Disciplinary session: **Climate: Past, Present & Future (CL)**
Display materials: **EGU22-5924**

Changes in future sub-daily extreme precipitation at convection-permitting scale over an alpine transect

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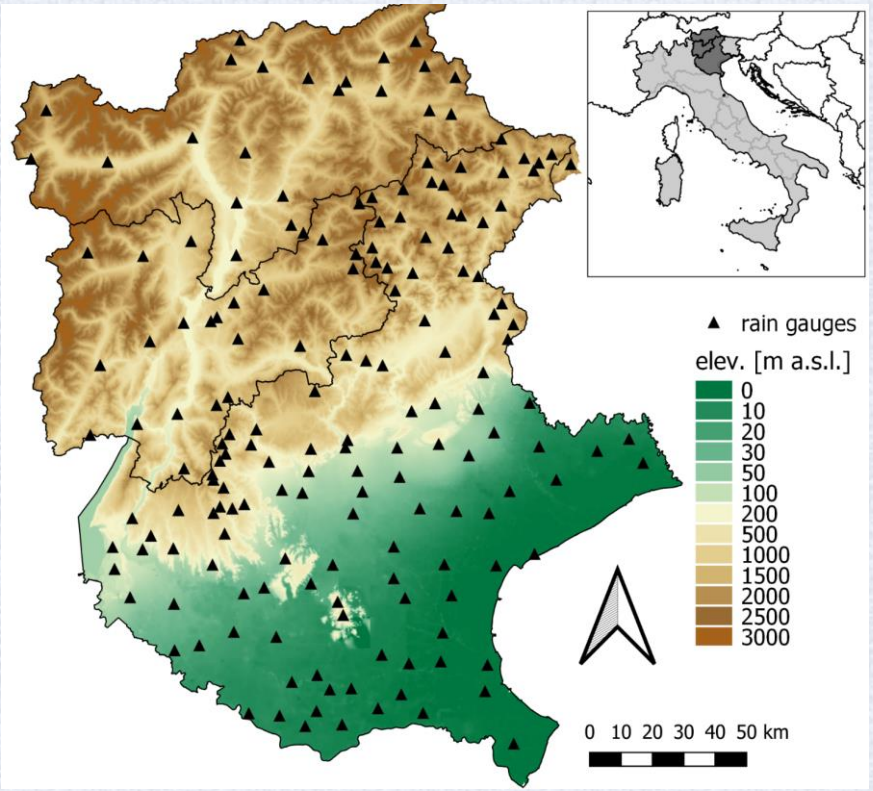
INTRODUCTION

Objective.

To characterize changes of **sub-daily precipitation extremes** in a complex-orography region based on

- **convection-permitting climate (CPM)** simulations (ten years time slices)
- **SMEV method** which provides reliable estimates of **long return time quantiles** even based on **short simulations**

Study area Eastern Italian Alps



DATA - METHODS

Data

174 Rain gauge stations

- Coverage period: 1992-2019 (Obs. time slice)
- Area: ~ 32000 km^2
- Elevation range (stations):
  -3÷2235 m a.s.l.
- Quality control: ≤10% gap per yr
- Data aggregation: 1h

COSMO-crCLIM simulations

- RCP8.5 scenario
- 3 ten years time slices
  - Historical 1996 – 2005
  - Near future 2041 -2050
  - Far future 2090 – 2099
- Time resolution: 1h
- Spatial resolution: ~2.2 km
- Station-collocated and all grid points

