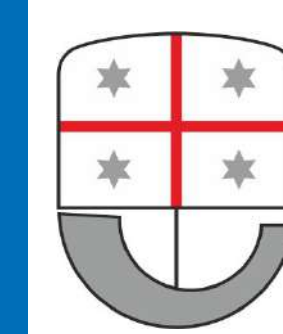


Analysis of hail size and vertically integrated liquid density over Liguria Region in northwestern Italy

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ARPAL



12th European conference on radar in meteorology and hydrology – ERAD 2024

motivations for a hail climatology

problem

- Liguria Region in northwestern Italy
- one of the areas most prone to **severe convective storms** in Europe
- neither** direct hail measurements **nor** structured historical datasets **available**

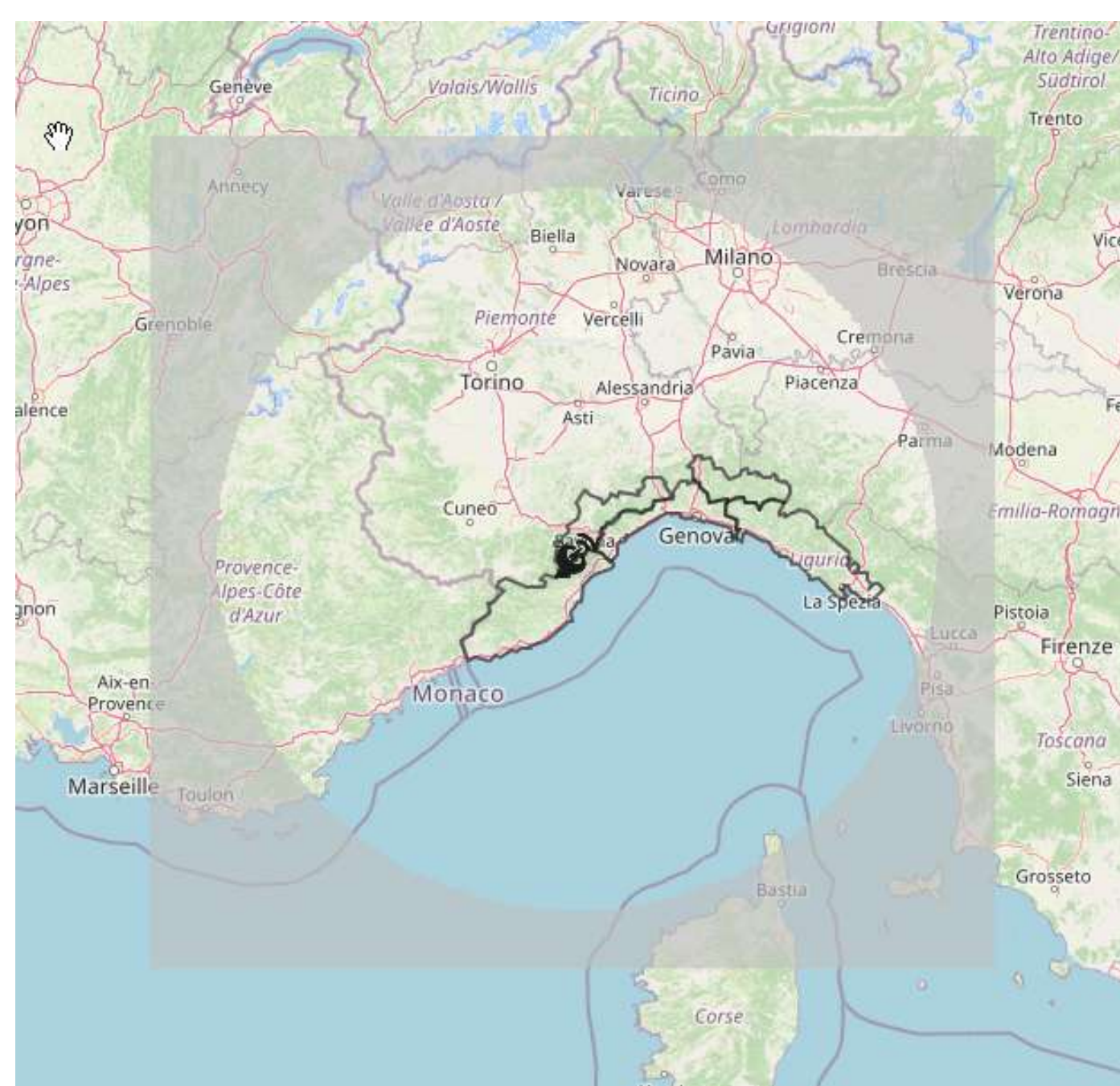
aim

- collect a dataset of hail events based on technical, citizen and press reports
- characterize the dataset by means of radar data
- compare different hail proxies e.g. VIL density and Waldvogel POH

