Version 1.0.0 SCoBi Introduction Tutorial 1

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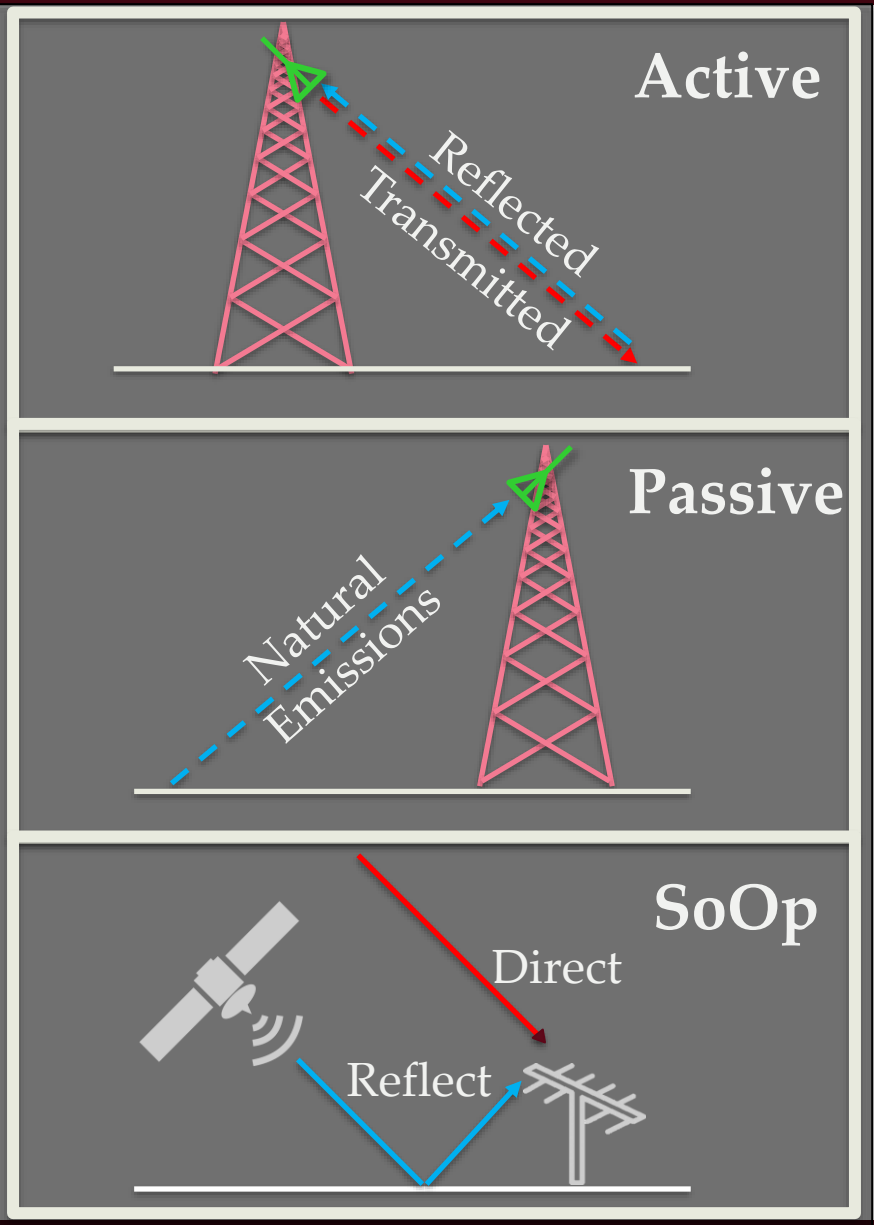
OUTLINE

