CIRCULATION TYPE SEQUENCES APPLIED TO SNOW AVALANCHES OVER ANDORRA AND CATALONIA

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What is a snow avalanche? → natural and human factors

Circulation types related to heavy precipitations

→ Natural factors

(Esteban P, Jones PD, Martín-Vide J, Mases M. 2005. IJC)

Snow layers → Circulation type sequences?

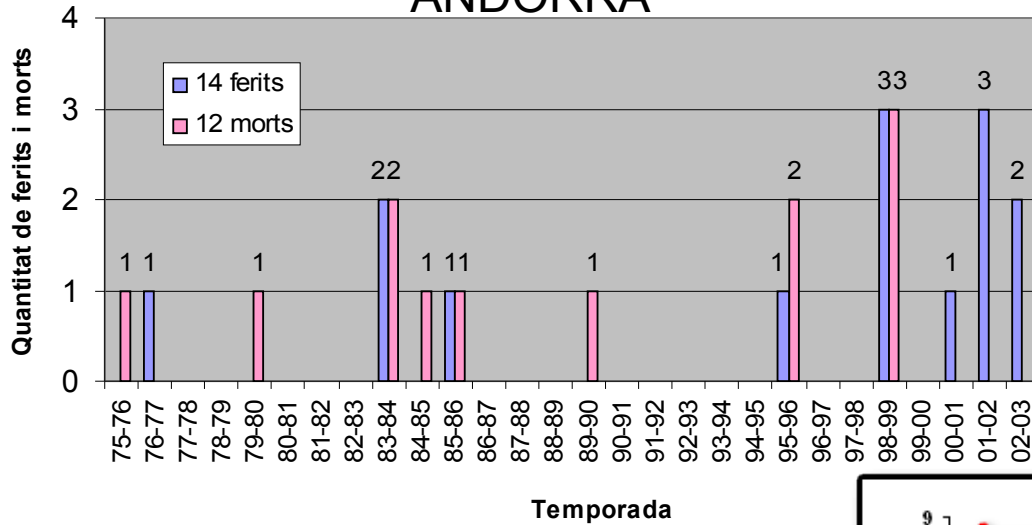**Circulation type sequences associated to accidental avalanches**

→ Mainly human factors

Les Fonts Avalanche (Andorra)
February 1996
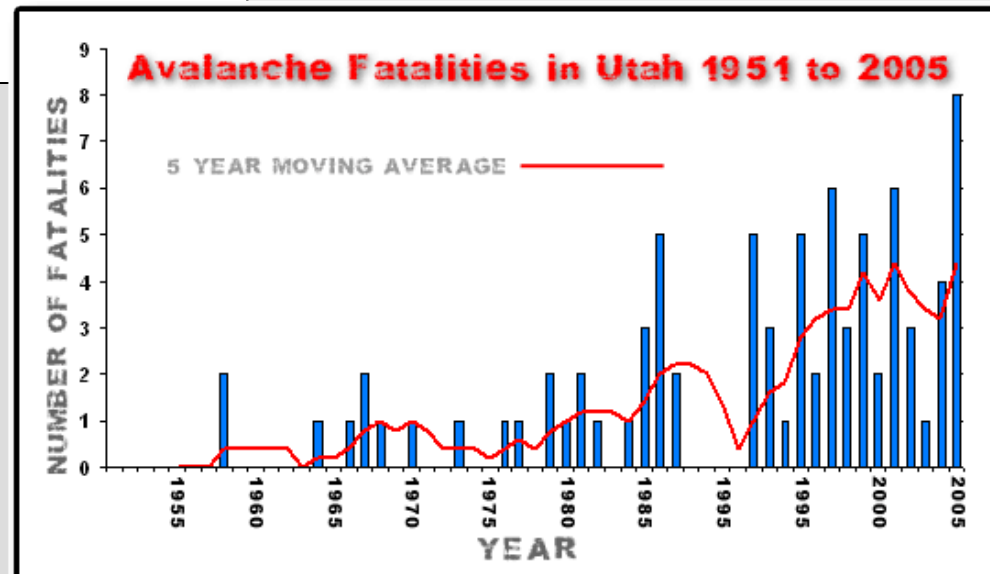
Ferits i morts per allaus per temporada entre 1975 i 2002

ANDORRA

Clear increase on fatalities, mainly related to increase of vulnerability:
- more mountainners
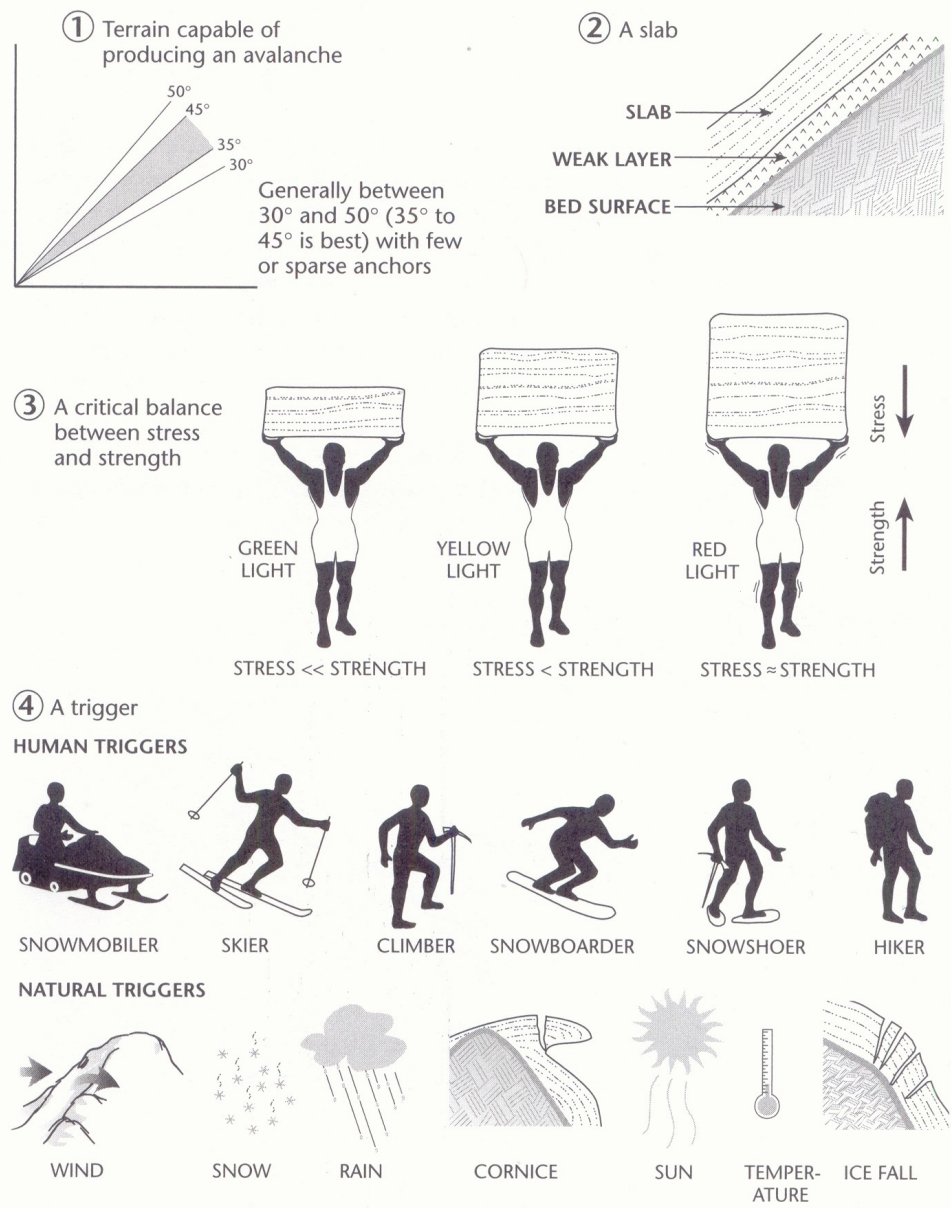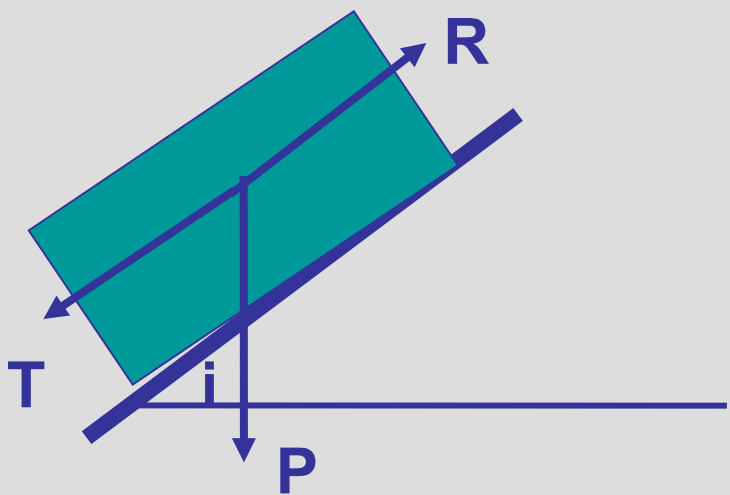- extension of urban areas.