Monte Settepani weather radar



a view of Monte Settepani weather radar

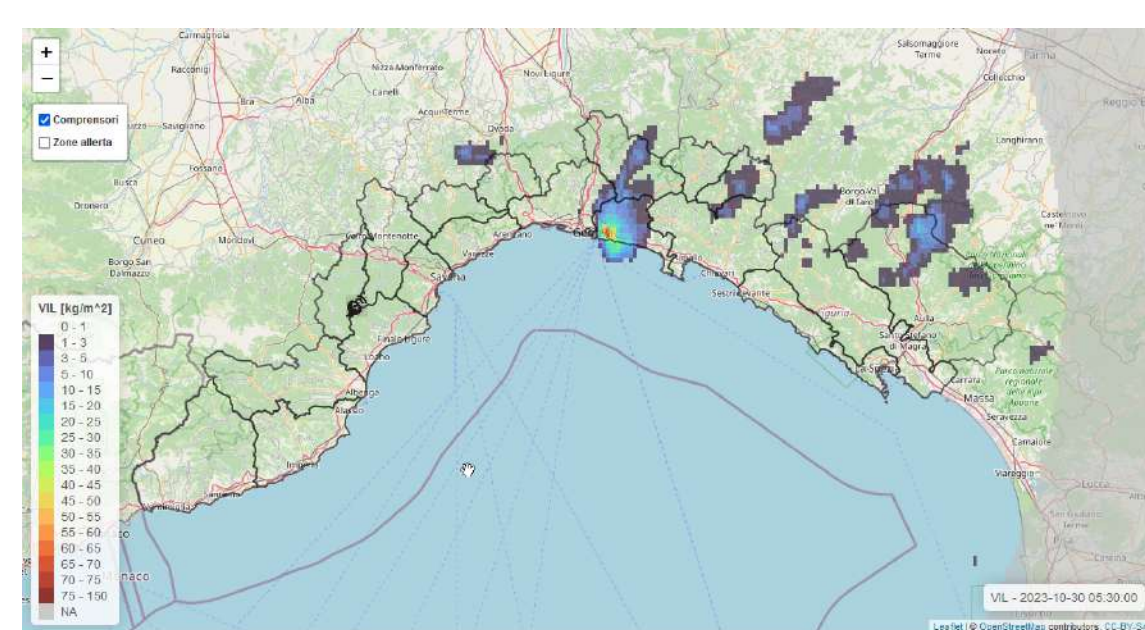


Monte Settepani scanning area

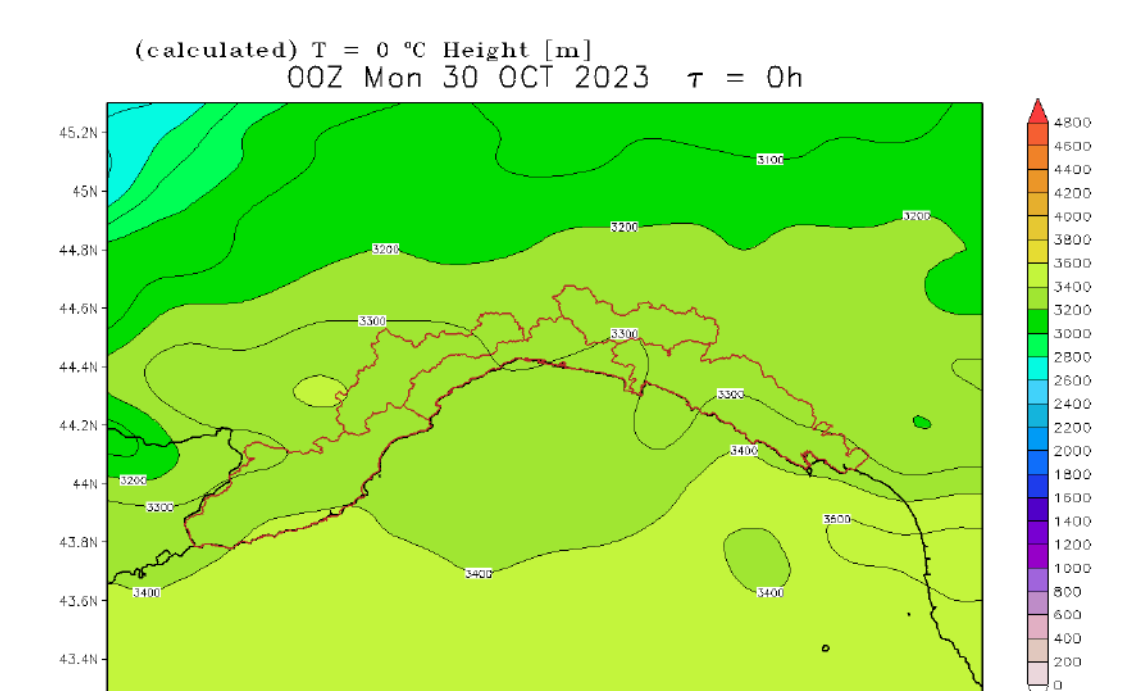
details

- municipality: Calizzano [Savona]
- ownership: Liguria Region, ARPA Piemonte
- location: (8.1975°, 44.2458°, 1390 m a.g.l.)
- maximum range: 250 km
- dual-polarimetric C-band

