



RFID TECHNOLOGY APPLIED TO GLACIAL ENVIRONMENT: MALATRA ELECTRONIC SYSTEM DESIGN AND EXPERIMENTAL DATA

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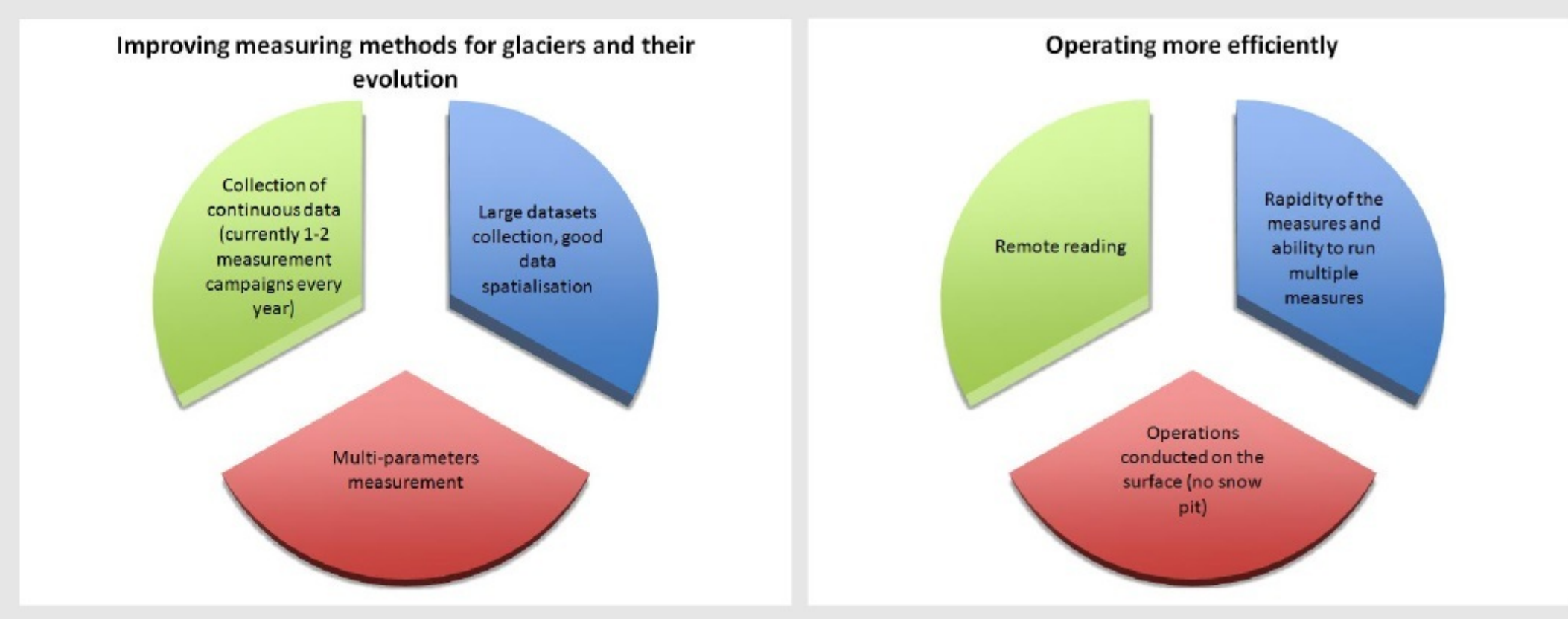


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MALATRA PROJECT

MALATRÀ (Monitoraggio dell'Ambiente gLaciale mediante Tecnologia RFID / Glacial Environment Monitoring by means of RFID Technology) is the first project of GLACIES research unit. It aims to develop a tracking and identification system for measuring physical parameters in glacial environment using RFID (Radio Frequency IDentification) technology. The system is composed by sensors equipped *tags* deployed on the glacier and a hand held *reader* to download the stored data. The devices allow to monitor the properties of the ice, in an easier and more widespread way than traditional procedures, in areas where human intervention is difficult and dangerous.



