SnowBall project

Measuring snow from space starts at the ground: from new station designs to collecting snow truth data

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Introduction

- Measuring geophysical parameters from space, associated with features and phenomena at the surface of the earth has a considerable number of advantages over the classical ground based observations:
  - Area covered
  - Access to places otherwise difficult – if not impossible to reach

- In-situ measurements originate from either automated stations - expensive to establish and operate or data collection campaigns – costly and logistically difficult to conduct (especially in remote areas).

- Remote sensing technique do not directly measure physical quantities but try to derive them from the electromagnetic radiation emitted/reflected by the objects and captured at the satellite instrument(s).

Direct and Indirect Measurements

- A crucial factor is the availability of accurate ground measurements used to calibrate the algorithms and validate the derived geophysical quantities of interest.

In Situ (Ground-Truth) Data Collection is based on Direct Measurements

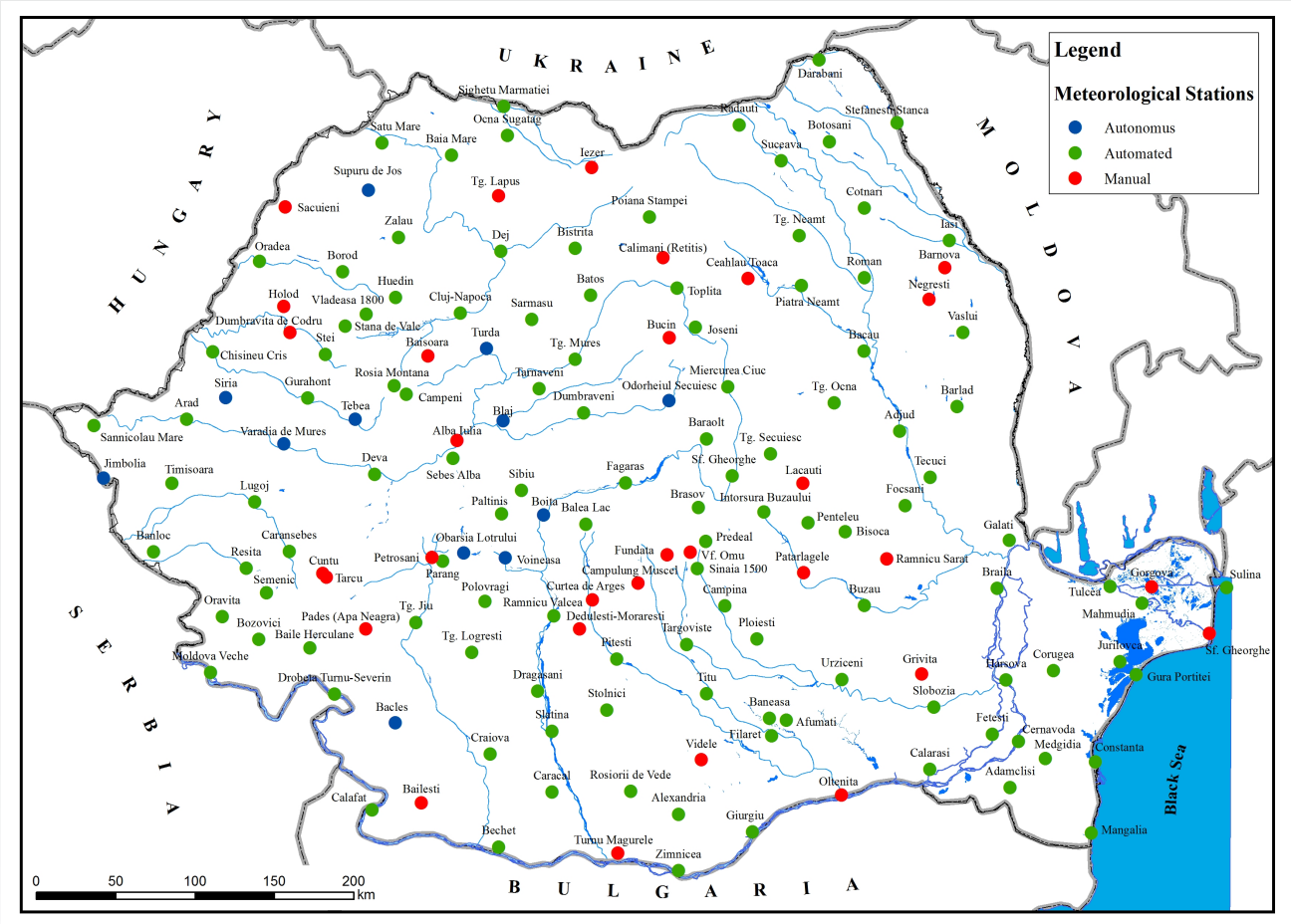
- The observation networks operated by national weather services are rather sparse, while calibration/validation of satellite data and products requires a higher spatial density over selected areas, but also better temporal sampling and new parameters to be measured.

Satellite Retrievals are Indirect Measurements

Data Collection

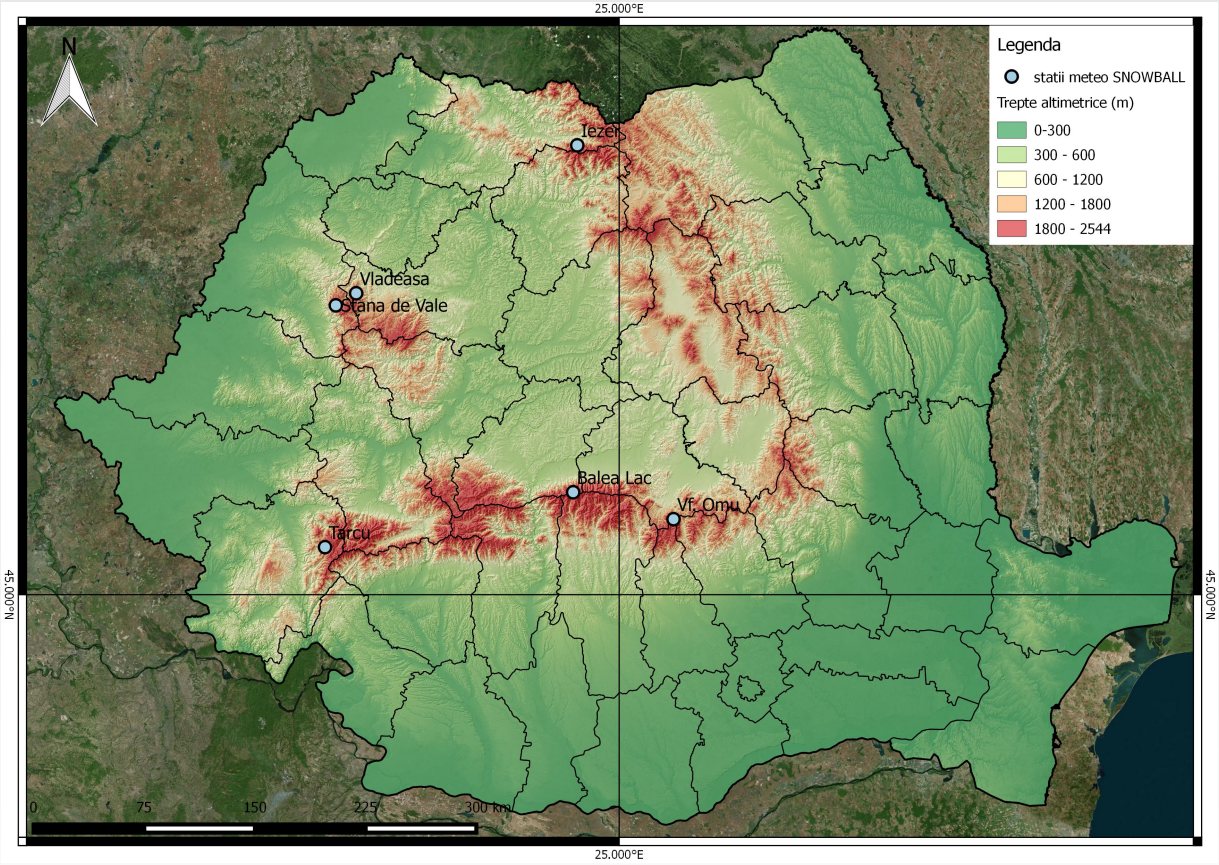
- Weather Station Network
- Collocated satellite/ in situ snow observations
- Field campaigns
- Snow Stations
- Cal/Val Sites

