# About the Nature of the Forecaster Profession and the Human Contribution to Very Short Range Forecasts

## Introduction

To maintain proficiency and professional skill the forecaster needs opportunities for training and self-study. In the long run, cumulative work experience is gained naturally in the job itself. The case-studies and other articles with a special Europe-centered view in this publication will be of use to us in learning and gathering information. Certainly, a thoughtful contemplation of our profession, its demands, and the future of forecasting is in the interest of the forecaster community.

An often expressed, though not necessarily well-founded, view on the future of weather forecasting is that the importance of a human forecaster will self-evidently diminish. The Copenhagen topic "the Human Factor", and Gaia & Fontannaz's article "The Human Side of Weather Forecasting"[1] draw attention to important but insufficiently discussed subjects. I wish to stimulate discussion and possibly raise some new questions for colleagues to consider. My focus and special concern is the role of humans in nowcasting and very short range warnings and aviation forecasts.

## About the forecaster's professional expertise and consciousness

Let's assume you are chatting with someone you don't know very well and they find out you are a weather forecaster. Every one of us certainly has experience of the interest and generally positive curiosity that is quite often aroused in a situation like that. Quite often it quickly becomes apparent, however, that your companion's understanding of the profession of a meteorologist or the essentials of weather forecasting is comparatively shallow.

It is entirely understandable and forgivable that an ordinary person doesn't know very much about our work. We do have a rare, perhaps an exceptional profession. A much more interesting question is whether we ourselves understand the nature of our own job completely. In particular, it is crucial to find out if this understanding is adequate in our national weather services. At least a satisfactory comprehension is needed among those who do not work as forecasters but make decisions which concern our daily job. This is a topic I think should be discussed much more extensively.

I am suggesting that there exists a basic, partly subconscious confrontation that tends to dominate our thinking about forecasting: Is it *primarily a technical process* that needs some human interference to generate forecasts, or is it *exercising of a profession* that requires scientific and technical knowledge but human contribution and ambition as well? I would venture to suggest that this confrontation is a paradigm that quite often underlies different views on e.g. the forecaster's role in the future. If we adopt the former "technical" view, we are apt to see the continuously improving forecasts as an inevitable automatic result of new model versions or radar products. The latter "professional" view more realistically reminds us of the fact that one important driving force behind any advancement, any invention or improvement, is the human factor, someone asking "how to provide better service, more useful forecasts, create something we haven't seen yet?" Tools are important, but more important is the intelligent use of the tools and the possible innovative ideas and new goals.

Generally speaking, it is easy to list the forecaster's needs: sufficient weather information, proper equipment and professional ability together yield good forecasts and accurate warnings. But when analyzed in detail, several questions immediately arise: What is the forecasting job really made of? What about the requirements for the necessary education and training, practical skills, and the ability to cope with stress and hectic situations?

Additionally, one can ask how the situation has changed for instance during the last 30 years. At a first glance it might seem that the work has become easier due to e.g. the superb achievements in the field of NWP. Firm opinions are sometimes expressed about the future change in weather forecasting, e.g. the inevitably diminishing human role in the future. On the other hand, it is perhaps not quite as clearly seen that the development and advancements also mean new, fresh challenges in the forecasting room.

It is also worth considering who generally understands and is able to extensively evaluate our work. Job analysis focusing on the work done in the forecasting room could produce new and significant knowledge. However, so far as our profession is concerned, I am aware of only a few investigations, mainly from the 1990s and 2000s. The report on warning forecasting by Klein Associates Inc.[2] is in my opinion constitutive in this field. Some profound, straightforward and often visionary discussion can be found from Doswell[3,4]. Stuart et.al.[5] emphasize the significance of understanding the psyche of forecasters and the importance of proper education. In the European context Gaia and Fontannaz's[1] article is possibly a pioneering effort and therefore much appreciated by colleagues.

In Finland, perhaps in other countries as well, the importance of the 24/7 service and the special warnings and other products for authorities and military are widely acknowledged and appreciated. The need to be able to forecast extreme or troublesome phenomena more successfully has increased. I see here a discernible trend which lends support to the idea that we will need to further our understanding of the real nature of the forecaster's job in the future. The sustainable organizing of such services naturally requires a clear view of how to recruit proficient and enthusiastic staff, how to encourage middle-aged, experienced forecasters to keep up and how to organize the most tiring shifts. And finally: how to construct a working environment that is both ergonomical and cognitively stimulating.

Above I have mentioned several issues related to the work and professional expertise of the forecaster. A thorough, all-inclusive solution would be beyond the scope of this article (and certainly likewise unreachable with my expertise), but I hope a simple and partial answer could be presented. It concentrates on the question "what is a good forecaster like?" The suggestion presented hereafter is significantly inspired by Doswell[3] and it will condense the answer into five points. I warmly recommend reading the entire essay to anybody interested in the subject.

