TESTING A CALIBRATION APPROACH FOR A LIMITED-AREA ENSEMBLE PRECIPITATION FORECAST USING REFORECASTS

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Objective

To implement a calibration technique for the precipitation output provided by COSMO-LEPS, the Limited-area Ensemble Prediction System based on the model COSMO.

To investigate the potential of using reforecasts for the calibration of the ensemble precipitation forecast, especially with respect to the improvement of the forecast skill for rare events.

To test three calibration techniques: Cumulative Distribution Function based corrections, Linear Regression and Analogs.

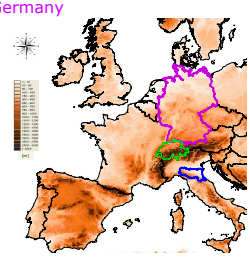
Calibration strategy

methodologies

- choice of methodologies which enable a calibration of 24h quantitative precipitation forecasts (QPFs), not only of the probabilities of exceeding a threshold
  - aim:
    - improvement of COSMO-LEPS QPFs especially as an input for hydrological applications
- selected methods:
  - Cumulative Distribution Function based corrections (CDF)
  - Linear Regression (LR)
  - Analogs
    - similarity of precipitation (ANL)
    - similarity of geopotential at 700 hPa (anlZ)

study areas

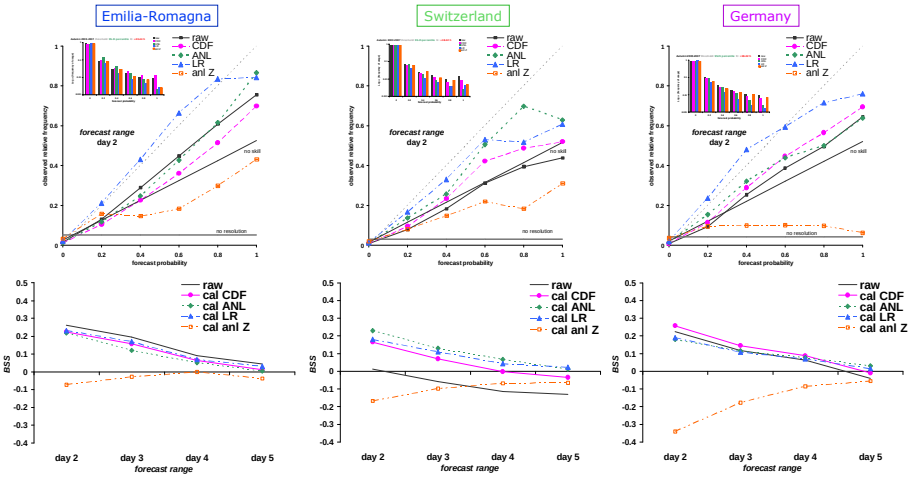
- Emilia-Romagna Region (Northern Italy)
- Switzerland
- Germany



data collection

- Observed precipitation
  - Emilia-Romagna Region (1971-2007)
  - Switzerland (1971-2007)
  - Germany (1989-2007)
- COSMO-LEPS reforecast QPFs
  - 30 years (1971-2000)
  - 1 member, nested on ERA40, COSMO v4.0
  - 1 run every three days (forecast range 90h)
- COSMO-LEPS operational QPFs
  - 5 years (2003-2007)
  - 5-10-16 members (depending on the year), nested on selected members of the ECMWF Ensemble Prediction System
  - 1 run every day (forecast range 120h)

Results



verification of the calibration in terms of QPFs

period: 2003-2007
season: autumn
verification threshold: 95-th percentile of climatological observations