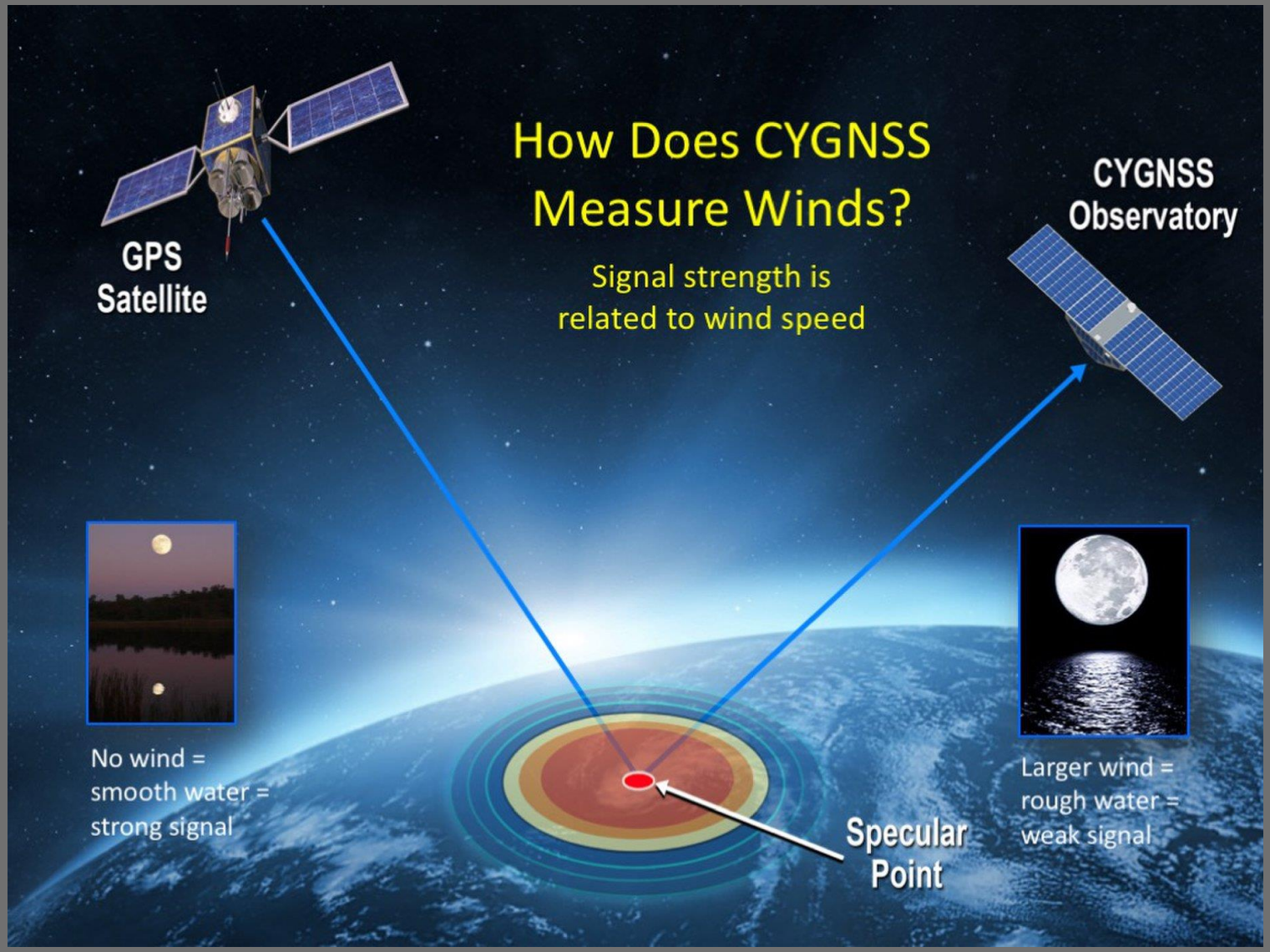
- Introduction to SoOp
- SCoBi Model
- Future Video Discussion:
  - Example 1: GNSS-R Over Vegetation
  - Example 2: P-Band Over Vegetation
  - Example 3: P-Band Over Root-Zone
- Using the SCoBi GUI
- Conclusion and Summary

SIGNALS OF OPPORTUNITY (SoOp)

A “third way”
for remote sensing



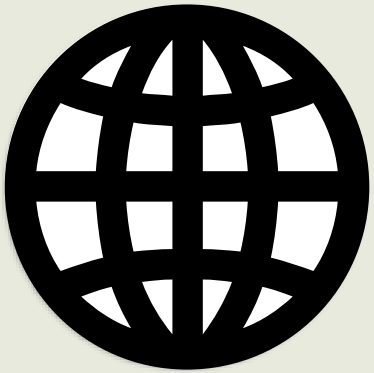
SoOp Example: CYGNSS



Credit: University of Michigan

SoOp Has Many Advantages for Remote Sensing

Lower Size, Weight, Power, and Cost (SWaP-C)



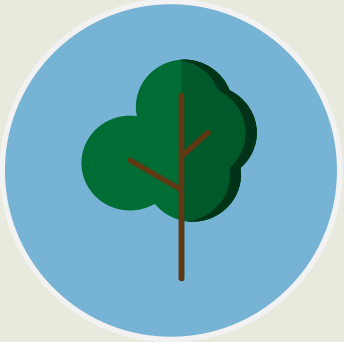
Global Coverage

Frequent Revisit Time

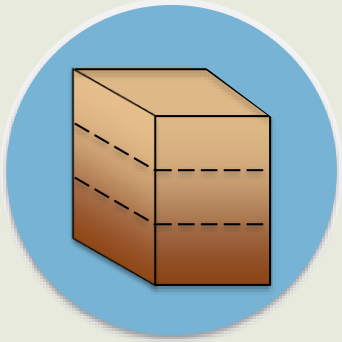
SoOp Faces Many Challenges from Geophysical Parameters!

Topography
Surface Roughness

Surface Soil Moisture
Root-Zone Soil Moisture



Vegetation Biomass
Canopy Scattering

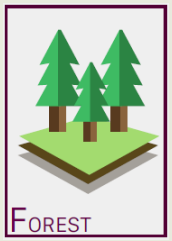


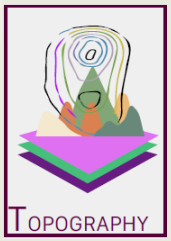
Multilayer Scattering
Volume Scattering

Snow-Water Equivalent
Permafrost

SCoBi – Physics-based Modeling & Simulation

Signals of Opportunity Coherent Bistatic Scattering Model





Polarimetric Effects

- Fully polarimetric
- Any combination of linear/circular polarization

Antenna Effects

- Cross-polarization coupling
- Beam divergence
- Polarization mixing
- Orientation
- Beamwidth
- Sidelobes

