Network Analysis and Simulation - Homework 4

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Exercise 2 - Read logs and analyze data

In this second exercise the goal was to extract a look-up table from a log file of a simulator and use it to compute some measurements on useful quantities in underwater optical communications. In particular, the log files are obtained from the simulations of the ambient light irradiance E_0 with the simulator HYDROLIGHT. From the 3 different dump files (each for a different value of $c \in [0.15, 0.4, 2.19]$ with c the attenuation coefficient) I recovered the values of E_0 and the corresponding depth z in meters using a `perl` script. It uses a regular expression to identify the right rows of the log and selects the columns with the desired values. In Figure 1 E_0 is plotted as a function of the depth z.

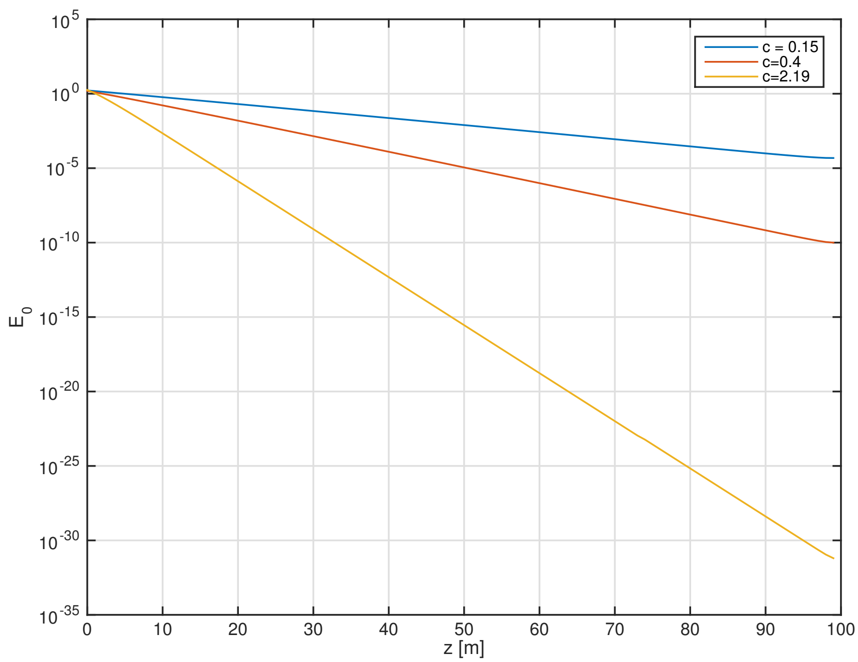


Figure 1: Irradiance E_0 vs. z

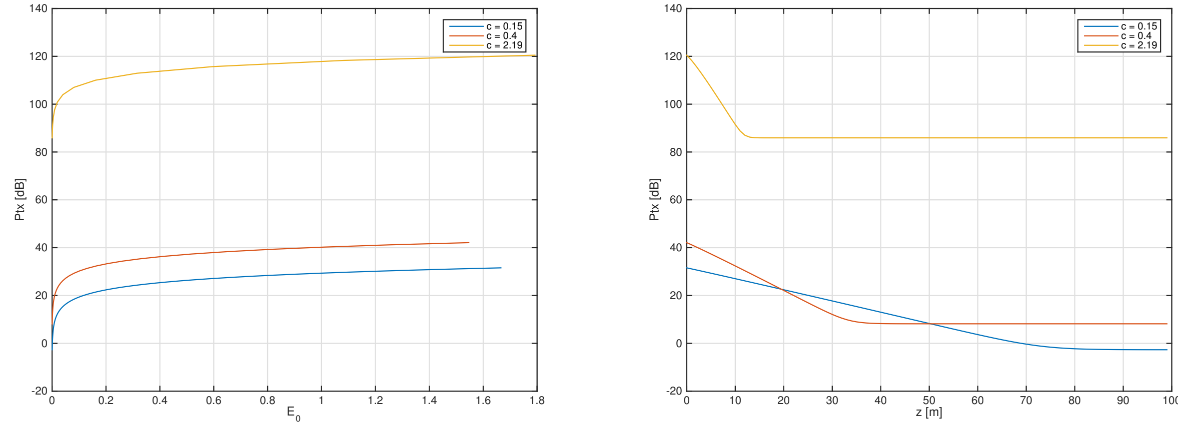
Some evaluation on the propagation are then carried out with a MATLAB script that uses the provided parameters for receiver and transmitter. The propagation model used the one proposed in [2] and assumes that there is a successful transmission if the SNR is over a certain threshold. In particular from the irradiance and the parameters S (sensitivity) and A_r (area of the receiver) of the considered modem it is possible to compute the power of ambient light noise, which is $N_A = (SE_0A_r)^2$. Let the received power P be

