

Observatorio
Cambio Global
Sierra Nevada

MONITORING OF SNOW IN SIERRA NEVADA GLOBAL CHANGE OBSERVATORY



Unión Europea

Fondo Europeo
de Desarrollo Regional



Jose A. Algarra
Granada, 2th november 2016



WHO WE ARE?

- Agencia de Medio Ambiente y Agua de Andalucía
(Environment and Water Agency of Andalusia)



- In charge: Jose A. Algarra
- Staff: 1 to 4 people (in Champaign)
- We are simultaneously in others projects





AIMS



➤ What's going on in the snow cover extend in Sierra Nevada?

- History records in physical characteristics
- Data changes, inter and intra annuals
- Share results in public network
- Security and avalanches (new)





METHODS



Javier Corripio

- Sampling First Desing
- Sensors & Station Desing
- Adviser

Javier Herrero

- Sampling Adaptation Desing
- Other Analysis Tasks
- Adviser



METHODS



HOW?



Weather station

- Multiparametric
- Snow
- Manual collect data & Maintenance

Direct sampling

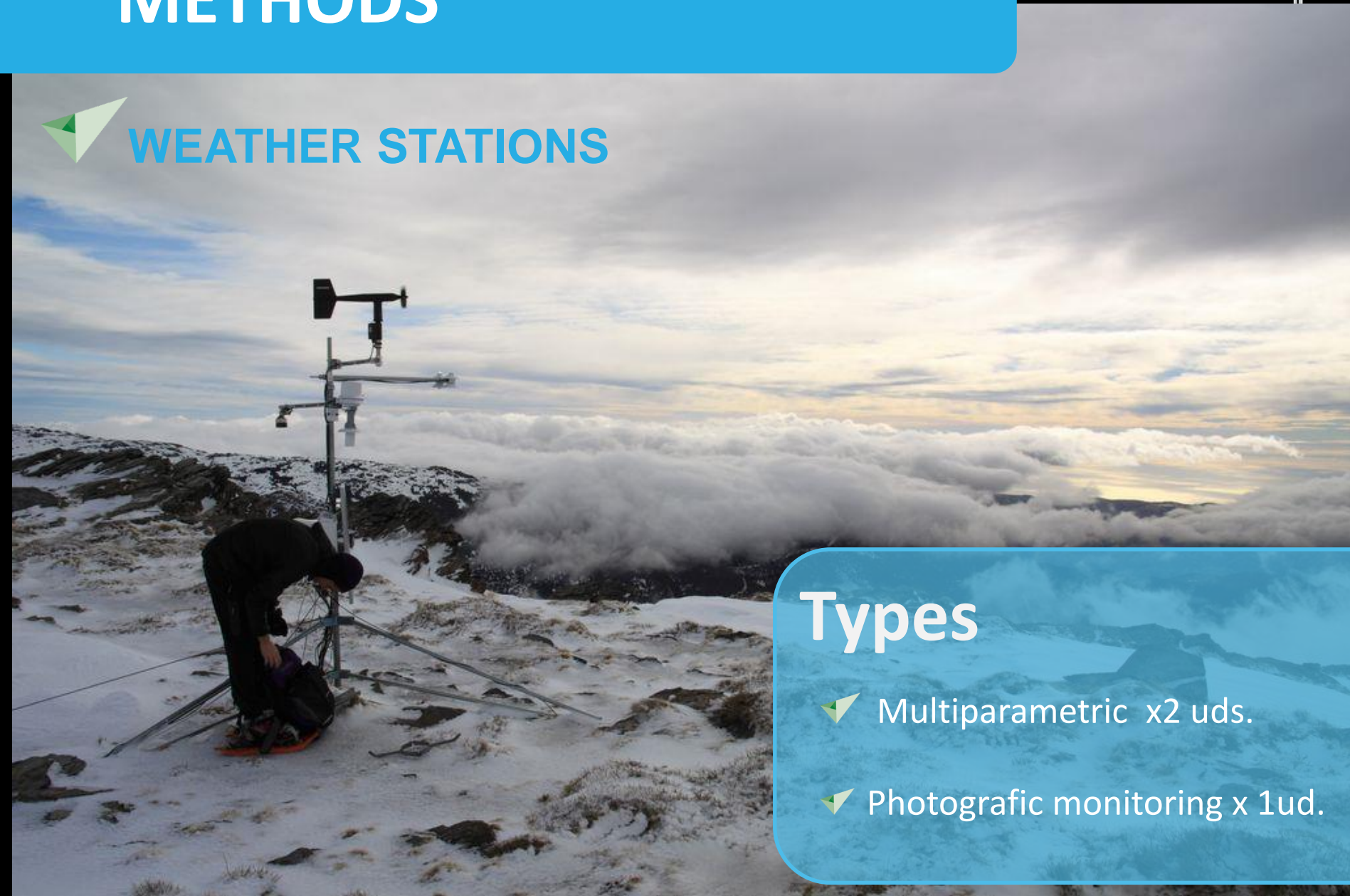
- Depth
- Density
- Snow pit (Snow cover profile)



METHODS



WEATHER STATIONS



Types

- Multiparametric x2 uds.
- Photografic monitoring x 1ud.



METHODS



Main Sensors

- Wind monitor (speed & direction)
- Temperature & Relative Humidity 50Y
- Temperature IR
- Pluviometer T-200B
- Short-wave radiation, Long-wave radiation, albedo & net radiation
- Barometric Pressure CS106
- Sonic Ranging Sensor (Snow depth)





