Improving the reliability of COSMO-LEPS forecasts of rare precipitation events

Felix Fundel[1], Mark A. Liniger[1], Christof Appenzeller[1], Andre Walser[1]

(1) MeteoSwiss, Kraebuehlstrasse 58, 8044 Zuerich

The uncertainties of numerical weather prediction can be subdivided into two groups. The first kind is due to uncertainties in the initial and boundary conditions and the non linear nature of the atmospheric system [1]. Ensemble prediction systems try to estimate the predictability of the weather system, producing a probability distribution of the future weather evolution [2]. The second group of uncertainty is caused by the incorrect representation of the weather system by numerical models. This can be due to the coarse spatial resolution and subsequently the inability to resolve meteorological phenomena, or the formulation of the physical model equations [1]. Here, we will focus on the correction for biases in precipitation forecasts caused by the second mentioned group of uncertainties.

These forecasts are particularly error-prone in orographically complex regions [3, 4 and 5]. Most calibration techniques statistically adjust the forecast based on the relation (e.g. regression) between the set of forecasts and observations. Therefore, a dense network of observations in the model domain is required. This is rarely available for the majority of model output parameters and thus, calibration techniques are often restricted to sub-domains of the model area.

This study shows, that reforecasts can help to improve the forecast skill greatly, mainly by increasing the forecasts reliability. We use a 30 years long COSMO-LEPS reforecast climatology to calibrate the ensemble forecasts of 24 hour total rainfall sums. A calibrated, probabilistic warning index based on the return periods of forecasted events is developed. The return periods are estimated from the model climatology and are therefore not subject to systematic model errors. Products based on the calibrated forecast are especially useful for warning platforms like e.g. MAP-DPHASE [6], where raw model output is used to give warnings of extreme events without any additional bias correction from forecasters. Further on, the new, calibrated warning products do not require observation data. This means calibrated warnings can be given for the whole model domain and for each forecast parameter.

Here, the skill improvement by calibrating 24h total precipitation forecasts with reforecasts will be shown. The strongest improvements can be achieved during winter. Calibrated forecasts for day four are as skillful as raw forecasts for day one. Less frequent, initially unskillful forecasts could be turned into skillful forecasts by calibration. Further on, a sensitivity study of the calibration method will be presented. It will be shown, that a significant skill improvement can be reached with smaller sets of reforecasts as well. However, the forecast calibration of rare events benefits from a large reforecast period.

Creating reforecasts is very time consuming. The calibration process can start earlier if only a seasonal subset of the reforecasts is used for calibration. We show the effect of the choice of the seasonal subset on the forecast skill. Again, a dependency on the amplitude of the event could be found. Frequent precipitation events can be calibrated with small subsets of the model climatology without loosing forecast skill. Rare events require a larger subset in order not to lose too much prediction skill.

References

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