

PERMAFROST IN THE PYRENEES: THE CHANGING MOUNTAINS

Marc Oliva

Universitat de Barcelona

Interreg
POCTEFA



Cofinanciado por
la UNIÓN EUROPEA
Cofinancé par
l'UNION EUROPÉENNE

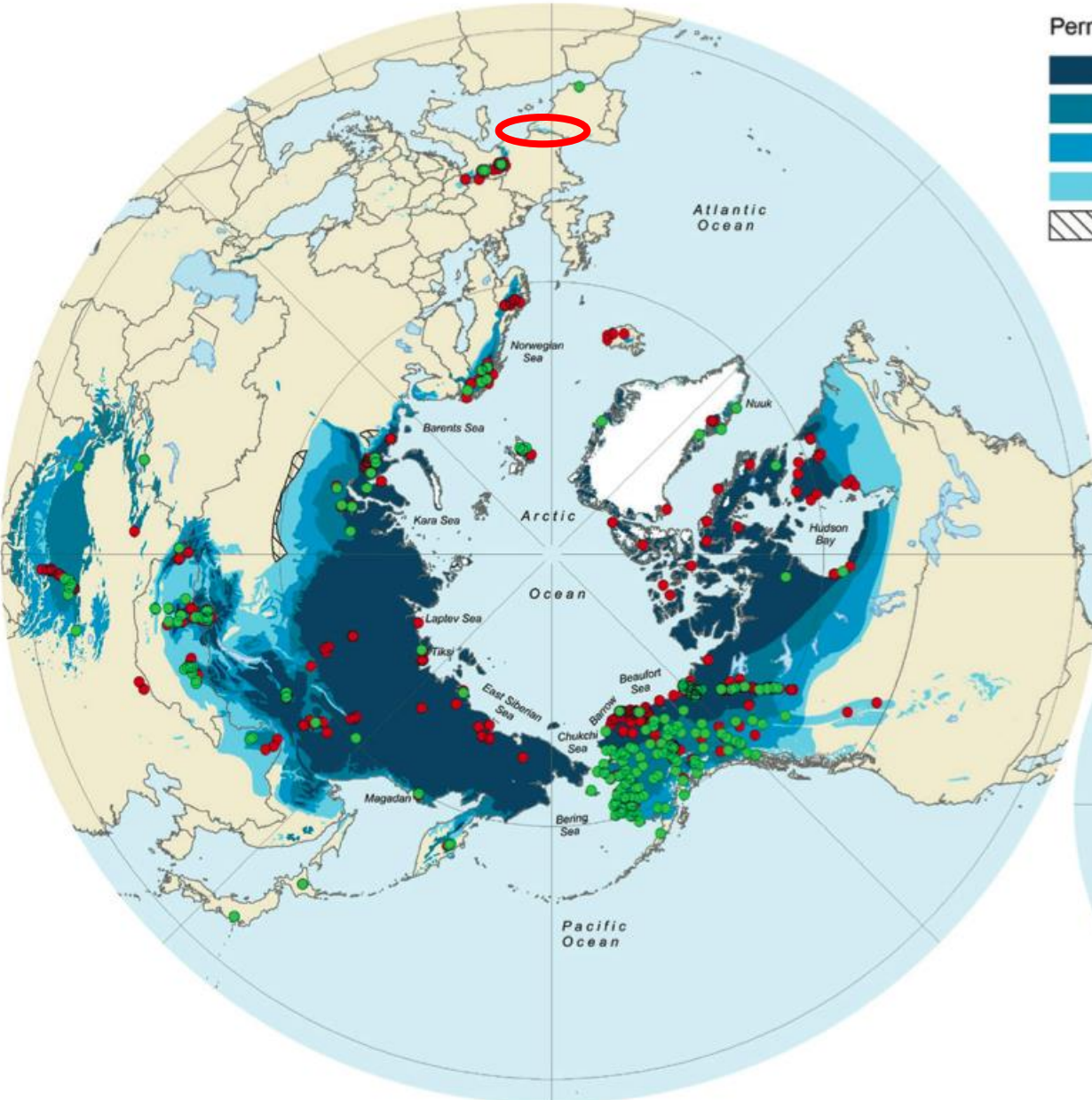
Partners



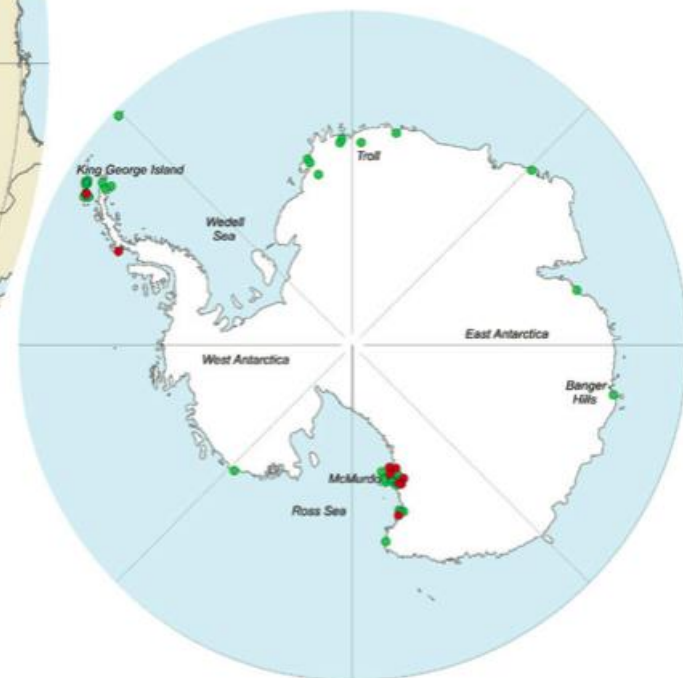
Associates



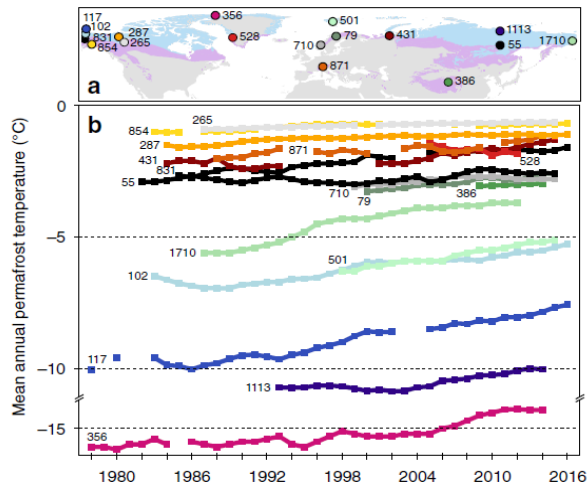
Permafrost in the Pyrenees



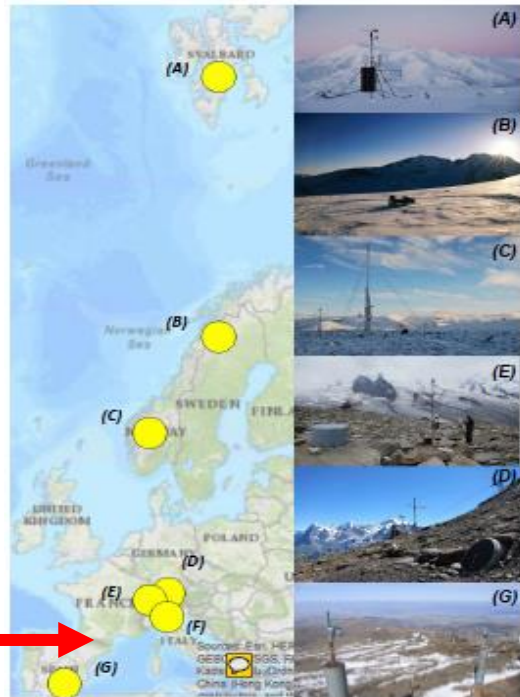
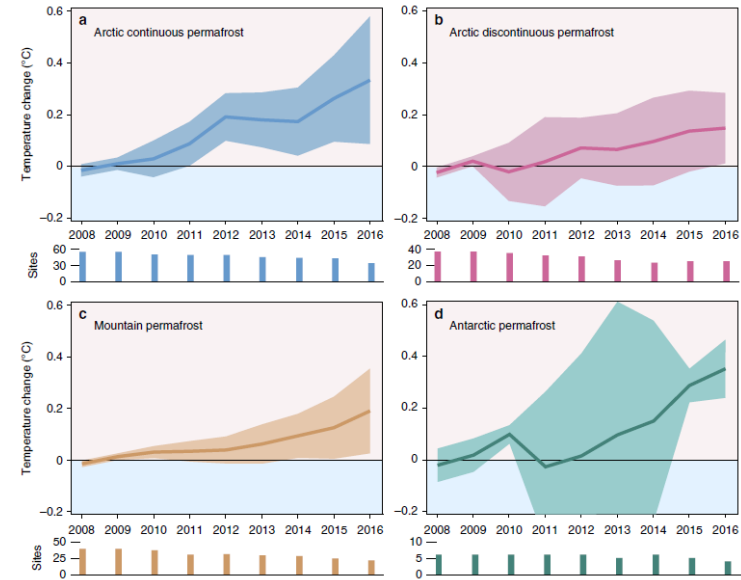
- | Permafrost Distribution | TSP Borehole |
|-------------------------|-----------------|
| Continuous | Deep (>10 m) |
| Discontinuous | Shallow (<10 m) |
| Sporadic | |
| Isolated | |
| Deep Relict | |



