RADIO WAVE DIFFRACTION BY TERRAIN IRREGULARITIES

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Abstract

Nowadays there is a renewed interest in the analysis of radio wave propagation over an inhomogeneous Earth. The motivation for such studies is the need of accurate path specific propagation models to be used, for instance, in the prediction of the coverage area of a broadcasting station and radio interference issues. The major difficulty in the analysis of the diffraction by terrain irregularities is to model the interaction between the electromagnetic wave and relief features. Propagation mechanisms such as ground wave over a smooth spherical Earth and multiple diffraction by isolated obstacles are examples where the accuracy is closely related to specific topographical features. There are consolidated algorithms to solve these limiting cases. Nevertheless, an important question remains, i.e., how to handle a situation where the variations of the relief are within the limits between smooth Earth and isolated obstacles? The rigorous solution to this problem is given by an integral equation where the terrain is represented by a completely arbitrary profile along the great circle path and the electrical properties of the medium can vary continuously. In other words, it can deal with complicated variations of terrain without introducing approximations based on the geometry of the problem. However, this solution has some limitations such as the need of a great deal of computer storage, a numerical instability for high frequencies and to the fact that steep slopes and cliffs cannot be included. This paper describes a semi-empirical model based on a statistical parameter Δh which characterizes the variations in ground height along part or all of a propagation path. Once this parameter is evaluated in a given path, it is possible to define the application of the above limiting cases (smooth Earth and multiple diffraction). The comparison between this model with experimental data has shown a reasonable agreement with a mean error near 6 dB and a standard deviation around 11 dB.

INTRODUCTION

MOTIVATION OF THIS STUDY

DEVELOPMENT OF ACCURATE PATH SPECIFIC MODELS.

EXAMPLES:

