The background of the slide features a close-up, high-angle view of ocean waves. The water is a deep teal or dark blue color, with white foam and highlights from sunlight creating a textured, shimmering effect across the surface. The waves are moving from the top towards the bottom of the frame.

# **GROUNDWATER** prediction for past and future **CLIMATES**

**Philip Groß**

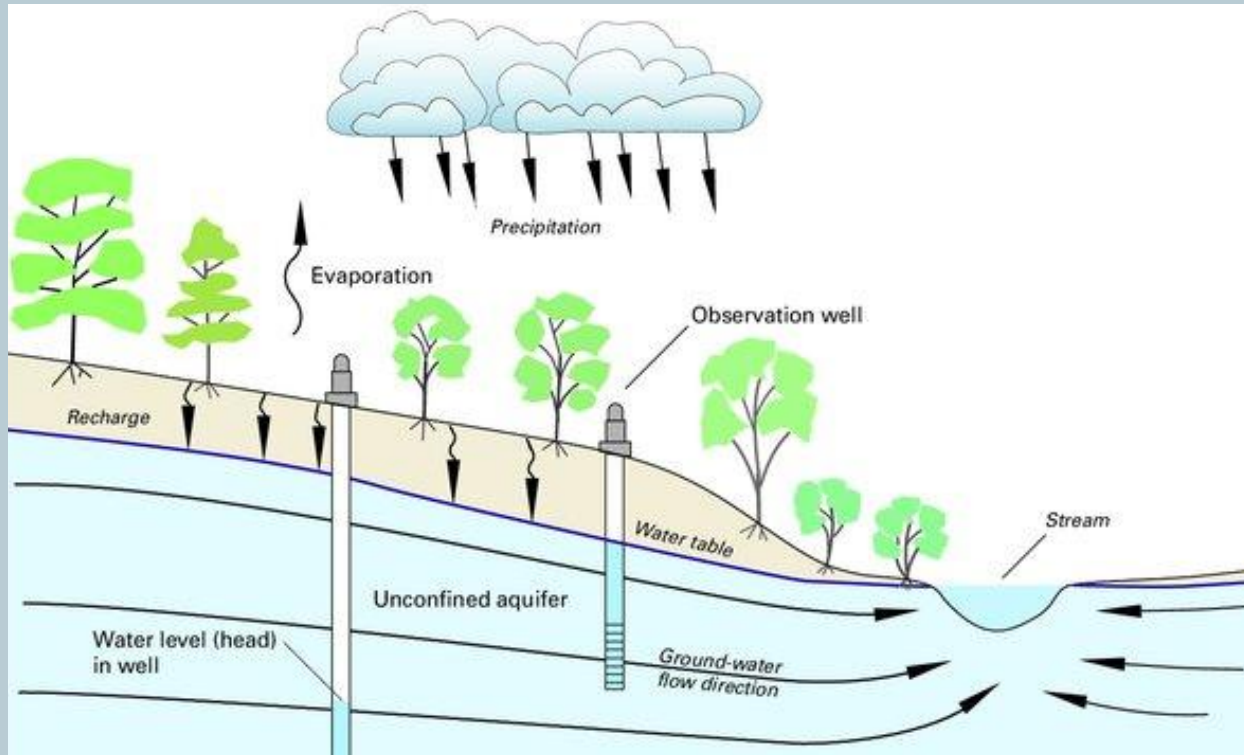
# Groundwater - a key resource!

~ 70%

of drinking water in Germany  
extracted from groundwater!

In some regions completely!

