

5th Workshop on Parameterization of Lakes in Numerical Weather Prediction and Climate Modelling

18. October 2017

Effects of Groundwater Discharge on mixis of Lake Steisslingen

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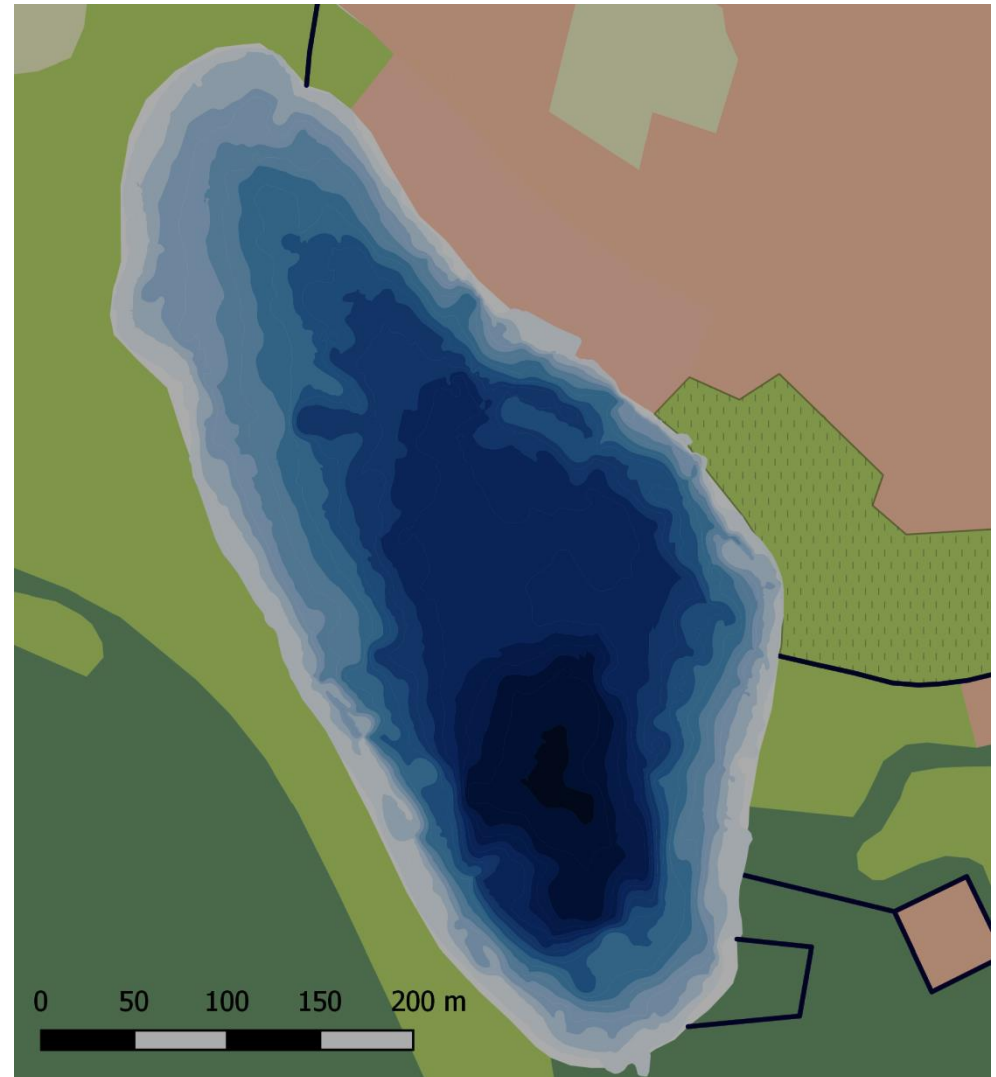
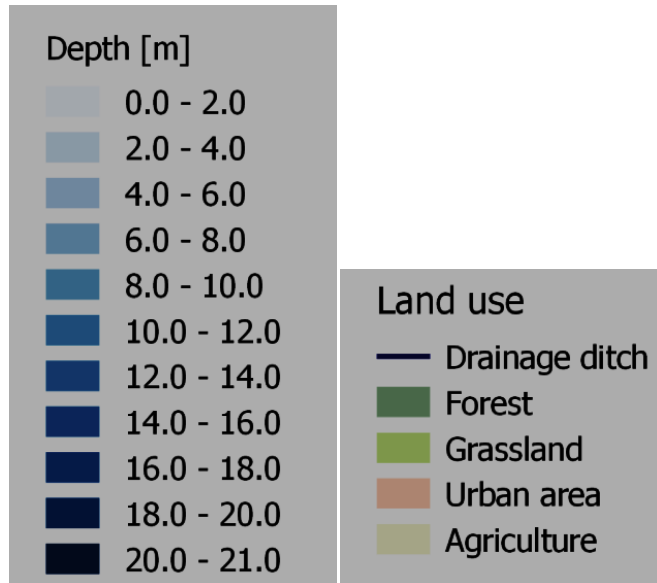


Image IBCAO
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image U.S. Geological Survey.
Image Landsat / Copernicus

