The new Road Forecast Tool (RFT) and its data management.

André-Charles Letestu and Urs Keller
Federal Office of Meteorology and Climatology
MeteoSwiss
CH-8044 Zürich
Email: andre-charles.letestu@meteoswiss.ch / urs.keller@meteoswiss.ch

Abstract:

With the development of new visualization and production tools at MeteoSwiss, the old road forecasting tool, which has been used for 14 years, needed to be redeveloped. The new tool has a new and more accurate energy balance model. Contrarily to the old system, the forecast can be stored into the MeteoSwiss data bank (DWH). The new road forecast tool (RFT) is a java based program developed conjointly between Bern Technical School and MeteoSwiss. It consists of interactive GUI which allows the forecaster to produce a local road forecast. A first guess is given by the COSMO 7 model for temperature, cloud cover, snowfall limit; wind direction and speed and precipitations. The temperature can be chosen between the direct model output or filtered (Kalman). A new energy balance model (EBM) provides the hourly temperature and the state of the road. This tool is used to forecast weather conditions on various locations of motorways in Switzerland corresponding to a road weather station. It is sent to both Boschung and Vaisala users systems. The EBM is initialized using data from Boschung, Micks or Vaisala road weather stations. The flexibility of the RFT will allow the forecast to be extended to as many locations as needed and forecast period up to 70 hours.

Introduction:

Recently, the forecasters at MeteoSwiss have experienced considerable changes in the forecasting room. New working methods and visualization tools have appeared. One of the most important changes was the launch of the Matrix system in Autumn 2008; this is a GUI used by the forecasters of the three weather centres to elaborate a forecast in numerical form which will be stored later in the DWH. The parameters forecasted are; temperature minimum, maximum, rain, cloud cover wind etc.. for various locations in Switzerland. This device has been developed mainly to ensure the coherence between the different products including the road forecast but also to produce automated forecasts. The old road tool (Letestu and Keller 2000) which was programmed on IDL language was independent of the DWH and couldn't import the Matrix's data. It had to be replaced; moreover, the SUN workstations on which the old road tool was running, will soon be replaces by Windows PC in the forecasting room. The old energy balance model used in the old tool was not completely satisfactory. The RFT is also compatible with the new visualisation tool NinJo. This enables the weather situation to be monitored in response to the forecast. In case of a large divergence between the two, an alarm can be raised.

Description of the RFT and the data management.

The altitude of the motorways network extends from 200 m to 1100 m; MeteoSwiss provides a forecast for the stretches of motorways according to their altitudes and their climate. A forecast is issued by the end of the morning and it's valid from 12h until 12h the following day. For some regions, the forecast is adjusted in the evening. Two forecasts format are produced according to the system the maintenance services are using (Boshung, Micks and Vaisala). Fig 1 shows the forecast regions in Switzerland.

