Improving WiFi communication with surface nodes at near-shore on tidal waters

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RTCM
Rede Temática de Comunicações Móveis

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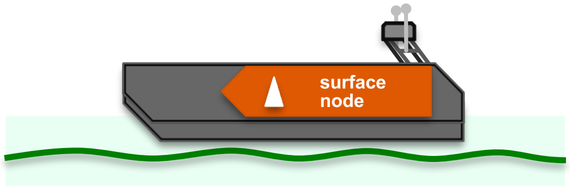
Abstract

We propose **two link-design methods** for improved communication between an onshore station and a surface node **over tidal waters**

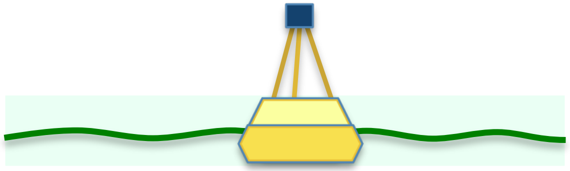
Method 1:
for <u>dynamic</u> surface nodes

It identifies a **favorable distance** region for good communication quality at each point of the tide.



Method 2:
for <u>stationary</u> surface nodes

It determines the **optimal height/distance** region that minimizes the path loss averaged during the whole tidal cycle.



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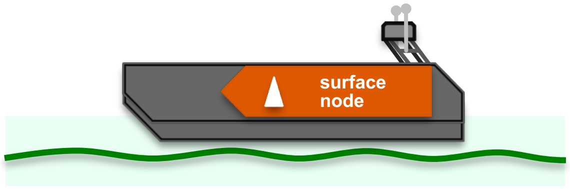

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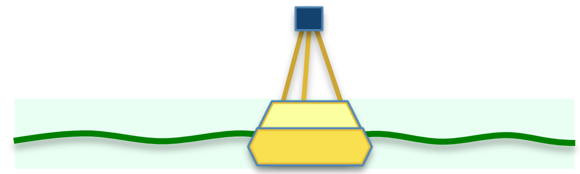

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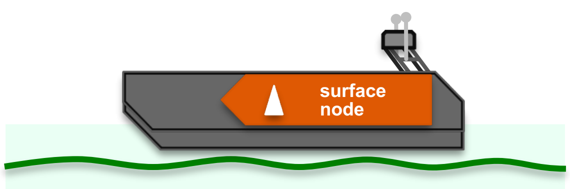

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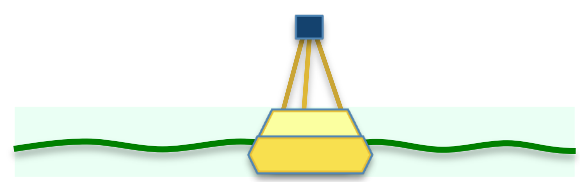
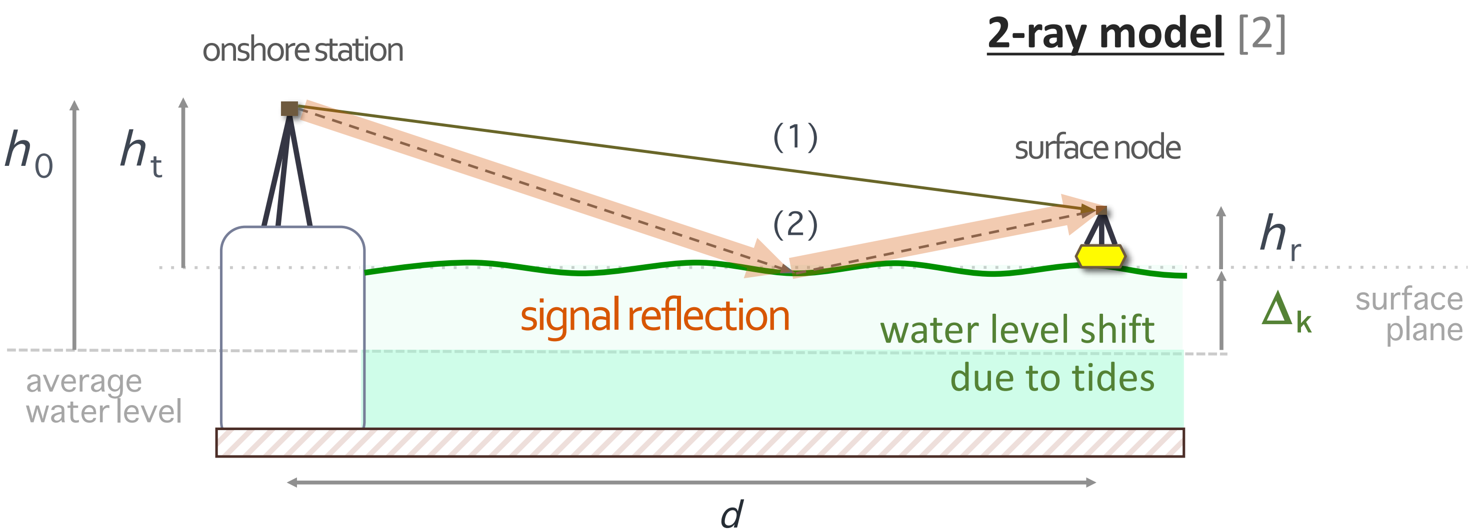


