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Downscaling and bias correction of seasonal forecasts to support climate services for the Alpine regions

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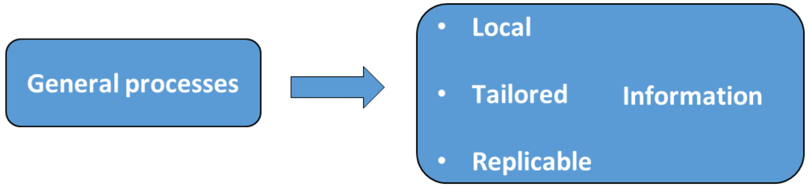
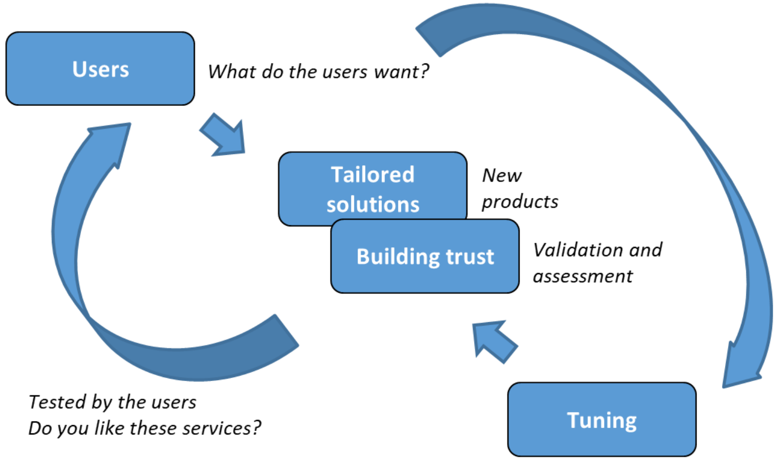
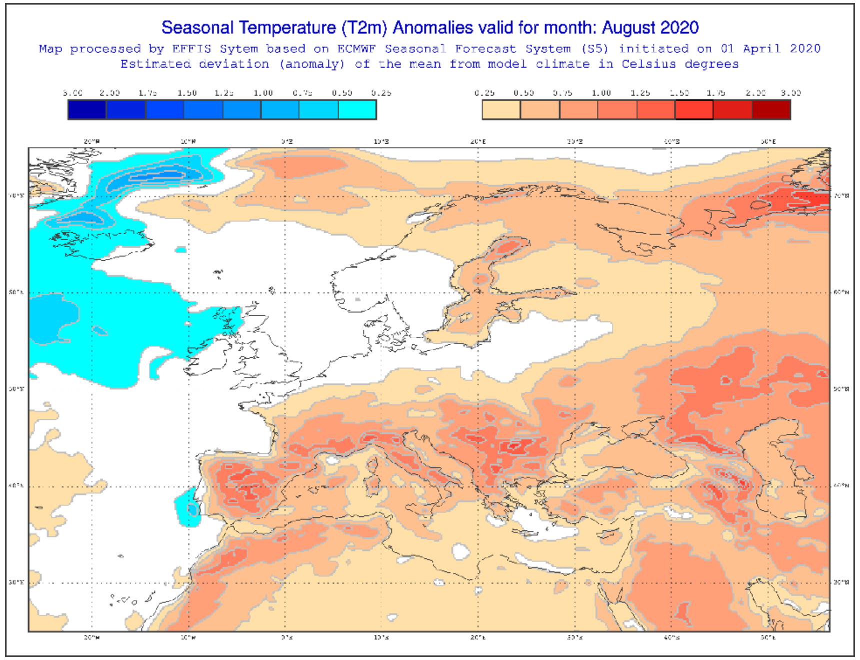
The value chain in climate services



Clear, operative and close to the users' needs climate information represents relevant a support tool for a wide range of decision-making policies, including risk management and energy production.

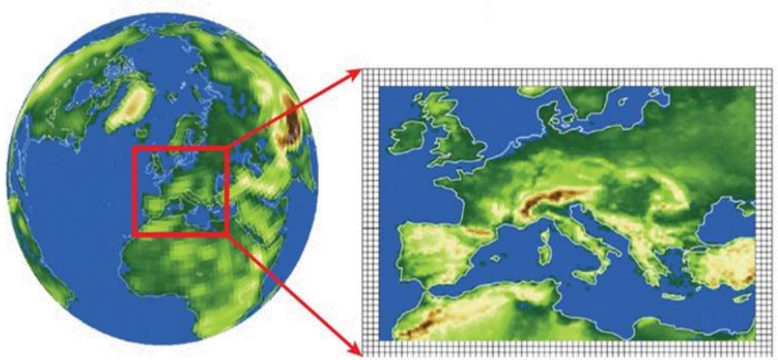




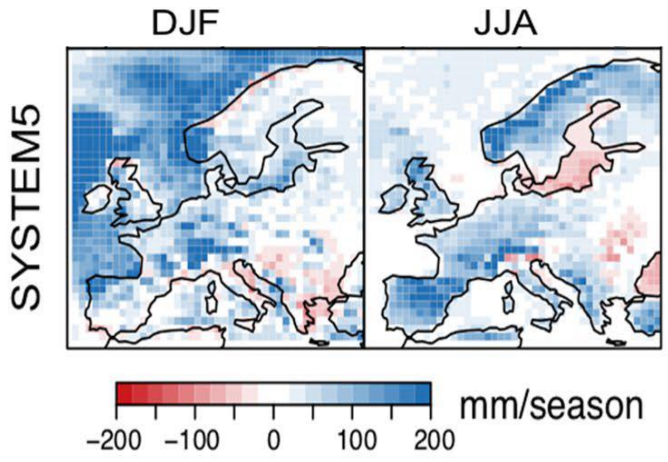
Seasonal forecasts (SF) provide predictions of the climate up to several months ahead and could support a wide range of activities, such as the optimization of renewable energy sector

https://effis.jrc.ec.europa.eu/applications/seasonal-forecast/

Towards tailored seasonal forecasts



The large spatial resolution of SF needs to be adapted to the local scales of specific applications. In orographically complex areas, such as the Alpine regions, predicted values could have relevant biases.



Manzanas et al., 2019
https://doi.org/10.1007/s00382-019-04640-4

SF downscaling and bias correction scheme

ECMWF seasonal forecasts
Variables: mean temp, tot prec
Time coverage: 1982 – 2018
Spatial coverage: Europe
Spatial resolution: 1° x 1°
Time resolution: monthly

DOWNSCALING/ REGRIDDING

***Seasonal forecasts** at 0.25° x 0.25°*

ERA-5
Variables: mean temp, tot prec
Time coverage: 1982 – 2018
Spatial coverage: Global
Spatial resolution: 0.25° x 0.25°
Time resolution: monthly

