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ANB Sensors, AQ^2 pH Sensor

Tidal Influence on pH in an Estuarine Environment: Continuous Monitoring with a Calibration-Free ANB Sensor

INTRODUCTION

ANB Sensors deployed a calibration-free pH sensor in the River Dart in South West England to evaluate long-term water quality dynamics in a tidally influenced estuarine environment. The deployment recorded continuous measurements of pH, temperature and salinity over multiple tidal cycles, revealing a clear relationship between water chemistry and tidal exchange.

The dataset demonstrates that pH fluctuates in response to changing tidal conditions, with corresponding variations in salinity and temperature. Independent spot measurements using conventional glass electrode instrumentation showed good agreement with the trends observed by the ANB sensor.

This deployment highlights the value of ANB's calibration-free technology for monitoring estuarine and coastal waters where rapidly changing salinity can challenge the performance and accuracy of traditional glass electrode systems.

ESTUARINE ENVIRONMENTS

Estuarine environments are among the most dynamic aquatic systems, with water chemistry influenced by the continuous mixing of freshwater and seawater. Parameters such as pH, salinity and temperature can change significantly over a single tidal cycle.

Accurate monitoring of pH in these environments is particularly challenging. Conventional glass pH electrodes are sensitive to changes in ionic strength and often require frequent maintenance and recalibration to maintain accuracy. In locations where salinity can vary rapidly, interpreting pH data from traditional sensors can be difficult and may introduce uncertainty into long-term datasets.

To investigate these dynamics, ANB Sensors deployed its calibration-free pH sensor in the River Dart at Totnes, a location strongly influenced by tidal exchange from the South Devon coast.

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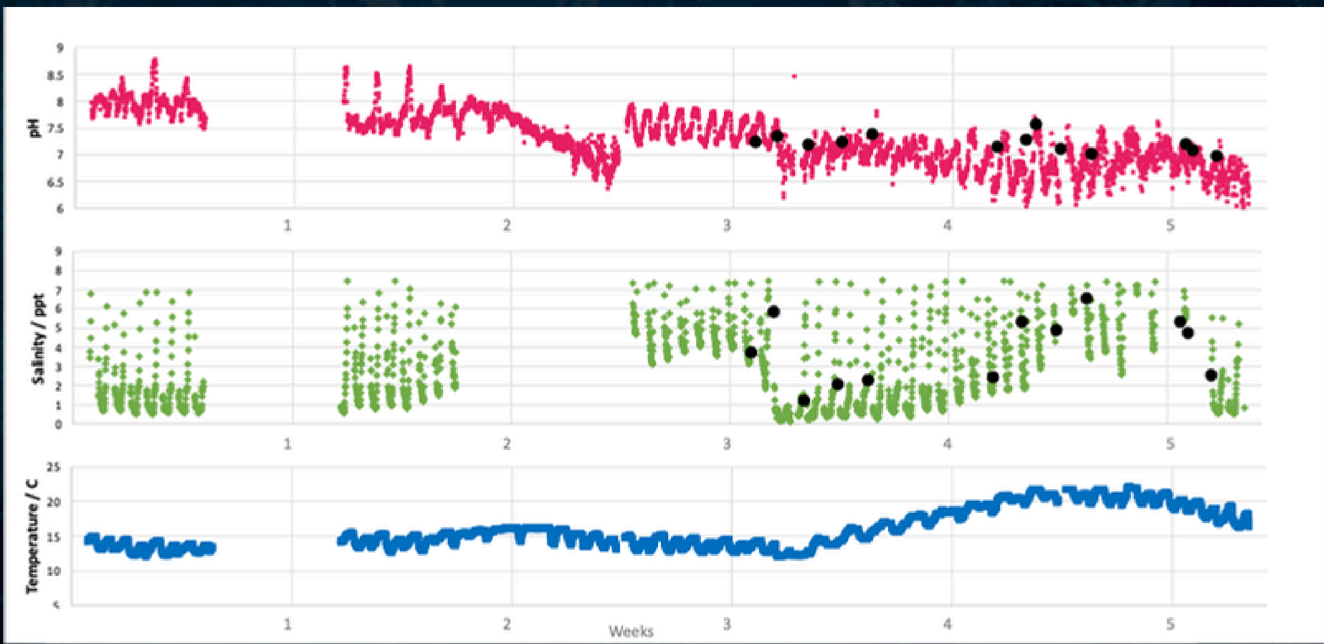
RESULTS & OBSERVATIONS

Monitoring Approach: The deployed sensor continuously measured pH, temperature and salinity at 10 minute intervals over several weeks, capturing multiple spring and neap tidal cycles and a wide range of environmental conditions. To provide an independent reference, periodic spot measurements were collected using conventional glass electrode instrumentation during the deployment period.