Introduction

Wireless radio links deployed over aquatic areas are strongly affected by the conductive properties of the **water surface**, strengthening **signal reflections** and increasing interference effects [1].



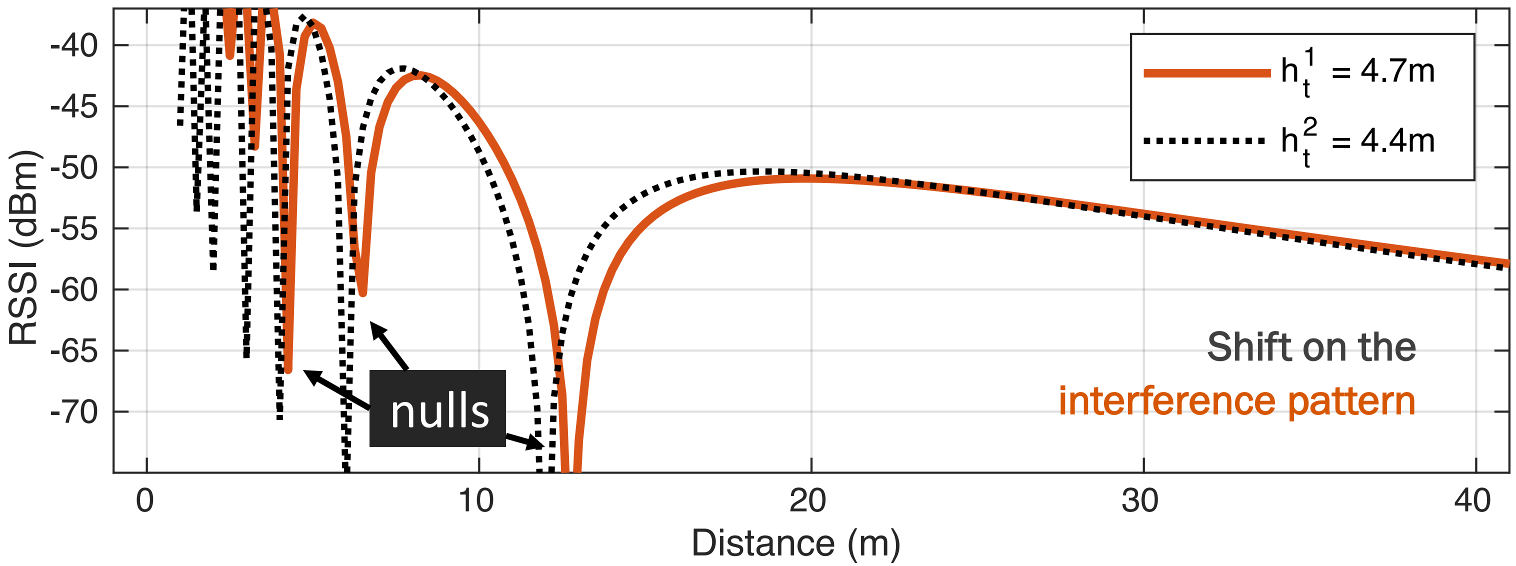
[1] M. Pereira, "Spread Spectrum Techniques in Wireless Communication, Part 2: Transmission issues in Free Space," IEEE Instrumentation & Measurement Magazine, vol. 13, no. 1, pp. 8–14, 2010.

[2] T. Rappaport, Wireless Communications: Principles and Practice. USA: Prentice Hall PTR, 2nd Ed., 2002.

Introduction

Recurrent **natural phenomena such as tides** or waves cause shifts in the water level that, in turn, change the **interference patterns** [3].

