Hiking accidents and strong northerly winds over Mediterranean Pyrenees

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Geographical Features (1)

Pallars-Aran Massif (3000 m a.s.l)

Eastern Pyrenees (2900 m a.s.l)

Montseny Massif (1700 m a.s.l)

Catalonian Pyrenees

Mediterranean Sea

Barcelona

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Cases (1)

In some cases, there is uncertainty in exact date, altitude and location. Sources: Newspapers, village councils, people’s memory, etc.

0) XIX century. *Noucreus* (2800 m a.s.l.). 9 hikers died.
2) 6 March 1944. *Matagalls* (1400 m). 2 skiers died.
7) 4 November 1984. *Puigmal* (2900 m). 1 hiker died. (SW flow)
Cases (2)

Geographical distribution

Cases 0, 3, 4, 5, 6, 7, 8, 9, and 10: Nuria Mountains (Mediterranean Pyrenees). (9 events). Case 1: Moixeró Range (Mediterranean Pyrenees).

Case 11: Aran Valley. Central Pyrenees.
Case 2: Montseny massif. Coastal Ranges.

Monthly and seasonal distribution

November: 2 cases (5 and 7)
December: 4 cases (3, 6, 8 and 10)
January: 0 cases
February: 2 cases (1 and 11)
March: 2 cases (2 and 4)
April: 1 case (9)

Autumn: 2 cases.
Winter: 8 cases.
Spring: 1 case.
Unknown: 1 case.
Cases (3)

Geographical and seasonal distribution

Some determining factors:

Social:
- High number of visitors (easy access with train): Nuria Mountains.
- Nearness to a very populated area (Barcelona).
- Period of holidays (December: Christmas).

Orographical:
- Mountain form and vegetation: Nuria Mountains are soft and rounded but high mountains. Easy hiking. Itineraries over timberline. Alpine meadows.

Meteorological:
- Corner effect in Mediterranean Pyrenees. Frequent winter sudden and strong northerly winds. Strong northerly and westerly winds also affects Montseny massif.
Geographical Features (2)

Nuria Mountains

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Geographical Features (3)

Cases 3 and 4: Freser Gorges

(Taken from 2100 m a.s.l. October)

Planell (*little plain*) de les Eugues 2000 m

Mountain hut

Path

Path

R. Pascual

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Geographical Features (4)

Case 6: Torreneules Massif

(Taken from 1200 m a.s.l. April)

Accident Torreneules 2711 m

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Geographical Features (5)

Case 7: Puigmal Massif

(Taken from 2400 m a.s.l. Autumn)

Puigmal 2910 m

Ll. Catasús

Puigmal 2910 m

Path

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Geographical Features (6)

Case 9: Canigó Massif

(Taken from 2400 m a.s.l. February) R. Pascual (Taken from 2465 m a.s.l. January 07!!) R. Pascual

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Accidents characteristics

Probable cause of death:

- Hypothermia
- Fall in a mountain stream (drowned and/or subsequent hypothermia).
- Fall (contusions and/or subsequent hypothermia).
- Avalanche (contusions, hypothermia and/or asphyxiation).

Probable cause of accident:

- Poor visibility conditions  →  Disorientation, loss, slip, fall
- Strong winds
- Freezing temperatures  →  Hypothermia, slip, fall

- Change in surface conditions  →  Slip, fall
- Change in snow cover stability  →  Avalanche
Weather conditions (1)

General conditions (Estimated from evidence survivors, newspapers, NCEP and ECMWF reanalysis, scarce observations):

- Rapidly changing conditions.
- Sometimes cloudy or overcast sky.
- Snowfall during accident and/or previous days (fresh, loose snow).
- Low or very low temperatures.
- Strong or very strong winds.
- Extremely low wind chill temperatures.
- Poor visibility because snowfall and/or blowing snow.
- Whiteout conditions.

Hazardous weather conditions comparable to blizzard or ground blizzard.

