Comparison between different methods to forecast snow events in a warm front in Catalonia: analyse of episodes

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Servei Meteorològic de Catalunya

Álvarez Manuel[1], Soler Xavi[1], Figuerola Francesc[1], Aran Montse[1], Gallego Sergio[1] , Vía Jordi[1]
[1]Meteorological Service of Catalonia (SMC), Barcelona, Spain
malvarez@meteo.cat

Generalitat de Catalunya
Departament de Territori i Sostenibilitat

INTRODUCTION

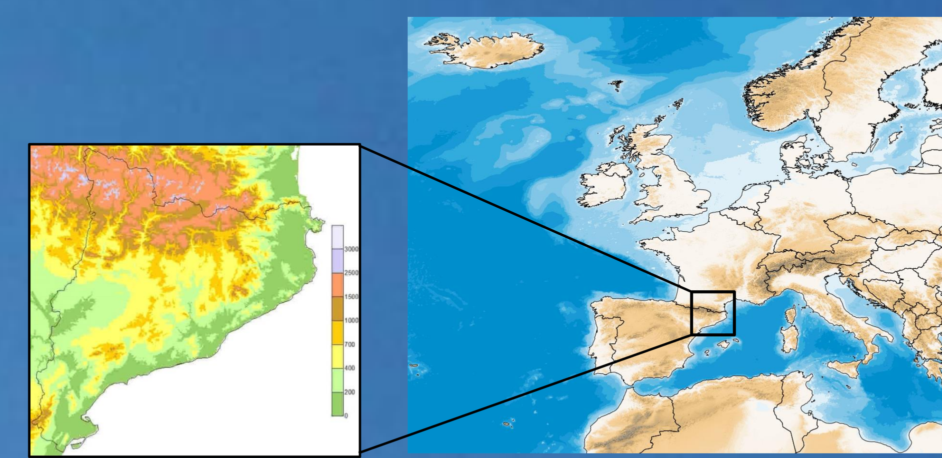
MAIN GOAL

Improve the calculation of the snow level line (SL) and determine which method works better in the different weather situations..

PREVIOUS WORK

- Asses the usage of the Wet Bulb Temperature (WBT) as an indicator to differentiate the atmospheric air masses leading to different types of precipitation.
- Evaluate three different methods aiming to obtain an accurate and improved snow level (SL) forecast

