# Spatial downscaling of climate projections of temperature and precipitation over complex mountain terrain:

# A case study in the north-eastern Italian Alps

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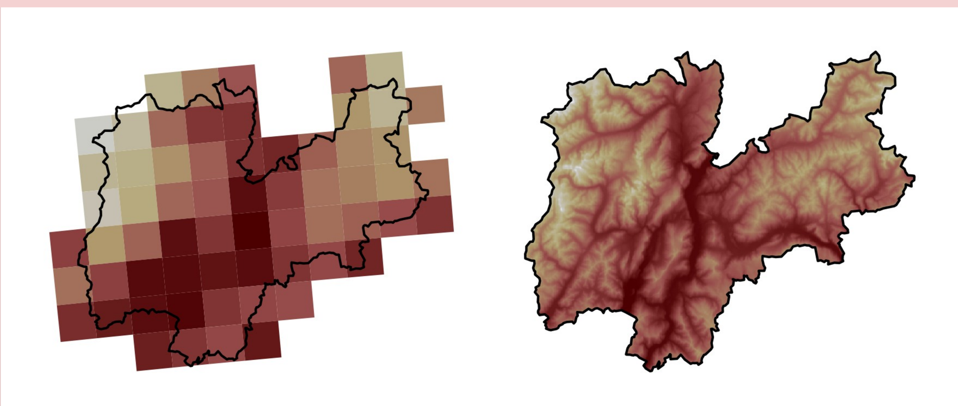
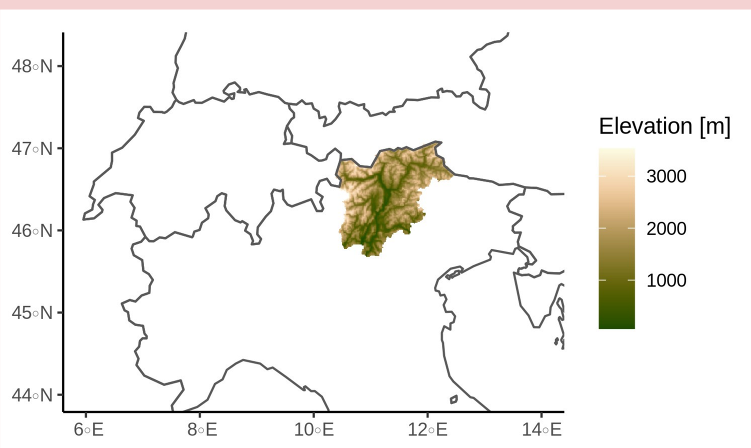
## 1 Introduction

**Motivation:**
From 12km regional climate model to 1km for local impacts in complex topography



**Study area:**
Trentino-Alto Adige region
NE Italy, Europe



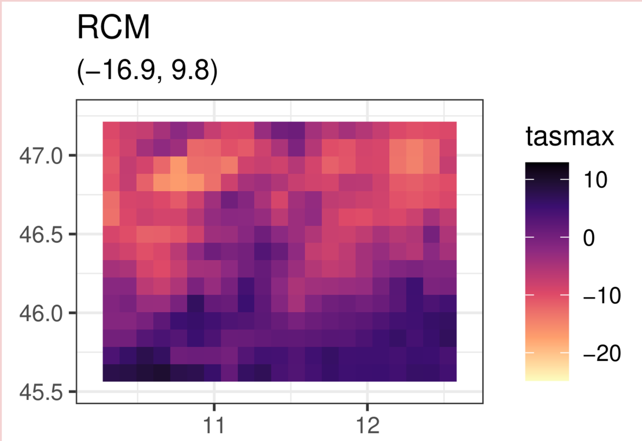

**Data (daily):**

- Model (12km) EURO-CORDEX RCMs, free-running GCM-driven
- Observations (1km) Spatial analysis (interpolation from stations): Crespi et al. 2021, ESSD, 10.5194/essd-13-2801-2021

## 2 Method (new)

Use a generalized additive model (GAM) to interpolate coarse resolution climate model to finer scale