Local name: Torb
## Weather conditions (2)

### Estimated values of some important variables

<table>
<thead>
<tr>
<th>Case</th>
<th>Temp. (ºC)</th>
<th>Wind Chill (ºC)</th>
<th>300 hPa W (m/s)</th>
<th>700 hPa W (m/s)</th>
<th>850 hPa W (m/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (Feb.)</td>
<td>-10 /-12</td>
<td>-23 /-27</td>
<td>-----------------</td>
<td>-----------------</td>
<td>(NE, SFC)</td>
</tr>
<tr>
<td>2 (Mar.)</td>
<td>-5 /-10</td>
<td>----------------</td>
<td>-----------------</td>
<td>-----------------</td>
<td>(NE, SFC)</td>
</tr>
<tr>
<td>3 (Dec.)</td>
<td>-8 /-11</td>
<td>-20 /-22</td>
<td>53 (NNW)</td>
<td>21 (NW)</td>
<td>14 (NW)</td>
</tr>
<tr>
<td>4 (Mar.)</td>
<td>-1 /-7</td>
<td>-9 /-17</td>
<td>45 (WSW)</td>
<td>20 (W)</td>
<td>10 (W)</td>
</tr>
<tr>
<td>5 (Nov.)</td>
<td>-10</td>
<td>-23</td>
<td>60 (N)</td>
<td>28 (N)</td>
<td>30 (N)</td>
</tr>
<tr>
<td>6 (Dec.)</td>
<td>-4 /-7</td>
<td>-16 /-19</td>
<td>65 (NNW)</td>
<td>40 (NNW)</td>
<td>23 (NW)</td>
</tr>
<tr>
<td>7 (Nov.)</td>
<td>-4</td>
<td>-12</td>
<td>31 (S)</td>
<td>23 (S)</td>
<td>14 (S)</td>
</tr>
<tr>
<td>8 (Dec.)</td>
<td>-14</td>
<td>-27</td>
<td>56 (WNW)</td>
<td>21 (NNW)</td>
<td>24 (N)</td>
</tr>
<tr>
<td>9 (Apr.)</td>
<td>-5 /-14</td>
<td>-14 /-28</td>
<td>54 (NE)</td>
<td>27 (N)</td>
<td>25 (N)</td>
</tr>
<tr>
<td>10 (Dec.)</td>
<td>-4 (-7)</td>
<td>-14 (-19)</td>
<td>60 (NNW)</td>
<td>24 (N)</td>
<td>27 (N)</td>
</tr>
<tr>
<td>11 (Feb.)</td>
<td>-8 /-13</td>
<td>-21 /-28</td>
<td>50 (N)</td>
<td>20 (NNE)</td>
<td>15 (NE)</td>
</tr>
</tbody>
</table>

### Event Maximum

- > 20 m/s
- > 40 m/s

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Synoptic Features (1)

Synoptic situation:

Cold and dry advection. Rapid change of airmass characteristics.

1. Northerly/northeasterly (continental) advection. Cold front ?
2. Northeasterly (continental) adv. Cold front ?
3. Northerly adv. Cold front: NE to SW.
4. Northerly adv. Cold front: N to S.
5. Northerly adv. Cold front: NW to SE.
7. Southwesterly adv. (warm/wet adv.). Cold front: W to E.
8. Northerly adv. Cold front: N to S.
10. Northerly/northeasterly (continental) adv. Warm&cold front: N to S.
11. Northeasterly (continental) adv. Cold front: N to S.
Synoptic Features (2)

Synoptic Features (3)

700 hPa. Z and T. Cases: 7, 8, 9 and 10.

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Synoptic Features (4)

Synoptic Features (5)

850 hPa. Z and T. Cases: 7, 8, 9 and 10.
Synoptic Features (6)

Cyclones Tracks (500 hPa, SLP). Events.

Map: ECMWF

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Synoptic Features (7)
Cyclones Tracks (500 hPa, SLP). Events.

General characteristics: Frequent *Mediterranean* cyclogenesis.

Special cases:


1986: *Algerian* Cyclogenesis.

1992: *North Sea low* with fast Southward displacement.

2000: Very fast eastward moving *Atlantic-Iberian* low.
Mesoscale Features (1)

With northerly synoptic flow over Pyrenees:

- Mesoscale pressure field deformation (≤ 850 hPa).
- Generation of enhanced regional wind: Tramontane.
- New air mass cold and dry with upstream blocking in the north side of the Pyrenees.
- Strong temperature/humidity gradient across the Pyrenees.
- Probably density current development affecting Mediterranean Pyrenees.
- Complex orography implies local wind acceleration in favourable places.
Mesoscale Features (2)

700 hPa. V. Cases: 3, 4, 5 and 6.
Mesoscale Features (3)

700 hPa. V. Cases: 7, 8, 9 and 10.
Mesoscale Features (4)

850 hPa. V. Cases: 3, 4, 5 and 6.
Mesoscale Features (5)

850 hPa. V. Cases: 7, 8, 9 and 10.

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Mesoscale Features (6)

Vertical velocity:

- Cases 3, 4, 5, 6, 8, 9, 10 and 11 show dry air subsiding over the Pyrenees both at 700 hPa and 850 hPa.
- Case 7 (SW flow) shows light upward motion.