AREA OF STUDY



Altitude of Catalonia (m.a.s.l Fig. 1: Catalonia location

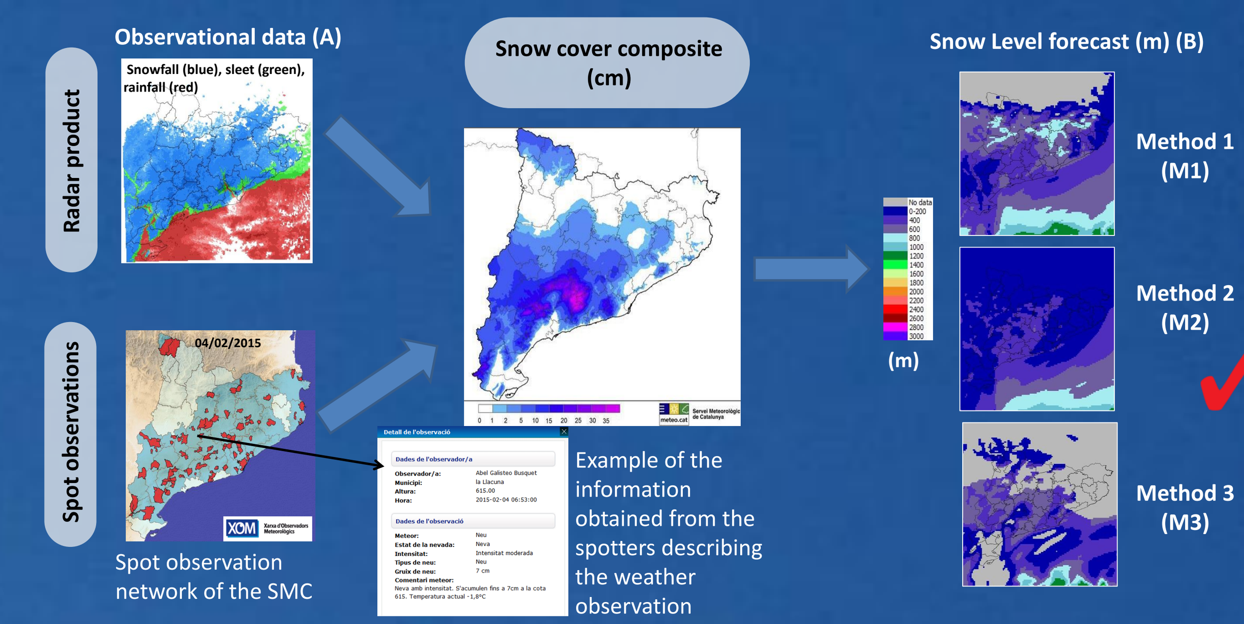
METHODOLOGY

3 methods are used to compared them in different synoptic situations.

Method 1 (M1): SL is defined using isozero altitude (m), and dropping 200m if HR>60%; and dropping 400m to the Wet Bulb Zero Level (WBZL) if HR<60%.

Method 2 (M2): SL is determined using the altitude (m) of the 1.5°C Wet Bulb Temperature (WBT1,5).

Method 3 (M3): SL is obtained from Lumb Curve (cooling by melting process is taken into account).



Validation scheme, comparison between spot observation network of the SMC (A) and the snow level forecast from the weather models (B):

A) Snow cover composite built up with observational data from radar products and spot observations.