Shift on the **water level** e.g., $\boldsymbol{\Delta_k = 30}$ **cm**



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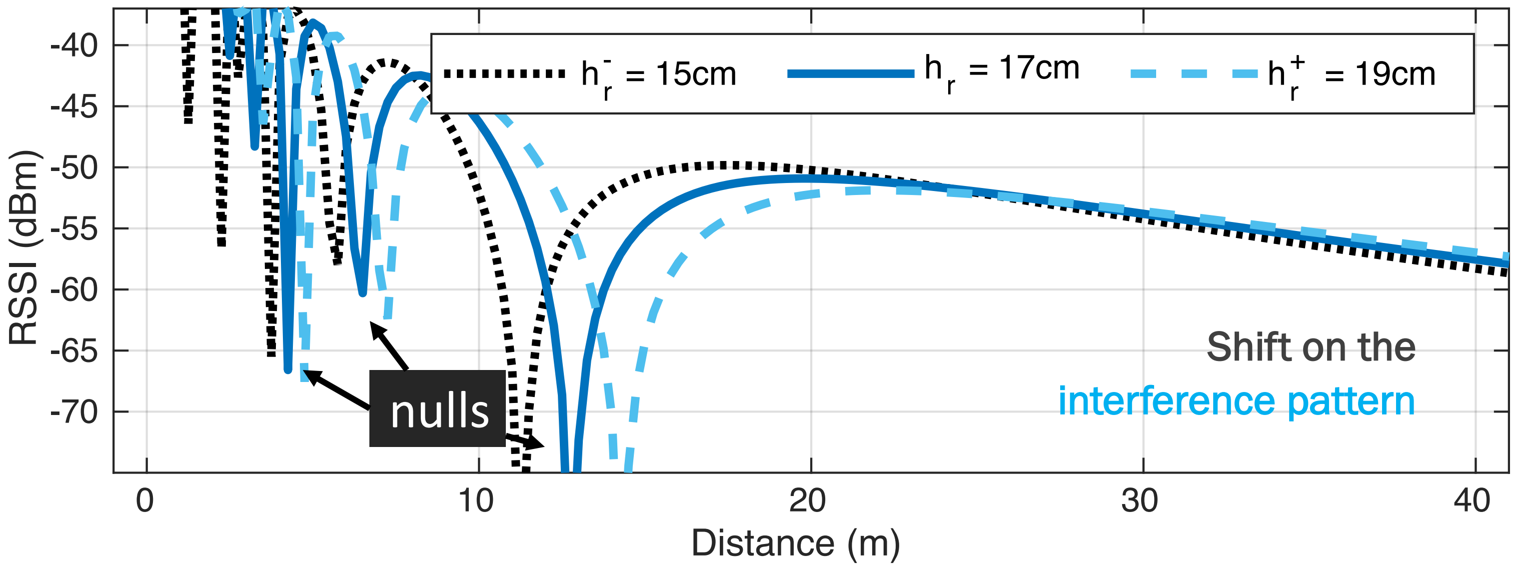
Shift on the **receiver height** e.g., $\boldsymbol{\Delta_k = 2}$ **cm**