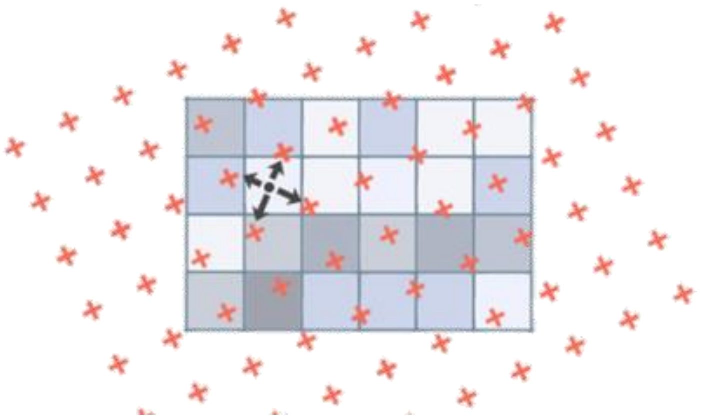
REPLICABILITY

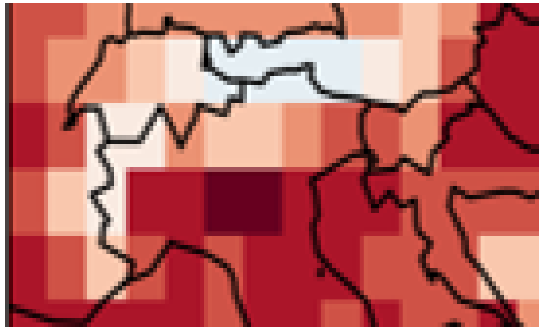
BIAS-CORRECTION

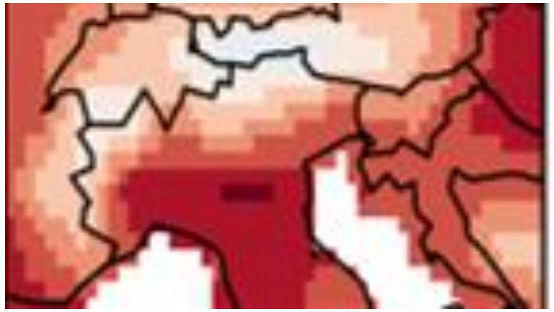
Bias-corrected seasonal forecasts
at 0.25° x 0.25° of monthly mean temperature and total precipitation

Downscaling and bias-correction of seasonal forecasts

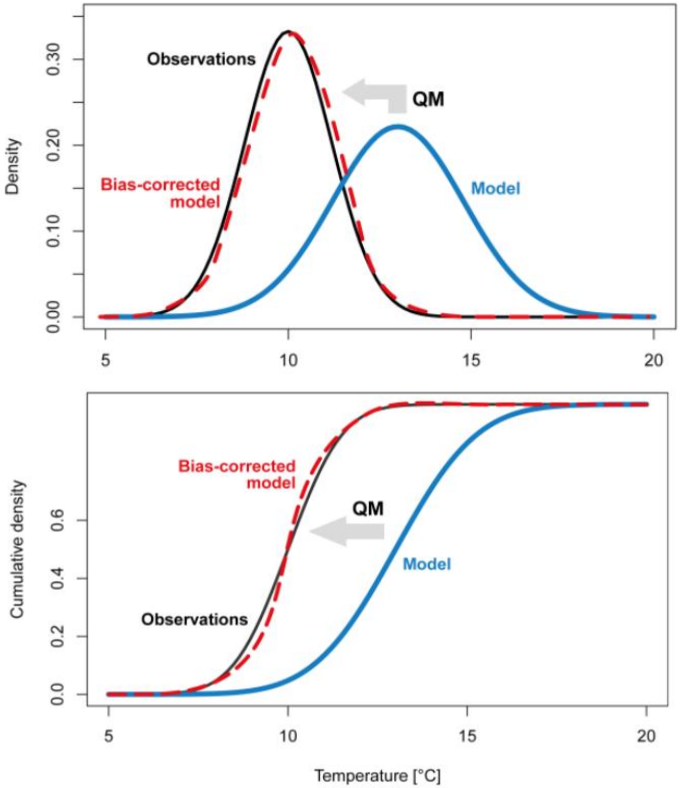
Downscaling/Regridding:
Bilinear interpolation







Bias correction:
Quantile mapping



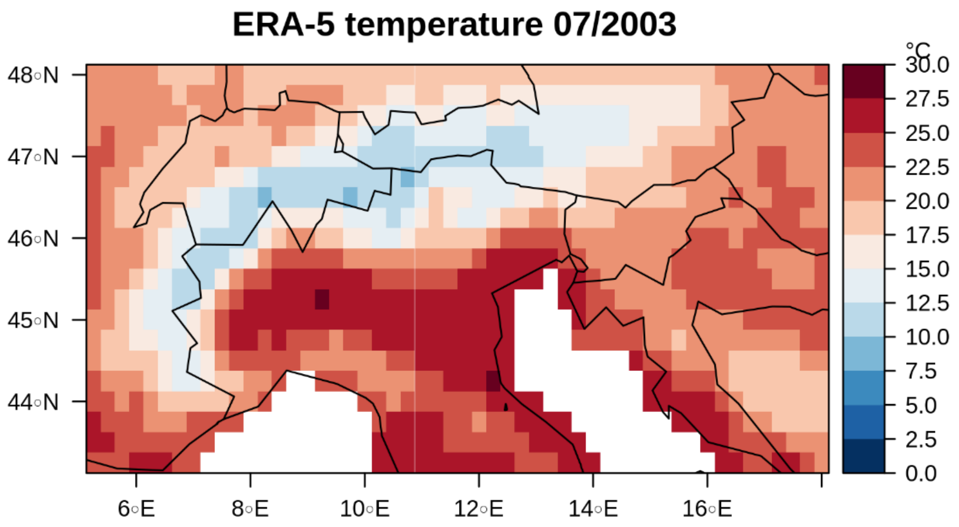
Feigenwinter et al., 2018
https://www.meteoschweiz.admin.ch/home/service-und-publikationen/publikationen.subpage.html/de/data/publications/2018/11/exploring-quantile-mapping-as-a-tool-to-produce-user-tailored-climate-scenarios-for-switzerland.html