Google Earth

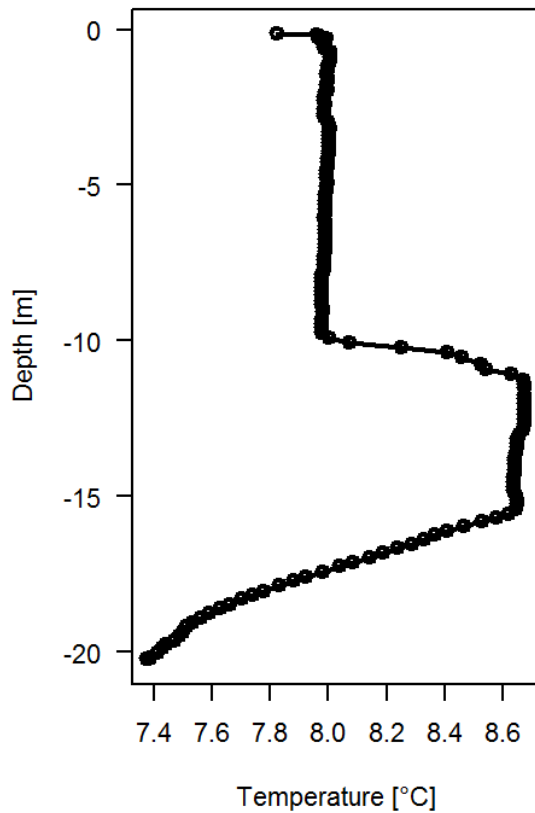
Lake Steisslingen

Area: ~ 10 ha
Max Depth: 21 m
Trophy: mesotrophic
Formation: death ice hole

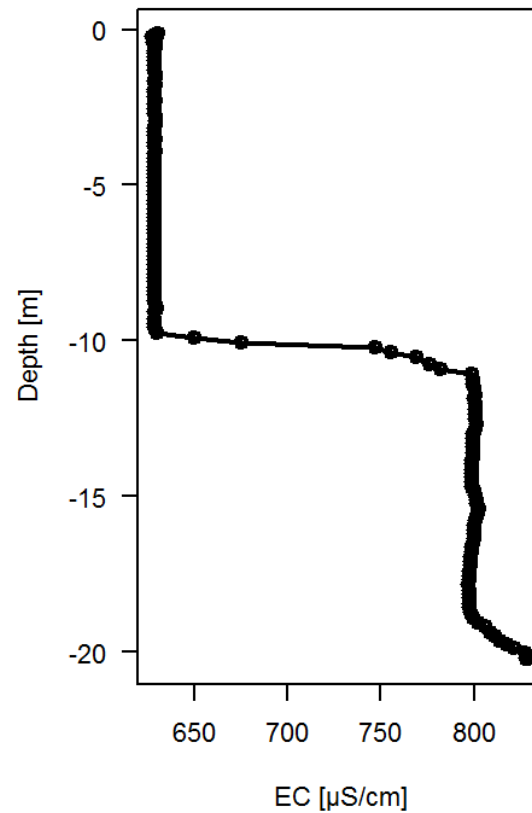


CTD Profile 8. December 2014

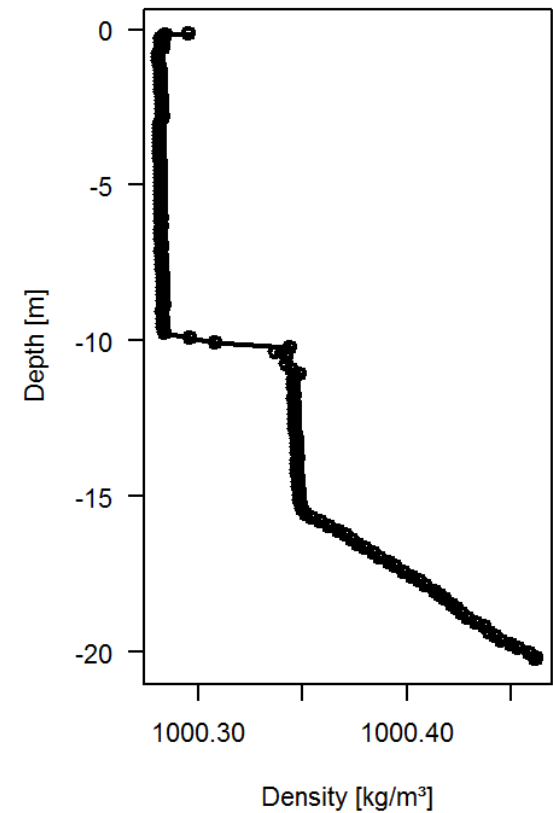
Temperature [°C]



EC [μS/cm]

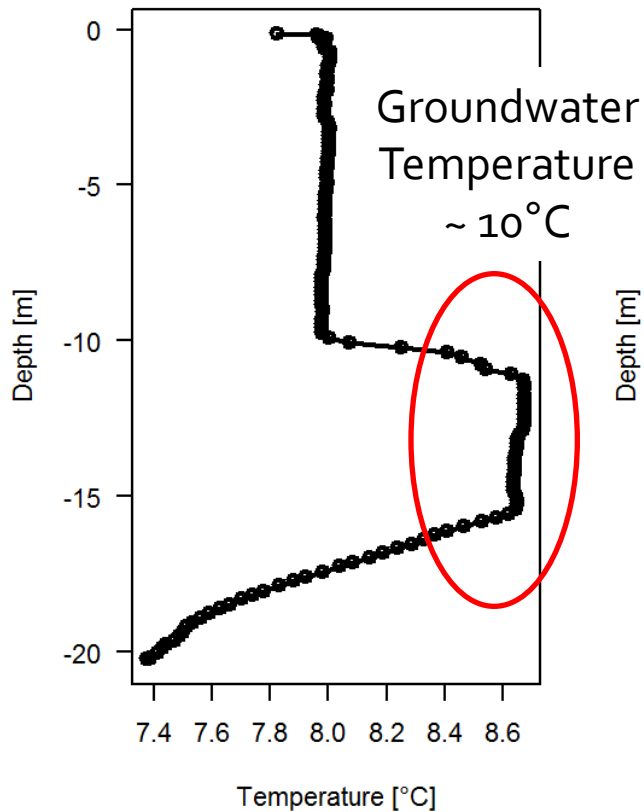


Density [kg/m³]

