8.11 COMPARISON OF FORECASTS OF WIDESPREAD PRECIPITATION DURING THE SYDNEY 2000 FORECAST PROJECT

Norman Donaldson[1*], Clive Pierce[2], Michael Sleigh[3], Alan Seed[4], Tom Saxen[5]

[1]Meteorological Service of Canada, King City, ON, Canada
[2] The Met Office, Bracknell, UK
[3] University of Salford, Greater Manchester, UK.
[4] Bureau of Meteorology, Melbourne, Vic., Australia
[5]National Centre for Atmospheric Research, Boulder, CO, USA

1. INTRODUCTION

The Sydney 2000 Forecast Demonstration Project (Keenan et al., 2001) included an international assembly of systems for producing extremely short term forecasts of widespread precipitation. These systems used differing combinations of techniques for projecting existing precipitation patterns into the future. The variations reflect, in part, the different objectives, resources and assumptions of their developers. One of the project's objectives was to illustrate the benefits and limitations of the various techniques. Resulting directly from the field experience, the current discussion will be conceptual and qualitative, but a more objective verification comparison exercise is under way (Brown et al, 2001).

The four systems that will be discussed here are SPROG (BoM), Autonowcaster (NCAR), Nimrod (the Met Office of the UK) and CARDS (Environment Canada). All used gridded precipitation fields, derived from radar, which were advected to produce precipitation forecasts. A limited set of products from the systems were available to forecasters in the New South Wales Forecast Office in real-time. Other forecast systems in Sydney, such as Gandolf, WDSS and Titan, were cell-oriented and not appropriate for widespread precipitation.

2. SYSTEMS

a) SPROG Spectral PROGnosis, (Seed, 2001), developed at the BoM, is an advection based nowcasting system that uses the observation that the evolution of precipitation features is dependent on the scale of the feature (large features evolve more slowly than small features). The process breaks up the observed field into different scales and evolves them separately at a particular scale based on their observed behaviour. This automatically causes the forecast field to become smooth as the structures at the various scales evolve through their life times. The input to SPROG was a 256x256km grid of radar CAPPI data at 1km resolution. When creating the CAPPI and attempt was made to flag ground and sea clutter by looking at vertical gradients of reflectivity. A single motion is used to advect the pattern forward for a series of forecasts at 10 minute increments. The resultant gridded forecasts were also used to produce meteograms: forecast time series over individual locations.

b) Auto-Nowcaster: (ANC) NCAR's nowcasting system's primary role is to collect weather data, execute algorithms for producing a combined thunderstorm forecast and provide a graphical display tool for viewing the various datasets. The baseline for the ANC includes a feature tracking algorithm that works on a gridded precipitation field and then advects it forward. (Tuttle and Foote 1990) This scheme requires different parameters for convective versus widespread rain.

c) Nimrod. The Nimrod system of the Met Office (UK) (Golding, 1998) was implemented with some modifications to account for limitations of the available data and computer resources. Essentially, there are three steps in the generation of a Nimrod precipitation forecast: (1) the production of a surface rain rate analysis from radar and other data sources (if available), (2) the generation of an advection forecast based upon the rain analysis, (3) blending the advection forecast with a mesoscale NWP rain forecast (the mesoLAPS of the BoM). The resultant "merged" forecast gives increasing weight to the NWP component as lead time increases. In Sydney, the input radar data was a regional composite at 2km resolution, and Nimrod's operational domain was 705 km by 750 km at 5 km resolution

d) CARDS. The CAnadian Radar Decision Support system (Lapczak et al, 1999) was an adapted version of a system used operationally in Canada to process radar data. The system is highly modular, deliberately designed to ingest data from different types of radars and produce multiple types of outputs. The system has a front-end that logs and stores incoming data and then starts individual processes to produce particular products. For widespread precipitation, processes produced, in

* Corresponding author address: Norman Donaldson, Meteorological Service of Canada, King Weather Radar Research Facility, 14780 Jane Street, King City, Ontario, Canada, L7B 1A3;
Email: Norman.Donaldson@ec.gc.ca.

order, 1.5km CAPPI grids (480x480km at 2km resolution), a 3x3 grid of cross correlation motions, and finally a set of forecasts of precipitation at selected points, using the most recent CAPPI and motions. Unlike the other systems, CARDS did not produce a gridded forecast. The widespread precipitation modules are adopted versions of software developed and run successfully at McGill University since the mid 1970's (Bellon and Austin, 1978). The cross correlation technique can exploit a ground clutter map, but one was never developed for the Kurnell radar. In the absence of good correlation motions, the 70kPa wind from the most recent sounding was used to advect echoes.

