Multi-scale interactions between moist-air flow and deep convection

During HyMeX IOP 15a heavy precipitation event

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- max. rainfall amount: **136.4 mm** (-1.3 °E, 42.89 °N)

- max. IWV: **42 kg m\(^{-2}\)** (0.3 °E, 40.9 °N)

**Daily rainfall**

**Hourly rainfall**

cross: IWV (GPS: 0.3 °E, 40.9 °N)
solid line: ave. rain-gauge
bar: max. rain-gauge
Target MCS

- Period: **from 1300 UTC to 1800 UTC** on 20 OCT
- Location: **CA**, South of Pyrenees

Dataset

- **HyMeX SOP 1 observational data**
  - LEANDRE 2 lidar onboard ATR42 ★
  - RASTA radar onboard F20 ○
  - MSG-SEVIRI
  - Ground-based radar network
  - Ground-based GPS network
  - WALI lidar ★

- **Modelling data**
  - AROME-WMED analyses
    : $\Delta x, \Delta y = 2.5 \text{ km}$
  - WRF model
    : $\Delta x, \Delta y = 10 \text{ km}$
Mean sea level, geopotential at 500 hPa, satellite image at 00 UTC on 20 October 2012

500 hPa geopotential

Upper low
Stationary front

(From HyMeX SOP 1 daily report)
WRF IWV results

06 UTC 20 OCT 2012

(a) PW (shade), wind 925 hPa

(b) IWV 700–300 hPa (shade), wind 700 hPa
AROME-WMED analyses results at **1200 UTC** on 20 OCT 2012

(a) PT (shading) and geopotential (contours) at PVU 1.5

(b) PV (shading) and wind (vector) at PVU 1.5

(c) Wind speed (shading) at 925 hPa

(d) CAPE (shading) and wind at 925 hPa (vector)
Divergence at 950 hPa (shading) and wind shear

- terrain-induced convergence
- strong wind shear

**IWV (AROME and surface GPS)**

1500 UTC OCT 2012

**IWV (AROME, shade), IWV (GPS, symbol)**

**high IWV**
Qv of LEANDRE 2

LEANDRE 2
Water vapour lidar

Qv of WALI

water vapour mixing ratio (WALI)
SEVIRI BT and ground-based radar network Reflectivity

(a) 1230 UTC 20 OCT 2012 BT
(b) 1300 UTC 20 OCT 2012 BT
(c) 1330 UTC 20 OCT 2012 BT
(g) 1230 UTC 20 OCT 2012 dBZ
(h) 1300 UTC 20 OCT 2012 dBZ
(i) 1330 UTC 20 OCT 2012 dBZ
SEVIRI BT and ground-based radar network Reflectivity

(d) 1400 UTC 20 OCT 2012  BT

(e) 1430 UTC 20 OCT 2012  BT

(f) 1500 UTC 20 OCT 2012  BT

(j) 1400 UTC 20 OCT 2012  dBZ

(k) 1430 UTC 20 OCT 2012  dBZ

(l) 1500 UTC 20 OCT 2012  dBZ
Reflectivity 18–20 dBZ at 7–8 km height

Updraft 6–8 m s\(^{-1}\) at 7–9 km height
SEVIRI BT and ground-based radar network Reflectivity

(a) 1530 UTC 20 OCT 2012  BT
(b) 1600 UTC 20 OCT 2012  BT
(c) 1630 UTC 20 OCT 2012  BT

g) 1530 UTC 20 OCT 2012  dBZ
(h) 1600 UTC 20 OCT 2012  dBZ
(i) 1630 UTC 20 OCT 2012  dBZ
Descended reflectivity 18–20 dBZ to 4–6 km height

Updraft 6–8 m s⁻¹ at 7–11 km height

Descended 10 dBZ Echo-top height to around 10 km
SEVIRI BT and ground-based radar network Reflectivity
Concluding remarks

- Low-level **wind convergence** ahead of a cold front and **local moist updraft** induced by terrain played an important role to **develop MCS**, resulting heavy rainfall over the **southern Pyrenees** for IOP 15a.
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