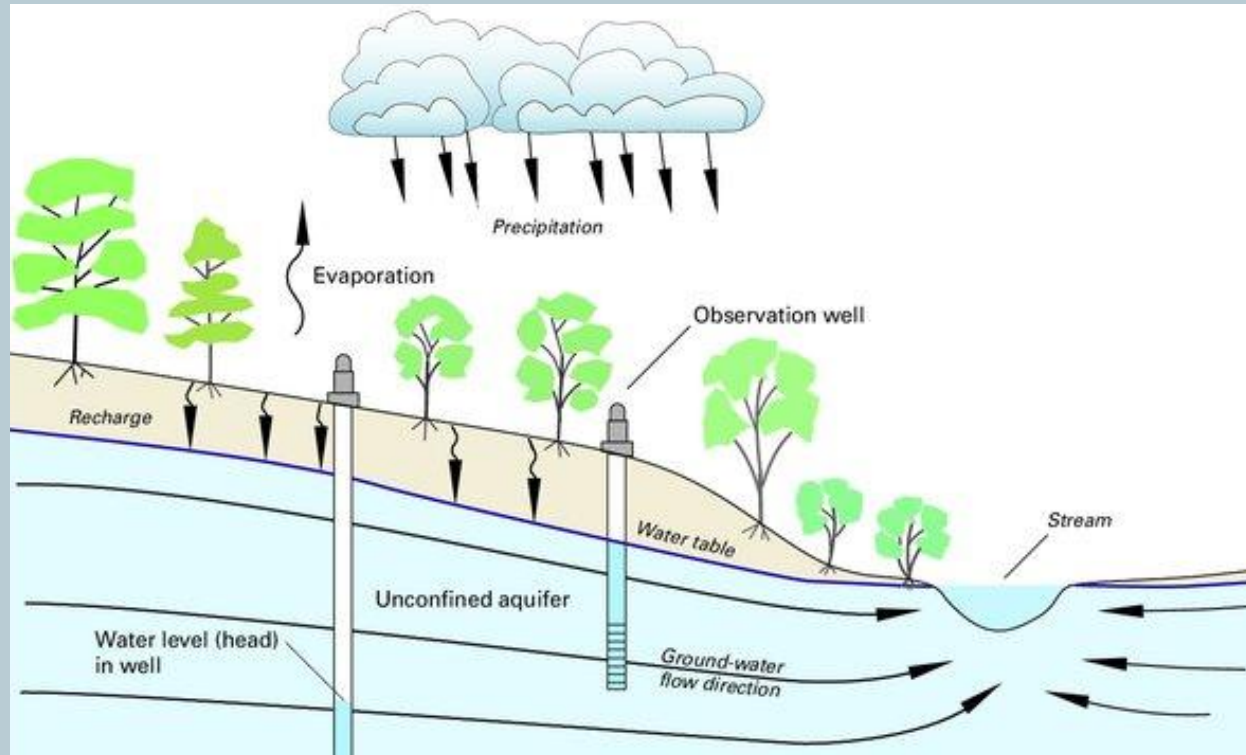
# Groundwater - a key resource!



Groundwater level controlled by:

- + precipitation
- surface runoff
- evaporation (soil)
- transpiration (plants)
- human extraction