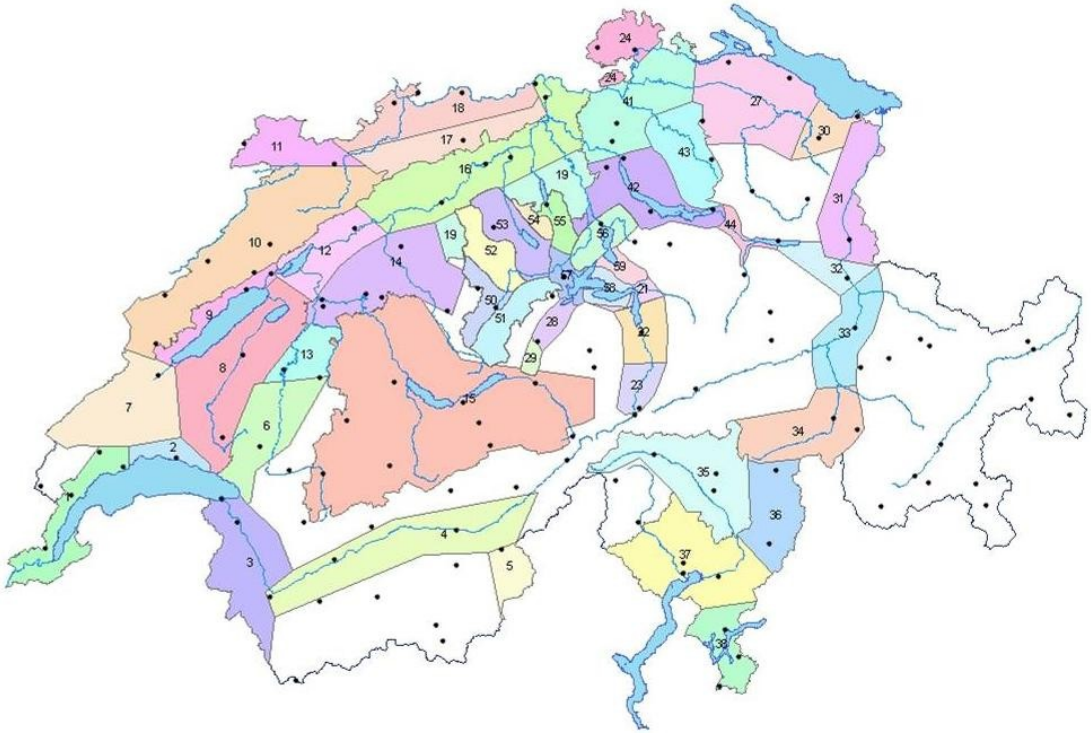

Fig 1: Forecast region of Switzerland.

The data used by the RFT is provided from the following sources.
Swiss Meteorological Network (SMN) station; this is the official MeteoSwiss network. Meteorological parameters are measured every 10 min. The locations are shown by a black dot on Fig 1.
Road station; provided from the Boschung, Micks and Vaisala station's network.
COSMO 7; provide the forecast data, this is a limited area model, non hydrostatic with a grid length of 6.6 km with 90 vertical levels. Direct Model Output (DMO) and filtered data (temperature and dew point) are used as first guess in the RFT.
Matrix data; temperature minimum and maximum, 6 hours precipitation, wind mean speed and direction, snowfall limit. The forecaster in charge of the road directly imports parameters established earlier by the chief forecaster.