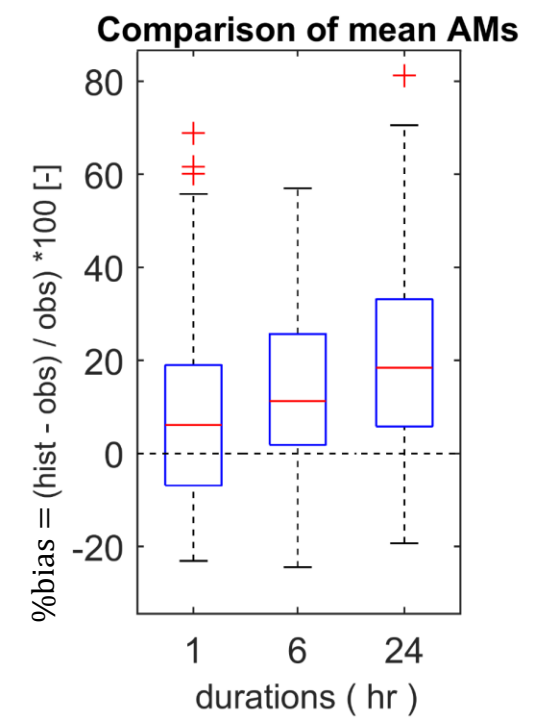
Method

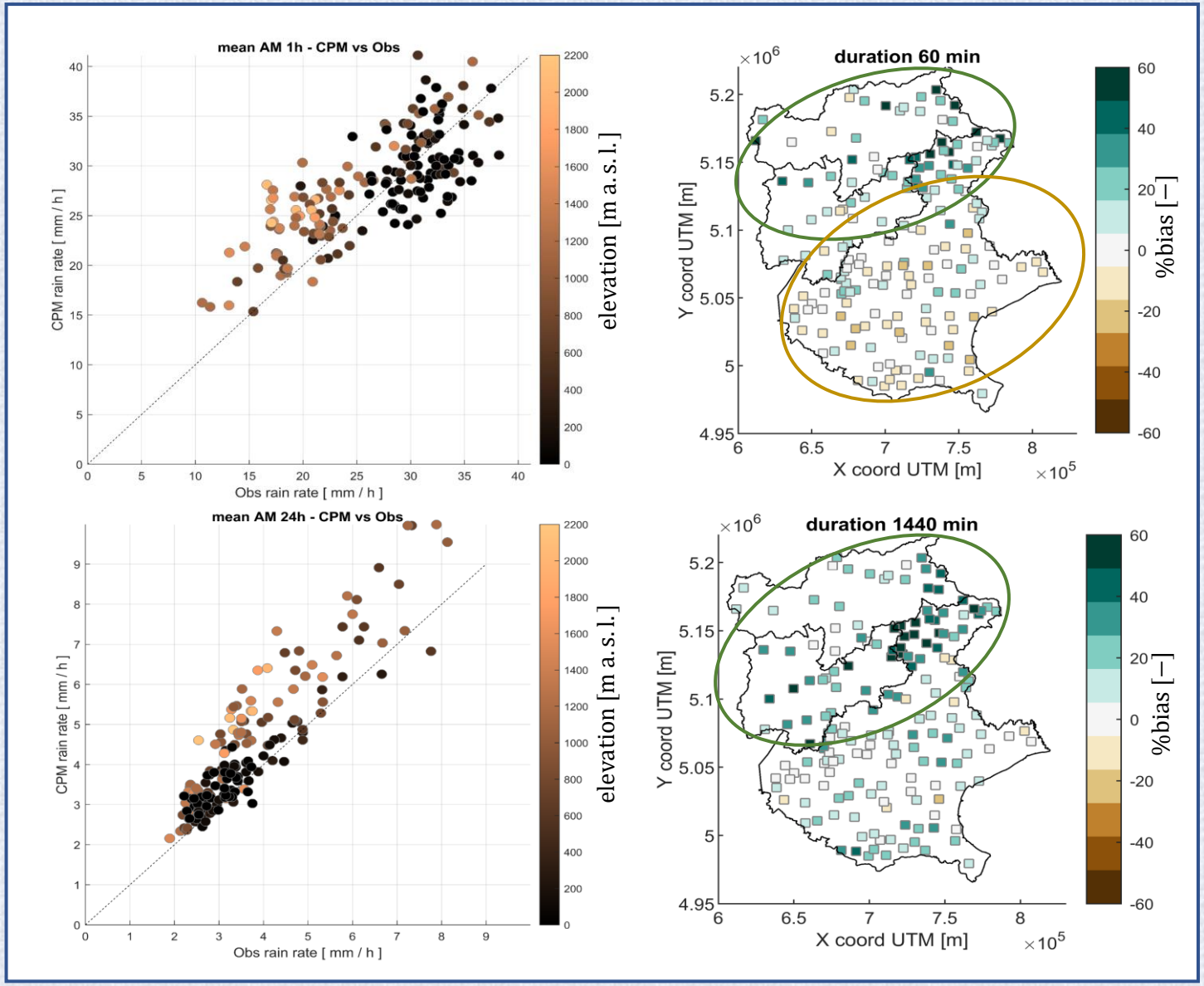
- **Frequency analysis** with Simplified Metastatistical Extreme Value distribution (SMEV)
- **Bias assessment**: historical CPM model (station-collocated) vs observations
- **Relative future changes**: near and future time slices vs historical

MODEL ASSESSMENT:
Annual Maxima - hist. model vs observation

$$\%\ bias[-] = \frac{X_{hist} - X_{obs}}{X_{obs}} \cdot 100$$

- General overestimation (bias median value = + 10-20%)
- Overestimation at high elevation
- Clear spatial pattern at 1h duration