METHODS



LOCATION

2008



EN1

2.851 msnm

2009

EN2

2.325 msnm



2011

EN3

2.460 msnm

2013





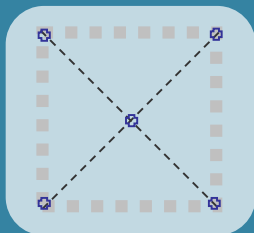
METHODS



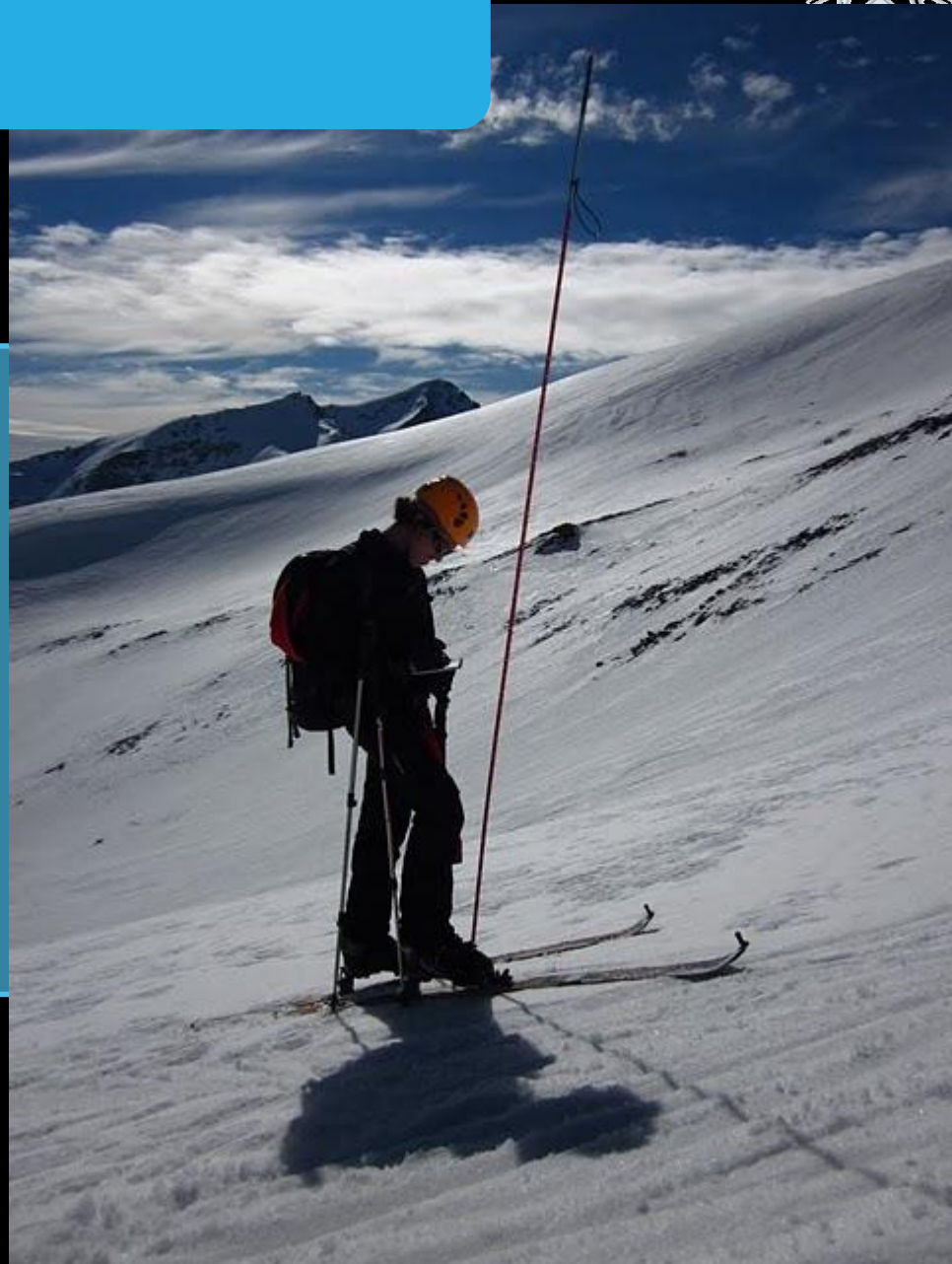
Direct Sampling



Depth



1 loc.
5 samples





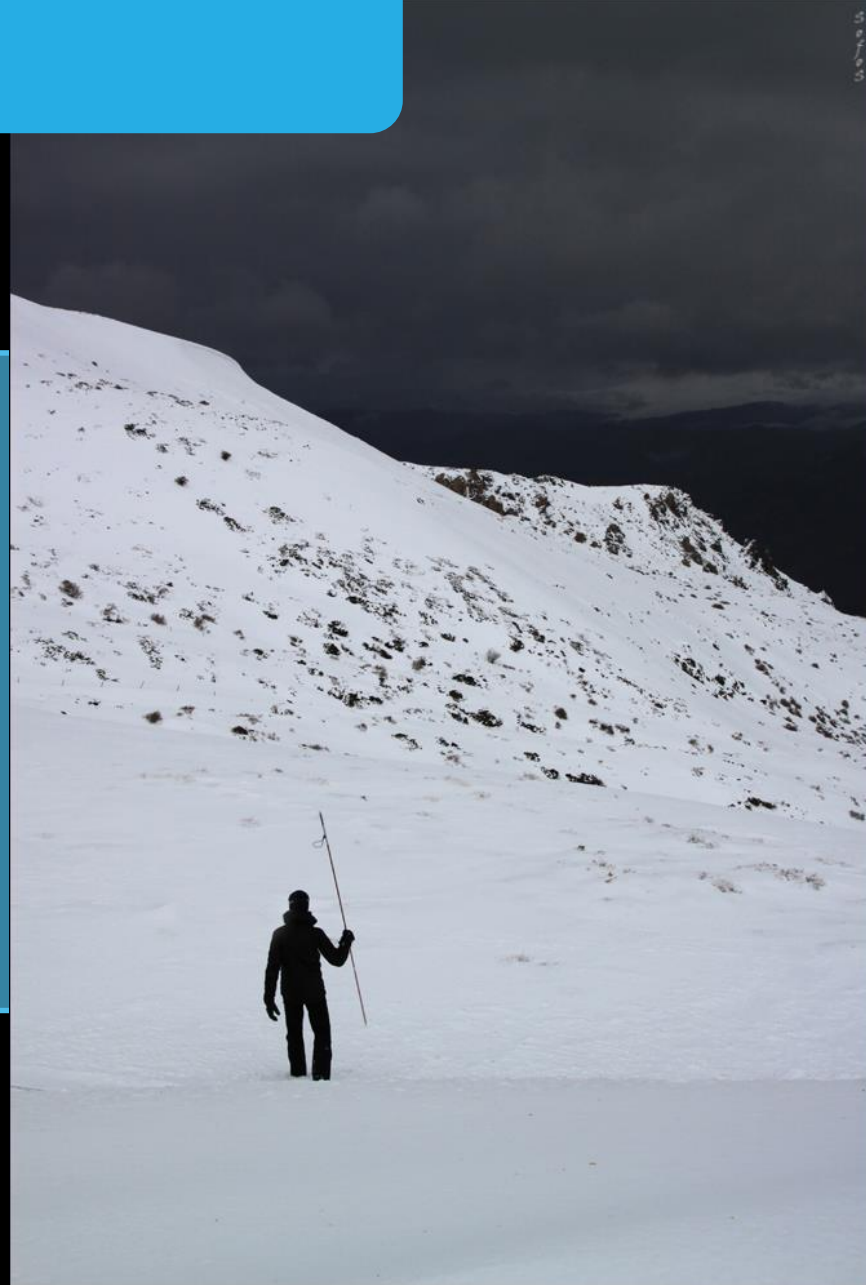
METHODS



Direct Sampling

➤ Depth

➤ Density





METHODS



Direct Sampling



Depth



Density



Snowpit

FIERZ, C. *et al.* (2009)

MCCLUNG & SCHAERER(1996)





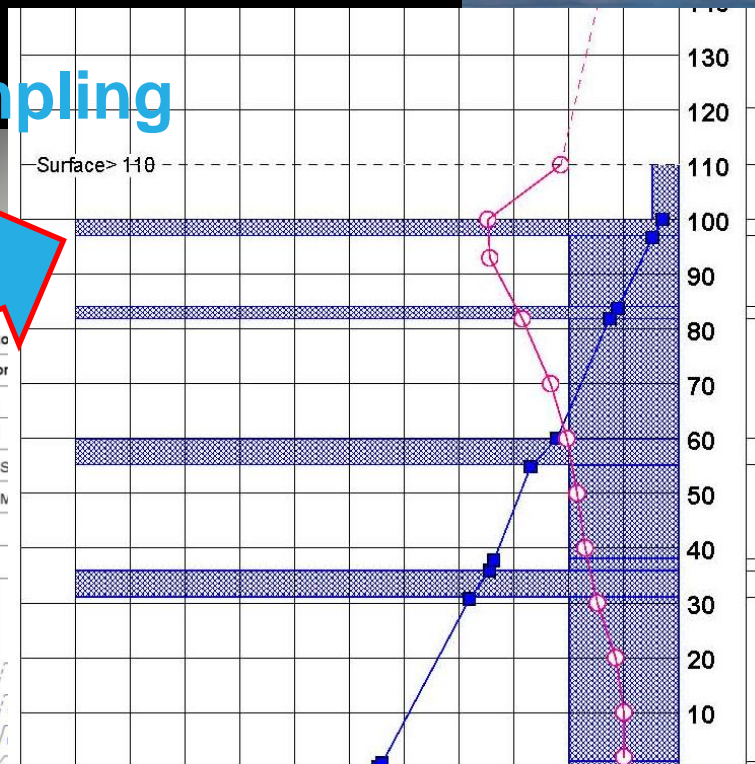
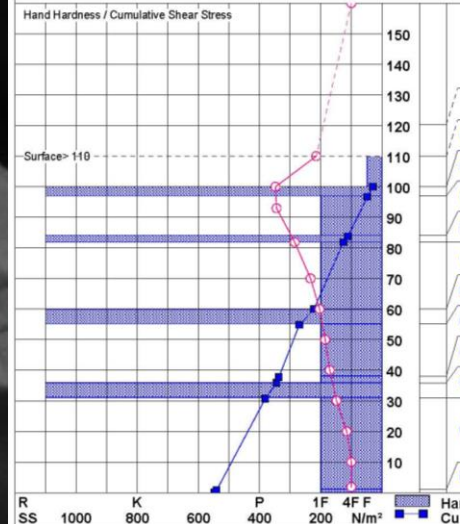
METHODS



Direct Sampling



SNOW COVER PROFILE		Obs	J.D. Rodríguez
Valle del río San Juan		Obs	J.D. Rodríguez
Sierra Nevada		Surface Ro	
Date	21/02/2011	Penetration	
Location	Sierra Nevada, Valle del río San Juan	Air Temp	
H.A.S.L.	2800 Metres	Wind Loading	✓
Aspect	North	Incline	8°
HS	110	HSW	399
p	362	R	
Lat	N37.04.46	Long	W03.22.29
Notable			
R	-20	K	-18
T	-16	K	-14
	-12	K	-10
	-8	K	-6
	-4	K	-2
	0	K	0
	0	K	0

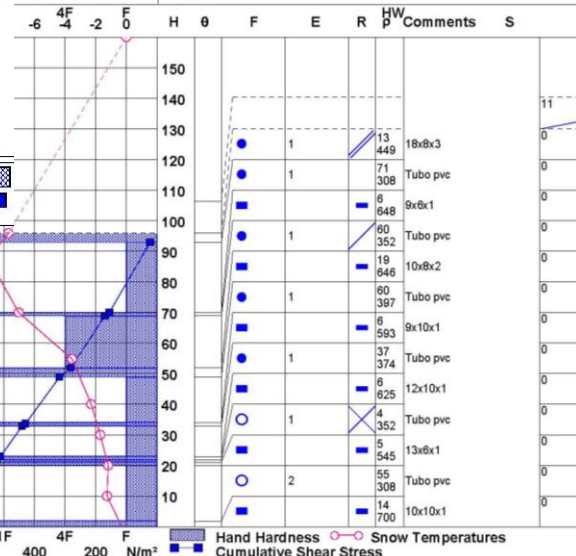


R	SS	1000	K	800	600
1	318	Tubo metal			
1	35 700	15x12x5			0
1	50 295				0
1	6 295	Tubo metal			0
1	25 508	15x15x3,5			0
1	116 388	Tubo metal			0
1	4 388				0

nd Hardness Snow Temperatures
Cumulative Shear Stress



J.D. Rodríguez	Profile Type	Full Profile
2 G. Muñoz	No	2012-13.08
	Surface Roughness	Wavy
11:11	Penetration	Foot 2 Ski
rio San Juan	Air Temp	0,0 C°
nd Loading	✓	Sky Cond
Incline 11°	Precip	No Precipitation
372	R	Wind
W03.22.29	Notable	Photo





