The extent and variability of storm-induced epilimnetic temperature changes in lakes worldwide using long-term and high-frequency data

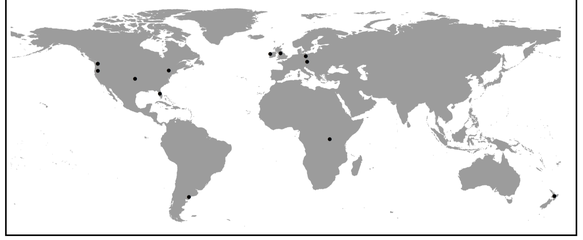
Jonathan Doubek, Rita Adrian, María Belén Alfonso, Orlane Anneville, Ruchi Bhattacharya, Curtis DeGasperi, Elvira de Eyto, Heidrun Feuchtmayr, Dur Gael, Evelyn Gaiser, Scott Girdner, Jennifer Graham, Hans-Peter Grossart, Josef Hejzlar, Bastiaan Ibelings, Stéphan Jacquet, Aleksandra Lewandowska, María Llames, Shin-ichiro Matsuzaki, Emily Nodine, Peeter Nõges, Vijay Patil, Alon Rimmer, Lars Rudstam, James Rusak, Christian Torsten Seltmann, Hilary Swain, Stephen Thackeray, Wim Thiery, Pablo Urrutia-Cordero, Nicole van Lipzig, Piet Verburg, R. Iestyn Woolway, Tamar Zohary, Jason Stockwell

HIGHLIGHTS

- Small change in day-to-day epilimnetic temperatures
- Largest changes in epilimnetic temperatures not associated with largest wind and rain events
- Wind and rain have largest impact on changes in epilimnetic temperatures in spring and fall when thermal stratification is already weak
- We hypothesize storm-induced changes in epilimnetic temperature are not a major driver for phytoplankton community dynamics

BACKGROUND

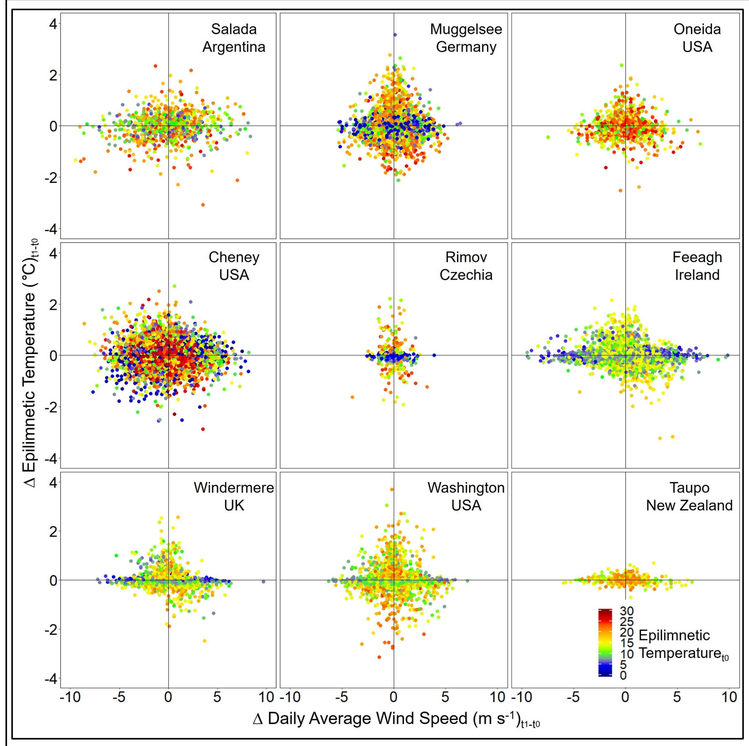
- Storms are expected to increase in frequency and severity in many regions worldwide
- A recent laboratory study concluded that storm-induced temperature changes of ± 10°C may be more important to phytoplankton than changes in nutrients and light (Bergkemper et al. 2018)
- Is 10°C a realistic storm-induced change for lakes?
- We analyzed high-frequency epilimnetic temperature data from 13 lakes across the world as part of GEISHA (Global Evaluation of the Impacts of Storms on freshwater Habitat and structure of phytoplankton Assemblages), a sub-group of GLEON Storm-Blitz



RESEARCH QUESTIONS

1) What is the empirical distribution of day-to-day and storm-induced changes in epilimnetic temperatures in lakes?
2) Are the greatest decreases in epilimnetic temperature correlated with the highest wind and rain events?
3) Do lake morphometry and season influence the impact of storm-induced changes in epilimnetic temperature?

