

# Underwater light field changes in Pärnu Bay influenced by weather phenomena and captured by Sentinel-3

K. Uudeberg, M. Uusõue, A. Aavaste,  
T. Soomets, K. Toming, A. Noorma

INSTITUTE FOR ENVIRONMENTAL SOLUTIONS



UNIVERSITY OF TARTU  
Tartu Observatory

**TAL  
TECH**



UNIVERSITY OF TARTU  
Estonian Marine Institute



BY

# Climate change effects

In the Pärnu Bay region (Baltic Sea), climate change is predicted to mean less ice cover, warmer temperatures, eutrophication, more precipitations and a slight increase in average wind speed; furthermore, extreme climatic events such as heavy rains, strong winds and storms will be more intense and frequent.

## STUDY QUESTIONS

What is the spatial and temporal scope of changes in water quality parameters captured by Sentinel-3 OLCI in Pärnu Bay?

What 30-year long *in situ* data tells about changes in Pärnu Bay?

How this impacts underwater light field?

How this can affect fishes?



# Pärnu Bay, the Baltic Sea

Pärnu

population 39 438

Area 400 km<sup>2</sup>

Mean depth 4.7 m  
(max 8 m)



Pärnu River

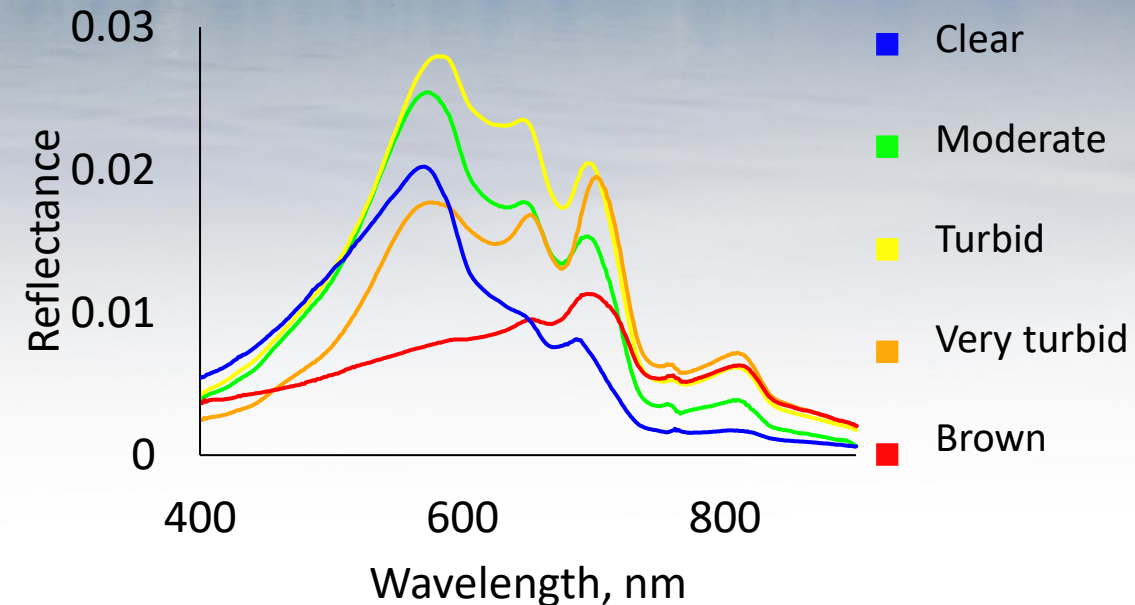


Sandy beaches and 800 fishermen



# Sentinel-3 OLCI images processing steps

1. Sentinel-3 OLCI Level 1 images were used.
2. Water-leaving reflectance was derived using C2RCC atmospheric correction processor.
3. Classification of optical water type (OWT) for inland and coastal waters were applied.
4. OWT guided approach was used to estimate water quality parameters.



Uudeberg, K.; Ansko, I.; Põru, G.; Ansper, A.; Reinart, A. Using Optical Water Types to Monitor Changes in Optically Complex Inland and Coastal Waters. *Remote Sens.* **2019**, *11*, 2297.

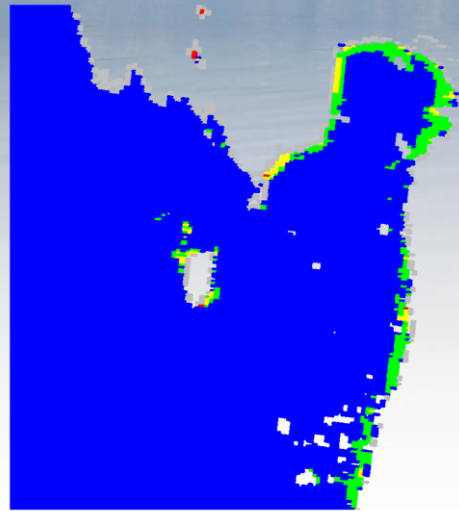
Uudeberg, K.; Aavaste, A.; Kõks, K.-L.; Ansper, A.; Uusõue, M.; Kangro, K.; Ansko, I.; Ligi, M.; Toming, K.; Reinart, A. Optical Water Type Guided Approach to Estimate Optical Water Quality Parameters. *Remote Sens.* **2020**, *12*, 931.





