

## 40,000 FT WINDS SINGAPORE - DARWIN

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## 1. INTRODUCTION

In June 1957, the R.A.F. Transport Command commenced operating a Comet Service on the route Singapore to Darwin. In view of the lack of upper air information at the level to be flown (approximately 40,000 ft), and as this was the first jet aircraft to be operated regularly on the route, and having in mind the impending operation of civil jet aircraft on the route, it was decided to investigate the winds "found". These aircraft were operated by specially selected crews and contained a more than usually comprehensive array of navigation instruments and the lack of vibration makes these aircraft very suitable for "astro" fixes so the "found" winds should be of more than average reliability. It was arranged in cooperation with the Changi Meteorological Office, that very careful debriefing would take place after each flight, and the results of the debriefing were exchanged by signal between each Office.

The "found" winds for 62 flights in period 8 June to 23 September, 1957, were obtained. Of these two navigators admitted that there was considerable doubt about the winds they found, and these, together with two other flights which contained probable navigational errors, were omitted leaving a total of 58 flights to be considered.

The winds were then broken up into five degree zones of longitude, the first zone out of Singapore being 105°E - 110°E and the first zone out of Darwin 125°E - 130°E. Mean winds were then obtained for each zone and a mean head or tail wind component for each zone was calculated. The aircraft usually climbed to 37,000 ft and then made a gradual ascent to about 42,000 ft. No consideration was given to the height changes which took place during the flight.

The period under consideration corresponded roughly to southern winter. None of the flights passed

through the Intertropic Convergence Zone which throughout this period was north of the equator.

## 2. DISCUSSION

The mean winds at 40,000 ft at Sourabaya, Singapore and Darwin were obtained for the period of the flights. Those at Sourabaya were not for the complete period as rawins at Sourabaya did not commence until 1 July. The mean winds were

	Direction	Strength	Standard Vector Deviation
Singapore	070°	39K	16K
Sourabaya	064°	25K	20K
Darwin	305°	9K	19K

The mean winds found by the aircraft, their standard vector deviations and other details for the various zones are given in Table 1. In mid-July, winds with a westerly component were reported as far west as 115°E. This boundary between easterlies and westerlies moved irregularly to the east and by mid-August easterlies were being "found" for the whole of the route. Towards the finish of the period in mid-September, winds with a westerly component were again being "found" close to Darwin.

It will be seen that the winds at Singapore of 070° 39K corresponded remarkably well with the mean "found" winds of 061° 38K for the zone 105°E - 110°E. The winds from Sourabaya of 064° 25K while corresponding well with the mean "found" direction of 065° did not correspond too well with the "found" velocity of 40K. The direct track is about 200 miles north of Sourabaya. The "found" winds for the zone 125°E - 130°E of 030 10K corresponded fairly well in strength with the mean 40,000 ft wind from Darwin of 305° 9K but not in direction.

From the available information a mean 40,000 ft streamline chart was drawn for the period. This is shown in Figure 1.

Table 1. Mean and standard vector deviation and other details of winds found by aircraft on the Darwin - Singapore air route for the period 8 June - 23 September, 1957

Zone	105°E-110°E	110°E-115°E	115°E-120°E	120°E-125°E	125°E-130°E
Mean wind	061/38	066/40	056/31	058/22	030/10
Standard vector deviation	22K	27K	26K	27K	24K
Mean component Darwin-Singapore	+21K	+25K	+15K	+11K	0
% of winds inside 90° range	94%	94%	80%	74%	47%
% of winds inside 70° range	90%	82%	76%	66%	30%
% of winds inside 50° range	77%	57%	70%	57%	25%
% of winds inside 30° range	62%	43%	52%	45%	22%
Max winds reported in zone	70K	80K	82K	*	45K
Min winds reported in zone	10K	20K	11K	0	0

\* A wind of 226° 85 knots was found in this zone but seems very doubtful. Ignoring this the maximum wind was 100° 60 knots.

