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TÍTULO: MAXIMUM WIND OVER BRAZIL - TEMPERATURE INTERSECTION METHOD

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MAXIMUM WIND OVER BRASIL - TEMPERATURE INTERSECTION METHOD

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ABSTRACT

Using the upper air temperatures at selected grid points over BRASIL, the temperature intersection method adopted by Capt. Leo S. Bielsinki of U.S. Air Force is attempted and made use of to locate the maximum wind over a selected region of Brasil and its variation season by season. The results of this preliminary study are presented and discussed.

INTRODUCTION:

With the increase of upper air stations together with stations regularly operated by Brazilian weather service and Navy it is made feasible for a preliminary understanding of the upper air situations over Brasil to some extent. Fig. 1. shows the station network in South Amercia in general and Brasil in particular. Cross-sections prepared along several meridians contribute to the knowledge of the structure of upper winds over regions. From such a picture maximum winds can be studied. Hess (1948) presented cross-sections over different longitudes of Northern and Southern Hemispheres for a better understanding of winds aloft. Later Riehl (1952) discussed the Northern and Southern Hemisphere Jet streams and their manifestations. Several studies on this aspect connecting to the meteorological conditions were made later (Riehl 1954, Koteswaran 1958, Krishnamurti 1961, Rieter 1969, Jagan Mohana Rao 1967, 1971, Dean 1971) and latest information of upper air over whole of Southern Hemisphere is now made available from the studies of Van Loon et al (1971) using the data archived at National center for Atmospheric Research, Boulder, Colorado and National Oceanic and Atmospheric Administration, Asheville, North Carolina (NCC and NCAR).

The present authors used an indirect method (Bielsinki 1960) to locate the maximum wind over the selected region of Brasil and its variation from season to season with help of temperature values at different levels. In turn using these temperature values near the levels of Jet Stream in general, the thermal wind shear is calculated, the values of which are used in the study.

METHOD:

Since near the ground the geostrophic wind is comparatively light, strong winds aloft depend almost entirely on thermal wind. The wind speed maximum is found to be at the isopycnic level where thermal wind shear is zero and with windspeed maximum taken at a height of intersection of temperatures of two adjacent stations, the strongest thermal wind shear under the axis of Jet Stream would indicate wind maxima (Pettersen, 1956). A short form of the derivation used by Bielsinki (1960) is given below.

The hypsometric equation can be written as

$$H = (R_d/g) \ln (P_l/P_u) T$$

where H is thickness between two pressure surfaces, R_d is the universal gas constant, g, the acceleration due to gravity, T is the mean temperature between P_l and P_u ($P_l = P_u + 20$mb). When considering two stations A and B which have the same pressure ratio for any particular pair of pressure surfaces we can write

$$H_A = (R_d/g) \ln (P_l/P_u) \bar{T}_A$$

$$H_B = (R_d/g) \ln (P_l/P_u) \bar{T}_B$$

$$H = H_B - H_A = R_d/g \ln (P_1/P_u) (\bar{T}_B - \bar{T}_A)$$

$$\text{or } H = K (\bar{T}_B - \bar{T}_A) \text{ where K is constant}$$

At the isopycnic level the temperature T is the same for the two stations

$$\text{At } P_1 \quad T_A = T + \frac{\partial T_A}{2}$$

$$T_B = T + \frac{\partial T_B}{2}$$

(∂T_A and ∂T_B are temperature changes from isopycnic level to lower level)

$$H = \frac{\partial T_B - \partial T_A}{2}$$

When this is substituted in thermal wind equation

$$V_T = (g/f) (\frac{\Delta H}{\Delta n})$$

$$V_T = (\frac{c}{\Delta n}) (\frac{\partial T_B - \partial T_A}{2})$$

Where $c = (\frac{R_d}{f}) l_n \ P_1/P_u$ f is coriolis parameter = $2\omega \sin \phi$ (ϕ is latitude)

$$V_T = \frac{R_d}{2\omega \sin \phi} \frac{l_n(P_1/P_u) \frac{\partial T_B - \partial T_A}{2}}{\Delta n}$$

$$= \frac{9.665 \log(P_1/P_u). \frac{\partial T}{2}}{\Delta n} \text{ metres/sec (if } \phi \text{ is } 25^o)$$