Configuration Effects

- Altitude
- Spreading loss over vegetation depth

Interferometric Effects

- Complex Voltage
- Orientation
- Beamforming

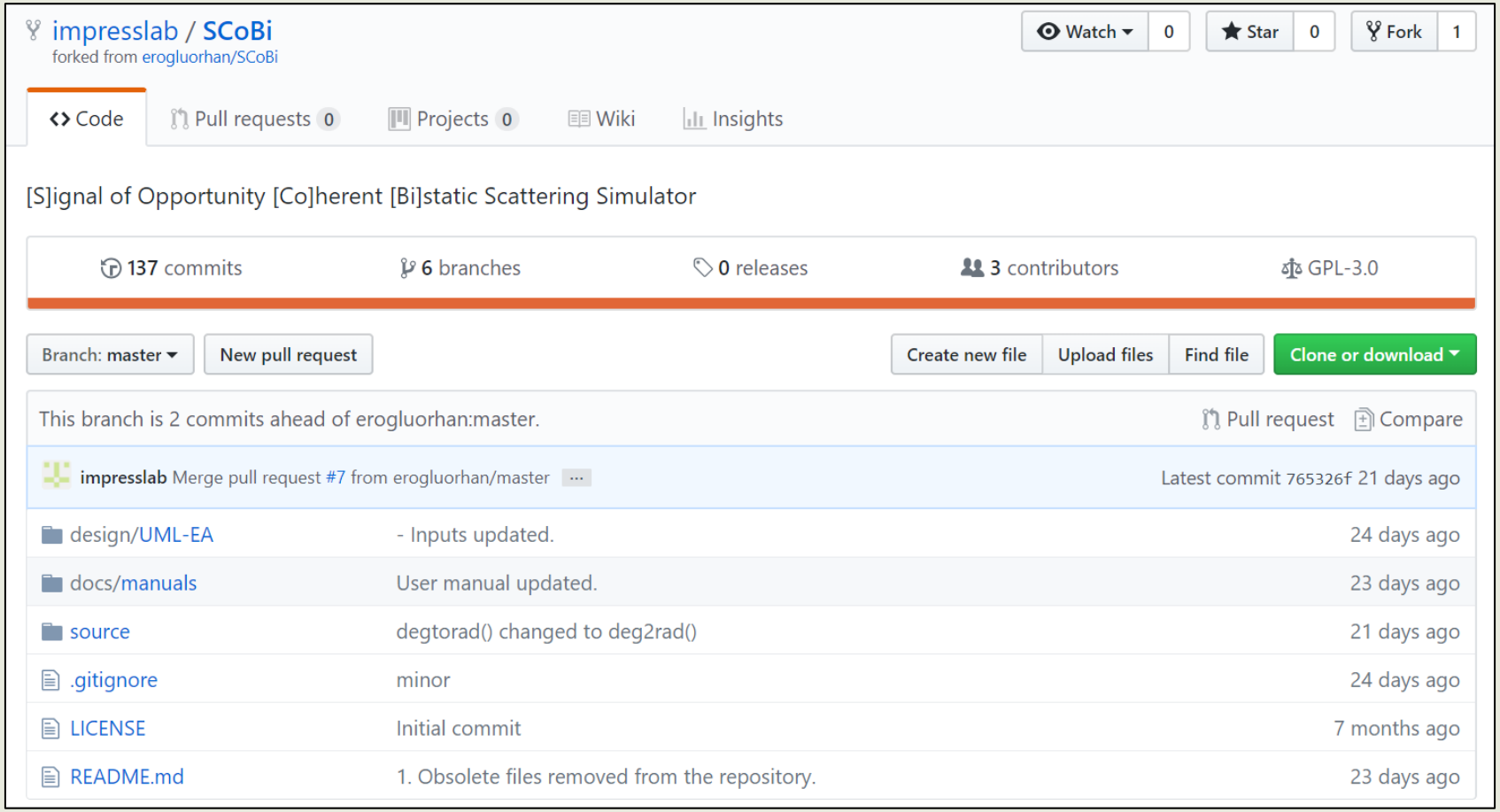
Multilayer Effects

- Model complex dielectric media
- Stratified layer division
- Vegetation and subsurface scattering