Data Collection: Weather Station Network



Data Collection

Collocated satellite/in situ snow observations: 2016 - 2017



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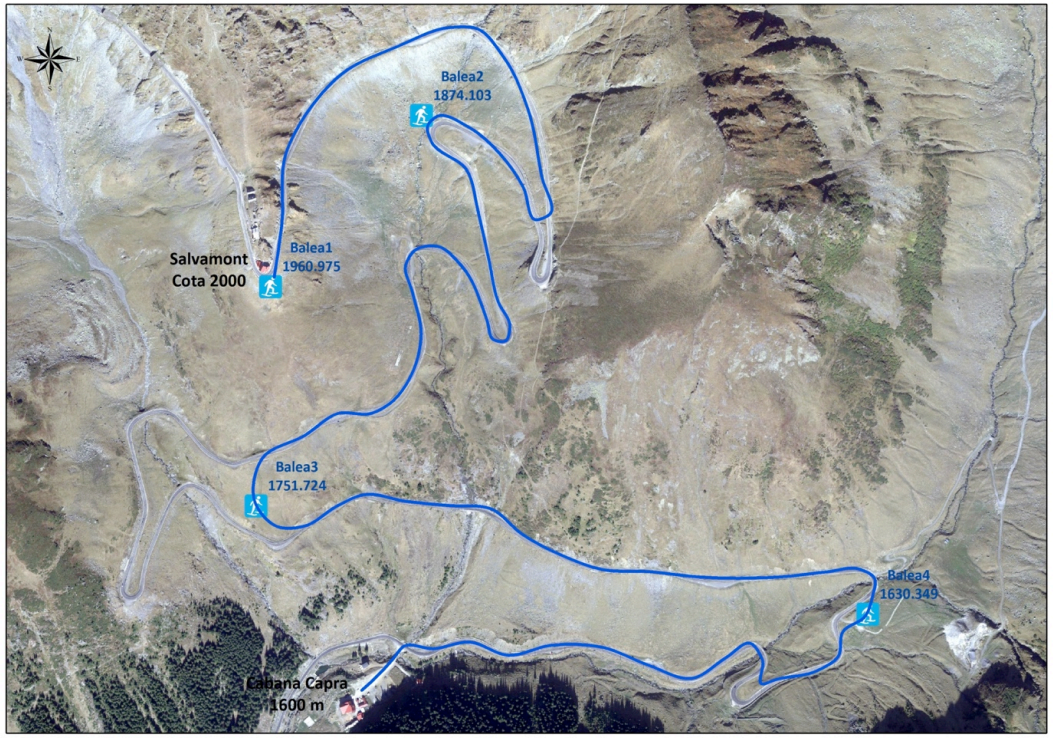
Data Collection: Field Campaigns 2015-2017

Valea Argesului/B (2000 m) Test Site

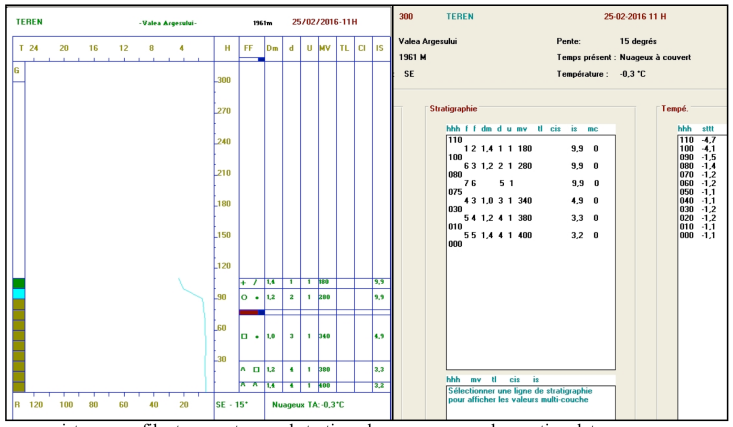
- 4 sites: 1630, 1751, 1874, and 1960 m.a.s.l.
- 4 air temperature probes installed/ 2 retrieved



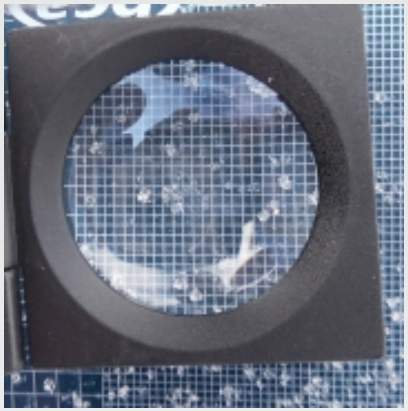
Data Collection: Field Campaigns 2015-2017

A little bit lower than Cota 2000 Salvamont refugee; N 45:59 ; E 24:63 ; ora 11,30

1964 m altitudine; 15 gr inclination; SE ; covered 8/8 ; air temperature -5.3 gr



resistance profile, temperature and stratigraphy observation data



METEO ROMANIA

SnowBall project Final Conference,
27 April 2017, Bucharest, Romania

Norsk Regnesentral

Universitatea Tehnică de Construcții București
Centrul de Cercetare Ingineria Apelor Subterane

