NOWCASTING METEOROLOGICAL HAZARDS

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1. Preface

The main work of regional forecasters and especially of meteorologists briefing general aviation and, especially, flight competitions is to provide most accurate Nowcasting (up to two hours) and Very Short Range Forecasting (VSRF, up to 12 hours) including warnings of hazardous weather events in general and in task actions. In co-operation with the German National Weather Service (DWD) our Working Group does research preparing a modular system which will work mostly automatically, and it includes empirical parts. This system will enable the forecaster to give objective information for proper decisions. A similar system working for several parts of the USA has been described by Eilts et al (1996).

2. Monitoring

Such a nowcasting system needs all available meteorological input in order to monitor the atmospheric elements like temperature, precipitation, gusts etc. All other measurements from radar, satellite, lightning location, and the modern profiler systems have to be available, too, in order to do proper monitoring. Furthermore computer derived information like vorticity, thunderstorm indices, advection rates, and probability values of nearly all meteorological elements of interest are processed and displayed by means of statistical model interpretation (Knupffer, 1996). Some of this information is available, already, in the German Weather Service systems.

However, missing are the "hard" values concerning extreme weather, i.e. weather hazards like maximum gusts, large amount of convective rain, conditions of flash floods, hail, and - in winter - sudden turning of rain into snow or to glaze conditions. "Warning points" are available in the DWD monitoring system, now, like hail heads derived from satellite cloud top temperature and thunderstorms, derived from radar and weather observations and, especially, from lightning location systems.

3. Special Methods for Nowcasting Hazards

We are developing an empirical system, combining all available Direct Model Output (DMO) and Model Output Statistics (MOS) information, in order to catch the seldom-occurring hazardous weather events. The goal of that system is to obtain objective and nearly automatically derived values of e.g. rain rates, maximum squalls, hail, etc. The following conditions should be available:

Firstly, the system enables the use of all meteorological observations (satellite, radar, radiosounding, synop, metar,

