Sensitivity of peatland respiration to vegetation community and temperature metric during a hot drought

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1 Aim

To investigate how peatland ecosystem respiration (ER) responded to a hot drought, and how to capture this response when we model and upscale ER. We examined how the following factors impacted ER and modelled ER (ERmod):

- Temperature metric (surface, air or soil)
- Vegetation community (hollow or hummock)

Site, setup and method

- Hemi-boreal peatland in Skogaryd, southern Sweden (58°23'N, 12°09'E)
- 6 soil chambers for manual ER measurements (LGR UGGA, see Fig. 1)
- ER measured in June-September 2018 and 2019
- Summer 2018 was a hot drought but 2019 had normal weather conditions (compared to long-term mean, 2018: ΔTair = +3 °C, precip. = 267 mm; 2019: ΔTair = +1.8 °C, precip. = 362 mm)
- During each ER measurement, we also measured air, soil (6 cm) and surface temperature
- Surface temperature images captured with a thermal camera FLIR A65 every 5 min (see Fig. 1)
- ER modelled based on the Global Polynomial Model (Heskel et al., 2016)

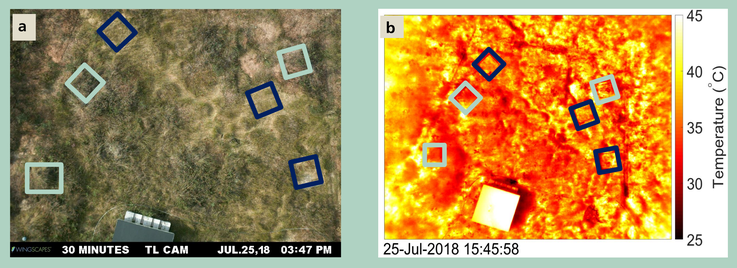

Fig 1. An example (a) RGB image and (b) thermal camera image with the location of the collars (dark blue = hollow, light green = hummock)

2 Impact of hot drought on ecosystem respiration

- ER decreased during the hot drought: more for hummocks (-48%) than for hollows (-15%), see Fig. 2

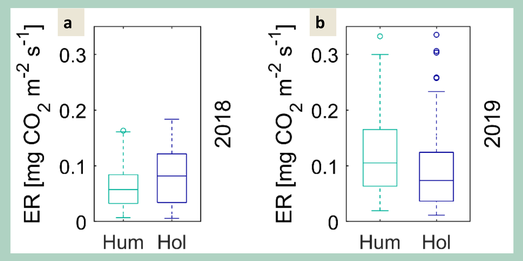

Fig 2. Observed ER of hollows (Hol) and hummocks (Hum) in 2018 (a hot drought) and 2019 (normal weather conditions).

Does vegetation community matter?

- ER is significantly different between hollows and hummocks (Fig. 2)
- Hollow ERmod is more sensitive to (i.e. increases faster with) temperature than hummock ERmod, especially during drought (not shown)

Does temperature metric matter?

- Temperature range impacts temperature sensitivity of ERmod (see Fig. 3), and therefore error propagation
- All temperature metrics produce similar ERmod accuracy (NRMSE, Tsurf = 49%, Tair = 48%, Tsoil = 54%)
- During drought, ERmod stops increasing at high temperatures, especially for surface temperature model (see Fig. 3)
- During drought, hollow ERmod using surface and air temperature stops increasing at high temperatures (not shown)
- But hollow ERmod using soil temperature continues increasing at high temperatures (not shown)

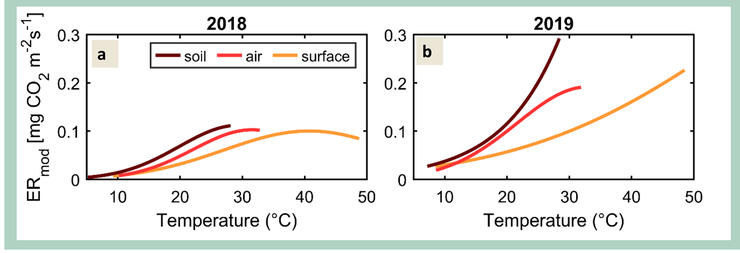

Fig 3. ERmod for hummocks and hollows combined in (a) 2018 (a hot drought) and (b) 2019 (normal weather conditions)

To find out more and see the full results of this project, please join the live discussion

Monday 4th May, 14:00-15:45

3 Conclusions

- Use ER models that allow for declining ER at high temperatures
- Otherwise, peatland C loss due to drought may be overestimated
- Impact of drought on peatland C balance depends on proportion of different vegetation communities
- ER for different vegetation communities should be modelled separately
- Do differences among ERmod using Tsurf/air/soil during drought indicate decoupling of air and surface from soil temperature OR does highly sensitive soil temperature overestimate ERmod?

References

Heskel, M. A., et al. (2016) Convergence in the temperature response of leaf respiration across biomes and plant functional types. *PNAS*, 113(14), 3832-3837

To find out more about using thermal cameras, in particular on UAVs, please see:
Kelly, J., et al. (2019) Challenges and Best Practices for Deriving Temperature data from an Uncalibrated UAV Thermal Infrared Camera, *Remote Sensing*, 11(5), 567.

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