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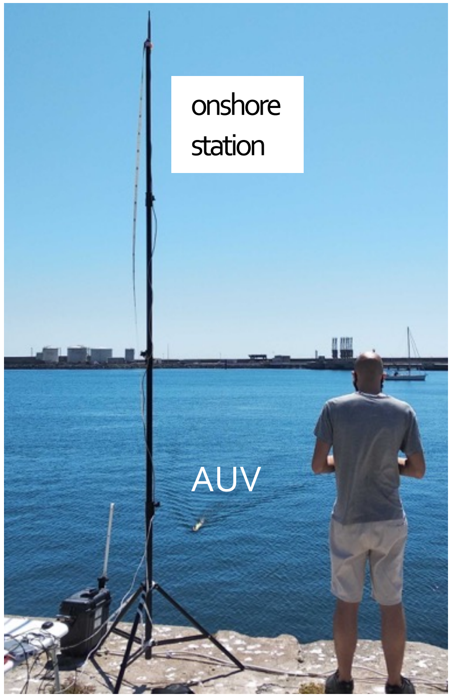
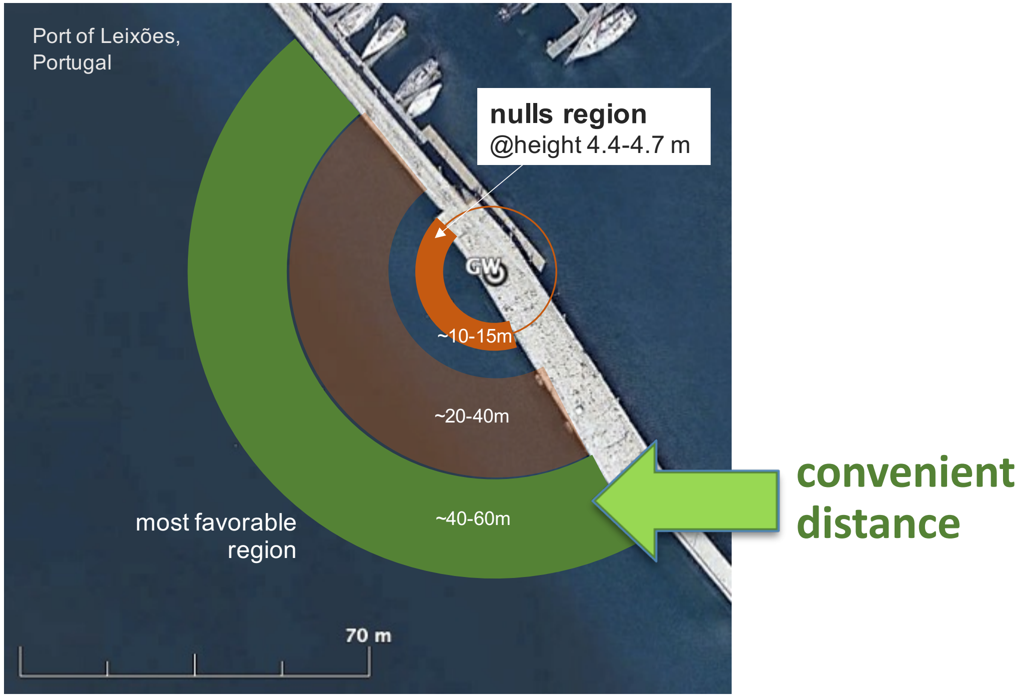
Scenario 1: Shore-to-AUV Wi-Fi link in LOS

Method 1: We determined a convenient distance to shore that will lead to **sustained high signal strength** in a broad region so that the vehicle can be driven to that distance and initiate **communication with high quality**.

