GEISHA/GLEON Storm-blitz: A collaborative project to better understand the responses of phytoplankton to meteorologically-induced variability in water column stability

Orlane Anneville[1], Jonathan Doubek[2], Vijay Patil[3], Jason Stockwell[2], Chun-Wei Chang[4,5], Viet Tran-Khac[1], Gaël Dur[6], Peeter Nõges[7], Tamar Zohary[8] , James Rusak [9], Shin-ichiro S. Matsuzaki[10], Piet Verburg[11], Patrick Venail[12], Stephen J. Thackeray[13], Lars Gosta Rudstam[14], Stéphan Jacquet[1], Alon Rimmer[8] and GEISHA/Storm-blitz contributors[15]

- There is concern about the impacts of extreme climatic events upon lake ecosystems
- Storms mix the water column and deliver sediments from watersheds, which can impact phytoplankton
- Limited understanding of how storms alter phytoplankton communities
- The GEISHA project provides room and time for an international team to work on this question

CHALLENGES

- Rarity of events → correlative approaches problematic
- Need to disentangle the effect of confounding factors (eg. seasonality)
- Short-term predictability of impacts may require high-frequency monitoring, but not yet available for phytoplankton taxonomic composition
- No universal definition of storm: climatological versus impact-related definitions → complicates comparisons among studies

ADVANTAGES of a Collaborative Research Team Strategy

- Long-term data-sets provide better coverage of storm events and better discrimination of storm effects from seasonal variability
- Large number of lakes facilitates across lake comparisons
- Interdisciplinary team → integrate skills, expertise, and ideas to test hypotheses of mechanistic links from physico-chemical properties to biological processes

Global Evaluation of the Impacts of Storms on freshwater Habitat and structure of phytoplankton Assemblages (GEISHA)

@ http://www.geisha-stormblitz.fr/

82 participants
32 data providers
22 investigators
28 GLEON members

46 lakes
(data commitment)

Safe data
(data sharing policy)

DATA

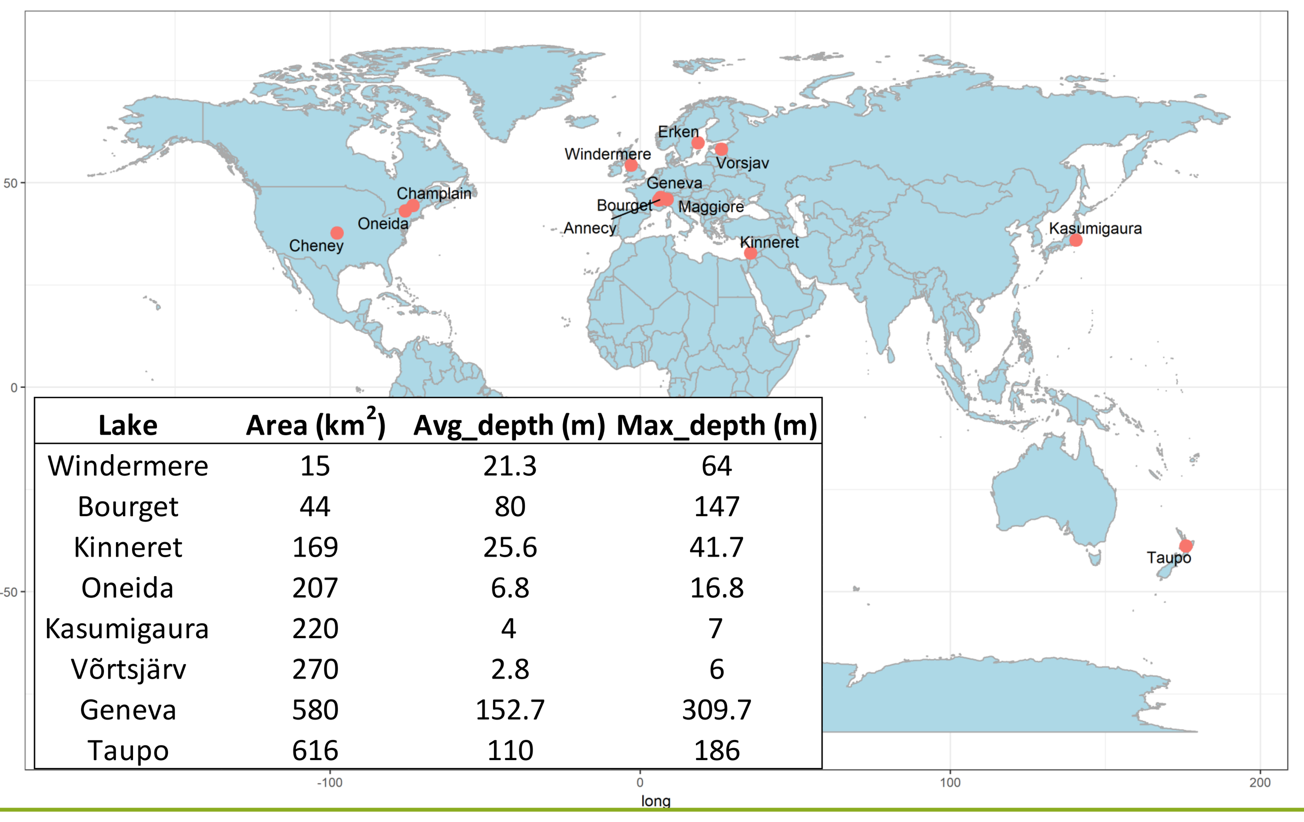
Long-term low-frequency
(min every 2 weeks, >5yrs)
Phytoplankton species abundance, nutrients, thermal profile, Secchi depth

