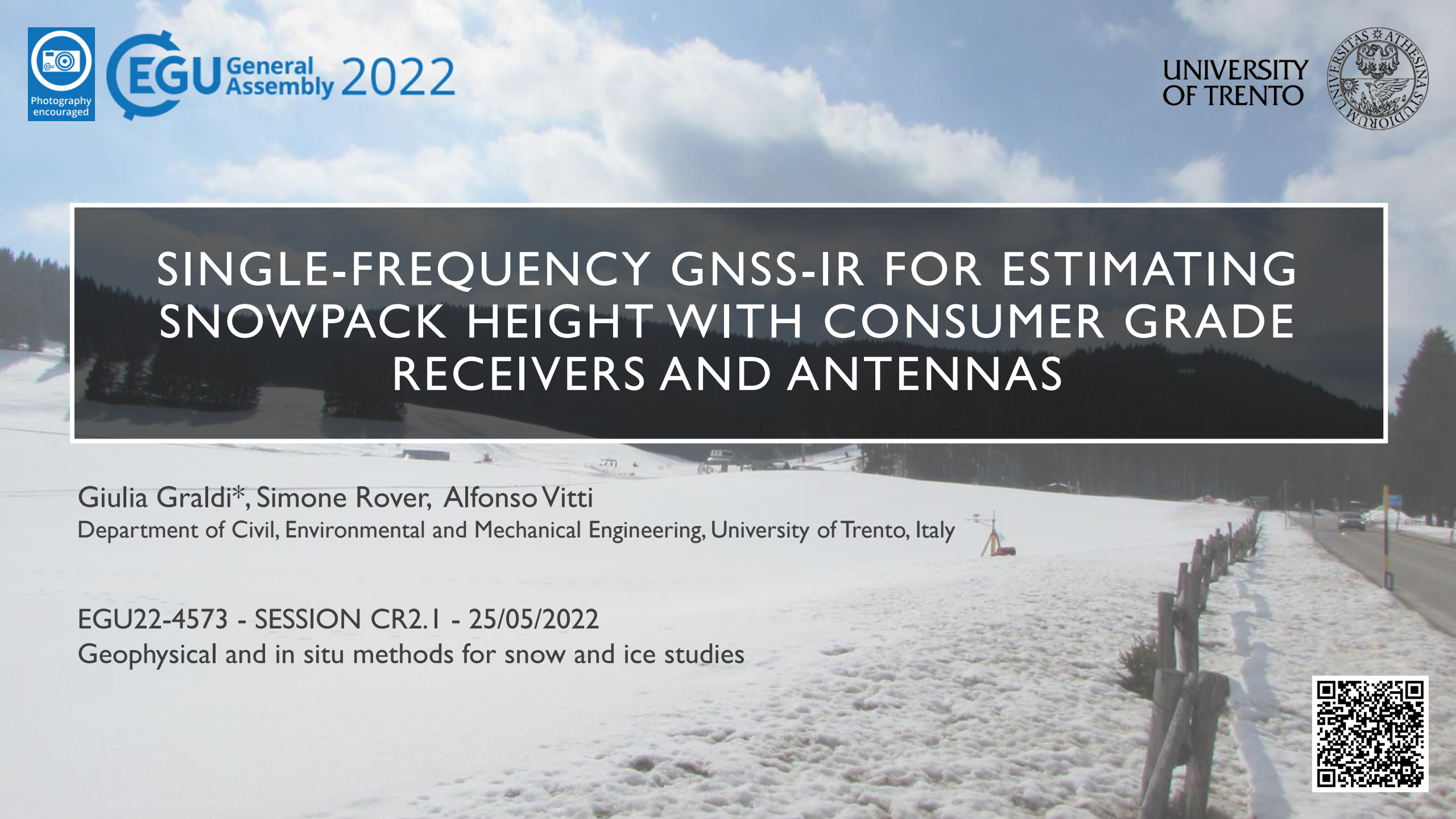


SINGLE-FREQUENCY GNSS-IR FOR ESTIMATING SNOWPACK HEIGHT WITH CONSUMER GRADE RECEIVERS AND ANTENNAS

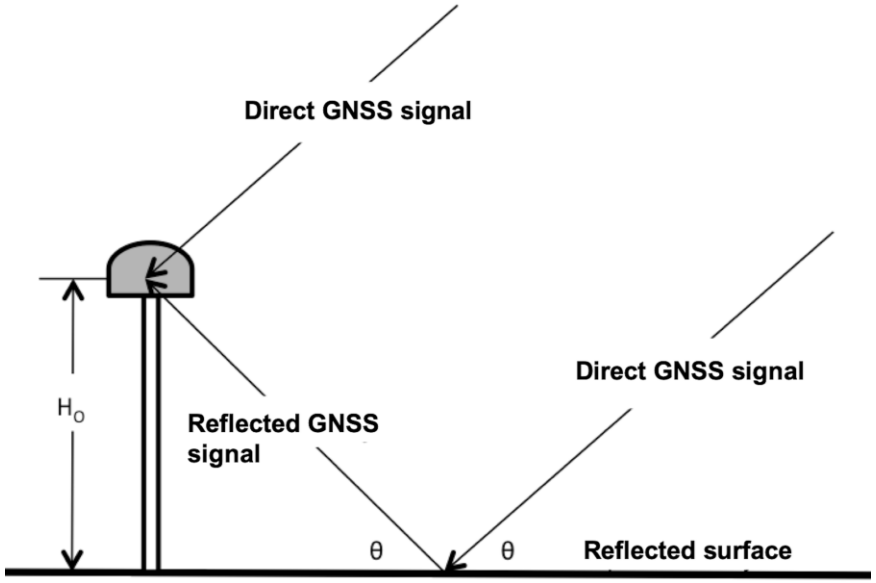
Giulia Graldi*, Simone Rover, Alfonso Vitti
Department of Civil, Environmental and Mechanical Engineering, University of Trento, Italy

EGU22-4573 - SESSION CR2.1 - 25/05/2022
Geophysical and in situ methods for snow and ice studies

