HamSCI: Eclipse Simulator Documentation

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1 Introduction

HamSCI's eclipse simulator (colloquially known as "`eclipsesim`") is a software package developed by members of the HamSCI team at the New Jersey Institute of Technology used to simulate HF (3-30 MHz) through the ionosphere. Specifically, the package was developed in order to simulate the effects of the August 21, 2017 total solar eclipse on HF amateur "ham" radio communications. The bulk of the package is developed in MATLAB. However, the inputs and outputs are both in the comma-separated values (CSV) format in order to allow for easy interoperability with other analysis tools (such as those written in Python, R, or Julia).

This document is written in order to provide the reader with an understand of the inner workings of the simulation package as well as justify some of the design decisions that were made during development. In addition, this document is intended to be used as a helpful guide to using the package. Because of this, as the package undergoes future changes, so too should this document in order to maintain parity between the package and its documentation.

2 Dependencies

The `eclipsesim` package relies on a few third-party dependencies in order to implement some specialized functionality. This section provides a brief overview of the different dependencies and their function.

2.1 PHaRLAP

PHaRLAP[1]is a robust HF raytracing toolkit developed by Dr. Manuel Cervera of the Defence Science and Technology Group, Australia. It is used to compute the actual ray paths of radio transmission from transmitter to receiver. More information on how it is used is provided in section 4. Although the core of the toolkit is written in FORTRAN, a MATLAB application programming interface (API) is provided. PHaRLAP also provides a simple API for the IRI (see below) that is compatible with the ray path computation API.

2.2 IRI

The International Reference Ionosphere (IRI)[2]is a ionospheric model developed by the Committee on Space Research (COSPAR) and International Union of Radio Science (URSI). It is periodically updated to incorporate new measurements. It generates monthly averages for several ionospheric measurements including electron density, and electron and ion temperatures.

[1] *"The results published in this paper were obtained using the HF propagation toolbox, PHaRLAP, created by Dr. Manuel Cervera, Defence Science and Technology Group, Australia (manuel.cervera@dsto.defence.gov.au). This toolbox is available by request from its author."*

[2] `http://irimodel.org/`

2.3 SAMI3

3 Usage

The `eclipsesim` package provides two methods of execution out-of-the-box: serially and in parallel. More information and specific instructions on each execution method is discussed in subsection 3.1 and subsection 3.2, respectively.

Regardless of the execution method used, `eclipsesim` is designed to be executed on a Linux-based machine. While limited success has been achieved on other operating systems (notably, Microsoft Windows), the execution scripts are developed with Linux in mind and may not execute as expected in incompatible environments. All instructions provided in this section are therefore intended for Linux-based systems and may require modification for other operating systems.

3.1 Serial

3.2 Parallel

3.3 Input

3.4 Output

4 Design

4.1 Rough Pass

4.2 Fine Pass

4.3 Plotting

5 Extensions

5.1 "10-hop"

6 Conclusion

7 References