

Weather forecasting, model monitoring or the third way?

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In a discussion on the future of the forecaster context plays an important role. The weather is international: it does not stop at our national borders. So, the future role of the forecaster has to be considered in an international context. In this paper, however, also the specific Dutch situation will be discussed since the governmental role which KNMI plays has an influence on the future of the operational forecasters. Weather forecasting has always been a profession in which experience is very important. Over the last decades numerical weather prediction has taken over a large part of the art of producing weather maps and making weather forecasts. Then, the questions: “Will future forecasters still be active at the heart of weather prediction, will they just be process controllers in model monitoring?” spring to mind. Or is there a third way? And if so, will it fit into the perspectives of our current operational forecasters? Will it be hell or paradise?

What is the role of KNMI?

What is the role of a national weather service which is no longer active on the commercial market? Currently, KNMI is playing an important role in weather forecasting alongside the commercial weather providers. However, one of the main tasks of KNMI is to focus on weather and safety as part of the governmental responsibility for the safety of the society. In addition, providing meteorological information to specific user groups such as to the general public (safety), to the Ministry of Transport, Public works and Water Management, and to aviation are defined as a KNMI task.

Up to 1990 KNMI was part of the Ministry of Transport, Public Works and Water Management, and had an undisputed task in meteorology, climatology, oceanography and seismology. In the nineties commercial activities were developed and the KNMI portfolio included a mix of public tasks and commercial activities. At the same time the private company MeteoConsult came into existence. In the mid-nineties, governmental organisations had to minimise their commercial activities, as a result of the recommendations by the committee Cohen. KNMI was one of the first governmental organisations to tackle this issue, which finally led to the splitting up of KNMI into a public part and into a commercial branch. The latter was Holland Weather Service (HWS). In April 1999 HWS became an independent commercial company. KNMI kept the governmental customers (although, at the time, it was not quite clear who they were).

Today, KNMI is a knowledge-based organisation, with its legal back-up laid down in a special KNMI law. KNMI wants to be an independent expert and want to be accepted by our commercial colleagues as such. Part of the governmental role of KNMI is still developing. This role is: to be an expert in (weather) safety now, and to be the developer of knowledge for future safety. This means we will focus on general weather forecasting, on severe weather forecasting and on the improvement of operational meteorological methodologies.

The KNMI organisation and the forecasting services department

The KNMI forecasting services department was reorganised in November 2001 (figure 1). The reorganisation consisted of: centralisation of the operational environment, a new working method (guidance), and efficiency measures. In addition, knowledge management became one of the guidelines in running the forecast operation. The objectives of the centralisation at the main office in De Bilt were: improvement of quality, optimisation of business processes,

broadening of public support, a change from routine production to growth of knowledge, and a strengthening of European co-operation such as on severe weather issues.

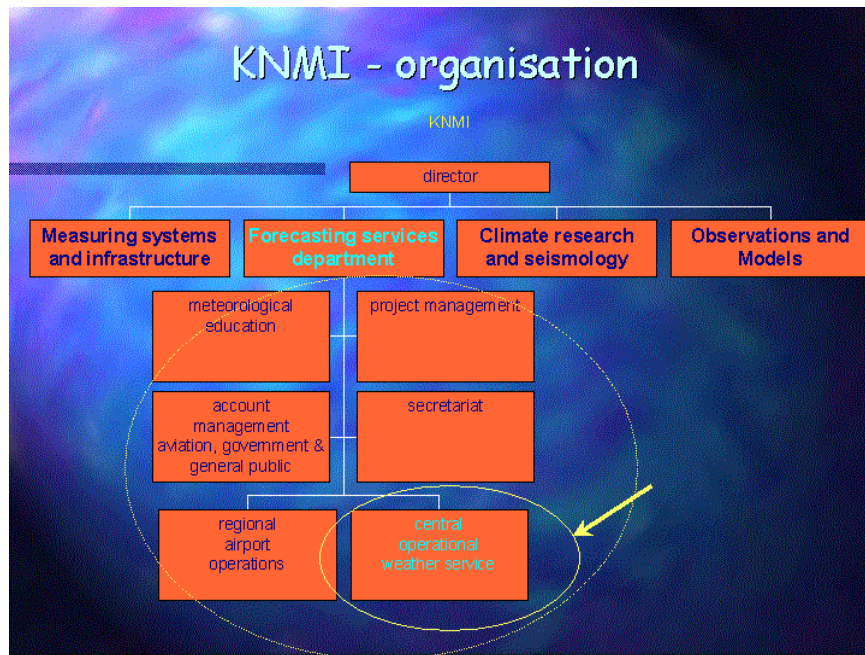


Figure 1. KNMI organisation and forecasting department

The new working method, with guidance at the heart of the operation, was introduced to cope with, on one hand, the increasingly more complex weather information and, on the other hand, more complex demands from society. In order to deal with this, a distinction was made between guidance meteorologists who focus on weather (model output and observations), and meteorological specialists, who focus on the specific demands of their user groups related to specific weather elements (see figure 2).

