Rainfall Retrieval Through Commercial Microwave Links in Valmalenco (North Italy)

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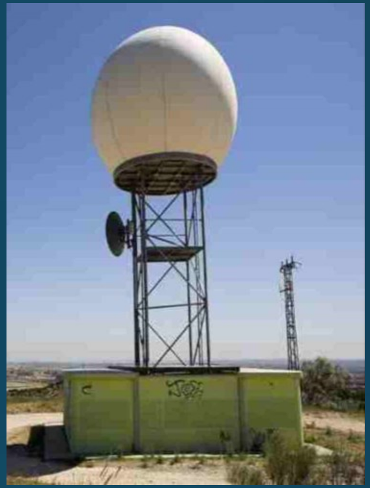
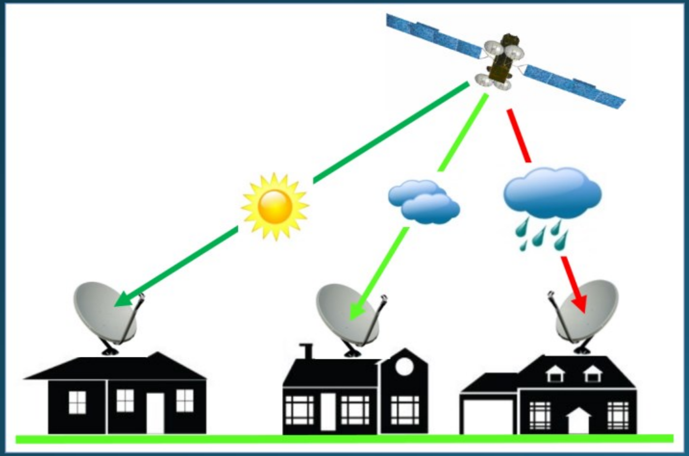
Precipitation Monitoring

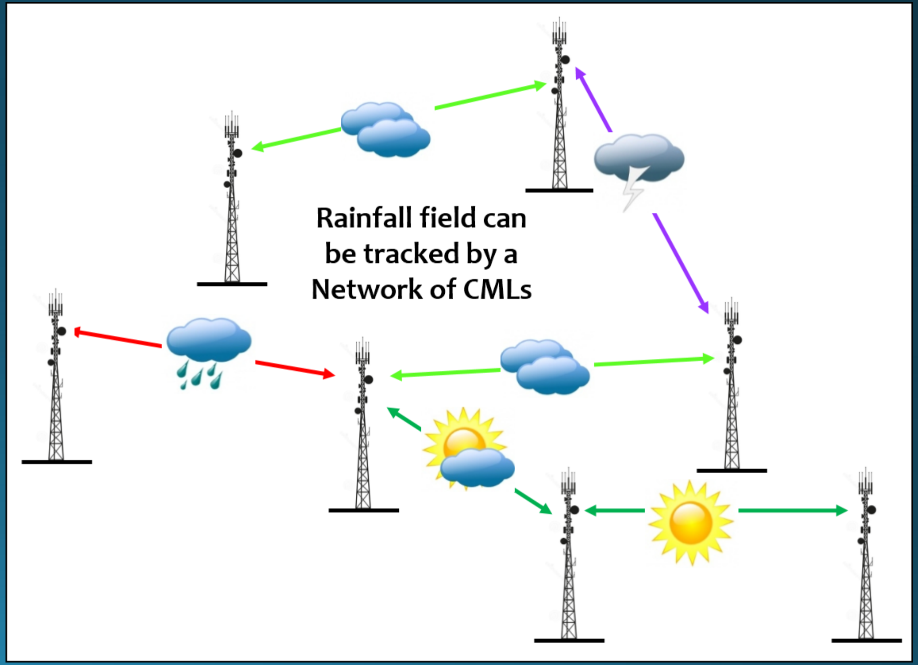
- Conventional sensors
  - Networks of rain gauges
  - Weather radar
  - Disdrometers



- Opportunistic sensors
  - TV-Sat receivers



- Commercial Microwave Links (CML)