**Input:**
Daily field of coarse resolution RCM data
(size = 23 x 17, n_gridcell = 391)



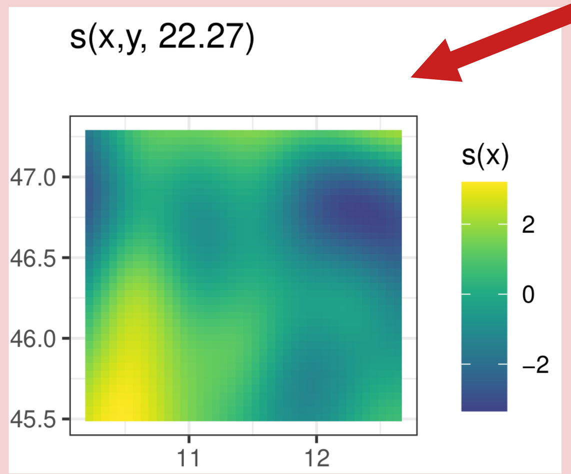

**Formula:**

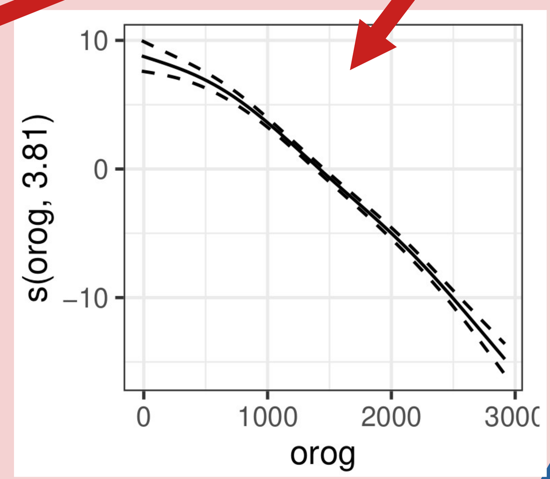
tasmax ~ s(x, y, k = 25) + s(orog, k = 5)

Spatial field

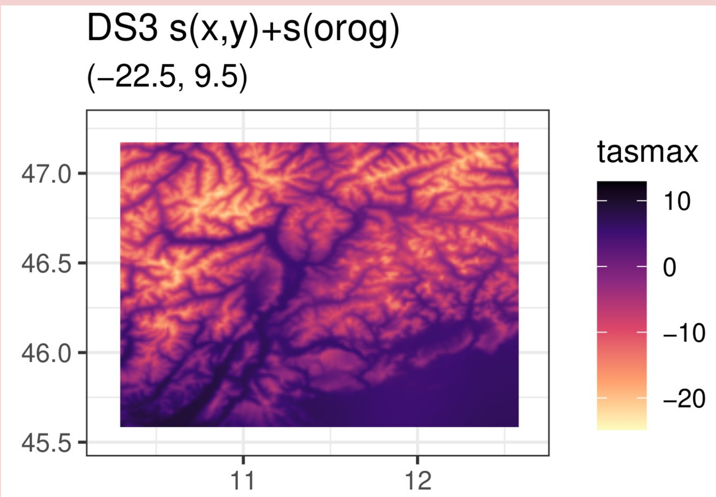
Elevation

**Example fitted smooth functions**




**Prediction on fine scale**
(size = 206 x 143, n_gridcell = 29458)



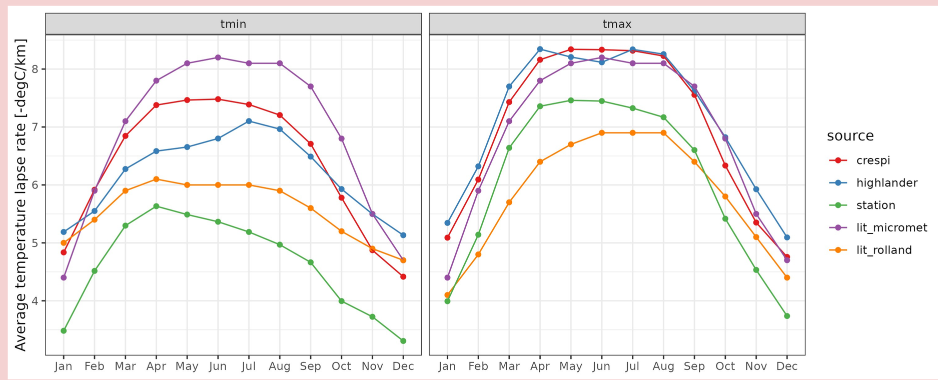

## 3 Method (other)

**"Abusing" EQM**

- Use bias-adjustment technique EQM (empirical quantile mapping) for downscaling, point-by-point
- Match hi-res obs gridcell with lo-res model gridcell
- Apply standard EQM (with wet-day correction), month-by-month
- Cross-validation framework (2-fold split 1981-2000, 2001-2020)

**Lapse rates**

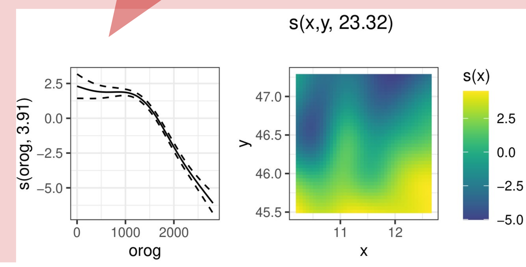
- Which lapse rates to choose for temperature?
  - Static 6.5K/km
  - monthly varying (e.g. Rolland 2003 J. Climate)
  - Micromet (Liston&Elder, 2006, 10.1175/JHM486.1)
- And precipitation?