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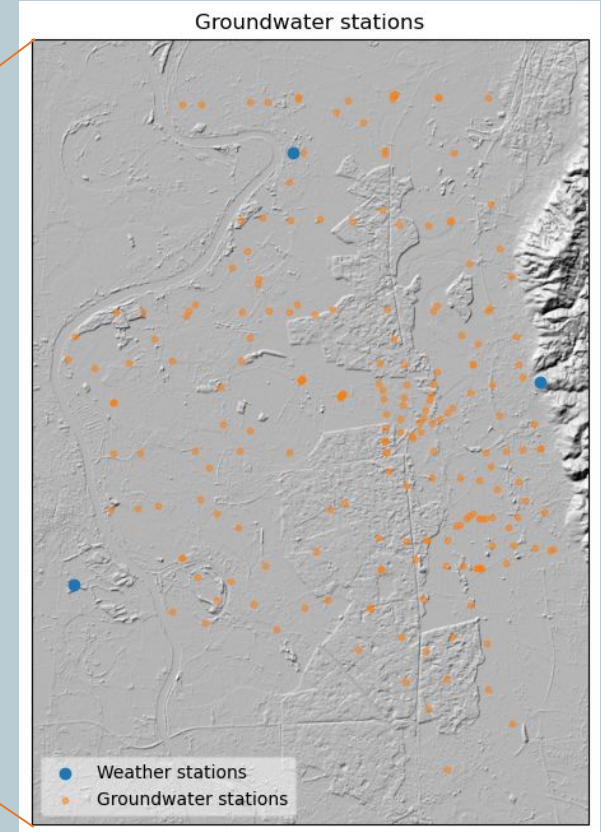
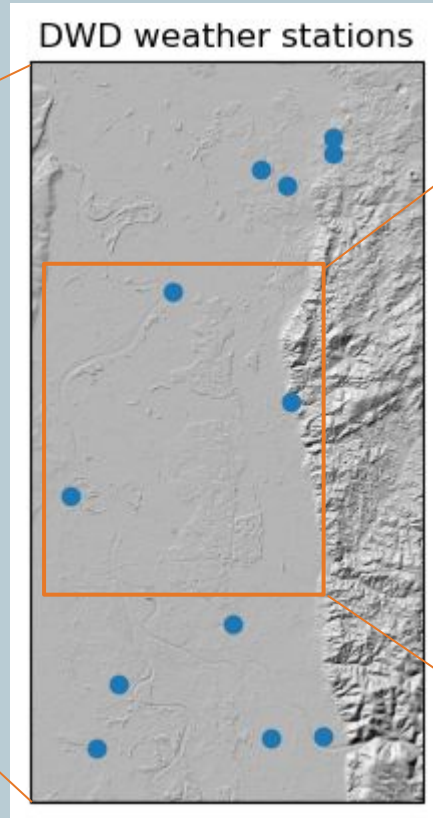
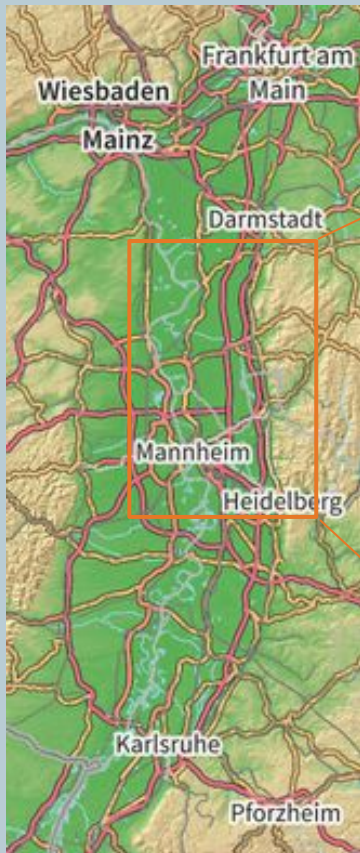
Effect of changing climate?



# Project goal

Predictive model for  
groundwater levels  
in past and future climates!

# Study area between MA and DA



# Model Pipeline

- Learning algorithm: HistGradientBoostingRegressor
- Train-test-split by stations including cross-validation
- Training parameters:
  - Initial groundwater station properties
  - Encoded station location data
  - Meteorological data over time
- Predicted label: Water depth below surface

Final prediction with trained model on all stations using past and future weather!