The **MOPRAM** Project

- MOPRAM (**MO**nitoring **PR**ecipitation through A network of **RA**dio links at **M**icrowaves) aims at:
  - assessing the usage of CML data for rainfall measurements, especially for extreme weather events
  - evaluating the output of an hydrological model when fed with CML-based rainfall estimates
- Validation in two areas in Northern Italy

- The project activity is divided into 2 main tasks:

1. Meteorological task

2. Hydrological task

THIS PRESENTATION

1.1
Estimation of rainfall intensity from CML signals and validation vs RG and DIS

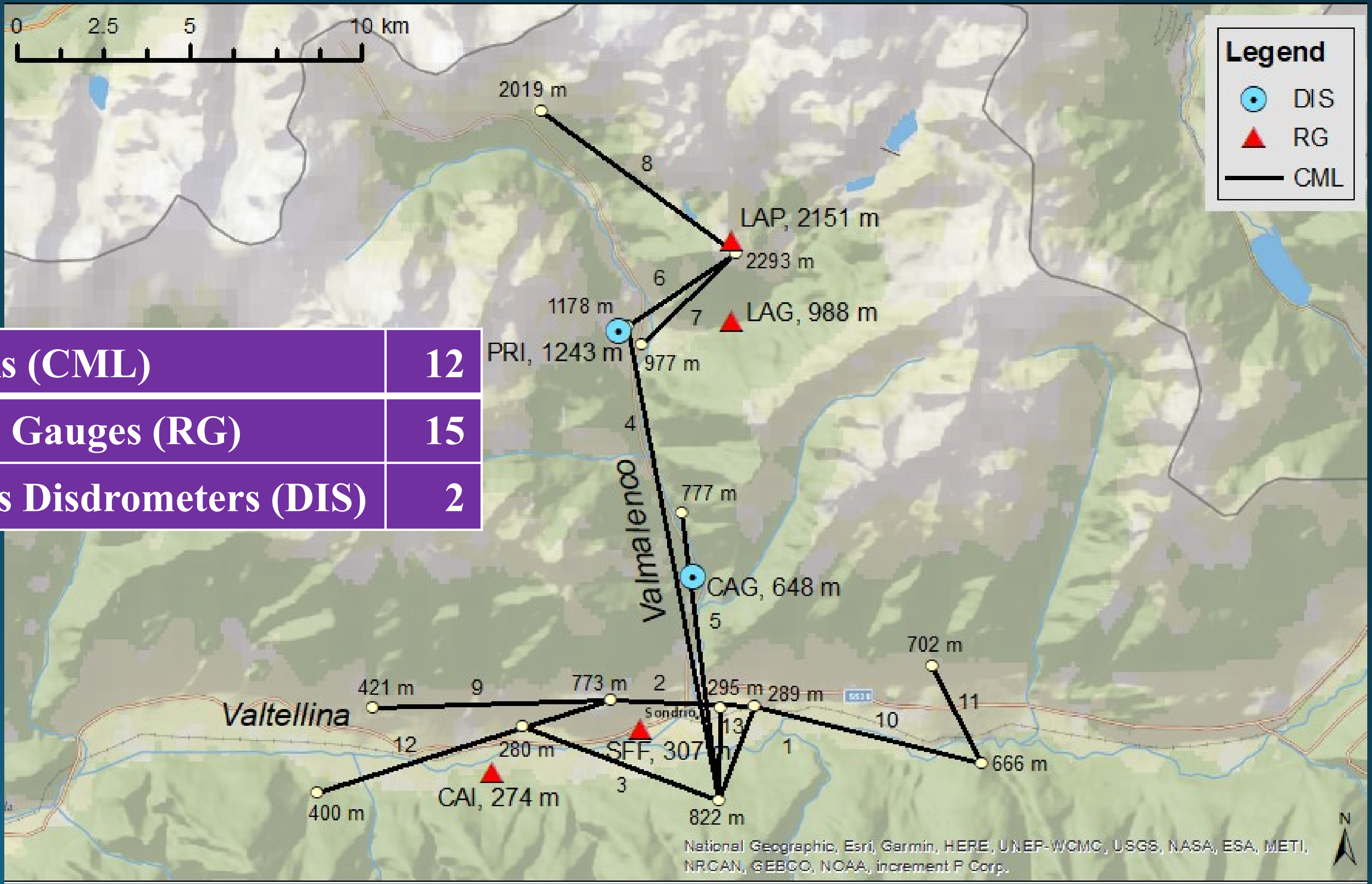
1.2
2D Rainfall field retrieval by a tomographic approach

