COMPARISON OF FORECAST WINDS WITH THOSE REPORTED BY AIRCRAFT ON HIGH ALTITUDE FLIGHTS

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Abstract: After assessing the errors involved in deriving upper winds from a 200 mb contour and isotach chart, and considering also the likely errors in "inflight" winds as computed by an aircraft navigator, it is concluded that computed and actual winds show reasonable agreement.

Forecast winds are then compared with those computed and it is found that in 22 of the 25 zones considered, the forecasts are under-estimates, the root mean square difference ranging from 11.5 to 13.5 kt. Some of the reasons for this difference and the weakness of the forecasting technique adopted are then discussed.

1. INTRODUCTION

During August, 1953, a number of long distance high altitude flights were conducted by Canberra aircraft over routes between Australian State Capital Cities and between Australia and New Zealand. Winds were computed in flight, and were made available for comparison with those forecast for corresponding sections. The sections chosen were five longitude degrees and 25 such zones were compared.

2. ESTIMATION OF ERROR IN ACTUAL WINDS

Before a check could be made, an estimate had to be obtained of the actual winds. These were obtained from the 200 mb. isotach charts, corresponding to the time of the flight (interpolating as necessary). The isotach charts were drawn according to the usual practice, by giving weight to the observed wind network rather than to the less accurate geopotential heights. Two independent drawings of relevant countour charts were made and two sets of estimated true wind values obtained. The root mean square (r.m.s.) difference between these sets of values was 8.5 kt. If the contour charts had been quite independent, the r.m.s. error in the true wind values of each set would be $\sqrt{\frac{(8.5)^2}{2}}$ or 6.0 kt. However, the r.m.s. error in the estimation of the true wind would be somewhat larger than this value, because, even though the charts were drawn up independently, they were based on the same observations and hence errors would be likely to occur in the same sense. (Durst, 1954).

3. ERRORS IN NAVIGATORS' COMPUTED WINDS

Computed winds were selected over five degree latitude or longitude intervals, eliminating any values involving climb or descent. The computed winds were, for the most part, at hourly intervals, and were based on position fixes which could be classed as 'A' or 'B' (Rutherford, 1954).

The standard errors appropriate to the position fix and time interval between fixes were also obtained and are summarised in Table 1 :-

TABLE 1

Class of Fix	Time Interval	Standard Error
A (within 80 miles of station)	20 mins	10 kt
	30 "	7 "
	60 "	4 "
B (80 to 150 miles distant)	20 "	18 "
	30 "	12 "
	60 "	6 "

Analysis showed that for the 25 zones, the r.m.s. difference between the aircraft computed winds and the estimated true winds was 6 knots. This agreement is satisfactory in view of the previously mentioned errors involved in the estimation of the true wind and the determination of the computed wind. That is to say, the navigators' computed winds over hourly intervals agreed closely with true values.

4. ERRORS IN FORECASTS OF WINDS

The forecasts were based on a rather sparse network of observations made at varying periods up to 12 hours before the times of flight. The r.m.s. difference of forecast winds from 'actual' winds was 13.5 kt., and forecast winds were an underestimate over 22 of the 25 zones. A similar error (11.5 kt) appeared when a check was made by preparing forecasts for the same flights from 200 mb. charts drawn in the Central Analysis Section (Melbourne). Errors were again in most cases an underestimate, although to a somewhat lesser degree.

5. DISCUSSION

A common method of forecasting winds from constant pressure isotach charts assumes that the jet stream will be displaced in the direction of its axis, and that the intensity of the maximum will not appreciably change. In most cases this longitudinal displacement method will give quite satisfactory results, but there are some occasions when the method appears inadequate.

For example :-

(a) A deepening, eastward moving surface low is often accompanied by a jet of increasing intensity located NW of the surface centre; an almost stationary and filling low may be accompanied by a weakening jet maximum located almost above the surface centre.

(b) A deepening surface low can be associated with an apparent east to west displacement of the jet maximum, as occurred on 2nd, 3rd and again on 10th, 11th November, 1953, when there was a deepening low at the surface west of the original position of the jet maximum.

(c) A latitudinal displacement may occur when a low deepens well south of the original jet maximum position. For example, between August the 1st and 5th, 1953, the jet maximum on the 200 mb. charts at 26°S was displaced on 6th (7th and 8th) to 38°S due to a low pressure centre near Macquarie Island deepening rapidly by 22 mb. in 24 hours.

(d) A jet maximum may remain stationary as frequently occurs about theeast and west coasts of the continent, following the behaviour of the upper troughs. For example, in September, 1953, a clustering of jet maxima over the west coast area appeared to be associated with a succession of surface lows passing southeastward off the coast, and a near-stationary upper trough.

(e) While there seems to be no clear position relationship between the surface front and the jet stream, reference has been made (Murray and Johnson 1952) to the lagging of the jet maximum further behind the surface front due to subsidence in the cold air causing the strongest thermal gradient to be well behind the surface front.

6. CONCLUSIONS

It has been shown that the upper winds computed in flight by an aircraft navigator using reliable fixes, agree reasonably well with estimates of the true wind taken from relevant contour charts based on observed upper wind and radiosonde data.

Errors occur in forecasting upper winds, and in the great majority of occasions examined true winds proved to be considerably stronger than those anticipated - the root mean square difference varying from 11.5 to 13.5 kt.

In an attempt to find the reason for this consistent underestimation, the method of forecasting upper winds in the vicinity of the jet stream from constant pressure streamline isotach patterns has been considered. It has been found that the commonly employed technique of transposing the jet maximum without change along the jet axis, is inadequate in cases where major cyclogenesis or cyclolysis is apparent at the surface level; where a marked upper trough becomes almost stationary, or possibly where there is evidence of marked subsidence in the cold air behind a cold front.

References:

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