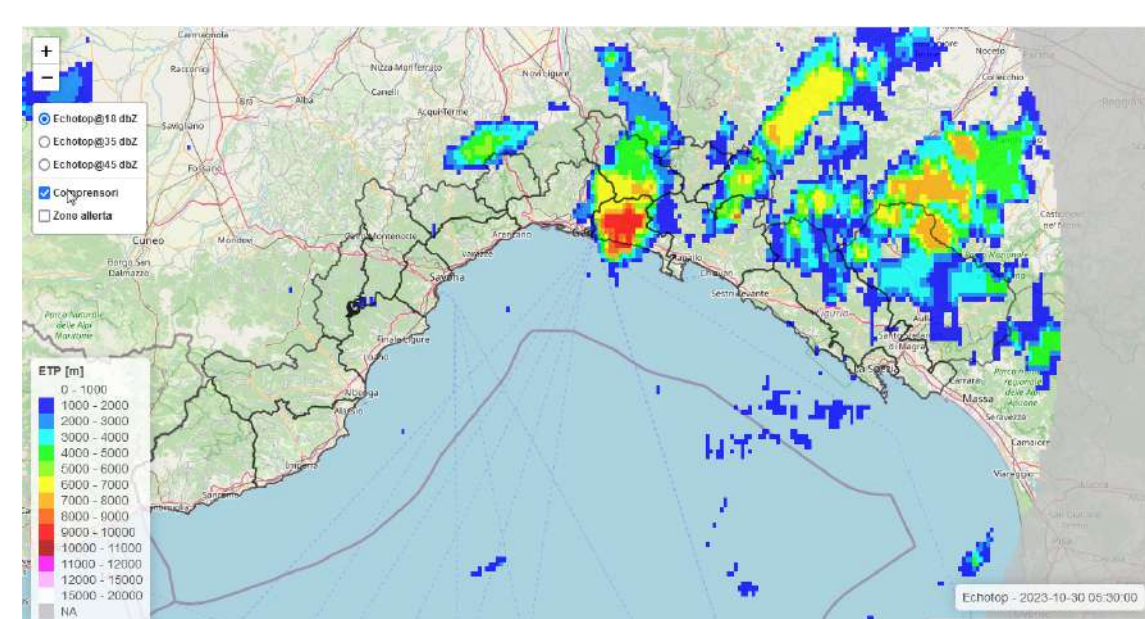
different hail proxies



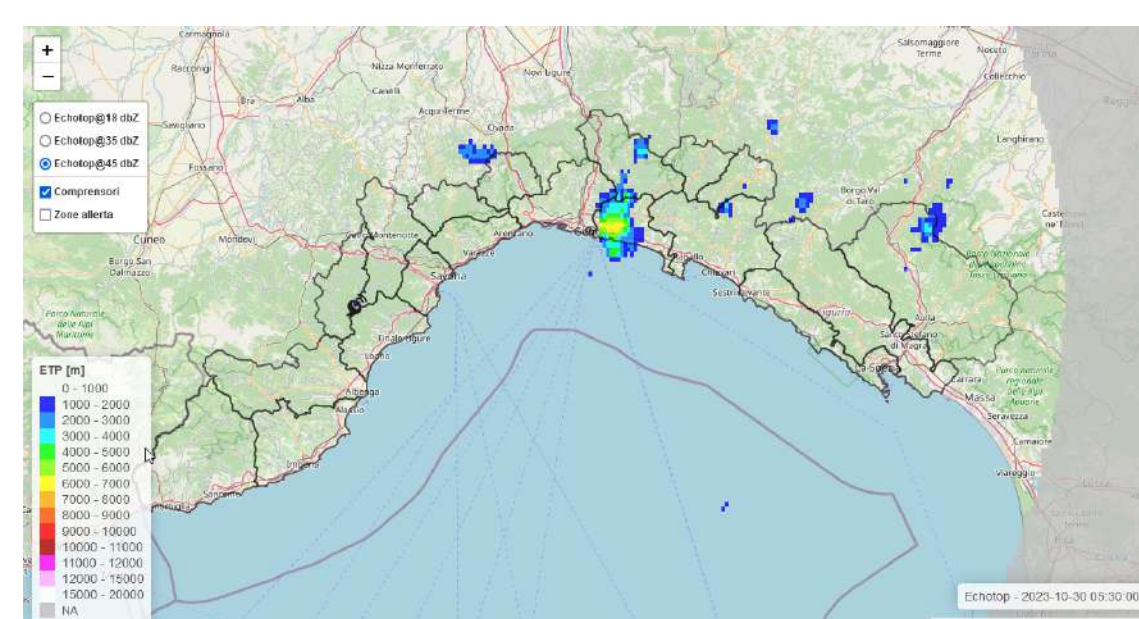
Vertically Integrated Liquid (VIL)



Height of 0 °C-level (IFS closest analysis) (Z_0)



18 dBZ Echotop (ETP_{18dBZ})



45 dBZ Echotop (ETP_{45dBZ})

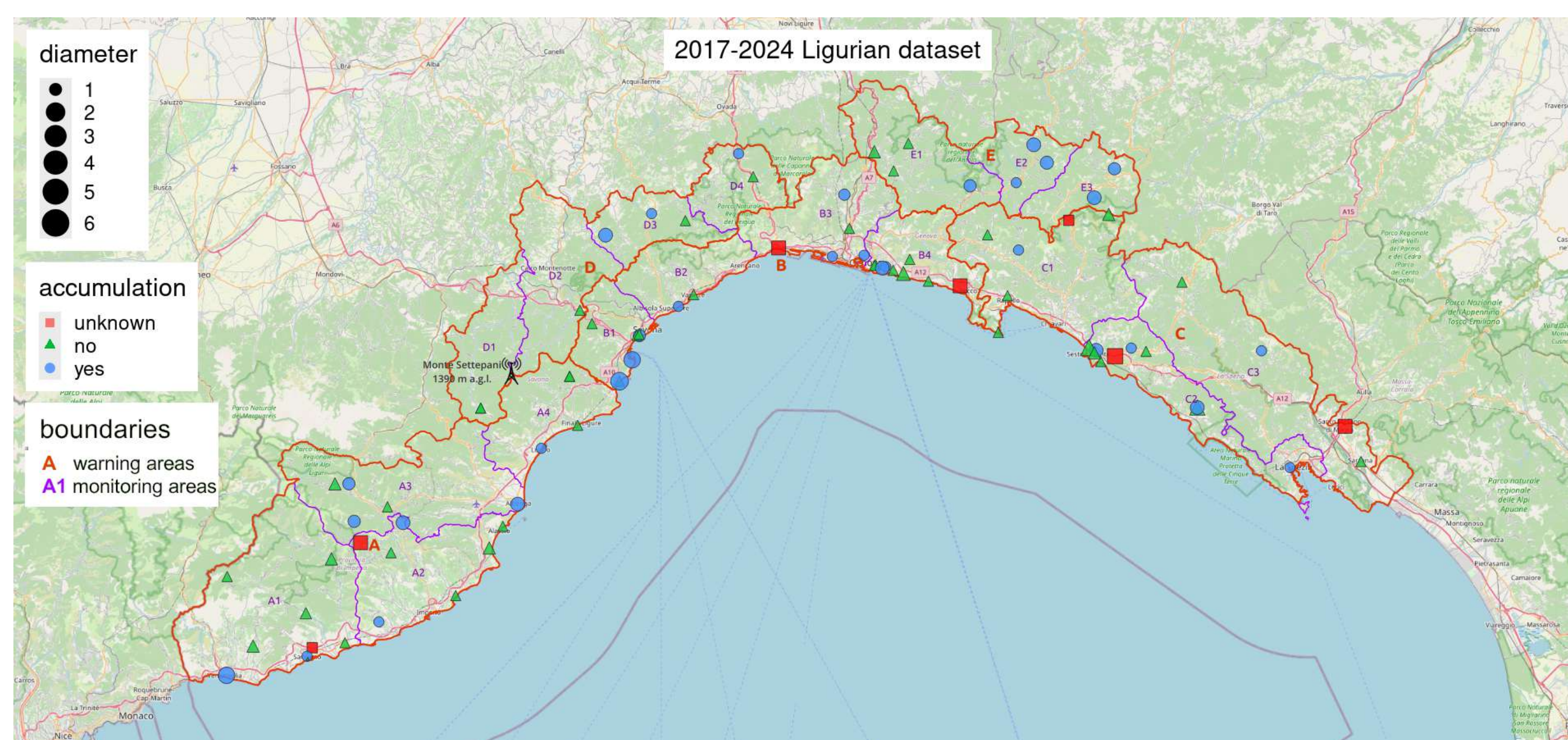
VIL density (VLD)

- $VLD = \frac{VIL}{ETP_{18dBZ}}$
- entirely derived from radar observations
- less season-dependent
- hail proxy **only for medium/high altitudes** due to Monte Settepani height

Waldvogel probability of hail (POH)

- $POH = f(ETP_{45dBZ} - Z_0)$
- straightforward interpretation
- Z_0 field **required** (e.g. from NWP models, which could be inaccurate in a storm environment especially during cold seasons)

geographical distribution of hailstorm events



2017-2024 hailstorm events; location mainly retrieved by reports when available; otherwise by maximum reflectivity