GNSS-R: BACKGROUND

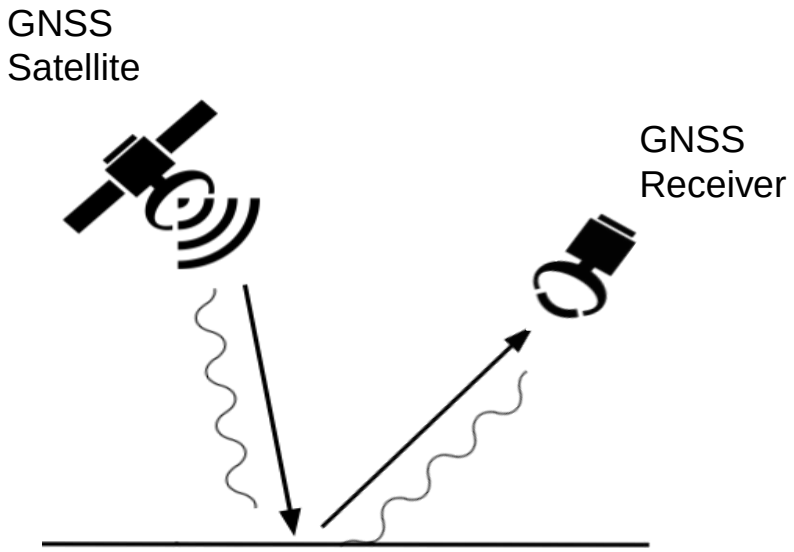
https://www.fieldbee.com

GROUND BASED



https://doi.org/10.5194/hess-24-3573-2020

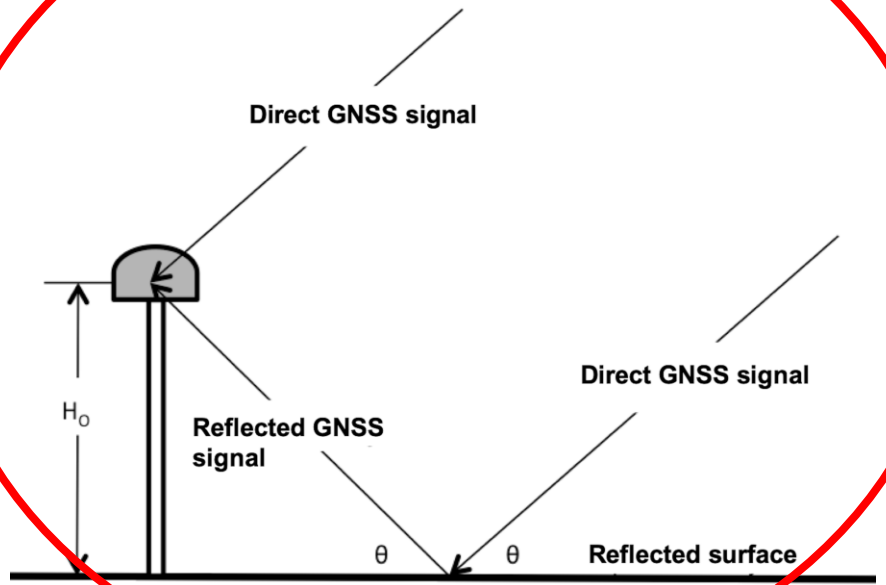
SPACE BASED



GNSS-R: BACKGROUND

https://www.fieldbee.com

GROUND BASED



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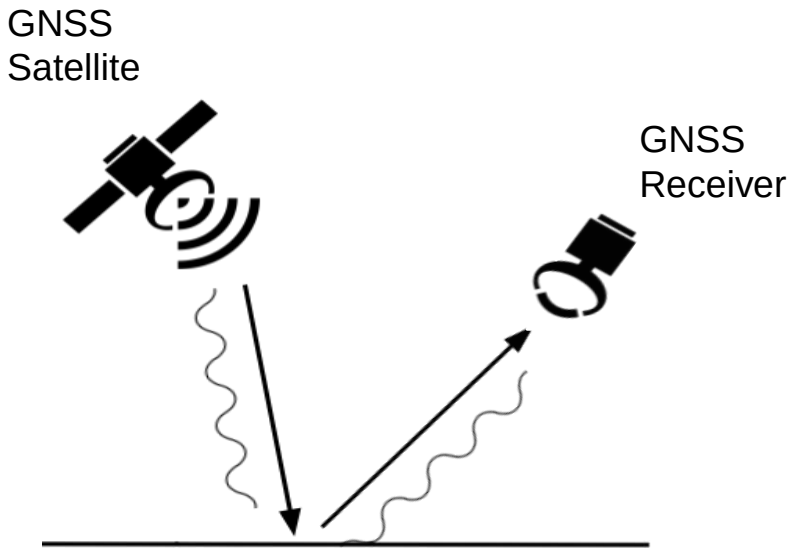
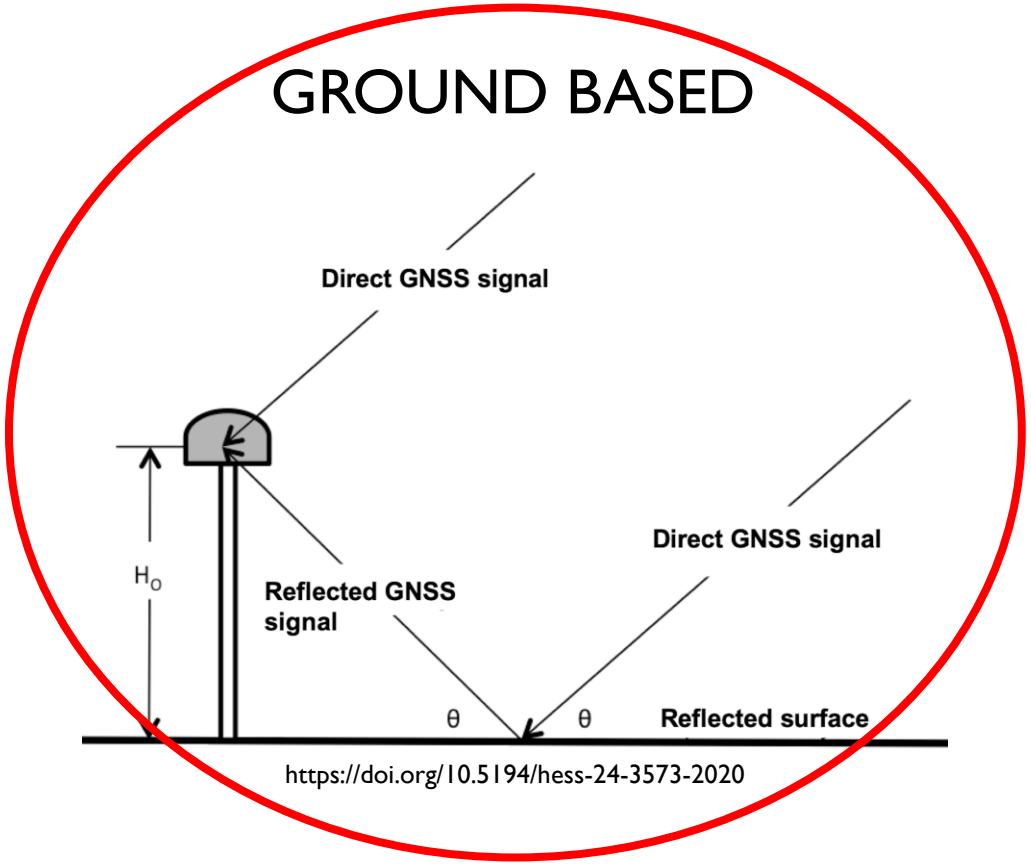