B) Snow level line (SL) forecasted resulting from apply M1, M2 and M3

WEATHER SITUATIONS ANALYSIS

WARM FRONT

SYNOPTIC ANALYSIS

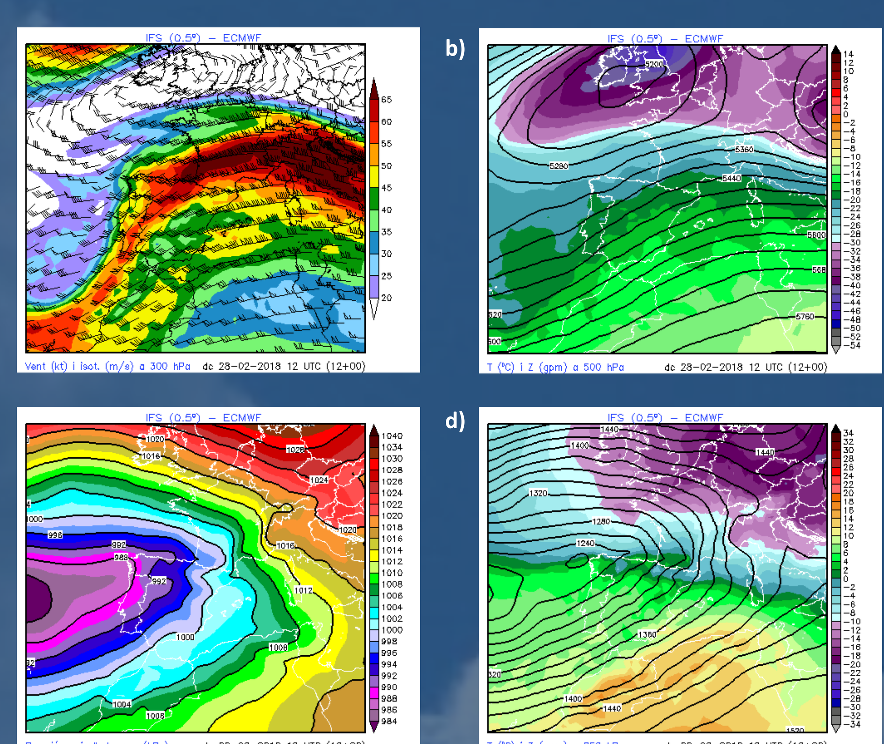


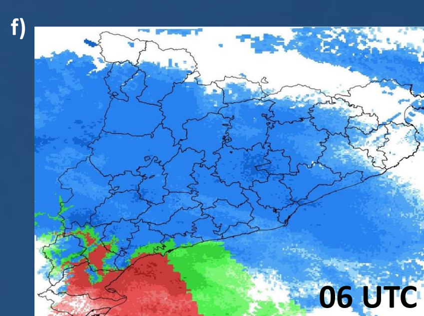
Figure. 2. a) Jetstream at 300hPa, **b)** T and geopotential at 500hPa, **c)** surface pressure, **d)** T and geopotential at 850 hPa.

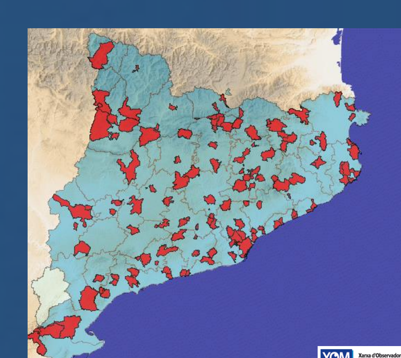
SPOT OBSERVATIONS

e)

WARM FRONT (28/02/2018)					
Observation data	**Snow observation**		**Snow level Forecast (m)**		
Hour	**Town**	**Altitude (m)**	**M1**	**M2**	**M3**
00 UTC	Alcoletge	220	150	150	0
01 UTC	Riudecanyes	200	200	200	0
04 UTC	Sunyer	200	0	0	0
05 UTC	Reus	130	200	0	0
05 UTC	St. Pol de Mar	0	0	0	0
05 UTC	Sabadell	150	0	0	0
06 UTC	Barcelona	0	100	100	100
17 UTC	Albanyà	730	1000	800	700
18 UTC	La Seu d'Urgell	690	1000	800	600
19 UTC	Bagà	860	1100	1050	1000

SL (m)	Error≤200	200<Error≤500	Error>500

f) 

g) 

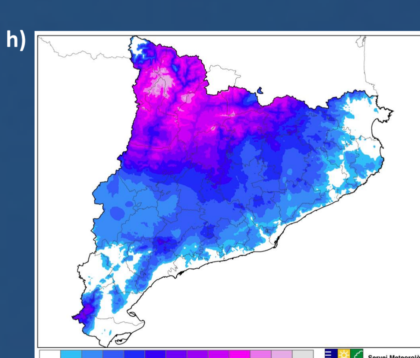
h) 

Figure. 3. e) Table with the error of each method compared with observations (only showed 10 of 309 spot observation), **f)** radar product is shown with an estimation of rain, sleet or snow; **g)** spot observations; **h)** snow depth.