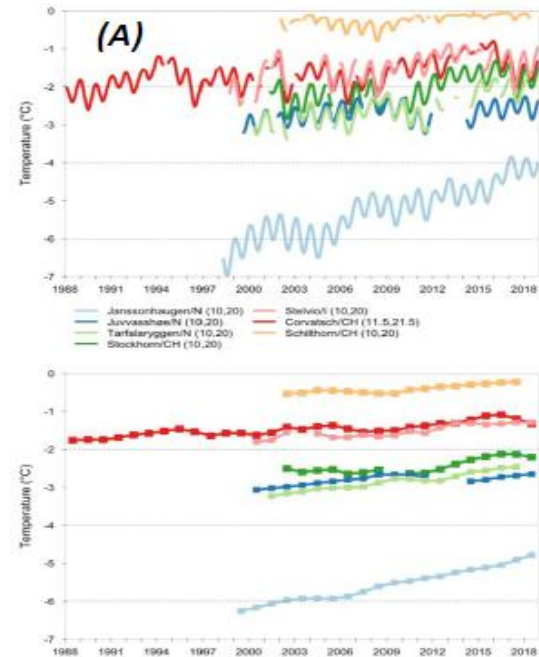
Permafrost in the Pyrenees



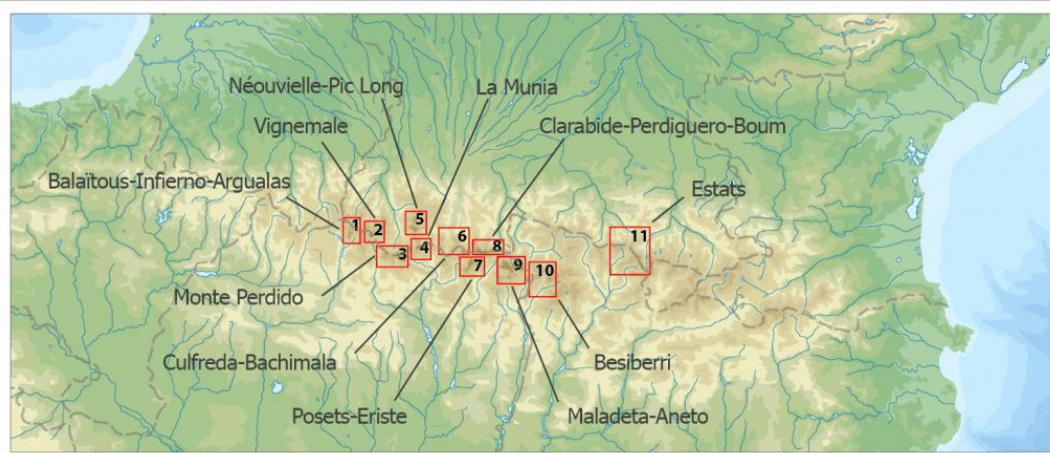
Biskaborn et al. (2020)



Etzelmuller et al. (2020)



Permafrost in the Pyrenees



Several massifs above 3,000 m

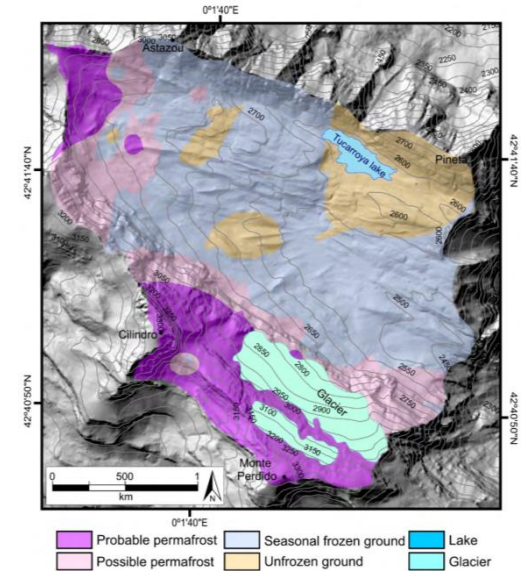
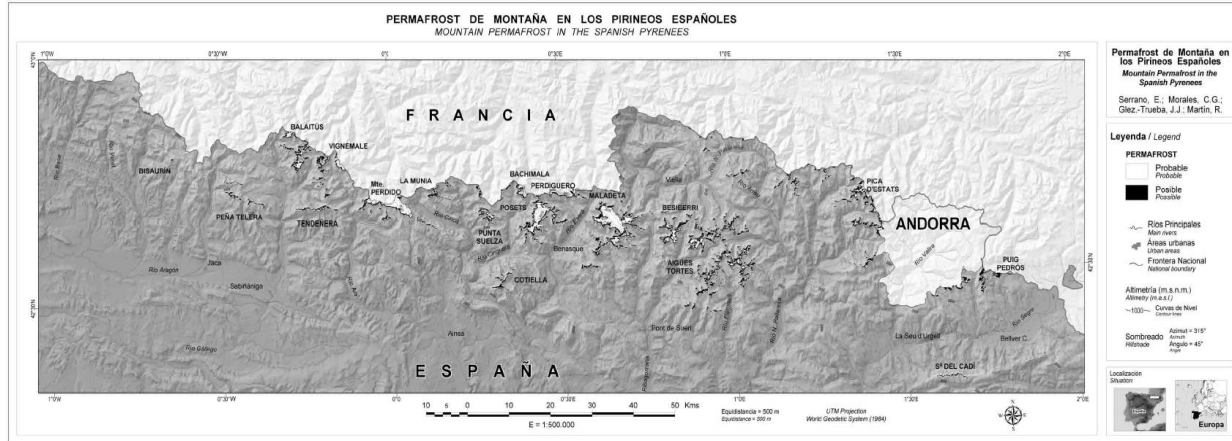
MAAT 0°C at 2950 m

Small glaciers in rapid retreat



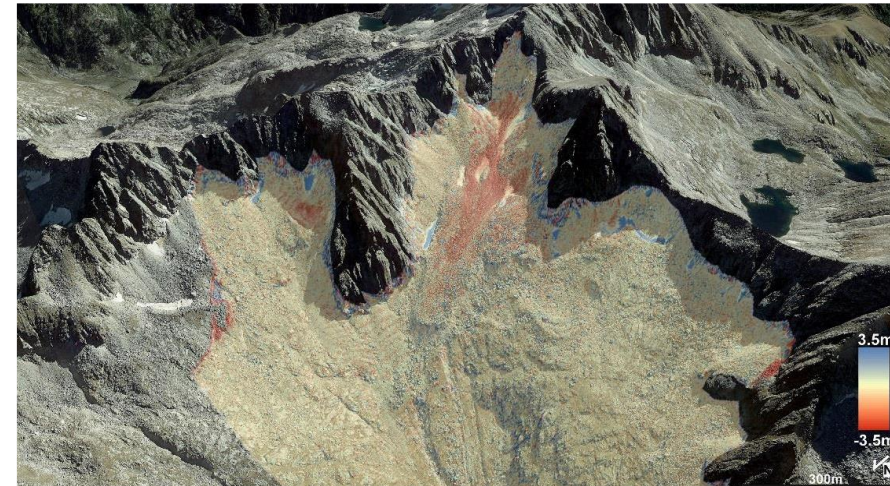
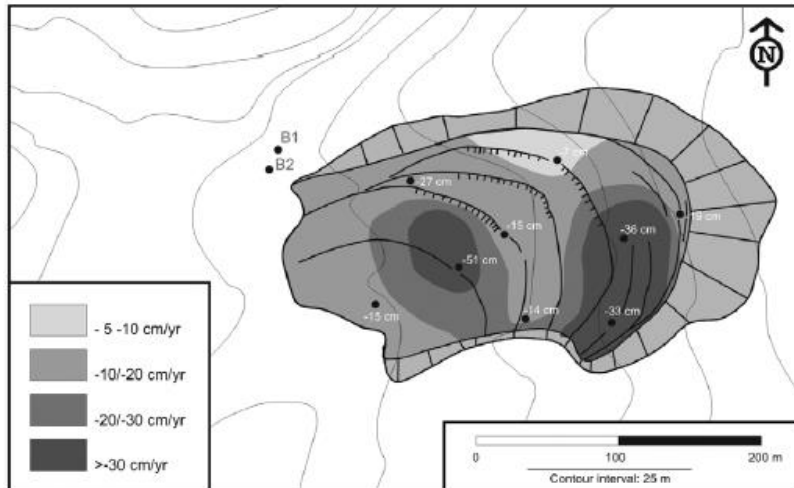
Little is known about permafrost in the Pyrenees