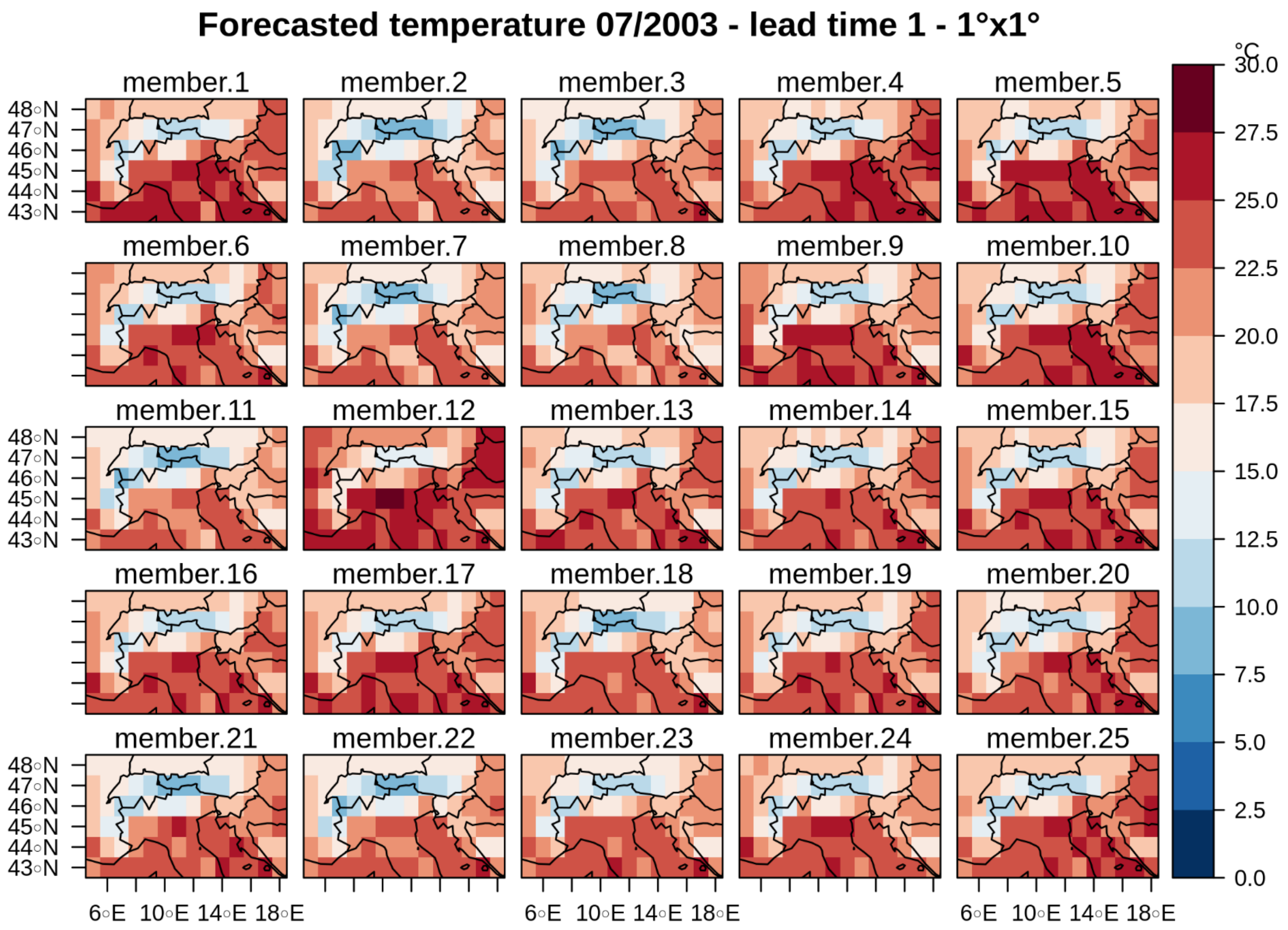
Downscaling and bias-correction of seasonal forecasts

Example of workflow for seasonal forecasts (lead time 1) of monthly temperature fields for July 2003

STEP 1: original seasonal forecasts

ERA-5 reference field



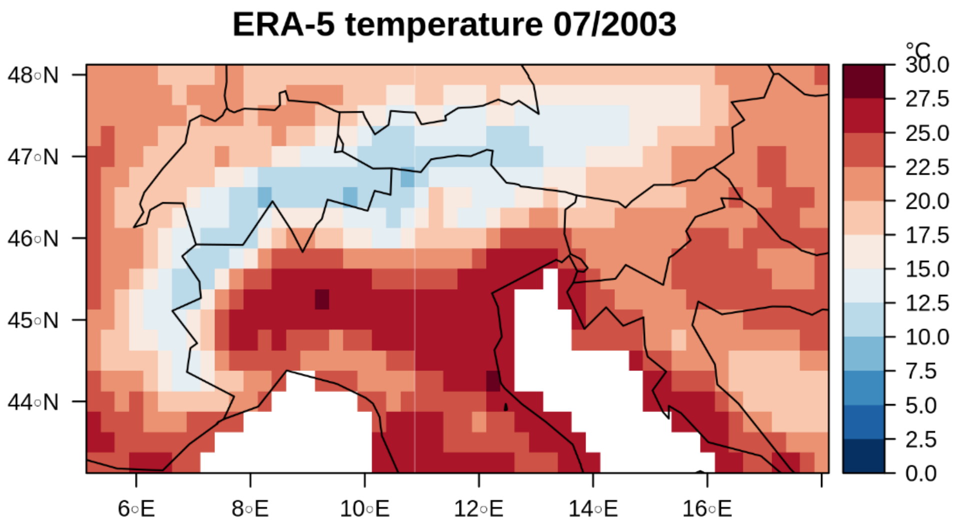


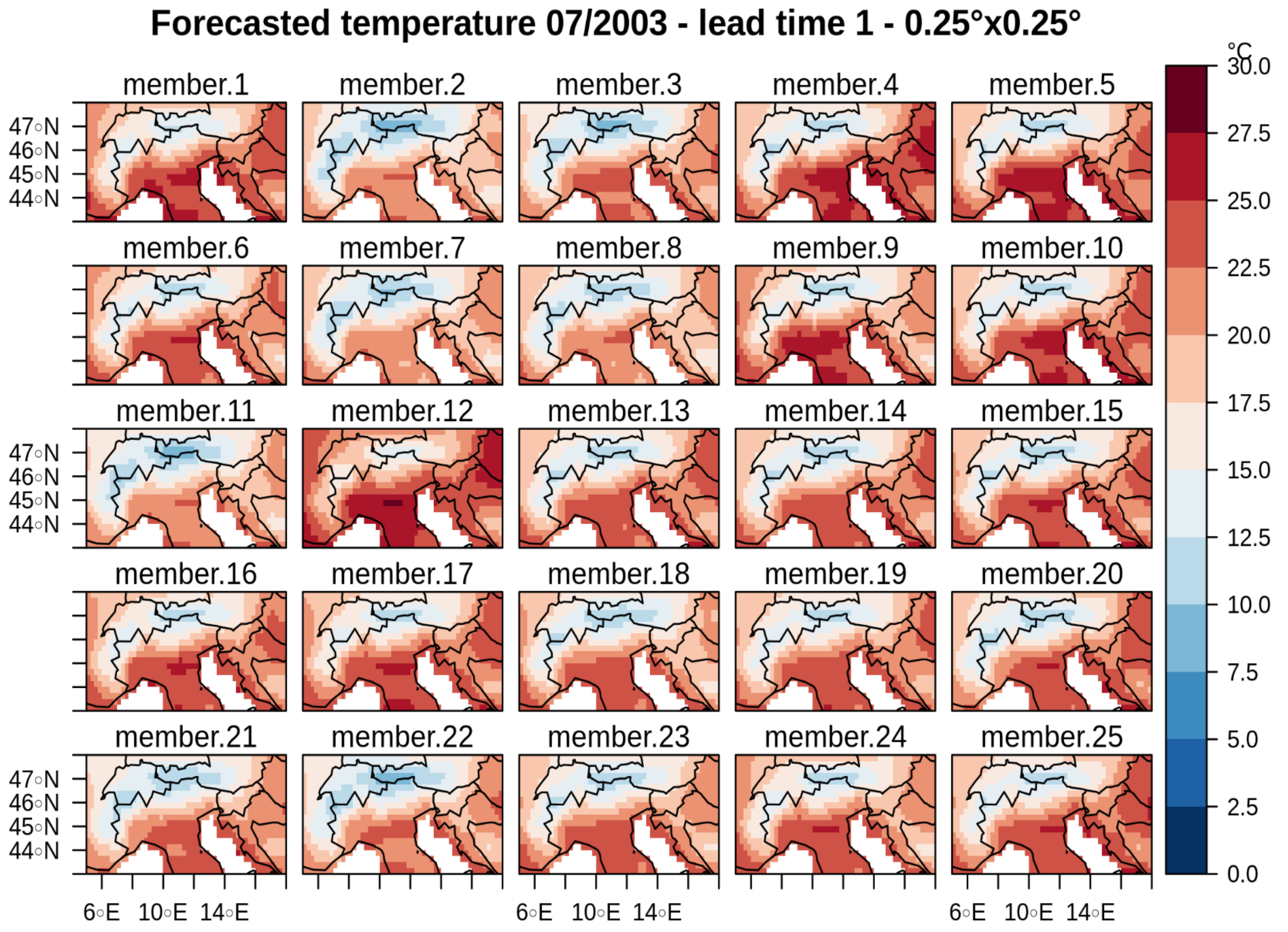
Downscaling and bias-correction of seasonal forecasts

