NEW FORECAST METHODS

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Introduction

For many years weather information has for many years been an important part of planning and performing winter road maintenance actions. In the beginning the weather services often consisted of worded summary forecasts for quite wide areas. But during the latest decade, the need of accurate, more detailed weather information has increased. Primarily this depends on higher society demands on an efficient infrastructure. Secondly on the fact, that users of the information are more qualified to use it. Thirdly the latest technique, like Internet, has given great possibilities to present new products in a clear way. This has enforced a development of many sophisticated weather products. One step to achieve these goals several road authorities have taken by building up road weather station networks of their own or together with the national meteorological institutes. All this is to get as detailed information as possible about the condition of the roads at the moment and for the following hours. But at the same time there is an ambition from the authorities to minimise costs. This puts the questions about quality, price and traffic security in focus.
The meteorological institutes and companies have two ways to face this situation:

- one extreme alternative is to deliver automatically produced weather forecasts
- the other is to find new methods to produce the forecasts in a more rational way, where the forecaster still in a high degree can influence the result. This is important when the model output looks wrong or misses the changes in the weather situation.

New methods

The production of weather forecasts has traditionally been "hand made" by the meteorologists with the help of different sources of information (e.g. numerical weather prediction models and remote sensing observations). Mostly the result is very good, particularly when the forecasts have been followed up frequently. Then it is important to distribute the corrected forecasts rapidly to the user so they can take advantage of the new information. But this way to produce forecasts is not the cheapest because of the personnel costs. On the other hand, if the effect of these manual efforts gives much better products, it is a question of cost- benefit for both the road authorities and society.
However, as the forecast models have been improved, it has been possible, to use model output directly in a higher degree, with or without statistic interpretation. But at the same time it is a reality that all models have their shortcomings. Therefore something has to be done to correct obvious faults. One way is to use Kalman filtering. The result of this correction

method depends on how good and developed the filtering is. Some parameters are easier to adjust than others are. A temperature is for example a typical parameter, which often can be corrected with the help of Kalman filtering. These corrections give good results when the model output gives systematic faults. A condition to achieve good improvements is that the model shows the right development of the weather situation. If not, no methods to correct the output data will give desired effect.

A forecast parameter, which causes problems, is cloudiness, especially low clouds. In all road surface temperature forecasts, the result depends on the quality of forecast cloudiness. An incorrect forecast will result in a misleading calculation of the energy flow in the road surface and the forecast will be useless.
What to do if statistic interpretation and Kalman filtering do not improve the forecasts enough? For instance, it is not realistic to manually change an hourly 7 hour forecast in hundreds of grid points. In this case it would be better to make the adjustments in the database from which all data is generated.
Lately years there has been a lot of research in many countries to find methods to make these data base corrections.
In Sweden a project called RiPP, Rationalisation in Production Process, has been going on for several years and is today partly in operation. Figures 1 and 2 below show a system overview.

What is new in this system?

Normally a meteorological institute or company has one or several numerical forecast models from which the forecasts are generated. In the Basic Production part of the RiPP system, the forecaster task is to continuously choose the most probable numerical model for every time step. One day one model looks good 120 hours ahead, another day the same model is useful only the first 12 hours, while a second model is preferable the next 12 hours. If the forecast is "hand-made" the meteorologists easily takes care of this situation, but in an automatic production system it is more complicated. One reason is that there is often only one model connected to the forecast system. Then it will be a lot of work to do all corrections.
In the new Swedish forecast system the meteorologist in the **Basic production** can mix the available models and the system takes care of the interpolation between the models. But when the best choice is made, there can still be obvious errors in the result. For instance the model output may show a wrong picture of the cloudiness and thereby also the temperature. Then the forecaster has another tool to use to make corrections. He or she can make further adjustments by a graphical tool. It is possible to add or delete in the suggested cloud and temperature forecast. These adjustments are then brought back to the central database. A lack today is that a corrected cloud forecast does not automatically result in a correction in the temperature forecast. Therefore the meteorologist has to make corrections in both parameters. After these adjustments the system again makes necessarily interpolations. Precipitation is another important parameter, which in a high degree has an influence on the winter road maintenance. The same graphical tool can be used to make corrections in the suggested model output. If the output gives rain instead of snow the meteorologist can also correct these faults. If there are more parameters, which need to be corrected, there is no limitation.
The central database is updated several times a day.
In the next step of the production chain, the forecaster in the **End user production** position, can make additional corrections or adaptations before the product is delivered to the customer. Perhaps the latest information from satellite or radar images shows that something in the forecast is going wrong. Then it is possible to make final adjustments before the forecast is sent away.

The effect of the new tools in the forecast production is that the corrections are made very early in the production chain and at **one position** instead of for instance 10 positions. This gives an appreciable rationalisation, where the meteorologist still has a controller function over delivered weather forecasts. Every customer gains from this way to work and the meteorologists get more time for consultation.

Improved forecast products

In the new production system all weather products based on forecast data will be improved. One of the most important information as help for an efficient winter road maintenance work is good road surface temperature predictions. This product will get a higher quality in the new way to produce forecasts, as the weak link, the cloud amount, can be efficiently corrected.

Does RiPP solve all forecast problems? Of course not! RiPP is only the instrument to do these improvements in the forecast process. But with a lot of efforts by the supervising meteorologist, the quality of all forecasts will be improved with fewer people in the production process. In the new way to produce forecasts it will also be possible to automatically generate weather maps with fronts, clouds and areas of precipitation and so on. So this is one way to produce higher quality forecasts in a more efficient way, which implies lower costs.