What is a snow avalanche?

Figure 1-1. Ingredients of a slab avalanche

Tremper, B (2001)

Circulation types related to heavy precipitations → Natural factors

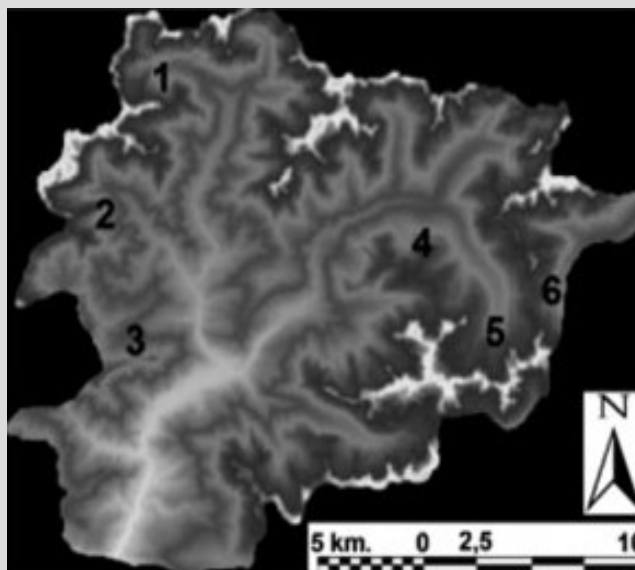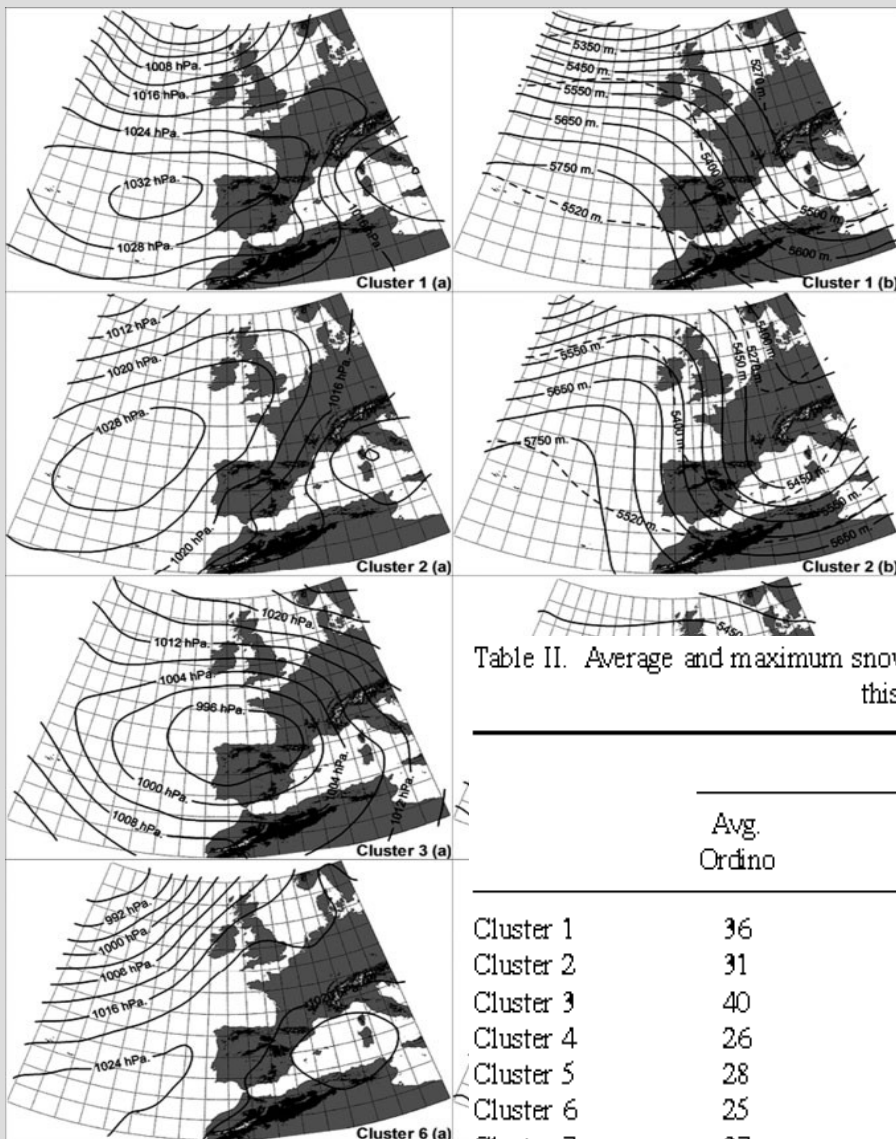(Esteban P, Jones PD, Martín-Vide J, Mases M. 2005. IJC)

Table II. Average and maximum snow precipitation for every cluster, registered in three of the weather stations used in this work (Ordino-Arcalís, Pas de la Casa, Arinsal)

	Snow precipitation in 24 h (cm)					
	Avg. Ordino	Max. Ordino	Avg. Pas Casa	Max. Pas Casa	Avg. Arinsal	Max. Arinsal
Cluster 1	36	57	27	65	23	32
Cluster 2	31	54	34	60	21	51
Cluster 3	40	65	44	75	45	70
Cluster 4	26	53	30	64	26	85
Cluster 5	28	43	23	42	17	50
Cluster 6	25	48	30	50	23	56
Cluster 7	37	63	34	46	25	45