GNSS-IR: BACKGROUND

https://www.fieldbee.com



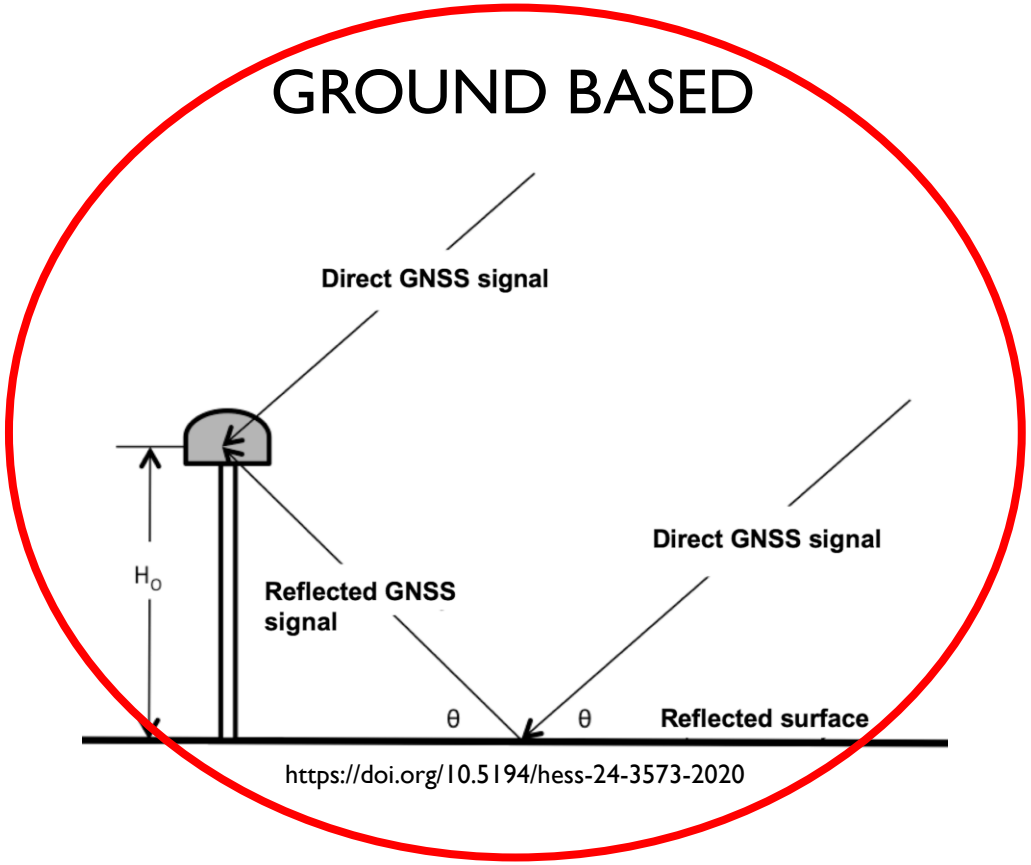
https://doi.org/10.5194/hess-24-3573-2020

INTERFEROMETRIC PATTERN TECHNIQUE (ITP)

SIGNAL TO NOISE RATIO (SNR)

GNSS-IR: BACKGROUND

https://www.fieldbee.com



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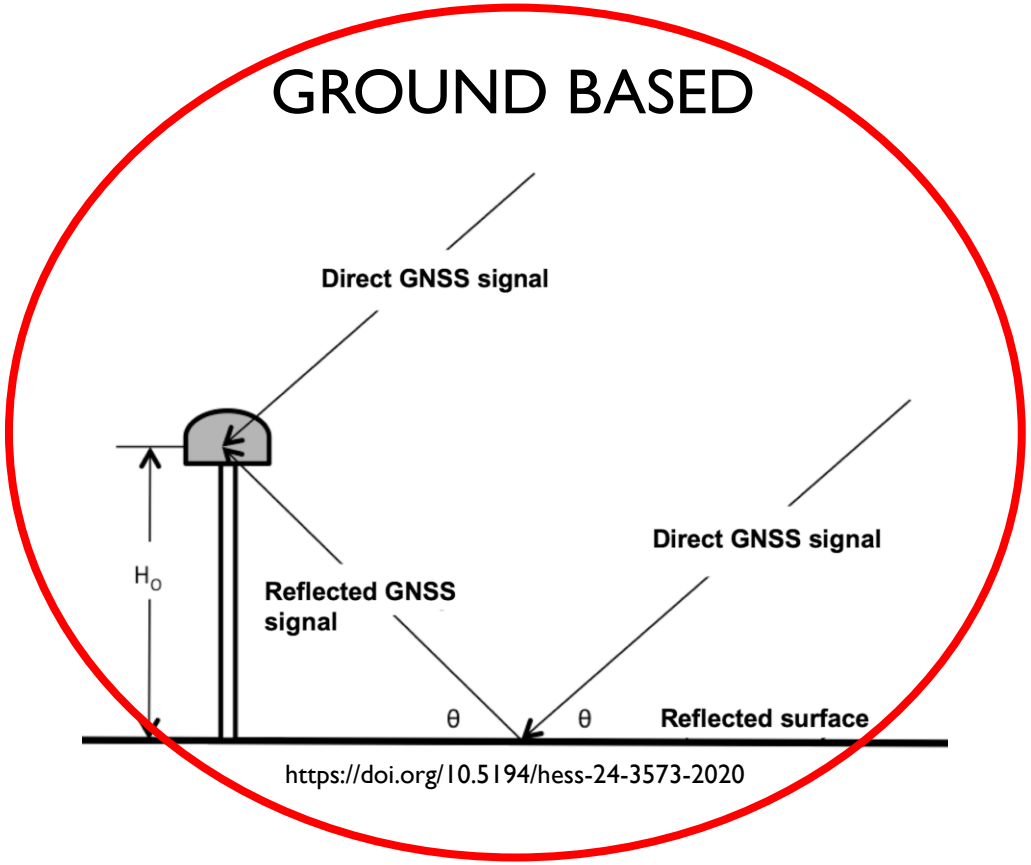
GNSS-IR

