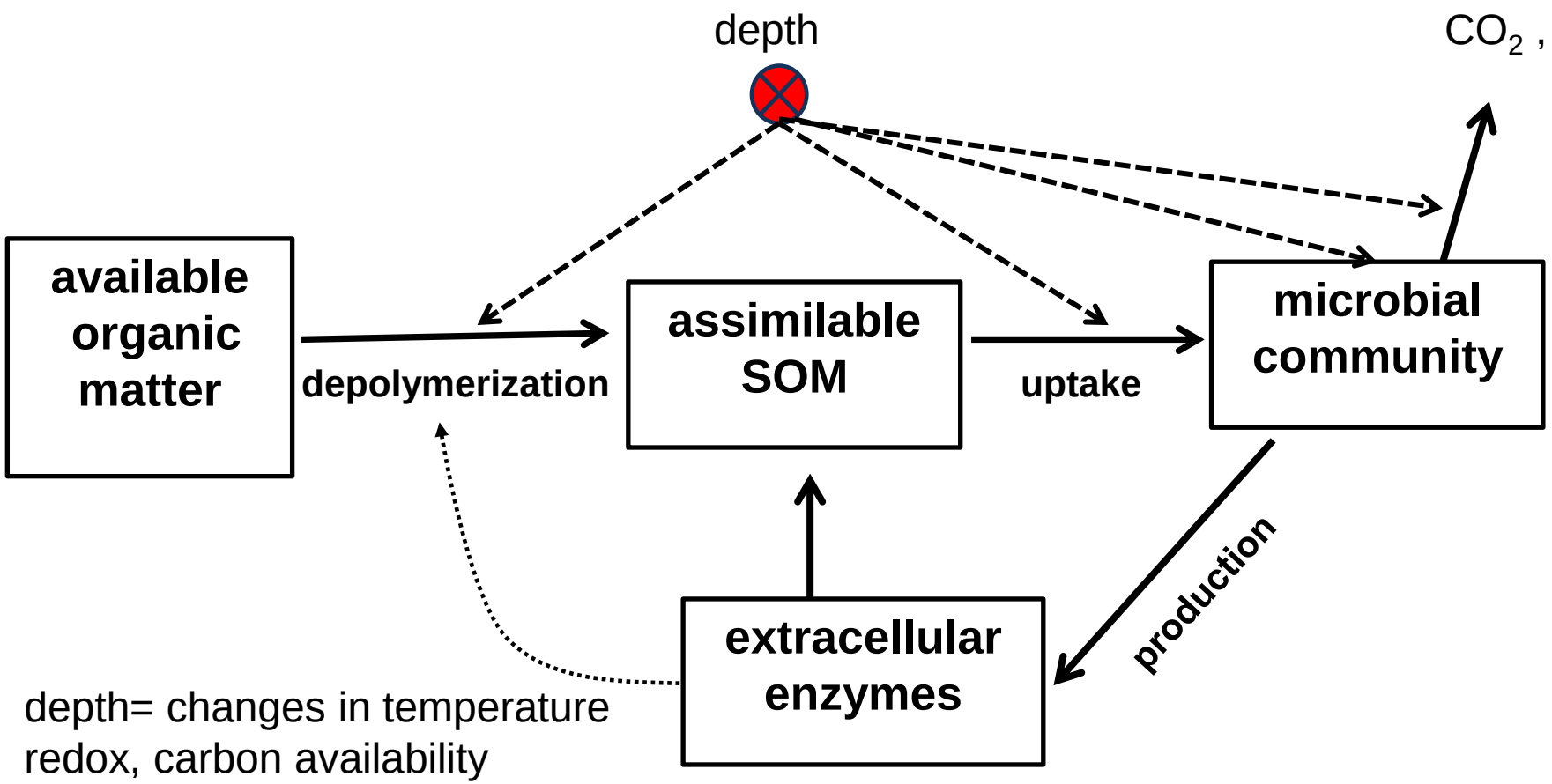
- **Poster #333, Session 2: Colleen Iversen**, "Spruce-Peatland Responses Under Climatic and Environmental Change: An In Situ Warming by CO2 Manipulation of an ombotrophic bog in northern MN
- http://mnspruce.ornl.gov/content/doe-office-science-ber-website