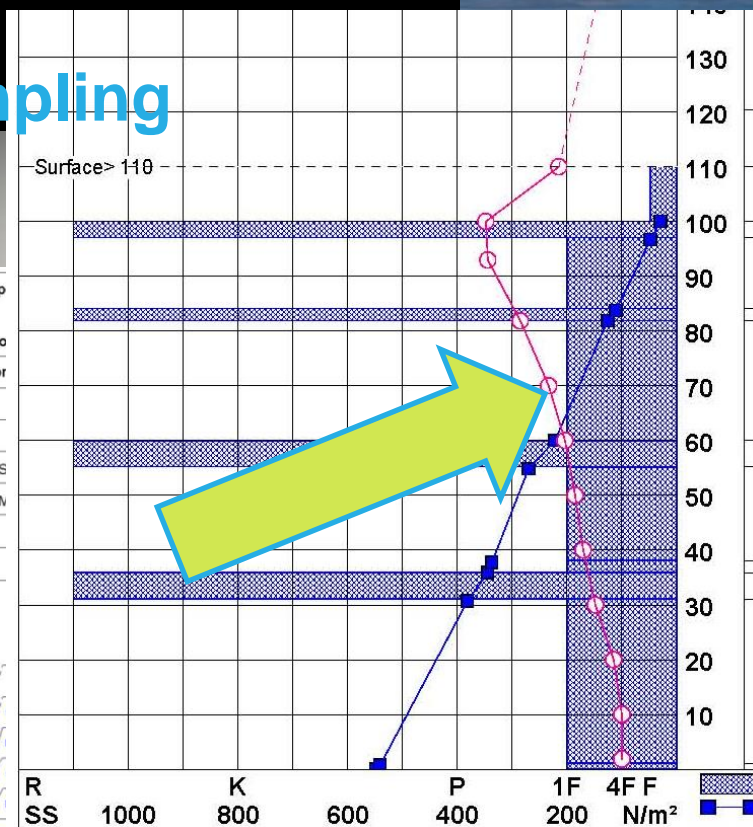
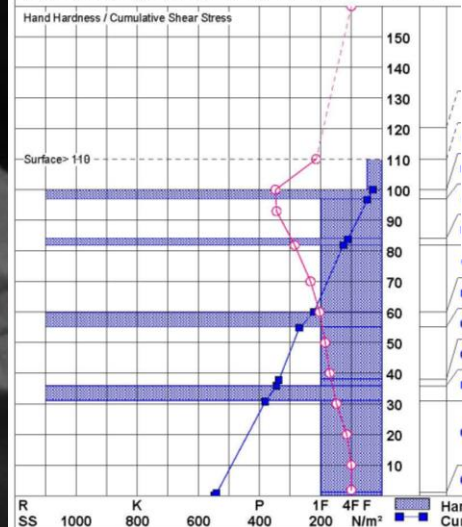
METHODS



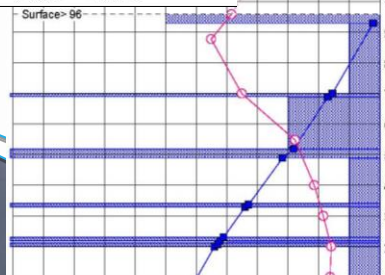
Direct Sampling



SNOW COVER PROFILE		Obs J.D. Rodríguez	Profile Type
Valle del río San Juan		Obs2 G. Muñoz	No
Sierra Nevada		DR	Surface Ro
Date	21/02/2013	Time 10:06	Penetration
Location Sierra Nevada, Valle del río San Juan		Air Temp	
H.A.S.L.	2800 Metres	Wind Loading √	Sky Cond
Aspect	North	0°	Incline 8°
HS	110	HSW	399
p	362	R	
Lat	N37.04.46	Long	W03.22.29
Notable			
Hand Hardness / Cumulative Shear Stress			



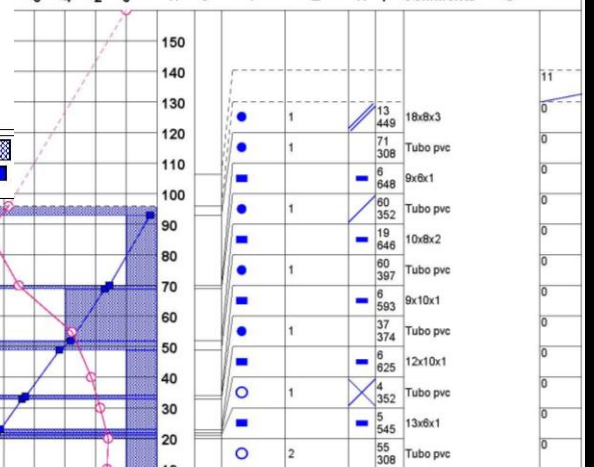
R	SS	1000	K	800	600	P	400	1F	4F	F	N/m²
1	1	318	35	700	15x12x5	0	0	0	0	0	0
1	1	50	295	6	295	0	0	0	0	0	0
1	1	6	295	15x15x3.5	25	508	0	0	0	0	0
1	1	116	388	Tubo metal	4	388	0	0	0	0	0



R	SS	1000	K	800	600	P	400	1F	4F	F	N/m²
1	1	13	449	18x3	71	308	0	0	0	0	0
1	1	6	648	9x6x1	60	352	0	0	0	0	0
1	1	19	648	10x8x2	60	397	0	0	0	0	0
1	1	6	593	9x10x1	37	374	0	0	0	0	0
1	1	6	625	12x10x1	4	352	0	0	0	0	0
1	2	5	545	13x6x1	55	308	0	0	0	0	0
1	2	14	700	10x10x1	14	700	0	0	0	0	0



J.D. Rodríguez	Profile Type	Full Profile
2 G. Muñoz	No	2012-13.08
	Surface Roughness	Wavy
11:11	Penetration	Foot 2 Ski
rio San Juan	Air Temp	0,0 C°
nd Loading √	Sky Cond	Scattered Clouds
Incline 11°	Precip	No Precipitation
372 R	Wind	Strong 41-60 km/hr
W03.22.29	Notable	Photo
-6 -4 -2 0	H	θ
F	E	R
HW	P	Comments
S		

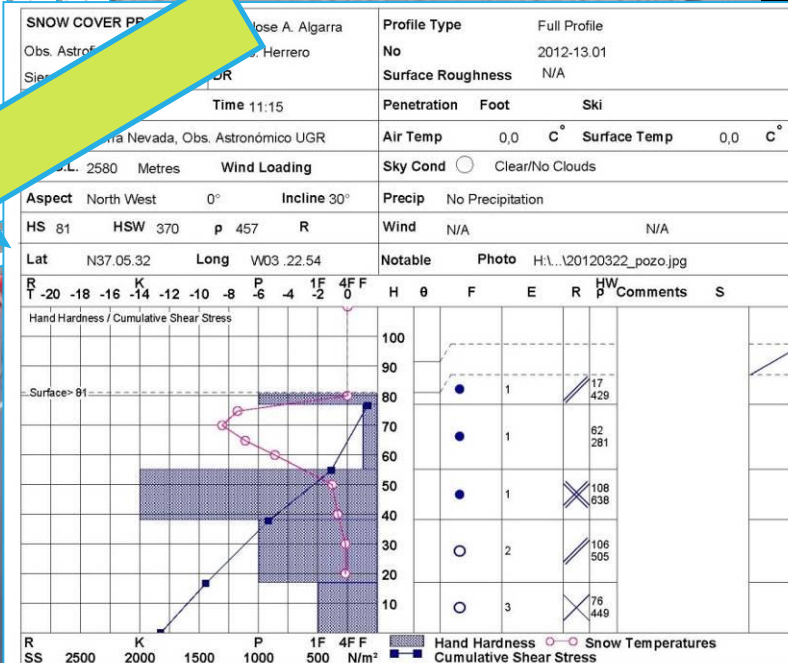
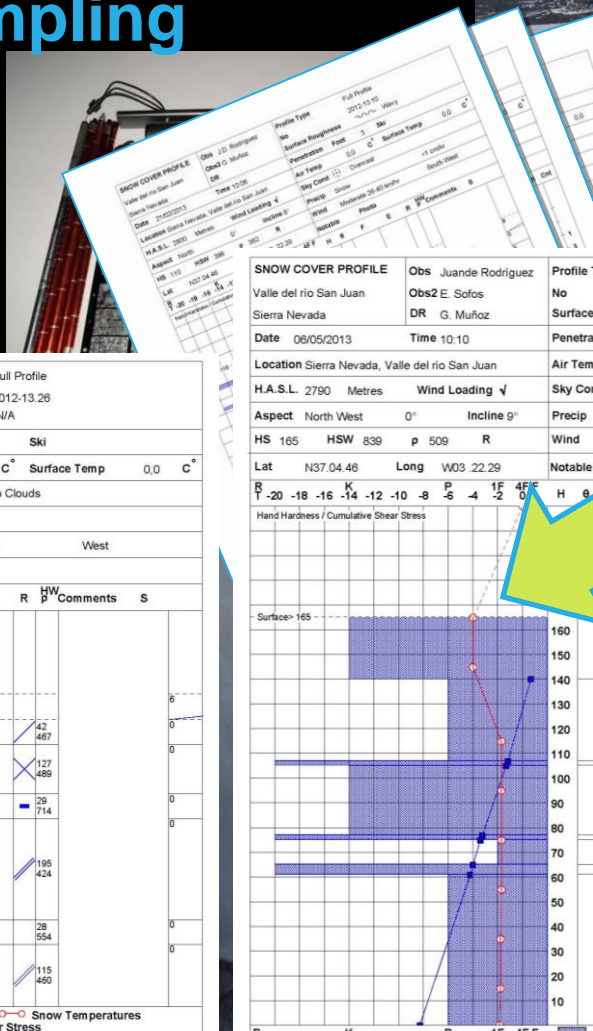
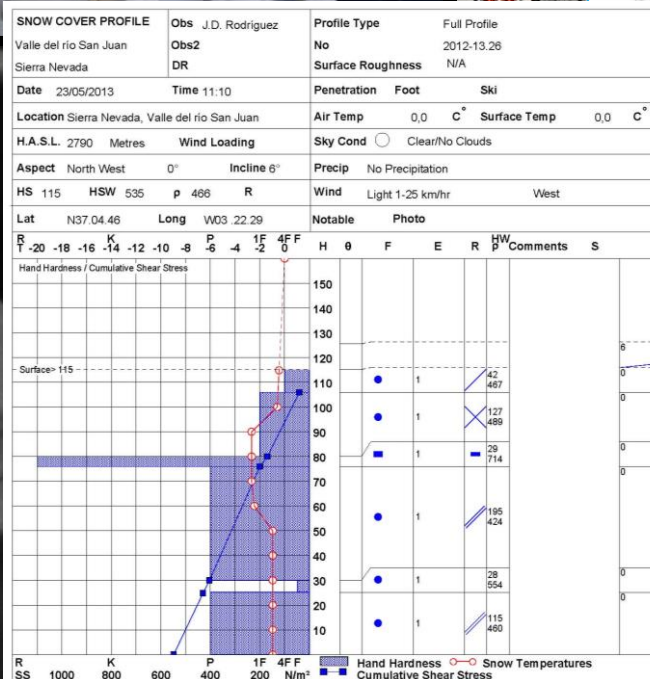




