The New Production Process at MeteoSwiss

Introduction

The organization of the work and the information exchange between the Swiss weather centres hasn't changed significantly for many years. With the constant development of new products and in order to rationalize the production, the former way of working had to be improved. Moreover, all three weather centres had a different forecast production schedule. The new organization is based on guidance and a matrix. The former, prepared by the leading centre describes the 7 day synoptic evolution. The latter, completed by the regional centre, provides a local forecast according to the guidance. The advantages of this new working method are; an improved coherence between the centre and the products and increased efficiency. The parameters forecast by all centres are stored in a unique database. A new fully automatic verification method will measure the added value of the forecaster compared to persistence or climatology.

Previous organization

Three weather centres are present in Switzerland; one for each national language (French, German and Italian). Fig 1 shows the partition based on the three languages. Zurich's weather centre is the headquarters of MeteoSwiss and issues the forecast for the largest area in German. The weather centre of Geneva is located within the WMO building and is responsible for the French speaking area. Finally, Locarno's weather centre produces the forecast in Italian. It covers the smallest area and is open between 7am and 6pm. An aerologic centre in Payerne, an ozone measurement station in Arosa and aeronautic briefings at Zurich and Geneva airport are also part of the structure of MeteoSwiss.

In order to produce a coherent national forecast, a telephone conference was scheduled twice a day. A summary of the forecast was sent earlier to the three centres in German, Italian and French.

It consisted of a short range forecast for day d+0 and d+1 and a medium range forecast for day d+2 until day d+5. Previously, Zurich's weather centre issued the medium range forecast for all Switzerland.

After the discussion, an official forecast was delivered by the centres in the national languages.

Verification

Each of the five official bulletins was regularly verified. The OPKO (objective control of the forecast) verification was used for the short term forecast and the KOMIFRI for

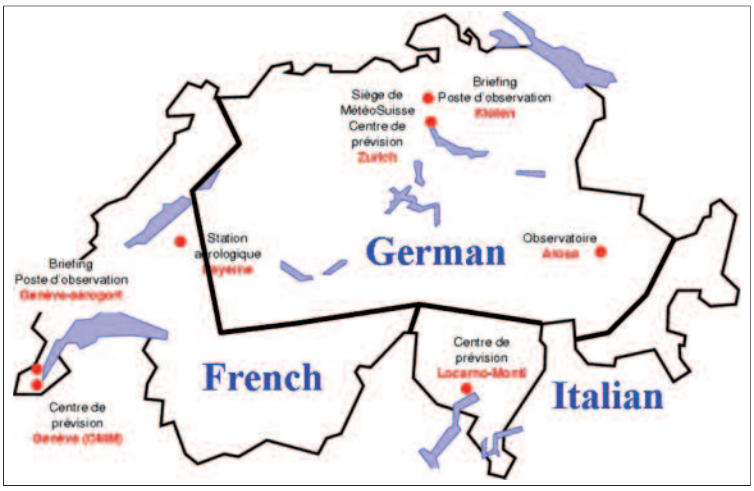


Figure 1: Map of Switzerland with the regions covered by the forecasts supplied by the three weather centres.

the medium range forecast. The method consisted of decoding the text of the bulletin, comparing it with the measurements of automatic weather stations and converting it into scores using a contingency table. For example, for the sunshine verification, the word overcast means between 0% and 4% of sunshine duration; cloudy means between 5% and 30% of sunshine duration, etc …

Each parameter contributed to a different weight to the final score; the weight depended on the synoptic situation.

New organisation

Even though the previous approach to work has been successful for many years, with the increase of products for different users, we needed a system which would improve the efficiency and coherence between outputs.

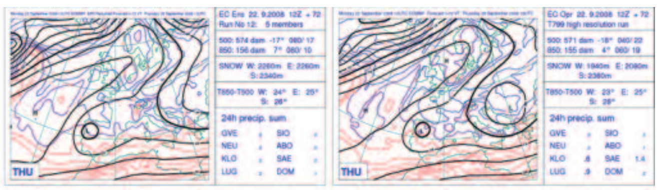
This new approach to working consists of two parts, guidance which is the synoptic scale of the forecast and the matrix, the local forecasting.