Virtual Vegetation

- Mix vegetation
- Growing vegetation
- Seasonal effects

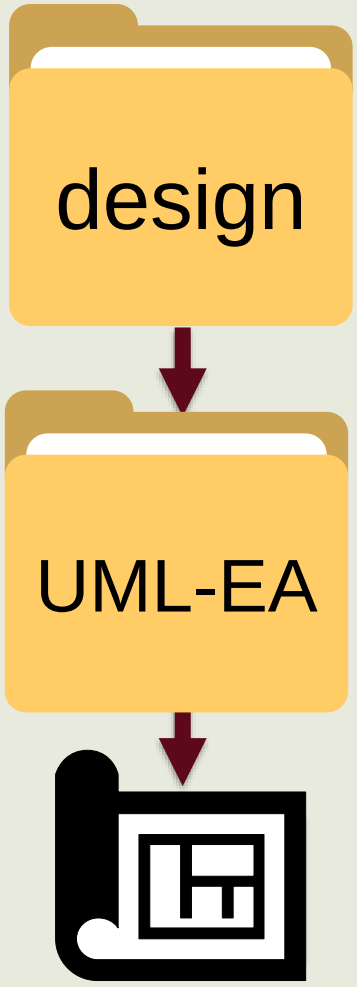
GitHub



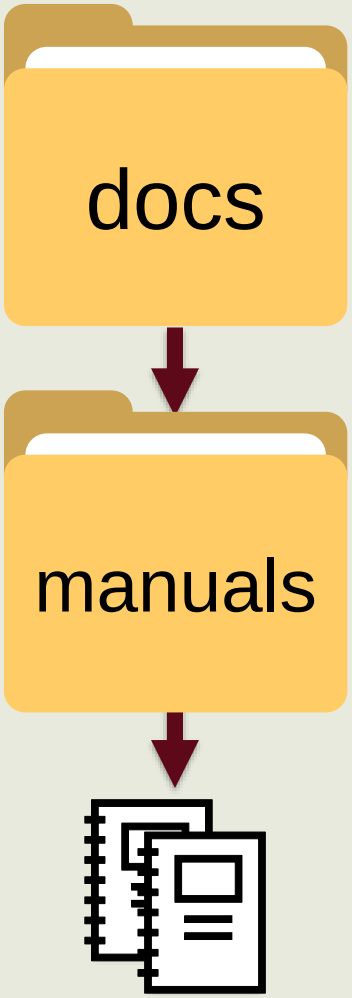
SCoBi Currently Available on GitHub!