Example of workflow for seasonal forecasts (lead time 1) of monthly temperature fields for July 2003

STEP 2: downscaled seasonal forecasts

ERA-5 reference field



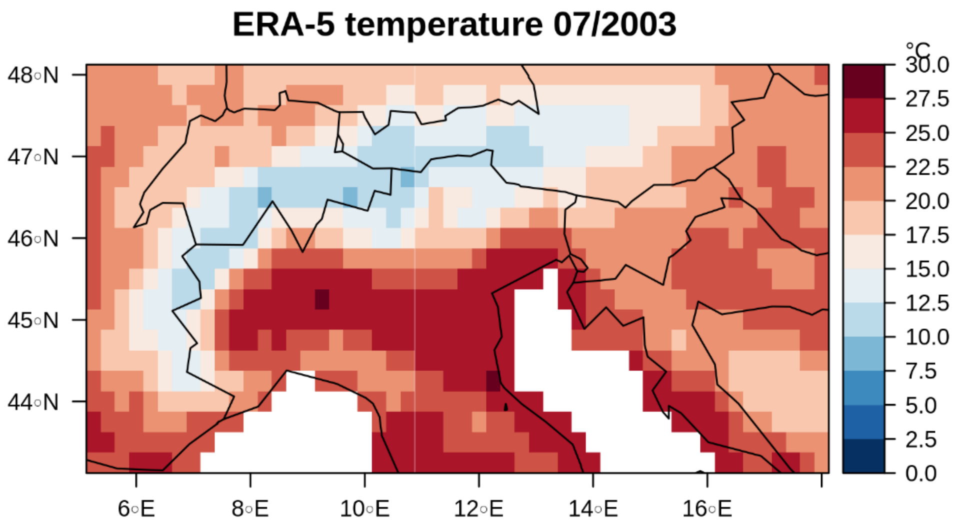


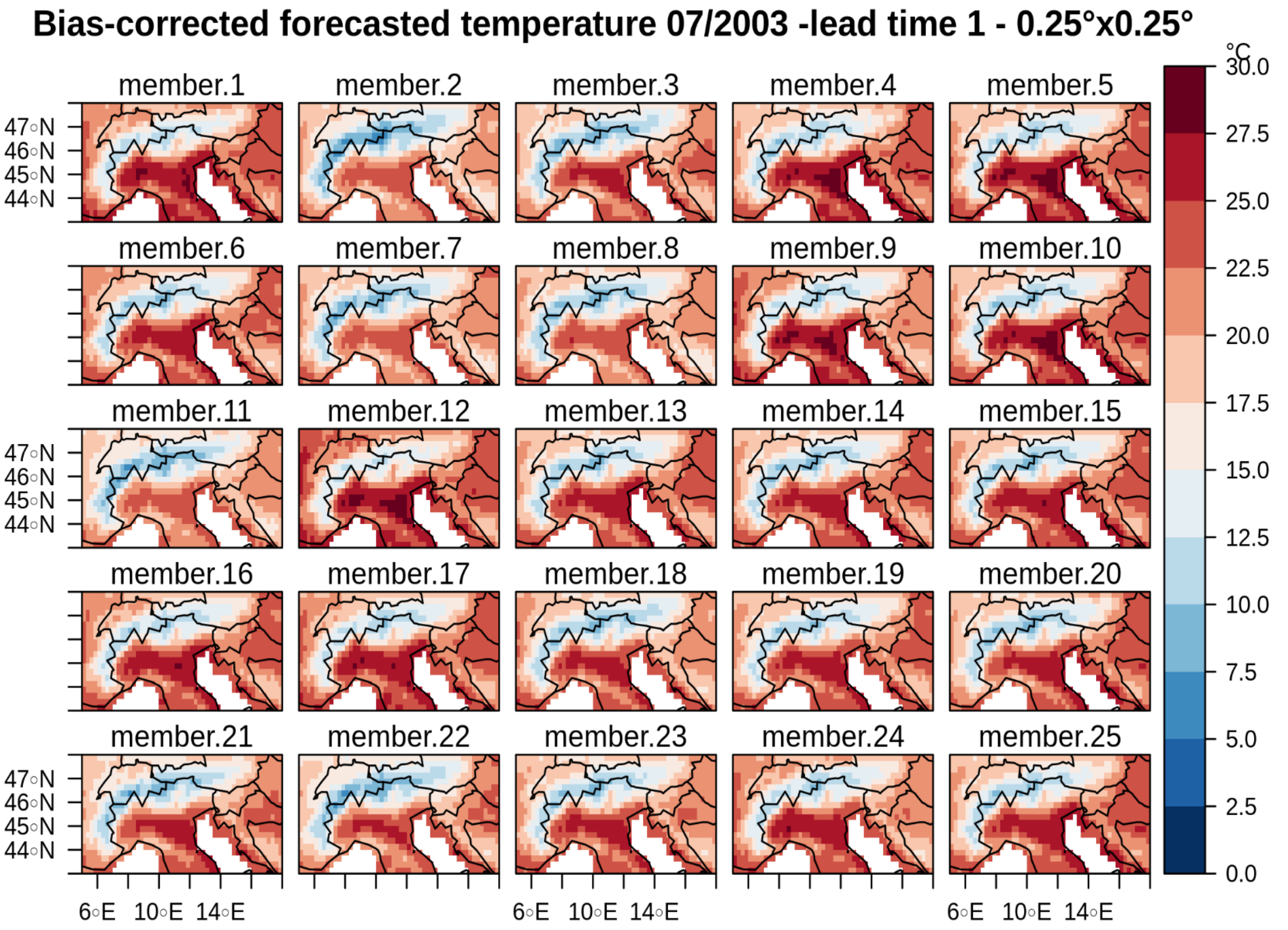
Downscaling and bias-correction of seasonal forecasts

Example of workflow for seasonal forecasts (lead time 1) of monthly temperature fields for July 2003

