

Observations of an elevated rotor and precipitation processes decoupled during a mountain wave event in the Eastern Pyrenees (Cerdanya-2017 Field Experiment)



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References:

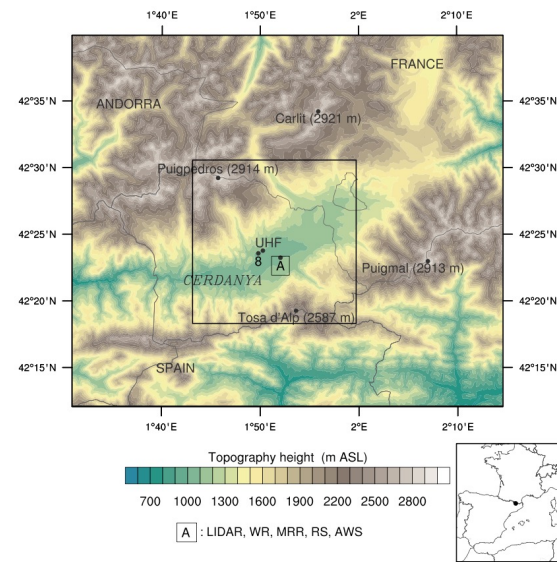
- Udina, M., Bech, J., Gonzalez, S., Soler, M. R., Paci, A., Miró, J. R., ... & Pineda, N. (2020). **Multi-sensor observations of an elevated rotor during a mountain wave event in the Eastern Pyrenees.** *Atmospheric Research*, 234, 104698. <https://doi.org/10.1016/j.atmosres.2019.104698>
- Gonzalez, S., Bech, J., Udina, M., Codina, B., Paci, A., & Trapero, L. (2019). **Decoupling between precipitation processes and mountain wave induced circulations observed with a vertically pointing K-band doppler radar.** *Remote Sensing*, 11(9), 1034. <https://doi.org/10.3390/rs11091034>

Area of study and observing network

The Pyrenees: a W to E oriented mountain range
Cerdanya valley unique oriented ENE-WSW:

- 15 km wide, flat bottomed
- Valley floor at 1000 m asl
- Summits exceeding 2900 m asl

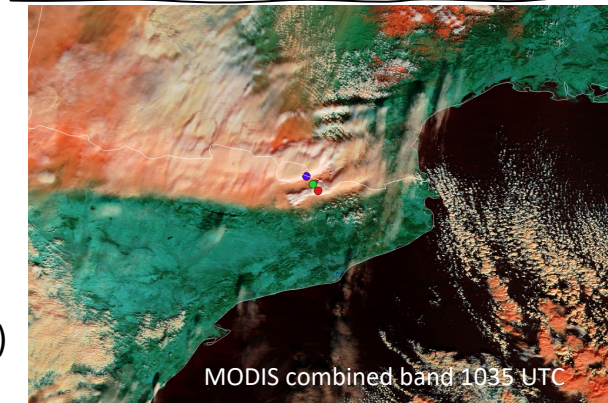
Rotors are likely to be generated in association with mountain waves over the valley (Udina et al., 2017, MWR)



The Cerdanya-2017 field experiment instrumentation

- Scanning Doppler wind lidar (LIDAR)
- Wind Radio Acoustic Sounding System (WR)
- Micro rain radar (MRR)
- Parsivel disrometer
- Atmospheric soundings (RS)
- Eddy covariance station (ECS)
- Automatic weather surface station (AWS)
- Ultra-high frequency wind profiler (UHF)

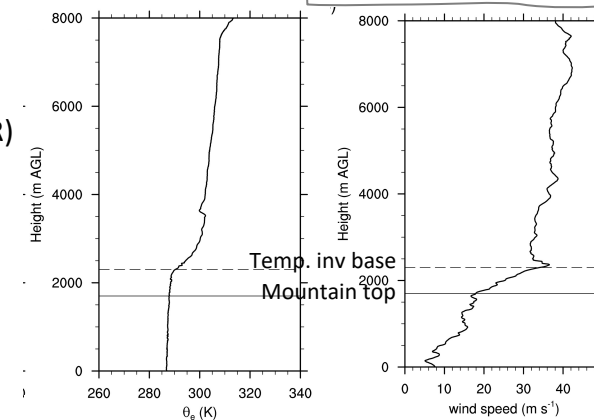
Episode 15 January 2017: mountain waves and strong precipitation



