Application and verification of ECMWF products 2012

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1. Summary of major highlights

At MeteoSwiss, the model setups COSMO-7 and COSMO-2 are used for operational numerical weather prediction at a regional and local scale, respectively. In addition, both the results of the ECMWF Ensemble Prediction System (EPS) and the products of deterministic models are used for short- and medium-range forecasts. As a part of our verification efforts, IFS forecasts are regularly contrasted with the COSMO models operated at MeteoSwiss. The results show that IFS stronger overestimates low precipitation and stronger underestimates high precipitation compared to the COSMO models.

2. Use and application of products

2.1 Post-processing of model output

2.1.1 Statistical adaption

For the local adaptation of short-term IFS model forecasts, a simple Kalman filter is applied to 3-hourly 2 m temperature, 2 m dewpoint and 10 m wind speed for a long list of Swiss and European measurement stations.

2.1.2 Physical adaptation

MeteoSwiss runs its own short-range forecasting system. The core of this system is the non-hydrostatic model COSMO (www.cosmo-model.org). It is running operationally at two spatial scales: The regional model COSMO-7 with a horizontal resolution of about 6.6 km is driven by the ECMWF global model IFS. The local model COSMO-2, having a horizontal grid spacing of about 2.2 km, is nested in COSMO-7. The nesting of NWP models is illustrated in Figure 1.

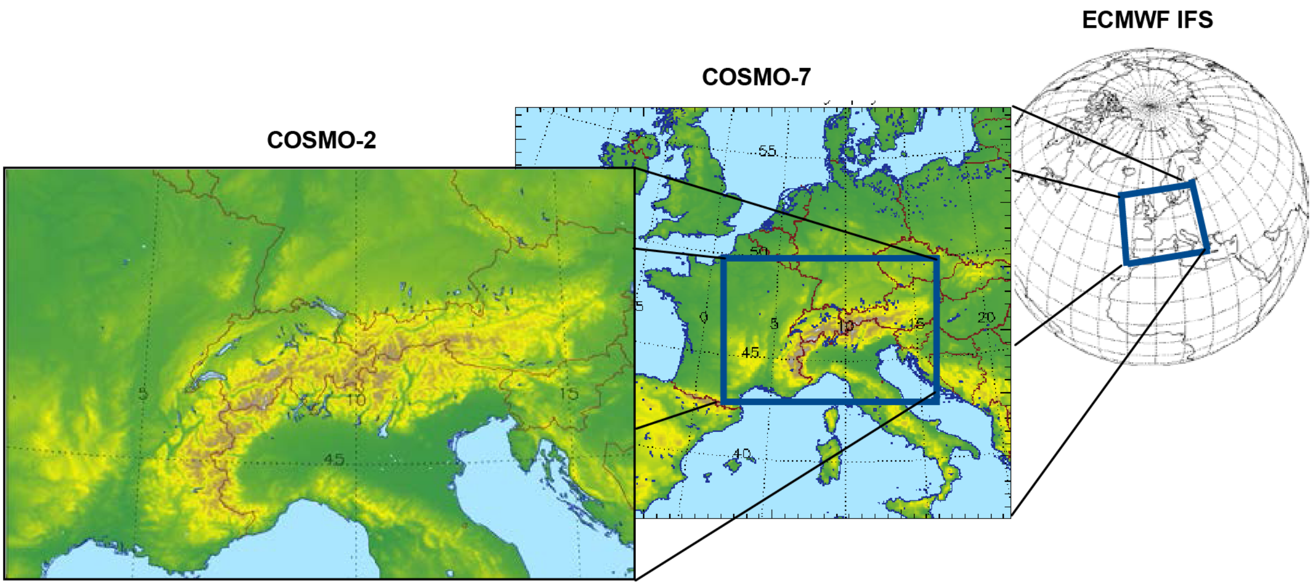

Figure 1 NWP System of MeteoSwiss

Both COSMO-7 and COSMO-2 have their own assimilation cycle, which is updated in intervals of 3 hours. Three daily 72 hours COSMO-7 forecasts are calculated, based on the 00, 06 and the 12 UTC IFS (main or boundary conditions) runs. One COSMO-2 forecast is computed every 3 hours just after the computation of the necessary COSMO-7 boundary conditions. The lead time of the COSMO-2 forecast starting at 03 UTC is 45 hours, and 33 hours otherwise. The cut-off time for all forecasts is 45 minutes.