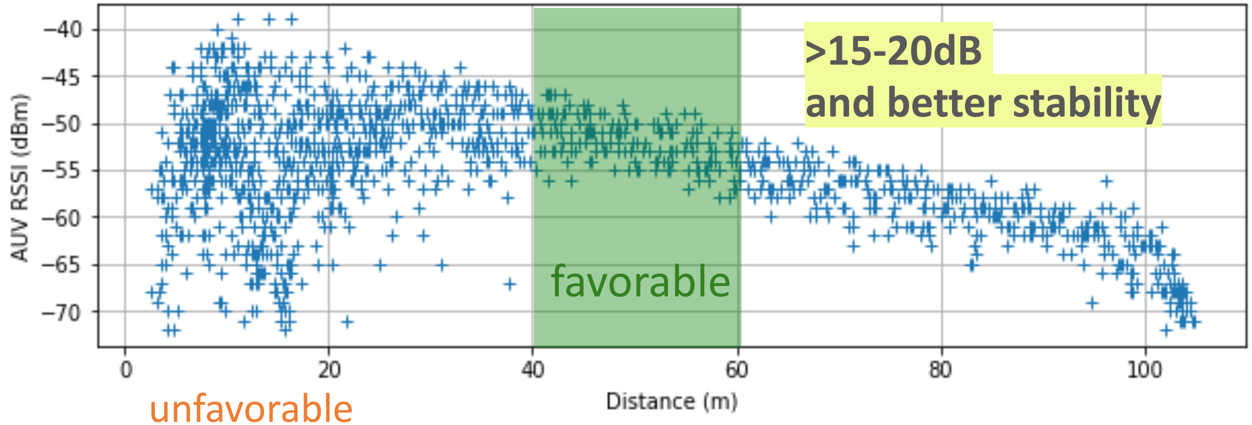




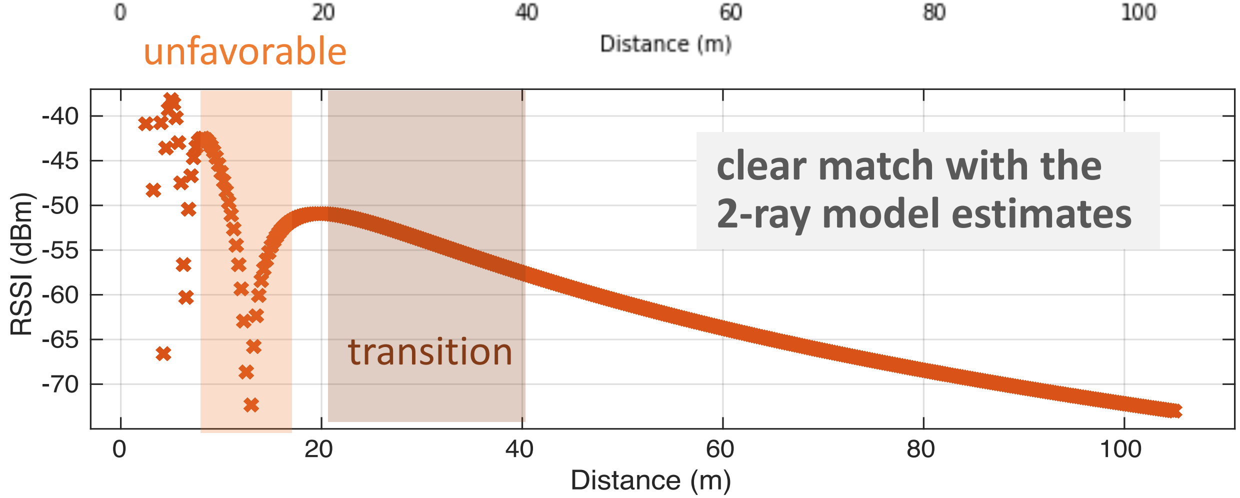
Method 1: Experimental Validation

Experimental results clearly show the validity of our **Link Quality Model** (LQM) and the interest of method 1.

RSSI
measurements



Analytical results
(two-ray model)