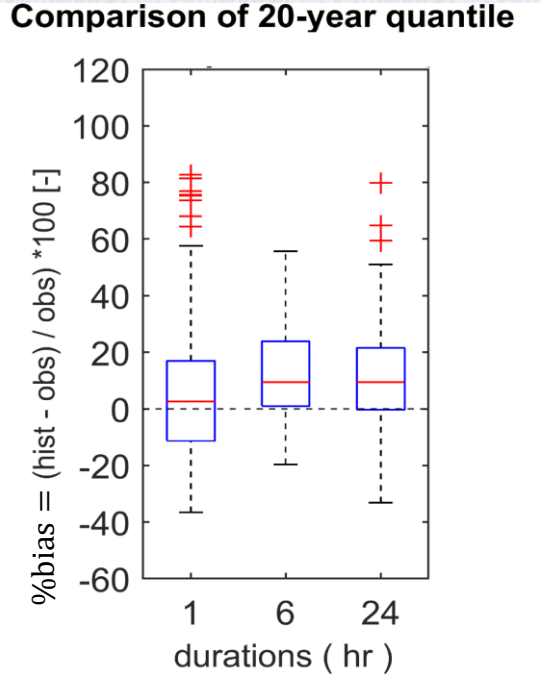


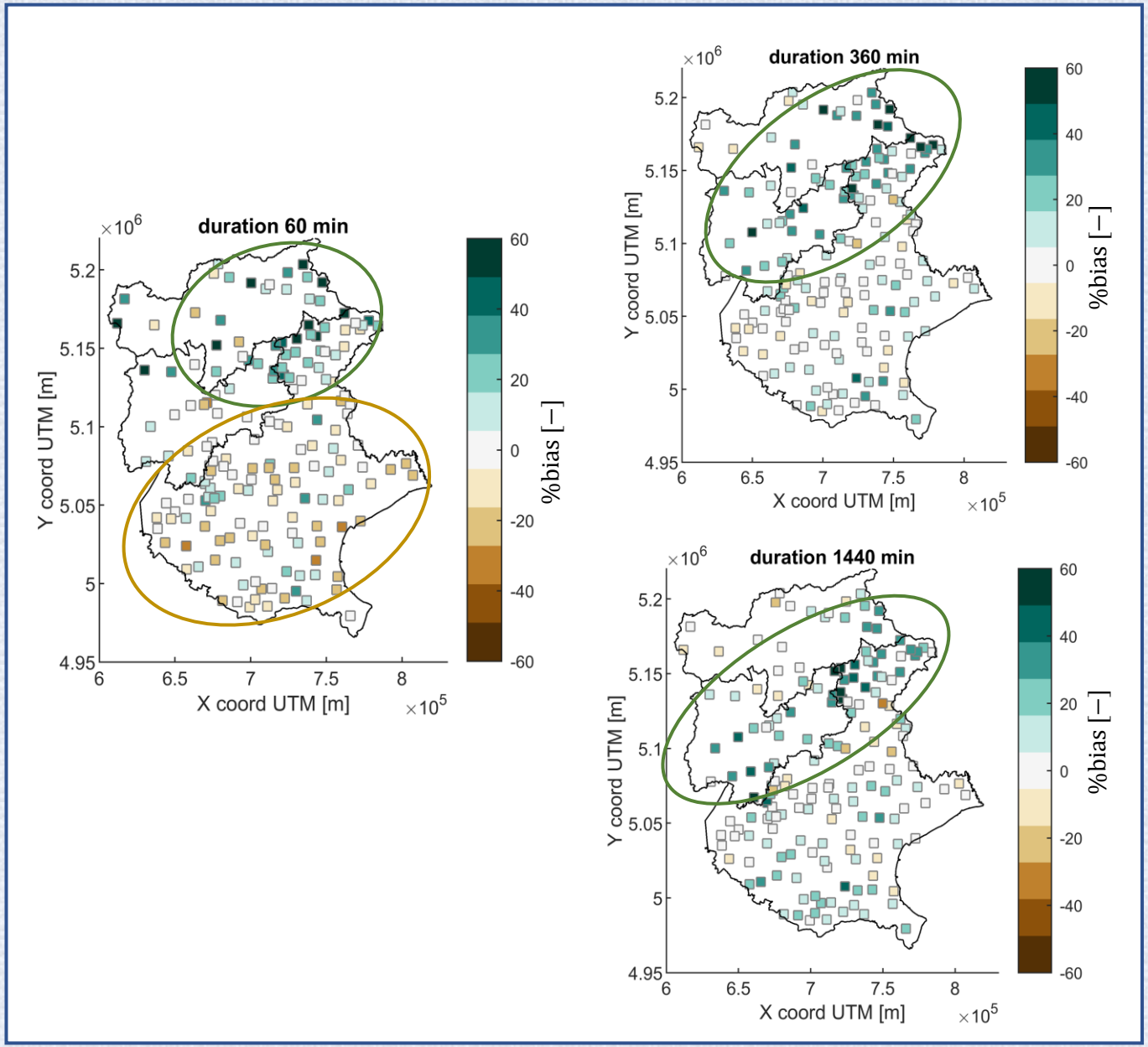


MODEL ASSESSMENT:
20yr return level- hist. model vs observation

$$\%\ bias[-] = \frac{X_{hist} - X_{obs}}{X_{obs}} \cdot 100$$

- Overestimation mostly at high elevation
- Underestimation in the lowlands at 1h duration