SYSTEM DESIGN

The research unit has studied and realised in its entirety both the design, both the realization of the layout of the printed circuit boards (PCB), the software and the firmware. The PCB hosts the sensors (magnetometer, accelerometer, PT1000 temperature sensor, pressure sensor), an antenna for the RFcommunication, a serial port and a microcontroller able to manage all the functionalities. Changing the firmware, the same board, connected to the PC via serial communication, can act as a reader or battery powered as a tag. In the tag version, sampling the sensors once a day, the battery life is estimated to last 5 years.



Software MALATRA Console: graphic interface that allows communication between *reader* and *tag*

"GLACIES" RESEARCH UNIT

The Research Unit GLACIES (GLaciers And Cryosphere International Expert Study group) was founded with the goal of developing sensors and systems for the monitoring of parameters characterizing the environment of high mountains, with particular reference to the glacial one.

It brings together two partners funded, Fondazione Montagna sicura and EnviSens Technologies and four other subjects who participate without funding: the Department of programation, protection of soil and water resources of the Autonomous Region of Aosta Valley, the regional environment agency - ARPA Valle d' Aosta, the Department of Innovative Technologies (DTI) of the University of Applied Sciences and Arts of Southern Switzerland (SUPSI) in Lugano, the Versuchsanstalt für Wasserbau, Hydrology und Glaziologie (VAW) of the Polytechnic (ETH) in Zurich. It is funded in the frame of operational programs "ERDF regional competitiveness 2007/13" and "ESF employment 2007/13" - Research



The *reader* in its packaging, specially manufactured to protect it from impacts and water.