High-frequency
Thermal and DO profiles, weather

Working Plan & Subtasks

Co-authorship & responsibilities

LARGE LAKES in GEISHA



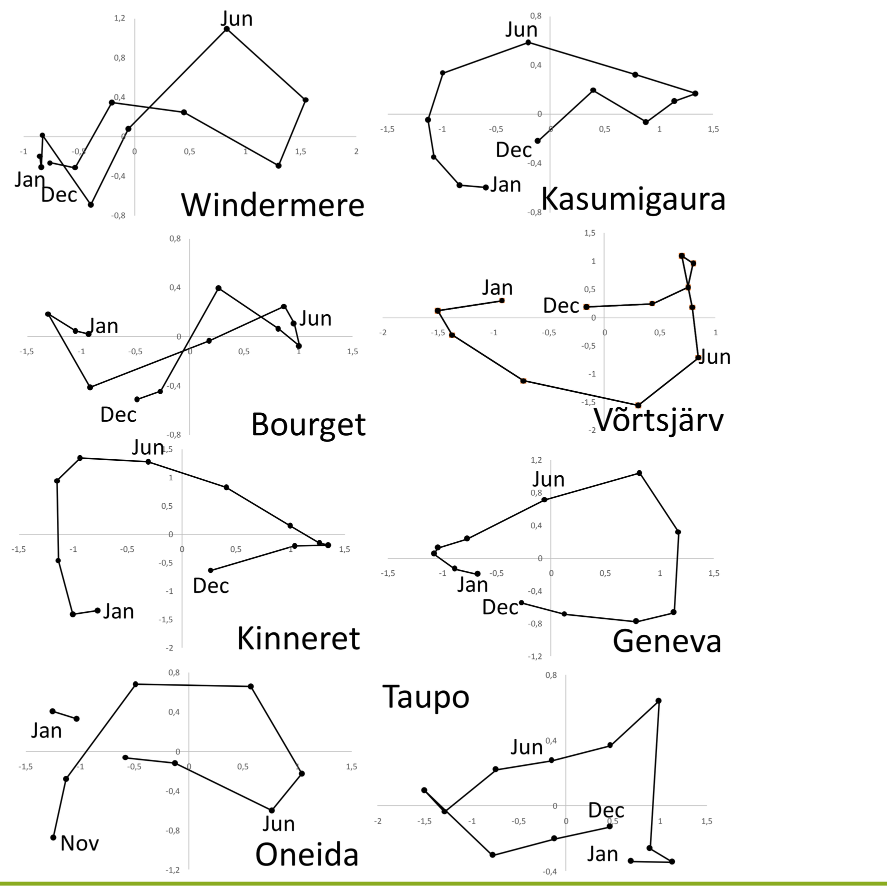
Lake	Area (km^2)	Avg_depth (m)	Max_depth (m)
Windermere	15	21.3	64
Bourget	44	80	147
Kinneret	169	25.6	41.7
Oneida	207	6.8	16.8
Kasumigaura	220	4	7
Võrtsjärv	270	2.8	6
Geneva	580	152.7	309.7
Taupo	616	110	186