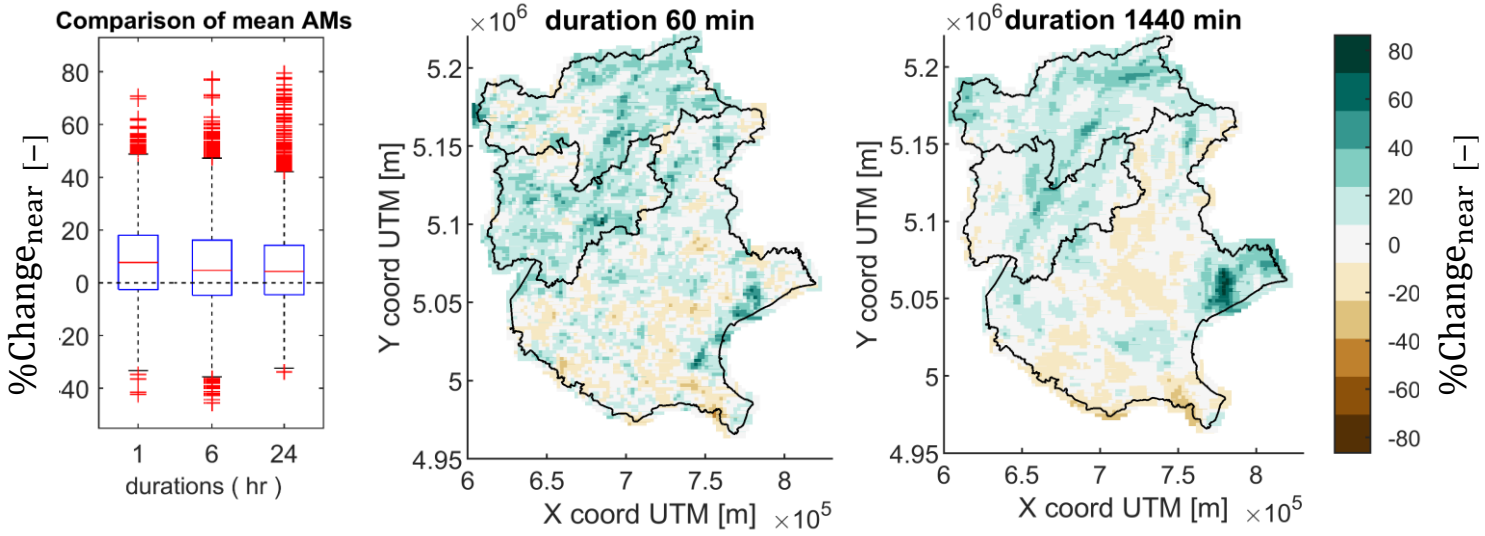




PROJECTIONS: Annual Maxima change

$$\%Change_{near,far}[-] = \frac{X_{near,far} - X_{hist}}{X_{hist}} \cdot 100$$

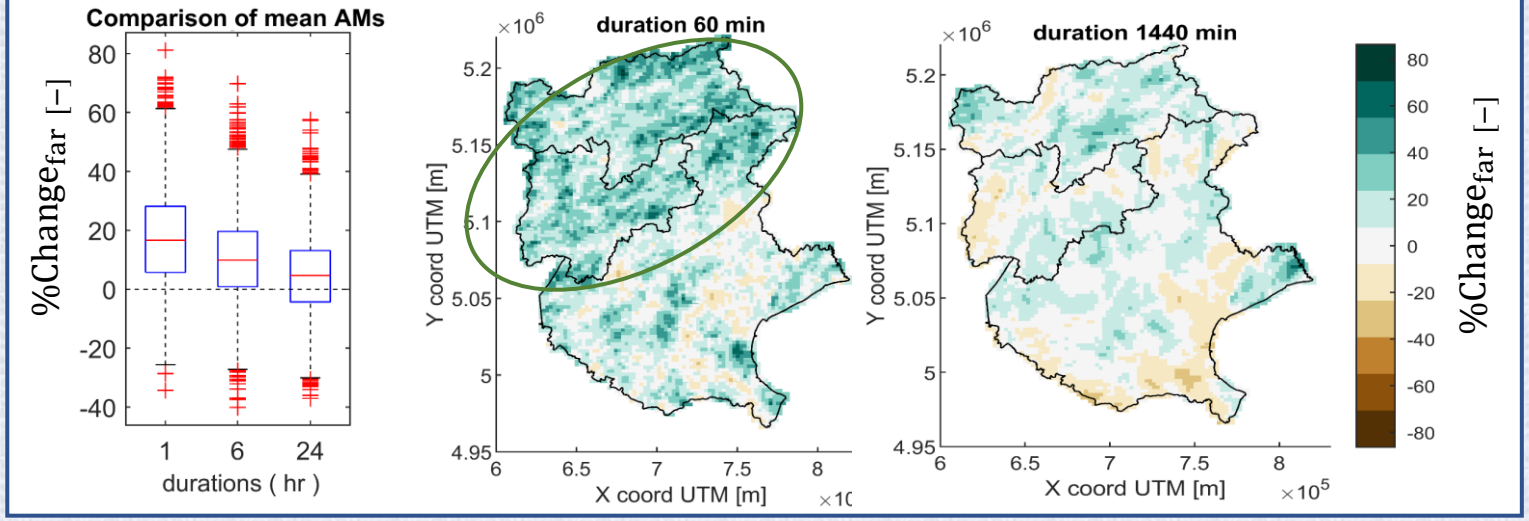
NEAR FUTURE



NEAR FUTURE

- Increasing intensity in mountains