microbe-centric belowground cycling



simplified from Conant et al. 2011, GCB

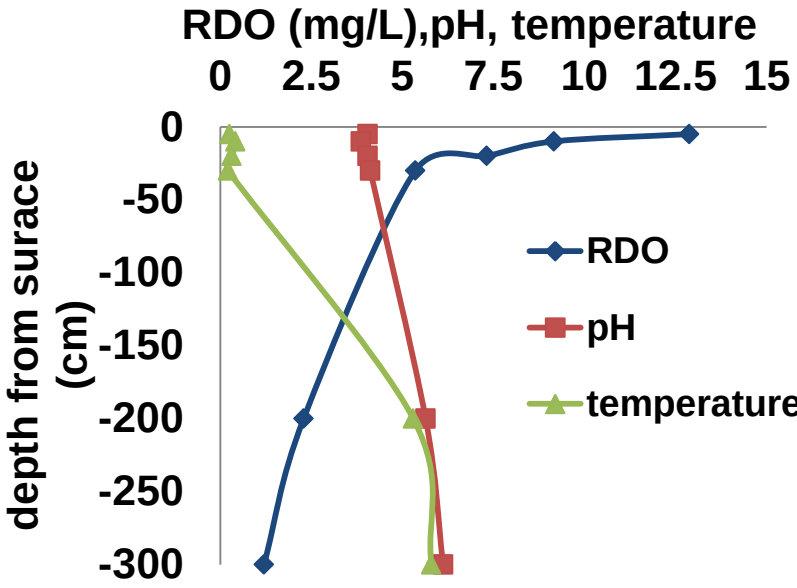
microbe-centric belowground cycling



simplified from Conant et al. 2011, GCB

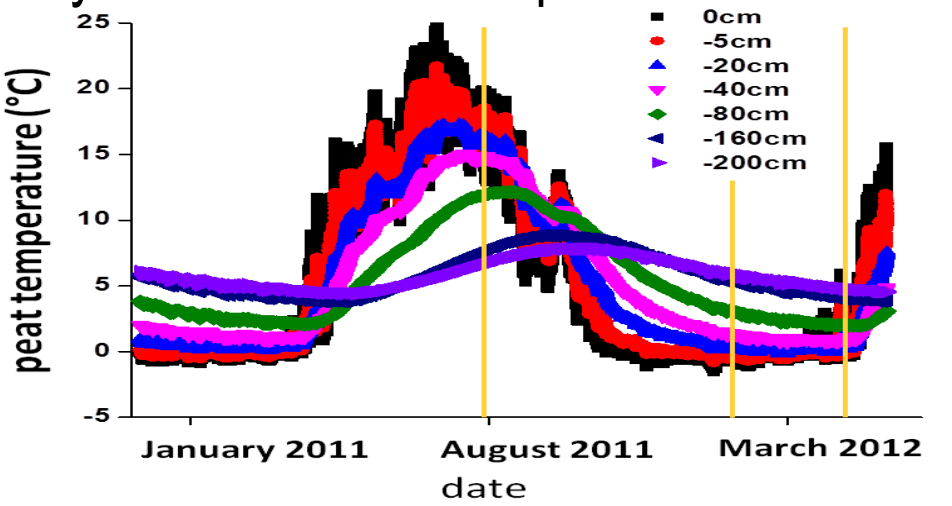
Hypotheses:

- enzyme activity decreases with depth
  - due to reduction in microbial biomass, and/or oxygen content



- temperature response of different enzymes
  - influence N and C depolyermization rates

- temperature response of enzyme activity decreases with depth
  - relatively stable temperature below 1m
  - Isoenzymes, enzymes with same function but different temperature optima, may be more prevalent at the surface.



methods: sample collection

- peat collected in summer, winter and spring
- peat cores 0-200cm, collected in 50cm increments
  - Divided into 10 or 25cm samples
- stored cold until frozen at -20° C

methods: potential enzyme activity

peat slurry with sodium acetate buffer, pH 4

mixed with fluorescently labeled substrate

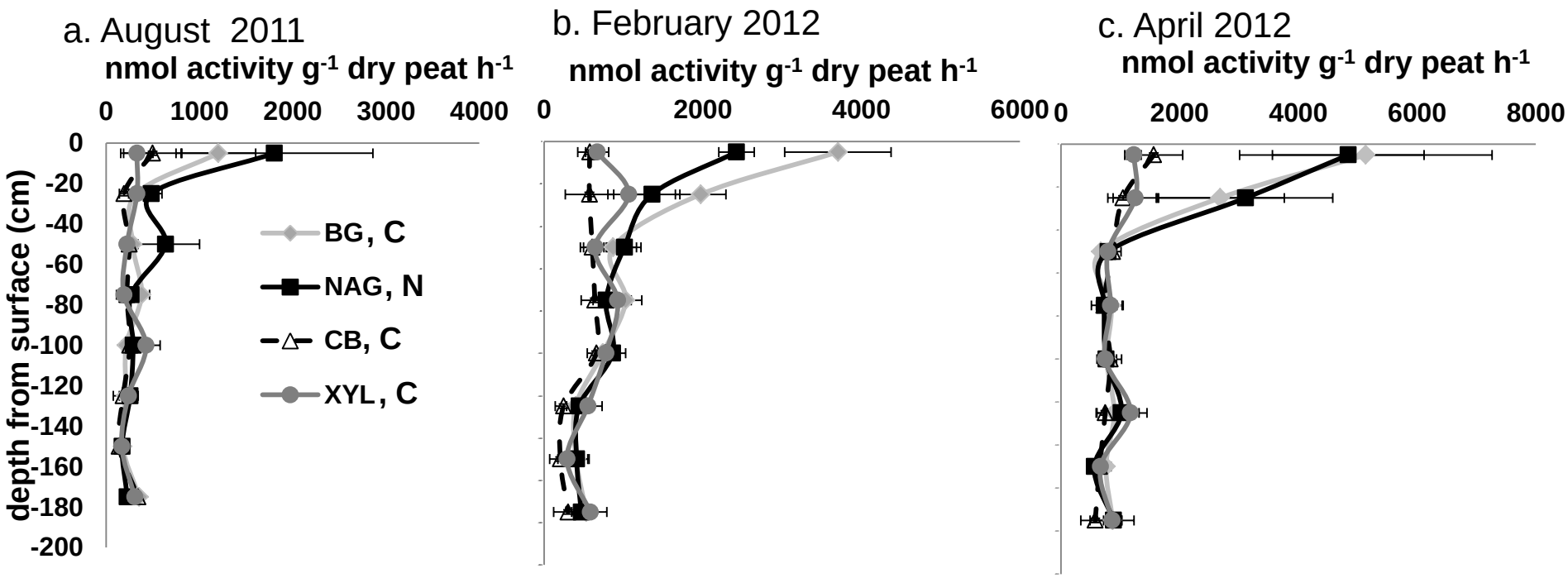
Enzyme Name	Abbreviation	Nutrient Cycle	Enzyme Function
β-glucosidase	BG	C	hydrolysis of terminal β-glucosyl residues
N-acetyl glucoaminidase	NAG	N	hydrolysis of chitin N-acetyl-β-glucosaminide
Cellobiohydrolase	CB	C	hydrolysis of β-D-glucosyl linkages
Xylosidase	XYL	C	hydrolysis of β-D-xylose residues