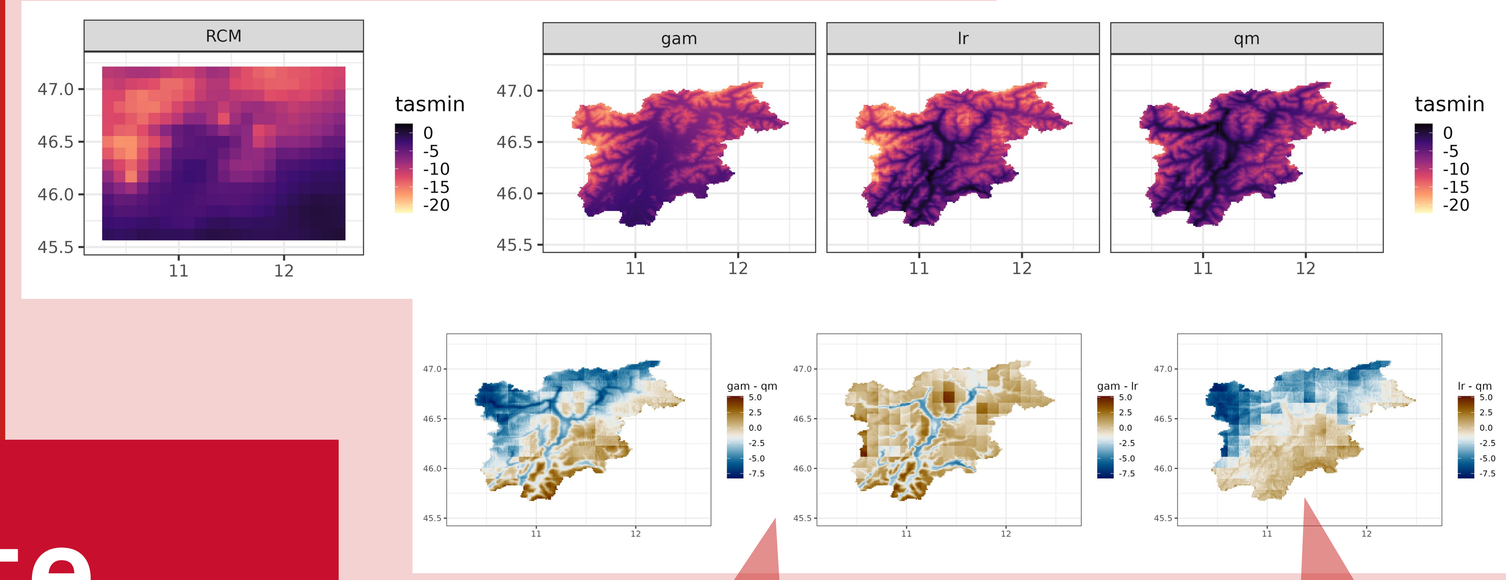



## 4 Results (temperature)

**Example:**
1 day minimum temperatures in winter

Nonlinear lapse rate.