https://github.com/impresslab/SCoBi

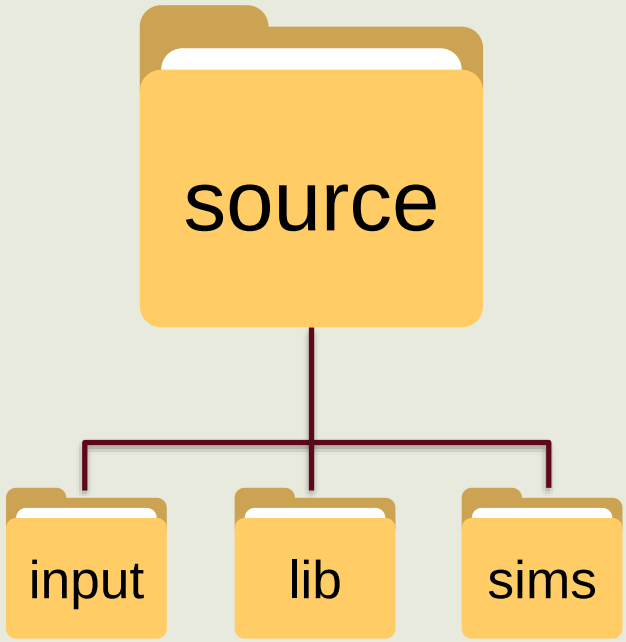
SCoBi File Structure



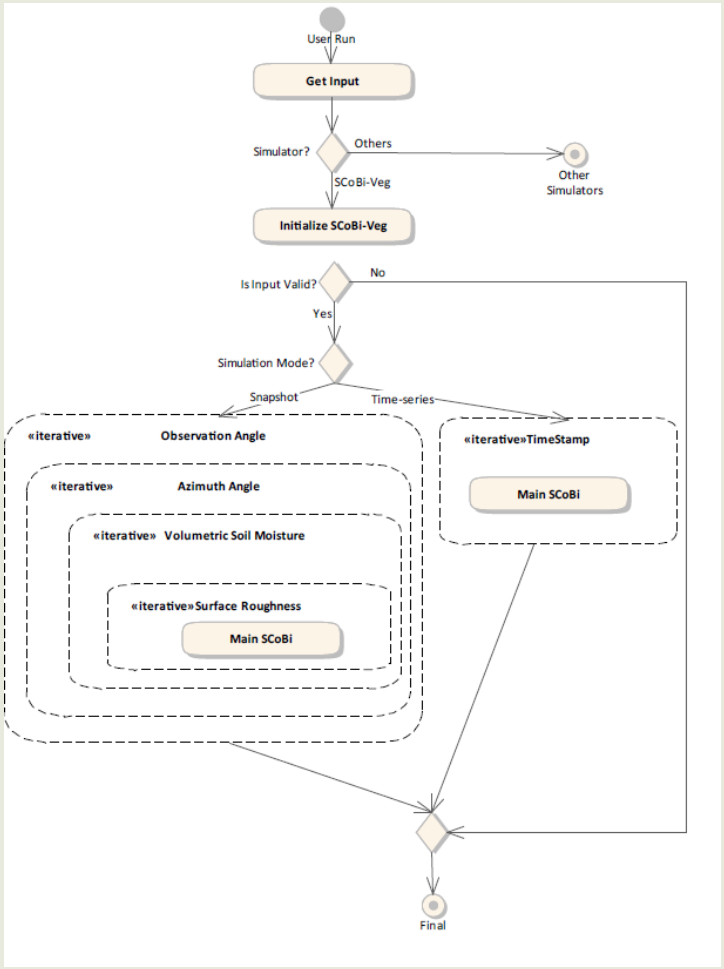
UML Files



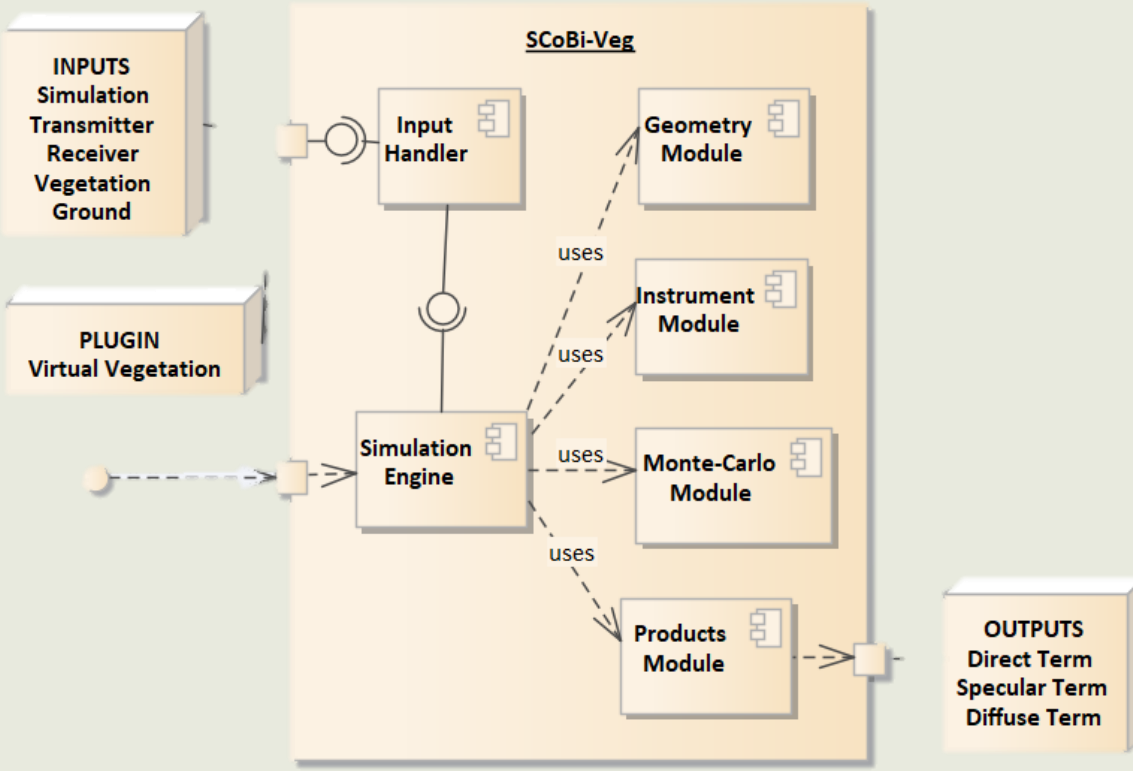
User Manual
Developer Manual



SCoBi Simulator Architecture (UML)