incubated at 4, 10, 19 and 30° C

fluorescence measured after 2, 4 and 7 hours

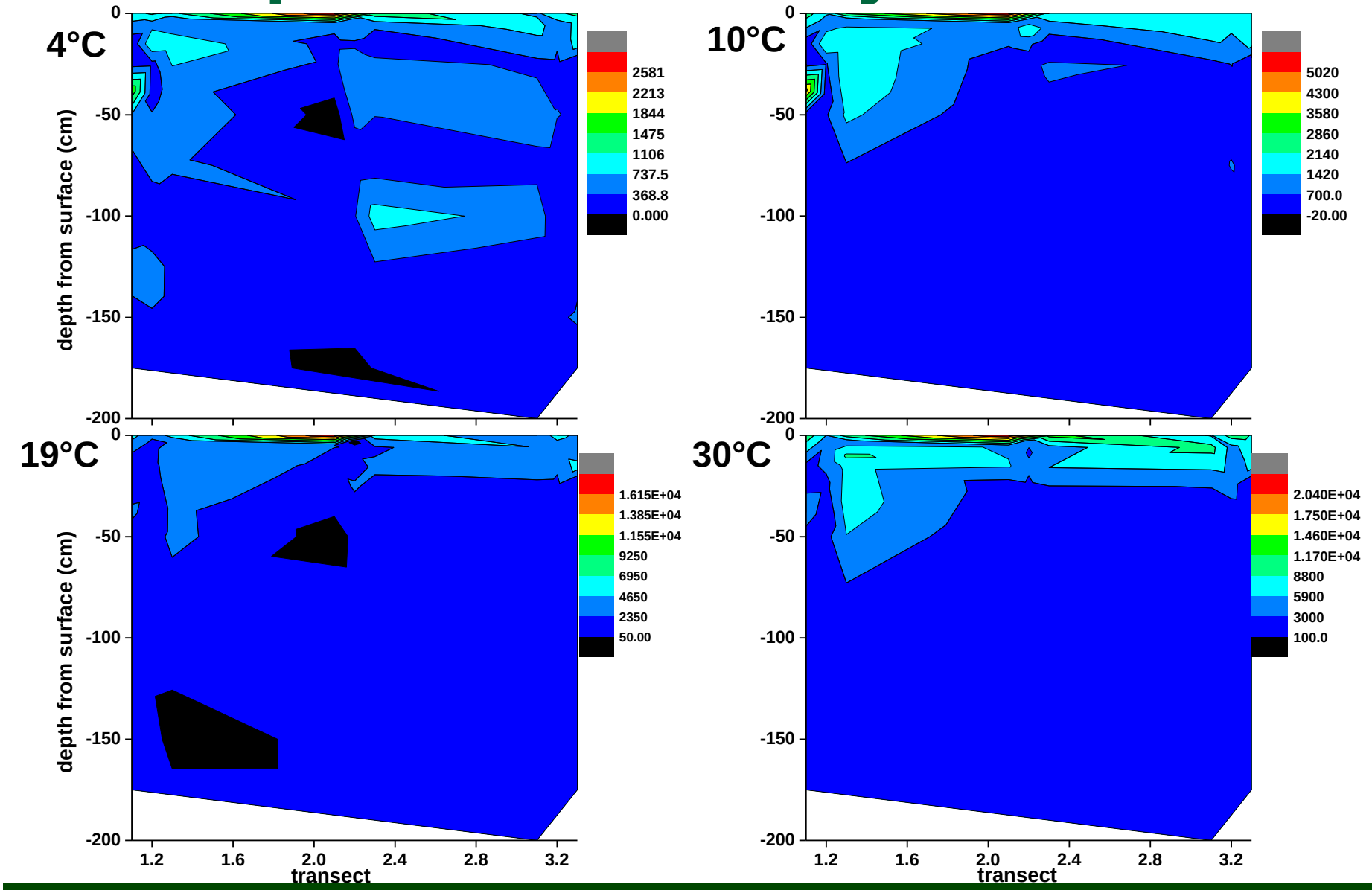
activity expressed as nmol activity g^{-1} dry peat hr^{-1}

