Snow measurement campaign for snowpack model and satellite retrieval validation in Italian Central Apennines within SMIVIA project

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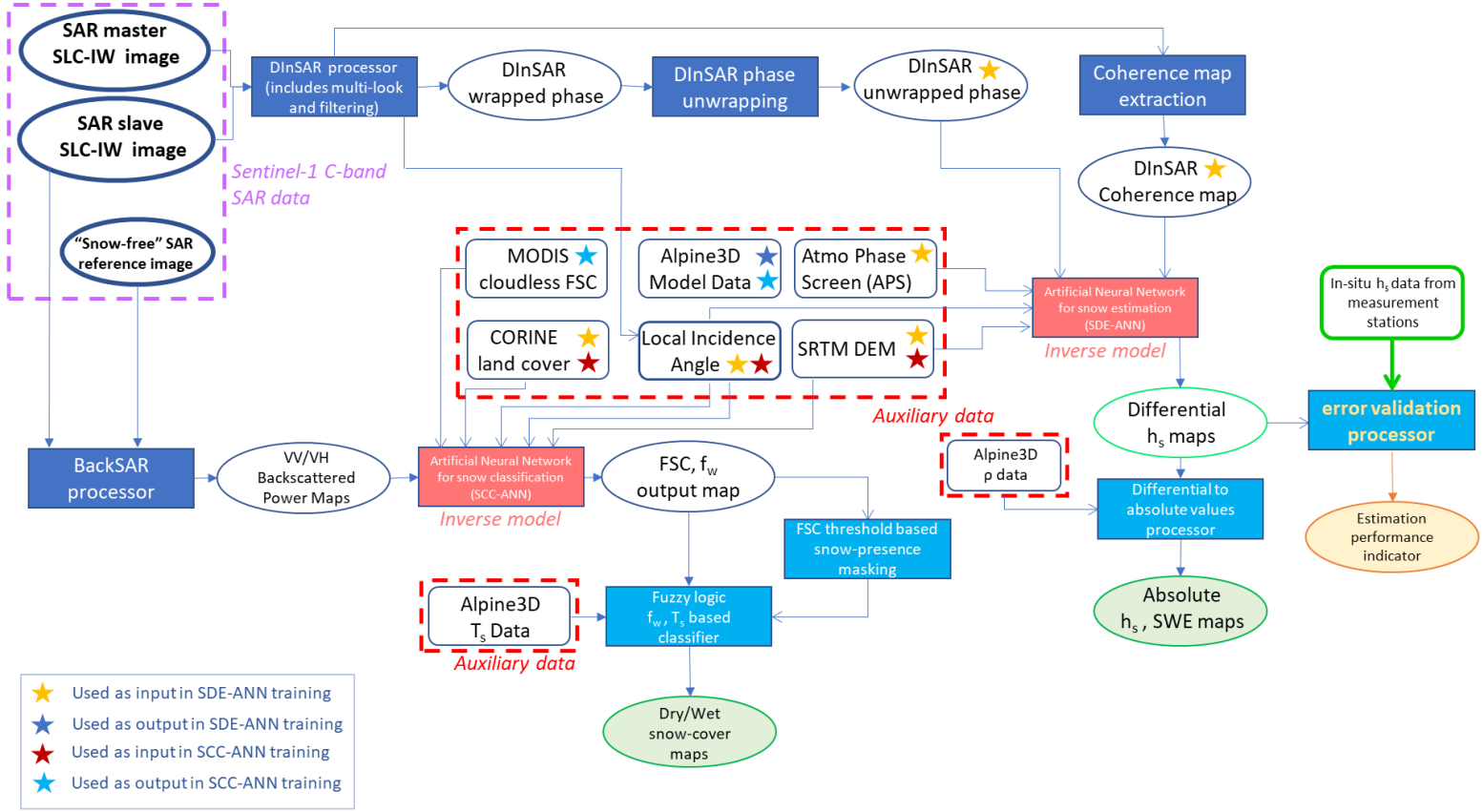
The SMIVIA project



- The SMIVIA project has the purpose of developing new techniques for the estimations of several snow cover properties using SAR and optical remote sensing observations, ground based meteorological radar data and snowpack numerical model outputs.