The Forecasting Office

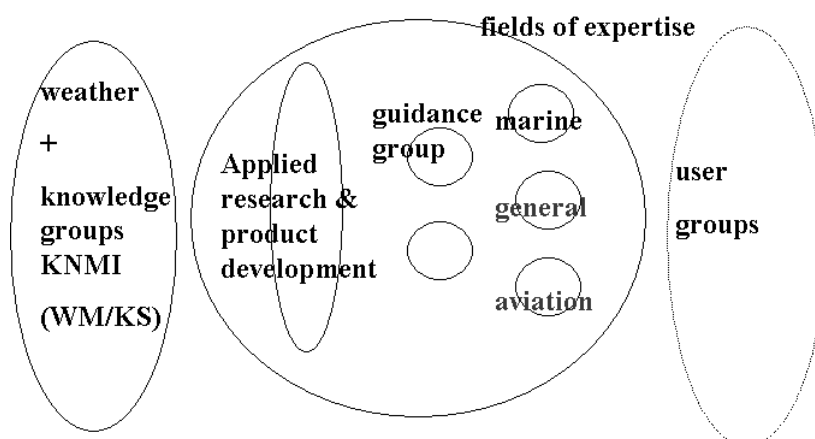


Figure 2. The forecasting office.

Within the guidance group, one of the forecasters focuses on nowcasting (N-forecaster) for the short forecast period (0-24 hours) mainly with the help of observations, the use of conceptual models of a regional SatRep and increasingly higher resolution models. For the

medium range (24 hours to 10 days ahead) the F-forecaster monitors the different models available (again with the help of SatRep), and the Ensemble Prediction System (EPS). Their findings and uncertainties are then laid down in a guidance bulletin with a corresponding graphical presentation. Recently, a start has been made with the OSFM (on screen field modification) technique (Carrol, 1997) within the guidance. With this technique the synoptic pattern (fields) can be modified in a meteorologically consistent way. Then, the controlled NWP output can be used by the various meteorological specialists and stored in a data base with quality controlled (the best estimate) forecasts for further use in automated production. This new working method therefore allows for further automation of routine production.

For the meteorological specialists the operational work has changed as well and will change even further. They are no longer as involved in the general weather monitoring, but deduce from the guidance relevant weather parameters for the users and in doing so add value to the weather prediction production chain. Moreover, specialists will make detailed, more realistic changes to maybe already altered model fields by the guidance meteorologist, for example to model cloud, precipitation and surface temperatures. In this way they can add important detail to relevant weather parameters for end-users. Also, meteorological specialists will become more involved in product development. Their role will evolve into a kind of meteorological consultant/advisor.

The purely governmental role of KNMI also has an influence on working methods and organisation structure. The weather safety task requires a separate severe weather shift, which is weather dependent. The improvement of meteorological methodologies has found itself in a try-out position within the forecast office, but also in the so-called "knowledge wheel". This wheel, described in the next section, is an applied research and development environment, in which the operational forecaster participates (rotates) for a limited period of time.

Role of knowledge management

Since research departments and the operational forecast office are two different worlds, especially at KNMI, some effort to bring these worlds together is needed. One of the solutions is the knowledge wheel. Forecasters participate for a certain period of time in the different working fields of the knowledge wheel (figure 3), preferably and necessarily with colleagues from research departments. During that time he or she will not be available for operational shifts. This may be for a period of months or even a year. The different working fields include: applied research, methodology and system development (e.g. OSFM, use of EFI's, the SatRep method), product developments (cost-loss, aviation capacity forecast), and try-out of new methods and techniques which includes further training.

The choice of subjects closely follows tasks laid down in the KNMI law: forecasting for the safety of the general public and forecasting for aviation, and more specific topics such as severe weather and the role of weather in water management. It is clear these research efforts have to be a joint effort of forecast office and research departments.

In addition to the knowledge wheel, another knowledge management measure is the introduction of the "knowledge broker". He brings together supply and demand in knowledge. This can involve taking interesting research results to the forecast office, but also bringing researchers and forecasters together in meetings, workshops or in courses for educational purposes. The broker uses an international network or a community and also translates research results into practical use.

