Observations and their importance in the verification process: View of the Joint Working Group on Forecast Verification Research

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Abstract

Observations, either as point data or gridded analysis, are an essential part of the verification process. They are generally considered as true representation of the status of the atmosphere. Forecast data and observations are matched to produce a paired forecast-observation dataset that is suitable for verification purposes. This matching process depends on the specific purpose of the verification. Moreover, issues like quality control, under-sampling of point observations, instruments errors need to be taken into consideration when verifying model output. These issues will be explored in details and the role of analyses in the verification process will be discussed.

1. Introduction

The Joint Working Group of Forecast Verification Research (JWGFVR) is a joint working group of World Weather Research Programme (WWRP) and Working Group on Numerical Experimentations (WGNE) within Commission for Atmospheric Sciences. Its activities started back in 2002 and since then it has organized four workshops and training courses to promote verification both in research and operational activities. The JWGFVR goals are to foster knowledge transfer on verification techniques, to encourage training and disseminate information on verification methodologies, as well as to promote collaboration among scientists conducting research on various aspect of forecast verification and to encourage the sharing of observational data for verification purposes.

Observations are used to produce an analysis, from which the forecast can be initiated, and to verify Numerical Weather Prediction (NWP) models. In addition observations can also be used to calibrate a forecast system. Despite their multiple uses and importance in the forecasting process, such observations are not easily shared because of restrictive data policies or just lack of resources to gather or send them.

2. Quality Control

Observations at a given location can be inaccurate for various reasons, quality control can help to spot such inaccuracies and correct them or discard the observational report so that it does not enter in the verification or assimilation process. Such inaccuracies may affect negatively a forecast or give a false measure of the model performance if used in the verification.

There are many approaches to quality control of observations needed for verification. Some methods rely on inter-comparisons of different observing platforms, while others compare observations against a background field, usually a short range forecast from a NWP model, to assess the observation error and/or reject observations. The latter approach is widely used in the data assimilation communities and the model used in the assimilation will influence the resulting quality control.

Lopez (2008) has shown the importance of a standardized quality control procedure that would guarantee quality observation across borders. He used radar data from the Operational Programme for the Exchange of Radar (OPERA) information and compared them to three other independent data sources. The results showed that the OPERA data exhibited consistent and systematic differences that were dependent on the geographical location.

3. Uncertainty in observations

In recent years the notion of observation uncertainty has become more accepted and a number of scientific papers have been published on this topic. The main issue is the definition of uncertainty. It is generally recognized that observation errors, like biases or instrumental errors, should be included as observational uncertainty. Studies involving co-located in situ point observations should shed light on instrumental error and be used to estimate observational uncertainty.

Representativeness errors are often ascribed to observations, but the real issue of point observation is "under-sampling". Model values at grid points and station observations "represent" two different quantities (area versus point). Models are not able to resolve all scales of the atmospheric flow and in particular not the scales represented by the observations. Therefore, the uncertainty relates to the mismatch between model and observation spatial scales. A way to resolve this uncertainty is to construct observation analysis whose grid points are area averages rather than point values and are model independent. One such example is described in Cherubini et al (2002) and Ghelli (2002) whereby high-density observation network data have been up-scaled to the model grid using a simple grid-box average.

Another way to deal with observation error is to include observation uncertainty in the scores. Bowler (2008), Ciach and Krajewski (1999), Candille and Talagrand (2008), Roberts and Lean (2008), and Santos et al. (2009) have suggested strategies that account for observation error.

4. Role of the analysis

Analyses use a variety of observational datasets simultaneously and provide coherent model fields, which can be used in verification. It is not straightforward to compare model forecasts directly to observations like AMSU-A and AMSU-B or METOP-A and obtain an evaluation of the model quality. However, the model evaluation becomes simpler if the forecast is compared to an analysis.

NWP analyses have been used for many years to evaluate forecast performance, especially for upper level fields. Good agreement between forecasts and analyses from the same NWP system are interpreted to mean that the predicted time evolution of the atmospheric flow is on track. NWP analyses start with a model-derived background field as a first guess, then modify the analysis fields with increments derived from sophisticated data assimilation schemes such as 3D- and 4D-variational analysis, ensemble Kalman filters, etc. Where the density of observational data is high, the analyses well represent the true spatial structure of the fields, at least to approximately the error of the observations. However, in data-sparse regions the analysis depends strongly on the model background field and may in fact contain a substantial portion of the bias and other errors present in the model first guess. These analyses, if used to verify the same model, may underestimate the error in the forecast fields.

5. Conclusions

Observations are very important in the verification process. They describe the status of the atmosphere and are used to produce model analyses without which quality forecasts could not be produced. Despite their importance in the forecasting process, observations are not shared because of restrictive data policies or simply lack of resources. Overarching organisations should use their influence to encourage all data collectors to freely share their data for the common good, and should provide access to software tools that will facilitate data sharing.

Standard procedures for quality control would insure that only quality data enter the forecasting and verification procedure. Moreover, it is important that observational errors and uncertainties ate taken into consideration in the verification process. The topic has been investigated in recent times and most likely more will appear in the scientific literature in the near future.

The paper also discusses the use of analyses for verification purposes. Analyses provide coherent model fields using all the observations available simultaneously. However, in order to generate these fields, they start with a model derived background field that will cause dependency with the model itself. In data-rich areas the analysis will represent the true spatial structures of fields, while in data sparse regions the model background field will be prevalent and consequently model errors and biases will be present. If analyses for data-sparse regions are used in the verification of the model forecast itself, they will most likely underestimate the error in the forecast fields.

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