3. DATA SOURCES

During the project there were 3 radars in the Sydney area: Kurnell (Doppler C-Band), CPOL (polarimetric Doppler C-Band), and Letterbox (S-Band). Kurnell was the primary source of radar data for the widespread precipitation forecasts. Nimrod used a BoM composite of radars across south-eastern Australia. In addition to the radars, soundings were available from Sydney Airport, and numerical weather predictions were obtained from the Australian mesoscale Limited Area Prediction System (mesoLAPS).

The data presented to the systems was different from that in their home environments. The radar data was less quality controlled than the data used "at home" by most of the systems. This caused some problems as the various systems needed some retuning to operate with this data. Some of the particular difficulties encountered were 1) ground clutter, which at times either remained in the data or was over-enthusiastically removed by Kurnell's filters, 2) sea-clutter, which could be spectacular on the shore based radar at Kurnell, 3) bright band contamination, 4) low numerical resolution of the Australian composite, 5) intermittent non-arrival of data (both complete loss of a radar or loss of individual rays) and 6) loss of data along the Vr=0 isotach from Kurnell. Figure 1 is a Kurnell image illustrating several of this issues. It shows an area of drop-out of echoes to the north west and the gap area to the south west which lies along the 0 isotach. The spoking patterns is presumably due to missed radials.

5. DISCUSSION

Three types of problems can occur with the techniques used during the Sydney forecast demonstration project: 1) incorrect assessment of current precipitation 2) failure to find the correction motion for advecting the current pattern and 2) failing to account for evolution. Detailed analysis of the forecasts has yet to begin, but the overall impression was that forecasts behaved well during the first half hour with quality decreasing at longer projection times.

