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DIAGNOSIS OF EAST COAST STORM SITUATIONS USING ANALOGUE TECHNIQUES

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ABSTRACT

A technique for diagnosing east coast storm situations by matching a set of "best fit" 500 mb pattern analogue dates against a set of east coast storm dates is described.

1. INTRODUCTION

The analogue method is based on the assumption that similar weather patterns have similar associated physical properties and will evolve in similar ways over at least a short period of time. Classical analogue techniques attempt to match current analyses with historical maps with the aim of using the climatological information of the historical sequences as forecast weather elements. With the classical aproach longer range forecasts require analogue matches over larger areas. The classical method is described by Namias (1951). More recent approaches use analogues in conjunction with NWP model predictions. Normally a number of analogues are chosen on the basis of their similarity to a model prediction and then the weather elements related to the analogues are averaged or converted to probabilistic forecasts for specific sites. Further details on this method can be found in Kruizinga and Murphy (1983), Wilson and Yacowar (1980), and Yacowar (1975).

The advantages of analogue techniques lie in the speed with which analogues can be selected and the simplicity in interpreting the results. The main disadvantages are that a very large sample of historical cases are required and most analogue matching is done only at one level rather than in 3 dimensions.

The east coast storm procedure being tested at the Maritimes Weather Centre is a slight variation on the above. It involves an initial analogue search for matches to the current and 48 hour forecast 500 mb fields, followed by a secondary selection of the best analogue matches based on a similarity to east coast storm patterns. The procedure relies on a once-daily analogue search of the 500 mb fields which is carried out at the Canadian Meteorological Centre (CMC). The resulting correleations and dates of the best analogue matches are transmitted to the Maritimes Weather Centre (MWC) for further processing.

2. CMC ANALOGUE SELECTION

The analogue selection for this east coast storm procedure is carried out at the CMC once a day following the completion of the 0000 GMT forecast cycle. The current 500 mb analysis and 48 hour 500 mb prognosis are passed through a pattern matching procedure which involves a search through a 33 year file of 0000 GMT 500 mb fields. The degree of similarity is measured by calculating the linear correlation coefficient for each of the pairs.

The historical file is currently available for the period 1949 - 1981. The fields are represented on a 105 point grid with 5°lat., 10°long. spacing, covering North America and adjacent ocean areas.

The analogue search is through a 3 month period centred on the current month. In practice dates more than 4 weeks either side of the current date are not too common, so this is a reasonable restriction. The search involves comparing the current analysis against each historical field as well as the 48 hour 500 mb prognostic field with that two days following the date used in the first comparison.

On this basis the best 20 analogues (10 best analysis correlations and 10 best prognosis correlations) are selected. The analogue dates and the corresponding correlation coefficients are transmitted to the M.W.C. as the FXCN02 bulletin which arrives daily at about 0730 GMT.

3. EAST COAST STORM SELECTION

The next step in the procedure is to compare the set of CMC analogue dates against a set of M.W.C. east coast storm dates. This set of storm dates which is being assembled continuously, dates back to 1966 and contains about 260 cases.

The selection criteria for east coast storms are as follows:

i) It must deepen at least 24 mb in 24 hours.

ii) Sustained winds of at least 35 kts over land or 45 kts over water must be observed at some time over the course of the storm.

iii) The storm centre, after condition i) has been met, must be in the specified area of interest as shown in figure 1.

In order to make the storm archives more complete, all tropical storms that invade the area of interest are also selected. It is not likely, however, that these cases can be utilized in an analogue sense.

The sequences of surface analyses for each storm selected are saved on microfilm. All M.W.C. surface analyses are archived on microfilm, duplicate rolls of which are relatively inexpensive. The storm sequences are simply cut out of a duplicate roll, numbered and stored in mylar jackets. These can then be easily accessed and viewed on a fiche reader. The actual storm sequence extracted normally extends from 48 hours before the completion of the maximum rate of deepening to 24 hours after. The corresponding range of dates, along with the deepest central pressure and time of deepest pressure are stored on a disc file for access by a program which compares the CMC analogue dates against the file of M.W.C. storm dates.

4. APPLICATION AND INTERPRETATION

The comparison software will be scheduled to run each day at 0800 GMT. At this time CMC analogue analysis dates and 48 hour prognosis dates are compared against the local file of east coast storm dates. All matches with a correlation of greater than 0.90 are flagged and displayed. At this point a forecaster can review the case to determine if the historical sequence might be useful as forecast guidance.

Ideally one would hope for a match at the beginning of a storm sequence with a high correlation. This could potentially provide 24-48 hours advance warning of development for an analysis match and 48-96 hours warning for a prognosis match. Of course, because of model errors at 48 hours, a prognosis match is not likely going to be as useful as an analysis match.

If the analysis correlation is less than about 0.94, one must be careful in judging the utility of the case. Even matches with higher correlations may prove to be false alarms because the fit may not be perfect in certain key areas, or because of differences in thermal patterns, or because of variations in external influences such as solar radiation and sea surface temperatures. Thus one must take care to use the analogue evidence along with a proper physical assessment of the situation and in concert with the NWP guidance.