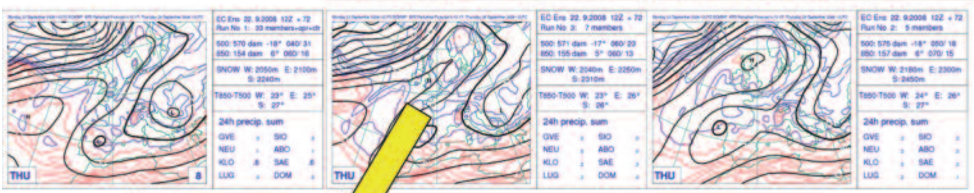
The Guidance

This consists of a spreadsheet filled by either Zurich and Geneva weather centres which entitle them to be the leading centre. A unique synoptic scale analysis is carried out for Switzerland.

The forecaster at the leading centre chooses a synoptic scenario for the next 7 days. It is sent before the telephone conference to the other centres. They in turn produce a summary of the local forecast according to the guidance.

Practically, the guidance is an Excel spreadsheet (fig 2). Firstly, the model is chosen. It is by default the operational version on the the ECMWF's model. The charts displayed on the spreadsheet show the 500 hPa geopotential and the 850 hPa isotherm lines. Other information is also displayed, such as forecast rainfall, snow limit, etc… for chosen locations in Switzerland. Scenarios amongst the most representative clusters can also be chosen; the guidance shows one member of the cluster. Each range is treated separately. In the future, other models will be added such as the GFS model. Once the synoptic scenario is chosen, a short text is added to describe briefly other features not shown or the reason why this particular version as been preferred. Finally, a confidence index is suggested according to the EPS meteograms and an outlook warning.





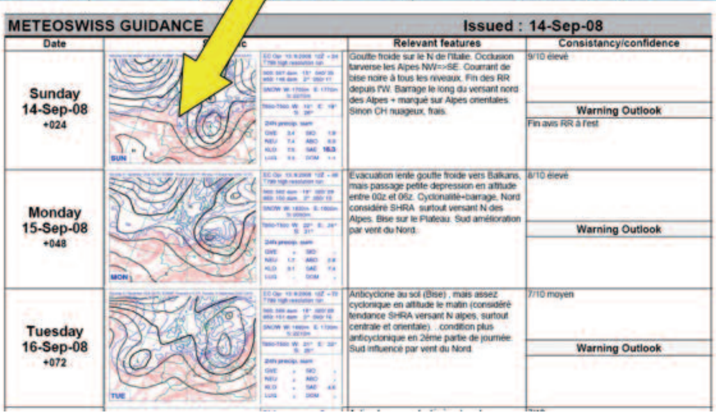


Figure 2: The lay out of the guidance, a cluster from the ensemble is chosen as the synoptic scenario. A short explanatory text is added as well as a confidence index and a warning outlook.

The Matrix

After the morning telephone conference, the main version of the matrix is initialised and completed according to the guidance. The matrix is initialized once a day but it can be updated at any time.

Initialization

At 3 am UTC, the initialization of the matrix is automatically generated with a first guess. The best source for each parameter has been chosen; it is unique and does not depend on the synoptic situation. All of the sources are retrieved from the DWH (DataWareHouse). Up to day 3, the local model COSMO 7 model (00z analysis) is used, thereafter; the matrix is initialised by the operational ECMWF model (the 12z analysis from the day before). The temperatures are filtered using a Kalman filter, the confidence index is determined using the EPS.

Edition

The Matrix is a unique and common tool to all the centres, only the regions under the responsibility of the centre are editable by that centre. A validation is carried out automatically at 10h30 am and it can then be validated manually at any time. The validation means that the updated data from the matrix are written into the DWH.