WORKING HYPOTHESIS: Wind-induced mixing events select for phytoplankton species that are adapted to turbulent environments, thereby altering seasonal successions under thermally-stratified conditions.

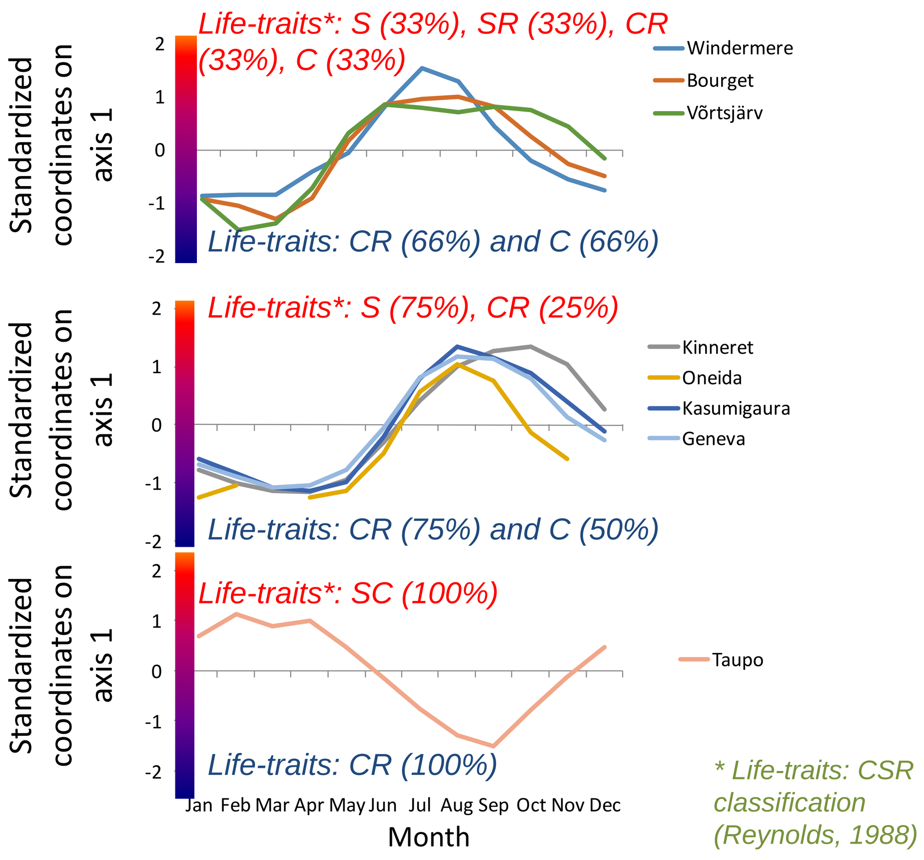
OBJECTIVE OF THE PRESENT STUDY: Better understand the contribution of storm-induced hydrographic variability of the pelagic environment to changes in taxonomic composition and seasonal succession.