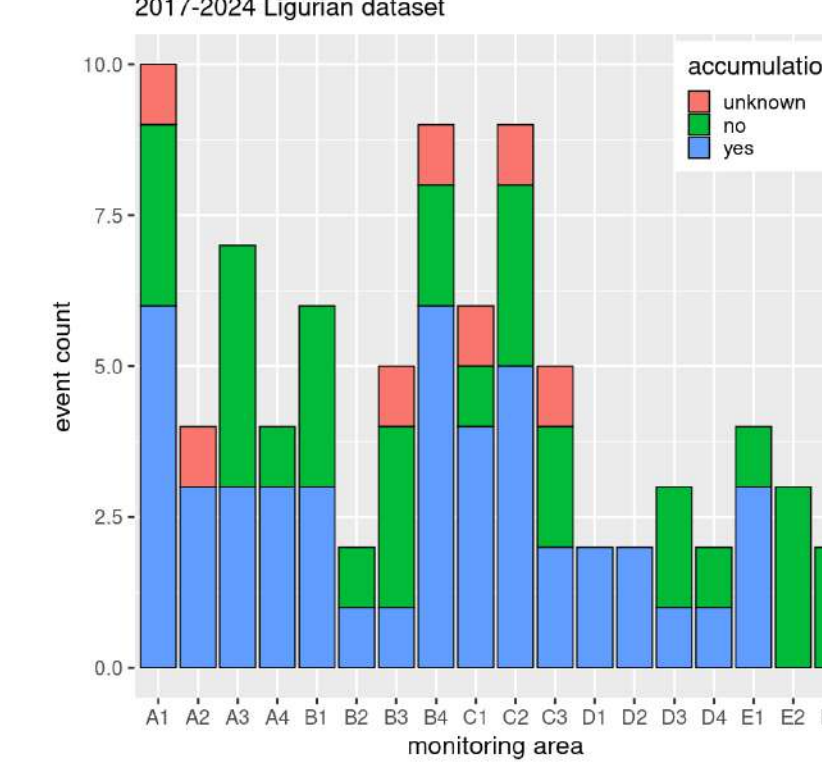
comment

- most reports concentrated along the coastal area due to **high urbanization**
- many reports across mountain areas (internal A, E2, E3) due to **enhanced convection**

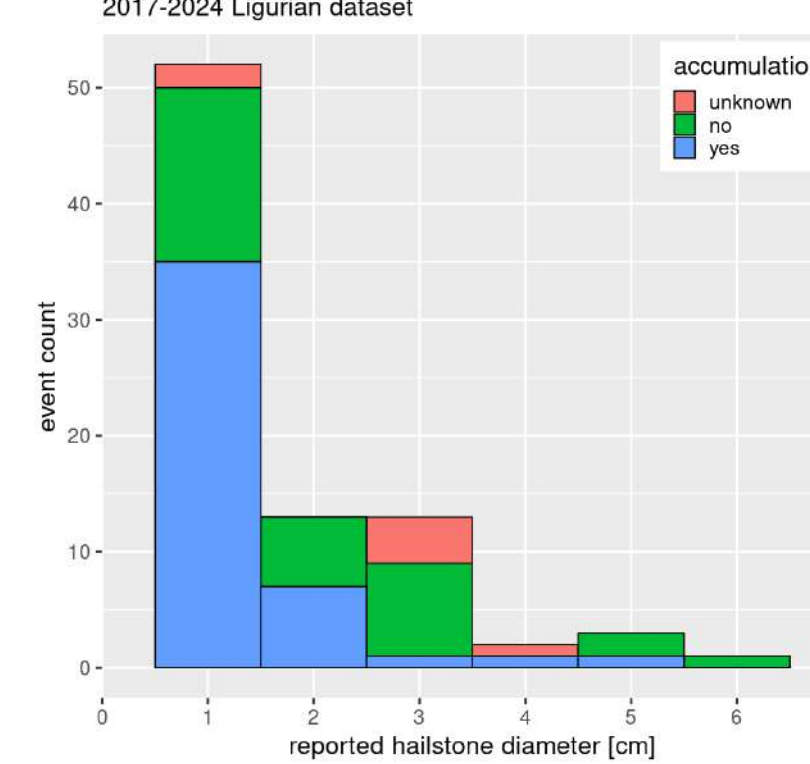
2017-2024 dataset statistics

	size [cm]	VLD _{max} [g/m ³]	POH _{max} [%]
min	1.0	1.00	35.9
25th	1.0	2.15	78.5
50th	1.0	2.82	96.6
75th	2.0	4.57	100.0
max	6.0	9.65	100.0
mean	1.8	3.64	87.8
# records	84	85	65
# NA	1	0	20