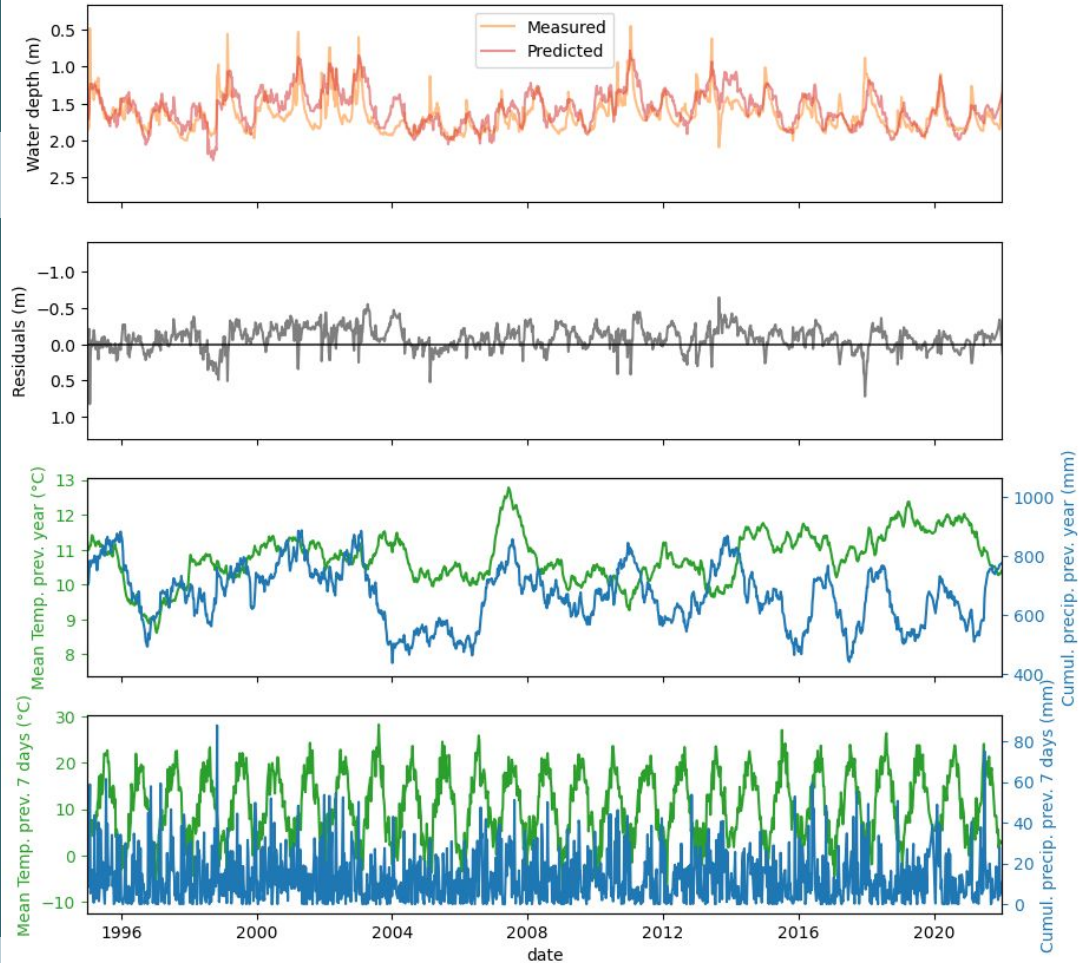
# Result for one station

Residuals

= measured - predicted

Temperature and precipitation  
for previous year

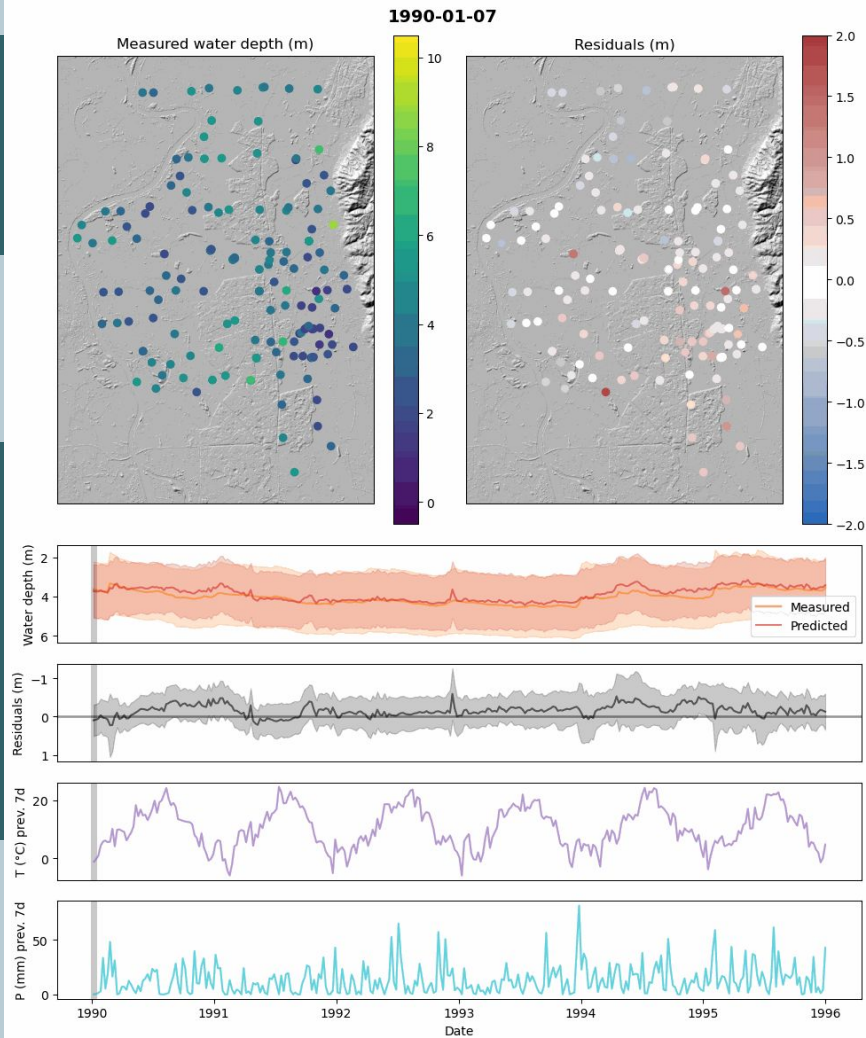
Temperature and precipitation  
for previous 7 days