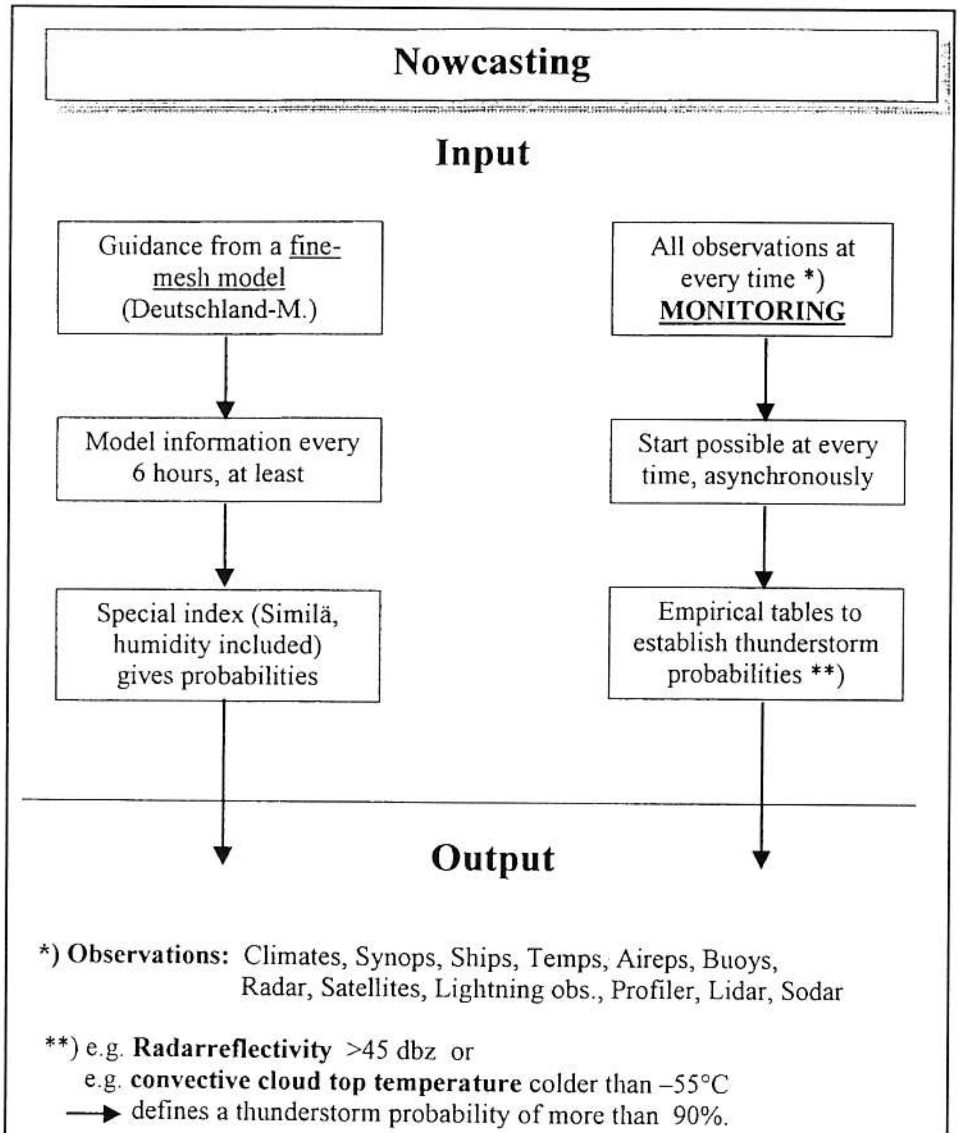

FIGURE 1A.

speci, lightning). Concerning flight information most of these data are available in Germany via PC met of the DWD. But the forecaster needs complete monitoring. So it is possible to provide that including hazardous parameters automatically by defined thresholds and numbers which are important for developing or existing hazards.

Secondly, most of these observations are available asynchronously. So it must be possible that the model starts and works automatically, at every time when new information is coming in or the forecaster wants to use it.

Thirdly, the model includes in particular the regional climatological background, e.g. the main distribution of thunderstorms, i.e. high numbers in hilly areas and less occurrences in lake areas. The model runs automatically, but may be enhanced because of the forecasters' experience and his empirical knowledge. So the model remains a man-machine-mix.

Fourth, nowcasting has to be done by the forecaster using both the automatically provided monitoring and the numerical guidance, esp. the fine-mesh forecast model output, available for every hour of the forecasting period; via PC met of DWD it is available every six hours. If these two parts are matching, the forecast will be easy. But if differences occur defined thresholds make up alertness, and the forecaster has to decide whether a hazardous situation is expected or not: He has to adjust the forecast what will be decisive in task settings. All pilots may get the results as an hourly update, too. This model is being developed, and first modules are tested within the German Weather Service MAP (Meteorological Work Station System).

3.1 Flow Charts

Defined numbers, thresholds and flow charts are developed in order to predict thunderstorms, flooding rain, hail, snow, sleet, freezing rain, and gusts. First verifications for the prediction of heavy rain and gusts for the Berlin area and for some areas in Central and South Germany prove the usefulness of such an objective and nearly automatic system.

The main idea of this model is demonstrated as a flow chart in Figure 1. a) "Input": On the one side (left part), the numerical guidance gives information about all weather events including hazardous ones. On the other side (Fig., right part), actual weather observations are used for a complete analysis of the weather situation at every moment, i.e., monitoring." In comparing the fields coming from the numerical guidance these observations have to be converted to fields, too. That is done with index values like the Simila-index (1949) which has been modified by Pelz (1970). It additionally includes humidity information of the atmosphere what is missing in the original value. This index (also possible are many other used convection indices, see e.g. Huntrieser et al. 1997) can be turned to probabilities of thunderstorms (see Table l), and these probabilities may be drawn as fields which are available from the numerical guidance, too.