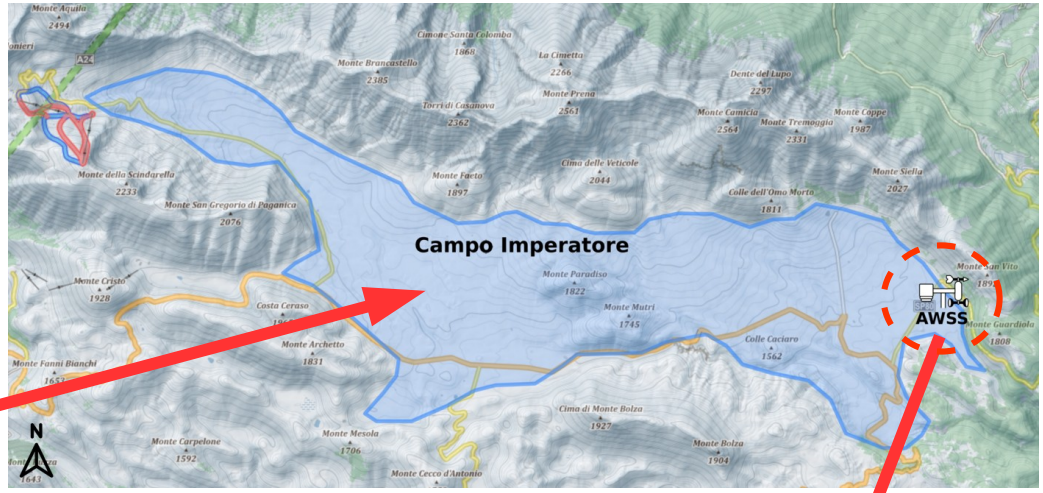
Objectives

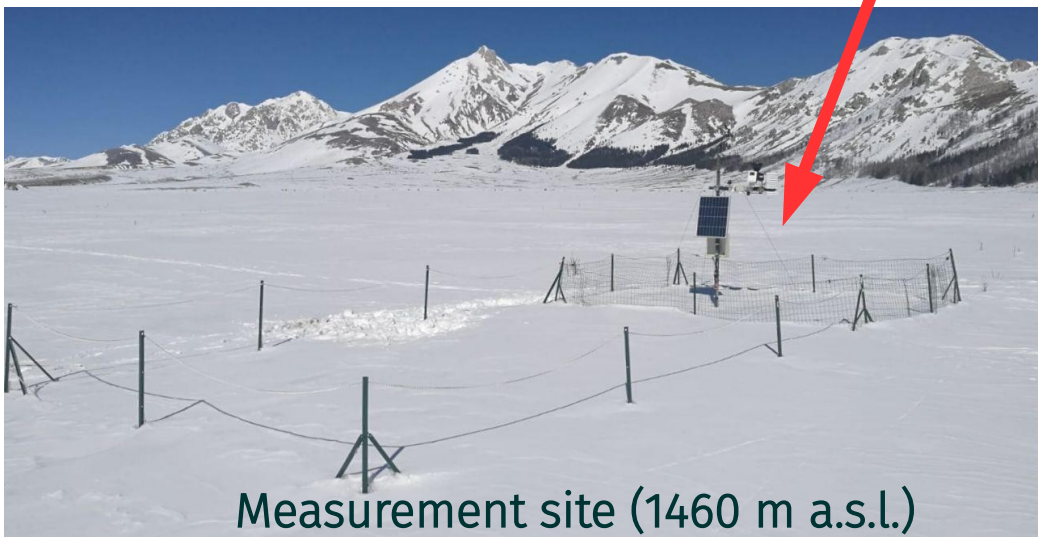
The **aim** of this measurement campaign is to:

- **validate** the results obtained within the **SMIVIA** project
- lay the basis for a **systematic monitoring** of the **snow** cover properties in **Central Apennines**

Thus we built a **measurement site** on **Campo Imperatore** plateau at 1460 m a.s.l., near Gran Sasso d'Italia (2912 m a.s.l.), the highest peak of the **Apennines**, where to observe the most important **snow** cover properties and collect data automatically and manually.

The measurement site





Instrumentation

Automatic measurements

Measured variable	Sensor manufactor
Air temperature	Davis VP2 temperature and humidity sensor
Relative humidity	Davis VP2 temperature and humidity sensor
Wind speed	Davis VP2 anemometer
Wind direction	Davis VP2 anemometer
Liquid precipittaion	Davis VP2 pluviometer
Incoming shortwave radiation	Davis VP2 pyranometer
Reflected shortwave radiation	Davis VP2 pyranometer
Snow height	Siemens The Probe
Snow surface temperature	MLX90614
Soil surface temperature	DS18B20
Pictures	Raspberry Pi Camera Module V1

- All the sensors (except anemometer and soil surface temperature sensor) positioned at 2.5 m above ground
- Anemometer at 3 m above ground
- Soil temperature sensor lays on ground surface
- Sensors connected to a Raspberry Pi Zero W which stores and send data to a server for real-time access (every 5 minutes)