METHODS



Direct Sampling

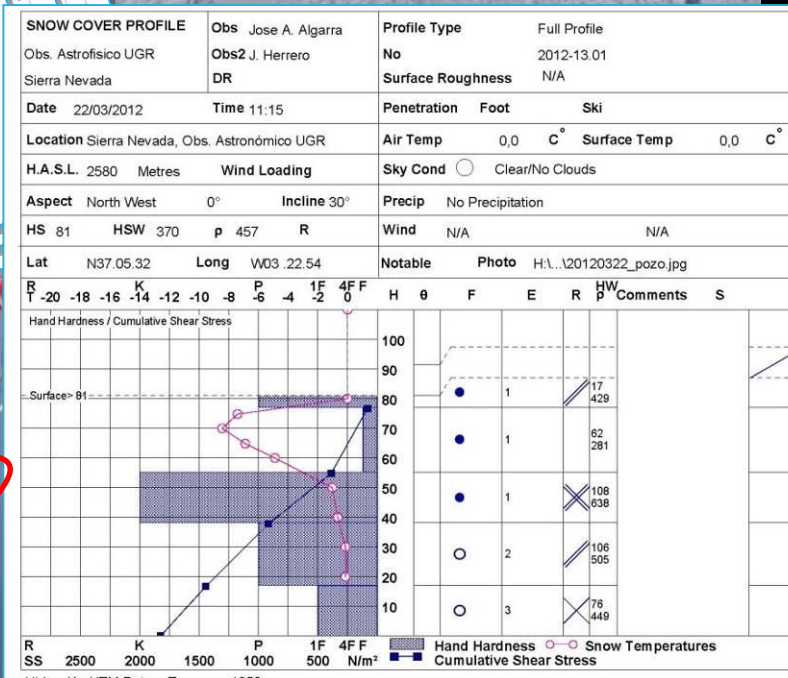
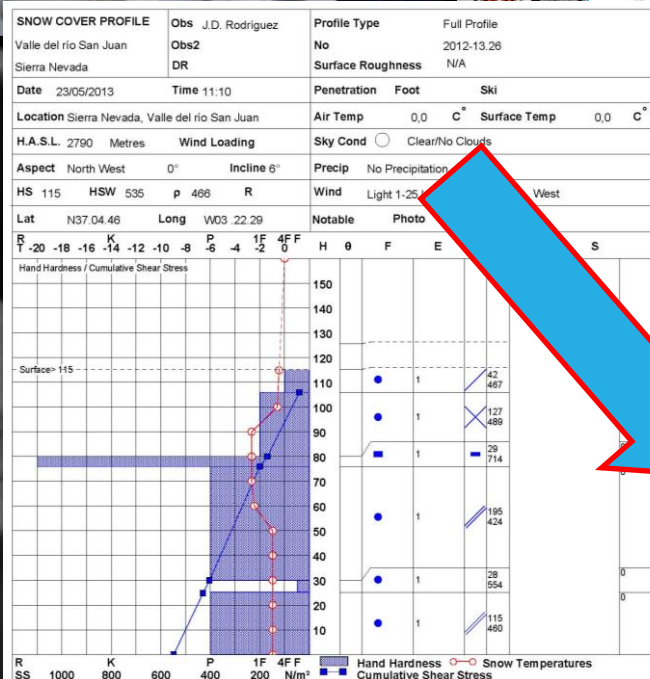