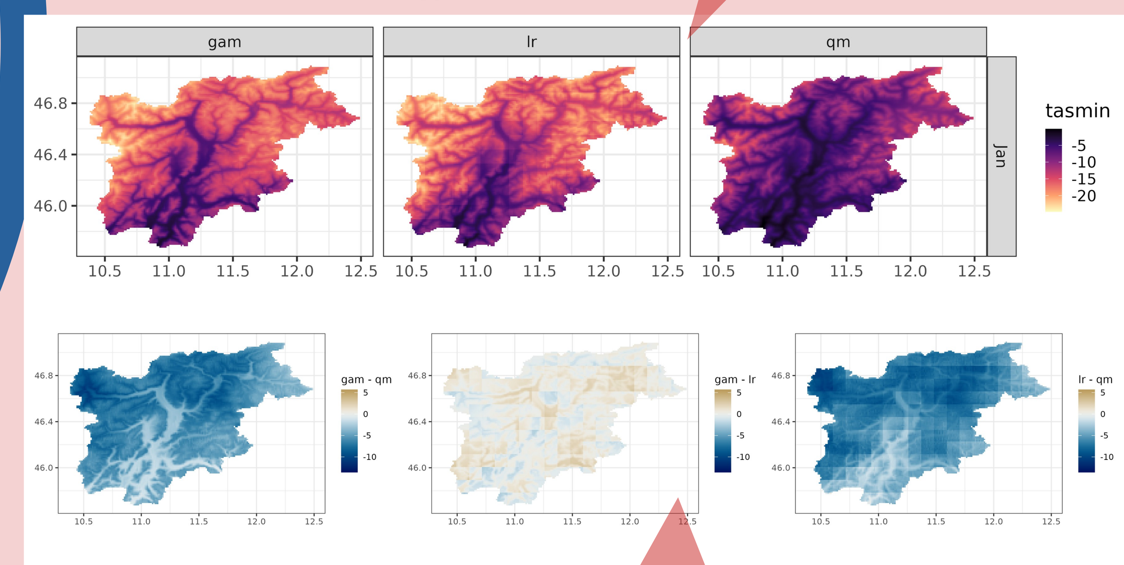




Coarse-scale grid cell boundaries

Large-scale gradients

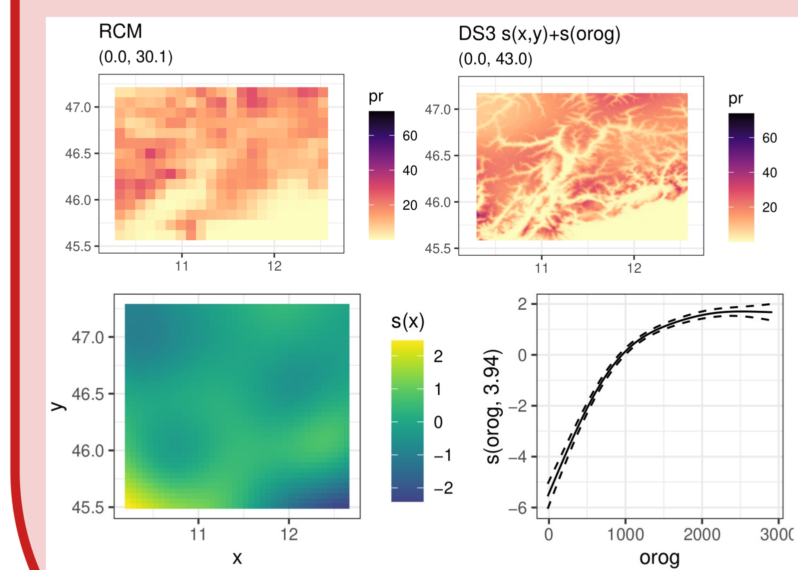
RCM winter cold bias

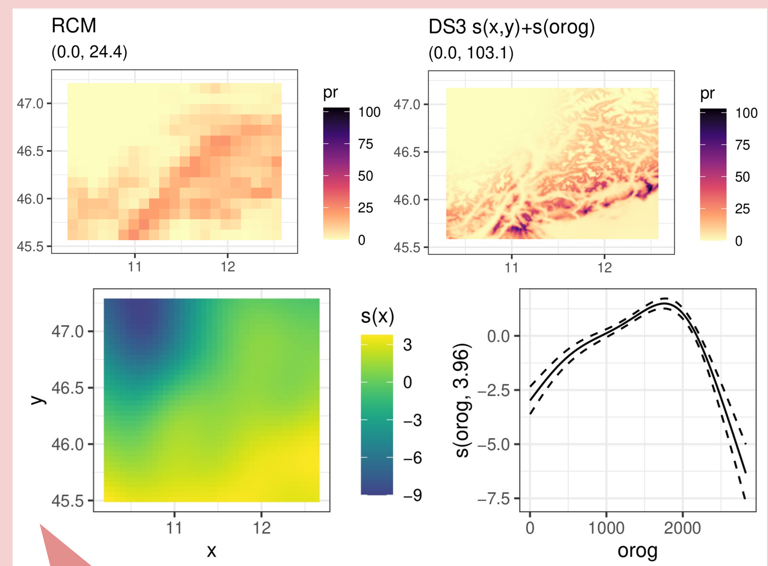
**Downscaled climatology**




Pure downscaling vs. Downscaling with bias-adjustment

## 5 And precipitation? ...not so sure...




Overestimation of elevation effect ? / Confounding of space and elevation ?

**Info:**
Used a Tweedie distribution to model intermittent nature of precipitation (occurrence and intensity)

## 6 Conclusions

- GAM generates smooth spatial field reflecting large-scale gradients and daily varying temperature lapse-rates
- Possibility to account for nonlinear temperature lapse-rates; however: depends on the accuracy of the RCMs at the respective scale
- Potential confounding of space and elevation (Mountains vs Po plain) particular to the choice of study area. Especially for precipitation, but also potentially for temperature.
- GAM and lapse-rate methods do not require observational data like QM
- QM does simultaneous bias-adjustment, too