Snow layers → Circulation type sequences?
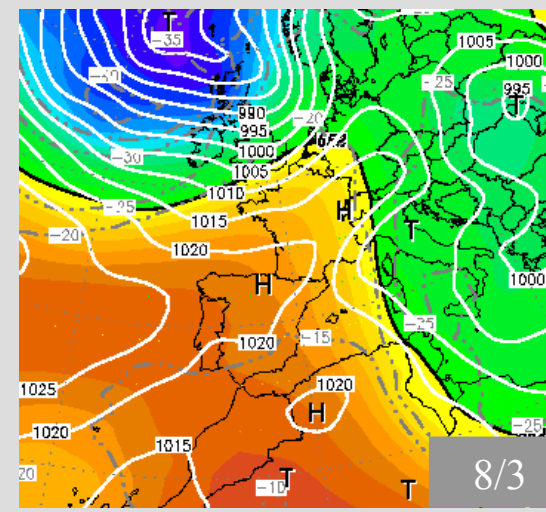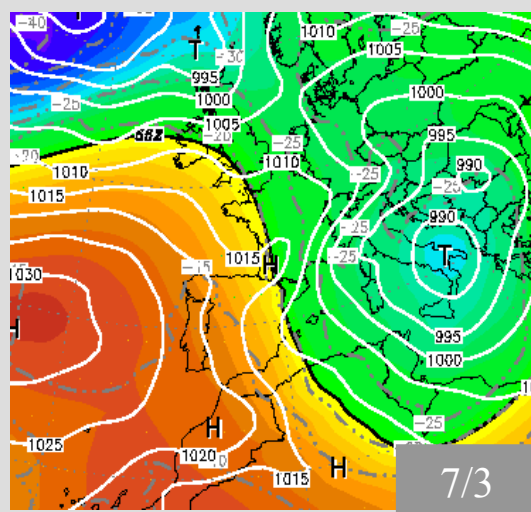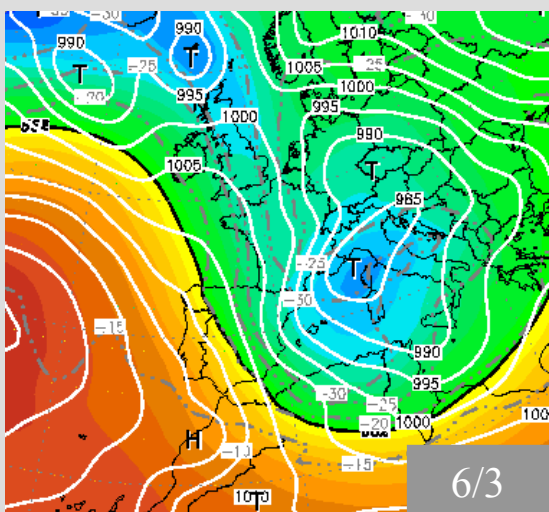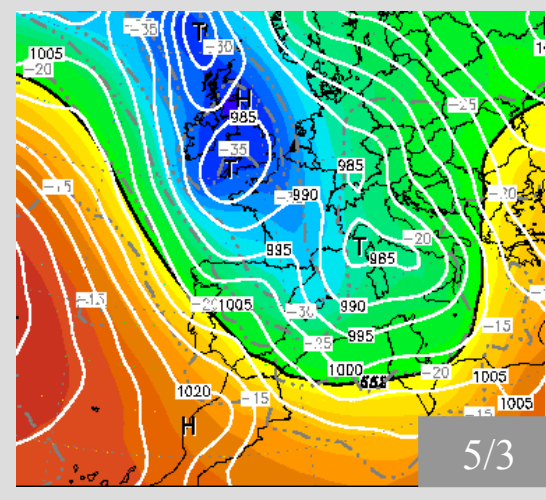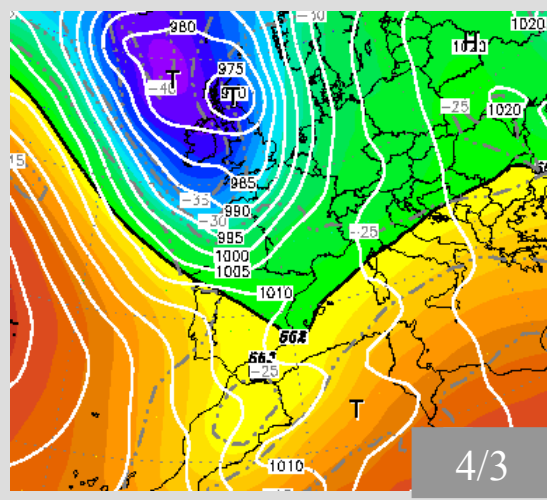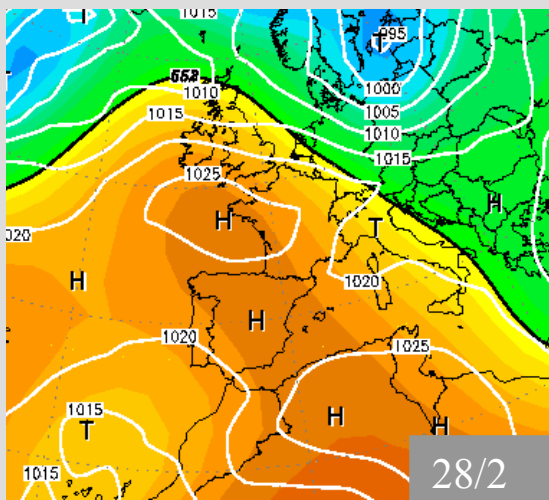
Snow layers → Circulation type sequences?
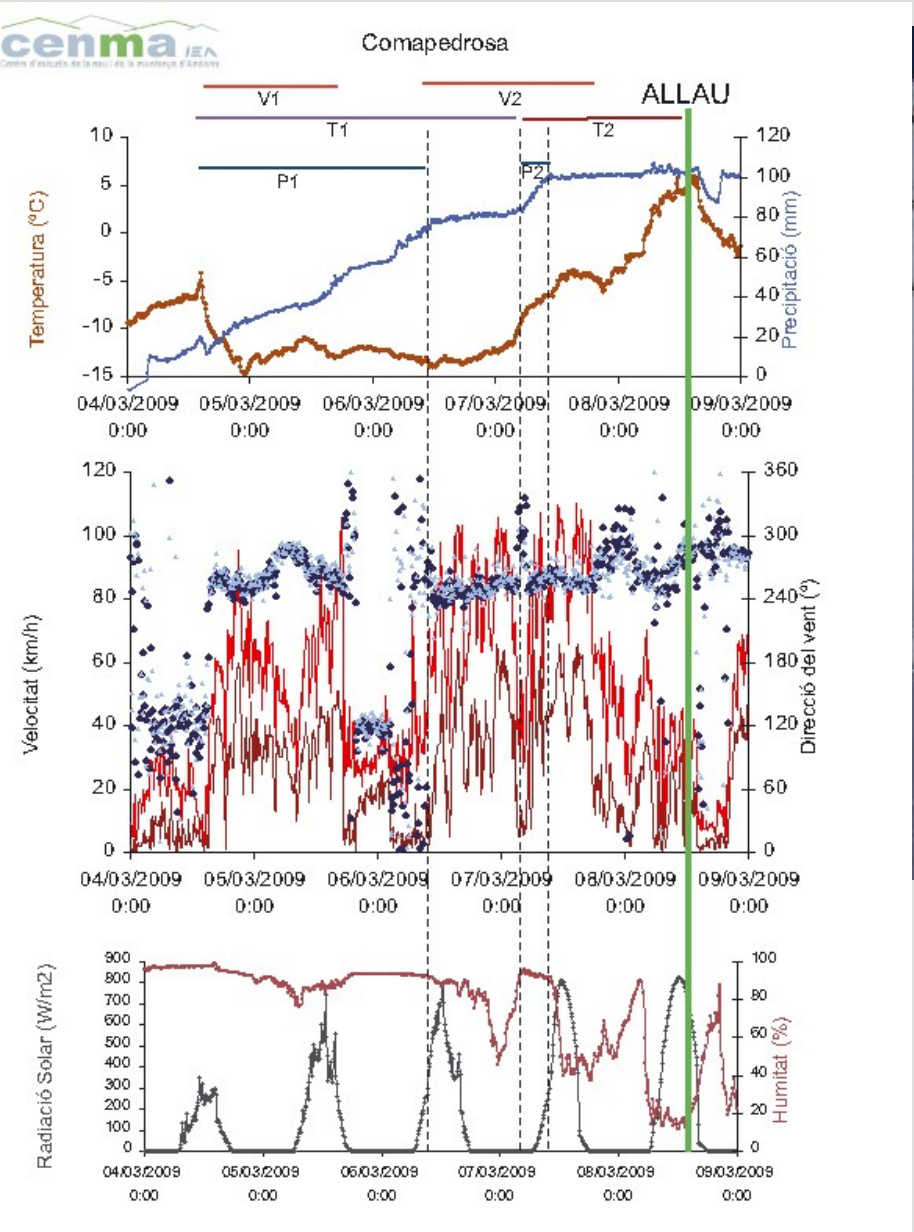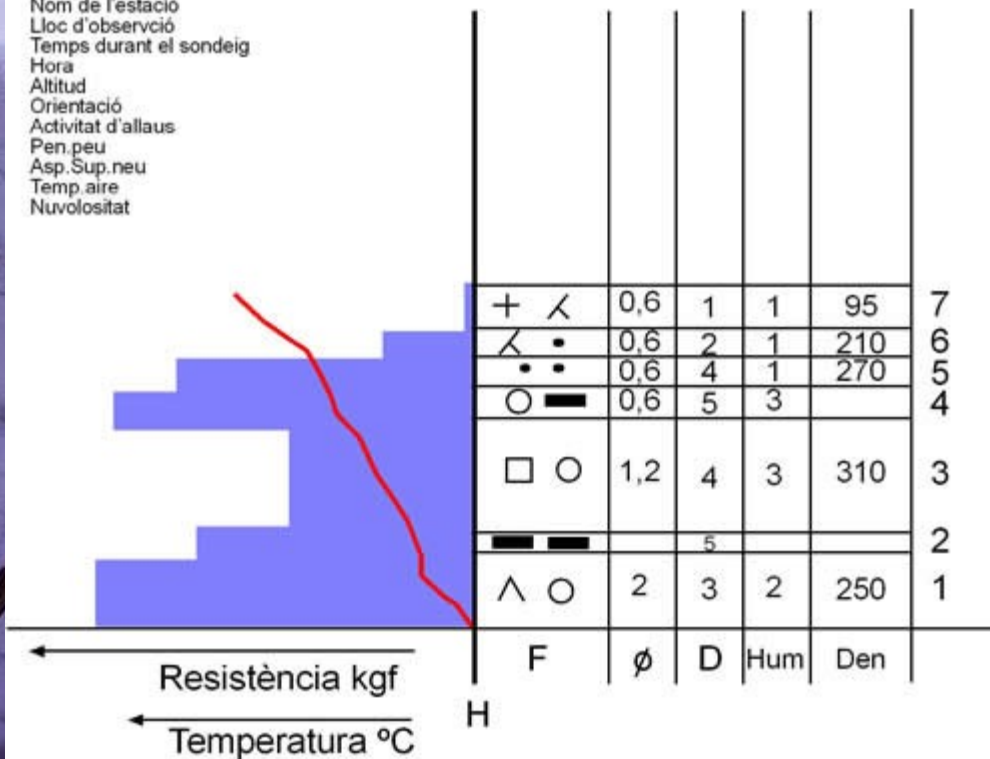