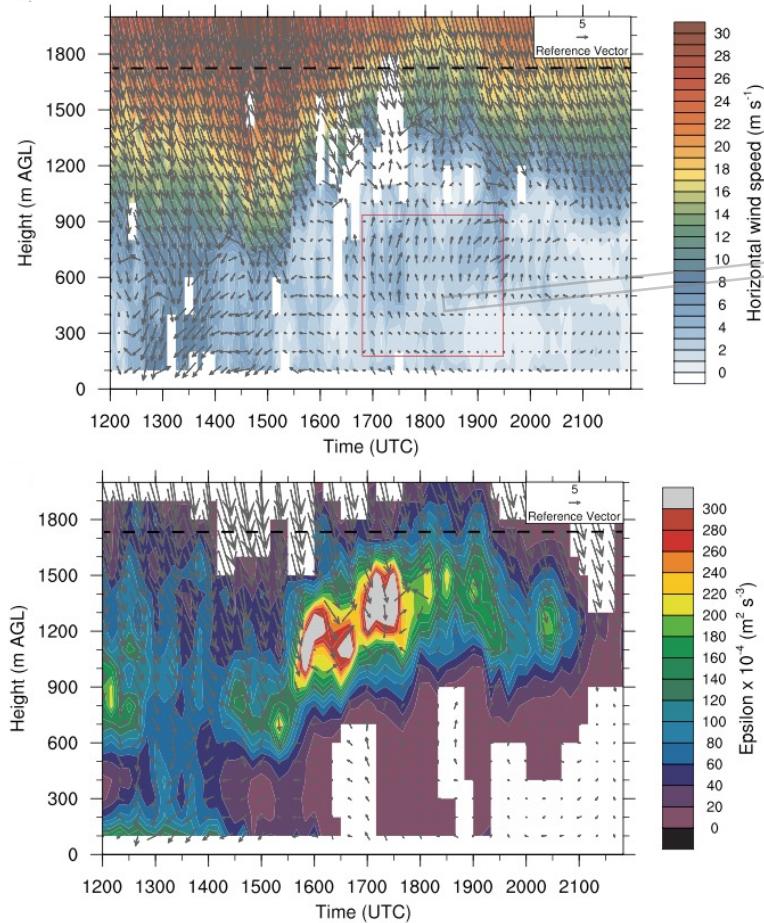
- UHF location

Well mixed boundary layer capped by a temperature inversion at 2400 m agl. Large positive wind shear -> Conditions favourable for **trapped lee waves** formation from the crestline (1700 m agl) up to 2400 m agl. Above 2400 m agl: **vertically propagating waves**, reaching the upper middle troposphere, visible through WV satellite imagery

RS measurements



Wind profiler (UHF) evolution



- Southern wind component during 2 hours between 150 to 850 m agl, indicating wind reversal, suggesting the formation of a **rotor**
- TKE dissipation** rate (epsilon) is maximum at the upper part of the rotor, along the upstream edge of the first lee wave (as in previous studies: Doyle and Durran 2002)

Mountain waves and rotor structure

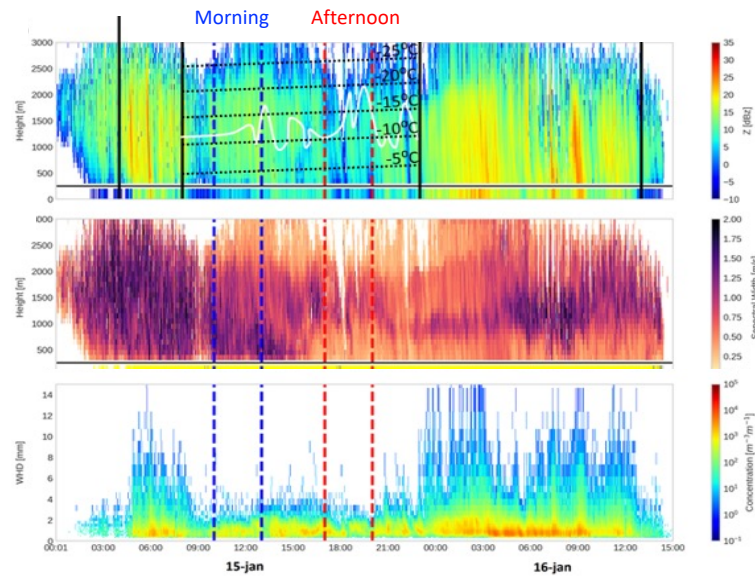
Morning: greater wavelength -> no rotor formed

Afternoon: shorter mountain wave wavelength (~ 14 km) and second wave crest aligned with the second valley ridge

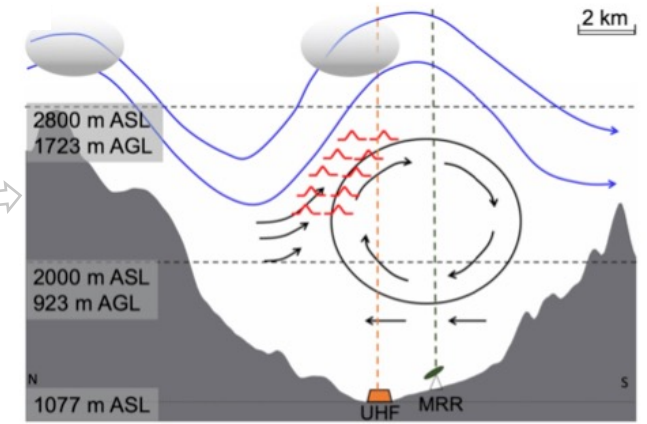
Rotor features:

- Horizontal extension ~ 2 -3 km, vertical extension ~ 1 -2 km
- Elevated ~ 140 m from the surface, disconnected from stable flow
- Strong turbulent area at the upstream edge of the wave
- Formed during 2 hours

Micro rain radar and disdrometer measurements



- Larger **reflectivity** and **spectral widths** during the morning, decreasing in the afternoon at low levels, where the stability of the flow is stronger
- Small **widest hydrometeor diameters** ($\text{WHD} < 3$ mm) during the whole episode
- Particle size distribution** (from disdrometer) does not change when the rotor is established



Still uncertain: to what extent the counter-flow of the rotor is influenced by La Molina valley outflow