GEODETIC GRADE INSTRUMENTS

GNSS-IR: BACKGROUND

https://www.fieldbee.com



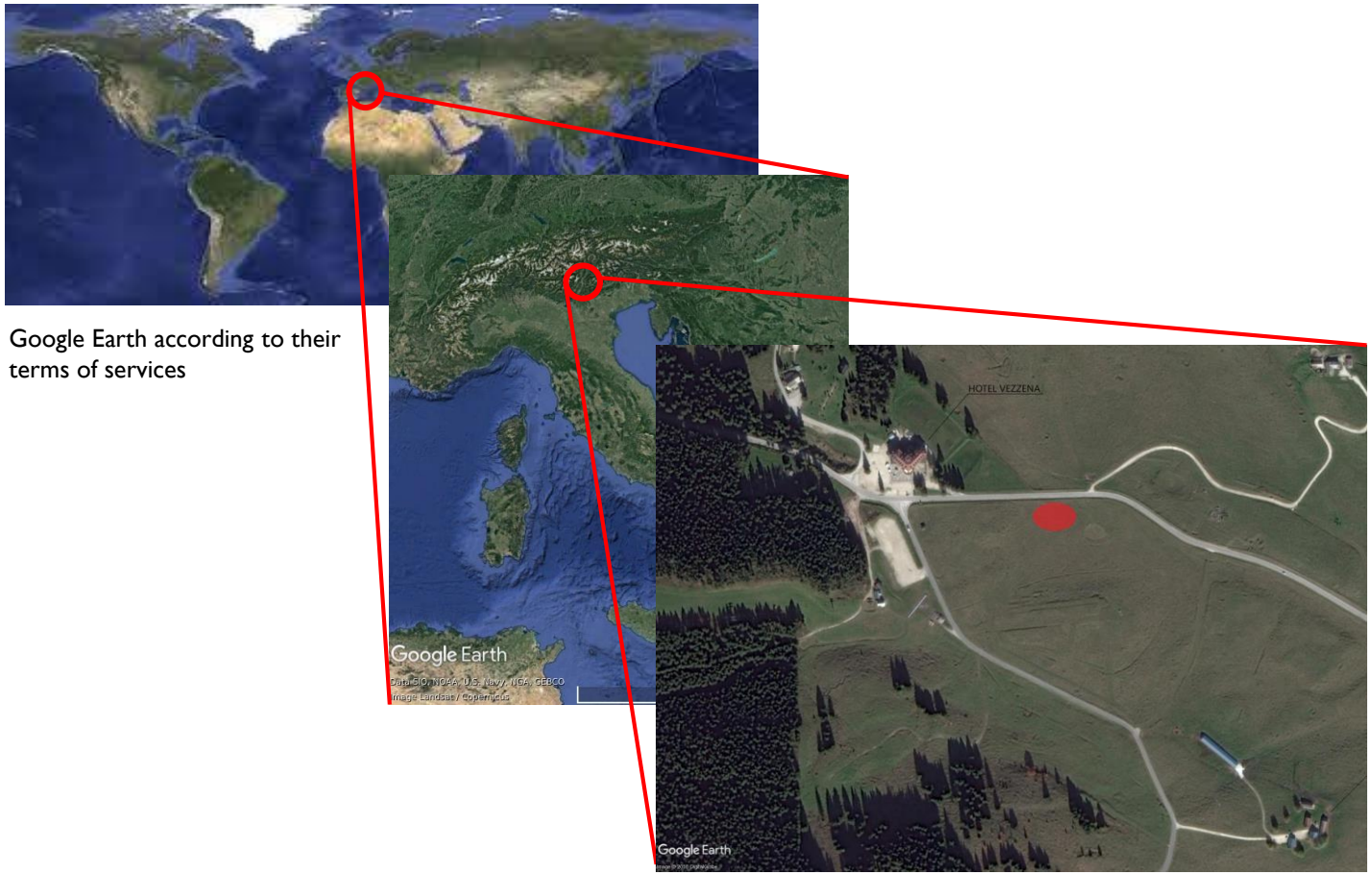
https://doi.org/10.5194/hess-24-3573-2020

GNSS-IR

GEODETIC GRADE INSTRUMENTS

… CONSUMER GRADE INSTRUMENTS?