Distribution by monitoring area 2017-2024 Ligurian dataset



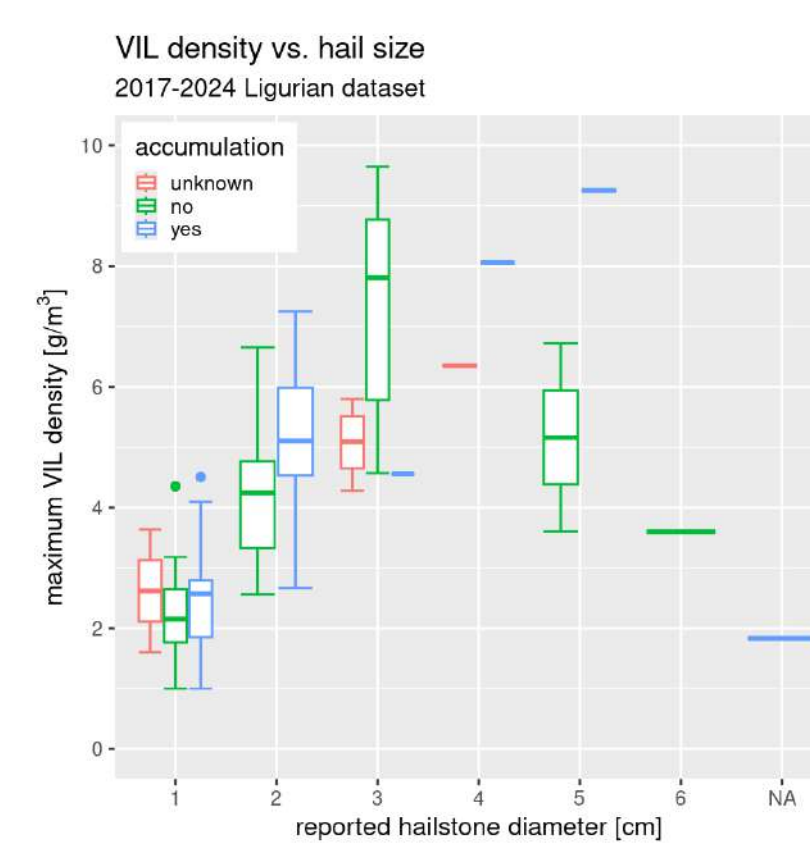
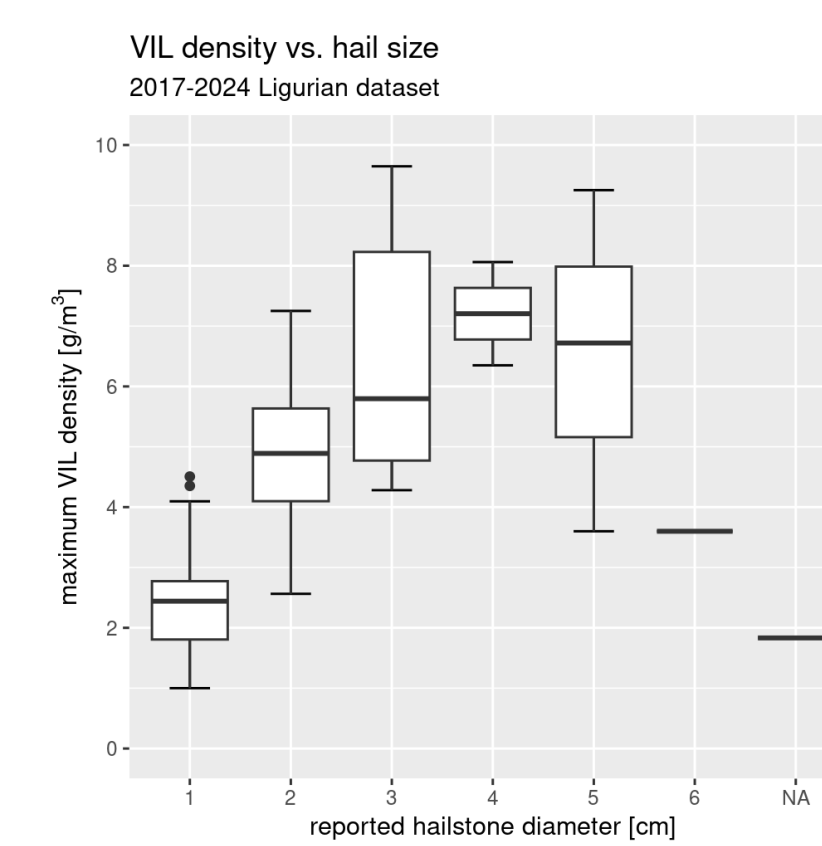
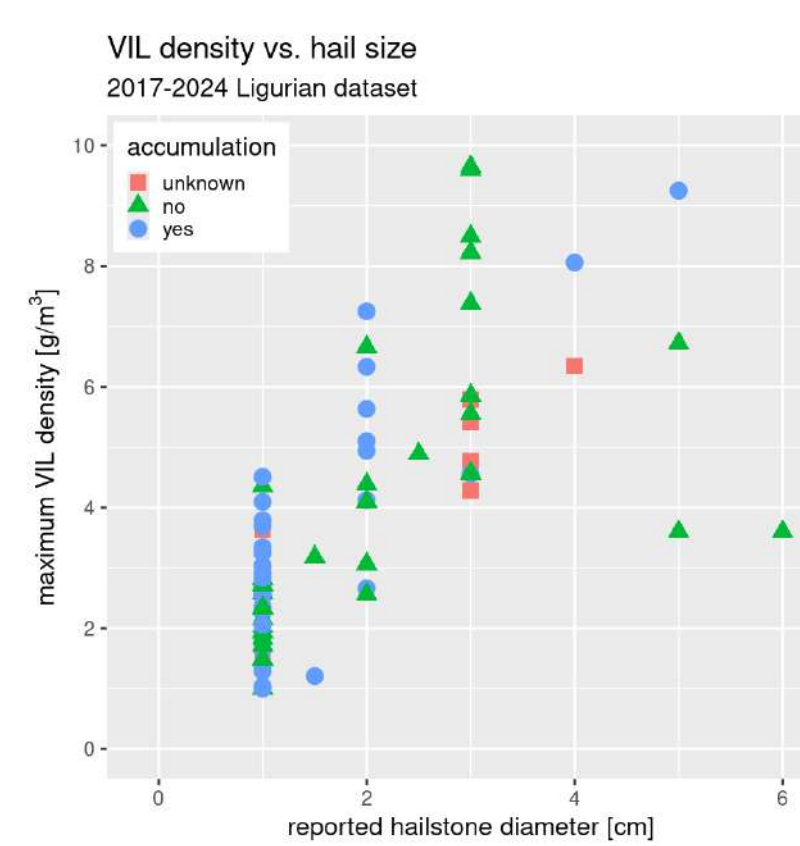
Hail size distribution 2017-2024 Ligurian dataset



comment

- accumulation reported mainly in case of **small hailstones** (1-2 cm)