- Generally decreasing in lowlands
- Similar change and its spatial pattern across durations

FAR FUTURE



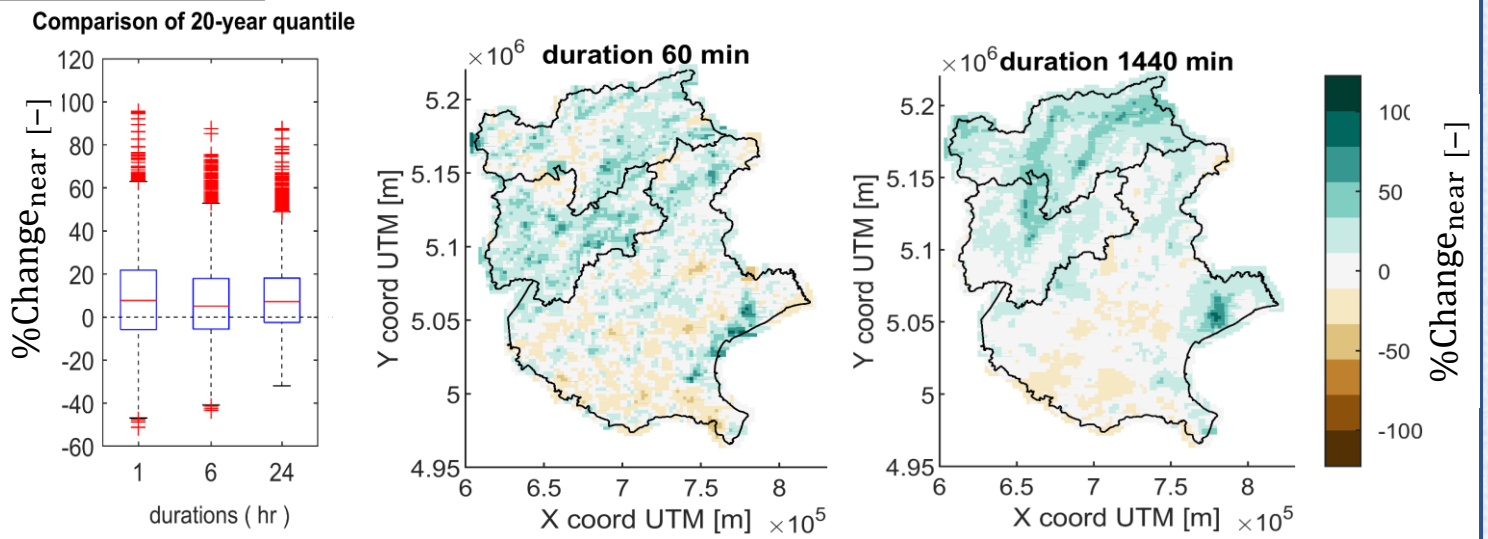
FAR FUTURE

- Stronger increase at 1h duration
- Expecially in the mountains
- 24h far future change similar to near future