DATA:

A selected region is taken for the preliminary study as shown in Fig. 2. The source of data used for this region is from "climate of the upper air: Shouthern Hemisphere" by vanloon et al (1969). The temperature data for selected grid points (20^oS, 40^oW and 30^oS, 40^oW as pair of stations namely I set), (20^oS, 50^oW and 30^oS, 50^oW - II set), (20^oS, 60^oW and 30^oS, 60^oW - III set), (20^oS, 70^oW and 30^oS, 70^oW - IVset) and (20^oS, 80^oW and 30^oS, 80^oW - V) is noted for 300, 200 and 100 mb levels for the months January, April, July and October which are the representative months for the different seasons of the year. The data is presented in Table 1. For each set (pair of stations), like that for all the five sets temperature Vs height graphs were drawn for the respective months of study. From these graphs the values P_l and P_u and ∂T are read off and the values of Thermal wind shear is calculated for each set and presented in Table 2a, 2b, 2c and 2d.

DISCUSSION:

Examining the shear values for the four months January, April, July and October, it can be observed the maximum value is at the III set, in the month of January, shifts to IV set in April, V set in July and V set in October. This indicates that there is a westward movement of wind maximum from January to October. The low values of V_T

in the last columm are due to the distance between the pair of stations selected which is 10^0 latitude. It is also known that the intensity of southerly Jet is less compared to that in the Northern Hemisphere. Viewing the values of P_1 which gives the height of maximum wind, it is observed that this height at 190 mb in April reaches to 206 mb, 220 mb and 224 mb in July, October and January respectively. Fig. 3 shows the 200 mb Geostrophic Zonal wind at different longitudes for the months of January, April, July and October. Compared to January and April, there is a tendency of the westward movement in July and October (Fig 4, 5a and 5b)

CONCLUSIONS:

(1) By using temperature soundings near to the height of maximum wind, the intersection method gives a preliminary understanding of the maximum wind (and not Jet maxima).

(2) Its variation from month to month shows a westward movement.

(3) The variation in height seems to be in the range of 190 to 220 mb.

A similar study is proposed to be extended for the whole of South America and the results be communicated in a future article.

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TABLE-1 - UPPER AIR TEMPERATURES (^{o}C)

January

	40°W			50°W			60°W			70°W			80°W		
	300mb	200	100	300	200	100	300	200	100	300	200	100	300	200	100
20°S	-34.2	-54.5	-75.3	-31.9	-54.0	-76.2	-30.8	-53.6	-76.9	-31.6	-53.6	-77.6	-32.9	-52.8	-78.0
30°S	-35.9	-54.1	-70.8	-34.2	-53.2	-71.1	-34.0	-52.0	-71.0	-35.4	-52.2	-70.9	-36.4	-52.7	-70.8

April

20°S	-34.5	-55.3	-73.8	-33.5	-54.4	-74.6	-33.1	-53.8	-74.8	-34.2	-54.4	-74.3	-35.4	-55.0	-73.6
30°S	-37.7	-55.5	-67.4	-37.1	-54.8	-67.9	-37.1	-54.9	-67.9	-38.7	-56.1	-67.8	-39.8	-56.8	-67.5

July

20°S	-36.7	-55.8	-70.2	-36.5	-55.6	-70.6	-36.1	-54.9	-70.6	-35.8	-54.7	-70.5	-35.6	-54.5	-70.2
30°S	-41.7	-56.8	-63.7	-41.8	-56.5	-63.7	-41.8	-55.5	-63.5	-42.0	-55.5	-63.4	-42.0	-55.7	-63.1