Specific humidity and vertical velocity. 26 Nov 1978 @ 18 UTC

Maximum downward motion

Dry air
Climatic context (1)

Objective: To compare atmospheric conditions between the selected days with “normal” conditions.


Variables analysed: Z@500 hPa, T@300, 500, 700, 850 hPa, SLP, Flow direction@ 500, SFC. Source: ERA-40 ECMWF.
Climatic context (2)

Temperature time series over the Pyrenees

Cold period: 1967-71(73)
Identifiable in 4 levels and 3 dates.

T850 Vs T700: good correlation.
Pearson’s corr. ≥ 0.8

Coldest date: 15 Feb.
Warmest date: 31 March.
Climatic context (3)

Climatological synoptic patterns over Pyrenees

More frequent patterns (≥ 10 %):

1: Strong westerly flow (cyclonic)
2: Strong westerly flow (anticyclonic)
4: Northerly advection
5: Northeasterly (European) advection
10: Centred cold low
11: Centred dynamic anticyclone

≥ 30 %
Climatic context (4)

Normal Flow direction over Pyrenees

500 hPa. Higher frequency (3 dates): Flow from 4 and 3 (W/NW; S/SW).
SFC. Higher frequency: Flow from 4 and 1 (W/NW; N/NE) (Dec.)
Flow from 1 and 4 (Feb., Mar.)

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Climatic context (5)

Flow direction Vs Temperature

<table>
<thead>
<tr>
<th></th>
<th>T300 (° C)</th>
<th>T500 (° C)</th>
<th>T700 (° C)</th>
<th>T850 (° C)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>31 DEC</strong></td>
<td>-49.5/ -47.3</td>
<td>-23.0/ -20.9</td>
<td>-7.5/ -5.6</td>
<td>-0.8/ 2.9</td>
</tr>
<tr>
<td>NE/NW</td>
<td>31 DEC MEAN</td>
<td>-48.7</td>
<td>-21.7</td>
<td>-5.3</td>
</tr>
<tr>
<td><strong>15 FEB</strong></td>
<td>-50.5/ -52.0</td>
<td>-22.2/ -21.0</td>
<td>-11.0/ -7.5</td>
<td>-2.5/ 1.5</td>
</tr>
<tr>
<td>NE/NW</td>
<td>15 FEB MEAN</td>
<td>-50.1</td>
<td>-21.8</td>
<td>-7.7</td>
</tr>
<tr>
<td><strong>31 MAR</strong></td>
<td>-49.2/ -46.3</td>
<td>-25.1/ -19.3</td>
<td>-9.3/ -2.7</td>
<td>-0.2/ 5.3</td>
</tr>
<tr>
<td>NE/NW</td>
<td>31 MAR MEAN</td>
<td>-48.4</td>
<td>-21.8</td>
<td>-5.2</td>
</tr>
</tbody>
</table>

Flow from 1(N/NE): Temperature < mean in all levels and dates.
Flow from 4(W/NW): Depending on actual configuration (airmass).

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Climatic context (6)

Temperature over Pyrenees: Events vs 40 years reanalysis, Monthly means. Mean from November to April.

Events temperature < mean

Exception: Case 7@1984. SW advection.

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Climatic context (7)

Geographical location of low centers (SL). 30 years.

- 31 DEC: 27 centers
  - North Atlantic lows.
- 31 DEC: 10 centers
  - Mediterranean lows
- 15 FEB: 9 centers
- 3 dates: 29 centers

Map: ECMWF

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Climatic context (8)

L and H centers location (SL). Northerly flow. 30 years.
Climatic context (9)

L and H centers location (SL). Events.
Climatic context (10)

L and H centers location (500 hPa). Northerly flow. 30 years.
Climatic context (11)

Low and high centers location (500). Events.

Map: ECMWF

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Mitigation measures

Knowledge of geographical features, accidents characteristics and climatological aspects suggests some mitigation measures to risk reduction:

• More accurate local forecasts and warnings for Mediterranean Pyrenees when northerly synoptic flow it is forecasted.

• Forecasts and warnings should be easy accessible at mountain resorts, tourism offices, etc.

• Local forecasts and warnings should contain explanations about expected environmental conditions as a whole, not only atmospheric elements.

• Education should be improved about mountain meteorology, specifically for mountaineers and visitors to risk areas.

• It should be stressed that environmental conditions can change very rapidly and rise to very dangerous levels.
Thank you for your attention

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