Sunny day (Sunday)

South - Southeast face

Human triggering:
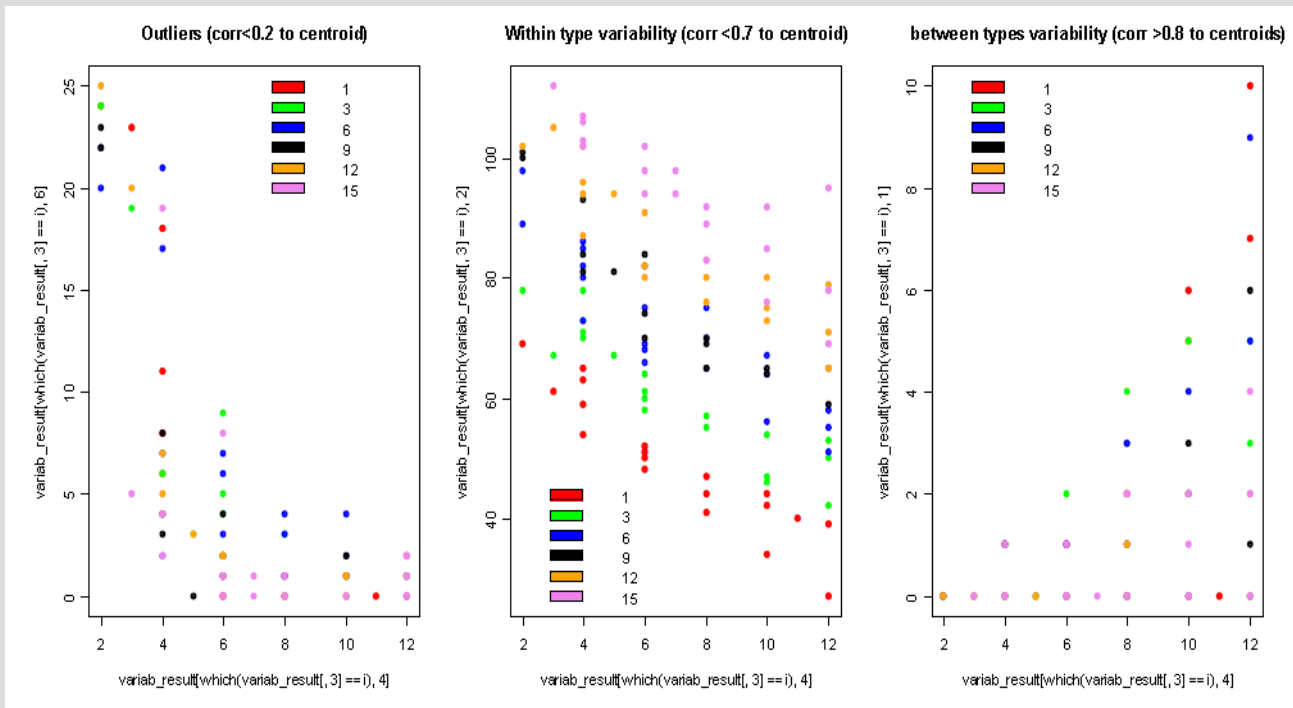two deaths

Snow layers → Circulation type sequences?