METHOD
1) Within-PCA (R-package ADE) → Describe the reference annual trajectory of changes in species composition (cf. Result 1/)
2) Pearson correlations → Identify the hydrographic factors which drive the annual trajectory and its variability (cf. Result 2/)
3) Decision tree model → Evaluate the link between wind-induced changes in physical conditions and alteration in successions (cf. Result 3/)

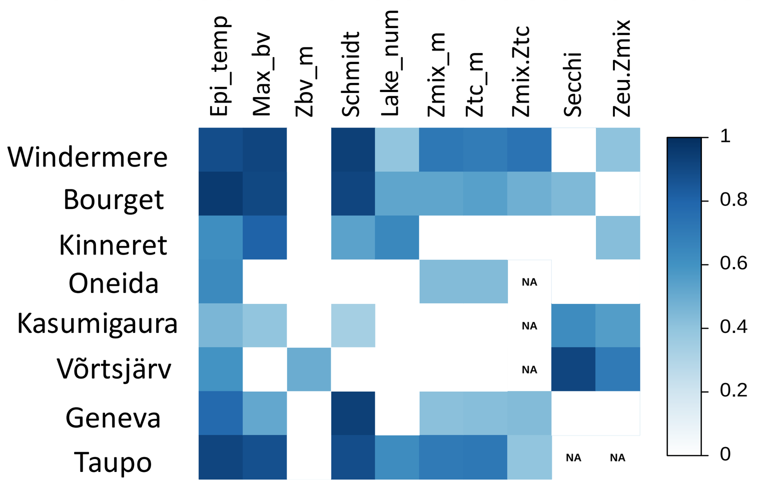
1 Average annual trajectories of phytoplankton species



