WAVPY: AN OPEN-SOURCE TOOL FOR THE GNSS+R COMMUNITY

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MOTIVATION

1) To provide an open source software tool for users of GOLD-RTR-MINING data pool: ***http://www.ice.csic.es/research/gold_rtr_mining/***

2) To establish a valid framework for the GNSS-R community.

SOFTWARE ASPECTS

An open-source C++/Fortran90 library compilable in Linux with **autotools**: *You can check and modify the code!*

An interface to **Python** enables the user to work with a high level language: *An user-friendly environment rather easy to employ!*

NOT JUST A WAVEFORM SIMULATOR!

A SET OF GNSS-R CLASSES

As an **object-oriented architecture**, each class has its own methods to be employed alone, or you can explode their **synergy** by combining them!

CHARACTERIZATION OF A GNSS+R SCENARIO

SPECULAR GEOMETRY CLASS

Defines a specular geometry from receiver and transmitter positions applying ellipsoid WGS84 plus an undulation value.

Computes several aspects related to geometry such as **specular point location**, **inertial delay** and **windup phase** [1].

REFLECTING SURFACE CLASS

Defines the basic aspects of a reflecting surface: **permittivity** and **roughness**.

Computes permittivity and reflectivity values (given incidence angle) from several media: **sea water**, **sea ice**, **wet snow**, **dry snow** and **soil** at L-band.

Computes **directional MSS** from **spectrum** (either user-loaded or computed by means of [2]) or from **wind speed fields** using [3].

RECEIVER FRONT-END CLASS

Defines the main aspects of a receiver front-end.

Computes interpolated antenna patterns from a few set of points using spline curves.

2D planar arrays are also implemented, with methods for applying **beamformer** towards a desired direction and computation of the **array factor**.

GNSS COMPOSITE SIGNAL CLASS

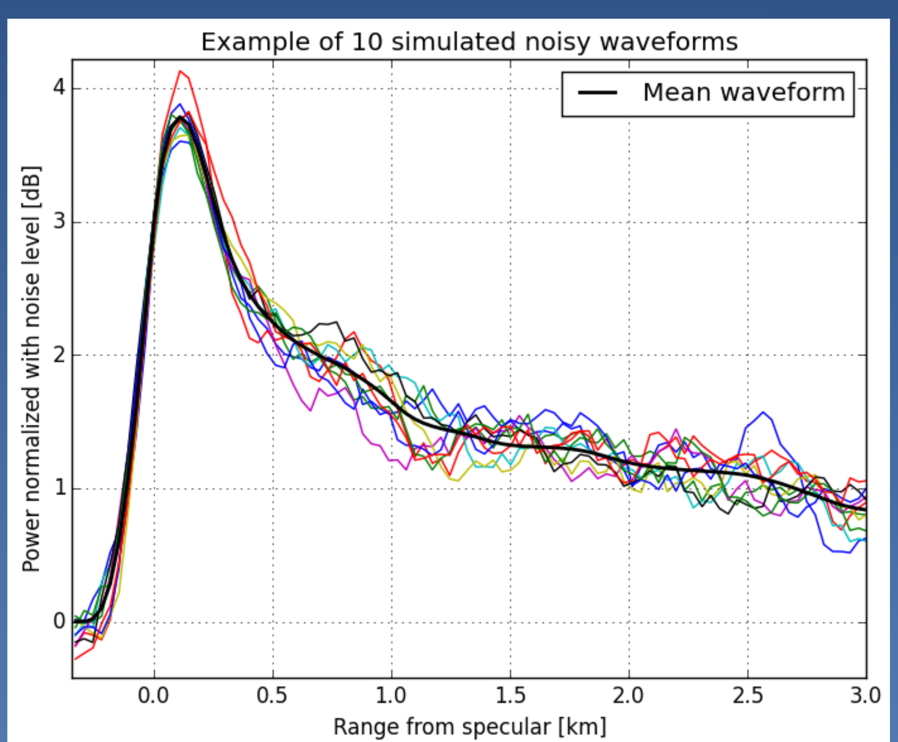
Defines a basic signal autocorrelation model.

