INTRODUCTION

CERDANYA VALLEY

The largest of the Pyrenees (35 km x 15 km)

- NE-SW orientation.
- Bounded by Pyrenees main axis (peaks > 2900 m asl) to the north and the Cadi mountain range (maximum height 2913 m asl) to the south.
- Valley bottom (1000 m asl) covered by grass and pastures, forests of conifers (southern slopes) and alpine pastures (northern side).
- Smaller tributary valleys oriented in the N-S direction.

OBSERVATIONS

Source: 6 AWS (fig 2):
- 3 AWS along the main valley axis:
  - Martín (MR): Valley end, narrow (1038 m asl).
  - Das (DA): wide + flat area (1097 m asl).
  - St. Lúcia (SL): Valley head (1320 m asl).
- 1 AWS at the upper part of a tributary valley (south-east of DA).
- Llã Molina (LM1, LM2, LM3): Valley bottom (1704 m asl).
- 2 AWS at valley crests:
  - Cadi Nord (CN): South (2143 m asl).
  - Molina (ML): north (2230 m asl).

Variables: Temperature (T), relative humidity (RH) at 1.5 m, wind speed (WS) and wind direction (WD) at 10 m height (6 m for ML) + insolación (Q) at DA.

- Statistical data show a valley regime with a diurnal cycle within the Cerdanya valley.
- Large amplitudes of T at the valley floor (MR, DA), smaller at the valleys head (SL) and smallest at valley crests (CN, ML).
- DA attains the lowest T and RH and SL measures the highest. A small hill between DA and MR blocks the down-valley flow, favoring a more intense cooling at this part of the valley floor (see next section).
- Nocturnal cooling rate is much larger at the valley floor.
- Steady down-valley winds at DA, while the nocturnal wind turns at the valley end (MR) and head (SL) due to other valleys’ influence.
- LM reflects the dynamics of down-valley at night and up-valley at the beginning of daylight.
- At high-altitudes (CN, ML), westerly wind has an in-out/valley component at night (day).
- Wind speed is minimum during the night-day transition regime for all stations.

COLD AIR POOL (CAP) STATISTICS

Period: 01/09/2010 — 31/08/2014

- CAP definition: Temperature difference between DA and SL must be below −3 K during at least 2 h.

- 59% of the nights with daily CAPs.
- Daily CAPs persist more than 5 h in January.
- Wind speed is low within the CAP.
- Wind direction is down-valley often perturbed with drainage flows from southern tributary valleys.

VERIFICATION AGAINST AWS: 1.5-m TEMPERATURE

- Simulation (dashed lines) is not able to reproduce the observed extreme values within the CAP (MR and DA). Differences ≤ 6 K.
- Results more accurate at the head valley (SL) and at the mountain crests.

VERIFICATION AGAINST SATELLITE

- On average, simulated surface temperature field matches with MODIS satellite observations.
- Generally, MODIS product gives higher values than the model, specially at the mountain peaks.

CONCLUSIONS

- A recurrent daily cold pool develops over the Cerdanya valley, which has been studied statistically through 4-year time series from 6 AWS distributed around the area.
- Drainage flows from tributary valleys disturb the down-valley regime, providing local singularities.
- A mesoscale simulation is able to reproduce the general features of valley wind circulations and cold air pool formation, but shows limitations in reproducing the cold pool strength.

Further Work: Analysis of the experimental campaign performed in October 2015, which provided vertical profiles of atmospheric variables and surface energy budget terms at DA.

Statistical Diurnal Cycle

Selection of stable nights. A filter is applied to DA time series to select those cases with clear skies and weak synoptic pressure gradients (Martínez et al., 2008). Indexes’ thresholds have been adapted to valley dynamics. Only days from March to October are considered to avoid snow events. The filtered dataset contains 163 days from a total of 980 (1%).

Mesoscale Simulation

Meso-NH model (Laforte et al., 1998) with two nested domains.
- Horizontal resolution: 2 km and 400 m.
- Vertical resolution: 3 m close to the ground and 8 m at 500 m height.
- Initial and lateral boundary conditions: ECMWF analysis every 6 h. One way nesting for domain 2.

- The simulated temperature fields at the surface and at 1.5 m are decomposed in three terms (Lundquist et al., 2008; Martínez et al., 2010):
  \[ T_{surf} = T_1 + T_2 + T_3 \]
  - Local spatial deviation term (3), used to illustrate the evolution of those areas with a stronger cooling.
  - Two CAPs form at the beginning of the night. Upper-valley CAP forms first and is colder.
  - Both CAPs merge when their depths overtake the small hill between them.

- Streamlines at the valley floor show the influence of tributary valleys (northern tributaries at MR, and southern tributaries at DA and SL) that disturb the down-valley regime.

- A 48-h long case study (12 UTC 30/09/2011 – 12 UTC 02/10/2011) is selected from the list of 163 days. Observations reflect a similar pattern to the statistics, with wind speeds generally very strong during CAP conditions.

References

Martínez et al. (2008). Bounded by Pyrenees main axis (peaks > 2900 m asl) to the north and the Cadi mountain range (maximum height 2913 m asl) to the south.

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