October

20°S	-35.4	-55.3	-72.2	-34.5	-54.4	-73.9	-34.0	-53.4	-74.4	-34.8	-54.0	-73.6	-36.1	-54.3	-72.4
30°S	-38.9	-55.3	-65.5	-38.5	-54.7	-66.2	-38.7	-53.5	-66.0	-40.2	-53.9	-64.7	-41.6	-54.3	-63.0

TABLE 2

VALUES OF THERMAL WIND SHEAR FOR SELECTED PAIRS OF GRID POINTS OVER BRASIL

a. January

SET NUMBER	STATIONS	P_1	P_u	∂T	$V_T = 9.665 \log P_1/P_u \times \frac{\partial T}{2}$ metres/sec/20mb
I	20^oS, 40^oW 30^oS, 40^oW	258mb	238mb	0.6^oC	.1015
II	20^oS, 50^oW 30^oS, 50^oW	253mb	233mb	0.8^oC	.1380
III	20^oS, 60^oW 30^oS, 60^oW	224mb	204mb	1.6^oC	.3137
IV	20^oS, 70^oW 30^oS, 70^oW	246mb	226mb	1.1^oC	.1956
V	20^oS, 80^oW 30^oS, 80^oW	227mb	207mb	0.8^oC	.1546

b. April

SET NUMBER	STATIONS	P_1	P_u	∂T	V_T
I	20^oS, 40^oW 30^oS, 40^oW	217	197	1.0	.2030
II	20^oS, 50^oW 30^oS, 50^oW	213	193	1.0	.2067
III	20^oS, 60^oW 30^oS, 60^oW	206	186	1.1	.2360
IV	20^oS, 70^oW 30^oS, 70^oW	190	170	1.4	.3274
V	20^oS, 80^oW 30^oS, 80^oW	198	178	1.2	.2685

c. July

SET NUMBER	STATIONS	P_l	P_u	∂T	V_T
I	20^oS, 40^oW 30^oS, 40^oW	209	189	1.0	.2107
II	20^oS, 50^oW 30^oS, 50^oW	207	187	1.2	.2557
III	20^oS, 60^oW 30^oS, 60^oW	213	193	0.9	.1897
IV	20^oS, 70^oW 30^oS, 70^oW	210	190	1.2	.2529
V	20^oS, 80^oW 30^oS, 80^oW	206	186	1.4	.2979

d. October

SET NUMBER	STATIONS	P_l	P_u	∂T	V_T
I	20^oS, 40^oW 30^oS, 40^oW	220	200	0.6	.1189
II	20^oS, 50^oW 30^oS, 50^oW	216	196	1.0	.2030
III	20^oS, 60^oW 30^oS, 60^oW	220	200	1.1	.2140
IV	20^oS, 70^oW 30^oS, 70^oW	220	200	1.2	.2378
V	20^oS, 80^oW 30^oS, 80^oW	220	200	1.2	.2378

LEGEND FOR THE FIGURES

FIG. 1 - Station network in South America

FIG. 2 - Selected region for the study

FIG. 3 - Displacement of Zonal Geostrophic Wind

FIG. 4 - Position of Jet on a day of January and on a day of July 1970.

FIG. 5a }
5b } ESSA-8 photographs for the above two days (12.01.70 and 26.07.70)