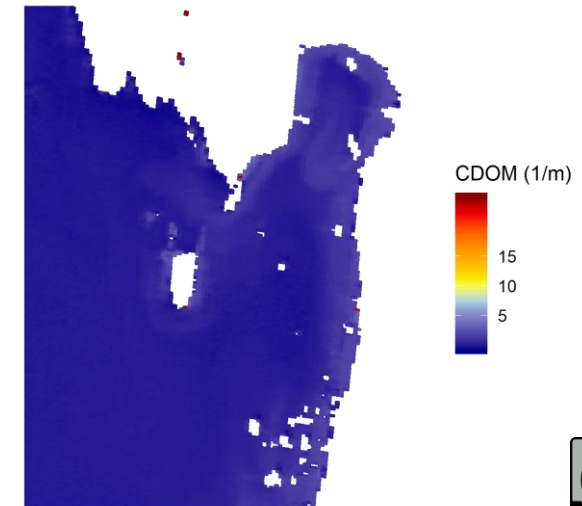
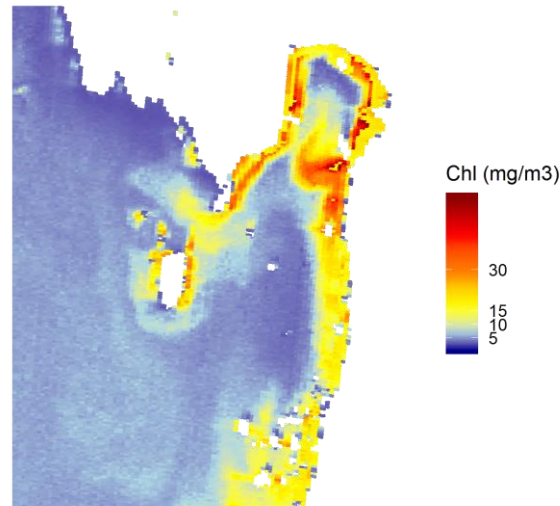
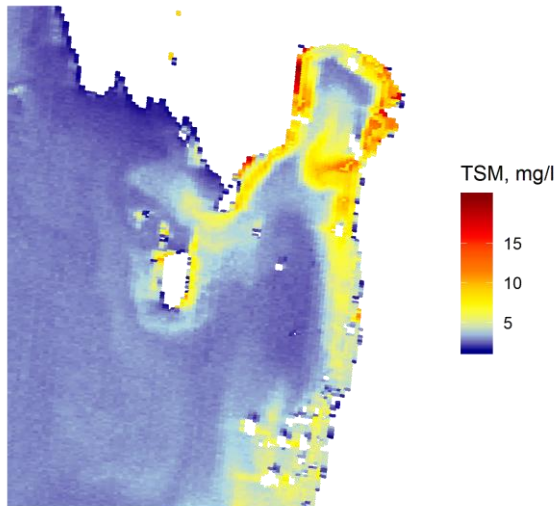
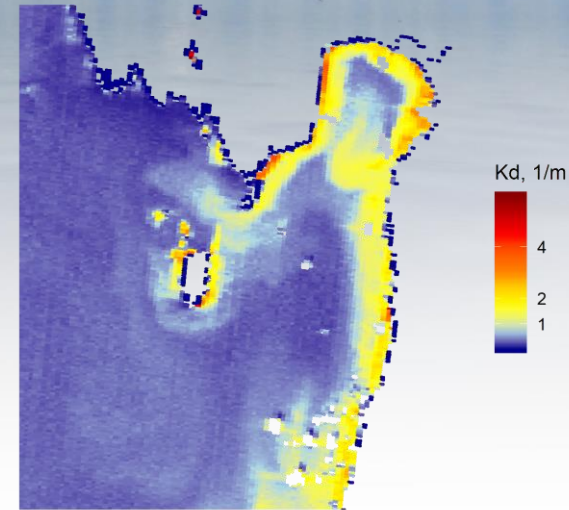
# Pärnu Bay during calm weather period