STUDY AREA

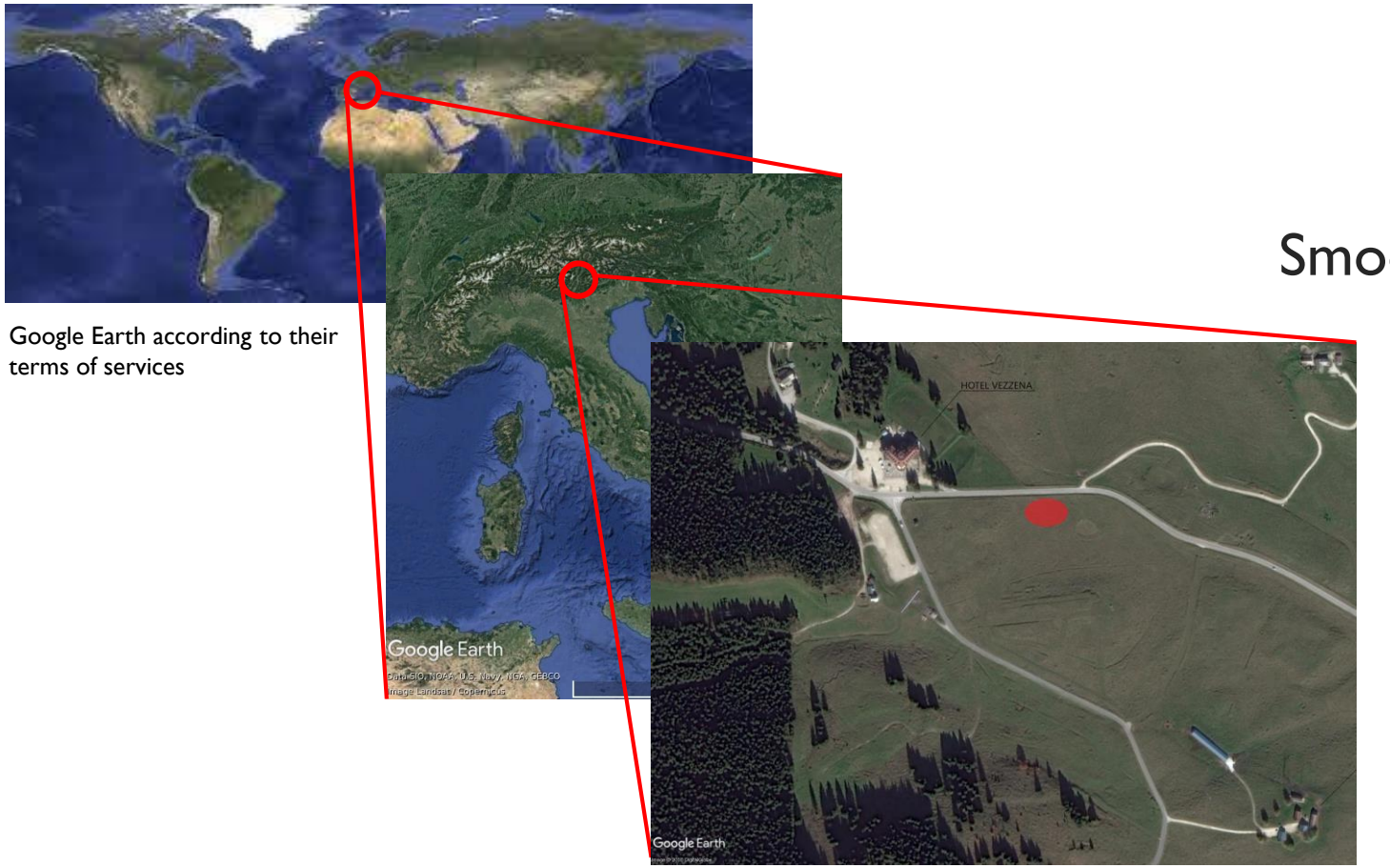


Google Earth according to their terms of services

Trentino, Italy

Lavarone Plateau, 1400 m

STUDY AREA



Google Earth according to their terms of services

Trentino, Italy

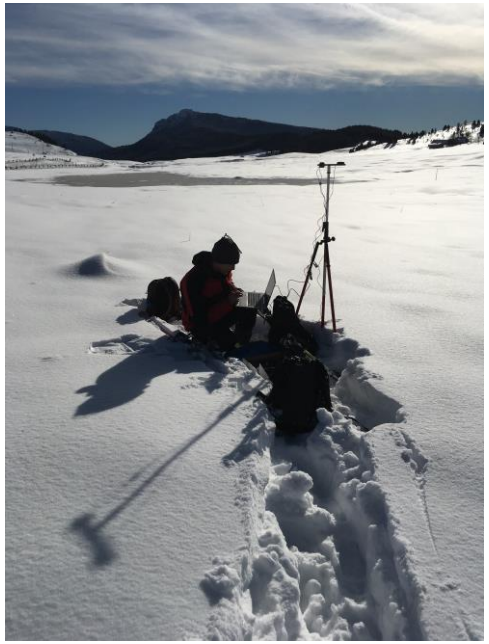
Lavarone Plateau, 1400 m

Smooth horizontal snowpack surface

DATA ACQUISITION

GEODETIC GRADE INSTRUMENTS
March 2018

CONSUMER GRADE INSTRUMENTS
February 2019



DATA ACQUISITION

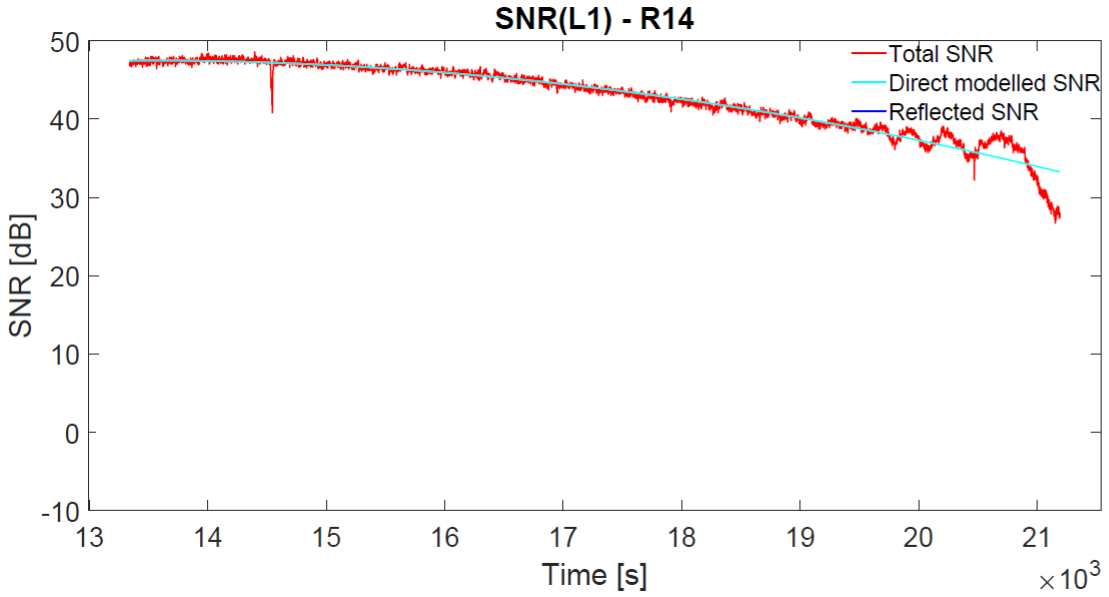
GEODETIC GRADE INSTRUMENTS
March 2018

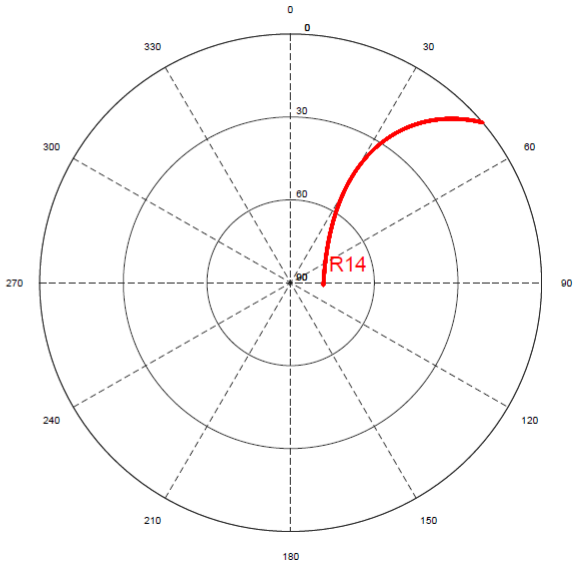
Antenna	Leica SmartAntenna ATX1230GG
Receiver	Leica GX1230GG
Δh	13 cm
Duration	120 mins
SNR resolution	0.25 dB
Frequency	GPS L1, GPS L2

CONSUMER GRADE INSTRUMENTS
February 2019

Antenna	1) Tallysman TW4721 2) u-blox ANN-MS
Receiver	u-blox NEO-M8T
Δh	15 cm
Duration	90 mins
SNR resolution	0.25 dB
Frequency	GPS L1

