README

Title: Earth (sea) Surface Bistatic Scattering Coefficient Prediction Model

Version: 1.0.0

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Computer Implementation Language: MATLAB, C

Third Party Code Contained: None. (MATLAB standard functions called)

1. General Introduction

This MATLAB code package provides tools for predicting the bistatic scattering coefficients and coherent reflection coefficients for the water surfaces which implements internationally recognized standard Recommendation ITU-R P.2146-0 see https://www.itu.int/rec/R-REC-P.2146. This code also conforms to established validation examples developed and approved by the International Telecommunications Union (ITU-R). The model can be applied at any elevation angle, except grazing incidence, and they work for frequencies between 1 and 100 GHz. For frequencies less than 1 GHz, the coherent component may be the dominant source of any interference effects, greatly simplifying the required modelling of Earth surface reflections.

Moreover, the following three analytic models which are widely used in academic literature for modelling bistatic scattering coefficients, are leveraged in the MATLAB code package:

– Small perturbation model (SPM);

– Kirchhoff approximation model (KA), and

– The two scale scattering model (TSSM).

2. Technical Description

This code calculates bi-static scattering coefficient of sea surface in the plane having the forward direction (plane of incidence) with fixing angle of incidence (theta\_i). The bistatic scattering coefficients (VV & HH) are given as a function of scattering angle (theta\_s) depending on wind speed velocity. The plane of incidence is produced by making the azimuth incidence angle (phi) and azimuth scattering angle (phs) equal to each other (phi=phs=0 Deg). These two angles can be changed to get the bistatc scattering coefficients into other planes. Also, the scattering angle can be fixed, and the angle of incidence can be varied.

SCRIPT ROUTINE:

There is a script style routine that will work by run execution called SEA\_SURFACE\_REFLECTIONS\_SCRIPT.m.

FUNCTION ROUTINE:

There is also a function style called SEA\_SURFACE\_REFLECTIONS.m routine that can be incorporated into a larger code framework or workspace.

This code also uses the following MATLAB function submodels:

i) saline\_water\_eps\_new: gives the complex relative permittivity of sea water

ii) sea\_sur\_mss\_itu: gives sea surface mean square slopes

iii) sea\_sur\_ka: gives bistatic scattering coefficients due long gravity waves

iv) sea\_sur\_short\_new1: gives bistatic scattering coefficients due to short capillary waves. uses two other MATLAB functions: gauss, and small\_pert\_model.

v) gauss: It gives Gauss quadrature nodes and weights required in performing integrals required in calculating bistatic scattering coefficient due to short capillary wave

vi) circpolcoef: gives polarization transformations for incident and scatter directions

Instructions for Successful Use of the Program

* The main function file: "SEA\_SURFACE\_REFLECTIONS\_SCRIPT.m ". Execution of the program begins by calling the function that this file defines.
* Be sure to have your current working MATLAB directory in the folder with the main function file.
* The input parameters are shared between those given as arguments to the function and those found in the initial several lines of the main function file. See the comments in the main file for descriptions of the input arguments for the algorithm. If a different set of input parameters for the main function is required, this can be easily remedied by commenting out the respective variable definitions in the main body of the main function and adding those variables to the input parameters.

Example Function Calls

1. SCRIPT

LAND\_SURFACE\_REFLECTIONS\_SCRIPT.m

2.FUNCTION CALL

Inputs:

Freq = 18600; % Frequency [MHz]

ThetaI = 20; % Incident Elevation Angle [deg]

PhiI = 0; % Incident Azimuth Angle [deg]

ThetaS = 20; % Scatter Elevation Angle [deg]

PhiS = 0; % Scatter Azimuth Angle [deg]

Temp = 30; % Temperature [C]

wmv = 0.5; % Volumetric water content

PS = 30.63; % Percentage of sand (%)

PC = 13.48; % Percentage of clay

PSilt = 55.89; % Percentage of Silt

PolI = 'L'; % Incident Polarization Angle ['L' linear,'C' - circular]

PolS = 'L'; % Scatter Polarization Angle ['L' linear,'C' - circular]

Function Call:

[co\_11,co\_12,co\_21,co\_22,di\_11,di\_12,di\_21,di\_22] = LAND\_SURFACE\_REFLECTIONS(Freq, ThetaI, PhiI, ThetaS, PhiS, Temp, wmv, PS, PC, PSilt, PolI, PolS)

Outputs:

co\_11 = coherent scatter coefficient of vert-vert pol

co\_12 = coherent scatter coefficient of vert-horz pol

co\_21 = coherent scatter coefficient of horz-vert pol

co\_22 = coherent scatter coefficient of horz-horz pol

di\_11 = diffuse scatter coefficient of vert-vert pol

di\_12 = diffuse scatter coefficient of horz-vert pol

di\_12 = diffusescatter coefficient of vert-horz pol

di\_22 = diffuse scatter coefficient of horz-horz pol

This README document is not meant to be exhaustive. And many answers to additional questions may be found in the in-line documentation.

Intended Use of the Program / Disclaimer

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POC:

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