27.07.2019



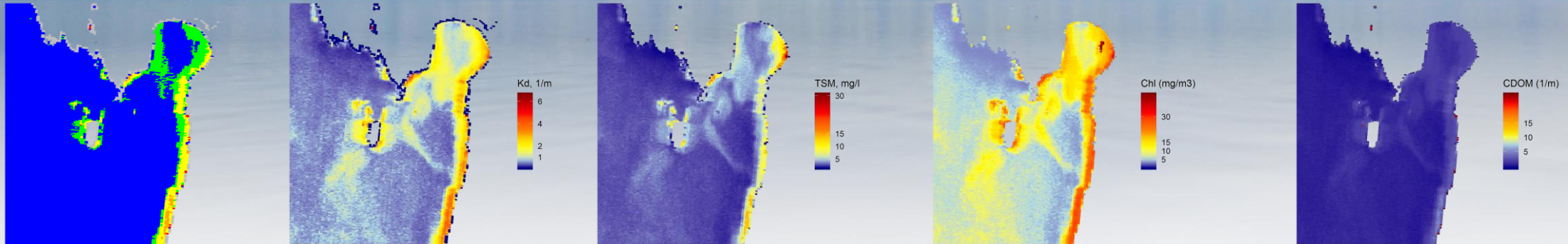
OWT

- Clear
- Moderate
- Turbid
- Very Turbid
- Brown



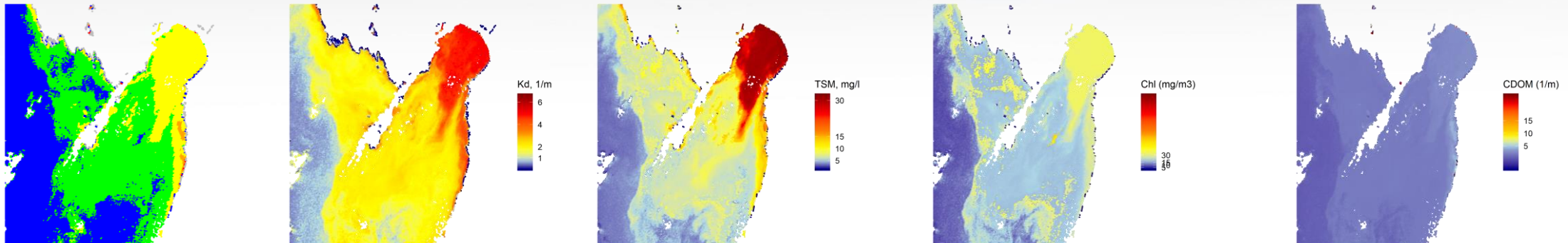
# Pärnu Bay influenced by strong wind

17.06.18

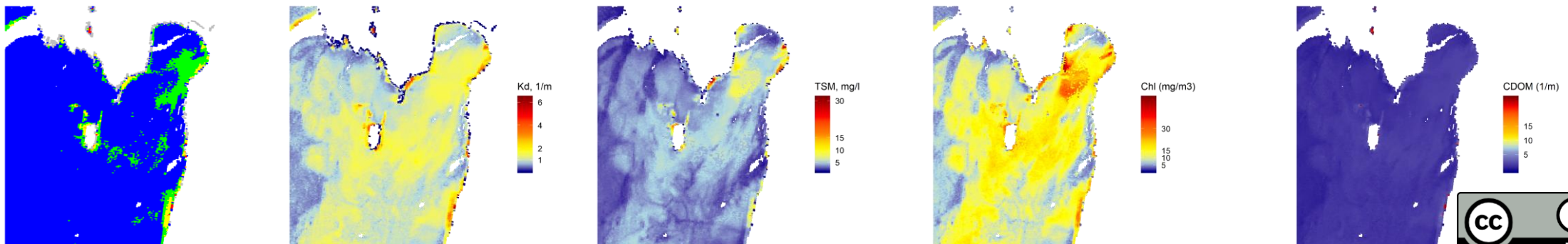


22.06.18 strong wind in Pärnu Bay: day average wind speed 11.2 m/s and the gust over 21 m/s.