COLD FRONT

SYNOPTIC ANALYSIS

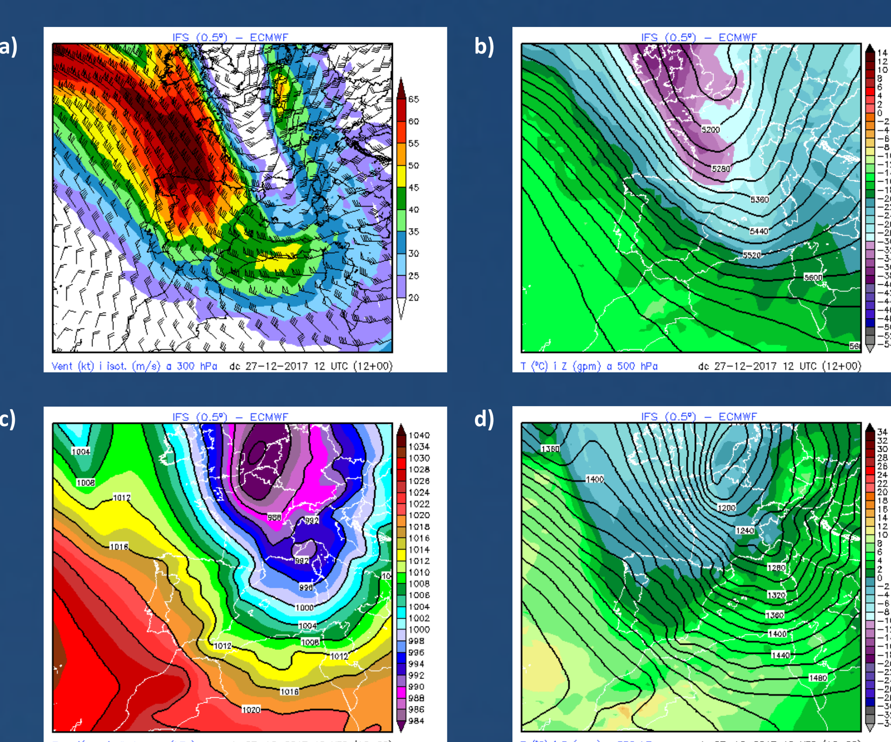


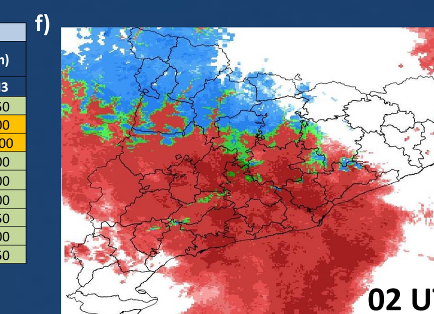
Figure. 4. a) Jetstream at 300hPa, **b)** T and geopotential at 500hPa, **c)** surface pressure, **d)** T and geopotential at 850 hPa

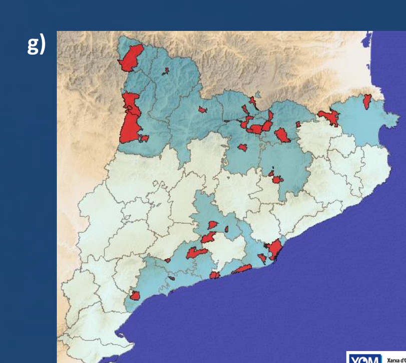
SPOT OBSERVATIONS

e)

COLD FRONT (27/12/2017)					
Observation data	**Snow observation**		**Snow level Forecast (m)**		
Hour	**Town**	**Altitude (m)**	**M1**	**M2**	**M3**
04 UTC	Tremp	468	600	500	550
02 UTC	la Seu d'Urgell	690	950	750	900
02 UTC	Muntanyola	944	800	500	1000
02 UTC	el Pont de Suert	840	850	800	800
17 UTC	Sant Julià de Cerdanyola	925	800	600	600
17 UTC	La Pobla de Lillet	873	700	600	700
17 UTC	la Seu d'Urgell	690	700	600	550
18 UTC	Albanyà	730	800	600	600
18 UTC	Ripoll	691	800	600	650

SL (m)	Error≤200	200<Error≤500	Error>500

f) 

g) 

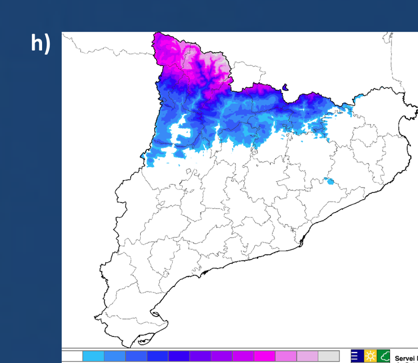
h) 

Figure. 5. e) Table with the error of each method compared with observations (only showed 9 of 53 spot observation), **f)** radar product is shown with an estimation of rain, sleet or snow; **g)** spot observations; **h)** snow depth.

