On the Two-Ray Model Analysis for Overwater Links with Tidal Variations

CISTER – Research Centre in Real-Time & Embedded Computing Systems

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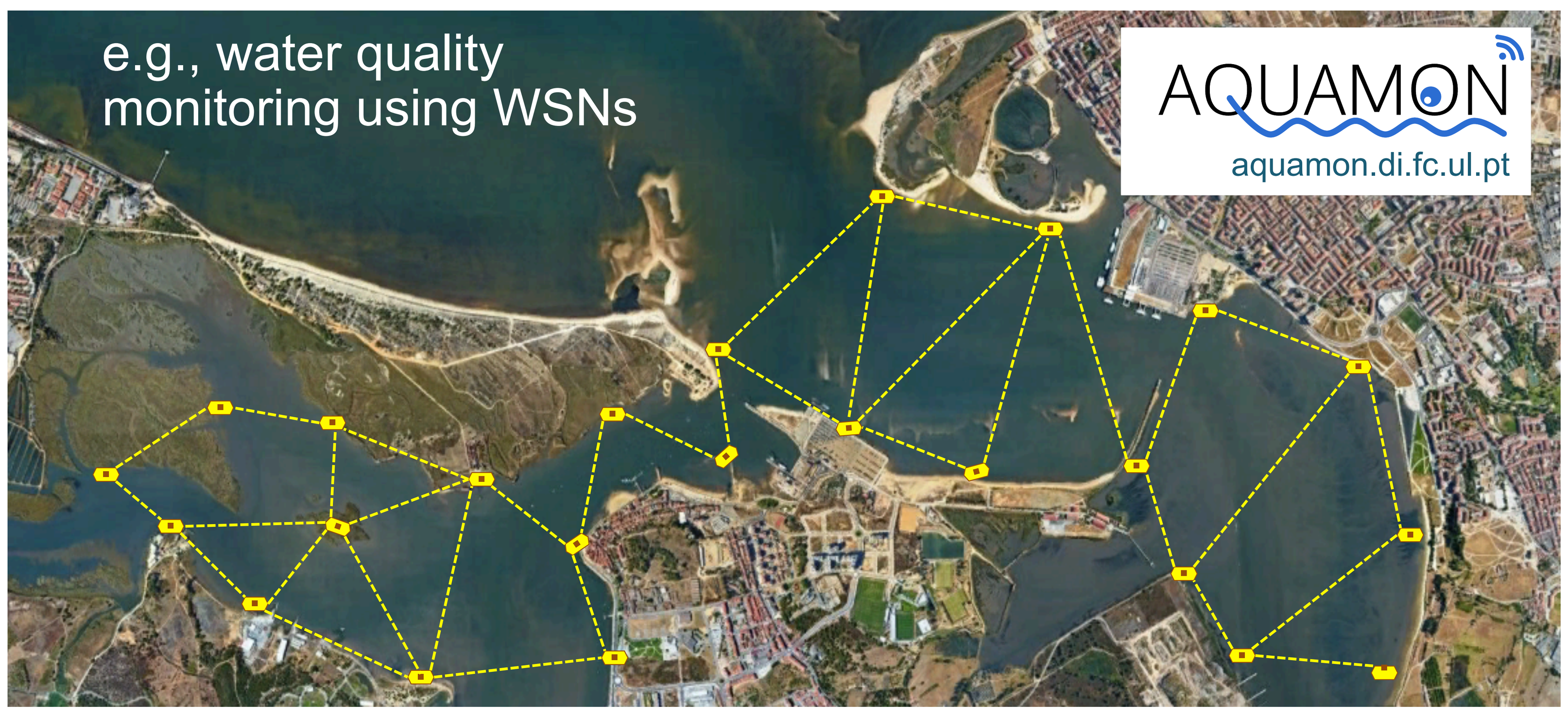
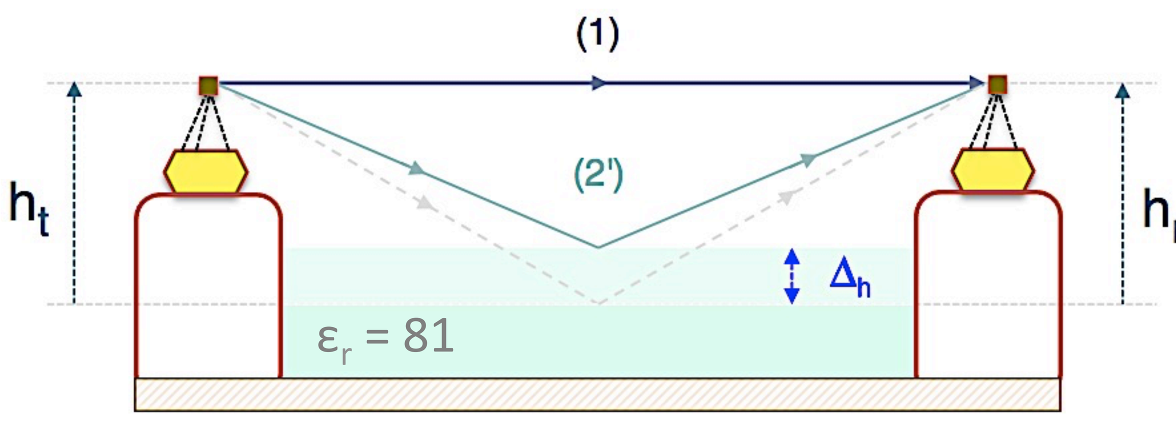
Motivation

- **Large-scale WSNs** in a coastal environment that involves:
  - Several links of short-to-medium range distance
  - Antennas installed at a few meters above the surface
  - Tidal variations in the range of the antennae height

Objective:
assess the impact of antenna height and polarization on overwater links during the cycle of tidal variations.