Key cryospheric component, snow plays a key role in its distribution



(Preliminary) Mapping based on geomorphic landforms (Serrano et al., 2009)

BTS measurements for some massifs (Serrano et al., 2020)

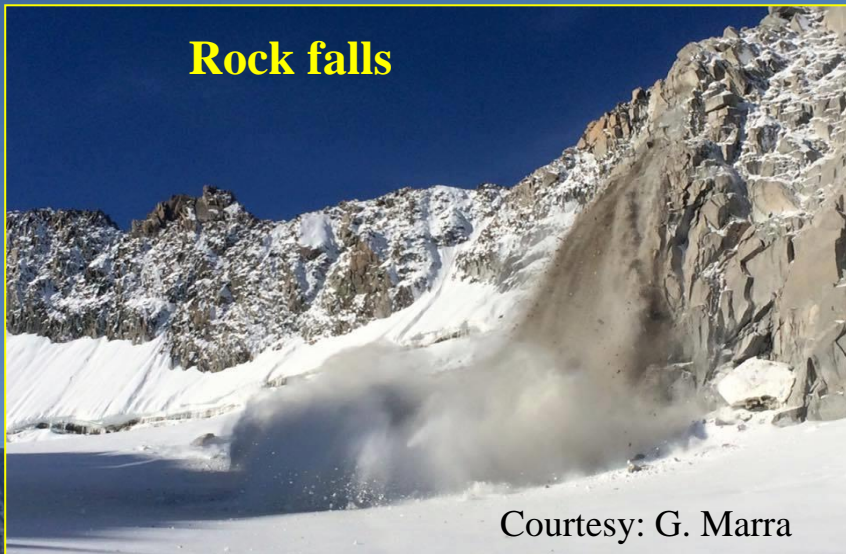


Monitoring permafrost related landforms (Serrano et al., 2010)

Multitemporal lidar monitoring (Bataller, 2020)

Permafrost in the Pyrenees

Rock falls

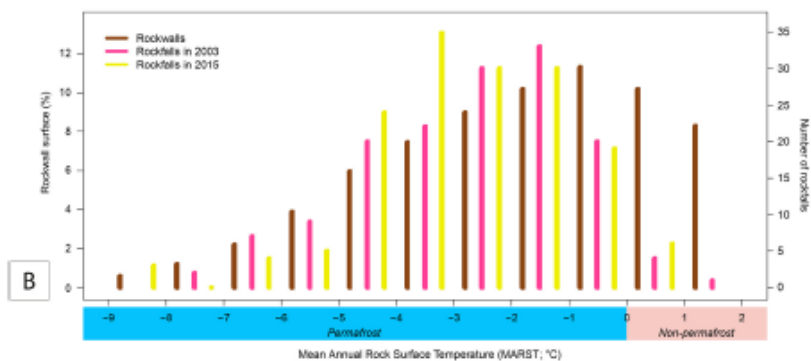
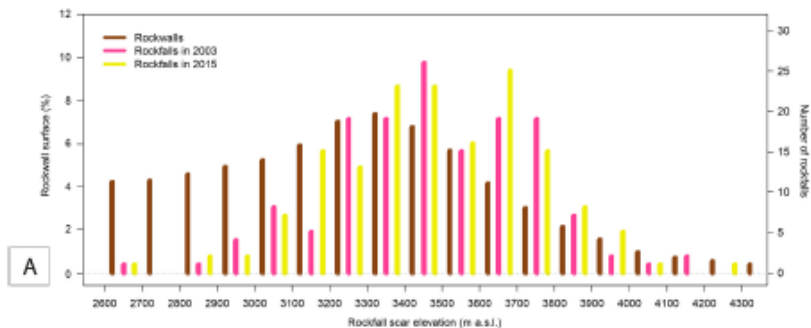


Courtesy: G. Marra



Ferit greu un excursionista en un despeniment a la cresta del Besiberri Nord

10/09/2024 - 19:53 | Redacció



bombers Bombers
@bomberscat · Follow

Al Besiberri Nord, a prop de la cresta, un alpinista ha patit una caiguda quan s'ha després la roca on hi tenia fixat l'ancoratge (14.06 h) #GRAE #Bomberscat hi hem accedit amb ràpel i l'hem extret, a ell i a l'acompanyant, amb un gruatge. A Barruera, l'ha atès @semgencat