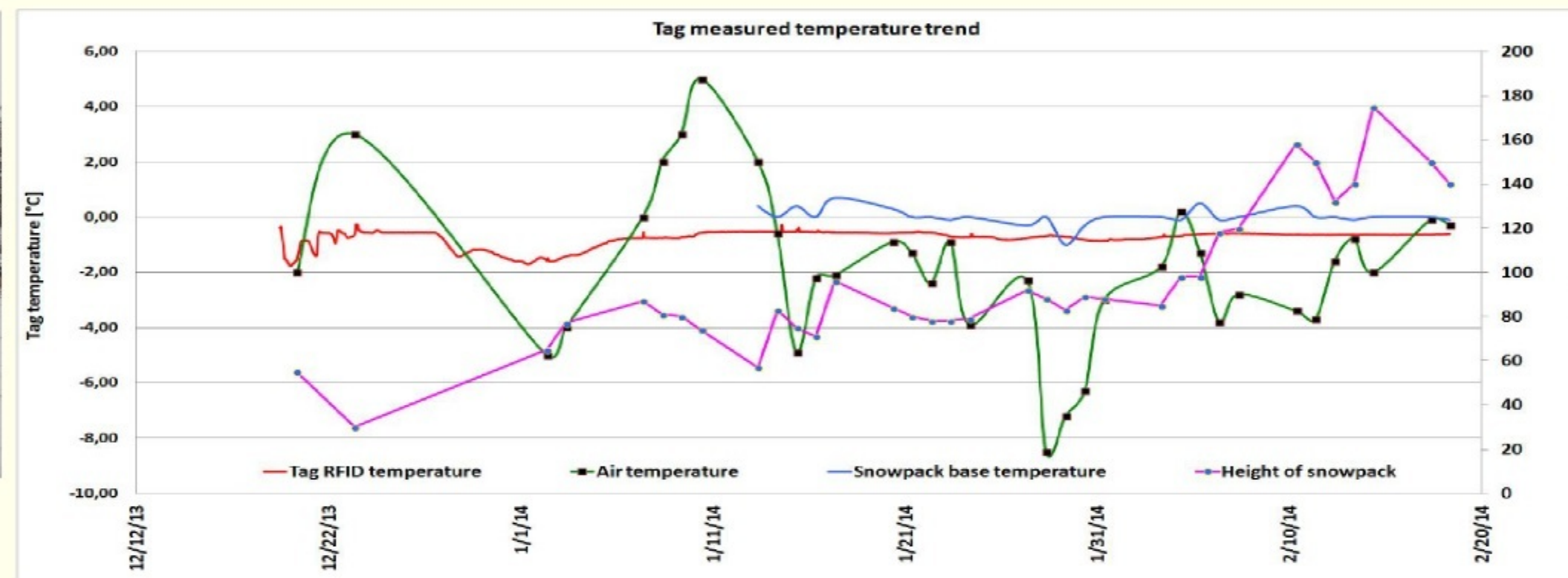
FIELD TEST

Period: 2013/12/19 - 2014/03/10
Altitude: 1450 m

Installation: capsule with tag+sensor at ground surface.

Measured parameters by MALATRA

devices: temperature (bottom of snowpack) - hourly; RSSI (Received signal strength indication) - daily



Temperature at the base of snowpack has a trend similar to air temperature until the thickness of snowpack is lower than 60 cm. When the cover increases, the temperature is stable and equal to about 0,6°C, according to manual measurements.

INDREN GLACIER INSTALLATION

Date: 2014/04/18

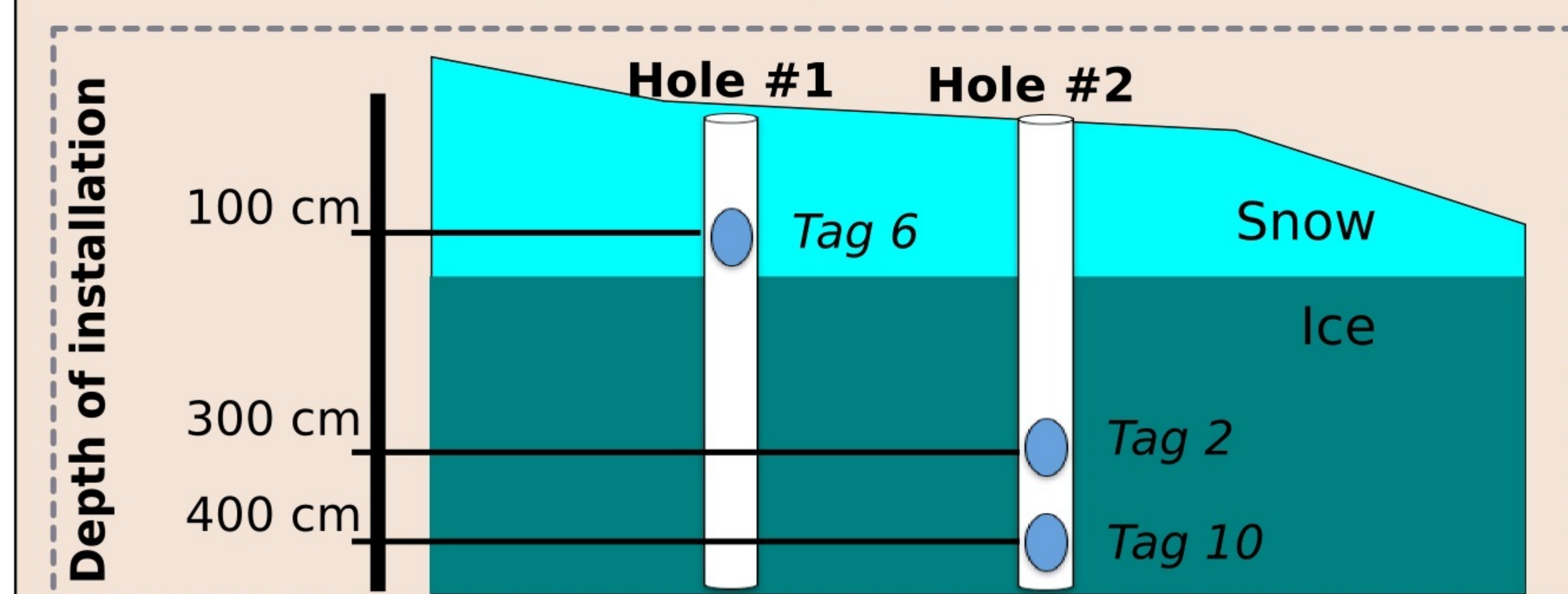
Altitude: 3300 m

Installation: *tags* with sensors have been installed in two holes and georeferenced using a GNSS receiver.