The impact of antennae height



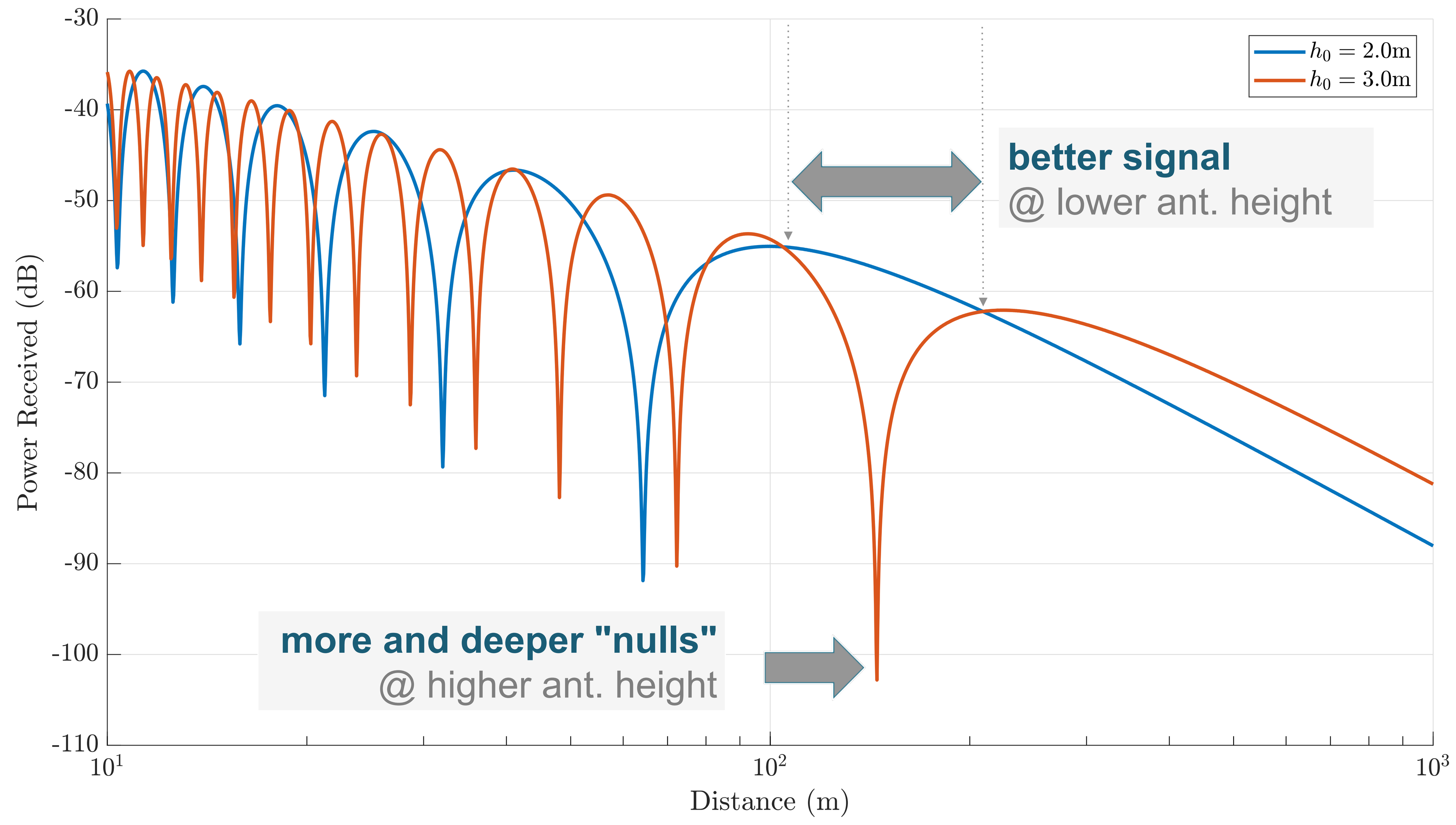
Two-ray model at two different time instants

Power received (Pr) is a function of the distance link (d), the wavelength (λ) and A(θ)

$$P_r(d,\theta) = A^2 \frac{\lambda^2}{(4\pi d)^2} P_t$$

$$A(\theta) = \sqrt{(1+\Gamma\cos\theta)^2 + (\Gamma\sin\theta)^2}$$

A(θ) is a geometrical factor depending on the two-ray model and the Fresnel reflection coefficient (**Γ**)



