

LMS AND H-SATCOM CHANNELS CHARACTERIZATION AT X AND KU BANDS

Edgar Lemos Cid

Advisors:

Ana Vázquez Alejos

Manuel García Sánchez

Signal Theory and Communications Department – University of Vigo



Motivation of the work:

- Communications between individuals and between portable devices are of great importance today.
- It is necessary to consider new frequency bands wherein large amounts of required data can be transmitted.
- In this work I study the characterization and modelling of the radio channel satellite communications in X and Ku bands using a transmitter located at a predominant position over the terrain.
- Two radio channels are investigated: Helicopter Satellite Communications (H-SATCOM) and Land Mobile Satellite (LMS).

Thesis Objectives:

The main objective of this research project is to study, characterize and modelling H-SATCOM and LMS radio channels in the X and Ku bands [1].

The objectives are:

- Design, fabricate and calibrate an ad-hoc measurement system using a sweep time delay cross-correlation (STDCC) sounder.
- Measurement of H-SATCOM and LMS radio channels.
- Wideband and narrowband study and modelling of the proposed radio channels.
- Analysis of spatial and polarization diversity technics to mitigate the radio channel impairments.
- Analysis of vegetation scattering under an anechoic chamber conditions.

Research Plan:

Task	Duration	Month																			
		9	10	11	12	1	2	3	4	5	6	7	8								
1 Literature review	4 M																				
2 Measurement system designs using STDCC techniq.	2 M																				
3 Definition of measurement scenarios	2 M																				
4 Carried out the H-SATCOM measurements	2 M																				
5 H-SATCOM radio channel analysis and modelling	6 M																				
6 Carried out the LMS measurements	1 M																				
7 LMS radio channel analysis and modelling	5 M																				
8 Carried out vegetation measurements	2 M																				
9 Vegetation scattering analysis and modelling	6 M																				
10 Documentation	3 M																				