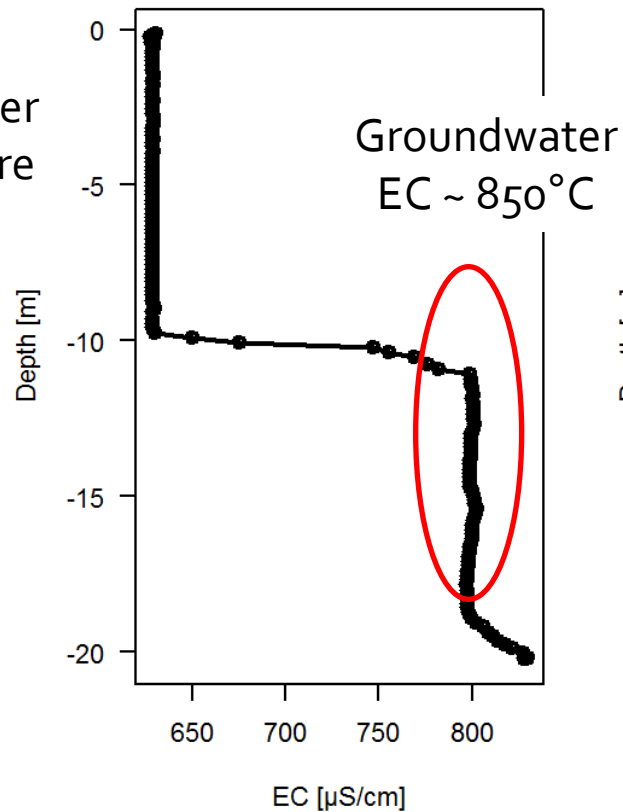


CTD Profile 8. December 2014

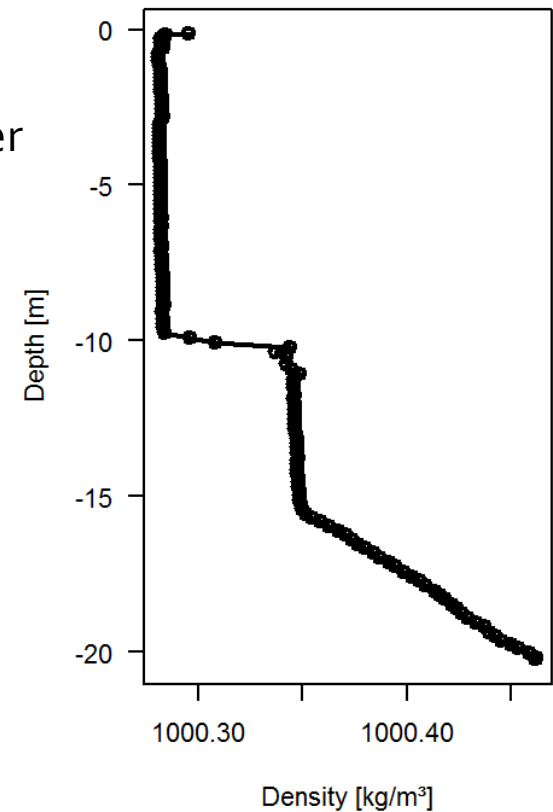
Temperature [°C]



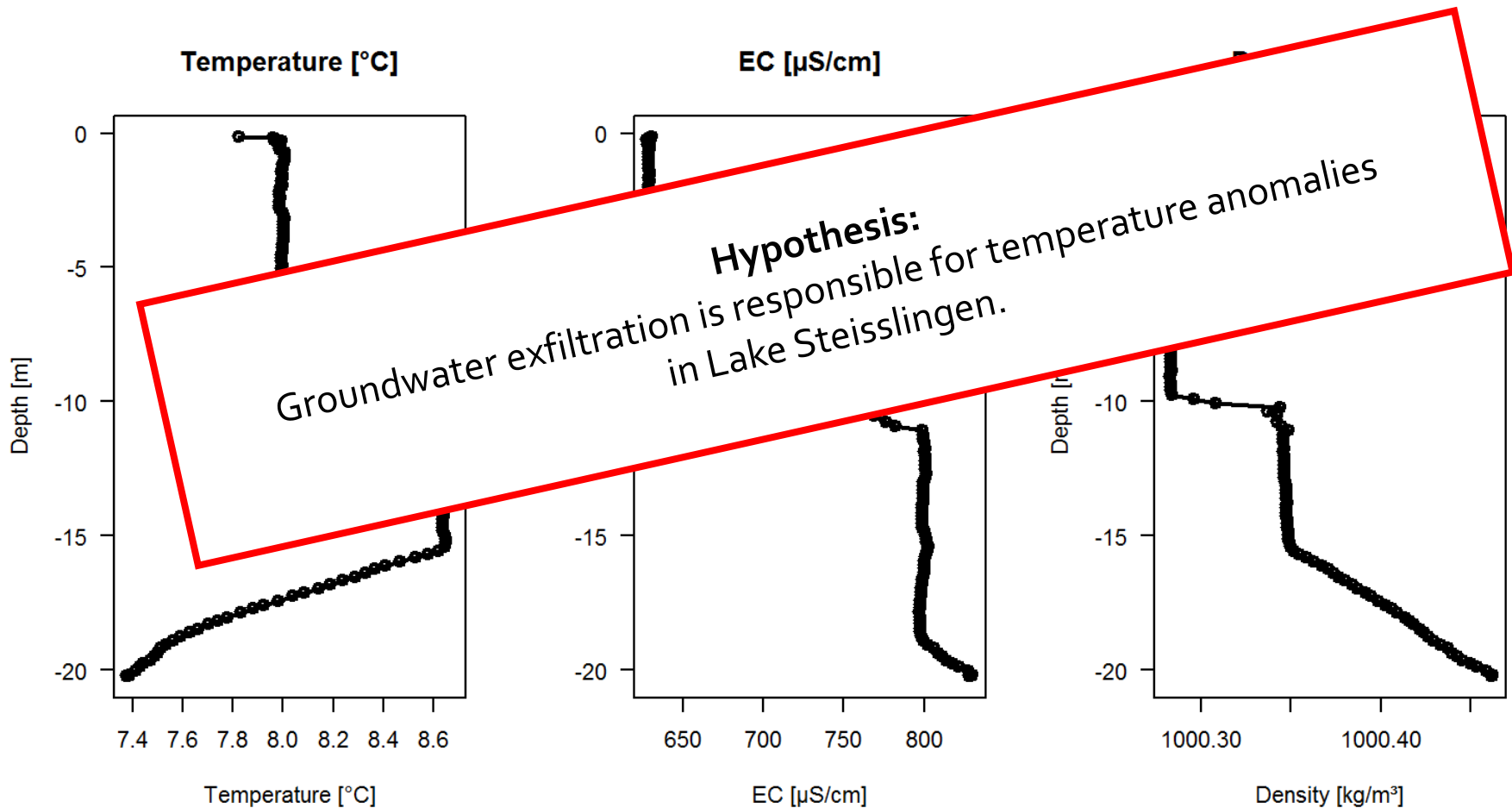
EC [μS/cm]