2.1
Integration of CML data into a hydrological model

2.2
Check of the hydrological response

Study Area & Experimental Set-Up

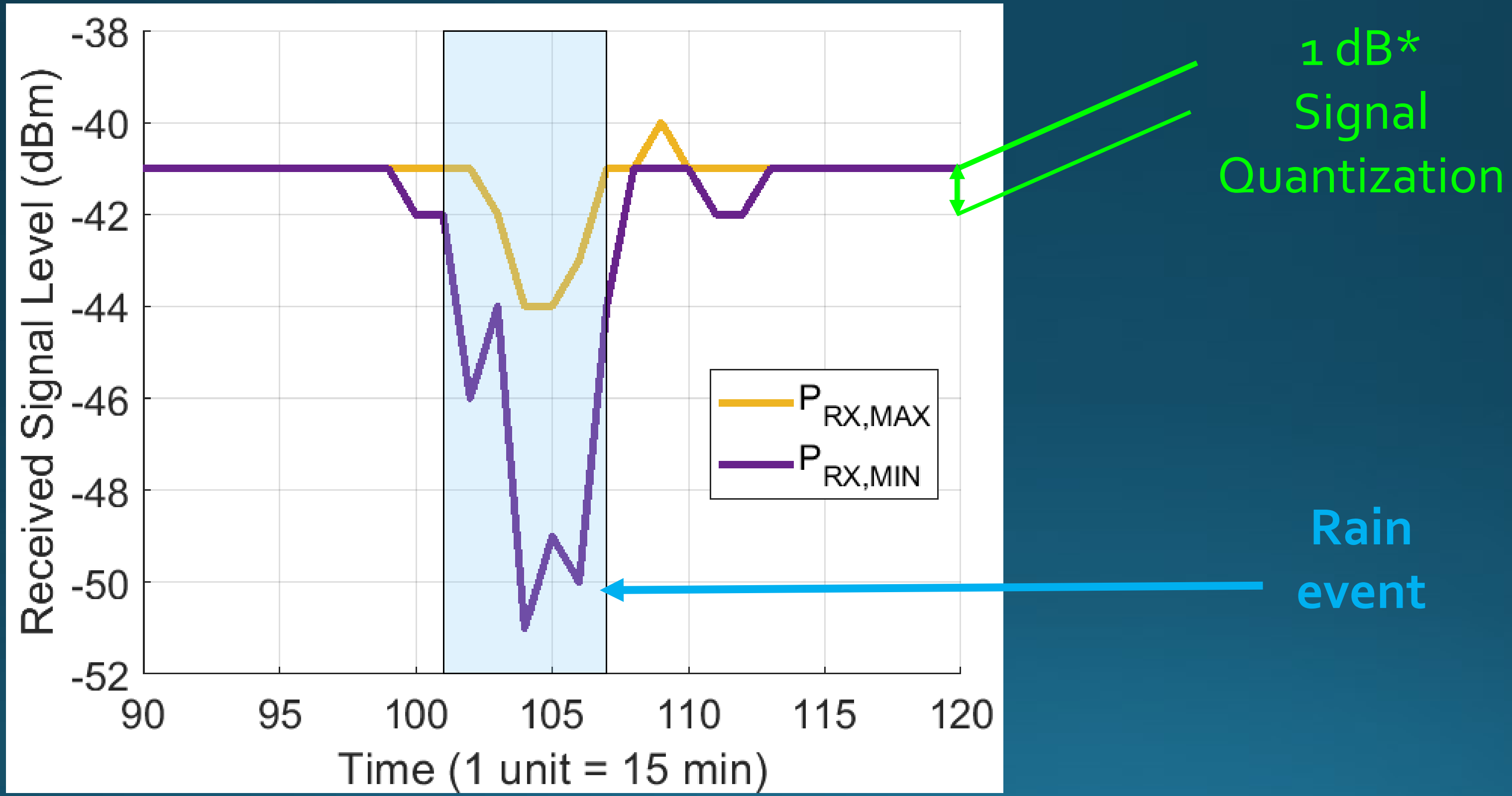
Links (CML)	12
Rain Gauges (RG)	15
Thies Disdrometers (DIS)	2