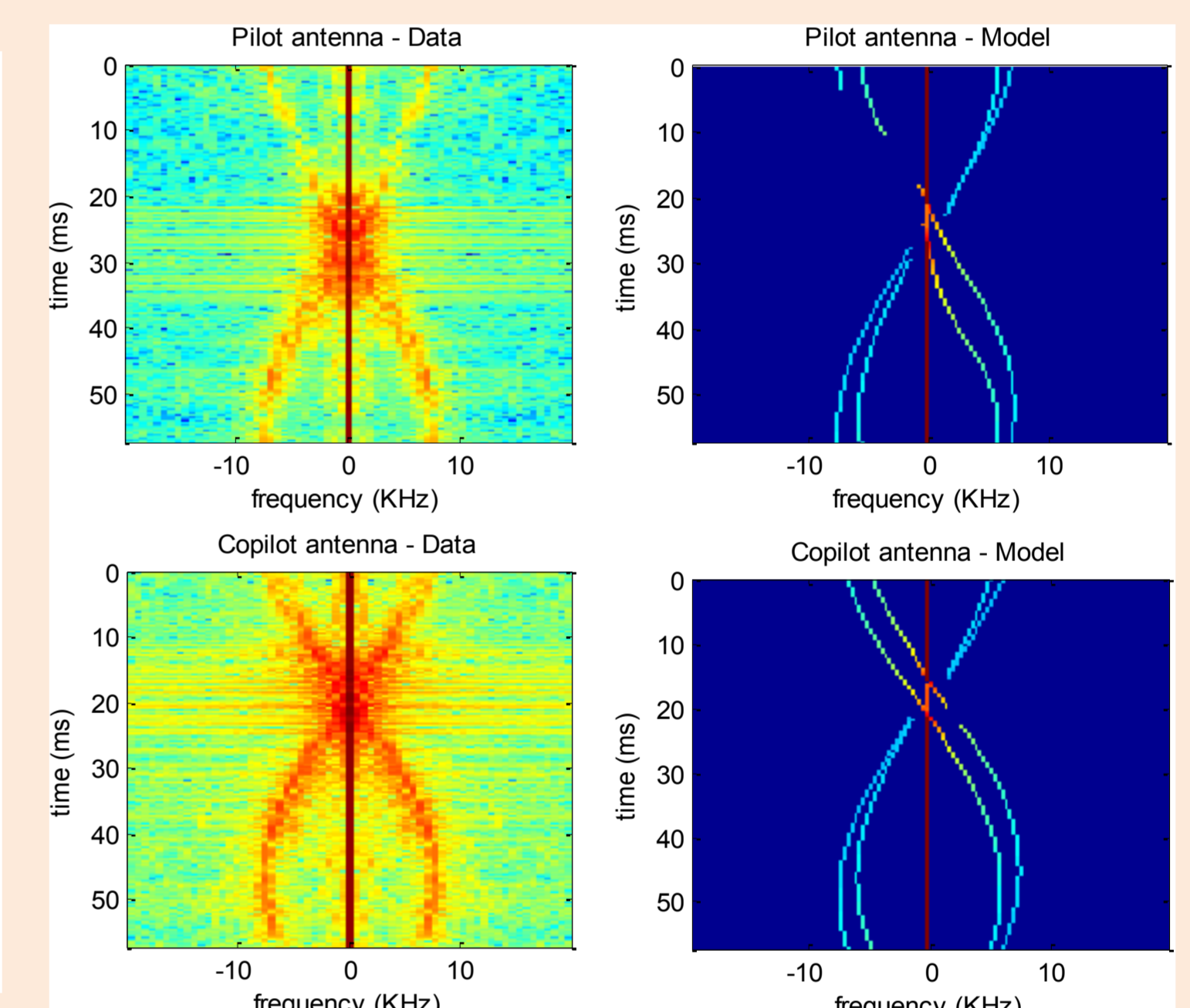
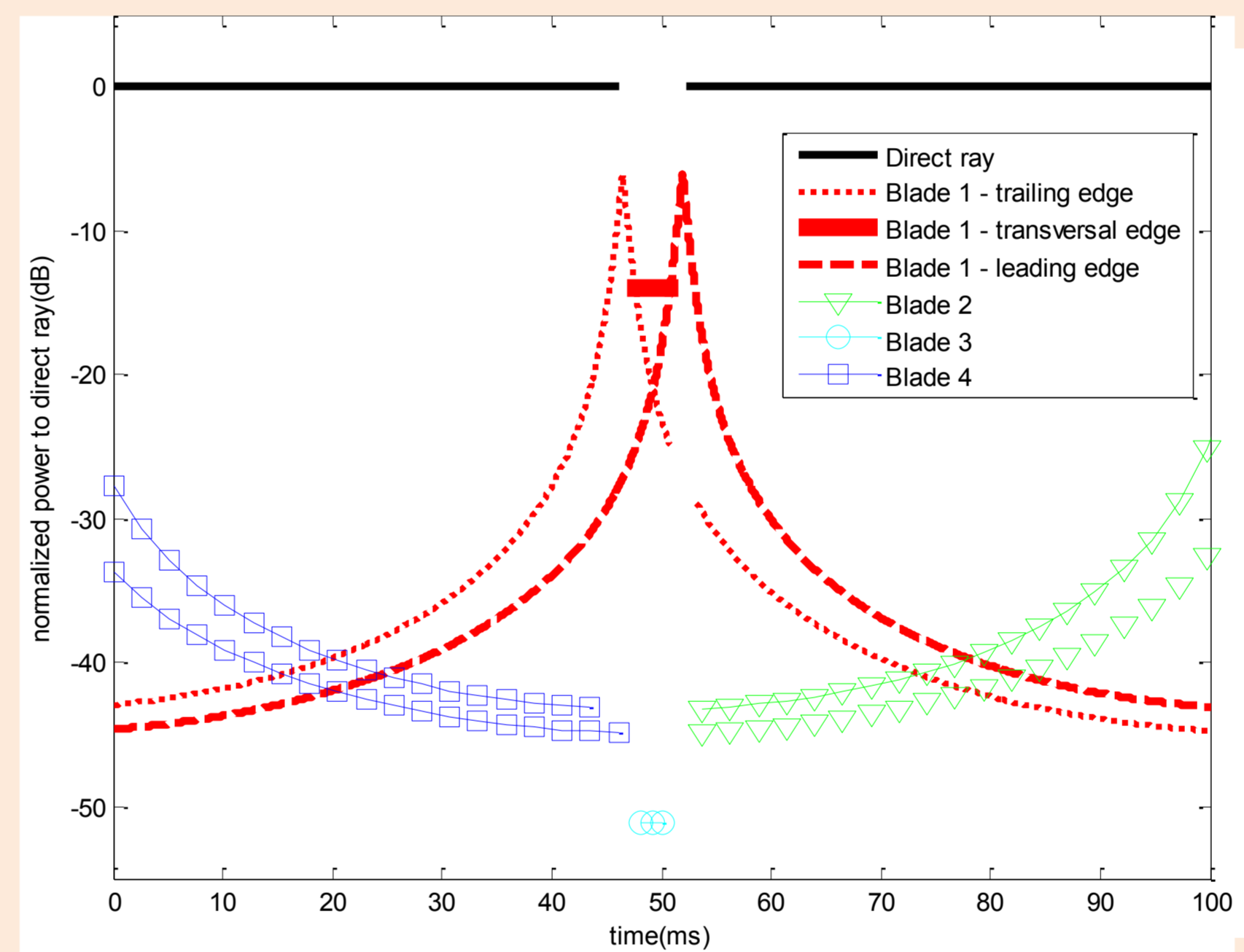
Next Year Planning:

- Document the Doctoral theses.

Results & Discussions:

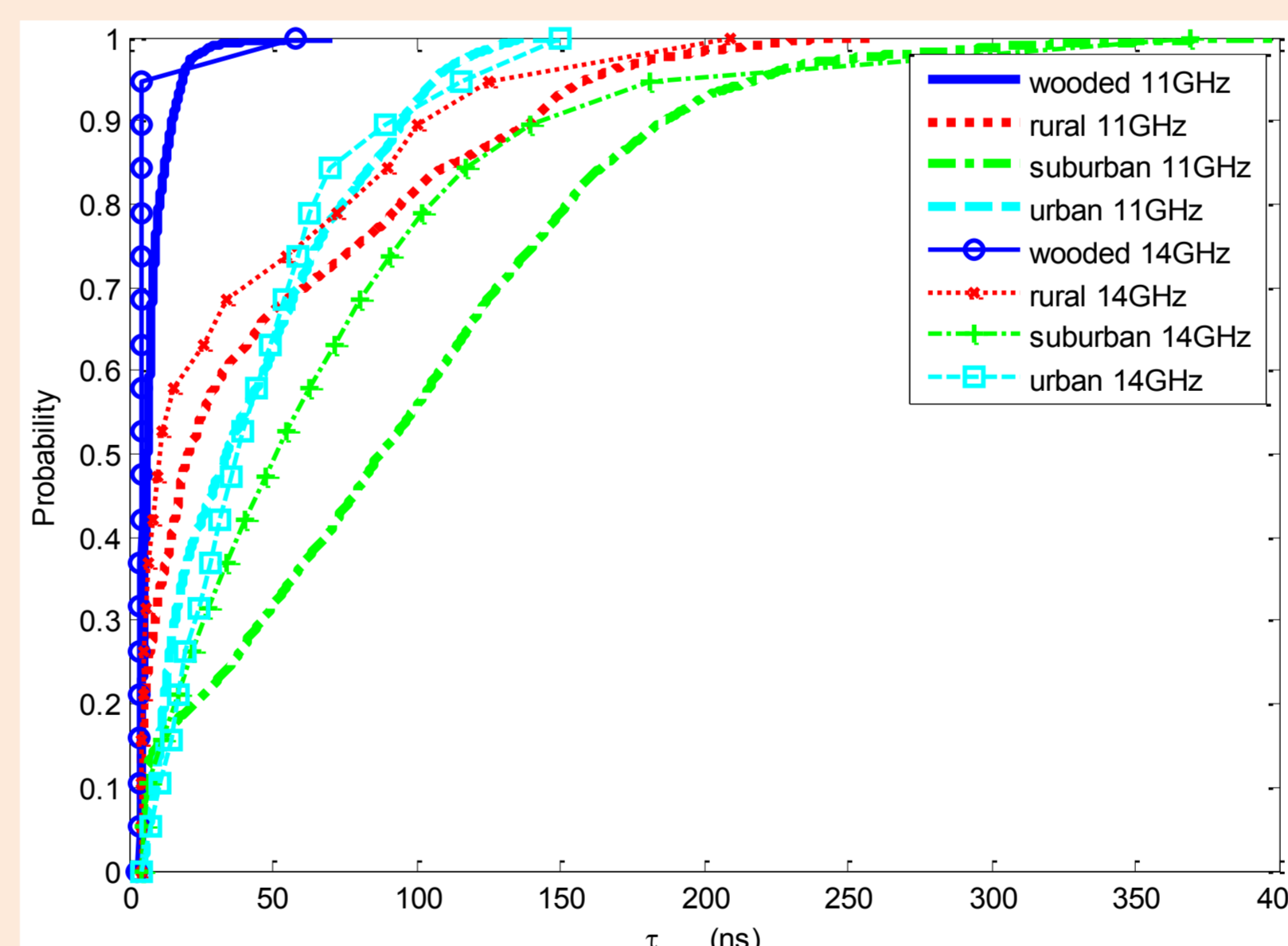
H-SATCOM [2]-[3]:

- Ku band analysis.
- Spatial and polarization diversity.
- Not selective in frequency for 32 or 72 MHz transponders.
- Time-varying complex signal envelope with a Deep signal fading and Oscillatory behaviour.
- 3D ray tracing model.



LMS [4]:

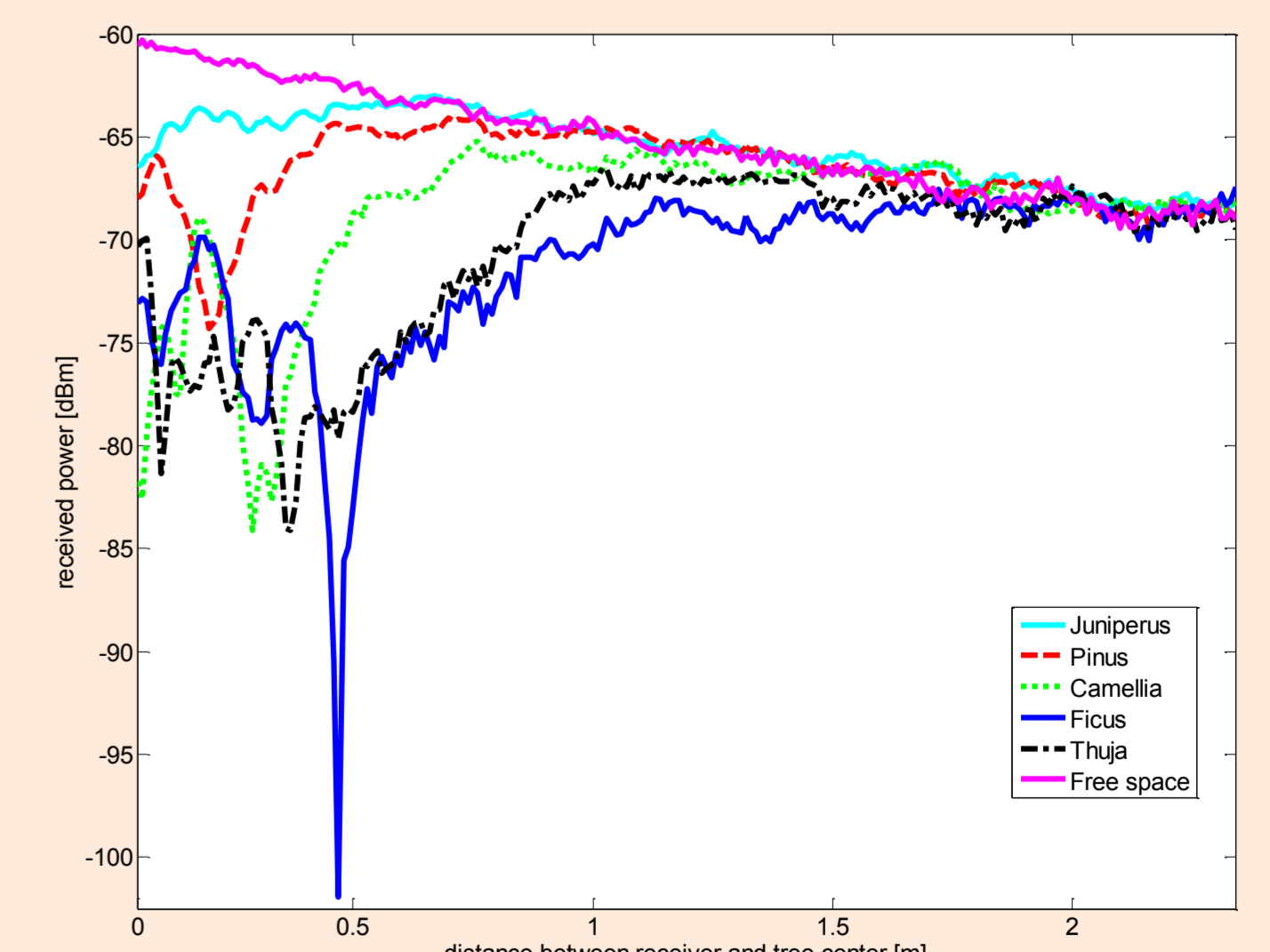
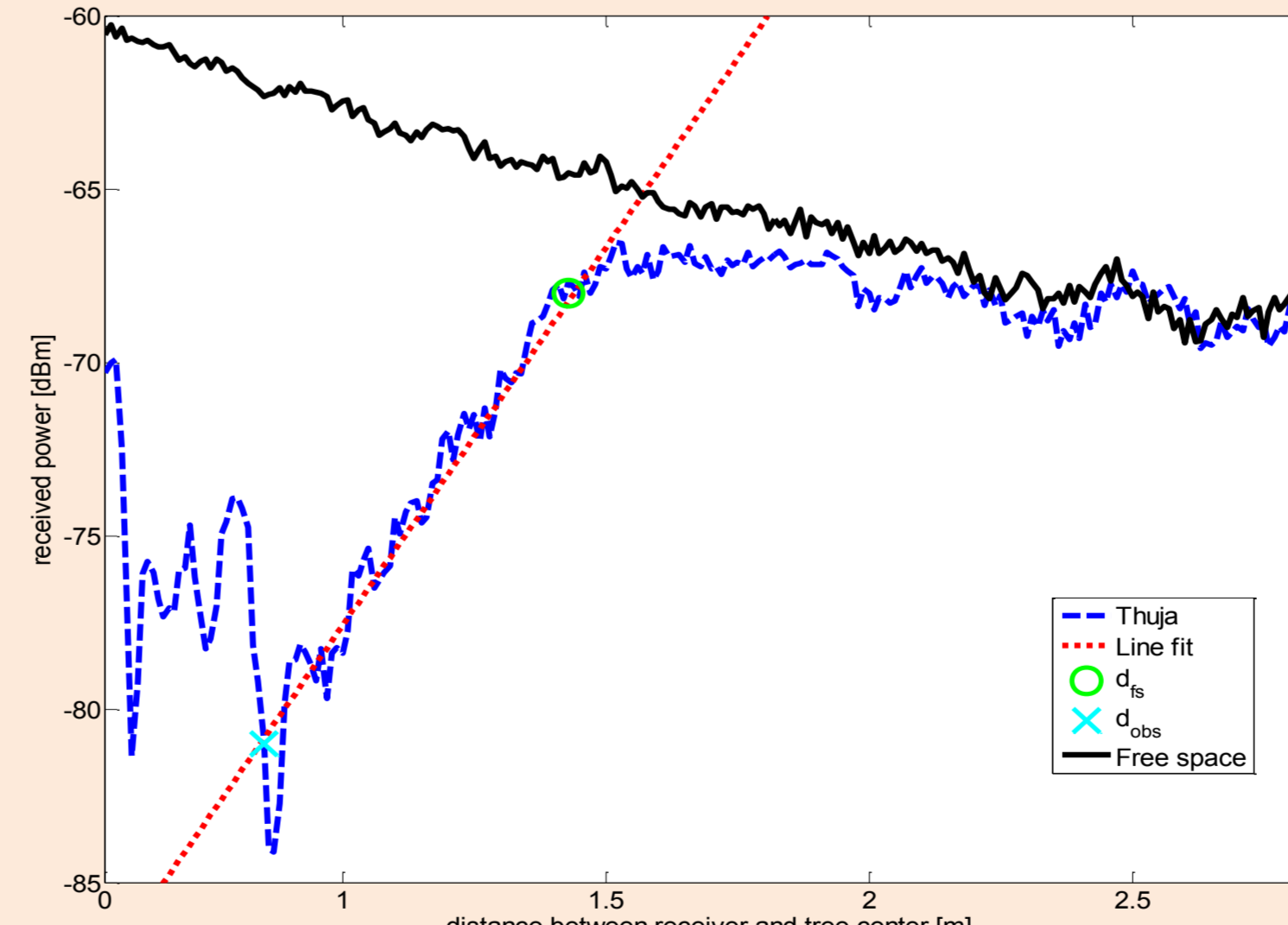
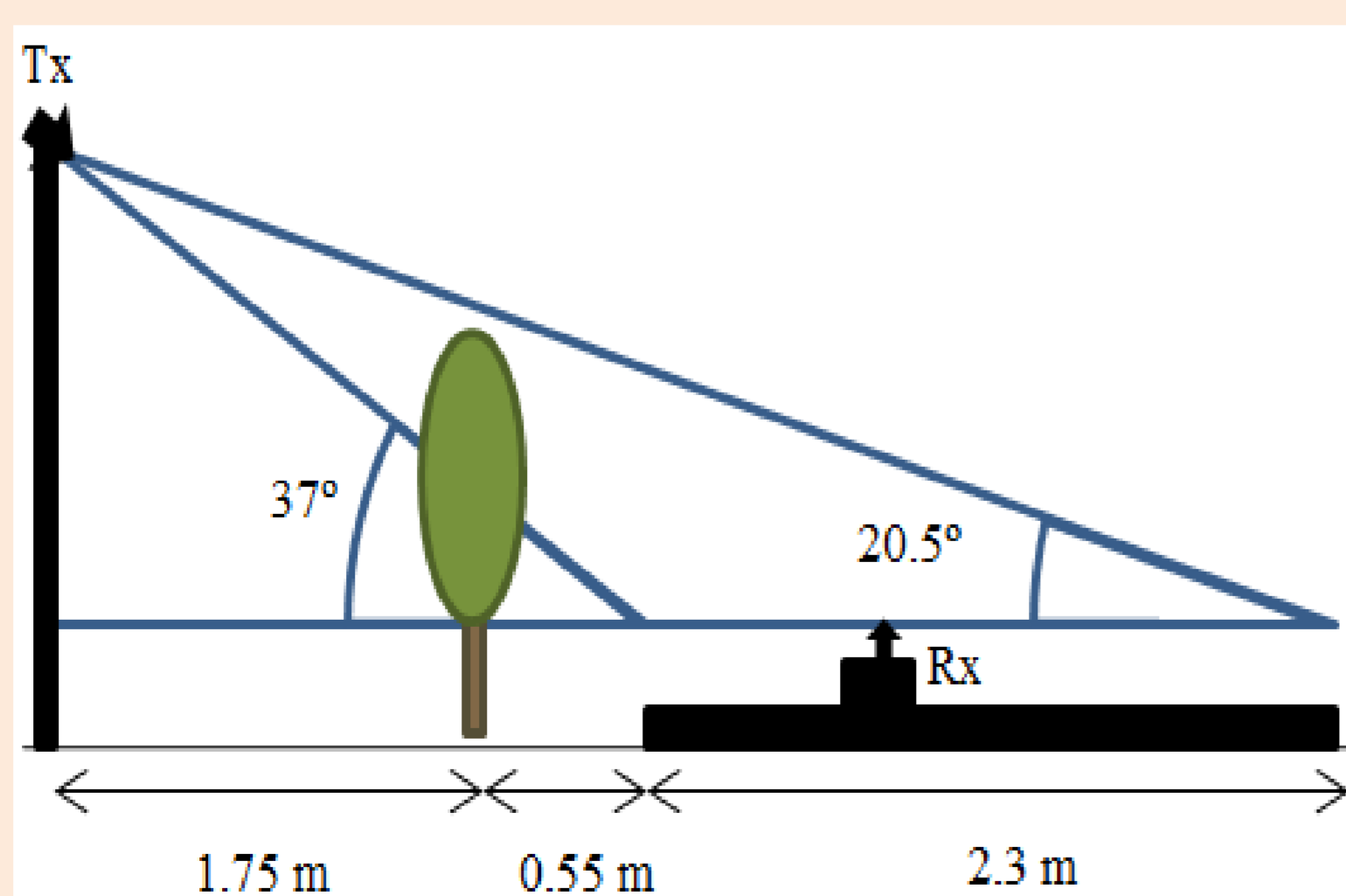
- Larger values have been obtained for the urban and suburban environments.
- Small or high τ_{rms} values at different positions in the rural environment.
- τ_{rms} values are smaller at wooded areas.