The dataset shows pronounced cyclical changes in salinity that are consistent with tidal exchange. During periods of tidal intrusion, salinity increased as seawater propagated upstream into the monitoring location, before decreasing as freshwater influence returned.

These shifts in salinity were accompanied by corresponding changes in pH, demonstrating the strong influence of tidal mixing on estuarine carbonate chemistry. As the relative contributions of freshwater and seawater changed, the sensor consistently captured repeatable increases and decreases in pH, reflecting the contrasting carbonate chemistry of the river and incoming coastal waters. Temperature also exhibited tidal variability, highlighting the differing thermal characteristics of the marine and riverine water masses.

During the early stages of the deployment, distinct diurnal variations in pH were also evident. Daytime pH values reached approximately 8.5, while nighttime values fell to around 7.5 during periods dominated by riverine conditions. The elevated daytime pH is consistent with enhanced photosynthetic activity, whereby phytoplankton and other aquatic plants consume dissolved CO_2, reducing carbonic acid concentrations and increasing pH. This interpretation is supported by observations of a green tinge in the river during this period, indicative of elevated algal biomass.

Overall, the dataset demonstrates how rapidly water chemistry can vary within a tidal estuary, with both tidal exchange and biological activity influencing pH over timescales of hours. The ability to resolve these short-term fluctuations caused by both tidal and biological activity provides valuable insight into estuarine processes that would be difficult to capture using periodic grab sampling alone.

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VALIDATION AGAINST SPOT MEASUREMENTS

A series of spot measurements collected using conventional glass electrode equipment showed good agreement with the ANB sensor data. The grab samples confirmed both the overall pH range and the temporal trends observed by the deployed sensor. This independent verification provides confidence that the measured pH variations reflect genuine environmental changes rather than sensor artefacts.

The close correspondence between the continuous dataset and the spot measurements demonstrates the reliability of the ANB platform in a challenging field environment.

WHY THIS DEPLOYMENT MATTERS

The Challenge of Variable Salinity

Traditional glass pH electrodes are well known to experience performance challenges in environments where salinity changes rapidly. Variations in ionic strength can influence measurement stability and increase uncertainty, often requiring frequent recalibration and maintenance. In tidal rivers and estuaries, where salinity can change substantially within hours, these effects can make long-term monitoring difficult.

Applications:

The findings from the River Dart deployment are relevant to a wide range of monitoring applications, including:

- estuarine water quality monitoring
- coastal ecosystem assessment
- aquaculture operations
- environmental compliance programmes
- carbon and carbonate chemistry studies
- river and catchment management.

ANB's Calibration-Free Advantages:

- Continuous operation without routine recalibration
- Stable performance during rapid salinity changes
- Simultaneous measurement of pH, temp and salinity
- Reduced maintenance requirements
- Improved suitability for long-term remote deployments

The ability to maintain reliable measurements across changing salinity conditions enables users to observe genuine environmental trends rather than instrument-related variability.

CONCLUSIONS

The deployment of an ANB calibration-free pH sensor in the River Dart at Totnes successfully captured the dynamic relationship between pH, salinity and temperature in a tidally influenced environment. The dataset clearly demonstrates that tidal exchange drives measurable changes in water chemistry and that these changes can be tracked continuously using ANB's technology. Independent spot measurements using conventional glass electrode methods provided validation of the observed pH trends.

Most importantly, the deployment highlights the suitability of ANB's calibration-free approach for dynamic environmental monitoring, where changing salinity and biological activity can present significant challenges for traditional pH measurement technologies. By delivering stable, maintenance-light operation under variable salinity conditions, ANB sensors provide a practical solution for long-term environmental monitoring.