METHOD: SNR

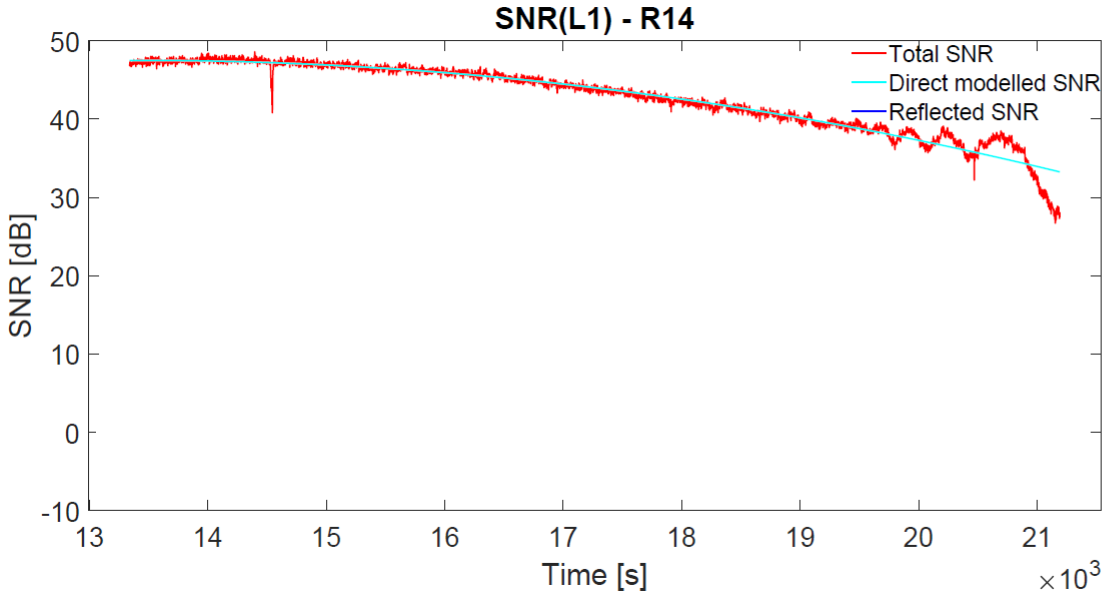


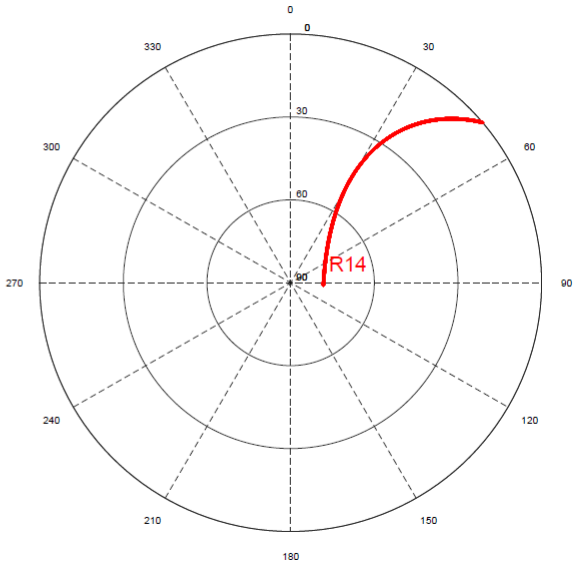


$$SNR^2 = A_D^2 + A_R^2 + 2A_D A_R \cos\Delta\phi$$

$$\Delta\phi = \frac{2\pi}{\lambda} 2h \sin(\theta)$$

METHOD: SNR





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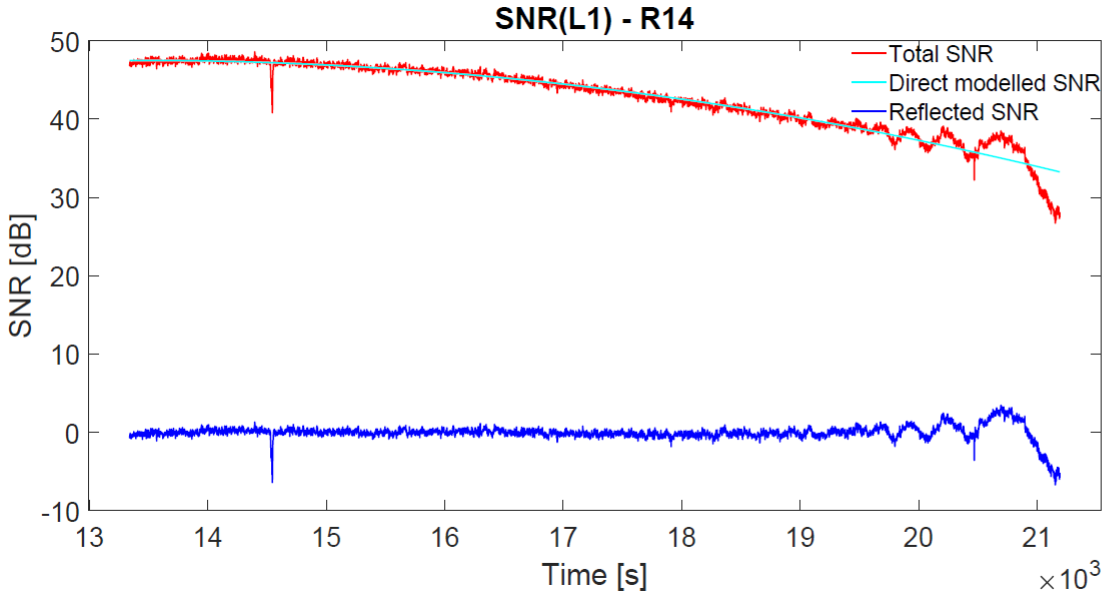