METHODS



Direct Sampling





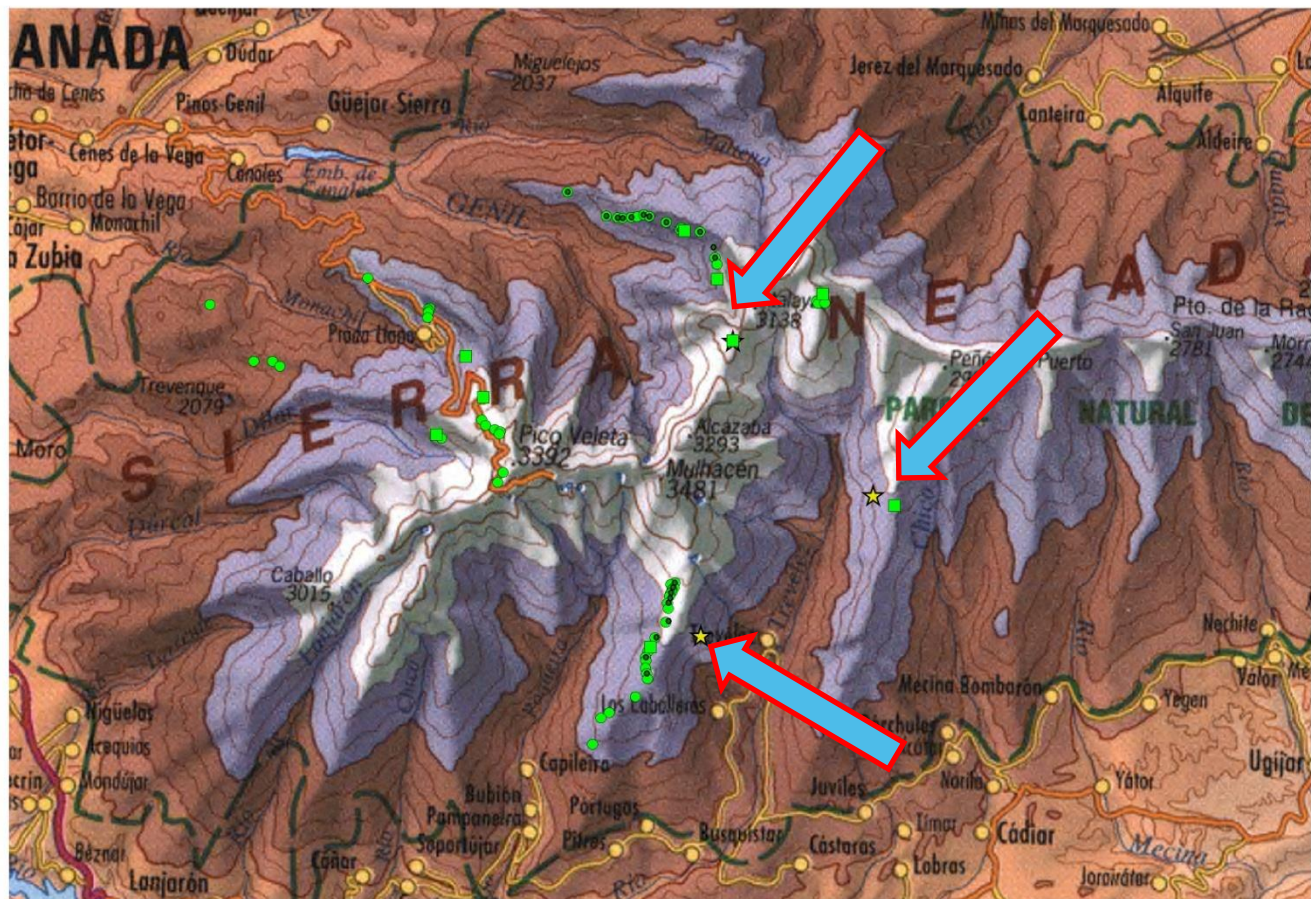
METHODS



Locations of samples



Stations





METHODS



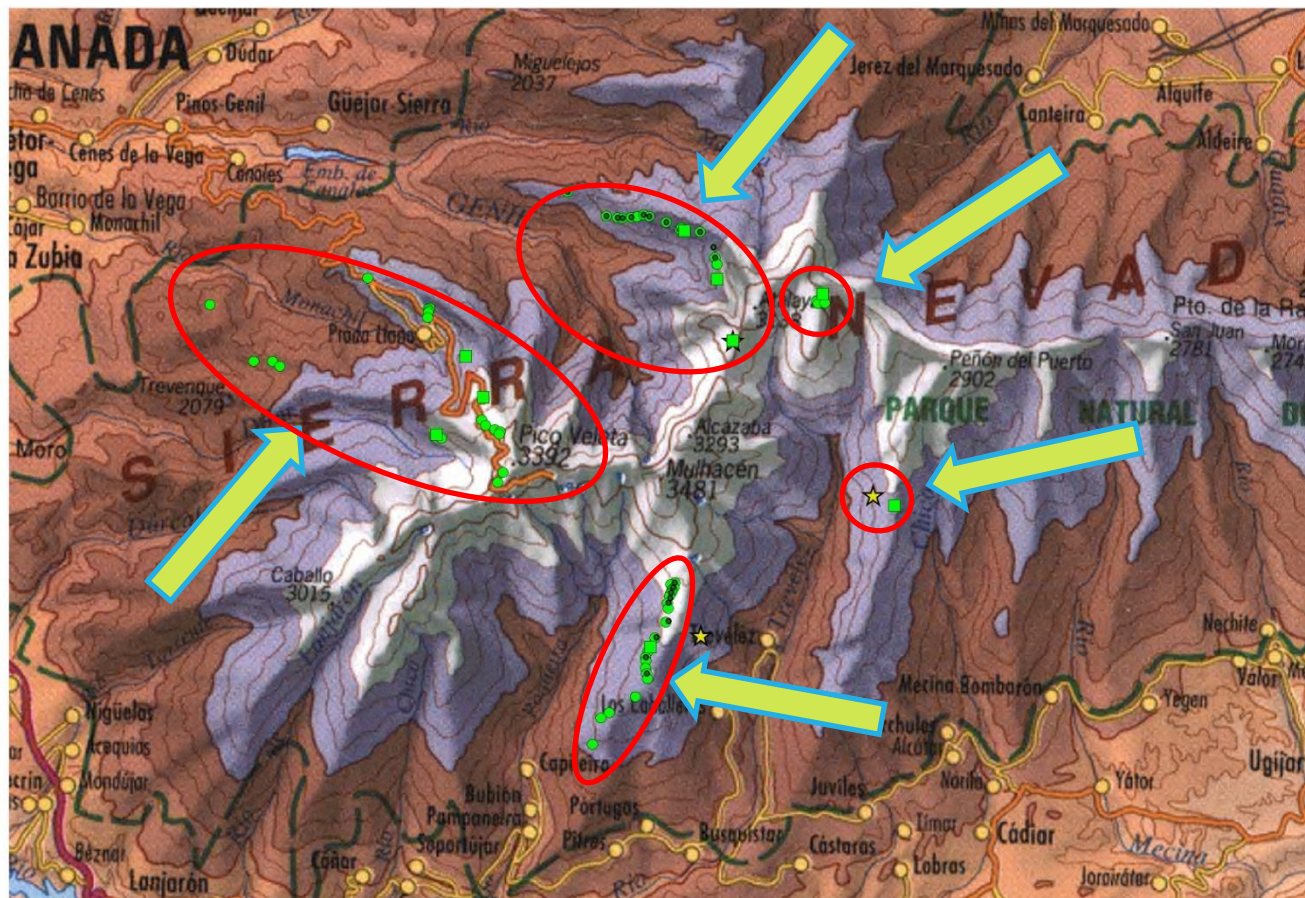
Locations of samples



Stations



Snow profile

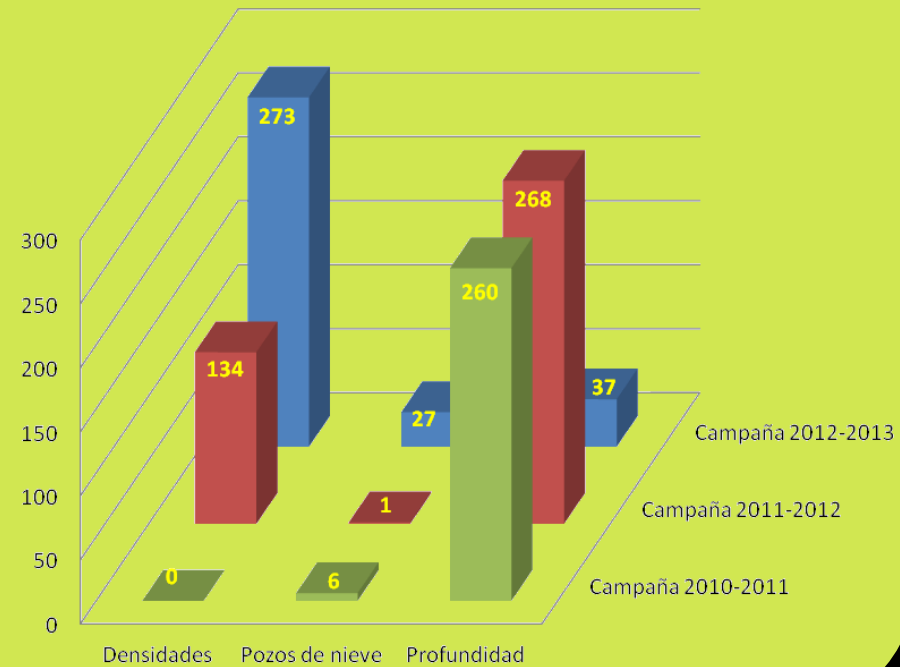




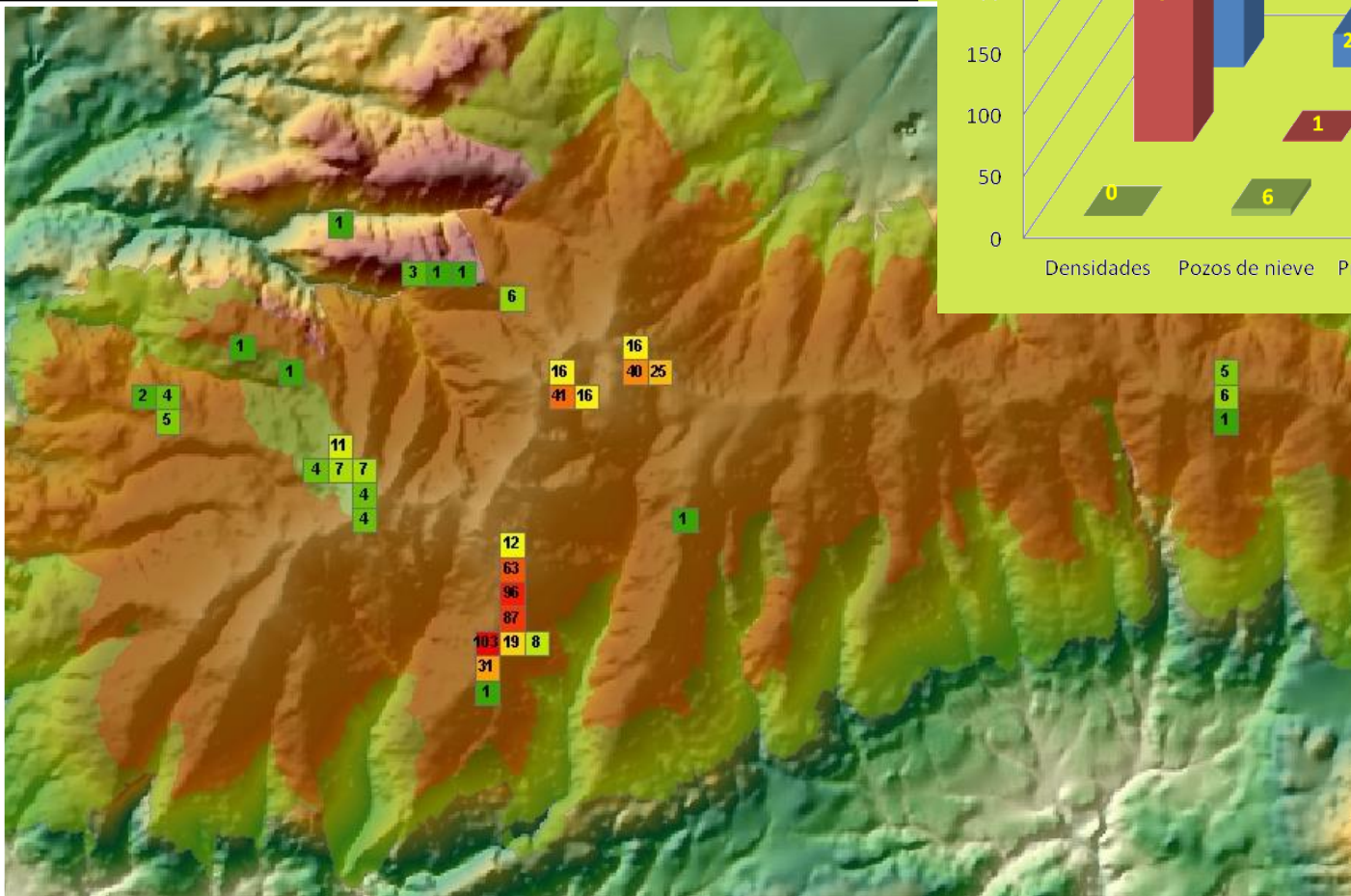
RESULTS

Numbers of samples