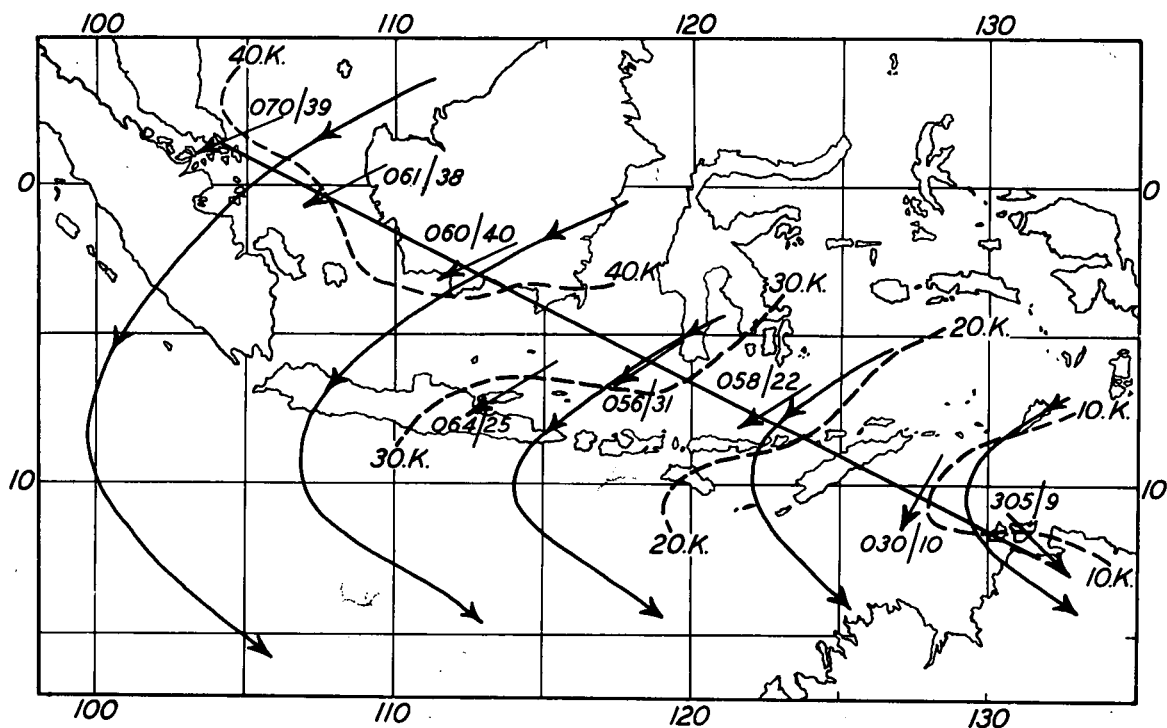


Figure 1. 40,000 ft Mean Streamlines and Isotachs  
Darwin-Singapore; 8 June to 23 September 1957.

The first three zones out of Singapore, i.e. from  $105^{\circ}\text{E}$  -  $120^{\circ}\text{E}$ , revealed very consistent north-easterly winds of approximately 40 knots. Over these three zones an average of more than 50 per cent of the "found" winds were within a range of  $30^{\circ}$  in direction, i.e. within  $15^{\circ}$  of the mean direction, and an average of over 80 per cent of the wind directions were within  $35^{\circ}$  of the mean direction. The next zone, i.e. from  $120^{\circ}\text{E}$  -  $125^{\circ}\text{E}$ , revealed a less consistent but still persistent north-easterly of smaller velocity. In this zone however 6 out of the 59 "found" winds had a westerly component. In the zone nearest Darwin, i.e. from  $125^{\circ}\text{E}$  -  $130^{\circ}\text{E}$ , the winds were much more irregular tending more northerly. Only 6 out of the 42 "found" winds had a southerly component.

The nearer to Singapore the more consistent were the winds. The closer to Darwin the less consistent were the winds. This was borne out by both the "found" winds and the Darwin upper winds.

The mean north-westerlies found in the Darwin upper winds would appear to fade out within 100 miles of Darwin giving place to north-easterlies which prevail to Singapore.

#### DEFINITION OF JET STREAM

The Executive Committee of the W.M.O. has recently adopted the following provisional definition of the jet stream:

A jet stream is a strong narrow current, concentrated along a quasi-horizontal axis in the upper troposphere or in the stratosphere, characterized by strong vertical and lateral wind shears and featuring one or more velocity maxima.

The Committee recommends that for operational purposes, the following numerical criteria be applied:

Normally a jet stream is thousands of kilometers in length, hundreds of kilometers in width and some kilometers in depth. The vertical shear of the wind is of the order 5-10 m. sec.<sup>-1</sup> per km. and the lateral shear is of the order 5 m. sec.<sup>-1</sup> per 100 km. An arbitrary lower limit of 30 m. sec.<sup>-1</sup> is assigned to the speed of the wind along the axis of a jet stream.