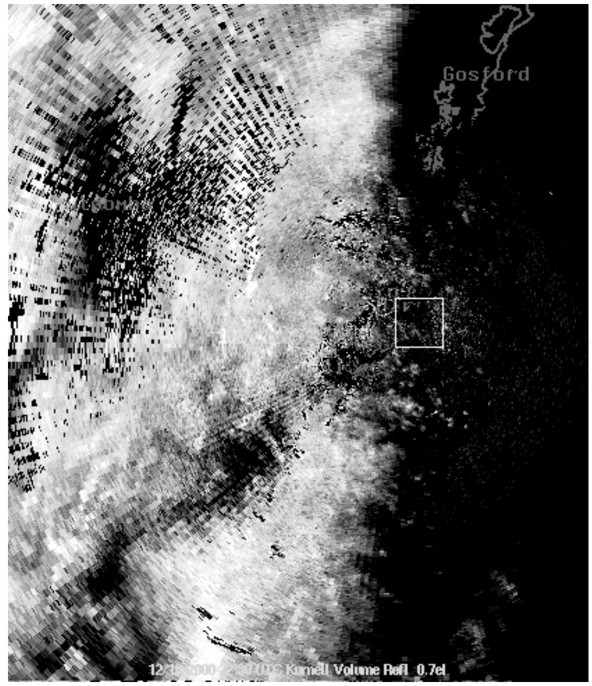

Figure 1 - Radar data for 2230Z, Oct 12,2001

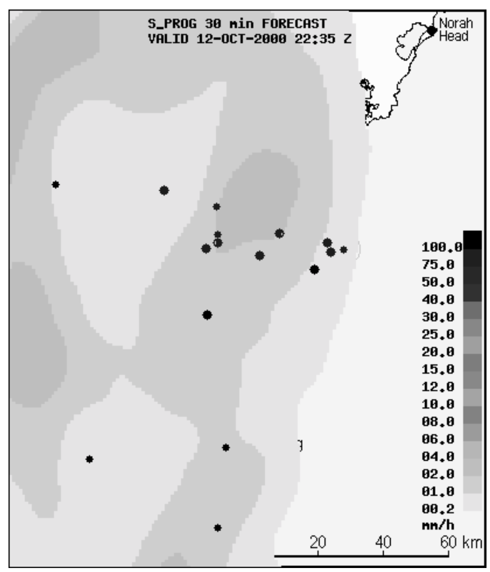

Figure 2- 30minute SPROG forecast valid for 2230Z Oct 12, 2001

The most serious issues that appeared were data related, as discussed above. These problems influence the quality of both the the precipitation analyses used as input and the tracking algorithm results. Ground clutter problems resulted in areas of stationary patterns of bad precipitation patterns. Depending on the configuration of the tracking algorithms, these patterns could result in low advection velocites, when algorithms attempted to keep the false patterns in place, or result in strangely divergent patterns when the algorithms incorrectly matched precipitation echoes to ground clutter echoes, Autonowcaster had some of the worst problems in this regard, but some post-experiment reruns indicate that better tuning of the algorithms, by choosing better area sizes for correlation analysis or choosing different reflectivity thresholds, can ameliorate these problems. Longer experience with the specific radars would allow better development of such things as appropriate ground clutter masks The issue of intermittent sea clutter remains problematic.

During the project, wide spread forecasts were presented both as gridded forecasts and as projected time series over specific locations. Forecasters seemed very pleased to have both presentation types.

The CARDS option of using sounding winds in the absence of good tracking was a mixed blessing. It did permit the advection of echoes in borderline cases, but also resulted in the advection of ground clutter on clear days, which resulted in frequent false precipitation forecasts at locations closest to the mountains. All systems advected ground clutter when there was a mix of clutter and weather echoes.

The SPROG system was probably the most interesting new system at Sydney. This system reflects the fact that knowledge of small scale features decreases rapidly with time. For example, Figure 2 shows a 30 minute forecast for the same time as Figure 1. Therefore these features are smoothed away with increasing forecast time. This was seen as a mixed blessing. SPROG will probably display best RMS errors, that is make best estimate of expected precipitation. On the downside, this comes at the expense of a sense of the variability of precipitation. Longer-term forecasts have a similar look whether they come from a uniform wide spread pattern or a variable pattern with strong cells of embedded convection.. The more classical schemes tend to produce “the right precipitation at the wrong place” which results in poor point comparisons. Obviously the “best” system is the one that answers the questions that are being asked. If one asks what is the most likely precipitation amount, SPROG will excel. If one poses a question like “is there likely to be strong precipitation within 10km of my site” then one of the classical techniques will probably do better.

Despite the evolution of patterns in SPROG and NIMROD evolution remains a significant problem. Sydney lies in a relatively flat area ringed with low mountains to the west and it has the ocean immediately to the east. Precipitation was clearly seen to evolve as it moved between areas. SPROG’s forecasts reflect the nature of predictability itself, rather than prediction of changes. Nimrod was dependent on the accuracy of the numerical weather prediction for its evolution. (It was probably a bit unfair to assess Nimrod on such a small scale as the Sydney area. It would look much better on a more regional assessment). ANC has modules for prediction of convective storms but not wide spread precipitation. Local evolution due to geographical features remains a topic to be addressed.

ACKNOWLEDGEMENTS

The authors wish to thank all the staff of the Bureau of Meteorology for their hard work and enthusiasm in organising and hosting this project. The authors are only a fraction of the teams that were involved in implementing their systems in Sydney, and all other members deserve the greatest credit for their labours.

REFERENCES

Bellon, A. and G.L. Austin, 1978: The evaluation of two years of real-time operation of a short-term precipitation forecasting procedure (SHARP), JAM 17, 1778-1787

Brown , B.G, et al., 2001: Forecast Verification activities for the Sydney 2000 forecast demonstration project. Paper 8.10, AMS 30th Int. Conf. Radar Met., Munich, Germany, 19-24 July, 2001

Golding, B, 1998: Nimrod: a system for generating automatic very-short-range forecasts. Met. Apps. **5**, 1–16.

Keenan, T. et al., 2001:The World Weather Research Programme Sydney 2000 Forecast Demonstration Project overview. Paper 8.1, AMS 30th Int. Conf. Radar Met., Munich, Germany, 19-24 July, 2001.

Lapczak, S et al., 1999, The Canadian National Radar Project. AMS 29th Int Conf Radar Met. Montreal, 12-16 July 1999. pp 327-330.

Seed, A:, 2001, A dynamic and spatial scaling approach to advection forecasting. Paper 8.7. AMS 30th Int. Conf. Radar Met., Munich, Germany, 19-24 July, 2001

Tuttle, J.D., and G.B. Foote, 1990: Determination of the boundary layer airflow from a single Doppler radar. Journal of Atmospheric and Oceanic Technology, 7, 218-232.