The matrix GUI is shown in fig 3. Fig 3a, 3b and 3c show respectively the display day0 to day 4, day 5 to day 7 and day 7 and day 8. The further ahead the forecast range, the larger the forecast regions become. The edited parameters include; minimum and maximum temperature, the 6h accumulated precipitation, 12 hour average cloud cover, the confidence index, the gust and rainfall probabilities and the temperature, and wind at upper levels. Before the validation, a coherence test is performed.

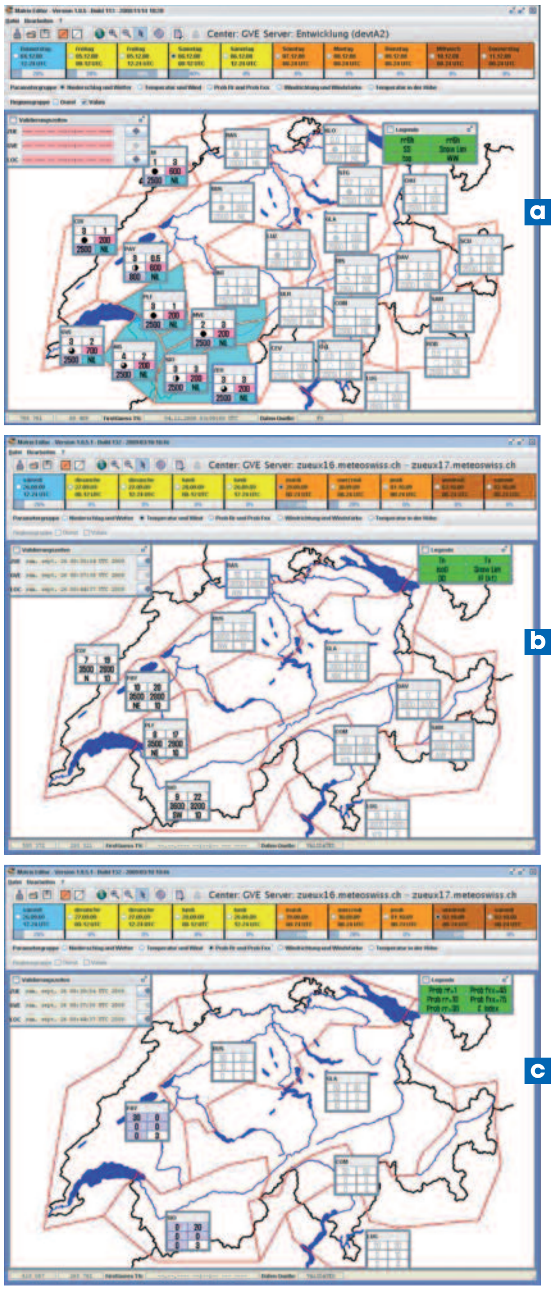


Figure 3: The matrix editor display, each box is associated with an automatic station; the grey boxes are not editable being the responsibility of another centre.
a - Forecast for day 0 up to day 2, the parameters display the 6h precipitation, the sunshine duration, the snow limit, the altitude of the top of the stratus or fog, type of weather.
b - Forecast for day 3 to day 5, the forecast regions are larger; the parameters displayed here are the minimum and maximum temperature, the wind (direction and speed) and the 0° isotherm.
c - Forecast for day 6 and 7, two regions for each centre remain. The parameters displayed here are the probabilities of precipitation (more than 1 mm, 10 mm and 30 mm), the probabilities of wind (more than 45 km/h and 75 km/h) and the confidence index (1 to 10).

Once the forecast is stored into the DWH, it is easily accessible with a retrieve command or using a visualisation tool (CLIMAP) which allows display of observed data (past and present) and forecasting data.

A function library has been developed to ease the retrieval of data; it contains algorithms which produce for example symbols for forecasts shown on television. Another application for the library is the post code forecast (fig 4). On the MeteoSwiss web site, it is possible to enter a location post code and a forecast is automatically generated by interpolating the nearest forecast point from the matrix. Previously, the forecast was generated using direct model output. The result was not satisfactory in the case of fog or low cloud for example, and often it was not coherent with the official bulletin. Now, the matrix output is used which produces far better results. The library function is used as an interface between the matrix and the final product.