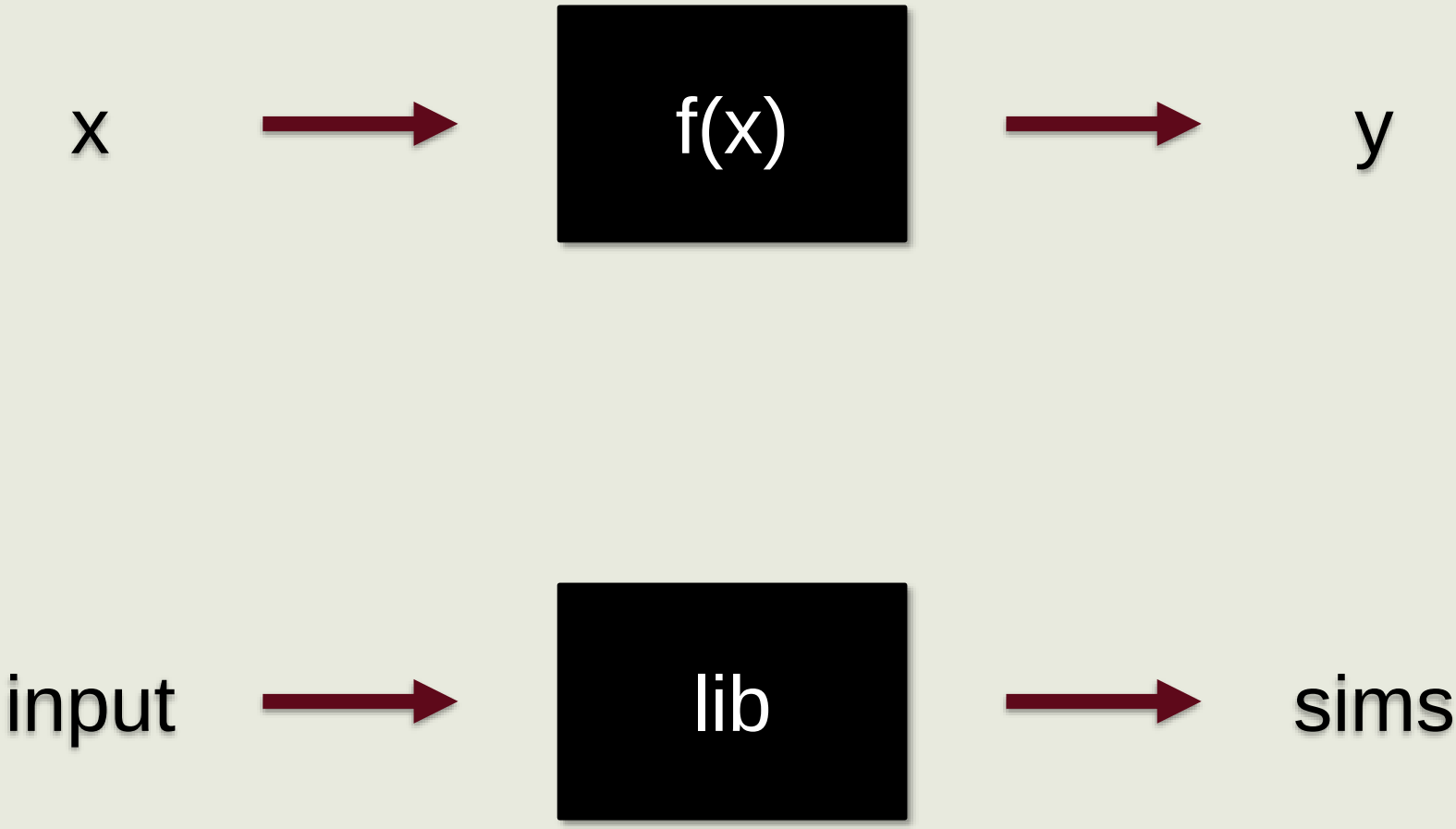


Runscobi Behavioral Model



SCoBi-Veg Component Model

Blackbox Structure



Required Inputs

input

XLSX

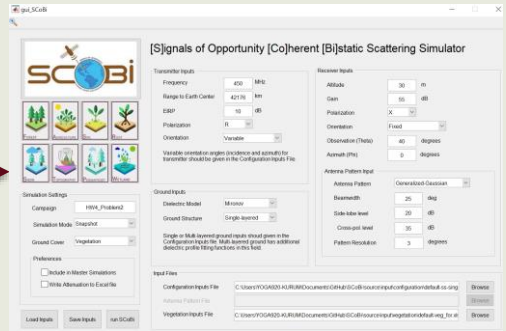
Config Inputs File

XLSX

Antenna Pattern File

XLSX

Veg Inputs File



GUI Window

lib

sims

Required Inputs (No Vegetation)