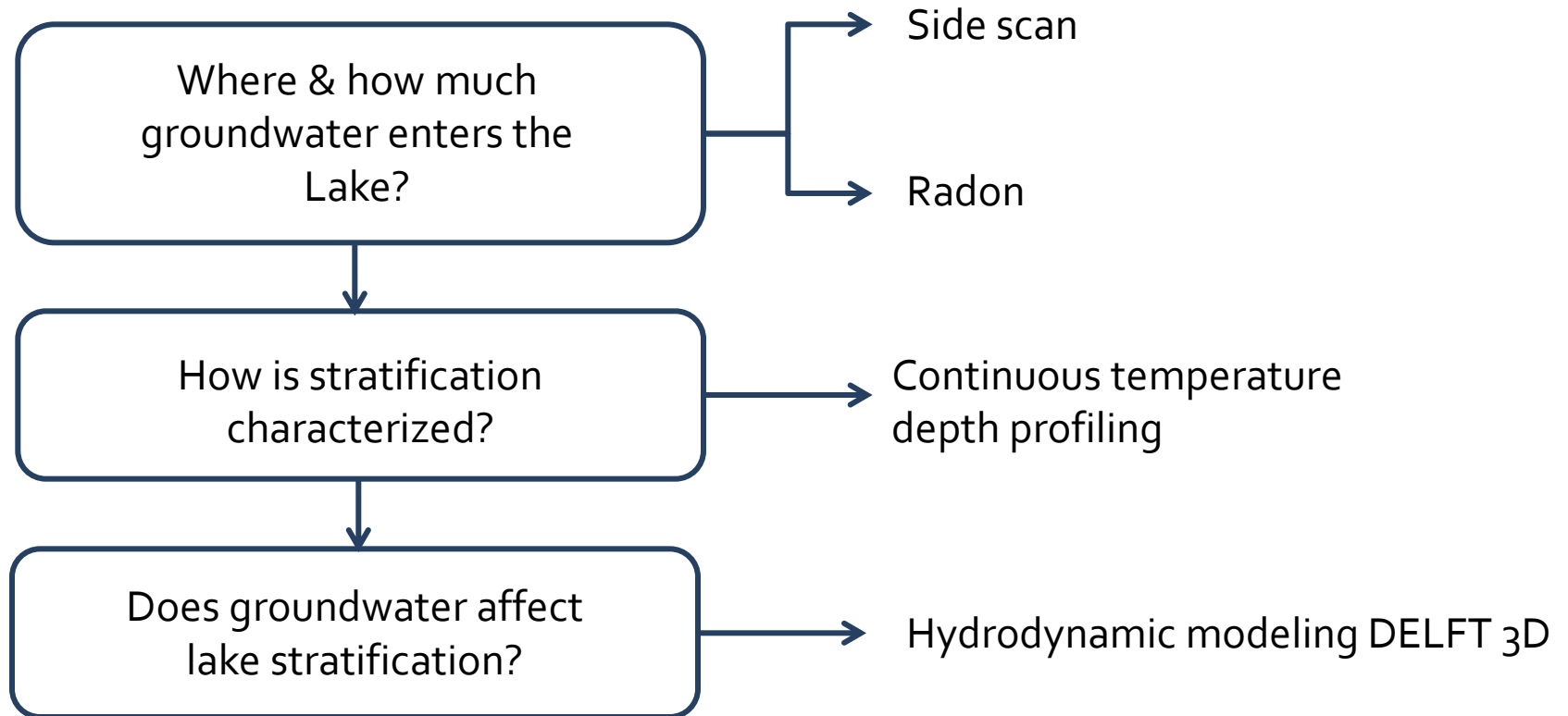


Density [kg/m³]