Inter-lake comparisons of average annual trajectories on axis 1

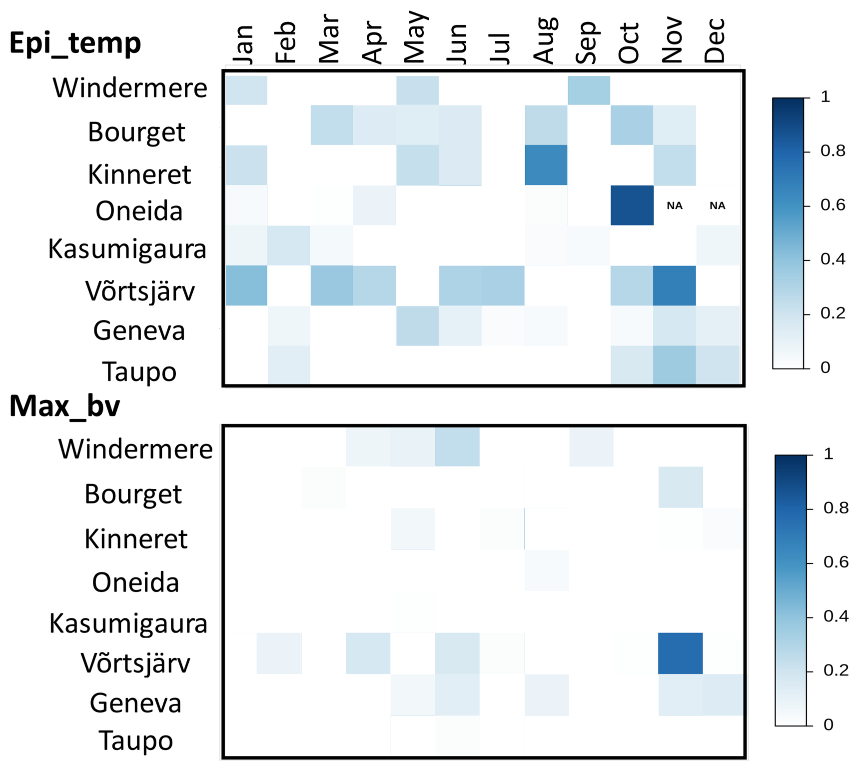


2 Drivers of annual trajectories: Correlation between derived physical variables and date coordinates, axis1



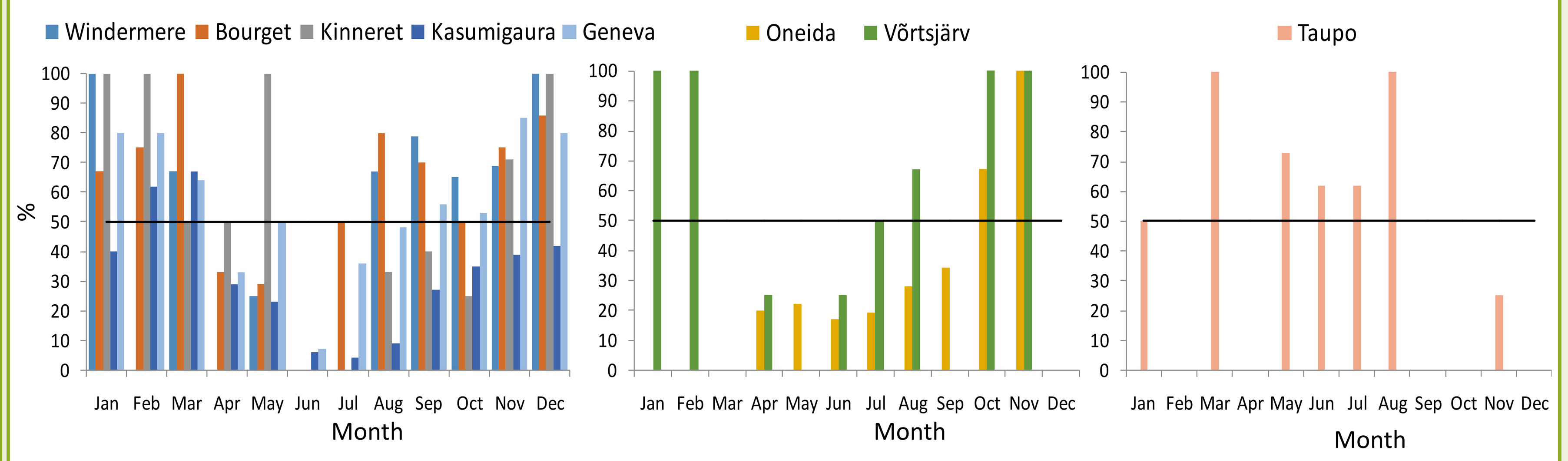
Physical variable	Notes
Epi_temp	Average temperature in the epilimnion
Max_bv	Buoyancy frequency
Zbv_m	Depth of maximum buoyancy frequency
Schmidt	Schmidt stability
Lake_num	Lake number
Zmix_m	Mixing depth
Ztc_m	Thermocline depth
Zmix.Ztc	Ratio of the mixing depth to thermocline depth
Secchi	Secchi disk depth
Zeu.Zmix	Ratio of photic zone depth to mixing depth

Within-month drivers : Correlation between derived physical variables and date coordinates, axis1