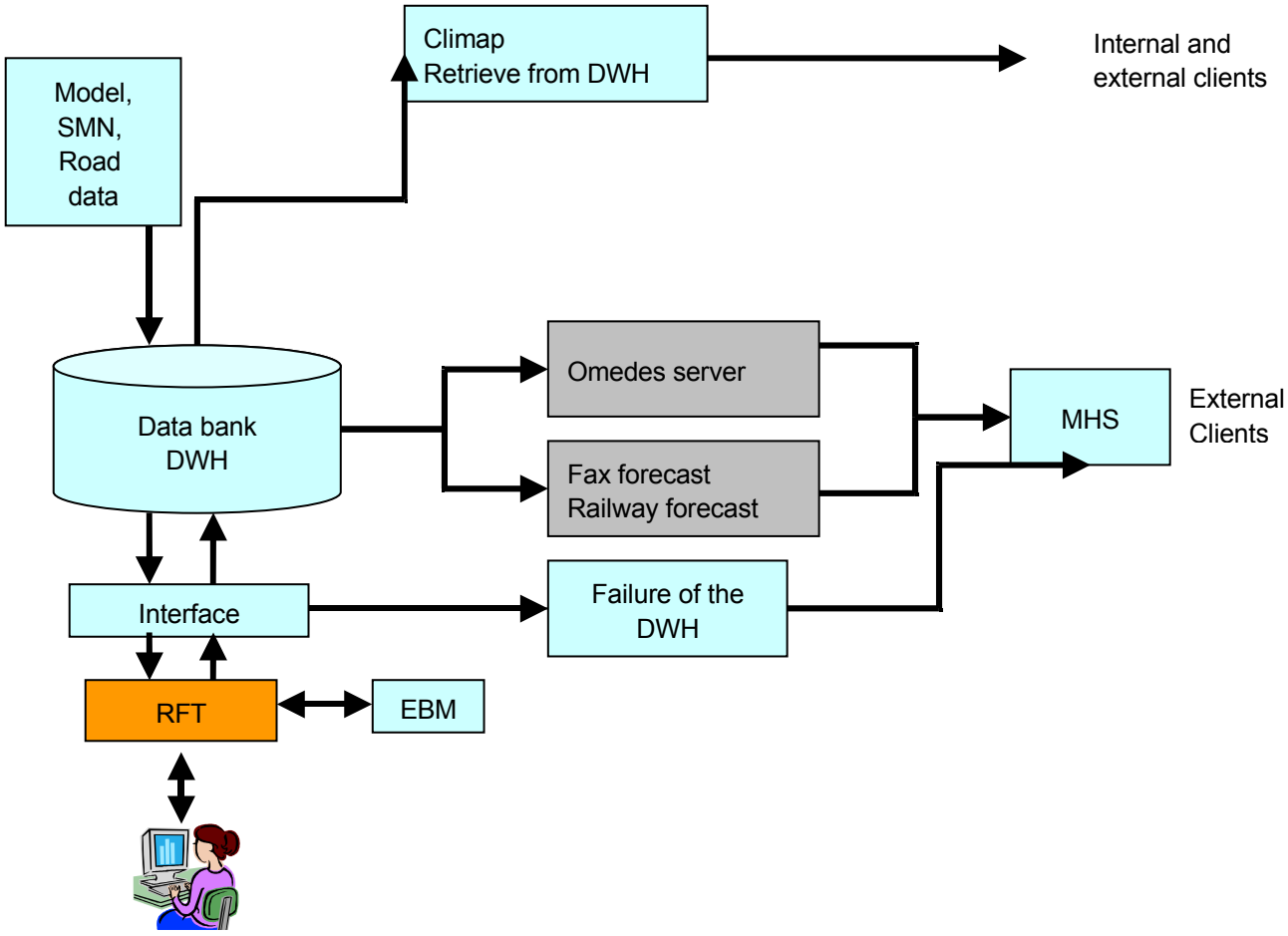

Fig 2: Flux of data associated with the RFT.

The fig 2 shows the flux of data associated with the RFT. Observations and the model's data are stored in the DWH. The RFT tool retrieves the data from the DWH through an interface. When the forecast is finalised, it is stored in the DWH through another interface. In case of failure of the DWH, there is an alternative way to send the forecast to the clients through the Message Handling System (MHS). Forecast data from the DWH needs to be formatted before being sent to the clients via MHS. This process is carried out by an Omedes server (see below). DWH data can be visualized through a tool called CLIMAP; tables, curves and 2D maps can be represented.
Finally, fax and railways forecasts are created from the RFT forecast. These are used by councils and railways stations to plan the snow clearing staff on duty during the night and the holidays; they are available by fax, e-mail and internet. Since a forecast is produced by the three weather centres of Switzerland, a configuration file introduces the local settings.

Running the RFT:

In Switzerland, a road forecast is produced every morning before 11 from 1 November to 15 April. For some regions, the forecast is assessed in the evening. The forecast is valid until the following day at 12z or 18z. It is possible to extend the forecast up to 70 hours.
The forecast is generated in two stages.
Firstly for large climatologic or basic regions. The model used to produce the first guess is COSMO7. The most representative station from the SMN network for the basic region is used as a reference for the 2m temperature and dew point. When the roads in the region have a wide range of altitude, two reference stations are provided. A choice between direct model output (DMO), filtered data or

persistence is available and MOS in the near future. An example is shown in Fig 3 a where the roads for the region Oestliches Mittelland lies between 432 and 559 m.