results: potential enzyme activity with depth

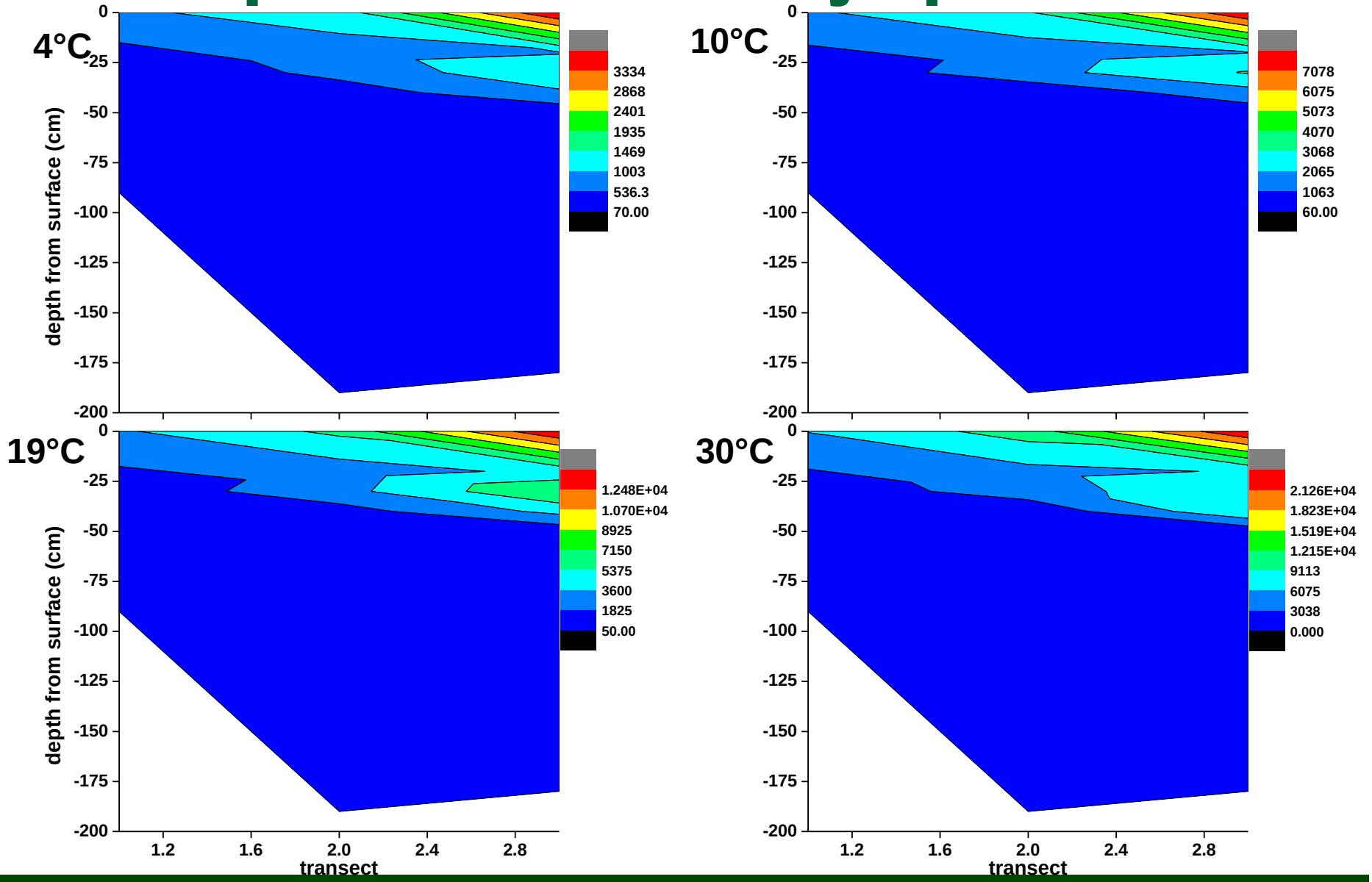


- variability greatest at the surface
- greatest activity in April 2012
- similar trends for all temperatures