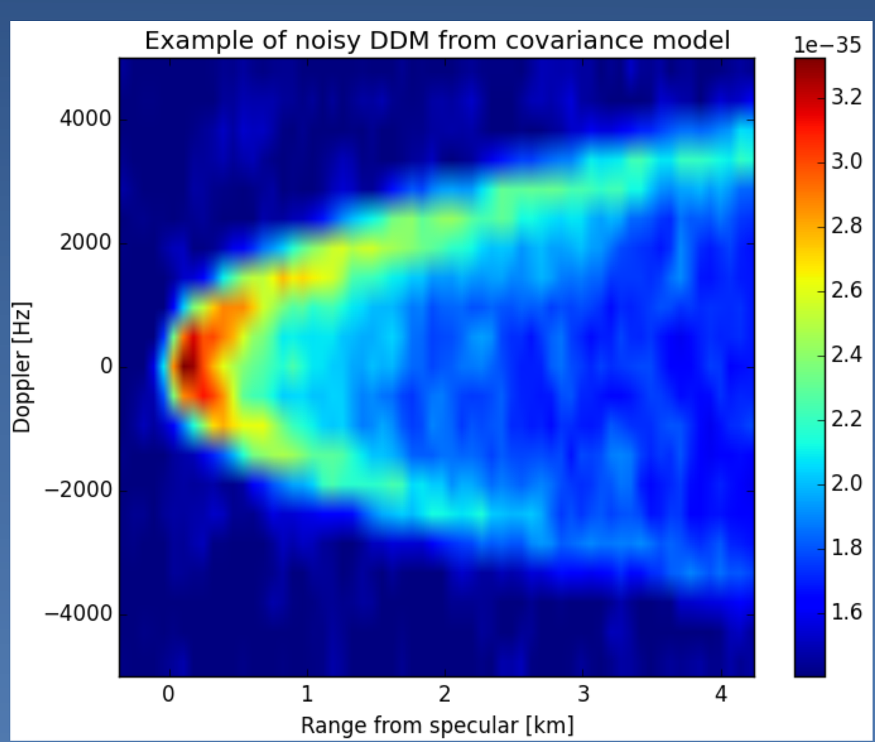
Computes the **auto-correlation** function of several GNSS signals: **GPS**, **Galileo**, **BeiDou** and **QZSS**.

WAVEFORM AND DDM MODELING

WAVEFORM Z-V MODEL CLASS

Given a GNSS+R scenario, it computes a **power waveform** or a **Delay-Doppler Map** (DDM) model based on [4].
The computation of the corresponding **covariance matrix** model is implemented based on [5]. From this point, a function provides **realistic noise (thermal and speckle) realizations** with a proper statistical characterization in **both range** and **Doppler** domains.