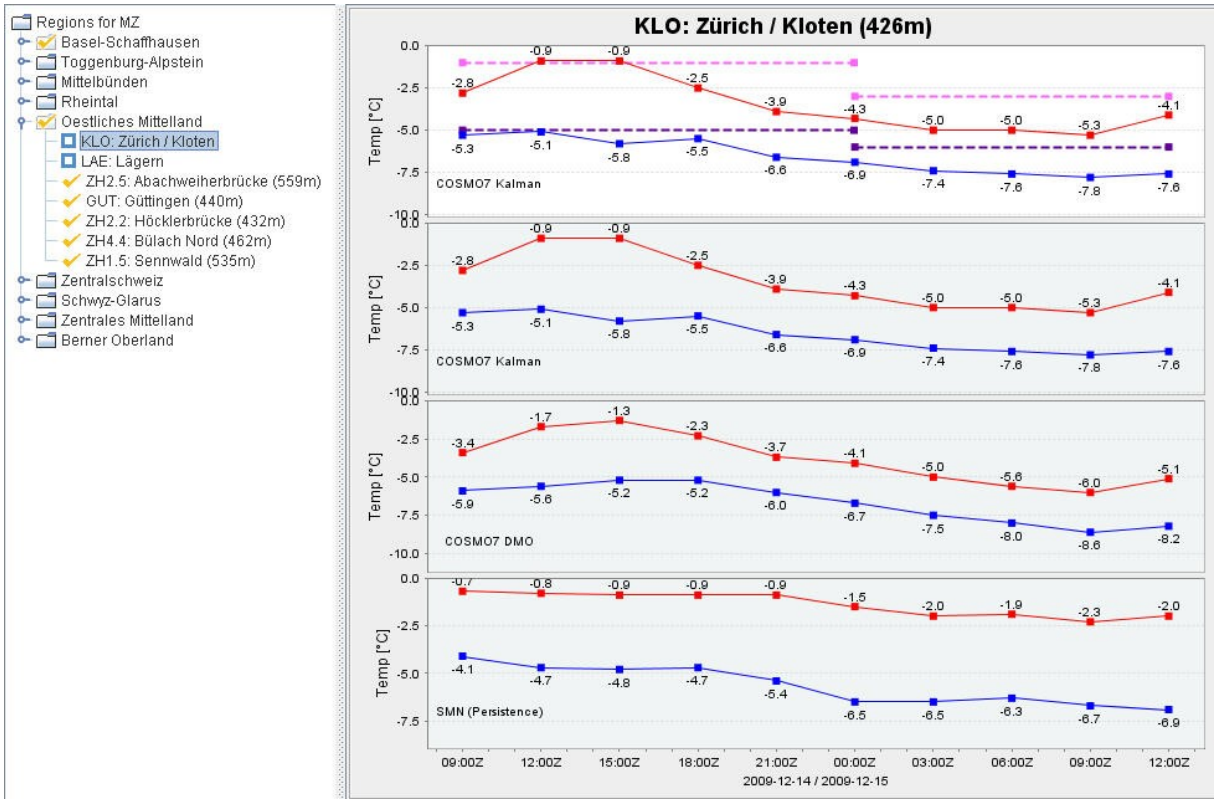

Fig 3a: The most appropriate 2 m temperature and 2m dew point curve is chosen between persistence, direct model output or filtered data.

Fig 3b shows the editable parameters for the basic region, model data for cloud cover, temperature, dew point, wind (mean, gust, and direction), precipitation amount and snow limit. The dash lines are the data imported from the matrix. The time resolution of the data differs between the two products. Nevertheless it guarantees the coherence between the general and the road forecast.