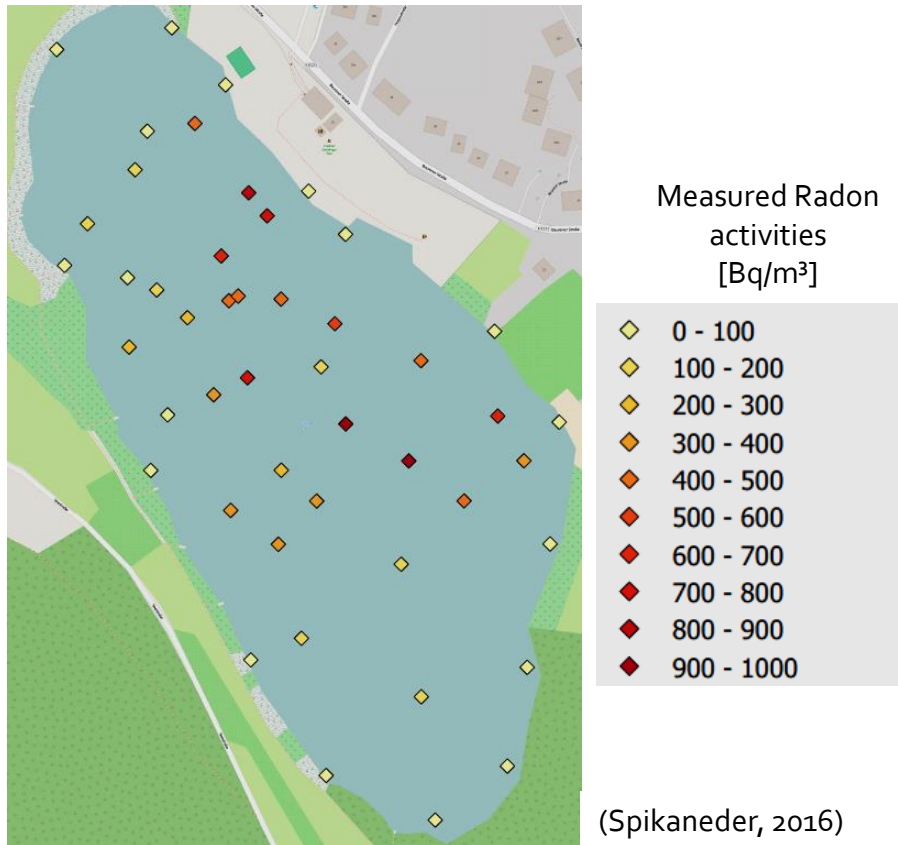
CTD Profile 8. December 2014





Where & how much groundwater enters the Lake?

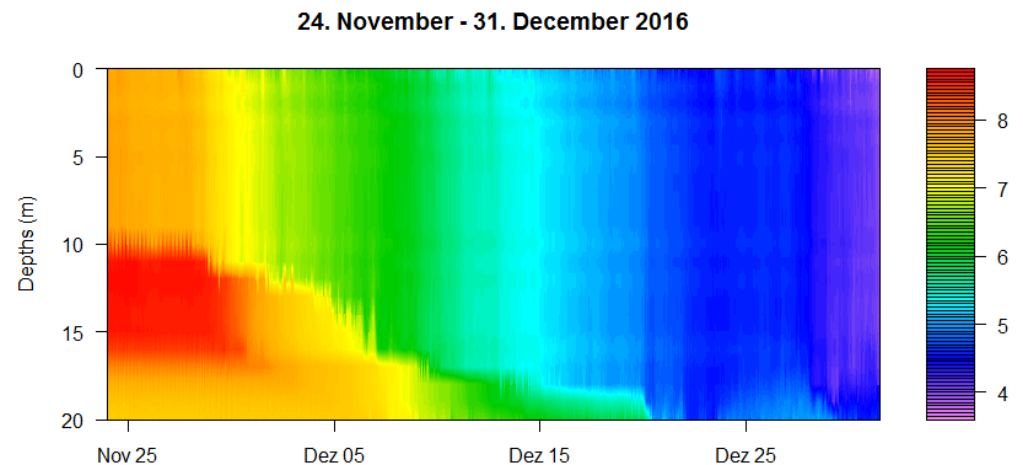
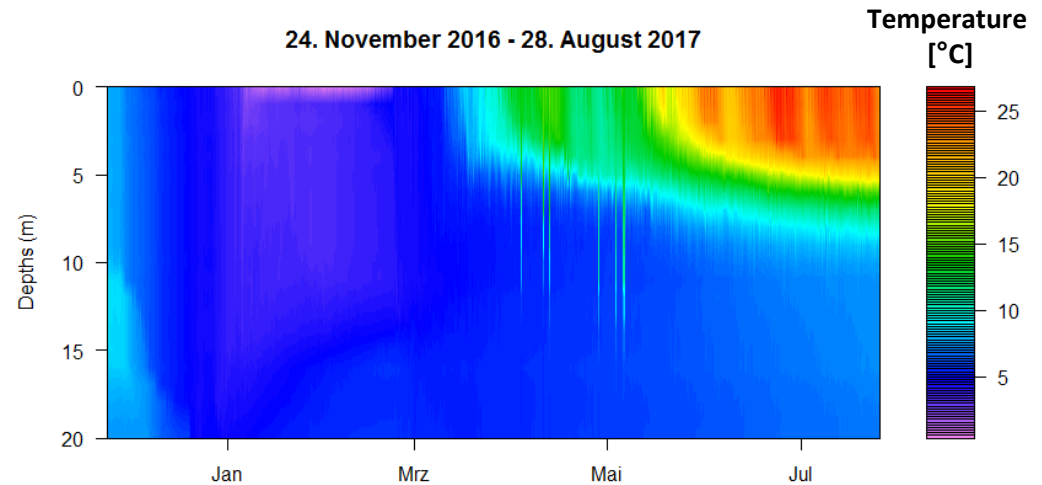
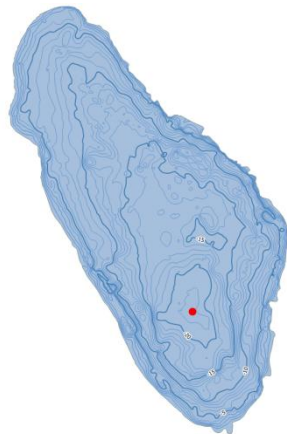
Water balance ~ 70 % groundwater



How is stratification characterized?