input

XLSX

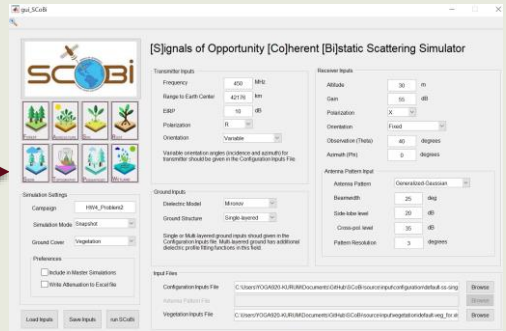
Config Inputs File

XLSX

Antenna Pattern File

XLSX

Veg Inputs File

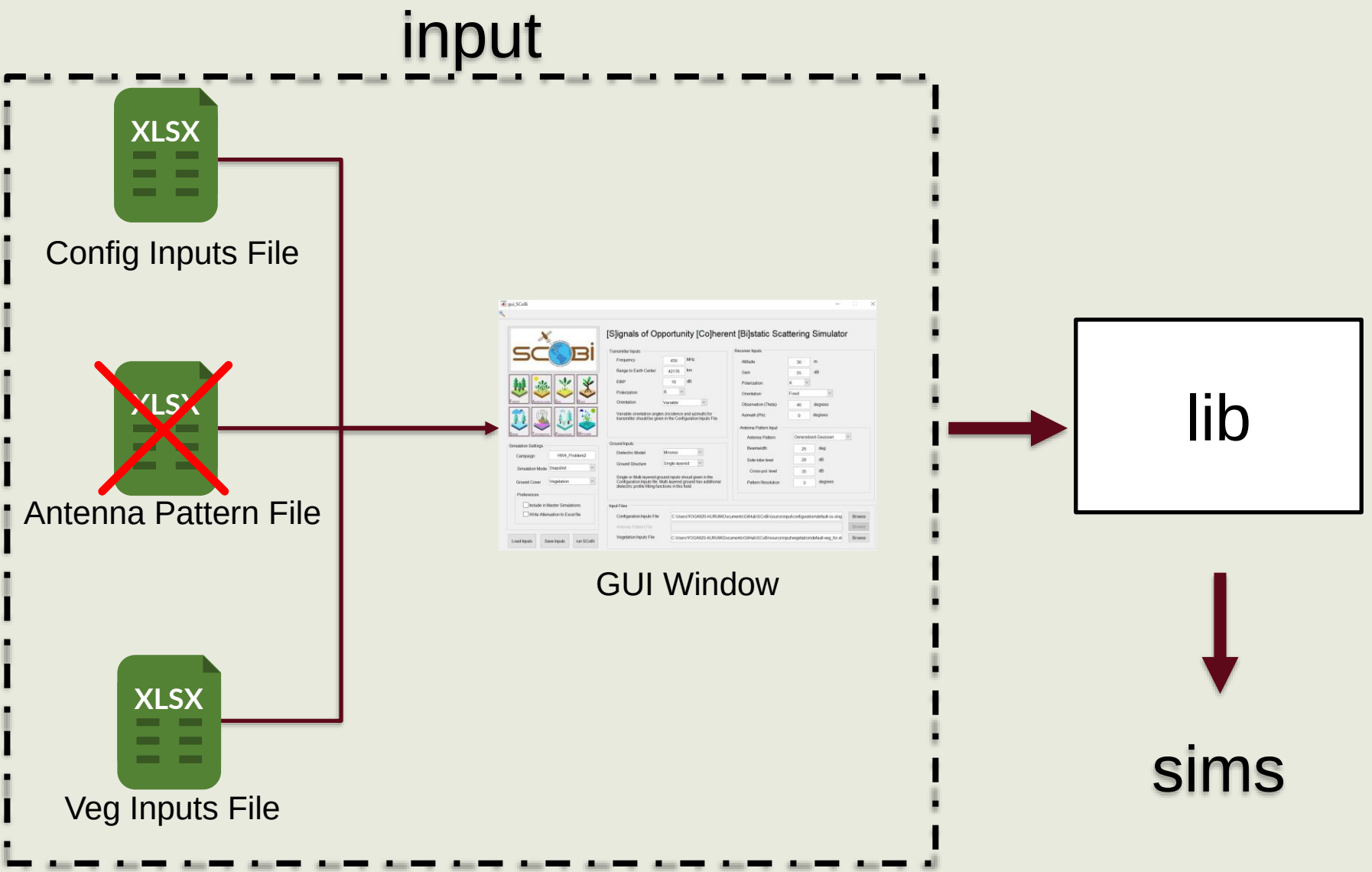


GUI Window

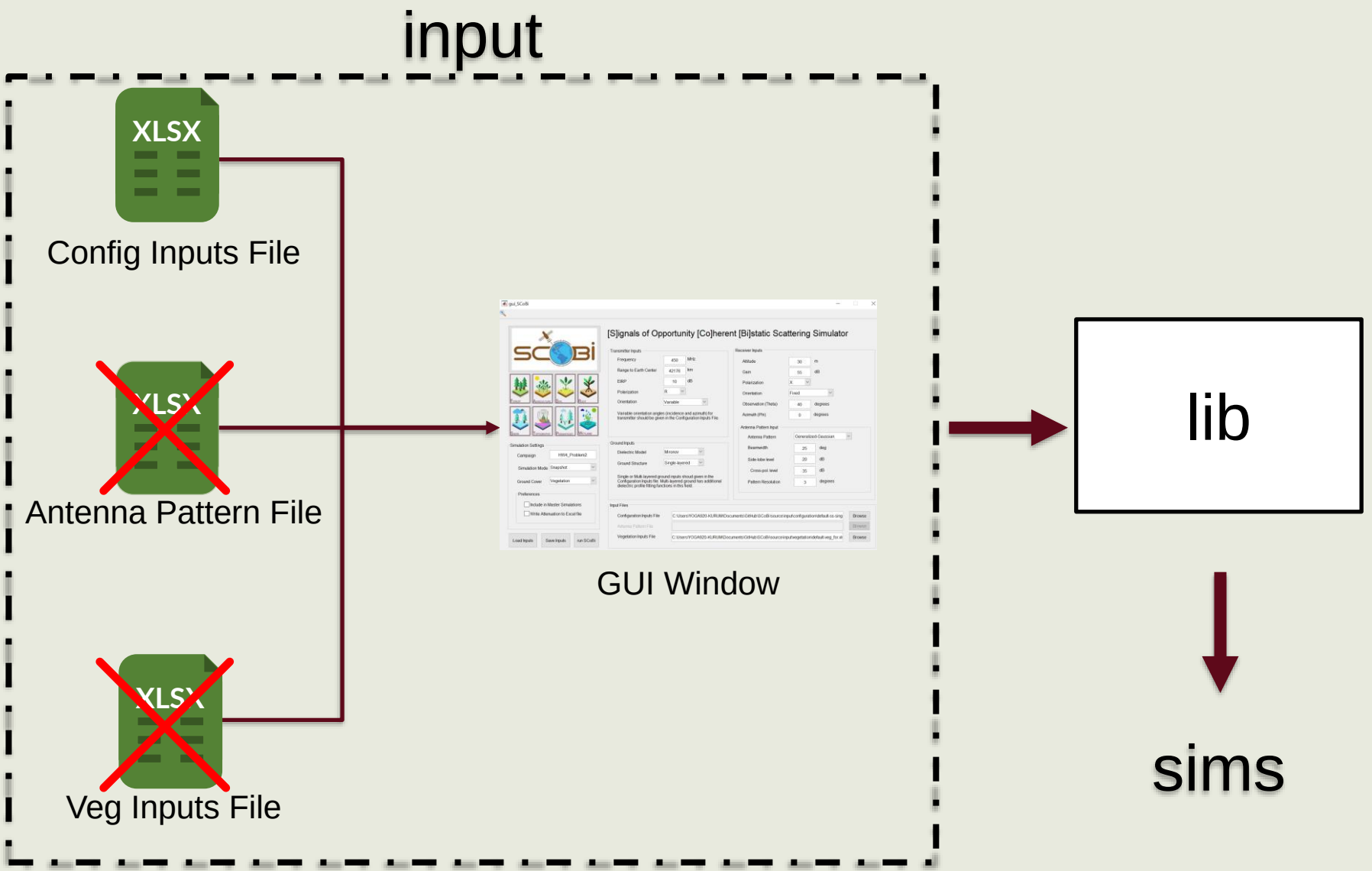
lib

sims

Required Inputs (No Antenna)