Circulation type sequences associated to accidental avalanches

→ Mainly human factors

(Esteban P, Beck C, Philipp A)

→ Classification of avalanche days (with some impact on society, i.e. accidents or damages)
→ Several COST733 methods used
→ Different number of types and lenght of sequences (Cost733 classification software)
→ Selected the "best" ones
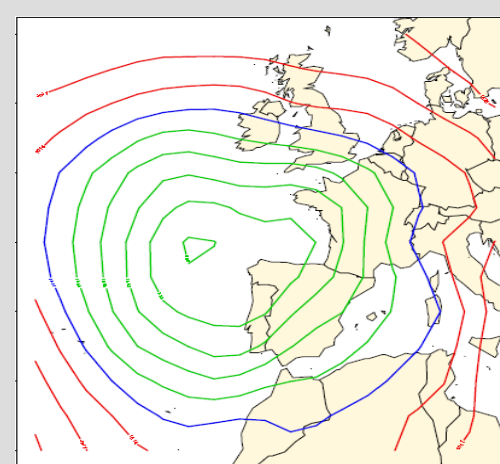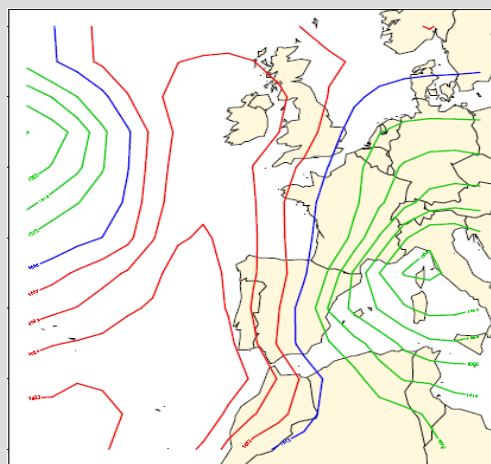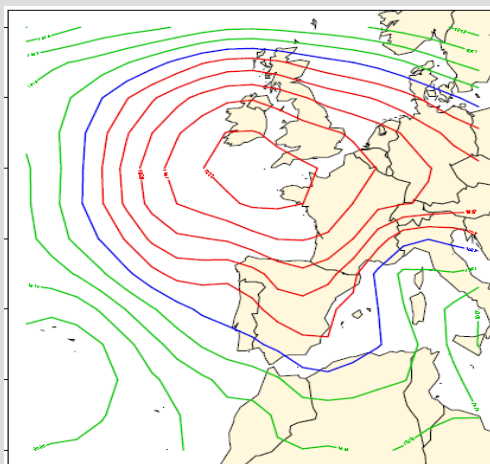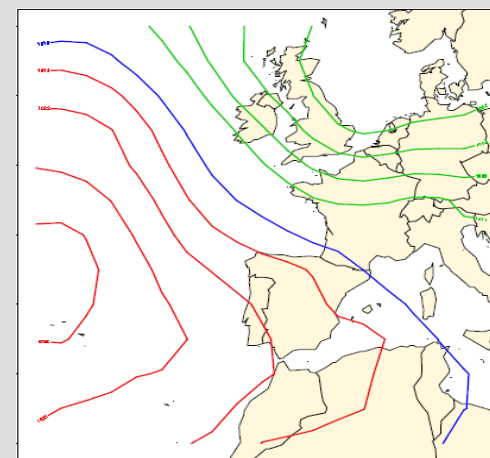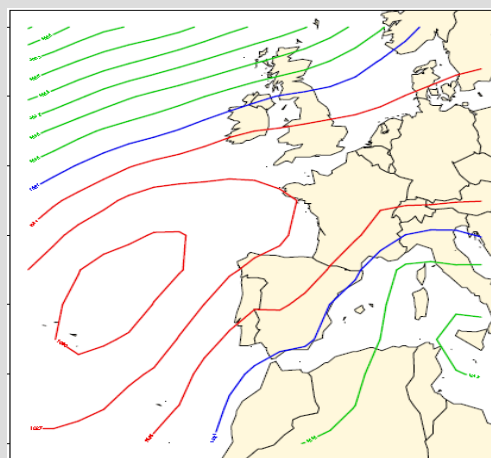

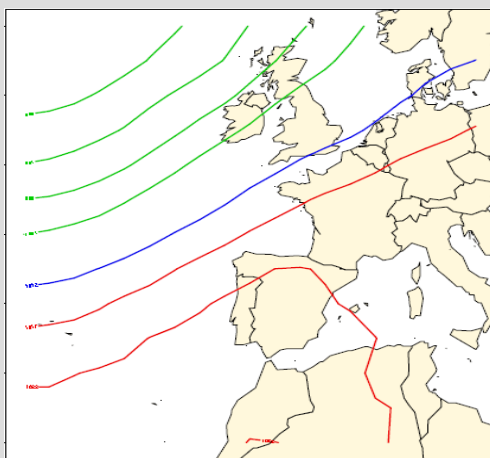Very simple criteria in terms of:
- Outliers
- Within type variability
- Between type variability

5- Circulation type sequences associated to accidental avalanches

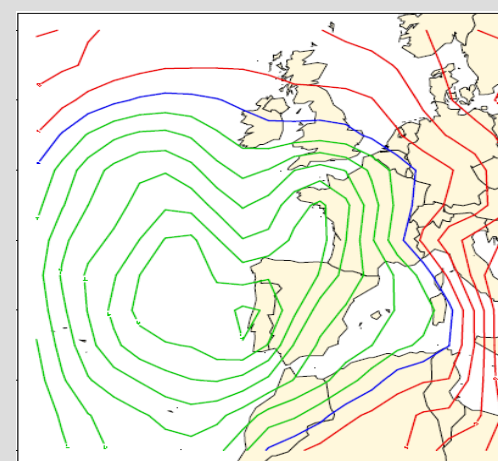### → Mainly human factors
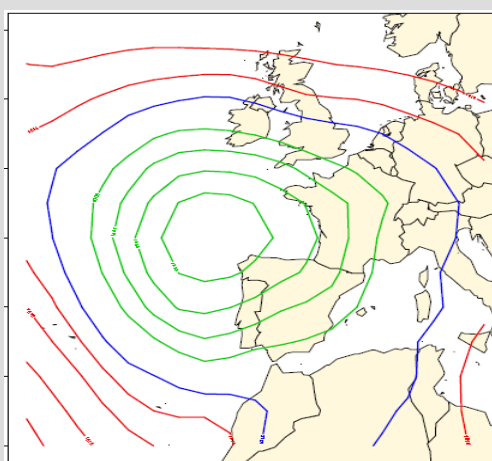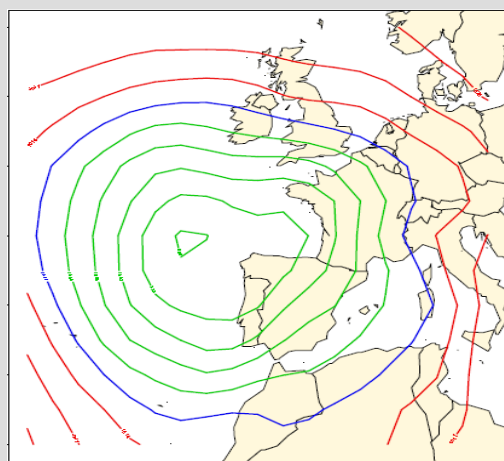
(Esteban P, Beck C, Philipp A)