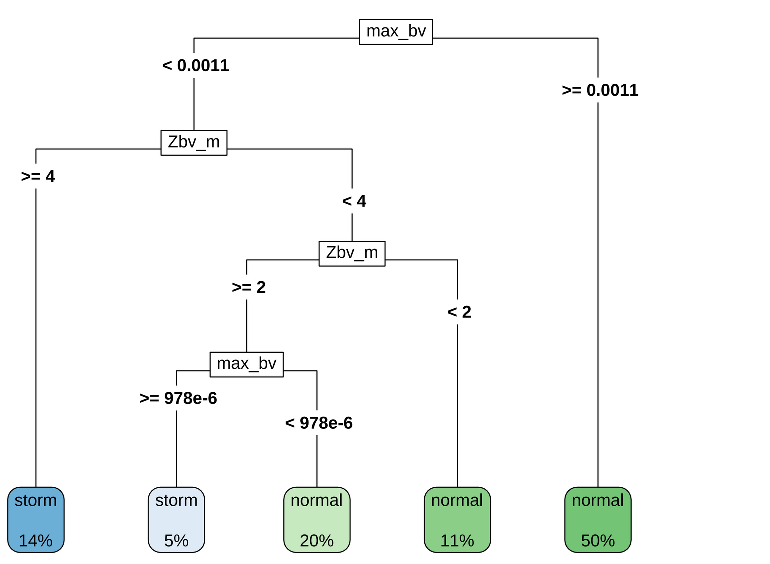
3 Percentage of « Storm events »* after which the phytoplankton annual trajectory was disturbed and returned to a community composition characterized by species presenting life-traits of CR and R strategists

** Storm events: meteorologically-induced events which result in a decrease in Max_bv and increase in Zbv_m*

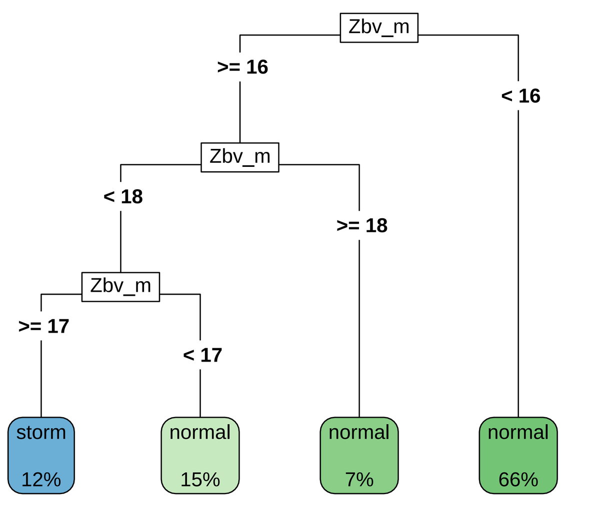


Decision tree models provided thresholds for Max_bv and Zbv_m which were likely to disturb annual trajectory and promote the develpment of CR and R strategists species

Kasumigaura (May-August)



Kinneret (May-August)



Accuracy table shows the percentage of matches between the observed and the predicted storm

Lake	Accuracy	Lake	Accuracy
Windermere	0.88	Geneva	0.71
Kinneret	0.81	Oneida	0.7
Taupo	0.78	Võrtsjärv	0.69
Bourget	0.73	Kasumigaura	0.68

CONCLUSIONS: i) Water stability: important driver of seasonal changes in most of the lakes – ii) Drivers of within-month variability are month and lake dependent – iii) Decrease in stability and depth of maximum buoyancy frequency is likely to set back community to a previous stage, especially when summer community is not well established

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1 - INRA, UMR CARRTEL, France, 2- Rubenstein Ecosystem Science Laboratory, University of Vermont, USA, 3- US Geological Survey, University of Alaska Fairbanks, USA, 4- Research Center for Environmental Changes, Academia Sinica, Taiwan, 5- National Central University, Taiwan, 6- Creative Science Course (Geosciences), Faculty of Science, Shizuoka University, Japan, 7- Estonian University of Life Sciences, Estonia, 8- Kinneret Limnological Laboratory, Israel Oceanographic & Limnological Research, 9- Ontario Ministry of the Environment and Climate Change, Canada, 10- Center for Environmental Biology & Ecosystem Studies, National Institute for Environmental Studies, Japan, 11- National Institute of Water and Atmospheric Research, New Zealand, 12- Department F.-A. Forel for Environmental and Aquatic Sciences, University of Geneva, Switzerland., 13- Centre for Ecology & Hydrology, UK, 14- Cornell Univeristy, USA, 15 - GEISHA/Storm-blitz contributors: http://www.geisha-stormblitz.fr/