What a CML actually measures

- Available data: Received Signal Level (RSL) in dBm*

15-min MinMax (standard CML data format)



* dBm are units of power on a logarithmic scale, i.e. P (dBm) $=10 \log_{10} P(mW)$

* 1 dB is a relative unit, corresponding to a 25% increment/decrement of a certain quantity

From RSL to rain intensity

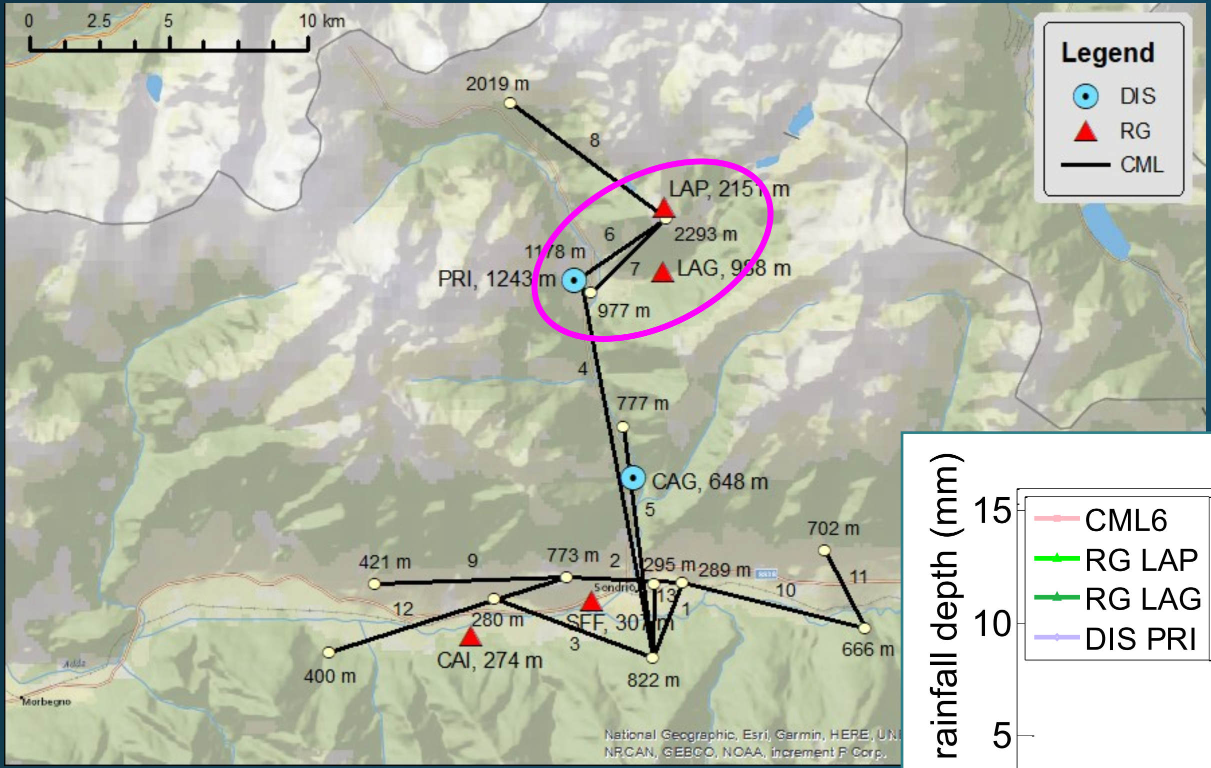
- Basic steps:
  - Classification of 15-min time slots into dry/wet
  - Baseline (BL) calculation (i.e. the mean or median value of RSL when it's not raining)
  - Calculate total attenuation $A_{tot}(t) = BL(t) - RSL(t)$
  - Compensation of residual non-rainy attenuation components: $A_r(t) = A_{tot}(t) - A_{notr}$
  - Rain intensity from $A_r(t) = L\kappa R(t)^{\alpha}$ (κ and α from ITU-R P.838-3, L is the path length)