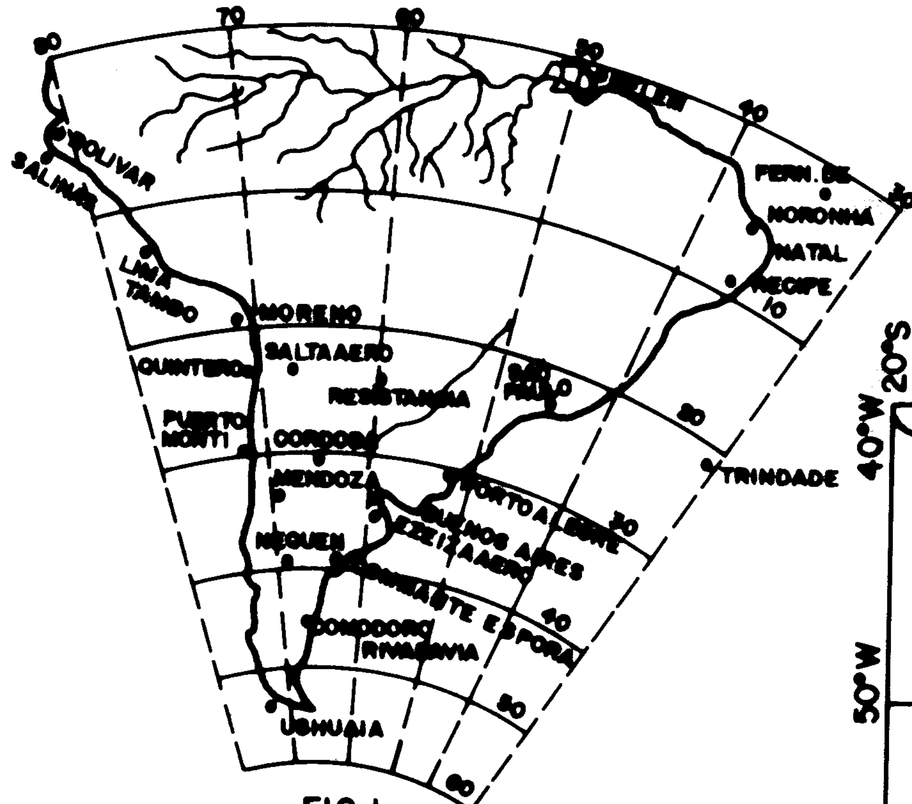

70
60
50
40
30
10
20
30
40
50
60
BOLIVAR
SALINAS
LIMA
TAMBO
MORENO
SALTA AERO
QUINTERO
RESISTANCIA
SAO PAULO
PUERTO MONTT
CORDOBA
MENDOZA
PORTO ALEGRE
BUENOS AIRES
EZEIZA AERO
NEQUEN
COMODORO RIVADAVIA
USHUAIA
FERN. DE NORONHA
NATAL
RECIFE
TRINDADE