OCCLUDED FRONT

SYNOPTIC ANALYSIS

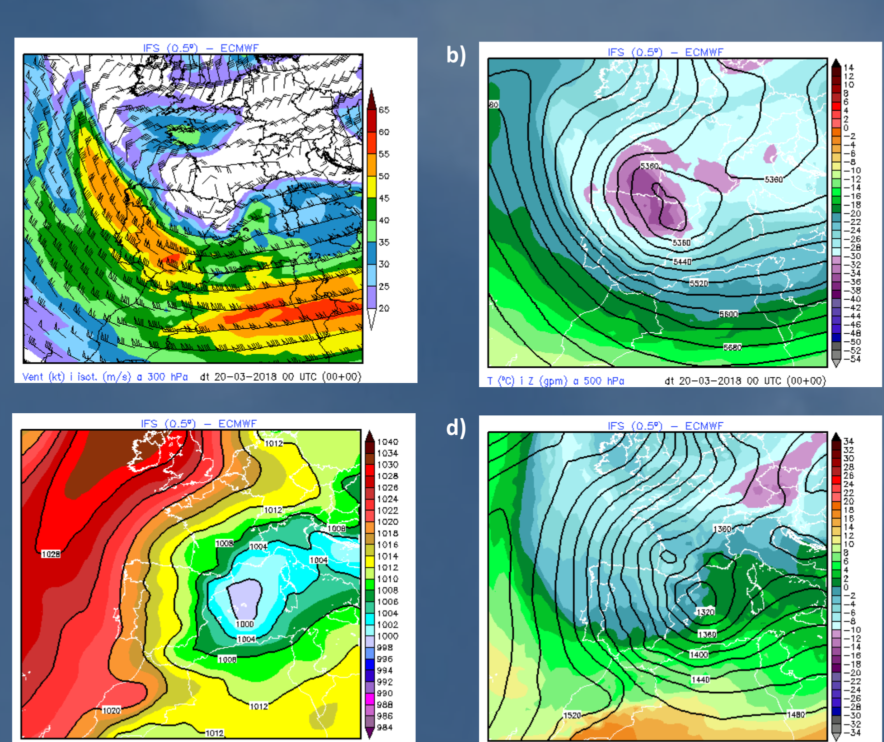


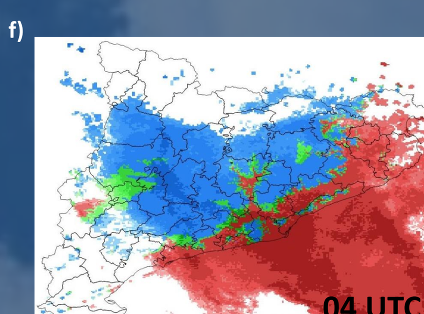
Figure. 6. a) Jetstream at 300hPa, **b)** T and geopotential at 500hPa, **c)** surface pressure, **d)** T and geopotential at 850 hPa.

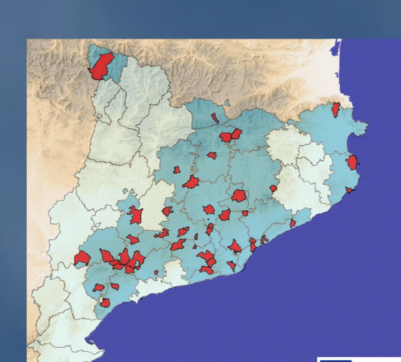
SPOT OBSERVATIONS

e)