23.06.18

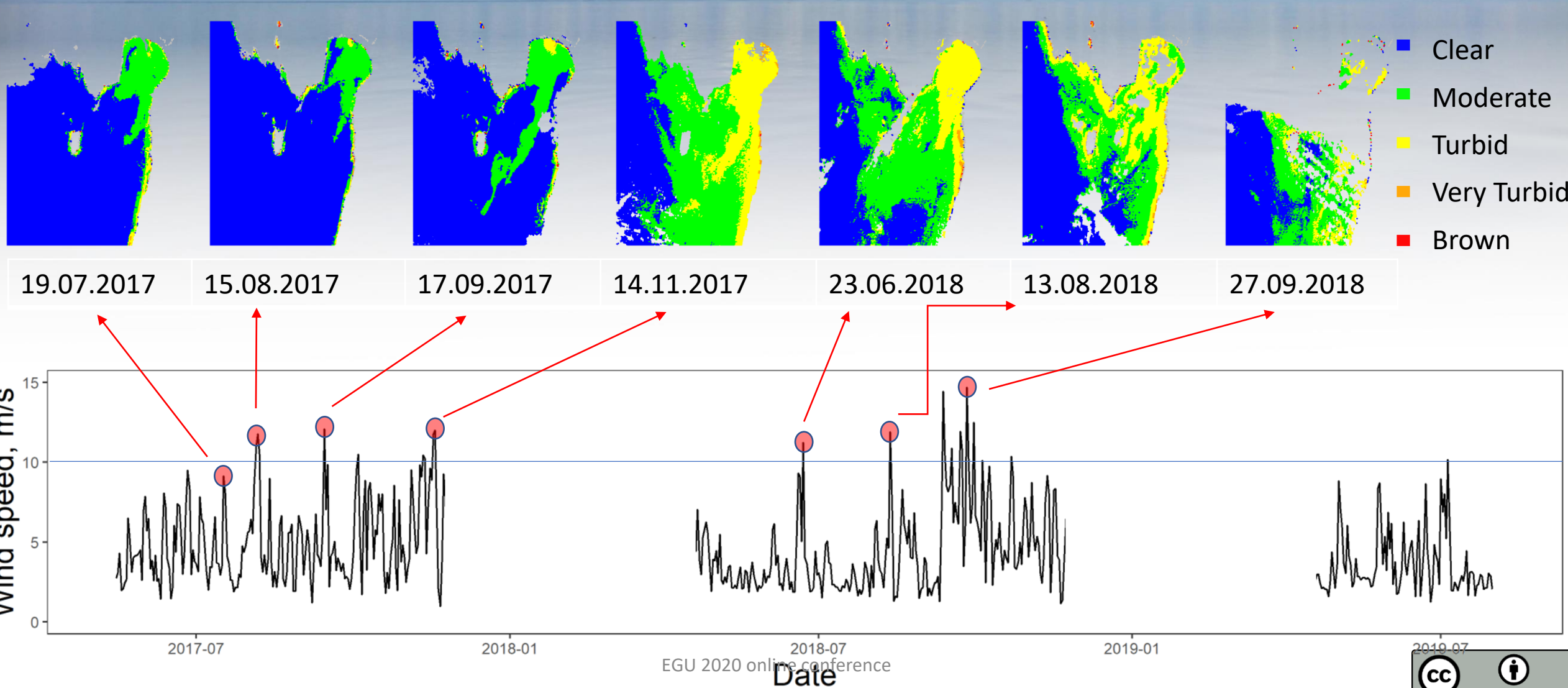


28.06.18

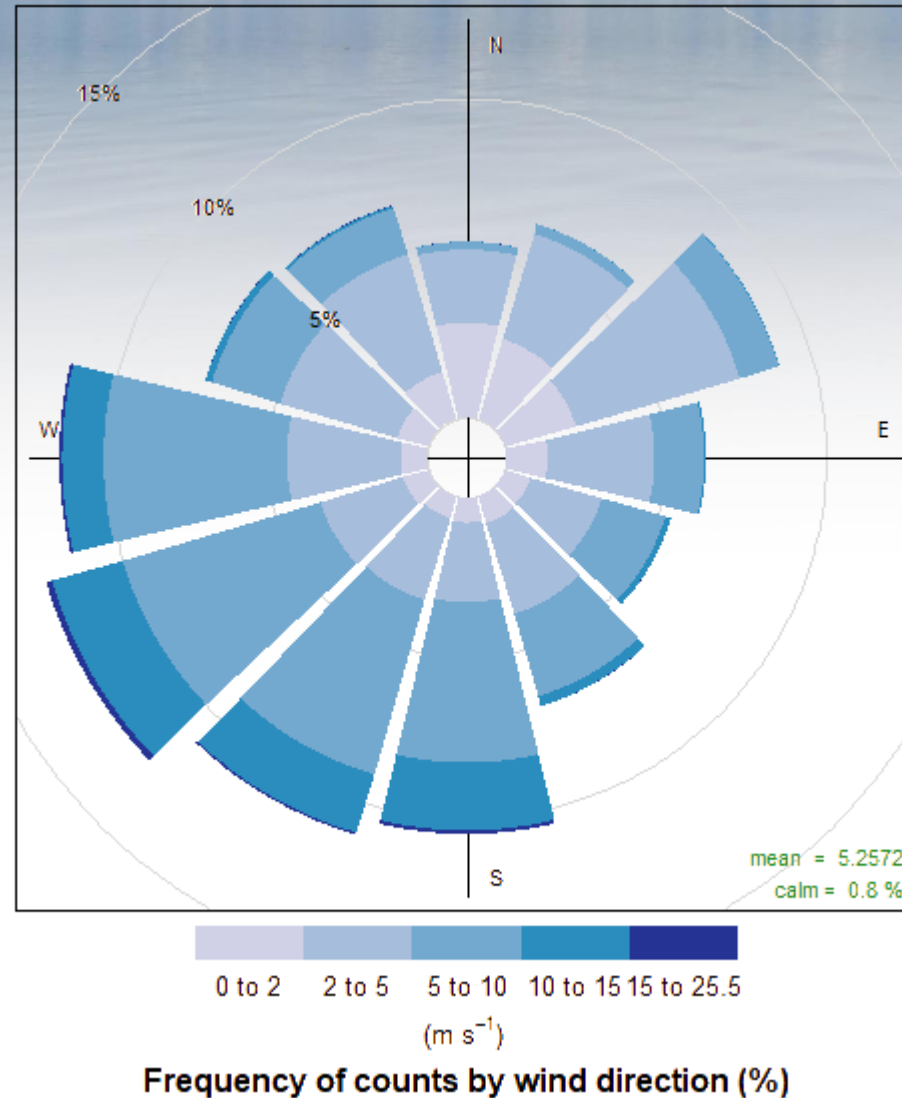




# Strong wind effects