Selected days with damages and accidents by avalanches

Circulation type sequences associated to accidental avalanches

→ Mainly human factors

(Esteban P, Beck C, Philipp A)

Avalanche days   Similar days 0.5 rPearson   Anomaly

Circulation type sequences associated to accidental avalanches

→ Mainly human factors

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Avalanche days

Similar sequence
rPearson 0.5

Circulation type sequences associated to accidental avalanches

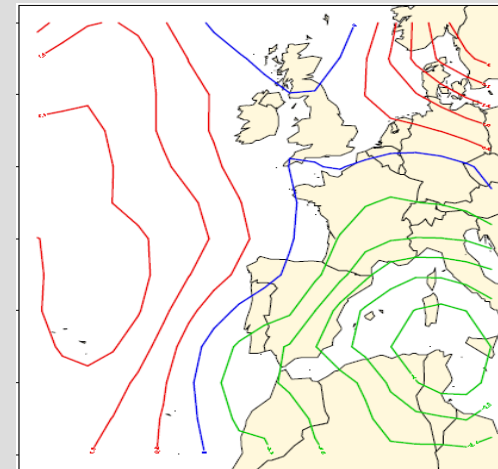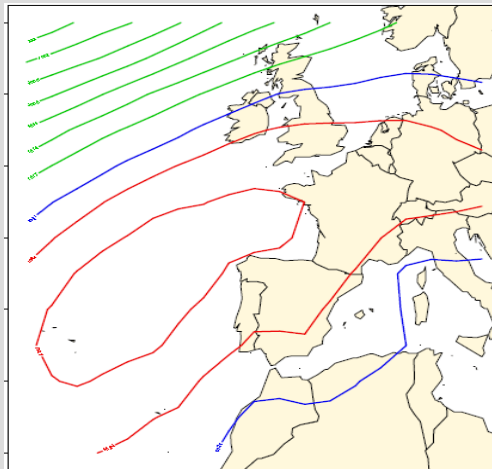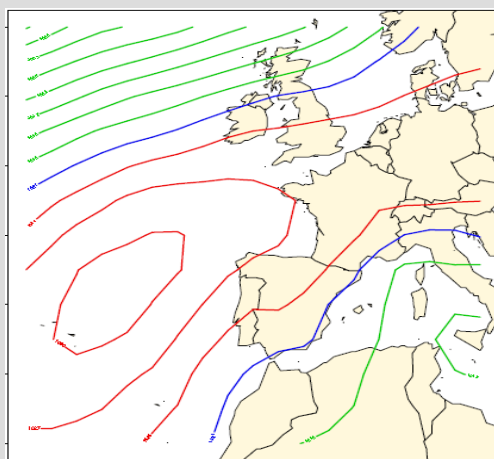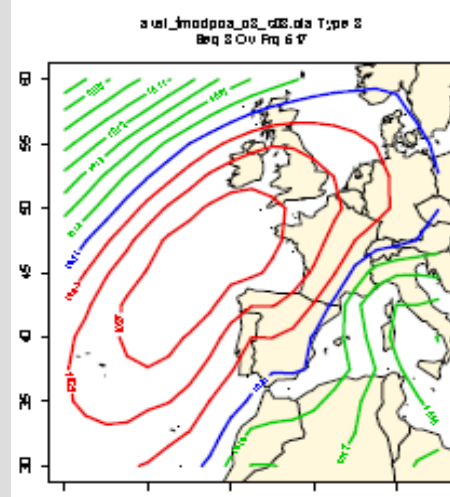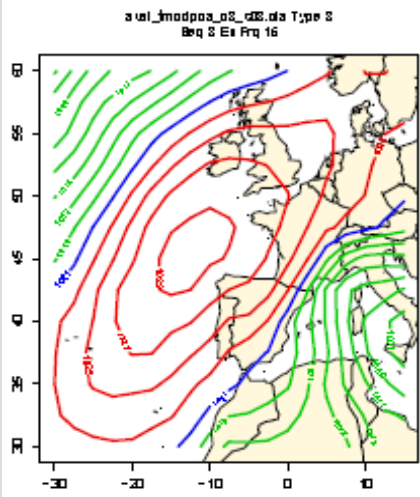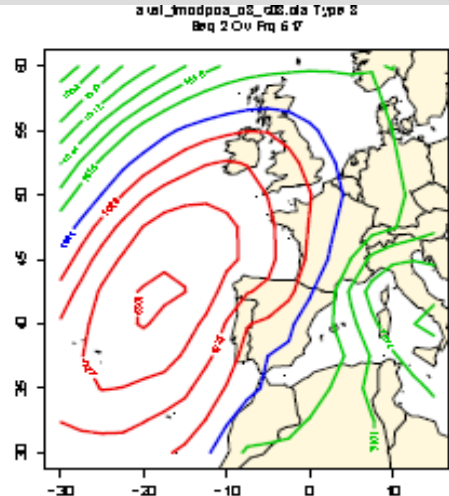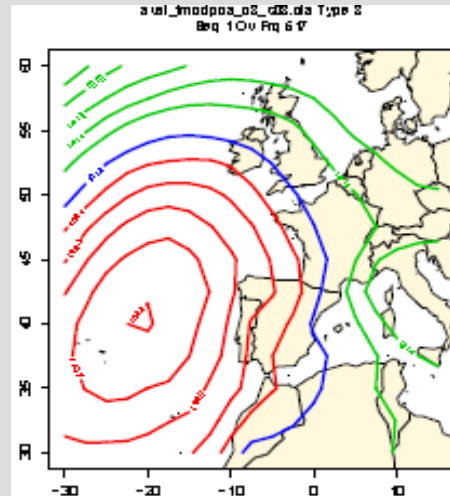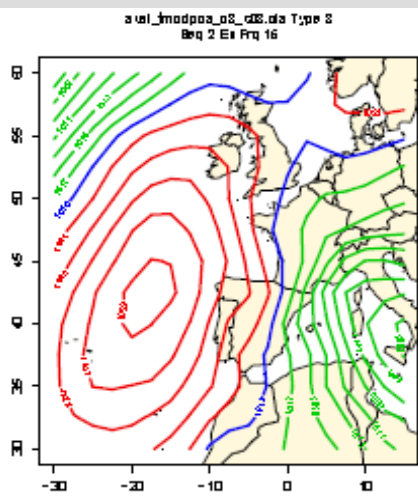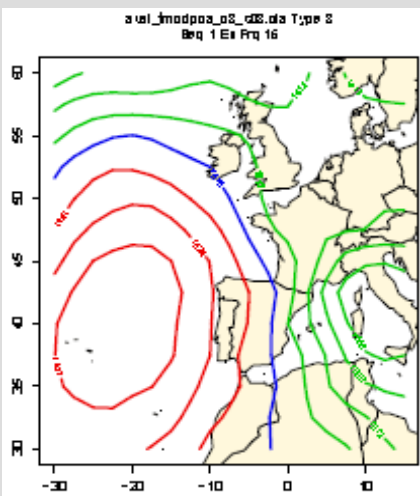→ Mainly human factors