Environment	STATE 1	STATE 2	STATE 3	Total
PROBABILITY AT 11.2 GHz / 14.155 GHz				
Wooded	0.18 / 0.08	0.33 / 0.25	0.48 / 0.67	1 / 1
Rural	0.23 / 0.09	0.25 / 0.21	0.52 / 0.69	1 / 1
Suburban	0.10 / 0.12	0.31 / 0.31	0.59 / 0.58	1 / 1
Urban	0.05 / 0.05	0.23 / 0.19	0.72 / 0.76	1 / 1
COHERENCE BANDWIDTH (MHz) EXCEEDED 95% OF THE TIME FOR C=0.7 AT 11.2 GHz / 14.155 GHz				
Wooded	58 / 60	34 / 42	14 / 18	19 / 37
Rural	57 / 13	31 / 15	13 / 10	20 / 13
Suburban	44 / 55	6 / 32	2 / 2	4 / 2
Urban	38 / 59	8 / 21	4 / 4	8 / 5

Vegetation [5]-[6]:

- Power fading models require to be improved to consider short propagation distances travelled through the vegetation medium.
- New model have been proposed.



References:

1. E. Lemos Cid, A. V. Alejos, M. G. Sanchez, "Emergency and Disaster Wideband Communication involving Satellites, Helicopters and Ground Mobile systems", 2014 Defence, Security and Space Forum, Rome, Italy, Oct. 6-9, 2014.
2. E. Lemos Cid, M. G. Sánchez, A. V. Alejos, S. García Fernandez, "Measurement, Characterization and Modeling of the Helicopter Satellite Communication Radio Channel", IEEE Transactions on Antennas and Propagation, vol. 62, no.7, pp.3776-3785. July 2014.
3. E. Lemos Cid, M. G. Sanchez, and A. V. Alejos, "An UTD Ray Tracing Model for Satellite-to-Helicopter Aeronautical Radio Channel Analysis," in Proc. 10th Euro. Conf. Antennas Propag. (EuCAP), Davos, Switzerland, Apr. 10-15, 2016.
4. E. Lemos Cid, M. G. Sanchez, and A. V. Alejos, "Wideband Analysis of the Satellite Communication Channel at Ku and X bands," IEEE Trans. on Vehicular Technology, vol. 64, no. 4, pp. 2787 – 2790. April 2016.
5. E. Lemos Cid, M. G. Sanchez, A. V. Alejos, "Experimental assessment of excess loss prediction models for satellite-to-Earth radio links shadowed by single in-leaf trees," IET Microwaves, Antennas & Propagation, vol. 10 no. 2, pp. 141 – 146. January 2016.
6. E. Lemos Cid, A. V. Alejos, M. G. Sanchez, "Empirical Loss Modelling for Low Elevation Angle Satellite Paths Obstructed by Isolated Thin Trees," Accepted for IEEE Vehicular Technology Magazine.