First of all – quite simply – a good forecaster is interested in the weather. The phenomena fascinate regardless of working hours or holiday periods. On the job the forecaster is sometimes able to discover new challenges even in a simple synoptic situation. It is worth noting that there are many top level researchers with a keen and regular interest in actual weather situations in the forecasting room. A good forecaster does not perceive the weather only as grid values and fields on the screen. Rather, the present state in the atmosphere is seen as weather phenomena with names and characteristics. The behavior of these phenomena can vary in different times and places but is hopefully possible to understand. It is seen as a professional challenge rather than routine work.

In the second instance: a good forecaster works in collaboration with colleagues, is inquisitive and eager to learn. When possible, interactive working is more effective than struggling alone. Learning by doing together is not only fruitful but fun at its best.

A capable meteorologist appreciates technical experts and the necessary technology. At the same time the forecaster is a demanding customer: ready and willing to test new tools but critical, too. An awareness of the new features and possible meteorological constraints in the technical working environment is a crucial part of the proficiency in forecasting. Good forecasters know when the automated forecasts will be useful and when they will be wrong.

Certain physical and mental characteristics are needed in the forecasting room: being able to tolerate irregular working times, to cope with uncertainty, to be on the alert for unexpected situations. The work must be completed in the required time frame, so rather a lot of decisiveness is needed, too.

Finally: a good forecaster has extensive knowledge of the needs of the forecast end-user on one hand and the meteorological basis of the forecasting process on the other hand. Relative to the customer, this means simultaneous ambition and realism: the forecaster wants to offer best possible service, but is willing to recognize the existing meteorological uncertainties. The confidence of the customer is the most valuable "capital" we have. We are familiar with the concepts of medical or economic ethics – meteorological ethics could as well be a useful and relevant term!

## Aviation weather forecasts are often warnings by nature

Traditionally, the term "severe weather" means phenomena related to strong cumulonimbus clouds or generally violent winds and torrential rain. Increasingly it is seen that we might as well include very poor visibilities and particularly low ceiling situations in the same category: "Lives can depend on the accurate and continuous monitoring of short-lived but severe weather situations such as fog or thunderstorms" (EUMETSAT Newsletter[6]). It is well-known that in "high latitude regions" like Scandinavia, Canada and Alaska we do have long-lasting episodes of bad aviation weather, which is demanding to forecast. In central parts of Europe the most critical time seems to be the winter solstice like before Christmas 2006, when severe fog caused chaos at London's airports[9].

Aviation meteorology has a long history and the work is internationally regulated. Some products, like Terminal Area Forecasts (TAFs), Significant Weather Charts (SWCs) or numerous military products are made round the clock at certain airports and air bases, and are therefore sometimes seen as "routine" forecasts. However, it is vital to be aware of the warning nature of these forecasts. Even in fair weather, it is possible that the forecasting process requires exclusionary reasoning of some dangerous elements though the final product may be simple: "everything OK, CAVOK, no warning". In difficult conditions aviation forecasts very quickly become more complicated and they have apparent warning components. In that case aviation forecasting is as demanding as any near-future weather warning responsibility. The three-dimensional aspect in aviation means additional struggle in the forecasting room: it is conceivable to have CAVOK on ground level but reason to issue a warning for higher altitudes.

So, the close relationship between aviation and other safety-weather products is evident. An interesting question is how the accuracy of such forecasts and their value to the customer is measured. By verifying a large amount of forecasts and studying e.g. mean errors? Or, after all, could a single crucial warning be much more valuable than hundreds of "routine" forecasts? What about the warning that was never given? The economic benefit, risk minimization or even the potential prevention of an accident would have been extremely important to the customer. No quick or even unambiguous answer exists.

Finally, there's one delicate process to consider. To what extent are (semi-)automatic tools needed in warning generation and where is the human contribution most crucial when aiming for the best results? Doswell[3] points out that so far as phenomena related to strong Cb clouds are concerned, the automatic warning algorithm output from radar systems already shows a tendency to become the de facto warning system. However, forecasting subtle very low cloud and visibility situations is different in nature and may not be suited to automatically tripped alarms. Naturally automatic "beep-systems" in the forecasting room which give a warning when certain limit values are crossed, are of help as forecaster guidance.

## Human forecasters – busy and necessary in the future?

Some years ago, when the future of the forecaster's job was considered, the vision of full automation in forecasting was brought up every so often. Today, it seems that the diversity of forecast products and the customers' needs is widely understood and the prevailing view has become that the human input in

the process will remain but significantly decrease. But how adequate and *meteorologically* well-founded is this view, the unavoidable diminishing of the human role? It is a common definition that the human forecaster is needed as long as she or he is able to add value to the numerical forecasts. Does that mean that the day will unavoidably come when an objective meteorological point, i.e. a certain quality-level of the models is reached: "from now on the forecasts will be high quality stuff without any human intervention"?

The primary objective of the final part of this paper will be to show there is a firm *meteorological basis* to expect and argue that 1. in "the window" of nowcasting and very short range forecasting special human challenges are faced and they will remain in the future, 2. the concept of "the human ability to add value" needs a proper definition and somewhat broader and more critical consideration than it has received hitherto and 3. the human input will remain, not self-evidently wither. It will be understood that other motives, particularly economic ones, for the diminishing of the human role may exist. In this article, no attempt will be made to discuss these.