captured by OLCI

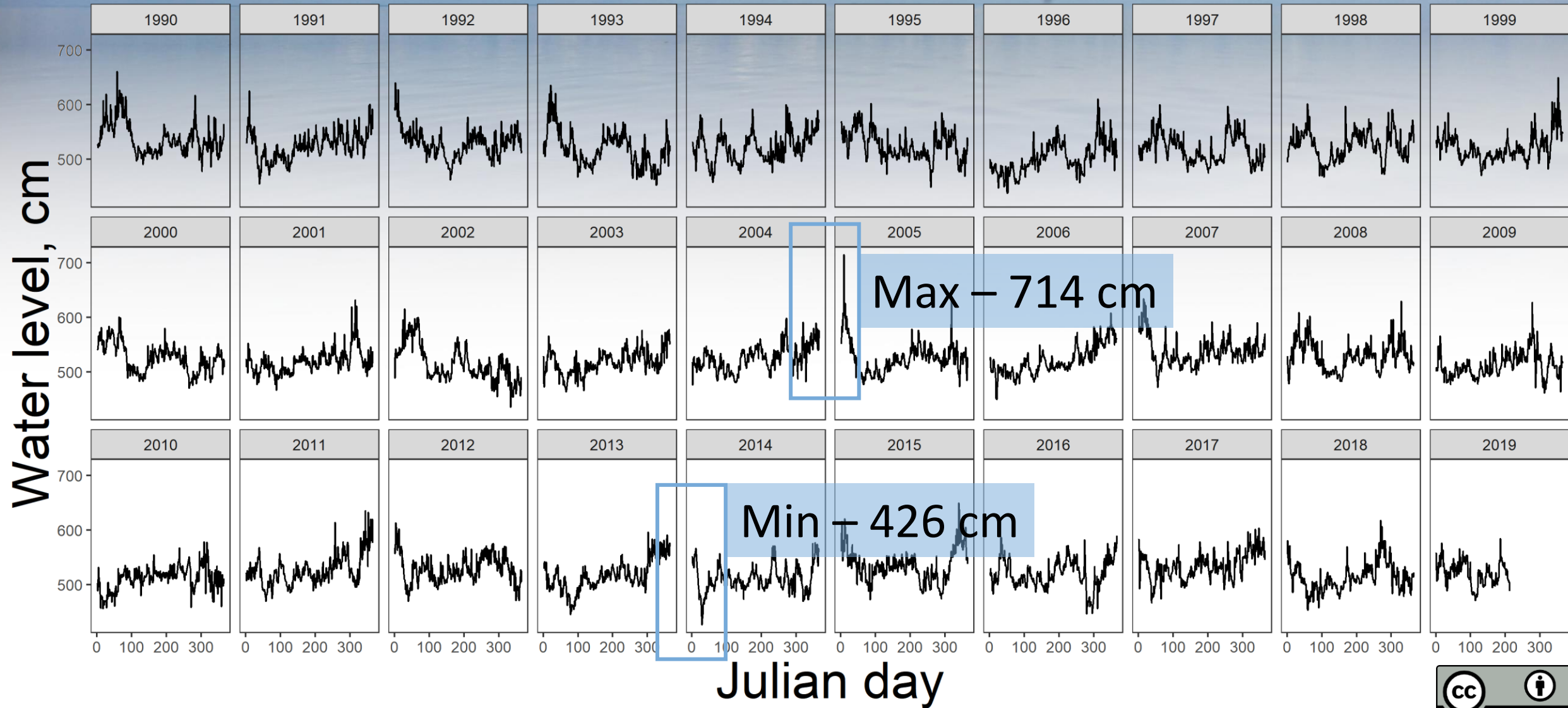


# SW wind dominate Pärnu Bay

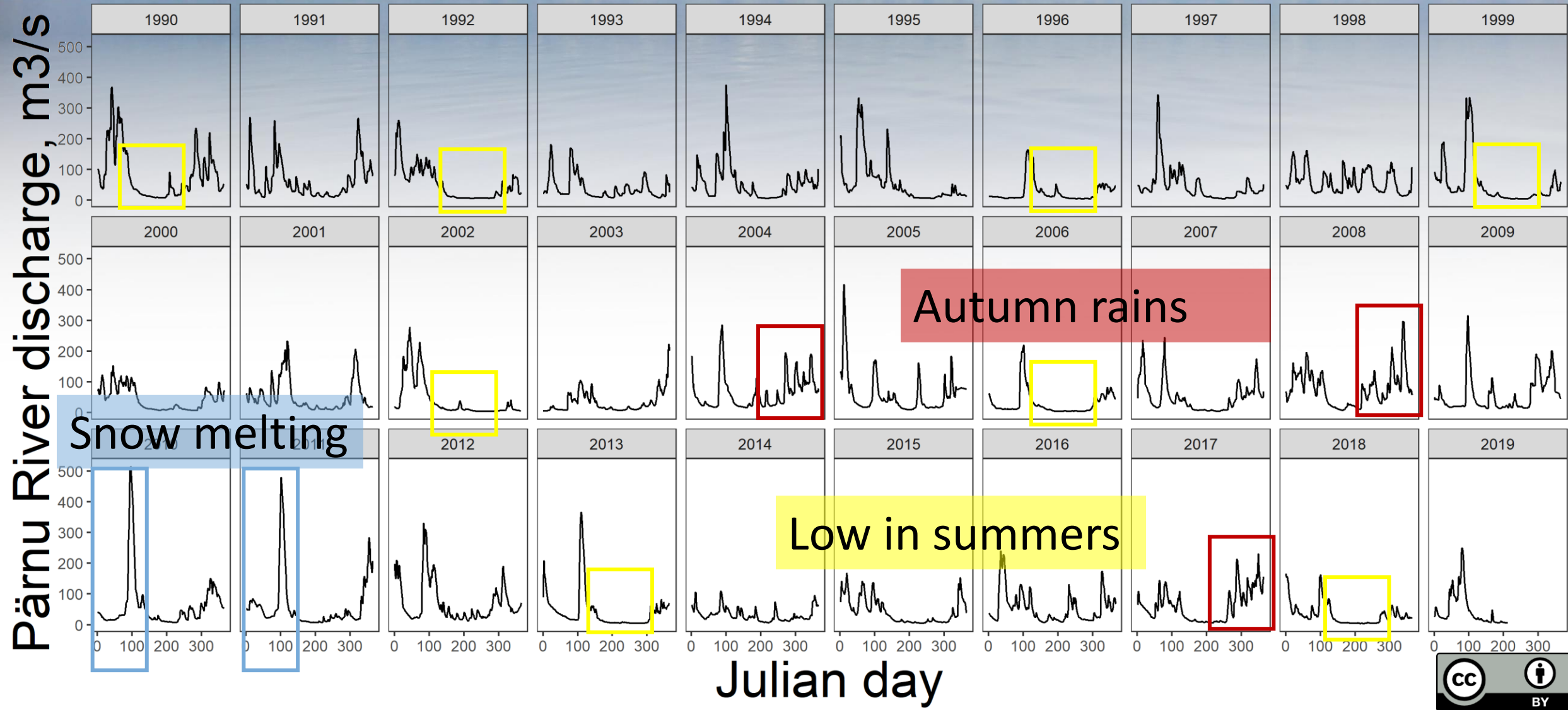