# Predicting past groundwater levels

- Model predictions are usually precise (low residuals for most stations)
- Some problems with extreme events
- few stations not working well



# Predicting **future** groundwater levels

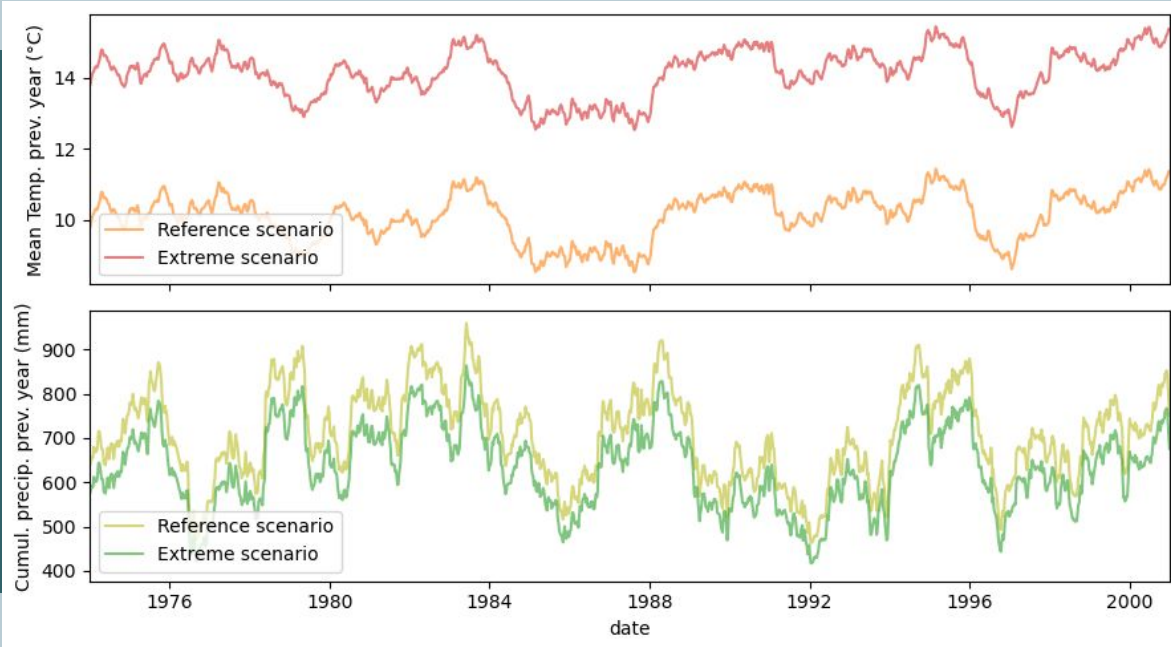
Use future climate projections to create “synthetic” future weather!