Universitatea de Vest din Timișoara

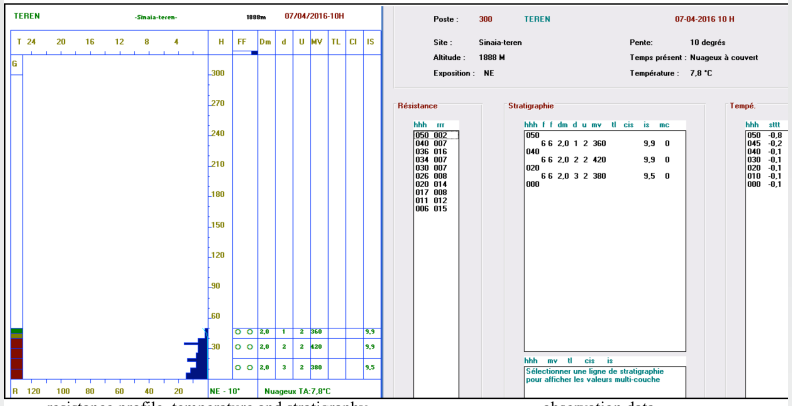

Cota 2000
Cota 1400
SINAIA

Data Collection: Field Campaigns 2015-2017

Sinaia (2000 m) Test Site
- 5 sites: 1758, 1793, 1808, 1835, 1888 m.a.s.l.
- 7 snow profiles (17 March: 5, 18 March: 2
- 5 air temperature probes installed / 5 retrieved

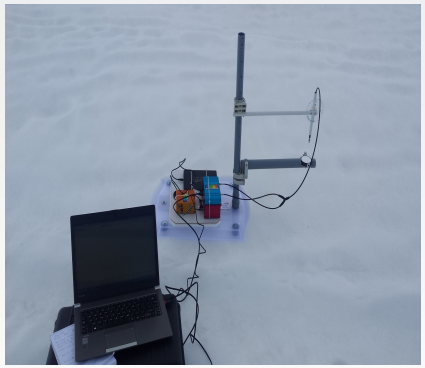
Data Collection: Field Campaigns 2015-2017

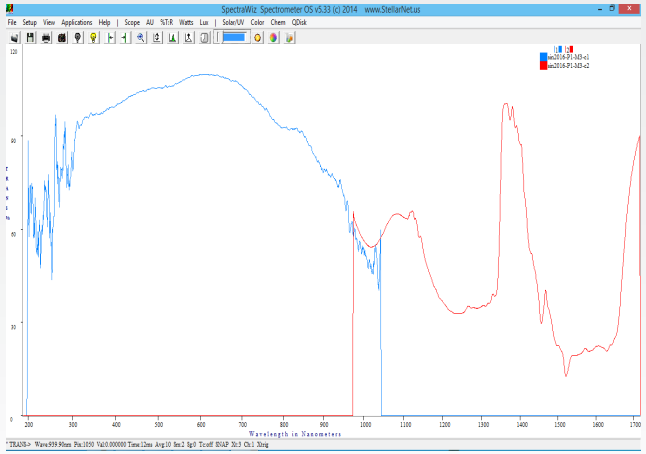
* **SONDAJ 1**
Valea Dorului; N 45:21:13.5 ; E 25:29:33.4; H 10,00
1888 m altitude; 10 gr inclination; NE ; covered ; air temperature 7.8 gr



resistance profile, temperature and stratigraphy observation data

50 cm of wet snow, on a wind exposed slope. Temperature inside the snow is almost 0 gr (isothermal), specific to spring snow. Snow is pretty soft, except the last 20 cm and some thin remaining crusts with rounded crystals embedded. The entire snow layer is stable.





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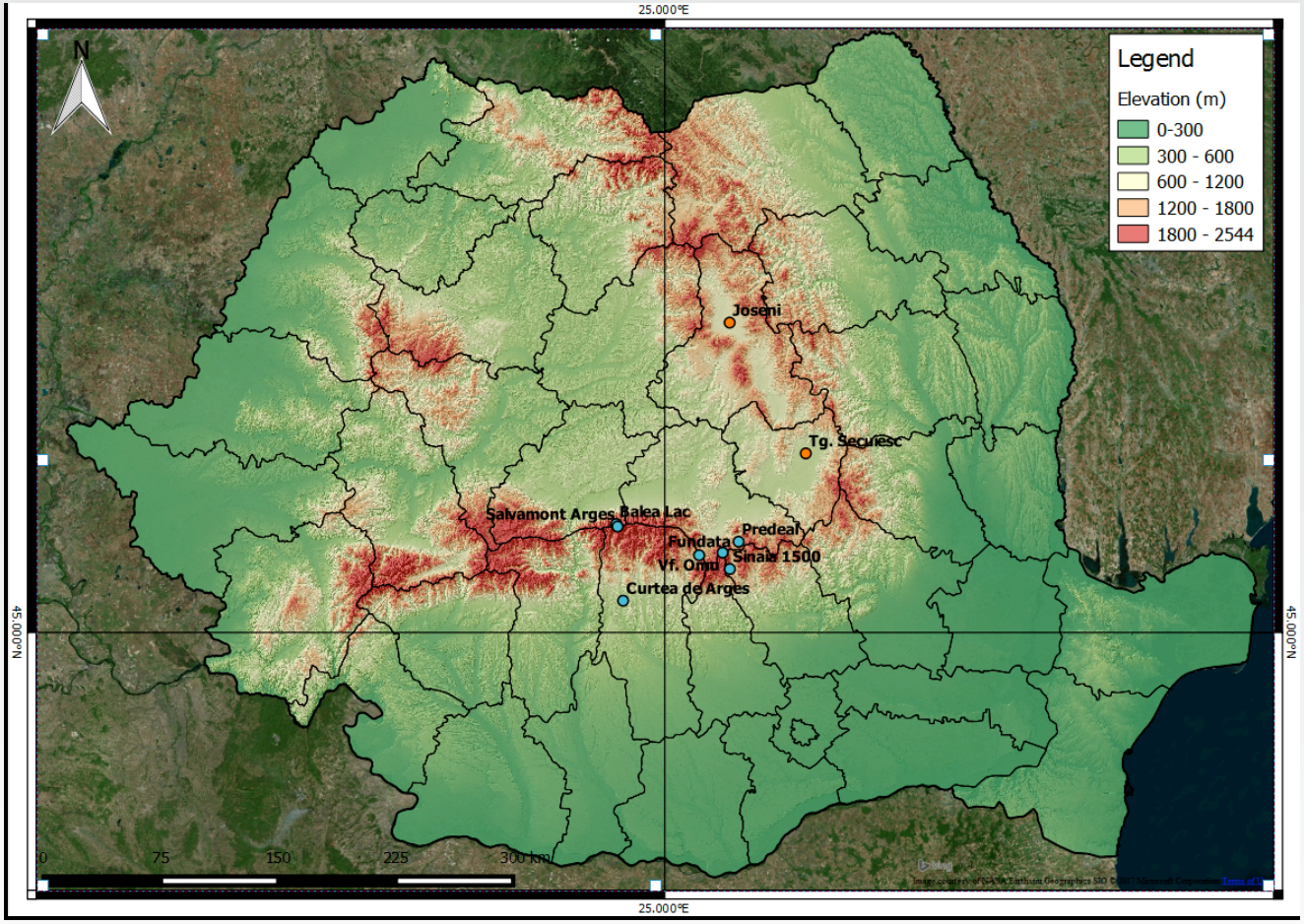
Data Collection: Snow Stations