# Waterlevel changes without pattern

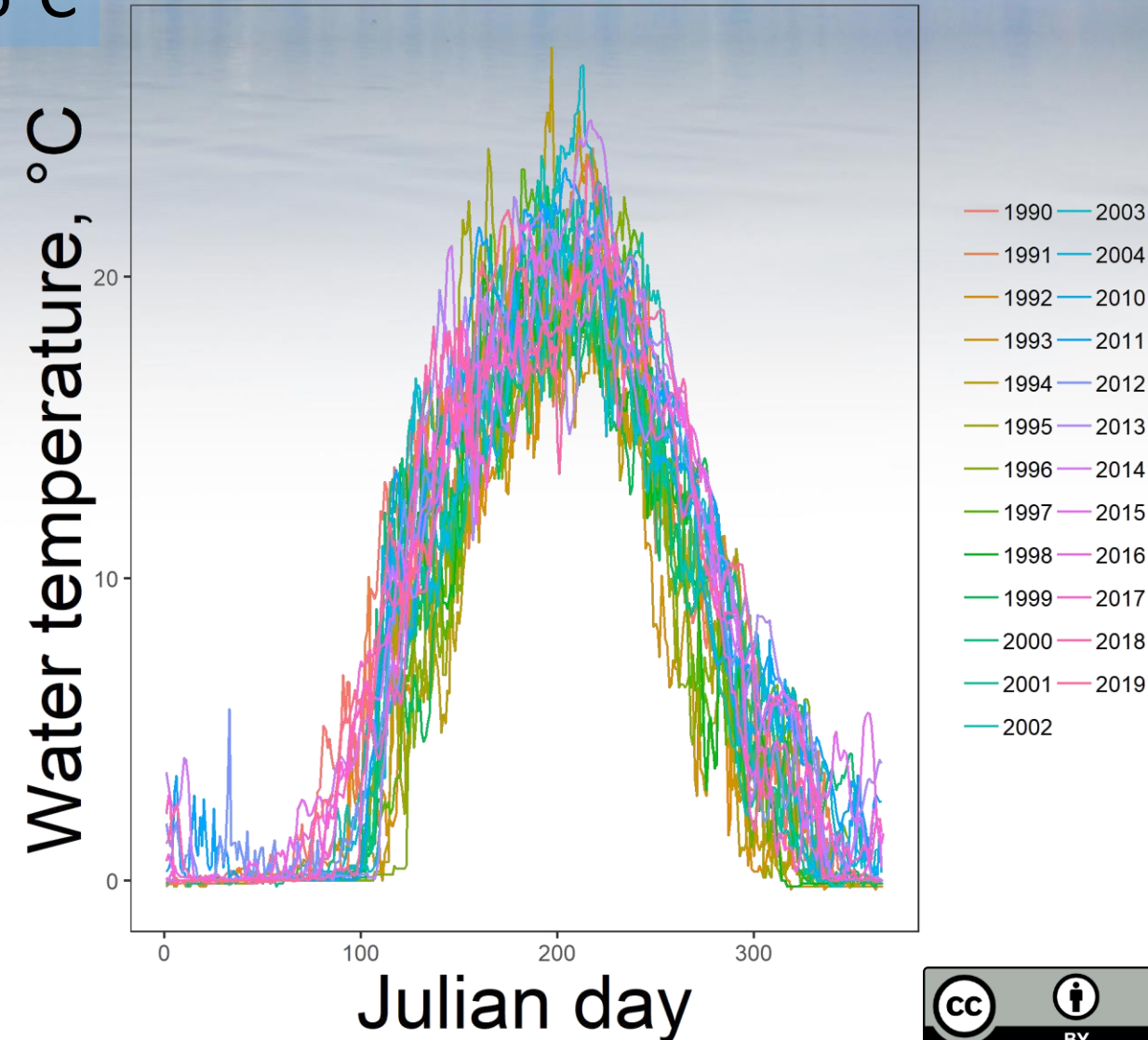
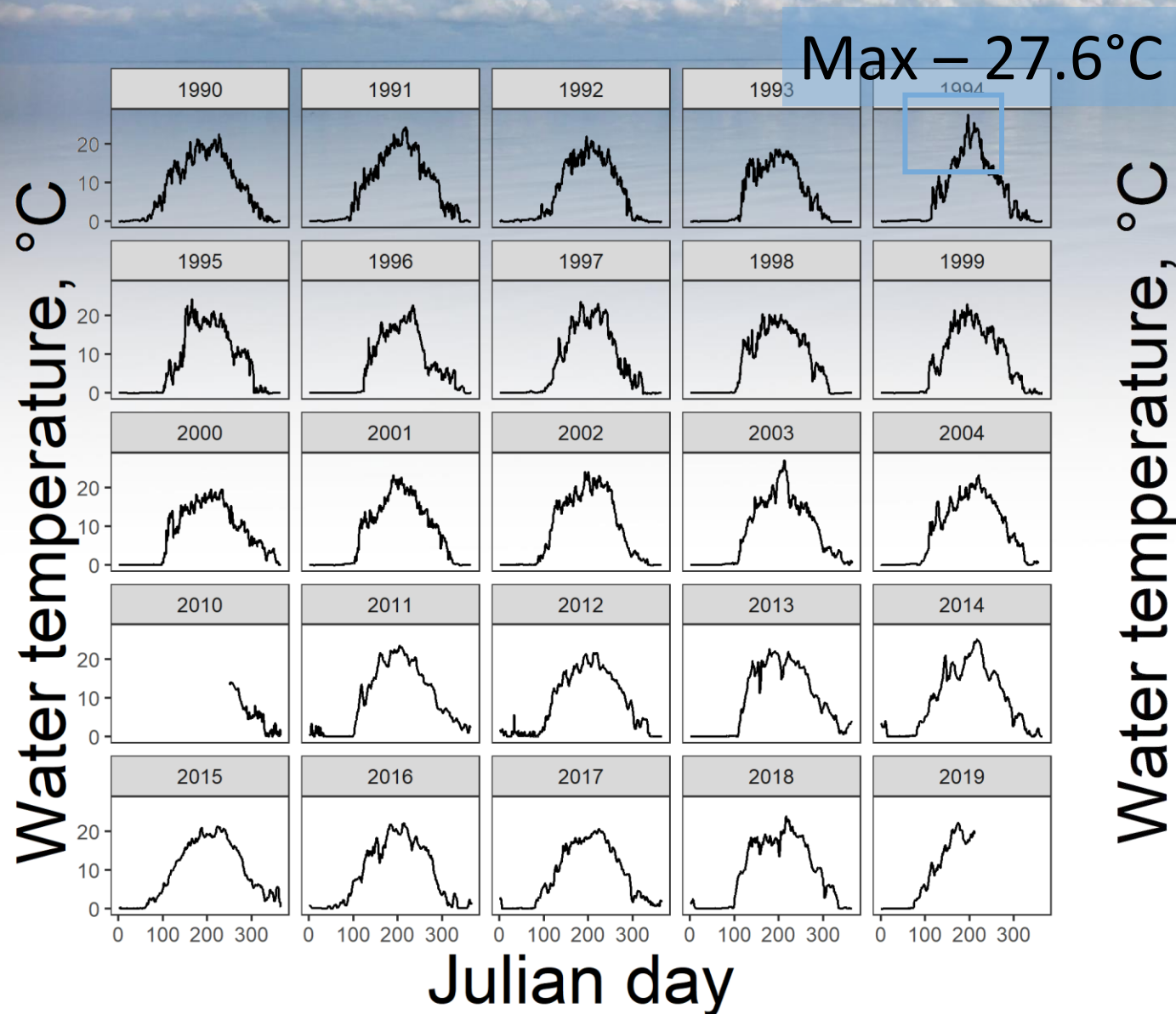