Figure lb shows the "Output": These hourly fields of thunderstorm probabilities will be automatically compared. If observations do not match the model fields, the, "observational side" of this scheme has to be taken. These fields are processed by means of extrapolation techniques, mainly, in order to obtain the fields for the next hour which will be compared, again. Both the numerical and the observational parts give objective results on hazardous weather

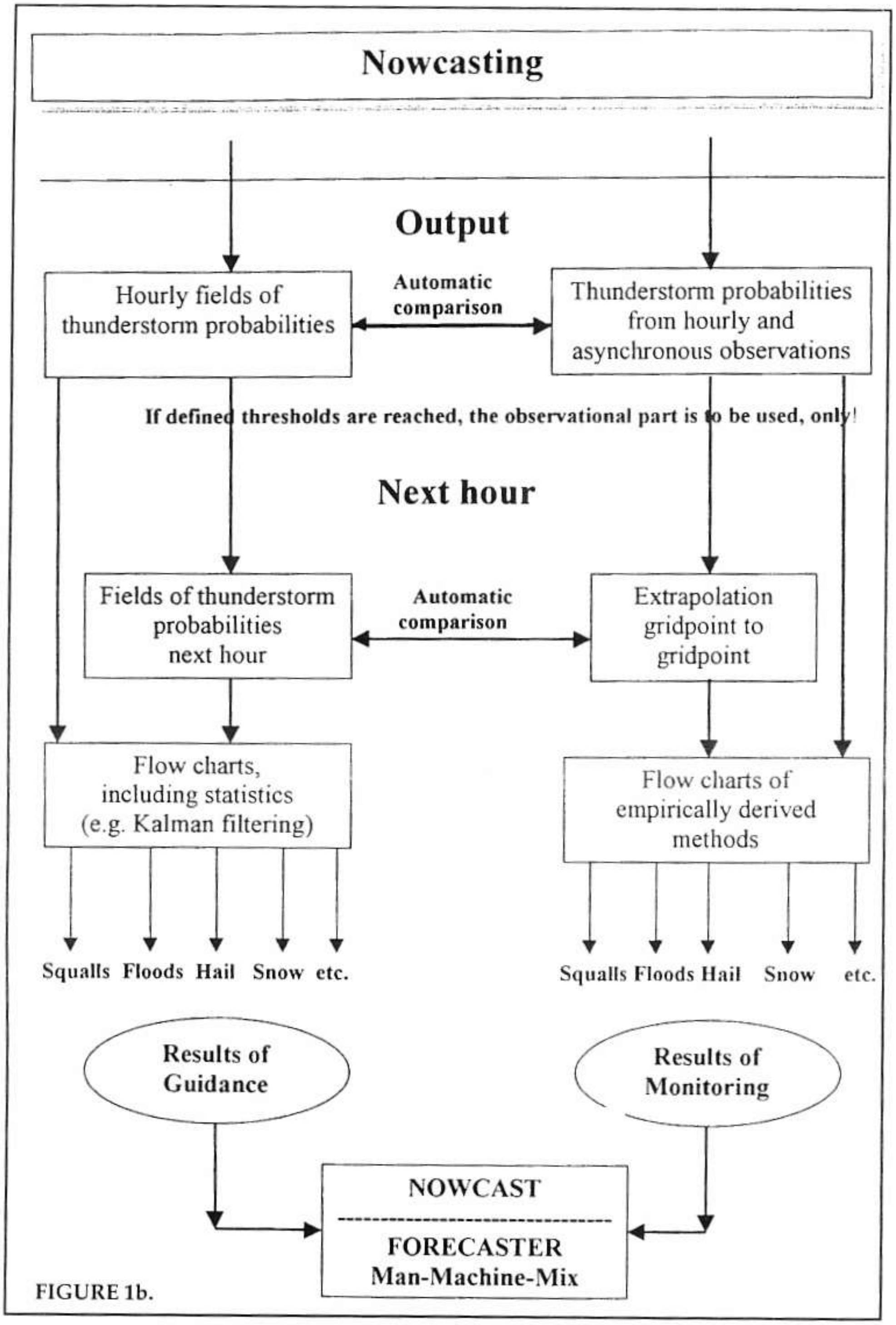

FIGURE 1b.

using the modified Simila-Index we tested and successfully used in our Institute since the 1970s in predicting thunderstorm activity at the Berlin area. For example: An observed altocumulus castellanus defines a thunderstorm probability of 20%, a non-precipitating (new) cumulonimbus 60%. Radar reflectivity is converted as follows: Up to 24 dBz 5%, up to 48 dBz 75%, 49 dBz or more 90% thunderstorm probability.