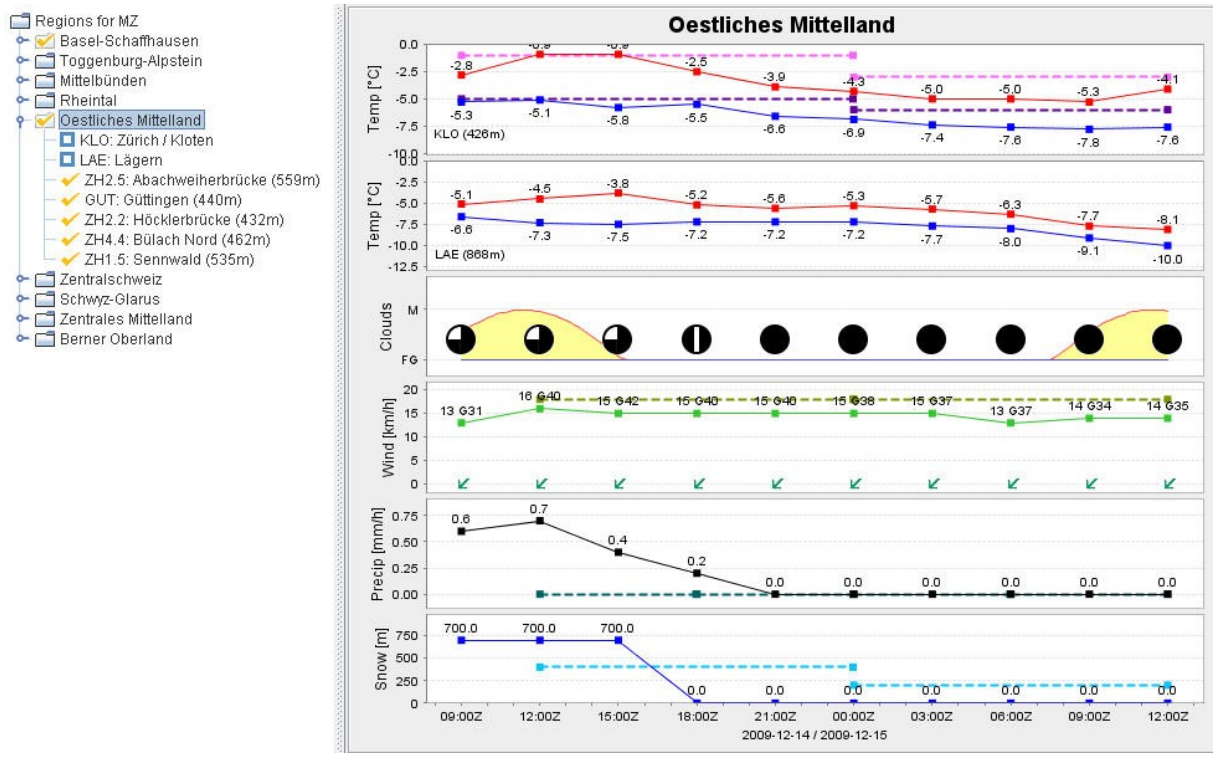

Fig 3b Editable windows for the basic region, the forecaster modify the first guess for each parameter.

The finer forecast can be completed in the second stage for each of the 45 locations most representative of the stretches of road. Data from the coarser regions are imported to these smaller regions and the temperatures are adjusted according to the altitude difference between the reference station and the stretch of road. The other parameters are used as such.