Reference scenario:  
1971-2000

Extreme scenario: 2071-2100

- Temp. increase by 4°C
- Precip. decrease by 10%

other scenarios are possible...



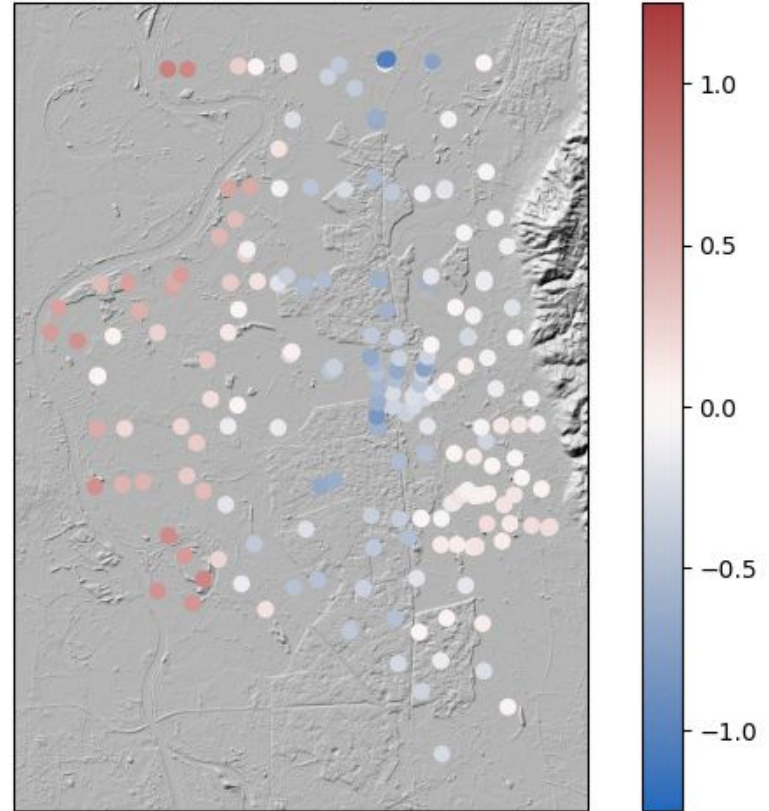
# Predicting **future** groundwater levels