$$P = \frac{2P_{tx}A_r\cos(\beta)}{\pi d^2(1-\cos(\theta))+2A_t}e^{-cd} \tag{1}$$

then the SNR is

$$\Gamma = \frac{(SP)^2}{2q(I_D+I_L)BW+\frac{4KTBW}{R}+N_A} \tag{2}$$

In the following, if the SNR is above the threshold of 20 dB then there is a successful transmission. In particular, by setting the threshold and a distance $d = 10$ m, by inverting (2) in order to get P and (1) in order to compute P_{tx} it is possible to know which is the minimum transmission power that can be used to reach a distance d. In Figure 2[a] there is the plot of the minimum P_{tx} against the irradiance E_0, while in Figure 2[b] the x axis is the depth z considered.

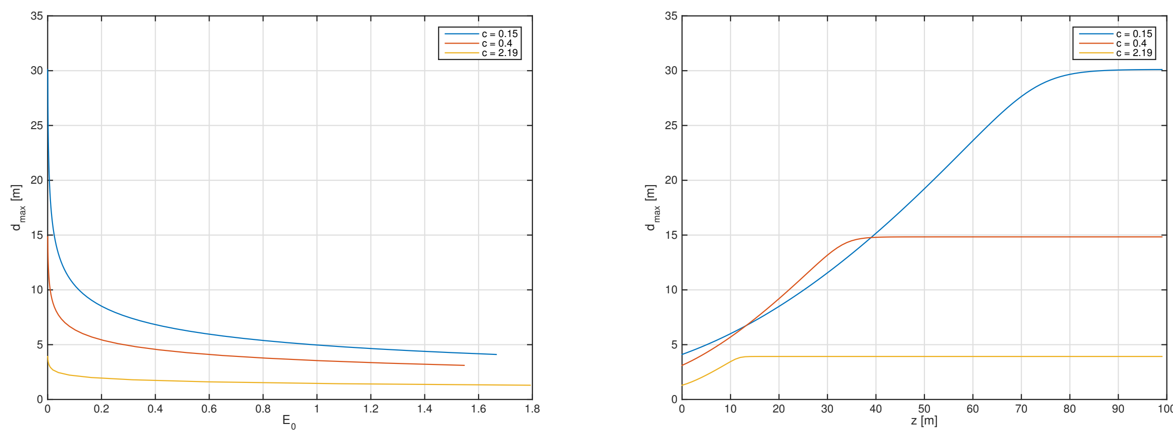


(a) P_{tx} to reach $d = 10$ m as a function of E_0

(b) P_{tx} to reach $d = 10$ m as a function of z

Figure 2: Transmitted power P_{tx} required to transmit at a distance of $d = 10$ meters

Finally, the transmit power is set to $P_{tx,max} = 100$ W and the maximum distance at which is possible to transmit is evaluated. Note that (1) is not invertible with respect to the distance d, therefore the received power P given by (1) is precomputed for $d \in [0, 50]$ m and stored in a vector `P_d`. Then, given a certain E_0, from (2) the minimum received power to guarantee an SNR of 20 dB is computed and the closest P in `P_d` is found. The corresponding value of d is chosen as the maximum distance d_{max} at which it is possible to transmit with $P_{tx,max} = 100$ W and that E_0 - or the corresponding z.
The results are in Figure **??**.



(a) d_{max} as a function of E_0, for $P_{tx,max} = 100$

(b) d_{max} as a function of z, for $P_{tx,max} = 100$

References

[1] Y. Le Boudec, Performance Evaluation of Computer and Communications Systems, EPFL, 2015

[2] D. Anguita et al., Optical wireless underwater communication for AUV: Preliminary simulation and experimental results, in Proc. IEEE/OES Oceans, Santander, Spain, Jun. 2011