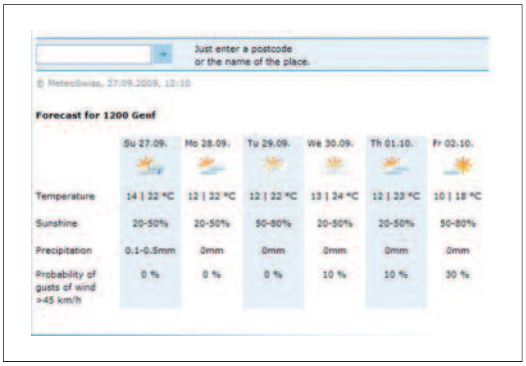


Figure 4: Example of a forecast by postcode available from the MeteoSwiss web site.

Verification, Quality control

Previously, the forecaster's score corresponded to the accuracy of the prediction. The new approach to verification is to estimate the added value of the forecaster. The former verification scheme had many disadvantages: a comparison with the model was not possible, it was performed manually which could be subjective, the scores were available only after a delay. And it led to standard text; forecasters were using banal terms which would be understood by the person in charge of the checking (irrespective of their regional language). The OPKO verification was completed only for 14 regions up to day 1 and 3 regions up to day 7 while the new verification scheme contains 27 regions up to day 2, 11 regions up to day 5 and 6 regions up to day 7. An extended number of parameters are now checked.

MOVI (MeteoSwiss Objective Verification Index)

The verification for continuous data is achieved differently than for those variables with values which fall naturally into classes. Eventually, both will be included in the same index.

Verification for the continuous variable

This is applied to the minimum and maximum temperature variables. The variance reduction (RV) is performed on the parameters; it reflects the quality of the forecast compared to a reference value. In our case, the persistence is used as reference up to day 2 and the climatology is used between day 3 and 7.

$$RV = 1 \left(\frac{RMSE_{Fct}}{RMSE_{Ref}} \right)$$

Where $RMSE_{Fct}$: Root Mean Square Error of the Forecast.
$RMSE_{Ref}$: Root Mean Square Error of the Reference value.

Verification for variable classes

This applies to sunshine duration, precipitation and wind (average speed and direction). The score used in this case is the Equitable Threat score (ETS). It measures the fraction of observed and/or forecast events that were correctly predicted, adjusted for hits associated with random chance.

ETXS = (a - ar)/(a + b + c - ar)

Where: ar = (a+ b(a + c)/n   n: number of forecasts; ar : hits expected by chance.

	YES	NO
YES	a	b
NO	c	d

The MOVI score is an adaptation of the UK index UNI. It is defined as: $MOVI = \frac{S}{SO} \times 100$

Where $S = \frac{1}{\sum_i w_i} \left(\sum_i (w_i SS_i)\right)$

SSi are the RV and ETS values.
S_0 is a reference value of the MOVI score. It can be set as an arbitrary value or as a mean sliding quantity of S during 2 or 3 years. In this later case, The MOVI score will represent the evolution of the forecast quality.

Conclusions

The new working method has been used for over a year. It represents a great innovation for forecasters, the methods used and for the organization of the Swiss weather services.

The regional responsibilities and competences are clearly defined and developed; the leading centre alternates between the different regions. Only the synoptic evolution is established, the local weather is generated by the local centre. Previously, the medium range forecast was produced by one centre.

The work organization has also been modified. With the new organization all the three centres are working together with the same schedule; the data from the matrix are automatically saved at a fixed time.

The forecasts are stored in the DWH. The generation of new forecast layouts is easy to produce. This also guarantees the coherence between forecasts delivered to different customers. Clients who currently receive raw model data for instance related to Energy business can improve the quality of the data by using information modified by the forecaster.

The new verification method (MOVI) is now objective and is produced accurately and instantaneously. The forecaster can monitor his forecast's score immediately instead of having to wait a few weeks.

To sum up, the new way to work is more time consuming than before but the benefits are important for the forecasters, the clients and the general organization of the weather service.

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