# Pärnu River discharge

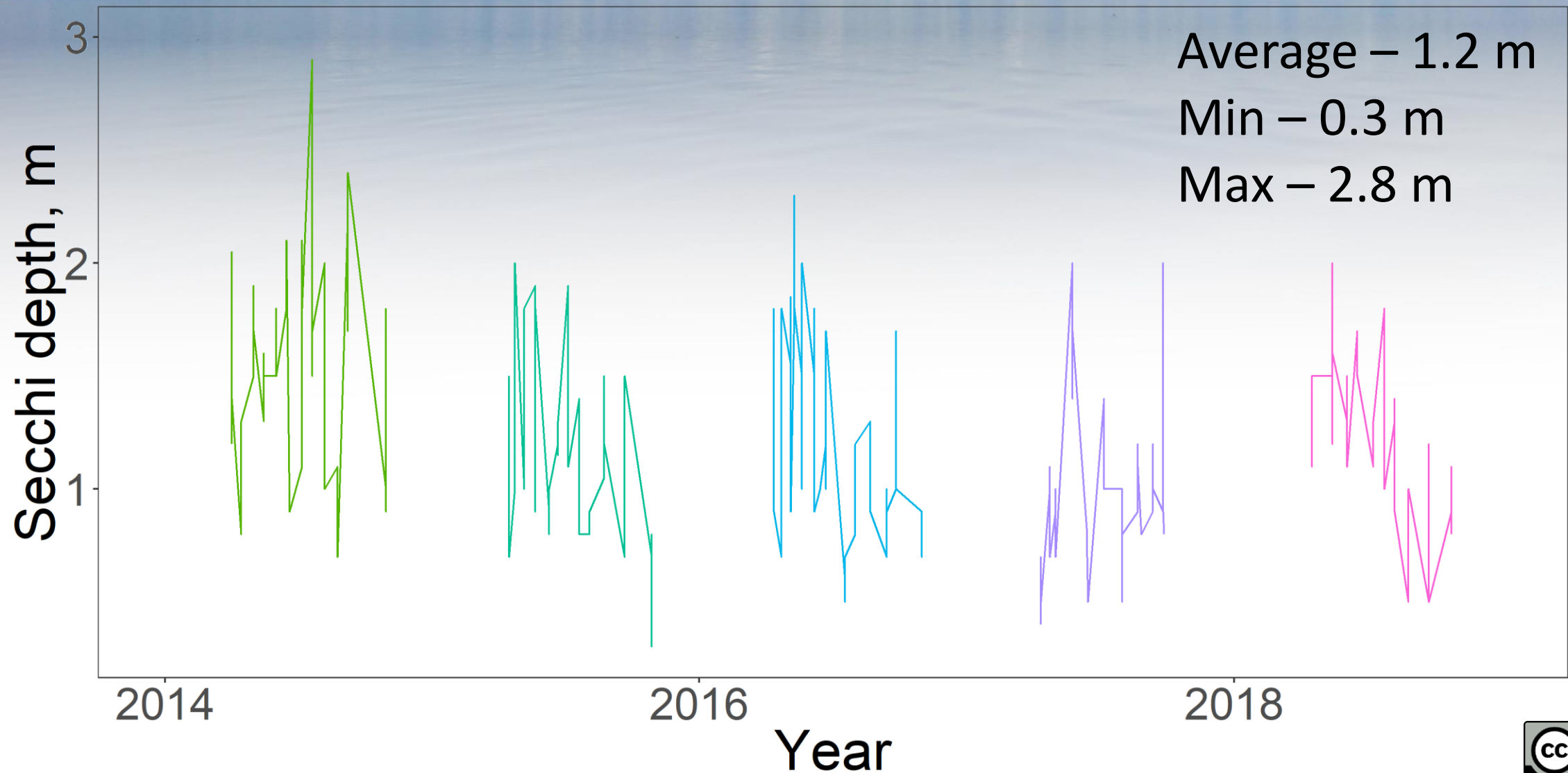




# Water warms up earlier and cools down later



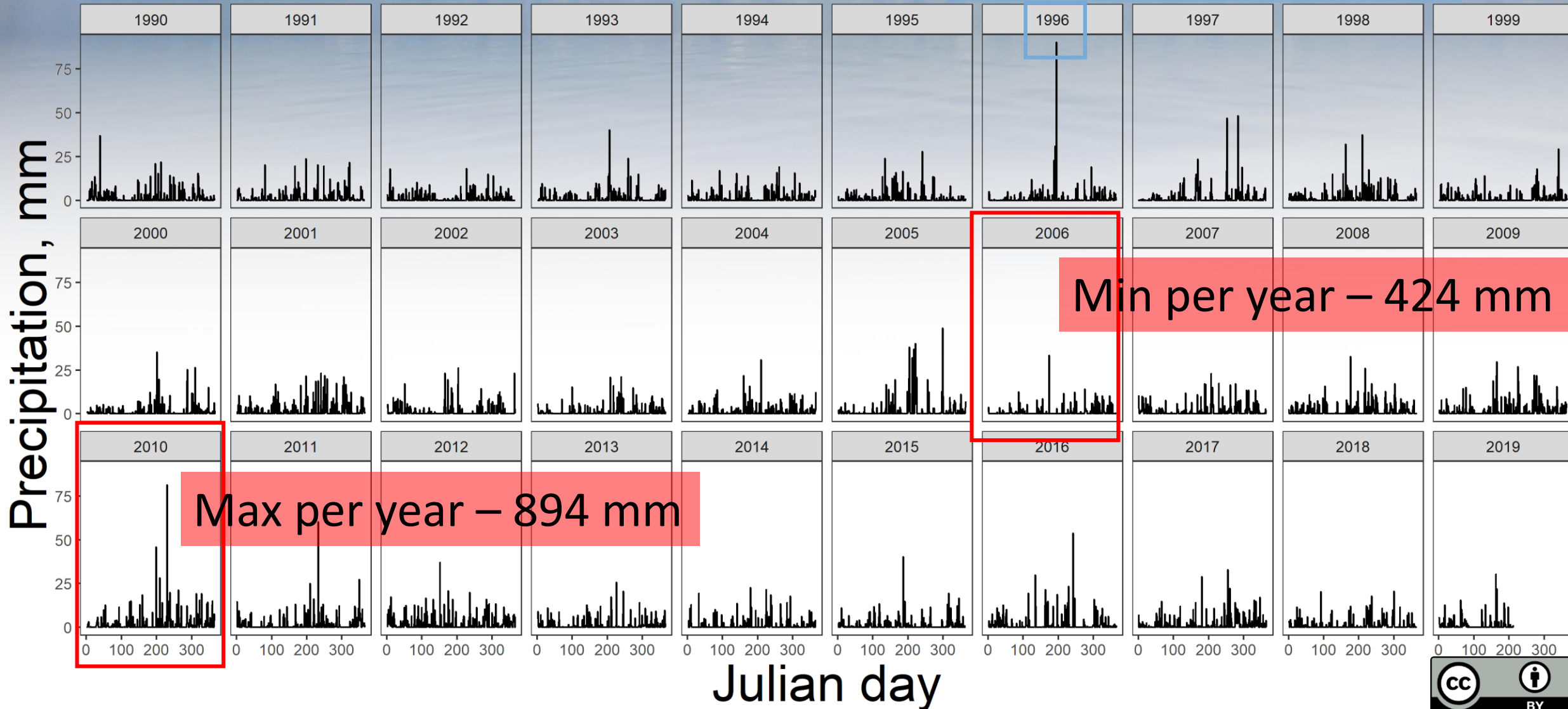
# Secchi depth slightly decreasing



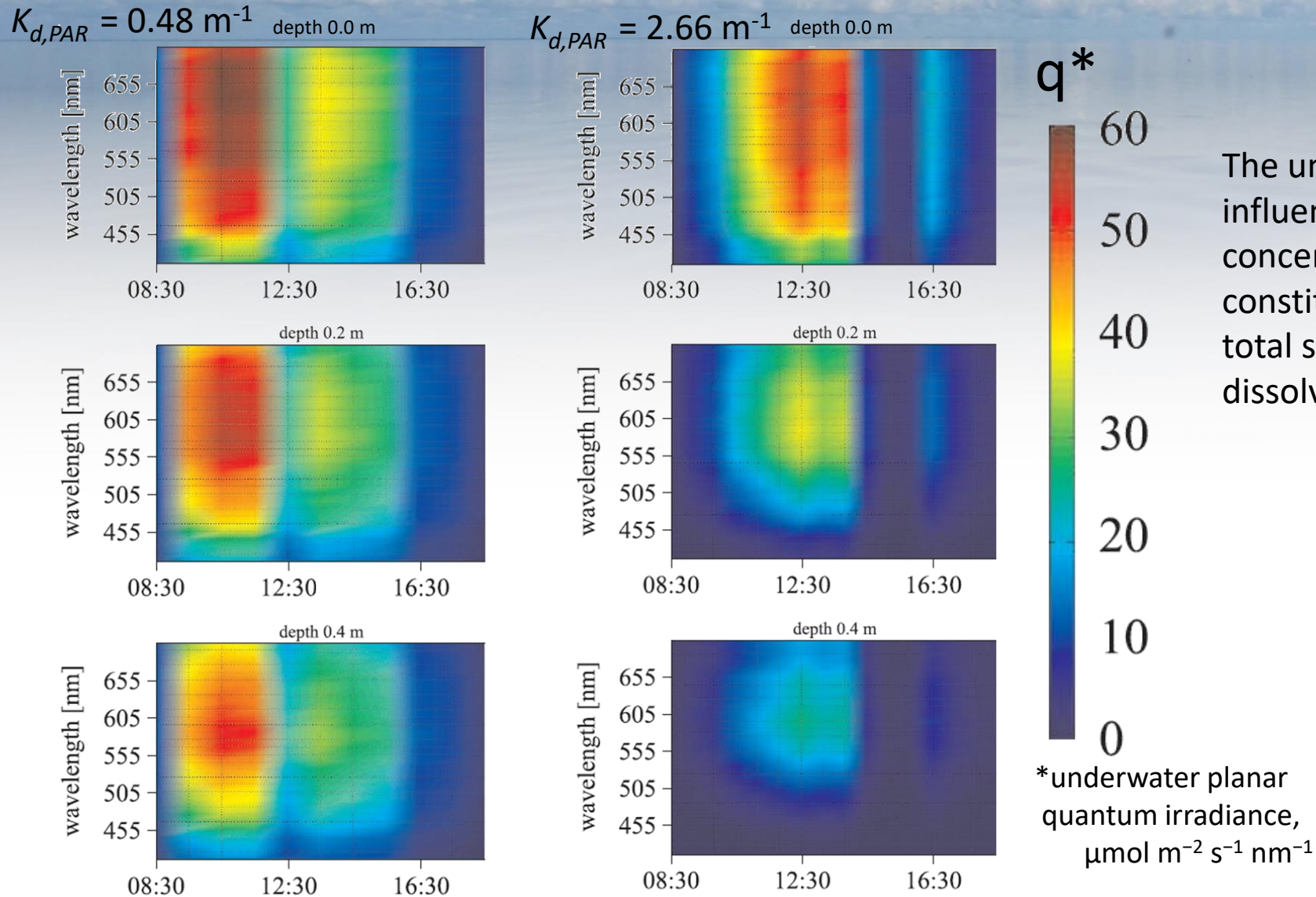


# Extreme precipitation has not increased

Max per day – 90.3 mm



# Underwater light field strongly influenced



The underwater light field is strongly influenced by changes of concentrations of optically significant constituents, such as phytoplankton, total suspended matter and coloured dissolved organic matter.



# Fishes in Pärnu Bay

Water transparency decreases

may shift from visual predators to tactical predators