STEP 3: bias-corrected seasonal forecasts

ERA-5 reference field

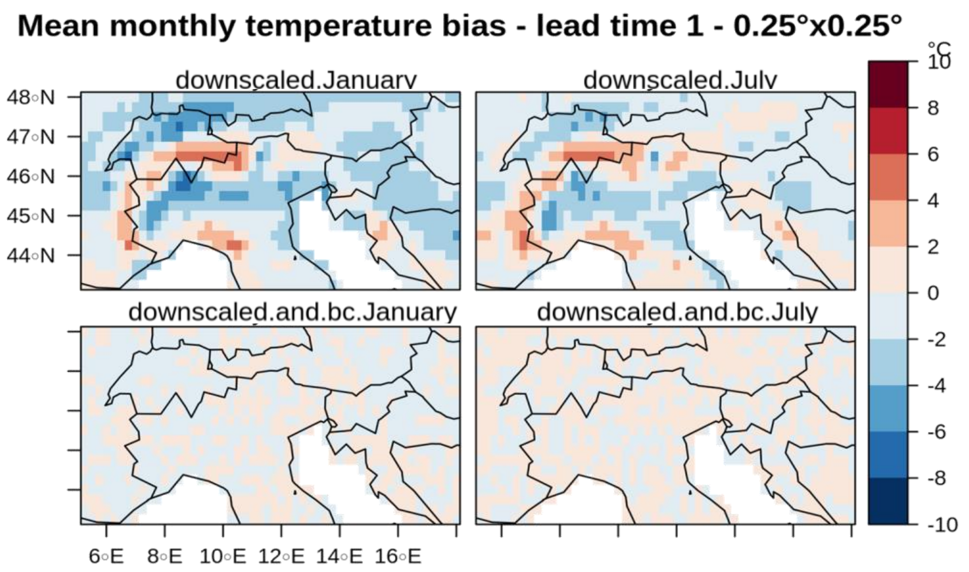


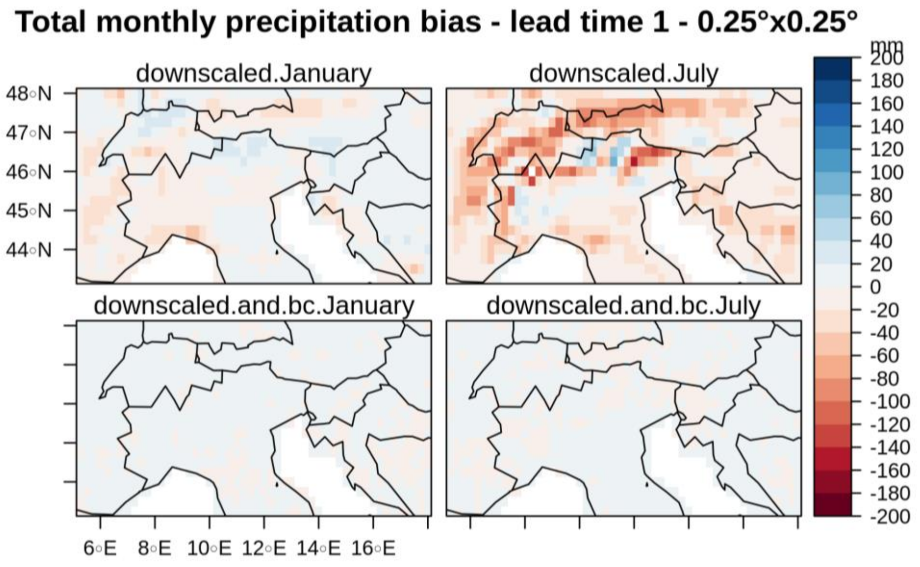


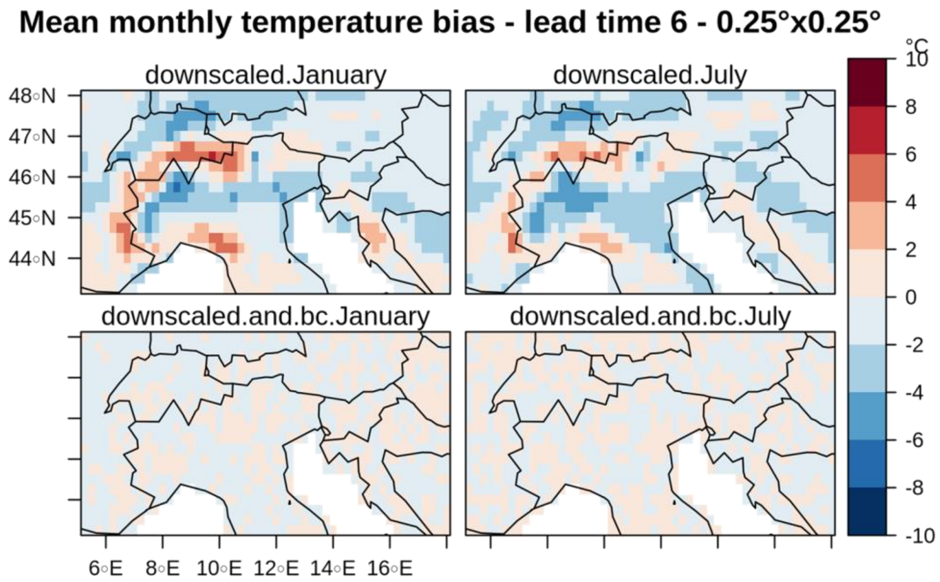
Downscaling and bias-correction of seasonal forecasts

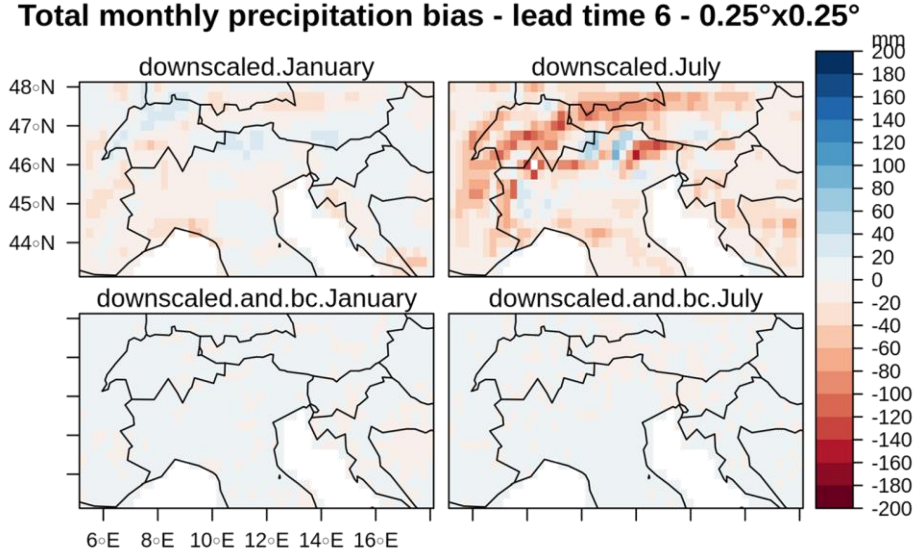
Evaluation of mean monthly bias over all members with respect to ERA-5 of forecasted monthly mean temperature and total precipitation over the period 1985-2014

Results for lead times 1 (top) and 6 (bottom) are reported









Downscaling and bias-correction of seasonal forecasts

?

Could a different downscaling approach reduce the final seasonal forecast errors?