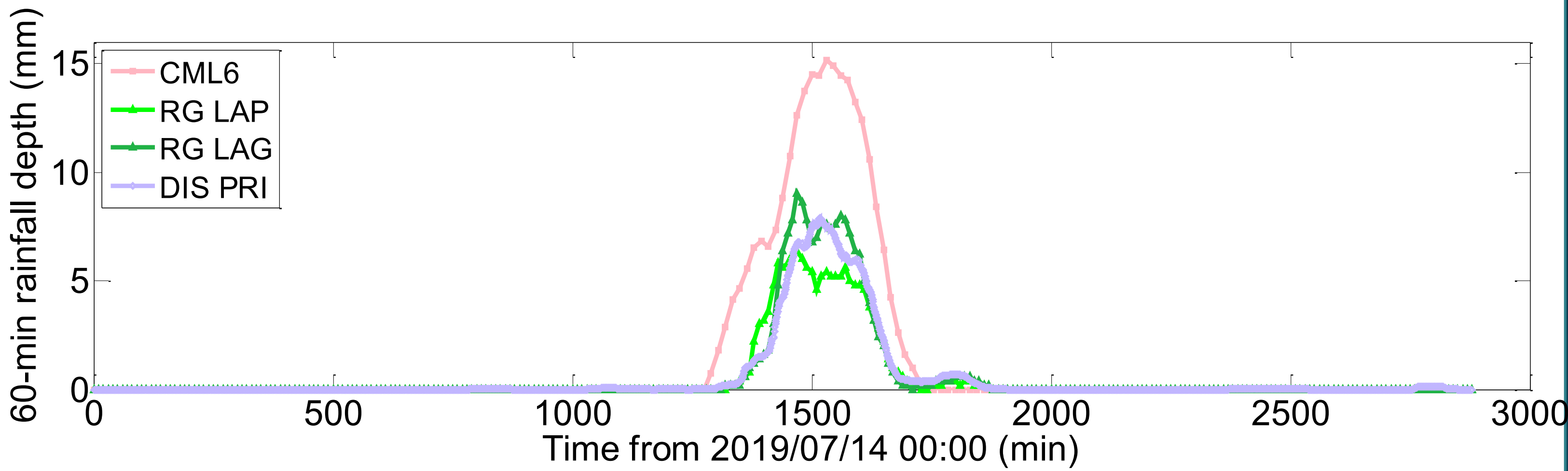
Observations and results

- Concurrent CML, disdrometer and rain gauge data were collected during two 48h rainy periods in July 2019 (see Table below).
- Four major episodes were detected, one in the first period and three in the second one.