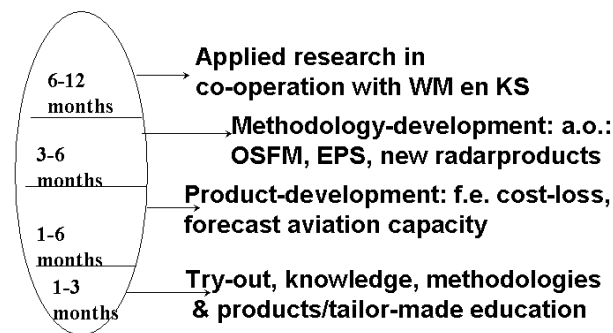
“Knowledge wheel”

Figure 3. Definition of the “knowledge wheel”.

For the co-operation between the forecast office and the research departments to succeed, a thorough education in meteorology – a university degree – is needed, as well as a feel for the weather. In addition, depending on a specialist or guidance career, skills in communication, advising, knowledge of business processes will be needed as well as academic skills.

Another important knowledge management issue is the clarification of working methods, which means that the working procedures have to be described. In order to achieve this implicit knowledge (years of forecasting experience) has to be converted to explicit knowledge (documented methodologies). The exchange between the culture of “black magic” of the forecast office and the culture of “black box” of model developers will help to increase understanding in both worlds.

Forecasting and models

Nowadays, forecasters are overwhelmed by many different models, each of them having their own specific characteristics. Some are more useful during extreme weather conditions (often the small scale, high resolution models), whereas other models – especially the large scale, lower resolution models – are more useful as a basis for routine production. On top of the direct model output, different post-processing actions take place (statistical methods, downscaling). How do the forecasters deal with this and what influence does it have on products?

Another problem is that deterministic models, in fact, only represent a possible scenario of weather development, because of certain assumptions in the selection of observations. With the arrival of high resolution limited area models (about 20km resolution or less), this has become very apparent. Large differences or inconsistencies may occur in consecutive model runs, when the atmosphere is in a sensitive state. Although the scale and severity of extreme weather events is much better predicted by a high resolution model, their location is not. For forecasters this means they have to be more critical in choosing their prediction tools. Now, most of the routine products are deterministic in nature and much of the additional probabilistic information is lost. In newer products this information is more likely to be included in a way the customer can deal with. This will become visible in products on both ends of the forecast range. The Ensemble Prediction System of ECMWF has made this clear for the medium range, but the inconsistencies of the high resolution models now show us that probabilistic methods are also needed in the very short range.

In the current operational environment the forecaster is caught between deterministic products and probabilistic models. So as a guideline, for routine operational use the Hirlam

55km model will be sufficient or a kind of poor men's ensemble of comparable LAM's of neighbouring countries. For applied research in, for example case studies, the higher resolution Hirlam 22 and the nested Hirlam 11 will certainly add value. For extreme weather events and for issuing warnings a combination of both can be used.

In the future, maybe model runs on request may become reality. Fields resulting from OSFM can then be used as new input for a new run of the model. Another interesting feature could be the zooming in on areas of interest. When will the model approach and the ongoing development of higher resolution alone no longer be most suitable and will the statistical post processing add much more added value to demands?

The on-going development in numerical weather prediction, asks for a more thorough meteorological, but also methodological background. In other words: "smart models require smart forecasters"(Mellink, pers. comm.).

A third way - innovative meteorology

Weather forecasting and model monitoring will remain part of the forecaster's job. However, less time will be taken up by these processes and the forecaster will develop into two directions. On one hand development of applied research (linked to operational use) and on the other hand the consultancy functionality or advisor. Both will benefit strongly from or even require the results from innovative meteorology. This third way encompasses a number of new developments. For example, the use of satellite images in combination with the recognition of meteorological objects therein (SatRep) will become an intrinsic part of the forecasting methodology. In the Satrep method (figure 4) model and satellite information is combined. The conceptual models help to understand atmospheric processes and to describe possible extreme events in the lower troposphere. In addition, these conceptual models can be used in the quality control (monitoring) of the used models.