FIG. 1

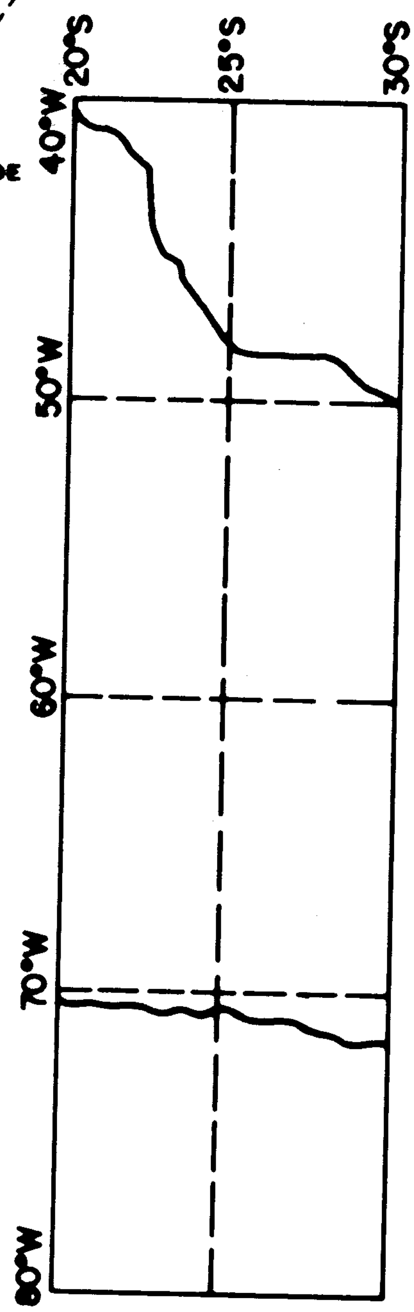
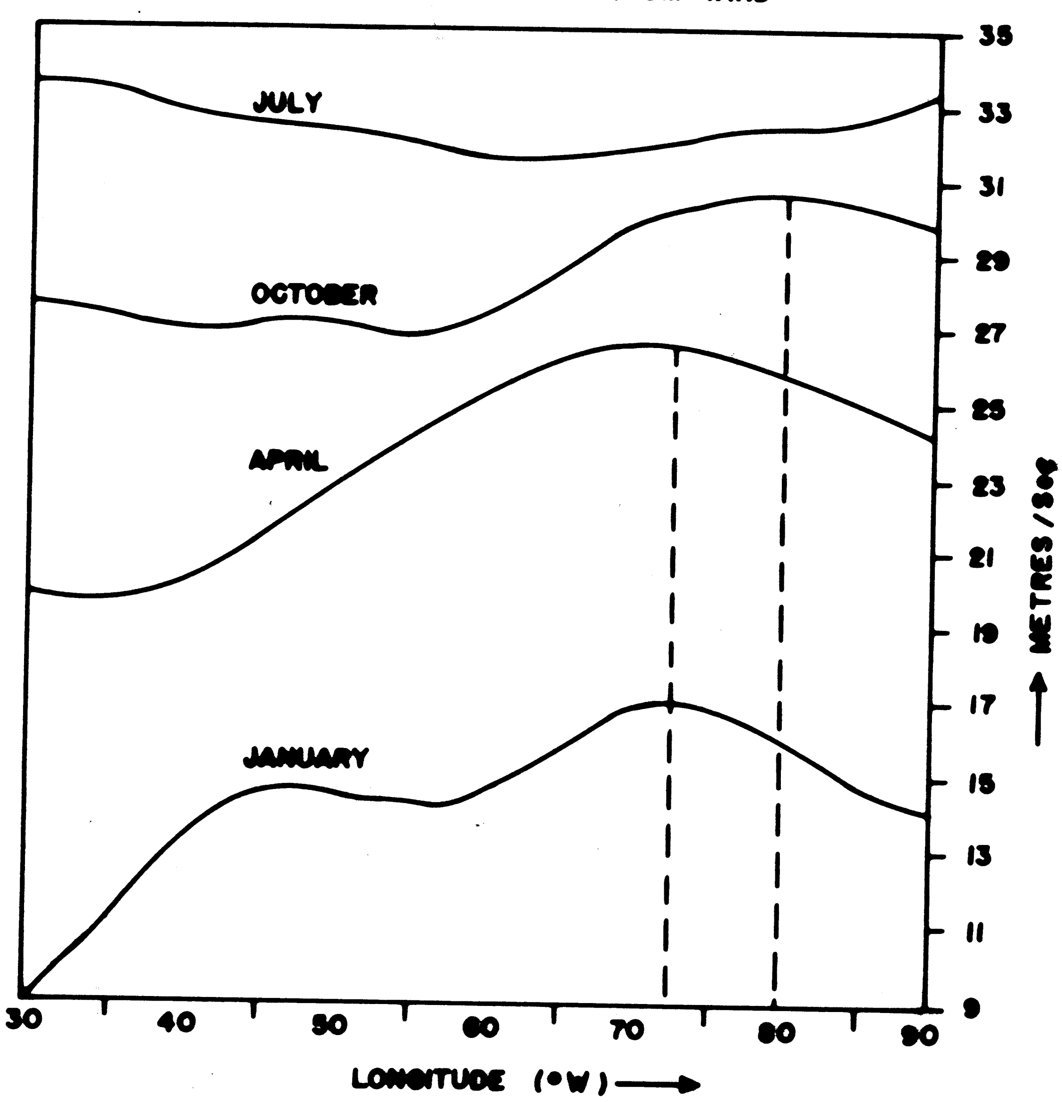