Muestras por campañas



**Season
2012-2013**



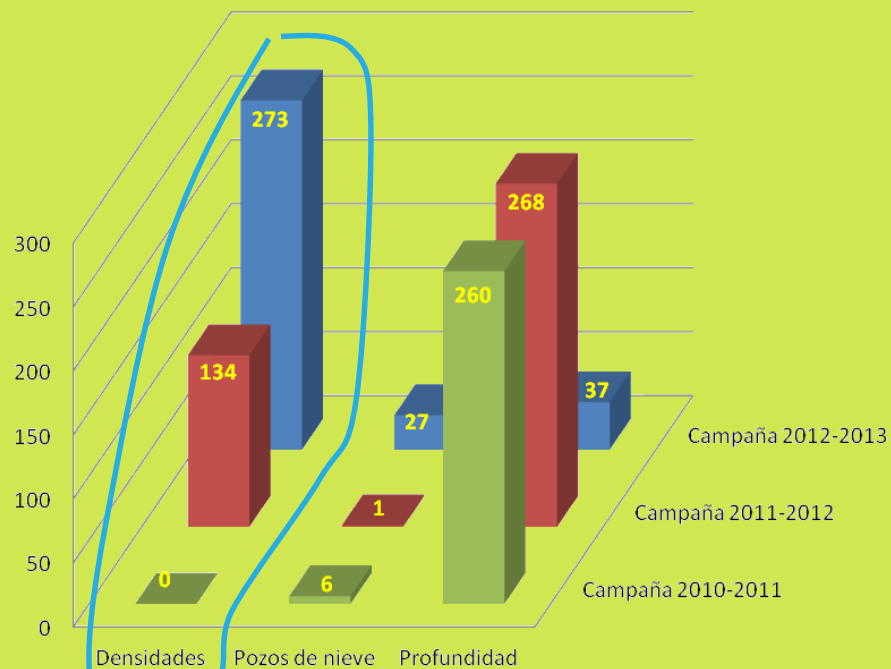


RESULTS



Density

Muestras por campañas



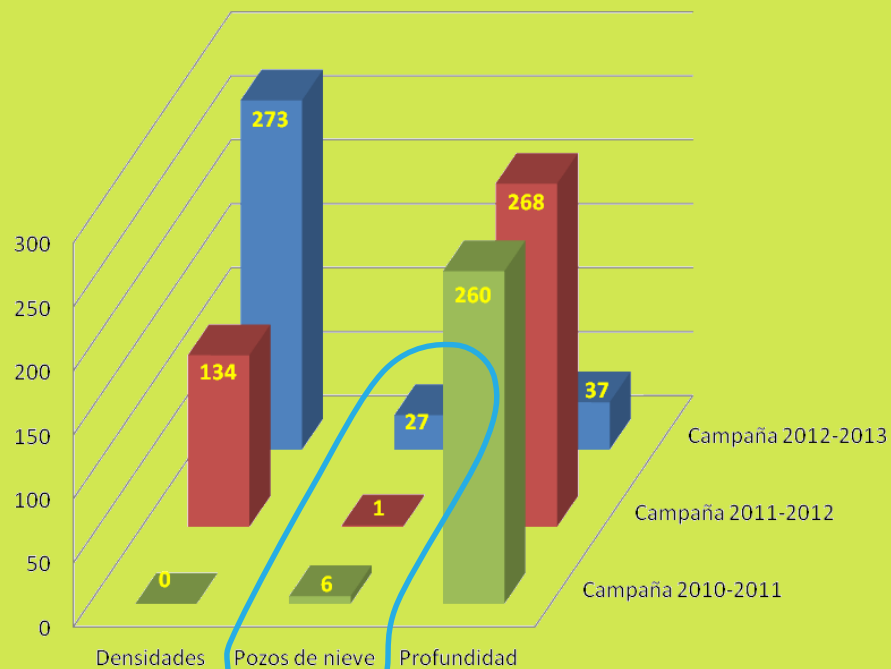


RESULTS



Full Snow Cover Profile

Muestras por campañas



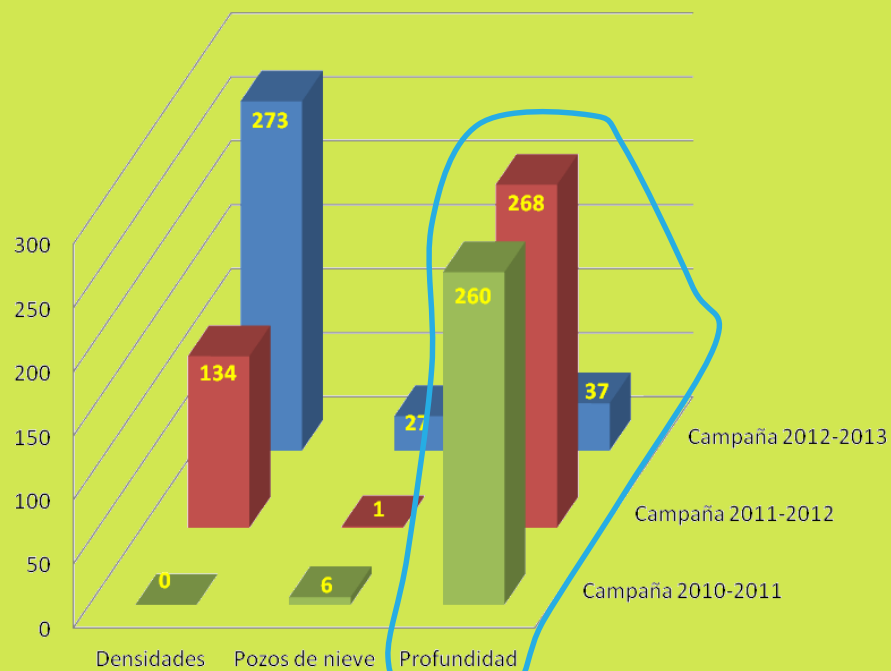


RESULTS



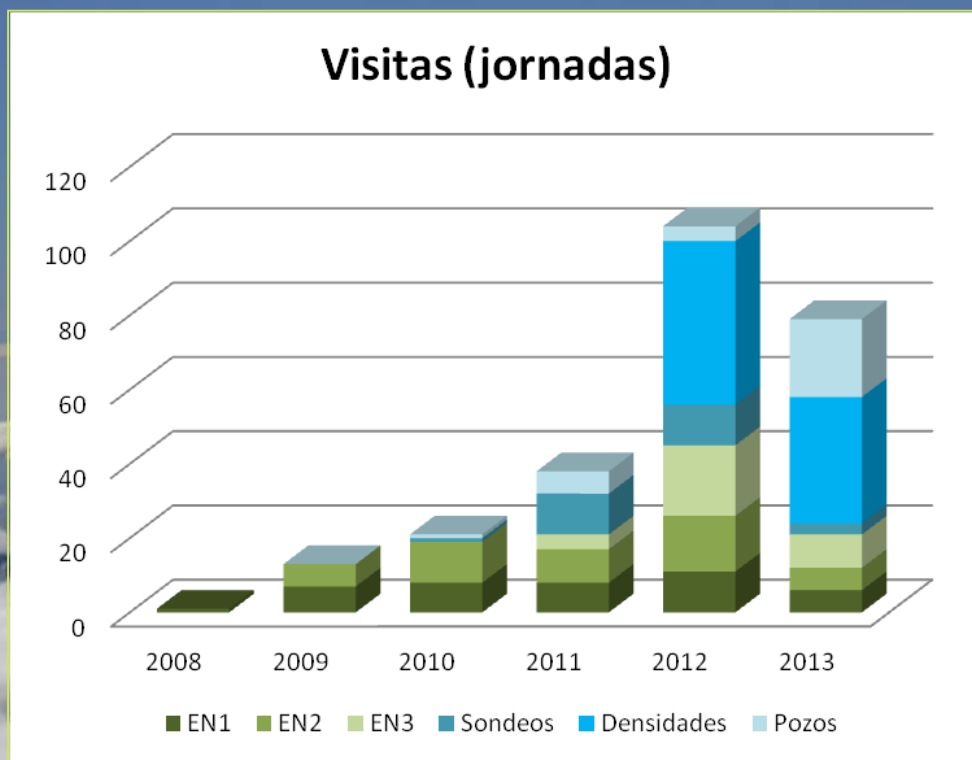
