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The new Road Forecast Tool (RFT) and it's data management

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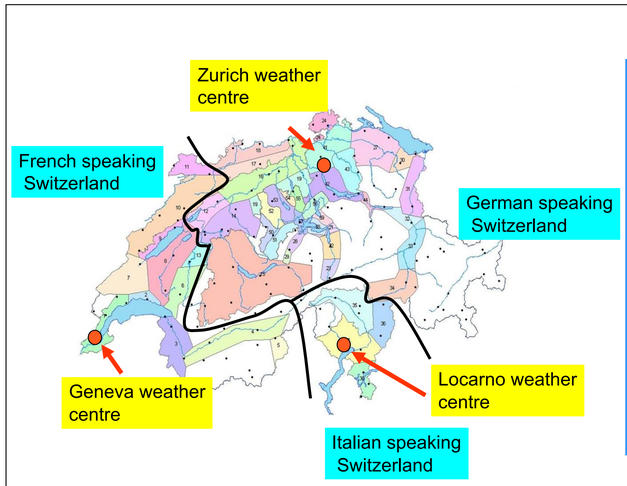
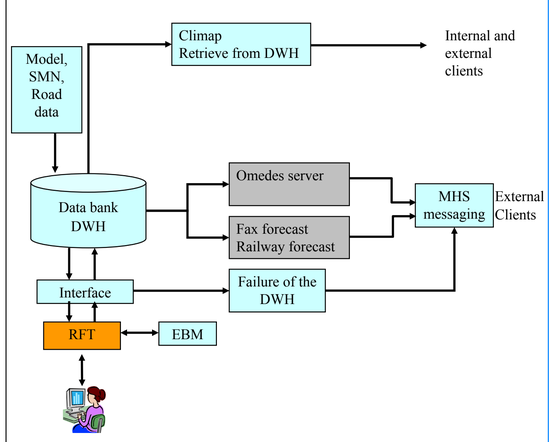
Introduction:
Recently, the forecasters at MeteoSwiss have experienced considerable changes in the forecasting room. New working methods and visualization tools have appeared. One of the most important changes was the launch of the Matrix system in Autumn 2008; this is a GUI used by the forecasters of 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 replaced 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.

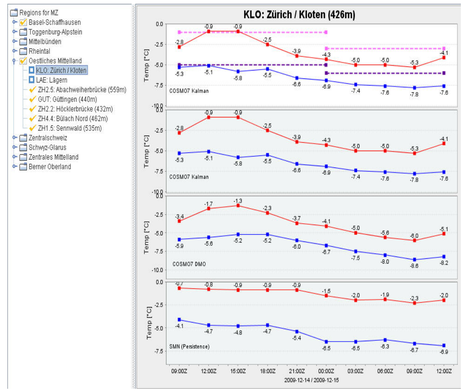


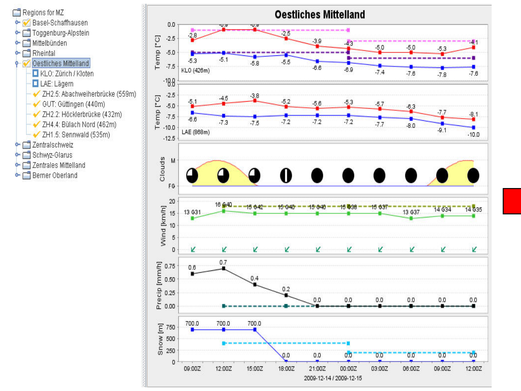
Forecast regions of Switzerland
The altitude of the national highway network extends from 200 m to 1100 m; MeteoSwiss provides a forecast for the stretches of motorways according to their altitudes and their climate. A forecast is issued by the end of the morning and is valid from 12h until 12h the following day. For some regions, the forecast is adjusted in the evening. Three formats are produced according to the system the maintenance services are using (Boschung, Micks or Vaisala).

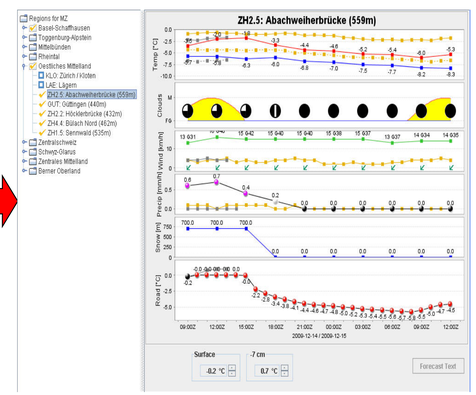


Flux of data associated with the RFT.
Observations and the model's data are stored in the DWH. The RFT tool retrieves the data from the DWH through an interface. When the forecast is finalised, it is stored in the DWH through another interface. In case of failure of the DWH, there is an alternative way 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 three stages. See below !







