

NOAA Technical Memorandum NWS WR-115

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

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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:

H_1 = Height at time T
 θ_1 = Azimuth angle at time T
 α_1 = Elevation angle at time T
 H_2 = Height at time T + ΔT
 θ_2 = Azimuth angle at time T + ΔT
 α_2 = Elevation angle at time T + ΔT .

2) Now store:

HI in R1, (HI STO 1)
 α 1 in R2, (α 1 STO 2)
 θ 1 in R3, (θ 1 STO 3)
H2 in R4, (H2 STO 4)
 α 2 in R5, (α 2 STO 5)
 θ 2 in R6, (θ 2 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 HI, α 1, 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.

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		KEY ENTRY	X	Y	Z	T	COMMENTS	REGISTERS
LINE	CODE							
00			-	-	-	-	Enter height and elevation angle.	R ₀ K
01		RCL1	H1	-	-	-		
02		RCL2	α 1	H1	-	-		
03		f TAN	$\tan \alpha$ 1	H1	-	-	Calculate horizon-	R ₁ H1
04		g 1/x	$\text{ctn } \alpha$ 1	H1	-	-	tal distance out.	x1
05		X	H1 $\text{ctn } \alpha$ 1	-	-	-		
06		9	9	H1 $\text{ctn } \alpha$ 1	-	-		R ₂ α 1
07		0	90	H1 $\text{ctn } \alpha$ 1	-	-	Azimuth angle	y1
08		RCL3	θ 1	90	H1 $\text{ctn } \alpha$ 1	-	adjustment.	
09		-	90- θ 1	H1 $\text{ctn } \alpha$ 1	-	-		R ₃ θ 1
10		X \leq y	H1 $\text{ctn } \alpha$ 1	90- θ 1	-	-		θ 2
11		f \rightarrow R	x1	y1	-	-	Calculate x1 and	
12		RCL4	CR4	x1	y1	-	y1. Retrieve R4	R ₄ H2
13		g x=0	CR4	x1	y1	-	test R4. If R4=0,	0
14		GTO 27	CR4	x1	y1	-	If R4 \neq 0, X1 stored	
15		R \downarrow	x1	y1	-	CR4	in R1, Y1 stored	R ₅ α 2
16		STO 1	x1	y1	-	CR4	in R2, retrieve θ 2	
17		X \leq y	y1	x1	-	CR4	and store in R3.	
18		STO 2	y1	x1	-	CR4		R ₆ θ 2
19		RCL6	θ 2	y1	x1	-		
20		STO 3	θ 2	y1	x1	-		
21		RCL 4	H2	θ 2	y1	x1	Retrieve H2	R ₇
22		RCL 5	α 2	H2	θ 2	y1	Retrieve α 2	
23		0	0	α 2	H2	θ 2		
24		STO 4	0	α 2	H2	θ 2	Store 0 in R4	
25		R \downarrow	α 2	H2	θ 2	0	Position H2 and α 2	
26		GTO 03	α 2	H2	θ 2	0		
27		R \downarrow	x2	y2	-	0	Position X2 and Y2	
28		RCL 1	x1	x2	y2	0	Retrieve X1 and	
29		-	x2-x1	y2	0	0	obtain (X2-X1)	
30		x \leq y	y2	x2-x1	0	0	Position Y2	
31		RCL 2	y1	y2	x2-x1	0	Retrieve Y1	
32		-	y2-y1	x2-x1	0	0	Obtain (Y2-Y1)	
33		x \leq y	x2-x1	y2-y1	0	0	Obtain windspeed	
34		g \rightarrow P	V	β	0	0	and direction.	
35		RCL 0	K	V	β	0	Scale windspeed	
36		X	.VV	β	0	0	make adjustment	
37		x \leq 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 \geq 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.	

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