Moored Station

- Meteorological parameter
- Temperature Depth Profiles
 - Nov 2016 – Nov 2017
 - 20 min Intervall
 - T sensor every meter

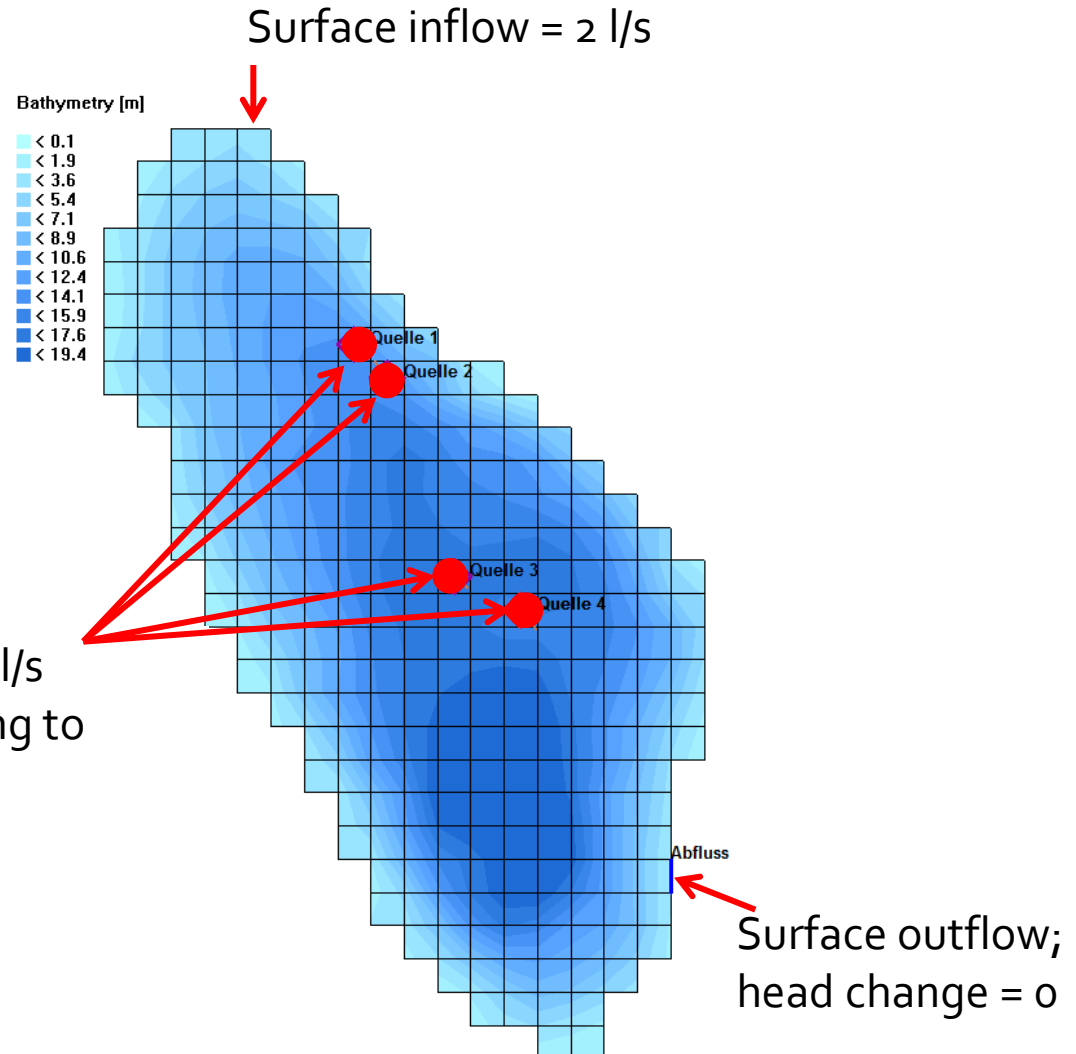


Does groundwater affect lake stratification?

DELFT 3D Model configuration

- Horizontal resolution = 20 m
- Vertical resolution = 30 Layer
- Z-Layer

4 Groundwater source = 11 l/s
(position selected according to
radon detection)



Does groundwater affect lake stratification?

Assumption:

- Groundwater temperature = 10 °C
- Groundwater salinity = 0.2 ppt

	Inputdata							Initial Condition	timeframe
	atmosphere	groundwater		surface water					
		T	S	inflow		outflow			
				T	S	T	S		
Reference	x							4 °C	2014 - 2016
Calibration 1	x	10		x		x		measured	2014 - 2016
Calibration 2	x	10	x	x	x	x	x	measured	2014 - 2016

Does groundwater affect lake stratification?