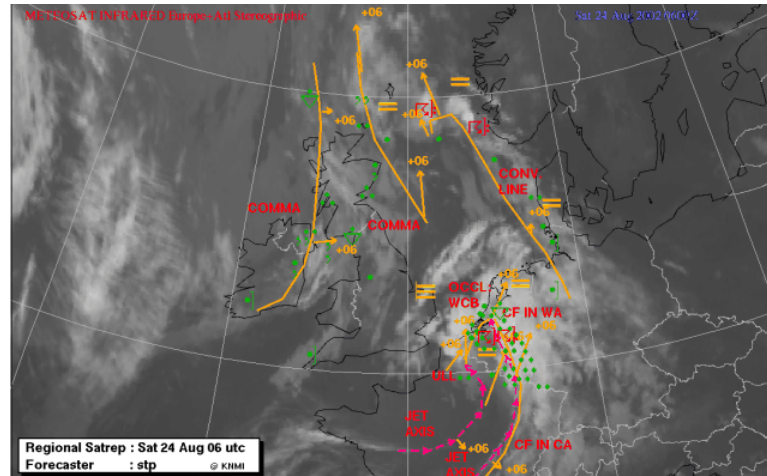


Figure 4. Example of a SATREP product.

The third way also involves more probabilistic forecasting and the use of EPS in combination with user specific applications. These can be fairly simple models that are coupled to the EPS outcomes. Examples of such models are the ice growth model (forecasting the thickness of an ice-layer), which is important for shipping as well for recreational purposes. This simple energy balance model of a water column is forced by the 50 scenarios of EPS for temperature, dewpoint, wind and precipitation. Also for wind surge a tailored "user" ensemble can be generated. The wind surge is the (wind-driven) sea level added to the astronomical tide. At KNMI a simple quasi-linear model is used for sensitivity purposes. EPS winds from the North Sea in combination with this simple model will then result in a probabilistic forecast of sea level ranges which gives the user in one glance the risks which are at stake (figure 5).

This approach can be easily extended to other uses as: detailed water level management, river run-off or an air pollution index.

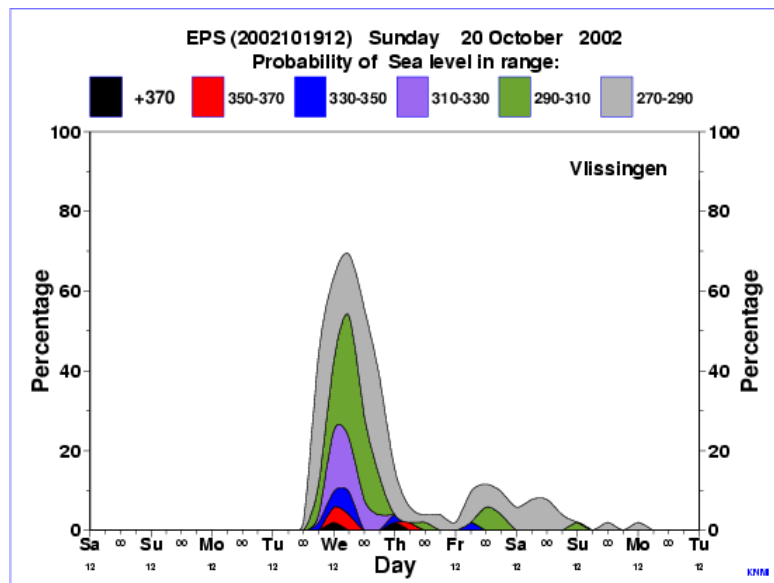


Figure 5. Example of EPS forecast of sea level change.

The third way also involves the better use of tools such as OSFM in combination with the “best forecast” database in combination with an automated routine production (GI-4D, BVD). Also, the benefits of high resolution LAM’s and downscaling are better used. More effort will be put into applied research on operational meteorology for general use as well as for aviation and maritime purposes. In the forecast office more knowledge has to be gained on the specifics of model development and observations (automation, MSG etc.). And, lastly, much focus will be on the development of severe weather indices. This development will benefit from a closer international co-operation. Also, impact studies from other countries as well as experiences with distributing warnings will help in finding best practices.

So what does the third way require from our future forecasters? Fewer forecasters will work in shifts; more will work in a research and development (R&D) environment. The forecaster will evolve in either a meteorologist or an advisor. From the organisation it requires a sound automated routine production as soon as possible. It also requires a method to upscale the operation when needed, that is in case of severe weather but also during calamities in which weather plays an important role.

In conclusion on the future role of operational forecasters – will it be hell or paradise for our current operational forecasters?

It might be hell

It can be paradise

It surely requires an enormous amount of hard work of both the KNMI-organisation as well as of our forecasters, but it can be done!

References

Carrol, E.B., 1997: a technique for consistent alteration of NWP output fields. *Meteorological Applications* 4, 171-178.