OCCLUDED FRONT (20/03/2018)					
Observation data	**Snow observation**		**Snow level Forecast (m)**		
Hour	**Town**	**Altitude (m)**	**M1**	**M2**	**M3**
00 UTC	Cardona	500	500	500	500
01 UTC	Igualada	330	400	400	200
02 UTC	Tàrrega	380	200	100	100
03 UTC	Sant Fost de C.	250	400	400	250
04 UTC	St. Cugat del V.	80	400	300	400
05 UTC	Badalona	100	400	250	100
05 UTC	Teià	150	400	150	100
05 UTC	Barcelona	10	400	250	200
06 UTC	Olivella	150	250	200	200
06 UTC	Vilassar de Dalt	200	600	100	200

SL (m)	Error≤200	200<Error≤500	Error>500

f) 

g) 

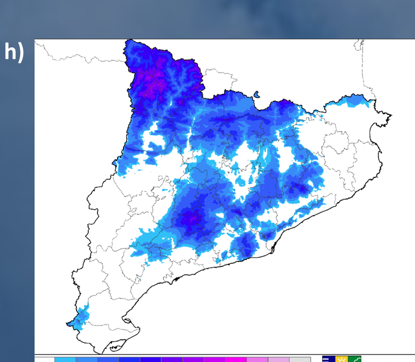
h) 

Figure. 7. e) Table with the error of each method compared with observations (only showed 10 of 83 spot observation), **f)** radar product is shown with an estimation of rain, sleet or snow; **g)** spot observations; **h)** snow depth.

CONVECTION

SYNOPTIC ANALYSIS

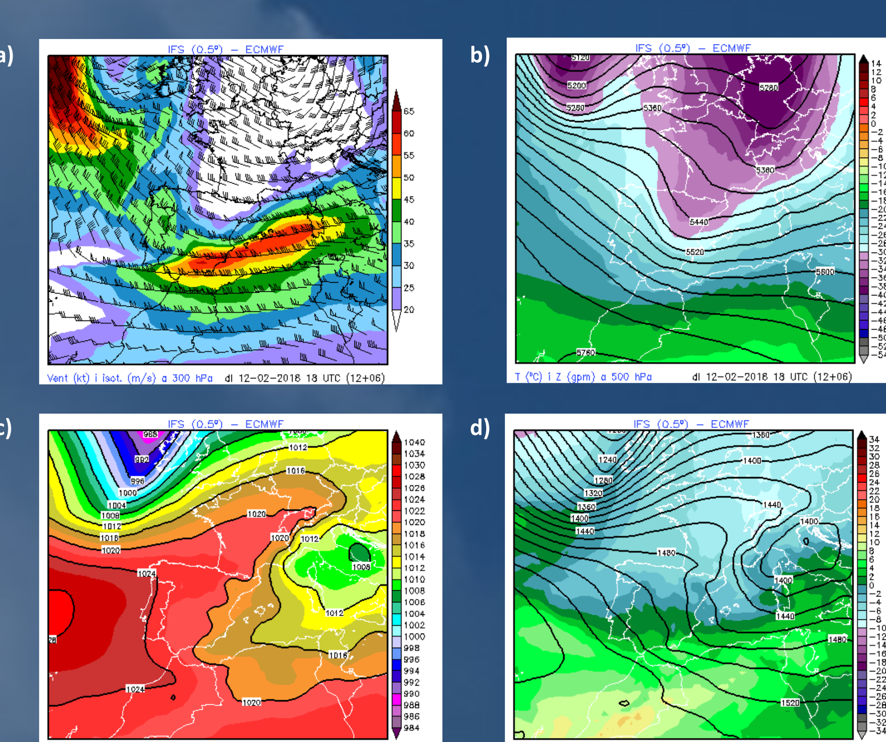


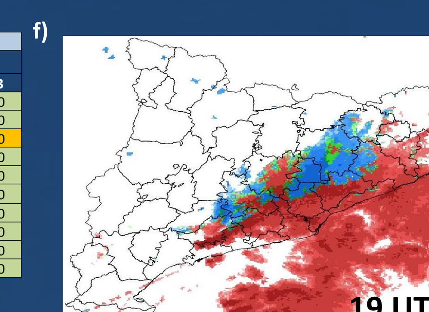
Figure. 8. a) Jetstream at 300hPa, **b)** T and geopotential at 500hPa, **c)** surface pressure, **d)** T and geopotential at 850 hPa