The impact of tidal cycle & polarization

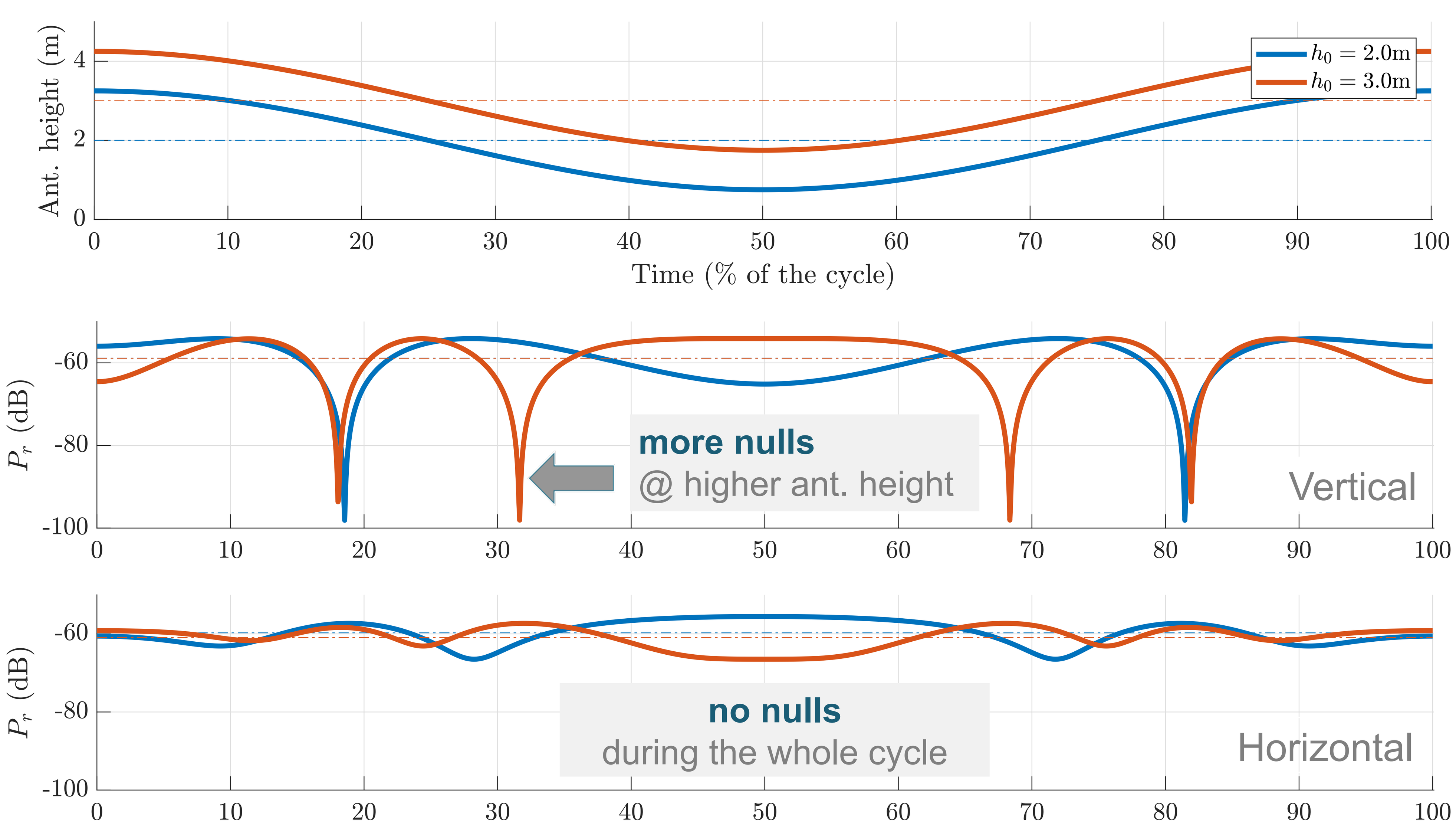
- The **tidal cycle** adds a temporal dimension to the analysis of the two-ray model
- The **vertical & horizontal polarizations** have an impact significantly different on Pr

Vertical Polarization

$$\Gamma_V(\theta) = \frac{-\varepsilon_r \sin\theta + \sqrt{\varepsilon_r - cos^2\theta}}{\varepsilon_r \sin\theta + \sqrt{\varepsilon_r - cos^2\theta}}$$

Horizontal Polarization

$$\Gamma_H(\theta) = \frac{\sin\theta - \sqrt{\varepsilon_r - cos^2\theta}}{\sin\theta + \sqrt{\varepsilon_r - cos^2\theta}}$$



Major observations

- We observed the **horizontal polarization** shows less susceptibility on signal degradation
- We also observed that **lower antenna heights** perform better for part of the tidal cycle

Conclusion & Future Work

- As a result, **traditional approaches** using **higher antenna heights** and **vertical polarization** may present **lower performance** when evaluated over a full tidal cycle
- In future works, we aim to understand which antenna configuration provides better link quality for a longer interval of the tidal cycle

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