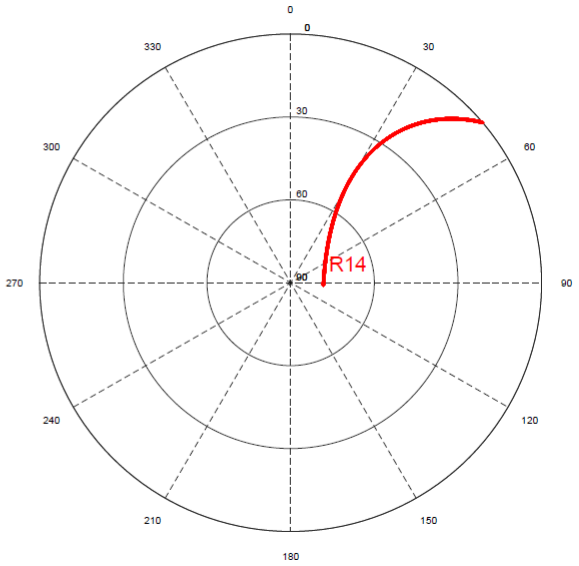

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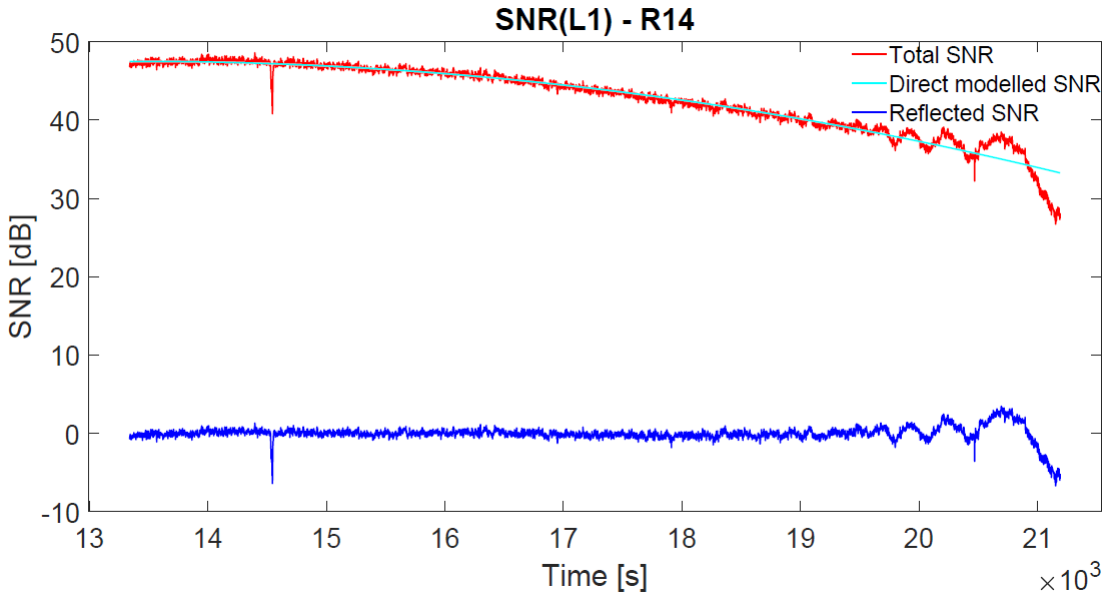
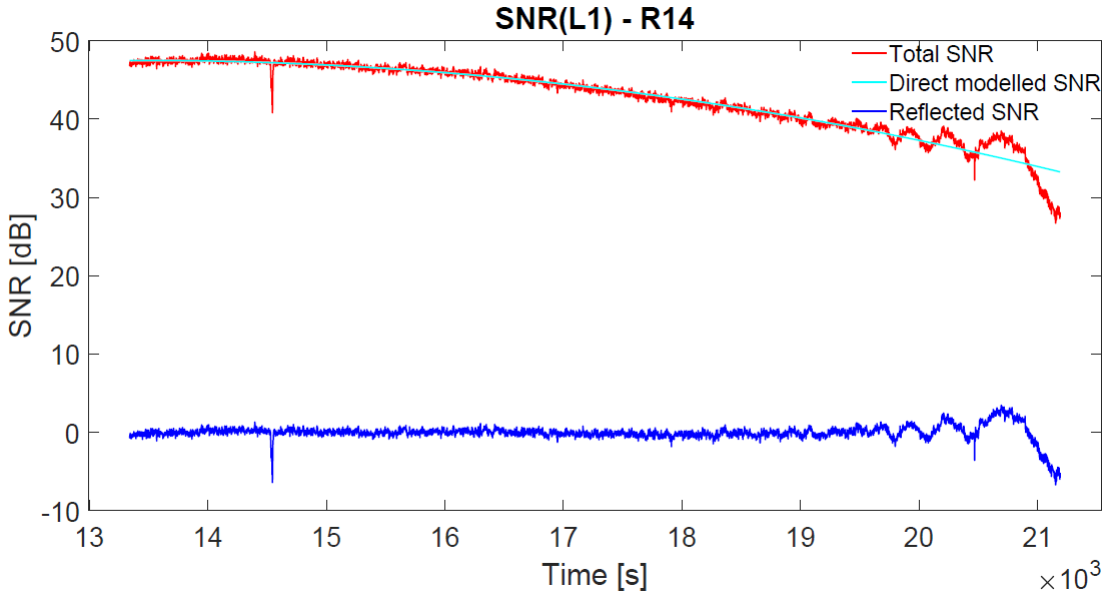


SPECTRAL ANALYSIS

$$h = \frac{\lambda f_M}{2\left[\sin(\theta_{max}) - \sin(\theta_{min})\right]}$$

f_M is the MULTIPATH FREQUENCY

METHOD: SNR



SNR written as a function of the elevation angle ($\sin\theta$)

- Uneven series
- Lomb Scargle Periodogram for spectral analysis

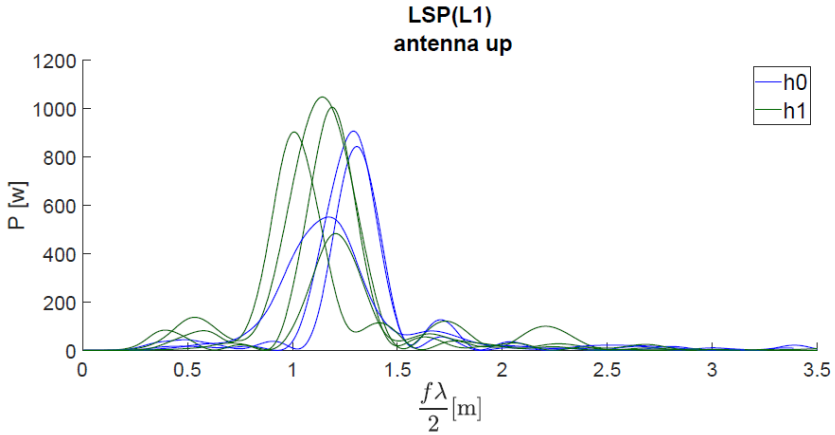
SPECTRAL ANALYSIS

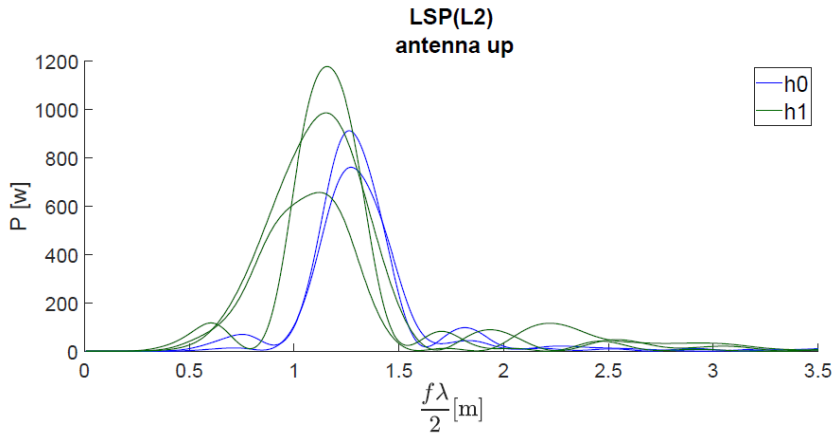
$$h = \frac{\lambda f_M}{2\left[\sin(\theta_{max}) - \sin(\theta_{min})\right]}$$