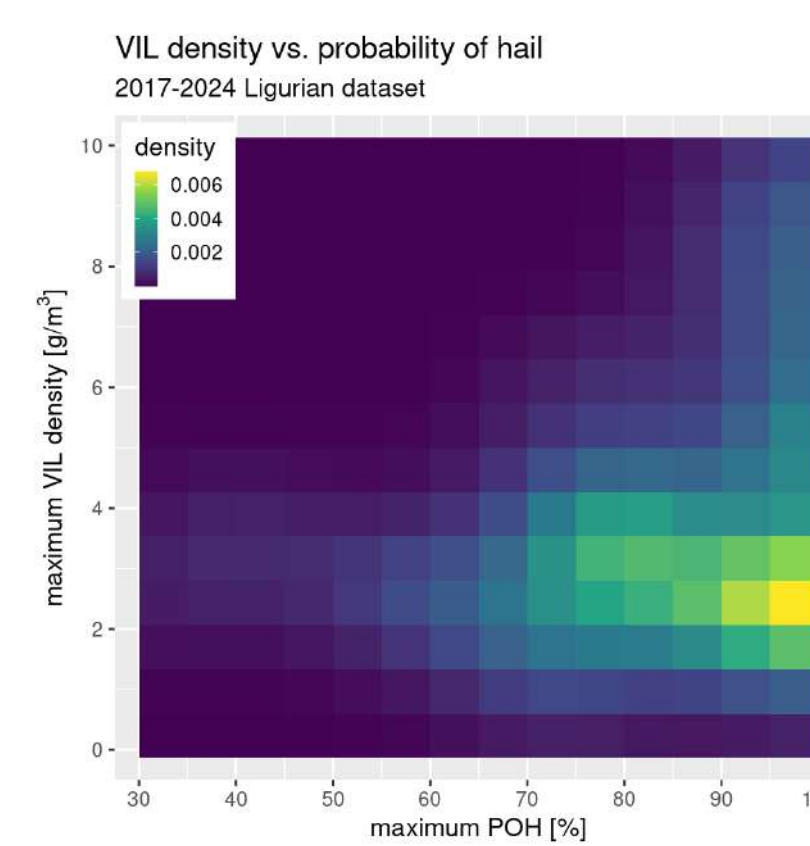
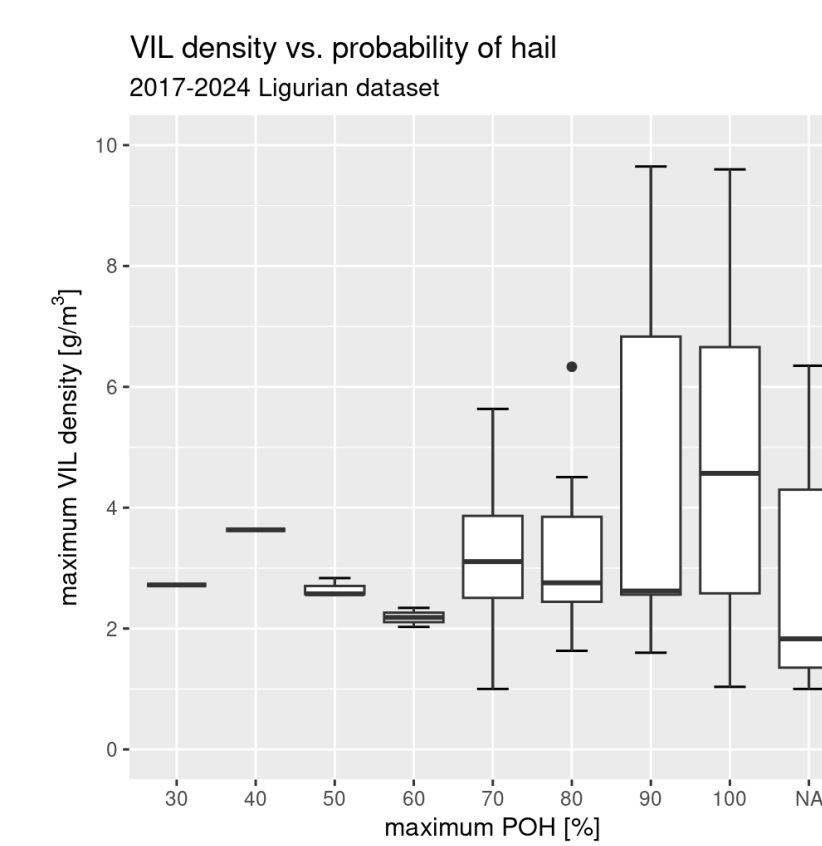
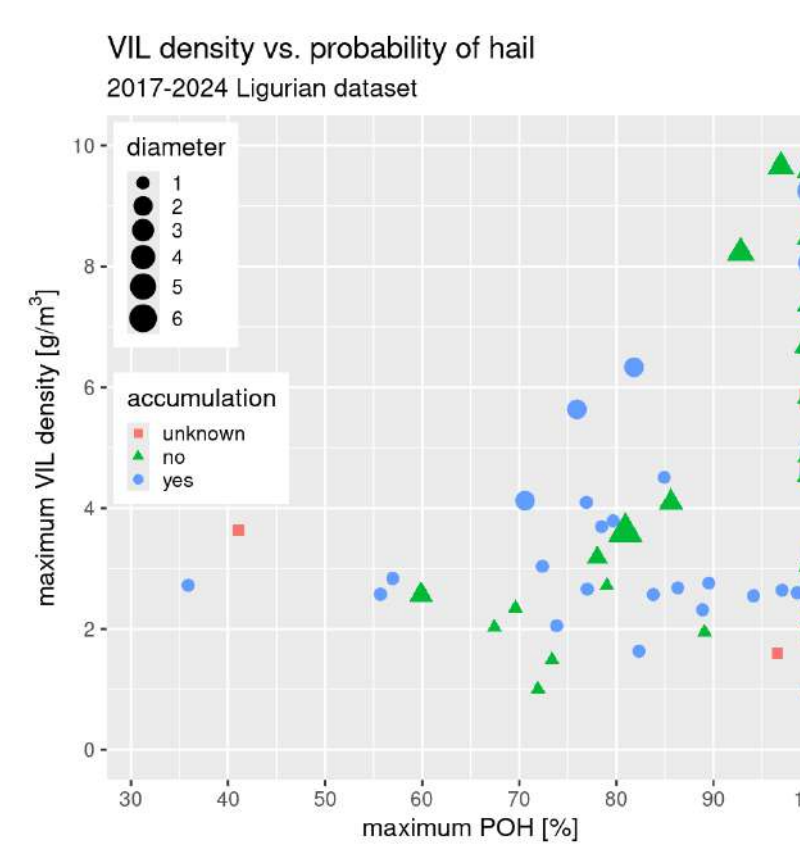
VIL density and hailstone size



comment

- slightly correlation between VLD_{max} and hail diameter D : $D > 3$ cm when VLD_{max} > 5 g/m³