So, the concept of the forecaster's ability to add value to NWP seems to be essential for the future of our work. Interestingly, a respectable definition of the concept or analytical discussion, for that matter, is not easy to find. When examining the matter more closely, several definitions emerge. One line of thought is founded on the assumption that there is a tolerably good NWP value or field available and the human's role is to fix it if necessary. The human ability, if it exists, should be seen both in the individual forecast and in verification results as well. Forecasting is predominantly seen as delivering values, fields and products to the customer.

Probably this somewhat constricted definition often dominates discussion of the human role in forecasting. It is vitally important to understand that this definition is inadequate in the fields of nowcasting and very short range forecasting. When working in this timescale, a method founded on the NWP is only one technique among several others (see e.g. Table 1., partly adapted from the EUMETSAT Newsletter[6]). Besides, most of these techniques relate to the nowcasting of rain, not the focal aviation parameters, i.e. visibility and ceiling.

Moreover, warnings and most aviation forecasts for the next few hours naturally consist of considerable number of subelements. Some parameters (e.g. upper winds) one can unquestionably pick directly from the models (Roebber et.al.[8]) or they lend themselves to other types of automation. However, there remain weather elements which are more reliably and successfully, quite frequently necessarily, nowcast by techniques other than pure NWP. We can see that this period of time or "near-future forecasting window" where the utilization of other techniques is essential, has a non-explicit, situation-dependent duration: typically a few hours but sometimes longer. The salient point is that here we actually face the region where other means than NWP may be the only possibility to forecast. At least in the near future reasoning, extrapolation, combination and merging of data, and human interpretation of weak signals required in the utilization of other forecast subelements will play a vital role.

It is of supreme importance to realize that this window will not disappear in the foreseeable future, if ever. The simple reason is that the gigantic stream from the constantly developing observation systems often (hopefully) enables almost immediate pattern recognition as well as monitoring or extrapolating of the phenomena. But, on the contrary, the full assimilation of all the information in the NWP system will be a formidable, in fact endless challenge and will always involve at least some time lag, which could be crucial in rapid forecasting situations. So the conclusion is that the human ability to add value can and should mean more than simply touching up the NWP fields. *It additionally and particularly means the human-based intelligent and professional operating in the near-future forecasting window.*

Secondly the human role in adding value means that regardless of the forecasting techniques the customers and forecast end-users have the possibility to consult the forecaster on duty. A fruitful and adequate interaction is possible only with a substantial situational awareness on the forecaster side. No less than the past, present and future weather must be mastered. Forecasting is not only delivering values, fields and products, but more: service that suits the customer's needs.

An overworked forecaster with an unsatisfying working environment for monitoring the present situation is "blind". We might reasonably call this state of affairs the modern form of the meteorological cancer. If the nature of the work is poorly understood, and the predominating requirement in the forecasting room is that of effectiveness, the risk of "cancer" will grow.

In the third place, a noteworthy aspect in the human ability to add value is the idea of cumulative, practical 24/7 experience of the forecaster. Not only the forecaster's experience of various weather situations, but also their knowledge of the customers' needs and the forecasting process is valuable in developing better quality products. Experience shows that new ideas and service innovations quite often emerge from the practical challenges first encountered in the forecasting room. When the potential of numerical modelling grows, the expectations human forecasters face will without a doubt increase, not ease up.

Building a better service undoubtedly means that all parties (research-operations-customers) need to be involved in the process. There are reasons for arguing that a capable forecaster has excellent readiness and competence, a unique chance, to act in a two-way intermediary role, to build the bridge between all parties.

Finally, the model development itself suggests that the human role may remain significant but take new and challenging forms. Here we refer to the new high-resolution models. For instance Schultz et.al[7] state: "High-resolution model output cannot be interpreted the same way as a coarser-resolution model output. Communication of high-resolution forecasts to end users is not simple (i.e., you cannot just send raw model output to users and expect them to use it). Forecasters need to be retrained. This ensures jobs for good forecasters in the future."

## Acknowledgements

I am grateful to Antti Pelkonen, the Finnish representative in the WGCEF, for encouragement and many fruitful discussions, and to Topi Mastosalo and Prof. David Schultz for their valuable comments. For several years, Janne Kotro and Elena Saltikoff have given me some vital insights concerning the "near future" forecasting problem.

### Table 1: Nowcasting is supported by a number of techniques

- Persistence
- Interpolation & linear extrapolation
- Advection of phenomena, based e.g. on model winds or Atmospheric Motion Vectors
- Conceptual models, well-defined meteorological features associated with patterns of cloud/rain distribution and clearly visible in satellite/radar imagery; a model can help to predict the evolution of the feature and its associated weather
- Methods based on determining the initial state of the atmosphere and/or interpretation of weak signals in order to determine the probability of the phenomenon (decision-trees/ checklists/ ingredients)
- Human experience
- Numerical methods
- Utilization of historical/statistical data(base), e.g. individual statistical peculiarities in the airport cloud and visibility distribution

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**Timo Erkkilä**
*Finnish Meteorological Institute*