

How can we effectively utilize atmospheric forecasts that include uncertainties?

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Today weather forecasts provide useful information for our daily life. The numerical weather forecast was one of the first applications of a computer invented more than 70 years ago. Since then, in addition to the rapid advance of computing resources, expansion of global satellite measurements and advance of data assimilation methods have contributed to the great improvement of the forecast skill. Today, operational centers offer not only daily weather forecasts but also weekly, monthly and seasonal forecasts, and a weather forecast system has thus become a fundamental infrastructure for the modern society.

The atmospheric circulation system is a highly nonlinear complex system with super high dimensions, and its behavior is therefore essentially chaotic. Thus, tiny observational errors in the initial field can gradually amplify, which will severely degrade the forecast skill within 10 days or so. For the extended or seasonal forecasts the ensemble forecast method therefore becomes essential, where parallel forecasts are performed from a number of slightly different initial fields into which tiny errors have been introduced artificially. The ensemble forecast is therefore probabilistic, and inter-member forecast spread as a measure of uncertainties of the forecast offers quite useful information to the users. The ensemble method is now being introduced even into daily forecasts, which today have high prediction skill but are by no means perfect in a deterministic sense. Furthermore, production of reanalysis data by assimilating observational data accumulated until today into a state-of-the-art forecast system can reproduce the atmospheric state four-dimensionally over the last several decades and thus provide useful data for assessing predictability of extreme weather events in the past.

For the effective risk reduction in case of an imminent disaster by a typhoon/hurricane, torrential rainfall or a snow storm, not only further improvement of forecast skill but also appropriate information of forecast uncertainty is necessary. It should be noted that prediction of behavior of pollutants once emitted into the atmosphere by volcanic eruption or a nuclear plant accident is basically a matter of atmospheric forecast. So, it becomes necessary for the society to understand the meaning and significance of forecasts that always include a certain level of uncertainties for their effective utilization. For this purpose, it is inappropriate to regard a forecast as perfect information by ignoring its uncertainties. It is also absolutely inappropriate to dismiss any forecasts simply because they contain uncertainties. With observations alone one cannot foresee what will happen in the future. Effective combination between observations and forecasts is of essential significance.

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