Depth

Muestras por campañas





RESULTS



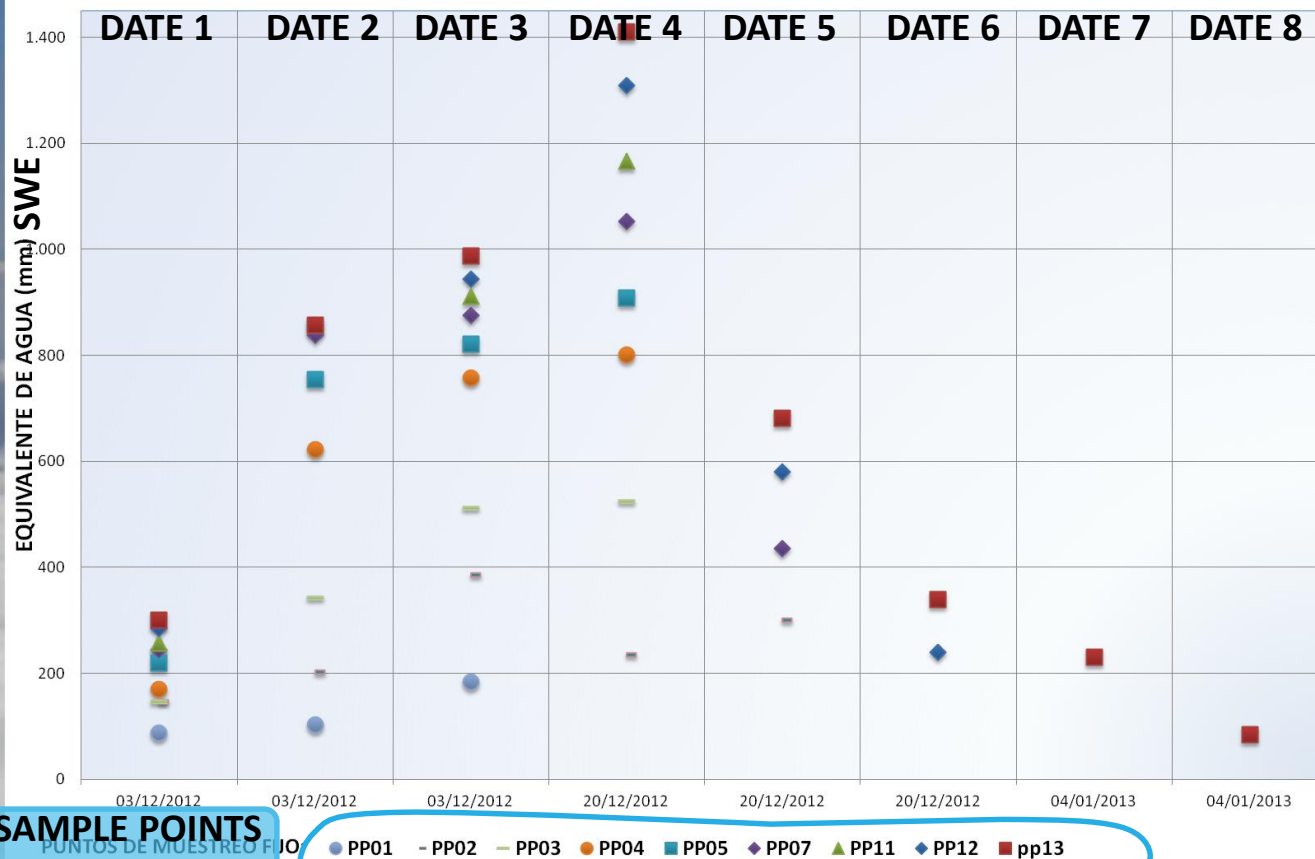
Sample Effort



RESULTS



SONDEOS DE DENSIDAD EN PIEDRA PARTIDA (por fecha y punto de muestreo)



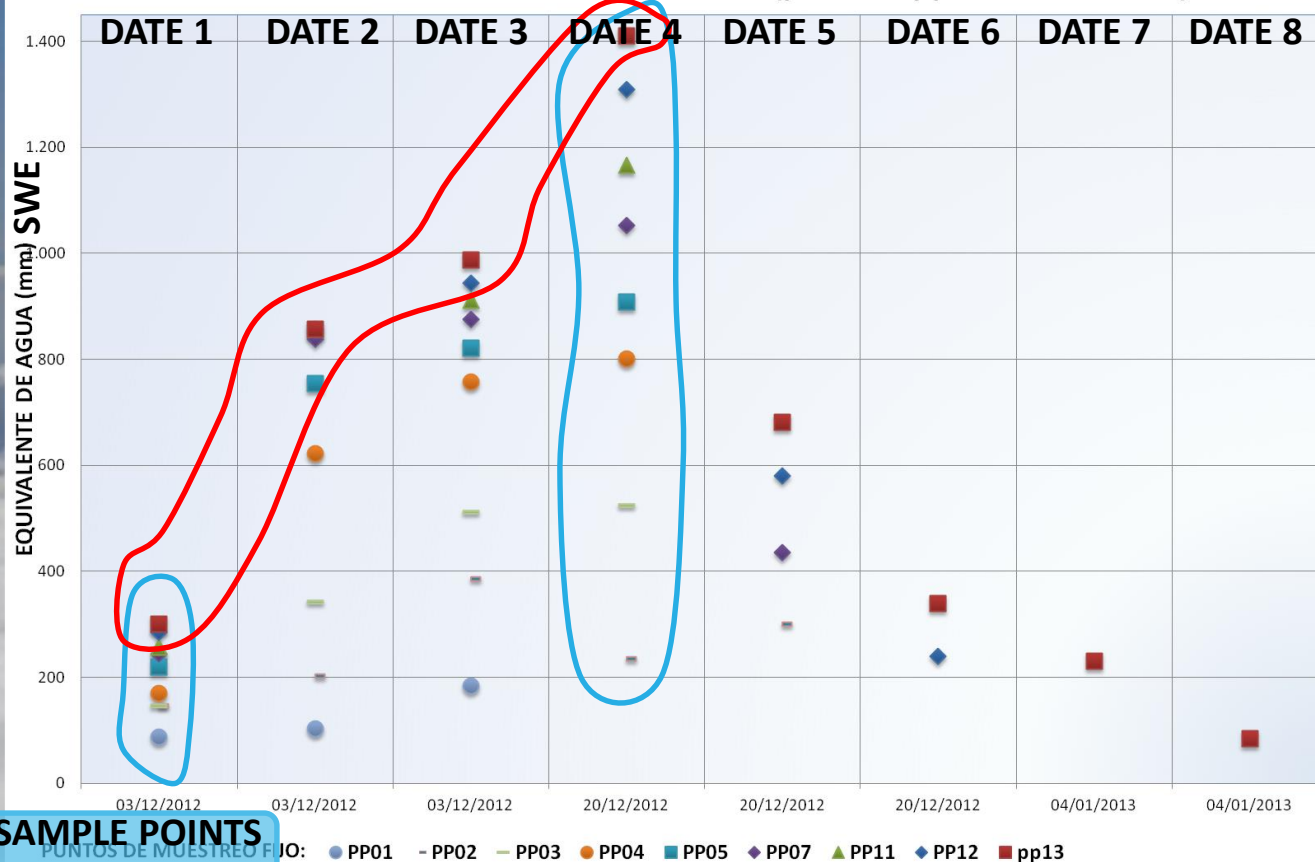
Repeat location of Samples



RESULTS



SONDEOS DE DENSIDAD EN PIEDRA PARTIDA (por fecha y punto de muestreo)