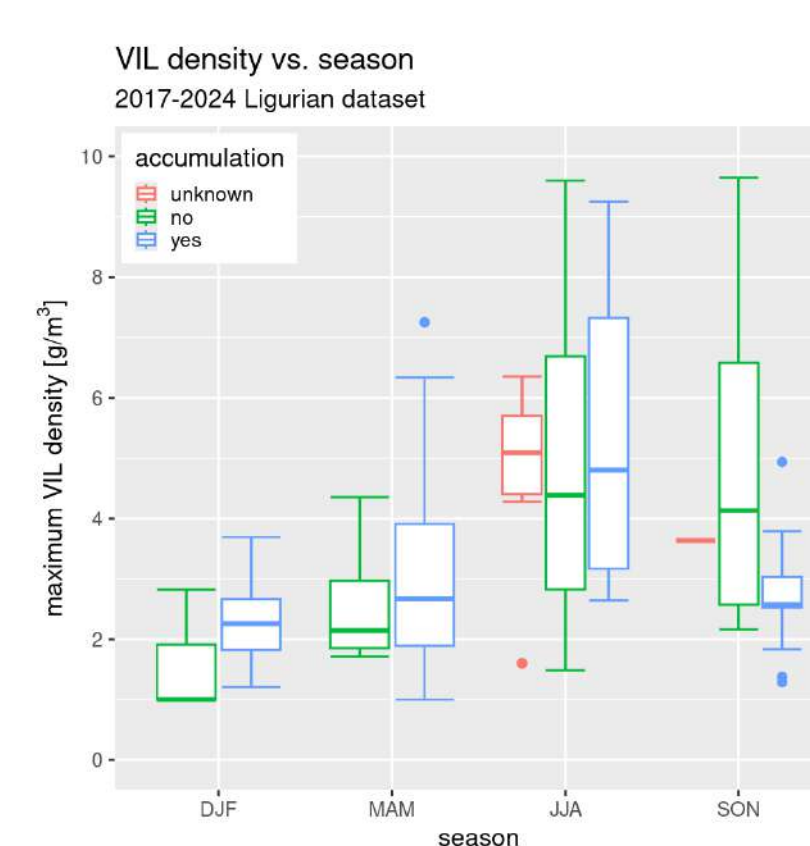
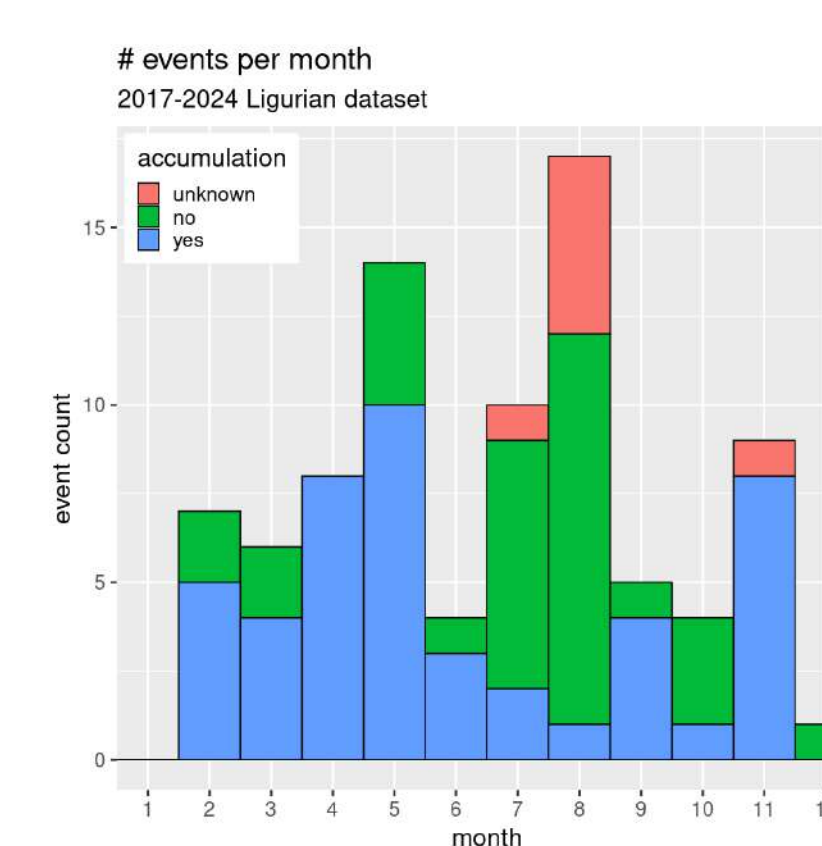
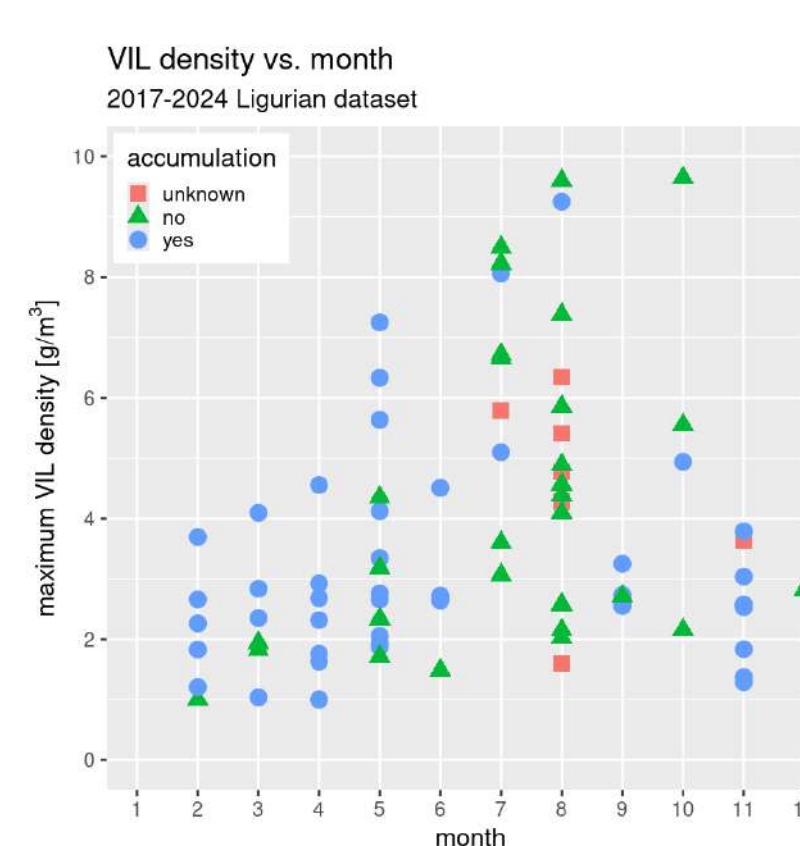
VIL density and POH



comment

- higher values of VLD_{max} confined at higher POH_{max}: VLD_{max} > 4 g/m³ for POH_{max} > 70%