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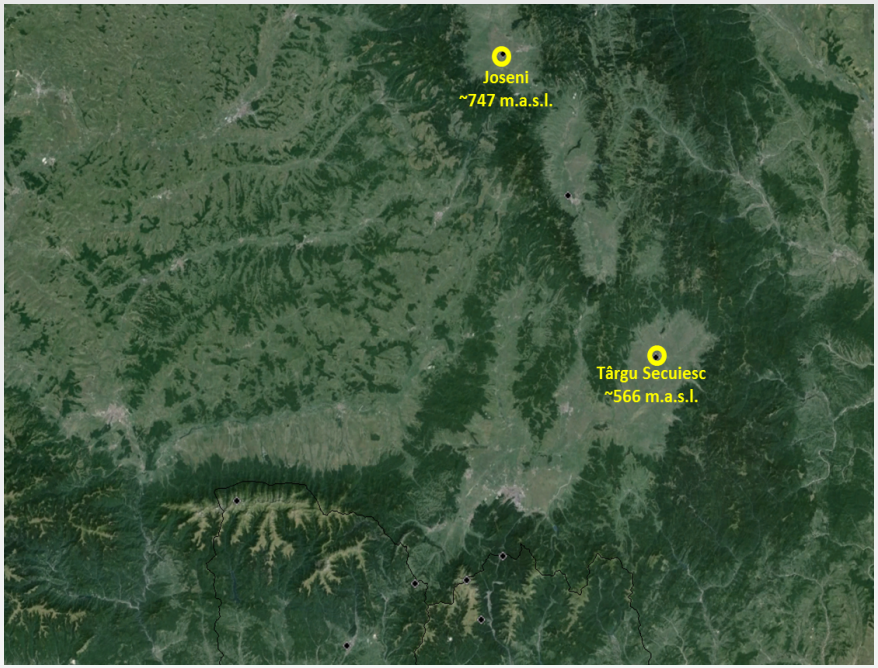
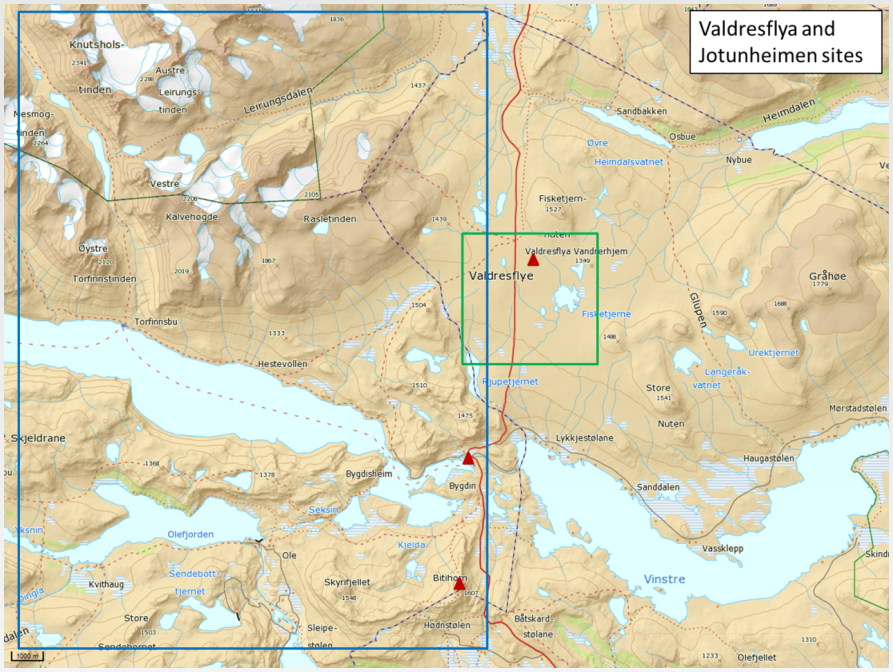
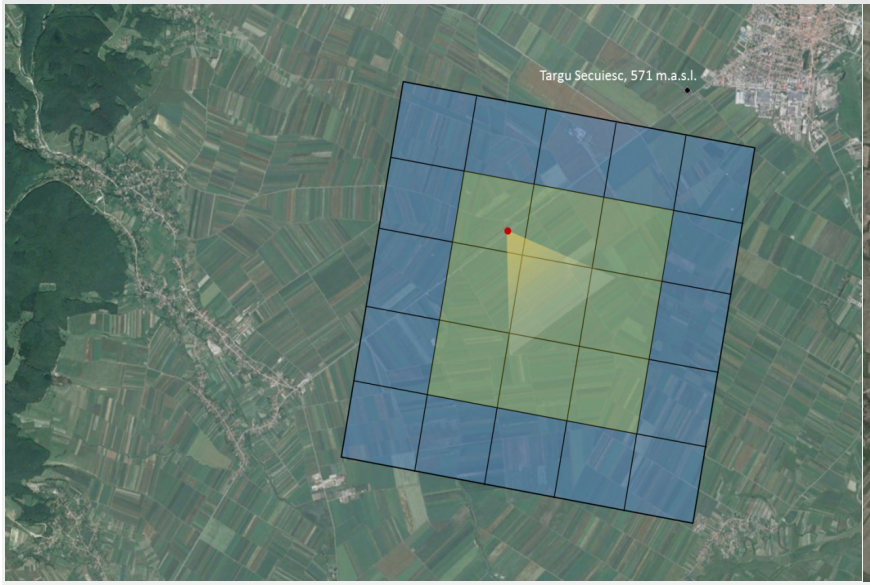
Snow Stations in Balea-Lac and Predeal

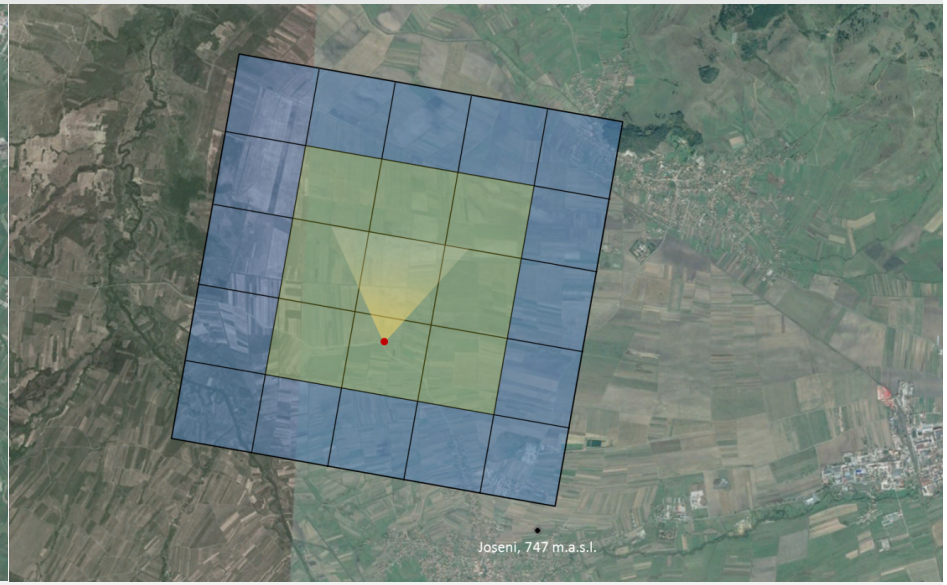
Data Collection: Cal/Val Sites





Data Collection: Cal/Val Sites





Data Collection: Cal/Val Sites Romania (Tg.Secuiesc & Joseni), Norway (Beitostolen)

Snow Stations & Cal/Val Stations: To Buy or To Build?