8:16 PM · Sep 10, 2024



PERMAPYRENEES: main tasks

1- Project management

1.1 Administrative management...

1.2 Economical management...

1.3 Action plan management...

2- Dissemination

2.1 Mandatory activities

2.2 Other outreach actions...

3- Identification of permafrost

3.1 SAR interferometry

3.2 Geophysical surveys

3.3 Boreholes and dataloggers

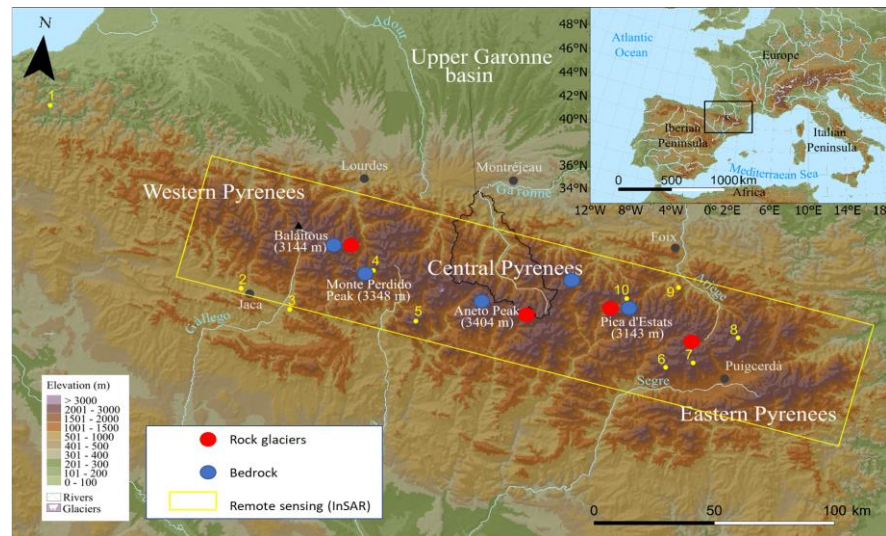
4- Evolution and response of permafrost

4.1 Permafrost in its setting

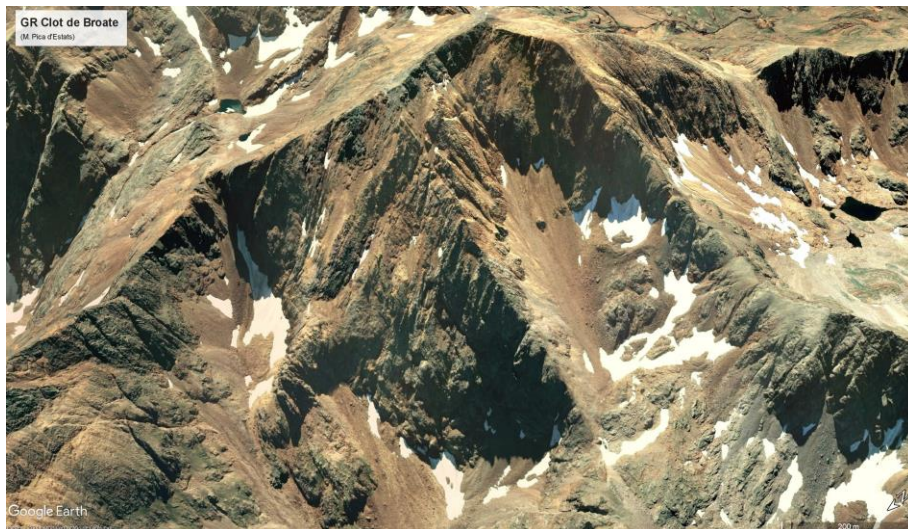
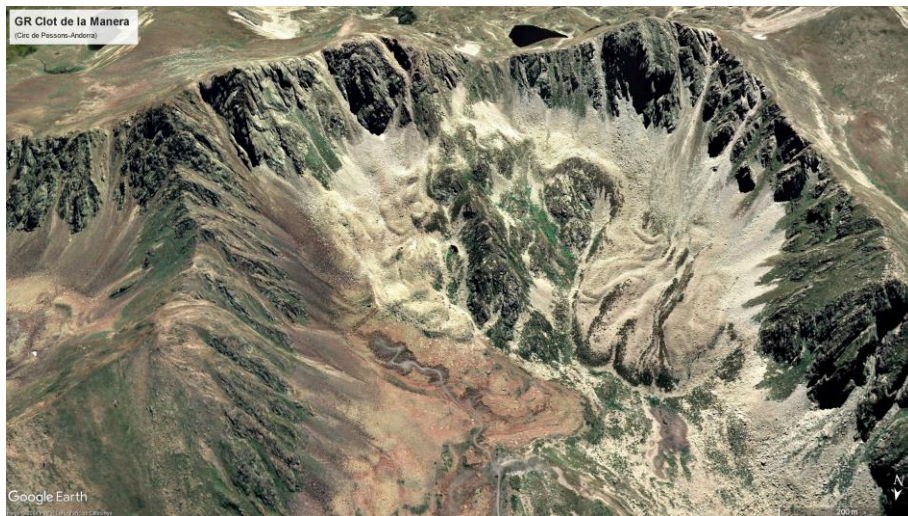
4.2 Monitoring permafrost

4.3 Rock properties

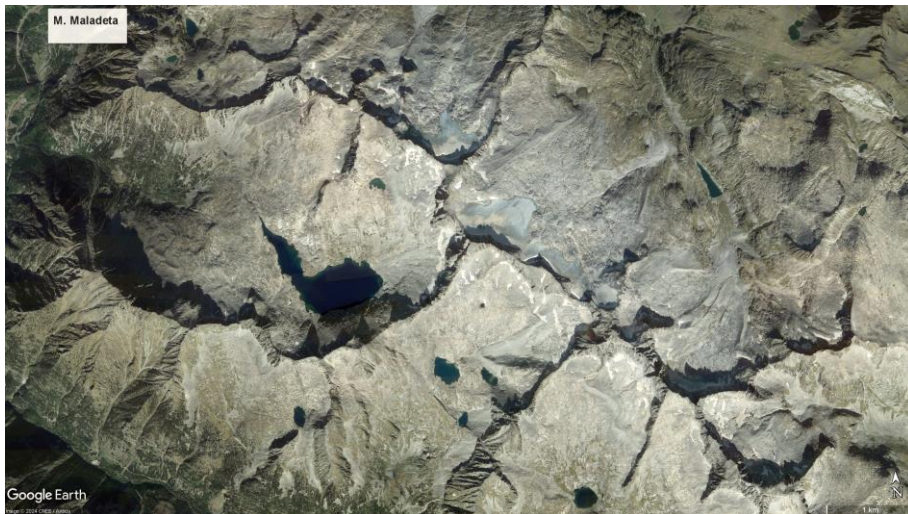
Massif / AOI	Geophysics (RMS)	Geotechnics Borehole (15 m) + Sensors (temp.) + Rock samples	Rock samples (potential instability modelling)	Wall sensors (continuous temperature)	Corner Reflectors (InSAR) Ground SAR (GB-SAR)	CRE- dating (Cosmogenics)
Vignemale Col de la Cerbillona (3198 m)		●	●	●		
Ardiden GR Ardiden- Lac Grand (2460 m)	●	●				●
Monte Perdido Pic Marboré (3251 m)		●		●		
Maladeta Pico de Coronas (3297 m)		●	●	●		
Besiberri GR Besiberri N (2600 m)	●	●		●	●	●
Pica d'Estats GR Clot de Broate (2800 m)	●	●				●
Pica d'Estats Montcalm (3078 m)		●				
Circ de Pessons GR Clot de la Menera (2492 m)	●	●				○ 2022