PROJECTION: 20yr return level change

$$\%Change_{near,far}[-] = \frac{X_{near,far} - X_{hist}}{X_{hist}} \cdot 100$$

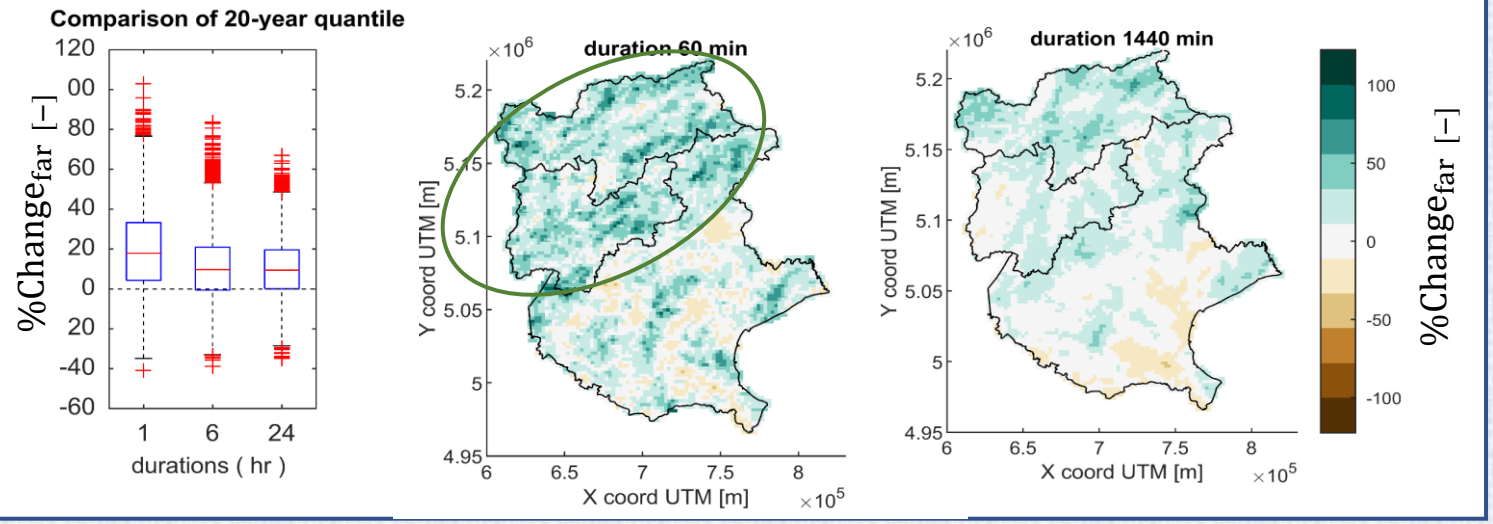
NEAR FUTURE



NEAR FUTURE

- Increasing intensity in mountains
- Generally decreasing in lowlands
- Similar change across durations

FAR FUTURE



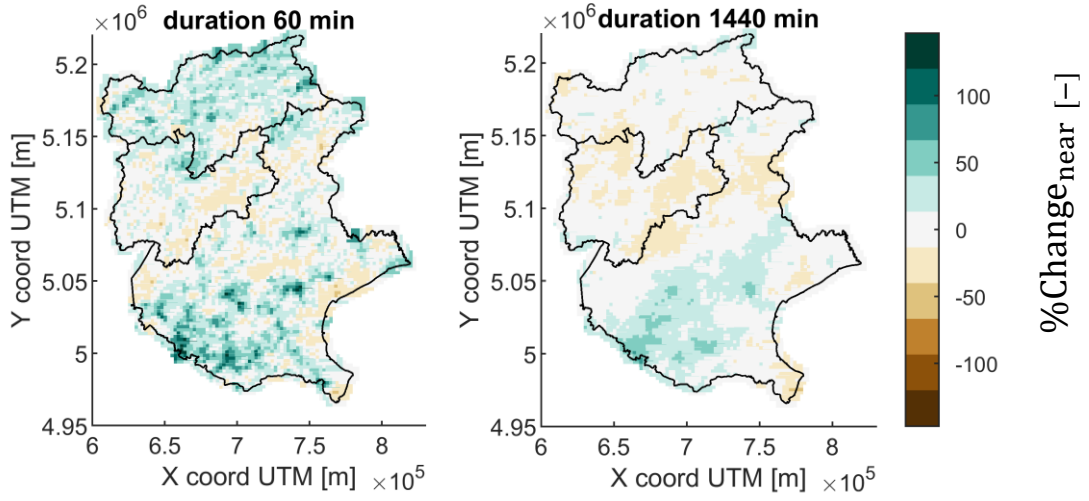
FAR FUTURE

- Stronger increase (50-70%) at 1h duration
- … in the mountains
- 24h far future change similar to near future