results: potential BG activity Feb 2012

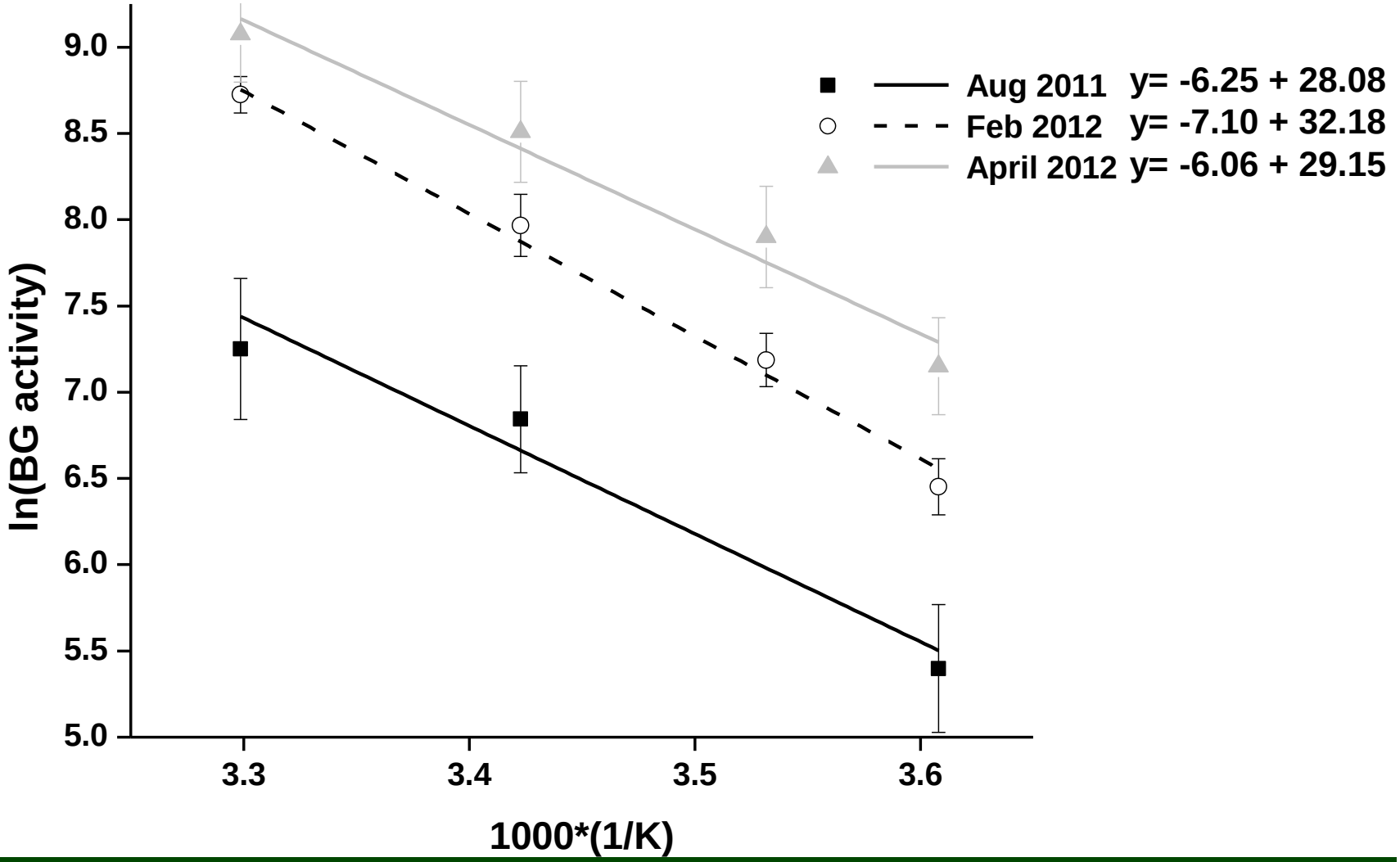


results: potential BG