Start	End	Max. intensity	Max. rainfall depth	Rainy time
14-Jul	15-Jul	17 mm/h	28 mm	393 min
25-Jul	26 Jul	125 mm/h	35 mm	195 min

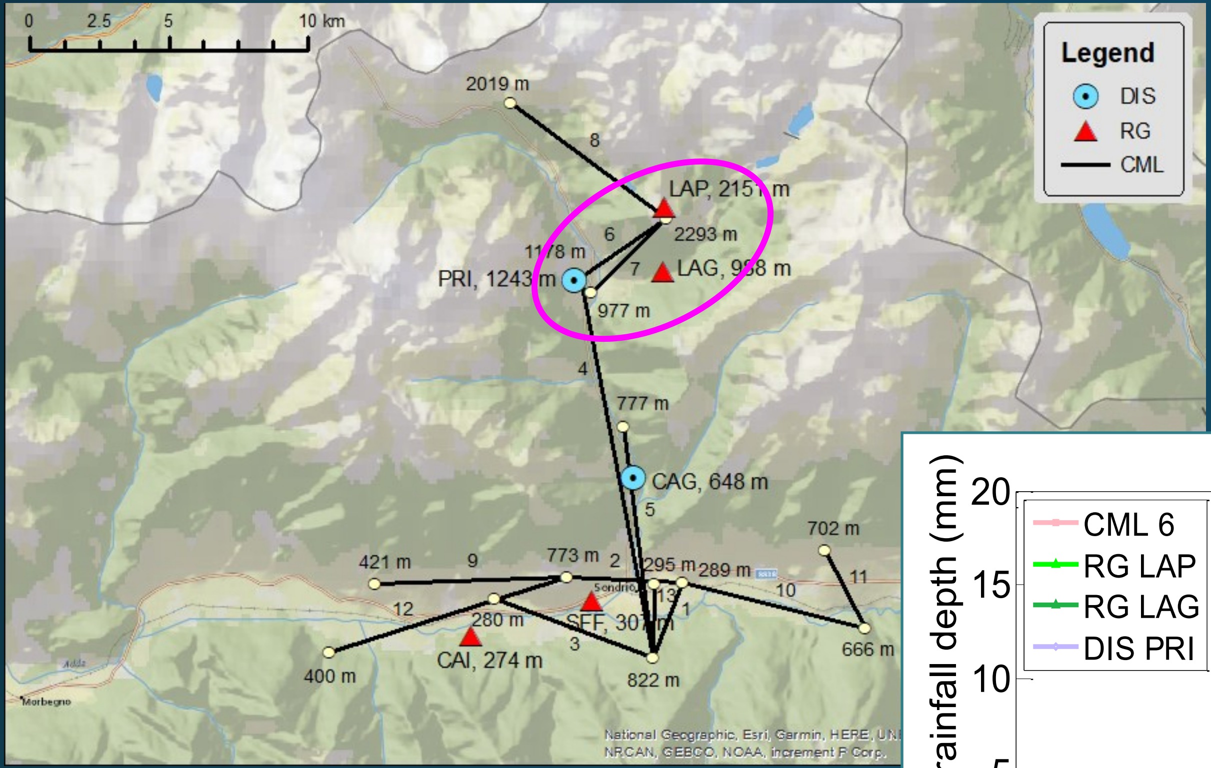
Validation: CML6 vs RG & DIS, Event #1

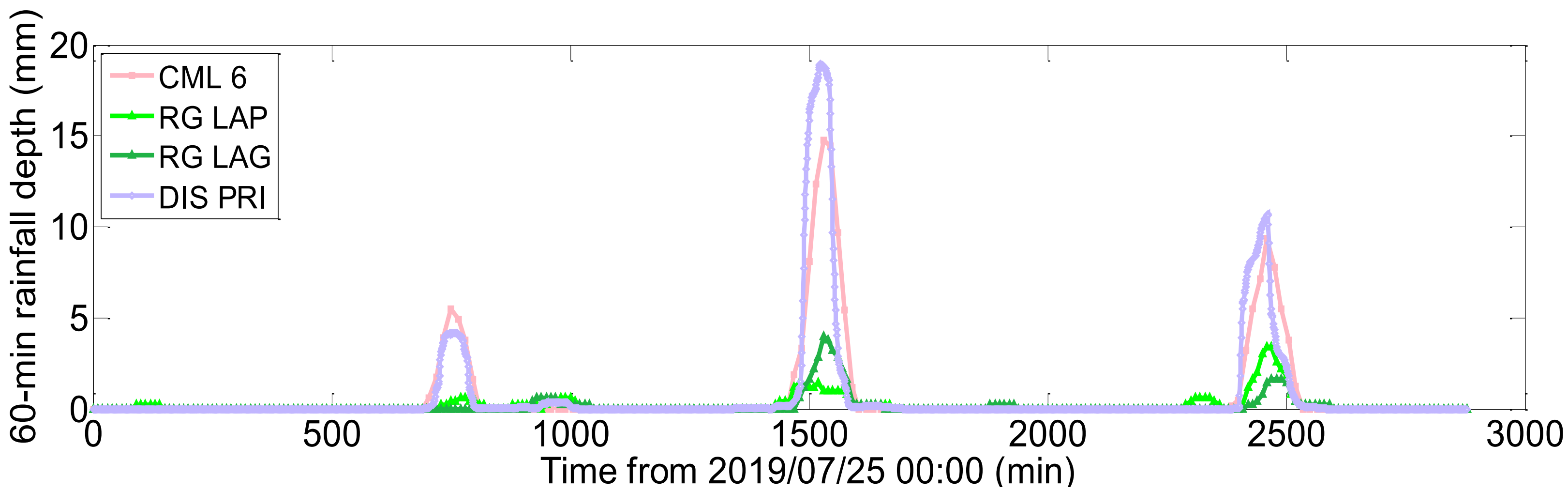




60-min accumulated rainfall on 14 and 15 July 2019: comparison between link 6, and the three rainfall sensors (two rain gauges and one Thies disdrometer) located close to its terminals.