An on-demand mode can be activated, e.g. in case of an incident in nuclear power plants. COSMO-2 is then computed hourly with at least 4 hours assimilation and 6 hours forecast.

A sophisticated set of scripts controls the whole operational suite, and allows for a very high reliability of the system, with less than 2% of the forecasts requiring manual intervention. This same environment is also used to run parallel suites to validate proposed modifications to the system and to facilitate experimentation by the modelling group.

The computing resources and expertise are provided by the Swiss National Supercomputing Centre (CSCS, www.cscs.ch). COSMO-7 and COSMO-2 are calculated on a Cray XT4 equipped with AMD Opteron Quad Core processors and achieve a sustained performance of 226 GFlops on 984 computational cores. Pre- and post-processing run on the service nodes of the machine. A similar machine with 688 computational cores is available as fail-over. A large multi-terabytes long-term storage is used for archiving purposes and a 1 GBit/s link connects the MeteoSwiss main building with the CSCS (on the other side of the Alps!).

2.1.3 Derived fields

2.2 Use of products

3. Verification of products

3.1 Objective verification

3.1.1 Direct ECMWF model output (both deterministic and EPS)

3.1.2 ECMWF model output compared to other NWP models

As part of the operational seasonal verification with SYNOP and upper air sounding observations IFS forecasts are regularly compared to the COSMO models operated at MeteoSwiss. For this, parameters such as pressure, 2 m temperature, 2 m dewpoint, 10 m wind speed, cloud cover, 12-hourly precipitation, and 10 m wind gusts are compared to associated observations. For precipitation as one of the most important parameters, an example of a verification summary is shown in Figure 3. Compared to COSMO-2 and COSMO-7, IFS shows a stronger overestimation of low precipitation amounts and also a stronger underestimation of high amounts. For thresholds of 5 mm/12 hours the values of all three models are quite similar.

