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

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

Power received \((P_r)\) is a function of the distance link \((d)\), the wavelength \((\lambda)\) and \(A(\theta)\):

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

\(A(\theta)\) is a geometrical factor depending on the two-ray model and the Fresnel reflection coefficient \((\Gamma)\).

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 \(P_r\)

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