EPILIMNETIC TEMPERATURES DO NOT CHANGE MUCH DAY-TO-DAY, REGARDLESS OF STORM EVENTS

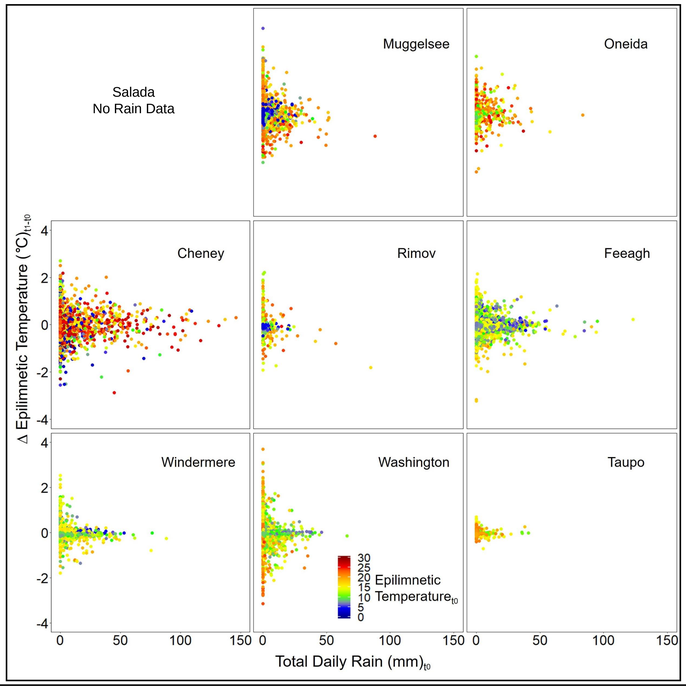


Wind

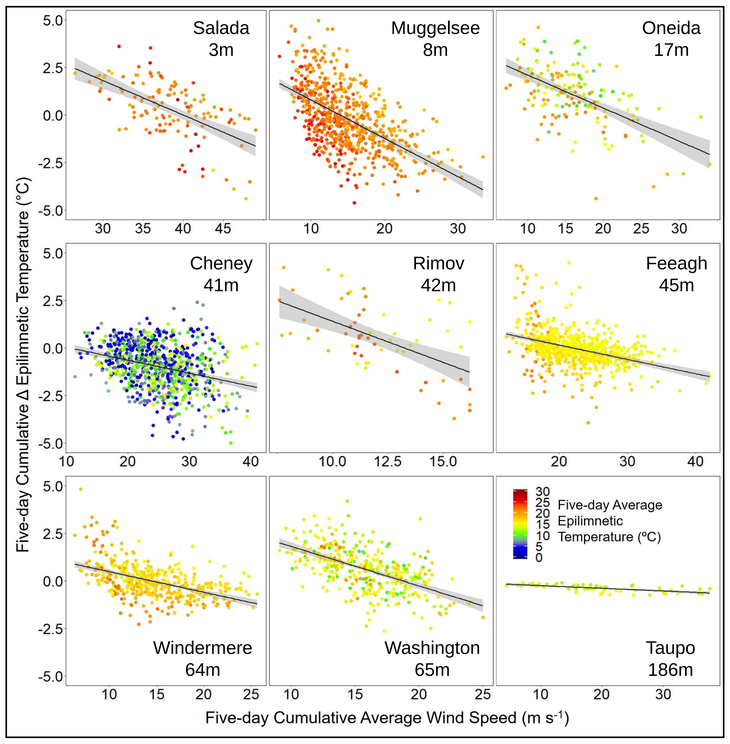
- Strongest winds do not correlate with greatest temperature decreases
- Day-to-day epilimnetic temperature changes similar across lakes
- Reservoirs and polymictic systems more variable day to day
- Maximum temperature decrease = -3.2 ºC
- Mean temperature decrease with ≥95% wind speed event = -0.2 ºC

Rain

- Strongest rain events also do not correlate with greatest temperature decreases
- Day-to-day variability in epilimnetic temperature changes with no rain is greater than with rain
- Results are similar whether using rain from one day or cumulative rain over multiple days
- Mean temperature decrease with ≥95% rain event = -0.1 ºC



WIND OR RAIN AND TEMPERATURE RELATIONSHIPS STRONGEST DURING WEAKER STRATIFICATION



Weak relationships between wind or rain and epilimnetic temperatures in periods with no thermal stratification

Larger and deeper systems exhibit less change in epilimnetic temperature as a function of wind or rain

NEXT STEPS

- Analyze data for remaining lakes with high-frequency epilimnetic temperature recordings (N = 3)
- Analyze the relationships of different quantiles of wind and rain on epilimnetic temperature changes across the lakes
- Include other covariates to assess the role of lake morphometry, fetch, and other lake characteristics on epilimnetic temperature changes
- Calculate hypolimnetic and metalimnetic temperature differences
- The observed small changes in epilimnetic temperatures (generally <1 ºC) with the largest wind and rain events suggest that storm-driven temperature modification may not be as important for phytoplankton communities as concomitant changes in nutrient concentration and light availability

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jonathan.doubek@uvm.edu


@jondoubek