

Forecasting of Extreme Weather Events

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1. Background

The forecasting of extreme weather events is of great interest to the Centre's Member States, Co-operating States and the world meteorological community in general. Zillman (1999) gave a comprehensive summary of extreme weather events, which play an important role in the operational practice of NMHSs around the world. These events exist on all time and space scales from tornadoes, flash floods to major storms and extended heatwaves and droughts. Forecasts and warning of these events according to national practices are required at all ranges from nowcasting to the seasonal prediction. However, the availability of appropriate, useful and reliable forecast guidance from NWP systems has been limited in the past, but with the recent and future developments in high resolution deterministic and stochastic NWP systems there appears to be a good basis for further progress also in the area of extreme weather event prediction. In its 10 year strategic plan, which was adopted by Council in 1999, the Centre was given as one of its targets, the

“provision of good forecasts of severe weather towards day 4 or day 5 ahead - this requires the development of a suitable performance evaluation relating to severe weather”.

Also, the WMO recently addressed the issue of extreme weather event forecasting and the 1998 session of the Commission for Basic Systems first attempts have been made to develop forecast procedures based on a cascading process for providing guidance from ensemble prediction systems and high resolution single/multiple model output.

The Centre will contribute to these developments and has embarked on a programme to develop a test system specifically designed to provide the users in the Member States and Co-operating States with tailored products for the detection and prediction of severe weather events in the medium range. The definition of severe weather events, the validation procedures and the evaluation of the skill of the forecasting system in predicting such events will need to be developed in close liaison with the users.

2. Definition of extreme weather events

The weather services in several ECMWF Member States and Co-operating States have a responsibility to issue a national warning or alert in the case of certain well defined weather events. These may, for example, be related to high winds, flooding or severe frost and icing. Most of these events will require warnings to be issued with a lead time of hours up to one day. Often the scale of the events will be meso-scale, well below the capability of a global model. There are other weather events which are severe but related to weather episodes of larger scales, e.g. synoptic or even large-scale for which medium-range forecasts are desirable and required. Examples are continuous heavy rains over river catchment areas leading to flooding, heavy snowfalls giving rise to risk of avalanches, intense cyclone development with strong gales or, away from Europe, the snow storms on the American east coast.

In defining the extreme weather events to be predicted in the medium-range it will be necessary to first determine the capability of the forecasting system in predicting these events, i.e. determine the time and space scales for which severe weather event forecasting is feasible, establish the probability of occurrence and the skill of the system in predicting such events.

3. The view of the users

The issue of severe weather event forecasting was discussed during a panel discussion at the ECMWF Seminar in September 1999.

Representatives from national meteorological services in the Member States stressed the importance of successful extreme weather event forecasting for the state funding on the NMHSs. However, it was noted that, since extreme events are rare events, it will be difficult to produce consistent records of forecast skill for these events. Several speakers noted the importance of minimising the false alarm rate in the system. In this respect, the probabilistic approach to forecasting in particular in the medium-range may be used with preference. The usefulness of the probabilistic forecast products needs to be explored with the end users and will depend on the application. The cost/loss analysis and evaluation of the forecast products was seen as particularly useful in this respect.

It was noted that the current ECMWF forecasting system (high resolution deterministic model and EPS) will not meet directly all the requirements of the Member States for their extreme weather event warnings. The capability of the current system to predict events on space and time scales it can handle should first be explored. Such events should be defined and then traced in Europe but also elsewhere thus widening the data sampling.

4. Development of the forecasting system for severe weather event prediction

During winter 1999/2000, several severe weather events occurred over Europe (Danish/Swedish storm 3 December 1999, French/German storm 26 December 1999 and French/Spanish storm 28 December 1999) and the North American continent (east coast snow storm 26 January 2000). These cases in particular will be used to test the impact of higher resolution in the data assimilation and the forecast model, higher resolution of the ensemble prediction system and the value of running the forecast system twice daily. In addition, Member States running limited area models will be encouraged to assess the benefit of using high resolution boundary conditions in predicting these events.

The Centre's current EPS approach is based on hemispheric perturbations of the initial conditions. In co-operation with interested Member States the use of a targeted ensemble prediction system will be considered with a particular view towards severe weather event prediction over Europe.

References:

Zillmann, J., The national meteorological service, WMO Bulletin Vol. 48 No. 2, April 1999