Measured parameters by MALATRA devices: temperature, tag tilt, tag orientation, pressure.

Program of measures: every 12 hours.

Tags verified via RF (Radio Frequency) with the *reader*.



Station of Cime Bianche (3100m)



Tags on Indren glacier (3300m)

Station of Lake Gabiet (2380m)



The holes were made by means of a steam driven ice drill

Each *tag*, after installation, has been interrogated and verified through the wireless communication using the MALATRA console.

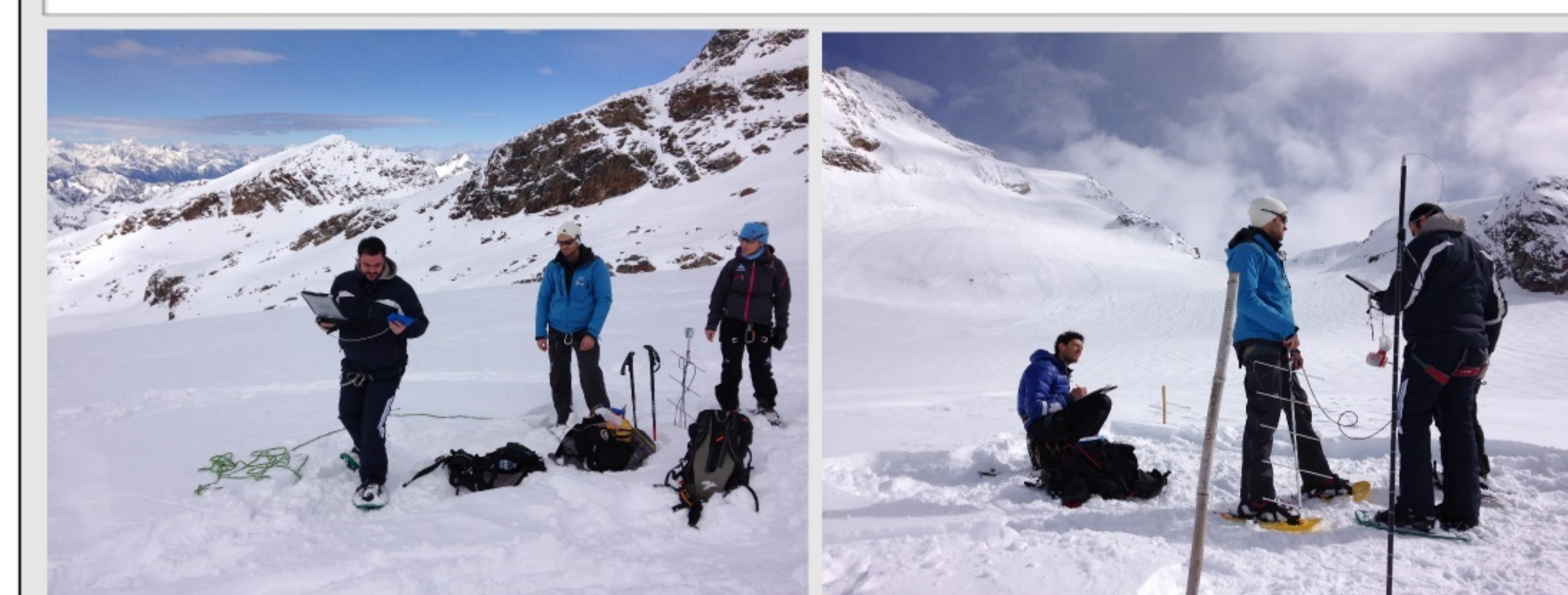
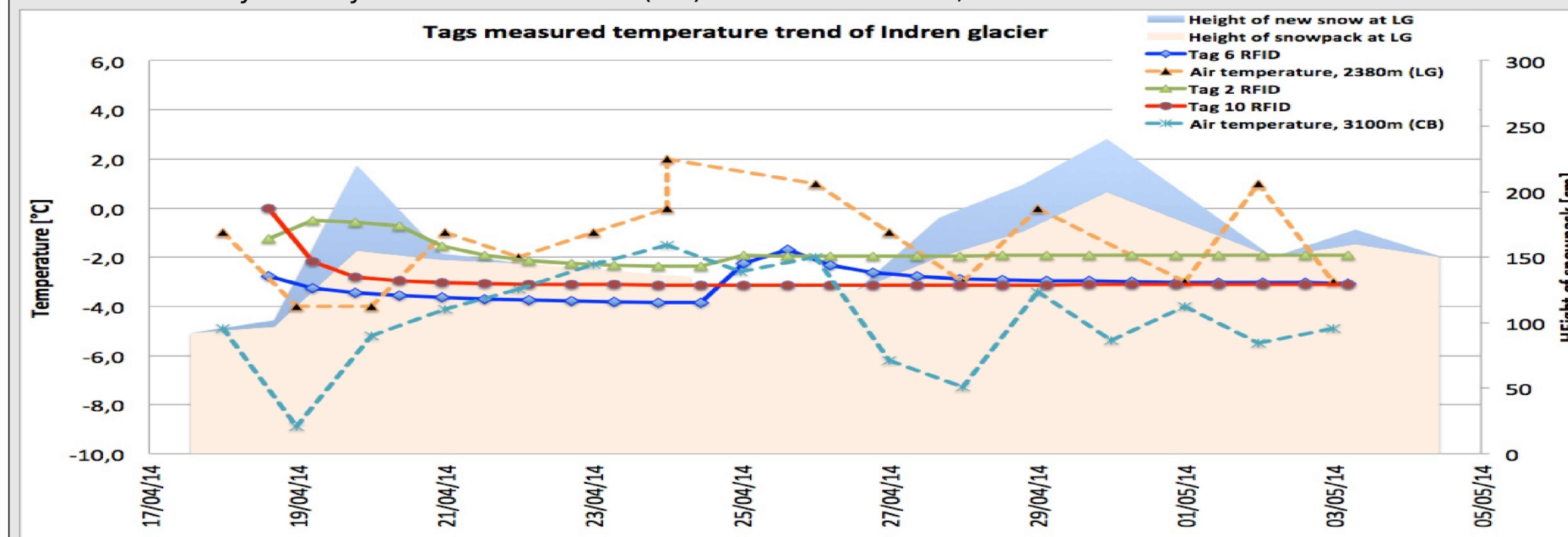