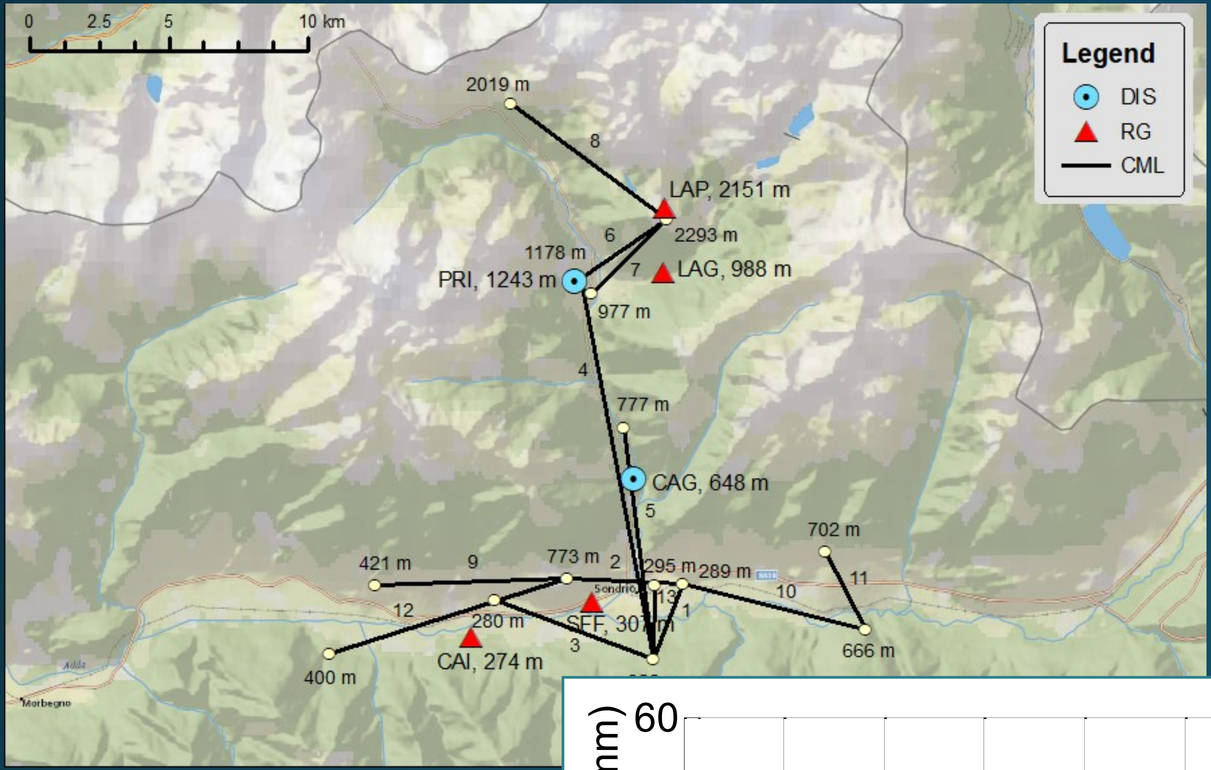
Validation: CML6 vs RG & DIS, Event #2



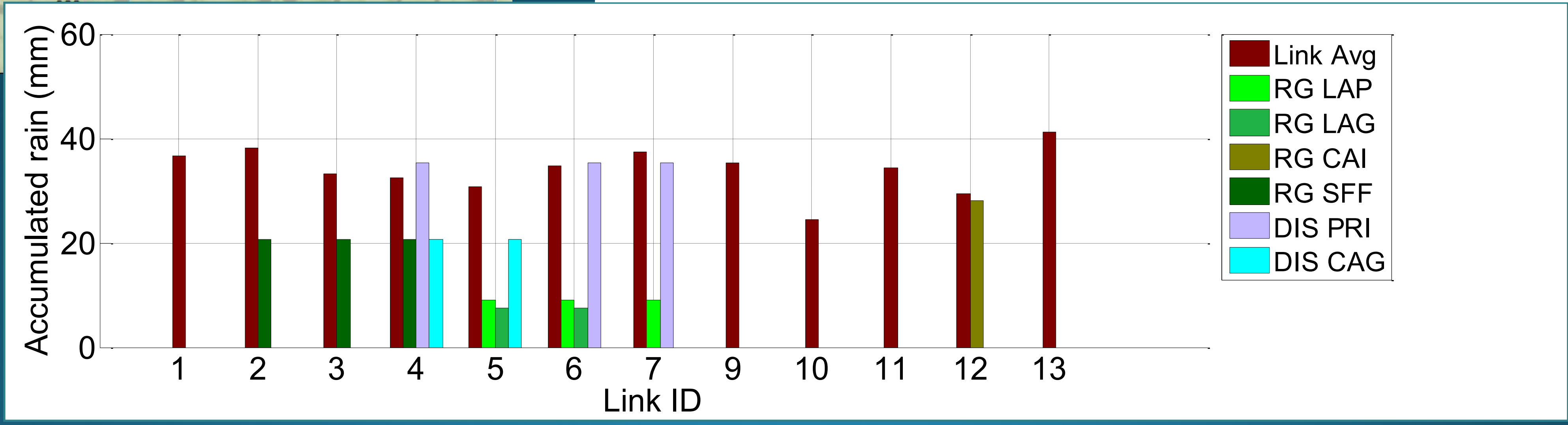


60-min accumulated rainfall during three rain episodes occurred on 25 and 26 July 2019: comparison between link 6 and the three rainfall sensors (two rain gauges and one Thies disdrometer) located close to its terminals.

Validation: All CMLs vs RG & DIS, Event #2



Accumulated rainfall at the end of the entire event: comparison between each link and the nearby rainfall sensors (if any).



Conclusions

Issues of CMLs as rainfall sensors:

- Data not optimized for this application (quantization, time resolution, only MINMAX values)
- Compensation of signal attenuation not due to rain
- Signal attenuation to rainfall rate conversion
- Rainfall measurement is path averaged

Despite the geomorphology of the measurement area is challenging, there is a fair agreement between accumulated precipitation estimated by the CML and conventional sensors.

CMLs tend to overestimate the rainfall values with respect to rain gauges and disdrometer measurements.
Future work: implementing procedures to cancel non-rain effects and to calibrate model parameters in order to reduce potential biases.

Thank You By The MOPRAM Team!

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Official site:

- **http://www.mopram.it/**

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