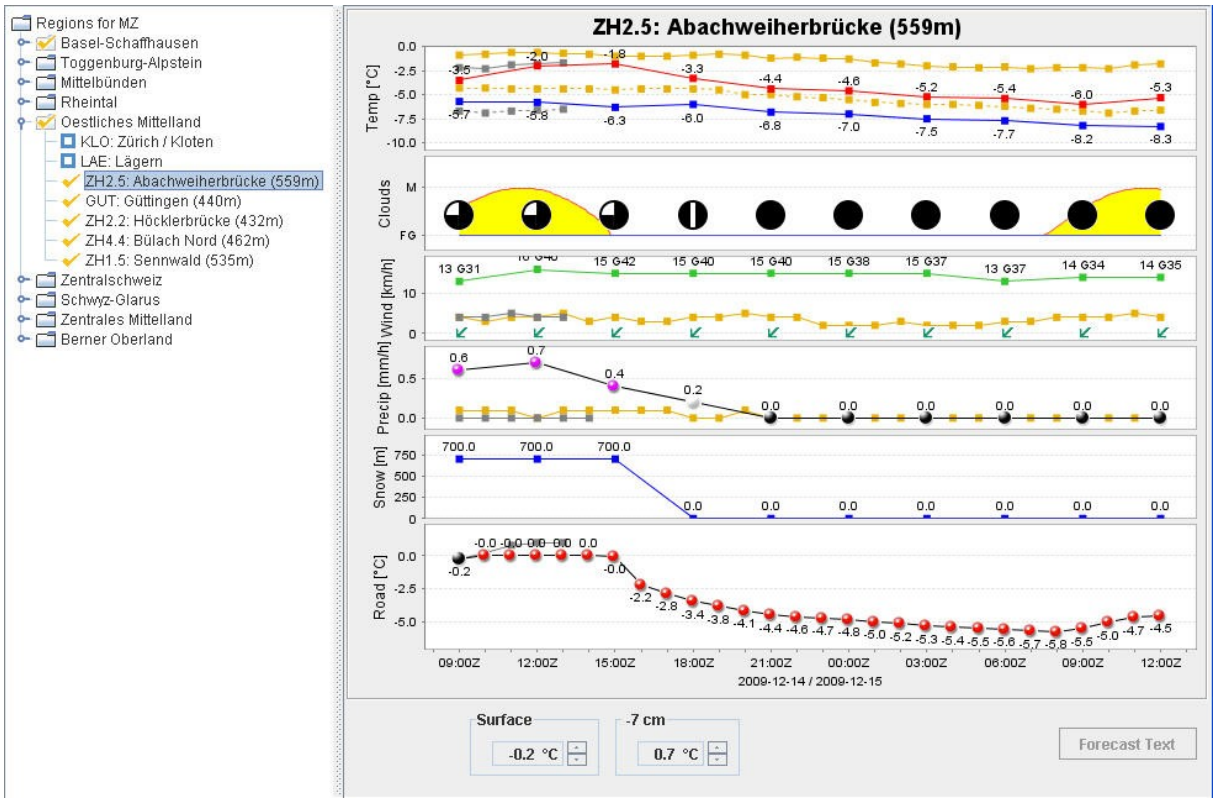

Fig 4: Working windows for the most representative weather station of the stretch of road.

An example of a forecast corresponding to the finer regions is shown in fig 4. The layout is similar to the basic region (fig 3) but the type of precipitation has been determined according to the 2 m temperature and the snowfall limit. By running the Energy Balance Model (EBM) program (Zgraggen 2001), the hourly temperature and the road state appears (bottom line), the colour dots represent the state of the road, here black and red mean respectively dry and icy roads. The forecast of the smallest region is carried out on the most representative location in the stretch of road with a measuring weather station. The road surface temperature and the temperature at 7 cm underground of this station (Boschung, Micks or Vaisala) provide the initial condition for the EBM. The Boschung's data are not yet fully included in the DWH, for some stretches of road; the forecast is completed at a MeteoSwiss station location. A plausibility test is carried out while running the EBM to avoid inconsistencies such as clear skies and precipitation, or fog and low humidity.
The main goal of this two layer forecast procedure is to ensure a good regional approach. Since the efficacy of the COSMO model is low for local effects such low cloud or fog, the judgement and the experience of the forecaster plays an important role in its interpretation.

The persistence (yellow lines) displays the previous day's values of the parameters except for cloud cover, wind direction and snow limit. Instead of using data from the basic region, the forecaster can use either the persistence or the actual measurements (grey lines) which are the parameters measured the days of the forecast. This enhances the forecast accuracy.

Export:

Once the forecast is completed, it is exported to the DWH. While in the data bank, the data can be retrieved using for example the Climap tool or used for the verification of the forecast.
To send the forecast to the client, the data have to be first formatted according to the requirements of the customer. This last process is performed by a word's Microsoft add-in named "Omedes" developed by the German weather service (DWD). It imports data from the DWH and produces a text document. At this stage, an explanatory text can be added.
Finally, the documents are sent to the end user via the MHS (Message handling system).

Other products:
As with the old road tool, two products are generated from the RFT; the road fax which is a forecast sent by fax or by e-mail to the road users and the station forecast targeted to the railway authorities.

Verification:

Previously, verification was difficult to achieve because the forecast was based on a stretch of road. With the new RFT, the forecast is performed for a road weather station; it is then possible to verify it. The forecast being stored within the DWH, an automated verification can be generated daily.

Future development:

The flexibility of the new RFT allows the forecasted regions and the number of the forecast location to be modified and extended. Filter (Kalman or MOS) will be applied on road station data to produce more accurate and local forecasts.
The next development of the system will be focus on downstream products. The fax road which is currently produced for large regions can be redesign for smaller ones in order to offer better targeted forecast for users.

References:

A.-C. Letestu and Urs Keller SIRWEC proceedings 10th converence Davos Switzerland (March 2000).
L. Zgraggen, 2001 : Strahlungsbilanz des Schweiz, Diss. ETH Nr. 14158, ETH Zürich.