(Esteban P, Beck C, Philipp A)

Antyciclonic conditions

↓

Northwesterly pattern

↓

North – Northeast pattern

↓

Antyciclonic conditions
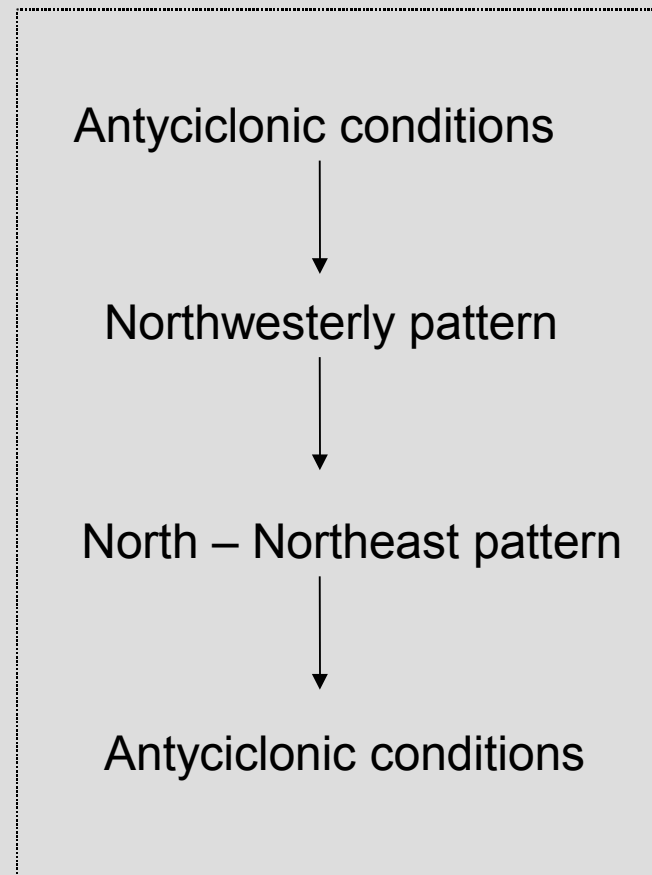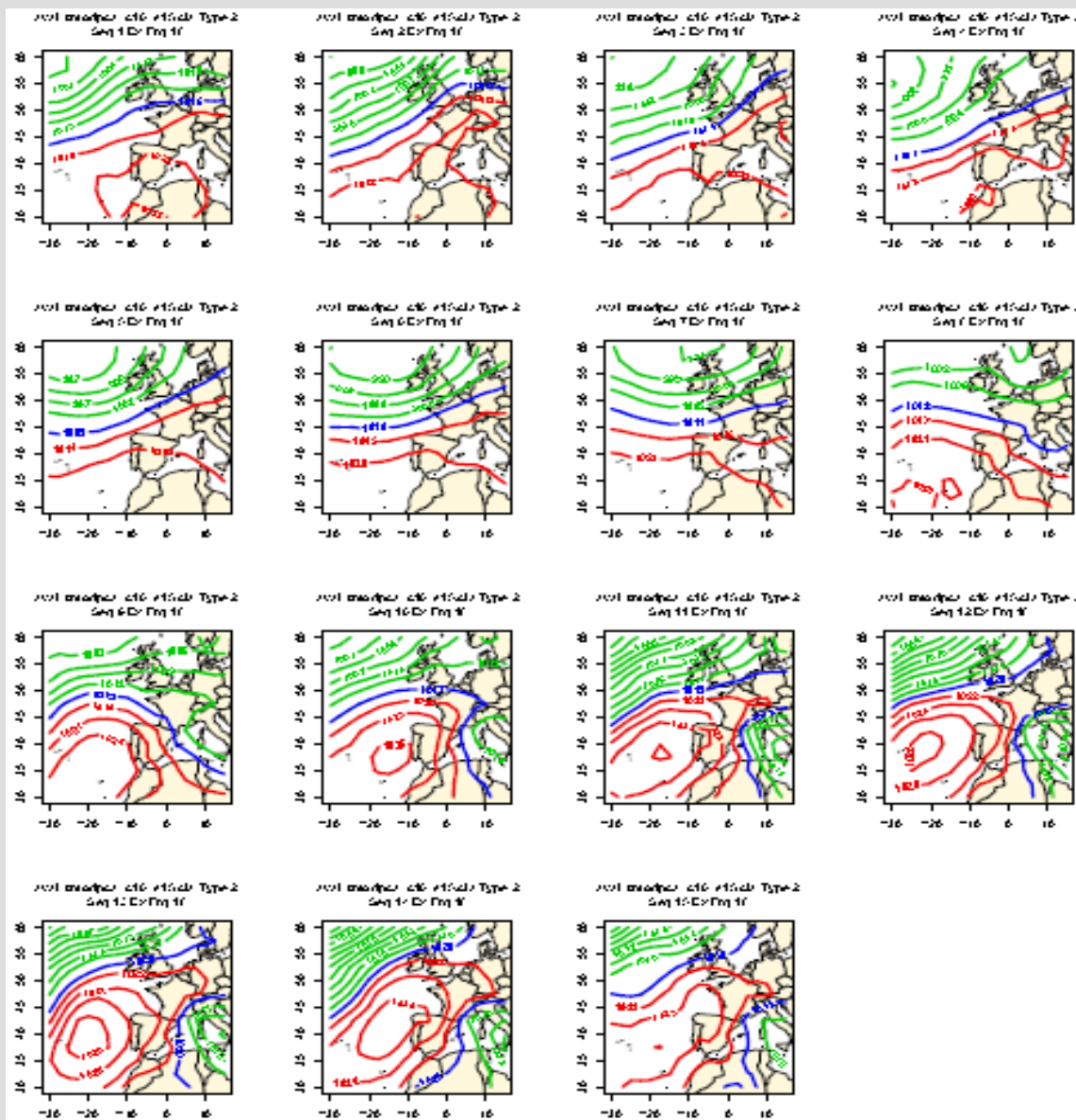
Circulation type sequences associated to accidental avalanches
NEW CATALOGUE ACTUALIZED TO 2010! → PCT and SAN
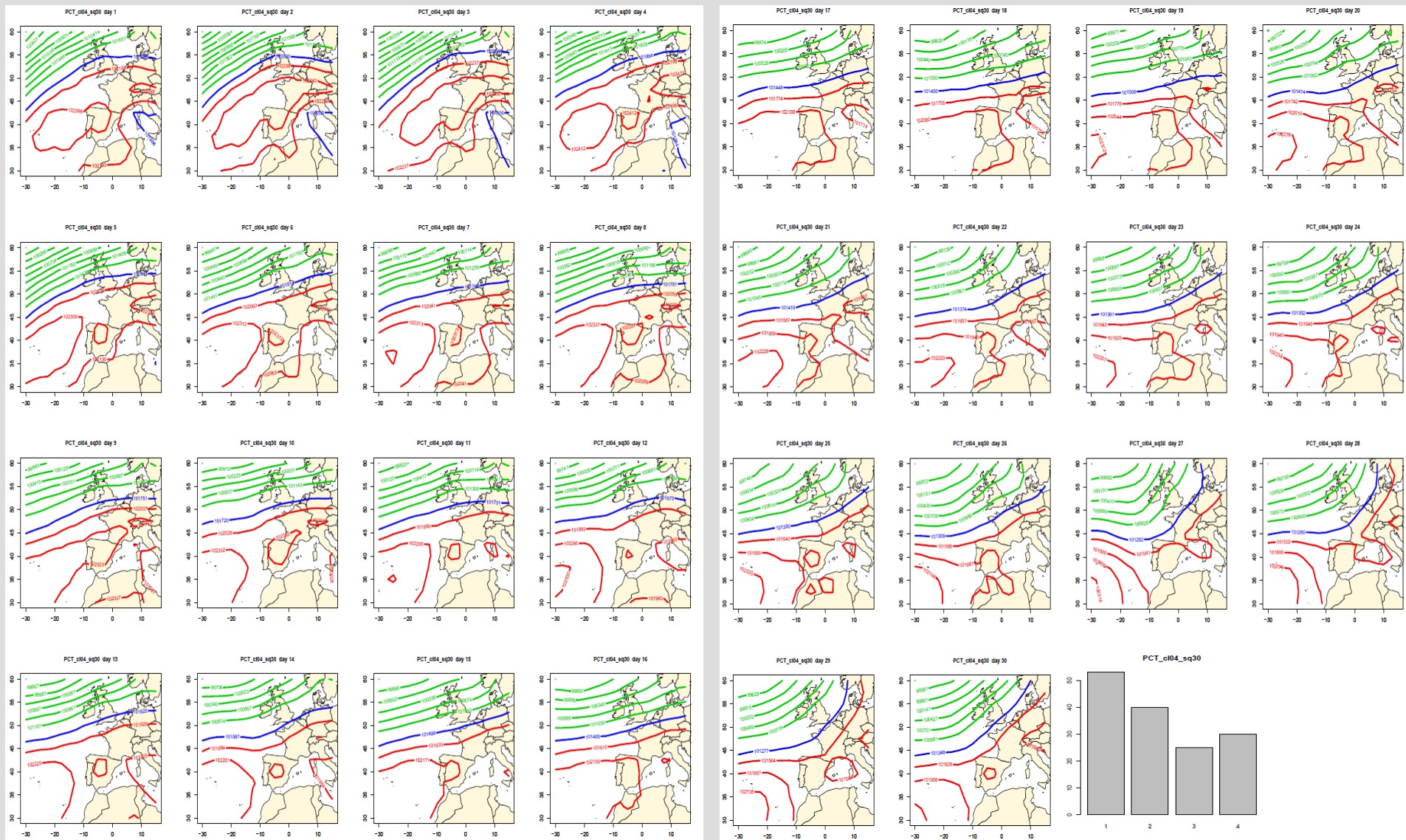
Circulation type sequences associated to accidental avalanches
NEW CATALOGUE ACTUALIZED TO 2010! → PCT and SAN