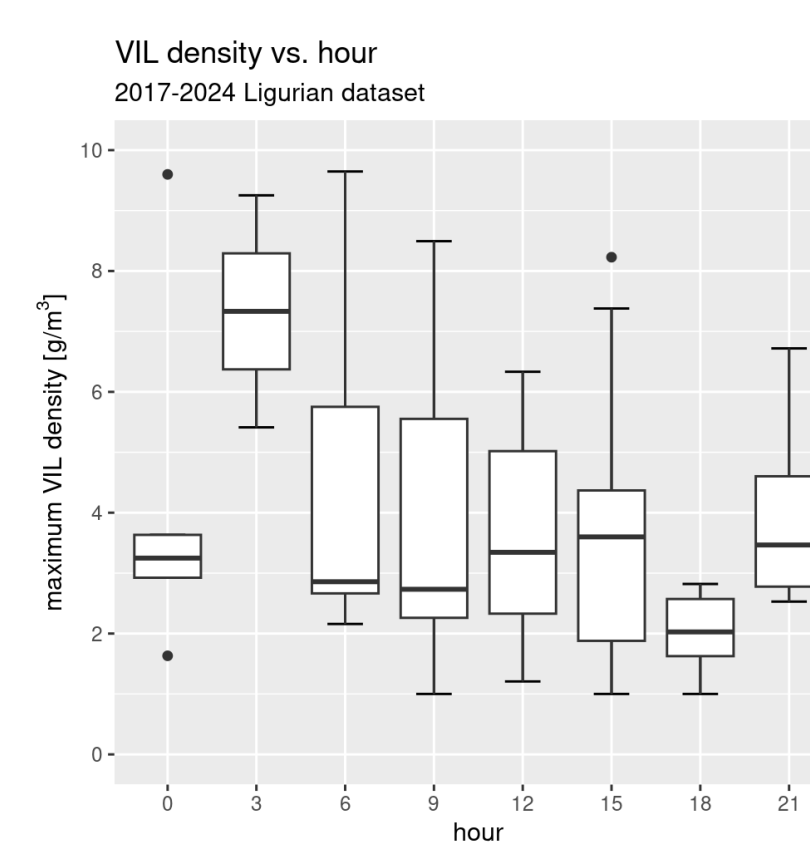
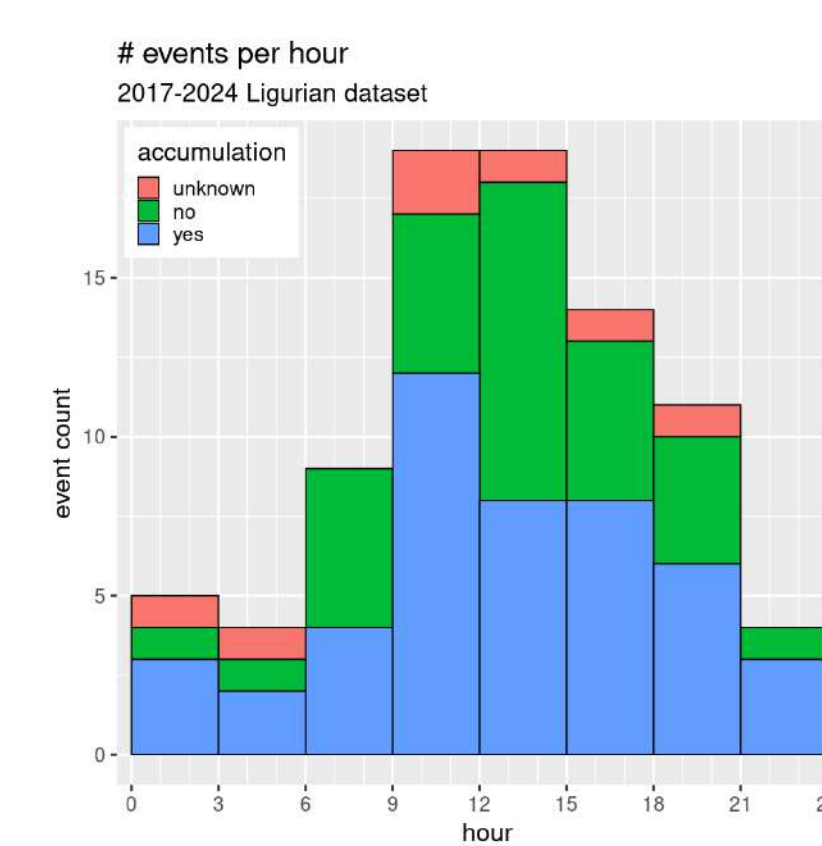
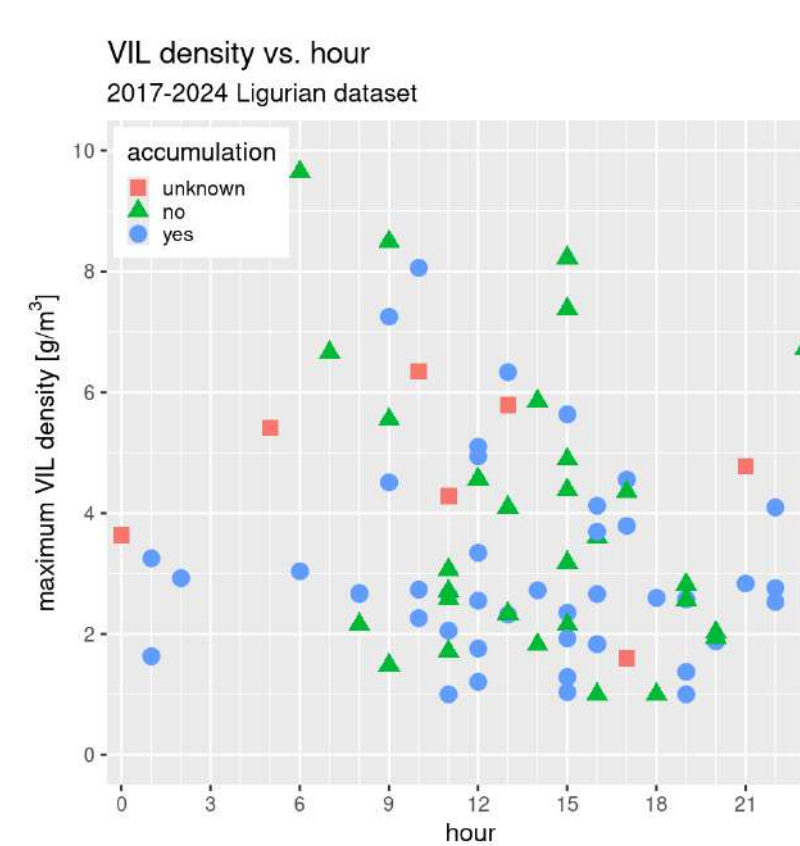
VIL density and seasonality



comment

- higher VLD_{max} during summer
- accumulation is not preferred during summer

VIL density and daytime



comment

- most of the events reported during late morning and afternoon

conclusion and perspectives

conclusions

- first hail climatology for Liguria based on radar data
- useful classification also for nowcasting purposes

perspectives

- evaluation of **radar polarimetric variables**
- inclusion of data from other sources (**satellite, storm severity index** by storm tracking tools)