Manual measurements

Measured variable	Instrument
Snow height	Meter
Snow temperature	Thermometer
Grain shape	Crystal card and lens; Microscope
Grain size	Crystal card and lens; Microscope
Snow hardness	Hand test
Snow density	Metal cylinder and scale

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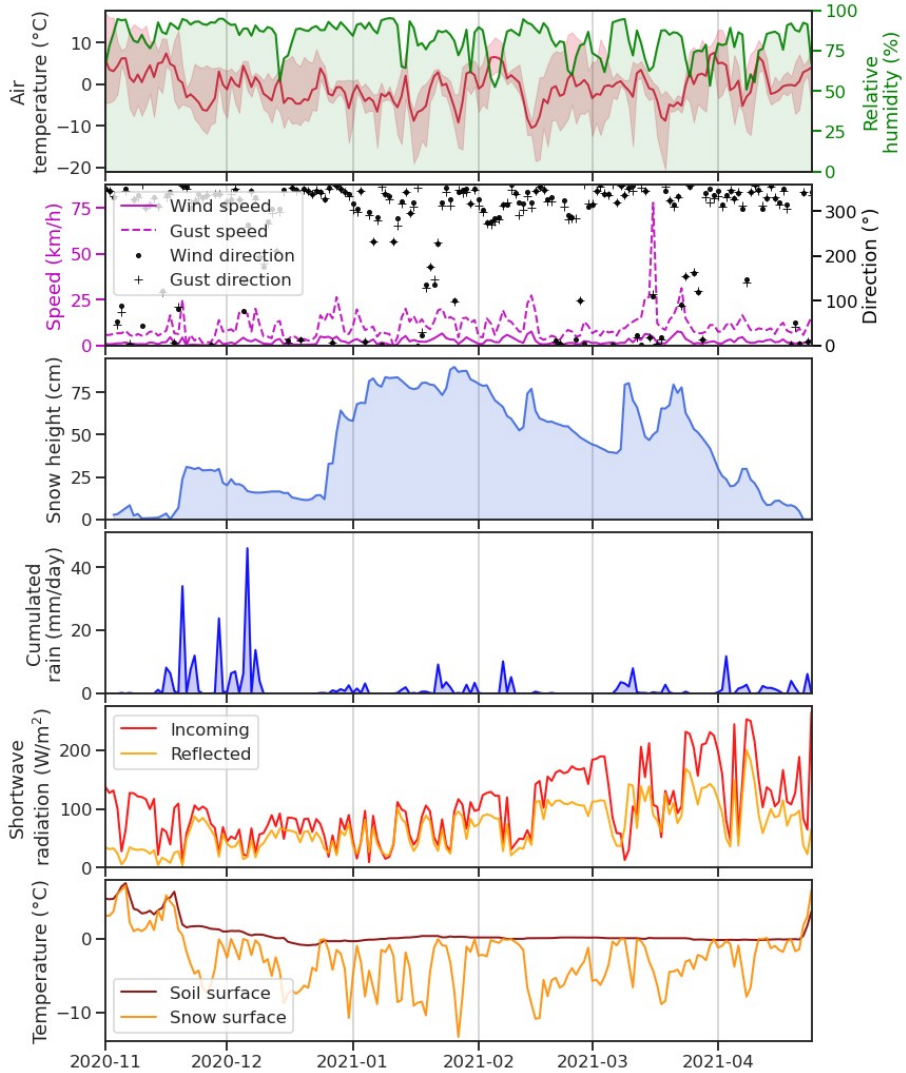
Automatic measurements: winter 2020-2021



- Entire database processed in order to remove non-physical values caused by sensor errors
- Data resampled from 5 minutes to 30 minutes
- Almost 6 months with snow on ground
- Maximum snow height of ~1 m
- Abrupt drop of snow height in some cases: likely due to the wind erosive effect
- Wind gusts reached moderate values during the day (above 70 km/h in some cases)
- Strong daily thermal inversions (20°C/day) observed at the measurement site