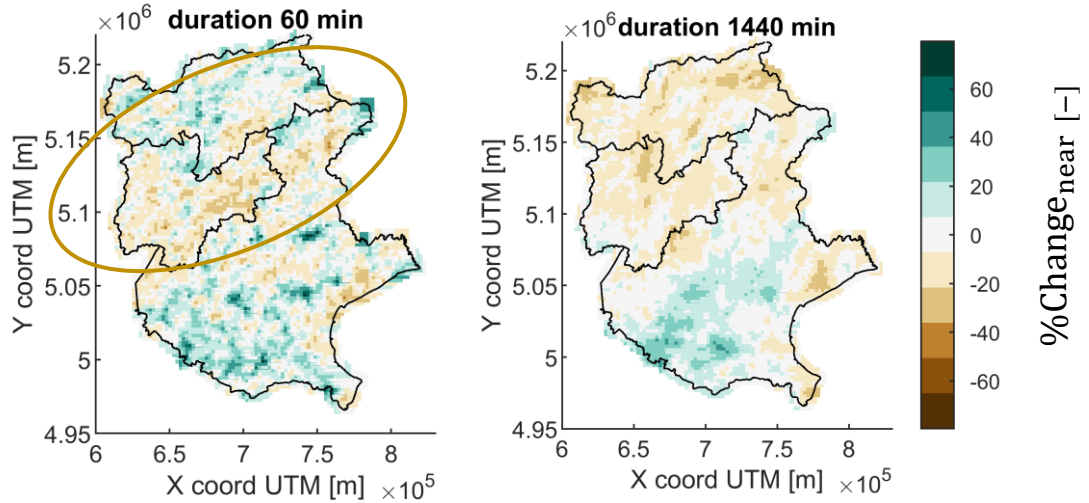
PROJECTION: parameters change (near f.)

$$\%Change_{near,far}[-] = \frac{X_{near,far} - X_{hist}}{X_{hist}} \cdot 100$$

NEAR FUTURE - SCALE



NEAR FUTURE - SHAPE



SCALE

- Generally increasing at 1h; but slightly decreasing in the central part of the area
- Weaker changes at 24h: decrease in mountains, increase in lowlands