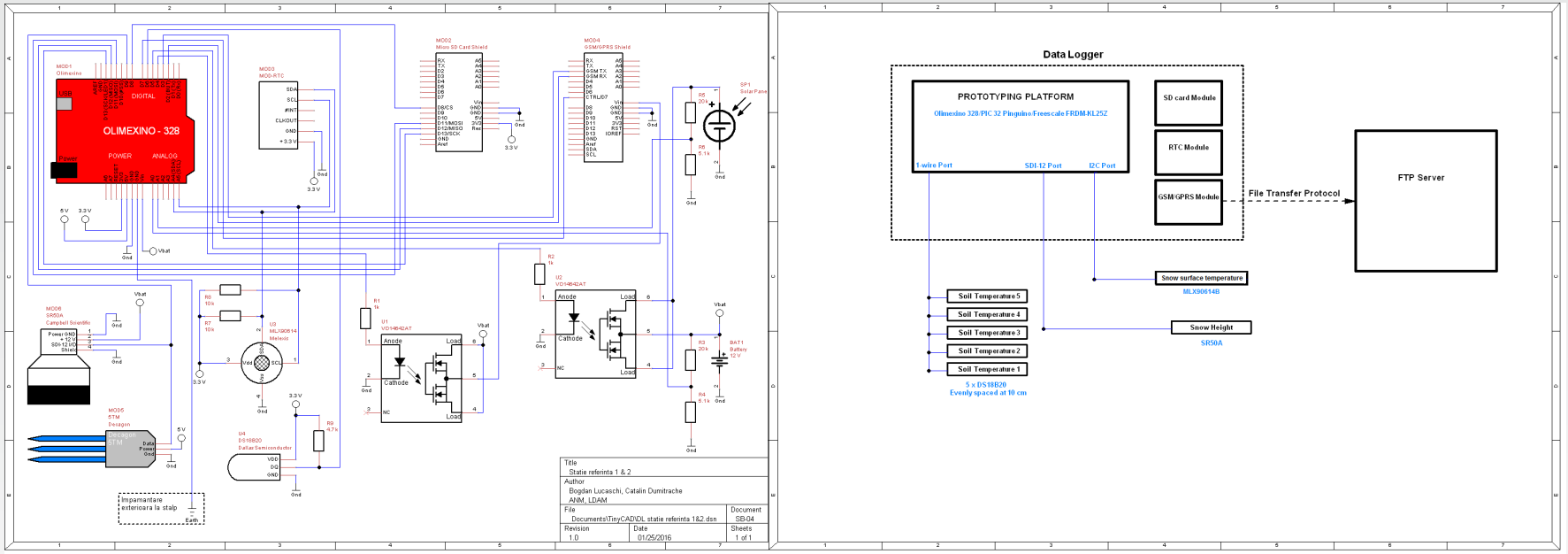
- Professional snow stations are expensive – they are designed and build to operate in harsh conditions and to last long
- Cheap, amateur weather stations, can neither stand difficult winter conditions, nor can they accommodate the type of sensors required for a snow station.
- But what about DIY?
  - Plus:
    - Cost
    - Flexibility – sensor wise
    - Existing expertise
  - Minus:
    - Development/Testing cycle length
    - Effort: 3 different (in varying degrees) types of stations

And the winner is…DIY !

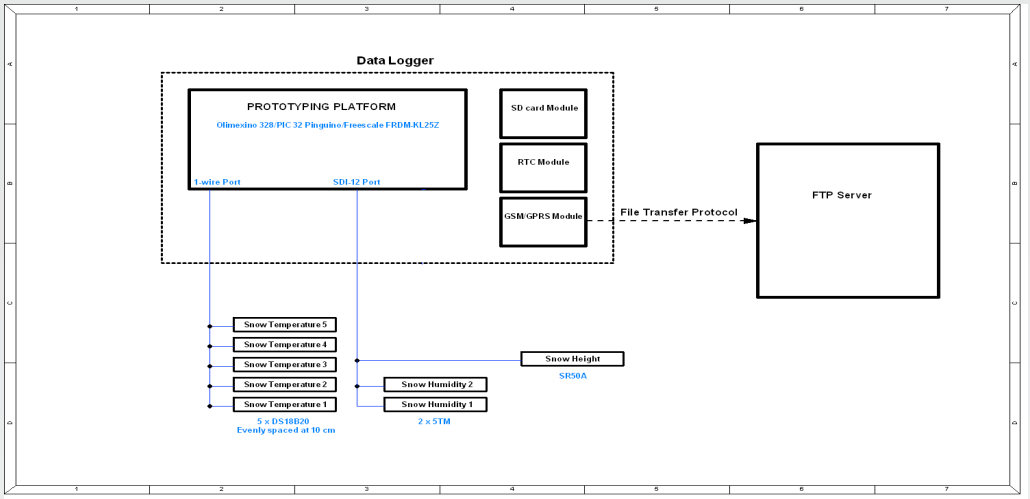
Requirements:

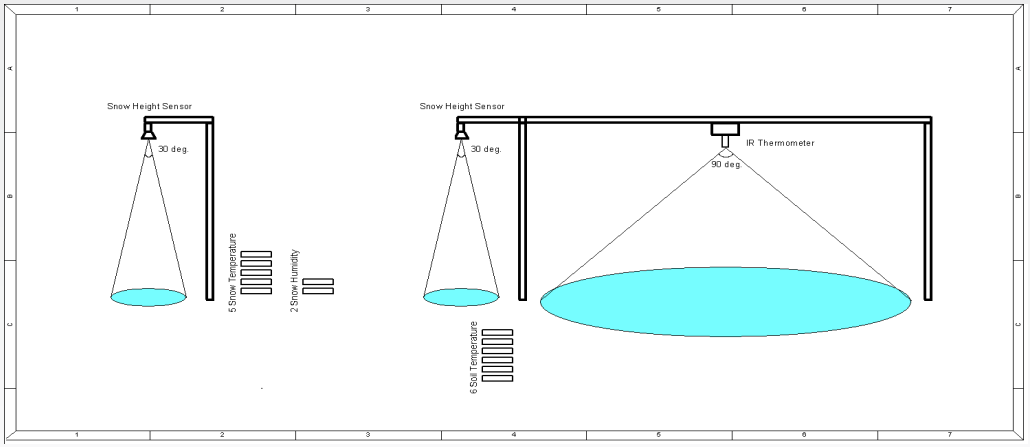
- Open source hardware/software
- Power independent (off grid) operation, low power consumption
- Data logger: software configurable, interfaces for all sensors available
- Data transmission: GPRS
- Capable of measuring: snow surface temperature, snow temperature (profile), soil temperature (profile), air temperature, snow depth, snow extent, snow wetness
- Fully automated operation
- Configurable data sampling rate
- Short/long term data storage
- Environmental: -30 C to +20 C