activity April 2012



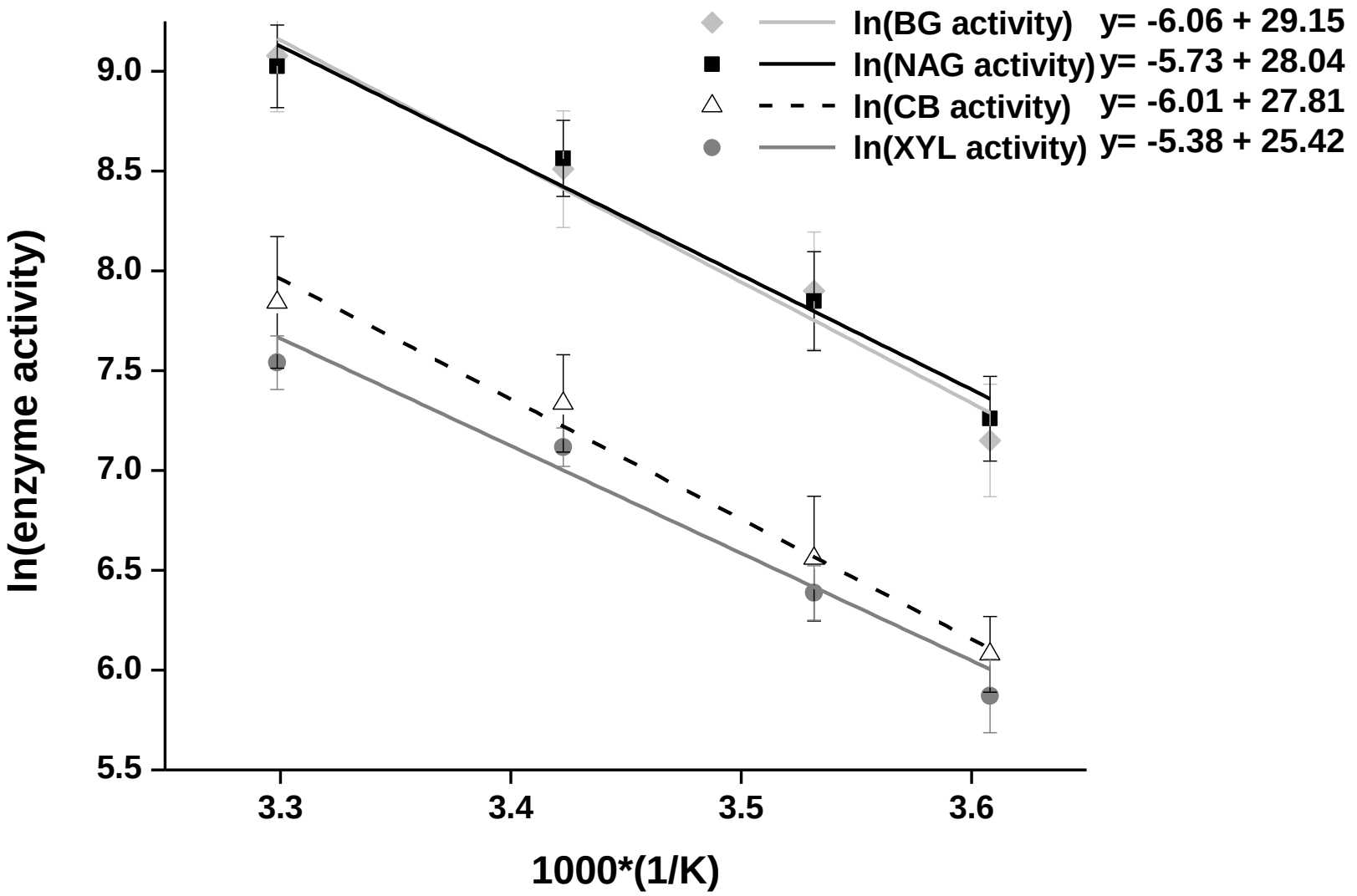
results: BG temperature response by season