SHAPE

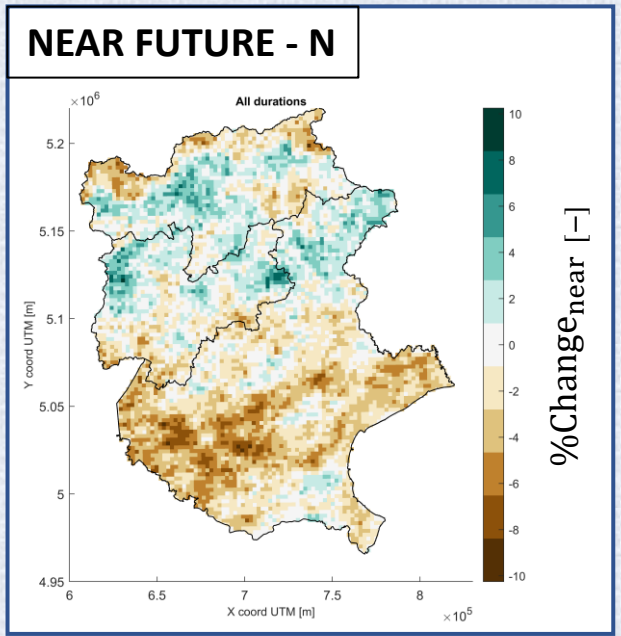
- Generally decreasing in mountains

→ heavier tails

N events

- Strong decrease in south-southwest

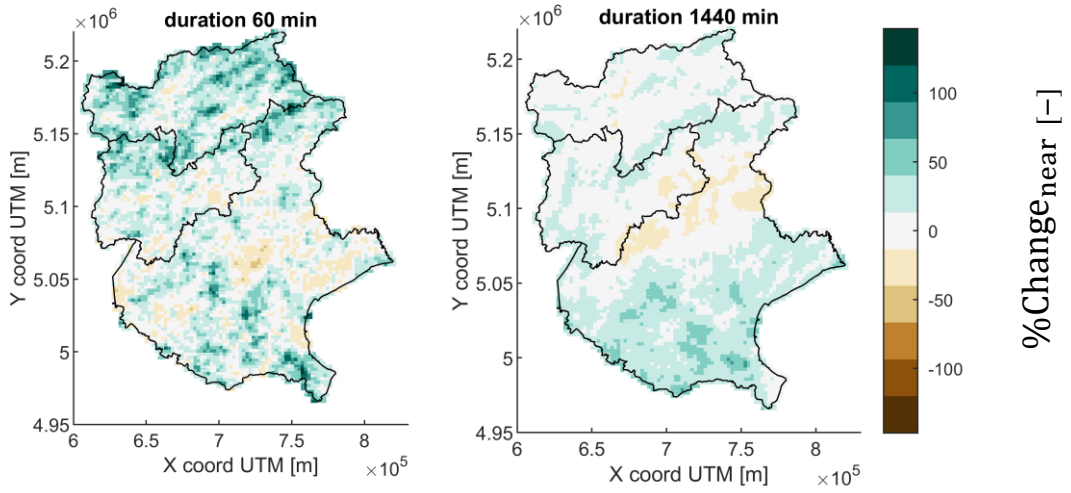
NEAR FUTURE - N



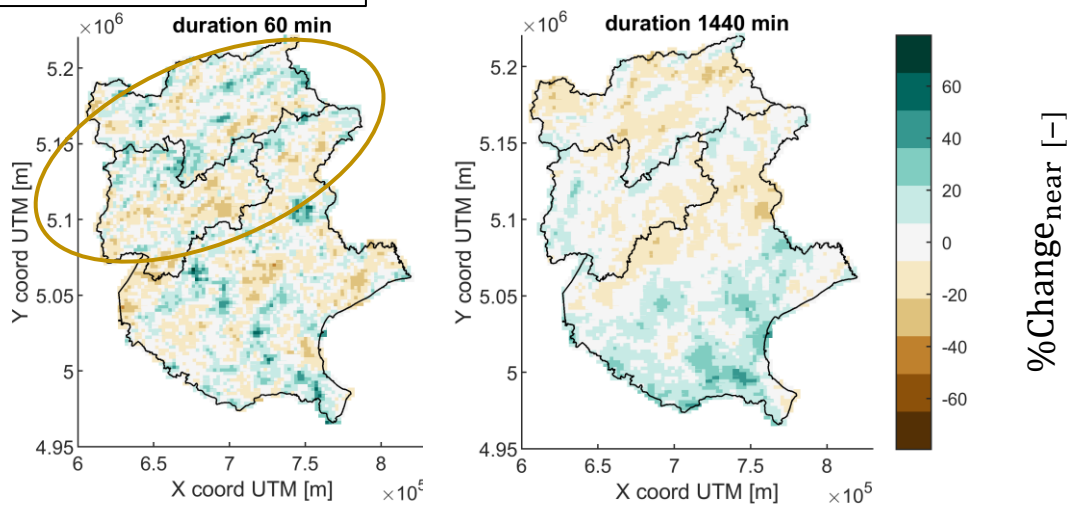
PROJECTION: parameters change (far f.)

$$\%Change_{near,far}[-] = \frac{X_{near,far} - X_{hist}}{X_{hist}} \cdot 100$$

FAR FUTURE - SCALE



FAR FUTURE - SHAPE



SCALE

- Generally increasing
- Stronger increase than near f. change

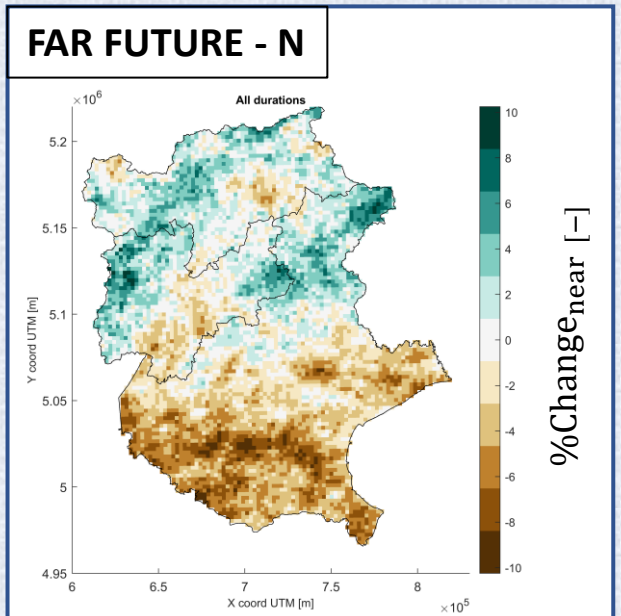
SHAPE

- Generally decreasing in mountains, milder than in near f. , and less defined spatial patterns → heavier tails where decreasing shape

N events

- Decreasing in lowlands, generally increase in mountains

FAR FUTURE - N



CONCLUSIONS

- CPM + SMEV → reliable estimates of long return time quantiles on high resolution future scenarios
- Elevation should be considered in CPM adjustment approaches
- Changes for subdaily extreme precipitation differ at the different durations and elevations
- A much stronger increase (50-70%) is expected for extreme precipitation in mountains at the short durations
- The distribution parameter can give further understanding on the changing processes

THANK YOU FOR YOUR ATTENTION

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