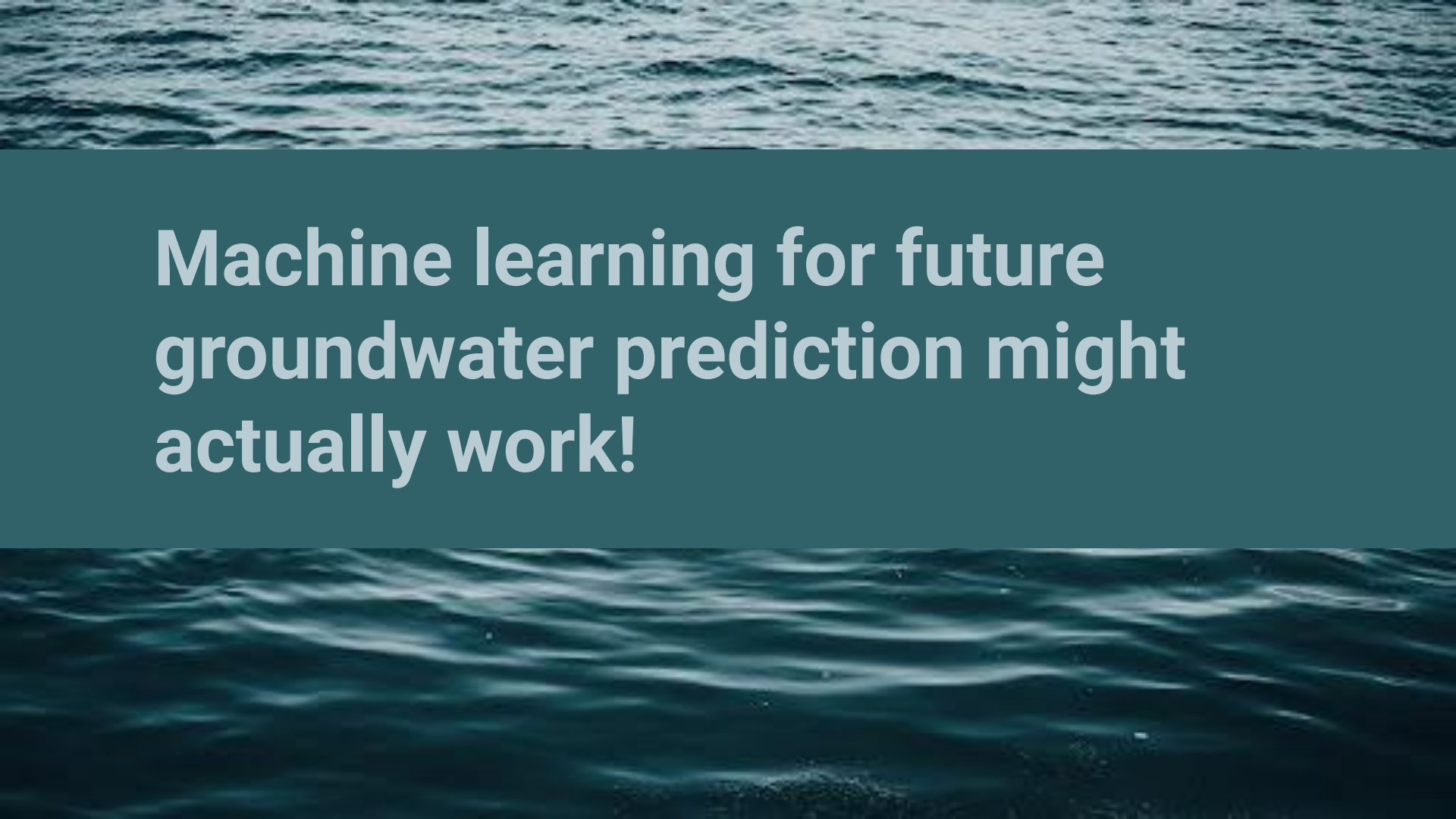
**Anomaly** = future prediction - reference  
**positive: deeper** future groundwater levels  
**negative: shallower** future groundwater levels

Model predicts complex change patterns in groundwater levels...

... but better future weather models are needed!

Water depth anomaly (m) - 1998Q4



The background of the slide is a photograph of water with ripples, overlaid with a semi-transparent teal band in the center where the text is located.

**Machine learning for future  
groundwater prediction might  
actually work!**



The background of the slide features a close-up, high-angle view of ocean waves. The water is a deep teal or slate blue color, with white foam and highlights from the sun reflecting off the crests of the waves. The texture is dynamic and slightly blurred, suggesting movement. A solid, medium-teal horizontal band cuts across the middle of the image, providing a clean space for the title text.

# Appendix

# Predicting **future** groundwater levels