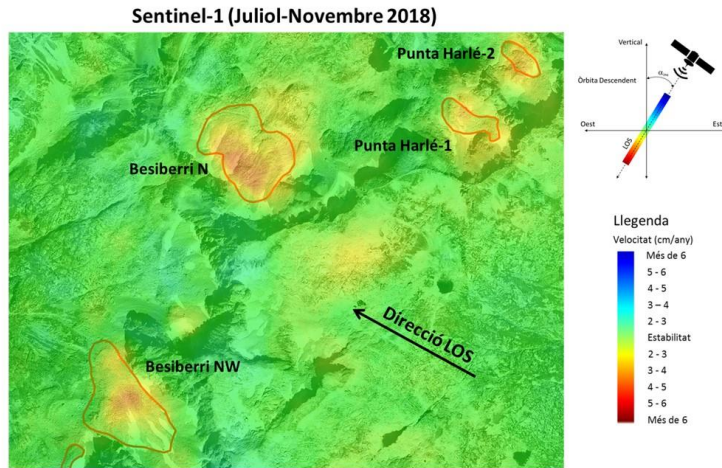
Permafrost in the Pyrenees



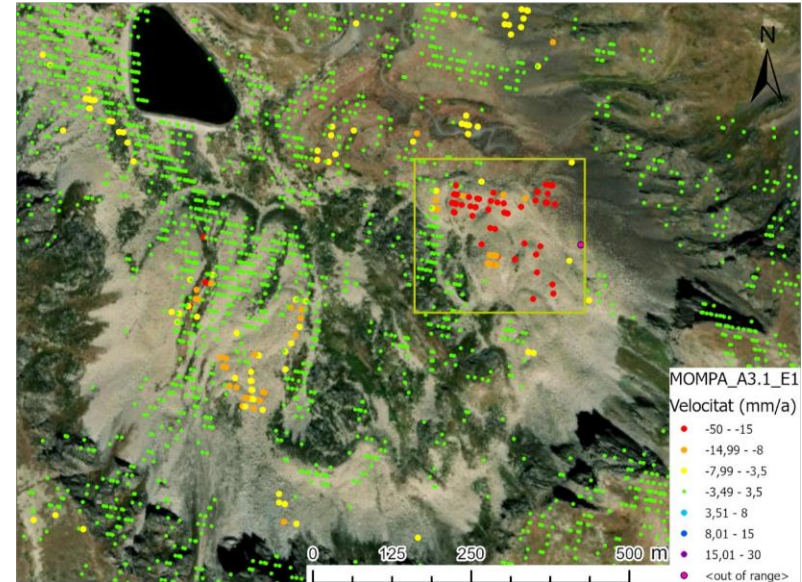
Permafrost in the Pyrenees



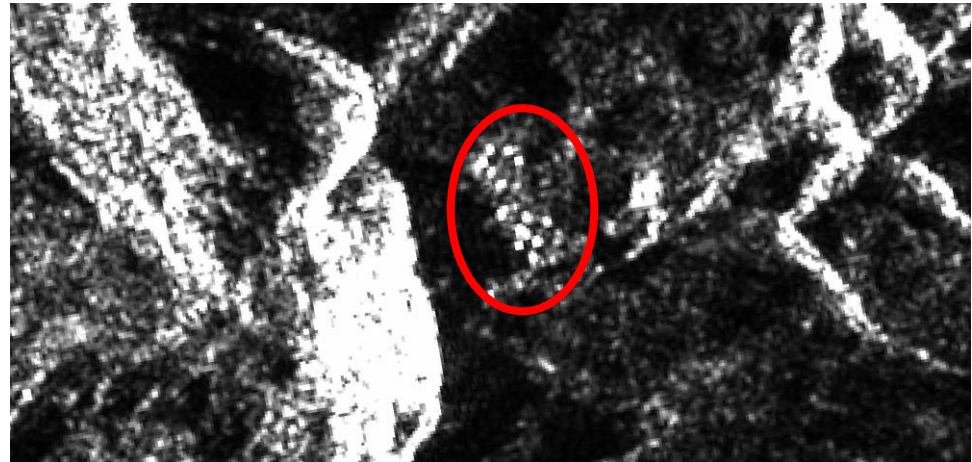
3.1 SAR interferometry



Besiberri massif



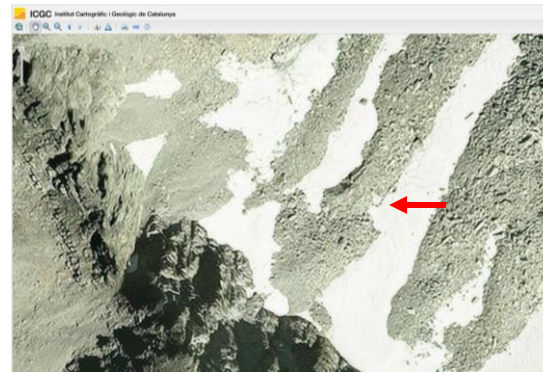
Clot de la Menera



Permafrost in the Pyrenees



2005



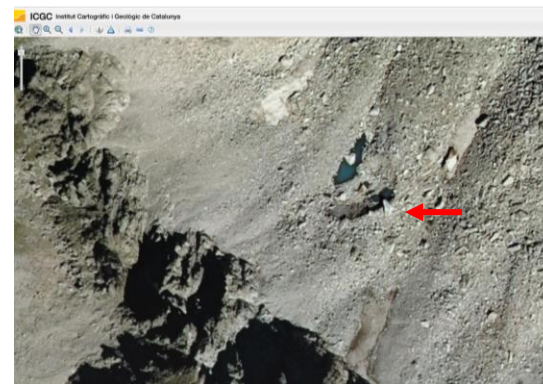
2008



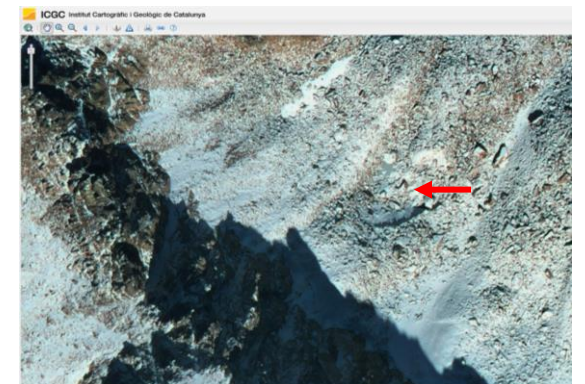
2011



2013

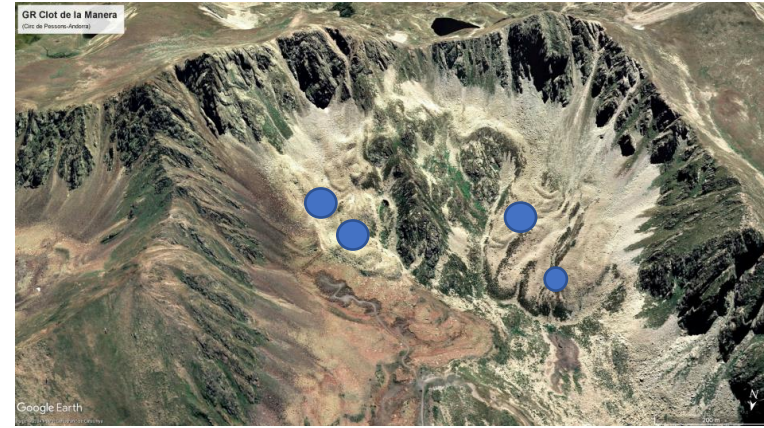


2015

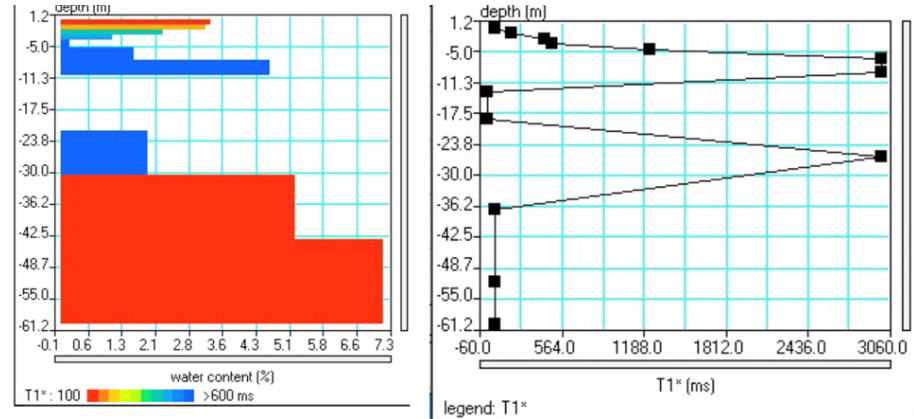
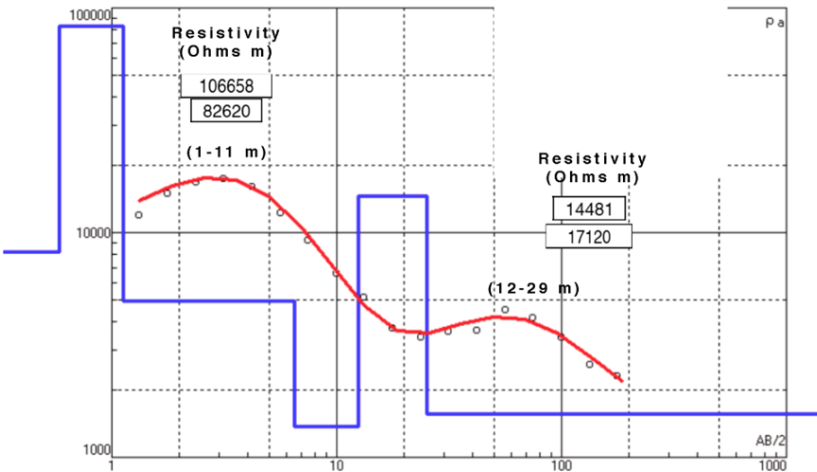
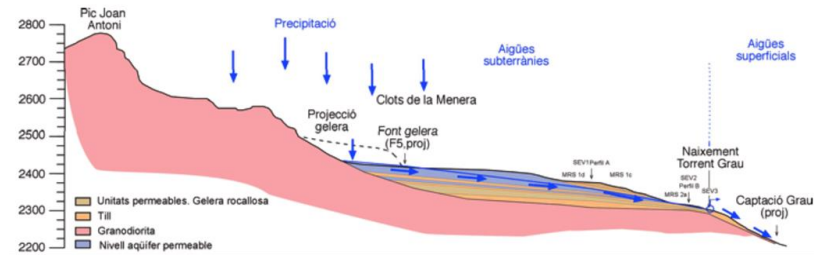