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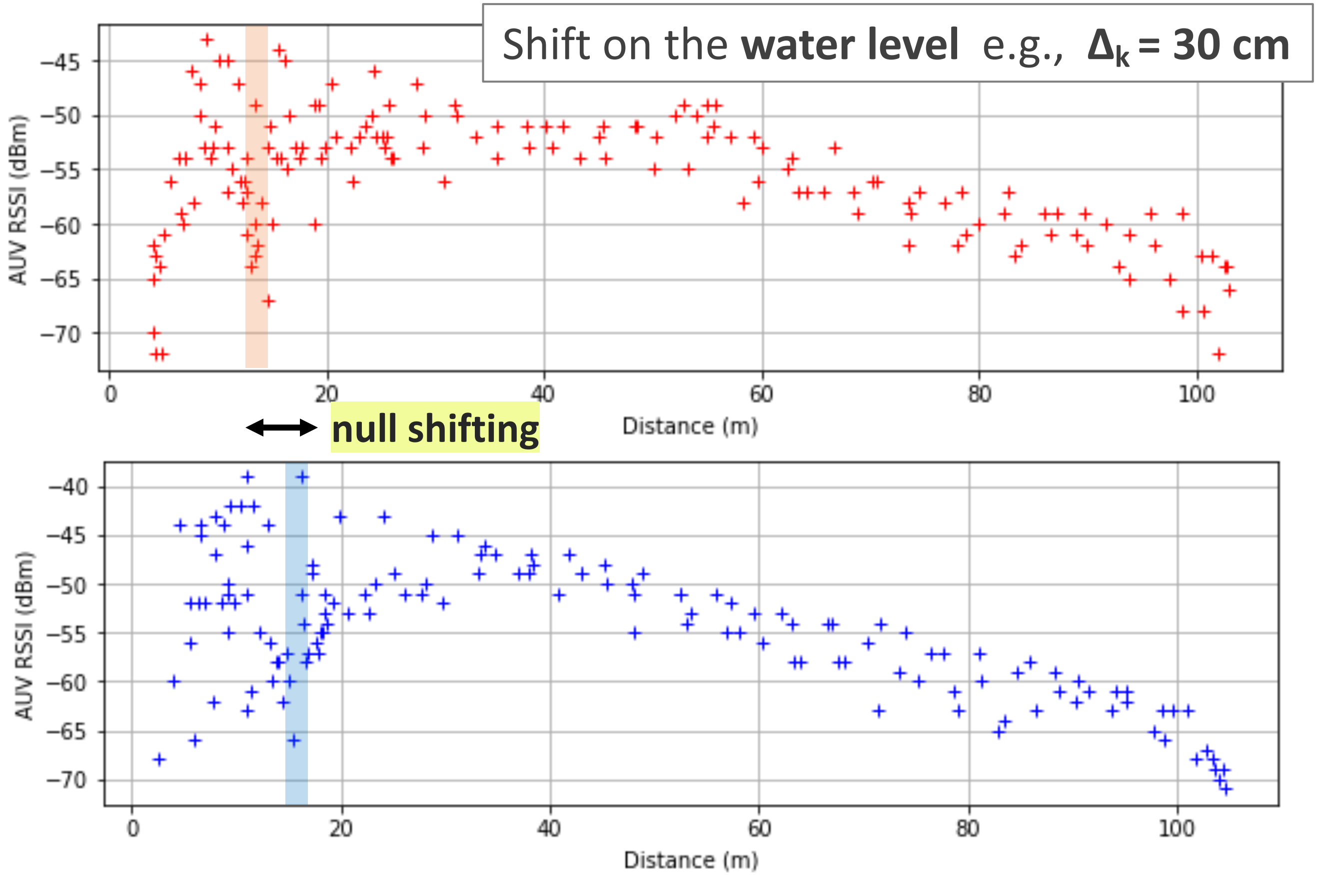
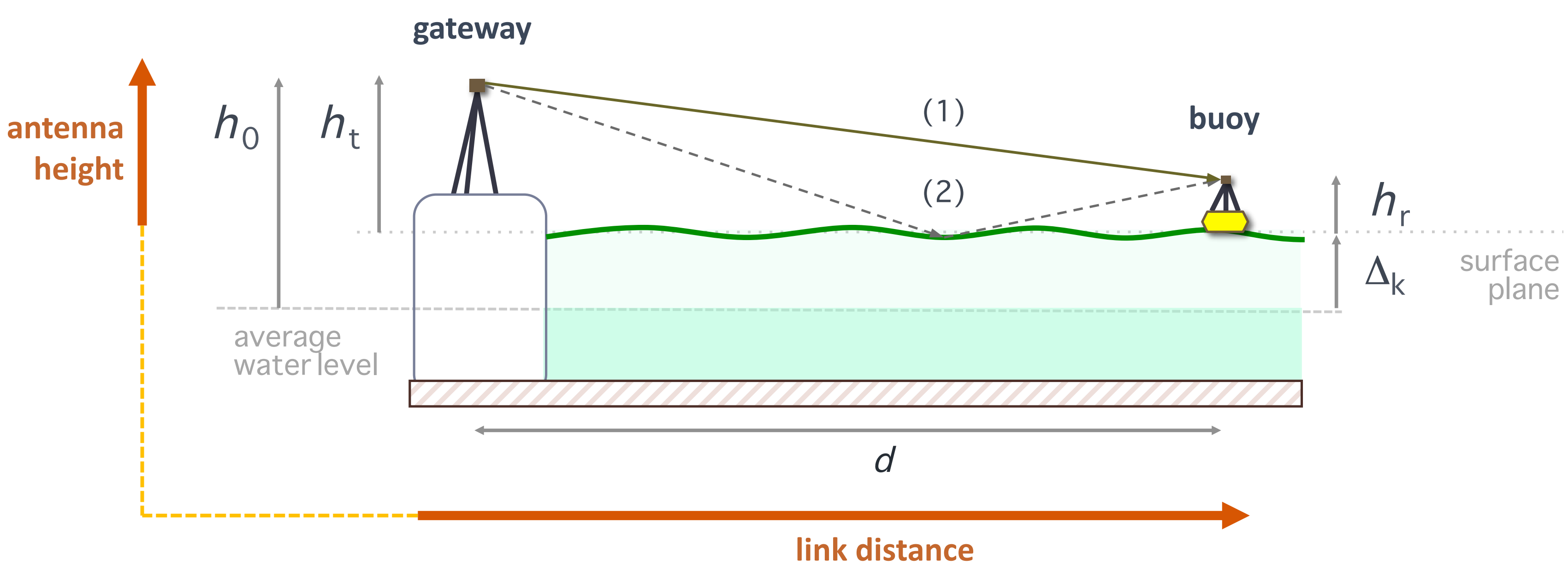
$h_{Tx} \sim$ **4.7 m**



Scenario 2: Shore-to-Buoy link in LOS

Method 2: Based on [4] we reduced the so-called **tidal fading** by acting on the **antenna height or link distance** to minimize the average path loss over a full tidal cycle, providing the **best channel conditions on average**.