BG activity, all sample dates, 0-25cm below surface

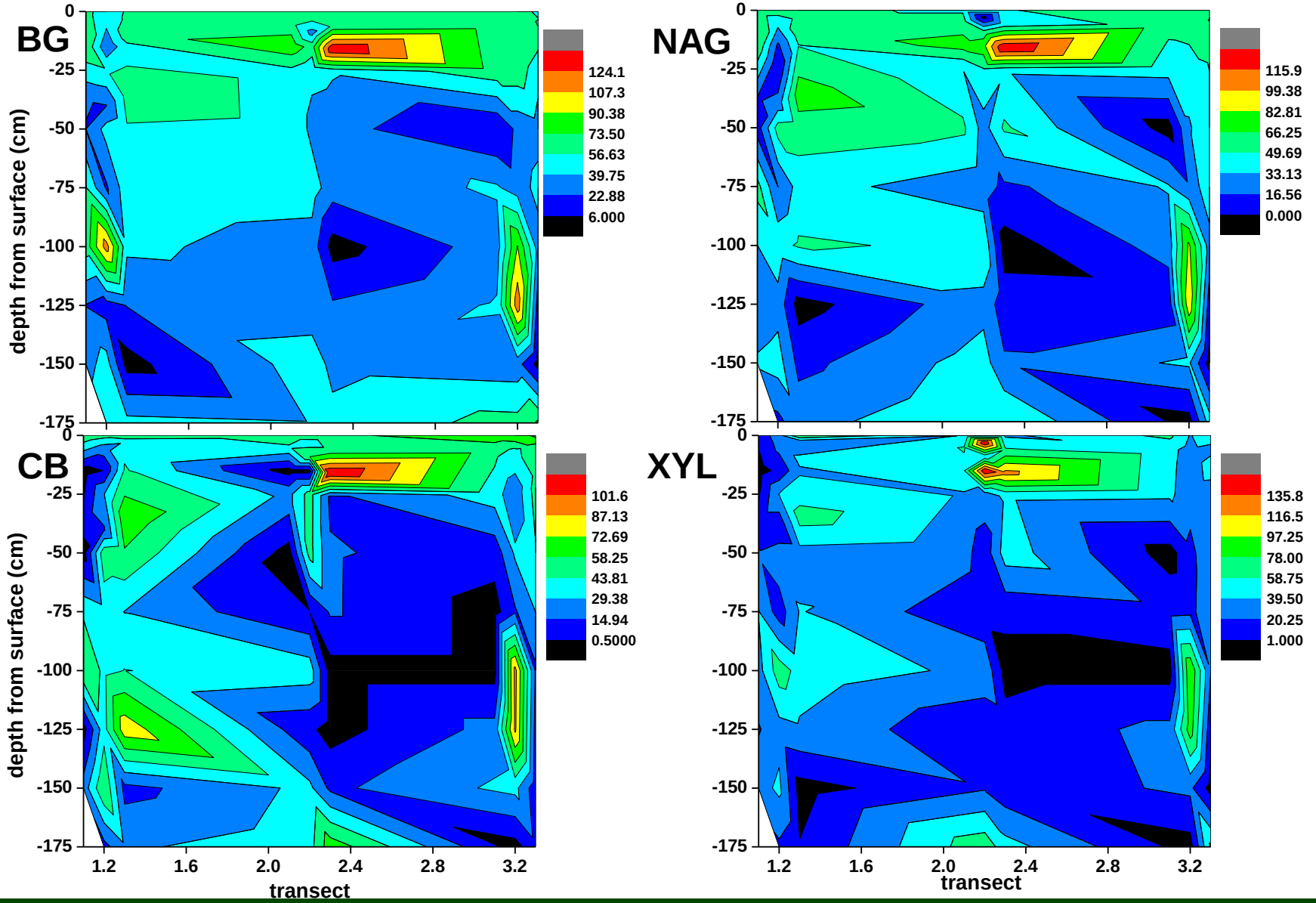


results: enzyme temperature responses

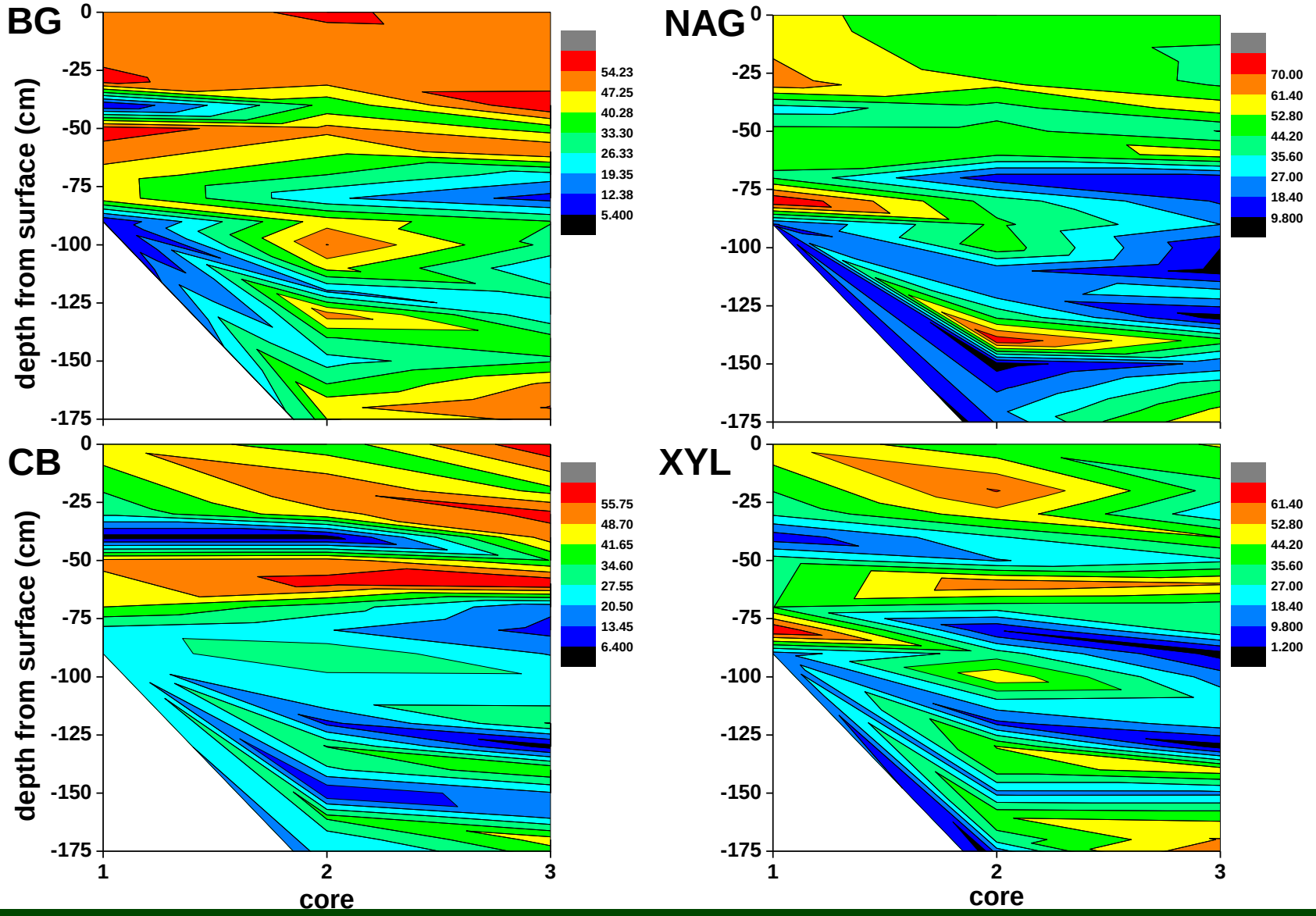
April 2012, 0-25cm below surface



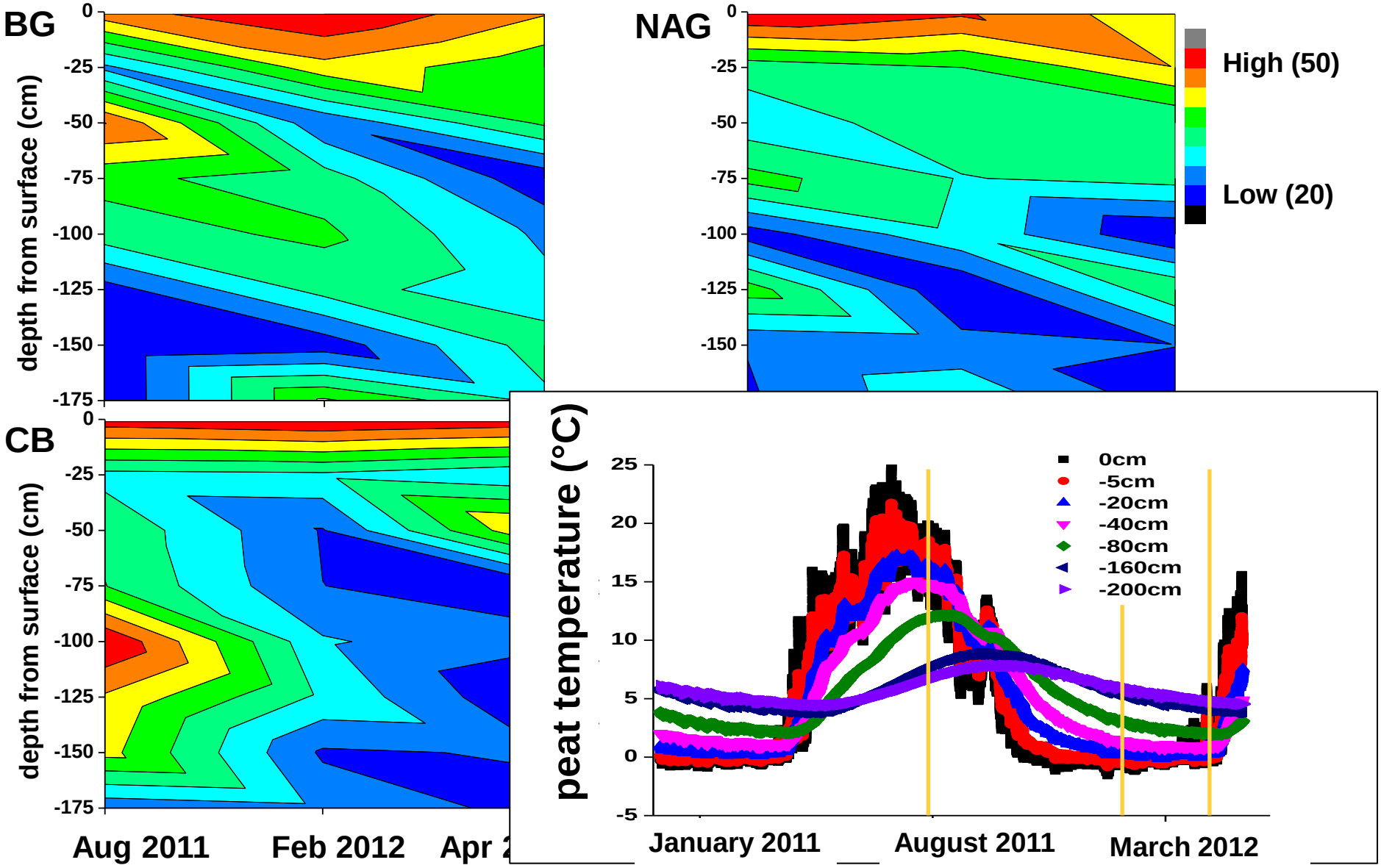
results: Feb 2012 temperature response by core



results: April 2012 temperature response by core



results: average enzyme temperature response



summary

- potential enzyme activity
  - spatially and temporally heterogeneous
  - greatest in winter, unlikely *in situ* activity greatest
- temperature response
  - spatially and temporally heterogeneous
  - season transitions

future work

- include N and P enzymes
- decrease sampling distance
- measure dissolved oxygen, characterize microbial community