Application of the technique to date has been limited to a few test runs over the winters of 1982-83 and 1983-84. Winter season analogue matches occurred approximately at the

rate of one every 4 to 5 days. In many of the matching situations east coast development had already taken place. Some cases were false alarms, while others, particularly those in which 2 or more independent matches were made, gave some indication of east coast development 24 to 36 hours in advance. It was also noted that certain historical east coast storm cases tend to be chosen relatively frequently.

5. CONCLUSIONS AND FUTURE WORK

An experimental technique to diagnose east coast storm situations using analogue methods has been described. Trial runs to date indicate that the technique may be operationally useful, but there are sufficient numbers of false alarms to suggest that the matches must be used with caution and should be weighed along with other available evidence.

The winter season frequency of occurrence of the analogue matches is greater than the frequency of occurrence of east coast storms. These can be brought to roughly the same frequency by increasing the linear correlation rejection limit slightly.

The repeated occurrence of certain analogue cases looks interesting. It suggests that many east coast development situations fall into a few basic types which are typified by these recurring analogue cases.

The next phase of the experiment will begin this fall when the technique will be run operationally. A full winter run should make available about 50 independent cases for detailed assessment. The results of the 1984-85 operational test will be published in a later technical note.

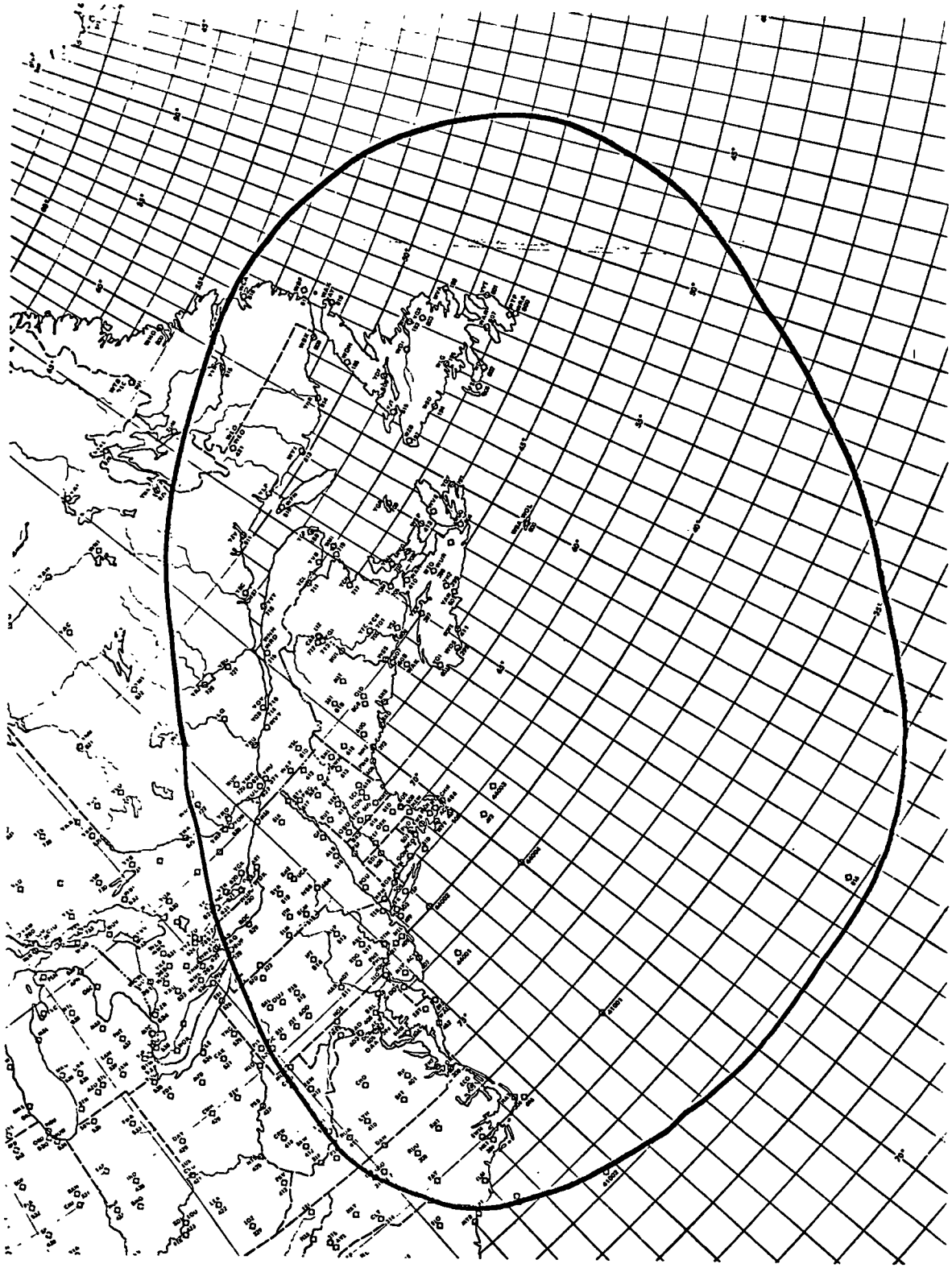

FIGURE 1: Area of interest for east coast storm selection.

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