The making of: a weather forecast

It might still be sunny outside, but the light is already changing; a rain shower is imminent. A rectangular, fenced-off area containing all kinds of meteorological equipment is visible at the edge of the open field. This measurement field is just one of thousands. The rain shower starts. As the first drops of rain fall into the rain gauge, they immediately become part of the very complex process involved when making a weather forecast.

As a weather company, we do our utmost to provide our customers with the most reliable forecasts possible. A chain of information processing and editing underlies all of the weather forecasts that we issue. The added value we have to offer is primarily due to our balanced model combinations and continuous, automatic quality checks to ensure that observations and model data are aligned optimally.

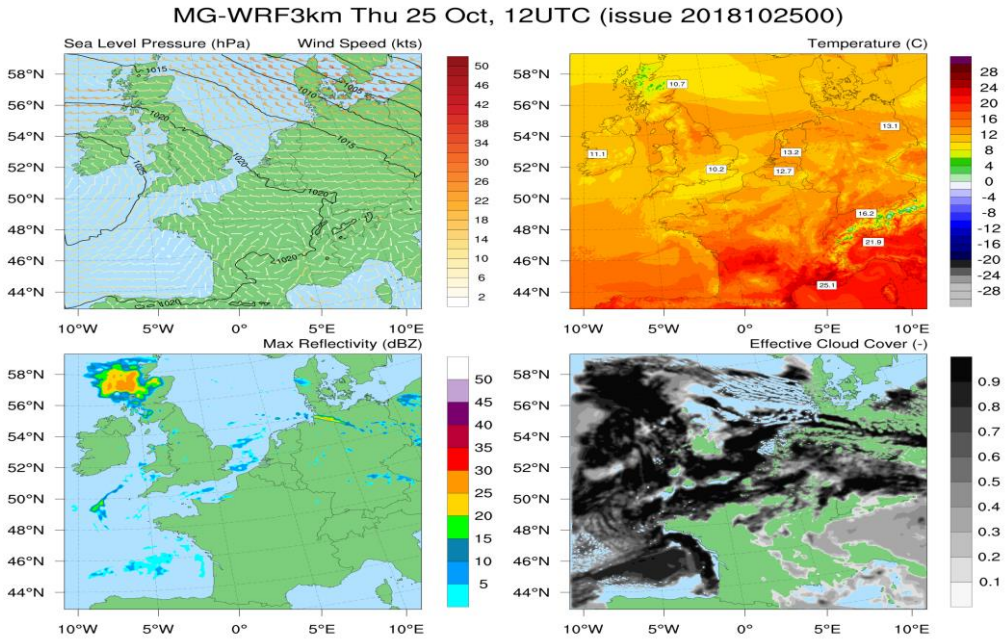
The improvements we make to raw model data ensure that our forecasts are of the highest quality. A large number of colleagues - meteorologists, programmers, data specialists and IT professionals - dedicate all of their working hours to the above. Weather forecasts are our core activity and we are only too happy to share what this process involves with you. We will take you on a tour: from observations and models, via comparisons, to the final round of editing in the weather room.

Input

All weather forecasts start with observations. Accurate observations are perhaps the most important part of the whole process. They are not just a vital starting point but also essential for last-minute updates and warnings, for corrections to our statistical operations and, ultimately, for the validation and verification of our continual efforts to make our procedures even better than they already were. There are almost 20,000 professional weather stations worldwide; each passes on its data on an hourly basis. As such, a drop of rain that falls into an official rain gauge will be passed on as part of an official observation within no more than one hour. It then takes just several minutes for the observation to arrive in our data systems.

From this point on, we use the data we receive to help us achieve the best forecast possible.

Besides observation data, we buy data produced by numerous weather models too. In these so-called numerical weather models, the various physical processes in the atmosphere are extrapolated on the basis of a certain initial situation. This starting point is recorded in an air pressure field with all of the corresponding weather elements, including cloud cover, precipitation, temperatures, dew points, hours of sunlight, wind and wave height. The models then extrapolate this mass of data to a date in the future, even up to a maximum of two weeks. MeteoGroup uses a combination of three weather prediction models to arrive at the best result. These are the European model (operated by ECMWF), the American model (operated by US NCEP), and the British model (produced by UKMO). Our long-standing use of each of these models has taught us how well each scores on the various elements, which allows us to give a certain weighting in relation to each weather element to be calculated.