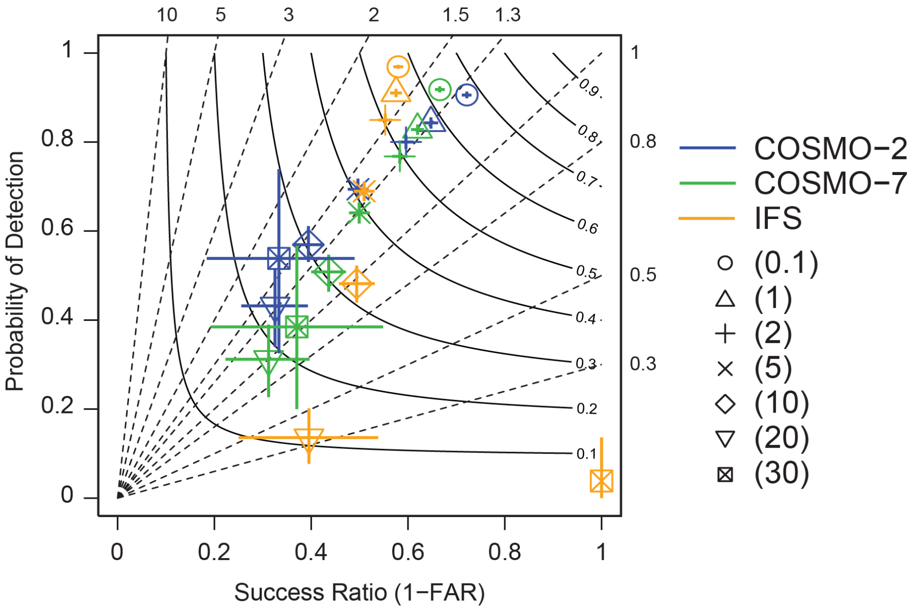

Figure 3 Comparison of the 12 hours accumulated precipitation forecast performance for Spring 2012 of COSMO-2, COSMO-7 and IFS for the Swiss stations and the lead time range 13-24 hours for 7 different thresholds in a performance diagram derived from the geometrical relationship between several scores based on the contingency table (Roebber, 2009). Plotted is the success ratio (1-false alarm ratio) against the probability of detection (POD) with the dotted auxiliary lines indicating the frequency bias (FBI) with the values at the margin axes of the plot and the solid black lines denoting isolines of the critical success index (CSI) with the values within the plot area on the right. The perfect forecast lies at the upper right corner of the plot. The different thresholds are visualised with different symbols, the results of the different models have different colours. The cross on each symbol depicts the 95th quantile of the sampling uncertainty derived from bootstrapping (with N=1000 random draws) giving an indication about the confidence in the result.

3.1.3 Post-processed products

3.1.4 End products delivered to users

3.2 Subjective verification

3.2.1 Subjective scores (including evaluation of confidence indices when available)

3.2.2 Synoptic studies

In Locarno a subjective very simple point forecast verification has been conducted for a long period of time. Following daily station parameter are considered: precipitation amount, relative sunshine duration, and temperature deviation from the climatology. The forecast method and verification are quite consistent in time. For this reason the improvement of the forecast is essentially due to the improvements of the available numerical models, particularly in the medium range (i.e. ECMWF). Figure 5 shows an improvement for 2011 compared with the mean values of the previous 5 years for all forecast lead times. The absolute values of the verifications are very specific to the verification method.

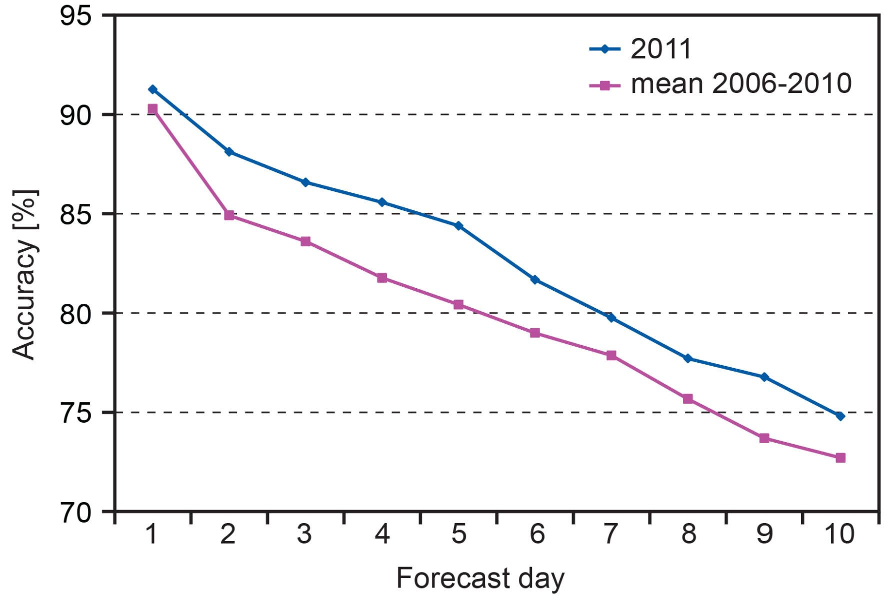

Figure 5 Forecast verification for Locarno. Improvement for 2011 compared with the mean values of the previous 5 years for all forecast lead time.

4. References to relevant publications

Paul J. Roebber, 2009: Visualizing Multiple Measures of Forecast Quality. *Weather and Forecasting* **24**:2, 601-608