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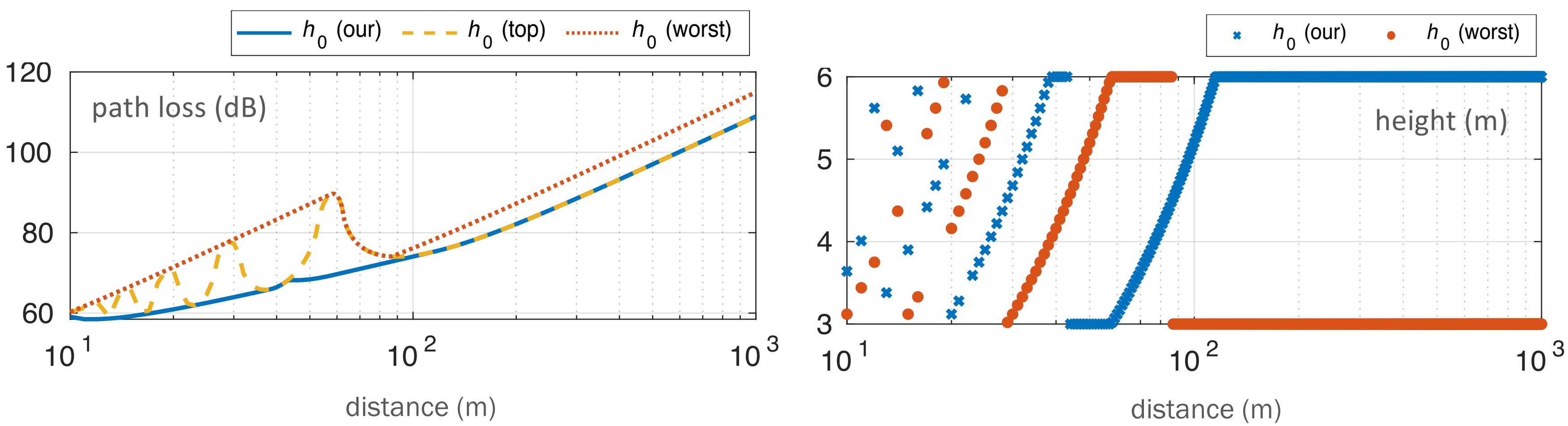

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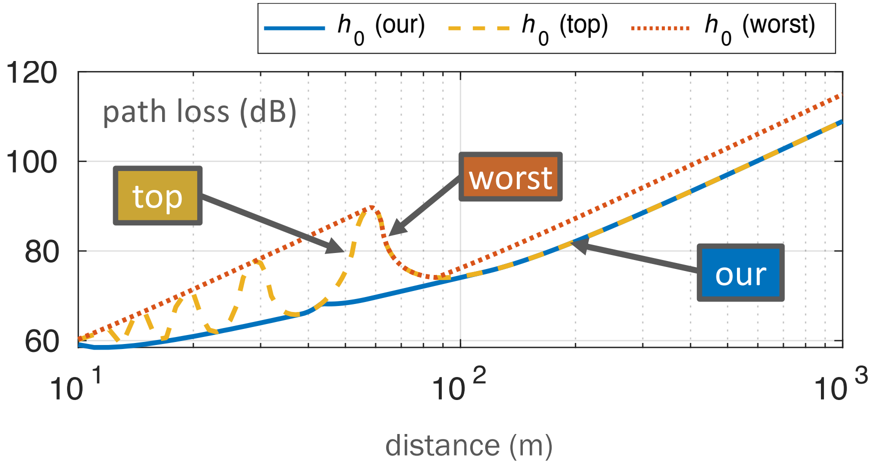