SOME CONCLUSIONS:

This is an on going work

We have to don't forget that avalanches and it's associated risk (natural and human factors) are complex study elements.

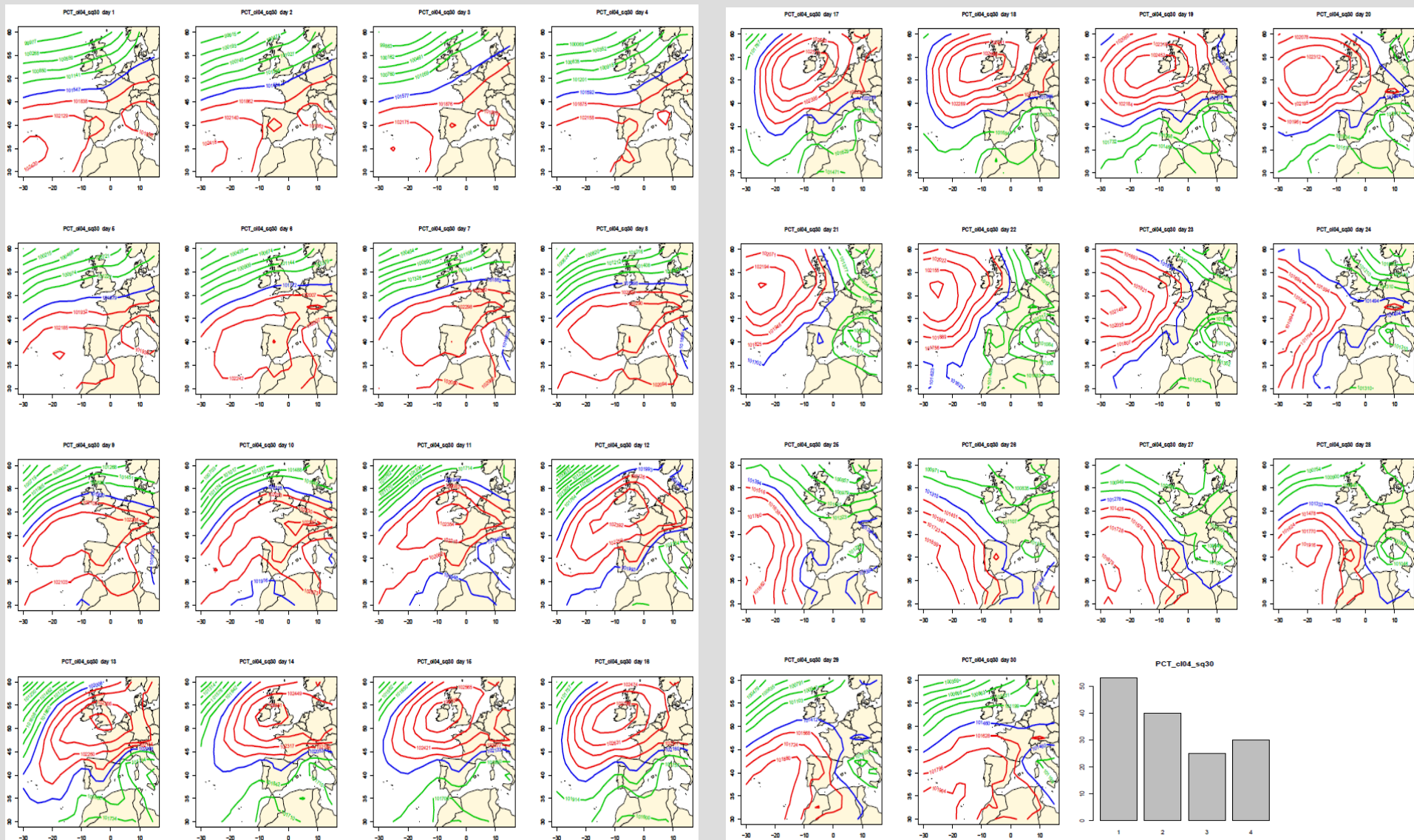The results helps us to advance in the understanding of the weather mecanisms related to snow and avalanches, including the snowpack evolution and the avalanche ocurrence in terms of weather sequences

Further research will focuse on:
a) Temporal evolution of the sequence: Is all the sequence relevant for the accident? Variability changes analysis (spatial and temporal)
b) Statistics / spatial distribution of accidents
c) Statistics of nivometeorological parameters (snowfalls, type of avalanche,...)
d) On deep "avalanche forecaster expert knowledge" analysis

The actual status of the results shows the capability of sequencing for representing well the variability of circulation types, permitting the coexistence of persistent patterns with other more dynamic ones.

THANK YOU!
and
CONGRATULATIONS!