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PROGRAM TO CALCULATE WINDS ALOFT USING A HEWLETT-PACKARD 25 HAND CALCULATOR

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CONTENTS

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I. INTRODUCTION

A method of calculating winds aloft data from theodolite observation is offered without resorting to the use of plotting boards. This program, utilizing the Hewlett-Packard 25 hand calculator, was originally intended for fire weather mobile unit use at going fires where time and space are at a premium. No new theory has been developed. The tangent plane approximation is the only compromise; but within the accuracy of the observations, this approximation results in no error.

II. METHOD

The program (Appendix A) is keyed into the calculator. If an HP 25C model is utilized, the program need only be initially inserted--as the HP 25C has a nonvolatile memory and the program will remain in the calculator's program memory until cleared (even during battery changes).

A constant "K" must now be calculated and stored in memory register 0. This constant will determine units of output for given units of input, i.e., meters/sec., knots, m.p.h., etc. A factor of .01 must be included in this constant to scale the wind speed for the output display.

Wind calculations can now be made using assumed balloon ascension rates (from tables) or actual heights from the pressure-altitude curve from a radiosonde run and the theodolite data.

1) Let:

$H1$ = Height at time T

$\theta 1$ = Azimuth angle at time T

$\alpha 1$ = Elevation angle at time T

$H2$ = Height at time $T + \Delta T$

$\theta 2$ = Azimuth angle at time $T + \Delta T$

$\alpha 2$ = Elevation angle at time $T + \Delta T$.

2) Now store:

H1 in R1, (H1 STO 1)

α1 in R2, (α1 STO 2)

θ1 in R3, (θ1 STO 3)

H2 in R4, (H2 STO 4)

α2 in R5, (α2 STO 5)

θ2 in R6, (θ2 STO 6).

3) Then push R/S key--in about 5 seconds the wind is displayed in the form DDD.VV where DDD is the wind direction in degrees and VV is the speed.

4) For the next level store H1, α1, etc. Repeat to end of run.

This program was used operationally at WSO(Av) LAX by Mr. Don DePauw. He experienced a time-saving factor of 25 - 50%. Simultaneous calculations were made using both the calculator and plotting board. No discernible difference was noted in accuracy, although one would expect the calculator to be far superior as internal calculations are carried out to 10 significant digits.

III. CONCLUSIONS

This program was developed for fire-weather mobile-unit use; however, it can be applied to other needs with no change. The program was supplied to the State of North Carolina Forestry Department for use in a smoke management program. It was supplied to the United States Forest Service Pacific Northwest Fire Behavior Team for pibal calculations at going wild fires.

APPENDIX A

HP-25 Program Form

Title PILOT BALLOON REDUCTION PROGRAM Page 1 of 2

Programmer Brian W. Finke

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	KEY IN PROGRAM			
2	COMPUTE CONSTANT K.			
	This constant is dependent on the units used in the altitude tables, the time interval; and the scaling factor to output wind speed for the display, i.e., to convert from ft/min to knots and scale result.			
	$K=(^{60min}/_{hr})$ $(^{1nmi}/_{6060\,ft})$ (10^{-2})			
3		K	STO 0	K
4		H1	STO 1	
		$\alpha 1$	STO 2	
		$\theta 1$	STO 3	
		H2	STO 4	
		$\alpha 2$	STO 5	
		$\theta 2$	STO 6	
			R/S	DDD.VV
	For next case go to Step 4. Note result is displayed as follows: DDD.VV.			
	Wind direction to left of decimal point. Wind speed to right of decimal point.			

HP-25 Program Form

Title PILOT BALLOON REDUCTION PROGRAM Page 2 of 2

Switch to PRGM mode, press [f] [PRGM], then key in the program.

DISPLAY LINE	DISPLAY CODE	KEY ENTRY	X	Y	Z	T	COMMENTS
00			-	-	-	-	Enter height and
01		RCL I	HI	-	-	-	elevation angle.
02		RCL2	∝I	HI	-	-	
03		f TAN	tan ∝I	HI	-	-	Calculate horizon-
04		g 1/x	ctn ∝I	HI	-	-	tal distance out.
05		X	HI ctn∝I	-	-	-	
06		9	9	HI ctn ∝I	-	-	
07		0	90	HI ctn ∝I	-	-	Azimuth angle
08		RCL3	~~θ~~I	90	HI ctn ∝I	-	adjustment.
09		-	90-~~θ~~I	HI ctn ∝I	-	-	
10		X ≶ y	HI ctn ∝I	90-~~θ~~I	-	-	
11		f → R	xI	yI	-	-	Calculate xi and
12		RCL4	CR4	xI	yI	-	yi. Retrieve R4
13		g x=o	CR4	xI	yI	-	test R4. If R4=0,
14		GTO 27	CR4	xI	yI	-	If R4≠0, XI stored
15		R↓	xI	yI	-	CR4	in RI, YI stored
16		STO I	xI	yI	-	CR4	in R2, retrieve ~~θ~~2
17		X ≶ y	yI	xI	-	CR4	and store in R3.
18		STO 2	yI	xI	-	CR4	
19		RCL6	~~θ~~2	yI	xI	-	
20		STO 3	~~θ~~2	yI	xI	-	
21		RCL 4	H2	~~θ~~2	yI	xI	Retrieve H2
22		RCL 5	∝2	H2	~~θ~~2	yI	Retrieve ∝2
23		0	0	∝2	H2	~~θ~~2	
24		STO 4	0	∝2	H2	~~θ~~2	Store 0 in R4
25		R↓	∝2	H2	~~θ~~2	0	Position H2 and ∝2
26		GTO 03	∝2	H2	~~θ~~2	0	
27		R↓	x2	y2	-	0	Position X2 and Y2
28		RCL I	xI	x2	y2	0	Retrieve XI and
29		-	x2-xI	y2	0	0	obtain (X2-XI)
30		x≶y	y2	x2-xI	0	0	Position Y2
31		RCL 2	yI	y2	x2-xI	0	Retrieve YI
32		-	y2-yI	x2-xI	0	0	Obtain (Y2-YI)
33		x≶y	x2-xI	y2-yI	0	0	Obtain windspeed
34		g→ P	IVI	β	0	0	and direction.
35		RCL 0	K	IVI	β	0	Scale windspeed
36		X	.VV	β	0	0	make adjustment
37		x≶y	β	.VV	0	0	back to meteorolo-
38		9	9	β	.VV	0	gical coordinate
39		0	90	β	.VV	0	system.
40		+	β	90	.VV	0	
41		CHS	90-β	V	0	0	If wind direction
42		g x≥0	90-β	V	0	0	<0.
43		GTO 48	90-β	V	0	0	
44		3	3	90-β	.VV	0	Add 360° to wind
45		6	36	90-β	.VV	0	direction.
46		0	360	90-β	.VV	0	Truncate wind
47		+	360+(90-β)	.VV	0	0	direction and add
48		f INT	DDD.00	.VV	0	0	to scaled wind
49		+	DDD.VV	0	0	0	speed.

REGISTERS	
R 0	K
R 1	HI
	xI
R 2	∝I
	yI
R 3	~~θ~~I
	~~θ~~2
R 4	H2
	0
R 5	∝2
R 6	~~θ~~2
R 7	

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