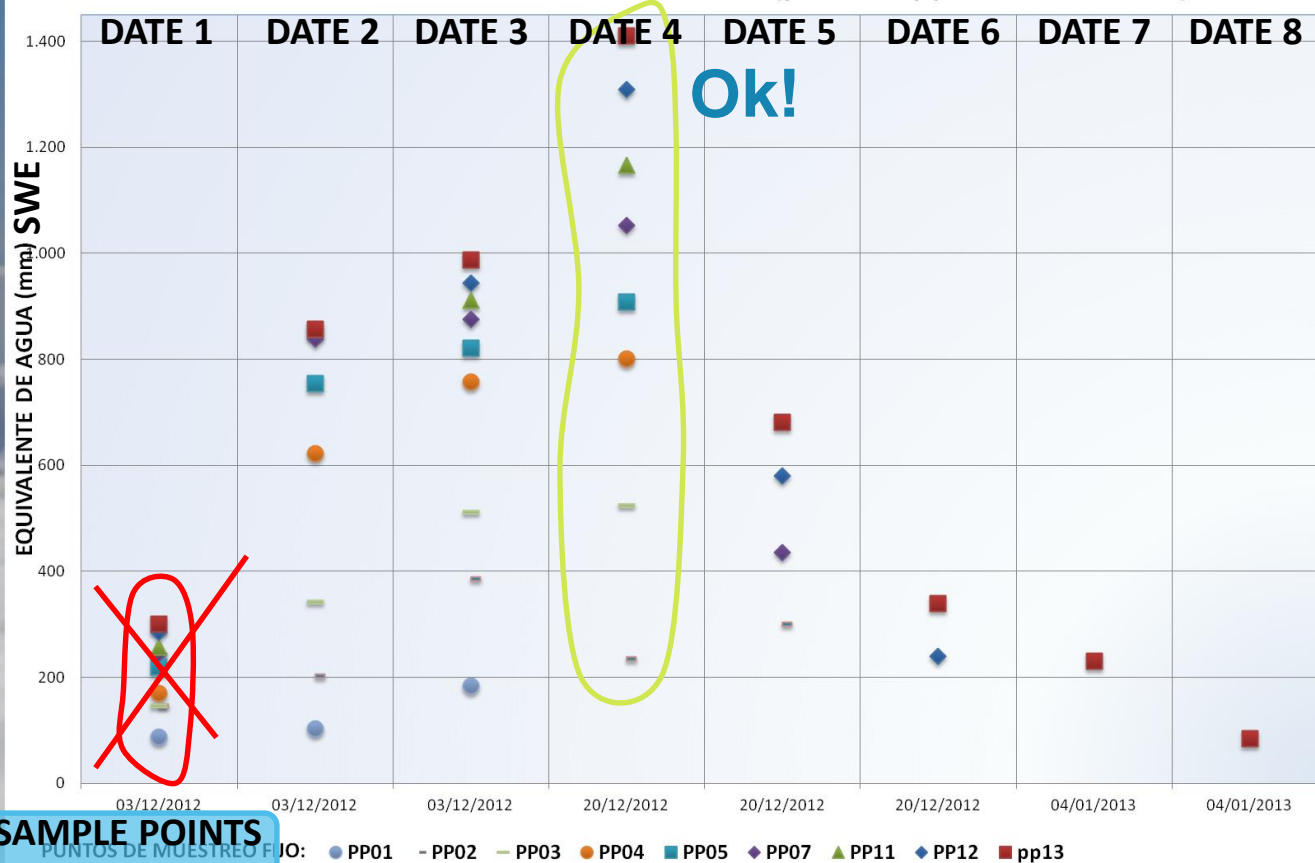
Repeat location of Samples



RESULTS



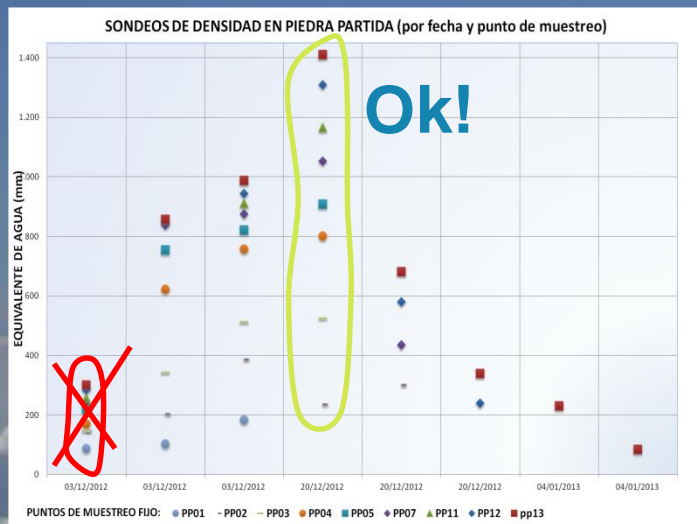
SONDEOS DE DENSIDAD EN PIEDRA PARTIDA (por fecha y punto de muestreo)



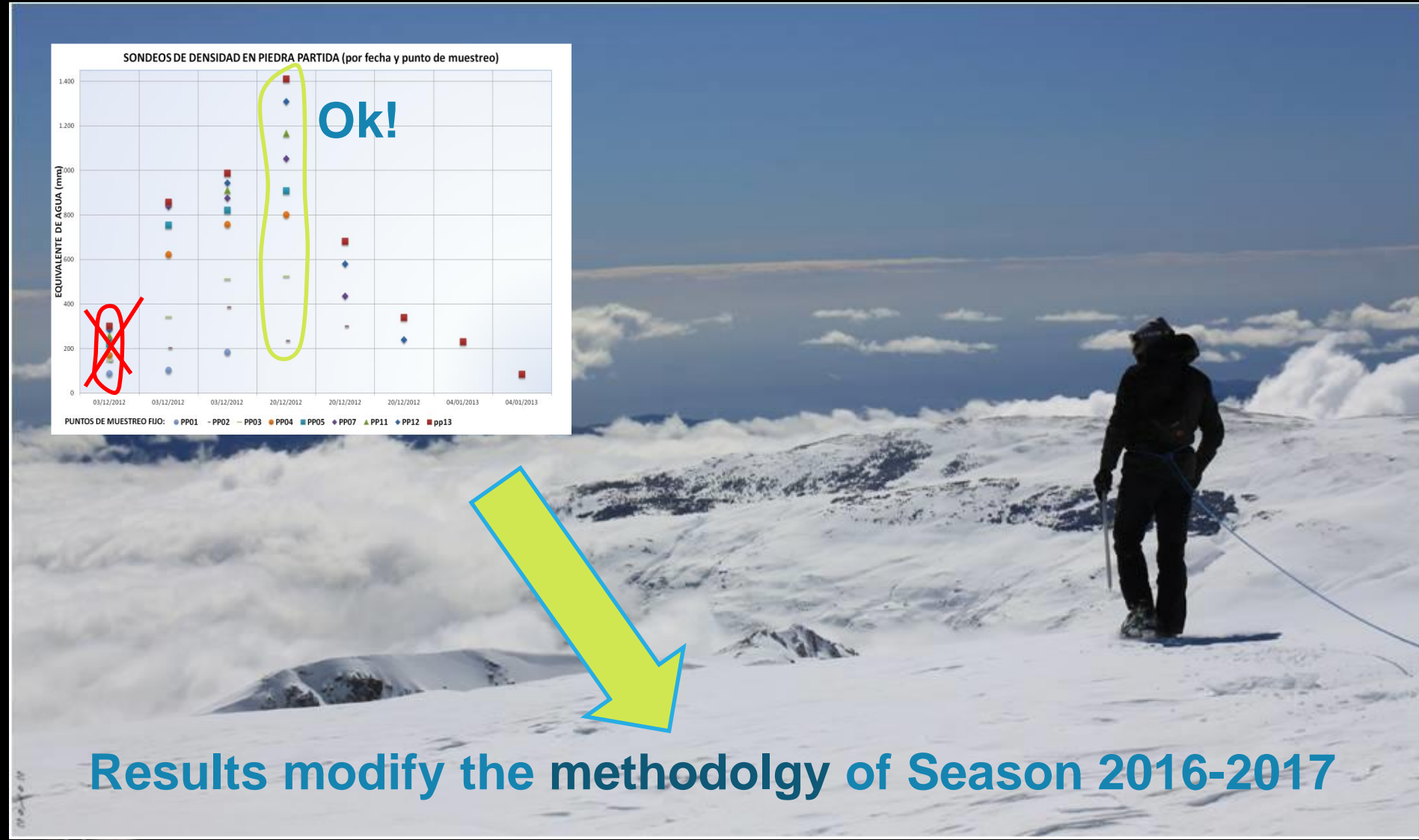
Repeat location of Samples



RESULTS



Results modify the methodology of Season 2016-2017





SHARE RESULTS



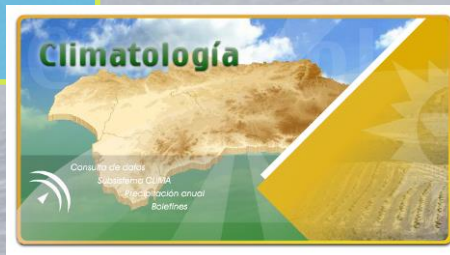
► Weather stations



SHARE RESULTS

► Weather stations

**NATIONAL
NETWORK FREE
ACCESS**

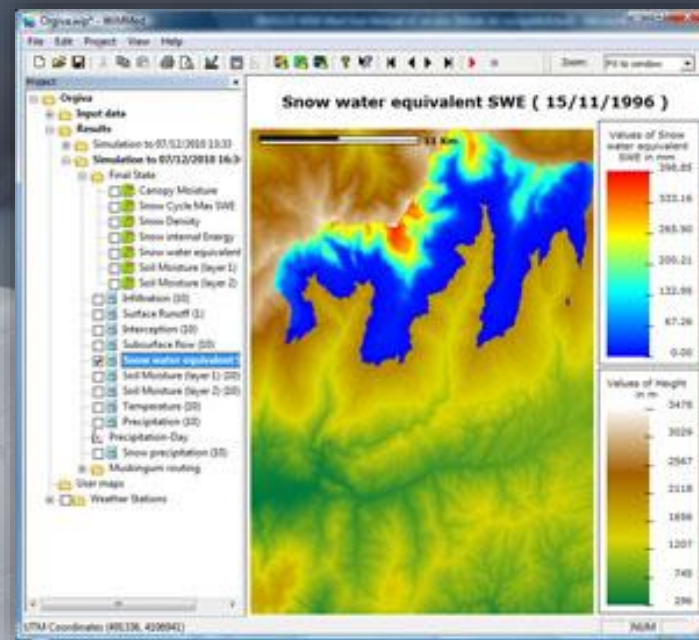




SHARE RESULTS



- Weather stations
- Integration with WiMMed





SHARE RESULTS

- ▶ Weather stations
- ▶ Integration with WiMMed
- ▶ Statical Analysis

ON WORK



SHARE RESULTS

EAWS - European Avalanche Warning Services (maybe...)

- ▶ Weather stations
- ▶ Integration with WiMMed
- ▶ Statical Analysis
- ▶ Share Snow Profile in real time

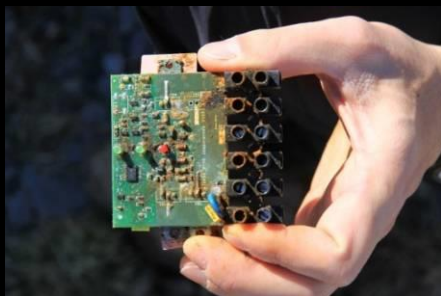
ON WORK



PROBLEMS



- Random Incidents
- Stability in the effort schedule



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SIERRA
NEVADA
PARQUE NACIONAL
PARQUE NATURAL



Thank You for your attention...



Colaboran:
Unión Europea
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