GNSS-R OPEN SOURCE SOFTWARE LIBRARY FOR DATA ANALYSIS AND SIMULATION

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MOTIVATION

1) To provide an open source software tool for users of GOLD-RTR-MINING data pool [1]:
http://www.ice.csic.es/research/gold_rtr_mining/
2) To establish a valid framework for the GNSS-R community.

Potential users: ranging from new researchers in the field that want to easily get in touch with GNSS-R data and its analysis, to more expert users that may add their own functions.

SOFTWARE ASPECTS

1) C++/Fortran90 library.
2) Compiled in **Linux** with **autotools**. *Do not worry about makefiles!*
3) Interface to **Python**: high level language. *An user-friendly environment rather easy to employ!*
4) Adapted to **numpy** (package for scientific computing).
5) Distributed under a control version software (**Git**).

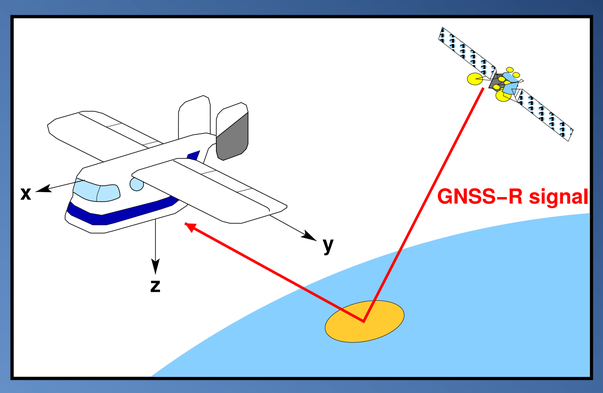
NOT JUST A WAVEFORM SIMULATOR!

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!

SPECULAR GEOMETRY *CLASS*

Defines a specular geometry from receiver and transmitter positions applying ellipsoid WGS84 plus an undulation value. Valid from ground- to space-based scenarios.

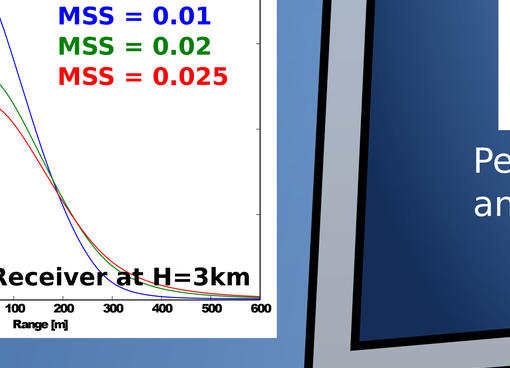


Computes several aspects related to geometry such as specular point location, inertial delay and windup phase [3].

REFLECTING SURFACE *CLASS*

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

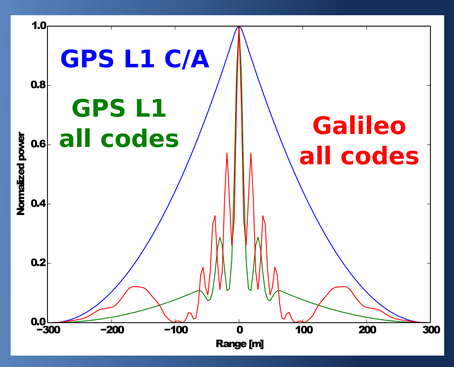
Computes permittivity and reflectivity values (given incidence angle) from several media: sea water, sea ice, wet snow, dry snow and soil at L-band [2].



GNSS COMPOSITE SIGNAL *CLASS*

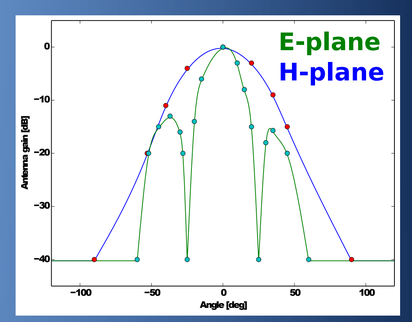
Defines a basic signal autocorrelation model.

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



RECEIVER FRONT-END *CLASS*

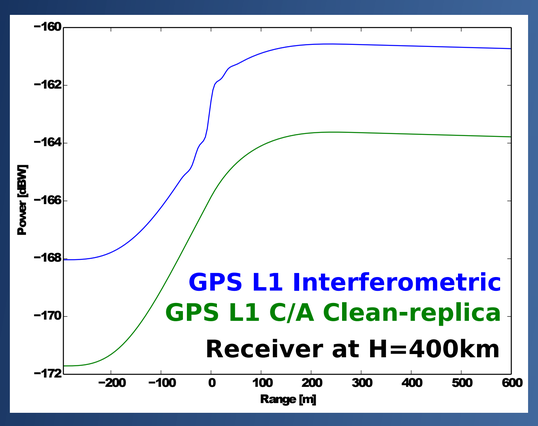
Defines the main aspects of a receiver front-end.



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

WAVEFORM MODEL *CLASS*

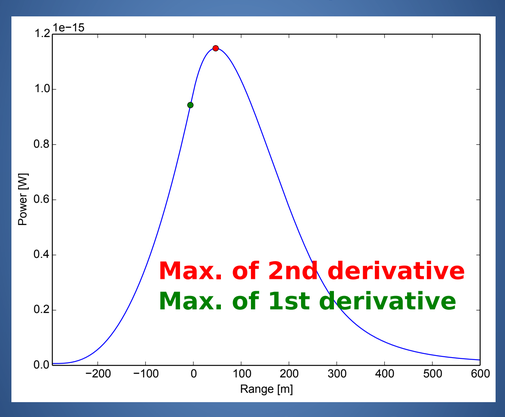
Once a GNSS-R scenario is defined by means of classes "*Specular geometry*", "*Reflecting surface*", "*Receiver front-end*" and "*GNSS composite signal*", it computes a power waveform model based on [4].



Both clean-replica and interferometric approaches can be simulated (including Delay-Doppler Maps).

POWER WAVEFORM *CLASS*

Defines a power waveform from a set of basic parameters.



Performs estimations of specular and scatterometric delays.

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 Delay-Doppler Map determination.

INT data
Integrated waveforms from GOLD-RTR mining or other instruments.

RAW data
Complex waveforms from GOLD-RTR mining or other instruments.

NEXT STEP

This library has been employed for the data processing of several ICE/IEEC experimental campaigns. External **beta-testers** with basic knowledge in GNSS-R are **required**!

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REFERENCES

[1] E. Cardellach, F. Fabra, O. Nogués-Correig, S. Oliveras, S. Ribó, and A. Rius. GNSS-R ground-based and airborne campaigns for Ocean, Land, Ice and Snow techniques: application to the GOLD-RTR datasets. Radio Science, 2011.
[2] F. T. Ulaby, R. K. Moore, and A. K. Fung. Microwave Remote Sensing Active and Passive, volume III. Artech House, Inc., 1990.
[3] G. Beyerle. Carrier phase wind-up in GPS reflectometry. GPS Solutions, 2009.
[4] V. U. Zavorotny and A. G. Voronovich. Scattering of GPS Signals from the Ocean with Wind Remote Sensing Application. IEEE Trans. Geosc. Remote Sensing, 2000.