2017

3.2 Geophysical surveys

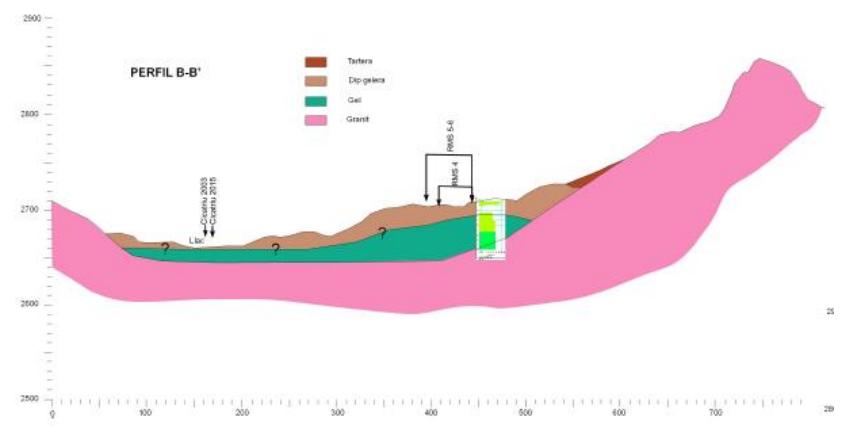
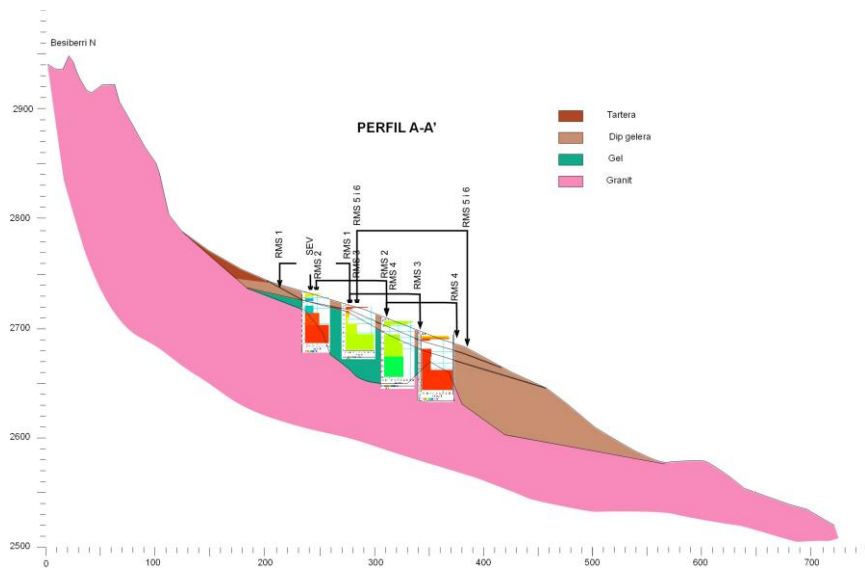
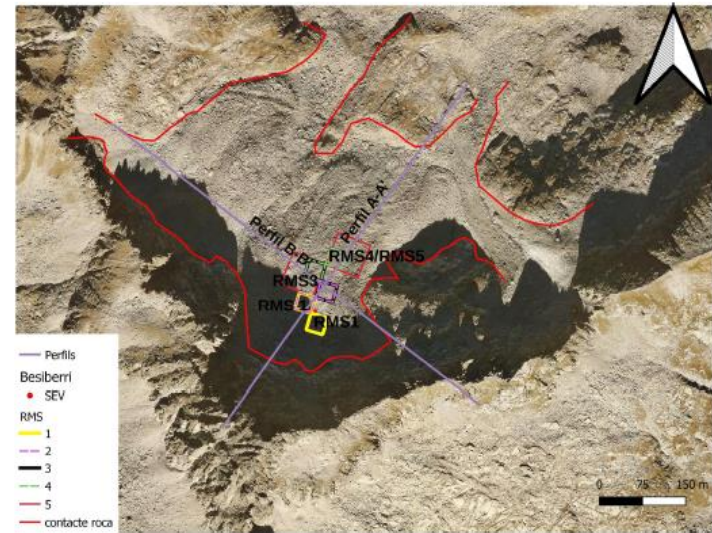


By using Magnetic Resonance Soundings we are able to detect the meltwater filling the empty spaces within the RG (large time decays).



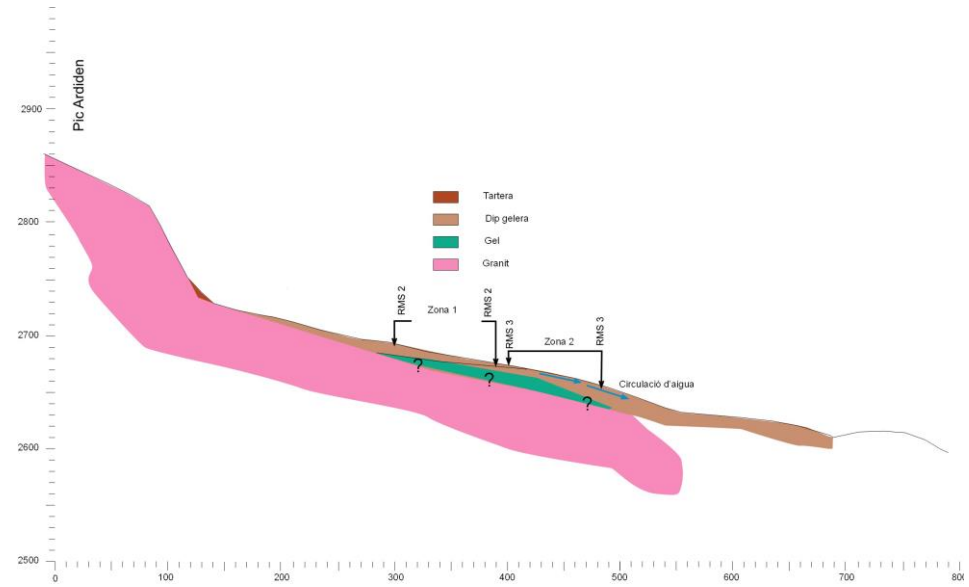
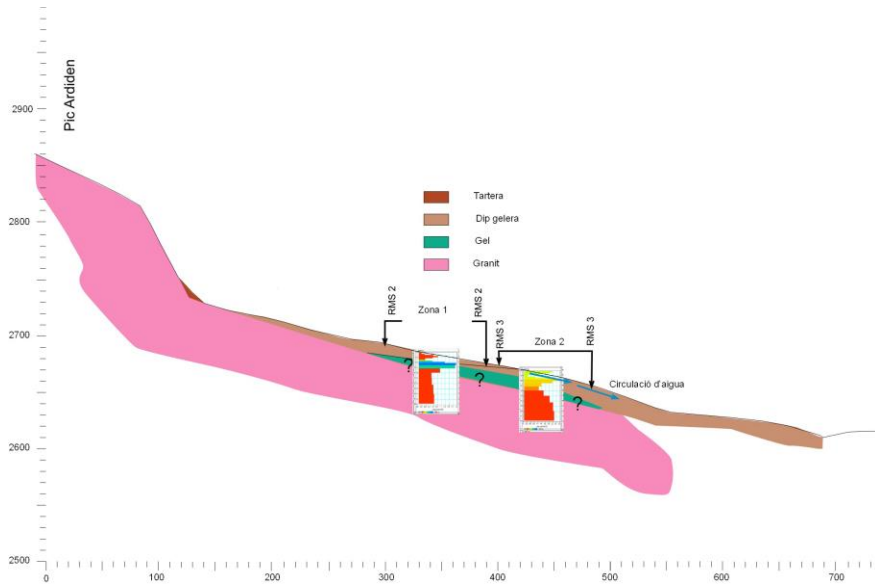
Two layers of extremely high time decays (5 m an 25 m depth)