Type 1 Cal/Val Station



Mechanical Setup Cal/Val Stations Type 1 & Type 2

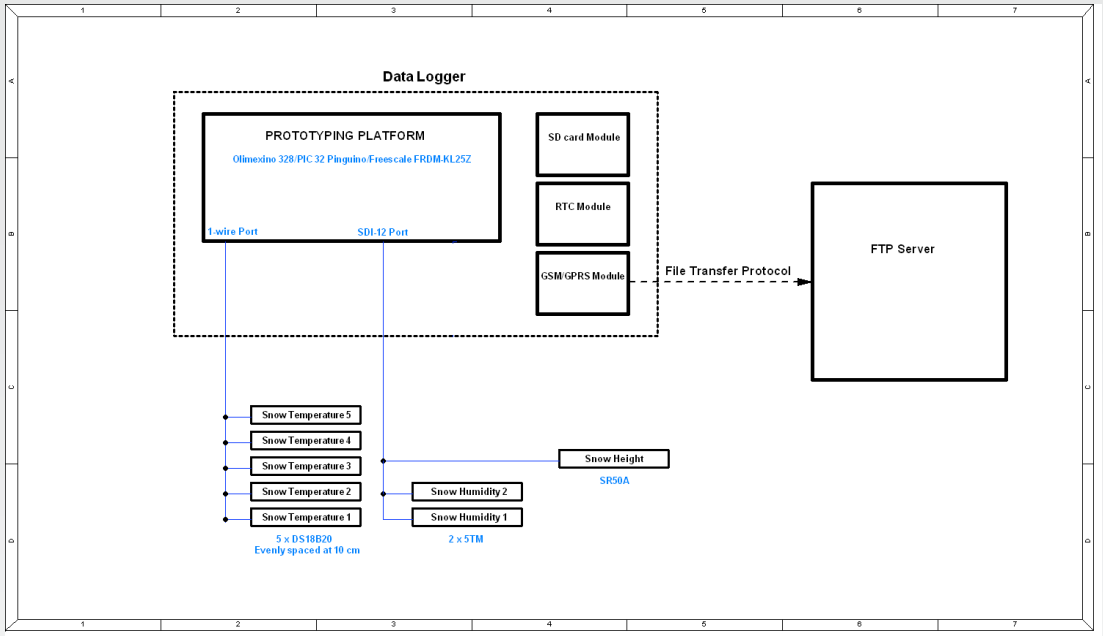


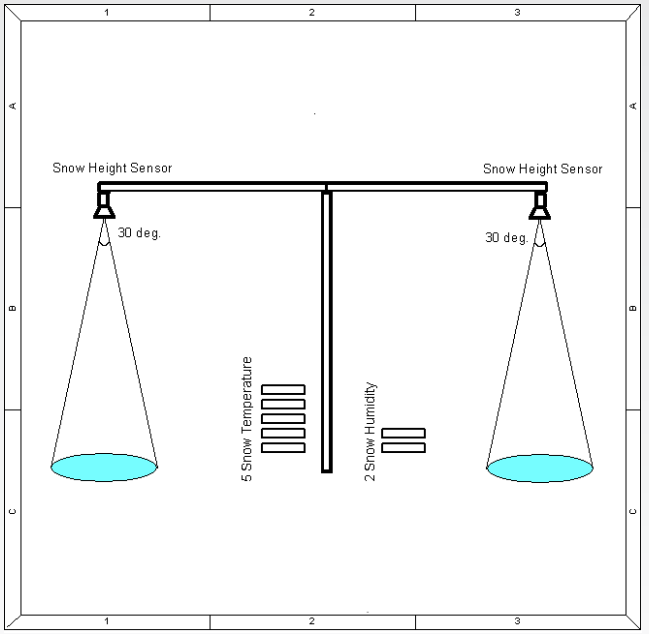


SnowBall Data Collection in figures:

- 7 field campaigns
- 10 air temperature sensors deployed
- 2 cal/val stations established (Joseni, Tg.Secuiesc)
- 6 participating high altitude weather stations
- 7 snow stations established