Downscaling by an anomaly-based scheme with linear interpolation

$$\bar{t}_m(x,y) = \alpha_m(x,y) + \beta_m(x,y) \cdot h(x,y)$$

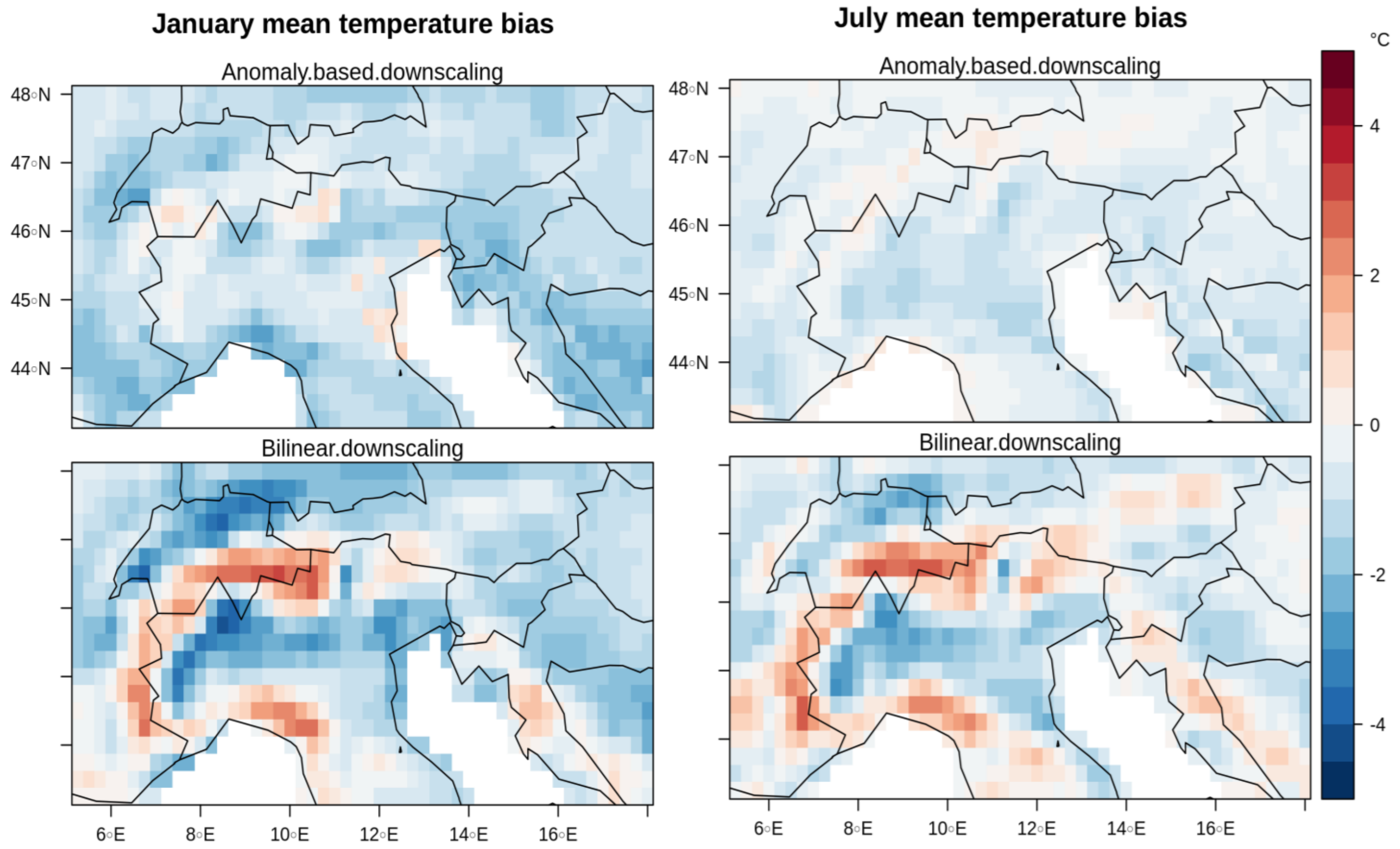
Interpolated long-term means *using* ***elevation*** *as predictor and weights depending on geographical features*

$$a_m(x,y) = \frac{\sum_j w_j(x,y) \cdot a_{m,j}}{\sum_j w_j(x,y)}$$

Interpolated monthly anomalies *by weighted average approach depending on distance and elevation*

$$t_m(x,y) = a_m(x,y) + \bar{t}_m(x,y)$$

Final fields *as superimposition of interpolated anomalies and long-term means*



The bias of downscaled fields (averaged over SF members and years) with respect to ERA-5 is lower by applying the anomaly-based (top) rather than the bilinear interpolation (bottom)

Downscaling and bias-correction of seasonal forecasts

?

Could a different downscaling approach reduce the final seasonal forecast errors?

Downscaling by an anomaly-based scheme with linear interpolation

$$\bar{t}_m(x,y) = \alpha_m(x,y) + \beta_m(x,y) \cdot h(x,y)$$

Interpolated long-term means *using* ***elevation*** *as predictor and weights depending on geographical features*

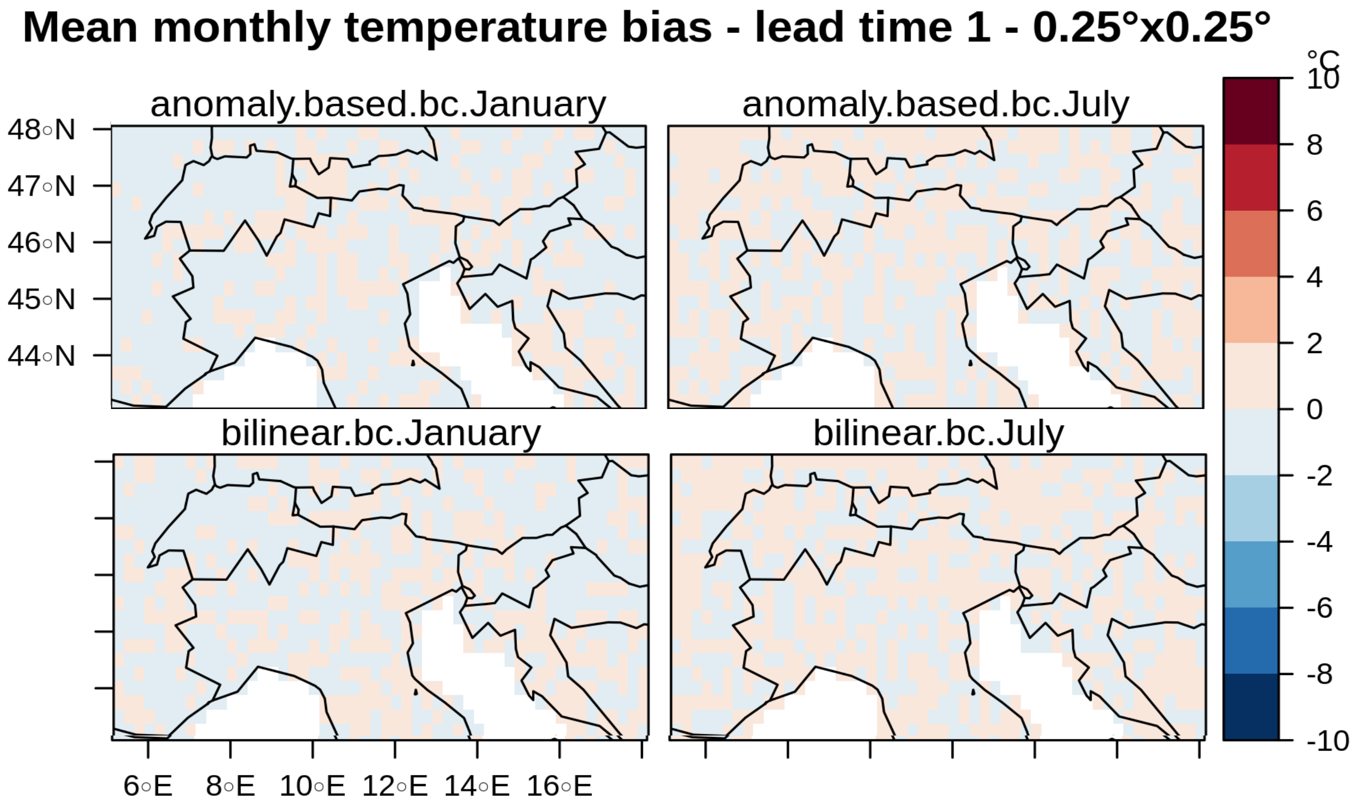
$$a_m(x,y) = \frac{\sum_j w_j(x,y) \cdot a_{m,j}}{\sum_j w_j(x,y)}$$