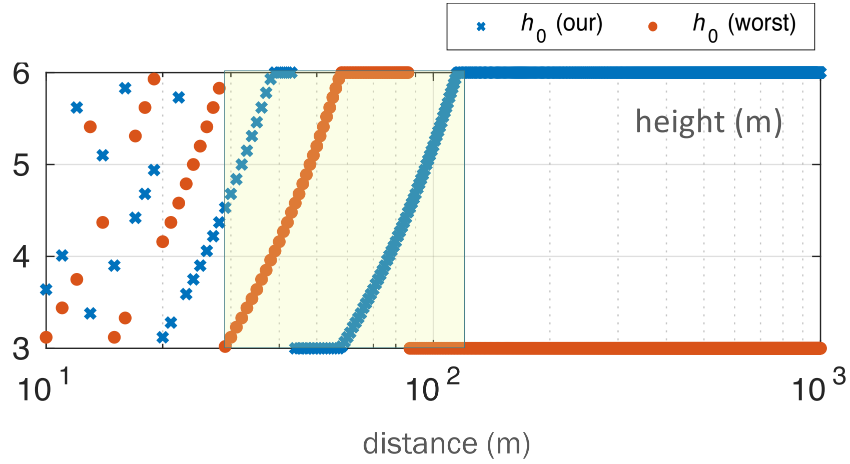

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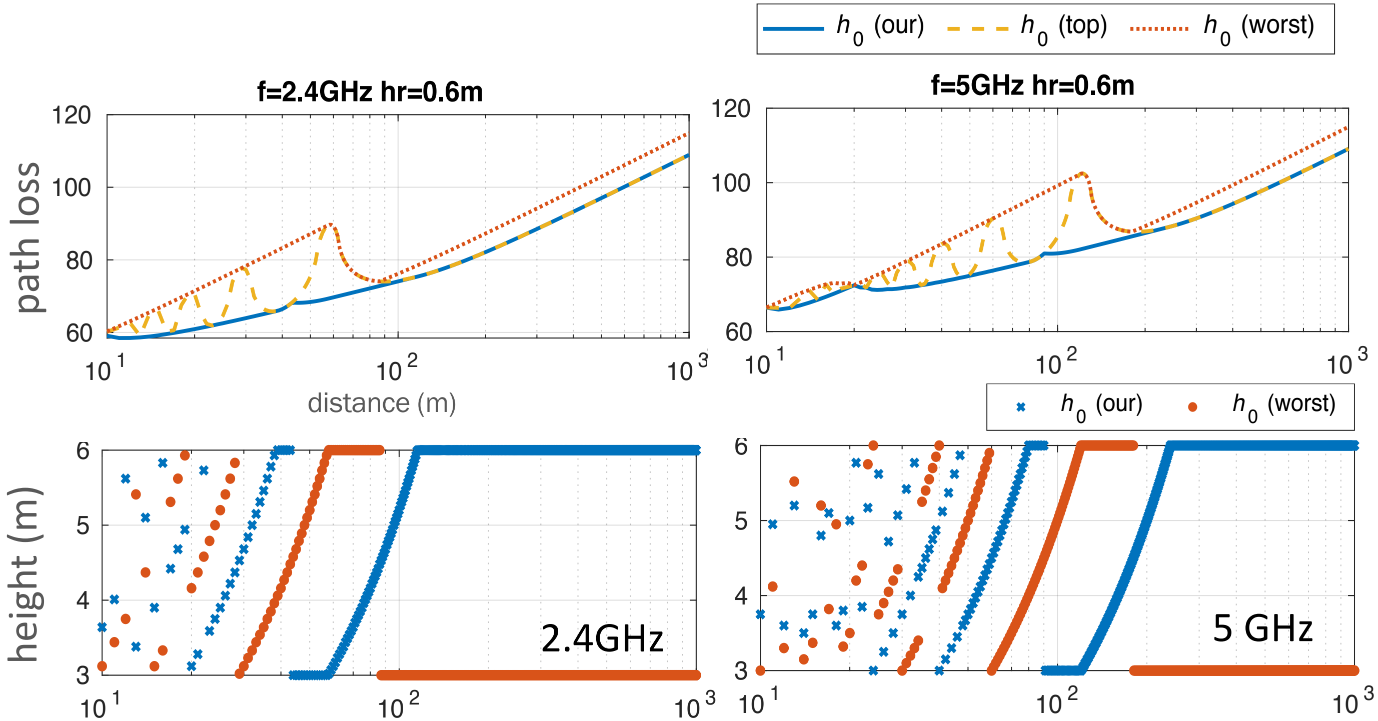

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Conclusions

This work provides novel **positioning** and **antenna-design** methods to **mitigate the impact of tides** on the LOS shore-to-surface channel.

We also provided a novel and clear **experimental validation** of the two-ray model with Wi-Fi technology over water at near-shore.

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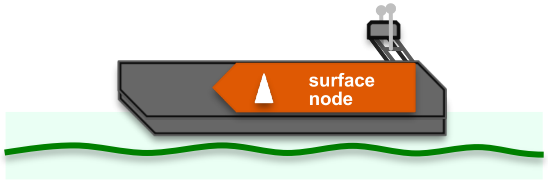

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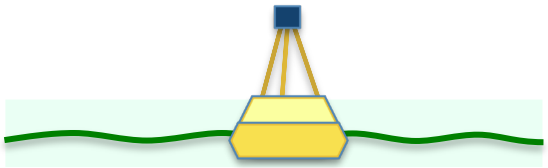

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Thank you!

EUMarineRobots Marine robotics research infrastructure network NORTE2020 FCT Fundação para a Ciência e a Tecnologia European Union European Social Fund