increase interbreeding

loss in diversity

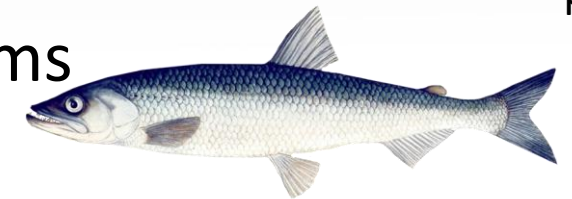
increasing difficulty to return their spawning streams



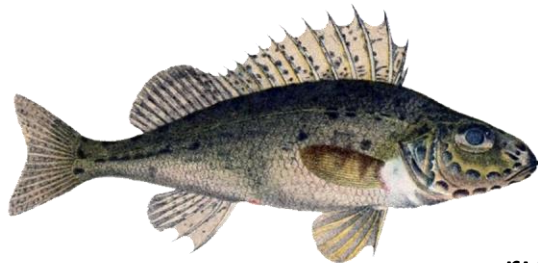
herring



perch



smelt



ruff



bream



pikeperch

# Thank you!

kristi.uudeberg@ut.ee

This work was supported by the Estonian Research Council grant (PSG10) and European Union's Horizon 2020 research and innovation programme (grant agreement n° 730066) and ERDF, Latvian state budget and IES proposal No.1.1.1.2/VIAA/1/16/137, Contract No. 1.1.1.2/16/I/001 *"Innovative tool for lake monitoring using remote sensing data"*.

Estonian Environment Agency and monitoring programs.



EOMORES