INDREN FIRST SURVEY

Date: 2014/05/03 Altitude: 3300 m

Period of activity: 16 days

The data were compared with those from daily snow and weather observations of the stations placed in Lake Gabiet (LG) at Gressoney-La-Trinité, at 2380m of altitude, and at Cime Bianche (CB) in Valtournenche, at 3100m of altitude.



Tests of RFID communication using a Yagi antenna: the maintenance of the RFID communication has been successfully checked up to a distance of approximately 100m.

NEXT INSTALLATIONS and OUTLOOKS

- Installation on Glacier of Thoula (Mont-Blanc), to be related with mass balance measurements.
- Use of the devices in other domains (landslides and rock glaciers monitoring).
- Further development of GLACIES unit through the involvement of local businesses and international scientific organisations.
- Improvement of methods for remote accurate localisation

We are witnessing an early stage of thermal variation, presumably related to the mass of snow and ice volume of the holes that has been restored to its original condition. After a transient, the temperatures become steady. Tags 2 and 10, in the ice, maintain a constant difference of about 1°C; tag 6, in snow, shows a little increase on 26th April, in correspondence of a slight air temperature growth (both for CB and LG), in a period with no new snow. After 27th April, tag 6 temperature becomes steady in spite of air temperature changes; this may be due to new snow accumulation