A similar procedure is proposed for satellite cloud top temperature, but not yet verified, at all. At first, it has to be decided that the cloud is a convective one, not a cirrus and not an anvil. If the temperature is higher than -45°C no thunderstorm probability (0%) is defined, -50°C gives 60% and -55°C equals more than 90% thunderstorm probability.

3.2 An Example: Heavy Rain

Figure 3 shows the scheme for obtaining hourly rain rates, or rates for ten minutes, perspectively. At first thunderstorm probability is taken from the nowcasting system described above, secondly cloud top temperature (CTT) of the half-hourly Meteosat images is - if available - derived and thirdly radar information is checked. If there is a reflectivity of more than 32 dBz strong precipitation will be possible. In that case the duration of the observed and extrapolated radar echo at each gridpoint is calculated, and rain rates connected with reflectivity amounts are derived.

The estimate delivers precipitation values of about 25 to 50 $1/m^2$ per hour what corresponds to 5 to 12 $1/m^2$ per ten minutes. The normally much higher precipitation rates for short (e.g. ten minutes) rain events are related to comparatively lower rates for longer (one hour) duration.

This system will enable meteorologists and forecasters to obtain additional objectively derived information to activate early alertness concerning weather hazards and to be able to give more accurate warnings and briefings, esp. for aviation purposes and flight competition meetings.

events in using special flow charts of empirically derived methods numerical post-processing like Kalman filtering or some different model output statistics (MOS).

Eventually, the forecaster has to weigh and to compare this information, look at the latest radar and weather observations - looking out of the window, too - add his experience, and then he will be able to issue the nearly automatically derived and objective warning.

Figure 2 shows the principal adjustment of observations to model gridpoints, in this case thunderstorms or showers. All available weather information is collected and then converted into numbers of thunderstorm probabilities,

Literature:

Eilts, D.M., et al. (1996): "Severe Weather Warning Deci-

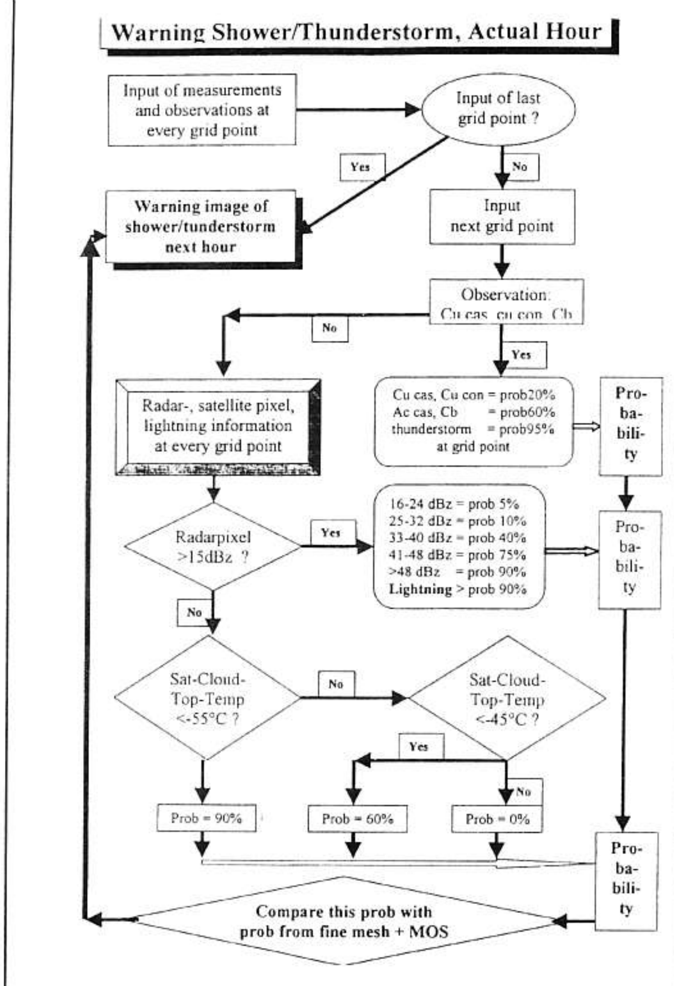

FIGURE 2.

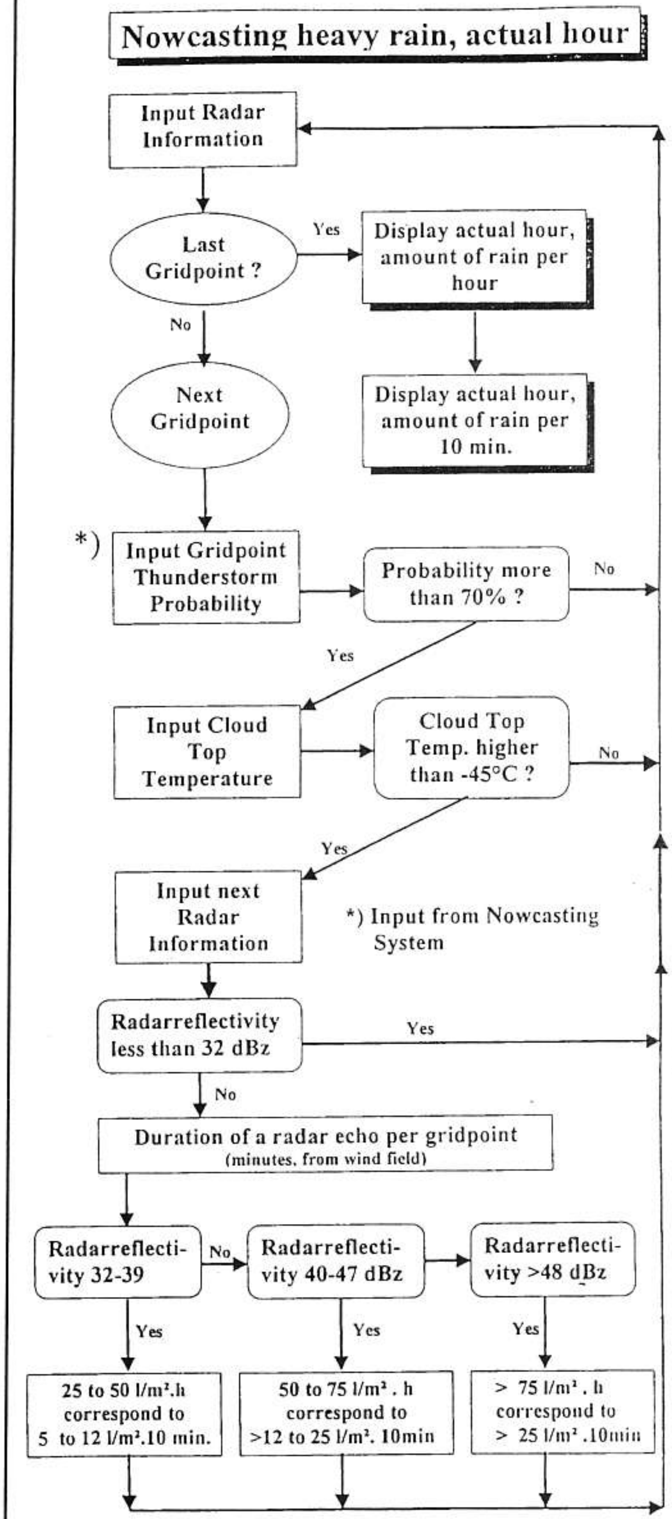

FIGURE 3.

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