Permafrost in the Pyrenees



Existence of permafrost at depths of 4-45 m

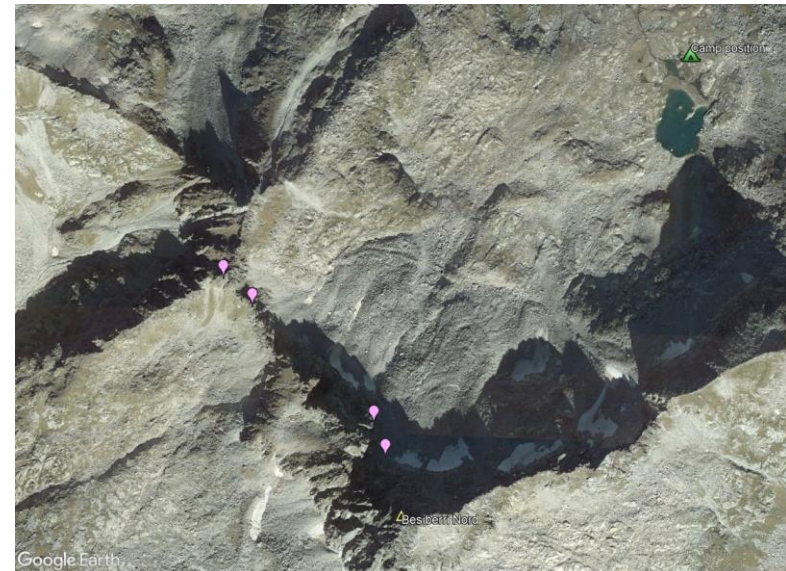
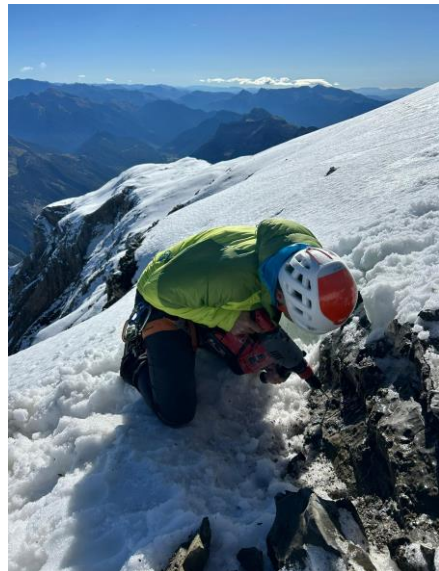
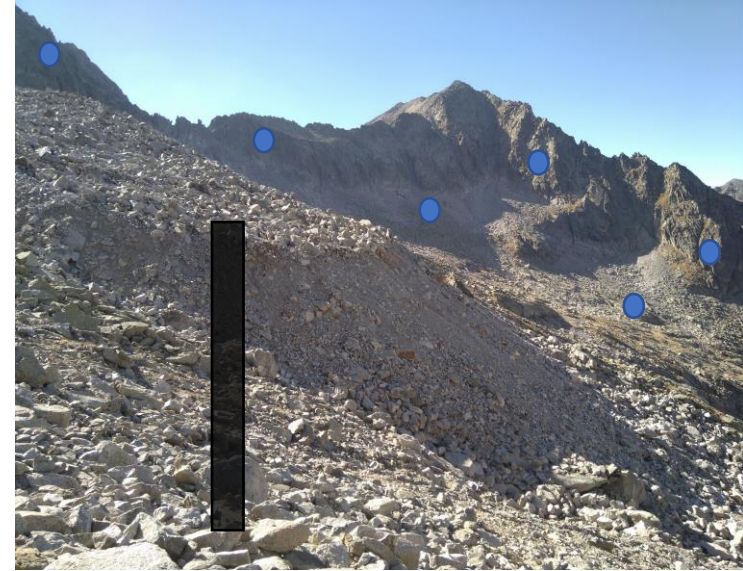
Permafrost in the Pyrenees



Existence of permafrost at depths of 5-18 m

3.3 Boreholes and dataloggers

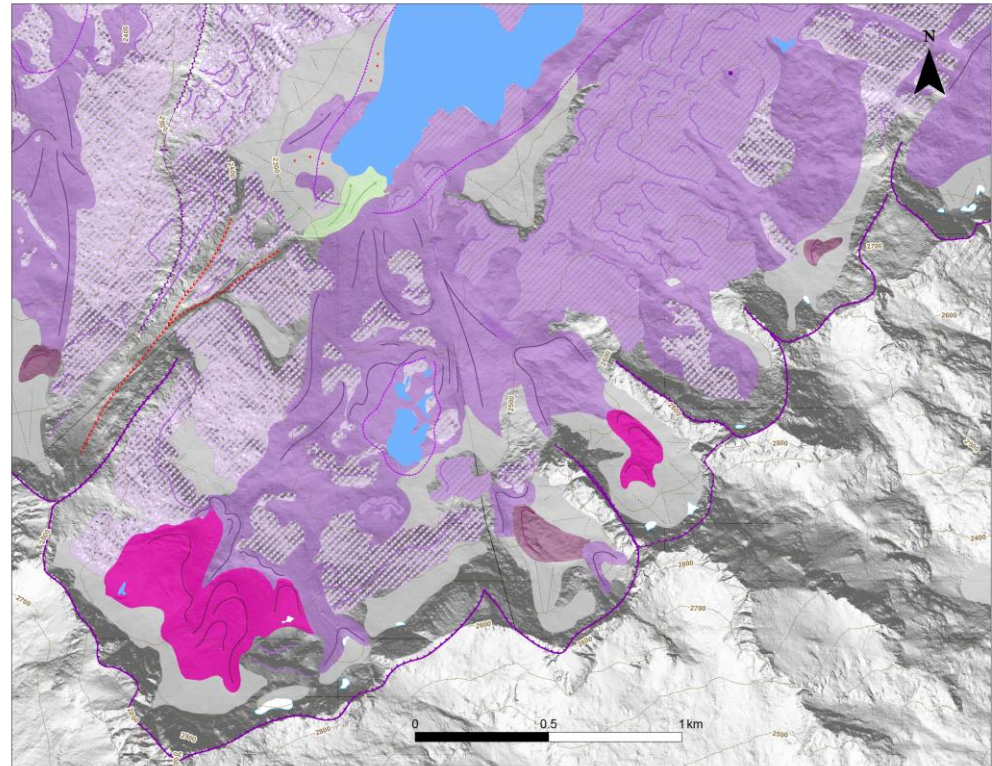
- Eight boreholes (15 m deep) will be drilled in summer '25
- Up to 20 rock wall temperature loggers have been already installed in two cirques





4.1 Permafrost in its setting

Geomorphological mapping
(sattelite images, UAV, field surveys)

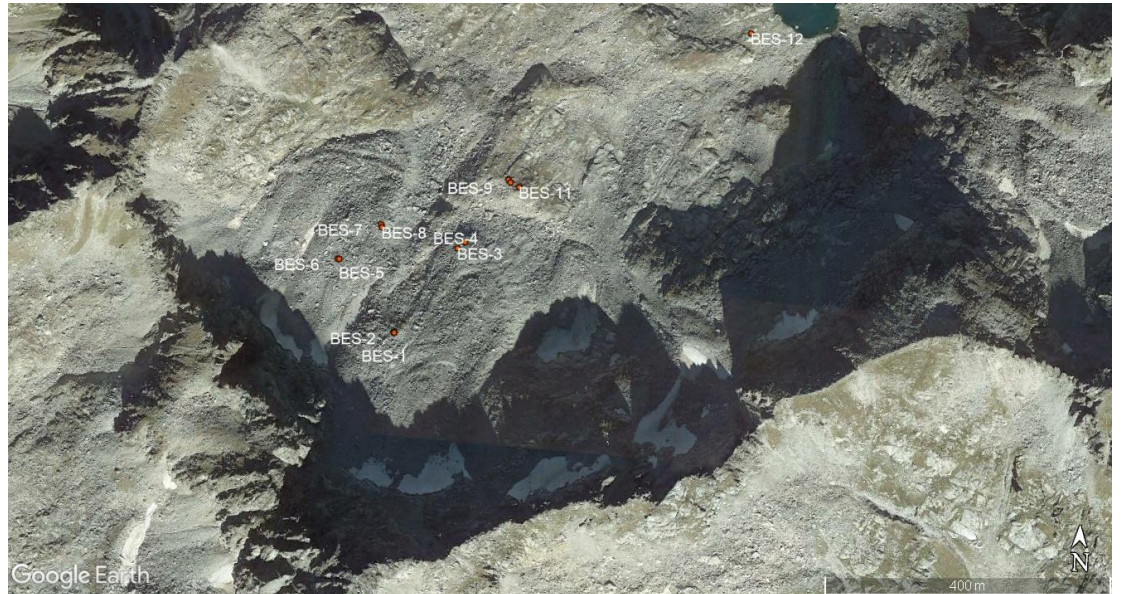
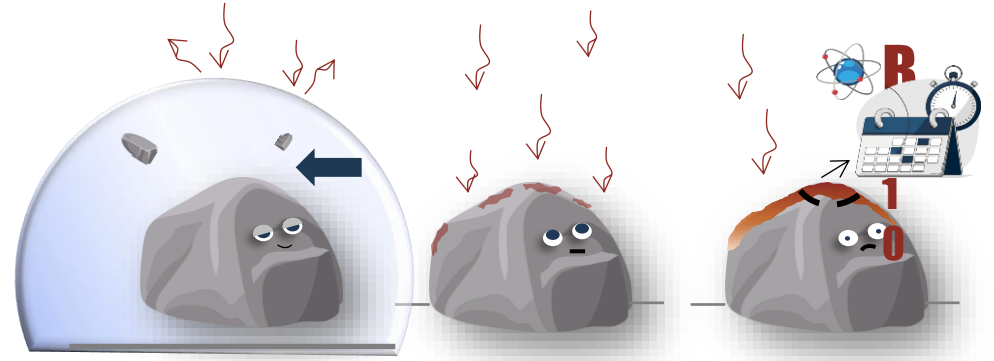