Interpolated monthly anomalies *by weighted average approach depending on distance and elevation*

$$t_m(x,y) = a_m(x,y) + \bar{t}_m(x,y)$$

Final fields *as superimposition of interpolated anomalies and long-term means*

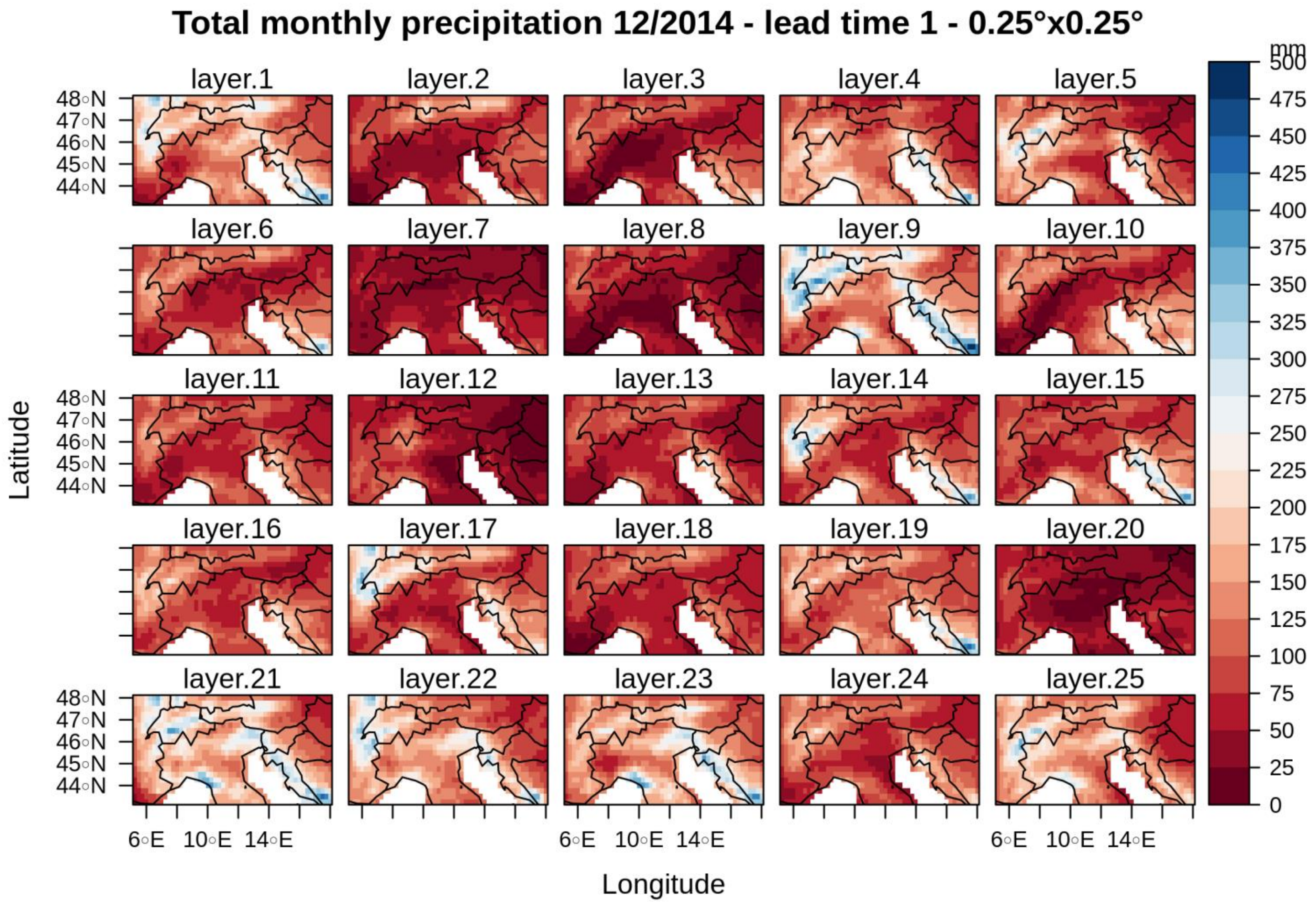
QUANTILE-MAPPING

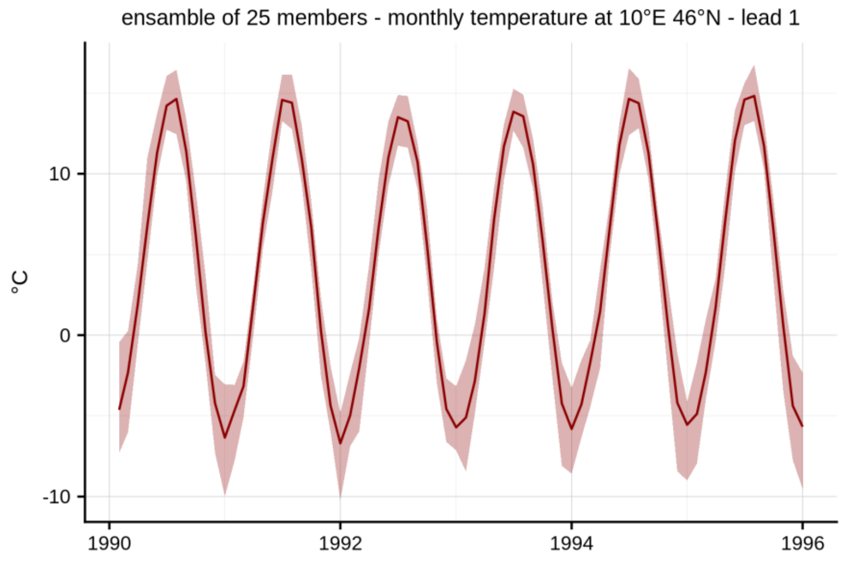


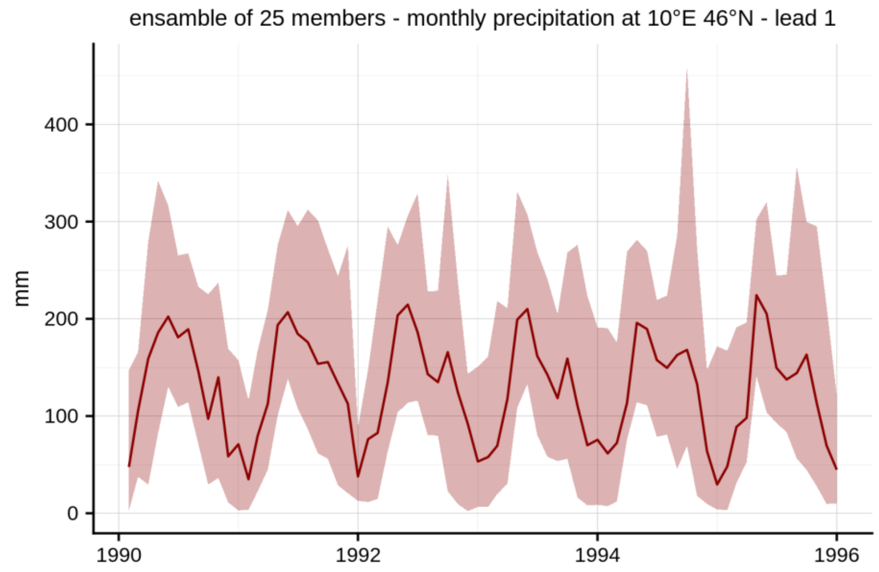
After the bias-correction, the errors with respect to ERA-5 are comparable