f_M is the MULTIPATH FREQUENCY

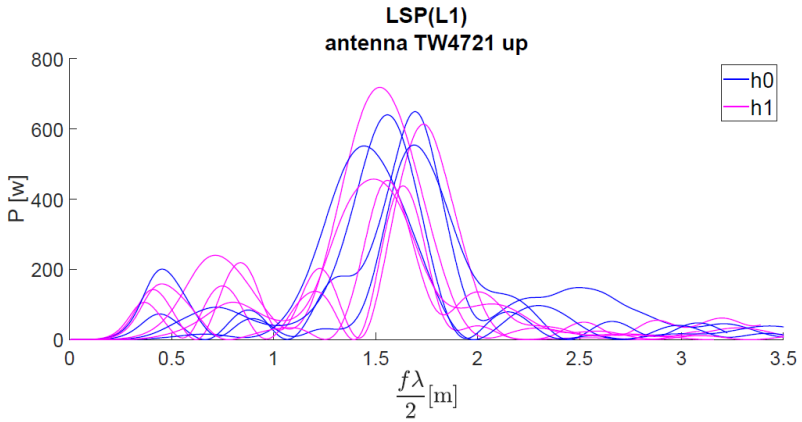
RESULTS: LOMB SCARGLE PERIODOGRAM

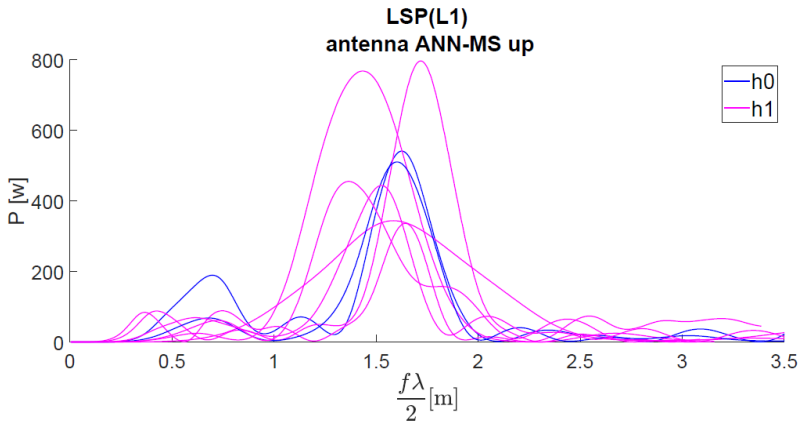
GEODETIC GRADE





CONSUMER GRADE





RESULTS: REFLECTOR HEIGHT

	Geodetic (L1, L2)		Consumer (Tallysman)		Consumer (u-blox)	
Heights [m]	h0	h1	h0	h1	h0	h1
Measured	1.29	1.16	1.71	1.56	1.71	1.56
Estimated (mean)	1.32	1.18	1.83	1.51	1.81	1.52
Error	-0.03	-0.02	-0.12	0.05	-0.01	0.04
N° estimations	5	7	4	5	2	6

- Extend the duration of data acquisition, in order to have more SNR time series to analyze
- Individuate more selection criteria based on the Fresnel reflection zones and on the LSP results

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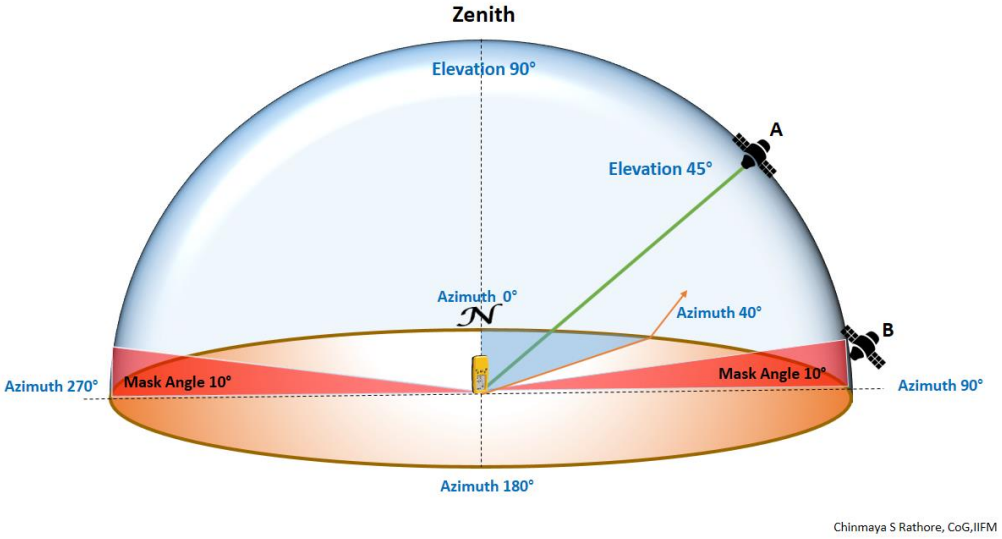
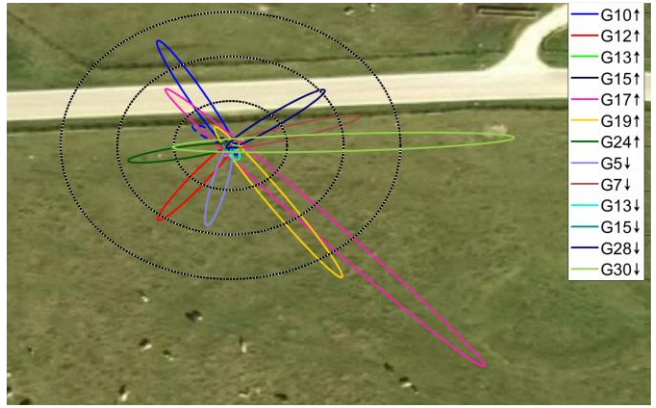
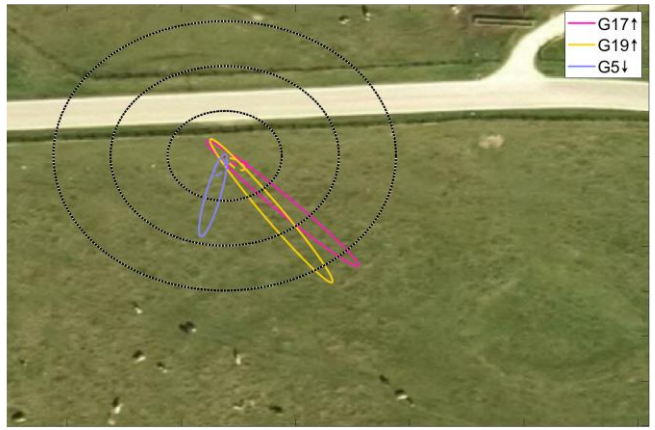
giulia.graldi@unitn.it

METHOD: DATA SELECTION







Azimuth: 90° - 270°
Elevation: 5° - 25°