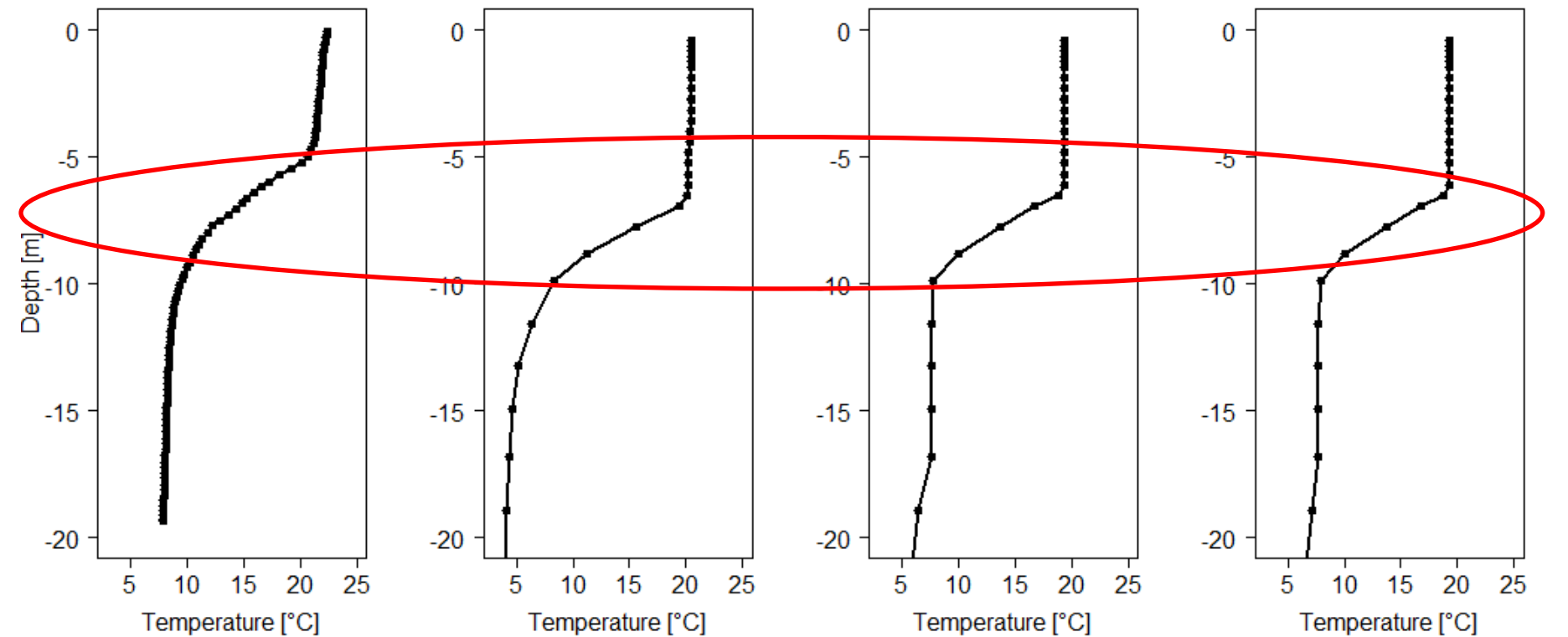
Measurement
15.7.2014 12:00

Without hypolimnetic
groundwater
discharge

With hypolimnetic groundwater discharge

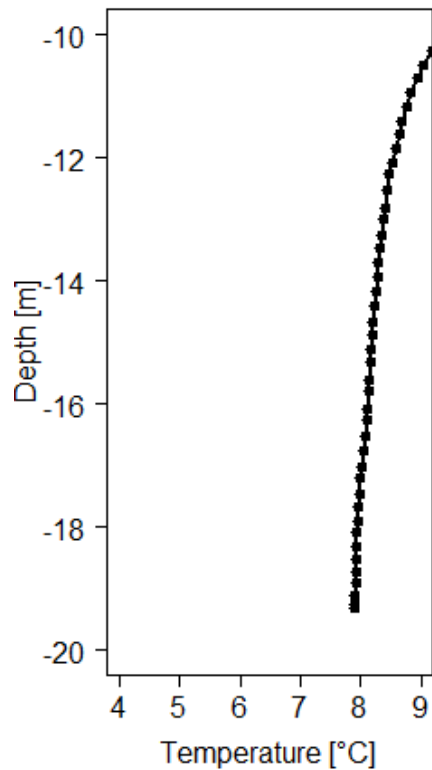
Temperature

Temperature & Salinity

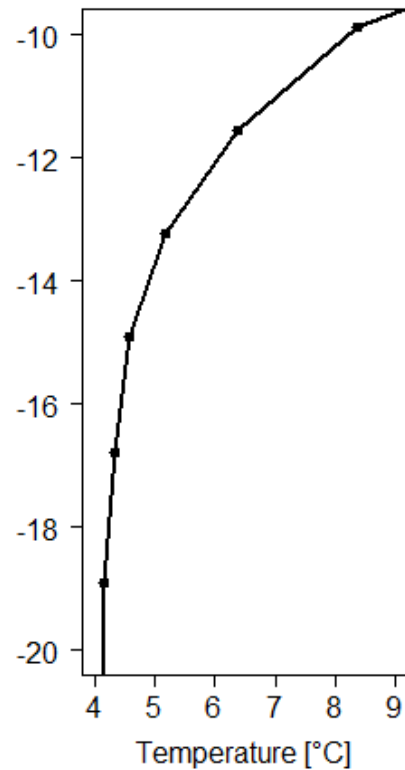


Does groundwater affect lake stratification?