a) PREDICTION OF COVERAGE AREA OF A BROADCASTING STATION

b) RADIO INTERFERENCE STUDIES

MAJOR DIFFICULTY

MODELLING THE INTERACTION BETWEEN THE ELECTROMAGNETIC WAVE AND TERRAIN FEATURES

LIMITING CASES

DIFFRACTION OVER A SMOOTH EARTH

DIFFRACTION OVER ISOLATED OBSTACLES

PARAMETER Δh

Δh – A STATISTICAL PARAMETER WITH CHARACTERIZES THE VARIATIONS IN GROUND HEIGHT ALONG PART OR ALL OF A PROPAGATION PATH

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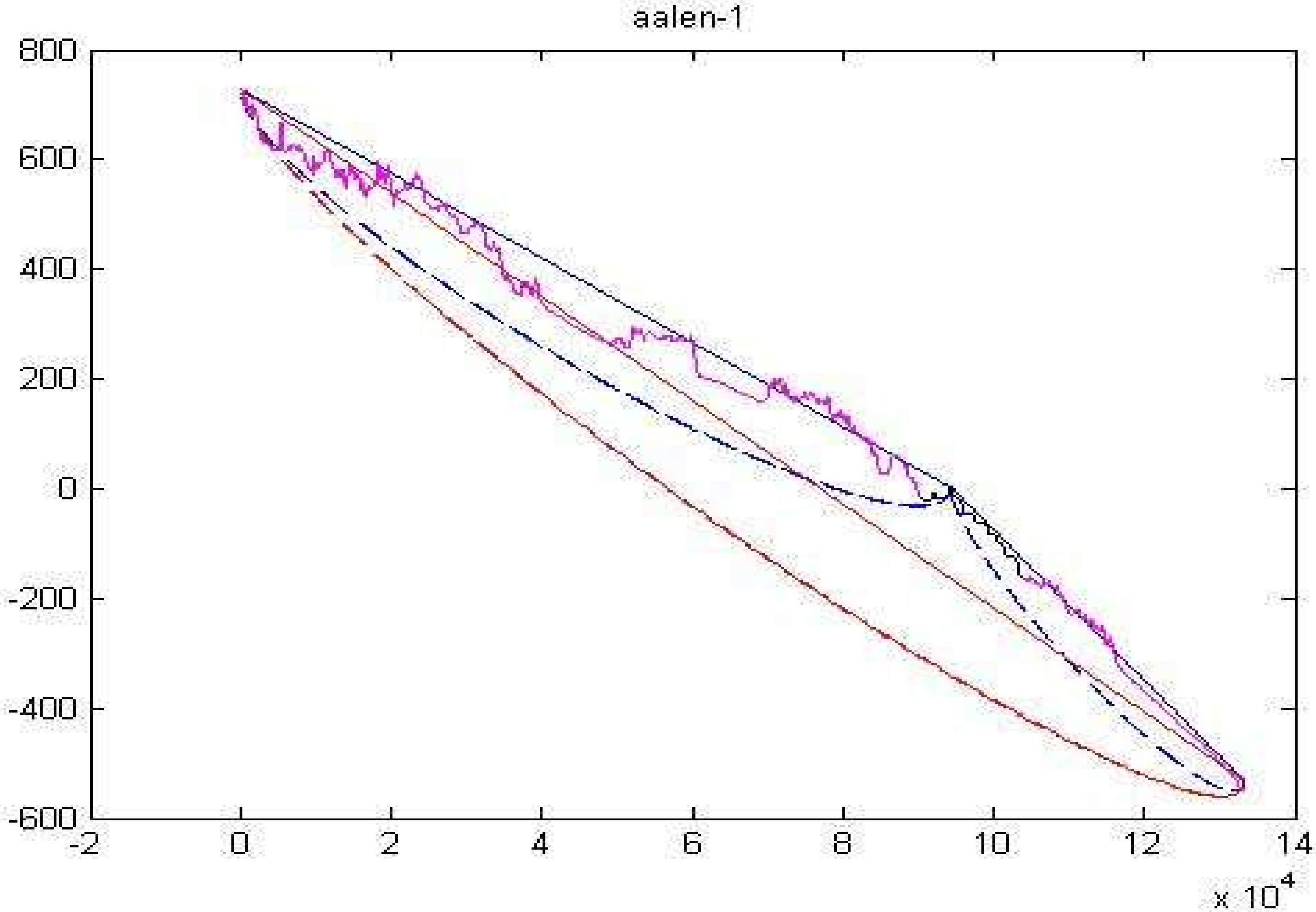
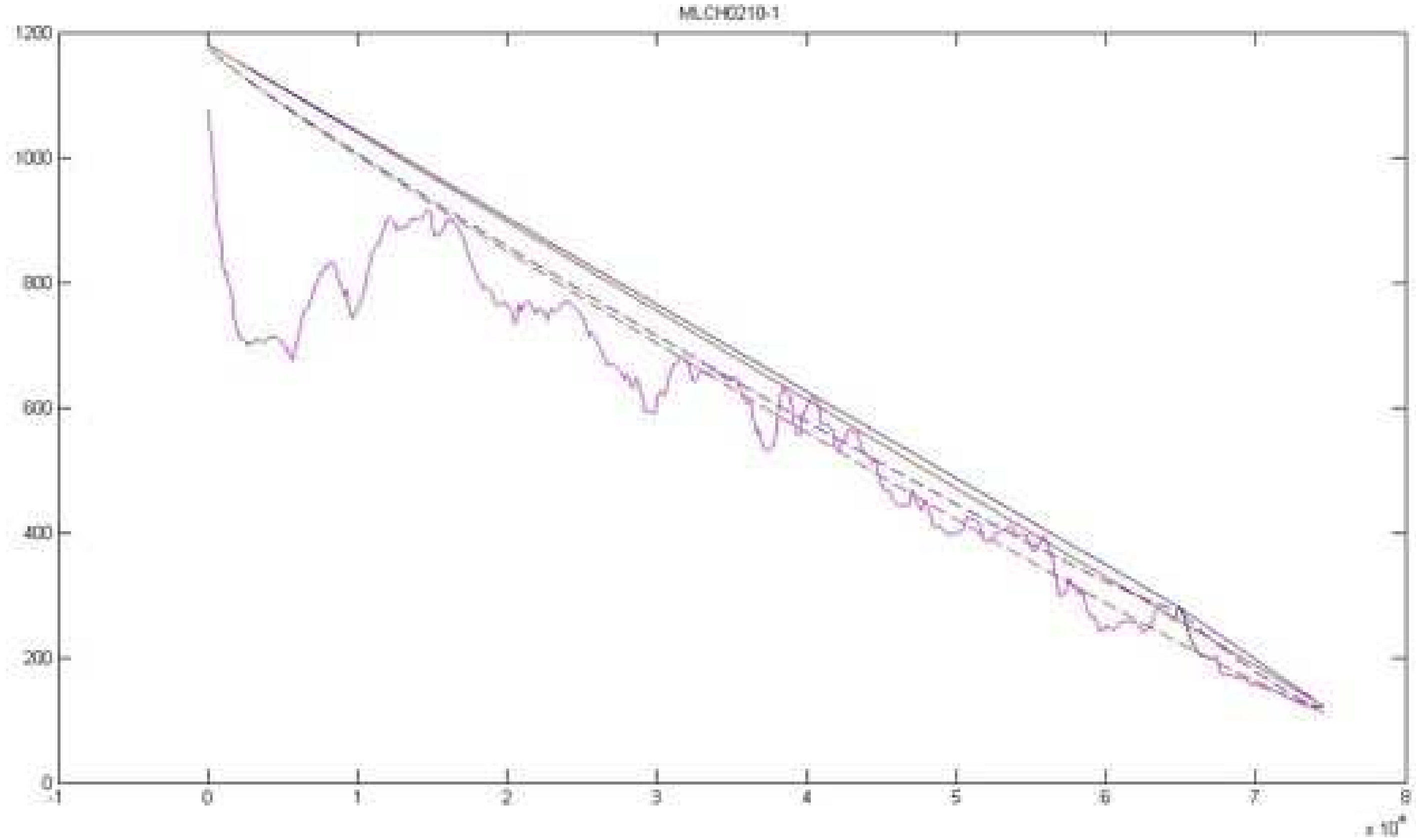
THE DIFFERENCE BETWEEN THE HEIGHTS EXCEEDED BY 10% AND 90% RESPECTIVELY OF THE TERRAIN HEIGHTS MEASURED AT REGULAR INTERVALS (THE INTERDECILE HEIGHT RANGE) ALONG A SPECIFIED SECTION OF A PATH