Snow Stations: Scheme & Mechanical Setup

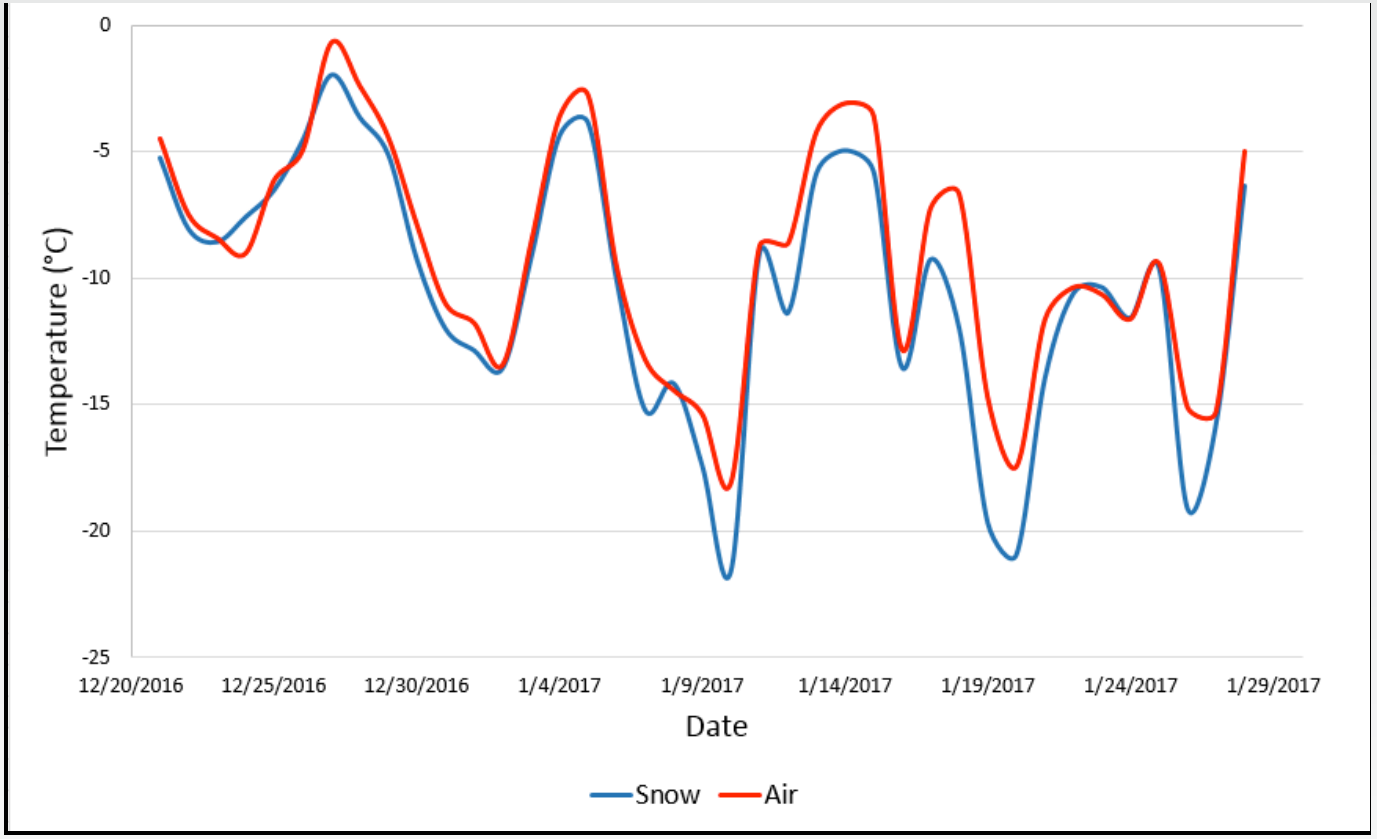




In Situ & Remote Sensing Snow Observations

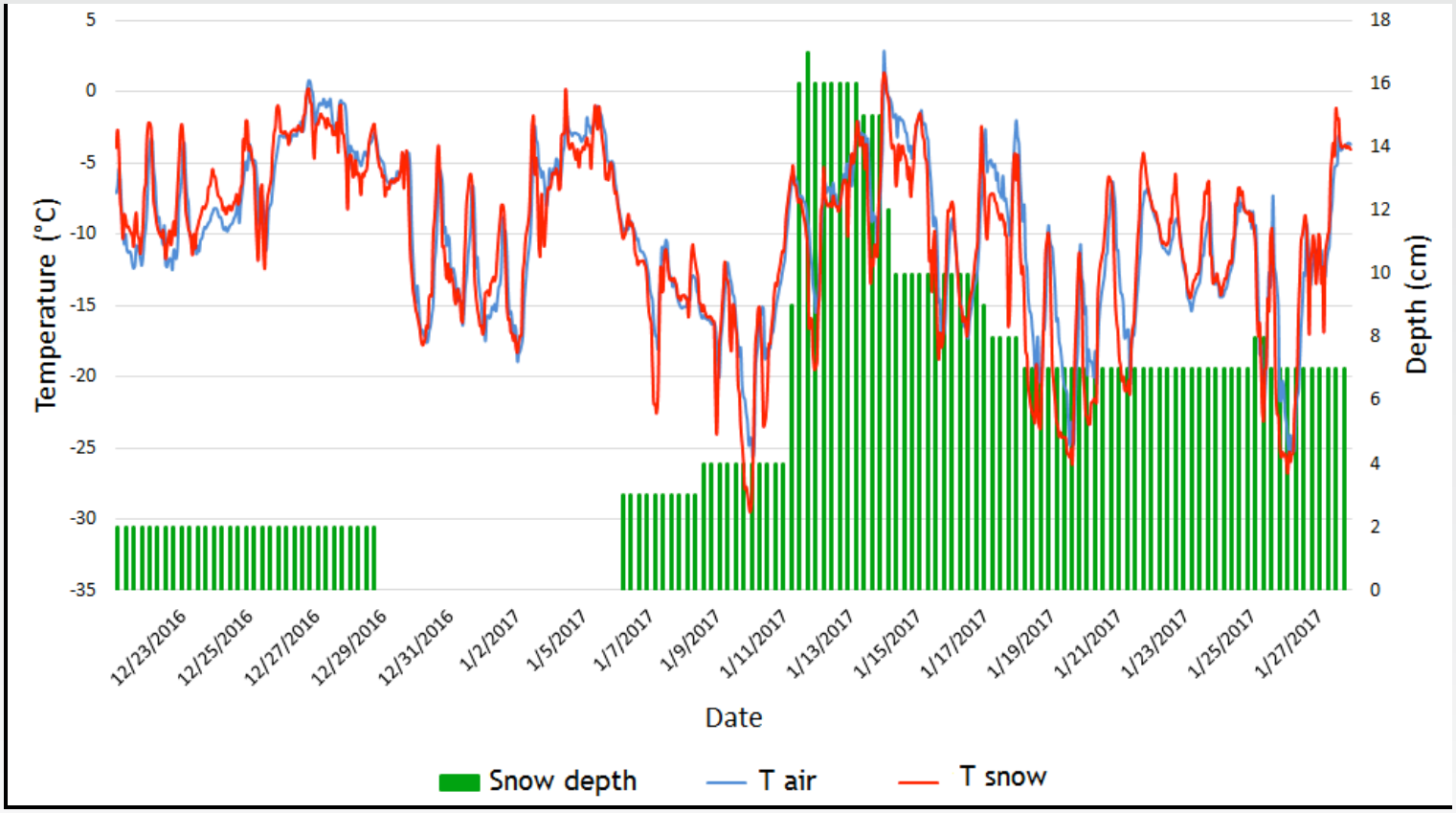
Variable	In Situ Measurements		Remote Sensing (Aerial/Satellite)
	Field Campaign	Snow Station	
	Measurements Principle		
Snow spectrum	Field spectrometer	Spectrometer	Albedo - Optical
Snow grain size	Contact spectroscopy	N/A	Optical (Near–infrared)
Snow liquid water	Dielectric probe	Dielectric probe (A) Snowball test (M)	Optical/Microwave
Snow density	Weight of 1 dm^3	Weight of 1 dm^3 (M)	N/A
Snow water equivalent	= Snow Depth * Snow Density	Snow pillow (A)	Microwave
Snow depth	Snow stick	Snow stick (M) Ultrasonic distance probe (A)	Optical
Snow cover	Aerial or VHR imagery	Visual (M) CCTV (A)	Optical (visible)
Snow temperature	Thermometer	IR temperature probe (A) Contact temperature probe (A)	Optical (thermal infrared)
Air temperature	Thermometer	Temperature probe (A)	N/A
Snow sample	Chemical analysis or particle study	N/A	N/A