Measurement
15.7.2014 12:00

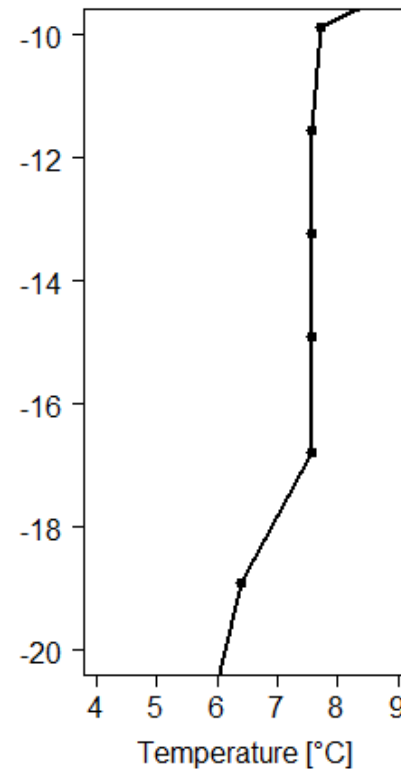


Without hypolimnetic
groundwater
discharge

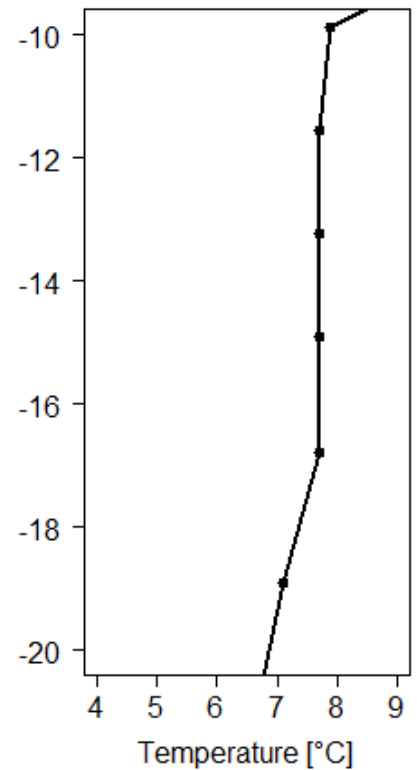


With hypolimnetic groundwater discharge

Temperature

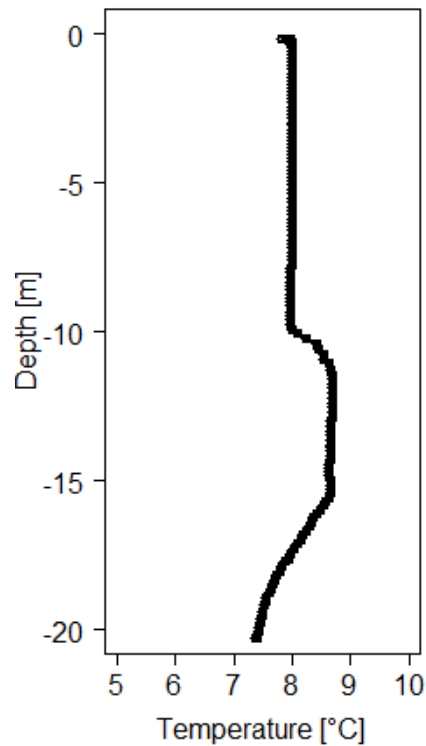


Temperature & Salinity

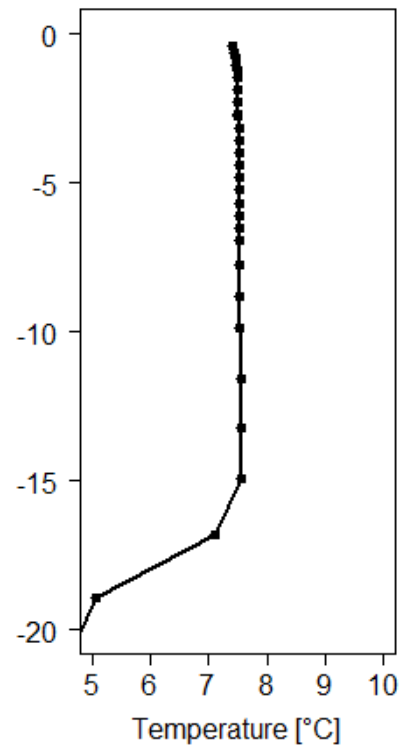


Does groundwater affect lake stratification?

Measurement
08.12.2014

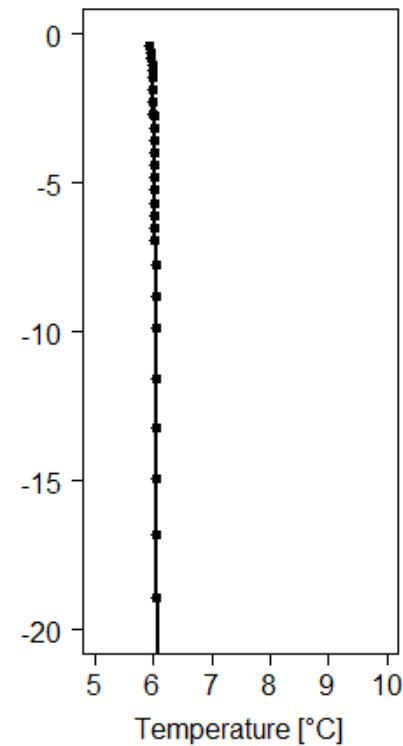


Without hypolimnic
groundwater
discharge

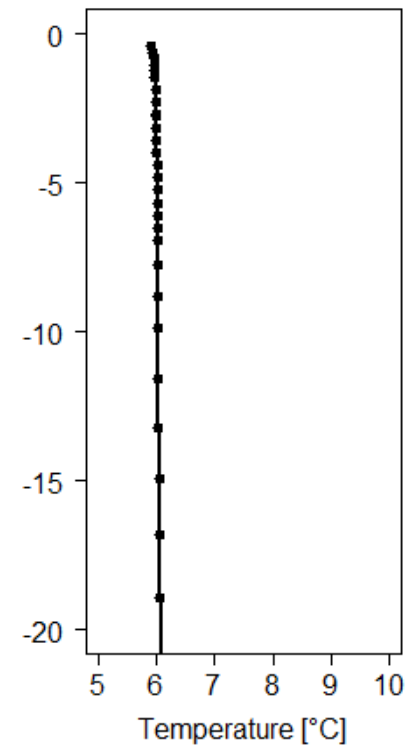


With hypolimnic groundwater discharge

Temperature



Temperature & Salinity



Conclusion & Outlook

- Hypolimnic groundwater discharge contributes significantly to lake water balance
- But: Difficult to estimate/ measure exfiltrating groundwater volumes, temperature and chemical composition

Model check:

- Temperature variability in groundwater?
- Density formula
- Groundwater discharge constant?



Thanks to

Andrea Spikaneder, Thomas Pflugbeil, Vera Winde, Anna Noffke, Sarah Weber,
Felix Quick, Klaus Weih, Catharina Keim, Marcel Edel, Anna Mathis

Founded by





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Felix Quick, Klaus Weih, Catharina Keim, Marcel Edel, Anna Mathis

Thank you for your attention!

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