Choice of Temperature curve:
The most representative station from the SMN network (matrix station) 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 COSMO 7), filtered data or persistence is available. MOS will be in the near future. The above example shows the region Oestliches Mittelland where the roads lie between 432 and 559 m asl.

Edition of the basic region:
For a large climatologic or basic region the model used as the first guess is COSMO7. The example above shows the editable parameters for the basic region, model data for temperature, dew point (preselected), cloud cover, wind (mean, gust, and direction), precipitation amount and snow limit. The dash lines are guidelines imported from the matrix. The time resolution of the data differs between the two sources. Nevertheless it guarantees the coherence between the general and the road forecast.

Edition of the local forecast:
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. The temperature is adjusted according to the altitude difference between the reference station and the stretch of road. The other parameters are imported as such.
The layout is similar to the basic region 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 local forecast is based on 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 road station provide the initial conditions 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 persistence (yellow lines) display the previous day's values of the parameters. It can be used as forecast when the weather situation is stable.

EBM:
The Energy Balance Model has been developed by L. Zgraggen and programmed by the Engineering school of Bern (Bättig et al 2006).
The station parameters used are the position and the horizon at the location of the station.
The initial conditions used are the surface temperature of the road, and 7 cm underground 3 hours prior to the beginning of the forecast.
The forecast parameters used are the temperature 2m, surface and dew point temperature, the cloud cover and levels (low, medium, high or fog), amount and type of precipitation and wind speed.
The time lapse of the energy balance model is 2 seconds. The result is displayed at hourly intervals.
Global radiation is calculated using the azimuth of the sun and corrected with a factor according to the cloud cover, 24 classes of cloudiness (3 clouds layers X 8 octas) plus one for the fog situation.
Two values of albedo are set for dry and wet roads or road cover in snow.
The inwards and outwards long wave radiation is calculated using the Stephan Boltzmann law using correction factors for fog or cloud.
A soil heat flux is calculated up to 1 metre underground using a unique soil conductivity factor.
The EBM includes 3 reservoirs corresponding to the water, snow and ice left on the road. Only the former two have a runoff, if more than one of these 3 reservoirs is present, the worst case is considered.
Finally, latent heat and sensible flux are computed using the 2m, ground and dew point temperature and also the wind strength.

DAT 10/01/14 - 11:56
DSC Prevision 24 h 07 Vallorbe 600-1000m

FID TYPE=CH24/00 MARGIN=4

HOR Prevision pour	13.00	16.00	19.00	22.00	1.00	4.00	7.00	10.00
CLD Nuages (0 bis 8/8)	8	8	8	8	8	8	8	8
T2M Temperature a 2m (oC)	0.7	0.9	0.2	0.5	1.3	2.0	1.2	0.7
TSC Temperature au sol (oC)	5.7	3.0	-0.3	-1.0	-1.2	-1.3	-1.6	0.0
T2D Point de rosee (oC)	0.2	-0.5	-1.5	-1.9	-0.7	-1.7	-1.8	-0.8
WDI Vent (direction/force km/h)	VRB/4	VRB/4	VRB/4	VRB/3	VRB/4	VRB/0	VRB/0	VRB/0
PQU Quantite de precipitation	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0
PTY Genre de precipitation	-	-	*	-	-	-	-	-
SNL Limite des chutes de neige	0	0	0	0	0	0	0	0
RST Etat de la chaussee	SEC	SEC	GLAS	GLAS	GLAS	GLAS	GLAS	GLAS

TXS Remarques
TXE Comment
Legende
Nuages: Nuages en huitiemes (nuages bas et moyens), 9= brouillard au sol
Precipitations: pluies en mm, neige en cm
Genre de precipitations: .: pluie, *: neige, ~: pluie congelante
Etat de la chaussee: SEC: sec; MOUI: mouillee, NEIG: neige
Etat de la chaussee: GLAS: plaques de glace et verglas; PGIV : plaques de givre
Par "Etat de la chaussee", il faut comprendre une situation de danger potentielle pour le trafic si le service hivernal devenait deficient.

Final product sent to the client
Once the forecast is completed, it is exported to the DWH. Whilst 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 firstly to be formatted according to the requirements of the customer. This last process is performed by a Word 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 at the railway authorities.

Conclusions:
The introduction of the RFT had many benefits; the forecast can now be verified since the data are stored in the DWH. It is flexible, a new forecasting region can be added easily, the accuracy of the surface temperature and the state of the road has been highly improved.

References:

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L. Zgraggen, 2001 : Strahlungsbilanz des Schweiz, Diss. ETH Nr. 14158, ETH Zürich.
D. Bättig, S. Stankowski, E. Wyler : Energiebilanzmodell EBM, Berner Fachhochschule, Technicher Bericht 2006.