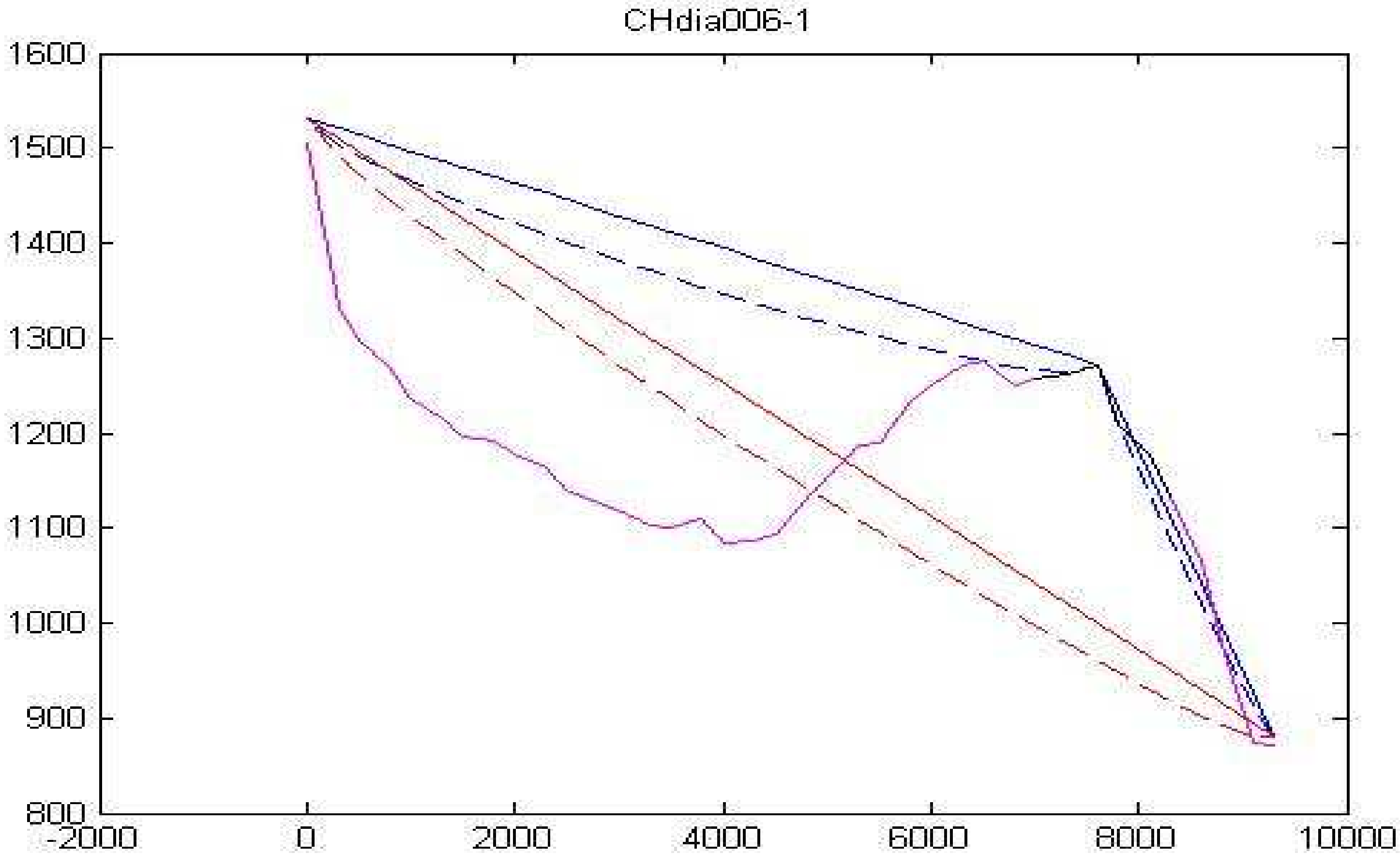
EXAMPLE 1



EXAMPLE 2

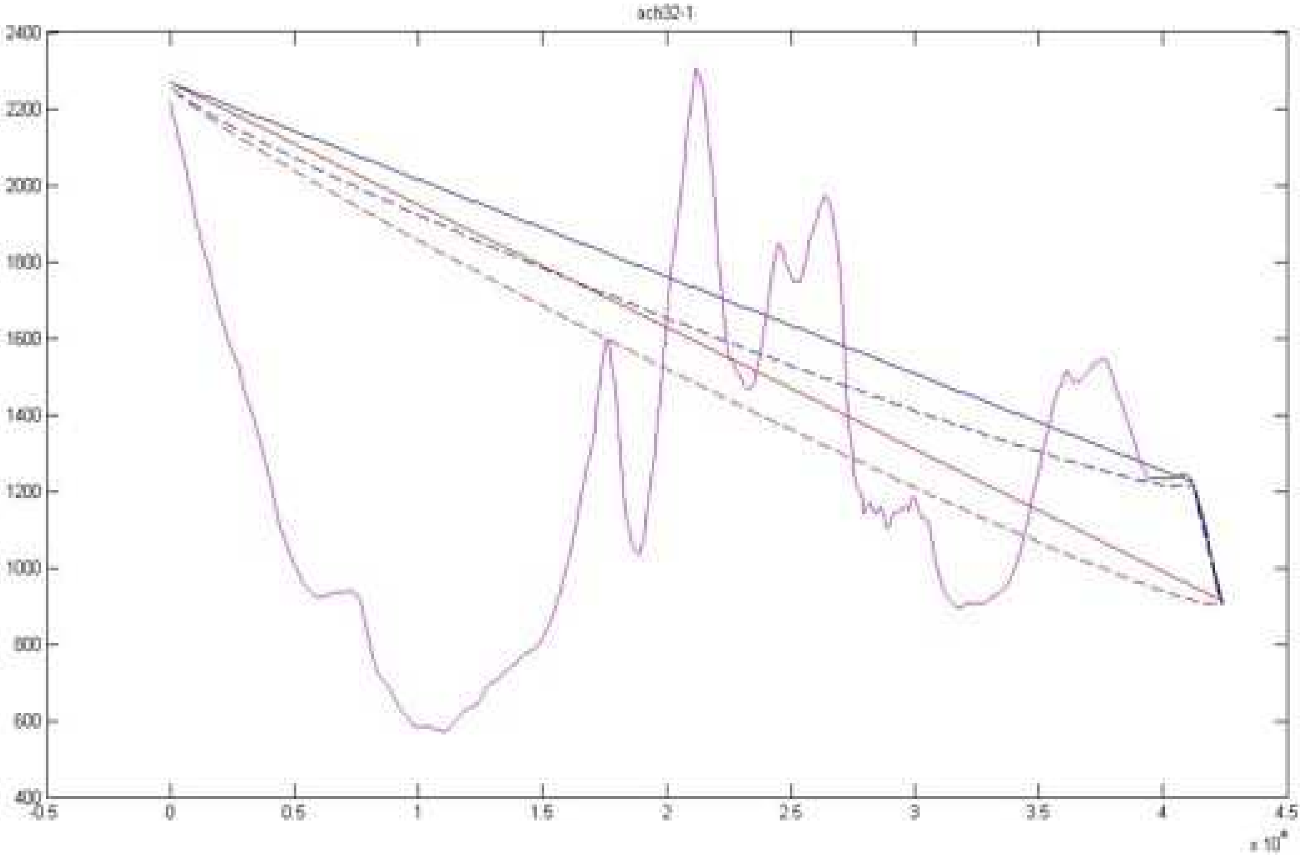


EXAMPLE 3



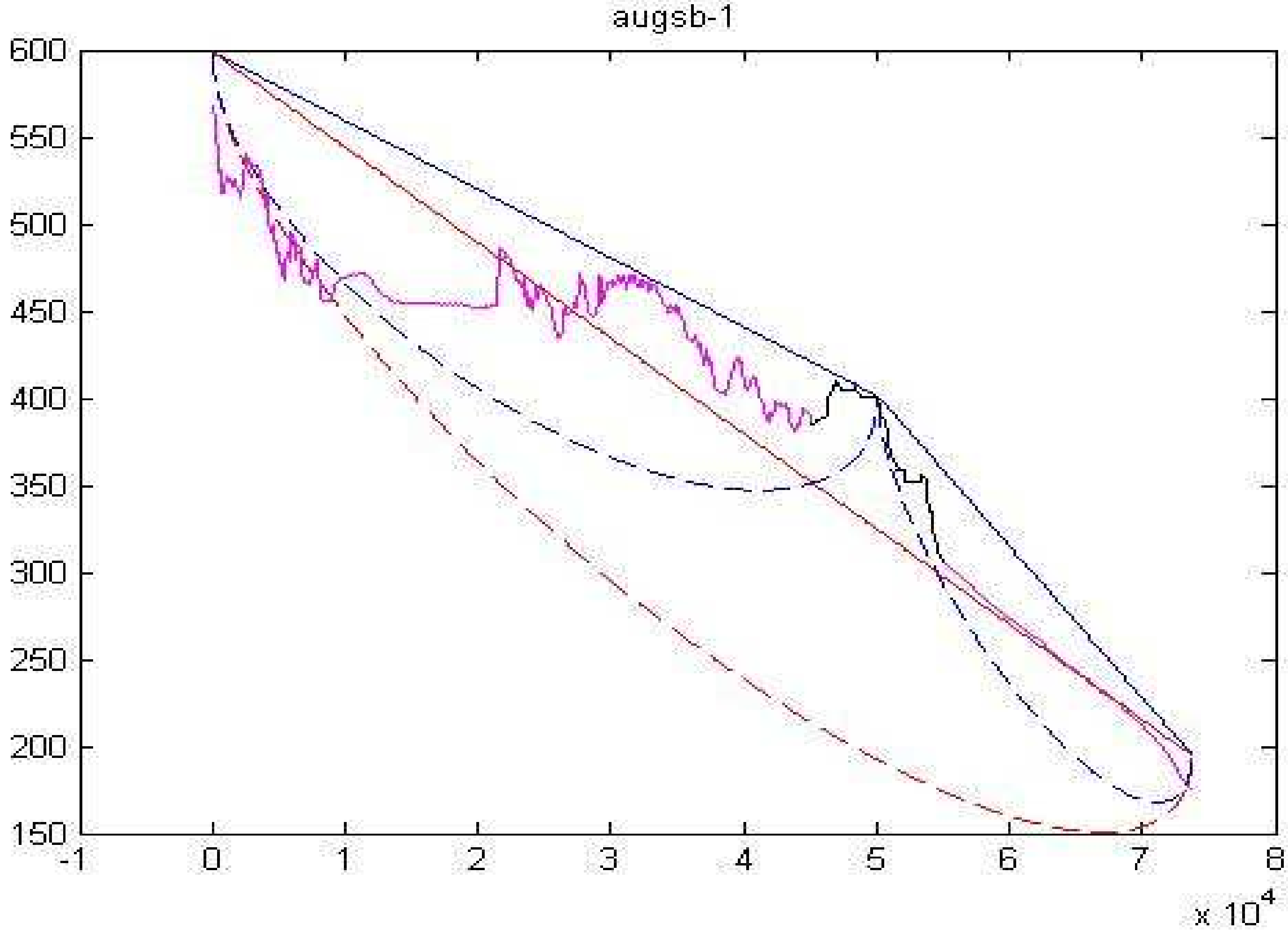
CHdia006-1
1600
1500
1400
1300
1200
1100
1000
900
800
-2000
0
2000
4000
6000
8000
10000

EXAMPLE 4



ach32-1
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
-0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
x 10^4

EXAMPLE 5


augsb-1
600
550
500
450
400
350
300
250
200
150
-1
0
1
2
3
4
5
6
7
8
x 10^4