Snow Data



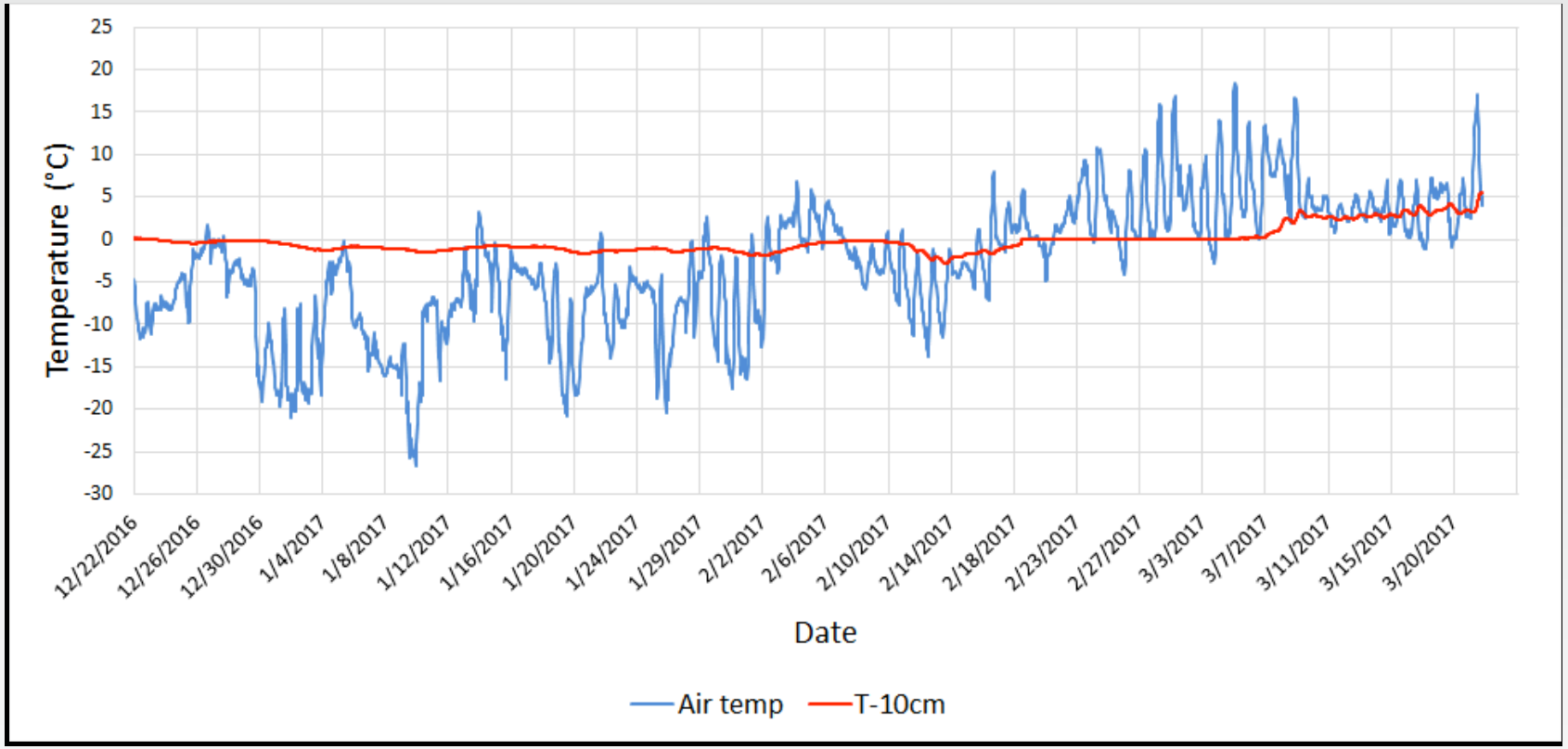
Snow suface temperature and air temperature at 2m at Joseni cal/val station

Snow Data



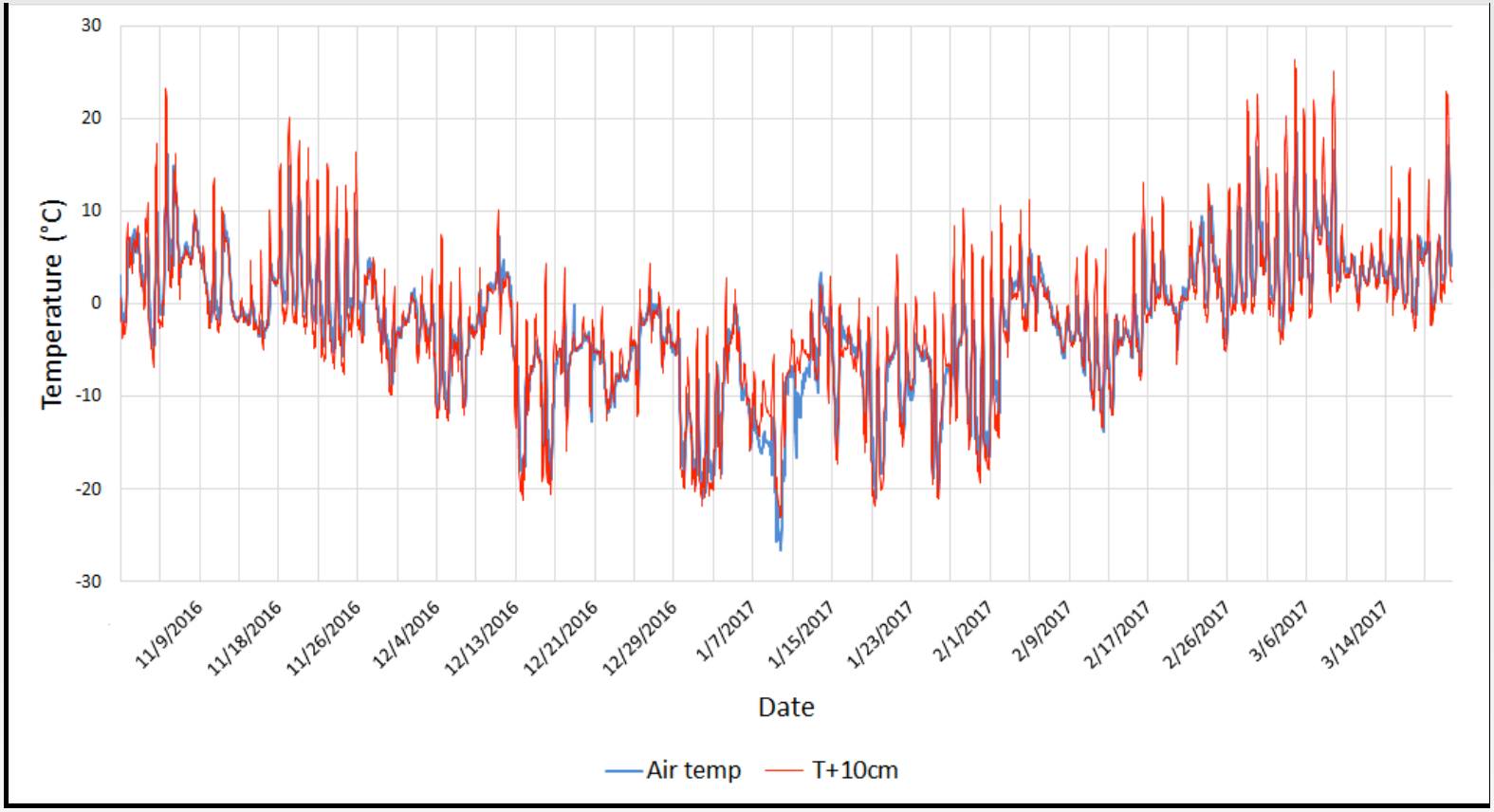
Snow surface temperature, air temperature at 2 m and snow depth at Joseni cal/val station

Snow Data



Snow temperature at 10 cm and air temperature at cal/val station Tg. Secuiesc

Snow Data



Soil temperature at -10 cm and air temperature at cal/val station Tg. Secuiesc

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Thank You Norway !

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