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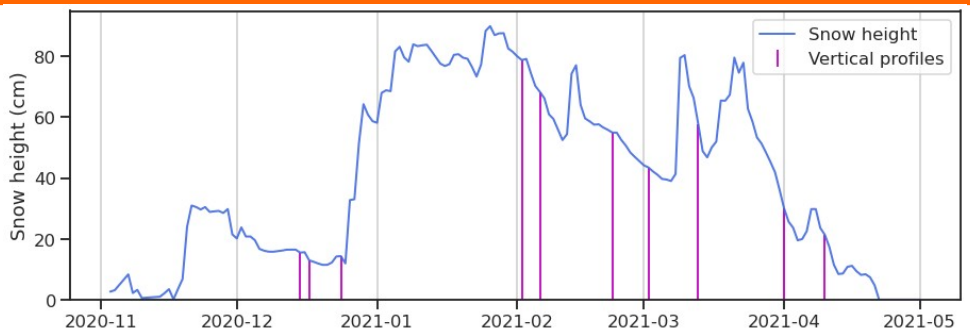
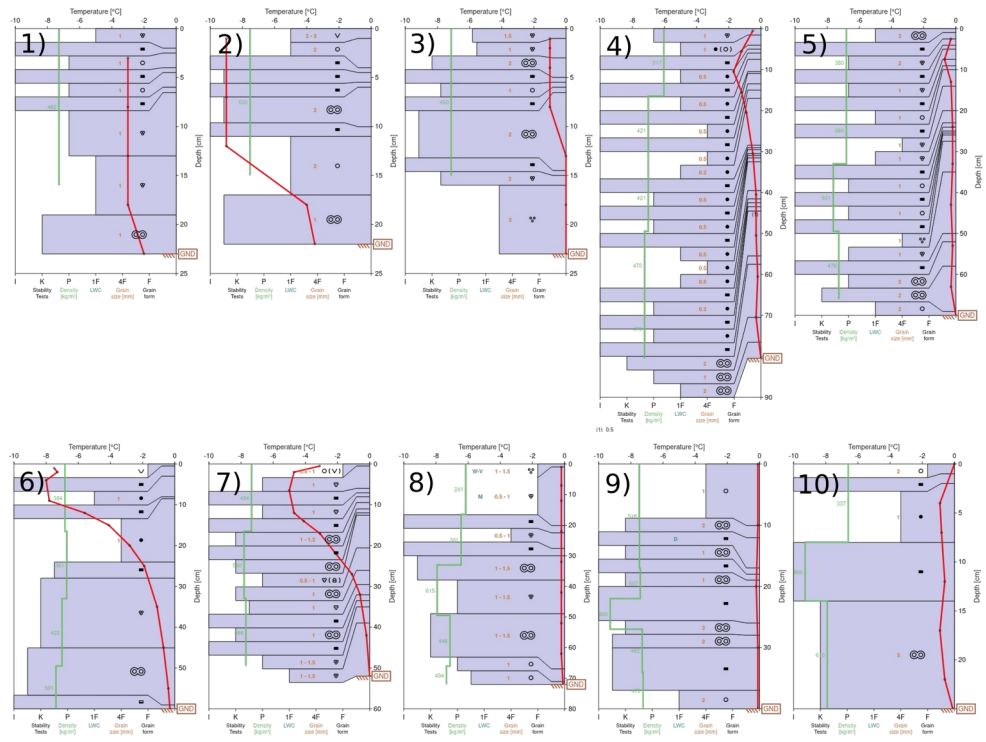
Manual measurements: winter 2020-2021





Profile date	ID	Snow height (cm)	SWE (kg/m^2)	Snow density (kg/m^3)
2020-12-15 15:45	1	23	111	482
2020-12-17 10:15	2	22	117	530
2020-12-24 09:15	3	23	104	450
2021-02-02 10:50	4	81	320	398
2021-02-06 10:10	5	70	313	447
2021-02-22 10:00	6	60	245	409
2021-03-02 10:10	7	52	286	550
2021-03-13 10:10	8	72	294	409
2021-04-01 11:11	9	40	220	551
2021-04-10 10:47	10	25	148	592

- Vertical profiles digitized with open source software niViz (https://niviz.org)
- It was not always possible to reach the measurement site just after the snowfall because of closed road
- Melt forms most frequently observed (due to relatively mild mean daily temperatures)
- Snowpack highly stratified, with lot of ice lenses and melt-refreeze crusts (due to strong thermal inversions)

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Conclusions

What we did:

- During 2020-2021 we measured automatically (every 5 minutes) and manually (10 vertical profiles) several atmospheric and snow cover properties on Campo Imperatore plateau
- We post-processed all the automatic measurements and digitized the manual measures

Next:

- We will use the collected data to validate the results that we are going to obtain within the SMIVIA project
- We will process all the data collected during winter 2021-2022
- During next summer we will add new sensors and replace some of them with more accurate ones, and we will install an additional measurement site in a more accessible place

Prof. Frank S. Marzano
1963 - 2022

Thanks!

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