Required Inputs (No Veg, No Ant)



Excel Inputs

Config Inputs File

Antenna Pattern File

Veg Inputs File

gnXX	gnXY	gnYX	gnYY

Dynamic	Ground

Layers	Kinds

Simulation Settings

SIMULATION MODE

Snapshot
or
Time-Series

GROUND COVER

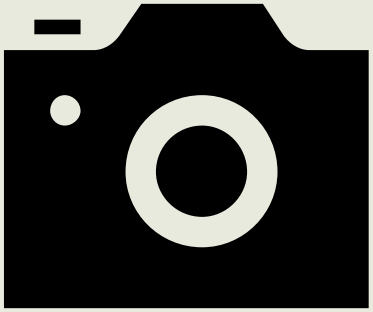
Vegetation
or
Bare Soil

GROUND STRUCTURE

Single Layer
Or
Multi-layer

Simulation Mode Options

SNAPSHOT



Used for analyzing several transmitter, VSM, and RMSH configurations

TIME-SERIES

Used for measuring specific transmitter, VSM, and RMSH configurations

Snapshot Mode Example

	A	B	C	D	E	F	G
1	Tx_th (deg)	Tx_ph (deg)	RMSH (cm)	VSM_5 (cm3/cm3)	VSM_10 (cm3/cm3)	VSM_20 (cm3/cm3)	VSM_40 (cm3/cm3)
2	10	0	0.5	0.37388012	0.364182428	0.373792751	0.435582659
3	20	15	1	0.37388012	0.361327493	0.37195469	0.440497283
4	30		1.5	0.37492744	0.355389374	0.374840242	0.439875431
5	40			0.371428366	0.331775187	0.38827597	0.439875431
6	50						
7	60						
8	70						
9							
10							
11							
12							
13							

Dynamic | Ground

Snapshot Mode will compute

$$(7 \cdot 2 \cdot 3 \cdot 4 \cdot 4 \cdot 4 \cdot 4) = 10{,}752$$

combinations of transmitter and RMSH configurations based on the above input.

Time-Series Mode Example

	A	B	C	D	E	F	G	H
1	DoY	Tx_th (deg)	Tx_ph (deg)	RMSH (cm)	VSM_5 (cm3/cm3)	VSM_10 (cm3/cm3)	VSM_20 (cm3/cm3)	VSM_40 (cm3/cm3)
2	146	40.7	200	1	0.265934564	0.321619451	0.357646656	0.441583981
3	146.0208	40	200	1	0.265825115	0.31938752	0.357556553	0.441583981
4	146.0417	40.1	200	1	0.264509531	0.319970761	0.357556553	0.441583981
5	146.0625	40.4	200	1	0.261202651	0.319873603	0.357466435	0.441583981
6	146.0833	39.6	200	1	0.261866094	0.320553296	0.357466435	0.441583981
7	146.1042	39.6	200	1	0.2626388	0.320359196	0.354483695	0.441583981
8	146.125	39.8	200	1	0.262528499	0.320262116	0.357736743	0.441583981
9	146.1458	39.7	200	1	0.26241817	0.318023865	0.357646656	0.441583981
10	146.1667	39.4	200	1	0.26241817	0.317926312	0.354302369	0.441583981
11	146.1875	40	200	1	0.262307813	0.318608763	0.354211682	0.441583981
12	146.2083	40.3	200	1	0.262969528	0.318511329	0.354120978	0.441506424
13	146.2292	41.3	200	1	0.262969528	0.318413876	0.354030259	0.441506424
14	146.25	41.8	200	1	0.262859314	0.318316403	0.35439304	0.441506424

Dynamic | Ground

Time-Series mode will compute <u>individual</u> configurations transmitter and RMSH configurations based on the above input

Ground Cover Options

BARE-SOIL

SoOp reflectometry over surfaces with no vegetation

VEGETATION

SoOp reflectometry over surfaces with vegetation layer

Ground Structure Options

SINGLE-LAYER

Soil is represented by a single, homogenous dielectric

MULTI-LAYER

Soil is represented by multiple layered dielectrics

Example 1: P-Band Over Forest

- Creating Input Vegetation Files
- Creating Configuration Input File
- GUI Window Inputs

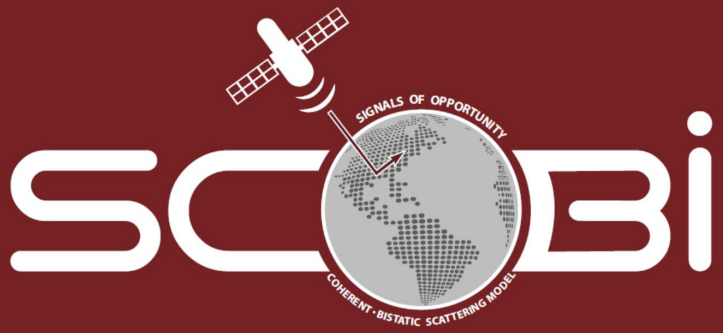
Credit: Alena Koval

Example 2: GNSS-R Over Corn Canopy

- Creating Input Vegetation Files
- Creating Configuration Input File
- GUI Window Inputs

Example 3: P-Band Over Multi-Layer Soil Profile

- Creating Configuration Input File
- GUI Window Inputs



Thank You!

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