Downscaling and bias-correction of seasonal forecasts

It could be explained by the fact that the signal is extracted from a highly noisy sample…

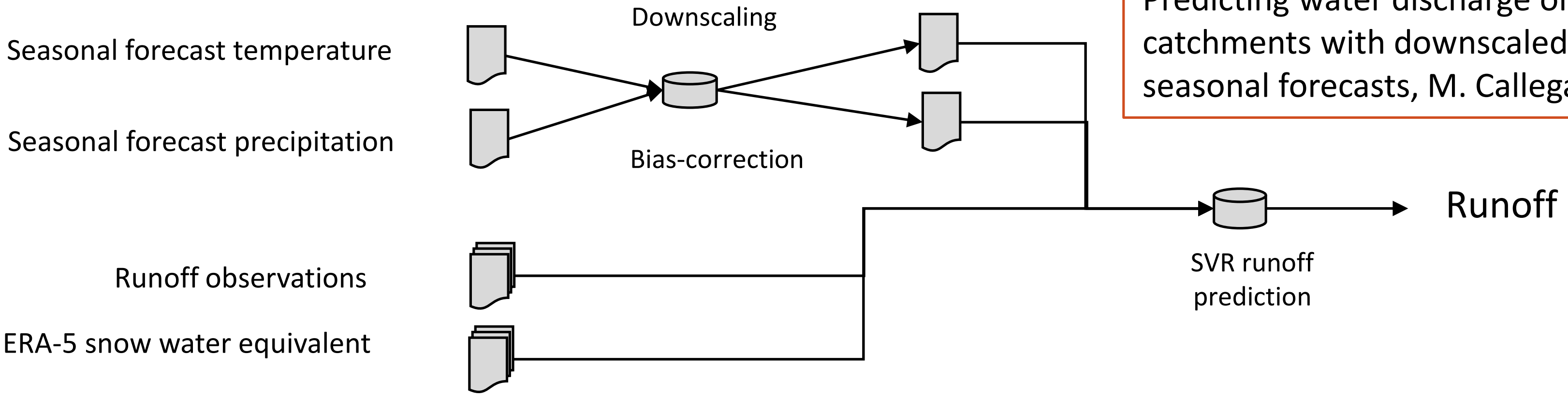






Case study application: forecast of catchment runoff

For more details: EGU2020-8869 - Predicting water discharge on alpine catchments with downscaled seasonal forecasts, M. Callegari et al.



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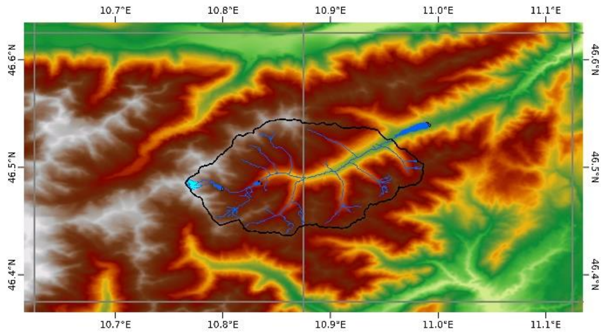

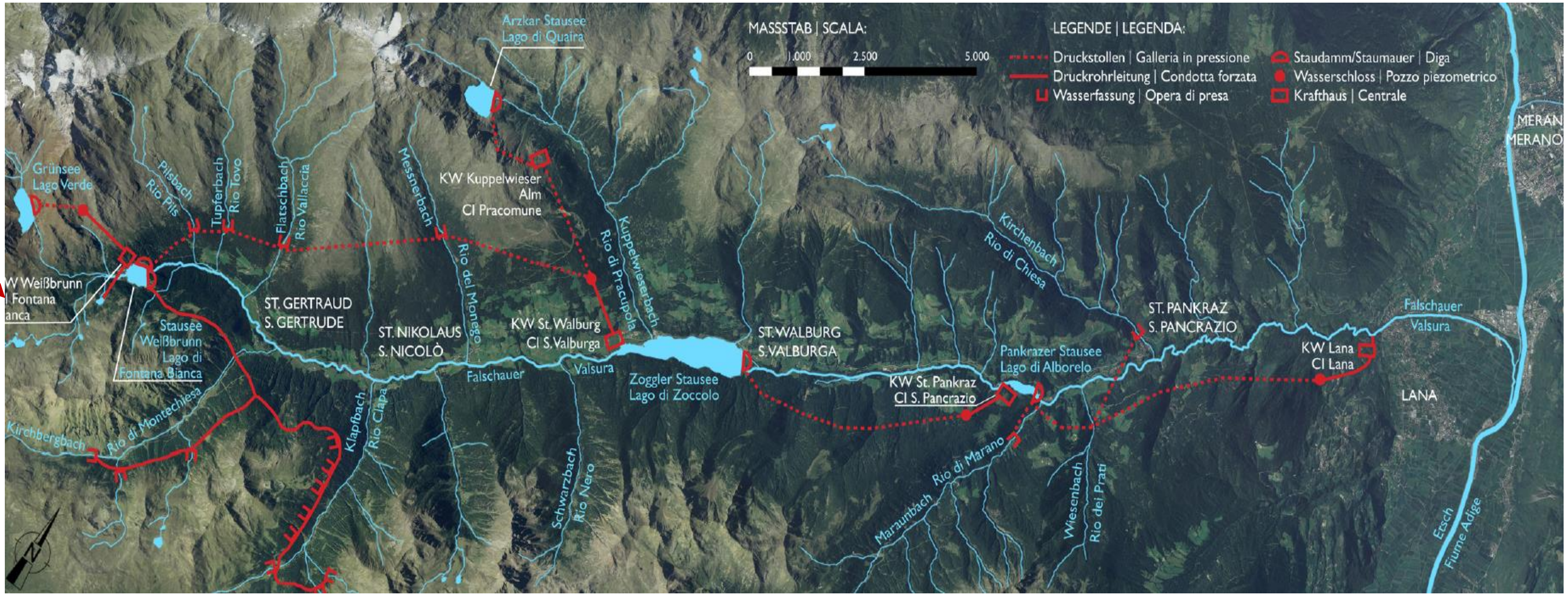

Conclusions and outlook

- An operative workflow for the provision of tailored and local seasonal forecast data to the end-users of the energy sector in the Alpine region was implemented in the framework of SECLI-FIRM project
- The overall accuracy of the bias-corrected data with respect to ERA-5 reference fields was analyzed
- The final mean errors are independently from the lead time and the applied downscaling method
- Further bias-correction methods for each specific variable will be investigated and evaluated for different test areas