Summary:

In the future there will be new ways to produce weather forecasts in support of the winter road maintenance work. In a way we are standing at a crossroad. Shall we choose a service with highly automatically produced forecasts? Or shall we use products where the meteorologists still have controlled and adjusted the information before distribution to the user? Or is a mix of both the best alternative? Many questions can be put about this.

- Is a customer aware of the difference between automatically produced forecasts and forecasts produced by a meteorologist?
- What responsibility will a meteorological institute or company take for the quality of delivered products produced in the two different ways?
- Does the maintenance staff have education enough to judge the quality of automatic forecasts and is it their task?
- Which factors shall have a determining role of the price, when different weather services are compared?
- In what way can the meteorologists improve the forecast service?
- Does the forecaster always improve the suggested solution from the forecast model?

At least one thing is clear. All weather companies, national or private, do really try to produce forecast products with higher quality more efficiently, and in the end it will promote traffic safety.

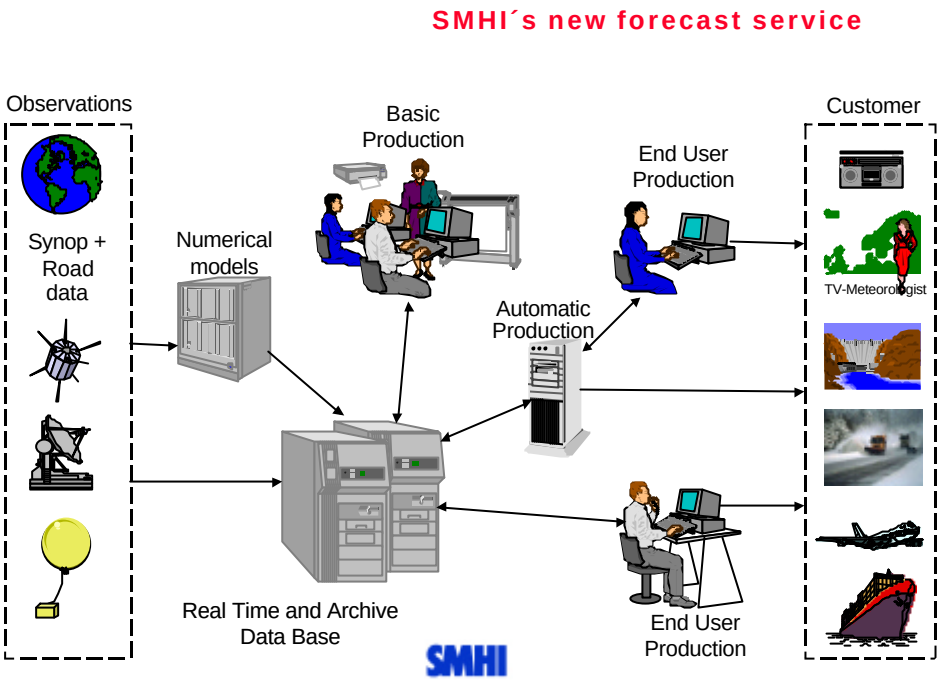

Figure 1

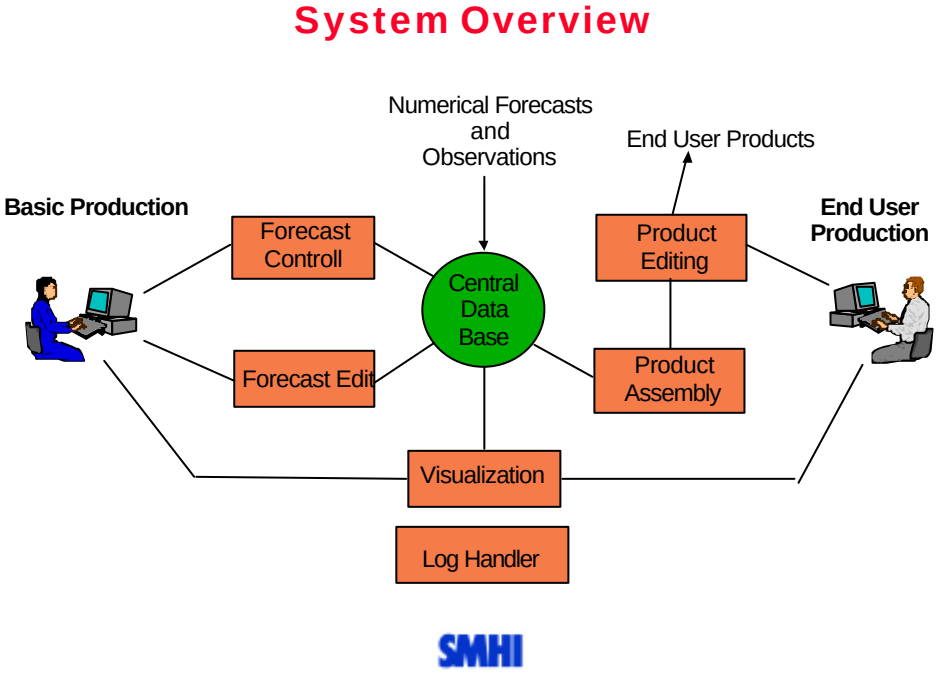

Figure 2.