- increase of forecast reliability and skill for the calibrated ensembles over Switzerland and Germany
- no significant beneficial impact provided by the calibration over Emilia-Romagna
- overconfident forecasts for the raw and calibrated ensembles, especially at the higher probabilities
- no single best calibration method for all areas
- the geopotential at 700 hPa is not a good predictor for precipitation

impact of using calibrated COSMO-LEPS QPFs on hydrological applications

the coupling strategy

the meteorological input

COSMO-LEPS
raw and calibrated QPFs

the hydrological model

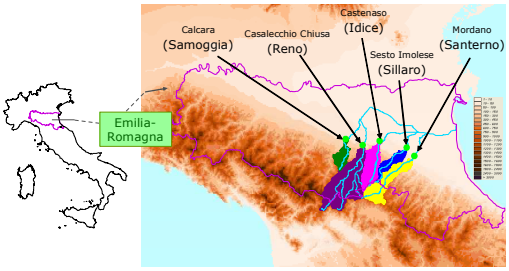
TOPKAPI
physically-based distributed rainfall-runoff model

autumn 2003 - 2008

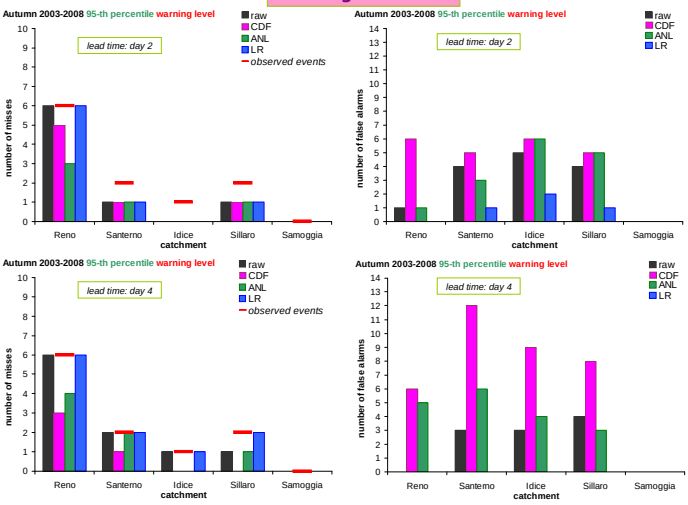
each day

⇒ ensemble of TOPKAPI runs driven by COSMO-LEPS (forecast range: 5 days)

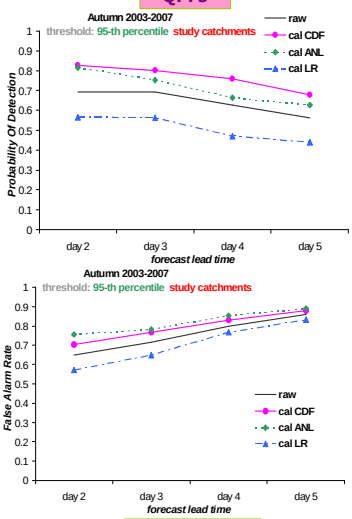
the study catchments



discharge forecasts



QPFs



missed events

main catchment (Reno)

- all the events missed by the raw and LR-calibrated ensembles
- reduction of misses for the ensembles calibrated by CDF and rainfall analogs

sub-catchments

- the positive impact of calibration on the reduction of misses is not evident as compared to Reno river basin (but few events occurred)

false alarms

main catchment (Reno)

- no additional false alarms for the ensemble calibrated by rainfall analogs at the shorter lead time, increase of false alarms only at the longer lead time
- many false alarms for the ensemble calibrated by CDF

sub-catchments

- similar performance in terms of false alarms for the raw and analog-calibrated ensembles; many false alarms for the CDF-calibrated ensemble at the longer lead time

POD & FAR

all the catchments

- the increase of POD and FAR for the ensembles calibrated by CDF and rainfall analogs with respect to the raw ensemble confirms the outcomes of the meteo-hydrological coupling

Conclusions & next developments

- The calibration of COSMO-LEPS QPFs provides a beneficial impact over Switzerland and Germany.
- No significant improvements result over Emilia-Romagna from the statistical analysis on the calibrated QPFs, but the coupling with an hydrological model reveals a beneficial impact of calibration on the reduction of missed events for the Reno river basin.
- The lack of a strong improvement, especially for Emilia-Romagna, is due to a weak relationship between reforecast and observed data.
- As the model error is likely to have a systematic dependence on geography, orography and flow direction, the calibration strategy should be improved by dividing the training sample in order to pool data which have similar model errors with respect to a given meteorological situation ⇒ need of weather-regime dependent correction functions for the calibration performed by the CDF based corrections and Linear Regression methods.