20°S
25°S
30°S
40°W
50°W
60°W
70°W
80°W

FIG. 2

Fig 3 DISPLACEMENT OF MAXIMUM WIND



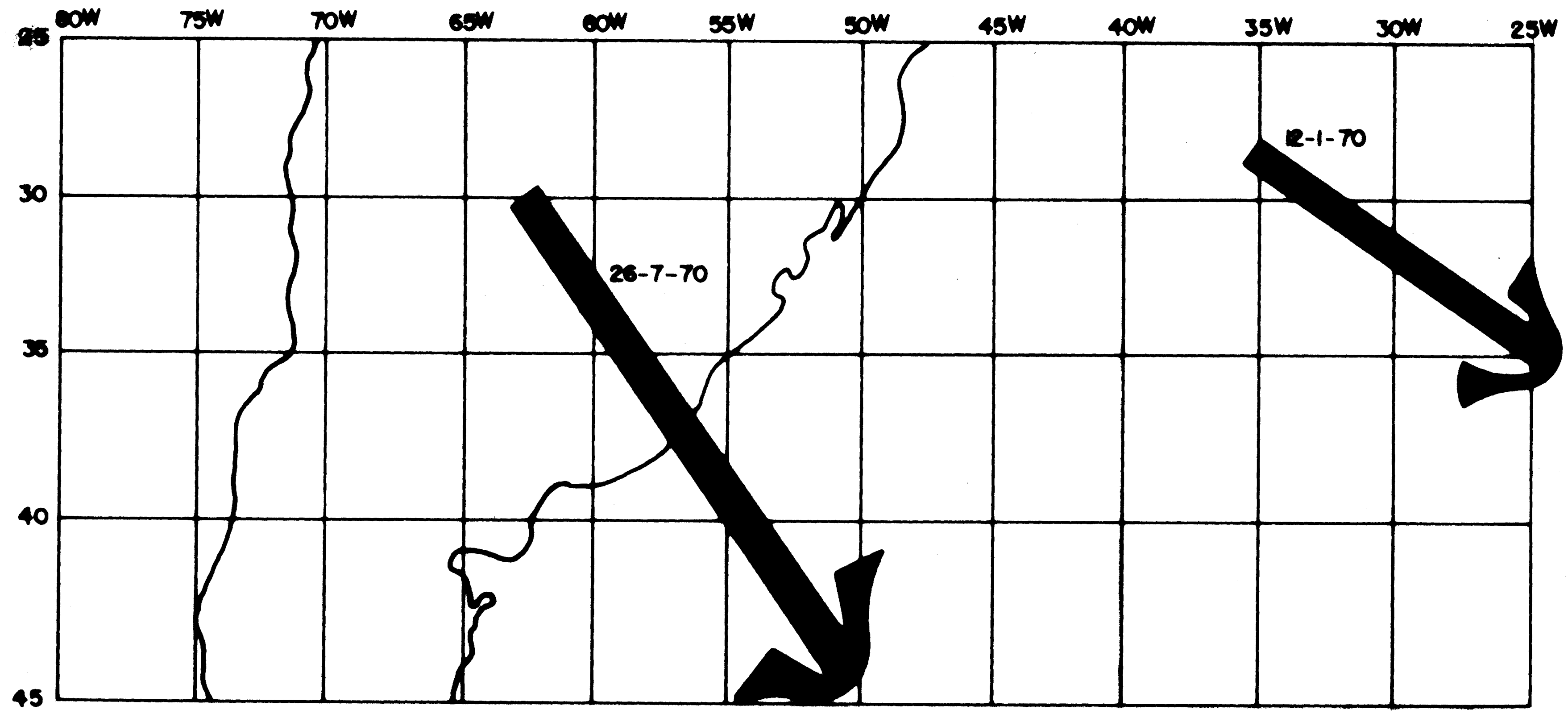

80W
75W
70W
65W
60W
55W
50W
45W
40W
35W
30W
25W
25
30
35
40
45
26-7-70
12-1-70

Fig. 4