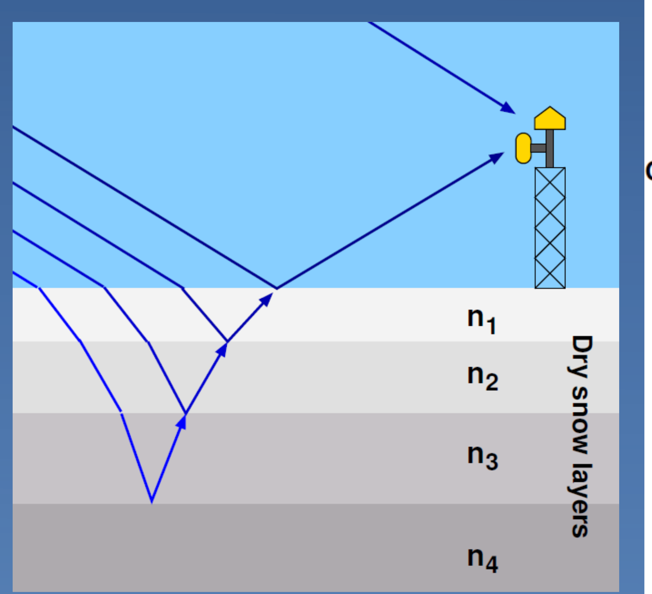




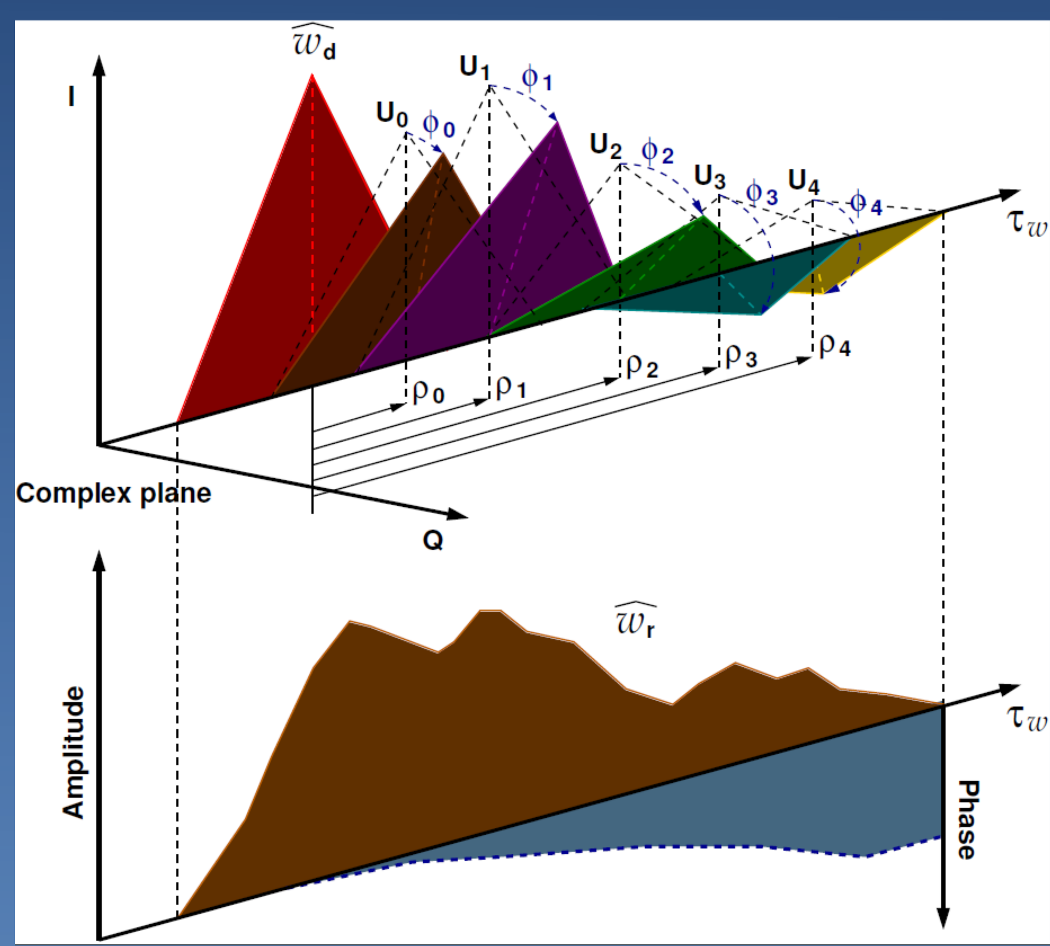
Example of noisy waveforms and DDM from a UK-TDS1 scenario.

MULTIPLE RAY SINGLE REFLECTION MODEL CLASS

Defines a GNSS+R multi-layer scenario with one ray reflected off each layer, as depicted in the bottom figure. Such approach was successfully tested in an Antarctic campaign [6].



The modeled complex waveform results from the **sum** of the **different contributions** coming from each of the layers. A **lag-hologram** analysis enables to extract such information afterwards.



DATA ANALYSIS FROM MODELS OR REAL DATA

POWER WAVEFORM CLASS

Defines a power waveform from a set of basic parameters.

Performs estimations of **specular** and **scatterometric** delays and their corresponding power levels.

COMPLEX WAVEFORM CLUSTER CLASS

Defines a cluster of complex waveforms.

Available methods include: different types of waveform **integration**, **coherent time** computation, **navigation bit** correction, phasor counter-rotation and **DDM** and **lag-hologram** determination.

HOW TO GET WAVPY

Visit the GOLD-RTR-MINING website, "Code" section, and download it after a free registration process.
In addition, wavpy will be submitted to IEEE GRSS RSCL soon.

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