Permafrost in the Pyrenees

40 samples for CRE dating have been collected in three rock glaciers and surrounding areas



Reconstruct permafrost formation and (glacial-periglacial) landscape evolution



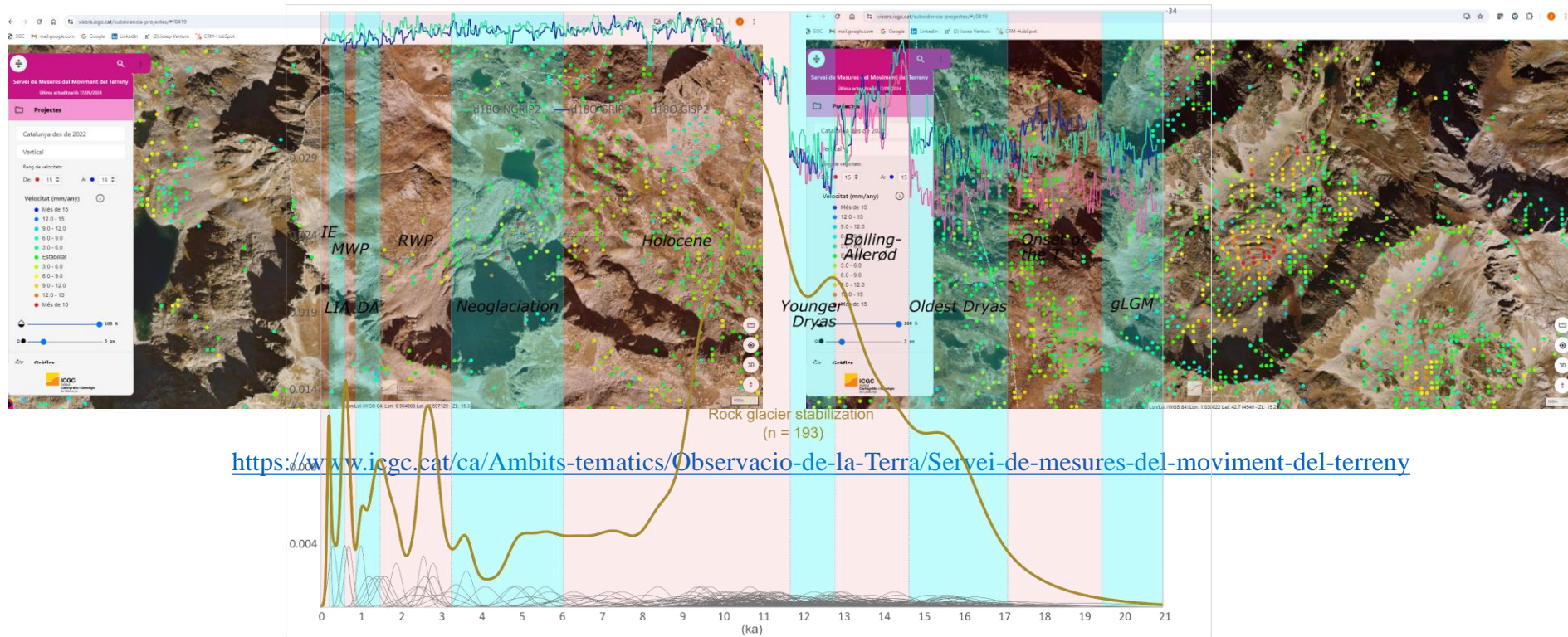
Open questions

What is the spatial distribution of permafrost in the Pyrenees?

How is it responding to recent warming?

Is it inherited/active under present-day climate regime?

What are we dating when applying CRE dating on permafrost-related landforms?



Distribution of density plots of CRE ages from rock glacier boulders in the Mediterranean mountains vs the NH past temp. reconstruction inferred from the Greenland Ice Cores

Permafrost in the Pyrenees



1st CIRCULAR

VIII Congreso Ibérico Permafrost



VII Congreso Ibérico Permafrost
Val d'Aran, Catalonia, Spain
June 25-27, 2024



See you in the Pyrenees in June'25!

谢谢大家

Thank you!



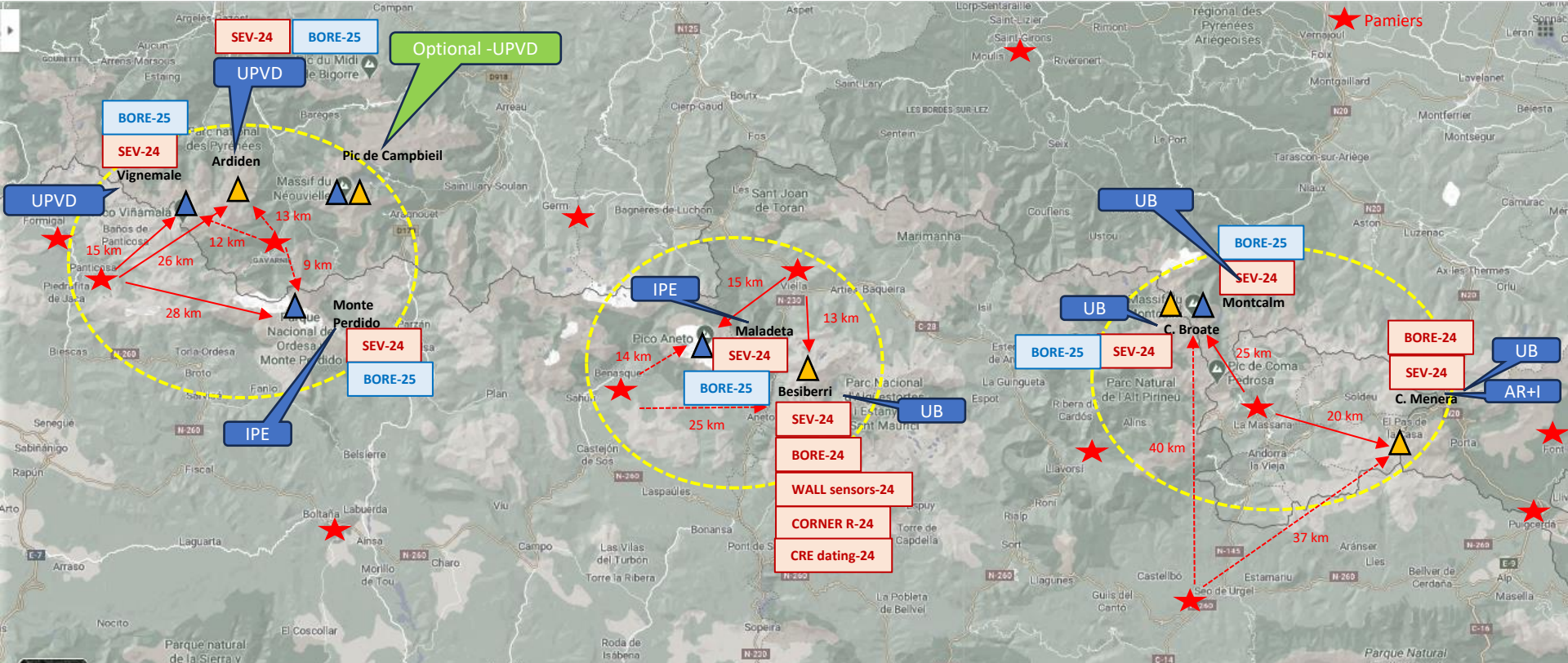
Interreg
POCTEFA



Cofinanciado por
la UNIÓN EUROPEA
Cofinancé par
l'UNION EUROPÉENNE



Kick-off meeting



PERMAPYRENEES : Geophysical surveys and drillings

Timing

Lithology

Socis responsables AOI:

- UB
- UPVD
- IPE
- AR+I

- Active rock glacier(4)
- Bedrock (4)
- Heliports

SEV-24	BORE-25
BORE-24	WALL sensors-25
WALL sensors-24	CORNER R-25
CORNER R-24	CRE dating-25
CRE dating-24	

GRANITES: Ardiden, Maladeta, Besiberri, Clot Manera
LIMESTONES: Monte Perdido
LIMESTONES + SLATES: Vignemale
SLATES: Montcalm, Clot de Broate, Pic de Campbieil