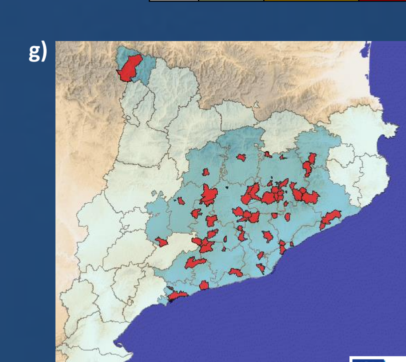
SPOT OBSERVATIONS

e)

CONVECTION (12/02/2018)					
Observation data	**Snow observation**		**Snow level Forecast (m)**		
Hour	**Town**	**Altitude (m)**	**M1**	**M2**	**M3**
15 UTC	Solsona	750	850	700	750
16 UTC	Arbúcies	300	700	500	200
16 UTC	Guissona	500	900	800	800
17 UTC	Avinyó	300	800	800	400
17 UTC	Vic	490	750	800	300
19 UTC	el Pont de Vilomara	350	600	300	300
19 UTC	Igualada	330	700	600	200
20 UTC	Sabadell	156	400	200	200
20 UTC	la Garriga	250	400	200	200
20 UTC	Badalona	70	500	300	100

SL (m)	Error≤200	200<Error≤500	Error>500

f) 

g) 

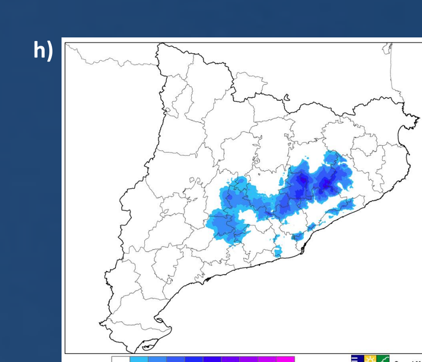
h) 

Figure. 9. e) Table with the error of each method compared with observations (only showed 10 of 95 spot observation); **f)** radar product is shown with an estimation of rain, sleet or snow; **g)** spot observations; **h)** snow depth.

CONCLUSIONS

This work evaluates three different powerful methods to forecast the snow level line (SL) comparing to observational data in different synoptic weather situations.

- ✓ In warm front, models have a good response in general. However, models have some troubles in the valleys oriented to south when warm air arrives because of topography. In this event, M2 and M3 offer a better forecast. Independently, according to Kain et al. (2000) in cases with strong low-level temperature advection, M3 could drop more the snow level line than the observed.
- ✓ There are no significant differences between the methods in a cold front. All of them estimate precisely the snow level line, but there is a tendency to underestimate the SL in the leeward side of the Pyrenees, especially M1 and M3 if precipitation jumps to the south slope. This situations usually occurs when the Jetstream is perpendicular to the mountain range.
- ✓ The case of the occluded front is complex. The big challenge to this situations is interpret the isotherm layer created by the melting process, especially in the north-west quadrant of the cyclone. This episodes seem to be well-considered by M3 and M2, specially if precipitation is well forecasted.
- ✓ There are no doubts that in convection weather, the cold air is fallen down to lower altitudes. Numerical models have some difficulties to describe the cooling due to melting process. In this case, this phenomenon is well forecasted by M3, and by M2 if the method is complemented with the radiosonde forecasted (in order to see if an isotherm stratum exists).

FUTURE WORK

- Going on building a bigger data base in order to obtain a precise method to estimate snow level line.
- Further research on the different meteorological parameters characterizing the dry and wet snowfall to achieve a better forecast for the snow accumulation rate.
- Try to implement a procedure that would take into account the best method in each situation.

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For **more information** about this work, see this **video:**