The added value of innovative capacity

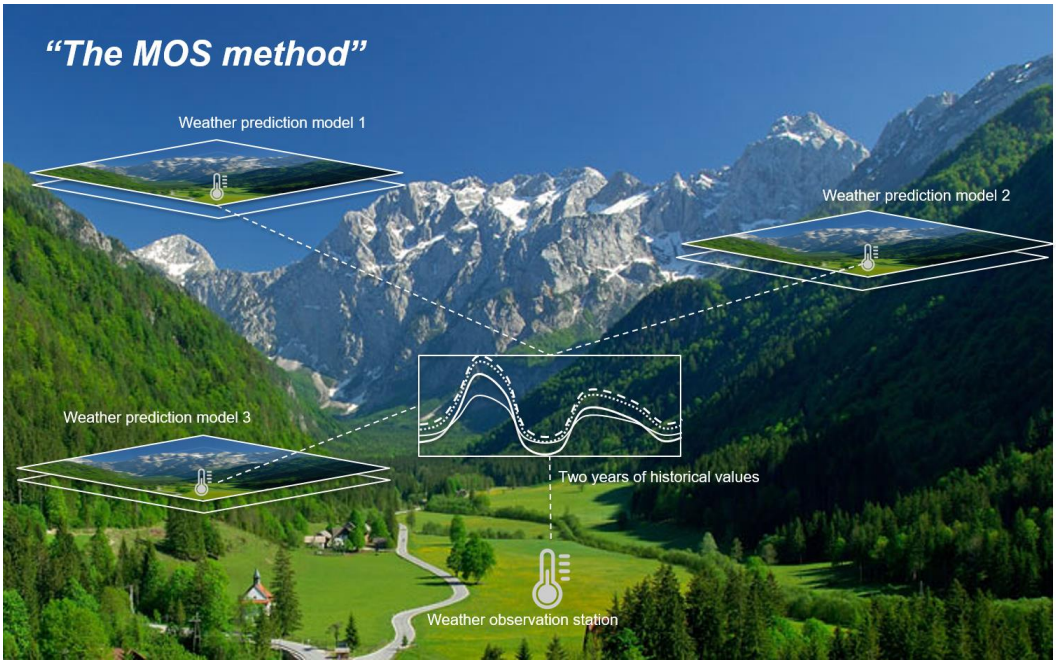
The most important step in our production of the specific forecasts we offer customers involves adding value to the data we buy. Our innovative, cross-functional Weather Systems Team is responsible for a bulk of (machine learning) post-processing algorithms we run on all of the data obtained from the models. Post-processing is used to correct the quite coarse-scale nature of model output; these corrections are necessary to ensure that local effects are taken into consideration. The process outlined above is at the heart of our high-quality forecasts and results in the MOS (Model Output Statistics).

It is with good reason that the MOS (also known as the MultiModel-MOS) is MeteoGroup's showpiece. We use it to correct for local influences and get closer to the actual situation as a result. The MOS takes account of two years of historical data

and compares local observations with the model data issued. This reveals a number of common errors, as each location has its own precise local characteristics which will not be fully reflected in a coarse-scale model. The MOS realigns the deviation and ensures that the appropriate weighting and characteristics are applied from the three main models. As such, a specific individual MOS forecast is generated for each MOS observation point.

For example, let's suppose that the park and observation station described in the introduction to this article are situated on the flank of a hill. The numerical weather models do not produce calculations based on the actual height but on a coarse-scale network of contours, as if the weather station is located in a stepped-terraced landscape. The numerical models do not include input to reflect the woodlands to the north, which act as a breaker for northern winds to a certain extent. However, the MOS has received this information over time, when observations and model forecasts diverged on certain points. This puts the MOS in a position to correct 'from experience'. The same applies for a weather station that has gradually become part of a built-up environment due to urban expansion, because of which the maximum temperature recorded in the summer season is for example 0.8 degrees higher than the temperature calculated by the combination of models in use.

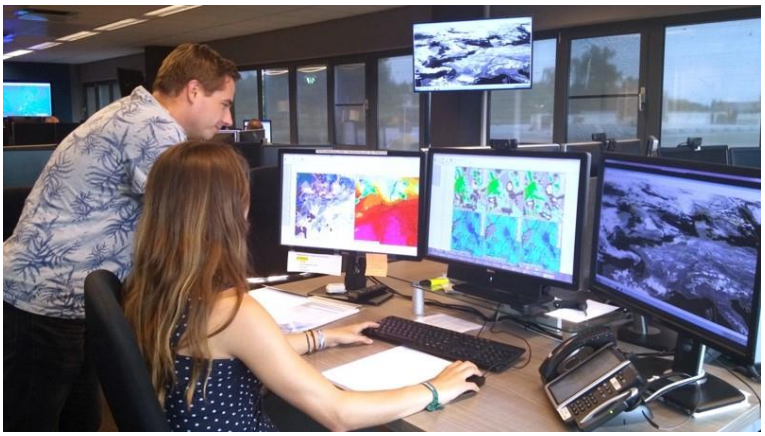
The continuous correction of model forecasts, based on observation points, results in the calculation of some 50 million mathematical equations every hour. Added to this, another algorithm that we have developed enables us to extrapolate the MOS forecasts generated by all the observation points into forecasts for any location. This algorithm is based on meteorological expertise, rules of thumb and high-resolution geographical information (a profile map, for example). We also use MOS weather parameters, such as temperature, wind speed, cloud cover and precipitation, to calculate a significant number of derived weather parameters. In short, we rely on a huge computing capacity to get the highest forecast quality. Naturally, we also continually strive to improve all the above equations.



Weather room for final correction

The meteorologists on duty are responsible for putting the finishing touch to the ultimate weather forecasts to be issued; of course, they have the full width of MOS data at their disposal. Senior forecasters are allowed to make changes to the MOS via the MeteoBase system. Besides meteorologists, the MOS is influenced by many different factors: real-time observations, radar and satellite images play a role too. Amongst other things, this ensures that the cloud cover and precipitation forecast are always in line with the current situation.

Meteorologists have great added value for MeteoGroup. With years of experience of countless weather situations, we are able to draw on a high level of knowledge and insight, making our forecasts much better than those you can expect to find anywhere else. Our meteorologists help customers to correctly interpret all the information provided, too.



What kind of changes a meteorologist is still able to make? Suppose that a meteorologist anticipates that the occurrence of a high number of rain showers means that the maximum temperature will be lower. He or she will enter these changes into the MeteoBase. Is that it?
No, this is by no means the end of the process. The MOS will continue to be alert, monitoring the situation to see whether the changes that the meteorologist has made do reflect the trend of the weather conditions over the course of the next full hour. If it does, the MOS will go along with the change in question. If not, the MOS will reverse the change made.

In this way, we as a weather company are constantly doing our utmost to provide customers with the very best forecasts. With an excellent reputation to maintain, it will not surprise you to learn that we carry out frequent quality checks, which also enable us to show our customers exactly how well we are doing.

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